Coriolis mass flowmeter

CMU
CT

# Operating Manual


**Please read the instructions carefully and store them in a safe place**


# Introduction

## I. Shipping and storage; product inspection

### Shipping and storage

The device is to be safeguarded against dampness, dirt, impact and damage.

### Product inspection

Upon receipt of the product, check the contents of the box and the product particulars against the information on the delivery slip and order form so as to ensure that all ordered components have been supplied. Notify us of any shipping damage immediately upon receipt of the product. Any damage claim received at a later time will not be honored.

## II. Warranty

Your flowmeter was manufactured in accordance with the highest quality standards and was thoroughly tested prior to shipment. However, in the event any problem arises with your device, we will be happy to resolve the problem for you as quickly as possible under the terms of the warranty which can be found in the terms and conditions of delivery. Your warranty will only be honored if the device was installed and operated in accordance with the instructions for your device. Any mounting, commissioning and/or maintenance work is to be carried out by qualified and authorized technicians only.

## III. Application domain the operating manual

The present manual applies to Coriolis mass flowmeters that are operated in conjunction with the CT transmitter.

## IV. Measures to be taken before sending your device to the manufacturer for repair

It is important that you do the following before shipping your flowmeter to Fluid Components Intl for repair:

- Enclose a description of the problem with your device. Describe in as much detail as possible the application and the physical and chemical properties of the fluid.
- Remove any residues from the device and be sure to clean the seal grooves and recesses thoroughly. This is particularly important if the fluid is corrosive, toxic, carcinogenic, radioactive or otherwise hazardous.

The operator is liable for any substance removal or personal damage costs arising from inadequate cleaning of a device that is sent for repair.

## V. Supplementary operating instructions regarding the HART® interface

For information regarding operation of the transmitter using the HART® hand-held terminal, see “Operation of the CT transmitter using the HART® hand-held terminal.”

## 1. Steps prior to operation

It is essential that you read these operating instructions before installing and operating the device. The device is to be installed and serviced by a qualified technician only. The CT transmitter is to be used exclusively to measure mass and volume flow, as well as liquid and gas density and temperature, in conjunction with a CMM, CMB or CMU sensor.

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FCI extends no express or implied warranty in regard to the applicability of the present document for any purpose other than that described.

We plan to optimize and improve the products described and in so doing will incorporate not only our own ideas but also, and in particular, any suggestions for improvement made by our customers. If you feel that there is any way in which our products could be improved, please send your suggestions to the following address:

FCI Fluid Components International LLC
Coriolis Product Manager

1755 La Costa Meadows Drive
San Marcos, CA 92078

or:
via fax: 760 - 736 - 6250
via E-mail: mailto:techsupport@fluidcomponents.com

We reserve the right to change the technical data in this manual in light of any technical progress that might be made. For updates regarding this product, visit our website at www.fluidcomponents.com/, where you will also find contact information for the FCI representative for your area. For factory direct questions, contact us at mailto:info@fluidcomponents.com.

## 1.1 Installation and servicing

The devices described in this manual are to be installed and serviced by qualified technical personnel.

**Warning**
Before servicing the device, it must be completely switched off, and disconnected from all peripheral devices. The technician must also check to ensure that the device is completely off-circuit. Only original replacement parts are to be used.

**Fluid Components International accepts no liability for any loss or damage of any kind arising from improper operation of any product, improper handling or use of any replacement part, or from external electrical or mechanical effects, overvoltage or lightning. Any such improper operation, use or handling shall automatically invalidate the warranty for the product concerned.**

In the event a problem arises with your device, please contact us at one of the following numbers to arrange to have your device repaired:

Phone: 760 – 744 - 6950
Fax: 760 – 736 - 6250

Contact our customer service department if your device needs repair or if you need assistance in diagnosing a problem with your device

## 1.2 Safety advisory for the user

The present document contains the information that you need in order to operate the CMU Series Coriolis mass flowmeter properly. The document is intended for use by qualified personnel. This means personnel who are qualified to operate the device described herein safely, including electronics engineers, electrical engineers, or service technicians who are conversant with the safety regulations pertaining to the use of electrical and automated technical devices and with the applicable laws and regulations in their own country.

Such personnel must be authorized by the facility operator to install, commission and service the product described, and are to read and understand the contents of the present operating instructions before working with the device.

## 1.3 Hazard warnings

The purpose of the hazard warnings listed below is to ensure that device operators and maintenance personnel are not injured and that the flowmeter and any devices connected to it are not damaged.

The safety advisories and hazard warnings in the present document that aim to avoid placing operators and maintenance personnel at risk and to avoid material damage are prioritized using the terms listed below, which are defined as follows in regard to these instructions and the advisories pertaining to the device itself.

### 1.3.1 Danger

means that failure to take the prescribed precautions **will result** in death, severe bodily injury, or substantial material damage.

### 1.3.2 Warning

means that failure to take the prescribed precautions **could result** in death, severe bodily injury, or substantial material damage.

#### 1.3.3 Caution

means that the accompanying text contains important information about the product, handling the product or about a section of the documentation that is of particular importance.

#### 1.3.4 Note

means that the accompanying text contains important information about the product, handling the product or about a section of the documentation that is of particular importance.

### 1.4 Proper use of the device

**Warning**
The operator is responsible for ensuring that the material used in the sensor and housing is suitable and that such material meets the requirements for the fluid being used and the ambient site conditions. The manufacturer accepts no responsibility in regard to such material and housing.

**Warning**
In order for the device to perform correctly and safely, it must be shipped, stored, set up, mounted operated and maintained properly.

### 1.5 Returning your flowmeter for servicing or calibration

Before sending your flowmeter back to us for servicing or calibration, make sure it is completely clean. Any residues of substances that could be hazardous to the environment or human health are to be removed from all crevices, recesses, gaskets, and cavities of the housing before the device is shipped.

**Warning**
The operator is liable for any loss or damage of any kind, including personal injury, decontamination measures, removal operations and the like that are attributable to inadequate cleaning of the device.

**Any device sent in for servicing is to be accompanied by a certificate as specified in Section** 18 *Decontamination certificate for device cleaning*.

The device is to be accompanied by a document describing the problem with the device. Please include in this document the name of a contact person that our technical service department can get in touch with so that we can repair your device as expeditiously as possible and therefore minimize the cost of repairing it.

### 1.6 Replacement of the transmitter electronics

Before replacing the transmitter electronics, read the safety instructions in Section 1.1 Installation and servicing on page 11.

**Warning**
Make sure that you abide by the applicable standards and regulations pertaining to electrical devices, device installation and process technology when replacing the transmitter electronics. The highly integrated electronic components in the device carry the risk of ESD hazards and are only protected when installed in the device pursuant to EMC standards.

Before dismantling the DAB data memory module (see Section **6.2.1 DSB** on page 36) remove it from the device and plug into the replacement part. To remove the electronics insert, first remove the four fastening screws. Then slowly slide in the replacement part, making sure that it is oriented the same way as the original part, until the component reaches the floor of the housing. Be careful not to damage the contact strip. Then reinstall the four fastening screws.

**Caution**
The complete insert is to be replaced with all of its printed boards (except for the memory module). This is particularly important for the explosion-proof transmitter. The specified precision and interchangeability of the electronics are only guaranteed if the complete insert is replaced.

## 2. Identification

| | |
|---|---|
| Manufacturer | FCI Fluid Components International LLC<br>1755 La Costa Meadows Drive<br>San Marcos, CA 92078<br><br>Phone: 760 – 744 – 6950<br>Fax: 760 – 736 – 6250<br><br>Internet: http://www.fluidcomponents.com<br>E-mail: mailto:techsupport@fluidcomponents.com<br><br>European Office:<br><br>Persephonestraat 3-01<br>5047 TT Tilburg<br>Netherlands<br><br>Phone: +31 – 13 – 515 9989<br>Fax: +31 – 13 – 579 9036 |
| Product type | Mass flowmeter for liquid and gaseous products |
| Product name | Sensor type CMU<br>Transmitter type CT, suitable for CMM, CMB and CMU Coriolis mass flowmeters |
| Version no. | 1.6, dated April 12, 2006 |

# 3. The CMU sensor

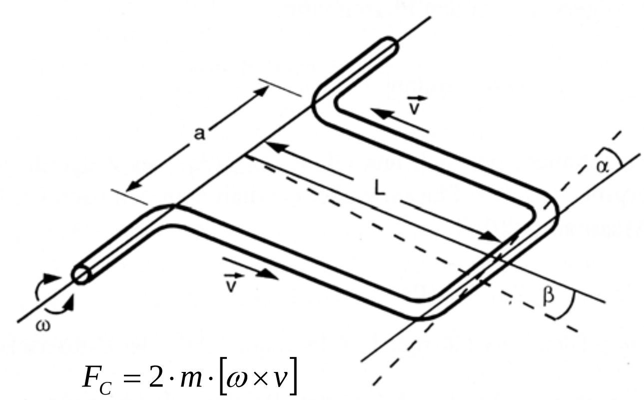
## 3.1 Application domain of the CMU sensor

The CMU sensor is intended for use solely for direct and continuous mass flow measurement of liquids and gases, irrespective of their conductivity, density, temperature, pressure, or viscosity. The sensor is also intended for use for the direct and continuous mass flow measurement of chemical fluids, suspensions, molasses, paint, varnish, lacquer, pastes and similar materials.

## 3.2 Mode of operation

### 3.2.1 Measuring principle

The Coriolis mass flowmeter is based on the principle whereby in a rotating system a force (known as the Coriolis force) is exerted on a mass at a rotation point that is moving towards or away from this point.




$$F_C = 2 \cdot m \cdot [\omega \times v]$$

### 3.2.2 System configuration

The flowmeter consists of a sensor that is mounted in a pipe, and a transmitter (see Section **5 Application domain of the CT** on pp. 35), that can be directly mounted on the sensor or installed separately (e.g. on a wall).

The transmitter oscillates the flow tubes in the sensor over a excitation coil and picks up, via the sensor coil, the measuring signal which is proportional to the mass flow. After being temperature compensated, the measuring signal is converted into an analog output signal that is consistent with the measuring range setting.

### 3.2.3 Input

Measured variables: mass flow, density, temperature; volume flow is calculated

## 3.3 Custody transfer operations

Units designated for custody transfer operation may be certified in accordance to the local or national ordinance.  Transmitters ordered for custody transfer applications incorporate special tamper-proof software, sealed and certified, that prevents the reset of the internal totalizer.

## 3.4 Performance characteristics of the CMU sensor

### 3.4.1 Reference conditions

- Established flow profile
- Inlet section has to correspond to mounting length
- Operation is to be realized in the presence of downstream control valves
- Measurement is to be realized in the absence of any gas bubbles
- Flow tubes are to be kept clean at all times
- Process temperature is to be regulated as specified in Section 3.6.1 Process temperature on page 23
- Process pressure is to be regulated as specified in Section 3.6.6 Process pressure range on page 23
- Ambient temperature is to range from + 10 °C to + 30 °C (50 °F to 86 °F)
- Warm-up period: 15 minutes
- Standard calibration is to be realized at 20 %, 50 % and 100 % (three times each)
- High-frequency interference is to be regulated as specified in Section 17.2 Electromagnetic compatibility on page 110

### 3.4.2 CMU flow ranges

| | Mass flow | | | |
|---|---|---|---|---|
| | Min. measuring range | Max. measuring range | Nominal (Δp=1bar) | Zero point stability (of range) |
| **Model** | kg/h [lbs/min] | kg/h [lbs/min] | kg/h [lbs/min] | kg/h [lbs/min] |
| CMU-C | 60 [2.2] | 600 [22.0] | 330 [12.1] | 0.06 [0.002] |
| CMU-D | 250 [9.2] | 2,500 [91.9] | 1,150 [42.3] | 0.25 [0.01] |
| CMU-E | 1,200 [44.1] | 12,000 [440.9] | 5,250 [192.9] | 1.2 [0.04] |
| CMU-G | 3,000 [110.2] | 30,000 [1,102.3] | 20,000 [734.9] | 3 [0.1] |
| CMU-H | 6,000 [220.5] | 60,000 [2,204.6] | 55,000 [2,020.9] | 6 [0.2] |
| CMU-J | 20,000 [734.9] | 80,000 [2,939.4] | 74,000 [2,719.0] | 8 [0.3] |
| CMU-K | 25,000 [918.6] | 120,000 [4,409.2] | 118,000 [4,335.7] | 12 [0.4] |
| CMU-L | 30,000 [1,102.3] | 200,000 [7,348.6] | 200,000 [7,348.6] | 20 [0.7] |
| CMU-N | 60,000 [2,204.6] | 460,000 [16,901.8] | 460,000 [16,901.8] | 46 [1.7] |
| CMU-P | 150,000 [5,511.5] | 700,000 [25,720.2] | 700,000 [25,720.2]* | 70 [2.6] |
| CMU-Q | 300,000 [11,022.9] | 1,500,000 [55,114.6] | 1,350,000 [49,603.2] | 150 [5.5] |
| CMU-R | 400,000 [14,697.2] | 2,200,000 [80,834.8] | 1,900,000 [69,811.9] | 220 [8.1] |

* (Δp=0,6bar)

Reference conditions: in conformity with IEC 770:
Temperature: 20 °C, relative humidity: 65 %, air pressure: 101.3 kPa
Fluid: water

### 3.4.3 Density measurement

The attainable accuracy depends on the selected calibration type.

**Without calibration no density measurement is possible and the empty pipe recognition is not available!**

| | Density accuracy | | |
|---|---|---|---|
| **Model** | without | 3-Point | 5-Point |
| CMU-C | no measurement of density | 5 g/l | 2 g/l |
| CMU-D | | 5 g/l | 2 g/l |
| CMU-E | | 5 g/l | 1 g/l |
| CMU-G | | 5 g/l | 1 g/l |
| CMU-H | | 5 g/l | 1 g/l |
| CMU-J | | 5 g/l | 2 g/l |
| CMU-K | | 5 g/l | 2 g/l |
| CMU-L | | 5 g/l | 2 g/l |
| CMU-N | | 5 g/l | 2 g/l |
| CMU-P | | 5 g/l | 2 g/l |
| CMU-Q | | 5 g/l | 2 g/l |
| CMU-R | | 5 g/l | 2 g/l |

### 3.4.4 Accuracy

| **Mass flow** | |
|---|---|
| Accuracy CMU-C to CMU-H | ± 0.1% of actual flow + zero point stability (see Section 3.4.2 CMU flow ranges) |
| Accuracy CMU-J to CMU-R | ± 0.15% of actual flow + zero point stability (see Section 3.4.2 CMU flow ranges) |
| Repeatability error | ± 0.05% of actual flow (sensor with transmitter) |
| | |
| **Additional measured values** | |
| Volume flow | ± 0.2 % of actual value + zero point stability |
| Temperature | ± 0.5 °C |
| Hysteresis | n/a |
| Settling time | 1 to 15 seconds |
| Startup drift | 15 minutes |
| Long-term drift | ± 0.02 % of upper-range value per year |
| Influence of ambient temperature | ± 0.005 % per K |
| Influence of fluid temperature | Compensated |
| Influence of fluid pressure | For fluids: too small to be relevant |

### 3.4.5 Pressure loss CMU

| Model | Min. measuring range | Max. measuring range | Pressure loss [water (20°C), 1 mPas] | | | | |
|---|---|---|---|---|---|---|---|
| CMU-C | 60 kg/h | 600 kg/h | 60 kg/h | 150 kg/h | 300 kg/h | 450 kg/h | 600 kg/h |
| | | | 0.05 bar | 0.25 bar | 0.84 bar | 1.70 bar | 2.82 bar |
| CMU-D | 250 kg/h | 2500 kg/h | 250 kg/h | 625 kg/h | 1250 kg/h | 1875 kg/h | 2500 kg/h |
| | | | 0.07 bar | 0.35 bar | 1.18 bar | 2.39 bar | 3.95 bar |
| CMU-E | 1200 kg/h | 12000 kg/h | 1200 kg/h | 3000 kg/h | 6000 kg/h | 9000 kg/h | 12000 kg/h |
| | | | 0.07 bar | 0.37 bar | 1.23 bar | 2.51 bar | 4.15 bar |
| CMU-G | 3000 kg/h | 30000 kg/h | 3000 kg/h | 7500 kg/h | 15000 kg/h | 22500 kg/h | 30000 kg/h |
| | | | 0.04 bar | 0.21 bar | 0.70 bar | 1.43 bar | 2.36 bar |
| CMU-H | 6000 kg/h | 60000 kg/h | 6000 kg/h | 15000 kg/h | 30000 kg/h | 45000 kg/h | 60000 kg/h |
| | | | 0.02 bar | 0.10 bar | 0.32 bar | 0.65 bar | 1.08 bar |
| CMU-J | 20000 kg/h | 80000 kg/h | 20000 kg/h | 35000 kg/h | 50000 kg/h | 65000 kg/h | 80000 kg/h |
| | | | 0.09 bar | 0.25 bar | 0.46 bar | 0.74 bar | 1.06 bar |
| CMU-K | 25000 kg/h | 120000 kg/h | 25000 kg/h | 48750 kg/h | 72500 kg/h | 96250 kg/h | 120000 kg/h |
| | | | 0.06 bar | 0.20 bar | 0.39 bar | 0.64 bar | 0.95 bar |
| CMU-L | 30000 kg/h | 200000 kg/h | 30000 kg/h | 72500 kg/h | 115000 kg/h | 157500 kg/h | 200000 kg/h |
| | | | 0.03 bar | 0.15 bar | 0.34 bar | 0.58 bar | 0.89 bar |
| CMU-N | 60000 kg/h | 460000 kg/h | 60000 kg/h | 160000 kg/h | 260000 kg/h | 360000 kg/h | 460000 kg/h |
| | | | 0.03 bar | 0.14 bar | 0.33 bar | 0.58 bar | 0.89 bar |
| CMU-P | 150000 kg/h | 700000 kg/h | 150000 kg/h | 287500 kg/h | 425000 kg/h | 562500 kg/h | 700000 kg/h |
| | | | 0.04 bar | 0.13 bar | 0.25 bar | 0.41 bar | 0.60 bar |
| CMU-Q | 300000 kg/h | 1500000 kg/h | 300000 kg/h | 600000 kg/h | 900000 kg/h | 1200000 kg/h | 1500000 kg/h |
| | | | 0.07 bar | 0.25 bar | 0.51 bar | 0.84 bar | 1.24 bar |
| CMU-R | 400000 kg/h | 2200000 kg/h | 400000 kg/h | 850000 kg/h | 1300000 kg/h | 1750000 kg/h | 2200000 kg/h |
| | | | 0.06 bar | 0.23 bar | 0.48 bar | 0.81 bar | 1.21 bar |

| Model | Min. measuring range | Max. measuring range | Pressure loss [water (20°C), 1 mPas] | | | | |
|---|---|---|---|---|---|---|---|
| CMU-C | 2.2 lbs/min | 22.0 lbs/min | 2.2 lbs/min | 5.5 lbs/min | 11.0 lbs/min | 16.5 lbs/min | 22.0 lbs/min |
| | | | 0.73 psi | 3.61 psi | 12.15 psi | 24.70 psi | 40.87 psi |
| CMU-D | 9.2 lbs/min | 91.9 lbs/min | 9.2 lbs/min | 23.0 lbs/min | 45.9 lbs/min | 68.9 lbs/min | 91.9 lbs/min |
| | | | 1.02 psi | 5.07 psi | 17.05 psi | 34.67 psi | 57.35 psi |
| CMU-E | 44.1 lbs/min | 440.9 lbs/min | 44.1 lbs/min | 110.2 lbs/min | 220.5 lbs/min | 330.7 lbs/min | 440.9 lbs/min |
| | | | 1.07 psi | 5.32 psi | 17.91 psi | 36.41 psi | 60.24 psi |
| CMU-G | 110.2 lbs/min | 1102.3 lbs/min | 110.2 lbs/min | 275.6 lbs/min | 551.1 lbs/min | 826.7 lbs/min | 1102.3 lbs/min |
| | | | 0.61 psi | 3.02 psi | 10.17 psi | 20.68 psi | 34.21 psi |
| CMU-H | 220.5 lbs/min | 2204.6 lbs/min | 220.5 lbs/min | 551.1 lbs/min | 1102.3 lbs/min | 1653.4 lbs/min | 2204.6 lbs/min |
| | | | 0.28 psi | 1.39 psi | 4.67 psi | 9.49 psi | 15.69 psi |
| CMU-J | 734.9 lbs/min | 2939.4 lbs/min | 734.9 lbs/min | 1286.0 lbs/min | 1837.2 lbs/min | 2388.3 lbs/min | 2939.4 lbs/min |
| | | | 1.36 psi | 3.61 psi | 6.74 psi | 10.67 psi | 15.35 psi |
| CMU-K | 918.6 lbs/min | 4409.2 lbs/min | 918.6 lbs/min | 1791.2 lbs/min | 2663.9 lbs/min | 3536.5 lbs/min | 4409.2 lbs/min |
| | | | 0.88 psi | 2.84 psi | 5.69 psi | 9.34 psi | 13.74 psi |
| CMU-L | 1102.3 lbs/min | 7348.6 lbs/min | 1102.3 lbs/min | 2663.9 lbs/min | 4225.5 lbs/min | 5787.0 lbs/min | 7348.6 lbs/min |
| | | | 0.47 psi | 2.18 psi | 4.89 psi | 8.48 psi | 12.88 psi |
| CMU-N | 2204.6 lbs/min | 16901.8 lbs/min | 2204.6 lbs/min | 5878.9 lbs/min | 9553.2 lbs/min | 13227.5 lbs/min | 16901.8 lbs/min |
| | | | 0.36 psi | 2.03 psi | 4.75 psi | 8.39 psi | 12.88 psi |
| CMU-P | 5511.5 lbs/min | 25720.2 lbs/min | 5511.5 lbs/min | 10563.6 lbs/min | 15615.8 lbs/min | 20668.0 lbs/min | 25720.2 lbs/min |
| | | | 0.59 psi | 1.83 psi | 3.62 psi | 5.92 psi | 8.68 psi |

### 3.4.6 Ambient temperature

− 40 °C to + 60 °C (-40 °F to 140 °F)

### 3.4.7 Ambient temperature range

− 40 °C to + 60 °C (-40 °F to 140 °F); a special cable is required for temperatures below − 20 °C (-4 °F)

### 3.4.8 Storage temperature

− 25 °C to + 60 °C (-13 °F to 140 °F), − 40 °C (-40°F) available as special version

### 3.4.9 Climatic category

In conformity with IEC 654-1. Unsheltered class D locations with direct open-air climate.

### 3.4.10 Ingress protection

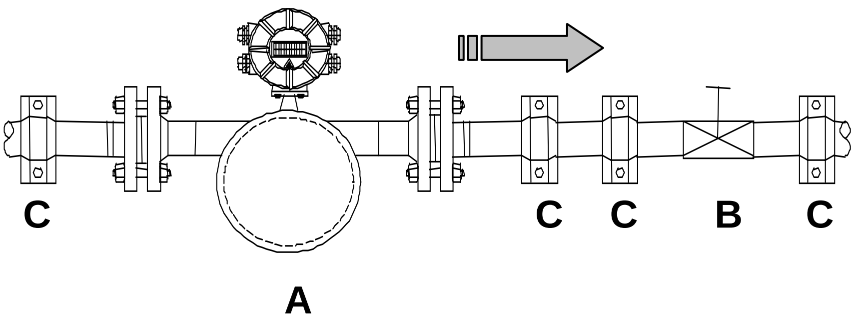
Standard version: IP 66 (NEMA 6); special version IP 68 (NEMA 6P) DIN EN 60529, if suitable and tightly screwed down cable glands are used.

## 3.5 Operating conditions

### 3.5.1 Installation

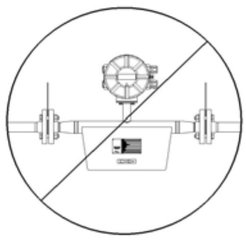
The sensor is to be protected, wherever possible, against valves, manifolds and similar fittings that generate turbulence. The sensor is to be installed in accordance with the following instructions.

Diagram showing flowmeter installation

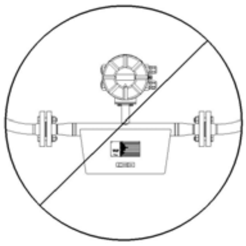



Flowmeter installation: A = sensor, B = valve, C = pipe clamps and supports

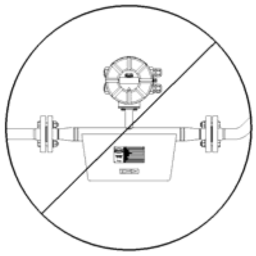
Under no circumstances is the sensor to be used to support a pipe.



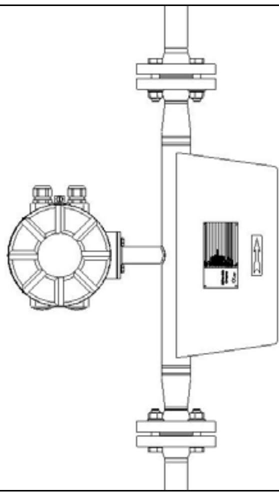
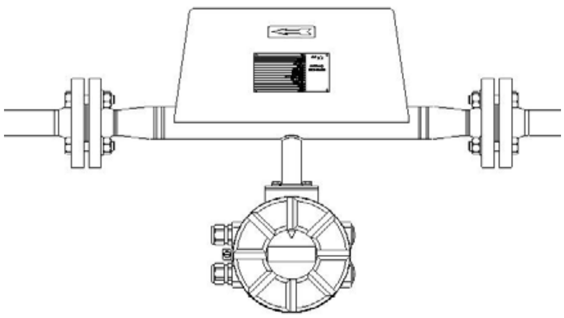
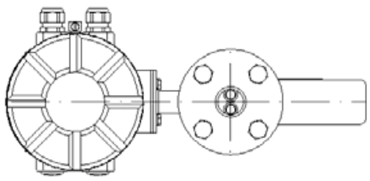
Do not install the sensor in suspended pipes.

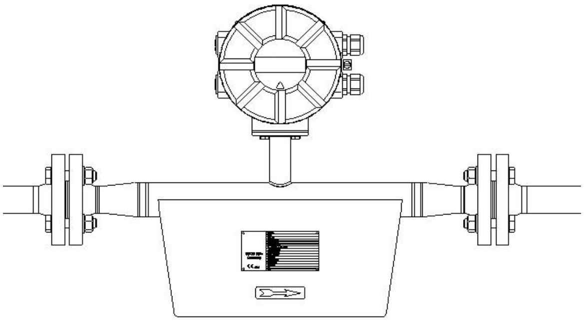


Do not adjust the position of a pipe by pulling or grasping the sensor.



### 3.5.2 Installation positions

| | |
|---|---|
| Standard installation position |  |
| Installation position A |  |
| Installation position B |  |

| | |
|---|---|
| Installation position C |  |

### 3.5.3 Assessment of installation position

| Type of fluid | Position | Assessment |
|---|---|---|
| Pure liquids | Standard installation position | Self-draining flow tubes |
| | Position A or B | OK |
| | Position C | Liquid residue remains in pipe |
| Liquids with gas bubbles | Standard installation position | Self-draining flow tubes, gas bubbles do not accumulate in flowmeter |
| | Position A | Not recommended owing to gas bubble accumulation in flowmeter |
| | Position B | Gas bubbles may accumulate in the presence of low flow velocities |
| | Position C | No gas bubble accumulation in flowmeter, liquid residues may remain in device after discharge |
| Liquids containing substances that could form deposits | Standard installation position | Self-draining flow tubes, no deposit formation |
| | Position A | OK |
| | Position B | Substances in the liquid could form deposits at low flow velocities |
| | Position C | Not recommended owing to presence in flowmeter of substances that could form deposits |
| Liquids containing gas bubbles, as well as gas bubbles containing substances that could form deposits | Standard installation position | Self-draining flow tubes, no accumulation of gases or substances that could form deposits |
| | Position A | Not recommended owing to gas bubble accumulation in flowmeter |
| | Position B | Gas bubbles or substances that could form deposits at low flow velocities |
| | Position C | Not recommended owing to presence in flowmeter of substances that could form deposits |
| Gases that do not form a condensate | Standard installation position, Position A, B or C | Any of these installations positions can be used |

| Type of fluid | Position | Assessment |
|---|---|---|
| Gas, condensate-forming gas/liquid, moisture | Standard installation position | Flow direction should be from top to bottom so that any condensate that forms can flow out efficiently |
| | Position A | OK |
| | Position B | Condensate might form in flowmeter |
| | Position C | Not recommended owing to condensate accumulation in flowmeter |
| Slurries | Standard installation position | Optimal installation position |
| | Position A | High density substances could accumulate in the flow-meter |
| | Position B | Gas bubbles could accumulate |
| | Position C | Gas bubbles or high density substances could accumulate in the flowmeter |

### 3.5.4 Pressure surges

Pressure surges in a pipe could be provoked by a sudden decrease in flow caused by rapid closing of a valve or similar factors. This change in pressure can lead to underpressure downstream from a valve that has been closed rapidly, and to outgasing. If the valve is mounted directly on the inlet section of the flowmeter, a gas bubble can form in the flow tube that can cause a measuring signal disturbance that would shift the zero point of the output signal. In extreme cases, a pressure surge could cause mechanical damage to the sensors and/or flow tube.

Whenever possible, quick-closing valves should be mounted downstream from the sensor. If this is not feasible, such valves are to be mounted a minimum of 10 x DIA (Φ) from the nearest sensor. Alternatively, valve closing speed can be reduced.

### 3.5.5 Using the device with hazardous fluids

The sealing technology used in the standard CMU mass flowmeter renders the device unsuitable for use with hazardous fluids. Only sensors that meet the standards for safety instruments are suitable for use with hazardous fluids.

The pathway between the sensor and transmitter must be pressure-tight so as to prevent fluid from leaking out of a sensor in the event a sensor develops a defect.

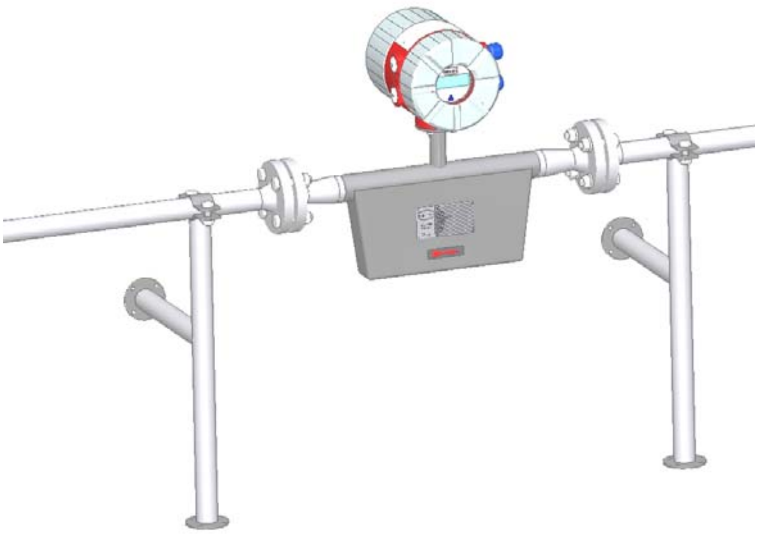
In the case of welded components, a colored liquid penetration test should be performed on the welds, or one joint (only the first one) should be x-rayed. Alternatively, an internal pressure monitoring device can be used to detect any defect.

### 3.5.6 Vibration stability

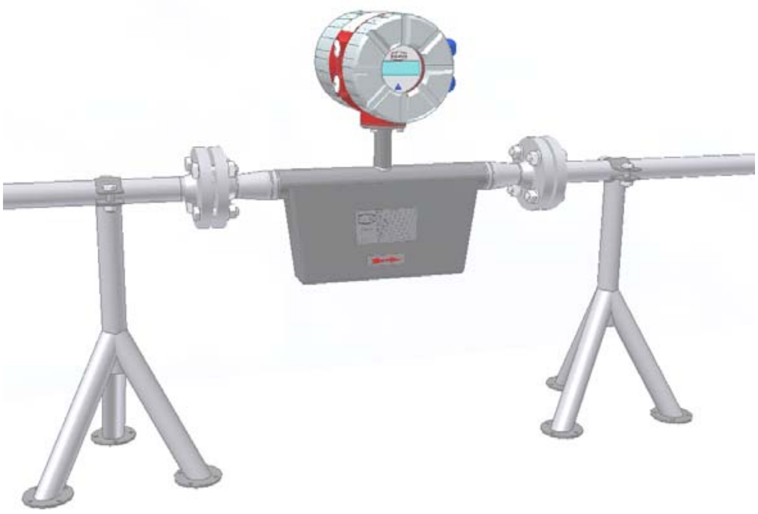
The sensors are insensitive to vibration; vibration stability has been validated in accordance with DIN IEC 68-2-6, for up to 1 g at 10 to 150 Hz.

If pipe vibration is greater than 1 g in the 10-150 Hz range, an additional fastening is to be mounted as shown in the following drawings. This fastening will prevent vibration from affecting the device's mechanical configuration and/or measurement readings. The following drawings are valid for a sensor with a nominal size of approximately 2 inches [DN 040]. Installation is to be realized as shown in this drawing.

Installation using wall supports



Foot-mounted installation



## 3.6 Process conditions

### 3.6.1 Process temperature

− 40 °C to + 260 °C (-40 °F to 500 °F); rating plate range must be observed

### 3.6.2 Physical state

| | |
|---|---|
| Liquid product | (maximum density 2 kg/l) |
| Gaseous product | (minimum density 0.002 kg/l in operating state) |

### 3.6.3 Viscosity

0.3 up to 50,000 mPas (0.3 to 50,000 cP)

### 3.6.4 Gas content

The use of products containing gas is not allowed for custody transfer operations. In other applications, the presence of gas will increase false readings. In order for the readings of products containing gas to be valid, small gas bubbles must be homogeneously distributed in the fluid. Large gas bubbles will automatically provoke extremely false readings and will shift the zero point. Thus, the extent to which readings are false is determined by the process conditions. A rule of thumb in this regard is as follows: A 1 % gas component will increase false readings by 1 %. The gas component is not to exceed 5 %.

### 3.6.5 Process temperature range

+ 260 °C (500 °F)

### 3.6.6 Process pressure range

According to PN16 pressure rating: 232 psig [16 bar] and PN40: 580 psig [40 bar]

### 3.6.7 Outlet pressure

Outlet pressure must be greater than the vapor pressure Ps (static pressure) of the measured product.

## 3.7 Connection to the transmitter

### 3.7.1 Integral mount configuration

When the transmitter is mounted directly on the sensor, no cable connection between the two components is needed. This connection is integrated at the factory.

### 3.7.2 Remote mount configuration

If the transmitter is <u>not</u> mounted directly on the sensor, installation regulations and applicable legal standards are to be adhered to. The maximum cable length is 300 m (1000ft). See Section 11.5.2 Wiring diagram on page 46 for information regarding the connection and cable specifications.

## 3.8 Construction details

### 3.8.1 Dimensions and weight

Standard versions:

| | A | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Model** | End connection | inch [mm] | End connection | inch [mm] | End connection | inch [mm] | End connection | inch [mm] | End connection | inch |
| CMU-C | SW10 | - - | SW12 | - - | DN10 | 14.2 [360] | ¼" NPT (f) | 11.8 [300] | ½" NPT (f) | 11.8 |
| CMU-D | SW12 | - - | DN10 | 15.4 [390] | DN15 | 15.6 [396] | ½" NPT (f) | 11.8 [300] | ½" 150lb | 16.4 |
| CMU-E | - | - - | DN15 | 20.3 [515] | DN25 | 20.5 [520] | ½" NPT (f) | - - | ½" 150lb | 21.1 |
| CMU-G | - | - - | DN25 | 24.9 [632] | DN40 | 25.3 [642] | ¾" 150lb | 25.9 [657] | 1" 150lb | 26.1 |
| CMU-H | - | - - | DN40 | 30.3 [770] | DN50 | 30.6 [776] | - | - - | 1½" 150lb | 31.7 |
| CMU-J | DN40 | 40.1 [1,018] | DN50 | 40.3 [1,024] | DN80 | 41.1 [1,044] | 1½" 150lb | 41.3 [1,050] | 2" 150lb | 41.5 |
| CMU-K | DN50 | 46.3 [1,176] | DN80 | 47.1 [1,196] | DN100 | 46.6 [1,184] | 2" 150lb | 47.5 [1,207] | 3" 150lb | 48.0 |
| CMU-L | DN80 | 53.9 [1,370] | DN100 | 53.5 [1,358] | DN150 | 42.9 [1,090] | 3" 150lb | 54.6 [1,388] | 4" 150lb | 55.1 |
| CMU-N | DN100 | 68.0 [1,726] | DN150 | 68.2 [1,732] | DN200 | 57.0 [1,448] | 4" 150lb | 69.7 [1,770] | 6" 150lb | 70.7 |
| CMU-P | DN150 | 86.0 [2,184] | DN200 | 86.5 [2,198] | DN300 | 73.4 [1,864] | 6" 150lb | 88.6 [2,250] | 8" 150lb | 89.4 |
| CMU-Q | DN200 | 89.3 [2,268] | DN250 | 89.9 [2,284] | DN300 | 74.8 [1,900] | 8" 150lb | 92.4 [2,348] | 10" 150lb | 92.4 |
| CMU-R | DN250 | 114.7 [2,913] | DN300 | 115.2 [2,925] | DN350 | 115.5 [2,933] | 10" 150lb | 117.2 [2,976] | 12" 150lb | 117.9 |

| | B | | | | | C | G |
|---|---|---|---|---|---|---|---|
| | Integral mount transmitter | | Remote mount transmitter | | | | |
| | -40°C - 100°C (-40°F to 212°F) | -40°C - 150°C (-40°F to 302°F) | -40°C - 100°C (-40°F to 212°F) | -40°C - 180°C (-40°F to 356°F) | -40°C - 260°C (-40°F to 500°F) | | |
| **Model** | inch [mm] | inch [mm] | inch [mm] | inch [mm] | inch [mm] | inch [mm] | inch [mm] |
| CMU-C | 12.9 [328] | 16.9 [430] | 8.9 [225] | 12.9 [327] | 16.8 [427] | 3.3 [85] | 1.6 [40] |
| CMU-D | 13.5 [343] | 17.5 [445] | 9.4 [240] | 13.5 [342] | 17.4 [442] | 3.9 [100] | 1.6 [40] |
| CMU-E | 15.6 [395] | 19.6 [497] | 11.5 [292] | 15.5 [394] | 19.4 [494] | 5.8 [148] | 1.9 [48] |
| CMU-G | 18.1 [460] | 22.1 [562] | 14.1 [357] | 18.1 [459] | 22.0 [559] | 7.9 [200] | 2.9 [74] |
| CMU-H | 20.8 [528] | 24.8 [630] | 16.7 [425] | 20.7 [527] | 24.7 [627] | 10.0 [255] | 4.0 [101] |
| CMU-J | 39.8 [1,010] | 43.8 [1,112] | 35.7 [907] | 39.7 [1,009] | 43.7 [1,109] | 24.2 [615] | 9.1 [230] |
| CMU-K | 47.6 [1,210] | 51.7 [1,312] | 43.6 [1,107] | 47.6 [1,209] | 51.5 [1,309] | 31.5 [800] | 9.8 [250] |
| CMU-L | 48.4 [1,230] | 52.4 [1,332] | 44.4 [1,127] | 48.4 [1,229] | 52.3 [1,329] | 32.1 [815] | 10.6 [270] |
| CMU-N | 61.4 [1,560] | 65.4 [1,662] | 57.4 [1,457] | 61.4 [1,559] | 65.3 [1,659] | 42.1 [1,070] | 15.0 [380] |
| CMU-P | 67.7 [1,720] | 71.7 [1,822] | 63.7 [1,617] | 67.7 [1,719] | 71.6 [1,819] | 47.6 [1,210] | 15.7 [400] |
| CMU-Q | 73.2 [1,860] | 77.2 [1,962] | 69.2 [1,757] | 73.2 [1,859] | 77.1 [1,959] | 51.2 [1,300] | 21.7 [550] |
| CMU-R | 73.4 [1,865] | 77.4 [1,967] | 69.4 [1,762] | 73.4 [1,864] | 77.3 [1,964] | 55.1 [1,400] | 20.1 [510] |

Weight:

| | Weight | |
|---|---|---|
| | Sensor | Transmitter |
| **Model** | kg [lbs] | kg [lbs] |
| CMU-C | 3.5 [7.7] | 4.5 [9.9] |
| CMU-D | 4 [8.8] | |
| CMU-E | 7 [15.4] | |
| CMU-G | 15 [33.1] | |
| CMU-H | 29 [63.9] | |
| CMU-J | 140 [308.6] | |
| CMU-K | 200 [440.9] | |
| CMU-L | 250 [551.2] | |
| CMU-N | 470 [1036.2] | |
| CMU-P | 750 [1653.5] | |
| CMU-Q | 850 [1873.9] | |
| CMU-R | 900 [1984.1] | |

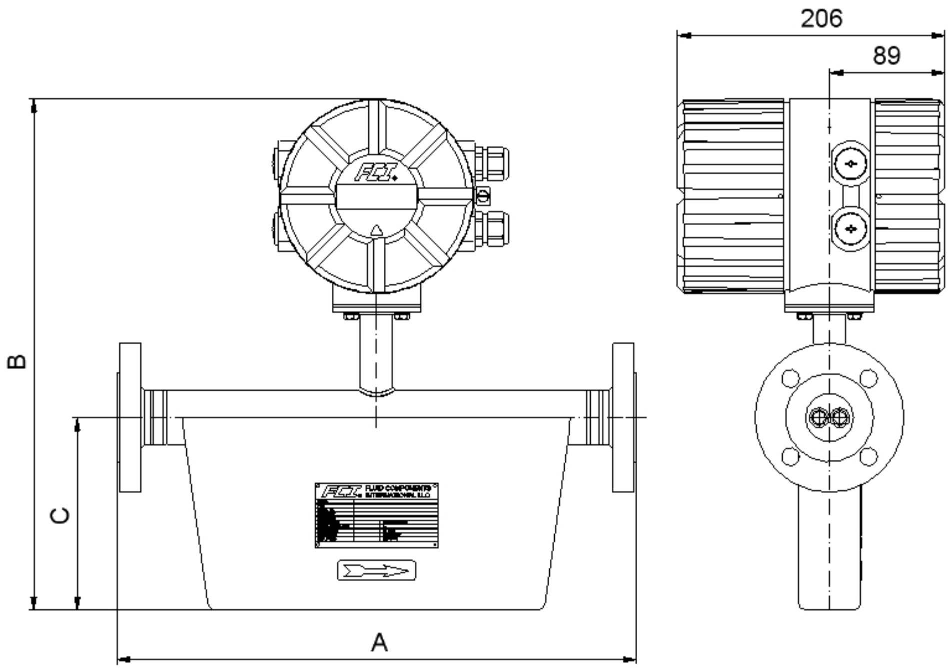
Heated versions:

| | K | L | M |
|---|---|---|---|
| **Model** | inch [mm] | inch [mm] | inch [mm] |
| CMU-J | 24.0 [610] | 26.8 [680] | 9.4 [240] |
| CMU-K | 31.5 [800] | 34.4 [875] | 9.8 [250] |
| CMU-L | 23.6 [600] | 30.9 [785] | 10.6 [270] |
| CMU-N | 42.5 [1080] | 46.9 [1190] | 12.8 [325] |
| CMU-P | 47.2 [1200] | 52.4 [1330] | 13.2 [335] |

### 3.8.2 Dimension drawing for the types CMU-C to CMU-H

#### 3.8.2.1 Standard version dimension drawing

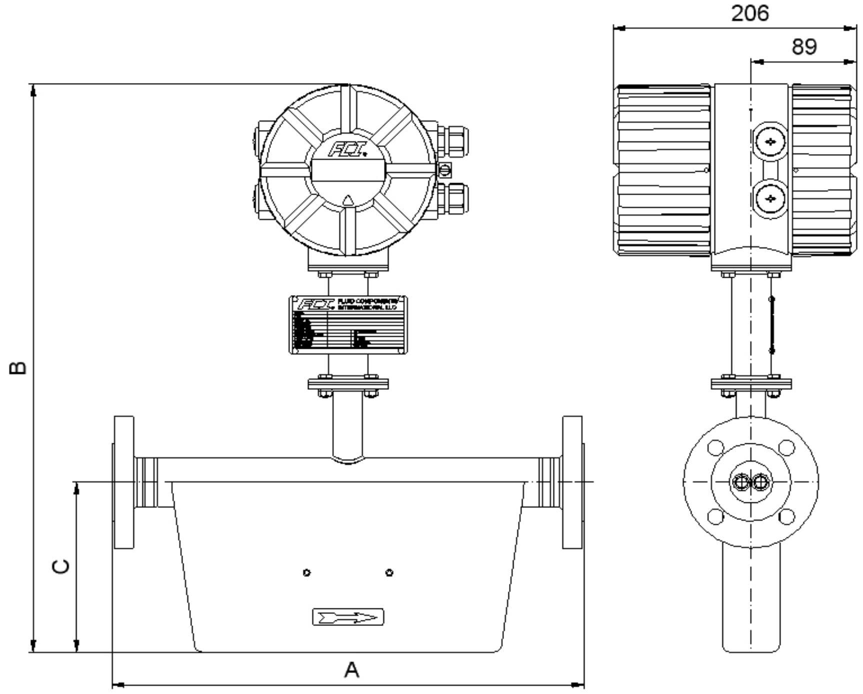
Integral mount configuration that is suitable for process temperatures up to 100 °C (212°F):




For all the dimensions and weight, see Section 3.8.1 Dimensions and weight on page 24.

#### 3.8.2.2 Integral mount version up to 150 °C (302 °F)

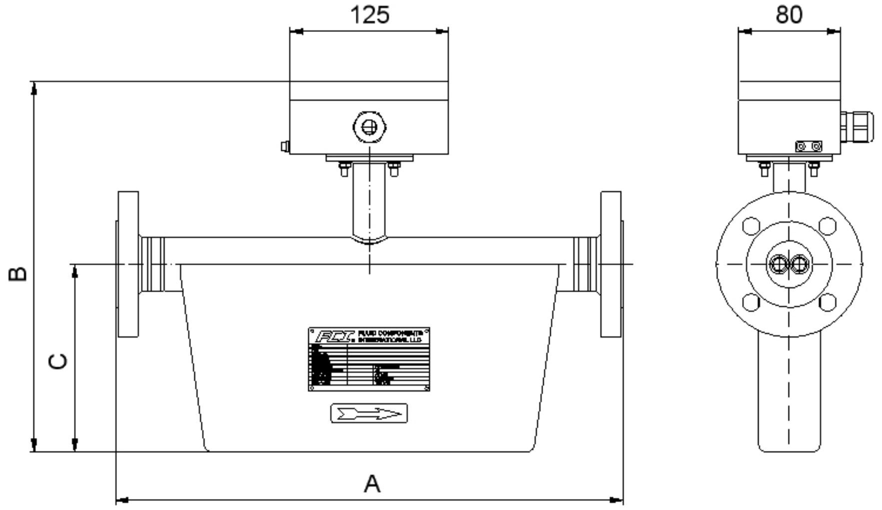
Integral mount configuration that is suitable for process temperatures up to 150 °C (302°F):




For all the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

#### 3.8.2.3 Remote mount version dimension drawing

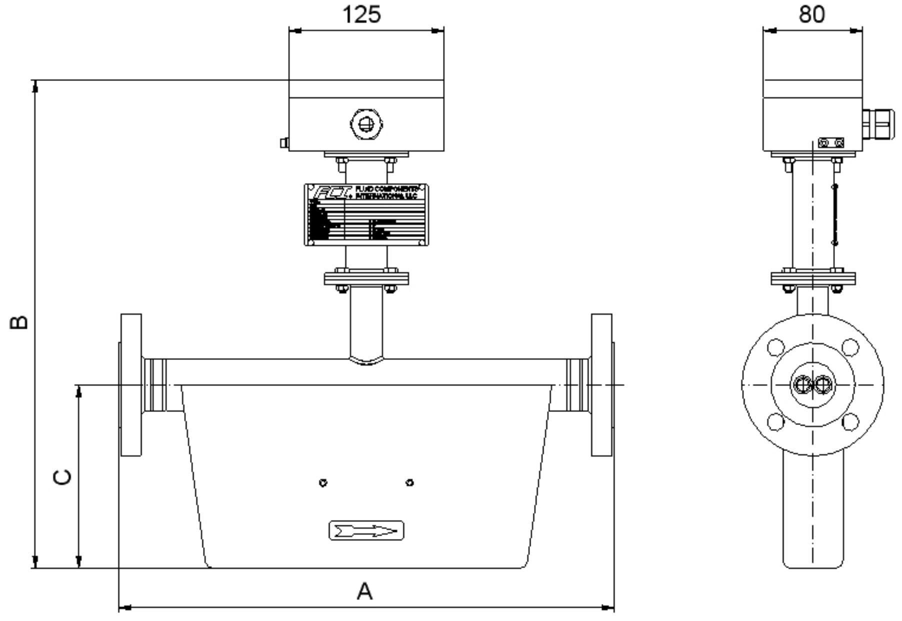
Remote mount configuration with junction box that is suitable for process temperatures up to 100 °C (212 °F):




For all the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

#### 3.8.2.4 Remote mount version dimension drawing up to 180 °C (356 °F)

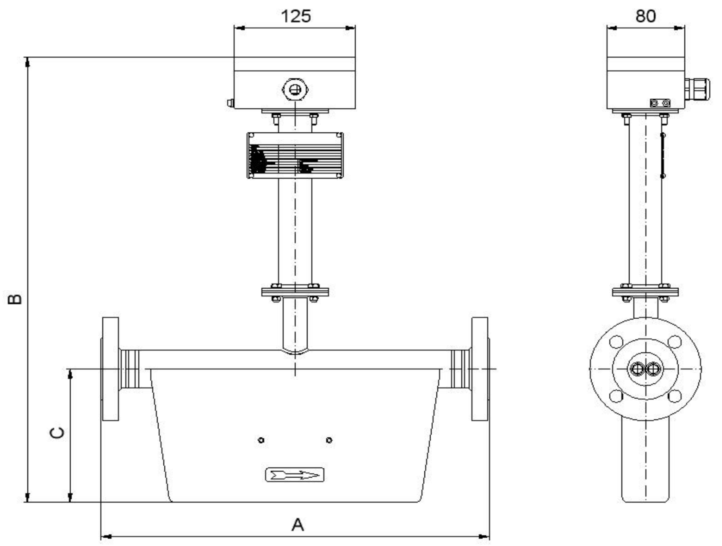
Remote mount configuration with junction box that is suitable for process temperatures up to 180 °C (356 °F):




For all the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

#### 3.8.2.5 Remote mount version dimension drawing up to 260 °C (500 °F)

Remote mount configuration with junction box that is suitable for process temperatures up to 260 °C (500 °F):

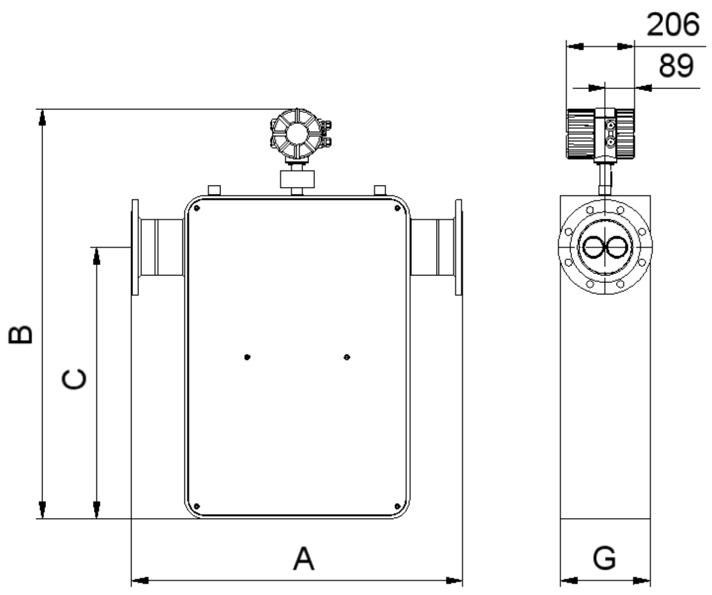



For all the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

### 3.8.3 Dimension drawing for the types CMU-J to CMU-R

#### 3.8.3.1 Standard version dimension drawing

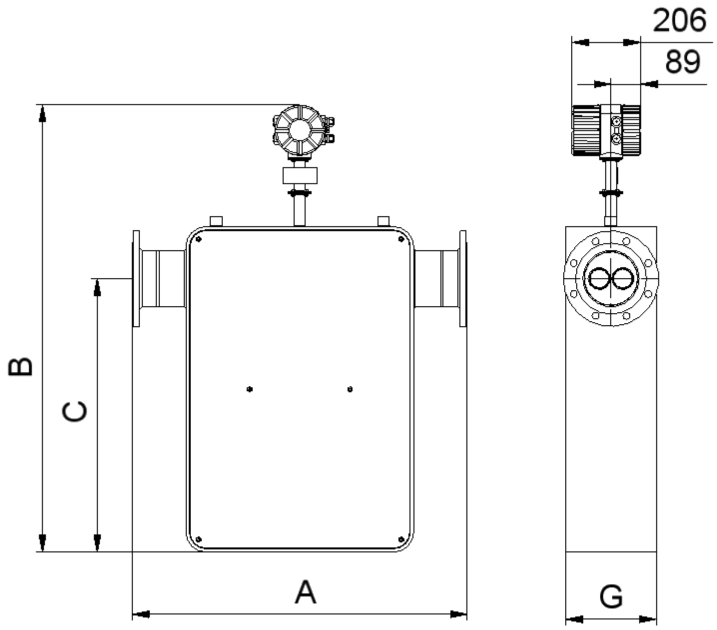
Integral mount configuration that is suitable for process temperatures up to 100 °C (212 °C):




For all the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

### 3.8.3.2 Integral mount configuration up to 180 °C (356°F)

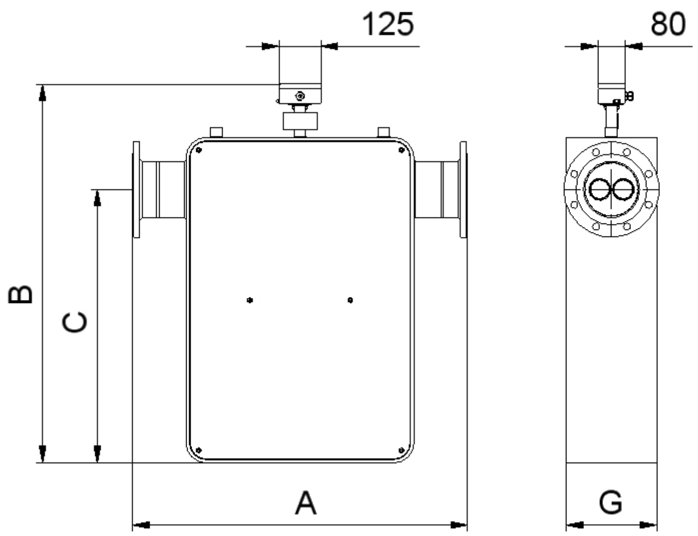
Integral mount configuration that is suitable for process temperatures up to 180 °C (356 °F):




For the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

### 3.8.3.3 Remote mount version dimension drawing

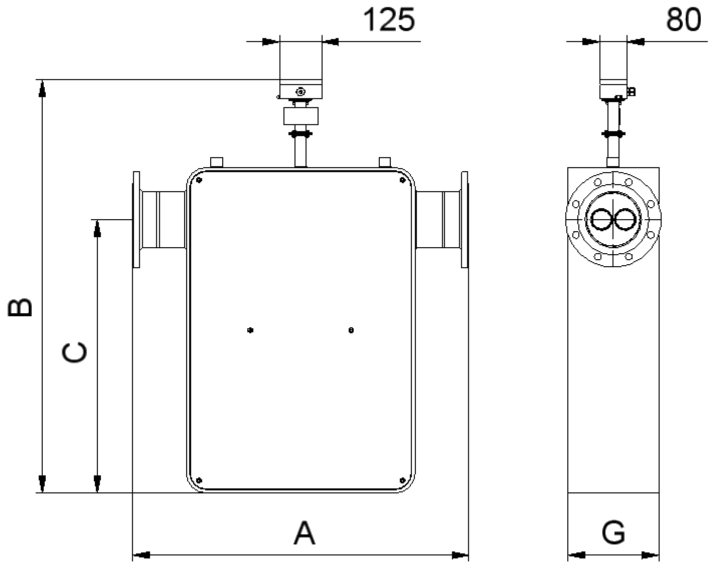
Remote mount configuration (with junction box) that is suitable for process temperature up to 100 °C (212 °F):




For the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

#### 3.8.3.4 Remote mount version dimension drawing up to 180 °C (356°F)

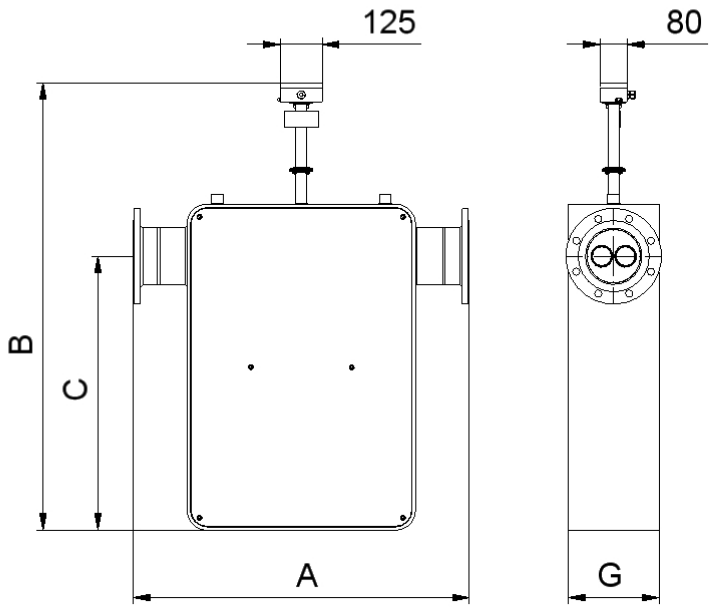
Remote mount configuration (with junction box) that is suitable for process temperatures up to 180 °C (356°F):




For the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

#### 3.8.3.5 Remote mount version up to 260 °C (500°F)

Remote mount configuration (with junction box) that is suitable for process temperatures up 260 °C (500 °F):

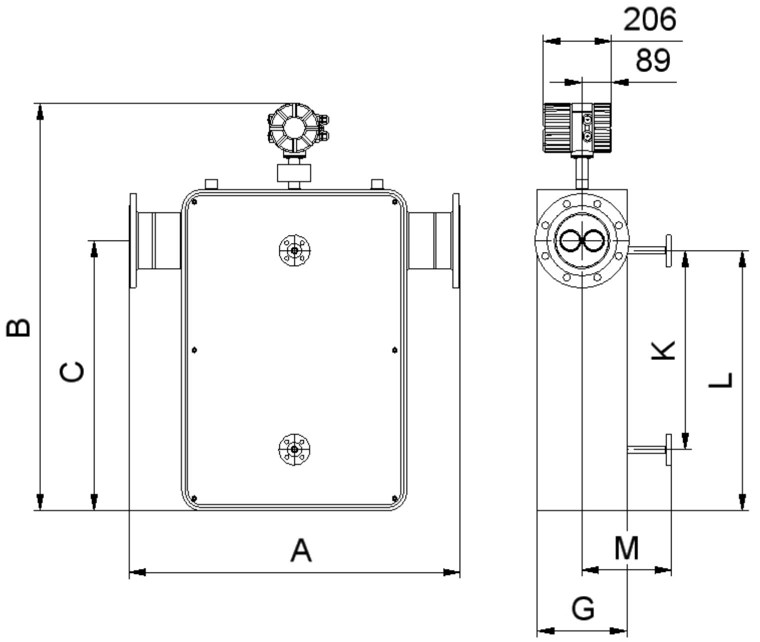



For all the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24

### 3.8.4 Heater dimension drawings for CMU-J up to CMU-R

#### 3.8.4.1 Heater for standard version

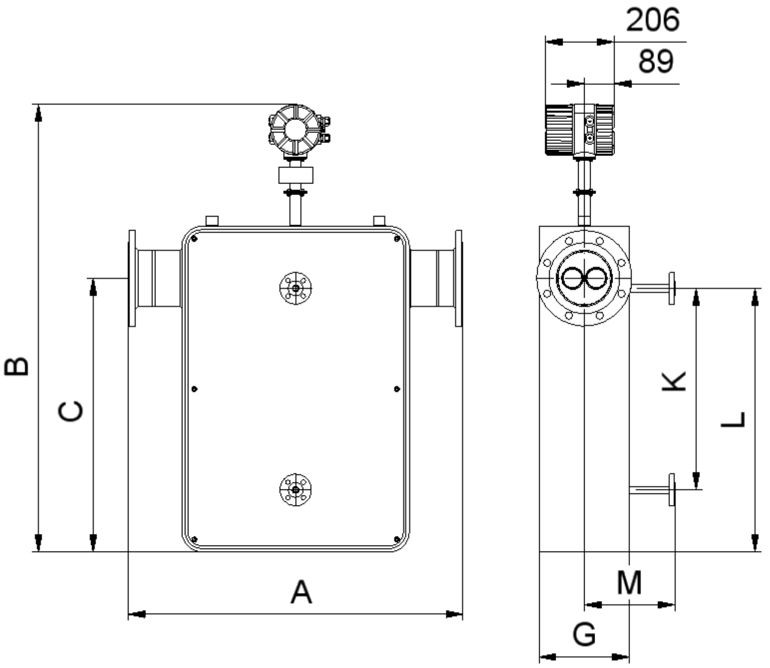
Integral mount configuration that is suitable for process temperatures up to 100 °C (212°F):




For all the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

#### 3.8.4.2 Heater for integral mount version up to 150 °C (302°F)

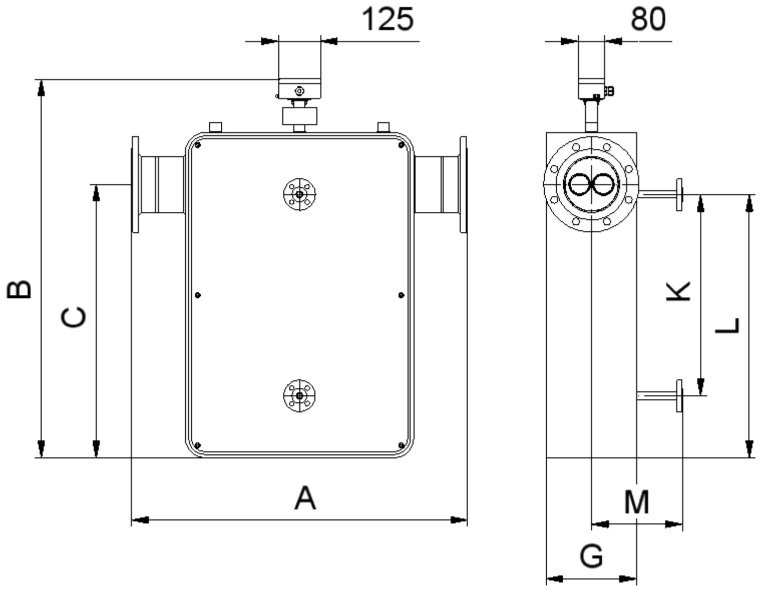
Integral mount configuration that is suitable for process temperatures up to 150 °C (302°F):




For the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

#### 3.8.4.3 Heater for remote mount version

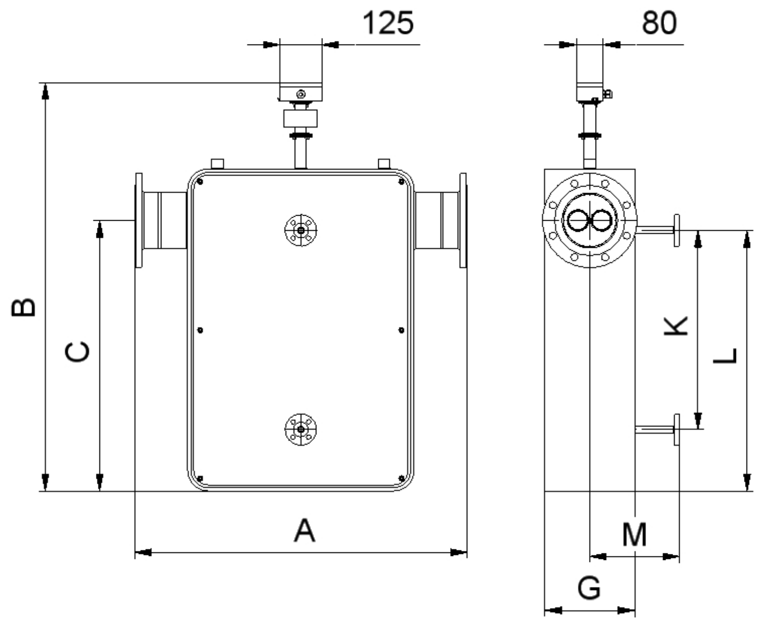
Remote mount configuration (with junction box) that is suitable for process temperatures up to 100 °C (212 °F):




For the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

#### 3.8.4.4 Heater for remote mount version up to 180 °C (356°F)

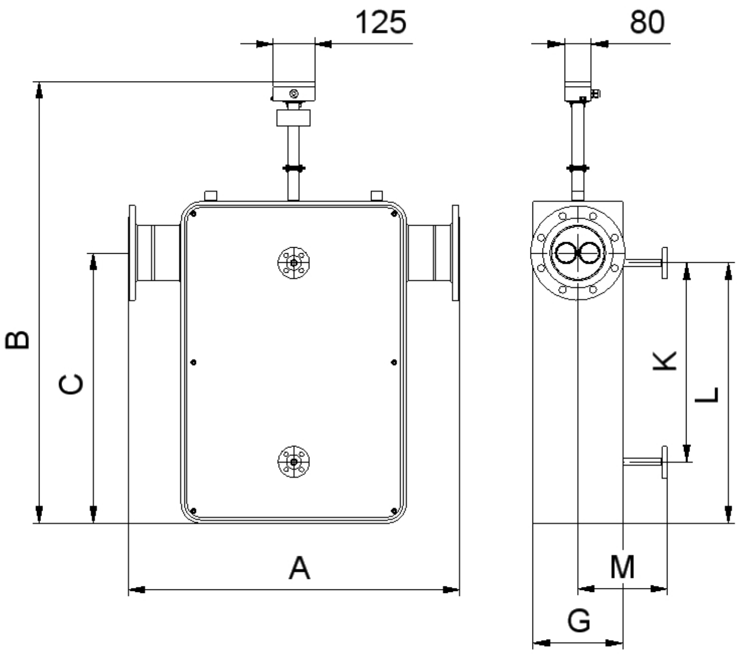
Remote mount configuration (with junction box) that is suitable for process temperatures up to 180 °C (356 °F):




For the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

### 3.8.4.5 Heater for remote mount version up to 260 °C (500 °F)

Remote mount configuration (with junction box) that is suitable for process temperatures up to 260 °C (500 °F):




For the dimensions and weights, see Section 3.8.1 Dimensions and weight on page 24.

### 3.8.5 Material

Sensor housing

| | |
|---|---|
| CMU up to 1.5 inch [DN040]: | 1.4301 (304L) |
| CMU starting from 2 inch [DN050]: | epoxy painted carbon steel, 1.4301 (304L) is available as an option |

| | |
|---|---|
| Flow tubes: | 1.4404 (316L) |
| Splitter: | 1.4571 (316Ti) |
| Sealing strip and/or flange: | Hastelloy<br>Tantalum<br>Other materials on request |

## 3.9 Sensor CMU approvals

### 3.9.1 Explosion protection

- Intrinsically safe sensor circuits
- BVS 05 ATEX E 145 X
- II 1/2G EEx ia IIC T6 – T2
- (Zone 0 permissible in flow tube)

The explosion protection approvals are available on our website upon request from the FCI factory.

3.9.2 CE marking

- Pressure Equipment Directive 97/23/EC
- Explosion Protection Directive 94/9/EC

### 3.9.3 Custody transfer operations

The declarations of conformity certifying FCI flowmeters for custody transfer operations are available upon request from the FCI factory.

# 4. Commissioning

## 4.1 Zero point calibration

In order to ensure that precise measurements are obtained, zero point calibration is to be realized the first time the device is put into operation and before any regular operations are carried out. Zero point calibration is to be carried out using a fluid.

The zero calibration procedure is as follows:

- Install the sensor as described in the manufacturer's instructions.
- Check to ensure that the sensor is completely filled with fluid and that there are no gas bubbles in the flow tubes.
- Define the process conditions such as pressure, temperature and density.
- Close a potential shut-off device behind the sensor.
- Operate the transmitter in accordance with the instructions in Section 13.4.4 Zero point calibration on page 66.
- Make sure that sufficient time is allowed for the electronics to warm up.
- Allowing fluid to flow through the sensor during the zero calibration procedure will skew the zero point and result in false readings.

## 4.2 Startup conditions

The device is not subject to specific startup conditions. However, pressure surges should be avoided.

# 5. Application domain of the CT transmitter

The microprocessor controlled CT transmitter (referred to as CT) for use with CMM, CMB and CMU sensors is a programmable transmitter that processes measurement data and displays and transmits various types of measurement results.

The CT is communication enabled and supports both the HART® protocol and Profibus-PA. The device can be customized using control unit BE2. Although basic configuration settings such as transmitter calibration are realized at the factory, other settings such as those for measurement data processing, analysis, display and output are user definable.

User settings are protected by a user definable password.

Settings that are essential for proper operation of the transmitter in conjunction with the sensor (e.g. calibration and initialization values) are accessible only to service technicians via a password that is not provided to customers.

# 6. CT transmitter: mode of operation and configuration

## 6.1 Measuring principle

The Coriolis mass flowmeter is based on the principle whereby in a rotating system a force (known as Coriolis force) is exerted on a mass at a rotation point that is moving towards or away from this point. By configuring the sensor in a specific fashion, this force can be used to measure mass flow directly. The CT transmitter evaluates the sensor signal (see Section 3.2.1 Measuring principle on page 14).

## 6.2 System configuration

Transmitter:
The CT transmitter regulates the excitation of the sensor vibration system and processes the sensor signals. The standard model is equipped with two analog 0/4 to 20 mA outputs, an impulse or frequency output and a status output, and is enabled for digital data transfer via the HART® protocol. The device is also available with a Profibus-PA field bus.

Sensor:
The CMM, CMB and CMU sensors measure flow, density and temperature in fluids. The device can be used to perform measurements with any liquid or gaseous product providing that the sensor material is suitable for the product being used.

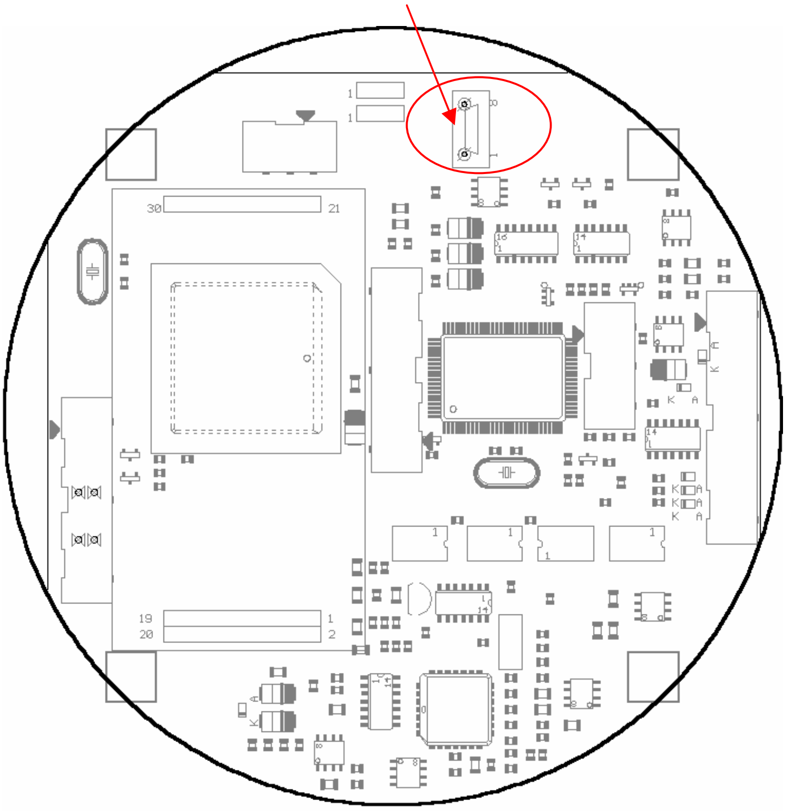
### 6.2.1 DSB data memory module

The replaceable plug and play memory module is mounted on a printed board and stores all sensor data such as sensor constants, model numbers, serial numbers, and so on. Consequently, the memory module is linked to the sensor and is attached to the transmitter housing with a nylon cord.

If the transmitter is replaced, the memory module should be transferred to the new transmitter. When the flowmeter is started up, the device continues using the values stored in the memory module. Thus, the DSB memory module provides maximum safety and comfort when device components are replaced.

Electronics compartment, CPU board UMC3-30

**DSB slot**



# 7. Input

## 7.1 Measured variable

Mass flow rate, temperature, density and volume flow (calculated from the preceding measured variables).

## 7.2 Measuring range

The measuring range, which varies according to which sensor (CMM, CMB or CMU) is used, can be found on the relevant data sheet or rating plate (see Section 3.4.2 CMU flow ranges on page 15).

# 8. Output

## 8.1 Output signal

All signal outputs

Electrically isolated from each other and from ground

Analog outputs

2 x 0/4 to 20 mA active( EEx “i” [outputs i.s.] or EEx “e”)

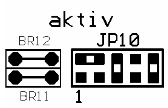
Current output 1:
Mass flow, volume flow, density, temperature
(when using the HART® protocol, output 1 is assigned to mass flow)
Current output 2:
Mass flow, volume flow, density, temperature

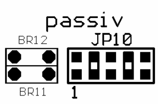
Pulse output
(Binary output 1)

Pulse duration: default value 50 ms
Pulse duration: adjustable range is 10 to 2000 ms
Mark-to-space ratio is 1:1 if the set pulse duration is not reached.

As a frequency output 1 kHz (optionally 10 kHz)

| | |
|---|---|
| Passive, via optocoupler<br>$U_i$ = 30 V<br>$I_i$ = 200 mA<br>$P_i$ = 3 W | Active, potential-free<br>(24 V =; max. 20 mA) |




The CT binary output 1 can be wired as a passive or an active output by inserting the JP10 plug-in jumpers on the UMC3-10 PCB accordingly. For the active output, the jumpers BR11 and BR12 must be closed in addition.

Pulse value

1 pulse/unit

The pulse value can be multiplied by a factor between 0.01 and 100.0 (decade increments) of the selected pulse unit, e.g. lbs, kg, $m^3$...

Status output

For: forward and reverse flow, MIN flow rate, MAX flow rate (Binary output 2): MIN density, MAX density, MIN temperature, MAX temperature, alarm

Second pulse output (out of phase by 90°)

Passive via optocoupler
$U_i$ = 30 V
$I_i$ = 200 mA
$P_i$ = 3 W

## 8.2 Failure signal

A failure in the meter can be indicated via the current outputs or the status output. The current outputs can be set to a failure signal (alarm) of I < 3.8 mA or I > 22 mA. The status output can be configured as make or brake contact.

## 8.3 Load

| | |
|---|---|
| Standard version: | ≤ 500 ohms |
| Explosion-proof version: | ≤ 500 ohms |
| HART® minimum load: | > 250 ohms |

## 8.4 Damping

Programmable from 0 to 60 seconds

## 8.5 Low flow cutoff

The low flow cutoff can be set to values between 0 and 20% using the software. The set value refers to the upper-range value. If the measured value is lower than the set volume, the flow rate will set to 0.0 (lb/m, kg/h). This results in the analog output being set to 0/4 mA, and the pulse output will stop generating pulses.

# 9. CT performance characteristics

## 9.1 Reference conditions

In conformity with IEC 770
Temperature: 20 °C (68 °F), relative humidity: 65 %, air pressure: 101.3 kPa (14.7 psi)

## 9.2 Measured error

Measured error  and zero point stability see sensor data sheet or Section 3.4.2 CMU flow ranges on page 15.

## 9.3 Repeatability error

± 0.05 % of actual value (sensor with transmitter)

## 9.4 Influence of ambient temperature

± 0.05 % per 10 K

# 10. CT operating conditions

## 10.1 Installation conditions and cable glands

The integral mount version of the CT transmitter in the SG1 housing is to be installed in accordance with Section 3.5.1 Installation on page 18. If the CT transmitter is installed separately, a vibration-free installation site must be ensured.

**Warning:**
Additional cable glands:
They are not contained in the scope of supply. The operator is responsible for the fact that according to the enclosure and ignition enclosure certified cable glands or screws are used. The kind of the thread is stamped on the rating plate.
At the connection between sensor and transmitter a metalized cable gland must be used for the screen.
(See 11.5.2.2 “Wiring diagram for the remote mount configuration of sensor and CT” page 47)

## 10.2 Environmental conditions

### 10.2.1 Ambient temperature

− 20 °C to + 60 °C (-4 °F to 140 °F), below 0 °C (32 °F) the readability of the LC display will be limited.

### 10.2.2 Ambient temperature range

− 20 °C to + 60 °C (-4 °F to 140 °F)

### 10.2.3 Storage temperature

−25 °C to + 60 °C (-13 °F to 140 °F)

### 10.2.4 Ingress protection

Standard housing SG1, IP 68 (NEMA 6P)
Explosion-proof electronics housing
Terminal compartment: with terminals and “Increased safety” type of protection.

**Warning:**
Ingress protection IP 68 is only achieved if suitable and tightly screwed down cable glands or conduit are used. If the cable glands are only tightened manually water may leak into the terminal compartment in the housing.

**Danger:**
Particular care must be taken if the window in the housing becomes fogged over or discolored because moisture, water or product might seep through the wire sheath into the terminal compartment in the housing.

**Warning**
Electromagnetic compatibility is only achieved if the electronics housing is closed. Leaving the enclosure open can lead to electromagnetic disturbances.

## 10.3 Process conditions

### 10.3.1 Fluid temperature

− 40 °C to + 260 °C (-40 °F to 500 °F)
The data sheet/rating plate of the connected transmitter must be observed.

### 10.3.2 Physical state

| | |
|---|---|
| Liquid product | (maximum density 2 kg/l (125lb/ft³)) |
| Gaseous product | (minimum density 0.002 kg/l in operating state) |

### 10.3.3 Viscosity

0.3 to 50,000 mPas (0.3 to 50,000cP)
The data sheet of the connected transmitter must be observed.

### 10.3.4 Fluid temperature limit

260 °C (500 °F)
The data sheet of the connected transmitter must be observed.

### 10.3.5 Flow rate limit

See sensor data sheet in Section 3.4.2 CMU flow ranges on page 15.

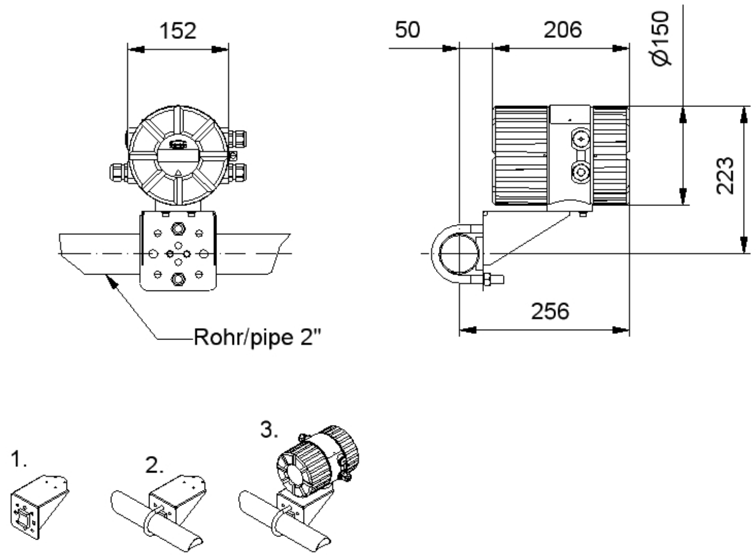
### 10.3.6 Pressure loss

See sensor data sheet in Section 3.4.5 Pressure loss CMU on page 17.

# 11. Construction details

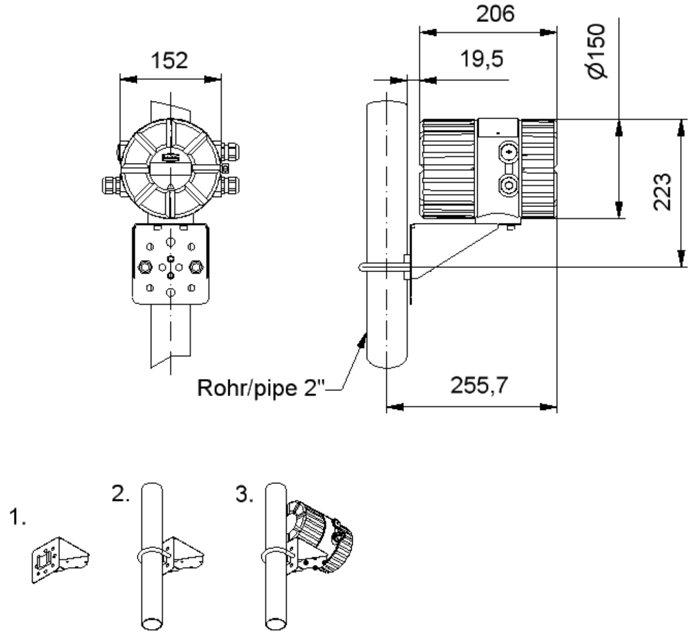
## 11.1 Type of construction/dimensions

**Horizontal pipe mounting - SG1**

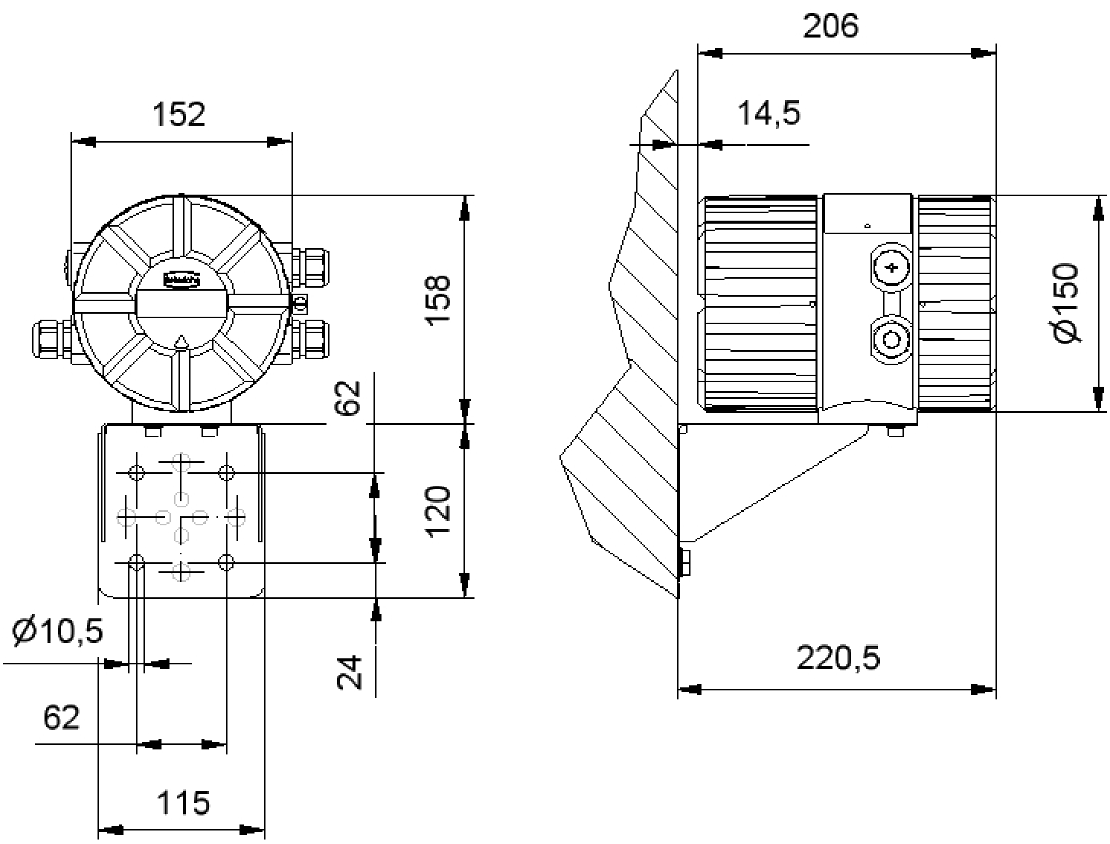



1. Mount pipe to carrier.
2. Tighten U-bolt clamp around pipe.
3. Mount transmitter onto carrier.

**Vertical pipe mounting - SG1**




**Separate mounting – SG1**




## 11.2 Weight

4.5 kg (10 lbs) (separate CT transmitter)

## 11.3 Material

Housing: GK Al Si 12 MG wa, passivated in chromic acid before being varnished

## 11.4 End connection

Direct (wireless) connection with the sensor or cable connection. For further details see Section 3.7 Connection to the transmitter on page 23, Section 11.5.2.1 Wiring diagram for the integral mount configuration of sensor and CT on page 46 and Section 11.5.2.2 Wiring diagram for the remote mount configuration of sensor and CT on page 47.

## 11.5 Electrical connection

| | | | |
|---|---|---|---|
| Auxiliary power | 90 V - 265 V AC | | 50/60 Hz |
| | 24 V AC | + 20 %, − 20 % | 50/60 Hz |
| | 19 V to 36 V DC | | |
| Power input | 7.5 VA | | |

Main fuse: 5x20 mm IEC 60127-2,V

| Main voltage | r. Current | rated voltage | breaking capacity |
|---|---|---|---|
| 90V ... 265V AC | 400mAT | 250V AC | 1500A / 250V AC |
| 24V AV | 800mAT | 250V AC | 1500A / 250V AC |
| 19V ... 36V DC | 800mAT | 250V AC | 1500A / 250V AC |

### 11.5.1 CT connections

Lines

| Designation | Terminal designation | Type of protection | | Standard |
|---|---|---|---|---|
| | | EEx ia | EEx e | (Not Ex) |
| **Power supply** | L(+), N(-),PE | | x | x |
| **Sensor lines** | | | | |
| SENSOR1 + | 1 | x | | x |
| SENSOR1 - | 2 | x | | x |
| SENSOR2 + | 3 | x | | x |
| SENSOR2 - | 4 | x | | x |
| TIk- | 5 | x | | x |
| Temperature sensor - | 6 | x | | x |
| Temperature sensor + | 7 | x | | x |
| TIk+ | 8 | x | | x |
| EXCITER1 | 9 | x | | x |
| EXCITER2 | 10 | x | | x |
| Shield | Shield | x | | x |

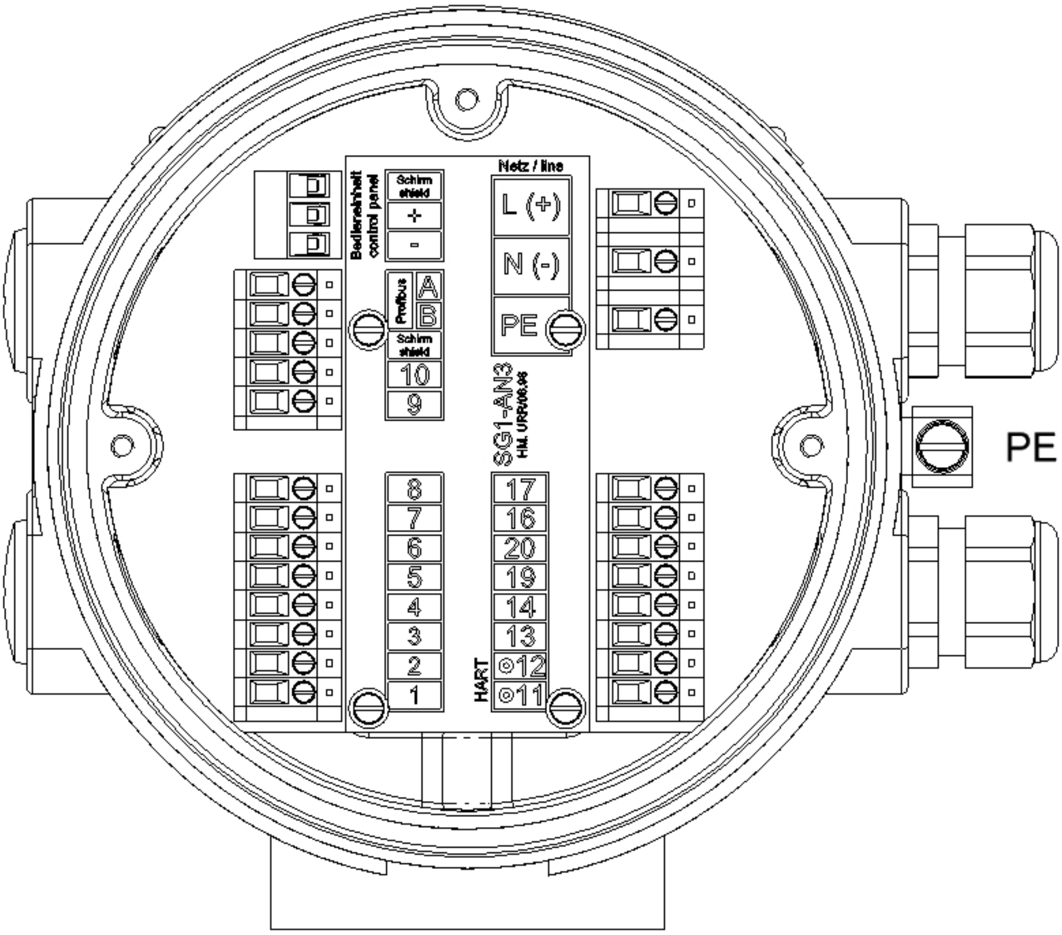
| Designation | Terminal designation | Type of protection | | Standard |
|---|---|---|---|---|
| | | EEx ia | EEx e | (Not Ex) |
| **Signal outputs** | | | | |
| Current 1, 0/4 to 20mA with HART® | 11 and 12 | x | | x |
| | 41 and 42 | | x | |
| Current 2, 0/4 to 20mA | 13 and 14 | x | | x |
| | 43 and 44 | | x | |
| Binary output 1 (passive pulse) | 16 and 17 | x | | x |
| | 46 and 47 | | x | |
| Binary output 1 (active pulse) | 45 and 48 | | x | |
| | 15 and 18 | | | x |
| Binary output 2 (status or second passive pulse output for custody transfer operations) | 19 and 20 | x | | x |
| | 49 and 50 | | x | |
| Option Binary output 3 (status output during custody transfer operations) | 33 and 34 | x | | x |
| | 53 and 54 | | x | |
| **Profibus PA** option | 39 (A) and 40 (B) | x | | |
| Control unit **BE** | Shield, -, + | x | | x |
| **Alternatives for current output 2** | | | | |
| Binary input | 21 and 22 | x | | x |
| | 51 and 52 | | x | |
| Modbus/Profibus DP with RS 485-IS | 35 (A) and 36 (B) (not currently available) | x | | x |
| Profibus DP | 37 (A) and 38 (B) (not currently available) | | x | |

- Since the signal outputs cannot be activated simultaneously owing to the limited number of terminals available, one of the aforementioned options must be selected. **Field bus devices (Profibus PA) are not outfitted with an analog or impulse output.**
- A maximum of 8 signal output terminals is available (in addition to the terminal for the control unit and Profibus PA).
- “Increased safety” type of protection signal outputs are to be connected only to "Extra low voltage" degree of protection circuits with safe electrical isolation in accordance with DIN VDE 0100 part 410.
- **Under no circumstances are “Increased safety” signal outputs to be combined with “Intrinsic safety” signal outputs**.
- If interface output RS 485 (under development and not currently available), which is only available in an “Increased safety” model, is selected, all signal outputs must also have this type of protection.
- If “Control input” or “RS 485 interface” are selected, current output 2 is not supplied.
- If the sensor and transmitter are interconnected using a cable, the following cable is to be used: **SLI2Y (SP) CY 5 x 2 x 0.5 mm (for explosion-proof applications, grey for non-explosion proof applications).**

### 11.5.2 Wiring diagram

#### 11.5.2.1 Wiring diagram for the integral mount configuration of sensor and CT

Supply and end connections
of the CT transmitter




| Process outputs wiring | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard EEx ia / Not Ex | | | Standard EEx e | | | Custody transfer | | | Modbus (planned) (RS485 - IS) | | |
| 17 | + | Binary output 1 | 47 | + | Binary output 1 | 17 | + | Binary output 1 | 17 | + | Binary output 1 |
| 16 | - | (pulse/frequency) | 46 | - | (pulse/frequency) | 16 | - | (pulse/frequency) | 16 | - | (pulse/frequency) |
| 20 | + | Binary output 2 | 50 | + | Binary output 2 | 20 | + | Binary output 2 | 20 | + | Binary output 2 |
| 19 | - | (status output) | 49 | - | (pulse/frequency) | 19 | - | (pulse/frequency) | 19 | - | (pulse/frequency) |
| 14 | + | Current output 2 | 44 | + | Current output 2 | 34 | + | Binary output 3 | 36 | B | RS485 |
| 13 | - | (0/4-20 mA) | 43 | - | (0/4-20 mA) | 33 | - | (status output) | 35 | A | (Modbus) |
| 12 | + | Current output 1 | 42 | + | Current output 1 | 12 | + | Current output 1 | 12 | + | Current output 1 |
| 11 | - | (0/4-20 mA HART®) | 41 | - | (0/4-20 mA HART®) | 11 | - | (0/4-20 mA HART®) | 11 | - | (0/4-20 mA) |

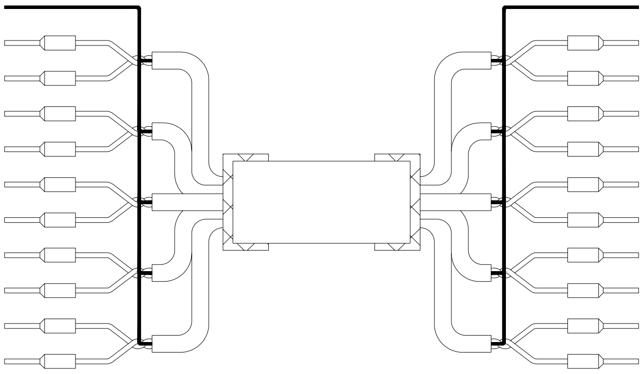
Note: RS 485 not currently available

#### 11.5.2.2 Wiring diagram for the remote mount configuration of sensor and CT

| | | | |
|---|---|---|---|
| Cable: | Non-explosion proof applications | SLI2Y(ST)CY 5 x 2 x 0.5 mm² | grey (max. 300 m) |
| | Explosion-proof applications | SLI2Y(ST)CY 5 x 2 x 0.5 mm² | blue (max. 300 m) |

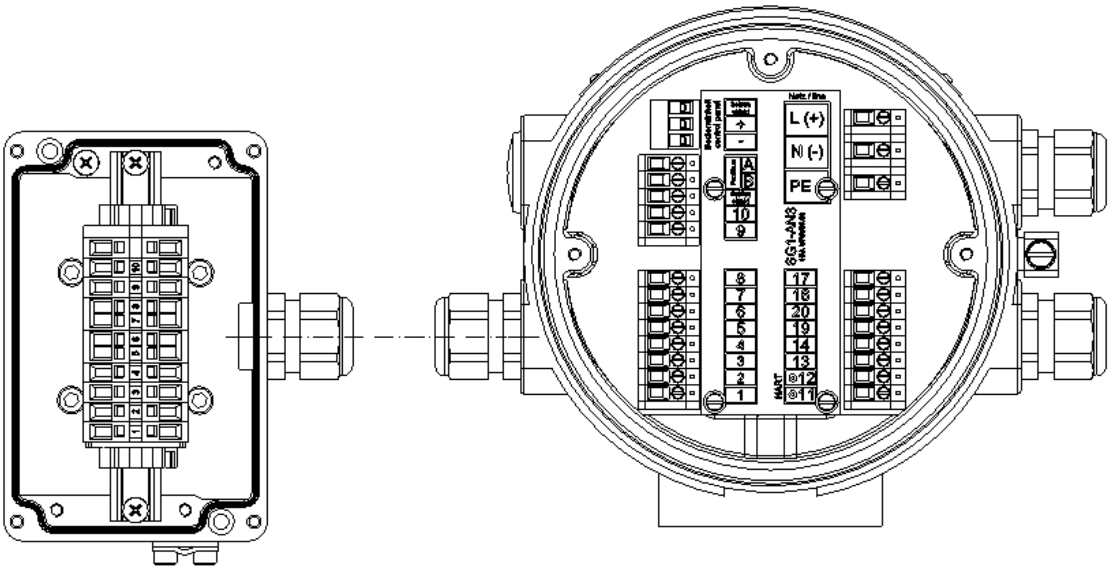
The outer shield is connected to the cable glands at both ends,
the inner shields are connected to each other and connected to the “Schirm / shield” terminal.

Schirm / shield
10 - rosa / pink
9 - grau / grey
8 - schwarz / black
5 - violett / violett
7 - blau / blue
6 - rot / red
4 - gelb / yellow
3 - grün / green
2 - weiß / white
1 - braun / brown



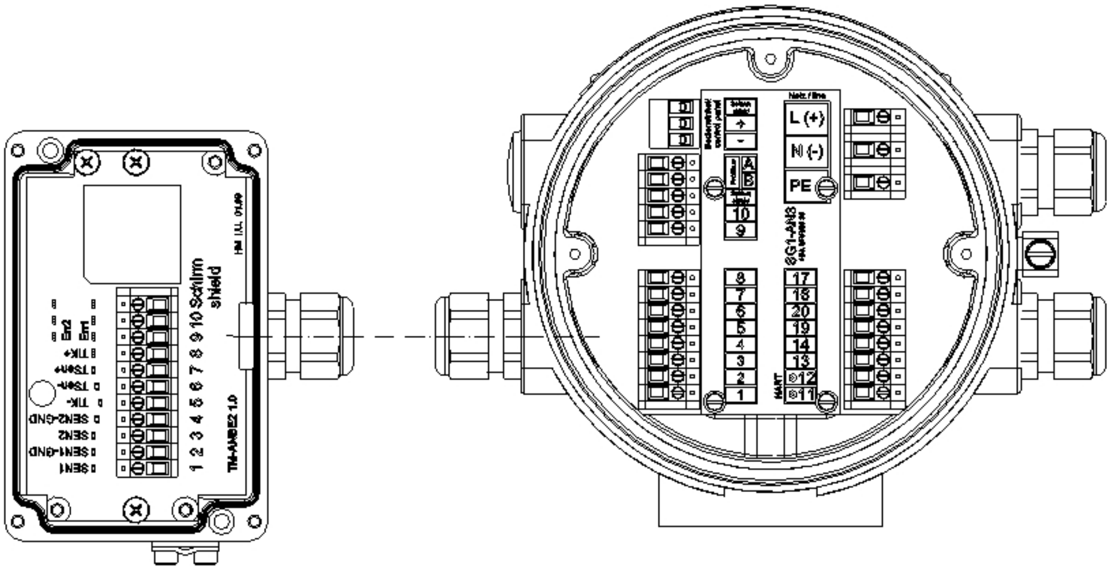
Schirm / shield
10 - rosa / pink
9 - grau / grey
8 - schwarz / black
5 - violett / violett
7 - blau / blue
6 - rot / red
4 - gelb / yellow
3 - grün / green
2 - weiß / white
1 - braun / brown

CMM, CMB, CMU with WAGO terminals
For terminal assignment, see Section 11.5.1 CT connections




Advices to cable glands: See also 10.1 “Installation conditions and cable glands” at page 40.

CMM, CMB, CMU with limit circuit and WAGO terminals
For the terminal assignment, see Section 11.5.1 CT connections




Cable glands: See also 10.1 “Installation conditions and cable glands” at page 40.

### 11.5.3 HART®

A number of options are available for HART® communication. However, for all these options loop resistance must be less than the maximum load specified in Section 8.3 Load (on page 39). The HART® interface is connected via terminal 11 and 12 or 41 and 42 with a minimum load impedance of 250 ohms.

For information regarding operation of the transmitter using the HART® hand-held terminal, see “Operation of the CT transmitter using the HART® hand-held terminal.”

### 11.5.4 Communication via SensorPort

SensorPort is the configuration software that is used to operate HART® or Profibus PA compatible devices.

To connect a desktop or laptop computer to the CT, a HART® interface is required in addition to communication software such as SensorPort. The HART® interface, which has two connections, converts the levels of the RS 232 interface into an FSK signal (frequency-shift keying). These connections consist of 9-pin sockets at the interface for the RS 232 connection, as well as a two-core cable with two mini terminals for current loop 1 in the transmitter.

The interface can be also installed in a separate control cabinet.

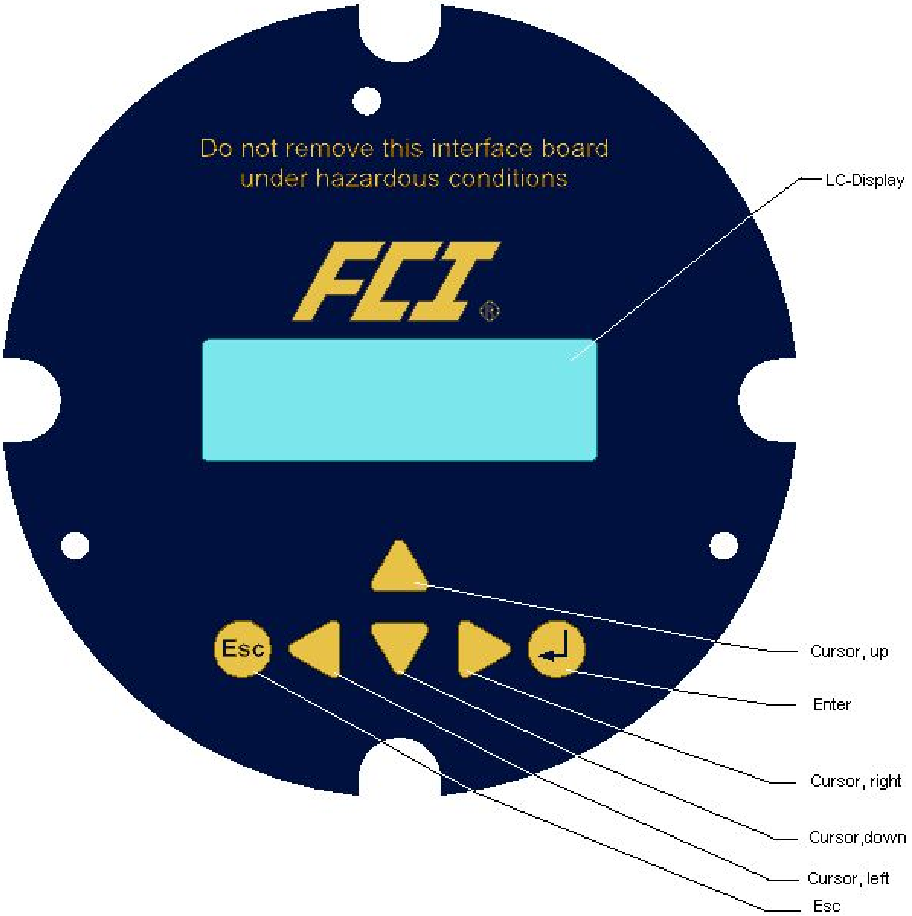
# 12. Control unit BE2

## 12.1 Introduction

The CT transmitter can be operated using control unit BE2, a desktop or laptop computer in conjunction with SensorPort software, or via HART® Communicator.

In the following, transmitter operation and parameterization using control unit BE2 (normally integrated into the terminal compartment) are described. The control unit can also be connected to the transmitter using an intrinsically safe cable that is up to 200 m in length. This allows a point-of-use display to be installed in a control room so that readings, counter status and settings can be accessed ergonomically.

Controlunit BE2




## 12.2 Display

Control unit BE2 in the CT has an integrated alphanumeric display with two 16-character lines (format 16 x 60 mm). Measurement data and settings can be read directly from this display.

The LCD display is designed be operated at temperatures ranging from − 20 °C to + 60 °C (-4° F to 140 °F) without incurring any damage. However, at freezing or near-freezing temperatures, the display becomes slow and readability of the measured values is reduced. At temperatures below − 10 C° (14 °F), only static values (parameter settings) can be displayed. At temperatures exceeding 60 C° (140 °F), contrast decreases substantially on the LCD and the liquid crystals can dry out.

## 12.3 Operating modes

The CT can be operated in the following modes:

1. Display mode: In display mode, measured values can be displayed in various combinations and CT settings can also be displayed. Parameter settings cannot be changed in this mode. Display mode is the standard (default) operating mode when the device is switched on.

2. Programming mode: In programming mode, CT parameters can be redefined. After entering the correct password, changes that are permissible for the customer (customer password) or all functions (service password for technicians) can be realized.

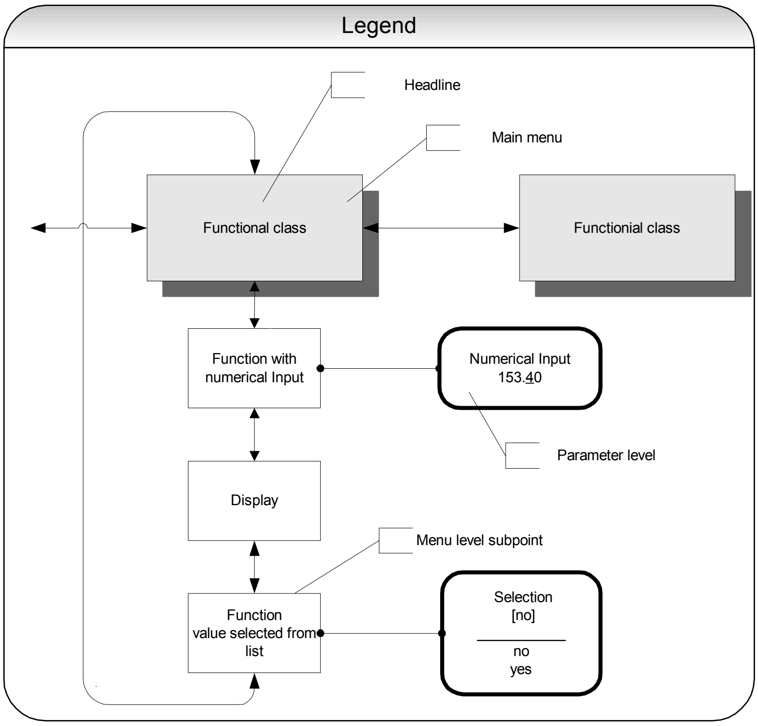
## 12.4 Operation

### 12.4.1 Operator interface

**Functional classes** are displayed as headings beneath which displays and parameters are shown in logical groups.

Beneath this is the **menu level**, which lists all measured value displays or the headings for their underlying parameters (**parameter level**).

All functional classes are interlinked horizontally, while all subpoints that are assigned to a functional class are displayed beneath the relevant class.



### 12.4.2 The keys and their functions

There are six keys to change the settings.

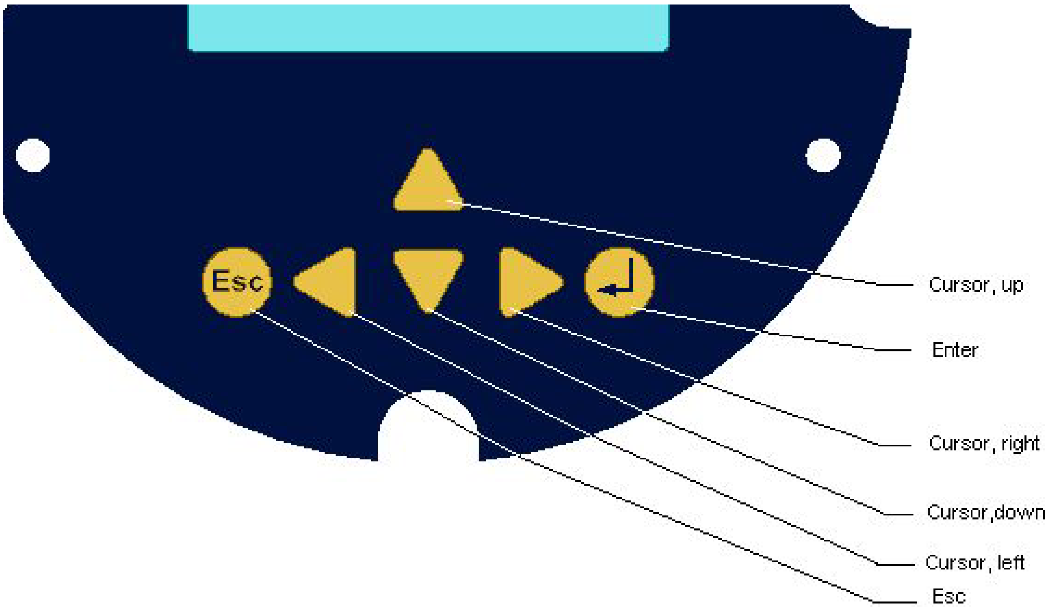
**Important note**
Do not press these keys with sharp or sharp-edged objects such as pencils or screwdrivers.

Cursor keys: Using the cursor keys, the operator can change numerical values, give YES/NO answers and select parameters. Each key is assigned a symbol in the following table:

| Descriptor | Symbol |
| --- | --- |
| Cursor key, arrow to the right | ▶ |
| Cursor key, arrow to the left | ◀ |
| Cursor key, arrow to the top | ▲ |
| Cursor key, arrow to the bottom | ▼ |

Esc key: **The "Esc" key allows you to cancel the current action.** Pressing Esc moves you to the next higher level where the operator can repeat the action. Pressing Esc twice moves you directly to the MEASURED VALUES functional class.

ENTER key: Pressing ↵ (ENTER key) moves you from the menu level to the parameter level. **You confirm all entries with the ↵ key.**



### 12.4.3 Functional classes, functions and parameters

Functional classes are written in all upper case letters (headings). The functions beneath each functional class are written in upper and lower case.

The various functional classes and functions are describes in Section 13 “CT transmitter functions” starting on page 54.

The lower lines contains the following elements:

- Informational texts
- YES/NO answers
- Alternative values
- Numerical values (with dimensions, if applicable)
- Error messages

If the user attempts to modify values for any of these parameters without entering the required password, the message “Access denied” will be displayed (see also 12.3 Operating modes on page 50 and 12.4.3.3 Pas on page 53).

#### 12.4.3.1 Selection window/make a selection

In the selection window, the first line of the LCD always contains the heading, while the second line displays the current setting. This setting is shown in square brackets if the system is in Programming mode.

| Function name |
|---|
| [Selection] |

In Programming mode (see 12.3 Operating modes on page 50), i.e. after a password has been entered (see 12.4.3.3 Passwords on page 53), the operator can navigate to the desired setting by using the ▲ key or the ▼ key and the operator can then confirm your selection by pressing ↵ (ENTER key). To retain the current setting, press Esc.

#### 12.4.3.2 Input window/modify a value

In the input window, the first line of the LCD always shows the heading, while the second line shows the current setting.

Example:

| Function name |
|---|
| -4,567 Unit |

These modifications can only be made in Programming mode (refer to 12.3 Operating modes on page 50), which means that a correct password (see 12.4.3.3 Passwords on page 53) must be entered. To move the cursor from one decimal place to the next, use the ◀ or ▶ keys. To increase the value of the decimal place just under the cursor by "1," use the ▲ key, and use ▼ key to lower the number by 1. To change the minus and plus sign, place the cursor in front of the first digit. To confirm and apply the change, press ↵ . To retain the current value, press Esc.

#### 12.4.3.3 Passwords

Programming mode is password protected. The customer password allows all changes to be made that are permissible for customers. This password can be changed when the device is first put into operation. Such changes should be kept in a safe place.

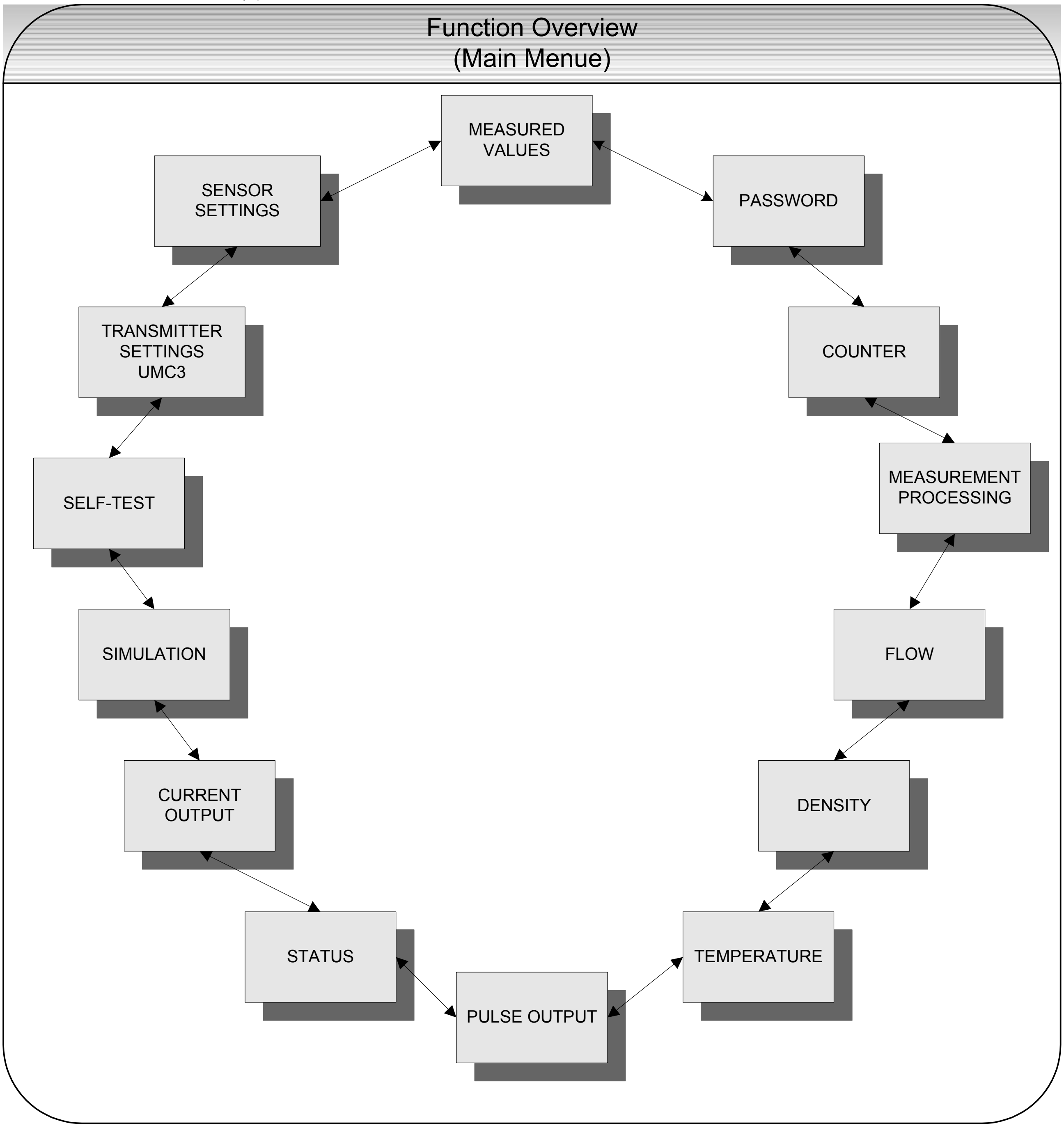
The CT customer password in the device when delivered is **0002**.

The service password allows for modification of all CT functions. This password is not given to customers.

For further information on customer passwords, see Section 13.2 PASSWORD functional class on page 60.

## 13. CT transmitter functions

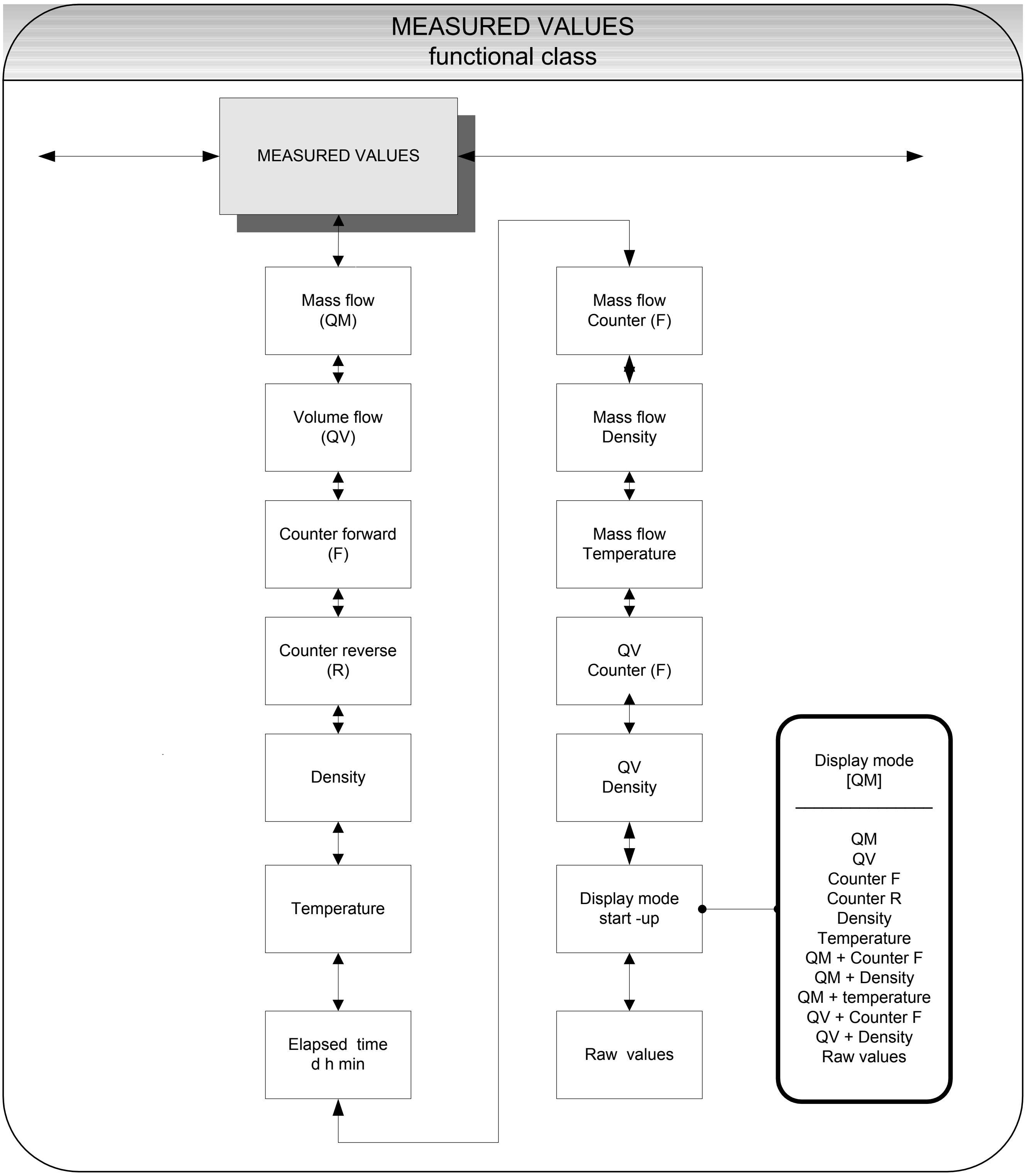
The software functions of the CT transmitter are divided into functional classes, are arrayed in a circle and can be navigated by using the ◄ or ► cursor keys. To go back to your starting point (the MEASURED VALUES functional class) press Esc.




In the following, all software functions that can be accessed using the customer password are described. Functions that are only accessible to the vendor (service functions) are not described in the present document.

## 13.1 MEASURED VALUES functional class

The MEASURED VALUES functional class contains all functions for displaying the measured values.



### 13.1.1 Mass flow

After selecting the Mass flow function, the following will be displayed:

| Mass flow |
|---|
| XXX.X kg/h |

The LCD shows the current mass flow. The operator can define the display unit in the FLOW functional class using the *Mass flow QM unit* function.

### 13.1.2 Volume flow

After selecting the *Volume flow* function, the following will be displayed:

| Volume flow |
|---|
| XXX.X $m^3$/h |

Volume flow can only be displayed if density measurement has been calibrated and activated. Otherwise, an error message is displayed. The operator can define the display unit in the FLOW functional class using the *Volume flow QV unit* function.

### 13.1.3 Counter forward

After selecting the *Counter forward* function, the current reading of the forward flow counter will be displayed.

| Counter forward |
|---|
| XXXXXXXX.XX kg |

The operator can define the display unit in the COUNTERS functional class using the *Unit of counters* function.

### 13.1.4 Counter reverse

After selecting the *Counter reverse* function, the current reading of the reverse flow counter will be displayed.

| Counter reverse |
|---|
| XXXXXXXX.XX kg |

The operator can define the display unit in the COUNTERS functional class using the *Unit of counters* function.

### 13.1.5 Density

Depending on the settings in the DENSITY functional class, the process or reference density will be displayed. Density can only be displayed if the sensor is suitable for density measurement and has been calibrated accordingly.

| |
|---|
| Density |
| XXX.X g/l |

The operator can define the display unit in the DENSITY functional class using the *Density unit* function.

### 13.1.6 Temperature

After selecting the *Temperature* function, the following will be displayed:

| |
|---|
| Temperature |
| XXX.XX °C |

The LCD shows the current temperature of the measured fluid in degrees Celsius, Fahrenheit or Kelvin.

### 13.1.7 Elapsed time

The LCD shows the operating time that has elapsed in d(ays), h(ours) and min(utes) since the system was initialized and commissioned by the vendor:

| |
|---|
| Elapsed time |
| 256 d 18 h 06 min |

### 13.1.8 Mass flow + Counter forward

After selecting the *Mass flow + Counter forward* function, the current mass flow will be displayed in the first line of the LCD:

| |
|---|
| XXX.X kg/h |
| XXXXXXXX.XX kg |

The second line shows the value of the counter forward. The operator can define the display unit in the FLOW functional class using the *Mass flow QM unit* function and the counter unit using the *Unit of counters* function in the COUNTERS functional class.

#### 13.1.9 Mass flow + Density

After selecting the *Mass flow + Density* function, the following will be displayed:

| |
|---|
| XXX.X kg/h |
| XXX.X g/cm³ |

The first line of the LCD shows the current mass flow and the second the density of the measured fluid. You define the display unit in the FLOW functional class using the *Mass flow QM unit* function and the density unit using the *Density unit* function in the DENSITY functional class.

#### 13.1.10 Mass flow + Temperature

After selecting the *Mass flow + Temperature* function, the following will be displayed:

| |
|---|
| XXX.X kg/h |
| XXX °C |

The first line of the LCD shows the current mass flow and the second line the temperature of the measured fluid. You define the display unit in the FLOW functional class using the *Mass flow QM unit* function.

#### 13.1.11 Volume flow + Counter forward

After selecting the *Volume flow + Counter forward* function, the current mass flow will be displayed in the first line of the LCD:

| |
|---|
| XXX.X m³/h |
| XXXXXXXX.XX m³ |

The second line shows the value of the counter forward. The operator can define the display unit in the FLOW functional class using the *Volume flow QV unit* function and the counter unit using the *Unit of counters* function in the COUNTERS functional class.

#### 13.1.12 Volume flow + Density

After selecting the *Volume flow + Density* function, the following will be displayed:

| |
|---|
| XXX.X m³/h |
| XXX.X g/cm³ |

The first line of the LCD shows the current volume flow and the second line the density of the measured fluid. The operator can define the display unit in the FLOW functional class using the *Volume flow QM unit* function and the unit for density measurement in the DENSITY functional class using the *Density unit* function.

### 13.1.13 Display mode during startup

By choosing the *Display mode during startup* function the operator can define the default display. After the operator switched the device on and did not touch any keys for a longer period of time, the defined default display will be shown:

| |
|---|
| Display mode |
| [QM] |

According to the description in Section 12.4.3.1 Selection window/make a selection, one of the following default displays can be selected.

- QM (Mass flow)
- QV (Volume flow)
- Counter f(orward)
- Counter r(everse)
- Density
- Temperature
- QM + Counter f
- QM + Density
- QM + Temperature
- QV + Counter f
- QV + Density
- and Raw values

### 13.1.14 Raw values

The “Raw values display” supports fault diagnosis and trouble shooting. Please inform our service department about the clear text error messages and the contents of this “Raw values display.”

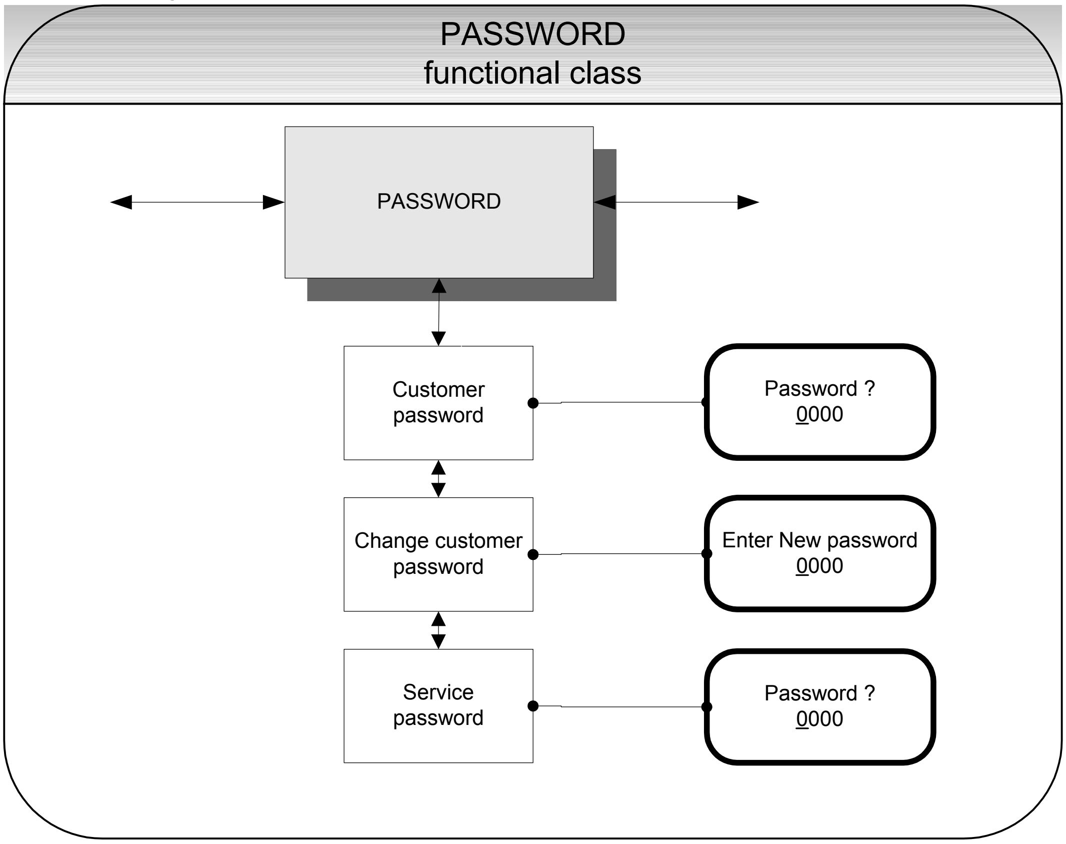
| | |
|---|---|
| xxx.xxx | ttt.tttt |
| fff.ffff | eee.aaa |

The displayed values have the following meaning:

| | |
|---|---|
| xxx.xxx: | Measure for the phase displacement between the sensor signals. |
| ttt.ttt: | Indicates the measured sensor temperature. |
| fff.ffff: | Indicates the current oscillation frequency of the system. |
| eee.aaa: | Indicates the value of the excitation current (eee) and the sensor voltage (aaa). |

## 13.2 PASSWORD functional class

The PASSWORD functional class is comprised of the functions for entering and changing the customer password and entering the service password. To cancel the current action, press Esc.




### 13.2.1 Customer password

After selecting the *Customer password* function and pressing ↵, the following will be displayed:

| |
|---|
| Password? |
| 0000 |

According to the description in Section 12.4.3.2 Input window/modify a value, the password can be changed.

If the entered password is correct, the following message will be displayed:

| |
|---|
| Password |
| valid |

If the entered password is not correct, the following message will be displayed:

| |
|---|
| Password |
| invalid |

The customer password in the device when delivered is **0002.**

A valid customer password allows all software parameter changes to be made that are permissible for customers. After the operator switched the device off or did not touch any keys for about 15 minutes, the authorization to change settings related to password entry will automatically be canceled. If the operator does not enter a valid password, all settings can be displayed but not changed. Parameter changes via HART or Profibus PA may be carried out any time without entering password.

### 13.2.2 Change customer password

After entering a valid customer password, you may change the existing password and enter a new one. After selecting the *Change customer password* function and pressing ↲, the following will be displayed.

| |
|---|
| Enter New password |
| 0000 |

According to the description in Section 12.4.3.2 Input window/modify a value the current value can be changed.

Press ↲ to confirm and save the new password. Make sure that you entered the desired password. **A copy of the password should be kept in a safe place.** Reactivation of a transmitter at the vendor's site due to a lost password is not part of our warranty.

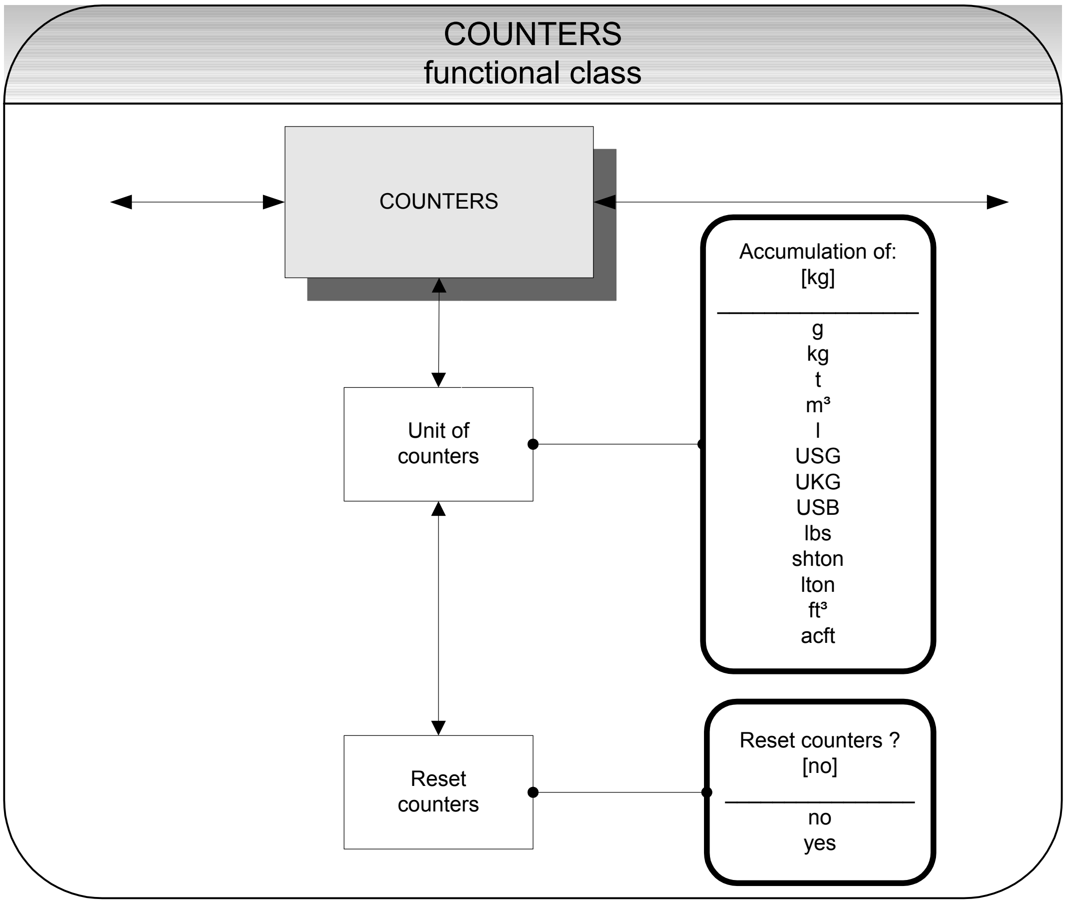
### 13.2.3 Service password

You do not need the service password for setting the functions necessary for operation.

The service password is reserved for service technicians and not provided to customers. Correct settings are essential for proper operation of the device (e.g. parameterization and calibration values).

## 13.3 COUNTER functional class

The COUNTERS functional class is comprised of the following functions:




To change the current settings, enter the customer password. Otherwise, the settings can only be displayed but not changed. To cancel the current action, press Esc.

### 13.3.1 Unit of counters

After choosing the *Unit of counters* function and pressing ↵, the current forward and reverse counter unit will be displayed:

| |
|---|
| Accumulation of: |
| [kg] |

According to the description in Section 12.4.3.1 Selection window/make a selection, one of the following units can be selected.

- Mass units: g, kg, and t as well as lbs, shton and lton
- Volume units: m³, and l as well as USG, UKG, USB, ft³ and acf

**When the unit is changed, the counters will be reset to 0.00 automatically.**
The volume unit only makes sense if the sensor has been calibrated for density measurement. Press ↵ to confirm and save the selection. Forward and reverse counters will now show the selected unit.

### 13.3.2 Reset counters

To reset the totalizing counters, you definitely need to toggle to [yes]. Forward and reverse counters will be reset at the same time (0.00).

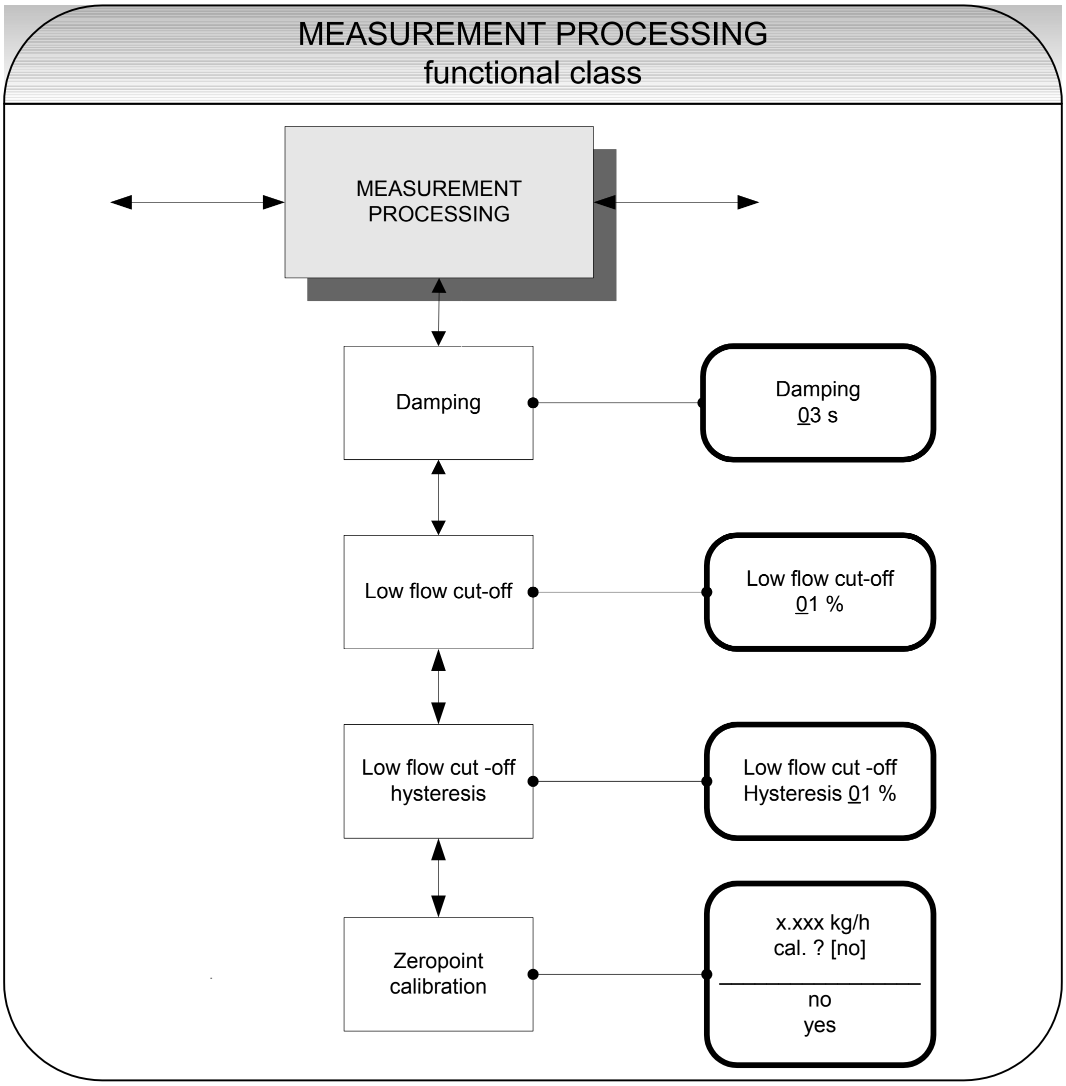
| |
|---|
| Reset counters |
| [no] |

According to the description in Section 12.4.3.1 Selection window/make a selection, one of the indicated units can be selected. By pressing Esc or toggling to [no] the operator can cancel the current action without changing the counter readings.

## 13.4 MEASUREMENT PROCESSING functional class

The MEASUREMENT PROCESSING functional class is comprised of all functions that affect the processing of the measured values.

To change the current settings, enter the customer password. Otherwise, the settings can only be displayed but not changed. To cancel the current action, press Esc.



### 13.4.1 Damping

The damping value is intended to dampen abrupt flow rate changes or disturbances. It affects the measured value display and the current and pulse outputs. It can be set in intervals of 1 second from 1 to 60 seconds. After choosing the *Damping value* function and pressing ↵, the following selection field will be displayed:

| |
|---|
| Damping |
| 03 s |

The current damping value will be displayed. According to the description in Section 12.4.3.2 Input window/modify a value, the current value can be changed. After setting the new damping value, press ↵ to confirm your entry.

### 13.4.2 Low flow cut-off

The value for low flow cut-off (low flow volume) is a limiting value stated as a percentage that relates to the upper-range value of the flow rate. If the volume drops below this value (e.g. leakage), the displayed value and the current outputs will be set to “ZERO.” The value for low flow cut-off can be set from 0 to 20 % in 1-percent increments. After choosing the *Low flow cut-off* function and pressing ↵, the following selection field will be displayed:

| |
|---|
| Low flow cut-off |
| 00 % |

The low flow volume will be displayed. According to the description in Section 12.4.3.2 Input window/modify a value, the current value can be changed. After setting the new low flow volume, you confirm your entry with ↵.

For devices used in custody transfer operations, you need to deactivate the low flow cut-off function, i.e. to set this value to 0 %.

### 13.4.3 Low flow cut-off hysteresis

The hysteresis of the low flow volume is the flow rate expressed as a percentage of the upper range value by which the volume must fall below or surpass the set low flow volume in order to activate or deactivate the function. The hysteresis of the low flow volume can be set in 1-percent increments from 0 to 10 %. After selecting the *Low flow cut-off hysteresis* function and pressing ↵, the following selection field will be displayed:

| |
|---|
| Low flow cut-off |
| Hysteresis 00 % |

The current hysteresis will be displayed. According to the description in Section 12.4.3.2 Input window/modify a value, the current value can be changed. After setting the new hysteresis value, you confirm your entry with ↵.

### 13.4.4 Zero point calibration

Using the *Zero point calibration* function the operator can recalibrate the zero point of your meter in the measuring system. Zero point calibration is to be realized after any installation procedure or after any type of work has been performed on in the pipes near the sensor.

**CAUTION:**
This function may only be carried out if it is certain that the fluid in the sensor is not flowing. Otherwise, the flow rates measured subsequently will be incorrect. The sensor may be completely empty or filled with fluid. A partially filled sensor or air bubbles will lead to an incorrect zero point calibration.

Calibrating a sensor filled with a fluid is better than calibrating an empty one.

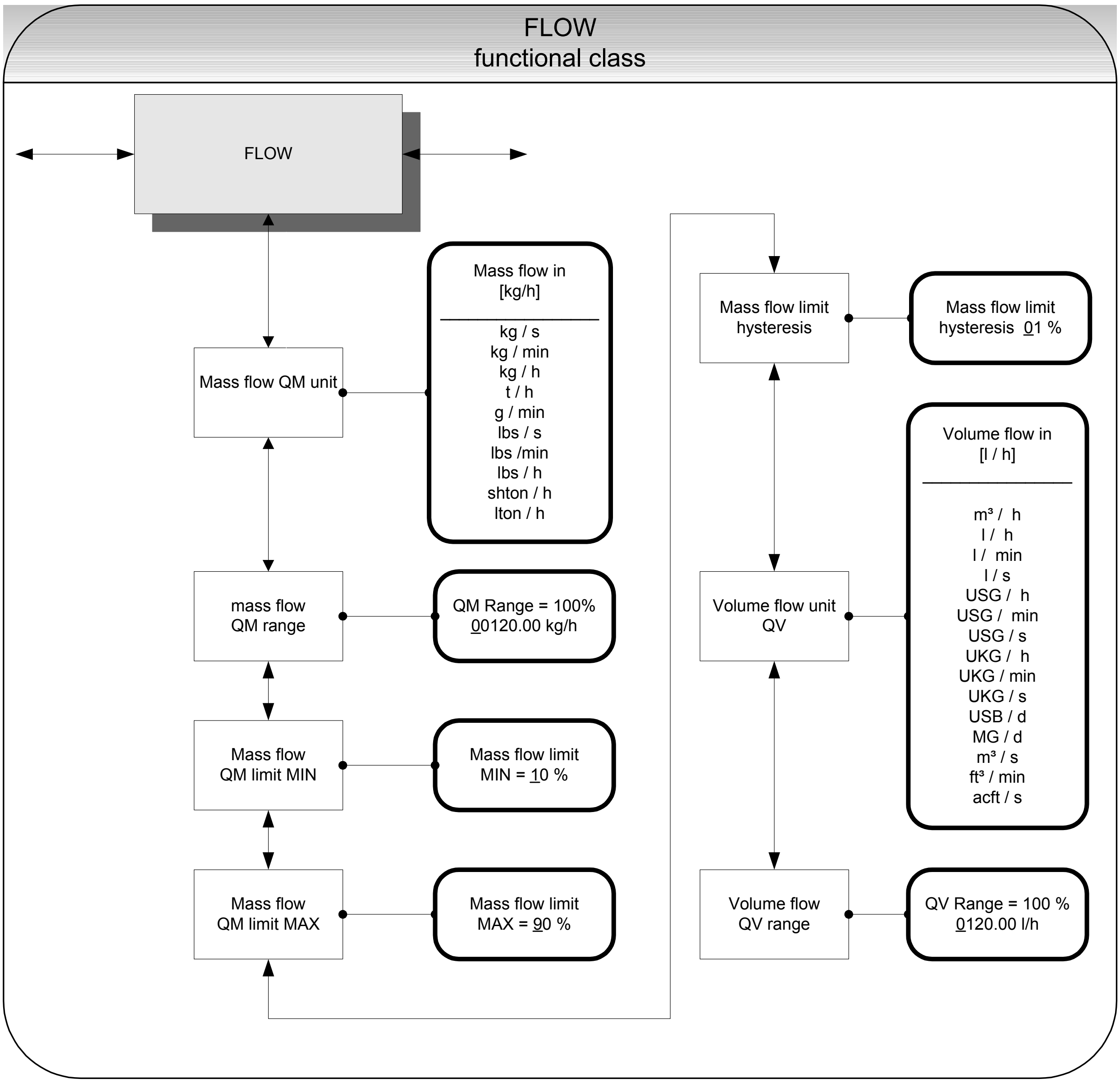
After choosing the *Zero point calibration* function and pressing ↵, the current remaining flow will be displayed:

QM = 0.00 kg/h
cal. ? [no]

According to the description in Section12.4.3.1 Selection window/make a selection, the operator can toggle between [yes] and [no]. After setting the new value, press ↵ to confirm your entry. Enter [yes] to have the zero point recalibrated.

## 13.5 FLOW functional class

The FLOW functional class is comprised of functions that affect lower- and upper-range values and the processing of the measured flow rates. In Programming mode (see 12.3 Operating modes), i.e. after a password has been entered (see 12.4.3.3 Passwords, 13.2 PASSWORD functional class), the operator can change the settings regarding flow.




To change the current settings, enter the customer password. Otherwise, the settings can only be displayed but not changed. To cancel the current action, press Esc.

### 13.5.1 Mass flow QM unit

Using this function, the operator can define the physical unit for all display functions, limit values and the upper-range value of mass flow. After choosing the *Mass flow QM unit* function and pressing ↵, the following selection field will be displayed:

| Mass flow QM unit |
|---|
| [kg/h] |

According to the description in Section 12.4.3.1 Selection window/make a selection, one of the following units can be selected:

- kg/s, kg/min, kg/h
- t/h
- g/min
- lbs/s, lbs/min, lbs/h
- shton/h
- lton/h

Press ↵ to confirm and save the selection.

### 13.5.2 Mass flow QM range

This function allows the operator to set the upper-range value for mass flow. The upper-range value takes on the unit defined using the *Mass flow unit* function. The upper-range value will scale the current and frequency outputs assigned to mass flow. After choosing the *Mass flow QM range* function and pressing ↵, the following selection field will be displayed:

| QM range=100% |
|---|
| XXXXX.XX kg/h |

The current upper-range value for mass flow will be displayed. According to the description in Section 12.4.3.2 Input window/modify a value, the current value can be changed.

### 13.5.3 Mass flow QM limit MIN

The MIN limiting value for mass flow can be evaluated via the status output. You enter the value as a percentage of the set upper-range value. If the mass flow is lower than that limit value, the status output will be set in case the corresponding assignment has been made. If the alarm function has also been activated for the assigned current output, the applied current will change to < 3.2 mA or > 20.5 mA / 22 mA. After choosing the *Mass flow QM limit MIN* function and pressing ↵, the following selection field will be displayed:

| Mass flow limit |
|---|
| MIN = 10 % |

The current MIN upper-range value for mass flow will be displayed. According to the description in Section 12.4.3.2 Input window/modify a value, the current value can be changed.

### 13.5.4 Mass flow QM limit MAX

The MAX limiting value for mass flow can be evaluated via the status output. You enter the value as a percentage of the set upper-range value. If the mass flow surpasses this limit value, the status output will be set in case the corresponding assignment has been made. If the alarm function has also been activated for the assigned current output, the applied current will change to < 3.2 mA or > 20.5 mA / 22 mA. After choosing the *Mass flow QM limit MAX* function and pressing ↵, the following selection field will be displayed:

| Mass flow limit |
|---|
| MAX = 90 % |

The current MAX upper-range value for mass flow will be displayed. According to the description in Section 12.4.3.2 Input window/modify a value, the current value can be changed.

### 13.5.5 Mass flow QM limit hysteresis

The hysteresis of the QM limiting values is the flow rate in percent based on the upper-range value and indicates the value which must fall below or surpass the set limiting values in order to activate or deactivate the function. The hysteresis of the QM limiting values can be set in 1-percent increments from 0 to 10 %. After choosing the *Mass flow QM limit hysteresis* function and pressing ↵, the following selection field will be displayed:

| Mass flow limit |
|---|
| Hysteresis 00 % |

The current hysteresis value will be displayed. According to the description in Section 12.4.3.2 Input window/modify a value, the current value can be changed.

### 13.5.6 Volume flow QV unit

This function allows the operator to define the physical unit for all display functions and the upper-range value for volume flow. After choosing the "Volume flow QV unit" function and pressing ↵, the following selection field will be displayed:

| |
|---|
| Volume flow QV unit<br>in [m³/h] |

According to the description in Section 12.4.3.1 Selection window/make a selection, one of the following units can be selected:

- m³/h, m³/s
- l/h, l/min, l/s
- USG/h, USG/min, USG/s
- UKG/h, UKG/min, UKG/s
- USB/d
- MG/d
- ft³/min
- acft/s

Press ↵ to confirm and save the selection.

### 13.5.7 Volume flow QV range

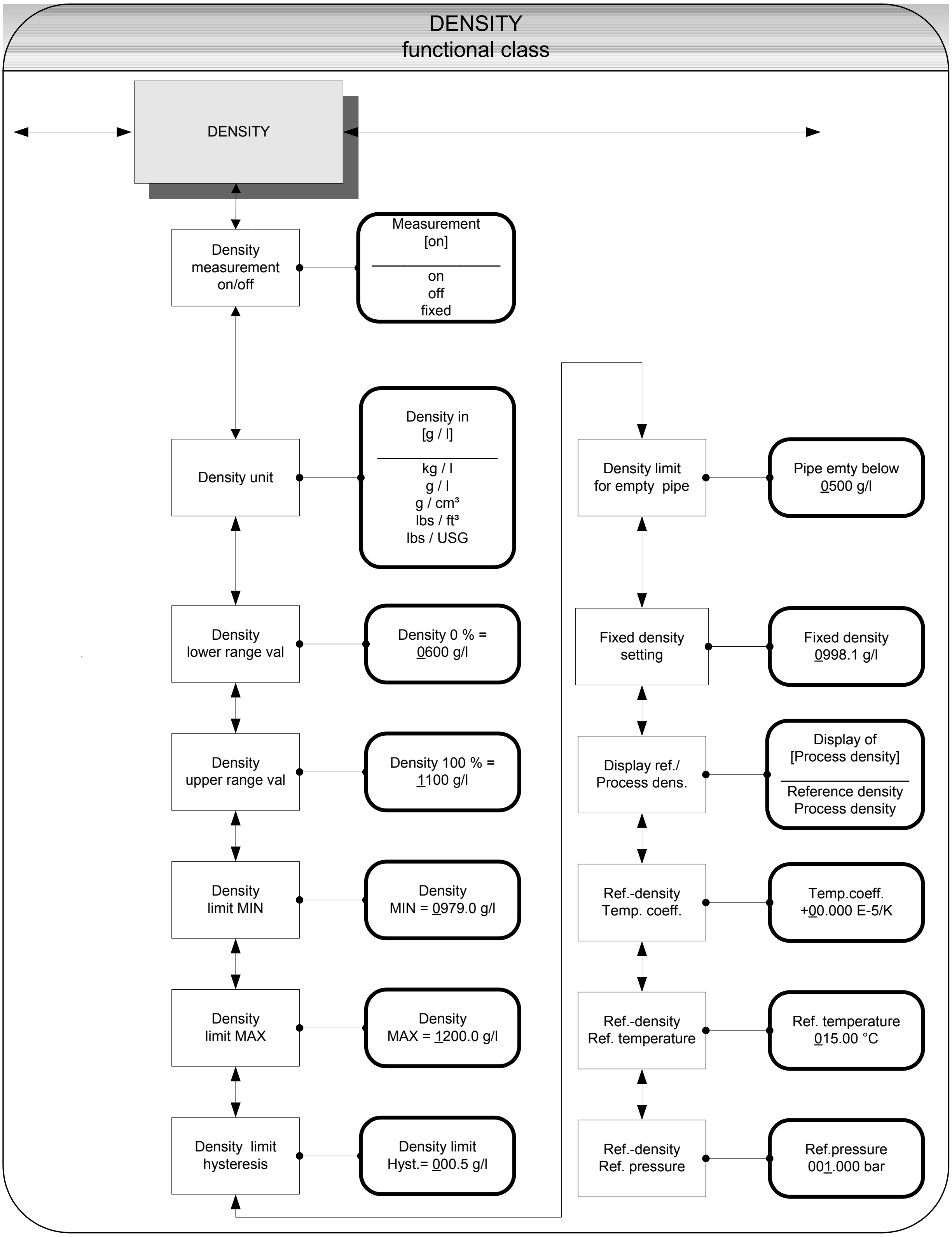
This function allows the operator to set the upper-range value for volume flow. The upper-range value takes on the unit defined using the *Volume flow QV unit* function. After choosing the *Volume flow QV range* function and pressing ↵, the following selection field will be displayed:

| |
|---|
| QV range=100 %<br>XXXXX.XX m³/h |

The current upper-range value for volume flow will be displayed. According to the description in Section 12.4.3.2 Input window/modify a value, the current value can be changed. Output and display of the measured value will only be realized for mass flowmeters for which a density calibration has been carried out.

### 13.6 DENSITY functional class

The functional class DENSITY is comprised of the functions that affect the lower- and the upper-range value and the processing of the measured density values. The additional service functions regarding density calibration will not be described in these instructions.




### 13.6.1 Density measurement on/off

This function allows the operator to activate density measurement. After selecting the *Density measurement on/off* function, press ↵ to display the following selection field:

| Measurement |
|---|
| [on] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:

- on density measurement is switched on
- off density measurement is switched off
- fixed density measurement is switched off; a fixed replacement value will be displayed and used for volume flow measurement
-

To confirm and apply the selection, press ↵. If density measurement was switched on and the message "Density not calibrated" is displayed, no density calibration was carried out by the vendor.

Density measurement can only be activated if density calibration has been carried out properly. Density calibration is realized at the factory using the service password.

If no density calibration has been carried out, the density and volume flow values will be set to "0.0" in the MEASURED VALUES functional class and the message "Density unknown" will be displayed.

### 13.6.2 Density unit

This function allows the operator to define the physical unit for all display functions and the density lower- and upper-range value. After selecting the *Density unit* function, press ↵ to display the following selection field:

| Density unit |
|---|
| [g/l] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following units:

- g/l
- kg/l
- g/cm³
- lbs/ft³
- lbs/USG

Press ↵ to confirm and apply the selection.

### 13.6.3 Density lower-range value

This function allows the operator to define the lower-range value for density measurement in the selected unit. If density is equal or below this value, the assigned current output will be set to its initial value of 0/4 mA.

After selecting the *Density lower-range value* function, press ↵ to display the following selection field:

| |
|---|
| Density 0 % =<br>XXXXX g/l |

The current lower-range value will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the lower-range value for density measurement.

### 13.6.4 Density upper-range value

This function allows the operator to define the upper-range value for density measurement in the selected unit. For this density, the assigned current output will be set 20 mA. The applied current of the current output assigned to the density value is linearly interpolated based on the ratio between the measured value and the difference between lower- and upper-range value.

After selecting the *Density upper-range value* function, press ↵ to display the following selection field:

| |
|---|
| Density 100 % =<br>XXXXX g/l |

The current upper-range value will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the upper-range value for density measurement.

### 13.6.5 Density limit MIN

The MIN limiting value for density can be evaluated via the status output and thus triggers an external alarm. This value is entered as an absolute value in the unit defined using the *Density unit* function.

After selecting the *Density limit MIN* function, press ↵ to display the following selection field:

| |
|---|
| Density limit<br>MIN = 0000.0 g/l |

The current MIN limiting value will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change MIN limiting value for density measurement.

### 13.6.6 Density limit MAX

The MAX limiting value for density can be evaluated via the status output. This value is entered as an absolute value in the unit defined using the *Density unit* function.

After selecting the *Density limit MAX* function, press ↵ to display the following selection field:

| Density limit |
|---|
| MAX = 0000.0 g/l |

The current MAX limiting value will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change MAX limiting value for density measurement.

### 13.6.7 Density limit hysteresis

The hysteresis of the density limiting values indicates the absolute density value in the unit defined using *Density unit* function. The measured density must fall below or surpass the set limiting values by the set hysteresis value in order to activate or deactivate the function.

After selecting the *Density limit hysteresis* function, press ↵ to display the following selection field:

| Density limit |
|---|
| Hysteresis 000.0 g/l |

The current value will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change hysteresis value for density measurement.

### 13.6.8 Density limit for empty pipe

If the measured density or the fixed value falls below this limiting value, the message “Empty pipe” will be displayed, and an alarm will be triggered.

Press ↵ to display the following selection field:

| Pipe empty below |
|---|
| 0500.0 g/l |

The current limiting value will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change value for density measurement.

### 13.6.9 Fixed density

If the operator selected the *fixed* option described in Section 13.6.1 Density measurement on/off (on page 72), density measurement will be switched off. The replacement value defined in the following selection field will be displayed.

Press ↵ to display the following selection field:

| Fixed density |
|---|
| 0998.1 g/l |

The current fixed density will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change this value. The density unit can be defined for all settings and displays described in Section 13.6.2 Density unit (on page 73).

### 13.6.10 Reference/process density display

When measuring density in a mass flowmeter, usually process density is displayed. Process density is the density of the fluid at the measured temperature. Reference (or standard) density can also be displayed as an option. In this case the measured process density will be converted based on a reference temperature. To do so, the reference temperature, the volume temperature coefficient of the fluid and the pressure at reference density (for gases) must be known and have been programmed.

Volume measurement also depends on this setting. If “Process density” is set, the measured (actual) volume flow will be displayed. If “Reference density” is set, a volume standardized to the reference density will be displayed.

| Display of |
|---|
| [Process density] |

The current operating mode for density measurement will be displayed. As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can toggle between the two modes.

### 13.6.11 Temperature coefficient

In order to calculate the reference density using the process density, the temperature coefficient of the fluid density must be known. In order to improve the resolution and facilitate data entry, the unit of the temperature coefficient is set to $10^{-5}$ 1/K.

| Temp. coeffic. |
|---|
| 00.00 E-5/K |

The current value of $10^{-5}$ 1/K will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the density temperature coefficient of the fluid.

### 13.6.12 Reference temperature

In order to calculate the reference density, the temperature to which the density relates is needed. The temperature for fuel oil usually is 15 °C.

| |
|---|
| Ref. temperature |
| 015.00 °C |

The reference temperature will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the value.

### 13.6.13 Reference pressure

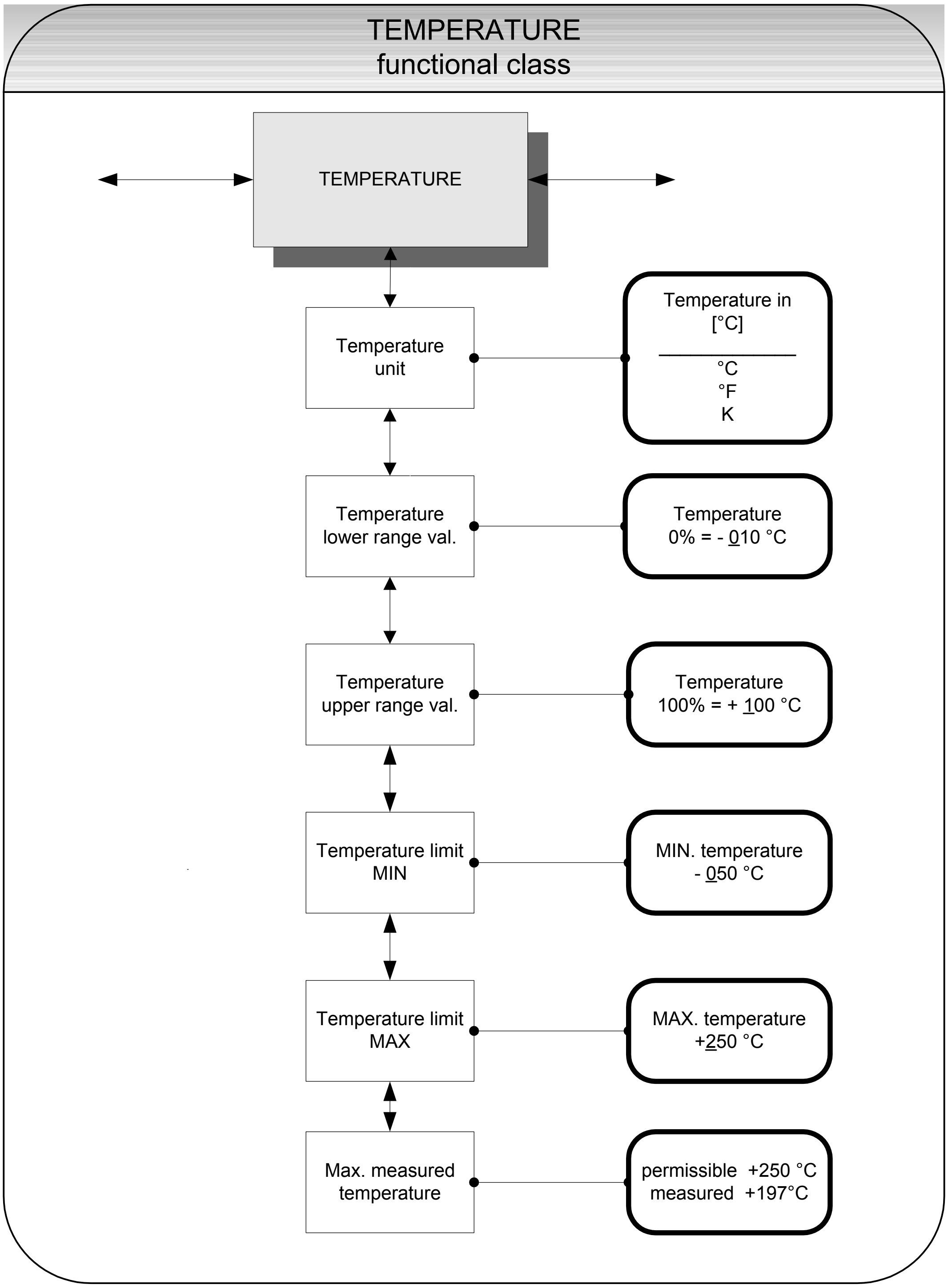
This function has been prepared for the consideration of gas equations for the measurement of reference density and volume for gases. In this software version, it will be used for entering the process pressure which is set equal to the reference pressure.

| |
|---|
| Ref. pressure |
| 001.00 bar |

The current value process pressure will be displayed in bar. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the value.

## 13.7 TEMPERATURE functional class

The TEMPERATURE functional class is comprised of the functions that affect the lower- and the upper-range value and the processing of the measured temperature. The additional service functions will not be described in these instructions. Modifications can only be made in Programming mode (see 12.3 Operating modes), which means that a correct password (see 12.4.3.3 Passwords, 13.2 PASSWORD functional class) must be entered.



### 13.7.1 Temperature unit

This function allows the operator to set the unit for temperature measurement. Press ↵ to display the following selection field:

| |
|---|
| Temperature in |
| [°C] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between °C, °F and K. All display windows, measuring ranges and limiting values refer to the selected unit.

### 13.7.2 Temperature lower-range value

This function allows the operator to define the lower-range value for temperature measurement. Lower temperatures will set the assigned current output to the minimum value of 0/4 mA. The temperature is entered in the set temperature unit. After selecting the *Temperature lower-range value* function, press ↵ to display the following selection field:

| |
|---|
| Temperature |
| 0% = + 005 °C |

The current lower-range value for temperature measurement will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the value. After setting the new lower-range value, press ↵ to confirm and apply the change.

### 13.7.3 Temperature upper-range value

This function allows the operator to define the upper-range value for temperature measurement. For this temperature, the assigned current output will be set to the upper-range value of 20 mA. The applied current of the current output assigned to the temperature value is linearly interpolated based on the ratio of the measured value to the difference between lower- and upper-range value.

The temperature is entered in the set temperature unit. After selecting the *Temperature upper-range value* function, press ↵ to display the following selection field:

| |
|---|
| Temperature |
| 100 % = +090 °C |

The current upper-range value for temperature measurement will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the value. After setting the new upper-range value, press ↵ to confirm and apply the change.

### 13.7.4 Temperature limit MIN

The MIN limiting value for temperature can be evaluated via the status output. This value is entered in the set temperature unit.

After selecting the *Temperature limit MIN* function, press ↵ to display the following selection field:

| |
|---|
| MIN temperature |
| -0̲10 °C |

The current MIN limiting value will be displayed. If the measured value falls below the limiting value, the “Alarm” status message will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the MIN limiting value for temperature measurement.

### 13.7.5 Temperature limit MAX

The MAX limiting value for temperature can be evaluated via the status output. This value is entered in the set temperature unit.

After selecting the *Temperature limit MAX* function, press ↵ to display the following selection field

| |
|---|
| MAX temperature |
| + 2̲50 °C |

The current MAX limiting value will be displayed. If the measured value falls below the limiting value, the “Alarm” status message will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the MAX limiting value for temperature measurement.

### 13.7.6 Max. measured temperature

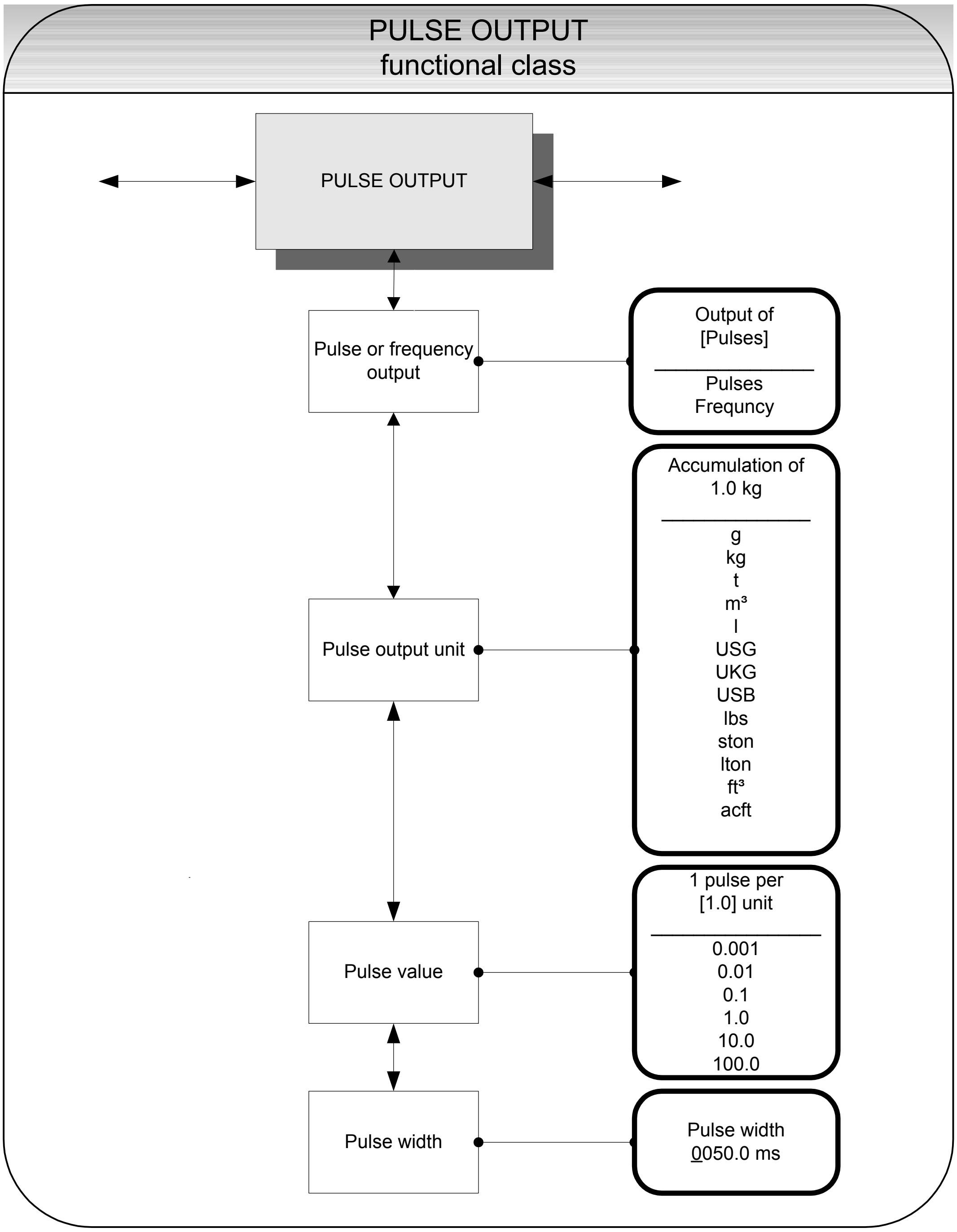
After selecting this display, the largest measured temperature will be displayed. For comparison, the set maximum limiting value will be displayed in the first line.

| | |
|---|---|
| permissible<br>+250 °C | |
| measured | +197 °C |

This value cannot be reset since it stores the maximum measured process temperature.

## 13.8 PULSE OUTPUT functional class

The PULSE OUTPUT functional class is comprised of the functions regarding the pulse output.




### 13.8.1 Pulse or frequency output

The *Pulse or frequency output* function allows the operator to define whether pulses represent a unit of flow, i.e lbs, kg, USG, for totalizing or a frequency between 0 and 1 kHz that represents an analog output over the measuring range.

After selecting the frequency setting, the maximum frequency of 1 kHz will be generated when the upper-range value for mass or volume flow is reached (depending on the selected pulse unit). If the flow rate falls below the low flow volume, the actual frequency is 0 Hz.

After selecting the pulse setting, pulse value and unit, the transmitter will determine the number of pulses per flow volume. When choosing a combination of these settings that cannot be fulfilled in real time for the upper-range value (e.g. the number of pulses per time unit cannot be generated due to the pulse width which is too large), the error message “Pulse width too large” or “Inconsistent parameter” will be displayed.

Press ↵ to display the current setting:

| Output of<br>[Pulses] |
|---|

According to the description in Section 12.4.3.1 Selection window/make a selection, the operator can toggle between frequency and pulse output (default setting).

### 13.8.2 Pulse output unit

This function allows the operator to define the unit to be counted. After selecting the *Pulse output unit* function, press ↵ to display the following selection field:

| Accumulation of<br>1.0 kg |
|---|

The current value will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can choose between the following units:

Mass units:

g, kg, t, lbs, ston, lton

Volume units

m³, l, USG, UKG, USB, ft³, acft

### 13.8.3 Pulse value

This function allows the operator to define how many pulses will be output per unit counted. After selecting the *Pulse value* function, press ↵ to display the current unit:

| 1 pulse per<br>[1.0] unit |
|---|

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following pulse values:

Values: 0.001, 0.01, 0.1, 1.0, 10.0, 100.0

### 13.8.4 Pulse width

This function allows the operator to change the width of the output pulse. If the pulse width is too large for the actual pulse number, it will be reduced automatically. In this case the warning “Pulse output saturated” will be displayed.

After selecting the *Pulse width* function, press ↵ to display the following selection field:

| Pulse width |
|---|
| 0050.0 ms |

The current pulse width will be displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the current value.

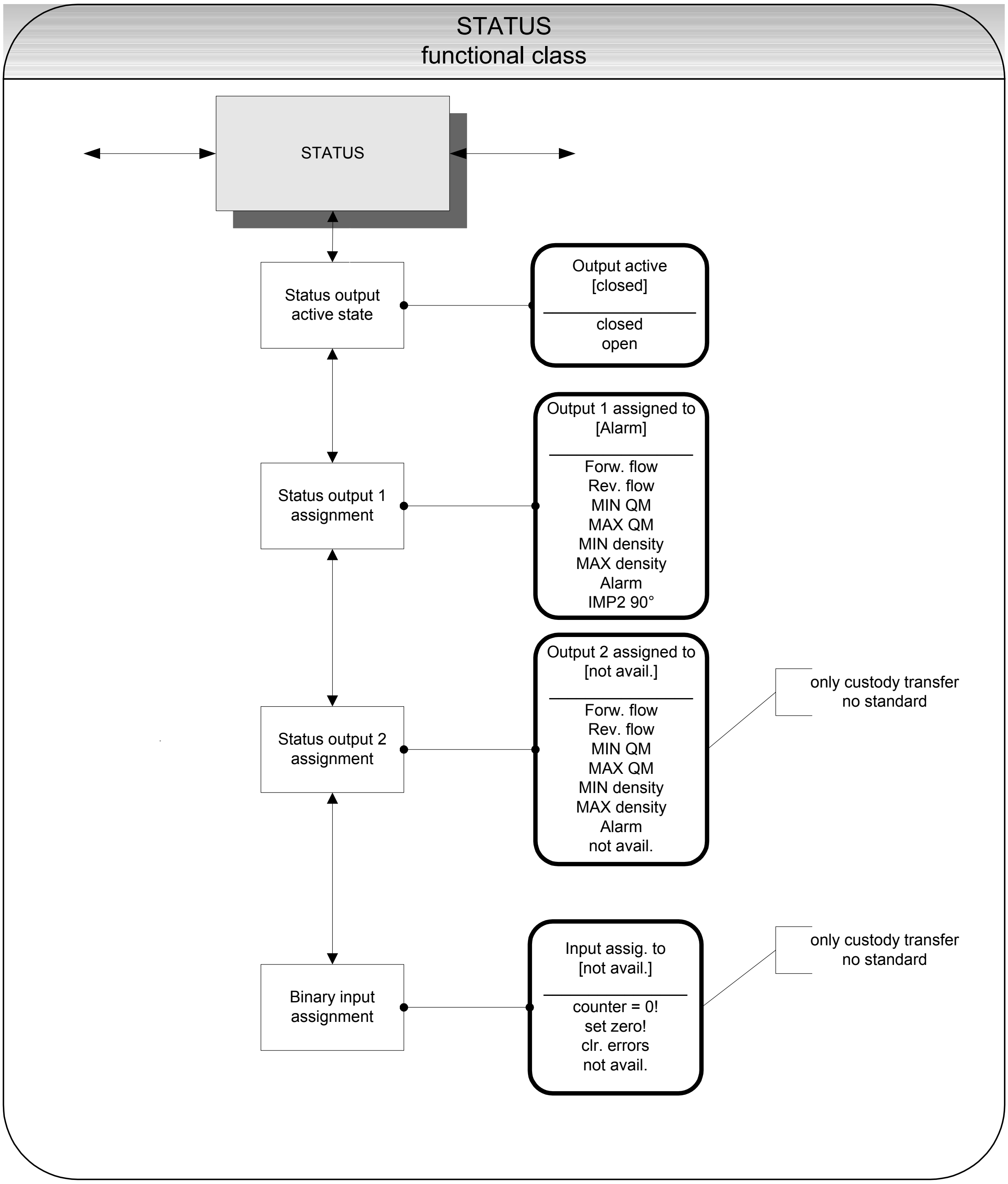
The maximum output frequency can be calculated from the following formula:

$$f = \frac{1}{2 * pulse\ width[ms]} \leq 1000 Hz$$

If connecting to electrical counter relays, we recommend pulse widths greater than 4 ms; for electromechanical counter relays the preset value should be 50 ms.

## 13.9 STATUS functional class

The functional class STATUS is comprised of the functions for setting the status output.



### 13.9.1 Status output active state

The status output can be compared to an electrical relay that can function as make or break contact. For safety-relevant applications, the operator will choose the break contact setting so that a power failure or failure of the electronics can be detected like an alarm. In standard applications, the output is used as make contact.

The *Status output state active state* function allows the operator to define the behavior of the status output.

| Status output active |
| --- |
| [closed] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:

- closed
- open

### 13.9.2 Status output 1 assignment

This function allows the operator to define to which event the status output is to be assigned. The most general assignment is the alarm assignment because all set limiting values and the self-test function are then monitored via the status output.

After selecting the *Status output assignment* function, press ↵ to display the current assignment.

| Output 1 assigned to |
| --- |
| [Alarm] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:

- Flow direction recognition
  - Forward flow
  - Reverse flow
- Limiting values:
  - MIN QM
  - MAX QM
  - MIN density
  - MAX density
- All limiting values and error detection
  - Alarm
- Pulse output 2 for custody transfer operations
  - IMP2 90°,

When selecting the IMP2 90° setting, a second pulse output will be realized via the status output that can be used for custody transfer operations.

### 13.9.3 Status output 2 assignment

Instead of current output 2 there is another status output available for custody transfer operations.
It has the same assignment possibilities as status output 1. However, it cannot be used as pulse output.

After selecting the *Status output assignment* function, press ↵ to display the current assignment.

| Output 2 assigned to<br>[not available] |
|---|

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:

- Standard setting
  - Not available
- Flow direction recognition:
  - Forward flow
  - Reverse flow
- Limiting values
  - MIN QM
  - MAX QM
  - MIN density
  - MAX density
  - Alarm all limiting values and error detection

### 13.9.4 Binary input assignment

For the custody transfer operations version, instead of current output 2 there is an additional input available for connecting an external pushbutton.

This pushbutton is assigned the following functions:

- Pressing the button for a short moment: display test
- Pressing the button for more than 5 seconds: error reset

| Input assigned to<br>[Reset error] |
|---|

The pushbutton may be assigned other functions for non-custody transfer operations. After selecting the Input is released function, press ↵ to display the current assignment.

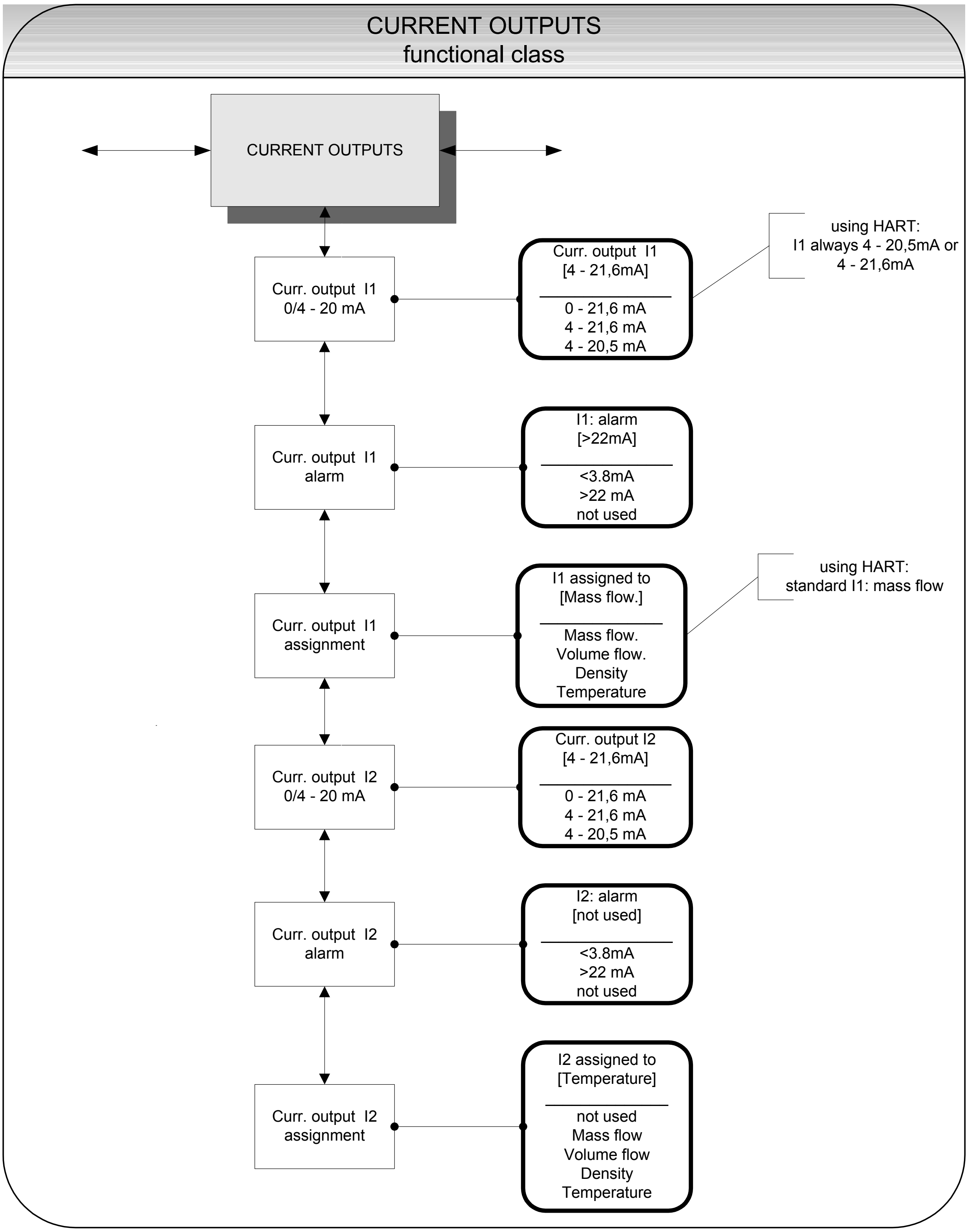
| Input assigned to<br>[Not available] |
|---|

According to the description in Section 12.4.3.1 Selection window/make a selection, one of the following assignments can be selected:

- Standard setting:
  - Not available
- Others:
  - Counters = 0, i.e. reset counters to zero.
  - Zero point, i.e. carry out zero point calibration
  - Reset error, i.e. acknowledge error messages

## 13.10 CURRENT OUTPUTS functional class

The CURRENT OUTPUT functional class allows the operator to perform the settings for the current outputs of the transmitter.



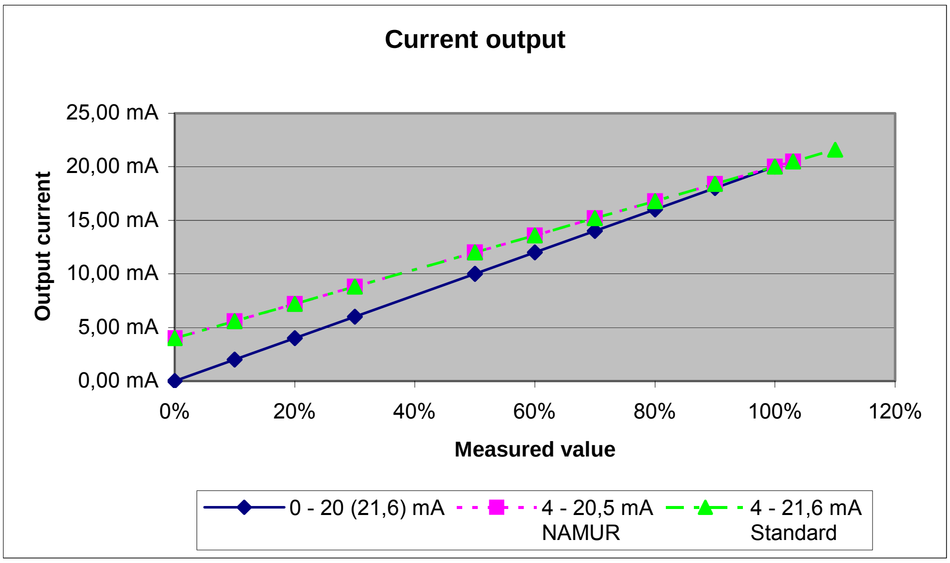
### 13.10.1 Current output I1 0/4 to 20 mA

The *Current output I1 0/4 to 20 mA* function allows the operator to define the range in which the current output is to be operated. Within the range from 0 to 21.6 mA (= 0 ... 110 %) HART® communication is not possible. The range from 4 to 20.5 mA follows the NAMUR recommendation and covers the range from 0 to 104 % of the measuring range. The standard range from 4 to 21.6 mA allows for a control of the measuring range of up to 110 %.

Press ↵ to display the current setting.

| Current output I1 |
|---|
| [4] – 21.6 mA |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:




### 13.10.2 Current output I1 alarm

This function allows the operator to define the state taken on by the current output when a state of alarm is detected. This information can be analyzed in the control system. Press ↵ to display the current setting:

| I1 : alarm |
|---|
| [>22mA] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:

- not used — no alarm function
- > 22 mA — current rise in the case of an alarm
- < 3.8 mA — current reduction in the case of an alarm

### 13.10.3 Current output I1 assignment

This function allows the operator to define the measured value to be output as an analog signal via current output I1. When devices with HART® communication capabilities are used, current output I1 is usually assigned to mass flow. Press ↵ to display the current setting.

| |
|---|
| I1 assigned to |
| [Mass flow] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:

- Mass flow
- Volume flow
- Density
- Temperature

#### 13.10.4 Current output I2 0/4 to 20 mA

The *Current output I2 0/4 to 20 mA* function allows the operator to define the range in which the current output is to be operated. The range from 4 to 20.5 mA follows the NAMUR recommendation and covers the range from 0 to 104 % of the measuring range. The standard range from 4 to 21.6 mA allows for a control of the measuring range of up to 110 %.

Press ↵ to display the current setting.

| |
|---|
| Current output I2 |
| [4] – 21.6 mA |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:

### 13.10.5 Current output I2 alarm

This function allows the operator to define the state taken on by the current output when a state of alarm is detected. This information can be analyzed in the control system. Press ↵ to display the current setting.

| I2 : alarm |
|---|
| [not used] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:

- not used — no alarm function
- > 22 mA — current rise in the case of an alarm
- < 3.8 mA — current reduction in the case of an alarm

### 13.10.6 Current output I2 assignment

This function allows the operator to define the measured value to be output as an analog signal via current output I2. Press ↵ to display the current setting.

| I2 assigned to |
|---|
| [Temperature] |

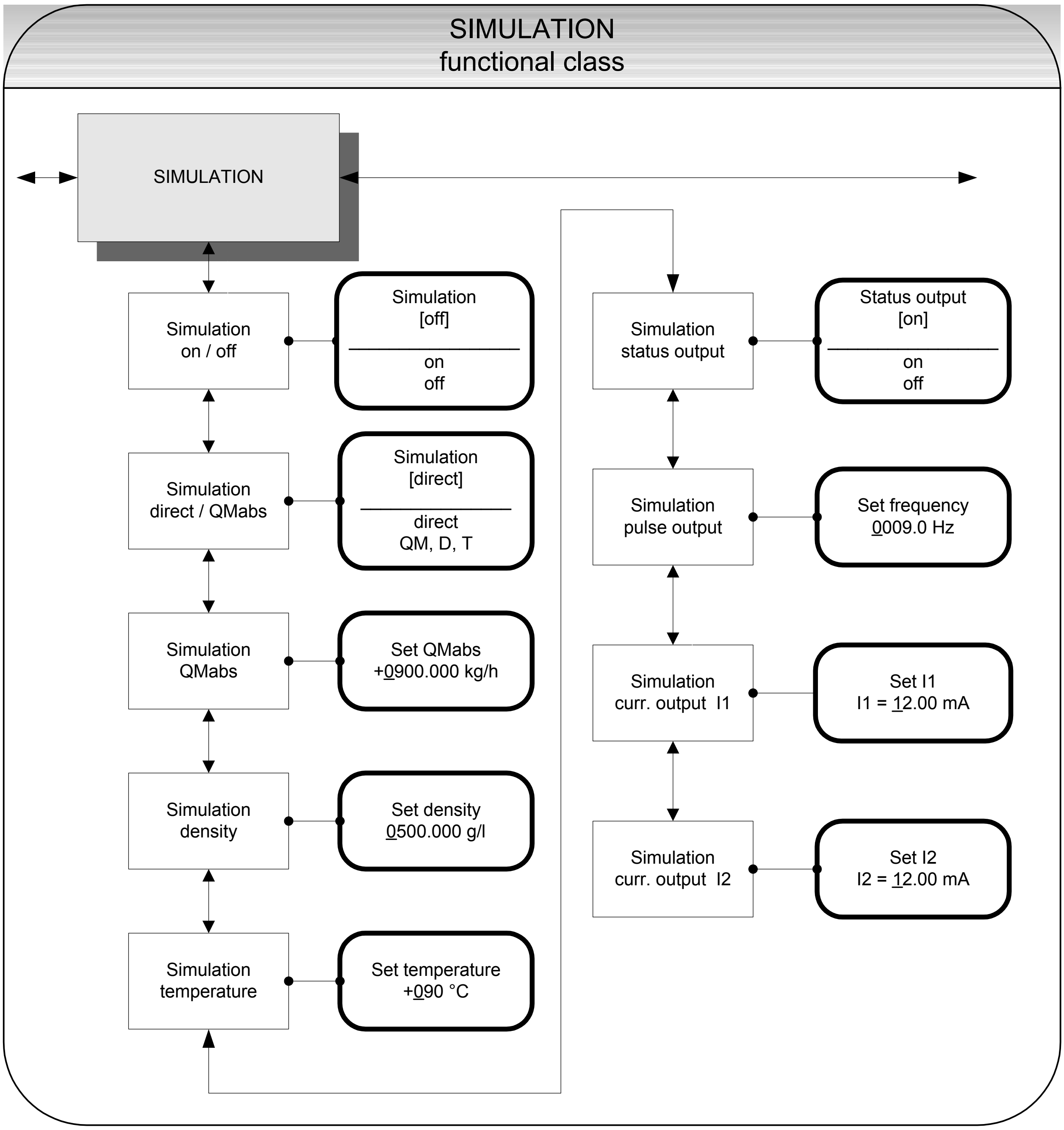
As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:

- Mass flow
- Volume flow
- Density
- Temperature
- not available (in this case the vendor setting must <u>not</u> be changed)

### 13.11 SIMULATION functional class

The functional class SIMULATION is comprised of the functions for simulating the outputs. If simulation is activated, all output signals will be generated based on the selected type of simulation. The peripherals connected to the device can be tested without a flowing product.

Simulation will be deactivated automatically if the operator switched the device off or did not touch any control unit keys for about 10 minutes. Simulation can also be activated and controlled via HART® commands.



### 13.11.1 Simulation on/off

The *Simulation on/off* function allows the operator to activate or deactivate simulation. If simulation is activated, all output signals will be generated based on the selected type of simulation. The peripherals connected to the device can be tested without a flowing product. Press ↵ to display the current status.

| Simulation |
|---|
| [off] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator toggle between the “on” and “off.”

Simulation will be deactivated automatically if the operator switched the device off or did not touch any control unit keys for about 10 minutes.

### 13.11.2 Direct simulation

This function allows the operator to define whether simulation is comprised of the measurement of the three physical values mass flow, density and temperature or whether the outputs will be set directly. Press ↵ to display the selected type of simulation.

| Simulation |
|---|
| [direct] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can choose between the following settings:

- Direct pulse and current outputs are programmed directly
- QM, D, T a measurement is simulated

If “direct” simulation is activated, any output will perform based on the settings described in Sections 13.11.4.1 Status output simulation to 13.11.4.4 Simulation current output I2. It is therefore recommended that the settings be defined before starting simulation. They can then be purposefully changed during simulation.

The status of the outputs during measured value simulation based on the setting “QM, D, T” depends on the selected simulation values of these three variables, the measuring range settings and the assignment of the outputs. If, for example, the pulse output is assigned to volume measurement, it will be affected by all three simulation values at the same time [V ≈ QM (T) / D (T)].

Simulation will be deactivated automatically if the operator switched the device off or did not touch any control unit keys for about 10 minutes.

### 13.11.3 Measured value simulation

If the operator selected the setting “QM, D, T” described in Section 13.11.2 on page 92, the following three possible settings will affect the output behavior during measured value simulation, where all measured values are simulated at the same time.

#### 13.11.3.1 Simulation mass flow QM abs

In order to simulate mass flow, the operator can define a “measured value.” The flow rates will be simulated in both directions. All outputs will perform based on the simulated measured value.

| Set QM abs |
|---|
| ±0900.0 kg/h |

The simulation value is entered as described in Section 12.4.3.2 Input window/modify a value.

#### 13.11.3.2 Density simulation

In order to simulate density/volume measurement, the operator can define a “density measured value.” If volume measurement is assigned to an output, it will change depending on mass flow and density simulation. All outputs will perform based on the simulated measured value.

| Set density |
|---|
| 0500.0 g/l |

The simulation value is entered as described in Section 12.4.3.2 Input window/modify a value.

#### 13.11.3.3 Temperature measurement simulation

In order to simulate a temperature, the operator can define a “measured value.” All outputs will perform based on the simulated measured value.

| Set temperature |
|---|
| +090 °C |

The simulation value is entered as described in Section 12.4.3.2 Input window/modify a value.

### 13.11.4 Direct simulation of outputs

If the operator selected the setting “Direct simulation” described in Section 13.11.2 Direct simulation on page 92, the following four possible settings will affect the output behavior during measured value simulation, where all measured values are simulated at the same time.

#### 13.11.4.1 Status output simulation

The *Status output simulation* function allows the operator to purposefully activate the status output. Press ↵ to display the current state.

| Status output |
|---|
| [off] |

As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can toggle between “on” and “off.”

#### 13.11.4.2 Pulse output simulation

The *Pulse output simulation* function allows the operator to define a frequency to be assigned to the pulse output. After selecting this function and pressing ↵, the following selection field will be displayed:

| Set frequency |
|---|
| 0210.0 Hz |

This field shows the current frequency. As mentioned in Section 12.4.3.2 Input window/modify a value, the definable frequency ranges from 6 Hz to 1100 Hz.

#### 13.11.4.3 Simulation current output I1

This function allows the operator to define a current for current interface 1. Press ↵ to display the set current.

| Set I1 |
|---|
| I1 = 10.50 mA |

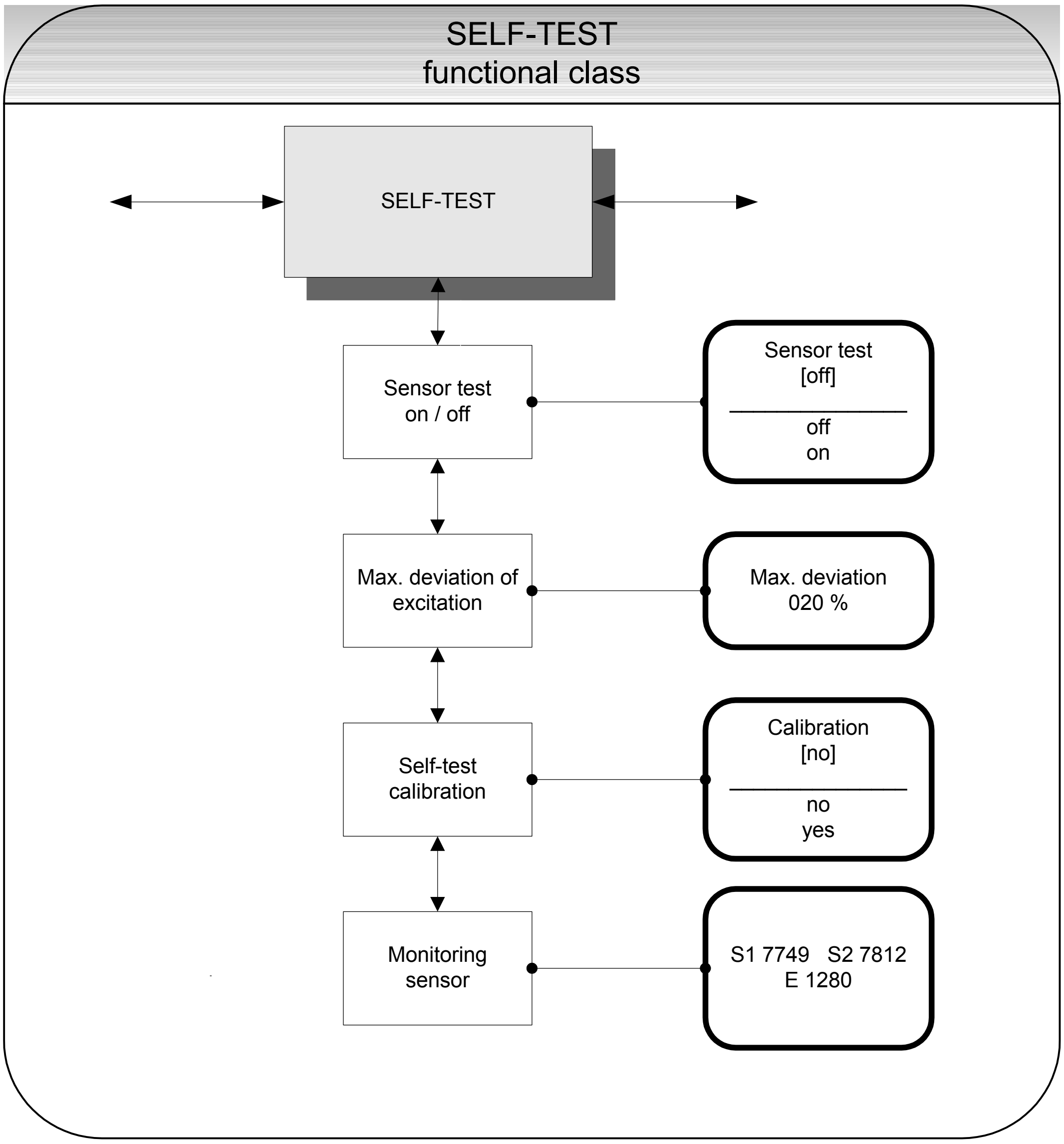
As mentioned in Section 12.4.3.2 Input window/modify a value, the current value can be changed.

#### 13.11.4.4 Simulation current output I2

As described in Section 13.11.4.3, current output 2 can also be configurated.

### 13.12 SELF-TEST function class

The SELF-TEST function class is comprised of the functions relating to the self-test of the sensor. The diagnostic functions of the transmitter, which monitor the proper functioning of the electronics and the software, are always active and cannot be switched off. The excitation current can be monitored in addition.




The excitation current of each sensor in the system individually depends on the sensor itself, the fluid and the installation conditions. If the excitation currents changes while the fluid remains the same, conclusions may be drawn for e.g. potential wear and tear, viscosity changes or air bubbles. The operator has the possibility of defining a “normal state” (“Self-test calibration”) and setting the limit for a permissible deviation. This function is deactivated in the device when delivered.

### 13.12.1 Sensor test on/off

The *Sensor test on/off* function allows the operator to activate or deactivate the monitoring function of the excitation current.

| Sensor test<br>[off] |
|---|

According to the description in Section 12.4.3.1 Selection window/make a selection, the operator can toggle between “on” and “off.” The standard factory setting is “off.”

### 13.12.2 Max. deviation of excitation

This function allows the operator to define a limiting value in the form of a percentage deviation from the normal value. The excitation current is electronically limited to 50 mA (display value 500) and may take on larger values for only a limited period of time (transient reactions).

| Max. deviation<br>020 % |
|---|

The current limiting value is displayed. As mentioned in Section 12.4.3.2 Input window/modify a value, the value can be changed taking into account permissible fluctuations.

### 13.12.3 Self-test calibration

Since the quantity of the excitation current does not only depend on the sensor itself but also on the installation conditions and the viscosity and density of the fluid, the normal value can only be calculated on site during operation using the *Self-test calibration* function.

| Calibration<br>[no] |
|---|

If the operator toggles to [yes] according to the description in Section 12.4.3.1 Selection window/make a selection, the normal value will be calculated automatically. No additional information is needed for this function.

### 13.12.4 Monitoring of sensor amplitude and excitation current

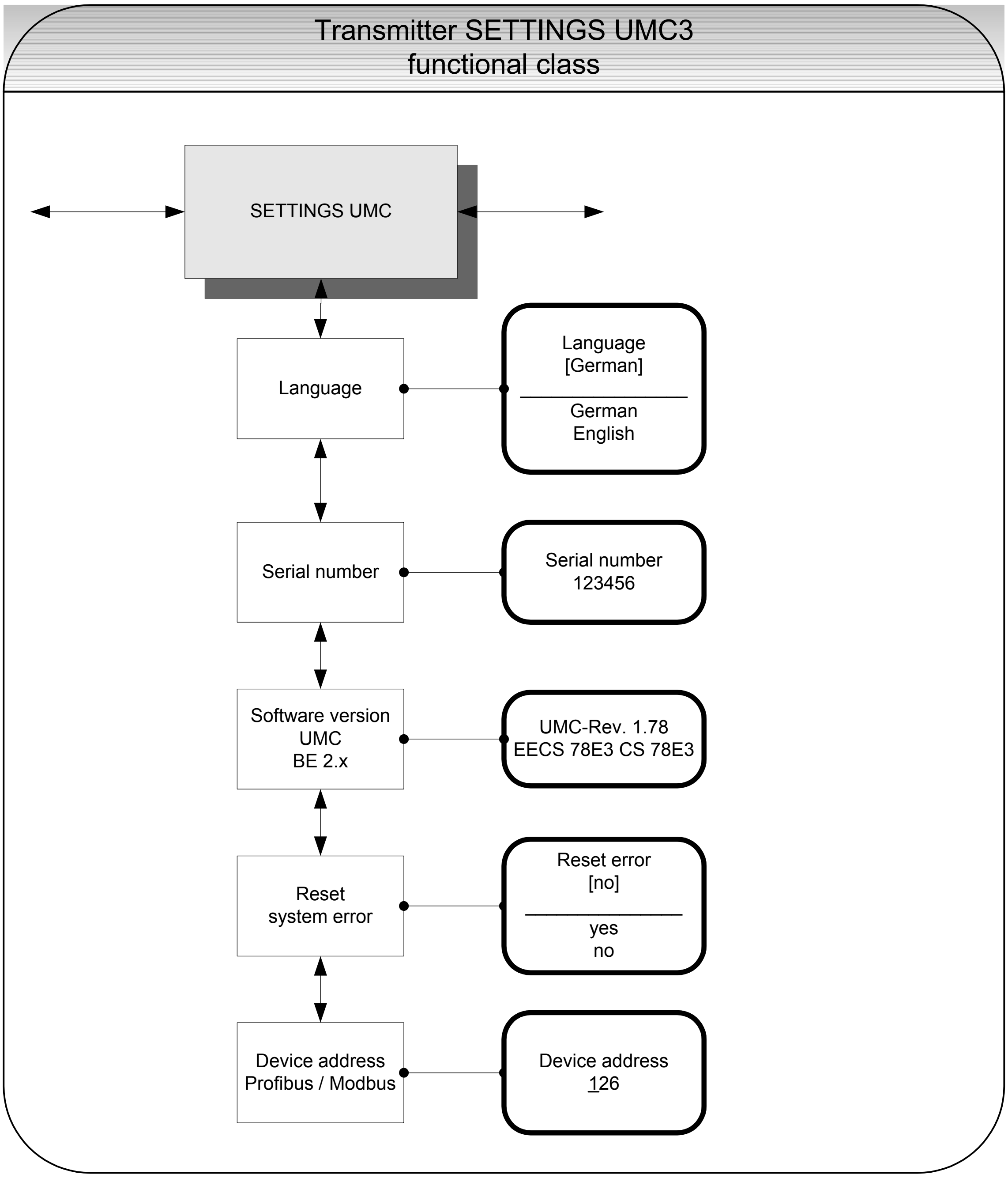
This first line of this window contains the amplitudes of the sensor signals S1 and S2 in 10 µV. Both values should be close to each other or identical (ideal case). The second line shows the excitation current in 10 µA units.

| S1 7749 S2 7812<br>E 1280 |
|---|

Example: The sensors have an amplitude of 77.49 mV and 78.12 mV. The excitation current is 12.8 mA.

## 13.13 UMC TRANSMITTER SETTINGS functional class

This functional class is comprised of the general settings (e.g. language) affecting the behavior of the transmitter.



### 13.13.1 Language

Two languages are available in the control unit BE2: English and German. As mentioned in Section 12.4.3.1 Selection window/make a selection, the operator can toggle between these languages.

| |
|---|
| Language |
| [English] |

Other languages such as French, Italian or Spanish will be available in a special version of the control unit BE2.

### 13.13.2 Serial number

With the help of the *Serial number* function, the transmitter is assigned to an order. This number provides access to internal vendor data if the device needs servicing. The serial number is printed on the rating plate of the transmitter. After selecting this function, press ↵ to display the following information field:

| |
|---|
| Serial number: |
| 100683 |

This entry should never be changed so as to ensure that the sensor, the transmitter and the documents created within quality management are assigned correctly.

### 13.13.3 Software version

When the function *Software version* is displayed, the software version of the control unit BE will be shown. Example: Version 2.0:

| |
|---|
| UMC Software |
| Version BE 2.0 |

After selecting this function, the version of the transmitter software will be shown (example: 1.78).

| |
|---|
| UMC Rev.: 1.78 |
| EECS 78E3   CS 78E3 |

The second line contains the hexadecimal checksum that was calculated via the program storage created during program development and the microcontroller checksum of the same storage. Both checksums must be identical, when the program storage has not been damaged.

### 13.13.4 Reset system error

The integrated diagnostic system of the CT transmitter distinguishes between two types of errors (see also Section 15 CT transmitter error messages). Self-test errors such as problems with a sensor line or inconsistent parameter inputs are displayed as textual error messages. Once the error has been eliminated, the message automatically disappears from the display. For further information, see Section 15.3.1 Display of self-test errors.

Errors that are attributable to system memory or software, division by zero, or a fault in the electronics unit are designated as system errors. These error messages are not reset automatically after the error (usually of very brief duration) is eliminated. **Before resetting a system error manually, we advise that you contact our technical service department.** For further information, see Section 15.3.1 Display of self-test errors.

| Reset error |
|---|
| [no] |

If the operator toggles to [yes] and confirms the action according to the description in Section 12.4.3.1 Selection window/make a selection, the error messages disappears from the display. If the message reappears shortly after, do contact our technical service department.

### 13.13.5 Profibus/Modbus device address

Before connecting fieldbus devices to a bus system, the operator must define a device address. This address is a unique assignment to a participant device in a bus system (similar to a street number).

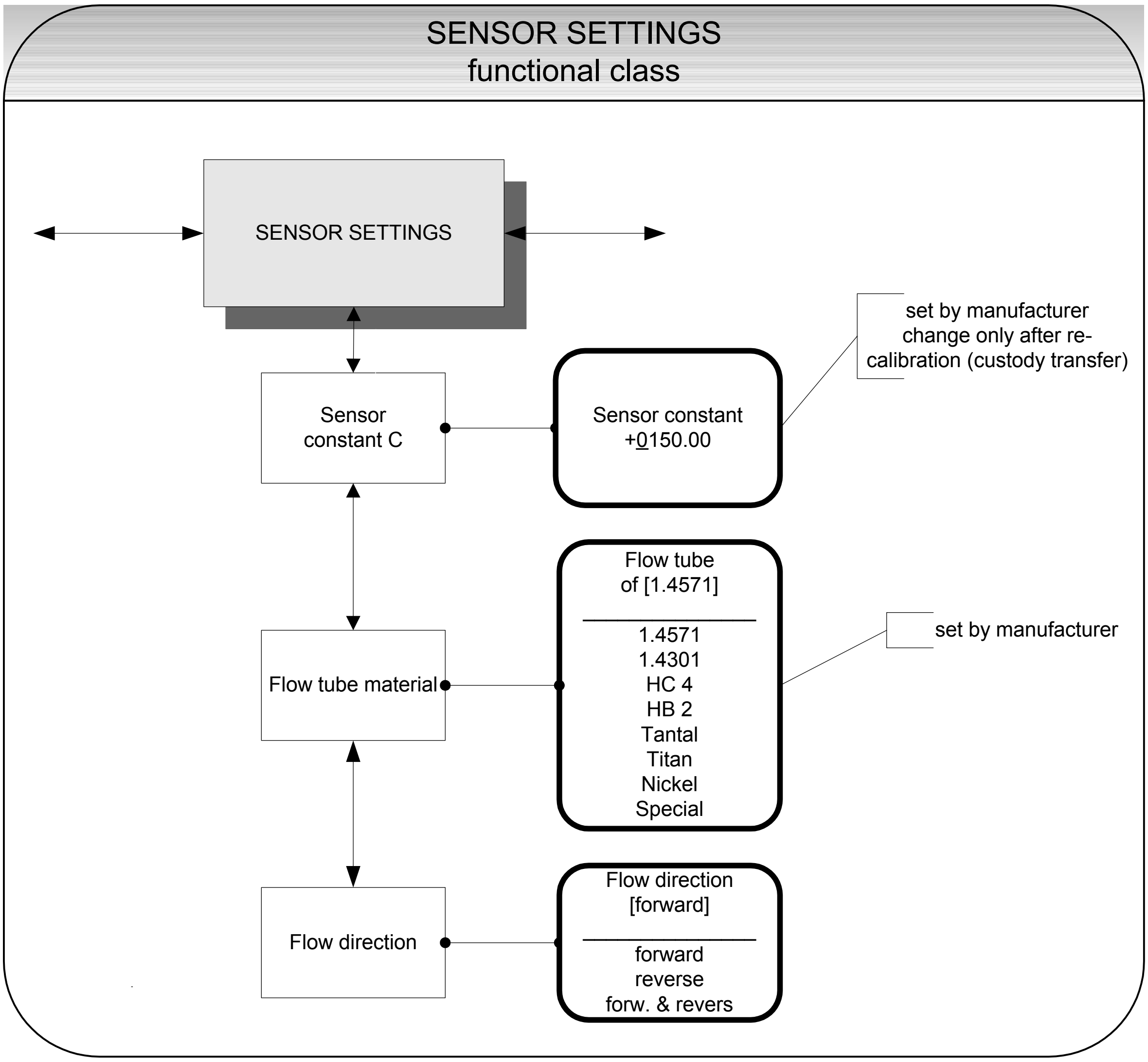
After selecting the *Profibus/Modbus device address*, press ↵ to display the set address:

| Device address |
|---|
| 126 |

As mentioned in Section 12.4.3.2 Input window/modify a value, the operator can change the displayed value. After setting the new device address, press ↵ to confirm and apply the change.

## 13.14 SENSOR SETTINGS functional class

The SENSOR SETTINGS functional class is comprised of the settings regarding the mass flow sensor.




### 13.14.1 Sensor constant C

Sensor constant C is the sensor calibration value for mass flow. This constant is defined when the flow-meter is calibrated at the factory and can be found on the rating plate.

| Sensor constant |
| --- |
| +0150.00 kg/h |

**CAUTION:**
Changing sensor constant C to a value that differs from the value on the rating plate of the sensor connected to the flowmeter will result in false readings.

Normally, the sensor constant is changed only when the device is calibrated, e.g. for a validation measurement for a custody transfer operation.

**Note:**
The sensor constant must always be preceded by a plus or minus sign. The delivery default setting is a plus sign. If inlet and outlet section are interchanged when the device is installed (the flow direction is indicated by an arrow on the sensor), the transmitter will display a “forward flow” negative measurement value. If the (plus or minus) sign of the sensor constant is then changed without changing the actual value, a plus sign will again be displayed. No changes need be made in the disposition of the electrical connections (wires).

### 13.14.2 Sensor material

The *Sensor material* function allows the flow tube material code to be entered. This material code can be found on the sensor rating plate. This setting is defined by the vendor when the device is first put into operation at the factory.

| Flow tube material |
|---|
| [1.4571] |

This field is for the operator’s information only.

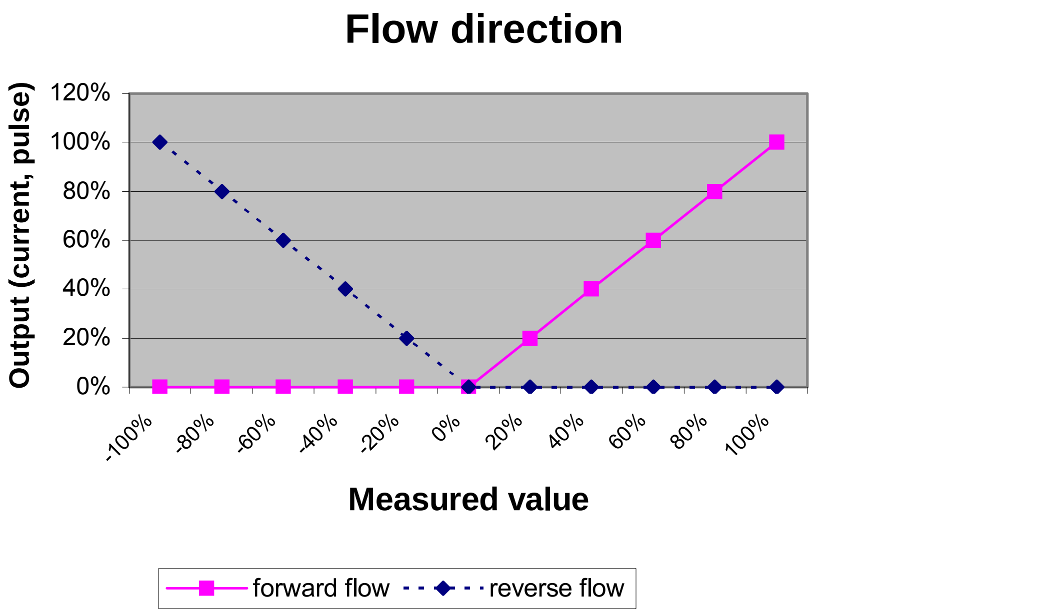
### 13.14.3 Flow direction

This function allows the operator to define the flow direction that the transmitter will evaluate. Only “forward” should be selected so as to prevent reverse flow from being measured. The standard factory setting is “forward & reverse.” After selecting the *Flow direction* function, press ↵ to display the current setting.

| Flow direction |
|---|
| [forward] |

As mentioned in Section 12.4.3.1 Selection window/make a selection the operator can choose between:

- forward
- reverse
- forward & reverse



# 14. Use of the CT for custody transfer operations

The CT functions are basically the same in *Standard mode* and *Custody transfer mode*. In both modes, the various CT security mechanisms are activated in compliance with international standards for custody transfer operations OIML R 105 and DIN 19217. However, the following additional factors come into play for custody transfer procedures.

## 14.1 Programming the transmitter

If the device is to be verified at a later time, the settings in the following table should be used:

| Settings | Definable options | Required for custody transfer |
|---|---|---|
| Binary output 1 | • Pulse<br>• Frequency | • Pulse |
| Binary output 2 | • 90°<br>• Status | • 90° |
| Binary input | • Clearing errors<br>• Resetting totals<br>• Zero point | • Clearing errors |
| Status<br>Active state | • “active” ON<br>• “active” OFF | • “active” OFF |
| Status output | • Forward flow<br>• Reverse flow<br>• Limiting values<br>• Alarm | • Alarm |
| Counter | • Units for mass flow rate<br>• Units for volume flow rate | • Units for mass flow rate |
| Pulse units | • Units for mass flow rate<br>• Units for volume flow rate | • Units for mass flow rate |

## 14.2 Binary input (resetter)

A pushbutton is connected to the binary input. To switch the counter display to a higher level of accuracy, hold this pushbutton down for less than 3 seconds and then release it. After about 1 minute, the display will automatically revert to the standard status. For better readability, the count display is “frozen” during this process.

To delete an error message and start the display test sequence, hold the pushbutton down for at least 5 seconds. During the display test, all digits (0 to 9) will be displayed at each of the 16 positions on each line of the display. This allows for detection of any defect in, damage to, or tampering with the display.
.

## 14.3 Self-test error

When the device is in Custody transfer mode, a self-test error message will remain on the display until it is cleared by pressing the external resetter pushbutton.

For further information regarding error messages, see Section 15 CT transmitter error messages.

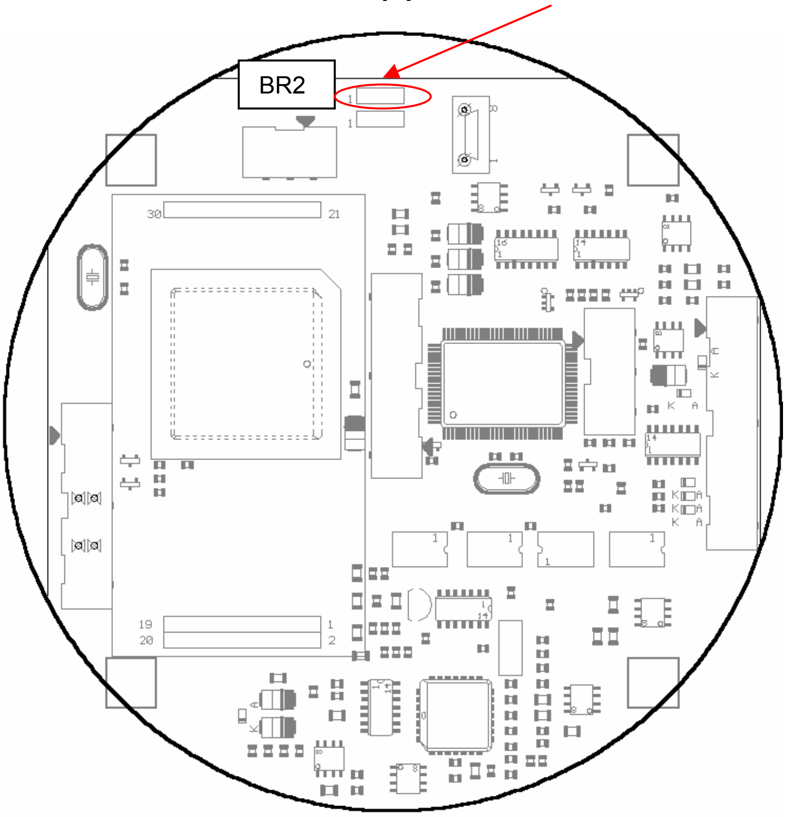
## 14.4 Verification stamp/stamp position

The transmitter will operate like a standard transmitter as long as no verification stamp has been affixed to it. This means that all settings that are allowable for customers are accessible, including on-site calibration. Once the verification stamp has been affixed to the transmitter (closing a jumper in the electronics compartment on the CPU printed board of the UMC3-30), no settings can be changed. After the verification stamp has been affixed, the SG1 housing is screwed on and sealed with leads.

**Stamp position**

The UMC3-30 printed board in the electronics compartment (SG1 housing) contains a jumper that indicates that the device is in Custody transfer mode. Once this jumper has been closed, no settings can be changed and the CT operates in Custody transfer mode.

**CT stamp position**




## 14.5 HART® communication in Custody transfer mode

Measured values can be transmitted and parameters can be read without restriction when the device is in Custody transfer mode. However, any attempt to change settings will be denied, which of course means that counts cannot be changed either.

# 15. CT transmitter error messages

The integrated CT transmitter distinguishes between two types of errors. Self-test errors such as problems with a sensor line or inconsistent parameter inputs are displayed as text error messages. Once the error has been eliminated, the message automatically disappears from the display. For further information, see Section 15.3.1 Display of self-test errors.

Errors that are attributable to system memory or software, division by zero, or a fault in the electronics unit are designated as system errors. These error messages are not reset automatically after the error (usually of very brief duration) is eliminated. **Before resetting a system error manually, we advise that you contact our technical service department.** For further information, see Section 15.3.2 Display of system error."

If the cause of any of the error messages described below cannot be eliminated, contact the device vendor.

## 15.1 Standard operating mode

The transmitter operates as described above. After the cause of the error message has been eliminated, the message automatically disappears. The self-test for monitoring the excitation current can be activated or deactivated via the "Sensor test" function.

## 15.2 Custody transfer mode

When the device is in Custody transfer mode, any error will remain on the display until it is cleared by pressing the external reset pushbutton.

## 15.3 List of error messages

### 15.3.1 Display of self-test errors

Self-test errors are displayed as plain text in the set language (English or German) on the second line of the LCD.

| Display (English) | Display (German) | Description | Possible cause of error and remedy |
|---|---|---|---|
| empty pipe | Rohr leer | Empty-pipe detection has been activated.<br>Fluid density is below the limit value for density; empty-pipe detection, pipe is empty. | Product contains air bubbles/pipe is empty. Bubble-free filling must be ensured. |
| Power fail? | Netzausfall? | Will detect the interruption of the supply voltage for transmitters approved for custody transfer operation if the flow rate is > 0.5 % of upper-range value. | Check power supply |
| malfunction T | Bruch/Schluß T | Interruption/short circuit in the temperature sensor measuring circuit | Check the lines between temperature sensor and transmitter.<br>Measure resistance of PT100 |

| Display (English) | Display (German) | Description | Possible cause of error and remedy |
|---|---|---|---|
| malfunction S1 | Bruch/Schluß S1 | Interruption/short circuit in the connection of sensor coil 1 | Check the lines between sensor coil and transmitter. Measure coil resistance. |
| malfunction S2 | Bruch/Schluß S2 | Interruption/short circuit in the connection of sensor coil 2 | Check the lines between sensor coil and transmitter. Measure coil resistance. |
| exc. too large | Erreger zu groß | A excitation current exceeding the limit will be detected. | Asymmetric filling of the flow tubes, air bubbles when measuring liquids or:<br>condensate in the flow tube when measuring vapor or gases<br>Electrical cause:<br>Check the lines between excitation coil and transmitter. Check for bonding. Check the excitation coil and the magnet. |
| exc. too small | Erreger zu klein | A excitation current exceeding the limit will be detected in the case of transmitters approved for custody transfer operations. | Check the lines between excitation coil and transmitter. |
| meas. circ. sat. | Messkreis überst. | The instrument transformer for phase metering is overloaded. The measured phase displacement is too large. | Mass flow rate is too high. |
| QM > 110 % | QM > 110 % | The mass flow rate exceeds the set upper-range value for the flow rate by more that 10 %. | Reduce the flow rate and adjust the measuring range if necessary. |
| curr. 1 saturated | Strom1 Überst. | The output of current interface 1 is overloaded. Based on the selected settings and the currently assigned measured variable, the current to be output is > 21.6 mA. | Check the upper-range value and the flow rate settings. |
| curr. 2 saturated | Strom2 Überst. | The output of current interface 2 is overloaded. Based on the selected settings and the currently assigned measured variable, the current to be output is > 21.6 mA. | Check the upper-range value and the flow rate settings. |
| pulse out satur. | IMP übersteuert! | The pulse output is overloaded. The current measured value requires a pulse rate, which can no longer be generated with the help of the set pulse duration and pulse value. | Check pulse duration, pulse value, and measuring range.<br>Check the flow rate. |
| Temperature > | Temperatur>MAX | The measured temperature exceeds the set upper-range value | Product temperature is too high; adjust the temperature range |

| Display (English) | Display (German) | Description | Possible cause of error and remedy |
|---|---|---|---|
| MAX | | for temperature. | and the limit values if necessary. |
| Temperature < MIN | Temperatur<MIN | The measured temperature is below the set lower-range value for temperature. | Product temperature is too low; adjust the temperature range and the limit values if necessary. |
| params inconsist | Parameter inkons. | Parameter is inconsistent. | Check the parameter settings.<br>The set parameters are contra-dictory.<br>Example: Upper-range value, pulse value and pulse duration must be matched in such a way that the combination fits for all measured values. |
| missing EEPROM | ext EEPROM fehlt | The data memory module (DSB) with the calibration data of the sensor and the customer-specific settings of the transmitter is not plugged-in. | Insert the data storage module (DSB/UMF33) in the correspond-ing receptacle on the CPU printed board UMC-30. |
| wrong EEPROM | falsches EEPROM | EEPROM of a former model (e.g. UMC2 or UMF) has been plugged-in as memory module. | |
| internal communi-cation faulty | interne Kommunika-tion gestört | Communication between control unit and transmitter is faulty. | Contact the device ven-dor/customer service depart-ment. |

**Information:**

**Error message: “Parameter is inconsistent” (system error 0x0400)?**

To generate a list of the inconsistencies, first enter a valid password and then an inva-lid password. The control unit will show a list of current errors (only once). The opera-tor can then correct the inconsistent settings after entering a valid password.

### 15.3.2 Display of system error

System errors consist of the message text “system error” and a 5-digit number in hexadecimal code. The meaning of the individual error codes is described in the following table. If several errors occur at the same time, the hexadecimal sum of the individual errors will be displayed. The errors are coded in such a way that the individual errors can be easily identified. The sums are unique.

| Descriptor label (never displayed) | Descriptor label (never displayed) | Constant/ display | Description |
|---|---|---|---|
| System failure Div0 | SystemfehlerDiv0 | 0x00001 | Arithmetical error/division by zero |
| System failure IntEEProm | SystemfehlerIntEEProm | 0x00002 | Transmitter data checksum is faulty; reinitialization is necessary. |
| | SystemfehlerPruefsumme | 0x00004 | Sensor data checksum is faulty. |
| | SystemfehlerLeeresEEPROM | 0x00008 | Ext. EEPROM is present but empty (no content). |
| | SystemfehlerEEPROM | 0x00010 | Value could not be stored/read out. |
| System failure Phase | SystemfehlerPhase | 0x00020 | Phase measurement/mass flow is faulty. |
| System failure frequency | SystemfehlerFrequenz | 0x00040 | Frequency measurement/density measurement is faulty. |
| System failure DSP Version | Systemfehler DSP Version | 0x00080 | DSP firmware is outdated (not adjusted to the transmitter operating system) |
| | SystemfehlerZeitkonstante | 0x00100 | Initialization of time constants failed. |
| | SystemfehlerMesswert | 0x00200 | Faulty calculation of measured value |
| System failure Parameter | SystemfehlerParameter | 0x00400 | Settings are inconsistent. |
| | SystemfehlerRAMPrüfsumme | 0x00800 | Defective main memory, inconsistent checksum (custody transfer operation) |
| | SystemfehlerFlashPrüfsumme | 0x01000 | Defective program memory, inconsistent checksum |

| | | | |
|---|---|---|---|
| | SystemfehlerZähler | 0x04000 | Custody transfer operation: count differs from corresponding back-up copy |
| | SystemfehlerWDG | 0x08000 | Internal watchdog: time limit has been exceeded. |
| | SystemfehlerSchreibfehler | 0x10000 | Defective memory location in the main memory |
| | SystemfehlerDSPKommu | 0x20000 | Faulty communication between DSP and microcontroller, no processing of measured values |

## 16. Certificates and approvals

| | |
|---|---|
| CE marking: | The measuring system complies with the legal requirements of the Electromagnetic Compatibility Directive 89/336/EC and the Explosion Protection Directive 94/9/EC.<br>The CE mark indicates that the device complies with the aforementioned directives. |
| Ex approval: | **CT transmitter**:<br>BVS 05 ATEX E 146 X<br>EEx de [ia] IIC / IIB T6 - T3<br>EEx d [ia] IIC / IIB T6 - T3<br><br>Sensor:<br>See Section 3.9 Sensor CMU approvals on page 34. |

## 17. Standards and authorizations

### 17.1 General standards and directives

EN 60529 Ingress protection class (IP code)
EN 61010 Safety requirements for electrical metering, control and laboratory devices
NAMUR guideline NE21, Version 10/02/2004
Explosion Protection Directive 94/9/EEC
OIML R 105 and DIN 19217 (international recommendations for custody transfer operations)

### 17.2 Electromagnetic compatibility

EMC Directive 89/336/EEC
EN 61000-6-2:1999 (immunity for industrial environments)
EN 61000-6-3:2001 (emissions residential environments)
EN 55011:1998+A1:1999 group 1, class B (emitted interference)
DIN EN 61000-4-2 to DIN EN 61000-4-6
DIN EN 61000-4-8
DIN EN 61000-4-11
DIN EN 61000-4-29
DIN EN 61326

### 17.3 Ex-Approval transmitter

Explosion Protection Directive 94/9/EEC
EN 50014 General guidelines
EN 50018 Flameproof enclosures “d”
EN 50019 Increased safety “e”
EN 50020 Intrinsic safety “i”
EN 50284 Group II Category 1G

## 18. Decontamination certificate for device cleaning

Company name: ............................... Address: ..................................

Department: ......................... Name of contact person: ..............................

Phone: ............................

Information pertaining to the enclosed Coriolis flowmeter

Model CM................

was operated using the following fluid:..................................

In as much as this fluid is water-hazardous / toxic / corrosive / combustible / a health hazard / environmentally hazardous

we have done the following:

- Checked all cavities in the device to ensure that they are free of fluid residues*
- Washed and neutralized all cavities in the device*
- Cleaned all seals/gaskets and other components that come into contact with the fluid*
- Cleaned the housings and all surfaces*

*cross out all non-applicable items

We hereby warrant that no health or environmental hazard will arise from any fluid residues on or in the enclosed device.

Date: ............................ Signature ...........................

Stamp

**Version / printed: 12.04.2006 / 12.04.2006**
**Part No 06EN003380 rev 1.6**

FCI Fluid Components International LLC
1755 La Costa meadows Drive
San Marcos, CA 92078
Phone: 1 - 760 – 744 - 6950
Fax: 1 - 760 - 736 - 6250
Internet: www.fluidcomponents.com
E-mail : info@fluidcomponents.com

We reserve the right to make changes without notice in the dimensions, weights and technical specifications.

File:
CMU_CT_BA_01_FCI.DOC

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