BA 209F/00/en/04.04
Nr. 52006313

Valid as of software version:
V 01.02.00 (amplifier)
V 01.02.00 (communication)

micropilot S
FMR 533
Level-Radar

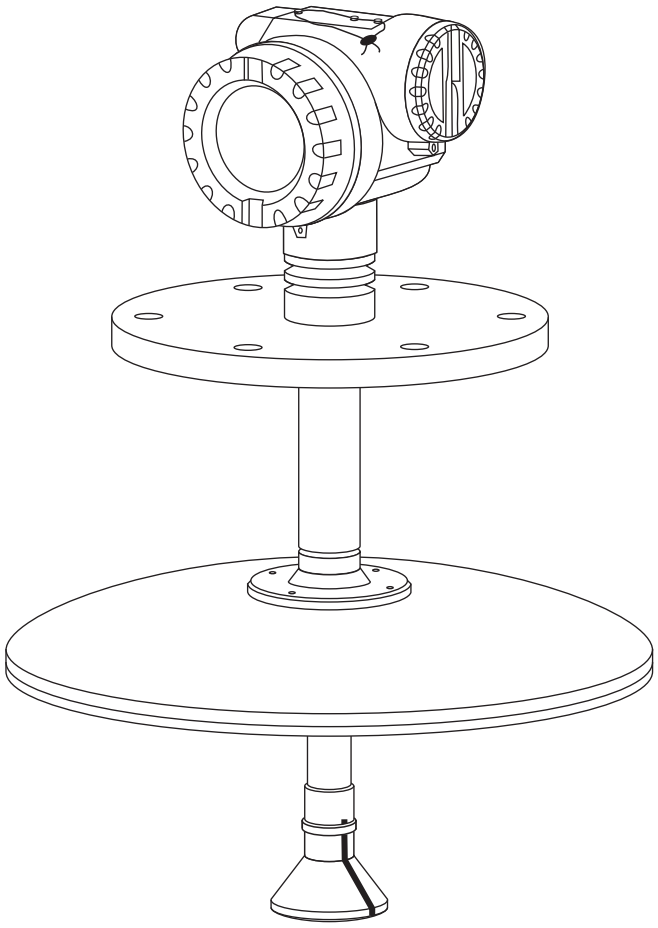






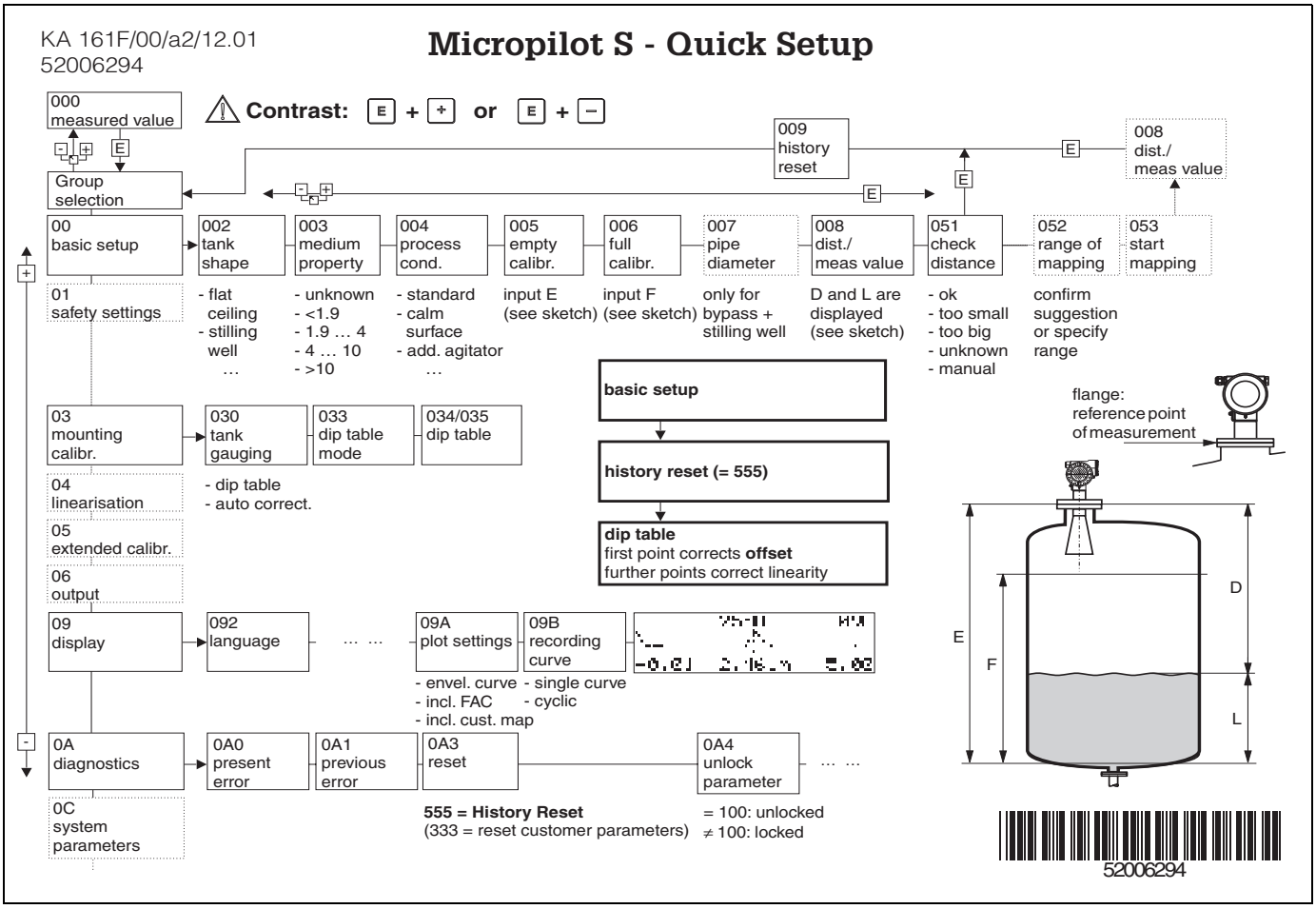


Operating Instructions



Endress + Hauser
The Power of Know How

Brief operating instructions



Note!
This operating manual explains the installation and initial start-up for the level transmitter measuring device. All functions that are required for a typical measuring task are taken into account here.
In addition, the Micropilot S provides many other functions that are not included in this operating manual, such as optimising the measuring point and converting the measured values.

An **overview of all device functions** can be found on Page 90.

The operating manual BA 217F/00/en provides an **extensive description of all device functions** – Description of the device functions for Micropilot S, which can also be found on the enclosed CD-ROM.

Table of contents

1 Safety instructions

1.1 Designated use

The Micropilot S FMR 533 is a compact radar level transmitter for the continuous, contactless measurement of liquids, pastes and sludge in **stilling wells**. The device can also be freely mounted outside closed metal vessels because of its operating frequency of about 6 GHz and a maximum radiated pulsed energy of 1mW (average power output 1 µW). Operation is completely harmless to humans and animals.

1.2 Installation, commissioning and operation

The Micropilot S has been designed to operate safely in accordance with current technical, safety and EU standards. If installed incorrectly or used for applications for which it is not intended, however, it is possible that application-related dangers may arise, e.g. product overflow due to incorrect installation or calibration. For this reason, the instrument must be installed, connected, operated and maintained according to the instructions in this manual: personnel must be authorised and suitably qualified. The manual must have been read and understood, and the instructions followed. Modifications and repairs to the device are permissible only when they are expressly approved in the manual.

1.3 Operational safety

Hazardous areas
Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an *integral part* of this Operating Manual. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory.
- Ensure that all personnel are suitably qualified.
- Observe the specifications in the certificate as well as national and local regulations.

FCC-approval
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Caution!
Changes or modifications not expressly approved by the part responsible for compliance could void the user's authority to operate the equipment.

1.4 Return

The following procedures must be carried out before a transmitter is sent to Endress+Hauser for repair:

- Always enclose a duly completed "Declaration of contamination" form. Only then can Endress +Hauser transport, examine and repair a returned device.
- Enclose special handling instructions if necessary, for example a safety data sheet as per EN 91/155/EEC.
- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid is dangerous to health, e.g. corrosive, poisonous, carcinogenic, radioactive, etc.

Note!
A copy of the "**Declaration of contamination**" is included at the end of this operating manual.

Caution!

- No instrument should be sent back for repair without all dangerous material being completely removed first, e.g. in scratches or diffused through plastic.
- Incomplete cleaning of the instrument may result in waste disposal or cause harm to personnel (burns, etc.). Any costs arising from this will be charged to the operator of the instrument.

1.5 Notes on safety conventions and symbols

In order to highlight safety-relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding symbol in the margin.

Safety conventions

Symbol	Meaning
	**Warning!** A warning highlights actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or destruction of the instrument
	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument
	**Note!** A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned

Explosion protection

	**Device certified for use in explosion hazardous area** If the Micropilot has this symbol embossed on its name plate it can be installed in an explosion hazardous area
	**Explosion hazardous area** Symbol used in drawings to indicate explosion hazardous areas. – Devices located in and wiring entering areas with the designation "explosion hazardous areas" must conform with the stated type of protection
	**Safe area (non-explosion hazardous area)** Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. – Devices located in safe areas still require a certificate if their outputs run into explosion hazardous areas.

Electrical symbols

	**Direct voltage** A terminal to which or from which a direct current or voltage may be applied or supplied
	Alternating voltage A terminal to which or from which an alternating (sine-wave) current or voltage may be applied or supplied
	**Grounded terminal** A grounded terminal, which as far as the operator is concerned, is already grounded by means of an earth grounding system
	**Protective grounding (earth) terminal** A terminal which must be connected to earth ground prior to making any other connection to the equipment
	**Equipotential connection (earth bonding)** A connection made to the plant grounding system which may be of type e.g. neutral star or equipotential line according to national or company practice

2 Identification

2.1 Device designation

2.1.1 Nameplate

The following technical data are given on the instrument nameplate:

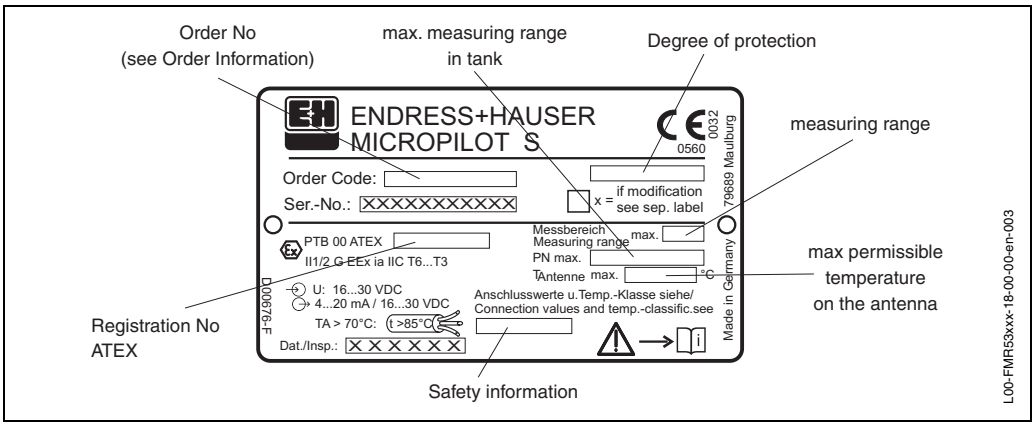


Fig. 1 Information on the nameplate of the Micropilot S FMR 533 (example)

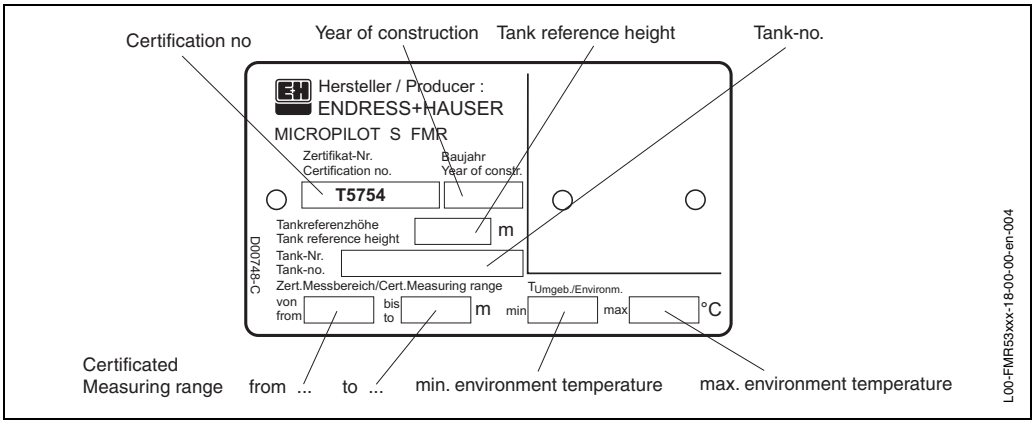


Fig. 2 Information on the NMi type plate for custody transfer applications of the Micropilot S FMR 533 (example)

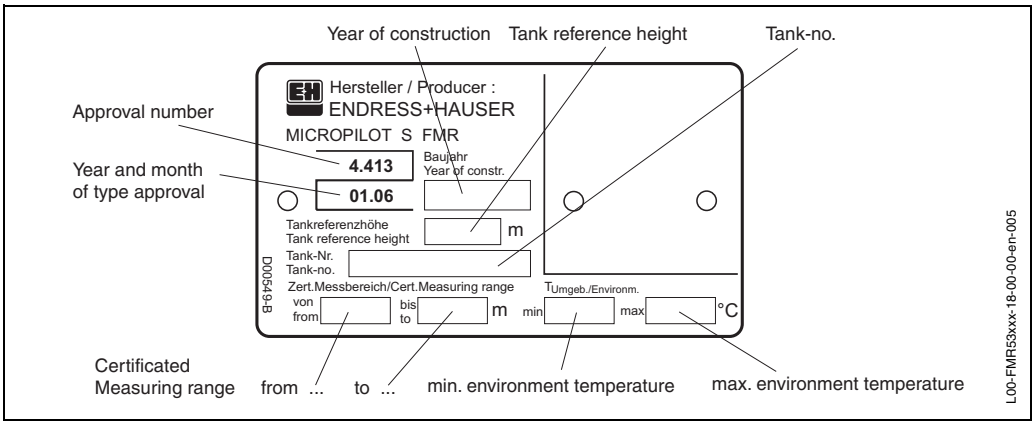


Fig. 3 Information on the PTB type plate for custody transfer applications of the Micropilot S FMR 533 (example)

2.1.2 Ordering structure

Ordering structure Micropilot S FMR 533

10	**Certificates**							**Basic weight**
	A	For non-hazardous areas						13.0 kg
	G	ATEX II 3G EEx nA II T6						
	K	TIIS	Ex ia IIC T3					
	L	TIIS	Ex ia IIC T6					
	S	FM	IS - Class I, Division 1, Group A-D					
	U	CSA	IS - Class I, Division 1, Group A-D					
	1	ATEX II 1/2 G	EEx ia IIC T6, note safety instruction (XA) for electrostatic charging!					
	6	ATEX II 1/2 G	EEx ia IIC T6 + WHG, note safety instruction (XA) for electrostatic charging!					
	Y	Special version						

20		**Antenna**						**Additional weight**
			Type	*Size*	*Material*	*sealing*		
		A	Parabolic antenna	DN450 / 20"	1.4435 / PTFE	not wetted o-ring		
		Y	Special version					

30			**Process connection**					
				Flange Dia/Pressure	*Standard*	*Material*		
			AVJ	6"/150 lbs / RF	ANSI B16.5	316/316L		11.3 kg
			A3J	8"/150 lbs / RF	ANSI B16.5	316/316L		19.6 kg
			A5J	10"/150 lbs / RF	ANSI B16.5	316/316L		28.8 kg
			CWJ	DN150 PN10 / 16 C	EN 1092,1, B1[1)]	316L		10.6 kg
			CXJ	DN200 PN16 C	EN 1092,1, B1[1)]	316L		16.5 kg
			C6J	DN250 PN16 C	EN 1092,1, B1[1)]	316L		25.6 kg
			KDJ	10 K 200A / RF	JIS B2210	SS316L		13.8 kg
			KV2	10 K 150A / RF	JIS B2210	SS316L		9.9 kg
			K5J	10 K 250A / RF	JIS B2210	SS316L		22.9 kg
			XXJ	with flange hub		316L		
			XVU	E+H UNI-Flange 6"/DN150/150A, max. 14.5LBS/PN1/1K, compatible with: - 6" 150LBS - DN150 PN16 - 10K 150A		304/1.4301		3.5 kg
					1) agreeable to DIN2527 Form C			
			YY9	Special version				

40				**Output and operation**				
				A	4…20 mA HART with VU 331, 4-line alphanumeric display			
				Y	Special version			

50					**Housing**			
					C	Aluminium T12-housing with separate connection compartment, coated, IP65		
					Y	Special version		

60						**Gland / Entry**		
						1	Pg13.5 cable gland	
						2	M20x1.5 cable gland	
						3	G ½ cable entry	
						4	½ NPT cable entry	
						9	Special version	

70							**Custody transfer approvals**	
						A	NMi, PTB type and test rig approval, weights&measures approved (< 1 mm)	
						F	NMi initial verification, type and test rig approval, weighth&measures approved (< 1 mm)	
						G	PTB initial verification, type and test rig approval, weights&measures approved (< 1 mm)	
						R	Inventory Control Version, not weights&measures approved (3 mm)	
						Y	Special approval for custody transfer	

80							**Additional options**	
						A	Without additional options	
						Y	Special version	
FMR 533-								Complete product designation

2.2 Scope of delivery

Caution!
It is essential to follow the instructions concerning the unpacking, transport and storage of measuring instruments given in the chapter »Incoming acceptance, transport, storage« on page 11

The scope of delivery consists of:
- Assembled instrument
- ToF Tool (operating program)
- Accessories (s. Chapter 8)

Accompanying documentation:
- Short manual (basic equalisation/troubleshooting): housed in the instrument
- Operating manual (this manual)
- Operating manual: Description of the instrument functions
- Approval documentation: if this is not included in the operating manual.

2.3 Certificates and approvals

CE mark, declaration of conformity
The instrument is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The instrument complies with the applicable standards and regulations in accordance with EN 61010 "Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures". The instrument described in this manual thus complies with the statutory requirements of the EG directives. Endress+Hauser confirms the successful testing of the instrument by affixing to it the CE mark.

2.4 Registered trademarks

KALREZ ®, VITON ®, TEFLON ®
Registered trademark of the company E.I. Du Pont de Nemours & Co., Wilmington, USA

TRI-CLAMP ®
Registered trademark of the company Ladish & Co., Inc., Kenosha, USA

HART ®
Registered trademark of HART Communication Foundation, Austin, USA

ToF ®
Registered trademark of the company Endress+Hauser GmbH+Co. KG, Maulburg, Germany

PulseMaster ®
Registered trademark of the company Endress+Hauser GmbH+Co. KG, Maulburg, Germany

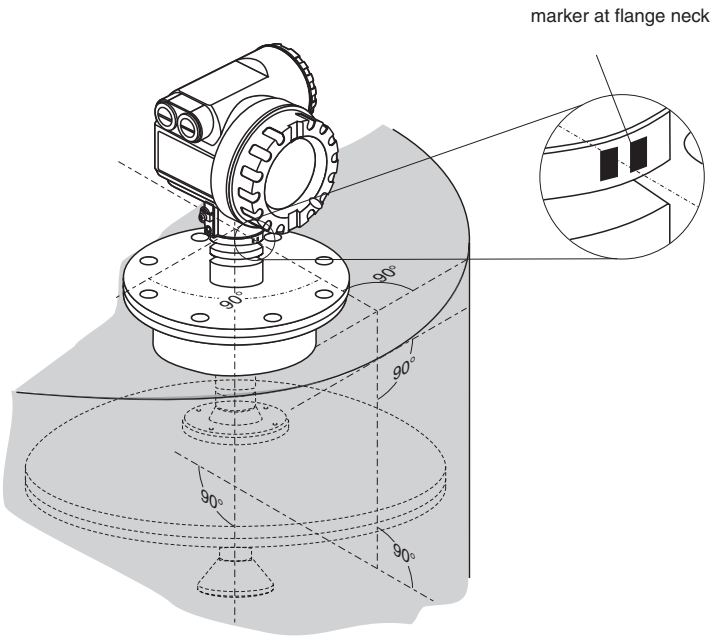
PhaseMaster ®
Registered trademark of the company Endress+Hauser GmbH+Co. KG, Maulburg, Germany

3 Mounting

3.1 Quick installation guide

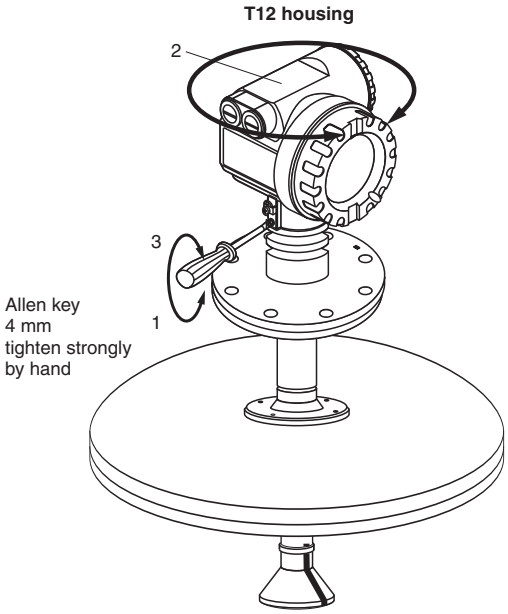
Observe orientation when installing!

Installation in tank (free space):
Mark on process connector facing the nearest tank wall!



Turn housing

The housing can be turned in order to simplify access to the display and the terminal compartment



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3.2 Incoming acceptance, transport, storage

3.2.1 Incoming acceptance

Check the packing and contents for any signs of damage.
Check the shipment, make sure nothing is missing and that the scope of supply matches your order.

3.2.2 Transport

Caution!
Follow the safety instructions and transport conditions for instruments of more than 18 kg. Do not lift the measuring instrument by its housing in order to transport it.

3.2.3 Storage

Pack the measuring instrument so that is protected against impacts for storage and transport. The original packing material provides the optimum protection for this.
The permissible storage temperature is -40 °C…+80 °C.

3.3 Installation Conditions

3.3.1 Dimensions

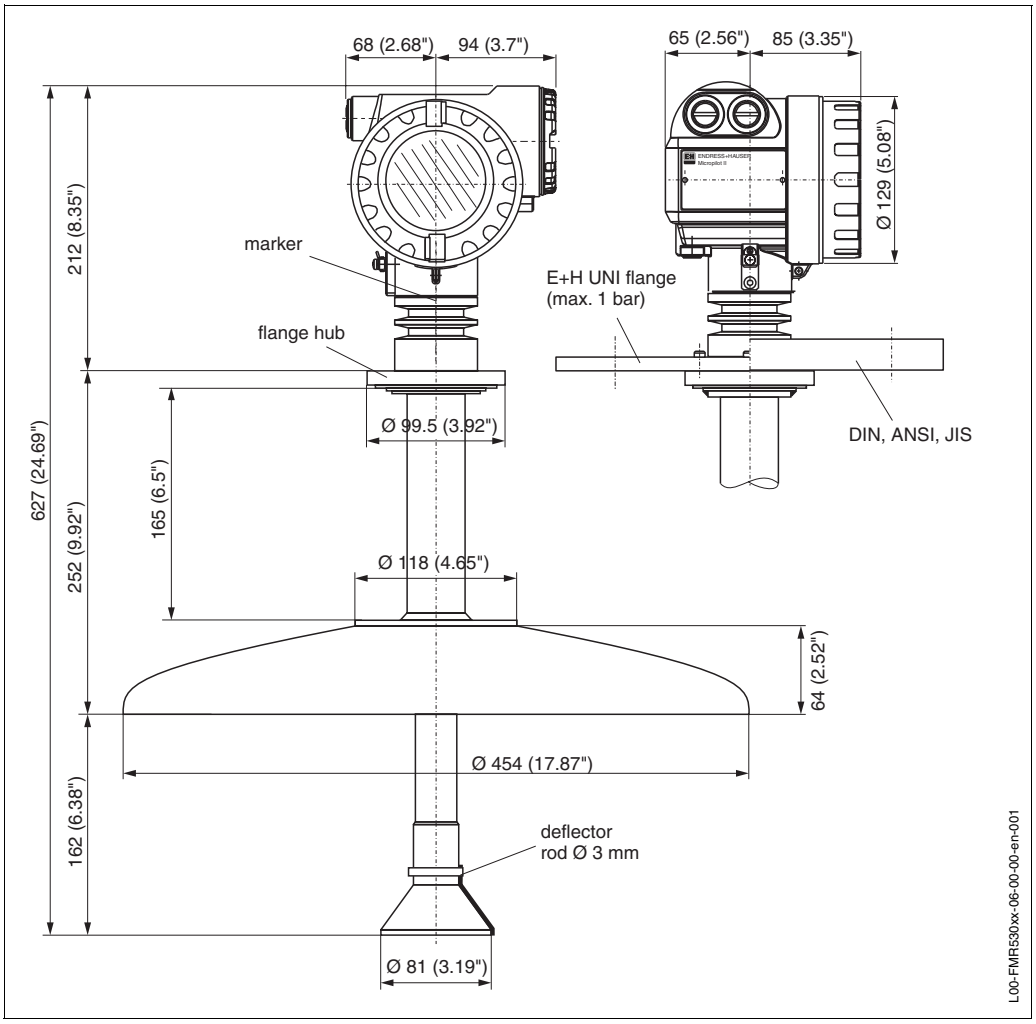
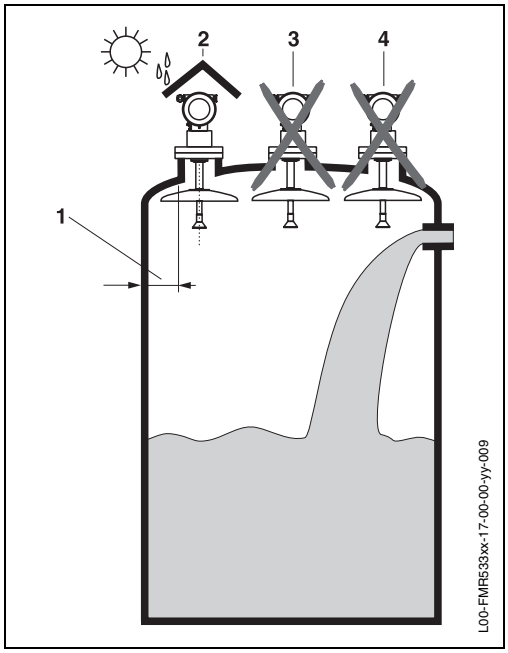


Fig. 4 Dimensions Micropilot S FMR 533

3.3.2 Engineering hints

Orientation

- Recommended distance (1) wall – **outer edge** of nozzle: ~ 1/6 of tank diameter.
- Mount the Micropilot S at a position where the tank movement due to filling/ emptying of the tank is of low influence.
- Not in the centre (3), interference can cause signal loss.
- Not above the fill stream (4).
- It is recommended to use a weather protection cover (2) in order to protect the transmitter from direct sun or rain. Assembly and disassembly is simply done by means of a tension clamp (see »Accessories« on page 74).



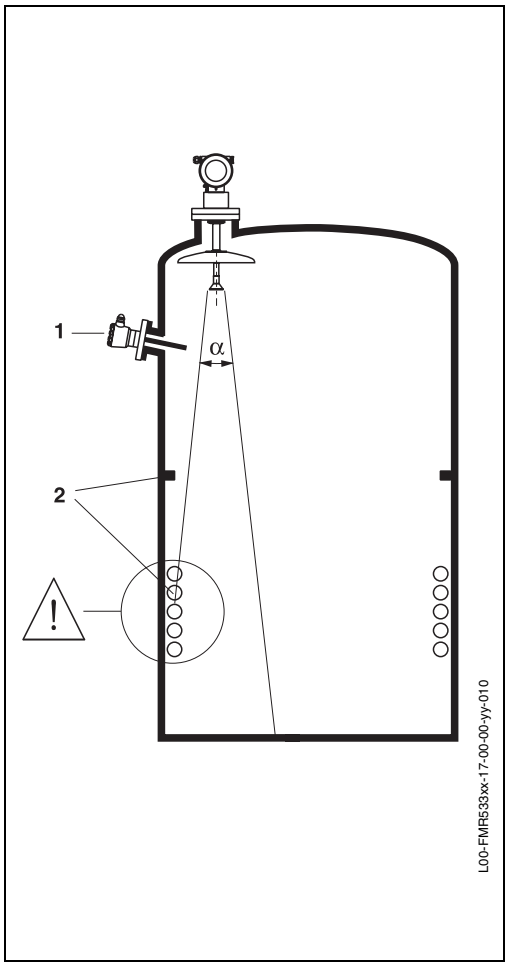
Tank installations

- Avoid any installations (1), like limit switches, temperature sensors, etc., inside the signal beam (refer to beam angle).
- It is essential that HiHi alarm is below the blocking distance (BD) and teh safety distance (SD) (see page 15).
- Symmetrical installations (2), e.g. vacuum rings, heating coils, baffles, etc., can also interfere with the measurement.

Optimization options

- Antenna size: the bigger the antenna, the smaller the beam angle, the less interference echoes.
- Mapping: the measurement can be optimized by means of electronic suppression of interference echoes.
- Antenna alignment: refer to "optimum mounting position"
- Stilling well: a stilling well can always be used to avoid interference. The FMR 532 with planar antenna is recommended for stilling wells with a diameter DN150 (6”) and larger.

Please contact Endress+Hauser for further information.

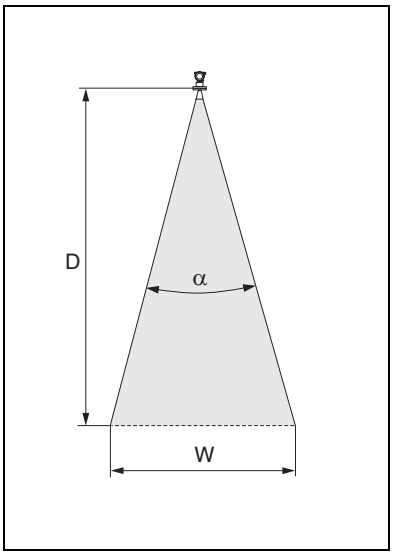


Beam angle

The beam angle is defined as the angle α where the energy density of the radar waves reaches half the value of the maximum energy density (3dB-width). Microwaves are also emitted outside the signal beam and can be reflected off interfering installations.
Beamwidth diameter **W** as function of antenna type (beam angle α) and measuring distance **D**:

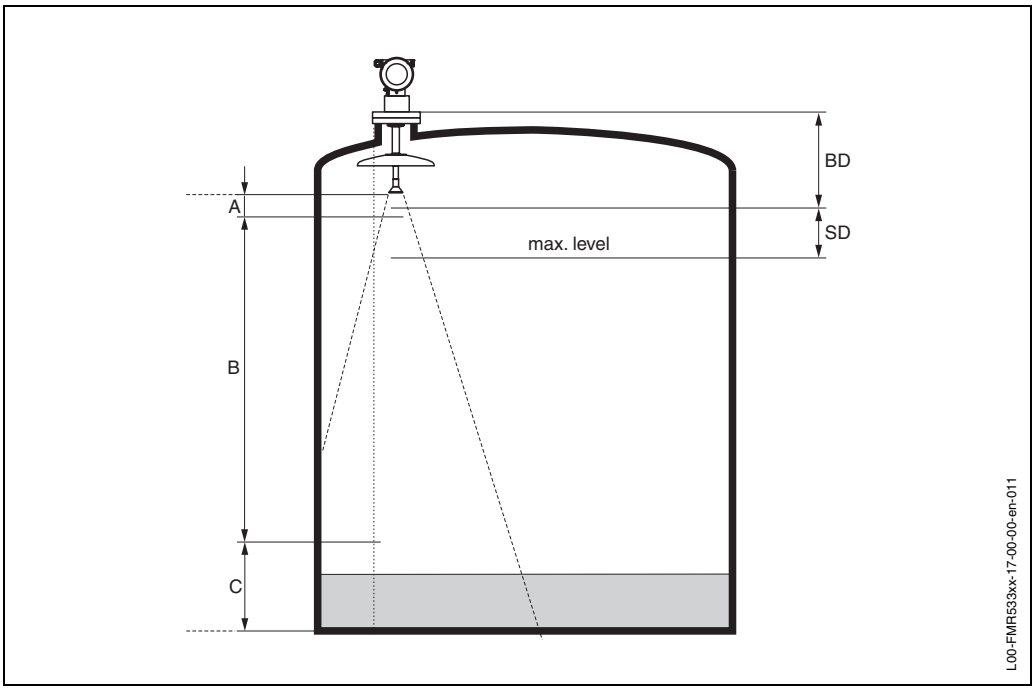
Antenna size	**FMR 533** parabolic
Beam angle α	7°

Measuring distance (D)	Parabol
3 m / 10 ft	0.37 m / 1.22 ft
6 m / 20 ft	0.73 m / 2.45 ft
9 m / 30 ft	1.10 m / 3.67 ft
12 m / 40 ft	1.47 m / 4.89 ft
15 m / 49 ft	1.83 m / 5.99 ft
20 m / 65 ft	2.45 m / 7.95 ft
25 m / 82 ft	3.06 m / 10.03 ft
38 m / 124 ft	4.65 m / 15.17 ft
40 m / 131 ft	4.89 m / 16.02 ft



Measuring conditions

- The measuring range begins where the beam hits the tank bottom. Particularly with dish bottoms or conical outlets the level cannot be detected below this point.
- In case of media with a low dielectric constant (groups A and B), the tank bottom can be visible through the medium at low levels. In order to guarantee the required accuracy in these cases, it is recommended to position the zero-point at a distance **C** above the tank bottom (see Fig.).
- In applications with **planar** or **parabolic** antennas, especially for media with low dielectric constants (see page 16), the end of the measuring range should not be closer than 1 m (40") to the flange.
- For **overspill protection**, it is possible to define a safety distance **(SD)** additionally to the blocking distance **(BD)**.
- This safety distance **(SD)** is set to 0.5 m (20") by default and generating an alarm in case the level rises inside the safety distance.
- For Micropilot S FMR 533 with parabolic antenna, this safety distance should be set to 0.5 m (20"). The response of the signal output should be configured to "**alarm**" in function "**in safety dist. (016)**" see operating manual **"Description of the instrument functions – BA 217F".**
- Distance **B** defined the smallest recommended measurement range.
- Depending on its consistence, foam can either absorb microwaves or reflect them off the foam surface. Measurement is possible under certain conditions.



	reference: flange / BD (cf. picture)		reference: antenna tip (cf. picture) recommended additional settings		
	Blocking distance	Safety distance			
	BD [m / ft]	SD [m / ft]	A [mm / inch]	B [m / ft]	C [mm / inch]
FMR 533 (parabolic)	1 / 3.28	0.5 / 1.6	1000 / 40	0.5 / 1.64	150…300 / 6…12

Behaviour if measuring range is exceeded

The behaviour in case of the measuring range being exceeded can be freely set: the default setting is a current of 22 mA and the generation of a digital warning (E681).

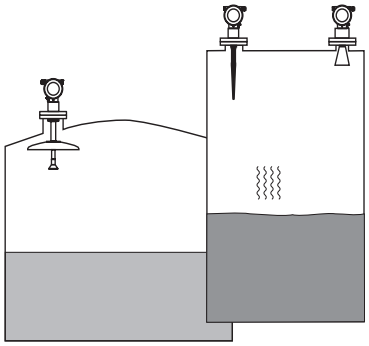
Measuring range

The usable measuring range depends on the size of the antenna, the reflectivity of the medium, the mounting location, and eventual interference reflections.
The following tables describe the groups of media as well as the achievable measuring range as a function of application and media group. If the dielectric constant of a medium is unknown, it is recommended to assume media group B to ensure a reliable measurement.

Product class	DK (εr)	Examples
A	1.4 … 1.9	non-conducting liquids, e.g. liquefied gas [1]
B	1.9 … 4	non-conducting liquids, e.g. benzene, oil, toluene, …
C	4 … 10	e.g. concentrated acids, organic solvents, esters, aniline, alcohol, acetone, …
D	> 10	conducting liquids, e.g. aqueous solutions, dilute acids and alkalis

1) Treat Ammonia NH3 as a medium of group A, e.g. always use a stilling well.

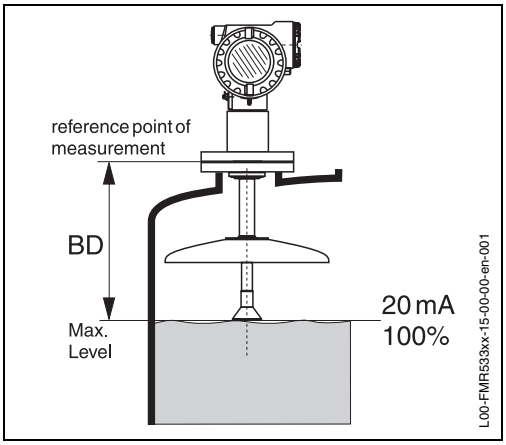
Measuring range depending on product class for Micropilot S FMR 533:

Product class		Free space (Storage tank)
		
		Measuring range
		FMR 533
A	DK(εr)=1,4…1,9	—
B	DK(εr)=1,9…4	40 m/131 ft
C	DK(εr)=4…10	40 m/131 ft
D	DK(εr)>10	40 m/131 ft
max. measuring range with custody transfer approvals		25 m/82 ft

Note!
Inside the blocking distance, a reliable measurement can not be guaranteed.

Blocking distance

The blocking distance (= BD) is the minimum distance form the reference point of the measurement (mounting flange) to the medium surface at maximum level.



Blocking distance (BD)	Free space (Storage tank)
	FMR 533
at Flange	1 m/ 40"

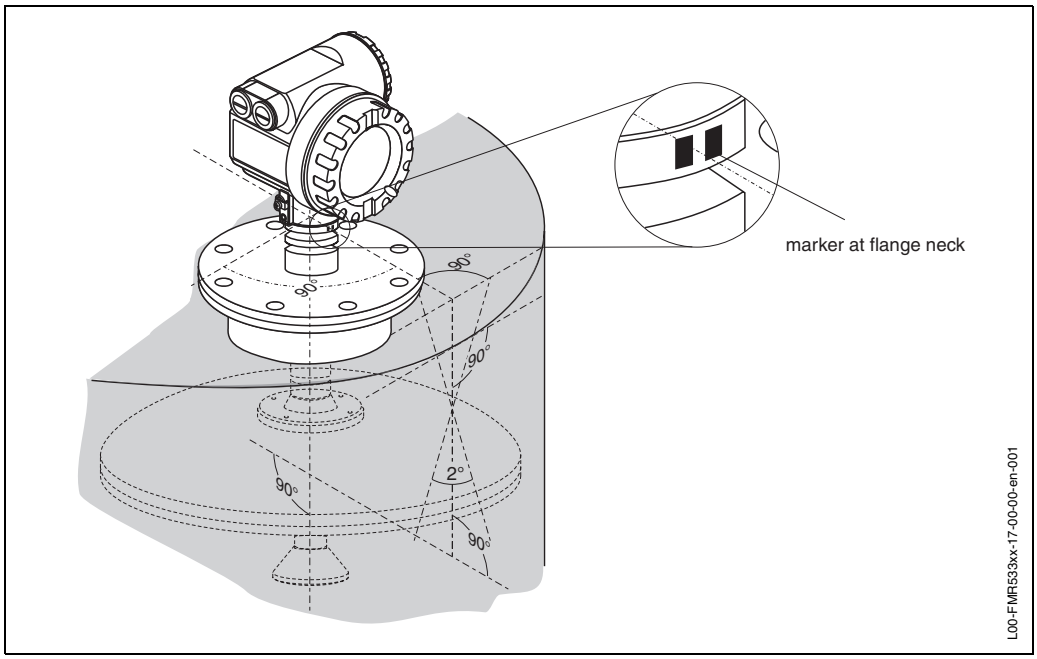
3.4 Installation instructions

3.4.1 Mounting kit

In addition to the tool needed for flange mounting, you will require the following tool:
- 4 mm Allen wrench for turning the housing.

3.4.2 Installation in tank (free space)

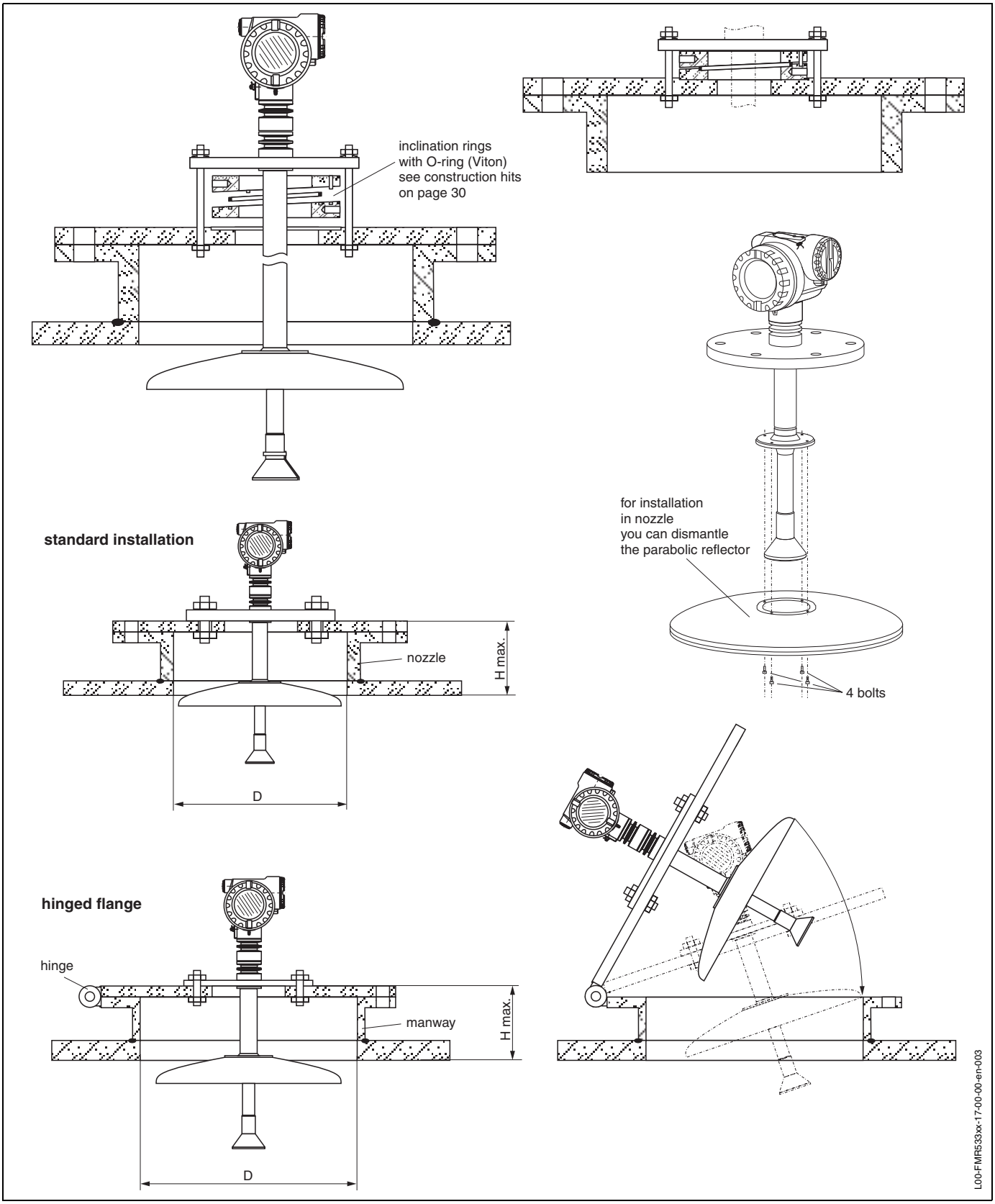
Optimum mounting position



Standard installation
When mounting in tank, please observe engineering hints on Page 13 and the following points:
- Marker is aligned towards tank wall.
- The marker is located below the housing at the neck of the flange.
- After mounting, the housing can be turned 350° in order to simplify access to the display and the terminal compartment.
- The parabolic mirror must extend below the nozzle.
- Align parabolic antenna vertically.

Mounting in manway
The parabolic antenna can be mounted on a manway cover.
The manway cover must have an opening with a diameter D1 or D2 for mounting of the antenna (refer to fig. below). It has to be possible to remove the cover in order to mount the antenna. The instrument can be mounted on the manway cover with a weld-on flange with a neck. Please consider the maximum height of the nozzle (H max. = 200 mm) for the diameter of the basis.

Examples for installation in a manway

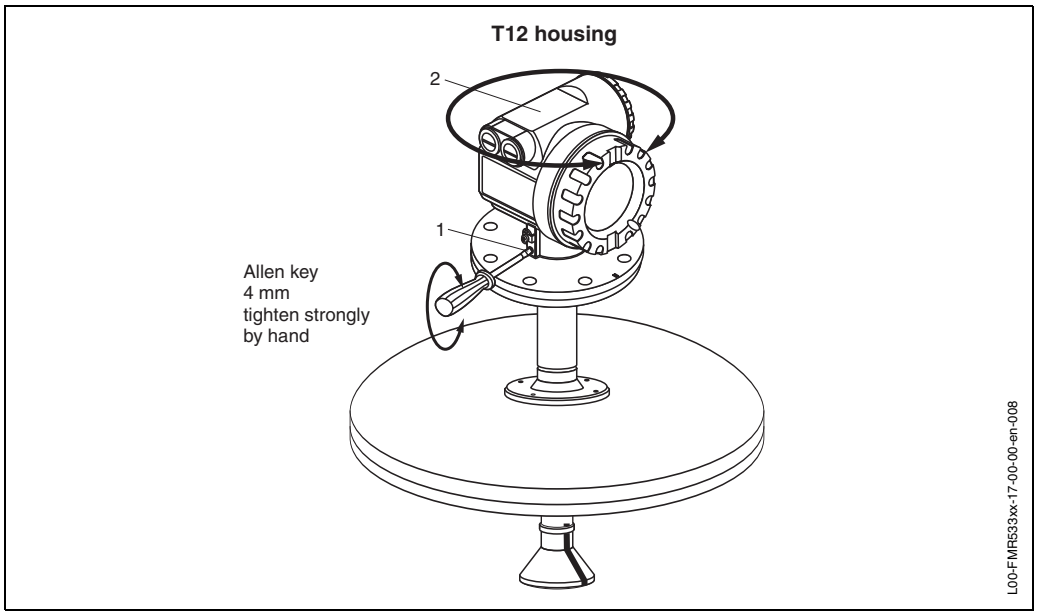


	D (=inside diameter of manway)	**H max.** (=maximum height of nozzle)
Standard installation	≥ 500 mm / ≥ 20"	200 mm / 8"
Hinged flange	≥ 600 mm / ≥ 24"	200 mm / 8"

3.4.3 Turn housing

After mounting, the housing can be turned 350° in order to simplify access to the display and the terminal compartment. Proceed as follows to turn the housing to the required position:

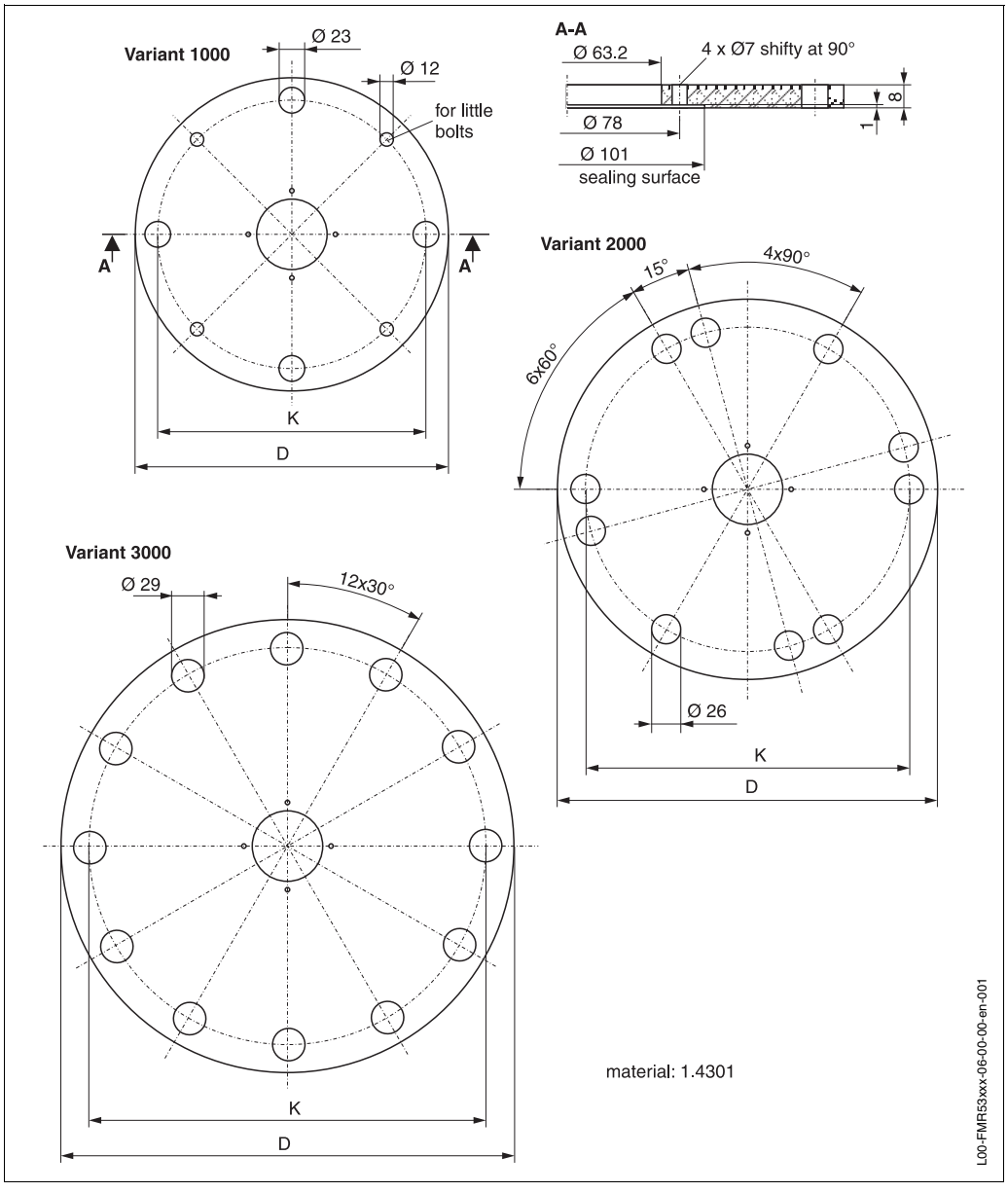
- Undo the fixing screws (1)
- Turn the housing (2) in the required direction
- Tighten up the fixing screws (1)



3.4.4 Mounting with E+H UNI flange

Installation hints

E+H UNI flanges are designed for non-pressurized operation respectively max. 1 bar absolute pressure. The number of bolts has sometimes been reduced. The bolt-holes have been enlarged for adaption of dimensions, therefore, the flange needs to be properly aligned to the counterflange before the bolts are tightened.

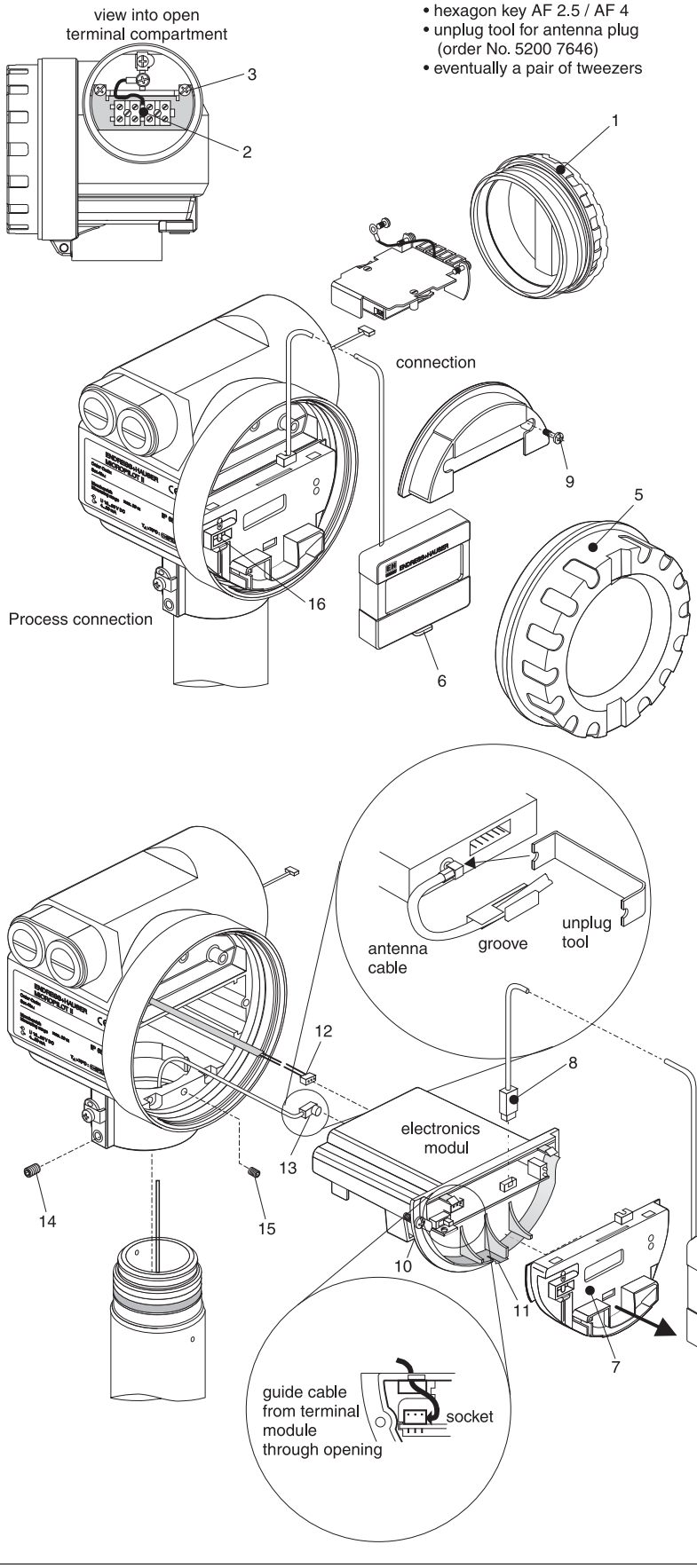


Version	Compatible with	D [mm]	K [mm]	Type plate no.
1000	DN150 PN16 ANSI 6" 150lbs JIS 10K 150	280	240	942455-3001
2000	DN200 PN16 ANSI 8" 150lbs JIS 10K 200	340	294.5	942455-3002
3000	DN250 PN16 ANSI 10" 150lbs JIS 10K 250	405	358	942455-3003

Preparation for the installation of the E+H UNI flange

The mounting requires the following tools:

- Philips screw driver size 1
- flat screw driver for M3 / M4
- hexagon key AF 2.5 / AF 4
- unplug tool for antenna plug (order No. 5200 7646)
- eventually a pair of tweezers



Order of exchange:

- Unscrew lid (1) from terminal compartment
- Disconnect cable at terminal module (2)
- Unscrew mounting screws (3) at terminal module and disconnect ground cable
- Pull out terminal module (4). A connection to a cable feed-through is located at the rear side of the module. (the feed-through can be unscrewed, if required)
- Unscrew lid (5) from electronics compartment
- If installed, take display out of holder by pushing the hook (6) upwards
- Break the calibration seal to unplug the sealing pin (16)

Note!

If the calibration seal is broken, the national calibration authority should be informed within 24 hours!

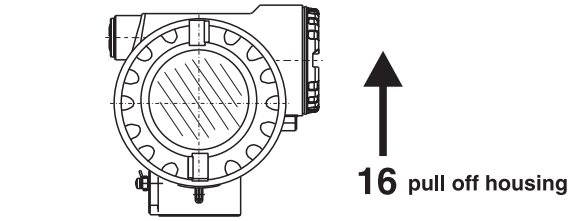
- pull front panel (7) off
- Unplug display cable (8)
- Loosen screw (9) in cover and remove cover
- Loosen mounting screws (10) at electronics module and pull module out of housing
- Press lower hook (11) at module housing slightly inwards
- Unplug connection cable (12) to the terminal module from the electronics
- Unplug antenna cable (13) with unplug tool
- Loosen the set screw (14) in the housing about 1 turn (hexagon key 4 mm)
- Unscrew the stop screw (15) in the housing about 4 - 5 turns (hexagon key 2.5 mm)
- While turning the complete antenna assembly, pull it out of the housing (16) (see next page).

Note!

Don`t damage the antenna cable!

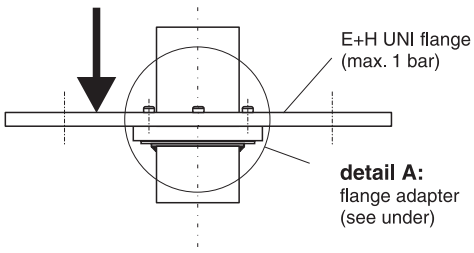
- Mount EH UNI flange (17) on flange-hub with screws (see next page).
- The mounting of housing and electronic raised last in - first out how disassembly.

L00-FMR532xx-00-00-06-en-002

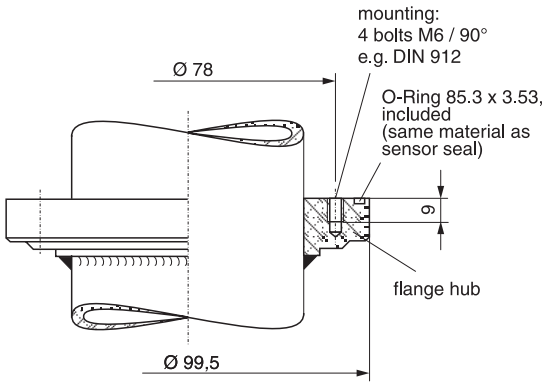


16 pull off housing

17 mount E+H UNI flange



detail A
flange hub for the connection
to flanges provided by the customer



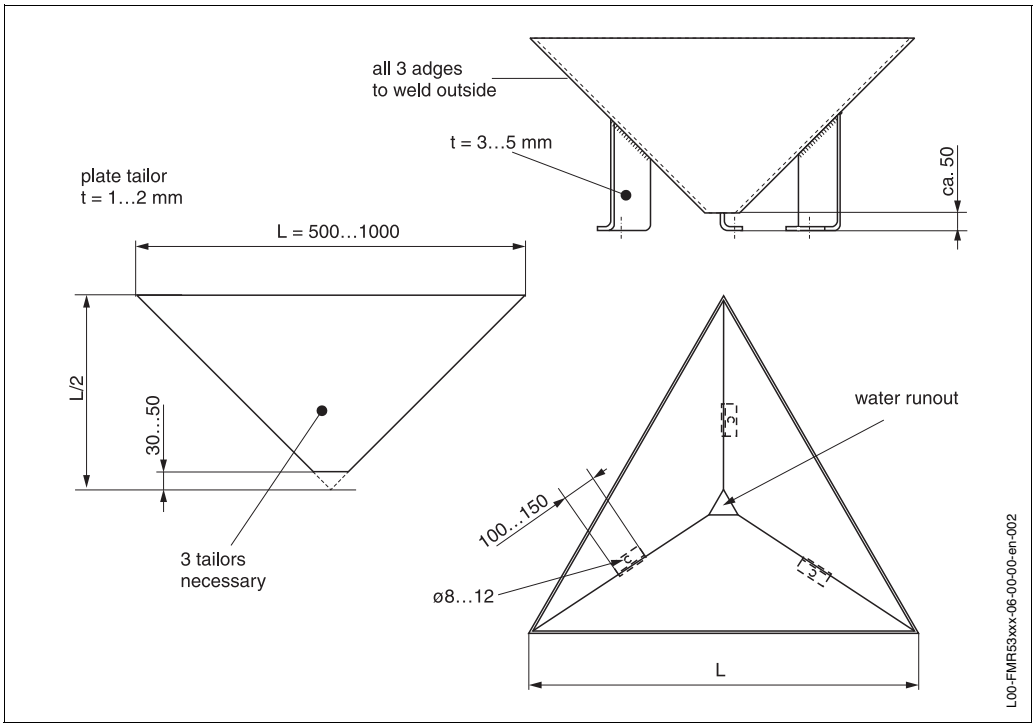
L00-FMR533xx-00-00-06-en-003

3.4.5 Mounting with Roof reflector

Reflector
Measurements on floating roofs are not recommended for highly accurate measurements due to the unsteady movements of the floating roofs. A special reflector can be used for applications on floating roofs (not for FMR 532 with planar antenna!).

Construction hints

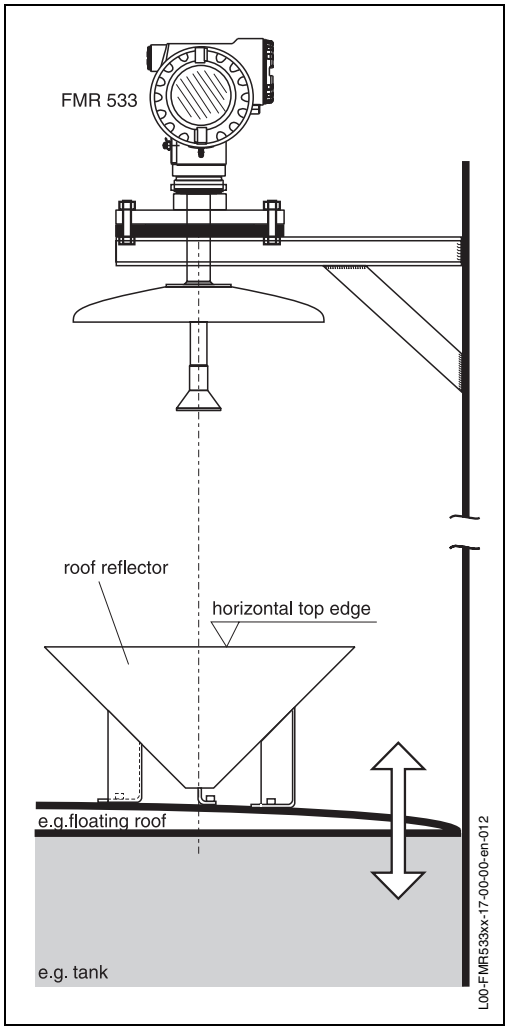
Note!
The roof reflector is not part of the standard offering from Endress+Hauser.



Optimum mounting position
Positioning of the reflector on a floating roof:

- The upper edges of the reflector have to be aligned horizontally.
- For slanted locations (e.g. dome-shaped floating roof), the feet must be extended accordingly.

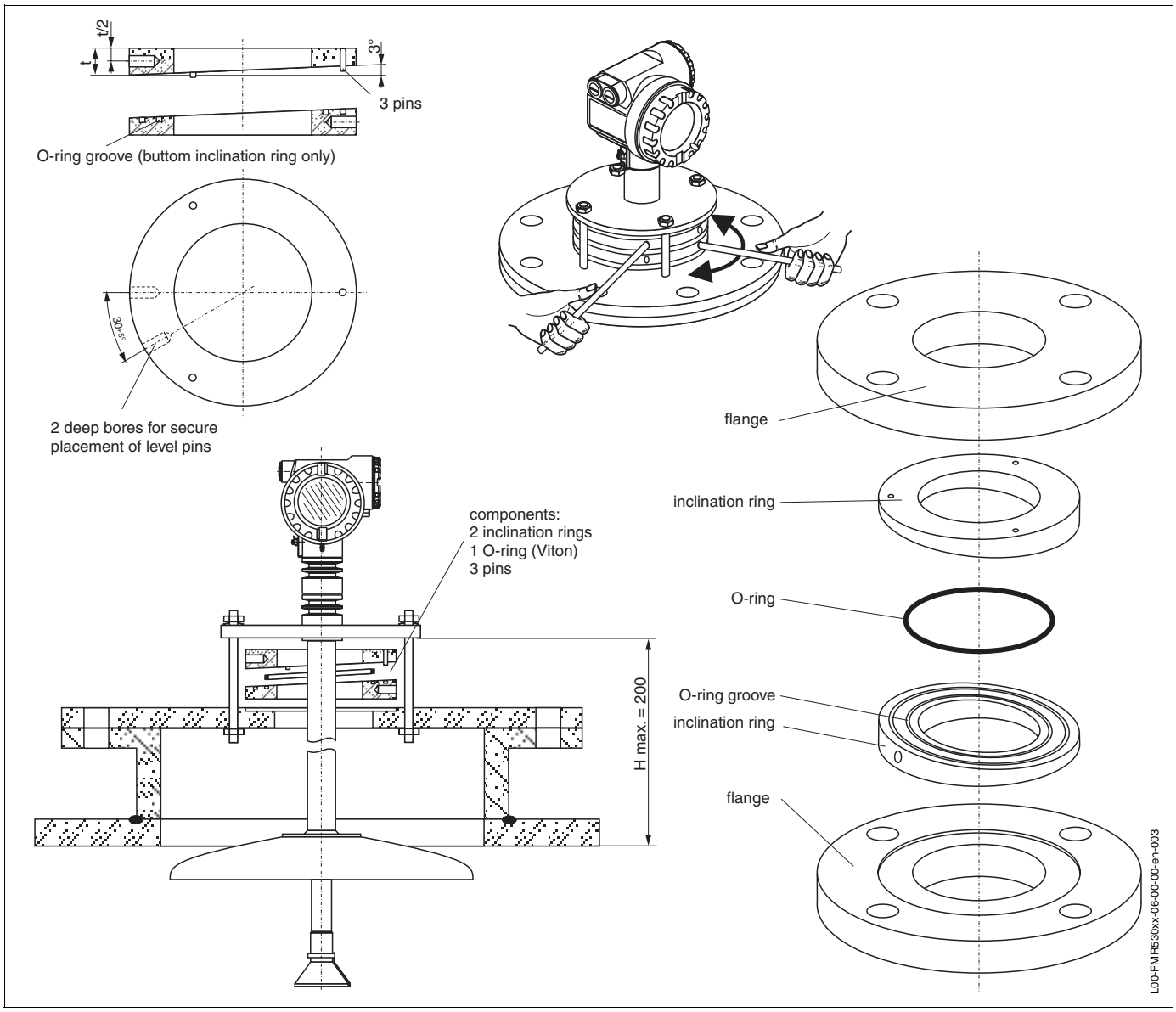
Please contact Endress+Hauser for further information.



3.4.6 Mounting with Inclination device

Installation hints
The inclination can be adjusted up to 6° by means of an inclination device.
The purpose is to align the antenna axis such that the radar beam is directed straight to the product surface.

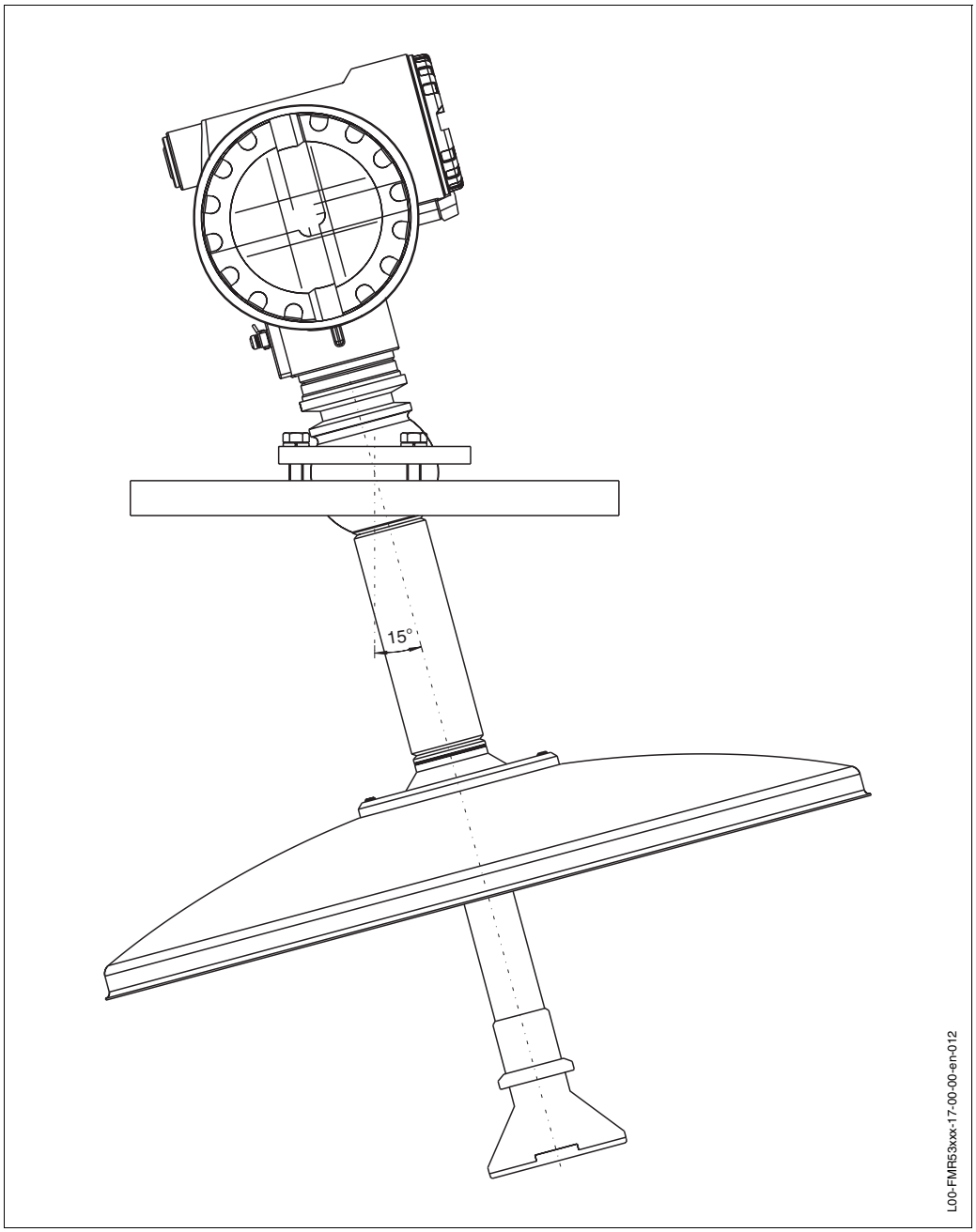
Note!
The inclination device shown below is presented as construction proposal only.



3.4.7 Parabolic antenna DN450/20" with alignment unit 15° adjustable

Installation hints
The alignment unit can be adjusted up to 15° by means of an inclination device. The purpose is to align the antenna axis such that the radar beam is directed straight to the product surface.

Note!
The alignment unit is not part of the standard offering from Endress+Hauser, special offers available under ref. number MVT6M0081.



3.5 Post-installation check

After the measuring instrument has been installed, perform the following checks:
- Is the measuring instrument damaged (visual check)?
- Does the measuring instrument correspond to the measuring point specifications such as process temperature/pressure, ambient temperature, measuring range, etc.?
- Is the flange marking correctly aligned? (see Page 10 ff.)
- Have the flange screws been tightened up with the respective tightening torque?
- Are the measuring point number and labeling correct (visual check)?
- Is the measuring instrument adequately protected against rain and direct sunlight (see Page 74 ff.)?

4 Wiring

4.1 Quick wiring guide

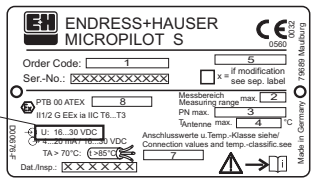
When grounding conductive screens, the corresponding directives EN 60079-14 and EN 1127-1 must be observed. Recommendation for safe grounding of conductive screens:

Wiring

Caution!

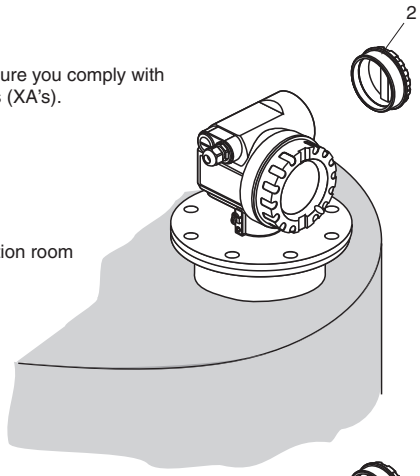
Before connection please note the following:

- The power supply must be identical to the data on the nameplate (1).
- Switch off power supply before connecting up the device.
- Connect Equipotential bonding to transmitter ground terminal before connecting up the device.
- Tighten the locking screw:
  It forms the connection between the antenna and the housing ground potential.



1

When you use the measuring system in hazardous areas, make sure you comply with national standards and the specifications in the safety instructions (XA's). Make sure you use the specified cable gland.



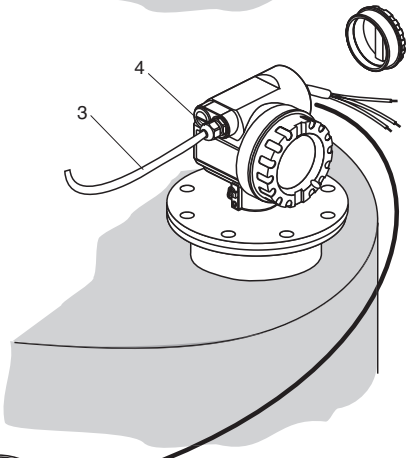
Connect up the Micropilot S as follows:

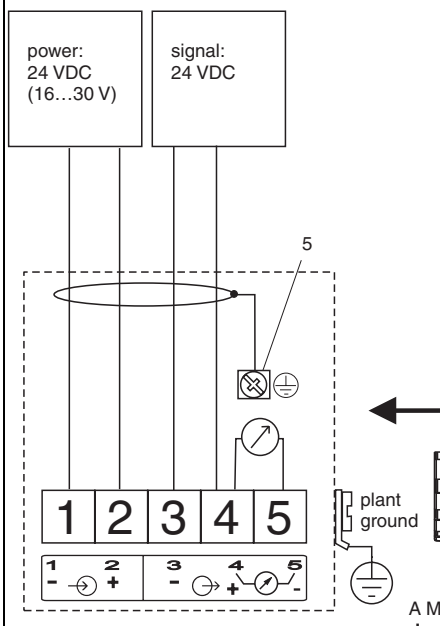
EX Before unscrew housing cover (2) at seperate connection room turn off the power supply!

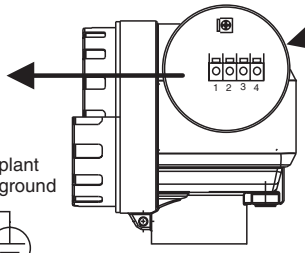
- Insert cable through gland (3).
  Use screened, twisted wire pair..

EX Only ground screening of the line (5) on sensor side.

- Make connection (see pin assignment).
- Tighten cable gland (4).
- Screw off housing cover (2).
- Switch on power supply.







A Micropilot S situated in a hazardous area is connected as a **single device** to a **power supply unit and transmitter** situated outside of the hazardous area. In this case, it is recommended that the screen be connected directly to the Micropilot at the housing's earth, whereby the Micropilot S and the power supply unit are connected to the same potential matching line (PML).

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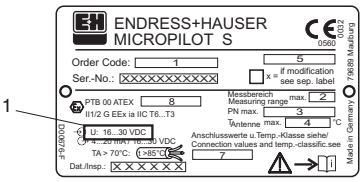
Wiring with Tank Side Monitor NRF 590

Caution!

Before connection please note the following:

- The power supply must be identical to the data on the nameplate (1).
- Switch off power supply before connecting up the device.
- Connect Equipotential bonding to transmitter ground terminal before connecting up the device.
- Tighten the locking screw:
  It forms the connection between the antenna and the housing ground potential.



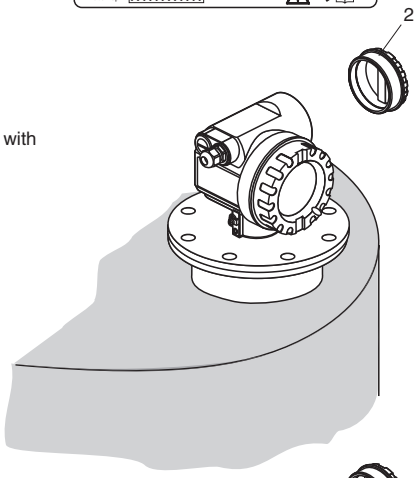
When you use the measuring system in hazardous areas, make sure you comply with national standards and the specifications in the safety instructions (XA's). Make sure you use the specified cable gland.

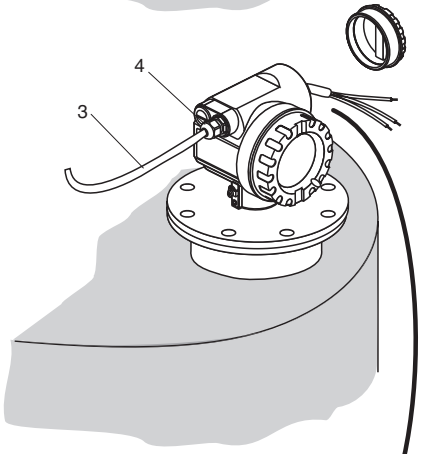
Connect up the Micropilot S as follows:

EX

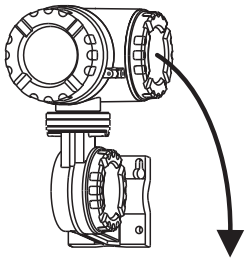
Before unscrew housing cover (2) at seperate connection room turn off the power supply!

- Insert cable through gland (3).
  Use screened, twisted wire pair.
- Make connection (see pin assignment).
- Tighten cable gland (4).
- Screw off housing cover (2).
- Switch on power supply.

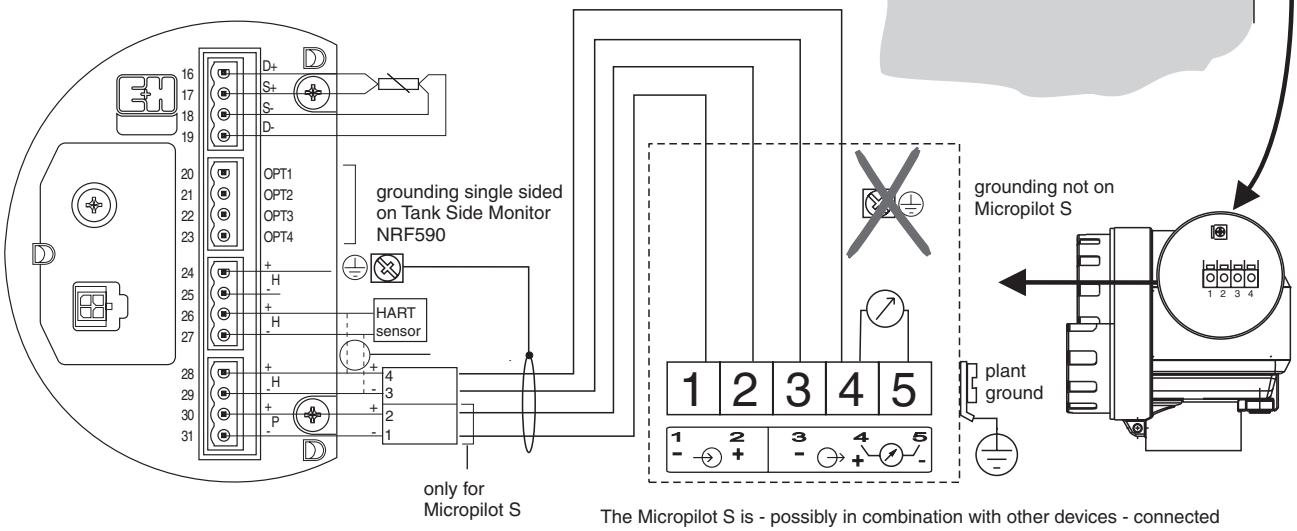




Tank Side Monitor NRF590



intrinsicaly safe terminal board



The Micropilot S is - possibly in combination with other devices - connected to a tank side monitor in a hazardous area. In this case, it is recommended that you ground the cable screen centrally at the **Tank Side Monitor** and connect all devices to the same potential matching line (PML). If, for functional reasons, a capacitive coupling is required between local earth and screen (multiple grounding), ceramic condensers with a dielectric strength of min. 1500 V_{eff} must be used, whereby the total capacitance of 10 nF must not be exceeded. Notes on grounding interconnected intrinsically safe devices are provided by the FISCO model.

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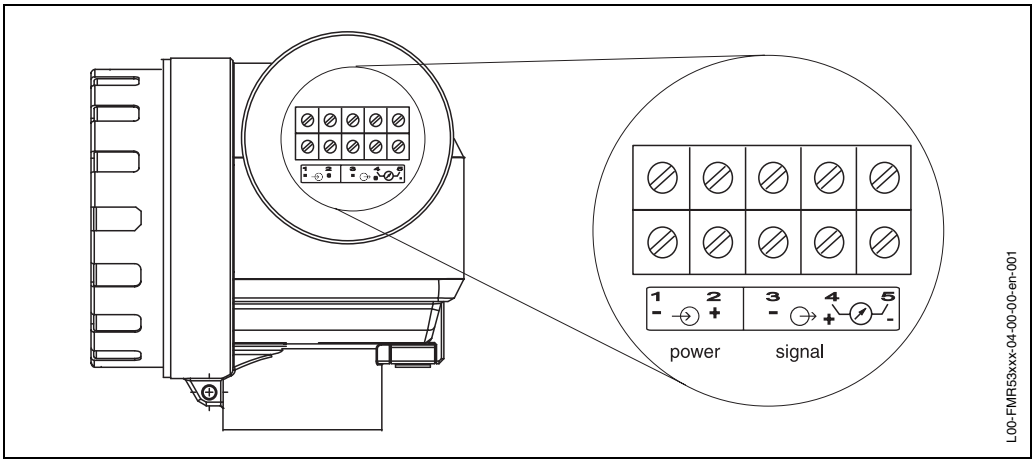
4.2 Connecting the measuring unit

Terminal compartment
The housing comes with a separate terminal compartment.



Load HART
Minimum load for Hart communication: 250 Ω

Cable entry
Cable gland: M20x1.5 or Pg13.5
Cable entry: G ½ or ½ NPT

Supply voltage
Direct current voltage: 16…36 VDC

.

Communication		Terminal voltage	minimal	maximal
Power supply	Standard	U (20 mA) =	16 V	36 V
	Ex	U (20 mA) =	16 V	30 V
Signal	Ex	U (4 mA) =	11,5 V	30 V
		U (20 mA) =	11,5 V	30 V

Power consumption
Max. 330 mW at 16 V, max. 500 mW at 24 V, max. 600 mW at 30 V.

Current consumption
Max. 21 mA (50 mA inrush current).

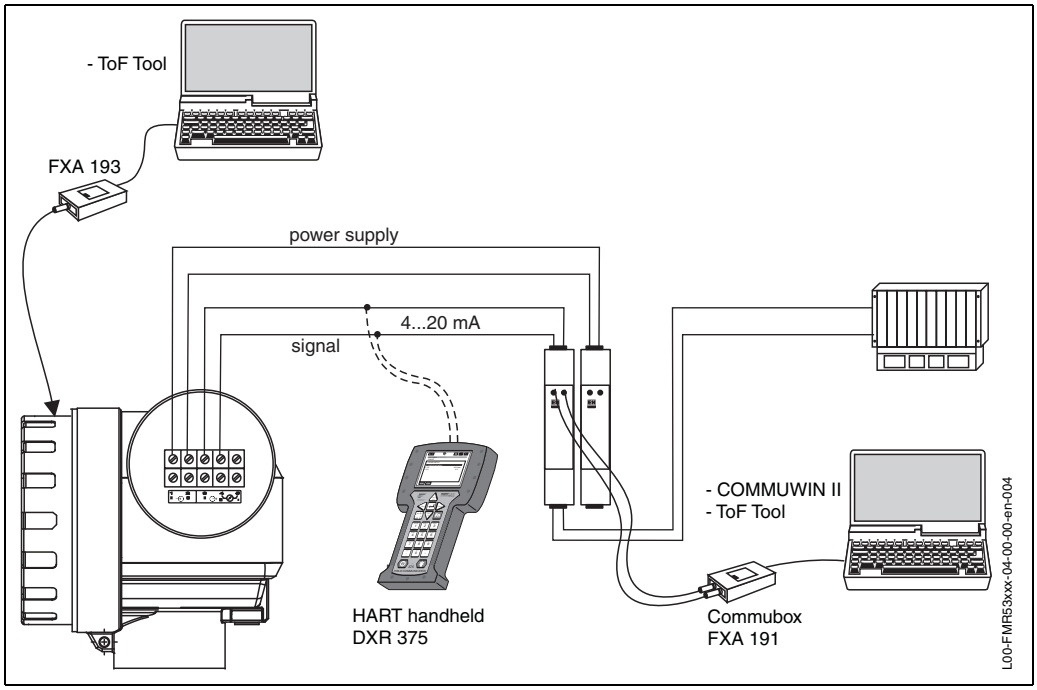
Power supply
For stand alone operation recommended via e.g. E+H RN 221 N.

mm accuracy
For measurements with mm accuracy the measured variable must be transmitted using HART protocol to ensure the necessary resolution.

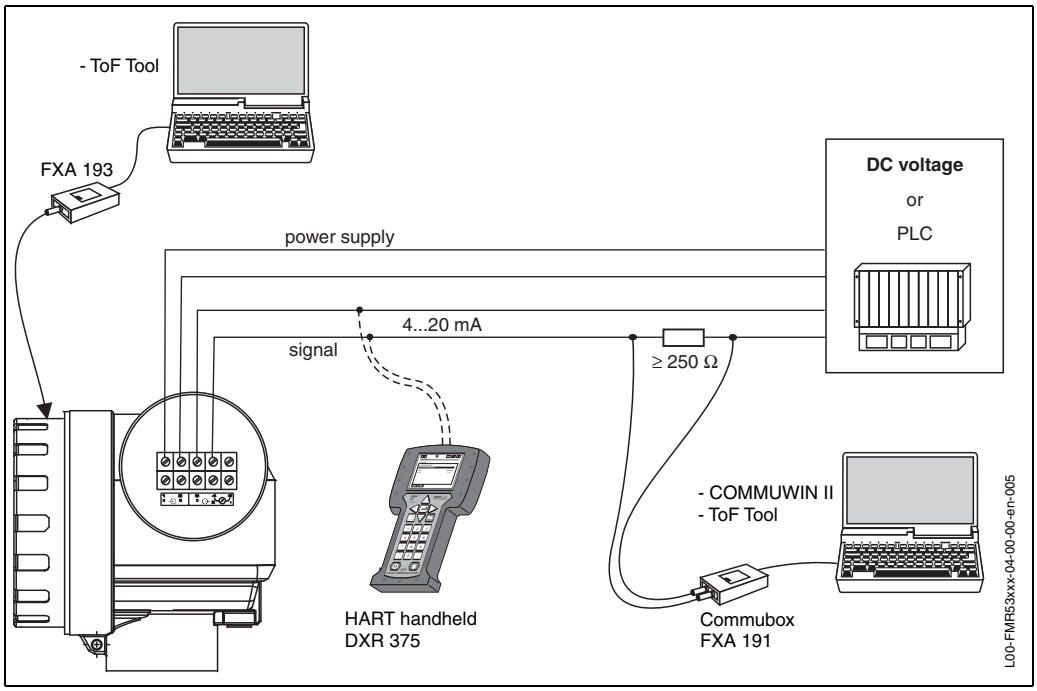
4.2.1 Connection to Tank Side Monitor NRF590

See Page 30.

4.2.2 HART connection with two E+H RN 221 N



4.2.3 HART connection with other supplies



Caution!
If the HART communication resistor is not built into the supply unit, it is necessary to insert a communication resistor of 250 Ω into the 2-wire line.

4.3 Equipotential bonding

Connect the Equipotential bonding to the external ground terminal of the transmitter.

Caution!
In Ex applications, the instrument must only be grounded on the sensor side. Further safety instructions are given in the separate documentation for applications in explosion hazardous areas.

4.4 Degree of protection

- housing: IP 65, NEMA 4X (open housing: IP20, NEMA 1)
- antenna: IP 68 (NEMA 6P)

4.5 Overvoltage protector

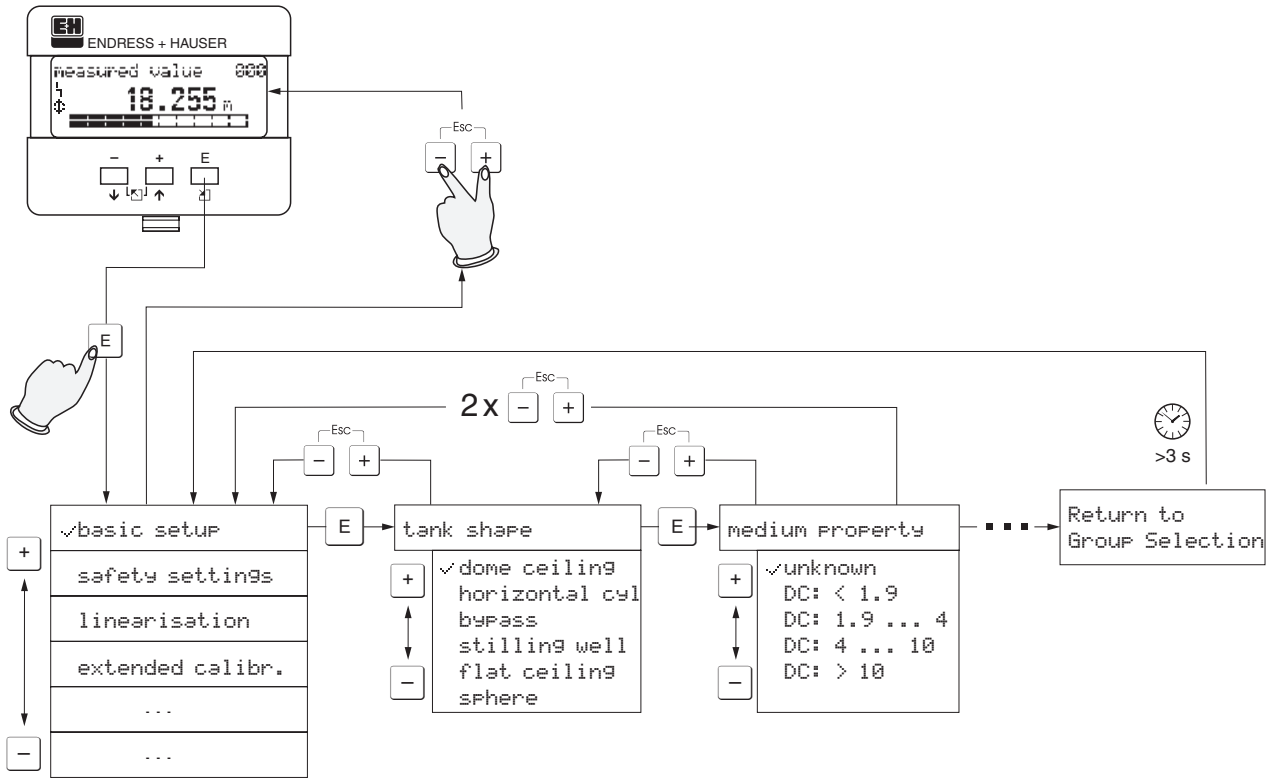
- The level transmitter FMR 53x is equipped with an internal overvoltage protector (600 Vrms electrode). Connect the metallic housing of the Micropilot FMR 53x to the tank wall directly with an electrically conductive lead to ensure reliable potential matching.
- Installation with additional overvoltage protector HAW 262 Z (see XA 081F-A "Safety instructions for electrical apparatus certified for use in explosion-hazardous areas").
  – Connect the external overvoltage protector and the Micropilot FMR 53x transmitter to the local potential matching system.
  – Potentials shall be equalised both inside and outside the explosion hazardous area.
  – The cable connecting the overvoltage protector and the Micropilot FMR 53x transmitter shall not exceed 1 m in length;
  – The cable shall be protected e.g. routed in an armoured hose.

4.6 Post-connection check

After wiring the measuring instrument, perform the following checks:
- Is the terminal allocation correct (see Page 29 ff.)?
- Is the cable gland tight?
- Is the housing cover screwed tight?
- If auxiliary power is available:
  Is the instrument ready for operation and does the liquid crystal display show any value?

5 Operation

5.1 Quick operation guide



Selection and configuration in Operation menu:

1.) Change from Measured Value Display to **Group Selection** by pressing E

2.) Press − or + to select the required **Function Group** (e.g.. "basic setup (00)") and confirm by pressing E ➜ First f**unction** (e.g. "tank shape (002)") is selected.

Note!
The active selection is marked by a ✓ in front of the menu text.

3.) Activate Edit mode with + or −.

Selection menus:

a) Select the required **Parameter** in selected **function** (e.g. "tank shape (002)") with − or +.
b) E confirms selection ➜ ✓ appears in front of the selected parameter
c) E confirms the edited value ➜ system quits Edit mode
d) + + − (= Esc) interrupts selection ➜ system quits Edit mode

Typing in numerals and text:

a) Press + or − to edit the first character of the **numeral / text** (e.g. "empty calibr. (005)")
b) E positions the cursor at the next character ➜ continue with (a) until you have completed your input
c) if a ↵ symbol appears at the cursor, press E to accept the value entered ➜ system quits Edit mode
d) + + − (= Esc) interrupts the input, system quits Edit mode

4) Press E to select the next **function** (e.g. "medium property (003)")

5) Press + + − (= Esc) once ➜ return to previous **function** (e.g. "tank shape (002)")
Press + + − (= Esc) twice ➜ return to **Group selection**

6) Press + + − (= Esc) to return to **Measured value display**

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5.1.1 General structure of the operating menu

The operating menu is made up of two levels:

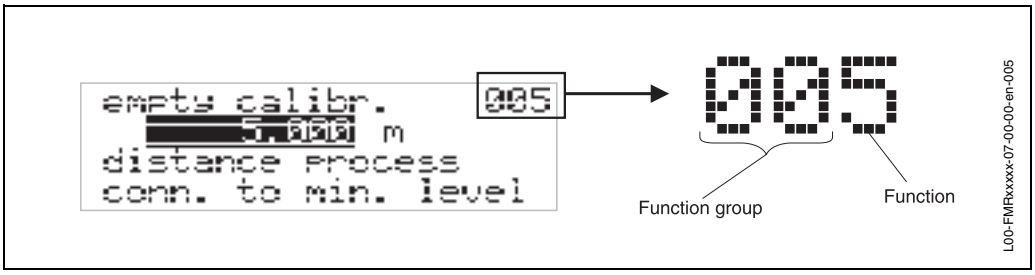
- **Function groups (00, 01, 03, …, 0C, 0D):**
  The individual operating options of the instrument are split up roughly into different function groups. The function groups that are available include, e.g.: "**basic setup**", "**safety settings**", "**output**", "**display**", etc.
- **Functions (001, 002, 003, …, 0D8, 0D9):**
  Each function group consists of one or more functions. The functions perform the actual operation or parameterisation of the instrument. Numerical values can be entered here and parameters can be selected and saved. The available functions of the "**basic setup (00)**" function group include, e.g.: "**tank shape (002)**", "**medium property (003)**", "**process cond. (004)**", "**empty calibr. (005)**", etc.

If, for example, the application of the instrument is to be changed, carry out the following procedure:

1. Select the "**basic setup (00)**" function group.
2. Select the "**tank shape (002)**" function (where the existing tank shape is selected).

5.1.2 Identifying the functions

For simple orientation within the function menus (see Page 90 ff.), for each function a position is shown on the display.



The first two digits identify the function group:

- **basic setup** **00**
- **safety settings** **01**
- **linearisation** **04**

…

The third digit numbers the individual functions within the function group:

- **basic setup** **00** →
  - **tank shape** **002**
  - **medium property** **003**
  - **process cond.** **004**

  …

Here after the position is always given in brackets (e.g. "**tank shape**" **(002)**) after the described function.

5.2 Display and operating elements

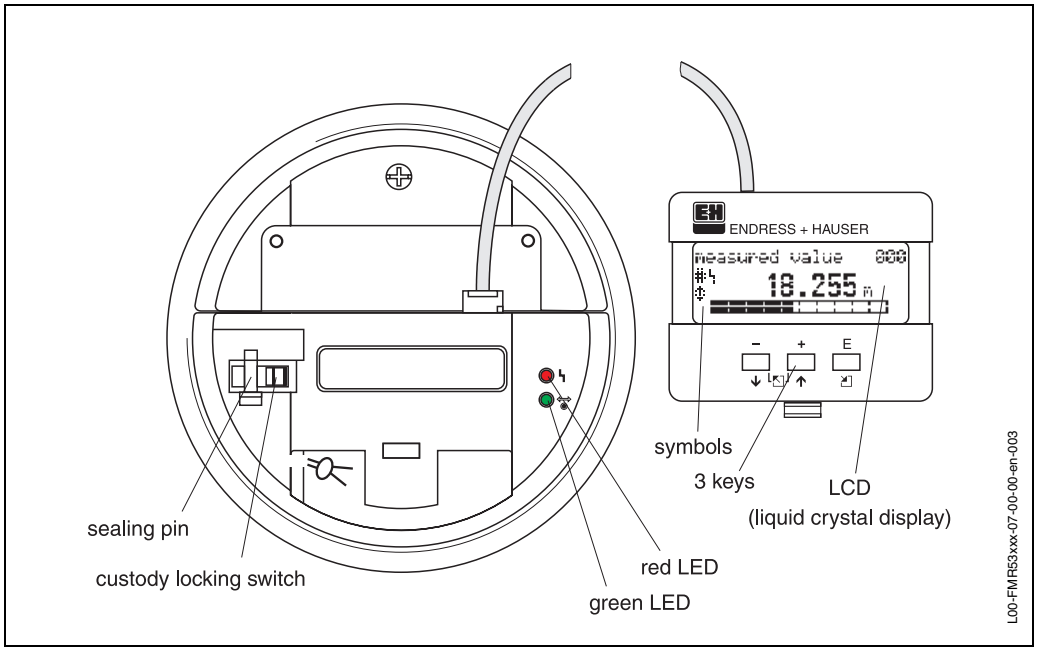


Fig. 5 Layout of the display and operating elements

5.2.1 Display

Liquid crystal display (LCD):
Four lines with 20 characters each. Display contrast adjustable through key combination.

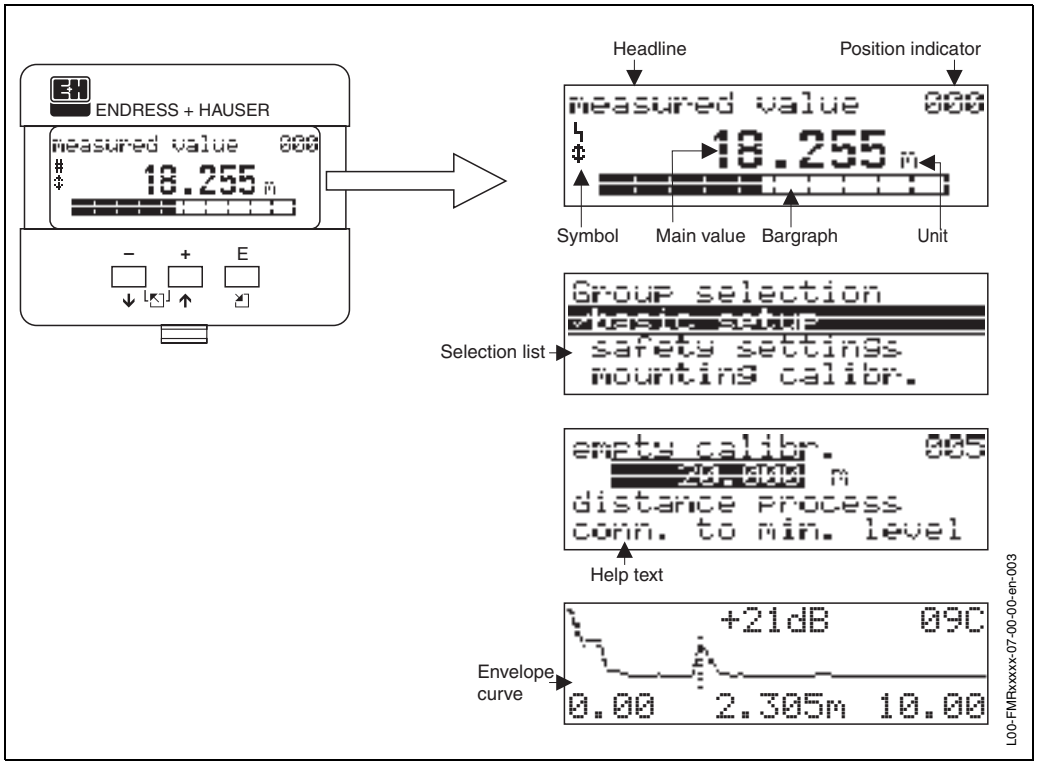


Fig. 6 Display

5.2.2 Display symbols

The following table describes the symbols that appear on the liquid crystal display:

Symbols	Meaning
	**ALARM_SYMBOL** This alarm symbol appears when the instrument is in an alarm state. If the symbol flashes, this indicates a warning.
	**LOCK_SYMBOL** This lock symbol appears when the instrument is locked,i.e. if no input is possible.
	**COM_SYMBOL** This communication symbol appears when a data transmission via e.g. HART, PFOFIBUS-PA or Foundation Fieldbus is in progress.
	**Calibration to regulatory standards disturbed** If the instrument is not locked or it cannot guarantee the calibration to regulatory standards, the situation will be indicated on the display via the symbol.

Tab. 1 Meaning of the symbols

Light emitting diods (LEDs):
There is a green and a red LED besides the Liquid Crystal Display.

LED	Meaning
red LED continuously on	Alarm
red LED flashes	Warning
red LED off	No alarm
green LED continuously on	Operation
Green LED flashes	Communication with external device

5.2.3 Key assignment

The operating elements are located inside the housing and are accessible for operation by opening the lid of the housing.

Function of the keys

Key(s)	Meaning
[+] or [↑]	Navigate upwards in the selection list Edit numeric value within a function
[−] or [↓]	Navigate downwards in the selection list Edit numeric value within a function
[Esc] [−] [+] or [←]	Navigate to the left within a function group
[E] or [E]	Navigate to the right within a function group, confirmation.
[+] and [E] or [−] and [E]	Contrast settings of the LCD
[+] and [−] and [E]	Hardware lock / unlock After a hardware lock, an operation of the instrument via display or communication is not possible! The hardware can only be unlocked via the display. An unlock parameter must be entered to do so.

Tab. 2 Function of the keys

Custody locking switch
Access to the electronics can be prevented by means of a custody locking switch that locks the device settings, cf fig. 4 on Page 36.
The custody locking switch can be sealed for custody transfer applications.

Software reliability
The software used in the radar instruments FMR 53x fulfills the requirements of OIML R85. This particularly includes:
- cyclical test of data consistency
- non-volatile memory
- segmented data storage

The radar instruments Micropilot S continuously monitor the compliance with accuracy requirements for custody transfer measurements according to OIML R85. If the accuracy cannot be maintained, a specific alarm is generated on the local display and via the digital communication

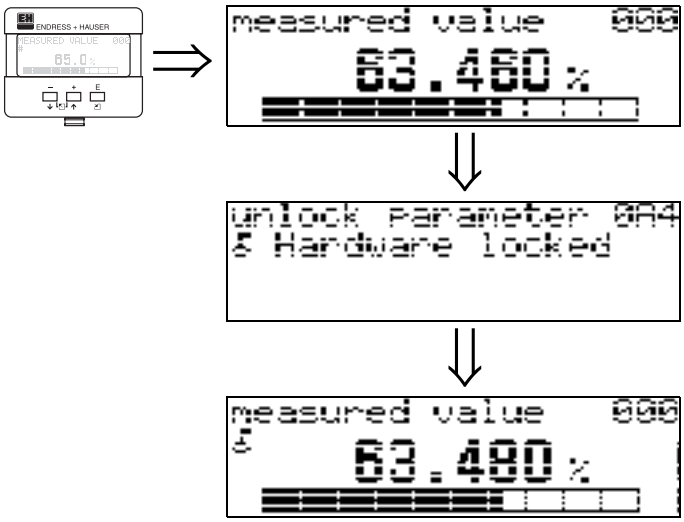
5.3 Local operation

5.3.1 Locking of the configuration mode

The Micropilot can be protected in two ways against unauthorised changing of instrument data, numerical values or factory settings:

"**unlock parameter**" **(0A4):**
A value **<> 100** (e.g. 99) must be entered in "**unlock parameter**" **(0A4)** in the "**diagnostics**" **(0A)** function group. The lock is shown on the display by the symbol and can be released again either via the display or by communication.

Hardware lock:
The instrument is locked by pressing the [+] and [−] and [E] keys at the same time. The lock is shown on the display by the symbol and can **only** be unlocked again via the display by pressing the [+] and [−] and [E] keys at the same time again. It is **not** possible to unlock the hardware by communication.
All parameters can de displayed even if the instrument is locked.



[+] and [−] and [E] press simultaneous

The LOCK_SYMBOL appears on the LCD.

5.3.2 Unlocking of configuration mode

If an attempt is made to change parameters when the instrument is locked, the user is automatically requested to unlock the instrument:

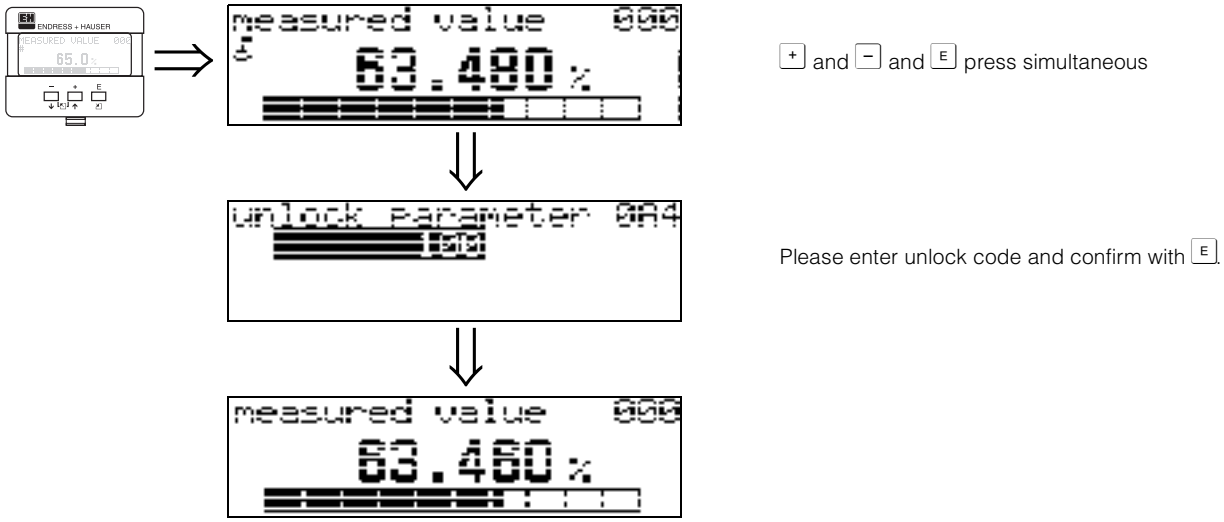
"**unlock parameter**" **(0A4):**
By entering the unlock parameter (on the display or via communication)

100 = for HART devices

the Micropilot is released for operation.

Hardware lock:
After pressing the [+] and [−] and [E] keys at the same time, the user is asked to enter the unlock parameter

100 = for HART devices.

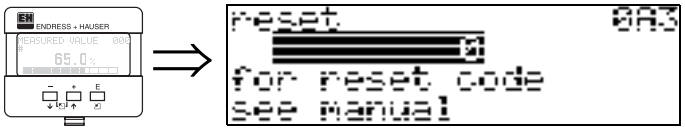


Caution!
Changing certain parameters such as all sensor characteristics, for example, influences numerous functions of the entire measuring system, particularly measuring accuracy. There is no need to change these parameters under normal circumstances and consequently, they are protected by a special code known only to the E+H service organization. Please contact Endress+Hauser if you have any questions.

5.3.3 Factory settings (Reset)

Caution!
A reset sets the instrument back to the factory settings. This can lead to an impairment of the measurement. Generally, you should perform a basic setup again following a reset.

A reset is only necessary:
- if the instrument no longer functions
- if the instrument must be moved from one measuring point to another
- if the instrument is being de-installed /put into storage/installed



User input ("reset" (0A3)):
- 333 = customer parameters
- 555 = History

333 = reset customer parameters
This reset is recommended whenever an instrument with an unknown 'history' is to be used in an application:
- The Micropilot is reset to the default values.
- The customer specific tank map is not deleted.
- A linearisation is switched to "**linear**" although the table values are retained. The table can be reactivated in the "**linearisation**" **(04)** function group.

List of functions that are affected by a reset:
- tank shape (002)
- empty calibr. (005)
- full calibr. (006)
- pipe diameter (007)
- output on alarm (010)
- output on alarm (011)
- outp. echo loss (012)
- ramp %span/min (013)
- delay time (014)
- safety distance (015)
- in safety dist. (016)
- Tank Gauging (030)
- Autokorrektur (031)
- level/ullage (040)
- linearisation (041)
- customer unit (042)
- diameter vessel (047)
- range of mapping (052)
- pres. Map dist (054)
- offset (057)
- low output limit (062)
- fixed current (063)
- fixed cur. value (064)
- simulation (065)
- simulation value (066)
- format display (094)
- distance unit (0C5)
- download mode (0C8)

555 = History Reset
After mounting and aligning the equipment, carry out a history reset before switching on the function "**auto correction**" **(031)** (see page 57).

The tank map can also be reset in the "**cust. tank map**" **(055)** function of the "**extended calibr.**" **(05)** function group.
This reset is recommended whenever an instrument with an unknown 'history' is to be used in an application or if a faulty mapping was started:
- The tank map is deleted. The mapping must be recommenced.

5.4 Display and acknowledging error messages

Type of error
Errors that occur during commissioning or measuring are displayed immediately on the local display. If two or more system or process errors occur, the error with the highest priority is the one shown on the display.
The measuring system distinguishes between two types of error:

- **A (Alarm):**
  Instrument goes into a defined state (e.g. MAX 22 mA)
  Indicated by a constant ϟ symbol.
  (For a description of the codes, see Table 9.2 on Page 76)
- **W (Warning):**
  Instrument continue measuring, error message is displayed.
  Indicated by a flashing ϟ symbol.
  (For a description of the codes, see Table 9.2 on Page 76)
- **E (Alarm / Warning):**
  Configurable (e.g. loss of echo, level within the safety distance)
  Indicated by a constant/flashing ϟ symbol.
  (For a description of the codes, see Table 9.2 on Page 76)

Error messages
Error messages appear as four lines of plain text on the display. In addition, a unique error code is also output. A description of the error codes is given on Page 76.

- The "**diagnostics (0A)**" function group can display current errors as well as the last errors that occurred.
- If several current errors occur, use [+] or [–] to page through the error messages.
- The last occurring error can be deleted in the "**diagnostics (0A)**" function group with the funktion"**clear last error**" **(0A2)**.

5.5 HART communication

Apart from local operation, you can also parameterise the measuring instrument and view measured values by means of a HART protocol. There are two options available for operation:
- Operation via the universal handheld operating unit, the HART Communicator DXR 375.
- Operation via the Personal Computer (PC) using the operating program (e.g. ToF Tool or Commuwin II) (For connections, see Page 32 ff.).
- Operation via the Tank Side Monitor NRF590.

5.5.1 Handheld unit DXR 375

All device functions can be adjusted via menu operation with the handheld unit DXR 375.

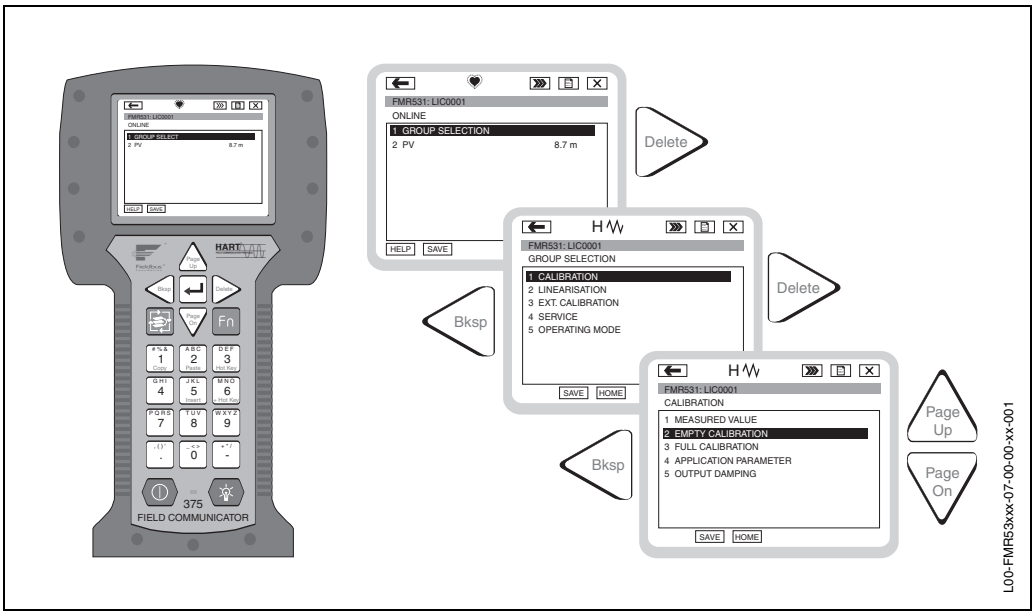


Fig. 7 Menu operation with the DXR 375 handheld instrument

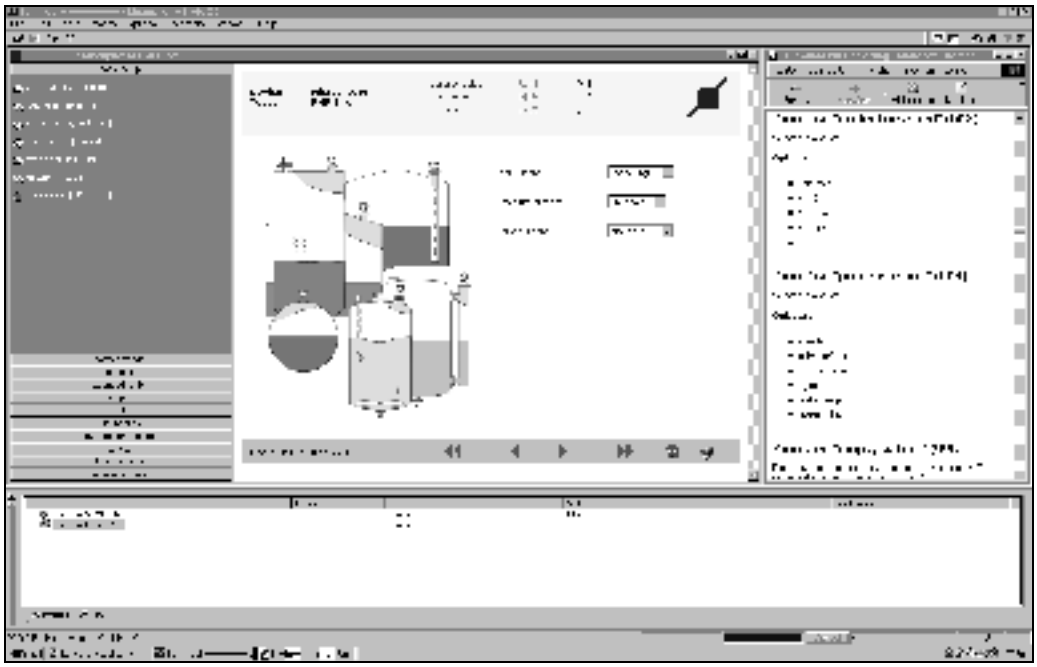
Note!
- Further information on the HART handheld unit is given in the respective operating manual included in the transport bag of the instrument.

5.5.2 ToF Tool operating program

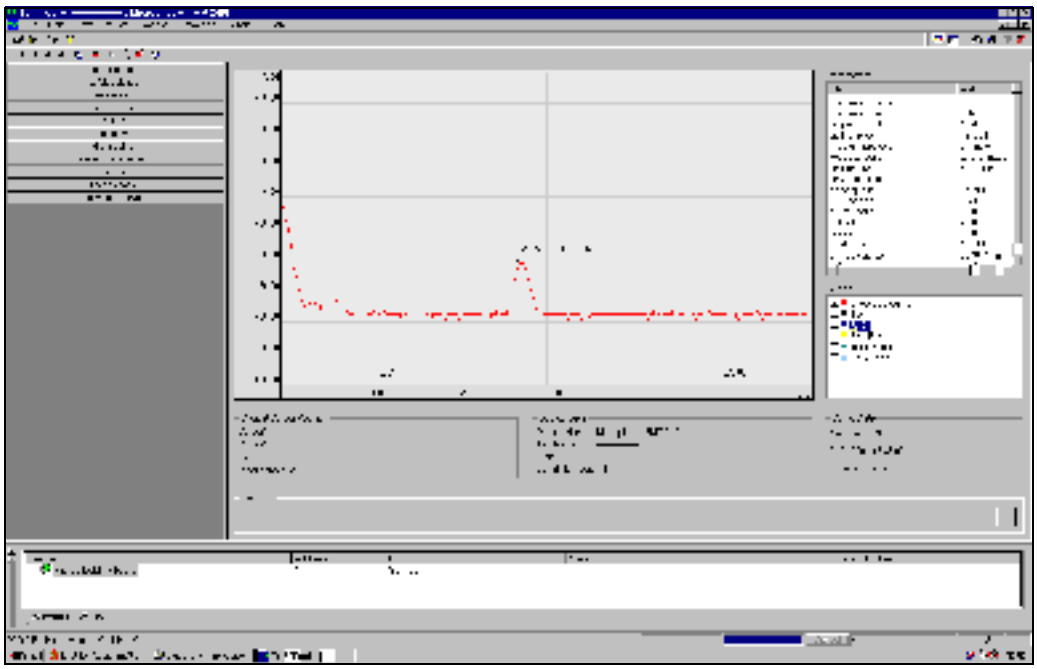
The ToF Tool is a graphical operating software for instruments from Endress+Hauser that operate based on the time-of-flight principle. It is used to support commissioning, securing of data, signal analysis and documentation of the instruments. It is compatible with the following operating systems: Win95, Win98, WinNT4.0, Win2000 and Windows XP.
The ToF Tool supports the following functions:
- Online configuration of transmitters
- Signal analysis via envelope curve
- Loading and saving of instrument data (Upload/Download)
- Documentation of measuring point

Note!
Further information you may find on the CD-ROM, which is enclosed to the instrument.

Menu-guided commissioning



Signal analysis via envelope curve



Connection options:
- Service-interface with adapter FXA 193 (see Page 32)
- HART with Commubox FXA 191 (see Page 32)

5.5.3 Commuwin II-Operating Programm

Commuwin II is an operating software with graphical support for intelligent transmitters with the communication protocols Rackbus, Rackbus RS 485, INTENSOR, HART or PROFIBUS-PA. It is compatible with the operating systems Win 3.1/3.11, Win95, Win98 and WinNT4.0. All functions of Commuwin II are supported. The configuration is made via operating matrix or graphic surface. A envelope curve can be displayed in ToF Tool.

Note!
Further information on Commuwin II is given in the following E+H documentation:
- System Information: SI 018F/00/en “Commuwin II”
- Operating Manual: BA 124F/00/en “Commuwin II” operating program

Connection
The table provides an overview of the Commuwin connections.

Interface	Hardware	Server	Device list
HART	Commubox FXA 191 to HART Computer with RS-232C interface	HART	Connected instrument
	Interface FXN 672 Gateway for MODBUS, PROFIBUS, FIP, INTERBUS, etc. Computer with RS-232C interface or PROFIBUS card	ZA 673 for PROFIBUS ZA 672 for other	List of all rack bus modules: the required FXN 672 must be selected

Note!
The Micropilot S can also be operated locally using the keys. If operation is prevented by the keys being locked locally, parameter entry via communication is not possible either.

6 Commissioning

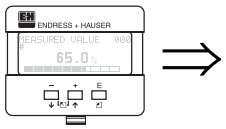
6.1 Function check

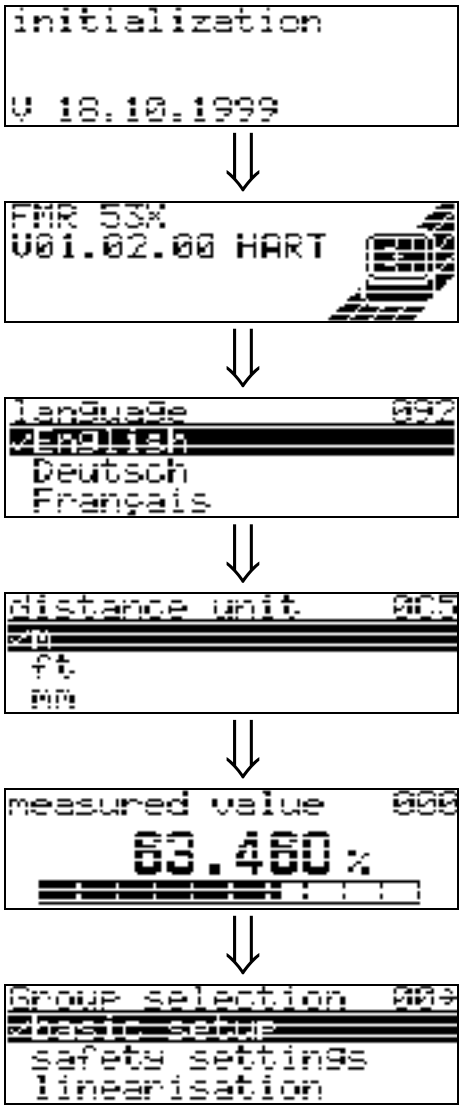
Make sure that all final checks have been completed before you start up your measuring point:
- Checklist “Post installation check” (see Page 28 ff.).
- Checklist “Post connection check” (see Page 33 ff.).

6.2 Commissioning

6.2.1 Switching on the measuring device

When the instrument is switched on for the first time, the following messages appear on the display:





After 5 s, the following message appears

After 5 s or after you have pressed [E] the following message appears

Select the language
(this message appears the first time the instrument is switched on)

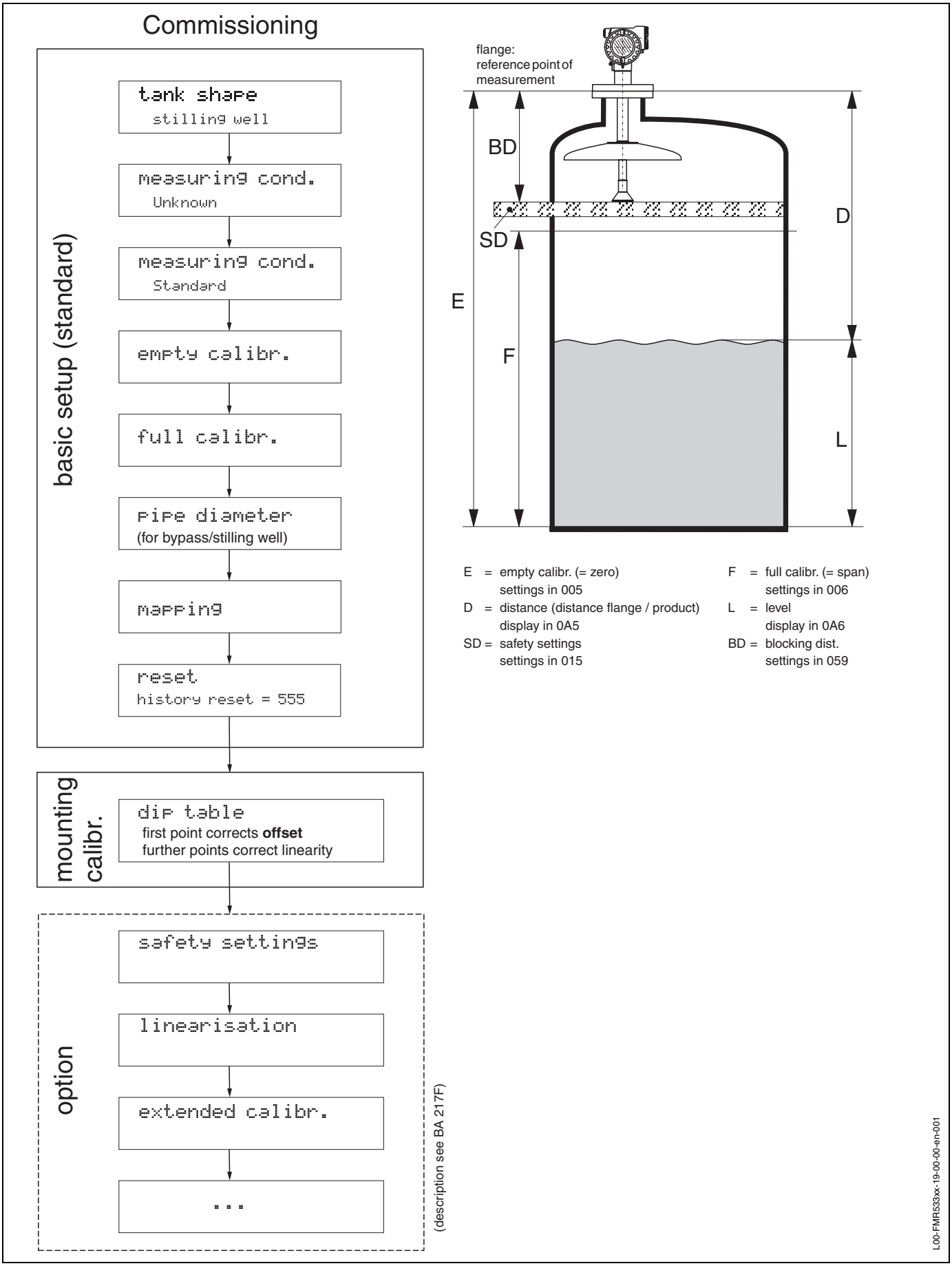
Select the basic unit
(this message appears the first time the instrument is switched on)

The current measured value is displayed

After [E] is pressed, you reach the group selection.

This selection enables you to perform the basic setup

6.3 Basic Setup



To successfully commission a precise measurement to the nearest mm, it is important you carry out a **history reset** on **first installation** after mechanical installation and **after** the basic setup of the device (see Page 56). Only after a history reset the **mounting calibration** is carried out. Enter the measurement **offset** as the first point in the dip table for the mounting calibration. When a value is dipped at a later date, make a second entry into the dip table, again using the semi-automatic mode. This way, you can easily carry out a **linearisation** of the measurement.
When configuring the function in "**basic setup**" **(00)** please take into account the following notes:

- Select the functions as described on Page 34.
- Some functions can only be used depending on the parameterisation of the instrument. For example, the pipe diameter of a stilling well can only be entered if **"stilling well"** was selected beforehand in the "**tank shape**" **(002)** function.
- Certain functions (e.g. starting an interference echo mapping (053)) prompt you to confirm your data entries. Press [+] or [−] to select "**YES**" and press [E] to confirm. The function is now started.
- If you do not press a key during a configurable time period (→ function group "display (09)"), an automatic return is made to the home position (measured value display).

Note!

- The instrument continues to measure while data entry is in progress, i.e. the current measured values are output via the signal outputs in the normal way.
- If the envelope curve mode is active on the display, the measured values are updated in a slower cycle time. Thus, it is advisable to leave the envelope curve mode after the measuring point has been optimised.
- If the power supply fails, all preset and parameterised values remain safely stored in the EEPROM.

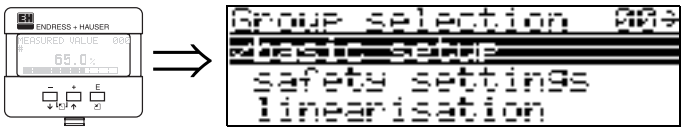
Caution!
All functions are described in detail, as is the overview of the operating menu itself, in the manual **"Description of the instrument functions – BA 217F"**, which is a separate part of this operating manual.

6.4 Basic Setup with the VU 331

Function "measured value" (000)

This function displays the current measured value in the selected unit (see "**customer unit**" **(042)** function). The number of digits after decimal point can be selected in the "**no.of decimals**" **(095)** function. The length of the bargraph corresponds to the percental value of the present measured value with regard to the span.

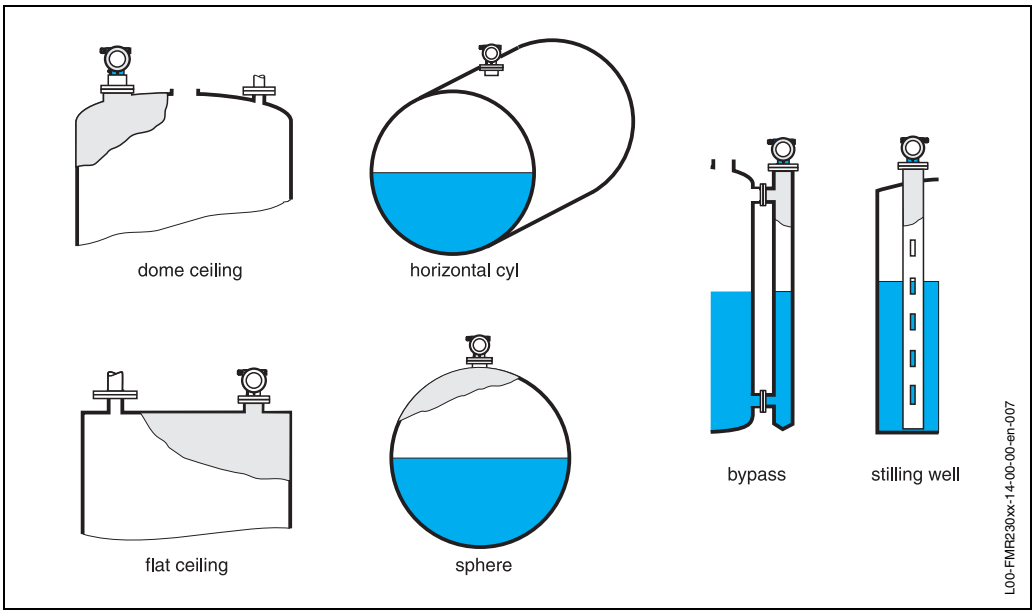
6.4.1 Function group "basic setup" (00)

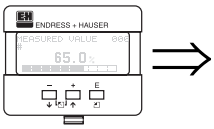


Function "tank shape" (002)

This function is used to select the tank shape.

Selection:
- dome ceiling
- horizontal cyl
- bypass
- stilling well
- **flat ceiling** (Typical ceiling of storage tanks: a slight slope of only a few degrees can be neglected.)
- sphere





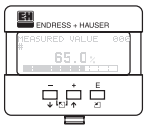
Function "medium property" (003)

This function is used to select the dielectric constant.

Selection:
- **unknown**
- < 1.9
- 1.9 ... 4
- 4 ... 10
- > 10

Product class	DK (εr)	Examples
A	1,4 … 1,9	non-conducting liquids, e.g. liquefied gas [2)]
B	1,9 … 4	non-conducting liquids, e.g. benzene, oil, toluene, …
C	4 … 10	e.g. concentrated acids, organic solvents, esters, aniline, alcohol, acetone, …
D	> 10	conducting liquids, e.g. aqueous solutions, dilute acids and alkalis

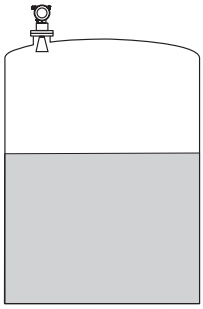
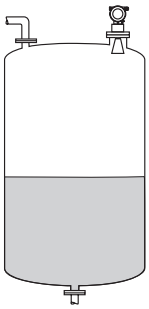
2) Treat Ammonia NH3 as a medium of group A, i.e. always use a stilling well.



Function "process cond." (004)

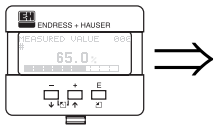
This function is used to select the process conditions.

Selection:
- **standard**
- calm surface
- turb. surface
- agitator
- fast change
- test:no filter

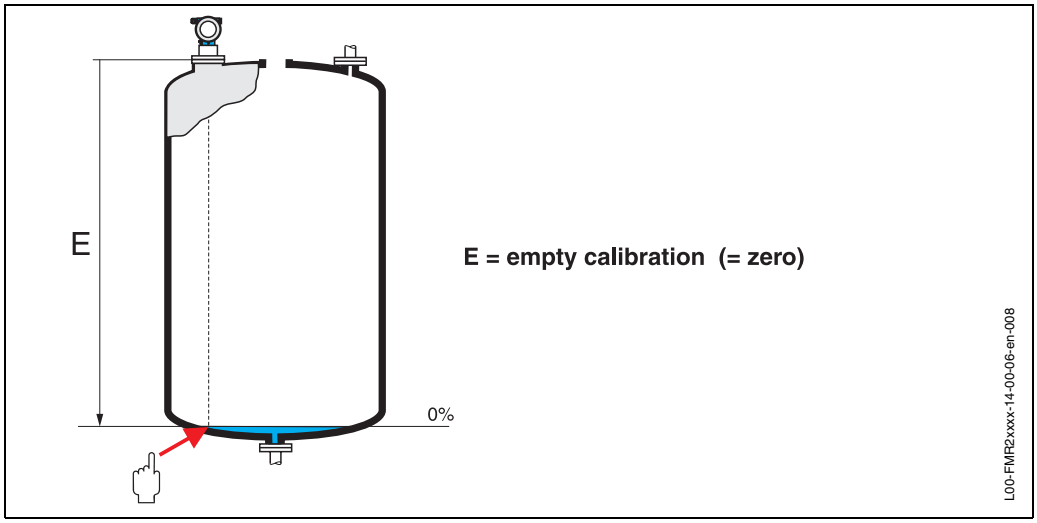
standard	**calm surface**
For all applications that do not fit into any of the following groups.	Storage tanks with immersion tube or bottom filling
	
The filter and output damping are set to average values.	The averaging filters and output damping are set to high values. -> steady meas. value -> precise measurement -> slower reaction time

Note!
The phase evaluation of the Micropilot S (see »Function "auto correction" (031)« on page 57) is only activated if you select the measuring conditions "**standard**" or "**calm surface**". We strongly recommend that, in the case of rough product surfaces or rapid filling, you activate the appropriate application parameters.

Function "empty calibr." (005)

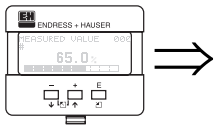


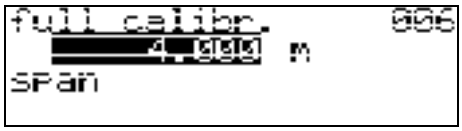
This function is used to enter the distance from the flange (reference point of the measurement) to the minimum level (=zero).



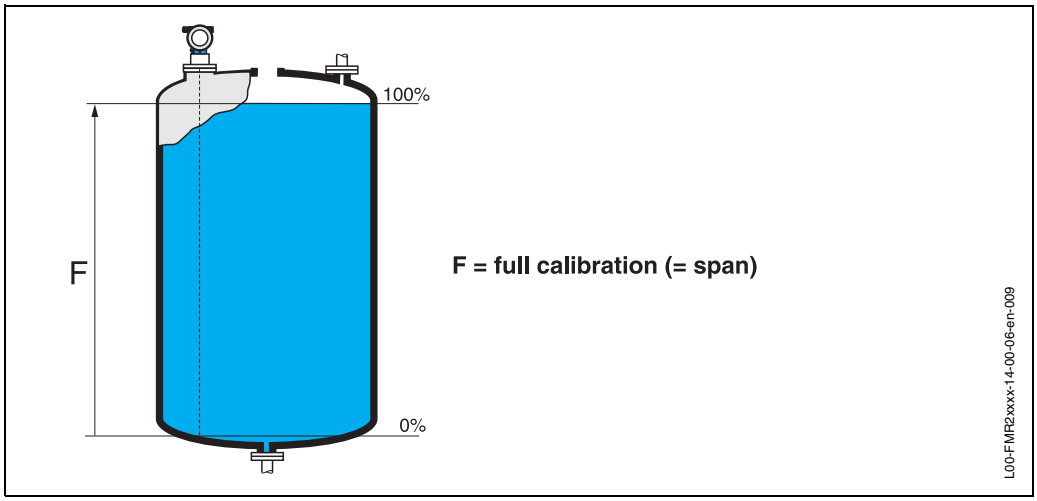
Caution!
For dish bottoms or conical outlets, the zero point should be no lower than the point at which the radar beam hits the bottom of the tank.

Function "full calibr." (006)





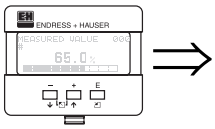
This function is used to enter the distance from the minimum level to the maximum level (=span).



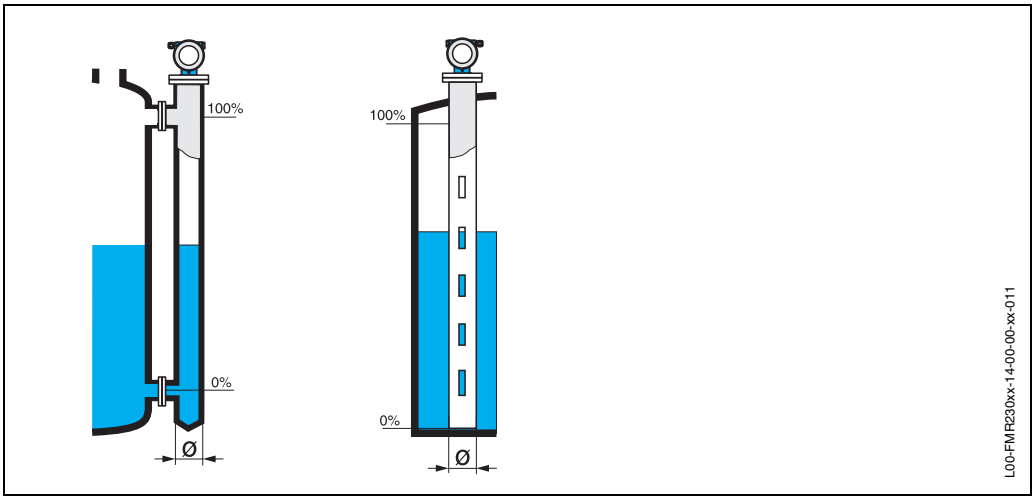
In principle, it is possible to measure up to the tip of the antenna. However, due to considerations regarding corrosion and build-up, the end of the measuring range should not be chosen any closer than 50 mm (2”) to the tip of the antenna.

Note!
If **bypass** or **stilling well** was selected in the "**tank shape**" **(002)** function, the pipe diameter is requested in the following step.

Function "pipe diameter" (007)

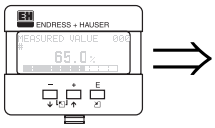


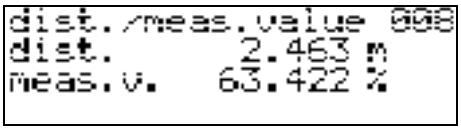
This function is used to enter the pipe diameter of the stilling well or bypass pipe.



Microwaves propagate slower in pipes than in free space. This effect depends on the inside diameter of the pipe and is automatically taken into account by the Micropilot. It is only necessary to enter the pipe diameter for applications in a bypass or stilling well.

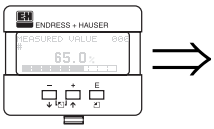
Function "dist./ meas. value (008)"

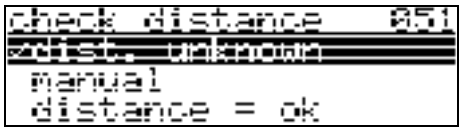




The **distance** measured from the reference point to the product surface and the **level** calculated with the aid of the empty adjustment are displayed. Check whether the values correspond to the actual level or the actual distance. The following cases can occur:

- Distance correct – level correct -> continue with the next function, "**check distance**" **(051)**
- Distance correct – level incorrect -> Check "**empty calibr.**" **(005)**
- Distance incorrect – level incorrect -> continue with the next function, "**check distance**" **(051)**



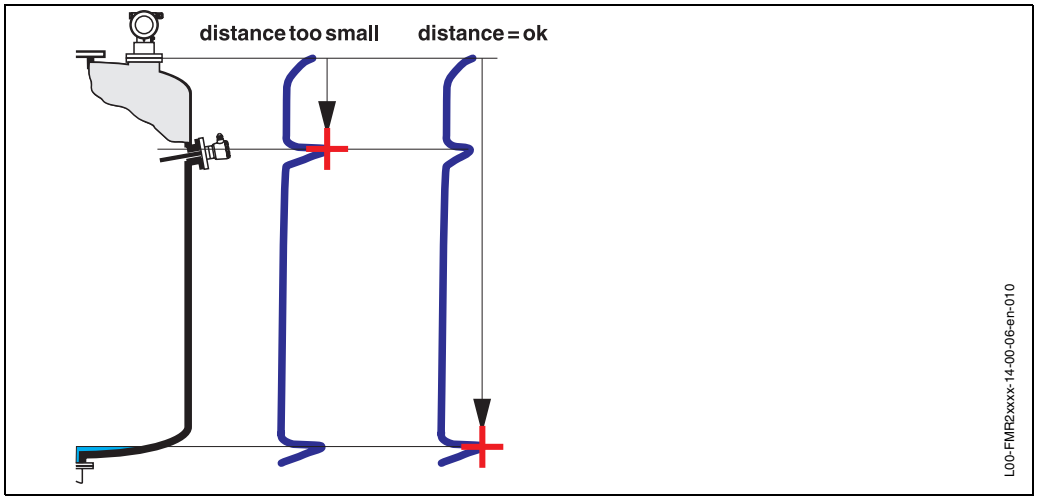


Function "check distance" (051)

This function triggers the mapping of interference echoes. To do so, the measured distance must be compared with the actual distance to the product surface. The following options are available for selection:

Selection:

- distance = ok
- dist. too small
- dist. too big
- **dist. unknown**
- manual



distance = ok

- mapping is carried out up to the currently measured echo
- The range to be suppressed is suggested in the "**range of mapping (052)**" function

Anyway, it is wise to carry out a mapping even in this case.

dist. too small

- At the moment, an interference is being evaluated
- Therefore, a mapping is carried out including the presently measured echoes
- The range to be suppressed is suggested in the "**range of mapping (052)**" function

dist. too big

- This error cannot be remedied by interference echo mapping
- Check the application parameters **(002), (003), (004)** and "**empty calibr.**" **(005)**

dist. unknown

If the actual distance is not known, no mapping can be carried out.

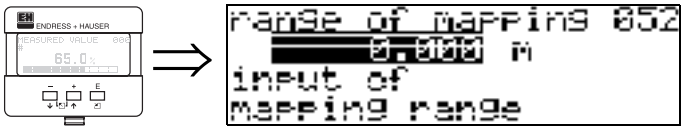
manual

A mapping is also possible by manual entry of the range to be suppressed. This entry is made in the "**range of mapping (052)**" function.

Caution!

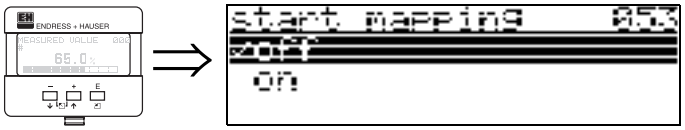
The range of mapping must end 0.5 m (20") before the echo of the actual level. For an empty tank, do not enter E, but E – 0.5 m (20").

Function "range of mapping" (052)



This function displays the suggested range of mapping. The reference point is always the reference point of the measurement (see Page 47 ff.). This value can be edited by the operator.
For manual mapping, the default value is: 0 m.

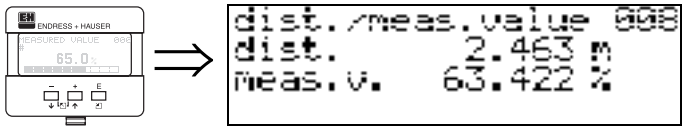
Function "start mapping" (053)



This function is used to start the interference echo mapping up to the distance given in "**range of mapping**" **(052)**.

Selection:
- **off**: no mapping is carried out
- on: mapping is started

Display "dist./meas.value (008)"



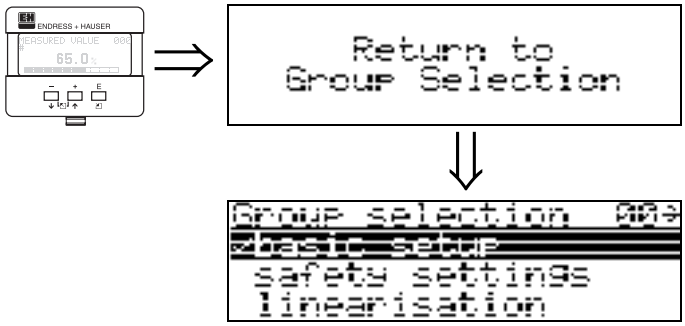
The distance measured from the reference point to the product surface and the level calculated with the aid of the empty alignment are displayed again. Check whether the values correspond to the actual level or the actual distance. The following cases can occur:

- Distance correct – level correct -> basic setup completed
- Distance incorrect – level incorrect -> a further interference echo mapping must be carried out "**check distance**" (**051)**.
- Distance correct – level incorrect -> check "**empty calibr.**" **(005)**

Function "history reset" (009)

By this function a history reset of the device is performed, i.e. the correspondance table between level an index values is deleted. A new correspondance table will be filled and stored after the history reset, cf. Page 57.

Caution!
Perform only after first installation (see »Function "auto correction" (031)« on page 57). In this case also effect a reset of the dip table in function "**dip table mode**" **(033)**.

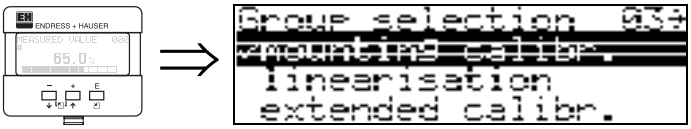


After 3 s, the following message appears

Note!
After basic calibration, it is wise to evaluate the measurement using the envelope curve (function group "**display**" **(09)**).

6.5 Mounting calibration with VU 331

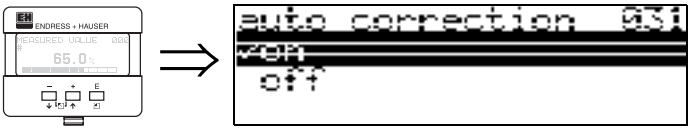
6.5.1 Function group "mounting calibr." (03)



Function "tank gauging" (030)

Using this function, you can either enter a dip table or carry out an auto-correction.

Function "auto correction" (031)



When measuring levels with radar systems, so-called "multipath reflections" can affect the level signal giving rise to serious measuring errors. "Multipath reflections" also include radar beams which are received by the radar system, which have not been reflected directly by the medium surface. They may reach the antenna via the basin wall and the medium surface. This phenomenon is particularly noticeable with devices mounted near to walls, as soon as the conical radar beam strikes the basin wall.
The Micropilot S can automatically discover and correct measuring errors due to this "multiple path" propagation. This is because it uses two independent sets of information when evaluating reflection signals:

- Firstly, it evaluates the **amplitude** of the reflected energy using the so-called envelope curve system.
- Secondly, it evaluates the **phase** of the reflected energy.

The decisive factor for a constant output signal is to assign the phase values to the associated level values. This assignment is ensured using a correspondence table (index correction table). The Micropilot S learns this for the specific application after installation (learning period).
Therefore, after mounting the device, and **after** completing the basic calibration, a **history reset** must be performed (enter "**yes**" in the "**history reset**" **(009)** function in the "**basic setup** " **(00)** function group).
We advise you not to switch off the radar system during filling and emptying operations during the teach-in phase. Switching off when there are only negligible level changes produces no error.

Caution!
During the learning period, fast filling/emptying or turbulent surfaces can result in switching off and on the phase evaluation. Subsequently observed measurement errors will disappear as soon as tank levels come back to areas measured by Micropilot S previously with activated phase evaluation. If the observed measurement errors are correted by dip table entries, the Micropilot S will take care of these corrections and automatically adjust the index correction table. Do NOT correct any settings in the basic calibration or the extended calibration.

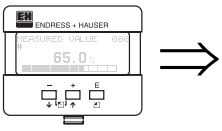
Note!
Immediately after installation, the Micropilot S measures with the specified mm-accuracy. Until the level range has been completely covered by the medium (setting up the correction table), the maximum permissible filling speed is 100 mm level change / min. After this, the fill speed has no limitation.

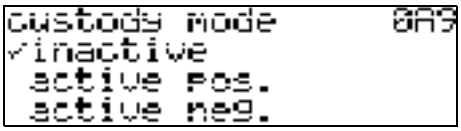
Function"pipe diam. corr." (032) (only relevant for FMR 532)

For level measurement in stilling wells, radar systems require highly precise pipe inner diameter data. An mm-exact level measurement cannot be guaranteed for deviations from the actual stilling well inner diameter of more than ± 0.1mm to the value entered in the function group "**basic setup**" **(00)**. The errors which occur as a result are linear and can be corrected with a dip table containing at least two entries.
The Micropilot S FMR 53x also has an automatic pipe inner diameter correction. This adjusts the entered stilling well inner diameter (input in the function group "**basic setup**" **(00)**) to the actual values. However, this presupposes that the value entered in the function group "**basic setup**" **(00)** matches the actual pipe inner diameter accurately as possible. The pipe diameter calculated by the instrument is contained in the service line "**Algorithms1 / Field present PD**". The user-defined value entered in the function group "**basic setup**" **(00)** can be corrected with this value. A permanently activated pipe diameter correction automatically accepts this value. After switching off the instrument, wait for a fill change of approx. 1 m until the value adjusts itself to the diameter given by the instrument, based on the user-defined input value.

Note!
Only if the **"pipe diameter" (007)** function has changed its value, it is necessary to perform a "**history reset**" **(009)** and to delete the dip table after activation of the **"pipe diam. corr." (032)** function. Otherwise the level change of 5 m has not yet been exceeded. The **"pipe diam. corr." (032)** function must be deactivated again and the procedure should be repeated at a later point of time.

Display "custody mode" (0A9)





This indicates the instrument calibration mode. The calibration mode (active) can be set using the hardware security lock on the electronics (see Page 36).

Selection:
- **inactive**
- active pos.
- active neg.

active pos.
The custody mode (instrument is lead-sealed and accurate to the nearest mm) is active and is held.

active neg.
Custody mode (instrument is lead-sealed and accurate to the nearest mm) is activated and not held, e.g. because the signal-to-noise ratio is less than 10 dB (refer to function "**echo quality**" **(056)** in the function group "**extended calibr.**" **(05)**).

Caution!
After entering all the values and completing mounting and aligning work, enter the Reset Code "**555**" in the function "**reset**" **(0A3)** to reset the instrument history for auto-correction.

Dip table
The dip table is used to correct the level readings of the Micropilot S using independently taken hand dips. The dip table is used in particular to adapt the level gauge to the specific application conditions as mechanical offset and tank/stilling well design.
Depending on national regulations, national inspectors will dip the tank at one to three levels during a calibration run and check the level readings.
Only one value pair must be entered into the dip table to correct the measurement **offset**.
If a second value pair is entered into the dip table, the Micropilot S accepts the corrected measured values identically for both value pairs. All other measured values are determined by linear extrapolation.
If you enter more than two value pairs, the system carries out a linear interpolation between adjacent value pairs. Outside these value pairs, extrapolation is also linear.

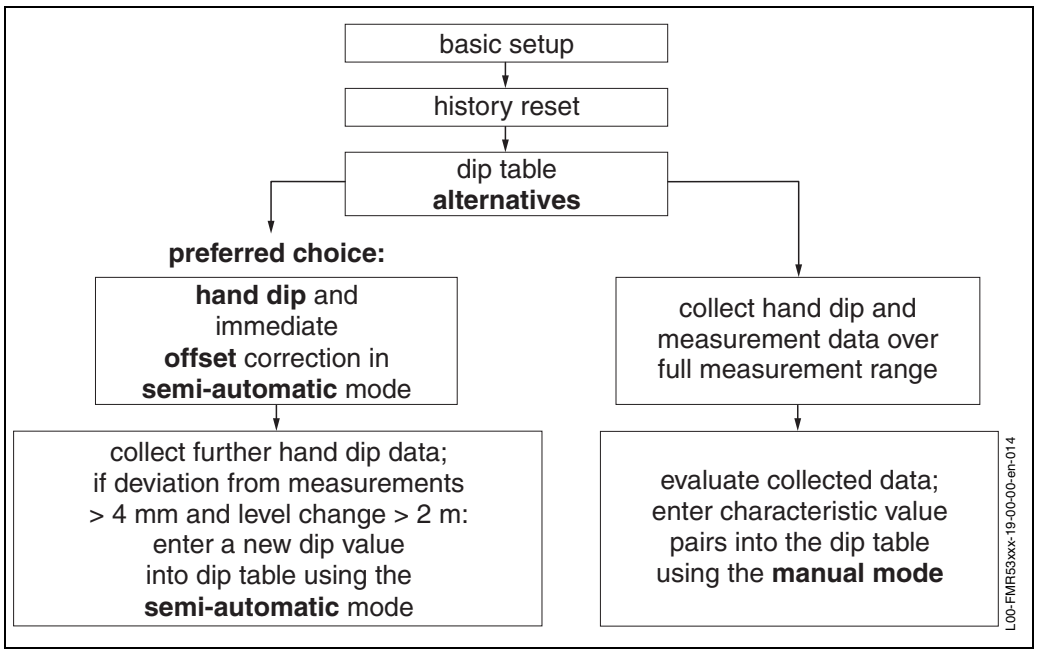


Fig. 8 Alternative procedures to fill the dip table.

To collect and enter data into the dip table, two alternative procedures may be carried out. In order not to mix up measurement values corrected by the offset or linearisation of the dip table with uncorrected measurement values, it is recommended to use the semi-automatic mode of the dip table to enter new data pairs. In this case, the first dip value should be entered immediately after the basic calibration. Further linearization points should be entered only after a level change of at least 2 m (cf. Fig. 8, preferred choice) and a deviation between the "uncorrected measurement value" and the hand dip value of at least 4mm.
If this procedure can not be followed, then **NO** value pair should be entered into the dip table after basic calibration. Measurement data and hand dip values should be collected over the full measurement range and be evaluated with regard to a good linear fit. Only then characteristic value pairs should be entered into the dip table using the "manual mode" (cf. Fig. 8, right side). If further linearisation is needed, further hand dip values should be entered **using only the "semi-automatic mode"**.

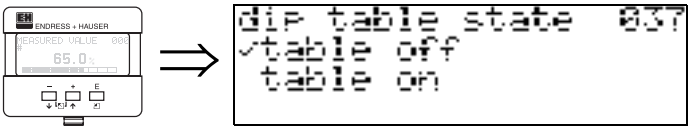
Note!
The offset should NOT be determined and entered within the close range of the antenna (conf. definition of the safety distance) or immediately in the range of the tank bottom, because within these ranges interferences of the radar signal may occur.

Note!
The dip table can be printed out using the ToF-Tool. Before doing this, the ToF Tool must be reconnected to the instrument in order to update the values within the ToF Tool.

Note!
Make your inputs into the dip table in semi-automatic mode. We advise you to leave "**auto correction**" **(031)** activated ("on") while you enter your inputs.

Caution!
After entering one or more points into the dip table, make sure that the dip table is activated and left in the "**table on**" dip table mode.

Function "dip table state" (037)



This function displays the dip table status.

Display:
- table on
- **table off**

table on
Indicates whether the dip table is active.

table off
Indicates whether the dip table is not active.

Function "dip table mode" (033)

The dip table can be switched on or off using this function.

Selection:
- manual
- semi-automatic
- table on
- **table off**
- clear table
- view

manual
The value pairs in the dip table can be read and written. You can enter the measured value and the dip value.
- uncorrected measured value:
  This is the measured value supplied by the instrument, **NOT** corrected by the dip table. The choice of measured value, level or remaining fill height is dependent on the instrument setting.
- Dip value:
  This is the level or distance to flange respectively, given by the hand dip. This value should be used to correct the measured value.
  The "manual mode" of the dip table can be used to enter collected data after a series of data pairs taken at different tank levels.

Note!
The bigger the distance between the different levels while taking hand dips, the more accurate the linearisation of the dip table will be.

semi-automatic
The value pairs in the dip table can be read. You can enter the dip value only. When there are new value pairs, the current level or distance is accepted as the measured value.

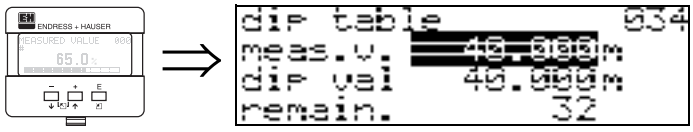
table on
The dip table is switched on.

table off
The dip table is switched off.

clear table
The complete dip table is deleted. The table is switched off. The number of free table entries is set to the maximum value (**= 32**).

View
The value pairs in the dip table can **only** be read. You can still select this menu option, even if there is no dip table available. In this case, the number of free table entries is at maximum value (**= 32**).

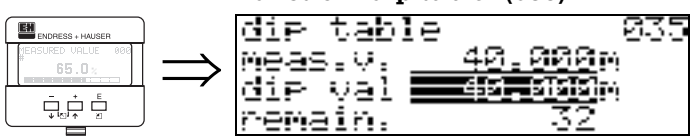
Function "dip table" (034)



This function edits measured variable. The number behind the entry "**remain**" indicates the current number of remaining free value pairs. The maximum number of value pairs is 32; after each entry, the remaining number is decremented.

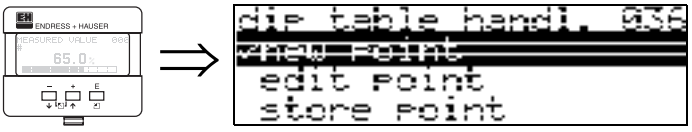
Note!
The uncorrected measured value is displayed in the "**dip table**" (034) function. This may differ considerably from the measured values when a dip table is activated.

Function "dip table" (035)



This function edits the dip value.

Function "dip table handl." (036)



Use this function to enter the dip value (level or distance) which will correct the measurement values.

Selection:
- **new point**
- edit point
- store point
- delete point
- return
- next point
- previous point

General procedure:
To enter a new point into the dip table, use
"new point" to enter the value (pairs),
"store point" to sort the new value (pairs),
"return" to go to the dip table mode and
"table on" to activate the dip table.

new point
You can enter a new point. A suggested value is displayed for the measured variable, the dip value of the current level or distance. With semi-automatic inputs, the current level or the current remaining fill height is displayed as proposed dip value. The new value pair can be altered without selecting the
"**edit point**" parameter.
If the table is full, you can still select this parameter. In this case, the number of free table entries stands at minimum value (**= 0**).

edit point
The displayed value pair can be changed. Only the dip value can be changed with semi-automatic input mode.

Caution!
To accept the value pair in the table, confirm it with "**store point**".

store point
The displayed value pair is sorted in the table.

Note!
For sorting, the following criteria must be met:
- Measured variables may not be equal but have different dip values.
- A measured variable available in the table is recognised as equal when it is closer than 1 mm to the sorting value.
- After successful sorting, the setting remains at "**edit point**" and the number of free table entries is decremented.

Caution!
If the value cannot be sorted, the setting remains at the previous menu option. No warning or error message is generated. However, the number of remaining table entries is not decremented.

delete point
The currently displayed point is deleted from the table. After deletion, the previous point is displayed. If the table only consisted of one point before deletion, then the current measured variable is displayed as a value pair.

return
By selecting this point, you return to the function "**dip table mode**" **(033)**.

next point
This scrolls down in the table. If the table is empty, you can still select this option. However, the displayed value does not change.

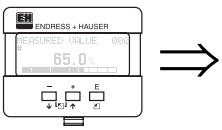
previous point
This scrolls up in the table. If the table is empty, you can still select this option. However, the displayed value does not change.

Caution!
After entering one or more points into the dip table, make sure that the dip table is activated in the "**table on**" dip table mode.

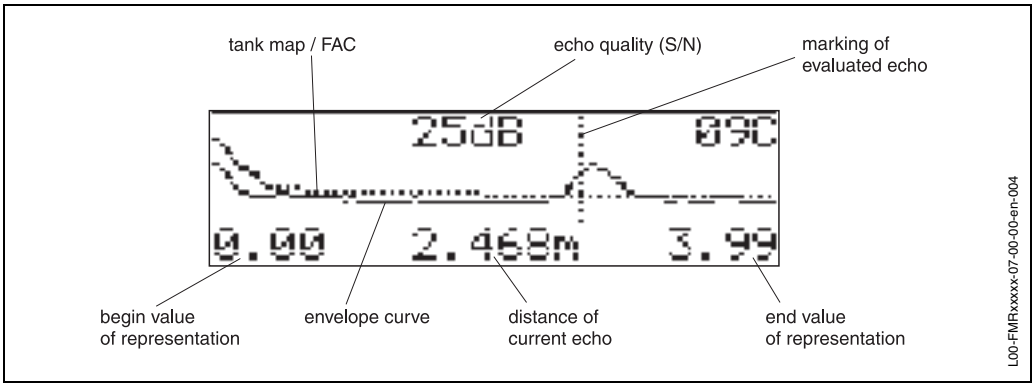
6.5.2 Envelope curve with VU 331

After the basic setup, an evaluation of the measurement with the aid of the envelope curve ("**display**" **(09)** function group) is recommended.

Function "plot settings" (09A)

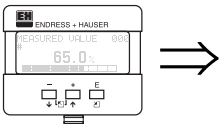


Here you can select which information is shown on the display:
- **envelope curve**
- env. curve+FAC (for FAC see BA 217F)
- env. curve+cust.map (i.e. the tank map is also displayed)



Function "recording curve" (09B)

This function determines whether the envelope curve is read as:
- **single curve**
  or
- cyclic



Note!
If the envelope curve mode is active on the display, the measured values are updated in a slower cycle time. Thus, it is advisable to leave the envelope curve mode after the measuring point has been optimised.

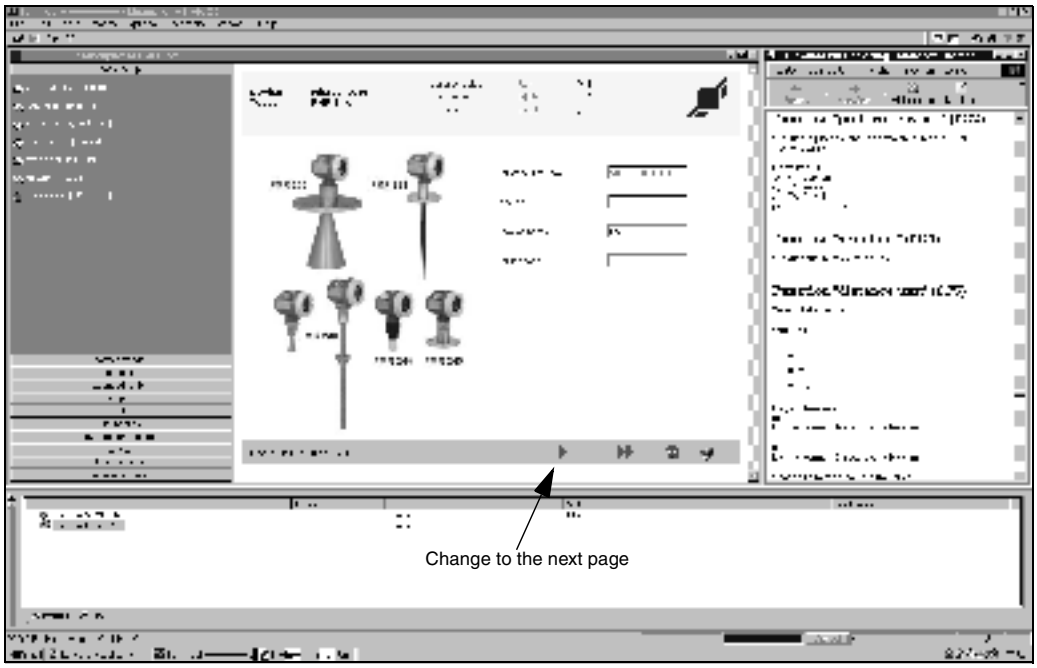
Note!
If the level of echo is very weak or there is a heavy interference echo, an **orientation** of the Micropilot can contribute to an optimisation of the measurement (increase of the level echo/reduction of the interference echo) (see »Orientation of the Micropilot«).

6.6 Basic Setup with the ToF Tool

To carry out the basic setup with the ToF Tool operating program, proceed as follows:
- Start the ToF Tool operating program and establish a connection
- Select the "**basic setup**" function group in the navigation bar

The following display appears on the screen:

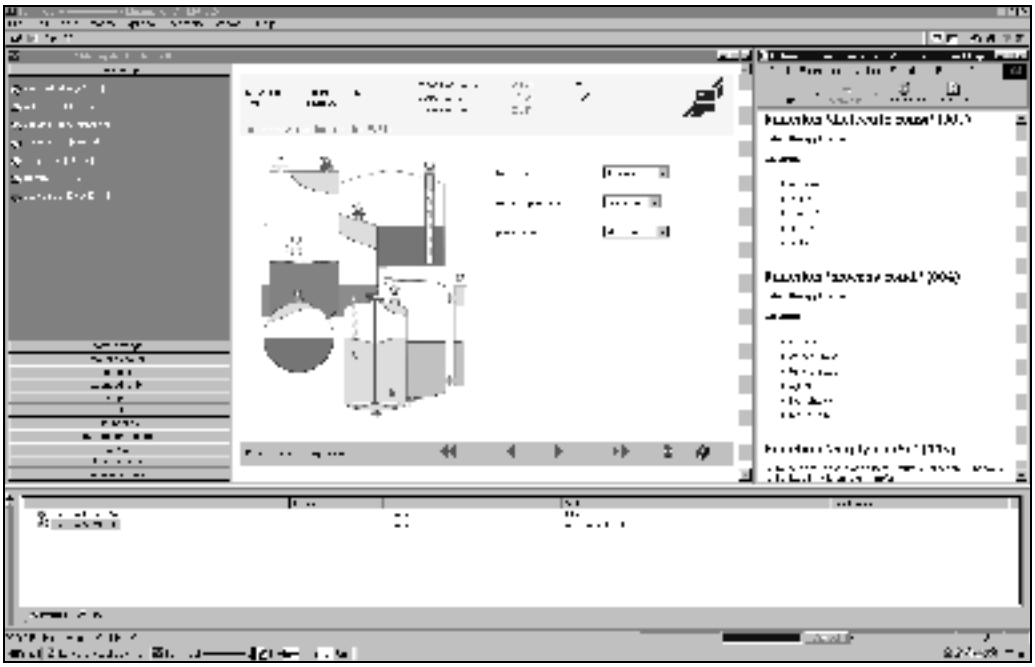
Basic Setup step 1/5:
- Status image
- Enter the measuring point description (TAG number).



Note!
- Each parameter that is changed must be confirmed with the **RETURN** key!
- The "**Next**" button moves you to the next screen display:

Basic Setup step 2/5:

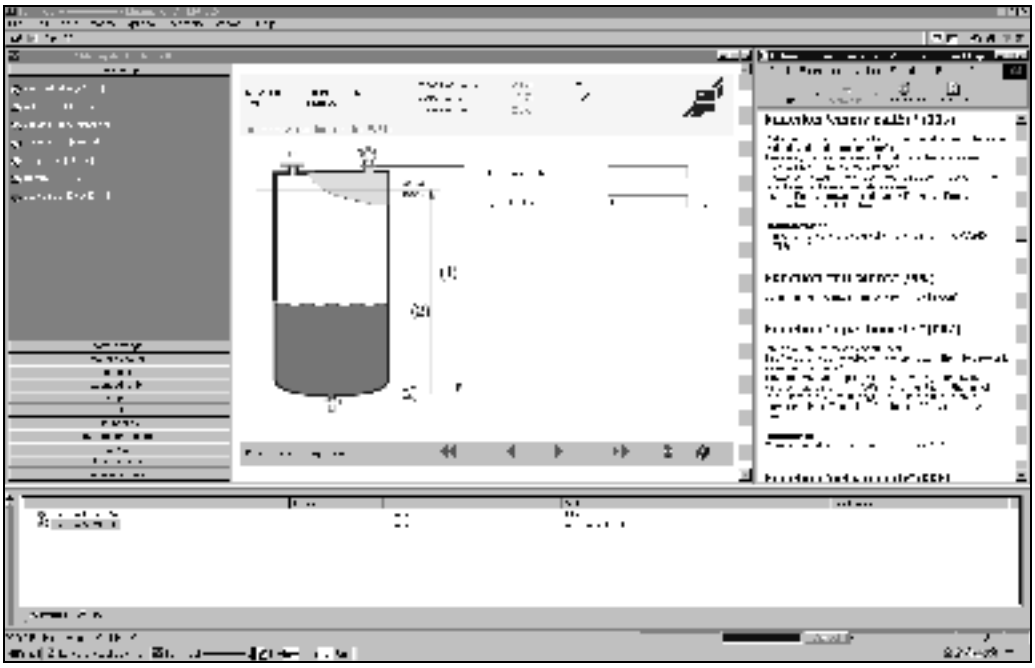
- Enter the application parameters:
  – tank shape (for a description, see Page 49)
  – medium property (for a description, see Page 50)
  – process cond. (for a description, see Page 51)



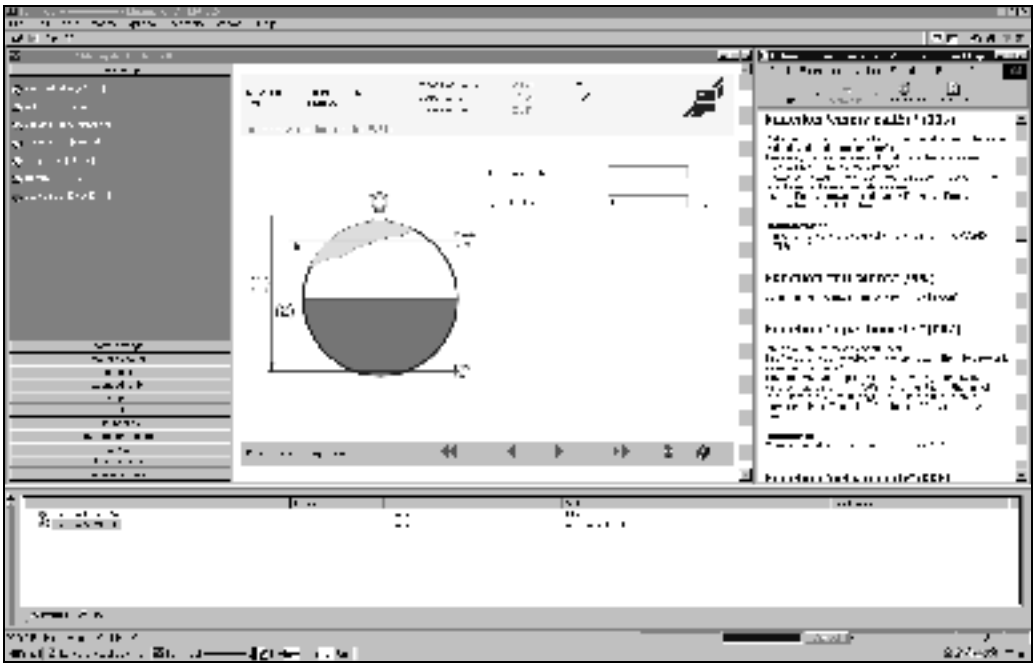
Basic Setup step 3/5:

If "**dome ceiling**" is selected in the "**tank shape**" function, the following display appears on the screen:

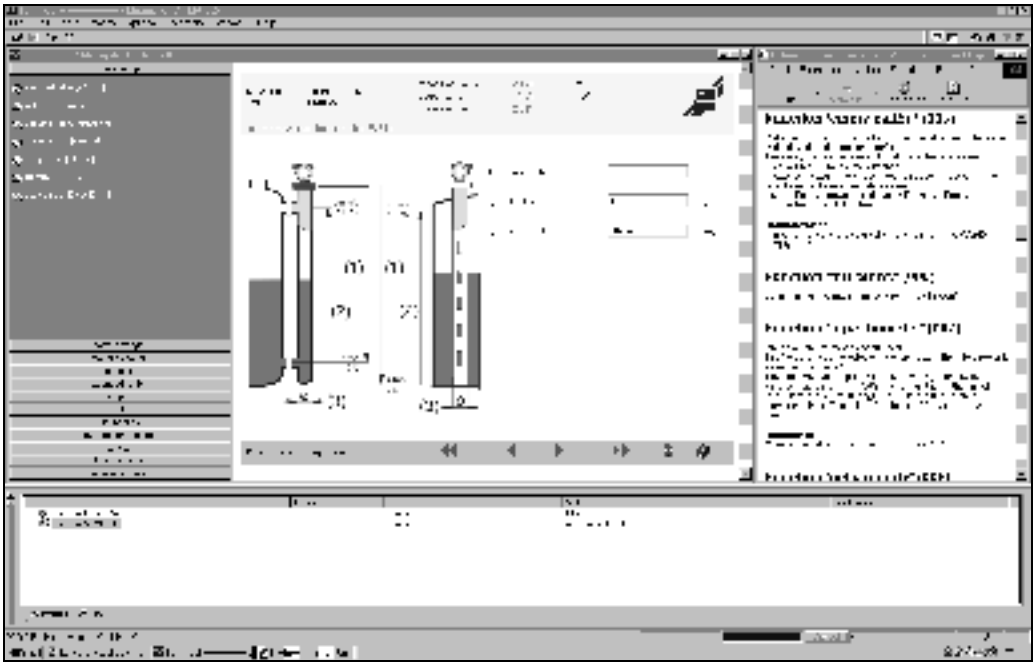
- empty calibr. (for a description, see Page 52)
- full calibr.(for a description, see Page 52)



If "**horizontal cyl**" or "**sphere**" is selected in the "**tank shape**" function, the following display appears on the screen:
- empty calibr. (for a description, see Page 52)
- full calibr. (for a description, see Page 52)

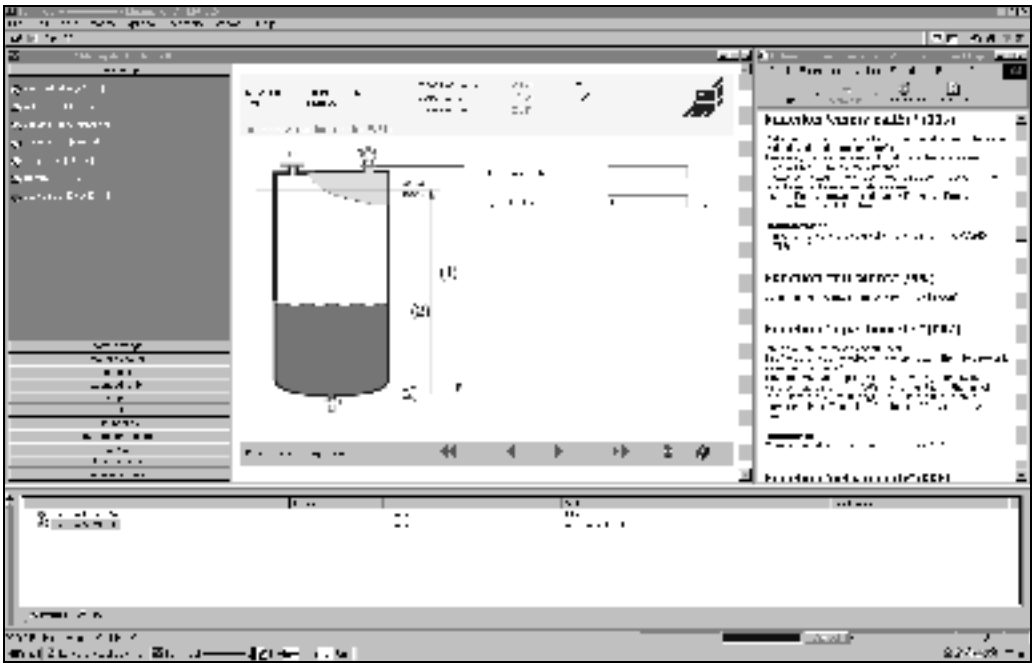


If "**stilling well**" or "**bypass**" is selected in the "**tank shape**" function, the following display appears on the screen:
- empty calibr. (for a description, see Page 52)
- full calibr. (for a description, see Page 52)
- Diameter of bypass / stilling well (for a description, see Page 53)

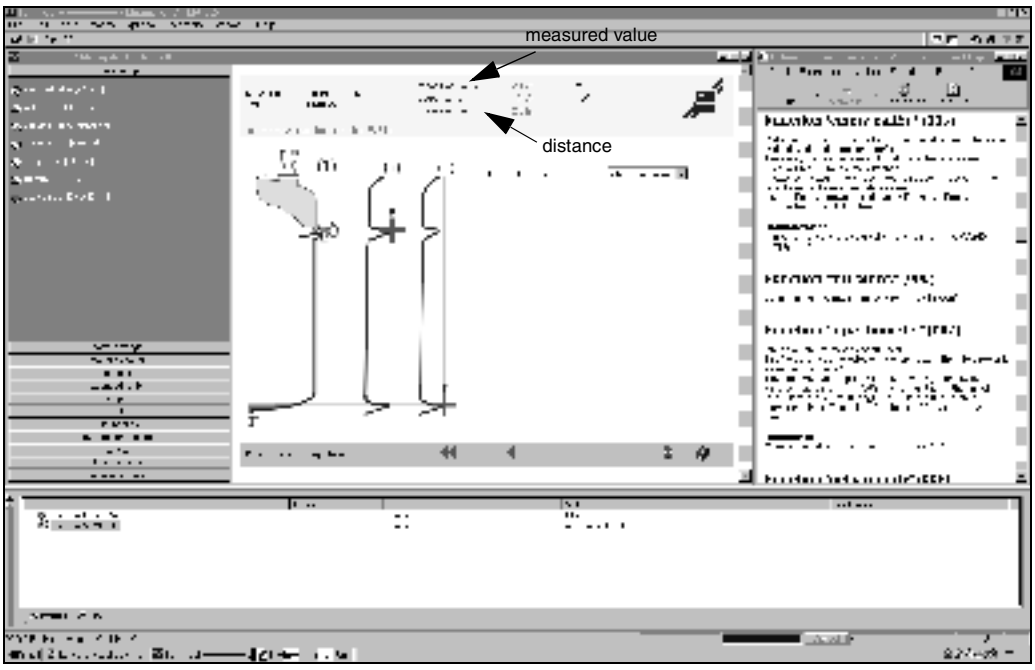


Note!
You can also specify the pipe diameter in this display.

If "**flat ceiling**" is selected in the "**tank shape**" function, the following display appears on the screen:
- empty calibr. (for a description, see Page 52)
- full calibr. (for a description, see Page 52)



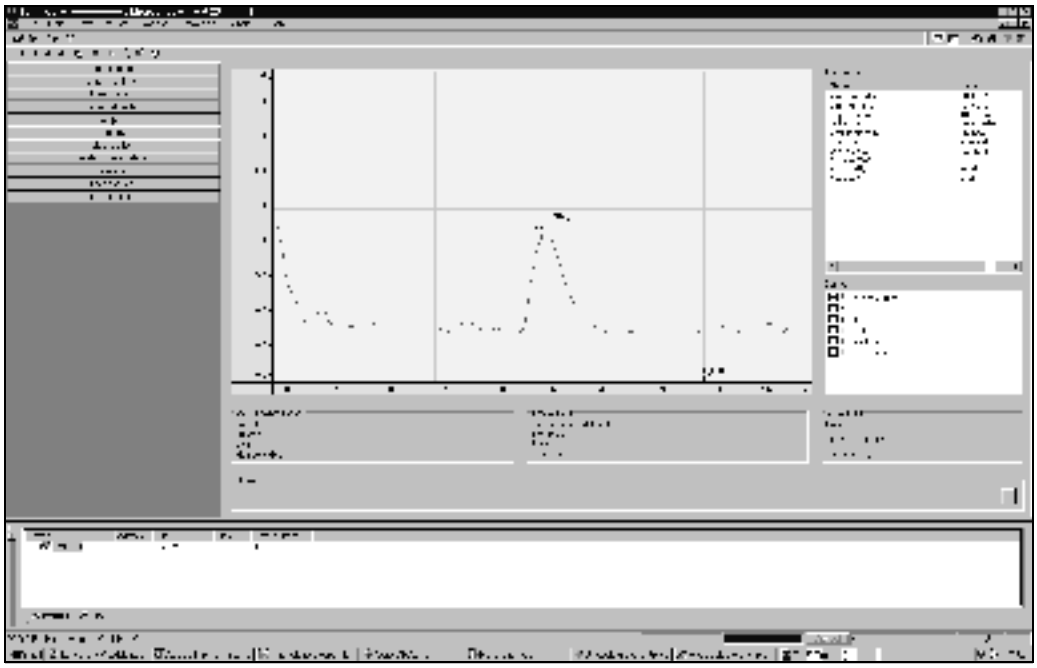
Basic Setup step 4/5:
- This step starts the tank mapping
- The measured distance and the current measured value are always displayed in the header
- A description is given on see Page 56



Step 5/5:
After the first installation of the device, initialise the index correction table (compare Page 57) by activating the history reset 555.

6.6.1 Envelope curve with the ToF Tool

After the basic setup, an evaluation of the measurement using the envelope curve is recommended.



Note!
If the level of echo is very weak or there is a heavy interference echo, an **orientation** of the Micropilot can help optimise the measurement (increase of the useful echo/ reduction of the interference echo) (see »Quick installation guide«).

6.6.2 User-specific applications (operation)

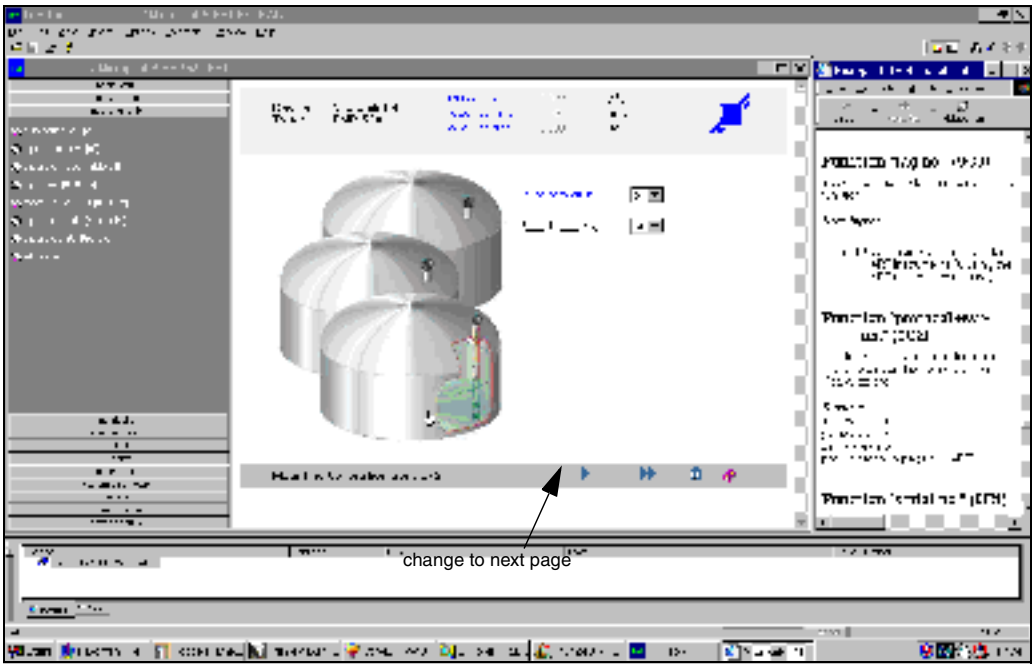
For details of setting the parameters of user-specific applications, see separate documentation BA 217F/00/en - description of the instrument functions of the Micropilot S.

6.7 Mounting calibration with the ToF Tool

To carry out the basic setup with the ToF Tool operating program, proceed as follows:
- Start the ToF Tool operating program and establish a connection
- Select the "**mounting calibr.**" function group in the navigation bar

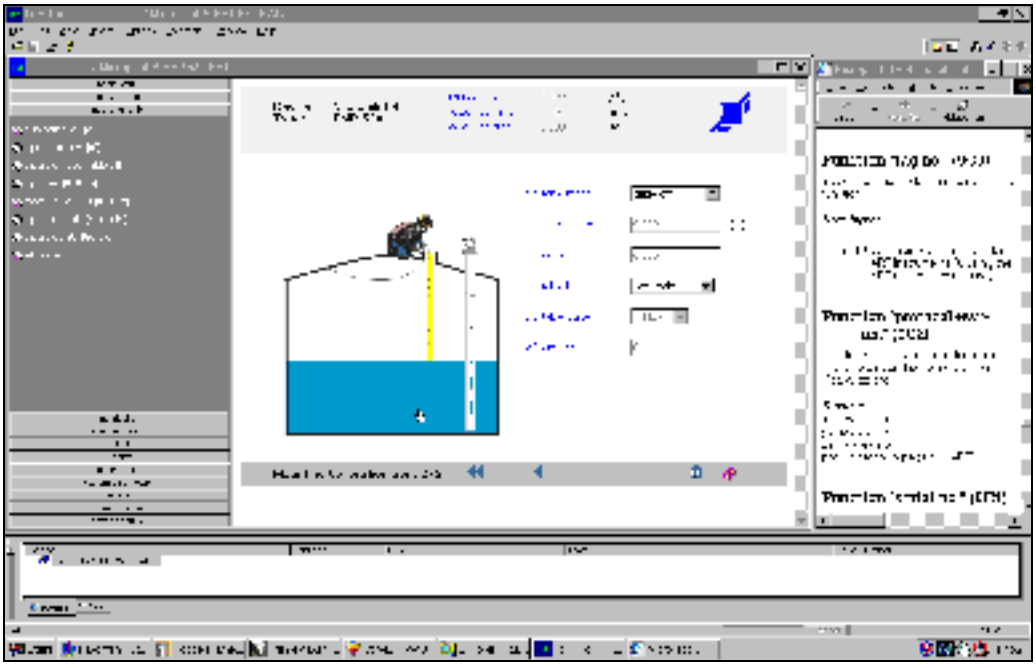
The following display appears on the screen:

Mounting calibration step 1/2:
- auto correction (description see Page 57)
- pipe diam. corr. (description see Page 58)



Note!
- Each parameter that is changed must be confirmed with the **RETURN** key!
- the "**Next**" button moves you to the next screen display:

Mounting calibration step 2/2:
- dip table mode (description see Page 61)
- meas. v. (description see Page 62)
- dip value (see Page 62)
- dip table handl. (description see Page 63)
- dip table state (description see Page 61)
- left dip t.entr. (description see Page 61)



7 Maintenance

The Micropilot S measuring instrument requires no special maintenance.

Exterior cleaning
When cleaning the exterior of measuring devices, always use cleaning agents that do not attack the surface of the housing and the seals.

Replacement
After a complete Micropilot or electronic module has been replaced, the parameters can be downloaded into the instrument again via the communication interface. Prerequisite to this is that the data were uploaded to the PC beforehand using the ToF Tool / Commuwin II.
Measurement can continue without having to carry out a new setup.

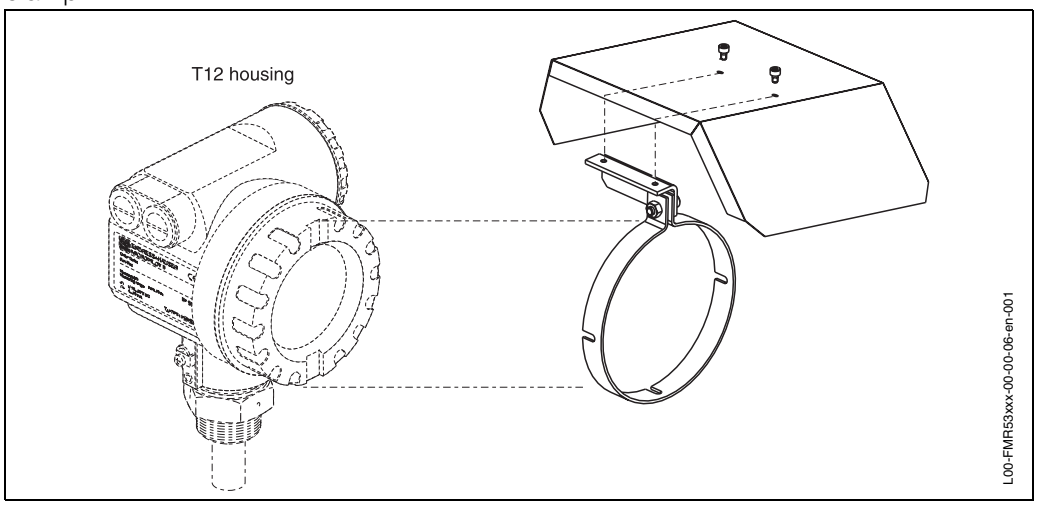
- You may have to activate linearisation (see BA 217F)
- You may need to record the tank map again (siehe Grundabgleich)

After an antenna component has been replaced, a new calibration must be carried out.

8 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the Micropilot S.

Weather protection cover
A Weather protection cover made of stainless steel is available for outdoor mounting (order code: 543199-0001). The shipment includes the protective cover and tension clamp.



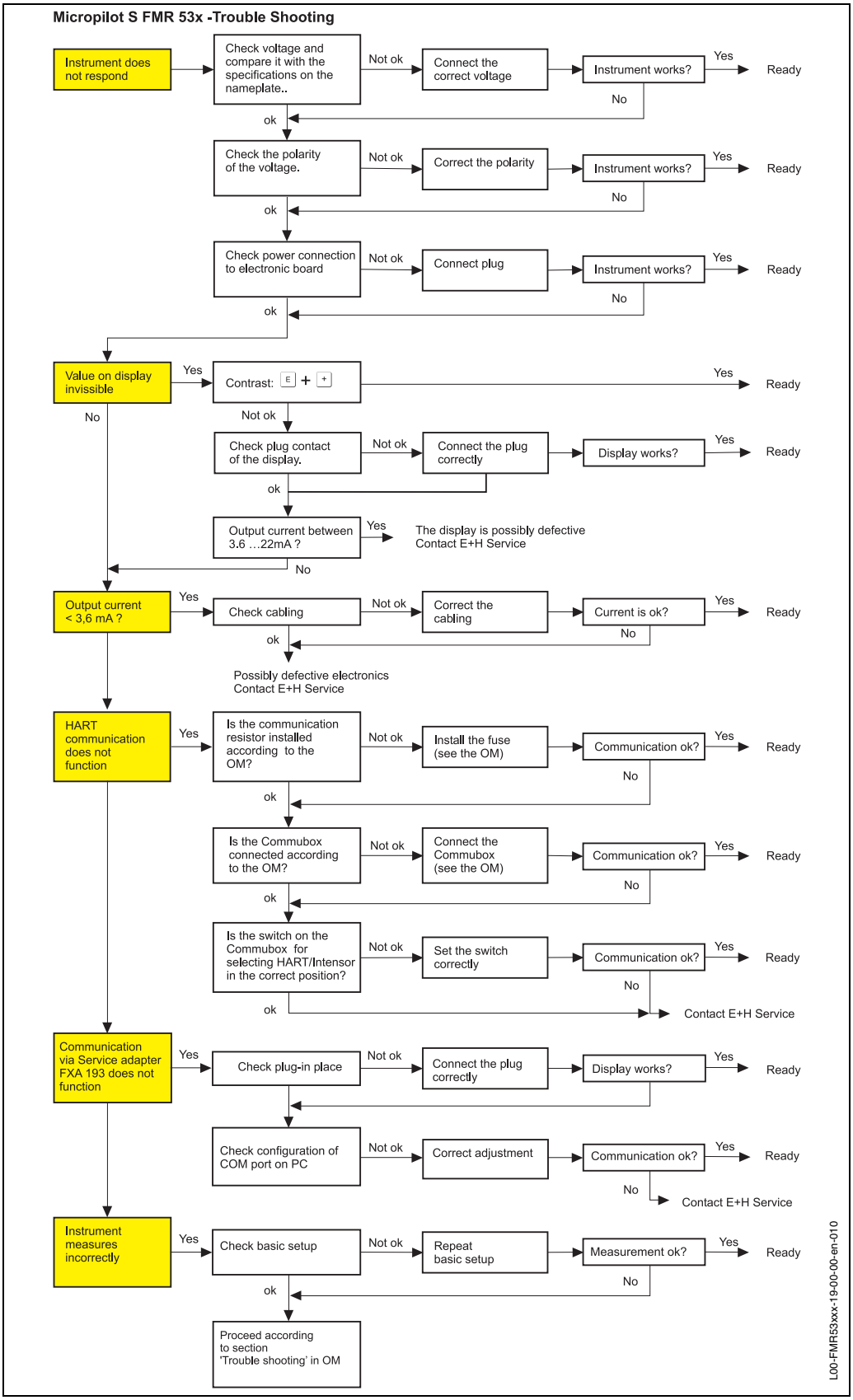
Commubox FXA 191 HART
For intrinsically safe communication with ToF Tool or Commuwin II via the RS 232C-interface.

Service adapter FXA 193
For communication with ToF Tool via the display connector. (Bestell-Nr.: 50095566).

Commuwin II
Operating software for intelligent instruments.

9 Trouble-shooting

9.1 Trouble-shooting instructions



9.2 System error messages

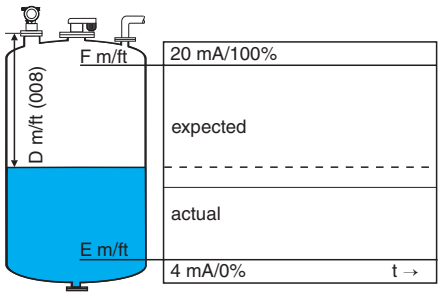
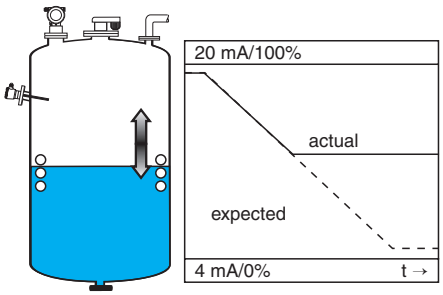
Code	Description	Possible cause	Remedy
A102	checksum error general reset & new calibr.required	device has been powered off before data could be stored; emc problem; E²PROM defect	reset; avoid emc problem; if alarm prevails after reset, exchange electronics
W103	initialising - please wait	E²PROM storage not yet finished	wait some seconds; if warning prevails, exchange electronics
A106	downloading please wait	processing data download	wait until warning disappears
A110	checksum error general reset & new calibr.required	device has been powered off before data could be stored; emc problem; E²PROM defect	reset; avoid emc problem; if alarm prevails after reset, exchange electronics
A111	electronics defect	RAM defective	reset; if alarm prevails after reset, exchange electronics
A113	electronics defect	ROM defective	reset; if alarm prevails after reset, exchange electronics
A114	electronics defect	E2PROM defective	reset; if alarm prevails after reset, exchange electronics
A115	electronics defect	general hardware problem	reset; if alarm prevails after reset, exchange electronics
A116	download error repeat download	checksum of stored data not correct	restart download of data
A121	electronics defect	no factory calibration existant; E²PROM defective	contact service
W153	initialising - please wait	initialisation of electronics	wait some seconds; if warning prevails, power off device and power on again
A155	electronics defect	hardware problem	reset; if alarm prevails after reset, exchange electronics
A160	checksum error general reset & new calibr.required	device has been powered off before data could be stored; emc problem; E²PROM defect	reset; avoid emc problem; if alarm prevails after reset, exchange electronics
A164	electronics defect	hardware problem	reset; if alarm prevails after reset, exchange electronics
A171	electronics defect	hardware problem	reset; if alarm prevails after reset, exchange electronics
A231	sensor 1 defect check connection	HF module or electronics defective	exchange HF module or electronics

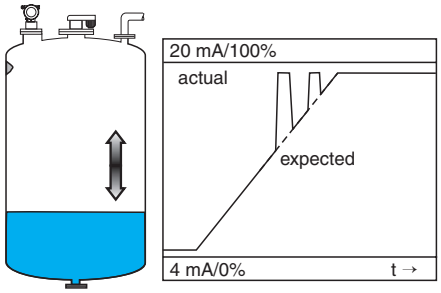
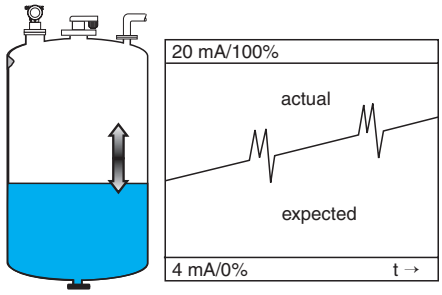
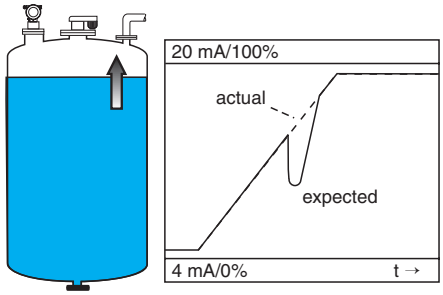
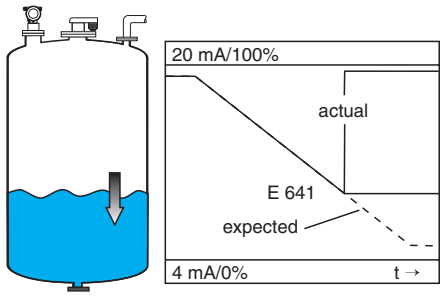
Tab. 3 System error messages

Code	Description	Possible cause	Remedy
A270	custody switch undef check position	switch for custody transfer may be defective	check position of custody switch exchange electronics
#		inconsistency between phase and amplitude evaluation inconsistent microfactor inconsistent index mapping	check basic calibration check mounting calibration check echo quality reset history "555" check stilling pipe diameter switch off autocorrection
A272	electrinics defect amplifier	inconsistency in amplification	exchange electronics
W275	electronics defect factory setting	ofset drift of A/D commuter	exchange electronics
W511	no factory calibration ch1	factory calibration has been deleted	record new factory calibration
A512	recording of mapping please wait	mapping active	wait some seconds until alarm disappears
W601	linearisation ch1 curve not monotone	linearization not monotonously increasing	correct linearisation table
W611	less than 2 linearisation points for channel 1	number of entered linearization points < 2	correct linearisation table
W621	simulation ch. 1 on	simulation mode is active	switch off simulation mode
E641	no usable echo channel 1 check calibr.	echo lost due to application conditions of built up on antenna	check installation; optimize orientation of antenna; clean antenna (cf. BA)
E651	level in safety distance - risk of overspill	level in safety distance	alarm will disappear as soon as level leaves safety distance;
A671	linearisation ch1 not complete, not usable	linearisation table is in edit mode	activate linearisation table
W681	current ch1 out of range	current out of range (3,8 mA ... 21,5 mA)	check calibration and linearisation

Tab. 3 System error messages

9.3 Application errors

Error	Output	Possible cause		Remedy
A warning or alarm has occurred.	Depending on the configuration	See table of error messages (see page 76)		1. See table of error messages (see page 76)
Measured value (00) is incorrect		Measured distance (008) OK?	yes →	1. Check empty calibr. (005) and full calibr. (006). 2. Check linearisation: → level/ullage (040) → max. scale (046) → diameter vessel (047) → Check table
		no ↓		
		Measurement in bypass or stilling well?	yes →	1. Is bypass or stilling well selected in tank shape (002)? 2. Is the pipe diameter (007) correct?
		no ↓		
		Is an FAR 10 antenna extension being used?	yes →	1. offset (057) correctly set?
		no ↓		
		An interference echo may have been evaluated.	yes →	1. Carry out tank mapping → basic setup
No change off measured value on filling/emptying		Interference echo from installations, nozzle or extension on the antenna		1. Carry out tank mapping → basic setup 2. If necessary, clean antenna 3. If necessary, select better mounting position

Error	Output	Possible cause		Remedy
If the surface is not calm (e.g. filling, emptying, agitator running), the measured value jumps sporadically to a higher level	 	Signal is weakened by the rough surface — the interference echoes are sometimes stronger		1. Carry out tank mapping → basic setup 2. Set the process cond. (004) to "turb. surface" or "agitator" 3. Increase the output damping (058) 4. Optimise the orientation (see Page 80) 5. If necessary, select a better mounting position and/or larger antenna
During filling/ emptying the measured value jumps downwards		Multiple echoes	yes →	1. Check the tank shape (002), e.g. "dome ceiling" or "horizontal cyl" 2. In the range of the blocking dist. (059) there is no echo evaluation → Adapt the value 3. If possible, do not select central installation position 4. Perhaps use a stilling well
E 641 (loss of echo)		Level echo is too weak. Possible causes: • Rough surface due to filling/ emptying • Agitator running • Foam	yes →	1. Check application parameters (002), (003) and (004) 2. Optimise alignment (see Page 80) 3. If necessary, select a better installation position and/or larger antenna
E 641 (loss of echo) after turn on the power supply	**If the instrument is configured to Hold by loss of echo the output is set to any value/current.**	noise level during the initialisation phase to high.		Repeat once more empty calibr. (005). Caution! Before conformation change with [+] or [−] to the edit mode.

9.4 Orientation of the Micropilot

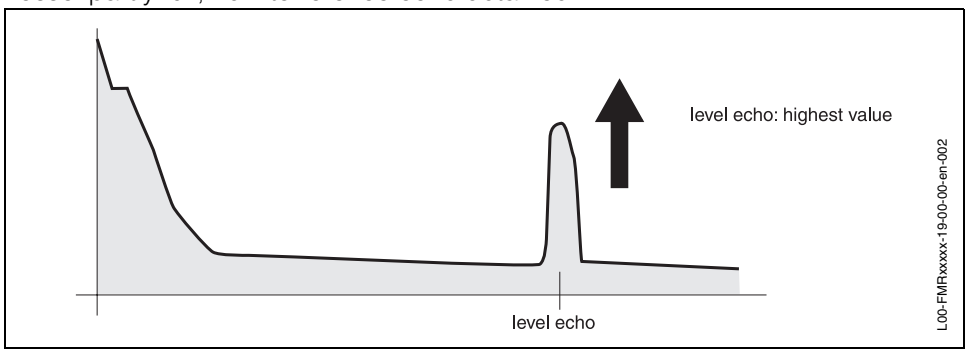
For orientation a marker is found on the flange or threaded boss of the Micropilot. During installation this must be oriented as follows:
- In tanks: to the vessel wall
- In stilling wells: to the slots
- In bypass pipes: vertical to the tank connectors

After commissioning the Micropilot, the "**echo quality**" **(056)** indicates whether a sufficiently large measuring signal is obtained. If necessary, the quality can be optimised later. Vice versa, the presence of an interference echo can be used to minimise this by optimum orientation. The advantage of this is that the subsequent tank mapping uses a somewhat lower level that causes an increase in the strength of the measuring signal.

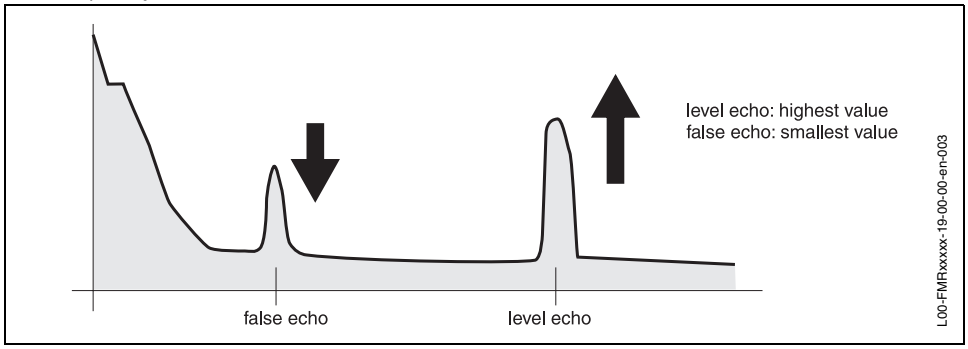
Proceed as follows:

⚠ **Warning!**
Subsequent alignment can lead to personal injury. Before you unscrew or loosen the process connection, make sure that the vessel is not under pressure and does not contain any injurious substances.

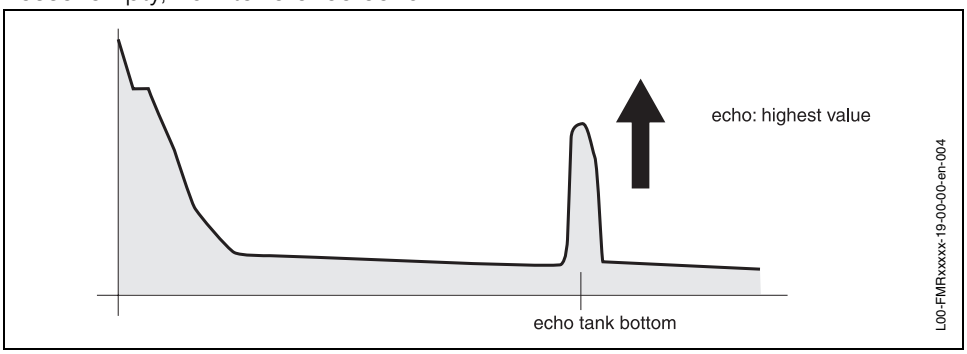
1. It is best to empty the container so that the bottom is just covered. However, alignment can be carried out even if the vessel is empty.
2. Optimisation is best carried out with the aid of the envelope graph in the display or the ToF Tool.
3. Unscrew the flange or loosen the threaded boss by a half a turn.
4. Turn the flange by one hole or screw the threaded boss by one eighth of a turn. Note the echo quality.
5. Continue to turn until 360° is reached.
6. Optimum alignment:
   a) Vessel partly full, no interference echo obtained:



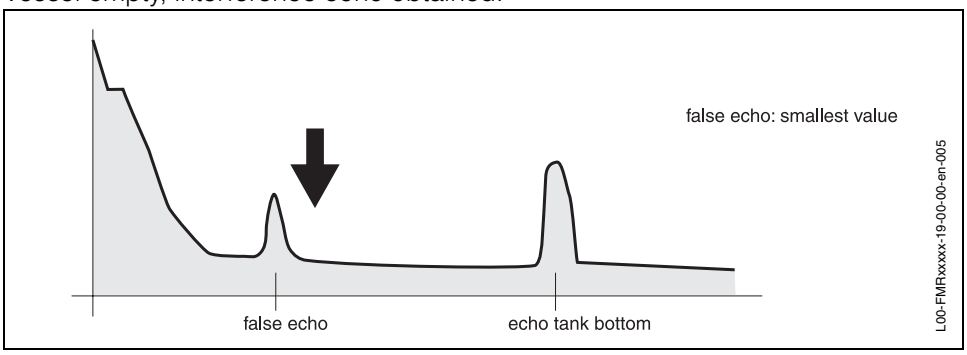
   b) Vessel partly full, interference echo obtained:



c) Vessel empty, no interference echo:



d) Vessel empty, interference echo obtained:



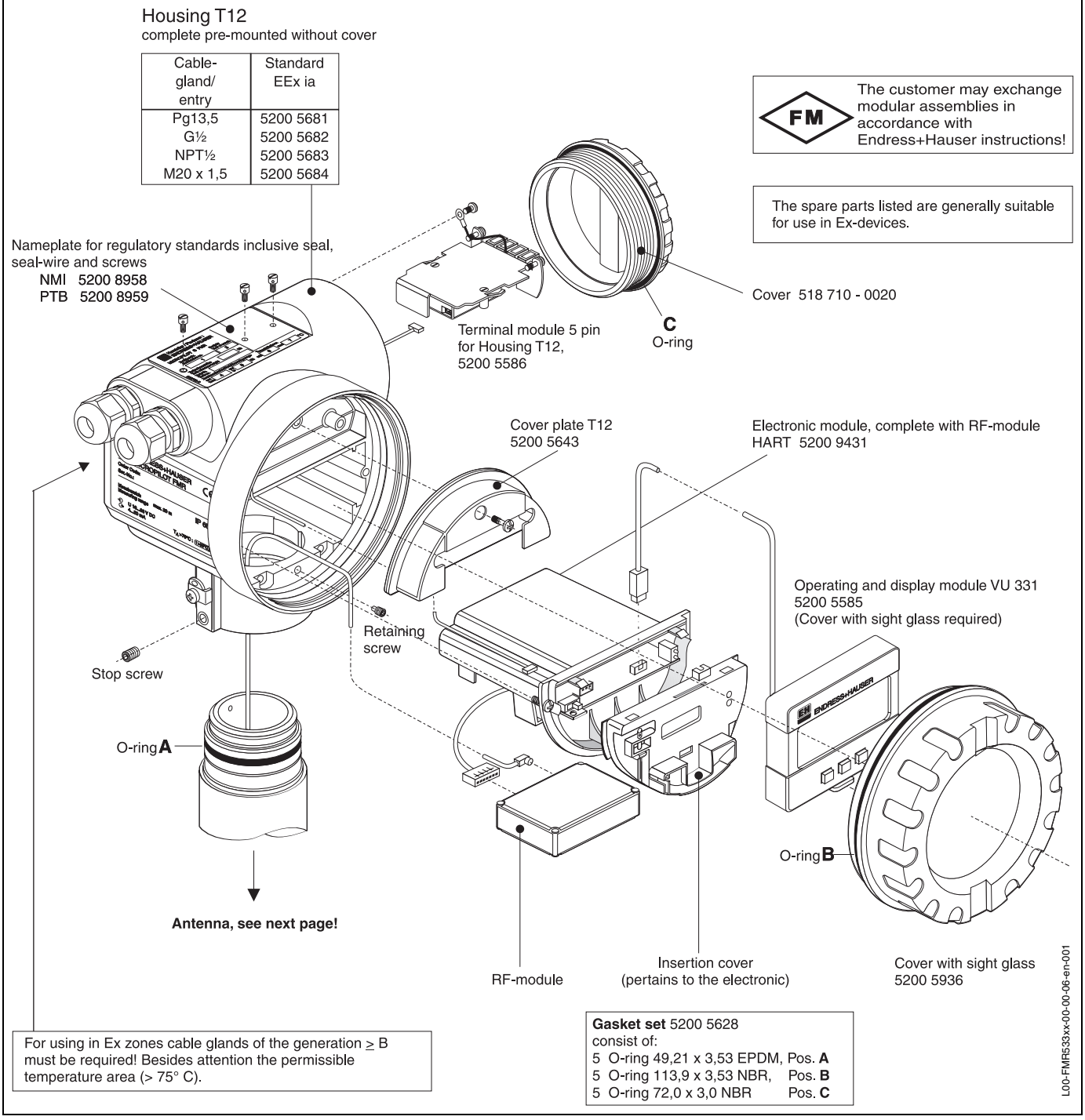
7. Fix the flange or threaded boss in this position.
   If necessary, replace the seal.
8. Carry out tank mapping, siehe Kapitel 6.1 bzw. 6.2.

9.5 Spare parts

Note!
You can order spare parts directly from your E+H service organization by giving the **order code** and the **serial number** which is printed on the measuring transducer nameplate (see Page 7 ff.). The corresponding spare part number also appears on each spare part. Installation instructions are given on the instruction card that is also delivered.

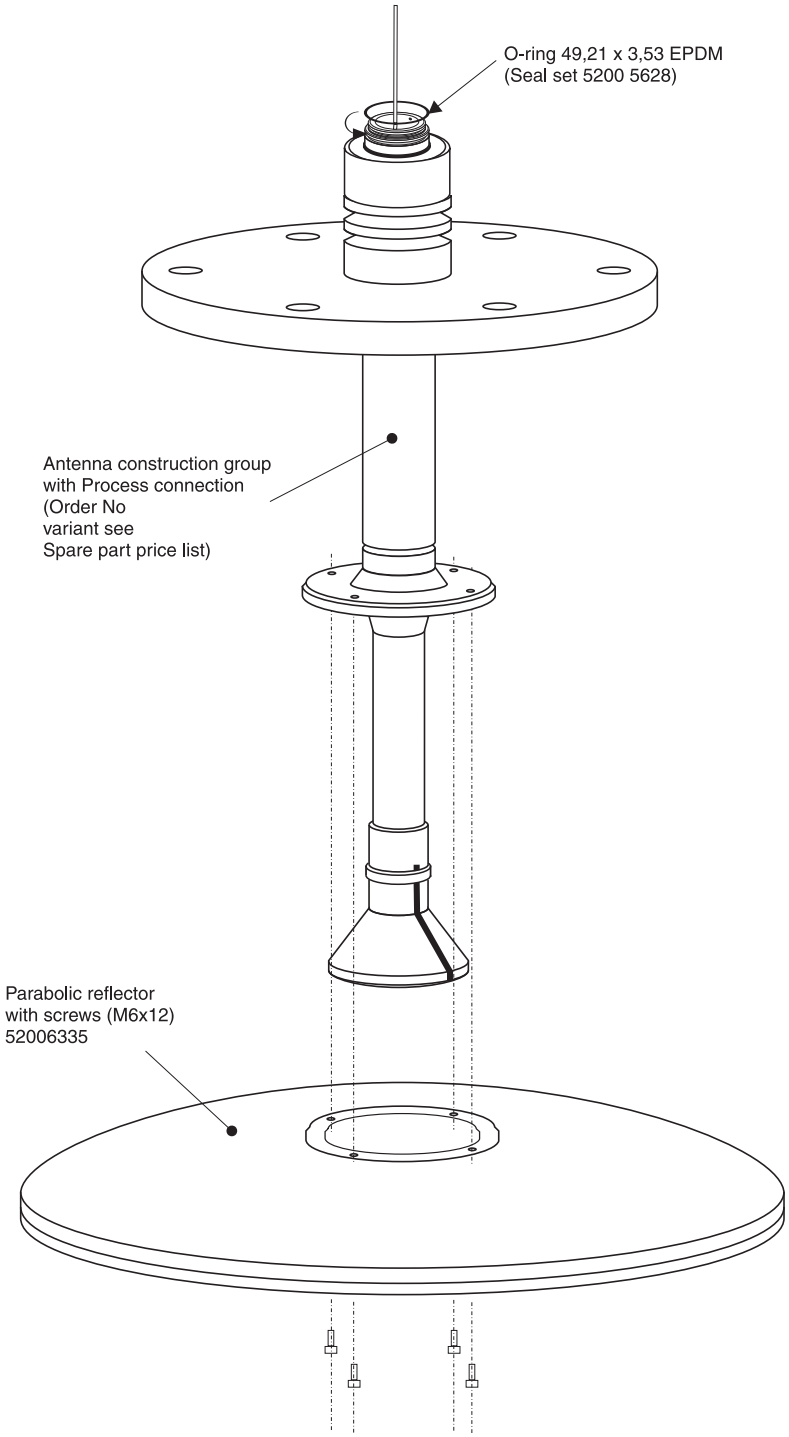
Caution!
If the calibration seal is broken, the national calibration authority should normally be informed within 24 hours.

Spare parts Micropilot S, FMR 533
Housing T12 with separate wiring compartment



Spare parts Micropilot S, FMR 533

Parabolic antenna



Modification nameplate
When ordering parts that are listed in the product structure (see Page 8 ff.) , a check must be made as to whether the instrument description on the nameplate is still valid, e.g. for:
- an antenna component,
- an electronics module,
- an RF module,
- a VU 331 operating and display module,
- a housing cover with window.

Housing T12
The complete order code must be specified when ordering the replacement housing so that the correct nameplate can be delivered, e.g.

- FMR 533-A4VCW2AA2A

You must label the nameplate yourself.

Caution!
- It is not possible to convert a standard instrument into an Ex instrument by simply exchanging parts.
- When repairing certified instruments, the relevant regualtions must be followed.
- For FM approved instruments, it is forbidden to make any changes to the instrument that are not expressly authorised in the operating manual. Contravening this prohibition can invalidate the approval for operation of the instrument.

9.6 Return

If you need to send a Micropilot back to Endress+Hauser for repair, please send a completed copy of the form printed on the last page.

- An exact description of the application.
- The chemical and physical characteristics of the product.
- A short description of the error that occurred.
- If necessary, give the error code.

Please carry out the measures described in Chapter 1.4 before sending a Micropilot back for repair.

9.7 Disposal

In case of disposal please seperate the different components according to their material consistence.

9.8 Software history

Software version / Date	Software changes	Documentation changes
V 1.00.00 / 12.2000	Original software. Operated via: – ToF Tool – Commuwin II (from version 2.05.03) – HART communicator DXR 375 with Rev. 1, DD 1.	
V 01.02.00 / 03.2002	simplyfied commissioning history reset in basic calibration Katakana. Operated via: – ToF Tool (V3.0) – Commuwin II (from version 2.05.03) – HART communicator DXR 375 with Rev. 1, DD 1.	

9.9 Contact addresses of Endress+Hauser

The addresses of Endress+Hauser are given on the back cover of this operating manual. If you have any questions, please do not hesitate to contact your E+H representative.

10 Technical data

10.1 Technical data at a glance

Application	
Application	The Micropilot S is used for highly accurate level measurement in storage tanks and can be applied in custody transfer applications. It meets the relevant requirements according to OIML R85 and API 3.1B. • The FMR 533 with parabolic antenna is excellently suited for free space applications up to 40 m (131 ft).
Function and system design	
Measuring principle	The Micropilot is a "downward-looking" measuring system, operating based on the time-of-flight method. It measures the distance from the reference point (process connection) to the product surface. Radar impulses are emitted by an antenna, reflected off the product surface and received again by the radar system.
Equipment architecture	The Micropilot S can be used for measurement in a stilling well as well as in free space. The different instrument versions are applied as follows: • The Micropilot S FMR 533 with parabolic antenna is preferred for free-space measurements. The Micropilot S FMR 530 with horn antenna can be used as an alternative for small nozzle diameters . • The instruments are equipped with a passive 4…20 mA output with HART protocol.
Input	
Measured variable	The measured variable is the distance between a reference point (mounting flange) and a reflective surface (e.g. medium surface). The measured value and all parameters are displayed using either metrical SI-units or US/UK-units (inch, ft, …). The level is calculated based on the tank height entered. The level can be converted into other units (volume, mass) by means of a linearization. In order to compensate for non-linear effects like movement of the tank roof, an additional correction table (diptable) can be entered.
Measuring range	see Page 16 ff.
Output	
Output signal	4…20 mA with HART protocol: this version can be operated via the PC operating software ToF Tool and Commuwin II. The instrument supports both point-to-point and multidrop operation.
Signal on alarm	Error information can be accessed via the following interfaces: • Local display: – Error symbol (see Page 37) – Plain text display – LED's: red LED continuously on = alarm, red LED flashes = warning • Current output • Digital interface
Galvanic isolation	500 V towards ground. 500 V between power supply and signal

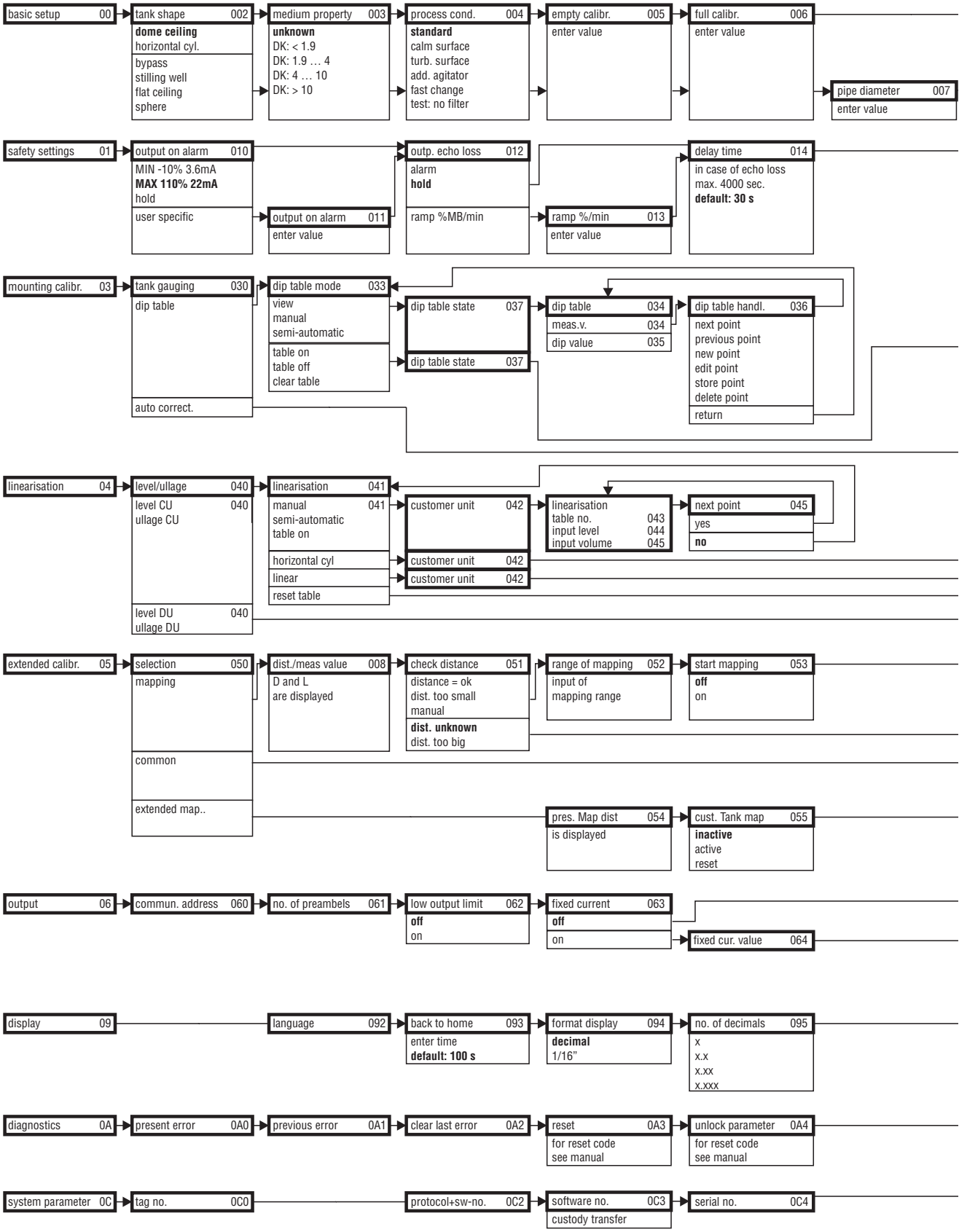
Auxiliary energy	
Electrical connection	Housing T 12 with separate terminal compartment.
Load HART	Minimum load for HART communication: 250 Ω
Cable entry	Cable gland: M20x1.5 or Pg13.5 Cable entry: G ½ or ½ NPT
Supply voltage	see Page 31 ff.
Power consumption	Max. 330 mW at 16 V, max. 500 mW at 24 V, max. 600 mW at 30 V.
Current consumption	Max. 21 mA (50 mA inrush current).
Power supply	For stand alone operation recommended via e.g. E+H RN 221 N/Z.
Performance characteristics	
Reference operating conditions	**According to OIML R85:** • Temperature = –25…+55 °C (-13…+131 °F) • Atmospheric pressure • Relative humidity (air) = 65 % ±15% • Medium properties: e.g. medium with good reflectivity and calm surface. • Tank diameter: signal beam hits the tank wall only at one side. **Note!** No major interference reflections inside the signal beam.
Maximum measured error	Absolute accuracy: 0.5 mm (2σ value) Inventory Control Versios: ±3 mm
Proof of accuracy for custody transfer versions	The accuracy of each Micropilot S is established through a calibration certificate that records the absolute and relative error at 10 equidistant points during the final test. A Laser Interferometer (Jenaer Messtechnik ZLM 500) with an absolute accuracy of 0.1 mm is used as a reference for the free space measurements with FMR 533. Each Micropilot S is delivered with the PTB and NMi type approval. Additional initial factory verifications for custody applications are available on demand for all radar instruments FMR 53x.
Maximum fill speed	By the first pass trough of measuring range: 100 mm/min., thereafter unlimited.
Non-repeatability	0,3 mm (1/64")
Hysteresis	0.3 mm
Resolution	digital: 0.1 mm analogue: 0.03 % of measuring range
Settling time	Typical 15 sec
Long-term drift	The long-term drift is within the specified accuracy.
Influence of ambiente temperature	Within the specified accuracy according to OIML R85.
Software reliability	The software used in the radar instruments FMR 53x fulfills the requirements of OIML R85. This particularly includes: • cyclical test of data consistency • non-volatile memory • segmented data storage The radar instruments Micropilot S continuously monitor the compliance with accuracy requirements for custody transfer measurements according to OIML R85. If the accuracy cannot be maintained, a specific alarm is generated on the local display and via the digital communication.

Inventory Control Versions	All device types can be delivered as "Inventory Conctrol Versions" with a reduced accuracy of ± 3mm (under reference conditions). To these versions, the calibration certificate or custody transfer type approval is NOT attached. The "Inventory Control Versions" can be selected by choosing the option »R« in feature »70« in the order code section »Custody transfer approvals« on page 8 ff.
Operating conditions	
Operating conditions	
Installation instructions	see Page 13 ff.
Beam angle	see Page 14 ff.
Environment	
Ambient temperature range	Ambient temperature for the transmitter: • Standard: -40 °C … +80 °C (-40 °F … +176 °F) • For calibration to regulatory standards: -25 °C ... +60 °C (-30 °F…+140 °F) With T_u<-20 °C and T_u>+60 °C the operability of the LC-display is reduced. A weather protection cover should be used for outdoor operation if the instrument is exposed to direct sunlight.
Storage temperature	-40 °C ... +80 °C (-40 °F … +176°F)
Climate class	DIN EN 60068-2-38 (test Z/AD)
Degree of protection	• housing: IP 65, NEMA 4X (open housing: IP20, NEMA 1) • antenna: IP 68 (NEMA 6P)
Vibration resistance	DIN EN 60068-2-64 / IEC 68-2-64: 20…2000 Hz, 5 $(m/s^2)^2$/Hz
Cleaning of the antenna	See »Technical Information« TI 344F
Electromagnetic compatibility	• emissions according to EN 61326; equipment class B • compatibility according to EN 61326; appendix A (industrial area, 10 V/m) and Namur recommendation EMC (NE 21).
Process conditions	
Process temperature range	See »Technical Information« TI 344F
Process temperature limits	See »Technical Information« TI 344F
Process pressure limits	See »Technical Information« TI 344F
Dielectric constant	• in a stilling well: $\varepsilon r \geq 1.4$ • in free space: $\varepsilon r \geq 1.9$
Wetted parts	• Parabolic, gas-tight Wetted parts: 1.4435 / SS 316 L / PTFE
Mechanical construction	

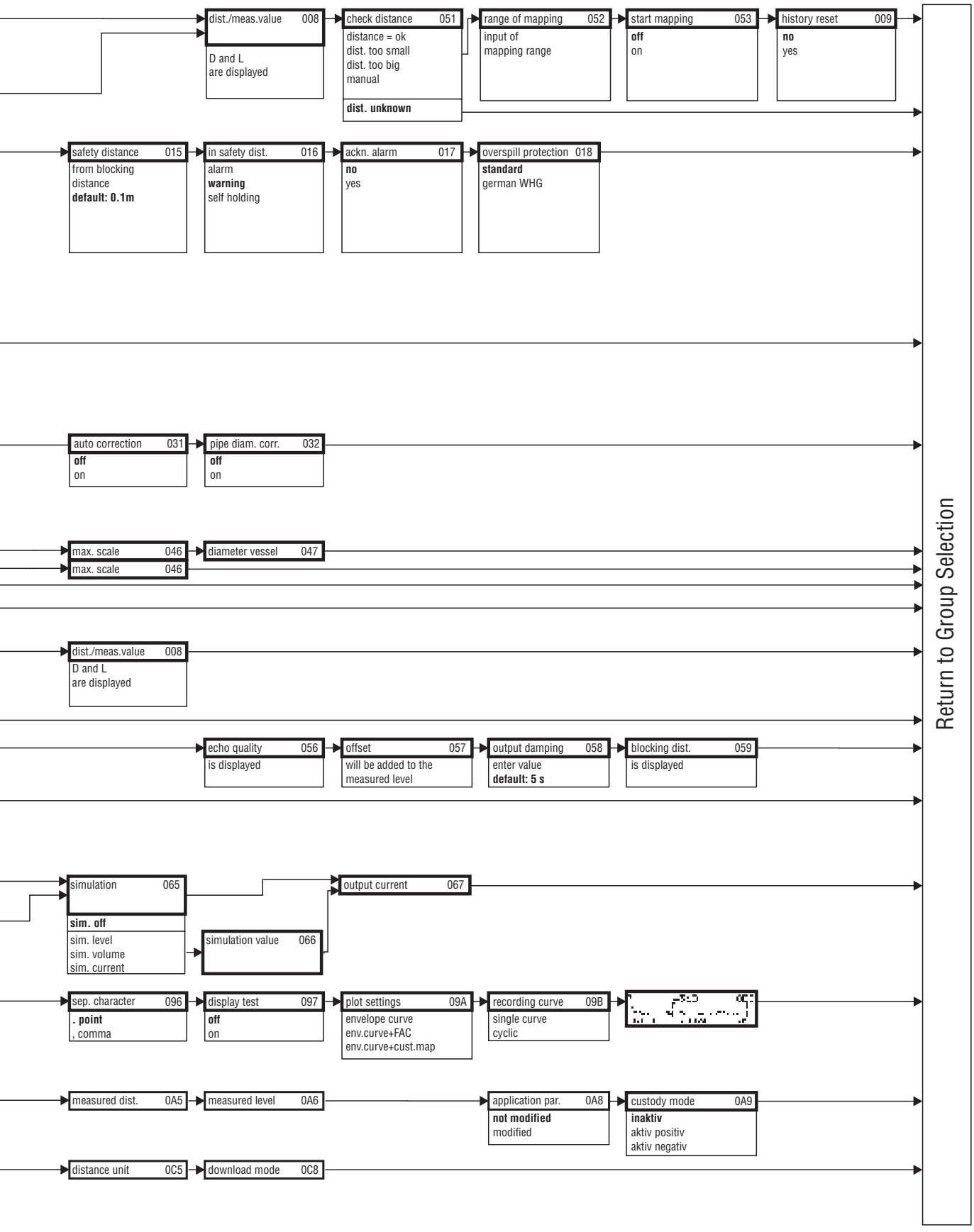
Design, dimensions	see Page 12
Weight	Approx 7.2 kg + weight of flange
Material	see Page 8
Process connection	see Page 8 All process connections dispose of a gas-tight glass feed-through to prevent any gas leakage to the inside of the housing.
Human interface	
Operation concept	see Page 34
Display	see Page 34
Certificates and approvals	
CE approval	The measuring system meets the legal requirements of the EC-guidelines. Endress+Hauser confirms the instrument passing the required tests by attaching the CE-mark.
RF approvals	R&TTE 1999/5/EG, FCC CRF 47, part 15
Overspill protection	PTB , NMi and many other national approvals
External standards and guidelines	**EN 60529** Protection class of housing (IP-code) **EN 61010** Safety regulations for electrical devices for measurement, control, regulation and laboratory use. **EN 61326** Emissions (equipment class B), compatibility (appendix A – industrial area) **NAMUR** Standards committee for measurement and control in the chemical industry **API (American Petroleum Institute)** Particularly "Manual of Petroleum Measurement Stadards". **OIML R85 (Organisation Internationale de Metrologie Legale)**
Ex approval	**XA 081F-A** Installation Micropilot S FMR 53x (T12 / EEx ia IIC T6…T1) PTB 00 ATEX 2067 X, Equipment marking: (II 1/2 G)
Ordering Information	
	The E+H service organisation can provide detailed ordering information an information on the order codes on request.
Accessories	
	see Page 74
Supplementary Documentation	
Supplementary Documentation	• System Information Micropilot (SI 019F/00/en) • Technical Information (TI 344F/00/en) • Operating Instructions "Description of instrument functions" (BA 217F/00/en)

11 Appendix

11.1 Operating menu HART (Display modul), ToF Tool



Note! The default values of the parameters are typed in boldface.


dist./meas.value 008
D and L
are displayed
check distance 051
distance = ok
dist. too small
dist. too big
manual
dist. unknown
range of mapping 052
input of
mapping range
start mapping 053
off
on
history reset 009
no
yes
safety distance 015
from blocking
distance
default: 0.1m
in safety dist. 016
alarm
warning
self holding
ackn. alarm 017
no
yes
overspill protection 018
standard
german WHG
auto correction 031
off
on
pipe diam. corr. 032
off
on
max. scale 046
diameter vessel 047
max. scale 046
dist./meas.value 008
D and L
are displayed
echo quality 056
is displayed
offset 057
will be added to the
measured level
output damping 058
enter value
default: 5 s
blocking dist. 059
is displayed
simulation 065
sim. off
sim. level
sim. volume
sim. current
simulation value 066
output current 067
sep. character 096
. point
, comma
display test 097
off
on
plot settings 09A
envelope curve
env.curve+FAC
env.curve+cust.map
recording curve 09B
single curve
cyclic
measured dist. 0A5
measured level 0A6
application par. 0A8
not modified
modified
custody mode 0A9
inaktiv
aktiv positiv
aktiv negativ
distance unit 0C5
download mode 0C8
Return to Group Selection

11.2 Operating matrix HART / Commuwin II

Operating Matrix HART / COMMUWIN II

Function group	V-CWII	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
00 basic setup	**V0**	measured value		tank shape	medium property	process cond.	empty calibr.	full calibr.	pipe diameter		
01 safety settings	**V1**	output on alarm	output on alarm	outp. echo loss	ramp %span/min	delay time	safety distance	in safety dist.	ackn. alarm	overspill protection	
03 mounting calibr.	**V2**	tank gauging	auto correction	pipe diam. corr.	dip table mode	dip table	dip table	dip table handl.	dip table state		
04 linearisation	**V3**	level/ullage	linearisation	customer unit	table no.	input level	input volume	max. scale	diameter vessel		
05 extended calibr.	**V4**		check distance	range of mapping	start mapping	pres. Map dist	cust. Tank map	echo quality	offset	output damping	blocking dist.
06 output	**V5**	commun. Address	no. Of preambels	low output limit	fixed current	fixed current	simulation	simulation value	output current		
09 display	**V6**			language	back to home	format display	no. of decimals	sep. character			
0D service	**V7**										
0A diagnostics	**V9**	present error	previous error	clear last error	reset	unlock parameter	measured dist.	measured level		application par.	custody mode
0C system parameter	**VA**	tag no.		protocol+sw-no.	software no.	serial no.	distance unit			download mode	

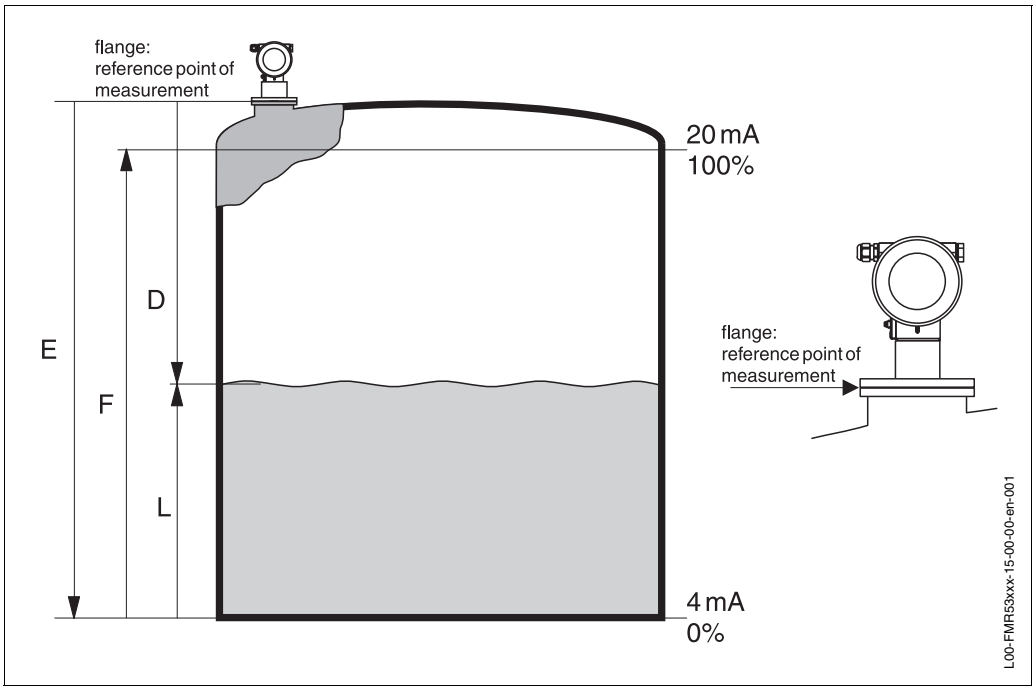
11.3 Description of functions

Note!
A detailed description of the function groups, functions and parameters is given in the documentation BA 217F/00/en - a description of the instrument functions of the Micropilot S.

11.4 Function and system design

11.4.1 Measuring principle

The Micropilot is a "downward-looking" measuring system, operating based on the time-of-flight method. It measures the distance from the reference point (process connection) to the product surface. Radar impulses are emitted by an antenna, reflected off the product surface and received again by the radar system.



Input
The reflected radar impulses are received by the antenna and transmitted into the electronics. A microprocessor evaluates the signal and identifies the level echo caused by the reflection of the radar impulse at the product surface. The unambiguous signal identification is accomplished by the PulseMaster® software based on many years of experience with time-of-flight technology. The mm-accuracy of the Micropilot S is achieved with the patented algorithms of the PhaseMaster® software.
The distance D to the product surface is proportional to the travel time t of the impulse:

$D = c \cdot t/2$,
with c being the speed of light.

Based on the known empty distance E, the level L is calculated:

$L = E - D$

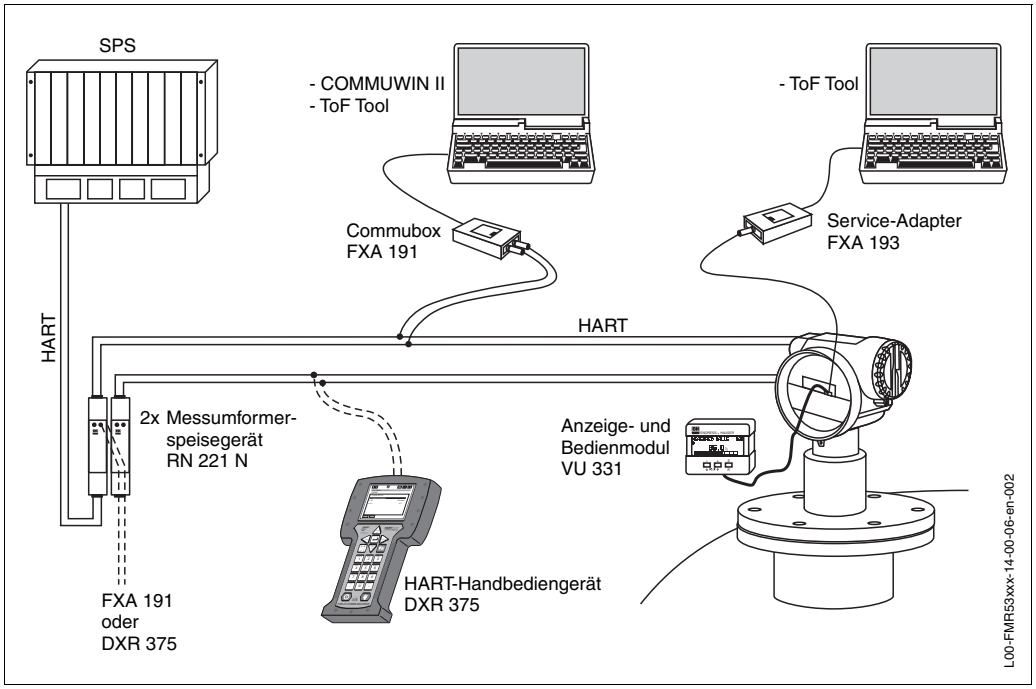
Reference point for "E" is the lower surface of the process connection.
The Micropilot is equipped with functions to suppress interference echoes. The user can activate these functions. They ensure that interference echoes (e.g. from edges and weld seams) are not interpreted as level echo.

Output
The Micropilot is commissioned by entering an empty distance E (=zero), a full distance F (=span), and an application parameter. The application parameter automatically adapts the instrument to the measuring conditions. The data points “E” and “F” correspond with 4mA and 20mA for instruments with current output. They correspond with 0 % and 100 % for digital outputs and the display module.
A linearization with max. 32 points, based on a table entered either manually or semi-automatically, can be activated locally or remotely. This function provides a measurement in engineering units and a linear output signal for spheres, horizontal cylindrical tanks, and vessels with conical outlet.

11.4.2 Equipment architecture

Stand-alone
The Micropilot S can be used for measurement in a stilling well as well as in free space. The different instrument versions are applied as follows:
- The Micropilot S FMR 532 with planar antenna is the preferred device in stilling wells ≥ 150 mm.
- The Micropilot S FMR 530 with horn antenna can be used in stilling wells with a diameter <150 mm. However, for these diameters no custody transfer approval is available.
- The Micropilot S FMR 533 with parabolic antenna is preferred for free-space measurements. The Micropilot S FMR 530 with horn antenna can be used as an alternative for small nozzle diameters .
- The Micropilot S FMR 531 with rod antenna (PTFE) should be used for measurements of highly aggressive media (e.g. sulphur).
- The instruments are equipped with a passive 4…20 mA output with HART protocol.

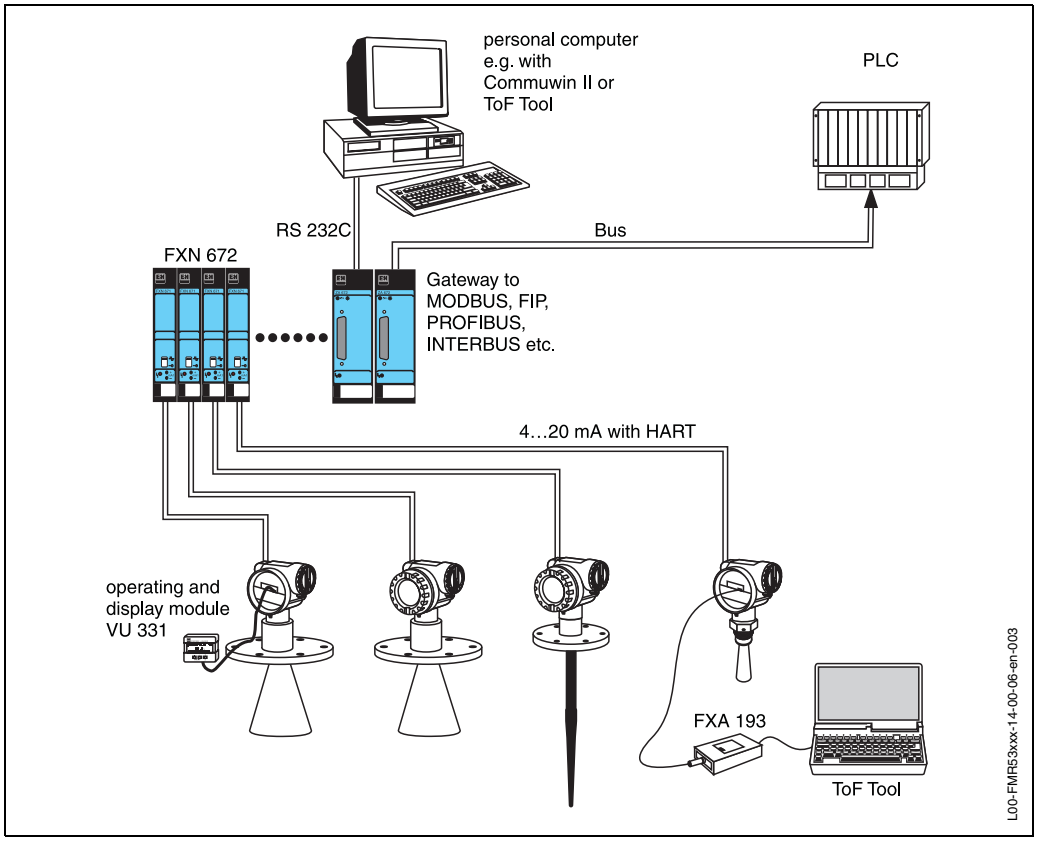
The complete measuring system consists of:



On-site operation:
- with display and operating module VU 331,
- with a Personal Computer, FXA 193 and the operating software ToF Tool.
  The ToF Tool is a graphical operating software for instruments from Endress+Hauser that operate based on the time-of-flight principle (radar, ultrasonic, guided micro-impulse). It assists with commissioning, securing data, trouble shooting, and documentation of the measuring point.

Remote operation:
- with HART handheld DXR 375,
- with a Personal Computer, Commubox FXA 191 and the operating software COMMUWIN II respectively ToF Tool.
- With a Personal Computer, TSM (Tank Side Monitor) and the operating software FuelsManager.

System integration via Rackbus
Multiple transmitters Micropilot S (or other instruments) can be connected to a higher-level bus system via a Gateway ZA:
- Every HART transmitter via one interface module FXN 672 each.
- Gateways are available for MODBUS, FIP, PROFIBUS, INTERBUS etc.
- Both on-site as well as remote operation are possible.



Integration into the Asset Management System
The HART interface allows the integration into the AMS® (Asset Management System) from Fisher-Rosemount.

11.4.3 Custody transfer mode

Micropilot S is a weight and measure approved level transmitter. Either the innage or the ullage can be selected as the custody transfer variable.

The selected variable is the basis for the subsequent calculation of the current amount of product in a tank, along with other measured variables such as (average) temperature and pressure.

This opens up numerous application options in custody transfer:
- Quantity calculation of mineral oils
- Quantity calculation of alcohols

11.4.4 Weight and measure approval, Standards Authorities approval, Compulsory reapproval

The *type approvals for custody transfer* issued by the PTB and NMi, a copy of which is enclosed with every device, prove the fundamental suitability of the various types for custody transfer.

In addition to this, the *accuracy* of every single device is documented using a calibration certificate, which is issued in the factory after the device has been tested on a reference test rig.

On request, a separate *initial verification* of the devices can be carried out with a National Standards Authorities inspector present, who issues a *preliminary test certificate* for every device. In the initial verification, the device is tested to ensure that it complies with the *limit of error in legal metrology*, which lies at +-2mm for radar measuring devices in Germany.

Essentially, this proves that the devices are *weight and measure approved*. The devices must not, however, be used in custody transfer mode straight away.

The measuring device is not approved until after the *approval after installation* by the Standards Authorities. For this, the device's level measurement is compared with the tank gauging by a National Standards Authorities inspector using manual dips (also "Initial verification"). As a rule, a quiescent tank gauging is dipped by hand three times in a row and then compared with the value displayed by the level radar. Depending on national regulations, the transfer error limit, calculated as the arithmetic mean of the absolute deviations of all three measurements, must not exceed double the limit of error in legal metrology (compare, for example, the German "Eichordnung" or the American "API 3.1B", in which the necessary procedures are also defined).

Depending on national regulations, this test is repeated with various tank gaugings. Using linearisation tables to compensate any non-linearities that occur in measurement is permitted. For this, the Micropilot S level radar offers a special dip table, compare Chapter 6.5.

After the measurement has been approved by an inspector, he seals the level radar at the stamp position and thereby also secures the programming status of the device.

Those operating an approved level transmitter are obligated to obtain *reapproval* in accordance with the applicable national regulations from the Standards Authorities.

11.4.5 Particularities in "approved" operation

The Micropilot S level radar is set to custody transfer mode after commissioning using a custody locking switch (see Page 38). The position of the custody locking switch is secured and sealed using the sealing pin.

During custody transfer measurement, all custody transfer-relevant functions for operation are automatically locked, so that the custody transfer-relevant device software can not be used, either via local operation or via digital communication settings. This locked status is displayed by the key symbol (⚷).

Micropilot S radar devices continuously monitor the compliance with accuracy requirements for custody transfer measurements according to OIML R85. If, for example, the accuracy cannot be maintained due to quick surface movements, this is reported via a separate alarm in the local display (displays "#" symbol) and via digital communication.

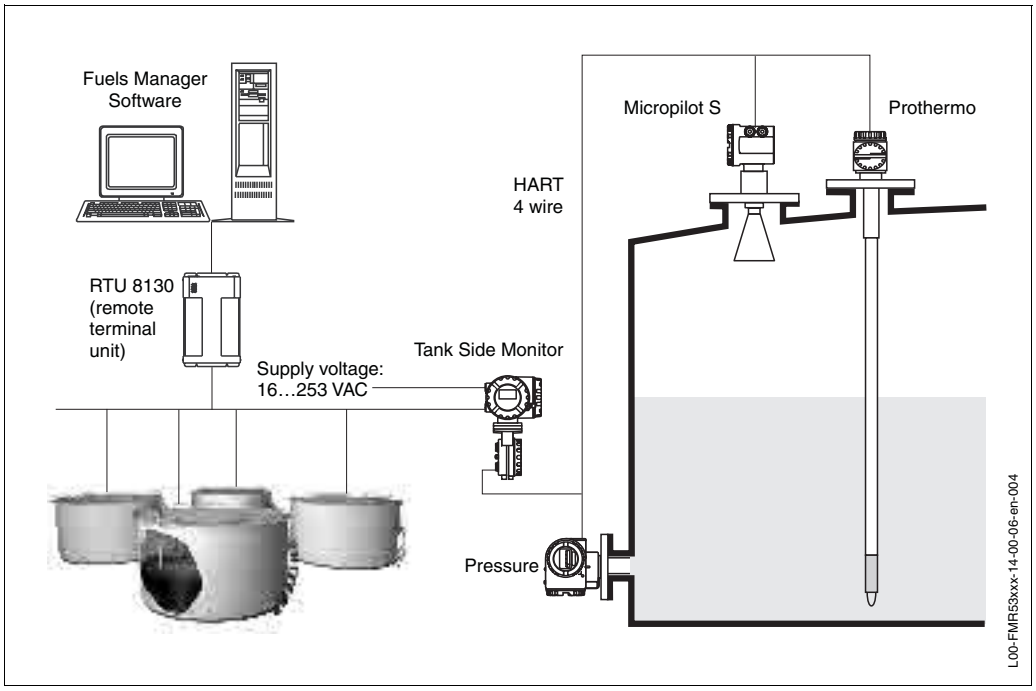
11.4.6 Definition of terms

For definitions and procedures please refer to the following documents:

- Manual of Petroleum Measurement Standards, Chapter 3 - Tank Gauging, Section 1.B - Standard Practice for Level Measurement of Liquid Hydrocarbons in Stationary Tanks by Automatic Tank Gauging, American Petroleum Institute, second edition, 2001
- OIML R 85, Organisation Internationale de Métrologie Légale, International Recommendation R 85, edition 1998 (E)

11.4.7 Integrated on tank gauging system

The Endress+Hauser Tank Side Monitor NRF 590 provides integrated communications for sites with multiple tanks, each with one or more sensors on the tank, such as radar, spot or average temperature, capacitive probe for water detection and/or pressure sensors. Multiple protocols out of the Tank Side Monitor guarantee connectivity to nearly any of the existing industry standard tank gauging protocols. Optional connectivity of analog 4...20 mA sensors, digital I/O and analog output simplify full tank sensor integration. Use of the proven concept of the intrinsically safe HART bus for all on-tank sensors yields extremely low wiring costs, while at the same time providing maximum safety, reliability and data availability.



This product may be protected by at least one of the following patents.
Further patents are pending.

- US 5,387,918 ≙ EP 0 535 196
- US 5,689,265 ≙ EP 0 626 063
- US 5,659,321
- US 5,614,911 ≙ EP 0 670 048
- US 5,594,449 ≙ EP 0 676 037
- US 6,047,598
- US 5,880,698
- US 5,926,152
- US 5,969,666
- US 5,948,979
- US 6,054,946
- US 6,087,978
- US 6,014,100

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Declaration of contamination

Dear costumer,
Because of legal determinations and for the safety of our employes and operating equipment we need this "Declaration of contamination" with your signature before your order can be handled. Please put the completely filled in declaration to the instrument and to the shipping documents in any case. Add also safety sheets and/or specific handling instructions if necessary.

type of instrument / sensor: _____ serial number: _____

medium / concentration: _____ temperature: _____ pressure: _____

cleaned with: _____ conductivity: _____ viscosity: _____

Warning hints for medium used:

☐ radioactive ☐ explosive ☐ caustic ☐ poisonous ☐ harmful of health ☐ biological hazardous ☐ inflammable ☐ safe

Please mark the appropriate warning hints.

Reason for return:

_____

_____

Company data:

company: _____ contact person: _____

_____ _____

_____ department: _____

address: _____ phone number: _____

_____ Fax/E-Mail: _____

_____ your order no.: _____

I hereby certify that the returned equipment has been cleaned and decontaminated acc. to good industrial practices and is in compliance with all regulations. This equipment poses no health or safety risks due to contamination.

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