Technical Documentation

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XT-1000

The magnetostrictive level sensor

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1 Properties

The high-precision and robust XT-1000 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. Magnetostriction is particularly ideal where level measurements are required to be extremely accurate, e.g. in the chemical industry.

The level sensor outputs measuring signals in the range 4 to 20 mA. Available in lengths of 8″ to 19′ it is compatible with a variety of tank dimensions. It also comes in the following versions:

- Version for installation on a bypass with magnetic float
- Version with flange
- Version with screw-in unit for infinitely variable positioning of the level sensor

The Ex-approved version of the level sensor can be installed in potentially explosive atmospheres in which electrical equipment of category 1 (zone 0) or category 1/2 (zone 0/1) are required.

Operating on the digital HART protocol, the XT-1000 HART level sensor is able to output the position of the first, second or both floats (refer to the XT-1000 HART documentation).

2 Safety instructions

The purpose of the XT-1000 level sensor is to gauge liquid levels in tanks. Use the level sensor for this purpose only. 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 state-of-the-art technology and with recognized safety rules and regulations. Nevertheless, hazards may arise from its use. For this reason, the following safety information 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, authorized personnel. Specialized knowledge must be obtained by undergoing regular training.

Operators, installers and service technicians must comply with all applicable safety regulations. This also applies to any local safety regulations and accident prevention regulations which are not stated in these operating instructions.

The safety instructions in this manual are labelled as follows:

⚠ **Failure to observe these safety instructions will result in a risk of an accident or of damage to the XT-1000 level sensor.**

☞ *Useful information designed to ensure continued and correct operation of the XT-1000 level sensor or helpful advice to make your work easier.*

3 Design and mode of operation

The design of the XT-1000 level sensor has been illustrated using the version with screw-in unit (see Figure 1).

Inside sensor 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 sensor head and by ground connector (4) at the bottom of the sensor head (see “Installation” and “User configuration”).

Probe tube (5) features a screw-in unit (6) (cutting ring or sealing gland coupling) for height adjustment capability or a flange (not shown) for fixed installation. Float (7) is the key component for continuous gauging of the product filling level or boundary layer and is held on the probe tube by a collar (8).

The XT-1000 B version is supplied without a process connection and float.

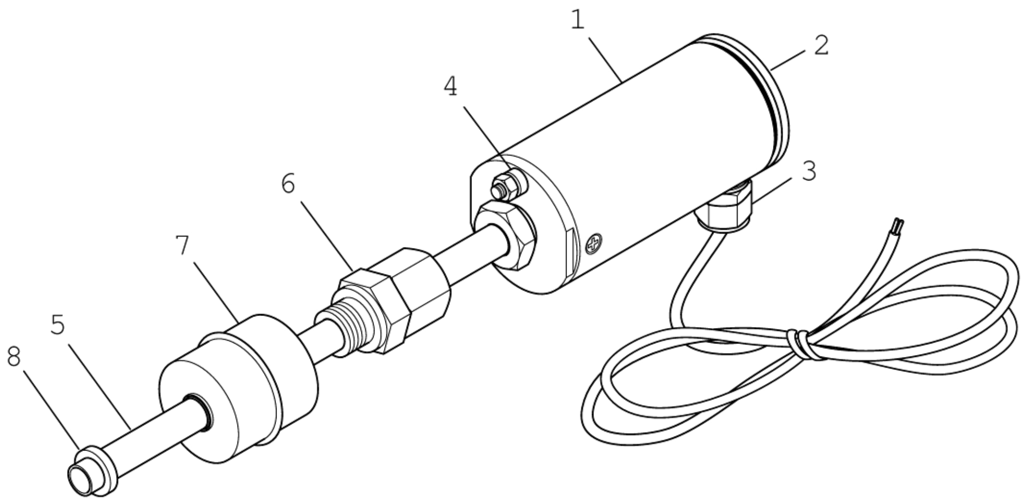

Figure 1: XT-1000 level sensor

The measuring principle illustrated in Figure 2 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) contained in the float acts as the 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 sensor 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 sensor head is measured. From these propagation times, it is possible to determine the current position of the float.

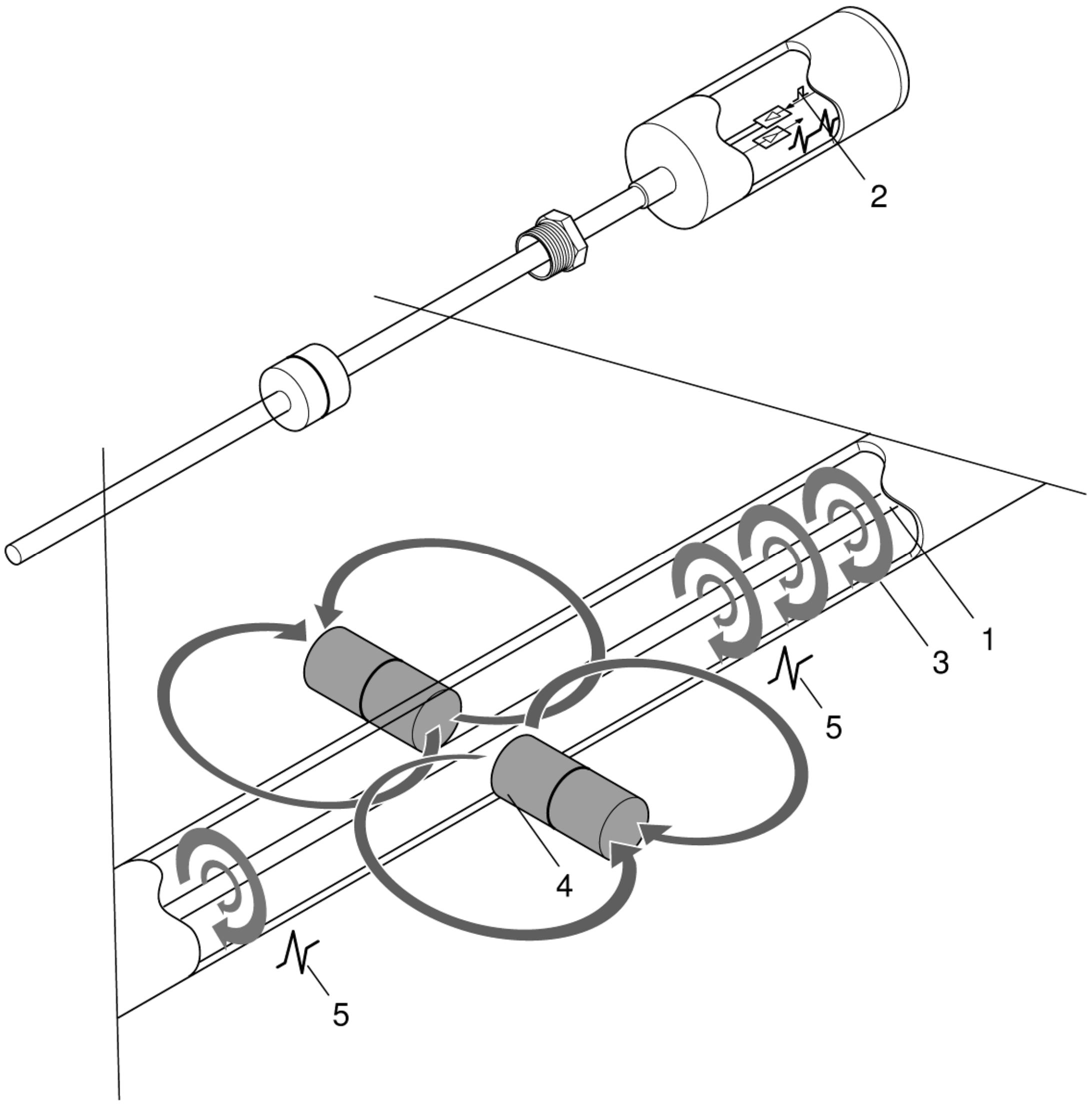

Figure 2: operating principle of the XT-1000 level sensor

4 Installation

⚠ **This product should not be installed in a potentially explosive application.**

⚠ **Also observe any local safety regulations and accident prevention regulations which are not stated in these operating instructions.**

This section describes how to install the level sensor. The procedures for each version are described separately (see Figure 3).

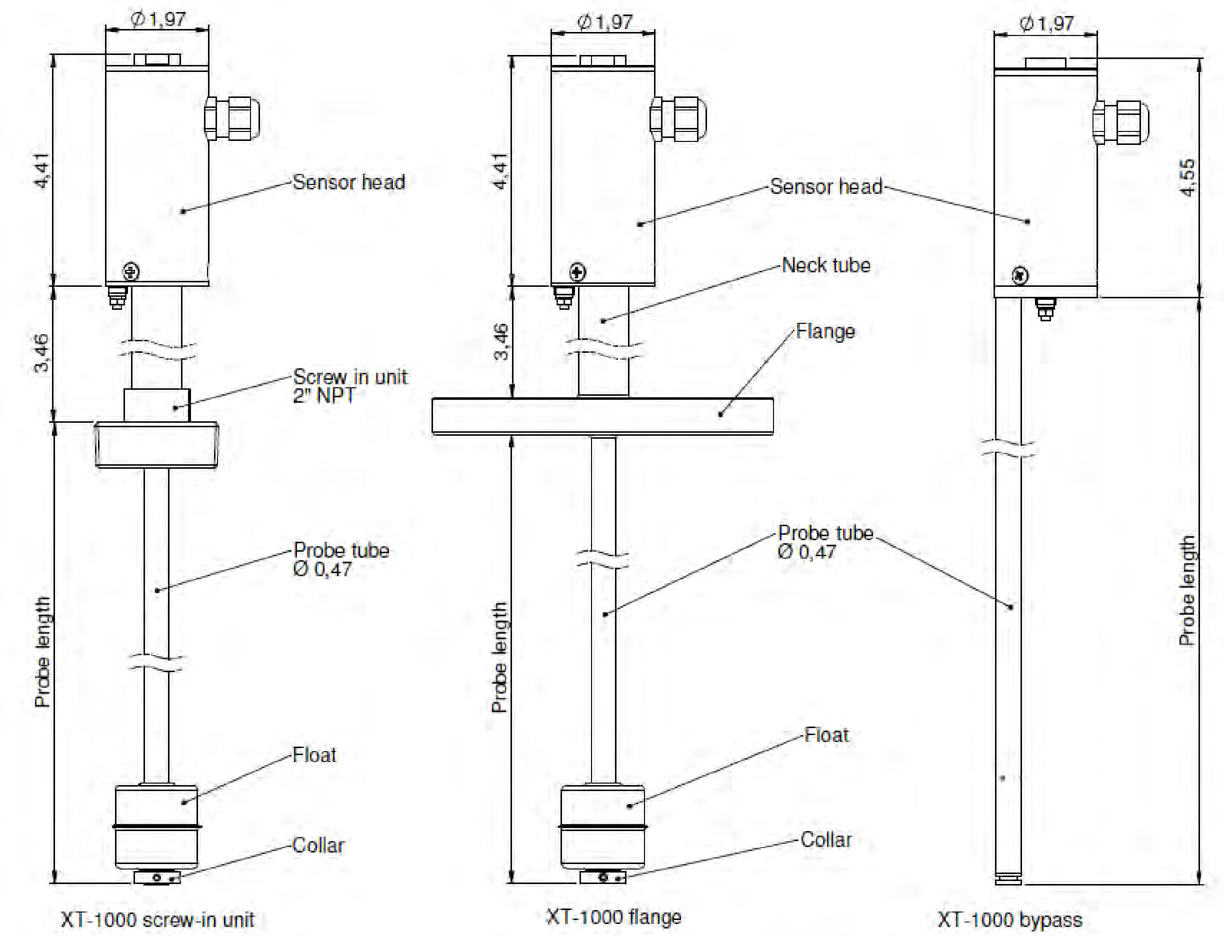

Figure 3: XT-1000 versions

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 recommended because this could impair gauging.

The level sensor can also be fitted into the tank from underneath.

If the float is removed during installation, it must be slid back onto the probe tube afterwards with the "TOP" marking oriented towards the sensor head end, to enable correct measurements to be made.

4.1 Installation with screw-in unit

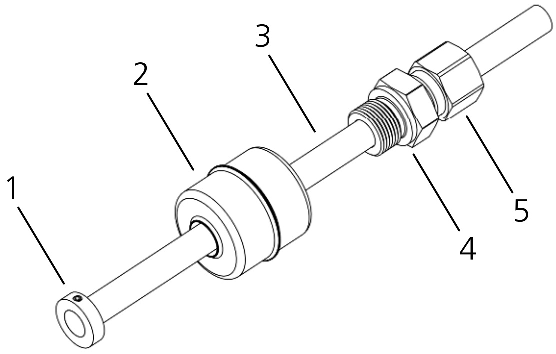

Figure 4: installation with screw-in unit

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 collar (1) and remove 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 unit 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 sensor head end, to enable correct measurements to be made.

(5) Refit collar (1) to hold float (2) on the tube, align the set screws with the groove and tighten.

(6) Adjust the height of the process connection and secure it in position by tightening union nut (5).

(7) If applicable, tighten the lock screw (not shown) on union nut (5).

In the case of installation with a cutting ring coupling, it is no longer possible to alter the position of the level sensor after the union nut has been tightened. In this event, it would be necessary to return the level sensor to the factory to have the probe tube replaced.

4.2 Installation with flange

The probe tube is permanently welded to the flange, which means that the installation length cannot be altered.

Secure the flange using the flange screws.

If the float does not fit through the installation opening, refer to the related installation instructions in section 4.1.

4.3 Installation on the bypass

The level sensor is installed on the bypass tube using suitable fasteners (nonmagnetic).

⚠ **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 floats approved by GEMS Sensors & Contr0ls can be used.

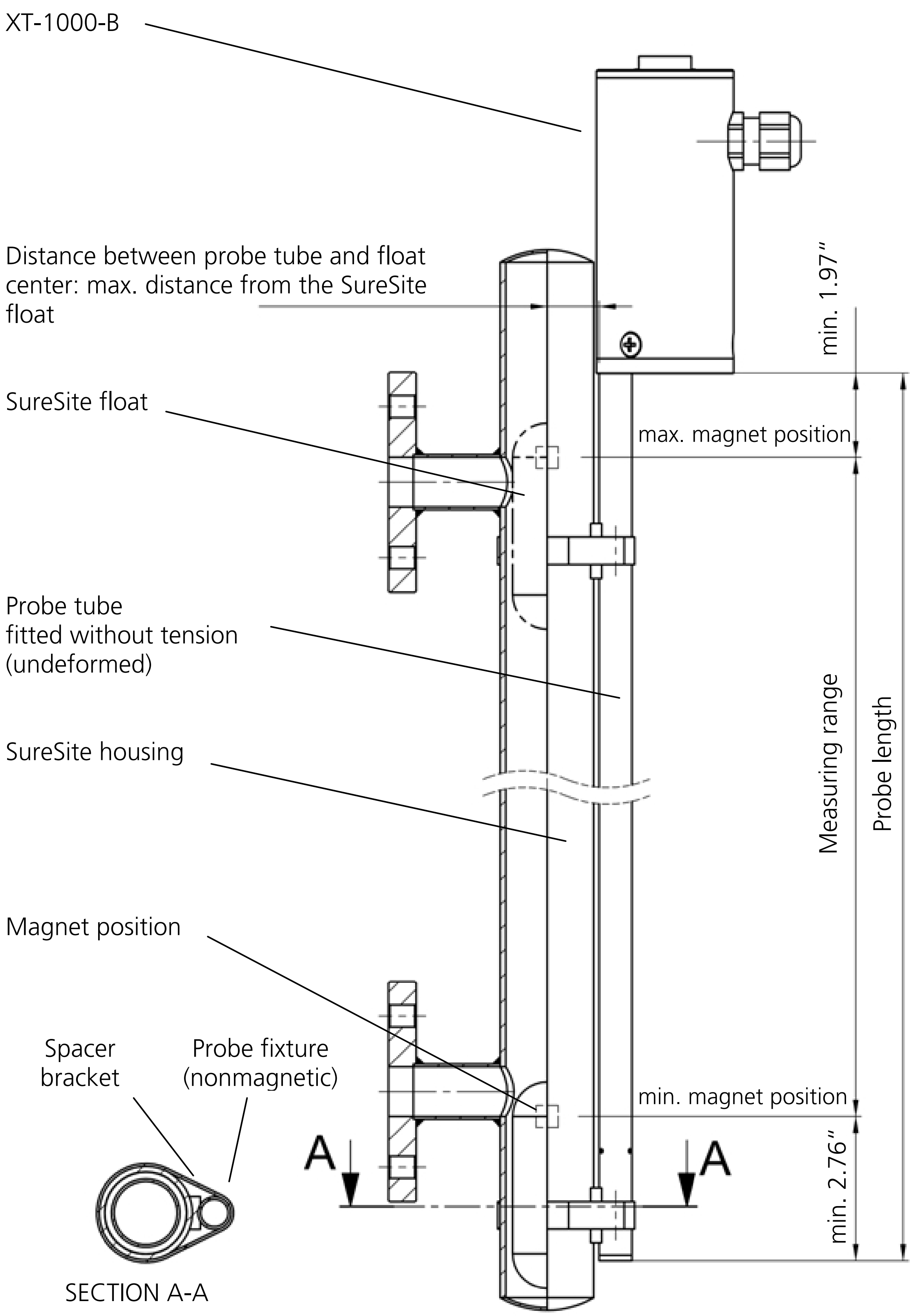

Figure 5: installation with SureSite

5 Electrical connection

It is essential that the correct minimum wire gauge be selected: the supply voltage at the level sensor must not fall below 8 V in the event of maximum current draw (21.5 mA).

The sensor head and probe tube of XT-1000 Standard are made of stainless steel.

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

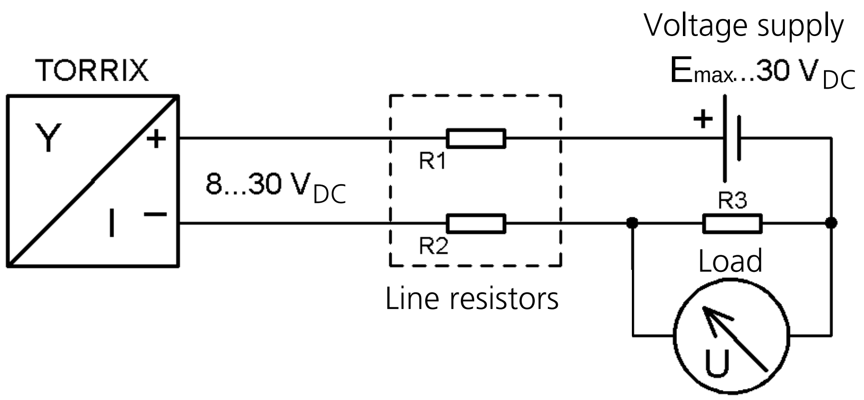

Figure 6: wiring diagram for XT-1000

To connect the level sensor, see Figures 7:

- Unscrew sensor head cap (1) using an open-ended spanner.
- Loosen union nut (2) of screwed cable gland (3).

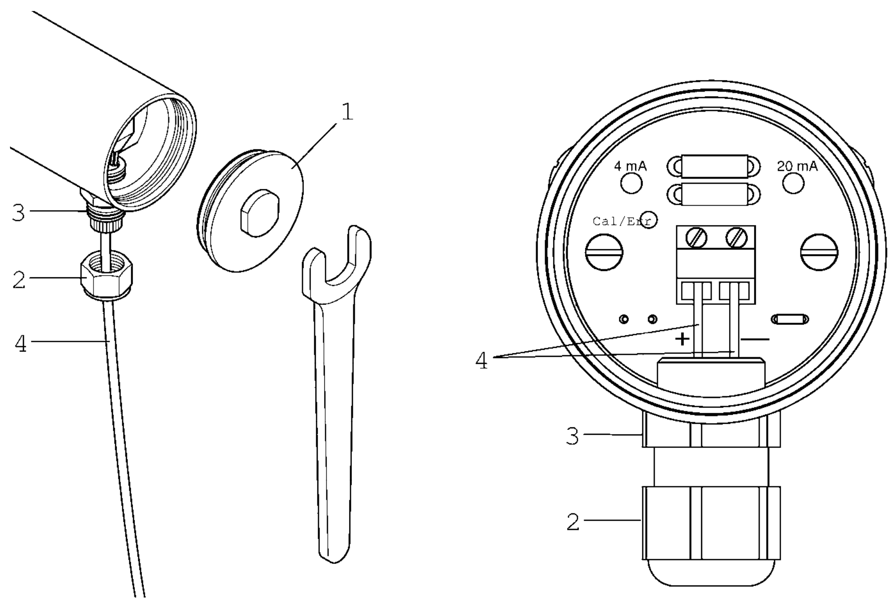

Figure 7: connecting the XT-1000 level sensor

- Feed the two conductor cable (4) into the union nut and retighten the union nut. The external diameter must be 0.2" to 0.4".
- Connect the two conductor cable to the screw terminals on the sensor head marked (+) and (–). Observe the proper polarity.
- Configuration of reference points if necessary (see section 6.1)
- Screw the sensor head cap (1) back on.

The ground connector on the underside of the sensor head can be used for grounding or equipotential bonding.

⚠ **Protect the sensor head against the ingress of water. An external cable diameter of 0.2" to 0.4" mm ensures reliable sealing of the cable entry. Make sure that the cable gland is screwed tight, and close the sensor head cap firmly.**

6 User configuration

Versions that support the HART protocol enable the adjustments described below to be carried out remotely without the sensor 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 XT-1000 level sensor, two buttons and an LED (light emitting diode) are provided near the terminals inside the sensor head.

By default, the level sensor is set to maximum measuring span with 4 mA at the sensor base and 20 mA at the sensor head. The measuring span is configurable for adaptation to the tank concerned. However, a minimum clearance of 0.4" 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 sensor head and 20 mA at the sensor base.

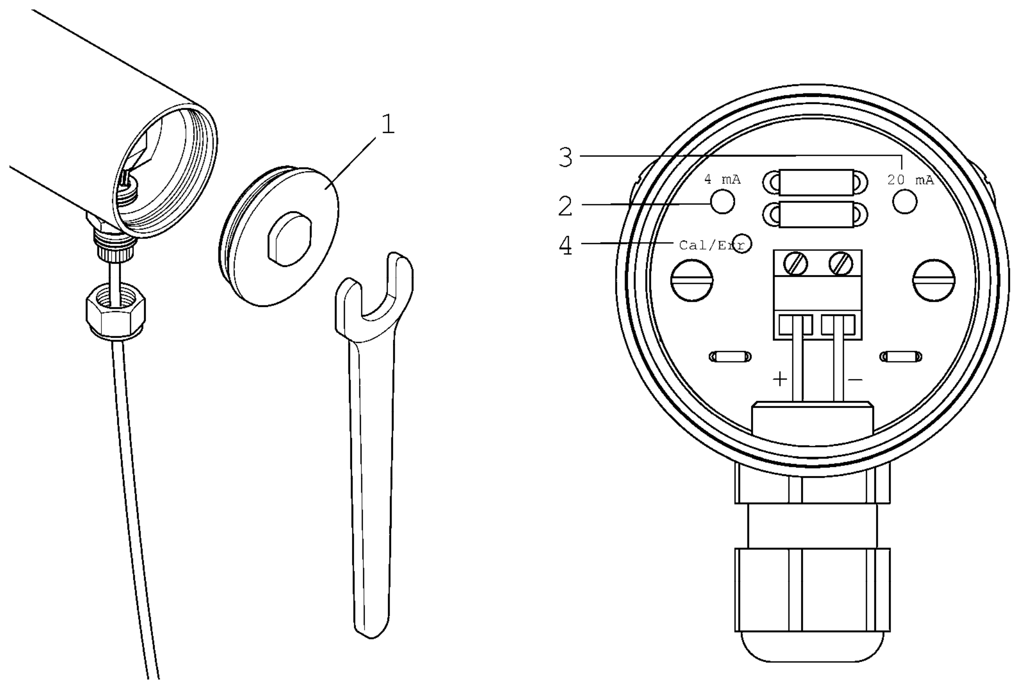

Figure 8: configuring the measuring span

- Unscrew sensor head cap (1) using an open-ended spanner.
- Press and hold 4 mA button (2) or 20 mA button (3) for at least 3 seconds. The green LED begins to flash.

- 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 discarding any changes. In configuration mode, the 4 mA or 20 mA reference point, or both, can be modified in any order.

To define a reference point:

- Move the float to the desired reference point
- 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 from adjustment mode to configuration mode automatically 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 failure mode after a short time. Failure mode signalling 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 current consumption in failure mode (see Figure 8)

- Unscrew sensor head cap (1) using an open-ended spanner.
- 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 current consumption value for failure mode for 2.5 seconds: if the LED lights up permanently, $I_{failure}$ = 21.5 mA; if the LED goes out, $I_{failure}$ = 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 the change.

To set a current consumption of 3.6 mA during the dwell period (10 s) in failure mode

- briefly press "4 mA" button (2) (0.1 to 2 seconds).

To set a current consumption of 21.5 mA during the dwell period (10 s) in failure mode

- briefly press "20 mA" button (3) (0.1 to 2 seconds).

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

- Screw sensor 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 Technical data

7.1 Sensor

Electrical connection	Two-line terminal 4 to 20 mA (3.8 to 20.5 mA) current consumption for level display 21.5 mA (3.6 mA) current consumption in failure mode
Supply voltage: XT-1000	8 to 30 V DC
Process connection	Screw-in unit with the option of infinitely variable height adjustment Standard G ½ (cutting ring coupling) 3” Ansi Flange 2” NPT screw-in unit
Sensor head	Height 4.53” Diameter 1.97” Index of protection IP 68 Material: stainless steel Cable diameter 0.2” to 0.4” Temperature –40 °F to +185 °F
Probe tube	Length 8” to 19’ (to order) Diameter .47” Material: 1.4571 standard (titanium, Hastelloy C, or other materials on request) Measuring range freely configurable (> 0.4”) Normal temperature (NT) -40 °F to +250 °F High temperature (HT) -40 °F to +450 °F Ultra high temperature (HHT) -40 °F to +840 °F Low temperature (LT) -85 °F to +250 °F
Communication	HART protocol (optional)

Accuracy Digital component	Linearity better than ± 0.04”or ±0.025 %, better than ±0.001 % per K, Repetition accuracy better than 0.004” Resolution better than 0.002”
Accuracy NT/LT Bypass digital component	Linearity better than ±0.04” mm or ±0.025 %, better than ±0.001 % per K, Repetition accuracy better than 0.004” Resolution better than 0.002”
Accuracy Bypass HT/HHT digital component	Linearity better than ±0.08” or ±0.1 %, better than ±0.001 % per K, Repetition accuracy better than 0.02” Resolution better than 0.002”
Accuracy Analog component	Linearity better than ±0.01 % Temperature drift better than ±0.01 % per K Resolution better than 0.5 μA (16 bit)

7.2 Floats

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.

The following floats are exchangeable and are available to order separately. Other float types and materials are available on request.

The density and magnet position of floats of the same type may vary slightly, in which case readjustment may be required.

All floats are also suitable for use at a pressure of 1 bar (vacuum).

Excerpt from available float range:

min. density of medium [g/cm³]	Material	max. operating pressure [bar] at 68 °F *)	Shape
0.5	Titanium	20	Ball ø 50
0.6	1.4571 / 316 Ti	20	Ball ø 52
0.7	1.4571 / 316 Ti	16	Cylinder ø 43
0.7	C276	10	Cylinder ø 46
0.85	1.4571 / 316 Ti	20	Ball ø 43
0.95	1.4571 / 316 Ti	50	Ball ø 43

*) above 120 °F the maximum operating pressure decreases

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.