Technical Information

Prosonic S FMU90

Transmitter in housing for field or top–hat rail mounting
for the ultrasonic sensors FDU90/91/91F/92/93/95/96

Application for level measurement

- Continuous, non-contact level measurement of fluids, pastes, sludge and powdery to coarse bulk materials with 1 or 2 ultrasonic sensors
- Measuring range up to 70 m (depending on sensor and material measured)
- Level limit detection (up to 6 relays)
- Pump control (alternating); rake control
- Option: additional pump control functions (pump function test, ...)
- Calculations: average, difference, sum

Application for flow measurement

- Flow measurement in open channels and measuring weirs with 1 or 2 ultrasonic sensors
- Simultaneous measurement of level and flow in a stormwater overflow basin with only 1 sensor
- Flow measurement with back water detection (2 sensors) or sludge detection
- Up to 3 totalizers and 3 (resettable) counters; optionally resettable via digital inputs
- Counting or time pulse output for control of external units
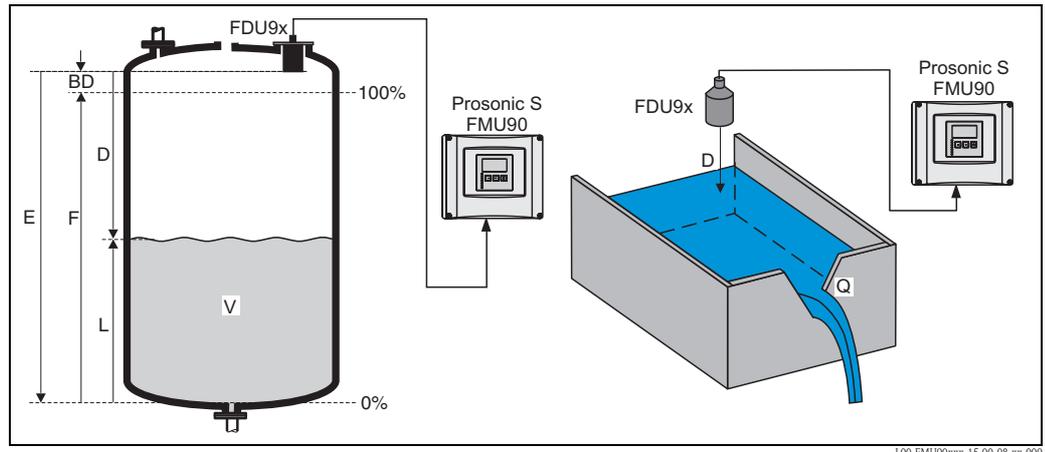
Your benefits

- Simple, menu–guided operation with 6-line plain text display; 15 languages selectable
- Envelope curves on the display for quick and simple diagnosis
- Easy operation, diagnosis and measuring point documentation with the supplied "ToF-Tool – FieldTool Package" operating program.
- Option: four digital inputs (e.g. for pump feedback) and one external temperature input
- Time-of-flight correction via integrated or external temperature sensors
- Linearisation (up to 32 points, freely configurable)
- Linearisation tables for the most common flumes and weirs pre–programmed and selectable
- Online calculation of the flume–/weir–flows via integrated flow curves
- Pre–programmed pump control routines
- System integration via HART or PROFIBUS DP
- Automatic detection of the sensors FDU9x
- The sensors of the former series FDU8x can be connected (for certificates see note on page 8)

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Table of Contents

Function and system design

Measuring principle

L00-FMU90xxx-15-00-08-xx-009

BD: *blocking distance;* **D:** *distance from sensor membrane to fluid surface;* **E:** *empty distance* **F:** *span (full distance);* **L:** *level;* **V:** *volume (or mass);* **Q:** *flow*

The sensor transmits ultrasonic pulses in the direction of the product surface. There, they are reflected back and received by the sensor. The transmitter Prosonic S measures the time t between pulse transmission and reception. From t (and the velocity of sound c) it calculates the distance D from the sensor membrane to the product surface:

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

From D results the desired measuring value:
- level L
- volume V
- flow Q across measuring weirs or open channels

Blocking distance

The span F may not extend into the blocking distance BD. Level echos from the blocking distance can not be evaluated due to the transient characteristics of the sensor. The blocking distances of the individual sensors are given in the following documents:

- TI 396F for the sensors FDU 90/91/91F/92/93/95/96
- TI 189F for the sensors FDU 80/80F/81/81F/82/83/84/85/86

Time–of–flight correction

In order to compensate for temperature dependent time–of–flight changes, a temperature sensor is integrated in the ultrasonic sensors.
Optionally, the Prosonic S FMU90 has an input for an external temperature sensor (FMU90–*******B***). The following sensor can be connected:
- Pt100
- FMT131 from Endress+Hauser

The external sensor mus be used for the heated version of the ulstrasonic sensors FDU90 and FDU91.

Interference echo suppression

The interference echo suppression feature of the Prosonic S ensures that interference echos (e.g. from edges, welded joints and installations) are not interpreted as a level echo.

Pump control

individaully configurable for each pump:
- pump switching delay, e.g. to prevent overlaod of the power supply system
- backlash time and backlash interval, e.g. for complete draining of shafts or channels
- crust reduction at pump shaft walls by fine adjustment of the switch point

Linearisation	**Pre-programmed linearisation curves**

Types of vessels

- horizontal, cylindrical tank
- spherical tank
- tank with pyramidal bottom
- tank with conical bottom
- tank with flat, inclined bottom

Flow curves for flumes and weirs[1]

- Khafagi-Venturi flume
- ISO-Venturi flume
- BST[2]-Venturi flume
- Parshall flume
- Palmer-Bowlus flume
- Rectangular weir
- Rectangular constricted weir
- NFX[3] rectangular weir
- NFX[3] rectangular constricted weir
- Trapezoidal weir
- V-notch weir
- BST[2] V-notch wier
- NFX[3] V-notch weir

The pre-programmed linearisation curves are calculated on-line.

Linearisation formula for flow measurements[1]

$Q = C (h^\alpha + \gamma h^\beta)$
"h" is the upstream level. The parameters α, β, γ and C can be freely programmed by the user.

Linearisation table

consisting of up to 32 linearisation points; to be entered manually or half-automatically.

Special functions	

- limit detection
- rake control
- alternating pump control or control according to pump rate (standard)
- option: additional pump control functions[4]:
  - Alternation accordint to runtime or starts
  - pump feedback via the optional digital inputs; stand-by pump configurable
  - pump function test after resting time
  - storm function to prevent unnecessary pump running times
  - flush control for regular pump shaft cleaning
  - pump control according to tariff times via digital input
  - output of operating hours alarm or pump alarm
  - recording of pump data (operating hours, number of starts, last running time)
- totalising of the flow volume with (resettable) counters and (non-resettable) totalisers[1]
- triggering of a sampler by time or quantity pulses[1]
- low flow cut off[1]
- backwater detection in flumes[1]
- sludge detection in flumes[1]
- trend detection

Datalog functions	

- Peak hold indicator of the min./max. levels or flows and the min./max. temperatures at the sensors
- Recording of the last 10 alarms
- Indication of the operating status
- Trend indication of the outputs on the on-site display
- Indication of the operating hours

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1) for instrument versions with flow software (FMU90 – *2**********)
2) BST: British Standard
3) French standard NFX 10-311
4) for instruments with software for additional pump control (FMU90-*3********** or FMU90-*4**********)

Endress + Hauser

Application examples for level measurements

Level measurement with limit detection and alarm output
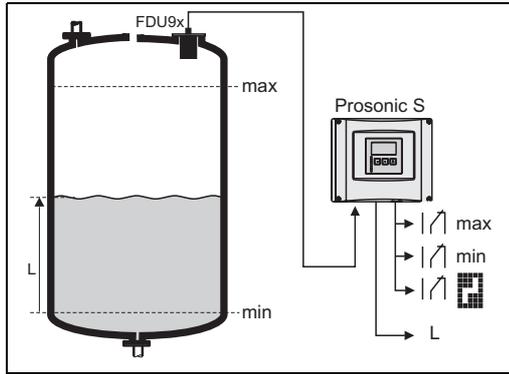
L00-FMU90xxx-15-00-00-xx-010

*Order code e.g.: FMU90 – *1***131****
(1 input, 3 relays, 1 outputs)*

Average level measurement
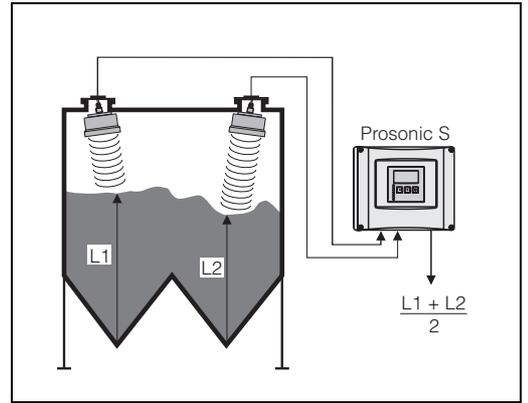
L00-FMU90xxx-15-00-00-xx-003

*Order code e.g.: FMU90 – *1***212****
(2 inputs, 2 outputs)*

**Rake control
(differential measurement)**
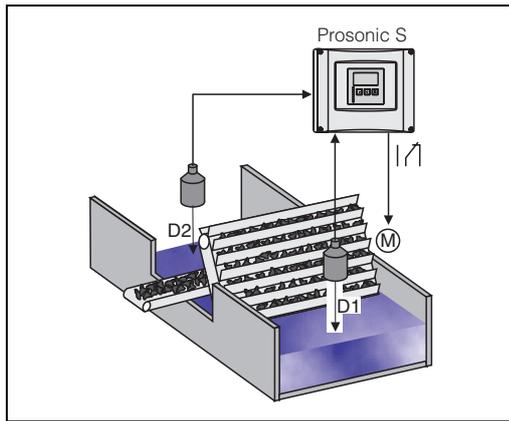
L00-FMU90xxx-15-00-00-xx-004

*Order code e.g.: FMU90 – *1***212****
(2 inputs, 1 relay, 2 outputs)*

**Alternating pump control
(up to 6 pumps)**
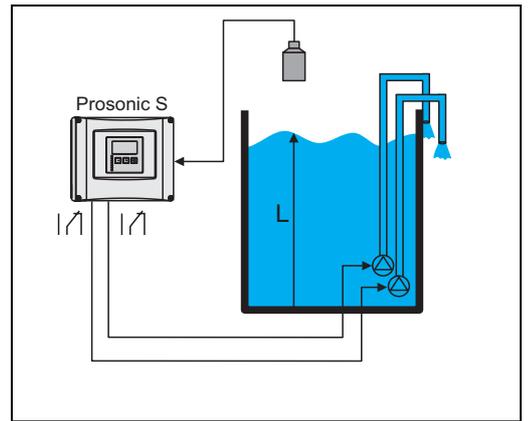
L00-FMU90xxx-15-00-00-xx-007

*Order code e.g.: FMU90 – *1***131****
(1 input, 3 relays)*

Conveyor belt
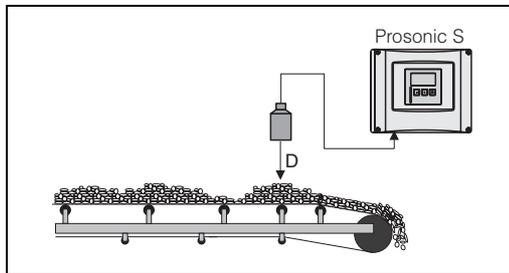
L00-FMU90xxx-15-00-00-xx-005

*Order code e.g.: FMU90 – *1***111****
(1 input, 1 output)*

Application examples for flow measurements	Pulses for volume counter + time pulses (e.g. for sampler)	Flow measurement with backwater alarm or sludge detection

Flow measurement with backwater alarm or sludge detection

If the ratio "downstream level:upstream level" rises above or falls below a critical value, an alarm will be generated.

Pulses for volume counter + time pulses (e.g. for sampler)

L00-FMU90xxx-15-00-00-xx-011
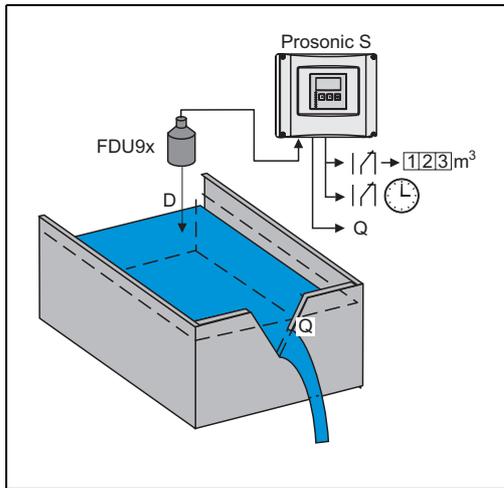
*Order code e.g.: FMU90 – *2***131****
(1 input, 3 relays, 1 output)*

L00-FMU90xxx-15-00-00-xx-008
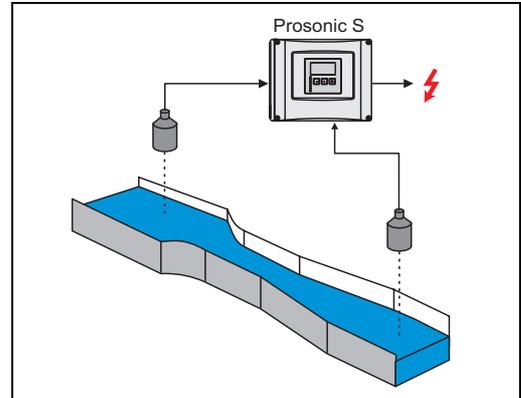
*Order code e.g.: FMU90 – *2***212****
(2 inputs, 1 relay, 2 outputs)*

Stormwater overflow bassin

Simultaneous measurement of level L and flow Q with 1 sensor.

L00-FMU90xxx-15-00-00-xx-006
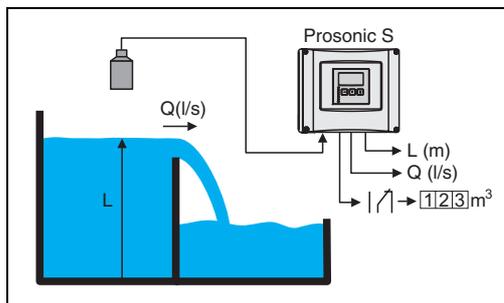
*Order code e.g.: FMU90 – *2***112****
(1 input, 2 outputs)*

System integration HART
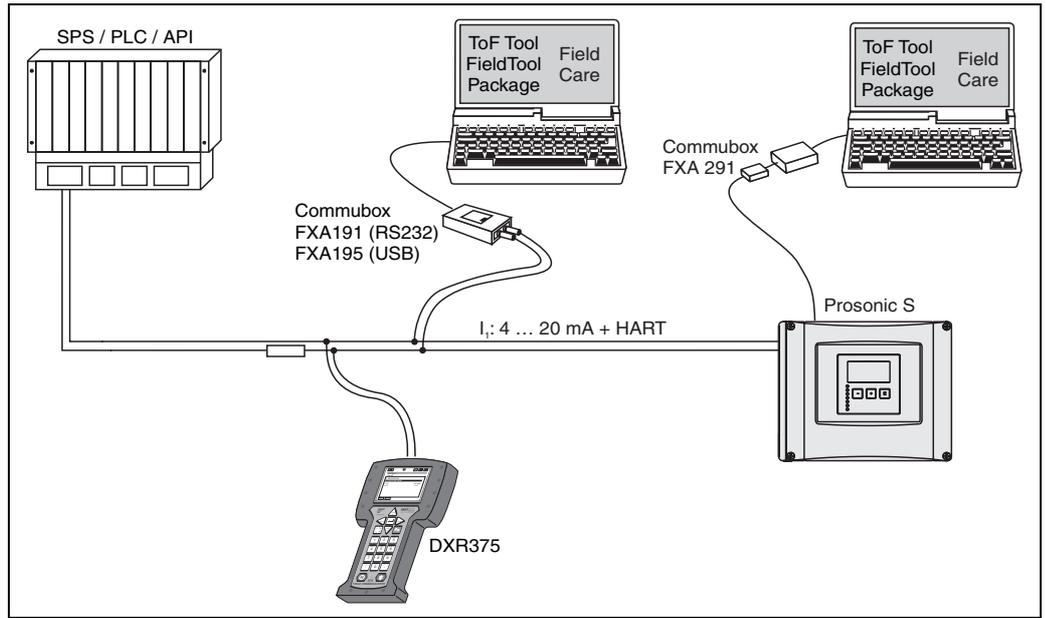
L00-FMU90xxx-14-00-00-xx-009

In the standard version a HART signal is superimposed onto the first output current. In order to use the HART communication, the circuit must contain a communication resistor of 250Ω.

Operating options

- via the operating and display module at the Prosonic S (if present)
- via the service interface of the Prosonic S with the Commubox FXA291 and the operating program "ToF Tool – FieldTool Package" or "FieldCare"
- via the HART protocol, e.g. with the Commubox FXA191 or FXA195 and the operating program "ToF Tool – FieldTool Package" or "FieldCare"
- via the HART handheld terminal DXR375

System integration PROFIBUS DP
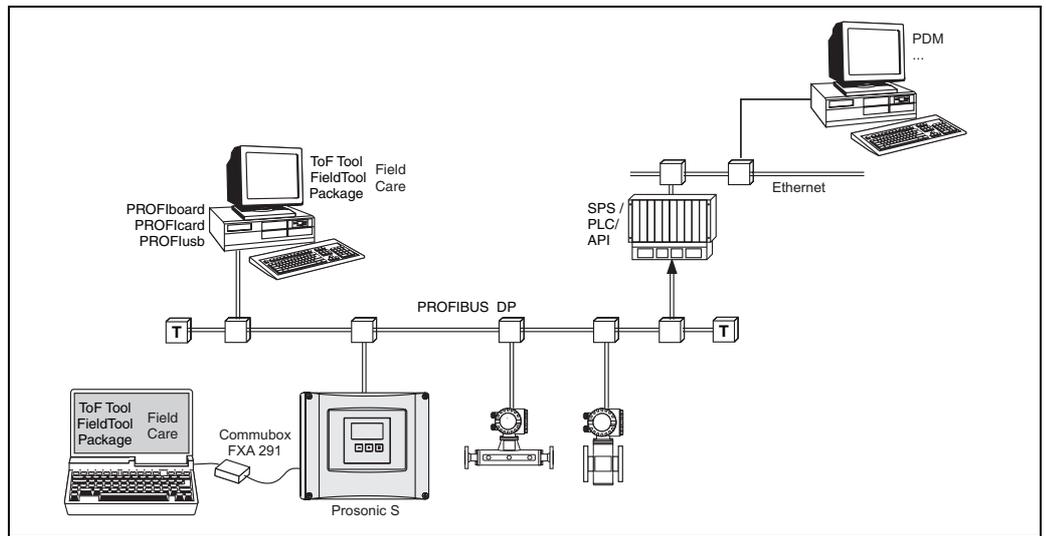
L00-FMU90xxx-14-00-00-xx-010

Operating options

- via the display and operating module at the Prosonic S
- via the service interface with the Commubox FXA291 and the operating program "ToF Tool – FieldTool Package" or "FieldCare"
- via PROFIBUS DP with Profiboard or Proficard and the operating program "ToF Fool – FieldTool Package" or "FieldCare"

Input

Sensor inputs

Depending on the instrument version, 1 or 2 of the sensors FDU90, FDU91, FDU91F, FDU92, FDU93, FDU95 and FDU96 can be connected. The Prosonic S identifies these sensors automatically.

Sensor	FDU90	FDU91 FDU91F	FDU92	FDU93	FDU95	FDU96
max. range[1] in liquids	3 m	10 m	20 m	25 m	-	-
max. range[1] in solids	1.2 m	5 m	10 m	15 m	45 m	70 m

[1] This table gives the maximum range. The range depends on the measuring conditions. For an estimation see Technical Information TI 396F, chapter "Input".

In order to support existing installations, the sensors of the former series FDU8x can be connected as well. The type of sensor must be entered manually.

Sensor	FDU80 FDU80F	FDU81 FDU81F	FDU82	FDU83	FDU84	FDU85	FDU86
max. range[1] in liquids	5 m	9 m	20 m	25 m	-	-	-
max. range[1] in solids	2 m	5 m	10 m	15 m	25 m	45 m	70 m

[1] This table gives the maximum range. The range depends on the measuring conditions. For an estimation see Technical Information TI 189F, chapter "Planning Recommendations".

⚠ Warning!
The sensors FDU83, FDU84, FDU85 and FDU86 with an ATEX, FM or CSA certificate are not certified for connection to the transmitter FMU90.

External limit switches (option)

Optionally, the Prosonic S FMU90 has four inputs for external limit switches (FMU90-********B***).

Switching options
- external passive limit switch (NC/NO switch)
- 0: < 8 V; 1: > 16 V

Usage (examples)
- pump feedback (for FMU90-*3******B***) and FMU90-*4******B***)
- pump tariff control (for FMU90-*3******B***) and FMU90-*4******B***)
- start/stop/reset of daily counters (for flow measurements)
  (for FMU90-*2******B*** and FMU90-*4******B***)
- min/max level detection, e.g. by Liquiphant

External temperature sensor

Optionally, the Prosonic S FMU90 has an input for an external temperature sensor (FMU90-********B***).

Connectable sensors
- Pt100 (3-wire or 4-wire connection)
  A Pt100 with 2-wire connection may not be used due to its insufficient accuracy.
- FMT131(from Endress+Hauser, see chapter "Accessories")

Usage (example)
- Time-of-flight correction for a heated sensor (FDU91-***B*).

Output

Analogue outputs

Number	1 or 2, depending on instrument version
Output signal	configurable at the instrument: ■ 4 ... 20 mA with HART[1] ■ 0 ... 20 mA without HART
Signal on alarm	■ for setting 4 ... 20 mA, selectable: – -10% (3,6 mA) – 110% (22 mA) – HOLD (last current value is held) – user specific ■ for setting 0 ... 20 mA: – 110% (21,6 mA) – HOLD (last current value is held) – user specific
Output damping	freely selectable, 0 ... 1000 s
Load	max. 600 Ω, influence negligible
max. ripple	U_{SS} = 200 mV at 47 ... 125 Hz (measured at 500Ω)
max. noise	U_{eff} = 2,2 mV at 500 Hz... 10 kHz (measured at 500Ω)

1)   The HART signal is assigned to the first analogue output. The second analogue output does not carry a HART signal.

Relay outputs

Number	1, 3 or 6; depending on the instrument version
Type	potential-free relay, SPDT, can be inverted
Assignable functions	■ limit (inband, out-of-band, trend, level limit) ■ counting pulse[1] for flow counting (max. frequency 2 Hz; pulse width adjustable) ■ time pulse[1] (max. frequency 2 Hz; pulse width adjustable) ■ alarm/diagnosis (e.g. indication of backwater[1], sludge[1], echo loss etc.) ■ pump control (alternating/fixed limit/pump rate) ■ for FMU90-*3********** and FMU90-*4**********): additional pump control (standby pump, storm function to avoid unnecessary run times of the pumps, pump function test, flush control to clean pump shafts, operating hours alarm, pump alarm) ■ rake control (difference or relative measurement) ■ fieldbus relay (to be switched direclty from the Profibus DP–bus)
Switching power	■ DC voltage: 35 V_{DC}, 100 W ■ AC voltage: 4 A, 250 V, 100 VA at cosφ = 0,7
State on error	selectable: ■ HOLD (last value is held) ■ energized ■ de-energized ■ present value is used
Behaviour after power failure	switch-on delay selectable
LEDs[2]	A yellow LED on the front panel is allocated to each relay, which lights if the relay is energized. The LED of an alarm relay lights during normal operation. The LED for a pulse relay briefly flashes at every pulse.

1)   for instrument versions with flow software (FMU90 – *2**********)

2)   for instrument versions with display and operating module

PROFIBUS DP interface

Profile	3.0
Transmittable values	■ main value (level or flow, depending on the instrument version) ■ distances ■ counters ■ temperatures ■ average/difference/sum ■ relay states ■ rake control ■ pump control
Function blocks	■ 10 Analog Input Blocks (AI) ■ 10 Digital Input Blocks (DI) ■ 10 Digital Output Blocks (DO)
Supported baud rates	■ 9.6 kbaud ■ 19.2 kbaud ■ 45,45 kbuad ■ 93.75 kbaud ■ 187.5 kbaud ■ 500 kbaud ■ 1.5 Mbaud ■ 3 Mbaud ■ 6 Mbaud ■ 12 Mbaud
Service Access Points (SAPs)	1
ID number 1540 (hex)	1540 (hex) = 5440 (dec)
GSD file	EH3x1540.gsd
Addressing	via dip switches at the instrument or via software (e.g. FieldCare) Default address: 126 per software
Termination	can be activated/deactivated in the instrument
Locking	The device can be locked by hardware or software.

Auxiliary energy

**Supply voltage/
Power consumption/
Current consumption**

Instrument version	Supply voltage	Power consumption	Current consumption
AC voltage (FMU90 – ****A****)	90 ... 253 V_{AC} (50/60 Hz)	max. 23 VA	max. 100 mA at 230 V_{AC}
DC voltage (FMU90 – ****B****)	10,5 ... 32 V_{DC}	max. 14 W (typically 8 W)	max. 580 mA at 24 V_{DC}

Galvanic isolation

The following terminals are galvanically isolated from each other:
■ auxiliary energy
■ sensor inputs
■ analogue output 1
■ analogue output 2
■ relay outputs
■ bus connection (PROFIBUS DP)

Fuse

■ 2 A T /DC
■ 400 mA T /AC

accesible in the terminal compartment

Electrical connection

Terminal compartment of the field housing

The field housing has a separate terminal compartment. It can be opened after loosening the four screws of the lid.
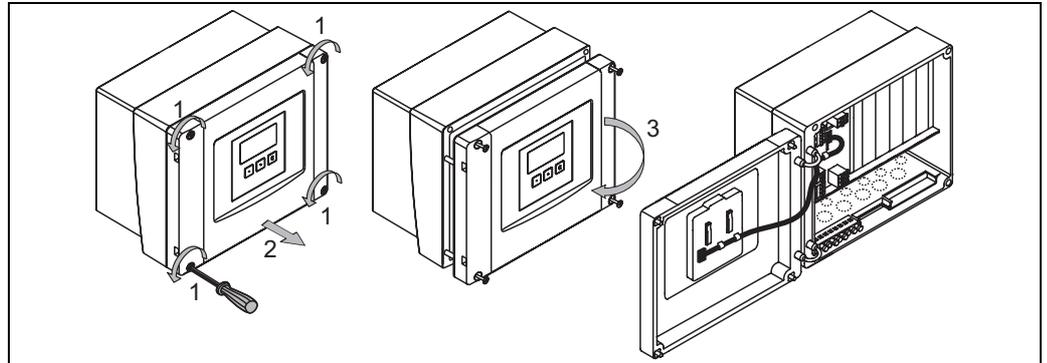
L00-FMU90xxx-04-00-00-xx-002

For easier wiring, the lid can be completely removed by unplugging the display plug (1) and loosening the hinges (2):
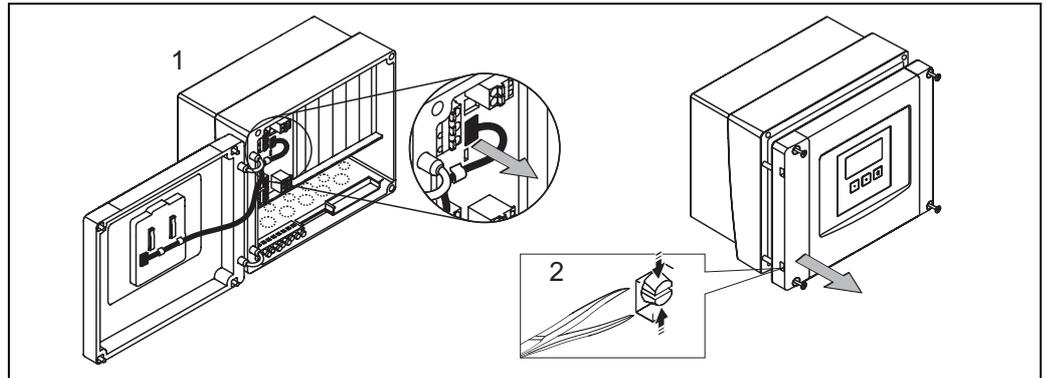
L00-FMU90xxx-04-00-00-xx-009

Cable entries of the field housing

On the bottom of the housing the following openings for cable entries are prestamped:
- M20x1,5 (10 openings)
- M16x1,5 (5 openings)
- M25x1,5 (1 opening)

A suitable cutting device must be used for cutting out the openings.

Terminal compartment of the DIN-rail housing

Single instrument
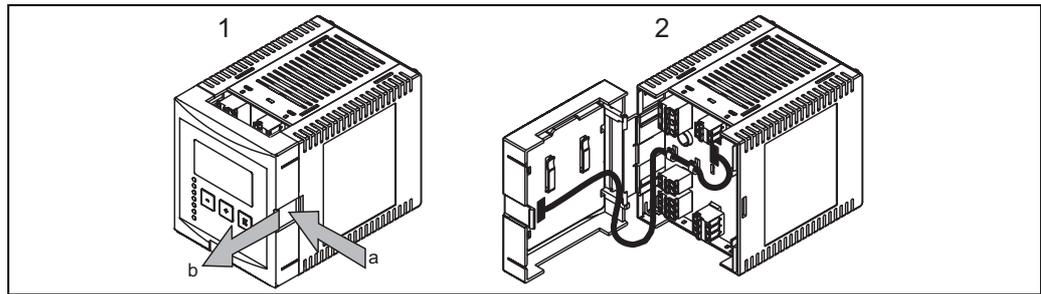
i00-fmu90xxx-04-00-00-xx-003

The catch can be unlocked by slightly pressing onto the clip. Then, the cover of the terminal compartment can be opened.

Several instruments mounted side by side
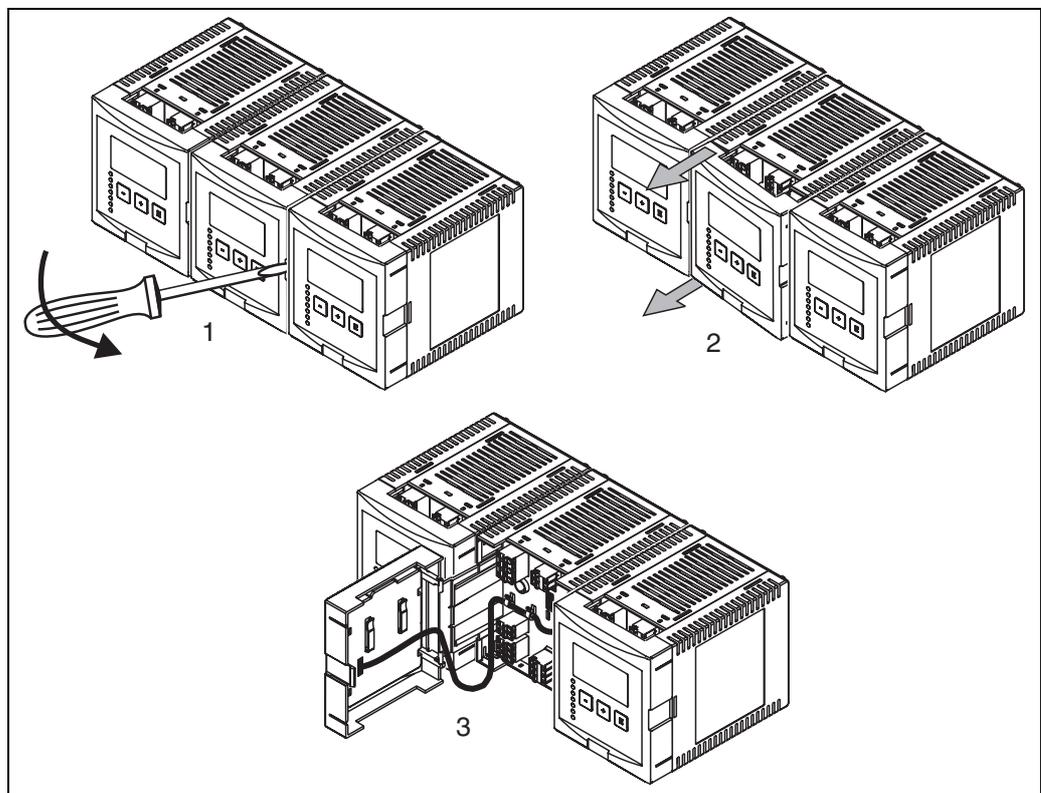
L00-FMU90xxx-04-00-00-xx-012

1.   Open the catch of the cover (e.g. by a screwdriver).

2.   Pull the cover out by approx. 2 cm.

3.   The cover can now be opened.

✎   Note!
   ▪ The cables can be inserted into the housing from above or from below.
   ▪ The pictures show the smallest housing version but are valid for the larger versions as well.
   ▪ If the instruments are mounted next to each other and if the sensor cables run in parallel, the synchronization terminals (39 and 40) must be interconnected (see sections "Terminal assignment" and Synchronization line").

Terminal assignment

Pluggable spring–force terminals for connection of the cables are supplied in the terminal compartment. Rigid conductors or flexible conductors with cable sleeve can directly be inserted and are contacted automatically.

Conductor cross section	$0,2 \text{ mm}^2 - 2,5 \text{ mm}^2$
Cable and sleeve cross section	$0,25 \text{ mm}^2 - 2,5 \text{ mm}^2$
min. stripping length	10 mm

The terminal configuration depends on the instrument version ordered. There is a basic terminal area, which is present in every instrument version. Additonal optional terminal areas are only present if the respective option has been selected in the product structure.

Terminal area		present for the following instrument versions
Basic area	A	for all versions
Optional areas	B	for instrument versions with 2 sensor inputs and/or 2 analogue outputs (FMU90 – *****2****** and/or FMU90 – *******2****)
	C	for instrument versions with 3 or 6 relays (FMU90 – ******3***** oder FMU90 – ******6*****)
	D	for instruments with external switch inputs and external temperature input (FMU90 – ********B***)
	E	for instrument versions with PROFIBUS DP interface (FMU90 – *******3****)

L00-FMU90xxx-04-00-00-xx-001
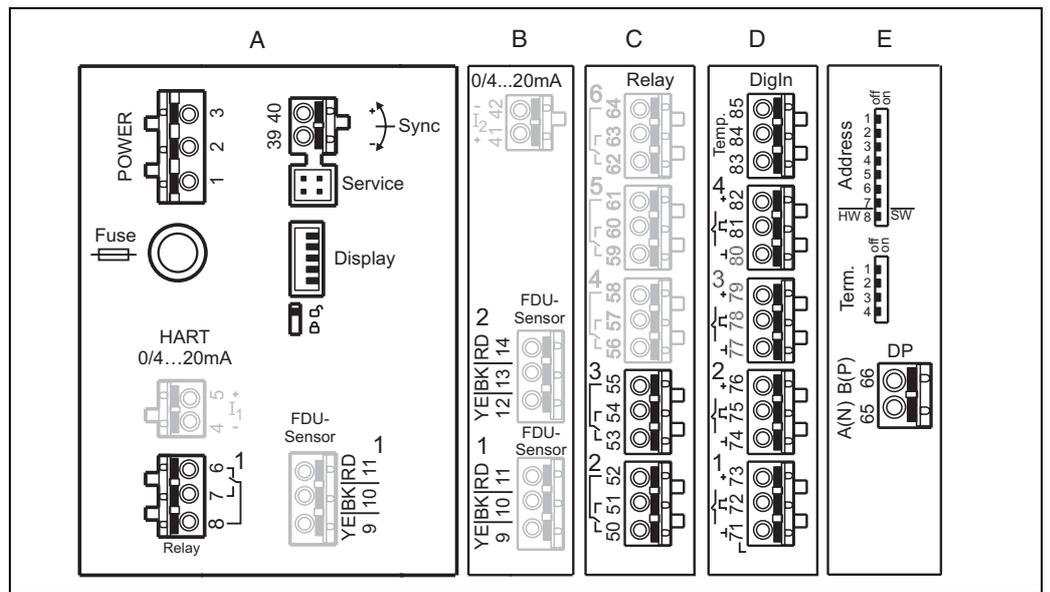
Terminals of the Prosonic S; the terminals depicted in grey are not present in every instrument version.
A: *Basic terminal area;* **B–E:** *Optional terminal areas (present if the respective option has been selected in the product structure)*

✎ Note!
The depicted switching states of the relays refer to the de–energized state.

Terminals	Meaning	Terminal area	Remarks
Auxiliary energy			
1, 2	▪ L (für AC version) ▪ L+ (for DC version)	A	depending on instrument version: ▪ 90 ... 253 V_{AC} ▪ 10,5 ... 32 V_{DC}
2	▪ N (for AC version) ▪ L- (for DC version)	A	
3	Potential equalization	A	
Fuse		A	depending on instrument version: ▪ 400 mA T (for AC) ▪ 2 A T (for DC)
Analog outputs (not available for Profibus DP instruments)			
4, 5	Analog output 1; 4 ... 20 mA with HART/ 0 ... 20 mA w/o HART	A	**not** present for the PROFIBUS DP version
41, 42	Analog output 2 (optional); 4 ... 20 mA/ 0 ... 20 mA	B	only for the version with two analog outputs; no HART signal at this output
Relay outputs			
6, 7, 8	Relay 1	A	
50, 51, 52	Relay 2 (optional)	C	only for the versions with 3 or 6 relays
53, 54, 55	Relay 3 (optional)	C	only for the versions with 3 or 6 relays
56, 57, 58	Relay 4 (optional)	C	only for the version with 6 relays
59, 60, 61	Relay 5 (optional)	C	only for the version with 6 relays
62, 63, 64	Relay 6 (optional)	C	only for the version with 6 relays
Bus communication (only available for Profibus DP instruments)			
65	PROFIBUS A (RxT/TxD – N)	D	only for the PROFIBUS DP version
66	PROFIBUS B (RxT/TxD – P)	D	
Synchronization			
39, 40	Synchronization	A	see section 4.6, "Synchronization line"
Level inputs			
9 (YE), 10 (BK), 11 (RD)	Sensor 1 (FDU8x/9x) YE: yellow strand BK: black strand RD: red strand	▪ A: for versions with 1 sensor input ▪ B: for versions with 2 sensor inputs[1]	
12 (YE), 13 (BK), 14 (RD)	Sensor 2 (FDU8x/9x) (optional) YE: yellow strand BK: black strand RD: red strand	B	only for the version with 2 sensor inputs
external switch inputs			
71, 72, 73	external switch input 1	D	0: < 8 V or 72 and 73 interconnected 1: > 16 V or 72 and 73 not interconnected
74, 75, 76	external switch input 2	D	0: < 8 V or 75 and 76 interconnected 1: > 16 V or 75 and 76 not interconnected
77, 78, 79	external switch input 3	D	0: < 8 V or 78 and 79 interconnected 1: > 16 V or 78 and 79 not interconnected
80, 81, 82	external switch input 4	D	0: < 8 V or 81 and 82 interconnected 1: > 16 V or 81 and 82 not interconnected
temperature input			
83, 84, 85	temperature input: ▪ PT100 ▪ FMT131 (Endress+Hauser)	D	see section "Connection of a temperature sensor"

1) In this case, terminals 9/10/11 are not present on terminal area A.

⚠ Warning!
When using the public supply mains, an easily accesible power switch must be installed in the proximity of the device. The power switch must be marked as a disconnector for the device (IEC/EN 61010)

✎ Note!
- In order to avoid interference signals, the sensor cables should not be laid parallel to high voltage or electric power lines.
- The cables may not be laid in the proximity to frequnecy converters.

Additional elements on the terminal areas

Designation	Meaning/Remarks
Fuse	Fuse: 2 A T /DC or 400 mA T/AC
Display	Connection of the display or the remote display and operating module
Service	Service interface for connection of a PC/Notebook via Commubox FXA291
🔒	Locking switch
Term.	Bus termination (only applicable for instruments with PROFIBUS interface)
Address	Bus address (only applicable for instruments with PROFIBUS interface)

Terminals

Pluggable spring–force terminals for connection of the cables are supplied in the terminal compartment. Rigid conductors or flexible conductors with cable and sleeve can directly be inserted and are contacted automatically.

Conductor cross section	0,2 mm^2 - 2,5 mm^2
Cable and sleeve cross section	0,25 mm^2 - 2,5 mm^2
min. stripping length	10 mm

Connection of the sensors FDU9x
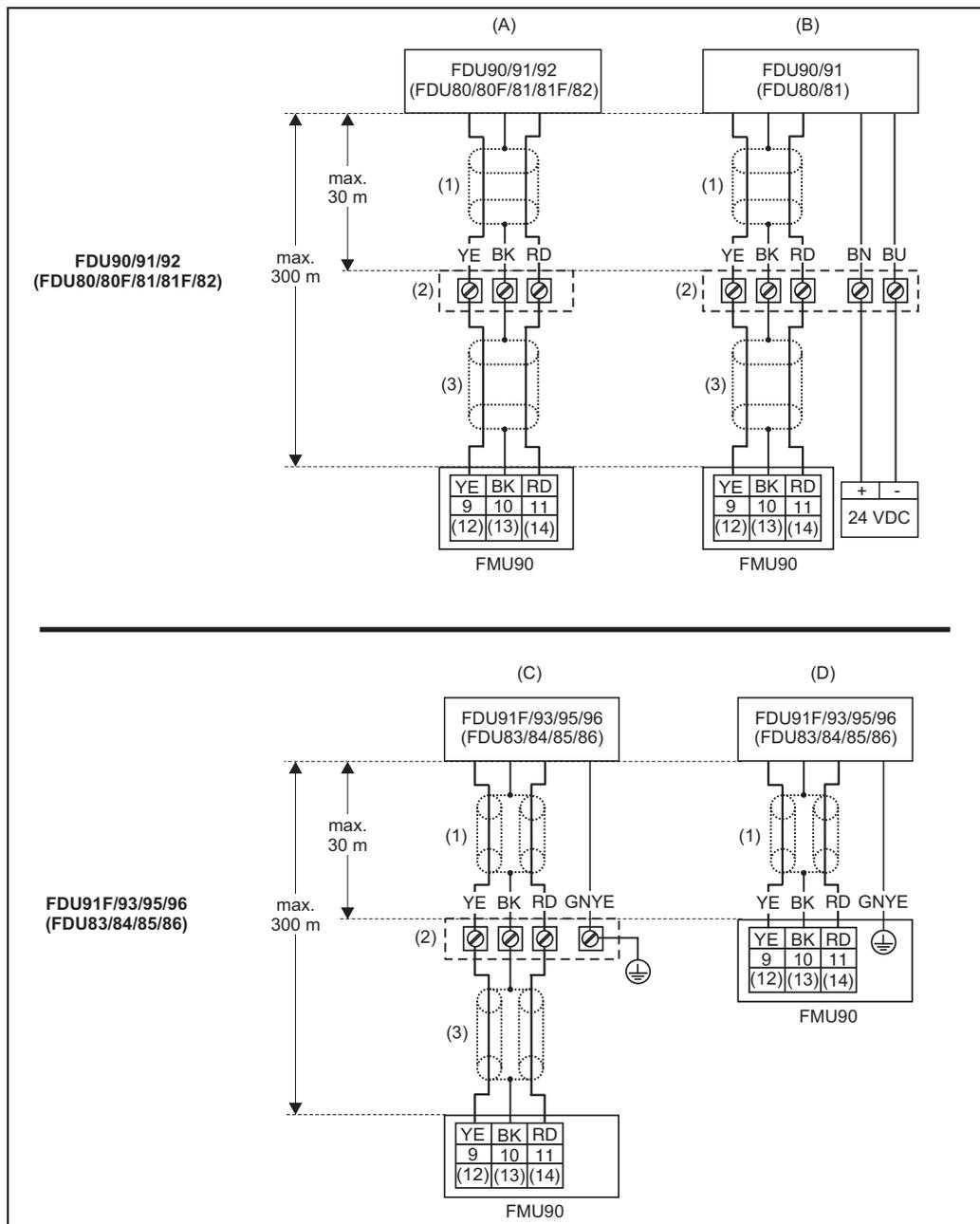
(A):*without sensor heater;*
(B):*with sensor heater;*
(C):*grounding at the terminal box;*
(D):*grounding at the transmitter FMU90;*
(1):*Screen of the sensor cable;*
(2):*Terminal box;*
(3):*Screen of the extension cable;*
Colours of the strands: YE = yellow; BK = black; RD = red; BU = blue; BN = brown; GNYE = green-yellow

For details refer to Technical Information TI 396F (FDU9x) or TI189F (FDU8x).

Synchronization line	- If wiring several Prosonic S (FMU90/FMU95) which are mounted in a common cabinet and if the sensor cables run in parallel, the synchronization terminals (39 and 40) must be interconnected. - Up to 20 instruments can be synchronized in this way. - If there are more than 20 instruments, groups must be formed, each containing a maximum of 20 instruments. For the instruments within each group, the sensor cables may run in parallel. The sensor cables of different groups must be seperated from each other. - Usual commercial screened cable can be used for synchronization - max. length: 10 m between the individual instruments - cross section: 2 x (0.75 - 2.5 mm^2) - for lengths up to 1 m, an unscreened cable can be used; for lenghts exceeding 1 m, screening is required. The screen must be connected to ground - Instruments of the Prosonic FMU86x family can be connected to the synchronization line as well. In this case a maximum of 10 instruments can be connected to each synchronisation line.

L00-FMU90xxx-04-00-00-xx-004

L00-FMU90xxx-04-00-00-xx-017
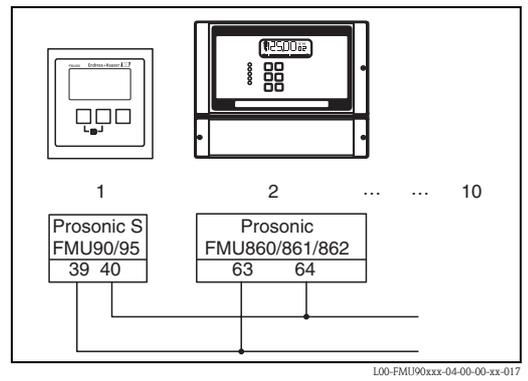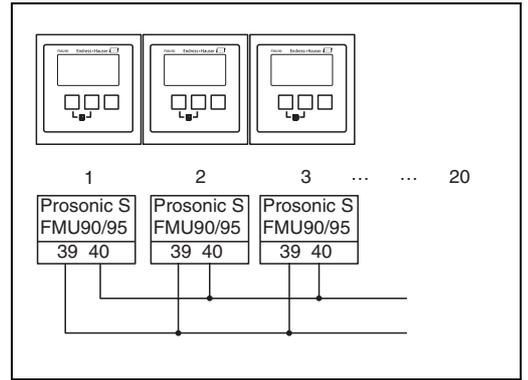
Connection of the separate display and operating module

L00-FMU90xxx-04-00-00-xx-005
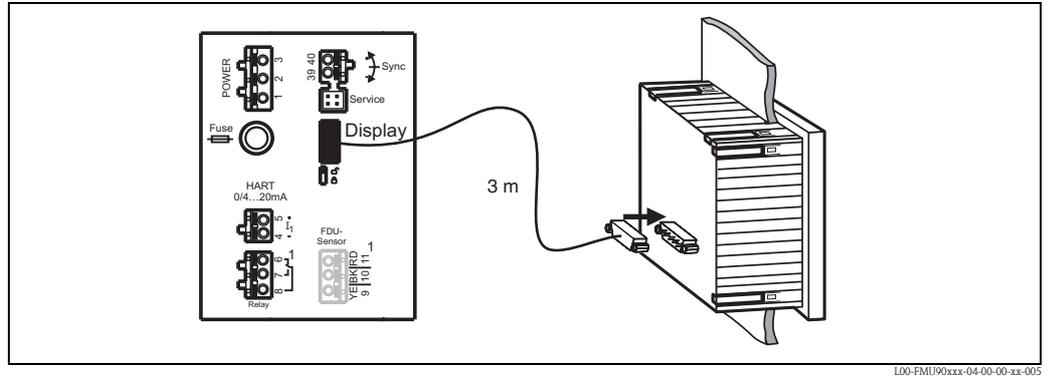
For the version of the Prosonic S with a separate display for panel mounting, a pre-assembled connecting cable (3 m) is supplied. The cable must be connected to the display plug of the Prosonic S.

✎ Note!
Minimum diameter for cable bushing: 2 cm

Connection of external switches
(for FMU90-******B***)**

A

FMU90

⊥   ⊓   +
A   B   C

24 V

FTL   ⊥

PNP

B

FMU90

⊥   ⊓   +
A   B   C

24 V

A: 71, 74, 77, 80
B: 72, 75, 78, 81
C: 73, 76, 79, 82

L00-FMU90xxx-04-00-00-xx-021
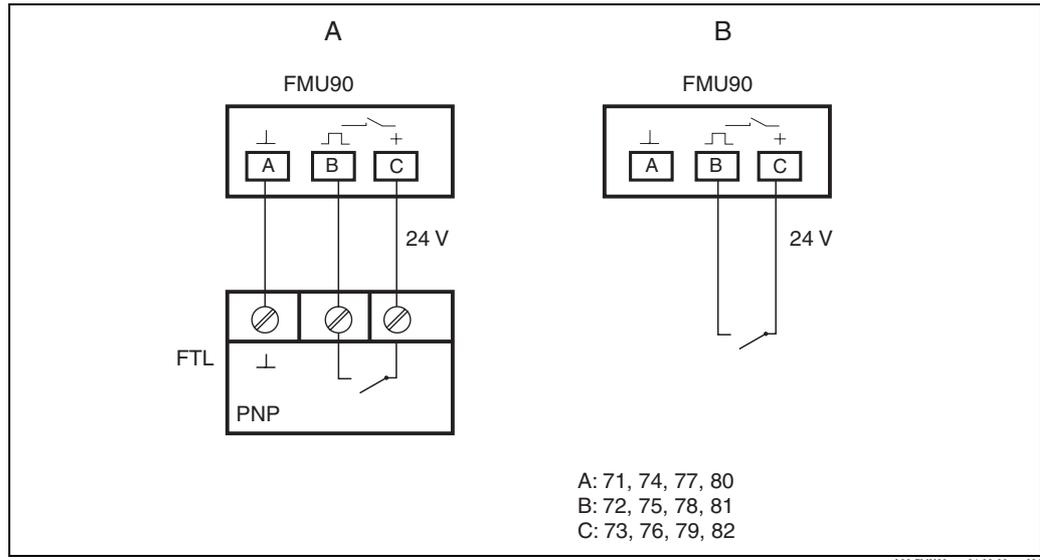
The maximum short–circuit current at 24 V is 20 mA.

Connection of a temperature sensor

The Prosonic S FMU90 transmitter has an optional input for an external temperature probe (in the product structure: feature 90 "Additional input", option B). The following probes can be connected:

- a FMT131 temperature probe from Endress+Hauser
- a Pt100 temperature probe

Note!
After connecting an external temperature sensor, the following is required:

1. The type of the connected sensor (Pt100 or FMT131) must be selected in "sensor management/ext. temp. sensor" in the "sensor type" parameter.

2. The external temperature sensor must be assigned to an ultrasonic sensor in "sensor management/FDU sensor/US sensor N" in the "temp. measurement" parameter.

Note!
If the option "alarm" has been selected for the case of an error in external temperature sensor, this alarm is indicated by the alarm relay.

FMT131 (Endress+Hauser)
(connectable to FMU90–*****B***)**

L00-FMU90xxx-04-00-00-xx-019
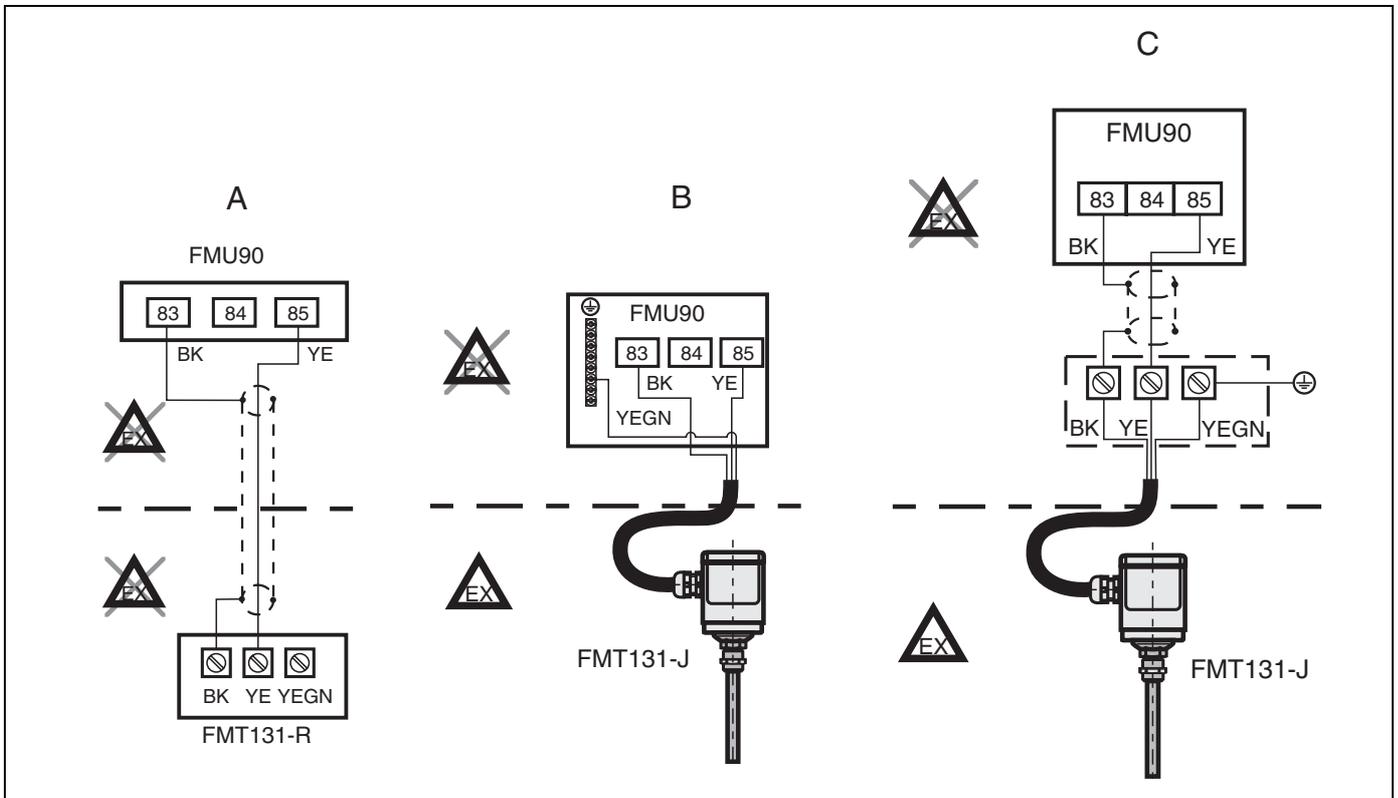
A: *Non-Ex area (FMT131-R);* B: *Ex area (FMT131-J) with grounding in the FMU90;*
C: *Ex area (FMT131-J) with crounding at a terminal box*
BK: *black;* YE: *yellow;* YEGN: *yellow-green*

Note!
For details refer to the Operating Instructions KA019F.

Pt100
(connectable to FMU90-******B***)**

L00-FMU90xxx-04-00-00-xx-020
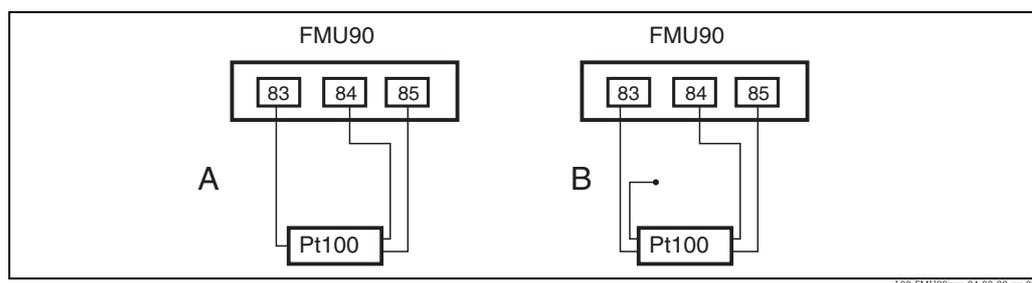
A: Pt100 with 3-wire connection; B: Pt100 with 4-wire connection (one connector remains unused)

Note!
A Pt100 with 2-wire connection may not be used due to its insufficient measuring accuracy.

Warning!
A Pt100 may not be connected in explosion hazardous areas. A FMT131 must be used instead.

Performance characteristics

Reference operating conditions

- Temperature = 24±5 °C
- Pressure = 960±100 mbar
- Relative humidity = 60±15 %
- Ideally reflecting surface, sensor vertically aligned
  (e.g. calm, plane liquid surface of 1 m^2)
- No interference echoes within the signal beam
- Settings of the application parameters:
  – tank shape = flat ceiling
  – medium property = liquid
  – process condition = calm surface

Measuring uncertainty[5]

±0,2 % of the maximum span of the sensor

Typical accuracy[6]

±2 mm + 0,17 % of the measured distance

Measured value resolution

1 mm with FDU91

Measuring frequency

max. 3 Hz
The exact value depends on the settings of the application parameters and the instrument version.

Note!
The maximum measuring frequency is obtained for "empty E" ≤ 2 m and "process condition" = "test: no filter".

Influence of the vapor pressure

The vapor pressure at 20 °C (68 °F) gives a hint on the accuracy of the ultrasonic level measurement. If the vapor pressure at 20 °C (68 °F) is below 50 mbar, ultrasonic level measurement is possible with a very high accuracy. This is valid for water, aqueous solutions, water-solid-solutions, dilute acids (hydrochloric acid, sulfuric acid, ...), dilute bases (caustic soda, ...), oils, greases, slurries, pastes, ...
High vapor pressures or outgassing media (ethanol, acetone, ammonia, ...) can influence the accuracy. If conditions like these are present, please contact the Endress+Hauser support.

5) according to NAMUR EN 61298-2
6) after calibration

Ambient conditions

Ambient temperature	–40 ... 60 °C The functionality of the LC display becomes restricted at $T_U < -20$ °C. If the device is operated outdoors in strong sunlight, a protective cover should be used (s. chapter "Accessories").
Storage temperature	–40 ... 60 °C
Climate class	▪ **Field housing:** according to DIN EN 60721-3 4K2/4K5/4K6/4Z2/4Z5/4C3/4S4/4M2 (DIN 60721-3 4K2 corresponds to DIN 60654-1 D1) ▪ **Housing for DIN rail mounting:** according to DIN EN 60721-3 3K3/3Z2/3Z5/3B1/3C2/3S3/3M1 (DIN 60721-3 3K3 corresponds to DIN 60654-1 B2)
Vibration resistance	▪ Housing for DIN rail: DIN EN 600068-2-64 / IEC 68-2-64; 20 ... 2000 Hz; 0,5 $(m/s^2)^2/Hz$ ▪ Field housing: DIN EN 600068-2-64 / IEC 68-2-64; 20 ... 2000 Hz; 1,0 $(m/s^2)^2/Hz$
Ingress protection	▪ Field housing: IP66 / NEMA 4x ▪ Housing for DIN rail: IP20 ▪ separate display: – IP65 / NEMA 4 (front panel , if mounted in cabinet door) – IP20 (rear panel, if mounted in cabinet door)
Electromagnetic compatibility (EMC)	▪ Interference emmission to EN 61326; Equipment class A ▪ Interference immunity to EN 61326; Annex A (Industrial) and NAMUR recommendation EMC (NE21)

Mechanical construction

Housing versions
- Field housing; optionally with integrated display and operating module
- Housing for top–hat rail mounting; optionally with intergrated display and operating module
- Housing for top–hat rail mounting with separated display and operating module for cabinet door mounting

Dimensions of the field housing

L00-FMU90xxx-06-00-00-xx-001
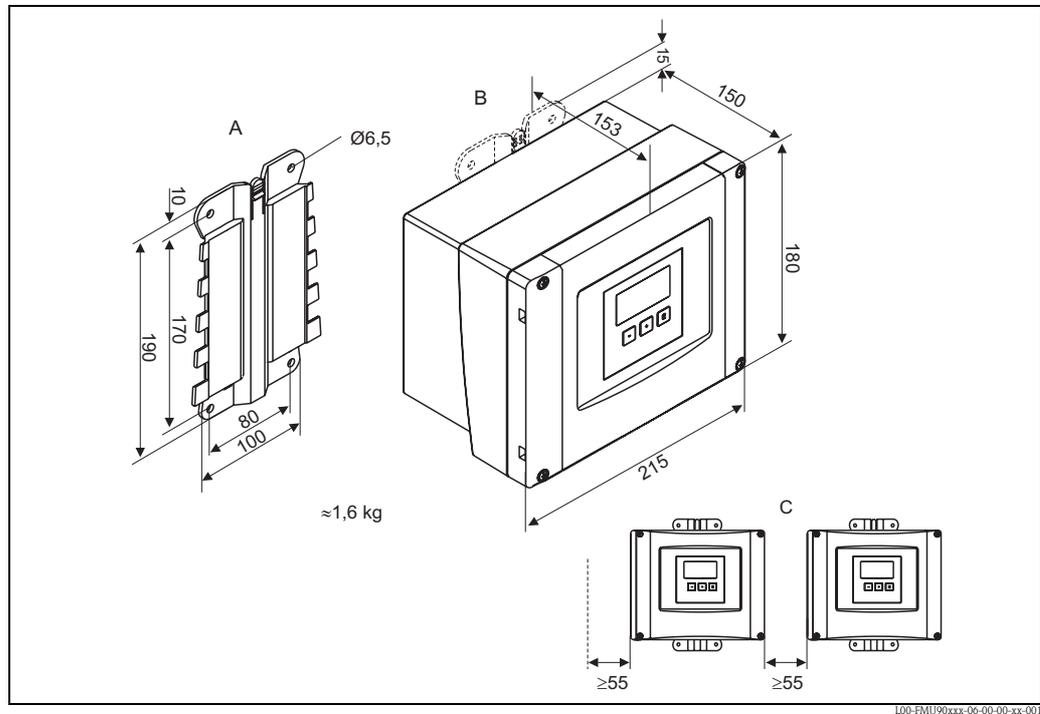
Dimensions in mm
A: *Mounting help (supplied); can also be used as drilling template ;* **B:** *Field housing;* **C:** *minimum mounting distance*

The dimensions of the field housing are the same for all instrument versions.
To open the housing, a minimum mounting distance of 55 mm is required on the left.

Note!
The mounting help must be mounted on a plane surface and must not become bent. Otherwise the mounting of the field housing may be difficult or impossible.

Dimensions of the DIN-rail housing

The dimensions of the DIN-rail housing depend on the instrument version. The version determines, which terminal areas the Prosonic S contains. The dimensions are influenced by the following features of the product structure (see chapter 2.3):
- 60: Level Input
- 70: Switch Output
- 80: Output

In order to determine the dimensions of a specific version, perform the following steps (see the example on page 24):

1. Using the product structure, determine the options of the features 60, 70 and 80 of the instrument version in question.

	10	20	30	40	50	**60**	**70**	**80**	**90**	100	110	120
FMU90 –												
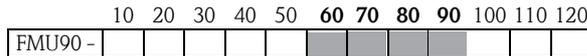
2. Using the following table, determine how many optional terminal areas this instrument version contains.

Feature and option of the product structure	corresponds to the following terminal area	present? yes = 1 no = 0
feature 60; option 2 and/or feature 80, option 2	2 sensor inputs and/or 2 analogue outputs	
feature 70, option 3 or 6	3 o 6 relays	
feature 80, option 3	PROFIBUS DP interface	
feature 90, option B	inputs for external switches and external temperature sensor	
	Sum =	

3. The appropriate dimensions are given in the following diagram:

Sum = 0
(only basic terminal area)

Sum = 1, 2 or 3
(1–3 optional terminal areas)
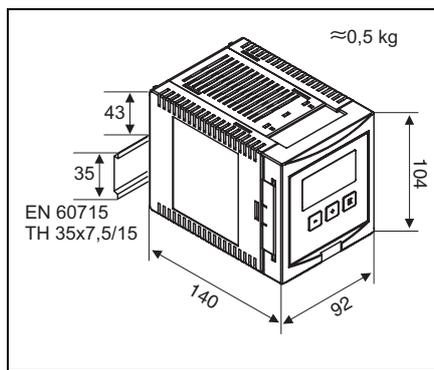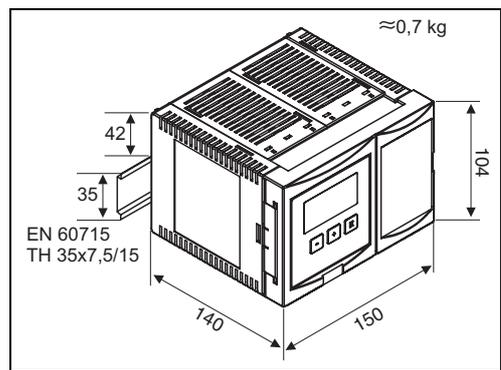
Dimensions in mm

Dimensions in mm

Sum = 4
(4 optional terminal areas)

≈0,9 kg

104

43

35

EN 60715
TH 35x7,5/15

210

140

L00-FMU90xxx-06-00-00-xx-009
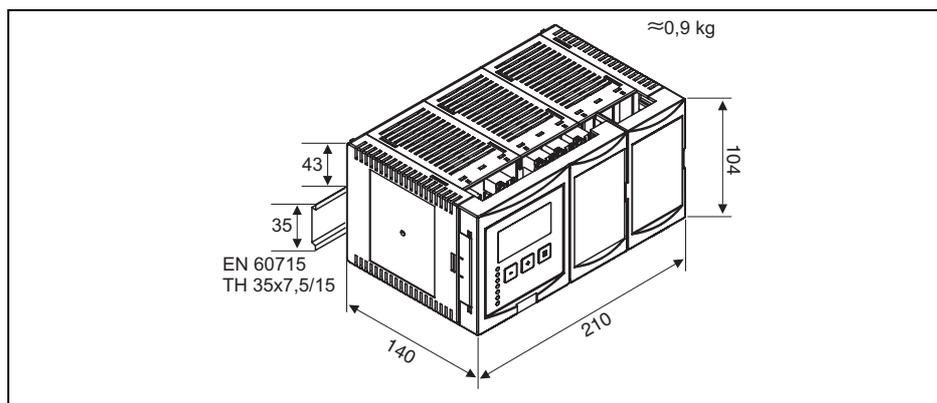
Dimensions in mm

Example

	10	20	30	40	50	**60**	**70**	**80**	**90**	100	110	120
FMU90 -	R	1	2	A	A	2	3	2	A	A	1	A

feature and option of the product structure	corresponds to the following terminal area	present?
feature 60; option 2 and/or feature 80, option 2	2 sensor inputs and/or 2 analogue outputs	1 (yes)
feature 70, option 3 or 6	3 or 6 relays	1 (yes)
feature 80, option 3	PROFIBUS DP interface	0 (no)
feature 90, option B	inputs for external switches and external temperature sensorr	0 (no)
	Sum =	2

Sum = 2
=> 104 mm x 150 mm x 140 mm

Dimensions of the separate display and operating module
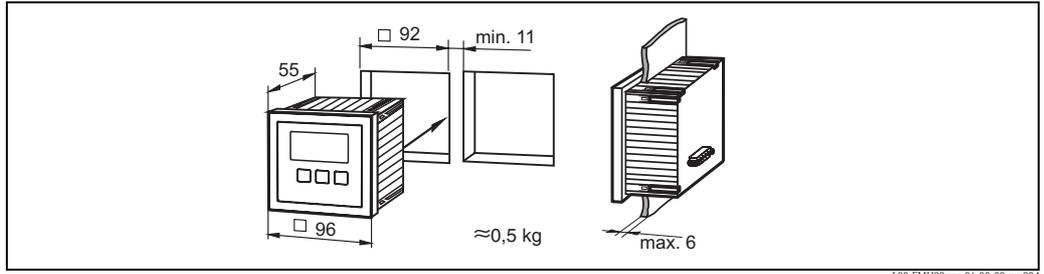
Dimensions in mm

Weight

Housing version	Weight
Field housing	approx.. 1,6 ... 1,8 kg; depending on instrument version
Housing for DIN rail	approx. 0,5 ... 0,7 kg; depending on instrument version (s. section: "Dimensions of the DIN-rail housing")
separate display and operating module	approx. 0,5 kg

Materials

- Field housing: PC
- Housing for DIN rail: PBT

Human interface

Display and operating module

L00-FMU90xxx-07-00-00-xx-002

(a): *name of the parameter;* **(b):** *value of the parameter, including unit;* **(c):** *display symbols;* **(d):** *softkey symbol;* **(e):** *LED indicating the operating state;* **(f):** *LEDs indicating the switching states of the relays;* **(g):** *keys*

Display (Examples)
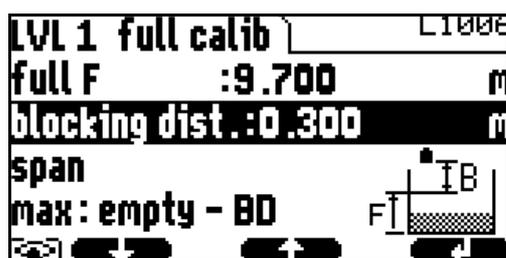
L00-FMU90xxx-07-00-00-en-041

Display of a function including help text and descriptive graphic
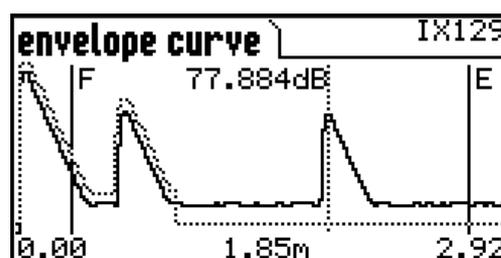
L00-FMU90xxx-19-00-00-en-089

Display of the envelope curve including the mapping. The level echo and the empty distance are marked.

Keys (softkey operation)

The function of the keys depends on the current position within the operating menu (softkey functionality). The key functions are indicated by softkey symbols in the bottom line of the display.

LEDs

- 1 LED (a) indicates the operating state ("normal operation", "alarm" or "warning")
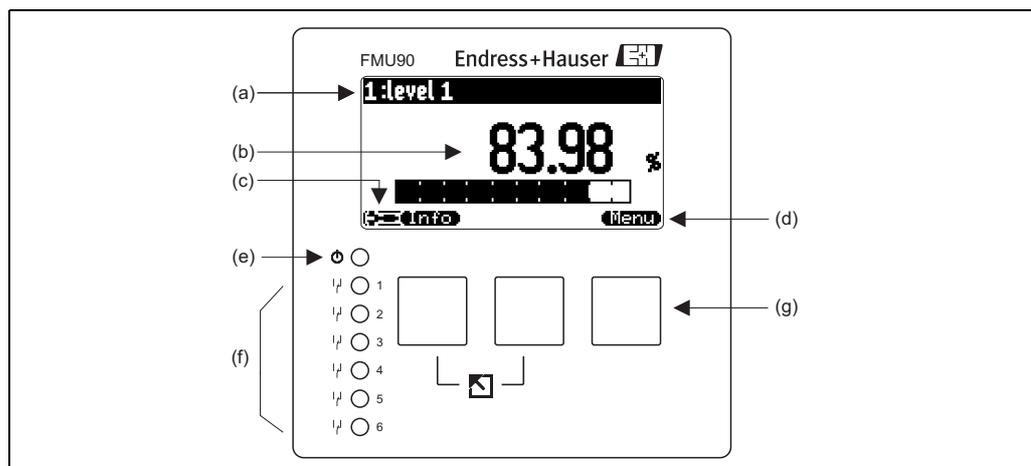- 6 LEDs (b) indicate the switching state of the relays (LED glows if the respective relay is energised)

Illuminated display

An illuminated display is available as an option (s. feature 40 of the product structure)

Operating menu

The Prosonic S has got a dynamical operating menu. Only those functions are visible which are relevant for the instrument version and installation environment at hand.

Basic setup

The operating menu contains basic setups for easy commissioning of level and flow measurements. The basic setups guide the user through the complete commissioning procedure.

Locking of the instrument

The instrument can be locked against parameter changes in the following ways:
- Locking switch in the terminal compartment
- Key combination at the operating module
- Input of a locking code via software (e.g. "ToF Tool" or "FieldCare")

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.

Ex approval

The available certificates are listed in the ordering information. Note the associated safety instructions (XA) and control or installation drawings (ZD).

Measuring systems for use in hazardous environments are accompanied by separate "Ex documentation", which is an integral part of this Operating Manual. Strict compliance with the installation instructions and ratings as stated in this supplementary documentation is mandatory.

- Ensure that all personnel are suitably qualified.
- Observe the specifications in the certificate as well as national and local standards and regulations.

The transmitter may only be installed in suitable areas.
Sensors with a certificate for hazardous areas may be connected to a transmitter without a certificate.

Warning!
For FM approvals:
Unauthorized substitution of components may impair the suitability for Division 1 or Division 2.

Warning!
Do not disconnect equipment unless the area is known to be non-hazardous.

Note!
The sensor must be installed and used in a way that eliminates any danger. Possible installation positions: in tanks, vessels, silos, over stockpiles, open channels, weirs or other bins.

Note!
Sensors FDU9x with Ex-approval can be connected to the transmitter FMU90 without Ex-approval.

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

US Standard UL 61010-1

CSA General Purpose Units FMU9x-N*********** are tested according to US standard UL 61010-1, 2nd eedition

Ordering information

Product structure

10												Approval
	R											Non-hazarous area
	J											ATEX II 3D
	N											CSA General Purpose

20												Application
		1										Level + pump control, alternating
		2										Flow + totalizer + level + sample control + preprogrammed OCM flow curves
		3										Level + additional pump control
		4										Universal instrument (Level + Flow + Additional pump control)

30												Housing, material
			1									Field mounting PC, IP66 NEMA 4x
			2									DIN rail mounting PBT, IP20

40												Operation
				C								Illuminated display + keypad
				E								Illuminated display + keypad, 96x96, panel mounting, front IP65
				K								w/o display, via communication

50												Power supply
					A							90-253 VAC
					B							10,5-32 VDC

60												Level input
						1						1x sensor FDU9x/8x
						2						2x sensor FDU9x/8x

70												Switch output
							1					1x relay, SPDT
							3					3x relay, SPDT
							6					6x relay, SPDT

80												Output
								1				1x 0/4-20mA HART
								2				2x 0/4-20mA HART
								3				PROFIBUS DP

90												Additional input
									A			w/o additional input
									B			4x limit switch + 1x temperature PT100/FMT131

100												Datalog function
										A		Basic version

110												Languages
											1	de, en, nl, fr, es, it, pt
											2	en, ru, pl, cs
											3	en, zh, ja, ko, th, id

120												Additional option
												A	Basic version

FMU90 –												complete product designation

(*): meaning of the language code:
cs: Czech; de: German; en: English; es: Spanish; fr: French; id: Bahasa (Indonesia, Malaysia); it: Italian; ja: Japanese; ko: korean; nl: Dutch; pl: Polish; pt: Portuguese; ru: Russian; th: Thai; zh: Chinese

Scope of delivery

- Instrument according to the version ordered
- Operating program: ToF Tool – FieldTool Package
- Operating Instructions (depending on communication version, see chapter "Supplementary documentation")
- for certified instrument versions: Safety Instructions (XAs) or Control Drawings (ZDs) (s. chapter "Supplementary documentation")
- field housing units for flow measurement FMU90–*21********* are delivered with 2 screws for plombing the device

Accessories

|	
Commubox FXA191 HART	For intrinsically safe communication with ToF Tool/FieldCare via the RS232C interface. For details refer to TI237F/00/en.
Commubox FXA195 HART	For intrinsically safe communication with ToF Tool/FieldCare via the USB interface. For details refer to TI404F/00/en.
Commubox FXA291	For intrinsically safe communication with ToF Tool/FieldCare via the service interface (IPC) of the instrument and the USB interface of a PC/Notebook. Ordering Code: 51516983

Protection cover for the field housing

- Material: 316Ti/1.4571
- is mounted by the mounting help of the Prosonic S
- Order-Code: 52024477
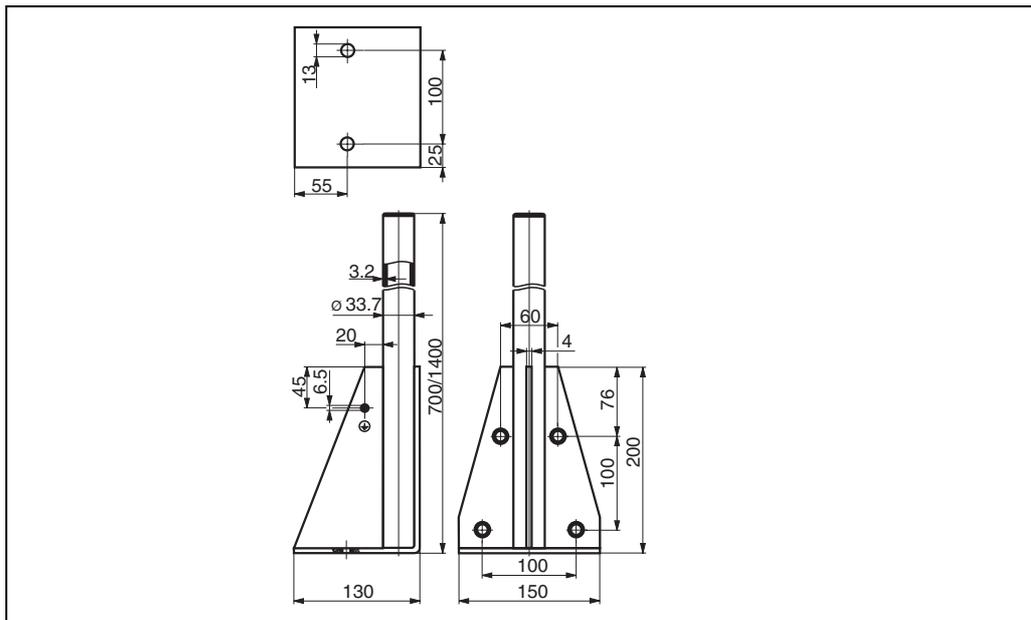

L00-FMU90xxx-06-00-00-xx-003
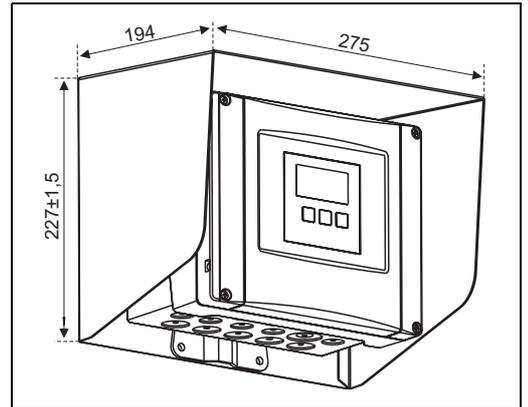
Mounting plate for the field housing

- suited for the mounting help of the Prosonic S
- for 1" – 2" tubes
- Dimensions: 210 mm x 110 mm
- Material: 316Ti/1.4571
- fixing clips, screws and nuts are supplied
- Order code: 52024478

L00-FMU90xxx-00-00-00-xx-001
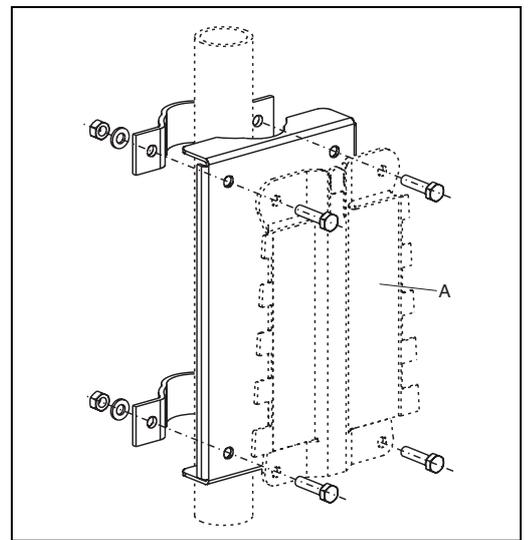
A: *mounting help of the field housing*

Mounting bracket

L00-FMU4x-00-00-00-yy-005

| Height	Material	Order Code
700 mm	galv. steel	919791-0000
700 mm	316 Ti	919791-0001
1400 mm	galv. steel	919791-0002
1400 mm	316 Ti	919791-0003

Adaption plate for remote display

Used to mount the remote display into the opening (138 mm x 138 mm) of the remote display module of the Prosonic FMU860/861/862 (Display size: 144 x 144 mm).

Order-Code: 52027441

✎ Note!
The adapter plate will be mounted directly in the old remote display of the FMU86x series. The housing of the remote display of FMU860/861/862 is the holder for the adapter plate and the new remote display of the FMU90/95 in the format 96x96 mm.
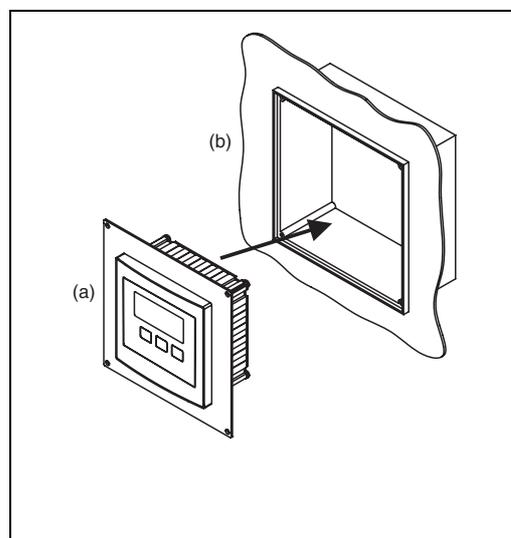
L00-FMU90xxx-00-00-00-xx-001

(a): *remote display of the Prosonic S with adaption plate;*
(b): *opening of the remote display FMU860/861/862*

Option:
Adaption plate 160x160 mm, thickness 3mm, aluminum, opening 92x92 mm for remote display of the FMU90 (size of the display: 96 x 96 mm).
Can be used to replace the FMU86x remote display or DMU2160/2260.
Order Code: TSPFU 0390
Please contact your Endress+Hauser representative.

**Overvoltage protection
HAW56x**

Application examples

| Measurement signal	Measurement point requirements	Connection diagram

• Current output 1
  0/4 to 20 mA
• Current output 2
  0/4 bis 20 mA
 	
Transducer Prosonic S FMU90 with 2 Prosonic FDU9x sensors
	• 2 x HAW560 + 562
	  for 0/4 to 20 mA output signal
	• 2 x HAW561
	  for power supply to the transducer
	• 2 x HAW560 + 566
	  for the sensor signal
	  Use gas discharge tube for indirect shield earthing.
		
		G09-HAW56xxx-04-10-xx-en-009

• Current output
  0/4 to 20 mA
 	
Prosonic S FMU90 transducer with Prosonic FDU9x level measurement sensors
	• 1 x HAW560 + 562
	  for 0/4 to 20 mA output signals
	• 2 x HAW561
	  for power supply to the transducers
	• 1 x HAW560 + 566
	  for the sensor signal
	  Use gas discharge tube for indirect shield earthing.
		
		G09-HAW56xxx-04-10-xx-en-010

Measurement signal	Measurement point requirements	Connection diagram
▪ no current output (only relay outputs) Prosonic S FMU90 transducer with Prosonic FDU9x level measurement sensor	▪ 1 x HAW560 + 1 x HAW566 for sensor signal. Use gas discharge tube for indirect shield earthing. ▪ 2 x HAW561 for power supply	G09-HAW56xxx-04-10-xx-en-008

✎ Note!
HAW560 with the HAW562 module can also be used to protect the signal line of the external temperature probe FMT131 (Ex or Non–Ex version).

Electrical connection

*Power supply: HAW561 and 561K*

G09-HAW56xxx-04-10-xx-xx-001
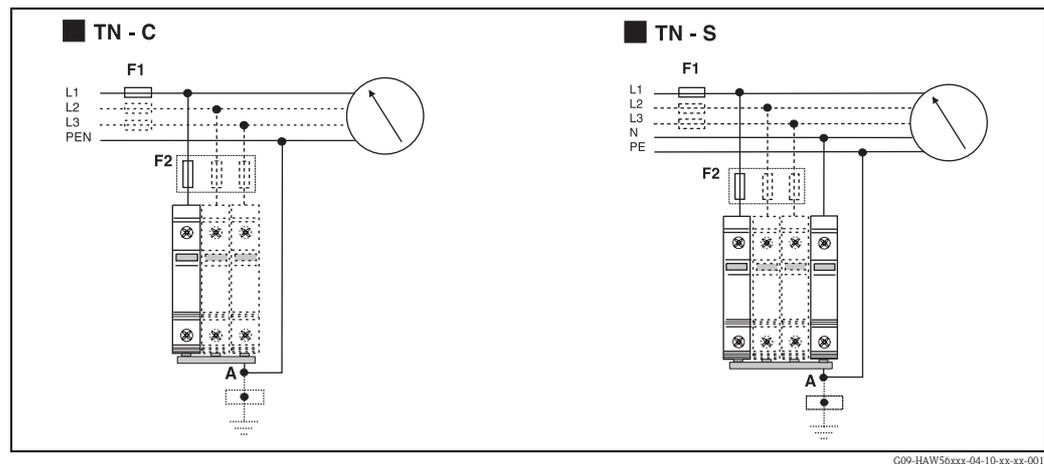
A fixed allocation of the phase and ground terminal is not allocated (pole security). The unit is fitted on both ends with a multi function connection terminal. This gives the opportunity to simultaneously connect a cable as well as a fork ferrule from standard busbars.
Connection of the unit is as in the diagram above. Dependent on the cabling, up to four units will be required.

Sensor signal: HAW560 with HAW566
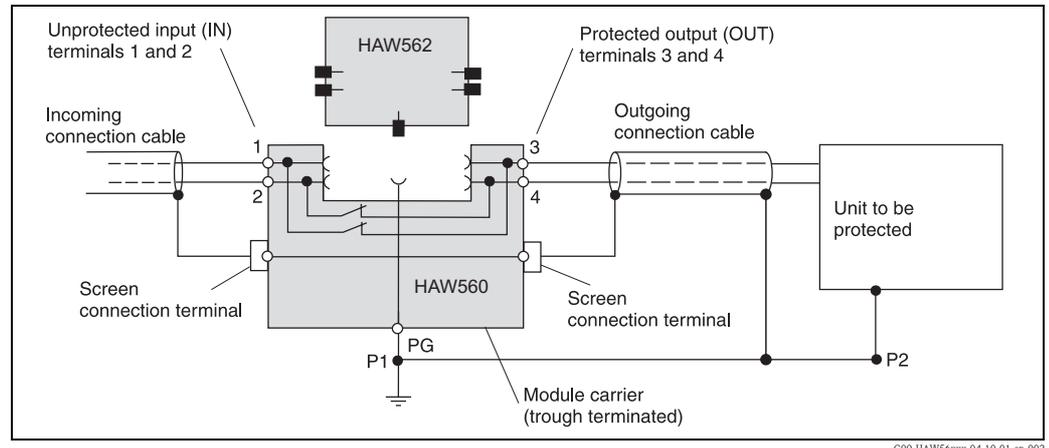

G09-HAW56xxx-04-10-01-en-001
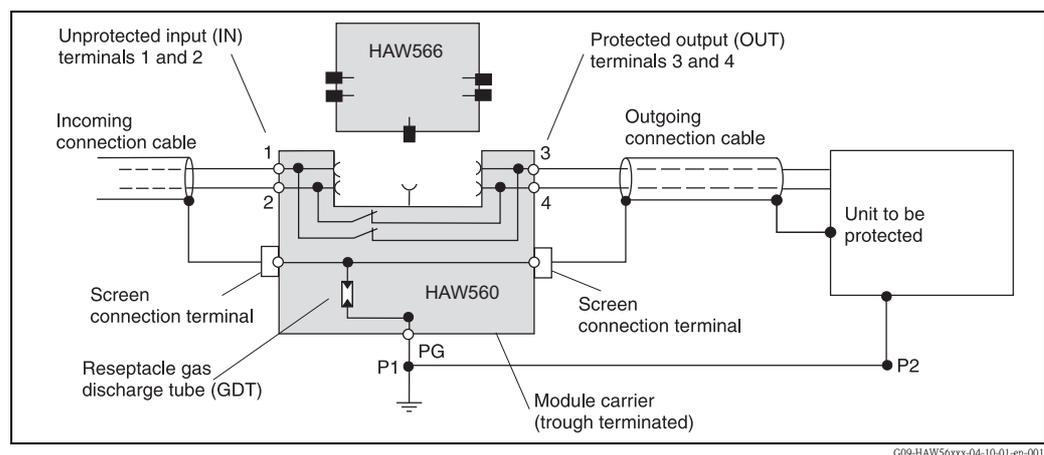
Connection of the unit as in the diagram. The ground connection is made using the DIN rail.
For indirect screening (as required if connecting the Prosonic S signal line to an HAW566) a gas–discharge arrester is supplied. It must be inserted into the provided plug-in bay on the HAW560:
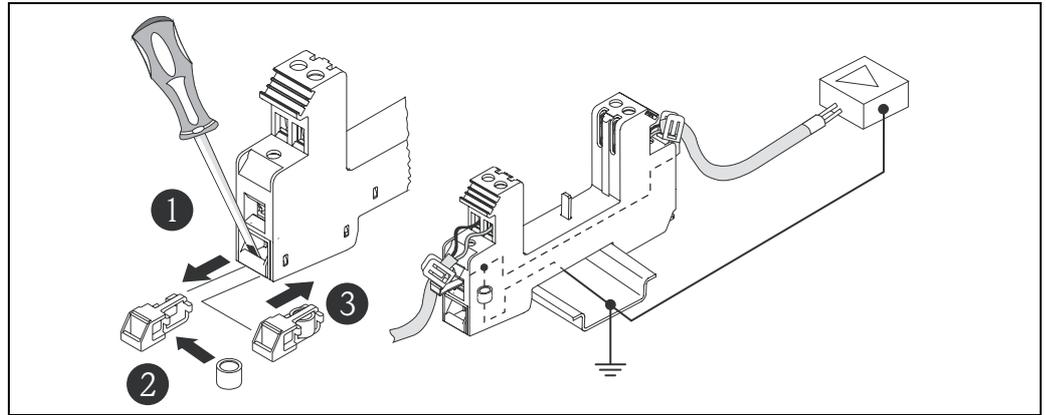
G09-HAW566xx-11-10-xx-xx-000

Output signal


G09-HAW56xxx-04-10-01-en-002

Connection of the unit as in the diagram. The ground connection is made using the DIN rail.

Product overview

Oreder code	Unit
51003569	**Surge arrester HAW561K** For low voltage users 24/48V, single pole, requirement class C, basic component with plugged in protection unit, defect display, 18 mm housing width
51003570	**Surge arrester HAW561** For standard voltage users 115/230 V, single pole, requirement class C, basic component with plugged in protection unit, defect display, 18 mm housing width
51003571	**Surge arrester module carrier HAW560** Two pole through terminated for fitting surge arrester modules for units in information technology, 12 mm housing width, colour grey
51003572	**Surge arrester module HAW562** For protection of 2 single lines, e.g. 2 asymmetrical single lines, e.g.: 0/4 to 20 mA, Profibus PA, 12 mm housing width, colour grey
51003573	**Surge arrester module HAW565** For protection of 2 single lines, e.g. 2 asymmetrical single lines with high frequency signal transmission, e.g.: Profibus DP, RS 485, 12 mm housing width, colour grey
51003574	**Surge arrester module carrier HAW560Z** Two pole through terminated for fitting surge arrester modules for units in information technology in Ex areas, 12 mm housing width, colour blue
51003575	**Surge arrester module HAW562** For protection of 2 single lines, e.g. 2 asymmetrical single lines in Ex areas, e.g.: 0/4 to 20 mA, Profibus PA, 12 mm housing width, colour blue
71028875	**Surge arrester module HAW566** Protection for 2 signal inputs, e.g. 2 asymmetrical inputs, e.g. Prosonic S signal 12 mm housing with, colour grey

For details see Technical Information TI093R.

Temperature sensor FMT131
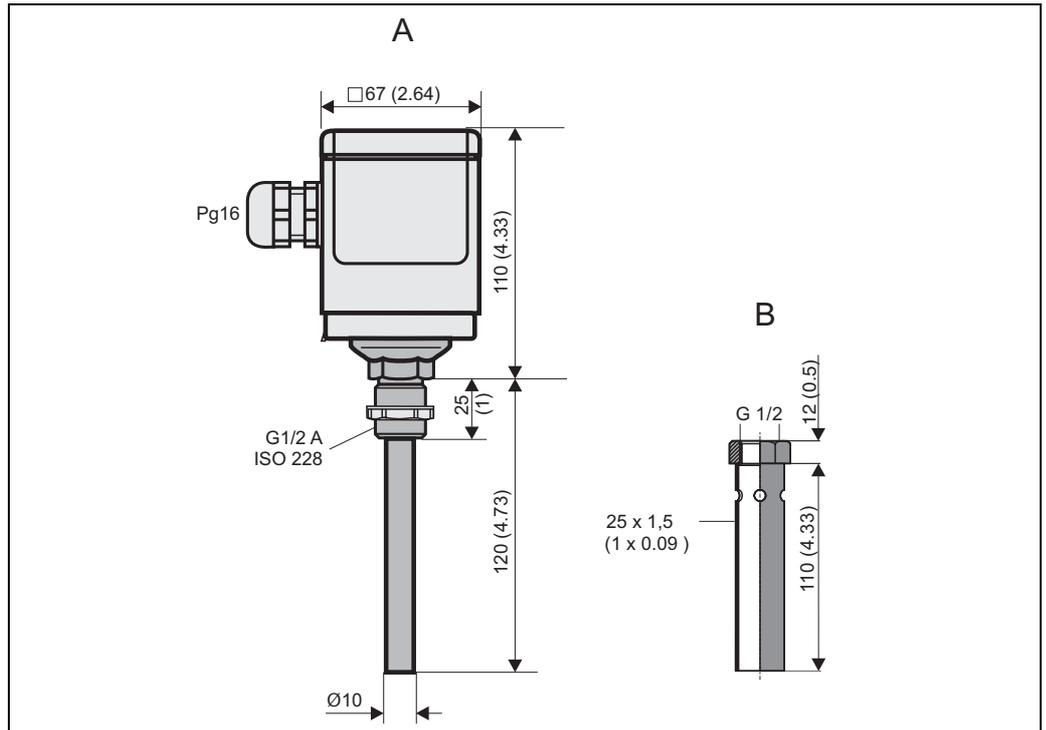
L00-FMU90xxx-00-00-00-xx-002

A: Temperature sensor FMT131; B: weather protector

Product structure

010		Approval
	R	Non-hazardous area
	J	ATEX II 2G EEx m II T6/T5
	Q	FM Cl.I Div. 1 Gr. A-D
	U	CSA General Purpose
	S	CSA Class I Div. 1

020		Cable length
	1	5 m/16 ft
	2	10 m/ 32 ft
	3	15 m/49 ft
	4	20 m/65 ft
	5	25 m/82 ft
	6	30 m/98 ft
	7	w/o cable, gland Pg16, IP66
	8	... m
	A	... ft

FMT131 –			complete product designation

Weather protection cover for FMT131
Order code: 942046-0000

Supplementary documentation

| Innovation booklet | **IN 003** |
| | Ultrasonic measurement – the solution for your application |

| Technical Information | **TI 396F** |
| | Technical Information for the ultrasonic sensors FDU90/FDU91/FDU91F/FDU92/FDU93/FDU95/FDU96 |

Operating instructions (for transmitter FMU90)

Depending on the instrument version, the following operating instructions are supplied with the Prosonic S FMU90:

Operating instructions	Output	Application	Instrument version
BA 288F	HART	▪ level measurement ▪ alternating pump control ▪ screen and rake control	FMU90 – *******1**** FMU90 – *******2****
BA 289F		▪ flow measurement ▪ backwater and dirt detection ▪ totalizers and counters	FMU90 – *2*****1**** FMU90 – *4*****1**** FMU90 – *2*****2**** FMU90 – *4*****2****
BA 292F	PROFIBUS DP	▪ level measurement ▪ alternating pump control ▪ screen and rake control	FMU90 – *******3****
BA 293F		▪ flow measurement ▪ backwater and dirt detection ▪ totalizers and counters	FMU90 – *2*****3**** FMU90 – *4*****3****

These operating instructions describe installation and commissioning of the respective version of the Prosonic S. It contains those functions from the operating menu, which are required for a standard measuring task. Additional functions are contained in the "Descripiton of Instrument Functions" (BA 290F, see below).

Description of Instrument Functions

BA290F

contains a detailed description of **all** functions of the Prosonic S and is valid for all instrument versions. A PDF file of this document can be found
- on the CD-ROM of the "ToF–Tool – FieldTool Package", which is supplied together with the instrument
- in the internet at "www.endress.com"

| Safety Instructions | **XA326F** |
| | Safety Instructions for ATEX II 3D |

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