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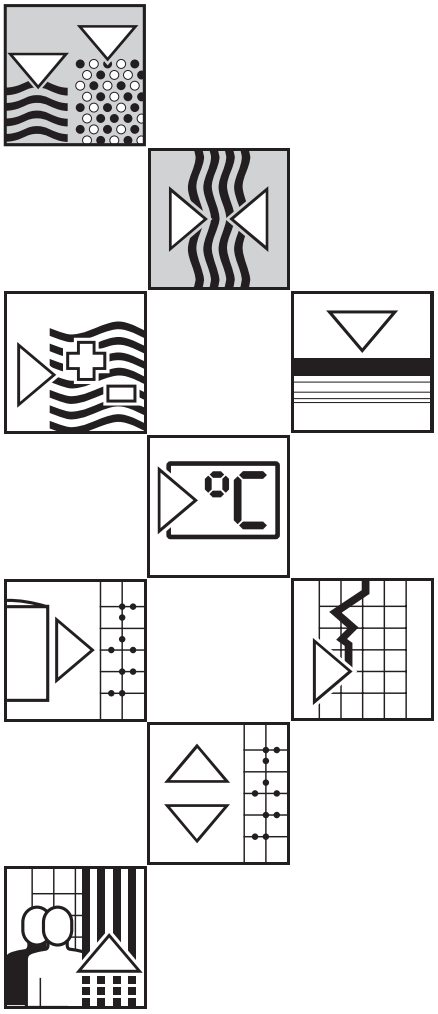
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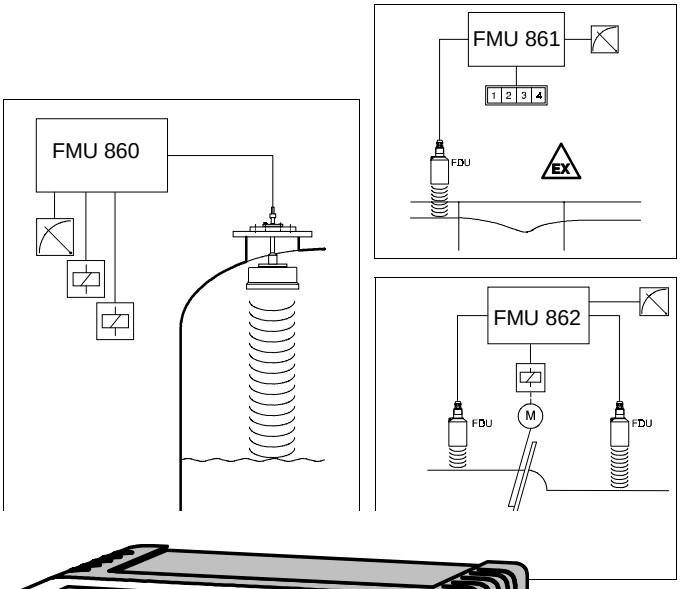
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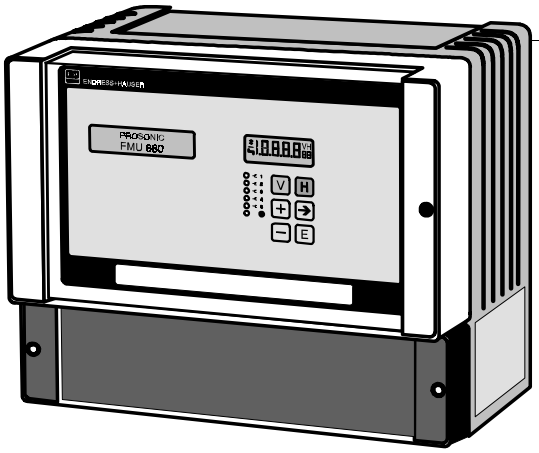
BA100F/00/en/07.05
016038-1010
Software version 2.3/2.4

Prosonic
FMU 860…862
Ultrasonic Measurement

Operating Instructions







Endress+Hauser

The Power of Know How

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These Operating Instructions are written for the software version 2.3/2.4 of the Prosonic transmitter. Version 2.4 is used for devices with a PROFIBUS-DP interface only.

Software History

SW / BA	Device and Software No.	Device revision	DD revision	Changes	Remarks
1.0 / 04.93	5910	1	1		No up/download between SW 1.x and SW 2.x possible
1.1 / 08.93 12.93	5911			No change in documentation	
2.0 / 09.95	5920	2	1	Extended functions	
2.1 / 09.95	5921			No change in documentation	
2.2 / 05.99	5922			Extended functions	
2.3/ 12.99	5923			Extended functions	
2.4/ 12.01	PROFIBUS-DP introduced For instruments without PROFIBUS-DP interface version 2.3 remains valid.				

Notes on Safety

Approved usage

The Prosonic FMU 860...862 is an ultrasonic transmitter which, depending on the particular version, can be used for the following measurement tasks:

- Flowrates in open channels and weirs
- Water levels
- Control of rakes and pumps
- Levels in silos and tanks
- Determining the volume or mass of contents on silos and tanks

Mounting, commissioning, operation

The transmitters Prosonic FMU 860, 861, 862 have been designed to operate safely in accordance with current technical, safety and EU standards. If installed incorrectly or used for applications for which they are not intended, however, it is possible that application-related dangers may arise, e.g. product overflow due to incorrect installation or calibration. For this reason, the instruments must be installed, connected, operated and maintained accordng to the instructions in this manual: personnel must be authorised and suitably qualified. The manual must have been read and understood, and the instructions followed. Modifications and repairs to the devices are permissible only when they are expressly approved in the manual.

Explosion hazardous areas

If the device is to be installed in an explosion hazardous area, then the specifications in the certificate as well as all national and local regulations must be observed.

Safety Conventions and Symbols

In order to highlight safety-relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding icon in the margin.

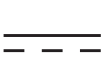
Safety conventions

Symbol	Meaning
 Note!	**Note!** A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned.
 Caution!	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument.
 Warning!	**Warning!** A warning highlights actions or procedures which, if not performed correctly, may lead to personal injury, a safety hazard or destruction of the instrument.

Explosion protection

Symbol	Meaning
	**Device certified for use in explosion hazardous area** If the device has this symbol embossed on its name plate it can be installed in an explosion hazardous area.
	**Explosion hazardous area** Symbol used in drawings to indicate explosion hazardous areas. – Devices located in and wiring entering areas with the designation "explosion hazardous areas" must conform with the stated type of protectin.
	**Safe area (non-explosion hazardous area)** Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. – Devices located in safe areas still require a certificate if their outputs run into explosion hazardous areas.

Electrical symbols

Symbol	Meaning
	**Direct voltage** A terminal to which or from which a direct current or voltage may be applied or supplied.
	**Alternating voltage** A terminal to which or from which an altenating (sine-wave) current or voltage may be applied or supplied.
	**Grounded terminal** A grounded terminal, which as far as the operator is concerned, is already grounded by means of an earth grounding system.
	**Protective grounding (earth) terminal** A terminal which must be connected to earth ground prior to making any other connection to the equipment.
	**Equipotential connection (earth bonding)** A connection made to the plant grounding system which may be of type e.g. neutral star or equipotential line according to national company practice.

1 Introduction

Quick reference operating manual

Users familiar with operating the Prosonic FMU can use the quick reference instructions in Section 10 or use the separate quick reference manual KA 017F on level measurement. First time users are recommended to read thoroughly the operating instructions, which apply to their application.

Operating manual

The Prosonic FMU is an intelligent ultrasonic transmitter for the Prosonic FDU... family of sensors. The operating manual is structured as follows:

- Section 1: Introduction;
  contains general information on applications
- Section 2: Installation;
  contains instructions on installation and electrical connections as well as technical data.
- Section 3: Display and controls;
  describes display and front panel controls of the Prosonic and operation with the DXR 275 HART handheld terminal.
- Section 4: Calibration for the measurement of level, differential and average measurement;
  describes basic calibration to rapidly display a measured value, and other functions, e.g. linearisation for volumetric measurement
- Section 5: Flow measurement;
  describes the basic calibration for flow measurement with open channels and also entering a Q/h curve for flow measurement
- Section 6: Analogue output;
  describes setting of the 0/4…20 mA signal output, including the fault response of the current output, as well as the signal response with an external limit switch
- Section 7: Relays and external counters;
  describes all relay functions and their adjustment, as well as the switch response with an external limit switch
- Section 8: Entries for the measuring point;
  Locking and unlocking the matrix, entering measuring point information including using the DXR 275 HART handheld terminal (measuring point tag, user text)
- Section 9: Diagnosis and Trouble-shooting;
  contains a description of the fault response, error messages, a trouble-shooting table, suppression of interference signals, simulation and instructions for replacement of the transmitter or sensor
- Section 10: Quick reference operating manual for all operating modes
- Section 11 PROFIBUS-DP Interface
  describes integration of the FMU into an PROFIBUS-DP network as well as cyclic and acyclic data transfer.

Appendix

- Appendix A: Tables of stored Q/h curves for flow measurement.
- Appendix B: To shorten the time taken for commissioning, for level measurement, an application parameter can be selected which automatically sets the ultrasonic measuring line to one of five different applications. These level applications are given in Appendix B.

Further documentation

In addition to this manual, the following publications also provide information on the Prosonic FMU:

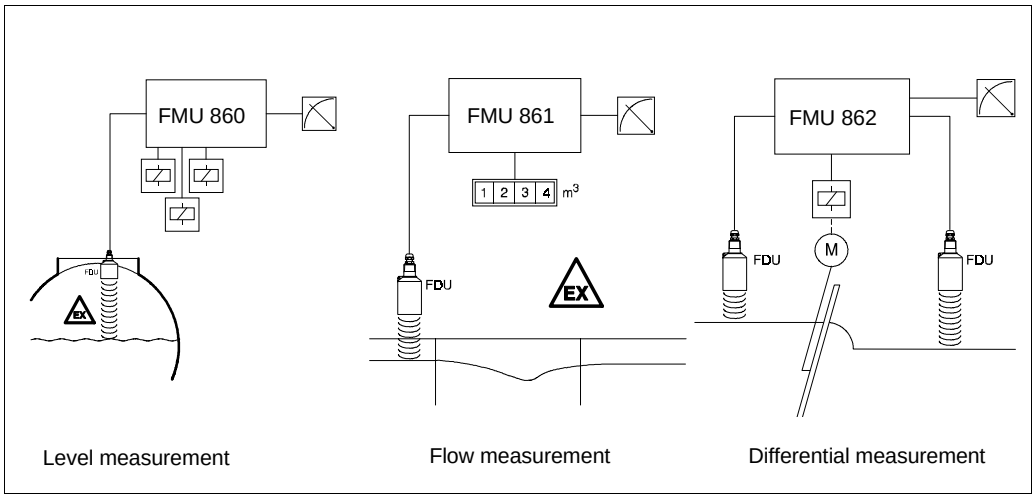
- TI 189F for installing the Prosonic FDU 8... ultrasonic sensor
- BA 139F for configuring the Prosonic using the HART Communicator DXR 275 handheld terminal
- BA 134F for connecting to the Rackbus RS 485
- KA 017F for quickly calibrating the most important functions for level measurement
- BA 198F PROFIBUS-DP/-PA: Guidelines for planning and commissioning
- XA 255F-A Safety Instructions (for the ATEX II 3 D version)

1.1 Features

The Prosonic transmitter is available in various versions...
- for the field or control room
- single or two-channel versions with three or five relays, also with totaliser
- with optional serial interface for remote operation (HART protocol).
- RS-485- or PROFIBUS-DP interface
- The analogue output signal is a standard 4…20 mA, current, selectable to 0…20 mA.

Simple operation and easy commissioning with
- all calibrated values arranged clearly in a matrix
- different functions for linearisation, totalising, all common Q/h curves can be called up.
- Signal pattern recognition using fuzzy logic elements and selectable application parameters to shorten commissioning times and to ensure long-term and correct ultrasonic measurement.

Fig. 1.1
Examples of Prosonic applications.



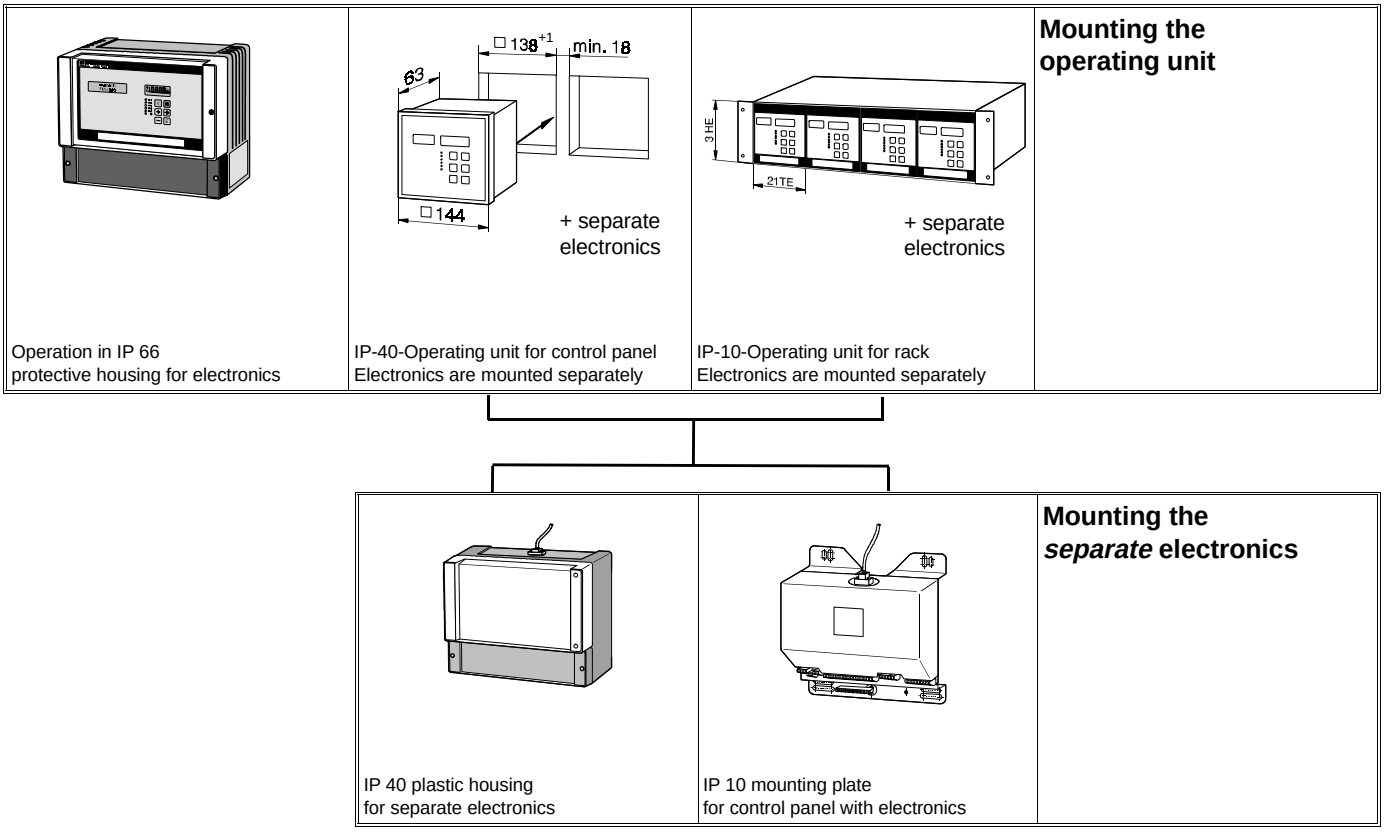
1.2 Measuring System

The measuring system consists of: the Prosonic transmitter with a Prosonic sensor. The two-channel version is for differential measurement or collecting data from individual measuring points. The certified sensor ensures that the measuring system can be used in explosion hazardous areas.
Other instruments can be connected to the Prosonic transmitter for special applications:
- separate temperature sensor, e.g. if the ultrasonic sensor is heated
- separate limit switch, e.g. for detection of level near the blocking distance.

Transmitters and their applications

Transmitter versions

Prosonic FMU 860 for continuous level and volumetric measurement of liquids and solids in tanks and silos.
Prosonic FMU 861 for flow measurement in channels and weirs,
Prosonic FMU 862 the two-channel version for
- the measurement of flow rate or level with the first channel and level measurement only with the second channel or
- differential or average measurement.



Tab. 1.2
The code on the nameplate states the version and configuration. The code is explained in this table.

Prosonic transmitter FMU 86…

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)
E ATEX II 3 D IP66 T 70 °C
U CSA General Purpose

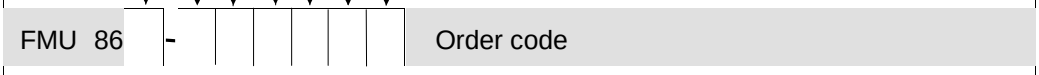
Housing for electronics
1 IP 66 protective housing, for field mounting and operation
2 Plastic housing IP 40 for remote operation
7 Mounting plate IP 10 for control panel mounting and remote operation

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 Operation and display via digital interface

Relays
1 Three potential-free change-over contacts
2 Five potential-free change-over contacts, only with versions without RS 485 or PROFIBUS-DP

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
3 Serial interface with HART protocol
4 Separate serial Rackbus RS 485 interface
5 Separate serieal PROFIBUS-DP interface



Accessories

- All-weather cover for the protective housing; material: aluminium, blue lacquered (Order No. 919 567-0000); stainless steel 1.4301 (Order No. 919 567-0001); Weight: approx. 1 kg. Mounting screws supplied.
- Post mounting material: galvanised steel (for 2" post Order No. 919 566-0000; for 1" post: 919 566-1000);
  stainless steel 1.4301; (for 2" post Order No. 919 566-0001; for 1" post: 919 566-1001); Weight: approx. 1 kg. Mounting screws and nuts supplied.
- HART Communicator DXR 275. Handheld terminal with integrated serial interface for HART protocol (see operating manual BA 139F/00/en).

- The overvoltage protection and power supply units for sensor heating for up to 2 sensors in IP 66 protective housing. Power supply unit (24 V DC) for sensor heating with integrated overvoltage protection for power supply.
  Power supply 230 V (+15%/-20%). Dimensions: IP 66 protective housing
  Order No.: 215095-0000
- Overvoltage protection unit in IP 66 protective housing.
  Dimensions: IP 66 protective housing. Order No.: 215095-0001
- Power supply unit (24 V DC) for sensor heating of up to 2 sensors in IP 66 protective housing.
  Power supply 230 V (+15%/-20%).
  Dimensions: IP 66 protective housing. Order No.: 215095-0002

1.3 Measuring Principle

Ultrasonic measurement

An ultrasonic emitter (sensor) mounted above the product is electrically excited and directs an ultrasonic pulse through the air towards the product. This pulse is reflected back from the surface of the product. The echoes partially reflected are detected by the same sensor, now acting as a receiver, and converted back into an electrical signal.
The time taken between transmission and reception of the pulse – the *run time* – is directly proportional to the distance between the sensor and the product surface. The distance D is determined from the velocity of sound c and the run time t by the formula:

$$D = c \cdot \frac{t}{2}$$

With a velocity of sound (in air under normal conditions) c = 340 m/s, a run time of

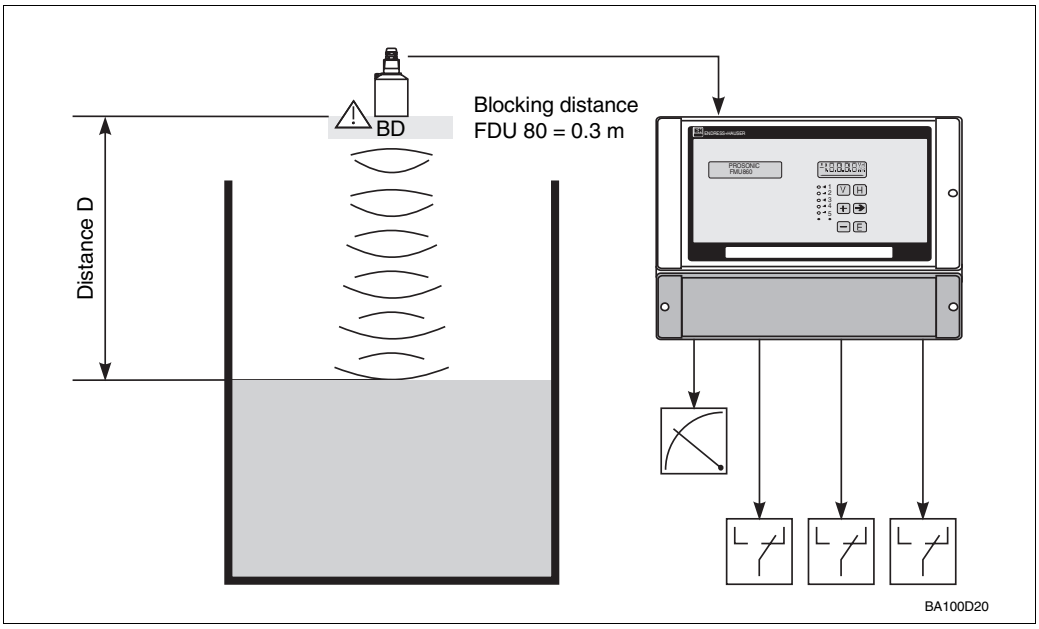


Fig. 1.3
Ultrasonic measuring principle

10 ms corresponds to a transmission path of 3.4 m and thus to a distance of 1.7 m.

The measurement is independent of

- product characteristics such as specific weight, conductivity, viscosity and dielectric constant.
- temperature changes within the tank or basin: The Prosonic FMU compensates for variations in temperature as the integrated sensor for temperature also provides temperature information.

Measuring range and blocking distance

The maximum measuring range of the measuring system dependent on the sensor used and is up to 5 m in liquids and up to 70 m in bulk solids (see also Technical Data pages 26…27). Due to the ringing time characteristics of the sensor, there is a zone immediately below it from which returning echoes cannot be detected. This is known as the *blocking distance BD* and determines the minimum distance between the sensor diaphragm and the maximum level in the silo. This is a function of the type of sensor used.
The end of the measuring range is determined by the attenuation of the ultrasonic pulse by the air as well as by the strength of the reflection from the product surface.



Note!

Note!
Please note when mounting: Levels coming within the blocking distance can cause the instrument to malfunction.

2 Installation

This chapter deals with:

- Mounting the Prosonic FMU in the field and control room
- Electrical connections
- Connecting the DXR 275 HART handheld terminal
- Technical data



Warning:
- The Standard version and the CSA General Purpose version of the Prosonic FMU transmitter must be installed outside the explosion hazardous area. The ATEX II 3 D version of the transmitter can be installed in explosion hazardous areas of Zone 22.
- When installing ultrasonic sensors in explosion hazardous areas, it is imperative to pay attention to the instructions on the certificate and local rules for installation.



Caution:
- For mounting the separate operating units or the mounting plate with electronics remember that: Electrostatic discharges can lead to faulty operation or damage to the electronic components. Touch an earthed object before handling the board.



Note:
The basic prerequisite for correct ultrasonic measurement is correct installation of the ultrasonic sensor. Notes on installation can be found in Technical Information TI 189F/00/en.

2.1 Mounting the Prosonic FMU

There are three ways of mounting the Prosonic FMU:

- In a protective housing (IP 66)
  for wall or post mounting in the field or control room
- In a separate operating unit for control panel mounting, when the board with the transmitter electronics can be mounted separately.
- In a separate operating unit for mounting in a rack, when the board with the transmitter electronics can be mounted separately.

The separate transmitter electronics is mounted
- in an IP 40 plastic housing or
- on an IP 10 mounting plate for control panel mounting



Notes:
- Mount the protective housing in a shaded area. If strong sunlight is expected, then it is advisable to fit an all-weather protective cover (obtainable as accessory).
- Overvoltage protection.
  An overvoltage protection unit in an IP 66 protective housing is recommended to protect the transmitter from voltage peaks especially when mounted in the open.

Mounting the IP 66 protective housing and the IP 40 plastic housing

The following illustrations provide all instructions needed for mounting. Mounting the all-weather protective cover on the IP 66 protective housing is also illustrated. Mounting material (screws or nuts) for post mounting and the all weather protective cover is enclosed.
Note: The separate transmitter electronics is connected by a standard multicore cable (in scope of delivery).

Fig. 2.1
Mounting dimensions and clearances of the IP 66 protective housing and the IP 40 plastic housing with separate operating unit (leave 10 cm area above the IP 40 plastic housing for the plug)

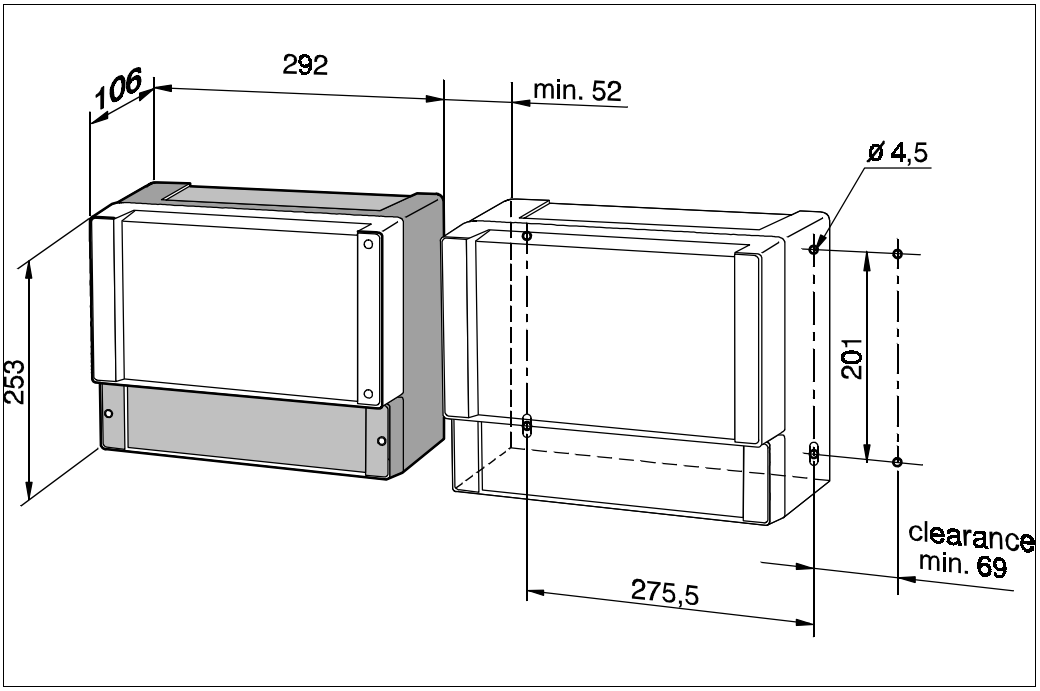
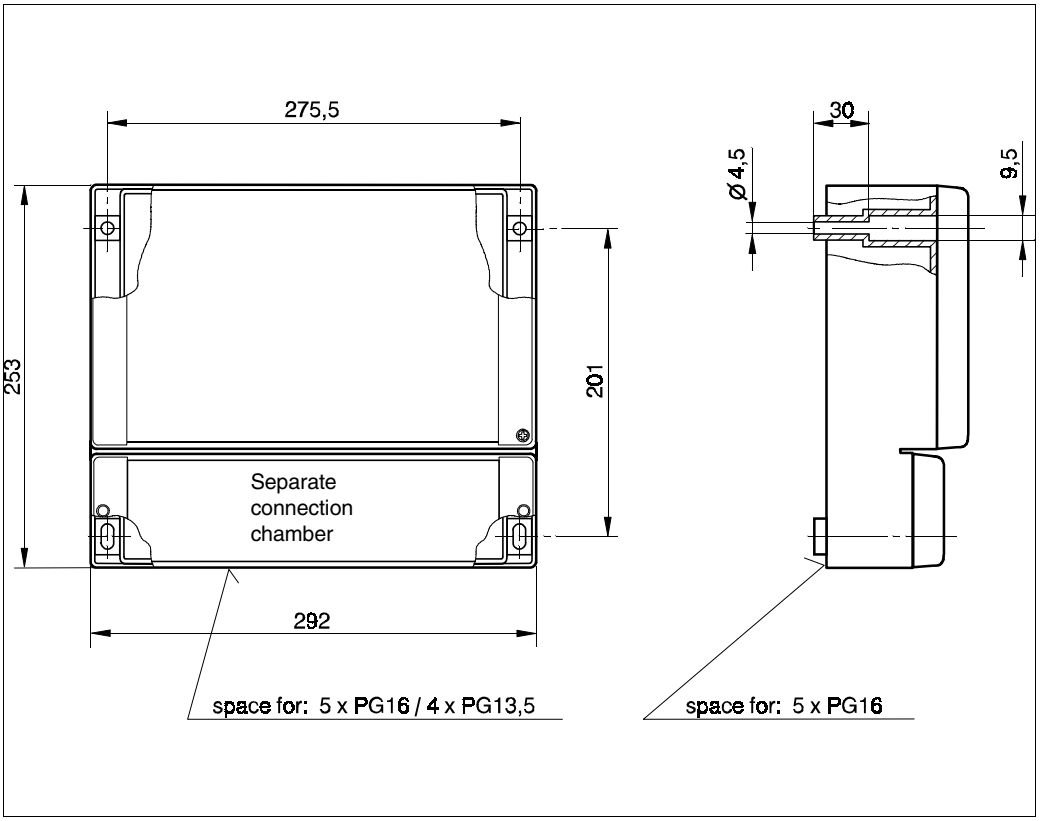


Fig. 2.2
Cable entry through the bottom or rear.
Mounting screws:
max. ø 4.5 mm,
screw head max. ø 9.5



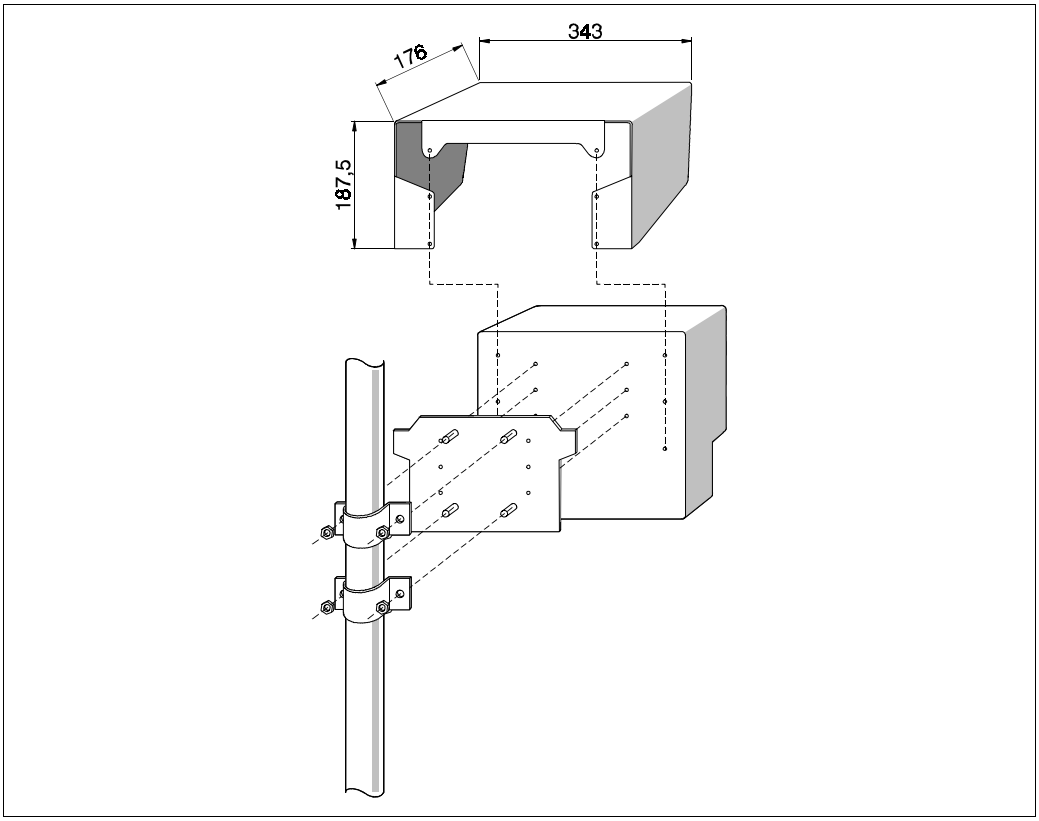


Fig. 2.3
Mounting all-weather protective cover and attaching the transmitter to a post

Mounting the IP 10 mounting plate

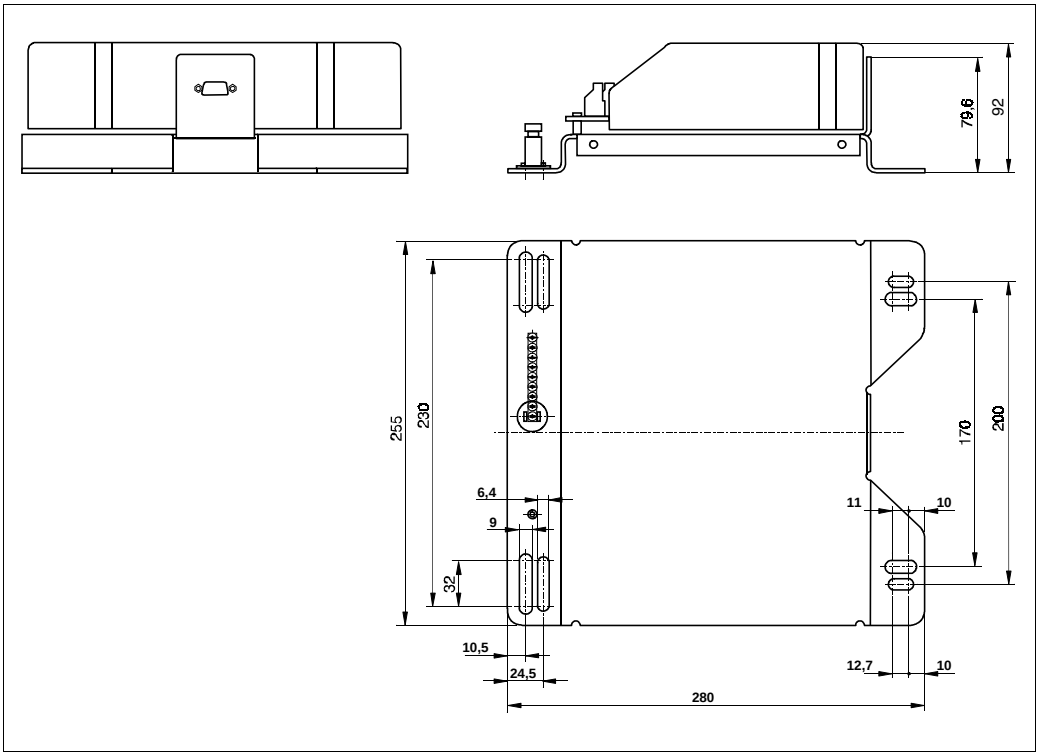


Fig. 2.4
Dimensions of the IP 10 mounting plate for control panel mounting (leave 10 cm area above the IP 40 plastic housing for the plug)

Mounting in a control panel

Fig. 2.5
Dimensions for mounting the operating unit in a control panel. The board with the transmitter electronics is mounted separately in the control cabinet.

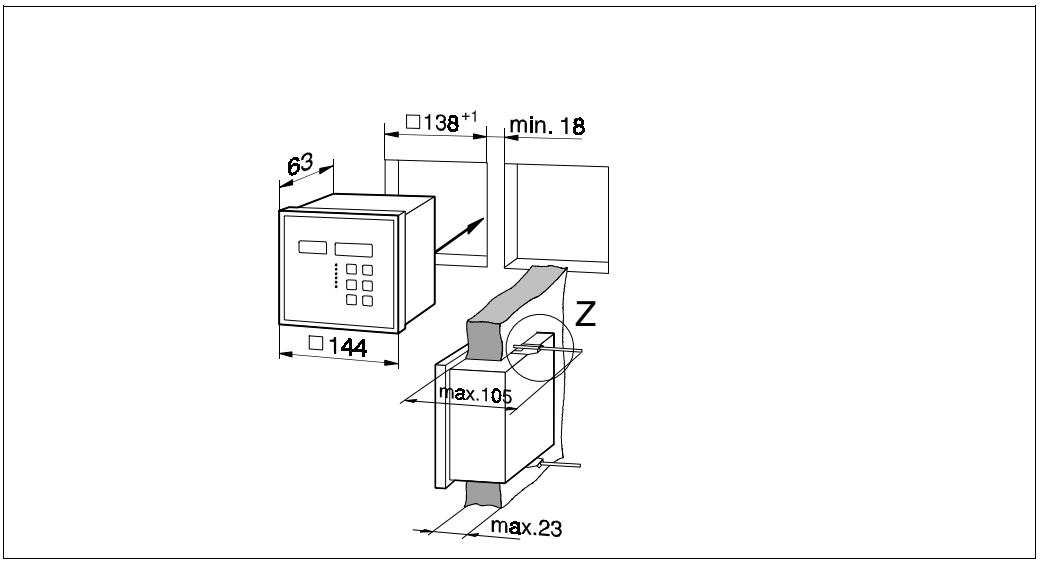
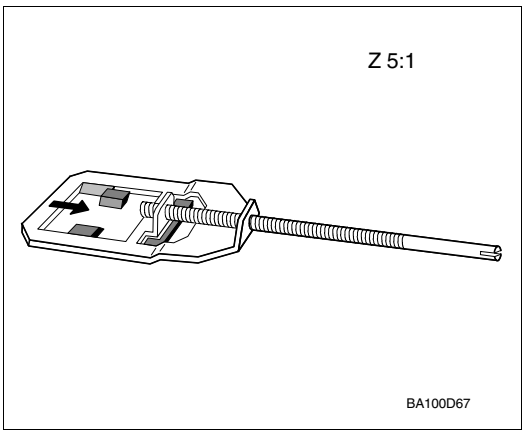
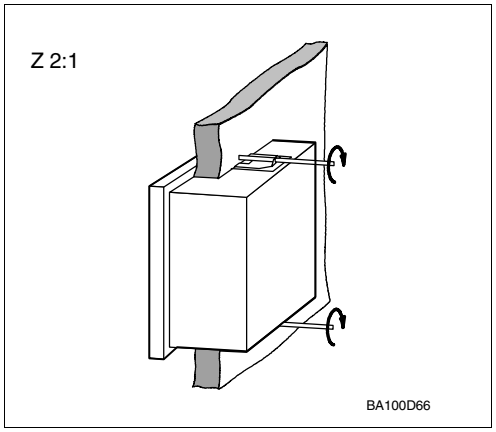


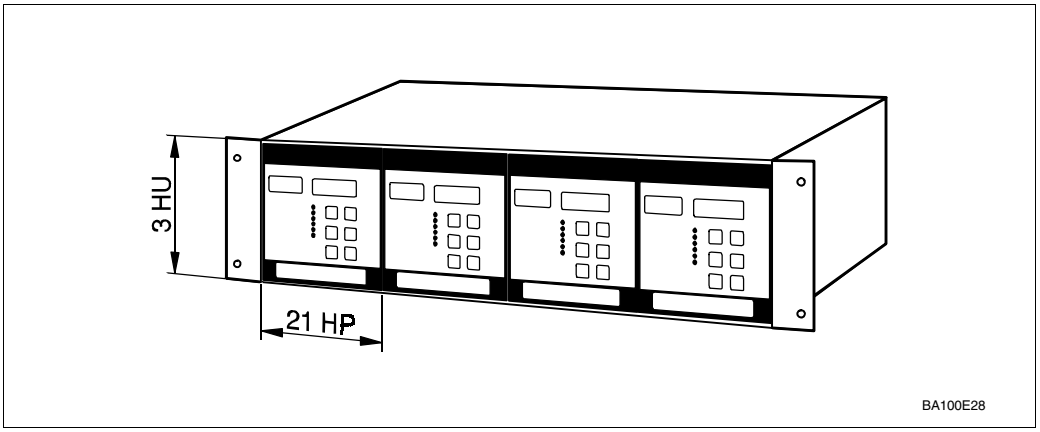
Fig. 2.6
The clips are inserted opposite one another on to the fixing points. With thick control cabinets, the fixing points at the rear may be used.





Mounting in a rack

Fig. 2.7
Mounting of an operating unit for a rack. The board of the transmitter electronics is mounted separately in the cabinet.



2.2 Electrical Connection

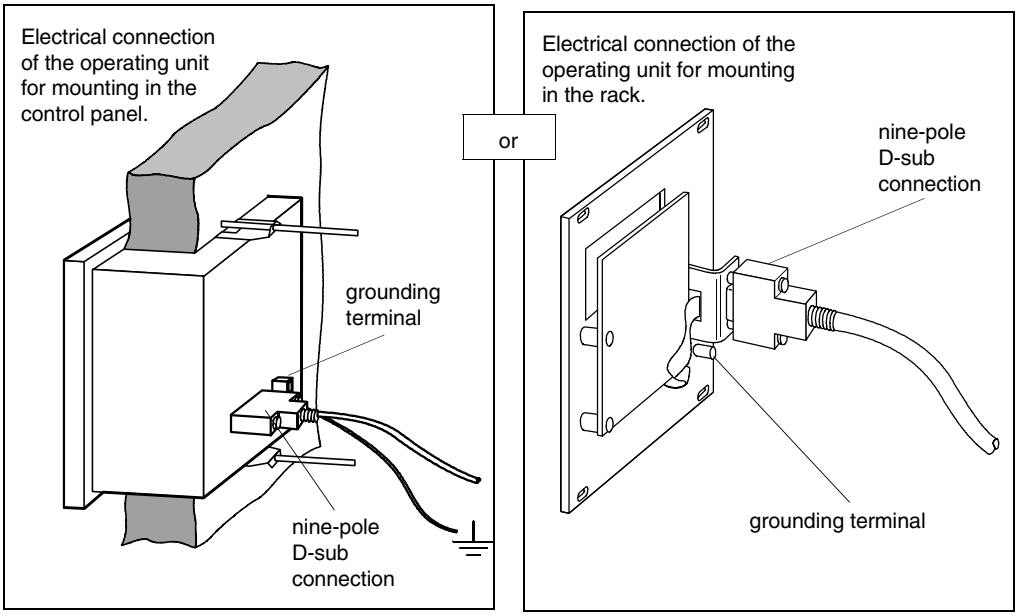


Warning!
- Ensure that the power is switched off when the unit is connected up.
- All regulations applicable must be observed if the ultrasonic sensor is to be used in an explosion hazardous area.

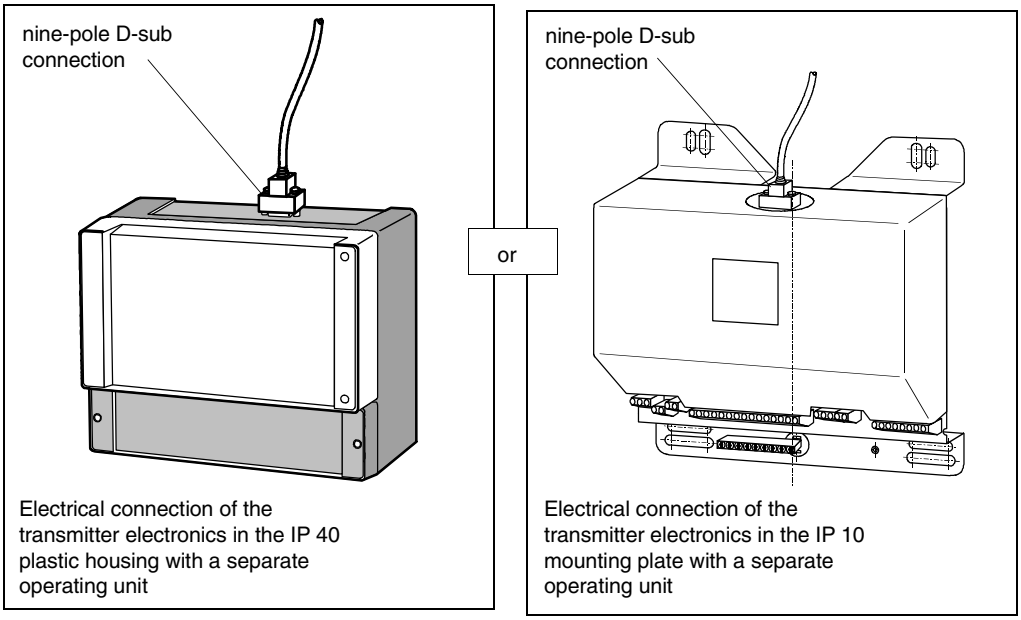
Separate Operating Unit

The separate operating unit is connected to the transmitter electronics by the connecting cable supplied which has nine-pole plugs at both ends (for nine-pole D-sub connections).

Press the plug of the connecting cable into the jack of the transmitter electronics and screw the plug in tightly using a small flat bladed screwdriver. Connect the other end of the connecting cable in the same way. The operating unit mounted in the control panel or rack must be grounded!



Electrical connection of Prosonic sensors ...

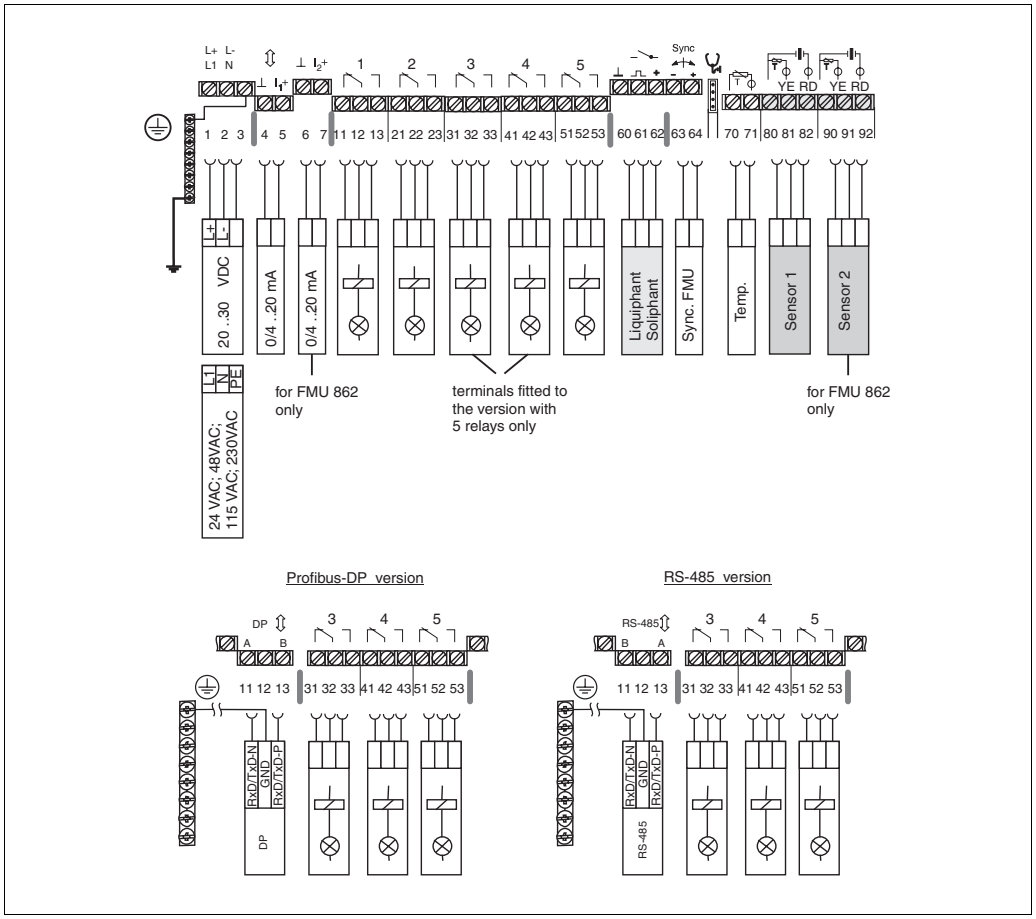


... with the transmitter electronics

Terminal block

The terminal block, for cable diameters up to 2.5 mm^2, is located in a separate connection chamber which is accessible by opening the plastic cover. The pre-pressed knock-outs in the connection area have to be removed for cable entry (underside for 5 x Pg 16, 4 x Pg 13.5, rear 5 x Pg 16). All terminals are clearly marked. Fig. 2.8 shows the wiring diagram of the Prosonic FMU (Terminal 3 is only for internal ground connection).

Fig. 2.8
Assignment of the terminal strip connections.The electrically isolated parts are separated by lines shown in half-tone.



Electrical isolation

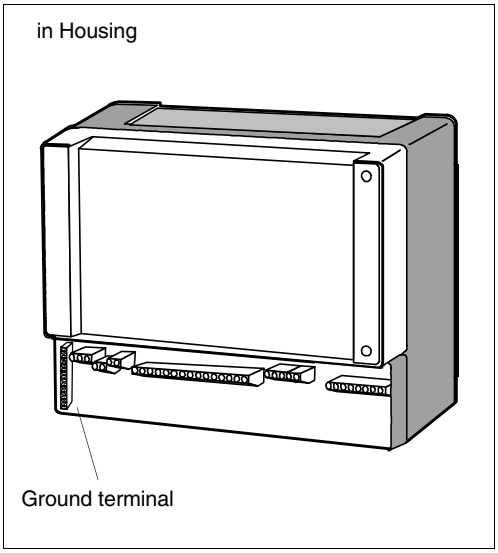
The current output, relay outputs, RS 485 interface, mains connection and sensor input are electrically isolated. On FMU 862, the two current outputs are electrically connected, likewise the two sensors inputs. (In Fig. 2.8, the electrically isolated areas are indicated by the thick, speckled lines).

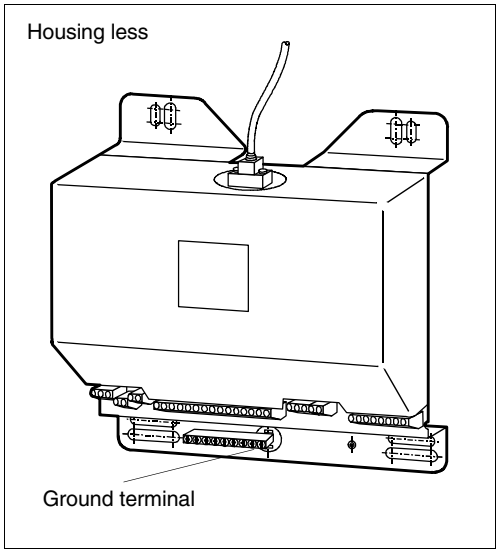
Power switch

When using the public powers supply, install an easily accectable power switch in the proximity of the device. Mark the power switch as a disconnector for the device (IEC/EN 61010).

Ground cable

In order to ensure protection from contact and reliable isolation according to DIN/VDE 0160, the ground cable must be connected to the metallic terminal block supplied.





Analog and relay outputs

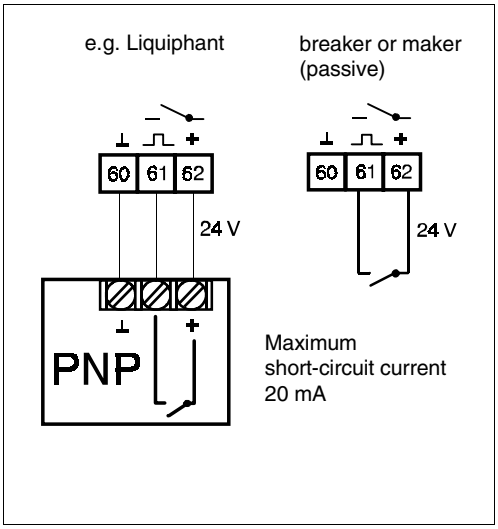
- Only a unit whose input is not potential-free may be connected direct to the current output.
- The number of potential-free units is unlimited, paying due respect to the min. or max. load, see technical data in this chapter.
- For max. permissible contact loading see technical data.

Separate limit switch input

All Prosonic transmitters have an additional limit switch input. Exceeding the level to come within the blocking distance of the sensor is also indicated promptly by the display, the signal output and the relays.

Caution!
The maximum short-circuit current is 20 mA; for 24 V supply

Caution!



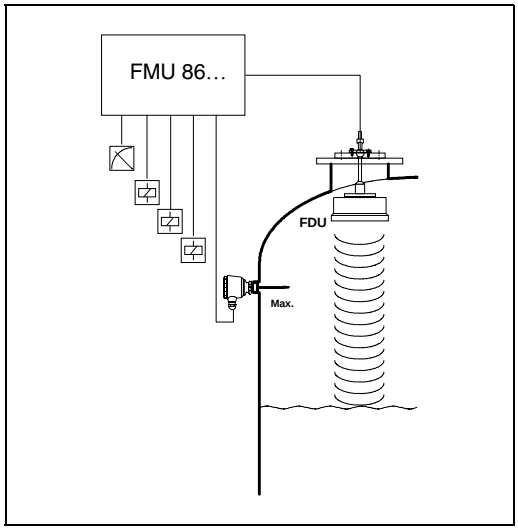


Fig. 2.9
Left:
All transmitters have a separate limit switch input

Right:
Separate switching input e.g. for Liquiphant or Soliphant or for an external passive maker or breaker

External temperature sensor

An external temperature sensor can be connected to the Prosonic transmitter. This is necessary if the sensor is heated (with the FDU 80 or FDU 81 only as required) or if the temperature is not to be measured inside the sensor.

Sensor connection

Switch off the transmitter power supply before connecting up a sensor.
Check that the power supply for the instrument agrees with that on the nameplate.
The sensors are supplied with a permanently attached cable (up to 30 m, cable diameter 0.75 mm^2). They can be connected as follows:

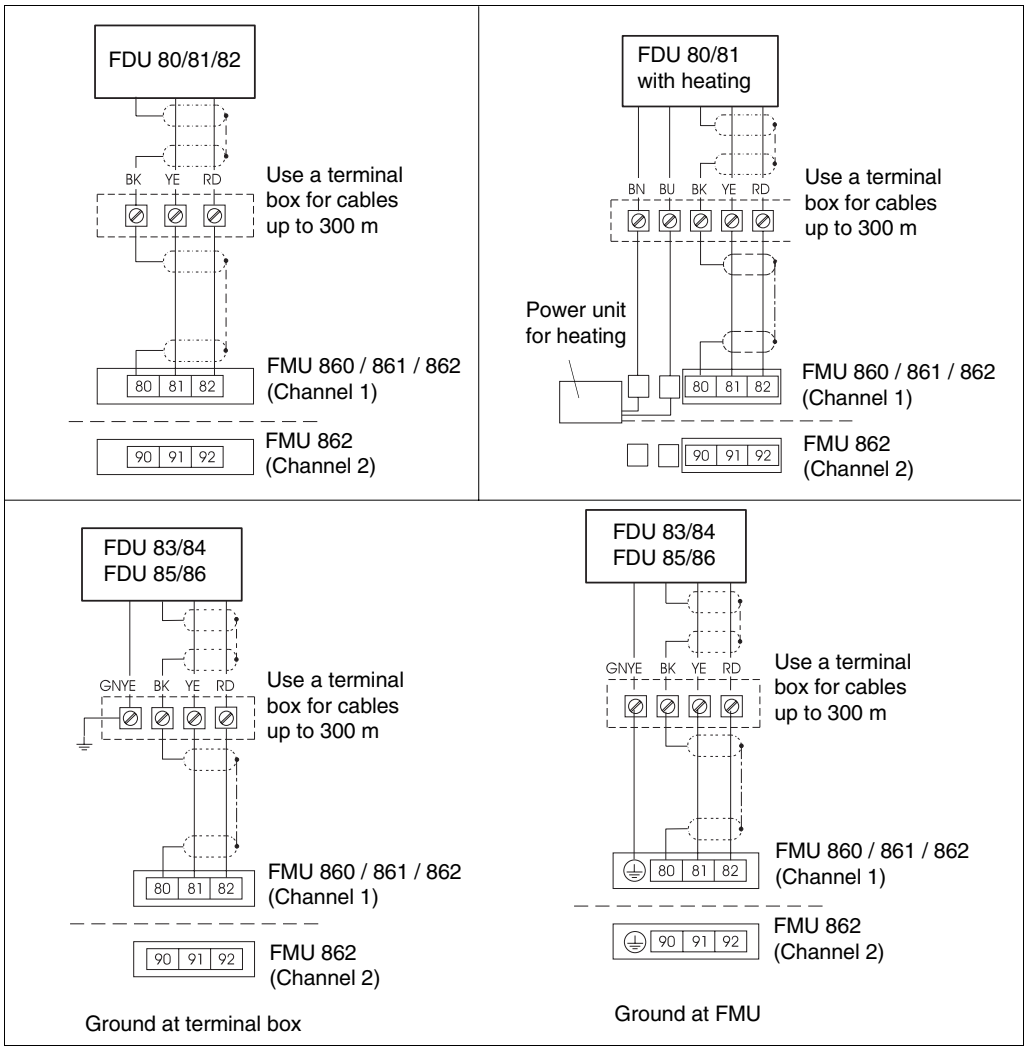
- Directly in the FMU connection area;
  the terminals are for cable diameters up to 2.5 mm^2
- Using a terminal box;
  – Use cable boxes with cable lengths up to 300 m
  – If terminal boxes are to be installed in explosion hazardous areas, then all local regulations governing installation are to be observed.

A two-core cable with fully braided shield is to be used for connecting the sensor and electronics (shield: metal braiding max. 6 Ω).
– Cable specifications (per core): max. 6 Ω , max. 60 nF total capacitance
– Caution – The fully braided shield serves as a return cable. Do not ground the shield and lay to the transmitter without any electrical break.
– FDU 83, 84, 85, 86: do not lay the potential compensation cable within the shield.
– If more sensor cables are laid parallel, then the appropriate Prosonic FMU transmitters must be synchronised (see also »Synchronizing connection« page 22).

Fig. 2.10
Electrical connection of Prosonic sensors.

Core colors		
BK	=	black
RD	=	red
YE	=	yellow
GNYE	=	green yellow
BN	=	brown
BU	=	blue

Sensor extension cable:
- FDU 80, 80F, 81, 81F, 82:
  Ord. No. 938278-0120
- FDU 83, 84, 85:
  Ord. No. 938278-1021
- FDU 86:
  Ord. No. 52000261



Shortening the sensor cable

The sensor cable can be shortened at a later date. Please note:
– Do not damage the cores when removing the insulation.
– The cable is shielded by metallic braiding. This shielding serves as a return cable and corresponds to the black wire of the unshortened cable. Loosen the metallic braiding, twist it together securely and connect it to terminal 80 (Channel 1) or terminal 90 (Channel 2) (Fig. 2.12). If a potential compensation cable is laid with the cable (colour code YE-GN), then it is not to be electrically connected to the shielding.
– The sensors are connected as shown in Fig. 2.11.

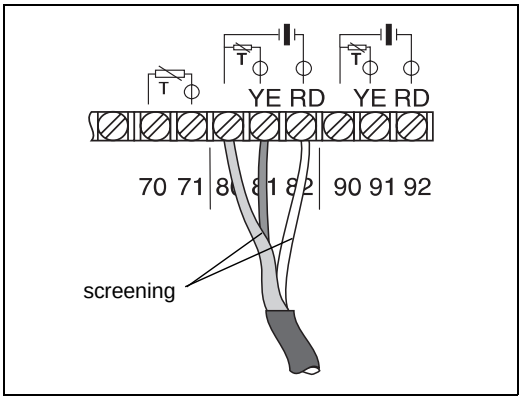
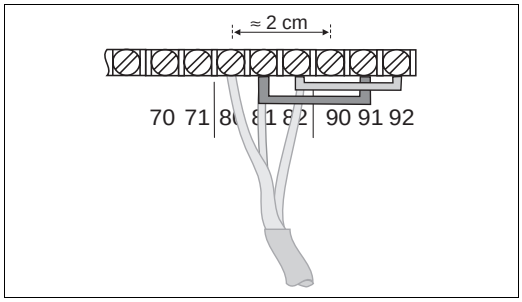


Fig. 2.11
Shortening the sensor cable
Loosen the screening and twist the metallic braiding to the third (black) wire.

Simultaneous level and flow measurement with one sensor

With the FMU862 it is possible to measure level and flow simultanesouly with one sensor only. For this purpose it is necessary to position the sensor above the basin. Then the sensor has to be connected parallely to both channels of the FMU862. To connect the sensor to both channels, the terminals 81 to 91 and 82 to 92 have to be bridged according to the figure. Then, it is possible, for example, to configure channel 1 for flow measurement and channel 2 for level measurement.



Ultrasonic sensor with heating

The sensors FDU 80 and FDU 81 can be supplied with heating units. For heated sensors: The connecting terminals for the heating unit are delivered with the sensor. They are to be mounted in the connection compartment of the transmitter; the mounting bore lies above the terminals 63 and 64 (see Fig. 2.13).
• Technical data for an external power supply for heating the sensor
24 V ± 10% DC, residual ripple smaller than Uss ≤ ±100 mV. For each heated sensor, 250 mA, 8 W.

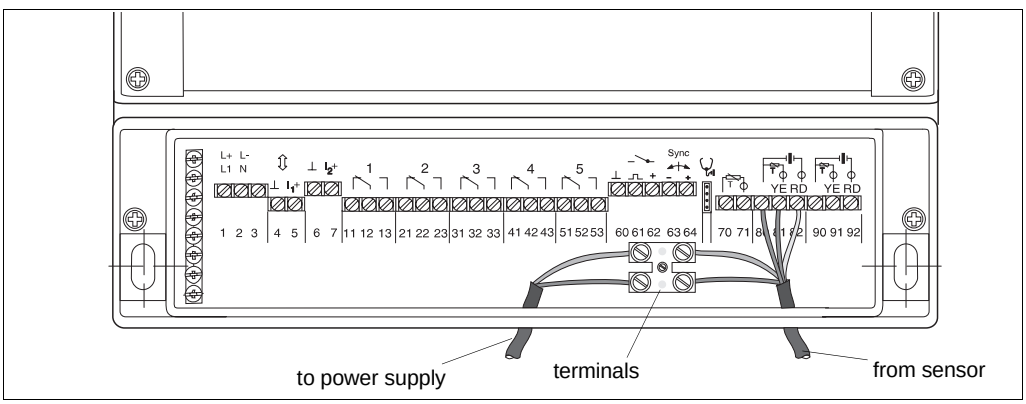
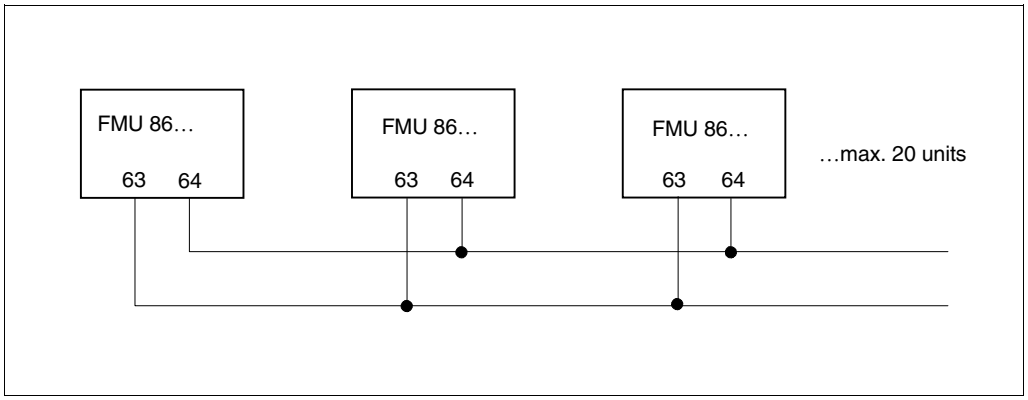


Fig. 2.12
Connecting Prosonic sensors with heating unit
(see also Fig. 2.11 "Electric Connection of Prosonic Sensors")

Synchronization line

In order to avoid cross-talk between parallel routed sensor lines connect the transmitters (max. 20) to a synchronisation line. The sensors are then scanned in sequence. If more devices are present, groups of 20 transmitters should be used. The cables within one group can be in parallel. The cables of different groups must be separated. Common screened cable can be used.

Fig. 2.13
Parallel connection of max. 20 units

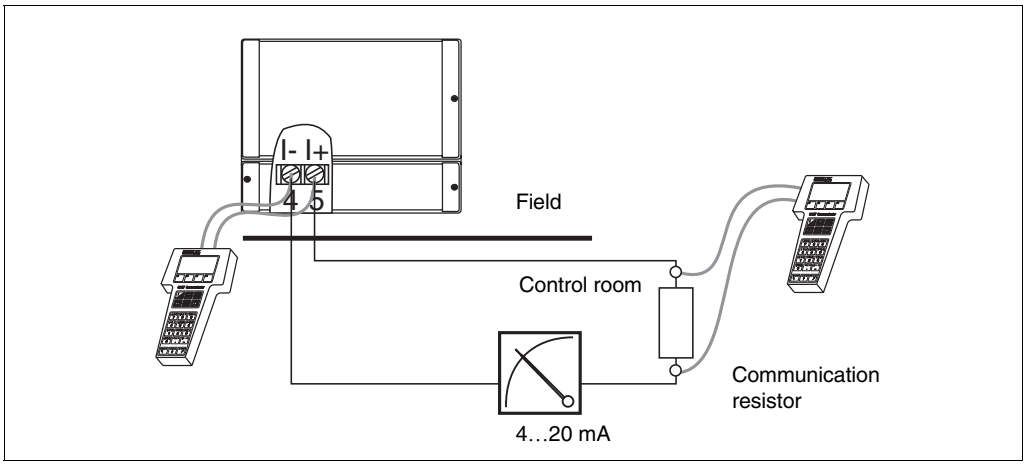


Connection of the HART handheld terminal

The Prosonic transmitter can be configured and addressed for operational status using a DXR 275 HART handheld terminal if a HART interface is available for it. In this case a plug-in module extends the function of the first current output, making it an interface with serial data transmission on the 0/4...20 mA signal line. Units connected to the current output are entirely unaffected by this digital signal. The plug-in module can be retrofitted.

The handheld terminal is connected on site either to current output 1 (Terminals 4 and 5) or in the control room to the communication resistor (see Fig. 2.15)
- R_{max} 600 Ω
- Use two-wire screened cable, maximum capacitance 60 nF.

Fig. 2.14
Connection of the HART Communicator DXR 275 in the field and in the control room.



2.3 Technical Data

General specifications

Manufacturer	Endress+Hauser GmbH+Co.
Function	Transmitter for level or flow measurement with one or two Prosonic sensors
Interfaces	0/4…20 mA, optional RS 485 or PROFIBUS-DP
Miscellaneous	CE-mark

Input characteristics

Signal input, channels 1 and 2	
Sensor:	one Prosonic FDU 8... (nominal measuring range 5...70 m). FMU 862: two Prosonic FDU 8... (may be different).
Separate switching input	external passive limit switch (maker or breaker) or PNP switch, e.g. Liquiphant or Soliphant (24 V, max. short-circuit 20 mA)
Separate temperature sensor input for FMT 131 (Temperature sensor FMT 131 is available as accessory)	– Applications: With heated sensors or if the temperature does not have to be measured in the sensor. – Function: For temperature compensation of the sound run time in flumes. – NTC design

Output characteristics

Analog outputs			
Output	– 4...20 mA, switchable to 0...20 mA (current signal with inverse function) – for FMU 862: same values for second channel, switchable together with channel 1 to 0…20 mA – with plug-in module for serial interface (HART) – 4 mA threshold switchable		
Signal underflow / Signal overflow		**Signal underflow**	**Signal overflow**
	4…20 mA	3.8…4 mA	20…20.5 mA
	0…20 mA	–0.5…0 mA	20…20.5 mA
Output on alarm		**0 ... 20mA**	**4 ... 20 mA**
	–10 %	–2 mA	2.4 mA
	110 %	22 mA	21.6 mA
	hold	last measured value	last measured value
Current limitation	24 mA		
Measuring uncertainty	0.2 % for maximum measuring span and smoth surface		
Damping	0…300 sec.		
Max. load	600 Ω Communication resistor: 250 Ω		
Load effekt	negligible		

Relays	
Typ	– Three (relay 1, 2, 5) or five independent relays each with a potential-free changeover contact – Prosonic with RS 485 or PROFIBUS-DP, as three relay version (relay 3, 4, 5) only
Function	– Limit switch – Fault message – Tendency message – Pulse generator (FMU 861 and 862 only) (max. counting rate 2 Hz, pulse with 200 msec) – Time pulse generator (FMU 861 and 862 only) – Back water alarm (FMU 862 only)
Limit values	4 A, 250 VAC, 1000 VA for cos φ = 0.7; 35 VDC and 100 W

Output characteristics (continued)

Displays and keyboard	
Display (LCD)	– 4 $^1/_2$-figure display for measured value, optional back light; – with segmental display of the current in 10% steps, – with different display elements (fault, signal under or overflow, communication)
Light emitting diodes	– Each relay has a yellow LED for signalling a fault or status of the relay (LED is lit for »relay energised«). – The LED of a relay for fault indication is lit when operating correctly. – A green LED also indicates that operation is free from faults and flashes on warning.
Totaliser	Typ: six-figure, cannot be reset (for FMU 861 standard, for FMU 862 optional)
Software totaliser	FMU 861 as standard, FMU 862 optional

Communication interface	
Hart-Communicator DXR 275	– Connections current output 1of transmitter or in signal line (smart transmitter only) – Communication resistor: 250 Ω
Rackbus RS 485	Optional interface for direkt connection to PC via adapter or interface card or to Rackbus via interface card FXA 675 Rackbus adress via 8 pin DIP switch in instrument, Bus termination via 4 pin DIP switch in connection compartment
PROFIBUS-DP	optional interface for connection to a PC via PROFICARD (PCMCIA card) or PROFIBOARD (PCI Board). 8-digit DIP-switch for addressing 4-digit DIP-switch for bus termination Supported baudrates: 19.2 kBaud, 45.45 kBaud, 93.75 kBaud, 187.5 kBaud, 500 kBaud, 1.5 MBaud
Synchronizing connection	Parallel link for twenty units when several sensor cables are run side by side over long distances.
Interface for Endress+Hauser Service	For rapid diagnosis

Power supply

Alternating voltage Power consumption	180…230 V (50/60 Hz); 90…132 V (50/60 Hz); 38…55 V (50/60 Hz); 19…28 V (50/60 Hz) maximal 15 VA, maximal 65 mA bei 230 V_{AC}
Direkt voltage Power consumption	20…30 V (Residual ripple within range) maximum 12 W (typically 8 W), maximum 500 mA at 24 VDC
Safe isolation	between current output, relay outputs, RS 485 interface, power supply and sensor input

Environment

Operating temperature	–20…+60 C
Storage temperature	–40…+80 °C
Climatic class	to table 10, Class R, DIN 40 040, instrument outdoors, average annual humidity 95 %, dew permissible
Ingress protection	DIN 40 050 – Protective housing IP 66 with closed housing and corresponding cable glands IP 40 with open housing IP 10 with open terminal compartment – Plastic housing and cable gland for same protection: IP 40 – Mounting plate: IP 10 – Separate operating unit for control panel: IP 40 – Separate operating unit for rack: IP 10

Electromagnetic compatibility	AC power supply: Emitted interference to EN 61326 ; Class B equipment; Immunity to interference to EN 61326 ; Annex A (industry sector) DC power supply: Emitted interference to EN 61326 ; Class A equipment Immunity to interference to EN 61326 ; Annex A (industry sector) for PROFIBUS-DP instruments: Emitted interference to EN 61326; Class A equipment Immunity to interference to EN 61326
Explosion proof	Standard; CSA General Purpose

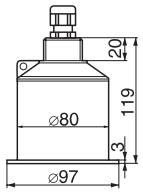
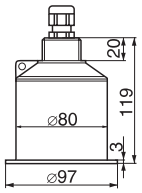
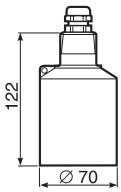
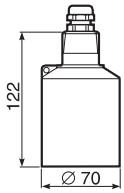
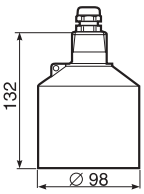
Mechanical specifications

Housing	
IP 66 Protective housing	– with electronics and operating unit – Material: body of PT/ABS, transparent cover PC (polycarbonate), blue front panel with field for marking – Weight: 2.6 kg
IP 40 Plasting housing	– Weight: 1 kg
IP 10 Mounting plate	– Weight: 0.8 kg
IP 40 Separate operating unit (keyboard and display)	– Version for mounting in a panel or rack – Connection cable to transmitter electronics 3 m long – Weight: 0.3 kg
Electrical connection	
Cable entries	Preskimped cable entries: 5 (resp. 4) x Pg16 each in rear wall and bottom, 4 x Pg13.5 (M20x1,5) in bottom of housing
Connection	Screw terminals for cable cross sections 0.5mm^2...2.5 mm^2
Cable	Commercial installation cable, max. 6 Ω, max. 60 nF (per core)

Certificates
– Transmitter FMU
– Sensors FDU
– Temperature sensor FMT

	FDU 80	FDU 80 F	FDU 81	FDU 81 F	FDU 82	FDU 83	FDU 84	FDU 85	FDU 86	FMU	FMT
ATEX II 1/2 D						X	X	X	X		
ATEX II 2 G	X	X	X	X	X				X		X
ATEX II 3 D	X	X	X	X	X	X	X	X	X	X	
ATEX II 3 G	X	X	X	X	X						
FM Class I; Div. 1; Groups A…D	X	X	X	X	X					X	X
FM Class I; Div. 2 Groups A...D									X		
FM Class II; Div. 1; Groups E, F, G						X	X	X	X		
CSA General Purpose	X	X	X	X	X	X	X	X	X	X	X
CSA Class I; Div. 1; Groups A…D	X	X	X	X	X						
CSA Class II; Div. 1; Groups E, F, G						X	X	X	X		
TIIS Ex is II T6	X		X		X						
TIIS dust Ex DP12						X		X	X		
GL, DNV, LR, ABS, BV, RINA	X		X		X	X	X	X		X	

Additional signal outputs

	FDU 80/FDU 80F [9]	FDU 81/FDU 81 F [9]	FDU 80	FDU 81	FDU 82
Dimensions					
Measuring ranges Liquids	5 m	10 m	5 m	10 m	20 m
Solids	—	—	—	5 m	10 m
Blocking distance	0.3 m	0.5 m	0.3 m	0.5 m	0.8 m
Materials Housing/thread/ diaphragm	ETFE	ETFE	PP-GF	PP-GF	PP-GF
Diaphragm seal	—	—	EPDM	EPDM	EPDM
Weight	0.5 kg	0.55 kg	0.55 kg	0.6 kg	1.2 kg
Operating temperature	–40…95 °C[10]	–40…95 °C[10]	–20 °C…+60 °C	–20 °C…+80 °C[1]	–20 °C…+80 °C
Limits	–40…95 °C[8]	–40…95 °C[8]	–40 °C…+60 C[8]	–40 °C…+80 °C[8]	–40 °C…+80 °C[8]
Ambient temperature	–40…95 °C	–40…95 °C	–40 °C…+60 °C	–40 °C…+80 °C	–40 °C…+80 °C
Max. Operating pressure $p_{absolute}$	4 bar[7]	4 bar[7]	2 bar[7]	2 bar[7]	2 bar[7]
Relative humidity	100 %	100 %	100%	100%	100%
Heating	—	—	X	X	—

1) FDU 81 with heating: operating temperature –20 °C...+60 °C

2) IP 68 tested in 1 m submersion, 24 h

3) A coating in 1.4301 around the PPA housing allows it to be used in Zone 10

4) 0.5 mm stainless steel 1.4571 with 4 mm closed-cell PE coating on side nearest product

5) 1 mm thick aluminium with 5 mm closed-cell PE coating on side nearest product

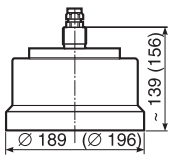
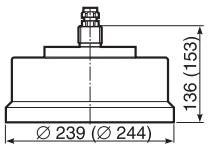
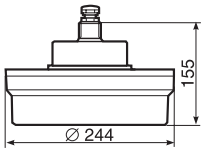
7) May be used at high pressures but only after first contacting Endress+Hauser

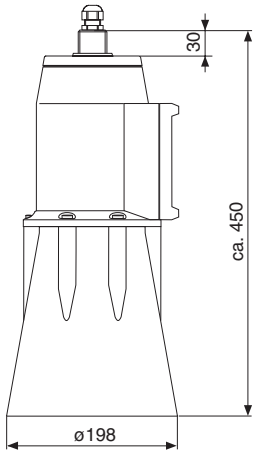
8) May be used at high temperatures but only after first contacting Endress+Hauser

9) With 3A approval optional

10) Flush-mounting possible:
– CIP at 95 °C
– Sterilisation 30 min. at 135 °C

11) With PTFE coated aluminium diaphragm

	FDU 83	FDU 84	FDU 85
Dimensions	 values for dust-Ex in brackets [3]	 values for dust-Ex in brackets [3]	
Measuring ranges Liquids	25 m	—	—
Solids	15 m	25 m	45 m
Blocking distance	1.0 m	0.8 m	0.8 m
Materials Housing Thread Diaphragm Diaphragm seal	PPA[3] 1.4301 or Aluminium 1.4571 EPDM	PPA[3] 1.4301 or Aluminium 1.4571/PE[4] EPDM	UP UP AL/PE[5] EPDM
Weight	3.1 kg	4.7 kg	5.0 kg
Operating temperature	–20 °C…+80 °C	–20 °C…+80 °C	–20 °C…+80 °C
Limits	–40 °C…+80 °C[8]	–40 °C…+80 °C[8]	–40 °C…+80 °C[8]
Ambient temperature	–40 °C…+80 °C	–40 °C…+80 °C	–40 °C…+80 °C
Max. operating pressure $p_{absolute}$	1.5 bar[7]	1.5 bar[7]	1.5 bar[7]
Relative humidity	100 %	100 % (at 60 °C) 95 % (at 80 °C)	100 % (at 60 °C) 95 % (at 80 °C)
Protection [2]	IP 68	IP 68	IP 68

Typ	FDU 86
Dimensions	
Measuring ranges Liquids	–
Solids	70 m
Blocking distance	1.6 m
Operating frequency at 23 °C	11 kHz
Materials Housing Thread Diaphragm Diaphragm seal	 UP VA/UP Al/PTFE [11] Silicone
Weight	5 kg
Operating temperature	–40 °C...+150 °C [8]
Limits	–40 °C...+80 °C [12] –40 °C...+140 °C [13]
Max. operating pressure $p_{absolute}$	3 bar [7]
Relative humidity	100 %
Protection [2]	IP 68
Mounting	G1A or 1 NPT
Integrated temperature sensor	X

12) Restriction according to certificates
FDU 86 - F...
- K...
- L...

13) Restriction according to certificates
FDU 86 - E...
- J...
- P...
- Q...
- S...
- T...

3 Controls

This Section describes how the Prosonic FMU is operated. It is divided into the following sections:

- Prosonic operating matrix
- Display and controls of the Prosonic FMU
- Display and controls of the DXR 275 HART handheld terminal

3.1 Prosonic Operating Matrix

All functions including the analogue outputs and relay switch points are configured via the operating matrix. Fig. 3.1 shows a part of the display and its relationship to the operating matrix of the Prosonic FMU:

- Each field in the matrix is accessed by a vertical (V) and horizontal (H) position which can be entered using the keys on the Prosonic or the handheld terminal.

The operating matrix is given at the back of this manual. A folded copy of the operating matrix is also found in the cover of the field housing.

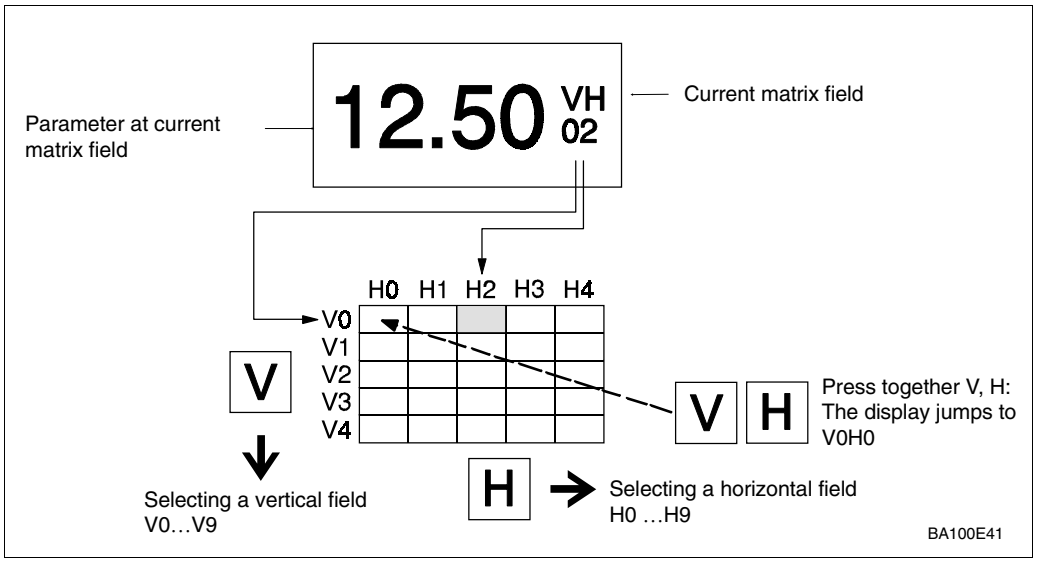


Fig. 3.1
Part of the Prosonic display and relationship to the operating matrix.
The complete matrix consists of 10 x 10 fields although not all have functions

The most important matrix fields for measured values are given in Table 3.1. (Channel 2 is only available with the FMU 862).

Tab. 3.1
The most important matrix fields for displaying measured values

Display field	Channel 1	Channel 2
measured value	V0H0	V4H0
distance	V0H8	V4H8
level	V0H9	V4H9

3.2 Display and Controls: Prosonic FMU

Display symbols

The display has 4 1/2 characters to indicate the value of the parameter, the matrix field V and H as well as other display symbols.

- A bar chart shows the signal current in 10% steps.
- If the entire bar chart is lit and the triangle to the right is also lit, then the current signal is larger than 20 mA (signal is exceeded). If the entire bar chart is not lit and the triangle on the left is lit, then the current – a function of the current range selected – is smaller than 4 mA or 0 mA (signal underflow)
- If the symbol for error indication is lit, then a fault has occurred. If the symbol flashes then the Prosonic FMU is indicating a warning and tries to continue measuring. Further information on error responses are described in Section 9.
- If the communications symbol is lit, the Prosonic is being operated via the HART Communicator DXR 275.

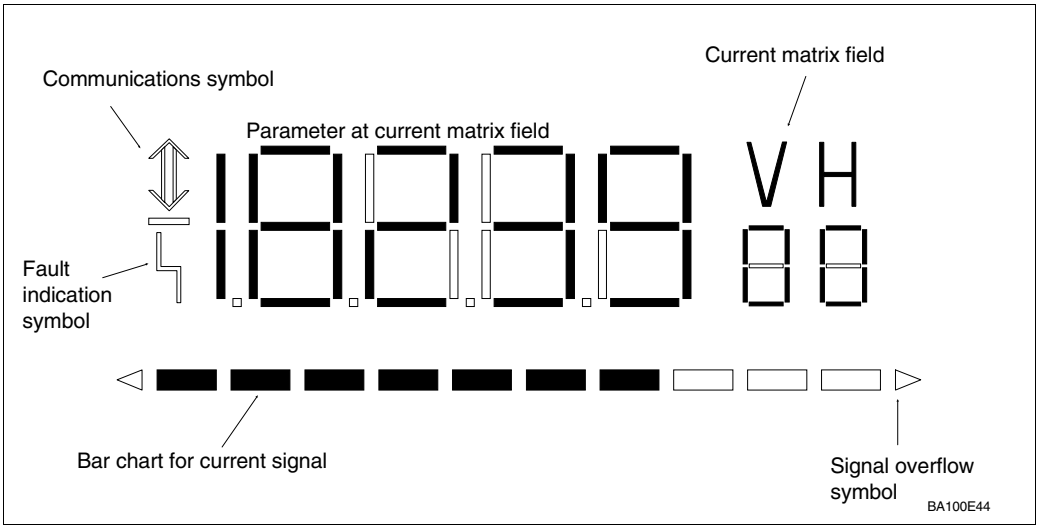


Fig. 3.2
Display symbols

Note!
- If a number cannot be displayed on the 4 ½ digit display, »E---« appears.
- Changes are not possible if the matrix has been locked (Section 8.2)
- Non-flashing parameters are either read-only indications or locked entry fields.

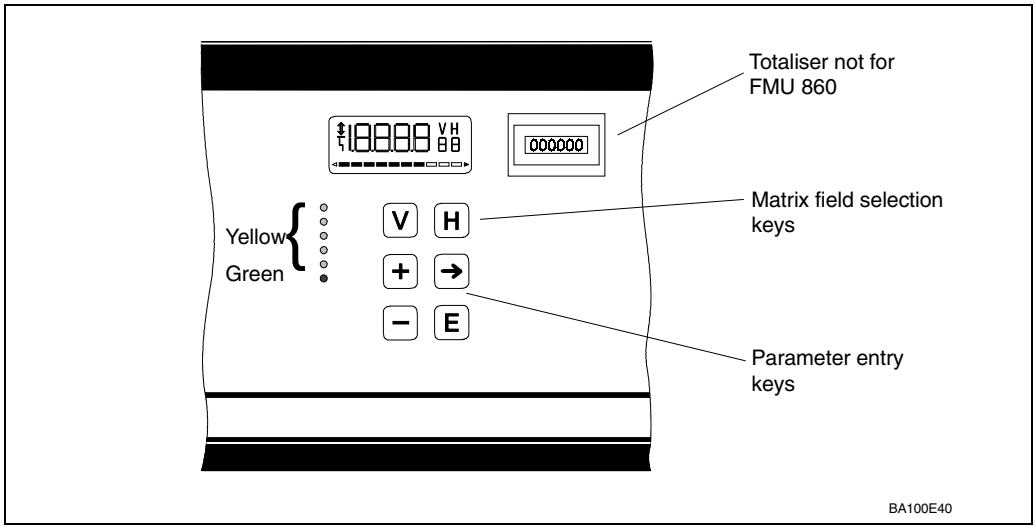
Note!

Fig. 3.3 shows the front panel with all controls and displays. Table 3.2 shows the function of the operating keys.

LEDs and totaliser

- A yellow LED is assigned to each relay which lights when the relay is energised. The »fault« function can be assigned to any of the relays (see Section 9).
- A green LED lights when the transmitter is in standby and flashes on warning (see Section 9).
- Six-digit totaliser (non-resetable):
  FMU 860 has no totaliser,
  FMU 861 always has a totaliser,
  FMU 862 has a totaliser as option.

Fig. 3.3
Front panel of the Prosonic FMU 86…



Tab. 3.2
Prosonic FMU 86…
Parameter entry and display keys

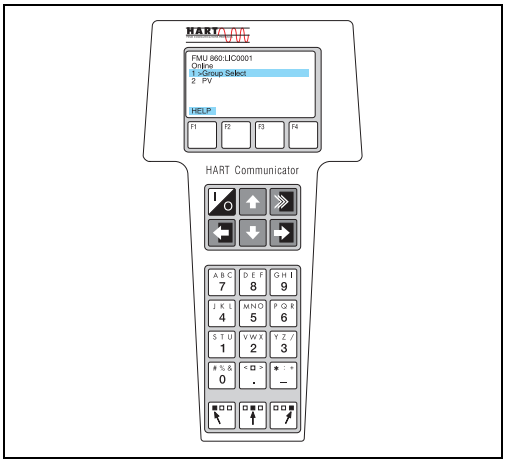
Keys	Function
Matrix selection	
V	• Press V to select the vertical position.
H	• Press H to select the horizontal position
V + H	• Press simultaneously to select the measured value field, V0H0
Parameter entry	
→	• Select the digit to be changed. The digit at the extreme left is selected and flashes. • Move to the next digit by pressing »⇒«again. When the last digit is reached »⇒«selects the leftmost digit again.
+ + →	• To change the position of the *decimal point*, press down both »⇒«and »+« The decimal point moves 1 space to the right.
+	• Increases the value of the flashing digit
−	• Decreases the value of the flashing digit • To enter a *negative number* decrease the leftmost digit until a minus sign appears in front of it
E	• Press »E«to register entry. • Unregistered entries remain ineffective and the instrument will operate with the old value.

Other functions for the FMU 862

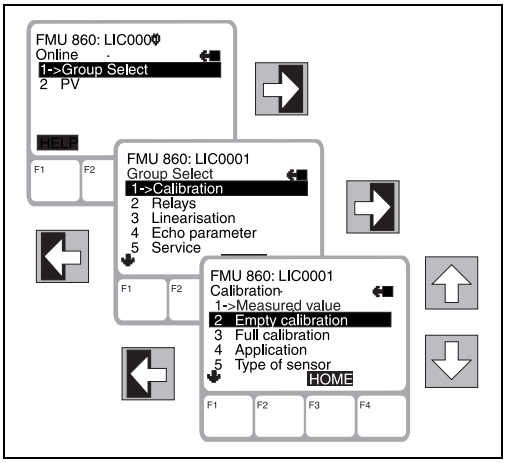
The two-channel Prosonic FMU 862 can show measured values alternately for both channels every two seconds. The channel is easily identified on the display:
V0H0 shows the value for Channel 1
V4H0 shows the value for Channel 2.

Step	Matrix	Entry	Significance
1	V0H0	»E«	The measured value for Channel 1 (V0H0) and Channel 2 (V4H0) are shown alternately until »E« is again pressed.

3.3 Operation via Universal HART Communicator DXR 275



When operating with the HART protocol, a menu is used which is based on the matrix
(see also the operating instructions of the handheld terminal, BA 139F).



- The menu »Group Select« calls up the matrix
- The bars show menu headings.
- The parameters are set using submenus.

Connecting the handheld terminal is described in Section 2.2 Electrical Connection, Page 22.

3.4 Operation with Commuwin II

When operating with the Commuwin II display and operating program (from Version 1.5 onwards) the Prosonic transmitter is set and operated using either

- an operating matrix or
- the graphic operating mode

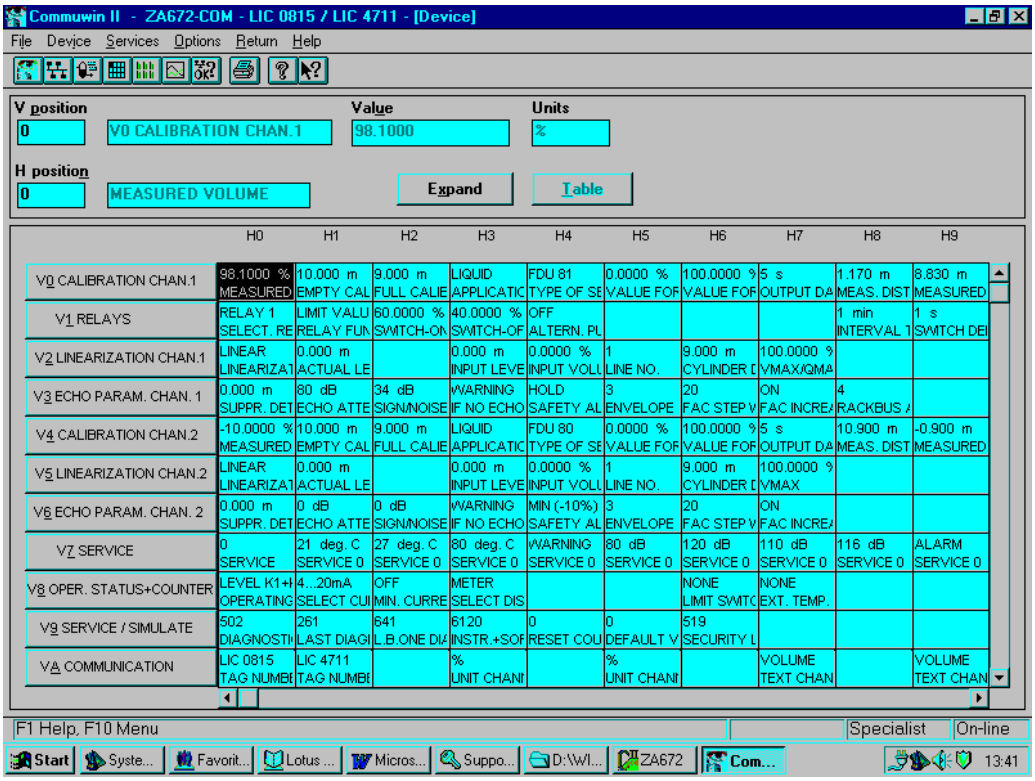
The appropriate server (e.g. HART, DPV1 or ZA 672) must be activated. A description of the Commuwin II operating program is given in the operating instructions BA 124F.

Operating matrix

Other functions of the Prosonic FMU can be called up in this operating mode within the instrument parameters menu.

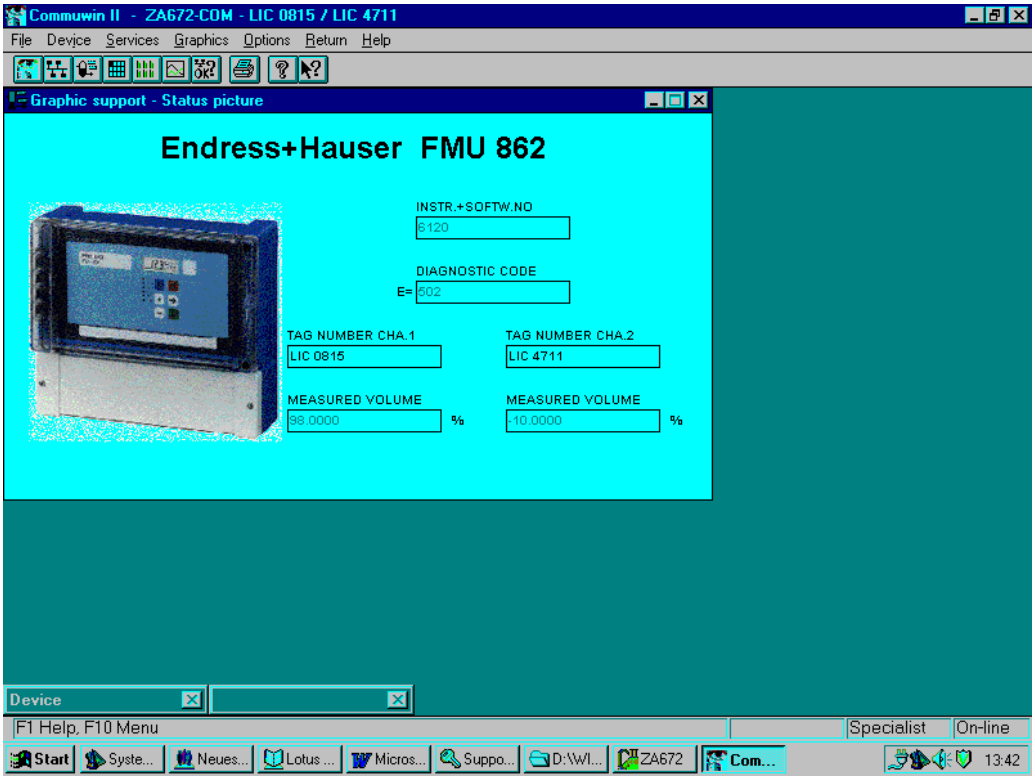
- Every row is assigned to a function group.
- Every field shows one parameter.

The calibration parameters are entered in the appropriate fields.



Graphical operation

In this operating mode the parameters for specific configuration procedures are entered in the appropriate places on the screen.



4 Level, Difference, Average Value

This chapter deals with the basic settings necessary to enable the Prosonic FMU to operate with the ultrasonic sensor and for you to obtain an indicated measurand rapidly:

- for level measurement or
- for the measurement of difference or average value

Setting is carried out in three steps:

- Basic settings
- Basic adjustment and
- Linearization, only necessary for special applications.



Note!

Note!
As long as the basic settings have not been concluded, the Prosonic FMU emits a warning message.
For FMU 862 we recommend that, after the basic settings, channel 1 should first be adjusted and linearized, then channel 2.
The matrix positions for channel 2 are on the right of the step-for-step entries.
Setting of the analog outputs and the relays is described in chapters 6 and 7.
When all parameters have been entered, the matrix can be locked
(see chapter 8).
After locking, all entries can be displayed, but not altered.

Note the settings

When entering the parameters the values entered can be noted in the table on page 111.

4.1 Basic Settings

In detail, the following entries have to be made for the basic setting of the Prosonic FMU:

- Reset the Prosonic FMU.
  When commissioning for the first time or after replacing the sensor or transmitter (only during initial commissioning) or after changing between the operating modes flow and level
- Setting the unit of length
- Setting the operating mode
- Entering the type of sensor or both sensors
- Entries regarding external measuring devices (external limit switch, external temperature sensor)

Resetting the transmitter

During initial commissioning a reset to the values preset in the works (known as default values) should be made.
By entering 333 (if operated via PROFIBUS-DP: 1) in matrix field V9H5 the default values can be reset.

Step	Matrix	Entry	Meaning
1	V9H5	333	Enter the value 333 (for operation via PROFIBUS-DP: 1)
2	-	»E«	Confirm entry



Note!

Note!
After resetting the transducer:
- The length unit is the same as that before the reset
- Any curve which has been previously entered by the user remains stored; the transmitter selects the »linear« mode.

Length units

The Prosonic FMU can be set in feet or metres (default). The length unit is changed in matrix field V8H3.

Step	Matrix	Entry	Meaning
1	V8H3	e.g. 1	1 = feet; 0 = metres (default value)
2	-	»E«	Confirm entry



Caution!

Caution!
- Units of length may only be altered immediately after a reset of the transmitter
- After determing the length unit, this can only be altered when all other parameters are also changed.
- Units of length are the same after resetting the Prosonic as before the reset

Setting the operating mode

Now enter a number in V8H0 for the operating mode:

- 0 = Level measurement in channel 1
- 1 = Level measurement in channels 1 and 2
- 3 = Level measurement in channel 2 (and rate of flow in channel 1)
- 4 = Difference measurement (Level channel 1 - Level channel 2)
- 5 = Measurement of average value (1/2(Level channel 1 + Level channel 2))
- 10 = Level measurement on Channel 2 and (differential measurement (Level Channel 1 - Level Channel 2) on Channel 1



Note!

Note!
- Modes 2 and 3 and 9 for flow measurement are described in chapter 5.
- For mode 3 and 9 the channel for measuring rate of flow should be set first.
- Modes 7 and 8, simulation of channels 1 and 2, are described in chapter 9.

Step	Matrix	Entry	Meaning
1	V8H0	e.g. 0	Mode 0, level measurement in channel 1
2	-	»E«	Confirm entry

Specify sensor type(s)

Now enter the type of sensor. For two-channel units the types of both sensors must be entered. The ultrasonic echo can not be evaluated for roughly 5 minutes after the entry of the sensor type. During this time (in which the optimum frequency is attained) the last measured value is displayed.

80 = FDU 80
80F = FDU 80 F
81 = FDU 81
81F = FDU 81 F
82 = FDU 82
83 = FDU 83
84 = FDU 84
85 = FDU 85
86 = FDU 86

Step	Matrix	Entry	Meaning
1	V0H4	e.g. 82	Sensor FDU 82 is connected to channel 1
2	-	»E«	Confirm entry
With FMU 862 now specify the sensor for channel 2.			
3	V4H4	e.g. 82	Sensor FDU 82 is connected to channel 2
4	-	»E«	Confirm entry

Entries regarding external measuring devices

If an external limit switch or temperature sensor, or both, are connected to the Prosonic FMU, it is necessary to activate the external measurements (see chapter 6 »Analog output« and chapter 7 »Relays«).

Limit switch

Step	Matrix	Entry	Meaning
1	V8H6	e.g. 2	Limit switch is connected and should operate at maximum in channel 1
2	-	»E«	Confirm entry

External temperature sensor

Step	Matrix	Entry	Meaning
1	V8H7	e.g. 1	external temperature sensor is connected and provides a temperature signal for channels 1
2	-	»E«	Confirm entry

4.2 Basic Adjustment: Empty/Full Adjustment

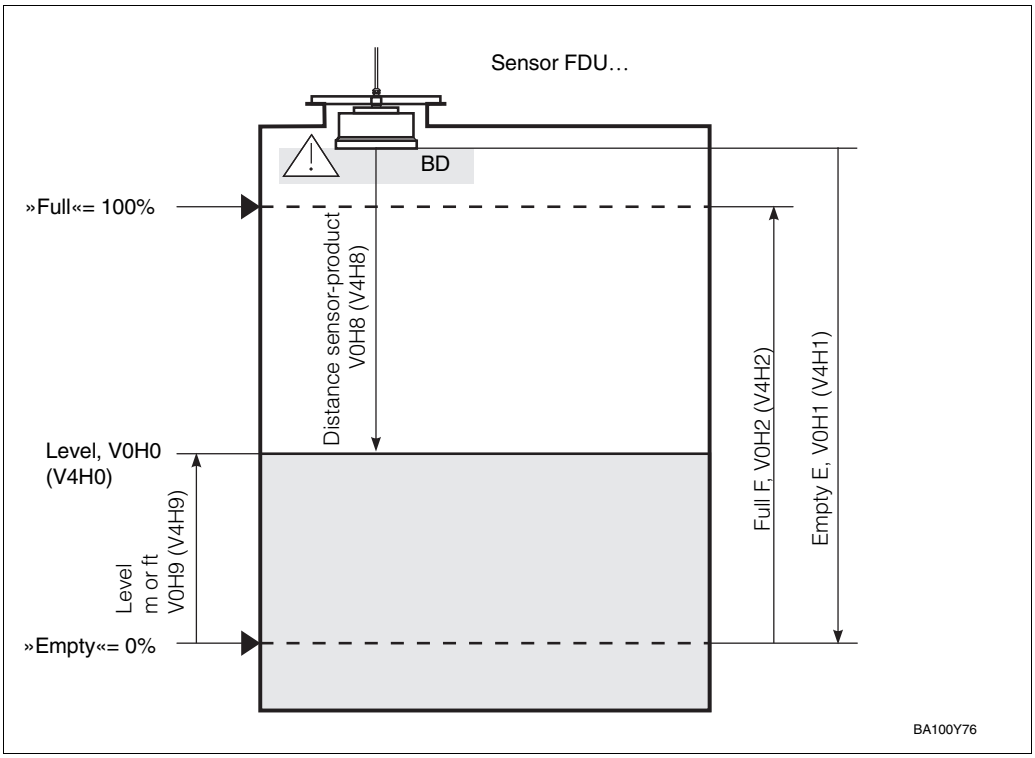


Fig. 4.1
Parameters needed for the Empty-Full adjustment
In brackets are the matrix positions for channel 2

For the empty/full adjustment it is necessary to enter two parameters

- Distance from sensor membrane to desired 0 % point,
- Distance from 0 % point to desired 100 % point.

Adjustment can be carried out in the reverse order.

Step	Matrix	Entry	Meaning	Channel 2
1	V0H1	e.g. 13	Distance between sensor membrane and »0% point«. If a value is entered which exceeds the measuring range of the sensor, the transmitter assumes the default value.	V4H1
2	-	»E«	Confirm entry	
3	V0H2	e.g. 12	Distance between the »0% point« and the 100% point«.The »100% point« may not be within the blocking distance of the sensors	V4H2
4	-	»E«	Confirm entry	
5	V0H0		The measurand is displayed as % of the range.	V4H0

After Empty/Full adjustment

The result of these entries is that:

- The transmitter in matrix field V0H0 indicates the measurand as percentage of the measuring range (for channel 2 in V4H0). If the measured value is not in a percentage but is shown in other units, then additional data entries are required. (see »Level measurement with any units« page 38)
- The distance between the sensor membrane and the material is shown in matrix field V0H8 (for channel 2 in V4H8) and from the 0 % point to the surface of the material in V0H9 (for channel 2 in V4H9) in ft or in m.
- The 0/4…20 mA signal refers to 0…100 %.
- When the mounting conditions are very unfavourable, it may be necessary to suppress noise signals (see chapter 9).

Level applications

Preset operating values that can be called off and used for various purposes shorten commissioning. By selecting only one application parameter the measuring line is automatically adapted to suit one of five typical applications. The level applications can be selected in matrix position V0H3.

- 0 = Liquid
- 1 = Liquid, application with rapid change in level
- 2 = fine-grained solids
- 3 = coarse-grained solids
- 4 = conveyor belt loading (solids, application with rapid change in level)

The effects of the various applications on the ultrasonic measurement are described in Appendix B.

Step	Matrix	Entry	Meaning	Channel 2
1	V0H3	e.g. 1	Level application »rapid liquids« is selected	V4H3
2	-	»E«	Confirm entry	

Actual level V2H1

When the measuring task demands high accuracy, the entry of an »Actual level« enhances the accuracy. The exact level is, for example, measured with a dip stick and then entered in V2H1.

Step	Matrix	Entry	Meaning	Channel 2
1	V2H1	e.g. 2.46	Actual level is 2.46 m	V5H1
2	-	»E«	Confirm entry	

Display of height in meters or feet

The level height in metres (or feet, depending on the original setting) can be displayed in matrix field V0H9 (V4H9 for channel 2).

Level measurement with any units

The following entries are only necessary when no linearization is made afterwards.
If the measurand in V0H0 is not to be indicated in % but in some other unit, the full scale value required is entered in V2H7. With these entries, for example, the contents or volume of a vertical, cylindrical tank can be measured. Below the term »volume« is used in the entry steps. Replace it by the numerical value of your unit of measurement.

Step	Matrix	Entry	Meaning	Channel 2
1	V2H7	e.g. 750	Enter volume 750 m^3 at 100%	V5H7
2	-	»E«	Confirm entry	
3	V2H0	0	Activate linearization »linear«	V5H0
4	-	»E«	Confirm entry	



Note!

Note!
A reset does not automatically set the display to a percentage! If the display is to return to a percentage, then »100« must be entered in V2H7 for 0…100 %.

Measurand indication

The measurand for channel 1 is indicated by V0H0 (channel 2 by V4H0). In addition, some matrix fields contain information on the system, e.g. for fault analysis, etc.
Table 4.1 summarizes the displayed and measured values.

Tab. 4.1
Measurand indication

Matrix	Measurand	Note
V0H0 V4H0	Level or volume	Indicated in %, hl, m^3, ft^3, t dependent of wether a linearization has been activated
V0H8 V4H8	Distance: Sensor - product surface	The distance between sensor and product surface in m or ft V0H8 for channel 1, V4H8 for channel 2
V0H9 V4H9	Level	indication of level in m or ft V0H9 for channel 1, V4H9 for channel 2
V3H1 V6H1	Echo attenuation db	The echo attenuation between emission and reception by the sensor V3H1 for channel 1, V6H1 for channel 2
V3H2 V6H2	Signal-noise ratio	Signal-noise ratio: The difference between a useful signal (echo) and a noise signal. The higher this ratio is the better the echo can be evaluated (10 dB or lager is acceptable).
V8H8	Internal counter high	The first four digits of the eight digit software counter are displayed.
V8H9	Internal counter low	The last four digits of the eight digit software counter are displayed.
V9H0	Diagnostic code	The current diagnostic code can be read off
V9H1	Last diagnostic code	The last diagnostic code can be read off and deleted.
V9H2	Last diagnostic code but one	The last diagnostic code but one can be read off and deleted.
V9H3	Unit code with Software version	The first two figures are the unit code, the last two are the software number

4.3 Linearization

In tanks and vessels in which the volume is not directly proportional to the level, a level measurement is converted into a volume measurement by linearization. The parameters of linearization are entered in matrix line V2 for channel 1 and line V5 for channel 2. The types of linearization, horizontal, cylindrical tank and tank with conical outlet, are described in sections 4.3 and 4.4.

The following linearizations can be selected in V2H0:

0 = linear (default)
1 = horizontal cylindrical
3 = manual entry
4 = automatic entry
5 = delete

After linearization

After linearization

- In V0H0 the volume in the tank or silo can be read (V4H0 for channel 2).
- In V0H9 the level can be read (V4H9 for channel 2).
- The switching points of the relays must be set in accordance with the volume units.
- Analogue outputs: confisure the analogue outputs accordingly.

Two important rules for linearization must be observed:

- Linearization zero
  The level entries for linearization and the level entry for the empty adjustment must both refer to the same zero point.

- Units of measurement:
  For all level entries the numerical values must always refer to the same unit of length, as defined in V8H3.
  Also for all volume entries the numerical values entered must always refer to the same dimensional unit. For example, all values entered for volume must be in litres, hl or other unit.



Caution!

Caution!

- When manual entries are made, always delete the old linearization (V2H0=5), before entering new points.
- If the linearization limit is exceeded or dropped below::
  The curve is extrapolated downwards (upwards) by a maximum 10% with the first two (or last two) points.

Switch off linearization »linear«

The setting »linear« in the matrix field Linearization V2H0 is used when the linearization has to be switched off for measuring level as a percentage of total level. The linearization table is still in the memory, but no longer active.

Step	Matrix	Entry	Meaning
1	V2H0	0	Choose linearization »linear«
2	-	»E«	Confirm entry

Horizontal cylindrical vessel

In this mode the Prosonic FMU utilizes a linearization table valid for all horizontal, cylindrical vessels to calculate the volume from the level of the filling. Consequently, after the Empty/Full adjustment only two entries have to be made so that the volume of the filling may be displayed in VOHO: the diameter of the tank and its volume.

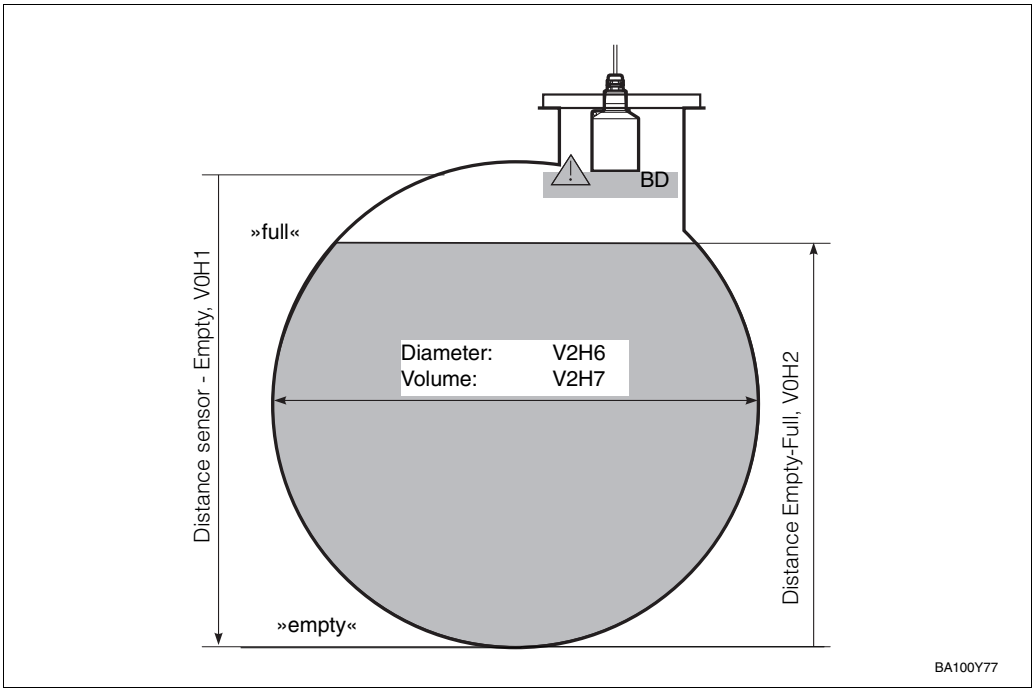


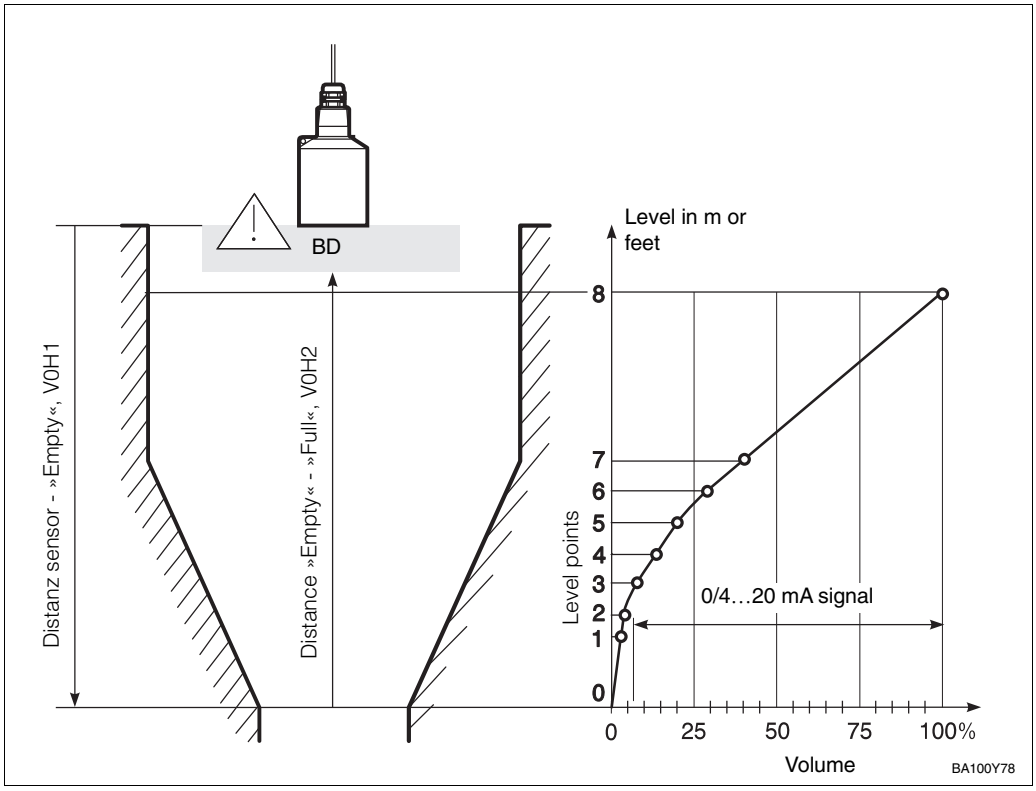
Fig. 4.2
Parameters needed by the first channel for calculation and linearization of the FMU with a horizontal, cylindrical tank.

Step	Matrix	Entry	Meaning	Channel 2
1	V2H6	e.g. 10	Enter tank diameter	V5H6
2	-	»E«	Confirm entry	
3	V2H7	e.g.200	Enter tank volume	V5H7
	-		If 100 is entered, the measurand is displayed as percentage volume	
4	-	»E«	Confirm entry	
5	V2H0	1	Activate linearization	
6	-	»E«	Confirm entry	

4.4 Linearization for Vessels of Any Shape

The linearization modes »manual« and »semiautomatic« are set to measure the volume of vessels which are not horizontal cylinders. A widespread example of such vessels is a tank with conical outlet. To measure the volume in such vessels the Prosonic FMU utilizes a table, in which the volume is stored for several levels. This table can be entered by hand.

Fig. 4.3
Parameters needed for linearization and the matrix fields for channel 1



The pairs of values in the table (volume/level) can be found in two ways and entered:

- when the level/volume ratio is known Linearization mode »Manual«:
  All pairs of values (volume/level) are entered from an existing table or a curve supplied by the tank manufacturer.
- when the level/volume ratio is unknown: filling the tank with known amount of liquids.
  »Automatic« linearization mode
  The following procedure has to be repeated several times: The tank is filled and the volume is measured (e.g. with a flow measuring unit). The measurand for the volume is entered in V2H4. The associated level is registered automatically. This procedure is repeated several times with different quantities, where possible uniformly spread over the whole range from empty to full vessel.

Note!



Note!

- It is reasonable to enter at least **three** points.
  With the first pair of values the smallest volume to be measured and the corresponding level should be entered.
  With the last pair of values the largest volume to be measured and the corresponding level should be entered.
- The more pairs of values you enter, the more exact is linearization. You can enter a maximum of 32 pairs of values.
- Having activated linearization, the points are sorted according to rising level and subjected to a plausibility check.
- After entering the point number the assigned pair of values, level and flow, can be displayed.

Manual linearisation with values from a table

Entering the slope for a known linearisation table

No V2H5	Level V2H3	Volume V2H4	No. V2H5	Level V2H3	Volume V2H4
1			17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		
16			32		

Step	Matrix	Entry	Meaning	Channel 2
1	V2H0	5	Deletes the active linearization characteristic	V5H0
2	-	»E«	Confirm entry	
3	V2H3	e.g. 0	Enter level	V5H3
4	-	»E«	Confirm entry	
5	V2H4	00.00	Enter volume	V5H4
6	-	»E«	Confirm entry	
7	V2H5	2	Second point is displayed	V5H5
8	-	»E«	Confirm entry. The FMU jumps to V2H3 (or V5H3), (the next point number is automatically selected)	
Repeat the following entries for all points:				
			Steps 3 to 8 must be repeated until the level and the volume have been entered for all points.	
9	V2H0	3	Select »manual«	V5H0
10	-	»E«	Activates the linearization characteristic entered.	

Manual linearization with automatic level recording (semiautomatic linearization)

Manual linearization with automatic level recording (semiautomatic linearization)

Step	Matrix	Entry	Meaning	Channel 2
1	V2H0	5	Deletes the active linearization characteristic	V5H0
2	-	»E«	Confirm entry	
3	V2H0	4	Activates automatic entry of a characteristic	V5H0
4		»E«	Confirm entry	
5	V2H4	00.00	Enter volume	V5H4
6		»E«	Confirm entry. The associated level in V2H3 (or V5H3) is registered automatically	
7	V2H5	2	Second point number displayed	V5H5
8	-	»E«	Confirm entry. The FMU jumps to V2H4 (or V5H4)	
Repeat the following entries for all points:				
			Steps 5 to 8 must be repeated until the level and the volume have been entered for all points.	
9	V2H0	3	Select »manual«	V5H0
10	-	»E«	Activates the linearization characteristic entered	

Error correction with manual and semiautomatic linearization

If an error was made in the entry, the wrong value can be overwritten by entering the table number in V2H5 and the new value in V2H3 or V2H4 (for FMU 862: enter the table number in V5H5 and the new values in V5H3 or V5H4 for channel 2).

- Having activated the linearization, the points are sorted and subjected to a plausibility check.

Step	Matrix	Entry	Meaning	Channel 2
1	V2H5	1…32	Enter the table number to be corrected	V5H5
2	-	»E«	Confirm entry	
3	V2H3/ V2H4	e.g. 10	Enter correct volume or level	V5H3/ V5H4
4	-	»E«	Confirm entry	
Carry out all corrections as per steps 1 to 4				
5	V2H0	3	Select manual	V5H0
6	-	»E«	Activates linearization characteristic	

Deleting a characteristic

All values in a linearization table can be deleted in one step; in the matrix field V2H0 for selection of linearization the setting »cancel« must be selected and confirmed.

Step	Matrix	Entry	Meaning	Channel 2
1	V2H0	»5«	Select linearization »cancel«	V5H0
2	-	»E«	Characteristic deleted	
3	V2H0	e.g. 1	Level, select horizontal cylindrical as new mode	V5H0
4 -		»E«	Confirm entry	



Note!

Note!
If a different linearizations mode is selected, the characteristic entered manually or semiautomatic remains stored in the Prosonic FMU, without being used. If linearization »manual« is later re-selected, the measuring properties of the Prosonic FMU are the same as before.

4.5 Level Difference Measurement for Screen Control

Fig. 4.4
Level difference measurement for screen control
The level can be shown on channel 1 or 2 depending on the operating mode used.

V8H0	Channel 1	Channel 2
4	h_1	h_1–h_2
10	h_1–h_2	h_2
	Display V0H0 (%)	Display V4H0 (%)

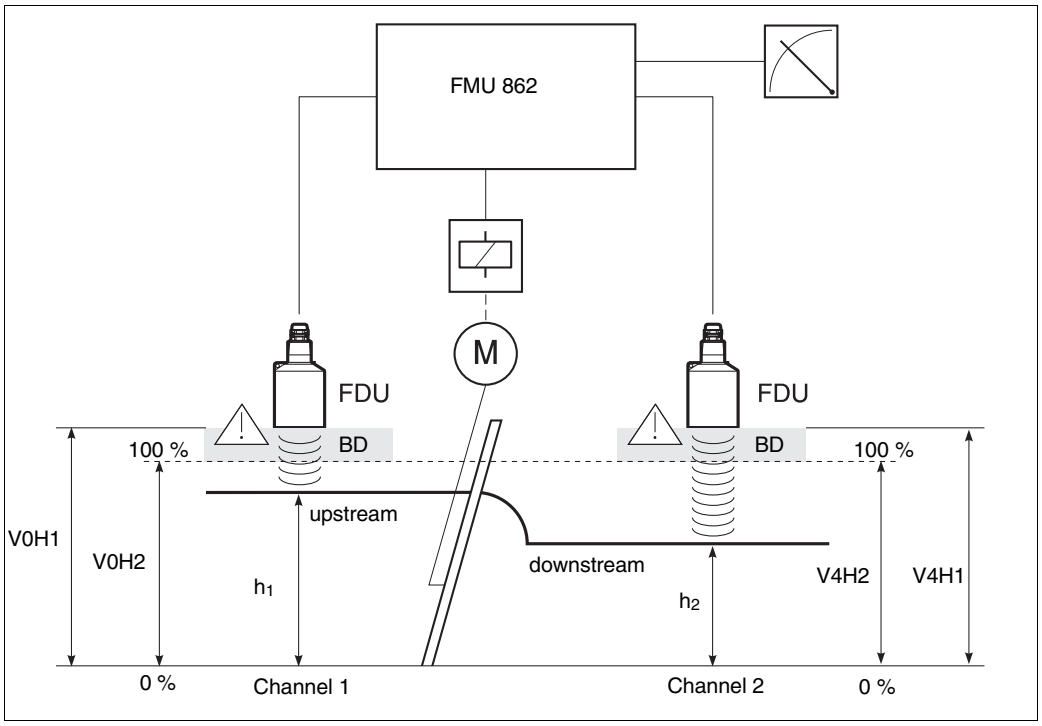


Fig. 4.4 shows a typical example of level difference measurement at a sewage plant. Two Prosonic sensors measure the difference between the levels h_1 and h_2. The difference in water level, h_1 -h_2, is indicated as a percentage of the measuring range of channel 1 of Prosonic FMU 862, and is a percentage of the set measuring range of channel 2 (V4H2). Output 1 provides a continuous indication of the level h_1 (the tail-race).

The following entries are necessary here, see Basic settings 4.1:
- Reset the transmitter
- Set the length units
- Select the operating mode »Difference«
- Enter the sensor types

Empty/Full calibration Channel 1

Step	Matrix	Entry	Meaning
1	V0H1	e.g. 1,3	Distance between sensor membrane and »0% point«. If a value is entered which exceeds the measuring range of the sensor, the transmitter assumes the default value.
2	-	»E«	Confirm entry
3	V0H2	e.g. 1,0	Distance between the »0% point« and the 100% point«.The »100% point« may not be within the blocking distance of the sensors
4	-	»E«	Confirm entry

Empty/Full calibration Channel 2

Step	Matrix	Entry	Meaning
1	V4H1	e.g. 1,3	Distance between sensor membrane and »0% point«. If a value is entered which exceeds the measuring range of the sensor, the transmitter assumes the default value.
2	-	»E«	Confirm entry
3	V4H2	e.g. 10	Distance between the »0% point« and the 100% point«.The »100% point« may not be within the blocking distance of the sensors
4	-	»E«	Confirm entry

If you enter the measuring range of channel 2 (max. downstream level) in V4H2 in metres, the difference is indicated at V4H0 in cm.
Example:
Measuring range of channel 2 = 1 m, 1% difference is 1 cm
Measuring range of channel 2 = 4 m, 1% difference is 4 cm

Relay setting

Step	Matrix	Entry	Meaning
1	V1H0	e.g. 1	Relay 1 is selected
2	-	»E«	Confirm entry
3	V1H1	1	Limit channel 2 is the relay function for the relay selected
4	-	»E«	Confirm entry
5	V1H2	e.g. 30	Switch-on point for selected relay
6	-	»E«	Confirm entry
7	V1H3	e.g. 28	switch-off point for the relay selected
8	-	»E«	Confirm entry

In this example, where V1H2 = 30, the relay switches when the difference between the upstream and downstream water levels is 30% relative to the measuring range of channel 2.
V0H0 shows upstream level h1 in %
V4H0 shows the difference in upstream and downstream levels in % relative to the measuring range of channel 2.

For further settings, set either the analogue output (see chapter 6) or a relay (see chapter 7).

4.6 Level Measurement with Calculation of the Average Value

A typical example of averaging is level measurement in a large silo. Two Prosonic sensors measure the level of the conical pile at separate points. The average value of readings h_1 and h_2 describes the contents of the silo much better than separate measurements.

The average value is indicated in channel 2 of the Prosonic FMU 862 i.e. $\frac{h_1 + h_2}{2}$.

Channel 1 provides a continuous indication of the level h1.
The following entries are needed:

- Reset the transmitter, mode »average value«, enter sensor types, see Basic settings 4.1.
- Empty/Full calibration for each channel, see Basic setting 4.2.
- Ist eine Linearisierung des gemittelten Wertes gewünscht, muß die Linearisierung im Kanal 2 erfolgen.

Analogue output Channel 1	Analogue output Channel 2
h_1	$\frac{h1 + h2}{2}$

For further settings, set either the analogue output (see chapter 6) or a relay (see chapter 7).

5 Flow

This chapter describes the basic settings for flow measurement which are necessary in order that Prosonic FMU may operate with the ultrasonic sensor so that a displayed measurand is rapidly obtained.
Setting is carried out in three steps:

- Basic setting
- Basic adjustment and
- Setting the totalisers

Note!
As long as the basic setting has not been concluded, the Prosonic FMU emits a warning. With FMU 862 we advise you to adjust and linearize channel 1 first after the basic setting (for channel 2 see chapter 4.2).


Note!

Setting of the analog outputs and the relays is described in chapters 6 and 7.
Having entered all parameters, the matrix can be locked (see chapter 8).
After locking, all entries can be displayed, but not altered.

Note the settings

When entering the parameters the values entered can be noted in the table on page 111.

5.1 Basic Settings

In detail the following entries are needed for the basic setting of the Prosonic FMU.

- Reset the Prosonic FMU, also after changing between the operating modes flow and level
- Setting the length unit
- Setting the operating mode
- Entering the type of sensor or for FMU 862 both sensors
- Entries relating to external measuring devices (external limit switch, external temperature sensor)

Reset the transducer

The first time the unit is commissioned, it should be reset to the values (default) set in the works.
By entering 333 (for operation via PROFIBUS-DP: 1) in matrix field V9H5 the unit is reset to the default values.

Step	Matrix	Entry	Meaning
1	V9H5	333	Enter the value 333 (for operation via PROFIBUS-DP: 1)
2	-	»E«	Confirm entry

Note!
After resetting the transducer:

- The length unit is the same as that before the reset
- Any curve which has been previously entered by the user remains stored; the transmitter selects the »linear« mode.


Note!

Length units

The Prosonic FMU can be set in metres (default) or feet. The change of length unit is made in matrix field V8H3.

Step	Matrix	Entry	Meaning
1	V8H3	e.g. 1	1 = feet; 0 = metres (default value)
2	-	»E«	Confirm entry


Caution!

Caution!
- Units of length may only be altered immediately after a reset of the transmitter.
- After determining the length units, this can only be altered when all other parameters are also changed.
- The length units are exactly the same after resetting the Prosonic as before the reset.

Setting the operating mode

Now enter a number in V8H0 for the mode:

- 2 = Flow measurement in channel 1
- 3 = Flow measurement in channel 1 (Level measurement in channel 2)
- 9 = Flow measurement with back pressure determination


Note!

Note!
The modes 7 and 8, Simulation channel 1 and channel 2, are described in chapter 9. All other modes are described in chapter 4.

Step	Matrix	Entry	Meaning
1	V8H0	e.g. 2	Mode 2, Flow measurement
2	-	»E«	Confirm entry

Specify sensor type(s)

Now specify the sensor type. For two-channel units both sensors must be specified.

80 = FDU 80
80F = FDU 80 F
81 = FDU 81
81F = FDU 81 F
82 = FDU 82
83 = FDU 83
84 = FDU 84
85 = FDU 85
86 = FDU 86

Step	Matrix	Entry	Meaning
1	V0H4	e.g. 80	Sensor FDU 80 is connected to channel 1
		»E«	Confirm entry
For FMU 862 specify the sensor for channel 2 as well			
3	V4H4	e.g. 80	Sensor FDU 80 is connected to channel 2
4	-	»E«	Confirm entry

External temperature sensor

If an external temperature sensor is connected to the Prosonic FMU, it is necessary to activate the external measurement (see chapter 6 »Analog output« and chapter 7 »Relays«).

Step	Matrix	Entry	Meaning
1	V8H7	e.g. 1	External temperature sensor is connected and supplies a temperature signal for channel 1
2	-	»E«	Confirm entry

5.2 Basic Adjustment

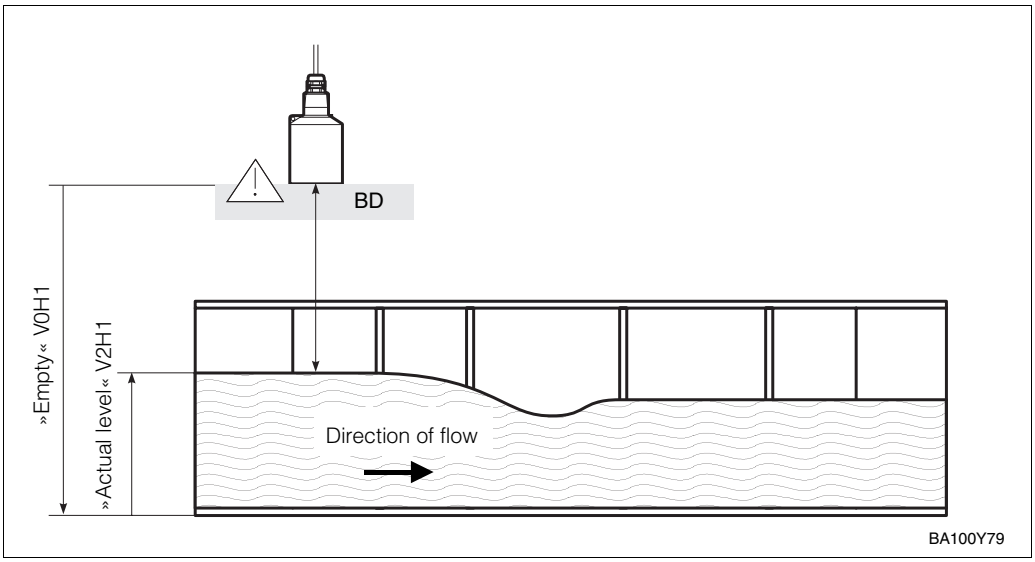


Fig. 5.1
Parameters needed for the basic adjustment of flow measurement. Example Khafagi Venturi channel

Three entries are necessary for the basic adjustment:

- Distance from sensor membrane to desired 0% point
- If the measuring task demands high accuracy, entering an »Actual level« can enhance the accuracy.
- Entries relating to the Q/h curve, either by entering the code of a stored characteristic or by entering a characteristic corresponding the data supplied by the manufacturer of the channel. A characteristic curve can be manually carried out with maximum 32 point for low damming heights.

The effect of these entries is that:

- the transmitter in matrix field V0H0 indicates the rate of flow.
- the distance between the sensor membrane and the water-level can be read in m or ft in matrix field V0H8 and the water-level itself in V0H9.

Adjustment »Empty«

Step	Matrix	Entry	Meaning
1	V0H1	e.g. 1.8	Distance between sensor membrane and »0% point«
2	-	»E«	Confirm entry

Actual level V2H1

If the measuring task demands high accuracy, the results of measurement can be improved by entering an »Actual level«.

Step	Matrix	Entry	Meaning
1	V2H1	e.g. 1.463	The actual level is 1.463 m
2	-	»E«	Confirm entry

Calling Up a Q/h Curve

The calculation performed by the Prosonic FMU converts the level measurement in the flume into a flow measurement. For this conversion a Q/h curve is needed.

- These characteristics are memorised for the weirs or flumes and the right one has to be activated by specifying a characteristic number. All available characteristics can be found in Appendix A.
- If the characteristic of your channel is not listed, the characteristic can be entered from a table drawn up by the manufacturer of the weir or flume.

Step	Matrix	Entry	Meaning
1	V2H2	e.g. 2	Select number of Q/h characteristic
2	-	»E«	Confirm entry
3	V2H0	e.g. 2	Activate linearization type of Q/h curve
4	-	»E«	Confirm entry
5	V0H0	-	Rate of flow is displayed

Entering a characteristic curve code determines the maximum flowrate Q_{max}. If the channel is only used in the lower range, then you can enter the actual maximum flow. All other entries (e.g. for current output) are then functions of the value entered (in V2H7).

Step	Matrix	Entry	Meaning
1	V2H7	e.g. 900	The actual maximum flowrate is 900 m3/h
2	-	”E”	Confirm input



Note!

Note!
After entering the curve (in V2H2), we recommend that the current output is calibrated, e.g. the value for Qmax can be enetered in VoH6, if the 20 mA current signal is for this flowrate (default value in VoH6: 100 m^3/h). The preset Q/h curves (see Appendix A) always have the flow unit m^3/h.
If you afterwards alter the flow units, the analogue output (see chapter 6) and the relays with the function »Limit value« must be set afresh (see chapter 7).

Crest length for rectangular sharp-crested weirs and trapezoidal (Cipoletti) sharp-crested weirs (V2H2=0, 1, 2 or 3)

Step	Matrix	Entry	Meaning
1	V2H2	e.g 1	Select the code with the H_{max} of the built-in weir
2	-	»E«	Confirm entry
3	V2H9	e.g. 2	Enter the width of the weir in m
4	-	»E«	Confirm entry
5	V2H0	2	Activate the Q/h curve
6	-	»E«	Confirm entry and activate curve

Note!
Modifying a weir is automatically updates the maximum flowrate Q_{max} of the Q/h curve and the entries dependent on it (e.g. the maximum counting factor). If the actual maximum flowrate is entered in V2H7, then the value for the new width of the weir must be altered accordingly.



Note!

Entering a Q/h Curve

For flumes and weirs whose Q/h characteristic cannot be called up by means of a code, the »manual« method of linearization is used. The characteristics are entered at up to 32 points as pairs of values (water-level l rate of flow) for each point.
The pairs of values in this table can be entered from a table or curve supplied by the manufacturer of the flume or weir.
Two important rules must be observed for the entries:

- Linearization zero point:
  The entries relating to the level for linearization and entry for empty adjustment must both refer to the same zero point.
- Units of measurement
  For all level entries the numerical values must always refer to the same unit of length, as defined in V8H3.
  Also for all flow data the numerical values entered must refer to the same unit as defined in V8H4.

Code in V8H4	0	1	2	3	4	5	6
Units	l/s	l/min	l/h	m^3/s	m^3/min	m^3/h	igps
Code in V8H4	7	8	9	10	11	18	19
Units	igpm	igph	ugps	ugpm	ugph	mgal/d	ft^3/s

Tab. 5.1
Flow units and their codes in V8H4

Unit of flow

Note!
If you subsequently change the unit of flow, the analog output (see chapter 6) and the relays with the function »Limit value« must be set afresh (see chapter 7).
If the flow unit selected is to small, the Prosonic automatically revents to the last unit with which the measurement was possible.



Note!

Entering the characteristic

- The first step is always to delete the old linearization (V2H0=5) before you enter any new points.
- After activating linearization, these points are sorted according to increasing level and subjected to a plausibility check.
- After entering the point number the asigned point of values, level and flow, can be displayed
- The more pairs of values you enter, the more exact the linearization will be. You can enter a maximum of 32 pairs of values.

No. V2H5	Level V2H3	Rate of flow V2H4	No. V2H5	Level V2H3	Rate of flow V2H4
1			17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		
16			32		

Step	Matrix	Entry	Meaning
1	V2H0	5	Delete the previously active linearization characteristic
2		»E«	Confirm entry
3	V8H4	2	Select flow unit, e.g. l/h
4	-	»E«	Confirm entry
5	V2H3	00.00	Enter level at point number
6	-	»E«	Confirm entry
7	V2H4	00.00	Enter rate of flow at point number
8	-	»E«	Confirm entry
9	V2H5	2	Second point number is displayed (automatically selected)
10		»E«	Confirm entry
The following entries must be repeated for every point			
			Steps 5 to 10 have to be repeated until the level and rate of flow have been entered for all the points
11	V2H0	3	Select »manual«
12	-	»E«	Activate the characteristic entered
13	V0H0	-	Rate of flow is displayed

Correction of entries with manual linearization

If an error is made when entering, the wrong value can be overwritten by entering the table number in V2H5 and the new values in V2H3 or V2H4.

Step	Matrix	Entry	Meaning
1	V2H5	1...32	Enter table number which has to be corrected
2	-	»E«	Confirm entry
3	V2H3/ V2H4	e.g. 10	Enter correct level or rate of flow
4	-	»E«	Confirm entry
Carry out all corrections as per steps 1 to 4			
5	V2H0	3	Select »manual«
6	-	»E«	Activate the characteristic

Deletion of individual points

If a curve point (with two values) is to be deleted, it is sufficient to enter the value 19999 in V2H4 when table number has been selected in V2H5.

Step	Matrix	Entry	Meaning	Channel 2
1	V2H5	1...32	Enter table number which has to be deleted	V5H5
2	-	»E«	Confirm entry	
3	V2H4	19999	Enter correct level or rate of flow	V5H4
4	-	»E«	Confirm entry	
Carry out all corrections as per steps 1 to 4				
5	V2H0	3	Select »manual«	V5H0
6	-	»E«	Activate the characteristic	

Deleting a characteristic

All values in the linearization table can be deleted in one step: in matrix field V2H0 for selecting linearization the setting »cancel« must be selected and confirmed.

Step	Matrix	Entry	Meaning
1	V2H0	5	Select linearization »cancel«
2	-	»E«	Confirm entry
3	V2H0	0	Select a new linearization mode, e.g. »linear«
4	-	»E«	Confirm entry

Note!
If a different linearisation is chosen, the manually entered characteristic remains stored in the Prosonic FMU, without being used. If, later, the »manual« mode is re-selected, the characteristic is activated and the Prosonic FMU exhibits the same measuring properties as before.



Note!

Measurand indication

The measurand for channel 1 is shown by V0H0 (for channel 2 V4H0). In addition, certain matrix fields show system information, e.g. for fault analysis, etc.
Table 5.2. summarizes the indicated and measured values.

Tab. 5.2
Measurand indication
Values in brackets apply to Channel 2

Matrix	Measurand	Note
V0H0 (V4H0)	Rate of flow (Level or volume)	Display in units of V8H4 or customers unit V0H0 for channel 1 (V4H0 level measurement for channel 2)
V0H8 (V4H8)	Distance: Sensor - product surface	The distance between sensor and product surface in m or ft V0H8 for channel 1, V4H8 for channel 2
V0H9 (V4H9)	Level	indication of level in m or ft V0H9 for channel 1, V4H9 for channel 2
V3H1 (V6H1)	Echo attenuation db	The echo attenuation between emission and reception by the sensor V3H1 for channel 1, V6H1 for channel 2
V3H2 (V6H2)	Signal-noise ratio	Signal-noise ratio: The difference between a useful signal (echo) and a noise signal. The higher this ratio is the better the echo can be evaluated (10 dB or larger is acceptable).
V8H8	Internal counter high	The first four digits of the eight digit software counter are displayed.
V8H9	Internal counter low	The last four digits of the eight digit software counter are displayed.
V9H0	Diagnostic code	The current diagnostic code can be read off
V9H1	Last diagnostic code	The last diagnostic code can be read off and deleted.
V9H2	Last diagnostic code but one	The last diagnostic code but one can be read off and deleted.
V9H3	Unit code with software version	The first two figures are the unit code, the last two are the software number

5.3 Setting the Totalizers

The Prosonic FMU possesses a software totalizer and an optional totalizer unit to determine the rate of flow. The totalizers switch in terms of

- the voluminar flow
- the counting unit (V8H5) and
- the counting factors.

The software totalizer and the optional totalizer unit are influenced by the adjustable low flow cut off in V2H8. Only the software totalizer can be reset. The first four figures of the eight digit software counter are shown by V8H8, the last four by V8H9. External totalizer can be controlled by the relays (see chapter 7.4).

Note!
When connecting an external totaliser, please note:
The maximum counting frequency of the Prosonic FMU 86_ is 2 Hz, the pulse width is 200 msec. To ensure that all counting pulses are fully picked up, the counting frequency of the external totaliser must be adjusted to these values.



Note!

We write: **Counting formula**
Total volume = Total number of counting pulses x counting factor **x counting unit**

The set counting unit (V8H5) applies to all counters. Table 5.3 lists all the counting units and their code numbers in field V8H5. **Counting unit**

Tab. 5.3
Counting units and their codes

Counting unit	Code in V8H5
l	0
hl	1
m^3	2
i gal	5
us gal	6
bls	7
$inch^3$	8
ft^3	9

Step	Matrix	Entry	Meaning
1	V8H5	2	m^3 was chosen as counting unit
2	-	»E«	Confirm entry

The counting factor Z2 in V1H6 is used for the software counter. **Counting factors**
The counting factor Z1 in V1H5 is used for the optionally connected totaliser.
Any value may be entered as counting factors in matrix fields V1H5 and V1H6. If a maximum value of 19999 is exceeded (e.g. after selecting a new Q/h curve), or the counting pulse rate is larger than 2 counting pulses per second with maximum flowrate, then the Prosonic counting factors are automatically adjusted. The warning message E 620 is displayed and the corrected counting factors in V1H5 and V1H6 can be confirmed. If no correction using the selected counting units is possible, then the warning message E 621 is displayed. Other technical units are then to be entered in V8H5.

Step	Matrix	Entry	Meaning
1	V1H5	10	»Counting factor C1« for the totalizer unit selected and entered as counting factor (e.g 10 m^3).
2	-	»E«	Confirm entry

Resetting the software counter

The software counter can be reset to 0 by entering 712 in V9H4

Step	Matrix	Entry	Meaning
1	V9H4	712	Code for resetting the software counter
2	-	»E«	Confirm entry
3	V8H8	-	0000 show the 4 highest figures of the software counter
4	V8H9	-	0000 show the 4 lowest figures of the software counter

Low flow cut off V2H8

The entry of a low flow cut off V2H8 is to prevent very small disturbing flows from being detected. It is entered as a percentage, referred to the maximum rate of flow (Qmax of the flow as given in the Tables in Appendix A or the largest value for flow rate of the linearization curve). If the actual maximum flowrate of the channel has been entered in V2H7, then the creep value entered is a function of the entry.
Any flow exceeding this percentage is taken into account when counting the volume. The setting applies to all counters.

Step	Matrix	Entry	Meaning
1	V2H8	e.g. 4	A low flow cut off of 4% of the maximum flow is ignored when counting the flow. Only when the flow exceeds 4% of maximum it is taken into account in the flow count.
2	-	»E«	Confirm entry

5.4 Flow Measurement and Back Water Alarm (Only after Selecting Operating Mode V8H0: 9 »Back Water Alarm«)

Process faults may occur in the flow in channels and weirs and result in back water which can determined and regulated. The size of the back water is the ratio h_2 (downstream water) to h_1 (head water), which can be given in V5H8 (in %).

- In a Venturi channel, the flowrate is measured at its optimum, if the ratio h_2 (downstream water) to h1 (head water) does not exceed the factor 0.8=80%.
- With h_2/h_1 values larger than 0.8 (and Q larger than Q_{max}), the quantity of flow moves continually towards zero. An alarm can also be selected which is activated when the critical ratio is exceeded.



Note!

Note on setting the current output on alarm!
Do not select the value –10 % for channel 1 (V3H4) and +110 % for channel 2 (V6H4): this causes the critical ratio h_2/h_1 to be exceeded on alarm, and the flow trends to zero

- With flowrates up to 0.8, Q_{max} is measured without a correction. An alarm is only activated if the ratio h_2/h_1 is larger than the value in V5H8

Step	Matrix	Entry	Meaning
1	V5H8	e.g. 85	The back water alarm is activated at 85% (h_2/h_1 = 0.85%)
2	-	»E«	Confirm entry
3	V1H0	1	Relay 1 is selected as alarm relay
4	-	»E«	Confirm entry
5	V1H1	9	”Back water alarm” is the function for Relay 1
6	-	»E«	Confirm entry

6 Analogue Output

This chapter describes the setting of the analogue output. The Prosonic FMU 860 or 861 has a current output for 4 ... 20 mA, which can be switched to 0...20 mA.
With the two-channel unit FMU 862 the changeover from 4...20 mA to 0...20 mA applies to both current outputs.

The current output for channel 1 is controlled by the measurand of channel 1 in field V0H0 or the current output for channel 2 in V4H0.
When measuring the difference or average, channel 1 shows the unchanged measurand of the sensor. Channel 2 shows the value calculated.
Fig. 6.1 and table 6.1 show the parameters for operation of the analogue outputs.

With 2 channels	
Measurand of channel 1	Measurand of channel 2
Difference	of sensor 2
of sensor 1	Average value

Channel 1	Channel 2	Meaning	Default
V8H1	as channel 1	0 = 0...20 mA 1 = 4...20 mA	0
V0H5	V4H5	0/4 mA-value (in calibration or linearization units)	0.0
V0H6	V4H6	20 mA-value (in calibration or linearization units)	100.0
V0H4	V4H4	Integration time in seconds	5
V3H4	V6H4	Output at fault 0 = -10% 1 = +110 % 2 = hold	1
V8H6	V8H6	With external limit switch 0 = None NO contact 1 = Minimum channel 1 2 = Maximum channel 1 3 = Minimum channel 2 4 = Maximum channel 2 5 = Minimum channels 1 and 2 6 = Maximum channels 1 and 2 NC contact the same as NO contacts 7...12	0

Table 6.1
Control parameters for analogue outputs

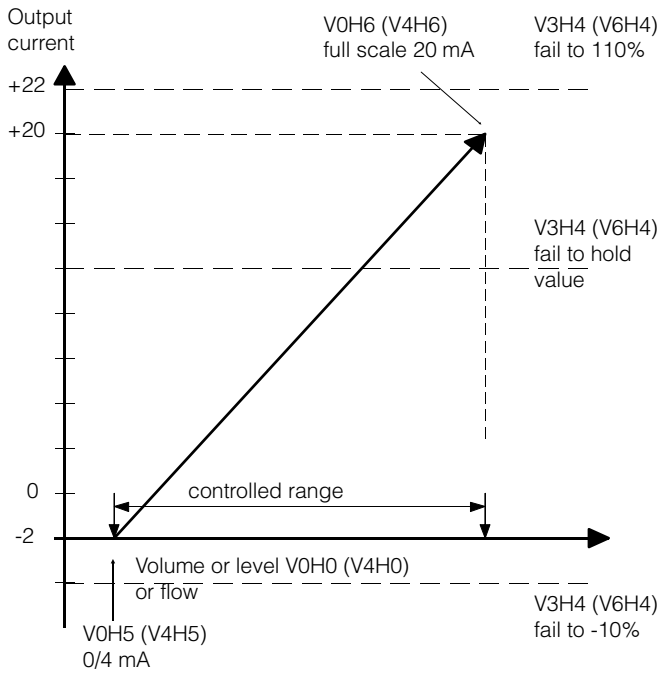


Fig. 6.1
Control parameters for analogue outputs (0…20 mA).
Matrix positions for channel 2 in brackets.

Current output

The unit provides two alternatives:

- 0 = 0...20 mA
- 1 = 4...20 mA (default)

Entries are made in V8H1. Changing over the current output to 4...20 mA also applies to channel 2 of FMU 862.

Step	Matrix	Entry	Meaning
1	V8H1	1	Select 4 ... 20 mA range
2	-	»E«	Confirm entry

4 mA threshold

If a 4...20 mA signal was selected in V8H2 and if the empty adjustment (= 4 mA) was made at a definite level, it may happen that signals **below** 4 mA are generated in normal operation.
If the units connected to the signal line cannot handle signals below 4 mA, it is possible to define a 4 mA threshold in V8H2, below which the analogue output may not drop.

- 0 = off (default)
- 1 = on


Caution!

Caution!

- A 4mA threshold is cancelled on alarm if a response »-10% of measurement range« is selected in V3H4 for channel 1 or in V6H4 for channel 2 (see »Output in the event of an alarm«).
- Even if the analogue output is set to 0...20 mA, the signal does not drop below the 4 mA threshold.

Step	Matrix	Entry	Meaning
1	V8H2	e.g. 1	smallest signal in normal operation = 4 mA, even if the level drops below the initial measuring range of the analogue signal
		»E«	Confirm entry.

Setting the analogue output

The analogue output parameters assign

- an initial measurand (for level, difference or flow, etc., depending on the mode) to the initial value of the current output (0 mA or 4 mA) and
- a final measurand to 20 mA.

Inverting the current signal

If an initial value is entered with is greater than the end value, then the current output has a continuously falling curve. The signal current reduces with increased values. Please note here that the current output for alarm responds according to the following table.

4…20 mA		0…20 mA	
V3H4:0 V6H4:0	21.6 mA on alarm	V3H4:0 V6H4:0	22 mA on alarm
V3H4:1 V6H4:1	2.4 mA on alarm	V3H4:1 V6H4:1	–2 mA on alarm

Note!
Spreading the measuring range: The beginning and end of the range can be defined arbitrarily, i.e. the 0/4…20 mA signal may also be assigned to parts of the total measuring range.



Note!

Step	Matrix	Entry	Meaning	Channel 2
1	V0H5	e.g. 200 l	when the vessel contains 200 l the signal current is 0/4 mA (initial value)	V4H5
2	-	»E«	Confirm entry	
3	V0H6	z.B. 2000 l	when the vessel contains 2000 l the signal current is 20 mA (end value)	V4H6
4	-	»E«	Confirm entry	

For signal exceeding range:

	Signal below	Signal above
4...20 mA	3.8...4 mA	20...20.5 mA
0...20 mA	-0.5...0 mA	20...20.5 mA

Output in the event of an alarm

The current output can be set so that it assumes a definite value in the event of an alarm. The relays follow the analogue output. The entry is made in field V3H4 for channel 1 or V6H4 for channel 2.

- 0 = -10% of the measuring range (default)
- 1 = +110% of the measuring range
- 2 = the last value is held

Step	Matrix	Entry	Meaning	Channel 2
1	V3H4	e.g. 1	In the event of a fault the indicationand the analogue output drops to +110% of the measuring range	V6H4
		»E«	Confirm entry	

4...20 mA		0...20 mA	
V3H4 (V6H4): 0	2,4 mA on alarm	V3H4 (V6H4): 0	-2 mA on alarm
V3H4 (V6H4): 1	21.6 mA on alarm	V3H4 (V6H4): 1	22.0 mA on alarm

Caution!
On setting 2, existing fault recognition systems on the 0/4…20 mA signal lines are put out of action. Although the fault recognition system of the transmmitter remains capable of operating (i.e. the fault relay de-energizes and the associated yellow LED goes out), all analogue devices on the signal line seem to continue emitting correct measurands.



Caution!

Integration time

Integration time

The effect of the integration time is to attenuate the analogue outputs and the measurand indication on the display of the Prosonic FMUs. When measuring levels, for example, where the liquid surface is not steady, a steady reading can be obtained with the aid of the integration time.

- 0 s = without attenuation
- 1…300 s = with attenuation
  (The set integration time is the time set for 63% of the ultimate measurand)

Step	Matrix	Entry	Meaning	Channel 2
1	V0H7	e.g. 20	Integration time = 20 s	V4H7
2	-	»E«	Confirm ent	

External limit switch

The setting of the external limit switch acts on the analogue outputs and all the relays. Depending on the height at which it is mounted, the limit switch acts as a minimum limit or a maximum limit switch. With Prosonic FMU 862 a distinction can be made between channels.
Table 6.2 provides an overview of the behaviour of the analogue outputs in terms of the settings of the limit switch.

Tab. 6.2
Analogue output with external limit switch

Setting V8H5	Meaning	Limit switch switches level to »full« or »empty«
0	None	without influence
NO contact		
1	Min. channel 1	»empty« for channal 1
2	Max. channel 1	»full« for channel 1
3	Min. channel 2	»empty« for channel 2
4	Max. channel 2	»full« for channel 2
5	Min. channel 1 and 2	»empty« for channel 1 und 2
6	Max. channel 1 and 2	»full« for channel 1 und 2
NC contact		
7	Min. channel 1	»empty« for channal 1
8	Max. channel 1	»full« for channel 1
9	Min. channel 2	»empty« for channel 2
10	Max. channel 2	»full« for channel 2
11	Min. channel 1 and 2	»empty« for channel 1 und 2
12	Max. channel 1 and 2	»full« for channel 1 und 2



Note!

Note!
- A warning *does not* influence the switching behaviour of the limit switch. See Table 6.2.

7 Relays

This chapter describes the setting of the relays and typical applications. The Prosonic FMU 86... has either three or five relays with potential-free changeover contacts. Each relay operates independently. One relay can be assigned different functions. The relay switches according to the function with its settings and an optional external limit switch (see next page).

Note!
A yellow LED is allocated to each relay, which indicates its status:
- The LED of the relay lights up when the relay energises.
- The LED of the relay for fault indication lights during normal operation.
- The LED of a relay for counting pulses briefly flashes at every counting pulse (maximum pulse rate of the relay 1 Hz).


Note!

Relay functions

The transmitter versions possess the following relay functions

Relay function	FMU 860	FMU 861	FMU 862
Limit	X	X	X
Alarm relay	X	X	X
Tendency	X	X	X
Count pulse		X	X
Interval timer		X	X
Back water alarm			X

- The available functions can be assigned to any of the relays.
- Each relay is assigned a number which has to be selected before entering the relay function.
- If only three relays are installed, the relay outputs 1, 2 and 5 are occupied.
- The Prosonic FMU with RS 485 or PROFIBUS-DP interface has relay outputs 3, 4 and 5 assigned.
- Relay 5 has the »alarm indication« function preset. The LED belonging to it lights up when operation is free from fault. Any other function can be assigned to this relay.
- If all the relays are used for pump control, alarms can be recorded by means of the 0/4…20 mA signal as a –10 or +110% signal. In this case the installation of separate means of protection against overflow or running dry is recommended.

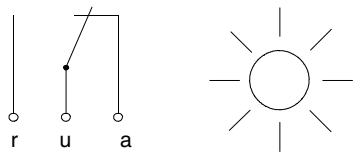
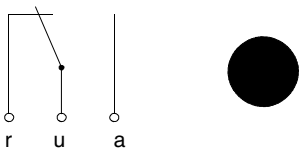
Procedure

The setting of a relay always begins with the following procedure:
- A relay is selected by entering a number in V1H0 and confirming the selection with »E«.
- A relay function is selected by entering a number in V1H1 and confirming with »E«. (for FMU 862: A relay function which concerns only channel 1 or channel 2 has its own number for each channel.)


Note!

Note!
- If linearization is subsequently performed in a different technical unit, all settings have to be altered for all relays acting as limit switches.

Notes on relay designations:

Relay »energised«	Relay »de-energised«
	
The relay is operational when it is energised, i.e. when its working contact is closed. The LED belonging to the relay on the front panel of the FMU lights up. With a working contact a (normally open) the current path u-a is open when the relay is de-energized and closed when it is energised.	The relay is in the de-energized state (dropped out) when the normally closed contact is closed. With a normally closed contact r the current path u-r is closed when the relay is de-energized and open when it is energised

External limit switch

The setting of the external limit switch acts on all the relays. Depending upon the position at which it is mounted, the external limit switch can be used to detect maximum or minimum limits. When the external limit switch responds, the relays react in accordance with the analogue output (setting »Min.« corresponds to 0% signal, »Max.« to 100% signal, see Chapter 6). In the case of the Prosonic FMU 862 the external limit switch can be assigned to either channel. Table 7.1 provides an overview of the switching behaviour according to the settings of the limit switch.

Tab. 7.1
Switching of the limit relay in relation to switching of the external limit switch

Setting V8H6	Meaning	Limit relay: switch-on point higher than switch-off point	Limit relay: switch-on point lower than switch-off point
0	None	No effect on relay	No effect on relay
NO contact			
1	Min.channel 1	Relay f.channel 1 de-energises	Relay f. channel 1 energises
2	Max.channel 1	Relay f.channel 1 energises	Relay f. channel 1 de-energises
3	Min.channel 2	Relay f. channel 2 de-energises	Relay f. channel 2 energises
4	Max.channel 2	Relay f. channel 2 energises	Relay f. channel 2 de-energises
5	Min.channel 1 and 2	Relays f.channels 1 and 2 de-energise	Relays f.channels 1 and 2 energise
6	Max.channel 1 and 2	Relays f.channels 1 and 2 energise	Relays f.channels 1 and 2 de-energise
NC contact the same as NO contacts 7...12			


Caution!

Caution!
Where possible, a warning message *does not* influence the switching of the external limit switch. If the external limit switch switches during an alarm condition in the Prosonic, the relays respond accordingly and the analogue outputs respond according to the settings in V3H4 (or V6H4), behaviour on alarm condition.

7.1 Relay Function »Limit«

The relay function »Limit« is used to monitor or control a level limit.
The relay switches according to the measurand in V0H0 and is governed by the switch-on and switch-off point of the relay which, for instance, can be entered as % level (V0H0 applies to channel 1; for FMU 862 the relays for channel 2 switch in terms of the measurand in V4H0). Fig. 7.1 shows the functions.
Depending on the application, it may be important for the switch-on point to be higher than the switch-off point, or vice versa. In the event of a fault in particular it must be assured that the alarm response of the Prosonic FMU conforms to the control task (see under "Behaviour in the event of a alarm").
Two additional settings allow that the switching behaviour of the relay to be modified: Alternating pump control (in V1H4: off, on) and delayed switching (in V1H9: time in seconds).

Matrix	Meaning
V1H0	Selection of relays (1,2,5 or 1,2,3,4,5)
V1H1	Relay function »Limit 1 f.channel 1«: 0; »Limit f.channel 2« : 1
V1H2	Switch–on point (in customer's unit)
V1H3	Switch–off point (in customer's unit)
V1H4	Alternating pump control (On, Off)
V1H9	Switching delay (in seconds)

Table 7.2
Relay settings for »Limit«

Switch-on point, switch-off point
For the switching behaviour of a relay there are two variants:

The relay energises when the switch-on point is exceeded, the yellow LED belonging to the relay on the front panel lights up.

Switch-on point > switch-off point

The relay energises at a level below the switch-on point and the LED belonging to the relay on the front panel lights up.

Switch-on point < switch-off point

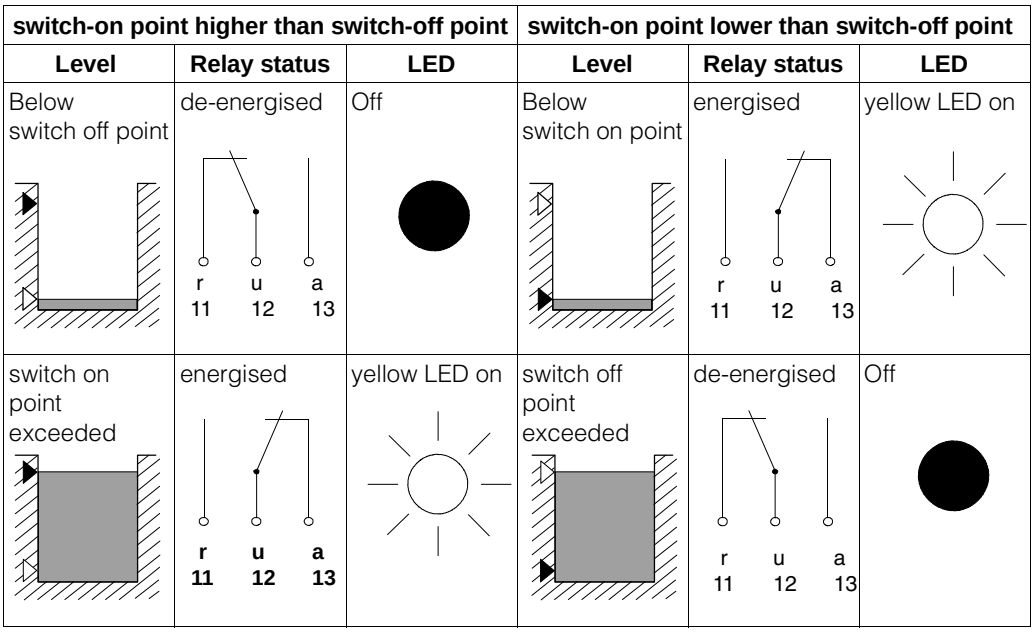


Fig. 7.1
Function of the relays as limit switch

▶ *Switch-on point*
▷ *Switch-off point*

Example: Switch-On Point Higher than Switch-Off Point

1.
Select relay and function

First a relay and the associated function must be selected. This is done by entering the relay number in V1H0 and the number for the relay function "Limit" in V1H1.

Step	Matrix	Entry	Meaning
1	V1H0	e.g. 1	Relay 1 is selected
2	-	»E«	Confirm entry
3	V1H1	0	»Limit for channel 1« is the relay function for the selected relay
4	-	»E«	Confirm entry

2.
Enter switching points

The switch-on point is entered in V1H2, the switch-off point in V1H3, both in the same units as the measurand in V0H0 (V4H0 for channel 2 with FMU 862).
In this example the switch-on point is higher than the switch-off point.

Step	Matrix	Entry	Meaning
1	V1H2	e.g. 200	Switch-on point for the selected relay (in the same units as the measurand)
2	-	»E«	Confirm entry
3	V1H3	e.g. 150	switch-off point for the selected relay (in the same units as the measurand)
4	-	»E«	Confirm entry

Relay at alarm

If the Prosonic FMU detects a alarm, the limit relays behave in accordance with the input for the alarm response of the analogue output in V3H4 (for FMU 862: for channel 1 in V3H4; for channel 2 in V6H4).

Table 7.3 shows an overview of the switching behaviour in terms of the relay settings. The inputs for alarm response are described in Chapter 6.

Table 7.3
Reaction of the limit relay to faults

Setting V3H4 (channel 2 V6H4)	switch-on point higher than switch-off point	switch-on point lower than switch-off point
0 = -10% (-2 mA)	Relay de-energises	Relay energises
1 = +110% (+22mA)	Relay energises	Relay de-energises
2 = Hold (last measurand)	No change	No change

Typical Applications

The size of the switching range, i.e. the difference between the switch-on and switch-off points, is defined in accordance with the control task.

- A relay operates as limit switch when the switching range is small or
- A relay operates as two point-control when the switching range is large (Fig.7.2).

Example: Limit switch

If the relay is to operate as limit switch, the switching range is small, i.e. the switch-on and switch-off points are close together. The difference between the switch-on point and the switch-off point should be at least 1%
If the switch-on point is higher than the switch-off point the relay energises when the switch-on point is exceeded. A level just below the switch-on point is then given as switch-off point. When this level is reached, the relay de-energises at once.

Step	Matrix	Entry	Meaning
1	V1H0	e.g. 2	Relay 2 is selected
2	-	»E«	Confirm entry
3	V1H1	0	Limit channel 1 is the relay function for the relay selected
4	-	»E«	Confirm entry
5	V1H2	e.g. 1	Switch-on point for selected relay (in the same units as the measurand, e.g. 1 m)
6	-	»E«	Confirm entry
7	V1H3	e.g. 0.95	switch-off point for the relay selected (in the same units as the measurand e.g. 0.95 m)
8	-	»E«	Confirm entry

Two-Point Operation with One Relay

If a definite level is to be maintained, this can be done by entering an appropriate clearance between the switch-on and switch-off points.

Example: Filling pump with overflow protection

The switch-on point is lower than the switch-off point: The filling pump operates and the level rises until the switch-off point is reached, at which the pump is switched off. The relay does not energise again until the level drops below the value for the switch-on point.

Step	Matrix	Entry	Meaning
1	V1H0	e.g. 2	Relay 2 is selected
2	-	»E«	Confirm entry
3	V1H1	0	Limit channel 1 is the relay function for the relay selected
4	-	»E«	Confirm entry
5	V1H2	e.g. 700	Switch-on point for the relay selected (in the same units as the measurand e.g. 700 hl)
6	-	»E«	Confirm entry
7	V1H3	e.g. 900	switch-off point for the relay selected (in the same units as the measurand, e.g. 900 hl)
8	-	»E«	Confirm entry

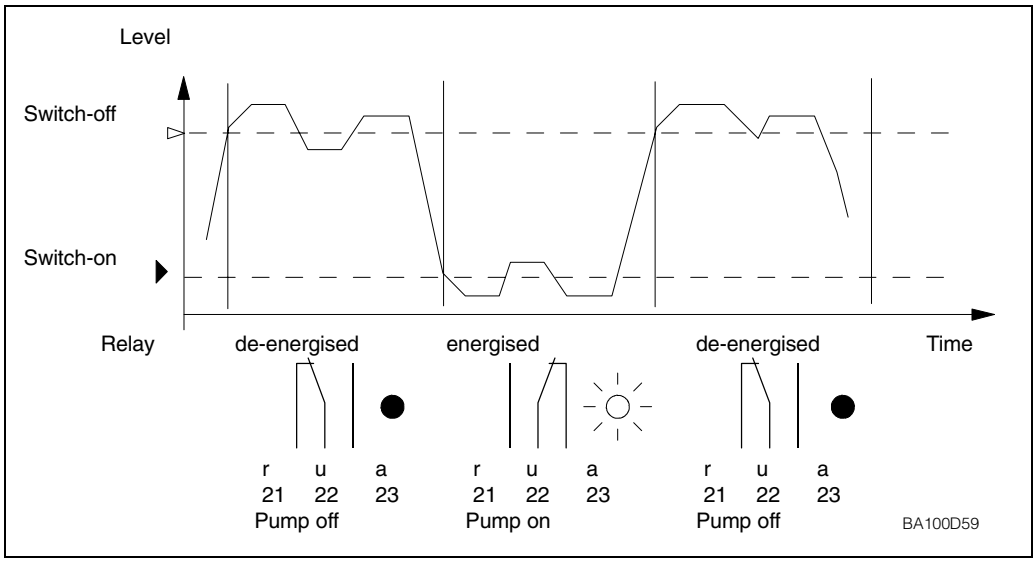
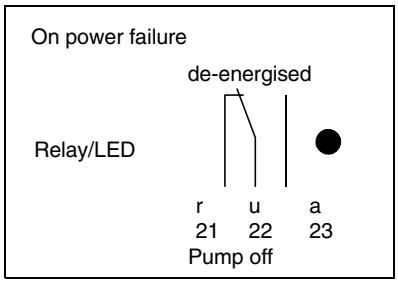


Fig. 7.2
Pump control:
Filling pump with overflow protection



Alternating Pump Control

If several limit relays are used for controlling pumps, it is often practical to ensure that the pumps are equally loaded. Here the additional function "Alternating pump control" can be helpful (V1H4) and can be realized for one channel.
If two relays possess the additional function "Alternating pump control", relay 1 switches on and off during the following repetitive level cycle, during the next cycle relay 2 switches on and off. The level rises until the first switch-on point is exceeded, and then drops until the first switch-off point is underrun.
One relay with the additional function "Alternating pump control" also switches in terms of the switch-on point of another alternating relay. If a switch-on point is exceeded, the relay nearest in the alternating row operates. If the function "Alternating pump control" is switched on for relays 1, 2 and 5, these relays operate in the order 1-2-5-1-2-5-1-2-5-. . .
The same applies to the switch-off points. If the level drops, the pumps are switched off in the order in which they were switched on.

Example: Alternating pump control

To control the water level 3 relays are to be connected in a row. If the water level rises, the emptying pumps switch on one after the other until all pumps are running at maximum level. If the level drops, the pumps are switched off in the order in which they were switched on. The relays have the following switching points:

Relay	Switch-on point	Switch-off point
1	40	10
2	60	40
5	90	60

Fig.7.3 shows the switching of the relays.

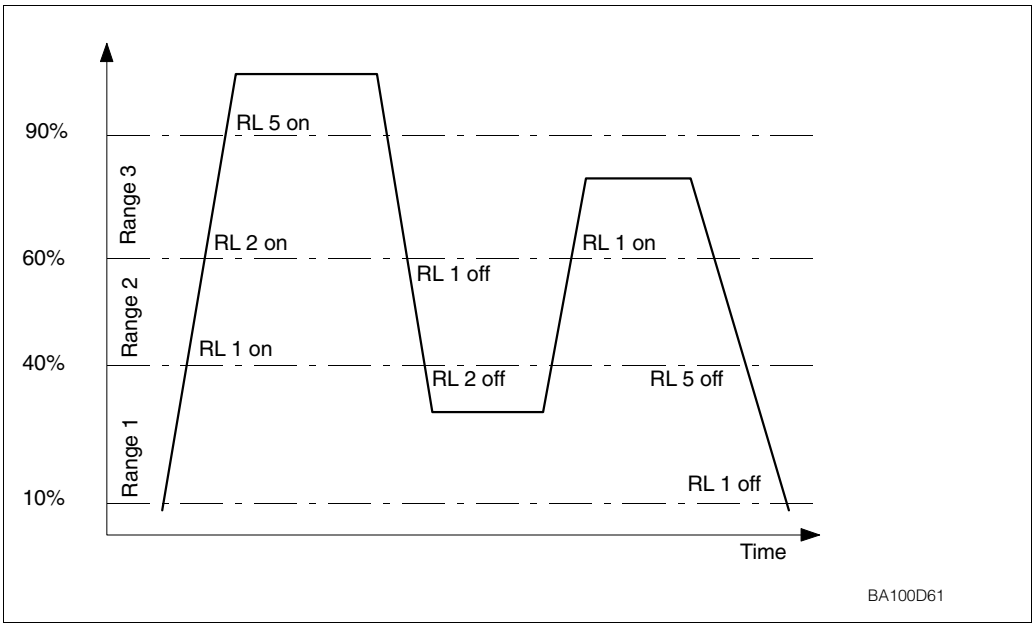


Fig. 7.3
Alternating pump control, for all relays the switch-on point is higher than the switch-off point

Step	Matrix	Entry	Meaning
1	V1H0	1 »E«	Relay 1 was selected
2	V1H1	0 »E«	Relay function for relay 1 is limit in channel 1
3	V1H2	40 »E«	Switch-on point 1 is say 40% (when % is the customer's unit)
4	V1H3	10 »E«	switch-off point is say 10% (when % is the customer's unit)
5	V1H4	1 »E«	Relay 1 was provided with additional function »Alternating pump control«
6	V1H0	2 »E«	Relay 2 was selected
7	V1H1	0 »E«	Relay function for relay 2 is limit in channel 1
8	V1H2	60 »E«	Switch-on point 1 is say 60% (when % is the customer's unit)
9	V1H3	40 »E«	switch-off point 1 is say 40% (when % is the customer's unit)
10	V1H4	1 »E«	Relay 2 was provided with additional function »Alternating pump control«
11	V1H0	3 »E«	Relay 3 was selected
12	V1H1	0 »E«	Relay function for relay 3 is limit in channel 1
13	V1H2	90 »E«	Switch-on point 1 is say 90% (when % is the customer's unit)
14	V1H3	60 »E«	switch-off point 1 is say 60% (when% is the customer's unit)
15	V1H4	1 »E«	Relay 3 was provided with the additional function »Alternating pump control«
16	V1H9	10 »E«	Switching delay of 10 seconds for all relays.



Note!

Note!

- "Alternating pump control" can, of course, only be effective when two or more limit relays in the same channel possess this function.
- The ranges with the switch-on and switch-off points may overlap, e.g. range 1 switch-on at 80%, switch-off at 30%, range 2 switch-on at 60%, switch-off and 20%. Where two pumps in the same range are to operate alternately, their switch-on and switch-off points are identical. This switching response can be achieved by assigning switch points to the second relay which can never be reached.
  Example: in the switching range between 60% and 40%, two pumps should be operated alternately, i.e. when pump 1 is running, pump 2 is switched off and vice versa. The relays are programmed as follows:
  Relay 1 Switch-on point 60%, switch-off point 40%;
  Relay 2 Switch-on point e.g. 160%, switch-off point e.g. 120%.
- If all the relays are employed for pump control, alarms denoted by the 0/4…20 mA signal may be registered as –10 or +110 % signals. The installation of a separate means of protection against overflow or running dry is then recommended.
- With "Alternating pump control" a switching delay of 0...100 s can be set in V1H9 (default = 1 s).

Switching delay

To prevent the load becoming too heavy when two or more connected units (e.g. pumps) are switched simultaneously, a switching delay can be set. This delay then applies to all relays with the function "Alternating pump control" (with FMU 862 for channel 1 *and* channel 2).

Function
If two relays ought to operate at the same level, the relay with the lower number operates at once, followed after a delay by the one with the higher number, i.e. the delay entered in V1H9 (default = 1 s).
If even a third relay ought to operate at the same level, the relay with the highest number is delayed by twice the time entered in V1H9.

Step	Matrix	Entry	Meaning
1	V1H9	e.g. 10	10 s is the minimum interval between operation of two relays
2	-	»E«	Confirm entry

7.2 Relay Function »Alarm Relay«

The function of the alarm relay is to signal disturbances, e.g. with the aid of external warning lamps, horns or other connected devices.
The relay is switched in accordance with the behaviour of the Prosonic FMU in the event of a alarm. The response in the absence of an echo can be set separately.
A comprehensive description of the behaviour can be found in Chapter 9. Supplementary settings to the switching behaviour of the relay are not necessary.

- The LED of an alarm indicating relay is alight when operation is free from fault, during which time the relay is energized.
- The fifth relay is preset for the function »Alarm relay«. The associated LED lights up when operation is free from fault. Any other relay function can be assigned to the fifth relay.
- For external indication of alarms warning or indicator lamps must be connected to the normally closed contact of the alarm relay.

Step	Matrix	Entry	Meaning
1	V1H0	e.g. 2	Relay 2 is selected
2	-	»E«	Confirm entry
3	V1H1	8	Alarm relay is the function of the selected relay
4	-	»E«	Confirm entry

7.3 Relay Function »Tendency«

The function of the tendency relay is to monitor or control the periodic differences in flowrate or level. The tendency is +1% if the measurand in V0H0 increases by 1% of the maximum flowrate or the maximum of the level within one minute. The tendency is –1% if the measurand in V0H0 drops by 1% of the maximum flowrate or level within one minute. The maximum flowrate is set by the chosen or entered Q/h curve. The maximum level is the linearised end value or the 100% level. Switching of the relay is done together with the switch-on point and switch-off point of the tendency.

Switch-on point greater than switch-off point

The relay energizes when the tendency exceeds the switch-on point and de-energizes when the tendency drops below the switch-off point.

Switch-on point smaller than switch-off point

The relay energizes when the tendency drops below the switch-on point and de-energizes when it exceeds the switch-off point.

Step	Matrix	Entry	Meaning
1	V1H0	e.g.. 2	Relay 2 is selected
2	-	»E«	Confirm entry
3	V1H1	2	»Tendency channel 1« is the function of the selected relay
4	-	»E«	Confirm entry
5	V1H2	e.g. 2	Enter switch-on point at 2% increase/min of measurand
6	-	»E«	Confirm entry
7	V1H3	e.g. 0.5	Enter switch-off point at 0.5% increase/min
8	-	»E«	Confirm entry

Tendency relay on alarm

If the Prosonic FMU identifies an alarm, then the tendency relay maintains its switching status.

7.4 Relay Function »Counting Pulses«

When the relay has the function »Counting pulses« it switches in accordance with

- The volume flowing
- The counting unit (V8H5) and
- Which of the three relay functions »Counting pulses 1«, »Counting pulses 2« or »Counting pulses 3« is selected. (To each of these relay functions a fixed counting factor of its own is assigned in V1H5, V1H6 or V1H7). The counting pulses are used, for instance, to actuate external counters or for controlling samplers as a function of the rate of flow.

Note!
When connecting an external totaliser, please note:
The maximum counting frequency of the Prosonic FMU 86_ is 2 Hz, the pulse width is 200 msec. To ensure that all counting pulses are fully picked up, the counting frequency of the external totaliser must be adjusted to the these values.


Note!

Three supplementary settings influence volume determination:

- Low flow cut off in V2H8
- Switch-on point in V1H2 and
- switch-off point in V1H3 for the counting pulses.

Note!
In the event of an error the counting pulses are interrupted.


Note!

Volume measurement

The transmitter measures the level and with the aid of the Q/h curve of the channel computes the exact flow or the momentary rate of voluminar flow per unit time. If the maximum flowrate Qmax of the channel curve characteristic exceeds the actual flowrate, then you can enter your value in V2H7. All other entries for Qmax are then a function of this value. For short periods the volume flowing can be determined by multiplying the current rate of flow by the time interval. The total volume over a long period is calculated by the Prosonic FMU by totalling the partial volumes during this period (i.e. in mathematical terms: the flow is integrated with respect to time).

Counting pulse

A relay energises briefly and emits a counting pulse when two conditions are satisfied:
- The total of the partial volumes flown through corresponds to the size range of the selected totaliser units.
- The counting factor is selected so that the counting pulse rate is slower than 2 counting pulses per second at maximum flow.

The following applies:
Total volume = Total number of pulses counted x counting factor **x counting unit**

Counting unit

The set counting unit (V8H5) applies to all counting factors.
Table 7.4 lists all counting units with their code numbers in field V8H5

Counting unit	Code in V8H5
l	0
hl	1
m^3	2
i gal	5
us gal	6
bls	7
$inch^3$	8
ft^3	9

Tab. 7.4
Counting units and their code numbers

Counting factors

The counting pulse rate of a relay depends on the assigned counting factor. There is a choice of three counting factors:

Tab. 7.5
Selecting the counting factors

Counting factor 1	In V1H5 and applies to relay function »counting pulses 1	If a totalizer is installed in the FMU, the counting factor 1 always applies to this unit too.
Counting factor 2	In V1H6 and applies to relais function »counting pulses 2«	With this counting factor the software totalizer in Prosonic FMU always counts
Counting factor 3	In V1H7 applies to relais function »counting pulses 3«	The counting factor applies solely to external flow measuring units

Any counting factor can be entered in the matrix field V1H5, V1H6 and V1H7 corresponding to the counting mode. If a maximum value of 19999 is exceeded (e.g. after selecting a new Q/h curve), or the counting pulse rate is larger than 2 pulses per second with maximum flowrate, then the Prosonic counting factors are automatically adjusted. A warning message E 620 is displayed and the counting factors in V1H5 and V1H6 and V1H7 can be calculated and confirmed. If no correction using the selected counting units is possible, then the warning message E 621 is displayed. Other technical units are then to be entered in V8H5.

Step	**Matrix**	**Entry**	**Meaning**
Select counting unit			
1	V8H5	2	m^3 was selected as counting unit
2	-	»E«	Confirm entry
*Select the relay and select one of the relay functions »Counting pulse*s«			
3	V1H0	1	Relay 1 is selected
4	-	»E«	Confirm entry
5	V1H1	5	Counting pulses 2 is the function for relay 1 (in V1H6 »counting factor 2)
6	-	»E«	Confirm entry
7	V1H0	2	Relay 2 is selected
8	-	»E«	Confirm entry
9	V1H1	4	Counting pulses 1 is the function for relay 2 (in V1H5 counting factor 1)
10	-	»E«	Confirm entry
11	V1H5	1000	Counting factor 1 is selected and 1000 is entered for 1000 m^3
12	-	»E«	Confirm entry

Low flow cut off V2H8

The entry of a low flow cut off V2H8 is to prevent very small flows from being detected. The entry is made in per cent of the maximum flow. If the actual maximum flowrate of the channel has been entered in V2H7, then the creep value entered is a function of the entry. A flow is not taken into account in the volume count until it has exceeded this percentage. The setting applies to all counters.

Step	Matrix	Entry	Meaning
1	V2H8	e.g. 4	A minimum flow of 4% of the maximum flow is not taken into account when counting the flow. Only when the flow exceeds 4% of the maximum flow it is taken into account in the flow count.
2	-	»E«	Confirm entry

Switch-on point V1H2 and switch-off point V1H3

For certain measuring tasks it is not desirable to determine every flow rate. Instead, the flow rates shall be totalled in terms of the current flow rate, e.g. measurement of floodwater. The volume count is only active as long as the flowrate is greater than the switch-on point but less than the switch-off point. The volume of the total flow is determined during this time. Provided that the switch-off point is selected as 111 %, the volume count is continued even when the switch-off point is exceeded.

Note!



Note!

- The switch-on and switch-off points are always entered as a percentage of the maximum flow.
- The switch-on point must always be lower than the switch-off point.
- The settings are for 0% switch-on point and 110 % switch-off point. If the flowrate exeeds the switch-off point or drops below the switch-on point, then the counting pulses are interrupted. If a switch-off point of 111 % is entered the measurement is continue with the max. frequency, even if the switch-off point is exceeded.

Measurement of storm water with a flume:
As setting for relay 1, counting pulses 1 are considered with the switch-on point V1H2: 30% and switch-off point V1H3: 80% (100% is always the prior setting in V1H3). Supposing the flow is 20% or 90% of the maximum flow, the relay does not emit any counting pulses. If the flow is, say, 40% of the maximum, the whole is counted and the relay emits counting pulses accordingly.

Step	Matrix	Entry	Meaning
1	V1H0	1	relay 1 is selected
2	-	»E«	Confirm entry
	V1H1	4	Counting pulses 1
4	-	»E«	Confirm entry
5	V1H2	30	As switch-on point 30% of the maximum rate of flow is selected
6	-	»E«	Confirm entry
7	V1H3	80	As switch-off point 80% of the maximum rate of flow is selected
8	-	»E«	Confirm entry

7.5 Relay Function »Timing Pulses«

The relay function »Timing pulses« can be used for controlling a sampler with respect to time, or for cleaning a screen at definite intervals of time.

- The relay switches when the time set in V1H8 in minutes expires.
- The shortest time is 1 min, the longest 1500 min.
- After the set time of the timing pulses has elapsed the relay energises briefly, the LED on the front panel of the Prosonic FMU flashes once. Thus an externally connected relay can be actuated to control a sampler or screen motor.


Caution!

Caution!
During a fault the timing pulses continue to be counted – if possible.

Step	Matrix	Entry	Meaning
1	V1H0	e.g.4	Relay 4 is selected
2	-	»E«	Confirm entry
3	V1H1	7	Timing pulse is the function of the relay selected
4	-	»E«	Confirm entry
5	V1H8	60	The selected relay energises once every 60 minutes
6	-	»E«	Confirm entry

7.6 Relay Function »Back Water Alarm«

The "back pressure" relay function indicates disturbances and back pressure in the channels and weirs, e.g. using the external warning lamps, horns or other downstream units. Switching on such a unit depends on the ratio h_2 (height downstream of the weir) to h_1 (height upstream of the weir) which is entered in V5H8. The relay is activated when the ratio is exceeded.

Step	Matrix	Entry	Meaning
1	V1H0	e.g. 4	Relay selected for alarm relay
2	-	"E"	Confirm entry
3	V1H1	9	"Back water alarm" is relay function for Relay 1
4	-	"E"	Confirm entry

8 Measuring Point Entries

This chapter describes various entries concerning the measuring point

- Refreshing information on the measuring point, i.e.»last diagnostic code« and »last diagnostic code but one«
- Locking the matrix

8.1 Refreshing Information on the Measuring Point

The Prosonic FMU permanently stores various items of information on the measuring point and updates them when the operating state changes.

- »Last diagnostic code« shows, for instance, whether the permissible temperature at the sensor has been exceeded since the last check on the measuring point (see also chapter 9.2)

Refreshing information on the measuring point

Step	Matrix	Entry	Meaning
1	V9H1	»E«	deletes the last diagnostic code and the last diagonstic code but one. 0 is then displayed

8.2 Locking the Matrix

When all parameters have been entered, the matrix can be locked and is thus protected against unintentional changes. After locking, all entries can be displayed, but not altered.

Locking the matrix

Step	Matrix	Entry	Meaning
1	V9H6	e.g. 888	Entry of a number for locking. Number flashes
		»E«	Confirm entry. The number stands still. The matrix is locked.

Cancellation of locking the matrix

On entering 519 locking can be cancelled (for operation via PROFIBUS-DP: 2457).

Step	Matrix	Entry	Meaning
1	V9H6	519 (2457)	Enter the code number for opening. Number flashes.
		»E«	Confirm entry. The number stands still. The matrix is open for entries.

9 Diagnosis and Trouble-Shooting

This section contains the following:

- Two types of faults: alarms and warnings
- Fault analysis and trouble-shooting tables
- Suppression of interference signals in unfavorable installation conditions
- Simulation mode for testing other units connected
- Instructions for replacing the transmitter or sensor
- Instructions on repairs

9.1 Two Types of Fault: Alarms and Warnings

The transmitter continuously monitors the operational function of the measuring line. If it recognises a fault, then it responds with the following:

- the LED on the front panel flashes
- symbols are shown on the display
- an error code is given in field V9H0 and
- the analogue outputs assume their preprogrammed values and
- connected units are deactivated by the programmed relay.

With serious faults, the status is shown as an *alarm*. All other faults are indicated as *warnings* (e.g. simple operating error).
No further measurement are made with a fault indication. Further measurements are always attempted with a warning but measuring errors cannot be ruled out.

Alarm **Alarm**

If the Prosonic FMU detects an alarm, i.e. a functional fault by which no further measurement is possible, then the following takes place:

- All yellow LEDs flash.
- The »alarm« relay de-activates.
- The symbol for status message ↯ appears on the display (see section 7).
- The analogue signal reverts to the status selected (either –10% or +110% of the current span or the last measured value (hold), see section 6).
- The »limit value« relays react according to the size of the analogue signal (see section 7).
  If other relay functions are available then these also apply:
  - The »tendency« relay maintain their switching position (see section 7).
  - »Count pulse« relays de-energise. As long as the fault remains, then no counting pulses are sent.
  - »Interval timer« relays remain unaffected and switch – if the function allows – after a given time for the time pulse.
- The diagnostic message on the source of the fault is shown in filed V9H0. Explanation of error codes is given in table 9.1.

Warning

Warning

If the Prosonic FMU detects a simple operating error or a fault which still allows measurement to be carried out, then it activates a *warning*. As long as the warning remains, then the measuring signal may be subject to significant measuring errors giving rise to the following responses:

- The green LED flashes.
- The »alarm« relay remains energised with all other relays remaining unaffected.
- The symbol for status indication flashes on the display.
- The poutput signal can – e.g. together with input errors – be subject to significant measurement errors.
- The diagnostic message on the source of the fault is shown in field V9H0. Explanation of error codes is given in Table 9.1.

Selectable warnings when no echo is detected

Special Case: Trouble-Shooting on Lost Echo

In two special measuring situations – when the *signal/noise ratio* is too small or the *echo attenuation* is too large – the response of the alarm relay can be set.

The fault handling of a non-existent echo is selected by entering a number in field V3H3 (Field V6H3 with a two-channel unit).

- 0 = »Warning« (default value), the last measured value is retained.
- 1 = »Alarm«.

A non-existent echo is to be treated as an alarm

Step	Matrix	Entry	Meaning	Channel 2
1	V3H3	1	If no echo is present, the Prosonic FMU should carry out all responses to an alarm.	V6H3
2	-	»E«	Register entry	

9.2 Fault Analysis

For analysing faults it is important to know,

- what fault has occured
- whether other faults have occured
- whtether a short-term fault has occurred but which no longer exists (e.g. too high temperature at the sensor for a brief period of time) and also
- which fault was last corrected.

Because:

- There are faults which are corrected immediately and others which can only be corrected by Endress+Hauser Service engineers.
- A fault can have more than one source at the same time.
- Correcting one fault can cause a new and additional fault to occur.

Fault indications Prosonic FMU

The Prosonic FMU provides you with the following information to carry out fault analysis.

- To indicate the source of the fault, the *»most important«* fault is shown in field V9H0.
  A fault is assigned a priority in the factory, i.e. if a fault of low priority exists and then one with a higher priority occurs, then the fault with the higher priority will be displayed in field V9H0 (see Table 9.1).
  Pressing the »+« key shows other faults which may be present.
- The *previously corrected* fault is shown in field *V9H1*. Pressing the »E« key clears this display (the last but one fault code is also cleared, for applications see below).
- The *last but one* fault is shown in field *V9H2*. Pressing the »E« key clears this display (the previously corrected fault is also cleared).

Example of using »previous fault« V9H1
Was the transmitter or sensor always fully operational? For example: was the sensor temperature always within the permissible range? The error code E661 is shown in V9H1, if the temperature range was exceeded. If the Prosonic FMU was correctly set in operation (instrument reset with commissioning and the display in V9H1 cleared, see Section 8) and was always fully operational, then no fault code should appear in the field »last but one fault«.
If no fault is shown in field V9H1, then the ultrasonic sensor and the transmitter were always fully operational from that point since the last reset.

Error messages

The cause and correction of an alarm or a warning are given in Table 9.1.

Table 9.1
Error codes and their meaning.
Given in their order of priority.

Error code in V9H0	Type	Cause Remedy
E 102	Warning	Initialisation of the RS 485. Lasts approx. 20 sec. If the error persists, then initalisation cannot be started.
E 106	Alarm	Downloading activated. Wait until procedure is completed!
E 111 E 112 E 113 E 114 E 115	Alarm	Electronic error in unit. To be corrected by Endress+Hauser Service.
E 116	Alarm	Faulty downloading via Rackbus. Check RS 485 link or eliminate fault by Reset 333 in V9H5. If fault persists, then restart downloading.
E 121 E 122	Alarm	Incorrect calibration values for the current output. To be corrected by Endress+Hauser Service. E 121 for Channel 1, E 122 for Channel 2.
E 613 E 614	Warning	Instrument in simulation mode. Warning removed when switched to another operating mode. E 613 for Channel 1, E 614 for Channel 2.
E 501 E 502	Warning	The sensor type must be specified to remove warning. For E 501, Channel 1, enter sensor type in field V0H4, for E 502, Channel 2, enter sensor type in field V4H4.
E 601 E 602	Warning	Linearisation contains errors: The curve does not rise monotonously (the values entered produce at least one increase in level; the volume does not increase but decreases) or the curve has only one reference point. Check linearisation curve, E 601 for Channel 1, E 602 for Channel 2.
E 603	Warning	Error in user-specificr Q/h curve. To be corrected by Endress+Hauer Service.
E 231 E 232	Alarm	Short-circuit in internal temperature sensor. Check the sensor connection in the Prosonic FMU. If a fault occurs when properly connected, call Endress+Hauser Service. E 231 for Channel 1, E 232 for Channel 2.
E 250	Alarm	Short-circuit in external temperature sensor. To be corrected by Endress+Hauser Service.
E 260 E 261 E 262	Alarm	Break in temperature sensor circuit. Check the sensor connection in the Prosonic FMU. If a fault occurs when properly connected,then to be corrected by Endress+Hauser Service. E 260 for external temperature sensor, E 261 for Channel 1, E 262 for Channel 2).
E 641 E 642	Warning or Alarm	The ultrasonic echo cannot be evaluated; last measured value is kept (hold). If the error continues, then check the sensor connection (see page 20). When properly connected, then to be corrected by Endress+Hauser Service. E 641 for Channel 1, E 642 for Channel 2.

E 643	Warning	Difference between Channel 1 and Channel 2 too large or negative.
E 661 E 662	Warning	Temperature at sensor too high. Check the measuring point. (Temperature compensation calculated for 80 °C). E 661 for Channel 1, E 662 for Channel 2.
E 620	Warning	Counting factor too small and has been automatically adjusted. Please confirm this adjustment: Go to the matrix fields V1H5, V1H6, V1H7 for counter factors and press »E« (see Chapter 7).
E 621	Warning	Counter factor too small and cannot be corrected in the selected units. Please enter other units in V8H5.

Error diagnosis

Table 9.2 gives instructions on error diagnosis with a transmitter fully operational.

Table 9.2
Trouble-shooting table for a fully operating transmitter

Fault	**Cause and Remedy**
Measured value is incorrect	Check the distance between sensor membrane and product surface shown in V0H8 – if the distance is correctly shown, then check the full and empty calibration in V0H1 and V0H2 – if linearisation has been carried out, then check linearisation parameters. *The same for Channel 2 in V4H8, V4H1, V4H2*
Measured value indicates"full" when empty or remains constant as level rises	Interference echoes: The sensor is measuring e.g. an edge of mounting pipe. Retarget the sensor. Select fixed target suppression (see Section 9.3).
Measured value indicates less than full when full. Measured value changes when product level constant	Multiple echoes – check whether the blocking distance is correct or – retarget the sensor or – select another level application in field V0H3 *The same for Channel 2 in field V4H3*
The measured value remains constant when the level drops below a specific value	Interference echos – retarget the sensor – fixed target suppression (see Section 9.3)
Sporadic measurement error with turbulent surface of liquid, e.g. agitators	No echo or else temporary spurious echo occurs – increase factor for envelope curve statistics, see Section 9.3 – increase integration time for analogue signal, see Section 6.1
Relay does not switch correctly	Incorrect settings, e.g. in incorrect units – check relay settings – simulate settings in simulation mode for level, see Section 9.4

9.3 Suppression of Interference Signals

There are two kinds of interference signals.

- Fixed internal structures intrude too far into the measuring zone of the ultrasonic sensor and reflect the ultrasonic echo. The *fixed target suppression* facility can be used in every operating mode.
- Specific periodic interference echoes occur, e.g. from agitator blades. *Envelope curve statistics* may be used.

Fixed Target Suppression with Interference Echoes from Internal Structures

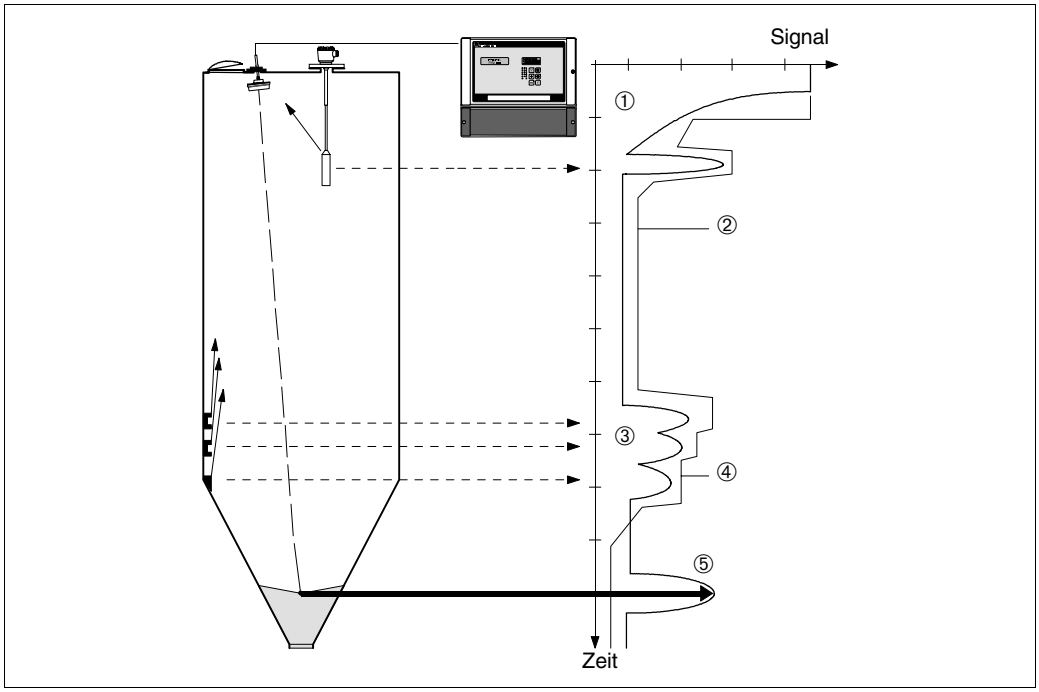


Fig. 9.1
Fixed target suppression
① Transmission pulse and signal decay
② Fixed target suppression threshold
③ Interference echo
④ Echo suppression by increase
⑤ Working echo from product surface

Interference echoes, e.g. those coming from internal structures inside the vessel, can be suppressed using the fixed target suppression mode. The prerequisite for this is that the working echo is to be stronger than the interference echo at any level: This is the case when internal structures are found at the edge of the detection zone of the ultrasonic sensor. Fixed target suppression is used

- when measuring level after selecting the *application*
- when measuring flow after selecting the operating mode.

Activating fixed target suppression

Step	Matrix	Entry	Meaning	Channel 2
1	V0H0	-	The level should be as low as possible.	V4H0
2	-	-	Check the measured distance between the sensor flange and the product surface.	
3	V3H0	e.g. 14	Wait until the display is steady. Enter the distance calculated. The FMU calculates all signals coming from a shorter distance as the level echo and suppresses these signals.	V6H0
4	-	»E«	Automatic suppression is activated.	

Fixed target suppression is deactivated by entering a 0 in V3H0 for Channel 1 and entering a 0 in V6H0 for Channel 2.

Deactivating fixed target suppression

Envelope Curve Statistics with Interference Echoes Coming from Agitator Blades or Filling Curtains

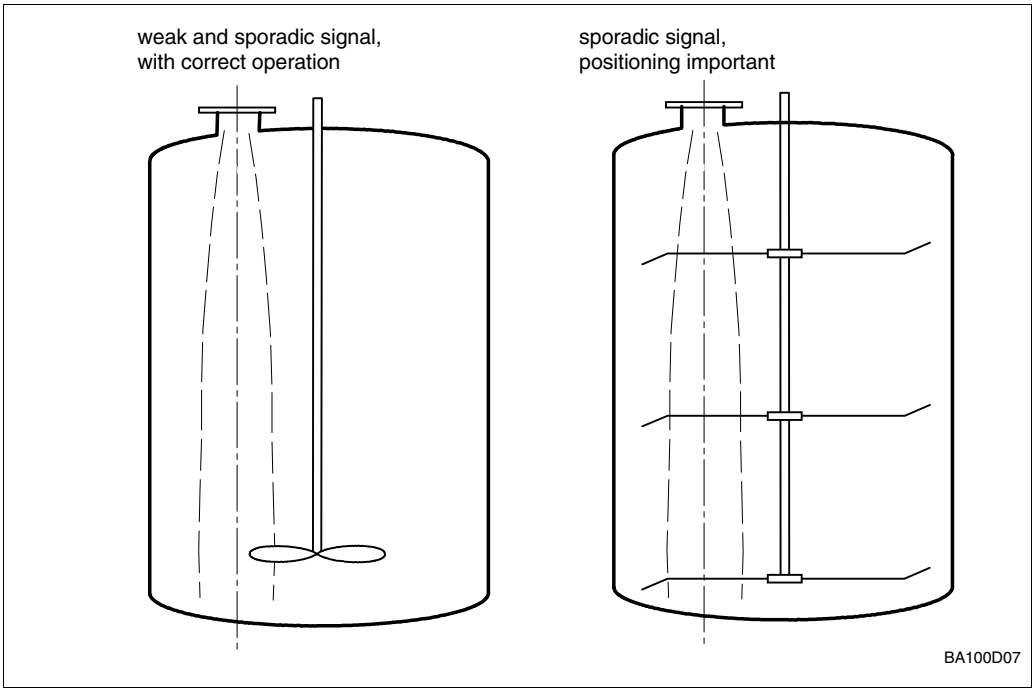


Fig. 9.2
Careful consideration for the positioning of the sensor can prevent interference echoes

All echo signals received by the sensor are temporarily stored in the transmitter. This procedure enables a statistical analysis to be carried out with regard to amplitude and run time of all signals received. Sporadic interference signals, e.g. from agitator blades or from filling curtains can be suppressed by selecting the appropriate filter factor.

This filter factor is freely selectable between 1 and 100. If the instrument has to determine very quick changes in level, then a low filter factor should be entered. With slow changes in level, a higher filter factor should be chosen resulting in a higher degree of interference immunity.

- 1 = no statistical evaluation
- 5 = low filtering, rate of change in level max. 20 cm/s (default)
- 10 = average filtering, rate of change in level max. 10 cm/s
- 20 = high filtering, rate of change in level max. 1 cm/s

Step	Matrix	Entry	Meaning	Channel 2
1	V3H5	e.g. 5	Filter factor 5 is selected.	V6H5
	-		The rate of change in level should not exceed 20 cm/s.	
2		»E«	Register entry.	

9.4 Simulation

By simulating an output signal current, external instruments, such as display units, plotters, controllers or counters, etc. can be adjusted or checked for correct functioning. The value given in e.g. field V9H9, is the resultant current at the analogue outputs. Values for level or volume can be simulated in order to check linearisation.

The green LED flashes for the duration while in field V8H0, Operating Mode 7 (simulation in Channel 1) or Operating Mode 8 (simulation in Channel 2).

Activating simulation, output current

Step		Matrix	Entry	Meaning
1		V8H0	7	Select simulation mode in Channel 1.
2	-		»E«	Register entry
3		V9H9	e.g. 16	A current of 16 mA is simulated.
4	-		»E«	Register entry

Simulating a level or volume

Step		Matrix	Entry	Meaning
1		V8H0	7	Select simulation mode in Channel 1.
2	-		»E«	Register entry
3		V9H7	e.g. 2	A level of 2 m is simulated.
4	-		»E«	Register entry. The outputs are dependent on calibration and linearisation and have a current corresponding to »2 m«. The »limit« relays respond according to their preset modes.
5		V9H8	e.g. 100	A volume of 100 l, 100 t or 100% is simulated.
6	-		»E«	Register entry. The outputs are dependent on calibration and have a current corresponding to »100 l, 100 t or 100%«. The »limit« relays respond according to their preset modes.

Quit simulation

The simulation mode is quit by selecting another operating mode.

Step	Matrix	Entry	Meaning
1	V8H0	e.g. 0	Entering the original operating mode, e.g. level
2	-	»E«	Register entry

9.5 Exchanging the Prosonic FMU or a Sensor

Transmitter

If the Prosonic FMU has to be exchanged, then you can key in the parameters you have noted and continue to measure without recalibrating.

- If parameters have to be in a given sequence when cinfiguring, e.g. linearisation, then they must also be entered in the same order.

Sensor

If a sensor has to be exchanged, then it is recommended that the Prosonic is checked for correct functioning. This is especially so in cases where fixed target suppression is carried out.
Refer to Section 9.2, »Fault analysis«.

9.6 Repairs

If an ultrasonic sensor or a Prosonic FMU has to be sent in to Endress+Hauser for repair, then please enclose a note containing the following information:

- An exact description of the application for which it was used.
- A brief description of the error.
- The chemical and physical properties of the product.

Special precautions must be observed when sending in a sensor for repair:


Caution!

- Remove all visible traces of product from the probe.
- This is especially important if the product can impair health, e.g. corrosive, poisonous, carcinogenic, radioactive, etc.
- Please do not send the probe for repair if the last traces of dangerous products cannot be removed, e.g. product has penetrated into fissures or diffused into plastic parts.

For your notes!

10 Summary of All Calibration Modes

Standard values for initial start-up	Page
Standard Adjustments	**89**

Entries for selected operating modes

Level Measurement	**90**
Flow Measurement with Preset Q/h Curve	**92**
Flow Measurement with Q/h Curve from Tables	**93**
Differential or Average Value Measurement, with FMU 862 only	**95**

Notes on tables:
Required entries are shown in this font size.
Entries for special applications are shown in this font size.


Note!

Simulation mode and trouble-shooting are given in Section 9

Display fields	Channel 1	Channel 2
Measured value	V0H0	V4H0
Distance	V0H8	V4H8
Level	V0H9	V4H9


Caution!

Caution!
Note regarding FMU 862: If the Enter key is pressed while in field V0H0, then the measured values from Channel 1 (V0H0) and Channel 2 (V4H0) flash alternately. Pressing any other key stops that function.

Standard adjustments

Standard adjustments are carried out

These are done with initial start-up or, e.g. after replacing a sensor or transmitter.

Channel 1		Channel 2
V9H5	Standard reset	
V8H3	Selecting units of length	
V8H0	Selecting operating mode	
V0H4	Selecting sensor type	
➤	*FMU 862 only* Select sensor type for Channel 2 at this point	V4H4
	For other measuring units	
V8H6	Entering limit switch	
V8H7	Entering external temperature sensor	

Level Measurement

For mode (V8H0): **0 : Level, Channel 1**
1 : Level, Channel 1 and Channel 2
3 : Level, Channel 2

		Channel 1		*FMU 862 only* Channel 2 *Calibrate after Channel 1*
% Level shown in V0H0 or V4H0 for Channel 2	Suppress interference signals at poor installation points (see Section 9)	V0H1	»Empty« calibration	V4H1
		V0H2	»Full« calibration	V4H2
		V0H3	Level application	V4H3

Linearisation mode: (for examples see next pages)
- if volumetric units are to be measured
- if values are displayed in special units given by customer.

Analogue output is set	0/4...20 mA is assigned to level	*V8H1*	Current output 0/4...20 mA	-
		V8H2	4 mA threshold	-
		V0H5	Value for 0/4 mA	V4H5
		V0H6	Value for 20 mA	V4H6
		V0H7	*Integration time*	*V4H7*
			Output on fault:	
		V3H4	*Selecting fail-safe mode*	*V6H4*
		V3H3	*If no echo present*	*V6H3*

Relay functions are set for a maximum of five relays	Relay 5 is set in the factory for error indication		***Limit relay***	
		V1H0	Selecting relay	V1H0
		V1H1 (0)	Selecting »limit«	V1H1 (1)
		V1H2	Switch-on point for relay	V1H2
		V1H3	Switch-off point for relay	V1H3
			Tendency relay	
		V1H0	Selecting relay	V1H0
		V1H1 (2)	Selecting »tendency«	V1H1 (3)
		V1H2	Switch-on point for relay	V1H2
		V1H3	Switch-off point for relay	V1H3
			Fault relay	
		V1H0	Selecting relay	V1H0
		V1H1 (8)	Selecting »Error: 8«	V1H1 (8)
			Pump control	
		V1H0	Selecting relay	V1H0
		V1H1 (0)	Selecting »Limit«	V1H1 (1)
		V1H2	Switch-on point for relay	V1H2
		V1H3	Switch-off point for relay	V1H3
		V1H4	*Turn on alternating pump control*	V1H4
		V1H9	For all relays for pump control: *enter the minimum time interval between the switching of two relays.*	V1H9

FMU 862 only: Calibrate Channel 2 at this point

Measuring point data are entered.
Matrix is locked.

V9H1	*Reset last error code and Reset last but one error code*	-
V9H6	*Locking (using 3-figure number)*	-

Linearisation mode:

Measured value in units given by customer Linearisation for *vertical* cylindrical vessel

Measured value in units given by customer are shown in V0H0 or V4H0 for Channel 2

Channel 1		Channel 2
V2H7	Enter volume at 100%	V5H7
V2H0	Activate (linear:0)	V5H0

Linearisation for horizontal cylindrical vessel

Measured value in units given by customer are shown in V0H0 or V4H0 for Channel 2

Channel 1		Channel 2
V2H6	Enter Vessel diameter	V5H6
V2H7	Enter vessel volume	V5H7
V2H0	Linearisation (cyl, horiz.:1)	V5H0

Linearisation for *any shaped vessel* given by the values in table for the vessel

Measured value in units given by customer are shown in V0H0 or V4H0 for Channel 2

Channel 1		Channel 2
	Repeat following entries	
V2H3	Enter level	V5H3
V2H4	Enter volume	V5H4
V2H5	Register next line number	V5H5
V2H0	Activate (manual:3)	V5H0

Linearisation for *any shaped* vessel by baling out from the vessel

Measured value in units given by customer are shown in V0H0 or V4H0 for Channel 2

Channel 1		Channel 2
V2H0	Linearisation (semiautomatic:4)	V5H0
	Repeat following entries	
V2H3	*Level is displayed*	*V5H3*
V2H4	Enter volume	V5H4
V2H5	Register next line number	V5H5
V2H0	Activate (manual:3)	V5H0

Switching off linearisation

Measured value in % level are shown in V0H0 or V4H0 for Channel 2

Channel 1		Channel 2
V2H0	Linearisation, linear (linear :1)	V5H0

Cancelling all table values for linearisation

Measured value in % level are shown in V0H0 or V4H0 for Channel 2

Channel 1		Channel 2
V2H0	Cancel linearisation (cancel :5) "Linearisation linear" is then shown.	V5H0

Notes on tables:
Required entries are shown in this font size.
Entries for special applications are shown in this font size.



Note!

Flow Measurement with Preset Q/h Curve

For mode (V8H0): **2: Flow, Channel 1**
3: Flow, Channel 1
9: Back water alarm

Flow is shown in V0H0

Suppress interference signals at poor installation points (see Section 9)

Channel 1

V0H1	»Empty« calibration
V2H1	*Actual level correction*
V2H2	Selecting Q/h curve number
V2H0	Selecting linearisation type (Q/h curve:2)
V8H4	*Change flow unit from m^3/h*

Counters are adjusted and counting

V8H5	Selecting counting units
	Changing counting factor:
V1H5	*for integrated totalizer*
V1H6	*for software counter*
V1H7	*for external counter*
V2H8	*low flow cut off applies to all counters*
	For external counters only
	Repeat for each counter:
V1H0	*Selecting the relay for the counter*
V1H1	*Selecting for relay function one of the three counting pulses*
V1H2	*Switch-on point for counting pulse (% of flow)*
V1H3	*Switch-off point for counting pulse (% of flow)*

Relay functions for flow measurement:
see Page 94

Analogue output is set

0/4...20 mA is assigned to flow

V8H1	*Current output 0/4...20 mA*
V8H2	*4 mA threshold*
V0H5	*Value for 0/4 mA*
V0H6	Value for 20 mA
V0H7	*Integration time*
	Output on fault:
V3H4	*Selecting fail-safe mode*
V3H3	*If no echo present*

FMU 862 only: Calibrate Channel 2 at this point
See level measuremant, Channel 2

Measuring point data are entered. Matrix is locked.

V9H1	Reset last error code and Reset last but one error code
V9H6	Locking (using 3-figure number)



Note!

Notes on tables:
Required entries are shown in this font size.
Entries for special applications are shown in this font size.

Flow Measurement Q/h Curve from a Table

For mode (V8H0): **2: Flow, Channel 1**
3: Flow, Channel 1
9: Back water alarm

Channel 1		
		Flow is shown in V0H0
Suppress interference signals at poor installation points (see Section 9)		
V0H1	»Empty« calibration	
V2H1	*Actual level correction*	
V8H4	Selecting flow units	
	Repeat the following entries	
V2H3	Enter level height	
V2H4	Enter flow	
V2H5	Register next line number	
V2H0	Activate (manual:3)	
V8H5	Selecting counting units	**Counters are adjusted and counting**
	Changing counting factor:	
V1H5	*for integrated totalizer*	
V1H6	*for software counter*	
V1H7	*for external counter*	
V2H8	*Low flow cut off applies to all counters*	
	For external counters only	
	Repeat for each counter:	
V1H0	*Selecting the relay for the counter*	
V1H1	*Selecting for relay function one of the three counting pulses*	
V1H2	*Switch-on point for counting pulse (% of flow)*	
V1H3	*Switch-off point for counting pulse (% of flow)*	
Relay functions for flow measurement: see Page 94		**Relay functions for other relays**
0/4...20 mA is assigned to flow		
V8H1	*Current output 0/4...20 mA*	**Analogue output is set**
V8H2	*4 mA threshold*	
V0H5	*Value for 0/4 mA*	
V0H6	Value for 20 mA	
V0H7	*Integration time*	
	Output on fault:	
V3H4	*Selecting fail-safe mode*	
V3H3	*If no echo present*	
FMU 862 only: Calibrate Channel 2 at this point See level measurement, Channel 2		
V9H1	Reset last error code and Reset last but one error code	Measuring point data are entered. Matrix is locked.
V9H6	Locking (using 3-figure number)	

Notes on tables:
Required entries are shown in this font size.
Entries for special applications are shown in this font size.



Note!

Relay Functions for Flow Measurement

Relay 5 is set in the factory for error indication

Channel 1		Channel 2
	Limit relay	
V1H0	*Selecting relay*	
V1H1	*Selecting »limit«*	
V1H2	*Switch-on point for relay*	
V1H3	*Switch-off point for relay*	
	Tendency relay	
V1H0	*Selecting relay*	
V1H1 (2)	*Selecting »tendency«*	
V1H2	*Switch-on point for relay*	
V1H3	*Switch-off point for relay*	
	Fault relay	
V1H0	*Selecting relay*	
V1H1	*Selecting »Error: 8«*	
	Relay for back pressure	
V5H8	Enter the % value of the level from which the back pressure is to be determined	
V1H0	Select relay	
V1H1	Select ”back pressure”	

Note!

Notes on tables:
Required entries are shown in this font size.
Entries for special applications are shown in this font size.

Differential Average Value Measurement with FMU 862 only

For mode: 4 : Differential measurement: (value Sensor 1 - value Sensor 2) channel 2
5 : Average value ([value, Sensor 1 - value Sensor 2] /2) channel 1
9 : Differential measurement: (value Sensor 1 - value Sensor 2) channel 1

Suppress interference signals at poor installation points (see Section 9)

Channel 1		Channel 2
V0H1	»Empty« calibration	V4H1
V0H2	»Full« calibration	V4H2
V0H3	Level application	V4H3

Linearisation mode: (for examples see next pages)
- if volumetric units are to be measured
- if values are displayed in special units given by customer.

0/4...20 mA is assigned to Difference or average value

Analogue output is set

V8H1	Current output 0/4...20 mA	-
V8H2	4 mA threshold	-
V0H5	Value for 0/4 mA	V4H5
V0H6	Value for 20 mA	V4H6
V0H7	*Integration time*	*V4H7*
	Output on fault:	
V3H4	*Selecting fail-safe mode*	*V6H4*
V3H3	*If no echo present*	*V6H3*

Relay 5 is set in the factory for error indication

Relay functions are set for a maximum of five relays

	Time pulse relay	
V1H0	Selecting relay	V1H0
V1H1 (7)	Selecting »time pulse«	V1H1 (7)
V1H8	Enter time pulse	V1H8
	Tendency relay	
V1H0	Selecting relay	V1H0
V1H1 (2)	Selecting »tendency«	V1H1 (3)
V1H2	Switch-on point for relay	V1H2
V1H3	Switch-off point for relay	V1H3
	Limit relay	
V1H0	Selecting relay	V1H0
V1H1 (0)	Selecting »limit«	V1H1 (1)
V1H2	Switch-on point for relay	V1H2
V1H3	Switch-off point for relay	V1H3
	Fault relay	
V1H0 (8)	Selecting relay	V1H0 (8)
V1H1	Selecting »Error :8«	V1H1

Calibrate Channel 2 at this point

Measuring point data are entered. Matrix is locked

V9H1	Reset last error code and Reset last but one error code	-
V9H6	Locking (using 3-figure number)	-

Notes on tables:
Required entries are shown in this font size.
Entries for special applications are shown in this font size.



Note!

Linearisation mode:

Difference or average in customer unit. Linearisation for *vertical* cylindrical vessel

Difference or average value in units given by customer are shown in V0H0 for Channel 1.
Measured value in customer units in V4H0 for Channel 2

Channel 1		Channel 2
V2H7	Enter volume at 100%	V5H7
V2H0	Activate (linear: 0)	V5H0

Linearisation for *horizontal* cylindrical vessel

Difference or average value in units given by customer are shown in V0H0 for Channel 1.
Measured value in units given by customer shown in V4H0 for Channel 2

Channel 1		Channel 2
V2H6	Enter vessel diameter	V5H6
V2H7	Enter vessel volume	V5H7
V2H0	Linearisation (cyl, horiz.:1)	V5H0

Linearisation for *any* shaped vessel given by the values in table for the vessel

Difference or average value in units given by customer are shown in V0H0 for Channel 1.
Measured value in units given by customer shown in V4H0 for Channel 2

Channel 1		Channel 2
	Repeat following entries	
V2H3	Enter level	V5H3
V2H4	Enter volume	V5H4
V2H5	Register next line number	V5H5
V2H0	Activate (manual:3)	V5H0

Linearisation for *any* shaped vessel by baling out from the vessel

Difference or average value in units given by customer are shown in V0H0 for Channel 1.
Measured value in units given by customer shown in V4H0 for Channel 2

Channel 1		Channel 2
V2H0	Linearisation (semiautomatic:4) Repeat following entries	V5H0
V2H3	*Level is displayed*	*V5H3*
V2H4	Enter volume	V5H4
V2H5	Register next line number	V5H5
V2H0	Activate (manual:3)	V5H0

Switching off linearisation

% difference or % average value is shown in V0H0
% level is shown in V4H0 for Channel 2

Channel 1		Channel 2
V2H0	Linearisation, linear (linear: 1)	V5H0

Cancelling the table values for linearisation

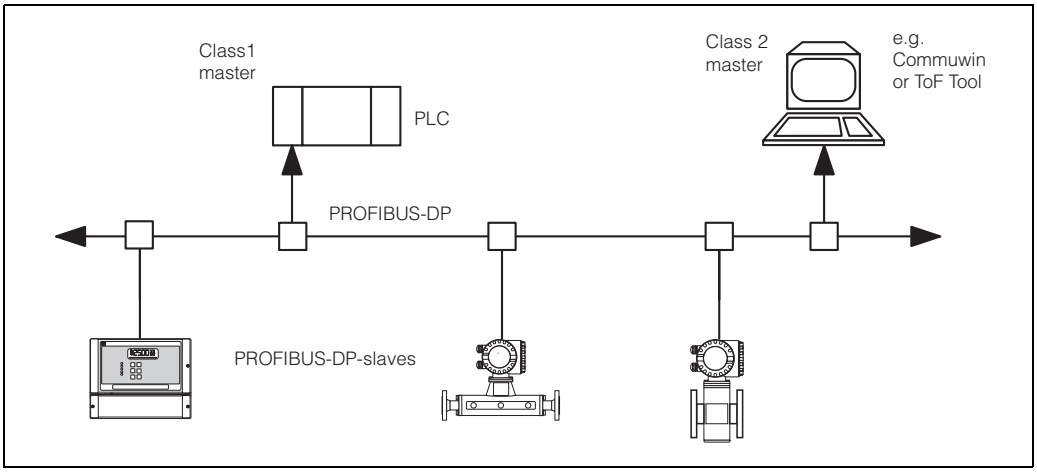
% difference or % average value is shown in V0H0
% level is shown in V4H0 for Channel 2

Channel 1		Channel 2
V2H0	Cancel linearisation (cancel:5) "Linearisation linear" is then shown.	V5H0

11 PROFIBUS-DP Interface

11.1 General notes on a PROFIBUS-DP network

11.1.1 Synopsis



Application

PROFIBUS-DP is used primarily for factory automation. In PROFIBUS-PA systems for process automation, a PROFIBUS-DP system is used at the control level for quick transmission of the data. Here, a variant of PROFIBUS-DP, DPV1 is used. In addition to the cyclic exchange of data with a PLC, this allows the field devices to be configured via acyclic services. The principle technical data for DPV1 are listed in Table 2.1.

Standard	EN 50170, Parts 1 - 3, Version DPV1
Support	PROFIBUS User Organisation (PNO)
Physical layer	RS-485 and/or fibre optics
Max. length	1200 m (copper) or several kilometres (optics)
Participants	Max. 126, including max. 32 as master
Transmission rate	up to12 MBit/s (for FMU 860 ... 862: 1.5 Mbit/s)
Bus access method	Token passing with master-slave

Tab. 2.1 Technical data PROFIBUS-DP

Participants

Depending upon the application at hand, the participants in a PROFIBUS-DP system might be frequency converters, remote I/Os, actuators, sensors, links, gateways etc. as well as the PLC or process control system.

11.1.2 Topology

PROFIBUS-DP is based on a linear topology. For lower data transmission rates, a tree structure is also possible.

Cable

EN 50 170 specifies two types of bus cable. For transmission rates up to 12Mbit/s, cable type A is recommended. The specification is given in Table 2.2

Terminator	135 Ω to 165 Ω at a measuring frequency of 3 MHz to 20 MHz
Cable capacitance	< 30pF per Meter
Core cross-section	>0.34 mm^2, corresponds to AWG 22
Cable type	twisted pairs, 1x 2, 2x 2 or 1x4 core
Loop resistance	110 Ω per km
Signal attenuation	max. 9 dB over the entire length of the segment
Screening	woven copper sheath or woven sheath and foil sheath

Tab. 2.2 Specification of Cable type A of the PROFIBUS-DP standard

Structure

The following points should be noted when the bus structure is being planned:
- The max. permissible cable length depends upon the transmission rate. For PROFIBUS RS-485 cable of type A (see table 2.2) the dependency is as follows:

Transmission rate(kBit/s)	19,2 - 93,75	187,5	500	1500
Cable length(m)	1200	1000	400	200

The maximum transmission rate is limited by the slowest instrument on the bus. The maximum rate of the Prosonic FMU is 1.5 Mbit/s. The FMU recognizes the rate present on the bus and adjusts its own rate automatically.

- A maximum of 32 participants per segment is allowed.
- A terminating resistance must be installed at both ends of every segment (ohmic load 220 Ω).
- The cable length and/or the number of participants can be increased by using repeaters.
- There must never be more than three repeaters between any two participants
- The total number of participants in the system is limited to 126 - (2x number of repeaters).

Spurs

A spur is the cable connecting the field device to the T-box. As a rule of thumb:
- For transmission rates up to 1500 kbits/s, the total length (sum) ot the spurs may not exceed 6.6 m.
- Spurs should not be used for transmission rates greater than 1500 kbits/s.

Examples

Figs. 2.2 and 2.3 show examples for a linear and tree bus structure.

Fig. 2.2. shows that three repeaters are necessary if the PROFIBUS-DP system is to be developed to the full. The maximum cable length corresponds to 4x the value quoted in the table above. Since three repeaters are used, the maximum number of participants is reduced to 120.

Fig. 2.3. shows how several repeaters can be used to create a tree structure. The number of participants allowable per segment is reduced by one per repeater: the total number of participants is limited to 126 - (2x number of repeaters).

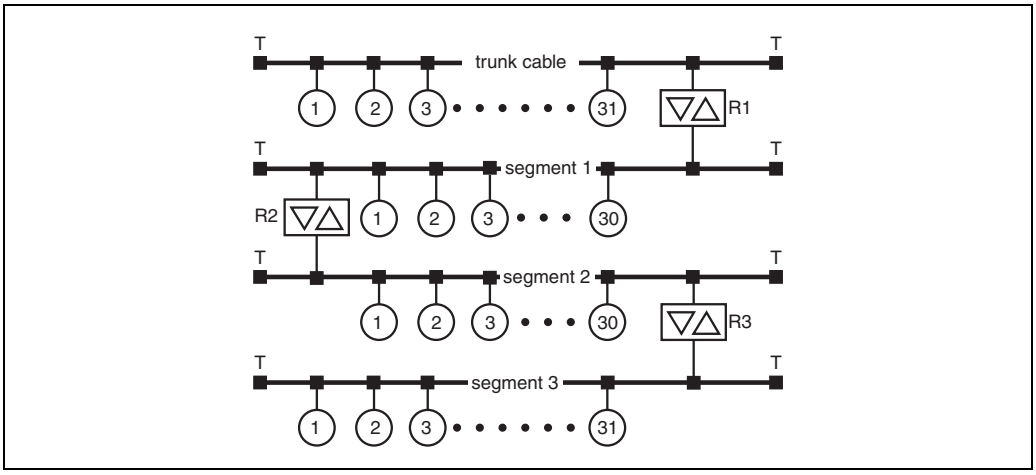


Abb. 2.2 PROFIBUS-DP system with linear structure
T = terminator
R = repeater
1...n = max. number of field devices on a segment

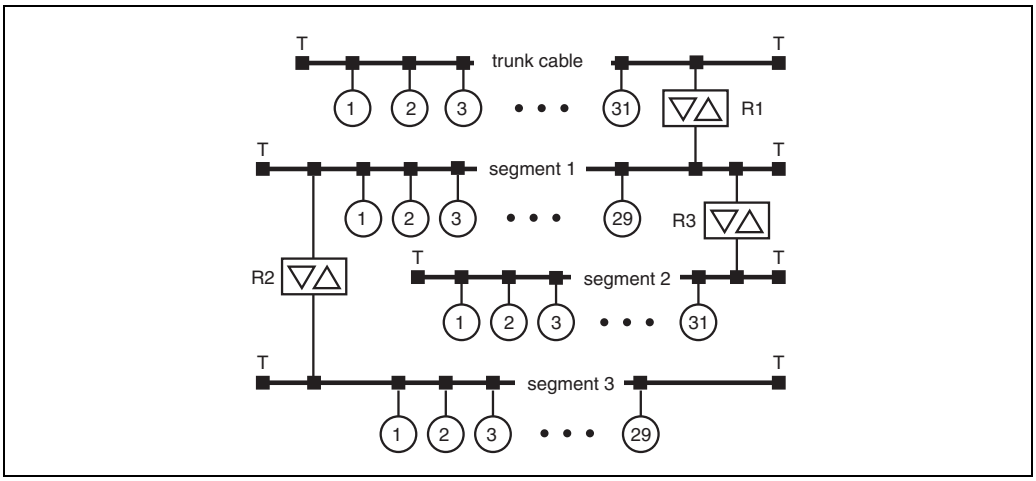


Abb. 2.3 PROFIBUS-DP system with tree structure
T = terminator
R = repeater
1...n = max. number of field devices on a segment

Optical network

If the PROFIBUS-DP system has to be routed over large distances or in a plant with heavy electromagnetic interference, then an optical or mixed optical/copper network can be used. Provided that all participants support them, very high transmission rates are possible. Fig. 2.4 shows a possible structure for an optical network, whereby the technical details can be taken from the PROFIBUS standard.

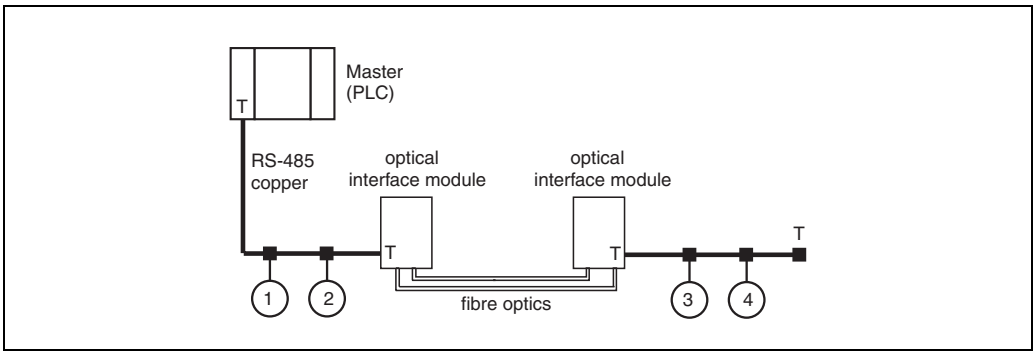


Abb. 2.4 Example for a mixed optical/RS-485 network
T = terminator
1...n = field devices(slaves)

11.2 Address, Termination

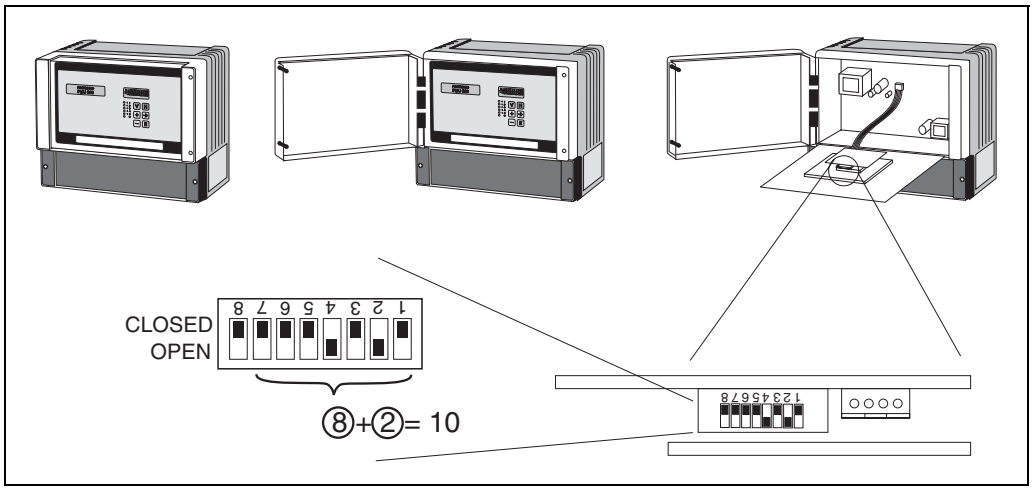
Address

Selecting the device address

- Every PROFIBUS-DP device must be given an address. If the address is not set correctly, the device will not be recognised by the process control system.
- A device address may appear only once within a particular PROFIBUS-DP network, see BA 198F.
- Valid device addresses are in the range from 1 to 126.

Setting of the device address

1. Open the protective cover.
2. Loosen the four cross-head screws of the operating plate.
3. Open the operating plate
4. Set the bus addres according to the table below.
5. Close operating plate and tighten screws.
6. Close the protective cover.



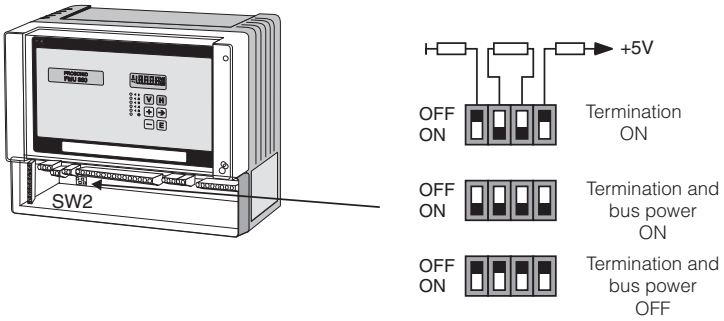
The address is determined by the position of the DIP-switches 1 to 7 according to the following table:

Switch No.	1	2	3	4	5	6	7
Value in position "CLOSED"	0	0	0	0	0	0	0
Value in position "OPEN	1	2	4	8	16	32	64

Note!
The new address becomes valid at a restart of the Prosonic (power on). For the Prosonic, DIP-switch 8 ist without function.

Termination

- At the last instrument on the bus, a terminating resistance must be switched on at DIP-switch SW 2: OFF, ON, ON, OFF.
- Optionally, the bus power can be supplied by this instrument: ON, ON, ON, ON.
- At the remaining instruments the terminating resistance must be switche off: OFF, OFF, OFF, OFF.



11.3 Device database and type files

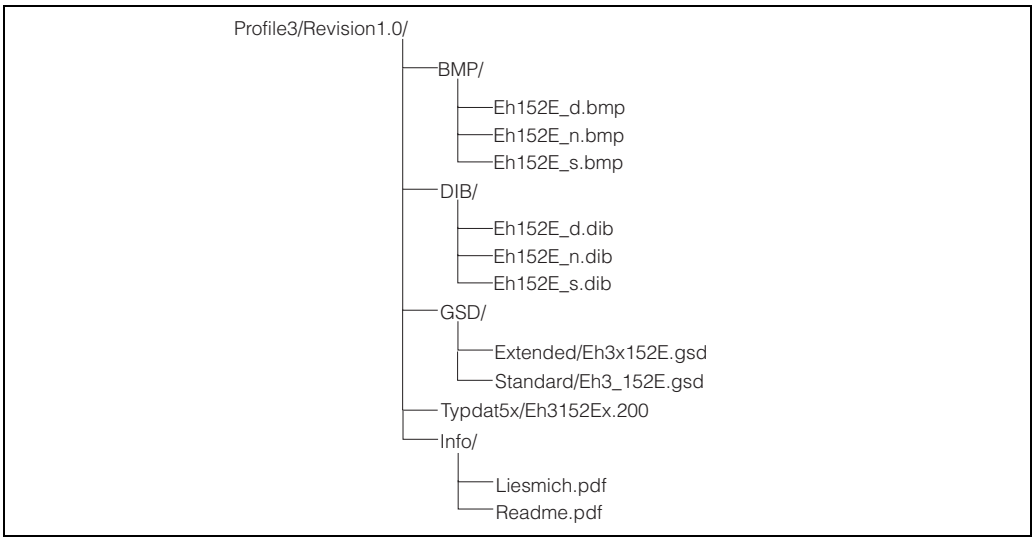
A device database file (*.gsd) contains a description of the properties of the PROFIBUS-DP device, e.g. the supported transmission rates and the type and format of the digital information that can be transfered to the PLC.
Additional bitmap files are required in order to represent the device by an icon in the network design software.
Every device is allocated an identity code by the PROFIBUS User Organisation (PNO). This appears in the device data base file name (.gsd). The Prosonic has the ID number 152E.

Source of supply

- Internet: www.endress.com
- CD-ROM with GSD files for all E+H devices. Order-Code: 50097200
- GSD library of the PROFIBUS User Organisation (PNO):http: //www.PROFIBUS.com

Directory structure

The files are oranized in the folowing strucutre:



- The GSD files in the directory "Extended" are needed for the network design software STEP 7 of the S7-300/400 PLC family.
- The GSD files in the directory "Standard" are used for PLCs, which do not support an identifier format but only an identifier byte (e.g. PLC5 of Allen-Bradley)
- For the network design tool COM ET200 with Siemens S5 instead of an GSD file the Type file "EH_1522x.200" and instead of the BMP files the DIB files have to be used.

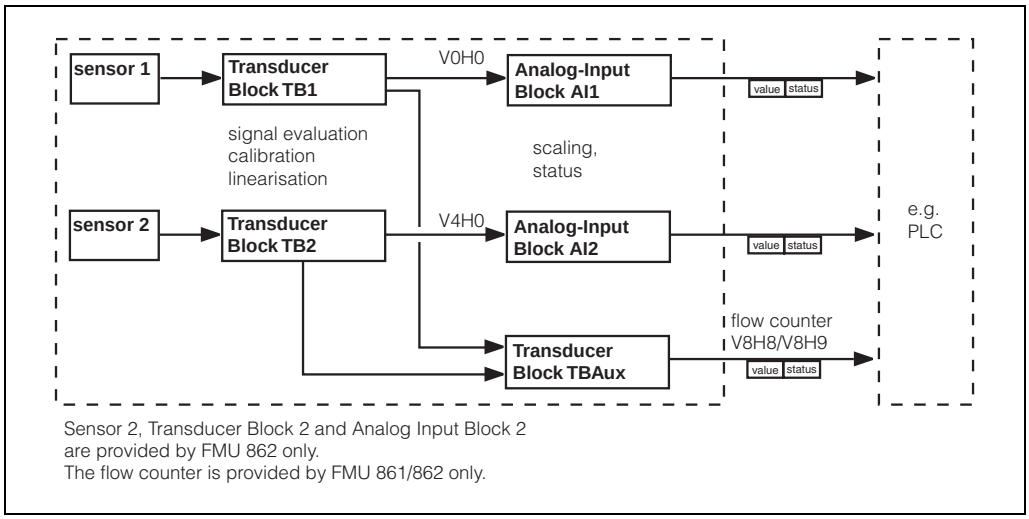
Universal Database File

The PNO also provides an universal database file with the designation PA139701.gsd for devices with two analogue input blocks. Should this be used instead of the Prosonic GSD, then only the two main values can be transmitted. The counter can not be transmitted.
If the universal profile is used, the option "profiles" must be selected in the Physical Block at the matrix position V0H4 (Ident number).

11.4 Cyclic data exchange

Block model of the Prosonic FMU 860/861/862

The block model shows, which data are exchanged continously (i.e. by cyclic data transfer) between the Prosonic and the PLC.



Modules for the cyclic data telegram

For the cyclic data telegram the Prosonic provides the following modules:

1. **Analog Input**
   Depending on the configuration (see below) this is main value 1 (V0H0) or main value 2 (V4H0). Before they are sent to the PLC these values may be scaled in the respective Analog Input Block.
2. **Counter**
   This flow counter is composed of the matrix fields V8H8 (counter high) and V8H9 (counter low).
3. **Empty**
   This module must be applied during configuration (see below), if main value 2 is not to appear in the data telegram.

Configuration of the cyclic data telegram

Use the configuration software of your PLC in order to compose the data telegram from these modules in one of the following ways:

1. **Main value 1**
   In order to transmit only main value 1, select the module **Analog Input**.
2. **Main value 1 and flow counter**
   In order to transmit main value 1 and the flow counter, select the modules in the following order: **Analog Input, Empty, Counter**.
3. **Main value 1 and main value 2**
   In order to transmit both main values , select **Analog Input** twice.
4. **Main value 1, main value 2 and flow counter**
   In order to transmit both main values and the flow counter, select the modules in the following order: **Analog Input, Analog Input, Counter**.

The exact way of performing the configuration depends on the configuration software of the PLC.

Data formats

Main value 1/2

Bytes	Data	Format
1, 2, 3, 4	main value	32 bit floating point number (IEEE-757, see below)
5	status code	see below "Status codes"

Flow counter

Bytes	Data	Format
1, 2, 3, 4	flow counter	LONG INTEGER (see below)
5	status code (identical to status of main value 1)	see below "Statuscodes"

IEEE-754 floating point number

The measured values are transmitted as IEEE 754 floating point numbers, whereby:

measured value = $(-1)^{VZ} \times 2^{(E-127)} \times (1+F)$

Byte 1								Byte 2							
Bit 7	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Sign	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}
	Exponent (E)							Mantissa (F)							

Byte 3								Byte 4							
Bit 7	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2^{-8}	2^{-9}	2^{-10}	2^{-11}	2^{-12}	2^{-13}	2^{-14}	2^{-15}	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}	2^{-22}	2^{-23}
Mantissa (F)															

Example

40 F0 00 00 (hex) = 0**100 0000 1**111 0000 0000 0000 0000 0000 (bin)

$= (-1)^0 \times 2^{(129 - 127)} \times (1 + 2^{-1} + 2^{-2} + 2^{-3})$

$= 1 \times 2^2 \times (1 + 0.5 + 0.25 + 0.125)$

$= 1 \times 4 \times 1.875$

$= 7.5$

LONG INTEGER

The flow counter is transmitted as LONG INTEGER, whereby:

Byte 1								Byte 2							
Bit 7	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2^{31}	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}

Byte 3								Byte 4							
Bit 7	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Status codes

The status codes comprise one byte and have got the following meaning:

Status-Code	Device status	Significance
0C Hex	BAD	non-specific
1F Hex	BAD	out-of-service (target mode)
40 Hex	UNCERTAIN	non-specific (simulation)
47 Hex	UNCERTAIN	last usable value (Fail-safe-Mode aktiv)
4B Hex	UNCERTAIN	Substitute set (fail-Safe mode active)
4F Hex	UNCERTAIN	initial value (fail-Safe mode active)
5C Hex	UNCERTAIN	Configuration error (limits not set correctly)
80 Hex	GOOD	OK
84 Hex	GOOD	Active block alarm (static revision counter incremented)
89 Hex	GOOD	LOW_LIM (alarm active)
8A Hex	GOOD	HI_LIM (alarm active)
8D Hex	GOOD	LOW_LOW_LIM (alarm active)
8E Hex	GOOD	HI_HI_LIM (alarm active)

11.5 Acyclic data exchange

The device parameters in the physical block, transducer blocks and analog input blocks, as well as the device management can be accessed by a Class 2 PROFIBUS-DP master (e.g. Commuwin II) using the acyclic data services.

Slot/Index-Tabellen

The device parameters are listed in the following tables. The parameters are accessed via the slot and index number.
The Analog-Input and physical blocks contain standard parameters, block parameters and manufacturer-specific parameters. The transducer blocks are E+H specific.

Physical Block

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standardparameter								
Physikal Block block objekt		0	16	20	DS32*	x		C
PB Static revision		0	17	2	unsigned16	x		N
PB Device tag		0	18	32	Octet String(32)	x	x	S
PB Strategy		0	19	2	unsigned16	x	x	S
PB Alert key		0	20	1	unsigned8	x	x	S
PB Target mode		0	21	1	unsigned8	x	x	S
PB Mode block		0	22	3	DS37*	x		D
PB Alarm summary		0	23	8	DS42*	x		D
Blockparameter								C
PB Software revision		0	24	16	Visible String(16)	x		C
PB Hardware revision		0	25	16	Visible String(16)	x		C
PB Device manufacturer identity		0	26	2	unsigned16	x		C
PB Device identity		0	27	16	Visible String(16)	x		C
PB Device serial number		0	28	16	Visible String(16)	x		C
PB Diagnosis		0	29	4	Octet String(4)	x		D
PB Diagnosis extention		0	30	6	Octet String(6)	x		D
PB Diagnosis mask		0	31	4	Octet String(4)	x		C
PB Diagnosis extention mask		0	32	6	Octet String(6)	x		C
PB Security locking	V9H6	0	34	2	unsigned16	x	x	N
PB General reset	V9H5	0	35	2	unsigned16	x	x	S
PB Device message		0	37	32	Octet String(32)	x	x	S
PB Ident Number selector		0	40	1	unsigned8	x	x	S
PB Diagnostic code	V9H0	0	54	2	unsigned16	x		D
PB Last diagnostic code	V9H1	0	55	2	unsigned16	x	x	D
PB Device and software number	V9H3	0	60	2	unsigned16	x		C
PB Last but one diagnostic code	V9H2	0	61	2	unsigned16	x	x	D
PB View 1		0	70	13	OSTRING	x		D

Transducer Block TBAux

Transducer Block TBAux contains those device parameters which can not be assigned to one of the channels.

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standardparameter								
Transducer block Aux block objekt		0	120	20	DS32*	x		C
TBAux Static revision		0	121	2	unsigned16	x		N
TBAux Device tag		0	122	32	Octet String(32)	x	x	S
TBAux Strategy		0	123	2	unsigned16	x	x	S
TBAux Alert key		0	124	1	unsigned8	x	x	S
TBAux Target mode		0	125	1	unsigned8	x	x	S
TBAux Mode block		0	126	3	DS37*	x		D
TBAux Alarm summary		0	127	8	DS42*	x		D

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
E+H-Parameter								
TBAux Relay selection	V1H0	0	128	1	unsigned8	x	x	S
TBAux Relay funktion	V1H1	0	129	1	unsigned8	x	x	S
TBAux Switch-on point	V1H2	0	130	4	floating point	x	x	S
TBAux Switch-off point	V1H3	0	131	4	floating point	x	x	S
TBAux Alternating pump control	V1H4	0	132	1	unsigned8	x	x	S
TBAux Count factor C1	V1H5	0	133	4	floating point	x	x	S
TBAux Count factor C2	V1H6	0	134	4	floating point	x	x	S
TBAux Count factor C3	V1H7	0	135	4	floating point	x	x	S
TBAux Internal time	V1H8	0	136	2	unsigned16	x	x	S
TBAux Switch delay	V1H9	0	137	1	unsigned8	x	x	S
TBAux Operating mode	V8H0	0	138	1	unsigned8	x	x	S
TBAux Select current	V8H1	0	139	1	unsigned8	x	x	S
TBAux 4 mA threshold	V8H2	0	140	1	unsigned8	x	x	S
TBAux Select distance unit	V8H3	0	141	1	unsigned8	x	x	S
TBAux Flow unit	V8H4	0	142	1	unsigned8	x	x	S
TBAux Counter unit	V8H5	0	143	1	unsigned8	x	x	S
TBAux Limit switch	V8H6	0	144	1	unsigned8	x	x	S
TBAux External temperatur sensor	V8H7	0	145	1	unsigned8	x	x	S
TBAux Internal counter high	V8H8	0	146	2	unsigned16	x		S
TBAux Internal counter low	V8H9	0	147	2	unsigned16	x		S
TBAux Reset counter	V9H4	0	148	2	unsigned16	x	x	D
TBAux Simulation level	V9H7	0	149	4	floating point	x	x	S
TBAux Simulation volume	V9H8	0	150	4	floating point	x	x	S
TBAux Simulation current	V9H9	0	151	4	floating point	x	x	S
TBAux View1		0	152	13	OSTRING	x		D

Device management

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Directory objekt header		1	0	12	OSTRING	x		C
Composite list directory entries		1	1	24	OSTRING	x		C

Analog Input Block AI1

Analog Input Block 1 transmits the measured value of channel 1. It is connected to the Transducer Block TB 1 and contains the following parameters:

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standardparameter								
Analog input block 1 block objekt		1	16	20	DS32*	x		C
AI1 Static revision		1	17	2	unsigned16	x		N
AI1 Device tag		1	18	32	Octet String(32)	x	x	S
AI1 Strategy		1	19	2	unsigned16	x	x	S
AI1 Alert key		1	20	1	unsigned8	x	x	S
AI1 Target Mode		1	21	1	unsigned8	x	x	S
AI1 Mode block		1	22	3	DS37*	x		D
AI1 Alarm summary		1	23	8	DS42*	x		D
Blockparameter								
AI1 OUT		1	26	5	DS33*	x		D
AI1 PV_SCALE		1	27	8	floating point(2)	x	x	S
AI1 OUT_SCALE		1	28	11	DS36*	x	x	S
AI1 LIN_TYPE		1	29	1	unsigned8	x	x	S
AI1 CHANNEL		1	30	2	unsigned16	x	x	S
AI1 PV_FTIME		1	32	4	floating point	x	x	S
AI1 ALARM_HYSTERESIS		1	35	4	floating point	x	x	S
AI1 HI_HI_LIMIT		1	37	4	floating point	x	x	S
AI1 HI_LIMIT		1	39	4	floating point	x	x	S
AI1 LO_LIMIT		1	41	4	floating point	x	x	S
AI1 LO_LO_LIMIT		1	42	4	floating point	x	x	S
AI1 HI_HI_ALM		1	46	16	DS39*	x		D
AI1 HI_ALM		1	47	16	DS39*	x		D
AI1 LO_ALM		1	48	16	DS39*	x		D
AI1 LO_LO_ALM		1	49	16	DS39*	x		D
AI1 SIMULATE		1	50	6	DS50*	x	x	S
AI1 OUT_UNIT_TEXT		1	51	16	Octet String(16)	x	x	S
AI1 View1		1	61	13	OSTRING	x		D

Transducer Block TB1

Transducer Block TB 1 contains the device parameters for channel 1.

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standardparameter								
Transducer block 1 block object		1	120	20	DS32*	x		C
TB1 Static revision		1	121	2	unsigned16	x		N
TB1 Device tag		1	122	32	Octet String(32)	x	x	S
TB1 Strategy		1	123	2	unsigned16	x	x	S
TB1 Alert key		1	124	1	unsigned8	x	x	S
TB1 Target mode		1	125	1	unsigned8	x	x	S
TB1 Mode block		1	126	3	DS37*	x		D
TB1 Alarm summary		1	127	8	DS42*	x		D
E+H-Parameter								
TB1 Measured value Channel 1	V0H0	1	128	4	floating point	x		D
TB1 Empty calibration Channel 1	V0H1	1	129	4	floating point	x	x	S
TB1 Full calibration Channel 1	V0H2	1	130	4	floating point	x	x	S
TB1 Application Channel 1	V0H3	1	131	1	unsigned8	x	x	S
TB1 Type of sensor Channel 1	V0H4	1	132	1	unsigned8	x	x	S
TB1 Value for 0/4mA Channel 1	V0H5	1	133	4	floating point	x	x	S
TB1 Value for 20mA Channel 1	V0H6	1	134	4	floating point	x	x	S
TB1 Output damping Channel 1	V0H7	1	135	4	floating point	x	x	S
TB1 Measured distance Channel 1	V0H8	1	136	4	floating point	x		D
TB1 Measured level Channel 1	V0H9	1	137	4	floating point	x		D
TB1 Linearization Channel 1	V2H0	1	138	1	unsigned8	x	x	S
TB1 Actual level Channel 1	V2H1	1	139	4	floating point	x	x	S
TB1 Q/h curve Channel 1	V2H2	1	140	1	unsigned8	x	x	S
TB1 Input level Channel 1	V2H3	1	141	4	floating point	x	x	D
TB1 Input volume Channel 1	V2H4	1	142	4	floating point	x	x	D
TB1 Line number Channel 1	V2H5	1	143	1	unsigned8	x	x	D
TB1 Diameter of vessel Channel 1	V2H6	1	144	4	floating point	x	x	S
TB1 Vmax / Qmax Channel 1	V2H7	1	145	4	floating point	x	x	S
TB1 Low flow cut off Channel 1	V2H8	1	146	4	floating point	x	x	S
TB1 Crest length Channel 1	V2H9	1	147	4	floating point	x	x	S
TB1 Range for auto. suppression Channel 1	V3H0	1	148	4	floating point	x	x	S
TB1 Echo attenuation Channel 1	V3H1	1	149	2	integer16	x		S
TB1 Signal / noise ratio Channel 1	V3H2	1	150	1	unsigned8	x		S
TB1 If no echo Channel 1	V3H3	1	151	1	unsigned8	x	x	D
TB1 Safety alarm Channel 1	V3H4	1	152	1	unsigned8	x	x	D
TB1 Envelope curve statistics Channel 1	V3H5	1	153	1	unsigned8	x	x	S
TB1 FAC threshold Channel 1	V3H6	1	154	1	unsigned8	x	x	S
TB1 FAC rise Channel 1	V3H7	1	155	1	unsigned8	x	x	S
TB1 Device tag Channel 1	VAH0	1	156	16	Octet String(16)	x	x	S
TB1 Unit Channel 1	VAH3	1	157	1	unsigned8	x	x	S
TB1 Text Channel 1	VAH7	1	158	1	unsigned8	x	x	S
TB1 View1		1	159	13	OSTRING	x		D

Analog Input Block AI2

Analog Input Block 2 transmits the measured value of channel 2. It is connected to Transducer Block TB 2 and contains the following parameters:

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standardparameter								
Analog input block 2 block objekt		2	16		DS32*	x		C
AI2 Static revision		2	17	2	unsigned16	x		N
AI2 Device tag		2	18	32	Octet String(32)	x	x	S
AI2 Strategy		2	19	2	unsigned16	x	x	S
AI2 Alert key		2	20	1	unsigned8	x	x	S
AI2 Target Mode		2	21	1	unsigned8	x	x	S
AI2 Mode block		2	22	3	DS37*	x		D
AI2 Alarm summary		2	23	8	DS42*	x		D

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Blockparameter								
AI2 OUT		2	26	5	DS33*	x		D
AI2 PV_SCALE		2	27	8	floating point(2)	x	x	S
AI2 OUT_SCALE		2	28	11	DS36*	x	x	S
AI2 LIN_TYPE		2	29	1	unsigned8	x	x	S
AI2 CHANNEL		2	30	2	unsigned16	x	x	S
AI2 PV_FTIME		2	32	4	floating point	x	x	S
AI2 ALARM_HYSTERESIS		2	35	4	floating point	x	x	S
AI2 HI_HI_LIMIT		2	37	4	floating point	x	x	S
AI2 HI_LIMIT		2	39	4	floating point	x	x	S
AI2 LO_LIMIT		2	41	4	floating point	x	x	S
AI2 LO_LO_LIMIT		2	43	4	floating point	x	x	S
AI2 HI_HI_ALM		2	46	16	DS39*	x		D
AI2 HI_ALM		2	47	16	DS39*	x		D
AI2 LO_ALM		2	48	16	DS39*	x		D
AI2 LO_LO_ALM		2	49	16	DS39*	x		D
AI2 SIMULATE		2	50	6	DS50*	x	x	S
AI2 OUT_UNIT_TEXT		2	51	16	Octet String(16)	x	x	S
AI2 View1		2	61	13	OSTRING	x		D

Transducerblock TB2

Transducer Block TB 2 contains the device parameters for channel 2.

Parameter	E+H Matrix (CW II)	Slot	Index	Size [bytes]	Type	Read	Write	Storage Class
Standardparameter								
Transducer block 2 block object		2	120	20	DS32*	x		C
TB2 Static revision		2	121	2	unsigned16	x		N
TB2 Device tag		2	122	32	Octet String(32)	x	x	S
TB2 Strategy		2	123	2	unsigned16	x	x	S
TB2 Alert key		2	124	1	unsigned8	x	x	S
TB2 Target mode		2	125	1	unsigned8	x	x	S
TB2 Mode block		2	126	3	DS37*	x		D
TB2 Alarm summary		2	127	8	DS42*	x		D
E+H-Parameter								
TB2 Measured value Channel 2	V4H0	2	128	4	floating point	x		D
TB2 Empty calibration Channel 2	V4H1	2	129	4	floating point	x	x	S
TB2 Full calibration Channel 2	V4H2	2	130	4	floating point	x	x	S
TB2 Application Channel 2	V4H3	2	131	1	unsigned8	x	x	S
TB2 Type of sensor Channel 2	V4H4	2	132	1	unsigned8	x	x	S
TB2 Value for 0/4mA Channel 2	V4H5	2	133	4	floating point	x	x	S
TB2 Value for 20mA Channel 2	V4H6	2	134	4	floating point	x	x	S
TB2 Output damping Channel 2	V4H7	2	135	4	floating point	x	x	S
TB2 Measured distance Channel 2	V4H8	2	136	4	floating point	x		D
TB2 Measured level Channel 2	V4H9	2	137	4	floating point	x		D
TB2 Linearization Channel 2	V5H0	2	138	1	unsigned8	x	x	S
TB2 Actual level Channel 2	V5H1	2	139	4	floating point	x	x	S
TB2 Input level Channel 2	V5H3	2	140	4	floating point	x	x	D
TB2 Input volume Channel 2	V5H4	2	141	4	floating point	x	x	D
TB2 Line number Channel 2	V5H5	2	142	1	unsigned8	x	x	D
TB2 Diameter of vessel Channel 2	V5H6	2	143	4	floating point	x	x	S
TB2 Vmax / Qmax Channel 2	V5H7	2	144	4	floating point	x	x	S
TB2 Limit back water alarm Channel 2	V5H8	2	145	1	unsigned8	x	x	S
TB2 Range for auto. suppression Channel 2	V6H0	2	146	4	floating point	x	x	S
TB2 Echo attenuation Channel 2	V6H1	2	147	2	integer16	x		D
TB2 Signal / noise ratio Channel 2	V6H2	2	148	1	unsigned8	x		D
TB2 If no echo Channel 2	V6H3	2	149	1	unsigned8	x	x	S
TB2 Safety alarm Channel 2	V6H4	2	150	1	unsigned8	x	x	S
TB2 Envelope curve statistics Channel 2	V6H5	2	151	1	unsigned8	x	x	S
TB2 FAC threshold Channel 2	V6H6	2	152	1	unsigned8	x	x	S
TB2 FAC rise Channel 2	V6H7	2	153	1	unsigned8	x	x	S
TB2 Device tag Channel 2	VAH1	2	154	16	Octet String(16)	x	x	S
TB2 Unit Channel 2	VAH5	2	155	1	unsigned8	x	x	S
TB2 Text Channel 2	VAH9	2	156	1	unsigned8	x	x	S
TB2 View1		2	157	13	OSTRING	x		D

Appendix A: Weirs and Flumes

A.1 Rectangular Sharp-Crested Weir

A.2 Trapezoidal Sharp-Crested Weir

A.3 Khafagi-Venturi Flumes

A.4 Parshall Flumes

A.5 British Standard Weir

A.6 Palmer-Bowlus Flume

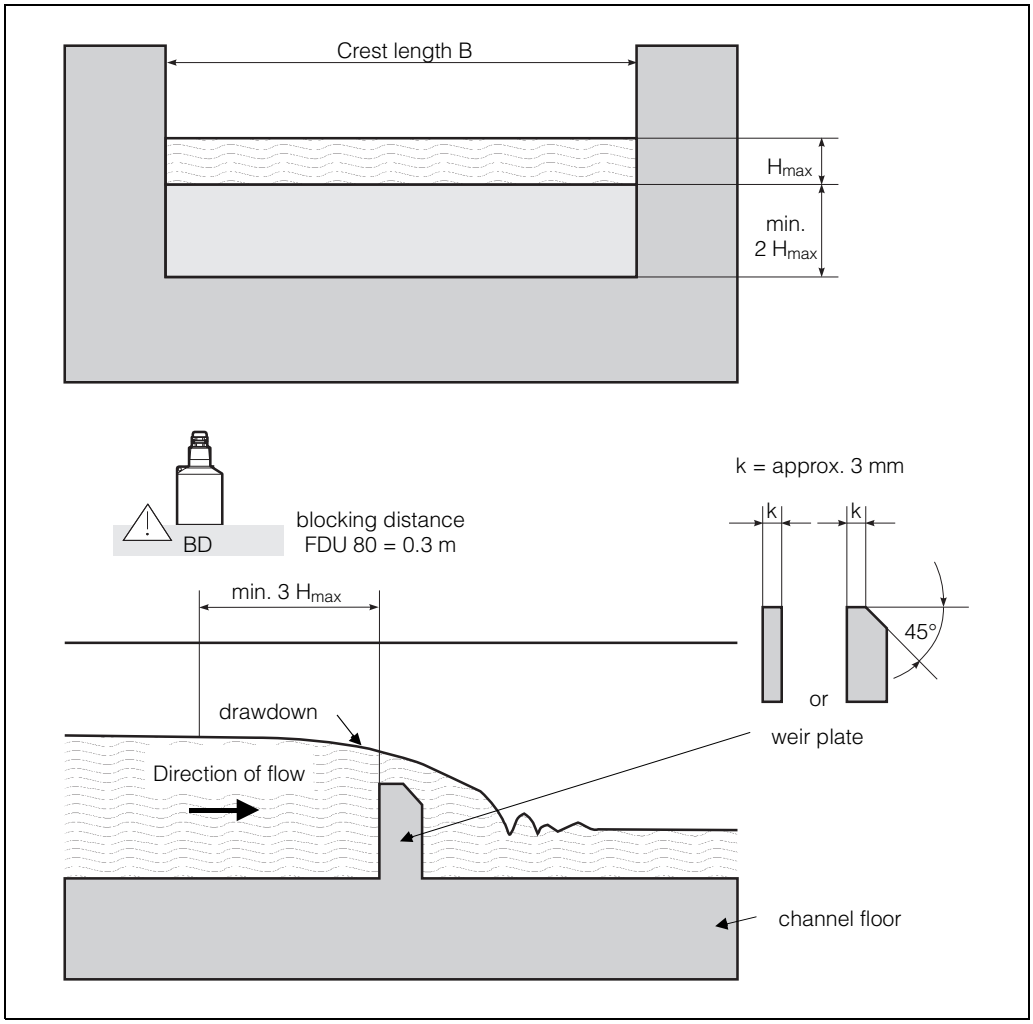
A.7 Rectangular Constricted Sharp-Crested Weir

A.8 V-Notch Sharp-Crested Weir

Triangular

Note: Codes 100 to 104 are reserved for customer-specific weirs.

A.1 Rectangular Sharp-Crested Weir



Tab. A.1
Pre-programmed drawdown weirs with rectangular section

V2H2 Code	B (mm)	H_{max} (mm)	Q_{max} (m^3/h)
0	1000	500	2418
1	1000	1500	12567

Adjusting a Q/h curve to the correct crest length

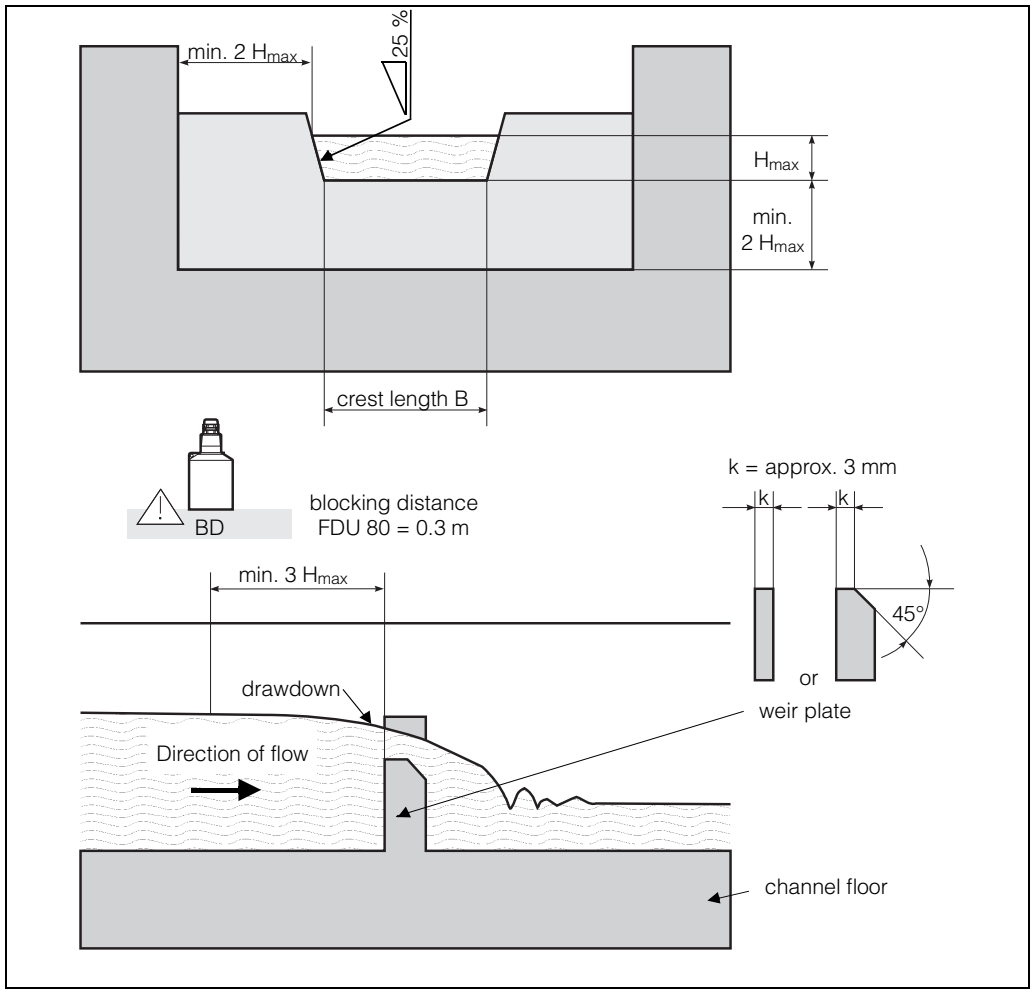
The Q/h-curves can be made to fit other crest lengths.
For crest length greater than 8.5 m for Code 0 (or greater than 1.65 m for Code 1).
Select greater flow units than m^3/h such as, e.g. m^3/sec.
(The largest value which can be displayed is 19999)

Step	Matrix	Entry	Meaning
1	V2H2	e.g. 1	Select the code with H_{max} of the weir.
2	-	»E«	Confirm entry
3	V2H9	e.g. 2	Give the weir throat in [m]
4	-	»E«	Confirm entry
5	V2H0	2	Enter 2 for the Q/h-curve
6	-	»E«	Confirm entry and activate curve

Note!

The factory setting for the current output assigns a maximum flowrate Q_{max} = 100 to the 20 mA current.
After entering a characteristic code, the maximum flow exceeds this vale and causes a signal overrun.
If you want to use the current output, then enter the flow value in V0H6 which is assigned to the 20 mA signal.

A.2 Trapezoidal Sharp-Crested Weir
(Cipoletti)



V2H2 Code	B (mm)	H_{max} (mm)	Q_{max} (m^3/h)
2	1000	300	1049
3	1000	1500	11733

Tab. A.2
Pre-programmed drawdown weirs with a trapezoidal section

Adjusting a Q/h curve to the correct crest length

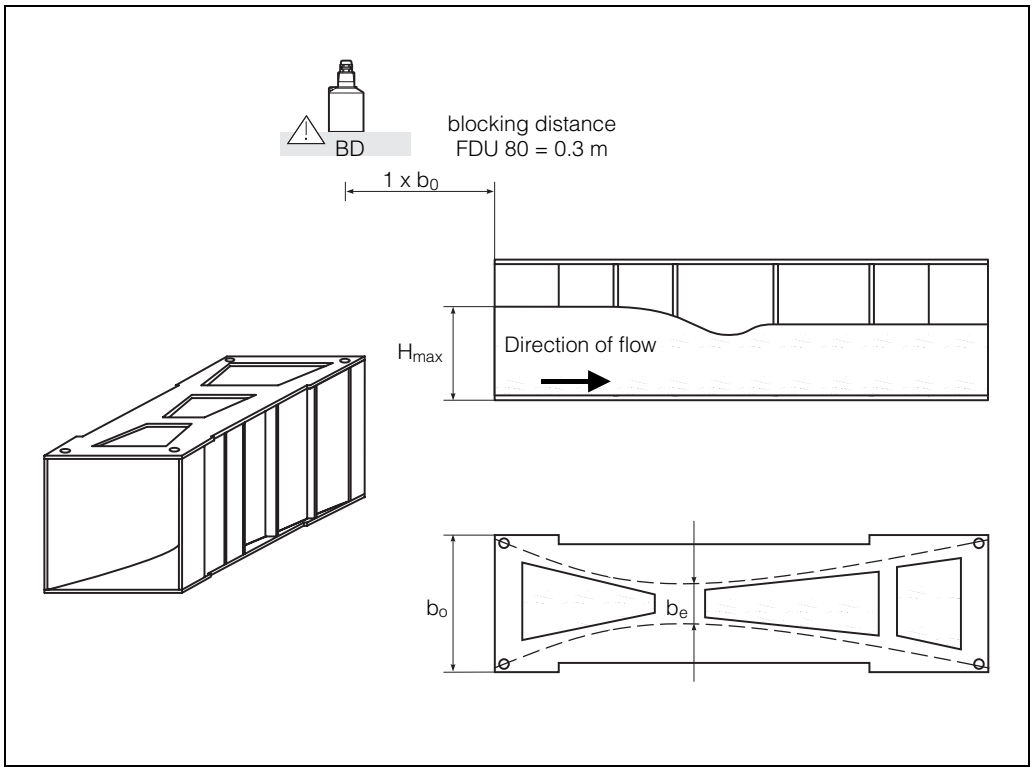
Step	Matrix	Entry	Meaning
1	V2H2	e.g. 2	Select the code with H_{max} of the weir.
2	-	»E«	Confirm entry
3	V2H9	e.g. 2	Give the weir throat in [m]
4	-	»E«	Confirm entry
5	V2H0	2	Enter 2 for the Q/h-curve
6	-	»E«	Confirm entry and activate curve

The Q/h-curves can be made to fit other crest lengths.
For crest length greater than 18.2 m for Code 2 or greater than 1.63 m for Code 3.
Select greater flow units than m^3/h such as, e.g. m^3/sec.
(The largest value which can be displayed is 19999)

The factory setting for the current output assigns a maximum flowrate Q_{max} = 100 to the 20 mA current.
After entering a characteristic code, the maximum flow exceeds this vale and causes a signal overrun.
If you want to use the current output, then enter the flow value in V0H6 which is assigned to the 20 mA signal.


Note!

A.3 Khafagi-Venturi Flumes



Tab. A.3
Pre-programmed
Khafagi-Venturi-flumes

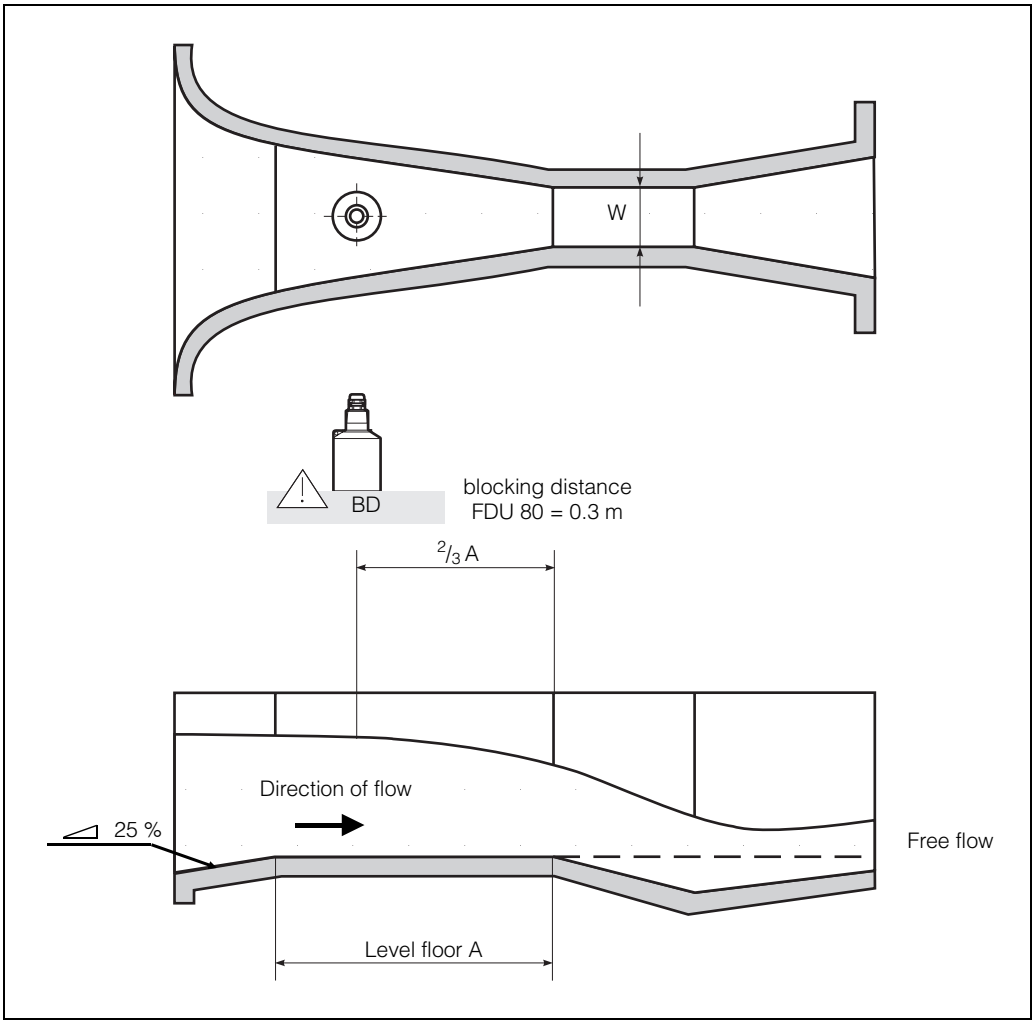
Khafagi-Venturi Flumes					
Code	**Type**	**bo (mm)**	**be (mm)**	**H_{max} (mm)**	**Q_{max} (m^3/h)**
10	QV 302	120	48	220	40.09
11	QV 303	300	120	250	104.3
12	QV 304	400	160	350	231.5
13	QV 305	500	200	380	323.0
14	QV 306	600	240	400	414.0
15	QV 308	800	320	600	1024
16	QV 310	1000	400	800	1982
17	QV 313	1300	520	950	3308
18	QV 316	1600	640	1250	6181

Increased Side Walls for Khafagi-Venturi Flumes					
Code	**Type**	**bo (mm)**	**be (mm)**	**H_{max} (mm)**	**Q_{max} (m^3/h)**
80	QV 302	120	48	330	81.9
81	QV 303	300	120	360	187.9
82	QV 304	400	160	460	359.9
83	QV 305	500	200	580	637.7
84	QV 306	600	240	580	748.6
85	QV 308	800	320	850	1790
86	QV 310	1000	400	1200	3812
87	QV 313	1300	520	1350	5807
88	QV 316	1600	640	1800	11110

Note!

The factory setting for the current output assigns a maximum flowrate Q_{max} = 100 to the 20 mA current.
After entering a characteristic code, the maximum flow exceeds this vale and causes a signal overrun.
If you want to use the current output, then enter the flow value in V0H6 which is assigned to the 20 mA signal.

A.4 Parshall Flumes



Code in V2H2	W	H_{max} (mm)	Q_{max} (m^3/h)
22	3"	480	204.2
23	6"	480	430.5
24	9"	630	950.5
25	1ft	780	1704
26	1.5ft	780	2595
27	2ft	780	3498
28	3ft	780	5328
29	4ft	780	7185
30	5ft	780	9058
31	6ft	780	10951
32	8ft	780	14767

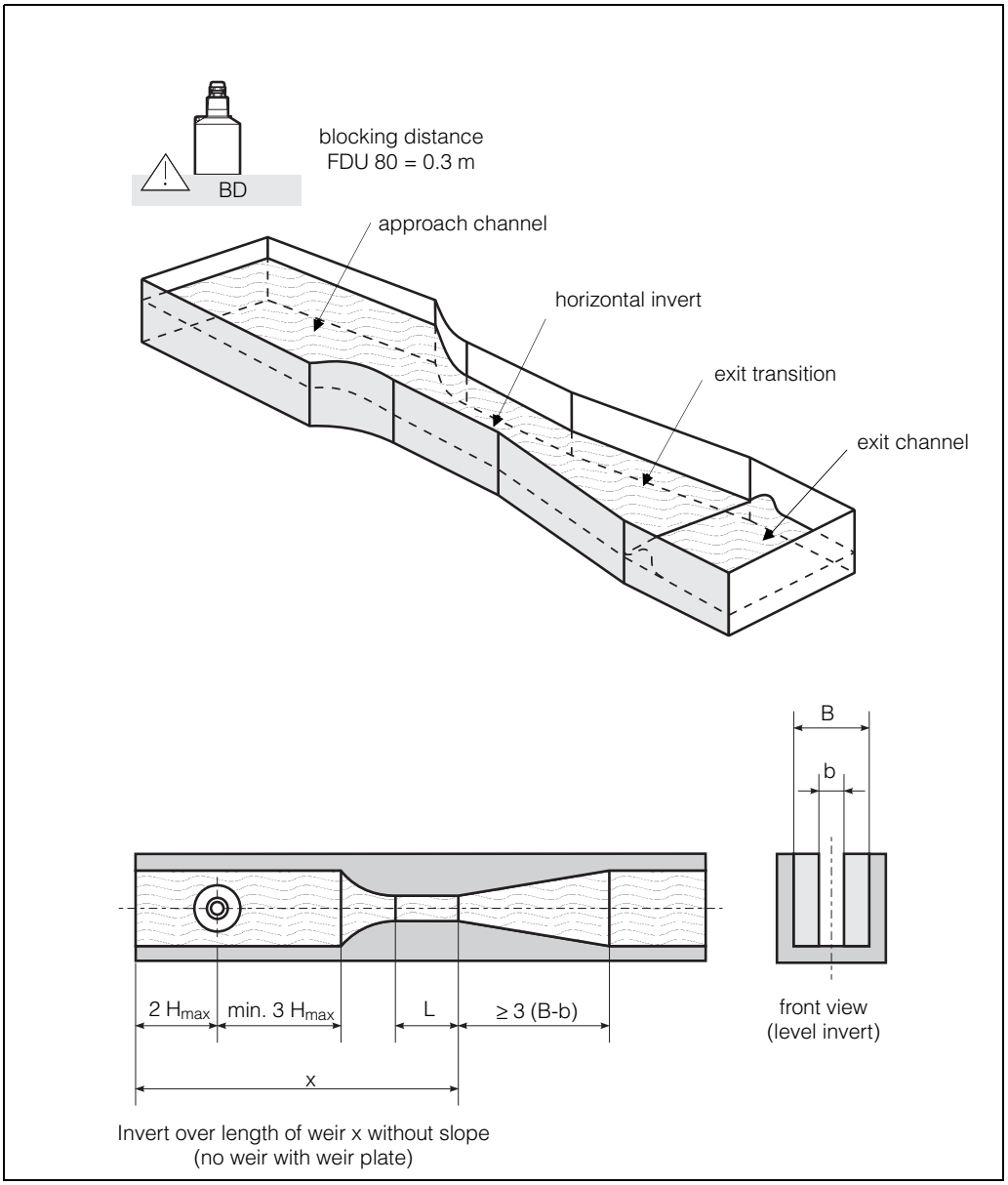
Tab. A.4
Pre-programmed Parshall flumes

The factory setting for the current output assigns a maximum flowrate Q_{max} = 100 to the 20 mA current.
After entering a characteristic code, the maximum flow exceeds this vale and causes a signal overrun.
If you want to use the current output, then enter the flow value in V0H6 which is assigned to the 20 mA signal.



Note!

A.5 British Standard Flume



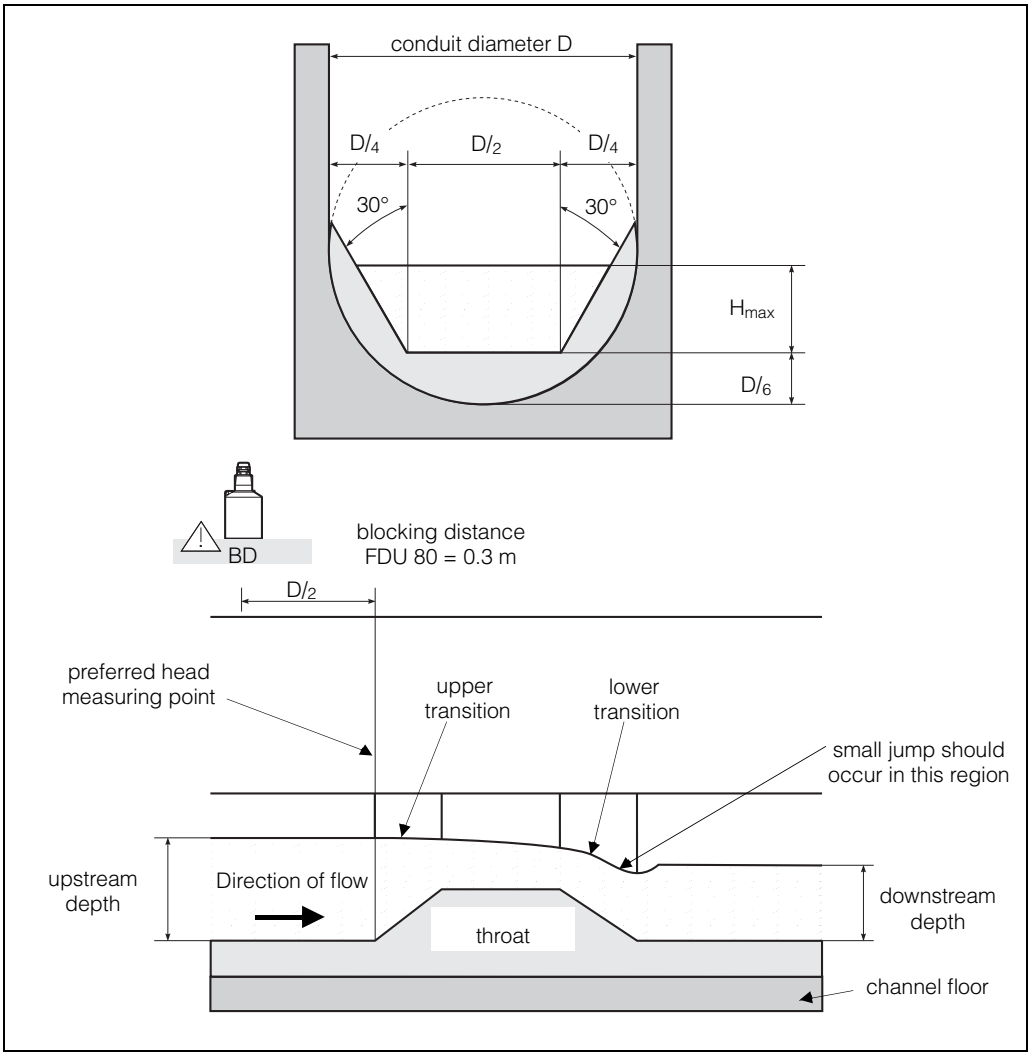
Tab. A.5
Pre-programmed
British Standard flume

Code	b_{max}	H_{max} (mm)	Q_{max} (m^3/h)
40	4"	150	36.25
41	7"	190	90.44
42	12"	340	371.1
43	18"	480	925.7
44	30"	840	3603

Note!

The factory setting for the current output assigns a maximum flowrate Q_{max} = 100 to the 20 mA current.
After entering a characteristic code, the maximum flow exceeds this vale and causes a signal overrun.
If you want to use the current output, then enter the flow value in V0H6 which is assigned to the 20 mA signal.

A.6 Palmer-Bowlus Flume



Code	D	H_{max} (mm)	Q_{max} (m^3/h)
50	6"	120	38.08
51	8"	150	68.86
52	10"	210	150.2
53	12"	240	215.8
54	15"	300	377.6
55	18"	330	504.0
56	21"	420	875.6
57	24"	450	1077
58	27"	540	1639
59	30"	600	2133

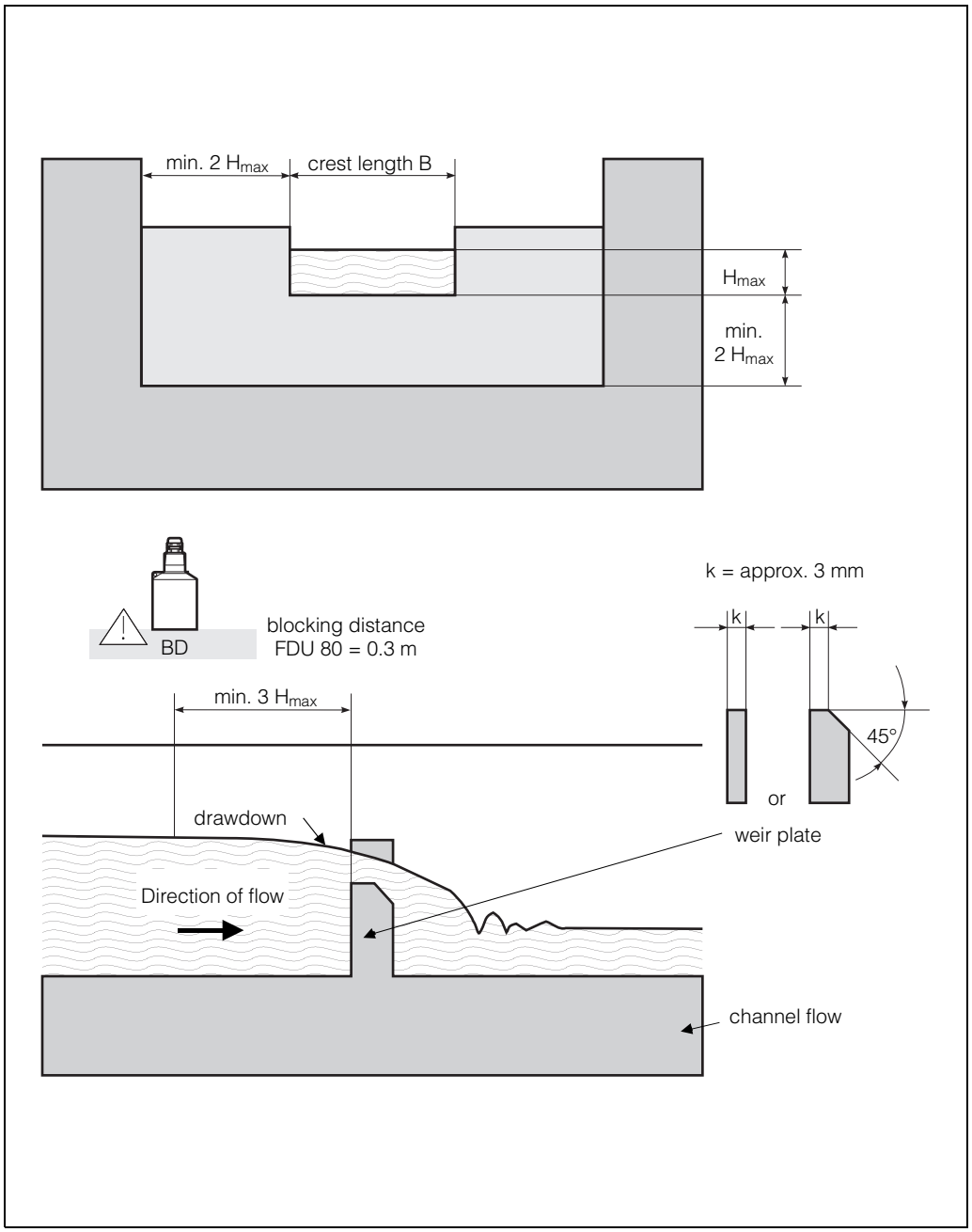
Tab. A.6
Pre-programmed
Palmer-Bowlus flume

The factory setting for the current output assigns a maximum flowrate Q_{max} = 100 to the 20 mA current.
After entering a characteristic code, the maximum flow exceeds this vale and causes a signal overrun.
If you want to use the current output, then enter the flow value in V0H6 which is assigned to the 20 mA signal.



Note!

A.7 Rectangular Constricted Sharp-Crested Weir



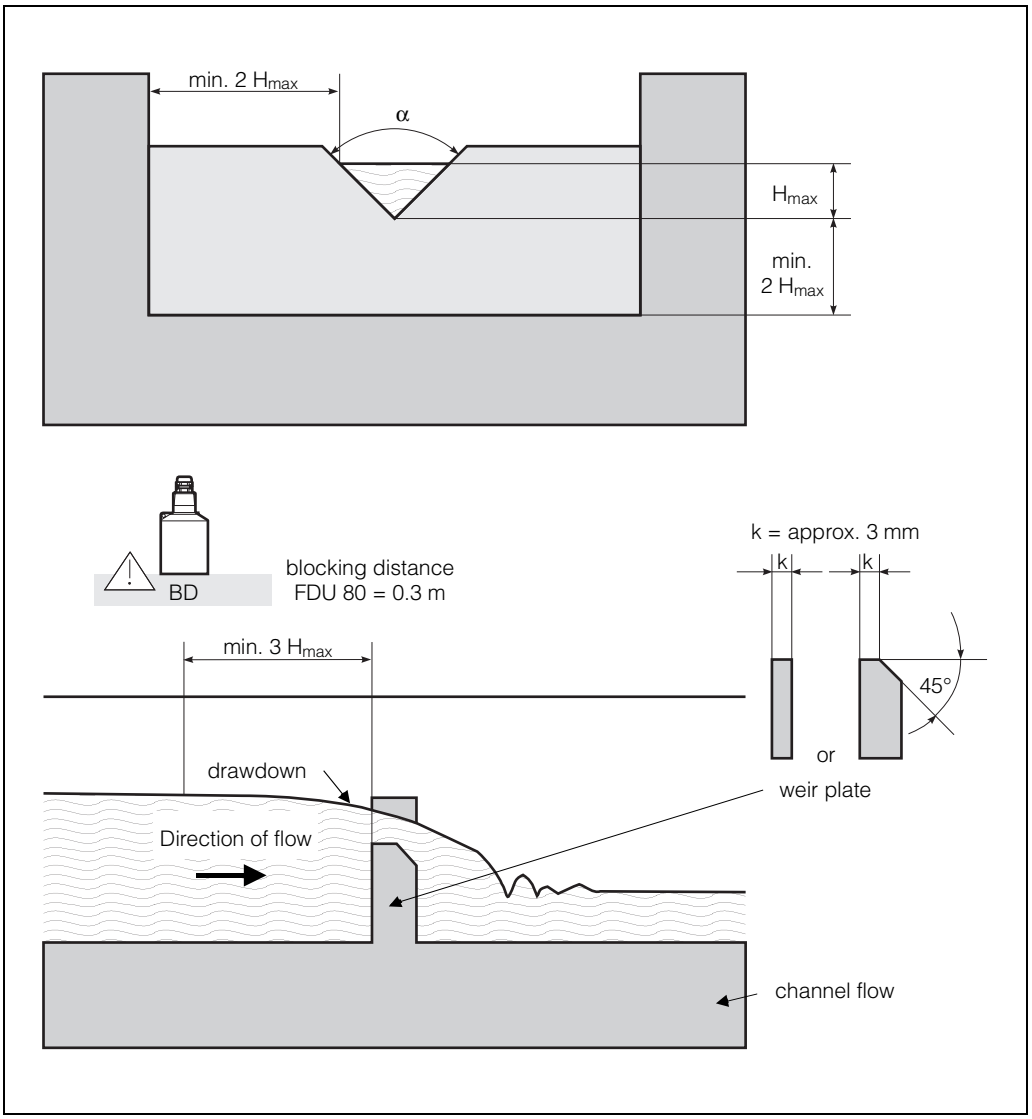
Tab. A.7
Pre-programmed rectangular constricted sharp-crested weir

Code in V2H2	B (mm)	H_{max} (mm)	Q_{max} (m^3/h)
60	200	120	51.18
61	300	150	108.4
62	400	240	289.5
63	500	270	434.6
64	600	300	613.3
65	800	450	1492
66	1000	600	2861

Note!

The factory setting for the current output assigns a maximum flowrate Q_{max} = 100 to the 20 mA current.
After entering a characteristic code, the maximum flow exceeds this vale and causes a signal overrun.
If you want to use the current output, then enter the flow value in V0H6 which is assigned to the 20 mA signal.

A.8 V-Notch Sharp-Crested Weir
(Triangular)



V-Notch Sharp-Crested Weir				
Code in V2H2	**Type**	**α**	**H_{max} (mm)**	**Q_{max} (m^3/h)**
70	V-notch	90°	600	1385
71	V-notch	60°	600	799.8
72	V-notch	45°	600	574.1
73	V-notch	30°	600	371.2
V-Notch Sharp-Crested Weir to British Standards				
75	V-notch	90°	390	473.2
76	V-notch	$^1/_2$ 90°	390	237.3
77	V-notch	$^1/_4$ 90°	390	120.1

Tab. A.8
Pre-programmed
V-Notch sharp-crested weir

The factory setting for the current output assigns a maximum flowrate Q_{max} = 100 to the 20 mA current.
After entering a characteristic code, the maximum flow exceeds this vale and causes a signal overrun.
If you want to use the current output, then enter the flow value in V0H6 which is assigned to the 20 mA signal.

Note!

A.9 Formula for Measurement in Open Weirs

Your weir can be accurately calculated by using the following formula and the information in the following table:

$Q = C (h^{\alpha} + \gamma h^{\beta})$

Where:
Q = flowrate in m^3/h
C = constant
h = damming height in mm
α = factor
β = factor
γ = factor

Weir, flume	Type	Qmax. (m^3/h)	α	β	γ	C
Khafagi-Venturi flume Increasing side walls result in identical α, β γ. This change only affects H_{max}.	QV 302	40,09	1.500	2.500	0.0013140	0.0095299
	QV 303	104,3	1.500	2.500	0.0004301	0.0238249
	QV 304	231,5	1.500	2.500	0.0003225	0.0317665
	QV 305	323,0	1.500	2.500	0.0002580	0.0397081
	QV 306	414,0	1.500	2.500	0.0002150	0.0476497
	QV 308	1024	1.500	2.500	0.0001613	0.0635329
	QV 310	1982	1.500	2.500	0.0001290	0.0794162
	QV 313	3308	1.500	2.500	0.0000992	0.1032410
	QV 316	6181	1.500	2.500	0.0000806	0.1270659
Parshall flume	1"	15,23	1.550	1.000	0.0000000	0.0048651
	2"	30,46	1.550	1.000	0.0000000	0.0097302
	3"	203,8	1.547	1.000	0.0000000	0.0144964
	6"	430,5	1.580	1.000	0.0000000	0.0249795
	9"	950,5	1.530	1.000	0.0000000	0.0495407
	1 ft	1704	1.522	1.000	0.0000000	0.0675749
	1.5 ft	2595	1.538	1.000	0.0000000	0.0924837
	2 ft	3498	1.550	1.000	0.0000000	0.1151107
	3 ft	5328	1.566	1.000	0.0000000	0.1575984
	4 ft	7185	1.578	1.000	0.0000000	0.1962034
	5 ft	9058	1.587	1.000	0.0000000	0.2329573
	6 ft	10951	1.595	1.000	0.0000000	0.2670383
	8 ft	14767	1.607	1.000	0.0000000	0.3324357
British standard weir	4"	36,25	1.500	1.000	0.0000000	0.019732
	7"	90,44	1.500	1.000	0.0000000	0.034532
	12"	371,2	1.500	1.000	0.0000000	0.059201
	18"	925,7	1.500	1.000	0.0000000	0.088021
	30"	3603	1.500	1.000	0.0000000	0.148003
Palmer-Bowlus flume	6"	38,08	0.200	2.000	0.0083313	0.3106790
	8"	68,86	0.200	2.000	0.0047711	0.6255716
	10"	150,2	0.200	2.000	0.0034924	0.9571182
	12"	215,8	0.200	2.000	0.0022844	1.6034450
	15"	377,6	0.200	2.000	0.0015814	2.5957210
	18"	504,0	0.200	2.000	0.0012679	3.5431970
	21"	875,6	0.200	2.000	0.0008765	5.5433280
	24"	1077	0.200	2.000	0.0006771	7.6652450
	27"	1639	0.200	2.000	0.0005672	9.7043720
	30"	2133	0.200	2.000	0.0004475	12.9501200

Weir, flume	Type	Qmax. (m^3/h)	α	β	γ	C
Rectangular constricted sharp-crested weir (with throat)	B 200	51,18	1.500	1	0.0000000	0.038931336
	B 300	108,4	1.500	1	0.0000000	0.059018248
	B 400	289,5	1.500	1	0.0000000	0.077862671
	B 500	434,6	1.500	1	0.0000000	0.097949584
	B 600	613,3	1.500	1	0.0000000	0.118036497
	B 800	1493	1.500	1	0.0000000	0.156346588
	B 1000	2861	1.500	1	0.0000000	0.194656679
	B 1500	6061	1.500	1	0.0000000	0.3106200
	B 2000	13352	1.500	1	0.0000000	0.4141600
Rectangular constricted sharp-crested weir (without throat) Adjusting a Q/h curve to the correct crest length is carried out using the appropriate factor in V2H9.	B 1000 ($H_{max.}$ 500)	2418	1.500	1.000	0.0000000	0.21632686
	B 1000 ($H_{max.}$ 1500)	12567	1.500	1.000	0.0000000	0.21632686
Trapezoidal sharp-crested weir (Cipolletti) Adjusting a Q/h curve to the correct crest length is carried out using the appropriate factor in V2H9.	B 1000 ($H_{max.}$ 300)	1049	1.500	1.000	0.0000000	0.2067454
	B 1000 ($H_{max.}$ 1500)	11733	1.500	1.000	0.0000000	0.2067454
V-notch sharp-crested weir (Triangular)	90°	1385	2.500	1.000	0.0000000	0.0001571
	60°	799,8	2.500	1.000	0.0000000	0.0000907
	45°	574,1	2.500	1.000	0.0000000	0.0000651
	30°	371,2	2.500	1.000	0.0000000	0.0000421
	22,5°	276,0	2.500	1.000	0.0000000	0.0000313
V-notch sharp-crested weir (British standard)	90°	473,2	2.314	2.650	0.1904230	0.0001980
	45°	237,3	2.340	2.610	0.2659230	0.0000880
	22,5°	120.1	2.314	2.649	0.1430720	0.0000590

Appendix B: Application Parameter V0H3

Five application parameters allow the ultrasonic measuring system to be adapted to the many possible bulk solid and liquid applications. The application parameters are selected at matrix position V0H3 (for channel two V4H3)

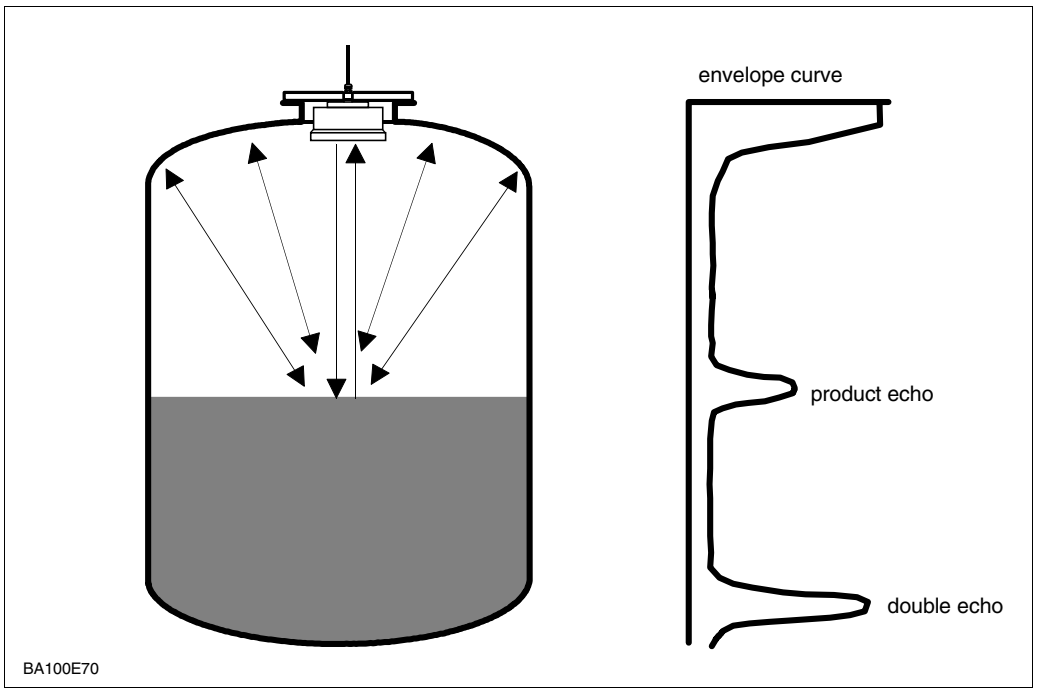
- Application parameter 0, liquids
- Application parameter 1, liquids with rapid level changes
- Application parameter 2, fine-grained bulk solids
- Application parameter 3, coarse bulk solids
- Application parameter 4, bulk solids with rapid level changes.

Application parameter 0 Liquids

Application parameter 0, see Fig. 1, provides optimised signal processing for liquids in closed storage tanks. For bowed-topped tanks in particular the focussing effect of the top causes double reflections which are often stronger than the echo from the product surface. This mode ensures that the product echo is evaluated even when the double echo is stronger.

Application parameter 0 »liquids« is suitable for the measurement of sludges and viscous products.

Fig. 1
Application parameter 0 ignores double echo



Application parameter 1
Liquids, rapid changes

Application parameter 1, see Fig. 2, is intended for liquid tanks, where appropriate with stirres outside the detection zone, where rapid level changes are to be expected, e.g. in small process or buffer tanks.

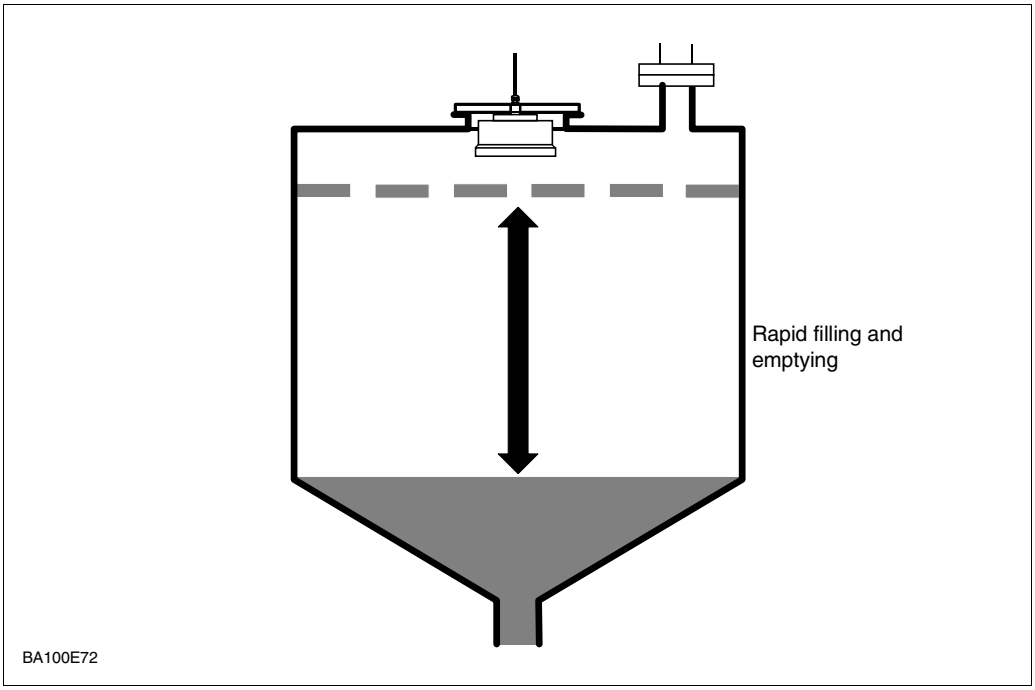


Fig. 2
Application parameter 1, rapid level changes

Application parameter 2
Fine bulk solids

Application parameter 2, see Fig. 3, is suitable for fine-grained, dry, fluidizable solids, such as cement, PVC powder and granules, and which tend to form build up and dust. The filling noise, which results from the pneumatic filling of the silo, is accounted for by a dynamic signal evaluation.

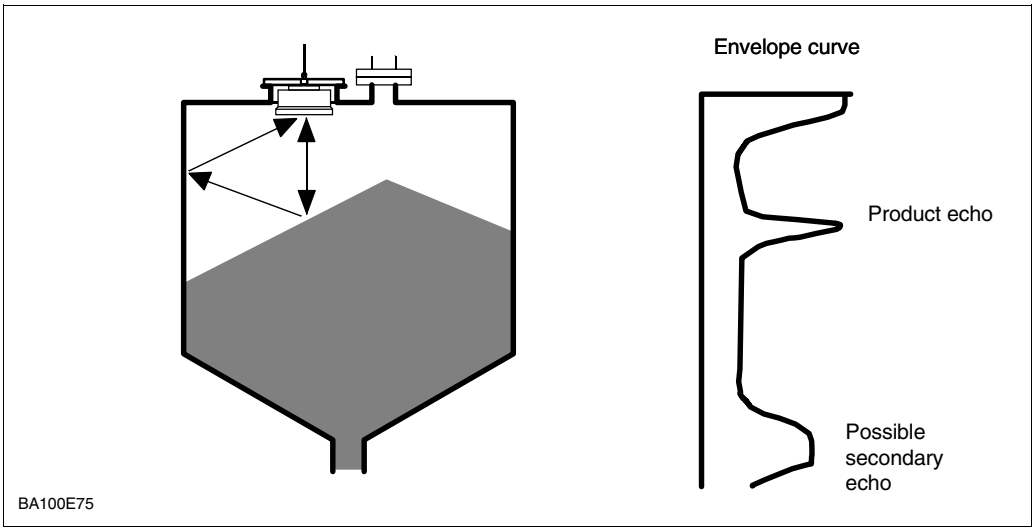
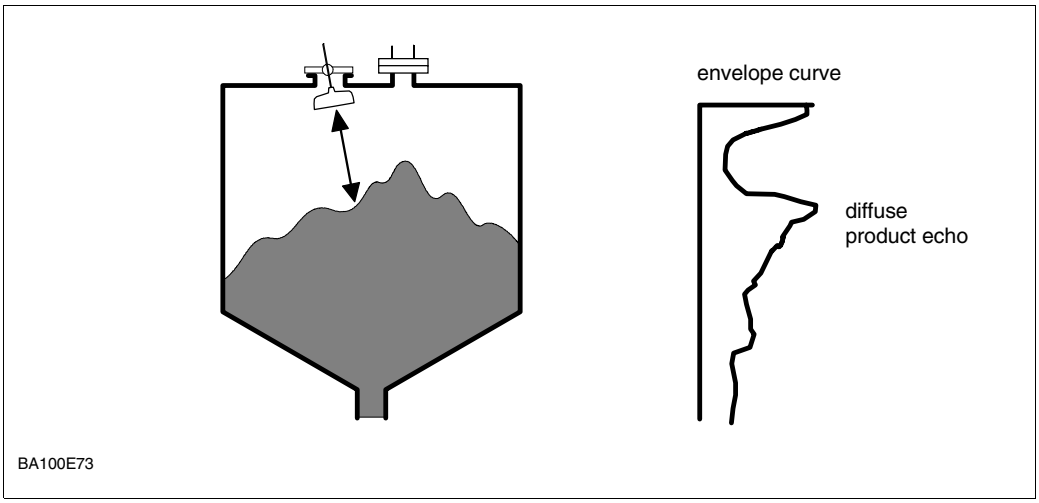


Fig. 3
Application parameter 2, filling noise and dust, diffuse secondary dchoes

Application parameter 3 Coarse bulk solids

Application parameter 3, see Fig. 4, is intended for coarse bulk solids such as stones and coal. The high noise level and diffuse echoes due to falling products and filling mound are accounted for by dynamic signal evaluation.

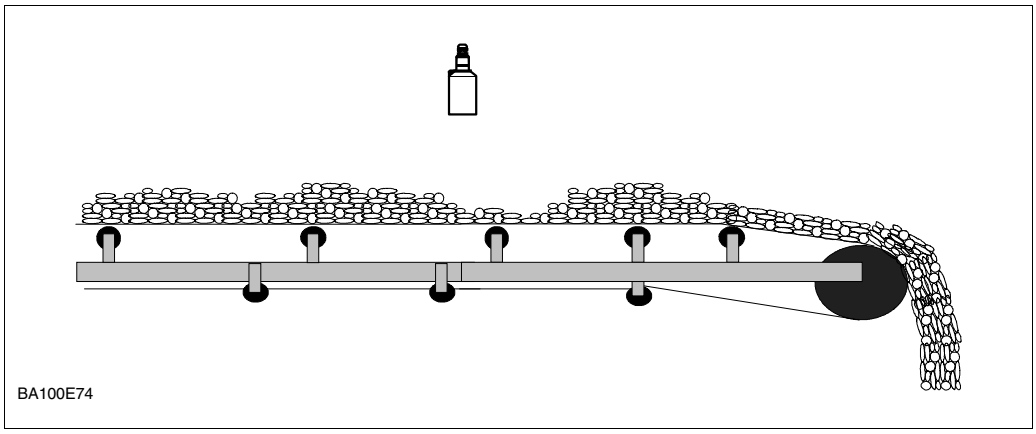
Fig. 4
Application parameter 2, lumpy materials which cause diffuse echoes



Application parameter 4 Bulk solids, rapid changes

Application parameter 4, see Fig. 5, is intended for the measurement of rapidly changing levels on conveyor belts.

Fig. 5
Application parameter 4, rapidly changing levels of bulk solids conveyor belts



Operating Matrix

Enter your Operating Parameters in the Matrix Below

	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0										
V1										
V2										
V3										
V4										
V5										
V6										
V7										
V8										
V9										

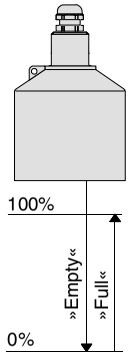
Display

Relay Settings:

V1H0	V1H1	V1H2	V1H3	V1H4
	Relay function	Switch-on point	Switch-off point	Alternating pump control
Relay 1				
Relay 2				
Relay 3				
Relay 4				
Relay 5				

Matrix FMU 860

	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0 Calibration Channel 1	Measured value *User unit*	Empty calibration [10] *Metre/Feet*	Full calibration [9] *Metre/Feet*	Application **Liquids : 0** Liquids fast : 1 Fine-grained solids: 2 Coarse-grained solids : 3 Conveyor belt : 4	Type of sensor **FDU 80 : 80** FDU 80 F : 80F . . . FDU 86 : 86	Value for 0/4 mA [0] *User unit*	Value for 20 mA [100] *User unit*	Output damping [5] *Seconds*	Measured distance *Metre/Feet*	Measured level *Metre/Feet*
V1 Relays	Relay selection Relay 1 : 1 Relay 2 : 2 **Relay 3 : 3** Relay 4 : 4 Relay 5 : 5	Relay function **Limit value : 0** Tendency : 2 Alarm relay : 8	Switch-on point [60] – *for limit value: user unit* – *for tendency: % change/min*	Switch-off point [40] – for limit value: user unit – for tendency: % change/min	Alternating pump control **off : 0** on : 1					Switch delay [1] *Seconds*
V2 Linearisation Channel 1	Linearisation **Linear : 0** Horizontal cylinder : 1 Manual : 3 Automatic : 4 Cancel : 5	Actual level [0] *Metre/Feet*		Input volume [0] *Metre/Feet*	Input volume [0] *User unit*	Line No. [1]	Diameter of vessel (for V2H0: 1 only) [9] *Metre/Feet*	– End value Linearisation (for V2H0: 0 only) – Volume of vessel (for V2H0: 1 only) [100] *User unit*		
V3 Echo parameter Channel 1	Range for automatic suppression [0] *Metre/Feet*	Echo attenuation *Decibel*	Signal/noise ratio *Decibel*	If no echo **Warning : 0** Alarm : 1	Safety alarm: **–10 % : 0** +110 % : 1 Hold : 2	Envelope curve statistics [3]	FAC threshold 1…100 [20]	FAC rise **off :0** on :1	Rackbus address (with RS 485 only)	
V4										
V5										
V6										
V7 Service	Service	Service	Service	Service	Service	Service	Service	Service	Service	Service
V8 Operating status	Operating mode Level : 0 Simulation : 7	Select current 0…20 mA : 0 **4…20 mA : 1**	4 mA threshold **off : 0** on : 1	Select distance unit **Metre : 0** Feet : 1			Limit switch **None : 0** *NO contact* Minimum : 1 Maximum : 2 *NC contact* *Minimum* : 7 *Maximum* : 8	External temperature sensor **None : 0** Activated : 1		
V9 Service and Simulation	Diagnostic code	Last diagnostic code E = clear	Last but one diagnostic code E = clear	Instrument and Software version		General Reset 333 (for DP: 1)	Security locking 519 (for DP: 2457)	Simulation level *Metre/Feet*	Simulation volume *User unit*	Simulation current *mA*



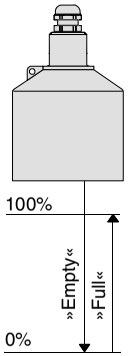
Bold = default value
[text in brackets] = default value

Display field

Input field

Matrix FMU 861

	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0 Calibration Channel 1	Measured value *User unit*	Empty calibration [10] *Metre/Feet*	Full calibration [9] *Metre/Feet*	Application **Liquids : 0** Liquids fast : 1 Fine-grained solids: 2 Coarse-grained solids : 3 Conveyor belt : 4	Type of sensor **FDU 80 : 80** FDU 80 F : 80F . . . FDU 86 : 86	Value for 0/4 mA [0] *User unit*	Value for 20 mA [100] *User unit*	Output damping [5] *Seconds*	Measured distance *Metre/Feet*	Measured level *Metre/Feet*
V1 Relay	Relay selection Relay 1 : 1 Relay 2 : 2 **Relay 3 : 3** Relay 4 : 4 Relay 5 : 5	Relay function **Limit value : 0** Tendency . 2 Count pulse 1 : 4 Count pulse 2 : 5 Count pulse 3 . 6 Interval timer : 7 Alarm relay : 8	Switch-on point [60] – *for limit value: user unit* – *for tendency: % change/min* – *for count pulse: % Q_{max}*	Switch-off point [40] – *for limit value: user unit* – *for tendency: % change/min* – *for count pulse: % Q_{max}*	Alternating pump control **off : 0** on : 1	Count factor C1 0…19999 [0]	Count factor C2 0…19999 [0]	Count factor C3 0…19999 [0]	Interval time [1] *Minutes*	Switch delay [1] *Seconds*
V2 Linearisation Channel 1	Linearisation **Linear : 0** Horizontal cylinder : 1 Q/h curve : 2 Manual : 3 Automatic : 4 Cancel : 5	Actual level [0] *Metre/Feet*	Q/h curve [1]	Input level [0] *Metre/Feet*	Input volume [0] *User unit*	Line No. [1]	Diameter of vessel (for V2H0 : 1 only) [9] *Metre/Feet*	– End value Linearisation (for V2H0: 0 only) – Volume of vessel (for V2H0 :1 only) – Max. flow [100] *User unit*	Low flow cut off [0] *% of max. flow*	Crest length *Metre/Feet*
V3 Echo parameter Channel 1	Range for automatic suppression [0] *Metre/Feet*	Echo attenuation *Decibel*	Signal/noise ratio *Decibel*	If no echo **Warning : 0** Alarm : 1	Safety alarm **–10% : 0** +110% : 1 Hold : 2	Envelope curve statistics [3]	FAC threshold 1…100 [20]	FAC rise **off : 0** on : 1	Rackbus address (with RS 485 only)	
V4										
V5										
V6										
V7 Service	Service	Service	Service	Service	Service	Service	Service	Service	Service	Service
V8 Operating status and counter	Operating mode Level : 0 Flow : 2 Simulation : 7	Select current 0…20 mA : 0 **4…20 mA : 1**	4 mA threshold **off : 0** on : 1	Select distance unit **Metre : 0** Feet : 1	Flow unit l/s : 0 l/min : 1 l/h : 2 m^3/s : 3 m^3/min : 4 **m^3/h : 5** igps : 6 igpm : 7 …	Counter unit l : 0 hl : 1 **m^3 : 2** igal : 5 usgal : 6 bls : 7 $inch^3$: 8 ft^3 : 9 …	Limit switch **None : 0** *NO contact* Minimum : 1 Maximum : 2 *NC contact* Minimum : 7 Maximum : 8	External temperature sensor **None : 0** Activated : 1	Internal counter high	Internal counter low
V9 Service and Simulation	Diagnostic code	Last diagnostic code E = clear	Last but one diagnostic code E = clear	Instrument and Software version	Reset counter 712	General reset 333 (for DP: 1)	Security locking 519 (for DP: 2457)	Simulation level *Metre/Feet*	Simulation volume *User unit*	Simulation current *mA*



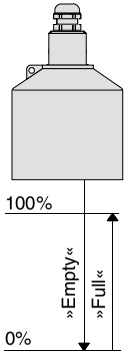
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Display field

Input field

Matrix FMU 862

	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0 Calibration Channel 1	Measured value *User unit*	Empty calibration [10] *Metre/Feet*	Full calibration [9] *Metre/Feet*	Application **Liquids : 0** Liquids fast : 1 Fine-grained solids: 2 Coarse-grained solids : 3 Conveyor belt : 4	Type of sensor **FDU 80 : 80** FDU 80 F : 80F . . . FDU 86 : 86	Value for 0/4 mA [0] *User unit*	Value for 20 mA [100] *User unit*	Output damping [5] *Seconds*	Measured distance *Metre/Feet*	Measured level *Metre/Feet*
V1 Relay	Relay selection Relay 1 : 1 Relay 2 : 2 **Relay 3 : 3** Relay 4 : 4 Relay 5 : 5	Relay function **Limit value Ch1 : 0** Limit value Ch2 : 1 Tendency Ch1 : 2 Tendency Ch2 : 3 Count pulse 1 : 4 Count pulse 2 : 5 Count pulse 3 : 6 Interval timer : 7 Alarm relay : 8 Back water alarm : 9	Switch-on point [60] – *for limit value: user unit* – *for tendency: % change/min* – *for count pulse: % Q_{max}*	Switch-off point [40] – *for limit value: user unit* – *for tendency: % change/min* – *for count pulse: % Q_{max}*	Alternating pump control **off : 0** on : 1	Count factor C1 0…19999 [0]	Count factor C2 0…19999 [0]	Count factor C3 0…19999 [0]	Internal time [1] *Minutes*	Switch delay [1] *Seconds*
V2 Linearisation Channel 1	Linearisation **Linear : 0** Horizontal cylinder : 1 Q/h curve : 2 Manual : 3 Automatic : 4 Cancel : 5	Actual level [0] *Metre/Feet*	Q/h curve	Input level [0] *Metre/Feet*	Input volume [0] *User unit*	Line No. [1]	Diameter of vessel (for V2H0 : 1 only) [9] *Metre/Feet*	– End value Linearisation (for V2H0: 0 only) – Volume of vessel (for V2H0 :1 only) – Max. flow [100] *User unit*	Low flow cut off [0] *% of max. flow*	Crest length *Metre/Feet*
V3 Echo parameter Channel 1	Range for automatic suppression [0] *Metre/Feet*	Echo attenuation *Decibel*	Signal/noise ratio *Decibel*	If no echo **Warning : 0** Alarm : 1	Safety alarm: **–10 % : 0** +110 % : 1 Hold : 2	Envelope curve statistics [3]	FAC threshold 1…100 [20]	FAC rise **off : 0** on : 1	Rackbus address (with RS 485 only)	
V4 Calibration Channel 2	Measured value *User unit*	Empty calibration [10] Metre/Feet	Full calibration [9] *Metre/Feet*	Application (see V0H3)	Type of sensor (see V0H4)	Value for 0/4 mA [0] *User unit*	Value for 20 mA [100] *User unit*	Output damping [5] *Seconds*	Measured distance *Metre/Feet*	Measured level *Metre/Feet*
V5 Linearisation Channel 2	Linearisation (see V2H0)	Actual level [0] *Metre/Feet*		Input level [0] *Metre/Feet*	Input volume [0] *User unit*	Line No. [1]	Diameter of vessel [9] (see V2H6)	Diameter of vessel (see V2H7)	Limit back water alarm *%*	
V6 Echo parameter Channel 2	Range for automatic suppression [0] *Metre/Feet*	Echo attenuation *Decibel*	Signal/noise ratio *Decibel*	If no echo **Warning : 0** Alarm : 1	Safety alarm: **–10 % : 0** +110 % : 1 Hold : 2	Envelope curve statistics [3]	FAC threshold 1…100 [20]	FAC rise **off : 0** on : 1		
V7 Service	Service	Service	Service	Service	Service	Service	Service	Service	Service	Service
V8 Operating status and counter	Operating mode Level Ch1 : 0 **Level Ch1, Ch2 : 1** Flow Ch1 : 2 Flow Ch1, Level Ch2 : 3 Difference Ch2, Level Ch1 : 4 Average value : 5 Distance : 6 Simulation Ch1 : 7 Simulation Ch2 : 8 Back water alarm : 9 Difference Ch1, Level Ch2 : 10	Select current 0…20 mA : 0 **4…20 mA : 1**	4 mA threshold **off : 0** on : 1	Select distance unit **Metre : 0** Feet : 1	Flow unit l/s : 0 l/min : 1 l/h : 2 m^3/s : 3 m^3/min : 4 **m^3/h : 5** ipgs : 6 ipgm : 7 …	Counter unit l : 0 hl : 1 **m^3 : 2** igal : 5 usgal : 6 bls : 7 $inch^3$: 8 ft3 : 9 …	Limit switch **None : 0** NO contact Min. Channel 1 : 1 Max. Channel 1 : 2 Min. Channel 2 : 3 Max. Channel 2 : 4 Min. Channel 1+2 : 5 Max. Channel 1+2: 6 NC contact as NO contact 7…12	External temperature sensor **None : 0** Channel 1 : 1 Channel 2 : 2 Channel 1+2 : 3	Internal counter high	Internal counter low
V9 Service and Simulation	Diagnostic code	Last diagnostic code E = clear	Last but one diagnostic code E = clear	Instrument and Software version	Reset counter 712	General reset 333 (for DP: 1)	Security locking 519 (for DP: 2457)	Simulation level *Metre/Feet*	Simulation volume *User unit*	Simulation current *mA*



Bold = default value
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Input field

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