

Safety manual in accordance with series of standards EN 61508

Level sensor type TORRIX ... and type VISY-Stick ...

I Range of application

The level sensors are suitable for areas in which a safety-related subsystem according to EN 61508 with SIL 2 is mandatory.

II Standards

The level sensors are designed in accordance with the following standards

EN 61508:2010, all parts Functional safety of electrical/electronic/programmable electronic safety-related systems

III Instructions for safe ...

III.a ... use

This safety manual applies to all level sensors from hardware version 4 and from firmware version V4.9 (sensors) or V1.2.0 (XTS) upwards. The version numbers can be read with differences:

TORRIX ... HART...: The version numbers can be read out using the configuration program FAFNIR HART-Setup.

TORRIX ... RS485...: The firmware version can be read out using the MODBUS ASCII protocol.

TORRIX ... SC... and VISY-Stick ...: The version numbers can be read out using the configuration program VISY-Setup or the FAFNIR protocol Universal Device Protocol (UDP). The respective technical documentation is to be consulted for the use of the named options.

TORRIX ... TAG...: The firmware version is issued at regular intervals in the identification message. The field name is "Firmware Version" and has a length of two bytes.

TORRIX ... XTS...: The version numbers can be called up in the menu and can be shown on the integrated display.

In principle, the level sensor indicates the correct fill level (plausibility check) and / or, in the case of a detected error, an error value (safe state), which corresponds to a mode of operation with a continuous requirement. The safe state is reached within ten seconds.

If there is an error in the communication, the higher-level system must classify this as a malfunction. The output of the safety function is ensured differently by the different level sensors.

It must be ensured that there are no strong magnetic fields in the area of the probe tube. In addition, the safe use with adhering liquids is not guaranteed.

Type	Approval	Electrical design	Construction	Measuring accuracy	Mechanical design	Process Temperature
						HHT Maximum temperature -40 °C ... +450 °C HT High temperature (HT) -40 °C ... +250 °C LLT Minimum temperature -200 °C ... +80 °C LT Low temperature -65 °C ... +125 °C NT Normal temperature -40 °C ... (+85) +125 °C
					Rigid sensor tube with 12 mm diameter <i>n</i> <i>n</i> = sensor tube Ø, e.g. 6 (mm) <i>n</i> B <i>n</i> = sensor tube Ø; Sensor tube not centered on the sensor head 90B Sensor tube bent 90° in front of the sensor head and Bypass B Sensor tube not centered on the sensor head (Bypass) Flex ... Flexible sensor tube (... Rigid parts: F = 200/300 mm; T = 500 mm) HY Version for use in the hygiene sector PL Plastic coating against very aggressive media SP Sampling tube, e.g. for sampling	
				Standard -5T With five temperature sensors -A5T Increased measurement accuracy and five temperature sensors -A Increased measurement accuracy (Advanced)		
			Standard structure I Structure of 1.4301 (304) VT Internal structure vibration resistant for portable tanks			
			4 ... 20 mA interface with internal setting buttons C 4 ... 20 mA interface without setting button HART 4 ... 20 mA interface with HART protocol and internal setting buttons HART C 4 ... 20 mA interface with HART protocol and without setting button RS485 RS-485 interface SC Serial communication (for connection to isolating amplifier VP-... or VPI) TAG TAG interface; signal transmission based on EN 14116 XT RS-485 and 4 ... 20 mA interface with HART protocol and setting button (Ex-d housing) XTS RS-485 and 4 ... 20 mA interface with HART protocol and setting button and digital display XTSH RS-485 and 4 ... 20 mA interface with HART protocol, setting button, digital display and heater (only Ex-d and without Ex)			
						Without Ex approval Ex With Ex approval intrinsic safety "ia" Exd With Ex approval flameproof enclosure "d" or protection by housing "t" and intrinsic safety "ia" for "... XT..."
TORRIX						Magnetostrictive level sensor (from version 5) with terminals or connection plug

Type code III.a1: Level sensor TORRIX ...

System	Type	VISY-Stick Sump (only)	Accuracy & sensor tube	Usage	Interface
VISY- Volume Information System	Stick	Manhole	Advanced Flex	Standard accuracy and rigid sensor tube Higher accuracy Flexible sensor tube	For connection to isolating amplifier VP-... or VPI
					RS485 For connection to an RS-485 interface
					TLS For connection to a TLS (Veeder-Root)
					Standard level sensor
					Biodiesel Level sensor; Biodiesel
					E15 Level sensor; Ethanol admixture up to 15 %
					Ethanol Level sensor; Ethanol
					LPG Level sensor; LPG
					N Level sensor; AdBlue
					Dispenser Manhole
Stick	Magnetostrictive level sensor with up to five temperature sensors in the sensor tube				
Stick Interstitial	Environmental sensor for monitoring intermediate chambers of double-walled tanks (possible subtypes only "interface")				
Stick Sump	Environmental sensor for monitoring sumps with the differentiation of liquids (product / water)				

Type code III.a2: Level sensor VISY-Stick ...

III.b ... assembling and dismantling

For level sensors with connection board, only the cover of the connection housing may be removed for electrical installation and - by means of push buttons - for adjusting the level sensor. After installation, the connection housing must be closed again.

Also, the floats may be removed from the probe tube. When mounting the floats, pay attention to the correct orientation.

III.c ... installation

To integrate the devices in the equipotential bonding, a PA terminal is provided on the sensor head. For functional safety, it is relevant that the probes are integrated in the equipotential bonding. For the level sensors with screw terminals, the terminal designation is "+" and "-" as well as "A" and "B" for the type TORRIX ... XT... (on the terminal block there are "+" and "-" for the heater). For level sensors with M12 male connectors, the pin assignments are as follows:

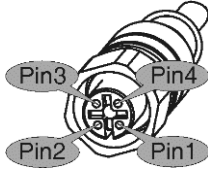
Pin	TORRIX ... SC... VISY-Stick ...	TORRIX ... C... TORRIX ... TAG... VISY-Stick ... TLS	TORRIX ... RS485... VISY-Stick ... RS485	M12 Cable (Female)
1	+	+	+	
2	A		A (+)	
3	-	-	-	
4	B		B (-)	

Table III.c: Terminal assignment of the sensors

III.d ... adjustment

No SIL-relevant adjustments are required for operation of the sensors.

III.e ... putting into service

Before putting into service, all devices must be checked of right installation and connection. The electrical supply, as well of connected devices, must be checked.

III.f ... maintenance (servicing and emergency repair)

Generally, the level sensor is maintenance-free. In the event of a defect, it must be sent back to the manufacturer or one of its representations.

If an error occurs, e.g. no float on the probe tube, the corresponding diagnostic error is issued. If the error is corrected during active operation, the sensor leaves the error mode.

Level sensors with 4 ... 20 mA interface

In the event of a fault, the fault current flows (3.6 mA or 21.5 mA, whichever is set). If the fault current of 21.5 mA can not flow, e.g. in case of low supply, the fault current is automatically set to 3.6 mA.

If the level sensor is equipped with buttons for configuration, the safe state can also be tested by using these buttons. For this press one or both buttons for a long time and the following sequence occurs:

- After three seconds, the sensor changes into configuration mode either for the measuring range (one button pressed) with a current consumption of 12 mA or for the fault current (both buttons pressed) with a current consumption of 16 mA. This is indicated by the LED flashing slowly (1.5 Hz).
- After ten seconds of pressing, the sensor changes into the safe state. If 21.5 mA flows, the LED flashes quickly (6 Hz), and at 3.6 mA the LED is off.
- Releasing the button returns to the configuration mode. The configuration mode is exited no later than 20 seconds after the last pressing and when functioning correctly, the current position of the float is displayed.

Level sensors with HART protocol

The second data byte of the level sensor response contains the device status. The flag "Device malfunction" (0x80, bit 7) signals a device error. If the "More Status Available" flag (0x10, bit 4) is also set, then device-specific status bits (byte 0) can be queried:

Bit	Fault	Description
0	HART parameters	HART parameters have been changed illegally
1	Sensor parameters	Sensor parameters have been changed illegally
2	Measurement	No measurement possible
3	Error counter	Too many errors during the measurement
4	Undervoltage	Supply voltage is too low

Table III.f1: Device-specific status bits in the HART protocol

Level sensors with DDA protocol

In the event of an error, the error code "E102" is output in the fill level data field.

Level sensors with H, Modbus, UC and UDP protocol

In the event of an error, the status code 1 is output.

Level sensors with LC protocol

In the event of an error, the status bit (bit 7) in the status byte is set to 1.

Level sensors with TAG protocol

In the event of an error, the status bit (bit 23) is set to 1 and the fill level indicates the cause of the error:

Fill level (only bits 22 ... 0)	Status information
0x000000	General problem with the sensor
0x000001	RAM error
0x000002	Parameter error
0x000003	The float is too close to the end
0x000005	The float is upside down
0x000007	Switched ON (power up) or reset (Reset)
0x7FFFFFF	Level overflow

Table III.f2: Device-specific status bits in the TAG protocol

Level sensors with TLS interface

For each measurement, the probes are switched on for approximately 500 ms. If the probe is unable to perform regular measurements, the measurement is marked as invalid by falsification of the parity bit.

IV Technical Data

Electrical connection and communication

TORRIX ..., TORRIX ... C...

2-wire connection (4 ... 20 mA interface; 3.8 mA to 20.5 mA current consumption for level display;
3.6 mA or 21.5 mA current consumption in the event of an error; optional HART protocol)

TORRIX ... RS485..., VISY-Stick ... RS485

4-wire connection (RS-485 signals and power supply; MODBUS ASCII, FDA or FAFNIR-UD protocol)

TORRIX ... SC..., VISY-Stick ...

4-wire connection (TTL signals and power supply; FAFNIR protocol)

TORRIX ... TAG...

2-wire connection (signal transmission based on EN 14116)

TORRIX ... XTS...

2-wire connection (4 ... 20 mA interface; 3.8 mA to 20.5 mA current consumption for level display;
3.6 mA or 21.5 mA current consumption in the event of an error; optional HART protocol) or 4-wire connection
(RS-485 signals and power supply; MODBUS ASCII, FDA or FAFNIR-UD protocol) as well as 2-wire connection for
the optional heating

VISY Stick ... TLS

2-wire connection (supply and communication via a TLS console)

Power supply

TORRIX ... SC... / VISY Stick ...	6 VDC ... 15 VDC
TORRIX Ex ... / VISY Stick ... RS485	8 VDC ... 30 VDC
TORRIX ... (not Ex)	8 VDC ... 50 VDC
TORRIX Ex XTS...	12 VDC ... 30 VDC
TORRIX ... XTS(H)...	12 VDC ... 50 VDC (heating: 24 VDC ± 10 %)
VISY Stick ... TLS	8 VDC ... 13 VDC

Temperatures

Ambient temperature (sensor head)

TORRIX ... & VISY Stick ...	-40 °C ... +85 °C
TORRIX ... XTS...	-20 °C ... +85 °C
TORRIX ... XTSH	-55 °C ... +85 °C

Process temperature (sensor tube)

Standard	-40 °C ... +85 °C
Normal (NT)	-40 °C ... +125 °C
High (HT)	-40 °C ... +250 °C
Highest (HHT)	-40 °C ... +450 °C
Low (LT)	-65 °C ... +125 °C
Lowest (LLT)	-200 °C ... +85 °C

Protection class through housing

Stainless steel housing IP68 (IPX8: 30 days at 2 m depth)

Safety related codes

Parameter	Value			
Safety Integrity Level	SIL 2			
Hardware fault tolerance	HFT = 0			
Security related subsystem	Type B			
Failure rate [h ⁻¹]		λ_S	λ_{DD}	λ_{DU}
	TORRIX ...	5,94E-07	5,83E-07	1,12E-07
	TORRIX ... C...	3,76E-07	4,00E-07	7,65E-08
	TORRIX ... HART...	7,08E-07	7,05E-07	1,39E-07
	TORRIX ... HART C...	4,74E-07	5,13E-07	9,52E-08
	TORRIX ... RS485... / VISY-Stick ... RS485	2,82E-07	3,40E-07	5,43E-08
	TORRIX ... SC... / VISY-Stick ...	1,95E-07	2,54E-07	4,49E-08
	TORRIX ... TAG...	3,28E-07	3,61E-07	5,75E-08
	TORRIX XTS..., TORRIX Ex XTS...	4,41E-07	6,69E-07	1,14E-07
	TORRIX Exd XTS...	4,95E-07	7,03E-07	1,18E-07
	VISY-Stick ... TLS	2,68E-07	3,79E-07	5,86E-08
Mean frequency of dangerous failure per hour, PFH [h ⁻¹]	See failure rate λ_{DU}			
Mean Time to Recovery	MTTR = 8 h			
Interval of the retest	$T_1 = 1$ year			
Architecture	1001			

Table IV.b: Safety related codes

V Additional requirements for software elements

There are no requirements for software elements.