

# Ultrasonic Level Measurement

## *prosonic T FMU 130, 131*

## *prosonic T FMU 230, 231, 232*

**Compact transmitter for continuous,  
non-contact level measurement**  
**Available as a Smart transmitter or  
for connection to process control systems**



### Application

The Prosonic T is a compact ultrasonic transmitter for continuous non-contact level measurement in liquids and in coarse-grained or pelleted solids. The Prosonic T series consists of three transmitters, which can be equipped with one of several electronic modules, with graduated measuring ranges from 0.25 m (0.8 ft) upwards.

- FMU 130, 230  
in coarse-grained solids (grain size from 4 mm/0.16 in) up to 2 m/6.6 ft  
in liquids up to 5 m/16.4 ft  
(2 wire instruments: 4 m/13 ft)
- FMU 131, 231  
in coarse-grained solids (grain size from 4 mm/0.16 in) up to 3.5 m/11.5 ft  
in liquids up to 8 m/26.2 ft  
(2 wire instruments: 7 m/23 ft)
- FMU 232  
in coarse-grained solids (grain size from 4 mm/0.16 in) up to 7 m/23 ft  
in liquids up to 15 m/49.2 ft

All transmitters are equipped with an integrated temperature sensor for time-of-flight compensation.

### Features and Benefits

*Fits exactly to the process*

- Threaded connections from G 1 $\frac{1}{2}$  or 1 $\frac{1}{2}$  NPT or flange 4" or DN 100
- Fully rotatable housing
- LEDs visible through housing cover allow quick monitoring of operational status

*Electronics versions*

- FMU 130, 131: 2-wire loop-powered general approval for "EEx ia"/ATEX II 2 G
  - FMU 230, 231: 2-wire loop-powered or 4-wire including mains power supply
  - FMU 232: 4-wire, optional approval for dust Ex Zone 10 / ATEX II 1/3 D including mains power supply
- Intelligent operation and evaluation*
- Simple local push-button operation, with optional display
  - HART protocol for remote operation
  - Digital communication with PROFIBUS-PA

HART is a registered trademark of the HART Communication Foundation

# Endress + Hauser

The Power of Know How



# Measuring System

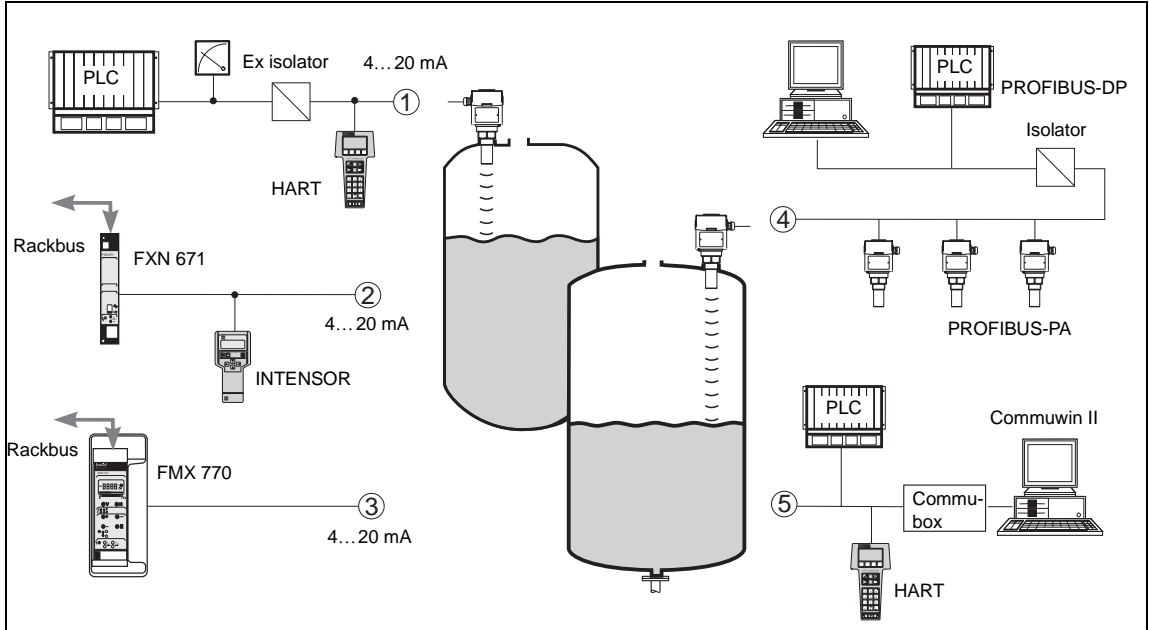
The Prosonic T compact ultrasonic transmitter is a complete measuring point within itself. The simplest version allows access to all functions required for basic operation. Calibration can be carried out using the four pushbuttons -, +, V, H on the instrument without the need for other equipment. With a plug-in display, the complete Endress+Hauser user matrix can be accessed.

The basic functionality may be enhanced by other optional operating possibilities or integration into a process control system, e.g. via:

- 2-wire loop-powered 4...20 mA (Smart) with INTENSOR or HART protocol or for connection to PROFIBUS-PA bus systems
- 4-wire, with separate power supply, 4...20 mA (Smart) with HART protocol

## 2-wire 4...20 mA Loop-Powered Applications in e.g. Storage Vessels

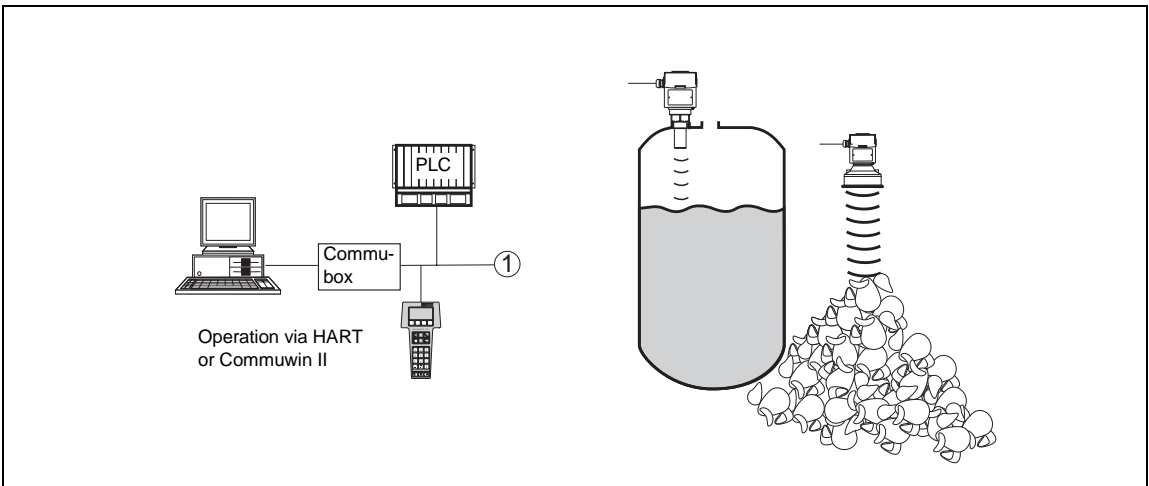
FMU 130, FMU 131: Certificate EEx ia  
FMU 230, FMU 231: Standard



- ① Power supply via the transmitter power pack e.g. PLC, with FMU 130, 131 connection via the Ex isolator (Zener barrier: <math><30\text{ V}\_{DC}</math> output voltage, <math><200\text{ mA}</math>, <math><1\text{ W}</math>): operation via handheld terminal (protocol: INTENSOR, HART)
- ② FXN 671: operation via Rackbus or handheld terminal (protocol: INTENSOR)
- ③ Silometer FMX 770: operation via Commute transmitter (protocol: INTENSOR)
- ④ Connection to PROFIBUS-PA bus for up to 10 transmitters, operated by a PC
- ⑤ Commu-box: interface to a PC for Smart transmitters, operated by a PC (protocol: INTENSOR, HART)

## 4-wire, 4...20 mA Separate Power Supply Applications with Rapid Changes in Level, e.g. Process Vessels

FMU 230, FMU 231: Standard  
FMU 232: Optional Dust Ex Zone 10



- ① Operation via HART protocol: point-to-point using handheld terminal or PC (Commu-box)

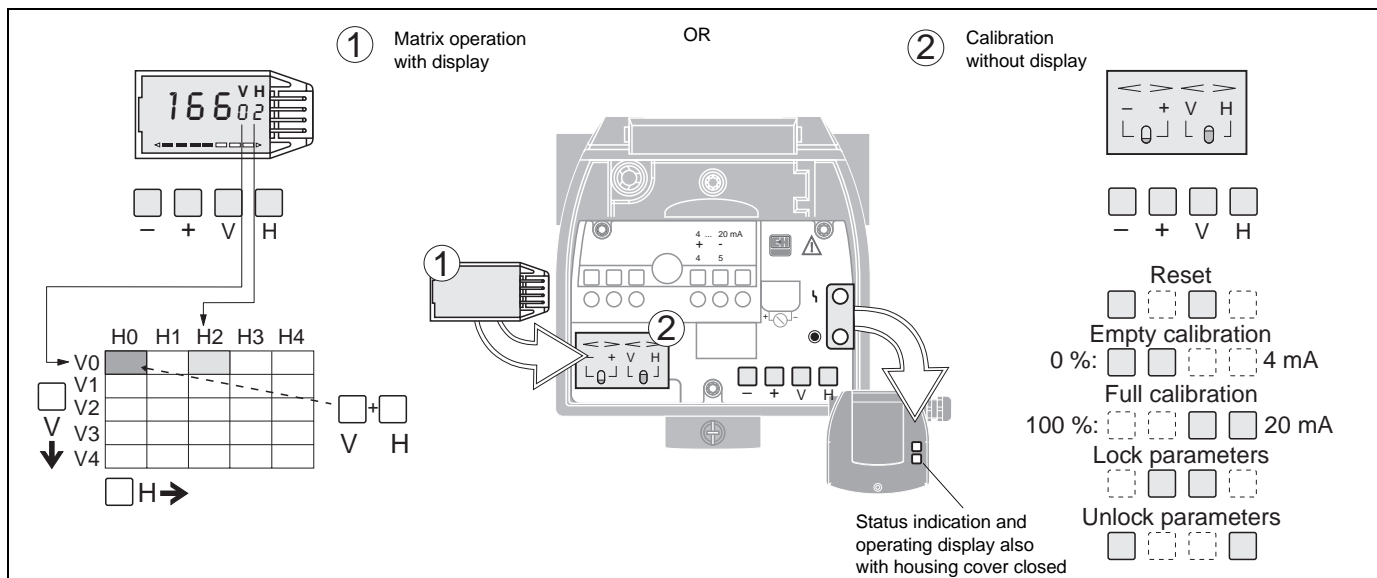
# Operation

Prosonic T compact transmitters offer operation tailored to all level applications:

- Local calibration or matrix operation by simply pressing buttons
- Smart – remote operation and display via the handheld terminal
- Comprehensive operating and display software for personal computer
- Calibration in the control room via a Silometer FMX 770 or FXN 671.

## Matrix Operation

Prosonic T can be operated by using the keyboard and display, a handheld terminal, a Silometer transmitter (FMX 770, FXN 671) or via a process bus. The identical operating matrices ensure that procedures are uniform and clear.



## Operation via Display

Parameters are entered and values displayed by using the four pushbuttons -, +, V, H on the front panel of the device. The optional display provides access to the Endress+Hauser operating matrix and to a wide selection of additional functions.

- The following application parameters are available:
  - Liquid
  - Rapid changes in levels of liquids
  - Measurement when mounted in the dome cover
  - Coarse-grained solids
  - Conveyor belt
- Automatic suppression of three fixed target echoes
- Linearisation (11 points)
- First echo detection (double echo)
- Automatic suppression of stirrer echoes

## Operation Without a Display

The basic functions of the Prosonic T can be set by using just the four pushbuttons -, +, V, H on the front panel of the instrument.

- Empty and full calibration
- Parameter protection by entry locking

**PROFIBUS-PA**

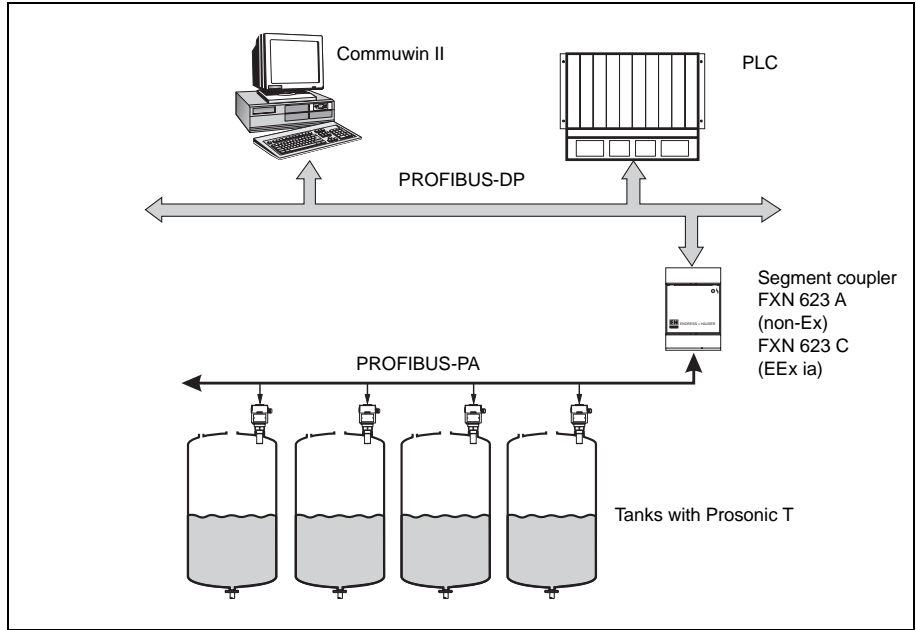
The PROFIBUS-PA is an open fieldbus standard for connecting sensors and actuators, which may also be in explosion hazardous areas, to one bus cable. The two-wire sensors are supplied with power over the PROFIBUS-PA and the process information of the sensor is digitally transmitted.

The number of instruments operated at one bus segment:

- up to 10 for EEx ia applications
- up to 32 for non-Ex applications

A Prosonic T with the PROFIBUS-PA protocol allows:

- local operation with display
- matrix operation with a personal computer and the Commuwin II operating program running under MS Windows 3.11



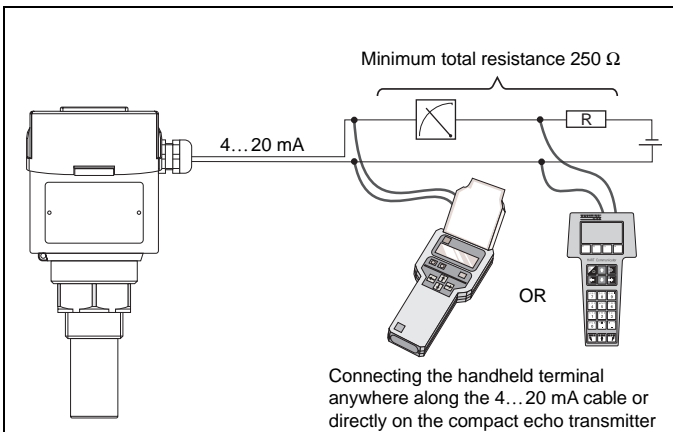
**Operation via Handheld Terminal**

With a handheld terminal, the Prosonic T can be configured, values displayed and additional functions activated from anywhere on the 4...20 mA signal line. There are two versions:

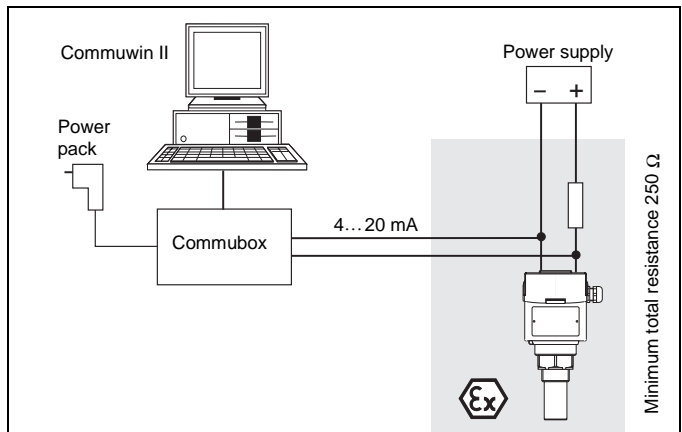
- Commulog VU 260 Z (INTENSOR)
- Universel HART Communicator DXR 275

**Operation with Commubox**

Commubox FXA 191 connects intrinsically safe Smart transmitters with INTENSOR or HART protocols to the RS 232 C serial interface of a personal computer, allowing remote operation by the Endress+Hauser Commuwin II operating program.



Connecting handheld terminals



Connecting the Commubox

# Installation

## Mounting

- Always mount the sensor such that the distance between it and the maximum product level exceeds the blocking distance. The lower edge of the transmitter should, however, project *below* the roof of the tank or silo.  
Exception: mounting in a nozzle.
- Never mount two Prosonic T in a vessel because the instruments may not function correctly.
- Do not mount the sensor in the centre of the vessel roof.
- Position the sensor at right angles to the surface of the material.
- Do not measure through the filling curtain.

## Interference Suppression

Interference echoes coming from internal fittings can be suppressed by using the fixed target suppression function. The signals are then no longer recorded or used for further processing. The ultrasonic pulse leaves the sensor as a narrow beam which widens with increasing distance from the device. Every object within this beam produces an interference echo which is received by the sensor.

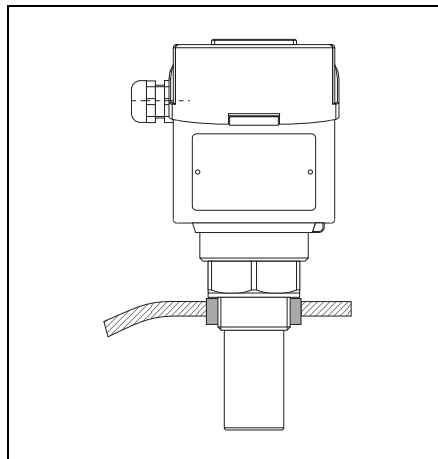
## Mounting on a Nozzle

If the maximum level to be measured falls within the blocking distance, the transmitter must be mounted on a nozzle.

- No build-up should form in the nozzle.
- The recommend nozzle dimensions are limits, within which the nozzle can vary. Check that the nozzle diameter is large enough, but keep the nozzle length to a minimum (see figure).
- The inner surface of the nozzle should be as smooth as possible – no edges or welding seams.

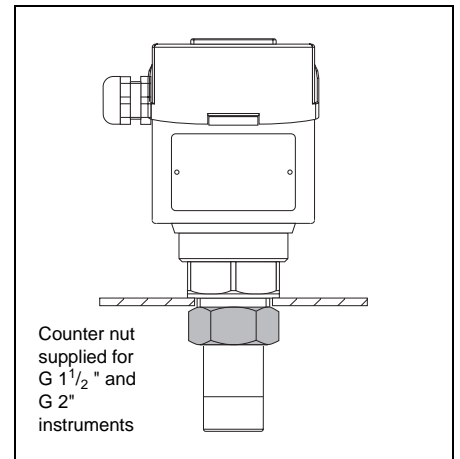
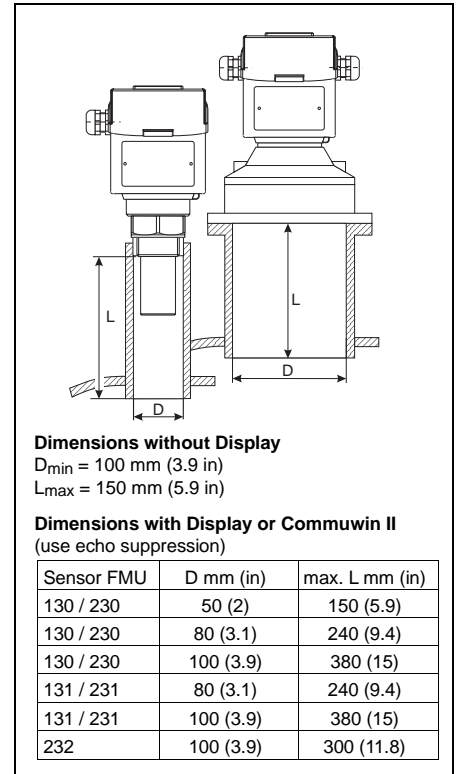
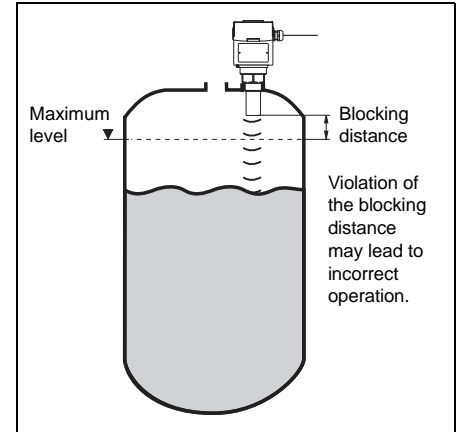
## Other Types of Mounting

- below left:  
mounting with welded sleeve
- below right:  
mounting with counter nut



## Blocking Distance

Due to the ringing time of the sensor, there is a zone immediately below it in which returning echoes cannot be detected. This so-called blocking distance determines the minimum distance between the sensor and the maximum level in the tank or silo (see Technical Data for values).



**Measuring Range**

The maximum measuring range of the Prosonic T is limited by the conditions at the measuring point and the reflection characteristics of the product surface. Optimum conditions are achieved if:

- the surface of the liquid is calm and without foam,
- no large concentrations of vapour are present in the tank,
- the solid material is hard and coarse-grained,
- no dust is present in the silo,
- temperature layering in the tank or silo is low.

**Example for Calculating Range**

Check the factors affecting your measurement in the table to the right. Add up their attenuation values (dB).

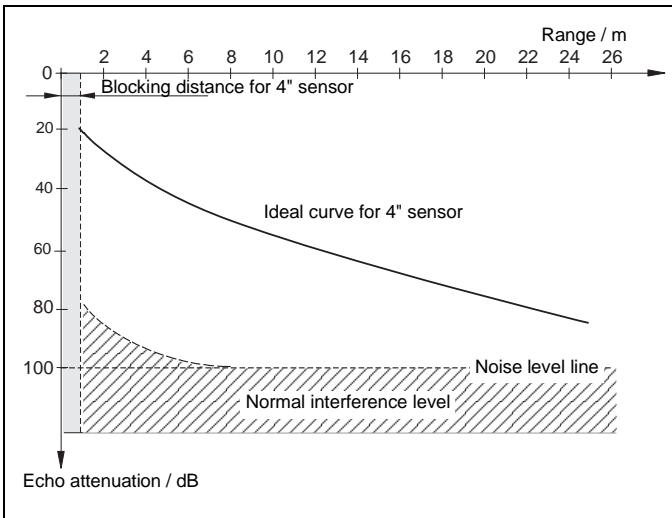
- Temperature difference in silo max. 40°C (104°F) 10 dB
  - Low amount of filling curtain in detection area 5 dB
  - Surface of liquid with strong turbulence 20 dB
- Sum of attenuation values 35 dB  
 Range below these factors thus approx. 5.8 m (19 in) with 2" sensor.

Effects	Attenuation (dB)
<b>Temperature layering</b> For air temperature difference between sensor and product surface	
up to 20°C (68°F)	0
up to 40°C (104°F)	5...10
up to 80°C (176°F)	10...20
<b>Filling curtain</b>	
Outside detection range	0
Small amount inside detection range	5...10
Large amount inside detection range	10...20
<b>Dust</b>	
None	0
Small amount	5
Large amount	5...10
<b>Solids surface</b>	
Coarse, hard	20
Soft	20...40
<b>Liquid surface</b>	
Calm	0
Heavy waves	5...10
Very turbulent (e.g. agitators)	10...20
<b>Foam</b>	
Please consult Endress+Hauser	

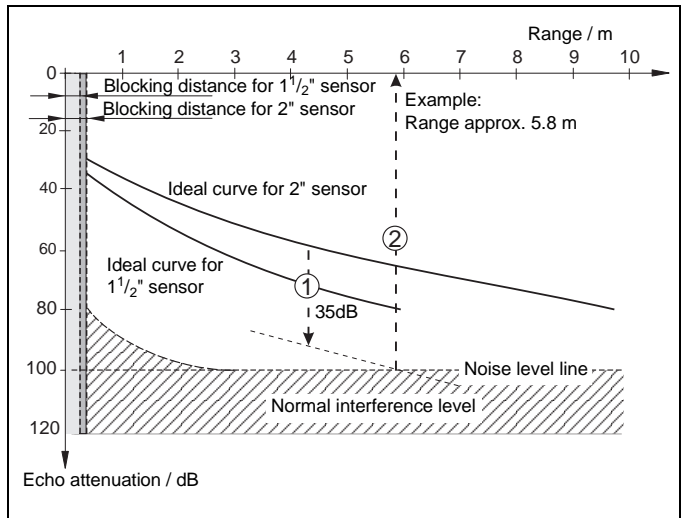
The diagram shows ideal echo attenuation curves.

- ① Move the ideal curve downwards corresponding to the sum of the attenuation values.
- ② The maximum range is indicated at the intersection where the ideal curve and the interference level line meet.

1 m = 3.28 ft  
 1 ft = 0.305 m



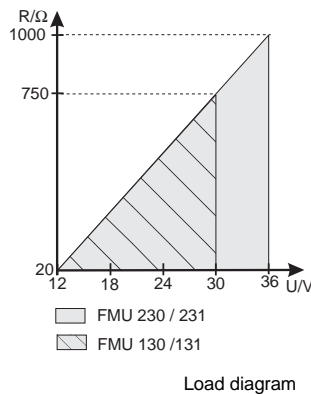
Echo attenuation FMU 232



Echo attenuation FMU 130, 131, 230, 231  
 Example for determining range

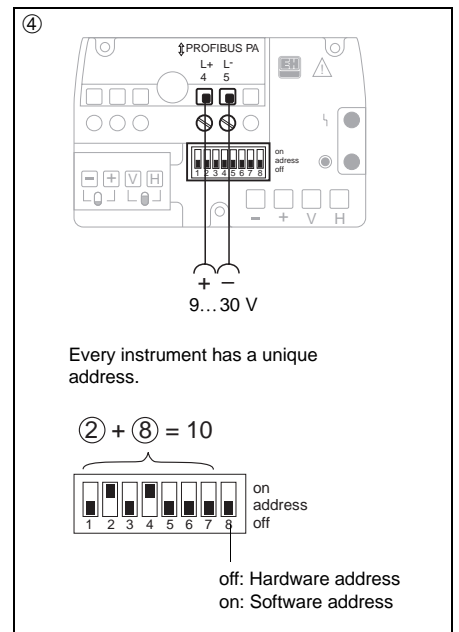
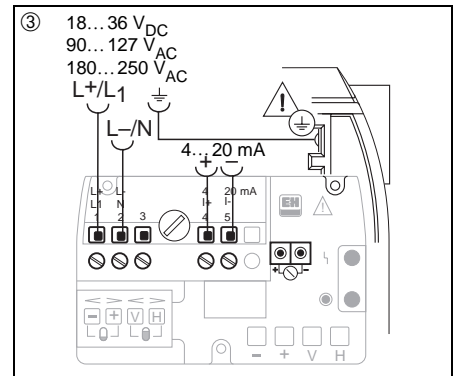
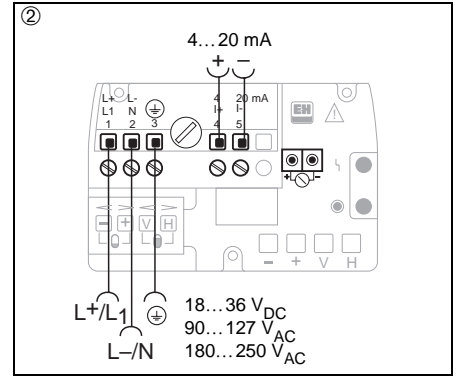
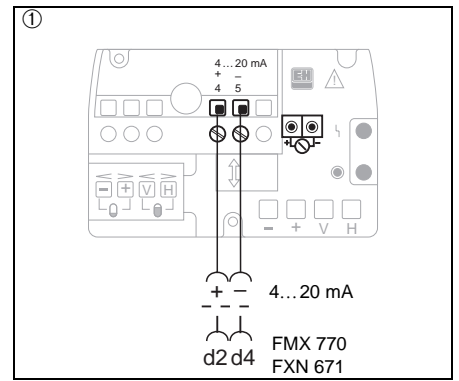
# Electrical Connection

- ① **FMU 130, 131, 230, 231**
  - 2-wire »loop-powered«
  - Communication: INTENSOR or HART
- ② **FMU 230, 231**
  - 4-wire, including mains power supply
- ③ **FMU 232**
  - 4-wire, including mains power supply
- ④ **FMU 130, 131 PROFIBUS-PA**
  - 2-wire
  - Communication: PROFIBUS-PA
  - Current consumption:  
FMU 130, 131, 230, 231: 12 mA ± 1 mA  
FMU 232: 16 mA ± 1 mA
  - Please see also: TI 260F and BA 166F



## Cabling

For FMU 130, 131, 230, 231 instruments with communication use screened commercial 2-wire cable for signal transmission or for FMU 230, 231, 232 4-wire cable for signal transmission and power. Under certain circumstances, the digital communication signal may be affected if unscreened cable is used.



# Technical data

## General Specifications

Manufacturer	Endress+Hauser
Instrument designation	Prosonic T
Others	CE mark

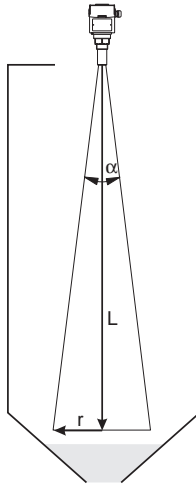
### Application

Continuous non-contact level measurement in liquids and coarse-grained bulk solids
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### Operation and System Design

Measuring principle	Ultrasonic measurement, time-of-flight measurement
Modularity	Compact ultrasonic sensor, with optional display Local operation or using – Universal HART Communicator DXR 275 (HART) or Commulog VU 260 Z (INTENSOR) handheld terminal – Silometer FMX 770, FXN 671 – PC (PROFIBUS-PA, Commubox)
Signal transmission	4...20 mA optional Smart (with superimposed communication signal), digital current output selectable 8/16 mA or 4/20 mA, digital communication signal via PROFIBUS-PA

### Input Variables



Measured variable	Level, determined from the distance between the sensor and surface of material																																
Measuring ranges	FMU 130, FMU 230: 0.25... 4 m (0.8... 13.1 ft), for 4-wire 0.25... 5 m (0.8... 16.4 ft) FMU 131, FMU 231: 0.4... 7 m (1.3... 23 ft), for 4-wire 0.4... 8 m (1.3... 26.2 ft) FMU 232: 0.6 m... 15 m (2... 49.2 ft)																																
Blocking distance	FMU 130, FMU 230: 0.25 m (0.8 ft) FMU 131, FMU 231: 0.4 m (1.3 ft) FMU 232: 0.6 m (2 ft)																																
Frequency	FMU 130, FMU 230: approx. 70 kHz FMU 131, FMU 231: approx. 50 kHz FMU 232: approx. 35 kHz																																
Pulse frequency	0.5... 3 Hz, depending on sensor and electronics																																
Min. delay time	2-wire: approx. 5 s; 4-wire: approx. 1 s																																
Application-specific effects on attenuation	Estimation of detection limits using beam angle (3 dB) $r = \tan \frac{\alpha}{2} \cdot L$ <b>Liquids</b> <table border="1"> <thead> <tr> <th></th> <th><math>\alpha</math></th> <th>L</th> <th>r</th> </tr> </thead> <tbody> <tr> <td>1 1/2" sensor</td> <td>5.5°</td> <td>4 m (13.1 ft)</td> <td>0.19 m (7.5 in)</td> </tr> <tr> <td>2" sensor</td> <td>5.5°</td> <td>7 m (23 ft)</td> <td>0.33 m (13 in)</td> </tr> <tr> <td>4" sensor</td> <td>3°</td> <td>15 m (49.2 ft)</td> <td>0.4 m (15.7 in)</td> </tr> </tbody> </table> <b>Bulk solids</b> <table border="1"> <thead> <tr> <th></th> <th><math>\alpha</math></th> <th>L</th> <th>r</th> </tr> </thead> <tbody> <tr> <td>1 1/2" sensor</td> <td>5.5°</td> <td>2 m (6.6 ft)</td> <td>0.1 m (3.9 in)</td> </tr> <tr> <td>2" sensor</td> <td>5.5°</td> <td>3.5 m (11.5 ft)</td> <td>0.16 m (6.3 in)</td> </tr> <tr> <td>4" sensor</td> <td>3°</td> <td>7 m (23 ft)</td> <td>0.1 m (3.9 in)</td> </tr> </tbody> </table> <p><math>\alpha = 3</math> dB angle of emission L = length of beam (calculated from max. measuring range of sensor)</p>		$\alpha$	L	r	1 1/2" sensor	5.5°	4 m (13.1 ft)	0.19 m (7.5 in)	2" sensor	5.5°	7 m (23 ft)	0.33 m (13 in)	4" sensor	3°	15 m (49.2 ft)	0.4 m (15.7 in)		$\alpha$	L	r	1 1/2" sensor	5.5°	2 m (6.6 ft)	0.1 m (3.9 in)	2" sensor	5.5°	3.5 m (11.5 ft)	0.16 m (6.3 in)	4" sensor	3°	7 m (23 ft)	0.1 m (3.9 in)
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### Output Variables

Output signal	4...20 mA, selectable digital current output 8/16 mA or 4/20 mA or digital communication signal
Output span	16 mA for analogue signal
Power failure signal (on error)	4...20 mA or 4/20 mA: selectable -10% = 2.4 mA (with 4-wire only), +110% = 21.6 mA or »hold« last current value is held 8/16 mA: selectable -10% = 7.2 mA, +110% = 16.8 mA or »hold«
Switching delay time	1... 255 s
Load	max. 600 $\Omega$

### Using the PROFIBUS-PA

Output signal	Digital communication signal, PROFIBUS-PA
PA function	Slave
Transmission rate	31.25 kBit/s
Response time	Slave: approx. 20 ms PLC: 300... 600 ms for approx. 30 devices (depending upon segment coupler)
Signal on alarm	Selectable -9999, +9999 or hold (last value)
Communication resistance	PROFIBUS-PA termination resistor
Physical layer	IEC 1158-2

### Measuring Accuracy

Reference conditions	Ideal reflection from calm, flat surface at 20°C (68°F)
Measuring uncertainty	0.25% for max. measuring span
Resolution	2-wire (FMU 130, 131, 230, 231): 3 mm (0.12 in) 4-wire (FMU 230, 231, 232): 2 mm (0.08 in)

### Communication Interfaces

Handheld terminal	Commulog VU 260 Z INTENSOR, Hart Communicator DXR 275 HART Connection direct to the current output or anywhere along the signal line Communication resistance: 250 $\Omega$
PROFIBUS-PA	Connection to PLC or PC via the FXN 623 A (not Ex) or FXN 623 C (Ex ia), PROFIBUS address via 8-pole switch, terminal resistance PROFIBUS-PA



### Application Conditions

<sup>1)</sup> Please check with Endress+Hauser before using sensors at higher temperatures and higher pressures.

When sensors are subjected to high temperatures and pressures (with limiting conditions), it is recommended that the coupling (process connection) be tightened.

Orientation	Perpendicular to the surface of the material
Medium temperature range <sup>1)</sup>	-40...+80°C (-40...+176°F) (built-in temperature sensor)
Operating temperature range (electronics)	-20...+60°C (-4...+140°F)
Storage temperature range	-40...+80°C (-40...+176°F)
Operating pressure $p_{abs}$ <sup>1)</sup>	Sensors with process connection G 1½ and G 2: 3 bar (43.5 psi) Sensor DN 100 or 4" with slip-on flange or mounting bracket: 2.5 bar (36.25 psi)
Climatic class	DIN / IEC 68 T2-30 Db
Type of protection (EN 60529)	IP 67 (NEMA 6), with housing cover open IP 20
Vibration resistance	DIN IEC 68 T2-6 Tab.2.C (10...55 Hz)
Electromagnetic compatibility (EMC)	Emitted interference to EN 61326; Class B equipment; Immunity to interference to EN 61326; Annex A (industry sector) and NAMUR EMC Recommendation
Explosion protection	FMU 130/131 (2-wire Ex): PTB EEx ia IIC T6 (PTB in Germany only) FMU 230/231 (2-wire not Ex and 4-wire): without FMU 232 (4-wire): dust Ex, Zone 10 (BVS in Germany only)

### Mechanical Design

Construction	Compact unit, Versions with threaded connection can be installed with 60 AF box spanner, max. torque 15...20 Nm (11.1...14.8 ft lbs)
Dimensions	See »Dimensions« page 12
Material	Housing: PBT (fibre-glass reinforced, flame-retarded) threaded boss and sensor: PVDF for FMU 232 UP (unsaturated polyester); sensor diaphragm stainless steel
Seals	Between threaded boss and sensor, internal: EPDM seal on threaded boss, external: EPDM seal
Process connection	FMU 130, FMU 230: G 1½ or 1½-11.5 NPT thread FMU 131, FMU 231: G 2 or NPT 2-11.5 NPT thread FMU 232: DN 100 or 4" with slip-on flange or mounting bracket
Cable entry	Pg 16, Cable diameter 5...9 mm (0.2...0.35 in) Sleeves for connection thread G½, ½ NPT or M 20x1.5 supplied
Cable	2-wire: Use standard screened 2-wire cable 4-wire: Use standard screened 4-wire cable for signal transmission and power supply Under certain circumstances, the digital communication signal may be affected if unscreened cable is used.

### Display and Operating Elements

Display (LCD)	4-character display, with segment display for current Dimension L x B x H: 40 x 20 x 10 mm (1.6 x 0.8 x 0.4 in)
LEDs	Red: indicates alarm or warning Green: Indicates power on (with 4-wire versions only) and entry acknowledgement

### Power Supply

AC voltage	4-wire: 180...250 V <sub>AC</sub> ; 90...127 V <sub>AC</sub>
Power consumption	< 4 VA
Switch-on current	100 mA, pulse width half life time 70 ms
DC voltage	4-wire: 18...36 V <sub>DC</sub> ; 2-wire: 12...36 V <sub>DC</sub>
Power consumption	< 2,5 W (4 wire instruments)
Switch-on current	7 A, pulse width half life time 2 ms
Current consumption	FMU 130, 131, 230, 231: 12 mA ±1 mA FMU 232: 16 mA ±1 mA
Ripple (Smart-devices)	<i>INTENSOR</i> max. ripple (measured at 500 Ω) 0 Hz...100 Hz: U <sub>SS</sub> =30 mV <i>HART</i> max. ripple (measured at 500 Ω) 47 Hz...125 Hz: U <sub>SS</sub> =200 mV max. noise (measured at 500 Ω) 500 Hz...10 kHz: U <sub>eff</sub> =2.2 mV
Electrical isolation	The evaluation electronics is electrically isolated from the power supply terminals with all 4-wire versions.

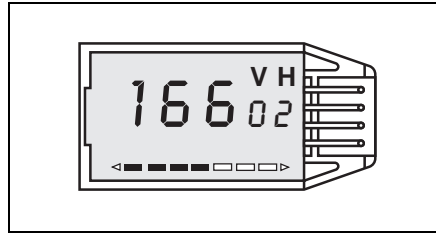
### Supplementary Documentation

Prosonic T System Information SI 021F/00/en Prosonic T Compact transmitter for limit detection Technical Information TI 247F/00/en Planning notes PROFIBUS-PA Technical Information TI 260F/00/en
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# Accessories

## Plug-in Display

- Order-No.: 942663-0000



## Slip-On Flange FAU 60 for FMU 232 only

- Order No.: FAU60-XOX

### Process connection

- D DN 100, PN 16
- A ANSI 4", 150 psi
- J JIS 16 K 100

### Material

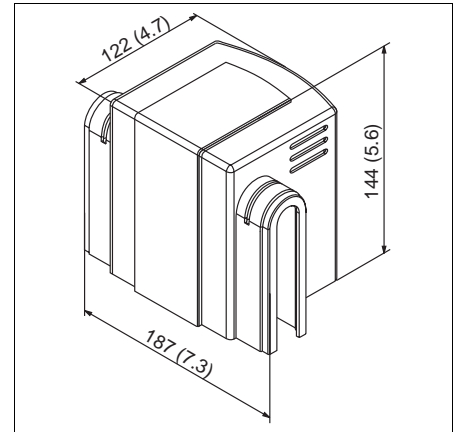
- P PPs (Polypropylene)
- S Steel painted
- R 1.4571 (AISI 316L)

FAU 60- 

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## Protective Hood for Electronic Housing

- Order No.: 942665-0000



Protective hood for electronics housing with dimensions in mm (in)

## Adapter Flange FAU 70 E for FMU X30, X31

- Order No.: 942636-XXXX

### Process connection

- 12 DN 50 PN 16
- 14 DN 80 PN 16
- 15 DN 100 PN 16

### Thread

- 3 G 1 1/2 ISO 228
- 4 G 2 ISO 228

### Material

- 2 1.4435 (AISI 316L)
- 7 PPs (Polypropylene)

FAU70E- 

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## Adapter Flange FAU 70 A for FMU X30, X31

- Order No.: 942636-XXXX

### Process connection

- 22 ANSI 2" 150 psi
- 44 ANSI 3" 150 psi
- 25 ANSI 4" 150 psi

### Thread

- 5 NPT 1 1/2 - 11,5
- 6 NPT 2 - 11,5

### Material

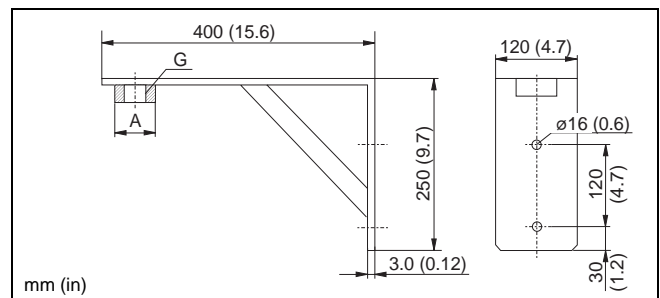
- 2 1.4435 (AISI 316L)
- 7 PPs (Polypropylene)

FAU70A- 

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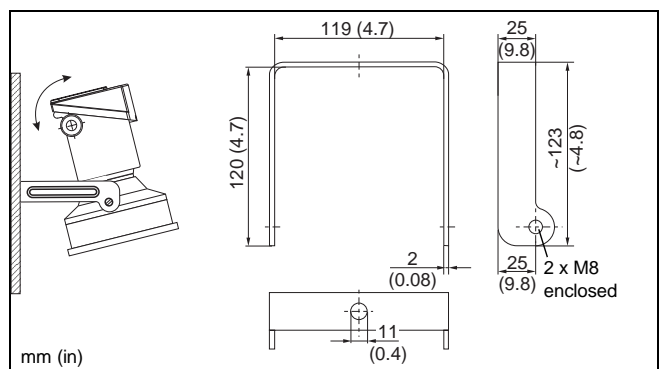
## Installation Bracket for FMU X30, X31

- G 1 1/2: A=55 mm (2.2 in) Order-No: 942669-0000
- G 2: A=66 mm (2.6 in) Order-No: 942669-0001
- Material: 1.4301 (AISI 304)



## Mounting Bracket for FMU 232

- Order-No: 942666-0000
- Material: 1.4301 (AISI 304)



# Product Structure

## Process Connection Versions with G or NPT Threads

FMU 130: G 1<sup>1</sup>/<sub>2</sub> or 1<sup>1</sup>/<sub>2</sub> NPT  
 Range: max. 2 m/6.6 ft (solids) or  
 max. 4 m/13.1 ft (liquids)

FMU 131: G 2 or 2 NPT  
 Range: max. 3.5 m/11.5 ft (solids) or  
 max. 7 m/23 ft (liquids)

Enter "Y" for special certificates or communication mode.

## Process Connection Versions with G or NPT Threads

FMU 230: G 1<sup>1</sup>/<sub>2</sub> or 1<sup>1</sup>/<sub>2</sub> NPT  
 Range: max. 2 m/6.6 ft (solids) or  
 2-wire: max. 4 m/13.1 ft (liquids)  
 4-wire: max. 5 m/16.4 ft (liquids)

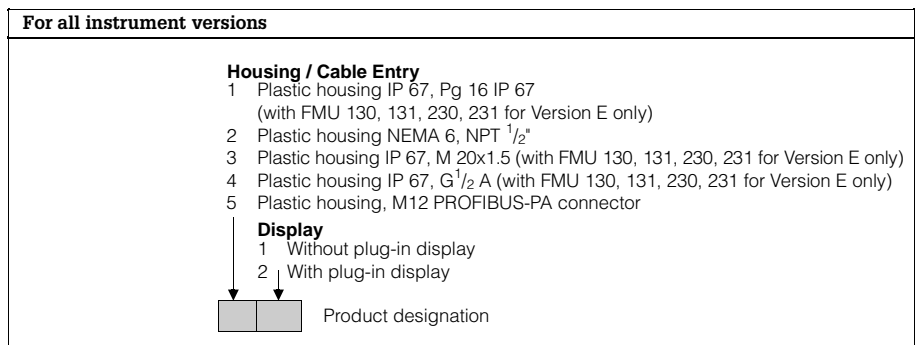
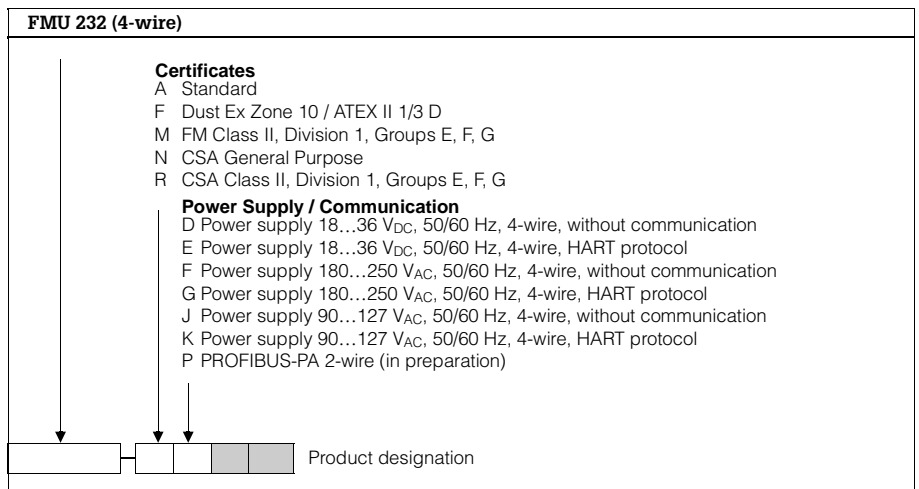
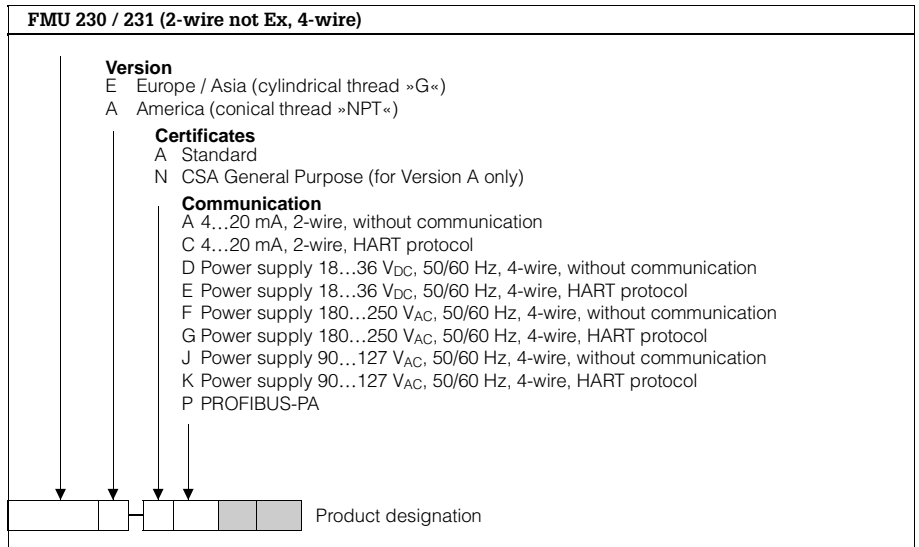
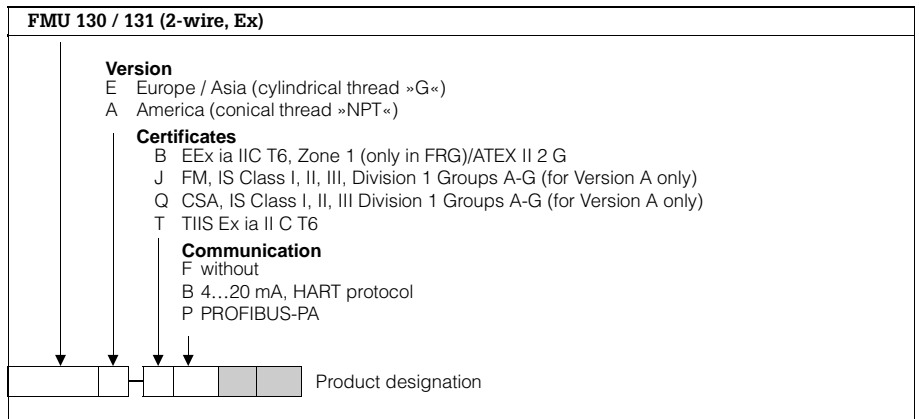
FMU 231: G 2 or 2 NPT  
 Range: max. 3.5 m/11.5 ft (solids) or  
 2-wire: max. 7 m/23 ft (liquids)  
 4-wire: max. 8 m/26.2 ft (liquids)

Enter "Y" for special certificates or communication mode.

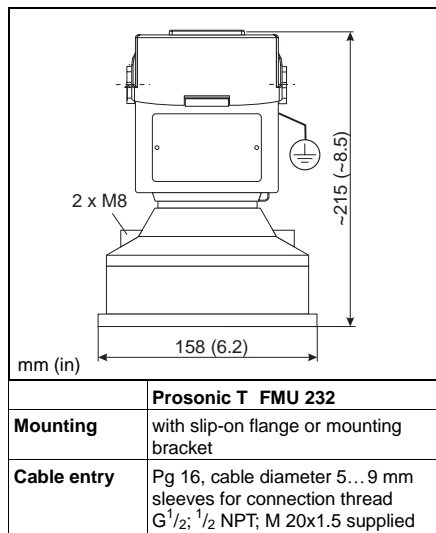
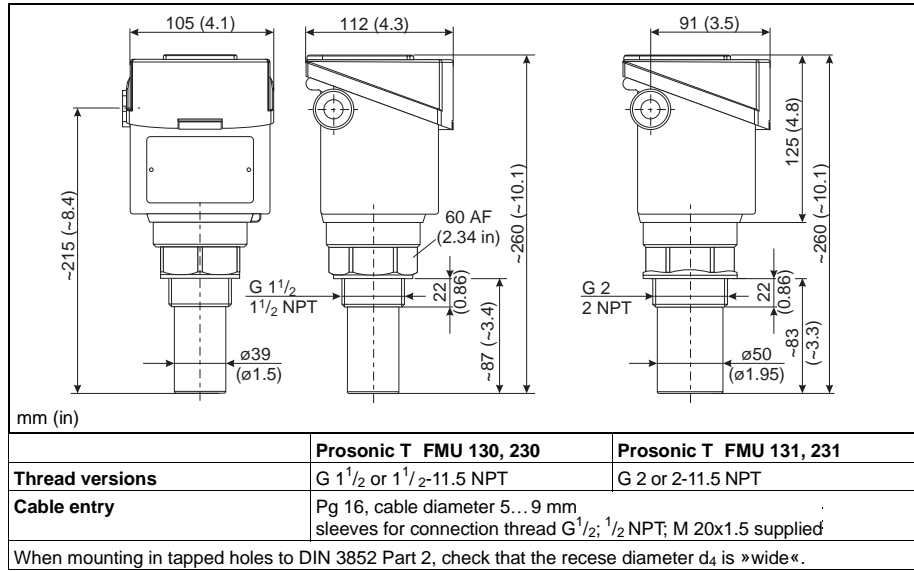
## Process Connection Versions:

Flange DN 100 / PN 16  
 Flange ANSI 4" / 150 psi  
 Flange JIS 16K 100  
 Range: up to 7 m/23 ft (solids) or  
 max. 15 m/49.2 ft (liquids)

Enter "9" for special display or housing versions.



# Dimensions



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