



User manual

FlowGuard® FT401 – Paddle wheel flow meter

Version 1.2



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1 DESCRIPTION OF DEVICE

The Flowguard® FT401 paddle wheel flow meter is designed for clean liquid fluids with flow velocity within the range of 0,3 ... 6 m/s (ideally 2 ... 3 m/s) and it is based on mechanical measurement principle according to which the flow velocity of a fluid is proportional to the speed of the paddle wheel populated with stainless steel needles picked up by the proximity sensor. Thanks to this solution, instead of using the magnetic needles and hall probe there is no deposition of minute ferrous particles and thus long service life and stability of the meter is ensured. Prompt and simple installation ranks among basic advantages as well as the price thanks to its simple construction.

The accuracy of paddle wheel flow meters may deteriorate for liquids with high viscosity. The liquids with high viscosity tend to create a laminar flow profile with impaired centre of the flowing liquid and thus the changed profile of the running liquid whereas it is desirable for accuracy that the liquid velocity is ideally equal across the entire pipe diameter. Therefore, Reynolds number of liquid should be higher than 4500. Reynolds number is a dimensionless value connecting the effects of viscosity, density and flow velocity.

The meter is manufactured in this version:

- Flowguard® FT401 – Pulse / switching contact +4 ... 20 mA

1.1 Scope of delivery

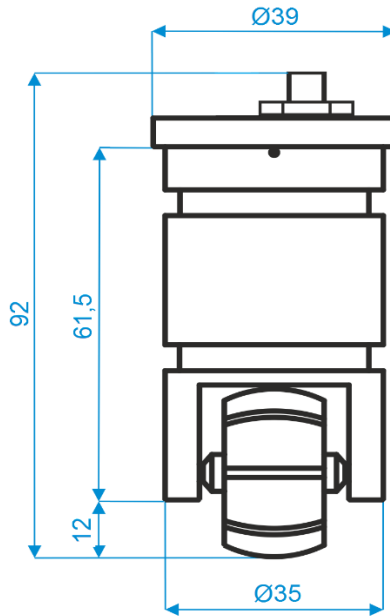
The device is delivered with an adapter for connection as per purchase order.

1.2 Process connection

The installation in the piping can be carried out by direct welding/bonding into the piping (according to material) or any of the fitting adapter delivered for simple installation (thread or mount) into diameter piping can be used. Drilling devices for simple installation without necessary welding and T-pieces in materials according to the customer requirements. The flow meter output can be connected to a display unit suitable for FlowGuard® FT401 this is not standard order, to be ordered separately or to various control systems.

Accessories to the flow meter can also be cable connections in various lengths with M12 (4-pin) connectors for electric connection. However, these are not part of delivery owing to standard solution of individual elements and thus the possibility of deliveries also from other manufacturers of these parts

1.3 Basic dimensions



2 STORAGE CONDITIONS

The temperature during transportation and storage of the meter must be within the range of -20°C up to 60°C.

3 WARRANTY

Unprofessional installation or improper use of the device may result in a loss of warranty rights as well as failure to comply with installation or operating conditions according to this manual. Repairs are not possible. The warranty becomes null and void by repairs or intervention in the device by a person other than the manufacturer.

4 INSTALLATION IN PIPELINE

4.1 Important information for selection of location

Prior to dismantling or splitting the piping or service carried on the meter always be particular about safety instructions for pressure and temperature in case of the fluid given. As there is a risk of pressurized liquid jet or high temperature, we recommend you to use essential personal protective equipment.

Outdoor conditions

It is necessary to ensure that the sensor is not exposed to weather effects and that the measured medium cannot freeze around the flow sensor as it would damage the sensor itself.

In case of outdoor location, the manufacturer recommends using a protective roof to avoid direct solar exposure so that the evaluation electronics cannot get overheated.

Vibration

Levels and range of vibrations must be under 2.2 in the frequency range of 20 ... 50 Hz according to IEC 068-2-34.

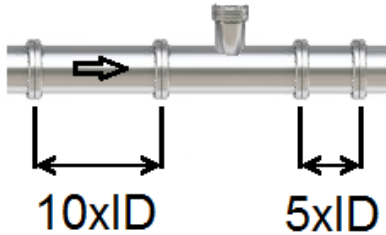
Actual location

The paddle wheel flow meters operate with clean liquids best. Particles and impurities may prevent the propeller from proper rotation and can contribute to faster component wear.

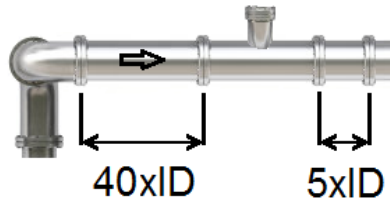
For installation of the meter, it is necessary to select such a location so that the correct length of straight pipe before and after the meter is available. Thanks to the fact that the paddle wheel interferes with the flow to a small extent only, the flow must have a consistent velocity all over the pipe's inside diameter and due to this accurate reading is made possible. Calming lengths of straight pipe segments make it possible to disperse possible whirling occurred in the flow prior to the respective measurement of the paddle wheel. The turbulent flow may be caused by obstacles such as an elbow, T-piece, pump, etc. Minimum lengths of the calming length of the pipe's straight segment will depend on the type of obstacle before the paddle wheel. The absolute minimum is typically ten times the amount of inside diameter of the straight pipe before the meter and five times the amount after the meter.

Recommended calming segments before the meter according to the obstacle on the piping, where ID means internal diameter of pipe (it is always 5×ID after the meter).

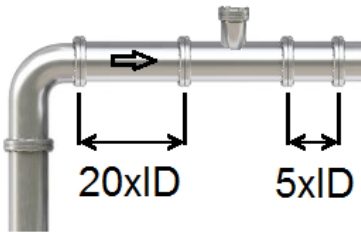
Standard calming segments – 10×ID



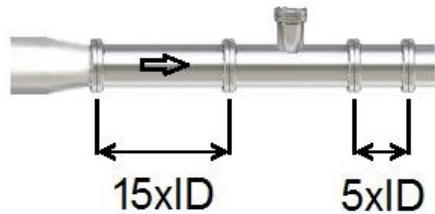
2x 90° elbow in two planes – 40×ID



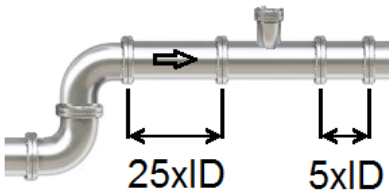
1x 90° elbow – 20×ID



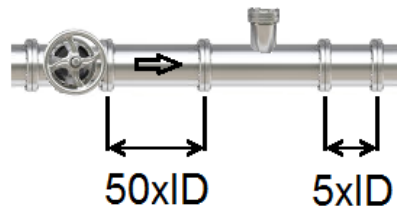
Reducer to pipe's inside diameter – 15×ID



2x 90° elbow in one plane – 25×ID



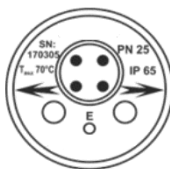
Valve – 50×ID



When installing the meter, be particular placing the meter in such a manner that the paddle wheel rotation axis is in horizontal position so that damage to the rotor by impurities in liquids can be avoided. In case of a vertical pipe, the positioning does not matter; however, we recommend you to place the meter in the ascending part to reduce the risk of aeration.

The measurement point must always be full of water free of bubbles; in case of air space, an erroneous measurement may take place. If necessary, it is possible to use the installation of measuring track in the form of U, by which means permanent submersion of the lower part with the meter is ensured. For the same reason, we recommend you to place the meter on the upstream side of the ascending piping.

For installation in piping, it is necessary to ensure the parallel run of the flow with the arrow indicated on the flow meter body.



WARNING: The actual installation of the weld-on adapter or fittings or gluing of plastic adapter onto the piping always carry out with the removed electronic unit so that mechanical and temperature damage can be avoided.

When blending a mixture, it is necessary to incorporate the flow meter either before the blending point or at a sufficient distance after it (min. 50×d), otherwise the indication may be inaccurate.

4.2 Paddle wheel flow meter arrangement

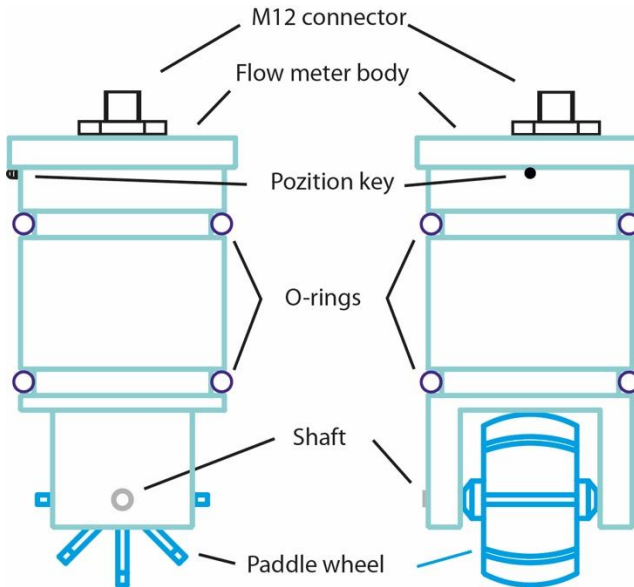
Paddle wheel flow meters consist of three basic components:

- Paddle wheel
- Wheel motion sensor (possibly display unit)
- Fitting adapters

These components can be purchased separately or as a package in order to meet particular requirements of your application. The paddle sensor is designed for insertion in the pipe fitting. Approximately a half of the paddle protrudes into the flow. The liquid flowing through the pipe causes the rotational motion of the rotor with paddles. The proximity sensor scans the movement of stainless steel rods located in the paddles and transforms them into electric pulses that are proportional to the flow velocity. Since the rotational motion of the paddle wheel depends on flow velocity, the number of output pulses (4 ... 20 mA current output) depends on velocity flow in the place of the paddle wheel and the volume flow depends on pipe cross-section and velocity flow. This relation is indicated by a figure called K-factor. The K-factor indicates then the number of output pulses per volume unit for every particular pipe size, eventually when using a particular pipe fitting as mounting accessories.

4.3 Paddle wheel and motion sensor

Individual parts of the meter



4.4 Fitting adapters

Particular fittings for installation:

Various pipe fixtures (fittings) are available. These are designed so as to facilitate the installation right into the piping by means of various connection methods, for example, with female or male threads, by welding, bonding, etc. These "in-line" fixtures are available in various materials, e.g. polypropylene, PVC, and stainless steels. Further, it is possible to use the drilling device where after simple drilling a hole in piping, the attachment yoke can be placed right onto the pipe. Thanks to this, it is not necessary to cut the piping or install it using special adapters. The offer is in "Optional accessories" section.

Table of K-factor for the most common size of pipes

Dimension of pipe	Inner diameter ID	Flow range	K-factor [imp/l]
48,3x2	44,3	2,7 ... 33 m ³ /h	24,8
53x1,5	50	3,5 ... 42 m ³ /h	19,5
60,3x2	56,3	4,5 ... 53 m ³ /h	11,0
76,1x2	72,1	7,5 ... 88 m ³ /h	8,0
84x2	80	9 ... 108 m ³ /h	6,6
88,9x2	84,9	10 ... 122 m ³ /h	5,5
108x4	100	14 ... 170 m ³ /h	3,9
114,3x2	110,3	17 ... 206 m ³ /h	3,5
139,7x2	135,7	26 ... 312 m ³ /h	2,2
168,3x2	164,3	38 ... 458 m ³ /h	1,5
219,1x2	215,1	65 ... 784 m ³ /h	0.9

ID = inner diameter of pipe OD = outside diameter of pipe

If the inside dimension of the piping is beyond the given table, K-factor is then given by the conversion formula:

$$\mathbf{K\text{-}factor_new = (K_{TABLE} \times ID_{TABLE}^2) / ID_{NEW}^2}$$

ID_{TABLE} is the closest inside diameter selected from the table to the tube used

K_{TABLE} is K-factor from the table to the corresponding ID_{TABLE} used

ID_{NEW} is the inside diameter of the tube used for installation

K-factors vary depending on the setting of pulse constant meter (dividing ratio). All values of K-factor are valid for water at 25°C.

All dimensions are in millimetre.

4.5 Assembly procedure using the fitting adapter

Before starting the actual assembly, make sure that the system is pressure less or discharged. Install then a suitable adapter, drilling device or T-piece by screwing or bonding, or possibly install the welding adapter if appropriate. Install then the paddle wheel flow meter by inserting it into the adapter. When installing the meter in the piping and for ensuring the most accurate flow rate evaluation, you need to observe the direction of angular displacement of the meter in such a way that the axis of the paddle wheel is perpendicular to the direction of the flow to which corresponds the positional key when inserting the meter (in the event of the weld-on version and the drilling device, the notch for the positional key must be created by the installation technician. That is why you should check the correct location of the slot for the positional key on the adapter against the piping.

Always place the meter in horizontal position, preferably from above onto the piping so that excess wear or possible damage to the paddle wheel shaft by deposits or impurities in the piping can be avoided.

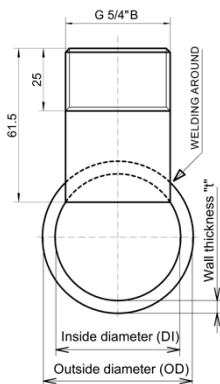
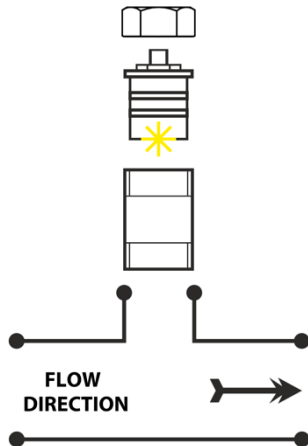
Before inserting the meter in the adapter, you should apply grease (silicone vaseline) to O-rings and to the interior of the adapter so as to avoid damage to the sealing EPDM O-rings. You need to proceed to insertion with due care and insert evenly and perpendicularly to the adapter. After insertion of the meter (the positional key must fit in the slot), screw in the sleeve nut and tighten it by hand until it does not come loose.

Warning: Do not cause pollution of paddle or axis by vaseline!

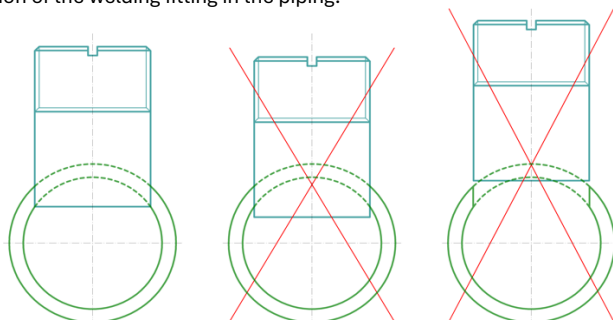
4.6 Installation by means of the welding fitting

In the location selected for installation of the meter, drill a 42 mm diameter hole in the piping with an annular bit. We recommend you to install the meter to the piping always from above so as to avoid excessive wear on the paddle wheel axle and potential damage to the paddle wheel by sediment deposits or debris in the piping. Now, you can weld the adapter on the selected place on the piping.

Screw the sleeve nut on the adapter to prevent it from falling into the piping by coincidence. Slide the adapter in the hole in the piping as shown in the Figure. It is suitable to make a mark on the adapter according to the thickness of the pipe wall so that the depth of insertion in the piping can be correct. Apply spot welding to two or three locations and check the perpendicularity to the piping axes. If everything is correct, make a weld all round, making sure that the adapter cannot be deformed by welding.



Correct installation of the welding fitting in the piping:



To complete the installation, you need to make a slot for the flow meter's positional key according to instruction page 12.

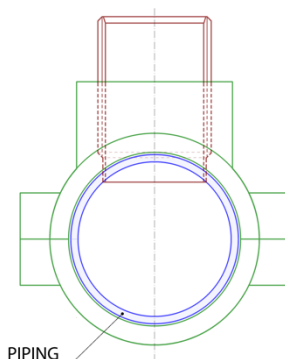
4.7 Installation by means of the drilling device

Find out the thickness of the pipe wall to which the drilling device will be mounted. Screw the sleeve nut on the adapter without the meter. Screw the adapter into the drilling device that after installation on the piping, the adapter is found as deep as illustrated in the figure. For checking, it is suitable to have a short pipe segment; apply the drilling device with the adapter to its edge and you will see right away if the adapter is dipped into the piping correctly. Seal the adapter in the drilling device preferably using Teflon tape or packing cord. Tighten with a wrench on the sleeve nut. For fine handling, you can catch the adapter at the thread just below the nut with the combination pliers.

In the location selected for installation of the meter, drill a 40 mm diameter hole in the piping with an annular bit. We recommend you to install the meter always from above to the piping so as to avoid excessive wear on the paddle wheel axle and potential damage to the paddle wheel by sediment deposits or debris in the piping.

Install the drilling device with the adapter on the bored hole in a standard way including sealing O-ring.

To finish the installation, it is necessary to make a slot for the insertion position key of the meter which guarantees the correct displacement of the meter in the adapter for the future. We recommend you to adhere to the maximum angle of deviation from straight direction of the piping (flow of the liquid) up to 3° whereas the slot forms the upstream side of the meter so that the medium can flow from the same side where this slot is found.



The respective slot can be made using a grinder, saw or file. The slot is about 3.4 mm wide and 3.4 mm deep. Remove the eventual burrs or chips and clean it mainly from the internal side to avoid damage to O-rings during installation!

Before inserting the meter in the adapter, you should apply grease (silicone vaseline) to O-rings and to the interior of the adapter so as to avoid damage to the sealing EPDM O-rings. You need to proceed to insertion with due care and insert evenly and perpendicularly to the adapter. After insertion of the meter (the key must fit in the slot), screw in the sleeve nut and tighten it by hand until it will not come loose.

Warning: Avoid fouling of the propeller and/or its shaft by vaseline!

4.8 Sources of disturbances

The following items rank among the most frequent sources of disturbances to the steady flow of liquid:

- The flow of liquid flow in the flow sensor should be **steady and free of whirling**. Recommended minimum length of straight segments is $10 \times d$ before the flow sensor and $5 \times d$ after the sensor (where d is the inside diameter in millimetres).
- Pumps and bends or elbows located close one after another in various planes.
- Abrupt changes in pipe cross-section (we recommend you to make reductions with the lowest possible cone angle α . (where α is the angle made by skewed walls of the pipe reduction).
- Anything interfering with the liquid flow.
- Branch pipes, T-pieces, bends, elbows, slide valves, cocks, flap valves. Closing, control, throttling and check valves. Pipe outlets from tanks, heat exchangers and filters.
- When blending a mixture of substances (or blending the same substances with different values), it is necessary to incorporate the flow meter either before the blending point or at a sufficient distance after it (min. $50 \times d$), otherwise it may cause measurement inaccuracy.

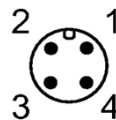
5 WIRING

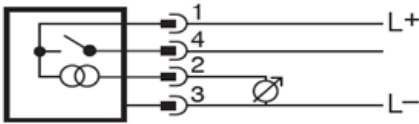
Any installation or manipulation with the device always carry out after disconnection of supply voltage! When the operations described below are performed unprofessionally, the claim on warranty becomes extinct!

5.1 Meter wiring

Connector M12 wiring

The meter is equipped with a standard 4-pin M12x1 connector.





Standard wiring:

PIN 1 – supply voltage +24 V

PIN 2 – 4 ... 20 mA output

PIN 3 – supply voltage GND

PIN 4 – pulse point /switching point PNP contact

5.2 Pulse output or make/break contact

Output mode can be selected either as pulse mode with a pulse constant according to K-factor of the individual fitting used or as a flow monitor with PNP wiring on PIN 4.

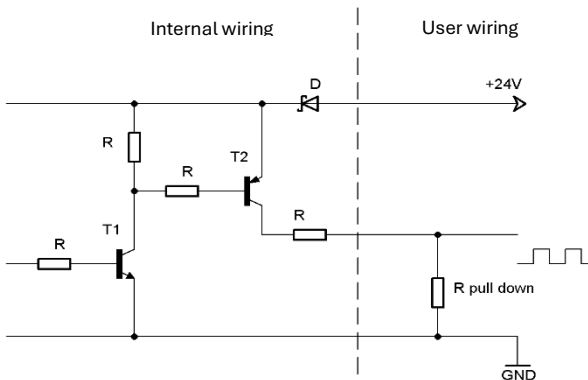
In case of flow monitor function, the meter is delivered with a switching point set as a switch.

If the flow is above the switching point, the PNP contact on PIN 4 is closed.

If the flow is below the switching point, the contact is open.

Note: The switching point is dependent on the fact if the flow velocity increases or decreases in time, i.e. these are switching points with hysteresis which is set by the manufacturer.

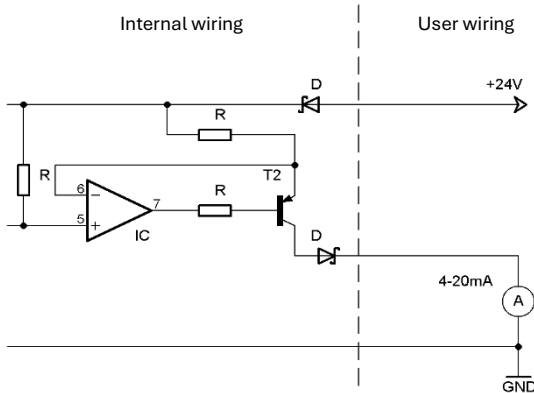
Wiring example:



5.3 4-20mA output

The manufacturer delivers the meter with output set to 4-20 mA in such a manner that at zero flow velocity of the medium, the output value is 4 mA and at 6 m/sec it is 20 mA. The dependence of flow on velocity is linear.

Wiring example:



6 PUTTING INTO OPERATION

After powering up, the meter runs the internal diagnostic and LED tests, followed by measurement mode.

Individual LED operation indications

Green	– POWER (indicates that the supply voltage is present)
Orange	– flow is zero or below minimum limit
Red	– flow is above maximum limit
Blue	– pulse output function (volume pulses on output are copied) / FlowSwitch function (indicates the state of FlowSwitch contact)

If no LED is lit or flashing, the meter is most likely disconnected from supply voltage!

7 CUSTOMIZATION AND CONTROL OF FLOWGUARD® FT401

Switching the pulse output to FlowSwitch function

Press down the button on the switching flow and hold it until the blue LED is lit. Release the button – this state is indicated by flashing of this LED. To confirm, press down the button again.

Unless you confirm, the setting will not be accepted and it will return to its original state after a few seconds.

Note: The hysteresis set by the manufacturer is applied to setting the flow meter into flow monitor mode.

Switching the FlowSwitch function to pulse output

Press down the button on and hold it until the red LED is lit. Release the button – this state is indicated by flashing of this LED. To confirm, press down the button again.

Unless you confirm, the setting will not be accepted and it will return to its original state after a few seconds.

Pulse constant setting

Press down the button on and hold it until the green LED is lit. Release the button – this state is indicated by flashing of this LED. The blue LED starts blinking at the same time. The number of blinks of this blue LED multiplied 2 indicates the factor of the meter's basic constant (K-factor). The maximum factor is 24 (12 blink of blue LED). Multiplied ration could be 2,4,6,8,10,12,14,16,18,20,22,24 Unless confirmed by the button within this limit, the setting will not be accepted and returns to original state.

Pulse constant is set in factory to a basic K-factor according to the table on page 8 and 9, it means without multiple ration (stable width of pulse is 1ms). When using divider ratio is pulse width / constant gap of 1:1. To return to the original settings without dividing ratio, it is necessary to make the "Factory settings".

Example setting for divider 4

Press the button and hold it until the green LED light. After that, release the button - the green LED start flashes. Wait until the blue LED flashes 2 times and then immediately that press the button for confirmation. Setting is finished.

20 mA limit setting

During the limit flow for 20 mA, press down the button and hold it until the orange LED is lit. Release the button – this state is indicated by flashing of this LED. To confirm, press down the button again. Wait until the red LED is lit to indicate that upper limit of the range has been reached. Setting is completed by this.

Unless you confirm, the setting will not be accepted and it will return to its original state after a few seconds.

Factory reset

Press down the button on and hold it until all LEDs are lit. Release the button – this state is indicated by flashing of all the LEDs. To confirm, press down the button again.

Unless you confirm, the factory setting will not be executed and it will return to its original state after a few seconds.

8 TECHNICAL PARAMETER







Power supply -	24 V DC
Operating voltage tolerance	±10%
Input power	<1 VA
Electrical connection	M12×1 (4 pin) with reverse polarity protection
Display	2×LED (voltage and current)
Outputs	Pulse output, analog output, adjustable NO contact
Current output	4 ... 20 mA, active
Load resistance	400 Ω
Flow velocity ranges	0.3 ... 6,0 m/s (according to the specific adapter and installation)
Accuracy	±3%
Repeatability	±1% of full scale
Hysteresis	2 ... 8 cm/s
Temperature of medium	-10 ... 100°C
Ambient temperature	0 ... 55°C
Material in contact with medium:	
Propeller support	PVDF
Propeller:	PEEK
Pins:	Stainless steel (DIN 1.4401)
Pin in propeller paddle:	stainless steel (DIN 1.4115) / zirconium ceramics
Maximum pressure	20 bar
Protection class	IP67
Ambient humidity	max. 90%
Dimensions (h×diameter)	90 × 39 × 39 mm
Weight	135g

Note: The output pulses are generated even when the maximum velocity is exceeded.

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