Installation, Operating Manual

SmartBox 1, SmartBox 2, SmartBox 3

Electronic contents indicators with control functions

TOC – Table of Contents

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Safety Instructions

SAFETY INFORMATION for water-polluting operating media:
Any material leakage occurring during maintenance must be collected.
Observe the respective legal regulations!

General

The electronic tank management system **SmartBox 1, SmartBox 2,** and **SmartBox 3** can be used for monitoring of the liquids contained in un-pressurized liquids tanks. In addition to the registration of tank contents, other functions can be implemented by system extensions, e.g. temperature measurement, data telecommunication, or connection to master-control systems of the building. **SmartBox 2** has additional relay control functions, e.g. for activating external alarm devices, solenoid valves, or the dry-run protection function of pumps. **SmartBox 3** has relay control functions and an acoustic transmitter for minimum level messaging. The alarm tone can be deactivated (acknowledged) with a button.
Thanks to its modular design, the system can be equipped with additional modules, e.g. with analogue interface or a GSM module for telecommunication.
The indicated measurements are not applicable for invoicing. The measuring probe is not a safety device, not even in connection with an electronic indicator. Accordingly, it will not replace a limit monitoring indicator at the tank. To operate the device as intended and to observe the warranty conditions, it is imperative that you adhere to this **Installation and Operating Manual** and hand it over to the user.

Design

The **SmartBox 1** has an 8-digit LC-display and a measuring input for connecting the probe. The **SmartBox 2** has additionally 2 programmable relays with make and break switching output. As a standard, the measuring probe can be installed with tank connecting thread G1, G1½, or G2.

Operating media

Fuel oil EL   acc. to DIN 51603-1
Petroleum   fire point > 55°C
Diesel fuel DK   acc. to DIN EN 590
Alcohol   fire point > 55°C
FAME (Biodiesel)   acc. to DIN EN 14214
Glycerin
Hydraulic oil
Glycol
Motor oil
Brake fluid
Vegetable oil
Water
Urea solution   e.g. AdBlue acc. to DIN 70700
Petrol   with fire point < 55°Conly with **SmartBox** in EX-version

Installation

Check the indicator and the probe element for transport damages before start of the installation. Indicator and measuring probe must only be installed and commissioned by qualified personnel. This requirement also applies to maintenance and repairs. In case of improper installation, any warranty claims will be forfeited.

- The device must only be installed into tanks which are not operated under pressure. This is to say that the tanks must be equipped with a tank ventilation according to the regulations. Additionally, heating oil and fuel tanks must have a functioning limit monitoring indicator as overfill protection.
- The inlet of the probe cable at the tank must be sealed in such a way that no smell will permeate or water will penetrate under operating conditions.

Notes on installation

Expert installation under observation of the technical regulations for planning, construction and operation of the system as a whole is the precondition for faultless functioning of the contents indicator. These regulations also include the accident prevention regulations of the employers' liability insurance associations, the VDE regulations, and the installation and operating instructions for the fluid tank. The housing of the indicator is suitable for wall mounting and is connected to the 230 V mains supply. Under normal circumstances, the indicator must be operated with the housing cover closed. It is installed and commissioned by the qualified technician while the unit is open.

Warning: Keep away from the area of the 230 V terminal.

Installation of the SmartBox

Mount the indicator to the wall in a suitable position. After loosening the four screws, open the indicator by removing the cover. Mount the unit to a smooth vertical wall by means of four dowels. Mount the housing of the indicator by the four fixing holes by means of the enclosed screws. Take care not to damage the housing! After connecting the terminals and setting the unit up, re-screw the cover.

Warning: The indicator must not be installed in areas subject to explosion hazards!

Mounting of the probe

- For welded basement steel tanks and buried tanks, the probe is installed by means of the enclosed screw fitting with cable bushing.
- In most cases of installation to basement tanks, the fuel gauge with float used before is dismounted so that its opening can be used to screw in the probe unit.
- With buried tanks, there usually is a free opening to screw in the probe element; it will be closed with a removable filler plug.

Installation of the probe into the tank by means of the enclosed screw fitting (see illustration):
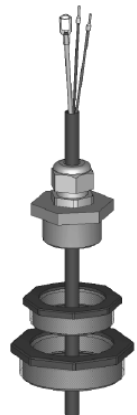
- If applicable, switch the oil burner off and lock the take-off pipe of the tank.
- Clear the opening at the tank.
- Push the screw fitting, if applicable with reduction bush(es), over the probe cable and insert the probe into the tank.
- Seal the screw fitting smell-tight (e.g. with PTFE tape) and screw it into the tank cover.
- Lower the probe into the tank until the probe head touches the tank floor (you will feel it via the cable). Then, screw down the cable gland to fix the cable. Optionally, the probe can also be fixed in a lying position on the tank floor.
- Usually, it is not necessary to perform a probe zero adjustment.
- Re-open the take-off line of the tank and reactivate the oil burner if applicable. Check the function of the oil burner.

Electrical Installation

Connection line between indicator and probe:

Voltage: Probe element 20 V DC

Connection: Probe connection cable to terminals 1 (red) and 2 (black) (see figure below)

Air capillaries: The cable must be installed in such a way that pressure equalization with the ambient air is ensured but no moisture can penetrate into the cable end.

Extensions: The probe cable can be extended by max. 200 m - e.g. with cable type NYM or YR (moisture-proof) or NYY (ground) and with min. cable cross-section 2 x 0.4 mm^2.
**For cable extension in the dome or outdoors, a waterproof connection box with special pressure equalization filter must be used (accessory).**

Shield: If the probe cable (or extension) runs close to power lines, a shielded signal line should be used (connect shield to PE terminal).

Connection of supply voltage:

Voltage: 230 V AC 50 Hz
Connection: Terminals PE, N + L to the indicator (cable is not part of the delivery)
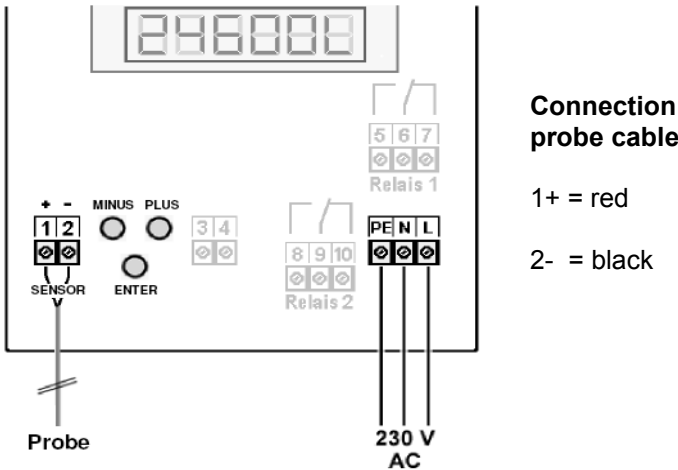
Connection probe cable

1+ = red

2- = black

Connection of the relay contacts of SmartBox 2 and SmartBox 3

The indicator **SmartBox 2** has two relays (**SmartBox 3** 1 relay) for the connection of external control circuits or for activating external alarm or signal devices. In case of failure of the unit and if the fill level (and optionally the temperature) is above the selected limit, the contact of relay terminals 6 + 7 and 9 + 10 are closed, or 5 + 6 and 8 + 9 are open- see the legend on the PCB in the unit.

| **Switching voltage max.:**	250 V AC		
Switching current max.:	3.5 A		
Connection:	closed for alarm	open for alarm	
Relay 1	terminals 5 + 6	terminals 6 + 7	SmartBox 2
Relay 2	terminals 8 + 9	terminals 9 + 10	SmartBox 2, 3

Connection of interface to SmartBox 4, SmartBox 5 or PC-Link

The measured values can be transmitted to the **SmartBox 4, SmartBox 5** or the **PC-Link** set via the integrated interface "SERIAL LINK OUTPUT" terminals 3 + 4.

Heating oil tank - wiring example Smart Box 1
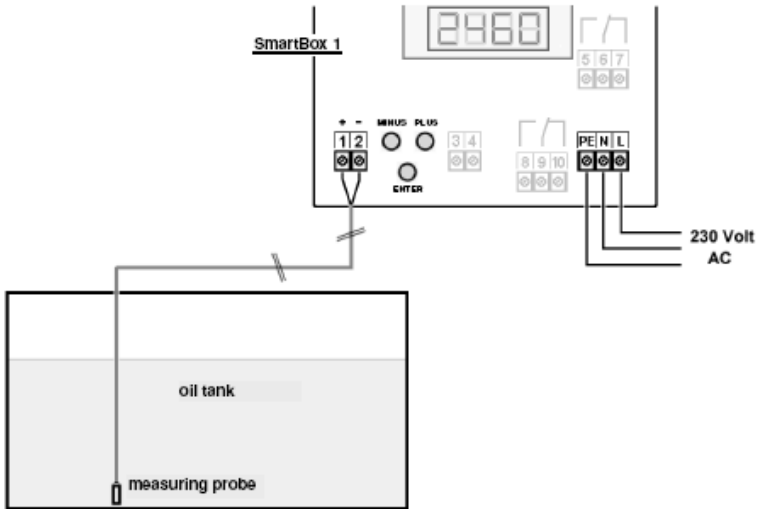
Rain water reservoir - wiring example SmartBox 2
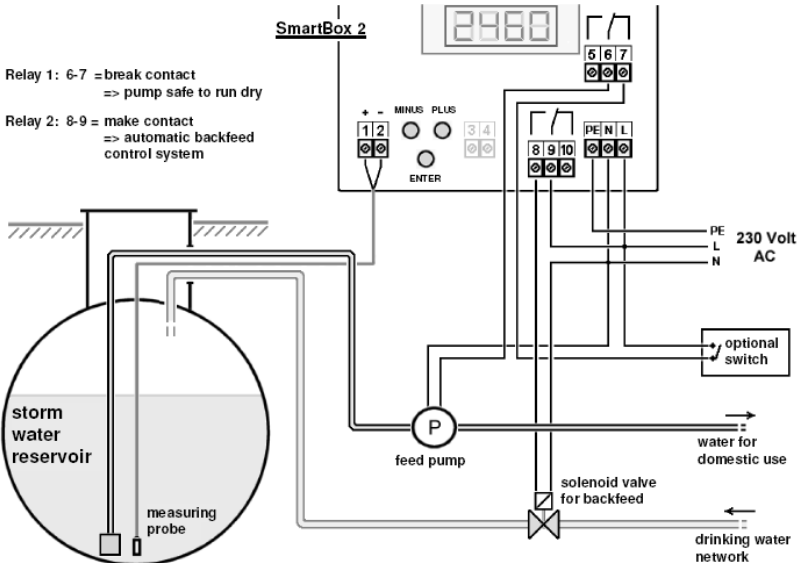
Startup

After the contents indicator has been installed, it can be started up. Before programming, you need to ascertain the tank data and enter the values into the right column Input value of the following table. Then, enter the values for the individual entry steps. Optionally, the device can also be programmed as explained in the enclosed Quick Guide.

Setting a parameter:	Press **ENTER** to call the setup mode. Select the desired setting parameter via PLUS. Press **ENTER** to call up the value selection for the parameter. Set the value with PLUS/MINUS, press **ENTER** to save.
Quitting the setup mode:	You can quit the setup mode at any time. Select 8. Exit and press **ENTER** to go back to the standard display mode.

Step	Input function	Input value
1. Probe	Select probe measuring range (see type label of the probe) - default value is 250 mbar	_____mbar
2. Fluid (medium)	Select the medium, e.g.: - **heating oil** (default): **Heat.oil** - **Diesel:** **Diesel** - select other stored media with + / - or enter density value **...kg/m3** For unknown density values, see the Notes on Programming	_____
3. Tank (tank shape)	Select the tank shape, e.g.: - **linear** (default): **Linear** - **cylindrical** horizontal: **Cyl.** - **cyl.** horizontal 50 to 100 m³: **Cyl.>50m3**	_____
4. Volume (tank volume)	Enter tank volume (or maximum fill level):e. g.: 20.000L **Important:** Please see a volume table for the highest value, if available. For a 100 m³ cyl. buried tank, this may for example be the value 100 600 litres.	_____L

5. Height (tank height or max. filling height)	Enter inner tank height in mm: e. g.: 2.500 mm (max. value = 9.999 mm) (height without dome) **Important:** Please see a volume table for the highest value, if available. For a 100 m³ cyl. buried tank, this may be f. e. the value 288 cm = 2.880 mm.	

Steps 6 + 7 are only required for SmartBox 2 and SmartBox 3		
➜ **SmartBox 2: 6. Relay1** or ➜ **SmartBox 3: 6. Beeper (acoustic alarm transmitter)**	Enter relay switch points as percentage from 01 to 99 (and/or as °C value from -99 to +99) – only for a probe with temperature measuring function) deactive activate with + / - to active press **Enter** to confirm On: 10% ON: set with + / - ➜**Enter** Off: 12% OFF: set with + / - ➜**Enter** On: +0°C ON: set with + / - ➜**Enter** Off: +0°C OFF: set with + / - ➜**Enter** Deactivate the relay and the beeper via **deactive** or input of 0% or 0°C (both for On and Off).	On ___% Off ___% On ___°C Off ___°C
7. Relay2	See 6. Relay 1 for the data for Relay 2	
8. Exit (quit)	Press Enter to return to display mode	

After performing entry steps 1 - 7, the programming process is completed. After confirmation of step 8 "Exit", the device automatically returns to standard display mode; the current tank contents is shown in the display. **Special functions are available under entry steps 9 to 13 (see later).** After the end of setup, do not forget to re-screw the housing cover!

Examples for programming

Example 1   **Basement tank for 6000 litres heating oil, litre indication, linear steel tank**
Inner height 165 cm, (fill level 125 cm)
Standard probe TDS-6023   0 – 250 mbar

Step	Entries/selection
1. Probe 250 mbar	250mbar
2. Medium: heating oil	Heat.oil
3. Tank shape: linear	Linear
4. Tank volume: 6000 litres	6000L (set with +/- keys)
5. Inner tank height: 165 cm	1.650mm (set with +/- keys)
6. Relay 1 – no function	deactive
7. Relay 2 – no function	deactive
8. Exit ➔ press ENTER to see the indication ➔ e.g. 4550L	

Example 2   **Buried tank, cylindrical, horizontal, for 100.600 litres Diesel oil**
Inner height 2.886 m, (fill level 54 cm)
Standard probe TDS-6023   0 – 250 mbar

Step	Entries
1. Probe 250 mbar	250mbar
2. Medium: Diesel	Diesel
3. Tank shape cyl. horiz. >50m³	Cyl. >50m3
4. Tank volume: 100.600 l	100600L (exact value from volume table)
5. Inner tank height: 288.6 cm	2886 (exact value from volume table)
6. Relay 1 – no function	inactive
7. Relay 2 - no function	inactive
8. Exit ➔ press ENTER to see the indication ➔ e.g. 12.800L	

Tank with inner casing
For tanks with inner casing (e.g. cyl. horizontal or basement-welded tanks), the entries for inner height and volume should be adjusted.
Examples:
➔ Wall thickness of inner casing 0.5 cm ➔ reduce value for inner height by approx. 1 cm, reduce volume for 10 m³ by 1.3%, for 20 m³ by 1%, for 50 m³ by 0.8% and for 100 m³ by 0.7%.

➔ Wall thickness of inner casing 2 cm ➔ reduce value for inner height by approx. 4 cm, reduce volume for 10 m³ by 5%, for 20 m³ by 4%, for 50 m³ by 3% and for 100 m³ by 2.5%.

Example 3 Well, 7.50 m maximum water level from ground of the well

(fill level 4.20 m), relay switching function is desired.
Probe TDS-6029 (measuring range 0 – 1000 mbar), indication in m water column.

Step	Entries
1. Probe 1000 mbar	1000mbar
2. Medium: water	H2O
3. Tank shape (well): linear	Linear
4. Volume 7500l (indicated in m)	7500L (set with +/- keys)
5. Inner tank height 7.50m	750 cm (set with +/- keys)
6. Relay1 – ON at <05% - OFF at >10%	active ➔ On: 05% ➔ Off:10%
7. Relay2 – no function	
8. Exit ➔ press PLUS key to go to	
12. Unit – indicated unit: m	Unit: m
13. Rounding: auto	auto (just confirm with ENTER)
14. Exit ➔ press ENTER to see the indication ➔ e.g. 4.20m	

Notes on programming

Menu item	Setting	Description
0. Exit		Back to display mode
1. Probe	100mbar	Tank height heating oil up to 1.2 m – water up to 1 m
	150mbar	Tank height heating oil up to 1.8 m – water up to 1.5 m
	250mbar	Standard probe - tank height heating oil up to 3 m – water up to 2.5 m
	500mbar	Tank height heating oil up to 6 m – water up to 5 m
	1000mbar	Tank height heating oil up to 12 m – water up to 10 m
	2000mbar	Tank height heating oil up to 24 m – water up to 20 m
	3000mbar	Tank height heating oil up to 36 m – water up to 30 m
	5000mbar	Tank height heating oil up to 60 m – water up to 50 m
	Set mbar Cal mode	Entry of a specific probe with different measuring range Is only indicated if item 10. Set h or 11. Set V has been activated

2.Fluid Medium	Heat.oil	0.845 - default setting
	H2O	0.999
	Diesel	0.830
	BioD	0.880
	RME,FAME	0.880 (rapeseed, methyl ester, fatty acid methyl ester)
	Rapsoil	0.915
	Palmoil	0.910
	Motoroil	0,865
	AdBlue	1.090
	Normal-B	0.743
	Super-B	0.750
	Set kg/m3	Entry of a specific density value
	Cal mode	is only indicated if item 10. Set h or 11. Set V has been activated

If the density of the stored medium is unknown, the reference height can be entered in menu item10. Set h. To this end, determine the current fill level in mm, deduct 10 mm from it and enter the resulting value - click YES to confirm the entry. Should the current fill level be smaller 75%, we urgently recommend to adjust the value after the next refuelling to achieve a good measuring accuracy.

3. tank tank shape	Linear	Default setting linear tank, rectangular tanks, vertical cylinders, basement-welded steel tanks.	
	Cyl.	cylindrical tank (optionally, see Cyl.>50m³), horizontal cylinders; tubular tanks, max. 45 m³; typical shape for steel outdoor or buried tanks.	
	Ball	spherical tank; buried tanks with spherical basic shape; frequently plastic buried tank(GRP).	
	Oval	oval basement tanks; typical shape of GRP tanks and single-walled sheet metal tanks	

	Convex	Plastic battery tanks, convex, slightly bellied shape, alternative to linear	
	Concave	Plastic battery tanks, concave, slightly caved-in shape, alternative to linear	
	Plastics	Plastic tank with recess. Plastic tank with a large recess (hollow) in the centre (without tape bindings)	
	Cyl.>50 m³	large cylindrical outdoor tank 50.000 litres to 100.000 litres; a special bearing chart conversion table can be ordered specifically for large cylindrical tanks of 50 m³ to 100 m³.	
4. Volume tank volume	xxx.xxxL	Default setting is 0L. 0L is an invalid value. This parameter must be set in all cases.	
5. Height Inner tank height	x.xxx mm (or cm)	Default setting is 2.000 mm (the maximum value is 9.999 mm) - for probes from 1.000 mbar, the height is indicated/set in cm, not in mm.	
6. Relay1	deactive active	Default setting (enter on deactive ➜ go to next entry step). Enter on active results in the next 'On' step	
	On: 10%	10% is the default setting, range is 0..99 Relay and beeper switches ON if the content of the tank falls below a limit of e.g. 10%.	
	Off:12%	12% is the default setting (hysteresis) Relay and beeper switches OFF again if the content of the tank rises above a limit of e.g. 12%. If On=0% and Off=0%, no fill level switching function is active.	
	On: +0C	Only if a temperature adapter is available; range is -99C .. +99C When On=0C and Off=0C, no	

		temperature switching function is active Relay switches ON if the temperature falls below a limit of e.g. 15°C.
	Off: +0C	Relay and beeper switches OFF again if the temperature rises above a limit of e.g. 17°C (hysteresis).
7. Relay2		For entries for Relay2, refer to 6.Relay1
8. Exit		Back to display mode
9. Offset	ESC Calibrat Default	Zero point adjustment (probe offset)is indicated only after a calibration has been performed
10. Set h	xxxx mm	Possibility to enter reference height for 2-point-measurement, for a different probe measuring range, or if density is unknown. Deduct 10 mm from the current fill level as measured*, and enter the resulting value. If tank height "5. Height" has been indicated in cm (e.g. for probe measuring range from 1,000 mbar), the value will be indicated in cm here!
	Cal: No Cal: Yes	If activated (Yes), a confirmation dialog follows because from now on, the system will not calculate with the density as entered but with a special factor. Then, "Cal Mode" is indicated in step 1+2. If this entry is made while the tank is almost empty, it is advisable to perform a readjustment later on, see 11.Set V.
11. Set V	xxx.xxxL	Readjustment of the fill level indication with +/- key.
	Cal: No Cal: Yes	See 10.Set h
12. Unit	Unit: m3Unit: %Unit: m	Default setting (3 decimal points: 999,900L) (2 decimal points: 75.50 m3) (2 decimal points: 99.50 %) (2 decimal points: 2.50 m)
13. Round	Auto Off 2, 5, 10, 20, 50, 100	Default setting (increments of 1). In dependence on the preset volume, one or two zeros are added. This is to say that a selected rounding value 2..100 refers to the 4th indicated position (e.g. for a 100.000L tank, 10= stands for 1.000L rounding)
14. –19. Exit		Back to display mode
20. LCD	Contr 52	Set the contrast of the LC-display
21. Info		Shows the following:

		Software version V1.00 Serial number SN1234 X0xxxx Bxxxx
22. Test		Indication of the current mA measured value and the hex value for the A/D-converter
23. TestR	Rel1 ON Rel1 OFF Rel2 ON Rel2 OFF	Relay test
24. Init	Sure: No Sure: Yes	Abort Clear all settings (factory settings)
26. Exit		Back to display mode

Error messages

Error Code	Significance
Error E1	The set value is invalid
Error E2	Measured value too small (<3mA => probe defective)
Error E3	Measured value too large for zero point calibration (probe must not be immersed)
Error E4	Not defined
Error E5	Not defined
Error E6	Set height is too great (measured value is too small - the probe must be immersed)
Error E7	Set volume is too great (measured value is too small - the probe must be immersed)
Error E8	Measured value is too great (probe short-circuited, defective, or incorrectly connected
Error E9	Measured value is 0 (no probe connected, or wire breakage, or reversed polarity)
Error E10	Calibration error
Error E11	Warning 'Tank empty' (tank content is actually too

	small for calibration) Press OK to continue nevertheless)
Checking the level probe signal:	

Checking the level probe signal:

At 0 cm fill level ➔ app. 3.5 – 4.5 mA. Can be checked in menu item 22.

For 1 m water column ➔ approx. 9 - 11 mA (for standard probe with measuring range of 250 mbar)

Operation

The contents indicator does not require any attention during ongoing operation.

Performance check

 After refuelling the tanks or once per year, check whether the indicated value corresponds to the fill level.

Maintenance

With correct installation and operation, the contents indicator is free of maintenance. The indicator and the probe element must be checked annually, as described under Performance Check

Repair

In case of repeated error or alarm message (relay output) while the tank content does not reach /remains under the set fill level alarm threshold at the probe element, check the connection line of the signal and probe element for breakage or short-circuit, re-install if necessary.

If the measures explained in sections Setup, Operation and Maintenance fail to achieve regular re-START, and unless the instructions have been misunderstood, the device must be removed and sent to the manufacturer for a check-up. Any unauthorized handling will result in loss of any warranty claims.

Technical specification

Indicator	
CE	Pursuant to EN 50081-1, EN 50082-1, EN 61010-1 / A2
Supply voltage:　　230 V AC 50 Hz	Degree of protection: IP 30 or IP 65 acc. to IEC 529
Power input:　　max. 2 VA	
Measuring input:　4 – 20 mA; 　　　　　　　U0 = 20 V	Resolution: 10 Bit
	Accuracy: ± 1 %
Relay output: Switching voltage: max. 250 V AC Switching current: max. 3.5 A	Optional (see accessories) Analogue output: 0 - 5 V DC 　　　　　　　　4-20 mA
Dimensions W x H x D in [mm]: 　120 x 120 x 49 (IP30) or 　130 x 130 x 60 (IP65)	Housing:　Polystyrene (IP30) 　　　　　　or 　　　　　Polycarbonate (IP65)
Probe element (relative pressure probe for level detection)	
Operating voltage: 20 V DC	Degree of protection: IP 68 acc. to IEC529
Material: V4A ; POM;FPM; HD-PE	Length of probe (without cable) 90 mm
Standard version: 250 mbar	Length of probe connection cable 6 m
Installation position: vertically suspended, or horizontally supine	
Temperature range: Ambience operating media: 0 °C to 80 °C	

Accessories

Order no.	Product description	Information on application
HW065	Data transmission module 0-5 V	Retrofittable module as interface to data transmission, e.g. for the master control system of the building
HW067	Data transmission module 4-20 mA	Retrofittable module as interface to data transmission, e.g. for the master control system of the building
HW088	M-Bus interface	For data transmission e.g. to building control systems
HW070	PC set	Retrofit kit for data transmission to a PC – incl. software for indication/evaluation and for sending messages via e-mail
HW079	Cable junction box IP 66, water-proof, with pressure equalization	To extend the probe cable - e.g. in the dome
HW021	**SmartBox 5** data transmitter	GSM telecommunication system for **SmartBox 1, 2,** or **3** and event messages (e.g. burner malfunction)
HW071	Additional antenna	Additional antenna for reception amplification at the **SmartBox 5** - data transmitter

Other products:

Wireless radio controlled filling and overfill prevention system:
LRC Small – Level Remote Control

Products for wireless data transfer in EX-zones:
SECU-DATA 420:   for 4-20 mA probes
SECU-DATA 500:   for 2 relay contacts
SECU-DATA 600:   for NAMUR probes
SECU-DATA 710:   for TRbF-probes
SECU-BAR 125:   active barrier

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