ISTRUCTION MANUAL

Magnetostrictive Level Transmitter MD and TLT Series

INDEX

1. DESCRIPTION

The high-precision MD and TLT series level sensor is designed to provide continuous gauging of liquid media levels in tanks. The measuring principle used by the sensor exploits the physical effect of magnetostriction and is largely unaffected by temperature. This method is particularly ideal where level measurements are required to be extremely accurate, such as in the chemical industry.
In this documentation, the MD and TLT series is described with cable connection on the side of the probe head. This connection can be an M12 cable gland (also with M16 adapter), an M12 plug, or an M20 resp. ½in NPT internal thread.

The TLT Series is a Reed chain Level Transmitter and it has his own Instruction Manual (see IST/156 “TLT Series Level Indicator”), in this manual is described the magnetostrictive version of this instrument.
The MD Series is designed to be installed as accessory on a 2000 Series Magnetic Level Gauge (see IST/162 “2000 Series Magnetic Level Indicator”).

The MD and TLT Series supplies a 4 ... 20 mA output signal which is configured using buttons in the probe head, or a digital output signal as HART® protocol. Probe lengths are possible from 100 mm to 6 m, as Flex version up to 10 m, as well as versions for different temperature and pressure ranges.
MD and TLT series can also be supplied as Ex version: the level sensors with Ex approval (ATEX, IECEx) can be installed in potentially explosive areas which require equipment protection level Ga (Ex Zone 0), Ga/Gb (Ex Zone 0/1) or Gb (Ex Zone 1) for electrical equipment.

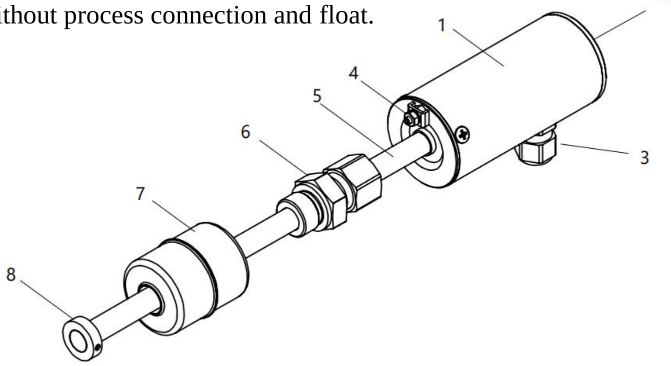
2. SAFETY INSTRUCTIONS

The purpose of the MD/TLT level sensor is to gauge liquid levels in tanks. The level sensor must be used exclusively for this purpose. The manufacturer accepts no liability for any form of damage resulting from improper use.
The level sensor has been developed, manufactured and tested in accordance with the latest good engineering practices and generally accepted safety standards. Nevertheless, hazards may arise from its use. For this reason, the following safety instructions must be observed:

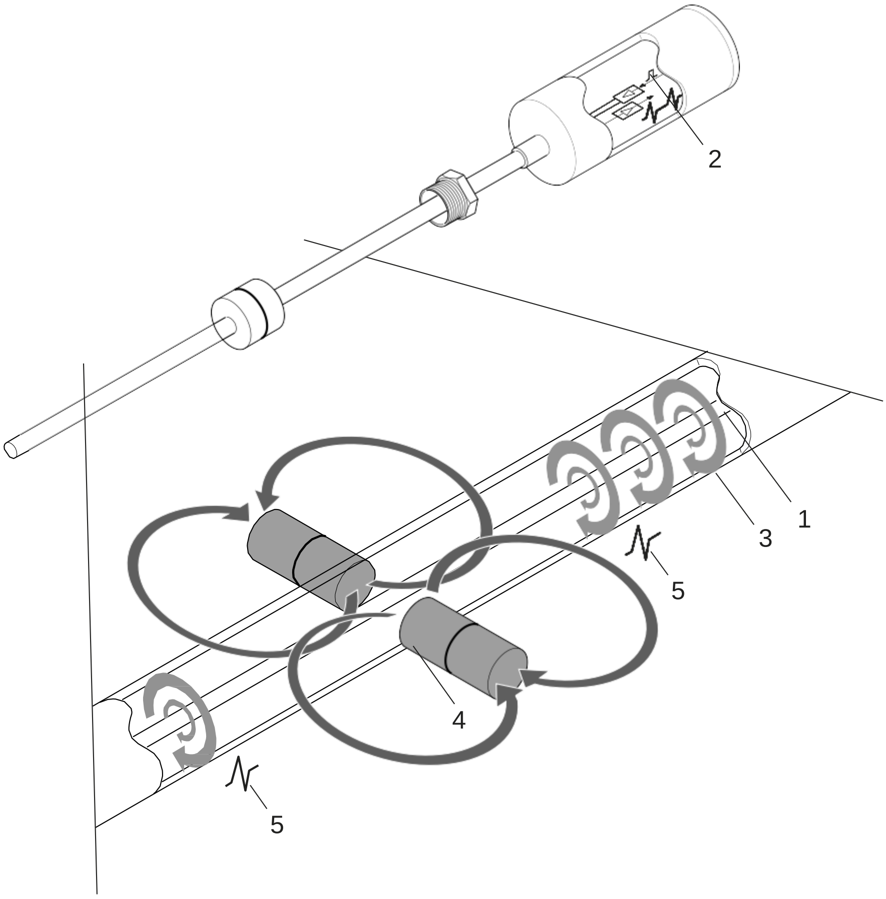
- Do not change or modify the level sensor or add any equipment without the prior consent of the manufacturer.
- The installation, operation and maintenance of the level sensor must be carried out only by expert personnel. Specialized knowledge must be acquired by regular training.
- Operators, installers and service technicians must observe all applicable safety regulations. This also applies to any local safety and accident prevention regulations which are not stated in this manual.

3. DESIGN AND FUNCTION

The design of the MD/TLT level sensor is illustrated in the version with screw-in unit (see following figure).
Inside probe head (1) of the level sensor, concealed by cap (2), are the protected terminal clamps and configuration buttons. The electrical connection is established by an M16 x 1.5 screwed cable gland (3) or M12 plug-in connection at the top of the probe head and by earth connector (4) at the bottom of the probe head (see chapters “Installation” and “User configuration”).
On the probe tube (5) is a screw-in unit (6) (cutting ring fitting or ferrule fitting) for height adjustment capability or a flange (not shown) for fixed installation. The float (7) is the key component for continuous gauging of the product filling level or interface and is held on the probe tube by a guard ring (8).
The MD Series is supplied without process connection and float.



The measuring principle illustrated in the following figure exploits the physical effect of magnetostriction and is largely unaffected by temperature. The probe tube contains a tensioned wire (1) made of magnetostrictive material. The sensor electronics transmit current pulses (2) through the wire, which generate a circular magnetic field (3). A magnet (4) inside the float acts as the filling level sensor. Its magnetic field applies an axial magnetic field to the wire. The superposition of the two magnetic fields produces a torsional wave (5) at the float position, which then propagates along the wire in both directions. One wave propagates directly to the probe head, the other propagates down to the bottom of the probe tube and is reflected. The time between the current pulse being transmitted and the wave arriving at the probe head is measured. From these propagation times, it is possible to determine the current position of the float.

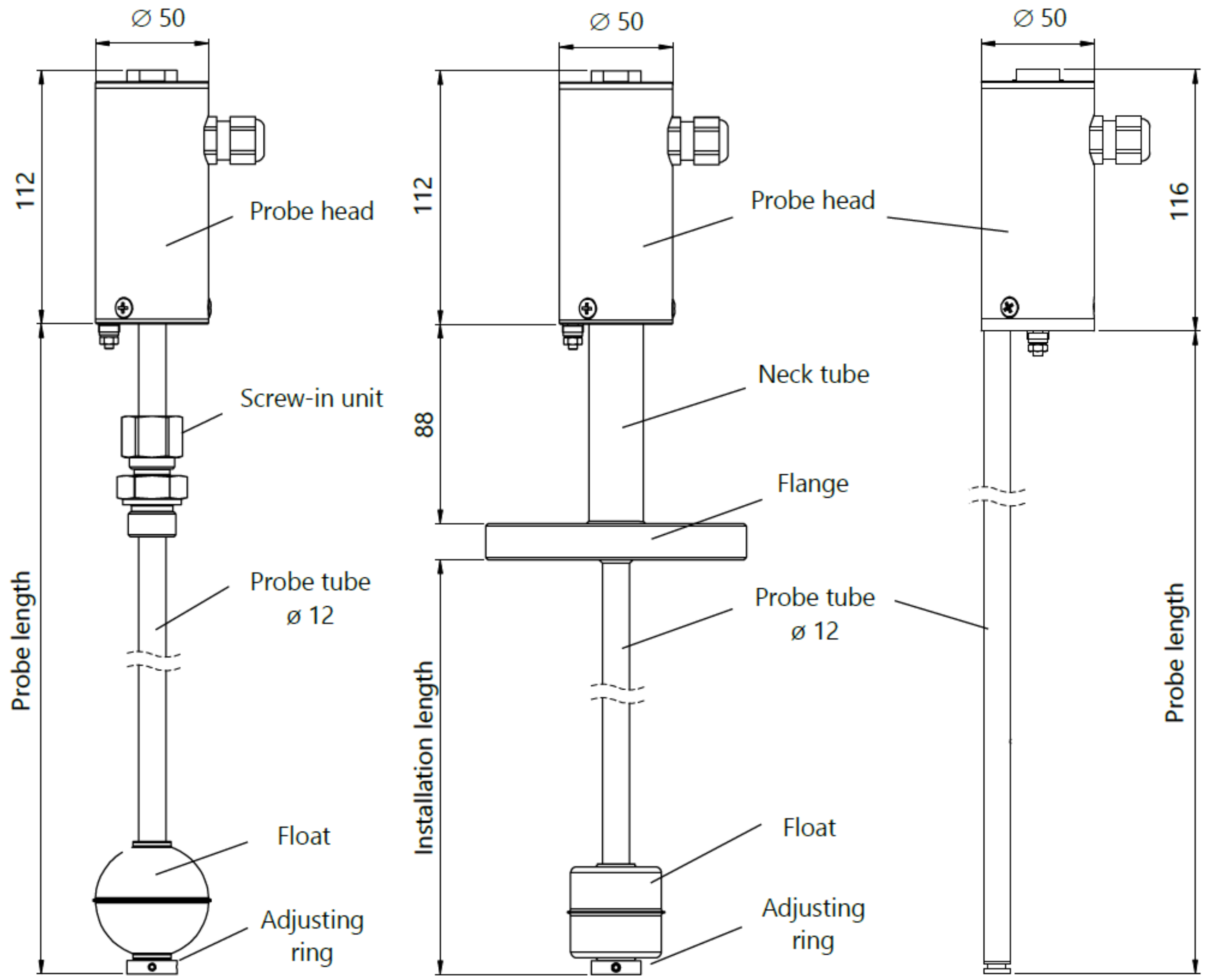


4. INSTALLATION

WARNING:

- When installing and maintaining the level sensor in potentially explosive areas, the national rules must be observed (Explosion Protection Regulations, Industrial Health and Safety Regulations, Equipment Safety Regulations and the specific conditions of the EC-Type Examination Certificates). The generally accepted rules of engineering and these operating instructions must be observed.
- All applicable local safety and accident prevention regulations not included in this manual must also be observed.

This section describes how to install the level sensor depending on the type (see the following figure).



TLT Series
Threated

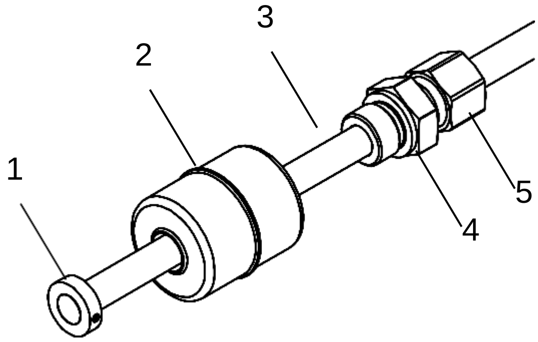
TLT Series
Flanged

MD Series

WARNING:

- During installation, take great care not to bend the probe tube, and protect the float from shock and impact loads.
- Installing a level sensor in areas exposed to a powerful external magnetic field is not permitted because this could impair gauging.
- The level sensor can also be fitted into the tank from underneath. If the container additionally is pressurized, then the maximum length of the level sensor is 2 m.
- If the float is removed during installation, it must be slid back onto the probe tube afterwards with the “TOP” marking oriented towards the probe head to enable correct measurements.

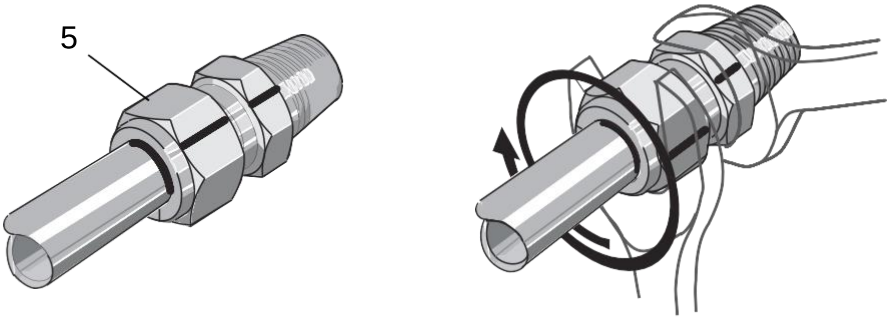
4.1 Installation TLT Series Threated



Removal of the float is necessary only if the float does not fit through the installation opening in the tank. Otherwise, please proceed directly to steps 3, 6 and, if applicable, 7.

Insert the level sensor into the tank (see Figure 4):

1. Loosen both set screws, remove guard ring (1) and float (2) from probe tube (3).
2. If necessary, slot screw-in unit (4) onto the probe tube.
3. Insert the level sensor into the tank, provide screw-in thread (4) with a suitable sealing material, screw it in and tighten.
4. Slide float (2) back onto probe tube (3). For correct gauging, the float must be slid onto the probe tube with the “TOP” marking oriented towards the probe head.
5. Refit guard ring (1) on the tube, align the set screws with the groove and tighten.
6. Adjust the height of the process connection and fix the union nut (5) by hand finger-tight.
7. Fix the union nut (5) with a wrench by a 1¼ clockwise turn (see following figure).



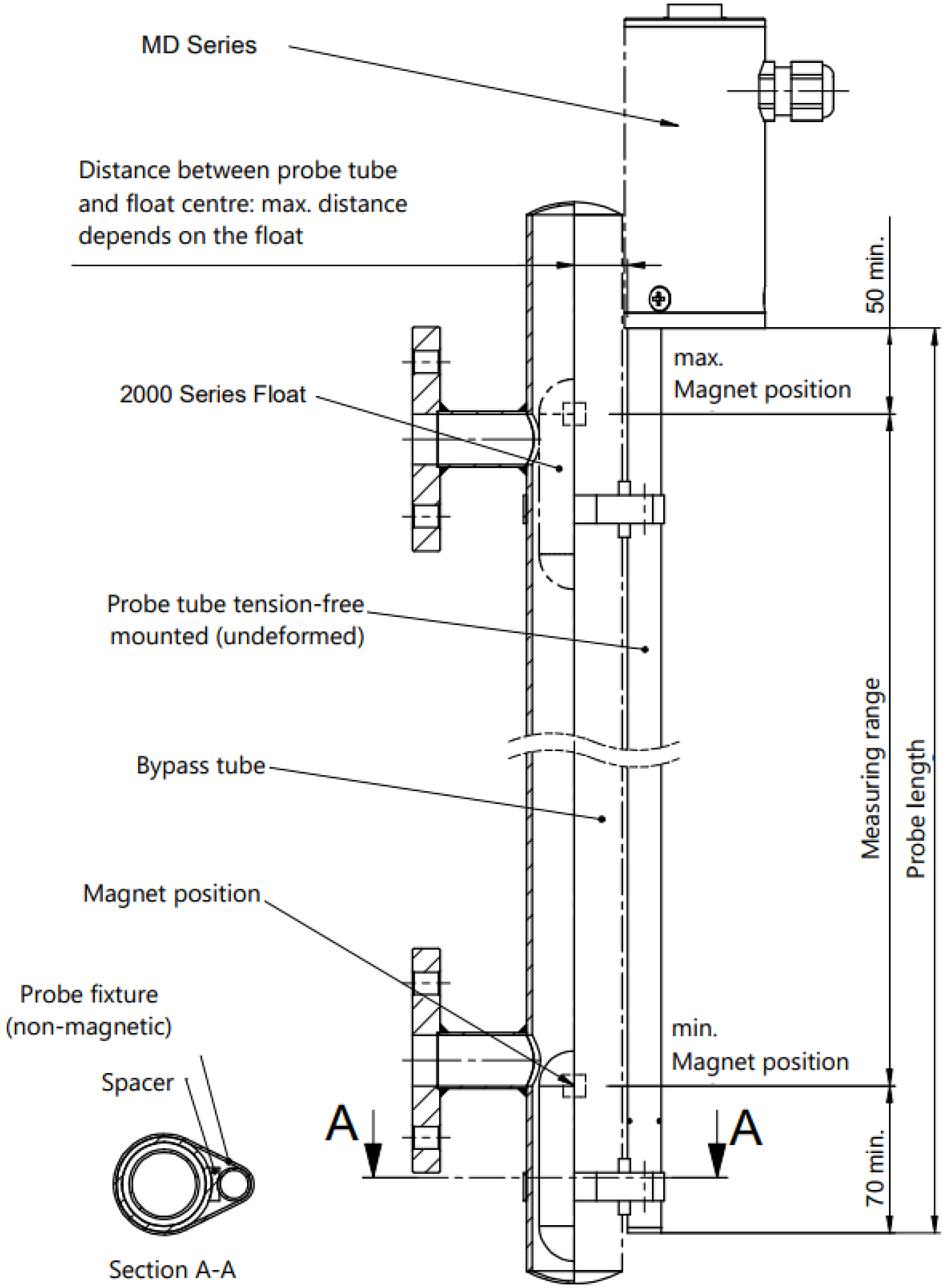
4.2 Installation TLT Series Flanged

The probe tube is permanently welded to the flange, which means that the installation length cannot be altered. Fasten flange and seal with the flange bolts and nuts. The screws or nuts and the seals are the responsibility of the operator and must be chosen depending on the fluid. The fasteners and seals must comply with the requirements of the standards EN 1092-1, EN 1514 and EN 1515.
If the float does not fit through the installation opening, see installation instructions chapter 4.1.

4.3 Installation MD Series

The level sensor is mounted at the side of the 2000 Series tube using suitable non-magnetic fasteners.

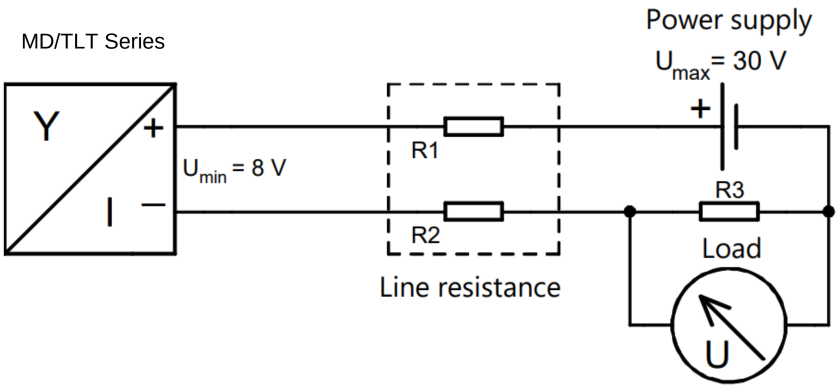
- To ensure reliable gauging, the probe tube must be fitted with no deformation on the outside.
- The distance between the probe and bypass tubes must be as small as possible.
- Only OFFICINE OROBICHE magnetic level indicators can be used.


MD Series
Distance between probe tube and float centre: max. distance depends on the float
50 min.
max.
Magnet position
2000 Series Float
Probe tube tension-free mounted (undeformed)
Bypass tube
Measuring range
Probe length
Magnet position
Probe fixture (non-magnetic)
Spacer
min.
Magnet position
A
A
70 min.
Section A-A

5. ELECTRICAL CONNECTION

5.1 Wiring Diagram for Safety Area Version

The level sensor without Ex approval is installed in accordance with the following wiring diagram:

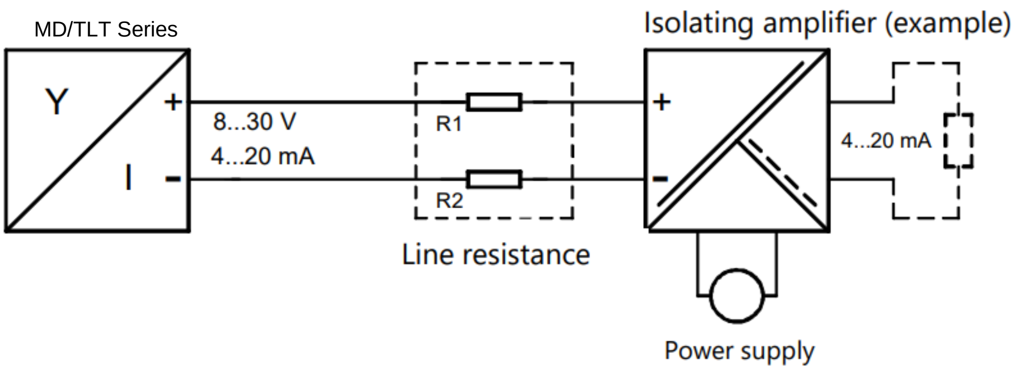


Power supply: U_{max} = 30 V DC
Minimum supply voltage: U_{min} = 8 V
Permissible total resistance (including cable resistance and load): $\Sigma R = (U - U_{min}) / 0.0215$ A

For connection of the cable, see chapter 5.4

5.2 Wiring Diagram for Ex Version

The level sensor with Ex approval is installed in accordance with the following wiring diagram:



Power supply: U_{max} = 30 V DC
Minimum supply voltage: U_{min} = 8 V
Permissible total resistance (including cable resistance and load): $\Sigma R = (U - U_{min}) / 0.0215$ A

The intrinsically safe version of the level sensor, when installed in a potentially explosive atmosphere, is permitted to be connected only to isolating amplifiers that have been certified by a recognized inspection authority and offer electrical outputs that meet the following conditions:

$U_0 \leq 30$ V
$I_0 \leq 200$ mA
$P_0 \leq 1$ W

Further data can be found in the EU-Type Examination Certificate (see Annex).
If the level sensor is to be used in a potentially explosive atmosphere, always make sure that the permissible external capacitance (C0) and inductance (L0) of the isolating amplifier are not exceeded (refer to the electrical data in the EU-Type Examination Certificate).
Used in an explosion-proof application, the connecting cable to the isolating amplifier must be marked, preferably as a blue cable for intrinsically safe electric circuits.

For connection of the cable, see chapter 5.4.

5.3 Cable Length

The maximum cable length depends on the total resistance (see chap. 5.1 / 5.2), composed of the line resistances and the load of connected devices.

- The cable (length and cross-section) must be chosen so that the supply voltage will not fall below the sensor-specific minimum voltage (8 V) in the event of a maximum current consumption (21.5 mA).
- If the level sensor is to be used in a potentially explosive atmosphere, always make sure that the permissible external capacitance (C_0) and inductance (L_0) of the associated equipment are not exceeded (refer to the electrical data in the EC-Type Examination Certificate).
- Because of the voltage drop of 12 V the connection housing HPH Ex d and the safety barrier SB1 can be used only at a supply voltage higher than 20 volts.

The following table shows the maximum total resistances at different supply voltages, and cable resistances at various cross-sections:

Supply voltage [V]	Max. total resistance [Ω]	Cable cross-section [mm²]	Cable resistance per m copper cable [Ω/m]	For connection housing HPH Ex d suitable (yes/no)
12 (-5%)	158	0.5	0.0356	no
		1.0	0.0178	no
		1.5	0.0119	no
24 (-5%)	688	0.5	0.0356	yes
		1.0	0.0178	yes
		1.5	0.0119	yes

The max. cable length is calculated as follows:

$$L = (((U - U_{min}) / I_{max}) - R_B) / R_Q$$

L = Cable length [m]
U = Supply voltage [V] (with negative tolerance value -5%)
U_{min} = Minimum supply voltage [V] = 8 V
I_{max} = Maximum power consumption [A] = 0,0215 A
R_B = Load
R_Q = Cable resistance per m copper cable [Ω/m] at cable cross-section Q [mm²]

<u>EXAMPLE:</u>

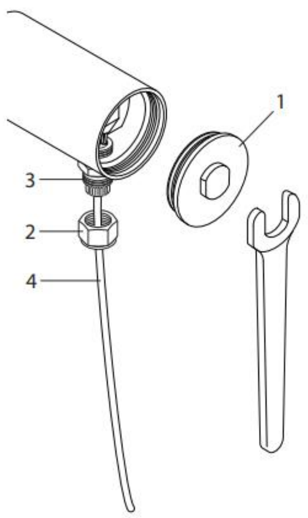
Supply voltage 12 V (± 5%)
Supply voltage U = 11.4 V (12 V - 5%)
Minimum supply voltage U_{min} = 8 V
Maximum power consumption I_{max} = 0.0215 A
Load R_B = 86,8 Ω
Cable resistance per m copper cable R_Q = 0.0356 Ω/m with cable cross-section Q = 0.5 mm²

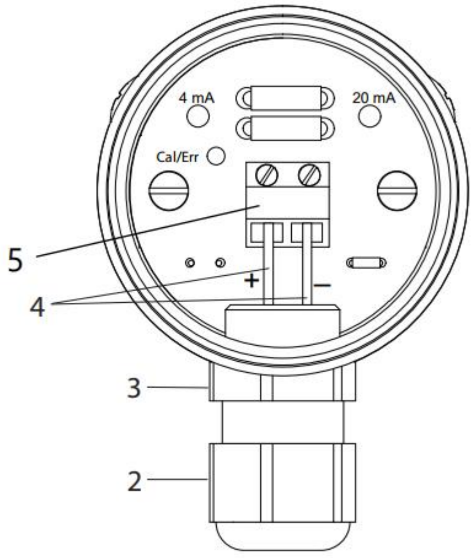
$$L = (((11{,}4 - 8) / 0{,}0215) - 86{,}8) / 0{,}0356 = 2000 \text{ m}$$

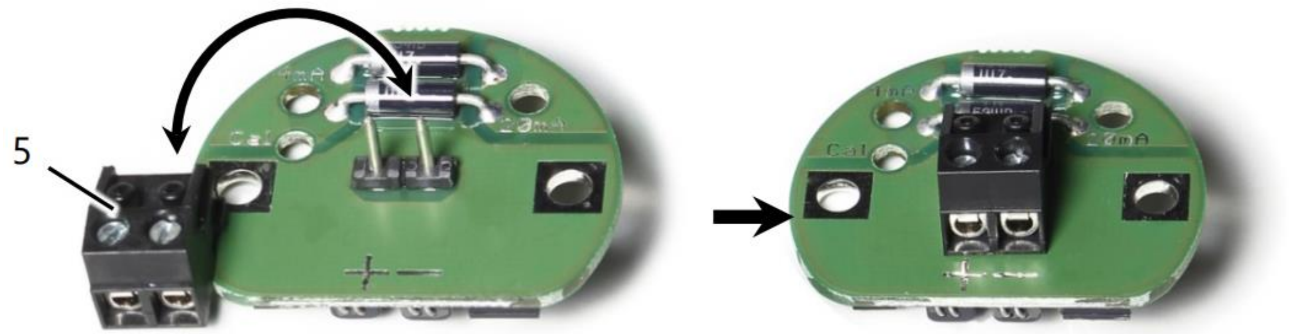
Thus a cable with forward and return line (2-wire) can be up to 1000 m long.

5.4 Wiring

5.4.1 with cable gland







The wiring must be carried out only with the power disconnected.
For the wiring of the level sensor, proceed as follows:

1. Unscrew probe head cover (1) using an open-ended spanner.
2. Loosen union nut (2) of screwed cable gland (3).
3. Feed the two-core cable (4) into the union nut (2) and tighten the nut. The outside diameter must be 5 to 10 mm.
4. Remove screw terminal (5).
5. Connect the two-core cable (4) to the (+) and (–) marked pols of the screw terminal (5).
6. Plug the screw terminal (5) back on. The cable must have no traction!
7. If necessary, set reference points (see chapter 6.1).
8. Screw probe head cover (1) back on.

The earth connector on the underside of the probe head can be used for earthing or equipotential bonding.

Protect the probe head against the ingress of water. An external cable diameter of 5 to 10 mm ensures reliable sealing of the cable entry. Make sure that the cable gland is screwed tight, and close the probe head cap firmly.

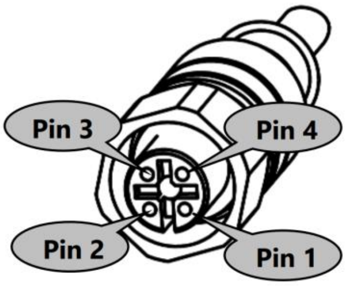
5.4.2 with M12 connection

Wiring work may only be performed with the power disconnected.

- If not already connected, plug the coupling of the Officine Orobiche connection cable onto the M12 connector of the probe head. First tighten the union nut of the M12 connector by hand and then use an open-ended spanner to tighten the nut further 180°. The tightening torque should be between 100 … 150 Ncm.

- Connect the cable coming from the evaluation unit with the Officine Orobiche connection cable, for example using an installation sleeve, in the following assignment:

Signal		Color coding of cables	Assignment of the M12 coupling
Voltage	+	Brown	Pin 1
not used		white	Pin 2
Voltage	–	blue	Pin 3
not used		black	Pin 4



The connection cable between the MD/TLT Series and the associated equipment must have the following properties:

- 2-wire unshielded cable
- For Ex applications color blue or marked blue (cable for intrinsically safe power circuits)

The earthing or equipotential bonding must be carried out by the installer in accordance with the national installation regulations applicable in each case. The earth connector of the probe head can be used for earthing or equipotential bonding requirements.

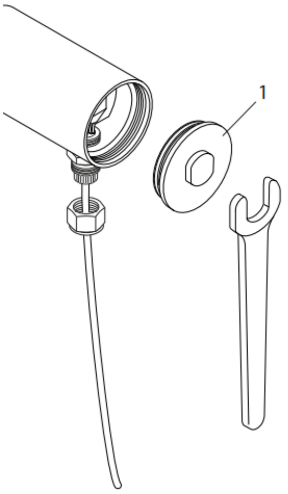
Note also the general installation regulations.

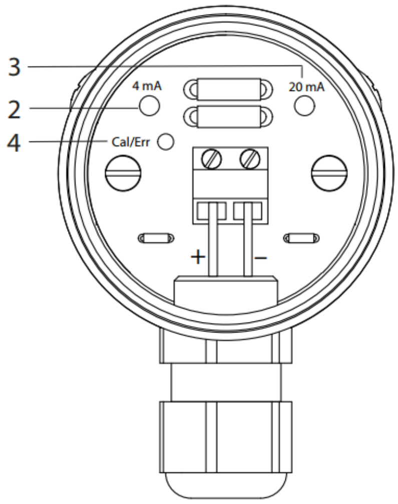
6. ADJUSTMENT

Versions that support the HART® protocol enable the adjustment described below to be carried out remotely without the probe head having to be opened.

6.1 Measuring span at the level sensor

To enable configuration of the 4 mA and 20 mA points at the MD/TLT level sensor, two buttons and an LED (light emitting diode) are provided near the terminals inside the probe head.
By default, the level sensor is set to maximum measuring span with 4 mA at the sensor base and 20 mA at the probe head. The measuring span is configurable for adaptation to the tank concerned. However, a minimum clearance of 10 mm must be observed.
If this minimum clearance is not observed, the display direction of the level sensor will be reversed automatically (ullage measurement).
Through configuration, it is also possible to have the measured value output inverted: e.g. the level sensor can be set to maximum measuring span with 4 mA at the probe head and 20 mA at the sensor base.





1. Unscrew probe head cap (1) using an open-ended spanner.
2. Press and hold 4 mA button (2) or 20 mA button (3) for at least 3 seconds. The green LED begins to flash.
3. The level sensor is now in configuration mode. The current consumption of the level sensor is 12 mA. If no button is pressed again, the level sensor remains in configuration mode for 20 seconds before reverting to measuring mode and dis- carding any changes. In configuration mode, the 4 mA or 20 mA reference point, or both, can be modified in any order.
4. To define a reference point move the float to the desired reference point and
   - briefly press (0.1 to 2 seconds) “4 mA” button (2) to define a current consumption of 4 mA at this position
   - briefly press (0.1 to 2 seconds) “20 mA” button (3) to define a current consumption of 20 mA at this position.

   When the “4 mA” button is pressed, the LED goes out for 5 seconds. When the “20 mA” button is pressed, the LED lights up permanently for 5 seconds.
   The sensor then remains in configuration mode for a further 15 seconds before storing the change and reverting to measuring mode.

The new measuring range configuration is not stored until the level sensor reverts automatically from adjustment mode to configuration mode and the LED goes out. The new configuration is retained even if the level sensor is subsequently disconnected from the power supply.

For “dry” settings to be possible in the case of bypass sensors, a magnetic system with spacer bracket will need to be obtained from the manufacturer of the bypass. Configuration can then be carried out even with the sensor removed.

6.2 Current consumption in failure mode
If a malfunction is preventing the level sensor from recording a plausible float position, i.e. the measured level is incorrect, the sensor will enter the failure mode after a short time. Failure mode signaling conforms to the NAMUR NE43 recommendation. The failure current is set by default to 21.5 mA but this value can also be set to 3.6 mA.

To configure the current consumption in failure mode (see Figure 11).
1. Unscrew probe head cap (1) using an open-ended spanner.
2. Press and hold both the “4 mA” (2) and “20 mA” (3) simultaneously for at least 3 seconds.
   Green LED (4) “Cal/Err” flashes rapidly. The current consumption of the level sensor is 16 mA. After 5 seconds, the LED stops flashing and indicates the selected failure current consumption for 2.5 seconds. If the LED is on permanently, $I_{failure}$ is 21,5 mA, if the LED turns off, $I_{failure}$ is 3,6 mA.
   If no button is pressed again, the level sensor remains in failure mode for a further 2.5 seconds before reverting to measuring mode and discarding any changes.
3. To set a current consumption
   - of 3.6 mA during the dwell time (10 sec) in the fault mode, briefly press the "4 mA" (2) button (0.1 … 2 seconds).

- of 21.5 mA during the dwell time (10 sec) in the fault mode, briefly press the "20 mA" (3) button (0.1 … 2 seconds).

The new measuring range configuration is not stored until the level sensor reverts automatically from adjustment mode to configuration mode and the LED goes out. The new configuration is retained even if the level sensor is subsequently disconnected from the power supply.

4. Screw probe head cap (1) back on.

If, during operation, the level sensor detects that the level cannot be output correctly due to an insufficient supply voltage, it enters failure mode and sets current consumption to 3.6 mA (regardless of any failure current settings).

7. MAINTENANCE

Before returning any equipment please contact Officine Orobiche.

The return of equipment is possible only with authorization by Officine Orobiche.

8. TECHNICAL DATA

8.1 Sensor

Electrical connection	2-wire terminal 4 to 20 mA (3.8 … 20.5 mA) current consumption for level display 21.5 mA (3.6 mA) current consumption in failure mode
Supply voltage: Ex Version	8 … 30 V DC 8 … 30 V DC
Process connection	Screw-in unit with possibility of variable height adjustment Standard G ½ (compression fitting) Flange on request For material, see probe tube 2000 Series Assembly
Probe head	Height 112 mm, MD Series 116 mm Protection class IP68 (according to TÜV NORD test report 13 993 120483 of 02.09.2013) Material stainless steel Cable diameter 5 … 10 mm Temperature -40 … +85 °C
Probe tube	Length 200 to 6,000 mm (to order) Diameter 12 mm (other diameters on request) Material: 1.4571 standard (Hastelloy, or other materials on request) Measuring range freely adjustable (> 10 mm) Maximum temperature (HHT) -40 °C … +450 °C High temperature (HT) -40 °C … +250 °C Normal temperature (NT) -40 °C … +125 °C Low temperature (LT) -65 °C … +125 °C
Communication	HART® protocol (available)
Accuracy NT/LT digital component	Linearity better than ±0.2 mm or ±0.01 %, better than ±0.001 % per K Repetition accuracy better than 0.05 mm Resolution better than 10 µm
Accuracy HT/HHT digital component	Linearity better than ±0.5 mm or ±0.025 %, better than ±0.01 % per K Repetition accuracy better than 0.1 mm Resolution better than 50 µm
Accuracy Bypass digital component	Linearity better than ±0.5 mm or ±0.025 %, better than ±0.001 % per K Repetition accuracy better than 0.05 mm Resolution better than 10 µm
Accuracy HT/HHT Bypass digital component	Linearity better than ±2 mm or ±0.1 %, better than ±0.01 % per K Repetition accuracy better than 0.5 mm Resolution better than 50 µm
Accuracy Analogue component	Linearity better than ±0.01 % Temperature drift better than ±0.01 % per K Resolution better than 0.5 µA (16 bit)

8.2 Float

The float is a key component of the level sensor that must be matched to the medium in respect of density, pressure resistance and material durability.

Pressure resistance is guaranteed for undamaged floats only. Even the most minor and invisible dents, which can occur if, for example, the float is dropped from a bench onto a stone floor, are sufficient to cause a significant deterioration in pressure resistance.