

Mikroimpuls-Level Measurement *levelflex FMP 232 E/332 E*

Level measurement of bulk solids Version for use in hazardous areas



left:
Levelflex FMP 332 E
with threaded flange
(accessory), heavy duty
8 mm rope and ballast
weight

right:
Levelflex FMP 232 E
with threaded
connection, 4 mm rope
and ballast weight



Application

Levelflex FMP 232 E/332 E is a compact level transmitter for bulk solid applications. It has a galvanically isolated current output, optionally with HART communication signal. The probe is mounted in the top of the silo and measures the time that a high frequency impulse requires to cover the distance from the process connection to the product surface and back – the time-of-flight.

Levelflex measures independent of the physical properties of the bulk solid, e.g. moisture content, grain size, pressure and temperature. It is suitable for all bulk solids with grain size up to 20 mm and a dielectric constant of 1.8 or greater, e.g. sand, cement, limestone, agricultural products, flour, animal feed, fly-ash or coal.

If the dielectric constant is not known, then the density of the material can be used as a good guide to estimate it. Experience has shown that measurement can easily be carried out with densities greater than 500g/l or if it has a high moisture content. The DK should be measured or a pilot trial carried out on very dry materials or if the density is below 500 g/l.

Features and Benefits

- Simple commissioning due to factory adjustment – on-site calibration is seldom required: mount and measure
- Safe measurement – no problems with pneumatic filling or extremely dusty conditions
- Measurement independent of product properties (moisture content, change of product), silo construction (materials, geometry) and operating conditions (dust, build-up)
- Remote operation through HART communication protocol

Endress + Hauser

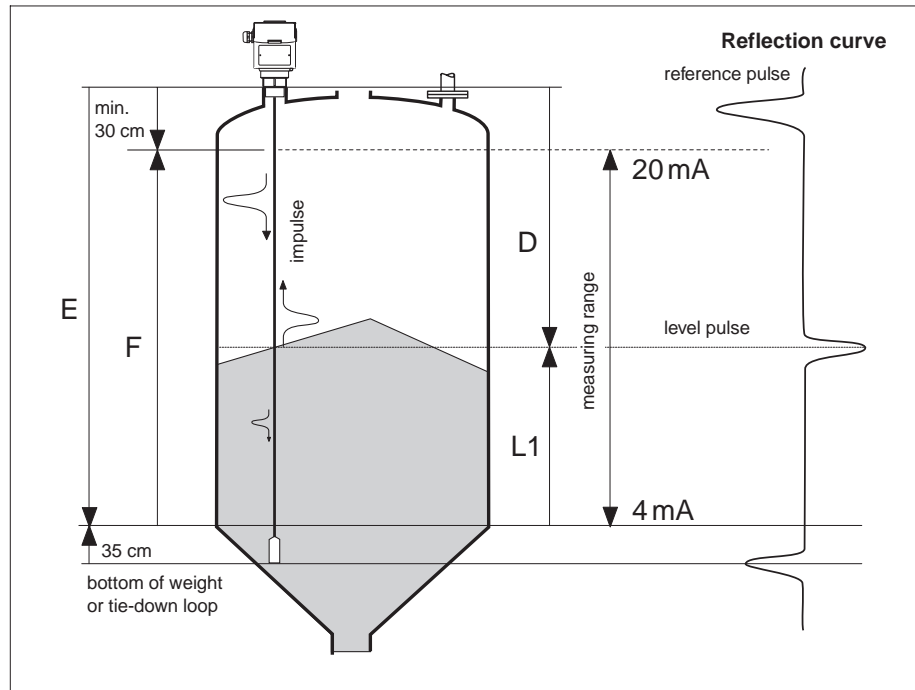
The Power of Know How



Measurement Principle

Measurement principle and signal processing of Levelflex FMP 232 E/332 E

Factory settings:
 E = (Zero) 35 cm above the probe end,
 F = (Span) 90 % E, but not nearer than 30 cm to top thread of process connection.



Levelflex is a “downward-looking” time-of-flight system, which measures the distance from the probe mounting (top of silo) to the material level. An electrical impulse is launched and guided down the probe rope, which acts as a surface wave transmission line.

When the surface wave meets a discontinuity in the surrounding medium, i.e. a sudden change in dielectric constant, it is partially reflected. The reflected impulse travels back up the probe to the pulse sampler where it is detected and timed.

Input

Each point along the probe is sampled for its pulse reflection behaviour. The information accumulated over the sampling cycle is captured and passed on to the signal processing, which identifies the signal produced by the change in dielectric constant at the air/product interface.

The distance D to the surface of the product is proportional to the time of flight of the pulse t :

$$D = c \cdot t/2,$$

where c is the speed of propagation.

Since the empty distance E is known to the system, it is a simple matter to calculate the level $L1$:

$$L1 = E - D$$

The datum point for “ E ” is the top thread of the process connection.

Output

Levelflex leaves the factory pre-calibrated:

- zero (E) is 35 cm above the end of the ballast weight or tie-down loop
- span (F) is 90% of E
- the measuring range is adjustable between a point 30 cm below the top of the process connection thread and a point 35 cm above the probe end for versions with ballast weight. For versions with tie-down, the lowest measurable point lies 5 cm above the top end of the tie-down loop, i.e. 200 mm above the probe end for FMR 232E and 350 mm above the probe end for FMR 332E.

In the factory adjustment these points correspond to the current output values 4 mA and 20 mA or digital output values 0 and 100. The range and units may be re-adjusted locally at the display or remotely via the foreign system interface.

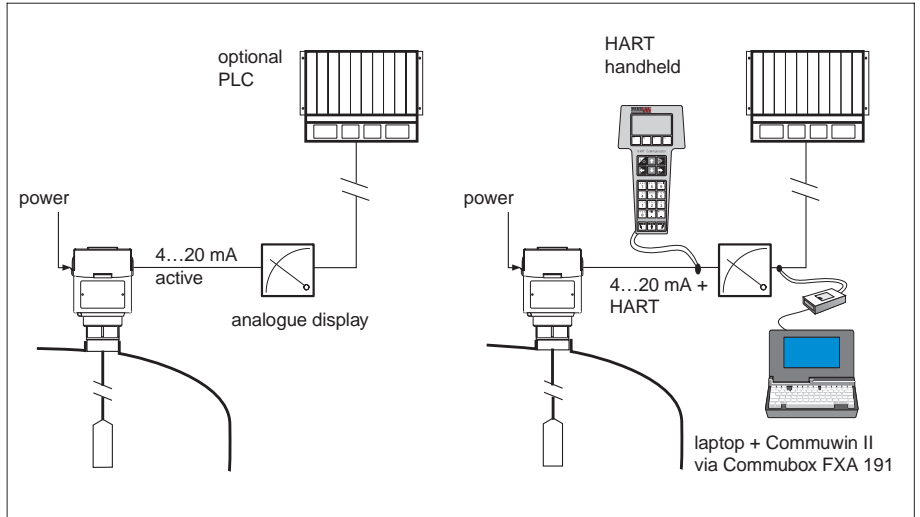
Accuracy

When fully extended and hanging vertical in the silo, Levelflex is capable of measuring at all points from the top of the ballast weight or tie-down loop to within 30 cm of the mounting point to a measured error of $\pm 1\%$, see Technical Data.

Measuring System

left:
Single measuring point with 4...20 mA signal

right:
Single measuring point with HART output



4...20 mA Current Output

Version with active current output and local configuration only.

4...20 mA HART Output

Version with active current output and superimposed HART digital signal.

- Can be configured locally, or remotely with a handheld terminal DXR 275.
- Alternatively a personal computer, Commuwin II and Commubox FXA 191 can be used.

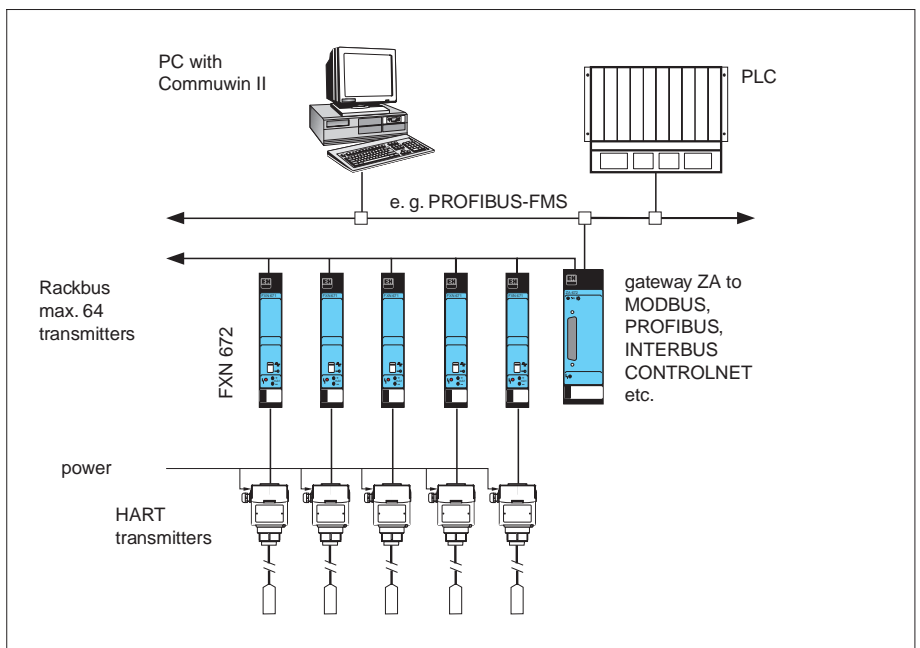
System Integration via Rackbus

Several Levelflex transmitters (or other devices) can be linked to a supervisory bus system with a gateway ZA.

- HART transmitters via one FXN 672 interface module each – also provides power.

- Gateways are available for MODBUS, PROFIBUS-FMS and -DP INTERBUS, CONTROLNET etc.
- Both on-site and remote operation is possible

System integration of HART transmitters via a Rackbus gateway



Probe Selection

Process Connection

Levelflex is equipped with either a BSP 1½" (G 1½" to DIN/ISO 228) or 1½" - 11,5 NPT threaded connection.

- The pressure and temperature derating curves are shown in the diagram.
- Standard adapter flanges with a threaded bore are available as accessories.

Rope Material

Two types of rope are available:

- stainless steel rope for standard and corrosive applications.
- PA 12-coated carbon steel rope for use with abrasive and build-up forming media

Rope Thickness and Length

Two thicknesses 4 mm und 8 mm and customer specific lengths of rope are available.

Standard Applications

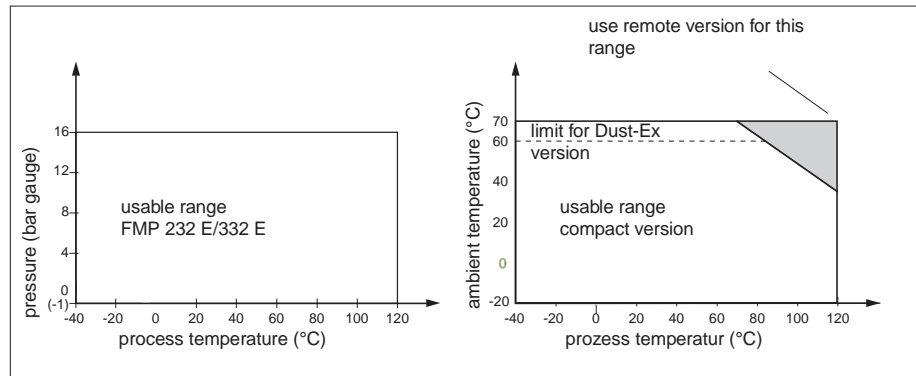
For standard applications an uncoated stainless steel rope with ballast weight is recommended.

Electrostatic Discharge

If the product tends to charge up during handling extremely, we recommend that a grounding chain is hung in the filling stream.

left:
pressure versus
temperature on process
connection

right:
ambient temperatur
versus temperature
on process connection



Safety

Down-Pull Forces

The silo roof and probe rope must withstand the down-pull of the medium.

- The down-pull is dependent upon the bulk density and coefficient of friction of the material, the size of the silo, the position in the silo and the selected probe.

Breaking Strength

The breaking strength for the standard rope (FMP 232 E) and heavy duty rope (FMP 332 E) is shown in the table.

| Type | Coated rope | Stainless steel rope |
|-----------|-------------|----------------------|
| FMP 232 E | 12.5 KN | 10.5 KN |
| FMP 332 E | 43.5 KN | 40.0 KN |

Forces on Ropes with Ballast Weight

The table below summarises the down-pull forces and permissible rope lengths for the **free-hanging** version with ballast weight. They are based on measurements, calculations and experience. The values for individual cases may be significantly different.

- For silos less than 10 m dia. the full length applies to all the cases described.
- The down-pull forces are shown to assist the user in considering safety factors.

Forces on Ropes with Tie-Down

Depending upon their position in the silo, the forces on ropes with tie-downs are two to ten times greater than on ropes with ballast weights.

- Forces increase with buried length and silo diameter. Both parameters are of equal importance.
- Allow a good safety factor.

Worst case pull-down forces as a function of fully buried rope and material for a 12 m diameter silo.
L max = maximum probe length

| Material | 4 mm uncoated | | 4 mm coated | | 8 mm uncoated | | 8 mm coated | |
|-----------------------|---------------|-----------|-------------|-----------|---------------|-----------|-------------|-----------|
| | L max | pull (kN) | L max | pull (kN) | L max | pull (kN) | L max | pull (kN) |
| Wheat | 10 | 1 | 10 | 1,4 | 20 | 5,2 | 20 | 7,2 |
| Polypropylene pellets | 10 | 0,7 | 10 | 0,9 | 20 | 3,6 | 20 | 3,6 |
| Gravel | 10 | 4,5 | 10 | 6 | 20 | 26 | 19 | 43 |
| Cement | 10 | 6 | 10 | 7 | 20 | 38 | 20 | 39 |

Installation Hints

Environment

The normal operating temperature range is -20°C to $+70^{\circ}\text{C}$.
Dust-Ex max. $+60^{\circ}\text{C}$

- For higher ambient temperatures, the remote mount option allows the head to be positioned at a cooler location up to 3 m away.
- For outdoor installation, we recommend the use of a protective cover.

Medium temperature

- The temperature of the medium may not exceed $+120^{\circ}\text{C}$.
 - The effects of abrasive media can be counteracted by the choice of a coated probe rope.
- Max. grain size 20 mm.

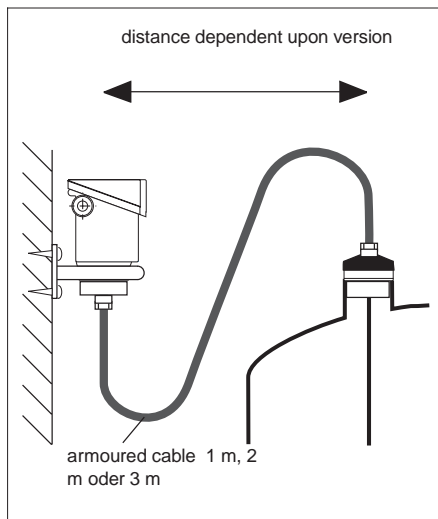
Remote housing

The remote housing is designed for use with high temperatures, moisture or strong vibration wherever the sensor is mounted.

Cable length of separat housing

For bulk solids with a dielectric constant of less than 2.5, the maximum measuring range decreases with the cable length of the separate housing according to the following table:

| Cable length of separat housing | Maximum measuring area |
|---------------------------------|------------------------|
| 1 m | 19 m |
| 2 m | 18 m |
| 3 m | 17 m |



separate housing

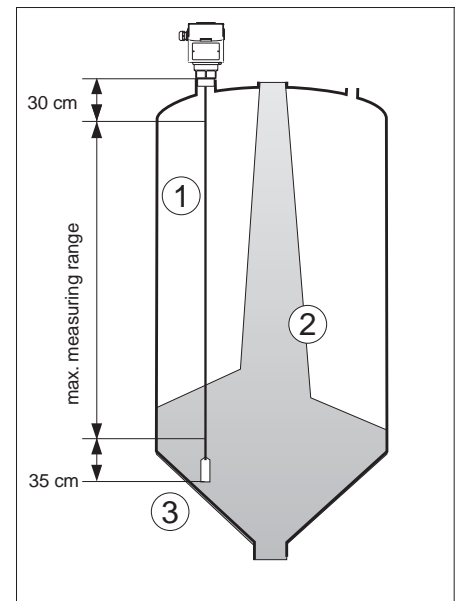
Medium

Levelflex measures reliably in fine-grained solids as varied as cement, sand lime, flyash, aggregates, plastic pellets, and powdered materials. For other media a guideline is a relative dielectric constant of 1.8 or more.

Mounting Position

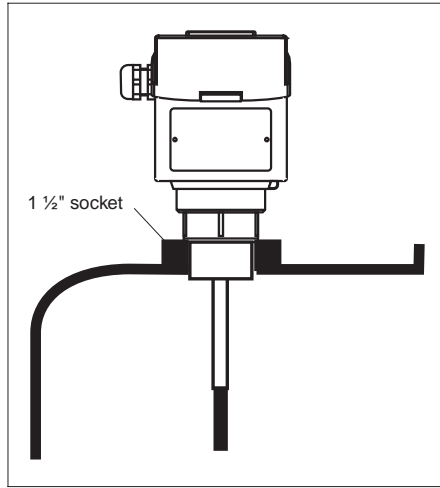
Levelflex is top-mounted. The probe rope must be hung, fully extended, across the entire distance where level readings are desired and well away from the silo wall.

- Select the rope length according to the measurement range required - it can be shortened by the customer.
- The probe must be installed at least 30 cm away from the wall in metal silos and 40 cm away from the wall in concrete silos.
- Do not install the probe in the centre of cylindrical, metal silos.
- Position the probe such that it is subject to the minimum of lateral force.
- The distance between the probe tip and silo bottom has no minimum requirement.



Selecting the best mounting position

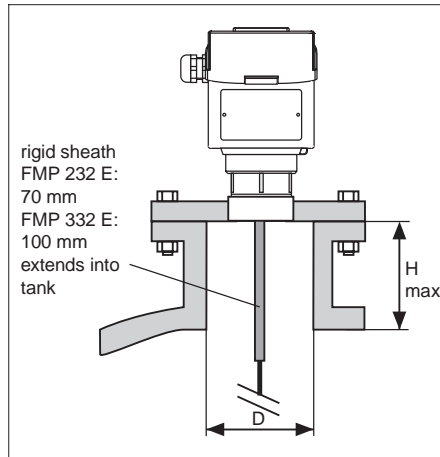
- ① At least 30 cm away from the silo wall or any structural element, but always off-centre
- ② Not in the filling stream
- ③ If there is a danger of the probe hitting fittings, use the tie-down option



Recommended mounting method

Threaded Connection

Ideally, the Levelflex is to be mounted on the silo in a 1 1/2" socket, such that the lower face of the thread projects into the silo or is flush with the inside of the silo roof.



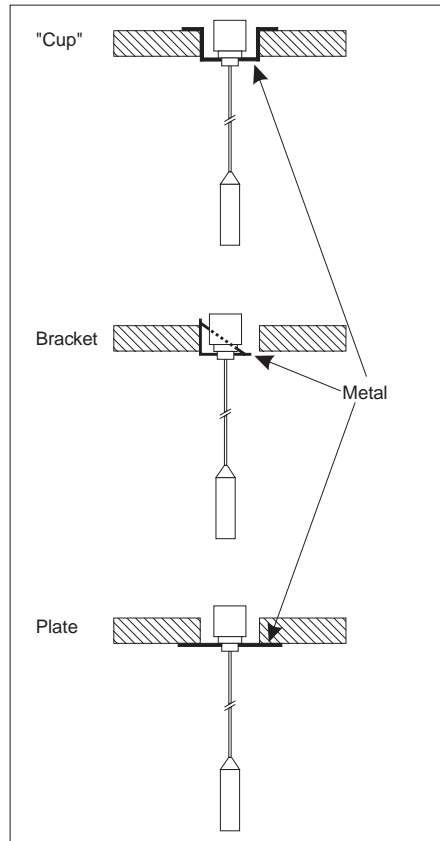
Mounting in a nozzle, see table for permitted nozzle dimensions

Nozzles

If it is not possible to mount the Levelflex in a socket, a nozzle may be used. Nozzles with the following dimensions are permitted:

| D | 50 mm | 80 mm | 100 mm |
|-------|-------|-------|--------|
| H max | 50 mm | 80 mm | 100 mm |

Nozzles with other dimensions should be avoided.



Mounting in Concrete roof

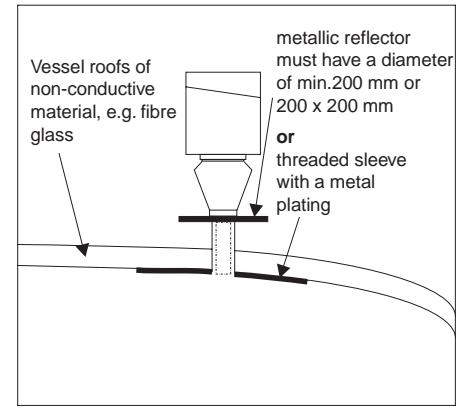
Installation in Concrete Bunkers

If the Levelflex is to be installed in a thick concrete bunker, for example, then the front face of the process connection should be flush with the inside of the bunker roof.

The figure shows installation examples.

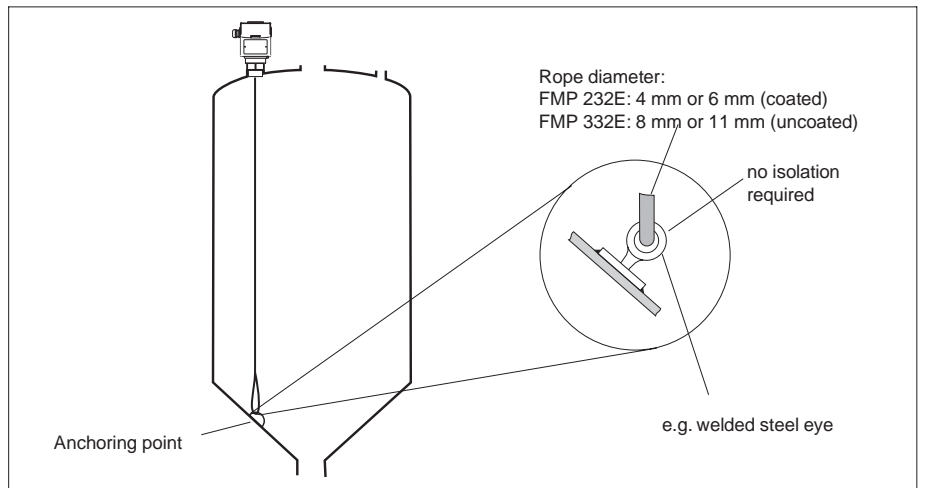
Installation in plastic or wood silos

The sensor must be installed in a metal part to act as a reflector when it is installed in a plastic or wood silo. This can be a flange from DN 100mm/4" or larger, or a reflector similar to that shown in the following picture:



Rope probe with loop

Anchoring a tie-down version at a suitable point



Ballast weight

Levelflex is usually provided with a ballast weight. The ballast weight should not be used for anchoring.

Version with loop

Secure the end of the rope is necessary, however,

- in order to prevent the probe from contacting the silo wall
- in order to prevent the probe from rubbing against internal fittings
- in order to prevent the ballast weight from working its way upwards in particularly heavy solids or material movements.

In this case the tie-down version of the Levelflex is recommended.

Secure the end of the rope

The probe rope itself is to be used for anchoring. In this case, order a longer probe than necessary for the application at hand. Special tie-down versions up to 22 m long can be ordered if a measuring range of 20 m is required. Pull the probe rope through a suitable anchoring point, e.g. welded eye. The rope need not be electrically isolated from the anchor, since this has no effect on the measurement.

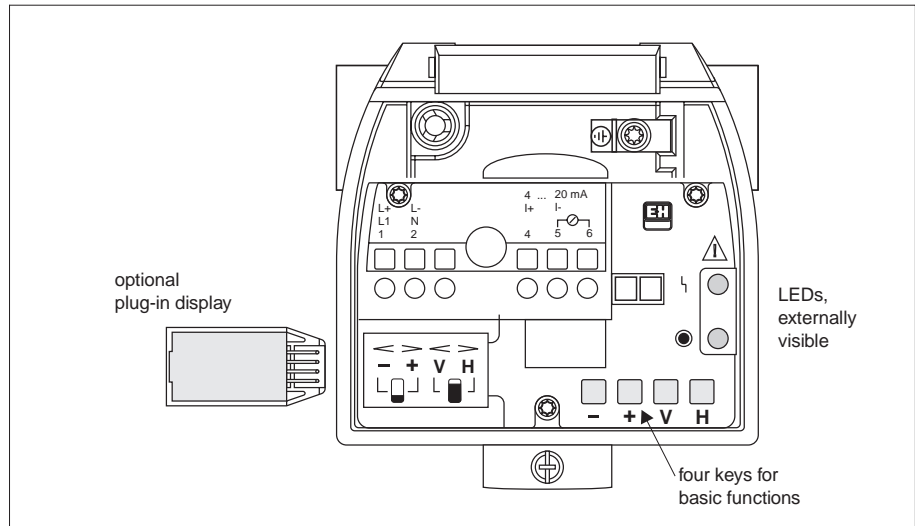
Important Note for Tie-Downs

A display module or version with HART communication is required for commissioning of the Levelflex FMP 232E or FMP 332E. The display can be unplugged after use and is available for other Levelflex units.

Versions with HART communication can in addition be operated from the Commuwin II operating and display program or with a HART handheld DXR 275.

User Interface

Operating elements of Levelflex



Operating Elements.

The operating elements are located within the probe housing and are accessible when the cover is open.

Basic Version

The Levelflex has four keys and two LEDs.

- The LEDs indicate the transmitter status:
 - the green LED lights during operation and blinks when the keys are pressed.
 - the red LED lights when there is a transmitter failure.
 - the LEDs are visible when the housing lid is closed.
- The keys can be used (see ①):
 - to change the "empty" and "full" output settings,
 - to lock and unlock the configuration mode,
 - to trigger "probe mapping", if the installation position calls for it,
 - to trigger a reset,

Plug-In Display

Levelflex can also be equipped with an optional display module for configuration and diagnosis.

- With the display in place, the keys enable local configuration of the Levelflex advanced functions via an operating matrix (see ②), e.g. entries after rope shortening.
- The display is not essential to normal operation and may be moved from unit to unit.

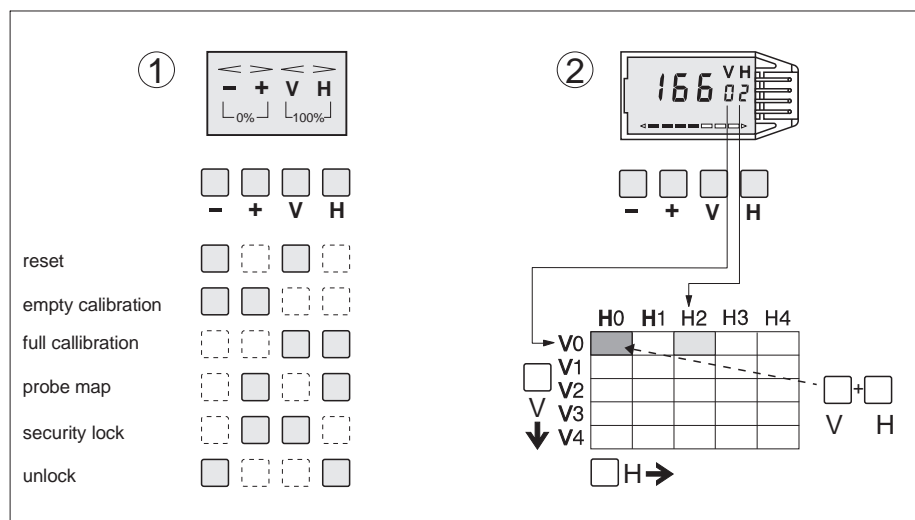
Remote Configuration

Levelflex versions with HART electronics can be remotely operated via the HART protocol. To this end, a HART handheld DXR 275 or a PC with the Commuwin II operating and display program is required.

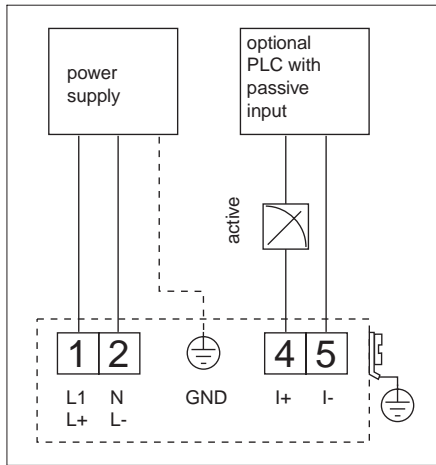
- Local configuration is still possible.

left:
Levelflex is configured by the four keys

right:
Advanced functions are called via the operating matrix using the optional display or PC and Commuwin II



Electrical Connection



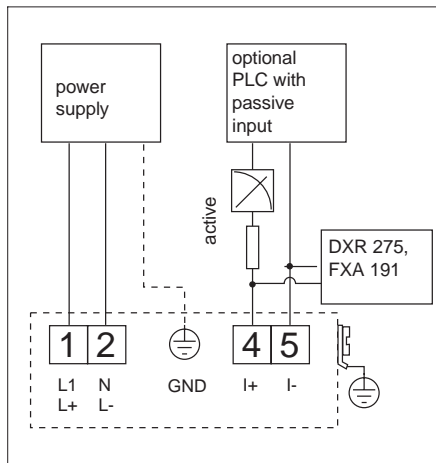
Wiring diagram 4...20 mA current output

4...20 mA Current Output

Four-wire transmitter with active current output.

- Maximum output load 500 Ohm,
- Power DC: 18...36 V, AC: 90...127 V or 180...253 V.
- Dust-Ex: DC: 18...36 V, AC: 104...127 V or 207...250 V.

Use separate standard installation cable for power and output lines.



Wiring diagram 4...20 mA HART output

4...20 mA HART Output

Four-wire transmitter with active current output and superimposed HART digital signal.

- Minimum output load 250 Ohm
- Maximum output load 500 Ohm,
- Power DC: 18...36 V, AC: 90...127 V or 180...253 V.
- Dust-Ex: DC: 18...36 V, AC: 104...127 V or 207...250 V.

Use standard installation cable for the power line, and shielded twisted pairs for the output line.

Technical Data

General information

| | |
|------------------------|-------------------------------|
| Manufacturer | Endress+Hauser |
| Instrument designation | Levelflex FMP 232 E/FMP 332 E |

Application

| |
|--|
| Continuous level measurement of fine to coarse grained solids using contact-type probe |
|--|

Function and system design

| | |
|-----------------------|--|
| Measurement principle | Guided time-of-flight via microimpulse time domain reflectometry (MITDR) |
| Modularity | Compact four-wire instrument comprising transmitter and integral probe Optional remoted electronics version, with pipe or wall mounting kit Optional display |
| Signal transmission | 4-20 mA with HART Protocol as option |

Input

| | |
|-------------------|---|
| Measured variable | Level, determined by the time-of-flight of a guided microwave impulse from process connection to product surface and back |
| Measuring range | FMP 232 E: 0.3 – 10 m; zero and span adjustable FMP 332 E: 0.3 – 20 m; zero and span adjustable |

Output

| | |
|-------------------|--|
| Versions | Analogue 4 – 20 mA output Analogue 4 – 20 mA output activ with superimposed HART digital signal |
| Output signal | Analogue: useable output current range 3.8mA...20.5mA Digital: –9999 to +9999 |
| Output resolution | 10 bit (equivalent to 0.1% FS or microamps) |
| Load | Analogue: max. 500 Ω HART: 250 Ω – 500 Ω |
| Signal on alarm | Adjustable: MIN, MAX or HOLD; analogue: MIN =2.4 mA, MAX=22.0 mA digital: MIN = –9999, MAX. = +9999 |
| Output damping | Adjustable 0 – 250 s |
| Turndown | Max. 10:1 |

Accuracy

| | |
|----------------------------|--|
| Reference conditions | Reflection from flat surface of 3mm plastic pellets; temperature 20°C; output scaled to 90% of probe length, probe rope fully extended |
| Measured error | ± 1% FS |
| Resolution | 0.3% of probe length |
| Repeatability | 0.2% FS |
| Hysteresis | better than 0.5% FS |
| Settling time | ≤ 2 s |
| Warm-up time | 30 s |
| Ambient temperature effect | ± 0.01% FS/K |
| Process temperature effect | ± 0.02% FS/K |
| Linearity | ± 1% FS (independent linearity) |

Operating conditions

| | |
|-----------------------|--|
| Installation | |
| Orientation | Vertical; top-mounted, minimum 30 cm from wall or structural element (in Concrete silos 40 cm) |
| Silo geometry effects | No influence on measurement by silo shape, materials of construction or sensor movement under above conditions |

Operating conditions (cont.)

Environment

| | |
|-------------------------------|--|
| Operating temperature range | -20°C...+70°C, Dust-Ex version -20°C...+60°C |
| Limiting temperature range | -40°C...+80°C, Dust-Ex version -20°C...+60°C |
| Storage temperature | -40°C...+80°C |
| Ingress protection | Housing: IP67, Nema 4X, 6 (open housing: IP20, Nema 1) Probe: IP68, Nema 4X, 6 |
| Climate class | DIN/IEC 68 part 2-30 Db, 4K2 per EN 60721-3-4 (1995) |
| Thermal shock rating | DIN/IEC 68 part 2-14 NB (1K/min across temp. range) |
| Vibrational resistance | DIN/IEC 68 part 2.6 (2g) |
| Electromagnetic compatibility | EN 61 326-1, EN 50 081-1, EN 50 082-2 The device is suitable for use in industrial environments |

Medium

| | |
|----------------------------------|---|
| Process temperature range | -40°C...+120°C on the Process connection |
| Process pressure range | Vacuum to 16 bar gauge |
| Properties and effects of medium | Medium must have a minimum relative dielectric constant of 1.8 No influence on measurement by density, particle size, surface angle, moisture content. |

Mechanical construction

Housing

| | |
|---------------------------|---|
| Material | PC/ABS Flame Retardant, housing gaskets and O-rings: EPDM |
| Cable and conduit entries | M 20x1.5 Pg 16 (gland supplied), ½ NPT, G ½ |
| Cable | See Electrical Connection, page 9 |

Process connection

| | |
|----------------------|--|
| Type | Threaded connection 1 ½ NPT or 1 ½ BSP (G 1 ½); compatible with installation in all flanges 1 ½" (or 40mm) nominal or larger |
| Seals | EPDM O-rings |
| Plastic wetted-parts | FMP 232 E: PPS, FMP 332E: PTFE; steel or stainless steel 1.4435 |

Probe

| | |
|--|--|
| Dimensions | see pages 12-14; clearance for mounting: FMP 232E: min. 600 mm, FMP 332E: min. 800 mm |
| Material of wire rope and ballast weight/tie-down loop | FMP 232E: Rope and weight in 1.4301, or Steel rope coated with PA 12 and steel weight FMP 332E: Rope and weight in 1.4401, or Steel rope coated with PA 12 and steel weight |
| Wire rope diameter | FMP 232 E: 4 mm uncoated, 6 mm coated FMP 332 E: 8 mm uncoated, 11 mm coated |
| Rope breaking strength | FMP 232 E: 10.5 kN (uncoated) / 12.5 kN (coated) FMP 332 E: 40.0 kN (uncoated) / 43.5 kN (coated) |
| Weight of probe + housing | FMP 232 E: 4.8 kg + 0.08 kg/m of probe, ballast weight 0.35 kg FMP 332 E: 5.6 kg + 0.3 kg/m of probe, ballast weight 2.07 kg |

User interface

| | |
|---------------------------------|--|
| Keypad | 4 rubberised keys for matrix navigation, data entry, and system security |
| Indication (externally visible) | Green and red LEDs indicate system status |
| Optional display (internal) | 4 digit LCD (parameter), with alphanumeric matrix location indication |
| Foreign system interface | None or HART, depending on version |

Power

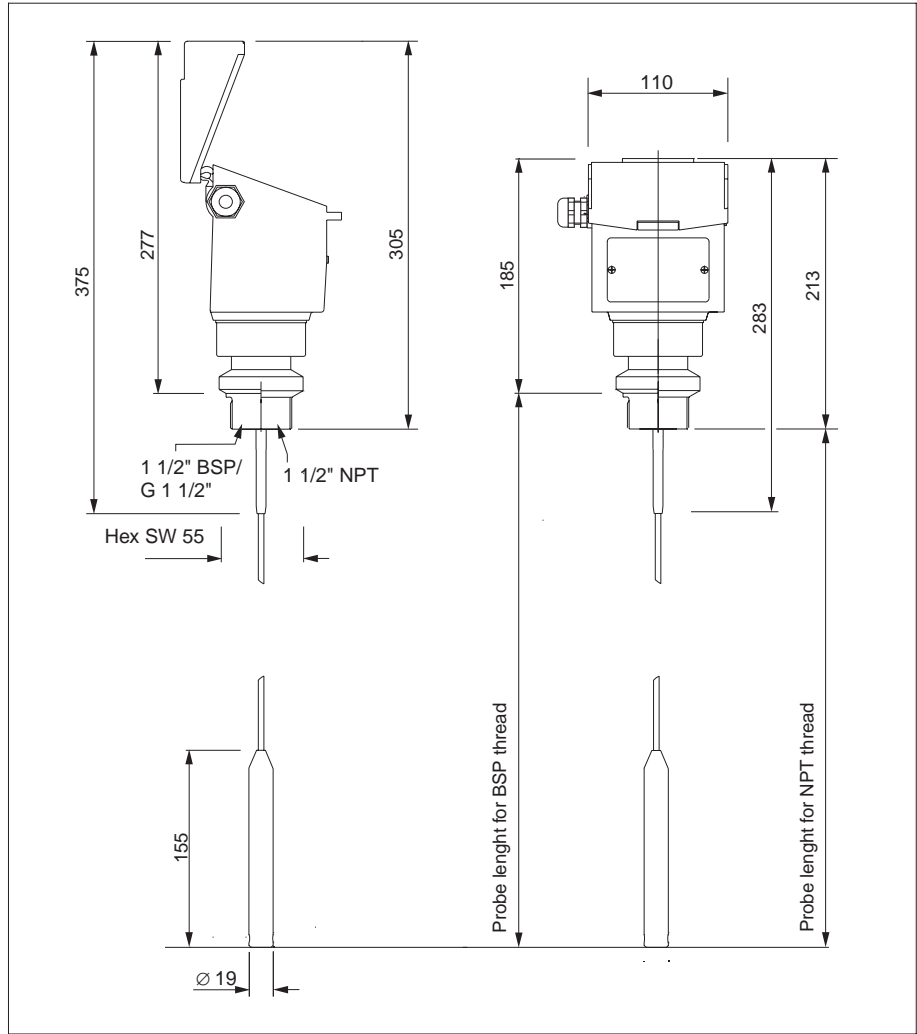
| | |
|----------------------------|---|
| Supply voltage/consumption | AC version: 90-127 VAC or 180-250 VAC; 50/60Hz; 3.5 VA for Dust-Ex: 104 - 127 VAC and 207 - 250 VAC DC version: 18-36 VDC; 1.5 W |
| Specifications for HART | Ripple: 47...125 Hz: $U_{pp}=200$ mV (measured at 500 Ω) max. noise: 500 Hz...10 kHz: $U_{rms}=2,2$ mV (measured at 500 Ω) |

Certificates and approvals

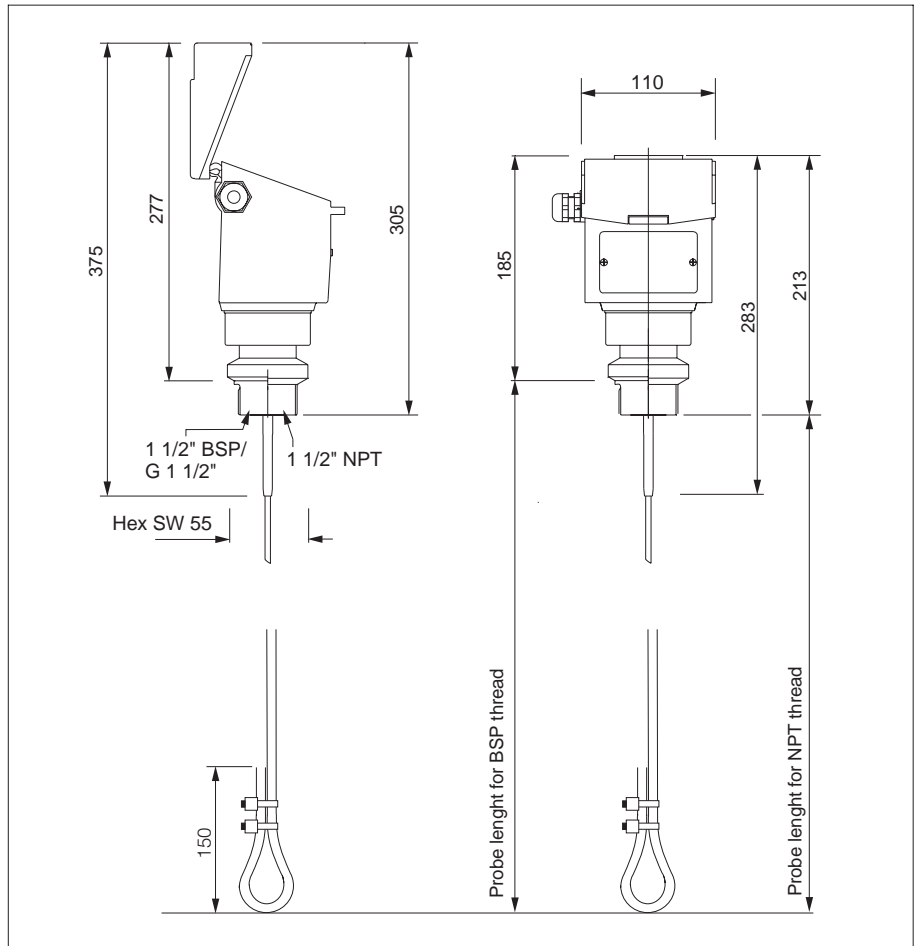
| | |
|--------------------------------|---|
| Electrical area classification | BVS Dust-Ex, Zone 10, ATEX II 1/3D FM Class II, Div 1, EFG with intrinsically safe probe Non-incendive Class I, Div. 2, A-D CSA: Associated equipment [Exi] Class II, Div. 1, Group G & coal dust Non-incendive Class I, Div. 2, Groups ABCD CSA General purpose TIIS Dust-Ex |
| Telecommunication | Meets FCC requirements for non-intentional radiators |
| CE Mark | In attaching the CE Mark, Endress+Hauser confirms that the device conforms to all relevant EU directives |

Dimensions FMP 232E

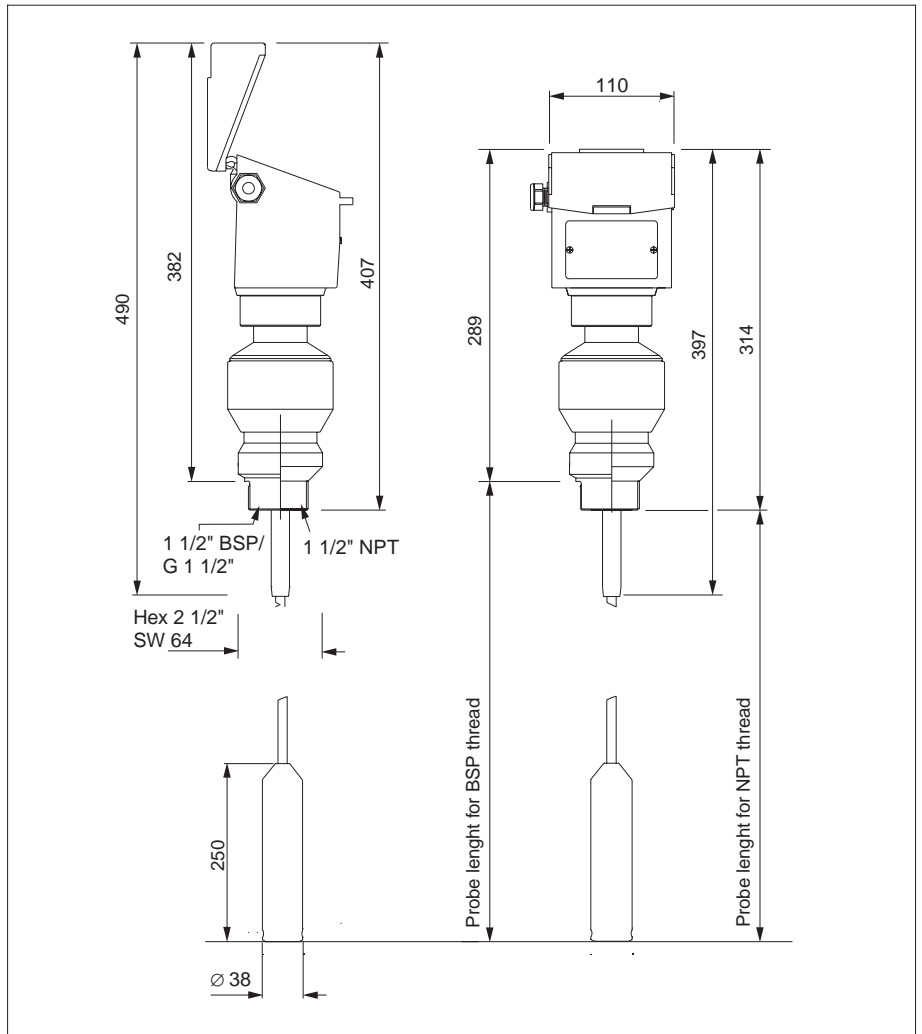
Principle dimensions
Levellflex FMP 232 E
with ballast weight:
Rope diameter:
4 mm uncoated
6 mm coated



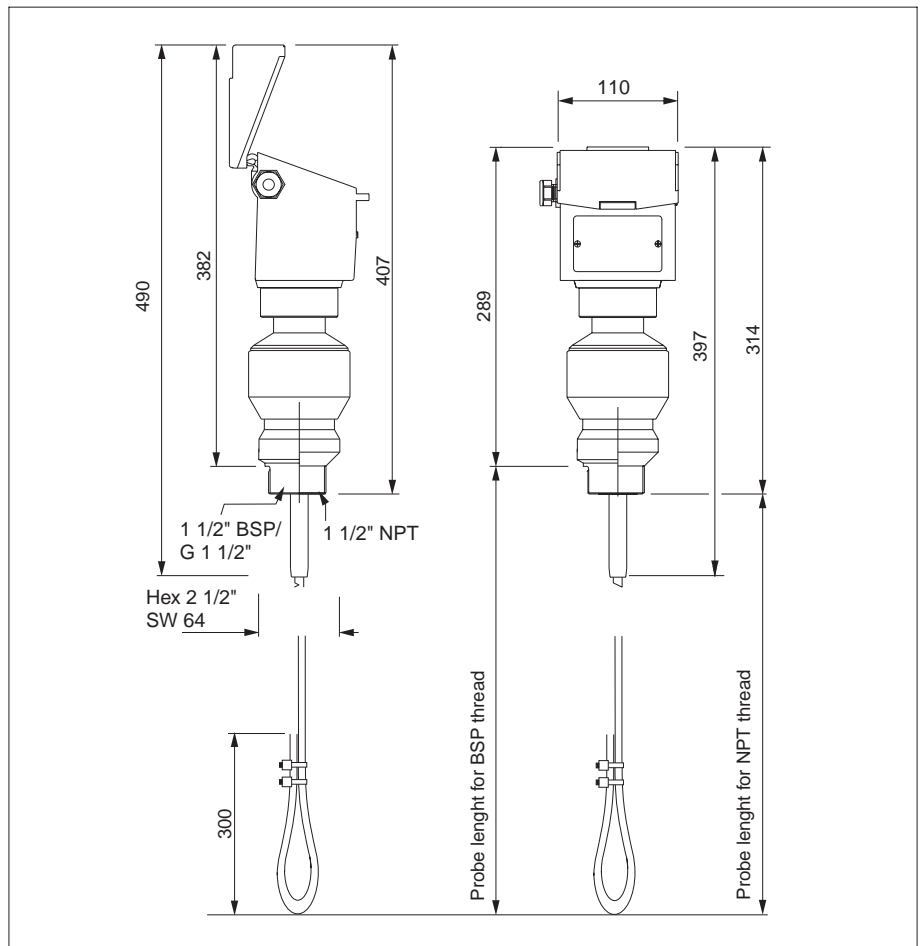
Principle dimensions
Levellflex FMP 232 E
with tie-down loop:
Rope diameter:
4 mm uncoated
6 mm coated



Dimensions FMP 332E



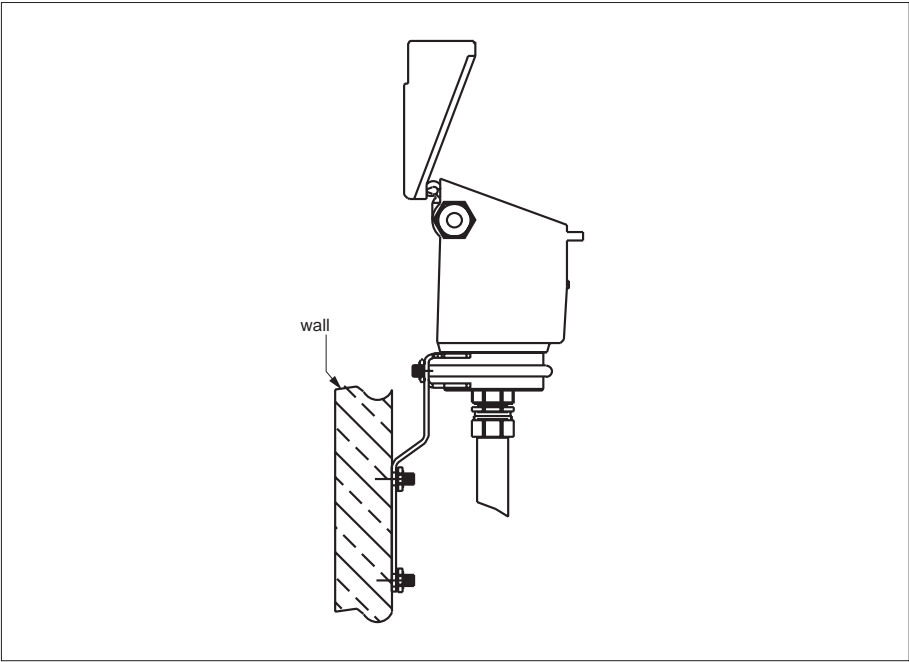
Principle dimensions
Levelflex FMP 332 E
with ballast weight:
Rope diameter:
8 mm uncoated
11 mm coated



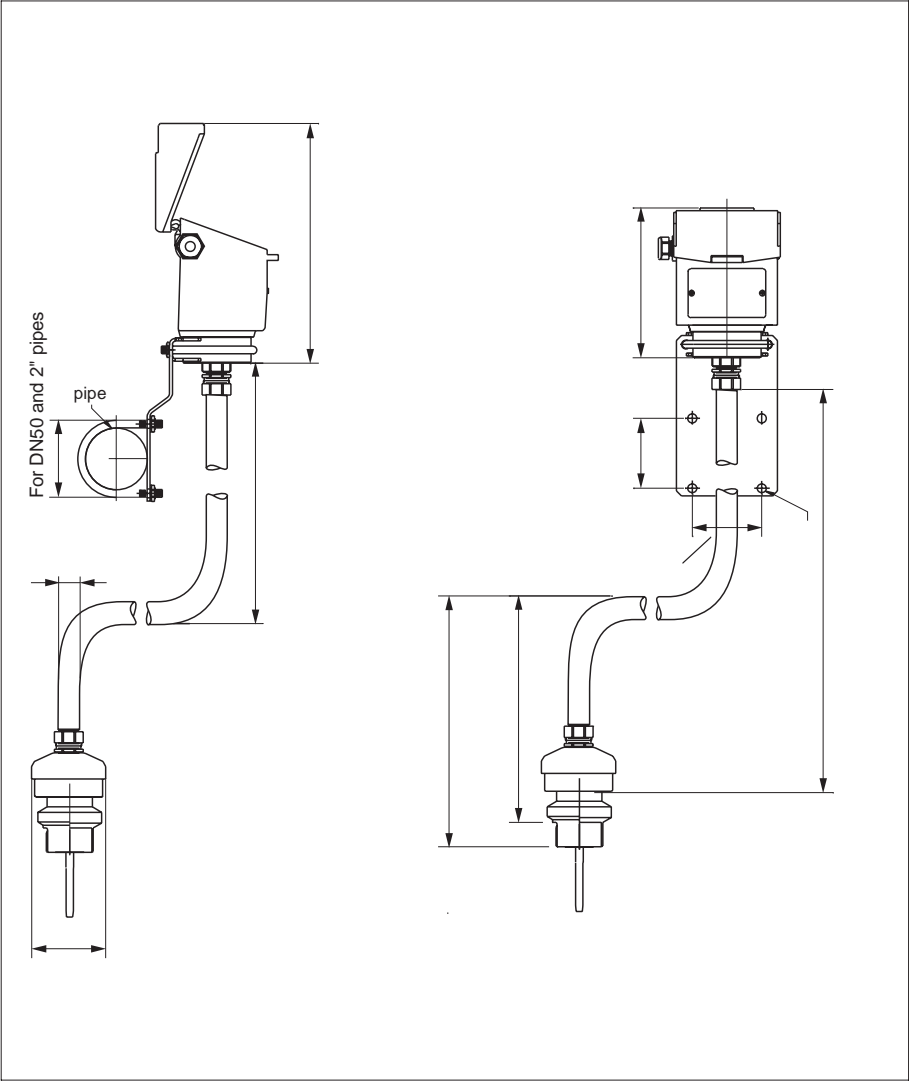
Principle dimensions
Levelflex FMP 232 E
with tie-down loop:
Rope diameter:
8 mm uncoated
11 mm coated

Dimensions

wall mounting



pipe mounting



Accessories

Adapter Flange with Threaded Connection

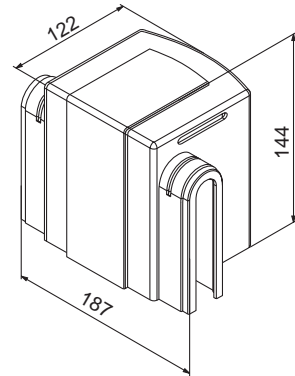
Stainless steel 1.4435 (AISI 316L)

| | |
|------------------------------|-----------------|
| Prozeßanschluß | |
| E12 | DN50 PN16 |
| E14 | DN80 PN16 |
| E15 | DN100 PN16 |
| A22 | ANSI 2" 150 psi |
| A24 | ANSI 3" 150 psi |
| A25 | ANSI 4" 150 psi |
| Sondenanschluß | |
| 3 | G 1 1/2 |
| 5 | NPT 1 1/2 |
| Flanschwerkstoff | |
| nichtrostender Stahl, 1.4435 | |

komplette Bestell-Nr.: **FAU70** **2**

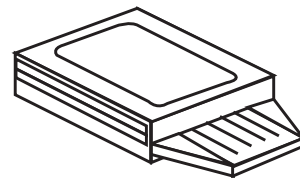
Protective Hood

Order Number: 942665-0000



Display Unit

Order No. 942663-0000



Special versions on request

e.g. version with replaceable rope

Supplementary Documentation

- Commuwin II
System Information SI 018F/00/en
- Rackbus
System Information SI014F/00/en
- HART handheld DXR 275
System-Information SI
- Commubox FXA 191
HART/RS-232 C Interface
Technical Information TI 237F/00/en
- FXN 672
Power supply unit for HART devices
Technical Information TI 295F/00/en

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