

## Data sheet

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Flow sensor FLT-M1\_i2

Version DN02

Rethink Sensing



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## General information on the data sheet

### Usage and storage

- This data sheet is an integral part of the flow sensor.
- Keep the data sheet in the immediate vicinity of the place of use.
- If the flow sensor is passed on to a third party, pass on the data sheet or the relevant contents to the third party along with it.
- Read the data sheet carefully.
- We reserve the right to make changes.

### Function

The data sheet provides information on the safe use and installation of the flow sensor.

## Safety instructions

### Designated use

- The flow sensor is to be used exclusively for flow measurement of liquids and gases within the scope of the product specification.
- Failure to observe the range of application may impair safety. The manufacturer is not liable for damage resulting from improper use.

### Requirements for personnel

The flow sensor may only be installed by qualified personnel.

### Product safety

The flow sensor is intended to act as an electronic component for integration into a device or system. The flow sensor is not a stand-alone measuring device and therefore does not require the CE mark to be affixed.

### Operational reliability

- The system builder or device manufacturer is responsible for safe integration into a system or device.
- The operator is responsible for trouble-free operation of the flow sensor.
- Only operate the flow sensor if it is in perfect technical condition and is performing reliably.
- If the medium temperature is high, ensure that the sensor is protected against accidental contact in order to avoid burns.
- Unauthorized modifications or repairs to the flow sensor are not permitted and can lead to unforeseeable dangers.



## Product specification

### Overview

The FLT-M1 flow sensor has been designed to determine the mass flow of liquids and gases. This is done with a mini Coriolis measuring system with an S-shaped measuring tube and a temperature sensor.

The flow sensor is installed directly in a flow pipe via a manufacturer-specific connection. If medium flows through the flow sensor, the measured value information is generated with the aid of Coriolis forces. The measured values are fed to the higher-level system via an I2C bus or Modbus TTL.

It is possible to take flow measurements for pressure lines up to 100 bar at a measuring rate of 200 Hz (200 measured values per second). Flow changes are recorded with a step response time of 50 ms.

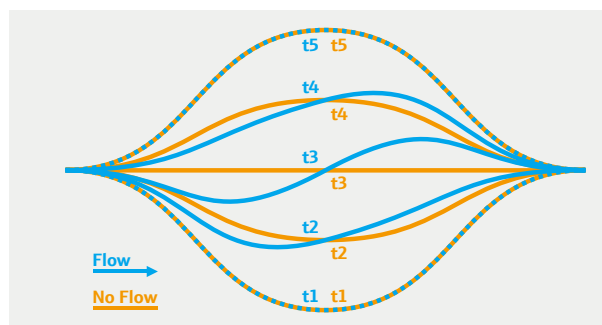
### Mini Coriolis measuring system

The heart of the mini Coriolis measuring system is a vibrating S-shaped measuring tube with a small diameter. Several sensors are located on the measuring tube for vibration generation and sensor signal acquisition purposes; these sensors are arranged in a way that is designed to achieve the best possible results. The temperature at the measuring tube is recorded to com-

pensate for temperature effects. The measuring tube is mounted on a plate which dampens vibrations from the outside. In addition, a compact and hermetically sealed metal housing protects the measuring system from further interference.

### Flow measurement

The mass flow is determined using the Coriolis force. The Coriolis force acts on a liquid flowing through a vibrating tube. In the process, it causes a change in the vibration of the tube. The change in the vibration of the tube is proportional to the mass flow.



*Change in pipe vibration due to Coriolis force*

Two vibration sensors attached to the measuring tube detect the change. These signals are evaluated by the electronics and made available as the mass flow. The

volume flow can also be calculated using the mass flow information and the density calculation.

### Density measurement

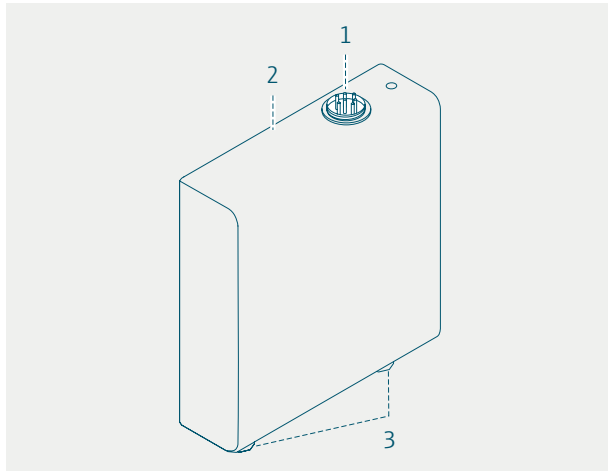
For the density measurement, the flow sensor analyzes the resulting natural frequency of the vibrating, filled measuring tube. The resulting natural frequency of the measuring tube depends on the mass and thus on the density of the medium in the measuring tube: the greater the medium density, the lower the natural frequency. The natural frequency is therefore a function of the medium density.

### Possible applications

The flow sensor can be used in combination with a pump and/or a valve as a mass flow controller.



## Product design



### Product design Flow Sensor FLT-M1

1 Electrical interface: solder pins, 7-pole

2 Hermetically sealed housing

3 Fluid interface: manufacturer-specific connection, DN 2

## Product identification

The flow sensor is identified by a consecutive 11-digit serial number. This is mounted on the outside of the housing.

## Product specification

### General information

<b>Measured values</b>	<ul style="list-style-type: none"> <li>■ Mass flow</li> <li>■ Density</li> <li>■ Temperature</li> </ul>
<b>Units of measurement</b>	Adjustable

### Measurement performance

<b>Max. measurement error*</b>	<ul style="list-style-type: none"> <li>■ Mass flow: <math>\pm 0.10\%</math> o.r.</li> <li>■ Zero-point stability of mass flow: <math>\pm 0.0057</math> kg/h</li> <li>■ Max. deviation of mass flow: <math>\pm 0.10\%</math> or <math>\pm 0.0057</math> kg/h</li> <li>■ Density: <math>\pm 5</math> kg/m<sup>3</sup></li> <li>■ Temperature: <math>\pm 1.0</math> K</li> </ul>
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<b>Repeatability</b>	<ul style="list-style-type: none"> <li>■ Mass flow: <math>\pm 0.05\%</math> o.r.</li> <li>■ Zero-point stability of mass flow: <math>\pm 0.00285</math> kg/h</li> <li>■ Max. deviation of mass flow: <math>\pm 0.05\%</math> or <math>\pm 0.00285</math> kg/h</li> <li>■ Density: <math>\pm 2.5</math> kg/m<sup>3</sup></li> <li>■ Temperature: <math>\pm 0.5</math> K</li> </ul>
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<b>Measuring rate</b>	200 Hz
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<b>Step response time</b>	50 ms
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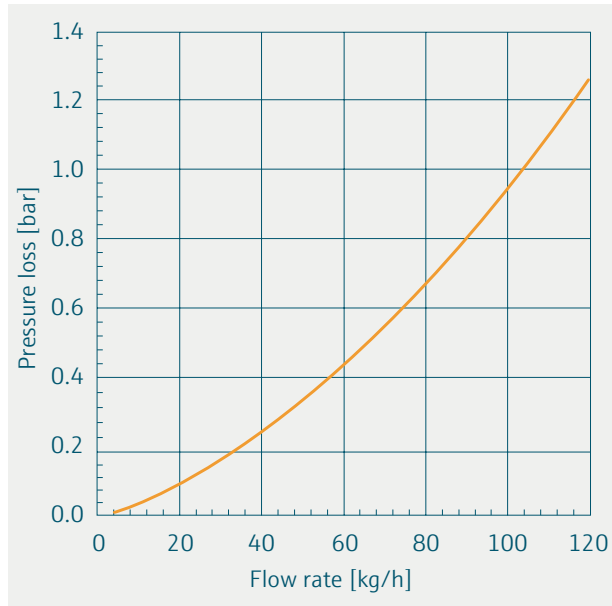
\*Valid under reference condition (see calibration protocol).

### Temperature conditions

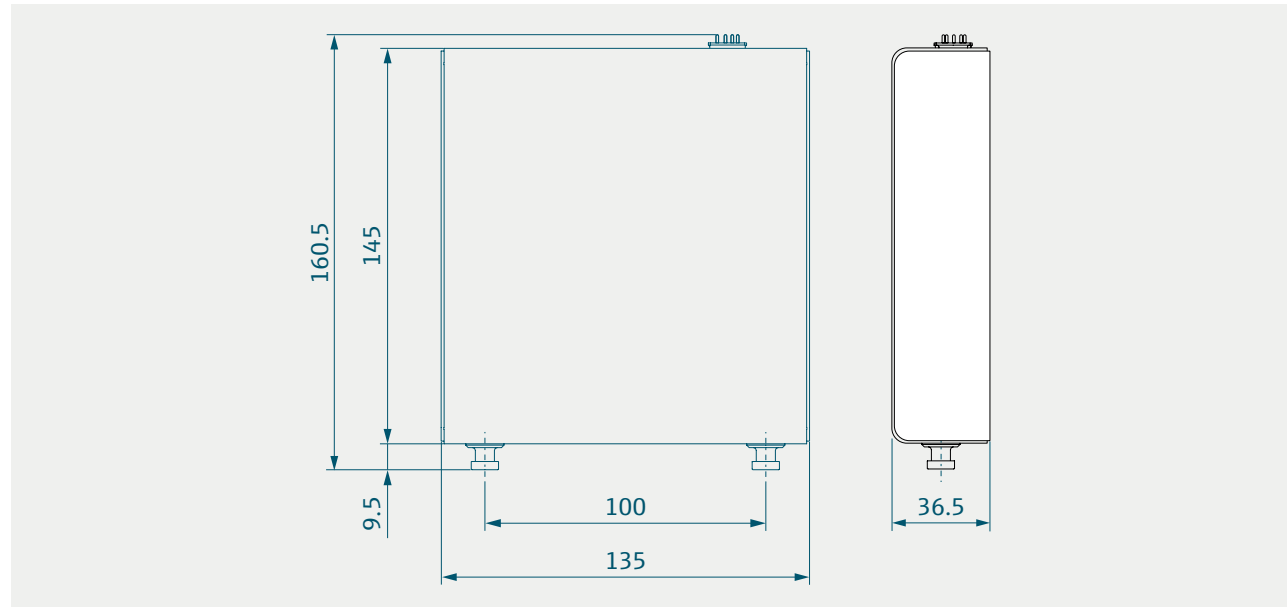
<b>Permitted medium temperature</b>	-10...+70 °C
<b>Permitted ambient temperature</b>	-10...+80 °C
<b>Permitted storage temperature</b>	-20...+85 °C

### Range of application

<b>Recommended flow measuring range</b>	0...120 kg/h Pressure loss as a function of flow rate, see pressure loss curve on page 6.
<b>Permitted medium pressure</b>	Max. 100 bar (rel.)
<b>Inlet and outlet sections</b>	Inlet and outlet distances have no influence on the measuring accuracy.



Pressure loss curve for water



Design, dimensions in mm

### Environmental conditions

<b>Climate class</b>	Not specified
<b>Electromagnetic compatibility</b>	Prepared for EMC 2014/30/EU (EN 61326-1)
<b>Vibration and shock resistance</b>	Prepared for the following standards: <ul style="list-style-type: none"> <li>IEC/EN 60068-2-6</li> <li>IEC/EN 60068-2-27</li> <li>IEC/EN 60068-2-31</li> <li>IEC/EN 60068-2-64</li> </ul>
<b>Degree of protection</b>	Housing is hermetically sealed, IP protection only when installed.

### Dimensions

<b>Dimensions</b>	135 x 36.5 x 145 mm <sup>3</sup>
<b>Weight</b>	2150 g
<b>Inner diameter of measuring tube</b>	2,5 mm

### Materials

<b>Housing</b>	Stainless steel, 1.4301 (304L)
<b>Wetted parts</b>	Stainless steel, 1.4404/1.4435 (316L)

### Electrical interfaces

<b>Connection</b>	Solder pins with 1 mm diameter, 7-pole
<b>Communication</b>	Ordering options: <ul style="list-style-type: none"> <li>I<sup>2</sup>C-Bus</li> <li>Modbus TTL</li> </ul>
<b>Power supply</b>	DC 10...35 V (max. 1 Watt) No galvanic isolation
<b>Connection pin assignment</b>	<p>Top view from outside</p>



Pin	Assignment	Modbus TTL
1	V+	Supply voltage
2	SDA	Modbus Tx
3	SCL	Modbus Rx
4	NC	Modbus T/R
5	CDI-Rx	Serial reception (service interface)
6	CDI-Tx	Serial transmission (service interface)
7	GND	Reference potential for all circuits

## General settings:

<b>Baud rate</b>	19200 BAUD
<b>Data transfer mode</b>	RTU
<b>Data bits</b>	8
<b>Parity</b>	Even
<b>Byte order</b>	1-0-3-2
<b>Stop bits</b>	1 bit
<b>Modbus Slave Address</b>	247
<b>Transmission type</b>	Modbus RTU (Protokoll)
<b>Temperature unit</b>	°C
<b>Pressure unit</b>	bar

<b>Density unit</b>	kg/l
<b>Mass flow unit</b>	kg/h
<b>Mass unit</b>	kg
<b>Volume flow unit</b>	l/h
<b>Volume unit</b>	m <sup>3</sup>
<b>Flow damping</b>	0 [s]
<b>Temperature damping</b>	0 [s]
<b>Pressure damping</b>	0 [s]
<b>Density damping</b>	0 [s]
<b>Reference temperature unit</b>	°C
<b>Reference temperature</b>	0 [°C]
<b>Reference pressure unit</b>	bar
<b>Reference pressure</b>	1.01325 [bar]
<b>Assign diagnostic behavior</b>	Alarm
<b>Failure mode</b>	NaN value
<b>Interpreter mode</b>	Standard
<b>Zero point adjustment control</b>	Cancel
<b>Flow override</b>	Off

<b>Assign process variable</b>	Mass flow
<b>Installation direction</b>	Flow in arrow direction

## Modbus RTU register information with read/write access:

Name	Address	Data type	Selection/ Input
<b>Modbus Slave Address</b>	4909	UINT16	1...247
<b>Baud rate</b>	4911	ENUM UINT16	0 = 1200 1 = 2400 2 = 4800 3 = 9600 4 = 19200 5 = 38400 6 = 57600 7 = 115200
<b>Data transfer mode</b>	4912	ENUM UINT16	0 = RTU 1 = ASCII
<b>Parity</b>	4913	ENUM UINT16	0 = Even / 1 stop bit 1 = Odd / 1 stop bit 2 = None / 2 stop bits 3 = None / 1 stop bit
<b>Byte order</b>	4914	ENUM UINT16	0 = 0-1-2-3 1 = 3-2-1-0 2 = 2-3-0-1 3 = 1-0-3-2
<b>Telegram delay</b>	4915	FLOAT32	0...100



<b>Assign diagnostic behavior</b>	4920	ENUM UINT16	0 = Off 1 = Warning 2 = Alarm 3 = Alarm or warning
<b>Failure mode</b>	4919	ENUM UINT16	0 = NaN value 1 = Last valid value
<b>Interpreter mode</b>	4924	ENUM UINT16	0 = Standard 1 = Ignore surplus bytes
<b>Access code</b>	2176	UINT16	0...9999
<b>Mass flow unit</b>	2100	ENUM UINT16	0 = g/s 1 = g/min 2 = g/h 3 = g/d 4 = kg/s 5 = kg/min 6 = kg/h 7 = kg/d 8 = t/s 9 = t/min 10 = t/h 11 = t/d 12 = oz/s 13 = oz/min 14 = oz/h 15 = oz/d 16 = lb/s 17 = lb/min 18 = lb/h 19 = lb/d 20 = STon/s

<b>Mass flow unit</b> (continued)			21 = STon/min 22 = STon/h 23 = STon/d 24 = User mass/s 25 = User mass/min 26 = User mass/h 27 = User mass/d
<b>Mass unit</b>	2101	ENUM UINT16	0 = g 1 = kg 2 = t 3 = oz 4 = lb 5 = STon 6 = User mass
<b>Volume flow unit</b>	2102	ENUM UINT16	0 = cm <sup>3</sup> /s 1 = cm <sup>3</sup> /min 2 = cm <sup>3</sup> /h 3 = cm <sup>3</sup> /d 4 = dm <sup>3</sup> /s 5 = dm <sup>3</sup> /min 6 = dm <sup>3</sup> /h 7 = dm <sup>3</sup> /d 8 = m <sup>3</sup> /s 9 = m <sup>3</sup> /min 10 = m <sup>3</sup> /h 11 = m <sup>3</sup> /d 12 = ml/s 13 = ml/min 14 = ml/h 15 = ml/d 16 = l/s 17 = l/min

<b>Volume flow unit</b> (continued)			18 = l/h * 19 = l/d 20 = hl/s 21 = hl/min 22 = hl/h 23 = hl/d 24 = Ml/s 25 = Ml/min 26 = Ml/h 27 = Ml/d
<b>Volume unit</b>	2103	ENUM UINT16	0 = cm <sup>3</sup> 1 = dm <sup>3</sup> 2 = m <sup>3</sup> 3 = ml 4 = l 5 = hl 6 = Ml Mega 8 = af 9 = cf 10 = fl oz (us) 11 = gal (us) 12 = Mgal (us) 13 = bbl (us;liq.) 14 = bbl (us;beer) 15 = bbl (us;oil) 16 = bbl (us;tank) 17 = gal (imp) 18 = Mgal (imp) 20 = bbl (imp;oil) 21 = User vol. 22 = kgal





<b>Density unit</b>	2106	ENUM UINT16	0 = g/cm <sup>3</sup> 2 = kg/dm <sup>3</sup> 3 = kg/l 4 = kg/m <sup>3</sup> 5 = SD4°C 6 = SD15°C 7 = SD20°C 8 = SG4°C 9 = SG15°C 10 = SG20°C 11 = lb/cf 12 = lb/gal (us) 13 = lb/bbl (us;liq.) 14 = lb/bbl (us;beer) 15 = lb/bbl (us;oil) 16 = lb/bbl (us;tank) 17 = lb/gal (imp) 18 = lb/bbl (imp;beer) 19 = lb/bbl (imp;oil) 20 = User dens. 21 = g/m <sup>3</sup> 22 = g/ml
<b>Temperature unit</b>	2108	ENUM UINT16	0 = °C 1 = K 2 = °F 3 = °R

<b>Pressure unit</b>	2129	ENUM UINT16	0 = bar 1 = psi a 2 = bar g 3 = psi g 4 = Pa a 5 = kPa a 6 = MPa a 7 = Pa g 8 = kPa g 9 = MPa g 10 = User pres
<b>Zero point adjustment control</b>	5120	ENUM UINT16	0 = Cancel 1 = Start 2 = Zero point adjust failure 8 = Busy
<b>Flow damping</b>	5509	FLOAT32	0...100.0
<b>Density damping</b>	5507	FLOAT32	0...999.9
<b>Temperature damping</b>	5126	FLOAT32	0...999.9
<b>Flow override</b>	5502	ENUM UINT16	0 = Off 1 = On
<b>Assign process variable</b>	5100	ENUM UINT16	0 = Off 1 = Mass flow 2 = Volume flow 3 = Corrected volume flow
<b>On value low flow cutoff</b>	5137	FLOAT32	

<b>Off value low flow cutoff</b>	5103	FLOAT32	
<b>Pressure shock suppression</b>	5139	FLOAT32	
<b>Installation direction</b>	5500	ENUM UINT16	0 = Flow in arrow direction 1 = Flow against arrow direction
<b>Zero point adjustment control</b>	5120	ENUM UINT16	0 = Cancel 1 = Start 2 = Zero point adjust failure 8 = Busy

ZP progress corresponds to progress in % (0-99)

Modbus RTU register information with read access:

Name	Adress	Data type	Selection/ Input
<b>Mass Flow</b>	2006	FLOAT32	
<b>Volume flow</b>	2008	FLOAT32	
<b>Corrected volume flow</b>	2010	FLOAT32	
<b>Density</b>	2012	FLOAT32	
<b>Reference density</b>	2014	FLOAT32	
<b>Temperature</b>	2016	FLOAT32	



<b>Locking status</b>	4917	INTEGER	256 = Hardware locked 512 = Temporarily locked
<b>Progress</b>	6796	UINT16	

### Fluidic interface

<b>Fluidic interfaces</b>	Manufacturer-specific connection.
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### Certificates and approvals

<b>CE mark</b>	The flow sensor is intended to act as an electronic component for integration into a device or system. The flow sensor is not a stand-alone measuring device and therefore does not require the CE mark to be affixed.
<b>RoHS</b>	All installed components meet the requirements of the RoHS Directive.

### Zero point adjustment

#### Zero point adjustment

A zeropoint adjust in the application is based on factory calibration and due to excellent zeropoint stability not required in general. However under certain circumstances a zero-point adjust can be recommended:

- When highest accuracy is needed at low flow rates.
- When process conditions are extreme, e.g. very high process temperature.

For a zeropoint adjust the following pre-conditions need to be fulfilled:

- Measuring line is completely shut off, i.e. real flow is truly zero!
- Measuring tube is filled homogeneously and pressurized with at least 15 psi (gauge) to avoid gas bubbles in the fluid, when measuring gas no condensation is allowed.

During the zeropoint adjust stability of measured flow rate is monitored and its mean value is built for new zeropoint value. This typ. takes 20 s. If the process conditions are not suitable zeropoint adjust is aborted and old zeropoint value remains valid.

### Flow damping

#### Flow damping

With this time constant (PT1 system) mass flow value can be dampened.

Factory default is 0 s (no dampening). This dampening increases system reaction (step response time) time on the other hand.

Especially for flow control application this should be considered. E.g. a time constant of 0.1 s leads to an increase of step response time from 50 ms to 550 ms.

### Low Flow Cutoff

#### Low Flow Cutoff

With this function mass flow value is cut off to zero, when threshold is underrun.

So it's ensured that totalizer is stopped properly and cannot creep away.

Low flow cutoff is left when mass flow overruns 150% of set threshold (hysteresis).

When low flow cutoff is active no status message is set.



### Empty Pipe Detection

**Empty Pipe Detection** With this function an empty or partly filled measuring tube is detected. When density underruns set threshold  
mass flow is set to zero and a status message is set correspondingly.

