

## Project Engineering Guidelines

### BM 70 A, BM 70 P, BM 702 LEVEL-RADAR



This documentation is designed to help the user and/or systems planning engineer select the optimum instrument type, assess measurement properties, and plan the mechanical and electrical installation.

Detailed information on installation, operation and control of type BM 70 A/P, BM 702 Level-Radar instruments is contained in the "BM 70 A/P or BM 702 Installation and Operating Instructions" and the Short Manual "Getting Started with BM 70 A", which are supplied together with the instruments.

The structure of this documentation is modelled on the lines of DIN V 19259 V Standard.

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# 1 Application range

The BM 70 A/P, BM 702 Level-Radar gauging system is used for distance, level, volume and reflection measurement of liquids, pastes, slurries, solids and particulate materials. It can be operated on storage and process tanks, and also on still wells.

BM 70 P is specially designed for applications on storage tanks with highest precision requirements.

BM 702 is a 2-wire Radar for the simpler applications in storage tanks, process tanks, stilling wells and side vessels.

Hazardous-duty versions BM 70 A/P, BM 702 Ex are suitable for use in Ex-Zone 0, 1 and 2.

In Germany (and, depending on the respective radio approval, in some other countries as well), its use is restricted to closed tanks or containers made of metal or concrete. Because of low output, however, the microwaves are not harmful to humans.

## Selection sheet

Application condition	BM 702	BM 70 A	BM 70 P
Measuring range ≤ 20 m / 66 ft	✓	✓	✓
Measuring range 20 ... 35 m / 66 ... 115 ft	—	✓	✓
Measuring range 35 ... 100 m / 115 ... 328 ft	—	K	—
Storage tanks	✓	✓	✓
Still wells / reference vessels	✓	✓	✓
Process tanks with slightly moving surface	✓	✓	K
Difficult process tanks (e.g. agitator)	—	✓	—
Large or many disturbing tank internals	—	✓	K
Solids	—	K	—
Extreme measuring accuracy (± 1 mm)	—	—	✓
High measuring stability / repeatability	—	—	✓
Current output 4-20 mA HART®	✓	✓	✓
2-wire connection	✓	—	—
Bus connection (RS 485, PROFIBUS-PA, FF)	K	✓	✓

### Legend:

- ✓ suitable
- not suitable
- K contact KROHNE

## 2 Mode of operation and system structure

### 2.1 Measurement principle (FMCW Radar)

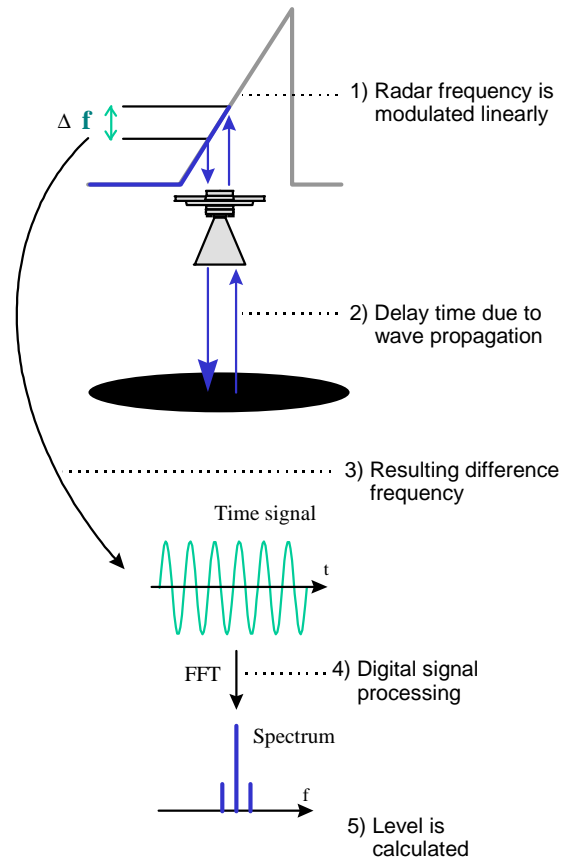
A radar signal is given via an antenna, reflected on the measuring surface and received after a delay time  $t$ .

#### FMCW: Frequency Modulated Continuous Wave

The FMCW-radar uses a high frequency signal ( $\sim 10$  GHz) which transmit 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 correspond 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.



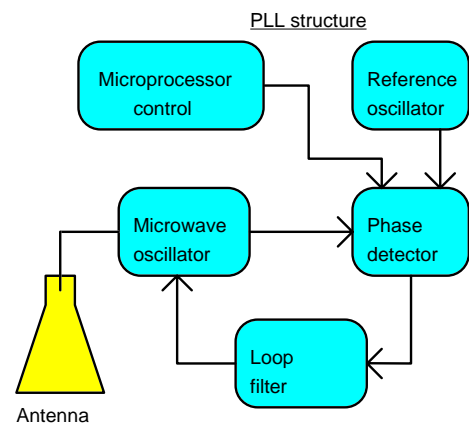
#### Linearity of frequency sweeps

The measuring accuracy of a 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. The non-linearity is corrected up to 98% (BM 702/BM 70 A).

An immediate frequency regulation is necessary with the BM 70 P 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 further processed digitally by a microprocessor. The processing system is distinguished by intelligent procedures taking into consideration plausibilities and history.

## 2.3 Advantages of radar technology

Compared to alternative level gauging methods, radar technology offers numerous advantages:

- Non-contact measurement
- It is independent of the gas composition and temperature of the tank atmosphere
- Will also work in tank atmospheres containing vapour and dust
- Independent of electrical properties of the product (conductivity, permittivity)
- Independent of product density and pressure
- No radiation hazard
- Extremely high measuring accuracy (version BM 70 P)

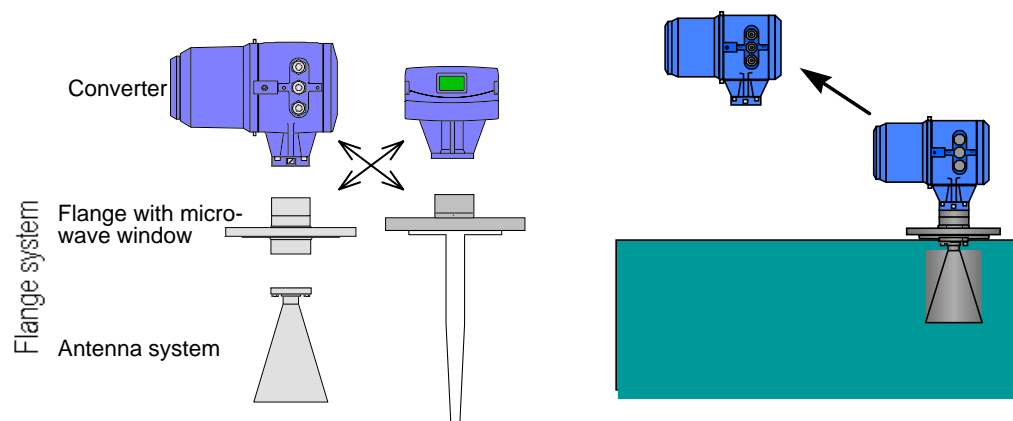
## 2.4 Modularity (signal converter, flange, antenna)

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 standardized output signal (4-20 mA or digital interface).

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



### 3 Input

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

The primary measured quantity 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 (only BM 70 A/P).

#### 3.2 Measuring range [0.5...20/35/40/100 m]

Minimum tank height: 0.5 m (1.64 ft)

The maximum measuring range is for:

BM 70 A	40 m (131 ft), optionally up to 100 m (328 ft)
BM 70 P	35 m (115 ft)
BM 702	20 m (65.6 ft)
Wave-Stick version	20 m (65.6 ft) recommended

The useful range depends on the antenna size, the reflection properties of the tank product, the installation position, and the presence of interference reflectors (see Sections 6.1 and 7.3).

#### 3.3 Block distance

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

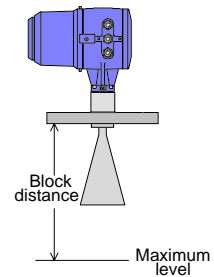
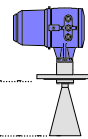
Recommended minimum values: see sketches.

##### Horn antenna without still well:

Antenna size\* = Type3: 22cm/8.7"; Type4: 34cm/13.4";  
\* Hastelloy: -3cm/1.2"

Recommended Antenna distance:

Storage tanks: 10cm/4"; Process tanks: 20cm/8"



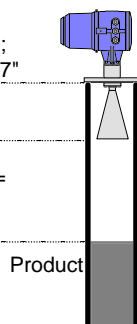
Length of any antenna extension used must be added on!

##### Still well / Wave-Guide:

Antenna size \* = Type1: 11cm/4.4";  
Type2: 15cm/5.9"; Type3: 22cm/8.7"

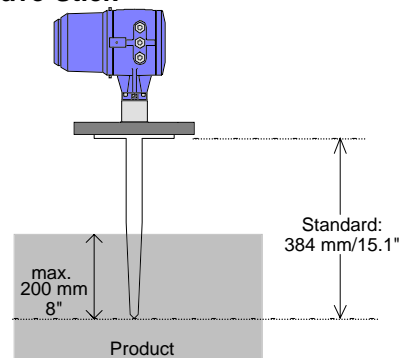
Wave-Stick SW: 6cm/2.4"  
(Wave-Guide: no antenna)

Recommended antenna distance =  
30 cm / 12" (BM 702: 50 cm / 20")



\* Hastelloy: -3cm (1.2")

##### Wave-Stick



Minimum block distance =  
Standard: 184 mm (7.24")  
General: Rod length - 200 mm (7.87")

#### 3.4 Behaviour when measuring range exceeded

In the event of the level measuring range being exceeded (including flooding) the measured value will stick at the block distance, which is adjustable.

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

## 4 Output

### 4.1 Variants

#### BM 70 A, BM 70 P:

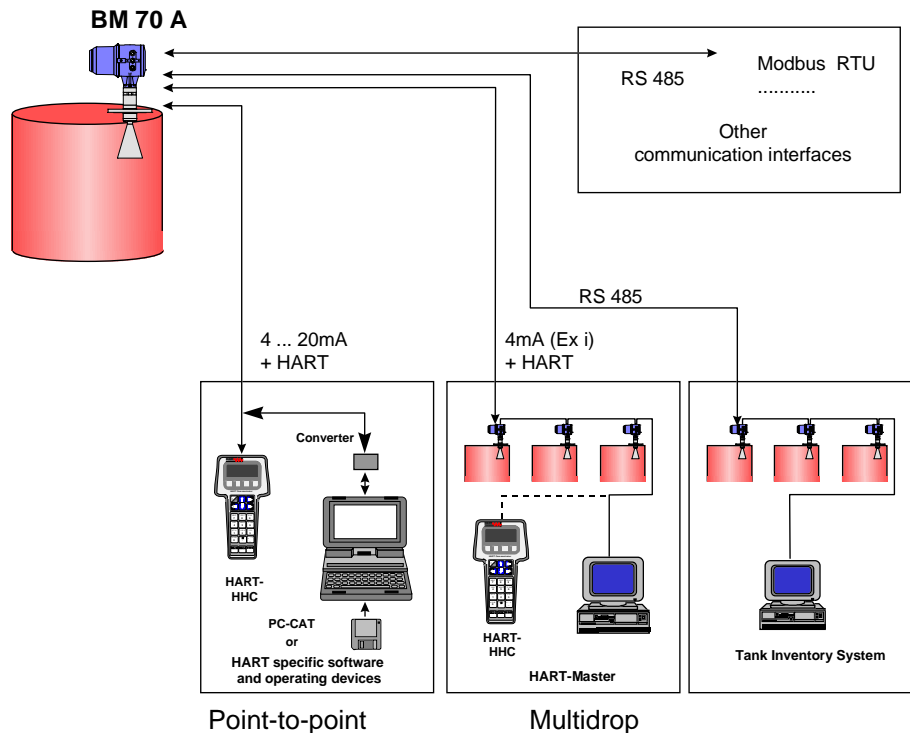
Variant	Comments	Described in Section
Ex-e current output HART <sup>®</sup>	Ex-e; active; HART <sup>®</sup> protocol; together with switching output and digital input	4.2 + 4.4
Ex-i (IS) current output HART <sup>®</sup>	intrinsically safe; passive; HART <sup>®</sup> protocol (optional with IS switching output)	4.3 + 4.4
Current output	Ex-e; active; not 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	-

#### BM 702:

Ex-i (IS) current output HART <sup>®</sup>	intrinsically safe; passive; HART <sup>®</sup> protocol	4.3 + 4.4
PROFIBUS-PA	intrinsically safe; in preparation	-
Foundation Fieldbus (FF)	intrinsically safe; in preparation	-

All versions with HART<sup>®</sup> or BM70 protocol can be operated with the PC program PC-CAT (see Section 7.7.7).

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 or 22 mA
Accuracy/linearity	0.05 % (rel. 20 mA; at T=20°C/68°F, 100Ω load and rated operating voltage)
Temperature drift	≤ 100 ppm/K (typically 30 ppm/K)
Load	≤ 500 Ω
Effect of load impedance	≤ 0.02 % (rel. 20 mA for R <sub>B</sub> = 0...500 Ω)
Effect of power	≤ 0.02 % (rel. 20 mA for U <sub>B</sub> 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 interrupt the entire measuring procedure (measurements are suspended) or to hot start the device.

Applicable voltage: 5...28 V DC

Input resistance: ≥ 1 kΩ

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

Can be programmed as limit switch, alarm contact or error message.

The contact is open in de-energized condition.

Operating data: max. 100 mA / 30 V DC or 30 V AC.

Internal resistance: ≤ 20 Ω

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

### BM 70 A, BM 70 P:

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 or 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/68°F, 10 V supply voltage and rated operating voltage)
Supply voltage U	8-30 V (between terminals 31 and 32)
Load	≤ (U <sub>S</sub> - 8 V) / 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 is 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 de-energized condition.

Operating data: 6...30 V; I<sub>Low</sub> ≤ 110mA; 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>i</sub> = 30 V; I<sub>i</sub> = 250 mA; P<sub>i</sub> = 1 W

Effective inner capacitance C<sub>i</sub> ≈ 0; effective inner inductance L<sub>i</sub> ≈ 0

### BM 702:

Function	Level, distance or volume (conversion table); and error identification; passive output (current sink)
Current	4-20 mA; without or with error message 3.6 mA or 22 mA; 4 mA constant, adjustable for HART®-Multidrop
Temperature drift	≤ 100 ppm/K (typically 30 ppm/K)
Accuracy/linearity	0.15 % (rel. 20 mA; at T = 20°C/68°F, 24 V terminal voltage)
Supply voltage U	13-30 V (between terminals); U <sub>min</sub> dependent on current (see Sect. 9.1)

Load  $\leq (U_S - 13 \text{ V}) / 20 \text{ mA}$  ( $U_S$  = external supply voltage)  
 Effect of supply voltage  $\leq 0.02 \%$  (rel. 20 mA for  $U = 13\text{...}30 \text{ V}$ )

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:  
 $U_i = 30 \text{ V}$ ;  $I_i = 100 \text{ mA}$ ;  $P_i = 1 \text{ W}$   
 Effective inner capacitance  $C_i = 11 \text{ nF}$ ; effective inner inductance  $L_i \approx 0$

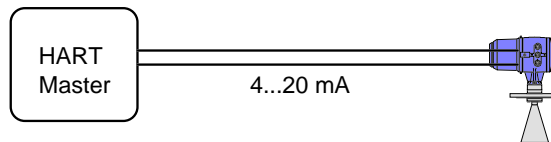
**4.4 HART® communication**

In accordance with the Rosemount Standard, the HART® communications protocol can be used with a BM 70 A/P, BM 702.

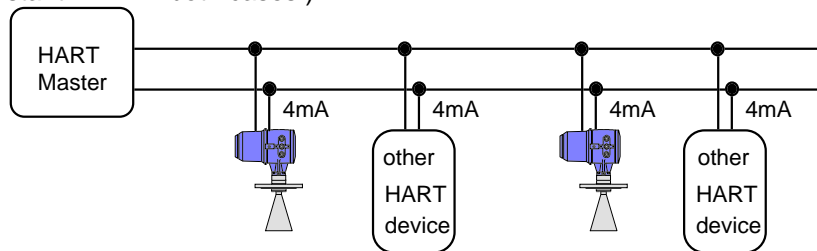
Electrical connection: see Section 7.6.

There are two ways of using the HART® communication:

- a) As a **point-to point** connection between the BM 70 A/P, BM 702 and the HART® Master equipment.  
 A BM 70 A/P, BM 702 can be used either with an Ex-e-current output HART® or with an Ex-i (IS) current output HART®.



- b) As a **multipoint connection (multidrop)** with up to 15 devices (BM 70, BM 70 A/P, BM 702 or other HART® equipment), in parallel on a 2-wire **bus**:  
 A BM70 A/P, BM 702 is normally used with Ex-i current output, but an Ex-e current output can also be used (constant 4 mA in both cases.)



**4.5 Current output, RS 485 version (no communication capability)**

Function Level, distance, volume (conversion table) or reflection, and error identification  
 Current 4-20 mA; without or with error message 2 mA or 22 mA  
 Accuracy/linearity 0.3 % (rel. 20 mA; at T = 25°C/77°F, 100Ω load and rated operating voltage)  
 Temperature drift  $\leq 200 \text{ ppm/K}$  (typically 70 ppm/K)  
 Load  $\leq 250 \Omega$   
 Effect of load impedance  $\leq 0.1 \%$  (rel. 20 mA for  $R_B = 0\text{...}250 \Omega$ )  
 Effect of power  $\leq 0.1 \%$  (rel. 20 mA for  $U_B$  within limits of tolerance)  
 Hazardous-duty version: Ex e

When operated as switching output (digital output):  
 Function Limit switch, alarm contact or error message  
 Low state Current < 2 mA  
 High state Current = 22 mA (when load  $\leq 250 \Omega$ )  
 No-load voltage  $\leq 18 \text{ V}$



## 4.6 Digital interface RS 485

RS 485 is a bus allowing two-way communication (half-duplex operation) with the BM 70 A/P Level-Radar. When the computer system sends out a request, the BM 70 A/P transmits: level, distance, volume (conversion table), reflection, parameters and status.

A PC can configure any BM 70 A/P 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 (6500 ft).

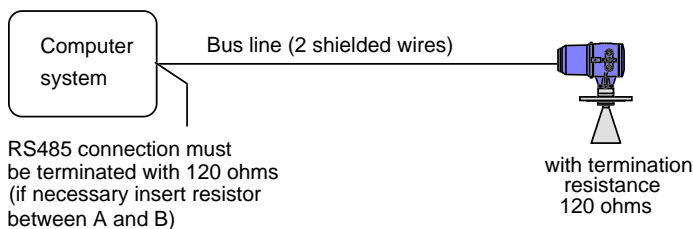
Transmission rate: 1200 to 38400 bauds  
 Address: 0 to 255  
 Protocols: KROHNE Protocol, Modbus RTU, HART®  
 Add'l information: see "BM70A/P Communication RS 485" instructions

Additional current output: The current output is conductively coupled to the RS 485 interface!  
 Technical data: see Section 4.5

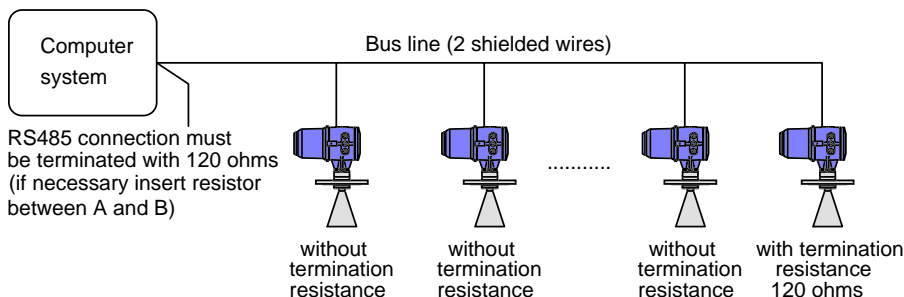
Note: Switching contact and digital input not available. However, the current output can be configured as a switching output.

### Various bus configurations

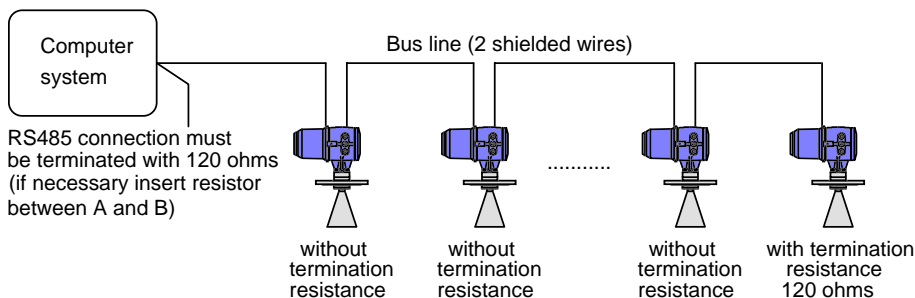
A) Connection of a BM 70 A/P as a single RS 485 user:



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



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



### Notes:

- If other devices are operated together with the BM 70 A/P Level-Radar on one bus, all devices must use the same communications protocol (e.g. ModBus devices of different manufacturers, or BM 70 and TTM70 with KROHNE protocol).

- 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  $\Omega$ ). Inside the BM 70 A/P, changeover can be made between "high-resistance" und "120  $\Omega$ ".

## 4.7 Signal on alarm

Alarm information can be called up via the following interfaces:

- Local display: flashing display, plain text information
- Current output: error signal 2 mA / 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" measurement 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 agitators, slide gates, ball valve in the still well. The last measured values in each case are present at the outputs and in the display.

## 5 Measuring accuracy

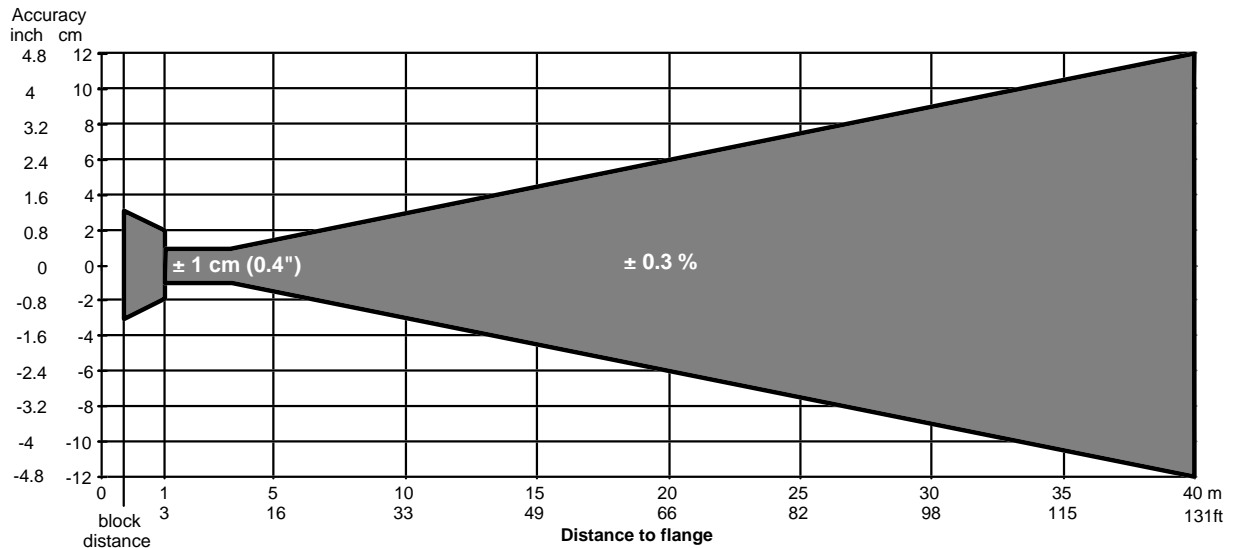
### 5.1 Reference conditions

- Temperature = +20°C (68°F)
- Pressure = 1013 mbar abs. (14.69 psia)
- Air humidity = 65%
- Product reflects well (e.g. water) with calm surface
- Tank diameter > 5 m (16.4 ft)
- Mounted at least 1/7 x tank height (BM 70 P: 1/5 x tank height) away from edge of tank
- No interference reflections inside radiation lobe ( $\pm 6...9^\circ$ ; see Section 6.1.1)

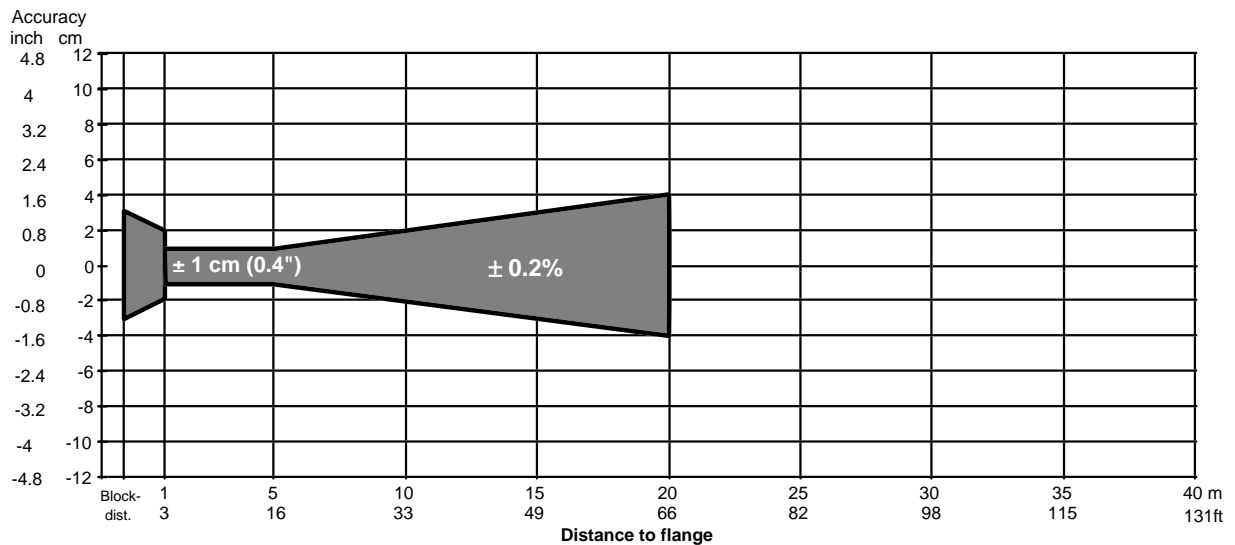
### 5.2 Error of measurement

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

#### BM 70 A:

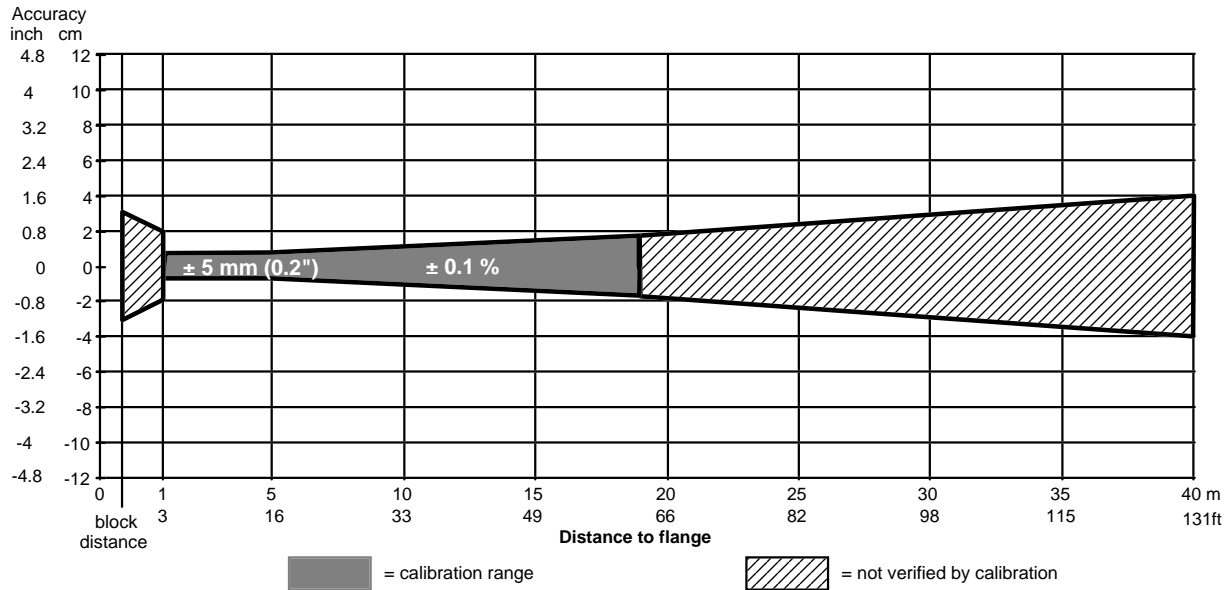


#### BM 702:



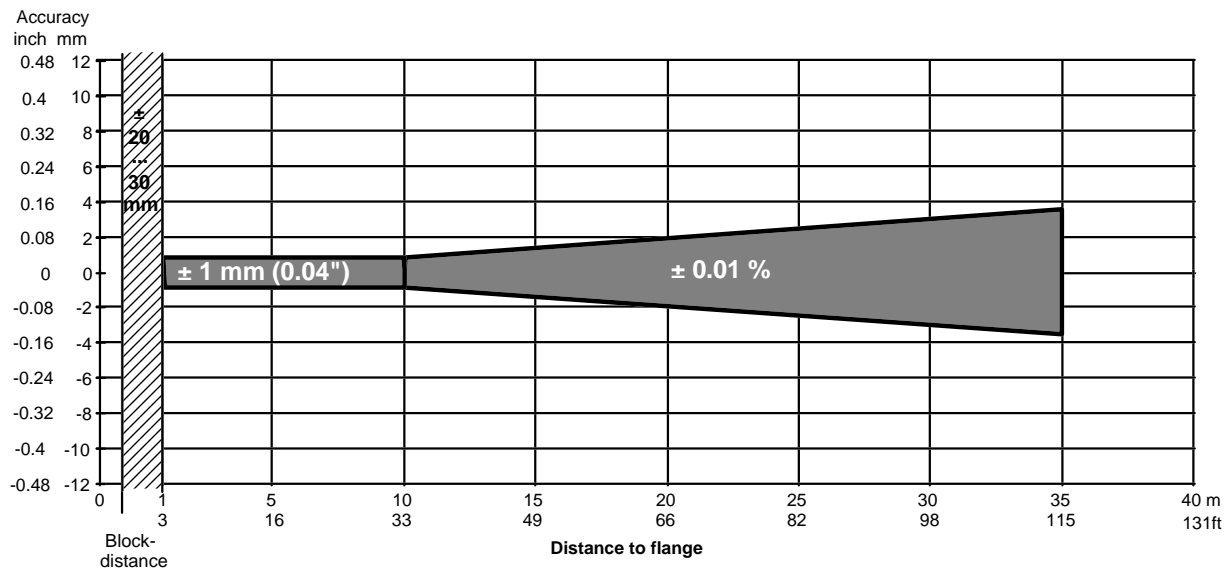
**BM 70 A Precision** (with special calibration and certificate):

Only with antenna type 4 (200 mm / 7.87") or still well 80 - 200 mm dia. (3 - 8")



**BM 70 P**

Only with antenna type 4 (200mm/7.87") or still well 80-200 mm dia. (3-8") +antenna 1S...4S, see 7.2



**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: 1 mm / 0.04" for BM 70 A and BM 702, and 0.1mm / 0.004" for BM 70 P

Hysteresis is at least 20 times smaller 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 approximately 4.6 times the time constant.

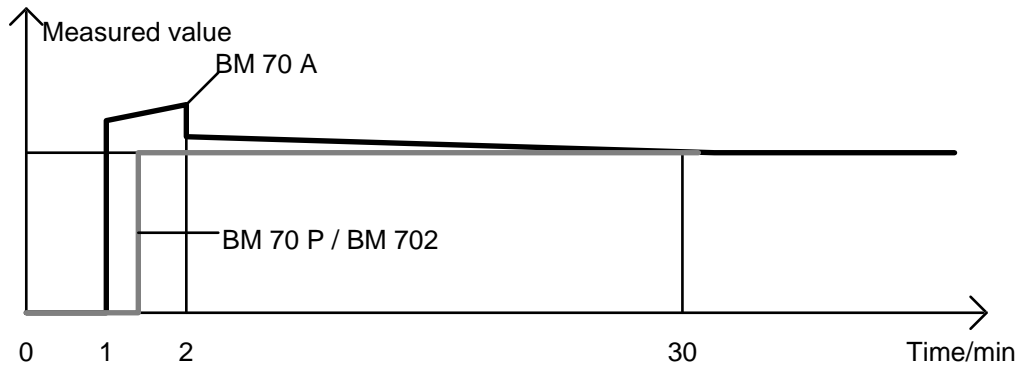
However, in the case of unusually rapid changes in level, the transient recovery time may deviate from this figure.

## 5.6 Turn-on drift / turn-on characteristics

After the BM 70 A has been switched on, a rough measured value is displayed after about 1 minute. The first self-calibration is completed after about 2 minutes. Full measuring accuracy is attained after 30 minutes operating time.

The measured value from the BM 70 P and BM 702 is accurate directly after the startup phase (approx. 1.5 minutes).

Typical turn-on drift (example):



## 5.7 Long-term drift

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

## 5.8 Effect of ambient temperature

Temperature coefficient, signal output:

Ex-e current output HART®:	< 100 ppm/K (typically: 30 ppm/K)
Ex-i (IS) current output HART®:	< 100 ppm/K (typically: 30 ppm/K)
Current output (RS 485 version):	< 200 ppm/K (typically: 70 ppm/K)
Digital interfaces:	no temperature influence

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

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

In respect of proof of temperature influence with the aid of reference measurements in liquid tanks, it needs to be borne in mind that liquids generally have a high coefficient of volume expansion (organic liquids: typically 0.15 %/°C)!

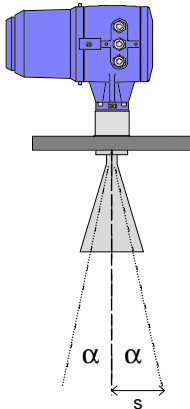
## 6 Application conditions

### 6.1 Installation conditions

See Section 7.3 for selection of optimum antenna type !

#### 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 beamwidth):

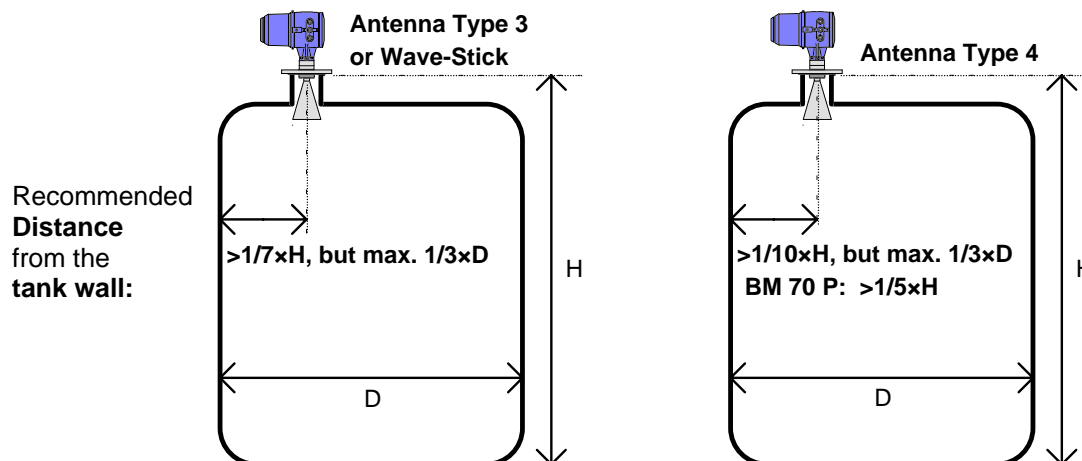


Antenna Type	Diameter	Transmission angle $\alpha$	Lobe expansion s per metre distance
Type 4	200 mm/8"	6°	10 cm / 4"
Type 3	140 mm/5.5"	8°	14 cm / 5.5"
Type 2 *	100 mm/4"	12° *	22 cm / 9"
Type 1 *	80 mm/3"	16° *	30 cm / 12"
Wave-Stick	25 mm/1"	9°	16 cm / 6.3"
Wave-Guide / still well	25-200 mm/ 1-8"	Propagation only inside the still well	

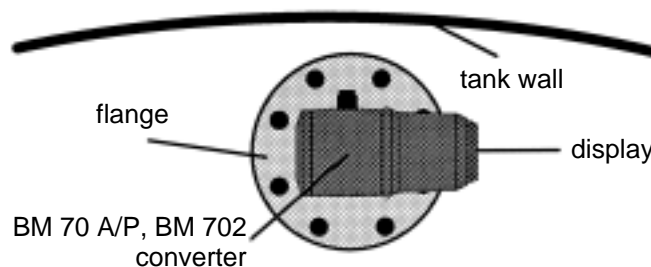
\* Should only be used in still wells; the transmission angle given applies to line-of-sight propagation, i.e. without still well.

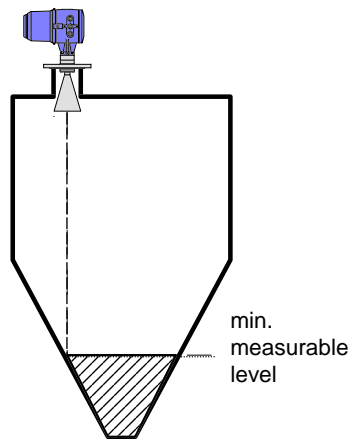
#### 6.1.2 Recommendations for positioning on the tank

##### A) Horn antenna or Wave-Stick without still well

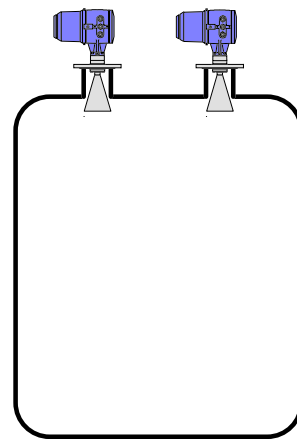


If possible, mount the flange in that way: the axis of the converter (direction display) is oriented tangentially to the tank wall (example):

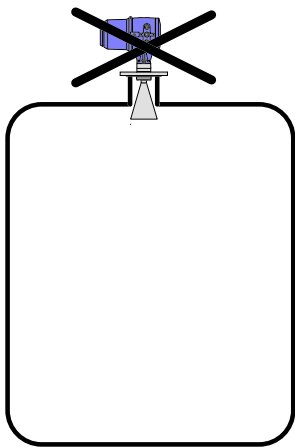




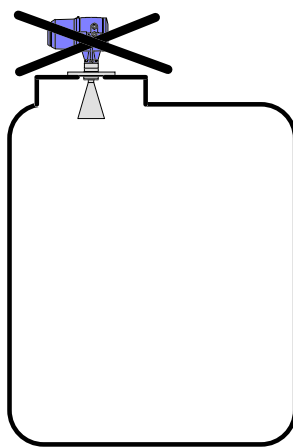
Lower measuring range limited when tank has tapered bottom.



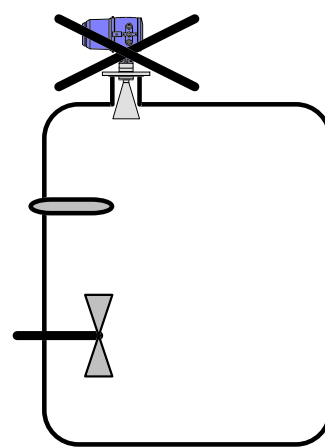
Several BM 70 A/P, BM 702 can be operated in one tank.



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



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

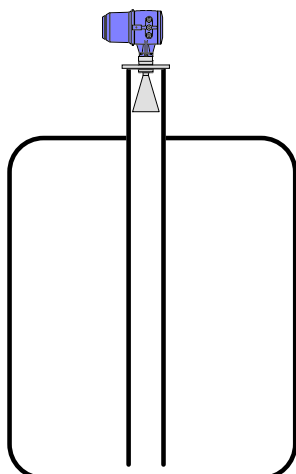


**Do not** position above **internals!**  
(interference reflections!)

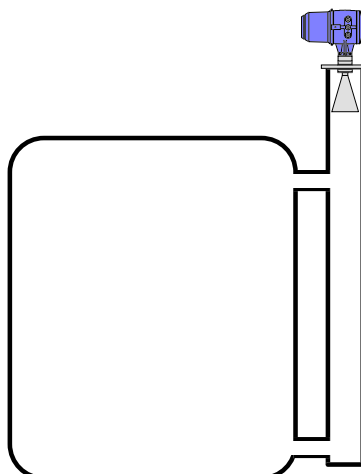
If these recommendations cannot be followed due to the tank geometry, please consult KROHNE!

### B) Still well or Wave-Guide

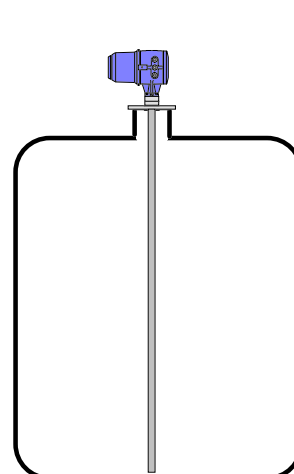
Any position of the still well or the Wave-Guide on the tank is allowed.  
(For layout: refer also to Section 6.1.4; for block distance: refer to Section 3.3)



Still well application

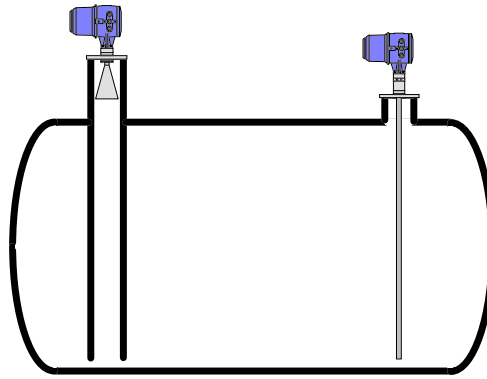


In a side vessel



BM 70 A Wave-Guide

Use of a still well or Wave-Guide is positively recommended for horizontal cylindrical tanks (avoidance of multiple reflections):



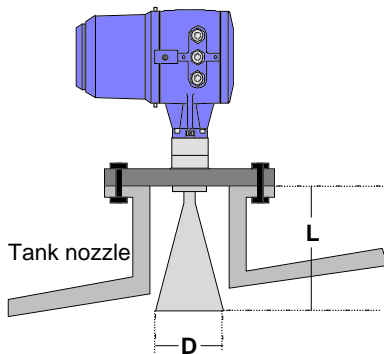
### 6.1.3 Mounting on tank fitting

#### Horn antenna

Should be mounted on the tank fitting as close to the horizontal as possible (deviation  $\leq \pm 2^\circ$ ).

Exception: when product surface is not horizontal (e.g. solids), the flange can be aligned roughly parallel to it.

The antenna should project out of the fitting:

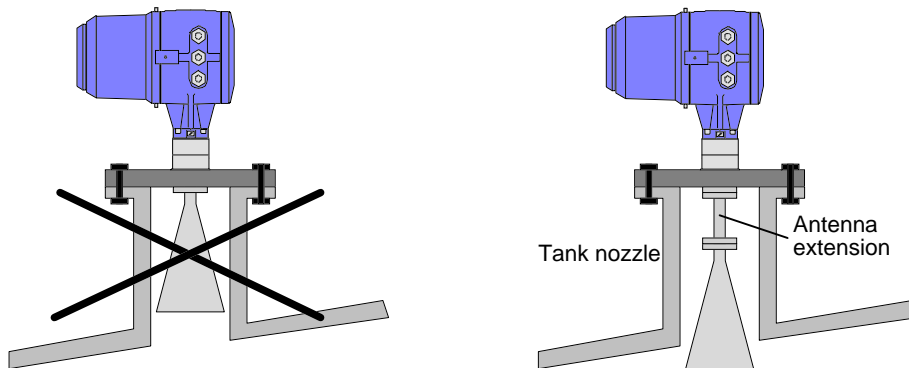


Antenna	Diameter D	Length L
Type 4	200 mm / 8"	335 mm / 13" *
Type 3	140 mm / 5.5"	223 mm / 8.8" *

\* Hastelloy: - 30 mm / 1.2"

(subject to change without notice)

An antenna extension should be fitted when the antenna does not project out of the tank nozzle:

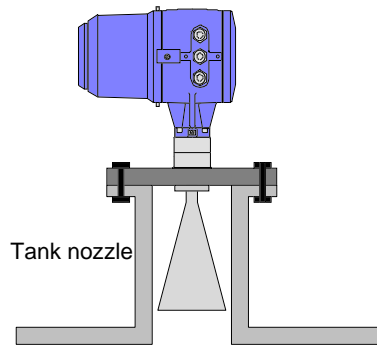


Antenna extensions are available from 100 to 2000 mm (4" to ~80") in steps of 100 mm (~4"). Several extensions can be joined up.



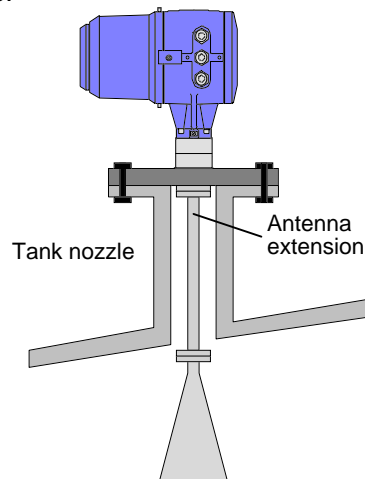
Exception:

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



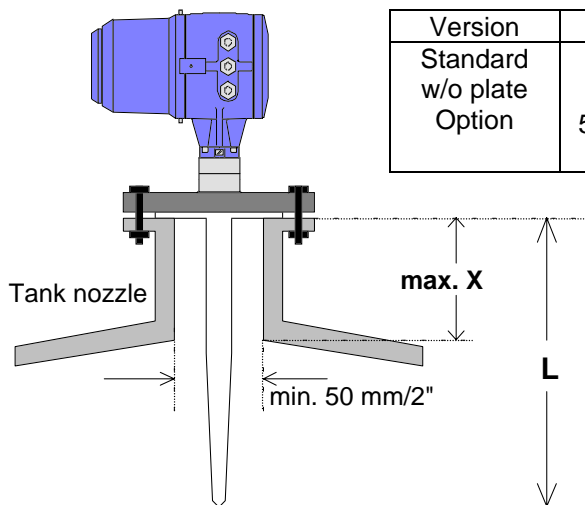
**Narrow tank nozzle**

If the inside diameter of the nozzle is smaller than the diameter of the antenna, and the nozzle is accessible from the inside of the tank, the antenna can be mounted from the inside with an extension (not for versions made of titanium or tantalum). The antenna extension should be about 10 cm (4") longer than the height of the nozzle.



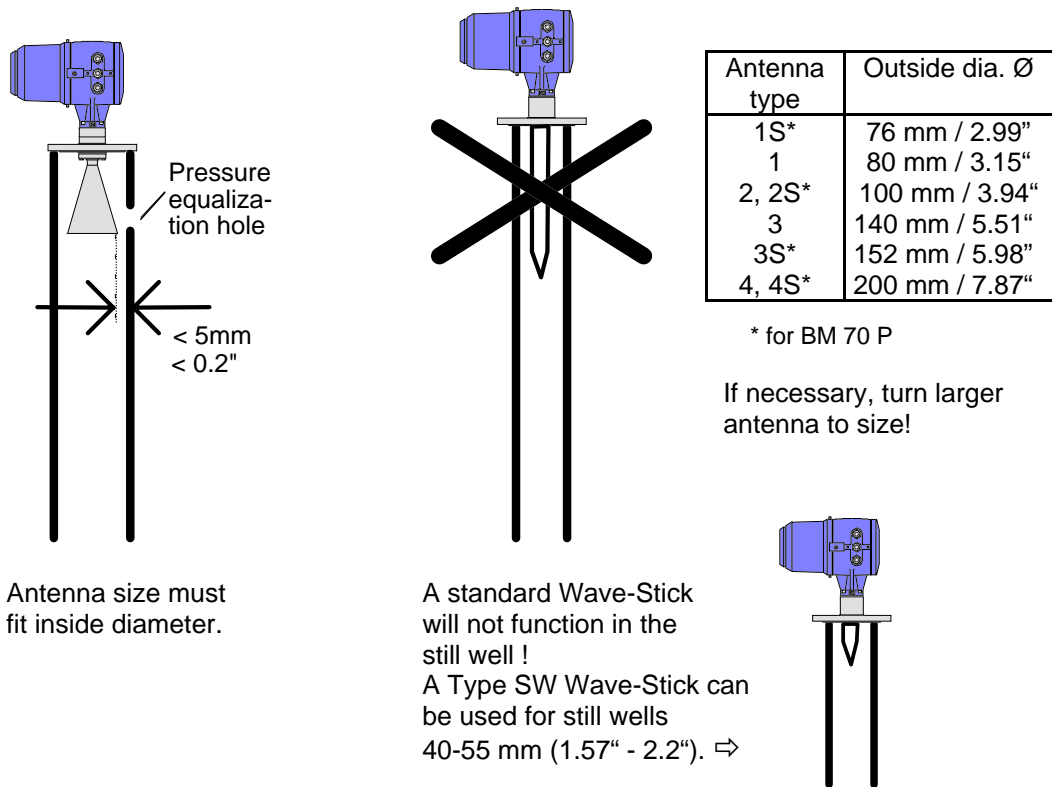
**Wave-Stick**

Note the requirements pertaining to diameter and length of the tank nozzle:



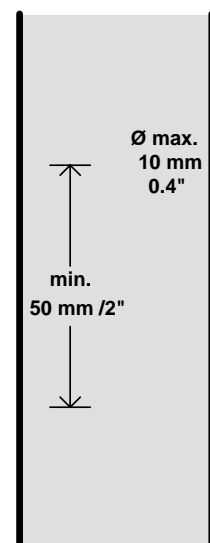
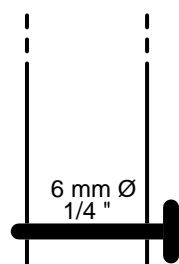
Version	Length L	Max. height of nozzle X
Standard	384 mm/15.1"	150 mm/6"
w/o plate	270 mm/10.6"	50 mm/2"
Option	500...1000 mm/ 20 to 40"	L – 234 mm L – 9.2"

## 6.1.4 Mounting on still wells



Further requirements concerning still wells:

- The still well must be electrically conductive.
- Minimum inside diameter of well: 40 mm (1.57") (BM 70 P: 80 mm (3"), better  $\geq 100$  mm (4")).
- If possible, use only smooth, straight still wells. If nevertheless an assembled still 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  $\pm 0.1$  mm (0.004").
- It is possible to measure through an open ball valve, provided the valve and the pipe adapters above and below the valve are relatively smooth-walled.
- Level measurements below the end of the still well are not possible.
- To ensure equalization of pressure, drill one or two small holes in the still well above the maximum filling level.
- If necessary, several holes can be drilled along the whole pipe. All holes must be deburred. The holes should be as small as possible and spaced wide apart (Recommendation: see drawing on the right).
- A reference point at the end of the still well is advisable. Use only a rod or screw of approx. 6 mm (1/4") diameter. See drawing below.



## 6.1.5 Wave-Guide

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

### Maximum length:

Ex: max. 3 m / 9.84 ft

Non-Ex: up to 3 m / 9.84 ft without additional support  
pipes longer than 3 m/9.84 ft need to be supported at two points.

## 6.2 Ambient conditions

### 6.2.1 Hazardous locations

BM 70 A/P Ex is suitable for use in hazardous locations of the following:

Zones: 0, 1, 2  
Temperature classes: T6...T2  
Danger groups: IIA...IIC

Refer to Section 10 for further information !

### 6.2.2 Ambient temperature of signal converter

Standard version: -20°C ... +55°C ( -4 to +131°F)

Special version: -40°C\* ... +55°C (-40 to +131°F)

\* below -20°C/-4°F the LC display will "freeze", but work normally again at higher temperatures

BM 702i is limited to an ambient temperature of +40°C / 104°F when operated in hazardous areas with temperature class T5 or T6!

A "BM 70 sunshade" should be fitted (see Section 7.7.5) when the signal converter is located in the open and exposed to strong sunshine.

### 6.2.3 Flange temperature

Minimum:	Horn antenna, Wave-Guide (V96 standard):	-30°C / -22°F
	Horn antenna, Wave-Guide (V96 special version) only with Kalrez4079 or Kalrez2035:	-60°C / -76°F
	Wave-Stick with flange plate:	-40°C / -40°F
	Wave-Stick without flange plate	-20°C / -4°F
Maximum:	V96 basic version:	+130°C / +266°F
	V96 High-temperature version with distance piece and FFKM gasket (Kalrez 4079 or KLR6375):	+250°C / +482°F **
	Kalrez 1091 gasket:	+250°C / +482°F
	Kalrez 2035 gasket:	+210°C / +410°F
	Viton gasket:	+200°C / +392°F
	FEP-sheathed gasket:	+200°C / +392°F
	Wave-Stick PP, permanently:	+100°C / +212°F
	Wave-Stick, pressure-dependent (see 6.3.5), with no mechanical loading radial to the rod:	up to +150°C / 302°F
Wave-Stick, steam cleaning (CIP, SIP) 30 minutes:	max. +160°C / 320°F	

\*\* Safety limit: +280°C (536°F)

### 6.2.4 Ambient temperature limits

#### Signal converter:

Measuring function OK, but LCD "freezes":

min. - 40°C / -40°F

Functional upper limit, for max. 2 hours:

max. +70°C / +158°F

#### Flange system:

see Section 6.2.3

### 6.2.5 Storage temperature

-20°C ... +60°C (-4 to +140°F)

## 6.2.6 Climate class

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

## 6.2.7 Ingress protection

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

## 6.2.8 Shock resistance

The device withstands 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 resistance

Type test conditions: to IEC 68-2-6 and prEN 50178 (10-57 Hz: 0.075 mm (2.95 10<sup>-3</sup>) / 57-150 Hz: 1g)

## 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).

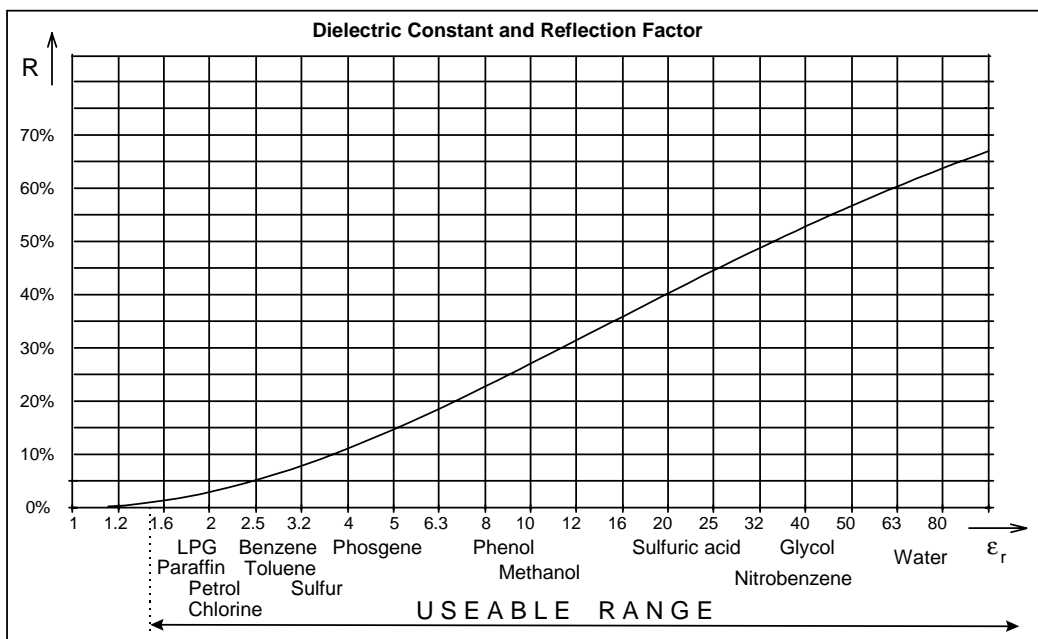
### 6.3.2 Relative permittivity

The relative permittivity of the product ( $\epsilon_r$ , Epsilon-R, "dielectric constant") 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  $\epsilon_r < 4$ , a stilling well should be used. The minimum relative permittivity of the product is approximately  $\epsilon_r = 1.5$ .

See also Section 7.3.

If the Wave-Stick is also to take measurements when immersed,  $\epsilon_r$  needs to be  $\geq 4$ .



## Table of dielectric permittivity

The following overview is based on data from the literature, tabular data, application experience and laboratory measurements ( $\epsilon_r$  values are rounded guide values for the examples given below).

Product group	$\epsilon_r$	Examples
<b>INORGANIC</b>	115	hydrogen cyanide HCN
	80	water H <sub>2</sub> O
	52	hydrazine N <sub>2</sub> H <sub>4</sub>
	22	sulphuric acid H <sub>2</sub> SO <sub>4</sub>
	9	hydrogen sulphide H <sub>2</sub> S
Tetrachlorides	2.4-2.9	Ge-, Pb-, Si-, Sn-, Ti- Cl <sub>4</sub>
Sulphur (liquid)	3.5	
<b>Inorganic liquid gases</b> (pressurized or at low temp.)		
- elemental	1.5	argon, nitrogen, oxygen, air
	1.5-2.1	chlorine, fluorine
- compounds	1.6	carbon dioxide CO <sub>2</sub>
	14	sulphur dioxide SO <sub>2</sub>
<b>ORGANIC COMPOUNDS</b>		
<b>Alkanes</b>		
- liquid gases	1.7	methane, ethane, propane, butane, LPG
- liquids	2	pentane, octane, decane, gasoline
- long-chain (>C <sub>16</sub> )	2	paraffins, vaseline
- oils	2.1-2.8	mineral, synth., silicon oil, tripene
<b>Alkenes</b>	2	ethylene, propylene, pentene, etc.
<b>Alcohols</b>	9-30	methanol, ethanol
	14-20	propanol, pentanol
- longer-chain	13-19	butanol, benzyl alcohol
- polyhydric	40	glycol, glycerol
<b>Aldehydes</b>	13-22	form-, acet-, propion-aldehyde
<b>Ketones</b>	20	acetone=propanone, butanone
<b>Acids &amp; derivatives</b>	58	formic acid
	6	acetic acid
	3	butyric acid
- long-chain	2.5	fatty acids
- ester	3-16	(various)
- anhydrides	20	acetic anhydride
<b>Ether</b>	3-8	diethyl ether, dioxan
<b>Cyclic compounds</b>	2.3	benzene C <sub>6</sub> H <sub>6</sub>
	2	cyclo-hexane C <sub>6</sub> H <sub>12</sub> , -hexene C <sub>6</sub> H <sub>10</sub>
	2.4	toluene, xylene, etc.
	10	phenols
<b>Halogen derivatives</b>	3.5	trichloroethylene
	2.2	carbon tetrachloride, tetrachloroethylene
	2.5-10	dichlorobenzene (o-,m-,p-)
	5-6	chlorobenzene, -phenol, chloroform
	5.1	chlorinated diphenyl = clophen
- acid halides	33	chloroacetic acid
	16	acetyl chloride
<b>Nitrogen derivatives</b>	10	methylamine
	3.5-5.5	isopropyl-, diethyl-, trimethyl-, benzyl-, amylamine
	35	nitrobenzene
	28	nitroethane
	5-7	aniline
- amides	60	acetamide
<b>SOLIDS</b> (effective $\epsilon_r$ )		
non-conductive	1.5-2.5	pulverized and granulated plastics
metallic	10 - ∞	metal powder, scrap

### 6.3.3 Product limitations

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

- liquid ammonia (NH<sub>3</sub>) under pressure
- liquid hydrogen (H<sub>2</sub>)
- liquid helium (He)

### 6.3.4 Product temperature (unlimited)

The product temperature is not relevant 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 (depends on construction)

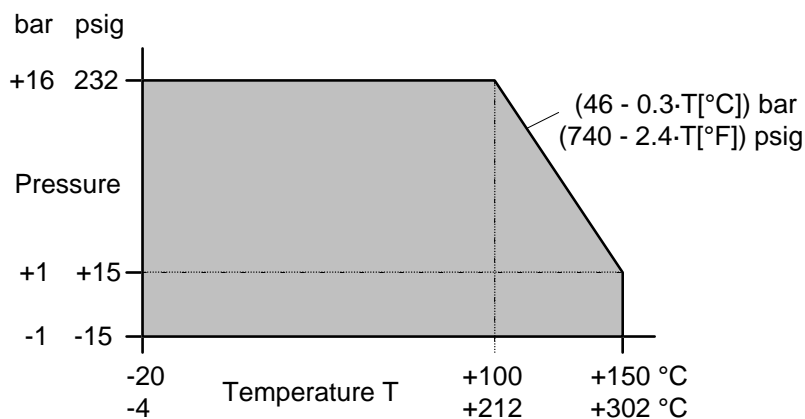
Flange system with horn antenna or Wave-Guide:

Nominal size to DIN(BS) ANSI DN mm inches	PN 16	PN 25	PN 40	PN 64
DN 80 mm 3"	16 bar/232 psig	---	40 bar / 580 psig	64 bar/928 psig
DN 100 mm 4"	16 bar/232 psig	---	<b>38 bar/551 psig</b>	<b>55 bar/797 psig</b>
DN 150 mm 6"	16 bar/232 psig	---	<b>34 bar/493 psig</b>	<b>47 bar/681 psig</b>
DN 200 mm 8"	16 bar/232 psig	25 bar/362 psig	<b>32 bar/464 psig</b>	<b>45 bar/652 psig</b>

Information on higher pressures (up to 400 bar / 5800 psi) supplied on request

**Wave-Stick without flange plate:** max. **2 bar (29 psig)**

**Wave-Stick with flange plate:** max. **16 bar (232 psig)**, dependent on temperature:



## 7 Design

### 7.1 Models



**BM 70 A/P with horn antenna**



**BM 70 A Wave-Stick**



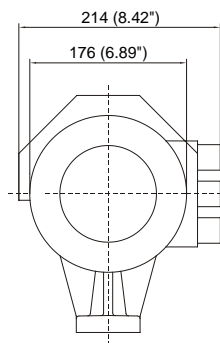
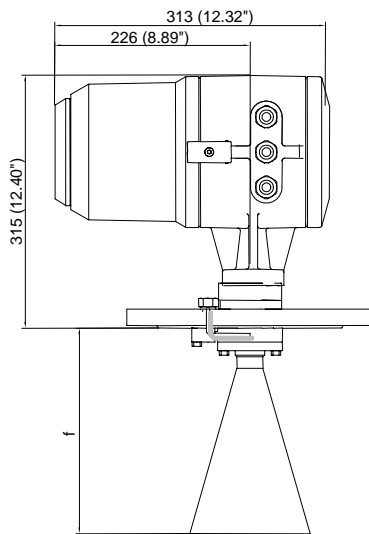
**BM 70 A Wave-Guide**



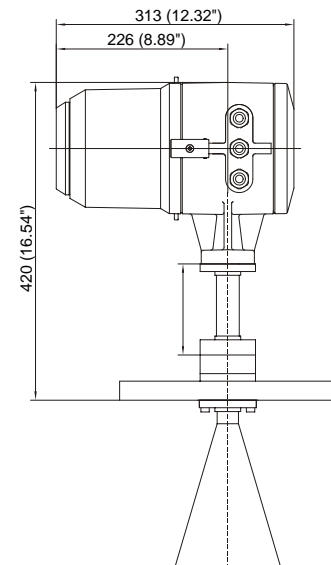
**BM 702 with horn**

### 7.2 Dimensions, weights

Basic version:



High-temperature version:



Nominal size		Standard antenna		Length *	Weight
DN mm	ANSI	Type	O.D. in mm / inch	f in mm / inch	kg / lb
80	3"	1	80 / 3.15"	110 / 4.3"	17 / 38
100	4"	2	100 / 3.94"	148 / 5.8"	18 / 40
150	6"	3	140 / 5.51"	223 / 8.8"	23 / 51
200	8"	4	200 / 7.87"	335 / 13.2"	30 / 66
80	3"	1S**	80 / 3.15"	420 / 16.5"	18 / 40
100	4"	2S**	100 / 3.94"	620 / 24.4"	19 / 42
150	6"	3S**	152 / 5.98"	820 / 32.2"	25 / 55
200	8"	4S**	200 / 7.87"	820 / 32.3"	32 / 70

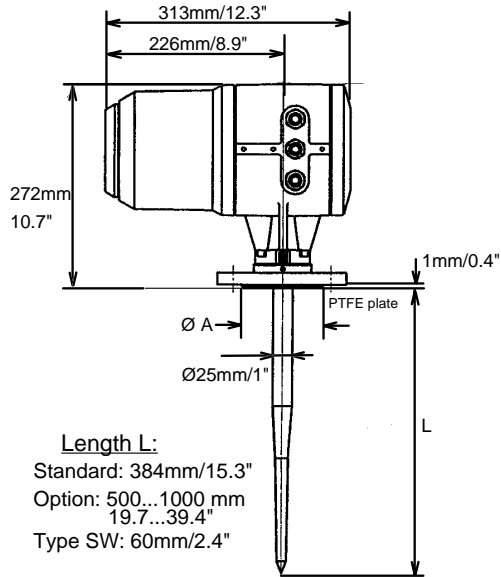
\* Hastelloy: -30 mm (1.2") / \*\* for BM 70 P on stilling well

Subject to change without notice!

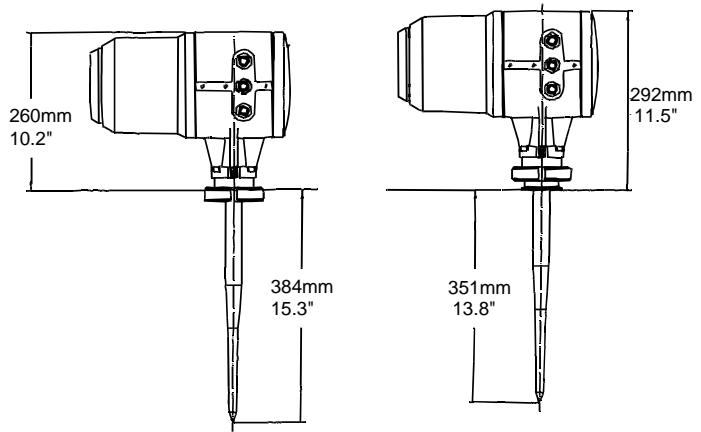
**Wave-Stick:**

*Options:*

Tri-Clamp 2", 3", 4"  
 SMS 51 mm, 63 mm, 76 mm  
 DIN 11851(dairy) DN 50, DN 65, DN 80



Wave-Stick with hygienic connections:  
 (DIN 11851 "dairy") (with adapter for Tri-Clamp)

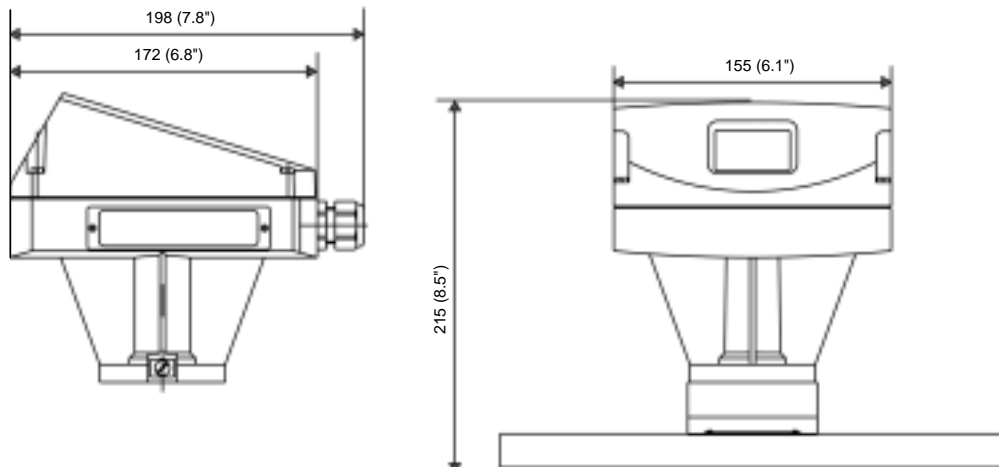


Flange size	$\varnothing A$ [mm/inch]	Weight [kg /lb]
DN 50 / ANSI 2"	100 / 3.9"	16 / 36
ANSI 3"	127 / 5.0"	17 / 38
DN 80	138 / 5.4"	17 / 38
DN 100 / ANSI 4"	158 / 6.2"	18 / 40
DN 150 / ANSI 6"	216 / 8.5"	23 / 51

Wave-Stick without flange plate / PTFE plate:

Length:  
 270 mm/400 mm/600 mm/800 mm/1000 mm  
 10.6" / 15.7" / 23.6" / 31.5" / 39.4"

**Converter BM 702**



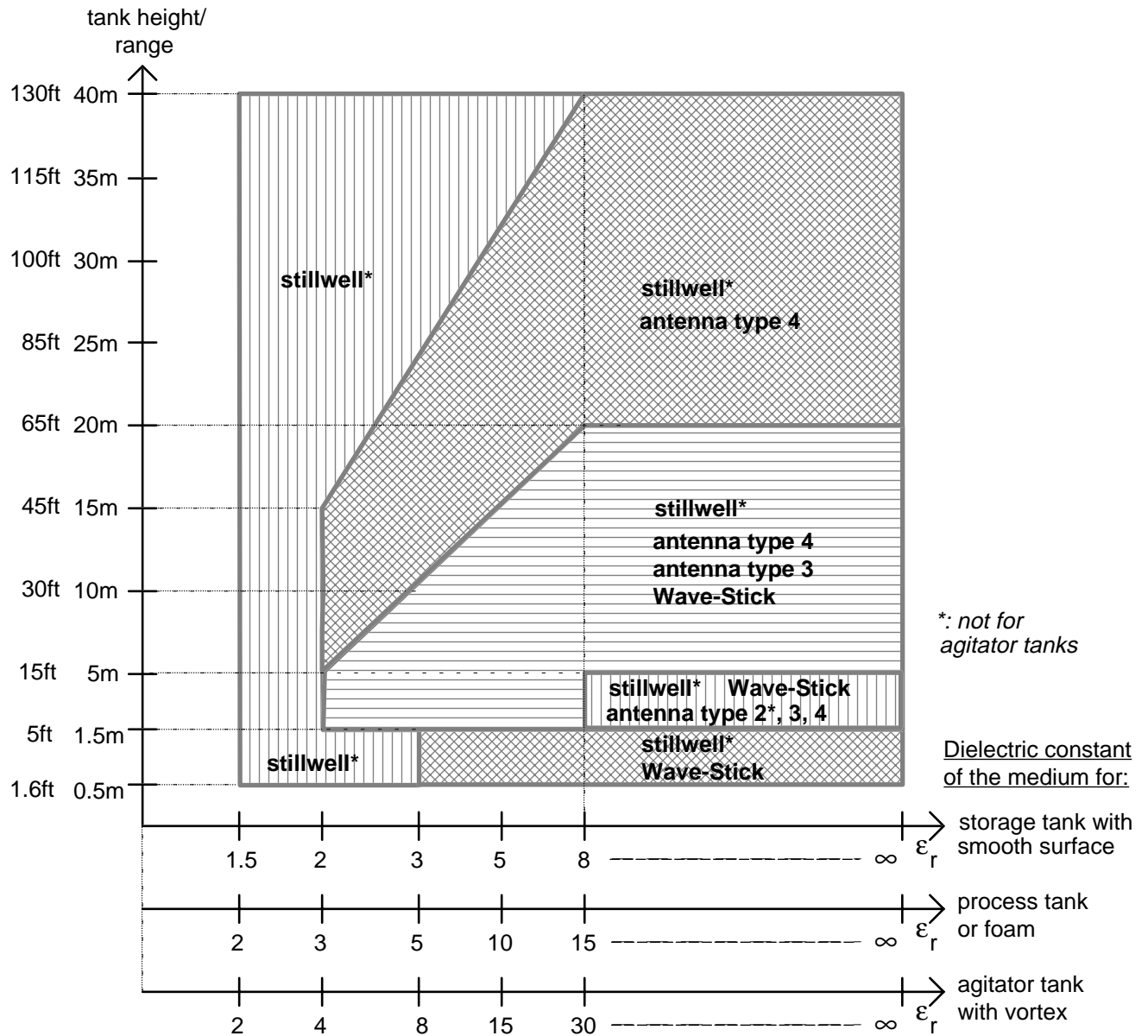


### 7.3 Choice of antenna type and size

This is a **BM 70 A recommendation** for the optimum application range, based on application experience, in order to minimize potential problems. If the recommended antenna cannot be accepted, **any other configuration** may also be tested.

Antennas **Type 1 und 2** should only be used with still wells (exception: small tanks).

For **BM 70 P** always antenna type 4 is recommended. If the application requires to use a still well, it should have an ID  $\geq 100$  mm / 4". With the Wave-Stick or Wave-Guide the accuracy specification of BM 70 P can not be met.



How to use the diagram:

- Determine the following application parameters:
  - a) Tank height or maximum measuring range/distance (e.g. H = 15m)
  - b) Tank type (one of the three types shown, e.g. process tank)
  - c) Relative permittivity of the product (e.g.  $\epsilon_r = 5$ )
- Find the relative permittivity on the relevant horizontal axis (e.g. 5 on the middle axis)
- Draw a line up to the required tank height = vertical axis (e.g. 15 m)
- The end point of the line defines the application range. The text contained in that area indicates the suitable antenna types (in the example: still well or Type 4)

## 7.4 Materials

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

### 7.4.1 Signal converter

Housing: Aluminium with electrostatic powder coating to DIN 55990-3

Sight window: Glass

### 7.4.2 Flange system

(Antenna, extensions and flange or flange plating)

Available materials for BM 70 A/P, BM 702 flange systems (in contact with the product):

	<i>DIN No.</i>	<i>AISI equivalent</i>
<u>Versions with horn antenna or Wave-Guide:</u>		
Stainless steel	1.4571	316 Ti
Stainless steel	1.4435	316 L
Stainless steel	1.4539	-
Hastelloy C4	2.4610	-
Hastelloy C22	2.4602	-
Hastelloy C276	2.4819	-
Hastelloy B2/B3	2.4617	-
Titanium	3.7035	-
Tantalum	-	-
Monell 400	2.4360	-
Inconell 600	2.4816	-
Enamel coating (only DN 150 / 6")		

(Information on other materials supplied on request)

#### Wave-Stick:

For the versions with PTFE flange plate, only PTFE is in contact with the product (no metal in contact with the tank contents)

Flange made of stainless steel 1.4571 / 316 Ti

### 7.4.3 Seals and gaskets

The following list is based on manufacturers' information and provides a rough overview of the chemical resistance of available seals and gaskets that come into contact with the tank product. However, KROHNE cannot assume any guarantee for the correctness of the information. Responsibility as to suitability rests solely with the user.

---

**1. Viton (FPM) max. 200°C/392°F temperature resistance**

**resistant to, for example:**

aliphatic, aromatic and cyclic hydrocarbons, halogenated hydrocarbons, phenols, ozone, oxidants.

**relatively resistant to, for example:**

alkalis, alcohols, amines, acids, water.

**not resistant to, for example:**

ketones, aldehydes, ether, ester, nitro compounds.

---

**2. FFKM (Kalrez4079 or KLR6375, DuPont) max. 250°C/482°F temperature resistance (safety limit: 280°C/536°F)**

**In general, very good chemical resistance to, for example:**

aliphatic and aromatic hydrocarbons, alkalis, alcohols, aldehydes, ether, ester, ketones, acids

**but only relatively resistant or not resistant to:**

acetaldehyde, acrylonitrile, amines, ammonium hydroxide (concentrated), bromine pentafluoride, bromine trifluoride, butyric aldehyde, calcium acetate, chloroacetic acid, chlorosulphuric acid, chlorotrifluoride, 1-chloro-1-nitroethane, dimethyl formamide, ethyl acetate, ethylene oxide, freons (various), hydrofluoric acid, hydrogen fluoride, iodine pentafluoride, methyl acetoacetate, methyl formate, liquid oxygen, propylene oxide, refrigerants (various), tetrahydrofuran, trichloroacetic acid, triethanolamine, steam (above 150°C/302°F)

---

**3. Kalrez 2035 (DuPont) max. 210°C/410°F temperature resistance**

**Excellent chemical resistance, also well suited for:**

- high-temperature steam / hot water
  - ethylene oxide, propylene oxide
  - amines
- 

**4. Kalrez 1091 (DuPont) max. 250°C/482°F temperature resistance**

**Food grade (FDA No. CFR 177.2400)**

**Excellent chemical resistance, also well suited for:**

- high-temperature steam / hot water
- amines

**but only very limited resistant to:**

- ethylene oxide, propylene oxide
  - strong oxidants
- 

**5. FEP-coated max. 200°C/392°F temperature resistance**

**excellent chemical resistance, similar to that of PTFE**

## 7.5 Process connection

The process connection is made by way of standard flanges of size DN 50-200 or relevant ANSI sizes (dependent on the version). For the Wave-Stick various hygiene connections are additionally available:

Antenna length:	335mm (13.2") [820mm <sup>(4)</sup> ]	223mm (8.8") [820mm <sup>(4)</sup> ]	148mm (5.8") [620mm <sup>(4)</sup> ]	110mm (4.3") [420mm <sup>(4)</sup> ]	any	384mm (15.1")
Antenna diameter:	200mm (7.9")	140mm (5.5") [152mm <sup>(4)</sup> ]	100mm (3.9")	80mm (3.2") [76mm <sup>(4)</sup> ]	30mm (1.2")	25mm (1.0")
<b>Antenna:</b>	<b>Type 4</b>	<b>Type 3</b>	<b>Type 2</b> (still well)	<b>Type 1</b> (still well)	<b>Wave-Guide</b>	<b>Wave-Stick</b>
<b>Flanged connection</b>						
DN50 (2")	-	-	-	(3)	S	X
DN80 (3")	(1)	(1)	(1)	X	X	X
DN100 (4")	(1)	(1)	X	X	X	X
DN150 (6")	(1)	X	X	X	X	X
DN200 (8")	X	X	X	X	X	(2)
>DN200 (>8")	S	S	S	S	S	(2)
G 1/2 "	-	-	-	-	-	X
Tri-Clamp 2"	-	-	-	-	-	X
Tri-Clamp 3"	-	-	-	S	S	X
Tri-Clamp 4"	-	-	S	S	S	X
SMS 51mm	-	-	-	-	-	X
SMS 63mm	-	-	-	S	S	X
SMS 76mm	-	-	S	S	S	X
DIN 11851 "dairy" DN50/65/80	-	-	-	-	-	X

Remarks:

- X = Standard variant; S = Special version ; - = not available
- (1) = available, but antenna must be installed from the inside of the tank (see 6.1.3)
- (2) = available as special version, but without PTFE flanged plate; only for atmospheric pressure
- (3) = with adapter for a 50 mm (2") still well in place of antenna
- (4) = Antenna type 1S...4S for BM 70 P on stilling wells

## 7.6 Electrical connection

The electrical connection for supply power and signal inputs and outputs is made in the terminal compartment of the signal converter. Observe requirements specified in VDE 165 and consult safety information given in Section 9.3!

Terminals: conductor cross-section 0.5 - 2.5 mm<sup>2</sup> (solid conductor: max. 4 mm<sup>2</sup>)

PE conductor or  
FE funct. GND (see 9.3): U-clamp terminal (max. 4 mm<sup>2</sup> conductor cross section)

Cable entries: BM 70 A/P:  
3x M25×1.5 (with standard cable gland: cable clamping area = 9 - 16 mm)  
BM 702:  
3x M20×1.5 (alternatively: Quickon<sup>®</sup> connection)

Signal cable shielding: required for RS 485 line,  
recommended for current output when line lengths > 100 m (350 ft)  
connect all shieldings on the shortest way with the FE terminal.

“Ex“ equipotential bonding: U-clamp terminal (max. 4 mm<sup>2</sup> conductor cross section) at “neck“ of signal converter

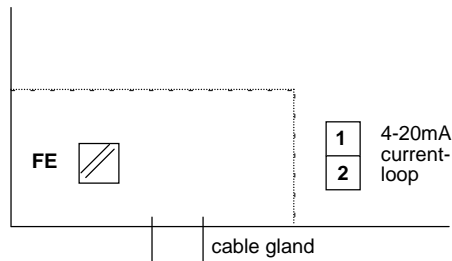
Rated temperature of connection cable:

Version	Max. flange temperature	Cable temperature rating
Without 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 (212°F)	70 °C (158°F)
	> 200 °C (212°F)	80 °C (176°F)

### Terminal assignment

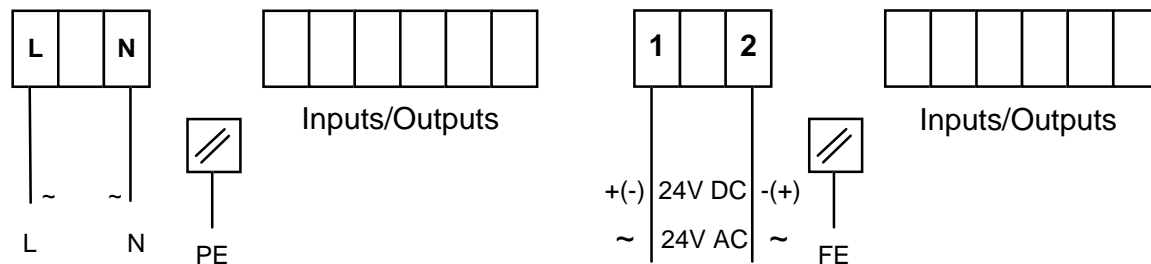
#### BM 702:

The polarity of the 4-20 mA connection is arbitrary.



#### BM 70 A/P:

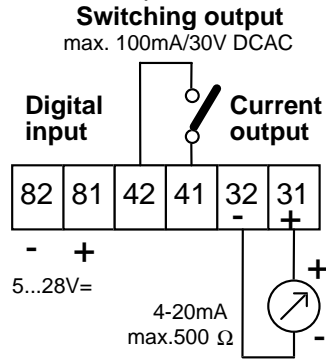
Supply power:



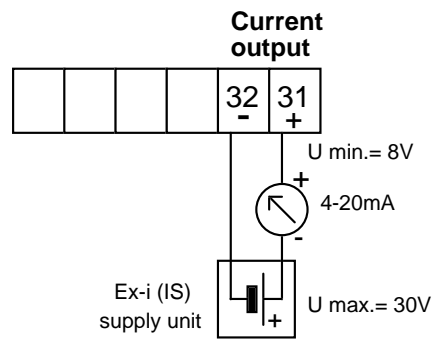
Connections for 115/230 V AC

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

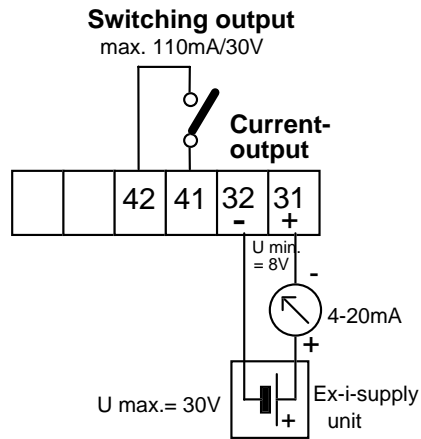
Current output HART<sup>®</sup>, Ex e:



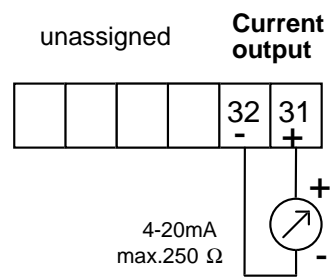
Ex-i current output HART<sup>®</sup>:



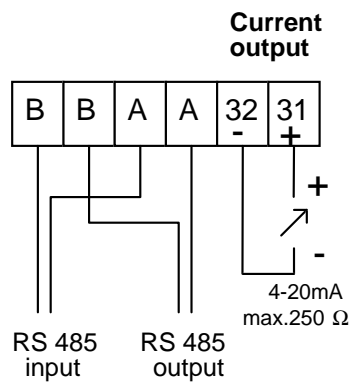
Ex-i Current output HART<sup>®</sup> with switching output:



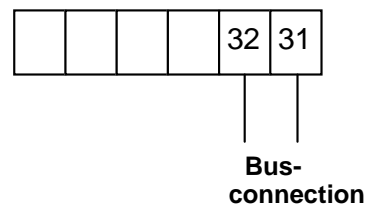
Current output (non-communicable):



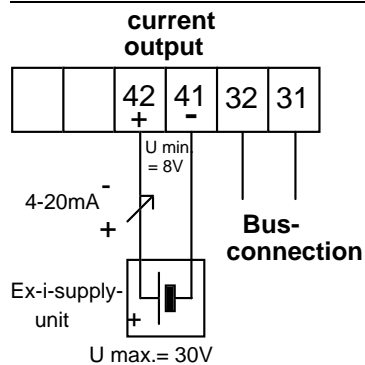
RS 485 version:



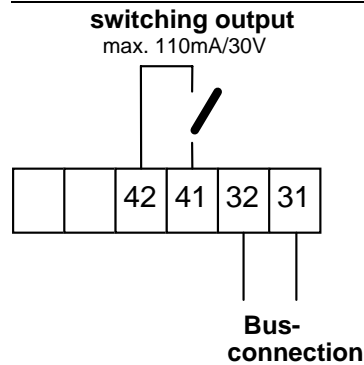
PROFIBUS-PA or Foundation Fieldbus (FF)



PROFIBUS-PA / FF with current output:



PROFIBUS-PA / FF with switching output:



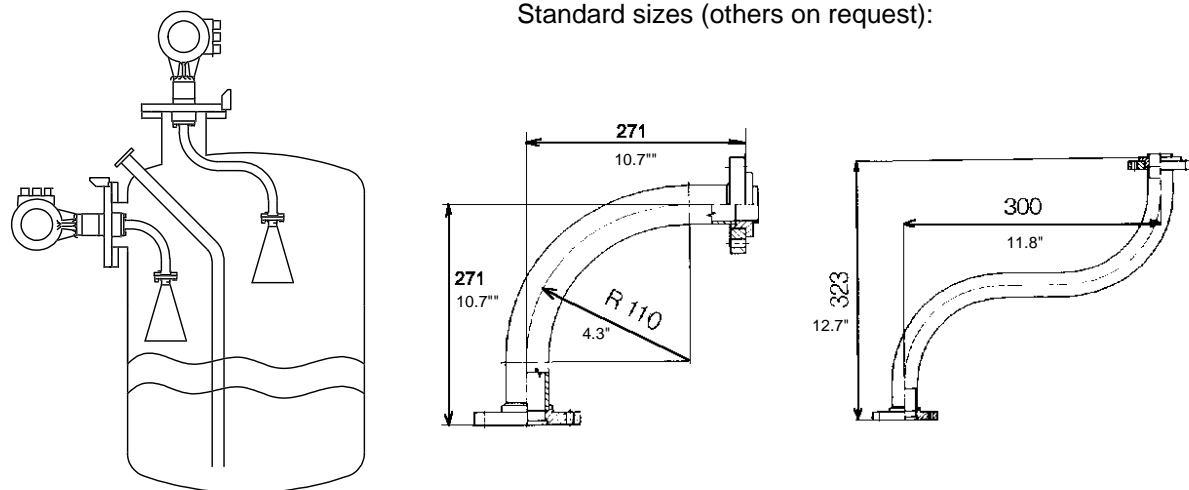
## 7.7 Accessories

### 7.7.1 Antenna extensions

For adjustment to the tank fitting geometry (see Section 6.1.3). Length: 100...2000 mm (4" to ~80") in steps of 100 mm (~4").

### 7.7.2 Curved antenna extensions

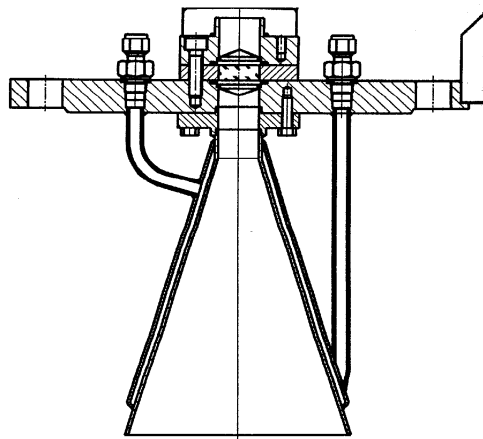
Rectangular and S-shaped extensions are available for particularly difficult application conditions. These extensions are used in cases where the antenna is exposed to particularly high temperatures and where there are problems of space. (e.g. around tank internals; positioning the antenna out of the centre of symmetry; mounting the signal converter on the side of the tank).



### 7.7.3 Antenna heating/cooling device ( $\geq$ DN150/6")

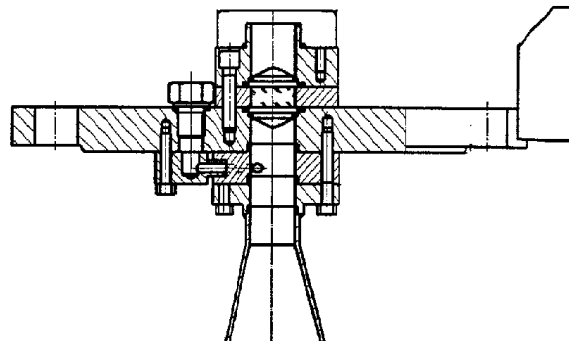
Double-walled antenna for cooling or heating, e.g. to avoid condensation (recommended for liquid sulphur).

Max. differential pressure at antenna:  
Standard DN150 (6") = 6 bar (87 psig)  
(information on other pressures provided on request).



### 7.7.4 Purging device ( $\geq$ DN100/4")

With connection for purging the inside surface of the antenna to prevent heavy deposits of product or to heat or cool the antenna.

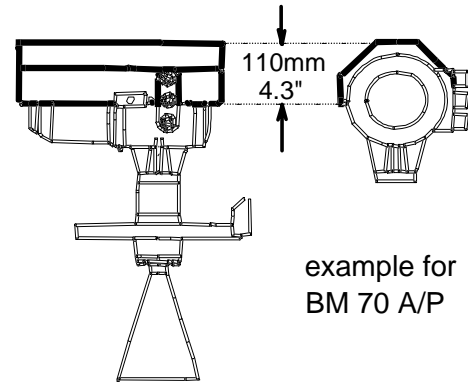


When a liquid is used for purging, this may interfere with the functioning of the BM 70 A/P, BM 702 during this process. Continuous purging with gas is not a problem, as it does not interfere with measurements.

The purging connection is closed off by the manufacturer by a 1/4" screw. When this screw is removed in order 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).

### 7.7.5 Sunshade

Recommended as protection for the signal converter against direct sunshine from above (increases overall height by approx. 20 mm (0.79"))



### 7.7.6 Special certificates at customer's request

For example: 3.1B certificate, helium leakage test

### 7.7.7 PC-CAT program

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 4.00 and higher can communicate with all current KROHNE level radar gauges including BM 70 A/P, and BM 702 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.

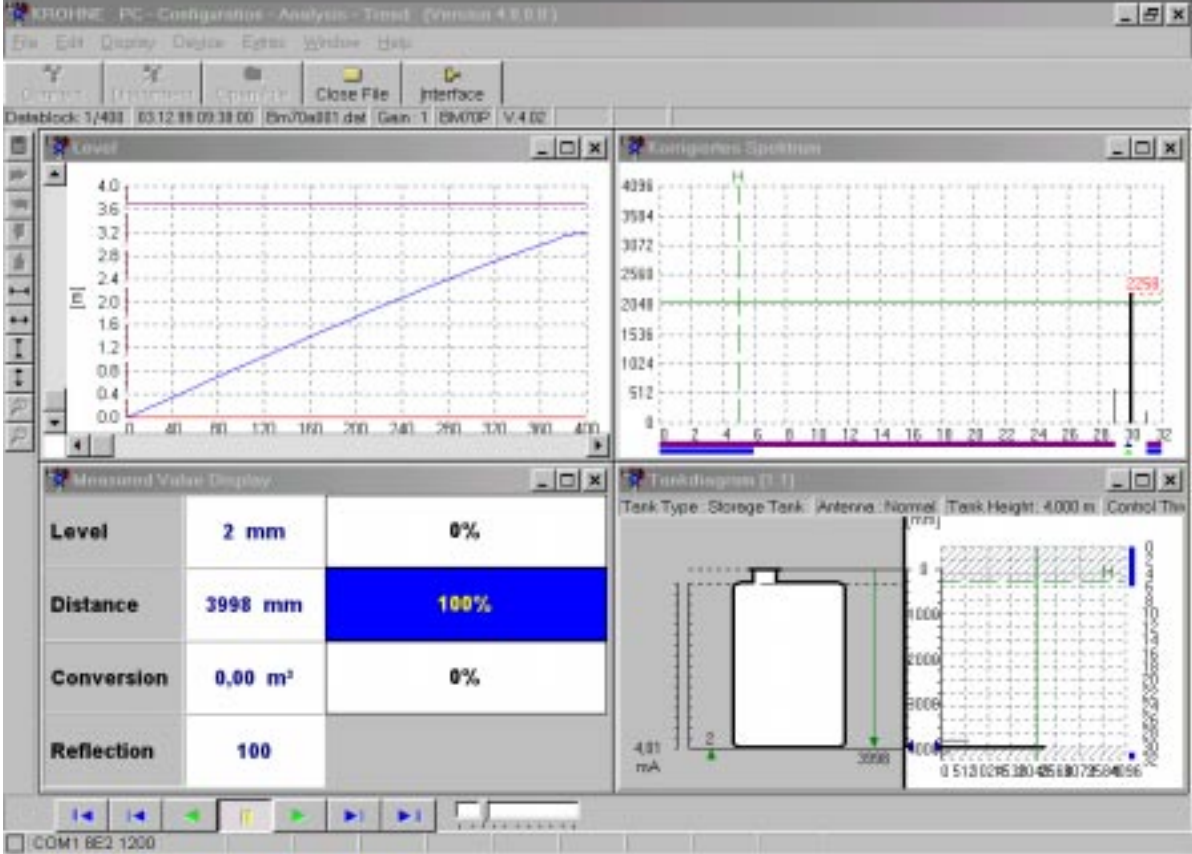
The customer's PC containing PC-CAT is connected to the current output via the supplied PC adapter, max. distance from the level gauge: 1000 m or 3300 ft. The PC adapter has no effect on in-line instruments such as milliammeters, recorders, etc., connected to the current output.

Available PC-CAT programs:

<i>PC-CAT version</i>	<i>Operating systems</i>
PC-CAT (DOS) 3.01	DOS ≥ 5.00 or DOS window in Windows 3.1x, 9x, ME (not NT, 2000)
PC-CAT Windows 4.00/4.01	Windows 95, 98, ME, 2000, NT
PC-CAT Windows Lite 4.01	Windows 95, 98, ME, 2000, NT



PC-CAT display (example):



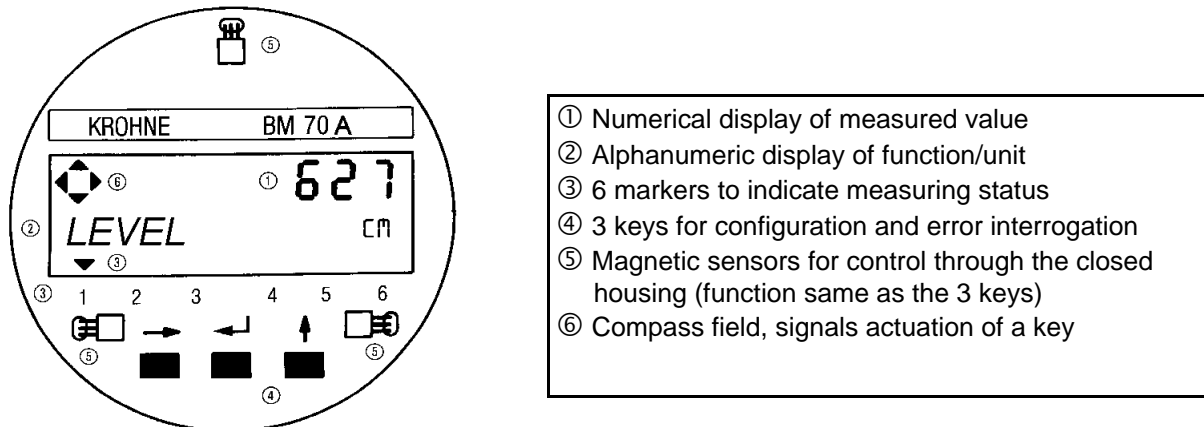
## 8 User interface

### 8.1 Local display

Units for level, distance: m, cm, mm, inch, ft, %  
 Units for volume: m<sup>3</sup>, Liter, US Gal, GB Gal, ft<sup>3</sup>, bbl (petroleum barrels), %  
 Operating and display language: English, German, French, Italian, Español, Português, Swedish

#### BM 70 A/P:

Structure of local display (illuminated; size of digits: 7 mm / 0.28"):

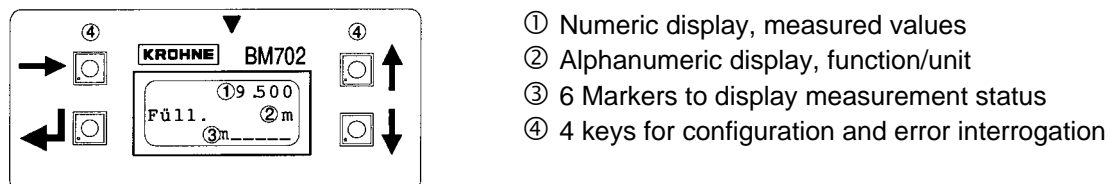


Option: jumbo display

16 mm (0.63") size digits for the max. 5-digit measured value; without functions ② and ⑥.

#### BM 702:

Structure of local display (not illuminated; size of digits: 5 mm / 0.2"), optional:



### 8.2 Operator control

Operator control by way of the following:

- PC Program PC-CAT, connection via the signal output
- Bar magnet for 3 magnetic sensors near the local display (same function as the keys, without opening the housing): only for Bm 70 A/P
- BM 70 A/P: 3 keys below the local display (the housing of the electronics compartment must be opened; only for service and repair work by specialist personnel; not allowed in the hazardous area)
- BM 70 A/P: 4 keys next to the local display (the housing of the electronics compartment must be opened; also allowed in the hazardous area)
- For devices with HART<sup>®</sup> protocol: commercially available HART<sup>®</sup> handheld communicator (e.g. Rosemount Type 275).

### 8.3 Parameter setting

At the least the following basic parameters must be known in order to be able to configure the BM 70 A/P, BM 702 measuring system:

- Tank height (from tank fitting to tank bottom)
- Maximum level likely to occur
- Measuring range for 4 - 20 mA (4 mA = level 1; 20 mA = level 2)
- Baud rate and address for digital interfaces

In order to suppress interference from fixed internals during the measuring mode, a so-called "empty-tank spectrum" normally needs to be recorded (except in the case of simple storage tanks). For this purpose, it will be necessary, just once, to empty the tank completely. If an agitator is used, this must be switched on during the recording of the empty-tank spectrum.

Other optional application parameters can be set for special operating conditions.

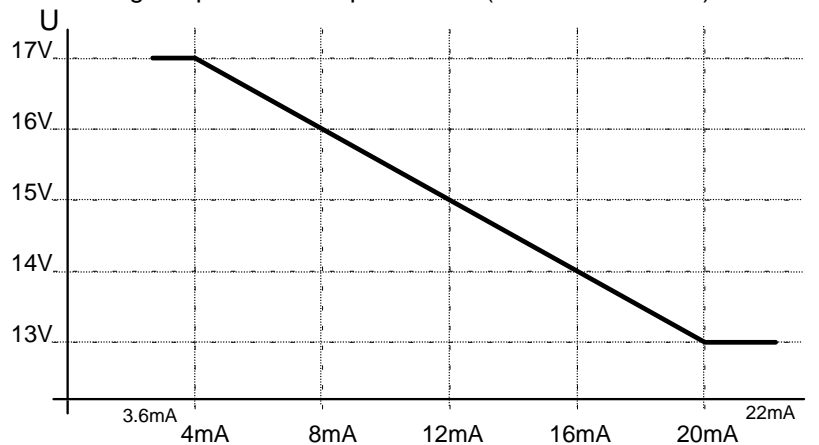
## 9 Supply power

### 9.1 Options, technical data

There is a choice of 2 supply power versions:

Version	Voltage U	Tolerance	Voltage range	Fre- quency	Power (typically)	Max. ripple / harmonic component
<b>24V DCAC</b> (BM 70 A/P)	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 W	10%
<b>115/230V AC</b> (BM 70 A/P)	115 V AC (to use for 100-120V)	-25% +10%	85-127 V	45-66 Hz	12 VA	10%
	230 V AC (to use for 200-240V)	-25% +10%	170-254 V	45-66 Hz	12 VA	10%
<b>BM 702</b>	13-30 V DC*	-	-	-	60-660 mW	within limits of tolerance

\* BM 702: Minimum voltage depends on output current (2-wire connection):



## 9.2 Fuses

Internal miniature fuses for supply power:	24 V DCAC*	T 1.25 A
	115 V AC**	T 0.315 A
	230 V AC**	T 0.16 A

\*: Both connections 1 and 2 are fuse-protected.

\*\*: Only connection L (for TN system, grounded supply) is fuse-protected; optionally also both connections N and L (for IT system, insulated supply).

In keeping with current regulations, it may be necessary to provide additional fuse protection when installing the plant.

Recommended line fuse protection:	24 V DCAC	min. T 2 A
	115 V AC	min. T 0.5 A
	230 V AC	min. T 0.25 A

## 9.3 Notes on safety

### Insulation rating

The insulation of type BM 70 A/P 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 instrument)

### Disconnecting device

Type BM 70 A/P, BM 702 level gauges do not feature any device for switching or disconnection.

### Class of protection

The BM 70 A/P level gauge is designed for safety class 1 in conformity with VDE 0106 Part 1.

### DC/AC power supply 24 V DCAC

When connected to a “**functional extra-low voltage with safety separation**“ power source (SELV or PELV) in accordance with VDE 0100, Part 410 or equivalent (inter)national regulations, connection of a PE safety conductor is not required.

### AC power supply 115/230 V AC

When connected to a power source with **dangerous contact voltage**: if stipulated on the basis of the protective measures to VDE 0100 or equivalent (inter)national regulations, the **PE safety conductor must** be connected to the separate U-clamp terminal in the terminal compartment of the signal converter.

### HAZARDOUS-DUTY SYSTEMS

- All cores and shields of the power cables not safety-connected to the equipotential bonding system for the hazardous location 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).
- Only BM 70 A/P: The incoming cables for **power supply** are of **non-intrinsically safe** design, also for the BM 70 A/P i version!
- Only BM 70 A/P: Independent of the type of supply power, the device must be incorporated in the **equipotential bonding system** in the hazardous location. This can be done by way of a suitable 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.

## 10 Certificates and approvals

### 10.1 Hazardous duty approvals

Country	Authority	Certificate No.	Class	Device type
Europa	PTB	PTB99 ATEX2061X	II1/2G EEx de IIC T6..T1 (Z.0)	BM 70 A/P;BM 700
			II1/2G EEx de [ia] IIC T6..T1 (Z.0)	BM 70 Ai/Pi
			II1/2G EEx ia IIC T6..T1 (Z.0)	BM 702i
USA	FM	J.I. 3000813	I Div.1 Gr.B/C/D; II Div.1 Gr.E/F/G; III	BM 70 A/P;BM 700
			I Div.2 Gr.B/C/D; II Div.2 Gr.F/G; III	BM 70 A/P;BM 700
USA	FM	J.I. 3006165	I Div.1 Gr.B/C/D; II Div.1 Gr.E/F/G; III	BM 70 Ai/Pi
			I Div.2 Gr.B/C/D; II Div.2 Gr.F/G; III	BM 70 Ai/Pi
USA	FM	in preparation		BM 702i
Canada	CSA	in preparation		BM 70 x
Japan	TIIS	in preparation		BM 70 x

### 10.2 Instructions from ATEX EEx approvals

The instruments BM 70 x are approved according to the new hazardous area directives **ATEX 100a** (certificate: PTB 99 ATEX 2061X).

Instruments were divided up to the following **Categories** according to the operating range:

Probability of hazardous atmosphere	Ex zone	Device in
Always, long-term or frequent	<b>Zone 0</b>	Device category <b>1G</b>
Occasional	<b>Zone 1</b>	Device category <b>2G</b>

The available standard **flange systems** are:

Construction	Short term in ATEX certificate	Device category	Installation in Ex zone
Horn antenna or Wave-Guide (with Metaglass)	V96	1G <sup>2)</sup>	Zone 0
Enamelled horn antenna	EA	1G <sup>2)</sup>	Zone 0
Wave-Stick with flange plate and Metaglass	WS 1C <sup>1)</sup>	1G <sup>2)</sup>	Zone 0
Wave-Stick with flange plate	WS 1B	2G	Zone 1
Wave-Stick without flange plate	WS 2A or 2B	2G	Zone 1
LP flange system (horn antenna/Wave-Guide)	Not in approval	Non-Ex	Non-Ex

Remarks:

1) For the Wave-Stick 1C (Zone 0) any electrostatic charging of the stick must be avoided in operation (otherwise only Zone 1).

2) Zone 0 is only defined for "**atmospheric conditions**" T = -20...+60 °C and p = 0.8...1.1 bar. Zone 0 is defined with the a.m. limits, the limitation is therefore not due to the instrument.

**Take note of the detailed information in the "BM 70x Supplementary Installation and Operating Instructions Ex"!**

### 10.3 EMC and quality certificates

Type	Company	Date/Certificate No.
CE declaration of conformity	Krohne	1997
Radio approval	BZT	Vfg1117/1989; Vfg241/1995
Radio Licence	FCC	JH5BM70
Preacceptance test to DruckbehV/TRB511 ( = German pressure vessel code)	RWTÜV	Nr. 5636602

# 11 Order information

## A) Summary of all technical information relevant to the order:

*BM 70 A/P, BM 702 Level-Radar*

- ◆ Connecting flange: .....
- ◆ Flange and antenna material:.....
- ◆ Waveguide seal:.....Viton FFKM Kalrez2035 other \_\_\_\_\_
- ◆ Antenna type: .....Type 4 (200mm) Type 3 (140mm)  
.....Type 1 (74mm) Type 2 (100mm) [for still well dia.: \_\_\_\_ ]  
.....Wave-Stick Wave-Guide (length: \_\_\_\_\_ )
- ◆ Antenna extension:.....
- ◆ Supply power:.....24V DCAC 200-240V AC 100-120V AC  
.....2-wire connection (BM 702)
- ◆ Signal output .....current output: active (Ex-e) Ex-i (IS) passive  
alternatively: .....Digital: RS 485 Bus: \_\_\_\_\_
- ◆ Explosion protection .....none Zone 0 (1G) Zone 1 (2G)

### *Special features*

- Additional calibration (BM 70 A Precision)
- High-precision version (BM 70 P)
- 90° antenna extension                       S-shaped antenna extension
- Purging connection                               Antenna heating
- Other: \_\_\_\_\_

## B) Additional information for application assessment, if known:

### *Tank dimensions*

- ◆ Tank height:.....
- ◆ Tank diameter: .....
- ◆ Height of tank fitting:.....
- ◆ Distance from tank wall: .....

### *Operating and design data for the device*

- ◆ Measuring range .....
- ◆ Product: .....
- ◆ Permittivity  $\epsilon_r$ : .....
- ◆ Operating pressure:.....
- ◆ Product temperature:.....

## 12 External standards, codes and directives

**DIN V 19259:** 1996-10. Documentation of devices, Data types with classification scheme for measuring equipment with analog 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**<sup>®</sup> FSK Physical Layer Specification Rev. 7.2: 1993-05

## 13. Quality assurance

KROHNE Messtechnik GmbH & Co. KG is certified in conformity with:

- DIN ISO 9001 / EN 29001 and
- ATEX 100a and
- KTA 1401 QSP 4A (nuclear power engineering)