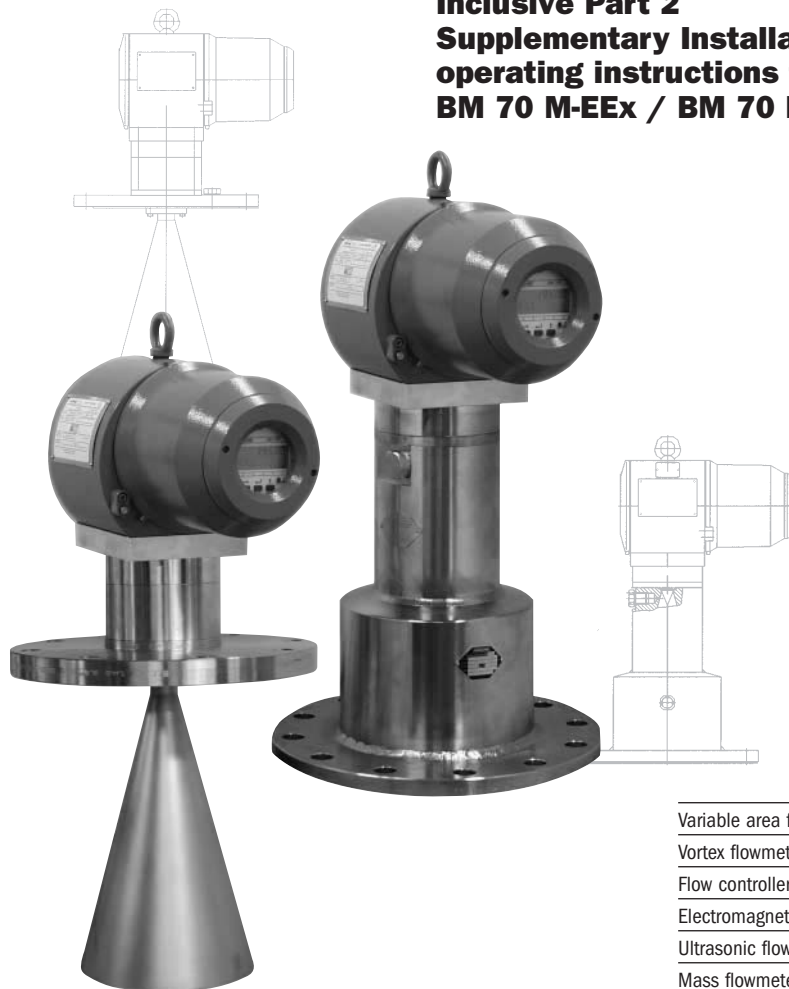


## Installation and operating instructions for

# BM 70 M

## Inclusive Part 2 Supplementary Installation and operating instructions for BM 70 M-EEEx / BM 70 Mi-EEEx



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Variable area flowmeters

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Vortex flowmeters

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Flow controllers

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Electromagnetic flowmeters

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Ultrasonic flowmeters

---

Mass flowmeters

---

**Level measuring instruments**

---

Communications engineering

---

Engineering systems & solutions

---

Switches, counters, displays and recorders

---

Heat metering

---

Pressure and temperature

---

---

## Part 1: Installation and operating instructions for BM 70 M

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## General advice on safety

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Weight: the device will weigh between approx. 55 kg (120 lb) and 70 kg (155 lb) or more!  
To carry, use both hands to lift the device carefully by the converter housing. If necessary, use lifting gear.  
Avoid hard blows, jolts, knocks, impacts, etc.

---

## Product liability and warranty

---

The BM 70 M level gauge is designed solely for measuring the distance, level, volume and reflection of liquids, pastes, slurries, solids and particulate materials.  
The BM 70 M level gauge does not form part of an overfill protection system as defined in WHG. Special codes and regulations apply to its use in hazardous areas.  
Responsibility as to suitability and intended use of these level gauges rests solely with the user. Improper installation and operation of our level gauges may lead to loss of warranty.  
In addition, the "General conditions of sale", forming the basis of the purchasing contract, are applicable.  
If you need to return the level gauge to the manufacturer or supplier, please refer to the information given on page 86.

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## Items supplied

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Depending on the version ordered we supply the following:

- Signal converter bolted to waveguide window and antenna  
Optional: antenna extension, sunshade (with fastening material in each case)
- Report on factory settings for the signal converter
- Bar magnet for operator control / parameter assignment (only in version with local display)
- Wrench for the covers
- Installation material (stud bolts, flange gasket and cabling) not supplied, to be provided by customer!

---

## Documentation supplied

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Condensed instructions: installation, connection, start-up and safety advice in condensed form, but sufficient for most applications. Please read through these instructions first!  
Instruction card: overview of the configuration menu and meaning of the markers in cheque card format.  
Installation and operating instructions (this manual): detailed user manual and reference book, including description of special versions and functions. This documentation is structured on lines similar to those given in the DIN V 19259 Standard.  
Approval documents, unless reproduced in the installation and operating instructions.

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## Software history

---

Introduction Mth./Yr	Firmware version	Device instructions	Remarks
06/02	4.04	06/02	First serial version
06/02	4.06	06/02	Minor amendments

---

## 1 Range of applications

---

The BM 70 M Level-Radar level gauging system is designed to measure the distance, level, volume and reflection of liquids, pastes, slurries, solids and particulate materials. BM 70 M Ex hazardous-duty versions are suitable for use in Ex-Zone 0, 1 and 2.

---

## 2 Mode of operation and system structure

---

### 2.1 Operating principle (FMCW-Radar)

A radar signal is given via an antenna, reflected on the measuring surface and received after a delay time  $t$ .

#### FMCW: Frequency Modulated Continuous Wave

The FMCW-radar uses a high frequency signal (~10 GHz) which transmits frequency increasing linearly 1 GHz during the measurement (frequency sweep) (1). The signal is emitted, reflected on the measuring surface and received time-delayed (2).

For further signal processing the difference  $\Delta f$  is calculated from the actual transmit frequency and the receive frequency (3). The difference is directly proportional to the distance i.e. a large frequency difference corresponds to a large distance and vice versa.

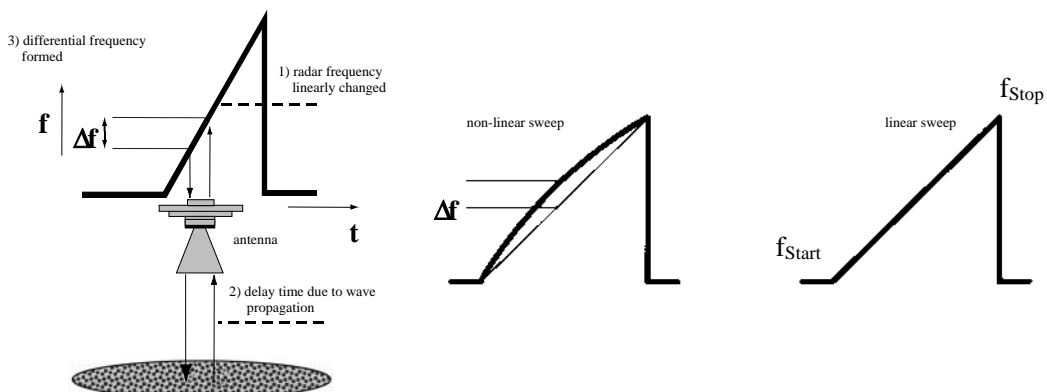
The frequency difference is transformed via a Fourier transformation (FFT) into a frequency spectrum and then the distance is calculated from the spectrum. The level results from the difference between tank height and distance.

#### Linearity of frequency sweeps

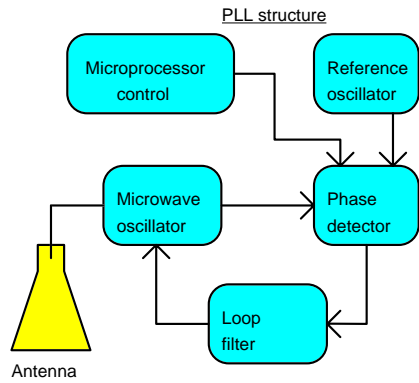
The measuring accuracy of an FMCW radar is determined from the linearity of the frequency sweeps and their reproducibility. The linearity correction is deduced via reference measurement of the oscillator.

An immediate frequency regulation is necessary with the BM 70 M device because of the higher demand on the measuring accuracy.

With the PLL technology (Phase Locked Loop) the signal frequency is directly recorded as a digital data and the converter oscillator locks automatically on the right frequency.



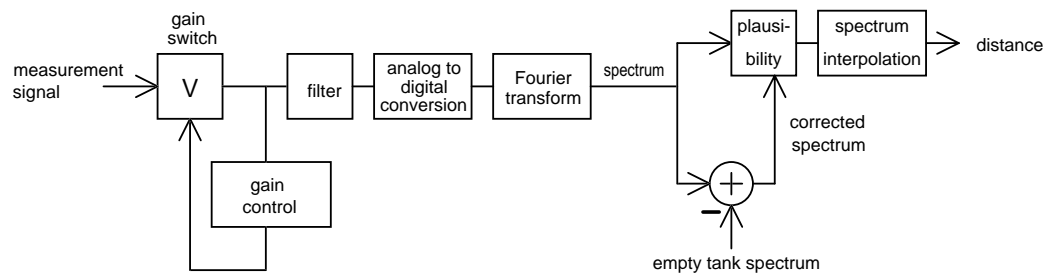
As the transmit frequency is changed during a short time interval by FMCW radar the transmitted frequency has to follow the nominal frequency within micro seconds. This ensues via modern, fast electronic and processors.



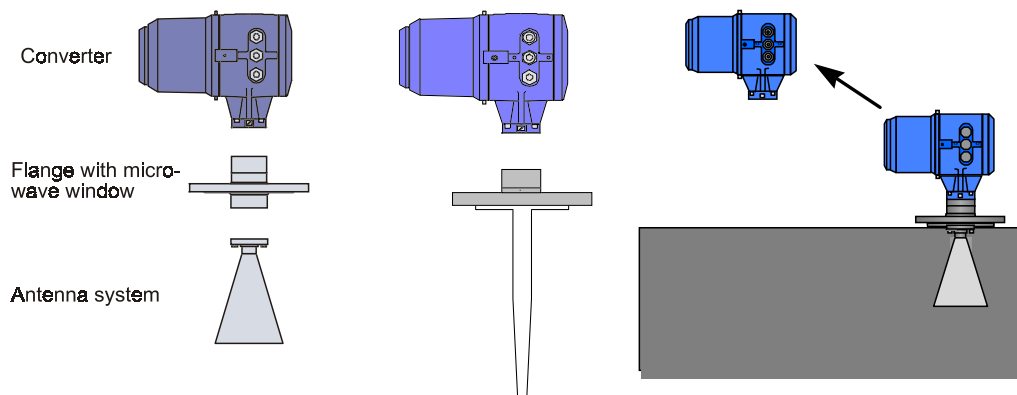
## 2.2 Signal processing (digital)

The radar signals are digitally processed by a microprocessor. The processing system is based on intelligent procedures that allow for plausibilities and history.

The following diagram describes the path of internal signal processing:



After automatic gain control, the measuring signal is filtered, digitized and converted into a frequency spectrum by means of the Fourier transform. Plausibility of the value obtained is assessed with the aid of the so-called empty-tank spectrum, which contains information about constant interference reflectors. Interpolation of the spectrum helps to improve resolution of the measured value.



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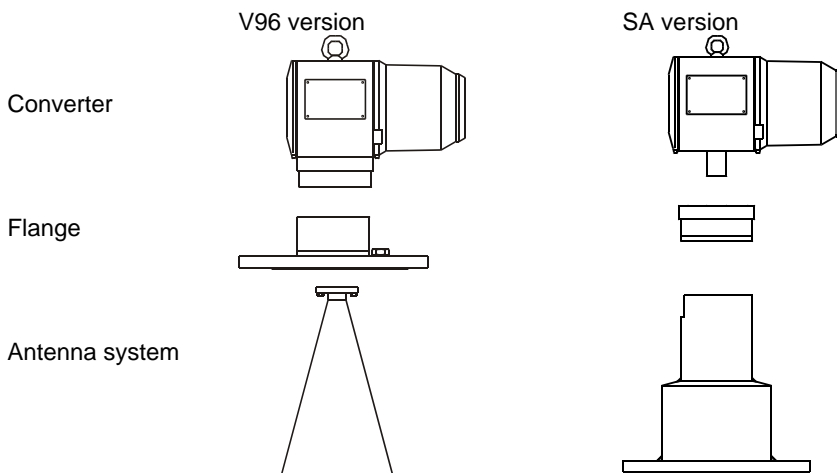
### 2.3 Modularity (signal converter, flange, antenna)

The measuring system consists of the flange system and the signal converter.

The flange system contains the microwave window separating product from pressure, and the antenna system.

The compact signal converter contains the microwave generator and the entire signal processing system, including provision of a standardised output signal (4 - 20 mA or digital interface).

The signal converter can be separated from the flange system under process conditions, without loss of pressure or escape of product.



---

## 3 Input

### 3.1 Measured variable (distance, level, volume, reflection)

The primary measured variable is the distance between a reference point (as standard: tank mounting flange) and a reflecting surface (e.g. surface of the liquid).

The filling level is determined by allowing arithmetically for the entered tank height.

Volume measurements are possible by entering a conversion table (max. 50 points).

The strength of the reflected signal can be measured for qualitative assessment of the tank product or its surface.

### 3.2 Measuring range

Maximum tank height	0.5 m (20 inch)
Maximum measuring range	35 m (115 ft)

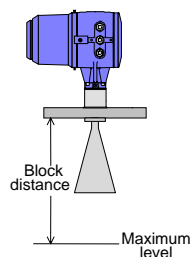
[0.5 - 35/40 m (1.64 - 115/131 ft)]


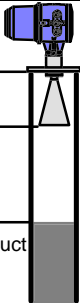
The useful range will depend on the antenna size, the reflection properties of the tank product, the installation position, and the presence of interference reflectors (see Sections 6.1).

### 3.3 Block distance

The block distance is the minimum measured distance between the mounting flange (reference point) and surface of the tank product.

Recommended minimum values:



Horn antenna without stilling well	Stilling well / Wave-Guide
 <p>Antenna size* = Type3: 22cm/8.7"; Type4: 34cm/13"; * Hastelloy: +3cm / 1.2"</p> <p>Recommended antenna distance: Storage tanks: 10cm/4"; Process tanks: 20cm/8"</p>	 <p>Antenna size * = Type1: 11cm/4"; Type2: 15cm/5.5"; Type3: 22cm/8.7" Wave-Stick SW: 6cm/2.4" (Wave-Guide: no antenna)</p> <p>Recommended antenna distance = 30 cm / 12"</p> <p>* Hastelloy: 3 cm (0.4")</p>
<p>The length of any antenna extension used must be added on!</p>	

### 3.4 Out-of-range performance

When the level measuring range is exceeded (including flooding) the measured value will stick at the (adjustable) block distance (see Sect. 8.6.14).

If the measured value drops below the level range, it will stay put at the set lower range limit (distance = tank height).

## 4 Output

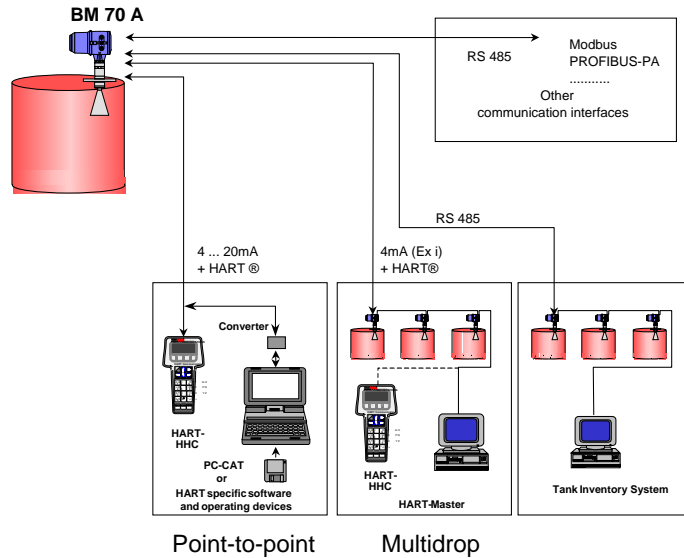
### 4.1 Variants

Variants	Remarks	Described in Section
Ex-e current output HART <sup>®</sup>	Ex-e; active; HART <sup>®</sup> protocol; together with switching output and digital input	4.2 + 4.4
Ex-i current output HART <sup>®</sup>	intrinsically safe; passive; HART <sup>®</sup> protocol (optionally with intrinsically safe switching output)	4.3 + 4.4
Current output	Ex-e; active; non-communicable	4.5
RS 485 + current output	BM70 protocol or ModBus-RTU or HART <sup>®</sup>	4.6 + 4.5
PROFIBUS-PA	intrinsically safe; see Supplementary Instructions	-
Foundation Fieldbus (FF)	intrinsically safe; see Supplementary Instructions	-

All versions with HART<sup>®</sup> or BM70 protocols can be operated with the PC-CAT PC program (see Section 8.12).



**Overview of digital Communication possibilities:**



**4.2 Ex-e current output HART®**

Function	Level, distance, volume (conversion table) or reflection, and error identification; galvanically isolated from digital input and switching output
Current	4-20 mA; without or with error message (2 mA and 22 mA)
Accuracy/linearity	0.05 % (rel. 20 mA; at T = 20°C, 100ohm load impedance and nominal operating voltage)
Temperature drift	< 100 ppm/K (typically 30 ppm/K)
Load impedance	< 500 ohm
Effect of load impedance	< 0.02 % (rel. 20 mA for RB = 0...500 ohm)
Effect of power	0.02 % (rel. 20 mA for UB within limits of tolerance)
Hazardous-duty version	Ex e
Note	together with switching output and digital input

**Digital input (terminals 81/82):**

Can be used to suspend the entire measurement procedure, i.e. measurements are "frozen" (standard setting), or to hot start the device (reprogramming by KROHNE Service).

Applicable voltage	5...28 V DC
Input resistance	> 1 kohm

**Switching output (terminals 41/42):**

Can be programmed as a limit switch, alarm contact or error message. The contact is open in the de-energized condition.

Operating data	max. 100 mA / 30 V DC or 30 V AC
Internal resistance	< 20 ohm

### 4.3 Ex-i current output HART® (type of protection: Ex de [ia])

Function	Level, distance, volume (conversion table) or reflection; and error identification; passive output (current sink)
Current	4-20 mA; without or with error message (3.6 mA / 22 mA); 4 mA constant, adjustable for HART®-Multidrop
Temperature drift	< 100 ppm/K (typically 30 ppm/K)
Accuracy/linearity	0.05 % (rel. 20 mA; at T = 20°C, 10 V supply voltage and nominal operating voltage)
Supply voltage U	8-30 V (between terminals 31 and 32)
Load impedance	< (U <sub>S</sub> - 8V) / 22 mA. (U <sub>S</sub> = external supply voltage)
Effect of supply voltage	< 0.02 % (rel. 20 mA for U = 8...30 V)
Effect of power	< 0.02 % (rel. 20 mA for U <sub>B</sub> within limits of tolerance)
Note	Digital input not available

#### Optional switching output (terminals 41/42):

Can be programmed as limit switch, alarm contact or error message. The contact is open in the deenergized condition.

Operating data	6...30 V; I <sub>Low</sub> < 110 mA; U <sub>Low</sub> < 2V; I <sub>High</sub> < 900 µA (U=30V) and I <sub>High</sub> = 200 µA (U=8V)
----------------	--

#### Ex-i safety limits

Signal circuit in type of protection: Intrinsic Safety EEx ia IIC/IIB or EEx ib IIC/IIB for connection to a certified intrinsically safe circuit with the following peak values:

U<sub>o</sub> = 30 V; I<sub>k</sub> = 250 mA

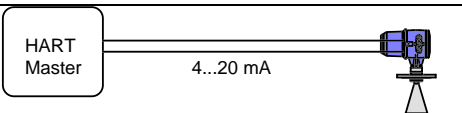
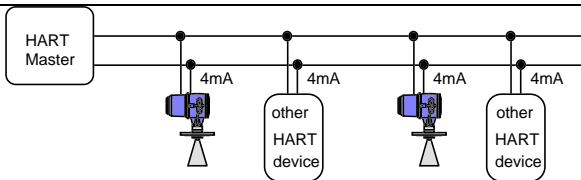
Effective inner capacitance ≈ 0; effective inner inductance ≈ 0

### 4.4 HART® communication

The HART® Communications protocol can, in accordance with the Rosemount Standard, be used with a BM 70 M.

Electrical connection: see Section 7.6.

There are two ways of using the HART® Communication:

Point-to-point connection	Multipoint connection (Multidrop)
<p>between the BM 70 M and the HART® master equipment. A BM 70 M can be used either with an Ex-e current output HART® or with an Ex-i current output HART®.</p> 	<p>with up to 15 devices (BM 70 M or other HART® equipment), in parallel on a 2-wire bus. A BM 70 M is normally used with Ex-i current output, but an Ex-e current output can also be used (constant 4 mA in both cases).</p> 

#### 4.5 Current output (non-communicable)

Function	Level, distance, volume (conversion table) or reflection, and error identification
Current	4-20 mA; without or with error message (2 mA and 22 mA)
Accuracy/linearity	0.3 % (rel. 20 mA; at T = 20°C, 100 Ohm load impedance and nominal operating voltage)
Temperature drift	< 200 ppm/K (typically 70 ppm/K)
Load impedance	< 250 Ohm
Effect of load impedance	< 0.1 % (rel. 20 mA for RB = 0...250 Ohm)
Effect of power	< 0.1 % (rel. 20 mA for UB within limits of tolerance)
Hazardous-duty version	Ex e

#### When operated as a switching output (digital output):

Function	limit switch, alarm contact or error message
Low status	current < 2 mA
High status	current = 22 mA (when load < 250 Ohm)
No-load voltage	< 18 V

#### 4.6 Digital interface RS 485

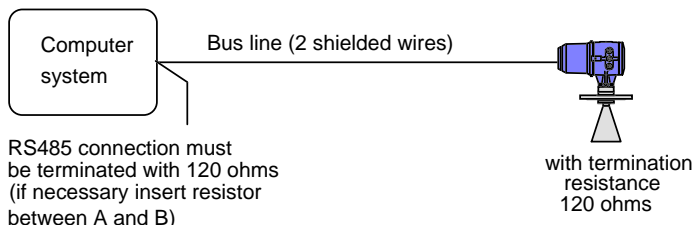
RS 485 is a bus that allows two-way Communication (half-duplex operation) with the BM 70 M Level-Radar. When the computer system sends out a request, the BM 70 M transmits: level, distance; volume (conversion table), reflection, setting parameters and status.

A PC can configure any BM 70 M via the bus (RS 485/RS232 converter required) by means of the PC-CAT program, provided no master is active. The maximum cable length - excluding amplifier - is 2000 m.

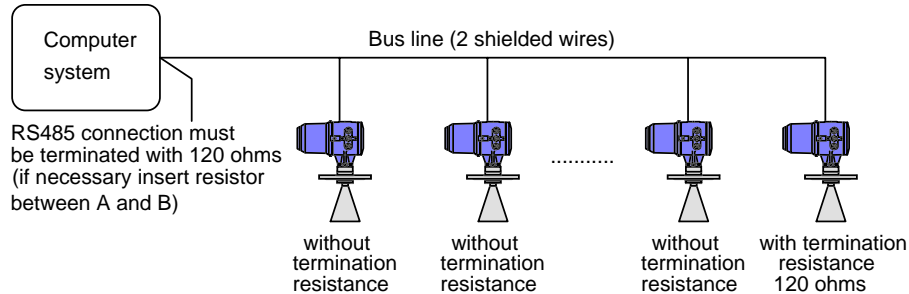
Transmission rate	1200 to 38400 bauds
Address	0 to 255
Protocols	KROHNE Protocol, HART <sup>®</sup> , Modbus RTU (from firmware V.3.02/4.02) Additional information: see "BM 70 A/P Communication RS 485" instructions.
Additional current output	The current output is conductively coupled to the RS 485 interface. Technical data: see Section 4.5
Note	Switching contact and digital input are not available. However, the current output can be configured as a switching output.

#### Various bus configurations

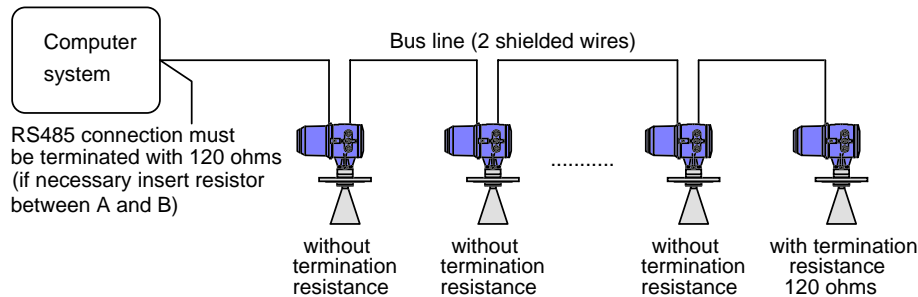
A) Connection of a BM 70 M as a single RS 485 user:



B) Connection of several BM 70 M in the RS 485 bus system via stubs to the bus cable:



C) Connection of several BM 70 M in the RS 485 bus system, with bus cable looped through to further field instruments:



- If other devices are operated together with the BM 70 M Level-Radar on one bus, all devices must use the same Communications protocol (e.g. ModBus devices of different makes or BM 70 M and MTM 70 with KROHNE Protocol).
- When "HART<sup>®</sup>" is set as the protocol type, use only the protocol in keeping with the "HART<sup>®</sup> Specification". The "Hardware Implementation RS 485" does not conform to the HART<sup>®</sup> Standard (see Sections 4.2 and 4.3).
- Since signal reflections at the line ends can interfere with Communication, both the line beginning (at the computer system) and the line end (at the last device) should be terminated with the typical surge impedance of the cable (120 Ohm). To do this inside the BM 70 M: see Section 7.7.

#### 4.7 Breakdown signal

Breakdown information can be called up via the following interfaces:

- Local display: flashing display, plain text information
- Current output: error signal 2 mA (Exi = 3.6 mA) or 22 mA
- Switching output: contact opens or closes
- Digital interfaces: interrogation of error flags

## 4.8 Digital input

The digital input (for electrical data: see Section 4.2) can be used for temporarily "freezing" measurements or for carrying out a hot start. It is only available in the "Ex-e current output HART<sup>®</sup>" version.

The "freeze" function can be used to blank out larger, temporary interferences, e.g. very slow agitator, slide gate, ball valve in the stilling well. The last measured values in each case are present at outputs I and S, and in the display. The digital input is also taken into account when the empty-tank spectrum is being recorded (totalizer does not continue). Marker 6 in the display indicates that the digital input is active in the "freeze" function.



The function of the digital input is set as standard to "freeze". To switch the function to "hot start" or to deactivate it completely, the setting will need to be changed in the Service menu of the BM 70 M.

## 5 Measuring accuracy

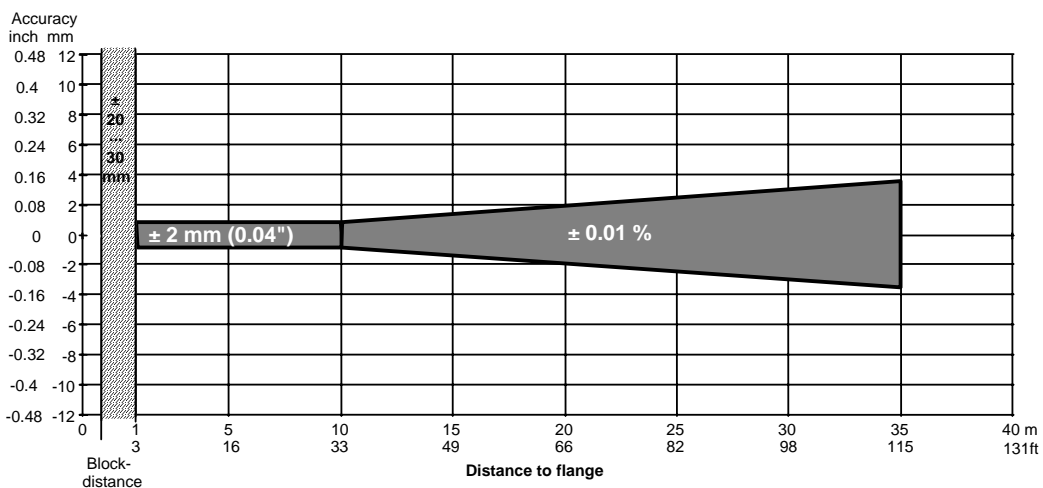
### 5.1 Reference conditions

Temperature +20°C / +68°F  
Pressure 1013 mbar abs. / 14.5 psia  
Air humidity 65%  
Highly reflecting product (e.g. water) with calm surface  
Tank diameter > 5 m / 16.4 ft  
Mounted at least 1/7 x tank height away from tank edge (BM 70 M: 1/5 x tank height)  
No interference reflections inside the radiation lobe ( $\pm 6...9^\circ$ ; see Section 6.1.1)

### 5.2 Error of measurement

Since the measuring process primarily determines distance, measuring accuracy can only be specified as a function of the distance. For that reason, all figures given in this Section 5 refer to the measured distance.

Only with antenna type 4 (200 mm / 7.87") or stilling well 100 - 200 mm dia. (4 - 8")



---

### 5.3 Repeatability

Repeatability is equal to half the value for the error of measurement.

### 5.4 Measured value resolution/hysteresis

Measured value resolution is 0.1 mm / 0.004" for BM 70 M.

Hysteresis is at least 20 times less than the error of measurement.

### 5.5 Transient recovery time

The transient recovery time is determined by the setting parameter "time constant" (1 ... 100 s).

The transient recovery time relative to 1% deviation from the steady-state value is approx. 4.6 times the time constant.

However, in the case of unusually rapid changes in level, the transient recovery time may deviate from this figure.

### 5.6 Long-term drift

The long-term drift is within the specified error of measurement.

### 5.7 Effect of ambient temperature

Temperature coefficient, signal output:

Ex-e current output HART <sup>®</sup>	< 100 ppm/°C (typically: 30 ppm/°C)
Ex-i current output HART <sup>®</sup>	< 100 ppm/°C (typically: 30 ppm/°C)
Current output	< 200 ppm/°C (typically: 70 ppm/°C)
Digital interfaces	no temperature effect

The temperature has no effect on the measured value as the device carries out a regular self-calibration.

The temperature of the atmosphere above the liquid product results theoretically in -1 ppm/°C for air.

When ascertaining temperature effects using reference measurements in liquid tanks, it needs to be remembered that liquids generally have a high coefficient of expansion (organic liquids: typically 0.15 %/°C)!

---

## 6 Operating conditions

### Hazardous-duty systems:

- The BM 70 M is certified in conformity with European Standard (ATEX) for use in Zone 0, 1 and 2 hazardous locations.
- The BM 70 M also has FM Approval (Factory Mutual) for CLASS I, DIV 1, GROUPS B,C,D; CLASS II/III, DIV 1, GROUPS E,F,G (in preparation)
- Attention is drawn to the information given on the nameplate and the specifications in the approval certificates.
- When carrying out installation, dismantling work or making electrical connections in the hazardous area, be sure to observe the pertinent wiring and installation regulations, e.g. as specified in VDE 0165.
- 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 signs of external damage and corrosion.
- Before opening the "flameproof enclosure" (e.g. to inspect the inside or for repair purposes) make absolutely certain in the hazardous location:
  - that the BM 70 M Level-Radar is disconnected from voltage, and then allow the prescribed waiting time of 22 minutes to elapse first,
  - and that there is no explosion hazard (gas-free certificate!).

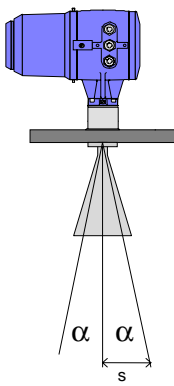
**Safety:**

- Operator control via the keys: on electrical safety grounds, operator control of the keys (below the display, with the housing open) may only be carried out by specialist personnel for service and repair work, on no account, however, when there is risk of explosion!
- Surface temperature: the housing of the signal converter can, in extreme ambient conditions, assume temperatures of more than 70°C (158°F)!

**6.1 Installation conditions**

**6.1.1 Transmission angle**

The transmission angle is defined as the angle  $\alpha$  to the vertical, in which the power density of the radar waves assumes half the value of the maximum power density (half-power beam width):



Antenna Type	Diameter mm (inches)	Transmissi on angle $\alpha$	Lobe expansion s per metre distance
Type 4	200 (7.87)	6°	10 cm (3.94")
Type 3s*	140 (5.51)	8°	14 cm (5.51")
Type 2s*	100 (3.94)	12° *	22 cm (8.67")
Type 1s*	80 (3.15)	16° *	30 cm (11.8")
Wave-Guide / stilling well	25-200 (0.98-7.87)	Propagation only inside the stilling well	

\* Should only be used in stilling wells; the transmission angle given applies to line-of-sight propagation, i.e. without stilling well.

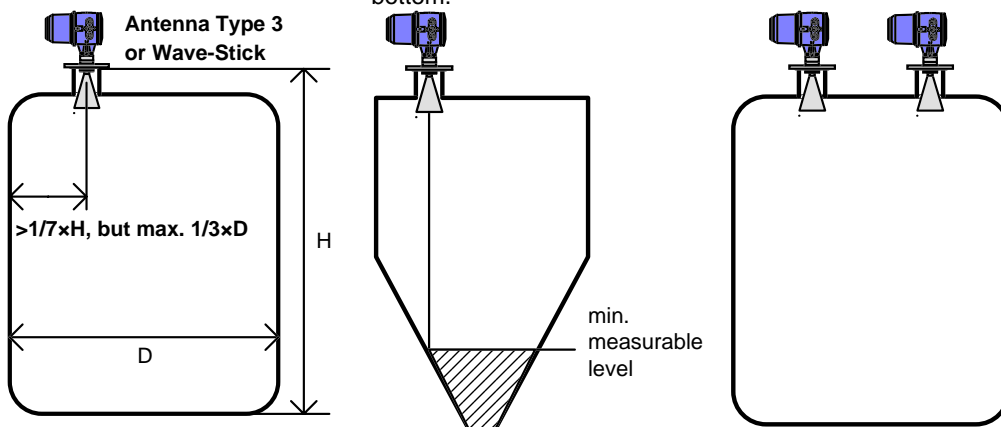
**6.1.2 Recommendations for positioning on the tank**

**A) Horn antenna or Wave-Stick without stilling well**

Recommended distance from the tank wall

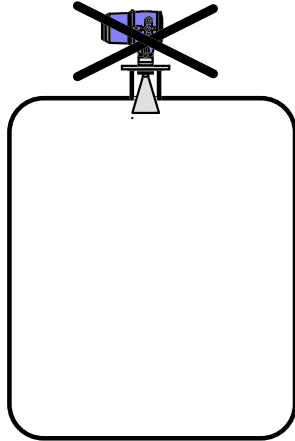
Lower measuring range limited when tank has tapered bottom.

Several BM 70 M can be operated in one tank.

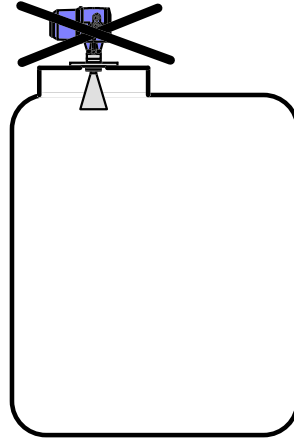


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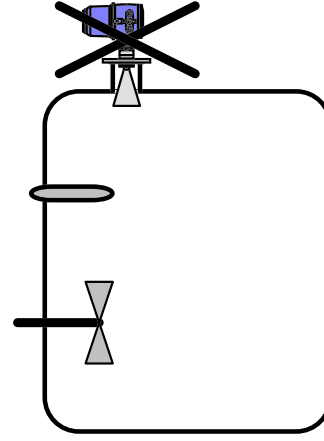
Do not position in tank centreline! (multiple reflections!)



Do not mount dead centre on manhole cover! (multiple reflections!)



Do not position above internals! (interference reflections!)

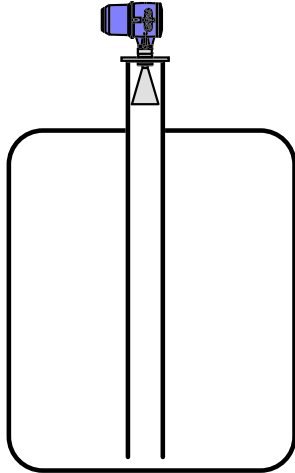


If these recommendations cannot be followed because of the tank geometry, please consult KROHNE.

### B) Stilling well or Wave-Guide

A stilling well or Wave-Guide may be mounted in any position on the tank.  
(For design layout: see also Section 6.1.4; for block distance: see Section 3.3).

Stilling well application



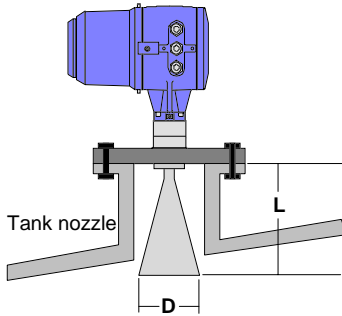


### 6.1.3 Mounting on tank fitting

#### A) Horn antenna

Should be mounted on the tank fitting as close to the horizontal as possible (deviation  $< \pm 2^\circ$ ).  
Exception: if product surface is not horizontal, (e.g. particulate materials) the flange can be aligned roughly parallel to it.

The antenna should project out of the fitting:

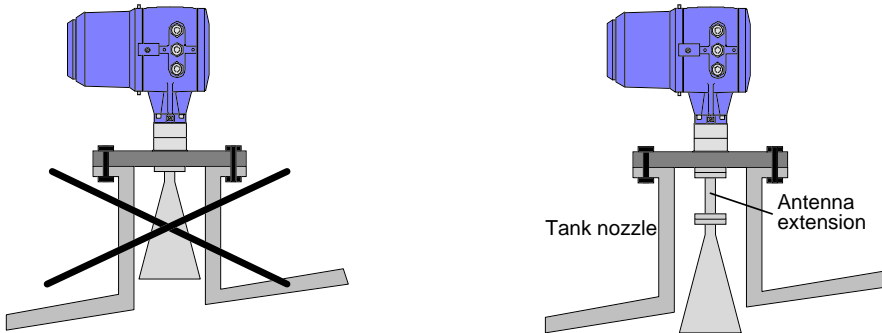


Antenna	Diameter D	Length l*
Type 4	200 mm (8")	335 mm (13.2")
Type 3	140 mm (5.5")	223 mm (8.8")

\* Hastelloy: + 30 mm (1.2")

(subject to change without notice)

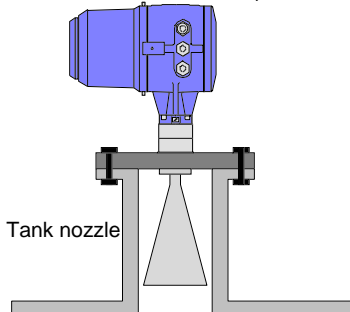
An antenna extension should be added if the antenna does not project out of the fitting:



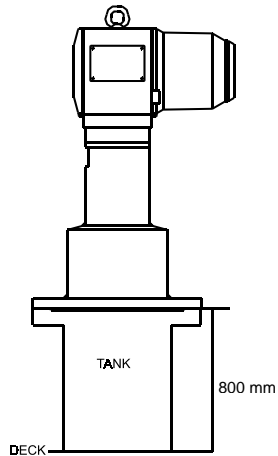
Antenna extensions are available from 100 to 2000 mm (3.94" to 78.74") in steps of 100 mm (3.94"). Several extensions can be joined up.

#### Exception:

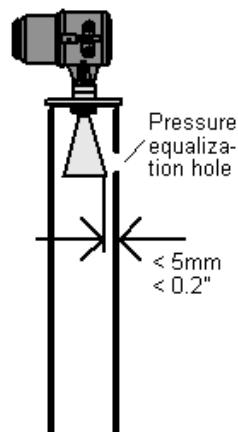
When the tank fitting is symmetrical, the antenna may end in the fitting so as to enlarge the measuring range (minimum dead zone to tank cover, see Sect. 3.3 "block distance" and Sect. 5.2 "error of measurement"):



## B) Solid antenna



### 6.1.4 Mounting on stilling wells/ trunks



Antenna Type	Outside diameter
1s	76 mm (2.99")
2s	100 mm (3.94")
3	140 mm (5.51")
3s	152 mm (5.98")
4s	200 mm (7.87")

If necessary, turn antenna to size!

Further requirements on stilling wells:

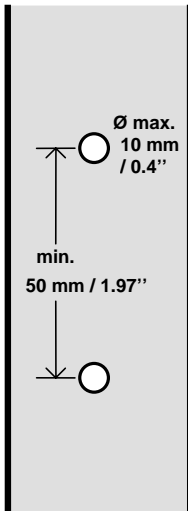
- The well must be electrically conductive.
- Minimum inside diameter of well: 40 mm (1.57"). (BM 70 M: 80 mm, better > 100 mm).
- If possible, use only smooth walled, straight stilling wells. If nevertheless an assembled stilling well is necessary, abrupt changes in diameter along the pipe should be less than 1 mm (0.04"). Surface roughness of the inside of the pipe should not be more than + 0.1 mm (0.004").
- For the BM 70 M the antenna types 1s, 2s, 3s or 4s have to be used to achieve a high measuring accuracy.

It is possible to measure through a full-bore open ball valve if the valve and the pipe adapters above and below the valve are relatively smooth-walled.

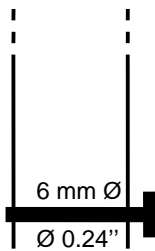
It is not possible to measure levels below the end of the stilling well.

To ensure equalization of pressure, drill one or two small holes in the stilling well above the maximum filling level.

If necessary, several holes can be drilled along the whole length of the pipe. All holes must be deburred. The holes should be as small as possible and spaced wide apart (Recommendation: see drawing below).



It is advisable to fit a reference point at the end of the stilling well in the form of a rod or screw of approx. 6 mm (0.24") diameter. See drawing below.



### 6.1.5 Wave-Guide

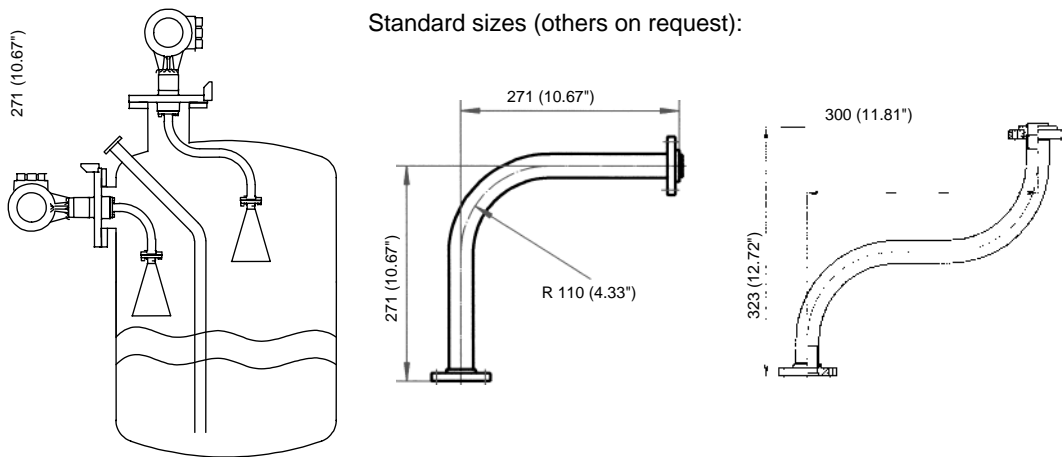
The "Wave-Guide" is a pipe with an outside diameter of 30 mm (1.18") and an inside diameter of 25 mm (0.98"), that is bolted direct to the BM 70 flange system (in the same way as an antenna extension). It functions like a stilling well and can be used for clean products. The Wave-Guide is not practical in conjunction with the BM 70 M as it will not provide high measuring accuracy.

Maximum length:

Ex:	max. 3 m (9.84 ft) (except tantalum: max. 1 m (3.28 ft)).
Non-Ex:	up to 3 m (9.84 ft) without additional support Pipes longer than 3 m (9.84 ft) need to be fixed at two points.

### 6.1.6 Curved antenna extensions

Rectangular and S-shaped extensions are available for particularly difficult operating conditions. Such extensions can be used in cases where the antenna is exposed to especially high temperatures and where there are problems of space, (e.g. to avoid internals; positioning the antenna away from the centre of symmetry; lateral mounting of the signal converter).



Dimensions in mm (inches)

### 6.1.7 Special options for the flange

Antenna heating/cooling device (> DN150/6")	Purging device (> DN100)
<p>Double-walled antenna for cooling or heating, e.g. to avoid condensation (recommended for liquid sulphur).                      max. differential pressure at antenna:                      Standard DN150 = 6 bar (87 psig)                      (information on other pressure levels provided on request)</p>	<p>With connection for purging the inside surface of the antenna to prevent heavy deposits of product or to heat or cool the antenna</p>

Antenna heating/cooling device (> DN150/6")	Purging device (> DN100)
<p>Hazardous-duty systems: In Zone 0, the temperature of the heating system and antenna may not exceed 80 % of the ignition temperature of the stored material. Continuous monitoring shall ensure, and operational inspections shall verify, that the 80% level of the ignition temperature stated in Point 1 above is not exceeded.</p>	<p>If a liquid is used for purging, this may interfere with the functioning of the BM 70 M during the process. Continuous purging with gas is not a problem as it does not interfere with measurements. The purge connection is closed off by the manufacturers with a ¼" screw. When this screw is removed to connect up a purging system, the operator is responsible for ensuring conformity with "Ex" requirements in connection with the purging circuit (e.g. fitting a flame trap).</p>

### 6.1.8 Ultimate installation on the tank

After carefully positioning the BM 70 M on the tank fitting flange (not forgetting the gasket), align the BM 70 M and the gasket.

Insert stud bolts and tighten nuts slightly (by hand). (These items not included with supply).

Tighten down stud bolts and nuts firmly. The torque is dependent on the strength properties of the stud bolts and the pressure rating of the tank.

## 6.2 Ambient conditions

### 6.2.1 Hazardous locations

BM 70 M Ex is suitable for use in hazardous locations of the following zones: 0, 1, 2

Temperature classes	T6...T2; danger groups: IIA...IIC
Further information	see Section 10

### 6.2.2 Ambient temperature of signal converter

BM 70 M with horn antenna or Wave-Guide:	-20 ... +55°C (-4 ... +131°F)
--	-------------------------------

A BM 70 sunshade should be fitted if the converter is located in the open with the likelihood of strong exposure to sunlight (see Section 6.1.9).

### 6.2.3 Flange temperature

Horn antenna, Wave-Guide ( $T_{amb}^* \leq 50^\circ\text{C}$ ):	-30 ... +130°C (-22 ... +266°F)
Horn antenna, Wave-Guide ( $T_{amb}^* \leq 55^\circ\text{C}$ ):	-30 ... +120°C (-22 ... +248°F)
High-temperature version with distance piece and FFKM gasket (Kalrez 4079 or Parofluor V3819-75)	-30 ... +250°C (-22 ... +482°F) **
Kalrez 2035 gasket	-30 ... +210°C (-22 ... +410°F)
Viton gasket	-30 ... +200°C (-22 ... +392°F)
FEP-sheathed gasket	-30 ... +200°C (-22 ... +392°F)

\*  $T_{amb}$  is the ambient temperature of the signal converter

\*\* Safety limit: +280°C (536°F)

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## 6.2.4 Ambient temperature limits

<b>Signal converter:</b> Measuring function OK, but LCD "freezes up" Functional upper limit, for max. 2 hours	min. - 40°C (-40°F) max. +70°C (+158°F)
<b>Flange system:</b> see Section 6.2.3	

## 6.2.5 Storage temperature

-20 ... +60°C (-4 ... +140°F)

## 6.2.6 Environment class

Locations exposed direct to open-air climate, D1 Severity in conformity with EN 60654-1

## 6.2.7 Protection category

Signal converter	IP 66 / IP 67 (equivalent to NEMA 6)
------------------	--------------------------------------

## 6.2.8 Shock resistance

The device has been found to withstand the impact test in conformity with EN 61010, Section 8.2, with 0.5 J energy, and the drop test to prEN 50178:1994.

## 6.2.9 Vibration endurance limit

Type test conditions	acc. to "IACS"
----------------------	----------------

## 6.2.10 EMC

The devices satisfy the requirements of EN 50081-1, EN 50082-2 and the NAMUR Recommendation.

## 6.3 Product conditions

### 6.3.1 Physical properties of the products

Physical properties (such as density, viscosity, conductivity, relative permittivity, magnetic properties, etc.) have no effect on measurement results.

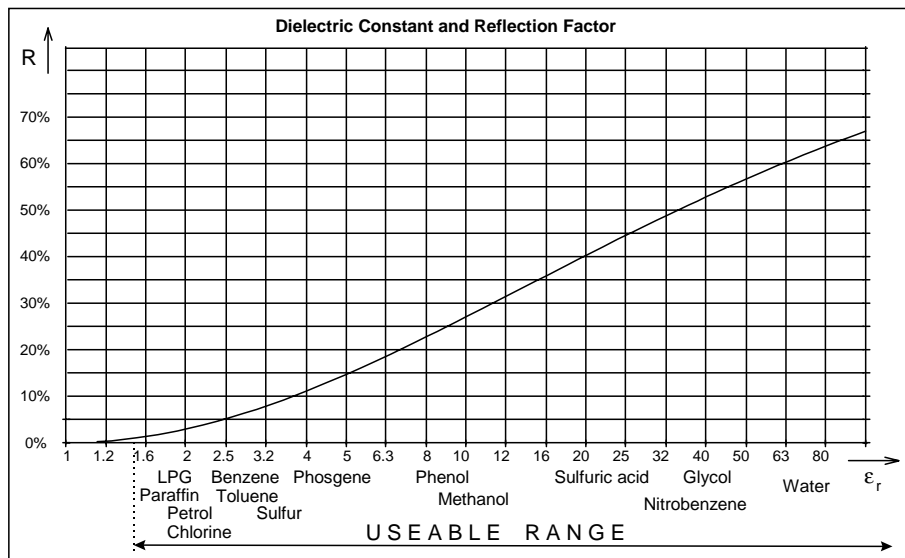
The relative permittivity is merely required to have a minimum value in order to ensure reliable measurements (see Section 6.3.2).

### 6.3.2 Relative permittivity ( $\epsilon_r \geq 1.5$ )

The (relative) permittivity of the product ( $\epsilon_r$ , Epsilon-R) determines the strength of the reflected signal. Measurement results are not affected so long as the reflected signal is strong enough, but reliability and the maximum measuring range are dependent upon the relative permittivity.

At  $\epsilon_r < 3$ , a stilling well should be used. The minimum relative permittivity of the product is approximately  $\epsilon_r = 1.5$ . (See also Section 7.5).

If the Wave-Stick is also to take measurements when immersed,  $\epsilon_r$  will need to be  $> 4$ .



### 6.3.3 Product limitations

Radar-based level measuring devices are not suitable for the following products:

- liquid ammonia
- liquid hydrogen
- liquid helium

### 6.3.4 Product temperature (unrestricted)

The product temperature is not a relevant factor, provided the ambient temperature (see 6.2.2) and the flange temperature (see 6.2.3) are within the specified limits.

### 6.3.5 Maximum allowable operating pressure

Flange system with horn antenna or Wave-Guide:

	PN 16	PN 25	PN 40
DN 80	16 bar (232 psig)	---	40 bar (580 psig)
DN 100	16 bar (232 psig)	---	38 bar (551 psig)
DN 150	16 bar (232 psig)	---	34 bar (493 psig)
DN 200	16 bar (232 psig)	25 bar (363 psig)	32 bar (464 psig)

Information on higher pressures supplied on request.

## 6.4 Maintenance

### Cleaning the antenna

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

The level of contamination at which such errors occur depends firstly on the product concerned, and secondly on the reflection index, which is mainly determined by the relative permittivity  $\epsilon_r$ . Regular cleaning, or use of the purging device (see Sect. 6.1.7), is advisable if the 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 bottom Teflon plug at the waveguide window (see Section 7.3 "Field assembly of the BM 70 M"). If cleaning agents are used, take material resistance into account!

## 7 Design

### Hazardous-duty systems

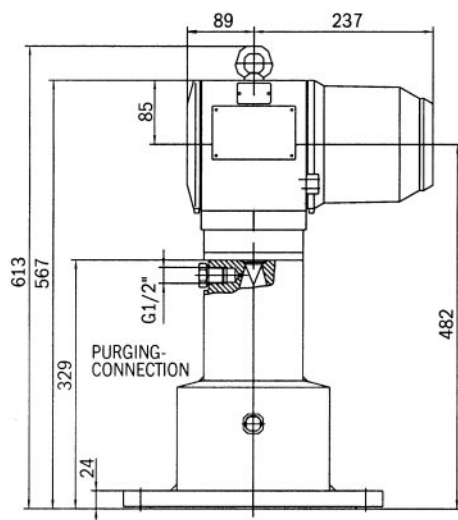
The BM 70 M-Ex is approved to European Standard EN 50014/18/19/20 for use in hazardous locations of Zones 0, 1 and 2.

Electronics compartment	Flameproof Enclosure "d"
Terminal compartment	Increased Safety "e" for signal output and power supply Optionally: Intrinsic Safety "i" for the signal output and Increased Safety "e" for the power supply. Special version: Flameproof Enclosure "d"
Pin coupler compartment	Increased Safety "e"

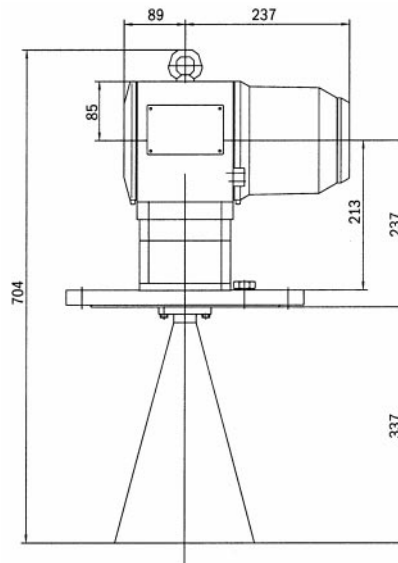
Further details are given in the Certificates of Conformity, see Section 10.

### 7.1 Dimensions and weights

SA version



V96 version





---

**Weights:**

Meter size		Standard antenna			Length		Weight	
DN (mm)	ANSI (")	Type	∅A (mm)	∅A (")	f (mm)	f (")	kg	lbs
200	8	4	200	7.87	335	19.19	30	66.14
80	3	1s	76	2.99	420	16.54	18	39.68
100	4	2s	100	3.94	620	24.41	19	41.89
150	6	3s	152	5.98	820	32.28	25	55.12
200	8	4s	200	7.87	820	32.28	32	70.55

\* Hastelloy: + 30 mm (1.12")

## 7.2 Replacement of the signal converter

Always disconnect from power source before commencing work!



### Hazardous-duty systems

Before replacing the signal converter (instrument "head") in the hazardous location, make absolutely certain that there is no explosion hazard (gas-free certificate). Allow the prescribed waiting time of 27 minutes to elapse before opening the housing!

1. Remove safety lock (see Sect. 9.3) with machinist's wrench, size 4 mm, and unscrew cover from the terminal box with the special wrench. If a sunshade is fitted, remove this first (see Section 6.1.9).
2. Disconnect all cables from the terminals in the terminal compartment, see Section 7.6.
3. Remove the 4 Allen screws M (Allen key size 5 mm) and lift off the signal converter. The flange unit (incl. waveguide window) will remain tight, also on pressurized tanks.



### Caution

On pressurized tanks, do not on any account remove the 4 screws H connecting the waveguide window to the BM 70 M flange!  
DANGER TO LIFE!

4. Install the new BM 70 M signal converter.
5. Check power voltage and fuse(s) (refer to instrument nameplate) and change or replace if necessary, see Sect. 9.2 and 9.3.
6. Reconnect all cables in the terminal compartment as described in Sect. 7.6.
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. 8.
8. Subsequently, record the empty-tank spectrum, see Sect. 8.6.12.

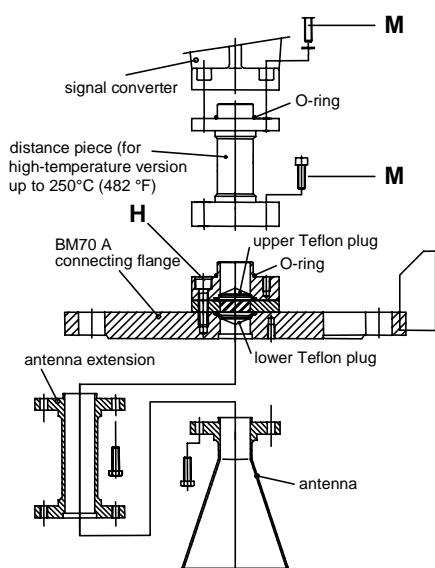


### Important

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

### 7.3 Field assembly

- When the BM 70 M needs to be field assembled, all required parts are included with the supply (stud bolts, washers, etc.).
- If supplied loose, bolt the waveguide window (flange assembly) or the distance piece to the BM 70 M. Tightening torque for the 4 Allen screws M (key size SW 5 mm): max. 8 Nm ~ 0.8 kpm.
- Note: The upper Teflon plug must be absolutely dry and clean! Moisture and dirt will negatively affect functionality of the BM 70 M!
- Bolt antenna and antenna extension together: torque for the 3 stud bolts: max. 8 Nm ~ 0.8 kpm.
- Do not on any account detach screws H!



### 7.4 Materials of construction

Check the materials of the antenna, extension, flange, gaskets, and PTFE (contained in all versions) for compatibility with the product!

#### 7.4.1 Signal converter

Housing	stainless steel W 1.4435 (or 1.4539) with electrostatic powder coating.
Sight window	borosilicate glass

## 7.4.2 Flange system

(Antenna, extensions and flange or flange plating)

Available materials for BM 70 M flange systems (in contact with the product):

### Version V96 antenna or Wave-Guide:

Material	DIN No.	AISI equivalent
Stainless steel	1.4571	316 Ti
Stainless steel	1.4435	316 L
Hastelloy C4	2.4610	-
Hastelloy B2	2.4617	-
Titanium	3.7035	-
Tantalum	-	-
Monell 400	2.4360	-
Inconell 600	2.4816	-

(Information on other materials supplied on request)

### Version SA:

Material	DIN No.	AISI equivalent
Stainless steel	1.4435	316 L

## 7.4.3 Seals and gaskets

Temperature limitations due to Ex approval; see Part 2 of this installation and operating instructions.

Responsibility as to suitability rests solely with the user.

Available materials for internal device seals and gaskets in the flange system in contact with the product:

### Version V96:

Material	Temperature resistance
FFKM (Kalrez 4079 or Parofluor V8545-75)	250°C/482°F (safety limit 280°C / 536°F)
DuPont Kalrez 2035	210°C/410°F
Viton (FPM)	200°C/392°F
FEP-coated	200°C/392°F

### Version SA:

Material	Temperature resistance
FPM (Viton)	200°C/392°F
Kalrez 6375 (others optional)	250°C/482°F

PTFE is also in contact with product.

## 7.5 Process connection

The process connection is by way of standard flanges sized DN 80-200 or equivalent ANSI sizes (dependent on the version).

## 7.6 Electrical connection

The electrical connection for supply power and signal inputs/outputs is made in the terminal compartment (Ex-e) of the signal converter. Observe requirements specified in VDE 165, and consult the safety advice given in Section 9.4.



In the BM 70 M version with intrinsically safe signal output, only certified intrinsically safe equipment may be connected to the blue terminals, even if the device is not operated in the hazardous area!

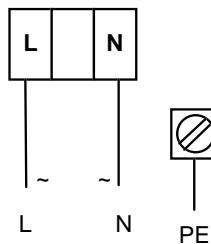
Terminals	conductor cross-section 0.5 - 2.5 mm <sup>2</sup> (solid conductor: max. 4mm <sup>2</sup> )
PE safety conductor and/or FE functional ground	U-clamp terminal (max. 4 mm <sup>2</sup> conductor cross-section) (see also terminal assignments below and in Sect. 9.4)
Cable entries	3x M25x1.5 (with standard cable gland: cable clamping area = 9-16 mm)
Signal cable shielding	required for RS 485 line recommended for current output when line lengths > 100 m (350ft)
"Ex" equipotential bonding:	U-clamp terminal (max. 4 mm <sup>2</sup> conductor cross-section) on "neck" of signal converter

### Rated temperature of power cables:

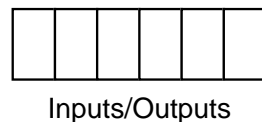
Version	Max. flange temperature	Rated temperature of power cables
w/o high temperature distance piece	≤ 100°C/212°F	70°C/158°F
	> 100°C/212°F	80°C/176°F
with high temperature distance piece	≤ 200°C/392°F	70°C/158°F
	> 200°C/392°F	80°C/176°F

### Terminal assignment:

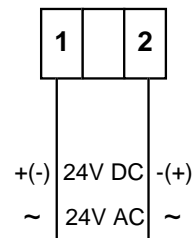
#### Supply power



Connections for 115/230 V AC

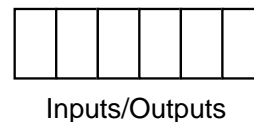


Inputs/Outputs



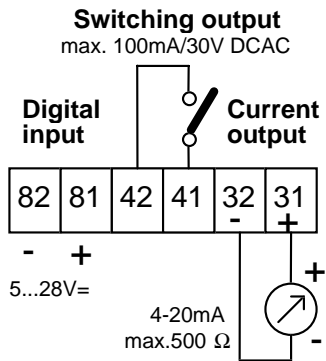
+(-) 24V DC -(+)  
~ 24V AC ~ FE

Connections for 24 V DC/AC (any polarity)  
Connection of an FE functional ground is not mandatory

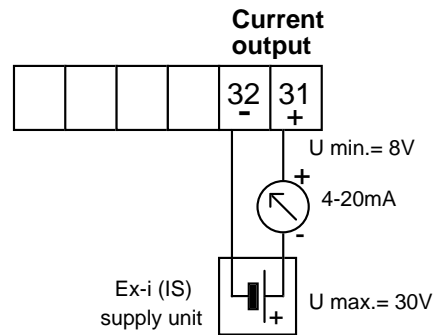


Inputs/Outputs

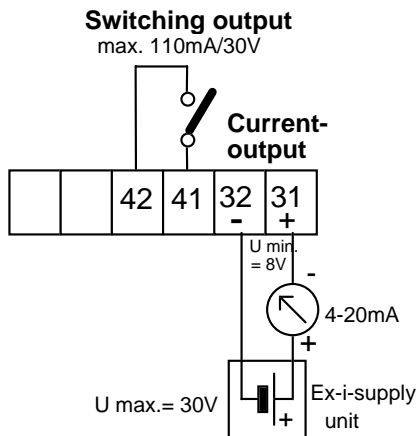
**Current output HART®, Ex e:**



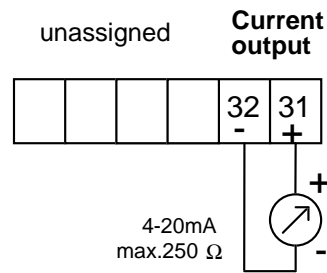
**Ex-i current output HART®:**



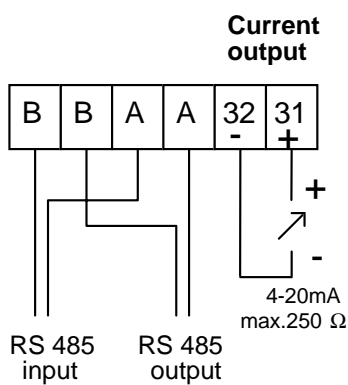
**Ex-i Current output HART® with switching output:**



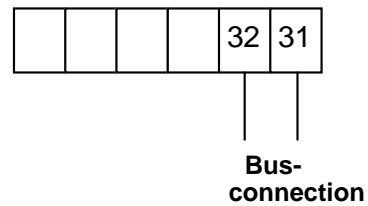
**Current output (non-communicable):**



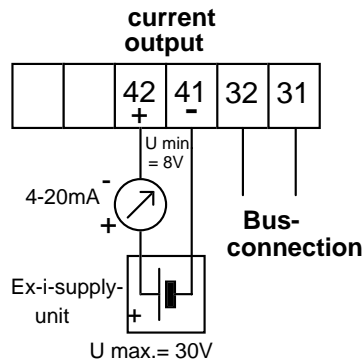
**RS 485 version:**



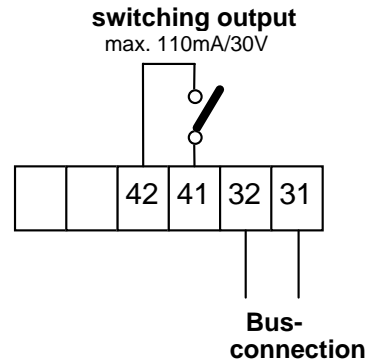
**PROFIBUS-PA or Foundation Fieldbus (FF)**



### PROFIBUS-PA / FF with current output:

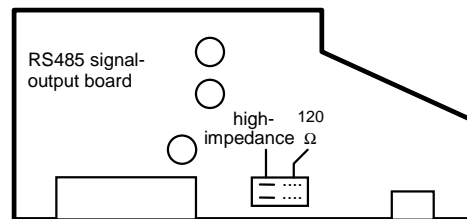


### PROFIBUS-PA / FF with switching output:



## 7.7 Terminating resistor for the RS 485 interface

A selector plug on the RS 485 board allows optionally a high-resistance termination (pre-setting) or a terminating resistor of 120 Ohm at the RS 485 connections A and B. For this purpose, the housing (flameproof enclosure) of the BM 70 M signal converter needs to be opened (see Sect. 9.3) and the selector plug turned 180°, see sketch on the right.



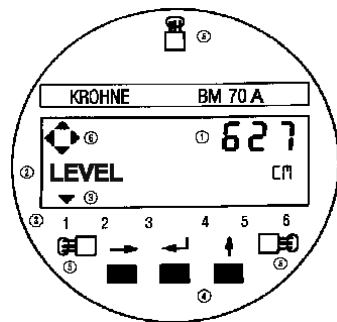
## 8 User interface

### 8.1 Local display

In the versions with local display at the BM 70 M signal converter, configuration can be carried out directly at the device. If a local display is not featured, the PC-CAT program (see Sect. 8.12) must be used to change the parameter setting (assuming a communicable interface is provided).

The available display is:

- Standard display with 2-line LCD display (7 mm high digits for the measured value).



#### Standard display

- 1 Numerical display of measured value
- 2 Alphanumeric display of function/unit
- 3 6 markers to indicate measuring status
- 4 3 keys for configuration and error inquiry
- 5 magnetic sensors for control through the closed housing (function same as the 3 keys)
- 6 Compass field, signals actuation of a key

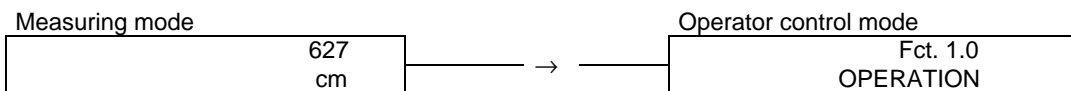
## 8.2 Function of the keys

The three keys have the following functions:

→ (Cursor key):	- selects the configuration menu - branches the menu to the next lower level, - moves the cursor* to the right to the next column.
↑ (Select key):	- branches the menu to the next digit in the same level, - changes the content (digit, character) at the cursor* position.
↵ (Enter key):	- selects the error memory, - branches the menu to the next higher level, - stores newly entered parameters, - executes displayed functions.

\* The cursor position is signalled by flashing of the character or selected point at the appropriate place.

### To start operator control:

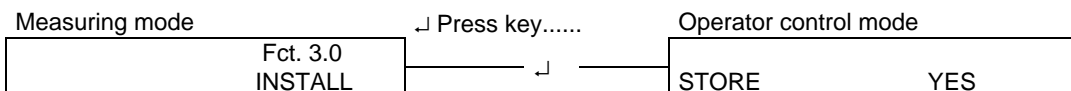


#### Note:

When "YES" is set under Fct. 3.4.2 and ENTRY CODE "CodE1 -----" appears in the display, the → key must be pressed  
The 9-keystroke Entry Code1 must then be entered:  
Factory setting: →→→↑↑↑↵↵↵ (each keystroke confirmed in the display 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.



### New parameters not to be stored

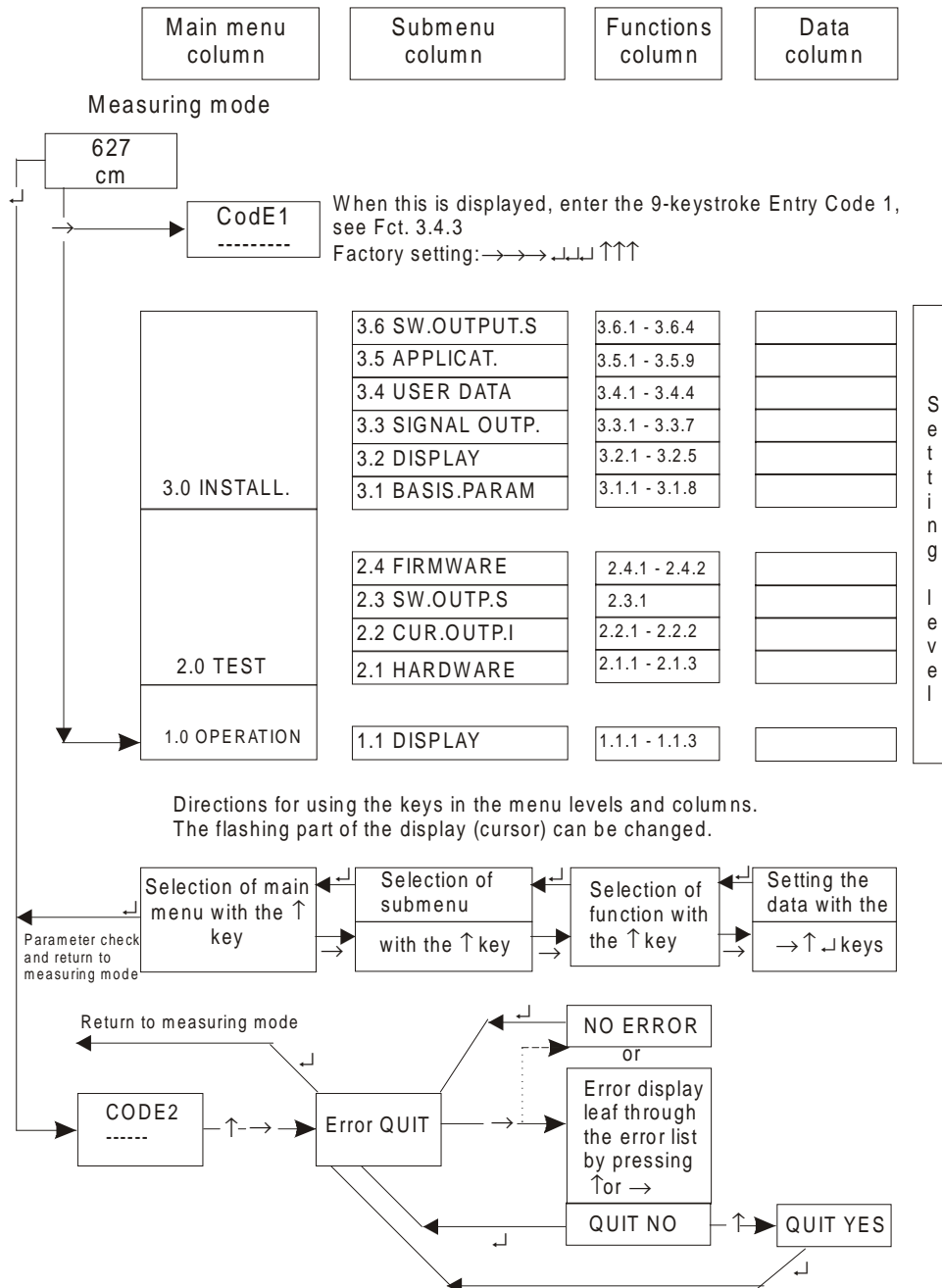
Press ↑ key to display "STORE.NO". Measuring mode continued with the "old" parameters after pressing the ↵ key; the "START" message is shown until a measured value is determined.

If instead you wish to return to Configuration, press the ↑ key first until "RETURN" is displayed, and then the ↵ key.

### Store new parameters

Confirm by pressing the □ key, "START" is displayed, and the measuring mode is continued with the new parameters.

### 8.3 Operator control concept



**Note:**

If after pressing a key "NO ACCESS" is displayed, this means that the keypad is temporarily blocked owing to a configuration access via the signal output. The keys are available again after Communication has finished.

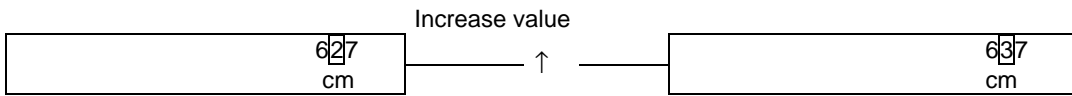


---

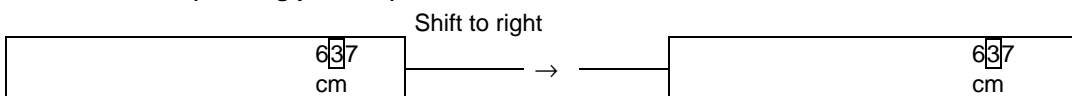
### Examples of key functions

The cursor (flashing part of display) is shown boxed in by dotted lines in the following description

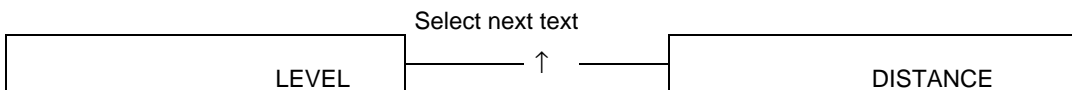
#### To change numbers



#### To shift cursor (flashing position)

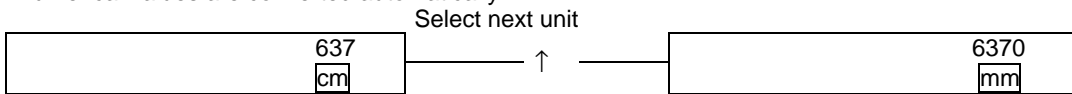


#### To change the text

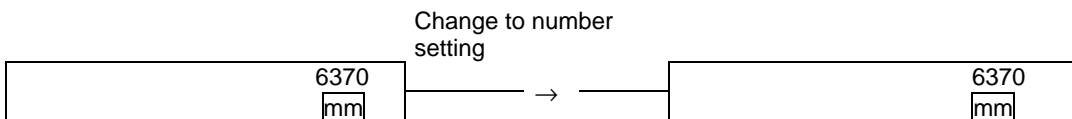


#### To change the unit (tank height)

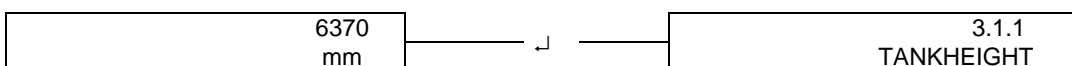
Numerical values are converted automatically



#### To revert from unit to number setting



#### To revert to function display



#### 8.4 Table of settable functions (Versions 4.04 – 4.06)

Function (Fct.)	Enter range	Default value	Description
<b>1.0 OPERATION</b>			
<b>1.1 DISPLAY</b>			
1.1.1 FCT.DISP	Options LEVEL DISTANCE CONVERSION REFLECTION	LEVEL	Select function of display (value to be displayed).
1.1.2 UNIT.LENGTH	Options m cm mm inch Ft PERCENT BARGRAPH	Meter [m]	Select unit for value of length to be displayed (level/distance).
1.1.3 UNIT. CONV	Options m3 l US Gal GB Gal Ft3 bbl PERCENT BARGRAPH USER UNIT	Cubic meter [m3]	Select unit for conversion value to be displayed ("volume table").
<b>2.0 TEST</b>			
<b>2.1 HARDWARE</b>			
2.1.1 MASTER	Special function		Tests the hardware of the master.
2.1.2 DISPLAY	Special function		Tests the hardware of the display.
2.1.3 STATUS	Options Module DIS Module MW		Displays ID-Number and Status Bytes
<b>2.2 CUR.OUTP.I</b>			
2.2.1 VALUE I	Value display		Displays the actual value of the current output.
2.2.2 TEST I	Options 2 mA 4 mA 6 mA 8 mA 10 mA 12 mA 14 mA 16 mA 18 mA 20 mA 22 mA	2 mA	Output of selected value to the current output.  IMPORTANT !!! With safety inquiry because of direct access to the current output !!!  (Exi = min. 3.6 mA)

Function (Fct.)	Enter range	Default value	Description
<b>2.3 SW.OUTPUT</b>			
2.3.1 TEST S	Options OPEN CLOSED	OPEN	Switching output on/off.  IMPORTANT !!! With safety inquiry because of direct access to the switching output !!!
<b>2.4 FIRMWARE</b>			
2.4.1 MASTER	Display		Displays the firmware version of the master.
2.4.2 DISPLAY	Display		Displays the firmware version of the display.
<b>3.0 INSTALL.</b>			
<b>3.1 BASIS.PARAM</b>			
3.1.1 TANKHEIGHT	Options, unit m cm mm inch Ft  Enter 0.50 [m]...max. tank height	M  10.00 m* / 20.00 m *	To input the tank height. The tank height is defined as the vertical distance between the bottom edge of the flange and the tank bottom.  The unit entered here is also used for all other length inputs.
3.1.2 BLOCKDIST	Enter 0.10 [m] ... tank height	0.50 m *	To input the block distance. The block distance marks the non-measurable range below the bottom edge of the flange.
3.1.3 ANTENNA	Options STANDARD	STANDARD*	Selection of the antenna type.
3.1.4 ANT.EXTENS	Enter 0.00 [m] ... Tank height	0.00 m *	To input the length of the antenna extension.
3.1.5 DIST.PIECE	Enter 0 ... 2000 [mm]	0 mm *	To input the length of the flange distance piece in [mm] (high-temperature version = 120 mm).
3.1.6 STILLWELL	Options NO YES  If "YES": Enter (restraint) STILLWELL DIA. 25 ... 200 [mm]	NO  100 mm	Select: with or without stilling well. When "YES" selected, the inside diameter of the stilling well is additionally entered in [mm].
3.1.7 REF.OFFSET	Enter -10.00 ... + 10.00 [m]	0.00 m	To input the reference offset (relocation of the upper reference point).

Function (Fct.)	Enter range	Default value	Description
3.1.8 TB. OFFSET	Enter -100.00 ... + 100.00 [m]	0.00 m	To input the tank bottom offset (relocation of the lower reference point).
<b>3.2 DISPLAY</b>			
3.2.1 FCT.DISP.	Options LEVEL DISTANCE CONVERSION REFLECTION	LEVEL	Select function of the display (value to be displayed).
3.2.2 UNIT.LENGTH	Options m cm mm inch Ft PERCENT BARGRAPH	Meter [m]	Select unit for length value to be displayed (level/distance). The unit selected here is used only for display of length values.
3.2.3 UNIT.CONV	Options m3 l US Gal GB Gal Ft3 bbl PERCENT BARGRAPH USER UNIT	Cubic meter [m3]	Select unit for conversion values to be displayed ("volume table"). The unit selected here is used only for display of the conversion value
3.2.4 USER UNIT	Text entry 10 ASCII characters	_____	Input of freely programmable unit for the conversion table (max. 10 characters).
3.2.5 ERROR MSG.	Options NO YES	YES	Select whether error messages are to be shown in the display
<b>3.3 SIGNAL.OUTP.</b>			
3.3.1 FUNCTION I	Options OFF LEVEL DISTANCE CONVERSION REFLECTION SW.OUTP.	LEVEL	Select function of the current output (measured value to be displayed, or OFF = current output switched off = constant 4 mA).
3.3.2 RANGE I	Options 4-20 mA/E22 4-20 mA/E2 4-20 mA	4-20 mA/E22	Select the range for the current output and error output.
3.3.3 SCALE 4 mA	Enter -200.00 ... +200.00 [m] 0.00... 99999.99 [m3] 0 ... 100 [Refl.]	0.00 m 0.00 m3 0	Input the lower range value for output to the current output. (Input is dependent on the selected function of the current output. The values for level and distance include the tank bottom and reference offset, resp.).

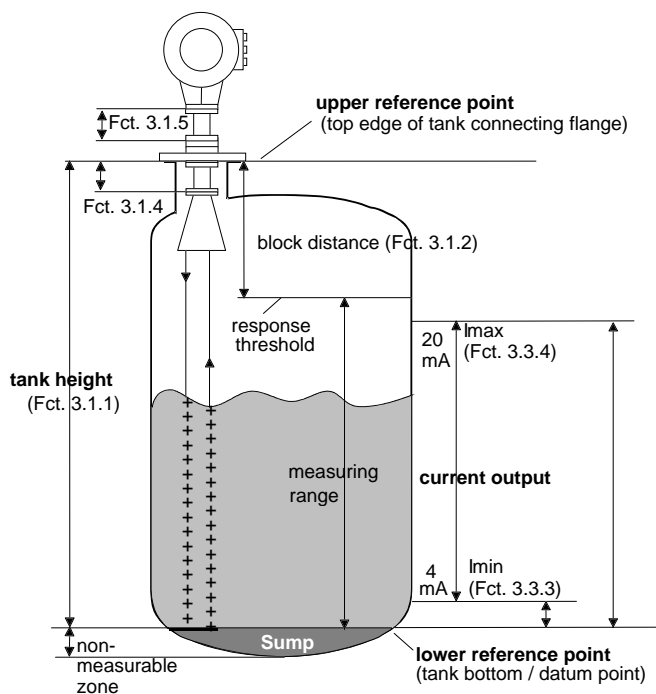
Function (Fct.)	Enter range	Default value	Description
3.3.4 SCALE 20 mA	Enter -200.00 ... +200.00 [m] 0.00 ... 99999.99 [m3] 0 ... 100 [Refl.]	10.00 m * 10.00 m3 100	Input of the full-scale range for output to the current output. (Input is dependent on the selected function of the current output. The values for level and distance include the tank bottom and reference offset, resp.).
3.3.5 BAUDRATE	Options 1200 Bd. 2400 Bd. 4800 Bd. 9600 Bd. 19200 Bd. 38400 Bd.	19200 Bd. *	Select the baud rate for the Communication interface (not relevant to HART® via current output). (For Fct. 3.3.7 = PROFIBUS-PA or F.FOUND.: deviating options.)
3.3.6 ADDRESS	Enter 0 ... 255	0	Input of the device address for Communication. (For Fct. 3.3.7 = PROFIBUS-PA or F.FOUND.: deviating input range)
3.3.7 PROTOCOL	Options HART® (MODBUS) (PROFIBUS-PA) (F.FOUND.)	HART®	Select the Communications protocol. (only when appropriate hardware provided)
<b>3.4 USER DATA</b>			
3.4.1 LANGUAGE	Options GB/USA D F I E P S	GB/USA *	Select language to be used in the display (English, German, French, Italian, Spanish, Portuguese, Swedish)
3.4.2 ENTRY CODE1	Options NO YES	NO	Switch the access lockout for the configuration menu on/off.
3.4.3 CODE 1	Enter code	RRREEUUU	Input of the Entry Code.
3.4.4 LOCATION	Text	BM70-00	Input of a max. 8-character device identifier.
<b>3.5 APPLICAT.</b>			
3.5.1 AUTO TANKH.	Special function		Automatic determination of the tank height

Function (Fct.)	Enter range	Default value	Description
3.5.2 EMPTY.SPEC.	Options OFF ON RECORD	OFF *	Switch the empty-tank spectrum (profile of the empty tank) on/off, or make new recording.
3.5.3 TIMECONST.	Value 10... 100 [s]	30 s	Input of the time constant for measured-value filtering (low-pass).
3.5.4 TRACING.VEL.	Value 0.01 ... 1.00 [m/Min]	0.10 m/min	Input of the maximum rate of change in the level that can occur in operation.
3.5.5 MULT.REFL.	Options NO YES	NO	Switch the multi-reflection identifier on/off.
3.5.6 BD-DETECT	Options NO YES	YES	Switch the block distance (overflow) detector on/off.
3.5.7 FUNCT. FTB	Options OFF PARTIAL	OFF	Select function of the tank bottom tracking system.
3.5.8 EPSILON R	Enter 1.1000 ... 8.0000	2.0000	Input of the relative permittivity of the product for the tank bottom tracking system.
3.5.9 TANKTYPE	Options STORAGE TANK PROC.TANK.	PROC.TANK.	Select the tank type.
<b>3.6 SW.OUTP.S</b>			
3.6.1 FUNCTION S	Options OFF LEVEL DISTANCE CONVERSION REFLECTION ERROR OPEN ERROR CLOSED	ERROR OPEN	Select the function of the switching output.
3.6.2 TYPE S	Option HIGH LOW	HIGH	Select type of limit value for the switching output. (not applicable to Function OFF, ERROR OPEN or ERROR CLOSED)

Function (Fct.)	Enter range	Default value	Description
3.6.3 THRESHOLD	Value -200.00 ... +200.00 [m] 0.00 ... 99999.99 [m3] 0 ... 100 [Refl.]	5.00 m 5.00 m3 50	Input of the threshold value for the switching output. (Input is dependent on the function of the switching output. The values for level and distance include the tank bottom and reference offset, resp.)
3.6.4 HYSTERESIS	Value 0.00 [m] ... Tank height 0.00 ... 99999.99 [m3] 0 ... 100 [Refl.]	0.10 m 0.10 m3 10	Input of the hysteresis for the switching output. (Input is dependent on the function of the switching output.)

\*:Default values following a parameter reset (use of a new EEPROM not yet described).  
The factory setting for the parameters marked with \* is dependent upon the device version and customer specifications (if the tank height is known at the time the order is placed).

## 8.5 Configuration examples



### 8.5.1 Level measurement (example)

Tank height	(Fct. 3.1.1)	6.00 m
Antenna extension	(Fct. 3.1.4)	0.20 m
Block distance	(Fct. 3.1.2)	0.70 m
Response threshold or maximum measurable level = 5.30 m (calculated from lower reference point)	= tank height - block distance (Fct. 3.1.1) (Fct. 3.1.2)	= 6.00 m - 0.70 m
Current output I	Function I (Fct 3.3.1)	LEVEL
	Range I (Fct. 3.3.2)	4 - 20 mA
	Scaling 4 mA (Fct. 3.3.3)	0.00 m, equivalent to 4 mA
	Scaling 20 mA (Fct. 3.3.4)	5.00 m, equivalent to 20 mA
Switching output	Function S (Fct. 3.6.1)	LEVEL
	Type S (Fct. 3.6.2)	LOW (= below threshold)
	Threshold (Fct. 3.6.3)	5.00 m
	Hysteresis (Fct. 3.6.4)	0.10 m
Display	Function, display (Fct. 3.2.1)	LEVEL
	Unit, length (Fct. 3.2.2)	m (meters)



**Note:**

Display and outputs can also be used for different measured variables, e.g.: display for conversion, current output I for level, and switching output S for error messages.

The value for Scaling 20 mA should not be greater than the response threshold.

### 8.5.2 Volume measurement (example)

- In order to be able to measure volume with the BM 70 M, a conversion table (volume table) needs to be compiled with the PC-CAT program (see Sect. 8.12).
- By means of the volume table, various levels are allocated to specific volumes previously calculated or measured out.
- In the case of non-symmetrical tanks, e.g. tanks with dished bottom, the accuracy of volume measurement will depend on the number of set "level/volume pairs". The maximum number of pairs (points) that can be set is 50; the volume is linearly determined (interpolated) between 2 points.

In the following example, 4 data pairs have been programmed:

Volume table	Unit volume (Fct. 3.2.3): m <sup>3</sup>			
	Set table (PC-CAT)	Point	Level	Volume
		1	0.00 m	0.25 m <sup>3</sup>
		2	0.25 m	0.70 m <sup>3</sup>
		3	0.50 m	1.40 m <sup>3</sup>
		4	5.30 m	16.80 m <sup>3</sup>
Tank height (Fct. 3.1.1):	6.00 m			
Antenna extension (Fct. 3.1.6)	0.20 m			
Block distance (Fct. 3.1.2)	0.70 m			
Response threshold, maximum measurable level = 5.30 m, equivalent to a volume of 16.80 m <sup>3</sup> (calculated from lower reference point)	= tank height - block distance (Fct. 3.1.1) (Fct. 3.1.2) = 6,00 m - 0,70 m			



Current output I	Function I (Fct 3.3.1)	CONVERSION
	Range I (Fct. 3.3.2)	4 - 20 mA
	Scaling 4 mA (Fct. 3.3.3)	0.00 m <sup>3</sup> , corresponds to 4 mA
	Scaling 20 mA (Fct. 3.3.4)	16.80 m <sup>3</sup> , corresponds to 20 mA
Switching output	Function S (Fct. 3.6.1)	LEVEL
	Type S (Fct. 3.6.2)	LOW (=if level drops below threshold)
	Threshold(Fct. 3.6.3)	5.00 m
	Hysteresis (Fct. 3.6.4)	0.10 m
Display	Function, display (Fct. 3.2.1)	CONVERSION
	Unit, conversion (Fct. 3.2.2)	m <sup>3</sup> (cubic meter)

## 8.6 Description of functions

### 8.6.1 Choice of units

#### Level/distance units

Select under Fct. 3.1.1 TANKHEIGHT

- m
- cm
- mm
- inch
- Ft

The unit selected here is also valid for the following functions:

Block distance	Fct. 3.1.2
Antenna extension	Fct. 3.1.4
Scaling 4 mA value, current output	Fct. 3.3.3
Scaling 20 mA value, current output	Fct. 3.3.4
Range for partial tank bottom tracing	Fct. 3.5.2
Threshold (limit value), switching output	Fct. 3.6.3
Hysteresis, switching output	Fct. 3.6.4
Tracking speed,	Fct. 3.5.4 (in m/min when Fct.3.1.1 = m, cm or mm or in ft/min when Fct.3.1.1 = inch or ft)

The Fct. 3.2.2 (length unit for display) can be set independently of the unit selected under Fct. 3.1.1.

#### Conversion units

By conversion is meant the transposition of an arbitrary level value into a "conversion value" (usually volume), so as, for example, to realise a non-linear function as a factor of the level. Options under Fct. 3.2.3 UNIT.CONV.

- m<sup>3</sup>
- l (= litres)
- US Gal
- GB Gal (Gal = gallons)
- Ft<sup>3</sup>
- bbl (petroleum barrels)

---

The unit selected here is also valid for the following functions:

Scaling 4 mA value, current output	Fct. 3.3.3
Scaling 20 mA value, current output	Fct. 3.3.4
Threshold (limit value), switching output	Fct. 3.6.3
Hysteresis, switching output	Fct. 3.6.4

Display range:

0.00	-	30000.00	m <sup>3</sup>
0	-	9999999	Liter
0	-	7925161	US Gal
0	-	6599265	GB Gal
0.0	-	999999.9	Ft3
0.0	-	99999.9	bbl (petroleum barrel)



**Note:**

When the display is set to Liter, ft<sup>3</sup> or Barrel, it is possible that the max. volume will no longer be shown. In such cases, the special symbol "==" is displayed and a change possibly made to a different unit. The current output will in any case output the correct value.

Conversion measurement requires that a conversion table be set with the PC-CAT program. By means of this table a conversion value is allocated to each level value (level / conversion pairs). The values are linearly established (interpolated) between 2 points.

Also, for the local display an arbitrary (max. 10-character) text (Fct. 3.2.4) can be defined as a unit under Fct. 3.2.4. Internally, this "user unit" is treated in the conversion in the same way as "m<sup>3</sup>".

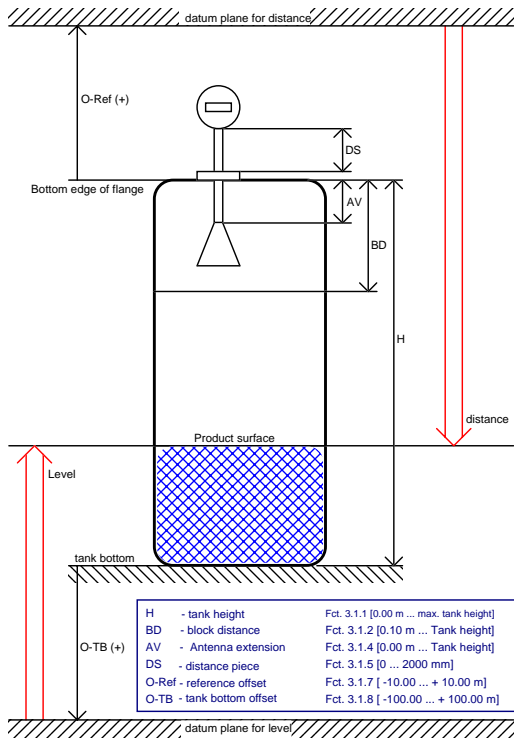
Examples of application and setting: see Sect. 8.5

**Reflection units**

The measuring range for "reflection" has a fixed setting of 0...100 (whole numbers). The "reflection" measured value is a relative measure of the strength of the reflected signal, converted into an exponential scale: each number step is approximately equivalent to a change by 0.4 dB; in other words, about 8 steps signify a doubling of the signal strength. At full reflection, a value of approx. 90...100 is measured.

Where measuring distances are greater, the natural weakening of the signal is automatically allowed for in the measured value (does not apply to stilling wells, i.e. when Fct. 3.1.6 = YES). The measured reflection can be regarded as being a measure of the reflectivity of a product.

## 8.6.2 Vessel (tank) height



### Fct. 3.1.1 TANKHEIGHT

- Definition of the tank height for the BM 70 M: Distance between the top edge of the tank fitting and the lower reference point.
- The lower reference point is that "point" in the vessel on which the microwaves emitted by the BM 70 M impinge and from which they are reflected. This can be the tank bottom (symmetrical tank with flat bottom) or the non-horizontal part of the bottom (e.g. tank with dished bottom) or an additionally fitted plate. The BM 70 M cannot measure below the lower reference point (usually a "sump" is left in the tank, see diagram in Sect. 8.5).
- Selection of unit, see Sect. 8.6.1.
- Setting ranges for the tank height BM 70 (standard):

00.50	-	40.00	m
0050	-	4000	cm
00500	-	40000	mm
0019.7	-	1574.74	inch
001.64	-	131.22	ft

For BM 70 M: max. 35m / 1377.9 inch / 114.8 ft

- Depending on the version, it is also possible to set an upper limit for the tank height. The maximum value can be increased by KROHNE Service to up to 100 m.
- The tank height set at this point is simultaneously the upper limit of the setting ranges for the following functions:
 

Block distance	Fct. 3.1.2
Antenna extension	Fct. 3.1.4
Hysteresis, switching output	Fct. 3.6.4
- If the tank height is changed to a value greater than 30 m, a new empty spectrum must subsequently be recorded, see Sect. 8.6.12.

### 8.6.3 Block distance, antenna type and antenna extension

#### Fct. 3.1.2 BLOCKDIST

- Caked deposits or contamination of the antenna, for example, can cause faulty measurements directly below the antenna. The function "block distance" is used to specify a zone below the flange in which measurements are not to be carried out.
- Signals within the block distance are suppressed; a rise in the level above this limit will result in a measurement corresponding to a distance = block distance, when Fct. 3.5.6 BD-DETECT = ON.
- Unit and setting range: same as Fct. 3.1.1 TANKHEIGHT.
- Recommended minimum value (see also Sect. 3.3):
  - for stilling wells
  - antenna length + 300 mm
  - all other versions in storage tanks:
    - antenna extension + antenna length + 100 mm
    - all other versions in process tanks:
      - antenna extension + antenna length + 200 mm

#### Fct. 3.1.3 ANTENNA

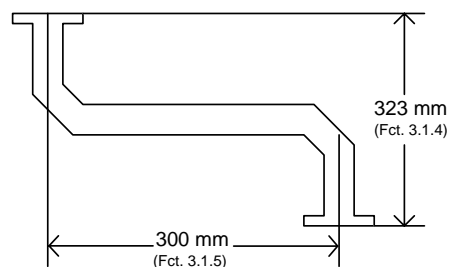
- The antenna type is factory-set here.
- STANDARD
- BM 70 M: only STANDARD setting possible.

#### Fct. 3.1.4 ANT.EXTENS.

The length of the supplied antenna extension is factory-set here.

- 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 M allows for this length when measuring. After changing any antenna extension, record a new empty spectrum, see Sect. 8.6.12. When a curved antenna extension is used, only the vertical component (vertical offset) should be entered here.

Example (S-shaped extension): Fct. 3.1.4 = 323 mm.



### 8.6.4 Distance piece

#### Fct. 3.1.5 DIST.PIECE

The length of any supplied distance piece above the mounting flange is factory-set here.

- Setting range: 0 ... 2000 mm
- Default value: 0 mm

The value of 120 mm should be entered for the high-temperature version of the flange system.

When a curved antenna extension is used, the horizontal component of this extension should additionally be entered (= geometric length of the pipe minus the vertical offset).

Example (see drawing above): Fct. 3.1.5 = 300 mm.

## 8.6.5 Stilling well

### Fct. 3.1.6 STILLWELL

If the device is operated with a stilling well, the option Stilling well = YES and the inside diameter of the pipe should be entered here in mm.

- NO: operation without stilling well
- YES: operation with stilling well

If YES has been selected, proceed with ↵ and enter the inside diameter:

- Setting range: 25 ... 200 mm
- Default value: 100 mm

If the diameter of the stilling well is greater than 200 mm, enter the maximum value = 200 mm.

## 8.6.6 Reference and tank bottom offsets

### Fct 3.1.7 REF. OFFSET

An arbitrary reference offset is added to the measured distance (positive when the reference point is above the flange; negative when the reference point is below the flange): see Example 1 below. The offset is effective for all distance values (local display, current output, switching output, digital information).

- Setting range: -10 m ... +10 m (32.8 ft)
- Default value: 0

### Fct 3.1.8 TB.OFFSET

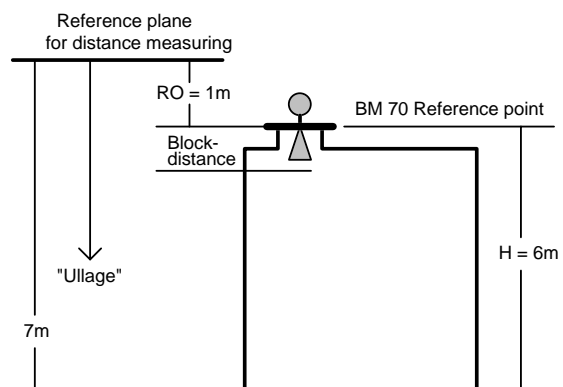
An arbitrary tank bottom offset is added to the measured level (positive, when the reference point is below the set tank height; negative, when the reference point is above the tank bottom): see Examples 2 and 3. The offset acts on all level values (local display, current output, switching output, conversion table, digital information).

- Setting range: -99.99 m ... +99.99 m (328 ft)
- Default value: 0

## Examples of setting the reference offset and tank bottom offset:

### Example 1:

Reference point for distance measurement (ullage) differs from flange position (in the example, 1 m above the flange). Let the tank height be  $H = 6$  m.



Input the following parameters:

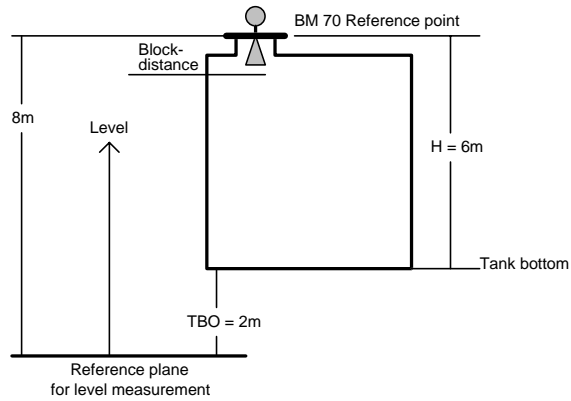
Tank height	6 m
Reference offset	+ 1 m
Tank bottom offset	0

The possible measuring range is:  
Distance = (1 m + block distance) to 7 m.

### Example 2

Reference point for level measurement differs from the programmed tank bottom position (in the example, 2 m below the tank bottom).

Let the tank height be  $H = 6$  m.



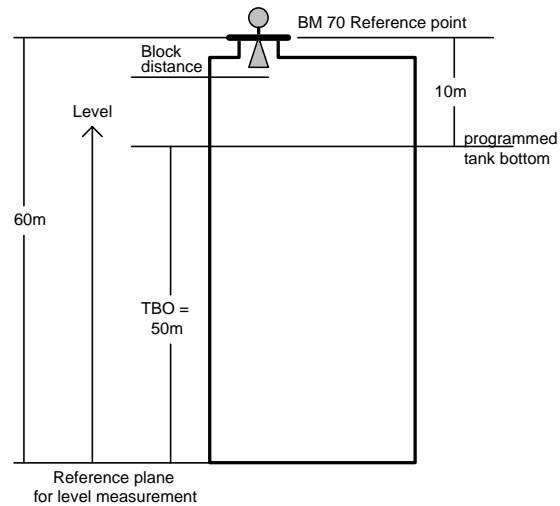
Input the following parameters:

Tank height	6 m
Tank bottom offset	+ 2 m
Reference offset	0

The possible measuring range is:  
Level = 2 m to (8 m - block distance)

### Example 3

Only a specific part of the level in a very tall tank is to be measured (in the example, levels 50m ... 60m).



Input the following parameters:

Tank height	10 m
Tank bottom offset	+ 50 m
Reference offset	0

The possible measuring range is:  
Level = 50 m to (60 m - block distance).

---

### 8.6.7 Display

#### **Fct. 3.2.1 (or Fct. 1.1.1) FCT.DISP.**

This function is used to select the measured variable.

- LEVEL
- DISTANCE                      Measuring range, see Figure in
- CONVERSION                  Sect. 8.5.
- REFLECTION

If the conversion value is to be displayed, a conversion table must be programmed first otherwise a parameter error will occur.

#### **Fct. 3.2.2 (or Fct. 1.1.2) UNIT.LENGTH**

Use this function to select the unit for displaying level and distance.

- m
- cm
- mm
- inch
- Ft
- PERCENT
- BARGRAPH

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 will occur.

Under "BARGRAPH", a maximum of 25 segments are displayed in the form of vertical lines in the first line of the display (0% = 1 segment, 100% = 25 segments).

#### **Fct. 3.2.3 (or Fct. 1.1.3) UNIT.CONV.**

Use this function to select the unit for conversion display.

- m<sup>3</sup>
- litres
- US Gal
- GB Gal (Gal = gallons)
- ft<sup>3</sup>
- bbl (petroleum barrels)
- PERCENT
- BARGRAPH
- User Unit (see Fct. 3.2.4)

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 will occur.

Under "BARGRAPH" in the first line of the display a maximum of 25 segments as vertical lines are displayed (0% = 1 segment, 100% = 25 segments).

#### **Fct. 3.2.4 USER UNIT**

Enter the text for the conversion "user unit" (see Fct. 3.2.3) here. It consists of a maximum of 10 alphanumeric characters.

Characters assignable to each of the 10 places:

- alpha characters A-Z / a-z
- numbers 0-9
- special signs + -
- blank characters (= underscore)

---

### **Fct. 3.2.5 ERROR MSG.**

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

- NO: Error messages shown only in the error list, see Sect. 8.8
- YES: When errors occur during measurement, display of the measured value will alternate with error messages.

### **8.6.8 Current output I**

#### **Fct. 3.3.1. FUNCTION I**

Use this function to select the measured variable.

- OFF (= deactivated, the output supplies a constant 4 mA, e.g. necessary for HART® Multidrop; Fct. 3.3.2 to 3.3.4 cannot then be selected, i.e. they are skipped over).
- LEVEL
- DISTANCE
- CONVERSION
- REFLECTION
- SW.OUTPUT. (function and switching threshold are set in Fct. 3.6).

#### **Fct. 3.3.2 RANGE I**

Use this function to define the current in error condition. E = Error at 2 mA or 22 mA.

- 4-20 mA (hold last measured value when error occurs)
- 4-20 mA/E=2 (min. 3.6 mA for Ex-i output!)
- 4-20 mA/E=22

#### **Fct. 3.3.3 SCALE 4 mA**

- This function does not appear (is skipped over) when "OFF" is set under Fct. 3.3.1.
- This function is used for I min = 4 mA to define the lower value for level, distance, conversion or reflection (scaling 4 mA).
- Setting LEVEL or DISTANCE under Fct. 3.3.1:  
Setting range and unit for SCALE 4 mA same as for Fct. 3.1.1 TANKHEIGHT. If a reference or tank bottom offset is set, this must be allowed for!
- Setting CONVERSION under Fct. 3.3.1:  
Unit for SCALE 4 mA same as in Fct. 3.2.3 UNIT.CONV. But value must be smaller than the maximum value in the conversion table.
- Setting REFLECTION under Fct. 3.3.1:  
The setting range for SCALE 4 mA is 0...99.

#### **Fct. 3.3.4 SCALE 20 mA**

- This function does not appear (is skipped over) when "OFF" is set under Fct. 3.3.1.
- This function is used for I max = 20 mA to define the upper value for level, distance, conversion or reflection (scaling 20 mA)
- Setting LEVEL or DISTANCE under Fct. 3.3.1:  
Setting range and unit for SCALE 20 mA as for Fct. 3.3.1 TANKHEIGHT. The value set here should not be greater than the response threshold. (Response threshold = tank height (Fct. 3.1.1) - block distance (Fct. 3.1.2)). If a reference or a tank bottom offset is set, this must be allowed for!
- Setting CONVERSION under Fct. 3.3.1:  
Unit for SCALE 20 mA same as in Fct. 3.2.3 UNIT.CONV. The value set here must be greater than that of Fct. 3.3.3, otherwise error during Parameter Check.
- Setting REFLECTION under Fct. 3.3.1:  
The setting range for I max = 20 mA is 1...100.  
The value set here must be greater than that of Fct. 3.3.3, otherwise error during Parameter Check.



---

## 8.6.9 Communication interfaces

### Fct. 3.3.5 BAUDRATE

- This function defines the transmission rate for RS 485 Communication.
  - 1200 Bd.
  - 2400 Bd.
  - 4800 Bd.
  - 9600 Bd.
  - 19200 Bd.
  - 38400 Bd.
- Default value = 19200 bauds
- For devices with PROFIBUS-PA (Ex-i) output the value has been set to 31250 bauds. and cannot be changed.
- The value set here is not relevant for digital Communication via the current output (e.g. HART®). For this, 1200 bauds are on principle processed, independent of the setting in Fct. 3.3.5!

### Fct. 3.3.6 ADDRESS

- This function is used for entering valid addresses from 0 to 255 (PROFIBUS: 0 to 126).
- If several devices are operated on one digital bus or via HART®-Multidrop, each device must be set to an individual address under which it can then be addressed in the bus.
- The default value is the address "0".

### Fct. 3.3.7 PROTOCOL

The following Communications protocols are available:

#### HART®:

The HART® protocol is a Communications protocol of the "HART® Communication Foundation". In addition to the "universal commands" and "common practice commands" there are "device-specific commands" for access to all parameters and functions of the BM 70 M. In addition there is the "device description" (DD) for BM 70 M, which can be used for universal HART® control units, such as the HART® Communicator or SIPROM.

The standard hardware platform for HART® is the current output 4-20 mA with superimposed FSK signals. For HART®-Multidrop (max. 15 devices on one bus), the version with Ex-i current output, set to a constant 4 mA (Fct. 3.3.1 = OFF) should be selected.

#### KROHNE/PC (KROHNE protocol):

The standard Communications protocol between the BM 70 M and the evaluation system is the standardised KROHNE protocol, which allows all dynamic values and setting parameters to be read and changed. If the BM 70 M is connected to existing user systems, this protocol must be applied to such systems. The protocol can also be used when the BM 70 M is connected to the KROHNE Tank Inventory System. For further information, please ask for the "BM 70 PC Communication" description.

#### MODBUS:

(not yet included in V. 3.00/3.01/4.00)

The Modbus protocol constitutes a quasi-standard for linking to programmable logic controls (PLC) and other systems. The BM 70 M uses the Modbus RTU Protocol with extended facilities to permit access to all dynamic values and setting parameters. For further information, please ask for the "BM 70 Modbus" description.

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#### PROFIBUS-PA:

(special signal output required)

The PROFIBUS-PA is defined and standardised in DIN 19245, Parts 1 and 2. A large number of devices with PROFIBUS-PA capability are available on the market. The BM 70 M is easy to connect to such bus systems; it has a purely slave function and allows access to all dynamic values and to setting parameters. The hardware interface we use is the intrinsically safe bus interface.

For further information, please ask for the "BM70A/P PROFIBUS-PA" description.

#### F.FOUND.:

(special signal output required)

Bus interface in conformity with the "Foundation Fieldbus" (FF). For further information, please ask for the "BM70A/P Foundation Fieldbus " description.

- in preparation -

### 8.6.10 Display

#### Language of display texts

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

GB/USA	English	E	Spanish (Español)
D	German	P	Portuguese
F	French	S	Swedish
I	Italian		

#### Coding desired for entry into setting level?

Set NO or YES in Fct. 3.4.2 ENTRY.CODE1.

- If NO set, simply press key  $\square$  to get into the setting level.
- If YES set, press key  $\rightarrow$  and then a 9-keystroke combination to get into the setting level.
- Factory-set Entry Code 1:  
 $\rightarrow\rightarrow\rightarrow\downarrow\downarrow\downarrow\uparrow\uparrow\uparrow$
- To change Entry Code 1  
Select Fct. 3.4.2 ENTRY CODE 1: set to YES.  
Select Fct. 3.4.3 CODE 1.  
Press key  $\rightarrow$ , display shows: CODE 1 \_ \_ \_ \_ \_  
Key-in required 9-keystroke combination; each keystroke confirmed by "\*". Then press the same keystroke combination again. "WRONG CODE" (= incorrect entry) appears if 1st and 2nd entries are not equal.  
Press keys  $\downarrow$  and  $\rightarrow$  and repeat entries.  
Take good note of the selected entry code!

#### Measuring-point identification (tag name)

- A max. 8-figure tag name can be set under Fct. 3.4.4 LOCATION (e.g. L123 A53)
  - Characters assignable to each of the 8 places:  
alpha characters A-Z / a-z; numbers 0-9; special signs: + - ; blanks (= underscore character)
- Factory setting: RADAR 000

---

## 8.6.11 Auto tank height

### FCT. 3.5.1 AUTO TANKH

With this function the height of the tank can be determined by the BM 70 M itself, provided the following conditions are met:

- The tank has been completely drained for at least 2 minutes.
- The tank bottom has good reflectivity (not suitable for dished and tapered bottoms without reference plate).
- The functions Fct. 3.1.3 (antenna), Fct. 3.1.4 (extension), Fct. 3.1.5 (distance piece) and Fct. 3.1.6 (stilling well) must previously have been correctly set.
- If the tank is taller than 30 m, the approximate tank height must previously be set manually with Fct. 3.1.1, as otherwise the measuring range will not suffice to locate the bottom.

After pressing the → key the display shows the currently measured value for the tank height.

Press key ↵; the inquiry "SURE NO" now appears. If you are not sure whether the measured value coincides with the true tank height, reject the value by pressing key ↵.

If the measured value seems plausible for the tank height and you wish to store it, change the option to "SURE YES" by pressing key ↑, and then press key ↵.

If the message: NO MEAS.VAL. appears, this means that the quality of measurement is not adequate (inadequate bottom reflection or too many interferences) for automatic determination of the tank height. Press key ↵ to abort the operation. In this case you will need to enter the tank height manually with Fct. 3.1.1.

## 8.6.12 Empty spectrum

### What is an empty spectrum ?

- Fixed and moving internals in the tank (including perhaps the tank wall) produce interference signals (reflections) that can result in incorrect measurements.
- To enable the BM 70 M to identify and blank out such interference signals, the tank profile (empty spectrum) needs to be recorded once only prior to (initial) start-up.
- For this purpose, the tank should if possible be completely empty and all moving parts (e.g. agitators) switched on. If these conditions cannot be met during start-up, the tank profile (empty spectrum) can also be recorded at a later time. Until it is recorded, however, measurements may be inaccurate.
- Recording of the tank profile involves 1000 measurements that are carried out by the BM 70 M and stored in the form of a so-called "empty spectrum".
- This allows the BM 70 M to discriminate between constant or regularly recurring interference signals and the actually useful or wanted signals (level). Interference signals are suppressed and only the useful signal is processed.
- If no appreciable interference from internals is to be expected, recording of the empty spectrum can also be omitted, because a partial empty spectrum (see below) of the flange system has been stored by the factory.

### Recording of the empty spectrum (sequence, example)

Key	Displayed	Description
→	1.0	OPERATION
2 x ↑	3.0	INSTALL.
→	3.1	BASIS.PARAM.
4 x ↑	3.5	APPLICAT.
→ ↑	3.5.2	EMPTY.SPEC.
→		ON
		Partial empty spectrum already recorded by factory
↑		RECORD
→		AVERAGE
		Factory-set is here AVERAGE (= normal empty spectrum). This setting is suitable for most applications (possible alternative)
↑		MAX. VALUES
↵		TOTAL
↑		PARTIAL
		Recording of the empty spectrum over the full range.
↵		40000 mm
		If the tank cannot be drained over the full range
		Enter distance value down to which the empty spectrum is to be recorded.
↵		WAIT
		1000...0
		Empty spectrum being recorded. Duration: approx. 1.5 minutes. Countdown is from "1000" to "0".
↵	3.5.2	READY
4 x ↵		EMPTY.SPECT.
		After 1.5 minutes. Tank profile recorded.
		Revert to measuring mode with display of actual level, distance or conversion. Empty spectrum is now stored and will be taken into consideration for measurements.

---

### FCT. 3.5.2 EMPTY.SPEC.

Under this function the empty spectrum is activated or deactivated, or recorded and stored. The display first gives information as to whether the empty spectrum is currently switched ON or OFF. You can then choose between:

- OFF: The empty spectrum is not considered for measurements but remains stored in the BM 70 M and can be activated again at a later date.
- ON: The empty spectrum is (again) activated and considered for measurements.
- RECORD: The previous empty spectrum is to be deleted and a new one recorded.

Conditions:

- Tank must be totally or partially drained.
- All moving parts, e.g. agitators, must be switched on.
- Tank height, antenna extension, distance piece and still well must be set correctly.

When you select "RECORD", the procedure is as follows:

If other configuration parameters have previously been changed, you will first be asked by "STORE YES" whether you wish to store the data. Confirm by pressing key ↵.

The next step is a choice of the following:

- AVERAGE  
Values are averaged. This setting can be used for most applications.
- MAX. VALUES  
Only maximum values considered when the empty spectrum is recorded.  
Of advantage in conjunction with "difficult" agitators, for example.

If the tank is not completely drained, the empty tank spectrum can nevertheless still be recorded up to a certain range. In this case, select menu item PARTIAL.

- After selecting AVERAGE or MAX. VALUES, press key ↵. Then select PARTIAL or TOTAL with key ↑, as follows.
- 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 same unit as used for the tank height, in the range of 0 m to tank height.
- It is recommended to maintain a safe distance of 20 to 30 cm (8" to 12") to the actual distance.

Subsequently press key ↵ to start recording of the empty-tank spectrum.

"WAIT" appears briefly in the display. Then countdown of measurements from "1000" to "0". "READY" is displayed after approx. 1.5 Minutes.

Press ↵ key 5 times to store the empty spectrum, which will then be taken into consideration during measurements.

Recording of the empty spectrum can be aborted by pressing key ↵. Displayed: BREAK.

Confirm by pressing key ↵.

The "old" empty spectrum is retained in this case.

---

### 8.6.13 Time constant and tracking speed

#### Fct. 3.5.3 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:  
010 - 100 Sec (BM 70 M)
- The tank bottom must supply a measurable reflection signal, so the method cannot be applied e.g. when a dished bottom is involved.
- Default value and recommended setting:  
030 Sec (BM 70 M)

#### Fct. 3.5.4 TRACING.VEL.

To avoid faulty measurements, the BM 70 M 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 valid measured value is identified, the BM 70 M enlarges the plausibility range with the tracing speed (Fct. 3.5.4) until a valid (plausible) measured value has again been found.

The measured value for level/distance cannot change at a faster rate than the set tracing speed.

- Under Fct. 3.5.4 the maximum rate at which the level can change in the tank should be set as the minimum value.
- Setting ranges:  
0.01 - 1.00 m/min (if Fct. 3.1.1. Unit m/ cm/ mm)  
0.03 - 3.28 ft/min (if Fct. 3.1.1. Unit inch/ft)
- Default: 0.1 m/min (BM 70 M)
- See also Sect. 8.8 (error message: NO M.VALUE)

### 8.6.14 Multiple reflections and block distance detection

#### Fct. 3.5.5 MULT.REFL

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

Such multiple reflections tend to simulate lower-than-actual levels. In such cases, activate the multiple reflections identifier, and see also references in Sect. 8.8.

- NO (default)  
Measurement without identification of multiple reflections.
- YES  
Measurement with identification of multiple reflections.

A better solution, however, is to change the mounting location of the BM 70 M so as to prevent the occurrence of multiple reflections in the first place, or at least to diminish the strength of the multiple reflections (see Sect. 6.1.2).

To ensure satisfactory identification of the first measured value after the BM 70 M has been switched on, always carry out measurements with the "empty spectrum" (Fct. 3.5.2) when the "multiple reflection identifier" is activated, see Sect. 8.6.12.

---

### Fct 3.5.6 BD-DETECT.

- NO
- YES (default)

To activate the block distance (overflow) detector:

So long as a significant signal is detected within the block distance, the measured value is "held" at the block distance limit. This avoids any possibility of the measured value skipping to a multiple reflection should the level rise into the block distance range.

The block distance can have a value that is at least equal to that specified in Sect. 8.6.3 as a recommendation!

Marker 6 in the display indicates when the block distance detector is active. If the measured value skips (e.g. contamination of the antenna) erroneously to the block distance limit, the BD-DETECT should be deactivated.

### 8.6.15 Tank bottom tracing system

#### Description

- The BM 70 M firmware includes an additional function for measuring in tanks with poorly reflecting (i.e. relative permittivity  $\epsilon_R \uparrow 3$ ) yet non-absorbing products. This function is designated "tank bottom tracing" (abbreviated to FTB) and utilises the apparent shift of the tank bottom signal resulting from different microwave propagation rates in the air and in the tank product.
- It is necessary that the tank bottom is reflecting. Therefore this method is not applicable e.g. in tanks with a conical bottom.
- This requires that the relative permittivity  $\epsilon_R$  of the tank product be as exact as possible. (This parameter can also be determined by a KROHNE Service technician from the recording of a tank filling or draining operation with the user program (see Sect. 8.12). The level in the tank should in this case change over the largest possible range.)
- When measurements are taken with activated FTB, an expectancy range for the measured value is determined on the basis of the shifted tank bottom signal, and inaccuracy of the  $\epsilon_R$  value of  $\pm 10\%$  is taken into consideration. If no evaluable measuring signal is obtained within this range, a substitute measured value is calculated direct from the tank bottom signal. This feature of the FTB even allows measurement in tanks without a direct useful signal, provided the tank bottom remains visible for the microwaves through the product.
- Since the exact position of the tank bottom must be known for this process, it is advisable when using the FTB to determine the tank height automatically with a completely empty tank, using Fct. 3.5.1, see Sect. 8.6.11.
- It needs to be borne in mind that, when measuring with the substitute measured value determined by way of the tank bottom signal, measuring accuracy will decrease by the factor  $(\sqrt{\epsilon_R} - 1)$ ! For a  $\epsilon_R$  of 2.25, accuracy decreases by one-half, i.e. the possible deviation will double; if  $\epsilon_R$  is only 1.56, accuracy decreases to one-quarter.
- With BM 70 M: when the (PARTIAL) tank bottom tracing system is used, the maximum measuring range is approx. 10% smaller, i.e. max. tank height = 31.5 m !

The tank bottom tracing system is operated by way of Fct. 3.5.7 and Fct. 3.5.8.

### Fct. 3.5.7 FUNCT. FTB

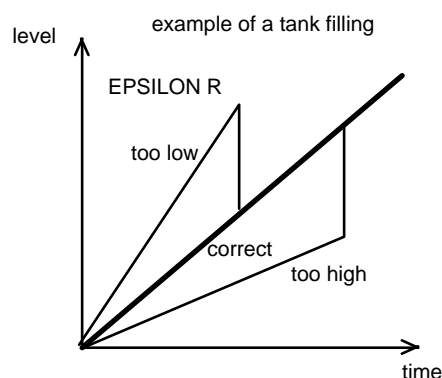
- The tank bottom tracing system is activated under this function:
- OFF  
The FTB is deactivated; the device operates in the standard mode.
- PARTIAL  
When this option has been selected, the tank bottom tracing system is activated only in the vicinity of the tank bottom, i.e. at low levels (max. 20% of the tank height but a minimum of 0.6 m). Given higher levels, the normal measuring method is used (reflection from the product surface). This method is sufficient for most applications with poorly reflecting products. The parameter EPSILON R (Fct. 3.5.8) must be as exact as possible.

### Fct. 3.5.8 EPSILON R

Use this function to enter the relative permittivity.

- Allowable input range: 1.1000 - 8.0000
- Default: 2.0000

Enter the figure of 2.0000 if the relative permittivity is not known, as numerous products have a  $\epsilon_R$  value  $\approx 2$ . However, expect reduced measuring accuracy and/or skipping of the measured value on changeover from tank bottom tracing to the normal measuring mode (= evaluation of reflection from the product surface), see diagram at the right:



### 8.6.16 Tank type, movement of product surface

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

### Fct. 3.5.9 TANKTYPE

- STORAGE T.  
Storage tank, still surface, slow rate of change in level
- PROC.TANK  
Process tank, slight surface movement, rapid rate of change in level

It is possible, for instance, that the measured value will change in small steps rather than linearly or will "freeze" at times when the setting is grossly incorrect.

### 8.6.17 Switching output

The functions for the switching output can be applied to:

- a) the additional switching output in the Version "Ex-e or Ex-i current output HART<sup>®</sup>", or
- b) the current output if Fct. 3.3.1 FUNCTION I is set to "SW.OUTP".



---

### **Fct. 3.6.1. FUNCTION S**

Use this function to select the measured variable.

- OFF (= deactivated; Fct. 3.6.2, 3.6.3 and 3.6.4 are no longer selectable, i.e. they are skipped over).
- LEVEL
- DISTANCE
- CONVERSION
- REFLECTION
- ERROR OPEN (default)
- ERROR CLOSED

(Explanatory notes: see Table overleaf)

### **Fct. 3.6.2. TYPE S**

- This function is not shown (is skipped over) when OFF or ERROR OPEN or ERROR CLOSED is set under Fct. 3.6.1. Not significant in this case!
- Use this function to set the type of switching output:  
HIGH (= contact closes when upper limit of threshold + hysteresis / 2) exceeded  
LOW (= contact closes when lower limit of threshold - hysteresis / 2) exceeded.

### **Fct. 3.6.3 THRESHOLD**

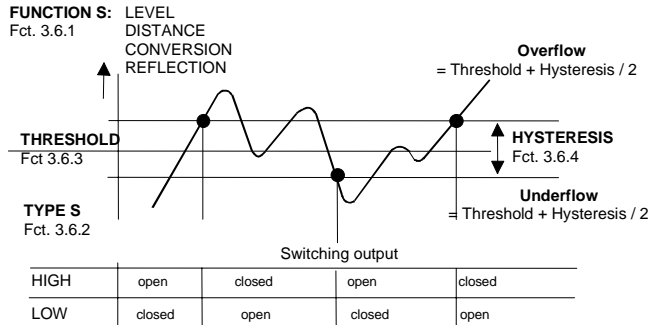
- This function is not shown (is skipped over) when OFF, ERROR OPEN or ERROR CLOSED is set under Fct. 3.6.1. Not significant in this case!
- Use this function to define the threshold (limit value).
- Setting of LEVEL or DISTANCE under Fct. 3.6.1:  
Unit same as for Fct. 3.1.1 TANKHEIGHT. If a reference or tank bottom offset is set, this must be taken into consideration!
- Setting: CONVERSION under Fct. 3.6.1:  
Unit same as in Fct. 3.2.3 UNIT.CONV.
- Setting: REFLECTION under Fct. 3.6.1:  
Setting range : 0...100.

### **Fct. 3.6.4 HYSTERESIS**

- This function is not shown (is skipped over) when OFF, ERROR OPEN or ERROR CLOSED is set under Fct. 3.6.1. Not significant in this case!
- Use this function to define the hysteresis.
- Setting: LEVEL or DISTANCE under Fct. 3.6.1:  
Setting range and unit same as for Fct. 3.1.1 TANKHEIGHT.
- Setting CONVERSION under Fct. 3.6.1:  
Unit same as in Fct. 3.2.3 UNIT.CONV.
- Setting REFLECTION under Fct. 3.6.1:  
Setting range: 0...100.

Examples of application and setting see Sect. 8.5

## Switching output characteristics



Sw.output application Examples see Sect. 8.5	Switching function settable by way of ...		Further parameters settable via ...	
	Fct. 3.6.1 FUNCTION S	Fct. 3.6.2 TYPE S	Fct. 3.6.3 THRESHOLD	Fct. 3.6.4 HYSTERESIS
<b>Error message</b>				
Contact opens when error occurs	ERROR OPEN	no *	no *	no*
Contact closes when error occurs	ERROR CLOSED	no *	no *	no*
<b>Limit value, level</b>				
- Contact closes when upper limit exceeded	LEVEL	HIGH	yes	yes
- Contact closes when lower limit exceeded	LEVEL	LOW	yes	yes
<b>Limit value, distance</b>				
- Contact closes when upper limit exceeded	DISTANCE	HIGH	yes	yes
- Contact closes when lower limit exceeded	DISTANCE	LOW	yes	yes
<b>Limit value, conversion</b>				
- Contact closes when upper limit exceeded	CONVERSION	HIGH	yes	yes
- Contact closes when lower limit exceeded	CONVERSION	LOW	yes	yes
<b>Limit value, reflection</b>				
- Contact closes when upper limit exceeded	REFLECTION	HIGH	yes	yes
- Contact closes when lower limit exceeded	REFLECTION	LOW	yes	yes
<b>e.g. operation indicator</b>				
Contact closed when supply power applied and open at power fail	OFF	no *	no *	no *

\* Setting has no effect on the function of the switching output!

Overflow =

Measured value higher than limit value (= threshold plus hysteresis / 2)

Underflow =

Measured value lower than limit value (= threshold minus hysteresis / 2)

## 8.7 Functional checks

### 8.7.1 Main menu 2.0 Test functions

Function (Fct.)	Input range	Description
2.0 TEST		
2.1 HARDWARE		
2.1.1 MASTER	Special function	Test of master hardware.
2.1.2 DISPLAY	Special function	Test of display hardware.
2.1.3 STATUS	Select Module DIS Module MW	Display of ID Number and status bytes.
2.2 CUR.OUTP.I		
2.2.1 VALUE I	Display of value	Display of actual value of the current output.
2.2.2 TEST I	Options 2 mA 4 mA 6 mA 8 mA 10 mA 12 mA 14 mA 16 mA 18 mA 20 mA 22 mA	Output of selected value to the current output.  NOTE !!! With safety inquiry because current output is accessed direct !!!  (Exi = min. 3.6 mA)
2.3 SW.OUTP.		
2.3.1 TEST S	Options OPEN CLOSED	Switches the switching contact on/off.  NOTE !!! With safety inquiry because current output is accessed direct !!!
2.4.0 FIRMWARE		
2.4.1 MASTER	Display	Display of master firmware version.
2.4.2 DISPLAY	Display	Display of master firmware version.

### 8.7.2 Hardware test

Testing of the BM 70 M hardware can be initiated as required with these functions when the device is operating. When an error is established, a message appears in the display (see Sect. 8.8). This hardware test is carried out automatically every time the BM 70 M is started up.

#### Fct. 2.1.1 MASTER

- Select Function 2.1.1, as described in Sect. 8.2 and 8.3.
- "TEST" is shown in the display during the automatic test, followed by "READY" on completion of the test.
- During the test the current output holds the last measured value; digital Communication is not possible during that time.





### 8.8.2 Pointers provided by 6 markers during measurement

Marker	Cause	Explanation
1	No current measured value	The device is currently searching for a new measured value in which the "measuring window" is opened. If the search for a plausible level fails, "SIGNAL DOWN" appears in the Error List, see Sect. 8.8.3.
2	Signal too strong	Mean of reflected microwaves is very high. Gain is automatically stepped down. Brief showing of this marker, e.g. while tank is being filled or drained, is insignificant. In conjunction with stilling wells, the marker can also show for a longer time.
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 or the error message "NO M.VALUE", see Sect. 8.8.3.
4	No measured value as yet	Evaluable measured values not available after the device has been started up. Measured value automatically set to the level of the 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 20 cm or 8" and maximum of 60 cm or 24"). The measured value is then automatically set to the level of the tank bottom.
6	Measurement frozen	The digital input is active (voltage at terminals 81,82) or the device is in the range of the block distance detector (see Sect. 8.6.12). Measurement is thus suspended (frozen); last measured values present at the outputs and in the display.

### 8.8.3 Error messages and their representation in display and at outputs

The following list gives all error messages that can occur:

Error messages		Description of error	To correct device fault	Output of errors via display and outputs, depending on setting					
Type	Text In 2nd line of display			Display ERROR MSG. Fct. 3.2.4	Current output I RANGE I Fct. 3.3.2	Switching output S FUNCTION S Fct. 3.6.1			
				yes	no	4-20/ 2=E  4-20/ 22=E	4-20	ERROR OPEN ERROR CLOSED	OFF LEVEL DISTANCE CONVERSION REFLECTION
b)	NO M.VALUE	Evaluable measuring signals not available	If this error is displayed for a lengthy period, this could mean application-induced errors. Check the application conditions!	yes	no	yes	no	yes	no
c)	LINE INTER- RUPT	Power failure detected	During restart following a brief power failure. Display vanishes as soon as a valid measured value is again present.	yes	no	yes	no	yes	no
	SWEEP LOW	Restricted functioning of microwave board	Measurement continued, possibly with reduced accuracy. If error present for longer time or "VCO SWEEP" error (see below) occurs, consult KROHNE Service!	yes	no	no	no	no	no
	WATCH DOG	Processor monitoring	If error present for longer time, this means an error on the CPU board; needs to be replaced by KROHNE Service!	yes	no	no	no	no	no
	SPECT. ERR.	Empty spectrum faulty	The current empty-tank spectrum does not match the changed operating parameters. Remedy: record new empty spectrum (Fct 3.5.2).	yes	no	no	no	no	no
	NO DISP.	Configuration faulty	Reset parameters for the displayed units (Fct. 3.2.2, 3.2.3).	yes	yes	no	no	no	no
	CAL. DATA	EEPROM error: current output calibration data	Calibration data of the current output need to be checked by KROHNE Service and reset if necessary.	yes	no	yes (22 mA)	no	yes	no
	CONFIG. ERR	EEPROM error: parameters faulty	Check all operating parameters and reset if necessary. If error persists: EEPROM defective. Needs to be replaced by KROHNE Service!	yes	yes	yes (22 mA)	no	yes	yes
d)	EEPROM ERR.	EEPROM defective	EEPROM defective. Needs to be replaced by KROHNE Service!	yes	no	yes	no	yes	no
	ADC ERR.	Analog/digital converter defective	CPU board defective. Needs to be replaced by KROHNE Service!	yes	no	yes	no	yes	no
	INTEGR.	Integrator defective	CPU board defective. Needs to be replaced by KROHNE Service!	yes	no	yes	no	yes	no
	SIGNAL DOWN	Measuring signal too weak for evaluation	No measuring signal, usually caused by a defect in the electronics.	yes	no	yes	no	yes	no
	VCO RISE	Fault on microwave board	Microwave board defective. Needs to be replaced by KROHNE Service!	yes	no	yes	no	yes	no
	VCO SWEEP	Fault on microwave board	Microwave board defective. Needs to be replaced by KROHNE Service!	yes	no	yes	no	yes	no
e)	FATAL ERROR	CPU board defective	After a device start-up. If still possible, invoke Error List and note down any other errors. Consult KROHNE Service!	yes	yes	no	no	no	no

---

#### 8.8.4 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. When YES set: "error message(s)" are displayed automatically to alternate with the measured value. The errors will continue to be displayed until their cause has been eliminated.

#### 8.8.5 Error list

All errors are stored in an Error List in the BM 70 M. The errors are retained in this list until: 1. the cause(s) of the error(s) 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.

To invoke the Error List, press keys  $\downarrow \uparrow \rightarrow$ . With  $\rightarrow$  you can page through the list.  
For further information on the Error List: see Sect. 8.3.

#### 8.9 Messages on start-up

When the BM 70 M is powered it will take about 1 minute before the first measured value is displayed. During this time the following flashing messages appear in sequence in the display:

STARTUP - READY - START

After a short line failure (lasting up to several minutes) it is possible that "LINE INTERRUPT" will be displayed. In such a case, measurement is continued subsequently taking into account the history prior to the interruption.

#### 8.10 Faults and symptoms during start-up and measurement

- You will be able to eliminate most of the faults and symptoms likely to occur with the BM 70 M by consulting the following chart.
- For easy reference, faults and symptoms are divided into the following groups:
  - Group D: Display
  - Group A: Signal output
  - Group DA: Display and signal output
  - Group M: Markers 1 - 6 in the display
  - Group S: Switching output
- 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 defective.	Change primary fuse as described in Sect. 9.3.
D2	Display flashes "FATAL ERROR" shortly after power has been switched on.	BM 70 M is defective.	Replace BM 70 M signal converter (instrument head) as described in Sect.7.2 .
D3	Display flashes "MIN VALUE" or " MAX VALUE" when numerical values are being set.	The set numerical value is outside the acceptable setting range.	Note MIN. or MAX.VALUE displayed and set higher or lower numerical value.



Group D: Display			
No.	Fault / Symptom	Cause	Corrective action
D4	Display shows "START".	Device carries out a hot start after a parameter change.	Wait until measured value appears.
D5	Display flashes "SPECT.ERR.".	Newly set operating parameters do not tally with the stored spectrum when e.g. the tank height (Fct. 3.1.1) and/or the antenna extension (Fct. 3.1.4) have been changed.	Record new empty spectrum as described in Sect. 8.6.12 (Fct. 3.5.2).
D6	Display indicates error message alternating with the measured value.	An error has occurred.	Note down error messages, eliminate as described in Sect. 8.8

Group A: Signal output			
No.	Fault / Symptom	Cause	Corrective action
A1	Receiver instruments connected to current output indicate "zero".	Polarity (connection) of receiver instruments is incorrect.	Connect up properly as described in Sect. 7.8.
		BM 70 M current output board or connected receiver instruments defective.	Test current output as described in Sect. 8.7.3. - All tests OK: Check receiver instruments and replace if necessary. - Test reveals faults: current output board defective; consult KROHNE Service or replace BM 70 M signal converter (see Sect. 7.3).
		"OFF" (= current output deactivated) is set under current output I, Fct. 3.3.1, "FUNCTION I".	Depending on the application, set LEVEL, CONVERSION, DISTANCE or REFLECTION under Fct. 3.3.1, see Sect. 8.6.8
A2	2 or 22 mA present at the current output.	An error has occurred.	Invoke display of error list, see Sect. 8.8. For cause and elimination, see Sect. 8.8.  If error message not to be displayed via the current output, set 4-20 mA without error message, as described in Sect. 8.6.8 (Fct. 3.3.2).
A3	The measured value at the current output is incorrect, but the measured value in the BM 70 M display is correct.	Settings of the current output are incorrect.	Set current output correctly as described in Sect. 8.6.8 (Fct.3.3.1 - 3.3.4).

Group A: Signal output			
No.	Fault / Symptom	Cause	Corrective action
A4	Data Communication via the digital interface not functioning.	Communication interface set incorrectly.	Set Communication interface, Sect. 8.6.9, correctly (Fct.3.3.5 - 3.3.7).
		The computer system for Communication with the BM 70 M is incorrectly configured.	Check computer system.
		Incorrect connection to the interface.	Check connection.
		Communication interface is defective.	Consult KROHNE Service or replace BM 70 M instrument head as described in Sect. 7.3.

Group DA: Display and signal output			
No.	Fault / Symptom	Cause	Corrective action
DA1	Display and current output supply incorrect measured values.	Display and current output are set incorrectly.	Set display (Fct. 3.2.1 -3.2.4) and current output (Fct. 3.3.1 - 3.3.4) correctly, as described in Sect. 8.6.7 and 8.6.8.
		An error has occurred. Display and current output are, however, not set for error messages; markers 1-6 are perhaps ON.	Invoke Error List, see Sect. 8.8, also for cause and elimination.  If (also) one or several markers are ON, see Sect. 8.8.2.
DA2	Display and current output supply a largely constant measuring error of approx. 19 cm.	Distance piece is provided but not configured correctly.	Set Fct. 3.1.5 DIST.PCE. (see Sect.8.6.4) to 120 mm when distance piece fitted, otherwise to 0 mm.
DA3	Display and current output supply a largely constant and large-size measuring error.	Tank height set incorrectly (level measurement).	Set Fct. 3.1.1 TANKHEIGHT (see Sect.8.6.2) correctly; if possible, use automatic tank height determination, Fct. 3.5.1 (see Sect. 8.6.11)
		Reference offset (distance measurement) or tank bottom offset (level measurement) incorrectly programmed.	Set offset values correctly, Fct. 3.1.7 - 3.1.8 (see Sect. 8.6.6).
DA4	Measuring error in the stilling well increases steadily in step with increasing distance.	Stilling well not included in the configuration.	Set Fct. 3.1.6 STILLWELL correctly (see Sect. 8.6.5).
DA5	major measuring errors (> 3 cm) with Wave-Stick in the close range (up to approx. 1 m distance)	Antenna type is incorrectly set.	Set Fct. 3.1.3. ANTENNA to "WAVE-STICK" (see Sect. 8.6.3)

Group A: Signal output			
No.	Fault / Symptom	Cause	Corrective action
DA6	When the empty tank is being filled, the measured value initially stays at "zero" and then, at 20...100 cm level, suddenly skips to the correct value.	The BM 70 M is receiving an additional signal from the tank bottom.	Activate "tank bottom tracking system", see Sect. 8.6.15 (Fct. 3.5.7 - 3.5.8)
DA7	Display and signal output do not respond to changes in level.	Digital input is activated, marker 6 is ON, measurement is suspended (frozen).	Deactivate the digital input, see Sect. 4.8.
		Device is within block distance detection range, marker 6 ▼ is ON; level too high or antenna contaminated.	Reduce level and/or clean antenna, or deactivate Fct. 3.5.6 BD-DETECT (see Sect. 8.6.14) or reduce size of Fct. 3.1.2 BLOCKDIST. (see Sect. 8.6.3).
		Foaming in vessel, inadequate reflectivity of the tank product, $\epsilon_R$ too small; additionally, markers 1+3 may be ON.	On tall storage tanks, mount the BM 70 M farther away from the tank wall. Select distance as recommended in Sect. 6.1.2.
DA8	Display and signal output indicate "zero" measured value, marker 5 ▼ is ON.	Tank with dished bottom: tank is more than 20% full, the BM 70 M is mistakenly located in the "tank bottom detection" range.	Drain tank or switch the BM 70 M off for a short while. If unsuccessful, please consult KROHNE Service.
DA9	Display and signal output indicate max. level but tank is empty.	Tank with dished bottom: the BM 70 M has stored an incorrect or incomplete empty spectrum.	Record new empty tank spectrum, see Sect. 8.6.12 (Fct. 3.5.2), or enlarge block distance (Fct. 3.1.2) as described in Sect. 8.6.3.

Group DA: Display and signal output			
No.	Fault / Symptom	Cause	Corrective action
DA10	Display and signal output frequently indicate the maximum level.	Excessive amounts of vapour, condensate or dust in the tank, or heavy contamination (deposits thicker than approx. 3 - 7 mm or 0.1" - 0.3") on the antenna.	Clean antenna (install cleaning device if necessary). If unsuccessful, enlarge BLOCKDIST. under Fct. 3.1.2 (see Sect. 8.6.3) or deactivate Fct. 3.5.6 BD-DETECT (see Sect.8.6.14).
		Antenna cleaning operations cause strong reflections.	Activate digital input during cleaning (marker 6 ▼ is ON), measurement suspended (frozen), see Sect. 4.8.

Group DA: Display and signal output			
No.	Fault / Symptom	Cause	Corrective action
DA11	Display and signal output indicate sizeable step changes in the direction of the maximum (possibly also minimum) level.	Storage tank: BM 70 M mounted centrally or on dome (manhole cover).	Change position of the BM 70 M. For recommended distance from tank wall, see Sect. 6.1.2, and note installation conditions in Sect. 6.1.3! Or activate "multiple reflection identifier" under Fct. 3.5.5, see Sect. 8.6.14.
		Process tank with extremely turbulent product surface.	Switch on tank type AGITATOR under Fct. 3.5.9, see Sect. 8.6.16.
DA12	Display and signal output indicate step changes: during filling upwards during draining downwards	Storage tank, smooth surface, steady filling or draining procedures, incorrect tank type set.	Set correct tank type (STORAGE TANK) under Fct. 3.5.9, see Sect. 8.6.16.
DA13	Signal output (recorder) shows sinusoidal variations about the actually measured value (deviation: up to $\pm 2$ cm) in the upper part of the tank (approx. 2 m).	This has physical reasons and occurs mostly with slow changes in level when sources of interference are located in the upper part of the tank.	Avoid all sources of interference in the upper part of the tank. A bigger antenna might help to solve the problem.
DA14	Display and signal output indicate constant measured values, although the level changes.	Fixed tank internals unfavourably positioned, thus permanently simulating a constant level to the BM 70 M. No empty spectrum recorded and/or measurements carried out without empty spectrum.	Activate the empty spectrum under Fct. 3.5.2 if measurements carried out without empty spectrum. If empty spectrum not recorded, record under Fct. 3.5.2, see Sect. 8.6.12.
		Digital input is activated, marker 6 ▼ is ON, measurement is suspended (frozen).	Deactivate the digital input, see Sect. 4.8
DA15	Display and signal output indicate measured values at the level of the agitator blades.	Tank with "difficult" agitator blades.	Record new empty spectrum with " MAX. VALUES" under Fct. 3.5.2. Or change position of the BM 70 M on the tank. Note conditions described in Sect. 6.1.2.
DA16	Display and/or signal output indicate incorrect conversion values, but level indication is correct.	Conversion table set incorrectly.	Reset conversion table with the PC-CAT program.

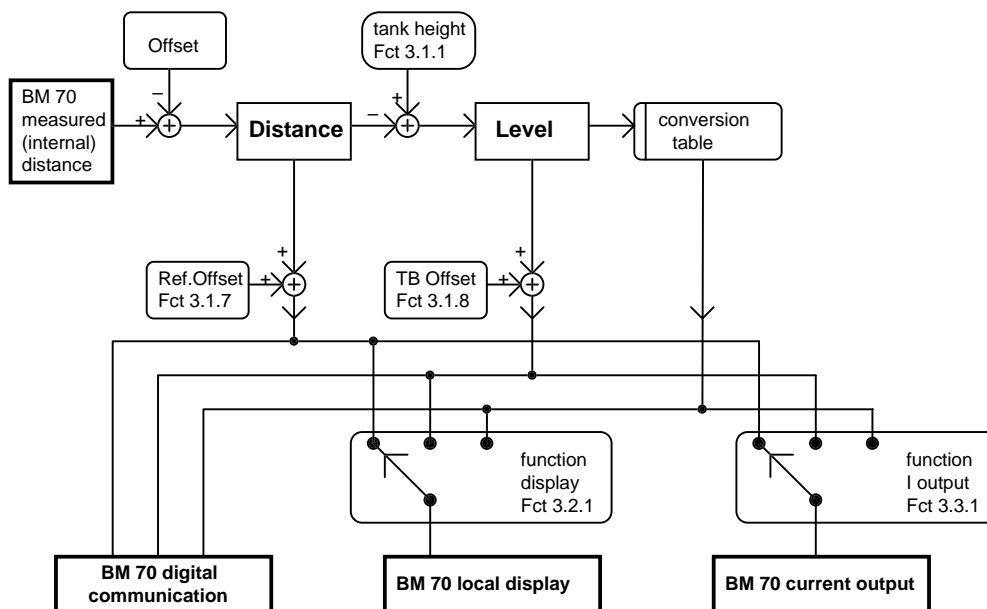
Group DA: Display and signal output			
No.	Fault / Symptom	Cause	Corrective action
DA17	Display and signal output go suddenly to "zero" or block distance limit when tank continuously topped up.	Level located in range of block distance in front of antenna, see Fct. 3.1.2 in Sect. 8.6.3.	Avoid this operating condition or, if empty spectrum (Fct. 3.5.2) is sufficiently good, reduce block distance (Fct. 3.1.2) as described in Sect.8.6.3.

Group M: Markers 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. 8.8 for significance of markers and elimination of possible faults.
M2	marker 2 ▼ ON for long periods or permanently.	Note: very strong reflection signal (e.g. measurement in the stilling well).	Not important if measured value is correct.
M3	marker 6 ▼ ON.	Digital input is activated, measurements suspended (frozen).	Deactivate digital input, see Sect. 4.8.
		Device located in block distance detection range.	Check conditions for block distance detection, see Sect. 8.6.14.
M4	markers 3 and 4 ▼ ON. Level indicator is "zero".	This is a status display and not an error. This usually occurs on tanks with dished bottom, when the tank is empty, after the BM 70 M has been switched on or after a new empty spectrum has been recorded.	Fill tank!

Group S: Switching output			
No.	Fault / Symptom	Cause	Corrective action
S1	Switching output does not operate at the desired limit value (threshold) or does so in the wrong mode (opens/closes).	Setting of switching function is incorrect.	Set switching output correctly as described in Sect. 8.6.17 (Fct. 3.6.1 - 3.6.4).
S2	Switching output does not operate.	Switching output defective.	Check switching output as described in Sect. 8.7.4: - Test OK: check setting and receiver instruments. - Test reveals faults: switching output defective. Consult KROHNE Service or replace BM 70 M signal converter as described in Sect. 7.2.

## 8.11 Calculation of the measured value

The following describes how the individual items of information are calculated from the measured distance:



The measured primary distance is corrected by the offset and consequently standardised to the reference point (= flange).

The level is calculated as the difference between tank height and distance.

Optionally, distance, level or a converted function can be output to the signal output and the local display.

All items of information can be accessed via the digital Communication. In addition, the measured value can be shifted by a reference offset (reference point for distance not equal to flange) or by a tank bottom offset (reference point for level not equal to tank bottom).

## 8.12 User program PC-CAT for Windows

Our instruments of the BM 70 product line are easy to install. To facilitate configuration, each unit is supplied with the intuitive and time-tried software, PC-CAT for Windows.

PC-CAT provides a number of useful features including:

- Quick on-site configuration
- Print-out of configuration protocol
- Simple conversion, volume or correction tables
- Check routine to monitor functionality of the instrument
- Monitoring and recording of the radar signal during operation
- Trend and evaluation of the signal during operation

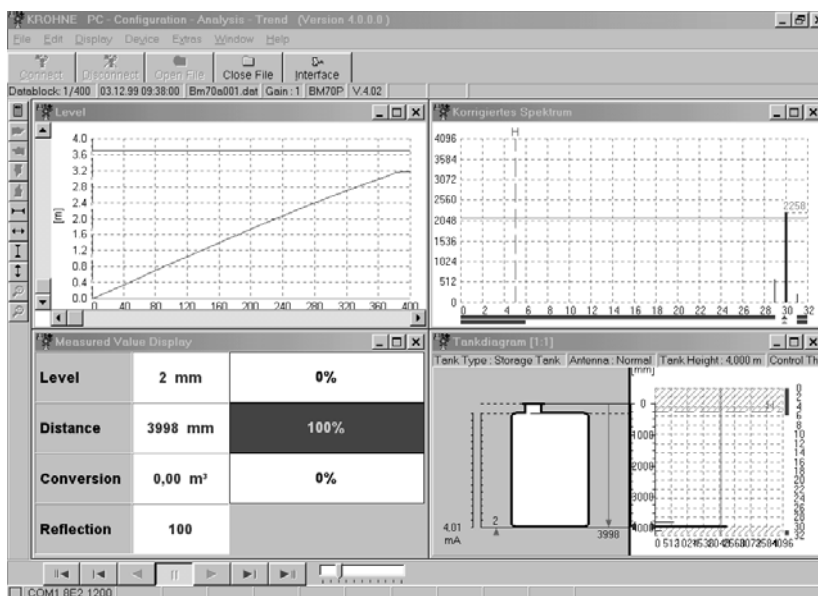
PC-CAT works on all IBM-compatible PC's using Windows 9x or NT.

PC-CAT Version 4.01 and higher can communicate with all current KROHNE level radar gauges including BM 70 M versions, also with HART<sup>®</sup> protocol and RS 485. The PC-CAT kit includes a PC adapter for current output. The adapter can be connected to the PC's standard RS 232 interface.

PC-CAT 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 graph of the output signal and threshold signal strength is also provided. All relevant instrument data can be recorded in the form of a data set small enough to be stored on a floppy disk or transferred electronically. Stored data can also be used for configuring other units of the BM 70 product line.

PC-CAT files can later be used to analyse the performance of the level gauge. All graphs and screens can be exported a word processing systems or other programs.

The customer's PC containing PC-CAT is connected to the current output via the supplied PC adapter, max. distance from the level gauge: 1000 m or 3300 ft. The PC adapter has no effect on in-line instruments such as milliamperemeters, recorders, etc., connected to the current output.



## 9 Power supply

### 9.1 Options, technical data

A choice is offered of 2 supply power versions:

Version	Voltage U	Tolerance	= voltage range	Frequency	Power (typical) *	max. ripple / harmonics
24V DC/ AC	24 V DC	-25% +30%	18-31.2 V	-	7.5 - 10 W	within limits of tolerance
	24 V AC	-25% +10%	18-26.4 V	45-66 Hz	10 VA	10%
115/230 V AC	115 V AC	-25% +10%	85-127 V	45-66 Hz	12 VA	10%
	230 V AC	-25% +10%	170-254 V	45-66 Hz	12 VA	10%

\* Hazardous-duty limit: 20W / 40 VA

## 9.2 Fuses

Device-internal fuses for power:

24 V DC/ AC*	T 1.25 A
115 V AC**	T 315 mA
230 V AC**	T 160 mA

\* Terminals 1 and 2 are both fuse-protected.

\*\* Only connection L (for TN system) is fuse-protected; optionally also both connections N and L (for IT system), see Sect. 9.3.

Location of fuses on the "line" board and replacement of fuses: see Sect. 9.3.

In accordance with operative regulations, it may be necessary to provide additional fuse protection when installing the system.

Recommended line fuse protection:

24 V DC/ AC	min. T 2 A
115 V AC	min. T 0.5 A
230 V AC	min. T 0.25 A

## 9.3 Changeover of operating voltage and replacement of fuses



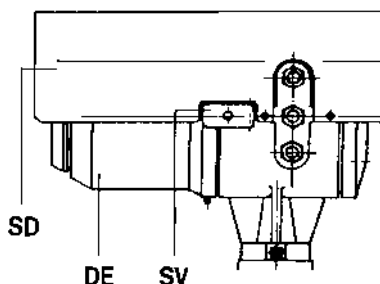
### Attention:

Always switch off power source before commencing work!

### Hazardous-duty systems:

Before opening the "flameproof enclosure" (large cover on the signal converter) in the hazardous area, make absolutely certain that there is no explosion hazard. Allow the prescribed waiting time of 10 minutes to elapse first!

1. Unscrew sunshade SD, if fitted.
2. Detach safety lock SV using Allen key (size 4 mm).
3. Remove cover DE from the electronic compartment (flameproof enclosure) with the supplied special wrench



- 4.1 Replacement of power fuse(s)  
Location of fuses: see drawings below. Use only the specified types.
- 4.2 Changeover of operating voltage (AC Version only)  
Through a different orientation of the voltage selector switch on the "line" board you can switch over between 115 V AC (85-127V) and 230 V AC (170-254V). For this purpose, pull the plug next to the fuse holders up and out (see drawing below), turn it 180° and plug it back into the holder. Also change the two fuses F2 and F3 to suit the selected voltage. Do not forget to alter the voltage information on the signal converter nameplate and in the terminal compartment!



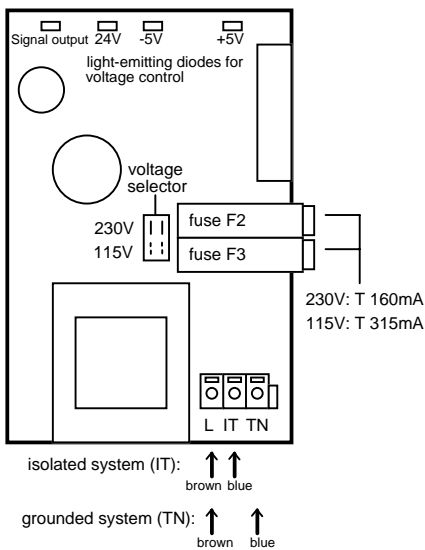
- 4.3 Changeover between 1 fuse (TN system) and 2 fuses (IT system) (AC-Version only)  
 Plug the blue wire on the "line" board into the desired position "TN" or "IT". Do not forget to alter the information TN or IT on the signal converter nameplate ("field power").
5. Reassemble in reverse order, Points 3-1.



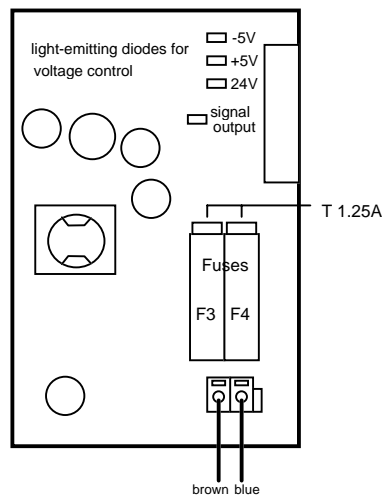
**Important:**

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

Power supply unit 115/230 V AC



Power supply unit 24 V DCAC



**9.4 Advice on safety**

**Insulation rating**

The insulation of type BM 70 M 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 (inside the device)

**Disconnecting device, miniature fuse**

Type BM 70 M level gauges do not feature any device for switching or disconnection.

**Class of protection**

The BM 70 M level gauge is designed for Safety Class 1 in conformity with VDE 0106 Part 1.

**24 V DCAC supply**

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 (international regulations, connection of a safety conductor (PE) is not required.

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### **115/230 V AC supply**

Connection to a power source with dangerous contact voltage: if due to protective measures in conformity with VDE 0100 a safety conductor PE is stipulated, it must be connected to the separate U-clamp terminal in the terminal compartment of the signal converter.

### **Hazardous duty systems**

- The incoming cables for power supply are not of intrinsically safe design, not even in the BM 70 M i version.
- Electrical connection to be in conformity with VDE 0165, Section 5.6, or equivalent national regulations.
- Before making the electrical connection, make sure all cables leading into the BM 70 M-Ex are disconnected from supply!
- When used in hazardous locations, the BM 70 M-Ex must, in conformity with VDE 0165, 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 outer U-clamp terminal on the "neck" of the BM 70 M-Ex. Cancellation of equipotential bonding is only permitted when the BM 70 M-Ex is disconnected from supply.

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## 10 Certificates and approvals

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### 10.1 Declaration of Conformity

**CE Manufacturer's declaration:**

#### DECLARATION OF CONFORMITY

We, **KROHNE Messtechnik GmbH & Co. KG**  
**Ludwig - Krohne - Straße 5**  
**D - 47058 Duisburg**

declare on our own responsibility that the products

- BM 70 M (Marine) Level-Radar

to which this declaration refers, are in conformity with the following standards:

- EN 61326-1 : 1997 + A1: 1998 + A2: 2001
- EN 61000-4-2 : 1995 + A1: 1998 + A2: 2001
- EN 61000-4-3 : 1996 + A1: 1998 + A2: 2001
- EN 61000-4-4 : 1995 + A1: 2001
- EN 61000-4-5 : 1995 + A1: 2001
- EN 61000-4-6 : 1996 + A1: 2001
- EN 61000-4-8 : 1993 + A1: 2001
- EN 61000-4-11 : 1994 + A1: 2001
- EN 61010-1 : 1994 + A2: 1996

in accordance with the provisions of Directives 89 / 336 / EEC and 73 / 23 / EEC.

Duisburg, 11.07.2002

(Place and date of issue)



(Company Management)

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## 11 Ordering information

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### Technical information relevant to the order

#### BM 70 M Level-Radar

Connecting flange: \_\_\_\_\_

Flange and antenna material: \_\_\_\_\_

Waveguide seal:  Viton  FFKM  Kalrez 2035  Other

Antenna type:  Type 4 (200 mm)  Type 3 (140 mm)  
 Type 1 (74 mm)  Type 2 (100 mm) [for stilling well dia.: \_\_\_\_\_  
 Wave-Stick  Wave-Guide length: \_\_\_\_\_

Antenna extension \_\_\_\_\_

Power supply:  24V DCAC  200-240V AC  100-120V AC

Signal output:  Current output  active (Ex-e)  Ex-i passive

alternatively: Digital:  RS 485  Bus: \_\_\_\_\_

Explosion protection  none  Zone 0  Zone 1

#### Special items

Additional calibration BM 70 M

90° Antenna extension \_\_\_\_\_  S-shaped antenna extension

Purge connection \_\_\_\_\_  Antenna heating/ cooling

Others: \_\_\_\_\_

## 12 External standards, codes and directives

DIN V 19259: 1996-10	Documentation of devices, Data types with classification scheme for measuring equipment with analogue or digital output for industrial process measurement [in German]
VDI/VDE 3519 (part 2): 1994-12.	Level measurement of liquids and solids (bulk solids) [in German]
DIN VDE 0165: 1991-02.	Installation of electrical apparatus in hazardous areas [in German]
DIN EN 50014: 2000-02.	Electrical apparatus for potentially explosive atmospheres, General requirements
DIN EN 50018: 1995-03.	Electrical apparatus for potentially explosive atmospheres, Flameproof enclosure "d"
DIN EN 50019: 1996-03.	Electrical apparatus for potentially explosive atmospheres, Increased safety "e"
DIN EN 50020: 1996-04	Electrical apparatus for potentially explosive atmospheres, Intrinsic safety "i"
DIN EN 50284: 2000-02.	Special requirements for construction, test and marking of electrical apparatus of equipment group II, category 1 G
DIN EN 50081-1 (VDE 0839 part 81-1): 1993-03.	Electromagnetic compatibility (EMC), Generic emission standard, Part 1: Residential, commercial and light industry
EN 50082-2: 1995-03.	Electromagnetic compatibility, Generic immunity standard, Part 2: Industrial environment
NE 21 NAMUR	recommendation „Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment“, 1998-08
DIN EN 61010-1 (VDE 0411 part 1):1993-04.	Safety requirements for electrical equipment for measurement, control and laboratory use, general requirements
pr EN 50178 / DIN EN 50178 1994-08	Electronic equipment for use in power installations
Directive 89/336/EWG (CE marking)	
DIN EN 60068-2 (IEC 68-2): 1995-03	Environmental tests
DIN IEC 68-2-6: 1990-06	Electrical engineering, Basic environmental test procedures
DIN EN 60654, part 1 (IEC 654-1): 1994-02	Industrial process measurement and control equipment; Operating conditions; Climatic Conditions
DIN EN 60529: 2000-09	Degrees of protection by enclosures (IP Code)
DIN 2501: 1972-02	Flanges - Fitting dimensions [in German]
DIN 2527: 1972-04	Blind flanges [in German]
ANSI B 16.5: 1988	Pipe Flanges and Flanged Fittings
DIN 11851: 1998-11	Fittings for food, chemical and pharmaceutical industry - Stainless steel screwed pipe connections - Design for rolling in and welding-on
DIN EN 10088, Teil 1: 1995-08	Stainless steels - Catalogue of the stainless steels
DIN 55990: 1979-12	Verification of paints and similar coating materials; Powder mould coatings [in German]
HUG-3: HART® FSK	Physical Layer Specification Rev. 7.2: 1993-05

## 13 Quality assurance

KROHNE Messtechnik GmbH & Co. KG is certified to:

- DIN ISO 9001 / EN 29001 and
- KTA 1401 QSP 4A (nuclear power engineering)

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## Annex A: Technical data

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<b>Application range</b>	Distance, level, volume and reflection measurement of liquids, pastes and slurries in storage tanks of metal, and also on still wells
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<b>Mode of operation and system structure</b>	FMCW Radar in X-Band (8.5-9.9 GHz) with digital signal Processing and quartz-controlled PLL frequency stabilisation; Compact instrument, modular construction
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### Input

Measured quantity	Primary quantities: distance, reflection; Derived quantities: level, volume
Measuring range	Min. distance: 0.5 m Max. measuring range: 35 m (stillwell: 30 m)
Block distance	= antenna length + 10...20 cm For high accuracy: 1 m
Rate of change in level	< 1 m/min
Behaviour when measuring range exceeded	Measured value will stick at the block distance

### Output

#### Output variants

• Variant 1	Ex-e current output HART <sup>®</sup> with switching output and digital input
• Variant 2	Ex-i current output HART <sup>®</sup> (optionally with Ex-i switching output or PROFIBUS-PA or FF)
• Variant 3	RS 485 (Krohne protocol or ModBus) with current output
• Variant 4	PROFIBUS-PA (Ex-i), also combined with Var.2 or Ex-i switching output
• Variant 5	Foundation Fieldbus FF (Ex-i), also combined with Var.2 or Ex-i switching output
Data: Ex-e current output	Type active (current source) Current range 4-20 mA (error: 2mA or 22mA) Accuracy/linearity 0.05 % (rel. 20mA; 20°C, R <sub>B</sub> =100Ω) Temperature drift ≤ 100 ppm/K (typical 30 ppm/K) Load ≤ 500 Ohm Load influence ≤ 0.02 % (rel. 20mA; R <sub>B</sub> = 0...500 Ω) Power supply influence ≤ 0.02 % (rel. 20mA; U <sub>B</sub> in Tol. limits)
Data: switching output	Max. 100 mA / 30 V DC or 30 V AC Inner resistance < 20 Ω
Data: Ex-i- current output	Type passive (current sink) Current range 4-20 mA (error 3.6mA or 22mA); 4 mA constant for HART <sup>®</sup> -Multidrop Accuracy/linearity 0.05 % (rel. 20mA; 20°C, U=10V) Temperature drift ≤ 100 ppm/K (typical 30 ppm/K) Supply voltage 8-30 V (at terminals 31/32) Load ≤ (U <sub>S</sub> - 8V) / 22mA (U <sub>S</sub> = ext.supply) Supply voltage influence ≤ 0.02 % (rel. 20mA for U = 8...30V) Power supply influence ≤ 0.02 % (rel. 20mA; U <sub>S</sub> in Tol. limits) Maximum safety values: U <sub>i</sub> = 30V; I <sub>i</sub> = 250mA; P <sub>i</sub> = 1W; C <sub>i</sub> ≤ 5nF; L <sub>i</sub> ≈ 0

Data: Ex-i switching output	$U = 6...30 \text{ V}$ ; $I_{\text{Low}} \leq 110 \text{ mA}$ ; $U_{\text{Low}} \leq 2 \text{ V}$ ; $I_{\text{High}} \leq 900 \mu\text{A}$ (@ $U=30\text{V}$ ) or $I_{\text{High}} = 200 \mu\text{A}$ (@ $U=8\text{V}$ ) Maximum safety values: $U_i = 30\text{V}$ ; $I_i = 250\text{mA}$ ; $P_i = 1\text{W}$ ; $C_i \leq 5\text{nF}$ ; $L_i \approx 0$
Data: current output (non-communicable; in combination with RS485)	Type active (current source) Current range 4-20 mA (error: 2mA or 22mA) Accuracy/linearity 0.3 % (rel. 20 mA; 20°C, $R_B=100\Omega$ ) Temperature drift $\leq 200 \text{ ppm/K}$ (typical 70 ppm/K) Load $\leq 250 \text{ Ohm}$ Load influence $\leq 0.1 \%$ (rel. 20 mA; $R_B = 0...250 \square$ ) Power supply influence $\leq 0.1 \%$ (rel. 20 mA; $U_B$ in Tol. limits) Used as switching output: Low status current $< 2 \text{ mA}$ High status current = 22 mA (Load $\leq 500 \Omega$ ) Open loop voltage $\leq 18 \text{ V}$
Data: RS485 interface	Baudrate: 1200 to 38400 Baud Address: 0 to 255 Protocols: Krohne protocol, Modbus-RTU, HART®
Data: PROFIBUS-PA	9... 30 V; Base current 10.5 mA; Fault current 6 mA Maximum safety values: $U_i = 30\text{V}$ ; $I_i = 300\text{mA}$ ; $P_i = 4.2\text{W}$ ; $C_i \leq 5\text{nF}$ ; $L_i \approx 0$ Suitable for connection to intrinsically safe Fieldbus systems acc. PTB's FISCO model
Data: FF interface	as for PROFIBUS-PA
Signal on alarm	Local display Current output: error signal 2 mA (Ex-i: 3.6 mA) or 22 mA Switching output: open or close contact Digital interfaces: error flags
Digital input	(only with Ex-e current output HART®): temporarily "freezing" of measurement Voltage: 5...28 V DC; Input resistance: $\geq 1 \text{ k}\Omega$
<b>Measuring accuracy</b>	
Reference conditions	Temperature: +20°C Pressure: 1013 mbar abs. Air humidity: 65% Well reflecting product (e.g. water) with calm surface Vessel diameter $> 5 \text{ m}$ Mounting distance from wall min. $1/5 \times$ tank height No interference reflections within the beam angle ( $\pm 6^\circ$ )
Error of measurement	(dependent on measuring distance a) Under reference conditions: a: block dist. ... 1m: $\pm 3...2 \text{ cm}$ a: 1 m ... 20 m: $\pm 2 \text{ mm}$ a: 20 m ... 35 m: $\pm 0.01 \%$ of distance
Repeatability	$< 0.5 \times$ Error of measurement
Measured-value resolution	0.1 mm
Hysteresis	$< 0.05 \times$ Error of measurement
Transient recovery time	Dependent on programmed time constant (1 ... 100 s)
Turn-on drift / characteristics	First measured value: approx. 1 minute after switching on full measuring accuracy: after 2 minutes operating time
Long-term drift	Within specified error of measurement

Effect of ambient temperature	Measured value: ± 0.08 mm/°C (quasi-static: $\Delta T \leq 0.5$ °C/min) ± 5 mm (change $\Delta T > 0.5$ °C/min) Influence of the propagation way (in air or N <sub>2</sub> or O <sub>2</sub> ): -1 ppm/°C of measured distance Signal outputs: see above
Application conditions	
Installation conditions	Avoid interfering reflections and multiple reflections
Ambient conditions	
Hazardous locations	Zone 0,1,2 Temperature classes: T6...T1 Explosion groups: IIA...IIC
Ambient temperature of signal converter	-40°C ... +60°C (depends on flange temperature)
Flange temperature	Horn antenna: -30°C ... +200°C (depends on Tamb) optional -60°C Solid antenna: -30°C ... +125°C (depends on Tamb)
Ambient temperature limits	Signal converter Measuring function OK, but LCD "freezes": min. -40°C Functional upper limit, for max. 16 hours: max. +70°C
Storage temperature	-20°C ... +60°C
Climate class	Environmental category F acc. GL Damp heat 55°C RH=95% for 96 hours Salt mist (4 times) 5% NaCl spray periods 2 hours, storage 7 days at 40°C RH=93% acc. GL
Ingress protection	(Signal converter) IP 66 / IP 67 (equivalent to NEMA 6/6X)
Shock resistance	Impact test in conformity with EN 61010, Section 8.2 with 0.5 J energy and drop test to prEN 50178:1994
Vibration resistance	2-13.2 Hz: ±1 mm; 13.2-100 Hz: 0.7g 1 octave/min 3 axes: 90 min on each resonance (Q>2) or at 30Hz 3 axes acc. GL
Insulation	HV test min. 1500 V eff. acc. GL Insul. resistance >10 MΩ at 500V DC
EMC	EN 50081-1, EN 50082-2 acc. Ship approvals: discharge 6kV/8kV field 10V/m 80MHz-1GHz AM burst 1kV/2kV conducted 3Veff. 10kHz-80MHz AM surge 1kV/2kV cond. emiss. 10kHz-30MHz rad. emiss. 150kHz-2GHz
Product conditions	
Physical properties	No effect on measurement results Minimum value or relative permittivity required to ensure reliable measurements
Relative permittivity	$\epsilon_r \geq 1.5$ ; $\epsilon_r \leq 2$ : stillwell recommended
Product limitations	Liquid ammonia(NH <sub>3</sub> ) under pressure; Liquid hydrogen(H <sub>2</sub> ); liquid helium (He)
Product temperature	Unlimited (pay attention to ambient and flange temperature)
Operating pressure	Dependent on flange size and pressure rate; standard: max. 16 bar



<b>Design</b>	Versions: solid antenna or standard horn antenna, both with flange connection DN200/PN16 or 8"/150 lbs
Dimensions and weights	Height above mounting flange: <ul style="list-style-type: none"> <li>• solid antenna: 730 mm;</li> <li>• horn antenna: 420 mm</li> </ul> Weight: approx. 40-70 kg (depends on antenna design)
Materials	<b>Signal converter:</b> Housing: Stainless steel 1.4435 (or 1.4539) with blue powder coating Sight window: borosilicate glass <b>Flange system / antenna:</b> stainless steel 1.4435 (or 1.4539) <b>Gaskets</b> FPM (Viton), Kalrez 6375 (others optional) PTFE is also in contact with product)
Process connection	DIN 2501 DN 200 / PN 16, Form C to DIN 2526; or ANSI B16.5 8", 150 lbs, RF
Electrical connection	In the terminal compartment of the signal converter) Terminals: 0.5-2.5mm <sup>2</sup> (solid conductor: max. 4mm <sup>2</sup> ), PE or FE: U-clamp terminal (max. 4 mm <sup>2</sup> ) Cable entries: 3x M25x1.5 or 3x NPT ½" Cable shielding: required for RS485 line, recommended for current output > 100 m "Ex" equipotential bonding: U-clamp terminal (max. 4 mm <sup>2</sup> ) at "neck" of signal converter Rated temperature of cables: 70°C (80°C for Tamb > 55°C or flange temp. > 135°C)
<b>User interface (optional)</b>	
Keyboard	3 keys
Magnetic sensors	for control through the closed housing
Local display	2-line illuminated LCD display + 6 status markers
Operating & display language	English, German, French, Italian, Español, Português, Swedish
Units	Length: m, cm, mm, inch, ft, % Volume: m <sup>3</sup> , Litre, US Gal, GB Gal, ft <sup>3</sup> , bbl, % Conversion unit: any text
Programming	Menu structure and parameters identical with BM 70 P
<b>Supply power</b>	
24 V DCAC version	18-31.2 V DC or 18-26.4 V AC (45-66 Hz)
115/230 V AC version	Switchable: 100-120 V AC (tolerance: 85-127V) / 200-240 V AC (tolerance: 170-254V); 45-66 Hz
Power consumption	Type 8 W / 12 VA
<b>Certificates and approvals</b>	
Ex approvals	According to ATEX
Radio approvals	R&TTE (Europe); FCC (USA) (based on general approvals for BM 70 A/P, BM 702)
Ship approvals	German Lloyd, Lloyds Registers, DNV, (ABS)

## Annex B: Type code / nameplates

The type code is made up of the following elements: <sup>(1)</sup>

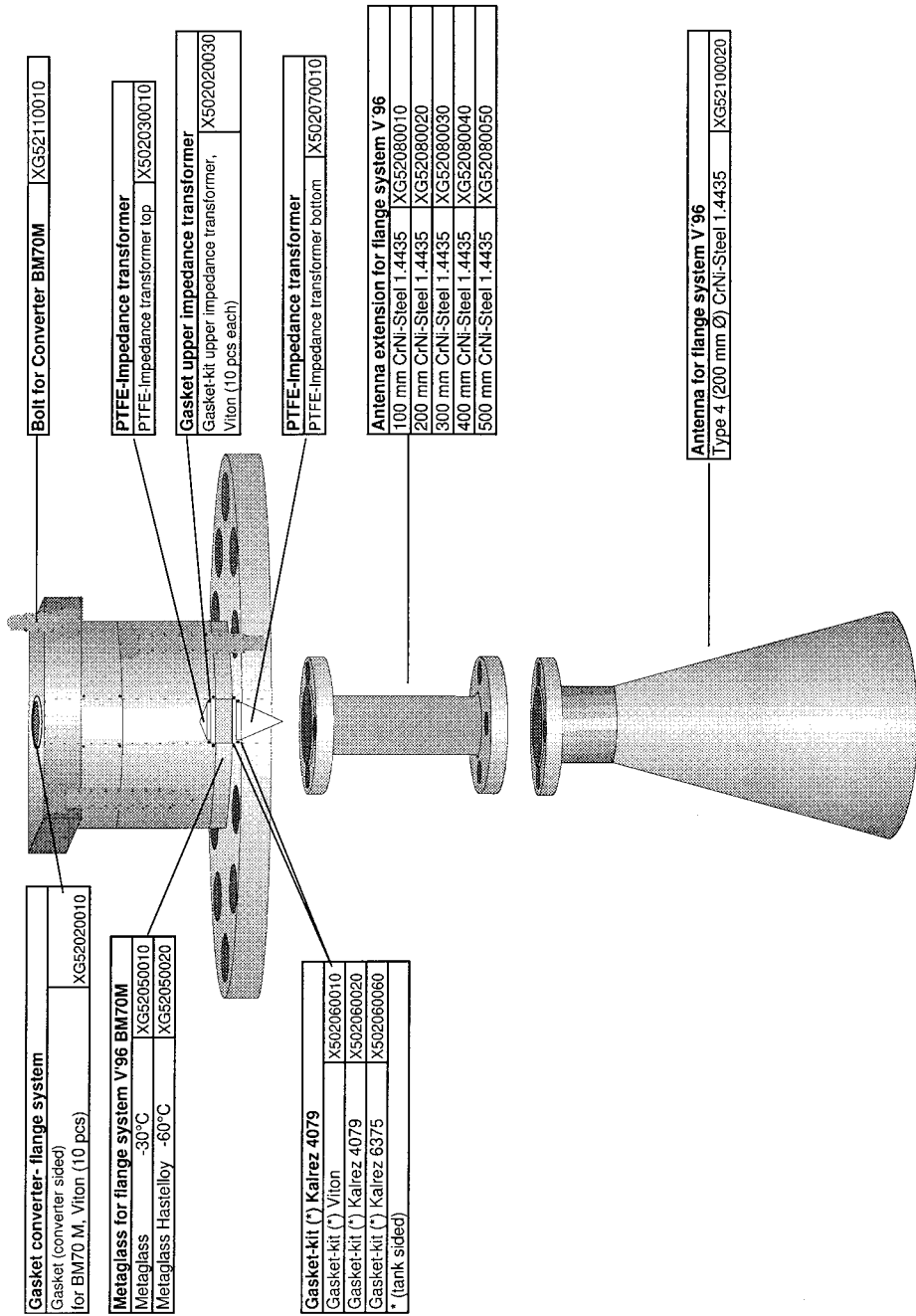
**BM 70M**    /    /    - **E** **Ex**  
1      2      3      4      5      6      7  
 SIGNAL CONVERTER
 

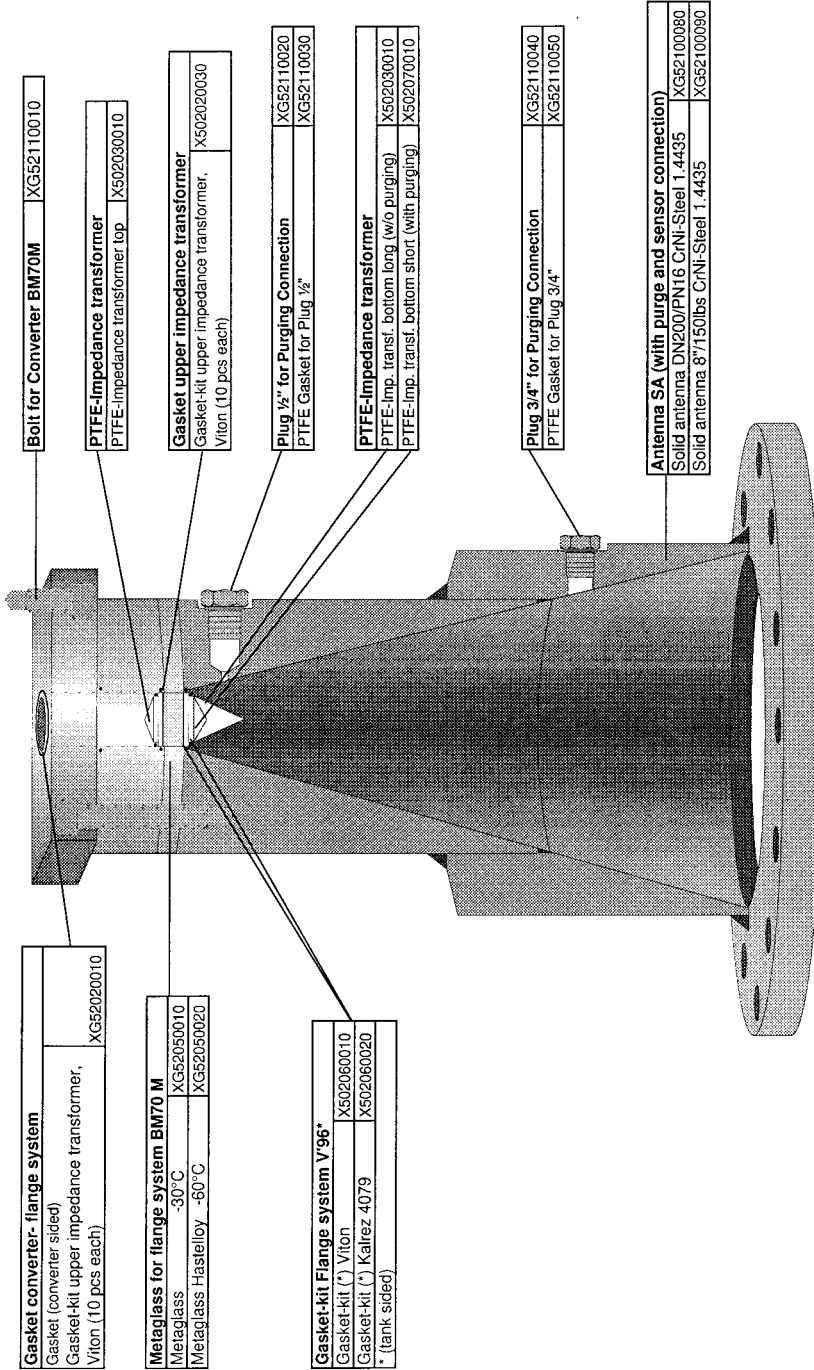
                                  
8      9      10      11  
 FLANGE SYSTEM

1	Tank level measuring device		
2	Signal converter series	70M	Marine
3	Type of protection symbol for signal outputs	i	intrinsically safe I/O function
		unassigned	non-intrinsically safe I/O function
4	Type of protection symbol for the terminal compartment	E	compartment in Increased Safety "e" (standard)
		D	compartment as Flameproof Enclosure "d" (option)
5	Ambient temperature range	S	extended temperature range from -40°C to +60°C
		unassigned	standard temperature range from -20°C to +60°C
6	Territorial application for explosion protection certification	E	Europe (EC, CENELEC)
7	Safety function	Ex	explosion-protected electrical equipment
8	Flange system series	V96	flange system V96
		SA	flange system SA
9	Type of waveguide window	unassigned	stainless steel (standard)
		H	Hastelloy
10	antennas and flanges including coating	SS	stainless steel
		HB	Hastelloy B (V96 only)
		HC	Hastelloy C (V96 only)
		Ti	titanium (V96 only)
		Ta	tantalum (V96 only)
		Mo	Monel
	gasket materials	K6375	Kalrez 6375
		K4079	Kalrez 4079
		K2035	Kalrez 2035
		K1091	Kalrez 1091
		FPM	Viton
		FEP	FEP sheathed gasket
11	Field of application, Device Group II	1G	Category 1G (use in Zone 0)

(1) places not needed in the type code may be omitted







**Gasket converter- flange system**  
 Gasket (converter sided)  
 Gasket-kit upper impedance transformer,  
 Viton (10 pcs each) XG52020010

**Metaglass for flange system BM70 M**  
 Metaglass -30°C XG52050010  
 Metaglass Hastelloy -60°C XG52050020

**Gasket-kit Flange system V96\***  
 Gasket-kit (\*) Viton X502060010  
 Gasket-kit (\*) Kallrez 4079 X502060020  
 \* (tank sided)

**Bolt for Converter BM70M** XG52110010

**PTFE-impedance transformer**  
 PTFE-impedance transformer top X502030010

**Gasket upper impedance transformer**  
 Gasket-kit upper impedance transformer,  
 Viton (10 pcs each) X502020030

**Plug 1/2" for Purging Connection**  
 PTFE Gasket for Plug 1/2" XG52110020  
 XG52110030

**PTFE-impedance transformer**  
 Gasket-kit upper impedance transformer, X502030010  
 PTFE-imp. transf. bottom long (w/o purging) X502070010  
 PTFE-imp. transf. bottom short (with purging) X502070010

**Plug 3/4" for Purging Connection**  
 PTFE Gasket for Plug 3/4" XG52110040  
 XG52110050

**Antenna SA (with purge and sensor connection)**  
 Solid antenna DN200/PN16 CrNi-Steel 1.4435 XG52100080  
 Solid antenna 8"/150lbs CrNi-Steel 1.4435 XG52100090

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**If you need to return a device for testing or repair to KROHNE**

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Your instrument has been carefully manufactured and tested. If installed and operated in accordance with these operating instructions, it will rarely present any problems. Should you nevertheless need to return an instrument for servicing or repair, please pay strict attention to the following points:

- Due to statutory regulations on environmental protection and safeguarding the health and safety of our personnel, KROHNE may only handle, test and repair returned instruments 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 instrument if accompanied by the following certificate confirming that the instrument is safe to handle. If the instrument has been operated with toxic, caustic, flammable or water-endangering liquids, you are kindly requested :
  - to check and ensure, if necessary by rinsing or neutralising, that all cavities in the instrument are free from such dangerous substances. (Directions on how you can find out whether the primary head has to be opened and flushed out or neutralised are obtainable from KROHNE on request.)
  - to attach a certificate to the instrument confirming that the instrument is safe to handle and stating the liquid used.

**We cannot service your instrument unless accompanied by such a certificate.**

**Specimen certificate**

Company: \_\_\_\_\_ Address: \_\_\_\_\_

Department: \_\_\_\_\_ Name: \_\_\_\_\_

Tel. No.: \_\_\_\_\_ Fax No.: \_\_\_\_\_

The enclosed instrument \_\_\_\_\_

Type: \_\_\_\_\_

KROHNE Order No. or Series No \_\_\_\_\_

has been operated with the following process  
liquid \_\_\_\_\_

Because this process liquid is

- |                          |                 |
|--------------------------|-----------------|
| <input type="checkbox"/> | water-hazardous |
| <input type="checkbox"/> | toxic           |
| <input type="checkbox"/> | caustic         |
| <input type="checkbox"/> | flammable       |

we have

- |                          |   |
|--------------------------|---|
| <input type="checkbox"/> | checked that all cavities in the instrument are free from such substances |
| <input type="checkbox"/> | flushed out and neutralised all cavities in the instrument                |

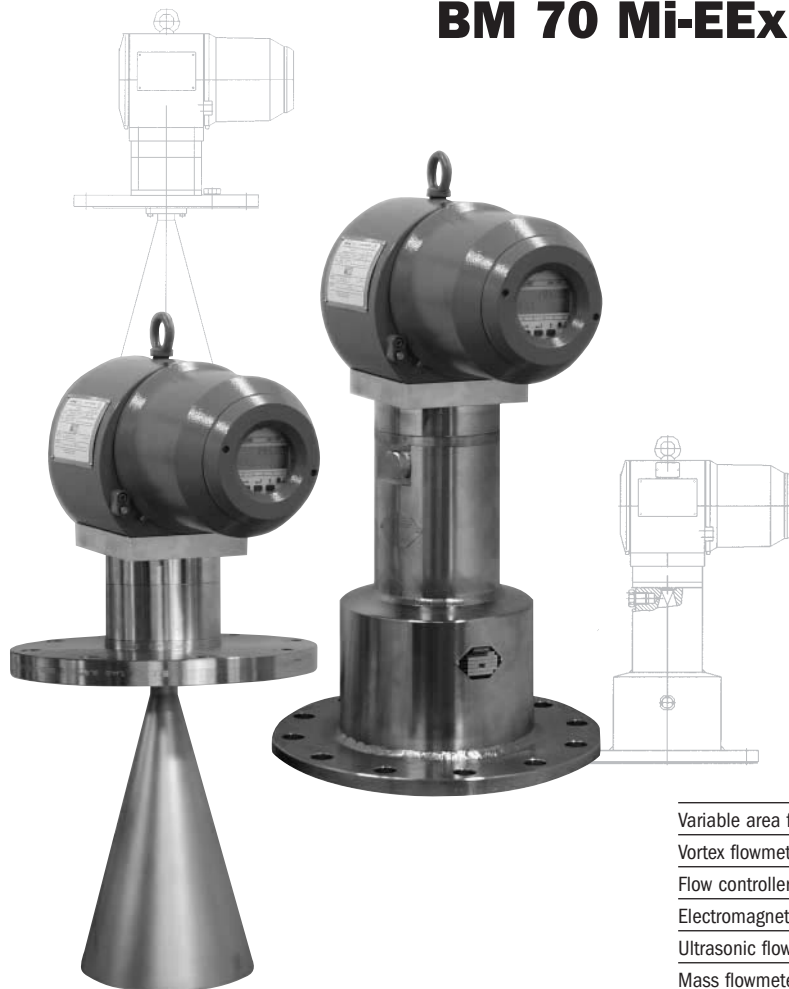
We confirm that there is no risk to humans or environment through any residual liquid contained in the instrument.

Date: \_\_\_\_\_ Signature: \_\_\_\_\_

Company stamp:

## Part 2 Supplementary Installation and operating instructions for

# BM 70 M-EEx BM 70 Mi-EEx



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Variable area flowmeters

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Vortex flowmeters

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Flow controllers

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Electromagnetic flowmeters

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Ultrasonic flowmeters

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Mass flowmeters

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**Level measuring instruments**

---

Communications engineering

---

Engineering systems & solutions

---

Switches, counters, displays and recorders

---

Heat metering

---

Pressure and temperature

---

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## 1 General safety information

These additional "Ex" Instructions apply to the hazardous-duty versions of BM 70 M-EEEx level gauges. They are supplementary to the Installation and Operating Instructions issued for the non-hazardous-duty versions.

The directions given in these Instructions contain only the data relevant to explosion protection. The technical details given in the Installation and Operating Instructions for the non-hazardous-duty versions apply unchanged unless excluded or superseded by these present Instructions. In compliance with European Directive 94/9/EC (ATEX 100a), level gauges of the BM 70 M-EEEx series are certified in conformity with European Standards EN 50xxx for use in hazardous areas under

**PTB 02 ATEX 1078**

by the Physikalisch-Technische Bundesanstalt (PTB).

It is absolutely necessary that the details contained in that approval certificate together with its boundary conditions be observed.



**Note:**

Assembly, installation, start-up and maintenance work may only be carried out by personnel who have been specially "trained in explosion protection".

## 2 Safety relevant Type Code

The safety-relevant type code is made up of the following elements: <sup>(1)</sup>

<b>BM 70M</b>	<b>.</b>	<b>/</b>	<b>.</b>	<b>/</b>	<b>.-</b>	<b>E</b>	<b>Ex</b>	<b>...</b>	<b>.</b>	<b>.....</b>	<b>-</b>	<b>..</b>	<b>..</b>
1	2	3	4	5	6	7		8	9	10	11		
SIGNAL CONVERTER							FLANGE SYSTEM						

1	Tank level measuring device		
2	Signal converter series	70M	Marine
3	Type of protection symbol for signal outputs	i	intrinsically safe I/O function
		unassigned	non-intrinsically safe I/O function
4	Type of protection symbol for the terminal compartment	E	compartment in Increased Safety "e" (standard)
		D	compartment as Flameproof Enclosure "d" (option)
5	Ambient temperature range	S	extended temperature range from -40°C to +60°C
		unassigned	standard temperature range from -20°C to +60°C
6	Territorial application for explosion protection certification	E	Europe (EC, CENELEC)
7	Safety function	Ex	explosion-protected electrical equipment
8	Flange system series	V96	flange system V96
		SA	flange system SA

9	Type of waveguide window	unassigned	stainless steel (standard)
		H	Hastelloy
10	Materials of wetted parts antennas and flanges including coating	SS	stainless steel
		HB	Hastelloy B (V96 only)
		HC	Hastelloy C (V96 only)
		Ti	titanium (V96 only)
		Ta	tantalum (V96 only)
	gasket materials	K6375	Kalrez 6375
		K4079	Kalrez 4079
		K2035	Kalrez 2035
		K1091	Kalrez 1091
	FPM	Viton	
	FEP	FEP sheathed gasket	
11	Field of application, Device Group II	1G	Category 1G (use in Zone 0)

(1) places not needed in the type code may be omitted

### 3 Main safety-relevant characteristics

#### 3.1 Signal converter

The BM 70 M-EEEx level gauges consist in each case of a combination of signal converter and flange system. The main characteristics of the explosion-protected signal converter are described below.

##### 3.1.1 Category / Zone allocation

The signal converter part of the BM 70 M-EEEx level gauges is basically designed in Category 2 for application in Zone 1.

##### 3.1.2 Types of ignition protection

BM 70 M-EEEx with non-intrinsically safe I/O functions			
Variant	Device part	Type of protection	Symbol
BM 70 M/E-EEEx	Electronics compt	Flameproof Enclosure	EEEx de
	Terminal compt	Increased Safety	
	Pin coupler compt	Increased Safety	
BM 70 M/D-EEEx	Electronics compt	Flameproof Enclosure	
	Terminal compt	Flameproof Enclosure	
	Pin coupler compt	Increased Safety	

BM 70 M-EEEx with intrinsically safe I/O functions			
Variant	Device part	Type of protection	Symbol
BM 70 Mi/E-EEEx	Electronics compt	Flameproof Enclosure	EEEx de [ia]
	Terminal compt	Increased Safety	
	Pin coupler compt	Increased Safety	
BM 70 Mi/D-EEEx	Electronics compt	Flameproof Enclosure	
	Terminal compt	Flameproof Enclosure	
	Pin coupler compt	Increased Safety	

### 3.1.3 Special lock

The sealing covers of terminal compartment and electronics compartment are secured by special locks. The locking screw requires use of an Allen key (4 mm size).

### 3.1.4 I/O functions

The following limit values need to be taken into account when connecting the I/O interfaces of the BM 70 M-Ex level gauges:

BM 70 M-Ex with non-intrinsically safe I/O functions		
I/O function <sup>(1)</sup>	Nominal values of the non-certified receiver instrument	Added restriction
Acc. to Standard Installation and Operating Instructions	Acc. to Standard Installation and Operating Instructions	Power for receiver instruments max. 250 V
<sup>(1)</sup> Only for connection to circuits with "functional extra-low voltage with safety separation (PELV)"		

BM 70 Mi-Ex with intrinsically safe I/O functions		
I/O function	Marking	Maximum safety values
Passive current output	EEx ia IIC or EEx ib IIC	U <sub>i</sub> ≤ 30V li ≤ 250mA Ci ≤ 5nF Li = negligible
Passive switching output	EEx ia IIC or EEx ib IIC	U <sub>i</sub> ≤ 30V li ≤ 250mA Ci ≤ 5nF Li = negligible
Interface Profibus-PA <sup>(1)</sup>	EEx ia IIC or EEx ib IIC/IIB	U <sub>i</sub> ≤ 30V li ≤ 300mA Ci ≤ 5nF Li = negligible
Interface Fieldbus FF <sup>(1)</sup>	EEx ia IIC or EEx ib IIC/IIB	U <sub>i</sub> ≤ 30V li ≤ 300mA Ci ≤ 5nF Li = negligible
<sup>(1)</sup> suitable for connection to intrinsically safe Fieldbus systems based on the FISCO Model		

The intrinsically safe circuits of the I/O functions are galvanically isolated both from ground and also from each other (test voltage > 500 VAC).

Furthermore, all intrinsically safe circuits are safety-separated from the non-intrinsically safe power circuits up to a peak voltage of 375 V.

## 3.2 Flange systems

### 3.2.1 Category / Zone allocation

The allowable operating conditions for the flange systems of the BM 70 M-Ex level gauges are given in the following tables.



**Note:**

The application restrictions marked with indices should be observed without fail.

Flange system		Allowed operating conditions		
Material	Version	Antenna in Zone	Flange temperature / product temperature [°C]	Max. allowable tank - pressure [bar]
V96 and SA all certified variants	0		- 20 ... 60°C <sup>(1)</sup>	-0.2 ... 0.1 <sup>(1)</sup> (0.8 ... 1.1 bar abs.)
	1		see Sect. 3.3.2	Acc. to Standard Installation and Operating Instructions
<sup>(1)</sup> limited to atmospheric conditions in accordance with EN 50 284				

---

#### Application restrictions:

- **Flange system V96 with heating**

The operator shall ensure that the temperature of the heating medium, when used in Zone 0, shall not exceed 80% of the ignition temperature (in °C) of the product(s) in the tank, and shall not exceed the maximum allowable flange temperature as a function of the temperature class. The operating pressure of the heating system to be limited to max. 6 bar. Ensure that the inlet and outlet of the heating system are correctly connected (see information plates on the upper side of the flange).

- **Flange system V96 or SA with purging device and/or sensor connection**

When delivered, the purge connection and sensor connection are each closed off by a G $\frac{1}{2}$ " or G $\frac{1}{4}$ " screw. Connection and operation of the purge and sensor connections fall within the responsibility of the operator. When the screw plug for the purge and/or sensor connection is removed, the operator is responsible for ensuring conformance with the "Ex" requirements pertaining to the purge and/or sensor connection (e.g. fitting a flame trap). The operator is also responsible for selecting a suitable purging medium.

### 3.3 Temperature classes, complete device

#### 3.3.1 General

In respect of maximum surfaces temperatures, level measuring devices are exposed to three heat sources:

- Ambient temperature  $T_{amb}$
- Electric power loss  $P_v$
- Product temperature  $T_m$

Accordingly, at a given maximum ambient temperature ( $T_{amb} < 60^{\circ}\text{C}$ ) and a given maximum loss power, we obtain maximum surface temperatures as a factor of the product temperature. For that reason, the devices are not allocated to any specific temperature class; rather, the temperature class of the devices is a function of the actual product temperature.

#### 3.3.2 BM 70 M-EEEx with flange system V96 or SA

To simplify definition of the temperature class of the BM 70 M-EEEx level gauges with flange system V96 or SA, the only reference temperature required is the temperature at the device flange of the level gauge. If the following maximum values are not exceeded at the device flange, this will ensure that all other thermal limit values at the device are also maintained.

The temperature class can be defined in one of two ways:

- Without measurement of the flange temperature  
If the flange temperature is not known, the product temperature shall be taken as being the reference temperature for the flange.
- With measurement of the flange temperature  
For operating conditions requiring Category 2 equipment, the product temperature may assume higher values than the flange temperature, taking into consideration the limit values of the temperature classes. The flange temperature should be established under "worst case" conditions (e.g. allowing for the maximum possible product level and any additional insulation measures).

For both systems – BM 70 M./V96 and BM 70 M./SA – the maximum product level to satisfy safety requirements is the tank mounting flange.

---

**Device versions BM 70 M -EEx /V96**

Temperature class	Ambient temperature [°C]	Maximum flange temperature [°C]
T6	60	85
T5	55	100
	60	95 *)
T4 ... T1	40	125
	45	120
	50	110
	55	105
	60	95 *)
*) heat-resistant cable required (min. 80°C)		

**Device versions BM 70 M -EEx /SA**

Temperature class	Ambient temperature [°C]	Maximum flange temperature [°C]
T6	60	85
T5	60	100
T4	55	135
	60	135 *)
T3 ... T1	45	200
	50	190 *)
	55	170 *)
	60	135 *)
*) heat-resistant cable required (min. 80°C)		

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## 4 Identifying Marking

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The level gauges bear the following marking:

- on the signal converter  
stick-on label or metal plate on the converter housing
- on the flange system  
metal plate on the tank mounting flange (V96) or on the side of the antenna (SA).

Matching of signal converter and flange system is assured by way of the serial number marked on the two nameplates.

The type code is described in Section 2.

### 4.1 Marking – Signal Converter

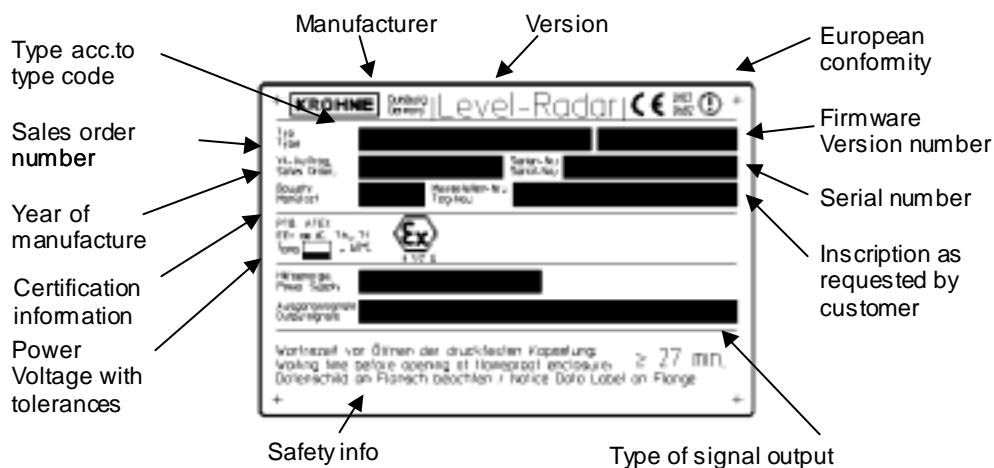
The signal converters are identified by means of the nameplates reproduced below:

#### 4.1.1 Signal converter without intrinsically safe I/O function

BM 70 M -EEx in Category 2G in combination with:

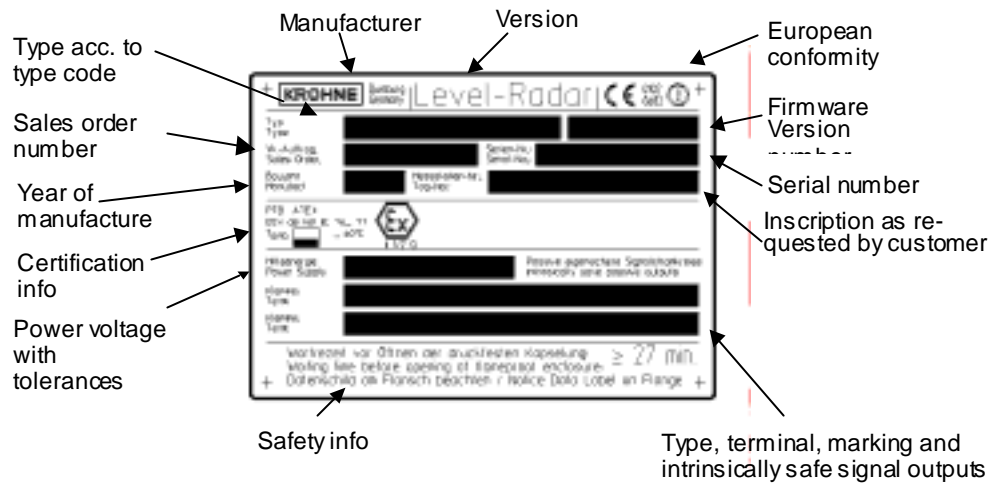
flange system V96 or SA in Category 1G

Marking: **II 1/2 G**



#### 4.1.2 Signal converter with intrinsically safe I/O functions

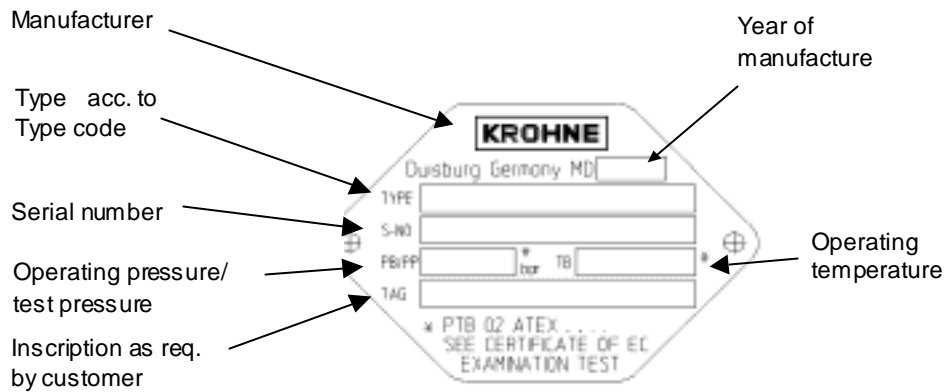
BM 70 Mi -EEx in Category 2G in combination with:  
 Flange system V96 or SA in Category 1G  
 Marking: II 1/2 G



#### 4.2 Marking of flange systems

The flange systems are marked with the metal plate reproduced below.

##### Flange systems V96 and SA



**Note:**

Refer to application restrictions in Section 3.2.1.

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## **5 Assembly and installation**

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Assembly and installation to be carried out in accordance with the valid installation standards for hazardous areas (e.g. EN 60079-14) by specialist personnel who have received training in explosion protection.

In this connection, take note of the directions given in the standard Installation and Operating Instructions, these Supplementary Installation and Operating Instructions (Ex), and the EC type test certificate.

Verify the suitability of the level gauge by comparing the data given on the nameplate with that given in Section 3.2.1 (Categories / Zone allocation), Section 2 (Type code) and 4 (Marking). Attention is drawn in particular to the following points.

### **5.1 Flange systems**

#### **5.1.1 Flange system V96 / SA (optionally with sensor connection)**

Install appropriately so as to avoid mechanical loads and sparking caused by blows to the antenna and extensions (e.g. by agitators).

#### **5.1.2 Flange system V96 with heating (optionally with sensor connection)**

The operator shall ensure that the temperature of the heating medium, when used in Zone 0, does not exceed 80% of the ignition temperature (in °C) of the products in the tank, and does not exceed the maximum allowable flange temperature as a function of the temperature class. The pressure of the heating medium should not exceed 6 bar. In addition, when operating the heating system, make sure that inlet and outlet are correctly connected (see information labels on flange).

#### **5.1.3 Flange system V96 / SA with purging system and/or sensor connection**

The locking screw for the purging system and/or for the sensor connection forms, together with the screw thread of the tank mounting flange, a flameproof joint when given at least five full turns. The quality grade of the thread of the inserted screw is "medium" in accordance with DIN 13 and ISO 965.

This screw must be removed before the purge/sensor connection can be used. But do not remove the locking screw for the purge/sensor connection unless the tank is in non-pressurized condition!

Take appropriate measures to ensure that the purge/sensor connection is fitted with a flame trap. Together with the thread of the tank mounting flange, the connection screwed into that flange must form a flameproof joint in conformity with EN 50 018 (note thread quality grade and threaded length).

The choice of a suitable purging medium and operation of the purge/sensor connection are the responsibility of the operator.

When the purge/sensor connection is used, the operator shall ensure that no unpermissible changes are made to process conditions (e.g. temperature, pressure, etc.).

#### **5.1.4 Flange system V96 with heating and purging systems**

Refer to the information and directions given in sections 5.1.1 and 5.1.2.

### **5.2 Electrical connection BM 70 M-EEEx**

#### **5.2.1 Terminal compartment**

The electrical connection for power and I/O functions is made in the terminal compartment of the signal converter. The terminal compartment may, as described in Section 2 (Type code) and Section 3 (Main safety-relevant characteristics), optionally be designed in types of protection EEx e, EEx d, EEx ei and EEx di:



---

### Terminal compartment in EEx e or EEx ei type of protection

Permissible as cable entries and blanking plugs are only parts certified to EN 50 019. The cable clamping area for the supplied cable entries measures 9 – 16 mm. Use cables with appropriate diameter or approved cable entries with matched clamping area in accordance with their test certificate.

### Terminal compartment in EEx d or EEx di type of protection

The cables can basically be routed into the flameproof terminal compartment in one of two ways. Direct entry of the connecting cables by way of flameproof **cable glands** into the flameproof terminal compartment using the certified NPT ½“ adapters fitted by the device manufacturer, or using flameproof glands with separate test certificate to EN 50 018. Tight fitting of the adapters in the housing to be ensured, especially after detaching from piping.

Direct entry of the connecting cables by way of **conduits** into the flameproof terminal compartment of the device requires, after the conduit has been screwed in, a flameproof joint in accordance with ISO 965 / DIN 13 with a minimum of five full turns depth of engagement. A suitable stopping box to be provided within 450 mm of the entry into the terminal compartment. Installation of the conduit must be carried out in conformity with its separate test certificate. Generally, a certified NPT ½“ adapter provided by the device manufacturer, or an EN 50018 certified adapter is required between the “PG” thread (heavy-gauge conduit thread) of the terminal compartment and the conduit thread.

#### 5.2.2 Connecting cables

The power cables for the non-intrinsically safe power circuits, and for the non-intrinsically or intrinsically safe I/O circuits shall be selected in keeping with the valid installation standard (e.g. EN 60079-14).

Where elevated product temperatures are concerned (see also Section 3.3.2 “Temperature classes“), use heat-resistant cables with a continuous service temperature of  $\geq 80^{\circ}\text{C}$  in conformity with the type test certificate.

#### 5.2.3 Connection of power and I/O functions

- Before connecting or disconnecting the electrical interconnecting cables of the device, make sure that all cables leading to the signal converter are isolated from the ground (reference potential) of the hazardous area. This also applies to safety conductors (PE) and equipotential bonding conductors (PA).
- All cores and shields of the power cables not safety-connected to the equipotential bonding system for the hazardous area should be carefully insulated from each other and from ground (test voltage  $500V_{\text{rms}}$  for conductors of intrinsically safe cables, test voltage  $1500V_{\text{rms}}$  for conductors of non-intrinsically safe cables).
- Connect all shields by the shortest possible route to the press-fitted U-clamp terminal (FE) in the terminal compartment. If shields are to be grounded at both ends (e.g. for EMC reasons), adequate equipotential bonding is required between the two shield ends to avoid unacceptable circulating currents.
- Independent of the type of power supply, the device must be incorporated in the equipotential bonding system of the hazardous area. This can be done by way of an appropriately conductive connection between the device flange system and the tank. If connection to the equipotential bonding system is to be made via a separate conductor, this must be connected to the outer press-fitted U-clamp terminal on the signal converter flange.

In the case of device versions with intrinsically safe I/O functions (BM 70 Mi -EEx), only certified intrinsically safe equipment with the maximum values (see Section 3.1.4 and type test certificate) may be connected to the power terminals marked as being intrinsically safe. This requirement also applies when the device is not operated in the hazardous area!

## 5.2.4 Terminal assignment

### Power supply

The power connection is of the non-intrinsically safe type for all variants of BM 70 M.-EEx.  
For detailed information and connection plan see Part 1: Installation and operating instructions for BM 70 M, Section 7.6 Electrical connection

### 5.2.5 Terminal assignment - I/O functions

Non-intrinsically safe I/O functions and intrinsically safe I/O functions are available for the BM70M.-EEx:

Non-intrinsically safe I/O functions BM 70 M-EEx				
I/O function <sup>(1)</sup>		Diagram	Variant	Electrical data
Digital input + switching output + current output HART	passive passive active	1	BM 70 M	See Section 3.1.4
Current output	active	2		
RS485 interface + current output	active	3		
<sup>(1)</sup> only for connection to circuits with functional extra-low voltage with safety separation (PELV)				

Intrinsically safe I/O functions BM 70 Mi-EEx				
I/O function		Diagram	Variant	Max. safety data
Current output HART	passive	4	BM 70 Mi	See Section 3.1.4
Current output HART + switching output	passive passive	5		
Fieldbus Profibus PA	passive	6		
Fieldbus Fieldbus Foundation	passive	6		
Fieldbus Profibus PA / + current output HART	passive passive	7		
Fieldbus Fieldbus Foundation + current output	passive passive	7		
Fieldbus Profibus PA + switching output	passive passive	8		
Fieldbus Fieldbus Foundation + switching output	passive passive	8		

For detailed information and connection plan see Part 1: Installation and operating instructions for BM 70 M, Section 7.6 Electrical connection

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## 6 Initial start-up

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Check the following before initial start-up:

- Verify suitability of the materials used for the flange system (e.g. flange, antennas, gaskets) for adequate resistance to corrosion from the tank product.
- Compare the data on the nameplates of the signal converter and flange with actual operating data.
- Check that signal converter and flange system are properly assembled.
- Check that the level gauge is properly mounted on the tank, including any optional equipment such as purging and/or heating system, and the signal converter.
- Check that the equipotential bonding system is properly connected.
- Check the connection for supply power and I/O functions.
- Check that the covers of the terminal and electronics compartments are firmly in place, that special locks have been tightened down.

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## 7 Operation

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Do not open the covers of terminal compartment and electronics compartment during operation in the presence of a potentially explosive atmosphere.

Should parameterization of the device become necessary in the presence of an explosive atmosphere, this can be done by using the supplied programming bar magnet and applying it to the glass window of the electronics compartment, without opening the housing, or digitally via the signal output.

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## 8 Preventive maintenance

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### 8.1 Signal Converter

The signal converter is maintenance-free under normal operating conditions and when used for the intended purpose.



**Caution:**

If any cleaning is required, avoid build-up of electrostatic charge, e.g. through friction.

Should it prove necessary to open the flameproof enclosure of the electronics compartment in the presence of a potentially explosive atmosphere, make sure that the device is disconnected from supply. Before opening the Flameproof Enclosure, be absolutely sure to allow the waiting time specified on the nameplate of the converter (27 minutes) to elapse first.

Should it prove necessary to open the flameproof enclosure of the electronics compartment in the presence of a potentially explosive atmosphere, make sure that the device is disconnected from supply. Before opening the Flameproof Enclosure, be absolutely sure to allow the waiting time specified on the nameplate of the converter (27 minutes) to elapse first.

Before connecting or disconnecting the device interconnecting cables, make sure that all cables leading into the signal converter are isolated from the ground (reference potential) of the hazardous area. This also applies to safety conductors (PE) and equipotential bonding conductors (PA).

---

After any maintenance work has been carried out, be sure to regrease the flameproof cover thread of the signal converter including cover gaskets with a grease suitable for stainless steel threads (e.g. Copper-Anticorrosion paste).

Within the scope of checks required to be carried out in hazardous areas to maintain systems in proper working order, the following visual inspections should be carried out at regular intervals:

- Inspection of the housing, cable entries and incoming cables for signs of corrosion and damage.
- Inspection of the tank connections for leakages.

## 8.2 Flange Systems

The flange systems do not require any maintenance under normal operating conditions and when used for the intended purpose. Depending on the application, however, in unfavourable operating conditions the measuring function may be impaired by contamination of the antenna system. The antenna should then be cleaned as described in the Installation and Operating Instructions for the non-hazardous-duty versions. Cleaning requires that the flange system be dismantled. Such dismantling work will need to be coordinated with field conditions (e.g. check for presence of a flammable liquid and/or potentially explosive atmosphere in or at the tank, pressurized tank) and is the responsibility of the operator.

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## 9 Dismantling

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### 9.1 Replacement of Signal Converter

The modular design of the BM 70 M-Ex level gauges allows replacement of the converter to be carried out by undoing bolts (M) as shown in the diagram below. The flange system need not be removed from the tank. This also applies to pressurized tanks.



**Caution:**

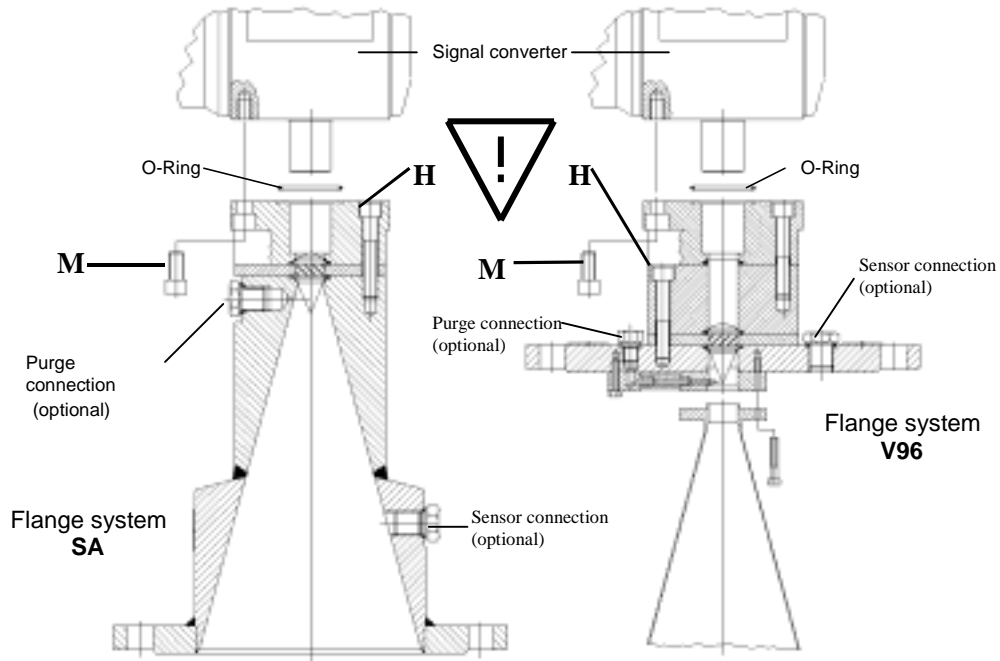
On pressurized tanks, do not remove the 4 screws (H) connecting the wave guide window to the tank mounting flange.  
**DANGER TO LIFE!**

Before detaching the interconnecting cables of the device, make sure that all cables leading into the signal converter are isolated from the ground (reference potential) of the hazardous area. This also applies to safety conductors (PE) and equipotential bonding conductors (PA).

Should it prove necessary to open the Flameproof Enclosure of the electronics compartment in the presence of an explosive atmosphere, first make sure that the device is disconnected from supply. Before opening the Flameproof Enclosure, be absolutely sure to allow the waiting time, specified on the converter nameplate (27 minutes), to elapse first.

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Assembly screws (M) for signal converter:



## 9.2 Replacement of complete device

The requirements described in Sect. 9.1 also apply in this instance.

In addition, make sure that all process connections and the tank are non-pressurized.



### Caution:

On pressurized tanks, do not remove the 4 screws (H) connecting the wave guide window to the tank mounting flange (refer to diagram in Sec. 9.1).  
**DANGER TO LIFE!**

In connection with environmentally critical products, carefully decontaminate the wetted parts of the flange system after dismantling.

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## 10 Maintenance Service

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Maintenance work of a safety-relevant nature within the meaning of explosion protection may only be carried out by the manufacturer, his authorized representative or under the supervision of authorized inspectors.

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## 11 Approvals

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### Declaration of Conformity in accordance with ISO/IEC Guide 22

No.: BM70xx 07/02

Supplier: KROHNE Messtechnik GmbH & Co. KG

Address: Ludwig-Krohne-Str. 5  
D - 47058 Duisburg  
Germany

Products: BM 70 M - EEx  
BM 70 Mi - EEx

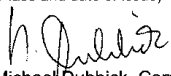
The products described above are in conformity with the European Standards:

EN 50014 : 1997 +A1 + A2  
EN 50018 : 2000  
EN 50019 : 2000  
EN 50020 : 1994  
EN 50284 : 1999

Additional information:

Applied directive: 94 / 9 / EC  
Notified body: PTB Braunschweig, Registration No. 0102  
EC type examination certificate: PTB 02 ATEX 1078

Duisburg, 22.07.02  
(Place and date of issue)

  
Michael Dubbick, Company Management  
(Name, function, signature)



**EG-Baumusterprüfbescheinigung**

- (1)
- (2) Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen - **Richtlinie 94/9/EG**
- (3) EG-Baumusterprüfbescheinigungsnummer  
**PTB 02 ATEX 1078**
- (4) Gerät: Mikrowellen-Füllstandmessgerät BM 70M.-EEx
- (5) Hersteller: KROHNE Messtechnik GmbH & Co. KG
- (6) Anschrift: Ludwig-Krohne-Str. 5, 47058 Duisburg, Deutschland
- (7) Die Bauart dieses Gerätes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage und den darin aufgeführten Unterlagen zu dieser Baumusterprüfbescheinigung festgelegt.
- (8) Die Physikalisch-Technische Bundesanstalt bescheinigt als benannte Stelle Nr. 0102 nach Artikel 9 der Richtlinie des Rates der Europäischen Gemeinschaften vom 23. März 1994 (94/9/EG) die Erfüllung der grundlegenden Sicherheits- und Gesundheitsanforderungen für die Konzeption und den Bau von Geräten und Schutzsystemen zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie.  
Die Ergebnisse der Prüfung sind in dem vertraulichen Prüfbericht PTB Ex 02-12164 festgehalten.
- (9) Die grundlegenden Sicherheits- und Gesundheitsanforderungen werden erfüllt durch Übereinstimmung mit  
**EN 50014:1997 + A1 + A2    EN 50018:2000    EN 50019:2000**  
**EN 50020:1994    EN 50284:1999**
- (10) Falls das Zeichen „X“ hinter der Bescheinigungsnummer steht, wird auf besondere Bedingungen für die sichere Anwendung des Gerätes in der Anlage zu dieser Bescheinigung hingewiesen.
- (11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf Konzeption und Prüfung des festgelegten Gerätes gemäß Richtlinie 94/9/EG. Weitere Anforderungen dieser Richtlinie gelten für die Herstellung und das Inverkehrbringen dieses Gerätes. Diese Anforderungen werden nicht durch diese Bescheinigung abgedeckt.
- (12) Die Kennzeichnung des Gerätes muß die folgenden Angaben enthalten:



**Ex II 1/2 G EEx de IIC T6 ... T1 bzw. EEx de [ia] IIC T6 ... T1**

Zertifizierungsstelle Explosionsschutz  
Im Auftrag

Braunschweig, 15. Juli 2002

Dr.-Ing. U. Johannsmeyer  
Regierungsdirektor



Seite 1/6

EG-Baumusterprüfbescheinigungen ohne Unterschrift und ohne Siegel haben keine Gültigkeit.  
Diese EG-Baumusterprüfbescheinigung darf nur unverändert weiterverbreitet werden.  
Auszüge oder Änderungen bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt.

Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

(13) **Anlage**

(14) **EG-Baumusterprüfbescheinigung PTB 02 ATEX 1078**

(15) Beschreibung des Gerätes

Das Mikrowellen-Füllstandmessgerät BM 70M-EEEx dient zur kontinuierlichen Füllstandmessung in ortsveränderlichen und festen Prozess-, Verfahrens-, Transport- und Lagerbehältern. Das Behälterinnere kann dabei ein explosionsgefährdeter Bereich der Zone 0 sein.

Ein linear frequenzmoduliertes Mikrowellensignal, dessen Amplitude konstant ist, wird über eine trichter- bzw. rohrförmige Antenne in den Behälterinnenraum abgestrahlt. Das abgestrahlte Signal wird vom Messstoff reflektiert und nach einer gewissen Zeit wieder von der Antenne empfangen. Aus der Laufzeit des Signals wird in der Messumformerelektronik der Füllstand berechnet. Es wird ein elektrisches Einheitssignal 0/4 ... 20 mA und/oder digitales Informationssignal erzeugt.

Technische Daten

**Baugruppe 1, Messumformer**

**BM 70M.**

Messbereich	0 ... 100 m
Umgebungstemperatur	-20 °C (optional -40 °C) bis +60 °C
Schutzart nach EN 60529	mindestens IP 54
Hilfsenergie	
Klemmen 1, 2	: 24 V - Ausführung $U_N = 24 \text{ V DC } +30 \% / -25 \%$ $U_N = 24 \text{ V AC } +10 \% / -25 \%$ Max. 8 W / 20 VA Interne Absicherung $I_N \leq 1,25 \text{ A}$ $U_m = 250 \text{ V}$ (nur BM 70Mi-EEEx)
Klemmen L, N	115 / 230 V – Ausführung $U_N = 115 \text{ V AC } +10 \% / -25 \%$ $U_N = 230 \text{ V AC } +10 \% / -25 \%$ Max. 8 W / 20 VA Interne Absicherung $I_N \leq 0,25 \text{ A}$ $U_m = 250 \text{ V}$ (nur BM 70Mi-EEEx)

Signalstromkreise je nach Geräteausführung

**BM 70M**

Signaleingänge und -ausgänge	nichteigensichere Stromkreise
Klemmen 31, 32 / 41, 42 / 81, 82 / A, B	$U < 25 \text{ V AC } / 60 \text{ V DC}$



**BM 70MI (max. 2 Ausgänge)**

Passiver Stromausgang  
Klemmen I, I<sub>L</sub>  
und / oder  
passiver Status-/ Frequenzausgang  
Klemmen B, B<sub>L</sub>

in Zündschutzart Eigensicherheit EEx ia IIC bzw.  
EEx ib IIC

nur zum Anschluss an eigensichere Stromkreise

Höchstwerte:

U<sub>i</sub> = 30 V

I<sub>i</sub> = 250 mA

P<sub>i</sub> = 1,0 W

C<sub>i</sub> = 5 nF

L<sub>i</sub> vernachlässigbar klein

und / oder

Profibus-PA / Feldbus-FF

in Zündschutzart Eigensicherheit EEx ia IIC bzw.  
EEx ib IIC / IIB

nur zum Anschluss an eigensichere Stromkreise

Höchstwerte:

U<sub>i</sub> = 30 V

I<sub>i</sub> = 300 mA

P<sub>i</sub> = 4,2 W

C<sub>i</sub> = 5 nF

L<sub>i</sub> vernachlässigbar klein

Geeignet zum Anschluss an eigensichere Feldbus-  
systeme nach dem FISCO- Modell.

**Baugruppe 2, Hohlleiterfenster**

**V96 und SA**

Einsatzbereich

Betriebsüberdruck PB

Betriebstemperatur TB

(unabhängig von den eingesetzten Werkstoffen)

**Zone 0 / Gasgruppe IIC**

-0,2 ... 0,1 bar (0,8 ... 1,1 bar absolut)

-20 ... +60 °C

Einsatzbereich

Betriebsüberdruck PB (Standard)  
(optional)

Zulässige Flanschttemperaturen abhängig vom Mikrowellenfenster aus:

- Edelstahl, Titan, Tantal

(Standardtemperatur)

-30 °C bis +250 °C\*

- Hastelloy

(Standardtemperatur)

-60 °C bis +250 °C\*

\* abhängig vom eingesetzten Dichtungsmaterial

Zulässige Einsatztemperaturen der Dichtungsmaterialien:

- K6375

-30 °C bis +250 °C

- K4079

-60 °C bis +250 °C

- K2035

-60 °C bis +210 °C

- K1091

-30 °C bis +250 °C

- FPM

-30 °C bis +200 °C

- FEP

-30 °C bis +200 °C

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(16) Prüfbericht PTB Ex 02-12164

(17) Besondere Bedingungen

keine

Zusätzliche Hinweise für den sicheren Betrieb:

**Anschlussbedingungen**

1. Das Mikrowellen-Füllstandmessgerät BM 70M.-EEx ist in der Ausführung mit druckfest gekapseltem Anschlussraum über dafür geeignete Kabel- und Leitungseinführungen bzw. Rohrleitungssysteme anzuschließen, die den Anforderungen der EN 50 018 Abschnitte 13.1 und 13.2 entsprechen und für die eine gesonderte Prüfbescheinigung vorliegt.
2. Kabel- und Leitungseinführungen (Pg-Verschraubungen) sowie Verschlussstopfen einfacher Bauart dürfen bei Ausführung mit Anschlussraum in Zündschutzart "Druckfeste Kapselung" nicht verwendet werden. Bei Anschluss des Mikrowellen-Füllstandmessgerätes BM 70M.-EEx über eine für diesen Zweck zugelassene Rohrleitungseinführung muss die zugehörige Abdichtungsvorrichtung direkt am Gehäuse angeordnet sein.
3. Nicht benutzte Öffnungen sind entsprechend EN 50 018 Abschnitt 11.9 zu verschließen.
4. Die Anschlussleitung des Mikrowellen-Füllstandmessgerätes BM 70M.-EEx ist fest und so zu verlegen, daß sie hinreichend gegen Beschädigung geschützt ist.

Diese Hinweise sind jedem Betriebsmittel in geeigneter Form beizufügen.

**Potenzialausgleich**

Das Mikrowellen-Füllstandmessgerät BM 70M.-EEx ist in den örtlichen Potenzialausgleich einzubeziehen.

**Antenne Bauart V96 mit Beheizung und Spülung**

Durch den Betreiber ist sicherzustellen, daß die Temperatur des Heizmediums, bei Einsatz in der Zone 0, nicht 80 % der Zündtemperatur der Medien in °C im Behälterinneren sowie die höchstzulässige Flanschttemperatur in Abhängigkeit von der Temperaturklasse, überschreitet. Der Betriebsdruck in der Heizung ist auf max. 6 bar zu begrenzen.

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Temperaturklassenzuordnung

Geräteausführungen BM 70M. –EEx /V96

Temperaturklasse	Höchstzulässige Umgebungstemperatur in °C	Höchstzulässige Flanschttemperatur in °C
T6	+60	85
T5	+55	100
	+60	95 <sup>1</sup>
T4 ... T1	+40	125
	+45	120
	+50	110
	+55	105
	+60	95 <sup>1</sup>

<sup>1</sup> Verwendung wärmebeständiger Anschlussleitung erforderlich ( $T_{\min} \geq 80 \text{ °C}$ )

Geräteausführungen BM 70M. –EEx /SA

Temperaturklasse	Höchstzulässige Umgebungstemperatur in °C	Höchstzulässige Flanschttemperatur in °C
T6	+60	85
T5	+60	100
T4	+55	135
	+60	135 <sup>1</sup>
T3 ... T1	+45	200
	+50	190 <sup>1</sup>
	+55	170
	+60	135

<sup>1</sup> Verwendung wärmebeständiger Anschlussleitung erforderlich ( $T_{\min} \geq 80 \text{ °C}$ )

Die angegebenen Höchstwerte können durch niedrigere Grenzwerte der verwendeten Materialien und Dichtungen des Flanschsystems eingeschränkt sein.

Die Höchstwerte der Flanschttemperatur gelten unter folgenden Voraussetzungen:

- Das Füllstandmessgerät wird in seiner bestimmungsgemäßen Lage betrieben.
- Das Füllstandmessgerät ist keiner Wärmestrahlung ausgesetzt (z.B. Sonneneinstrahlung, benachbarte heiße Anlagenteile)
- Isolierungen behindern nicht die freie Belüftung des Messumformergehäuses.

**Wartezeit**

Nach dem Abschalten des Gerätes ist eine Wartezeit von mindestens 27 Minuten bis zum Öffnen der druckfesten Kapselung einzuhalten.

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# Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

Anlage zur EG-Baumusterprüfbescheinigung PTB 02 ATEX 1078

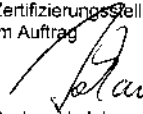


(18) Grundlegende Sicherheits- und Gesundheitsanforderungen

Erfüllt durch die Übereinstimmung mit den vorgenannten Normen.

Zertifizierungsstelle Explosionsschutz  
Im Auftrag

Braunschweig, 15. Juli 2002

  
Dr.-Ing. U. Johannsmeyer  
Regierungsdirektor



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**If you need to return a device for testing or repair to KROHNE**

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Your instrument has been carefully manufactured and tested. If installed and operated in accordance with these operating instructions, it will rarely present any problems. Should you nevertheless need to return an instrument for servicing or repair, please pay strict attention to the following points:

- Due to statutory regulations on environmental protection and safeguarding the health and safety of our personnel, KROHNE may only handle, test and repair returned instruments 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 instrument if accompanied by the following certificate confirming that the instrument is safe to handle. If the instrument has been operated with toxic, caustic, flammable or water-endangering liquids, you are kindly requested :
- to check and ensure, if necessary by rinsing or neutralising, that all cavities in the instrument are free from such dangerous substances. (Directions on how you can find out whether the primary head has to be opened and flushed out or neutralised are obtainable from KROHNE on request.)
- to attach a certificate to the instrument confirming that the instrument is safe to handle and stating the liquid used.

**We cannot service your instrument unless accompanied by such a certificate.**

**Specimen certificate**

Company: \_\_\_\_\_ Address: \_\_\_\_\_

Department: \_\_\_\_\_ Name: \_\_\_\_\_

Tel. No.: \_\_\_\_\_ Fax No.: \_\_\_\_\_

The enclosed instrument \_\_\_\_\_

Type: \_\_\_\_\_

KROHNE Order No. or Series No \_\_\_\_\_

has been operated with the following process  
liquid \_\_\_\_\_

Because this process liquid is

- |                          |                 |
|--------------------------|-----------------|
| <input type="checkbox"/> | water-hazardous |
| <input type="checkbox"/> | toxic           |
| <input type="checkbox"/> | caustic         |
| <input type="checkbox"/> | flammable       |

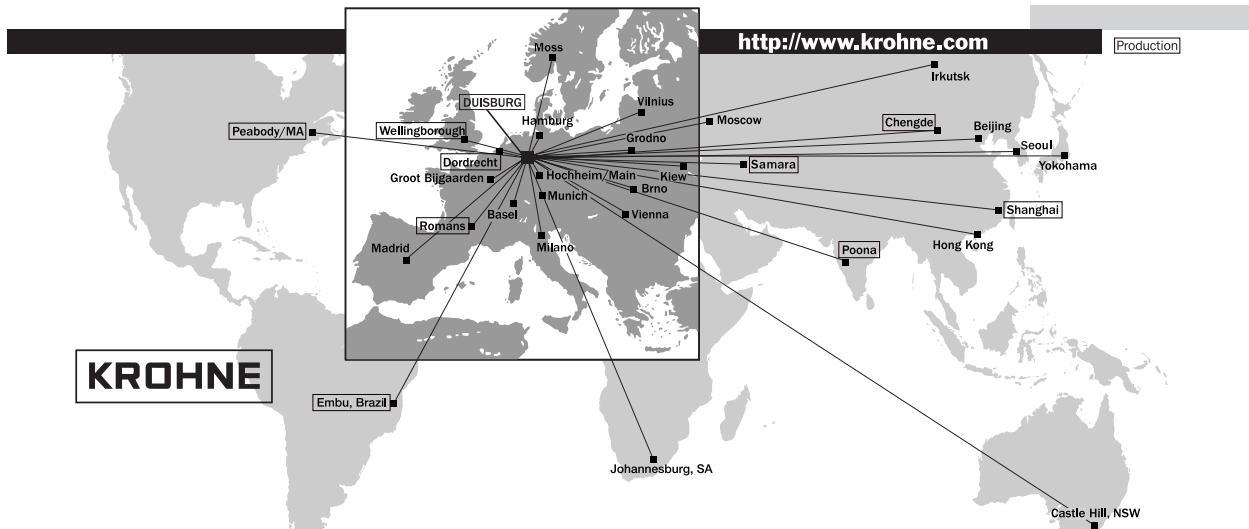
we have

- |                          |   |
|--------------------------|---|
| <input type="checkbox"/> | checked that all cavities in the instrument are free from such substances |
| <input type="checkbox"/> | flushed out and neutralised all cavities in the instrument                |

We confirm that there is no risk to humans or environment through any residual liquid contained in the instrument.

Date: \_\_\_\_\_ Signature: \_\_\_\_\_

Company stamp:



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