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Technical Information
Prosonic S FDU90

Ultrasonic measuring technology

Ultrasonic sensor for level measurement and flow measurement

Application

- Continuous, non-contact level measurement of liquids and bulk solids in silos, on conveyor belts, in material stockpiles and in crushers
- Flow measurement in open flumes and measuring weirs
- Maximum measuring range: 3 m (9.8 ft) in liquids; 1.2 m (3.9 ft) in bulk solids

Your benefits

- Integrated temperature sensor for time-of-flight correction, enabling accurate measurements even if temperatures change
- Hermetically welded PVDF sensor for maximum chemical resistance
- Suitable for harsh ambient conditions thanks to separate transmitter installation (up to 300 m (984 ft))
- Self-cleaning effect ensures minimum deposit build-up
- Weather resistant and flood-proof (IP68)
- International Dust-Ex and Gas-Ex certificates available

Endress+Hauser
People for Process Automation

Table of contents

Important document information 3
Document conventions 3

Function and system design 4
Level measurement 4
Flow measurement in flumes or weirs 4
Temperature-dependent time-of-flight correction 5

Input 5
Blocking distance 5
Measuring range 5
Operating frequency 6

Power supply 6
Supply voltage 6
Power supply to integrated sensor heater 6
Electrical connection 6
Connection diagram for sensor → FMU90 7
Connection diagram for sensor → FMU95 7
Extension cable specifications 7
Shortening the sensor cable 8

Installation 8
Installation conditions for level measurement 8
Installation conditions for flow measurement 9
Installation instructions 10
Installation options (examples) 10
Nozzle mounting 10
Ultrasound guide pipe for measurement in narrow pits 12
Securing the sensor 12

Environment 12
Degree of protection 12
Vibration resistance 12
Storage temperature 12
Thermal shock resistance 12
Electromagnetic compatibility 12

Process 13
Process temperature 13
Process pressure 13

Mechanical construction 13
Dimensions 13
Dimensions of G1" counter nut 14
Weight 14
Materials 15
Materials of connecting cable 15
Material of G1" counter nut 15

Certificates and approvals 15
CE mark 15
RoHS 15
RCM-Tick marking 15
Ex approval 15
Other standards and guidelines 15

Ordering information 16
Ordering information 16
5-point linearity protocol 16
Scope of delivery 17

Accessories 17
Sensor extension cable 17
Weather protection cover 17
Screw-in flange FAX50 18
Flooding protection tube 18
Cantilever arm for the sensors 19
Mounting bracket for ceiling mounting 23
FAU40 alignment unit 23
RNB130 power supply unit for the sensor heater 24
IP66 protective housing for RNB130 power supply unit . . . 25

Supplementary documentation 25
Documentation for FMU90 transmitter 25
Documentation for FMU95 transmitter 25
Other documentation 25

Important document information

Document conventions

Safety symbols

DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

Electrical symbols

⏚
Ground connection

A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.

Tool symbols

Open-ended wrench

Symbols for certain types of information and graphics

Permitted
Procedures, processes or actions that are permitted

Forbidden
Procedures, processes or actions that are forbidden

Tip
Indicates additional information

Reference to documentation

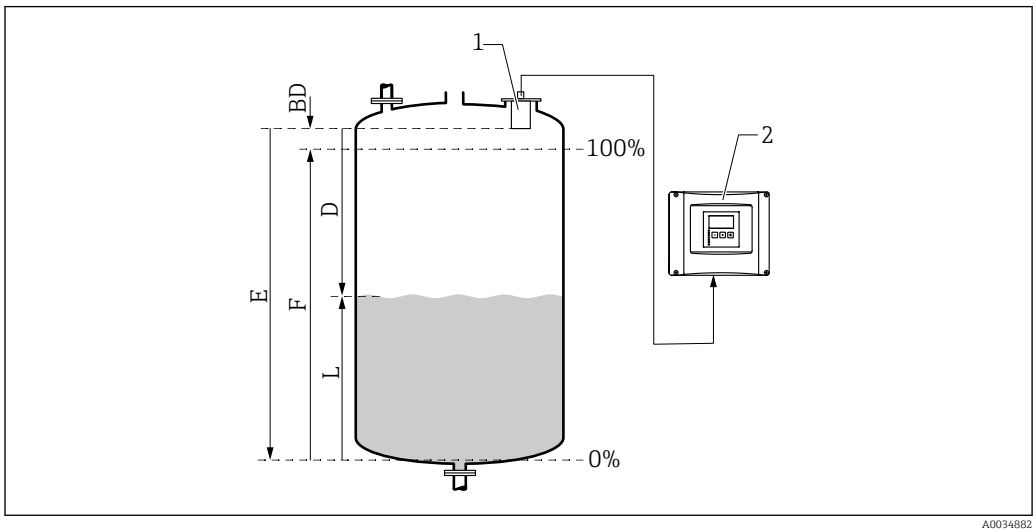
1., 2., 3.
Series of steps

1, 2, 3, ...
Item numbers

A, B, C, ...
Views

Function and system design

Level measurement



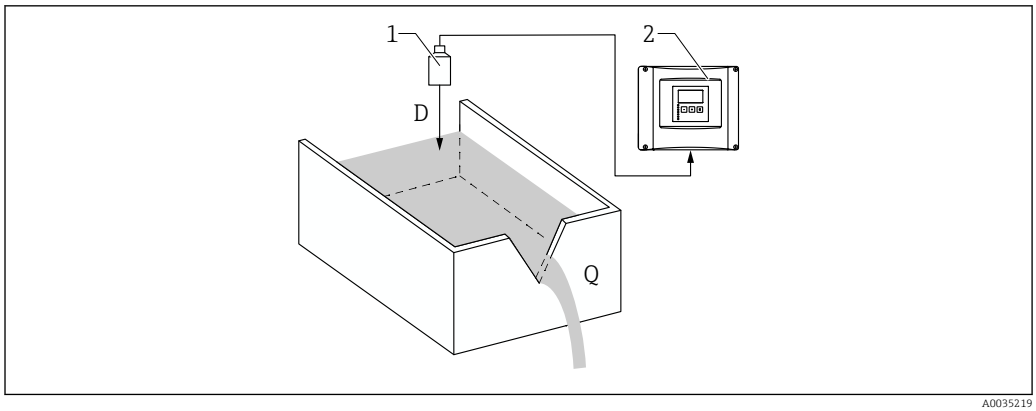
1 Prosonic S sensor
2 Prosonic S transmitter
BD Blocking distance
D Distance between reference point (sensor membrane) and surface of medium
E Empty distance
F Span
L Level

The sensor transmits ultrasonic pulses in the direction of the surface of the medium. There, they are reflected back and received by the sensor. The transmitter measures the time t between the transmission and reception of a pulse. From this time, and using the sonic velocity c, the transmitter calculates the distance D between the reference point (sensor membrane) and the surface of the medium:

$D = c \cdot t/2$

The level L is derived from D. With linearization, the volume V or the mass M is derived from L.

Flow measurement in flumes or weirs



1 Prosonic S sensor
2 Prosonic S transmitter
D Distance between sensor membrane and surface of liquid
Q Flow

The sensor transmits ultrasonic pulses in the direction of the surface of the liquid. There, they are reflected back and received by the sensor. The transmitter measures the time t between the transmission and reception of a pulse. From this time, and using the sonic velocity c, the transmitter calculates the distance D between the (reference point) sensor membrane and the surface of the liquid:

$D = c \times t/2$

The level L is derived from D. With linearization, the flow Q is derived from L.

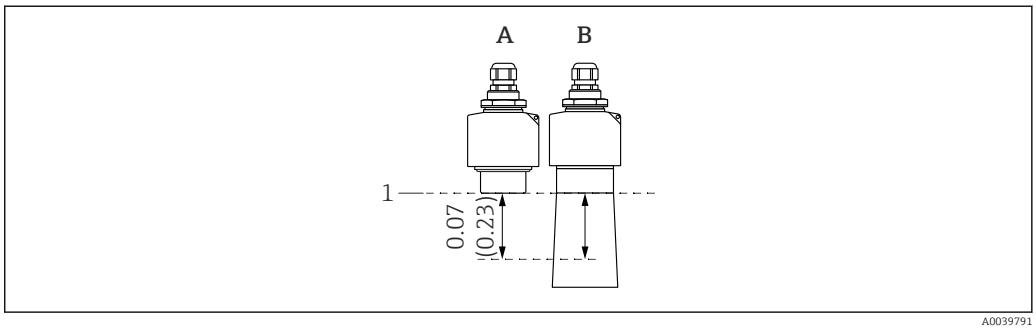
Temperature-dependent time-of-flight correction

Temperature-dependent time-of-flight correction via an external temperature sensor, to be connected to the FMU90 transmitter.

Input

Blocking distance

Signals within the blocking distance (BD) range cannot be measured due to the transient response of the sensor.



1 *Blocking distance of the ultrasonic sensor. Engineering unit m (ft)*

A FDU90 without flooding protection tube
B FDU90 with flooding protection tube
1 Reference point (sensor membrane) of measurement

Measuring range

Estimation of the effective sensor range depending on the operating conditions

1. Add up all the applicable attenuation values from the following lists.
2. From the total calculated attenuation, use the range chart below to calculate the range of the sensor.

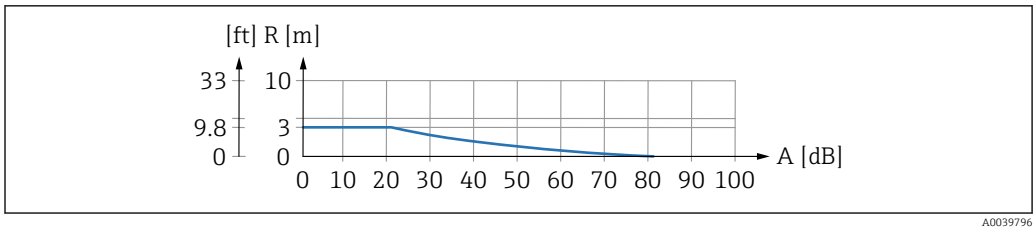
Attenuation caused by surface of liquid
- Calm surface: 0 dB
- Waves on surface: 5 to 10 dB
- Very turbulent surface: 10 to 20 dB
- Frothy surface: contact Endress+Hauser: http://www.endress.com/contact

Attenuation due to bulk solids surface
- Hard, rough surface (e.g. rubble): 40 dB
- Soft surface (e.g. peat, dust-covered clinker): 40 to 60 dB

Attenuation due to dust
- No dust formation: 0 dB
- Minor dust formation: 5 dB
- Major dust formation: 5 to 20 dB

Attenuation caused by filling curtain in detection range
- No filling curtain: 0 dB
- Small volumes: 5 dB
- Large volumes: 5 to 20 dB

Attenuation caused by temperature difference between sensor and product surface
- Up to 20 °C (68 °F): 0 dB
- Up to 40 °C (104 °F): 5 to 10 dB
- Up to 80 °C (176 °F): 10 to 20 dB



2 *Range chart for ultrasonic sensors*

A Total attenuation in dB
R Range in m (ft)

Operating frequency

90 kHz

Power supply

Supply voltage

Is provided by the transmitter.

Power supply to integrated sensor heater

Device versions with sensor heater
FDU90-***B*

Connection data

- Supply voltage: 24 V_{DC} ± 10 %
- Residual ripple: < 100 mV
- Current consumption: 250 mA per sensor
- Suitable power supply unit: RNB130 from Endress+Hauser

- When the sensor heater is active, the integrated temperature sensor cannot be used. Instead, use one of the following external temperature sensors:
  - Pt100
  - Omnigrad S TR61 from Endress+Hauser
- For information on connecting the external temperature sensor, see Technical Information TI00397F.

Electrical connection

General information

NOTICE

Interference signals may cause malfunctions

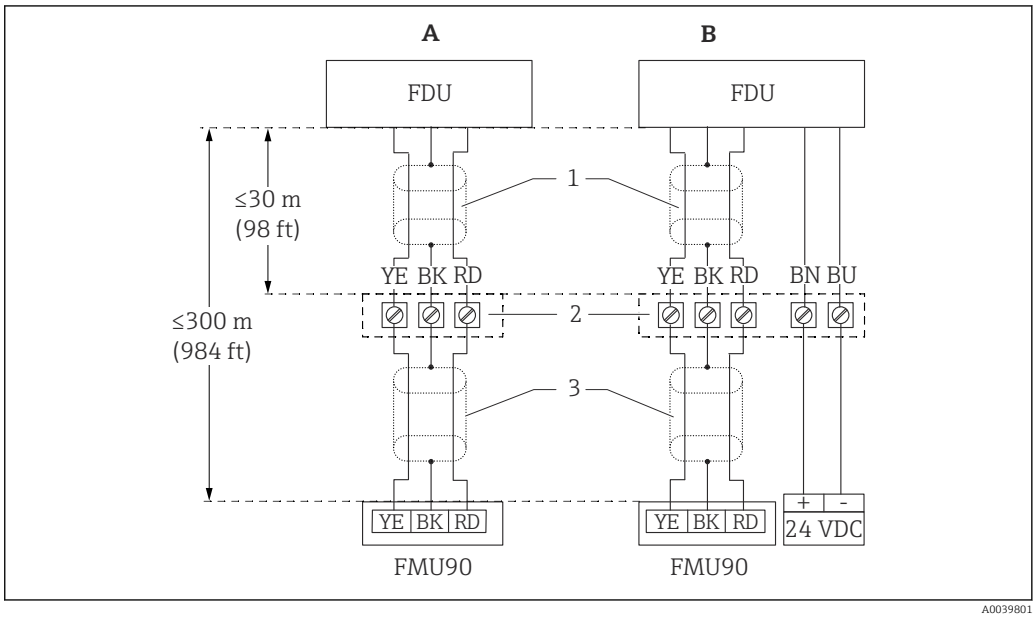
► Do not route the sensor cables parallel to high-voltage electric power lines or near frequency converters.

NOTICE

A damaged cable shield may cause malfunctions

► For pre-terminated cables: connect the black wire (shield) to the "BK" terminal.
► For extension cables: twist the shield and connect to the "BK" terminal.

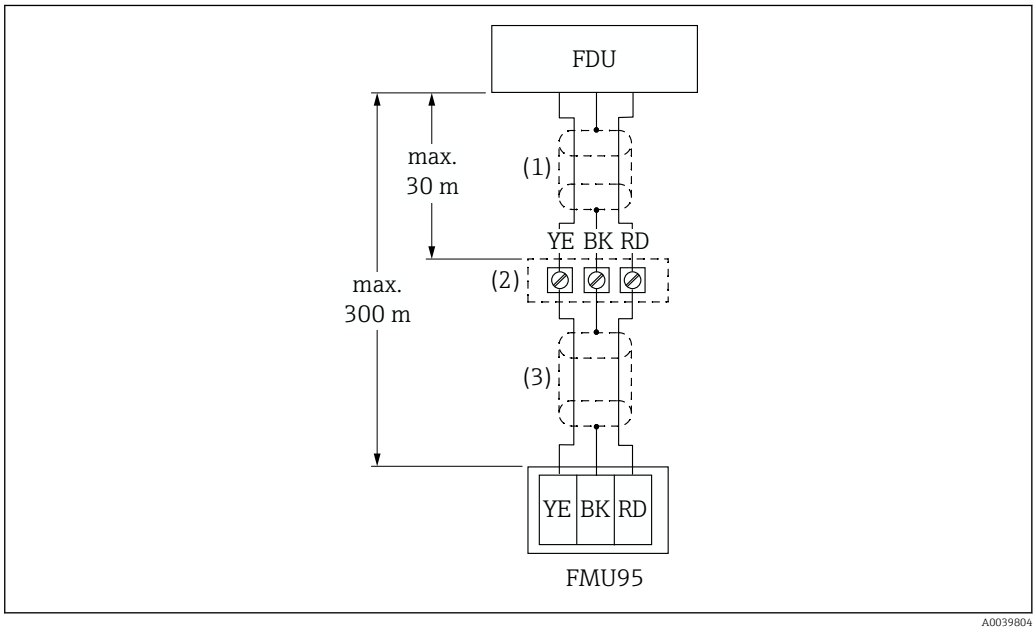
Connection diagram for sensor → FMU90



3 *Connection diagram for sensor; YE: yellow, BK: black; RD: red; BU: blue; BN: brown; protective conductor GNYE: green/yellow*

A Without sensor heater
B With sensor heater
1 Shielding of sensor cable
2 Terminal box
3 Shielding of extension cable

Connection diagram for sensor → FMU95



4 *Connection diagram for sensor; YE: yellow, BK: black; RD: red; BU: blue; BN: brown; protective conductor GNYE: green/yellow*

1 Shielding of sensor cable
2 Terminal box
3 Shielding of extension cable

Extension cable specifications

- **Maximum total length (sensor cable + extension cable)**
  300 m (984 ft)
- **Number of wires**
  As per connection diagram
- **Shielding**
  One shielding braid for the YE wire and one for the RD wire (no foil shield)

- **Cross-section**
  0.75 to 2.5 mm² (18 to 14 AWG)
- **Resistance**
  Max. 8 Ω per wire
- **Capacitance, wire to shield**
  Max. 60 nF

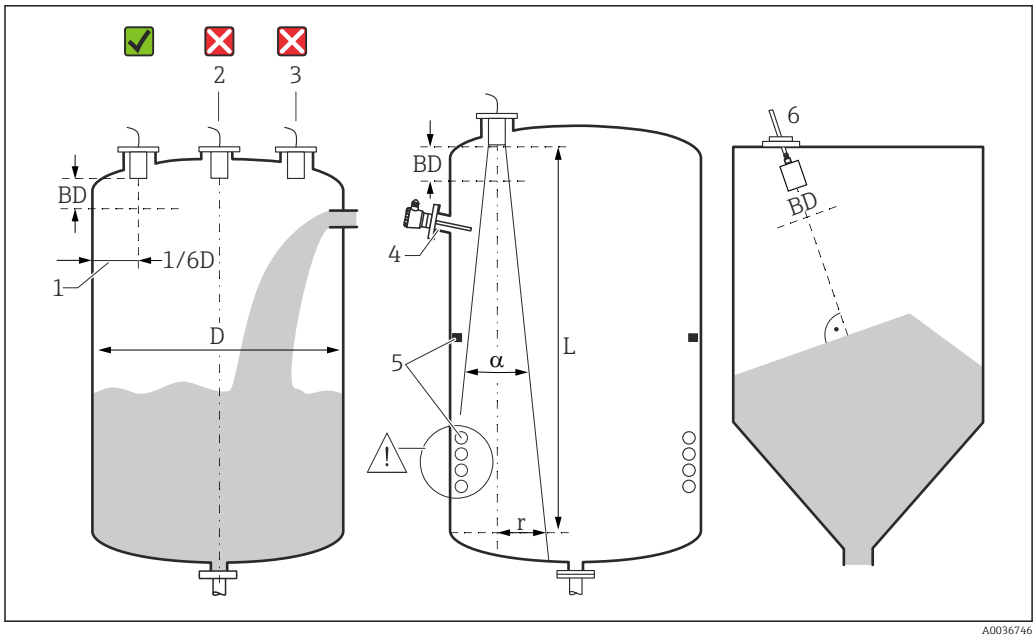
Suitable extension cables are available from Endress+Hauser.

Shortening the sensor cable

The sensor cable can be shortened if necessary (see the Operating Instructions for the FMU90 or FMU95 transmitter).

Installation

Installation conditions for level measurement



5 *Installation conditions for level measurement*

1 *Recommended distance to the vessel wall: 1/6 of the vessel diameter D.*
2 *Do not mount in the center of the vessel.*
3 *Avoid measurements through the filling curtain.*
4 *There must be no internal fixtures in the signal beam.*
5 *Symmetrical internal fixtures, in particular, negatively impact the measurement.*
6 *For bulk solids: using the FAU40 alignment unit, align the sensor so that it is perpendicular to the surface of the product.*
BD *Blocking distance*

Emitting angle/beam
- α (typical) = 12 °
- L (max) = 3 m (9.8 ft)
- r (max) = 0.31 m (1.0 ft)

Other conditions
- The lower edge of the sensor should be located inside the vessel
- The maximum level may not enter the blocking distance

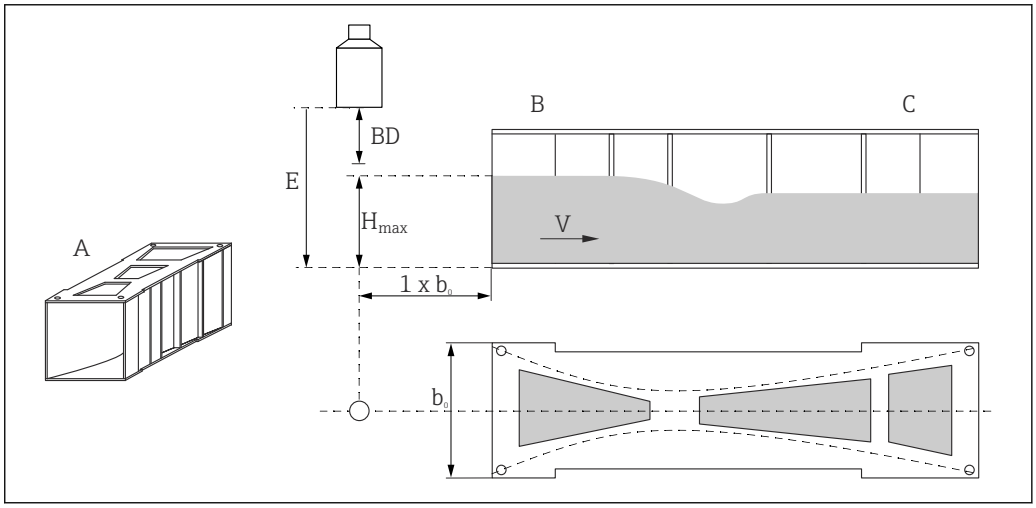
Several sensors in one vessel
Sensors that are connected to a common FMU90 or FMU95 transmitter can be used in one vessel.

Installation conditions for flow measurement

Conditions

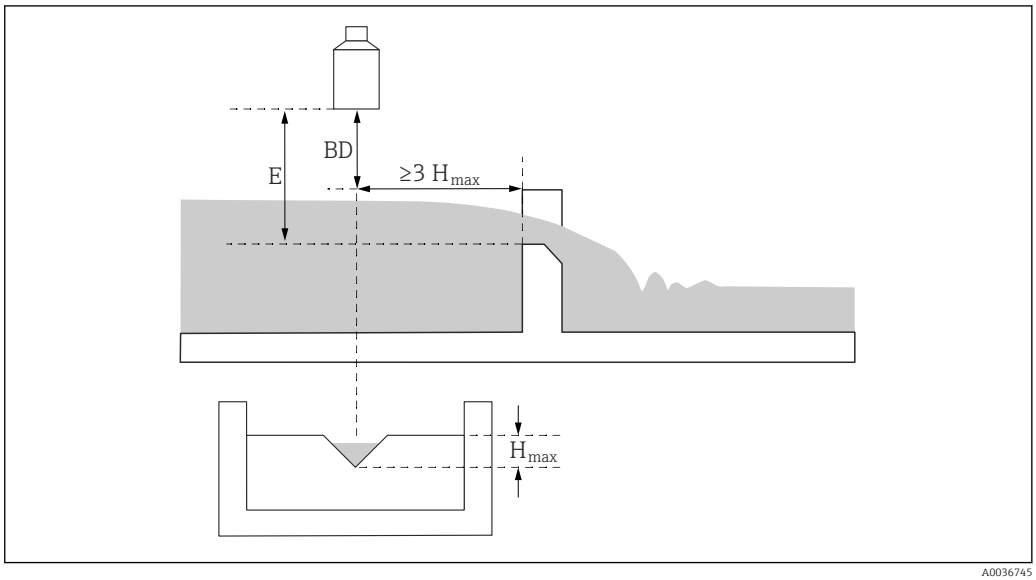
- Mount the sensor on the upstream side above the maximum upstream level H_{max} plus the blocking distance BD
- Position the sensor in the center of the channel or weir
- Align the sensor so that it is perpendicular to the surface of the water
- Observe the specified mounting distance (clearance) to the flume constriction or weir edge
  See the Operating Instructions for FMU90 / FMU95
- Protect the sensor against sun and precipitation using the weather protection cover

Example: Khafagi-Venturi flume



A Khafagi-Venturi flume
b_0 Width of Khafagi-Venturi flume
B Upstream side
C Downstream side
BD Blocking distance of the sensor
E Empty calibration (to be entered during commissioning)
H_{max} Maximum upstream level
V Flow

Example: Triangular weir

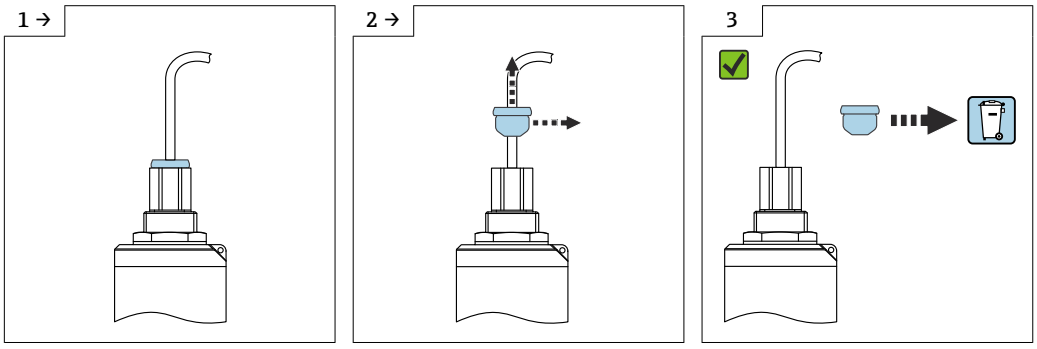


BD Blocking distance of the sensor
E Empty calibration (to be entered during commissioning)
H_{max} Maximum upstream level

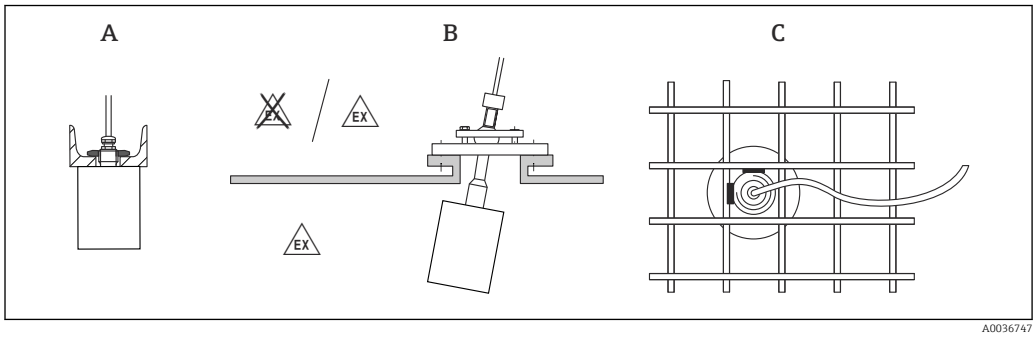
Installation instructions

Removing the cable transportation guard

In the case of devices with a rear-side process connection "FNPT1/2 conduit", the cable protective plug must be removed before installation.

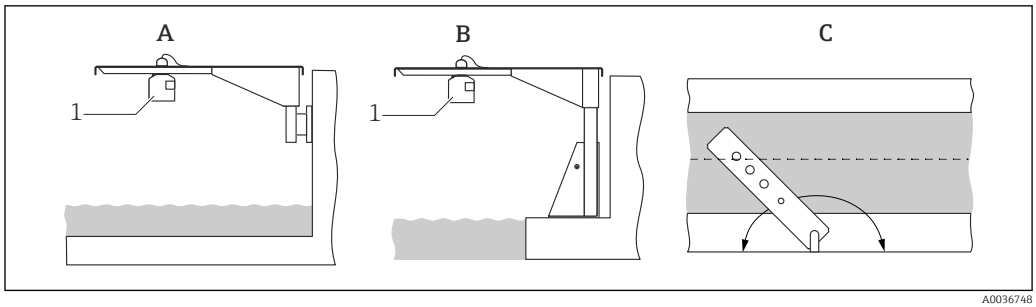


Installation options (examples)



6 *Installation in systems*

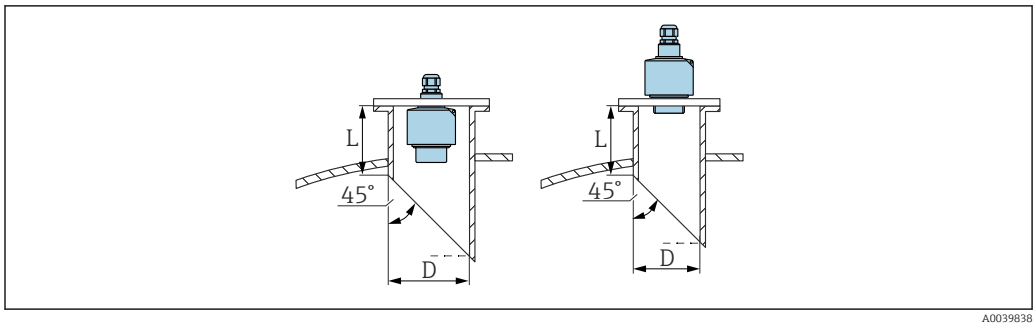
A On U-rail or bracket
B With FAU40 alignment unit
C With 1" sleeve welded to a grating



7 *Installation with cantilever arm over open channels or flumes*

A Arm with wall bracket
B Cantilever with mounting frame
C The arm can be turned (e.g. to position the sensor over the center of the channel)

Nozzle mounting



D Nozzle diameter
L Nozzle length

Conditions at the nozzle

- Smooth interior, without edges or welds
- No burr on the inside of the nozzle end on the tank side
- Beveled nozzle end on tank side (ideally: 45 °)

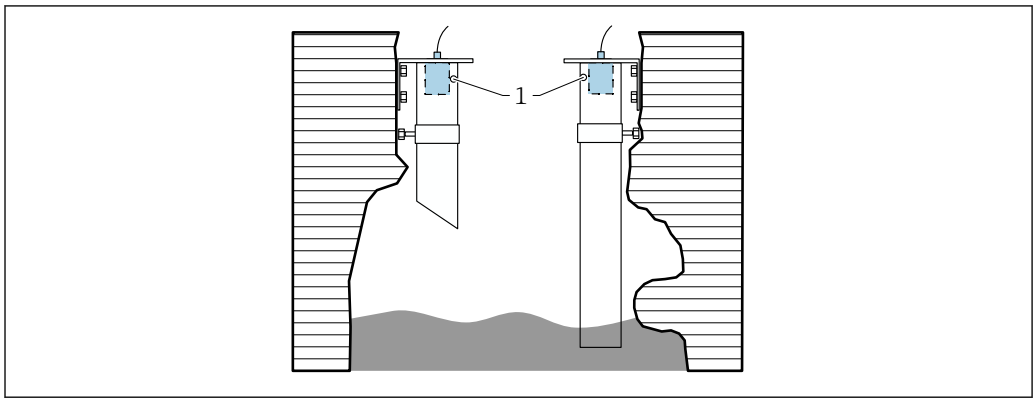
Maximum nozzle length - mounted on rear thread

- D = DN80/3": L_{max} = 340 mm (13.4 in)
- D = DN100/4": L_{max} = 390 mm (15.4 in)
- D = DN150/6" to DN300/12": L_{max} = 400 mm (15.7 in)

Maximum nozzle length - flush mounting

- D = DN50/2": L_{max} = 50 mm (1.97 in)
- D = DN80/3": L_{max} = 250 mm (9.84 in)
- D = DN100/4" to DN300/12": L_{max} = 300 mm (11.8 in)

Ultrasound guide pipe for measurement in narrow pits



1 Venting hole

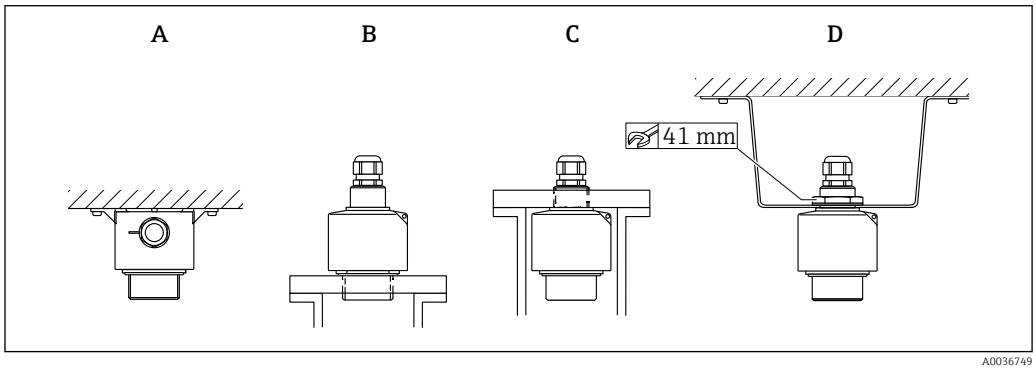
- Suitable ultrasound guide pipe: e.g. PE or PVC wastewater pipe
- Minimum diameter: DN80
- Venting hole at top
- No contamination from built-up dirt (clean regularly where necessary)

Securing the sensor

NOTICE

Risk of damage to the sensor

- ▶ Do not use the sensor cable for suspension purposes.
- ▶ Do not damage the sensor membrane when installing.



8 Securing the ultrasonic sensor

A Ceiling installation
B Mounted at front thread
C Mounted at rear thread
D Mounted with counter nut

Environment

Degree of protection	Tested according to IP68/NEMA6P (24 h at 1.83 m (6 ft) under water)
Vibration resistance	DIN EN 600068-2-64; 20 to 2 000 Hz; 1 $(m/s^2)^2/Hz$; 3x100 min
Storage temperature	Identical to process temperature
Thermal shock resistance	Based on DIN EN 60068-2-14; test according to min./max. process temperature; 0.5 K/min; 1 000 h
Electromagnetic compatibility	Electromagnetic compatibility in accordance with all the relevant requirements outlined in the EN 61326 series and NAMUR Recommendation EMC (NE 21). For details, refer to the Declaration of

Conformity. With regard to interference emission, the devices meet the requirements of class A, and are only designed for use in an "industrial environment".

Process

Process temperature

−40 to +80 °C (−40 to +176 °F)

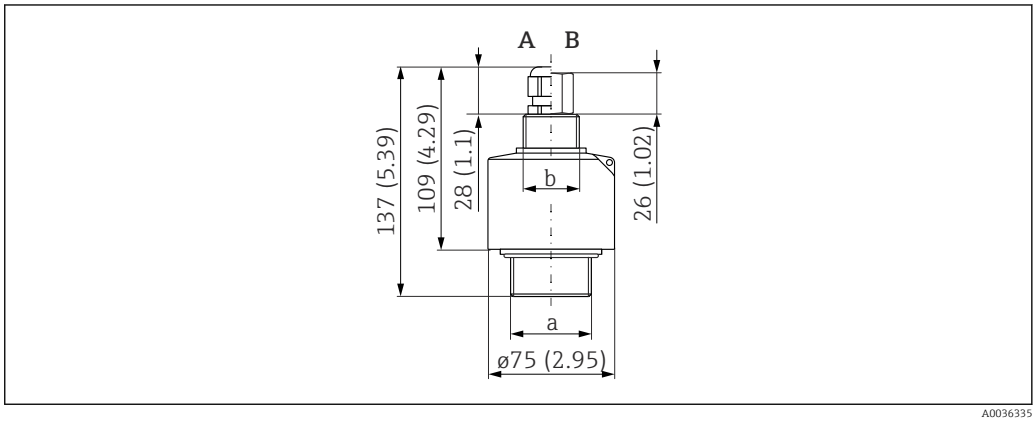
To prevent the build-up of ice on the sensor, the sensors are available in a version with integrated sensor heating.

Process pressure

0.7 to 4 bar (10.15 to 58 psi)

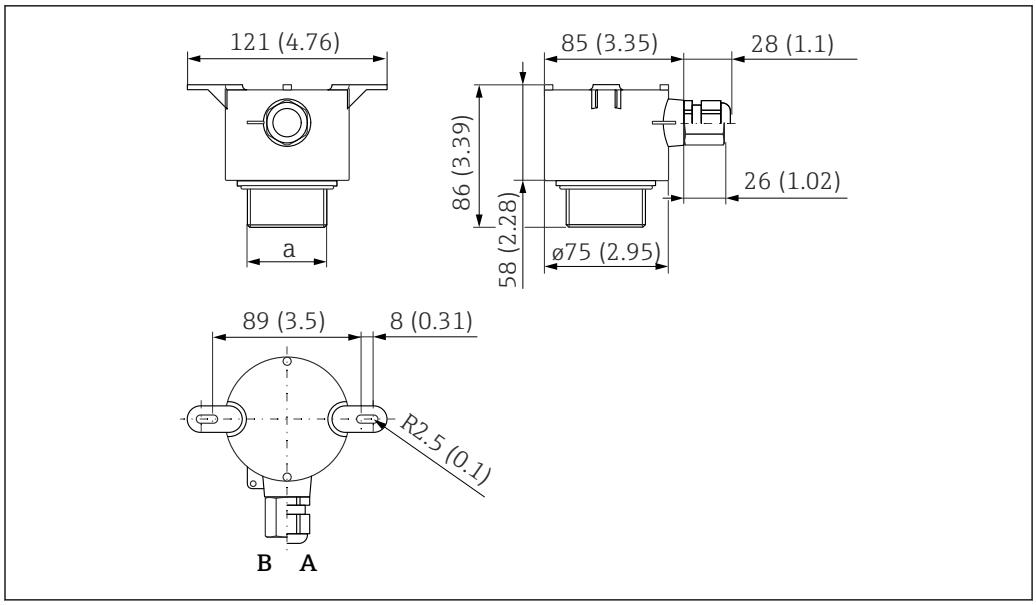
Mechanical construction

Dimensions



9 *FDU90-*G*** (G1 and G1-1/2 thread); FDU90-*N*** (NPT 1 and NPT 1-1/2 thread). Unit of measurement mm (in)*

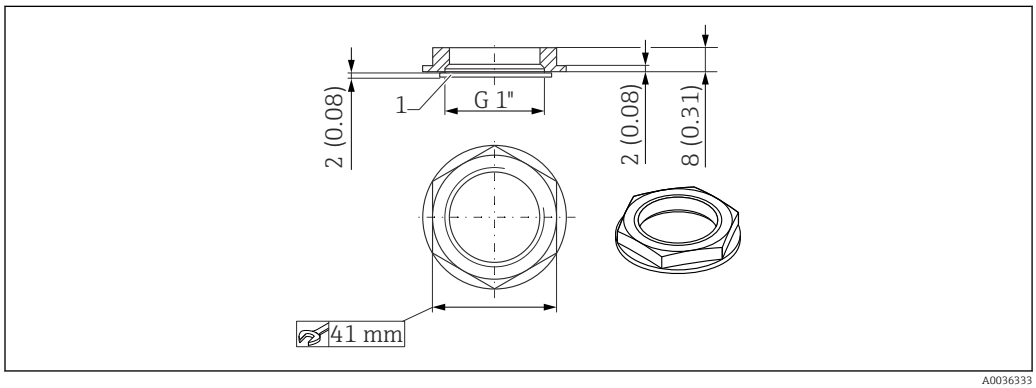
A Cable gland
B Pipe adapter
a Front thread; G1-1/2 or NPT1-1/2
b Rear thread; G1 or NPT1



10 *FDU90-*W*** (ceiling mounting). Unit of measurement mm (in)*

A Cable gland
B Pipe adapter
a Front thread; G1-1/2 or NPT1-1/2

Dimensions of G1" counter nut



11 *Counter nut; dimensions. Unit of measurement mm (in)*

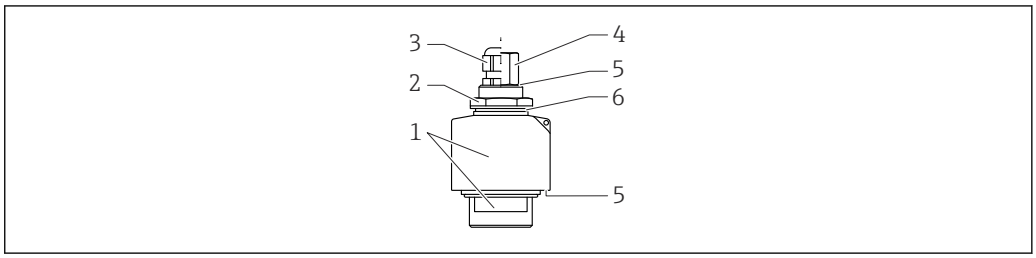
- The counter nut is included in the delivery for the following sensors: FDU90-*G*** (rear G1 thread)
- The counter nut is not suitable for NPT threads.

Weight

Weight including cable 5 m (16 ft))

- Excluding flooding protection tube: approx. 0.9 kg (1.98 lb)
- Including flooding protection tube: approx. 1.0 kg (2.21 lb)

Materials



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12 *Materials*

1 *Sensor housing: PVDF*
2 *Counter nut: PA6.6*
3 *Cable gland: PA*
4 *Pipe adapter: CuZn nickel-plated*
5 *O-ring: EPDM*
6 *Seal: EPDM*

Materials of connecting cable

PVC

Material of G1" counter nut

- **Counter nut**: PA6.6
- **Seal (included in the delivery)**: EPDM

Certificates and approvals

CE mark

The measuring system meets the legal requirements of the applicable EU Directives. These are listed in the corresponding EU Declaration of Conformity along with the standards applied.

Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

RoHS

The measuring system complies with the substance restrictions of the Restriction on Hazardous Substances Directive 2011/65/EU (RoHS 2).

RCM-Tick marking

The supplied product or measuring system meets the ACMA (Australian Communications and Media Authority) requirements for network integrity, interoperability, performance characteristics as well as health and safety regulations. Here, especially the regulatory arrangements for electromagnetic compatibility are met. The products are labelled with the RCM- Tick marking on the name plate.

A0029561

Ex approval

Available Ex approvals: see Product Configurator

Sensors with an Ex approval can be connected to the FMU90 transmitter without an Ex approval.

Other standards and guidelines

EN 60529
Degrees of protection provided by enclosures (IP code)

EN 61326 series
EMC product family standard for electrical equipment for measurement, control and laboratory use

NAMUR
User association of automation technology in process industries

Ordering information

Ordering information

Detailed ordering information is available for your nearest sales organization www.addresses.endress.comor in the Product Configurator under www.endress.com

1. Click Corporate
2. Select the country
3. Click Products
4. Select the product using the filters and search field
5. Open the product page

The Configuration button to the right of the product image opens the Product Configurator.

Product Configurator - the tool for individual product configuration

- Up-to-the-minute configuration data
- Depending on the device: direct input of information specific to the measuring point, such as the measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

5-point linearity protocol

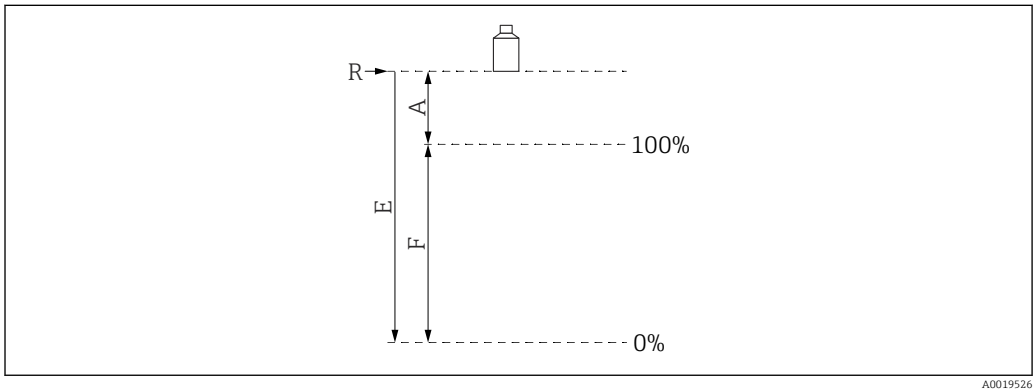
Conditions for 5-point linearity protocol

- The 5-point linearity protocol applies for the entire measuring system, consisting of the sensor and transmitter. When ordering, specify the transmitter sensor input where the sensor is to be tested.
- The linearization test is conducted under the reference operating conditions of the transmitter.

Position of the linearization points

- The 5 points of the linearity protocol are evenly distributed over the span S.
- In order to define the span, values for **Empty calibration** (E) and **Full calibration** (F) must be specified when ordering.
- The specified values are only used to create the linearity protocol. **Empty calibration** and **Full calibration** are then reset to their factory settings.

Conditions for defining the span



13 *Variables to define the span*

R Reference point (sensor membrane)
E "Empty calibration" (distance from sensor membrane to 0%-point)
F "Full calibration" (distance from 0%-point to 100%-point)
A Distance from sensor membrane to 100%-point

- E ≤ 3 000 mm (118 in)
- F =100 to 2 900 mm (3.94 to 114 in)
- A ≥ 160 mm (6.3 in)

Scope of delivery

- Ordered version of the sensor
- For certified versions: Safety Instructions (XAs)
- For sensors with sensor heater: terminal module for installation in the field housing of the FMU90 transmitter
- For sensors with G1" process connection: counter nut (PA6.6) and seal (EPDM)

Accessories

Sensor extension cable

- Maximum permissible total length (sensor cable + extension cable): 300 m (984 ft)
- The sensor cable and extension cable are the same type of cable.

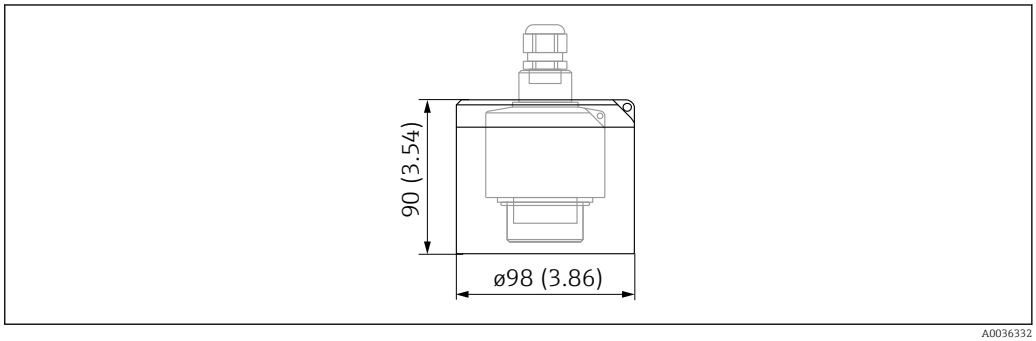
Sensor without sensor heater

- Cable type: LiYCY 2x(0.75)
- Material: PVC
- Ambient temperature:–40 to +105 °C (–40 to +221 °F)
- Order number: 71027742

Sensor with sensor heater

- Cable type: LiYY 2x(0.75)D+2x0.75
- Material: PVC
- Ambient temperature:–40 to +105 °C (–40 to +221 °F)
- Order number: 71027746

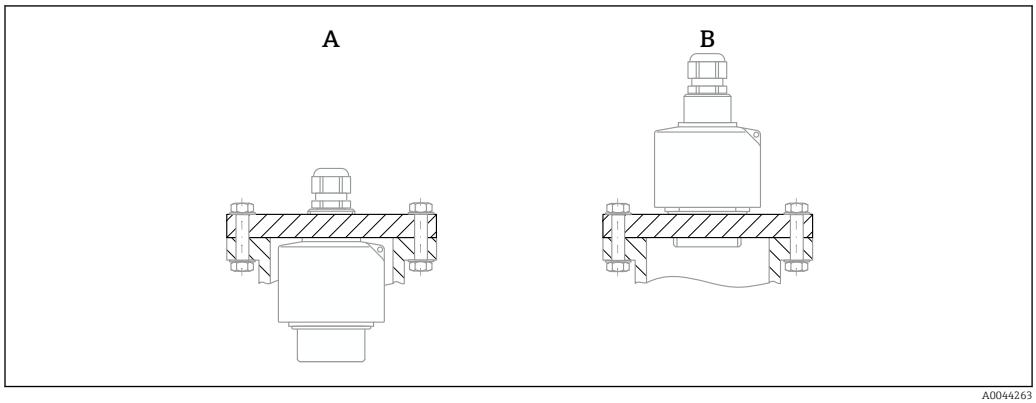
Weather protection cover



14 Weather protection cover. Unit of measurement mm (in)

- **Material**: PVDF
- **Order number**: 52025686

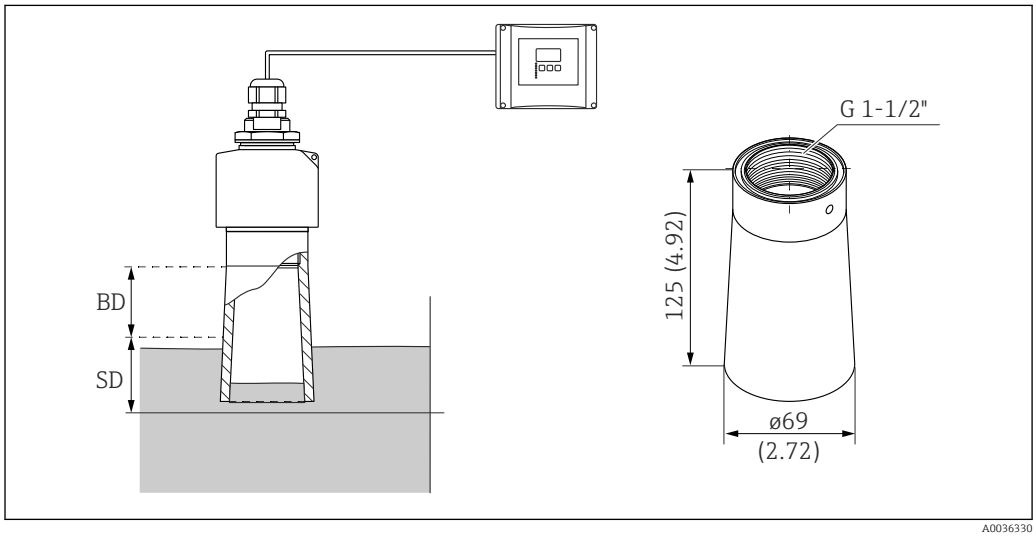
Screw-in flange FAX50



A Mounting on the rear thread G1 or NPT 1
B Mounting on the front thread G 1-1/2 or NPT 1-1/2

- Can be used for:
  - Front thread G1-1/2 or NPT1-1/2
  - Rear thread G1 or NPT1
- Available flange sizes: see Product Configurator
- Minimum nominal diameter: DN80 / NPS 3"

Flooding protection tube



15 Flooding protection tube. Unit of measurement mm (in)

BD Blocking distance
SD Safety distance (user-defined)

Use

Prevents the level of medium from entering the sensor blocking distance in the event of flooding.

Technical data

- **Thread**: G1-1/2"
- **Tube material**: PP
- **Seal material**: EPDM
- **Weight**: 0.12 kg (0.26 lb)

Ordered as an accessory

Order no.: 71091216

Ordered with sensor

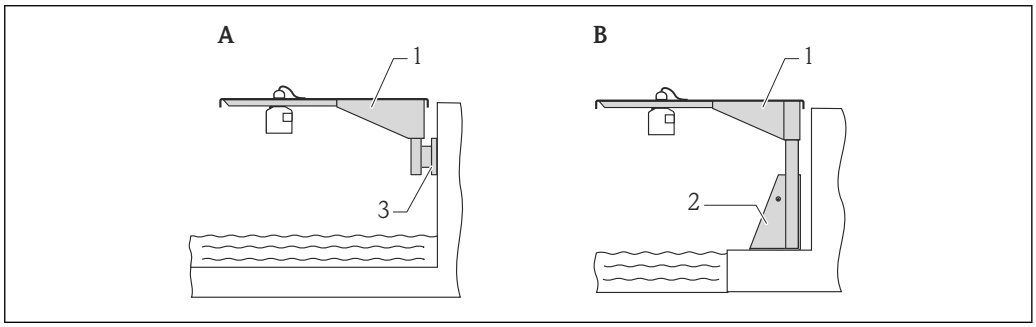
- Order code: FDU90-****B
- The sensor then always has a G 1-1/2" thread on the front - irrespective of the option selected under code 020, "Process connection".

Installation

1. Insert the seal supplied and tighten the flooding protection tube hand-tight to the end stop.
2. Perform a new basic setup including interference echo suppression (mapping).

Cantilever arm for the sensors

Application



16 *Mounting of sensor with cantilever arm*

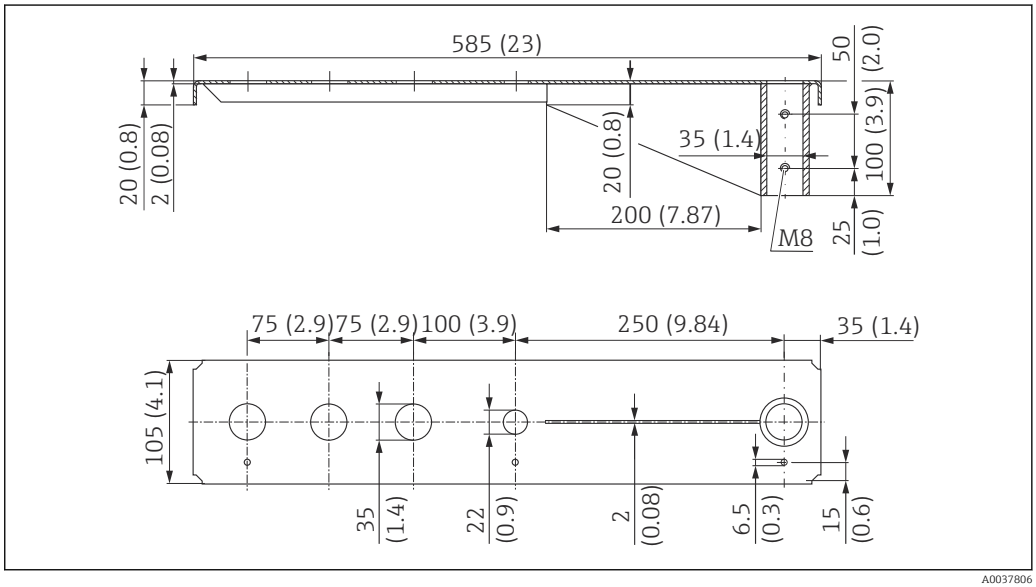
A Installation on arm with wall bracket
B Installation on arm with mounting frame
1 Cantilever
2 Mounting frame
3 Wall bracket

Use of orifices

- 35 mm (1.4 in) orifice
  Sensor with counter nut
- 22 mm (0.9 in) orifice
  Temperature sensor (e.g. Omnigrad TR61 with TA50 process connection)

Dimensions

Cantilever arm 500 mm, for G 1" or MNPT 1" connections on rear



17 *Dimensions. Unit of measurement mm (in)*

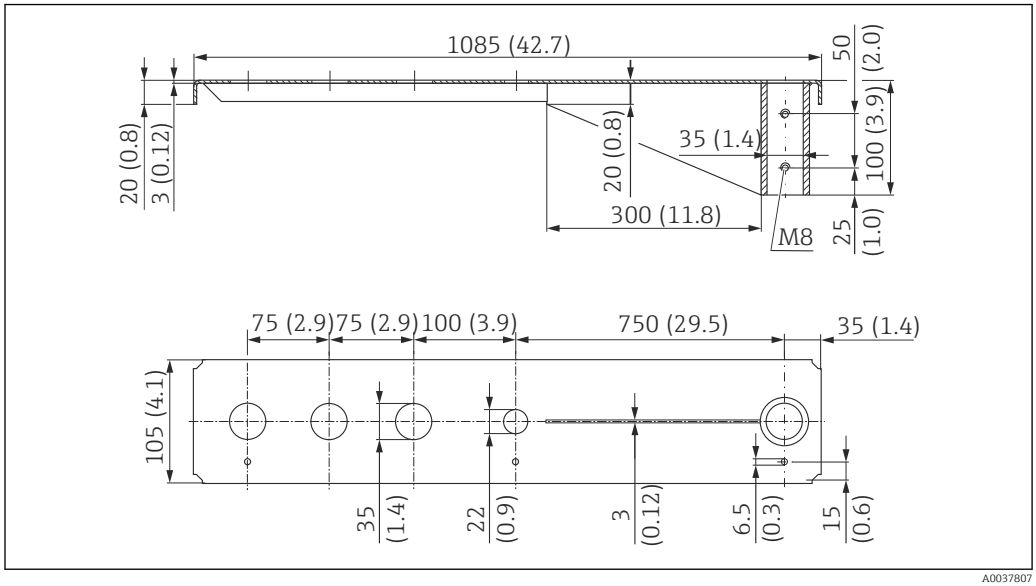
Weight:
3.0 kg (6.62 lb)

Material
316L (1.4404)

Order number
71452315

- 35 mm (1.38 in) openings for all G 1" or MNPT 1" connections on rear
- 22 mm (0.87 in) opening can be used for any additional sensor
- Retaining screws are included in delivery

Cantilever arm 1 000 mm, for G 1" or MNPT 1" connections on rear



18 *Dimensions. Unit of measurement mm (in)*

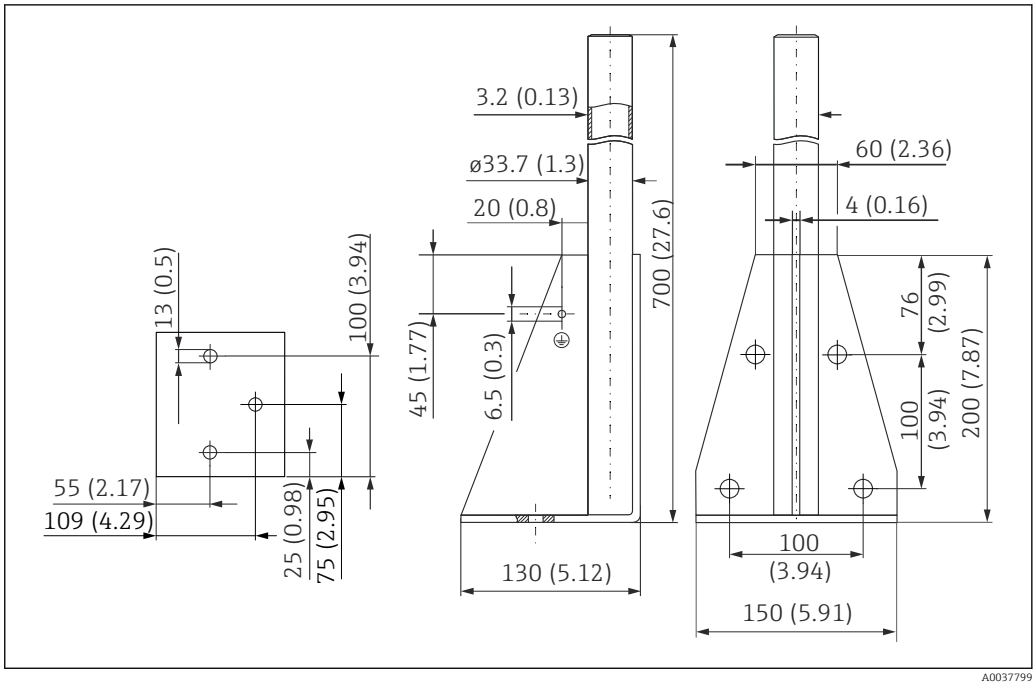
Weight:
5.4 kg (11.91 lb)

Material
316L (1.4404)

Order number
71452316

- 35 mm (1.38 in) openings for all G 1" or MNPT 1" connections on rear
- 22 mm (0.87 in) opening can be used for any additional sensor
- Retaining screws are included in delivery

Frame, 700 mm (27.6 in)



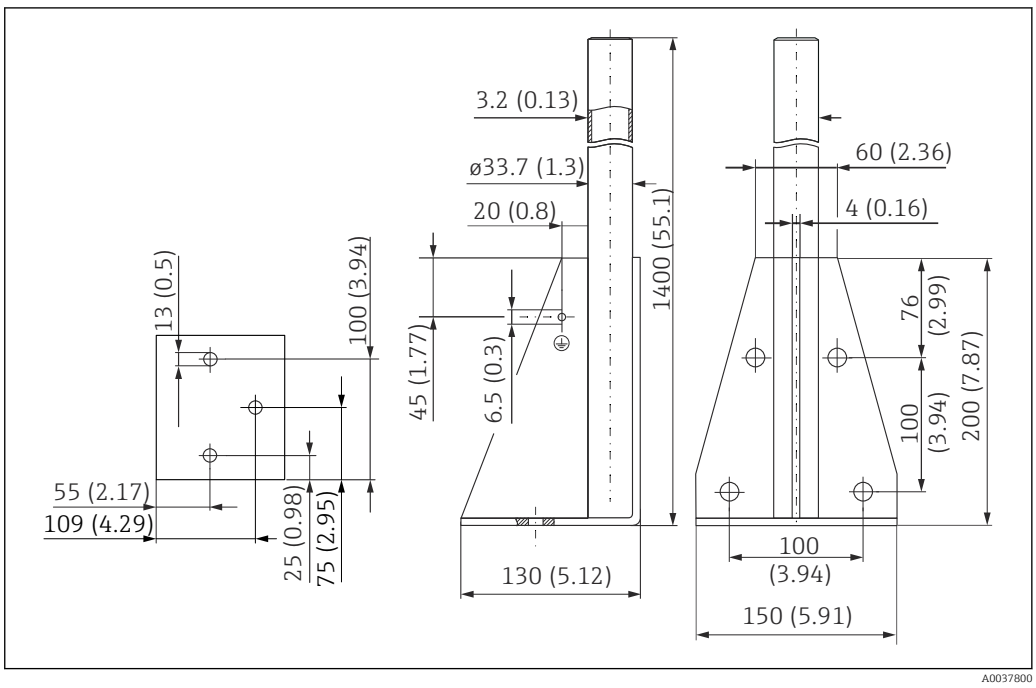
19 *Dimensions. Unit of measurement mm (in)*

Weight:
4.0 kg (8.82 lb)

Material
316L (1.4404)

Order number
71452327

Frame, 1400 mm (55.1 in)



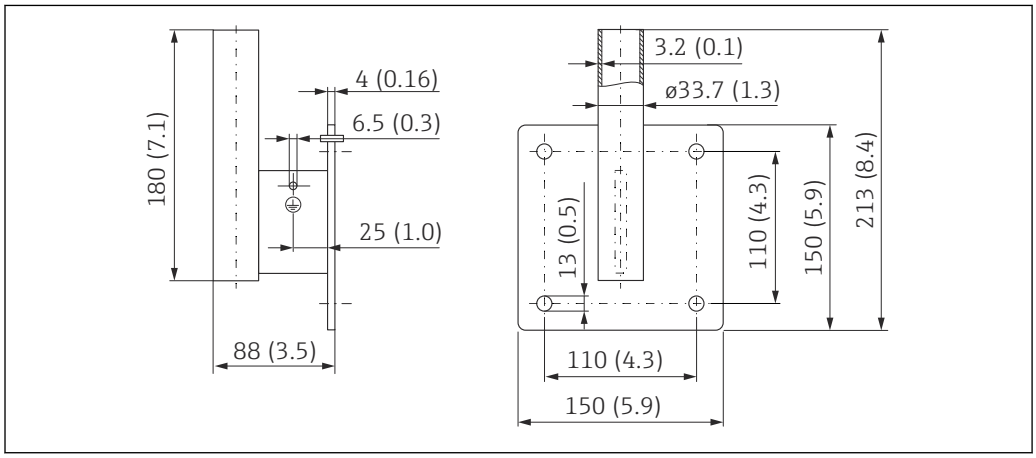
20 *Dimensions. Unit of measurement mm (in)*

Weight:
6.0 kg (13.23 lb)

Material
316L (1.4404)

Order number
71452326

Wall bracket for cantilever with pivot



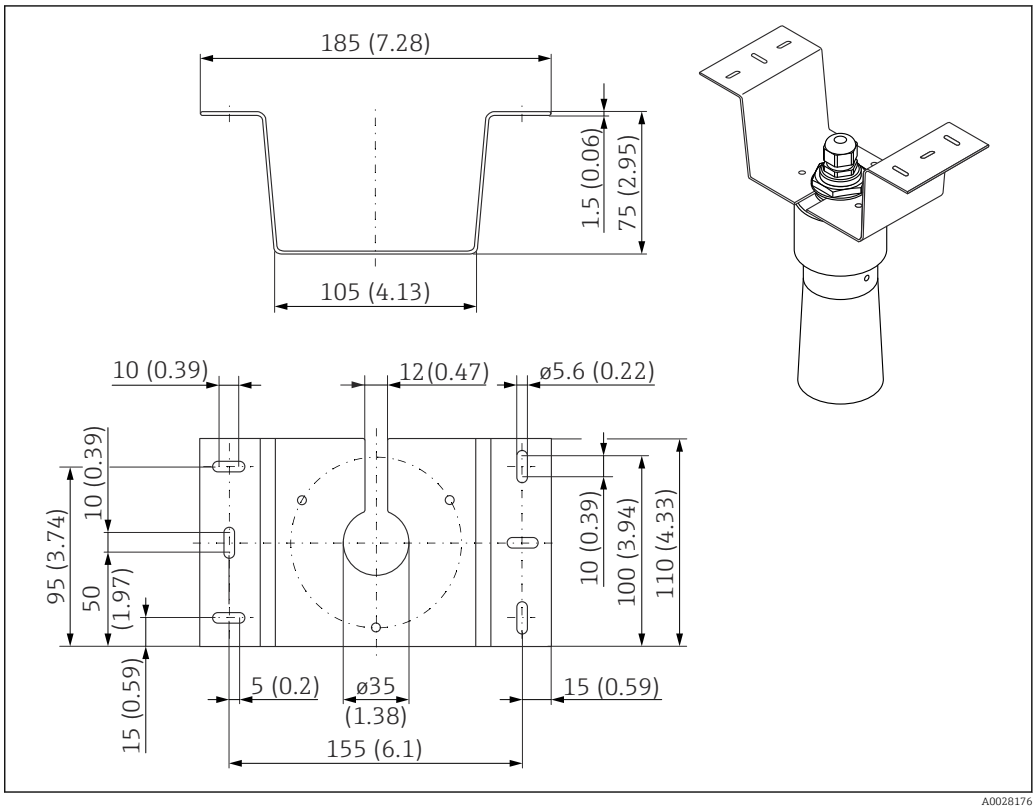
21 Dimensions of the wall bracket. Unit of measurement mm (in)

Weight
1.21 kg (2.67 lb)

Material
316L (1.4404)

Order number
71452323

Mounting bracket for ceiling mounting



22 Mounting bracket for ceiling mounting. Unit of measurement mm (in)

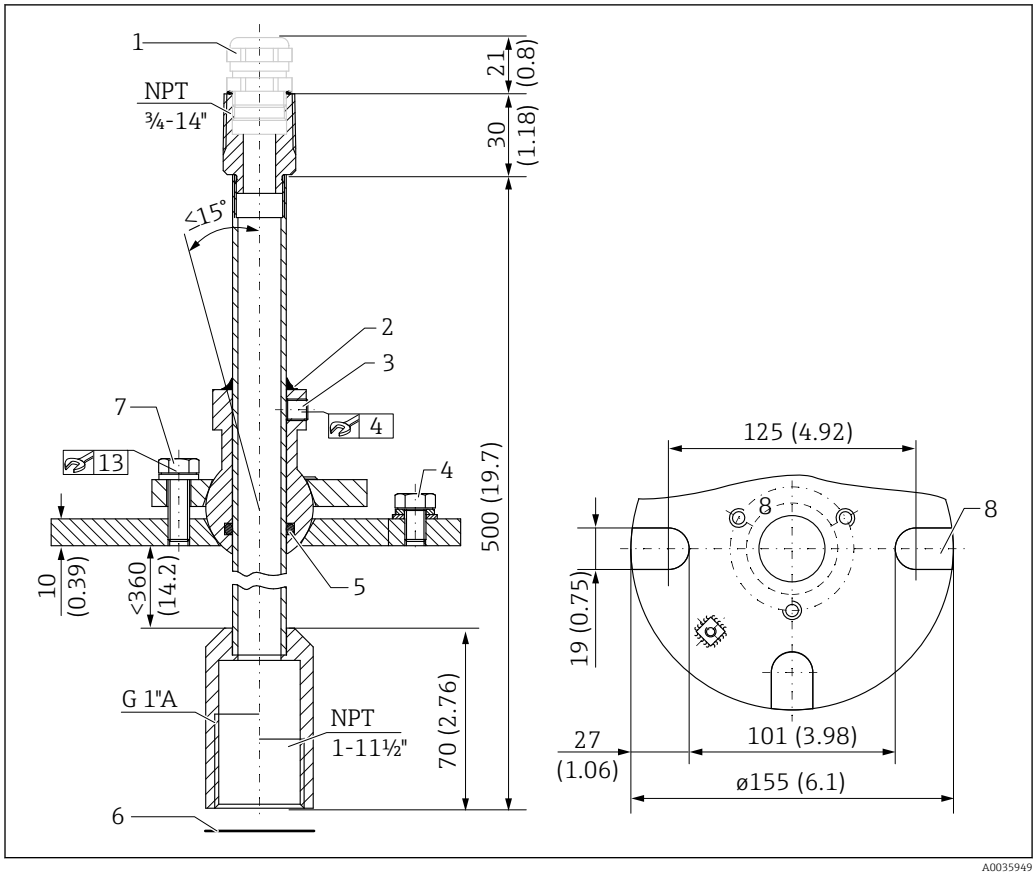
- Material: 316L (1.4404)
- Order No.: 71093130

FAU40 alignment unit

Use

- To align an ultrasonic sensor with the bulk solids surface
- Swivel range: 15 °
- Zone separation for explosion hazardous areas

Dimensions



23 FAU40 alignment unit. Unit of measurement mm (in)

1 *Cable gland M20x1.5 (if selected in the product structure)*
2 *Seal here*
3 *Two Allen screws for height adjustment (8 Nm (6 lbf ft)±2 Nm (±1.5 lbf ft))*
4 *Grounding screw*
5 *O-ring*
6 *Seal supplied with the sensor, must be used for applications in ATEX Zone 20*
7 *Screw for lateral adjustment (18 Nm (13.5 lbf ft)±2 Nm (±1.5 lbf ft))*
8 *Mounting slots (on version with UNI flange)*

Additional information

Technical Information TI00179F

RNB130 power supply unit for the sensor heater

Technical data

- **Function**: Primary switched-mode power supply
- **Input**: 100 to 240 V_{AC}
- **Output**: 24 V_{DC}; max 30 V in the event of an error

Connection options

- Single-phase A/C mains system
- Two phase conductors of three-phase supply systems (TN, TT or IT system according to VDE 0100 T 300/IEC 364-3)

Optionally available: IP66 protective housing

Additional information

Technical Information TI00120R

IP66 protective housing for RNB130 power supply unit	▪ **Order number**: 51002468 ▪ **Additional information**: Technical Information TI00080R

Supplementary documentation

Documentation for FMU90 transmitter	▪ Technical Information TI00397F
	▪ Operating Instructions:
	  ▪ BA00288F (HART, level measurement)
	  ▪ BA00289F (HART, flow measurement)
	  ▪ BA00292F (Profibus DP, level measurement)
	  ▪ BA00293F (Profibus DP, flow measurement)
	▪ Description of Device Parameters: GP01151F

Documentation for FMU95 transmitter	▪ Technical Information TI00398F ▪ Operating Instructions: BA00344F ▪ Description of Device Parameters: GP01152F
Other documentation	Further information and the documentation currently available can be found on the Endress+Hauser- website: www.endress.com→ Downloads.

www.addresses.endress.com

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