

Ultrasonic Measurement *prosonic FMU 860...862*

Level and flow measurement with ultrasonics
Simple to start up, easy to use, flexible
Field mounted ultrasonic transmitters



The Prosonic ultrasonic transmitter in the IP 66 protective housing

Applications

Prosonic FMU 860...862 ultrasonic transmitters are for use with the Prosonic FDU 80...86 family of sensors.

The transmitter determines levels in silos and tanks and calculates the volume of solids and liquids they contain.

With the appropriate certified sensor, measurements can be made in explosion hazardous areas, zone 1 or in combustible dusts.

When used for applications in fresh and waste-water, Prosonic measures

- flow rates in flumes and weirs
- water levels

and can control screen cleaning and pumps.

Features and Benefits

A customised instrument programme for the specific application.

Choice of transmitters

- For the field or control room
- Single or two-channel versions with three or five relays, also with optional totaliser
- With optional serial interface for remote configuration (INTENSOR or HART protocol)
- With RS-485 interface

Intelligent commissioning, ultrasonic measurement par excellence

- Instrument parameters arranged in a simple matrix
- Various linearisation functions, totalisers, and all common Q/h curves on call
- Quick commissioning and stable measurement thanks to signal pattern recognition by fuzzy logic and the application parameter

Endress + Hauser

The Power of Know How



Measuring System

Measuring System

The measuring system consists of the Prosonic transmitter with a Prosonic sensor chosen according to the application at hand. The two-channel version is for differential measurement or for controlling two measuring points. The certified sensor ensures that the measuring system can be used in explosion hazardous areas. Other units can be connected to the Prosonic transmitter for special applications:

- separate temperature sensor, e.g. if the ultrasonic sensor is heated
- separate external limit detector.

The Prosonic transmitter can be integrated into automation systems using the RS-485 interface (see page 5...6).

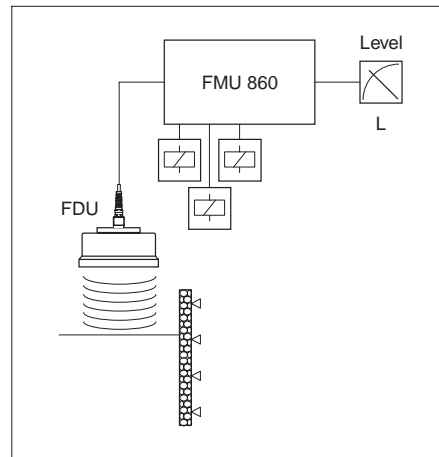
Transmitters and Applications

Prosonic FMU 860 for continuous level and volumetric measurement of liquids and solids in tanks and silos.

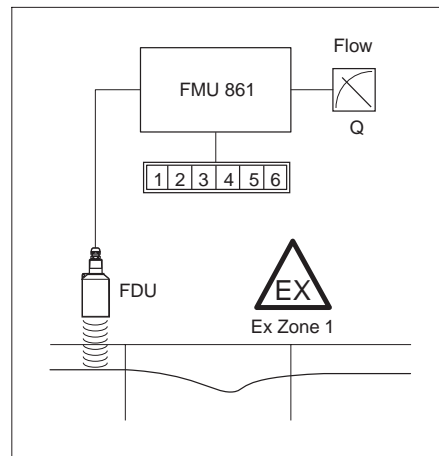
Prosonic FMU 861 for flow rate measurement in flumes and weirs.

Prosonic FMU 862 two-channel version for:

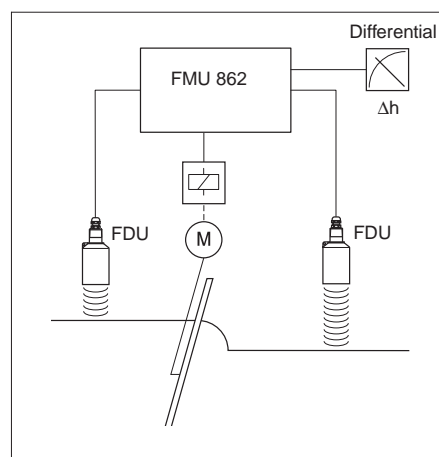
- measurement of flow rate or level on channel 1 and level measurement only on channel 2 or
- differential or average measurement (On request: FMU 862 D version for distance measurement between two sensors).



Level measurement for pump control



Flow measurement



Differential measurement for cleaning control

Prosonic FMU 860

Water level measurement, e.g. for controlling water inflow and outflow, or for pump control in up to 5 stages. Also:

- alternating pump control,
- adjustable switch delay.

Prosonic FMU 861

Flow rate measurement in flumes or weirs to determine water level with millimeter accuracy.

The linearisation curves of all common standard flumes and weirs are preset and can be called up as required. For the version with IP 66 housing, the amount flowing through is summated and displayed by the totaliser. Also:

- low flow cut-off,
- separate display of floodwater on external counters,
- sample control using a quantity or time function.

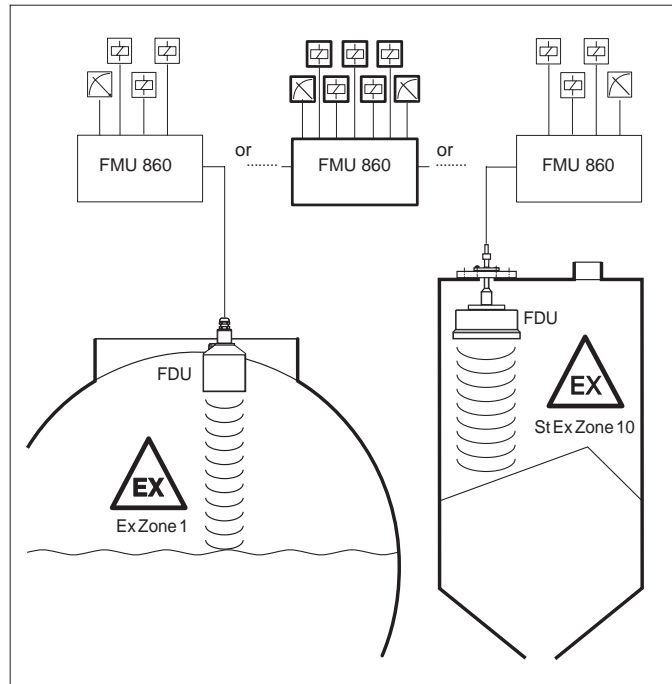
Prosonic FMU 862

The two-channel unit is used for differential level measurement, e.g. for controlling the screen cleaning process as a function of clogging. Also:

- superimposed interval timer,
- trend indication,
- back water alarm.

Back water in weirs is detected, signalled and the flowrate automatically adjusted.

Level measurement in a tank or a silo. The FMU 862 two-channel version is used to collect data from individual measuring points.



Prosonic FMU 860

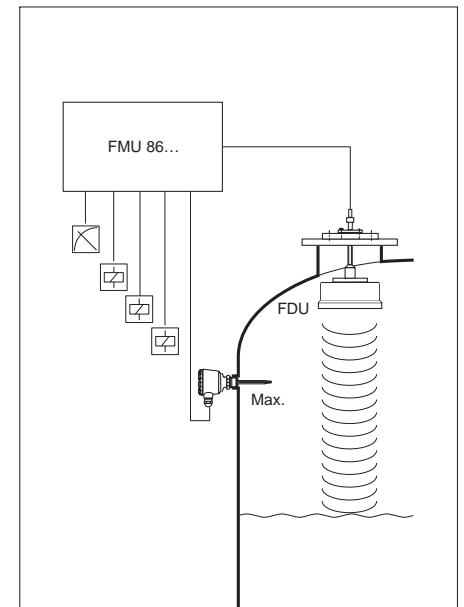
Ultrasonic measurement in a silo or tank. Non-contact level measurement with no maintenance even under poor conditions.

Prosonic FMU 862

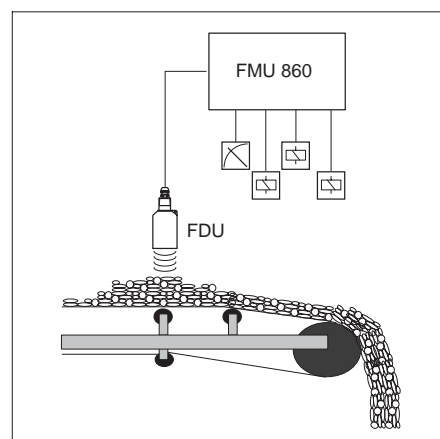
The two-channel version is especially cost-effective. When the five relay version is used to operate two measuring points, for example, a maximum and minimum switchpoint can be allocated to each channel. The alarm relay signals any abnormal operation.

Prosonic FMU 86...

Double protection against overflow: all Prosonic transmitters have an additional connection for an external limit detector. Even when the level moves within the blocking distance of the sensor, this is promptly indicated by the display, the signal output and relays.



All Prosonic transmitters have an input for an external limit switch.



Example of ultrasonic measurement for monitoring belt loads

Prosonic FMU 860

Installation on conveyor belts: rapid changes in load height are easily dealt with by the Prosonic FMU 860.

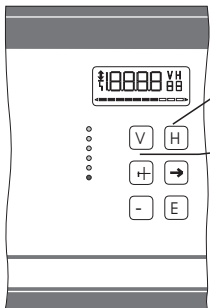
Operation and Signal Processing

Principle of Operation

An ultrasonic pulse emitted from the sensor is reflected back by the surface of the material or liquid and is received by the same sensor as an echo signal. The product height or water level is then calculated from the run time of the ultrasonic signal (echo level determination).

Simple Operation

The keypad on the front panel is used to configure the transmitter and call up parameters, which are shown on a 4 1/2 character display. Input dialogue is based on the standard Endress+Hauser operating matrix in which every input field is quickly and easily selected using the »V« (vertical) and »H« (horizontal) keys. Parameters are simply entered using the three keys »-«, »+«, »→« and are registered and stored once the »E« key has been pressed.



Only a few input steps are required for calibrating all standard applications.

Measured value	Empty calibration	Full calibration	Application	Sensor type
Relay selection	Relay function	Switch-on point	Switch-off point	Pump control
Linearisation	Preset height	Q/h char. curve	Level	Volume
Fixed target suppress.	Echo attenuation	S/N factor	Warning/ Fault	Output with fault

Intelligent Software with Fuzzy Logic Elements

The Prosonic transmitter is based on state-of-the-art evaluation methods including fuzzy logic elements for intelligent echo analysis. No other special procedures are required as this method enables the true level echo to be clearly distinguished from:

- sporadic reflections (e.g. from agitator blades),
- interference echoes and noise (e.g. from filling) or
- multiple reflections (e.g. with closed tanks).

Even with almost unfavorable mounting points, the advantages of continuous, non-contact ultrasonic measurement can be used by activating a special fixed target suppression mode or filtering factor.

Simple Start-Up

The time required for start-up is minimised by using preset operating parameter values. Selecting just one parameter automatically sets the measuring line to one of five typical applications.

- liquid
- vessels with rapid changes of liquid
- fine-grained bulk solids
- coarse-grained bulk solids
- conveyor belts

Complete Functionality

- For level measurement
The characteristic curve is already programmed for volumetric measurement in a horizontal cylinder. The linearisation curve of any vessel can be easily entered (maximum 32 points). The Prosonic FMU 862 also has a differential measurement mode

(Value 1 – Value 2)

or average value mode

$$\frac{(\text{Value 1} + \text{Value 2})}{2}$$

- For flow rate measurement
All common Q/h characteristic curves for measuring flow rates with flumes and weirs are stored in the Prosonic. Other Q/h curves can be entered (up to a maximum of 32 points). Three different programmable counting pulses for totalising can be sent to the relay outputs for controlling external counters. The transmitter itself has a resettable software counter: a non-resettable totaliser is available as an option.

Remote Operation

Handheld Terminal

Operating the Prosonic transmitter is even easier if it is connected via a serial interface. All values can then be entered using a handheld terminal. The user has comprehensive and detailed information on inputs both on-site and in the control room. The measurement remains totally unaffected during the interactive input. Two different handheld terminals are available:

- Commulog VU 260 Z is used with the serial interface for the INTENSOR protocol. It can be connected to all Endress+Hauser instruments with an INTENSOR protocol.
- Universal HART communicator via the serial interface with the HART protocol (Type C).

Electrical Connection

A minimum resistance must be present in the circuit for correct transmission of the communications signal to take place (see Technical Data).

The handheld terminal is connected either

- directly to current output 1 of the transmitter or
- to a communications resistor.

In general: The handheld terminal can be connected anywhere in the signal circuit as long as there is a resistance between its terminals which is larger than the minimum communications resistor.

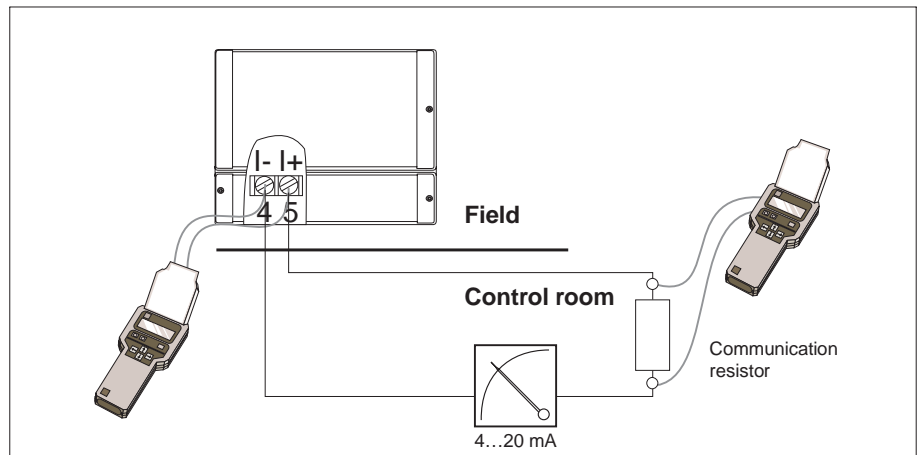
Technical Data

Maximum load: 600 Ω

Communications resistor: 250 Ω

Screened cable recommended, maximum capacitance 100 nF.

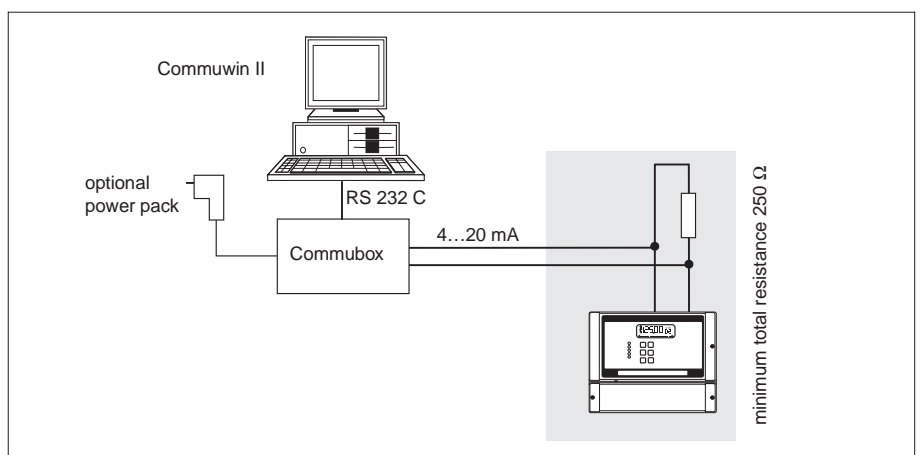
Connection of handheld terminals Commulog VU 260 Z (INTENSOR) and Universal HART Communicator DXR 271 (HART) in the field and in the control room.



Operation via Commuwin II

The Commubox FXA 191 connects intrinsically safe Smart transmitters that have an INTENSOR- or HART protocol to the RS 232 C serial interface of a personal computer. This enables the transmitter to be remotely operated with the Endress+Hauser Commuwin II operating program.

Connecting the Commubox



System Integration

Other System Components with an RS-485 Rackbus interface

Hardware

- For connecting to a personal computer via an RS-485 card or RS-232C/RS-485 adapter.
- For connecting to the Rackbus via the FXA 675 interface card.

Software for the personal computer

- Fieldmanager 485: configuration and display program for small and medium-sized plants.
- Commugraph: easy-to-use visualisation program with limit display.
- Commuwin II: display and operating program under Windows.

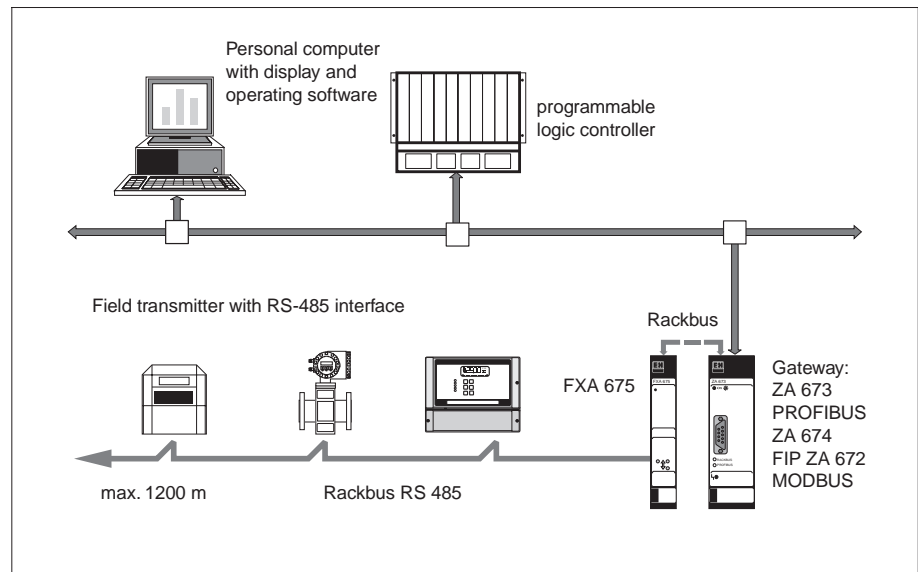
Connecting to Process Control Systems

The Prosonic FMU 86... can be easily linked to existing process control systems via the RS-485 interface.

The FXA 675 interface card (or the Monorack II RS-485) connects two individual Rackbus RS-485 networks with up to 25 transmitters via the Rackbus. A second card (Gateway) serves as the bus connection for standard networks such as PROFIBUS, FIP or MODBUS.

The Prosonic P level measurement system also enables a number of widely distributed ultrasonic measuring points to be controlled by a personal computer.

Integration into process control systems: connecting a network to the Rackbus via an FXA 675 interface card. A Gateway links it to a higher control system.



Housing Versions

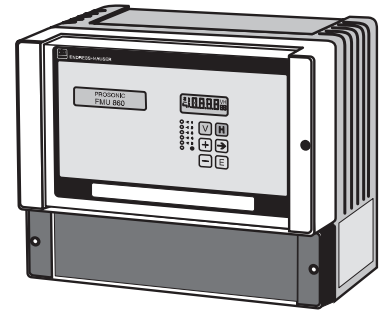
Housing Versions

Prosonic transmitters for mounting in the field or control room are available with different electronic housings.

- Field operation.

The transmitter electronics are built into an IP 66 housing. The transmitter is parameterised via an operating unit with a keyboard and display or – by using an additional serial interface – with a handheld terminal.

An external totaliser can also be connected to the Prosonic FMU 861.



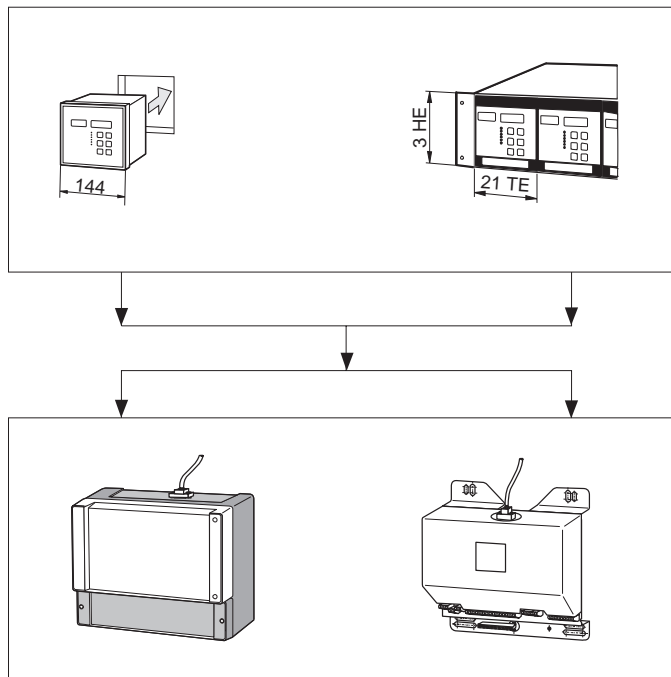
IP 66 protective housing
for wall or post mounting

- Control room operation

The operating unit is separated from the transmitter electronics. A transmitter with the serial interface can be configured using a handheld terminal.

The operating unit is available for mounting in a control cabinet (144 mm x 144 mm) or for mounting in an assembly rack (21 HP).

The transmitter electronics are mounted in an IP 40 housing or else are on an IP 10 mounting panel in the control cabinet.



Operating unit versions

- Left:
The housing for control panel mounting
- Right:
The operating panel for the assembly rack

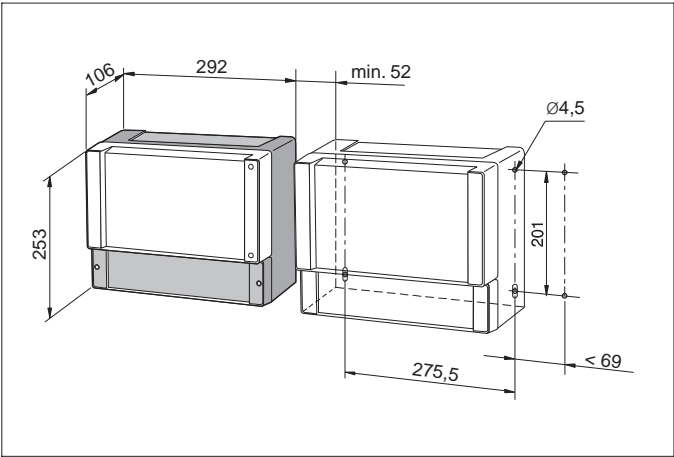
Versions with separate transmitter electronics

- Left:
The IP 40 plastic housing
- Right:
The IP 10 mounting plate

Mounting

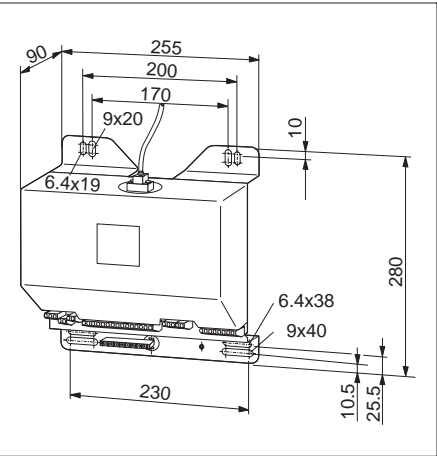
Explosion Hazardous Areas

For certified systems, the sensor only may be installed in the explosion hazardous area. The transmitter must always be installed in a safe area. All local regulations concerning installation must be observed.



Mounting and dimensions of the

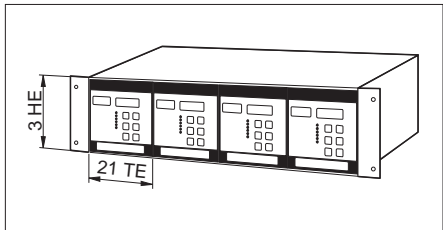
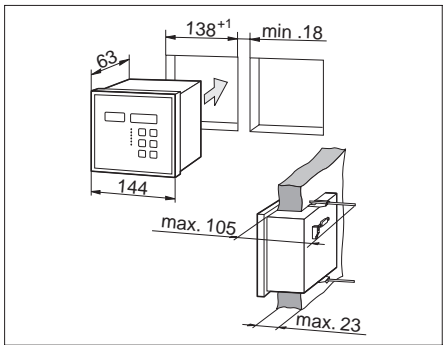
- IP 66 protective housing
- IP 66 protective housing with overvoltage protection
- IP 40 plastic housing



Dimensions of the IP 10 mounting plate

Operating units when the board of the transmitter electronics is installed separately.

- right: in control panel
- lower right: in rack



Accessories

All-Weather Cover for the Protective Housing

- Material: aluminium, blue lacquered
Order No.: 919567-0000
- Material:
stainless steel 1.4301
Order No.: 919567-0001
- Weight: approx. 1 kg
- Mounting screws supplied.

Post Mounting

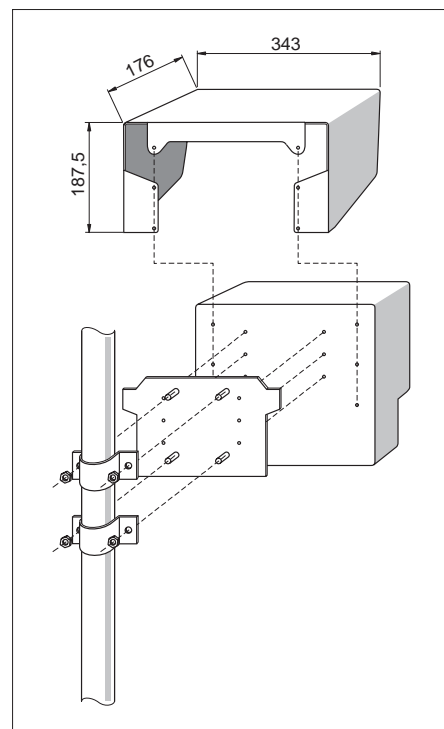
- Material: galvanised steel
Order No.:
– for 2" post: 919566-0000
– for 1" post: 919566-1000
- Material:
stainless steel 1.4301
Bestell-Nr.:
– for 2" post: 919566-0001
– for 1" post: 919566-1001
- Weight: approx. 1 kg
- Mounting screws and nuts supplied.

Commulog VU 260 Z

Handheld terminal for Prosonic with integrated serial interface and INTENSOR protocol (see Technical Information TI 140/00/en).

HART Communicator DXR 275

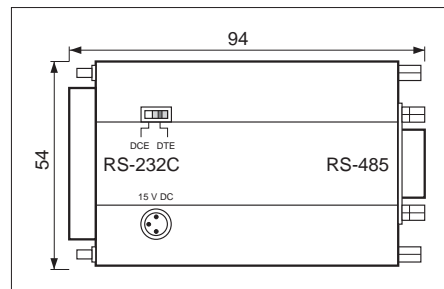
Handheld terminal with integrated serial interface for HART protocol (see operating manual BA 139F/00/en).



Mounting and dimensions of the all-weather protective cover

Converter: RS 232C/RS 485 Interface

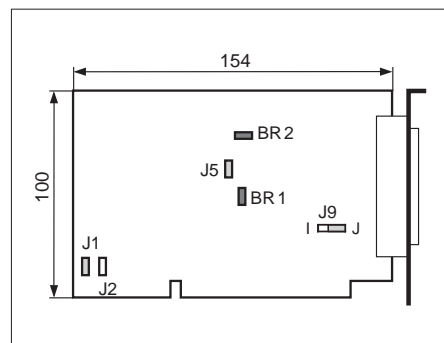
- Order No.:
– for 230 V: 016398-0000
– for 115 V: 016398-0050
- Connector for PC: 25-pin Min-D plug
- for bus: 9-pin Min-D plug, plug supplied with screw terminals
- Baud rate: 19 200 Bits/s
- RS 485-output electrically isolated
- Power supply: 15 V DC; power unit 230 V or 115 V to order
- RS 232 C interface, can be configured as DCE/DTE



Dimensions of the adapter

RS 485 PC Interface Card

- Order No.: 016399-0000
- Connector: 25-pin Min-D plug, plug supplied with screw terminals
- Baud rate: 19 200 Bits/s
- Configuration: supplied configured for COM 3, address 3E8H, with protective ground at Pin 1 of connector, Slot: 8 or 16 bit
- RS 485 output electrically isolated



Dimensions of the RS 485 PC board and position of the jumper (grey = factory settings)

Spare Sensor Cable

Connection from the Prosonic FMU 86... transmitter to the sensors

- FDU 80, FDU 80 F, FDU 81, FDU 81 F, FDU 82
Order No. 938278-0120
- FDU 83, FDU 84, FDU 85
Order No. 938278-1021
- FDU 86
Order No. 52000261

Overvoltage Protection in IP 66 Protective Housing

Overvoltage protection unit for power supply

- Order No. 215095-0001
- Dimensions: see page 8 (IP 66 protective housing)

Overvoltage Protection and Power Supply Unit for Sensor Heating in IP 66 Protective Housing

Power supply unit (24 V DC) for sensor heating with integrated overvoltage protection for power supply.

- Order No. 215095-0000
- Power supply 230 V (+15 %/–20 %)
- Dimensions: see page 8 (IP 66 protective housing)

Power Supply Unit for Sensor Heating in IP 66 Protective Housing

Power supply unit (24 V DC) for sensor heating

- Order No. 215095-0002
- Power supply 230 V (+15 %/–20 %)
- Dimensions: see page 8 (IP 66 protective housing)

Electrical Connection

Terminal Strip

The terminal strip for cable diameters up to 2.5 mm² is in a separate connection chamber. The cable entries are prestamped for easy removal.

- underside 5 x Pg 16 und 4 x Pg 13.5
- rear 5 x Pg 16

Sensor Cable

Connection is with the cable supplied or by using an extension via a terminal box with commercial, two-core screened cabling (also available from E+H).

Maximum values: up to 6 Ω per core, maximum 60 nF.

Ø mm ²	0.5	0.75	1
Total cable length (m)	150	250	300

Electrical Isolation

Current output, relay outputs, power connection and sensor input are all electrically isolated from one another. With the FMU 862, the two current outputs are electrically connected to one another, as are the two sensor inputs.

Power Supply

- Alternating voltage:

180...253 V	+10% / –15%	50/60 Hz
90...132 V	+15% / –22%	50/60 Hz
38...55 V	+15% / –20%	50/60 Hz
19...28 V	+15% / –20%	50/60 Hz

– Power consumption: maximum 15 VA, maximum 65 mA at 230 V_{AC}

- Direct voltage:

– 20...30 V (residual ripple within tolerance), integrated reverse connection protection.

– Power consumption: maximum 12 W (typical 8 W), maximum 500 mA at 24 V_{DC}

Connecting to a Separate Keypad

A separate keypad is connected to the transmitter electronics via a cable with a 9-pin sub-miniature D connector (cable supplied).

Technical Data

General Information

Manufacturer	Endress+Hauser GmbH+Co.
Instrument	Ultrasonic transmitter
Designation	Prosonic FMU 860, 861, 862
Technical documentation Version Technical data	TI 190F/00/en 07.99 according to DIN 19259

Application

Non-contact,, continuous level measurement in liquids and solids, for determining flowrates in open channels and weirs, water levels or for controlling screens and pumps
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Operation and System Design

Measuring principle	Ultrasonic echo, time of flight measurement
Modularity	<ul style="list-style-type: none"> – FMU 860: One signal input for level measurement – FMU 861: One signal input for flow measurement – FMU 862: Two signal inputs for differential level measurement

Mechanical Construction

Transmitters	<ul style="list-style-type: none"> – IP 66 field housing for post and wall mounting – Separate operating unit (keyboard and display) for control panel mounting or for rack mounting 3 m connecting cable supplied – IP 40 plastic housing with electronics for connecting a separate operating unit – IP 10 mounting plate for connecting a separate operating unit
Ultrasonic sensors	FDU 80, 80F, 81, 81F, 82, 83, 84, 85, 86
Separate switch input	external passive limit switch (NO contact or NC contact) or PNP switch, 24 V, maximum short-circuit current 20 mA
Separate temperature sensor	to compensate for temperature effects on time of flight in open channels, NTC version
Signal transmission	4...20 mA analogue signal, can be switched to 0...20 mA

Input

Measured variable	Time of flight measurement of the ultrasonic pulse using ultrasonic sensors
Measuring range	2...70 m depending on the ultrasonic sensors

Output

Analogue output

Output signal	<ul style="list-style-type: none"> – 4...20 mA, switchable to 0...20 mA (can be inverted), superposed digital communications signal INTENSOR or HART – FMU 862: same values for second signal input, simultaneous switchover of Channel 1 to 0...20 mA – with plug-in module and also serial interface – 4-mA level for coupling
Output on error	<ul style="list-style-type: none"> – 0...20 mA: –10 % (-2 mA), +110 % (22 mA), HOLD (last current value is held) – 4...20 mA: –10 % (2.4 mA), +110 % (21.6 mA), HOLD (last current value is held)
Current limit	24 mA
Integration time	0...300 s
Load	max. 600 Ω
Effect of load	negligible

Relays

Version	optional three or five independent relays each with one potential-free change-contact always three relays only with RS-485 interface
Functions	<ul style="list-style-type: none"> – limit value – alarm relay – trend – time pulses (FMU 861 and FMU 862 only) – max. counting frequency 2 Hz, pulse width 200 ms – time pulses (FMU 861 only) – back-up (FMU 862 only)
Switching power	4 A, 250 V, 100 VA at $\cos \varphi = 0.7$, 3.5 V DC and 100 W

Accuracy

Measured error (sum of linearity, hysteresis and reproducibility)	typical 0.2 % for maximum measurement span with smooth surface
Max. resolution	1 mm for FDU 80
Effect of load	Negligible within permissible range

Process Conditions**Ambient conditions**

Ambient temperature	–20...+60 °C
Storage temperature	–40...+80 °C
Shock resistance	2 g (10...55 Hz) and 15 g for 11 ms (DIN 40040, Typ W)
Climatic class	DIN 40040 Type R Relative air humidity 95 % in yearly average, condensation permissible
Ingress protection	DIN 40050 <ul style="list-style-type: none"> – Field housing: IP 66 with closed housing and Pg identical protection – IP 40: plastic housing with Pg identical protection – IP 10: plate for mounting in control cabinet – IP 10: separate operating unit (keyboard and display)
Electromagnetic compatibility	<ul style="list-style-type: none"> – AC power supply: interference emission to EN 50081-1 interference resistance to EN 50082-2 and NAMUR industry standard, with 10 V/m – DC power supply: interference emission to EN 50081-2 interference resistance to EN 50082-2 and NAMUR industry standard, with 10 V/m

Mechanical Construction**Materials**

IP 66 field housing	<ul style="list-style-type: none"> – Housing body: PC/ABS – Transparent cover: PC (polycarbonate) – Front plate with tag area – Weight: 2.6 kg
IP 40 plastic housing	<ul style="list-style-type: none"> – PC/ABS – Weight: 1.0 kg
IP 10 mounting plate	<ul style="list-style-type: none"> – Al/PS – Weight: 0.8 kg
Separate operating unit	<ul style="list-style-type: none"> – PC/ABS – Weight: 0.3 kg

Accessories

Protective cover for field housing	<ul style="list-style-type: none"> – Materials: Aluminium blue lacquered or SS 304 (1.4301) – Weight: approx. 1.0 kg – Mounting screws supplied
Post mounting	<ul style="list-style-type: none"> – Materials: galvanised steel or SS 304 (1.4301) – Weight: approx. 1,0 kg – Mounting screws and nuts supplied

Display and Operating Interface**Display and operating elements in IP 66 field housing**

Display (LCD)	<ul style="list-style-type: none"> – 4½-character display, optional lighting – with segment display of current in 10 % steps – Display elements: error, signal overflow or underflow, communication
LEDs	<ul style="list-style-type: none"> – one yellow LED each for indicating the switching status of the relay (lit = relay energised) – one yellow LED error indication (lit = error-free operation) – one green LED indicates error-free indication (lit = error-free operation, flashing = warning)
Counter	<ul style="list-style-type: none"> – FMU 861 standard only, FMU 862 optional – Version: six-character, cannot be reset
Software counter	<ul style="list-style-type: none"> – FMU 861 standard only, FMU 862 optional

Communication interfaces

Handheld terminals	<ul style="list-style-type: none"> – INTENSOR: Commulog VU 260 Z – HART: Universal HART-Communicator DXR 275
Commuwin II operating program from Endress+Hauser	<ul style="list-style-type: none"> – via Commubox FXA connection to serial interface RS 232C of a PC
Rackbus RS 485	<ul style="list-style-type: none"> – via FXA 675 interface board connection to Rackbus RS 485 network
Synchronising connection	<ul style="list-style-type: none"> – Parallel link for up to 20 instruments if several sensor cables are laid together over long distances.

Power Supply

AC	180...253 V (50/60 Hz), 90...132 V (50/60 Hz), 38...55 V (50/60 Hz), 19...28 V (50/60 Hz)
DC Power consumption	20...30 V (residual ripple within tolerances) max. 12 W (typical 8 W), max. 500 mA at 24 V DC
Ripple with Smart transmitters	INTENSOR max. ripple (measured to 500 W) 0...500 kHz: U _{PP} =30 mV HART max. ripple (measured to 500 W) 47...125 Hz: U _{PP} =200 mV max. noise (measured at 500 W) 500 Hz...10 kHz: U _{eff} =2.2 mV
Reliable galvanic isolation	between current output, relay outputs, interfaces, power supply and sensor inputs
Sensor cable	common, two-wire screened cable Maximum values: to 6 Ω per wire, max. 60 nF

Certificates and Approvals

Ignition protection	see Product Structure Page 15
CE Mark	By attaching the CE Mark, Endress+Hauser confirms that the instrument fulfils all the requirements of the relevant EC directives.

Order Code

See "Product Structure"

Supplementary Documentation

Technical Information TI 189F/00/en Prosonic Ultrasonic Sensors FDU 80...86 Operating Instructions BA 100F/00/en Prosonic FMU 860...862
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Product Structure

* Shipbuilding approvals:
GL; DNV, LR, ABS, BV, RINA on request

Prosonic Transmitter FMU 86...							
Instrument versions							
0	One channel for level measurement with ultrasonics						
1	One channel for flow measurement with ultrasonics						
2	Two channels for flow and/or level measurement, differential measurement						
Certificates *							
R	Standard (non-certified transmitter, also for all certified sensors)						
U	CSA General Purpose						
Housing for electronics							
1	IP 66 protective housing, for field mounting and operation						
2	Plastic housing IP 40 for remote operation						
7	Mounting plate IP 10 for control panel mounting and remote operation						
Versions for operation/display/totaliser for flow measurement							
A	Keypad in protective housing/with display/without totaliser, not for FMU 861						
B	Keypad in protective housing/with display/with totaliser, not for FMU 860						
E	Keypad in protective housing/with illuminated display/without totaliser, not for FMU 861						
F	Keypad in protective housing/with illuminated display/with totaliser, not for FMU 860						
D	Separate keypad for control panel/with display/without counter/without RS-485						
H	Separate keypad for control panel/with illuminated display/without counter/ without RS-485						
C	Separate keypad for rack/with display/without counter/without RS-485						
G	Separate keypad for rack/with illuminated display/without counter/without RS-485						
K	Without keypad/without Display/without counter, operation over serial interface (with INTENSOR or HART protocol)						
Relays							
1	Three potential-free change-over contacts						
2	Five potential-free change-over contacts, only with versions without RS-485						
Power supply							
A	AC	180...	253 V	50/60	Hz		
B	AC	90...	132 V	50/60	Hz		
C	AC	38...	55 V	50/60	Hz		
D	AC	19...	28 V	50/60	Hz		
E	DC	20...	30 V				
Interface/protocol							
1	Without interface						
2	Serial interface with INTENSOR protocol						
3	Serial interface with HART protocol						
4	Separate serial Rackbus RS-485 interface						
FMU 86							Product designation

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