KROHNE

3/98

ALTOSONIC Ultrasonic Flowmeters

Installation and operating instructions

UFM 400 K/F
UFM 500 K/F

software version 6.97.003.00

UFM 500 K, DN65 – 3000 (2½” – 120”)

UFM 500 K, DN25 – 50 (1” – 2”)

7.30787.32.0

Contents

Part A System installation and start-up

Part B Signal converter UFC 500...

Part C Special applications, functional check and service

Part D Technical data, measuring principle, block diagram

Part E Index

How to use these Operating Instructions

- These installation and operating instructions are divided into 5 parts for easy use.
- Only **Part A** (pages 4 - 11) is needed for **installation and initial start-up.**
- All ultrasonic flowmeters are factory-set to your order specifications. Therefore, no further adjustments are necessary prior to initial start-up.

Part A Install flowmeter in the pipeline (sect.1), connect up (sect. 2), power the flowmeter (sect. 3), that's all!
The system is operative.

Part B Operator control and action of the UFC 500... signal converter.

Part C Special applications, service, and functional checks.

Part D Technical data, dimensions, block diagram and measuring principle.

Part E Index.

The purchaser is solely responsible for suitability in accordance with the technical regulations and applicability of our instruments

Warranty may be voided unless these instructions are followed

Available versions

Compact systems	**Signal converter**	**Local display**	**Primary head**
UFM 400 K	UFC 400	no	UFS 500
UFM 500 K	UFC 500	yes	UFS 500
UFM 500 K-EEx	UFC 500-EEx	yes	UFS 500
Remote systems			
UFM 400 F	UFC 400 F	no	UFS 500 F
UFM 500 F	UFC 500 F	yes	UFS 500 F
UFM 500 F-EEx	UFC 500 F-EEx	yes	UFS 500 F-EEx

All versions are available as single or double beam flowmeter. The available meter sizes for all versions range from DN 25 (1") to DN 3000 (120").

System description

The UFM 400... and UFM 500... ultrasonic flowmeters are precision instruments designed for linear flow measurement of fluids.

The full scale range can be set (factory setting for UFM 400...) between 0.9 and 450 000 m^3 per hour or between 3.9 and 1987 200 US gallons per minute, dependent on the meter size DN 25 through 3000 / 1" to 120". This corresponds to a flow velocity of 0.5 to 18 m/s, which is equivalent to 1.6 to 59 ft/sec.

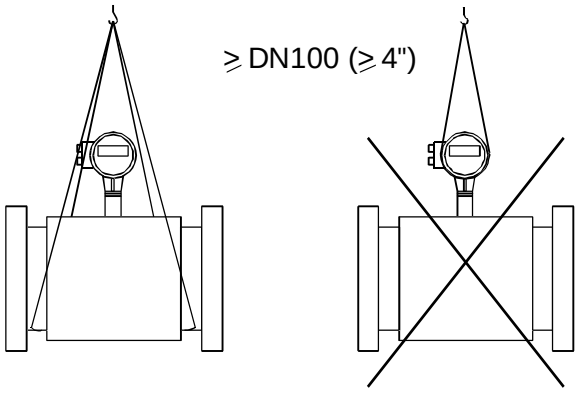
Items included with supply

Compact	**Separate units**	
– Flowmeter UFM 400 K or UFM 500 K	– Primary head – Signal converter – Signal cable	see Table above

– Installation and operating instructions
– Certificate of system calibration data
– Report on factory setting of the signal converter

Transporting the compact flowmeter

Important: Never lift UFM 400 K and UFM 500 K compact flowmeters sized DN 100 (4") and larger by the mounted signal converter housing!

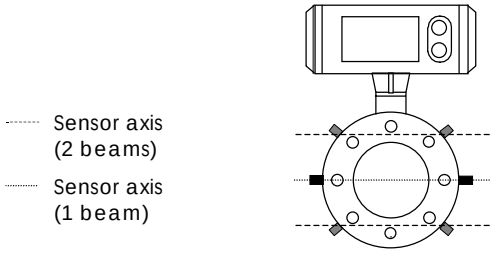


Part A System installation and start-up

1. Installation in the pipeline

1.1 Preliminary information

1. **Location and position as required,** but sensor axis must be approximately horizontal if flowmeter is installed in slightly ascending or horizontal pipe runs.
2. **Hard-to-reach locations**



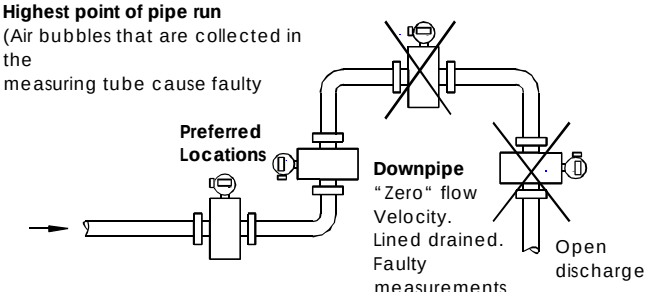
Where UFM 400 K and UFM 500 K compact flowmeters have not been ordered and supplied in accordance with Versions 1 to 10 (see sect. 8.6), the configuration can be changed subsequently:

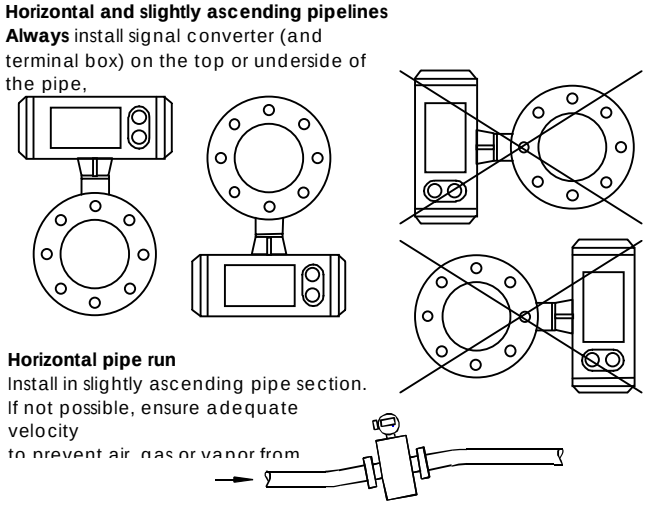
- Turn the indicating circuit board through ± 90° or 180° to obtain horizontal positioning of the display (see sect. 8.4)
- Turn signal converter housing through ± 90° (see sect. 8.5)

3. **Measuring tube must be completely filled at all times.**
4. **Flow direction +/-:** note arrows on flowmeter and also fct. 3.1.7 (refer to sections 4.3 and 5.4).
5. **Bolts and nuts:** to install make sure there is sufficient room next to the pipe flanges.
6. **Vibration:** support the pipeline on both sides of the flowmeter.
7. **Large meter sizes, DN>200 (8"):** use adapter pipes to permit axial shifting of counter flanges to facilitate installation.
8. **Inlet and outlet sections**
   (DN = meter size)

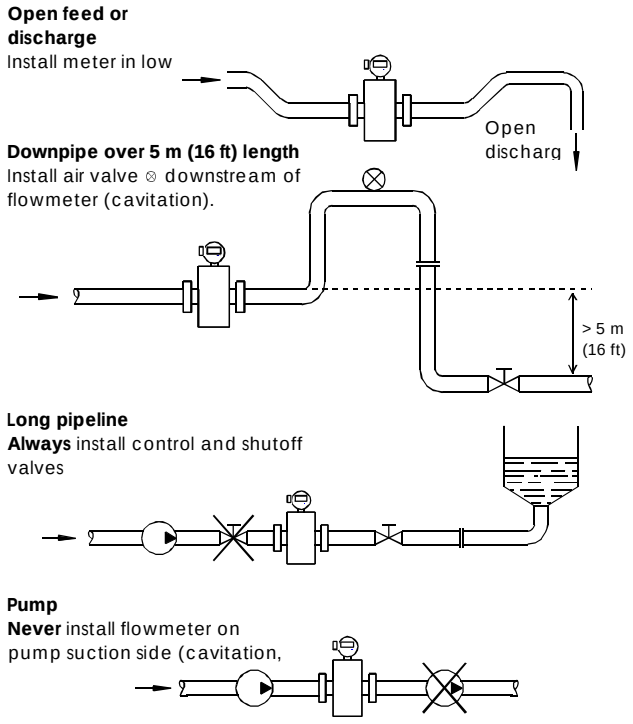
Inlet section	single beam	double beam
– Downstream of pump	50 × DN	15 × DN
– Downstream of fully opened control valve	50 × DN	10 × DN
– Downstream of 2 quarter bends on different levels	40 × DN	10 × DN
– Downstream of 2 quarter bends on one level	25 × DN	10 × DN
– Downstream of 1 quarter bend	20 × DN	10 × DN
– Downstream of reducer ($\alpha/2 = 7°$)	15 × DN	no additional inlet section
– Outlet section	5 × DN	5 × DN

9. **Vortex or corkscrew flow:** increase inlet and outlet sections or install flow straighteners.
10. **Zero setting** is normally not necessary, but it can be checked under flowing conditions as outlined in sect 7.2. Shutoff valves should therefore be provided upstream and/or downstream of the primary head unless the pipe configuration already rules out the possibility of the primary head being drained of fluid. (For zero check see section 7.2).
11. **Mixing different fluid products.** Install the flowmeter upstream of mixing point or at an adequate distance downstream, minimum distance 30x DN (DN = meter size), otherwise output/display may be unsteady.
12. **Ambient temperature:**
    product temperature ≤ 60 °C/140°F
    all systems: -25 to +60°C/ -13 to +140°F
    product temperature > 60 °C/140 °F
    compact systems: -25 to +40 °C/ -13 to +104 °F
    separate systems: -25 to +60 °C/ -13 to +140 °F
13. **Pipeline along a wall:** where possible, the distance between pipe centerline and wall must be more than 0.5 m (1.6 ft) for the UFM 400 K and UFM 500 K flowmeters. If less, first connect all cables to the terminals in the terminal compartment (power supply and outputs), and install an intermediate connection box before installing flowmeter in pipeline.
14. **Insulated pipeline:** do not insulate UFM 400 K and UFM 500 K compact flowmeters.
15. **Suggestions for installation**
    To avoid measuring errors due to air inclusion, please observe the following:





(Suggestions for installation continued):



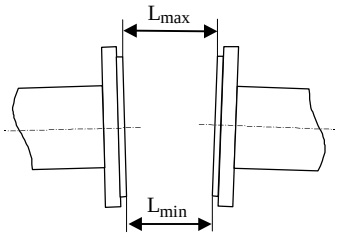
1.2 Pipe flanges

Flange spacing

Refer to dimensional drawings (section 10.4 and 10.5), in addition allow for thickness of gaskets.

Position of flanges

- Install flowmeter in line with pipe axis.
- Pipe flange faces must be parallel to each other, max. permissible deviation: $L_{max} - L_{min} \leq 0.5$ mm (0.02").



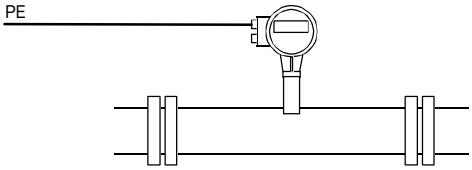
1.3 Grounding

Warning
Instrument should be properly grounded to avoid personnel shock hazard!

1.3.1 Standard grounding

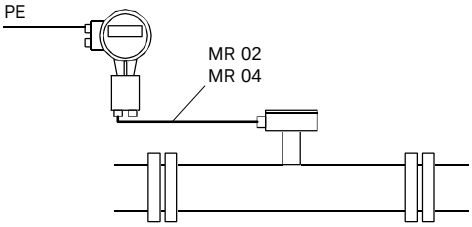
The flowmeter must normally be grounded via the **protective conductor PE** incorporated in the power supply cable. Connect the protective conductor to the separate U-clamp terminal in the terminal compartment of the signal converter. See sect. 2.1.2 for the compact flowmeters, and sect. 2.2.2 for the separate systems.

❶ Standard grounding of compact flowmeters UFM 400 K / 500 K



PE Protective conductor incorporated in the power supply cable, see sect. 2.1.2.

❷ Standard grounding of separate system flowmeters UFM 400 F / 500 F



PE Protective conductor incorporated in power supply cable, see sect. 2.2.2

MR 02/04 Sensor cables, factory supplied, see sect. 2.2.3 for connection.

1.3.2 Grounding with measuring ground M

This type of grounding must be employed if at least one of the two following operating conditions occurs:

A If **large potential differences** occur between protective ground and electric furnaces or electrolysis plants.

B If a **protective ground conductor** is **not** provided, e.g. for DC voltage operation.

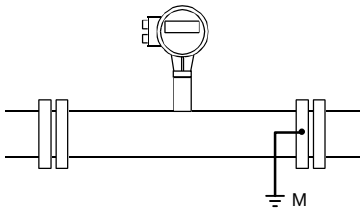
Observe the following when grounding with separate measuring ground M:

Do **not** connect up the protective ground conductor PE in the terminal box if measuring ground M is connected.

If the **AC supply voltage exceeds 50 V_{rms},** then the measuring ground simultaneously acts as the protective ground conductor (combined protective/functional ground). Refer to appropriate national codes for specific requirements for this type of installation, which may require the addition of a ground fault detection circuit interrupter.

❸ Grounding with measuring ground M for compact flowmeters UFM 400 K / 500 K

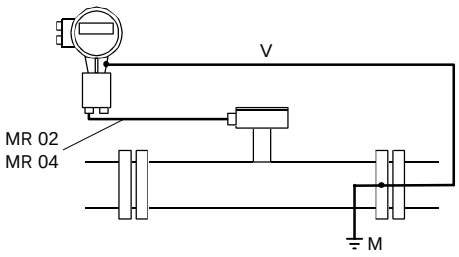
Do not connect up protective conductor **PE** incorporated in the power supply cable, see sect. 2.1.2!



M Measuring ground; ground conductor, cross-section ≥ 4 mm² (AWG 10) Cu with M6 cable lugs, customer supplied. Threaded hole in housing M4 by 6 mm.

❹ **Grounding with measuring ground M for separate system flowmeters UFM 400 F / UFM 500 F**

Do not connect up protective conductor **PE** incorporated in the power supply cable, see sect. 2.2.2!



MR 02/04 Sensor cables, factory supplied, see sect. 2.2.3 for connection.

V Connecting cable, cross-section ≥ 4 mm² (AWG 10) Cu, equip with M6 cable lugs, customer supplied.

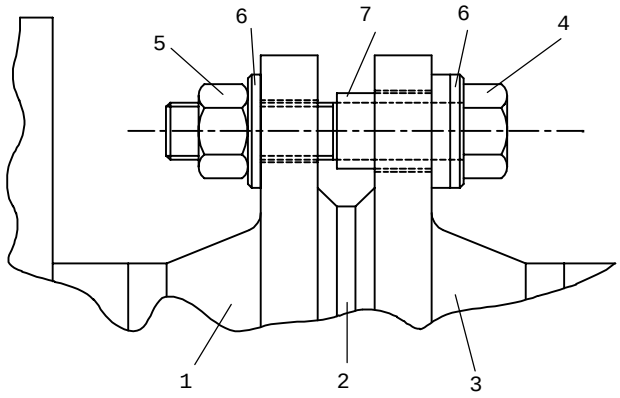
M Measuring ground; ground conductor, cross-section ≥ 4 mm² (AWG 10) Cu, equip with M6 cable lugs, customer supplied. Threaded hole in housing M4, 6 mm (0.24") deep.

1.3.3 Grounding in hazardous areas

Special regulations are applicable, refer to sect. 6.1, and the special "Ex" installation instructions.

1.4 Pipes with cathodic protection

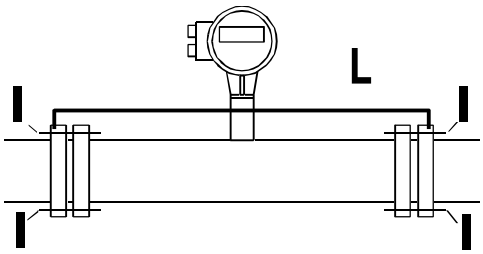
- Pipes with electric corrosion protection are generally insulated inside and outside so that the fluid has no conductive connection to ground. The primary head must be insulated from the pipe. Note the following when installing the flowmeter:
- The pipe flanges must be connected to each other using a copper cable (L), but must not be connected to the primary head.
- The bolts for the flange connections must be **insulated.** Use **sleeves and washers that made of insulating material**. Must be provided by customer.



1 Flange of Primary head
2 Gasket
3 Pipe flange
4 Bolt
5 Nut
6 Washer
7 Insulating sleeve

- **Grounding**

I Insulated bolts } Not included with meter, must
L Copper cables } be provided by customer.



For grounding, be sure to read the instructions given in sect. 1.3.1 and 1.3.2!

2. Electrical connection

2.1 Compact flowmeters UFM 400 K, UFM 500 K

2.1.1 Installation location and cable diameter

Location

- Do not expose the compact flowmeter to direct sunlight. Install a sunshade if necessary.
- Do not expose to intensive vibration. If necessary, support the pipeline to the left and right of the flowmeter.

Cable diameter

To conform to protection category requirements, observe the following recommendations:

- Cable diameter: 8 to 13 mm (0.31" to 0.51").
- Enlarge inside diameter by removing the appropriate onion ring(s) from the seal of the screwed conduit entry only if cables have extremely tight fit.
- Fit blanking plug Pg 16 and apply sealant to unused cable entries.
- Do not kink cables directly at conduit entries.
- Provide water drip point (U-bend in cable).

Conduit installation, general wiring consideration

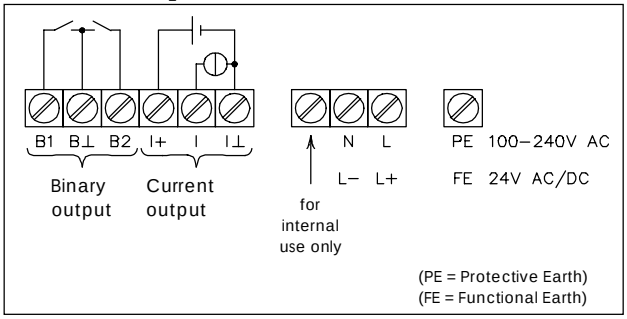
- When electrical codes require conduit, it must be installed in such a manner that the meter terminal compartment remains **dry** at all times.
- Power and output wiring should be run in separate conduit.
- Use twisted pairs for output wiring.

Warning: Power wiring should utilize a grounded neutral conductor to avoid possible shock hazard / damage to component parts.

2.1.2 Connection to power

- Note information given on the instrument nameplate (voltage, frequency)!
- Electrical connection in conformity with VDE 0100 "Regulations governing heavy-current installations with rated voltages up to 1000V" or equivalent national standard.
- Special regulations apply to installation in **hazardous areas.** Refer to sect. 6.1 and special "Ex" installation instructions.
- The **PE protective ground conductor** for supply power
  ⇒ **must** be connected to the separate U-clamp terminal in the terminal box of the signal converter in case of "standard grounding" see sect. 1.3.1, point 1,
  ⇒ **must not** be connected in case of "grounding with measuring ground M", see sect. 1.3.2, point 3.
- Do not cross or loop the cables in the terminal box of the signal converter. Use separate Pg or NPT screwed conduit entries for power and output cables.
- Ensure that the **screw thread of the round cover** on the terminal box is well greased at all times.

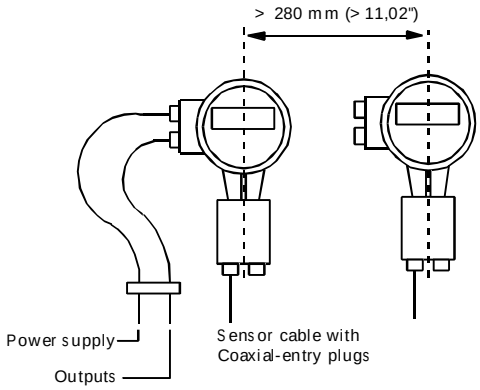
Connection to power



2.2 Signal converters UFC 400 F and UFC 500 F separate systems

2.2.1 Location

- Do not expose signal converter to direct sunlight. Install a sunshade if necessary.
- Do not expose to intensive vibration
- Install signal converter as closely as possible to the primary head.
- The rotating design of the housing makes it easier to connect the two cables for power and outputs to the terminals in the rear terminal box.
- Cable routing



- On normal customer orders, the GK (primary constant) of the signal converter is factory-programmed to match that of the primary head with which it is ordered. The GK is engraved on the primary head nameplate and also shown on the converter nameplate. **These instruments should be installed together,** otherwise reprogramming of the converter is required (see sect. 4.3 and 8.2, fct. 3.1.1, 3.1.5 and 3.1.6, only possible with UFC 500 F signal converter).
- Electrical connection between primary head and signal converter by way of factory-supplied sensor cables MR02 (for single-beam versions) or MR04 (for double-beam version). Refer to sect. 2.2.3 for the connection diagrams.

2.2.2 Connection to power

- Note the information given on the **instrument nameplate** on the signal converter (voltage, frequency)!
- **Electrical connection in conformity with VDE 0100** "Regulations governing heavy-current installations with rated voltages up to 1000 V" **or equivalent national standard.** Refer to sect. 6.1 and special "Ex" installation instructions.
- Special regulations apply to installation in **hazardous areas.** Refer to sect. 6.1 and special "Ex" installation instructions.
- The **PE protective ground conductor** for supply power
  ⇒ **must** be connected to the separate U-clamp terminal in the terminal box of the signal converter in the case of "standard grounding", see sect. 1.3.1, point 1,
  ⇒ **must not** be connected up in the case of "grounding with measuring ground M", see sect. 1.3.2, point 3.
- **Line resistance for 24 V**DC **and 21, 24, 42 and 48 V**AC

  Max. internal resistance R_{max} of voltage supply
  (transformer or DC voltage source and cable)
  24 Volt DC / 24 Volt AC: $R_{max\,24} \leq 1.6$ ohms
  42 Volt AC: $R_{max\,42} \leq 2.8$ ohms

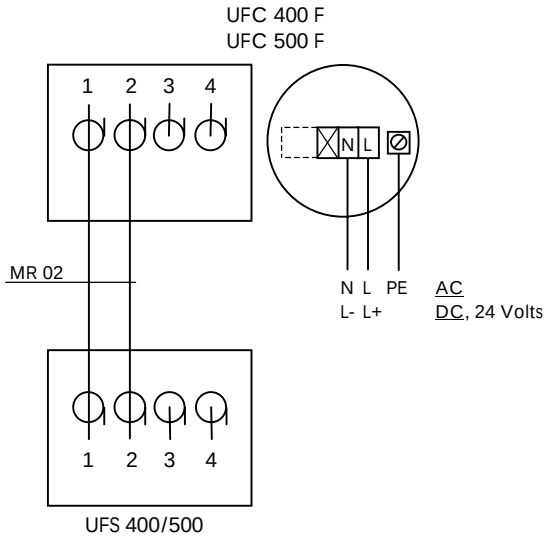
  Maximum length L_{max} of power cable.
  $L_{max} = 28 \times A \, (R_{max} - R_i)$
  A Cross-section of power cable in mm^2 copper wire.
  R_{max} Internal resistance of voltage supply
  $R_{max\,24}$ or $R_{max\,42}$, see above.
  R_i Internal resistance of transformer or DC voltage source.

  Example:
  42 VAC/A = 1.5 mm^2 / R_i = 0.2 ohm / $R_{max\,42}$ = 2.8Ω
  L_{max} = [28 x 1.5 x (2.8 - 0.2)] = 109.2 m
  109.2 m x 3.3 ft/m ≈ 360 ft

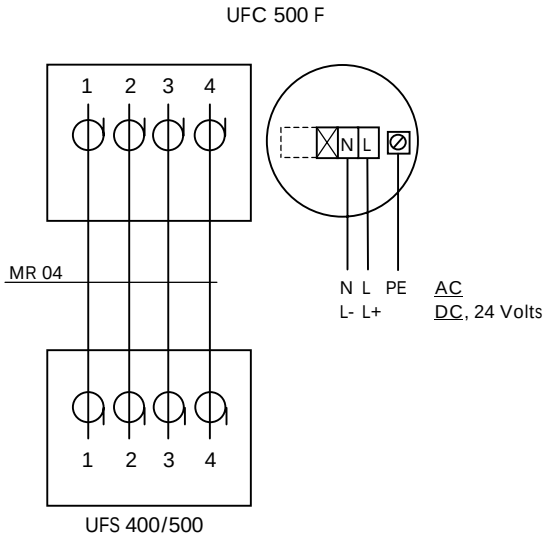
  Connection of several signal converters to 1 transformer (n = number of converters)
  Separate power cable: R_i increases by factor "n" (R_i x n)
  Common power cable: L_{max} decreases by factor "n" (Lmax/n).

2.2.3 Connections diagrams

1-beam system, sensor cable MR 02
UFM 400 F, all meter sizes
UFM 500 F, meter size ≤ DN 40 / ≤ 1½”



2-beam system, sensor cable MR 04
UFM 500 F, meter size ≥ DN 50 / ≥ 2”.



2.3 Outputs

2.3.1 Abbreviations

Abbreviation	Stands for	Setting via fct. no. ...	Description see sect. ...
EC	Electronic counter	-	5.8 + 2.3.5
EMC	Electro-mechanical counter	-	5.8 + 2.3.5
F	Frequency (pulse) output	3.4.1 & seq.	5.8
$F_{100\ \%}$	Pulses for Q = 100% flowrate **or** pulse value	3.4.2 + 3.4.3	5.8
F_{max}	Pulses at Q higher than 100% flow (max. 125% of $F_{100\%}$)	-	5.8
I	Current output	3.3.1 & seq.	5.7
$I_{0\%}$	Current at Q = 0% flow	3.3.2 + 3.3.3	5.7
$I_{100\%}$	Current at Q = 100% flow	3.3.2 + 3.3.4	5.7
I_{max}	Current at Q = over 100% flow	3.3.5	5.7
$Q_{0\%}$	0% flowrate	-	5.3 (5.7 + 5.8)
$Q_{100\%}$	Full-scale range, 100% flowrate	**F:** 3.1.1 / **R:** 3.1.2 + 3.1.3	5.3 (5.7 + 5.8)
Q_{max}	Max. flow, Q greater than 100% corresponding to I_{max} + F_{max}	-	5.3 (5.7 + 5.8)
SMU	Low-flow cutoff for I + F	**I:** 3.3.7 / **F:** 3.4.6	5.10
SMU-I	Low-flow cutoff I / on value	3.3.8	5.10
	off value	3.3.9	5.10
SMU-F	Low-flow cutoff F /on value	3.4.7	5.10
	off value	3.4.8	5.10
S.VELO	Sound velocity of ultrasonic waves in the product.	3.1.8 + 3.1.9 / 3.2.4	5.17 / 5.5
		I: 3.3.1 & seq.	5.7
		F: 3.4.1 & seq.	5.8
F/R	Forward/reverse flow	-	5.11

2.3.2 Current output I

- **The current output I can be used passively or actively.** If used passively it is galvanically insulated from all other input and output circuits.
- **All functions and operating data can be set,** see sect. 4 + 5.7 (**not** applicable to UFC 400 ... signal converter).
- **Factory-set data and functions** are listed in the enclosed report on settings. This can also be used to record any changes made to the operating parameters.
- **Maximum load at terminals I+, I, I⊥**
  Maximum load in ohms ≤ 680.
- **Time constant I,** adjustable between 0.04 and 3600 seconds (fct. 3.3.6), refer to sect. 5.7.
- **Low flow cutoff SMU-I,** can be set independently of SMU-F (frequency output). Cut-off "on" value between 1 and 19% of $Q_{100\%}$ (fct. 3.3.7 + 3.3.8), cut-off "off" value from 2 to 20% of $Q_{100\%}$ (fct. 3.3.7 + 3.3.9), refer to sect. 5.10.
- **Connection diagrams,** see below.

2.3.3 Frequency (pulse) output F

- **The pulse output is galvanically insulated from the current output** if the current output is used passively. Furthermore, the pulse output is galvanically insulated from all other circuits except for the status output with which it shares a common (ground).
- **All functions and operating data can be set,** see sect. 4 + 5.8 (**not** applicable to UFC 400... signal converter).
- **Factory-set data and functions** are listed in the enclosed report on settings. This can also be used to record any changes made to the operating parameters.
- **Active frequency output,** for electro-mechanical totalizers **EMC** (terminals B1/B⊥) or for electronic totalizers **EC** (terminals B1/B⊥), 10 to 3,600,000 pulses/hr (0.0028 to 1000 Hz), voltage between 19 to 32 V_{DC}. Note that the total current for the active frequency/pulse and status outputs together (drawn from I+) may not exceed 50 mA. (see connection diagram 3 below).
- **Passive frequency output,** open collector output for connection of active electronic counters EC or switchgear (terminals B1/B⊥), input voltage ≤ 32 V_{DC} / ≤ 24 V_{AC}, load current max. 150 mA.
- **Time constant F,** adjustable to 0.04 seconds or same as current output I (fct. 3.4.5)
- **Low-flow cutoff SMU-F,** can be set independently of SMU-I (current output). Cut-off "on" value between 1 and 99% of $Q_{100\%}$ (fct. 3.4.6 + 3.4.7), cut-off "off" value from 2 to 20% of $Q_{100\%}$ (fct. 3.4.6 + 3.4.8), refer to sect. 5.10.
- **Connection diagrams,** see below.
- The following table shows the possible pulse widths for F ≤ 10 Hz:

$F_{100\%}$	Pulse-width
$F_{100\%}$ ≤ 10 Hz	30 or 50 ms
$F_{100\%}$ ≤ 5 Hz	100 ms
$F_{100\%}$ ≤ 2.5 Hz	200 ms
$F_{100\%}$ ≤ 1.0 Hz	500 ms

If $F_{100\%}$ > 10 Hz and ≤ 1000 Hz, the pulse-width duty cycle is 50%.

2.3.4 Status output S

- **The status output is galvanically insulated** from the current output if the status output is used passively. Furthermore the status output is galvanically insulated from all other circuits except for the status output with which it shares a common (ground).
- **All functions and operating data can be set,** see sect. 5.9 (**not** applicable to UFC 400... signal converter).
- **Factory-set data and functions** are listed in the enclosed report on settings. This can also be used to record any changes made to the operating parameters.
- **Active status output,** for electromechanical indicators or for electronic indicators, voltage between 19 to 32 V_{DC}. Note that the total current for the active frequency/pulse and status outputs together (drawn from I+) may not exceed 50 mA. (see connection diagram 3 below).
- **Passive status output,** open collector output for connection of electronic indicators, input voltage ≤ 32 V_{DC} / ≤ 24 V_{AC}, load current max. 150 mA.
- **Connection diagrams,** see below.

2.3.5 Connection diagrams for outputs

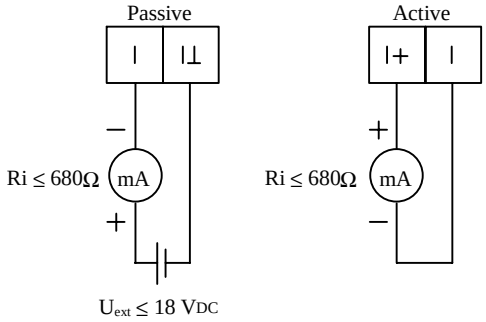
B1 pulse output (**P**)
B2 status outputs (**S**)

Electrical connection in conformity with VDE 0100 "Regulations governing heavy current installations with mains voltages up to 1000 V" or an equivalent national standard.

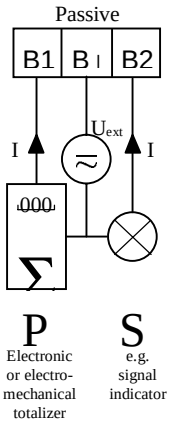
In case the meter is to be connected to a functional extra-low voltage source of ≤ 18 V_{DC}, protective separation in conformity with VDE 0100, part 410 or an equivalent national standard must be ensured.

The connection diagrams are shown by the figures below.

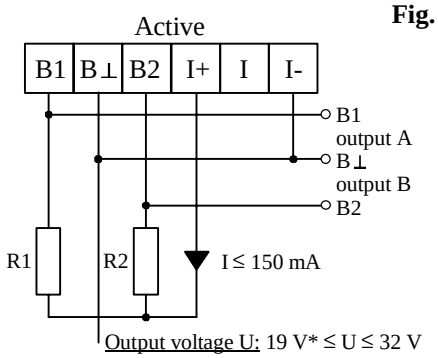
Current output (I) **Fig. 1**



Pulse output (P)
Status output (S) **Fig. 2**



Pulse output (P)
Status output (S) **Fig. 3**



Remark: In case of one active output (A or B), the resistance R1 or R2 ≥ 650 Ω.
In case of two active outputs the equivalent resistance of R1 and R2 ≥ 650 Ω.

* 19 V at full load on all active outputs

3. (Initial) Start-up

- Check that the system has been correctly installed as described in sect. 1 and 2.
- With separate systems, check before initial start-up that the following details on the primary head nameplate agree with the data specified in the report of settings for the signal converter. If not, new setting will be necessary:

  Order No., see instrument nameplates
  Meter size (DN), fct. 3.1.5, sect. 5.3
  Primary constant GK, fct. 3.1.6, sect. 5.16
  Flow direction, fct. 3.1.7, sect. 5.4

- Before every start-up it is advisable to carry out a zero check if the flow can be zeroed, as described in sect. 7.2.
- When powered, the signal converter operates in the measuring mode. *TEST, NO ERROR* and *IDENT NO.* _ _ _ _ _ _ _ of the signal converter appear in succession in the display. This is followed by display of the actual flowrate and/or the internal count on a continuous or alternating basis (depends on setting, see report on settings)

If the compass field flashes (see sect. 4.4) on flowmeters UFM 500... it may prove necessary to change the system grounding, see sect. 1.3.2.

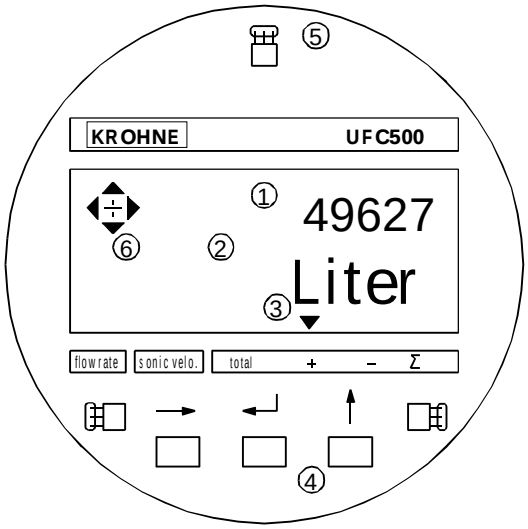
Part B Signal converter UFC 500 ...

4. Operation of the signal converter

This section 4 is repeated in the form of pull-out condensed operating instructions (pages 17-20).

4.1 Operating and check elements

The operating elements are accessible after removing the cover of the electronics section using the special wrench.
Caution: Do not damage the screw thread, never allow dirt to accumulate, and make sure it is well greased at all times.



①② Display 1st (top) and 2nd (middle) lines.

③ Display 3rd (bottom) line: Arrows (▼) to identify actual display.

Flowrate	actual flowrate
Sonic.velo	Sound velocity
+	Totalizer (**F**orward flow)
-	Totalizer (**R**everse flow)
Σ	Sum totalizer (+ and -)

④ Keys for setting the signal converter, refer to "Setting diagram" (on the right) and sect. 4.2.2

⑤ Magnetic sensors to set the converter by means of a hand-held bar magnet (optional) without having to open the housing, refer to sect. 6.4. Function of sensors same as keys ④.

⑥ Compass field, see sect. 4.4.

4.2 KROHNE operator control concept

4.2.1 Description

The operator control concept for the UFC 500... signal converter consists of 3 levels (horizontal), see below.

Setting level: This level is subdivided into 3 main menus.

Fct. 1.0 OPERATION: This menu contains only the most important parameters and functions of menu 3 to allow rapid changes to be made during the measuring mode.

Fct. 2.0 TEST: Test menu for checking the signal converter.

Fct. 3.0 INSTALL.: All flow measurement- and flowmeter-specific parameters and functions can be set in this menu.

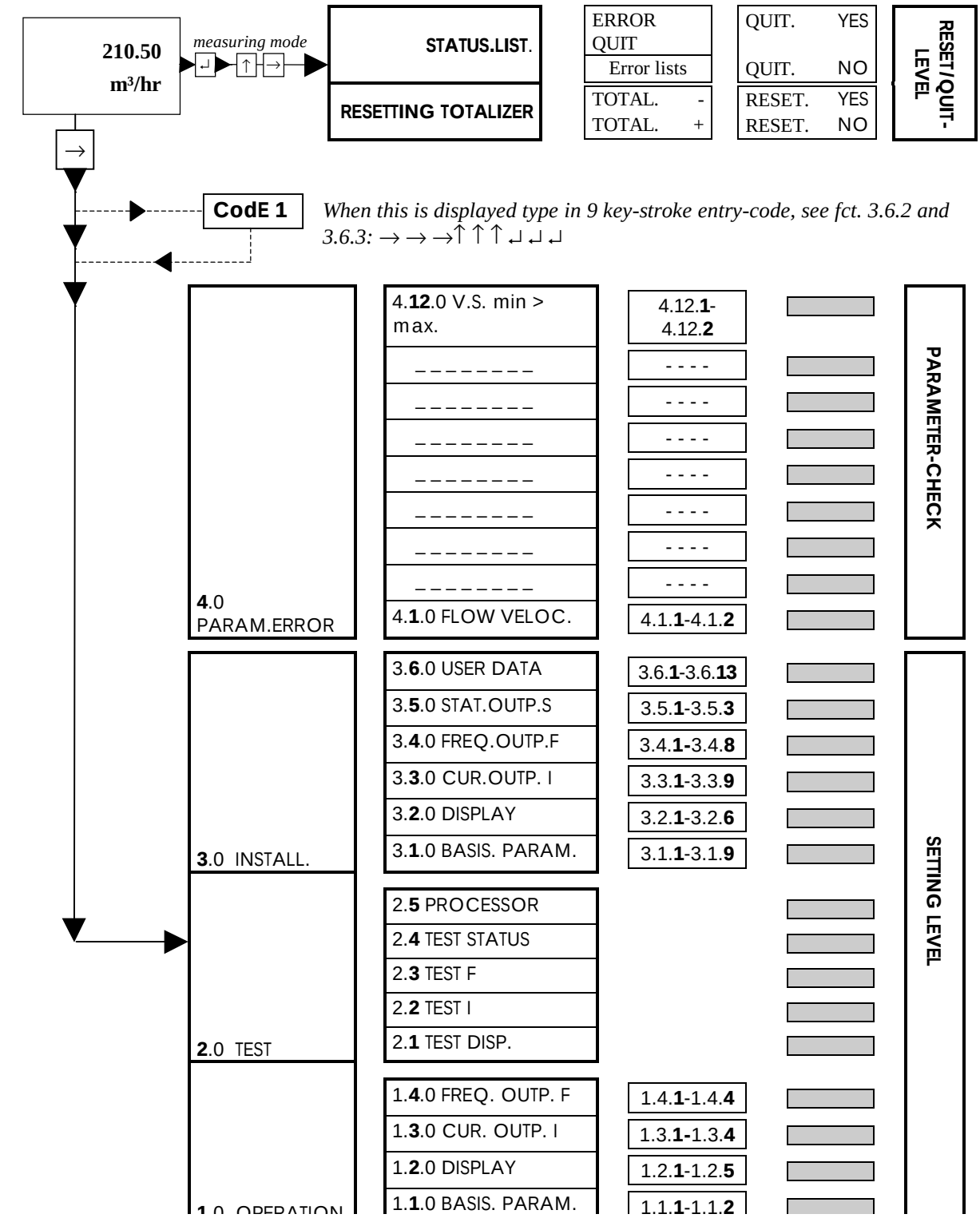
Parameter check level: **Fct. 4.0 PARAM.ERROR**: This level is not selectable. After exiting from the "setting level", the signal converter checks new data for plausibility (inconsistency). If an error is established, the signal converter reverts to menu 4. In this menu, all functions can be scanned and those, that are inconsistent, changed.

Reset/acknowledge level: This menu has two tasks and is selected via Entry Code 2 (↵↑→), see sect. 4.2.5

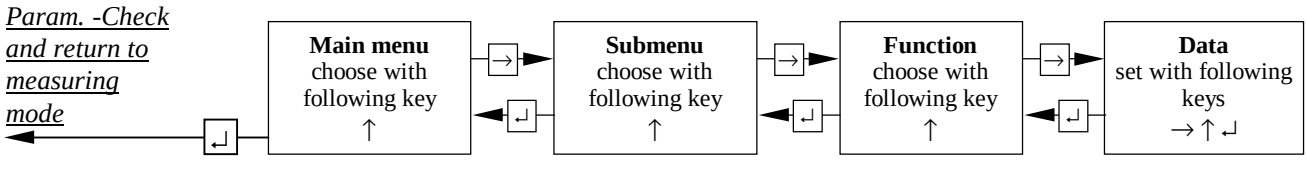
1) Separate resetting of totalizers, provided that resetting is enabled by setting "YES" under fct. 3.6.10 ENABL.RESET.

2) Error scanning and acknowledgment (Quit)
Errors that have occurred since the last acknowledgment are indicated in a list. After acknowledgment and elimination of the cause(s), these errors are deleted from the list.

4.2.2 Overview of functions



Possible direction of keys in menu levels and sub-levels
The flashing part of the display (cursor) can be changed, here in **"bold"** type.

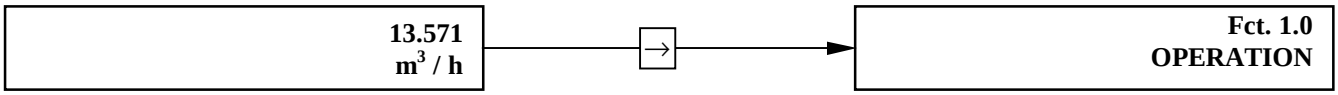


4.2.3 Function of keys

The gray areas in the following text represent the flashing part of the display, the **cursor**.

To start

Measuring mode *Operating mode*

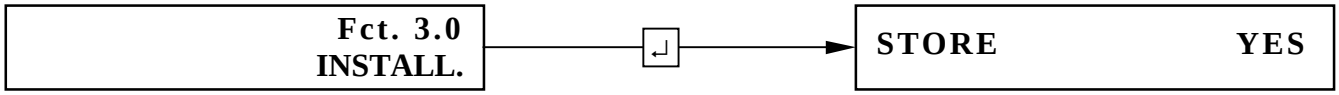


PLEASE NOTE: When **ENTRY CODE 'YES'** is set in fct. 3.6.2, then, after pressing the → key, the display will show: **"CodE 1 - - - - - - -".** Now type in the 9 key-stroke the entry-code: Factory setting → → → ↵ ↵ ↵ ↑ ↑ ↑ (Each key-stroke is represented by a "∗" in the display).

Function of the keys in the 3 levels	
Cursor	Is the flashing part of the display. This can be a digit, a text, a unit or a sign.
→	The **cursor key** shifts the cursor to a new (different) position in the display. For the menu columns (see diagram in sect. 4.2.2) this means: transfer to the next "right" column, i.e. from left or right, up to the data column. Only in the data column parameters can be changed and functions can be initiated.
↑	The **select key** changes the contents (digit, text) of the flashing cursor. - Digit Increase value by "1". (With fct. _ _ _, display next main or submenu or next function). - Text/unit: Display (select) next text/unit from a list. - Sign: Change from "+" to "-" or, with exponents, from "E" to "E-", and vice versa.
↵	The **accept key** (return key) is used for: - acceptance of new parameters, - acknowledgment of displayed error messages in the reset/ackn. Menu, and - execution of displayed functions. For the menu columns (see diagram in sect. 4.2.2) this means: transfer to the next "left" column, i.e. from right to left, up to the main menu column. Only from the main menu column it is possible to exit the 3 levels and return to the measuring mode.
Important	• If numerical values are set, which are outside the permissible input range, the display will flash after the "Accept" key ↵ has been pressed. 1st line: permissible minimum **or** maximum value displayed. 2nd line: *TOO LOW* **or** *TOO HIGH.* The incorrect numerical value is displayed again after pressing the ↵ key; set correct numerical value. • Time-out function: if the signal converter is in the setting level and if no key-strokes are set for approx. 15 minutes, the signal converter will automatically revert to the measuring mode without accepting any previously changed data.

To terminate

Keep pressing ↵ until menu **fct. 1.0 OPERATION, fct. 2.0 TEST, or fct. 3.0 INSTALL.** is



Storing the new parameters

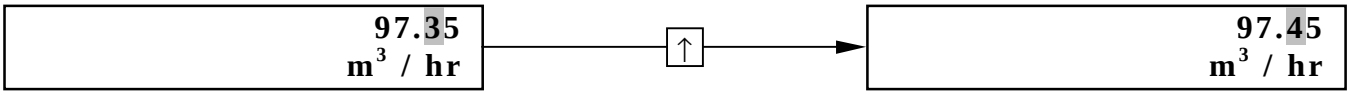
Acknowledge with ↵, display shows: "PARAM.CHECK". When no errors occur, the measuring mode will continue with the new parameters.

In case of an error, the display will show: "Fct. 4.0 PARAM.ERROR". In this menu all functions that are inconsistent can be scanned. For this turn to sect. 4.2.2 and 4.3.

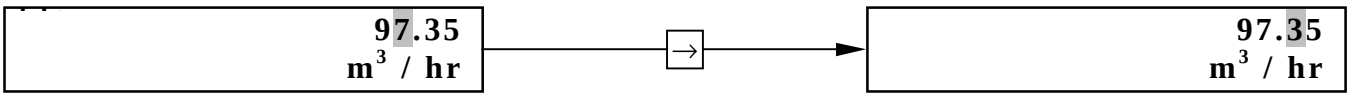
Do not store new parameters

Press the ↑ key, display shows "STORE NO". After pressing the ↵ key the measuring mode will continue with the "old" parameters.

Changing the numbers.

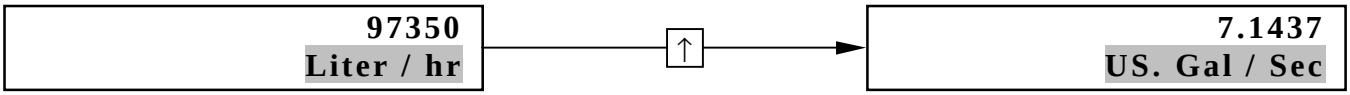


Moving the cursor (blinking part) **to the**

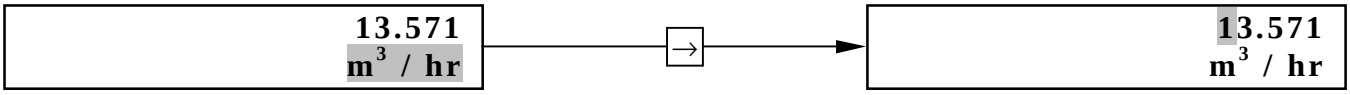


Changing the texts (units).

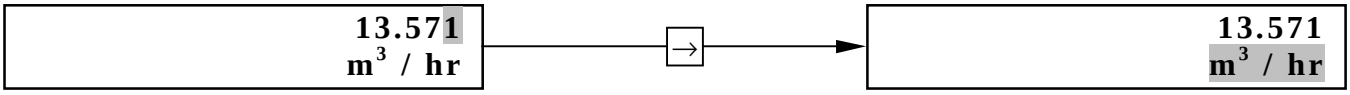
When the units are changed, the totalizer value is automatically converted.



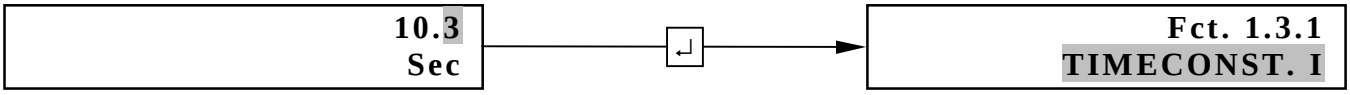
Changing from text (unit) **to totalizer setting.**



Changing from totalizer setting back to text.



Return to display of functions.



4.2.4 Example for setting the signal converter

The following example shows how to change the pulse rate of the frequency output (function: fct. 3.4.3 PULSRATE, see sect. **4.3**). The cursor (flashing part of display) is shown here in "**bold**" type.

- **"old" setting:** 1 pulse per second (1.000 E 0 PuLSe/Sec)
- **change to:** 1000 pulses per hour (1.000 E 3 PuLSe/hr)

Keys	Display		Explanation
	1st line	2nd line	
	- - - - -	- - - - - - -/ - -	Measuring mode
→	Fct. **1**.0	**OPERATION**	When ENTRY CODE 1 "YES" is set in fct. 3.6.2 the 9 key-stroke **"CodE 1"** must be typed in**.** Factory setting → → → ↑ ↑ ↑ ↵ ↵ ↵ Main menu operation
2 x ↑	Fct. **3**.0	**INSTALL.**	Main menu setting
→	Fct. 3.**1**	**BASIS PARAM**	Submenu Frequency output
3 x ↑	Fct. 3.**4**	**FREQ.OUTP. F**	
→	Fct. 3.4.**1**	**FUNCTION F**	
2 x ↑	Fct. 3.4.**3**	**PULSRATE**	Change pulse rate
→	1.0000 E	**PuLSe/Sec**	

Keys	Display		Explanation
	1st line	2nd line	
↑	6.0000E 1	PuLSe/min	Change pulse rate (Continuation)
↑	3.6000E 3	PuLSe/hr	
→	**3**.6000E 3	PuLSe/hr	
8 x ↑	**1**.6000E 3	PuLSe/hr	
→	1.**6**000E 3	PuLSe/hr	
4 x ↑	1.**0**000E 3	PuLSe/hr	
↵	Fct. 3.4.**3**	**PULSRATE**	Return to measuring mode
↵	Fct. 3.**4**	**FREQ.OUTP.F**	
↵	Fct. **3**.0	**INSTALL.**	
↵		**STORE YES**	
↵		PARAM.CHECK	If fct. 4.0 PARAM.ERR. should appear: plausibility error, see sect. 4.3
	- - - - - - -	- - - - - - -/ - - -	Measuring mode

4.2.5 RESET / QUIT Menu, reset totalizers and delete error messages

Resetting totalizers

Keys	Display		Description
	- - - - - - -	- - - - - - / - - -	Measuring mode.
↵	**CodE 2**	- -	Type in entry-code 2 for RESET/QUIT-menu: ↑ →.
↑ →		**TOTAL.RESET**	Totalizer menu only appears when ENABL.RESET "YES" is set in fct. 3.6.10, if not display will show "ERROR LIST", see next section.
→		**TOTAL. +**	
(↑)		**(TOTAL. -)**	If necessary, choose "-Totalizer" with ↑ key.
→		**RESET NO**	**Do not** reset totalizer, press ↵ 3 times to return to measuring mode.
↑		**RESET YES**	Reset totalizer.
↵		**TOTAL. + (-)**	"+" (or "-") totalizer has been reset.
			If necessary choose the other totalizer with ↑ key and reset as well.
↵		**TOTAL.RESET**	
↵	- - - - - - -	- - - - - - / - - -	Return to measuring mode.

Displaying and deleting error messages

Keys	Display		Description
	- - - - - - -	- - - - - - / - - -	Measuring mode.
↵	**CodE 2**	- -	Type in entry-code 2 for RESET/QUIT-menu: ↑ →.
↑ →		**TOTAL.RESET**	Totalizer menu only appears when ENABL.RESET "YES" is set in fct. 3.6.10, if not display will show "ERROR.LIST", see next section.
↑		**ERROR.LIST**	Menu for status messages.
→		- - - - - - - - - - -	1. Error message is displayed.
↑		- - - - - - - - - - -	2. Error message is displayed.
↑, ↑, ...		- - - - - - - - - - -	Further error messages are displayed, if present at the end of the list.
		ERROR.LIST	ERRORLIST is displayed.
→		**QUIT.NO**	**Do not** delete error messages, press ↵ key three times = return to measuring mode.
↑		**QUIT.YES**	Delete error messages.
↵		**ERROR QUIT**	Error messages have been deleted.
↵		**ERROR.LIST**	
↵		- - - - - - / - - -	Return to measuring mode.

4.3 Setting table

Fct. no.	Text	Description and settings
1.0	**OPERATION**	**Main menu 1.0 Operation**
1.1.0	**BASIS.PARAM**	**Submenu 1.1.0 Basis parameters**
1.1.1	FULL SCALE	**Full-scale range for flowrate $Q_{100\%}$** see Fct. 3.1.1
1.1.2	REV. SCALE	**Different range for reverse flow** required? See Fct. 3.1.2
1.1.3	REV. VALUE	**Full-scale range for reverse flow $Q_{R100\%}$** see Fct. 3.1.3
1.1.4	ZERO SET.	**Zero setting**, see Fct. 3.1.4
1.2.0	**DISPLAY**	**Submenu 1.2.0 Display**
1.2.1	DISP. FLOW	**Unit for flowrate display**, see Fct. 3.2.1
1.2.2	DISP. TOTAL.	**Function of totalizer display**, see Fct. 3.2.2
1.2.3	UNIT TOTAL.	**Unit for totalizer display?** See Fct. 3.2.3
1.2.4	DISP. S.VEL	**Display of sound velocity** required? See Fct. 3.2.4
1.2.5	CYCL. DISP.	**Cyclic display** required? See Fct. 3.2.5
1.3.0	**CUR. OUTP. I**	**Submenu 1.3.0 Current output I**
1.3.1	TIMECONST.I	**Time constant of current output I**, see Fct. 3.3.6
1.3.2	L.F.CUTOFF I	**Low-flow cutoff** (SMU) **for current output** required? See Fct. 3.3.7
1.3.3	CUTOFF ON	**Cutoff "on" value SMU-I**, see Fct. 3.3.8
1.3.4	CUTOFF OFF	**Cutoff "off" value SMU-I**, see Fct. 3.3.9
1.4.0	**FREQ. OUTP.F**	**Submenu 1.4.0 Frequency output F**
1.4.1	PULSRATE **or** PULSE/UNIT	**Pulse rate for 100% flowrate or for sound velocity**, see Fct. 3.4.3 or **Pulse value for flowrate unit**, see Fct.3.4.3
1.4.2	L.F.CUTOFF F	**Low-flow cutoff** (SMU) **for frequency output** required? See Fct. 3.4.6
1.4.3	CUTOFF ON	**Cutoff "on" value SMU-F**, see Fct. 3.4.7
1.4.4	CUTOFF OFF	**Cutoff "off" value SMU-F**, see Fct. 3.4.8
2.0	**TEST**	**Main menu 2.0 Test functions**
2.1	TEST DISP.	**Carry out display test** (Sect. 7.1.1) Start with → key, duration approx. 30 Sec. Test interruption with ↵ key.
2.2	TEST I	**Test current output I** (Sect. 7.1.2) • 0 mA • 4 mA • 20 mA • 2 mA • 10 mA • 22 mA Displayed value present directly at current output. Actual value again present at output after pressing the ↵ key.
2.3	TEST F	**Test frequency output F** (Sect. 7.1.3) • 1 Hz • 100 Hz • 10 Hz • 1000 Hz Displayed value present directly at current output. Actual value again present at output after pressing the ↵ key.
2.4	TST STATUS.	**Test status output S** (Sect. 7.1.4) • STATUS OFF • STATUS ON • Displayed value present directly at current output. Actual value again present at output after pressing ↵ key.
2.5	PROCESSOR	**Test microprocessor** (Sect. 7.1.5) Start with ↵ key, duration approx. 2 Sec. End of test: NO ERROR or ERROR displayed.
3.0	**INSTALL**	**Main menu 3.0 Installation**
3.1.0	**BASIS.PARAM**	**Submenu 3.1.0 Basis parameters**
3.1.1	FULL SCALE	**Full-scale range for flowrate $Q_{100\%}$** Unit: select from list under Fct. 3.2.1 Value: $9.5*10^{-7}$ to 150.8 m^3/Sec **or** 3.9 to 1,987,200 US Gal/min (see Sect. 5.2 + 5.3) After selecting unit, call numerical value with ENTER key, 1st digit flashes.
3.1.2	REV. SCALE	**Different range for reverse flow** required? Setting NO or YES

Fct. no.	Text	Description and settings
3.1.3	REV. VALUE	**Full-scale range for reverse flow** (appears only if YES set under Fct. 3.1.2) Unit: select from list under Fct. 3.2.1 Value: $9.5*10^{-7}$ to 150.8 m^3/Sec **or** 3.9 to 1,987,200 US Gal/min (see Sect. 5.2 + 5.3). Value must not be larger than that of Fct. 3.1.1! After selecting unit, call numerical value with ↵ key, 1st digit flashes.
3.1.4	ZERO SET	**Zero setting**, see Sect. 7.2 • FIXED.VALUE • VALUE.MEASU. (Carry out only at "zero" flow and with completely filled measuring tube). 1) Inquiry: CALIB. NO **or** YES 2) if YES: calibration (duration approx.20 Sec) with zero display in PERCENT of $Q_{100\%}$ 3) Inquiry: STORE NO **or** YES
3.1.5	METER SIZE	**Meter size**, see Sect. 5.3 Unit: mm **or** inches Value: 25 to 4000 mm **or** 0.98 to 157.48 inches After selecting unit, call numerical value with ↵ key, 1st digit flashes.
3.1.6	GK VALUE	**Primary head constant GK**, see Sect. 5.16 (see also primary head nameplate). Range: 0.5 to 14
3.1.7	FLOW DIR	**Define direction of forward flow**, see Sect. 5.4. Setting: + or −, acc. to direction of arrow on primary head.
3.1.8	MIN S.VELO.	**Minimum sound velocity**, see Sect. 5.16. Minimum value used for $I_{0\%}$ or $F_{0\%}$ (when function SOUND.VELO selected in 3.3.1 or 3.4.1) Value: 0 to 5000 m/s
3.1.9	MAX S.VELO	Maximum sound velocity, s. Sect. 5.16 Maximum value used for $I_{100\%}$ or $F_{100\%}$ (when function SOUND.VELO selected in 3.3.1 or 3.4.1) Value: 1 to 5000 m/s
3.2.0	**DISPLAY**	**Submenu 3.2.0 Display**
3.2.1	DISP. FLOW	**Unit for flowrate**, see Sect. 5.1+5.5 • m^3/Sec • Liter/Sec • US Gal/Sec • m^3/min • Liter/min • US Gal/min • m^3/hr • Liter/hr • US Gal/hr • h Liter/hr **or** US.MGal/DAY (factory set, can be changed as required, see Fct. 3.6.6, 3.6.7+3.6.8 and Sect. 5.15) • PERCENT • NO DISPLAY
3.2.2	DISP. TOTAL	**Function of totalizer display**, see Sect. 5.5 • + TOTAL. (forward totalizer) • − TOTAL. (reverse totalizer) • +/− TOTAL. (forward and reverse totalizers, alternating) • SUM TOTAL. (sum of + and − totalizers) • ALL TOTAL. (sum, + and − totalizers, alternating) • TOTAL. OFF (totalizer switched off)
3.2.3	UNIT TOTAL.	**Unit for totalizer display**, see Sect. 5.5 • m^3 • Liter • US Gal • h Liter **or** US.MGal (see Fct. 3.2.1 "hLiter/hr" and "US.Mgal/DAY")
3.2.4	DISP. S.VEL	**Display of sound velocity** (in m/s) required? Setting: NO **or** YES

Fct. no.	Text	Description and settings
3.2.5	CYCL. DISP.	**Cyclic display** required? Setting: NO **or** YES
3.2.6	ERROR MSG.	**Which error messages** to be displayed? See Sect. 4.4. • NO MESSAGE (no error messages) • US ERRORS (only ultrasonic errors) • TOTAL.ERROR (only errors of internal totalizer) • ALL ERRORS (all errors)
3.3.0	**CUR. OUTP. I**	**Submenu 3.3.0 Current output I**, see Sect. 5.7.
3.3.1	FUNCTION I	**Function, current output I**, see Sect. 5.7.1 + 5.7.3. • OFF (switched off) • F/R IND. (F/R indication, e.g. for F) • 1 DIR. (1 flow direction) • I<I 0 PCT. (**F**orward / **R**everse flow, e.g. in 0 to 20 mA range: **F**=10 to 20 mA and **R**=10 to 0 mA) • 2 DIR. (Forward/Reverse flow, F/R-measurement) • SOUND.VELO (sound velocity)
3.3.2	RANGE I	**Range for current output I**, see Sect. 5.7.2 • 0 - 20 mA • 4 - 20 mA • OTHER RANGE (see Fct. 3.3.3, 3.3.4 + 3.3.5)
3.3.3	I 0 PCT.	**Current for 0% flow ($I_{0\%}$)**, see Sect. 5.7.2 (appears only if OTHER RANGE set under Fct. 3.3.2). Value: 00 to 16 mA
3.3.4	I 100 PCT.	**Current for 100% flow ($I_{100\%}$)** of full-scale range (Fct. 3.1.1), see Sect. 5.7.2 (appears only if OTHER RANGE set under Fct. 3.3.2). Value: 04 to 20 mA (value must be at least 4 mA greater than that of Fct. 3.3.3).
3.3.5	I MAX mA	**Current limitation (I_{max})**, see Sect. 5.7.2 (appears only if OTHER RANGE is set under Fct. 3.3.2) Value: 04 to 22 mA (value must greater than that of Fct. 3.3.4).
3.3.6	TIMECONST.I	**Time constant of current output I**, see Sect. 5.7.2 Value: 0.04 to 3600 Sec
3.3.7	L.F.CUTOFF I	**Low flow cutoff** (SMU) **for current output** required? See Sect. 5.10. Setting: NO or YES
3.3.8	CUTOFF ON	**Cutoff "on" value for SMU-I**, see Sect. 5.10 (appears only if YES set under Fct. 3.3.7) Value: 01 to 19 PERCENT of $Q_{100\%}$ (Fct. 3.1.1)
3.3.9	CUTOFF OFF	**Cutoff "off" value for SMU-I**, see Sect. 5.10 (appears only if YES set under Fct. 3.3.7) Value: 02 to 20 PERCENT of $Q_{100\%}$ (Fct. 3.1.1), value must be greater than that of Fct. 3.3.8.
3.4.0	**FREQ. OUTP.F**	**Submenu 3.4.0 Frequency output F**, see Sect. 5.8
3.4.1	FUNCTION F	**Function, frequency output F**, see Sect. 5.8.1 + 5.8.3 • OFF (switched off) • F/R IND. (F/R indication, e.g. for I) • 1 DIR. (1 flow direction) • 2 DIR. (forward/reverse flow, F/R measurement) • SOUND.VELO (sound velocity)
3.4.2	PULSOUTP	**Unit of frequency output F**, see Sect. 5.8.2 • PULSRATE (setting in pulses per unit time) • PULSE/UNIT (setting in pulses per unit volume)
3.4.3	PULSRATE	**Pulse rate for 100% flowrate or for sound velocity**, see Fct. 3.1.1 or 3.1.8 + 3.1.9 (appears only if PULSRATE set under Fct. 3.4.2) Value: $2.778*10^{-3}$ to 1000 PuLSe/Sec (= Hz) **or** 0.1667 to 60,000 PuLSe/min **or** 10 to 3,600,000 PuLSe/hr After selecting unit, call numerical value with ↵ key, 1 digit flashes.
3.4.3	PULSE/UNIT	**Pulse value for flowrate unit** (appears only if PULSE/UNIT set under Fct. 3.4.2) Unit: PuLSe per m^3, Liter, US Gal **or** unit of Fct. 3.6.6, 3.6.7+3.6.8 (see Sect. 5.15). Value: 0.0001 to $9.9999*10^9$ PuLSe (**no** check, but $Q_{100\%}$*pulse value ≤ 3.600.000 pulses/hr). After selecting unit, call numerical value with ↵ key, 1 digit flashes.
3.4.4	PULSWIDTH	**Pulse width for frequencies ≤ 10 Hz**, see Sect. 2.3.3 + 5.8.2 • 30 mSec • 200 mSec • 50 mSec • 500 mSec • 100 mSec
3.4.5	TIMECONST.F	**Time constant of frequency output F**, see Sect. 5.8.2 • 40 mSec • SAME AS I (time constant for F same as for I, see Fct. 3.3.6)
3.4.6	L.F.CUTOFF F	**Low-flow cutoff** (SMU) **for frequency output** required? See Sect. 5.10 Setting: NO or YES
3.4.7	CUTOFF ON	**Cutoff "on" value SMU-F**, see Sect. 5.10 (appears only if YES set under Fct. 3.4.6) Value: 01 to 19 PERCENT of $Q_{100\%}$ (Fct. 3.1.1)
3.4.8	CUTOFF OFF	**Cutoff "off" value SMU-F**, see Sect. 5.10 (appears only if YES set under Fct. 3.4.6) Value: 02 to 20 PERCENT of $Q_{100\%}$ (Fct. 3.1.1), value must be greater than that of Fct. 3.4.7
3.5.0	**STAT.OUTP.S**	**Submenu 3.5.0 Indication output S, see Sect. 5.9**
3.5.1	FUNCTION S..	**Function, status output S,** see Sect. 5.9 • FATAL ERR. (system failure or measuring circumstances too bad to produce reliable output data) • US ERROR (one or two measuring paths fail) • F/R IND. (Forward/Reverse flow indication, POINT 1 is used as hysteresis in percentage of forward flow scale) • TRIP POINT (if POINT 1 > POINT 2: contact will close, if flow is higher than POINT 1 and contact will be open if flow is lower than POINT 2. IF POINT 2 > POINT 1: contact will open if flow is higher than POINT 2 and contact will close if flow is lower than POINT 1).
3.5.2	POINT1	First trip point when Fct. 3.5.1 set TRIP POINT or Hysterises (in % of full forward flow scale) for Forward/Reverse indication when set under 3.5.1.
3.5.3	POINT 2	Second trip point, when Fct. 3.5.1 set TRIP POINT.
3.6.0	USER DATA	Submenu 3.6.0 User data
3.6.1	LANGUAGE	**Language for display texts**, see Sect. 5.12 • GB/USA (English) and • D (German) or • F (French)

Fct. no.	Text	Description and settings
3.6.2	ENTRY.CODE.1	**Entry code 1 for setting level** required? See Sect. 5.13 • NO = Entry with → key only • YES = Entry with → key **and** 9-keystroke code Setting of the code under Fct. 3.6.3
3.6.3	CODE 1	**Set Code 1**, see Sect. 5.13 (appears only if YES set under Fct. 3.6.2) • Factory setting: →, →, →, ↵, ↵, ↵, ↑, ↑, ↑ • Different code required: Press any 9-keystroke combination and then press the **same** combination again. Each keystroke acknowledged by "∗". WRONG CODE appears if 1st and 2nd entries are **not equal**. Press ↵ + → keys and repeat entries.
3.6.4	LOCATION	**Tag name setting** (measurement point no.) max. 10 digits, see Sect. 5.18. Required only for flowmeters of "HHC" design (operator control via Hand-Held Communicator MIC 500, connected to current output). Factory setting: ALTOMETER Characters assignable to each place: A..Z / a..z / 0..9 / + / − / underscore character = blank character.
3.6.5	OUTP. HOLD	**Hold values of outputs during settings?** See Sect. 5.14. Setting: NO or YES
3.6.6	UNIT TEXT	**Text for user-defined unit**, see Sect. 5.15. Factory setting: hLiter/hr or US.MGal/DAY Characters assignable to each place: A..Z / a..z / 0..9 / + / − / underscore character = blank character. Fraction bar "/" in 7th place is unalterable.
3.6.7	FACT. QUANT	**Conversion factor for quantity F_M**, see Sect. 5.15. F_M = quantity per 1 m^3! Factory setting: 1.00000 E1 (for hecto-Liter) **or** 2.64172 E-4 (US M.Gallons) Value setting: $0.00001*10^{-9}$ to $9.99999*10^{+9}$
3.6.8	FACT. TIME	**Conversion factor for time F_T**, see Sect. 5.15. F_T in seconds! Factory setting: 3.60000 E3 (for hour) **or** 8.64000 E4 (for day) Value setting: $0.00001*10^{-9}$ to $9.99999*10^{+9}$
3.6.9	TOTAL. RESET	**Totalizer reset** (+ and − totalizer together), see Sect. 5.6 Inquiry: NO or YES
3.6.10	ENABL. RESET	**Enable totalizer reset**, refer to Sect. 5.6 for RESET/QUIT menu. Inquiry: NO or YES
3.6.11	PLAUS ERR.	**Error limit** in % of measured value for plausibility statement. Measured values that are outside the specified band are not processed. Every measured value outside the specified band will increase an internal counter by "1", until a maximum counter value (see Fct. 3.6.13) has been reached. The corresponding measurement channel will then be made inactive and an indication will be visible on the display. Value setting: 1 to 99 PERCENT Factory setting: 20 PERCENT
3.6.12	WEIGHT P.OK	**Weight factor** for correct measurements. The internal plausibility counter is increased by the number programmed, when the measured value is correct. The higher the number the faster an inactive channel will become active again. Value setting: 1 to 50 Factory setting: 4

Fct. no.	Text	Description and settings
3.6.13	N.PLAUS.ER	**Limit value for the counter of incorrectly measurements** (see Fct. 3.6.11). When '0' is set, the plausibility function will become inactive. Value setting: 0 to 10,000 Factory setting: 0
4.0	**PARAM. ERROR**	**Main menu 4.0 Parameter error**
4.1.0	**FLOW VELOC.**	**FLOW VELOCITY "v" incorrect:** Ensure condition 0.5 m/s ≤ v ≤ 18 m/s **or** 1.5 ft/s ≤ v ≤ 59 ft/s is met!
4.1.1	FULL SCALE	**Full-scale range for flowrate $Q_{100\%}$** see Fct. 3.1.1
4.1.2	METER SIZE	**Meter size**, see Fct. 3.1.5
4.2.0	**F/R FLOW**	**FULL-SCALE RANGE(S) for forward/reverse flow incorrect:** Ensure condition F ≥ R is met!
4.2.1	FULL SCALE	**Full-scale range for forward flowrate $Q_{F100\%}$** see Fct. 3.1.1
4.2.2	REV. SCALE	**Different range for reverse flow** required? See Fct. 3.1.2
4.2.3	REV. VALUE	**Full-scale range for reverse flow $Q_{R100\%}$** see Fct. 3.1.3
4.3.0	**I RANGE**	**CURRENT OUTPUT I RANGE incorrect:** Ensure condition $I_{100\%} - I_{0\%} \geq 4$ mA is met!
4.3.1	I 0 PCT	**Current for 0% flow** ($I_{0\%}$), see Fct. 3.3.3
4.3.2	I 100 PCT	**Current for 100% flow** ($I_{100\%}$), see Fct. 3.3.4
Fct. no.	**Text**	**Description** and settings
4.4.0	**I MAXIMUM**	**CURRENT LIMITATION incorrect:** Ensure condition $I_{max} \geq I_{100\%}$ is met!
4.4.1	I 100 PCT	**Current for 100% flow** ($I_{100\%}$), see Fct. 3.3.4
4.4.2	I MAX mA	**Setting of max. output current** (I_{max}), see Fct. 3.3.5
4.5.0	**LFC. I RANG.**	**LOW-FLOW CUTOFF RANGE I incorrect:** Ensure condition cutoff "off" − cutoff "on" ≥ 1% is met!
4.5.1	L.F. CUTOFF I	**Low-flow cutoff** (SMU) **for current output** required? See Fct. 3.3.7
4.5.2	CUTOFF ON	**Cutoff "on" value SMU-I**, see Fct. 3.3.8
4.5.3	CUTOFF OFF	**Cutoff "off" value SMU-I**, see Fct. 3.3.9
4.6.0	**LFC. F RANG.**	**LOW-FLOW CUTOFF RANGE F incorrect:** Ensure condition cutoff "off" − cutoff "on" ≥ 1% is met!
4.6.1	L.F. CUTOFF F	**Low-flow cutoff** (SMU) **for frequency output** required? See Fct. 3.4.6
4.6.2	CUTOFF ON	**Cutoff "on" value SMU-F**, see Fct. 3.4.7
4.6.3	CUTOFF OFF	**Cutoff "off" value SMU-F**, see Fct. 3.4.8
4.7.0	**F > 1 kHz**	**OUTPUT FREQUENCY too high:** must be less than 1 kHz!
4.7.1	FULL SCALE	**Full-scale range for flowrate $Q_{100\%}$** see Fct. 3.1.1
4.7.2	PULSOUTP.	**Unit of frequency output F**, see Fct. 3.4.2
4.7.3	PULSRATE **or** PULSE/UNIT	**Pulse rate for 100% flowrate or for sound velocity**, see Fct. 3.4.3 or **Pulse value for flowrate unit**, see Fct. 3.4.3
4.8.0	**F <> PULSW.**	**FREQUENCY/PULSE WIDTH ASSIGNMENT is incorrect:** Refer to Table in Sect. 2.3.3
4.8.1	PULSOUTP.	**Unit of frequency output F**, see Fct. 3.4.2
4.8.2	PULSRATE **or** PULSE/UNIT	**Pulse rate for 100% flowrate or for sound velocity**, see Fct 3.4.3 or **Pulse value for flowrate unit**, see Fct. 3.4.3
4.8.3	PULSWIDTH	**Pulse width for frequencies ≤ 10 Hz**, see Fct. 3.4.4
4.9.0	**PULS/S.VELO**	**Incorrect ASSIGNMENT of UNIT for F and SOUND VELOCITY:** Refer to conditions given in Sect. 5.8.2
4.9.1	FUNCTION F	**Function of frequency output F**, see Fct. 3.4.1
4.9.2	PULSOUTP.	**Unit of frequency output F**, see Fct. 3.4.2

Fct. no.	Text	Description and settings
4.10.0	**LFC. I/S.VEL**	**LOW-FLOW CUTOFF I incorrect:** Ensure low-flow cutoff is "off" when function of current output is sound velocity.
4.10.1	FUNCTION I	**Function of current output I**, see Fct. 3.3.1
4.10.2	L.F.CUTOFF I	**Low-flow cutoff** (SMU) **for current output** required**?** See Fct. 3.3.7
4.11.0	**LFC. F/S.VEL**	**LOW-FLOW CUTOFF F incorrect:** Ensure low-flow cutoff is "off" when function of frequency output is sound velocity.
4.11.1	FUNCTION F	**Function of frequency output F**, see Fct. 3.4.1
4.11.2	L.F.CUTOFF F	**Low-flow cutoff** (SMU) **for frequency output** required**?** See Fct. 3.4.6
4.12.0	**V.S. min>max**	**MAX. SOUND VELOCITY MUST BE LARGER THAN MIN. SOUND VELOCITY.**
4.12.1	MIN S.VELO	**Minimum sound velocity**, sound velocity for $I_{0\%}$ or $F_{0\%}$
4.12.2	MAX S.VELO	**Maximum sound velocity**, sound velocity for $I_{100\%}$ or $F_{100\%}$

4.3 Error messages

4.3.1 Description of error messages as shown in display

The following list gives all errors that can occur during process flow measurement.

List of errors

Error messages	Description of error	Rectify instrument fault and / or clear error message	Error output in measuring mode via display (see fct. 3.2.6) dependent on setting.			
Display *2nd (middle) line*			*NO MESS*	*US ERROR*	*TOTAL ERROR*	*ALL ERROR*
LINE INT.	**Power failure since last setting** Note: no counting during power failure	❑ Reset totalizer(s) if necessary	-	-	yes	yes
TOTALIZER	**Counts lost or totalizer overflow** Note: totalizer was reset!	❑	-	-	yes	yes
EEPROM 2	**Data error in EEPROM 2 (totalizer)** Note: totalizer deviation possible	❑ Reset totalizer(s) if necessary	-	-	yes	yes
RAM	**Check-sum error in RAM**	❍	-	-	-	yes
ROM	**Check-sum error in ROM**	❍	-	-	-	yes
*US PATH 1 ****	**US path 1 faulted**	✧	-	yes	-	yes
*EMPTY PIPE ****	**Measuring tube empty**	✧	-	yes	-	yes
*US PATH 2 ****	**US path 2 faulted**	✧	-	yes	-	yes
FREQ.OUTP. F	**Frequency output overranged**	❑ If necessary check data, fct.3.4.0	-	-	-	yes
CUR. OUTP. I	**Current output overranged**	❑ If necessary check data, fct.3.3.0	-	-	-	yes
EEPROM 1	**Data error in EEPROM 1 (parameters)**	Check instrument parameters ❍	**	**	**	**
CAL. DATA	**Calibration data lost**	Recalibrate signal converter, please consult factory	**	**	**	**
EE1 EE2	**Current calibration values EEPROM 1 + 2 are different**	Terminate setting mode (press 1 x ↵-key), values corrected automatically.	**	**	**	**

* **When errors are displayed during the measuring mode and in the ERRORLIST** in the Reset/Quit menu, "a numeral" and "*Err*" will appear in the 1st (top) line. The numeral gives the number of momentarily occurring errors that are displayed alternately with the actual measured value.

** **No output in measuring mode.** With these errors, the signal converter is automatically in the setting mode.

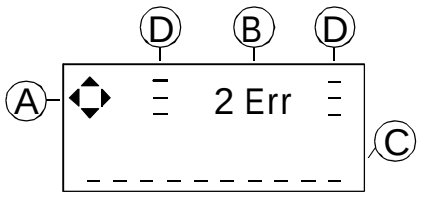
*** These errors are additionally identified by the flashing compass field.

❑ Invoke and then terminate setting mode.
Keystrokes: → and ↵ or → / [9-keystroke entry code 1] and ↵ (dependent on setting in fct. 3.6.2); then acknowledge error(s) in Reset/Quit menu.

❍ Invoke and then terminate setting mode.
Keystrokes: → and ↵ or → / [9-keystroke entry code 1] and ↵ (dependent on setting in fct. 3.6.2); then acknowledge error(s) in Reset/Quit menu.
Consult factory if these errors occur several times in succession.

✧ Check electrical connection of US path 1+2 and make sure that the measuring tube is completely filled with fluid. If in order, please consult factory.

Error representation



A Compass field (flashes when errors marked "***" above occur).
B Number of errors that have occurred.
C Plain text for error message(s).
D **With** bar:
"new" errors, not yet acknowledged.
Without bar:
"old", acknowledged errors.
} see section 4.4.3

4.3.2 Error display during measuring (display) mode

In the setting level under fct. 3.2.6 *ERROR MSG.* (error messages), it is possible to select whether and, if so, which errors are
to be displayed during measurement (display mode). Depending on setting under fct. 3.2.5 *CYCL.DISP* (cyclic display), set *YES* or *NO*, either "measured value(s)" and "error message(s)" will alternate automatically in the display or can be alternated manually by pressing the ↑ key. The errors will continue to be displayed until their cause has been eliminated.

4.3.3 Error list in Reset/Quit menu

All errors are stored in the *ERROR.LIST* in the Reset/Quit menu. The errors are retained in this list until: **1.** The cause of the error has been eliminated **and 2.** the error has been acknowledged. Errors that have been acknowledged, but whose cause has not been eliminated, are retained in the Error List but are displayed **without** bar. This allows identification of "old" and "new" errors.

5. Description of functions

5.1 Physical units

Fct. 3.1.1 Full-scale range $Q_{100\%}$
(**F**orward flow).

Fct. 3.1.3 Full-scale range $Q_{100\%}$
(**R**everse flow).

Fct. 3.2.1 Units for flowrate display

- *m^3/Sec* • *Liter/Sec* • *US Gal/Sec*
- *m^3/min* • *Liter/min* • *US Gal/min*
- *m^3/hr* • *Liter/hr* • *US Gal/hr*

(Gal = gallons)

- 1 user defined unit, refer to fct. 3.6.6 to 3.6.8, sect. 5.15 for flowrate, e.g. liters per day, hectoliters per hour, or for mass flowrate where density is consistent and known, e.g. kg per hour or tons per day.
  Factory-set: *hLiter/hr* (hectoliters per hour), for US version *US Mgal/DAY* (US million gallons per day).
- *PERCENT* (%), only for fct. 3.2.1 (display).

Fct. 3.1.5 Diameter (meter size)
in *mm* (millimeters) or *inch* (inches).

Fct. 3.2.3 Unit for totalizer display
m^3, *Liter*, *US Gal* (Gal = gallons) and 1 user-defined unit, e.g. deciliters (d Liters), hectoliters (h Liter) or US million gallons (US Mgal) factory-set, see fct. 3.2.1.

Fct. 3.4.2 Unit for frequency output F
Pulse rate: Enter in pulses per second, minute, or hour.
Pulses per unit: *Pulse/m^3*, *Pulse/Liter*, *Pulse/US Gal(lons)*.

5.2 Numerical format

- **Display of actual flowrate**
  Maximal 7-digit with floating decimal point.
- **Display of internal totalizers**
  Max. 7-digit floating decimal point. Where count values exceed 9,999,999, automatic changeover to exponent notation, max. *9.999 E 19* (= 9.999×10^{19}).
- **Display overflow**
  The display format is fixed by the parameters set in the submenu "*3.2.0 DISPLAY*". The following display will appear when a displayed value exceeds the limit:
  - Top line: - - - - - -
  - Middle line: Unit of measured variable.
  - Bottom line: Marker ▼ identifies the measured variable for which the selected display format is no longer adequate.

  Necessary action: Check the data in submenu "*3.2.0 DISPLAY*" and alter if necessary.
- **Setting of numerical values**

Examples	Exponent notation	Setting
0.0008	$0.8 * 10^{-3}$	*8 -4*
0.5	$0.5 * 10^{0}$	*5 -1*
1.378	$1.378 * 10^{0}$	*1.378 0*
10,000	$1.0 * 10^{4}$	*1 4*
36,000,000	$3.6 * 10^{7}$	*3.6 7*

5.3 Full-scale range $Q_{100\%}$ and meter size

Fct. 3.1.1. Full-scale range $Q_{100\%}$
(**F**orward flow).
Set full-scale range $Q_{100\%}$ depending on meter size DN, fct. 3.1.5 (forward flow in the case of F/R measuring mode.; if different full-scale range is required for reverse flow, see fct. 3.1.2 + 3.1.3.

- Unit: see sect. 5.1. Change of unit will cause automatic conversion of numerical value.
- Range:

628.3	$\times 10^{-9}$	to	150.8	m^3/Sec
377.0	$\times 10^{-7}$	to	9,048.0	m^3/min
226.2	$\times 10^{-5}$	to	542,880	m^3/hr
628.3	$\times 10^{-6}$	to	150,800	Liter/Sec
376.9	$\times 10^{-4}$	to	9,048,000	Liter/min
226.2	$\times 10^{-2}$	to	542,880,000	Liter/hr
166.0	$\times 10^{-6}$	to	39,837.1	US Gal/Sec
99.57	$\times 10^{-4}$	to	2,390,229	US Gal/min
59.76	$\times 10^{-2}$	to	143,413,724	US Gal/hr

- If the numerical value is changed in fct. 3.1.1, it is advisable to record the totalizer counts and then reset the totalizers (see sect. 5.6), otherwise an incorrect count will be displayed.

Fct. 3.1.2 Separate full-scale range required for reverse flow?
Set "*YES*" if a separate range is required for reverse flow, which is different from the forward flow range. If not required, set "*NO*".

Fct. 3.1.3 Full-scale range $Q_{100\%}$ for reverse flow

This function will only appear during setting if "*YES*" has been set under fct. 3.1.2.

- Unit: see sect. 5.1. Change of unit will cause automatic conversion of numerical value.
- Range: see above, fct. 3.1.1.

The set value must be smaller than that set in fct. 3.1.1 otherwise a parameter check error will occur (fct. 4.2.0) see sect. 4.3. This function has no effect on the totalizers.

Fct. 3.1.5 Meter size

- Unit: *mm* (millimeters) or *inch* (inches)
- Range: *25* to *4000 mm* **or** *0.98* to *157.048 inch*
- If the numerical value in fct. 3.1.5 is changed, it is advisable to record the totalizer counts and reset the totalizers (see sect. 5.6), otherwise an incorrect count will be displayed.

Special settings

- For fct. 3.1.1, 3.1.3, 3.1.5 + 3.4.3, set the unit first and then the numerical value.
- Proceed as follows: select appropriate function number then press → key. The signal converter is now in the data column. The "units" abbreviation in the bottom line of the display flashes. First select the unit by pressing the ↑ key. After pressing the → key, the left digit of the numerical value on the top line of the display will flash. Pressing the ↑ key will increase the numerical value. Pressing the → key will shift the flashing digit (cursor) 1 place to the right.
- If the flashing digit (cursor) is in the last position (to the right) and the → key is pressed again, the unit in the 2nd (middle) line of the display will start flashing again.
- Exit from the data column by pressing the ↵ key.

5.4 Flow direction

- The flow direction or, in case of F/R operation, the direction of the forward flow is determined for full-scale range $Q_{100\%}$ (see fct. 3.1.1) under fct. 3.1.7.
- Two arrows on the primary head identify the possible flow directions with "+" and "-".
- Set "+" or "-" under fct. 3.1.7 in accordance with the actual direction of flow.

5.5 Display

The following measured variable and functions are displayed making markers ▼identify the active display.

- actual flowrate Q
- s.velo (sound velocity)
- + totalizer (in F/R mode, forward totalizer)
- - totalizer (in F/R mode, reverse totalizer)
- Σ totalizer (sum of + and - totalizers)

These five displays depend on the setting. If only one display is set, the marker indicated the active display continuously. If more than one display is set, the display sequences from one display to the next every 6 seconds, and the marker indicates the active display (see fct. 3.2.5).

Note: the signs for + and - totalizers identify forward and reverse flow, resp., and have nothing to do with definition of the flow direction "+/-" (see sect. 5.4, fct. 3.1.7). For example, assume forward flow according to the arrow on the primary head is the "-" direction. Forward flow, however, is always counted with the "+" totalizer.

Display overflow is shown as follows:

Top line: - - - - - -

Middle line: Unit of measured variable.

Bottom line: Marker ▼ identifies the measured variable for which the selected display format is no longer adequate.

Necessary action: check data in submenu *"3.2.0 DISPLAY"* and change if necessary (e.g. select different unit).

Display for flow Q=100% (full-scale range) in F/R mode and setting in *PERCENT* (fct. 3.2.1).

The display reading always refers to the setting of the forward flow full-scale range (fct. 3.1.1).

Fct. 3.2.1 Unit for flowrate display

Selectable units, refer to sect. 5.1.
If *"NO DISPLAY"* is set, actual flowrate is not displayed.

Fct. 3.2.2 Function of totalizer display

+ TOTAL.	Forward flow totalizer only.
- TOTAL.	Reverse totalizer only.
+/- TOTAL.	Forward and reverse flow totalizers, alternating.
SUM TOTAL.	Sum of + and – totalizers.
ALL TOTAL.	Sum, + and - totalizers, alternating.
NO DISPLAY	Internal totalizer in operation, but no display.
TOTAL.OFF	Internal totalizer switched off.

Fct. 3.2.3 Unit for totalizer values on display

Selectable units, refer to sect. 5.1

Fct. 3.2.4 Display of sound velocity

The display for the sound velocity of ultrasonic waves can be switched on or off if *YES* or *NO* is set, resp. Refer to sect. 5.17.

Fct. 3.2.5 Cyclic display

Select whether the display of measured values (and possibly error messages, see fct. 3.2.6) is to alternate automatically approximately every 6 seconds (set: *YES*) or manually by pressing the ↑ key (set: *NO*).

Fct. 3.2.6 Error messages

Select error messages (see E-List, sect. 4.4).

NO MESSAGE	No error messages.
US ERROR	Only ultrasonic errors.
TOTAL.ERR.	Internal totalizer errors.
ALL ERRORS	All errors.

Error messages alternate with actual flow data, either automatically or manually by pressing the ↑ key, see fct. 3.2.5.

5.6 Internal electronic totalizer

- The internal electronic totalizer counts the volume in mathematically determined volumetric units. These numerical values are put into a non-volatile memory (EEPROM), converted into the set physical units and displayed every 0.3 seconds.

  Counting is interrupted in the event of a power failure, entry into the setting mode or when the low-flow cut off (SMU) is activated. After these conditions have been eliminated, counting continues with the values stored prior to the interruption.
- The counting period without overflow is at least 1 year at 100% of flow ($Q_{100\%}$)
- Set the time constant under fct. 3.4.5:
  40 mSec Time constant F = 0.04 seconds.
  SAME AS I *Same time constant as current output I* (see fct. 3.3.6)

Resetting the totalizers *(TOTAL.RESET)*

- There are two ways of resetting the totalizers:

1st way, separate resetting of "+" and "-" totalizers in the Reset/Quit menu. Only possible if *YES* entered under fct. 3.6.10 Reset Enable!

Key	Display
↵	*CodE 2*
↑ →	*TOTAL.RESET*
→	*TOTAL.+*
(↑)	*TOTAL. -*
	(possible selection)
→	*RESET NO*
↑	*RESET YES*
↵	*TOTAL. +* reset
	(if necessary, select totalizer by pressing the ↑ -key, and reset as well: press → ↑ ↵ keys)
↵	*TOTAL. RESET*
↵	Measuring mode with actual data display.

2nd way, combined resetting of "+" and "-" totalizers.

Key	Display
→	If Entry Code 1 is selected, see fct. 3.6.2, enter 9-digit code 1 now.
	1.0 OPERATION
2 * ↑	*3.0 INSTALL.*
→	*3.1 BASIS.PARAM*
4 * ↑	*3.6 USER DATA*
→	*3.6.1 LANGUAGE*
6 (7) * ↑	*3.6.9 TOTAL.RESET*
→	*RESET NO*
↑	*RESET YES*
↵	*3.6.9 TOTAL.RESET*
4 * ↵	Measuring mode with actual data display.

- The measuring mode is interrupted during the reset.
- Before changing the numerical values in fct. 3.1.1, 3.1.5 + 3.1.6 (e.g. if the full-scale range is changed, see fct. 3.1.1, or in the case of separate systems the signal converter is replaced, see sect. 8.2),it is advisable to note down the totalizer counts first and then reset the totalizer otherwise an incorrect count will be displayed.

5.7 Current output I

5.7.1 Application I (fct. 3.3.1)

Application I	**Setting** via fct. 3.3.1 or 3.4.1		**Other functions** set via fct. 3.3.7 to 3.3.9	**Characteristic** of outputs, see sect. 5.7.3
	I 3.3.1	***F*** 3.4.1	***SMU I*** 3.3.7 to 3.3.9	
1 flow direction	*1. DIR*	any	possible	I 1
F/R-operation F/R-changeover via F	*2 DIR*	*F/R IND.*	possible	I 2
Direction indication for F	*F/R IND.*	*2 DIR*	possible	I 3
e.g. operation indicator	*OFF*	any	no	I 4
F/R-operation with one indicating instrument	*I < I 0 PCT*	any	possible	I 5
Sound velocity measurement	*SOUND.VELO*	any	no	I 6

For connection diagrams of outputs, see section 2.3.5.

5.7.2 Other functions for I

Fct. 3.3.2 Ranges for current output I
Fixed ranges: *0 to 20 mA* or *4 to 20 mA.*
Variable ranges: Set to *OTHER.RANGE* (= other ranges).
Lower and upper range values and a current limitation are freely selectable, see fct. 3.3.3, 3.3.4 + 3.3.5.

Fct. 3.3.3 Current for 0% flowrate ($I_{0\%}$)
(appears only if "*OTHER.RANGE"* is set under fct. 3.3.2).
Range from *00 to 16 mA* (e.g. 01 mA at output span 1 to 5 mA).

Fct. 3.3.4 Current for 100% flowrate ($I_{100\%}$)
(appears only if "*OTHER.RANGE"* is set under fct. 3.3.2).
Range from *04 to 20 mA* (e.g. 05 mA at output span 1 to 5 mA). This value must be at least 4 mA greater than that of fct. 3.3.3, otherwise errors in parameter check (fct. 4.3.0), see sect. 4.2 + 4.3.

Fct. 3.3.5 Maximum output current I_{max}
(appears only if "*OTHER.RANGE"* is set under fct. 3.3.2).
Range from *04 to 22 mA* (e.g. 06 mA at output span 1 to 5 mA, prevents damage to connected 5 mA instruments). This value must be greater than or equal to that of fct. 3.3.4, otherwise errors in parameter check (fct. 4.4.0), see sect. 4.2 + 4.3.

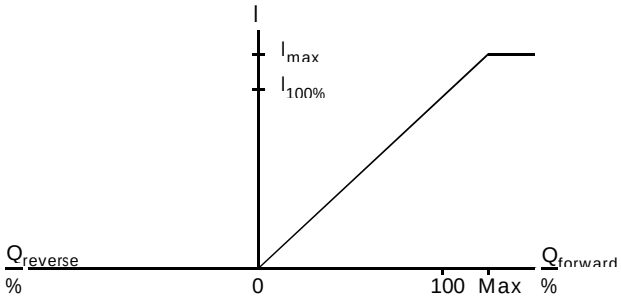
Fct. 3.3.6 Time constant for I
Range can be optionally set from *0.04 to 3,600 seconds.*

Fct. 3.3.7 to 3.3.9 Low-flow cutoff SMU
Refer to section 5.10.

Sound velocity measurement (see also sect. 5.17)
- Set the minimum and maximum sound velocity under fct. 3.1.8 and 3.1.9.

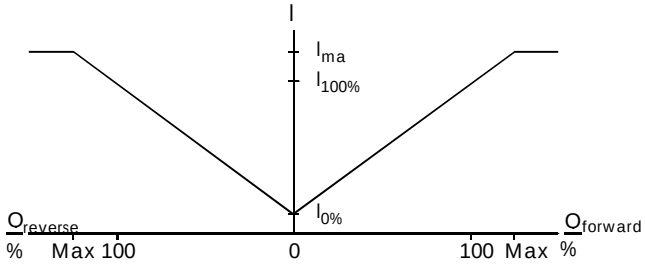
5.7.3 Characteristics of current output I

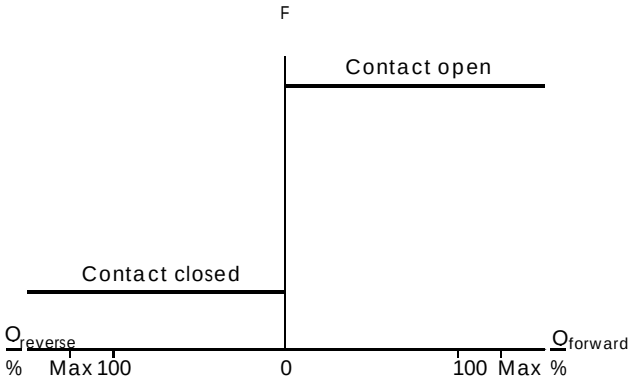
I1 **1 flow direction**



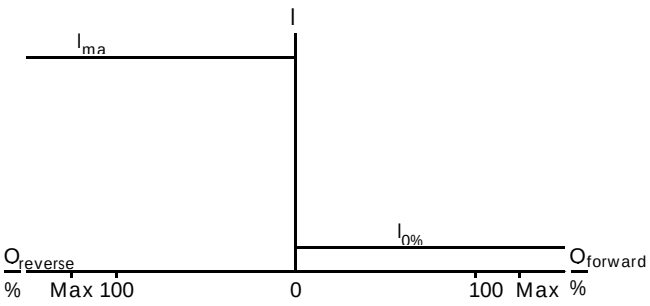
I2 **F/R operation**

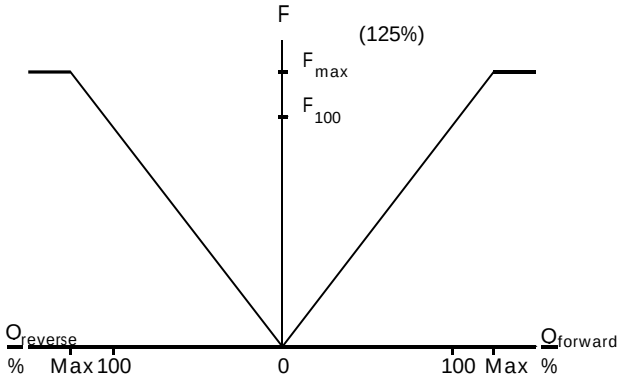
F/R changeover via F





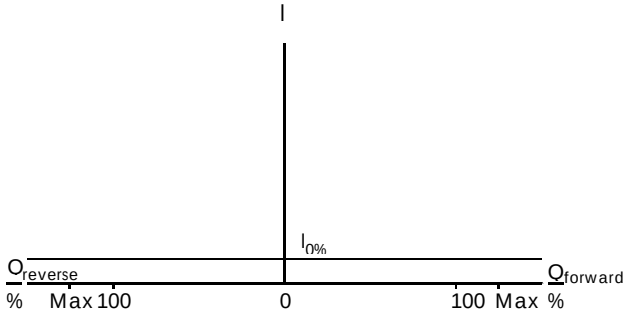
I3 **Direction indication for F**





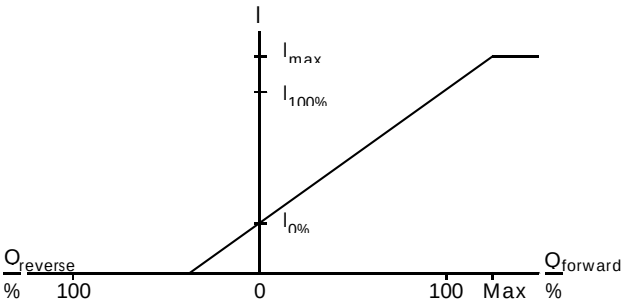
I4 **Switched off**

(Operation indicator)

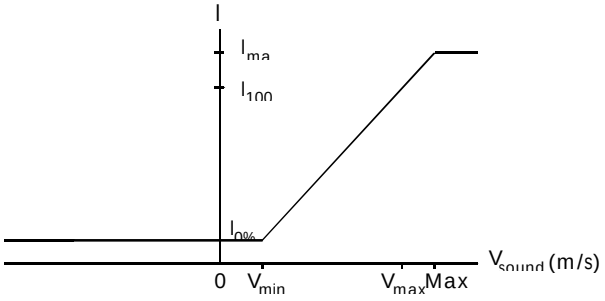


I5 **F/R operation**

With 1 indicating instrument



I6 **Sound velocity measurement**



5.8 Frequency output F

5.8.1 Application F (fct. 3.4.1)

Application F	**Setting** via fct.3.4.1 or 3.3.1		**Other functions** set via fct.3.4.6 to 3.4.8	**Characteristic** of outputs, see sect. 5.8.3
	F 3.4.1	***I*** 3.3.1	***SMU F*** 3.4.6 to 3.4.8	
1 flow direction	*1. DIR*	any	possible	F 1
F/R-operation F/R-changeover via I	*2 DIR*	*F/R IND.*	possible	F 2
Direction indication for I	*F/R IND.*	*2 DIR*	possible	F 3
Switched off (= 0 Hz / 0V)	*OFF*	any	no	F 4
Sound velocity measurement	*SOUND.VELO*	any	no	F 5

For connection diagrams of outputs, see sect. 2.3.5.

5.8.2 Other functions for F

Fct. 3.4.2 Unit for frequency output F
PULSRATE Setting pulses per unit of time (see fct. 3.4.3).
PULSE/UNIT Setting pulses per unit of volume (see fct. 3.4.3).

Example of *PULSRATE*
Full -scale setting: 1,000 Liter per second (set via fct. 3.1.1).
Pulse rate: 1,000 pulses per second (set via fct. 3.4.3).
Pulse value: 1 pulse per Liter.
Changeover of full-scale setting: 2,000 Liter per second (change over via fct. 3.1.1).
Pulse rate: unchanged (see above), 1,000 pulses per second.
Pulse value **now:** 1 pulse per 2 liter.

Example of *PULSE/UNIT*
Full-scale setting: 1,000 Liter per second (set via fct, 3,1.1).
Pulse value: 1 pulse per Liter (set via fct. 3.4.3).
at 1000 Liter per second: 1,000 pulses per second ≙ 1 pulse per Liter.
Changeover of full-scale setting: 2,000 Liter per second (change over via fct. 3.1.1).
Pulse value: unchanged (see above) 1 pulse per Liter.
at 2000 Liter per second: 2,000 pulses per second ≙ 1 pulse per Liter as before.

Fct. 3.4.3 Pulse rate for 100% flowrate ($F_{100\%}$)
(appears only if *"PULSRATE"* set in fct. 3.2.2).
Range: 2.778×10^{-3} *to* *1,000* *PuLSe/Sec*
0.1667 *to* *60,000* *PuLSe/min*
10 *to* *3,600,000* *PuLSe/hr*
Setting: Refer to sect. 5.3 "Special settings"!

Fct. 3.4.3 Pulse value
(appears only if "*PULSE/UNIT*" set in fct. 3.4.2).
Unit: Select from List in section 5.1.
Range: *0.0001 to 9.9999* $\times 10^9$ *PuLSe/Unit.*
Setting: Refer to sect. 5.3 "Special settings"!
Setting is **not** checked **but:** $Q_{100\%} \times$ pulse value must be less than or equal to 3,600,000 pulses/hr (equivalent to kHz)!

Fct. 3.4.5 Pulse width
Five pulse widths (*30 / 50 / 100 / 200 / 500 m Sec)* can be selected for programmed output frequencies ($F_{100\%}$, fct. 3.4.3) less than or equal to 10 Hz (note output load and frequency ranges, see table in sect. 2.3.3).
Fixed pulse widths (50% duty cycle) are provided for programmed output frequencies above 10 Hz (see sect. 2.3.3) regardless of the pulse width (see above) that has been set.

Fct. 3.4.5 Time constant for F
40 mSec Time constant = 0.04 seconds (best for counting and/or batching processes).
SAME AS I Same time constant as for current output I, see fct. 3.3.6.
(practical if frequency output F is used for instantaneous-value measurement).

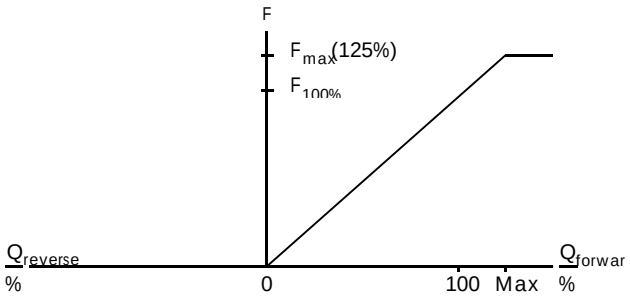
Fct. 3.4.6 to 3.4.8 Low-flow cutoff SMU
Refer to sect. 5.10.

Sound velocity measurement (see also sect. 5.17)

- Set the minimum and maximum sound velocity under fct. 3.1.8 and 3.1.9.
- *PULSRATE* **must** be set under fct. 3.4.2 "Unit, frequency output", otherwise error in parameter check (fct. 4.9.0), see sect. 4.2 + 4.3.
- Under fct. 3.4.3, set the pulse rate for the full-scale range of the sound velocity in pulses per second, minute or hour.

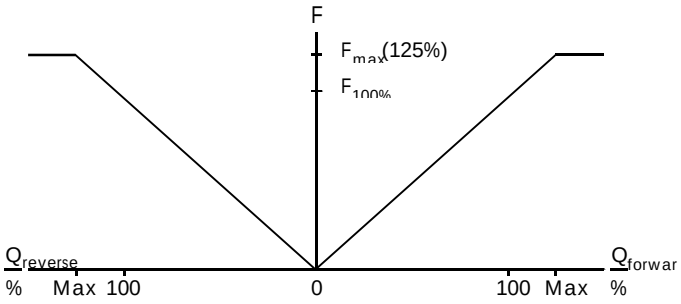
5.8.3 Characteristics of frequency output F

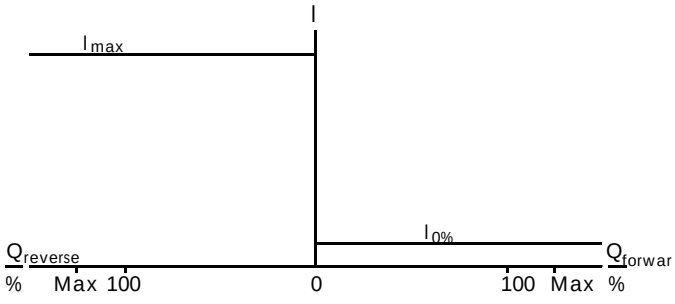
F1 **1 flow direction**



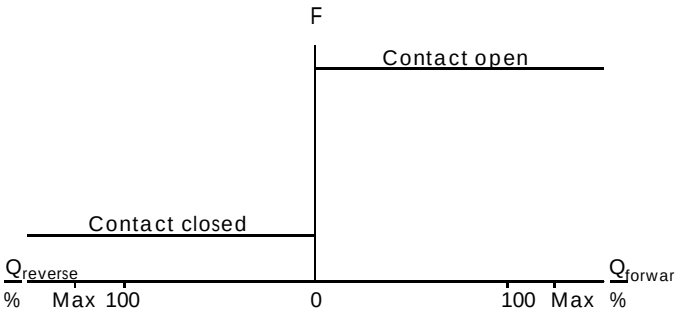
F2 **F/R operation**

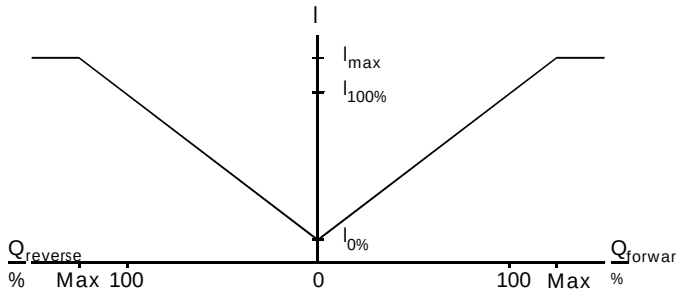
F/R changeover via I

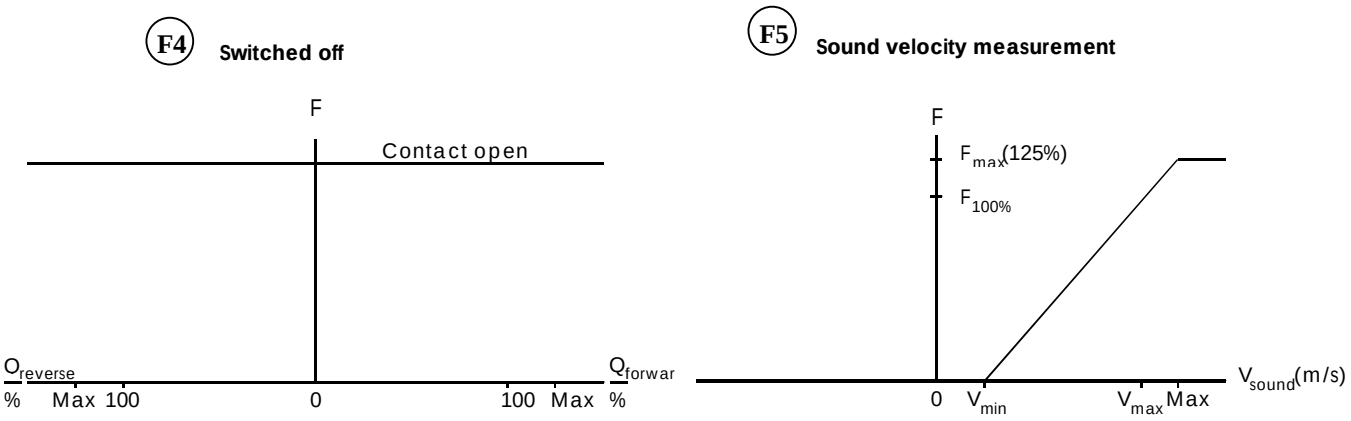




F3 **Direction indication for I**







Frequency output for flowrate Q = 100% (full-scale range) for F/R operation and setting in *PULSE/UNIT* (fct. 3.4.2 + 3.4.3).

The frequency at the output always refers to the setting of the forward range $F_{100\%}$ (in case of forward flow) or to the reverse range $R_{100\%}$ (in case of reverse flow).

5.9 Status output S

5.9.1 Application S (fct. 3.5.1)

Application S	Setting via fct. 3.5.1
Fatal error	*FATAL ERR.*
Ultrasonic error	*US ERROR*
Forward/Reverse indication	*F/R IND.*
Trip point	*TRIP POINT*

(Note: when the indication output contact is closed, the open collector output is active.)
For connection diagrams of the status output, see sect. 2.3.5.

Fatal error - Data error in EEPROM 1(parameters).
- Calibration data lost. (EEPROM 2).
- Current calibration values.
- Totalizer counts lost or totalizer overflow.
- RAM error.
- ROM error.
- F overrange (125%).
- I overrange (125%).
- Empty pipe.

Contact will be open with Fatal error and closed when no error occurs.

US error One or both ultrasonic paths fail. Contact will be open in case of path failure and closed when no path failure.

F/R ind. Flow direction indication point 1 is used as hysteresis in percentage of the forward full-scale. Contact will be open during forward flow and closed during reverse flow.

Trip point Possibility for opening or closing status output contact, when flow exceeds a pre-defined point.

If (point 1 > point 2) The contact will close if flowrate rises above point 1 and it will open if flowrate drops below point 2.

If (point 2 > point 1) The contact will open if flowrate rises above point 2 and it will close if flowrate drops below point 1.

5.10 Low-flow cutoff (SMU) for I + F

- To avoid erroneous measurements at low flowrates, the SMU switches the current and frequency outputs (I+F) off. I goes to 0/4 mA (fct. 3.3.2) or to $I_{0\%}$ (fct. 3.3.3) and F to 0 Hz.
- If "*NO*" is set under functions 3.3.7 + 3.4.6, fixed cutoff "on" and cutoff "off" values of 0.1 and 0.25%, resp., of $Q_{100\%}$ (full-scale range, see fct. 3.1.1) act on the outputs I + F.
- If "*YES*" is set under functions 3.3.7 + 3.4.6, the cutoff "on" and cutoff "off" values for I + F are separately adjustable in the ranges specified below.

Fct. 3.3.7 Low-flow cutoff (SMU) for I desired?

Set *NO* or *YES*.

Fct. 3.3.8 Cutoff "on" value for SMU-I
(appears only if "*YES*" set in fct. 3.3.7).

Range: *01 to 19 PERCENT* of $Q_{100\%}$.

The low-flow cutoff drives the current output to 0/4 mA (fct. 3.3.2) or to $I_{0\%}$ (fct. 3.3.3) when the flow decreases to the cutoff "on" value.

Fct. 3.3.9 Cutoff "off" value for SMU-I
(appears only if "*YES*" set in fct. 3.3.7).
Range: *02 to 20 PERCENT* of $Q_{100\%}$.
This value must be greater than that of fct. 3.3.8, otherwise a "parameter check" error (fct. 4.5.0) will occur, see sect. 4.2 + 4.3. When the flow returns to the cutoff "off" value, the current output returns to normal.

Fct. 3.4.6 Low-flow cutoff (SMU) for F desired?
Set *NO* or *YES.*

Fct. 3.4.7 Cutoff "on" value for SMU-F
(appears only if "*YES*" is set in fct. 3.4.6).
Range: *01 to 20 PERCENT* of $Q_{100\%}$.
The low-flow cutoff drives the frequency output to 0 Hz when the flow decreases to the cutoff "on" value.

Fct. 3.4.8 Cutoff "off" value for SMU-F
(appears only if "*YES*" is set in fct. 3.4.6).
Range: *02 to 20 PERCENT* of $Q_{100\%}$.
This value must be greater than that of fct. 3.4.7, otherwise a "parameter check" error (fct. 4.6.0) will occur, see sect. 4.2 + 4.3. When the flow returns to the cutoff "off" value, the frequency output returns to normal.

5.11 F/R operation for I or F

Electrical connection, characteristic and setting of outputs, refer to sect. 2.3, 5.7 + 5.8.

Fct. 3.1.7 Define direction of forward (normal) flow (+ or -).
In the case of F/R operation, set the direction of the forward flow with "+" or "-", in accordance with the arrows marked "+" and "-" on the primary head. Note that if the flowmeter does not have a "+" and "-" on the primary head the "+" direction is the direction in which the arrow is pointing. When the low-flow cutoff is active, it will also operate with the F/R operation.

Fct. 3.1.1 Full-scale setting for flowrate $Q_{100\%}$
Set the full-scale range. Unit and range, see sect. 5.1 + 5.3.

Fct. 3.1.2 Separate range desired for reverse flow?
Set "*YES*" only if the range required for reverse flow is different from the normal (forward) flow. If not, set "*NO*".

Fct. 3.1.3 Full-scale range for reverse flow
(appears only if "*YES*" is set in fct. 3.1.2).
This is used for setting the full-scale range for reversed flow. Unit and range, see sect. 5.1 + 5.3. This value must not be greater than that of fct. 3.1.1, otherwise "parameter check" error (fct. 4.2.0) will occur, see sect. 4.2 + 4.3.

5.12 Language of display texts

A choice of languages for other display texts is offered in fct. 3.6.1. The software is equipped with the languages:

GB/USA	English and
D	German **or**
F	French.

Other languages can be delivered on request.

5.13 Coding desired for entry into setting level?

- Set *NO* or *YES* in fct. 3.6.2.
- If *NO* is set, only press the → key to get into the setting mode.
- If *YES* is set, press the → key and then a 9-keystroke combination to enter the setting mode.
- **Factory-set Entry Code 1:**
  → → → ↵ ↵ ↵ ↑ ↑ ↑
- **To change the Entry Code 1:**
  Select fct. 3.6.2 *ENTRY.CODE 1*: set *YES.*
  Select fct. 3.6.3 CODE 1 (appears only if YES is set in fct. 3.6.2). Press the → key, displayed:
  Code 1 _ _ _ _ _ _ _
  Press any 9-keystroke combination. Every keystroke acknowledged by "*". Then set the **same** keystroke combination again. *WRONG CODE* (= incorrect entry) appears if 1st and 2nd entries are **not equal**.
  Press the ↵ and the → keys and repeat settings.

5.14 Behavior of outputs during setting

- Behaviour of outputs during setting Set in fct. 3.6.5 whether or not the outputs shall hold the last values (before entry into the setting mode).
- If "*YES*" is set: output values prior to entry into the setting mode are retained during setting. After leaving the setting mode, the outputs go to the values corresponding to the actual operating conditions.
- If "*NO*" is set: the outputs go to the set minimum values:
  I to 0/4 mA (see fct. 3.3.2)
  or to the value of $I_{0\%}$ (see fct. 3.3.3).
  F or to 0 V, consequently no pulses.

5.15 User-defined unit

An arbitrary volumetric flow unit or, if density of the fluid product is consistent and known, a unit of mass (weight) can be set in fct. 3.6.6 to 3.6.8. The unit " *h Liter/hr*" (hecto-liters per hour) is factory-set unless another special unit is specified. US-version: "*US Mgal/DAY*" (US million gallons per day).

Fct. 3.5.6 Text for user-defined unit
- Volumetric (or mass) unit per unit of time.
- Text for volume (mass): 6 characters (places).
- Text for time: 3 characters (places).
- The fraction bar "/" in the 7th place has a fixed position.
- Alpha characters A-Z and a-z, numbers 0-9, symbols +, - or blank character (= underscore) are selectable for every place.
- Pressing the ↑ key will sequence the alpha characters and numbers in the order given above.
- The → key shifts the cursor 1 place to the right.
- Text examples are given in the following tables in brackets (...../..).

Fct. 3.6.7 Conversion factor Quantity F_M
Set the factor F_M = quantity per 1 m^3.

Volumetric unit	Factor F_M	Setting
Cubic meters (*m^3*)	1.0	*1.00000 E 0*
Liters (*Liter*)	1,000	*1.00000 E 3*
Hectoliter (*h Liter*)	10	*1.00000 E 1*
Deciliter (*d Liter*)	10,000	*1.00000 E 4*
Centiliter (*c Liter*)	100,000	*1.00000 E 5*
Milliliter (*m Liter*)	1,000,000	*1.00000 E 6*
US gallons (*US Gal*)	264.172	*2.64172 E 2*
US million gallons (*US Mgal*)	0.000264172	*2.64172 E -4*
Imperial gallons (*GB Gal*)	219.969	*2.19969 E 2*
Imperial mega-gallons (*GB MGal*)	0.000219969	*2.19969 E -4*
Cubic feet (*Foot^3*)	35.3146	*3.53146 E 1*
Cubic inches (*inch^3*)	61,024.0	*6.10240 E 4*
US barrels crude oil	6.29874	*6.29874 E 0*
US fluid ounces	33,813.5	*3.38135 E 4*

Fct. 3.6.8 Conversion factor Time F_T
Set the factor F_T in seconds.

Time unit	Factor F_T [seconds]	Setting
Second (Sec)	1	*1.00000 E 0*
Minute (min)	60	*6.00000 E 1*
Hour (hr)	3,600	*3.60000 E 3*
Day (DAY)	86,400	*8.64000 E 4*
Year (YR) (≙ 365 days)	31,536,000	*3.15360 E 7*

Examples of volume per unit of time

Desired unit:	**Hectoliters per year**	**Deciliters per hour**
Volumetric unit in fct. 3.6.6	*h Liter*	*d Liter*
Factor F_M (see table)	10	10,000
Setting in fct. 3.6.7	*1.00000 E 1*	*1.00000 E 4*
Time unit in fct. 3.6.6	*YR*	*hr*
Factor F_T (see table)	31,536,000 (seconds)	3,600 (seconds)
Setting in fct. 3.6.8	*3.15360 E 7*	*3.60000 E 3*

Examples of mass per unit of time
Product density ρ = 1.2 g/cm^3 = 1,200 kg/m^3 = constant
Mass of 1 m^3 product = 1,200 kg = 2,646 pounds.

Desired unit:	**Kilograms per minute**	**Pounds per hour**
Mass unit in fct. 3.6.6	*kg*	*lb*
Factor F_M (see table)	1,200	2,646
Setting in fct. 3.6.7	*1.20000 E 3*	*2.64600 E 3*
Time unit in fct. 3.6.6	*min*	*hr*
Factor F_T (see table)	60	3,600
Setting in fct. 3.6.8	*6.00000 E 1*	*3.60000 E 3*

5.16 Primary constant GK

Fct. 3.1.6 GK value
The primary constant GK is factory-set. Range: *0.5 to 14*, dependent on primary head, see instrument nameplate.

The value of fct. 3.1.6 must not be changed!
Exception: replacement of primary head (**not** compact version, see sect. 8.2).

5.17 Sound velocity measurement for product identification

In liquid products of varying composition, the ultrasonic waves will travel at an approximately faster or slower rate (e.g. in oil-water mixtures). This is identifiable by way of measuring the sound velocity.

- Set the range for the sound velocity to be measured in fct. 3.1.8/3.1.9. Setting range: 0 to 5,000 m/s.

5.18 Tag Name (measuring point identification)

- Tag Name of max. 10 places (e.g. TQ1-53.21I) can be set in fct. 3.6.4.
- Only required for flowmeter UFM 500... of type HHC: operator control via the Hand-Held Communicator MIC 500 (remote control). Refer to special operating instructions for electrical connection to current output I and for operation of the MIC 500.
- The following can be assigned to each of the 10 places:
  - Alpha characters *A-Z / a-z.*
  - Numerals *0-9* or
  - Special characters + / - / blank (= underscore).
- Factory setting: Altometer.

Part C Special applications, functional checks and service

6. Special applications

6.1 Use in hazardous areas

The ALTOSONIC UFM 500 K-Ex ultrasonic flowmeter is certified to European Standard as an electrical appliance suitable for use in hazardous areas.

Allocation of temperature class to temperature of the fluid, meter size and material of the measuring tube liner is specified in the test certificate.

Test certificate, certificate of conformity and wiring instructions are attached to the Installation and Operating Instructions (applies only to hazardous-duty equipment).

6.2 Empty measuring tube

When the measuring tube is empty, the two outputs and the display will go to "zero" or to the set minimum values, as for "zero" flow.

This means

Display	→	0
Current output	→	0 or 4 mA or value of $I_{0\%}$ (see fct. 3.3.3)
Frequency output	→	0 Volt (= no pulses)

With the UFC 500... signal converter, the error *EMPTY PIPE* then appears in the Error List in the "Quit./Reset menu", see sect. 4.4, and the compass field shows a steady light.

6.3 High-temperature version (>180°C/>356°F)

The ALTOSONIC UFM 500 F flowmeter is also available as a special version for process temperatures in excess of 180°C/356°F. Special supplementary installation instructions are supplied with these systems.

6.4 Magnetic sensors, setting with hand-held bar magnet

- The UFC 500... signal converter can **optionally** be equipped with magnetic sensors, see sect. 4.1, Item 5.
- This allows setting of the signal converter by means of a hand-held bar magnet. Function of sensors without removing the front cover is the same as the corresponding keys. Sensor response is acknowledged by symbols in the 1st line of the display.
- Hold the bar magnet by the rubber cap. Apply the end of the magnet (North Pole) to the glass pane above the magnetic sensors.

7. Functional checks

7.1 Test functions of UFC 500... signal converter fct. 2.1 to 2.5

7.1.1 Display test, fct. 2.1

- Select function 2.1 as described in sect. 4.2 and 4.3.
- Press ↵ key to start display test, duration approx. 30 seconds.
- All segments in the 3 lines of the display are activated sequentially.
- The test can be terminated by pressing the ↵ key.

7.1.2 Test, current output I, fct. 2.2

- A milliamp-meter must be connected to terminals I/I+ for this test, see sect. 2.3.2 and 2.3.5, connections diagram ①.
- Select fct. 2.2 as described in sect. 4.2 and 4.3.
- Select current value with ↑ key:
  - *0 mA*
  - *2 mA*
  - *4 mA*
  - *10 mA*
  - *20 mA*
  - *22 mA*

The milliamp-meter indicates the current value selected.

- Press the ↵ key to terminate the test and display the actual value again.

7.1.3 Test, frequency output F, fct. 2.3

- An electronic totalizer (EC) must be connected to; terminals B1 and B⊥ for this test, see sect. 2.3.3 and 2.3.5, connections diagram ②.
- Select function 2.3 as described in sect. 4.2 and 4.3.
- Select frequency value with ↑ key:
  - *1 Hz*
  - *10 Hz*
  - *100 Hz*
  - *1,000 Hz*

  The totalizer indicates the frequency value selected.
- Press the ↵ key to terminate the test and display the actual value again.

7.1.4 Test, status output S, fct. 2.4

An electronic indicator must be connected to terminals B2 and B⊥ for this test; see sect. 2.3.4 and 2.3.5, connection diagram ②. Select fct. 2.4 as described in sect. 4.2 and 4.3. Select the status with ↑ key:

- STATUS OFF or
- STATUS ON.

The indicator indicates the selected status. Press the ↵-key to terminate the test and display the actual value again.

7.1.5 Test, microprocessor, fct. 2.5

- Select function 2.5 as described in sect. 4.2 and 4.3.
- Press the → key, displayed: *TESTING.*
- Approx. 2 seconds test duration, display:
  either *NO ERROR* = signal converter in order
  or *ERROR* = signal converter possibly defective.

Corrective action: Switch power source briefly off and repeat test. If error message is still shown, replace electronic unit, see sect. 8.1.

7.2 Zero check with UFC 500 ... signal converter

7.2.1 Measure zero value

Set **"zero" flow** in the pipeline, but make sure that the **primary head** is **completely filled** with fluid.

Key	Display		Description
→	*1.0*	*OPERATION*	If Entry Code 1 is selected see fct. 3.6.2, set 9-keystroke Code 1 now.
→	*1.1.0*	*BASIS.PARAM*	
→	*1.1.1*	*FULL SCALE*	
3 (2)* →	*1.1.4*	*ZERO SET.*	
→		*VALUE. MEASU*	If *FIXED.VALUE* appears here, set *VALUE. MEASU* (measured value) with ↑ key.
↵		*CALIB. NO*	
↑		*CALIB. YES*	
↵	*0.0*	*PERCENT*	Zero measurement in progress (approx. 20 seconds duration). Display: actual flowrate in percent of full-scale range, max. deviation ± 0.2%; if greater, check whether flowrate is actually "zero".
		STORE NO	If new value is not accepted, press ↵ key 5 times = return to measuring mode.
↑		*STORE YES*	
↵	*1.1.4*	*ZERO SET.*	Zero set to new value.
4 * ↵	.....	.....	Measuring mode with new zero value.

7.2.2 Fixed zero value

If "zero" flow in the pipeline is **not** adjustable, zero can be set to a specified fixed value (factory setting).

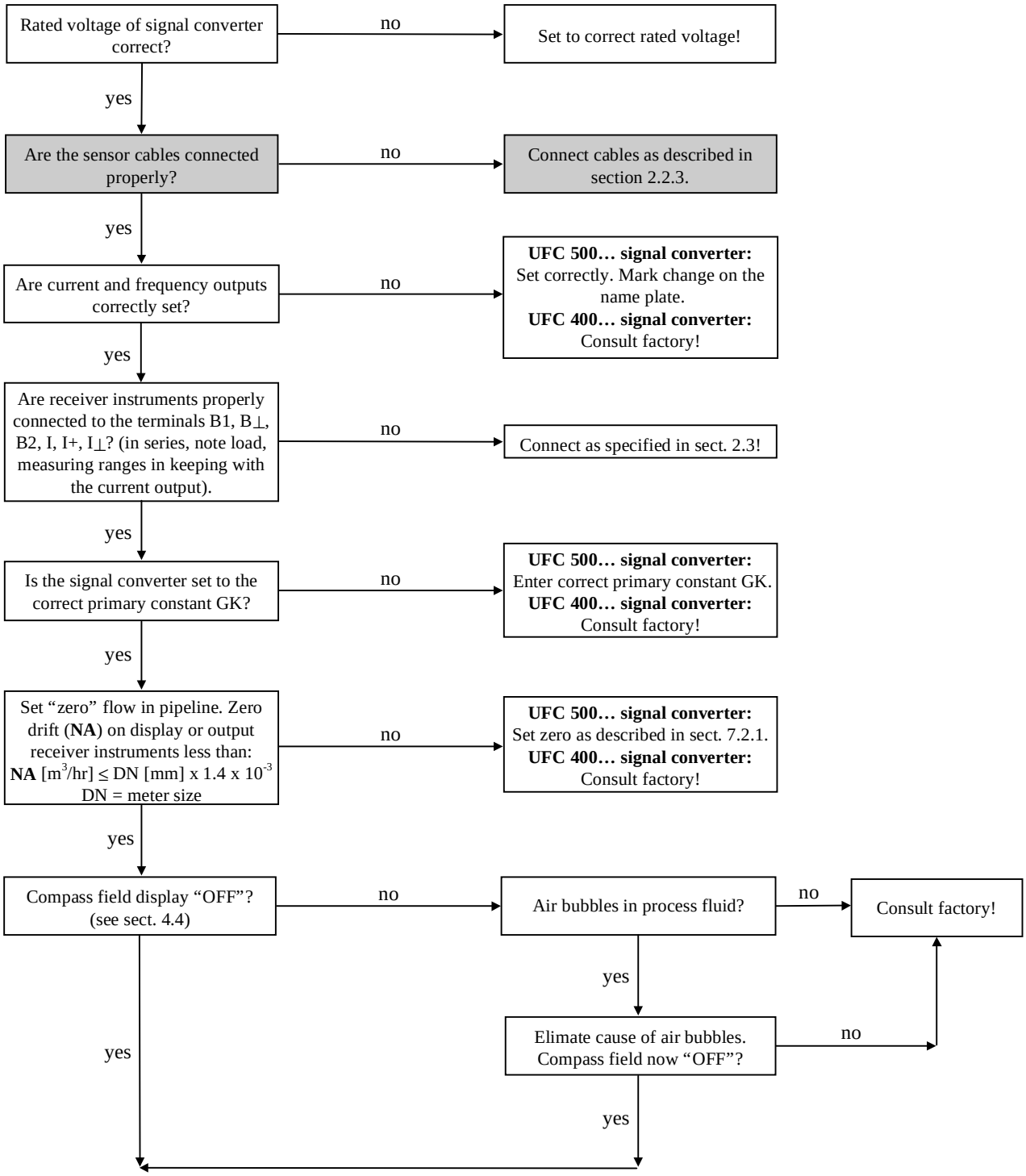
NOTE: Additional measuring error possible in this case, to avoid it, see sect. 7.2.1 "measure zero value".

Key	Display		Description
→	*1.0*	*OPERATION*	If Entry Code 1 is selected see fct. 3.6.2; set 9-keystroke Code 1 now.
→	*1.1.0*	*BASISPARAM.*	
→	*1.1.1*	*FULL SCALE*	
3 (2) * ↑	*1.1.4*	*ZERO SET.*	
→		*FIXED.VALUE*	If *VALUE. MEASU* (measured value) appears here, set *FIXED.VALUE* with ↑ key.
↵	*1.1.4*	*ZERO SET.*	Zero set to fixed value.
4 * ↵	.....	.....	Measuring mode with fixed zero value.

7.3 System check-out

Always switch off power source before connecting and disconnecting cables!

The test points in the grey-colored boxes can only be carried out on systems with separate signal converter!



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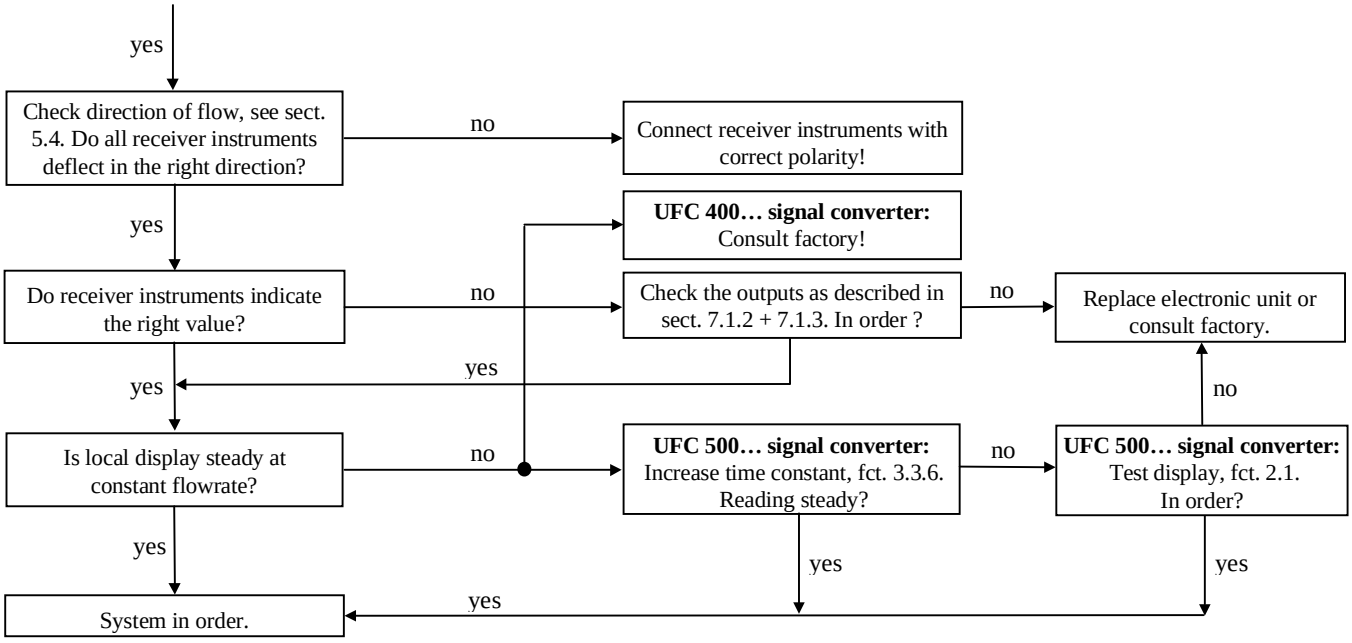

yes
Check direction of flow, see sect. 5.4. Do all receiver instruments deflect in the right direction?
no
Connect receiver instruments with correct polarity!
yes
UFC 400… signal converter: Consult factory!
Do receiver instruments indicate the right value?
no
Check the outputs as described in sect. 7.1.2 + 7.1.3. In order ?
no
Replace electronic unit or consult factory.
yes
yes
no
Is local display steady at constant flowrate?
no
UFC 500… signal converter: Increase time constant, fct. 3.3.6. Reading steady?
no
UFC 500… signal converter: Test display, fct. 2.1. In order?
yes
yes
yes
System in order.
yes

8. Service

8.1 Replacement of electronic unit of signal converter

Replacement of electronic units

The electronic unit **UFC 400/S** can be used as **replacement unit for the following signal converters**:

UFC 400 K (UFM 400 K compact flowmeters)
UFC 400 F (F = field housing, separate system)

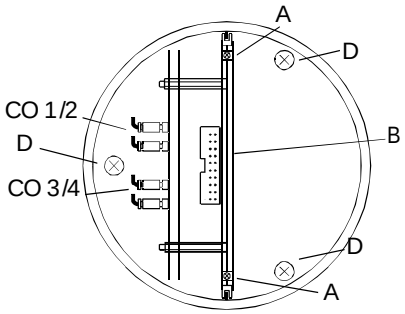
The **UFC 500 S** electronic unit can be used as a **replacement unit for the following signal converters**:

UFC 500 K (UFM 500 K compact flowmeters)
UFC 500 F (F = field housing, separate system)

A special electronic unit is available for **hazardous-duty** versions (see special "Ex" installation instructions).

Always switch off power source before commencing work!

1. Use the special wrench to remove the cover from the terminal box.
2. Disconnect all cables from the terminals.
3. Use the special wrench to remove the cover from



the electronic compartment.

4. Remove screws **A**, fold display board to side, and remove plug **B** (ribbon cable, display board). Not applicable to UFC 400... signal converter!
5. Remove screws **D** using a screwdriver for recessed-head screws [size 2, blade length min. 200 mm (8")] and carefully remove the complete electronics.
6. Remove plug **CO 1/2 or CO 1/2 + CO 3/4** (depending on flowmeter version).
7. On the new electronic unit, check the power supply voltage and fuse F1 and change over /replace if necessary, see sect. 8.3.
8. Reassemble in reverse order (points 6 to 1).

Important: Ensure that the screw thread of the covers on the electronic and terminal compartment is well greased at all times.

Following only applies for UFC 500... signal converter.

9. All data must be reset after replacement of the electronic unit. The supplied report on settings contains the standard factory setting. The customer-specific data should be recorded in the report before setting as described in sect. 4 + 5.
10. Subsequently be sure to check the zero and store the new zero value, see sect. 7.2 and fct. 1.1.4.

8.2 Replacement of primary head in separate systems

Always switch off power source before commencing work!

- Specific calibration data for each primary head are determined during factory calibration. The primary head constant GK is specified on the nameplate.
- New data must be set when a primary head is replaced.

UFC 400 F signal converter
New setting by KROHNE Service personnel.

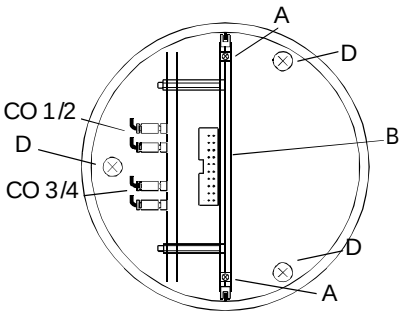
UFC 500 F signal converter

- Internal totalizer as described in sect. 5.6. Note down totalizer counts beforehand.
- Enter value of path lengths in fct. 5.3.2 and 5.3.3 (in service menu).
- Enter value of primary constant GK in fct. 3.1.6.
- If the new primary head has a different meter size, this must be set under fct. 3.1.5. Also the full-scale range for $Q_{100\%}$ must be changed in fct. 3.1.1 (for F/R operation see also fct. 3.1.2 and 3.1.3).
- A zero check (fct. 1.1.4) is advisable following setting of new data, see sect. 7.2.

8.3 Change of power fuse F1

Always switch off power source before commencing work!

1. Use the special wrench to remove the cover from the front compartment.
2. Remove screws A, fold display board to side, and remove plug B (ribbon cable, display board). Not



applicable to UFC 400... signal converter!

3. Power fuse F1 is now accessible. It must be replaced by the same type of fuse (see marking on fuse holder).
4. Reassemble in reverse order.

8.4 Turning the display circuit board

To ensure horizontal positioning of the display irrespective of the location of compact flowmeters UFM 500 K (equipped with UFC 500 C signal converter) the display circuit board can be turned through ± 90° or 180°.

- **Switch off power supply!**
- Unscrew cover from electronics compartment using the special wrench.
- Remove 2 screws from the display circuit board.
- Turn circuit board into desired position.
- Replace screws, if necessary transposed, in the circuit board (do not kink or squeeze the ribbon cable).
- Grease screw thread before replacing housing cover.

8.5 Turning the signal converter housing

To facilitate access to connecting, indicating and operating elements on the compact flowmeters UFM 400 K and UFM 500 K installed in locations that are hard to reach, the signal converter housing can be turned through ± 90° (see versions 1 to 10 in sect. 8.6), but not hazardous-duty version!

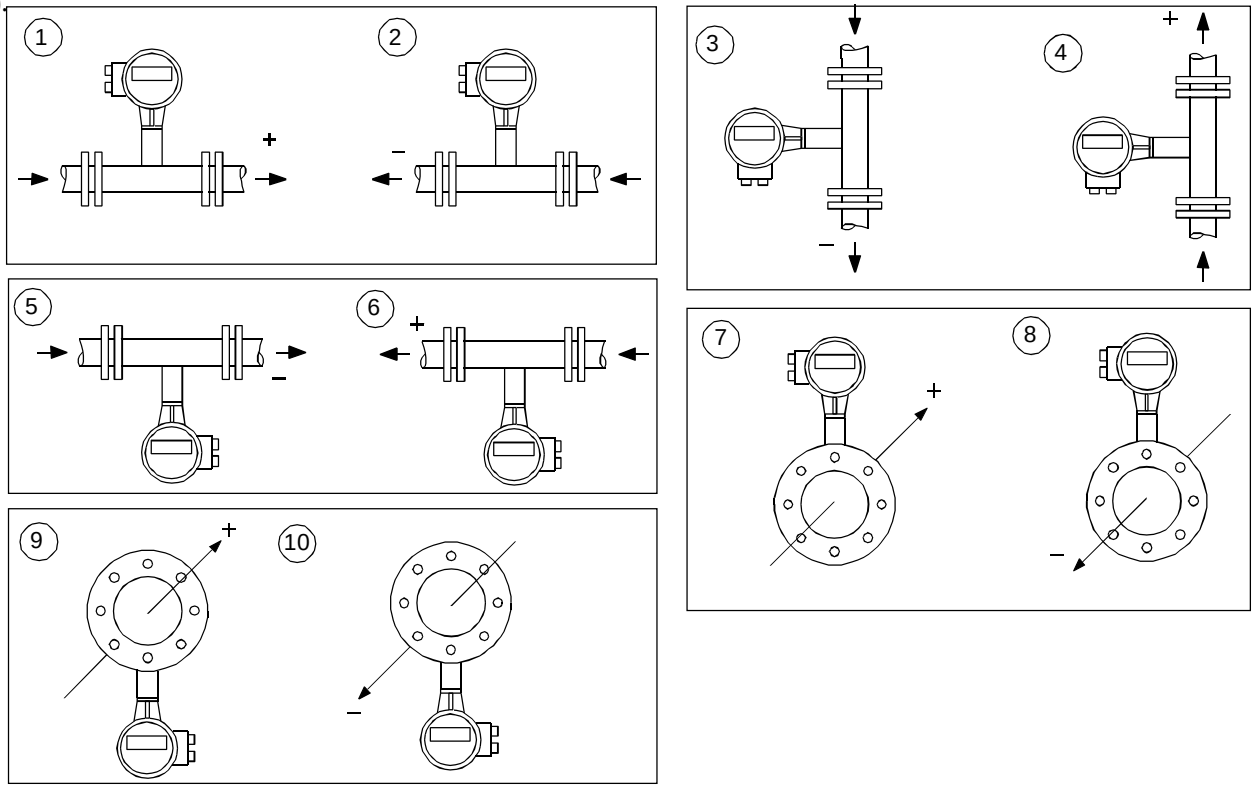
Any faults resulting from failure to follow these instructions scrupulously shall not be covered by our warranty!

The connection wires between the primary head and signal converter housing are extremely short and can easily break.

- **Switch off power source!**
- Clamp the flowmeter firmly by the primary head housing.
- Secure converter housing against slipping and tilting.
- Remove the 4 hexagon socket screws connecting the two housings.
- Carefully turn the converter housing clockwise or anti-clockwise a maximum of 90°, but do not lift the housing. If the gasket should stick, do not attempt to lever it off.
- To conform to the requirements of protection category IP 67 (equivalent to NEMA 6) keep connecting faces clean and tighten the 4 hexagon socket screws uniformly at diametrically opposed points.
- To prevent corrosion, paint the gap between two parts.

8.6 Available versions of compact flowmeters UFM 400 K and UFM 500 K

Compact flowmeters are supplied in 10 different versions for various positions of the display circuit board and signal converter housing and for the set flow indication. The arrow indicates the flow direction as set in fct. 3.1.7 (see sect. 4.3 + 5.4).



9. Voltage settings and spare parts

For information on these subjects please contact your local sales representative!

Part D Technical data, measuring principle, block diagram

10. Technical data

10.1 Versions, measuring ranges, accuracies

Versions

Compact systems (K)	Signal converter (C)	Local display	Primary head (S)
UFM 400 K	UFC 400	no	UFS 500
UFM 500 K	UFC 500	yes	UFS 500
UFM 500 K-EEx	UFC 500-EEx	yes	UFS 500
Remote systems (F)			
UFM 400 F	UFC 400	no	UFS 500 F
UFM 500 F	UFC 500	yes	UFS 500 F
UFM 500 F-EEx	UFC 500 F-EEx	yes	UFS 500 F-EEx

Measuring ranges

Full-scale range $Q_{100\%}$ UFM 400: factory setting UFM 500: user-defined	lowest	highest
Meter size DN in mm	$Q_{100\%\,min}[m^3/hr] = \left(\frac{DN}{100}\right)^2 \times 14.2$	$Q_{100\%\,max}[m^3/hr] = DN^2 \times 0.05$
Meter size (DN) in inches	$Q_{100\%\,min}[m^3/hr] = DN^2 \times 0.9$	$Q_{100\%\,max}[m^3/hr] = DN^2 \times 31.25$
	$Q_{100\%\,min}[USGPM] = DN^2 \times 3.9$	$Q_{100\%\,max}[USGPM] = DN^2 \times 138$

Measurement accuracies UFM 400/500

Linearity	for v > 0.5 m/s (> 1.6 ft/s): within ± 0.5% for v ≤ 0.5 m/s (≤ 1.6 ft/s): within ± 2.5 mm/s (0.1 inch/s)
Uncertainty	for size ≥ DN100 (≥ 4"): within ± (0.001 x DN [mm]) m^3/hr for size < DN100 (<4"): within ± (0.0015 x DN [mm]) m^3/hr
Influence of temperature	Less than ± 0.1% per 10K
Influence of Reynolds number (Re) • single beam flowmeters • double beam flowmeters	± 1% of measured value for Re > 5000 ± 0.1% of measured value for a change of Re =100 within the Re 1000 - 4000 range.
Repeatability single beam flowmeters double beam flowmeters	 better than 0.3% of measured value better than 0.2% of measured value

10.2 Primary head UFS 500

Flange connections		**Body pressure rating**
to DIN 2501	DN 25 to 50: PN 40	40 bar ≙ 580 psig
	DN 65 to 150: PN 16	16 bar ≙ 230 psig
	DN 200 to 1000: PN 10	10 bar ≙ 150 psig
	DN 1200 to 2000: PN 6	6 bar ≙ 90 psig
	DN 2200 to 3000: PN 2.5	2.5 bar ≙ 37 psig
to ANSI B16.5	1" to 2": ANSI Class 150 lb/RF full rating	12 barg ≙ 175 psig (with 150°C/300°F product temperature)
	2½"to 12": ANSI Class 150 lb/RF full rating	15.8barg ≙ 230 psig (with 150°C/300°F product temperature)
	14" to 24": ANSI Class 150 lb/RF	10 barg ≙ 145 psig
	26" to 40": MSS-SP44 Class 150 lb/RF	10 barg ≙ 145 psig
to AWWA	24" to 120": Class B/FF	6 barg ≙ 90 psig
Special versions	on request	

Product temperature	
Compact systems	-50 to +140°C / -58 to +284°F
Separate systems	-50 to +150°C / -58 to +302°F
High temperature version	up to 500°C or 932°F on request

Ambient temperature	
product temperature ≤ 60°C / 140°F	-25 to +60°C / -13 to +140°F
product temperature > 60°C / 140°F	
compact systems	-25 to +40°C / -13 to +104°F
separate systems	-25 to +60°C / -13 to +140°F

Protection category (IEC529/EN60529)	UFS 400/500 K	UFS 400/500 F
Standard	IP 67 equivalent to NEMA 6	IP 65 equivalent to NEMA 4 and 4X
Special version	-	IP 68 equivalent to NEMA 6

Materials	
Measuring tube	
DN 25 - 50 **or** 1" - 2"	SS 316 L (comparable with stainless steel 1.4404)
DN 65 - 300 **or** 2½" - 12"	SS 316 L (comparable with stainless steel 1.4404) **or** SS 316 Ti (comparable with stainless steel 1.4571) dependent on availability
DN 350 - 3000 **or** 14" - 120"	Steel
Sensor / sensor windows	
≤ DN 50 / ≤ 2"	SS 316 Ti (comparable with stainless steel 1.4571)
≥ DN 65 / ≥ 2½"	SS 316 L (comparable with stainless steel 1.4404)
Flanges	
DN 25 - 50 or 1" - 2"	SS 316 L (comparable with stainless steel 1.4404)
DN 65 - 3000 or 2½" - 120"	Steel
Connection box* (only separate systems)	Die-cast zinc
Other materials or liner UFS 500	on request

* *With polyurethane finish*

10.3 Signal converters UFC 400 and UFC 500

Versions	
Compact systems (K)	Signal converter mounted on primary head
Separate systems (F)	Signal converter with wall mount (rotating design) and additional terminal box
UFC 400...	Without local display, all operating data are factory-set.
UFC 500…	All operating data can be set via the local display and the 3 keys, user-defined. The UFC 500 is additionally equipped with magnet sensors to set the signal converter by means of a hand-held bar magnet without opening the housing.
UFC 500...-EEx	Explosion protected version with approval according to the European Standards. These apparatus are marked "EEx de ib IIC T6 ... T3". Its functioning is identical with the UFC 500 standard version.

Current output (term. I+, I, I⊥)	Galvanically insulated
Functions	• continuous flowrate measurement; • measurement of sound velocity to determine (composition of) liquid product; • status output.
Voltage	18 VDC
Current	
$I_{0\%}$ for Q = 0% $I_{100\%}$ for Q = 100%	0 to 16 mA 4 to 20 mA } settings in increments of 1 mA (I_{max} = 22 mA)
Low-flow cut-off (SMU)	
cut-off "on" value cut-off "off" value	1 to 19% 2 to 20% } of $Q_{100\%}$, setting in 1% increments, independent of pulse output
Forward/reverse measurements (F/R)	Direction identified via pulse output or status output.
Time constant	0.04 to 3600 seconds, setting in increments of 1, 0.1 or 0.01 seconds
Maximum load at I = 100%	≤ 680 ohms
Pulse output	Galvanically insulated
Functions	• continuous flow counting; • measurement of sound velocity to determine (composition of) liquid product; • status output.
Pulse rate for Q = 100%	10 to 3,600,000 pulses per hour 0.167 to 60,000 pulses per minute 0.0028 to 1,000 pulses per second (= Hz) optionally in pulses per liter, m^3 or US gallons
Active output	
Terminals B1, B⊥, I+, I	For electromechanical (EMC) or electronic (EC) totalizers
Voltage	19 - 32 VDC
Current	≤ 50 mA
Load rating	≥ 650 ohms for single load as well as equivalent load (see figure 3 on page 5)
Passive output	
Terminals B1, B⊥	Open collector for connection of active electronic totalizers (EC) or switchgear
Input voltage	≤ 32 VDC / ≤ 24 VAC
Load current	≤ 150 mA
Low-flow cut-off (SMU)	
cut-off "on" value cut-off "off" value	1 to 19% 2 to 20% } of $Q_{100\%}$ setting in 1% increments, independent of current output
Forward/reverse measurements (F/R)	direction identified via current output or status output
Time constant	0.04 seconds or same as current output
Status output	
Functions	• FATAL ERROR • US ERROR • F/R INDICATION • TRIP POINT
Active output	
Terminals B⊥ , B2, I+, I⊥	for electromechanical or electronic indicators
Voltage	19 to 32 VDC
Current	≤ 50 mA
Load rating	≥ 650 ohms for single load as well as equivalent load* (see sect. 2.3.5, figure 3)
Passive output	
Terminals B ⊥, B2	open collector for connection of active indicators
Input voltage	≤ 32 VDC / ≤ 24 VAC
Load current	≤ 150 mA

* *Load on B1 and B2 terminals in parallel*

Local display, at UFC 500 only	
Display functions	3-line back-lit LCD actual flowrate, sound velocity, forward, reverse and sum totalizers (7-digit), each can be set for continuous or sequential display, and output of error messages
Display units	
Actual flowrate	liters, m^3 or US gallons per second, minute or hour 1 user-defined unit (e.g. hectoliters per day or US million gallons per day)
Totalizers	liters, m^3 or US gallons and 1 user-defined unit (e.g. hectoliters or US million gallons) min. 1 year overflow time
Language of plain texts	English and German or French as second optional language (others on request)
Display	
1st line (top)	8-digit, 7-segment numeral and sign display, symbols for key acknowledgement
2nd line (middle)	10-character, 14-segment text display
3rd line (bottom)	5 markers ▼ to identify actual display
Power supply	
1. AC-version	230 V_{AC} $^{+13\%}_{-13\%}$ (200 - 260 V) or 115 V_{AC} $^{+13\%}_{-13\%}$ (100 - 130 V), frequency 48 to 63 Hz
2. AC-version	200 V_{AC} $^{+10\%}_{-15\%}$ (170 - 220 V) or 100 V_{AC} $^{+10\%}_{-15\%}$ (85 - 110 V), frequency 48 to 63 Hz
3. AC-version	48 V_{AC} ± 13% 24 V AC ± 13%, 48-63 Hz
4. AC/DC-version	24 V_{AC} $^{+12.5\%}_{-16,7\%}$ (20 - 27 V), 48 to 63 Hz 24 V_{DC} $^{+33.3\%}_{-25.0\%}$ (18 - 32 V)
Power consumption	AC: approx. 10 VA DC: approx. 8 W } including primary head
Housing	
Material	Die-cast aluminum with polyurethane finish.
Protection category	
(IEC529/EN60529)	IP 65 equivalent to NEMA 4 and 4X
Compact systems (C)	(Option: IP 67 equivalent to NEMA 6)
Remote systems (F)	IP 65 equivalent to NEMA 4 and 4X (Primary: optional IP 68, equivalent to NEMA 6P) (Signal converter: optional IP 67, equivalent to NEMA 6)
EEx version	IP 65 (optional IP 67, equivalent to NEMA 6)
Signal cable length	only for separate systems
Standard	up to 10 m ≙ 30 ft
Longer cable lengths	on request

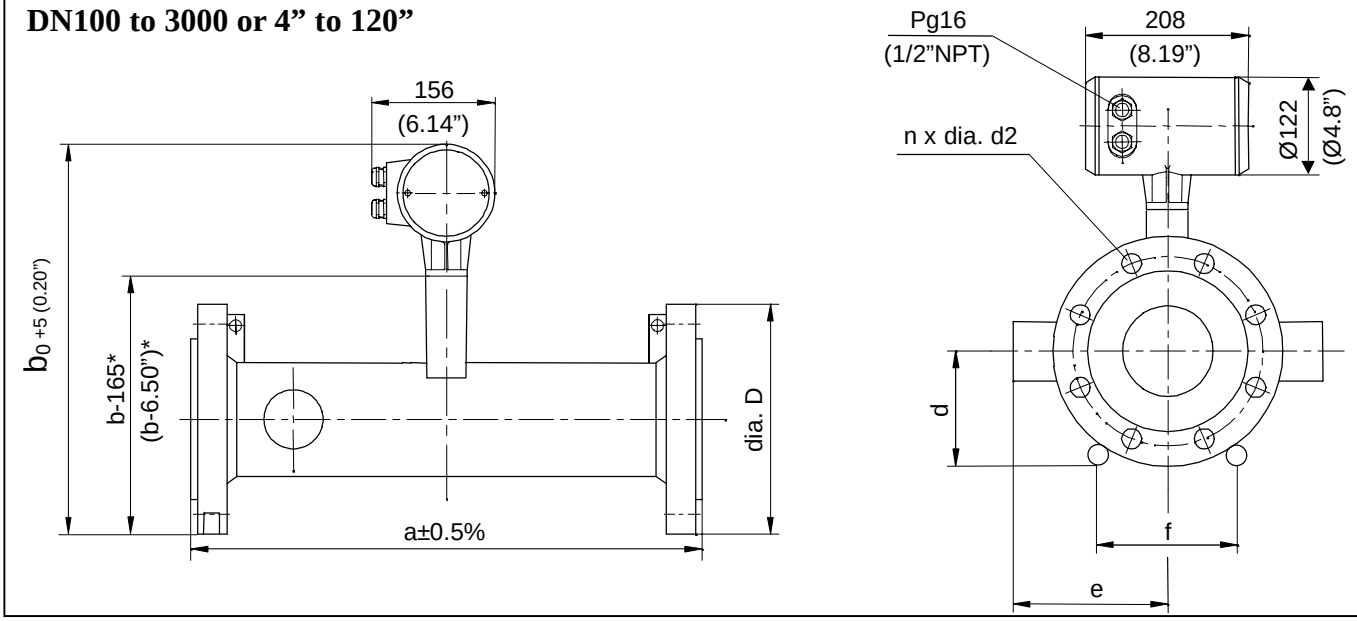
10.4 Dimensions and weights UFM 400 / 500 single beam

Dimensions in mm (inches in brackets)

*** Dimension b** for compact systems: see tables (next page)
for separate systems: dimensions b - 165 mm or b - 6.50”

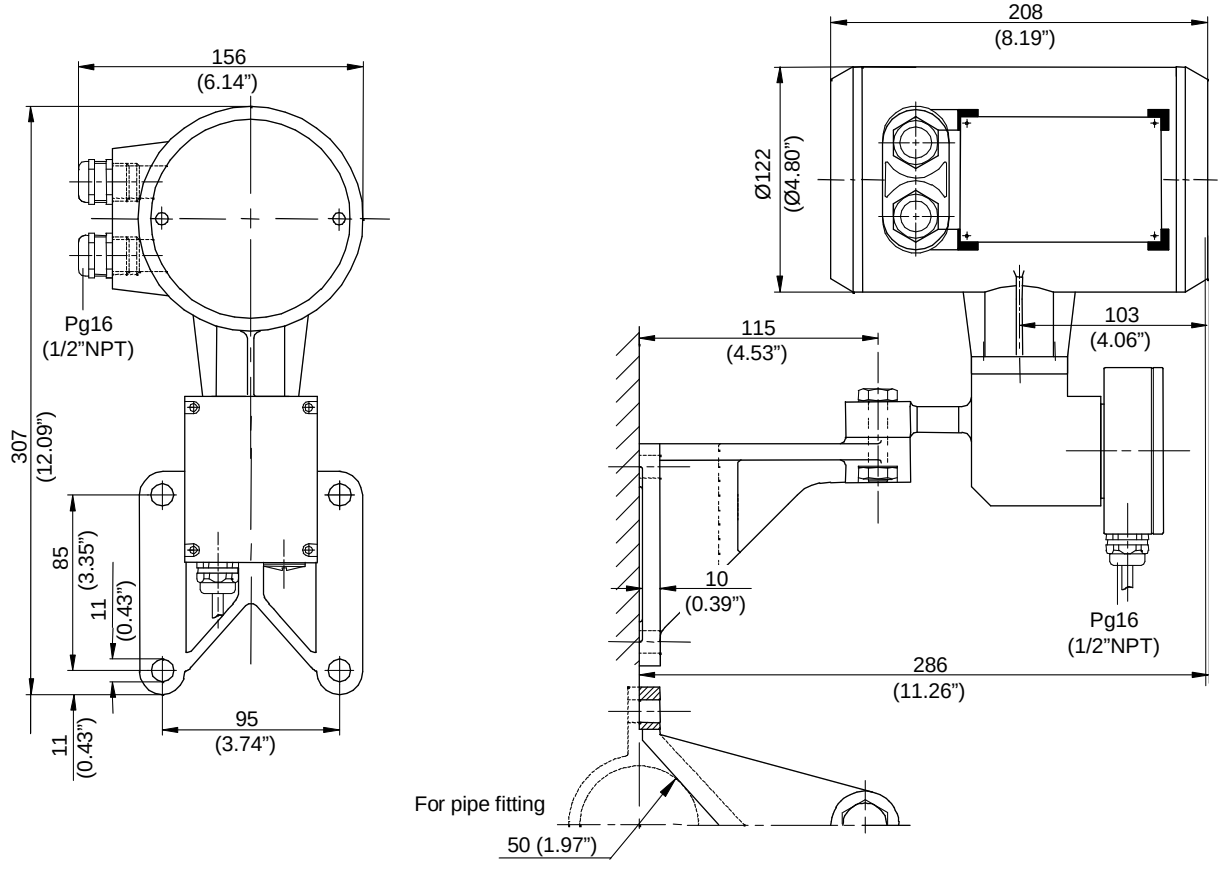
** max. body pressure rating for
150°C / 302°F product temperature

DN100 to 3000 or 4” to 120”



Signal converter UFC 400 F

wall-mounting signal converter
without local display



UFM 400 / 500 single beam

Flange to **DIN 2501**		**Body pressure rating** in bar (psig)	**Dimensions** in mm (and inch)							**Weight** approx. in kg (lb)
Meter size	Flange rating		a	b*	d	e	f	dia. D	n x dia. d2 (n = number)	
DN 100	PN16	16 (230)	300 (11.81)	430 (16.93)	110 (4.33)	154 (6.06)	-	220 (8.66)	8 x 18 (8 x 0.71)	20 (44)
DN 125	PN16	16 (230)	300 (11.81)	460 (18.11)	125 (4.92)	167 (6.57)	-	250 (9.84)	8 x 18 (8 x 0.71)	23 (51)
DN 150	PN16	16 (230)	350 (13.78)	492 (19.37)	143 (5.63)	181 (7.13)	-	285 (11.22)	8 x 22 (8 x 0.87)	28 (62)
DN 200	PN10	10 (150)	400 (15.75)	539 (21.22)	170 (6.69)	201 (7.91)	-	340 (13.39)	8 x 22 (8 x 0.87)	38 (84)
DN 250	PN10	10 (150)	450 (17.72)	594 (23.39)	198 (7.80)	229 (9.02)	-	395 (15.55)	12 x 22 (12 x 0.87)	45 (99)
DN 300	PN10	10 (150)	500 (19.69)	645 (25.39)	223 (8.78)	254 (10.00)	-	445 (17.52)	12 x 22 (12 x 0.87)	54 (121)
DN 350	PN10	10 (150)	600 (23.62)	692 (27.24)	253 (9.96)	272 (10.71)	253 (9.96)	505 (19.88)	16 x 22 (16 x 0.87)	67 (148)
DN 400	PN10	10 (150)	600 (23.62)	748 (29.45)	283 (11.14)	297 (11.69)	283 (11.14)	565 (22.24)	16 x 26 (16 x 1.02)	81 (179)
DN 450	PN10	10 (150)	700 (27.56)	798 (31.42)	308 (12.13)	323 (12.72)	308 (12.13)	615 (24.21)	20 x 26 (20 x 1.02)	92 (203)
DN 500	PN10	10 (150)	700 (27.56)	852 (33.54)	335 (13.19)	348 (13.70)	335 (13.19)	670 (26.38)	20 x 26 (20 x 1.02)	111 (245)
DN 550	PN10	10 (150)	900 (35.43)	932 (36.69)	390 (15.35)	373 (14.69)	390 (15.35)	780 (30.71)	20 x 30 (20 x 1.18)	218 (481)
DN 600	PN10	10 (150)	900 (35.43)	958 (37.72)	390 (15.35)	399 (15.71)	390 (15.35)	780 (30.71)	20 x 30 (20 x 1.18)	183 (403)
DN 650	PN10	10 (150)	1000 (39.37)	1040 (40.92)	448 (17.64)	423 (16.65)	448 (17.64)	895 (35.24)	24 x 30 (24 x 1.18)	316 (697)
DN 700	PN10	10 (150)	1000 (39.37)	1066 (41.97)	448 (17.64)	449 (17.68)	448 (17.64)	895 (35.24)	24 x 30 (24 x 1.18)	279 (615)
DN 750	PN10	10 (150)	1100 (43.31)	1152 (45.35)	508 (20.00)	474 (18.66)	508 (20.00)	1015 (39.96)	24 x 33 (24 x 1.30)	431 (950)
DN 800	PN10	10 (150)	1100 (43.31)	1177 (46.34)	508 (20.00)	500 (19.69)	508 (20.00)	1015 (39.96)	24 x 33 (24 x 1.30)	373 (822)
DN 850	PN10	10 (150)	1200 (47.24)	1251 (49.25)	558 (21.97)	523 (20.59)	558 (21.97)	1115 (43.90)	28 x 33 (28 x 1.30)	524 (1155)
DN 900	PN10	10 (150)	1200 (47.24)	1278 (50.31)	558 (21.97)	548 (21.57)	558 (21.97)	1115 (43.90)	28 x 33 (28 x 1.30)	489 (1078)
DN 950	PN10	10 (150)	1300 (51.18)	1361 (53.58)	615 (24.21)	574 (22.60)	615 (24.21)	1230 (48.43)	28 x 36 (28 x 1.42)	694 (1530)
DN1000	PN10	10 (150)	1300 (51.18)	1386 (54.57)	615 (24.21)	599 (23.58)	615 (24.21)	1230 (48.43)	28 x 36 (28 x 1.42)	611 (1347)
DN1200	PN 6	6 (90)	1500 (59.06)	1576 (62.05)	703 (27.68)	703 (27.68)	703 (27.68)	1405 (55.31)	32 x 33 (32 x 1.30)	577 (1272)
DN1400	PN 6	6 (90)	1700 (66.93)	1788 (70.39)	815 (32.09)	803 (31.61)	815 (32.09)	1630 (64.17)	36 x 36 (36 x 1.42)	842 (1856)
DN1600	PN 6	6 (90)	2000 (78.74)	1989 (78.31)	915 (36.02)	902 (35.51)	915 (36.02)	1830 (72.05)	40 x 36 (40 x 1.42)	1209 (2665)
DN1800	PN 6	6 (90)	2200 (78.74)	2196 (86.46)	1023 (40.28)	1001 (39.41)	1023 (40.28)	2045 (80.51)	44 x 39 (44 x 1.54)	1586 (3497)
DN2000	PN 6	6 (90)	2400 (94.49)	2405 (94.69)	1133 (44.61)	1100 (43.31)	1100 (43.31)	2265 (89.17)	48 x 42 (48 x 1.65)	2055 (4530)
DN2200	PN 2.5	2.5 (37)	2600 (103.36)	2578 (101.50)	1203 (47.36)	1201 (47.28)	1203 (47.36)	2405 (94.69)	52 x 33 (52 x 1.30)	1918 (4228)
DN2400	PN 2.5	2.5 (37)	2800 (110.24)	2778 (109.37)	1303 (51.30)	1301 (51.22)	1303 (51.30)	2605 (102.56)	56 x 33 (56 x 1.30)	2262 (4987)
DN2600	PN 2.5	2.5 (37)	3000 (118.11)	2978 (117.24)	1403 (55.24)	1401 (55.16)	1403 (55.24)	2805 (110.43)	60 x 33 (60 x 1.30)	2634 (5807)
DN2800	PN 2.5	2.5 (37)	3200 (125.98)	3192 (125.67)	1515 (59.65)	1501 (59.09)	1515 (59.65)	3030 (119.29)	64 x 36 (64 x 1.42)	3550 (7826)
DN3000	PN 2.5	2.5 (37)	3400 (133.86)	3392 (133.54)	1615 (63.58)	1601 (63.03)	1615 (63.58)	3230 (127.17)	68 x 36 (68 x 1.42)	4201 (9262)

Flange to **ANSI B16.5** and **AWWA**		**Body pressure rating**** in bar (psig)	**Dimensions** in mm (and inch)							**Weight** approx. in kg (lb)
Meter size	Flange rating		a	b*	d	e	f	dia. D	n x dia. d2 (n = number)	
4"	150 lbs	16 (230)	300 (11.81)	430 (16.93)	114 (4.49)	151 (5.94)	-	228.6 (9.00)	8 x 19.1 (8 x 0.75)	24 (53)
5"	150 lbs	16 (230)	300 (11.81)	459 (18.07)	127 (5.00)	164 (6.46)	-	254.0 (10.00)	8 x 22.2 (8 x 0.87)	26 (57)
6"	150 lbs	16 (230)	350 (13.78)	484 (19.06)	140 (5.51)	177 (6.97)	-	279.4 (11.00)	8 x 22.2 (8 x 0.87)	32 (71)
8"	150 lbs	10 (150)	400 (15.75)	540 (21.26)	171 (6.73)	201 (7.91)	-	342.9 (13.50)	8 x 22.2 (8 x 0.87)	46 (101)
10"	150 lbs	10 (150)	450 (17.72)	600 (23.62)	203 (7.99)	229 (9.02)	-	406.4 (16.00)	12 x 25.4 (12 x 1.00)	59 (129)
12"	150 lbs	10 (150)	500 (19.69)	663 (26.10)	241 (9.49)	254 (10.00)	-	482.6 (19.00)	12 x 25.4 (12 x 1.00)	85 (188)
14"	150 lbs	10 (150)	800 (31.50)	706 (27.80)	267 (10.51)	272 (10.71)	267 (10.51)	533.4 (21.00)	12 x 28.6 (12 x 1.13)	110 (242)
16"	150 lbs	10 (150)	800 (31.50)	763 (30.04)	298 (11.73)	297 (11.69)	298 (11.73)	596.9 (23.50)	16 x 28.6 (16 x 1.13)	137 (303)
18"	150 lbs	10 (150)	900 (35.43)	808 (31.81)	318 (12.52)	323 (12.72)	318 (12.52)	635.0 (25.00)	16 x 31.7 (16 x 1.25)	157 (347)
20"	150 lbs	10 (150)	900 (35.43)	866 (34.09)	349 (13.74)	348 (13.70)	349 (13.74)	698.5 (27.50)	20 x 31.7 (20 x 1.25)	200 (440)
22"	150 lbs	10 (150)	1100 (43.31)	917 (36.10)	375 (14.76)	373 (14.69)	375 (14.76)	749.3 (29.50)	20 x 34.9 (20 x 1.37)	228 (502)
24"	150 lbs	10 (150)	1100 (43.31)	974 (38.35)	406 (15.98)	399 (15.71)	406 (15.98)	812.8 (32.00)	20 x 34.9 (20 x 1.37)	258 (568)
26"	150 lbs	10 (150)	1200 (47.24)	1027 (40.43)	435 (17.13)	423 (16.65)	435 (17.13)	869.9 (34.25)	24 x 34.9 (24 x 1.37)	291 (641)
28"	150 lbs	10 (150)	1200 (47.24)	1082 (42.60)	464 (18.27)	449 (17.68)	464 (18.27)	927.1 (36.50)	28 x 34.9 (28 x 1.37)	342 (753)
30"	150 lbs	10 (150)	1300 (51.18)	1136 (44.72)	492 (19.37)	474 (18.66)	492 (19.37)	984.2 (38.75)	28 x 34.9 (28 x 1.37)	390 (860)
32"	150 lbs	10 (150)	1300 (51.18)	1200 (47.24)	530 (20.87)	500 (19.69)	500 (19.69)	1060.4 (39.96)	28 x 41.3 (28 x 1.63)	460 (1015)
34"	150 lbs	10 (150)	1400 (55.12)	1249 (49.17)	556 (21.89)	523 (20.59)	556 (21.89)	1111.2 (43.75)	32 x 41.3 (32 x 1.63)	515 (1135)
36"	150 lbs	10 (150)	1400 (55.12)	1304 (51.34)	584 (22.99)	548 (21.57)	584 (22.99)	1168.4 (46.00)	32 x 41.3 (32 x 1.63)	614 (1353)
38"	150 lbs	10 (150)	1500 (59.06)	1365 (53.74)	619 (24.37)	574 (22.60)	619 (24.37)	1238.2 (48.75)	32 x 41.3 (32 x 1.63)	706 (1557)
40"	150 lbs	10 (150)	1500 (59.06)	1416 (55.75)	645 (25.39)	599 (23.58)	645 (25.39)	1289.0 (50.75)	36 x 41.3 (36 x 1.63)	763 (1682)
48"	AWWA:B	6 (90)	1700 (66.93)	1629 (64.13)	756 (29.76)	703 (27.68)	756 (29.76)	1511.3 (59.50)	44 x 41.3 (44 x 1.63)	991 (2184)
56"	AWWA:B	6 (90)	1900 (74.80)	1846 (72.68)	873 (34.37)	803 (31.61)	873 (34.37)	1746.2 (68.75)	48 x 47.6 (48 x 1.87)	1182 (2606)
64"	AWWA:B	6 (90)	2200 (86.61)	2090 (82.28)	1016 (40.00)	902 (35.51)	1016 (40.00)	2032.0 (80.00)	52 x 47.6 (52 x 1.87)	1798 (3965)
72"	AWWA:B	6 (90)	2400 (94.49)	2272 (89.45)	1099 (43.27)	1001 (39.41)	1099 (43.27)	2197.1 (86.50)	60 x 47.6 (60 x 1.87)	2071 (4566)
80"	AWWA:B	6 (90)	2600 (103.36)	2453 (96.57)	1181 (46.50)	1100 (43.31)	1181 (46.50)	2362.2 (93.00)	64 x 54.0 (64 x 2.13)	2285 (5037)
88"	AWWA:B	6 (90)	2800 (110.24)	2728 (107.40)	1353 (53.27)	1201 (47.28)	1353 (53.27)	2705.1 (106.50)	68 x 60.3 (68 x 2.37)	2783 (6136)
96"	AWWA:B	6 (90)	3000 (118.11)	2913 (114.69)	1438 (56.61)	1301 (51.22)	1438 (56.61)	2876.5 (113.25)	68 x 60.3 (68 x 2.37)	3111 (6859)
104"	AWWA:B	6 (90)	3200 (125.98)	3099 (122.01)	1524 (60.00)	1401 (55.16)	1524 (60.00)	3048.0 (120.00)	72 x 66.7 (72 x 2.63)	3365 (7418)
112"	AWWA:B	6 (90)	3400 (133.86)	3372 (132.76)	1695 (66.73)	1501 (59.09)	1695 (66.73)	3390.9 (133.50)	76 x 73.0 (76 x 2.87)	5162 (11380)
120"	AWWA:B	6 (90)	3600 (141.73)	3558 (140.08)	1781 (70.12)	1601 (63.03)	1781 (70.12)	3562.4 (140.25)	76 x 73.0 (76 x 2.87)	6039 (13314)

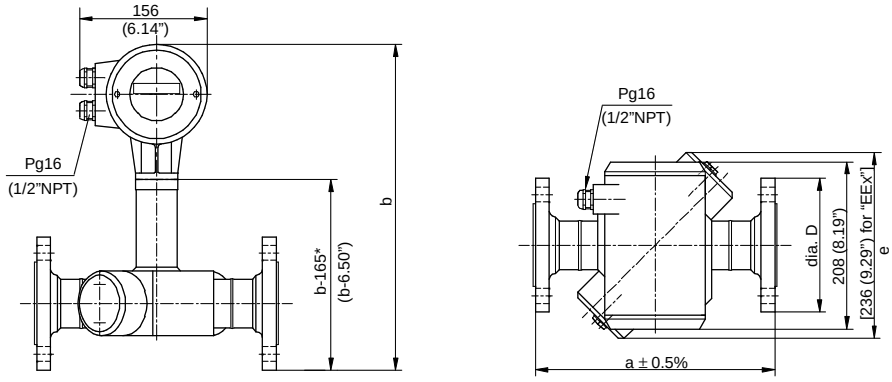
10.5 Dimensions and weights UFM 400 / 500 double beam

Dimensions in mm (inches in brackets)

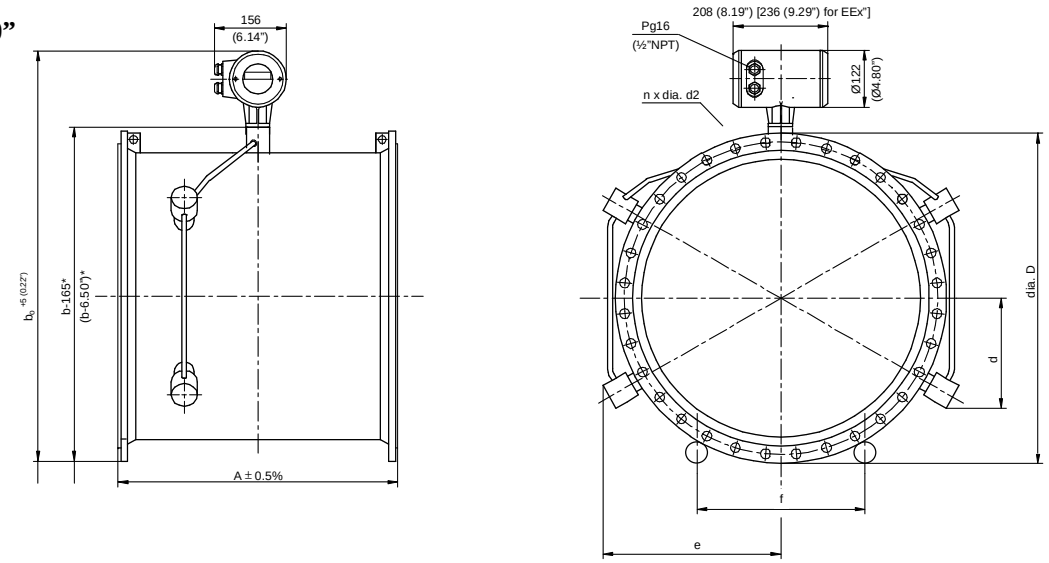
*** Dimension b** for compact systems: see tables (next page)
for separate systems: dimensions b - 165 mm or b – 6.50”

** max. body pressure rating for
150°C / 302°F product temperature

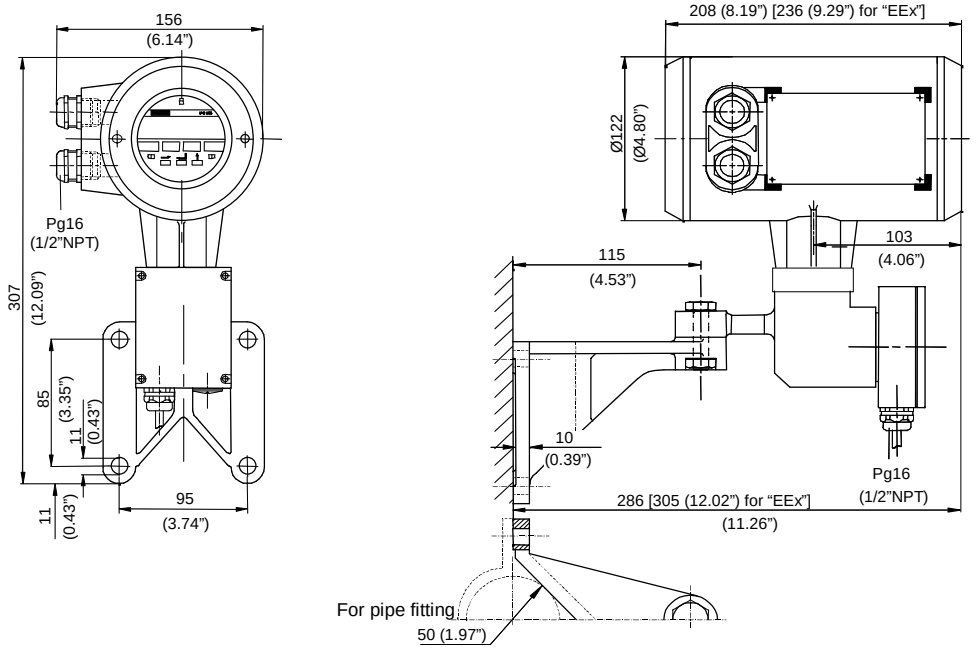
DN25 to 50 or 1” to 2”



DN65 to 3000 or 2½” to 120”



Signal converter UFC 500 F
(wall-mounted signal
converter with local display)



UFM 400 / 500 double beam

Flange (standard) to **DIN 2501**		**Body pressure rating** in bar (psig)	**Dimensions** in mm (and inch)							**Weight** approx. in kg (lb)
Meter size	Flange rating		a	b*	d	e	f	dia. D	n x dia. d2 (n = number)	
DN25	PN40	10 (150)	250 (9.84)	368 (14.49)	-	192 (7.56)	-	115 (4.53)	4 x 14 (4 x 0.36)	15 (33)
DN32	PN40	10 (150)	260 (10.23)	381 (15.00)	-	196 (7.72)	-	140 (5.51)	4 x 18 (4 x 0.71)	17 (38)
DN40	PN40	10 (150)	270 (10.63)	388 (15.27)	-	206 (8.11)	-	150 (5.91)	4 x 18 (4 x 0.71)	19 (42)
DN50	PN40	10 (150)	300 (11.81)	401 (15.79)	-	234 (9.21)	-	165 (6.50)	4 x 18 (4 x 0.71)	20 (44)
DN65	PN40	10 (150)	300 (11.81)	438 (17.24)	62 (2.44)	133 (5.24)	-	185 (7.28)	8 x 18 (8 x 0.71)	16 (36)
DN80	PN40	10 (150)	300 (11.81)	458 (18.03)	85 (3.34)	138 (5.43)	-	200 (7.87)	8 x 18 (8 x 0.71)	18 (40)
DN100	PN16	10 (150)	350 (13.78)	430 (16.93)	102 (4.02)	146 (5.75)	-	220 (8.66)	8 x 18 (8 x 0.71)	20 (44)
DN125	PN16	10 (150)	350 (13.78)	460 (18.11)	109 (4.29)	160 (6.30)	-	250 (9.84)	8 x 18 (8 x 0.71)	23 (51)
DN150	PN16	10 (150)	350 (13.78)	492 (19.37)	115 (4.53)	172 (6.77)	-	285 (11.22)	8 x 22 (8 x 0.87)	28 (62)
DN200	PN10	10 (150)	400 (15.75)	527 (20.75)	127 (5.00)	190 (7.48)	-	340 (13.39)	8 x 22 (8 x 0.87)	38 (84)
DN250	PN10	10 (150)	400 (15.75)	599 (23.58)	141 (5.55)	213 (9.39)	-	395 (15.55)	12 x 22 (12 x 0.87)	45 (99)
DN300	PN10	10 (150)	500 (19.69)	652 (25.67)	154 (6.06)	235 (9.25)	-	445 (17.52)	12 x 22 (12 x 0.87)	54 (121)
DN350	PN10	10 (150)	500 (19.69)	692 (27.24)	163 (6.42)	251 (9.88)	253 (9.96)	505 (19.88)	16 x 22 (16 x 0.87)	67 (148)
DN400	PN10	10 (150)	600 (23.62)	748 (29.45)	175 (6.89)	273 (10.75)	283 (11.14)	565 (22.24)	16 x 26 (16 x 1.02)	81 (179)
DN450	PN10	10 (150)	600 (23.62)	798 (31.42)	188 (7.40)	295 (11.61)	308 (12.13)	615 (24.21)	20 x 26 (20 x 1.02)	92 (203)
DN500	PN10	10 (150)	600 (23.62)	852 (33.54)	201 (7.91)	316 (12.44)	335 (13.19)	670 (26.38)	20 x 26 (20 x 1.02)	111 (245)
DN550	PN10	10 (150)	600 (23.62)	932 (36.69)	213 (8.39)	339 (13.35)	390 (15.35)	780 (30.71)	20 x 30 (20 x 1.18)	218 (481)
DN600	PN10	10 (150)	600 (23.62)	958 (37.72)	226 (8.90)	361 (14.21)	390 (15.35)	780 (30.71)	20 x 30 (20 x 1.18)	183 (403)
DN650	PN10	10 (150)	700 (27.56)	1040 (40.92)	238 (9.37)	382 (15.04)	448 (17.64)	895 (35.24)	24 x 30 (24 x 1.18)	316 (697)
DN700	PN10	10 (150)	700 (27.56)	1066 (41.97)	251 (9.88)	404 (15.91)	448 (17.64)	895 (35.24)	24 x 30 (24 x 1.18)	279 (615)
DN750	PN10	10 (150)	800 (31.50)	1152 (45.35)	264 (10.39)	426 (16.77)	508 (20.00)	1015 (39.96)	24 x 33 (24 x 1.30)	431 (950)
DN800	PN10	10 (150)	800 (31.50)	1177 (46.34)	277 (10.91)	448 (17.64)	508 (20.00)	1015 (39.96)	24 x 33 (24 x 1.30)	373 (822)
DN850	PN10	10 (150)	900 (35.43)	1251 (49.25)	288 (11.34)	468 (18.43)	558 (21.97)	1115 (43.90)	28 x 33 (28 x 1.30)	524 (1155)
DN900	PN10	10 (150)	900 (35.43)	1278 (50.31)	301 (11.85)	490 (19.29)	558 (21.97)	1115 (43.90)	28 x 33 (28 x 1.30)	489 (1078)
DN950	PN10	10 (150)	1000 (39.37)	1361 (53.58)	314 (12.36)	512 (20.16)	615 (24.21)	1230 (48.43)	28 x 36 (28 x 1.42)	694 (1530)
DN1000	PN10	10 (150)	1000 (39.37)	1386 (54.57)	326 (12.83)	534 (21.02)	615 (24.21)	1230 (48.43)	28 x 36 (28 x 1.42)	611 (1347)
DN1200	PN 6	6 (90)	1200 (47.24)	1576 (62.05)	378 (14.88)	624 (24.57)	703 (27.68)	1405 (55.31)	32 x 33 (32 x 1.30)	577 (1272)
DN1400	PN 6	6 (90)	1400 (55.12)	1788 (70.39)	428 (16.85)	711 (27.99)	815 (32.09)	1630 (64.17)	36 x 36 (36 x 1.42)	842 (1856)
DN1600	PN 6	6 (90)	1600 (62.99)	1989 (78.31)	478 (18.82)	797 (31.38)	915 (36.02)	1830 (72.05)	40 x 36 (40 x 1.42)	1209 (2665)
DN1800	PN 6	6 (90)	1800 (70.87)	2196 (86.46)	527 (20.75)	882 (34.72)	1023 (40.28)	2045 (80.51)	44 x 39 (44 x 1.54)	1586 (3497)
DN2000	PN 6	6 (90)	2000 (78.74)	2405 (94.69)	577 (22.72)	968 (38.11)	1133 (44.61)	2265 (89.17)	48 x 42 (48 x 1.65)	2055 (4530)
DN2200	PN 2.5	2.5 (37)	2200 (86.61)	2578 (101.50)	627 (24.69)	1056 (41.57)	1203 (47.36)	2405 (94.69)	52 x 33 (52 x 1.30)	1918 (4228)
DN2400	PN 2.5	2.5 (37)	2400 (94.49)	2778 (109.37)	677 (26.65)	1142 (44.96)	1303 (51.30)	2605 (102.56)	56 x 33 (56 x 1.30)	2262 (4987)
DN2600	PN 2.5	2.5 (37)	2600 (103.36)	2978 (117.24)	727 (28.62)	1229 (48.39)	1403 (55.24)	2085 (110.43)	60 x 33 (60 x 1.30)	2634 (5807)
DN2800	PN 2.5	2.5 (37)	2800 (110.24)	3192 (125.67)	777 (30.59)	1315 (51.77)	1515 (59.65)	3030 (119.29)	64 x 36 (64 x 1.42)	3550 (7826)
DN3000	PN 2.5	2.5 (37)	3000 (118.11)	3392 (133.54)	827 (32.56)	1402 (55.20)	1615 (63.58)	3230 (127.17)	68 x 36 (68 x 1.42)	4201 (9262)

Flange (standard) to **ANSI B16.5** and **AWWA**		**Body pressure rating**** in bar (psig)	**Dimensions** in mm (and inch)							**Weight** approx. in kg (lb)
Meter size	Flange rating		a	b*	d	e	f	dia. D	n x dia. d2 (n = number)	
1"	150 lbs	10 (150)	250 (9.48)	365 (14.37)	-	192 (7.56)	-	107.9 (4.25)	4 x 15.9 (4 x 0.63)	15 (33)
1¼"	150 lbs	10 (150)	260 (10.23)	370 (14.56)	-	196 (7.72)	-	117.5 (4.62)	4 x 15.9 (4 x 0.63)	17 (38)
1½"	150 lbs	10 (150)	270 (10.63)	377 (14.84)	-	206 (8.11)	-	127.0 (5.00)	4 x 15.9 (4 x 0.63)	19 (42)
2"	150 lbs	10 (150)	300 (11.81)	395 (15.55)	-	234 (9.21)	-	152.4 (6.00)	4 x 19.1 (4 x 0.75)	20 (44)
2½"	150 lbs	10 (150)	300 (11.81)	434 (17.09)	62 (2.44)	133 (5.23)	-	177.8 (7.00)	4 x 19.1 (4 x 0.75)	16 (36)
3"	150 lbs	10 (150)	300 (11.81)	453 (17.83)	85 (3.34)	138 (5.43)	-	190.5 (7.50)	4 x 19.1 (4 x 0.75)	18 (40)
4"	150 lbs	10 (150)	350 (13.78)	430 (16.93)	102 (4.02)	146 (5.75)	-	228.6 (9.00)	8 x 19.1 (8 x 0.75)	24 (53)
5"	150 lbs	10 (150)	350 (13.78)	459 (18.07)	109 (4.29)	157 (6.18)	-	254.0 (10.00)	8 x 22.2 (8 x 0.87)	26 (57)
6"	150 lbs	10 (150)	350 (13.78)	484 (19.06)	115 (4.53)	168 (6.61)	-	279.4 (11.00)	8 x 22.2 (8 x 0.87)	32 (71)
8"	150 lbs	10 (150)	400 (15.75)	540 (21.26)	127 (5.00)	190 (7.48)	-	342.9 (13.50)	8 x 22.2 (8 x 0.87)	46 (101)
10"	150 lbs	10 (150)	400 (15.75)	600 (23.62)	141 (5.55)	213 (8.39)	-	406.4 (16.00)	12 x 25.4 (12 x 1.00)	59 (129)
12"	150 lbs	10 (150)	500 (19.69)	663 (26.10)	154 (6.06)	235 (9.35)	-	482.6 (19.00)	12 x 25.4 (12 x 1.00)	85 (188)
14"	150 lbs	10 (150)	700 (27.56)	706 (27.80)	163 (6.42)	251 (9.88)	267 (10.51)	533.4 (21.00)	12 x 28.6 (12 x 1.13)	110 (242)
16"	150 lbs	10 (150)	800 (31.50)	763 (30.04)	175 (6.89)	273 (10.75)	298 (11.73)	596.9 (23.50)	16 x 28.6 (16 x 1.13)	137 (303)
18"	150 lbs	10 (150)	800 (31.50)	808 (31.81)	188 (7.40)	295 (11.61)	318 (12.52)	635.0 (25.00)	16 x 31.7 (16 x 1.25)	157 (347)
20"	150 lbs	10 (150)	800 (31.50)	866 (34.09)	201 (7.91)	316 (12.44)	349 (13.74)	698.5 (27.50)	20 x 31.7 (20 x 1.25)	200 (440)
22"	150 lbs	10 (150)	800 (31.50)	917 (36.10)	213 (8.39)	339 (13.35)	375 (14.76)	749.3 (29.50)	20 x 34.9 (20 x 1.37)	228 (502)
24"	150 lbs	10 (150)	800 (31.50)	974 (38.35)	226 (8.90)	361 (14.21)	406 (15.98)	812.8 (32.00)	20 x 34.9 (20 x 1.37)	258 (568)
26"	150 lbs	10 (150)	900 (35.43)	1027 (40.43)	238 (9.37)	382 (15.04)	435 (17.13)	869.9 (34.25)	24 x 34.9 (24 x 1.37)	291 (641)
28"	150 lbs	10 (150)	900 (35.43)	1082 (42.60)	251 (9.88)	404 (15.91)	464 (18.27)	927.1 (36.50)	28 x 34.9 (28 x 1.37)	342 (753)
30"	150 lbs	10 (150)	1000 (39.37)	1136 (44.72)	264 (10.39)	426 (16.77)	492 (19.37)	984.2 (38.75)	28 x 34.9 (28 x 1.37)	390 (860)
32"	150 lbs	10 (150)	1000 (39.37)	1200 (47.24)	277 (10.91)	448 (17.64)	530 (20.87)	1060.4 (39.96)	28 x 41.3 (28 x 1.63)	460 (1015)
34"	150 lbs	10 (150)	1100 (43.31)	1249 (49.17)	288 (11.34)	468 (18.43)	556 (21.89)	1111.2 (43.75)	32 x 41.3 (32 x 1.63)	515 (1135)
36"	150 lbs	10 (150)	1100 (43.31)	1304 (51.34)	301 (11.85)	490 (19.29)	584 (22.99)	1168.4 (46.00)	32 x 41.3 (32 x 1.63)	614 (1353)
38"	150 lbs	10 (150)	1200 (47.24)	1365 (53.74)	314 (12.36)	512 (20.61)	619 (24.37)	1238.2 (48.75)	32 x 41.3 (32 x 1.63)	706 (1557)
40"	150 lbs	10 (150)	1200 (47.24)	1416 (55.75)	326 (12.83)	534 (21.02)	645 (25.39)	1289.0 (50.75)	36 x 41.3 (36 x 1.63)	763 (1682)
48"	AWWA:B	6 (90)	1400 (55.12)	1629 (64.13)	378 (14.88)	624 (24.57)	756 (29.76)	1511.3 (59.50)	44 x 28.6 (44 x 1.13)	991 (2184)
56"	AWWA:B	6 (90)	1600 (62.99)	1846 (72.68)	428 (16.85)	711 (27.99)	873 (34.37)	1746.2 (68.75)	44 x 34.9 (44 x 1.37)	1182 (2606)
64"	AWWA:B	6 (90)	1800 (70.87)	2090 (82.28)	478 (18.82)	797 (31.38)	1016 (40.00)	2032.0 (80.00)	52 x 34.9 (52 x 1.37)	1798 (3965)
72"	AWWA:B	6 (90)	2000 (78.74)	2272 (89.45)	527 (20.75)	882 (34.72)	1099 (43.27)	2197.1 (86.50)	60 x 34.9 (60 x 1.37)	2071 (4566)
80"	AWWA:B	6 (90)	2200 (86.61)	2453 (96.57)	577 (22.72)	968 (38.11)	1181 (46.50)	2362.2 (93.00)	64 x 41.3 (64 x 1.63)	2285 (5037)
88"	AWWA:B	6 (90)	2400 (94.49)	2728 (107.40)	627 (24.69)	1056 (41.57)	1353 (53.27)	2705.1 (106.50)	68 x 47.6 (68 x 1.87)	2783 (6136)
96"	AWWA:B	6 (90)	2600 (103.36)	2913 (114.69)	677 (26.65)	1142 (44.96)	1438 (56.61)	2876.5 (113.25)	68 x 47.6 (68 x 1.87)	3111 (6859)
104"	AWWA:B	6 (90)	2800 (110.24)	3099 (122.01)	727 (28.62)	1229 (48.39)	1524 (60.00)	3048.0 (120.00)	72 x 54.0 (72 x 2.13)	3365 (7418)
112"	AWWA:B	6 (90)	3000 (118.11)	3372 (132.76)	777 (30.59)	1315 (51.77)	1695 (66.73)	3390.9 (133.50)	76 x 60.3 (76 x 2.37)	5162 (11380)
120"	AWWA:B	6 (90)	3200 (125.98)	3558 (140.08)	827 (32.56)	1402 (55.20)	1781 (70.12)	3562.4 (140.25)	76 x 60.3 (76 x 2.37)	6039 (13314)

11. Measuring principle

A sound wave travelling in the direction of flow of the fluid requires less time between one fixed point and another than one travelling in the opposite direction.

This is the principle employed to measure the flow rate with ultrasonic waves. Different flight times are an indication of the flow velocity of the fluid concerned.

Double-beam version: The ultrasonic sensors A + B and A' + B' are located in symmetrical arrangement on the outside of the measuring tube.

Single-beam version: The ultrasonic sensors A + B are located in symmetrical arrangement on the outside of the measuring tube at an angle of 180°.

Each line of measurement (A + B and A' + B') forms an angle φ with the tube centerline.

The ultrasonic waves travel from point A to point B at speed

$$v_{AB} = c_0 + v_m \times \cos\varphi$$

and, conversely, from point B to point A at speed

$$v_{BA} = c_0 - v_m \times \cos\varphi$$

The following applies to the different flight times from points A to B

$$t_{AB} = \frac{L}{c_0 + v_m \times \cos\varphi}$$

and from point B to A

$$t_{BA} = \frac{L}{c_0 - v_m \times \cos\varphi}$$

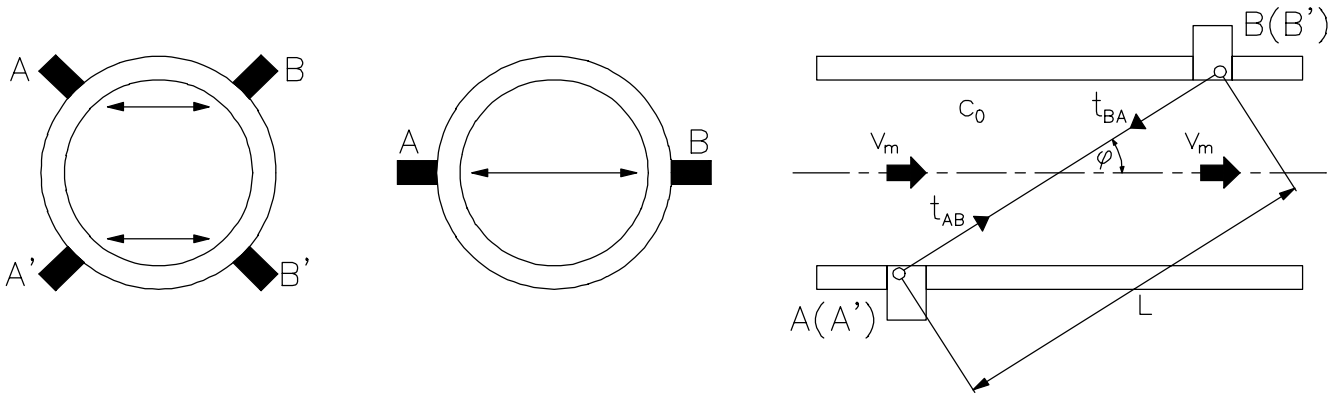
The mean flow velocity v_m of the product is calculated using the last two equations:

$$v_m = GK \times \frac{t_{BA} - t_{AB}}{t_{AB} \times t_{BA}}$$

t_{AB} and t_{BA} are measured continuously.

A (A')	Transmitter and receiver
B (B')	Transmitter and receiver
L	Distance between ultrasonic sensors
v_m	Average flow velocity of fluid
t_{AB} (v_{AB})	Time of flight (propagation speed) of sound waves from points B to A
c_0	Sound velocity in the medium (fluid)
GK	Calibration constant
φ	Angle between tube centerline and line of measurement

Double-beam **Single-beam**



12. Block diagrams

12.1 Signal converter UFC 400 ...

Signal converter UFC 400
The UFC 400 consists of four functional groups.

Functional group 1 generates the ultrasonic waves, controls the sensors and carries out high-precision measurement of the propagation time.

In **functional group 2** the digitized data supplied by μP 01 are evaluated by microprocessor μP 02 in accordance with the functions, operating and primary head data which are factory set. With the aid of the KROHNE-developed LSI circuit (KSA), microprocessor μP 02 controls the outputs that are galvanically isolated by opto-couplers (functional groups 3 and 4).

The KSA module is also used to feed last counts to the EEPROM. In the event of a power failure, last counts are saved in EEPROM 2. In the same way as operating and functional check data are permanently stored in EEPROM 1, both are retained for 10 years without auxiliary power.

Functional group 3 converts an output signal into a proportional current. This group is galvanically isolated from the other groups.

Functional group 4 consists of power drivers to allow control of electronic (EMC) or electromechanical (EC) totalizers and indicators. The group is galvanically isolated from the other groups. Note that the pulse output and the status output share the same common.

12.2 Signal converter UFC 500 ...

Signal converter UFC 500
The UFC 500 consists of four functional groups.

Functional group 1 generates the ultrasonic waves, controls the sensors and carries out high-precision measurement of the propagation time.

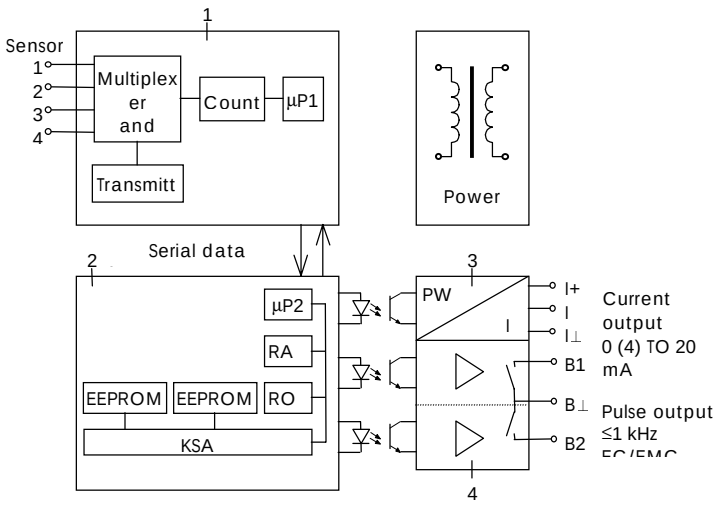
In **functional group 2** the digitized data supplied by μP 01 are evaluated by microprocessor μP 02 in accordance with the functions, operating and primary head data set by way of the 3 keys. With the aid of the KROHNE-developed LSI circuit (KSA), microprocessor μP 02 controls the outputs that are galvanically isolated by opto-couplers (functional groups 3 and 4). The last measured value and other information are forwarded via this circuit to the alphanumeric LCD for indication.

The KSA module is also used to feed last counts to the EEPROM. In the event of a power failure, last counts are saved in EEPROM. In the same way as operating and functional data are permanently stored in EEPROM 1, both are retained for 10 years without auxiliary power.

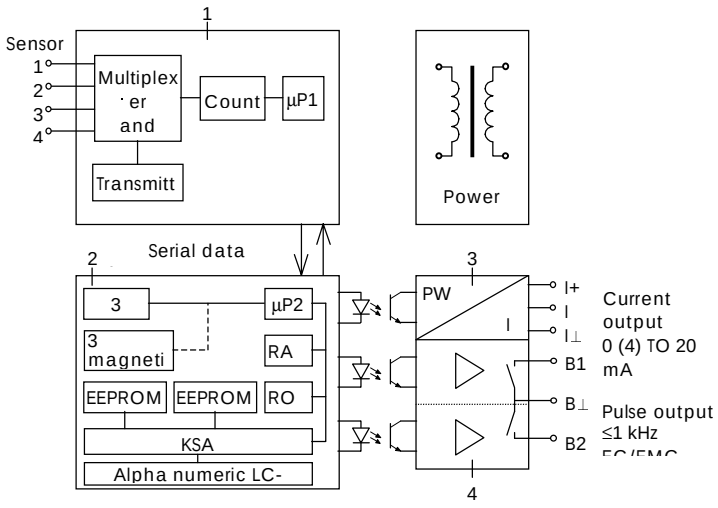
Functional group 3 converts an output signal into a proportional current. This group is galvanically isolated from the other groups.

Functional group 4 consists of power drivers to allow control of electronic (EMC) or electromechanical (EC) totalizers and indicators. The group is galvanically isolated from the other groups. Note that the pulse output and the status output share the same common.

Block diagram UFC 400...



Block diagram UFC 500...



Part E Index

- quantity factor	5.14	3.6.7
- text	5.14	3.6.6
- time factor	5.14	3.6.8
US path 1 + 2	4.4	ERROR LIST
V		
v = flow velocity	4.3+5.3	4.1
VDE 0100	1.3.1, 1.3.2, 2.1.2+2.2.2	
W		
Weights, see dimensions	10.4+10.5	
Z		
Zero check (adjustment)	7.2	3.1.4