KROHNE

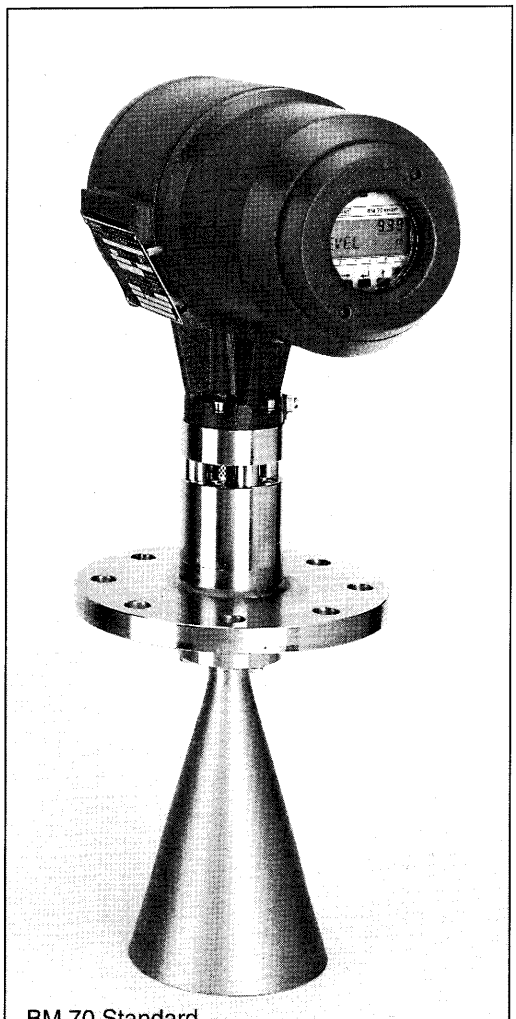
04/96

Level-Radar

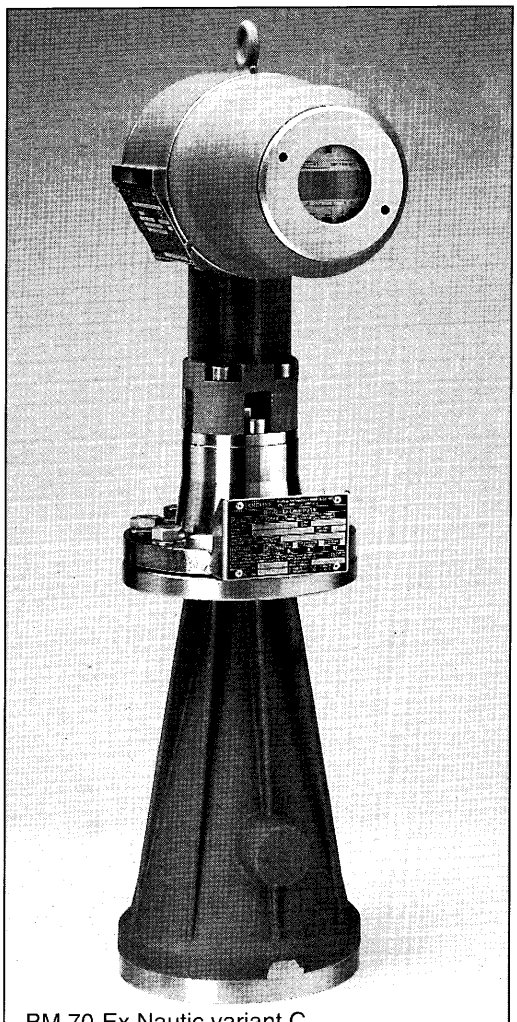
Non-contact level gauging using electromagnetic waves

Installation and operating instructions

BM 70



BM 70 Standard



BM 70-Ex Nautic variant C

Krohne Messtechnik GmbH & Co. KG certified by

TÜV CERT DIN ISO 9001

4M27EA4 049622

Order No. DIN A4: 7.02182.34.00
US Size: 7.02182.74.00

How to use these Installation and Operating Instructions

- For easy reference these Instructions are divided into 5 parts.
- Only **Part A** (pages 6–19) is needed for **installation and initial start-up.**
- All BM 70 level gauges are factory-set to your order specifications. Therefore, no further adjustments are necessary prior to start-up.

Part A (pages 6 – 19)	Mount level gauge on tank (Sect. 1), connect up (Sect. 2), power the unit (Sect. 3), that's all! **The instrument is operative**
Part B (pages 20 – 36)	Operator control and action of the BM 70 signal converter
Part C (pages 37 – 51)	Special applications, functional checks and service
Part D (pages 52 – 68)	Technical data, operating principle, approvals
Part E (pages 69 + 70)	Index

Product liability and warranty

The BM 70 level gauge is used solely for measuring the level and volume of liquids, pastes, slurries and solids.

The BM 70 is **not** part of an overfill protection system.

Special codes and regulations apply to its use in hazardous areas.

Responsibility as to suitability and intended use of our instruments rests solely with the operator.

Improper installation and operation of the level gauges may lead to loss of warranty.

In addition, the "General conditions of sale" forming the basis of the purchase contract are applicable.

If the level gauge has to be returned to Krohne, please note the information given on page 71.

System description

The BM 70 is a level gauge designed for the continuous and non-contact measurement of liquids, pastes, slurries and solids in closed metal process and storage vessels, max. vessel height: 35 m (115 ft), min. vessel height: 1 m (3.28 ft).

BM 70 level gauges allow measurements to be made even under extreme and exceptionally difficult conditions.

Sensor and signal converter form a compact unit that is mounted on a tank fitting. The signal converter can be replaced under process conditions.

A 0 (4) to 20 mA current output is available for long-distance data transmission; optionally, an RS 485 interface, HART® protocol (Modbus, PROFIBUS in preparation).

Simple clear text operator prompting in various languages via 3 keys **or** via bar magnet and magnetic sensors without opening the housing.

The built-in smart interface allows remote control and data interrogation via the MIC 500 hand-held communicator (option).

Long-distance data transmission and measured-value analysis via an MS-DOS PC are possible with the PC-CAT interface module (option).

Items included with supply

Version as ordered:

- Signal converter bolted to waveguide window and antenna
  option: antenna extension, sunshade (with fixing material in each case)
- Shielding material with tightening strap (not for US market)
- Installation and operating instructions with pull-out condensed instructions for the signal converter plus instruction card
- Report on factory settings of the signal converter
- Approval documents, unless reproduced in these Instructions
- Bar magnet for operator control
- Wrench for cover

Mounting accessories (stud bolts, flange gasket and cabling) not supplied, to be provided by customer!

Contents

Part C Special applications, functional checks and service 37–51

Part D Technical data, operating principle, approvals 52–68

Part E Index 69+70

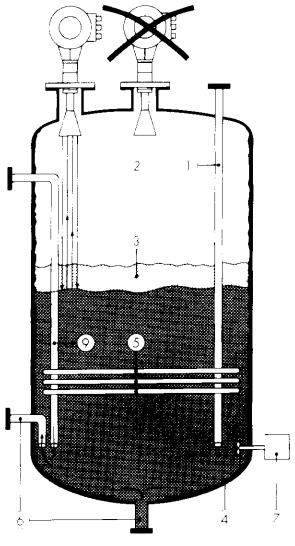
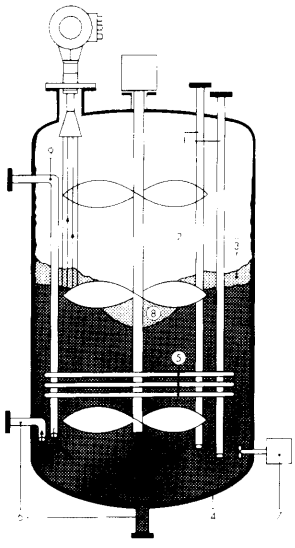
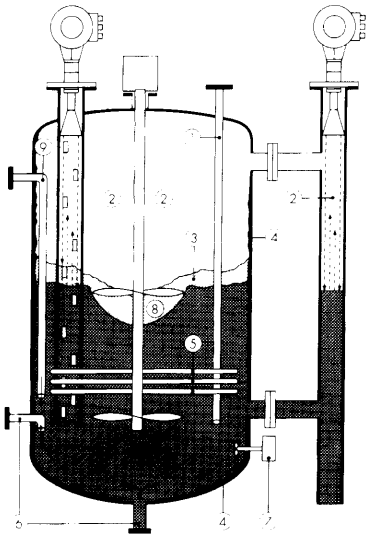
Part A BM 70 Installation and start-up

1. Mounting the BM 70 on the vessel

For certification reasons, in some countries the BM 70 may only be operated on hermetically sealed metal vessels. However, if a vessel has to be opened occasionally, no health hazard need be feared from the microwaves.

1.1 Selecting the installation location

Choice of vessel types with possible vessel constellations

1 Dip pipe 2 Steam, condensate	**Storage vessels** with smooth product surface and relatively constant liquid level. **Process vessels** with running processes. rough product surface, rapidly changing levels, without agitators	**Process vessels with agitators,** with running processes, rough product surface, rapidly changing levels	**Communicating pipes and stilling wells**
3 Froth 4 Caked deposits in vessel 5 Heating coil 6 Drainage, discharge 7 Circulating device 8 Vortex/turbulence 9 Inflow			
Vessel height Sect. 4.3 + 5.2, Fct. 3.1.1	1 m to 30 m **or** 3.3 to 100 ft	1 m to 10 m **or** 3.3 to 33 ft	1 m to 20 m **or** 3.3 to 66 ft
Interference reflections	Interference reflections can occur with reflecting internals, in the vicinity of agitator shafts or filler necks. Install the BM 70 as far away as possible from such internals. Always record the empty spectrum, if possible, see Sect. 4.3 + 5.15, Fct. 3.5.1 + 3.5.2.		
Multiple reflections	Can occur if BM 70 mounted on blind flanges or manhole covers > DN 250 **or** > 10", or positioned in the centre of dished ends or flat vessel tops. Avoid such locations.		do not occur
Distance from vessel wall	**Recommended:** $^1/_6$ to $^1/_3$ of vessel diameter D. Wherever possible, always mount the BM 70 off-centre. For large tank diameters D, the following minimum distance will suffice: Antenna type 3: $^1/_7$ of tank height H (if D > $^1/_2$ H) Antenna type 4: $^1/_{10}$ of tank height H (if D > $^1/_3$ H)		no effect
Antenna type Connection flange Sect. 4.3+5.3, Fct. 3.1.5	Type 3, DN 150 **or** 6" Type 4, DN 200 **or** 8"	Type 3, DN 150 **or** 6" Type 4, DN 200 **or** 8"	Type 1, DN 80 **or** 3" Type 2, DN 100 **or** 4" Type 3, DN 150 **or** 6"
Hold distance Sect. 4.3 + 5.3, Fct. 3.1.2	≥ 10 cm **or** ≥ 4"	≥ 20 cm **or** ≥ 8"	≥ 50 cm **or** ≥ 20"
Additional measuring error for measured distance (non-calibrated)			DN 80: approx. 3% DN 100: approx. 2% DN 150: approx. 1%

1.2 Selection of BM 70 connection flange, antenna type and extension, material(s) of wetted parts

Select BM 70 connection flange, antenna type and material(s)

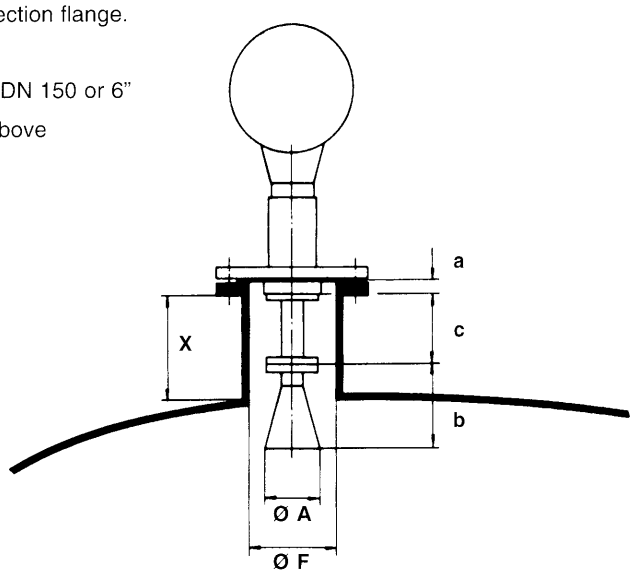
BM 70 connection flange	– to DIN 2501 *	**DN 80**	**DN 100**	**DN 150**	**DN 200**
	– to ANSI B 16.5 *	3"	4"	6"	8"
	– diameter **Ø F** (flange or vessel fitting) in mm and (inches)	<85 (3.50)	<115 (4.50)	<170 (6.50)	<220 (8.50)
Antenna	– type *	**Type 1**	**Type 2**	**Type 3**	**Type 4**
	– max. diameter **Ø A** in mm and (inches)	74 (2.91)	98 (3.86)	139 (5.47)	200 (7.87)
	– length **b** in mm and (inches) Standard: material stainless steel 1.4571 **or** SS 316 Ti-AISI Special version: material Hastelloy C4	93 (3.66) 84 (3.31)	134 (5.28) 125 (4.92)	221 (8.70) 212 (8.35)	352 (13.86) 348 (13.70)
	– length of BM 70 fittings **a** in mm and (inches) Standard: material stainless steel 1.4571 Special version: material Hastelloy C4	 32 (1.26) 50 (1.97)	 32 (1.26) 50 (1.97)	 32 (1.26) 50 (1.97)	 32 (1.26) 50 (1.97)

* These are the usual combinations of antenna type and BM 70 connection flange.

Standard: Antenna type 3 with connection flange DN 150 or 6"

Special versions: Combinations other than those given above are of course also possible.

Section 1.2 not applicable to antenna type 0.



Is an antenna extension needed, if so of what length (c)?

- Antenna extensions are supplied in lengths of 100 to 1000 mm or approx. 4" to 40", graded in steps of 100 mm or approx. 4". Intermediate sizes **not** available!
- Is the max. antenna diameter **Ø A smaller** than the connection flange diameter **Ø F**?
  Yes,
  Determine antenna extension according to **Case** Ⓐ.
  No,
  Determine antenna extension according to **Case** Ⓑ.

Case Ⓐ : antenna diameter **Ø A smaller** than **Ø F**, diameter of vessel fitting or flange?

- Is dimension (a+b) longer than dimension (X) = length of vessel fitting?
  Yes: antenna extension not required!
  No: antenna extension required!
- Determine length (c): X – (a+b) = **c**, select at least the next length up, gradings 100 mm or approx. 4".
- **Example:** antenna type 3, connection flange DN 150 equivalent to 6",
  material stainless steel 1.4571 or SS 316 Ti-AISI
  length of vessel fitting (X): 437 mm, incl. flange
  Dimensions **a** and **b** acc. to Table above:
  a = 221 mm, b = 32 mm
  a+b = 221 mm + 32 mm = 253 mm
  X – (a+b) = 437 mm – 253 mm = 184 mm
  Therefore antenna extension of min. 200 mm length required!

Length of vessel fitting X		**Antenna extension c**			
		with antenna type 3		**with antenna type 4**	
in mm	in inches	in mm	in inches	in mm	in inches
less than 250	less than 9.84	Extension not needed		Extension not needed	
251– 350	9.9 –13.8	100	4	Extension not needed	
351– 450	13.8 –17.7	200	8	100	4
451– 550	17.8 –21.7	300	12	200	8
551– 650	21.7 –25.6	400	16	300	12
651– 750	25.6 –29.5	500	20	400	16
751– 850	29.6 –33.5	600	24	500	20
851– 950	33.5 –37.4	700	28	600	24
951–1050	37.4 –41.3	800	32	700	28
1051–1150	41.4 –45.3	900	36	800	32
1151–1250	45.3 –49.2	1000	40	900	36
1251–1350	49.3 –53.1	–	–	1000	40

Case Ⓑ : antenna diameter **Ø A larger** than **Ø F**, diameter of vessel fitting or flange?

- In this case installation must be carried out from inside the vessel.
- To simplify the work, an antenna extension should always be used even if vessel fitting lengths (X) are smaller than 50 mm or 2".
- Please refer to the Table on the right to determine the minimum length **(c)** of the antenna extension, which in this case depends only on the length of the vessel fitting (X).
- Refer to Sect. 1.4 for installation.

Length of vessel fitting X		Antenna extension c	
in mm	in inches	in mm	in inches
less than 50	less than 1.97	Extension not needed	
51– 150	2.01– 5.91	100	4
151– 250	5.94– 9.84	200	8
251– 350	9.88–13.78	300	12
351– 450	13.82–17.72	400	16
451– 550	17.76–21.65	500	20
551– 650	21.69–25.59	600	24
651– 750	25.63–29.53	700	28
751– 850	29.57–33.46	800	32
851– 950	33.50–37.48	900	36
951–1050	37.44–41.34	1000	40

1.3 Installation requirements

Hazardous-duty systems
If to be installed in hazardous areas, make certain there is no explosion hazard (gas-free certificate).
The instrument is certified to **European Standard** for use in hazardous areas of Zones 1 and 2, with the possibility of mounting it on vessels in which Zone 0 conditions prevail.

The BM 70 is also approved to **FM (Factory Mutual):**
Class I, Div 1, Groups B, C, D / Class II, III, Div 1, Groups E, F, G.

- **Caution:** The vessel must be depressurized before installing or dismantling the BM 70.
- **Installation material** supplied: see "Items included with supply" on page 3.

Connection flanges and max. operating pressure for the BM 70

Flanges to DIN 2501 = BS 4504

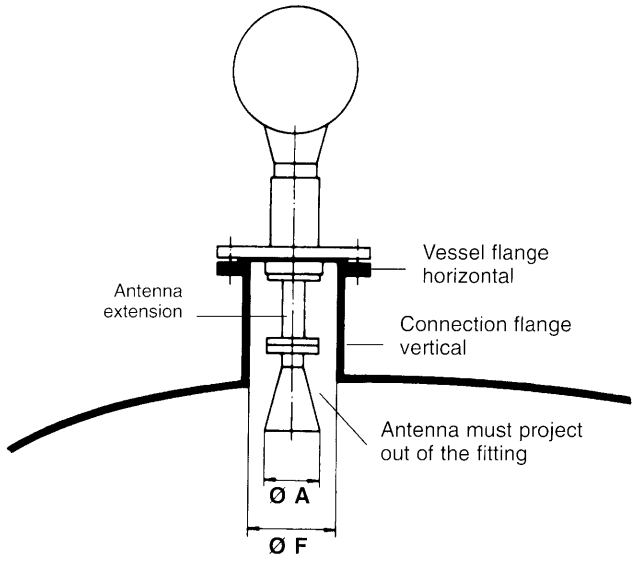
Nominal size in mm	Flange pressure rating	Max. operating pressure	
		in bar	in psig
DN 80	PN 16	16	232
DN 100	PN 16	16	232
DN 150 (Standard)	PN 16	16	232
DN 200	PN 10	10	145
DN 80	PN 40	40	580
DN 100	PN 40	40	580
DN 150	PN 40	40	580
DN 200	PN 16	16	232

Flanges to ANSI B 16.5

Nominal size in inches	Flange class	Max. operating pressure	
		in bar	in psig
3"	150 lbs	* < 19	* < 275
4"	150 lbs	* < 19	* < 275
6" (Standard)	150 lbs	* < 19	* < 275
8"	150 lbs	* < 19	* < 275
3"	300 lbs	40	580
4"	300 lbs	40	580
6"	300 lbs	40	580
8"	300 lbs	40	580

* **dependent on product temperature,**
refer to pressure/temperature table
ASME/ANSI B 16.5 – 1988 for detailed values

- Check **material compatibility:** antenna, antenna extension and flange with liquid product.
- Avoid hard blows, jolts, impacts, etc. when **handling** the BM 70.
- **Ambient temperature at the BM 70 signal converter must not be higher than + 60°C or 140°F, + 50°C or 122°F for hazardous-duty versions, and + 60°C or 140°F for the BM 70-Ex Nautic.** Fit a sunshade if exposed to direct sunlight, available as option.
- The **bottom edge of the antenna** (microwave aperture area) must project out of the vessel fitting. This also applies to domes if the BM 70 is mounted on manhole covers, blind flanges, etc. To meet this condition it may be necessary to fit an antenna extension, see Sect. 1.2.
- The **vessel fitting** must be **vertically** aligned and the **vessel connecting flange horizontally** aligned.



1.4 Installation

1.4.1 BM 70 Standard and BM 70-Ex Nautic, Variant A

- **BM 70 with antenna extensions of 300 mm or 12" and more** are for transportation reasons supplied in disassembled condition.
- It is possible that the **waveguide window** may also be supplied loose.

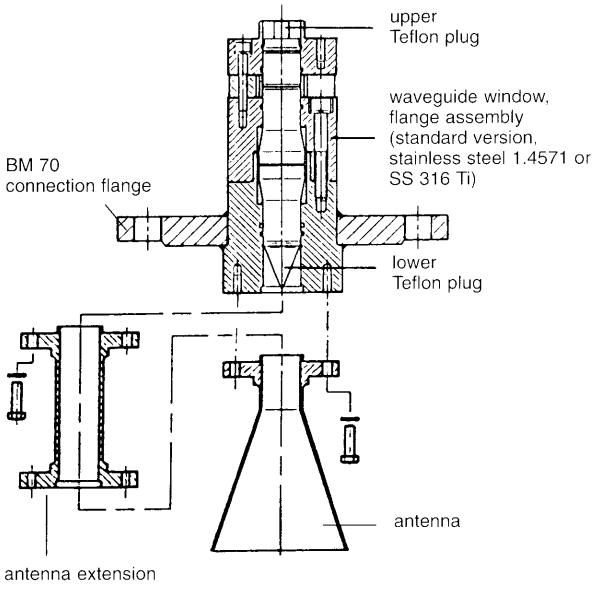
Hazardous-duty systems
For European Standard only Ex-certified waveguide windows may be used for the hazardous area, see instrument nameplate!
This waveguide window is standard for all US versions.

- If the BM 70 needs to be field assembled, all parts required are included with the supply (stud bolts, washers, etc.).

Field assembly of the BM 70

- If supplied loose, **bolt the waveguide window** (flange assembly) **to the BM 70.** Tightening torque for the 4 Allen screws (key size 4 mm) max. 16 Nm ~ 11.6 ft lbf (see drawing in Sect. 8.1).

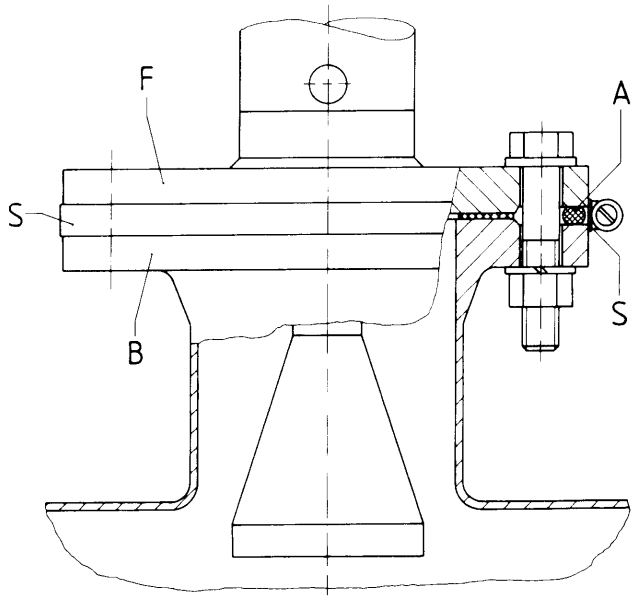
  Note: The Teflon plugs at the top and bottom of the wave-guide window must not be damaged. The plug at the top must be absolutely dry and clean. Moisture and dirt will impair the operativeness of the BM 70.
- **Bolt together antenna and antenna extension.** Tightening torque for the 3 stud bolts: max. 8 Nm ~ 5.8 ft lbf.
- Antenna diameter **Ø A smaller than Ø F** vessel fitting or flange diameter (see Sect. 1.2)
  Fix antenna and antenna extension to the waveguide window of the BM 70 using 3 stud bolts and washers. Tightening torque: max. 8 Nm ~ 5.8 ft lbf. Then carefully position the BM 70 on the vessel flange, not forgetting the flange gasket.
- Antenna diameter **Ø A larger than Ø F** vessel fitting or flange diameter (see Sect. 1.2)
  Position flange gasket loosely on the flange of the vessel fitting. Insert antenna together with antenna extension through the flange from inside the vessel, and fasten carefully to the waveguide window of the BM 70 using 3 stud bolts and washers. Tightening torque: 8 Nm ~ 5.8 ft lbf. Then lower the BM 70 onto the vessel flange.



Ultimate installation on vessel

- After carefully positioning the BM 70 on the vessel fitting flange (do not forget the gasket), align the BM 70 and the gasket.
- Insert stud bolts and tighten nuts slightly (by hand). (These items not included with supply).
- Press **shielding strip C*** in the gap between vessel flange and the BM 70 flange and secure with **strap retainer S** (both items included with supply).
- **Strap retainer S*** must fit closely and overlap both flanges.

  * Only required by the European FTZ and PTT authorities.

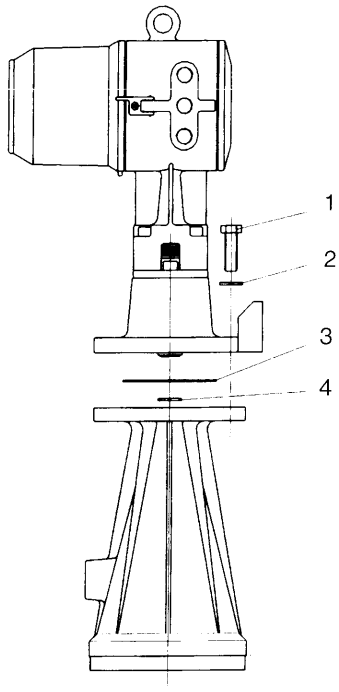


C* = shielding strip
S* = strap retainer
B = BM 70 instrument flange
F = vessel flange

- Tighten down stud bolt nuts firmly. The tightening torque is dependent on the strength properties of the stud bolts and the pressure rating of the vessel.

1.4.2 BM 70-Ex Nautic, Variants B + C

- Cast steel antennas for the BM 70-Ex Nautic Variants B + C are for transportation reasons always supplied in disassembled condition.



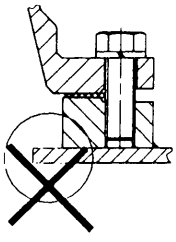
Fitting the antenna

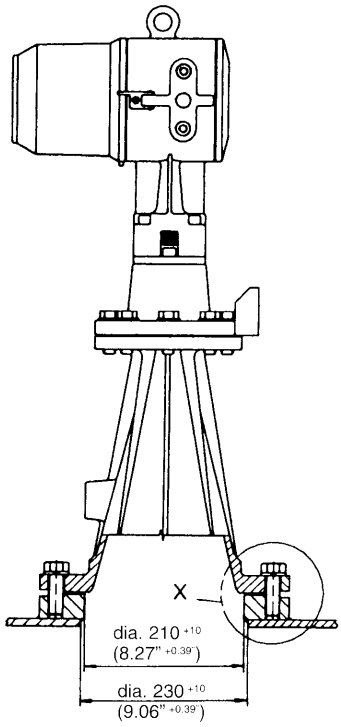
(See Drawing Variant C, otherwise installation identical with Variant B)

- Gaskets and fixing material included with supply.
- Fit as shown in the drawing, place gaskets 3 and 4 on the antenna.
- Position BM 70 signal converter carefully on the antenna, and align.
- Screw stud bolts (1) together with lock washers (2) into the antenna. The tightening torque is dependent on the strength properties of the stud bolts and the pressure rating of the vessel.

Fitting Variant B

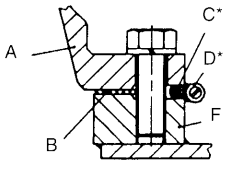
Prepare the tank cutout as shown in the drawing. Edges of the cutout must not extend beyond dimensional tolerances.

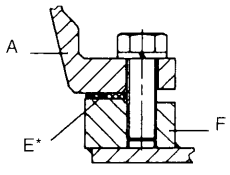




The customer-supplied vessel flange (F) must be welded on as shown in the drawing.
After carefully positioning the BM 70 on the vessel fitting flange (not forgetting the gasket), align the BM 70 and gasket (B or E*).

* only required
for European FTZ and PTT approvals





A = antenna
B = gasket
C* = shielding strip
D* = strap retainer
E* = special gasket with metal edge (customer supply)
F = vessel flange

Insert stud bolts and tighten lock washers by hand (bolts not included with supply).
Press **shielding strip C*** in the gap between vessel flange and BM 70 flange and secure with **strap retainer D*** (both items included with supply).
Stap retainer D* must fit closely and overlap both flanges.
Tighten down stud bolts firmly. The tightening torque is dependent on the strength properties of the bolts and the pressure rating of the vessel.

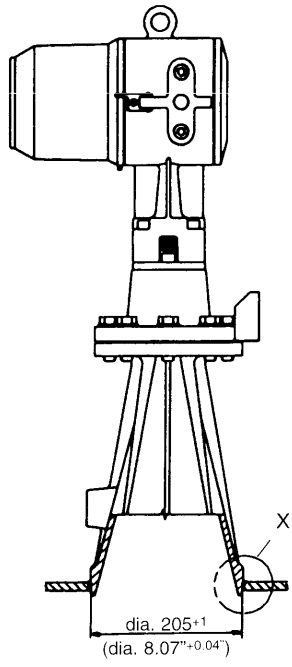
Fitting Variant C

Prepare vessel cutout as shown in the drawing.

Mandatory requirements (technical regulations) concerning materials, manufacture, calculations, equipment, testing, approval and operation are contained in the "AD-Bulletins" issued by the "Arbeitsgemeinschaft Druckbehälter (AD)".
Welds shall be such that their properties satisfy the mechanical, thermal and chemical loads imposed during operation.
Such properties must be established by appropriate tests and verified by certificates of compliance with order, test or inspection reports (DIN 50049).

Insert antenna into the prepared cutout and weld in accordance with conditions.

Antenna material: stainless steel 1.4462 (KES 3229 W).

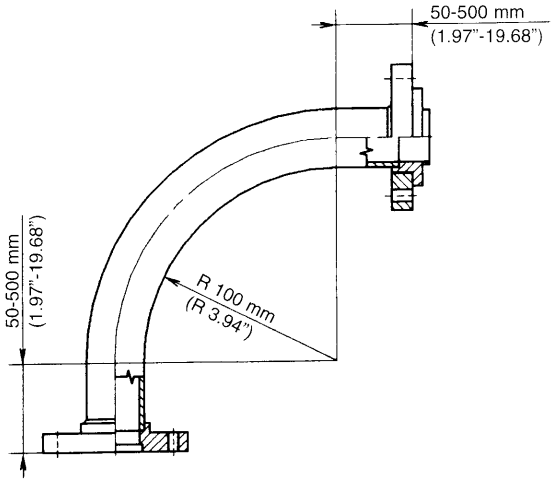


Example of welded joints (X):

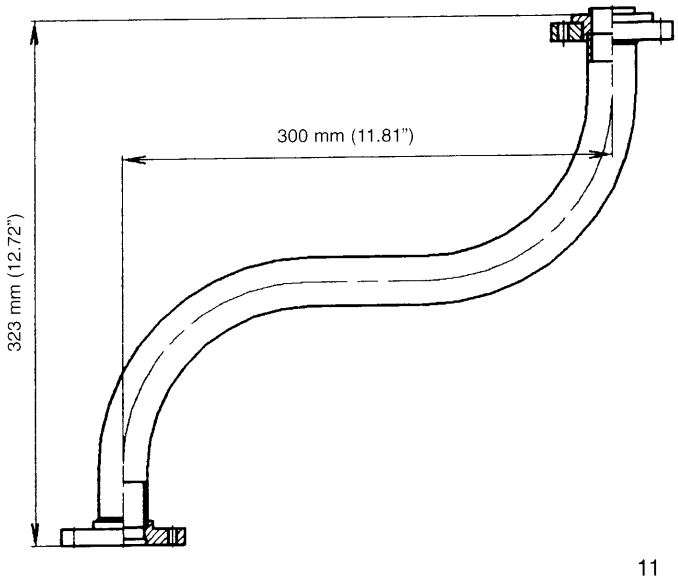
1.4.3 Rectangular and S-shaped extensions

Rectangular and S-shaped extensions are available for particularly difficult application conditions. These extensions are used in cases where the antenna is exposed to particularly high temperatures and where there are problems of space. When ordered, these extensions are supplied with an installation description in keeping with the application, or installation is carried out by the Service technician.

Rectangular extension



S-shaped extension



Information on other dimensions supplied on request.

2. Electrical connection

Important information – please note!

1. Insulation rating
The insulation of type BM 70 level gauges is rated in conformity with VDE 0110/01.89, equivalent to IEC 664, and takes into account the following ratings:

- overvoltage category for the power line circuit: **III**
- overvoltage category for the output circuit: **II**
- insulation contamination level: **2**[1])
- Class of protection: **1**

[1]) The contamination level applies to the inside of the instrument; the complete unit is protected against ingress of water and solid foreign bodies (≥ IP 65, equivalent to NEMA 4 and 4X) and, assuming proper installation, is thus dimensioned to operate under contamination 4 conditions.

2. Disconnecting device, miniature fuse
Type BM 70 level gauges do not feature any device for switching or disconnection. In conformity with operative regulations, devices must be provided for safety isolation or disconnection of the equipment when the system is installed.

The active phase conductor (L) of the incoming line circuit, but not the neutral conductor (N), is protected inside the instrument by a miniature fuse[2]). If necessary, additional fuse protection should be provided when installing the system, in keeping with operative regulations.

In the BM 70 version with 100 – 240 V AC power supply **and** Ex-i current output or RS 485 interface, internal fuse protection at both connections (L) and (N) is also optionally possible.

In the BM 70 version with 24 V DC-AC power supply, both connections (1) and (2) are internally fuse-protected.

[2]) Radio interference suppression capacitors, in part without limiters, are connected directly to the power system. To protect these components, frequent peak voltages should be avoided in the supply line.

3. Voltage tests
All type BM 70 level gauges are subjected to a voltage test. If an additional voltage test is to be carried out by the operator, care must be taken to avoid unacceptable stressing of the insulation and components. Before carrying out such a test, please consult Krohne for the relevant test specifications.

4. Class of protection
The BM 70 level gauge is designed for safety class 1 in conformity with VDE 0106 Part 1.

2.1 Installation location and cable diameter

Location

- Do not expose the BM 70 to direct sunlight. Install a sunshade if necessary. Ambient temperature less than 60°C = 140°F; hazardous-duty version: less than 50°C = 122°F.
- Do not expose to intense vibration.

Cable diameter
To conform to protection category requirements, observe the following recommendations:

- Cable diameter: 8 to 13 mm or 0.31" to 0.51".
- Enlarge inside diameter by removing the appropriate onion ring(s) from the seal of the PG screwed conduit entry only if cables have extremely tight fit.
- Fit PG 16 blanking plug and apply sealant to unused PG cable entries.
- Do not kink cables directly at PG entries.
- Provide water drip point (U bend in cable).

2.2 Use in hazardous areas

The BM 70-Ex is certified to European Standard EN 50014/18/19 for use in hazardous areas of Zones 1 and 2, with the possibility of mounting it on vessels in which Zone 0 conditions prevail.

- **Electronics compartment:** flameproof enclosure "d"
- **Terminal compartment**
  Standard: increased safety "e"
  Special version: flameproof enclosure "d"
- **Special version**
  Intrinsic safety "i" for the current output, and
  Increased safety "e" for the power supply.
- **Pin coupler compartment:** increased safety "e"
- **Further details**
  are given in the Certificate of Conformity, reproduced in Sect. 12.2, and in the **"Hazardous-duty systems"** boxes (shaded grey in the text) which must without fail be heeded for the BM 70-Ex.

Hazardous-duty systems

- All incoming cables are of **non-intrinsically safe** design!
- **Electrical connection** to be in conformity with VDE 0165, Section 5.6 or equivalent national regulations.
- **Gas-free certificate:** make certain there is no explosion hazard.
- Before making the electrical connection, make sure all cables leading into the BM 70-Ex are safely **isolated from supply.**
- Allow the prescribed waiting time to elapse; 10 minutes for BM 70-Ex, 50 minutes for the BM 70-Ex Nautic!
- These specifications are equivalent to the FM requirements in Div I and Div II

2.3 General

- Unscrew cover from the terminal compartment of the BM 70 using the special wrench provided.
- **For the electrical connection:** consult relevant wiring specifications, particularly **VDE 0100** and/or **VDE 0165** or equivalent national regulations.
- Do not cross or loop **cables in the terminal compartment** of the signal converter. Use separate PG or NPT screwed conduit entries for power and output cables.
- Make sure that the **screw thread of the round cover** on the terminal compartment is well greased at all times.

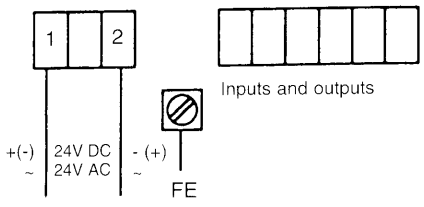
2.4 Connection to power

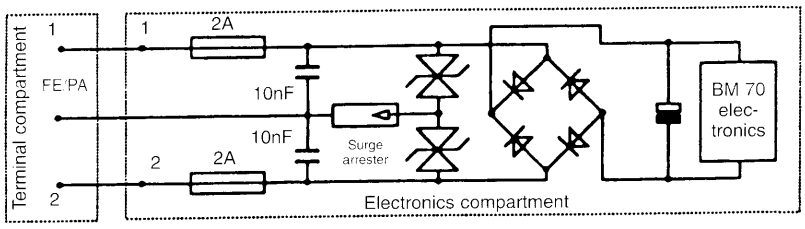
- Note information given on the instrument nameplate (voltage, frequency).

Hazardous-duty systems
When used in hazardous areas, the BM 70-Ex **must** be incorporated in the **PA equipotential bonding system,** irrespective of the type of power supply! If the PA is connected via a separate conductor, this must be connected to the separate U-clamp terminal at the "neck" of the BM 70-Ex.
Cancellation of equipotential bonding is only permitted when the BM 70 is **disconnected from supply.**

2.4.1 DC/AC supply 24 V DCAC

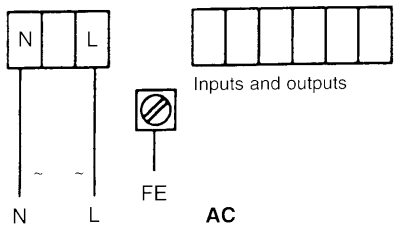
- The instrument can be operated optionally with 24 V AC or 24 V DC without regard to the **polarity** of connections 1 and 2.
- When connected to a "**functional extra-low voltage with safety separation**" power source (SELV or PELV) in accordance with VDE 0100, Part 410 or equivalent (inter)national regulations, connection of a PE protective conductor is not required.
- The supply power is galvanically isolated from the housing and PA equipotential bonding system. The maximum allowable static **insulation test voltage** between connections 1 and 2 and the housing, resp., due to the protective measures taken against high-energy transients, amounts to: 210 V AC or 300 V DC. Higher static test voltages can cause short-circuiting between capacitors and housing.
- The instrument is equipped with **2 internal miniature fuses** 2 A at both connections 1 and 2.
- The voltage at the BM 70 must be within the limits of tolerance. Any drop in voltage below the lower limit, even if of short duration, can lead to brief failure of measurement and automatic restart of the instrument. Note voltage drop due to **line resistance!**
  Operating current is approx. 0.5 A.





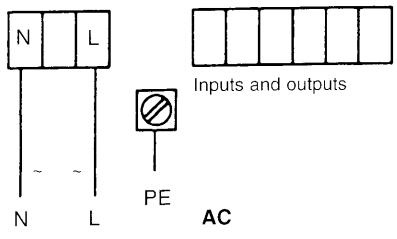
2.4.2 AC power supply 21 – 48 V AC

- Depending on the internal voltage setting, the instrument can be operated with 21 V, 24 V, 42 V or 48 V AC at connections N and L.
- When connected to a "**functional extra-low voltage with safety separation**" (SELV or PELV) power source (e.g. 21 V or 24 V AC) in conformity with VDE 0100, Part 410 or equivalent (inter)national regulations, connection of a safety conductor (PE) is not required.
- If connection is to a power source with **dangerous contact voltage, the PE safety conductor must** be connected to the separate U-clamp terminal in the terminal compartment of the signal converter if the PE is stipulated on the basis of the protective measures to VDE 0100.
- The instrument is equipped with **1 internal miniature fuse** at connection L.
- The voltage at the BM 70 must be within the limits of tolerance. Any drop in voltage below the lower limit, even if of short duration, can lead to brief failure of measurement and automatic restart of the instrument. Note voltage drop due to **line resistance!** Operating current is approx. 1 A.
- **Connection diagram**



2.4.3 AC power supply 100 – 240 V AC

- Depending on the internal voltage setting, the instrument can be operated with 100 V, 110 V, 120 V, 200 V, 220/230 V or 240 V AC at connections N and L.
- Connection to a power source with **dangerous contact voltage**: if due to protective measures in conformity with VDE 0100 a **PE protective conductor** is stipulated, it **must** be connected to the separate U-clamp terminal in the terminal compartment of the signal converter.
- In the version with a standard current output, the instrument is equipped with **1 internal miniature fuse** at connection L. In the version with Ex-i current output or RS 485 interface, optionally 1 **internal miniature fuse** at connection L or (for IT systems) **2 internal miniature fuses** at connections L and N may be fitted (repluggable in the electronics compartment).
- The voltage at the BM 70 must be within the limits of tolerance. Any drop in voltage below the lower limit, even if of short duration, can lead to brief failure of measurement and automatic restart of the instrument. Note voltage drop due to **line resistance!** Operating current is approx. 0.1 A to 0.2 A, depending on the operating voltage.
- **Connection diagram**



Connect PE protective conductor first!

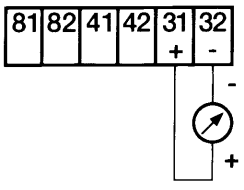
2.5 Connection of input and outputs

2.5.1 Current output I

- **The current output is galvanically isolated** from all other circuits.
- **All functions and operating data can be set,** see Sect. 4.3 + 5.6.
- **Factory-set data and functions** are listed in the enclosed report on settings. This can also be used to record any changes made to the operating parameters.
- **Max. load,** see Table:

Current range Fct. 3.3.2 *RANGE I*	**Error message** Error (=E)	**Load** Terminals 31/32
0 – 20 mA	no (hold when error occurs)	≤ 700 ohms
4 – 20 mA	no (hold when error occurs)	≤ 700 ohms
4 – 20 mA / 2=E	yes, 2 mA = E (error)	≤ 700 ohms
0 – 20 mA / 22=E	yes, 22 mA = E (error)	≤ 500 ohms
4 – 20 mA / 22=E	yes, 22 mA = E (error)	≤ 500 ohms

- **Connection diagram, current output I**

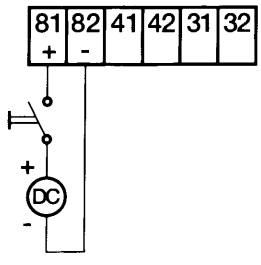


- **Connection of options** to current output, see Sect. 6.3 and 6.4.

2.5.2 Digital input

- **The digital input is galvanically isolated** from all other circuits.
- The control voltage is a DC voltage of 5 to 24 V.
- Internal resistance of digital input: ≥ 1 kohm.

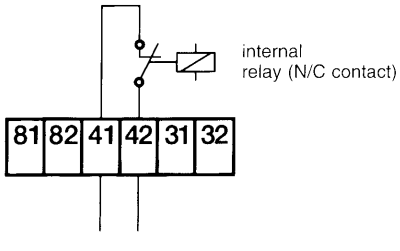
- **Connection diagram, digital input**



Protection against electrical shock must be assured by separated extra low voltage (SELV) or protective extra low voltage (PELV) supply in accordance with VDE 0100 Part 410 or equivalent (inter)national regulations, e.g. IEC 364-4-41.

2.5.3 Relay output R

- **The relay output is galvanically isolated** from all other circuits.
- **All functions and operating data can be set,** see Sect. 4.3 + 5.7.
- **Factory-set data and functions** are listed in the enclosed report on settings. This can also be used to record any changes made to the operating parameters.
- **The contact is open in the fault-free state,** and closes when specific conditions arise: a set threshold is over- or undershot, an error occurs, or a power failure occurs.
- The contact is closed in the off-load (no operating voltage) state
- **Connection diagram, relay output**

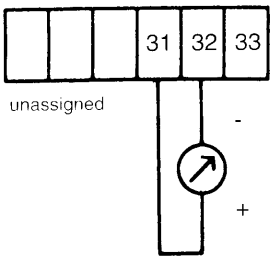


Max contact rating:
24 V DC/AC
1A

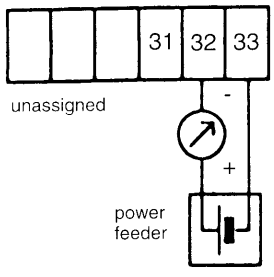
Protection against electrical shock must be assured by separated extra low voltage (SELV) or protective extra low voltage (PELV) supply in accordance with VDE 0100 Part 410 or equivalent (inter)national regulations, e.g. IEC 364-4-41.

2.5.4 Intrinsically safe current output (in preparation)

- The current output is galvanically isolated from all other circuits.
- Depending on the power terminals selected, it can be operated as an active current output (source mode) or passive current output (sink mode).
- The 3 unassigned blue power terminals can be used for through-connection of an external intrinsically safe current circuit.
- The maximum load is 500 ohms when operated in the source mode. In the passive mode, the current sink may not drop below a voltage of 4 V or exceed 40 V at terminals 32 and 33.
- **Connection diagram, Ex-i current output:**



BM 70 as current source



BM 70 as current sink

IS safety limit data
Converter: EEx de [ia] IIC T6 ... T3 or EEx de [ia] IIB T6 ... T3
Signal circuit in protection category Intrinsic Safety EEx ia IIC/IIB or EEx ib IIC/IIB

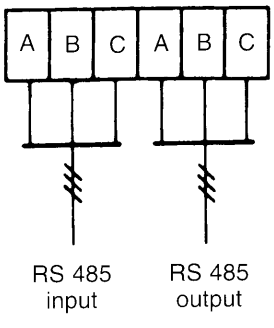
Passive mode (terminal 32 and 33):
For connection to a certified intrinsically safe circuit with the following peak values: U_0 = 40 V; I_K = 250 mA
Effective inner self-capacitance = 5 nF; effective inner self-inductance = 120 µH

Active mode (terminal 31 and 32):
Maximum values: U_O = 19 V; I_K = 73 mA; P = 600 mW; trapezium shaped characteristic

	EEx ia				EEx ib	
	IIC			IIB	IIC	IIB
Max. allowed external inductance	0.5 mH	2 mH	4 mH	10 mH	5 mH	23 mH
Max. allowed external capacitance	90 nF	65 nF	35 nF	260 nF	240 nF	1100 nF

2.5.5 RS 485 interface

- **The RS 485 interface is galvanically isolated** from all other circuits.
- **The same-name connections (A, B, C)** for RS 485 input and RS 485 output are device-internally interconnected.
- As standard, the following communication parameters are factory-set: transmission rate = 1200 bauds; device address = 0.
- All functions and operating data are settable, see Section 4.3 + 5.7.
- An internal terminator is not factory-set. However, a 120-ohm resistance can be obtained using soldering jumpers in the electronics compartment, see Additional Instructions.
- Detailed descriptions of the technical specifications, hardware requirements, instrument configuration and the communications protocol are given in the Additional Instructions "BM 70 Communication RS 485".
- **Connection diagram, RS 485 interface:**



3. BM 70 Startup and measurement

3.1 (Initial) startup

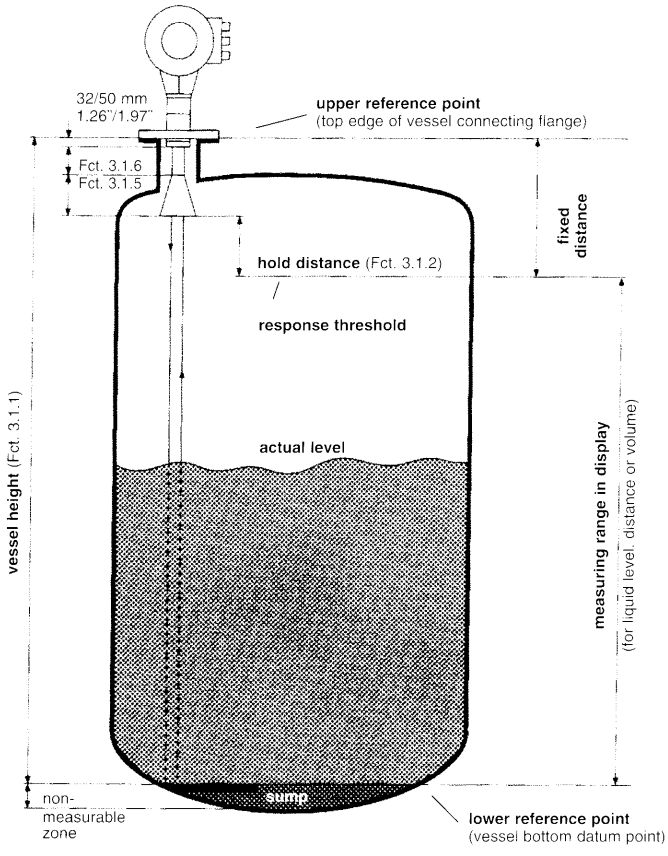
- The BM 70 level gauge is supplied in operable condition, i.e. all operating parameters have been factory set on the basis of the data, as far as known, specified in your order.
- Before switching on the power source, please check once again that the level gauge has been correctly installed and cabled in accordance with Sect. 1 and 2.
- Also check against the enclosed report on settings that the following parameters are correct for your application. If not, the parameters will need to be reset, see Sect. 4 and 5:

Vessel height (tank height): plumb before mounting BM 70	Fct. 3.1.1	= top edge of vessel connecting flange (upper reference point) **to** lower reference point (vessel bottom or datum point)
Scaling I_{min}:	Fct. 3.3.3	} Relevant heights or volume values must be set here for 0/4 mA and 20 mA.
Scaling I_{max}:	Fct. 3.3.4	
Tank type:	Fct. 3.5.3	

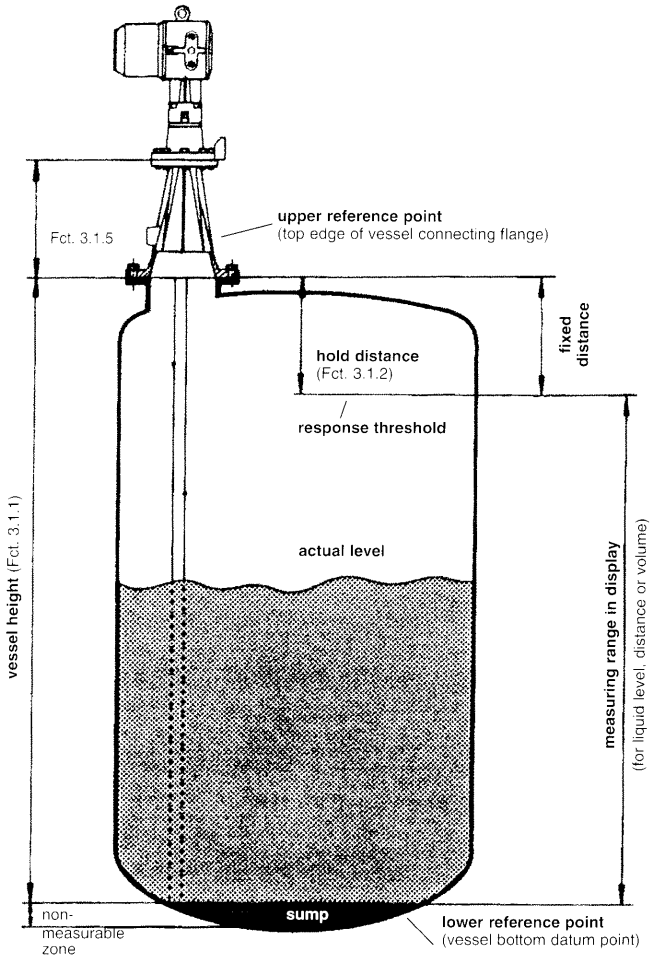
Tank type	Surface motion
Storage tank	none
Process tank	slight
Agitator 1	moderate
Agitator 2	strong

- Recording of the empty spectrum (vessel profile) is recommended before startup, refer to Sect. 5.15. This will allow the BM 70 to identify constant or recurring interference signals (internals, agitator blades, etc.) and to blank them out (suppress) during measurement. To record the empty spectrum the vessel must be **completely** empty and the agitators (if any) switched on.
- After powering, the BM 70 will carry out a self-test, duration: approx. 15 seconds. The display indicates *"TEST"* and then the No. of the instrument version, e.g. *"BM 70 V. 2.02"*. If no error occurs, the actual measured value appears in the display for liquid level, volume or distance, depending on the setting of Fct. 3.2.1, see report on settings.
- The three types of measurement that are possible with the BM 70 are described by way of examples: **liquid level measurement** (Sect. 3.2), **volume measurement** (Sect. 3.3) and **distance measurement** (Sect. 3.4.).

BM 70 Standard
BM 70-Ex Nautic
Variant A



BM 70-Ex Nautic
Variant B+C



3.2 Liquid level measurement (example)

Vessel height (Fct. 3.1.1): *6.00 m = 235"* (approx. 20 ft)

Antenna TYPE 3 (Fct. 3.1.5): 0.253 m ≈ 0.250 m (= dimension a+b = 32 mm + 221 mm, see Sect. 1.2)
Material CrNi steel 1.4571 (= 316 Ti) 9.96" ≈ 10.00" (= dimension a+b = 1.26" + 8.70", see Sect. 1.2)

Antenna extension (Fct. 3.1.6): *0.20 m ≈ 8.00 inch*

Hold distance (Fct. 3.1.2): *0.15 m ≈ 6.00 inch*

Response threshold or max. measurable level = 5.40 m = 211" or approx. 17.6 ft
(calculated from lower reference point)

	= Tank height (Fct. 3.1.1)	– Hold distance (Fct. 3.1.2)	– Antenna type/length (Fct. 3.1.5)	– Antenna extension (Fct. 3.1.6)
=	6.00 m	– 0.15 m	– 0.25 m	– 0.20 m
=	235"	– 6.0"	– 10.00"	– 8.00"

Current output I

Function I (Fct. 3.3.1): *LEVEL*
Range I (Fct. 3.3.2): *4 – 20 mA*
Scaling I_{min} (Fct. 3.3.3): *0.00 m or 0.00 inch,* corresponds to 4 mA
Scaling I_{max} (Fct. 3.3.4): *5.00 m or 200.00 inch,* corresponds to 20 mA

Relay output R

Function R (Fct. 3.6.1): *LEVEL*
Type R (Fct. 3.6.2): *HIGH* (= threshold exceeded)
Threshold/limit value (Fct. 3.6.3): *5.00 m = 200 inch*
Hysteresis (Fct. 3.6.4): *0.10 m = 4 inch*

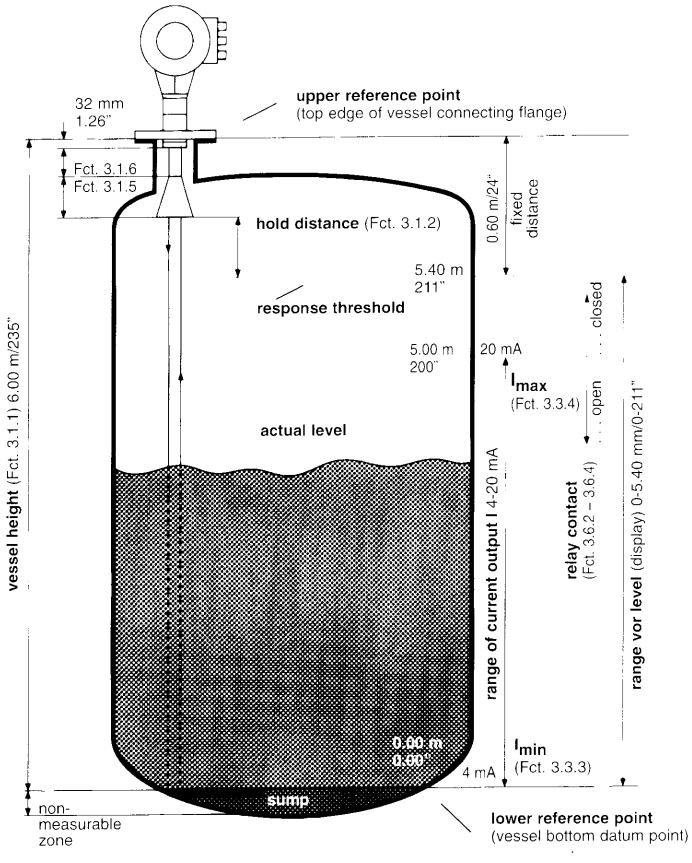
Display

Function, display (Fct. 3.2.1): *LEVEL*
Unit length (Fct. 3.2.2): *m (metres)* ***or*** *inch (or ft)*

Please note

Display and outputs can also be used for different measured quantities, e.g.: display for volume, current output I for liquid level, and relay output R for error messages.

The value for scaling I_{max} must not be greater than the response threshold.



3.3 Volume measurement (example)

- To use the BM 70 for volume measurement, the conversion table pertaining to the vessel must be set under Fct. 3.7.2.
- The conversion table is used to assign specific, previously calculated or gauged volumes to various levels.
- If vessels are non-symmetrical. e.g. with dished ends, the accuracy of volume measurement is dependent on the number of set "level/volume pairs". A maximum of 50 pairs (points) can be set, see Sect. 5.8. The volume is linearly determined (interpolated) between 2 points.
- The following **example** gives the settings for 4 pairs.

Conversion table
Unit, volume (Fct. 3.7.1):
Set table (Fct. 3.7.1):

	m3		*US Gal*	
Point	**Level**	**Volume**	**Level**	**Volume**
①	*0.00 m*	*0.25 m3*	*0.00 inch*	*65 US Gal*
②	*0.25 m*	*0.70 m3*	*10.00 inch*	*185 US Gal*
③	*0.50 m*	*1.40 m3*	*20.00 inch*	*370 US Gal*
④	*5.40 m*	*16.80 m3*	*211.00 inch*	*4400 US Gal*

Vessel height (Fct. 3.1.1): *6.00 m = 235" (approx. 20 ft)*

Antenna *TYPE 3* (Fct. 3.1.5): 0.253 m ≈ 0.250 m (= dimension a+b = 32 mm + 221 mm, see Sect. 1.2)
Material CrNi steel 1.4571 (= 316 Ti)

Antenna extension (Fct. 3.1.6): *0.20 m ≈ 8.00 inch*

Hold distance (Fct. 3.1.2): *0.15 m ≈ 6.00 inch*

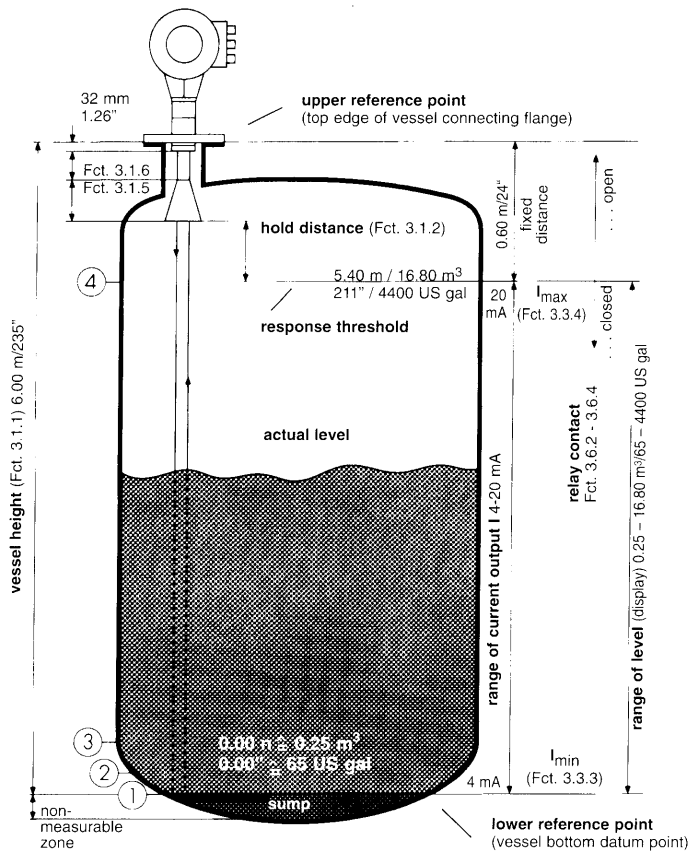
Response threshold or max. measurable level = 5.40 m = 211" or approx. 17.6 ft equivalent to a volume of 16.80 m³
(calculated from lower reference point)

	Tank height (Fct. 3.1.1)	–	Hold distance (Fct. 3.1.2)	–	Antenna type/length (Fct. 3.1.5)	–	Antenna extension (Fct. 3.1.6)
=	6.00 m	–	0.15 m	–	0.25 m	–	0.20m
=	235"	–	6.00"	–	10.00"	–	8.00"

Current output I
Function I (Fct. 3.3.1): *CONVERSION*
Range I (Fct. 3.3.2): *4 – 20 mA*
Scaling I_{min} (Fct. 3.3.3): *0.25 m3* ≈ 65 US Gal, corresponds to 4 mA
Scaling I_{max} (Fct. 3.3.4): *16.80 m3* ≈ 4400 US Gal, corresponds to 20 mA

Relay output R
Function R (Fct. 3.6.1): *LEVEL*
Type R (Fct. 3.6.2): *LOW* (= below threshold)
Threshold/limit value (Fct. 3.6.3): *5.40 m = 211 inch*
Hysteresis (Fct. 3.6.4): *0.00 m = 0.00 inch*

Display
Function, display (Fct. 3.2.1): *LEVEL*
Unit length (Fct. 3.2.2): *m* (metres) **or** inch (or ft)



3.4 Distance measurement (example)

- The distance measuring range is identical with the height of the vessel, which is set under Fct. 3.1.1.
- The "zero" for distance measurement is the upper reference point = top edge of vessel connecting flange.
- The BM 70 automatically allows for the clearance between upper reference point (= vessel connecting flange) and response threshold, see diagram below.
- This fixed distance, which is 0.70 m in the following **example**, is determined by the mechanical design of the BM 70, antenna type/length (Fct. 3.1.5) and antenna extension (Fct. 3.1.6), and also the set hold distance (Fct. 3.1.2).

Vessel height (Fct. 3.1.1): *11.50 m ≈ 450 inch (≈ 38 ft)*

Antenna *Type 3* (Fct. 3.1.5): 0.264 m ≈ 0.26 m (= dimension a+b = 50 mm + 214 mm, see Sect. 1.2)
Material: Hastelloy C4 10.40" ≈ 11.00" (= dimension a+b = 2.00" + 8.40", see Sect. 1.2)

Antenna extension (Fct. 3.1.6): none = *0.00 m = 0.00 inch*

Hold distance (Fct. 3.1.2): *0.44 m = 17.00 inch*

Response threshold or min. measurable clearance = 0.7 m = 28 inch
(calculated from upper reference point)

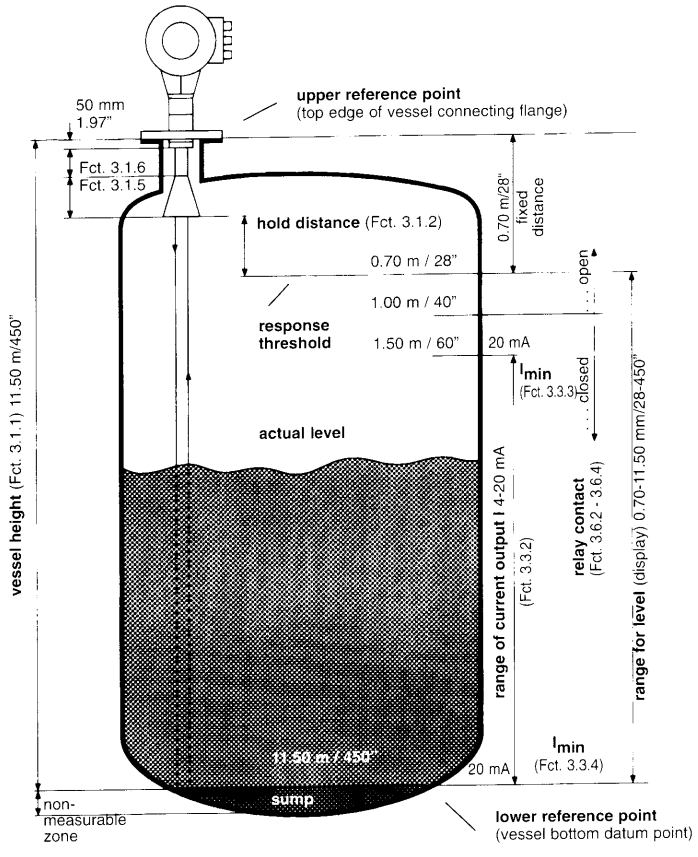
= Hold distance (Fct. 3.1.2)	+ Antenna type/length (Fct. 3.1.5)	+ Antenna extension (Fct. 3.1.6)
= 0.44 m	+ 0.26 m	+ 0.00 m
= 17.00 inch	+ 11.00 inch	+ 0.00 inch

Current output I
Function I (Fct. 3.3.1): *DISTANCE*
Range I (Fct. 3.3.2): *0 – 20 mA*
Scaling I_{min} (Fct. 3.3.3): *1.50m or 60.00 inch,* corresponds to 0 mA
Scaling I_{max} (Fct. 3.3.4): *11.50m or 450.000 inch,* corresponds to 20 mA

Relay output R
Function R (Fct. 3.6.1): *DISTANCE*
Type R (Fct. 3.6.2): *LOW*
Threshold/limit value (Fct. 3.6.3): *1.00m or 40.00 inch*
Hysteresis (Fct. 3.6.4): *0.05m or 2.00 inch*

Display
Function, display (Fct. 3.2.1): *DISTANCE*
Unit length (Fct. 3.2.2): *m* (metres) or inch (or ft)

Please note
Display and outputs can also be used for different measured quantities, e.g.: display for distance, current output I for volume, and relay output R for level limit.



Part B BM 70 Signal converter

Pull-out **condensed instructions** for operating the signal converter, pages I-IV, are located in the centrefold of these Installation and Operating Instructions.

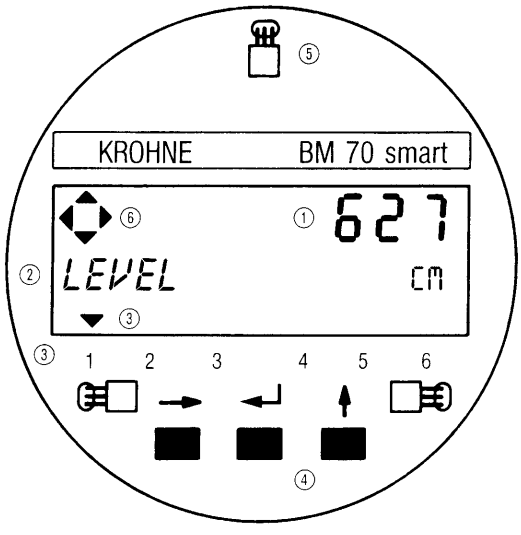
4 Operation of the signal converter

4.1 Operating and check elements

The operating elements are accessible after removing the cover of the electronics compartment using the special wrench. However, the safety lock must first be unscrewed with an Allen key (size: 4 mm). Using the handheld bar magnet, operation is also possible by way of the magnetic sensors without opening the housing.

Hazardous-duty systems
Before opening the **"flameproof enclosure"**, make absolutely certain that there is no explosion hazard. Gas-free certificate! Allow the prescribed waiting time of 10 minutes, or 50 minutes for the BM 70-Ex Nautic, to elapse before opening the housing.

Note: Always ensure that the screw thread and gasket of the cover are undamaged and never allow dirt to accumulate. Replace any defective cover gasket immediately to ensure conformity with the protection category.



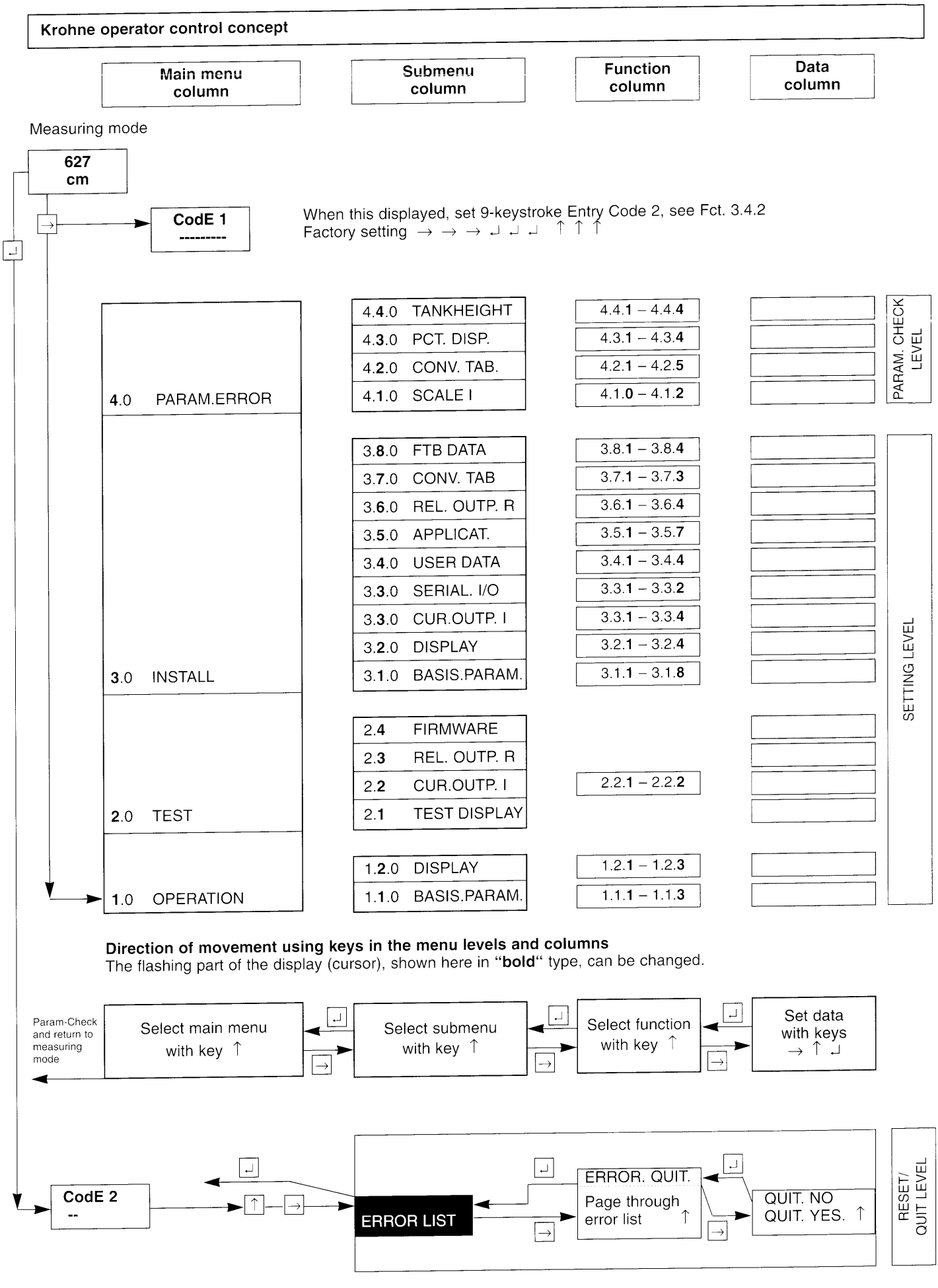
① Display, 1st (top) line
② Display, 2nd (middle) line
③ Display, 3rd (bottom) line: arrows to identify display
④ Keys to operate the converter
⑤ Magnetic sensors to operate the converter by means of the handheld bar magnet without opening the housing. This is also possible during the measuring mode in hazardous areas. Function of sensors same as keys (4).
⑥ Compass field, signals actuation of a key

The **operator control concept** for the signal converter consists of 3 levels (horizontal), see next page.

Setting level: This level consists of 3 main menus:
Fct. 1.0 OPERATION: contains the most important parameters of Menu 3 to allow rapid changes to be made during the measuring mode.
Fct. 2.0 TEST: test menu for checking the signal converter.
Fct. 3.0 INSTALL: allows setting of all parameters and functions.

Parameter check level: **Fct. 4.0 PARAM.ERROR:** this level is not selectable. After exiting from the setting level, the converter checks all new data for plausibility. When an error is established, the converter responds by indicating Fct. 4.0 PARAM.ERROR, and all inconsistent functions can then be selected and changed.

Reset/acknowledge (quit) level (menu) This menu is selected via Entry Code 2 (↵ ↑ →), see Sect. 4.4.
Status messages and acknowledgement (QUIT)
Status messages that have occurred since the last acknowledgement are displayed in a list. After elimination of the cause and acknowledgement, these messages are deleted from the list.


Krohne operator control concept
Main menu column
Submenu column
Function column
Data column
Measuring mode
627 cm
CodE 1
When this displayed, set 9-keystroke Entry Code 2, see Fct. 3.4.2
Factory setting → → → ↵ ↵ ↵ ↑ ↑ ↑
4.0 PARAM.ERROR
3.0 INSTALL
2.0 TEST
1.0 OPERATION
4.4.0 TANKHEIGHT
4.3.0 PCT. DISP.
4.2.0 CONV. TAB.
4.1.0 SCALE I
4.4.1 – 4.4.4
4.3.1 – 4.3.4
4.2.1 – 4.2.5
4.1.0 – 4.1.2
PARAM. CHECK LEVEL
3.8.0 FTB DATA
3.7.0 CONV. TAB
3.6.0 REL. OUTP. R
3.5.0 APPLICAT.
3.4.0 USER DATA
3.3.0 SERIAL. I/O
3.3.0 CUR.OUTP. I
3.2.0 DISPLAY
3.1.0 BASIS.PARAM.
3.8.1 – 3.8.4
3.7.1 – 3.7.3
3.6.1 – 3.6.4
3.5.1 – 3.5.7
3.4.1 – 3.4.4
3.3.1 – 3.3.2
3.3.1 – 3.3.4
3.2.1 – 3.2.4
3.1.1 – 3.1.8
SETTING LEVEL
2.4 FIRMWARE
2.3 REL. OUTP. R
2.2 CUR.OUTP. I
2.1 TEST DISPLAY
2.2.1 – 2.2.2
1.2.0 DISPLAY
1.1.0 BASIS.PARAM.
1.2.1 – 1.2.3
1.1.1 – 1.1.3
Direction of movement using keys in the menu levels and columns
The flashing part of the display (cursor), shown here in "bold" type, can be changed.
Param-Check and return to measuring mode
Select main menu with key ↑
Select submenu with key ↑
Select function with key ↑
Set data with keys → ↑ ↵
CodE 2
ERROR LIST
ERROR. QUIT.
Page through error list ↑
QUIT. NO
QUIT. YES. ↑
RESET/ QUIT LEVEL

4.2 Function of keys

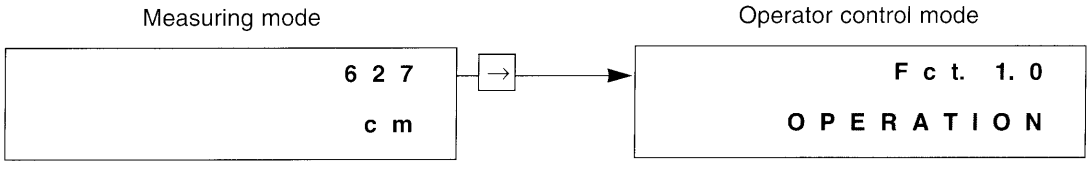
→ The **cursor key** shifts the cursor to the next right column up to the data column.

↑ The **select key** changes the content (digit, text) of the flashing cursor.

↵ The **accept key** (return key) is used for:
- acceptance of new parameters,
- acknowledgement of displayed error messages in the reset/quit menu, and
- execution of displayed functions.

The **cursor** (flashing part of display) has a **grey** background in the following descriptions.

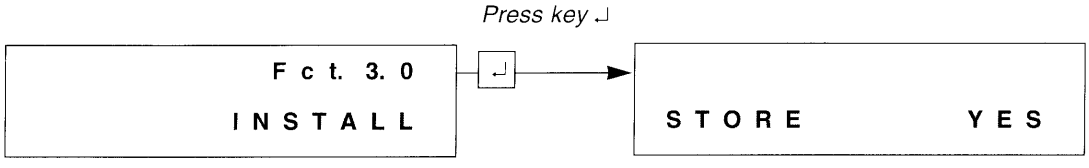
To start operator control



PLEASE NOTE: When "**YES**" is set under **Fct. 3.4.2 ENTRY CODE,** "**CodE 1 -------**" appears in the display after key → has been pressed.
Now enter the 9-keystroke Entry Code 1:
factory setting → → → ↵ ↵ ↵ ↑ ↑ ↑ (each keystroke acknowledged by "⋆").

To terminate operator control
Press key ↵ repeatedly until one of the following menus is displayed:

Fct. 1.0 OPERATION, Fct. 2.0 TEST or **Fct. 3.0 INSTALL.**



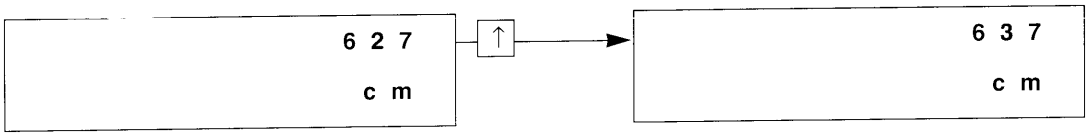
Store new parameters
Acknowledge by pressing key ↵
"PARAM.CHECK" displayed.
If no error present, the measuring mode is continued with the new parameters.

If error present, "Fct. 4.0 PARAM.ERROR" is displayed. In this menu, all functions can be invoked that are inconsistent, refer to Sect. 4.4

New parameters not to be stored
Press key ↑ to display "STORE NO". The measuring mode is continued with the "old" parameters after pressing key ↵ .

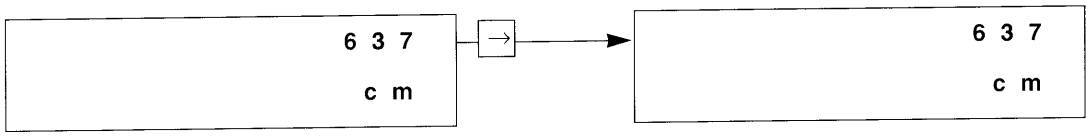
To change numbers

raise number



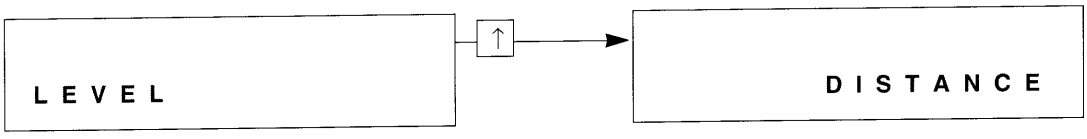
To shift cursor (flashing position)

shift to right



To change texts

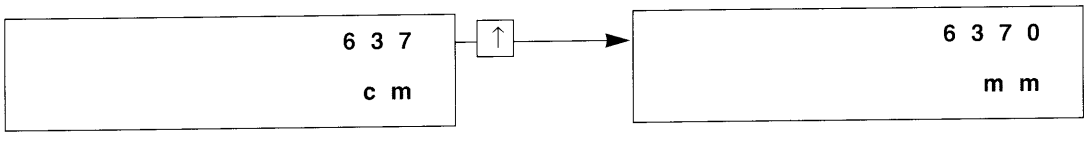
select next text



To change units (tank height)

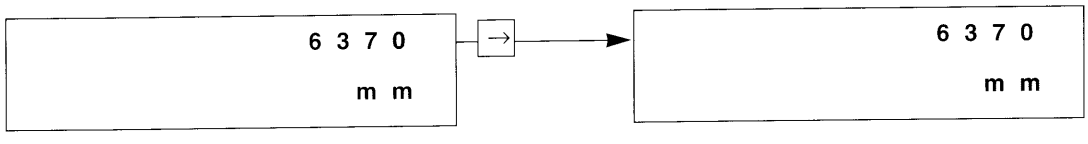
Numerical values are converted automatically

select next unit

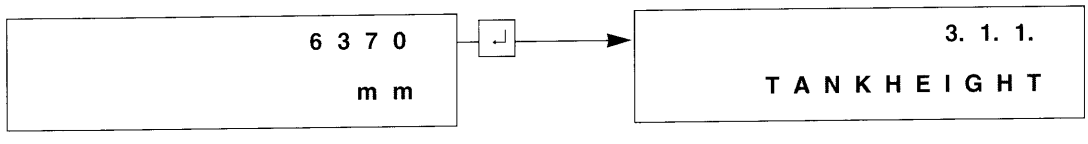


To revert from number setting back to text (unit)

change to number setting



To revert to function display



4.3 BM 70 Table of settable functions

Version 2.22.1 / 2.22.1 H

Fct. No.	Text	Description and setting
1.0	OPERATION	Main menu 1.0 Operation
1.1.0	BASIS.PARAM.	**Main menu 1.1.0 Basis parameters**
1.1.1	HOLD DIST.	**Hold distance below antenna,** see Fct. 3.1.2
1.1.2	TIMECONST.	**Time constant for filtering measured values,** see Fct. 3.1.3
1.1.3	TRACING.VEL.	**Tracking speed,** see Fct. 3.1.4
1.2.0	DISPLAY	**Display**
1.2.1	FCT.DISP	**Submenu 1.2.1 Function of display,** see Fct. 3.2.1
1.2.2	UNIT.LENGTH	**Unit for display of level or distance,** see Fct. 3.2.2
1.2.3	UNIT CONV.	**Conversion unit for display,** see Fct. 3.2.3
2.0	TEST	Main menu 2.0 Test functions (Sect. 7.1)
2.1	TEST DISP.	**Test of the display** (Sect. 7.1.2) → key: switch on all segments ↑ key: switch off all segments ↵ key: terminate test.
2.2.0	CUR.OUTP. I	**Test of curent output I** (Sect. 7.1.3)
2.2.1	VALUE I	**Display of actual value at current output in** *mA*
2.2.2	TEST I	**Test current output I** Safety interrogation: *SURE NO* *SURE YES* • *0 mA* • *4 mA* • *20 mA* • *2 mA* • *10 mA* • *22 mA* Select with ↑ key. Displayed value present directly at current output. Actual value again present at output after pressing ↵ key.
2.3	REL. OUTP. R	**Test of relay output R** (Sect. 7.1.4) Safety interrogation: *SURE NO* *SURE YES* • *OFF* (= relay contact open) • *ON* (= relay contact closed) Select with ↑ key. Relay contact adopts set state directly. Relay contact adopts actual state again after pressing ↵ key.
2.4	FIRMWARE	**Test version** → indicates version installed ↵ terminates test
3.0	INSTALL.	**Main menu 3.0 Installation**
3.1.0	BASIS.PARAM.	**Submenu 3.1.0 Basis parameters**
3.1.1	TANKHEIGHT	**Vessel/tank height** (see Sect. 5.1 and 5.2) = distance between top edge of vessel connecting flange and bottom reference point (datum point). Selection of unit and setting ranges • *00.50 – 35.00 m* • *0050 – 3500 cm* • *00050 – 35000 mm* • *0019.7 – 1378.0 inch* • *001.64 – 114.83 ft* After selecting unit, call numerical value with → key, 1st digit flashes. Note: The unit length selected **also applies** to Fct. 3.1.2/3.1.4/3.1.6/3.3.3/3.3.4 and 3.7.2! If level or distance set under Fct. 3.6.1 (relay) it also applies to Fct. 3.6.3 and 3.6.4!
3.1.2	HOLD DIST.	**Hold distance below antenna** (Sect. 5.3) = distance between max. measurable liquid level and bottom edge of antenna Setting ranges and unit: same as Fct. 3.1.1 *TANKHEIGHT.* Recommended minimum value: *100 mm* or *4 inch*
3.1.3	TIMECONST.	**Time constant,** damping of measured values (Sect. 5.4) Setting range: *0001* to *1000 Sec* Recommended value: *10 Sec*
3.1.4	TRACING.VEL.	**Tracking speed** (Sect. 5.4) Setting range: *0.01* to *5.00 m/min* *0.03* to *16.40 ft/min* Recommended value: *0.50 m/min* or *2 ft/min*

Fct. No.	Text	Description and setting
3.1.5	ANTENNA	**Antenna type/length** (Sect. 5.3 and 1.2) • *Type 1* • *Type 3* (standard) • *Type 5* • *Type 2* • *Type 4* • *Type 0* The antenna type is factory set and may only be altered if, e.g., antenna Type 3 changed to Type 2.
3.1.6	ANT.-EXTENS.	**Antenna extension** (Sect. 5.3 and 1.2) Setting ranges and unit: same as Fct. 3.1.1 *TANKHEIGHT.*
3.1.7	OFFSET REF	Offset added to displayed distance • - 10 to + 10 m
3.1.8	OFFSET TB	Offset added to displayed level • - 99.99 to + 99.99 m
3.2.0	DISPLAY	**Submenu 3.2.0 DISPLAY** (Sect. 5.5)
3.2.1	FCT.DISP.	**Function of display** Select measured quantity: • *LEVEL* • *DISTANCE* • *CONVERSION* (only possible if conversion table set under Fct. 3.7.1 and 3.7.2, otherwise Parameter Error, Fct. 4.2.0.)
3.2.2	UNIT.LENGTH	**Unit of length** Select unit for the measured quantities Level and Distance: • *m* • *cm* • *mm* • *inch* • *ft* • *PERCENT,* referred to scaling range of current output I, Fct. 3.3.3 and 3.3.4, therefore current output I must **also** measure Level or Distance, otherwise Parameter Error, Fct. 4.3.0!
3.2.3	UNIT. CONV.	**Conversion unit** Select unit for the measured quantity Volume: • *m3* • *Liter* • *US Gal* • *m* • *GB Gal* • *ft 3* • *bbl* (petroleum barrels) • *PERCENT.* referred to scaling range of current output I, Fct. 3.3.3 and 3.3.4, therefore current output I **also** measures volume, otherwise Parameter Error, Fct. 4.3.0!
3.2.4	ERROR MSG.	**Display errors?** (Sect. 4.4) • *NO* Error messages can only be called via the Quit/Reset menu. • *YES* Errors signalled by flashing display. Press ↑ key for interrogation of all errors alternating with measured value
3.3.0	CUR.OUTP. I	**Submenu Current output I** (Sect. 5.6)
3.3.1	FUNCTION I	**Function of current output I** Select measured quantity: • *OFF* (= deactivated, in which case Fct. 3.3.3 and 3.3.4 cannot be set!) • *LEVEL* • *DISTANCE* • *CONVERSION* (only possible if conversion Table set under Fct. 3.7.1 and 3.7.2, otherwise Parameter Error, Fct. 4.2.0).
3.3.2	RANGE I	Select **ranges for current output I:** • *0 – 20 mA* • *4 – 20 mA* • *4 – 20 mA/E=2* • *0 – 20 mA/E=22* • *4 – 20 mA/E=22* E = 2 and E = 22 signify error message via current output at 2 and 22 mA, resp.
3.3.3	SCALE. I MIN.	**Scaling I_{min} for 0/4 mA** (lower range value) **Not** shown when *OFF* set under Fct. 3.3.1! Setting range for Level and Distance: same as Fct. 3.1.1 *TANKHEIGHT,* but value must be lower! Setting range for Conversion: same as Fct. 3.7.2 *TAB. INPUT,* but value must be lower!
3.3.4	SCALE. I MAX.	**Scaling I_{max} for 20 mA** (full-scale range) **Not** shown when OFF set under Fct. 3.3.1! Setting range for Level and Distance: same as Fct. 3.1.1 *TANKHEIGHT.* Setting range for Conversion unit: same as Fct. 3.7.2 *TAB. INPUT* Value must be greater than that of Fct. 3.3.3, otherwise Parameter Error, Fct. 4.1.0!

Fct. No.	Text	**Description** and setting
3.3.0	SERIAL I/O	**Submenu RS 485 interface** (Sect. 5.7.5)
3.3.1	BAUD RATE	**BAUD RATE** Define transmission rate for RS 485 communication: • *1200 Bd* • *9600 Bd* • *2400 Bd* • *19200 Bd* • *4800 Bd* Default value: 1200 bauds
3.3.2	ADDRESS	**Enter address** Permissible addresses from 0 to 239 Default value Address *0*
3.4.0	USER DATA	**Submenu 3.4.0 User data**
3.4.1	LANGUAGE	**Language for display texts** (Sect. 5.10) • *GB/USA* (= English) • *D* (= German) • *F* (= French) • others pending
3.4.2	ENTRY. CODE 1	**Entry Code 1 for entry into setting level** required? (Sect. 5.11) • *NO* = entry with → key • *YES* = entry with 9-keystroke code. Code set under Fct. 3.4.3
3.4.3	CODE 1	**Set Code 1** (9-keystroke combination) • Factory setting: → → → ↵ ↵ ↵ ↑ ↑ ↑ • If different code required: press any 9-keystroke combination and then press the same keystroke combination again. Each keystroke acknowledged by "*". *WRONG. INPUT* (= incorrect entry) appears if 1st and 2nd entries are not equal. Press ↵ and → keys and repeat entries. • Appears only if YES set under Fct. 3.4.2.
3.4.4	LOCATION	Set **tag name** (measuring point No.), max. 10 digits. To identify units operated with the MIC 500 hand-held communicator (remote control) or PC user program (PC-CAT), see Sect. 5.6, 5.7, 6.2 and 6.4. Factory setting: *BM 70 0001* Characters assignable to each place: A...Z / a...z / 0...9 +/– / _ (underscore character = blank character)
3.5.0	APPLICAT.	**Submenu 3.5.0 Application**
3.5.1	SPECT. ANALY.	Select **empty spectrum function** (Sect. 5.15) • *NORMAL* (normal empty spectrum) • *ADAPTIVE* (adapt empty spectrum during measurement) • *OFF* (empty spectrum deactivated. Existing empty spectrum still stored but not considered for measurements).
3.5.2	REC. SPECT.	**Record empty spectrum** (Sect. 5.16) • *AVERAGE* (values averaged) • *MAX. VALUES* (maximum values only to be considered) After selecting *AVERAGE* or *MAX. VALUES*, press ↵ key to select *TOTAL* or *PARTIAL* recording of the empty spectrum. Enter distance value 0 to max. tank height with ↵ key. Press ↵ key to record 1000 spectra, duration: approx. 3 minutes. Displayed: *WAIT* and countdown from 1000 to 0. *READY* appears at the end. Acknowledged by pressing ↵ key. • *ADAPTATION* (storage of last adaptive empty spectrum).
3.5.3	TANKTYPE	**Select vessel type** (Sect. 5.13) The vessel type describes the movement of the product surface. • *STORAGE T.* (storage vessel, still surface, no rapid changes in liquid level) • *PROC. TANK* (process vessel, slightly ruffled surface, rapid changes in level). • *AGITATOR 1* (process vessel with agitator, rough surface) • *AGITATOR 2* (process vessel with agitator, turbulent surface, vortex formation).
3.5.4	HIST. CONTR.	**History check,** take preceding measured-value trend into consideration? (Sect. 5.14). • *NO* • *YES*
3.5.5	MULT. REFL.	**Identification of multiple reflections** required? (Sect. 5.15) • *NO* • *YES*
3.5.7	HD DETECT	**Activation of overfill detection** • *NO* • *YES*

Fct. No.	Text	**Description** and setting
3.6.0	REL. OUTP. R	**Submenu 3.6.0 Relay output** (Sect. 5.8)
3.6.1	FUNCTION R	**Function of relay output R** Select measured quantity: • *OFF* (= deactivated, in which case Fct. 3.6.2/3.6.3 and 3.6.4 cannot be set). • *LEVEL* • *DISTANCE* • *CONVERSION* • *ERROR* (error message, see Sect. 4.4) • *ERROR INV*
3.6.2	TYPE R	**Select relay type** **Not** shown when *OFF* set under Fct. 3.6.1! • *HIGH* (signals **over**shooting of set threshold, limit value ± hysteresis) • *LOW* (signals **under**shooting of set threshold, limit value ± hysteresis) Setting here is irrelevant if *OFF* or *ERROR* set under Fct. 3.6.1!
3.6.3	THRESHOLD	**Define threshold, limit value** **Not** shown when *OFF* set under Fct. 3.6.1! Setting range: same as Fct. 3.3.3 *SCALE. I MIN.* Setting here is irrelevant if *OFF* or *ERROR* set under Fct. 3.6.1!
3.6.4	HYSTERESIS	**Define hysteresis of threshold (limit value)** **Not** shown when *OFF* set under Fct. 3.6.1! Setting range: same as Fct. 3.3.3 *SCALE. I MIN.* Setting here is irrelevant if *OFF* or *ERROR* set under Fct. 3.6.1!
3.7.0	CONV. TAB.	**Submenu 3.7.0 Conversion table** (Sect. 5.9)
3.7.1	UNIT. CONV.	**Define conversion unit** • *m3* • *Liter* • *m* • *US Gal* • *GB Gal* • *ft 3* • *bbl* (petroleum barrels) **Unit** for „**level setting**", same as Fct. 3.1.1 TANKHEIGHT!
3.7.2	TAB.INPUT	**Enter conversion table** • *01* to *50* points (= level/conversion pairs) • "Level" setting range: same as Fct. 3.1.1 *TANKHEIGHT* • Conversion setting ranges: *0.00 – 30000.00 m³* 0 00 – 99999999 Liter 0 – 7925161 US Gal 0 – 6599265 GB Gal 0.0 – 999999.9 ft 3 0.0 – 99999.9 bbl 0.00 – 30000.00 m Use ↵ key to sequence through "Point No." / "Level" and "Conversion".
3.7.3	DELETE TAB.	**Delete conversion table?** Safety interrogation: *SURE NO* *SURE YES* Select with ↑ key. After *SURE YES*, press ↵ key to delete table. Displayed: *DELETED.*
3.8.0	FTB DATA	**Submenu 3.8.0** **Tank bottom tracking** (Sect. 6.5)
3.8.1	FUNCT. TBF	**Record tank bottom tracking** • *OFF* Tank bottom tracking system is inactive. • *LEARN* Learning phase for automatic determination of FTB parameters • *HOLD* Storage of learning phase, appears only when learning phase successfully completed. • *MANUAL* Manual entry following external evaluation of parameters.
3.8.2	EPSILON R	**Function of Epsilon R** • Display of stored or entered relative permittivity • Acceptable input range: *0.0000 – 8.0000*
3.8.3	BOTTOM	**Tank bottom** • Display or entry of spectrum line index of the actual tank bottom • Acceptable input range: *0.0000 – 127.0000*
3.8.4	TANK HEIGHT	**Tank height** • After learning phase completed, the actual tank height is displayed in the unit used for the configured tank height.

Fct. No.	Text	Description and setting
4.0	PARAM.ERROR	**Main menu 4.0 Parameter errors**
4.1.0	SCALE I	**SCALING OF CURRENT OUTPUT I is incorrect:** Ensure following condition is met: value of *SCALE. I MAX.* **greater** than value *SCALE. I MIN.*
4.1.1	SCALE. I MIN.	**Scaling of MIN value for current output I** see Fct. No. 3.3.3
4.1.2	SCALE. I MAX.	**Scaling of MAX value for current output I** see Fct. No. 3.3.4
4.2.0	CONV. TAB	**CONVERSION TABLE NOT set or INCOMPLETELY set,** but current output I, relay output R and/or display are set to "conversion display"!
4.2.1	TAB. INPUT	**Enter conversion table** see Fct. 3.7.2
4.2.2	DELETE TAB.	**Delete conversion table** see Fct. 3.7.3
4.2.3	FCT. DISP.	**Function of display** see Fct. 3.2.1
4.2.4	FUNCTION I	**Function of current output I** see Fct. 3.3.1
4.2.5	FUNCTION R	**Function of relay output R** see Fct. 3.6.1
4.3.0	PCT. DISP.	**PERCENT. DISPLAY** incorrect When the display is set in PERCENT. of level (distance) or conversion, the current output I **must** accordingly be set to level (distance) or conversion!
4.3.1	FCT. DISP.	**Function of display** see Fct. 3.2.1
4.3.2	UNIT. LENGTH	**Unit for level or distance** see Fct. 3.2.2
4.3.3	UNIT. CONV.	**Unit conversion** see Fct. 3.2.3
4.3.4	FUNCTION I	**Function of current output I** see Fct. 3.3.1
4.4.0	TANKHEIGHT	**TANK HEIGHT incorrect:** Ensure following condition is met: the sum of antenna length, antenna extension and hold distance **must be less** than the value for the tank height!
4.4.1	TANKHEIGHT	**Tank height** see Fct. 3.1.1
4.4.2	HOLD DIST.	**Hold distance (dead distance)** see Fct. 3.1.2
4.4.3	ANTENNA	**Antenna type** see Fct. 3.1.5
4.4.4	ANT. EXTENS.	**Antenna extension** see Fct. 3.1.6

4.4 Pointers and error messages (ERROR) during measurement

4.4.1 Kinds of message: a, b, c and d

a) **Pointers** (operating status) during measurement provided by 6 markers ▼ in the 3rd (bottom) line of the display, refer to Sect. 4.4.2 below.

b) **Minor errors,** signalling the failure of functions that do not affect measurement, refer to "Error List" in Sect. 4.4.3.

c) **Correctable errors,** which can be remedied by operator action (manual) at the BM 70, or possibly by Krohne Service, or which can be eliminated by altering the operating status, see "Error List" in Sect. 4.4.3.

d) *FATAL ERROR:* renders operation of the BM 70 impossible. Occurs only when instrument started up (powered), and the self-test identifies errors in the electronics and/or microwave part of the BM 70, see "Error List" in Sect. 4.4.3.

4.4.2 Pointers provided by 6 markers ▼ during measurement

Marker	Cause	Comments
1	**Signal too weak**	Mean of reflected microwaves is too weak, gain is automatically stepped up. If signal remains weak, the "correctable error (c)" *SIGNAL. DOWN* appears in the Error List, see Sect. 4.4.3.
2	**Signal too strong**	Mean of reflected microwaves is too strong, gain is automatically stepped down. Brief showing of this marker, e.g. while vessel is being filled or drained, is insignificant. If permanently on, this may result in uncertain (incorrect) measured values. If so, consult factory.
3	**Poor spectrum**	Number of acceptable spectra is too low. Brief showing of this marker has no significance. If permanently on, this may result in uncertain (incorrect) measured values. Consult factory.
4	**No measured value as yet**	Evaluable measured values not available after an instrument startup. Measured value automatically set to level of tank bottom. This marker disappears when the first valid measured value is obtained.
5	**Tank bottom**	In tanks with dished bottom, for example, the measuring signal can "disappear" if measurements are carried out near the bottom (within a range of 10% of the tank height, see Fct. 3.1.1, but minimum of 200 mm or 8" and maximum of 600 mm or 24"). The measured value is then automatically set to the level of the tank bottom.
6	**Digital input**	Digital input is active, voltage of 5 – 24 V DC applied, see connection diagram in Sect. 2.5.2. Measurement suspended (frozen); last measured values present at outputs I and R and in the display.

4.4.3 Error list (ERRORLIST) and how shown in display

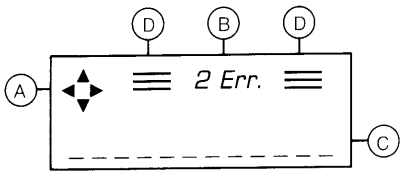
The following list gives all errors that can occur.

Error list

Error messages		Description of error	rectify instrument fault and / or	Error message via display and outputs dependent on setting					
				Display		Current output I		Relay output R	
Type see Sect. 4.4.1	Text in 2nd line of display	see Sect. 4.2.2	clear error messages see Sect. 4.2.2	*ERROR MSG.* Fct. 3.2.4		*RANGE I* Fct. 3.3.2		*FUNCTION R* Fct. 3.6.1	
				YES	*NO*	*4/20/2=E 0-20/22=E 4-20/22=E*	*0-20 4-20*	*ERROR*	*OFF LEVEL DISTANCE CONVERSION*
b) *	*SWEEP LOW*	**Restricted function of microwave pcb**	Measurement continues, possibly with reduced accuracy. Possibly, error (c) *"MICROWAVE"* **also displayed, see below**	yes	no	no	no	no	no
	SPECT.ERR.	**Empty spectrum faulty**	The empty spectrum does not tally with the changed operating parameters. Remedy: record new spectrum with changed operating parameters, see Fct. 3.5.1 and 3.5.2.	yes	no	no	no	no	no
	SERIAL I/O	**Serial interface faulty**	BM 70 is operational but data exchange with a PC or the MIC 500 communicator not possible. Please consult factory.	yes	no	no	no	no	no
c) *	*EEPROM. ERR.*	**EEPROM defective**	Contact Krohne Service for replacement of EEPROM.	Occurs only in connection with *CONFIG.ERR* or *SERVICE.ERR.* For mode of action, see following 2 lines.					
	CONFIG. ERR.	**Error in EEPROM** Parameters faulty	Check all operating parameters and reset if necessary. EEPROM defective if error persists. Please consult factory.	yes	yes	yes (22 mA)	yes	yes	yes
	SERVICE. ERR.	**Error in EEPROM** Service parameters faulty	Service parameters to be checked by Krohne Service and reset if necessary. Please consult factory.	yes	no	yes (22 mA)	no	yes	no
	CAL. DATA	**Error in EEPROM** Calibration data of current output faulty.	Current output calibration data to be checked by Krohne Service and reset if necessary. Please consult factory.	yes	no	yes (22 mA)	no	yes	no
	SIGNAL. DOWN	**Measuring signal too weak for evaluation**	Application-induced error, e.g. due to poorly reflecting liquid product or contaminated antenna.	yes	no	yes	no	yes	no
	NO M. VALUE	**No evaluable measuring signals available**	If this error displayed for a lengthy period, application-induced faults may be the cause. Please consult factory.	yes	no	yes	no	yes	no
	MICROWAVE	**Fault in microwave pcb**	If this error displayed, it usually means that the microwave pcb is defective. Please consult factory.	yes	no	yes	no	yes	no
d)	*CPU ERROR*	**CPU board defective**	Invoke Reset/Quit menu, if still possible, and check what error(s) have occurred. Then consult factory.	**FATAL ERROR** appears only after BM 70 startup (power on) if one or several errors identified by BM 70 during self-test.		no	no	no	no
	ROM ERROR	**ROM defective**				no	no	no	no
	RAM ERROR	**RAM defective**				no	no	no	no
	INTER.CONT.	**Interrupt controller defective**				no	no	no	no
	TIMER/CNTR.	**Counter/Timer module defective**				no	no	no	no

* **When errors are displayed during the measuring mode and in the ERRORLIST** in the Reset/Quit menu, "a numeral" and *"Err"* will appear in the 1st (top) line. The numeral indicates the number of momentary errors, which is displayed alternately with the actual measured value.

Error representation



Ⓐ Compass field

Ⓑ Number of errors that have occurred

Ⓒ Plain text for error messages

Ⓓ **with** bar:
"new" errors, not yet acknowledged
without bar:
"old", acknowledged errors but cause not yet eliminated

} see Sect. 4.4.5

4.4.4 Error display during measurement

In the setting level under Fct. 3.2.4 *ERROR MSG.* (error messages), it is possible to select whether errors are to be displayed during measurement. If *YES* set, "error message(s)" can be displayed by pressing the ↑ key. The errors will continue to be displayed until their cause has been eliminated. All displays, including measured values, flash!

4.4.5 Error list in Reset/Quit menu

All errors are stored in the *ERROR LIST* in the Reset/Quit menu. The errors are retained in this until: **1** the cause of the error has been eliminated, **and 2** the error has been acknowledged. Errors that have been acknowledged, but whose cause has not been eliminated, are retained in the Error List but are displayed **without** bar. This allows identification of "old" and "new" errors.

5.0 Description of functions

5.1 Physical units

for liquid level

Select under Fct. 3.1.1 *TANKHEIGHT:*

- m
- cm
- mm
- inch
- ft

The unit selected is also valid for the following functions:

- hold distance, Fct. 3.1.2
- antenna extension, Fct. 3.1.6
- scaling min-value current output, Fct. 3.3.3
- scaling max-value current output, Fct. 3.3.4
- threshold, limit value relay output, Fct. 3.6.3
- hysteresis, relay output, Fct. 3.6.4
- input of level under conversion table, Fct. 3.7.2
- tracking speed, Fct. 3.1.4:
  in *m/min* for m, cm or mm } under Fct. 3.1.1.,
  in *ft/min* for inches or ft } see above

for conversion

Select under Fct. 3.7.1 *UNIT. CONV.*

- m3
- liter
- US Gal
- GB Gal
- ft3
- bbl (petroleum barrels)
- m

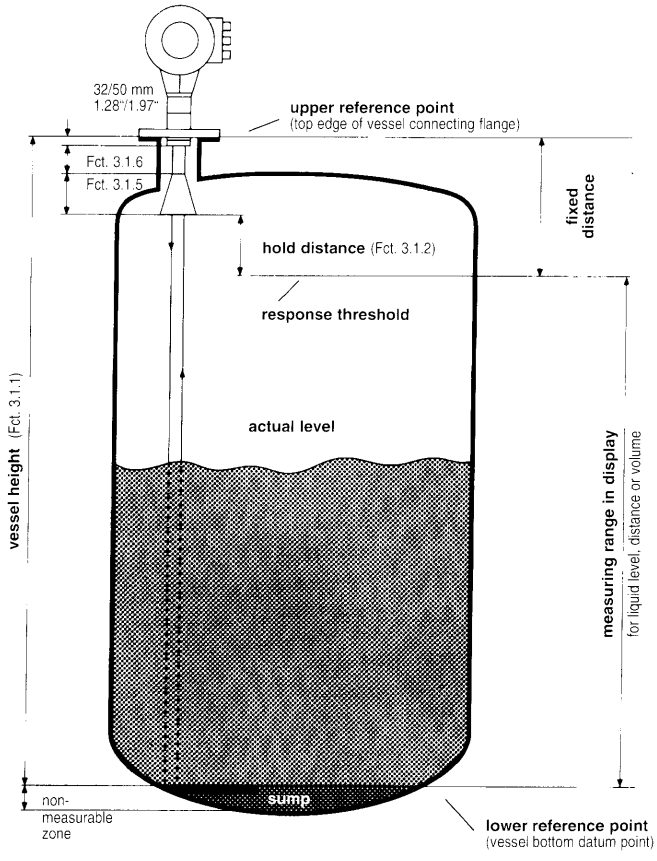
The unit selected is also valid for the following functions:

- scaling min-value current output, Fct. 3.3.3
- scaling max-value current output, Fct. 3.3.4
- threshold, limit value relay output, Fct. 3.6.3
- hysteresis, relay output, Fct. 3.6.4

5.2 Vessel (tank) height

Fct. 3.1.1 *TANKHEIGHT*

- **Definition of vessel (tank) height** for the BM 70: distance between top edge of vessel connection flange and bottom reference point.
- The **bottom reference point** is that "point" in the vessel on which the microwaves impinge and from which they are reflected. This can be the vessel bottom (symmetrical vessels with flat bottom) or the non-horizontal part (e.g. vessels with dished bottom) or an additionally fitted plate. The BM 70 cannot measure below this point (usually a "sump" is left in the vessel, see diagram on the right and those in Sect. 3.2 to 3.4).
- **Selection of unit,** see Sect. 5.1
- **Setting ranges for the vessel height:**
  - *01.00 – 35.00 m*
  - *0100 – 3500 cm*
  - *01000 – 35000 mm*
  - *0039.4 – 1377.9 inches*
  - *003.28 – 114.82 ft*
- The vessel height set here is at the same time the upper limit for the setting ranges of the following functions:
  - hold distance, Fct. 3.1.2
  - antenna extension, Fct. 3.1.6
  - scaling min-value current output, Fct. 3.3.3
  - scaling max- value current output, Fct. 3.3.4
  - threshold, limit value relay output, Fct. 3.6.3
  - hysteresis, relay output, Fct. 3.6.4
  - input of height under conversion table, Fct. 3.7.2
- If the tank height is changed to a value greater than 17 m (55.77 ft), the empty spectrum must subsequently be recorded, see Sect. 5.16.



5.3 Hold distance, antenna type (length) and antenna extension

Fct. 3.1.2 *HOLD DIST.*

- Caked deposits or contamination of the antenna, for example, can cause faulty measurements directly below the antenna. The function "hold distance" is used to specify a zone below the antenna in which measurements are not to be carried out.
- Signals within the hold distance are suppressed. A rise in the liquid level above this limit will cause undefined measuring results.
- Unit and setting range: same as Fct. 3.1.1 *TANKHEIGHT.*
- Recommended value: *100 cm* **or** *4 inch.*

Fct. 3.1.5 *ANTENNA* (length)

- The antenna type is factory-set.
- *TYPE 1 TYPE 2 TYPE 3* (Standard) *TYPE 4 TYPE 0*
- This setting may only be changed if, e.g., antenna Type 3 is replaced by Type 4. Otherwise faulty measurements may result because the BM 70 automatically allows for the length of the set antenna type. Refer to Sect. 1.2 for antenna dimensions.

Antenna type 0 for the BM 70-Ex Nautic version. This additional antenna type is entered with a length of 0 cm. This allows the upper reference point for the measuring range, or the tank height, to be referred to the antenna aperture, i.e. the mounting position.

Fct. 3.1.6 *ANT. EXTENS.*

- The length of the supplied antenna extension is factory-set.
- Unit and setting range: same as Fct. 3.1.1 *TANKHEIGHT.*
- This setting may only be changed when a longer or shorter antenna extension is installed. Otherwise faulty measurements may result because the BM 70 allows for this length when measuring. Subsequently, record new empty spectrum, see Sect. 5.16.

5.4 Time constant and tracking speed

Correlation between time constant (Fct. 3.1.3) and tracking speed (Fct. 3.1.4)

- To avoid faulty measurements, the BM 70 places a symmetrical "plausibility range" around the last valid measured value in which the next measured value is expected. Measured values outside this range are identified as invalid and are suppressed.
- If no measured value is identified, the BM 70 increases the plausibility range together with the tracking speed (Fct. 3.1.4) until a valid (plausible) measured value has again been found.

Fct. 3.1.3 *TIMECONST.*

- New measured values are damped (filtered) with the time constant so as to avoid abrupt changes in measured values, and thus also in the current output I and the display.
- Setting range: *0001 – 1000 Sec*
- Recommended setting: *0010 Sec*

Fct. 3.1.4 *TRACING.VEL .*

- Set as minimum value the maximum speed at which the liquid level can change in the vessel.
- Setting ranges:
  0.01 – 5.00 m/min (if Fct. 3.1.1 unit m/cm/mm)
  0.03 – 16.40 ft/min (if Fct. 3.1.1 unit inch/ft)
- Refer also to Sect. 4.4 and 7.3 (error message: *NO M. VALUE*).
- Recommended setting: *0.5 m/min* ***or*** *2 ft/min.*

5.5 Display

Fct. 3.2.1 *FCT. DISP.*

Use this function for selection of the measured variable.

- *LEVEL*
- *DISTANCE*
- *CONVERSION*

} For measuring range see diagram in Sect. 5.2, and see also Sect. 3.2-3.4

If volume is to be displayed, the conversion table must be set under Fct. 3.7.1 and 3.7.2 (see Sect. 5.8), otherwise parameter error, Fct. 4.2.0 (see Sect. 4.3).

Fct. 3.2.2 *UNIT. LENGTH*

Use this function to select the unit for display of liquid level and distance.

- *m*
- *cm*
- *mm*
- *inch*
- *ft*
- *PERCENT*

The "percent display" refers to the scaling range of current output I. Therefore the current output must **also** be set to level or distance, otherwise a parameter error, Fct. 4.3.0 *PCT. DISP.*, will occur. See also Sect. 4.3.

Fct. 3.2.3 *UNIT. CONV.*

Use this function to select the unit for conversion display.

- *m3*
- *liter*
- *US Gal*
- *GB Gal*
- *ft3*
- *bbl* (petroleum barrels)
- *PERCENT*
- *m*

The "percent display" refers to the scaling range of current output I. Therefore the current output must **also** be set to conversion, otherwise a parameter error, Fct. 4.3.0 *PCT.DISP.*, will occur. See also Sect. 4.3.

Fct. 3.2.4 *ERROR MSG.*

Use this function to select whether errors are to be displayed during measurement.

- *NO* Error messages shown only in Quit/Reset menu, see Sect. 4.4
- *YES* If errors occur during measurement, the display flashes.
  Press the ↑ key for measured value to alternate with error messages.

5.6 Current output I

The various output PCBs for the BM 70 feature hardware coding allowing automatic adjustment of the menu to the respective facilities of the used output.

5.6.1 smart-EMC current output I

The smart-EMC current output is the standard output. EMC devices are equipped with a relay output. The relay functions are enabled in the menu.

- Configuration of relay output, see Fct. 3.6.0.
- Relay output test function, Fct. 2.3.
- The smart current output allows connection of a MIC 500 handheld communicator or a PC with the PC-CAT or CONFIG user program, see Sect. 5.7.

Fct. 3.3.1 *FUNCTION I*
Use this function to select the measured variable.

- *OFF* (= deactivated; Fct. 3.3.3 and 3.3.4 cannot then be selected and are skipped over)
- *LEVEL*
- *DISTANCE*
- *CONVERSION*

Fct. 3.3.2 *RANGE I*
Use this function to define the current range.
E = error at 2 mA or 22 mA, see Sect. 4.4.3.

- *0–20 mA*
- *4–20 mA*
- *4–20 mA/E=2*
- *0–20 mA/E=22*
- *4–20 mA/E=22*

Fct. 3.3.3 *SCALE. I MIN.*

- This function does not appear (is skipped over) when *"OFF"* set under Fct. 3.3.1.
- Use this function to define the value for liquid level, distance or volume (scaling Imin) for Imin = 0 or 4 mA.
- To set *LEVEL* or *DISTANCE* under Fct. 3.3.1:
  Setting range and unit for I_{min} = 0 or 4 mA, same as for Fct. 3.1.1 *TANKHEIGHT.* However, value must be lower than that of Fct. 3.1.1!
- To set *CONVERSION* under Fct. 3.3.1:
  Setting range and unit for I_{min} = 0 or 4 mA, same as for Fct. 3.7.2, *INPUT TAB.* However, value must be lower than that of Fct. 3.7.2!

Fct. 3.3.4 *SCALE. I MAX*

- This function does not appear (is skipped over) when *"OFF"* set under Fct. 3.3.1.
- Use this function to define the value for liquid level, distance or volume (scaling I_{max}) for Imax = 20 mA.
- To set *LEVEL* or *DISTANCE* under Fct. 3.3.1:
  Setting range and unit for I_{max} = 20 mA, same as for Fct. 3.1.1 *TANKHEIGHT.*
- To set *CONVERSION* under Fct. 3.3.1:
  Setting range and unit for I_{max} = 20 mA, same as for Fct. 3.7.2 *TAB. INPUT*
- The value set here must be greater than that of Fct. 3.3.3, otherwise error during parameter check, Fct. 4.1.0!
- The value set here must not be greater than the response threshold.
  Response threshold = tank height (Fct. 3.1.1)
  – dimension a + b (see Sect. 1.2)
  – antenna extension (Fct. 3.1.6)
  – hold distance (Fct. 3.1.2)

Connection diagram: see Sect. 2.5.1.

Application and setting examples: see Sect. 3.2 to 3.4.

5.6.2 Ex-i current output (in preparation)

The Ex-i current output ensures conformance not only with Ex-i regulations but also with the "HART® FSK physical layer" hardware specifications of the HART® Communication Foundation.

To ensure faultless data communication (smart/HART®), the output signal of the Ex-i current output should not drop below 2 mA. The configuration menu is adapted as follows:

- When the current output, Fct. 2.2.2, is tested, it is not possible to set the value "0 mA".
- For the range of the current output, Fct. 3.3.2, the options "0 – 20 mA" and "0 – 20 mA, 22 mA in case of error" are no longer available.
- If (after upgrading of the firmware or alteration of the current output PCB) one of these values is selected, the warning *RANGE I* appears. The range of the current output must then be changed to an acceptable setting.

If the Ex-i current output is deactivated, Fct. 3.3.1, a constant current of 4 mA is output (necessary for HART® multidrop).

5.7 Communications interfaces

Special descriptions are provided for all the following interfaces and user programs.

5.7.1 Krohne smart

All setting parameters and dynamic values can be transferred to a control unit via the standard interface, see Sect. 5.6. The parameters can be changed and transferred back.

5.7.2 HART® protocol

The BM 70 firmware V 2.21 H contains the HART® interface instead of the smart protocol. The communication signals are also transmitted via the current output, see Sect. 5.6. The HART® version, however, contains the menu texts in English only. The BM 70 user program PC-CAT, Version 2.00 and higher, can be operated with the HART® firmware variant. HART® is suppoted by a large number of manufacturers.

5.7.3 CONFIG

The Krohne PC operator package CONFIG is used for convenient setting of the BM 70 parameters with the user interface to VDI Code 2187. Parameters can be stored, printed out and compared. The BM 70 signal converter is linked via a converter to the RS 232 interface at the PC. The control unit is the PC.

5.7.4 PC-CAT

User-friendly software package for setting and evaluating BM 70 data, see Section 6.4.

5.7.5 RS 485 interface

Description and function

An RS 485 interface can be installed in place of a current output PCB, in which case however the current output, the relay output and the digital input are omitted. The firmware recognizes this interface PCB and in the configuration menu replaces the functions for the **current output Fct. 3.3.0** with **RS 485 functions.**

Fct. 3.3.1 *BAUD RATE*

- This function defines the transmission rate for RS 485 communication:
  - *1200 Bd*
  - *2400 Bd*
  - *4800 Bd*
  - *9600 Bd*
  - *19200 Bd*
- Default value = 1200 bauds

Fct. 3.3.2 *ADDRESS*

- This function is used for entering valid addresses from 0 to 239.
- If several devices are operated on an RS 485 bus, each device must be set to an individual address under which it can be addressed in the bus.
- The default value is the address *"0".*
- In addition, when started, the BM 70 is automatically set to the RS 485/PC protocol, which for instance allows communication with the BM 70 user program PC-CAT. Changeover to a different protocol is not possible.
- Extensions of the RS 485 interface to bus systems are described in a special operating guide.

Communications protocol

The following communications protocols are available for the RS 485 interface:

Krohne protocol:
The standard communications protocol between the BM 70 and the evaluation system is the Krohne standardized protocol, which allows all dynamic values and setting parameters to be read and changed. If the BM 70 is connected to existing user systems, the protocol is easy to apply to such systems. The protocol can also be used when the BM 70 is connected to the Krohne Tank Inventory System TIS. For further information, please ask for the "BM 70-RS 485 protocol" description.

Modbus protocol:
This protocol constitutes a quasi-standard for linking to programmable logic controls (PLC). The hardware interface we use is the busable RS 485 interface. The BM 70 uses the Modbus RTU Protocol with extended facilities so as to be able to access all dynamic values and setting parameters. For further information, please ask for the "BM 70-Modbus" description.

PROFIBUS protocol:
The PROFIBUS is defined and standardized in DIN 19245, Parts 1 and 2. A number of devices with PROFIBUS capability are available on the market. The BM 70 is easy to connect to such bus systems, whereby it has a purely slave function and allows access to all dynamic values and setting parameters. For further information, please ask for the "BM 70-PROFIBUS" descripton.

Krohne Tank Management System

Besides the straightforward measurement of liquid levels with the BM 70, Krohne also provides complete Tank Management Systems. In addition to the BM 70, a number of other measuring instruments, e.g. temperature measuring devices, also from other manufacturers, can be connected to a Tank Inventory System on PC-basis either via RS 485 field bus or via data acquisition systems (e.g. PLCs). For further information, please ask for the "Krohne Tank Management System" description.

5.8 Relay output R

The relay output R menu is only enabled if a smartEMC current output is provided.

Fct. 3.6.1 *FUNCTION R*
Use this function to select the measured variable.
- *OFF* (= deactivated; Fct. 3.6.2, 3.6.3 and 3.6.4 cannot then be selected and are skipped over).
- *LEVEL* • *DISTANCE* • *CONVERSION*
- *ERROR* (to signal error messages, see Sect. 4.4.3)
- *ERROR INV.*

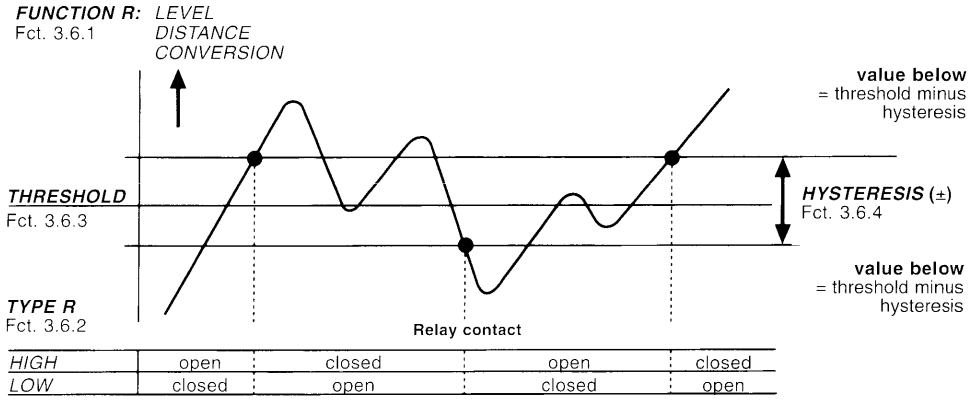
Fct. 3.6.2 *TYPE R*
- This function is not shown (is skipped over) when *OFF* or *ERROR* set under Fct. 3.6.1. Irrelevant in this case!
- Use this function to set the relay type:
  HIGH (= contact opens when value **exceeds** threshold, limit value ± hysteresis)
  LOW (= contact closes when **value drops** below threshold, limit value ± hysteresis)

Fct. 3.6.3 *THRESHOLD*
- This function is not shown (is skipped over) when *OFF* or *ERROR* set under Fct. 3.6.1. Irrelevant in this case!
- This function is used to determine the threshold (limit value).
- Setting of *LEVEL* or *DISTANCE* under Fct. 3.6.1:
  Setting range and unit same as for Fct. 3.1.1 *TANKHEIGHT.*
- Setting of *CONVERSION* under Fct. 3.6.1:
  Setting range and unit same as for Fct. 3.7.2 *TAB. INPUT*

Fct. 3.6.4 *HYSTERESIS*
- This function is not shown (is skipped over) when *OFF* or *ERROR* set under Fct. 3.6.1. Irrelevant in this case!
- This function is used to define the hysteresis.
- Setting of *LEVEL* or *DISTANCE* under Fct. 3.6.1:
  Setting range and unit same as for Fct. 3.1.1 *TANKHEIGHT.*
- Setting of *CONVERSION* under Fct. 3.6.1:
  Setting range and unit same as for Fct. 3.7.2 *TAB. INPUT*

Connection diagram, see Sect. 2.5.3
Application and setting examples, see Sect. 3.2 to 3.4

Relay switching performance



Relay application Application examples, see Sect. 3.2 to 3.4	**Relay function** settable via ...		**Other functions** settable via ...	
	Fct. 3.6.1 *FUNCTION R*	Fct. 3.6.2 *TYPE R*	Fct. 3.6.3 *THRESHOLD*	Fct. 3.6.4 *HYSTERESIS*
Error message				
Contact closes when error occurs	*ERROR*	no *	no *	no *
Contact opens when error occurs	*ERROR INV*	no *	no *	no *
Limit value – level				
– Contact closes when value above	*LEVEL*	*HIGH*	yes	yes
– Contact closes when value below	*LEVEL*	*LOW*	yes	yes
Limit value – distance				
– Contact closes when value above	*DISTANCE*	*HIGH*	yes	yes
– Contact closes when value below	*DISTANCE*	*LOW*	yes	yes
Limit value – conversion				
– Contact closes when value above	*CONVERSION*	*HIGH*	yes	yes
– Contact closes when value below	*CONVERSION*	*LOW*	yes	yes
e.g. operation indicator				
Contact is open when power applied	*OFF*	no *	no *	no *

* Setting has no effect on relay function!

value above = measured value **greater than** limit value (= threshold plus hysteresis)
value below = measured value **less than** limit value (= threshold minus hysteresis)

5.9 Conversion table

For conversion measurement of e.g. volumes, a table must be set under Fct. 3.7.1 and 3.7.2. With the aid of this table a specific volume can be assigned to each liquid level value (level/volume pairs). The values are determined linearly (interpolated) between 2 points.

For application and setting examples refer to Sect. 3.3

Fct. 3.7.1 *UNIT. CONV.*

- Use this function to determine the conversion unit for input into the table.
- m^3 • *Liter* • m^3
- *US Gal* • *GB Gal*
- *ft 3* • *bbl* (= petroleum barrels)
- Unit for level is the same as for Fct. 3.1.1 *TANKHEIGHT.*

Fct. 3.7.2 *TAB. INPUT*

- Use this function to set the level/volume pairs, max. 50 (= points).
- Order for setting:
  1. Point No. **2.** Level **3.** Conversion
- After invoking Fct. 3.7.2 and pressing the → key, the number of the last set level/volume pairs (highest point No.) is shown in the display.
- A minimum of 2 points (pairs) must be set.
- 2 points may be enough for symmetrical vessels, e.g.:
  Point 1 –
  Vessel bottom = *00.00 m* equivalent to *00.00* m^3 **or**
  = *00.00 ft* equivalent to *00 US Gal*

  Point 2 –
  Max. filling = *10.00 m* equivalent to *25.00* m^3 **or**
  = *30.00 ft* equivalent to *2500 US Gal*
- With non-symmetrical vessels, the accuracy of volumetric measurement depends on the number of points that have been set (level/volume pairs).
- The point Nos. must be sorted in ascending or descending order, starting with *"01"* at the vessel bottom (bottom reference point), see Sect. 3.3.
- If the vessel "sump" cannot be sensed by the BM 70, the setting for Point 01 may consist of the following level/volume pair, for example:

  Point *01* Level *00.00 m* **or** Conversion *01.00* m^3 **or**
  00.00 ft *200 US Gal*
- After every setting, Point No. – level value – conversion value, press the ↵ key to acknowledge. Fct. 3.7.2 *"TAB. INPUT"* is then shown in the display again.
- If further level/conversion pairs have to be set, press the → key, etc., until the last level/volume pair (point No.) has been set.
- Setting range for level value same as Fct. 3.1. *TANKHEIGHT.*
- Setting range for conversion:
  0.00 – 30000.00 m3
  0 – 9999999 Liter
  0 – 7925161 US Gal
  0 – 6599265 GB Gal
  0.0 – 999999.9 ft3
  0.0 – 99999.9 bbl (petroleum barrels)
  0.00 – 30000.00 m

Note: If displayed in Liter, ft^3 or Barrel, the situation may arise that the max. volume cannot be displayed. In such cases, the special character " ≡ " is shown and it may be necessary to change to a different physical unit. The current output will in any case indicate the correct value.

Fct. 3.7.3 *DELETE TAB.*

- Use this function to delete the complete conversion table of Fct. 3.7.2.
- Safety interrogation first, to make certain table is not inadvertently deleted:
  SURE NO, press ↑ key to display
  SURE YES. Table deleted now only after the ↵ key has been pressed. Display shows *DELETED.*

5.10 Language of display texts

A choice of languages for the display texts is offered in Fct. 3.4.1:

- *GB/US* English
- *D* German
- *F* French

other languages pending

5.11 Coding desired for entry into setting level?

- Set *NO* or *YES* **in Fct. 3.4.2**
- If *"NO"* set, all that needs to be done is to press the → key to get into the setting level.
- If *"YES"* set, press the → key and subsequently a 9-key-stroke combination to get to the setting level.
- **Factory-set Entry Code 1**

  → → → ↵ ↵ ↵ ↑ ↑ ↑
- **Changing Entry Code 1**
  Select Fct. 3.4.2 *ENTRY.CODE 1*: set YES.
  Select Fct. 3.4.3 *CODE 1*.
  Press → key, displayed: *CODE 1* _ _ _ _ _ _ _ _ _
  Press any 9-keystroke combination; each keystroke acknowledged by *"*"*. Then press the **same** keystroke combination again. *WRONG CODE* (= incorrect entry) appears if 1st and 2nd entries are **not equal**.
  Press ↵ and → keys and repeat entries.

5.12 Measuring-point identification (tag name)

- A max. 10-figure tag name can be set under **Fct. 3.4.4** (e.g. TQ1 53 21 I).
- Only required for smart units (HHC design): operator control via MIC 500 Hand-Held Communicator (remote control) or PC-CAT user program, see Sect. 6.3 and 6.4. Refer to special operating instructions for electrical connection to current output I and operation of the MIC 500.
- Characters assignable to each of the 10 places:
  alpha characters *A-Z / a-z*
  numbers *0-9*
  special sign *+ –*
  blank character (= underscore character)
- Factory setting: *BM 70 0001*

5.13 Vessel (tank) type, movement of product surface

For optimum results the data acquisition and evaluation must be matched to typical vessel characteristics: movement of the product surface, rapid or slow changes in the product level, agitators, etc.

Fct. 3.5.3 *TANKTYPE*

- *STORAGE T.*
  Storage vessel, still surface, slow changes in level.
- *PROC. TANK*
  Process vessel, slight surface movement, rapid changes in liquid level.
- *AGITATOR 1*
  Process vessel with agitator, rough surface
- *AGITATOR 2*
  Process vessel with agitators, turbulent surface, vortex formation

5.14 History check, consideration of previous measured values

Use this function to determine whether measurements are to be carried out **with** or **without** giving consideration to the previous trend of measured values.

Fct. 3.5.4 *HIST. CONTR.*

- *NO*
  Previous measured-value trend not considered.
- *YES*
  Allow for previous measured-value trend. This setting to be selected only when **tracking speeds are less than approx. 0.5 m/min** and incorrect measured values are occasionally displayed. This can occur in vessels with turbulent product surface.

5.15 Multiple reflections

Multiple reflections frequently occur in storage vessels with an extremely calm surface, typically when the BM 70 is mounted on a dome or centrically on a "dished cover" or the vessel is fitted with a flat or only very slightly dished head.

Such multiple reflections tend to simulate lower-than-actual liquid levels. In such cases, activate the "identification of multiple reflections", and see also references in Sect. 7.2.

A better solution, however, is to change the mounting location of the BM 70 so as to prevent the occurrence of multiple reflections in the first place or at least to diminish the strength of multiple reflections.

To ensure satisfactory identification of the first measured value after the BM 70 has been switched on, always carry out measurements with the "empty spectrum" (Fct. 3.5.1 and 3.5.2) when the "multiple reflection identification" is activated, see Sect. 5.16.

Fct. 3.5.5 *MULT. REFL.*

- *NO*
  Measurement **without** identification of multiple reflections.
- *YES*
  Measurement **with** identification of multiple reflections.

5.16 Empty spectrum

What is an empty spectrum?

- Fixed and moving internals in the vessel (incl. perhaps the vessel wall) produce interference signals (reflections) resulting in false measurements.
- To enable the BM 70 to identify and blank out such interference signals, the vessel profile (empty spectrum) needs to be recorded once only prior to (initial) startup.
- For this purpose, the vessel must be completely empty and all moving parts (e.g. agitators) switched on. If these conditions cannot be met during startup, the vessel profile (empty spectrum) can also be recorded at a later time. Until it is recorded, however, inaccurate measurements may occur.
- Recording of the vessel profile involves 1000 measurements that are carried out by the BM 70 and stored in the form of a so-called "empty spectrum".
- This allows the BM 70 to discriminate between constant or regularly recurring interference signals and the actually useful or wanted signals (liquid level). Interference signals are suppressed and only the useful signal is processed.

Recording the empty spectrum (sequence)

Key	Displayed		Description
→			If "9 underscores" now shown in display, key in the 9-keystroke Entry Code 1.
	1.0	*OPERATION*	
2 x ↑	*3.0*	*INSTALL.*	
→	*3.1*	*BASIS.PARAM.*	
4 x ↑	*3.5*	*APPLICAT.*	
→	*3.5.1*	*SPECT. ANALY.*	*NORMAL* (= normal empty spectrum) is factory-set here. This setting is suitable for most applications.
↑	*3.5.2*	*REC. SPECT.*	
→		*MAX. VALUES*	
↵		*TOTAL*	Recording of the empty-tank spectrum over the full range
↑		*PARTIAL*	If the tank cannot be drained over the full range
↵		*35000 mm*	Entry of the distance value up to which the empty-tank spectrum is to be recorded.
↵	*1000...0*	*WAIT*	Empty spectrum being recorded. Duration: approx. 3 minutes. Countdown is from "1000" to "0".
		READY	After 3 minutes.
↵	*3.5.2*	*REC. SPECT.*	Vessel profile recorded.
4 x ↵			Revert to measuring mode with display of actual level, distance or volume. Empty spectrum now stored and will be taken into consideration for measurements.

Fct. 3.5.1 *SPECT. ANALY.*

This function is used for selecting the application of the empty spectrum during measurement.

- *NORMAL*
  The stored empty spectrum is given full consideration, without limitation, during measurement. Standard application.
- *ADAPTIVE*
  The stored empty spectrum is adapted continually during measurement. For example, if deposits build up on internals, the empty spectrum is adapted to these changed conditions and taken into consideration for measurement.
  Note: The adapted spectrum is lost if the BM 70 is switched off for a short time. When restarted, the BM 70 will operate with the empty spectrum that was originally stored. The adapted empty spectrum can be stored under Fct. 3.5.2 *REC. SPEC., "ADAPTATION"*, see below.
- *OFF*
  The empty spectrum function is deactivated. This means that the BM 70 is not capable of considering any empty spectrum that has been stored. Set this function when an invalid or faulty empty spectrum is stored and a new empty spectrum cannot be recorded for the time being.

Fct. 3.5.2 *REC. SPECT.*

This function is used for recording and storing the empty spectrum.

- Requirements:
  - Vessel must be completely empty.
  - All moving parts, e.g. agitators, must be switched on.
  - Tank height and antenna extension must be set correctly.
- *MAX. VALUES*
  Only maximum values considered when the empty spectrum is recorded. Standard factory setting for recording the empty spectrum. Of advantage in conjunction with "difficult" agitators, for example; see also Sect. 7.3.
- *AVERAGE*
  Values are averaged. This setting can be used for most applications.
- *ADAPTATION*
  The originally recorded empty spectrum is deleted and replaced with the adaptive spectrum that was determined during measurements. After selecting this function, press ↵ key 5 times to store the new adaptive spectrum for subsequent measurements.
- If the tank cannot be completely drained, the empty-tank spectrum can nevertheless still be recorded up to a certain range. In this case, select menu item *PARTIAL* (possible with firmware V. 2.2.0 and higher).
- After selecting *AVERAGE* or *MAX. VALUES* with the ↑ key, select *TOTAL* with the ↵ key or *PARTIAL* with the ↑ key.
- If *TOTAL* selected, the empty-tank spectrum is recorded over the complete range.
- If *PARTIAL* selected, interrogation is carried out via the ↵ key concerning input of the distance value up to which the empty-tank spectrum shall be recorded.
- The tank area below the current product level is excluded from the recording of the empty-tank spectrum.
- The distance value is entered in the unit used for the tank height in the range of 0 m to max. tank height.
- It is recommended to maintain a safe distance of 20 to 30 cm (8" to 12") to the actual distance.
- Subsequently press the ↵ key to start recording of the empty-tank spectrum.
  Countdown from "1000" to "0" measurements, shown in the display. The display flashes *"WAIT"*, *"READY"* is displayed after approx. 3 minutes.
  Press ↵ key 5 times to store the empty spectrum for subsequent use.
  Recording of the empty spectrum can be aborted by pressing the ↵ key. Displayed: *BREAK*. Acknowledge by pressing the ↵ key. The "old" empty spectrum is retained.

5.17 Resetting the configuration

- The BM 70 configuration data are stored automatically after every alteration in a read-only memory (EEPROM). Errors in these data are normally identified and displayed as *CONF. ERR.* or *SERV. ERR.*
- However, if the data are already erroneous when stored, e.g. due to a power failure during storage, the instrument can in certain circumstances no longer start properly. In such a case, or if the basic instrument setting is required for some other reason, this can be achieved as follows:
- Switch off the BM 70 (disconnect from power). If the instrument makes continuous attempts to restart, recognisable by the fact that *TEST* and the firmware version are repeatedly displayed, the instrument need not be switched off and the procedure can be directly continued as follows:
- Press → and ↑ keys simultaneously and switch on the instrument.
- After the *TEST* message, the *DEFAULT* message appears in the display. If you now release the keys, the text *SURE NO* will appear.
- Use key ↑ to choose between *SURE NO* and *SURE YES*.
- Press the Enter key ↵ once you have made your choice.
- If *NO* selected, the configuration data are read from the EEPROM; if *YES* selected, the standard default values are used.

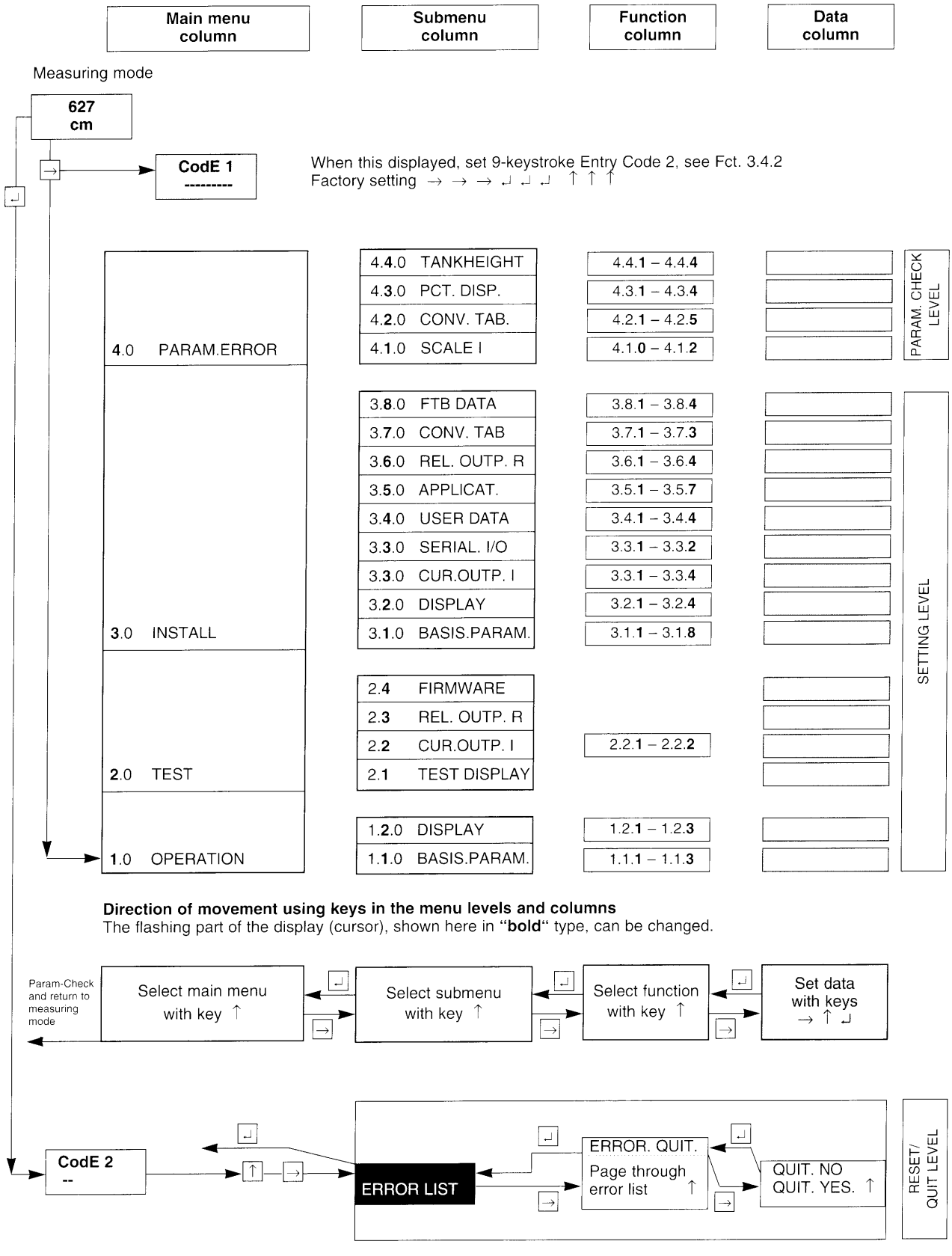
Note: When reset to standard values the current configuration is lost. Empty-tank spectrum and conversion table are erased, and the instrument must be readjusted (offset and calibration of the current output).

KROHNE

04/96

Condensed Instructions BM 70 Signal converter

4M27EA4 049622



BM 70 Table of settable functions

The Sect. Nos. referred to in these Condensed Instructions will be found in the Installation and Operating Instructions. (Version 2.22.1/2.22.1 H)

Fct. No.	Text	Description and setting
1.0	OPERATION	Main menu 1.0 Operation
1.1.0	BASIS.PARAM.	**Main menu 1.1.0 Basis parameters**
1.1.1	HOLD DIST.	**Hold distance below antenna,** see Fct. 3.1.2
1.1.2	TIMECONST.	**Time constant for filtering measured values,** see Fct. 3.1.3
1.1.3	TRACING.VEL.	**Tracking speed,** see Fct. 3.1.4
1.2.0	DISPLAY	**Display**
1.2.1	FCT.DISP	**Submenu 1.2.1 Function of display,** see Fct. 3.2.1
1.2.2	UNIT.LENGTH	**Unit for display of level or distance,** see Fct. 3.2.2
1.2.3	UNIT CONV.	**Conversion unit for display,** see Fct. 3.2.3
2.0	TEST	Main menu 2.0 Test functions (Sect. 7.1)
2.1	TEST DISP.	**Test of the display** (Sect. 7.1.2) → key: switch on all segments ↑ key: switch off all segments ↵ key: terminate test.
2.2.0	CUR.OUTP. I	**Test of curent output I** (Sect. 7.1.3)
2.2.1	VALUE I	**Display of actual value at current output in** *mA*
2.2.2	TEST I	**Test current output I** Safety interrogation: *SURE NO* *SURE YES* • *0 mA* • *4 mA* • *20 mA* • *2 mA* • *10 mA* • *22 mA* Select with ↑ key. Displayed value present directly at current output. Actual value again present at output after pressing ↵ key.
2.3	REL. OUTP. R	**Test of relay output R** (Sect. 7.1.4) Safety interrogation: *SURE NO* *SURE YES* • *OFF* (= relay contact open) • *ON* (= relay contact closed) Select with ↑ key. Relay contact adopts set state directly. Relay contact adopts actual state again after pressing ↵ key.
2.4	FIRMWARE	**Test version** → indicates version installed ↵ terminates test
3.0	INSTALL.	**Main menu 3.0 Installation**
3.1.0	BASIS.PARAM.	**Submenu 3.1.0 Basis parameters**
3.1.1	TANKHEIGHT	**Vessel/tank height** (see Sect. 5.1 and 5.2) = distance between top edge of vessel connecting flange and bottom reference point (datum point). Selection of unit and setting ranges • *00.50 – 35.00 m* • *0050 – 3500 cm* • *00050 – 35000 mm* • *0019.7 – 1378.0 inch* • *001.64 – 114.83 ft* After selecting unit, call numerical value with → key, 1st digit flashes. Note: The unit length selected **also applies** to Fct. 3.1.2/3.1.4/3.1.6/3.3.3/3.3.4 and 3.7.2! If level or distance set under Fct. 3.6.1 (relay) it also applies to Fct. 3.6.3 and 3.6.4!
3.1.2	HOLD DIST.	**Hold distance below antenna** (Sect. 5.3) = distance between max. measurable liquid level and bottom edge of antenna Setting ranges and unit: same as Fct. 3.1.1 *TANKHEIGHT.* Recommended minimum value: *100 mm* or *4 inch*
3.1.3	TIMECONST.	**Time constant,** damping of measured values (Sect. 5.4) Setting range: *0001* to *1000 Sec* Recommended value: *10 Sec*
3.1.4	TRACING.VEL.	**Tracking speed** (Sect. 5.4) Setting range: *0.01* to *5.00 m/min* *0.03* to *16.40 ft/min* Recommended value: *0.50 m/min* or *2 ft/min*
3.1.5	ANTENNA	**Antenna type/length** (Sect. 5.3 and 1.2) • *Type 1* • *Type 3* (standard) • *Type 5* • *Type 2* • *Type 4* • *Type 0* The antenna type is factory set and may only be altered if, e.g., antenna Type 3 changed to Type 2.
3.1.6	ANT.-EXTENS.	**Antenna extension** (Sect. 5.3 and 1.2) Setting ranges and unit: same as Fct. 3.1.1 *TANKHEIGHT.*
3.1.7	OFFSET REF	Offset added to displayed distance • - 10 to + 10 m
3.1.8	OFFSET TB	Offset added to displayed level • - 99.99 to + 99.99 m
3.2.0	DISPLAY	**Submenu 3.2.0 DISPLAY** (Sect. 5.5)
3.2.1	FCT.DISP.	**Function of display** Select measured quantity: • *LEVEL* • *DISTANCE* • *CONVERSION* (only possible if conversion table set under Fct. 3.7.1 and 3.7.2, otherwise Parameter Error, Fct. 4.2.0.)
3.2.2	UNIT.LENGTH	**Unit of length** Select unit for the measured quantities Level and Distance: • *m* • *cm* • *mm* • *inch* • *ft* • *PERCENT,* referred to scaling range of current output I, Fct. 3.3.3 and 3.3.4, therefore current output I must **also** measure Level or Distance, otherwise Parameter Error, Fct. 4.3.0!
3.2.3	UNIT. CONV.	**Conversion unit** Select unit for the measured quantity Volume: • *m3* • *Liter* • *US Gal* • *m* • *GB Gal* • *ft 3* • *bbl* (petroleum barrels) • *PERCENT,* referred to scaling range of current output I, Fct. 3.3.3 and 3.3.4, therefore current output I **also** measures volume, otherwise Parameter Error, Fct. 4.3.0!
3.2.4	ERROR MSG.	**Display errors?** (Sect. 4.4) • *NO* Error messages can only be called via the Quit/Reset menu. • *YES* Errors signalled by flashing display. Press ↑ key for interrogation of all errors alternating with measured value
3.3.0	CUR.OUTP. I	**Submenu Current output I** (Sect. 5.6)
3.3.1	FUNCTION I	**Function of current output I** Select measured quantity: • *OFF* (= deactivated, in which case Fct. 3.3.3 and 3.3.4 cannot be set!) • *LEVEL* • *DISTANCE* • *CONVERSION* (only possible if conversion Table set under Fct. 3.7.1 and 3.7.2, otherwise Parameter Error, Fct. 4.2.0).
3.3.2	RANGE I	Select **ranges for current output I:** • *0 – 20 mA* • *4 – 20 mA* • *4 – 20 mA/E=2* • *0 – 20 mA/E=22* • *4 – 20 mA/E=22* E = 2 and E = 22 signify error message via current output at 2 and 22 mA, resp.
3.3.3	SCALE. I MIN.	**Scaling I_{min} for 0/4 mA** (lower range value) **Not** shown when *OFF* set under Fct. 3.3.1! Setting range for Level and Distance: same as Fct. 3.1.1 *TANKHEIGHT,* but value must be lower! Setting range for Conversion: same as Fct. 3.7.2 *TAB. INPUT,* but value must be lower!
3.3.4	SCALE. I MAX.	**Scaling I_{max} for 20 mA** (full-scale range) **Not** shown when OFF set under Fct. 3.3.1! Setting range for Level and Distance: same as Fct. 3.1.1 *TANKHEIGHT.* Setting range for Conversion unit: same as Fct. 3.7.2 *TAB. INPUT* Value must be greater than that of Fct. 3.3.3, otherwise Parameter Error, Fct. 4.1.0!
3.3.0	SERIAL I/O	**Submenu RS 485 interface** (Sect. 5.7.5)
3.3.1	BAUD RATE	**BAUD RATE** Define transmission rate for RS 485 communication: • *1200 Bd* • *9600 Bd* • *2400 Bd* • *19200 Bd* • *4800 Bd* Default value: 1200 bauds
3.3.2	ADDRESS	**Enter address** Permissible addresses from 0 to 239 Default value Address *0*
3.4.0	USER DATA	**Submenu 3.4.0 User data**
3.4.1	LANGUAGE	**Language for display texts** (Sect. 5.10) • *GB/USA* (= English) • *D* (= German) • *F* (= French) • others pending

Fct. No.	Text	Description and setting
3.4.2	ENTRY. CODE 1	**Entry Code 1 for entry into setting level** required? (Sect. 5.11) • *NO* = entry with → key • *YES* = entry with 9-keystroke code. Code set under Fct. 3.4.3
3.4.3	CODE 1	**Set Code 1** (9-keystroke combination) • Factory setting: → → → ↵ ↵ ↵ ↑ ↑ ↑ • If different code required: press any 9-keystroke combination and then press the same keystroke combination again. Each keystroke acknowledged by "*". *WRONG. INPUT* (= incorrect entry) appears if 1st and 2nd entries are not equal. Press ↵ and → keys and repeat entries. • Appears only if YES set under Fct. 3.4.2.
3.4.4	LOCATION	Set **tag name** (measuring point No.), max. 10 digits. To identify units operated with the MIC 500 hand-held communicator (remote control) or PC user program (PC-CAT), see Sect. 5.6, 5.7, 6.2 and 6.4. Factory setting: *BM 70 0001* Characters assignable to each place: A...Z / a...z / 0...9 +/– / _ (underscore character = blank character)
3.5.0	APPLICAT.	**Submenu 3.5.0 Application**
3.5.1	SPECT. ANALY.	Select **empty spectrum function** (Sect. 5.15) • *NORMAL* (normal empty spectrum) • *ADAPTIVE* (adapt empty spectrum during measurement) • *OFF* (empty spectrum deactivated. Existing empty spectrum still stored but not considered for measurements).
3.5.2	REC. SPECT.	**Record empty spectrum** (Sect. 5.16) • *AVERAGE* (values averaged) • *MAX. VALUES* (maximum values only to be considered) After selecting *AVERAGE* or *MAX. VALUES*, press ↵ key to select *TOTAL* or *PARTIAL* recording of the empty spectrum. Enter distance value 0 to max. tank height with ↵ key. Press ↵ key to record 1000 spectra, duration: approx. 3 minutes. Displayed: *WAIT* and countdown from 1000 to 0. *READY* appears at the end. Acknowledged by pressing ↵ key. • *ADAPTATION* (storage of last adaptive empty spectrum).
3.5.3	TANKTYPE	**Select vessel type** (Sect. 5.13) The vessel type describes the movement of the product surface. • *STORAGE T.* (storage vessel, still surface, no rapid changes in liquid level) • *PROC. TANK* (process vessel, slightly ruffled surface, rapid changes in level). • *AGITATOR 1* (process vessel with agitator, rough surface) • *AGITATOR 2* (process vessel with agitator, turbulent surface, vortex formation).
3.5.4	HIST. CONTR.	**History check**, take preceding measured-value trend into consideration? (Sect. 5.14). • *NO* • *YES*
3.5.5	MULT. REFL.	**Identification of multiple reflections** required? (Sect. 5.15) • *NO* • *YES*
3.5.7	HD DETECT	**Activation of overfill detection** • *NO* • *YES*
3.6.0	REL. OUTP. R	**Submenu 3.6.0 Relay output** (Sect. 5.8)
3.6.1	FUNCTION R	**Function of relay output R** Select measured quantity: • *OFF* (= deactivated, in which case Fct. 3.6.2/3.6.3 and 3.6.4 cannot be set). • *LEVEL* • *DISTANCE* • *CONVERSION* • *ERROR* (error message, see Sect. 4.4) • *ERROR INV*
3.6.2	TYPE R	**Select relay type** **Not** shown when *OFF* set under Fct. 3.6.1! • *HIGH* (signals **over**shooting of set threshold, limit value ± hysteresis) • *LOW* (signals **under**shooting of set threshold, limit value ± hysteresis) Setting here is irrelevant if *OFF* or *ERROR* set under Fct. 3.6.1!
3.6.3	THRESHOLD	**Define threshold, limit value** **Not** shown when *OFF* set under Fct. 3.6.1! Setting range: same as Fct. 3.3.3 *SCALE. I MIN.* Setting here is irrelevant if *OFF* or *ERROR* set under Fct. 3.6.1!
3.6.4	HYSTERESIS	**Define hysteresis of threshold (limit value)** **Not** shown when *OFF* set under Fct. 3.6.1! Setting range: same as Fct. 3.3.3 *SCALE. I MIN.* Setting here is irrelevant if *OFF* or *ERROR* set under Fct. 3.6.1!
3.7.0	CONV. TAB.	**Submenu 3.7.0 Conversion table** (Sect. 5.9)
3.7.1	UNIT. CONV.	**Define conversion unit** • *m3* • *Liter* • *m* • *US Gal* • *GB Gal* • *ft 3* • *bbl* (petroleum barrels) **Unit** for **„level setting"**, same as Fct. 3.1.1 TANKHEIGHT!
3.7.2	TAB.INPUT	**Enter conversion table** • *01* to *50* points (= level/conversion pairs) • "Level" setting range: same as Fct. 3.1.1 *TANKHEIGHT* • Conversion setting ranges: *0.00 – 30000.00 m³* 0 00 – 99999999 Liter 0 – 7925161 US Gal 0 – 6599265 GB Gal 0.0 – 999999.9 ft 3 0.0 – 99999.9 bbl 0.00 – 30000.00 m Use ↵ key to sequence through "Point No." / "Level" and "Conversion".
3.7.3	DELETE TAB.	**Delete conversion table?** Safety interrogation: *SURE NO* *SURE YES* Select with ↑ key. After *SURE YES*, press ↵ key to delete table. Displayed: *DELETED.*
3.8.0	FTB DATA	**Submenu 3.8.0** **Tank bottom tracking** (Sect. 6.5)
3.8.1	FUNCT. TBF	**Record tank bottom tracking** • *OFF* Tank bottom tracking system is inactive. • *LEARN* Learning phase for automatic determination of FTB parameters • *HOLD* Storage of learning phase. appears only when learning phase successfully completed. • *MANUAL* Manual entry following external evaluation of parameters.
3.8.2	EPSILON R	**Function of Epsilon R** • Display of stored or entered relative permittivity • Acceptable input range: *0.0000 – 8.0000*
3.8.3	BOTTOM	**Tank bottom** • Display or entry of spectrum line index of the actual tank bottom • Acceptable input range: *0.0000 – 127.0000*
3.8.4	TANK HEIGHT	**Tank height** • After learning phase completed, the actual tank height is displayed in the unit used for the configured tank height.
4.0	**PARAM.ERROR**	**Main menu 4.0 Parameter errors**
4.1.0	SCALE I	**SCALING OF CURRENT OUTPUT I is incorrect:** Ensure following condition is met: value of *SCALE. I MAX.* **greater** than value *SCALE. I MIN.*
4.1.1	SCALE. I MIN.	**Scaling of MIN value for current output I** see Fct. No. 3.3.3
4.1.2	SCALE. I MAX.	**Scaling of MAX value for current output I** see Fct. No. 3.3.4
4.2.0	CONV. TAB	**CONVERSION TABLE NOT set or INCOMPLETELY set,** but current output I, relay output R and/or display are set to "conversion display"!
4.2.1	TAB. INPUT	**Enter conversion table** see Fct. 3.7.2
4.2.2	DELETE TAB.	**Delete conversion table** see Fct. 3.7.3
4.2.3	FCT. DISP.	**Function of display** see Fct. 3.2.1
4.2.4	FUNCTION I	**Function of current output I** see Fct. 3.3.1
4.2.5	FUNCTION R	**Function of relay output R** see Fct. 3.6.1

Fct. No.	*Text*	**Description** and setting
4.3.0	*PCT. DISP.*	**PERCENT. DISPLAY** incorrect When the display is set in PERCENT. of level (distance) or conversion, the current output I **must** accordingly be set to level (distance) or conversion!
4.3.1	*FCT. DISP.*	**Function of display** see Fct. 3.2.1
4.3.2	*UNIT. LENGTH*	**Unit for level or distance** see Fct. 3.2.2
4.3.3	*UNIT. CONV.*	**Unit conversion** see Fct. 3.2.3
4.3.4	*FUNCTION I*	**Function of current output I** see Fct. 3.3.1
4.4.0	*TANKHEIGHT*	**TANK HEIGHT incorrect:** Ensure following condition is met: the sum of antenna length, antenna extension and hold distance **must be less** than the value for the tank height!
4.4.1	*TANKHEIGHT*	**Tank height** see Fct. 3.1.1
4.4.2	*HOLD DIST.*	**Hold distance (dead distance)** see Fct. 3.1.2
4.4.3	*ANTENNA*	**Antenna type** see Fct. 3.1.5
4.4.4	*ANT. EXTENS.*	**Antenna extension** see Fct. 3.1.6

Pointers and error messages (ERROR) during measurement

Kinds of message: a, b, c and d

a) **Pointers** (operating status) during measurement provided by 6 markers ▼ in the 3rd (bottom) line of the display, see below.

b) **Minor errors,** signalling the failure of functions that do not affect measurement, refer to "Error List".

c) **Correctable errors,** which can be remedied by operator action (manual) at the BM 70, or possibly by Krohne Service, or which can be eliminated by altering the operating status, see "Error List".

d) *FATAL ERROR:* renders operation of the BM 70 impossible. Occurs only when instrument started up (powered), and the self-test identifies errors in the electronics and/or microwave part of the BM 70, see "Error List".

Pointers provided by 6 markers ▼ during measurement

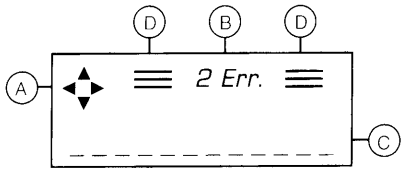
Marker	Cause	Comments
1	**Signal too weak**	Mean of reflected microwaves is too weak, gain is automatically stepped up. If signal remains weak, the "correctable error (c)" *SIGNAL. DOWN* appears in the Error List..
2	**Signal too strong**	Mean of reflected microwaves is too strong, gain is automatically stepped down. Brief showing of this marker, e.g. while vessel is being filled or drained, is insignificant. If permanently on, this may result in uncertain (incorrect) measured values. If so, consult factory.
3	**Poor spectrum**	Number of acceptable spectra is too low. Brief showing of this marker has no significance. If permanently on, this may result in uncertain (incorrect) measured values. Consult factory.
4	**No measured value as yet**	Evaluable measured values not available after an instrument startup. Measured value automatically set to level of tank bottom. This marker disappears when the first valid measured value is obtained.
5	**Tank bottom**	In tanks with dished bottom, for example, the measuring signal can "disappear" if measurements are carried out near the bottom (within a range of 10% of the tank height, see Fct. 3.1.1, but minimum of 200 mm or 8" and maximum of 600 mm or 24"). The measured value is then automatically set to the level of the tank bottom.
6	**Digital input**	Digital input is active, voltage of 5 – 24 V DC applied. Measurement suspended (frozen); last measured values present at outputs I and R and in the display.

Error representation

Error messages		Description of error
Type	Text	
b) *	*SWEEP LOW*	**Restricted function of microwave pcb**
	SPECT. ERR.	**Empty spectrum faulty**
	SERIAL I/O	**Serial interface faulty**
c) *	*EEPROM. ERR.*	**EEPROM defective**
	CONFIG. ERR.	**Error in EEPROM,** Parameters faulty
	SERVICE.ERR.	**Error in EEPROM,** Service parameters faulty
	CAL. DATA	**Error in EEPROM,** Calibration data of current output faulty
	SIGNAL.DOWN	**Measuring signal too wak for evaluation**
	NO M. VALUE	**No evaluable measuring signals available**
	MICROWAVE	**Fault in microwave pcb**
d) * FATAL ERROR	*CPU ERROR*	**CPU board defective**
	ROM ERROR	**ROM defective**
	RAM ERROR	**RAM defective**
	INTER.CONT.	**Interrupt controller defective**
	TIMER/CNTR.	**Counter/Timer module defective**

* **When error are displayed during the measuring mode and in the ERRORLIST** in the Reset/Quit menu, "a numeral" and "Err." will appear in the 1st (top) line. The numeral indicates the number of momentary errors, which is displayed alternately with the actual measured value.

Error representation



Ⓐ Compass field

Ⓑ Number of errors that have occurred

Ⓒ Plain text for error messages

Ⓓ **with** bar:
"new" errors, not yet acknowledged
without bar:
"old", acknowledged errors but cause not yet eliminated

Error display during measurement

In the setting level under Fct. 3.2.4 *ERROR MSG.* (error messages), it is possible to select whether errors are to be displayed during measurement. If *YES* set, "error message(s)" can be displayed by pressing the ↑ key. The errors will continue to be displayed until their cause has been eliminated. All displays, including measured values, flash!

Error list in Reset/Quit menu

All errors are stored in the *ERROR LIST* in the Reset/Quit menu. The errors are retained in this until: **1** the cause of the error has been eliminated, **and 2** the error has been acknowledged. Errors that have been acknowledged, but whose cause has not been eliminated, are retained in the Error List but are displayed **without** bar. This allows identification of "old" and "new" errors.

Part C Special applications, functional checks and service

6.0 Special applications

6.1 Magnetic sensors, setting (programming) with hand-held bar magnet

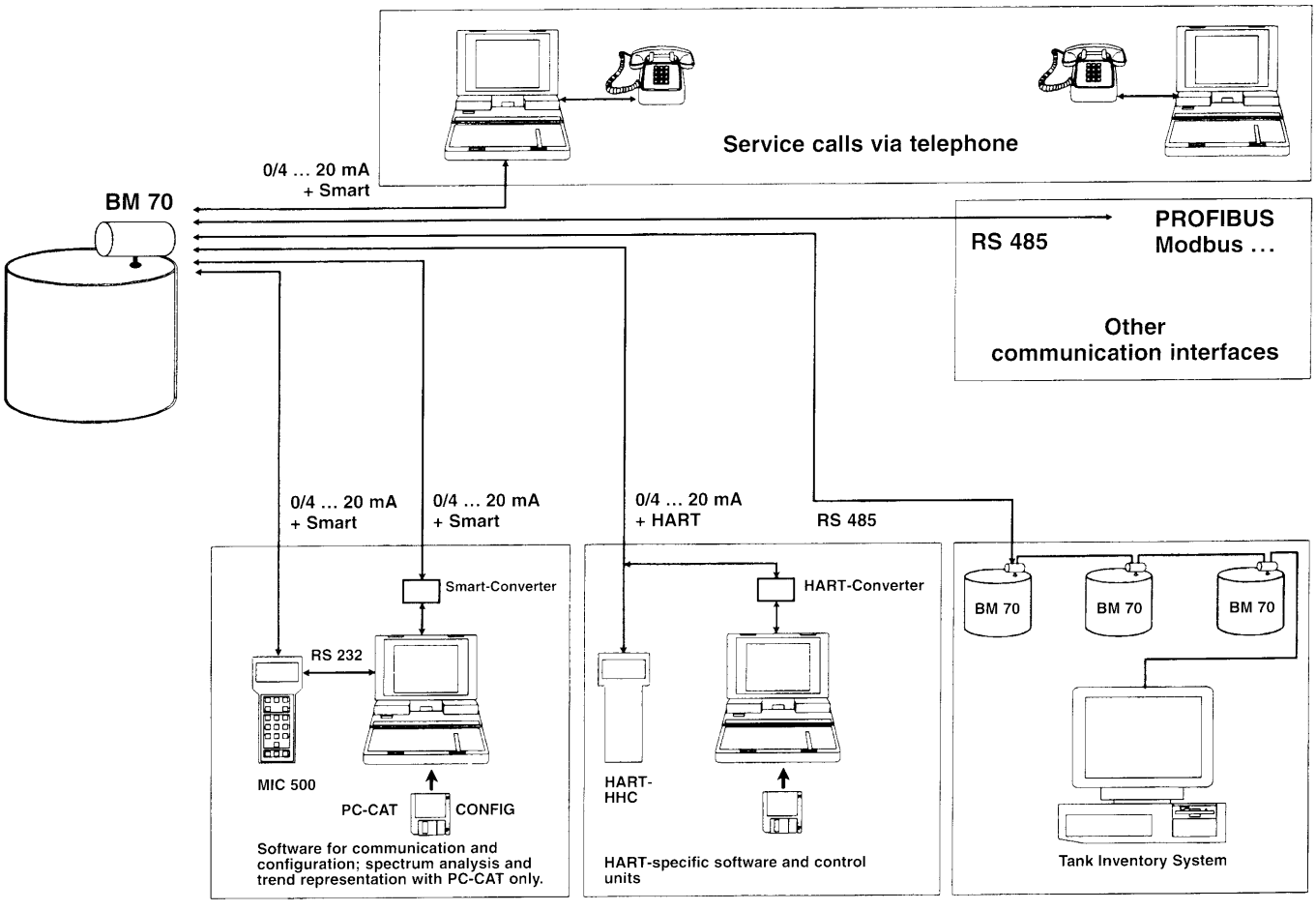
The BM 70 is equipped with magnetic sensors to allow operator control by means of a hand-held bar magnet without opening the housing.

Function of the magnetic sensors is the same as the corresponding keys. Sensor response is acknowledged by the compass field in the first line of the display.

Hold the bar magnet by the black rubber cap. Apply blue end of the magnet (north pole) to the glass pane above the sensors.

6.2 Communication system

The BM 70 level gauge can be operated with various communication interfaces, see Sect. 5.7.



6.3 MIC 500 hand-held communicator

The signal converter can be operated by remote control with the MIC 500 hand-held communicator.

For this purpose, the MIC 500 is connected to the two current output cables, max. distance from signal converter: 1000 m **or** 3300 ft. Receiver instruments, such as milliammeters, recorders, connected to the current output are not affected by the MIC 500. Refer to Sect. 5.12, Fct. 3.4.4 for identification of measuring point (tag name).

Further details concerning connection and operation are given in the MIC 500 operating instructions.

6.4 PC-CAT user program

This program allows convenient remote control of all functions of the signal converter. The vessel can be shown in schematic form together with the associated measured values and the measured spectrum. A trend representation of the output signal and control threshold (signal strength) is also provided. All relevant instrument data can be recorded in the form of a data-set, stored on a floppy disk, forwarded to Krohne by modem (long-distance data transmission) or transmitted on-line. Evaluation of such data forms the basis of a telephone service. Stored data can also be used for configuring other BM 70 units.

PC-CAT also has a reproduction function for recorded files for subsequent analysis of the measurement performance. All graphic illustrations can be exported in PCX format for further processing in word processing systems or similar.

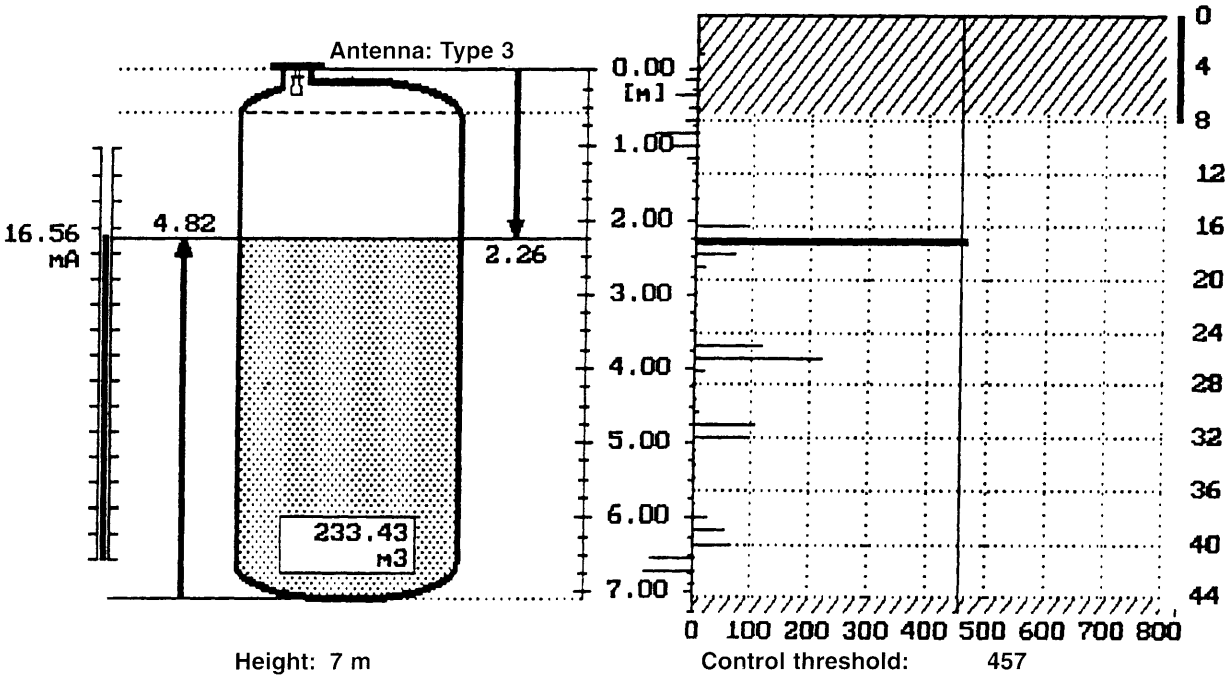
The program is loaded into a user PC and connected to the current output via an interface module, max. distance from the BM 70: 1000 m **or** 3300 ft. The PC interface module has no effect on receiver instruments, such as milliammeters, recorders, etc., connected to the current output. Refer to Sect. 5.10, Fct. 3.4.4 for identification of measuring point (tag name). Further details concerning connection and operation are contained in the "PC-CAT user program" operating instructions.

6.4.1 Spectrum and measured value

The diagram shows, on the left, a schematic of the tank with actual measured values, and on the right the spectrum following correction with the empty spectrum (fixed tank interference signals). The thick horizontal line in the chart shows the actual value measured, while the vertical line represents the control threshold (in this case, a signal strength of 457).

The control threshold (signal strength) is dynamically corrected to provide the target number of evaluable spectra, which is defined by way of the tank type. The hatched area marks that part of the tank in which measurements cannot be made or are deliberately blanked out.

BM 70 tank data

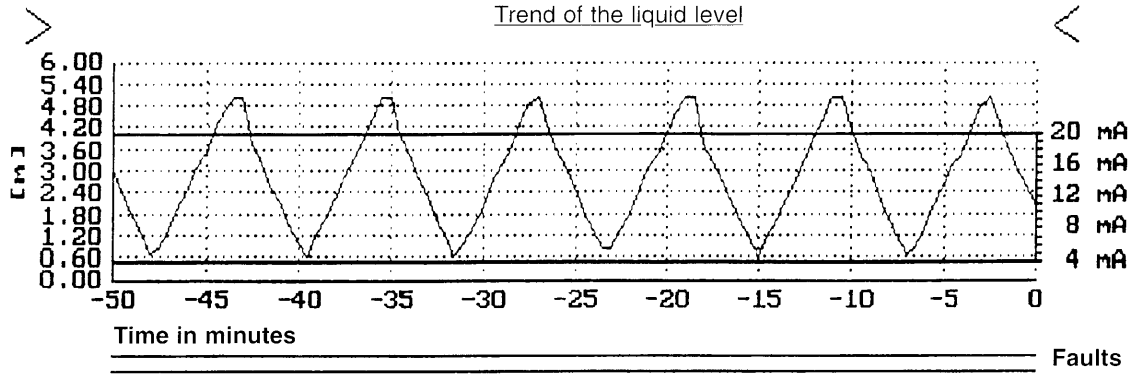


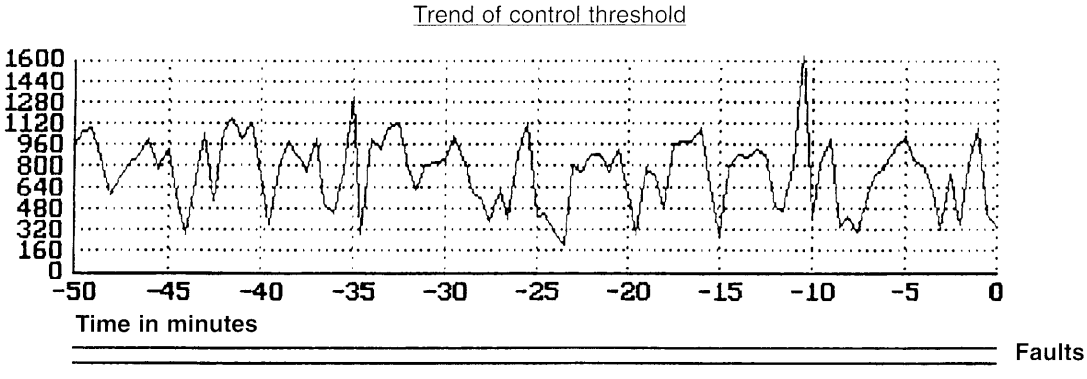
Height: 7 m
Type: Process tank

Control threshold: 457
Gain: 3

6.4.2 Trend representation of the output signal and control threshold

Output signal values (liquid level, distance or volume) and control threshold (signal strength) are stored temporarily during the program run time.
The x-axis represents the retrospective time in minutes, and the y-axis the current output in relation to the set measured value. Any instrument fault occurring in the same period is recorded between the parallel lines below the trend diagrams.

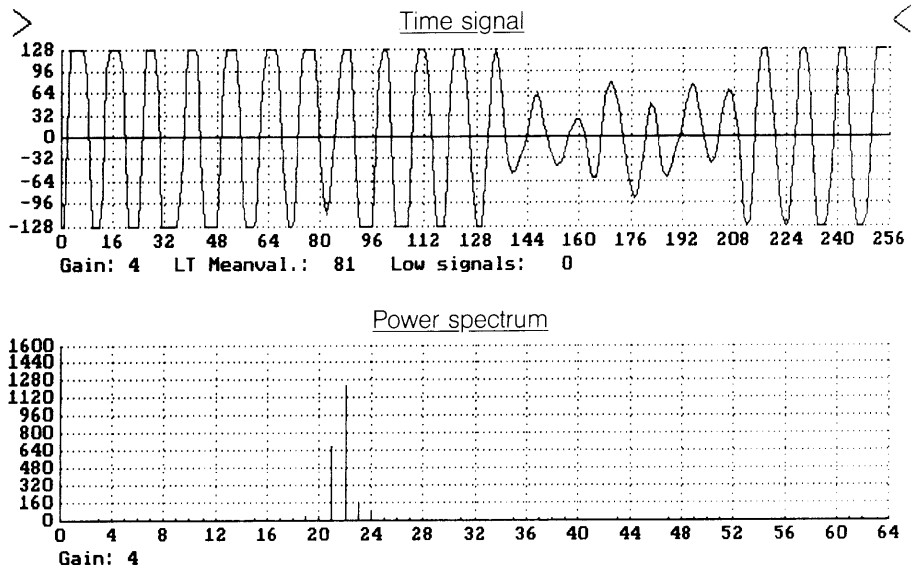




6.4.3 Time signal and spectra

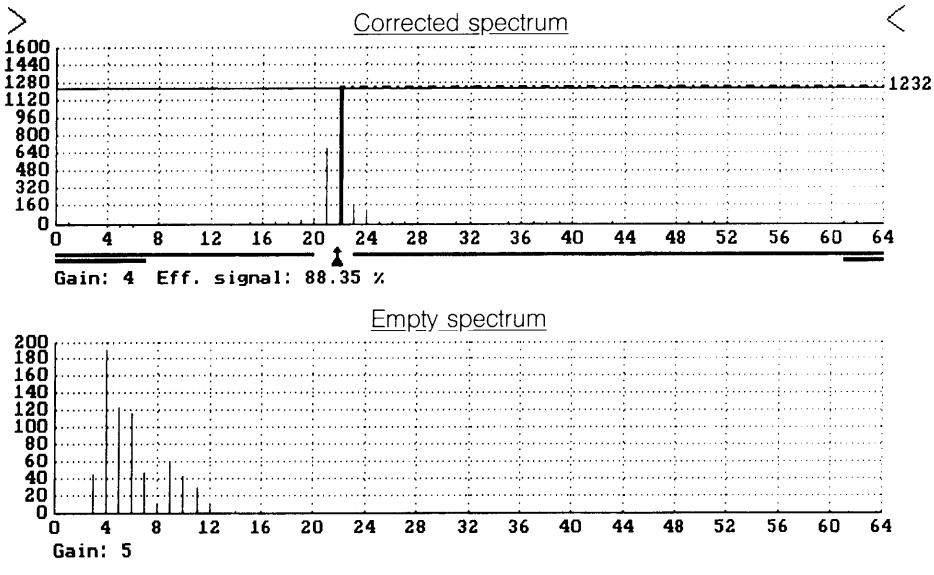
Analog/time signal
The time signal represents the first stage of measurement. Ideally, this would be a pure sinusoidal signal whose frequency is proportional to the distance to be measured. In reality, this signal is to a greater or lesser degree distorted and blanketed by interference signals, which may be due firstly to the mechanical design of the BM 70 and secondly to interference reflections in the tank.

Power spectrum
The power spectrum represents the spectrum determined from the time signal, and consequently contains all interference signals.



Corrected spectrum
The corrected spectrum corresponds to the spectrum from the tank diagram. It is obtained, allowing for the respective gain stages, by subtraction of the empty-tank spectrum from the power spectrum.
Two bars are indicated below the spectrum which represent different ranges. The lower bar marks the measurable range, also termed **"search range".** They are identical with the bars to the right of the spectrum in the tank diagram. The upper bar, on the other hand, indicates the **"plausibility range".** Only within this range, which is defined by way of special algorithms, is a new measured value "plausible" and will be evaluated. Signals outside this range are implausible and are suppressed.

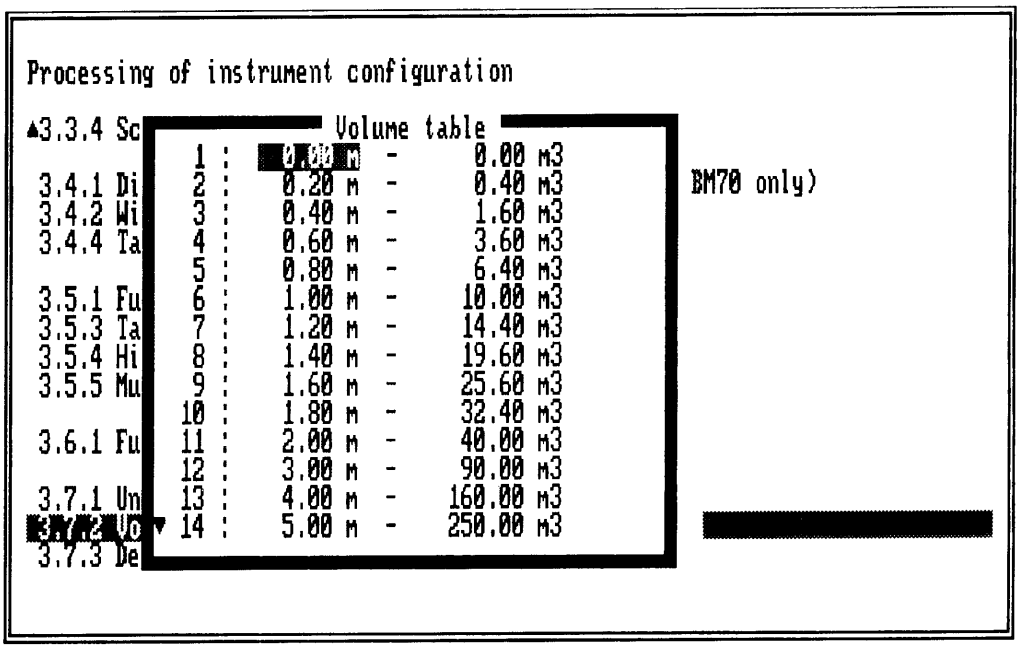
Empty-tank spectrum
The empty-tank spectrum is used for blanking out fixed interference signals from the power spectrum. It is normally recorded when the tank is empty; using firmware V 2.20 and higher, partial recording with partially filled tank is also possible.



6.4.4 Conversion table

Entries and editing of the conversion table form a special function within the configuration menu.
Actual entry and editing of the conversion table is carried out under Fct. 3.7.2. As the current value, this menu item only shows the number of points in the conversion table. If you select this function, this opens a window containing the values in the current conversion table:

In keeping with the entries made at the instrument, the window shows a sequential No., a level value, and the associated conversion value. You can conveniently edit individual values, delete or insert pairs of values,and shift the entire table in the direction of the conversion unit axis or in the direction of the level axis (e.g. when the programmed tank height needs to be changed).



6.5 Tank bottom tracking

6.5.1 Description

- The BM 70 firmware version 2.20 and higher contains as option an extra function for carrying out measurements in vessels with poorly reflecting (i.e. relative permittivity $\varepsilon_R \leq = 2.5$) yet non-absorbing media. This function is the "tank bottom tracking" (abbreviated to FTB) that utilizes an apparent shift of the tank bottom signal due to the different propagation speed of microwaves in air and in the tank product.
- This requires knowing the exact position of the tank bottom reflection in an empty tank and the relative permittivity ε_R of the product in the tank. These parameters can be established by appropriately trained Krohne Service engineers on the basis of the recording of a tank filling or draining procedure with the PC-CAT user program, and manually set in the instrument. The product level should change by at least 0.5 to 1 m (1.64 ft to 3.28 ft) in the upper or middle tank range; the greater the rate of change in level, the more accurately can the parameters be calculated.
- It is also possible by way of an integrated learning function to established the parameters direct using the BM 70. However, the results of this **learning phase** are generally **less accurate and less reliable** than the evaluation of a PC-CAT recording, and should therefore be used only provisionally and after verification of their plausibility (established tank height and ε_R). During the learning phase, the useful signal should not disappear completely and must still be traceable at least in partial areas.
- When measurements are carried out with the active tank bottom tracking system, an expectancy range for the measured value is established on the basis of the shifted tank bottom signal, allowing for an inaccuracy of ± 10 % for the ε_R value and of ± $^1/_2$ line for the tank bottom position. If no evaluable measuring signal is obtained within this range, then an equivalent measured value is calculated direct from the tank bottom signal. This characteristic feature of the FTB even allows measurement in tanks without a direct useful signal, provided the tank bottom remains visible through the product for the microwaves. The FTB parameters must in this case be established solely by way of the tank geometry and the properties of the product or a comparison measurement.
- It needs to be borne in mind that, when measuring with the equivalent measured value determined by way of the tank bottom signal, measuring accuracy decreases by the factor ($\sqrt{\varepsilon_R} - 1$)! For a ε_R of 2.25, accuracy decreases by one-half, i.e. the possible deviation doubles; if ε_R is only 1.56, accuracy decreases to one-quarter and the measuring error quadruples.

6.5.2 Operator control

Control of tank bottom tracking is carried out via **Fct. 3.8.0** *FTB DATA* once this function has been activated by Service.

Fct. 3.8.1 ***FUNCT. TBF***
Tank bottom tracking is recorded under this function.

- *OFF*
  Tank bottom tracking is inactive; the instrument operates in the standard mode according to Version 2.2.1.
- *LEARN*
  The learning phase for automatic determination of the FTB parameters is run through. After successful completion of this phase, the values so determined are displayed under Fct. 3.8.2 and 3.8.3, and the learning phase is run through once again. The parameters are not automatically stored, i.e. they are lost when the instrument is switched off. They are stored only after the *HOLD* option has been selected. During the learning phase, measurements are carried out in the standard mode.
- *HOLD*
  This option appears only if, in the *LEARN* mode, the learning phase has been successfully completed. The current correction parameters are stored and are also available directly after the instrument has been restarted. The tank bottom tracking is activated; no further learning phase is run through.

Note: Do not accept values from the internal learning function without having checked them first!

- *MANUAL*
  When this option is selected, the parameters established by external evaluation can be manually keyed in. The parameters are stored and are also available directly after the instrument has been restarted. Tank bottom tracking is activated.

Fct. 3.8.2 *EPSILON R*
The stored or keyed-in relative permittivity is displayed under this function.

- The relative permittivity ε_R, established in the learning phase, is displayed under the *LEARN* and *HOLD* function modes; in the *MANUAL* mode, the value can be manually keyed in here:
- Acceptable input range: *0.000 – 8.000*

Fct. 3.8.3 *BOTTOM*
- In the same way as under Fct. 3.8.2, the spectrum line index of the actual tank bottom is displayed or can be entered here.
- Acceptable input range: *0.000 – 127.000*

Fct. 3.8.4 *TANKHEIGHT*
- In the *LEARN* function mode, after the learning phase has been completed, the established actual tank height is displayed in the unit used for the configured tank height. This menu item is **omitted** in the other modes.

Note: The values displayed under Fct. 3.8.3 and 3.8.4 describe a fictitious point in the area of the tank bottom from which the microwaves are reflected. This point may also be a built-in item (e.g. heating coil) located above the actual tank bottom. The tank height from Fct. 3.8.4 is therefore not necessarily identical with the tank height used for calculating the level from the standard configuration (Fct. 3.1.1)!

Procedure for the following applications

To start up measurement with tank bottom tracking

- Recording of a tank filling or draining procedure using the PC-CAT user program, with short backup interval (1 min.).
- Evaluation of the recording by a trained Service engineer or by Applications Engineering at Krohne.
- Selection of the *MANUAL* function in menu item Fct. 3.8.1 and input of parameters established for *EPSILON R* and *BOTTOM.*
- Tank bottom tracking is now active.

If, by way of exception, parameters are to be determined via the LEARN function

- Prepare the tank for filling or draining.
- Select FTB function *LEARN* and terminate menu with *STORE YES.*
- Start tank filling or draining procedure. The liquid level should not drop below a minimum level of 0.5 m (1.64 ft) from the tank bottom.
- Watch display of Fct. 3.8.2 or 3.8.3. After successful completion of the learning phase, a value differing from 0 is shown here.
- Check parameters for plausibility: is the established ε_R within the anticipated range? Does the displayed tank height differ substantially from the configured tank height?
- If parameters are plausible, select the *HOLD* function to activate tank bottom tracking.
- If parameters are implausible, repeat the sequence. To restart the learning phase, set the FTB function to *OFF,* terminate the menu with *STORE YES,* and then switch on the *LEARN* function again.

6.6 Digital input

- The digital input is used to suspend (freeze) measurements for a specific time.
- The last measured values in each case are present at outputs I and R and in the display.
- The digital input is also allowed for when the empty-tank spectrum is recorded.
- Marker 6 in the display shows that the digital input is active. No measurements are carried out, and the totalizer does not carry on counting.

7. Functional checks

7.1 BM 70 test functions

7.1.1 Main menu 2.0 Test functions

Fct. No.	*Text*	**Description** and setting
2.0	*TEST*	**Main menu 2.0 Test functions (Sect. 7.1)**
2.1	*TEST DISP.*	**Test of the display** (Sect. 7.1.2) → key: switch on all segments ↑ key: switch off all segments ↵ key: terminate test.
2.2.0	*CUR.OUTP. I*	**Test of curent output I** (Sect. 7.1.3)
2.2.1	*VALUE I*	**Display of actual value at current output in** *mA*
2.2.2	*TEST I*	**Test current output I** Safety interrogation: *SURE NO* *SURE YES* • *0 mA* • *4 mA* • *20 mA* • *2 mA* • *10 mA* • *22 mA* Select with ↑ key. Displayed value present directly at current output. Actual value again present at output after pressing ↵ key.
2.3	*REL. OUTP. R*	**Test of relay output R** (Sect. 7.1.4) Safety interrogation: *SURE NO* *SURE YES* • *OFF* (= relay contact open) • *ON* (= relay contact closed) Select with ↑ key. Relay contact adopts set state directly. Relay contact adopts actual state again after pressing ↵ key.

7.1.2 Test of display

- Select Function 2.1, as described in Sect. 4.2 and 4.3.
- Press → key to switch on all segments in the display.
- Press ↑ key to switch off all segments.
- This procedure (switching on/off) can be repeated any number of times with the ↑ key.
- Press the ↵ key to terminate the test.

7.1.3 Test of current output I

Fct. 2.2.1 *VALUE I*

- Select Function 2.2.1 as described in Sect. 4.2 and 4.3.
- Press the → key to display the actual value of the current output (terminals 31 and 32) in "mA".
- Press the ↵ key to terminate the test.

Fct. 2.2.2 *TEST I*

- A milliammeter must be connected to terminals 31 and 32 for this test, see Sect. 2.4.1.
- Select Function 2.2.2 as described in Sect. 4.2 and 4.3.
- Press the → key.
- Safety interrogation: *SURE NO* / *SURE YES* } select with ↑ key
- After *SURE YES*, press the ↵ key to display the 1st value in the following list.
- Select current value with ↑ key: *0 mA*, *2 mA*, *4 mA*, *10 mA*, *20 mA*, *22 mA*
- The milliammeter indicates the current value selected.
- Press the ↵ key to terminate the test and display the actual value again.

7.1.4 Test of relay output R

Fct. 2.3 *REL. OUTP. R*

- In this test the relay contact (terminals 41 and 42) may be either opened or closed.
- Select Function 2.3 as described in Sect. 4.2 and 4.3
- Press the → key.
- Safety interrogation: *SURE NO* / *SURE YES* } select with ↑ key
- After *SURE YES*, press the ↵ key:
- Display: *OFF* = relay contact open
- Press the ↑ key.
- Display: *ON* = relay contact closed
- Press the ↵ key to terminate the test; the relay contact then reverts to its actual state.

7.1.5 Display of firmware version

Fct. 2.4 ***FIRMWARE***
Under this function the current firmware version (e.g. BM 70 V. 2.21) is shown in the configuration menu.

7.2 Faults and symptoms during start-up and measurement

- Most of the faults and symptoms likely to occur with the BM 70 can be eliminated by consulting the following charts.
- For easy reference, faults and symptoms are divided into the following groups:
  Group D Display
  Group I Current output I
  Group DI Display and current output I
  Group M Markers 1 – 6 ▼ in the display
  Group R Relay output R
- Please go through these charts before contacting Krohne Service. Thank you!

Group D Display

No.	Fault / symptom	Cause	Corrective action
D1	Display totally "dead".	Power source switched off.	Switch on power source.
		Primary fuse F3 defective.	Change fuse F3 (see Section 8.2).
D2	Display flashes *"FATAL.ERROR"* shortly after power has been switched on.	BM 70 is defective.	Replace BM 70 signal converter (see Sect. 8.1).
D3	Display flashes *"MIN.VALUE"* or *"MAX.VALUE"* when numerical values are being set.	Set numerical value is outside acceptable setting range.	Note *MIN.* or *MAX.VALUE* displayed and set higher or lower numerical value.
D4	Display shows *"Fct. 4.0 PARAM.ERROR"*.	New data set are implausible (do not tally).	Press → key and set correct data under Fct. 4.1, 4.2, 4.3 and/or 4.4 (see also Sect. 4.3 and 5.1 et seq.).
D5	Display flashes *"SPECT.ERR."*.	New operating data do not tally with the stored spectrum if e.g. the vessel height (Fct. 3.1.1) and/or the antenna extension (Fct. 3.1.6) have changed.	Record new empty-tank spectrum – see Sect. 5.15 – (Fct. 3.5.1 and 3.5.2).
D6	Display flashes when in measuring mode.	An error has occurred.	Press ↑ key to display error. Rectify as described in Sect. 4.4.3.

Group I Current output I

No.	Fault / symptom	Cause	Corrective action
I1	Receiver instruments connected to current output indicate "zero".	Polarity (connection) of receiver instruments is incorrect.	Connect up correctly as described in Sect. 2.5.1.
		BM 70 current output board or receiver instruments defective.	Check current output (see Sect. 7.1.3): – All tests OK: check instruments and replace if necessary. – Test reveals fault: current output board defective; consult factory or replace BM 70 signal converter (see Sect. 8.1).
		"OFF" (= current output switched off) set under current output I, Fct. 3.3.1 *"FUNCTION I"*.	According to application, set *LEVEL, CONVERSION or DISTANCE* under Fct. 3.1.1 (see Sect. 5.6)
I2	2 or 22 mA present at current output.	An error has occurred.	Invoke Reset/Quit menu, see Sect. 4.2.2, for display of error list. Refer to Sect. 4.4.3 for cause and remedy. If error message not to be displayed via current output, set different range w/o error message as described in Sect. 5.6 (Fct. 3.3.2).
I3	Measured value at current output is incorrect but measured value in BM 70 display is correct.	Current output settings are incorrect.	Set current output correctly as described in Sect. 5.6 (Fct. 3.3.1–3.3.4).
I4	Current output (recorder) shows sinusoidal variations about the actually measured value (deviation approx. ± 2 cm or 1") in the upper part of the vessel (approx. 2 m or 6 ft).	This has physical reasons and occurs mostly with slow changes in the liquid level.	Avoid all sources of interference in the upper part of the vessel. A bigger antenna might help to solve the problem.

Group DI	Display and current output I		
No.	**Fault / symptom**	**Cause**	**Corrective action**
DI 1	Display and current output supply incorrect measured values.	Display and current output set incorrectly.	Set display (Fct. 3.2.1–3.2.4) and current output (Fct. 3.3.1–3.3.4) correctly as given in Sect. 5.5 and 5.6.
		An error has occurred, but display and current output are not set for error messages. Markers 1 – 6 ▼ are perhaps ON.	Invoke Reset/Quit menu, see Sect. 4.2.2, for display of error list. Refer to Sect. 4.4.3 for cause and remedy. If (also) one or more markers ▼ are ON, see Sect. 4.4.2.
DI 2	Display and current output do not react to level changes.	Digital input is activated, marker 6 ▼ is ON, measurement suspended (frozen).	Switch digital input off, see Sect. 2.5.2 and 4.4.2.
		Frothing in vessel, therefore inadequate reflectivity of liquid product, ε_R less than 4, see Sect. 10.3; in addition, marker 3 ▼ may also be ON.	On tall storage vessels, mount the BM 70 farther away from the vessel wall. Distance = greater than 1/3rd of vessel diameter, see Sect. 1.1.
DI 3	Display and current output indicate "zero" measured value, marker 5 ▼ is ON.	Vessel with dished bottom is more than 20% full. BM 70 mistakenly located in the "vessel bottom detection" range.	Switch BM 70 off for a short while, see also Sect. 4.4.2, marker 5 ▼. If unsuccessful consult factory.
DI 4	Display and current output indicate max. level but vessel is empty.	Vessel with dished bottom: BM 70 has stored incorrect or incomplete empty spectrum.	Record new spectrum – Sect. 5.15 (Fct. 3.5.1 and 3.5.2) or increase hold distance (Fct. 3.1.2) – see Sect. 5.3.
DI 5	Display and current output indicate the max. level frequently.	Excessive amounts of vapour, condensate or dust in vessel or heavy contamination (deposits thicker than approx. 3 – 7 cm or 0.1" – 0.3") of antenna.	Clean antenna (install cleaning device if necessary). If this measure unsuccessful, increase *HOLD DIST.* under Fct. 3.1.2, see Sect. 5.3.
		Antenna cleaning procedures cause strong reflections.	Activate digital input (marker 6 ▼ is ON), measurement suspended (frozen), see Sect. 2.4.2.
DI 6	Display and current output indicate sizeable step changes in the direction of maximum (possibly also minium) level.	Storage vessel: BM 70 installed centrically or on dome (manhole cover).	Change position of the BM 70; distance from vessel wall: approx. 1/3rd of vessel dia., see Sect. 1.1. Note installation conditions in Sect. 1.1! Or activate "identification of multiple reflections" under Fct. 3.5.5.
		Process vessel with extremely rough liquid product surface.	Activate history control under Fct. 3.5.4, see Sect. 5.14 and 5.13.
DI 7	Display and current output indicate step changes: during filling → upwards during emptying → downwards	Storage tank, smooth surface, steady filling or emptying procedure, incorrect vessel type set.	Set correct vessel type under Fct. 3.5.3, see Sect. 5.12.
DI 8	Display and current output indicate constant measured values although liquid level changes.	Vessel internals unfavourably positioned thus permanently simulating a constant level. No empty spectrum recorded and/or measurements carried out without empty spectrum.	Activate empty spectrum under Fct. 3.5.1 if measurement carried out without empty spectrum. If empty spectrum not recorded, record under Fct. 3.5.1 and 3.5.2, see Sect. 5.15.
		Digital input is activated, marker 6 ▼ is ON, measurement suspended (frozen).	Deactivate digital input, see Sect. 2.5.2 and 4.4.2.
DI 9	Display and current output indicate measured value at the level of agitator blades.	Vessel with "difficult" agitator blades.	Record new empty spectrum with *"MAX. VALUES"* under Fct. 3.5.1 and 3.5.2. Or change position of BM 70 on vessel, note conditions described in Sect. 1.1.
DI 10	Display and/or current output indicate incorrect converted value but level indication is correct.	Conversion table set incorrectly.	Reset conversion table under Fct. 3.7.1 and 3.7.2,see Sect. 5.8.
DI 11	Display and current output go suddenly to "zero" when vessel continuously topped up.	Liquid level located in range of hold distance in front of antenna, see Fct. 3.1.2 in Sect. 5.3.	Avoid this condition or, if empty spectrum is sufficiently good (Fct. 3.5.1 and 3.5.2), reduce hold distance (Fct. 3.1.2) – see Sect. 5.3.

Group M	Marker 1–6 ▼ in display		
No.	**Fault / symptom**	**Cause**	**Corrective action**
M1	Markers 1–5 ▼ (one or several) ON	Reference(s) to possible faulty measurements.	See Sect. 4.4.2 for significance of markers and elimination of possible faults.
M2	Marker 6 ▼ ON.	Digital input is activated, measurements suspended (frozen).	Deactivate digital input, see Sect. 2.5.2. and 4.4.2.
M3	Markers 3 and 4 ▼ ON. Level indication is "zero".	This is a status display and not an error. This usually occurs on vessels with dished bottom, when the vessel is empty, after the BM 70 has been switched on or after the empty spectrum has been re-recorded.	Fill vessel! Please also refer to Sect. 4.4.2.

Group R	Relay output R		
No.	**Fault / symptom**	**Cause**	**Corrective action**
R1	Relay output does not switch at the desired limit value (threshold) or does so in the wrong mode (make/break contact).	Relay function set incorrectly.	Set relay output correctly as described in Sect. 5.7 (Fct. 3.6.1 – 3.6.4).
R2	Relay output does not switch.	Relay output defective.	Check relay output acc. to Sect. 7.1.4: – Test OK: check setting and receiver instruments. – Test reveals fault: relay (output) defective. Consult factory or replace BM 70 signal converter (Sect. 8.1.).

7.3 Check of measured values (Error: *NO M.VALUE*)

- Error message: *NO M.VALUE*, see also Sect. 4.3.
- This error occurs if there is no valid measuring signal within a **time t_a**.
- Once a valid measuring signal is present, it must be so for a **time t_b** before it is available as a measured value in the display and at the current output.
- This rules out the possibility of any chance interference signal, occurring after the "disappearance" of the measuring signal, being immediately accepted as a valid measuring signal.
- Times t_a and t_b in minutes are calculated as follows:

$$t_a = 3 \times t_b \qquad t_b = \frac{h_t - d_s}{V_{nl}}, \text{ minimum of 2.43 minutes}$$

where:
h_t = vessel height in m, Fct. 3.1.1 (e.g. 5.00 m)
d_s = safety clearance in m
= antenna type (length) + antenna extension + hold distance
Fct. 3.1.5 (e.g. type 3 ≙ 0.22 m) + Fct. 3.1.6 (e.g. 0.1 m) + Fct. 3.1.2 (e.g. 0.1 m)
V_{nl} = max. tracking speed in m/min, Fct. 3.1.4 (e.g. 0.5 m/min)

- Therefore, using the above figures:

$$t_a = 3 \times t_b = 3 \times 9.16 \text{ minutes} = 27.48 \text{ minutes}$$

$$t_b = 1 \times \frac{5 \text{ m} - (0.22 \text{ m} + 0.1 \text{ m} + 0.1 \text{ m})}{0.5 \text{ m/min}} = 9.16 \text{ minutes}$$

8.0 Service

8.1 Replacement of the BM 70 signal converter

Order No. of signal converter: refer to Sect. 9.3.

Always switch off power source before commencing work!

Hazardous-duty systems
Before replacing the signal converter in hazardous areas make absolutely certain that there is no explosion hazard (gas-free certificate). Allow the prescribed waiting time of 10 minutes for BM 70 Ex (50 minutes for the BM 70-Ex Nautic) to elapse before opening the housing.

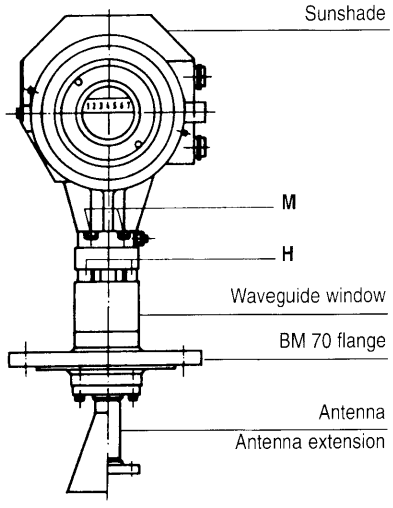
1. Unscrew cover from terminal compartment using the special wrench. If a sunshade (option) is fitted, remove this first.
2. Disconnect all cables from the terminals, see Sect. 2.
3. Remove the 4 Allen screws **M** (Allen key size 4 mm for BM 70 Standard and key size 10 mm for BM 70-Ex Nautic) and lift off.
4. Install the new BM 70 signal converter.

CAUTION
On pressurized vessels, do not on any account remove the 4 screws **H** which connect the waveguide window to the BM 70 flange. DANGER!

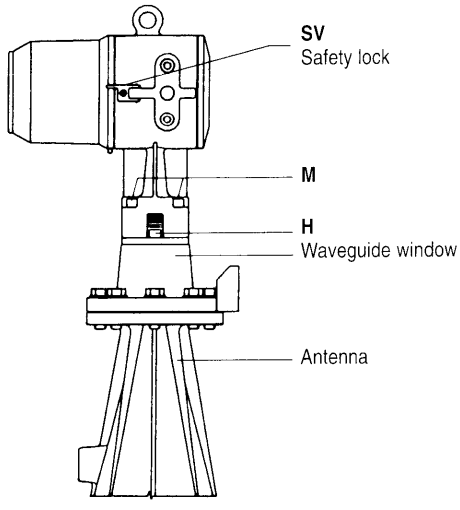
5. Check power voltage and fuse(s) (instrument nameplate) and change or replace if necessary, see Sect. 8.2.
6. Reconnect all cables in the terminal compartment as described in Sect. 2.
7. Check against the attached report on settings whether the factory-set parameters are correct for your application. If not, reset the parameters as described in Sect. 4 and 5.
8. Record the empty spectrum, see Sect. 5.15.

Important: Ensure that the screw thread of the covers on the terminal and electronic compartments is well greased at all times.

BM 70 Standard



BM 70-Ex Nautic



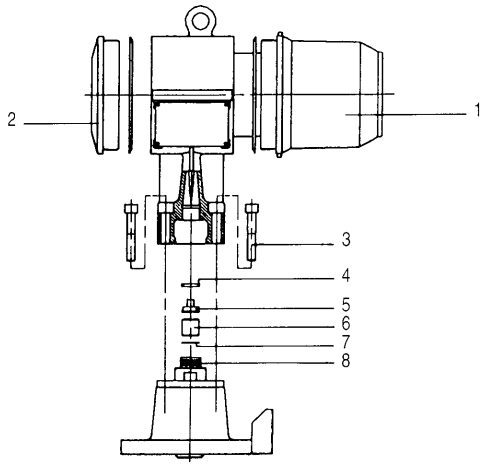
8.2 Dismantling the signal converter BM 70-Ex Nautic

Always switch off power source before commencing work!!

Hazardous-duty systems
Before opening the "flameproof enclosure" in the hazardous area, make absolutely certain that there is no explosion hazard (gas-free certificate). Allow the prescribed waiting time of 50 minutes for the BM 70-Ex Nautic to elapse first.

1. Detach safety lock **SV**, see Sect. 8.3, with Allen key (4 mm size).
2. Cap (1) and cover (2) can be unscrewed with a special wrench (supplied).
3. Remove Allen screws (3) with a size 10 mm Allen key.
4. The gasket (4) and PTFE plug (5) can be removed from the "neck" of the BM 70 signal converter.
5. Remove the glass plug (6) and PTFE washer (7) from the perforated ring (8).
6. Order numbers for spare parts shown on the right.
7. Reassemble in reverse order, Points 5 to 1.

Important: Ensure that the screw thread of cap (1) and cover (2) is always well greased.



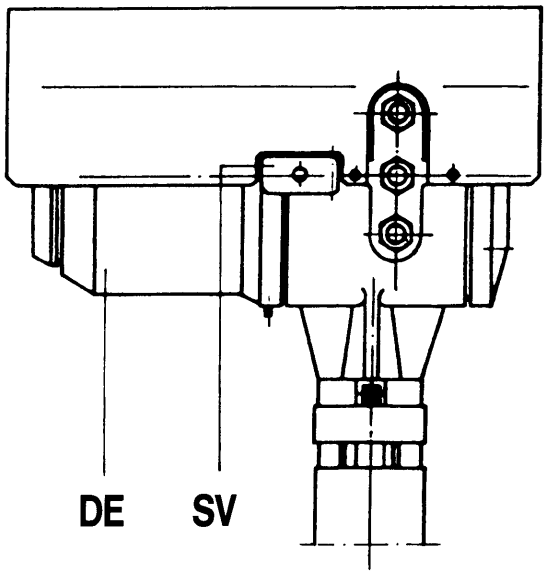
		Order No.
1.	Cap	2.10280.01
2.	Cover	3.14963.01
3.	Screws M 12x70	5.04944.00
4.	Gasket	3.15186.01
5.	PTFE plug	3.14530.01
6.	Glass plug	3.14742.01
7.	PTFE washer	3.14744.01
8.	Perforated ring	

8.3 Change of operating voltage and replacement of power fuse

Always switch off power source before commencing work!

Hazardous-duty systems
Before opening the "flameproof enclosure" in the hazardous area, make absolutely certain that there is no explosion hazard (gas-free certification). Allow the prescribed waiting time of 10 minutes, or 50 minutes for the BM 70-Ex Nautic, to elapse first.

1. Remove sunshade, if fitted.
2. Detach safety lock **SV** using Allan key (SW 4).
3. Remove cover **DE** from the electronic compartment (flameproof enclosure) with special wrench.



4.1 Replacement of power fuse(s)

For location of the fuse(s), refer to drawings of the "line" circuit board: AC version, Sect. 9.1, fuse **F3**
DC version, Sect. 9.2, fuses **F1+F2**

Voltage		Rating	Order No.
F3:	200/220/230/240 V AC	T 0.16/250 G	5.07379
	110/120 V AC	T 0.315/250 G	5.05804
	100 V AC	T 0.4/250 G	5.05892
	42/48 V AC	T 0.8/250 G	5.08085
	21/24 V AC	T 1.6/250 G	5.07823
F1+F2: 24 V DC		T 2/250 G	5.08452

4.2 Change of operating voltage, AC version

Transpose voltage select cable **E** on "line" circuit board, see drawing in Sect. 9.2, 9.3 to obtain the desired voltage. For 230 V AC, use the 240 V AC winding. If necessary, change power fuse **F3** to suit the new voltage. For ratings, refer to Table under Point 4.1 above.

5. Reassemble in reverse order, Points 3 to 1.

Important: Ensure that the screw thread of cover **DE** on the electronic compartment is well greased at all times.

8.4 Cleaning the antenna

Particular process applications can cause severe contamination of the antenna. Microwaves cannot be emitted or received if reflected off deposits on the antenna. In such cases, the BM 70 will usually indicate maximum level (volume) or minimum distance.

The level of contamination at which such an error occurs depends firstly on the liquid product concerned, and secondly on the reflection index, which is mainly determined by the relative permittivity ε_R.

Regular cleaning is advisable if the liquid product has a tendency to form deposits, etc.

When spraying, washing down or cleaning with mechanical aids, take special care not to damage either the horn antenna or the Teflon plug below the waveguide window (see Sect. 1.4 "field assembly of the BM 70"). If cleaning agents are used, take material resistance into account.

8.5 Replacement of antenna and antenna extension

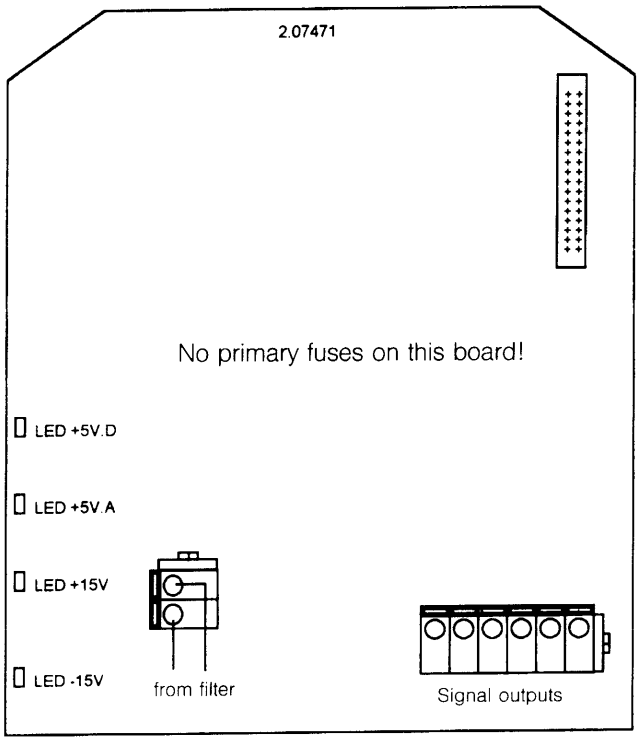
In cases of extreme contamination, corrosion or caking deposits formed by the product, or if damaged, it may be necessary to replace the antenna and/or antenna extension. Replace as described in Sect. 1.4 "field assembly of the BM 70".

8.6 Visual inspection of the "flameproof enclosure"

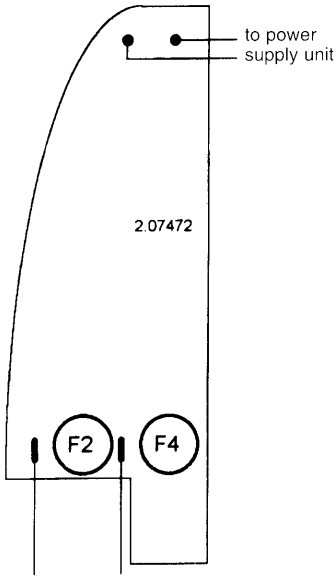
Hazardous-duty systems
Within the scope of routine checks required to be carried out on systems operated in hazardous areas (maintaining the system in good working order), the "flameproof enclosure" (large cover on signal converter) should also be visually inspected for external damage and signs of corrosion.
Before opening the "flameproof enclosure" in the hazardous area to inspect the inside, make absolutely certain that there is no explosion hazard (gas-free certificate). Allow the prescribed waiting time of 10 minutes, or 50 minutes for the BM 70-Ex Nautic, to elapse first.

9. Connection and operating points on the circuit boards, and Part No.

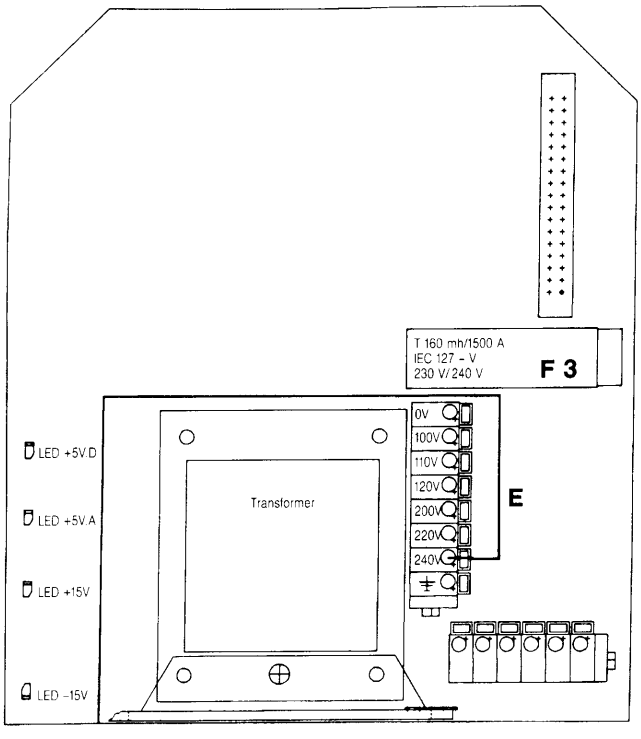
9.1 24 V DCAC power supply circuit board



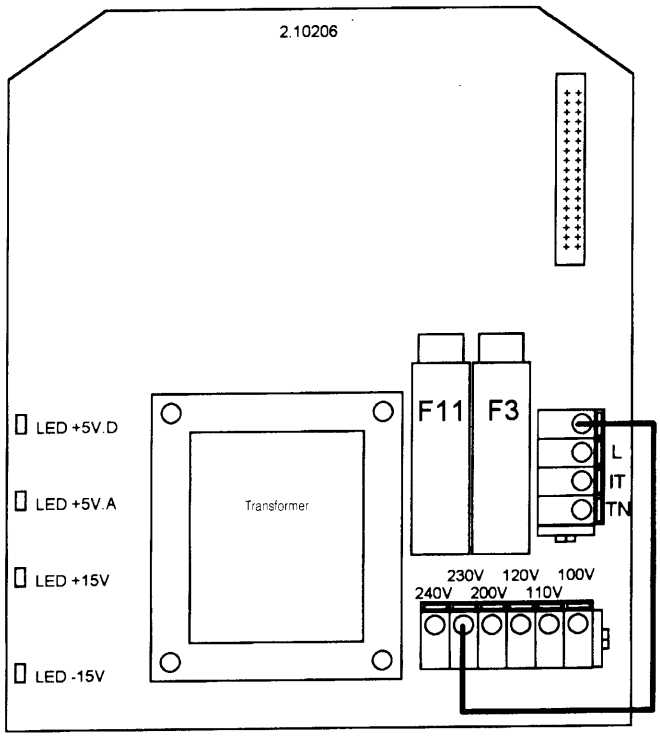
24 V DCAC filter board
(behind cover plate at edge of housing)



9.2 AC power supply circuit board for version with standard current output, relay input and digital input



9.3 AC power supply circuit board for versions with RS 485 or Ex-i current output



9.4 Part numbers

BM 70 signal converter, complete

Version	Power supply	
	24 V DC/AC	100 to 240 V AC
BM 70 (current output)	2.10754.00	2.10749.00
BM 70 i (Ex-i current output)	2.10759.00	2.10752.00
BM 70 (RS 485)	2.10756.00	2.10750.00
BM 70 US current output	2.10353.00	2.10352.00
BM 70 US i (Ex-i current output)	_	2.10752.00.90
BM 70 US (RS 485)	_	2.10400.00
BM 70 Nautic (current output)	2.10755.00	_
BM 70 i Nautic (Ex-i current output)	2.10760.00	2.10753.00
BM 70 Nautic (RS 485)	2.10757.00	2.10751.00

Please specify voltage required!

Line fuses		**Rating**	**Order No.**
F3 (F11) für	230 (240), 220, 200 V AC	T 0.16/250 G	5.07379
	120, 110 V AC	T 0.315/250 G	5.05804
	100 V AC	T 0.4/250 G	5.05892
	48/42 V AC	T 0.8/250 G	5.08085
	24/21 V AC	T 1.6/250 G	5.07823
F1 + F2 (F4) for	24 V DC	T 2/250 G	5.08452

Antenna type 3, stainless steel 1.4571 (316 Ti)	2.04880.01
Antenna type 4, stainless steel 1.4571 (316 Ti)	2.10142.01
Antenna extension, stainless steel 1.4571 (316 Ti)	
Length 100 mm or 4 inches	2.04881.01
Length 200 mm or 8 inches	2.04881.02
Strap retainer for DN 150 or 6" flanges	2.04940.03
Strap retainer for DN 200 or 8" flanges	8.12253.01
Microwave shielding strip for DN 150 or 6" flanges	5.08443.03
Housing cover for electronics compartment (cap at front)	
Standard	2.10001.02
Hazardous-duty version (flameproof enclosure)	2.10001.03
Nautic version	2.10280.01
Gasket for housing cover	3.14482.01
Special wrench for housing cover	3.07421.01
Bar magnet	2.07053
Circuit boards	
PCB – 24 V DCAC power supply (for all versions)	2.10741
PCB – 100 to 240 V AC power supply, for BM 70 with RS 485 or Ex-i current output	2.10739
PCB – 100 to 240 V AC power supply, for BM 70 with standard current output, relay input and digital input	2.10740
PCB – filter, 24 V DCAC	2.07472
PCB – filter, 100 to 240 V AC	2.10090
CPU board	2.10735
PCB – current output	2.10211
PCB – RS 485 interface	2.10308
Display unit	2.10203
Microwave unit	2.10094
Microwave unit, US version	2.10326

Part D Technical data, operating principle, approvals

10. BM 70 Technical data

10.1 Mechanical and electrical data

Level measuring system	for closed metal process and storage tanks, incl. those with agitators or small internals, and for stilling wells and side vessels (communicating pipes)
Product	liquids, pastes and slurries, incl. those with foaming tendency; note reflection characteristics of tank product. Solids: information supplied on request and after verification of application
Measured variables and units	
Level	m, cm, mm, inches, feet, %
Distance (free tank space)	m, cm, mm, inches, feet, %
Conversion	m^3, litres, US gallons, petroleum barrels, %
Tank height (measuring range)	0.5 to 35 m (1.64 to 114.83 ft)
Measuring accuracy	± 1 cm (± 0.4") for measuring distance 1 to 3.3 m (3 – 10.8 ft); ± 0.3% for measuring distance > 3.3 m (> 10.8 ft) at reference conditions (see Sect. 10.2)
Change in liquid level	0.01 to 5 m/min or 0.04" to 197"/min (tracking speed)
Max. allowable operating pressure PB	– 1 bar (vacuum) to 40 bar (580 psig), dependent on flange pressure rating, Nautic cast steel antenna: – 1 to 10 bar (vacuum to 145 psig)
Operating temperature at flange	– 20 to + 150°C (– 4 to + 302°F)
Ambient temperature signal converter	
Standard	– 20 to + 60°C (– 4 to + 140°F)
Hazardous-duty version	– 20 to + 50°C (– 4 to + 122°F)
Nautic Ex version	– 20 to + 60°C (– 4 to + 140°F)
Operating range	– 40 to + 70°C (– 40 to + 158°F)
Current output I (Standard)	(not in conjunction with RS 485)
Function	level, distance or volume, and error identification, galvanically isolated from all inputs and outputs
Current	0 – 20 mA or 4 – 20 mA; with or without error message at 2 mA or 22 mA
Load	≤ 700 ohms up to 20 mA; ≤ 500 ohms with 22 mA error message
Relay output R	(only in conjunction with standard current output)
Function	suitable as upper or lower limit switch for liquid level, distance or volume, for error message or as status display, galvanically isolated from all inputs and outputs
Type of contact	1 N/C contact
Contact rating	max. 24 V DC/AC; 1 A
Digital input	(only in conjunction with standard current output)
Function	suspends (freezes) measurements. Last measured values then present at the outputs and shown in display, galvanically isolated from all inputs and outputs
External voltage	5 to 24 V DC
Internal resistance	≥ 1 kohm
Ex-i current output (in preparation)	(without relay output, digital input or RS 485)
Function	level, distance or volume, and error identification, galvanically isolated from all inputs and outputs, operable in active (source) mode or passive (sink) mode
Current	4 – 20 mA; with or without error message 2 mA or 22 mA
Temperature drift	≤ 100 ppm / K
Load (active mode)	≤ 500 ohms
No-load voltage (active mode)	≤ 20 V
Terminal voltage (passive mode)	min. 4 V, max. 40 V
Internal impedance	≥ 100 kohms, parallel ≤ 5 nF (@ 0.5 – 10 kHz)
smart/HART interface	modulated output current (1 mApp) in accordance with HART® specifications

RS 485 interface	(without current output, relay output or digital input)
Function	both-way communication for measured-value and status inquiry, and for configuration of the measuring system; galvanically isolated
Transmission rate	1200, 2400, 4800, 9600 or 19200 bauds (8 data bits, even parity, 2 stop bits)
Address coding	0 to 239
Krohne protocol	standard communications protocol for the RS 485 interface
Modbus/PROFIBUS	aside from the Krohne protocol, Modbus or PROFIBUS protocols can also be supplied
Power supply	
24 V DCAC (standard)	24 V DC (+30%/-25%) (18 – 31,2 V DC) any polarity or 24 V AC (45 – 66 Hz) (+10%/-25%) (18 – 26,4 V AC), short-time +20% (1.5 sec)
Power consumption	approx. 10 W
230 V AC	230 V AC (48 – 63 Hz) (+10%/-15%) (196 – 253 V AC) optionally 100, 110, 120, 200, 220 or 240 V AC (+10%/-15%)
Power consumption	approx.: 12 VA
Microwaves	
Application information	only for use in closed metal or concrete vessels (condition imposed by PTT approval), no health hazard (≤ 60 µW/cm² with type 3 antenna)
Frequency range	X-band, 8.1 – 9.4 GHz (FCC version: 8.5 – 9.9 GHz)
General approvals	FTZ No. G490 353X (use exempt from individual approvals and licensing fees) other approvals: see Sect. 12
Antenna radiation angle	Type 3: ± 8°, Type 4: ± 6°
Hazardous-duty versions	
To European Standard	EEx de IIC T3, T4, T5 or T6 or EEx de [ia] T6 ... T3, approved for mounting on vessels containing flammable liquids of dangerous materials classes AI, AII, and B (Zone 0), PTB No. Ex-90.C.1067X (standard) and PTB No. Ex-93.C.1061X (Nautic)
FM (Factory Mutual)	Class I, Division 1, Groups B, C, D; Class II/III, Division 1, Groups E, F, G
Operator control (standard)	
Keypad	3 keys
Local display	
Type	3-line illuminated LCD 1st (top) line: 8-character, 7 segments for numerals and signs 2nd (middle) line: 10-character, 14 segments for texts 3rd (bottom) line: 6 markers for reference to functions
Function	actual measured value and error output; parameter setting
Plain text language	German, English, French (HART®: English only)
Magnetic sensors	same function as the 3 keys: operation by means of hand-held bar magnet without opening the housing
smart interface	(incorporated in BM 70 as standard)
Operator control	with RS 232 interface module and PC-CAT software for MS-DOS (see Sect. 5.6, 5.7.4, 6.2) or with MIC 500 hand-held communicator (see Sect. 5.6, 6.2)
Signal characteristics	FSK voltage signals 1.2/2.2 kHz superposed on current output
Electrical connection	to the terminals of the current output, also in parallel with DCS (digital control system) and receiver instruments without affecting their function
Distance	max. 1000 m (3280 ft) between BM 70 and MIC 500 or PC
HART communication	(firmware option)
Signal characteristics	FSK signals 1.2/2.2 kHz, superposed on current output
Topology	a) point-to-point connection between BM 70 and HART® control unit (with standard or Ex-i current output) b) multidrop bus with max. 15 devices, operated in passive mode (only in conjunction with Ex-i current output)
Operator control	with universal HART® control unit or HART® communications system, if necessary via HART®-compatible Ex-i isolating transformer

Antenna	
Type 3 (standard)	for process and storage tanks
Type 4	for severe operating conditions, e.g. foaming or tank height > 12 m (39 ft) or $\varepsilon_R < 4$
Type 5	for Wave-Stick
Type 1 and Type 2	for stilling wells and reference vessels
Type 0 (Nautic cast steel antenna)	for welding into or flange-mounting on ship's deck
Connecting flanges	
... to DIN 2501	
Standard	DN 150/PN 16, Form C (to DIN 2526)
Special version	DN 80, DN 100, DN 200 / PN 6 to PN 40, Form C or other
... to ANSI B 16.5	3" to 8", Class 150 lbs or 300 lbs, RF
Wave-Stick	DN 50, DN 80, DN 100, DN 150 (2" to 6") Dairy screw connection to DIN 11851 (Tri-) clamp connection to ISO 2852
Housing	
Design	electronics compartment in flameproof enclosure, with separate terminal compartment
Protection category to EN 60529	
Standard version	IP 65, equivalent to NEMA 4 and 4X
Nautic version	IP 67
Environment class	to DIN 40040
Standard version	HUD (ambient temperature – 25 to + 60°C (– 13 to + 140°F), relative humidity ≤ 80% annual mean)
Hazardous-duty version	HWD (ambient temperature – 25 to + 50°C (– 13 to + 122°F), relative humidity ≤ 80% annual mean)
Nautic version	Ambient temperature – 25 to + 55°C (– 13 to + 131°F), relative humidity ≥ 95% annual mean
Materials	
Housing	
Standard version	aluminium with electrostatic powder coating
Nautic version	stainless steel 1.4581 (DIN 17445) (window cover 1.4571 [316 Ti])
Antenna *	
Standard version	stainless steel 1.4571 (316 Ti)
Nautic version	stainless steel 1.4435 (316 L)
Option (not for BM 70-Ex Nautic)	Hastelloy C4 or B2, tantalum, titanium, others on request
Antenna extension *	
Standard	stainless steel 1.4571 (316 Ti)
Special version	Hastelloy C4
Connecting flange	
Standard version	stainless steel 1.4571 (316 Ti)
Nautic version	stainless steel 1.4435 (316 L)
Option	Hastelloy C4, B2 coated, titanium coated, tantalum coated, others on request
Waveguide *	quartz glass and PTFE
Device-internal gasket *	Viton, FFKM, Kalrez 2035 or FEP-coated

* These BM 70 components may come into contact with the liquid product

Temperature classes BM 70-Ex

Provided that the temperature does not exceed 70°C or 158°F at the cable entry, 80°C or 176°F at the connecting parts (terminals), and 80°C or 176°F at the pin coupler, the maximum surface temperature at the vessel mounting flange and waveguide window is defined by the temperature class established for the installation location. In other words, the instrument has the temperature class T6 irrespective of the product temperature, provided the surface temperature at the vessel mounting flange does not exceed 85°C or 185°F:

If the temperature at the vessel mounting flange is not known, or if the maximum surface temperature of the vessel mounting flange is the same as the product temperature, the instrument has the following temperature classes:

Temperature class	Surface temperature	Product temperature
T6	≤ 85°C/≤ 185°F	any

Temperature class	Product temperature
T6 ... T1	≤ 85°C / ≤ 185°F
T5 ... T1	≤ 100°C / ≤ 212°F
T4 ... T1	≤ 135°C / ≤ 275°F
T3 ... T1	≤ 150°C / ≤ 302°F

Temperature classes BM 70-Ex Nautic

Subject to the temperature at the reference point (junction between reinforcing rib and signal converter housing) not exceeding a value of T_{ref} = 70°C (158°F), the maximum surface temperature at the vessel mounting flange and waveguide window is determined by the temperature class applicable to the installation location.
In other words, the temperature of the tank product can be arbitrarily high provided the surface temperature at the vessel mounting flange does not exceed 85°C (185°F) and the temperature at the reference point does not exceed a maximum of 70°C (158°F). This could be the case when the liquid level is far below the vessel mounting flange or when always at the maximum filling level. Accordingly, the temperature will then amount to

- not more than 70°C (158°F) at the cable entries
- not more than 80°C (176°F) at the connections (terminals)
- not more than 100°C (212°F) at the pin coupler.

Temperature class	Surface temperature	Product temperature
T6	≤ 85°C/≤ 185°F	any

Where the temperature at the vessel mounting flange is not known or if the maximum surface temperature of the mounting flange is equal to the product temperature, the following temperature classes apply to the instrument:

Temperature class	**Max. product temperature**							
	Tu = 40°C (104°F)		Tu = 50°C (122°F)		Tu = 55°C (131°F)		Tu = 60°C (140°F)	
	Tm in °C	Tm in °F	Tm in °C	Tm in °F	Tm in °C	Tm in °F	Tm in °C	Tm in °F
T_6 ... T_1	85	185	85	185	85	185	75*	167*
T_5 ... T_1	100	212	100	212	100	212	75*	167*
T_4 ... T_1	135	275	135	275	115*	239*	75*	167*
T_3 ... T_1	150*	302*	150*	302*	115*	239*	75*	167*

Tu = ambient temperature
Tm = product temperature
* limited for operational reasons

10.2 Error limits

Reference:

Antenna:
Type 3

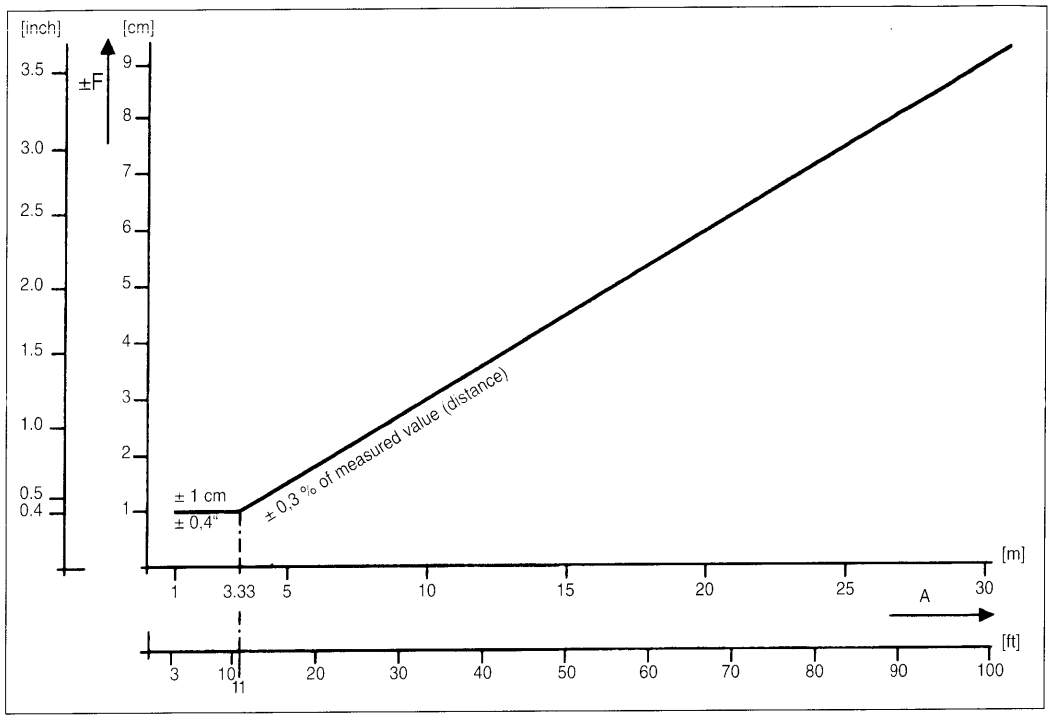
Tank product:
water, smooth surface

Product temperature:
20 °C (68 °F)

Ambient temperature:
20 °C (68 °F)

Vessel diameter:
> 5 m (16.4 ft)

Measuring error ± F
absolute error in cm (inches)
Distance A in metres (feet),
between tank fitting
(top edge of flange)
and product surface

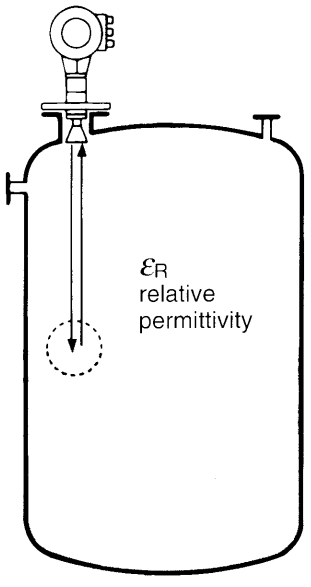


10.3 Reflection characteristics

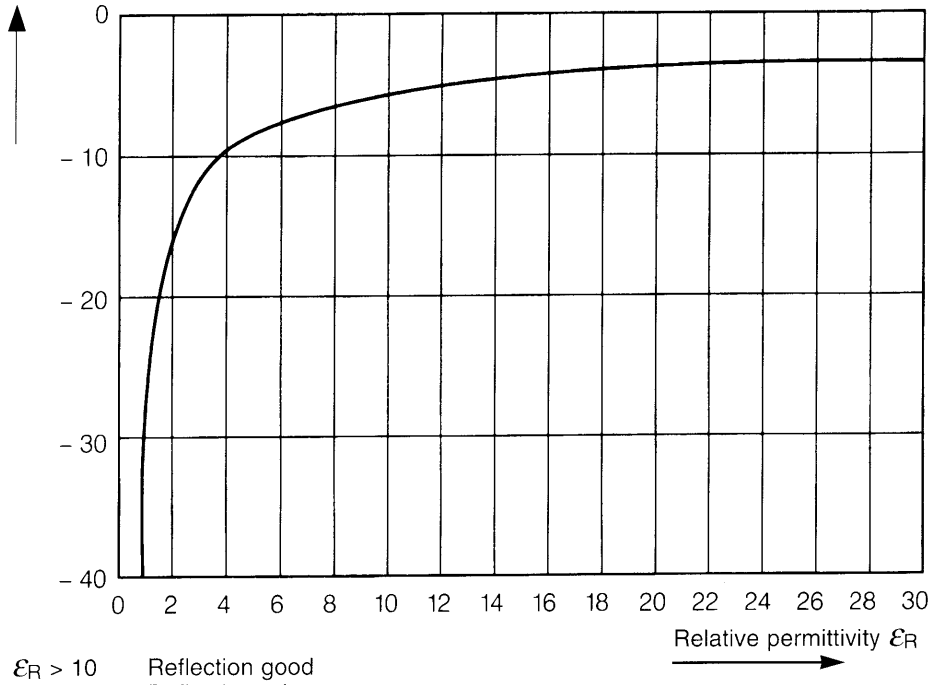
The strength of the reflected effective signal depends mainly on the relative permittivity ε_R of the tank product. Relative permittivity is affected by temperature variations and transmitting frequency.

The unreflected portion of the emitted signal passes into, or is absorbed by, the liquid and cannot be utilized as an effective signal.

Reflection at the atmosphere/product interface



Return loss
[dB]

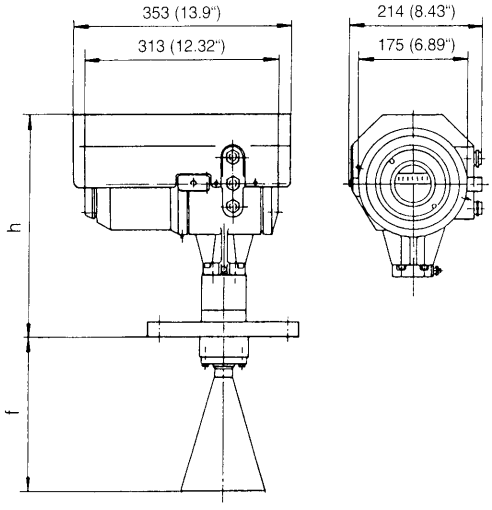


ε_R > 10 Reflection good
ε_R > 4 – 10 Reflection adequate
ε_R < 4 Reflection poor
Check application by performing reflection test with testing device

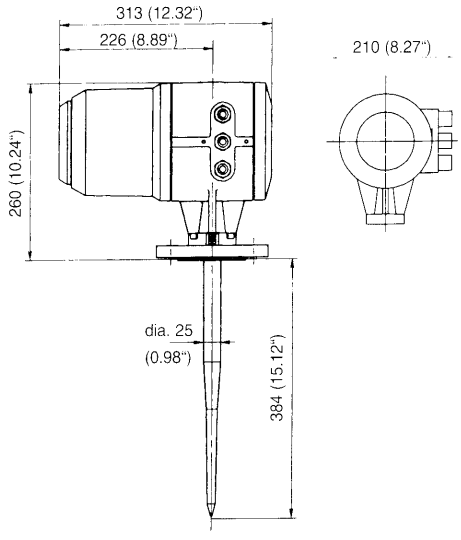
10.4 Dimensions and weights

Dimensions in mm and (inches)

BM 70 Standard



BM 70 Wave-Stick

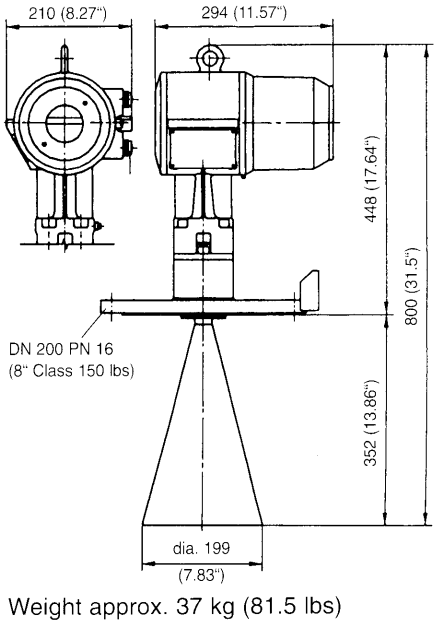


Flange connections to:
DIN 2501 (= BS 4504) DN 80 – DN 150 / PN 16 or 40
DIN 2501 (= BS 4504) DN 200 / PN 10 or 16
ANSI B 16.5 / 3" to 8" / Class 150 or 300 lbs, RF

Nominal size to ...			**Dimensions** in mm and (inches)				approx. **Weight** in	
DIN (BS)		**ANSI**	Stainless steel 1.4571 or SS 316 Ti		Hastelloy C4			
DN mm	PN	inches	f	h	f	h	kg	lbs
80	16	3	125 (4.92)	400 (15.75)	134 (5.28)	380 (14.96)	20	45
100	16	4	166 (6.54)	400 (15.75)	175 (6.89)	380 (14.96)	21	47
150	16	6	253 (9.96)	400 (15.75)	262 (10.31)	380 (14.96)	26	58
200	16	8	384 (15.12)	400 (15.75)	398 (15.67)	380 (14.96)	33	74

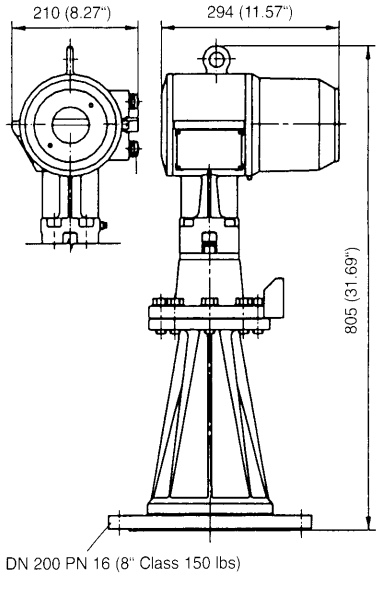
BM 70-Ex Nautic

Variant A
Standard, flange DN 200 (8")



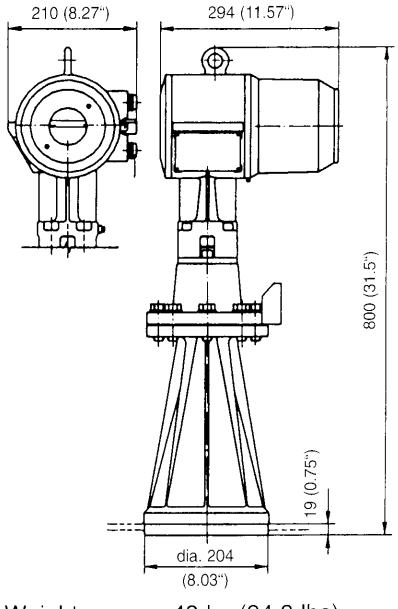
Weight approx. 37 kg (81.5 lbs)

Variant B
Cast steel antenna with flange DN 200 (8")



Weight approx. 53 kg (116.8 lbs)

Variant C
Cast steel antenna for welding to tank



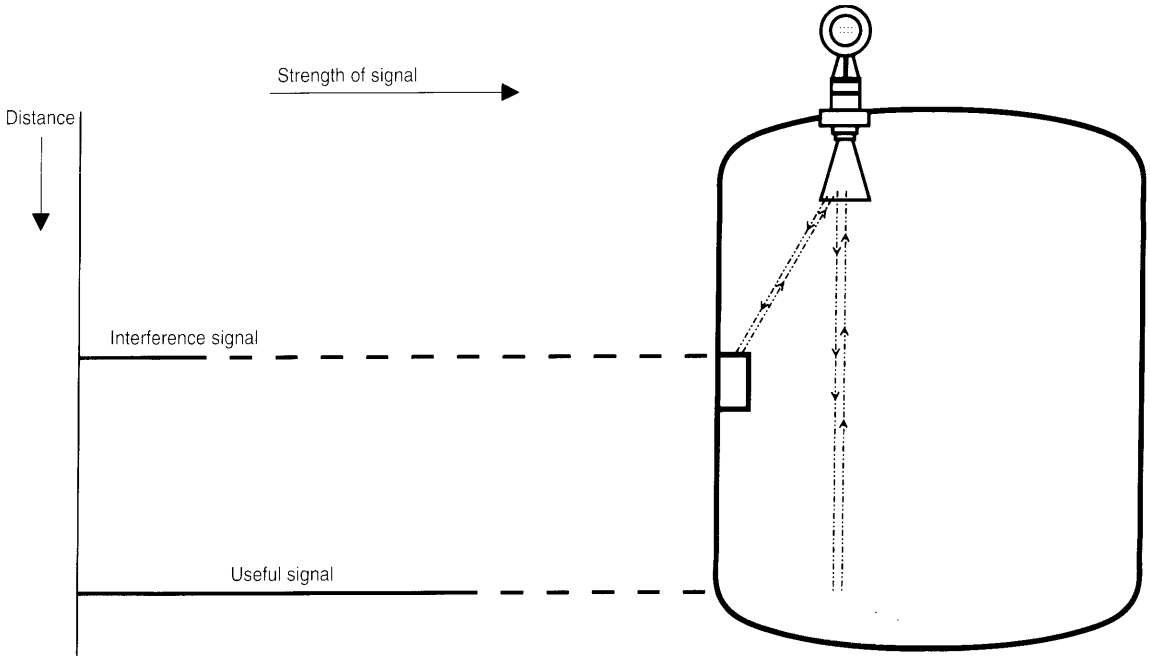
Weight approx. 43 kg (94.8 lbs)

11. Operating principle

A radar signal is emitted via an antenna and reflected from an object (e.g. product surface), and the reflected signal is received after a time interval t_O. The microwaves propagate at the velocity of light c (300 000 km/s) largely independent of the atmosphere above the product even under vacuum conditions.
The measuring distance

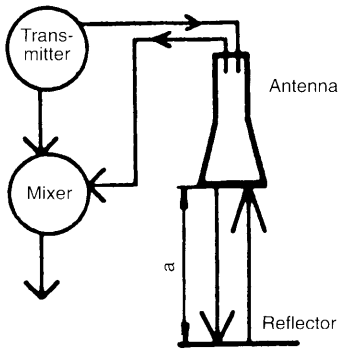
$a = \frac{t_O}{2c}$ is calculated from time interval t_O.

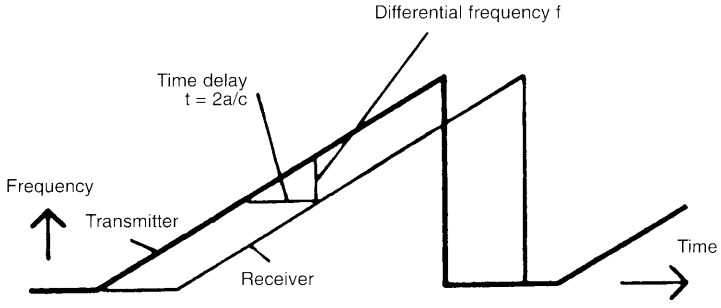
The filling level is obtained from the difference between tank height and distance.
In the FMCW radar process used, the signal frequency is proportional to the reflector distance. Further evaluation is performed by digital signal processing, which provides a simple means of distinguishing between signals from interference reflectors and the useful signal.



FMCW radar principle and FFT signal evaluation

Microwaves are high-frequency electromagnetic waves above 1 GHz, which propagate at the speed of light (c = 300 000 km/s) in a vacuum and in gases. In a radar system, the distance of a target is measured by way of the transit time of a microwave signal: from transmission by an antenna via the reflection from the target to reception by an antenna. For every metre from a target the waves travel a distance of 2 m (6.56 ft), for which they require a time of 6.7 ns.
The FMCW radar system generally uses a linear frequency-modulated high-frequency signal.

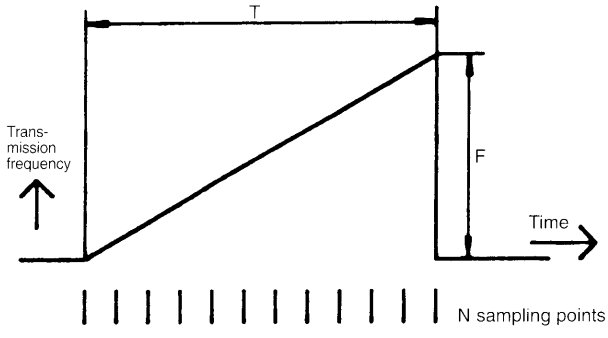


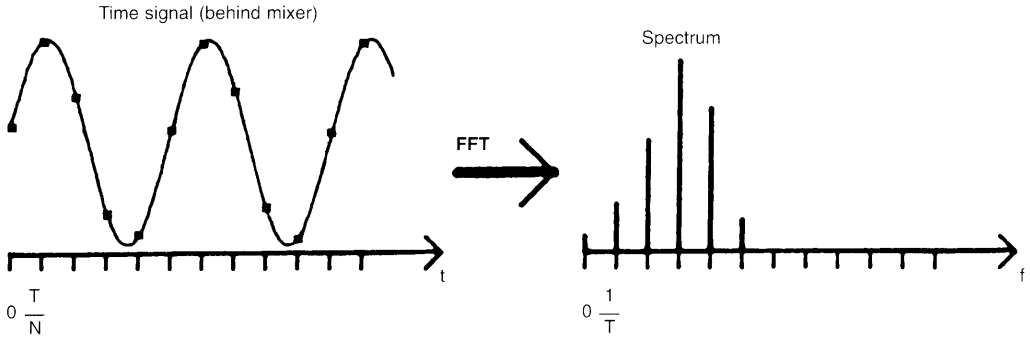


Since the transmission frequency changes due to the time delay occurring during signal propagation, a low-frequency signal, the frequency f of which is proportional to the reflector distance a, is obtained from the difference between the current transmission frequency and the received frequency:

$$f = F/T \cdot 2a/c$$

The signal is evaluated by digitizing the low-frequency signal and discrete Fourier transformation (FFT) in the frequency range.





12. Official approvals

Application	Approved by	Device version	Certification
Explosion protection	PTB	BM 70-Ex	Ex-90.C.1067X
EEx de IIC T3-T6 AI, AII, B (Zone 0)	PTB	BM 70-Ex Nautic	Ex-93.C.1061X
	NEMKO	BM 70-Ex Nautic	Ex 93 C.361
	FM (USA)	BM 70-Ex	J.I OW 8A5.AE
	RIIS (Japan)	BM 70-Ex	granted Dec. 1992
	CSA (Canada)	BM 70-Ex	LA 3000-7159
EEx de [ia] IIC T6	PTB	BM 70 i	Ex-90.C.1067X Ex-93.C.1061X
Radio approvals	Germany: FTZ		Z-G490 / 353X
	Austria		PTE
	Belgium		pending
	Britain: DTI		licence
	Canada: DOC		currently no approval required
	China		currently no approval required
	CIS		currently no approval required
	CS/SR: PROVALENE STP		to hand
	Denmark: TELESTYRELSEN		to hand
	Finland		currently no approval required
	France: PTE		to hand
	Hungary		currently no approval required
	Ireland: DWV/BIE		to hand
	Israel		currently no approval required
	Italy: PPTT		to hand
	Japan		currently no approval required
	Netherlands: HDTP		to hand
	Norway		FTZ approval accepted
	Poland: ZASTEPCA-PREZESA		to hand
	South Africa:		SABS
	Sweden: TELEVERKET-RADIO		to hand
	Switzerland: SEV		to hand
	USA: FCC		Licence IH5 BM 70
General certificates	American Bureau of Shipping		94 BE 5119
	Bureau Veritas		3741/5528/A00-H
	China Classification		Type approval pending
	Det Norske Veritas		A-5119
	Germanischer Lloyd		89906-94 HH
	GOS-Standard (CIS)		T 3889-94
	Lloyds Register		94/00055
	Nippon Kaiji Kyokuil		94 LG 002
	Register of Shipping (CIS)		Type approval pending
	Registro Italiano Navale		Type approval pending

12.1 (Post Office) Approvals

FTZ-Zulassung
Original German text

Fernmeldewesen

Vfg 1117/1989
Allgemeingenehmigung Nr. 353 für Sende- und Empfangsfunkanlagen

1. Das Errichten und Betreiben der Sende- und Empfangsfunkanlage „BM 70 Level Radar" sowie „BM 70 – Ex Level Radar" der Firma KROHNE Meßtechnik GmbH & Co. KG, 4100 Duisburg, für Fernwirkzwecke (Füllstandsmessungen in Metalltanks) auf einer Frequenz im Frequenzbereich 8.1 – 9.4 GHz, wird aufgrund der §§ 1 und 2 des Gesetzes über Fernmeldeanlagen in der Fassung der Bekanntmachung vom 3. 7. 1989 hiermit genehmigt. Die Funkanlagen dürfen nur innerhalb allseits geschlossener Metalltanks betrieben werden.
2. Andere Fernmeldeanlagen und Telekommunikationseinrichtungen, die öffentlichen Zwecken dienen, sowie Funkanlagen dürfen nicht gestört werden.
3. Funkanlagen, die unter den vorgenannten Typenbezeichnungen in den Verkehr gebracht werden, bedürfen keiner besonderen Genehmigung im einzelnen, wenn sie mit den beim Zentralamt für Zulassungen im Fernmeldewesen (ZZF) technisch geprüften Baumustern elektrisch und mechanisch übereinstimmen und mit dem Zulassungszeichen der Deutschen Bundespost wie folgt: „Postsignum Z G490353X" sowie mit dem Namen der Firma KROHNE Meßtechnik GmbH & Co. KG, 4100 Duisburg, und der Typenbezeichnung „BM 70 Level Radar" bzw. „BM 70 – Ex Level Radar" gekennzeichnet sind. Die Kennzeichnung muß in das Gehäuse bzw. auf einem Plättchen aus Metall oder ähnlich festem Material eingeprägt oder eingraviert sein. Das Plättchen muß so mit dem Gehäuse verbunden sein, daß es nicht oder nur mit Gewalt von diesem entfernt werden kann. *Die Kennzeichnung muß von außen jederzeit sichtbar sein.*
4. Der Betreiber solcher Funkanlagen genießt keinerlei Schutz vor Störungen durch andere Fernmeldeanlagen und Telekommunikationseinrichtungen (z. B. auch durch Funkanlagen, die ordnungsgemäß im gleichen Frequenzbereich betrieben werden).
5. Die obengenannten Funkanlagen dürfen ohne eine besondere Genehmigung der Deutschen Bundespost nicht mit anderen Fernmeldeanlagen oder Telekommunikationseinrichtungen verbunden werden.
6. Diese „Allgemeingenehmigung" kann insgesamt – oder im Einzelfall auch für einzelne Funkanlagen durch die örtlich zuständige Genehmigungsbehörde – jederzeit widerrufen werden.

Zusatzhinweise für die Herstellerfirma und die Benutzer

1. Die Herstellerfirma dieser allgemein genehmigten Funkanlagen hat sich gegenüber der Deutschen Bundespost verpflichtet, jedem unter dem o. g. Zulassungszeichen in Verkehr zu bringenden Gerät einen Nachdruck dieser „Allgemeingenehmigung" beizufügen.
2. Die Genehmigung zum Verbinden dieser Funkanlagen mit anderen Fernmeldeanlagen oder Telekommunikationseinrichtungen richtet sich nach den jeweiligen Vorschriften (Bestimmungen über private Drahtfernmeldeanlagen bzw. der Telekommunikationsordnung). Auskünfte hierzu erteilen die zuständigen Fernmeldeämter (Abnahme- und Prüfdienst).

281-3 A 3553-2/A Amtsblatt 129, 20. 11. 1989

FTZ approval
English translation

Telecommunications

Decree 1117/1989
General licence No. 353 for radio transmitting and receiving installations

1. The installation and operation of the radio transmitting and receiving system "BM 70 Level Radar" and "BM 70 – Ex Level Radar" manufactured by KROHNE Messtechnik GmbH & Co. KG, 4100 Duisburg, for telecontrol purposes (level gauging in metal tanks) at a frequency in the 8.1 – 9.4 GHz frequency range, is hereby authorized pursuant to Sections 1 and 2 of the law concerning telecommunication systems as adopted in the official announcement dated 3.7.1989. The radio systems may only be operated inside totally enclosed metal tanks.
2. Other telecommunication systems and telecommunication equipment serving the public sector, including radio systems, must not suffer any interference.
3. Radio systems that are put onto the market under the abovementioned type designations do not individually require special approval if they are electrically and mechanically consistent with the models examined and tested by the Central Approval Office for Telecommunications (ZZF), and bear the following certification mark of the Deutsche Bundespost: "Post Office mark Z G490353X", and the name of KROHNE Messtechnik GmbH & Co. KG, 4100 Duisburg, and the type designation "BM 70 Level Radar" or "BM 70 – Ex Level Radar". The identification mark must be embossed or engraved on the housing or on a plate made of metal or similarly strong material. The plate must be attached to the housing in such a way that it is impossible to remove or can only be removed by the use of force. *The identification mark must be visible at all times from the outside.*
4. The operator of such radio systems has no benefit of protection whatsoever against interference from other telecommunication systems or telecommunication equipment (e.g. including radio systems that are duly operated in the same frequency range).
5. The above-mentioned radio systems may not be linked to other telecommunication systems or telecommunication equipment without special approval from the Deutsche Bundespost.
6. This "general licence" can at any time be revoked in toto – or in isolated cases can also be revoked for individual radio systems by the relevant local licensing authority.

Additional notes for manufacturer and users

1. The manufacturer of these generally licensed radio systems has the responsibility towards the Deutsche Bundespost to ensure that a reprint of this "general licence" accompanies each and every instrument brought onto the market under the above-mentioned certification mark.
2. The licence to link these radio systems with other telecommunication systems or telecommunication equipment is governed by the respective requirements (provisions concerning private-sector cabled telecommunication equipment, and the telecommunication regulations). Information in this respect is available from the appropriate telecommunication offices (acceptance and testing service).

281-3 A 3553-2/A Gazette 129, 20. 11. 1989

12.2 BM 70 – Ex Certificate of Conformity

Original German text

Physikalisch-Technische Bundesanstalt

(1) KONFORMITÄTSBESCHEINIGUNG

(2) **PTB Nr. Ex-90.C.1067 X**

(3) Diese Bescheinigung gilt
Behälterstand-Meß
Typ BM70-Ex Lev dar

(4) der Firma Krohne Meßtechnik GmbH & Co. KG
4100 Duisburg 1

(5) Die Bau des elektrischen Betriebsmittels sowie die verschiedenen zulässigen Ausführungen sind in der A zu dieser Konformitätsbescheinigung festgelegt.

(6) Die Physikalisch-Technische Bundesanstalt bescheinigt als Prüfstelle nach Artikel 14 der Richtlinie des Europäischen Gemeinschaften vom 18. Dezember 1975 (76/117/EWG) die Übereinstimmung dieses elektrischen Betriebsmittels mit den harmonisierten Europäischen Normen

Elektrische Betriebsmittel für explosionsgefährdete Bereiche

EN 50 014:1977 + A1...A5 (VDE 0170/0171 Teil 1/1.87) Allgemeine Bestimmungen
EN 50 018:1977 + A1...A3 (VDE 0170/0171 Teil 5/1.87) Druckfeste Kapselung "d"
EN 50 019:1977 + A1...A3 (VDE 0170/0171 Teil 6/1.87) Erhöhte Sicherheit "e"

nachdem das Betriebsmittel mit Erfolg einer Bauartprüfung unterzogen wurde. Die Ergebnisse dieser Bauartprüfung sind in einem Prüfprotokoll festgelegt.

(7) Das Betriebsmittel ist mit dem folgenden Kennzeichen zu versehen:

EEx d e IIC T3, T4, T5 bzw. T6

(8) Der Hersteller ist dafür verantwortlich, daß jedes derart gekennzeichnete Betriebsmittel in seiner Bauart mit den in der Anlage [illegible] übereinstimmt und daß die vorgeschriebenen [illegible] durchgeführt werden.

(9) Das elektrische Betriebsmittel darf mit dem hier abgedruckten gemeinschaftlichen Unterscheidungszeichen gemäß Anhang II der Richtlinie des Rates vom 6. Februar 1979 (79/196/EWG) gekennzeichnet werden.

Im Auftrag Braunschweig, 04.02.1991

Dr.-Ing. Johann
Oberregierungsrat

Prüfbescheinigungen ohne Unterschrift und Dienststempel haben keine Gültigkeit.
Die Bescheinigung darf nur unverändert weiterverbreitet werden.
Auszüge oder Änderungen bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt, Bundesallee 100, Postfach 3345, D-3300 Braunschweig.

English translation

Physikalisch-Technische Bundesanstalt

(1) CERTIFICATE OF CONFORMITY

(2) **PTB No. Ex-90.C.1067 X**

(3) This Certificate applies to the electrical apparatus
Tank level gauge
Type BM70-Ex Level Radar

(4) of Messrs. Krohne Meßtechnik GmbH & Co. KG
D-4100 Duisburg 1

(5) The basic model of this electrical apparatus and any acceptable variation thereto are specified in the Annex to this Certificate of Conformity.

(6) The Physikalisch-Technische Bundesanstalt, being an Approved Certification Body in accordance with Article 14 of the Council Directive of the European Communities of 18 December 1975 (76/117/EEC), confirms that the apparatus has been found to comply with the harmonized European Standards

Electrical Equipment for Use in Hazardous Areas

EN 50 014:1977 + A1...A5 (VDE 0170/0171 Part 1/1.87) General Provisions
EN 50 018:1977 + A1...A3 (VDE 0170/0171 Part 5/1.87) Flameproof Enclosure "d"
EN 50 019:1977 + A1...A3 (VDE 0170/0171 Part 6/1.87) Increased Safety "e"

said apparatus having successfully undergone a type test. The results of this type test are set down in a confidential Test Report.

(7) The apparatus shall bear the following marking:

EEx d e IIC T3, T4, T5 or T6

(8) The manufacturer has the responsibility to ensure that each and every apparatus bearing such marking conforms in respect to type with the approval documents listed in the Annex to this Certificate, and that the prescribed routine tests have been successfully performed.

(9) The electrical apparatus is permitted to be marked with the Distinctive Community Mark as herein printed in accordance with Annex II to the Council Directive of 6 February 1979 (79/196/EEC).

On behalf of Official stamp of the PTB Brunswick, 04.02.1991
(signed)

Dr.-Ing. Johannsmeyer
Oberregierungsrat

Test certificates not valid without signature and official stamp.
Certificates may be circulated only in the unaltered state.
Extracts or alterations require the approval of the Physikalisch-Technische Bundesanstalt, Bundesallee 100, Postfach 3345, D-3300 Braunschweig.

Physikalisch-Technische Bundesanstalt

ANLAGE
zur Konformitätsbescheinigung PTB Nr. Ex-90.C.1067 X

Das Behälterstand-Meßgerät Typ BM70-Ex Level Radar dient der kontinuierlichen, berührungslosen Erfassung des Füllstandes in metallischen Prozeß-, Verfahrens- und Lagerbehältern.

Die Temperaturklasse des Behälterstand-Meßgerätes ist abhängig von der Meßstofftemperatur und wird wie folgt festgelegt:

Temperaturklasse	maximal zulässige Meßstofftemperatur
T6	85°C
T5	100°C
T4	135°C
T3	150°C

Elektrische Daten

Hilfsnennspannung ..... max. 240 V, 48...63 Hz
oder
Gleichspannung 24 V

Nennleistung ..... max. 20 W bzw. 40 VA

Digitaleingang ..... Betriebswerte: $U_n \leq 24$ V, $I_n \leq 25$ mA

Partyline ..... Betriebswerte: $U_n \leq 5$ V, $I_n \leq 60$ mA

Stromausgang ..... Betriebswerte: $U_n \leq 30$ V, $I_n \leq 20$ mA

zulässiger Umgebungstemperaturbereich -20 ... +50°C

Stückprüfung

Für die Stückprüfung nach EN 50 018 Abschnitt 15.1.1 ist ein Bezugsdruck von 7,8 bar zugrunde zu legen.

Prüfungsunterlagen		unterschrieben am
1. Beschreibung (33 Blatt)		02.02.1990
2. Zeichnung Nr.	8.11681.01.00	02.02.1990
	8.11681.02.01	12.07.1990
	8.11681.03.01	12.07.1990
	8.11681.04.01	12.07.1990
	8.11681.05.00	02.02.1990
	8.11681.06.01	12.07.1990
	8.11681.07.00	02.02.1990

Blatt 1/2

Physikalisch-Technische Bundesanstalt

ANNEX
to Certificate of Conformity PTB No. Ex-90.C.1067 X

The type BM70-Ex Level Radar tank level gauge is used for the continuous non-contact measurement of liquid levels in metal process and storage vessels.

The temperature class of the tank level gauge is dependent upon the product temperature and is defined as follows:

Temperature class	Max. permissible product temperature
T6	85°C
T5	100°C
T4	135°C
T3	150°C

Electrical data

Rated voltage ..... max. 240 V, 48 to 63 Hz
or
DC voltage 24 V

Nominal output ..... max. 20 W or 40 VA

Digital input ..... operating characteristics:
$U_n \leq 24$ V, $I_n \leq 25$ mA

Party line ..... operating characteristics:
$U_n \leq 5$ V, $I_n \leq 60$ mA

Current output ..... operating characteristics:
$U_n \leq 30$ V, $I_n \leq 20$ mA

Permissible ambient temperature range -20 to +50°C

Routine test

The routine test in conformity with EN 50 018, Section 15.1.1, shall be based on a reference pressure of 7.8 bar.

Approval documents		signed on
1. Description (33 sheets)		02.02.1990
2. Drawing No.	8.11681.01.00	02.02.1990
	8.11681.02.01	12.07.1990
	8.11681.03.01	12.07.1990
	8.11681.04.01	12.07.1990
	8.11681.05.00	02.02.1990
	8.11681.06.01	12.07.1990
	8.11681.07.00	02.02.1990

Sheet 1/2

Original German text

Physikalisch-Technische Bundesanstalt

Anlage zur Konformitätsbescheinigung PTB Nr. Ex-90.C.1067 X

		unterschrieben am
Zeichnung Nr.	8.11681.08.00	02.02.1990
	8.11681.09.00	02.02.1990
	8.11681.10.00	02.02.1990
	8.11681.11.00	02.02.1990
	8.11681.12.00	02.02.1990
	8.11681.13.00	02.02.1990
	8.11681.14.00	02.02.1990
	8.11681.15.00	02.02.1990
	8.11681.16.00	02.02.1990
	8.11681.17.00	02.02.1990
	8.11681.18.00	02.02.1990
	8.11681.19.00	02.02.1990
	8.11681.20.00	02.02.1990
	8.11681.21.00	02.02.1990
	8.11681.22.00	02.02.1990
	8.11681.23.00	02.02.1990
	8.11681.24.00	02.02.1990
	8.11681.25.00	12.07.1990
	8.11681.26.00	12.07.1990
	8.11681.27.00	12.07.1990

3. Prüfmuster

Besondere Bedingungen

1. Das Behälterstand-Meßgerät Typ BM70-Ex Level Radar kann in der Ausführung mit einer behälterseitigen aufladbaren Beschichtung des Hohlleiterfensters (Oberflächenwiderstand der Beschichtung > 10^9 Ohm) nur für Meßstoffe, deren Gas/Dampf/Luft-Gemische der Explosionsgruppe IIB zuzuordnen sind, eingesetzt werden.

2. Das Behälterstand-Meßgerät Typ BM70-Ex Level Radar ist bei Ausführung mit druckfest gekapseltem Anschlußraum über dafür geeignete Kabel- und Leitungseinführungen bzw. über Rohrleitungssysteme anzuschließen, die den Anforderungen von EN 50 018 Abschnitte 12.1 und 12.2 entsprechen und für die eine gesonderte Prüfbescheinigung vorliegt.

Im Auftrag

Dr.-Ing. Johannsmeyer
Oberregierungsrat

Braunschweig, 04.02.1991

Anlage zur Bauartzulassung
BAZ-Nr.: 08/PTB Nr.Ex-90.C.1067X
Zentralstelle für
Sicherheitstechnik
des Landes NW
vom 12. April 1991

Blatt 2/2

Physikalisch-Technische Bundesanstalt

Anlage 2 zur Konformitätsbescheinigung PTB Nr. Ex-90.C.1067 X

Zusätzliche Hinweise für den Anbau des Behälterstand-Meßgerätes Typ BM70-Ex Level Radar an Behälter (Bereiche) der Zone 0

Für den Einsatz des Behälterstand-Meßgerätes Typ BM70-Ex Level Radar im Geltungsbereich der "Verordnung über elektrische Anlagen in explosionsgefährdeten Räumen" (ElexV) gilt zusätzlich folgendes:

1. Auf Grund der eingereichten Prüfungsunterlagen bestehen nach dem derzeitigen Stand der Kenntnisse in sicherheitstechnischer Hinsicht keine Bedenken das Behälterstand-Meßgerät Typ BM70-Ex Level Radar in Zone 0

   a) in der Ausführung mit einer behälterseitigen nicht aufladbaren Beschichtung (Oberflächenwiderstand der Beschichtung ≤ 10^9 Ohm) des Hohlleiterfensters für alle brennbaren Flüssigkeiten, und

   b) in der Ausführung mit einer behälterseitigen aufladbaren Beschichtung (Oberflächenwiderstand der Beschichtung > 10^9Ohm) des Hohlleiterfensters nur für brennbare Flüssigkeiten, deren Gas/Dampf/Luft-Gemische der Explosionsgruppe IIB zuzuordnen sind, zu verwenden.

2. Zusätzlich zu der nach VDE 0171 durchzuführenden Stückprüfung ist jedes Hohlleiterfenster des Behälterstand-Meßgerätes Typ BM70-Ex Level Radar mit dem 1,5fachen des maximal möglichen Betriebsdruckes auf Dichtheit zu prüfen.

3. Das Behälterstand-Meßgerät Typ BM70-Ex Level Radar ist in die wiederkehrende Druckprüfung des Behälters einzubeziehen.

Im Auftrag

Dr.-Ing. Johannsmeyer
Oberregierungsrat

Braunschweig, 04.02.1991

Anlage zur Bauartzulassung
BAZ-Nr.: 08/PTB Nr.Ex-90.C.1067X
Zentralstelle für
Sicherheitstechnik
des Landes NW
vom 12. April 1991

English translation

Physikalisch-Technische Bundesanstalt

Annex to Certificate of Conformity PTB No. Ex-90.C.1067 X

		signed on
Drawing No.	8.11681.08.00	02.02.1990
	8.11681.09.00	02.02.1990
	8.11681.10.00	02.02.1990
	8.11681.11.00	02.02.1990
	8.11681.12.00	02.02.1990
	8.11681.13.00	02.02.1990
	8.11681.14.00	02.02.1990
	8.11681.15.00	02.02.1990
	8.11681.16.00	02.02.1990
	8.11681.17.00	02.02.1990
	8.11681.18.00	02.02.1990
	8.11681.19.00	02.02.1990
	8.11681.20.00	02.02.1990
	8.11681.21.00	02.02.1990
	8.11681.22.00	02.02.1990
	8.11681.23.00	02.02.1990
	8.11681.24.00	02.02.1990
	8.11681.25.00	12.07.1990
	8.11681.26.00	12.07.1990
	8.11681.27.00	12.07.1990

3. Test specimen

Special conditions

1. The type BM70-Ex Level Radar tank level gauge, in the variation featuring a chargeable coating of the waveguide window (surface resistance of coating > 10^9 ohms) on the tank side, may be used only for products whose gas/vapour/air mixes are assignable to danger group IIB.

2. The type BM70-Ex Level Radar tank level gauge, in the variation featuring a flameproof terminal compartment, shall be connected up via suitable cable and line entries or via conduit systems which conform to the requirements specified in EN 50 018, Sections 12.1 and 12.2, and for which a separate approval certificate has been issued.

On behalf of

(signed)

Official stamp of PTB

Dr.-Ing. Johannsmeyer
Oberregierungsrat

Brunswick, 04.02.1991

Schedule to Type Approval
BAZ No.: 08/PTB No. Ex-90.C.1067X
Central Office for
Safety Engineering
of the State of North Rhine-Westphalia
Dated: 12 April 1991

Sheet 2/2

Physikalisch-Technische Bundesanstalt

Annex 2 to Certificate of Conformity PTB No. Ex-90.C.1067 X

Additional information for mounting the Type BM70-Ex Level Radar tank level gauge on Zone 0 vessels (areas)

The following additionally applies to the use of the type BM70-Ex Level Radar tank level gauge within the scope of the "Regulation governing electrical systems installed in hazardous areas" (ElexV):

1. On the basis of the approval documents submitted, there are, according to the present state of engineering knowledge, no objections in terms of safety to using the type BM70-Ex Level Radar tank level gauge in Zone 0

   a) in the variation featuring a non-chargeable coating (surface resistance of coating ≤ 10^9 ohms) of the waveguide window for all flammable liquids, and

   b) in the variation featuring a chargeable coating (surface resistance of coating > 10^9 ohms) of the waveguide window only for flammable liquids whose gas/vapour/air mixes are assignable to danger group IIB.

2. In addition to the routine test required to be carried out in conformity with VDE 0171, every waveguide window of the type BM70-Ex Level Radar tank level gauge shall be tested for leak-tightness using 1.5 times the maximum possible operating pressure.

3. The type BM70-Ex Level Radar tank level gauge shall be included in the periodic pressure testing of the vessel.

On behalf of

(signed)

Official stamp of PTB

Dr.-Ing. Johannsmeyer
Oberregierungsrat

Brunswick, 04.02.1991

Schedule to the Type Approval
BAZ No.: 08/PTB No.Ex-90.C.1067X
Central Office for
Safety Engineering
of the State of North Rhine-Westphalia
Dated: 12 April 1991

Original German text

Physikalisch-Technische Bundesanstalt

1. NACHTRAG

zur Konformitätsbescheinigung PTB Nr. Ex-90.C.1067 X

der Firma Krohne Meßtechnik GmbH & Co. KG
D-4100 Duisburg 1

Folgende Änderungen werden durchgeführt:

1. Das Behälterstand-Meßgerat Typ BM70-Ex Level Radar kann, gemaß den Festlegungen in den Unterlagen dieses Nachtrages zur Konformitätsbescheinigung,
   - mit zusätzlichen Einbauten zur Verbesserung der EMV-Eigenschaften ausgerüstet werden;
   - mit den Hohlleiterfenstern Version D und E sowie der Hohlleiterverlängerung ≤ 2 m als auch mit der Impedanzwandler-Ausführung B ausgerüstet werden.
2. Die Schauglaseinheit des Behälterstand-Meßgerätes Typ BM70-Ex Level Radar wird künftig, gemäß den Festlegungen in den Unterlagen zu diesem Nachtrag, in einer geänderten Version (Einschmelzglas) ausgeführt. Desweiteren werden der Typenschlüssel und die Typenschilder wie in den Unterlagen beschrieben neu festgelegt.
3. Die Auflistung der "**Elektrischen Daten**" der Konformitätsbescheinigung wird wie folgt ergänzt:

   Relaisausgang ..... Betriebswerte: $U_n \leq 24$ V, $I_n \leq 1$ A

4. Die Festlegungen zur Temperaturklasseneinordnung wird wie folgt ergänzt:

Temperaturklasse ohne Berücksichtigung der Meßstofftemperatur
T6

5. Die "**Besonderen Bedingungen**" der Konformitätsbescheinigung werden wie folgt ergänzt:

   3. Bei dem Einbau des Behälterstand-Meßgerätes Typ BM70-Ex Level Radar ohne Berücksichtigung der Meßstofftemperatur ist zu beachten, daß folgende Temperaturen nicht überschritten werden:

   3.1 an der Leitungseinführung: 70°C,

Blatt 1/2

Physikalisch-Technische Bundesanstalt

Anlage zum 1. Nachtrag zur Konformitätsbescheinigung PTB Nr. Ex-90.C.1067 X

3.2 an den Anschlußteilen: 80 °C,

3.3 am Stiftkoppler: 80 °C,

3.4 am Montageflansch: die durch die jeweilige Temperaturklasse festgelegte maximale Oberflächentemperatur.
Diese maximale Oberflächentemperatur wird durch die für den Errichtungsort des Behälterstand-Meßgerätes Typ BM70-Ex Level Radar festgelegte Temperaturklasse bestimmt, falls hierbei die vorgenannten Temperaturgrenzen nicht einschränkend wirken.

Prüfungsunterlagen

1. Beschreibung (10 Blatt) unterschrieben am 29.01.1992

2. Zeichnung Nr. 8.11681.01.01
8.11681.04.02
8.11681.12.01
8.11681.14.01
8.11681.15.01
8.11681.16.01
8.11681.24.01
8.11681.25.01
8.11681.27.01
8.11681.28.00
8.11681.29.00
8.11681.30.00
8.11681.31.00
8.11681.32.00
8.11681.33.00
8.11681.34.00
alle unterschrieben am 29.01.1992

Im Auftrag — Braunschweig, 17.06.1992

Dr.-Ing. Johannsmeyer
Oberregierungsrat

EEx d e IIC T3...T6 — Blatt 2/2

English translation

Physikalisch-Technische Bundesanstalt

SUPPLEMENT No. 1
to Certificate of Conformity PTB No. Ex-90.C.1067 X

issued to Messrs. Krohne Meßtechnik GmbH & Co.KG
D-4100 Duisburg 1

The following alterations will be carried out:

1. The type BM70-Ex Level Radar tank level gauge may, as specified in the documents to this Supplement to the Certificate of Conformity
   - be equipped with additional internals to improve its EMC properties;
   - be equipped with waveguide windows Version D and E and the waveguide extension ≤ 2 m, and also with the impedance transformer Version B.
2. The sight glass unit of the type BM70-Ex Level Radar tank level gauge will in future, in accordance with the specifications given in the documents to this Supplement, be constructed in a modified version (sealing glass). Furthermore, the type code and the nameplates will be redefined as described in the documents.
3. The following addition is made to the list of "electrical data" in the Certificate of Conformity:

   Relay output ..... operating characteristics: $U_n \leq 24$ V, $I_n \leq 1$ A

4. The following addition is made to the specifications relating to temperature classification:

Temperature class without regard to product temperature
T6

5. The following additions are made to the "Special Conditions" stated in the Certificate of Conformity:

   3. In cases where the type BM70-Ex Level Radar tank level gauge is installed without regard being paid to the product temperature, care must be taken to ensure that the following temperature levels are not exceeded:

   3.1 at the cable entry: 70°C,

Sheet 1/2

Physikalisch-Technische Bundesanstalt

Supplement No. 1 to Certificate of Conformity
PTB No. Ex-90.C.1067 X

3.2 at the connecting pieces: 80°C,

3.3 at the pin coupler: 80°C,

3.4 at the mounting flange: the maximum surface temperature as defined by the relevant temperature class.
This maximum surface temperature is determined by the temperature class defined for the installation location of the type BM70-Ex Level Radar tank level gauge, provided that the aforementioned temperature limits do not have a restrictive effect.

Approval documents

1. Description (10 sheets) signed on 29.01.1992

2. Drawing No. 8.11681.01.01
8.11681.04.02
8.11681.12.01
8.11681.14.01
8.11681.15.01
8.11681.16.01
8.11681.24.01
8.11681.25.01
8.11681.27.01
8.11681.28.00
8.11681.29.00
8.11681.30.00
8.11681.31.00
8.11681.32.00
8.11681.33.00
8.11681.34.00
all signed on 29.01.1992

On behalf of (signed) — Official stamp of PTB — Brunswick, 17.06.1992

Dr.Ing. Johannesmeyer
Oberregierungsrat

EEx d e IIC T3...T6 — Sheet 2/2

Original German text

Physikalisch-Technische Bundesanstalt

1. Nachtrag zur Anlage 2

der Konformitätsbescheinigung PTB-Nr. Ex-90.C.1067 X

Zusätzliche Hinweise für den Anbau des Behälterstand-Meßgerätes Typ BM70-Ex Level Radar an Behälter (Bereiche) der Zone 0

Für den Einsatz des Behälterstand-Meßgerätes Typ BM70-Ex Level Radar im Geltungsbereich der "Verordnung uber elektrische Anlagen in explosionsgefährdeten Räumen" (ElexV) gilt zusatzlich folgendes:

Die durchgeführten Anderungen zu diesem 1. Nachtrag zur Anlage 2 entsprechen denen des 1. Nachtrages zur Konformitätsbescheinigung. Die bisherigen Anforderungen gemäß Konformitätsbescheinigung und Anlage 2 sind weiterhin gültig.

Auf Grund der eingereichten Prüfungsunterlagen zu diesem Nachtrag bestehen nach dem derzeitigen Stand der Kenntnisse in sicherheitstechnischer Hinsicht keine Bedenken, das Behälterstand-Meßgerät Typ BM70-Ex Level Radar in Zone 0 zu verwenden.

Im Auftrag

Dr.-Ing. Johannsmeyer
Oberregierungsrat

Braunschweig, 17.06.1992

Blatt 1/1

English translation

Physikalisch-Technische Bundesanstalt

Supplement No. 1 to Annex No. 2
to Certificate of Conformity PTB No. Ex-90.C.1067 X

Additional information for mounting the Type BM70-Ex Level Radar tank level gauge on Zone 0 vessels (areas)

The following additionally applies to the use of the type BM70-Ex Level Radar tank level gauge within the scope of the "Regulation governing electrical systems installed in hazardous areas" (ElexV):

The alterations made in respect of this Supplement No. 1 to Annex No. 2 correspond to those in Supplement No. 1 to the Certificate of Conformity. The requirements hitherto as specified in the Certificate of Conformity and Annex No. 2 shall continue to be valid.

On the basis of the approval documents submitted pursuant to this Supplement, there are, according to the present state of engineering knowledge, no objections in terms of safety to using the type BM70-Ex Level Radar tank level gauge in Zone 0.

On behalf of — Official stamp of PTB — Brunswick, 17.06.1992

(signed)

Dr.-Ing. Johannsmeyer
Oberregierungsrat

Sheet 1/1

Physikalisch-Technische Bundesanstalt

2. NACHTRAG
zur Konformitätsbescheinigung PTB Nr. Ex-90.C.1067 X

der Firma Krohne Meßtechnik GmbH & Co. KG
D-Duisburg

Das Behälterstand-Meßgerät Typ BM70-Ex Level Radar darf auch mit der Schauglaseinheit gemäß den nachfolgenden Unterlagen ausgerüstet werden.

Die Verwendung des Behälterflansches "Version F" ist zulässig.

Prüfungsunterlagen	unterschrieben am
1. Beschreibung (3 Blatt)	27.01.1993
2. Zeichnung Nr. 8.11681.36.00	27.01.1993
8.11681.35.00	27.01.1993

Im Auftrag

Dr.-Ing. Klausmeyer
Regierungsrat

Braunschweig, 21.07.1993

Anlage zur Bauartzulassung
BAZ-Nr.: 08/PTB Nr.Ex-90.C.1067X
Zentralstelle für
Sicherheitstechnik
des Landes NW
vom 24. Sep. 1993

EEx de IIC T3, T4, T5 bzw. T6

Blatt 1/1

Physikalisch-Technische Bundesanstalt

SUPPLEMENT No. 2
to Certificate of Conformity PTB No. Ex-90.C.1067X

issued to Krohne Messtechnik GmbH & Co. KG
D-Duisburg

The Type BM70-Ex Level Radar tank level gauge may also be equipped with the sight glass unit in conformity with the documents specified below.

Use of the "Version F" tank flange is permitted.

Approval documents	signed on
1. Description (3 sheets)	27.01.1993
2. Drawing No. 8.11681.36.00	27.01.1993
8.11681.35.00	27.01.1993

On behalf of — Official Stamp of the PTB — Brunswick, 21.07.1993

(signed)

Dr.-Ing. Klausmeyer
Regierungsrat

EEx de IIC T3, T4, T5 or T6

Sheet 1/1

12.3 BM 70-Ex Certificate of Conformity

Original German text

Physikalisch-Technische Bundesanstalt

(1) KONFORMITÄTSBESCHEINIGUNG

(2) **PTB Nr. Ex-93.C.1061 X**

(3) Diese Bescheinigung gi

Mikrowellen-Fü ndmeßgerät
Typ BM 70-Ex tic

(4) der Firma he Meß & Co. KG
uisbu

(5) Die Baua es elek en Betriebsmittels sowie die verschiedenen zulässigen Aus gen sind in der A zu diese ormitätsbescheinigung festgelegt.

(6) Die B alisch-Tech e Bundesanstalt bescheinigt als Prüfstelle nach Artikel 14 de tlinie des der Europä Gemeinschaften vom 18. Dezember 1975 (76/117/EWG) die ein- st ng dieses elektris triebsmittels mit den harmonisierten Europäischen Normen

Elektrisch hmittel für ex sgefähr ereiche

EN 014:1977 + A5 (VDE 0170/0171 Te Allgemeine Besti gen
EN 18:1977 + ..A3 (VDE 0170/0171 Tei) Druckfeste Kaps g "d"
EN 5 :1977 + ..A3 (VDE 0170/0171 Teil) Erhöhte Siche "e"

nachdem s triebsm mit Erfolg einer Bauartprüf wurde. Die E sse dieser Bauartprüfu in eine protok egt.

(7) Das Betriebsm mit dem lo Kennzeichen EG versehen:

Ex de IIC T3... T6 bzw. EEx de IIB T3...T

(8) Der Hersteller ist dafü ntwortlich, daß jedes derart gekennzeichnete Be mittel in seiner Bauart mit den in der Anlage gen übereinstimmt und daß die vorgeschriebene

(9) Das elektrische Betriebsmittel darf mit dem hier abgedruckten gemeinschaftlichen Unterscheidungszeichen gemäß Anhang II der Richtlinie des Rates vom 6. Februar 1979 (79/196/EWG) gekennzeichnet werden.

Anlage zur Bauartzulassung
BAZ-Nr.: 08/PTB Nr.Ex-93.C.1061 X

Im Auftrag
Dipl.-Ing.

vom 19. April 1994
Landesanstalt
für Arbeitsschutz
Nordrhein-Westfalen
Postfach 10 11 63
40225 Düsseldorf

Braunschweig, 03.03.1994

Prüfbescheinigungen ohne Unterschrift und ohne Dienststempel haben keine Gültigkeit
Die Bescheinigungen dürfen nur unverändert weiterverbreitet werden
Auszüge oder Änderungen bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt, Bundesallee 100, Postfach 3345, D-3300 Braunschweig

English translation

Physikalisch-Technische Bundesanstalt

(1) CERTIFICATE OF CONFORMITY

(2) **PTB No. Ex-93.C.1061X**

(3) This Certificate applies to the electrical apparatus

Microwave level gauge
Type BM 70-Ex Nautic

(4) of Krohne Messtechnik GmbH & Co. KG
D-Duisburg

(5) The basic model of this electrical apparatus and any acceptable variation thereto are specified in the Annex to this Certificate of Conformity.

(6) The Physikalisch-Technische Bundesanstalt, being an Approved Certification Body in accordance with Article 14 of the Council Directive of the European Communities of 18 December 1975 (76/117/EEC), confirms that the apparatus has been found to comply with the harmonized European Standards

Electrical Equipment for Use in Hazardous Areas

EN 50 014:1977 + A1...A5 (VDE 0170/0171 Part 1/1.87) General Provisions
EN 50 018:1977 + A1...A3 (VDE 0170/0171 Part 5/1.87) Flameproof Enclosure "d"
EN 50 019:1977 + A1...A3 (VDE 0170/0171 Part 6/1.87) Increased Safety "e"

said apparatus having successfully undergone a type test. The results of this type test are set down in a confidential Test Report.

(7) The apparatus shall bear the following marking:

EEx de IIC T3...T6 or EEx de IIB T3...T6

(8) The manufacturer has the responsibility to ensure that each and every apparatus bearing such marking conforms in respect to type with the approval documents listed in the Annex to this Certificate, and that the prescribed routine tests have been successfully performed.

(9) The electrical apparatus is permitted to be marked with the Distinctive Community Mark as herein printed in accordance with Annex II to the Council Directive of 6 February 1979 (79/196/EEC).

On behalf of — Official Stamp — Brunswick, 03.03.1994
(signed)
Dipl.Ing. Loper

Physikalisch-Technische Bundesanstalt

ANLAGE 1
zur Konformitätsbescheinigung PTB Nr. Ex-93.C.1061 X

Bauart

Das Füllstandmeßgerät besteht aus einem Edelstahlgehäuse mit Elektronikraum in Zündschutzart "d", einem Anschlußraum wahlweise in Zündschutzart "e" oder "d" und einem Stiftkopplerraum in Zündschutzart "e".
Es dient zum berührungslosen Erfassen des Füllstandes in metallischen Behältern.

Technische Daten

Nennspannung	max. 240 V, 48...63 Hz oder Gleichspannung 24 V
Nennleistung	max. 15 W bzw. 30 VA
Meßstromkreise	max. 30 V, 1000 mA
Betriebsüberdruck im Behälter	-1...40 bar
Meßstofftemperatur	-20...+150 °C siehe "Besondere Bedingungen"
Umgebungstemperaturbereich	-20...+60 °C
Frequenzbereich Mikrowelle	8...9,5 GHz
Mikrowellenleistung	max. 62,5 mW

Prüfungsunterlagen — unterschrieben am 23.06.1993

1. Beschreibung (20 Blatt)

2. Zeichnungen Nr. 8.12277.01.00
8.12277.02.00
8.12277.03.00
8.12277.04.00
8.12277.05.00
8.12277.06.00
8.12277.07.00
8.12277.08.00
8.12277.09.00
8.12277.10.00
8.12277.11.00
8.12277.12.00
8.12277.13.00
8.12277.14.00
8.12277.15.00
8.12277.16.00
8.12277.17.01
8.12277.18.00
8.12277.19.00
8.12277.20.00
8.12277.21.00

Blatt 1/3

Physikalisch-Technische Bundesanstalt

ANNEX No. 1
to Certificate of Conformity PTB No. Ex-93.C.1061X

Type of construction

The level gauge consists of a stainless steel housing with electronics compartment in type of protection "d", a terminal compartment optionally in type of protection "e" or "d", and a pin coupler compartment in type of protection "e".
It is used for non-contact measurement of the level of contents in metal vessels.

Technical data

Nominal voltage	max. 240 V, 48 to 63 Hz or DC voltage 24 V
Nominal output	max. 15 W or 30 VA
Measuring circuits	max. 30 V, 1000 mA
Max. allowable operating pressure in the vessel	-1 to 40 bar
Process temperature	-20 to +150°C see "Special conditions"
Ambient temperature range	-20 to +60°C
Frequency range, microwave	8 to 9.5 GHz
Microwave output	max. 62.5 mW

Approval documents — signed on 23.06.1993

1. Description (20 sheets)

2. Drawings No. 8.12277.01.00
8.12277.02.00
8.12277.03.00
8.12277.04.00
8.12277.05.00
8.12277.06.00
8.12277.07.00
8.12277.08.00
8.12277.09.00
8.12277.10.00
8.12277.11.00
8.12277.12.00
8.12277.13.00
8.12277.14.00
8.12277.15.00
8.12277.16.00
8.12277.17.01
8.12277.18.00
8.12277.19.00
8.12277.20.00
8.12277.21.00

Sheet 1/3

Original German text

Physikalisch-Technische Bundesanstalt

Anlage 1 zur Konformitätsbescheinigung PTB Nr. Ex-93.C.1061 X

Zeichnung Nr. 8.12277.22.00
8.12277.23.00
8.12277.24.00
8.12277.25.00

3. Prüfbescheinigung PTB Nr. Ex-90.C.1067 X

Stückprüfung

Die Stückprüfung nach EN 50 018 Abschnitt 15.1.1 ist mit einem raltiven statischen Druck von 14 bar durchzuführen.

Besondere Bedingungen

1. Unter Beachtung, daß die Temperatur am Referenzpunkt (Übergang zwischen Verstärkungsrippe und Meßumformergehäuse) den Wert von T_{Ref} = 70 °C nicht überschreitet, wird die maximale Oberflächentemperatur am Behälter-Montageflansch bzw. am Hohlleiterfenster durch die für den Einbauort geltende Temperaturklasse bestimmt.

Hierbei beträgt dann die Temperatur
- an den Leitungseinführungen maximal 70 °C
- an den Anschlußteilen (Klemmen) maximal 80 °C
- am Stiftkoppler maximal 100 °C.

Unabhängig von der Meßstofftemperatur hat das Gerät die Temperaturklasse T6, sofern die Oberflächentemperatur am Behältermontageflansch 85 °C nicht überschreitet.

Temperaturklasse	max. Oberflächtentemperatur [°C]	Meßstofftemperatur [°C]
T6	85	beliebig

Blatt 2/3

Physikalisch-Technische Bundesanstalt

Anlage 1 zur Konformitätsbescheinigung PTB Nr. Ex-93.C.1061 X

2. Sofern die Temperatur am Behälter-Montageflansch nicht bekannt ist bzw. wenn die maximale Oberflächentemperatur des Behälter-Montageflansches gleich der Meßstofftemperatur ist, besitzt das Gerät die nachfolgenden Temperaturklassen:

Temperatur-Klasse	max. Meßstofftemperatur [°C]			
	T_{amb} = 40 °C	T_{amb} = 50 °C	T_{amb} = 55 °C	T_{amb} = 60 °C
T6	85	85	85	75
T5	100	100	100	75
T4	135	135	115	75
T3	150	150	115	75

T_{amb} = maximal zulässige Umgebungstemperatur

3. Das Füllstandmeßgerät kann in der Ausführung mit einer behälterseitigen aufladbaren Beschichtung des Hohlleiterfenstrs (Oberflächenwiderstand der Beschichtung > 10^9 Ohm) nur für Meßstoffe, deren Gas/Dampf/Luft-Gemische der Explosionsgruppe IIB zuzuordnen sind, eingesetzt werden.

4. Das Füllstandmeßgerät ist bei Ausführung mit druckfest gekapseltem Anschlußraum über dafür geeignete Kabel- und Leitungseinführungen bzw. über Rohrleitungssysteme anzuzuschließen, die den Anforderungen von EN 50 018 Abschnitt 12.1 und 12.2 entsprechen und für die eine gesonderte Prüfbescheinigung vorliegt.

Im Auftrag

Dipl.-Ing.

Braunschweig, 03.03.1994

Anlage zur Bauartzulassung
BAZ-Nr.:08/PTB Nr.Ex-93.C.1061X
vom 19. April 1994
Landesanstalt
für Arbeitsschutz
Nordrhein-Westfalen
Ulenbergstr. 127-131 · Tel. Nr. 0211/3104-0
40225 Düsseldorf

Blatt 3/3

English translation

Physikalisch-Technische Bundesanstalt

Annex No. 1 to Certificate of Conformity PTB No. Ex-93.C.1061X

Drawing No. 8.12277.22.00
8.12277.23.00
8.12277.24.00
8.12277.25.00

3. Certificate of conformity PTB No. Ex-90.C.1067 X

Routine test

The routine test as specified in EN 50 018 Section 15.1.1 shall be carried out using a relative static pressure of 14 bar.

Special conditions

1. Subject to the temperature at the reference point (junction between reinforcing rib and signal converter housing) not exceeding a value of T_{Ref} = 70°C, the maximum surface temperature at the vessel mounting flange and waveguide window is determined by the temperature class applicable to the installation location.

Accordingly, the temperature will then amount to
- not more than 70°C at the cable entries
- not more than 80°C at the connections (terminals)
- not more than 100°C at the pin coupler.

Independent of the product temperature, the device has the temperature class T6 provided the surface temperature at the vessel mounting flange does not exceed 85°C.

Temperature class	Max. surface temperature (°C)	Product temperature (°C)
T6	85	any

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Physikalisch-Technische Bundesanstalt

Annex No. 1 to Certificate of Conformity PTB No. Ex-93.C.1061X

2. Where the temperature at the vessel mounting flange is not known or if the maximum surface temperature of the mounting flange is equal to the product temperature, the following temperature classes shall apply to the device:

Temperature class	Max. product temperature (°C)			
	T_{amb} = 40°C	T_{amb} = 50°C	T_{amb} = 55°C	T_{amb} = 60°C
T6	85	85	85	75
T5	100	100	100	75
T4	135	135	115	75
T3	150	150	115	75

T_{amb} = maximum permissible ambient temperature

3. In the variation featuring on the vessel side a chargeable coating of the waveguide window (surface resistance of the coating > 10^9 ohms), the level gauge may be used only for products whose gas/vapour/air mixes are assignable to danger group IIB.

4. In the variation featuring a flameproof terminal compartment, the level gauge shall be connected up via suitable cable and line entries or via conduit systems that conform to the requirements specified in EN 50 018 Section 12.1 and 12.2, and for which a separate approval certificate has been issued.

On behalf of

Official Stamp of the PTB

Brunswick, 03.03.1994

(signed)

Dipl.-Ing. Löper

Sheet 3/3

German original text

Physikalisch-Technische Bundesanstalt

Anlage 2 zur Konformitätsbescheinigung PTB Nr. Ex-93.C.1061 X

Anbau des Füllstandmeßgerätes Typ BM 70-Ex Nautic
an Behälter (Bereiche) der Zone 0

Für den Einsatz des Füllstandmeßgerätes im Geltungsbereich der "Verordnung über elektrische Anlagen in explosionsgefährdeten Räumen" (ElexV) gilt zusätzlich:

Aufgrund der Bauart und Prüfung bestehen nach dem derzeitigen Stand der Kenntnisse in sicherheitstechnischer Hinsicht keine Bedenken, das Füllstandmeßgerät an Behälter der Zone 0 anzubauen.

Die "Besonderen Bedingungen" der Anlagen 1 sind zu beachten.

Im Auftrag

Dipl.-Ing. Löper

Braunschweig, 03.03.1994

Anlage zur Bauartzulassung
BAZ-Nr.: 08/PTB Nr. Ex-93.C.1061 X
vom 19. April 1994
Landesanstalt
für Arbeitsschutz
Nordrhein-Westfalen
Postfach 10 11 05 · Tel. Nr. 0211 / 31 01-0
4000 Düsseldorf

Blatt 1/1

English translation

Physikalisch-Technische Bundesanstalt

Annex No. 2 to Certificate of Conformity PTB No. Ex-93.C.1061 X

Mounting the Type BM70-Ex Nautic level gauge
on Zone 0 vessels (areas)

The following applies additionally to application of the level gauge within the scope of the "Regulation governing electrical systems installed in hazardous areas" (ElexV):

On the basis of its type of construction and testing, there are, according to the present state of engineering knowledge, no objections in terms of safety to mounting the level gauge on Zone 0 vessels.

The "Special conditions" specified in Annex No. 1 shall be observed.

On behalf of

Official Stamp of the PTB

Brunswick, 03.03.1994

(signed)

Dipl.-Ing. Löper

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12.4 FM Approval Report

For further information please contact Krohne America Inc.

NOT to be distributed outside the FACTORY MUTUAL SYSTEM, except by CLIENT.

APPROVAL REPORT

BM 70 EX SERIES LEVEL-RADAR GAUGE FOR HAZARDOUS (CLASSIFIED) LOCATIONS

Prepared For:
Krohne Messtechnik GmbH & Co. KG
Ludwig-Krohne-Strasse 5
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D-47008 Duisburg
GERMANY

J.I. 0W8A5.AE
(3615)
January 28, 1993

Factory Mutual Research
1151 Boston-Providence Turnpike
P.O. Box 9102
Norwood, Massachusetts 02062

Part E Index

If you need to return level gauges for testing or repair to Krohne

If installed and operated in accordance with these operating instructions, your level gauges will rarely present any problems.

Should you nevertheless need to return a BM 70 unit for checkout or repair, please pay strict attention to the following points:

Due to statutory regulations concerning protection of the environment and the health and safety of our personnel, Krohne may only handle, test and repair returned level gauges that have been in contact with liquids if it is possible to do so without risk to personnel and environment. This means that Krohne can only service your unit if it is accompanied by a certificate in line with the following model confirming that the level gauge is safe to handle.

If the unit has been operated with toxic, caustic, flammable or water-endangering liquids, you are kindly requested

- to check and ensure, if necessary by rinsing or neutralizing, that all cavities are free from such dangerous substances.
  (Directions on how you can find out whether the unit has to be opened and then flushed out or neutralized are obtainable from Krohne on request.)
- to enclose a certificate with the level gauge confirming that it is safe to handle and stating the liquid used.

KROHNE regret that they cannot service your level gauge unless accompanied by such a certificate.

S P E C I M E N certificate

Company: ..... Address: .....

Department: ..... Name: .....

Tel. No.:

The enclosed liquid level gauge

BM 70: ..... Krohne Order No. or Series No.: .....

has been operated with the following liquid: .....

Because this liquid is

water-endangering * / toxic * / caustic * / flammable *

we have

– checked that all cavities in the unit are free from such substances *

– flushed out and neutralized all cavities in the unit *

(* delete if not applicable)

We confirm that there is no risk to man or environment through any residual liquid contained in this level gauge.

Date: ..... Signature: .....

Company stamp:

KROHNE

Krohne Messtechnik GmbH & Co. KG

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