Technische Information
TI 366F/00/en
(replaces TI 246F/00/en)

Ultrasonic Level Measurement *prosonic T* *FMU 230/231*

Compact transmitters for non-contact level measurement of fluids and coarse bulk materials

Application

The compact transmitters Prosonic T are used for continuous, non-contact level measurement in fluids and coarse bulk materials.

The maximum measuring range is
- FMU 230:
  - 4m in fluids
  - 2m in bulk materials
- FMU 231:
  - 7m in fluids
  - 3,5m in bulk materials

Features and Benefits

- Non-contact measurement method, therefore almost independent of product properties
- Integrated temperature sensor for time-of-flight correction. Accurate measurements, even for temperature changes
- Linearisation function for measured value output in any units
- with optional display

Endress+Hauser
The Power of Know How

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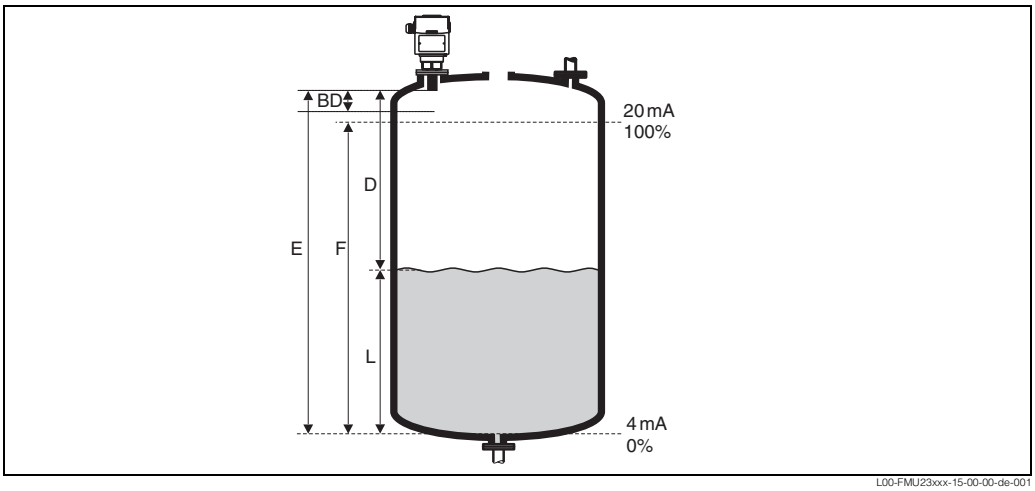
Function and system design

Time-of-flight method



E: *Empty distance;* ***F:*** *Span (full distance);* ***D:*** *Distance from sensor membrane - product surface;* ***L:*** *Level;* ***BD:*** *Blocking distance*

The sensor of the Prosonic T transmits ultrasonic pulses in the direction of the product surface. There, they are reflected back and received by the sensor. The Prosonic T measures the time t between pulse transmission and reception. The instrument uses the time t (and the velocity of sound c) to calculate the distance D between the sensor membrane and the product surface:

$D = c \cdot t/2$

As the device knows the empty distance E from a user entry, it can calculate the level as follows:

$L = E - D$

An integrated temperature sensor compensates for changes in the velocity of sound caused by temperature changes.

Signal evaluation

- Automatic suppression of up to 3 interference echoes (fixed target echoes)
- First echo detection

Calibration

Calibration is performed by entering the empty distance E (=zero) and the full distance F (= span).

E and F correspond to
- 4 mA or 20 mA respectively for the current output
- 0% or 100% respectively for the local display

Span F may not extend into the blocking distance BD. Level echos from the blocking distance cannot be evaluated due to the transient characteristics of the sensor.

For the version with on-site display, E and F can be entered directly as numbers. For the version without display, calibration can be performed for example by filling the vessel to the E and F point consecutively.

Linearisation

The linearisation function of the Prosonic T allows conversion of the measured value into any unit of length or volume. A linearisation table consisting of up to 11 value pairs can be entered manually or semi-automatically (by filling the vessel under controlled conditions).

Input

Measured variable

The distance D between the sensor membrane and the product surface is measured .

Using the linearisation function, the device uses D to calculate:
- level L in any units
- volume V in any units

Measuring range

Upper limit: blocking distance

Instrument	blocking distance (BD)
FMU 230	0,25 m
FMU 231	0,4 m

The upper limit of the measuring distance is given by the blocking distance (page 2). Level echos within the blocking distance cannot be evaluated due to the transient characteristics of the sensor.

Lower limit: Range of the sensor

The measuring range is limited by the range of a sensor. The sensor range is, in turn, dependent on the operating conditions. To estimate the actual range, proceed as follows (see also the calculation example in the diagram):

1. Determine which of the influences shown in the following table are appropriate for your process.
2. Add the corresponding attenuation values.
3. From the total attenuation, use the diagram to calculate the range.

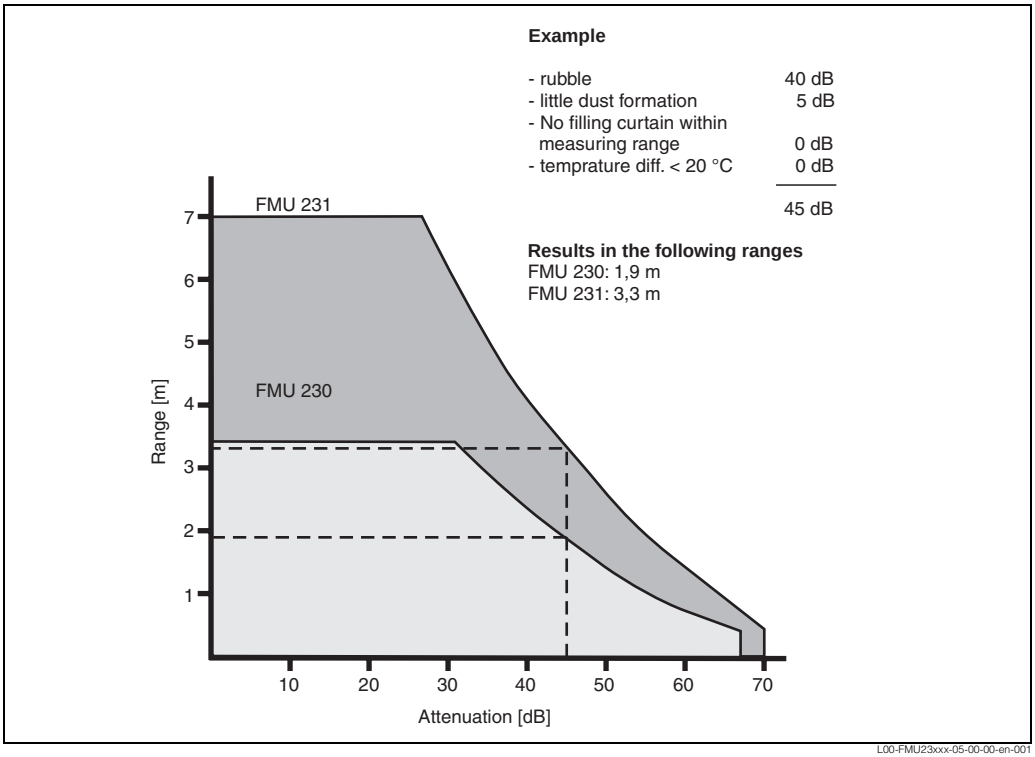
Fluid surface	Attenuation
Calm	0 dB
Waves	5 ... 10 dB
Strong turbulence	10 ... 20 dB
Foaming	Ask E+H

Bulk material surface	Attenuation
Hard, rough (e.g. rubble)	40 dB
Soft (e.g. peat, dust-covered clinker)	40 ... 60 dB

Dust	Attenuation
No dust formation	0 dB
Little dust formation	5 dB
Heavy dust formation	5 ... 20 dB

Filling curtain in detection range	Attenuation
None	0 dB
Small quantities	5 ... 10 dB
Large quantities	10 ... 40 dB

Temperature difference between sensor and product surface	Attenuation
to 20 °C	0 dB
to 40 °C	5 ... 10 dB
to 80 °C	10 ... 20 dB



Operating frequency

Instrument	Operating frequency
FMU 230	approx. 70 kHz
FMU 231	approx. 50 kHz

Output

Output signal

4 ... 20 mA analog signal

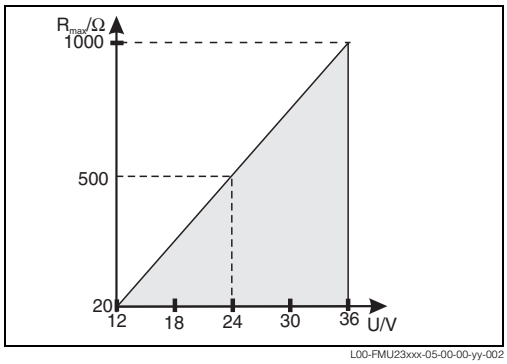
Signal on alarm

configurable:
- 3,8 mA
- 22 mA
- hold last value

Output damping

0 ... 255 s

Load



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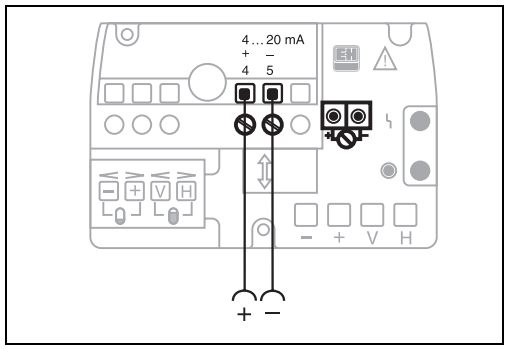
The maximum load (R_{max}) depends on the supply voltage (U).

Auxiliary energy

Electrical connection



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Use screened two-core instrumentation cable.For optimal protection against electromagnetic interference, the screen should be grounded in the control room or the nearest earthing point. A good connection to ground is essential to good screening.

Supply voltage	12 ... 36 V_{DC}
Power consumption	< 0,8 W
Cable entry	• Cable gland M20x1,5 • Cable entry G ½ or ½ NPT cable diameter 5 ... 9mm

Performance characteristics

Reference operating conditions

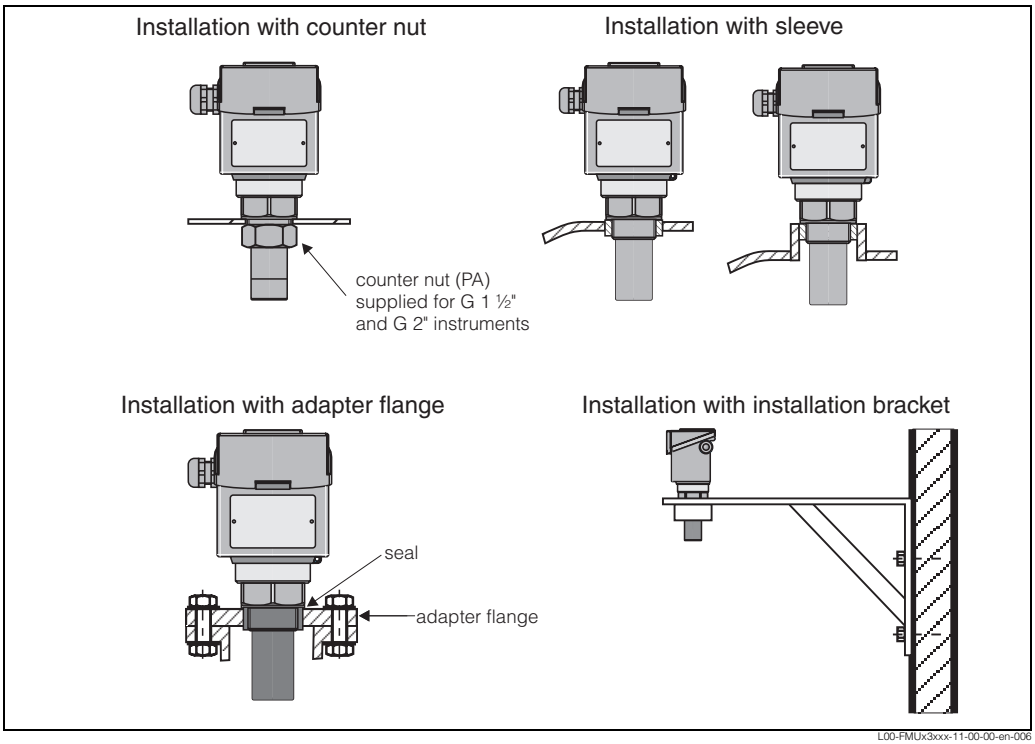
The specified performance characteristics are valid under the following reference conditions:

- Temperature = +20 °C
- Pressure = 1013 mbar abs.
- Humidity = 60 %
- Ideal reflective surface (e.g. calm, smooth fluid surface)
- No interference reflections within signal beam

Measured value resolution	3 mm
Measuring error	0,25% of maximum measuring range (includes linearity, repeatability, and hysteresis)
Pulse frequency	0,5 ... 1 Hz
Reaction time	approx. 5 s

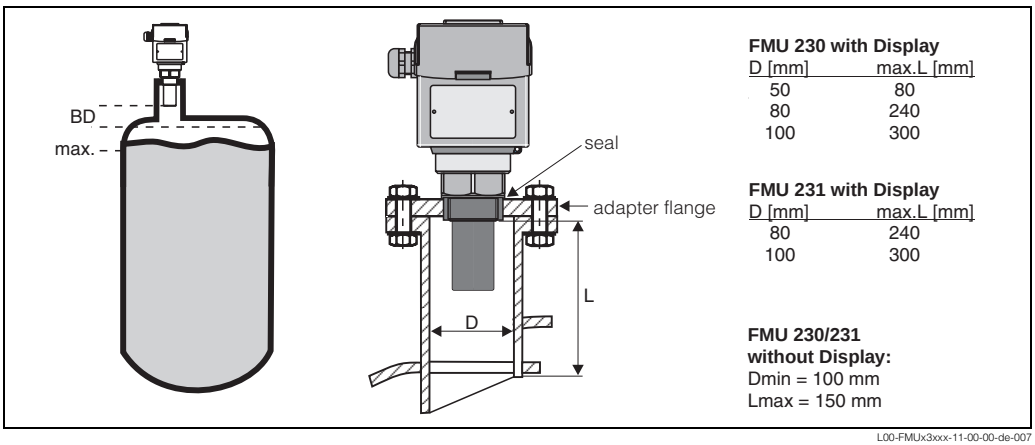
Installation conditions

Installation variants



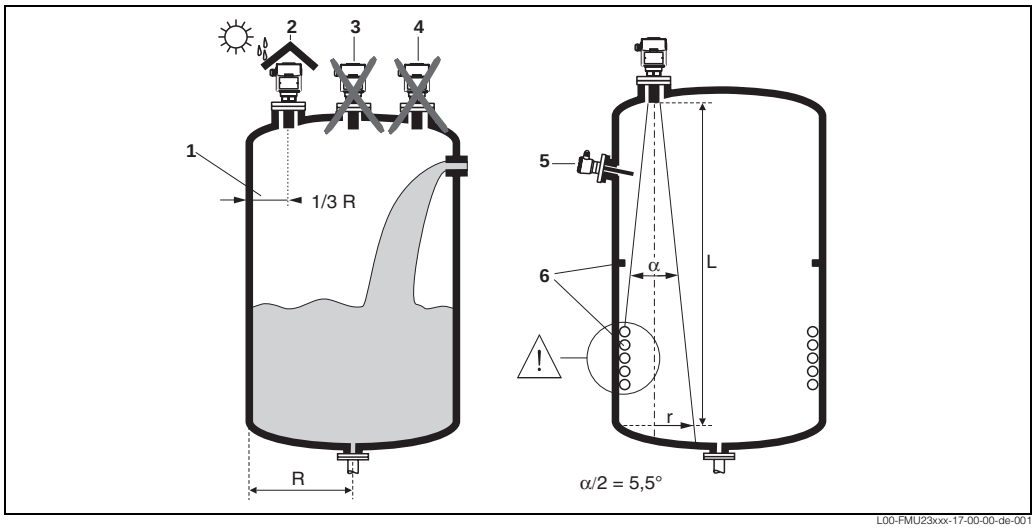
Blocking distance, nozzle mounting

Level echos from the blocking distance (BD) cannot be evaluated due to the transient characteristics of the sensor. Install the Prosonic T at a height so that the blocking distance BD is not undershot, even at maximum fill level. Use a pipe nozzle if you cannot maintain the blocking distance in any other way. The interior of the nozzle must be smooth and may not contain any edges or welded joints. In particular, there should be no burr on the inside of the tank side nozzle end. Note the specified limits for nozzle diameter and length.



Caution!
If the blocking distance is undershot, it may cause device malfunction.

Installation position



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- Do not install the sensor in the middle of the tank (3). We recommend leaving a distance between the sensor and the tank wall (1) measuring 1/3 of the tank radius.
- Use a protective cover, in order to protect the device from direct sun or rain (2).
- Avoid measurements through the filling curtain (4).
- Make sure that equipment (5) such as limit switches, temperature sensors, etc. are not located within the emitting angle α. In particular, symmetrical equipment (6) such as heating coils, baffles etc. can influence measurement.
- Align the sensor so that it is vertical to the product surface.
- Never install two identical ultrasonic measuring devices in a tank.
- To estimate the transmitted echo beam and its detection range, use the 3 dB emitting angle α:

Sensor	α	L	r
FMU 230	11°	4 m	0,38 m
FMU 231	11°	7 m	0,67 m

Ambient conditions

Ambient temperature

-20 °C ... +60 °C

Storage temperature

-40°C ... +80°C

Climate class

DIN/IEC 68 T2-30Db

Ingress protection

- with closed housing: IP 67, NEMA 6
- with open housing: IP 20, NEMA 1
- Sensor: IP 68

Vibration resistance

DIN IEC 68 T2-6 Tab. 2C (10 ... 55 Hz)

Electromagnetic compatibility (EMC)

- Interference emmission to EN 61326, Equipment class B
- Interference immunity to EN 61326, Appendix A (Industrial) und NAMUR reccomendation NE 21 (EMC)

Process conditions

Process temperature

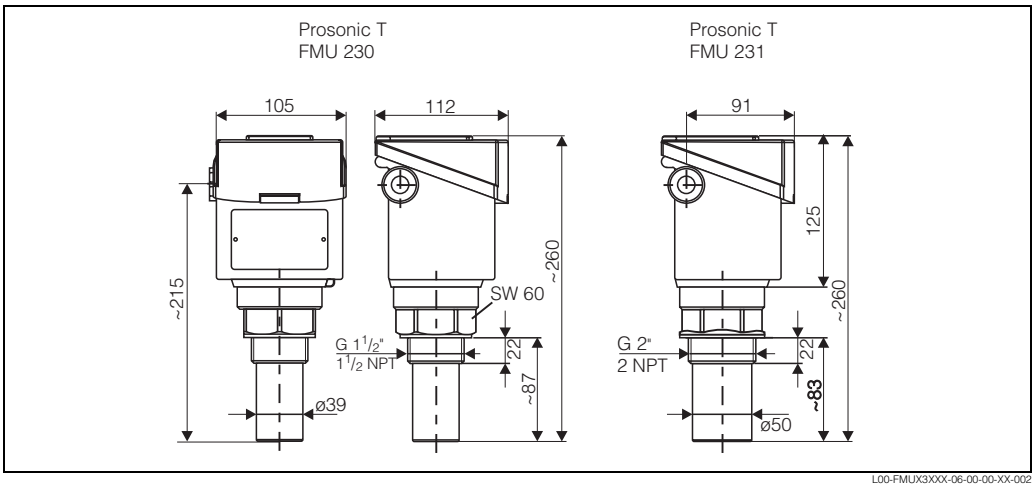
-40°C ... +80°C

Process pressure

0,7 ... 3 bar abs.

Mechanical construction

Design / Dimensions



Weight

Instrument	Weight
FMU 230	approx. 1,5 kg
FMU 231	approx. 1,6 kg

Housing material

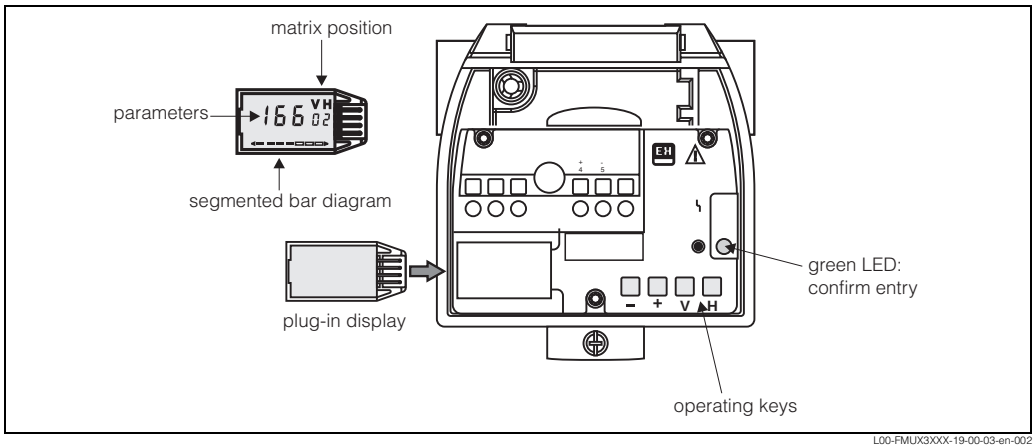
PBT glass reinforced / flame-retended

Process connection

Instrument	Process connection	seal and sensor material
FMU 230	• thread G 1½" • thread NPT 1½" - 11,5	PVDF / EPDM
FMU 231	• thread 2" • thread NPT 2" - 11,5	PVDF / EPDM

Human interface

Operating elements



LED

Pressing of a key is confirmed by a flash of the green LED.

Display module (optional)

When the display module is used, the Prosonic T is operated via an operating matrix. The current matrix position and the associated parameter (e.g. measured value) are displayed on the module. The bargraph represents the measured value or the echo quality, depending on the matrix position.
The basic functions for simple applications (empty and full calibration, locking and unlocking) are accesible without the display module.

Certificates and Approvals

CE mark

The measuring system meets the legal requirements of the EC-guidelines. Endress+Hauser confirms the instrument passing the required tests by attaching the CE-mark.

External standards and guidelines

EN 60529

Protection class of housing (IP-code)

EN 61326

Electromagnetic compatibility (EMC requirements)

NAMUR

Standards committee for measurement and control in the chemical industry

Ordering information

Product structure

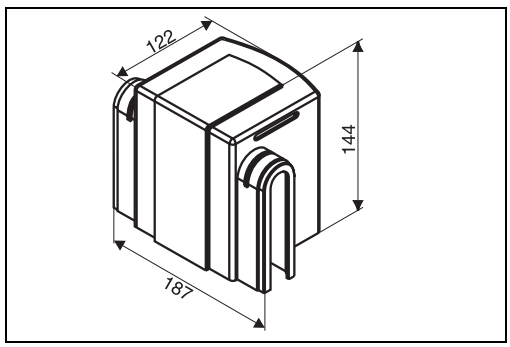
Version							
E	Europe / Asia (cylindrical thread „G“)						
A	America (conical thread „NPT“)						
	Certificate						
	A	Standard					
	N	CSA General Purpose (for Version A only)					
		Communication					
		A	4...20mA, 2-wire				
			Housing/cable entry				
			2	Plastic housing NEMA 6, NPT ½			
			3	Plastic housing IP 67, M 20x1,5 (for Version E only)			
			4	Plastic housing IP 67, G ½ (for Version E only)			
				Display			
				1	without display module		
				2	with display module		
FMU 230 -							product designation
FMU 231 -							product designation

Scope of delivery

- Instrument in the ordered version
- Operating Instructions
- for versions FMU 230E and FMU 231E: Counter nut (PA)
- EPDM process seal
- for versions M20x1,5: cable gland

Accessories

Protective cover



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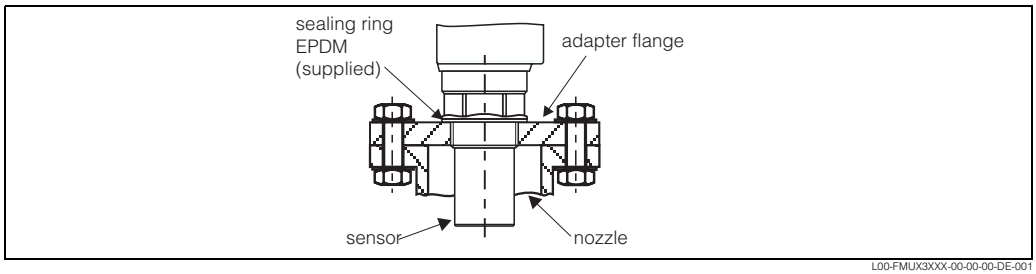
Order-Code:
942665-0000

Adapter flange



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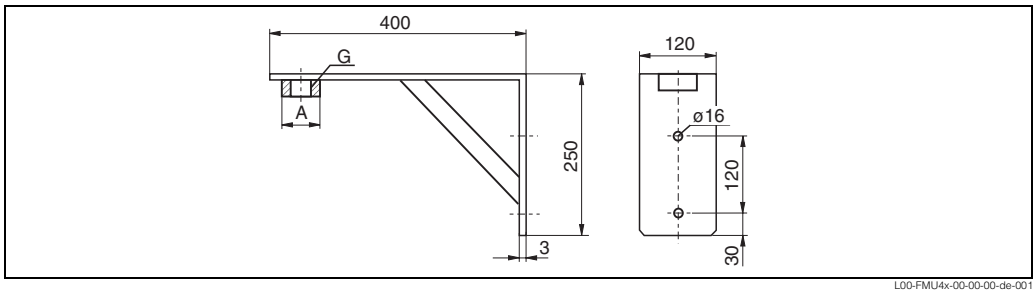
for metrical thread (FAU 70 E)

	Process connection				
	12	DN 50 PN 16			
	14	DN 80 PN 16			
	15	DN 100 PN 16			
		Sensor connection			
		3	G 1½, ISO 228		
		4	G 2, ISO 228		
			Material		
			2	1.4435	
			7	Polypropylene, PPS	
FAU 70 E					Order Code

for conical thread (FAU 70 A)

	Process connection				
	22	ANSI 2" 150 psi			
	24	ANSI 3" 150 psi			
	25	ANSI 4" 150 psi			
		Sensor connection			
		5	NPT 1½ - 11,5		
		6	NPT 2 - 11,5		
			Material		
			2	1.4435	
			7	Polypropylene, PPS	
FAU 70 A					Order Code

Mounting bracket



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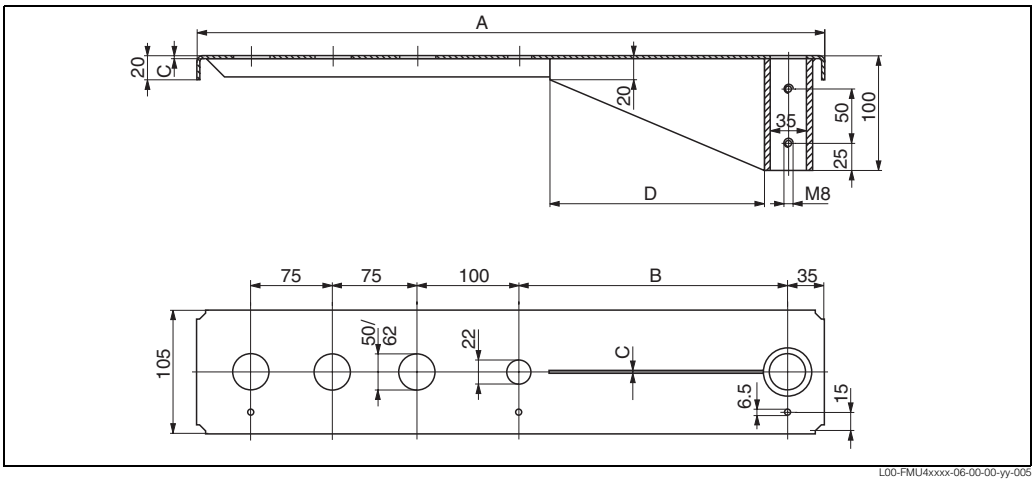
- for FMU 230, G1½: Order code: 942669-0000
- for FMU 231, G2: Order code: 942669-0001
- Material: 1.4301
- suited for NPT 1½" und 2" as well

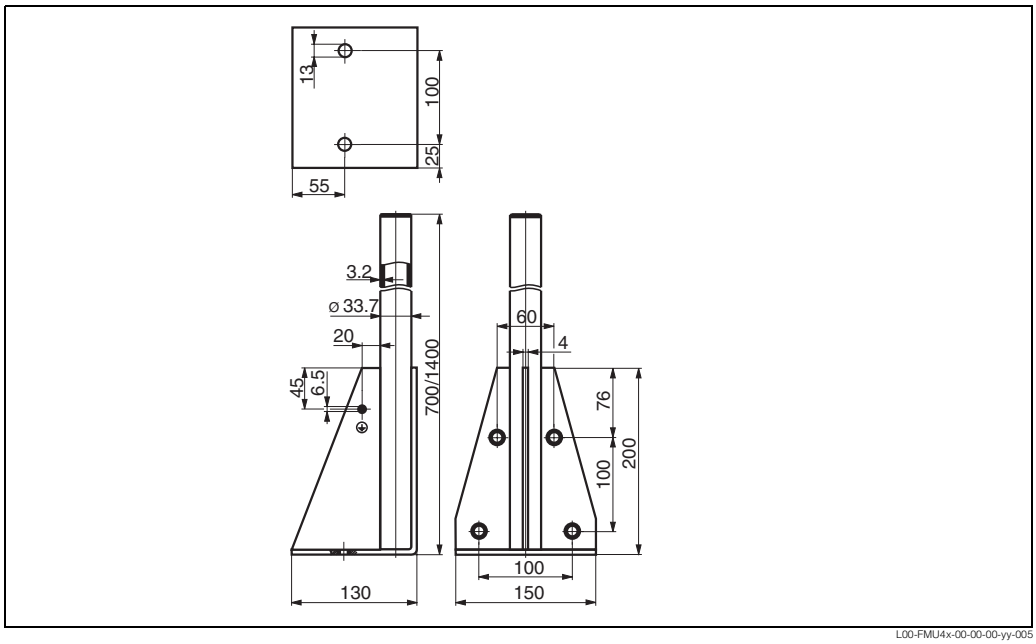
Cantilever



A	B	C	D	for Sensor	Material	Order Code
585 mm	250 mm	2 mm	200 mm	FMU 230	1.4301 (AISI 304)	52014132
					galv. steel	52014131
				FMU 231	1.4301 (AISI 304)	52014136
					galv. steel	52014135
1085 mm	750 mm	3 mm	300 mm	FMU 230	1.4301 (AISI 304)	52014134
					galv. steel	52014133
				FMU 231	1.4301 (AISI 304)	52014138
					galv. steel	52014137

The 50 mm or 62 mm orifices serve for the mounting of the FMU 230 or FMU 231 sensor, respecitvely.

Mounting bracket for cantilever



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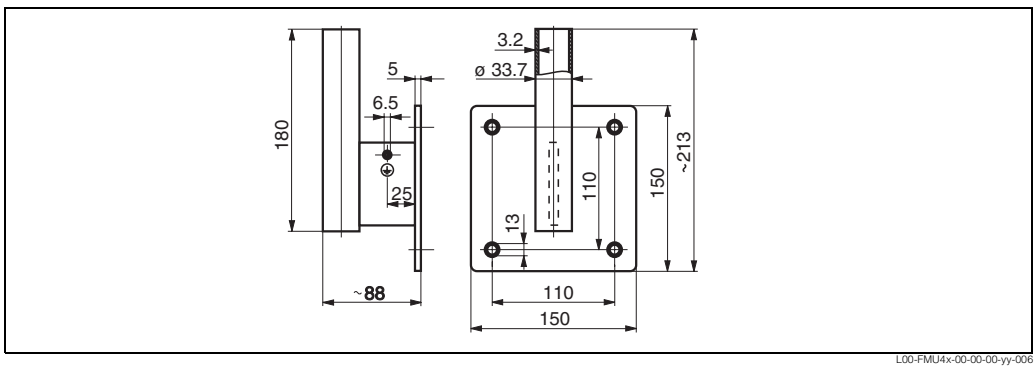
Height	Material	Order Code
700 mm	galv. steel	919791-0000
700 mm	1.4301 (AISI 304)	919791-0001
1400 mm	galv. steel	919791-0002
1400 mm	1.4301 (AISI 304)	919791-0003

Wall bracket for cantilever



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Material	Order Code
galv. steel	919792-0000
1.4301 (AISI 304)	919792-0001

Supplementary documentation

System-Information	**SI 005F** Ultrasonic level measurement
Operating manual	**KA 042F**

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FM+SGML 6.0 ProMoDo