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**Turbine Meter  
with Universal Smart Transmitter  
and HART® Communication**

**RQ  
UST**

Ex ia - Version

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**Operating manual**



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## Introduction

### I. Transport, Delivery, Storage

#### Storage and Transport:

Protect devices against moisture, dirt, shock and damage.

#### Inspection of the Delivery:

Check shipment for completeness immediately upon receipt. Compare the instrument data with the information on the packing slip and the order documents.

Report any transport damage immediately after receipt of the delivery. Damages, which are reported later, will not be recognized.

### II. Warranty

Scope and duration of warranty are defined in the contractual terms of delivery. Any warranty claims require proper installation and start-up of the devices according to the applicable operating instructions. The required installation, putting into operation and servicing work may only be performed by qualified and authorized personnel.

The evaluation electronics use CMOS chips. Therefore, when the electronics casing is opened, static electricity discharges must be avoided. These can damage the evaluation electronics. Bopp & Reuther Messtechnik GmbH is not liable for damages, which are caused either indirectly or directly by improper handling.

For the transport of electronic assembly groups antistatic transport containers are to be used.

### III. General Notes on Safety

***Read and observe the operating instructions carefully and keep them in a safe place.***

***Only qualified personnel may carry out installation.***

***ElexV regulations as well as generally accepted technical rules and the operating instructions installations must be observed.***



***Bopp & Reuther Messtechnik GmbH decline any liability for damages due to improper handling, use, installation and servicing of the devices.***

***Check suitability of material of counter when using it with corrosive media.***

***Put defective devices out of operation immediately.***

Symbols used



#### **Warning!**

Failure to observe this warning can lead to injury of persons or a security risk.



#### **Attention!**

Non-compliance can lead to faulty operation or damage to the device.

## 1 Notes

### 1.1 Intended Use

The turbine meter is used to measure flow and volume of liquid media of low and medium viscosity such as:

- crude oils
- mineral oils
- acids
- alkaline solutions
- solvents
- water
- liquefied gases
- liquid food and beverages

Turbine meters of the RQ series are available with nominal widths of 10 to 300. According to nominal width it may be used for PN6 to PN 320, the maximum temperature of the measured media may be up to 250°C depending on the model.

The Universal Smart Transmitter USTI represents new evaluation electronics of the latest technical design. The USTI processes the electrical signals from the various sensor systems and displays the values of volume and flow. The flow is put out on an analog 4 to 20 mA current loop (according to NAMUR NE 43). The USTI is equipped with two-wire technology serving as its power supply. In addition there is a separate pulse output according to NAMUR.

Due to the integrated electronics, HART®-communication with a control room or with a portable data terminal on-site is feasible using the analog current loop. All relevant operating or configuration data can be read out from the transmitter or stored into the transmitter. Thus the measurement tasks of the turbine flow meter is functionally optimized and can be set directly on-site or via a control system.

Always state ID-number of the meter if you have any questions or wish to order spare parts.

### 1.2 Attention

The turbine meter RQ is state of the art and has been designed for maximum operational safety. It has been carefully checked and is delivered in perfect condition as regards safety. Improper use respectively use in conditions the device has not been explicitly certified for may incur danger.

Mind the warnings in the operating instructions!



### 1.3 Personnel for Installation, Start-up and Operation

- Only qualified and authorized personnel may perform installation, mounting, electrical installation, putting into operation, servicing and operation. Any such person must have read and understood the operating instructions and follow the instructions therein.
- Check the material's resistance of all parts coming into contact with the measured media when using the device with aggressive media (gaskets, turbine wheels, etc.).
- Make sure to observe your country's specific regulations and provisions.

### 1.3.1 Start-Up

- Vent pipeline by means of a vent valve placed upstream of the Turbine Meter.



### Attention!

Large amounts of air or gas cause excessive acceleration of the rotor and may damage the meter or the bearings.

- Fill pipeline by means of a by-pass line – slowly open shut off valve.

### 1.3.2 Factory settings

The counters' factory pre-settings correspond to the conditions of operation stated in the order form. Pre-set values are specified in the configuration data sheet.

## 1.4 Repairs, Hazardous Media

Before sending the turbine meter to Bopp & Reuther Messtechnik make sure to observe the following:

- Attach a note describing the malfunction, state the field of application as well as the chemical/physical properties of the measured media.
- Remove all residues of the media and pay special attention to sealing grooves and slits. This is of extreme importance if the medium is hazardous to health, i.e. when it is caustic, toxic, carcinogenic or radioactive, etc.
- Please do not return the device if you are not perfectly sure that all media hazardous to health have been cleaned off.

Costs incurred due to inadequate cleaning of the device and possible costs for disposal and/or personal injuries (causticity etc.) will be billed to the operating company.

Please ask our customer service for help and advice if your turbine meter does not work properly:

Bopp & Reuther Messtechnik GmbH  
Service  
Am Neuen Rheinhafen 4  
D-67346 Speyer  
Phone: +49 6232 657-420  
Fax : +49 6232 657-561

## 1.5 Technical Changes

All dimensions, weights and technical data given are subject to change without prior notice as Bopp and Reuther Messtechnik GmbH is continuously looking for further improvement and development and striving for quick and non-bureaucratic implementation.

### 1.5.1 Delivery

***Depending on the series the turbine wheel meters are delivered as described below:***

Series 1

DN 10 ... 65

One part, completely mounted

- Check the smooth running of the rotor  
Blowing your breath through the meter is sufficient
- Counter ready to be mounted

Series 2

DN 80 ... 300

Several parts, mounting to be performed on-site

## 2 System

The USTI is equipped with two-wire technology serving as its power supply. Due to the integrated electronics, HART®-communication with a control room or with a portable data terminal on-site is feasible using the analog current loop. All relevant operating or configuration data can be read out from the transmitter or stored into the transmitter. Thus the measurement tasks of the turbine flow meter is functionally optimized and can be set directly on-site or via a control system.

### 2.1 Measuring Principle

The turbine meter is an indirect volume meter. Its main component is an axial turbine wheel turning freely in the flowing liquid.

The turbine wheel is rotated by the liquid and spins at a rotational speed, which corresponds to the average flow velocity of the liquid in the free cross section of the turbine flow meter. The rotational movement is transmitted through the casing wall in a non-interacting manner to the USTI, which supplies a 4 to 20 mA signal, proportional to the volumetric rate of flow, and displays the respective value directly on-site.

### 2.2 Measured Quantity

The number of revolutions of the turbine wheel meter is directly proportional to the volumetric rate of flow with the number of revolutions being proportional to the volume that has passed through the meter.

## 2.3 Measuring Range

### Series 1

Nominal width		Flow rate $Q_{\max}$ [m³/h]	Meter factor Imp/dm³	Frequency $f_{\max}$ [Hz]	Pulses per revolution
DN	ANSI				
10	-	1.5	1750	730	4
15	½	6	310	517	
20	¾	12	170	567	
25	1	18	105	525	
32	1¼	30	58	467	
40	1½	42	22	257	
50	2	72	12.4	248	
65	2½	120	6	200	

### Series 2

Nominal width		Flow rate $Q_{\max}$ [m³/h]	Meter factor Imp/dm³	Frequency $f_{\max}$ [Hz]	Pulses per revolution
DN	ANSI				
80	3	180	15	750	12
100	4	300	6	500	10
150	6	600	3.4	567	18
200	8	1200	1.84	613	24
250	10	1800	1.24	600	40
300	12	2400	0.78	520	44



### 3 Output

#### 3.1 Output signal

The output signals are available as analog output, as current pulse output with two-wire technology, and as separate NAMUR pulse output.

##### 3.1.1 Analog current output

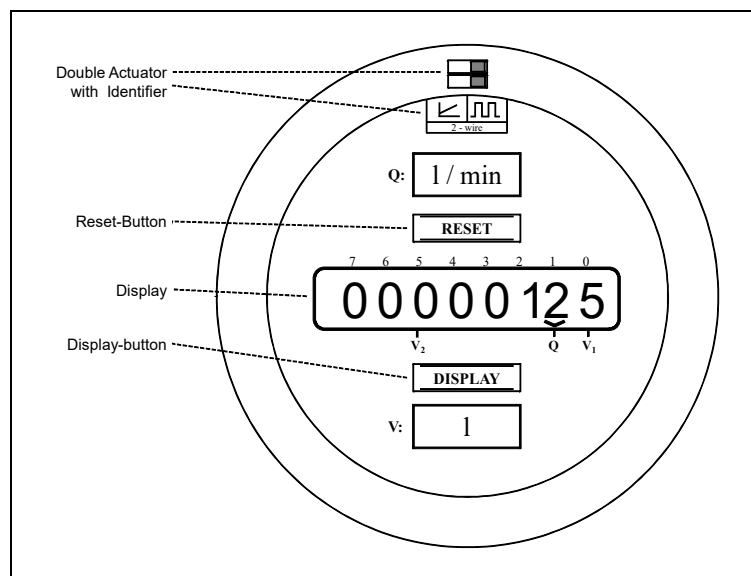
The flow is a standard signal output of 4 to 20 mA. Initial value, final value and attenuation can be pre-set. The analog current output transmits the flow value measurement from 4 to 20 mA.

##### 3.1.2 Pulse Output

Two different types of pulse outputs (current pulse or NAMUR pulse) are available for the transmission of the volume flow. The output can either be set as original pulse without evaluation or as scaled pulse with selectable pulse width. This applies to both types of pulse outputs. The pulse value can be scaled with an additional factor regarding the internal meter increments. The original pulse has a set pulse width of 0.5 ms. The maximum output frequency is 1 kHz. The pulse width for the scalable pulse can be selected.

##### a) 2-Wire Current Pulse Output:

On the 2-wire current loop, the output signal is a current pulse between 4 mA = low and 20 mA = high. This pulse output can be activated by means of a double actuator on the power supply circuit board. The current pulse is provided at terminal 1 and 2 of the current loop. (The analog signal of 4 to 20 mA for the volume flow is no longer available). HART®-communication is restricted.



##### b) Pulse Output according to NAMUR

The NAMUR-output is provided at terminals 3 and 4. The signals are structured according to the European standard, EN 60947-5-6.

### 3.2 Load

Several parameters have to be considered for the load tolerance.

To ensure trouble-free HART®-communication, the minimal load is  $R_L \geq 230 \Omega$  and the maximum load is  $R_L \leq 1100 \Omega$ .

#### Maximum Load:

The maximum load is dependent on the supply voltage:

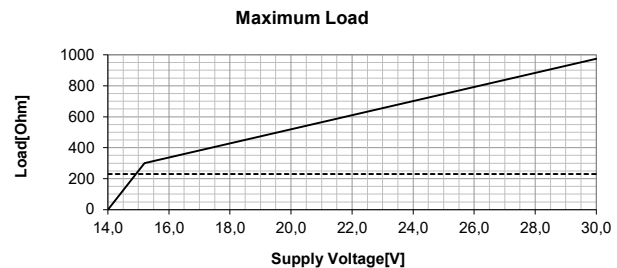
For  $U_B < 15.2 \text{ V}$  :

$$R = (U_B - 14 \text{ V}) / 0.004 \text{ A}$$

For  $U_B \geq 15.2 \text{ V}$ :

$$R = (U_B - 8.5 \text{ V}) / 0.022 \text{ A}$$

The values of resistances are displayed in  $\Omega$ .



### 3.3 Electrical and Thermal Safety Data

- Power supply and signal circuit (terminals 1 and 2) to be connected to an approved, intrinsic safe 4-20 mA current loop:

Voltage	$U_i$	=	DC 30V
Amperage	$I_i$	=	110 mA
Output	$P_i$	=	825 mW
Internal inductivity	$L_i$	<	0.6 mH
Internal capacity	$C_i$	<	34 nF

- Floating NAMUR opto-coupler output (terminals 3 and 4) to be connected to intrinsic safe circuits:

Voltage	$U_i$	=	DC 18 V
Output	$P_i$	=	100 mW
Internal inductivity	$L_i$	≤	4 $\mu\text{H}$
Internal capacity	$C_i$	≤	16 nF

- Sensor circuit with protection type EEx ia IIC to be connected to passive sensors, galvanically connected with power supply and signal circuits.

Sensor	Coil	Contact
Connection terminals	7 and 8	5 and 6
Voltage $U_o$	1 V	6.6 V
Amperage $I_o$	4 mA	23 mA
Output $P_o$	1 mW	37 mW
Max. external capacity $C_o$	≤ 100 $\mu\text{F}$	≤ 22 $\mu\text{F}$
Max. external inductivity $L_o$	≤ 1 H	≤ 35 mH
Max. external capacity $C_o$ (mixed connection)	≤ 4 $\mu\text{F}$	≤ 0.9 $\mu\text{F}$
Max. external inductivity $L_o$ (mixed connection)	≤ 1 H	≤ 1.5 mH
Relation inductivity-resistance $L_o/R_o$	40.5 mH/ $\Omega$	0.93 mH/ $\Omega$

- The ambient temperature for the Universal Smart Transmitter series \*\*\*USTI\*\*\* is:  
 $-20^\circ\text{C} \leq T_a \leq +70^\circ\text{C}$  (Ex i Version)

The influence of the process temperature on the transmitter has to be taken into account.

### Special conditions for safe use

For variations of the Universal Smart Transmitter for direct mounting on the sensor the influence of external heat sources (process temperature) on the housing temperature must be taken into account.

An optional thermal insulation may extend to half of the extension. The ambient temperature must be maintained directly next to the electronics housing.

class	$T_U$	$T_{media}$
T3	64	170
T4	66	135
T4	67	110
T4	70	70
minimum	-20	-10
		optional -60

for all classes

## 4 Mounting and Installation

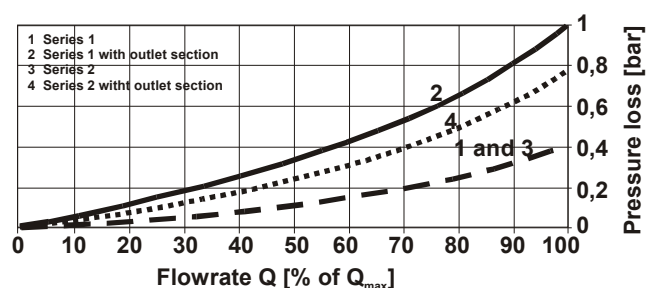
### 4.1 General Information

The stated measuring accuracy of the turbine wheel meter can only be guaranteed if the following is strictly observed:

- All media have to be introduced in pure phase, i.e. liquids without air or gas inclusions and solids.
- Use of a strainer (mesh width 0,25 ... 0,80 mm)
  - uniform flow profile at the meter's entrance
  - To be mounted behind a straight, undisturbed pipe of at least 15 x DN length or use of a flow straightening system (Turbine wheel meters for fiscal metering are delivered with inlet pipe and integrated flow straightening system).
  - Inclusion of air or gas can lead to over-torque and thus to the destruction of the measuring device. The use of a gas and air separator is therefore strongly recommended.
  - Undisturbed outlet pipe with the absence of any interaction
  - Additional installation of a straight, undisturbed pipe of at least 5 x DN length behind the meter
- Installation of flow regulating valves and/or pressure valves only behind the turbine wheel meter
- Observe minimum overpressure during operation in the meter to prevent cavitation:

$$P_{min} \geq 2 \times \Delta P_{RQ} + 1,25 \text{ pv}$$

with:  $\Delta P_{RQ}$  = pressure loss of the turbine flow meter  
 pv = vapor pressure of the media to be measured



Standard value is an operating pressure of approximately 2 bar above saturated vapor at the respective operating temperature.

In- and outlet sections: The dimensions given in table (5.1.2) are to be maintained.

- For custody transfer (fiscal metering) these dimensions are prescribed and obligatory. When calibrating the meter at the manufacturing plant, the aforementioned inlet and outlet sections are to be included.

## 4.2 Installation

- Flush and purge the pipe for cleaning purposes. When doing so, replace the turbine wheel meter with a suitable piece of piping
- When mounting the turbine wheel meter including the inlet pipe please pay special attention to
  - direction of flow
  - installation position:
    - series 1 (DN15-DN65) horizontally or vertically
    - series 2 (DN80-DN300) horizontally
- Use appropriate flange gaskets and make sure that they are correctly mounted (should not jut out into the pipe).

## 4.3 Mounting of the Sensors

### 4.3.1 In- and Outlet Sections

To ensure best measurement results, the velocity profile in the inlet section needs to be a fully turbulent flow, free of any disturbances.

The in- and outlet sections must have a minimum length of:

Inlet section: minimum length of 10 x nominal width

Outlet section: minimum length of 5 x nominal width

### 4.3.2 Flow Straightener

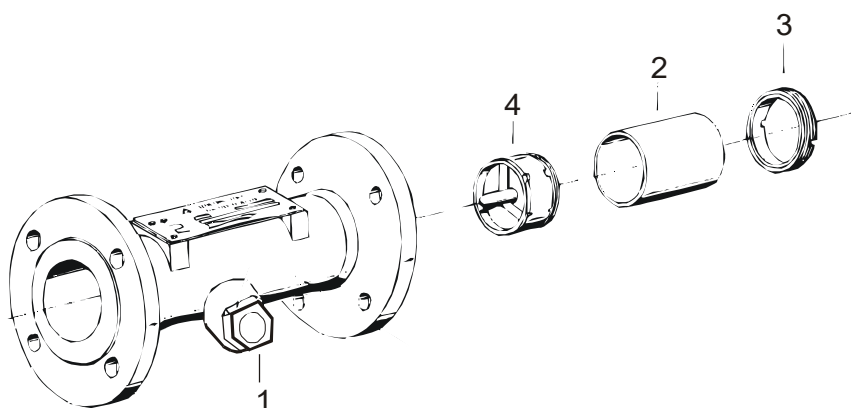
Installation of flow rectifiers reduces the impact of disturbances. Thus the length of the inlet section can be reduced, too. To achieve highly accurate measurement results the impact of flow rectifiers must be taken into account during the calibration process.

### 4.3.3 Pressure- and Temperature Compensation

If pressure- and temperature measuring points are required, these must be placed in the outlet section behind the meter housing (distance: 3 x nominal width for the pressure and 5 x nominal width for temperature measuring point).

## 4.4 Replacement of measuring system and/or bearings

### 4.4.1 Series 1



#### List of Parts

Pos.	Piece	Name
1*	1	Spring clamp, ring, thrust screw
2	1	Spacer tube
3	1	Screw down nut
4	1	Measuring system (complete)

\* for turbine wheel meters with two sensors, there are two spring clamps, rings and thrust screws.

#### Disassembly

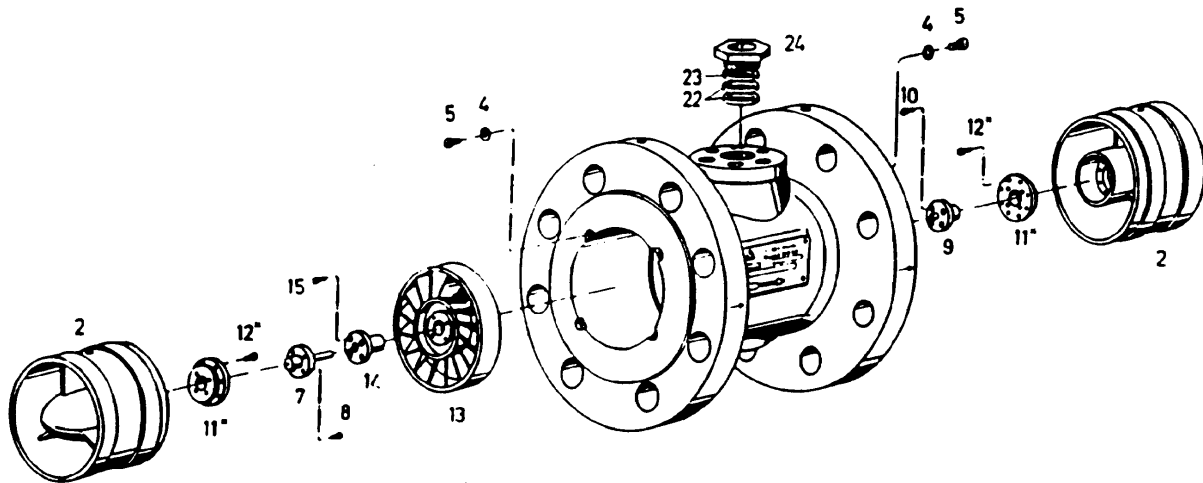
- Remove screw down nut (1)
- Remove spacer tube (2)
- Remove complete measuring system (4)

For mounting proceed in reverse order.

#### Attention:

When mounting the meter, please take care that the arrows on the measuring system and the arrows on the counter point in the same direction.

#### 4.4.2 Series 2



List of Parts

Pos.	Pieces	Name
2	2	Bearing joint
13	1	Impeller
7	1	Bearing Axle
8	4	Cylinder head screw
9	1	Counter bearing
10	4	Cylinder head screw
14	1	Bearing bush
15	4	Cylinder head screw
24*	1	Thrust screw
22*	1	Ring
23*	1	Spring clamp

\* for turbine wheel meters with two sensors, there are two spring clamps, rings and thrust screws (positions 22, 23 and 24).

#### Disassembly

- position the meter in such a way that it rests on its inlet flange
- loosen and remove rear cylinder head screws (5) plus washers (4)
- remove rear bearing joint (2)
- remove impeller (13)
- loosen and remove front cylinder head screws (5) plus washers (4)
- remove rear bearing joint (2)
- loosen and remove cylinder head screws (10, 15)
- remove counter bearing (9) and bearing bush (14)
- loosen cylinder head screws (8)
- remove bearing axle (7)

For mounting the spare parts proceed in reverse order.

#### Attention:

Please take care that the positioning of the bearing joints (marks „0“ and „1“) corresponds to the marks on the housing.

## 5 Electrical Connections

### 5.1 Power Supply

The voltage supply range is 14 - 30 V DC and may not be higher than 30 V DC.

Cable fitting	:	M20 x 1.5 or NPT ½"
Cable diameter	:	6 to 12 mm
Terminals	:	GKDS-Ex
Wire cross section	:	0.2 – 2.5 mm²

The electrical connections are located under the cover of the shorter casing side.

The connection must be carried out as follows in accordance with IEC 60079-11.

When connecting the transmitter is essential to ensure that no individual free wires are longer than 50mm. This can be by cutting the mantle, an insulating tube or a wire tie immediately before the terminal.

For the operation of the USTI only a two-wire connection (terminals 1 and 2) is needed. This line serves three purposes

- Transmission of the analog signal for the flow volume with 4 to 20 mA.
- Generation of auxiliary energy by the USTI itself from the live zero with 4 mA.
- Modulation of the FSK-signal (Frequency Shift Keying) on the current loop for digital data transmission according to HART® specifications.

The output of the NAMUR-pulses are terminals 3 and 4.

No further connections are required. For test purposes the connection circuit board is equipped with three solder posts (see below) to which either a HART®-Interface for data-transmission on-site or a measuring device for the current can be connected.

There are several possibilities to connect HART®-communication, but the loop resistance must be within the values given under 3.2. The HART®-interface can be connected to test-points TP2 and TP3 in the terminal while the cover is open. If the HART®-interface is to be used at another point in the loop, it can be connected to points X-Y or X-Z as shown in figure 1. However it may not be connected directly to the power supply device at point Y-Z.

In the example of figure 1 the connections of the HART®-communicator can be interchanged with those of the PC or laptop.



#### **Attention!**

When installed in areas with potentially atmospheres observe the respective country's specific regulations (for Germany: EN 60079-14 resp. VDE 0165).

## RQ with USTI

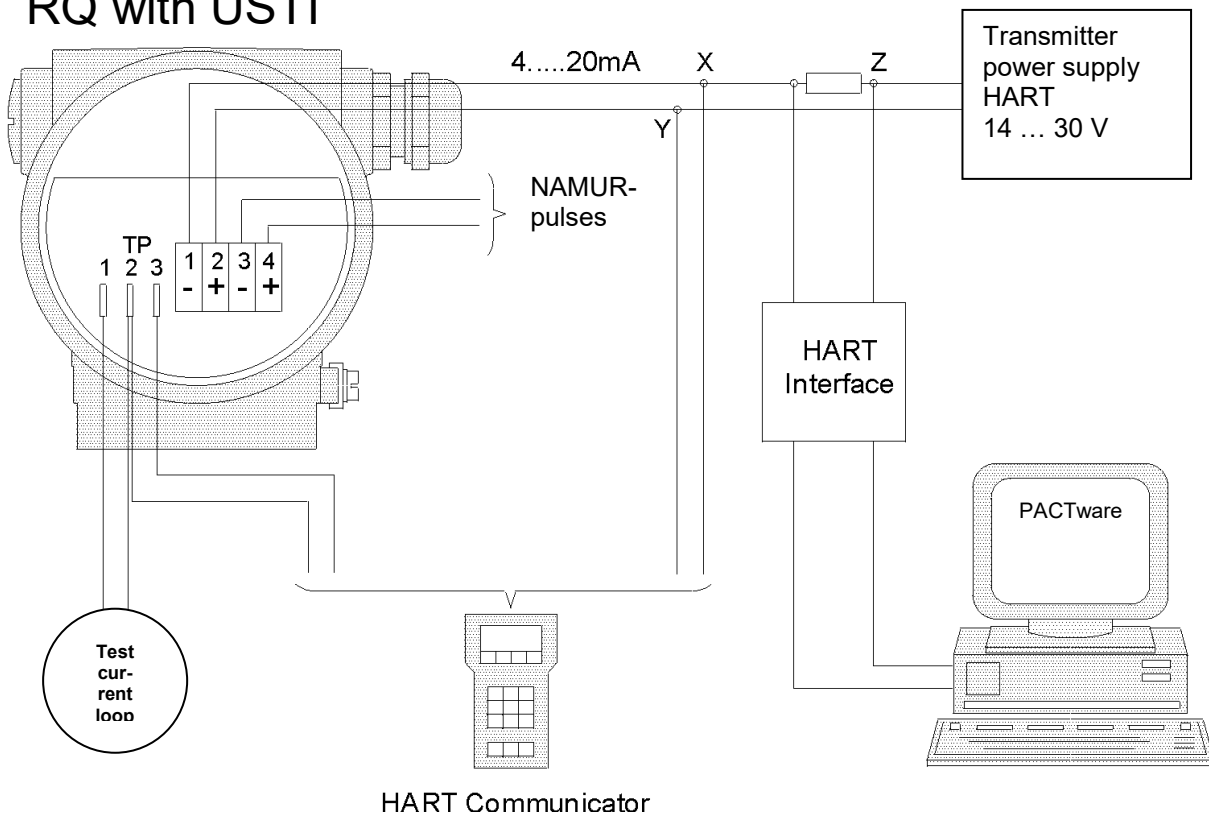


Figure 1 shows the connection options described in 5.1

### 5.2 Operation with the Software PACTware

To operate the USTI with the PACTware operating software a HART®-Interface is required. The Interface transforms the level of the RS232 interface or USB- interface into a frequency shift keying (FSK) signal. The interface can also be installed permanently. The connection is set up as shown in figure 1.



### Warning!

The use of a PC or a Laptop and HART® - Interface in an EX - Zone requires special approval certificates.

## 6 Display and User Interface

### 6.1 General Information

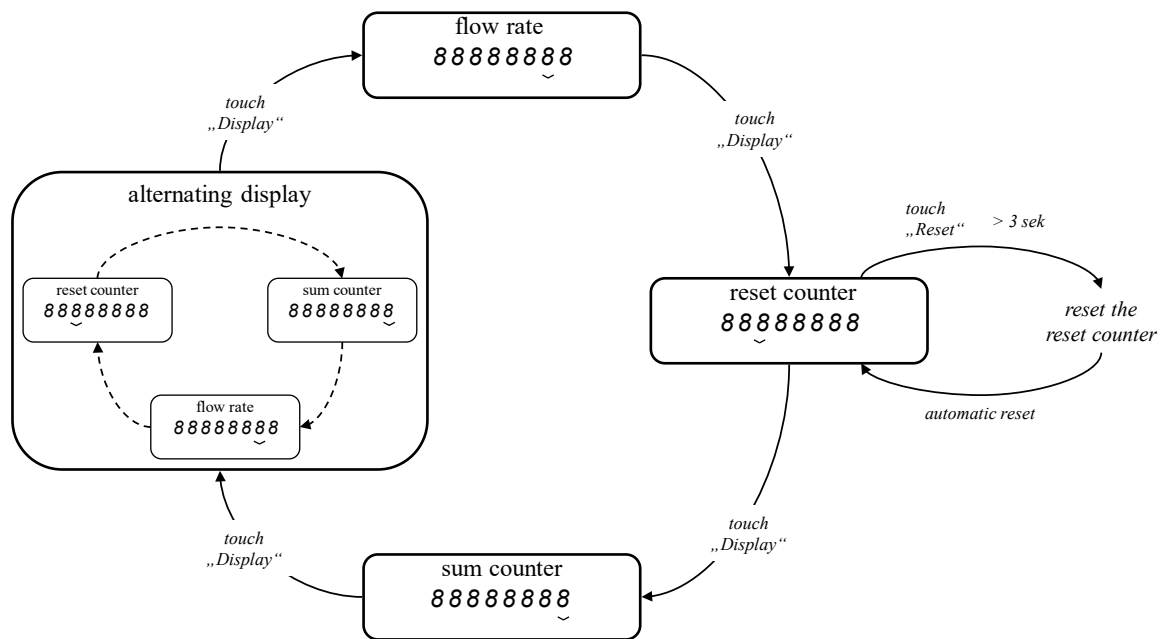
The meters are set before delivery according to the operating conditions specified in your order. For further information please refer to attached configuration data sheet. For configuration respectively operation of the transmitter you have the choice between following two options:

1. HART®-communication
2. On-site control of simple functions by means of a switching magnet.

### 6.2 LCD Display

The values of the flow, of the sum and of the reset meter can be displayed on the 8-digit LCD display. The selection of the displayed value can be chosen via the switching magnet, which is operated by touching the "Display" button below the display window. The value chosen is identified by a mark below the decimal point. After activating the button, the display switches as shown in the overview below:





In the alternating display mode all three values are shown sequentially in preset time intervals.

The “resetting” of the reset meter can only be effected while this specific value is being displayed. The button must be pressed for at least three seconds. For better legibility the display circuit board may be rotated mechanically by 90° or 180° (see chapter 11.3).

## 6.3 Operation with HART®-communication

### 6.3.1 PACTware

To operate the Oval Wheel Meter with USTI the PACTware software can be used. PACTware is a configuration- and operation software that provides all USTI functions via HART®-communication. The individual functions are listed in chapter 6.4 “Instrument Functions”. A PC is required for the use of PACTware with the following minimum system requirements:

- Pentium III 400
- Windows XP, VISTA or 7
- Hard drive with 100 MB free space

The software is free to download: <https://www.bopp-reuther.com/en/download/> software

USTI is connected to the RS232 or USB-interface of the PC using a HART®-interface (see chapter 5.2).

### 6.3.2 HART®-Communicator

A HART®-communicator (e.g. handheld HC-375 from Emerson) is another operating element which can be used. The operating functions for HC-375 are defined in a DD (Device Description). Using the HC-375 it is possible to operate or configure the OI on-site. The connection is described in chapter 5.

The Device Description Language (DD) can be downloaded from the Internet (HART®-Foundation [www.hartcomm.org](http://www.hartcomm.org)).

## 6.4 Instrument Functions and HART®-Parametrisation

### 6.4.1 Measurement Values

- **Volume Flow:**  
Display of the actual volumetric flow in the selected unit.
- **Flow Unit:**  
Units to define the volumetric flow. Options are: l/s, l/min, l/h, m<sup>3</sup>/s, m<sup>3</sup>/min, m<sup>3</sup>/h, gal/s, gal/min, gal/h, impgal/s, impgal/min, impgal/h, ft<sup>3</sup>/s, ft<sup>3</sup>/min, ft<sup>3</sup>/h.
- **Reset Meter:**  
The Reset Meter adds the volume values measured in the selected unit and can be reset. After a power outage the meter is automatically reset to zero.
- **Sum Meter:**  
The Sum Meter adds the volume values measured in the selected unit. This meter can only be reset when being serviced. The value displayed does not change after a power outage.
- **Unit of Volume:**  
This unit defines the value of the reset and the sum meter. If this unit is changed during operation, the new volume units are added to the old volume units. Therefore please set the meters to zero before changing the unit. Choose between l, m<sup>3</sup>, gal, impgal, ft<sup>3</sup>.
- **Frequency history:**  
The maximum sensor frequency is recorded. The display cannot be set to zero or altered (drag hand function) and remains the same after a power outage.
- **Pulse Meter:**  
The Pulse Meter displays the number of all original pulses without evaluation. The display cannot be set to zero and remains the same after a power outage.

### 6.4.2 Output

- **Final Value of Measurement Range:**  
The final sensor value is pre-set in the USTI of all meters regardless of the series. This value must not be exceeded during operating.
- **Initial Value of Measurement Range:**  
The initial sensor value is pre-set in the USTI of all meters regardless of the series. Below this value there is no defined error curve.
- **Minimum Measurement Span:**  
The minimum measurement span can be set as desired within the measurement range. The minimum measurement span should be maintained as a lower value can lead to fluctuations of the output current.
- **Initial Value of Current Output:**  
The desired initial flow value in the selected unit is assigned to the initial value of 4 mA. Usually the flow value of zero is assigned to 4 mA.
- **Final Value of Current Output:**  
The desired final flow value in the selected unit is assigned to the final value of 20 mA.
- **Attenuation:**  
Attenuation effects the output current and the flow display. Choose a value between 1s and 200s. The resolution is about 1s.
- **Current Alarm:**  
When the current alarm is activated the current output is set to 22 mA, as soon as a current alarm occurs.
- **Pulse Output:**  
The pulse output can either be set as original pulse with the frequency und pulse value corresponding to the K-factor of the meter or as a scaled pulse with a pulse value and pulse width that can be scaled in decade steps.

### 6.4.3 Device Parametrisation

- **Sensor Type**

Indicates to which sensor type (Wiegand, Reed or inductive pick-up) the electronics are set.

- **K<sub>P</sub> Factor:**

The test factor is a constant that is specific for the individual device and may not be changed. It is determined during the calibration process, the unit is pulses/l.

- **K<sub>K</sub> Factor:**

The correction factor is without dimension and serves to adjust the error curve to various media. The factor can be adjusted by the servicing staff. Thus viscosity correction is possible.

- **K<sub>B</sub> Factor:**

The operating factor is the product of the test and correction factor. This factor is not saved in the USTI but calculated and displayed by the PACTware.

- **Display Mode:**

The display can be switched from flow to reset meter and sum meter. The three values are shown alternately at intervals of about 2 seconds.

- **Pulse Value Factor:**

The value of the output pulses and of the meter are set using the pulse value factor  $F_w$ . Together with the selected unit the pulse value factor corresponds to the pulse value and to the increment of the meter.

Example: pulse value factor 0.1 means:  $1 \text{ pulse} \hat{=} \underbrace{0,1}_{\text{Factor}} \cdot \underbrace{l}_{\text{Unit}}$   
value

When the factor is set, the display automatically adjusts the decimal point accordingly so that the values can be read directly from the meter.

The pulse value factor can be set as follows:

Pulse value factor	1	0.1	0.01	0.001
--------------------	---	-----	------	-------

If this factor is changed during operation, the meters should be set to zero as otherwise mixing various volume evaluations will lead to incorrect figures. Please check that the maximum output frequency is not exceeded, which depends on the selected pulse width (see table "pulse width" below). If the output frequency is exceeded, the excessive pulses are counted into a buffer memory; the output is effected with a time delay.

- **Pulse Relation Factor:**

Using the pulse relation factor  $F_i$  the meter and the pulse output can be evaluated differently. The pulse relation factor is the relation of the value of the meter increment and the value of the pulse output.

**The standard setting is  $F_i=1$ , i.e. one increment on the meter corresponds to one pulse output.**

If the factor is set to  $F_i \neq 1$  the value of the pulse output is changed whereas the value of the meter remains unchanged. The maximum output frequency must be checked.

- **Pulse Width:**

Choose the pulse width according to the table below:

Pulse width	150 ms	50 ms	20 ms	10 ms
Maximum output frequency	3,3 Hz	10 Hz	25 Hz	50 Hz

This setting applies to both pulse outputs, i.e. current pulse and NAMUR pulse. The maximum output frequency has to be taken into account when choosing pulse value and pulse relation factor.

#### 6.4.4 Dialog / Functions

- **Reset of the Reset Meter:**  
The reset meter can be reset to zero at any time.
- **Reset of the Sum Meter:**  
The sum meter may only be reset by our service staff. If the unit of the volume or the pulse value are changed, this meter has to be reset to zero.
- **Current Simulation:**  
For testing serially connected devices a fixed output current may be set. After testing the current value 0 mA has to be entered to end the simulation.
- **Calibration of Current Output:**  
The characteristic curve of the analog current output can be calibrated at 4 mA for the zero point and at 20 mA for the final value. Please note that the zero point has to be calibrated before the final value.

#### 6.4.5 HART®

- **Software Version:**  
The number indicates the version of the USTI software.
- **Hardware Version:**  
The number indicates the version of the USTI hardware.
- **Polling Address:**  
If the USTI is to be installed for multi-drop application, a polling address from 1 – 15 must be entered. This means that a point-to-point connection with the desired address has to be configured beforehand. If the polling address is set to zero, the operation is analog.

### 6.5 Checking the Maximum Output Frequency of the Pulse Output

To ensure that the maximum output frequency is not exceeded, observe the following:

For  $F_i=1$ ,  $F_w \hat{=} W_{\text{count}}=W_{\text{puls}}$  the following applies:

$$F_w \geq \frac{Q_{\text{max}}}{f_{\text{max}}}$$

For  $F_i \neq 1$ ,  $F_w \hat{=} W_{\text{count}}$  the following applies:

$$F_w \geq \frac{Q_{\text{max}}}{f_{\text{max}}} \cdot F_i$$

and

$$W_{\text{puls}} = \frac{W_{\text{count}}}{F_i}$$

#### Meaning of Formula Symbols:

$Q_{\text{max}}$ : maximum flow  $\left[ \frac{\text{unit} - \text{as} - \text{selected}}{\text{Second}} \right]$

$f_{\text{max}}$ : maximum output frequency. see table:

Pulse width	150 ms	50 ms	20 ms	10 ms
Maximum output frequency	3.3 Hz	10 Hz	25 Hz	50 Hz

$F_w$ : pulse value factor

pulse value factor	1	0.1	0.01	0.001
--------------------	---	-----	------	-------

$F_i$ : pulse relation factor

$W_{count}$ : counting value in l, m<sup>3</sup>, ...

$W_{puls}$ : pulse value in l, m<sup>3</sup>, ...

### Calculation examples to check the scaled pulse output taking into account the maximum output frequency

- Example  
for a selected pulse width of 150 ms the  
maximum output frequency is  $f_{max} = 3.3\text{Hz}$ .

- selected volume unit [l]

- maximum flow (e.g. RQ 20)  $Q_{max} = 3.3\text{ l/s}$

The smallest possible pulse value factor is calculated as follows:

$$F_w \geq \frac{Q_{max}}{f_{max}} = 3.3 / 3.3 = 1$$

According to the table (see page 23) for the pulse value factors

$$F_w = 1$$

the next larger value or the same value must be selected.

Thus the value of the meter and the pulse output is 1 l and 1 l per pulse.

- The same meter data as in example 1 are assumed, but the value on the meter is to be one tenth of the value of the pulse output (meter is 10 times faster). A pulse relation factor of 0.1 needs to be set.

The smallest possible pulse value factor is calculated as follows:

$$F_w \geq \frac{Q_{max}}{f_{max}} \times F_i = 3.3/3.3 \times 0.1 = 0.1$$

For the pulse value factor

$$F_w = 0.1$$

the next larger value or the same value must be selected.

The pulse value of the pulse output is calculated as follows:

$$W_{puls} = \frac{W_{count}}{F_i} = 0.1 / 0.1 = 1\text{ l} \quad (\text{for } F_i \neq 1 \text{ ist } F_w \hat{=} W_{count})$$

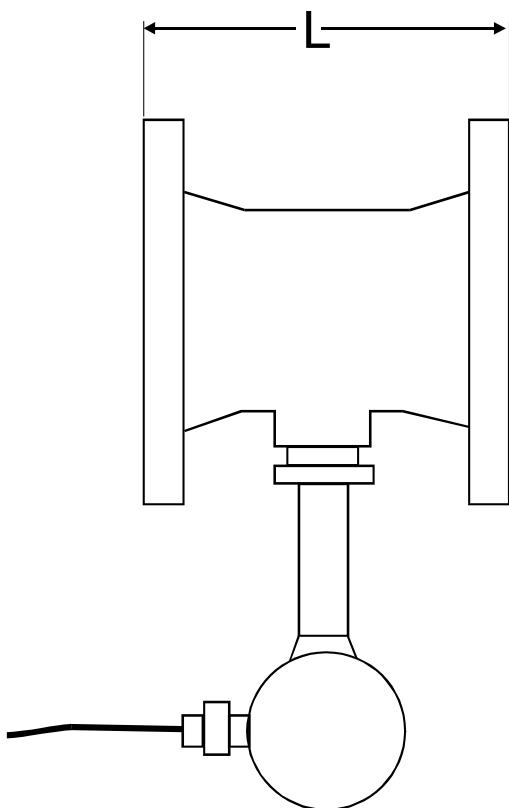
Higher pulse values can be selected by setting the pulse value factor to a higher decimal level.

**Note: The maximum output frequency will be exceeded, if the pulse value factors are smaller than the calculated critical value.**

## 7 Dimensions and Weights

### 7.1 Dimensions of Various Meters of the Series

#### 7.1.1 Design / Dimension Turbine Meter



DN	PN	L	Weight PN40
DIN	DIN	[mm]	kg
10	From PN 10 to PN 100	140	4
15		140	4
20		150	5
25		150	6
32		160	8
40		170	10
50		170	12
65		190	15
80		200	19
100		200	28
150		300	62
200		400	110
250		500	170
300		600	240



## 8 Technical Data

### 8.1 Material

#### 8.1.1 Turbine Meter

Series 1 (DN15-65): stainless steel 1.4429, housing stainless steel 1.4425

Series 2 (DN80-DN300): Housing steel or stainless steel, cast or forged.

More materials upon request (Hastelloy etc.)

#### 8.1.2 In-/Outlet section

Material group	Flanges	Pipe	Material	
			Pipe bundle ≥ DN 65	≥ DN 80
F	1.4571	1.4571	1.4571	
F 2	1.0425 1.0432	1.0305	1.4571	1.0305

### 8.2 Process Connection

Flange: DN 10 – 300 (1/2" – 12")

PN 6 – 320

Class 150 – 2500 in accordance with DIN 2501 or ANSI B16.5

### 8.3 Environmental Conditions

Avoid exposure of the electronics housing and the turbine wheel meter to sudden temperature changes.

#### 8.3.1 Ambient Temperature

-10°C up to +70°C

#### 8.3.2 Storage Temperature

RQ: -25°C to +100°C

USTI: -25°C to +70°C

RQ with USTI: -20°C to +70°C

#### 8.3.3 Climatic Category

Class DIEC 654-1

#### 8.3.4 Degree of Protection

IP 67

#### 8.3.5 Electromagnetic Compatibility

DIN EN 61000-6-2, DIN EN 61000-6-3, as well as NAMUR NE 21

## 8.4 Process Conditions

### 8.4.1 Viscosity Range

0.2 to 50 mPa·s

### 8.4.2 Media Temperature Range

Compact design -40...+70°C

Wall design -65...+180°C

Design for low or high temperature -196...+250°C



## 8.5 Characteristic Values

### 8.5.1 Accuracy

High accuracy	≤0.15 % of reading over a reduced flow range
Standard accuracy	≤0.25 – 0.3 % of reading for normal flow range

The given values for the accuracy are for viscosities of 0.2 – 0.7 mPa·s.

The accuracy depends on the viscosity, flow range and the requested nominal size.  
Please contact our sales engineers for specific information.

### 8.5.2 Repeatability

±0.02 % of measured value

### 8.5.3 Response Time

1 s

### 8.5.4 Turn-On Drift

2 s

### 8.5.5 Long Term Drift

< 0.005 % / year

### 8.5.6 Influence of Ambient Temperature

< 0.005 % / °C

## 9 Standards and Guidelines

DIN EN 9001 certified

Guideline 94/9/EG	(Ex- Guideline)
IEC 60079-0	General Provisions
IEC 60079-11	Intrinsic Safety „i“

Electromagnetic compatibility according to DIN EN 61000-6-2, DIN EN 61000-6-3

NAMUR Recommendation NE21

EN 60529 Protection Type through Casing (IP-Code)

EN 61010 Safety Regulations for Electrical Measurement, Control-, Regulating- und Laboratory Devices

EN 60947-5-6:2000 Low Voltage Switching Devices

Guideline 97/23/EG (Pressure equipment directive))

## A. Appendix

### A.1 Error Detection / Trouble Shooting

The turbine flow meters with USTI do not require servicing. In case of malfunctions or supposed incorrect measurements the following instructions offer help.



#### **Warning!**

When working on electrical connections, observe local regulations and all safety instructions of these operating instructions.

For Ex-devices all information and regulations from the Ex-documentation must be observed in addition to the above. The following describes possible malfunctions and the necessary measures for remedy. For some tests it is necessary to remove the USTI electronics from the casing. To do so, remove the cover and the face of the counter so that you can loosen both diagonally opposed cylinder head studs on the circuit board. Please take care not to lose the two plastic washers.

### A.2 Error Detection in the Evaluation Electronics

#### **No LCD display:**

Check the current loop, the load and the voltage supply. The supplied voltage should be between 14 V DC and 30 V DC. The maximum load is based on the supply voltage. see 3.2.

#### **No flow information on the LCD:**

If a „zero“ flow is shown, although there is a flow, check the coding on the jumpers above the LCD according to the following diagram. To do so, first remove the dial face. (See chapter 6.4.3: Type of Sensor).

Coding	Type (Sensor)	Type name
	Turbine inductive	AG 81/82/83

#### **Volume Meter cannot be reset to zero:**

With the Reed "RESET" above the display, only the reset meter may be reset to zero, not the sum meter. The reset meter can only be reset, when this function is displayed. The display mode may be changed by means of the HART®-protocol or with the Reed "DISPLAY" below the display. Touching time > 3 seconds.

#### **Current output does not work properly:**

If the value of the output current deviates from the theoretical reference value, the supply voltage and the maximum load limits must be checked. A load which is too large may result in a substantial decrease of the terminal voltage for the USTI. The calibration of the 4 mA and the 20 mA points of the output characteristic curve must be checked, too.

If the current output does not show analog values check the selection switch on the supply circuit board. (See also diagram in chapter 3.1.2)

**Pulse output does not work properly:**

IF the USTI current pulse output is used, the double actuator must be set correctly (see diagram in chapter 3.1.2).

The current pulse is available at terminals 1 and 2, the NAMUR-pulse at terminals 3 and 4!

If the high level is lower than 20 mA check the supply voltage and the load (see chapter 3.2).

**Pulse output when flow is zero:**

If pulses are sent to the pulse output when there is no flow check pulse value, pulse relation factor and pulse width. If a large pulse width has been selected, the output of the pulses is processed rather slowly. If the factors have been selected in such a way that the theoretical output frequency is significantly higher than the maximum possible frequency, the excess pulses are stored. The overflow memory then sends signals with a maximum frequency even if the flow is zero until the memory is empty. Thus no volume pulses are lost.

**Meter increments are too small:**

Check the volume rate unit,  $K_P$ -,  $K_K$ - and pulse value factors as well as the decimal point.

**Meter increments are too big:**

Check the volume rate unit,  $K_P$ -,  $K_K$ - and pulse value factors as well as the decimal point.

**Output current is over 20 mA:**

The flow of the turbine meter is larger than the end of the range of the measurement output. The range end must be increased accordingly.

**Output current remains at 4 mA for small flows:**

The beginning of the range of the measurement output is set at a value that is too high. The beginning of the range must be reduced accordingly.

**Output current fluctuates significantly:**

The revolutions of the turbine meter or the pulse frequency is very low. The minimum measurement range has not been reached. Attenuation of > 1 s may result in a smoothing.

**Values on the flow display are too high:**

Check the flow unit and the  $K_P$ - und  $K_K$ -factors.

**Values on the flow display are too small:**

Check the flow unit and the  $K_P$ - und  $K_K$ -factors.

**Data Transmission does not work properly:**

The minimum load must be attained for reliable communication. The optimal minimum loop resistance is about 230  $\Omega$ . If the load is higher a sufficiently high supply voltage must be available (chapter 3.2).

**Data Transmission is not possible:**

The USTI must be connected with a point-to-point connection. Only one master may access the interface. The multi-drop address must be set to 0. Loop resistance and supply voltage must be within the limits given in chapter 3.2 . With these settings communication should be possible.

**General information:**

If the cause of a malfunction cannot be detected, please contact the Bopp & Reuther service or send the device to Bopp & Reuther for repair.

**A.3 Rotation of the display**

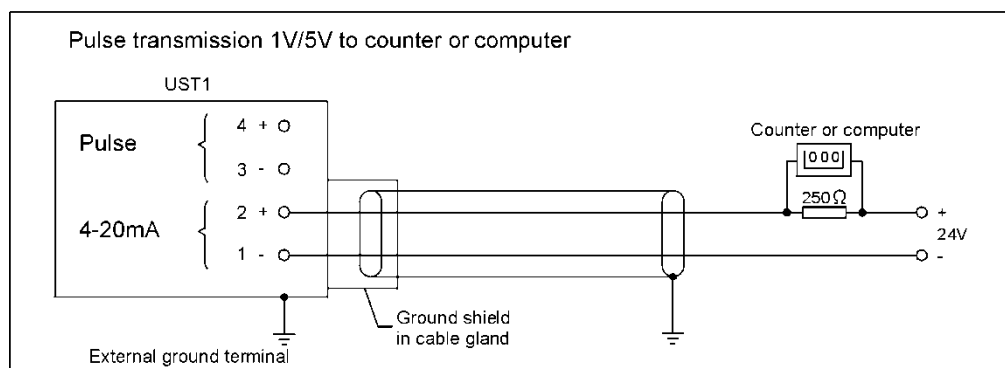
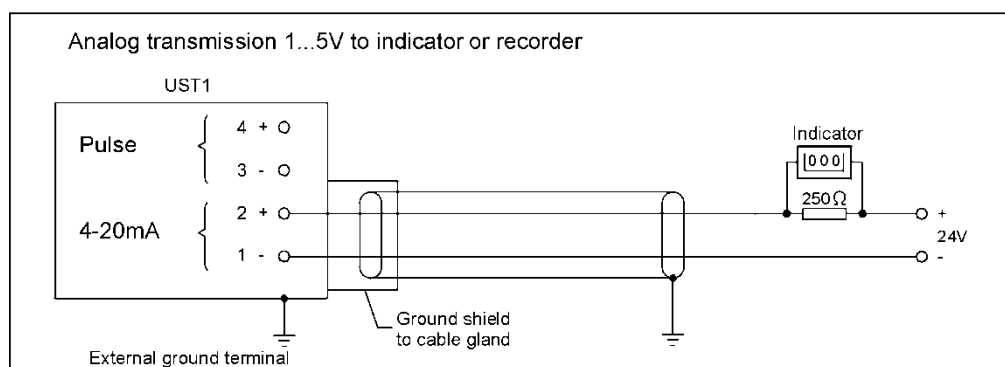
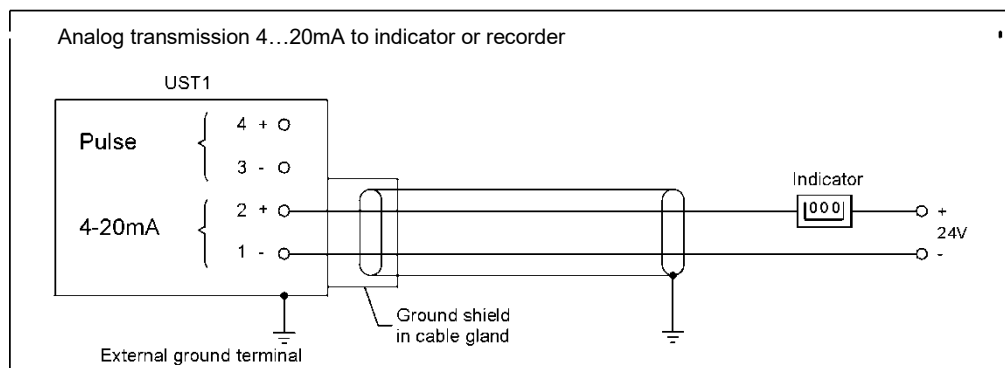
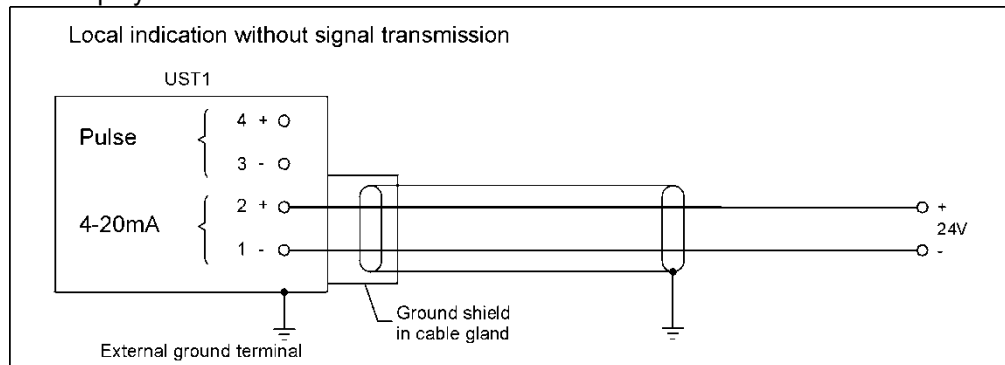
If you want to change the display direction, the LCD can be rotated 90° by our service personnel or by yourself. Remove the cover with the pane of glass and unscrew the fastening screws of the dial face. If you want to rotate the display 180° you only need to remove the electronics block and rotate it. If you want to rotate the display 90° you must remove the electronics block and the mounting plate below and rotate both. All assembly work may only be performed off-circuit.

## B. Connection Examples

### B.1 Connection Example 1

for

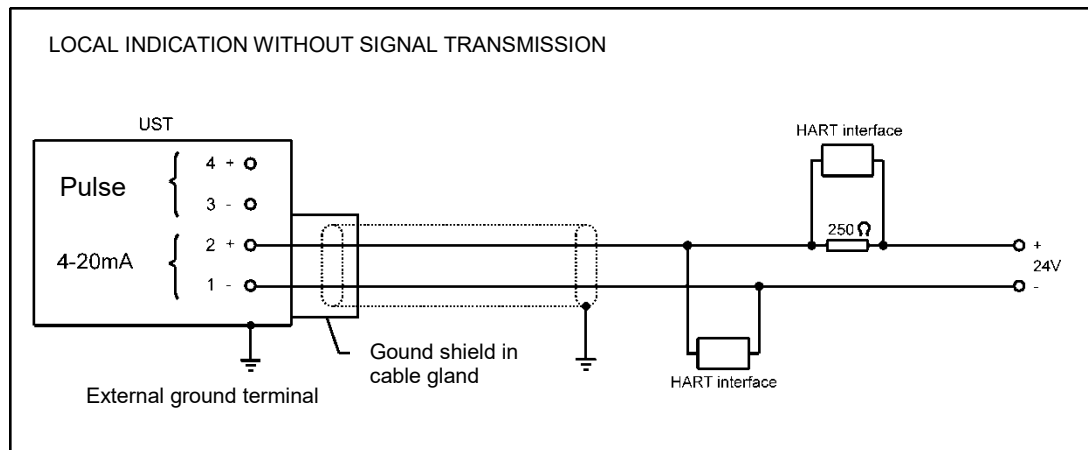
- Employment in a non-hazardous area



## B.2 Connection Example 2

for

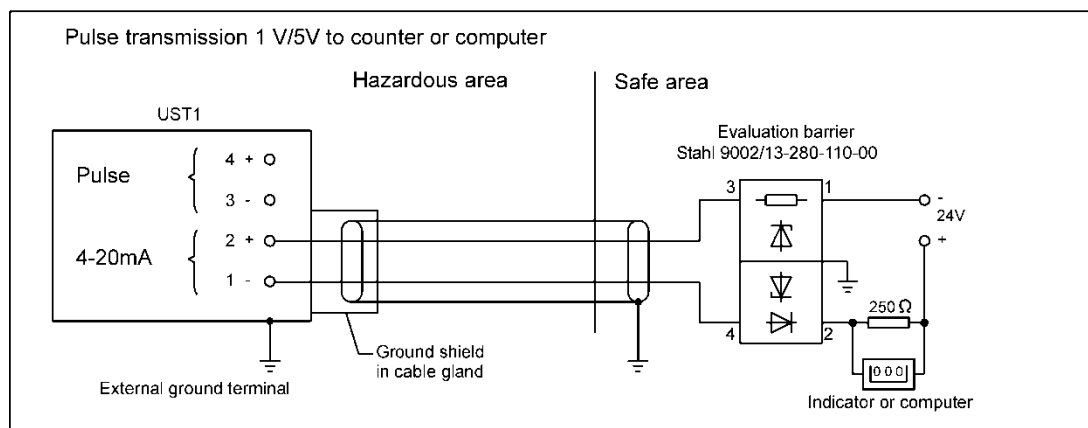
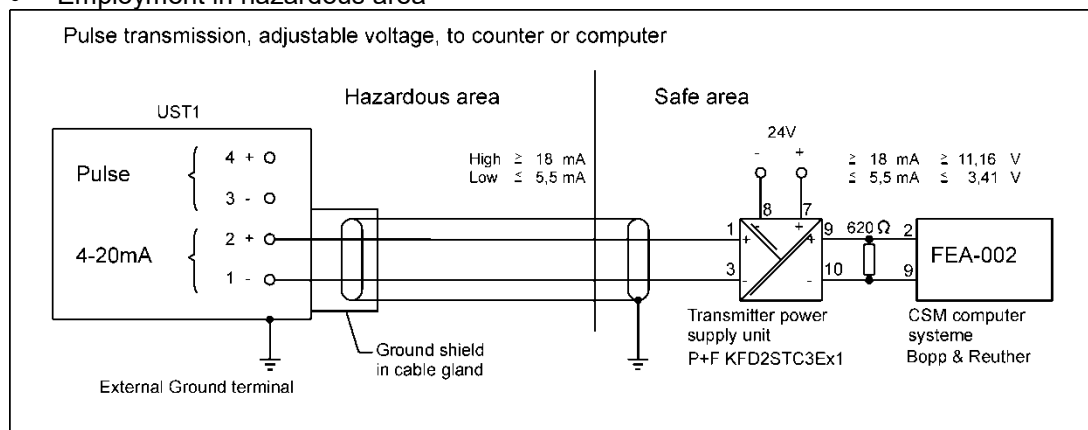
- Employment in non-hazardous area with HART®



## B.3 Connection Example 3

for

- Employment in hazardous area

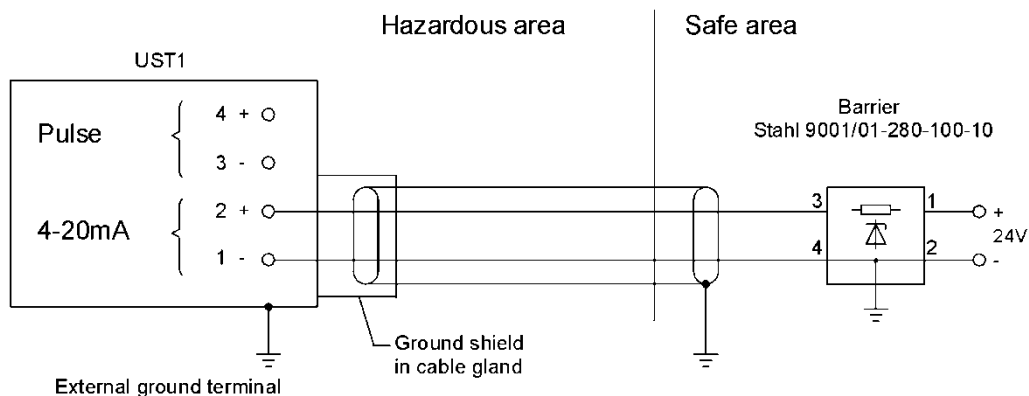


## B.4 Connection Example 4

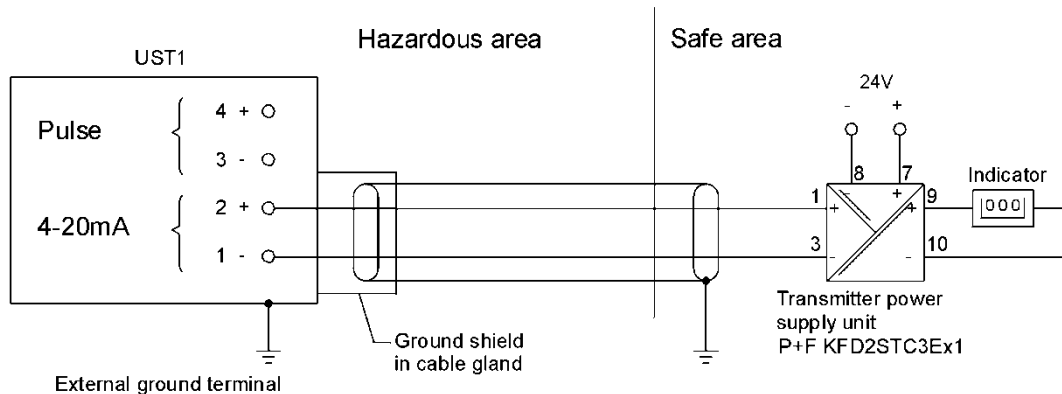
for

- Employment in hazardous area with or without HART®

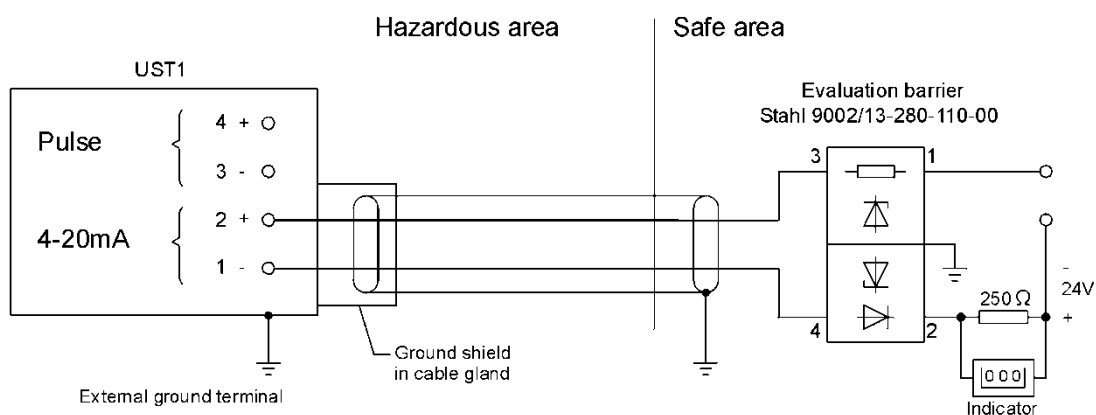
Local indication without signal transmission



Analog transmission 4...20mA to indicator or recorder, electrically isolated



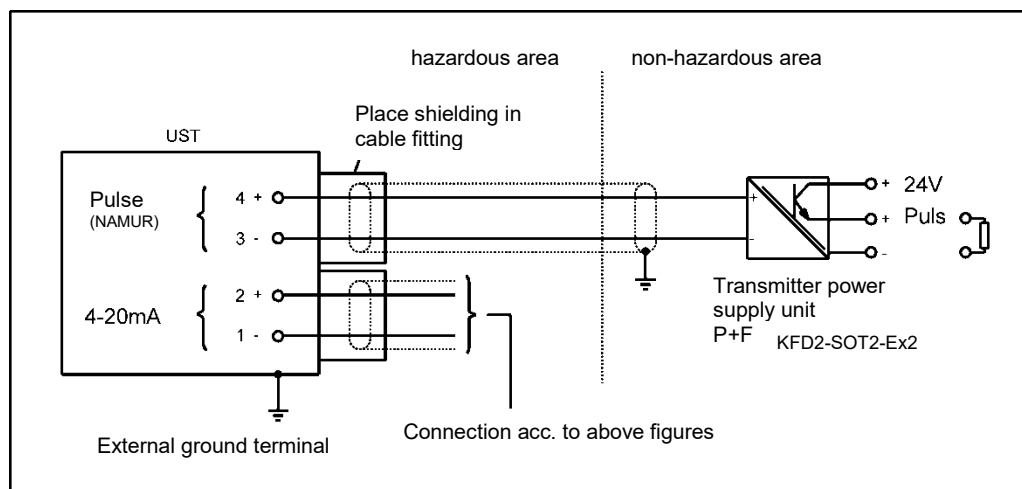
Analog transmission 1...5V to indicator or recorder



## B.5 Connection Example 5

for

- Employment of the pulse output according to NAMUR in an hazardous area





## C. Declaration on Decontamination

**Bopp & Reuther Messtechnik GmbH**  
Am Neuen Rheinhafen 4  
67346 Speyer  
Germany

**BOPP & REUTHER**  
**MESSTECHNIK** 

ERA number:

Telephone: +49 (0) 6232 / 657 420  
Fax: +49 (0) 6232 / 657 561  
Mail: [service@bopp-reuther.com](mailto:service@bopp-reuther.com)  
Web: [www.bopp-reuther.com](http://www.bopp-reuther.com)

### DECLARATION ON DECONTAMINATION OF METERS AND COMPONENTS

Please complete this form and return in advance by email or by Fax to +49(0)6232 / 657 561 in order to receive an Equipment Return Authorisation (ERA) number (not necessarily required). No action to repair or examine the meter will be done, until a valid declaration of decontamination has been received.

#### Contact information

Company Name:

Contact Person:

Company Address:

Name:

Phone:

Email:

#### Meter information

Type:

Serial no.:

Id. no.:

Reason for return (e.g. calibration, repair). Please describe in detail.

#### Contamination information

The meter was contaminated with:

☐ poisonous



☐ corrosive,  
irritant



☐ flammable



☐ hazardous



☐ oxidizing



☐ cancer-causing,  
harmful



☐ explosive



☐ environmental  
hazardous



☐ other:

The meter was cleaned with:

#### Packaging and shipping Instructions

- Remove all cables, connectors, separate filters and mounting materials
- Please pack each item in two suitable sealed protective foil bags
- Transport in suitable shipping package (e.g. original Bopp & Reuther Messtechnik shipping package)
- Include a copy of this declaration form along with the shipping documents on the outside

By signing this form, you are accepting the full responsibility for its contents and confirming that appropriate decontamination has taken place in accordance with legal regulations.

Print name:

Date:

Legally valid signature:



ZERTIFIKAT ◆ CERTIFICADO ◆ CERTIFICAT ◆ CERTIFICATE ◆ 認証証書 ◆ CERTIFICATE ◆ ZERTIFIKAT



Industrie Service

# ZERTIFIKAT Certificate

**Konformität mit der Bauart (Modul C1)  
nach Richtlinie 97/23/EG**  
*Conformity to Type (Module C1) according to Directive 97/23/EC*

**Zertifikat-Nr.:** Z-IS-DDB-MAN-15-05-100067376-007  
*Certificate No.:*

**Gültigkeit / Validity:** 10 Jahre / 10 Years

**Name und Anschrift  
des Herstellers:**

*Name and postal address of manufacturer:*

**Bopp & Reuther Messtechnik GmbH  
Am Neuen Rheinhafen 4  
D-67346 Speyer**

**Der Hersteller ist nach Prüfung der Voraussetzungen berechtigt, die von ihm im  
Rahmen des Geltungsbereichs hergestellten Druckgeräte mit unserer Kenn-  
nummer gemäß dem abgebildeten CE-Kennzeichen zu kennzeichnen:**

*The manufacturer is - after examination of the prerequisites - authorised to provide his pressure equip-  
ment manufactured within the scope of the examination our identification number to the CE-mark as  
illustrate:*

**CE 0036**

**Prüfbericht Nr.:**  
*Test report No.:*

**P-IS-DDB-MAN-15-05-100067376-009**

**Geltungsbereich:**  
*Scope of examination:*

**Durchfluss Messgeräte (Ovalradzähler  
OI, OUI, OaP, OuaP, OV, OK, OT, Turbi-  
nenradzähler RQ, Wirbeldurchflussmes-  
ser VTX2, Kompaktblende Oriflow und  
Oriflow PVDF, Filter (Na, NC, N, Nu)**

**Fertigungsstätte:**  
*Manufacturing plant:*

**Bopp & Reuther Messtechnik GmbH  
Am Neuen Rheinhafen 4  
D-67346 Speyer**

**Mannheim, 08. Juni 2015  
(Ort, Datum)**

*Bitte beachten Sie die Hinweise auf der zweiten Seite.  
Please note the remarks on the second page..*



**D.4 EU – Declaration of conformity****D.4 EU-Konformitätserklärung**

**EU - Konformitätserklärung**  
**EU - Declaration of conformity**  
**UE - Déclaration de conformité**

**Hiermit erklärt der Hersteller in alleiniger Verantwortung, dass die nachfolgend bezeichnete Baueinheit den Anforderungen der zutreffenden EU-Richtlinien entspricht. Bei nicht mit uns abgestimmten Änderungen verliert diese Erklärung ihre Gültigkeit.**

*The manufacturer herewith declares under sole responsibility that the unit mentioned below complies with the requirements of the relevant EU directives. This declaration is no longer valid if the unit is modified without our agreement.*

Par la présente, le fabricant déclare sous sa seule responsabilité que les appareils décrits ci-dessous, correspondent aux exigences de la réglementation UE qui les concerne. Toute modification des appareils sans notre accord entraîne la perte de validité de cette déclaration de conformité

<b>Hersteller</b> Manufacturer Fabricant	Bopp & Reuther Messtechnik GmbH Am Neuen Rheinhafen 4 D-67346 Speyer
<b>Bezeichnung</b> Description Description	Turbinenradzähler Turbine Meter Compteur à turbine
<b>Typ, Modell</b> Type, model Type, modèle	RQ mit with avec UST, AG

<b>Richtlinie</b> Directive Directive	2014/30/EU /UE Elektromagnetische Verträglichkeit Electromagnetic interference Compatibilité électromagnétique	L 96/79
<b>Normen und normative Dokumente</b> Standards and normative documents Normes et documents normatifs	EN IEC 61000-6-2:2019 EN IEC 61000-6-3:2021	

<b>Richtlinie</b> Directive Directive	2014/34/EU /UE Explosionsschutz Explosion protection Protection contre les explosions	L 96/309
<b>Baumusterprüfbescheinigung</b> Type examination certificate Certificat d'approbation de type	DMT 99 ATEX E 014 X	USTI
	DMT 00 ATEX E 025 X	USTD
	BVS 04 ATEX E 022 X	USTX
	DMT 00 ATEX E 062 X	AG81/82/83 (PV10)
<b>Notifizierte Stelle</b> Notified Body Organisme Notifié	BVS, DMT, DEKRA EXAM	0158
<b>Normen und normative Dokumente</b> Standards and normative documents Normes et documents normatifs	EN IEC 60079-0:2018	USTI, USTD, USTX, PV10
	EN 60079-1:2014	USTD, USTX
	EN 60079-11:2012	USTI, USTD, USTX, PV10
	EN 60079-26:2015	USTI

Bopp & Reuther Messtechnik GmbH, Am Neuen Rheinhafen 4, D-67346 Speyer  
 Telefon: +49(0)6232 657-0, Telefax: +49(0)6232 657-505, Email: [info@bopp-reuther.com](mailto:info@bopp-reuther.com), Internet: [www.bopp-reuther.com](http://www.bopp-reuther.com)

Z-ML-KE RQ-V8 2023-01-30



<b>Richtlinie</b> <i>Directive</i> Directive	2014/68/EU /UE Druckgeräte <i>Pressure equipment</i> Équipements sous pression	L 189/164
<b>Konformitätsbewertungsverfahren</b> <i>Conformity assessment procedure</i> Procédures d'évaluation de la conformité	Modul B + Modul C2	
<b>Notifizierte Stelle</b> <i>Notified Body</i> Organisme Notifié	0036 TÜV SÜD Industrie Service GmbH Dudenstraße 28, D-68167 Mannheim	
<b>Normen und normative Dokumente</b> <i>Standards and normative documents</i> Normes et documents normatifs	AD 2000 Regelwerk <i>AD 2000 Code</i> Code AD 2000	
<b>Klassifizierung</b> <i>Classification</i> Classification	Rohrleitungsteil <i>Pipe</i> Tuyauterie	
<b>Fluid Kategorie ; Diagramm</b> <i>Fluid category ; Diagramm</i> Dangerosité du fluide ; Tableau	Gruppe 1 ; Anhang II / 6 <i>Group 1 ; Attachment II / 6</i> Groupe 1 ; Appendice II / 6	
<b>Einstufung Druckgerät</b> <i>Classification équipement sous pression</i> Classification pressure equipment	Kategorie III <i>Category III</i> Catégorie III	

**Die Angaben zur Richtlinie 2014/68/EU ist nur gültig für Druckgeräte die unter Artikel 4 Absatz 1 und 2 fallen, alle anderen unterliegen der guten Ingenieurspraxis nach Artikel 4 Absatz 3.**


*The information on Directive 2014/68 / EU is only valid for pressure equipment that falls under Article 4 Paragraph 1 and 2, all others are subject to good engineering practice according to Article 4 Paragraph 3.*

*Les informations sur la directive 2014/68 / UE ne sont valables que pour les équipements sous pression relevant de l'article 4, paragraphes 1 et 2, tous les autres sont soumis aux bonnes pratiques d'ingénierie conformément à l'article 4, paragraphe 3.*

<b>Richtlinie</b> <i>Directive</i> Directive	2011/65/EU /UE Beschränkung gefährlicher Stoffe <i>Restriction of hazardous substances</i> Limitation de substances dangereuses	L 174/88
<b>Delegierte Richtlinie</b> <i>Delegated Directive</i> Directive Déléguée	(EU /UE) 2015/863 Änderung Anhang II der Richtlinie 2011/65/EU <i>Amending Annex II to Directive 2011/65/EU</i> Modifiant l'annexe II de la directive 2011/65/UE	L 137/10
<b>Normen und normative Dokumente</b> <i>Standards and normative documents</i> Normes et documents normatifs	EN IEC 63000:2018	

**Ort, Datum / Place, Date / Lieu, Date:**

**Speyer, 2023-01-30**

  
**Dr. J. Ph. Herzog**  
**Geschäftsführer**  
*Managing director / Gérant*

  
**i. V. J. Riedl**  
**stv. QM Beauftragter**  
*Deputy QM Officer / Adjoint chargé de la qualité*

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Z-ML-KE OC-V3 2023-01-30

**NOTES:**

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## **Our product portfolio:**

### **Volume flowmeter:**

- Oval wheel meter
- Turbine meter
- Electromagnetic flowmeter

### **Mass flowmeter:**

- Vortex meter
- Compact orifice
- Coriolis mass flowmeter

### **Density and concentration meter (Measuring and testing equipment)**

### **Dosing measurement technology**

- Electromagnetic flowmeter
- Coriolis mass flowmeter
- Oval wheel meter
- Dosing control system

### **Measurement Accessories**

- Processing electronics
- Mechanical indicator
- Pulse pick-ups
- Components

### **Measuring and testing equipment**

### **Conformity assessment according to MID Directive 2014/32/EU**

### **After Sales Service**

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