

# Technical Information

## Prosonic S FDU90, FDU91, FDU91F, FDU92, FDU93, FDU95

Ultrasonic measuring technology



## Ultrasonic sensors for level 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
  - FDU90: 3 m (9.8 ft) in liquids; 1.2 m (3.9 ft) in bulk solids
  - FDU91/FDU91F: 10 m (33 ft) in liquids; 5 m (16 ft) in bulk solids
  - FDU92: 20 m (66 ft) in liquids; 10 m (33 ft) in bulk solids
  - FDU93: 25 m (82 ft) in liquids; 15 m (49 ft) in bulk solids
  - FDU95: 45 m (148 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

## Table of contents

<b>Important document information</b> . . . . .	<b>3</b>	Weight . . . . .	28
Document conventions . . . . .	3	Materials of FDU90 . . . . .	29
<b>Function and system design</b> . . . . .	<b>5</b>	Materials of FDU91 . . . . .	29
Ultrasonic level measurement . . . . .	5	Materials of FDU91F . . . . .	29
Ultrasonic flow measurement in flumes or weirs . . . . .	5	Materials of FDU92 . . . . .	30
Temperature-dependent time-of-flight correction . . . . .	6	Materials of FDU93 . . . . .	30
<b>Input</b> . . . . .	<b>7</b>	Materials of FDU95 . . . . .	30
Blocking distance . . . . .	7	Materials of connecting cable . . . . .	30
Measuring range . . . . .	7	Material of G1" counter nut . . . . .	31
Operating frequency . . . . .	8	<b>Certificates and approvals</b> . . . . .	<b>32</b>
<b>Power supply</b> . . . . .	<b>9</b>	CE mark . . . . .	32
Power supply for ultrasonic sensors . . . . .	9	Ex approval . . . . .	32
Power supply for integrated sensor heater (FDU90, FDU91) . . . . .	9	Other standards and guidelines . . . . .	32
<b>Electrical connection</b> . . . . .	<b>10</b>	<b>Ordering information</b> . . . . .	<b>33</b>
General information . . . . .	10	Ordering information . . . . .	33
Connection diagram for FDU9x → FMU90 . . . . .	11	5-point linearity protocol . . . . .	34
Connection diagram for FDU9x → FMU95 . . . . .	12	Scope of delivery . . . . .	34
Sensor extension cable . . . . .	13	<b>Accessories</b> . . . . .	<b>35</b>
Shortening the sensor cable . . . . .	14	Extension cables for sensors . . . . .	35
<b>Installation</b> . . . . .	<b>15</b>	Weather protection cover for FDU90/FDU91 . . . . .	35
Installation conditions for level measurement . . . . .	15	Screw-in flange FAX50 . . . . .	36
Installation conditions for flow measurement . . . . .	17	Flooding protection tube for FDU90 . . . . .	36
Installation options (examples) . . . . .	18	Cantilever arm for FDU90, FDU91 and FDU92 sensors . . . . .	37
Nozzle mounting . . . . .	19	Mounting bracket for ceiling mounting . . . . .	39
Ultrasound guide pipe for measurement in narrow pits . . . . .	21	FAU40 alignment unit . . . . .	39
Securing the sensor . . . . .	21	RNB130 power supply unit for the FDU90 and FDU91 sensor heater . . . . .	40
Slip-on flange without adapter flange for flush mounting of FDU91F . . . . .	22	IP66 protective housing for RNB130 power supply unit . . . . .	40
Slip-on flange with adapter flange for flush mounting of FDU91F . . . . .	23	<b>Supplementary documentation</b> . . . . .	<b>41</b>
<b>Environment</b> . . . . .	<b>24</b>	Safety Instructions FDU90 . . . . .	41
Degree of protection . . . . .	24	Safety Instructions FDU91 . . . . .	41
Vibration resistance . . . . .	24	Safety Instructions FDU91F . . . . .	41
Storage temperature . . . . .	24	Safety Instructions FDU92 . . . . .	42
Thermal shock resistance . . . . .	24	Safety Instructions FDU93 . . . . .	42
Electromagnetic compatibility . . . . .	24	Safety Instructions FDU95 . . . . .	43
<b>Process</b> . . . . .	<b>25</b>	Documentation for FMU90 transmitter . . . . .	43
Process temperature . . . . .	25	Documentation for FMU95 transmitter . . . . .	43
Process pressure . . . . .	25		
<b>Mechanical construction</b> . . . . .	<b>26</b>		
Dimensions of FDU90 . . . . .	26		
Dimensions of FDU91 . . . . .	26		
Dimensions of FDU91F . . . . .	27		
Dimensions of FDU92 . . . . .	27		
Dimensions of FDU93 . . . . .	27		
Dimensions of FDU95 . . . . .	28		
Dimensions of G1" counter nut . . . . .	28		

## 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



Alternating current



Direct current and alternating current




Direct current



Ground connection

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

 **Protective earth (PE)**

Ground terminals that must be connected to ground prior to establishing any other connections.

The ground terminals are located on the interior and exterior of the device:

- Interior ground terminal: protective earth is connected to the mains supply.
- Exterior ground terminal: device is connected to the plant grounding system.

### Tool symbols



Phillips head screwdriver



Flat blade screwdriver



Torx screwdriver



Allen key



Open-ended wrench

### Symbols for certain types of information and graphics



**Permitted**

Procedures, processes or actions that are permitted



**Preferred**

Procedures, processes or actions that are preferred



**Forbidden**

Procedures, processes or actions that are forbidden



**Tip**

Indicates additional information



Reference to documentation



Reference to graphic



Notice or individual step to be observed

**1., 2., 3.**

Series of steps



Result of a step



Operation via operating tool



Write-protected parameter

**1, 2, 3, ...**

Item numbers

**A, B, C, ...**

Views

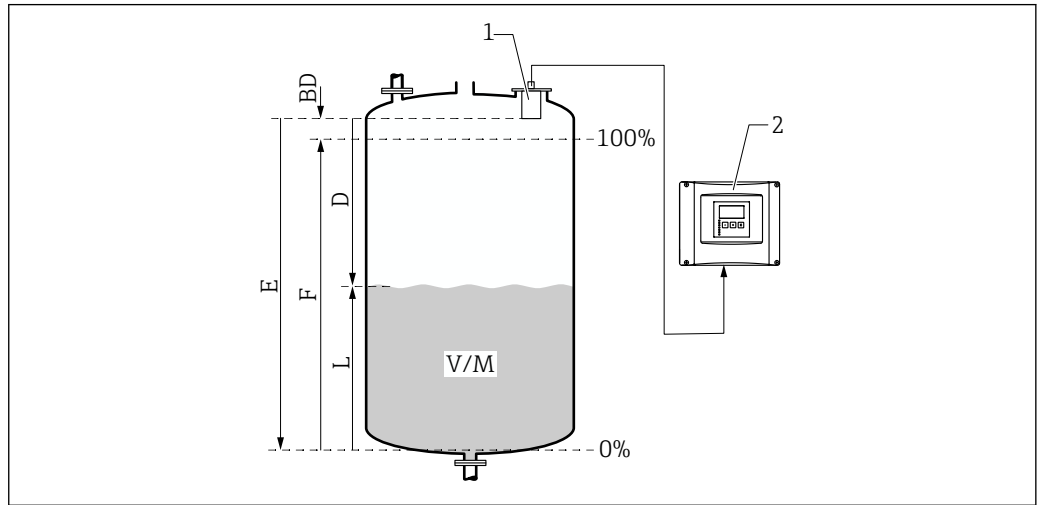


**Safety instructions**

Observe the safety instructions contained in the associated Operating Instructions

## Function and system design

### Ultrasonic level measurement



1 Ultrasonic level measurement

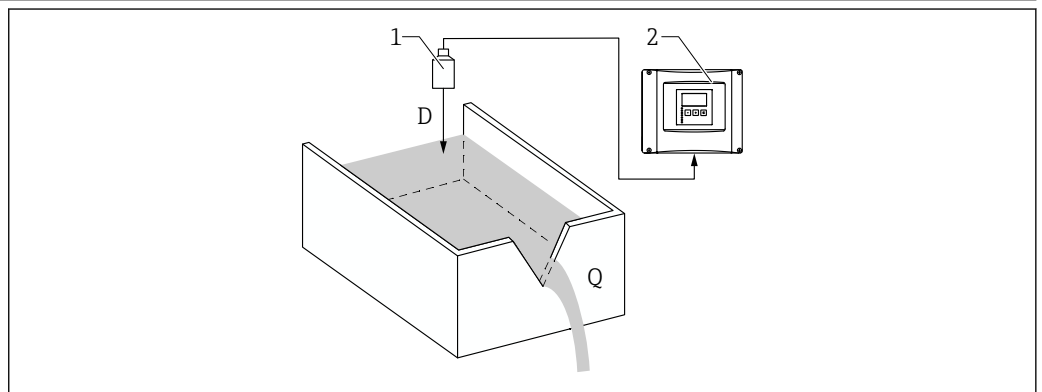
- 1 FDU9x sensor
- 2 FMU90/FMU95 transmitter
- BD Blocking distance
- D Distance between sensor membrane and product surface
- E Empty distance
- F Span
- L Level
- V/M Volume/mass

The sensor transmits ultrasonic pulses in the direction of the surface of the product. 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 sensor membrane and the surface of the product:

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

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

### Ultrasonic flow measurement in flumes or weirs



2 Ultrasonic flow measurement

- 1 FDU9x sensor
- 2 FMU90/FMU95 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 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.

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**Temperature-dependent  
time-of-flight correction**

**For sensors without sensor heating**

Via the temperature sensors integrated in the ultrasonic sensors

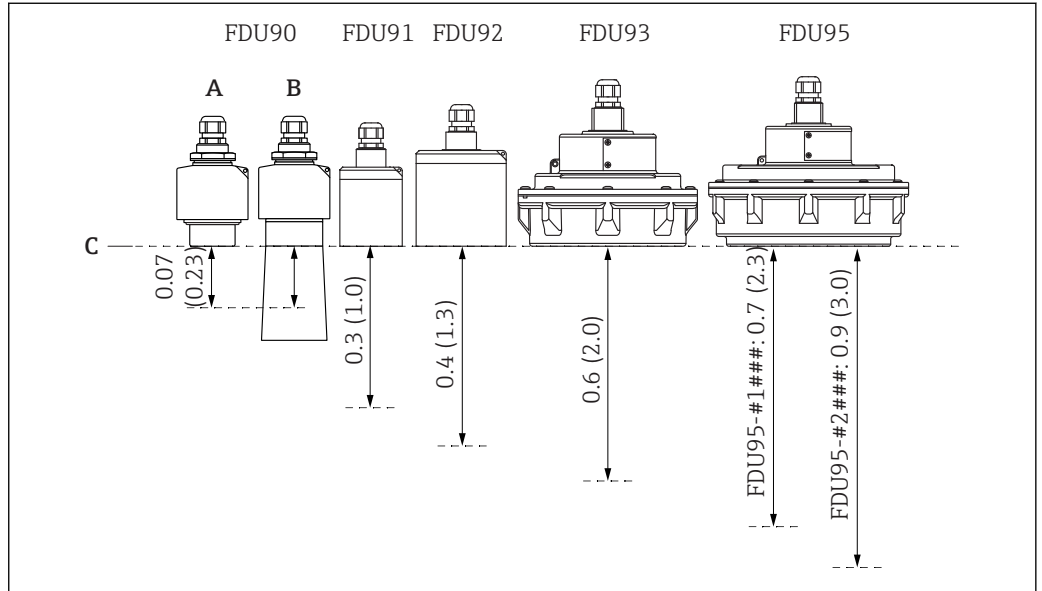
**In the case of FDU90 and FDU91 with sensor heating**

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.



3 Blocking distance of FDU9x ultrasonic sensors. Engineering unit m (ft)

- A FDU90 without flooding protection tube
- B FDU90 with flooding protection tube
- C Reference point of measurement

### Measuring range

#### Estimation of the 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 caused by surface of bulk solids

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

#### Attenuation due to dust

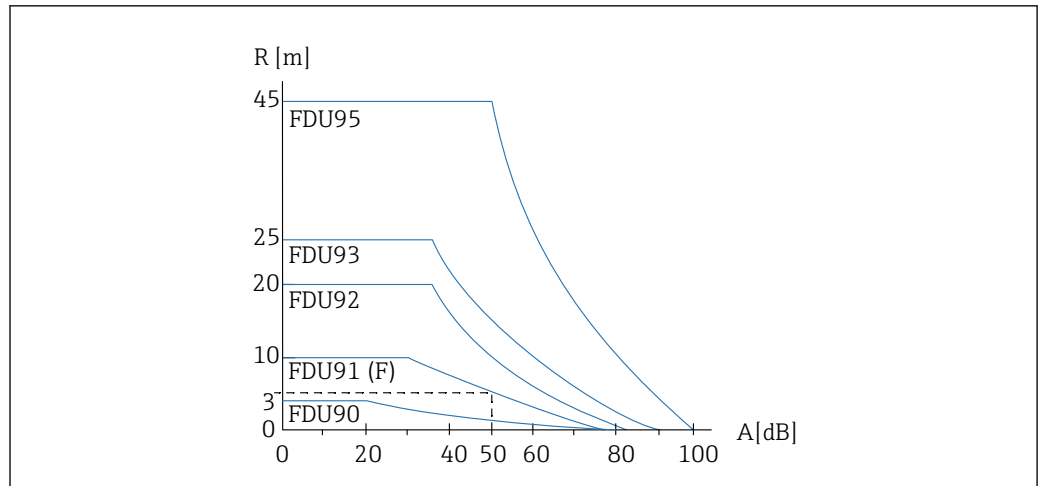
- No dust formation: 0 dB
- Minor dust formation: 5 dB
- Major dust formation: 5 to 20 dB

#### 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



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4 Range chart for ultrasonic sensors

A Total attenuation in dB

R Range in m

**Operating frequency**

- FDU90: 90 kHz
- FDU91: 43 kHz
- FDU91F: 42 kHz
- FDU92: 30 kHz
- FDU93: 27 kHz
- FDU95-\*1\*\*\*: 17 kHz
- FDU95-\*2\*\*\*: 18 kHz



## Power supply

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### Power supply for ultrasonic sensors

Is provided by the transmitter.

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### Power supply for integrated sensor heater (FDU90, FDU91)

#### Device versions with sensor heater

- FDU90-\*\*\*B\*
- FDU91-\*\*\*B\*

#### Connection data

- Supply voltage:  $24 V_{DC} \pm 10 \%$
- Residual ripple:  $< 100 \text{ mV}$
- Current consumption: 250 mA per sensor
- Suitable power supply unit: RNB130 from Endress+Hauser <sup>1)</sup>



- 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.

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1) See →  40

## Electrical connection

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### General information

#### **⚠ CAUTION**

##### **Inadequate potential equalization can compromise electrical safety**

- ▶ Connect the yellow/green protective ground of the FDU91F, FDU93 and FDU95 sensors to local potential equalization after a **maximum distance of 30 m (98 ft)**. This can be done in a terminal box, at the transmitter or in the cabinet.

#### **NOTICE**

##### **Interference signals may cause malfunctions**

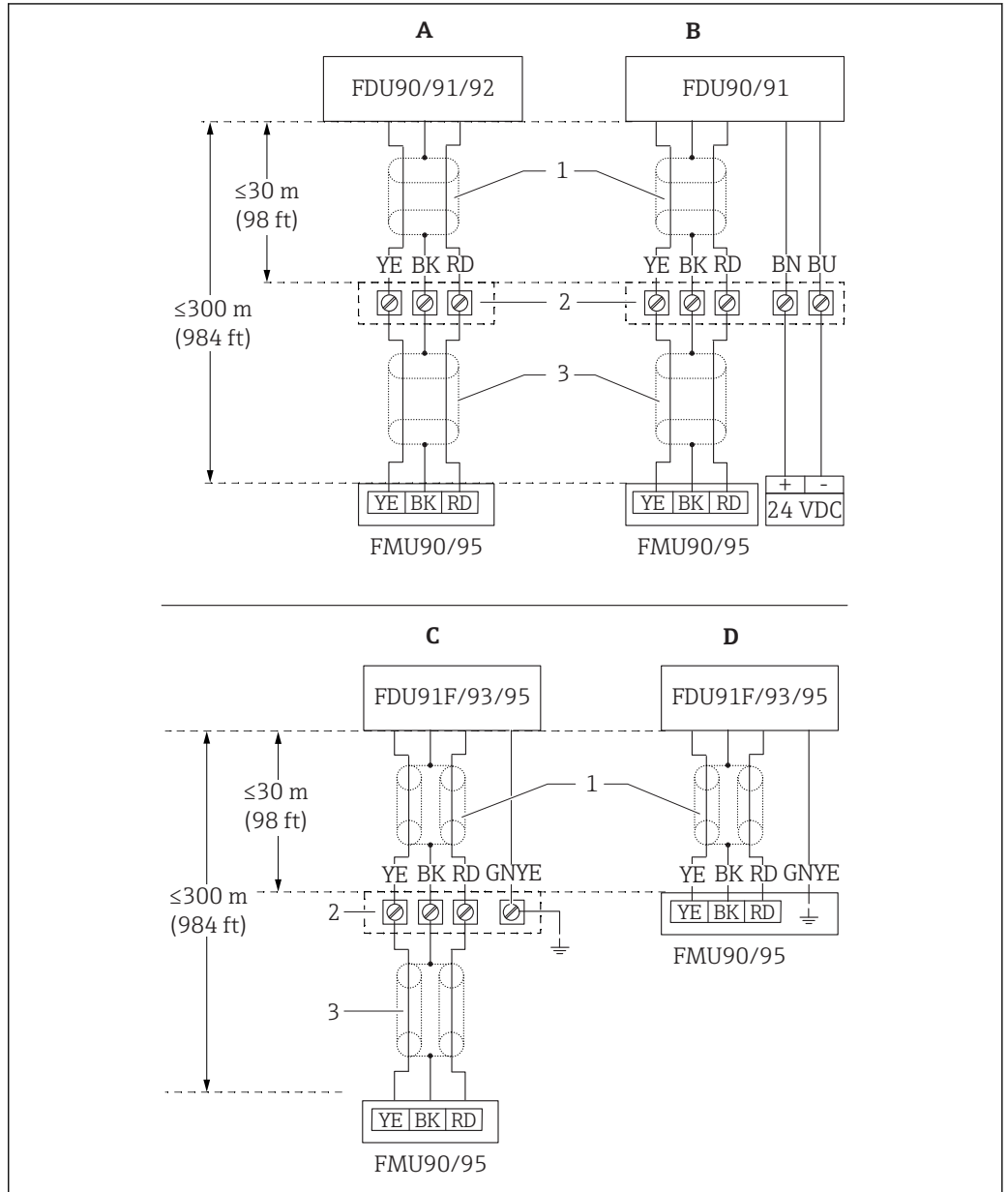
- ▶ Do not route the sensor cables parallel to high-voltage electric power lines or near frequency converters.

#### **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  
FDU9x → FMU90

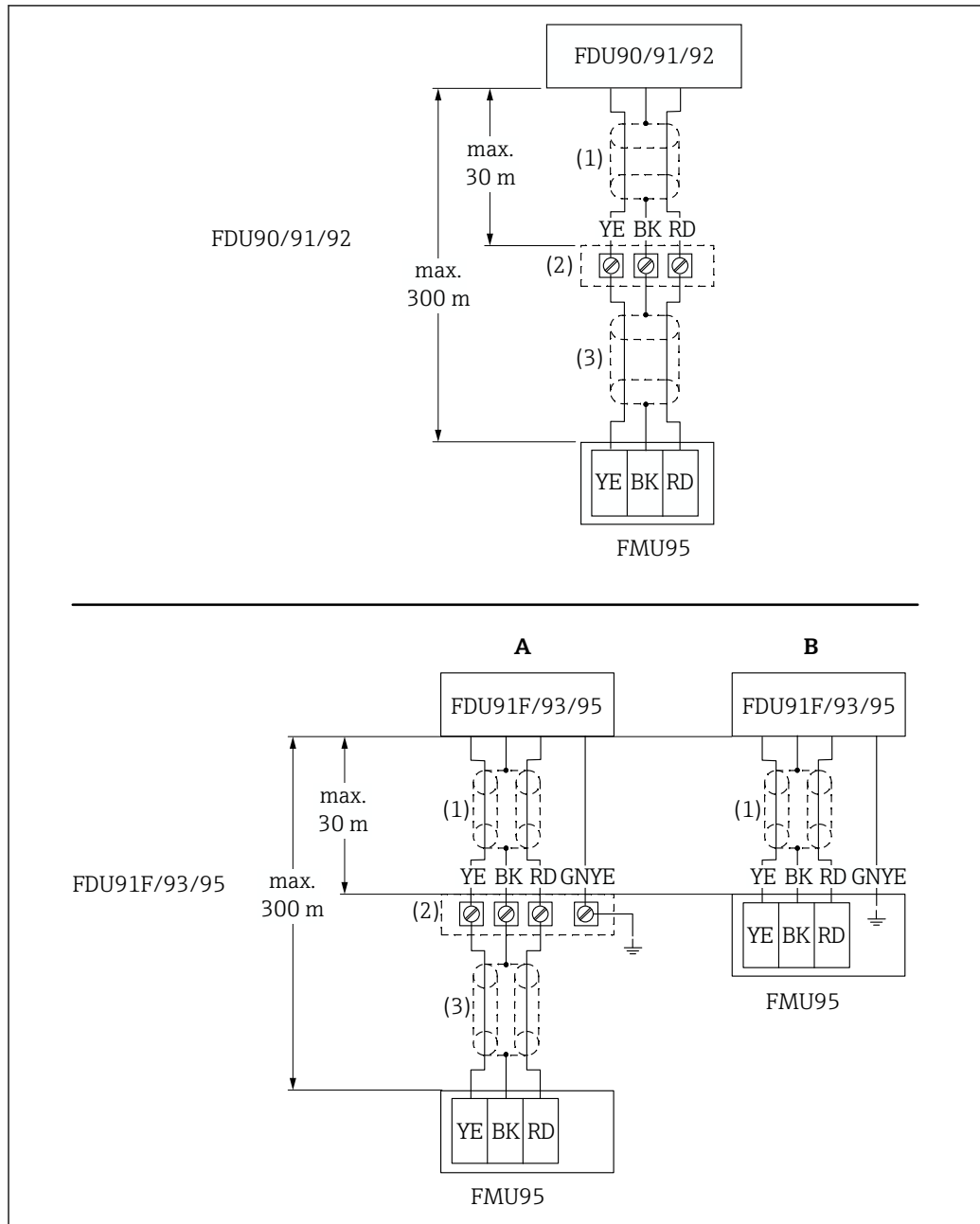


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5 Connection diagram for sensors FDU9x; YE: yellow, BK: black; RD: red; BU: blue; BN: brown; GNYE: green/yellow

- A Without sensor heater
- B With sensor heater
- C Grounding at terminal box
- D Grounding at transmitter FMU90
- 1 Shielding of sensor cable
- 2 Terminal box
- 3 Shielding of extension cable

Connection diagram for  
FDU9x → FMU95



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6 Connection diagram for sensors FDU9x; YE: yellow, BK: black; RD: red; BU: blue; BN: brown; GNYE: green/yellow

- A Grounding at terminal box
- B Grounding at transmitter FMU95
- 1 Shielding of sensor cable
- 2 Terminal box
- 3 Shielding of extension cable

## Sensor extension cable

### **WARNING**

#### Explosion Hazard

- ▶ Use a terminal box to connect the extension cable.
- ▶ If the terminal box is installed in hazardous areas, comply with applicable national requirements.

#### 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 mm<sup>2</sup> (18 to 14 AWG)
- **Resistance**  
Max. 8 Ω per wire
- **Capacitance, wire to shield**  
Max. 60 nF
- **Protective ground (for FDU91F/93/95)**  
May not be within the shielding.



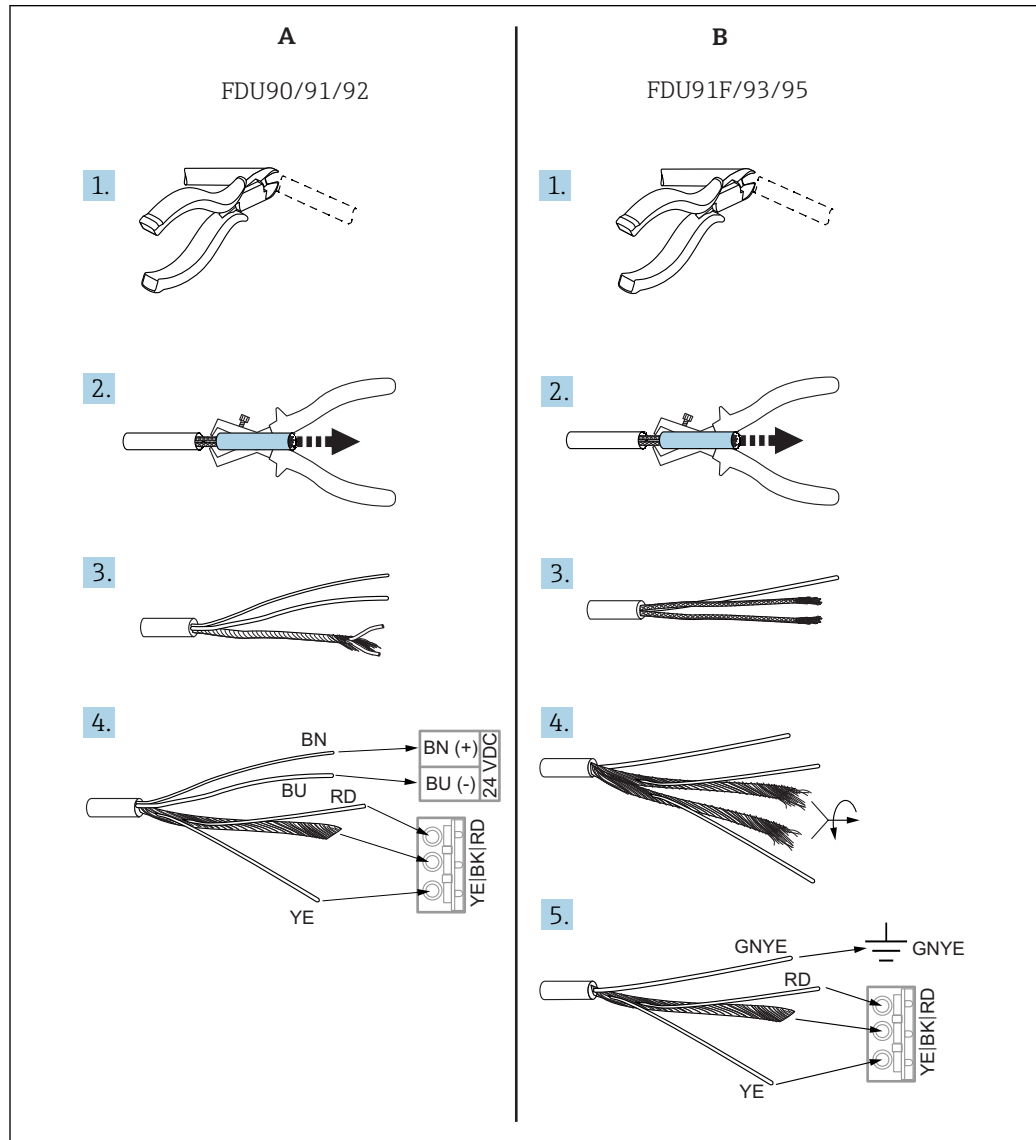
Suitable connection cables are available from Endress+Hauser (→  35).

Shortening the sensor cable


**NOTICE**

**Damaged wires or no return conductor may cause malfunctions**

- ▶ Do not damage the wires when removing the insulation.
- ▶ After shortening the cable, twist the shielding metal braiding and connect it to the "BK" terminal.
- ▶ If the cable has a protective ground (GNYE), do **not** connect the protective ground to the cable shield.




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 7 Shortening the sensor cable

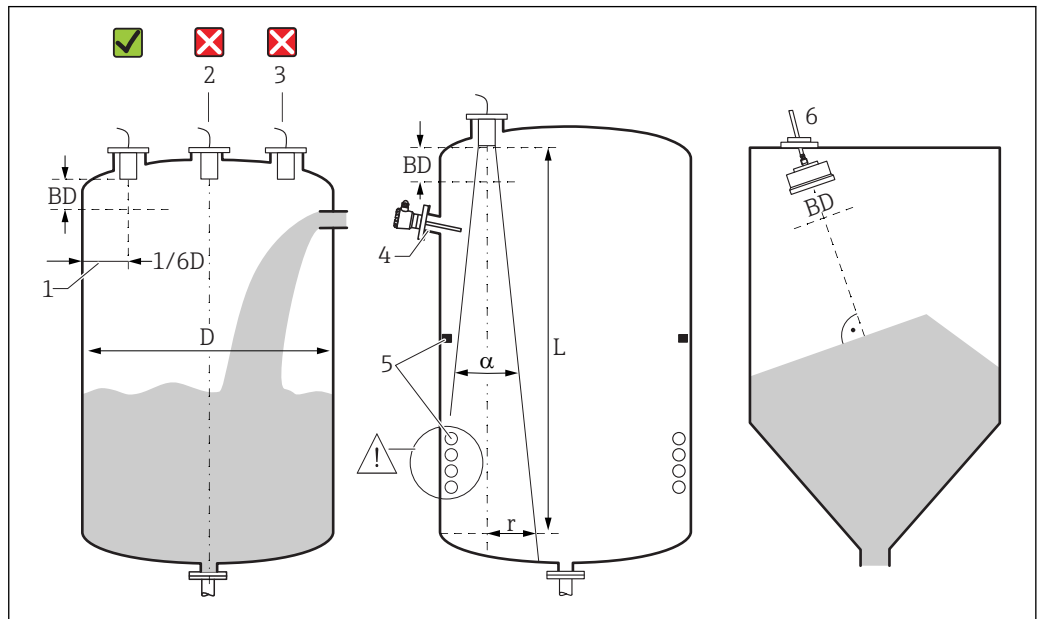
A FDU90/91/92 sensors

B FDU91F/93/95 sensors

 The "BU" (blue) and "BN" (brown) wires are only provided on sensors with a heater.

## Installation

### Installation conditions for level measurement



#### 8 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 ( $\rightarrow$  39), align the sensor so that it is perpendicular to the surface of the product.
- BD Blocking distance ( $\rightarrow$  7)

#### Emitting angle/beam, FDU90

- $\alpha$  (typical) =  $12^\circ$
- $L$  (max) = 3 m (9.8 ft)
- $r$  (max) = 0.31 m (1.0 ft)

#### Emitting angle/beam, FDU91

- $\alpha$  (typical) =  $9^\circ$
- $L$  (max) = 10 m (33 ft)
- $r$  (max) = 0.79 m (2.6 ft)

#### Emitting angle/beam, FDU91F

- $\alpha$  (typical) =  $12^\circ$
- $L$  (max) = 10 m (33 ft)
- $r$  (max) = 1.05 m (3.4 ft)

#### Emitting angle/beam, FDU92

- $\alpha$  (typical) =  $11^\circ$
- $L$  (max) = 20 m (66 ft)
- $r$  (max) = 1.92 m (6.3 ft)

#### Emitting angle/beam, FDU93

- $\alpha$  (typical) =  $4^\circ$
- $L$  (max) = 25 m (82 ft)
- $r$  (max) = 0.87 m (2.9 ft)

#### Emitting angle/beam, FDU95

- $\alpha$  (typical) =  $5^\circ$
- $L$  (max) = 45 m (148 ft)
- $r$  (max) = 1.96 m (6.4 ft)

#### Other conditions

- The lower edge of the sensor should be located inside the vessel.
- The maximum level may not enter the blocking distance ( $\rightarrow$  7).

**Several sensors in one vessel**

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

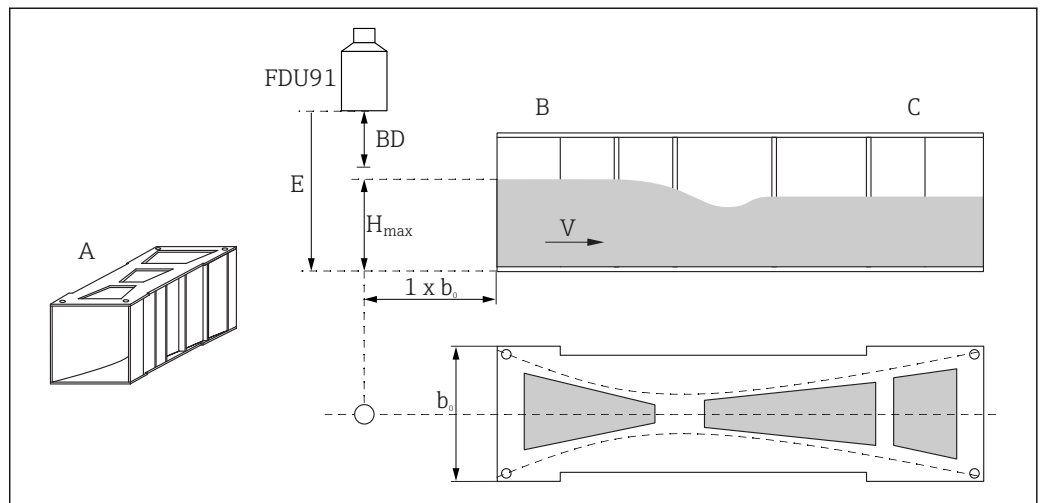


**Installation conditions for flow measurement**

**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 flume 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. The mounting distances for important flumes and weirs are provided in the following Operating Instructions:
  - BA00289F (FMU90, HART)
  - BA00293F (FMU90, PROFIBUS DP)
- Protect the sensor against sun and precipitation using the weather protection cover (→ 35).

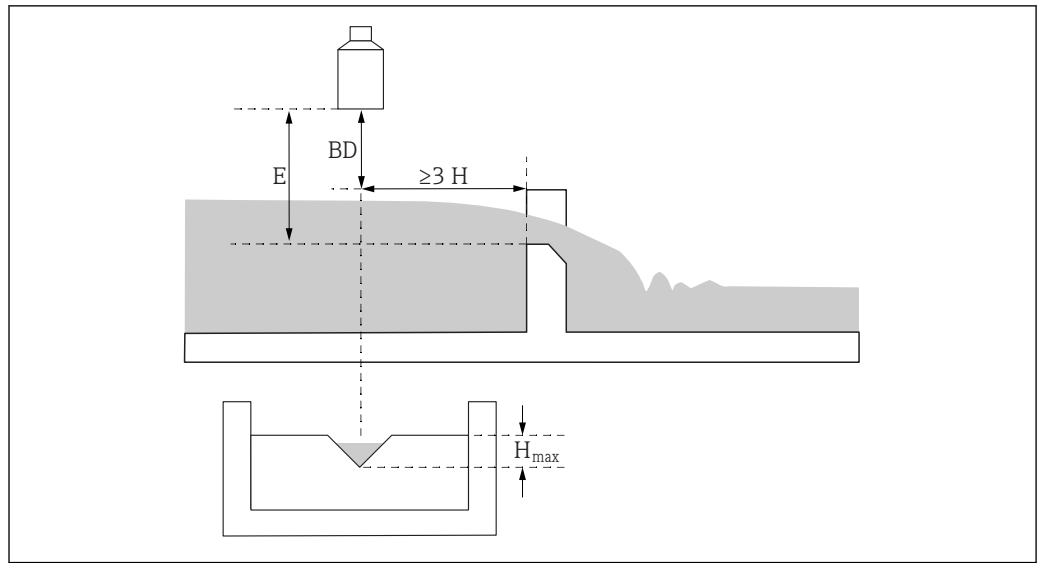
**Example: Khafagi-Venturi flume**



9 Installation conditions for a 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**



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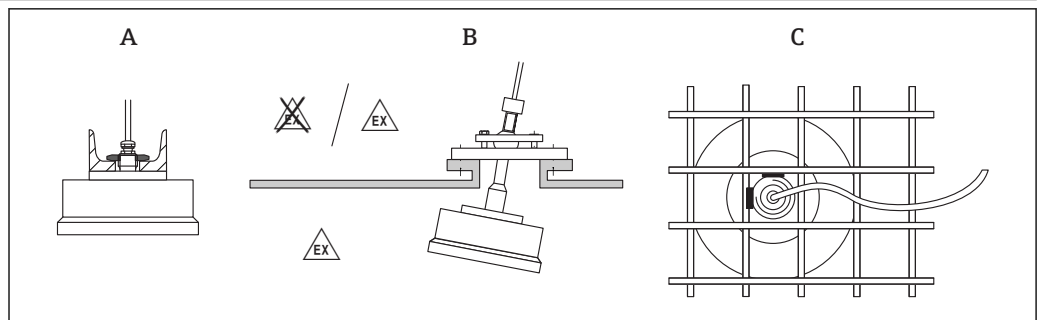
10 Installation conditions for a triangular weir

*BD* Blocking distance of the sensor

*E* Empty calibration (to be entered during commissioning)

*H<sub>max</sub>* Maximum upstream level

**Installation options (examples)**



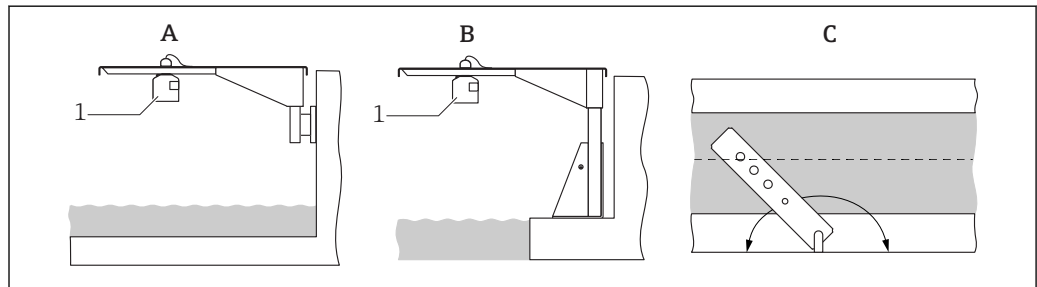
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11 Installation in systems

*A* On U-rail or bracket

*B* With FAU40 alignment unit (→ 39)

*C* With 1" sleeve welded to a grating



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12 Installation with cantilever arm over open channels or flumes

*A* Arm (→ 37) with wall bracket (→ 39)

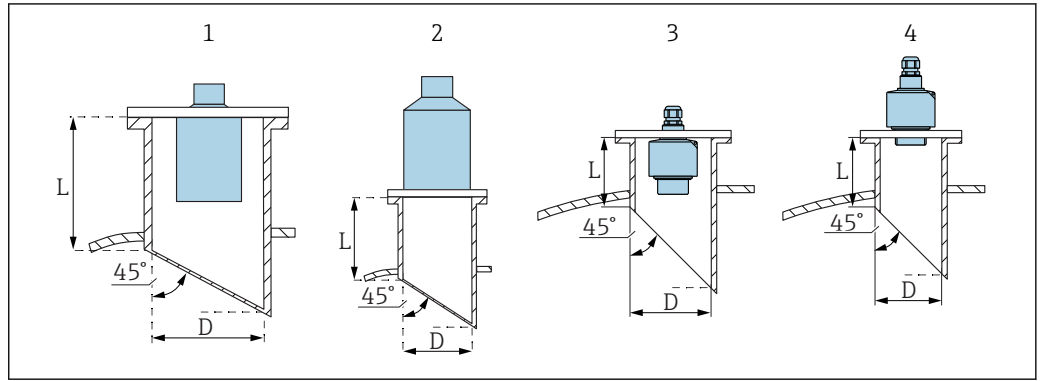
*B* Arm (→ 37) with mounting frame (→ 38)

*C* The arm can be turned (e.g. to position the sensor over the center of the channel)



The FDU91F can also be flush-mounted with a slip-on flange.

Nozzle mounting



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13 Nozzle mounting of FDU9x sensors

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, FDU90 - mounted on rear thread

- D = DN80/3"  
L<sub>max</sub> = 340 mm (13.4 in)
- D = DN100/4"  
L<sub>max</sub> = 390 mm (15.4 in)
- D = DN150/6" to DN300/12"  
L<sub>max</sub> = 400 mm (15.7 in)

Maximum nozzle length, FDU90 - flush mounting

- D = DN50/2"  
L<sub>max</sub> = 50 mm (1.97 in)
- D = DN80/3"  
L<sub>max</sub> = 250 mm (9.84 in)
- D = DN100/4" to DN300/12"  
L<sub>max</sub> = 300 mm (11.8 in)

Maximum nozzle length, FDU91

- D = DN80/3"  
L<sub>max</sub> = 340 mm (13.4 in)
- D = DN100/4"  
L<sub>max</sub> = 390 mm (15.4 in)
- D = DN150/6" to DN300/12"  
L<sub>max</sub> = 400 mm (15.7 in)

Maximum nozzle length, FDU91F

- D = DN80/3"  
L<sub>max</sub> = 250 mm (9.84 in)<sup>2)</sup>
- D = DN100/4" to DN300/12"  
L<sub>max</sub> = 300 mm (11.8 in)<sup>2)</sup>

Maximum nozzle length, FDU92

D = DN150/6" to DN300/12"  
L<sub>max</sub> = 400 mm (15.7 in)

2) Applies to flush-mounted installation; for installation via rear thread, see FDU91

**Maximum nozzle length, FDU93**

D = DN200/8" to DN300/12"

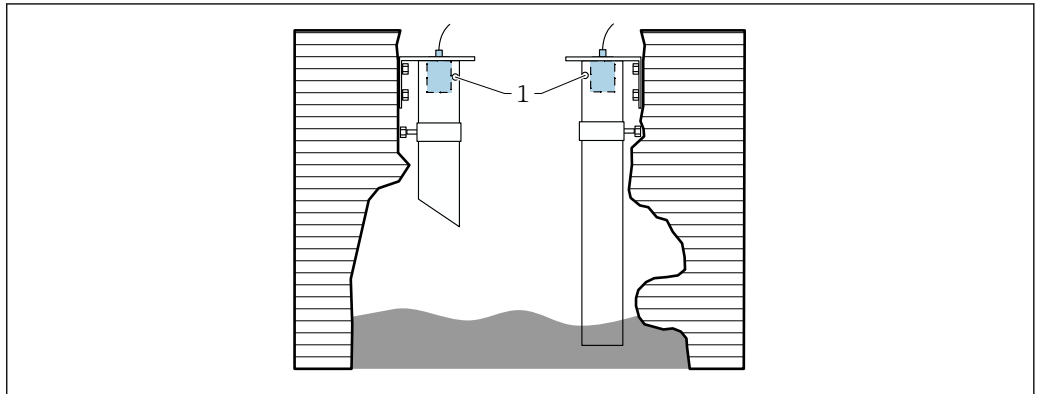
$L_{\max}$  = 520 mm (20.5 in)

**Maximum nozzle length, FDU95**

D = DN250/10" to DN300/12"

$L_{\max}$  = 630 mm (24.8 in)

**Ultrasound guide pipe for measurement in narrow pits**



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14 Ultrasound guide pipe for ultrasonic measurement in narrow pits

1 Venting hole

**Suitable ultrasound guide pipe**

e.g. PE or PVC wastewater pipe

**Minimum diameter**

- FDU90: DN80
- FDU91: DN100
- FDU92: DN200

**Additional conditions**

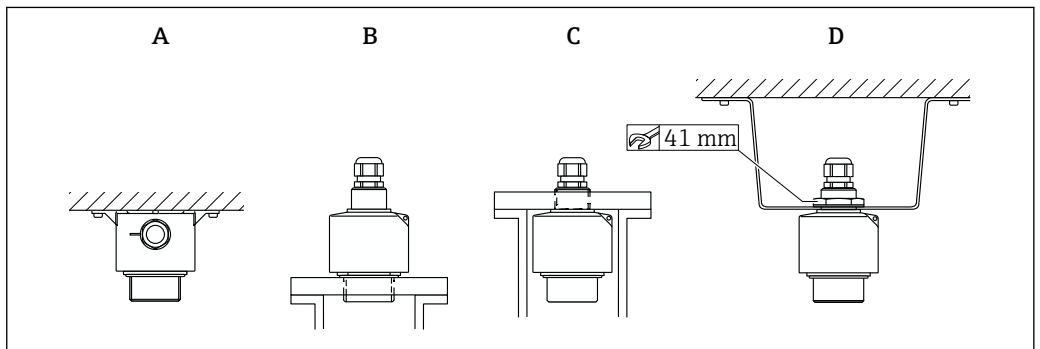
- Venting hole at top
- No contamination from built-up dirt. Clean regularly where necessary.

**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.



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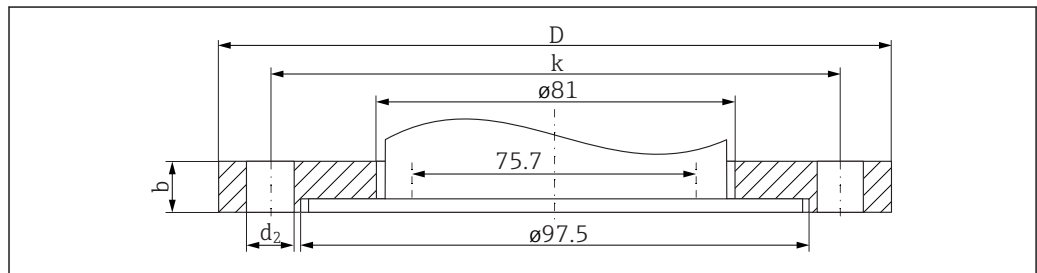
15 Securing the ultrasonic sensor

- A Ceiling mounting (FDU90)
- B Mounted at front thread (FDU90)
- C Mounted at rear thread (FDU90/91/91F/92/93/95)
- D Mounted with counter nut (FDU90/91/92)

### Slip-on flange without adapter flange for flush mounting of FDU91F



- The process seal is not included in the scope of supply.
- Endress+Hauser supplies DIN/EN flanges made of stainless steel AISI 316L with the material number 1.4435 or 1.4404. With regard to their stability-temperature property, the materials 1.4435 and 1.4404 are grouped together under 13EO in EN 1092-1 Tab. 18. The chemical composition of the two materials can be identical.
- For 3A applications:  
The internal diameter of the adapter must be selected according to the applicable tolerance limits for 3A applications. Usually, the internal diameter of the nozzle should be larger than or equal to the internal diameter of the sensor.
- Maximum process pressure for PPs slip-on flanges: 1.5 bar(abs)



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16 Dimensions of FAU80 slip-on flange without adapter flange

#### Version suitable for DN80 PN16

- $b = 20$  mm (0.79 in)
- $D = 200$  mm (7.87 in)
- $k = 160$  mm (6.3 in)
- $d_2 = 18$  (0.71)
- Number  $d_2 = 8$
- Order code for PPs material: FAU80-CAP
- Order code for 316L (1.4435) material: FAU80-CAJ

#### Version suitable for NPS 3" Cl.150 FF

- $b = 23.9$  (0.94)
- $D = 190.5$  (7.5)
- $k = 152$  (6.0)
- $d_2 = 19.1$  (0.75)
- Number  $d_2 = 4$
- Order code for PPs material: FAU80-AAP
- Order code for 316L (1.4435) material: FAU80-AAJ

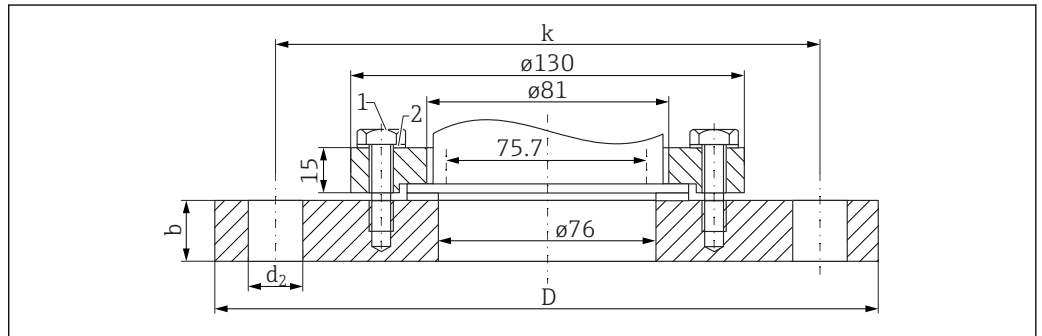
#### Version suitable for 10K 80A FF

- $b = 18$  (0.71)
- $D = 185$  (7.28)
- $k = 150$  (5.9)
- $d_2 = 19$  (0.75)
- Number  $d_2 = 8$
- Order code for PPs material: FAU80-KAP
- Order code for 316L (1.4435) material: FAU80-KAJ

**Slip-on flange with adapter flange for flush mounting of FDU91F**



- The process seal is not included in the scope of supply.
- Endress+Hauser supplies DIN/EN flanges made of stainless steel AISI 316L with the material number 1.4435 or 1.4404. With regard to their stability-temperature property, the materials 1.4435 and 1.4404 are grouped together under 13EO in EN 1092-1 Tab. 18. The chemical composition of the two materials can be identical.
- For 3A applications:  
The internal diameter of the adapter must be selected according to the applicable tolerance limits for 3A applications. Usually, the internal diameter of the nozzle should be larger than or equal to the internal diameter of the sensor.
- Maximum process pressure for PPs slip-on flanges: 1.5 bar(abs)



A0036742

**17** Dimensions of FAU80 slip-on flange with adapter flange

- 1 Hexagonal-headed bolts made of V2A; included in the delivery
- 2 Washers made of PPs or 316L (1.4435); included in the delivery

**Version suitable for DN80 PN16**

- b = 20 mm (0.79 in)
- D = 220 (8.66)
- k = 180 (7.09)
- d<sub>2</sub> = 18 (0.71)
- Number d<sub>2</sub> = 8
- Order code for PPs material: FAU80-CHP
- Order code for 316L (1.4435) material: FAU80-CHJ

**Version suitable for NPS 3" Cl.150 FF**

- b = 23.9 (0.94)
- D = 228.6 (9.0)
- k = 190.5 (7.5)
- d<sub>2</sub> = 19.1 (0.75)
- Number d<sub>2</sub> = 4
- Order code for PPs material: FAU80-AHP
- Order code for 316L (1.4435) material: FAU80-AHJ


**Version suitable for 10K 80A FF**

- b = 18 (0.71)
- D = 210 (8.27)
- k = 175 (6.89)
- d<sub>2</sub> = 19 (0.75)
- Number d<sub>2</sub> = 8
- Order code for PPs material: FAU80-KHP
- Order code for 316L (1.4435) material: FAU80-KHJ

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## Environment

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<b>Degree of protection</b>	Tested according to IP68/NEMA6P (24 h at 1.83 m (6 ft) under water)
<b>Vibration resistance</b>	DIN EN 600068-2-64; 20 to 2 000 Hz; 1 (m/s <sup>2</sup> ) <sup>2</sup> /Hz; 3x100 min
<b>Storage temperature</b>	Identical to process temperature (→  25)
<b>Thermal shock resistance</b>	Based on DIN EN 60068-2-14; test according to min./max. process temperature; 0.5 K/min; 1 000 h
<b>Electromagnetic compatibility</b>	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".

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## Process

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### Process temperature

- **FDU90**  
-40 to +80 °C (-40 to +176 °F)<sup>3)</sup>
- **FDU91**  
-40 to +80 °C (-40 to +176 °F)<sup>3)</sup>
- **FDU91F**
  - Non-Ex: -40 to +105 °C (-40 to +221 °F)
  - Non-Ex, max. 30 min: 135 °C (275 °F)<sup>4)</sup>
  - Ex: -40 to +80 °C (-40 to +176 °F)
- **FDU92**
  - Non-Ex: -40 to +95 °C (-40 to +203 °F)
  - Ex: -40 to +80 °C (-40 to +176 °F)
- **FDU93**
  - Non-Ex: -40 to +95 °C (-40 to +203 °F)
  - Ex: -40 to +80 °C (-40 to +176 °F)
- **FDU95-\*1\*\*\***  
-40 to +80 °C (-40 to +176 °F)
- **FDU95-\*2\*\*\***
  - Non-Ex: -40 to +150 °C (-40 to +302 °F)
  - Dust-Ex: -40 to +130 °C (-40 to +266 °F)

### Process pressure

- **FDU90**  
0.7 to 4 bar (10.15 to 58 psi)
- **FDU91**  
0.7 to 4 bar (10.15 to 58 psi)
- **FDU91F**  
0.7 to 4 bar (10.15 to 58 psi)
- **FDU92**  
0.7 to 4 bar (10.15 to 58 psi)
- **FDU93**  
0.7 to 3 bar (10.15 to 43.5 psi)
- **FDU95**  
0.7 to 1.5 bar (10.15 to 22 psi)

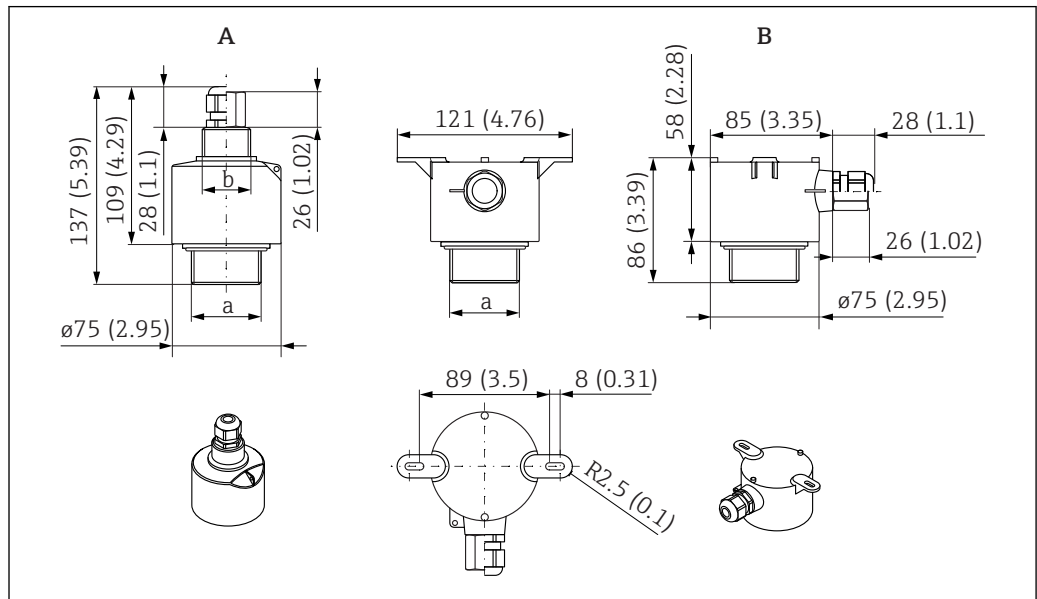
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3) To prevent the build-up of ice on the sensor, a version of the FDU90 and FDU91 sensors is available with integrated sensor heating.

4) for Tri-Clamp or flush mounting

## Mechanical construction

### Dimensions of FDU90



A0036335

18 Dimensions of FDU90. Unit of measurement mm (in)

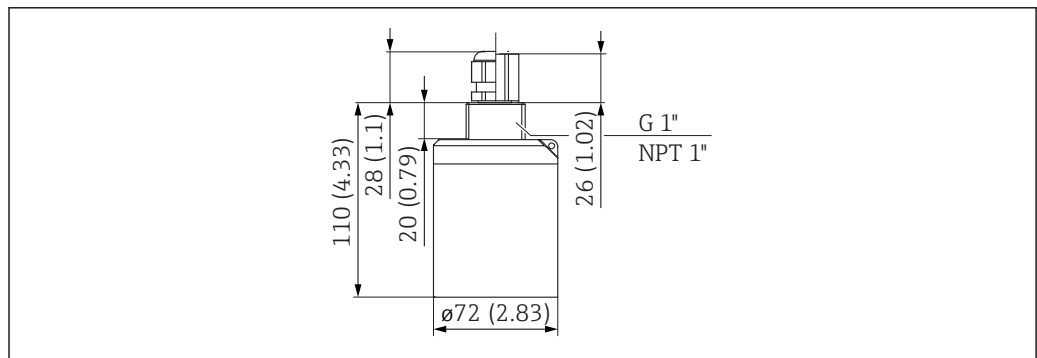
A FDU90-\*G\*\*\* (G1 and G1-1/2 thread); FDU909-\*N\*\*\* (NPT 1 and NPT 1-1/2 thread)

B FDU90-\*W\*\*\* (ceiling mounting)

a Front thread; G1-1/2 or NPT1-1/2

b Rear thread; G1 or NPT1

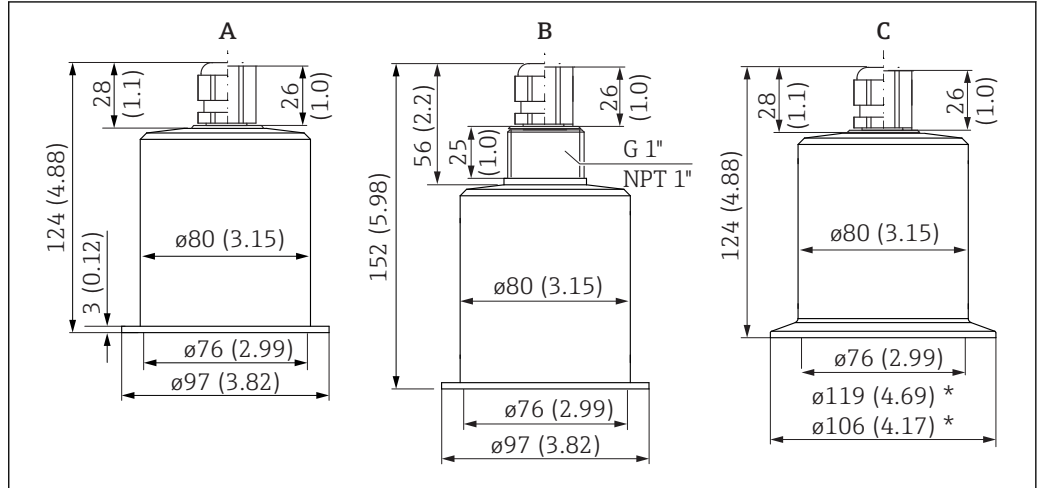
### Dimensions of FDU91



A0036336

19 Dimensions of FDU91. Unit of measurement mm (in)

**Dimensions of FDU91F**

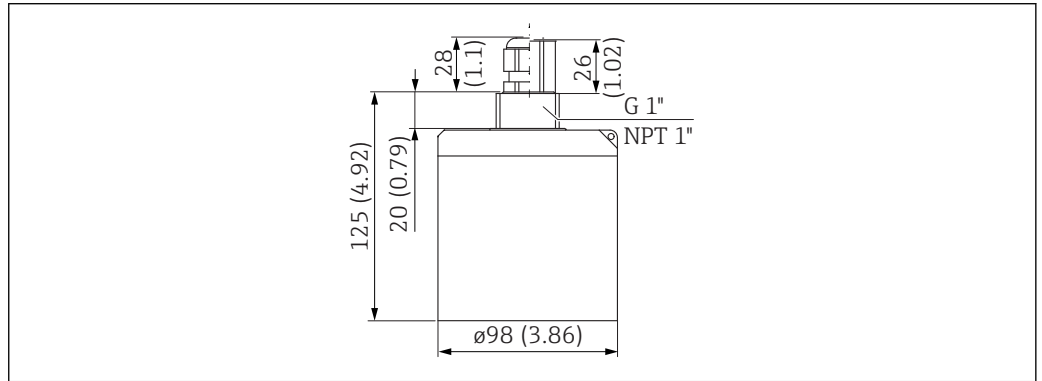


A0036344

20 Dimensions of FDU91F. Unit of measurement mm (in)

- A FDU91F-\*F\*\* (for FAU80 slip-on flange)
- B FDU91F-\*G\*\* (G1 thread); FDU91F-\*N\*\* (NPT1 thread)
- C FDU91F-\*S\*\* (Tri-Clamp DN101); FDU91F-\*T\*\* (Tri-Clamp DN88)

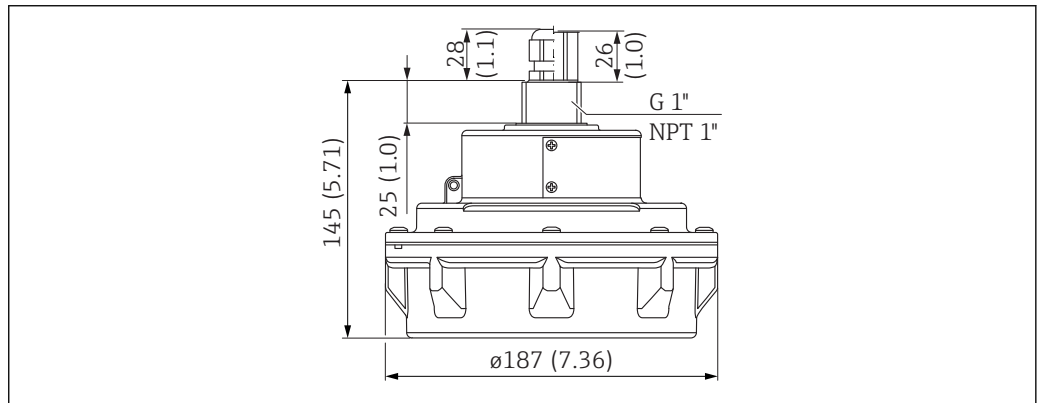
**Dimensions of FDU92**



A0036345

21 Dimensions of FDU92. Unit of measurement mm (in)

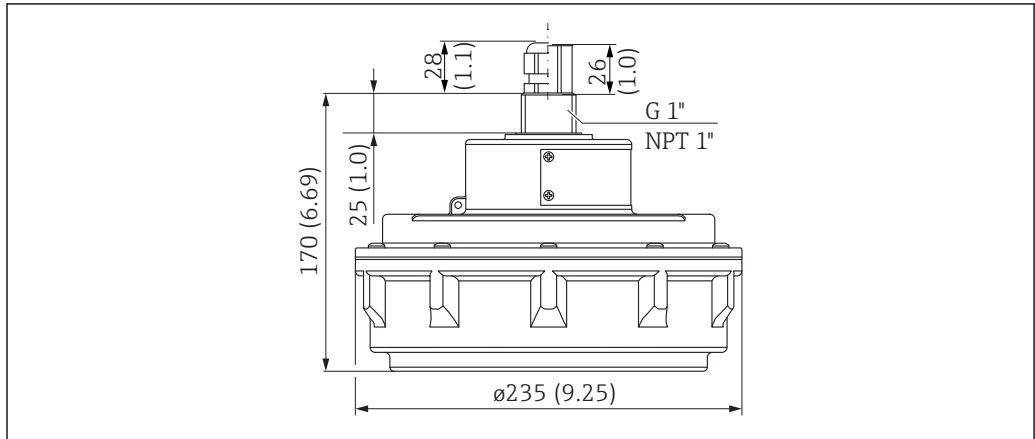
**Dimensions of FDU93**



A0036346

22 Dimensions of FDU93. Unit of measurement mm (in)

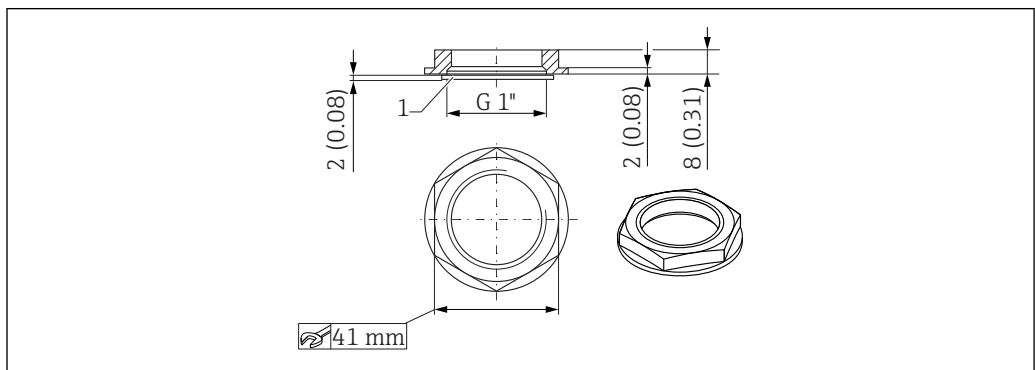
**Dimensions of FDU95**



A0036422

23 Dimensions of FDU95. Unit of measurement mm (in)

**Dimensions of G1" counter nut**



A0036333

24 Counter nut for FDU90/91/92; dimensions: mm (in)

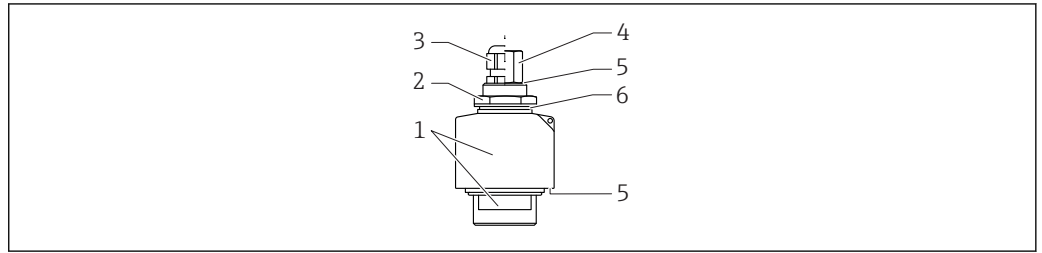
- i** The counter nut is included in the delivery for the following sensors:
  - FDU90-\*G\*\*\* (rear G1 thread)
  - FDU91-\*G\*\*\* (rear G1 thread)
  - FDU92-\*G\*\* (rear G1 thread)
- The counter nut is not suitable for NPT threads.

**Weight <sup>5)</sup>**

- **FDU90**
  - Excluding flooding protection tube: approx. 0.9 kg (1.98 lb)
  - Including flooding protection tube: approx. 1.0 kg (2.21 lb)
- **FDU91**  
Approx. 1.1 kg (2.43 lb)
- **FDU91F**  
Approx. 1.6 kg (3.53 lb)
- **FDU92**  
Approx. 2 kg (4.41 lb)
- **FDU93**  
Approx. 2.9 kg (6.39 lb)
- **FDU95**  
Approx. 4.5 kg (9.92 lb)

5) Including cable 5 m (16 ft)

**Materials of FDU90**

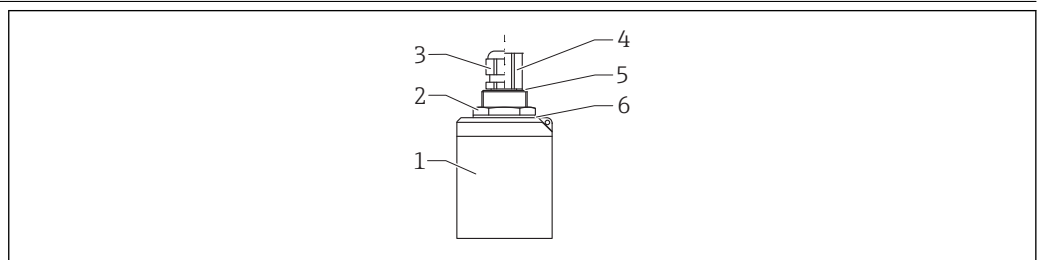


A0038714

25 *Materials of FDU90*

- 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 FDU91**

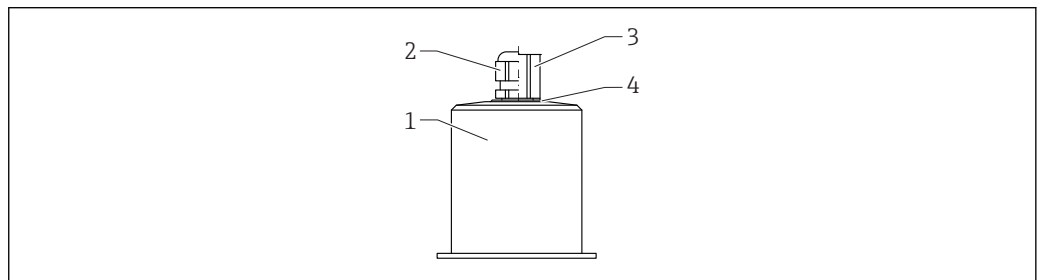


A0038715

26 *Materials of FDU91*

- 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 FDU91F**

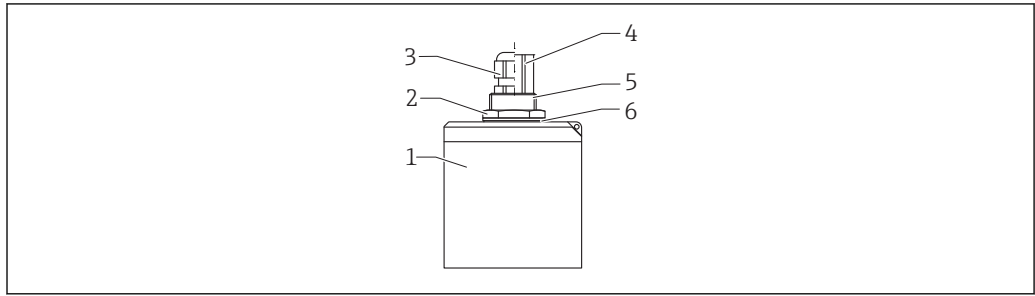


A0038716

27 *Materials of FDU91F*

- 1 *Sensor housing: 316L (1.4404/1.4435)*
- 2 *Cable gland: PA*
- 3 *Pipe adapter: CuZn nickel-plated*
- 4 *O-ring: EPDM*

**Materials of FDU92**

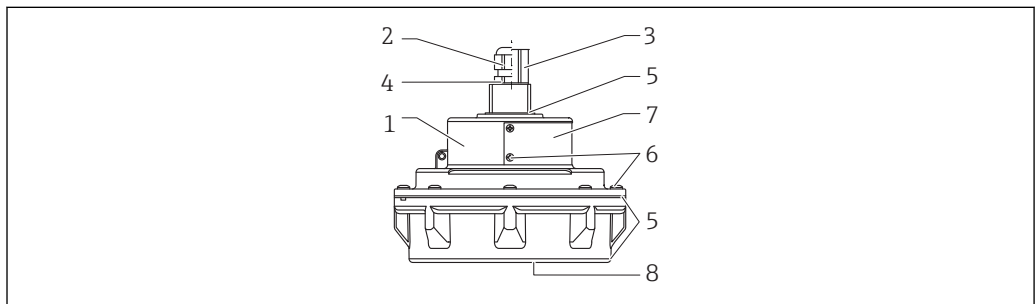


A0038717

28 **Materials of FDU92**

- 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 FDU93**

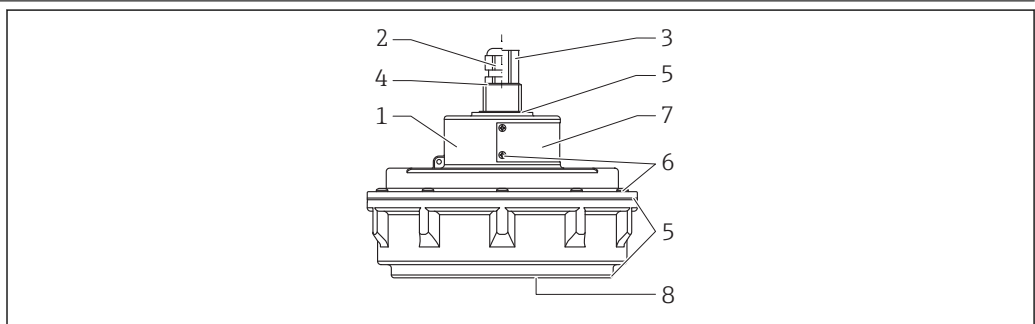


A0038708

29 **Materials of FDU93**

- 1 Sensor housing: UP (unsaturated polyester resin)
- 2 Cable gland: CuZn nickel-plated
- 3 Pipe adapter: CuZn nickel-plated
- 4 O-ring: VMQ
- 5 Seal: VMQ
- 6 Screws: V2A
- 7 Nameplate: 304 (1.4301)
- 8 Sensor membrane: aluminum, PFA-coated

**Materials of FDU95**



A0038709

30 **Materials of FDU95**

- 1 Sensor housing: UP (unsaturated polyester resin)
- 2 Cable gland: CuZn nickel-plated
- 3 Pipe adapter: CuZn nickel-plated
- 4 O-ring: VMQ
- 5 Seal: VMQ
- 6 Screws: V2A
- 7 Nameplate: 304 (1.4301)
- 8 Sensor membrane: FDU95-\*1\*\*\*: 316L (1.4404) with PE coating; FDU95-\*2\*\*\*: 316L (1.4404)

- Materials of connecting cable**
- FDU90/91/91F/92/93: PVC
  - FDU95: VMQ

- Material of G1" counter nut**
- Counter nut: PA6.6
  - Seal (included in the delivery): EPDM


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## Certificates and approvals

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**CE mark** The measuring system meets the legal requirements of the applicable EC guidelines. These are listed in the corresponding EC Declaration of Conformity together with the standards applied.  
Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

**Ex approval**

- Available Ex approvals: see Product Configurator
- Associated Safety Instructions: (→  41)

 FDU9x 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

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### Ordering information

Detailed ordering information is available from the following sources:

- In the Product Configurator on the Endress+Hauser website: [www.endress.com](http://www.endress.com) -> Click "Corporate" -> Select your country -> Click "Products" -> Select the product using the filters and search field -> Open product page -> The "Configure" button to the right of the product image opens the Product Configurator.
- From your Endress+Hauser Sales Center: [www.addresses.endress.com](http://www.addresses.endress.com)



#### **Product Configurator - the tool for individual product configuration**

- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as 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

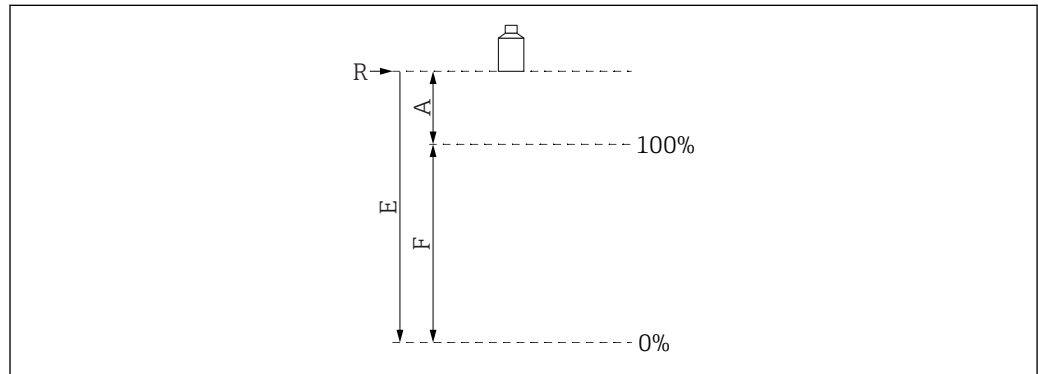
Conditions for 5-point linearity protocol

- 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 after the test.

Conditions for defining the span



A0019526

31 Variables to define the span

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

- **FDU90**
  - E ≤ 3 000 mm (118 in)
  - F = 100 to 2 900 mm (3.94 to 114 in)
  - A ≥ 160 mm (6.3 in)
- **FDU91/91F**
  - E ≤ 10 000 mm (394 in)
  - F = 100 to 9 700 mm (3.94 to 382 in)
  - A ≥ 300 mm (11.8 in)
- **FDU92**
  - E ≤ 20 000 mm (787 in)
  - F = 200 to 19 600 mm (7.87 to 772 in)
  - A ≥ 400 mm (15.7 in)
- **FDU93**
  - E ≤ 20 000 mm (787 in)
  - F = 250 to 19 400 mm (9.84 to 764 in)
  - A ≥ 600 mm (23.6 in)
- **FDU95**
  - E ≤ 20 000 mm (787 in)
  - F = 450 to 18 000 mm (17.7 to 709 in)
  - A ≥ 2 000 mm (78.7 in)

Scope of delivery

- Ordered version of the sensor
- Technical Information TI00396F (serves as the Installation Instructions and Operating Instructions)
- For certified versions: Safety Instructions (XAs)
- For FDU90/91 with a sensor heater: terminal module for installation in the field housing of the FMU90 transmitter
- For FDU90/91/92 with G1" process connection: counter nut (PA6.6) and seal (EPDM)
- For FDU93/95 with Ex-certificate: process seal (VMQ)

## Accessories

### Extension cables for sensors



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

#### FDU90/FDU91 without sensor heater

- Cable type: LiYCY 2x(0.75)
- Material: PVC
- Ambient temperature:
- Order number: 71027742

#### FDU90/FDU91 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

#### FDU92

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

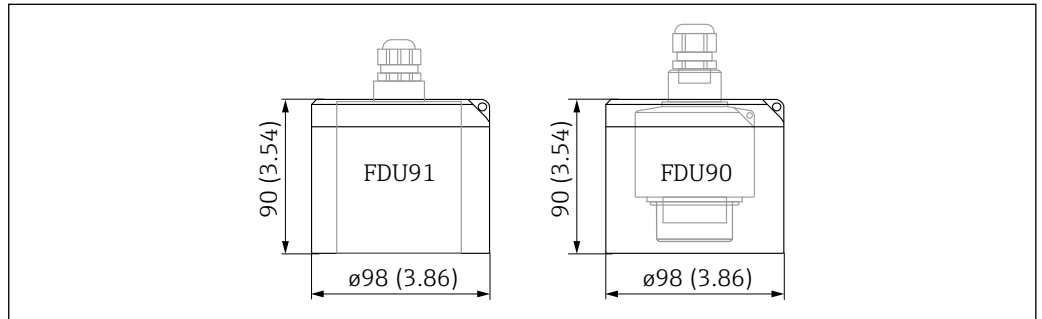
#### FDU91F/FDU93/FDU95

- Cable type: LiYY 2x(0.75)D+1x0.75
- Material: PVC
- Ambient temperature: -40 to +105 °C (-40 to +221 °F)
- Order number: 71027743

#### FDU95

- Cable type: Li2G2G 2x(0.75)D+1x0.75
- Material: silicone
- Ambient temperature: -40 to +150 °C (-40 to +302 °F)
- Order number: 71027745

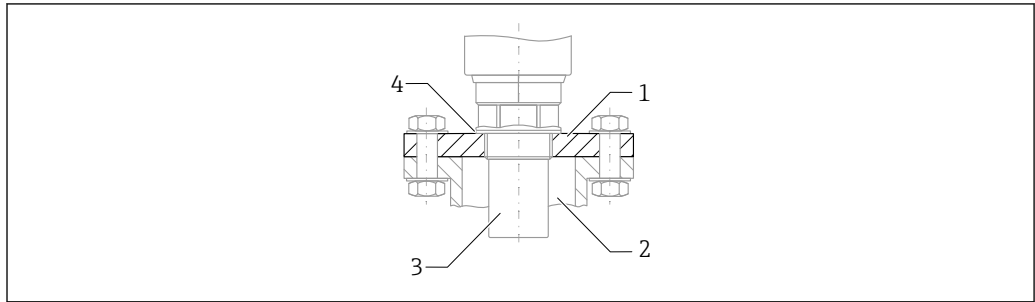
### Weather protection cover for FDU90/FDU91



32 Weather protection cover for FDU90/FDU91. Unit of measurement mm (in)

- Material: PVDF
- Order number: 52025686

### Screw-in flange FAX50



A0036331

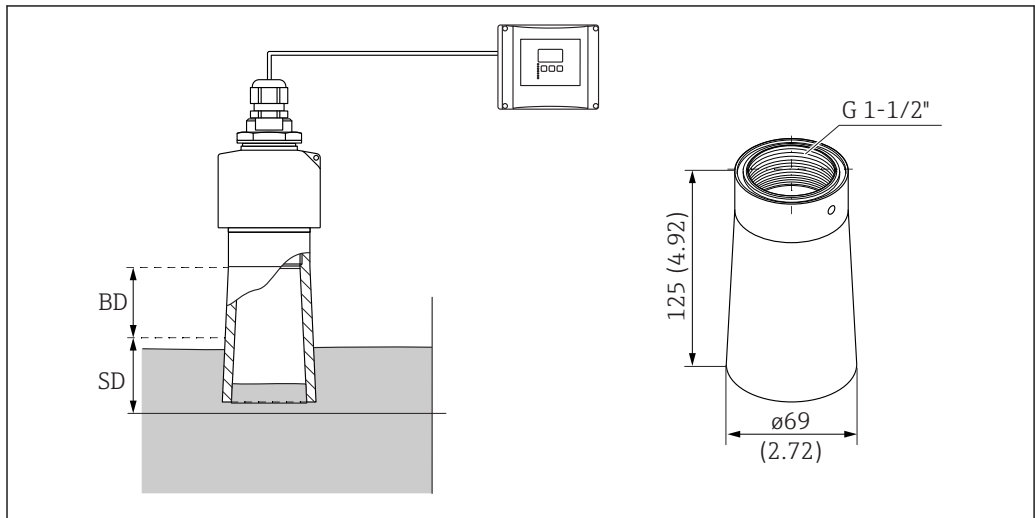
33 Screw-in flange FAX50

- 1 Screw-in flange
- 2 Nozzle
- 3 Sensor
- 4 EPDM process seal; included in the delivery



- Can be used for FDU90 (front G1-1/2 or NPT1-1/2 thread)
- Available flange sizes: see Product Configurator (→ 33)

### Flooding protection tube for FDU90



A0036330

34 Flooding protection tube for FDU90. 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 FDU90

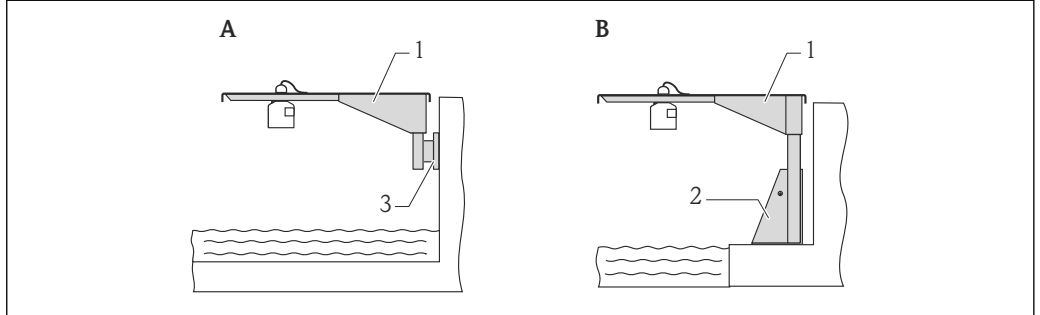
- Order code: FDU90-\*\*\*\*B
- The sensor then always has a G 1-1/2" thread on the front - irrespective of the option selected under code 020, "Process connection".

**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 FDU90, FDU91 and FDU92 sensors**

**Application**



A0019589

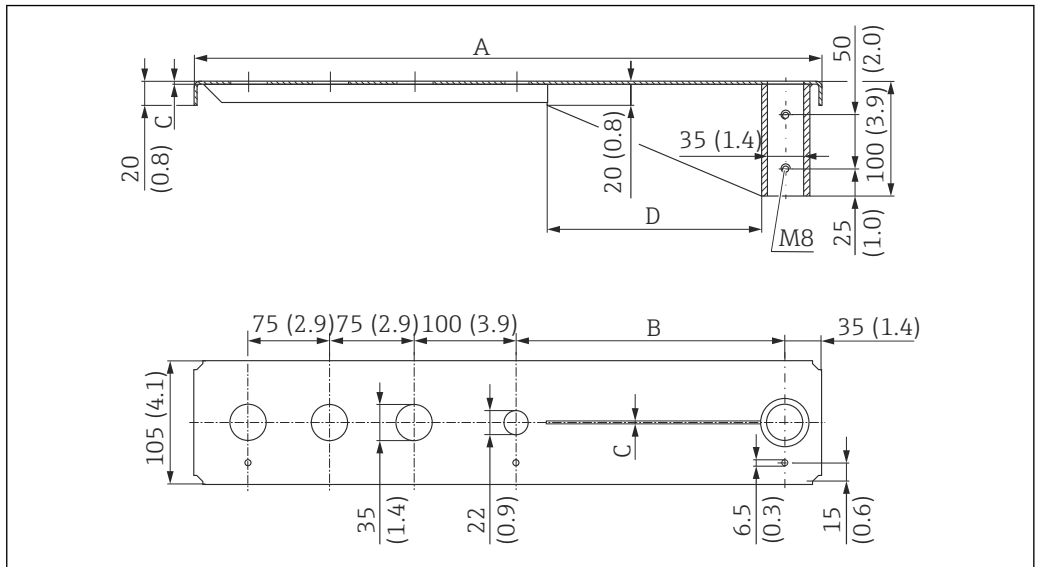
35 Mounting of FDU90, FDU91 or FDU92 with cantilever arm

- A Installation on arm with wall bracket  
 B Installation on arm with mounting frame  
 1 Arm (→ 37)  
 2 Mounting frame (→ 38)  
 3 Wall bracket (→ 39)

**Use of orifices**


- 35 mm (1.4 in) orifice
  - FDU90 with counter nut
  - FDU91 with counter nut
  - FDU92 with counter nut
- 22 mm (0.9 in) orifice
  - Temperature sensor (e.g. Omnigrad TR61 with TA50 process connection)

**Dimensions**



A0019592

36 Cantilever arm for FDU90, FDU91 and FDU92. Unit of measurement mm (in)

 Retaining screws (M8) are included in delivery.

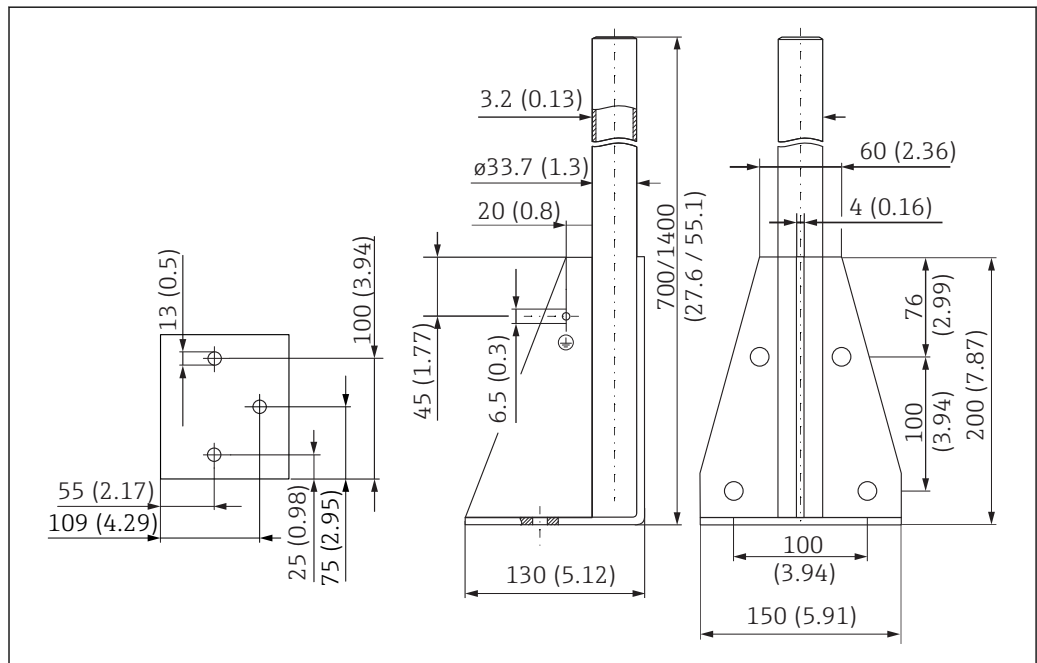
*Dimensions of the 583 mm (23 in) version*

- A = 583 mm (23 in)
- B = 250 mm (9.48 in)
- C = 2 mm (0.08 in)
- D = 200 mm (7.87 in)
- Material: steel, hot-dip galvanized
  - Weight: 2.1 kg (4.63 lb)
  - Order No.: 919790-0000
- Material: 316Ti (1.4571)
  - Weight: 2.0 kg (4.41 lb)
  - Order No.: 919790-0001

*Dimensions of the 1085 mm (42.7 in) version*

- A = 1085 mm (42.7 in)
- B = 750 mm (29.5 in)
- C = 3 mm (0.12 in)
- D = 300 mm (11.8 in)
- Material: steel, hot-dip galvanized
  - Weight: 4.5 kg (9.92 lb)
  - Order No.: 919790-0002
- Material: 316Ti (1.4571)
  - Weight: 4.3 kg (9.48 lb)
  - Order No.: 919790-919790-0003

**Mounting frame**



A0019279

37 Dimensions of mounting frame. Unit of measurement mm (in)

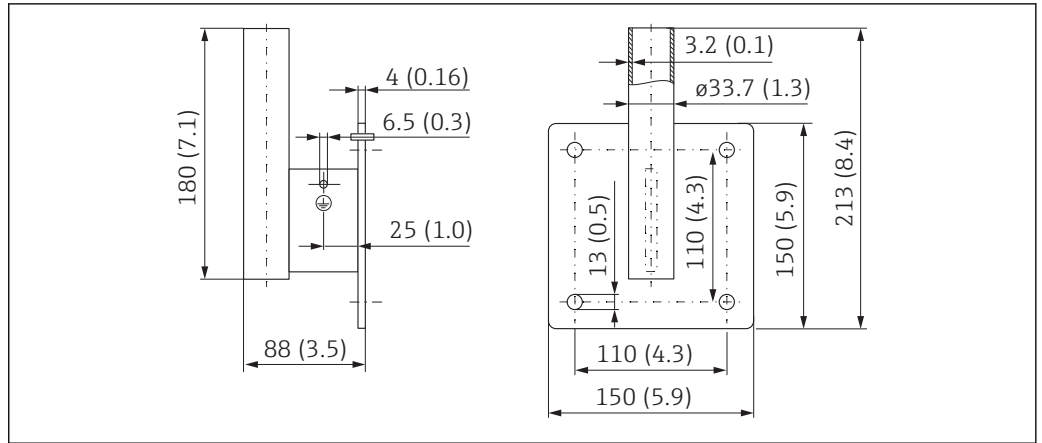
**Version 700 mm (28 in)**

- Weight: 3.2 kg (7 lb)
- Order number (steel, galvanized): 919791-0000
- Order number (316Ti, 1.4571): 919791-0001

**Version 1400 mm (55 in)**

- Weight: 4.9 kg (10 lb)
- Order number (steel, galvanized): 919791-0002
- Order number (316Ti, 1.4571): 919791-0003

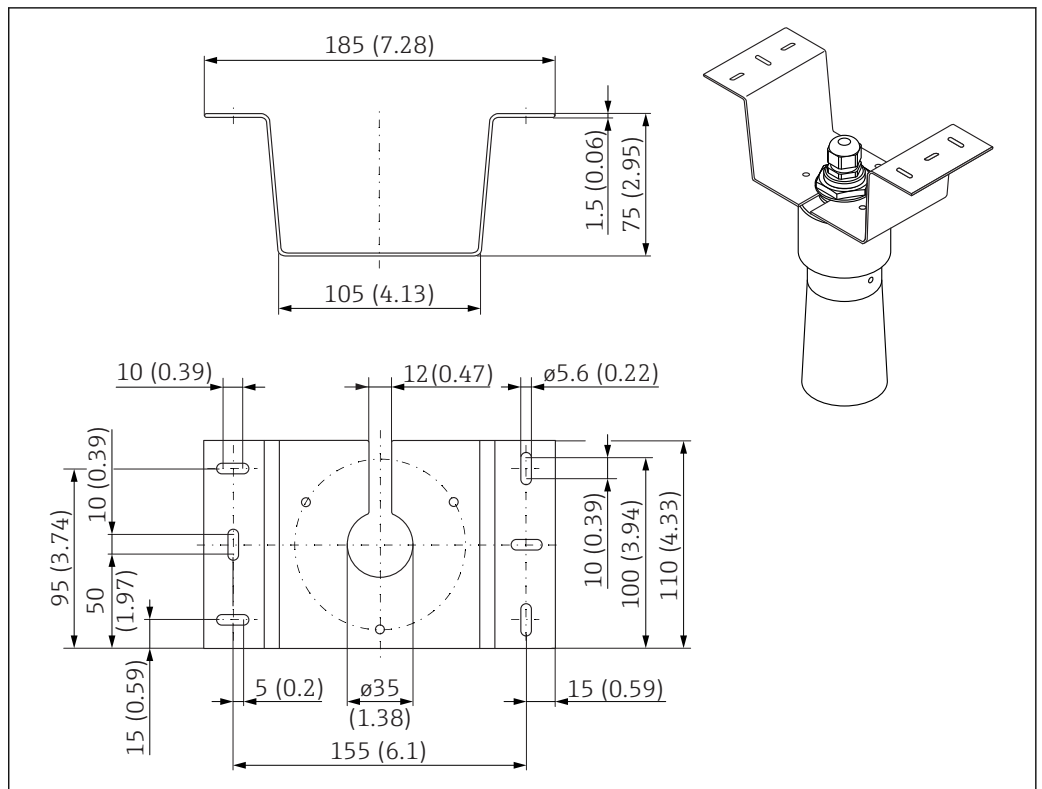
**Wall bracket**



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

- **Weight:** 1.4 kg (3.1 lb)
- **Order No.:**
  - Steel, galvanized version: 919792-0000
  - 316Ti (1.4571) version: 919792-0001

**Mounting bracket for ceiling mounting**



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

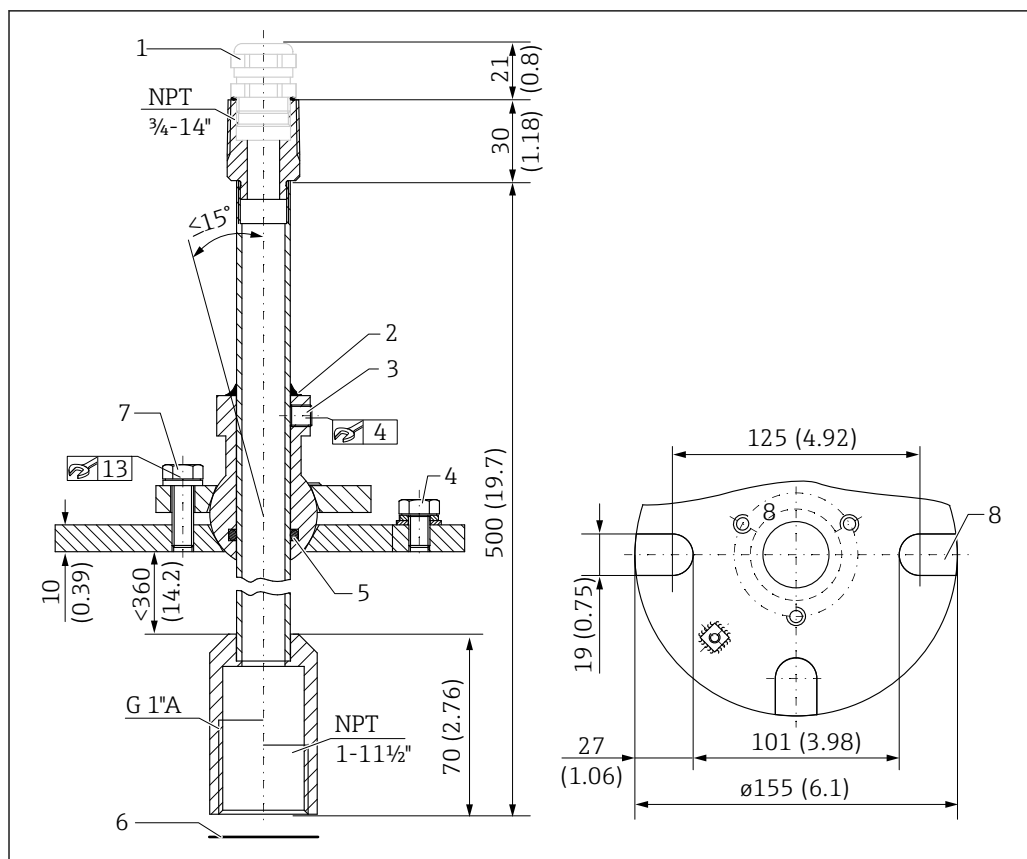
- Suitable for sensors FDU90, FDU91, FDU91F, FDU92
- Material: 316L (1.4404)
- Order No.: 71093130

**FAU40 alignment unit**


**Use**

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

## Dimensions



A0035949

 40 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 FDU90 and FDU91 sensor heater


### Technical data

- **Function:** Primary switched-mode power supply
- **Input:** 100 to 240 V<sub>AC</sub>
- **Output:** 24 V<sub>DC</sub>; 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 200/IEC 364-3)

## Additional information

 Technical Information TI00120R

## IP66 protective housing for RNB130 power supply unit

- **Order number:** 51002468
- **Additional information:** Technical Information TI00080R



## Supplementary documentation

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### Safety Instructions FDU90

- XA00321F**  
ATEX II 2G Ex ma IIC T5
- XA00322F**
- ATEX II 1/2D Ex ta/tb IIIC
  - ATEX II 2G Ex ma IIC T5
- XA00481F**
- IEC Ex ta/tb IIIC Da/Db
  - IEC Ex ma IIC T5 Gb
- XA00482F**  
IEC Ex ma IIC T5 Gb
- XA00609F**
- ATEX II 3G Ex na IIC T5 Gc
  - ATEX II 3D Ex tc IIIC Dc
- XA00665F**  
NEPSI Ex ma II T5, DIP A20/21 IP65
- XA00666F**  
NEPSI Ex ma II T5
- XA01342F**  
INMETRO Ex ma IIC T5 Gb
- XA01343F**
- INMETRO Ex ta/tb IIIC Da/Db
  - INMETRO Ex ma IIC T5 Gb

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### Safety Instructions FDU91

- XA00321F**  
ATEX II 2G Ex ma IIC T6
- XA00322F**
- ATEX II 1/2D Ex ta/tb IIIC
  - ATEX II 2G Ex ma IIC T6
- XA00481F**
- IEC Ex ta/tb IIIC Da/Db
  - IEC Ex ma IIC T6 Gb
- XA00482F**  
IEC Ex ma IIC T6 Gb
- XA00609F**
- ATEX II 3G Ex nA IIC T6 Gc
  - ATEX II 3D Ex tc IIIC Dc
- XA00665F**  
NEPSI Ex ma II T6, DIP A20/21 IP65
- XA00666F**  
NEPSI Ex ma II T6
- XA01342F**  
INMETRO Ex ma IIC T6 Gb
- XA01343F**
- INMETRO Ex ta/tb IIIC Da/Db
  - INMETRO Ex ma IIC T6 Gb

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### Safety Instructions FDU91F

- XA00321F**  
ATEX II 2G Ex ma IIC T6
- XA00322F**
- ATEX II 1/2D Ex ta/tb IIIC
  - ATEX II 2G Ex ma IIC T6
- XA00481F**
- IEC Ex ta/tb IIIC Da/Db
  - IEC Ex ma IIC T6 Gb

**XA00482F**

IEC Ex ma IIC T6 Gb

**XA00609F**

- ATEX II 3G Ex nA IIC T6 Gc
- ATEX II 3D Ex tc IIIC Dc

**XA00665F**

NEPSI Ex ma II T6, DIP A20/21 IP65

**XA00666F**

NEPSI Ex ma II T6

**XA01342F**

INMETRO Ex ma IIC T6 Gb

**XA01343F**

- INMETRO Ex ta/tb IIIC Da/Db
  - INMETRO Ex ma IIC T6 Gb
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**Safety Instructions FDU92**

**XA00321F**

ATEX II 2G Ex ma IIC T6

**XA00322F**

- ATEX II 1/2D Ex ta/tb IIIC
- ATEX II 2G Ex ma IIC T6

**XA00481F**

- IEC Ex ta/tb IIIC Da/Db
- IEC Ex ma IIC T6 Gb

**XA00482F**

IEC Ex ma IIC T6 Gb

**XA00609F**

- ATEX II 3G Ex nA IIC T6 Gc
- ATEX II 3D Ex tc IIIC Dc

**XA00665F**

NEPSI Ex ma II T6, DIP A20/21 IP65

**XA00666F**

NEPSI Ex ma II T6

**XA01342F**

INMETRO Ex ma IIC T6 Gb

**XA01343F**

- INMETRO Ex ta/tb IIIC Da/Db
  - INMETRO Ex ma IIC T6 Gb
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**Safety Instructions FDU93**

**XA00322F**

- ATEX II 1/2 D Ex ta/tb IIIC
- ATEX II 2 G Ex ma IIC T6

**XA00323F**

ATEX II 1/2 D Ex ta/tb IIIC

**XA00481F**

- IEC Ex ma IIC T6 Gb
- IEC Ex ta/tb IIIC Da/Db

**XA00483F**

IEC Ex ta/tb IIIC Da/Db

**XA00609F**

- ATEX II 3G Ex nA IIC T6 Gc
- ATEX II 3D Ex tc IIIC Dc

**XA00665F**

NEPSI Ex ma II T6, DIP A20/21 IP65

**XA00667F**

NEPSI DIP A20/21 IP65

**XA01343F**

- INMETRO Ex ta/tb IIIC Da/Db
  - INMETRO Ex ma IIC T6 Gb
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**Safety Instructions FDU95**

**XA00322F**

- ATEX II 1/2 D Ex ta/tb IIIC
- ATEX II 2 G Ex ma IIC T6

**XA00323F**

ATEX II 1/2 D Ex ta/tb IIIC

**XA00481F**

- IEC Ex ma IIC T6 Gb
- IEC Ex ta/tb IIIC Da/Db

**XA00483F**

IEC Ex ta/tb IIIC Da/Db

**XA00609F**

ATEX II 3D Ex tc IIIC Dc

**XA00665F**

NEPSI Ex ma II T6, DIP A20/21 IP65

**XA00667F**

NEPSI DIP A20/21 IP65

**XA01343F**

- INMETRO Ex ta/tb IIIC Da/Db
- INMETRO Ex ma IIC T6 Gb

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**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: BA00290F
- Safety Instructions (ATEX II 3D): XA00326F

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**Documentation for FMU95 transmitter**

- Technical Information TI00398F
- Operating Instructions: BA00344F
- Description of Device Parameters: BA00345F
- Safety Instructions (ATEX II 3D): XA00326F

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