Operating instructions

Level sensor model FFG

Level sensor, magnetostrictive measuring principle, model FFG; flange connection

FLUID CONTROL
A division of the WIKA group

Contents

WARNING!
Instructions on correct installation and proper operation. Failing to comply with these instructions can lead to malfunction of or damage.

DANGER!
Instructions which must be complied with to avoid injury or property damage or loss of the type permit.

DANGER!
Instructions for proper electrical installation.

Information
Facts and information concerning proper operation.

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1. Safety information

Please read these instructions carefully before installing and commissioning the model FFG level sensor system. These instructions are directed to trained personnel implementing the assembly, installation and set-up of the system. The level sensor serves for indicating the level of liquids in containers. Use it for no purpose other than this! No liability will be assumed by Manufacturer for damage resulting from use other than specified! The level sensor has been designed, manufactured and tested in accordance with the state of art and the accepted safety regulations. Notwithstanding this, certain risks might be involved.

The following safety instructions should, therefore, be observed:
Do not modify, supplement or change the level sensor system unless with Manufacturer's express approval. Unauthorized changes or non-permitted use will result in immediate loss of warranty or liability claims.

The installation, operation and maintenance must be performed by expert and authorized personnel only. The required expertise must be obtained by regular training.

It is imperative for operators, installers and servicers to comply with all applicable safety regulations. This provision shall extend to all local safety and accident preventing regulations not expressly referred to herein.

The current and voltage values specified for an intrinsically safe operation must be complied with.

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1. Safety information

Prior to starting operation please check all devices for their proper connection, operability and power supply; this shall also apply to assemblies coupled thereto.

The general operating instructions of all devices as used must be abided by.

Measures should be taken preventing personal injuries and damage to property from occurring in case of a defective condition of the level sensor system.

The level sensor system must not be operated in the direct vicinity of strong electromagnetic fields (minimum distance: 1 m).

The level sensor system must not be exposed to heavy mechanical strain.

The maximum power and voltage values for the intrinsically safe operation as specified in the assembling and operating instructions should be adhered to.

The safe operation of the system with a view to pressure and temperature of the materials as employed shall be Operator's responsibility.
As even in case of failure, the guide tube does not exhibit a source of ignition there are no objections, in terms of safety, to use the sensor (float and guide tube) as an operating unit of the 1/2 category with containers for combustible fluids (except for carbon disulphide and silicon-organic compounds) under varying atmospheric conditions at excess pressures of up to 25 bar and temperatures of between -60 ... +250 °C.

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DANGER!
Work in containers involves the danger of intoxication and suffocation. No work is allowed to be carried out unless by taking suitable personal protective measures (e.g. respiratory protection apparatus, protective outfit etc.).

Danger of explosion
Inside the container, there is danger of an explosive atmosphere. Corresponding measures for preventing sparking should be taken. No work is allowed in this area unless by technically skilled staff in accordance with applicable safety regulations.

2. Description of functions and design

The WIKA model FFG level sensor acts as a measured value transmitter for high-accuracy, continuous level measurement of liquids and is based on identifying the position of a magnetic float following the magnetostrictive measuring principle.

The design of the level sensor system is shown in figure 1 in the form of embodiment furnished with a screwed-in element. Provided in the probe head (1) is the area of connection and adjustment protected by lid (2). The electrical connection is via an M16x1.5 cable gland (3) at the top of the probe head while the earth connection (4) is at the bottom of the probe head. Seated on the probe tube (5) for vertically adjustable assembling purposes, within the container, is a compression fitting (6) (G 1/2, W 27) or a flange (not shown). The float (7) serves for continuously gauging the product level or interface layer, and is held on the probe tube by a guiding or locking ring (8) etc.

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2. Description of functions and design

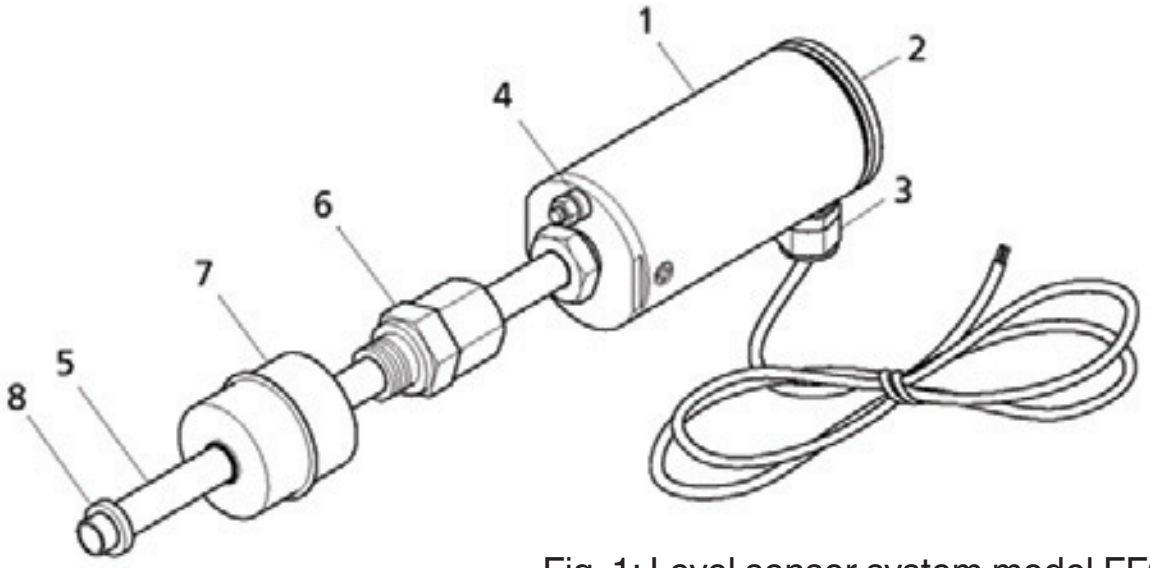

Fig. 1: Level sensor system model FFG

The level sensor shown in figure 2 serves for the continuous measurement of fluids. To transmit the liquid level value to the sensor, a float is sliding on the sensor tube. The operating principle of the sensor is based on the magnetostriction effect. The float contains a magnet while a wire made of magnetostrictive material is installed under tension inside the sensor tube. The magnetic field of the float is twisting the wire. A second, temporary magnetic field is generated along the wire by a current pulse within the wire. The superposition of the two magnetic fields will release a mechanical wave on the wire.
At the end of the wire within the sensor head, the mechanical wave is converted by a piezo-ceramic transducer into an electrical signal. The starting point of the mechanical wave and, hence, the float position is then determined by measuring the transit time.

The results of such measurements are feasibility-tested by a microcontroller located in the sensor head and are then converted into a current value by a digital analog transformer. The sensor is provided with a 2-wire connection so that the current consumption indicates the position of the float at the same time. The current values are restricted to a range of between 3.5 ... 23 mA.

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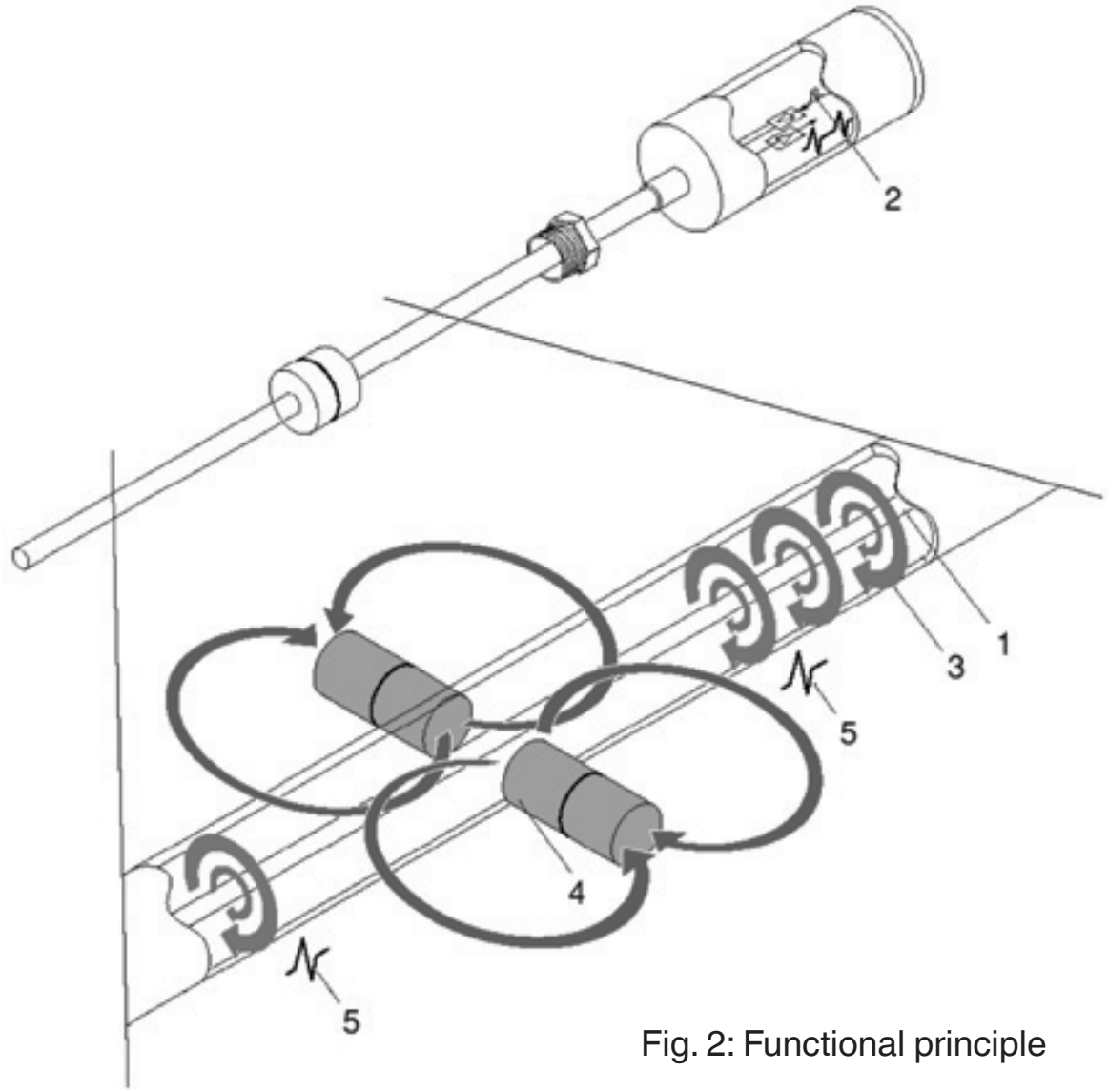

Fig. 2: Functional principle

Transport and storage

Transport and storage for level sensors are only allowed in designed packaging.

Removal of the transportation packing and transportation safety bolts

Carefully remove the level sensor from the transportation packing. Please observe the warning on the shipment packing and remove all transportation safety bolts, prior to discharging the level sensor system. Never remove the level sensor system from the packing by applying force to the guide tube!
Prior to assembly the safety bands are to be removed from the floats. Make sure that all packing elements have been removed and that the floats are free to move on the guide tube.

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3. Area of application

The level sensor system is available for employment in varying container heights of between 200 and 6000 mm. Flange-model or screw-model designs are available allowing a stepless positioning within the container, depending on the design thereof.

Probe tube and float can be installed up to the screw element or flange in areas exposed to danger of explosion, in which electric units of the category 1/2 (zone 0) are required. In respect of the bypass model, the complete system is allowed to be installed in areas exposed to danger of explosion that require electric unit of category 2 (zone 1). The sensor head of the level sensor can be operated at ambient temperatures of between -40 ... +85 °C, while the sensor tube is operable within a temperature range of between -25 ... +250 °C. The permitted process temperatures in case of employment in zones subject to danger of explosion that require operating units of categories 1/2 or 2, are set out in the tables.

The technical specifications set out in these operating instructions should be observed.

4. Assembly

Assembly and servicing in areas exposed to danger of explosion shall be in accordance with the provisions stipulated by ElexV and the Act on Appliance Safety and shall be in accordance with all applicable rules of technology and the present operating instructions. Moreover, please also observe all local safety and accident preventing regulations that have not been expressly mentioned in these operating instructions.

Make sure, during assembly that the probe tube is not bent and that the float is not exposed to shock. The level sensor having Ex-approval must be so mounted that the probe head is not located in the Ex-zone 0

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4. Assembly

The level sensor systems, depending on the design thereof, will be mounted into the container by means of a flange or a screw-in thread. Make sure, prior to assembly, that the assembly port provided on the container and the attachment means of the level sensor system conform in size and dimension. Depending on the design of the level sensor system, assembly thereof into the container must be externally. Assembly must be in the vertical position. To insure a safe function, the angle of assembly is allowed to differ from the vertical by 30° max. The guide tube of the level sensor is to be externally introduced through the assembly port of the container. Attachment thereof is by tightening the screw-in thread in respect of threaded plugs; by bolting the cap nut in respect of dairy pipe fittings; screwing in respect of flange-model designs or closing of the locking rings (articulated clamp) in triclamp-model clamp connections.

- Level sensors having screw-in threads are to be screwed across the entire thread length.
- Level sensor systems having dairy pipe fittings are furnished, ex factory, with suitable cap nuts.
- Level sensor systems of flange-model design are to be fixed by suitable screws, washers and nuts.
- Level sensor systems having clamp connections of the triclamp model are to be secured by means of suitable locking rings (articulated clamp).

Please observe the torque value of the screws!

Suitable sealants should be used. Please make sure that the sealing material is resistant to the fluid and its vapours and to the anticipated temperatures and pressures.

In designs having floats mounted thereon the diameters of which exceed the core diameter of the mounting port the floats should be removed from the guide tube prior to assembly thereof.

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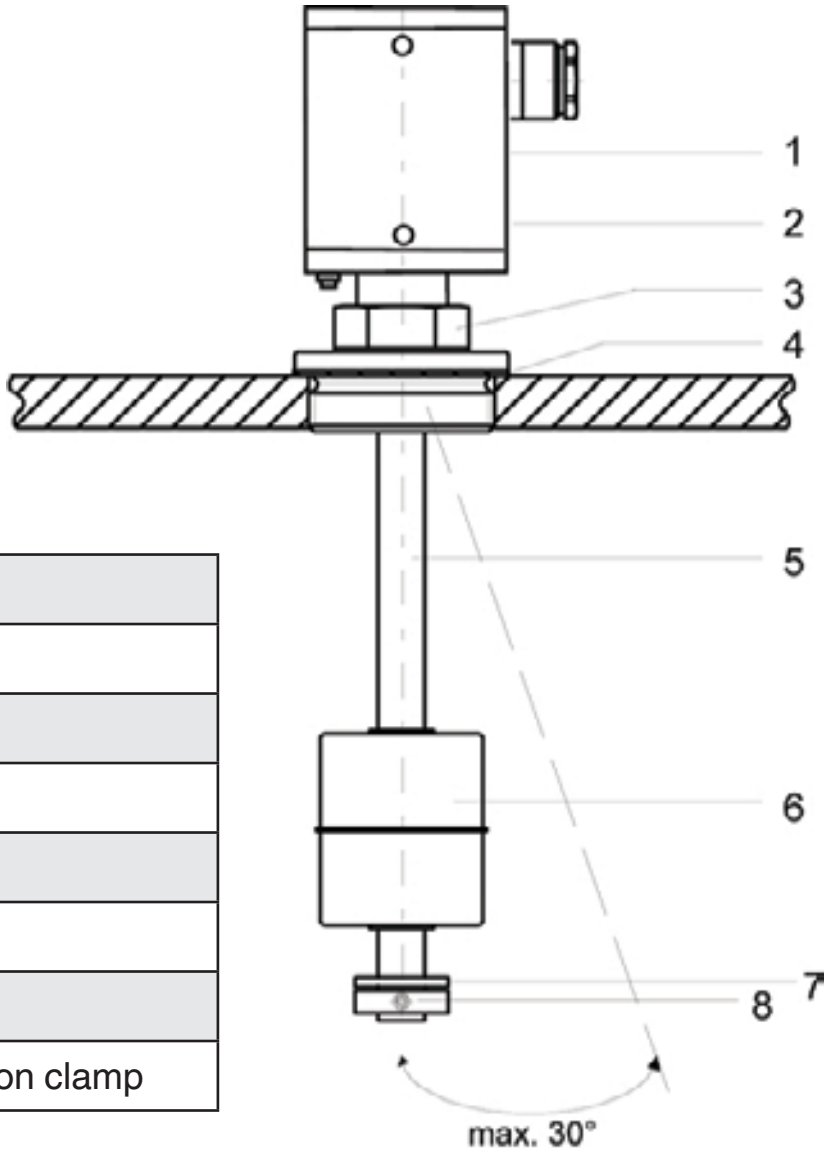
Fig. 3: Level sensor system with mounting thread



1	Terminal box
2	Cable gland
3	Mounting thread
4	Gasket
5	Guide tube
6	Float
7	PTFE washer
8	Set collar or tension clamp

Procedure:

- To mark upper side of floats (e.g. by "top")
- To mark position of locating rings
- To remove locating rings and drop protection rings
- To lift floats
- To assemble the level sensor
- To mount floats, locating rings and drop protection rings from inside of container. Please observe markings!

The drop protection rings serve to avoid the formation of ignition sparks in the event of an impact of the float on the locating ring. No operation is permitted without the use of drop protection rings.

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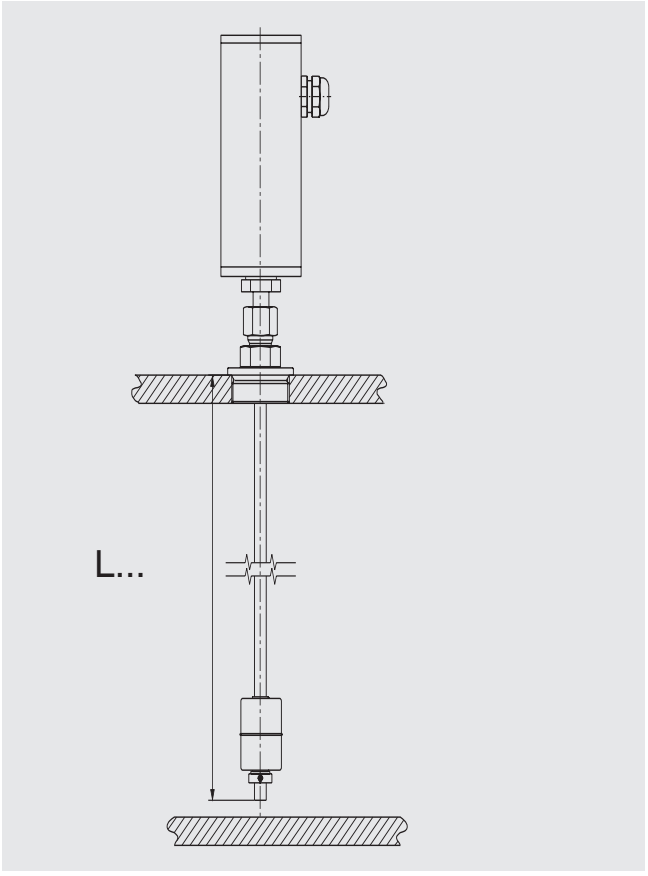
When using a float made of titanium in areas exposed to danger of explosion of category 1/2, please make sure, during installation and operation, that the said float will generate no sparks caused by friction or shock.

Maximum lengths of guide tubes

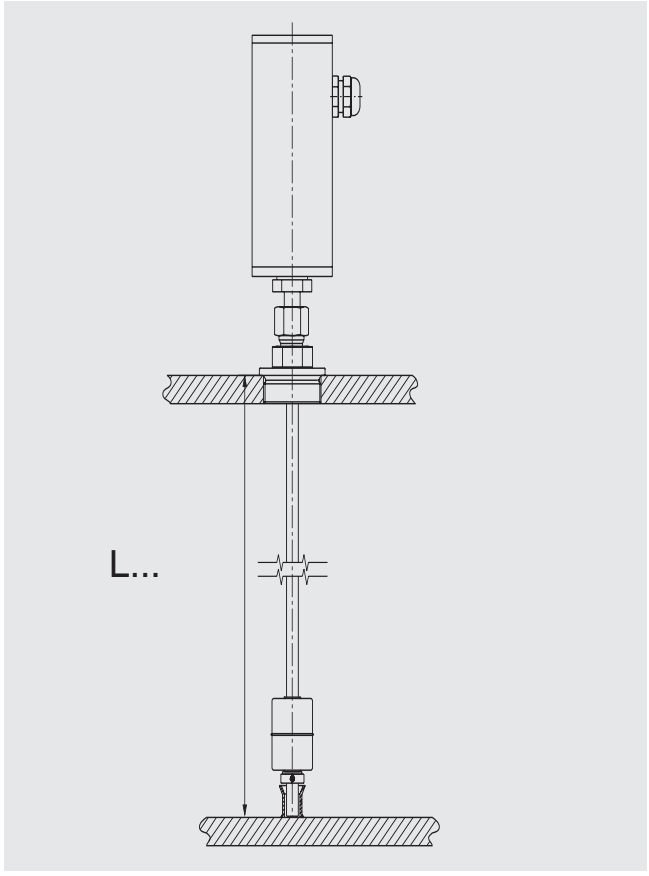
Depending on the length and design of the guide tube, the level sensor must be fixed to the container bottom (see table).

Guide tube	Max. guide tube length L	
	Version A	Version B
12 x 1 mm	660	3500
16 x 1 mm	1270	6000
17.2 x 1.6 mm	2100	6000
18 x 1.5 mm	3000	6000

Version A: Fixed to the tank ceiling



Version B: Fixed to the tank ceiling and floor



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5. Electrical connection

The level sensor in areas exposed to danger of explosion are allowed to be connected to buffer amplifiers only if these are certificated by a generally accepted test institute, and if the electric specifications thereof are compliant with the following conditions:

Ui = ≤ 30 V
Ii = ≤ 0.2 A
Pi = ≤ 1 W

Level sensor model FFG
(Standard and pharmaceutical design) EEx ia

The electric specifications (see product label) and the additional provisions for installing intrinsically safe circuits should be abided by. No work is allowed to be carried out unless by trained experts.
The electric connection of the level sensor is via built-in clamps. The given connecting pattern is conveyed by the connection diagram within the interior of the terminal box, or by the mounting and operating instructions.

Selection of connection cable

Wiring requires a 2-core cable to be connected in the probe head of the sensor. The cable cross-section must be selected so that the supply voltage on the level sensor is no less than 10 V in the borderline case of maximum current consumption (21.5 mA) in a given cable length L.
A copper cable with a cable cross-section of 1 mm^2 and a length of 100 m (100 m forward and 100 m return line) has a resistance of 3.4 Ω (R = 0.034 Ω x L(m)/F(mm^2).

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If a supplier provides, for example, 13 V at 21.5 mA, the sum of resistors contained in the supply line is not allowed to be in excess of (13 V – 10 V) / 0.0215 A = 139 Ω. If the cable is of a cross-section of 0.5 mm^2 and if no burden is contained in the line, the feeder line is not allowed to have a length greater than L = 139 (Ω) x 0.5 (mm^2)/0.034 m = 2050 m.

Note the given connecting pattern

The connection should be carried out with light-blue-marked cable. The diameter of the connecting cable must be within the clamping range of the cable gland (5-10 mm). Using other cable diameters involves the danger of moisture ingress.

The use of individual strands is not permitted!

Cable capacity and inductivity

When determining the required cable length, the highest permitted inductivities and capacities of the connected intrinsically safe control unit should be observed. These values are not allowed to be exceeded.

Connecting the cable

Wiring must be in a voltage-free condition. Compliance with all special VDE regulations and local provisions of installation is imperative.

- Unscrew lid (1) of probe head with open-end wrench
- Loosen sleeve nut (2) of cable bolting
- Insert dual-core cable(4) through sleeve nut and re-tighten the same
- Connect dual-core cable (4) to screw terminals in probe head, marked by (+) and (-)
- Re-screw lid (1) on probe head

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5. Electrical connection

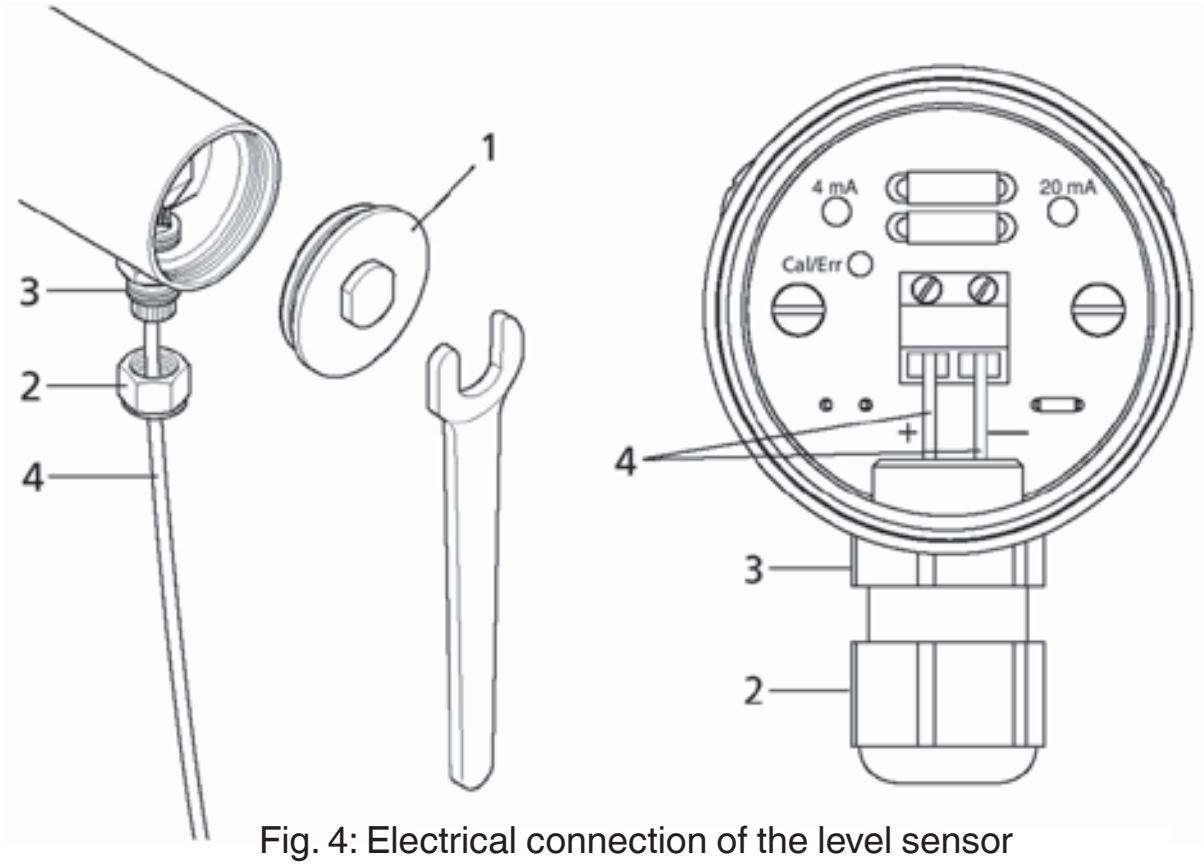

Fig. 4: Electrical connection of the level sensor

Observe the general prescriptions of installation!
The connections on the separating amplifier are marked accordingly. During connection of the poles, there will be no current flow.

Potential balance and PE connection
Grounding or potential balance can be via the earth terminal at the bottom side of the probe head.

Protect the probe head against the ingress of water!
Safe sealing of the cable inlet is safeguarded from a 5 mm outer diameter of the cable.
Tighten cable glands. Lock lid of probe head.

Wiring of the level sensor for supplying purposes (in Ex, preferably blue cable) is by a dual-core cable. The cable cross-section is to be selected so that the supply voltage to the sensor is no less than 10 V in the borderline case of maximum current consumption (21.5 mA) with a given cable length L.

A copper cable having a length of 100 m (100 m forward and 100 m return line) has a resistance of 3.4 Ω in a cable cross-section of 1 mm^2. (R = 0.034 Ω x L(m)/F(mm^2). If a supplier generates, for example, 13 V at 21.5 mA, the resistivity R is allowed to be 3 V/0.0215 A = 139 Ω. If the cable is of a cross-section of 0.5 mm^2 , the feeder line is allowed to have a length L = R(Ω) x F(mm^2)/0.034 m = 2044 m.

Connecting pattern in an area exposed to danger of explosion

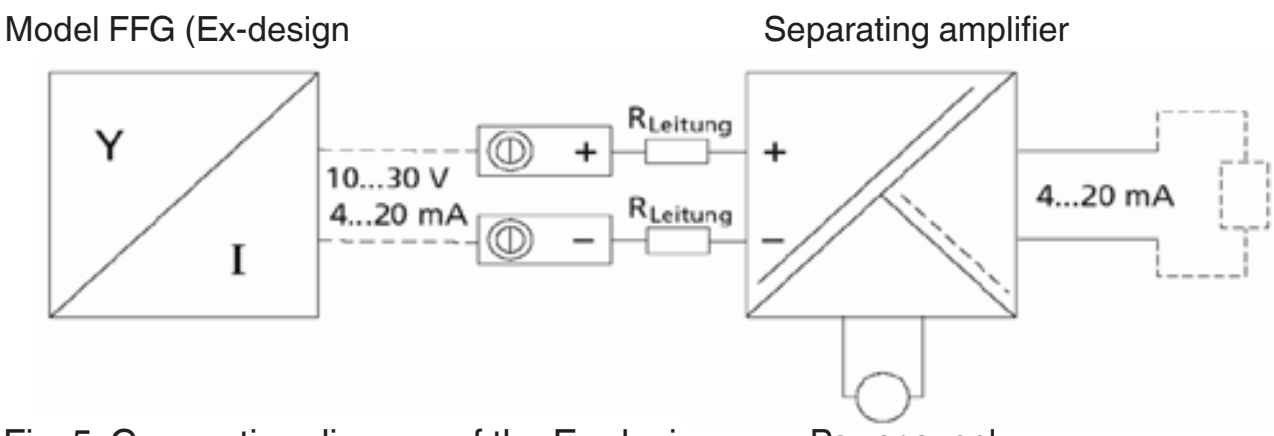

Fig. 5: Connecting diagram of the Ex-design

Minimum voltage: U_{min} = 10 V + 0.0215 A x ∑R
∑R = Sum of all cable resistancess including feeder line and burden

Adjusting measures

Measuring range span

Two keys and one illuminated diode (LED) in the connecting area of the probe head serve for adjusting the 4 mA- and 20 mA-points. The level sensor system is adjusted, ex factory, to the maximum range from 4 mA on the probe base to 20 mA at the probe head. The range of measurement for adaptation to the given container can be individually adjusted; however, the distance must be no less than 5 mm. Otherwise the indication direction of the sensor is automatically reversed.

For further details of adjusting the range of measurement reference (see Fig. 6):

- Unscrew lid (1) of probe head with open-end wrench
- Keep 4 mA-key (2) pressed for no less than 3 seconds

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The level sensor system now is in the adjusting mode with the green LED (4) "Cal/Err" flashing. The current consumption of the level sensor is 12 mA. Without pressing the key again, the level sensor remains in the adjusting mode for 20 seconds before changing back to the measuring mode without modifying the adjustment.

To fix the 4 mA point within this period

- move the float to the desired position,
- and press down key "4 mA" (2) for a short period of time (0.1 ... 2 seconds)

The LED display will disappear for 5 seconds, with the current consumption being 4 mA, and thereafter again 12 mA. The level sensor will remain in the adjusting mode for another 15 seconds before changing back to the gauging mode.

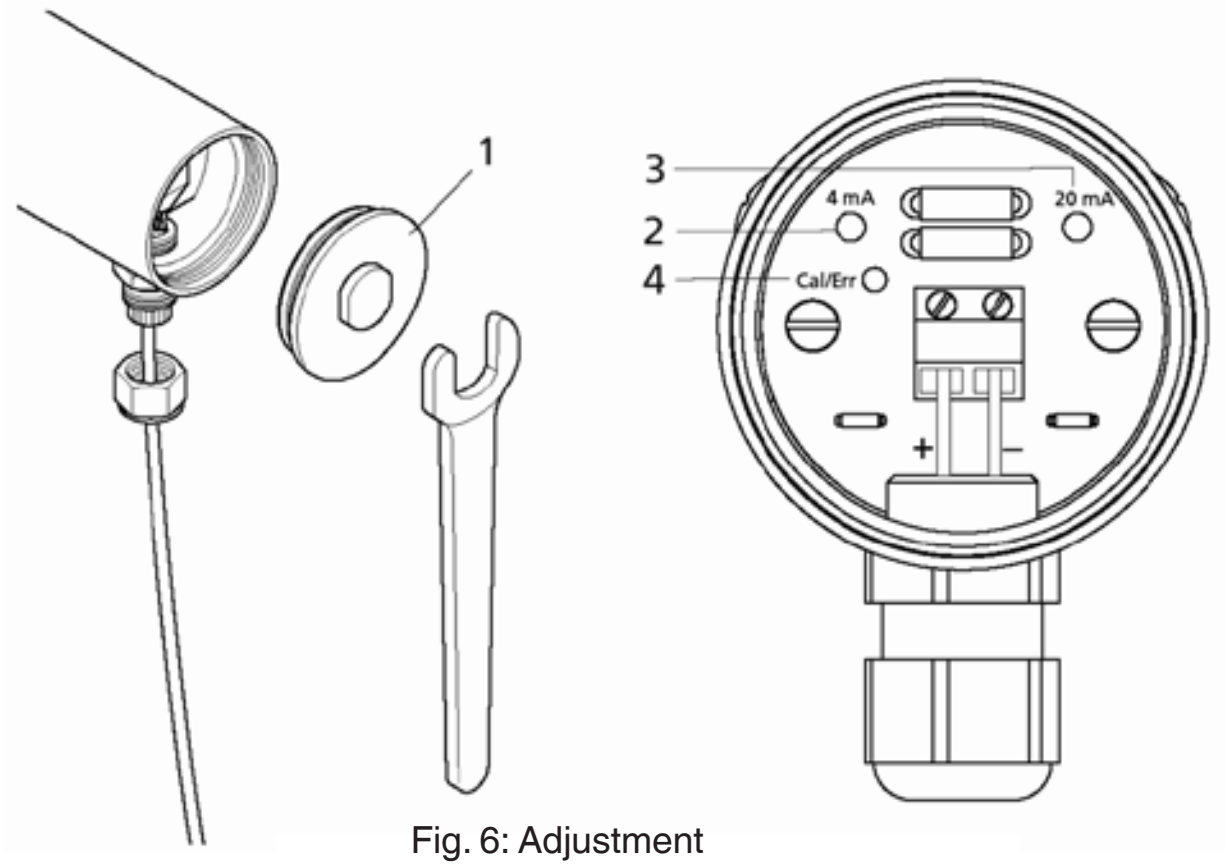

Fig. 6: Adjustment

To fix the 20 mA point within this period

- advance the float to the desired position,
- and press down key "20 mA" (3) for a short period of time (0.1 ... 2 seconds)

The LED display will disappear for 5 seconds, with the current consumption of the level sensor being 20 mA, and thereafter again 12 mA. The level sensor will remain in the adjusting mode for another 15 seconds before changing back to the gauging mode.

The new adjustment will not be adopted until it automatically changes from the adjusting mode into the measuring mode (with LED disappearing). For this reason, the level sensor should not be cut off from the current supply before.

Current Consumption in the error mode

If the level sensor is due to a failure unable to determine a proper float position, i.e. a correct filling level, it will change to an error mode after a short period of time. The current consumption in the error mode has been adjusted, ex factory, to 21.5 mA although it can be switched to 3.6 mA, also.

For adjusting the current consumption in the error mode (see Fig. 5), proceed as follows

- unscrew lid (1) of probe head with open-end wrench hold both "4 mA" (2) and "20 mA" keys (3) simultaneously in pressed for a period of time of no less than 3 seconds. The green LED (4) "Cal/Err" is flashing fast, with the current consumption being 16 mA. LED, after 5 seconds, will cease to flash, displaying, for 2.5 seconds, the set error current consumption. Once the LED is permanently illuminated, I error = 21.5 mA; once it extinguishes I error = 3.6 mA. With the key not being pressed down again, the level sensor will remain in the error mode for another 2.5 seconds before changing back into the gauging mode without modifying the adjustment. For setting a current consumption of 3.6 mA during the 10-second dwelling time in the error mode
- briefly press down the key "4 mA" key (2) (for 0.1 ... 2 seconds). For adjusting a current consumption of 21.5 mA during the 10-second dwelling time in the error mode
- briefly press down the "20 mA" key (3) (for 0.1 ... 2 seconds).

The new adjustment will not be adopted by the level sensor until it automatically changes from the adjusting mode to the gauging mode (with LED disappearing). The level sensor should, therefore, not be cut off from the power supply before.

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6. Maintenance

The level transmitters operate free of maintenance and wear when used properly.

However, within the scope of routine inspections they should undergo visual checks and be part of the container pressure test.

7. Trouble shooting

In the following table the most frequent failure causes and the required corrective measures are listed.

Trouble	Cause	Measure of correction
No or undefined function	Incorrect terminal positioning	Compare with connecting diagram
	Insulation secured under terminals	Check terminal points
	Locating rings displaced or incorrectly mounted after removal from the guide tube	Check position of locating ring
Incorrect 0 ... 100 % values	Float wrongly mounted	Turn float around
	Incorrect specifications in order	Contact factory
	Waveguide in defective condition caused by mechanical interference	Return to factory
	Incorrect setting	Re-adjust or contact factory
Cannot be attached to the proper point within the container	Thread size or flange size of WFFG-T...EX sensor and container not conforming	Re-design the container
		Re-design of level sensor in factory
	Thread of attachment sleeve on container in defective condition	Re-work thread or replace mounting socket
	Screw-in thread on level sensor in defective condition	Return to factory

Please give us a call in case of any difficulties. We will do everything we can to provide you with the required advice and help.

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8. Technical specifications

Type of protection, explosion and temperature class

II 1/2 G EEx ia IIC T6–T2	II 2 D T95 °C IP 6X
II 1/2 G EEx ia IIB T6–T2	II 2 D T95 °C IP 6X (pharmaceutical design)

Equipment group: II
Equipment category: 1G (float and guide tube)
2G / 2D (connecting case)
Type of protection: EEx ia
Explosive sub-group: IIC or IIB (drop protection PTFE)
Temperature class: T2, T3, T4, T5, T6

Summary of electrical specifications of authorized design variants

Power supply:

Voltage	Consumption of power	Inductivity (extern. effective)	Capacity (extern. effective)	Type of protection
DC 10 ... 30 V	max. 700 mW	max. 250 µH	max. 5 nF	EEx ia

Permissible data of control unit:

Ui	Ii	Pi	Li	Ci	Type of protection
≤ 30 V	≤ 200 mA	≤ 1	≥ 250 µH	≥ 5 nF	EEx ia

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8. Technical specifications

Temperatures, standard and pharmaceutical design

Tempera-ture class	Maximum process temperature	Maximum ambient temperature (sensor head of level sensor)	Dust maximum sur-face temperature (sensor head of level sensor)
Category 1/2			
T6	-60 ... 60 °C	-40 ... +40 °C	
T5	-60 ... 80 °C	-40 ... +55 °C	
T4	-60 ... 100 °C	-40 ... +85 °C	
T3	-60 ... 150 °C	-40 ... +85 °C	
T2	-60 ... 150 °C	-40 ... +85 °C	
Category 2			T≤ +95 °C
T6	-60 ... 85 °C	-40 ... +40 °C	
T5	-60 ... 100 °C	-40 ... +55 °C	
T4	-60 ... 135 °C	-40 ... +85 °C	
T3	-60 ... 200 °C	-40 ... +85 °C	
T2	-60 ... 250 °C	-40 ... +85 °C	

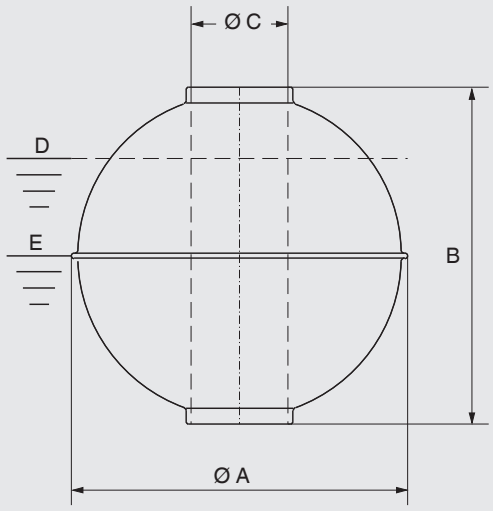
Nominal pressures

Process connection Nominal pressure			Nom. pressure
Flanges [1) 2)]		**Triclamp connection per DIN 32676** [1) 3)]	
PN 6	6 bar	DN 10 - DN 50 0.5 inch - 2 inch	16 bar
PN 16	16 bar	DN 65 - DN 100 2.5 inch - 4 inch	10 bar
PN 40	25 bar	**Dairy fitting** [1)]	
PN 64	25 bar	DN 10 - DN 40	25 bar
150 lbs	15 bar (max. 148 °C)	DN 50 - DN 100	25 bar
300 lbs	25 bar (max. 148 °C)	DN 125 - DN 150	16 bar
600 lbs	25 bar (max. 148 °C)	**Mounting thread G1 - G3** [1)]	
These pressures can be applied on use of suitabble: 1. Gaskets 2. Bolts 3. Tensioning rings		In cases of maximum bolt threading length and suitable gaskets at the process connection, the float pressure specification applies	
		Ingold-Stutzen [1)]	
		DN 25	4 bar

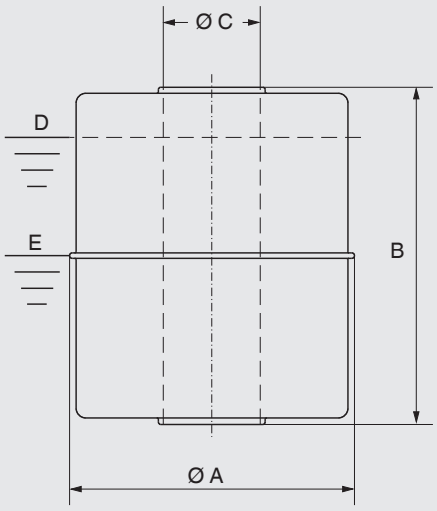
If the pressure specifications for the process connection (e.g. flange) and float differ, the lowest pressure figure is then the nominal pressure

9. Float selection

Spherical floats (K)



Cylindrical floats (Z)



D = Limit S. G. of the medium, immersed float volume 85 %

E = Nominal S. G. of the medium, immersed float volume 50 %

Material	Suits guide tube Ø mm	Form	Ø A mm	B mm	Ø C mm	Max. working pressure bar	Max. working temp. °C	Limit S. G. 85 % kg/m³	Nominal S. G. 50 % kg/m³
Stainless steel 1.4571	**12**	Z	44	52	15	16	200	818	1390
	12	K	52	52	15	40	200	769	1307
	12	K	62	61	15	32	200	597	1015
	12	K	83	81	15	25	200	408	693
	18	K	80	76	23	25	200	679	1155
	18	K	98	96	23	25	200	597	1016
	18	K	105	103	23	25	200	533	907
	18	K	120	117	23	25	200	389	661
	18	K	120	116	38	25	200	537	914
Titanium 3.7035	**12**	Z	44	52	15	16	200	720	1224
	12	K	52	52	15	25	250	707	1201
	12	K	52	52	15	110	250	1040	1770
	12	K	62	62	15	25	250	505	859
	12	K	83	81	15	25	250	278	473
	18	K	80	76	23	25	250	665	1130
	18	K	98	96	23	25	250	595	841
	18	K	105	103	23	25	250	369	627
	18	K	120	117	23	25	250	329	560
Stainless steel 1.4571	**18**	K	81	77	22	25	depending on medium	718	1220
E-CTFE coated	**18**	K	99	97	22	25	depending on medium	675	1148
	18	K	106	104	22	25	depending on medium	633	1076
	18	K	121	118	22	3	depending on medium	459	781
PVC	**16**	Z	55	54	22	3	60	798	1357
	20	Z	80	79	25	3	60	537	974
Polypropylene	**16**	Z	55	54	22	3	80	582	989
	20	Z	80	79	25	3	80	431	723
PVDF	**16**	Z	55	69	22	3	100	821	1396
	20	Z	80	79	25	3	100	681	1157
Pharmaceutical design									
Stainless steel 1.4435	**17.2**	K	80	88	23	16	150	790	1350
Stainless steel 1.4539	**17.2**	K	80	76	23	16	150	621	1056

Note: The optimum float will be selected after a feasibility test carried out by TC Fluid Control

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