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Technical Information
Prosonic S FDU91F

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: 10 m (33 ft) in liquids; 5 m (16 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

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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

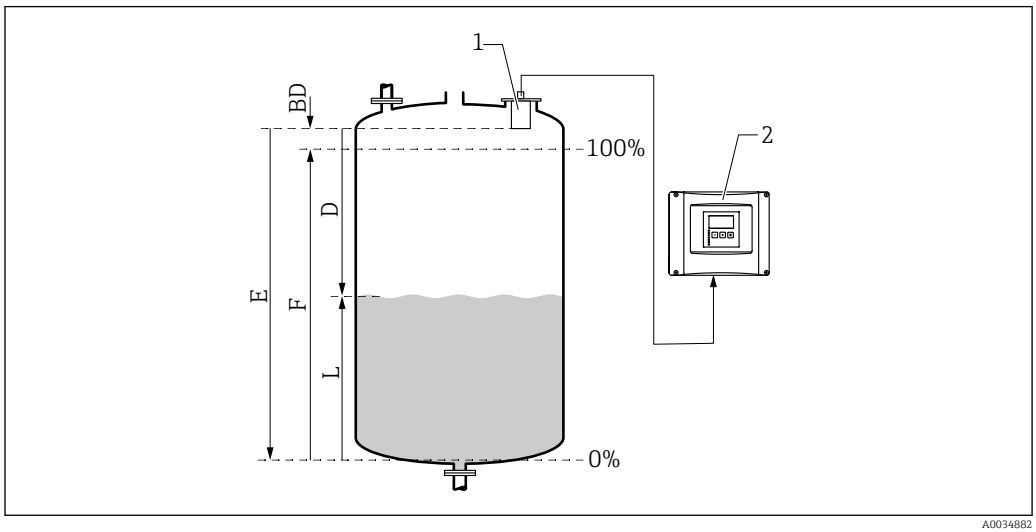
1., 2., 3.
Series of steps

1, 2, 3, ...
Item numbers

A, B, C, ...
Views

Function and system design

Level measurement



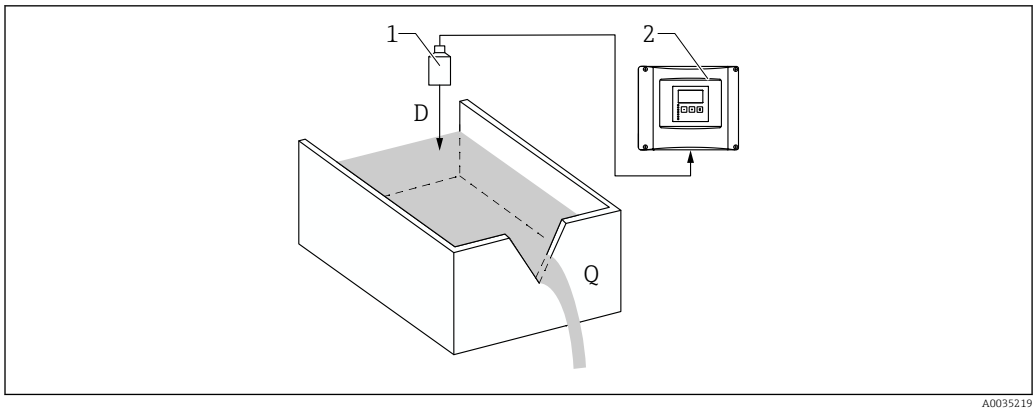
1 Prosonic S sensor
2 Prosonic S transmitter
BD Blocking distance
D Distance between reference point (sensor membrane) and surface of medium
E Empty distance
F Span
L Level

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.

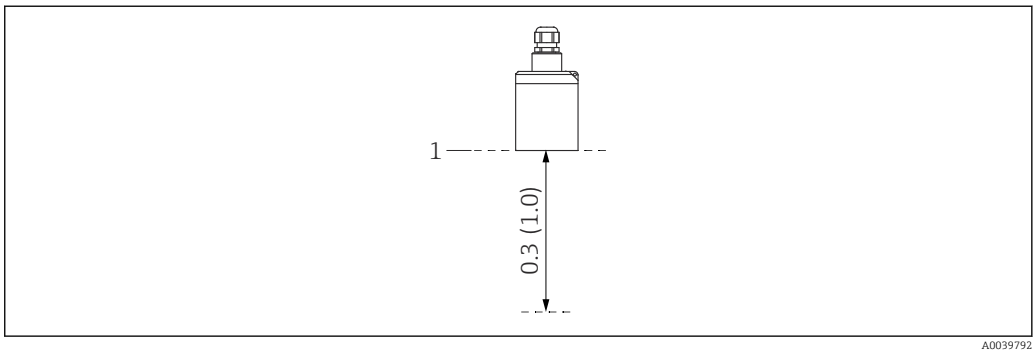
Temperature-dependent time-of-flight correction

Temperature-dependent time-of-flight correction via the temperature sensors integrated in the ultrasonic sensors.

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)*

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.

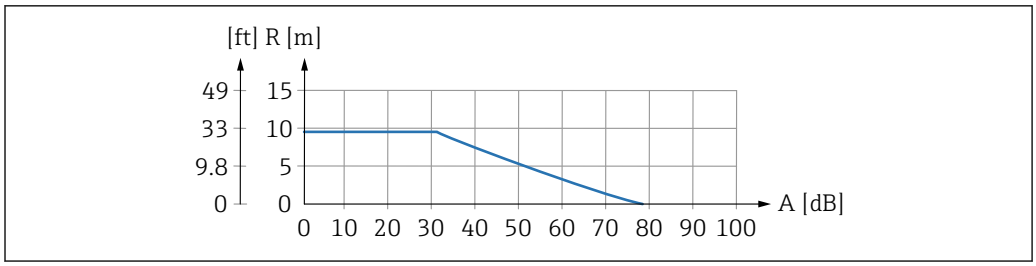
Attenuation caused by surface of liquid
- Calm surface: 0 dB
- Waves on surface: 5 to 10 dB
- Very turbulent surface: 10 to 20 dB
- Frothy surface: contact Endress+Hauser: http://www.endress.com/contact

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

42 kHz

Power supply

Supply voltage

Is provided by the transmitter.

Electrical connection

General information

CAUTION

Inadequate potential equalization can compromise electrical safety

- Connect the yellow/green protective conductor (GNYE) of the sensor 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

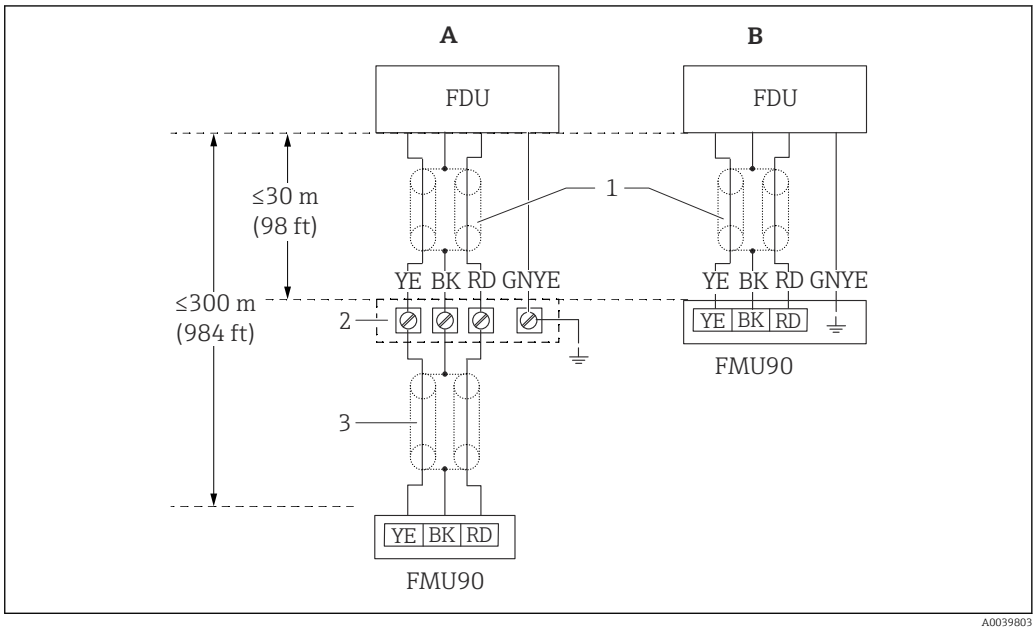
- Do not route the sensor cables parallel to high-voltage electric power lines or near frequency converters.

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.

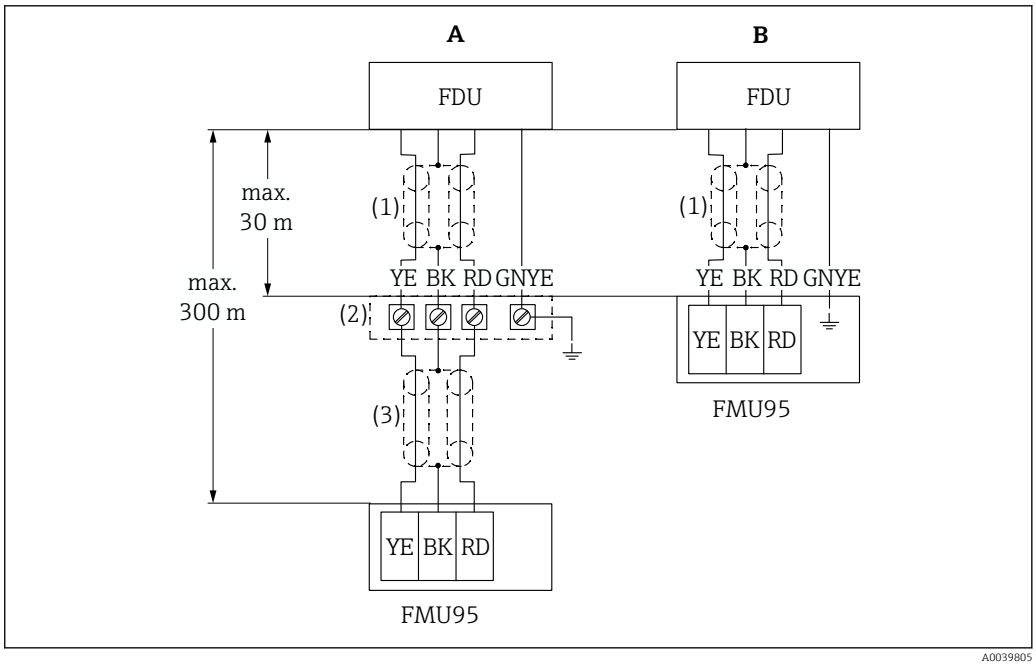
Connection diagram for sensor → FMU90



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

A Grounding at terminal box
B Grounding at transmitter FMU90
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*

A Grounding at terminal box
B Grounding at transmitter FMU95
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
- **Protective ground**
  May not be within the shielding.

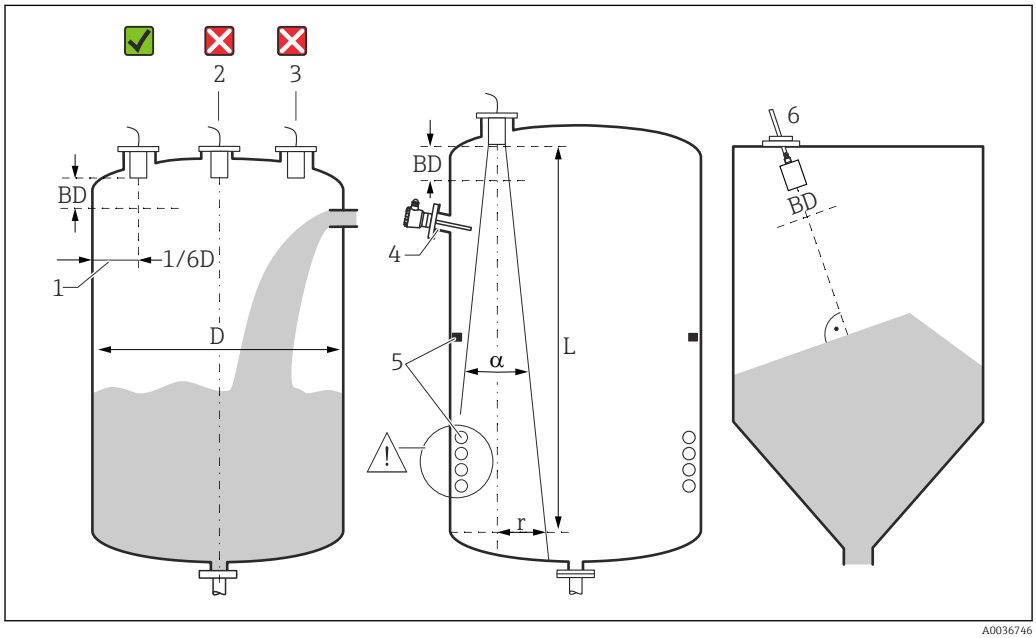
Suitable extension cables are available from Endress+Hauser.

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) = 10 m (33 ft)
- r (max) = 1.05 m (3.4 ft)

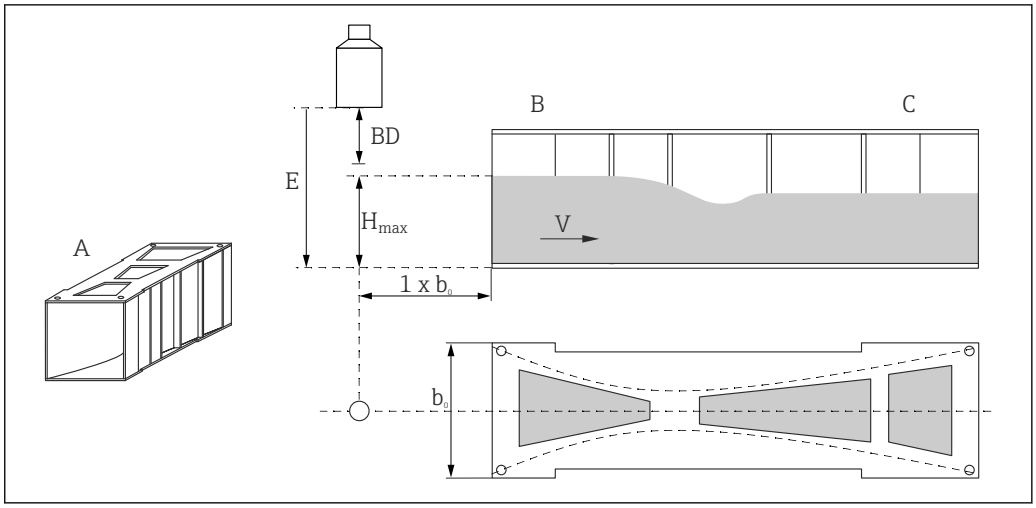
Other conditions
- The lower edge of the sensor should be located inside the vessel
- The maximum level may not enter the blocking distance

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

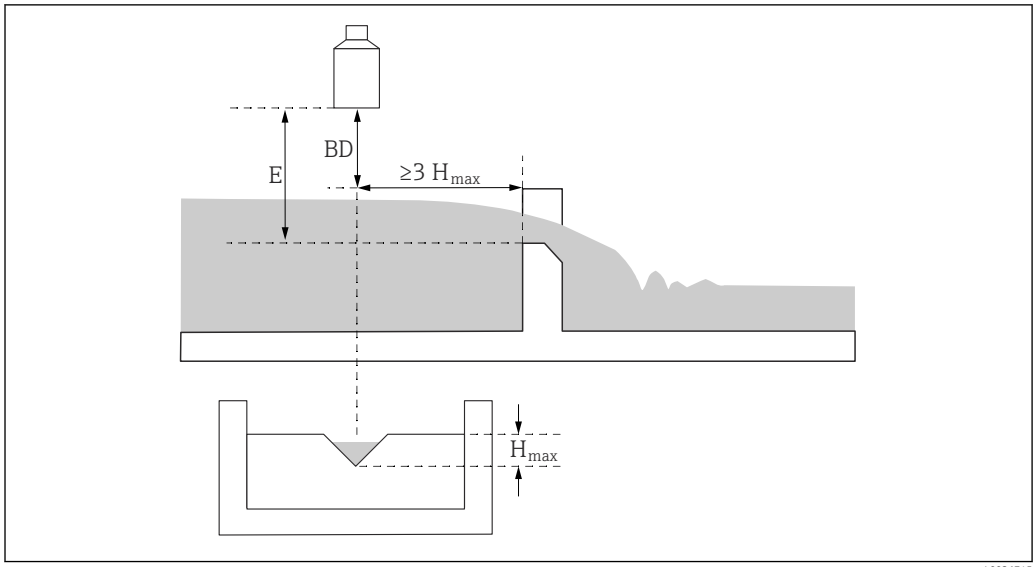
Conditions
- Mount the sensor on the upstream side above the maximum upstream level H_{max} plus the blocking distance BD
- Position the sensor in the center of the channel or weir
- Align the sensor so that it is perpendicular to the surface of the water
- Observe the specified mounting distance (clearance) 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

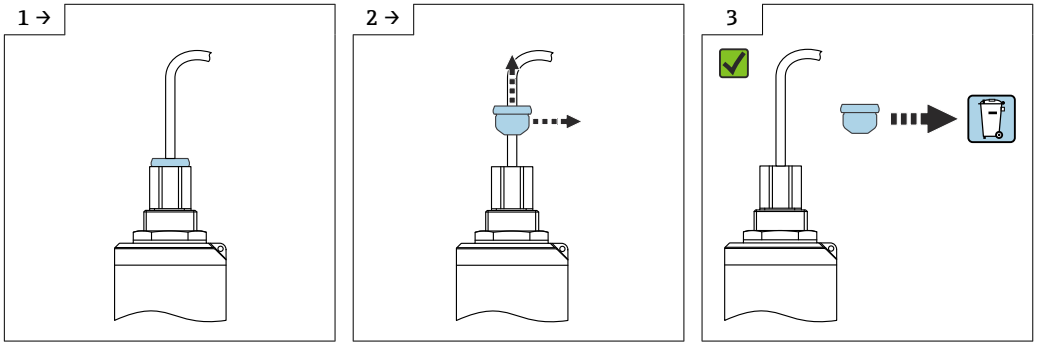


BD Blocking distance of the sensor
E Empty calibration (to be entered during commissioning)
H_{max} Maximum upstream level

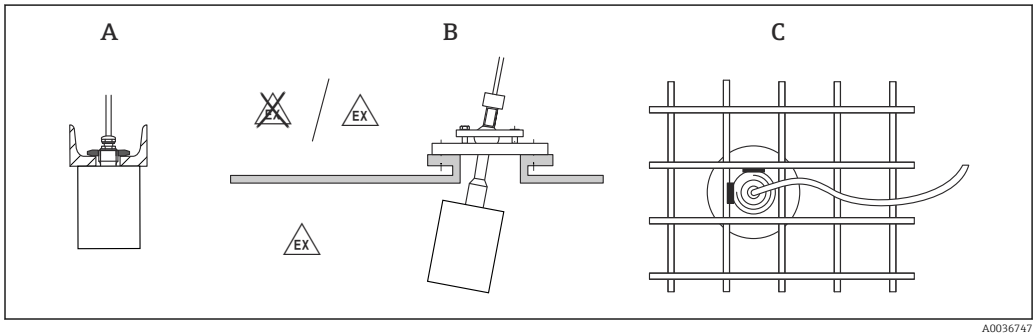
Installation instructions

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)

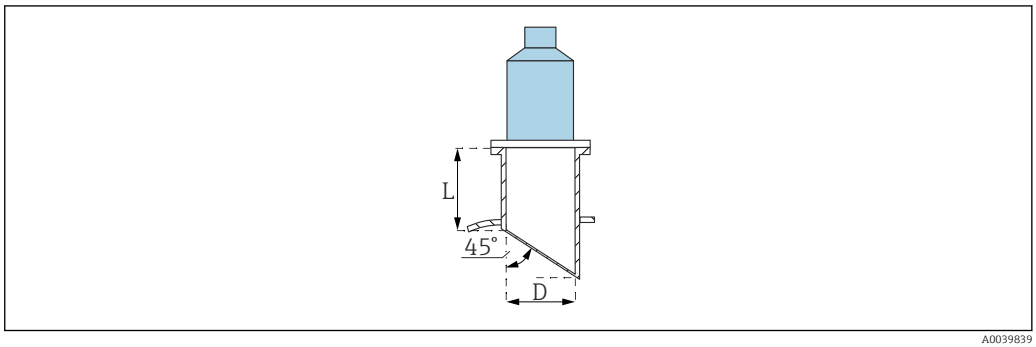


6 *Installation in systems*

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

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

Nozzle mounting



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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

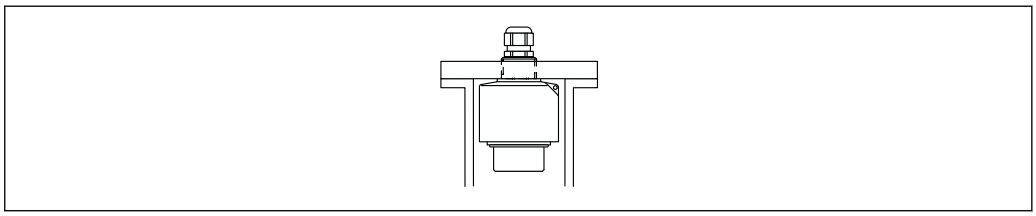
- D = DN80/3": L_{max} = 250 mm (9.84 in)
- D = DN100/4" to DN300/12": L_{max} = 300 mm (11.8 in)

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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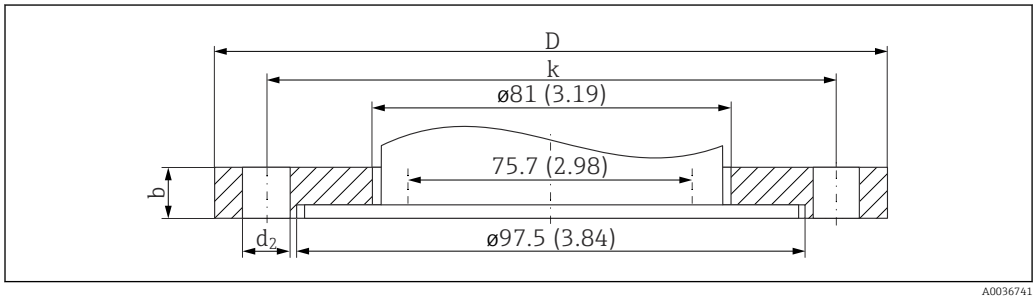
7 *Securing the ultrasonic sensor; mounted with counter nut*

Slip-on flange without adapter flange for flush mounting

- 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)



8 Dimensions of FAU80 slip-on flange without adapter flange. Unit of measurement mm (in)

Version suitable for DN80 PN16 A (EN1092-1)

- 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 (ASME B16.5)

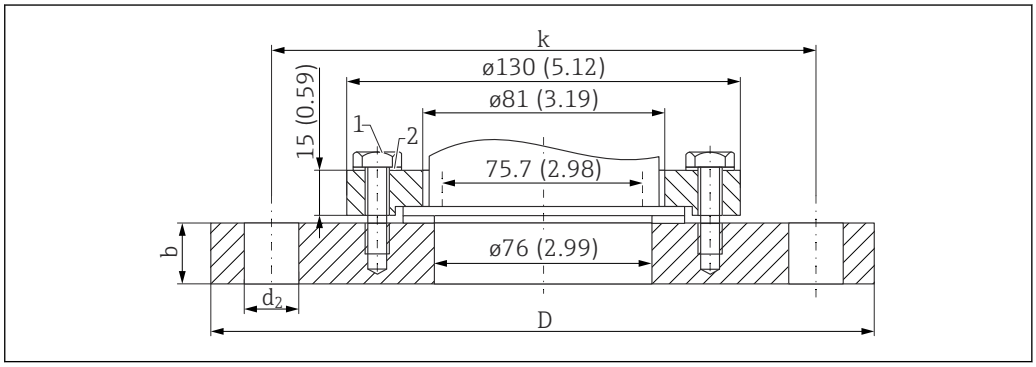
- b = 23.9 (0.94)
- D = 190.5 (7.5)
- k = 152 (6.0)
- d_2 = 19.1 (0.75)
- Number d_2 = 4
- Order code for PPs material: FAU80-AAP
- Order code for 316L (1.4435) material: FAU80-AAJ

Version suitable for 10K 80A FF (JIS B2220)

- 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

- 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)



9 *Dimensions of FAU80 slip-on flange with adapter flange. Unit of measurement mm (in)*

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 DN100 PN16 A (EN1092-1)

- b = 20 mm (0.79 in)
- D = 220 (8.66)
- k = 180 (7.09)
- d_2 = 18 (0.71)
- Number d_2 = 8
- Order code for PPs material: FAU80-CHP
- Order code for 316L (1.4435) material: FAU80-CHJ

Version suitable for NPS 4" Cl.150 FF (ASME B16.5)

- b = 23.9 (0.94)
- D = 228.6 (9.0)
- k = 190.5 (7.5)
- d_2 = 19.1 (0.75)
- Number d_2 = 4
- Order code for PPs material: FAU80-AHP
- Order code for 316L (1.4435) material: FAU80-AHJ

Version suitable for 10K 100A FF (JIS B2220)

- b = 18 (0.71)
- D = 210 (8.27)
- k = 175 (6.89)
- d_2 = 19 (0.75)
- Number d_2 = 8
- Order code for PPs material: FAU80-KHP
- Order code for 316L (1.4435) material: FAU80-KHJ

Environment

Degree of protection

Tested according to IP68/NEMA6P (24 h at 1.83 m (6 ft) under water)

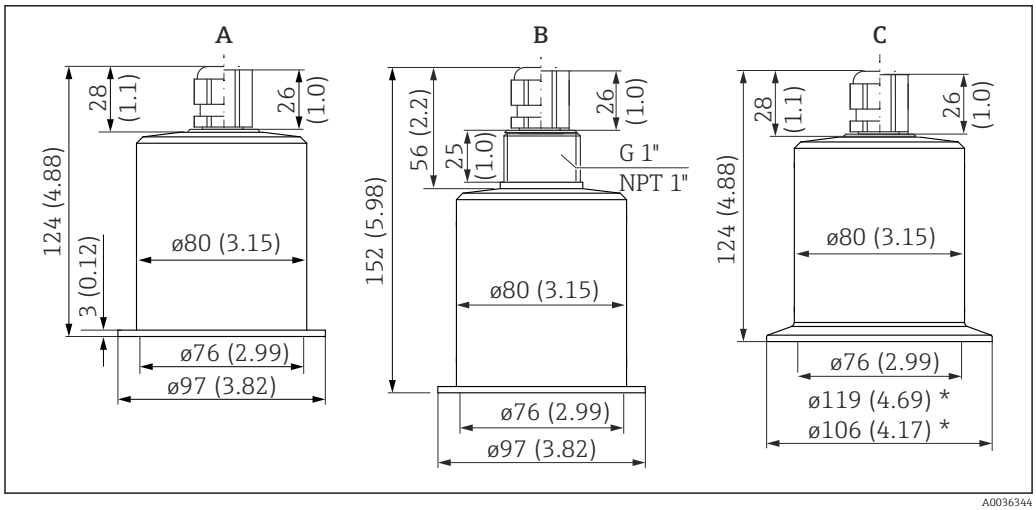
Vibration resistance	DIN EN 600068-2-64; 20 to 2 000 Hz; 1 $(m/s^2)^2$/Hz; 3x100 min
Storage temperature	Identical to process temperature
Thermal shock resistance	Based on DIN EN 60068-2-14; test according to min./max. process temperature; 0.5 K/min; 1 000 h
Electromagnetic compatibility	Electromagnetic 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	▪ Non-Ex, max. 30 min: 135 °C (275 °F) (for Tri-Clamp or flush mounting) ▪ Ex: −40 to +80 °C (−40 to +176 °F)
Process pressure	0.7 to 4 bar (10.15 to 58 psi)

Mechanical construction

Dimensions



10 Dimensions. Unit of measurement mm (in)

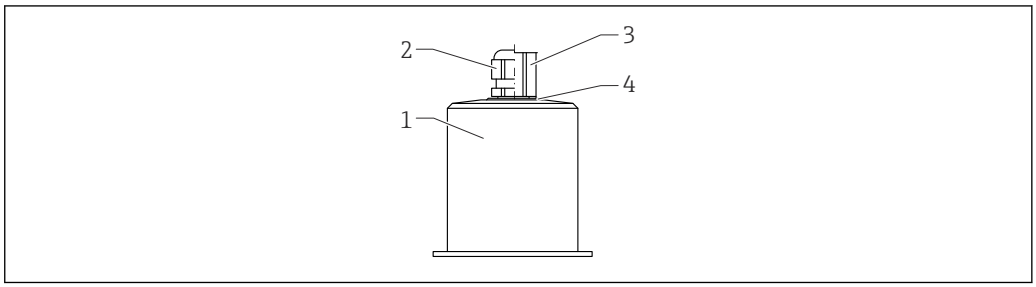
*A FDU91F-*F** (for FAU80 slip-on flange)*
*B FDU91F-*G** (G1 thread); FDU91F-*N** (NPT1 thread)*
*C FDU91F-*S** (Tri-Clamp DN101); FDU91F-*T** (Tri-Clamp DN88)*

Weight

Weight including cable 5 m (16 ft))

Approx. 1.6 kg (3.53 lb)

Materials



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11 *Materials*

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

Materials of connecting cable

PVC

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.

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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

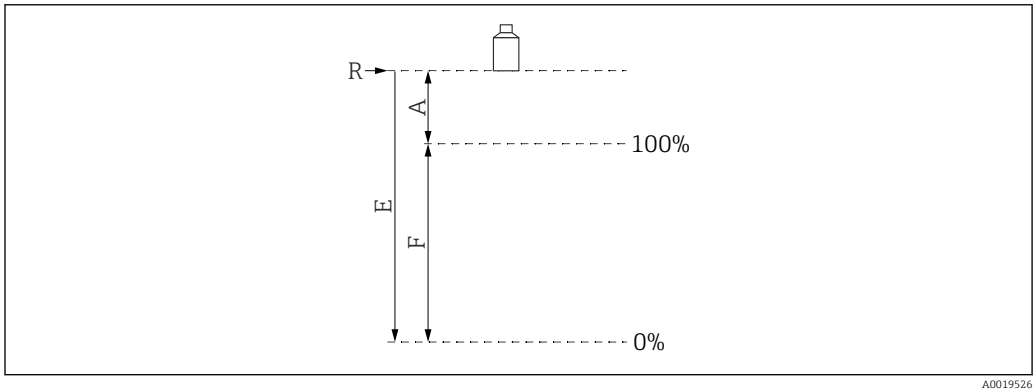
Conditions for 5-point linearity protocol

- 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



12 *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 ≤ 10 000 mm (394 in)
- F =100 to 9 700 mm (3.94 to 382 in)
- A ≥ 300 mm (11.8 in)

Scope of delivery

- Ordered version of the sensor
- For certified versions: Safety Instructions (XAs)

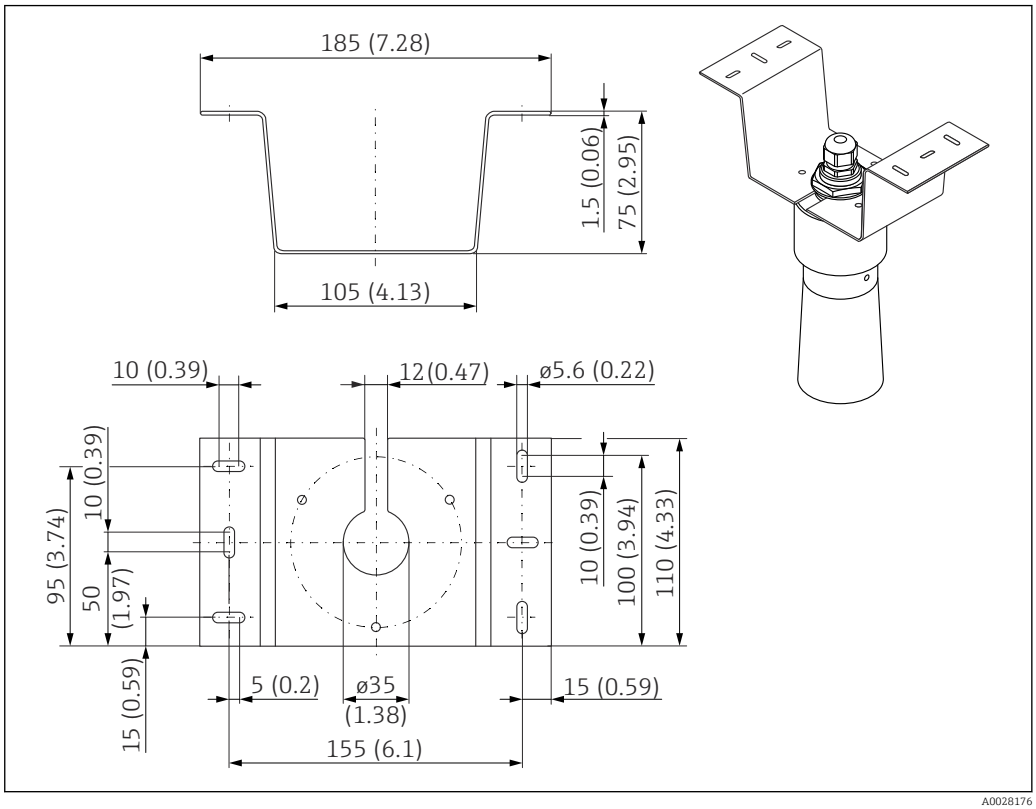
Accessories

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.

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

Mounting bracket for ceiling mounting



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

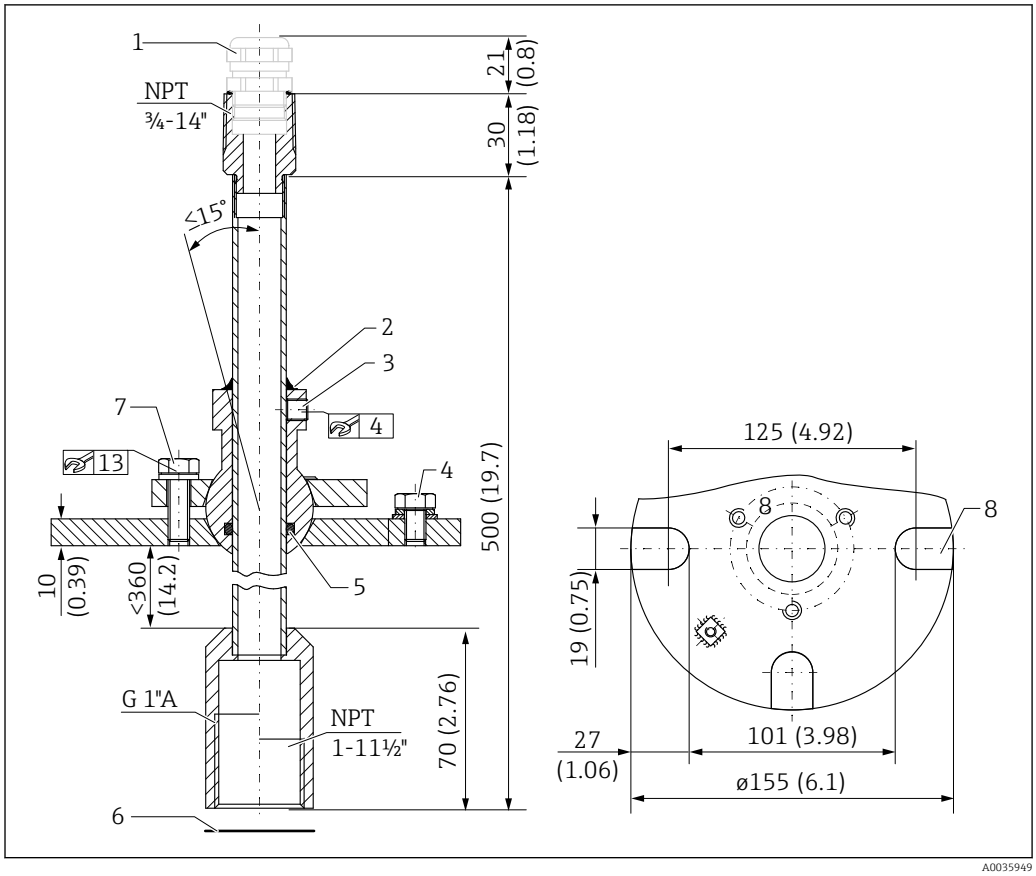
- Material: 316L (1.4404)
- Order No.: 71093130

FAU40 alignment unit

Use

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

Dimensions



14 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

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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