M921

Electromagnetic flowmeter

User's manual

MEATEST

Content

Tables

1 Basic information

1.1 Basic features

The inductive flow meter M921 is designed to measure, indicate and record the instantaneous and total flow of the conductive media flowing through the sensor. The flow meter M921 records both forward and reverse flows. As there are no moving parts in the flow profile the M921 can be used to measure extremely dirty liquids containing solids. The only limitation is that the flowmeter can be used solely with conductive liquids.

Range of applications. The inductive flow meter M921 is for use in the Chemical Industry, Paper Industry, Water and Wastewater Treatment Industry and most other process industries.

Features. The inductive flowmeter M921 is a highly accurate and stable device. The construction of the M921 flowmeter uses components with long-term, time and temperature stability. Configuration data is backed up and can be recovered after a power failure. The back-up structure enables data recovery even if a partial loss of data occurs as a result of (e.g. high level electrostatic discharge or a noisy power supply). Internal CPU provides all functions usually built in electronic flow meters, incl. low flow rate correction, frequency response setting, bandwidth of sensitivity setting at low flow rates, etc.

Outputs. Flowmeter M921 is equipped with 6 standard isolated outputs: 4 to 20mA either active or passive, frequency output, impulse output, status output (with relay), RS485 and USB/RS232 output. User can configure these outputs.

Inputs. Flowmeter M921 has one programmable digital input (PLC).

Power supply. Basic power supply version is 85 to 264 V AC. 12, 24 and 48 DC power supply versions are also available as an option.

1.2 Warranty

Within the manufacturers general supply conditions, all material and manufacturing faults are covered by warranty. Upon warranty claim, Meatest will test the item and decide whether to repair it or replace with a new one. Place of the warranty obligation is Czech Republic. Further claims on compensation, especially for loss of production or resultant of damages, are strictly excluded.

Any defects caused by improper use are absolutely not included in the warranty. Excluded from warranty are also expendable items (as i.e. accumulators, batteries, pushbuttons after attained life time, ribbons, etc.)

In case of a warranty claim the user is asked to give detailed description of the defect and also of the application for which user use the product. This information is important in order to avoid time and cost extensive tests and for the eventual achievement of warranty claims from our suppliers and sub-suppliers. For the item or instrument, returned after the expired warranty time, repair or replacement on warranty can only be accepted, if manufacturer has been informed in time that a warranty case has occurred.

Warranty period for all types of electromagnetic flowmeter is 24 months.

The flowmeter should only be used according to the instructions described in this operating manual.

2   Mechanical installation

2.1 Sensor location

Observe the following instructions to avoid measurement errors due to air bubbles or partially filled pipe. Flowmeter should be installed in such way, that all electronic controls (such as display, keyboard, input/output connectors) are easily accessible. Please observe and allocate enough room for opening flowmeter hinged lid.

Horizontal (standard) mounting

The sensor tube must always remain full. The best way to achieve this is to locate the sensor in a low section of pipe, see the following picture. It is recommended to install the sensor in a section of straight pipe with at least 5 times the pipe diameter before sensor and 3 times after sensor.
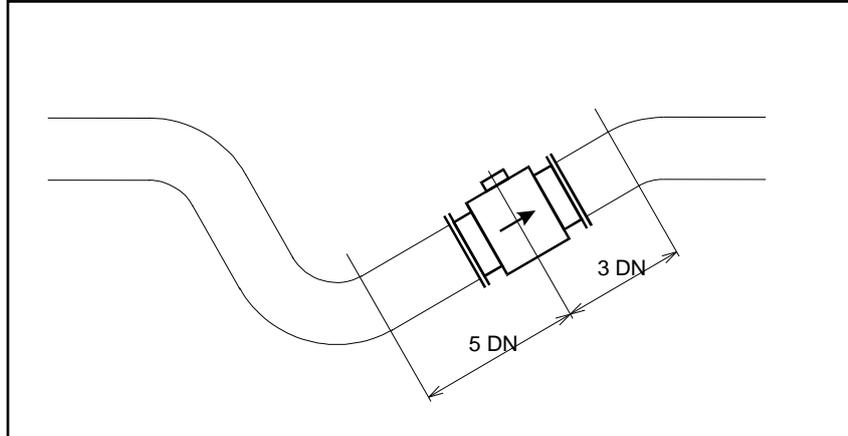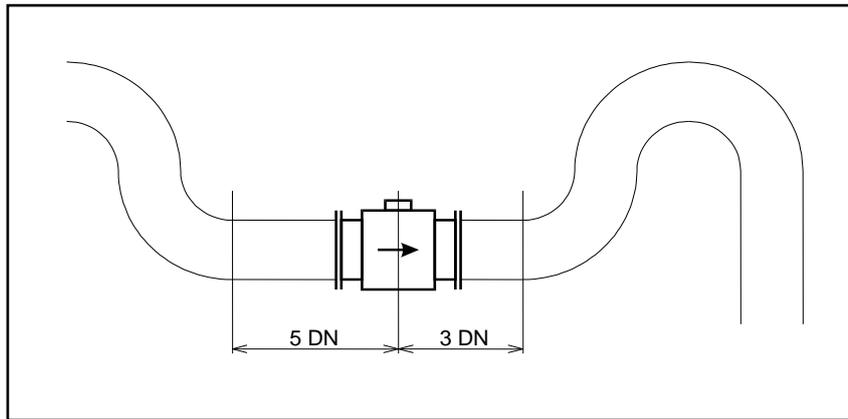
Pipe reducers

If the pipe diameter is not the same as the diameter of sensor, then pipe reducers can be used. So as not to lose accuracy of the measurement, the slope of reducers should not exceed 8°.
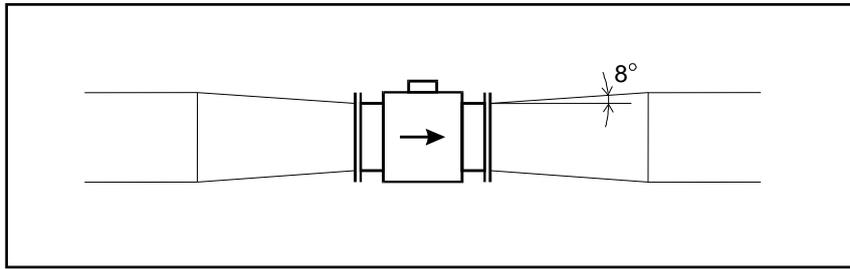
Vertical mounting

When the sensor is mounted on a vertical section of pipe, the flow direction must be upwards. In the case of a downward flow direction, air bubbles could collect in the sensor resulting in unstable and inaccurate measurement.
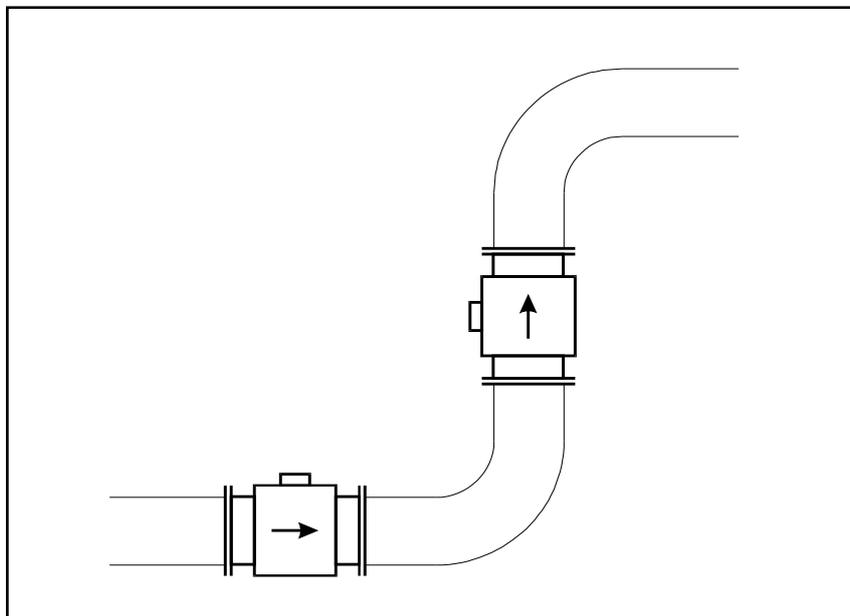
Pumps

Never install the sensor on the suction side of a pump or on a section of pipe where a vacuum is possible.
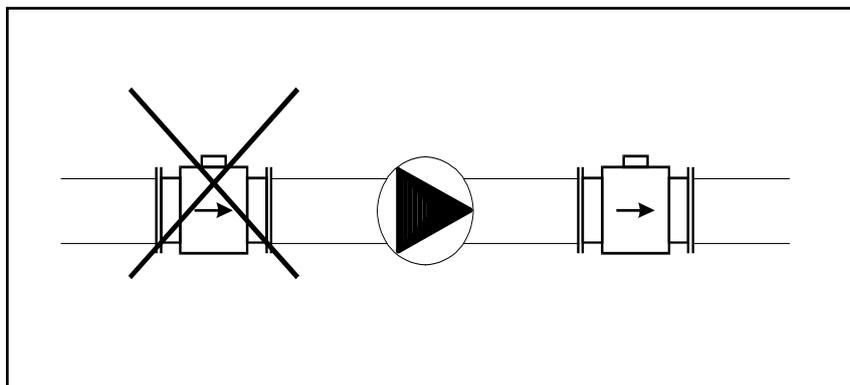
Valves

Suitable location of a shutoff valve is downstream of a sensor.
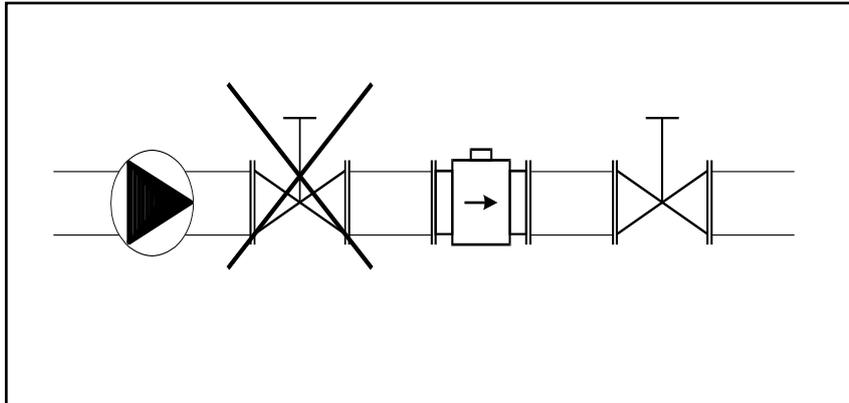
Removal during maintenance

If the application requires removal of the sensor for periodic maintenance, it is recommended to install a bypass section as the following drawing.
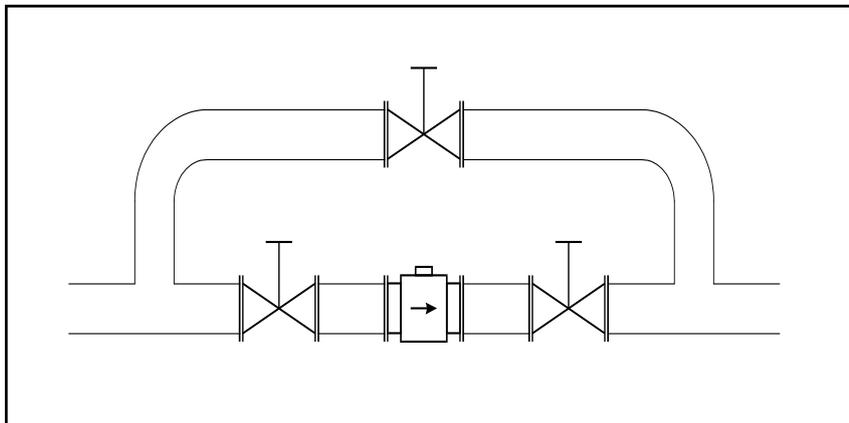
Position of electrodes

The axis of measuring electrodes must be approximately horizontal (see picture).

YES   **NO**

Vibration

To avoid mechanical damage protect both electronic unit and sensor against mechanical vibrations. When strong vibrations are possible, both the input and output pipe must be mechanically fixed or the remote version with a separate electronic unit should be used.

Overheating

To avoid overheating, the electronic unit should be protected against direct sunlight especially in areas with a warm climate with ambient temperatures over 30 °C. If necessary a sunshade has to be mounted over the electronic unit or a remote version with a separate electronic unit should be used.

2.2 Sensor grounding

> ## Caution!
>
> - Do not switch the flow meter on if it's not properly grounded.
>
> - Follow instructions in chapter 3 : *Preparing for start up* for proper electrical installation before switching flow meter on.

Proper grounding is critical for correct flow meter operation. The sensor is equipped with screw connection for a grounding wire. This screw has to be connected to both pipeline flanges. Use Copper wire to connect between the flange and the grounding screw on the sensor.

If the pipeline is made of an electrically nonconductive material, or if the pipe is lined with a similar material, special grounding rings must be installed between flanges.

Sensor grounding without grounding rings   Sensor grounding with grounding rings
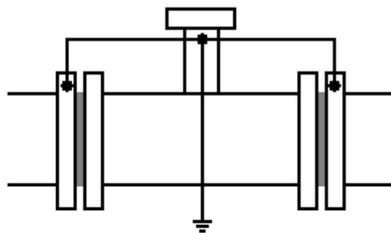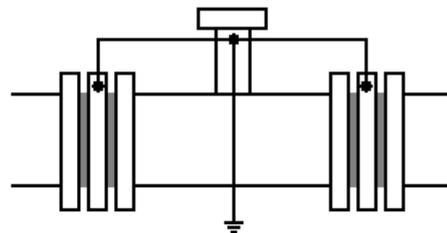
3 Preparing for start up

3.1 Safety precautions

The instrument has been designed according to EN 61010-1:2011. Safety is ensured by the design and by the use of specific component types. Manufacturer is not liable for the damage caused by not following instructions present in this manual or modification of the construction or replacement of parts with non-original ones.

Caution!

- Only a competent person may connect the flowmeter to the mains power supply.

- To prevent accidents, connect main power only after all other wiring has been completed.

- Use only specified voltage and frequency for user flow meter version.

- Take national applicable laws and rules into account.

3.1.1 Safety symbols used on the equipment

Warning, reference to the documentation

3.2 Inspecting contents of the package

Basic package includes the following items:

- Flanged sensor
- Electronic Transmitter (integral or remote)
- Spare fuse
- Operating manual.
- Calibration certificate
- Software FlowAssistant
- USB A-B cable

The flowmeter is delivered ready for use after connecting to the power supply. Please check that it has been correctly installed according to chapter Mechanical before turning power on. Only a power supply with the appropriate voltage and frequency must be used, see ordering information in chapter "Power supply".

3.3 Electronic unit description

3.3.1 Front panel
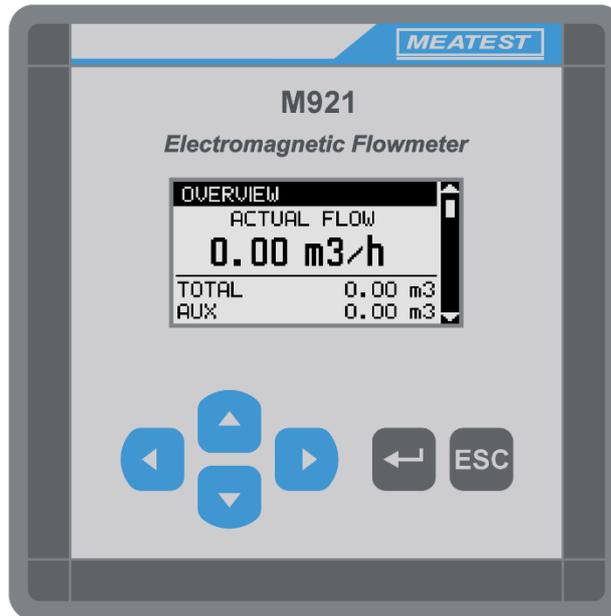
Display

Flowmeter features graphic display with backlight with resolution of 128x64 pixels.

Keyboard

6 keys enable user to change flowmeter configuration. Menus can be navigated with four arrow keys, user can confirm or cancel configuration with <u>Enter</u> and <u>Escape</u> keys.

Hinged lid

Lid can be opened by first pulling hinge retainer to the direction outside of the case, then pulling lid in the front to open it. Lid is mounted to open from left to right, opposite direction is available as option. Hinge assembly can be also reassembled by qualified user later if needed, to enable lid to be opened from opposite side of the case.

3.3.2   Under the lid of the flowmeter case
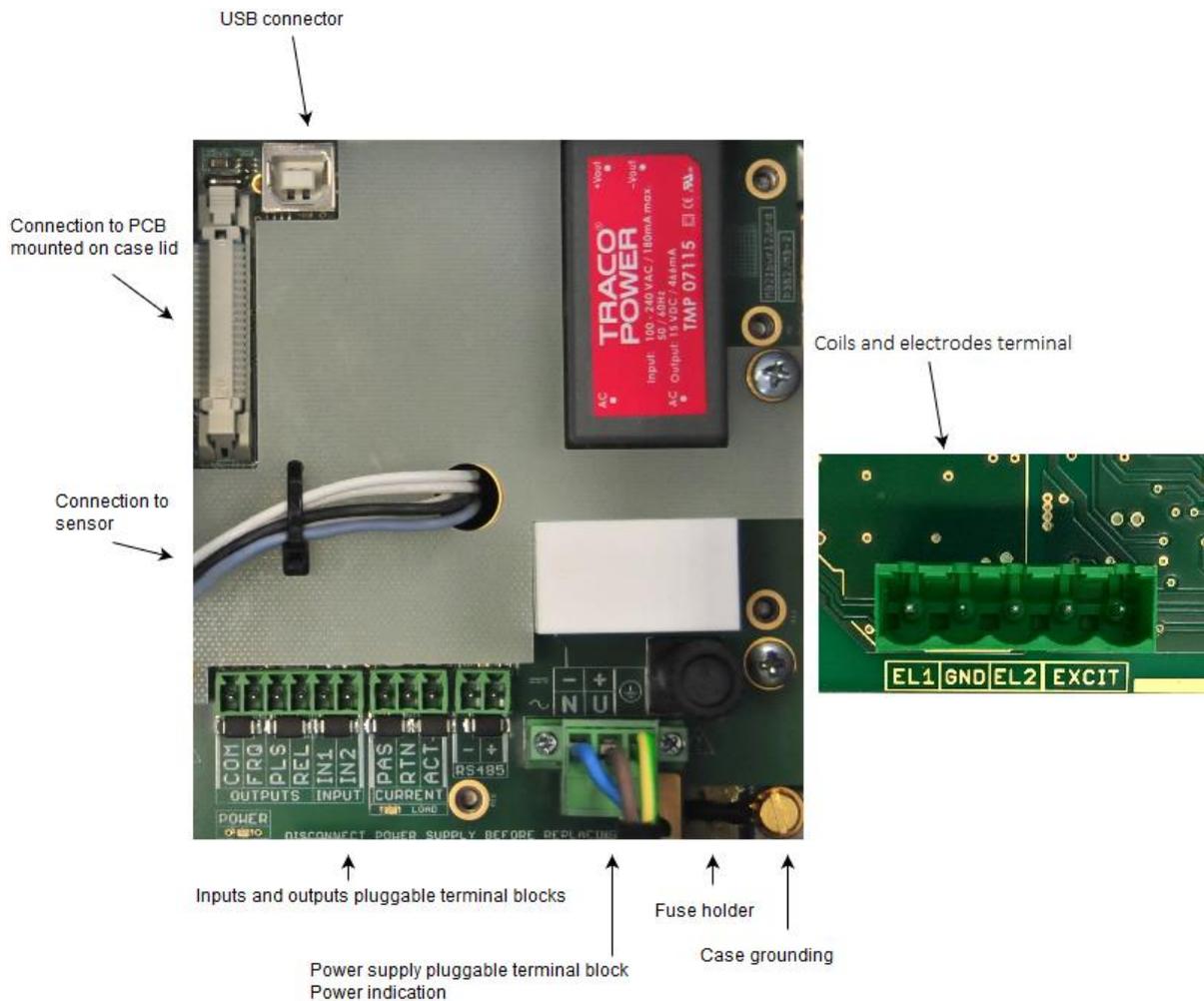
Power supply voltage terminal, fuse holder

Connect appropriate supply voltage to pluggable terminal block. For more information please refer to chapter *Electrical connection*.

I/O interface terminals

Connect desirable input or output to pluggable terminal blocks. Frequency, impulse and status outputs are galvanically connected to each other (sharing common ground – COM), and galvanically isolated from other electronic circuits of flowmeter. For more information and configuration of input and outputs please refer to chapter *Inputs and outputs configuration*.

USB connector

Flowmeter configuration can be changed by remote commands. For more information please refer to chapter *USB/RSR232*.

Coils and electrodes terminal

Please connect coil, electrodes to pluggable terminal block.

3.4 Electrical connection

> ## Caution!
>
> - Only a **competent person** may connect the flowmeter to the mains power supply.
>
> - **Protective earth conductor (PE)** must be **longer** than neutral (N) and phase (L) conductors after mounting mains supply voltage wires into pluggable terminal block on PCB.
>
> - Pluggable part of terminal block for mains voltage have to be secured by side flange screws during flowmeter operation.
>
> - To prevent accidents, **connect main power** only **after** all other wiring has been completed.
>
> - In the case of a fixed connection an independent **power switch or circuit breaker** should be located as close as possible to the flowmeter.
>
> - Only **cables rated for** appropriate voltage, current and temperature should be used for wiring any electrical connections to the flowmeter.
>
> - **Do not cross or loop** cables inside electronic unit.
>
> - Use **separate cable entries** for power supply, input/output signal wires and electrodes/coils (remote version) Each of the cable entries has its own cable grommet.
>
> - **Take national applicable laws and rules into account.**

The flowmeter can be connected to the power supply with either a fixed power cable or with a flying lead cable and plug. Cable entries on the electronic unit can be used for flexible electrical cables. Cables with a diameter between 8 and 10 mm must be used to keep protection IP67. It is not recommended to use rigid metal or plastic conduits.

If user use a cable and plug it is recommended that the cable has a cross-section of 3 x 1.5mm^2 and with a minimum length of 1 m.

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3.4.1   Power supply

To connect the compact version to the power supply the following procedure should be used :

1. Disconnect power to the unit before attempting any connection changes.

2. Open flowmeter case.

3. Connect the protective earth (PE) – ground wire, line and neutral to supplied pluggable part of terminal block.

4. Insert pluggable part of terminal block to connector on PCB. Connector has 3 pins and is located in the bottom right corner of the bottom PCB. Please observe connector polarity.

5. Secure pluggable connector flanges tightening screws.

6. Close flowmeter case

7. Switch on the power supply.

Flow meter electronics unit case : DC power supply version

Fuse holder

To change fuse:
a) turn to the left
b) pull outside
c) change fuse
d) reinsert back

FUSE

PCB Header

3. secure screws **2. insert** **3. secure screws**

Pluggable terminal

-
Negative

+
Positive

1. Insert conductors and secure screws

Cable grommet

External power supply
12V or 24V or 48V DC
(depends on version)
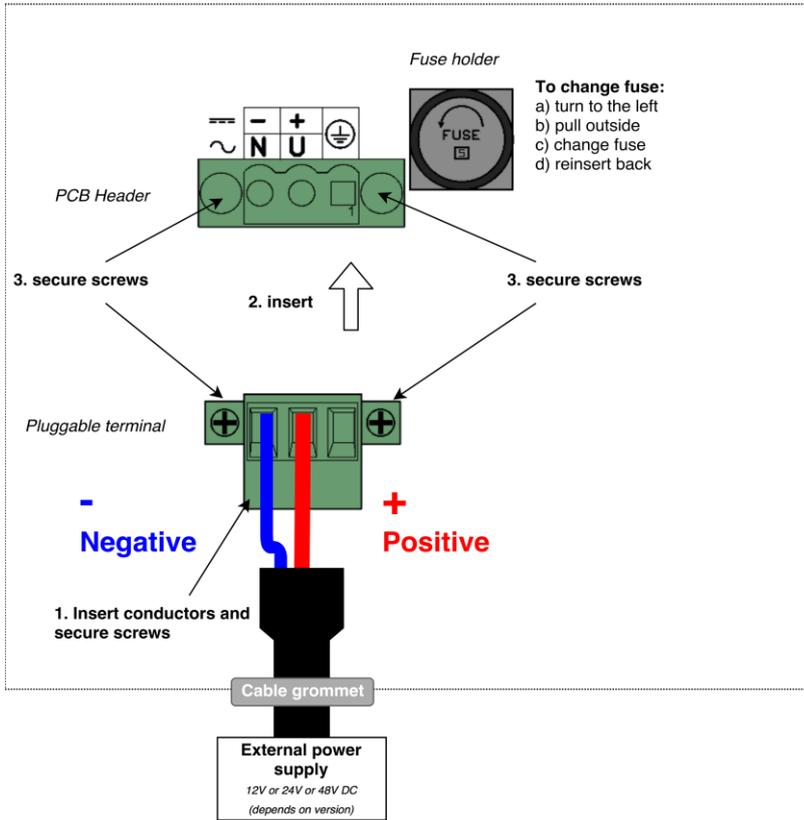
Flow meter electronics unit case : AC power supply version

Fuse holder

To change fuse:
a) turn to the left
b) pull outside
c) change fuse
d) reinsert back

FUSE

PCB Header

3. secure screws **2. insert** **3. secure screws**

Pluggable terminal

N
Neutral

L
Phase

PE
Protective earth (ground)

Must be the longest !

1. Insert conductors and secure screws

Cable grommet

External power switch or circuit breaker

Distribution network
115/230V AC 50/60Hz
(with protective earth)

3.4.2   Fuse replacement

A mains fuse is located in the bottom left corner of the flowmeter case. The fuse must only be exchanged by a competent person. Procedure is as follows:

1. Disconnect the power supply from the flowmeter before attempting any connection changes.

2. Open flowmeter case.

3. Unscrew top part of the fuse holder by a hand turning top part to the left. Remove the fuse. Replace it with new fuse with the same voltage and current rating. Fuse parameters can be seen in Table 1.

4. Close flowmeter case.

5. Switch on the power supply.

Flowmeter is delivered in four power supply versions with different fuses:

Nominal range	Range	Version	Fuse
230/115V AC 50/60Hz	85 V to 264 V AC 47-65 Hz	M921-Vxx**0**x	315 mA
12V DC	9 V to 18 V DC	M921-Vxx**1**x	2 A
24V DC	18 V to 36 V DC	M921-Vxx**2**x	1 A
48V DC	36 V to 75 V DC	M921-Vxx**3**x	1 A

Table 1: Power supply ranges and fuse ratings

3.4.3   Electric connection between converter and sensor – Remote version

> **Caution!**
>
> - Unsealed box has ingress protection level IP65 only.

Converter and flanged sensor are connected with two (2-wire unshielded and 3-wire shielded) cables. Standard length of cables is 6 meter. It is recommended to mount the transmitter as close as possible to flanged sensor. Five-terminal connector is located in separated box. The same box is used for the converter and also for the sensor. Colors of wires are following:

 :

3-wire shielded cable (shielding is connected to the green wire)	
Blue (Brown)	Electrode 1 (EL1)
Green	Ground
Red (White)	Electrode 2 (EL2)
2-wire cable	
Brown	Excitation 1 (EXCITATION)
White	Excitation 2 (EXCITATION)

Table 2 : Remote version connections

Use the following procedure to connect sensor cable to the transmitter or sensor:

1. Switch off power supply.
2. Dismount top cover of connection box. Four screws must be removed.
3. Connect 5 wires to the connector.
4. Fill the box with connected wires with reenterable insulating and sealing compound to archieve ingress protection corresponding to IP67 (transmitter) and IP68 (sensor). One piece of compound is standard part of delivery.
5. Mount the cover back.
6. Switch on power supply.

4 Flowmeter configuration

4.1 Main menu

Main menu is the first menu that appears on power up and can be always reached from all other menus by pushing the ESC key repeatedly. Main menu can be navigated by using four direction arrow buttons. UP and DOWN buttons are used to switch to next and previous screen in main menu. Pressing LEFT button, user can switch instantly to first main menu screen, by pressing RIGHT button to last main menu screen. On the right side of the screen, navigation bar can be seen, to note user of actual screen.
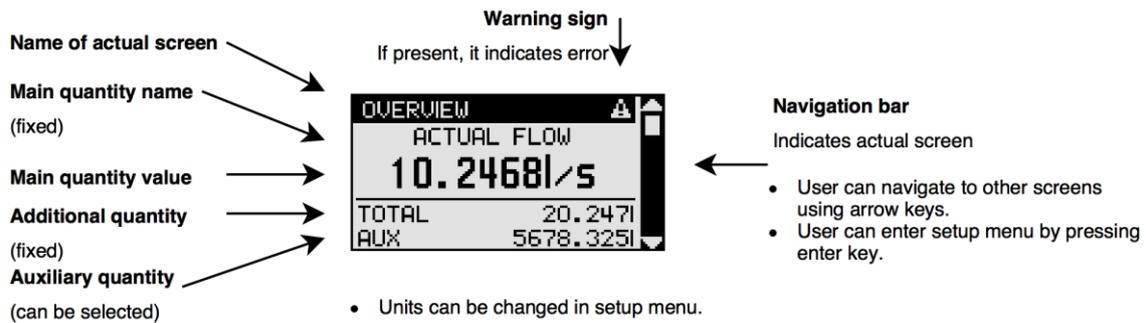
4.1.1 Overview

This screen is displayed as first after device start as default. Actual flow, total volume and auxiliary volume is displayed on this screen. Bottom item (auxiliary volume as default) can be changed to display other types of volume in Setup menu/General/Display.

4.1.2 Datalogger

This screen displays and provides access to Datalogger function. Datalogger records can be reviewed using LEFT and RIGHT buttons.

4.1.3 Status

This screen displays information about device state and configuration. On the first line, date and time are displayed.

4.1.4 Flow

This screen displays actual and other types of measured flow.

4.1.5 Volume

This screen displays total and other types of measured volume.

4.2 Setup menu

Setup menu provides access to flowmeter configuration and can be accessed by pressing <u>Enter</u> button from Main menu and entering appropriate password. There are three levels of acces to flowmeter. Passwords can be changed in *Setup menu/General/User access*. In the following tables, settings requiring Calibration access are marked as <u>underlined</u>.

Access level	Default password
User	00000
<u>Calibration</u>	10000
Service	Only for qualified service personal.

Table 3 : User access

4.2.1 General

Setup menu/**General**		
Level 1	Level 2	Description
About device		Basic information about device such as serial number, SW/HW versions and pipe diameter can be displayed on screen.
	Language	User can switch flow meter language in this menu.
Display	Backlight	Display backlight can be set on or off in this menu.
	Contrast	Configuration of display contrast.
	Startup screen	User can specify which screen of main menu should be displayed after flowmeter startup.
	Aux item	User can choose from various types of measured flow to display as bottom item on Overview screen in main menu.
Date & time	Time	Date, time and date format can be changed here. Flow meter features backup voltage source to date and time backup in case of power outage.
	Date	
	Date format	
User access	Change basic password	Flowmeter user acces control.
	Change calibration password	
<u>Factory settings</u>	Restore calibration points	User can restore flowmeter settings to factory configuration here.
	Restore other settings	
	Restore all settings	

Table 4 : General settings

4.2.2   Measurements

Setup menu/**Measurements**		
Level 1	Level 2	Description
Flow	Unit	Function enables user to set flowrate units. Available units are: • l/s (litres per second) • m3/h (cubic metres per hour) • UG/m (US gallons per minute) • IG/m (imperial gallons per minute) • user user-defined unit
	User unit	Function enables user to set the name of user unit. Maximum length is three letters.
	User constant	Function enables user to set the conversion constant for user unit. This constant is calculated as the ratio between flowrate in [l/s] and flowrate in [user unit].
	Resolution	Setting enables user to change number of displayed digits for flow measurement in main menu.
	Direction	Function enables user to switch between "Positive" and "Negative" flow direction (change the sign in flowrate value). *Note: Flowmeters are working in both flow directions. However standard calibration is made for positive direction only.*
	Low flow cutoff	Function enables user to set limit for suppressing low flowrates. Available range is according to the nominal diameter. *Note: All flowrates below this value will be displayed as 0. This setting is valid for display and all outputs.*
	Moving average	Function enables user to change sampling time in seconds for moving average calculation. Available range is between 1 and 20 seconds. *Note: Response time of flow meter to fast changing flow can be compromised if large number of samples to average is selected.*
	Clear min,max flow	User can clear minimal and maximal measured flow.
Volume	Unit	Function enables user to set volume units. Available units are: • m3 (cubic metres) • l (litres) • UG (US gallons) • IG (US gallons) • user (user-defined unit)
	User unit	Function enables user to set the name of user unit. Maximal length is three letters.
	User constant	Function enables user to set the conversion constant for user unit. This constant is calculated as the ratio between volume in [l] and volume in [user unit].
	Resolution	Setting enables user to change number of displayed digits for volume measurement in main menu.
	Clear volume	User can clear auxiliary or daily or positive and negative measured volume.

Temperature	Unit	Function enables user to set temperature units. Available units are: • °C • °F • K
Datalogger	Interval	Function enables user to set sample interval for internal datalogger between 5 and 240 minutes, or turn datalogger off.
	Memory usage	Function displays memory usage in %. Datalogger capacity is over 100 000 samples.
	Clear	Function enables user to clear datalogger memory.

Table 5 : Settings for measurement

4.2.3   Input/output interface

Following table lists only brief explanation of configuration of inputs and outputs. For more detailed guide on inputs and outputs configuration see chapter Inputs and outputs configuration.

Setup menu/**I/O interface**		
Level 1	Level 2	Description
PC interface	Active bus	Active bus can be selected between RS232 and RS485 protocols.
	RS485 address	RS485 address can be assigned from 0 to 31.
	Baudrate	Baudrate can be selected from 1200 to 115200.
	RS485 Modbus	Modbus on RS485 can be selected from Off, Modbus RTU and Modbus ASCII.
	Modbus parity	Modbus parity mode can be selected from none, even or odd parity.
	Modbus address	Modbus address can be selected from 1 to 247.
Current output	Mode	Output mode can be selected from Off, Positive flow, Negative flow, Absolute flow, Bipolar flow and Fixed.
	Fixed current	Item allows setting current amplitude in the current mode f) (Fixed). The range is from 4 mA to 20 mA.
	Qi 20mA	Item allows setting the Qi constant. Qi represents a flowrate for a current of 20 mA and can be set independently to the nominal diameter of the sensor.
	Loop test	Item allows enable/disable the current loop test. The flowmeter will detect a fault (Error 08 – Current open) if the test is enabled and current loop is not connected.
	Error current	Item allows setting current loop error current from 3 mA to 3.75 mA or from 21 mA to 24 mA. Current output is switched to selected value in case of present error state in flow meter.
Frequency output	Mode	Output mode can be selected from Off, Positive flow, Negative flow, Absolute flow, On positive, On negative, On In, On out, Dose on, Dose off, On<F2, On>F2 and Fixed.
	Fixed frequency	Item allows setting frequency in the frequency mode m) (Fixed). The range is between 10 and 12000 Hz.
	Qf 1kHz	Item allows setting the Qf constant. Qf represents the flowrate for the frequency 1000Hz and can be set independently to the nominal diameter of the sensor.
Pulse output	Mode	Output mode can be selected from Off, Positive flow, Negative flow, Absolute flow, On positive, On negative, On In, On out, Dose on, Dose off, On<F1, On>F1 and Fixed.
	Pulse width	Item allows setting pulse width in ms. Available widths are 2.5, 5, 10, 25, 50, 100, 250 and 500 ms.

	Qp 1 pulse	Item allows setting the Qp constant. Qp represents the volume for one impulse.
Status output	Mode	Output mode can be selected from Off, On positive, On negative, On In, On out, Dose on, Dose off, On<F1, On>F1, Error on, Error off.
	Error mask	The Mask allows selecting which errors will be reported via the Status Output. Mask value is calculated as sum of bit values all enabled errors. See Table 11 : Error mask.
Digital input	Mode	Input mode can be selected from Off, Start dose, Clear aux. volume, Clear all volumes, State out on, State out off, State out toggle, Empty pipe.
Limits	Limit PF1	Low flowrate limit.
	Limit PF2	High flowrate limit.
	Hysteresis	Hysteresis of flowrate limits.
Dosing	Volume	Function enables user to set volume for dosing.
	Actual	Function displays actual state of measured dose.
	Stop dosing	Function enables user to stop dosing in progress.

Table 6 : Input/output interface setup

4.2.4 Calibration

4.2.4.1 Basic calibration

Following table lists basic calibration. This menu recalculates all internal calibration points.

User can change calibration values only if the correct calibration password has been entered. Default factory set Calibration password is "10000".

Setup menu/**Calibration**	
Level 1	**Description**
Set zero flow	Recalibrates flowmeters zero point. Before starting recalibration measuring tube must be completely filled and flowrate must be '0'.
Relative difference	Recalibrates flowmeters slope (relative). Slope can be selected from -15 % to +15 %.
Actual flow	Actual measured flow (actual average - Setup menu/Flow/Moving average)
30s average flow	Actual measured flow (30s average)

Table 7 : User calibration

**User can restore calibration settings to factory values
(Setup menu/General/ Factory settings/ Restore calibration points).**

4.2.4.2 Extended calibration

Flowmeter M921 enables calibration at 2, 3 or 4 points. Each calibration point contains 2 values. Nominal value of calibration point is selected by user in range between +/- QMAX (for maximum flowrates see table 1: M921 flowrates). It is expressed in flowrate units. To this nominal value is attached a calibration constant. Calibration constant doesn't have a unit. In the calibration process user change this calibration constant to reach similarity between standard flowmeter and the calibrated flowmeter. Higher calibration constant means lower displayed value.
Calibration constants must be different. In the case of two equal calibration constants, the measured values could be wrong.

<div style="border: 2px solid black; padding: 10px;">

Setting any new value in calibration menu changes calibration data! Calibration should be performed in an appropriate equipped laboratory.

</div>

<div style="border: 2px solid black; padding: 10px;">

**User can restore calibration settings to factory values
(Setup menu/General/ Factory settings/ Restore calibration points).**

</div>

We recommended using software FlowAssistant for easy Extended Calibration. It contains „calibration wizard" and can prevent flowmeter from incorrect calibration.

Extended Calibration is available via the USB interface only.

User can change calibration values only if the correct calibration password has been entered. Default factory set Calibration password is "10000".

4.3 Nominal values (standard factory setting)

4.3.1 General

General	
Language	English
Display/Backlight	On
Display/Contrast	Medium
Display/Startup	Overview
Display/Aux item	Aux. Volume
Date & time/Time	Actual time
Date & time/Date	Actual date
Date & time/Format	M/D/Y
Basic password	00000
Calibration password	10000

Table 8 : Nominal values - general

4.3.2 Measurements

Flow	
Unit	m3/h
Resolution	default
User constant	1.0
Direction	Positive
LF cutoff	flowrate Q 1% /2
MA samples	4 s
Empty pipe detect	On
Volume	
Unit	m3
Resolution	default
User constant	1.0
Datalogger	
Interval	Off
Temperature	

Unit	°C

Table 9 : Nominal values – measurements

4.3.3   Inputs / outputs

PC interface	
Active bus	RS232
RS485 address	2
Baudrate	9600
Mode	Normal
Modbus parity	None
Modbus address	10
Current output	
Mode	Off
Fixed current	10 mA
Qi 20mA	flowrate Qn (nominal flowrate)
Loop test	Off
Error current	3.75 mA
Frequency output	
Mode	Off
Fixed frequency	1000 Hz
Qf 1kHz	flowrate Qn (nominal flowrate)
Pulse output	
Mode	Off
Pulse width	100 ms
Qp 1 pulse	flowrate Qn (nominal flowrate)
Status output	
Mode	Off
Error mask	All errors (255)
Digital input	
Mode	Off
Limits	
Limit PF1	flowrate -Qn (- nominal flowrate)
Limit PF2	flowrate +Qn (+ nominal flowrate)
Hysteresis	flowrate Qn/10
Dosing	
Dose volume	1 m3/h

Table 10 : Nominal values - inputs/outputs

5   Inputs and outputs configuration

5.1 General purpose inputs and outputs

5.1.1   Current output

Current loop 4 to 20 mA can be set as passive type connecting to terminals PAS and RTN or as active type by connecting to terminals ACT and RTN. In both cases outputs are galvanically separated from all other electronic circuits of the flowmeter. Voltage drop on the passive current loop is 4 V. Active current loop can work with maximum load of 800Ω.

5.1.1.1   Mode

Current loop output can be programmed in one of the following modes:

a)	**Off**	current output is adjusted to 4mA (error message 01 - "Current output" is switched off)
b)	**Positive Flow**	current 4+16*Flowrate / Qi [mA] is generated for a positive flowrate direction. For a negative flowrate direction 4mA is generated.
c)	**Negative Flow**	current 4-16*Flowrate / Qi [mA] is generated for a positive flowrate direction. For a positive flowrate direction 4 mA is generated.
d)	**Absolute Flow**	current 4+16*abs(Flowrate) / Qi [mA] is generated for both flowrate directions.
e)	**Bipolar Flow**	current 12+8*Flowrate / Qi [mA] is generated for both flowrate directions.
f)	**Fixed**	current output is adjusted to fixed value (4.000 … 20.000 mA)

5.1.1.2   Fixed current

Item allows setting current amplitude in the current mode f) (Fixed). The range is from 4 mA to 20 mA. Fixed current mode is suitable for testing purposes.

5.1.1.3   Flowrate for 20mA (Qi 20mA)

Item allows setting the Qi constant. Qi represents a flowrate for a current of 20 mA and can be set independently to the nominal diameter of the sensor. The range of Qi value is proportional to the flowrate range of range of the flowmeter (DN diameter).

5.1.1.4   Current loop test

Item allows enable/disable the current loop test. The flowmeter will detect a fault (Error 08 – Current open) if the test is enabled and current loop is not connected.

5.1.1.5   Error current

Item allows setting current loop error current from 3 mA to 3.75 mA or from 21 mA to 24 mA. Current output is switched to selected value in case of present error state in flow meter.
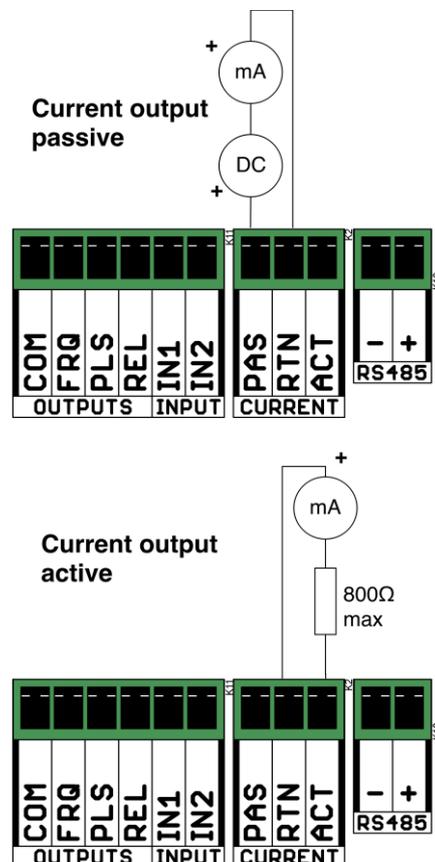
5.1.2   Frequency output

Frequency output is provided via galvanically isolated NPN transistor switch. Voltage drop on the switch is 1 V during on state. Maximum switched voltage is 50 V. Maximum switched current should not exceed 100 mA. Positive output is on terminal FREQ, negative output is on terminal COM. Frequency range of the output is 10 Hz to 12 kHz.

Note 1: *Frequency, impulse and status outputs are galvanically connected to each other and galvanically isolated from other electronic circuits.*

Note 2: *Active frequency output uses the power supply of the current output. Total current consumption from this power supply must be less than 40 mA. Active frequency output is galvanically connected to current output.*

Note 3: *In case of using this output as a passive, external source and current limiting is necessary.*
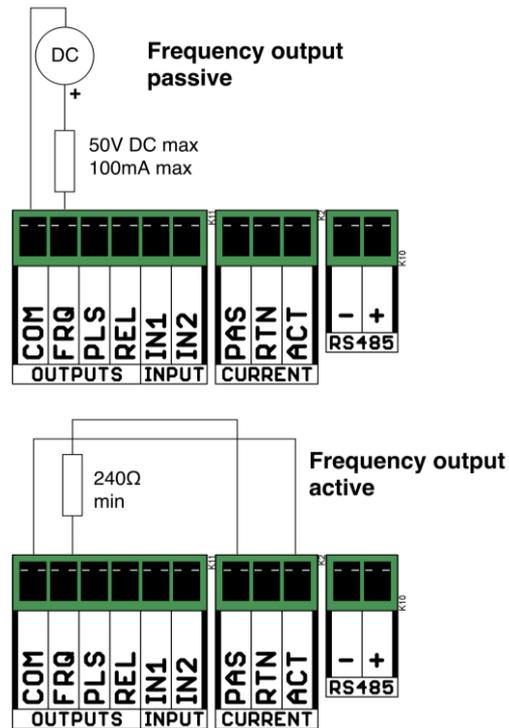
5.1.2.1   Mode

The frequency output can be programmed in one of following modes:

a) **Off**   output is not active (HI state).
b) **Positive Flow**   frequency 1000*Flowrate/Qf [Hz] is generated for positive flowrate direction.
c) **Negative Flow**   frequency -1000*Flowrate/Qf [Hz] is generated for negative flowrate direction.
d) **Absolute Flow**   frequency 1000*abs(Flowrate)/Qf [Hz] is generated for both flowrate directions.
e) **On Positive**   output is HI in case of negative flow and LO in case of positive flow.
f) **On Negative**   output is HI in case of positive flow and LO in case of negative flow.
g) **On In**   output is LO, when flowrate is higher than PF1 and lower than PF2, otherwise it is HI.
h) **On Out**   output is HI, when flowrate is higher than PF1 and lower than PF2, otherwise it is LO.
i) **Dose On**   output is LO, when programmed dose is being measured and HI when the dose is out.
j) **Dose Off**   output is HI, when programmed dose is being measured and LO when the dose is out.
k) **On<F2**   output is LO, when flowrate is lower than PF2, otherwise it is HI.
l) **On>F2**   output is LO, when flowrate is higher than PF2, otherwise it is HI.
m) **Fixed**   frequency output is adjusted to fixed value (10 … 12000 Hz)

If setting the flow limit is chosen, hysteresis H can be set too. Hysteresis is a tolerance field on one side of flow limits PF1 and PF2. The output status changes (indicates crossing over the pre-set limit), when the immediate flowrate crosses over the value PF2 (or goes below limit PF1). The output status comes back to the default status, when the immediate flowrate decreases under the value PF2-H (or increases over limit PF1+H) again.

Mode g) with non-zero hysteresis:

Mode h) with non-zero hysteresis:

Mode k) with non-zero hysteresis:

Mode l) with non-zero hysteresis:
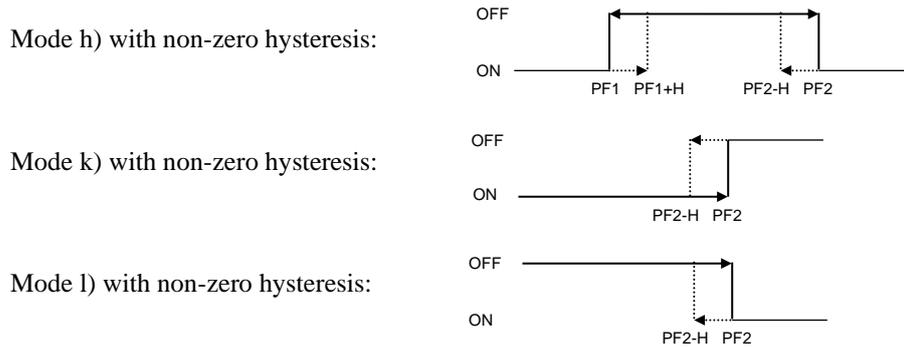
Qf value represents flowrate for frequency 1000 Hz and can be set independently to the nominal diameter of the sensor. Values PF1, PF2 and H are described in the chapter "LIMITS".

5.1.2.2   Fixed frequency

Item allows setting frequency in the frequency mode m) (Fixed). The range is between 10 and 12000 Hz. Fixed frequency mode is suitable for testing purposes.

5.1.2.3   Flowrate for 1kHz (Qf 1kHz)

Item allows setting the Qf constant. Qf represents the flowrate for the frequency 1000Hz and can be set independently to the nominal diameter of the sensor. The range of Qf value is proportional to the flowrate range of range of the flowmeter (DN diameter).

5.1.3   Pulse output

Pulse output is formed by a galvanically isolated NPN transistor switch. Voltage drop on the switch is 1 V in HI state. Maximum switched voltage is 50 V. Maximum switched current should not exceed 100 mA. Positive output is on terminal PLS, negative output is on terminal COM. Width of the impulse can be set. Maximum frequency of impulse output is limited by the impulse width. For the shortest impulse 2.5 ms there is maximal frequency of 200 Hz.

Note 1: Frequency, impulse and status outputs are galvanically connected to each other and galvanically isolated from other electronic circuits.

Note 2: Active pulse output uses the power supply of the current output. Total current consumption from this power supply must be less than 40 mA. Active frequency output is galvanically connected to current output.

Note 3: In case of using this output as a passive, external source and current limiting is necessary.
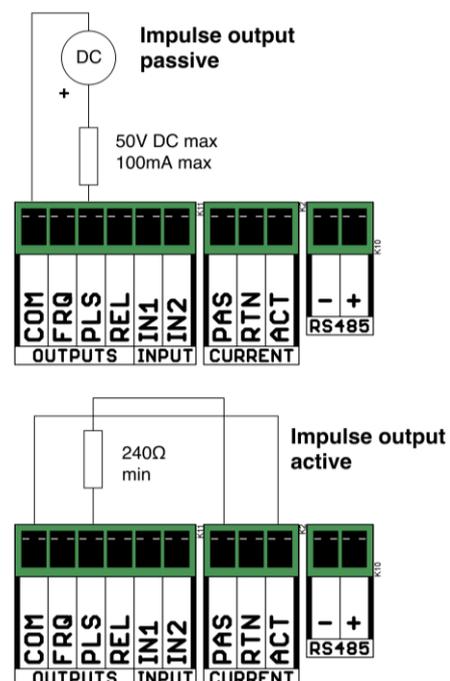
5.1.3.1   Mode

Pulse output can be programmed in one of the following modes:

a)	**Off**	output is not active (HI state).
b)	**Positive Flow**	1 impulse is generated every time when volume Qp has flown in positive direction.
c)	**Negative Flow**	1 impulse is generated every time when volume Qp has flown in negative direction.
d)	**Absolute Flow**	1 impulse is generated every time when volume Qp has flown in any direction.
e)	**On Positive**	output is HI in case of negative flow and LO in case of positive flow.

f)	**On Negative**	output is HI in case of positive flow and LO in case of negative flow.
g)	**On In**	output is LO, when flowrate is higher than PF1 and lower than PF2, otherwise it is HI.
h)	**On Out**	output is HI, when flowrate is higher than PF1 and lower than PF2, otherwise it is LO.
i)	**Dose On**	output is LO, when programmed dose is being measured and HI when the dose is out.
j)	**Dose Off**	output is HI, when programmed dose is being measured and LO when the dose is out.
k)	**On>F1**	output is LO, when flowrate is higher than PF1, otherwise it is HI.
l)	**On<F1**	output is LO, when flowrate is lower than PF1, otherwise it is HI.

If setting of flow limit is chosen, hysteresis H can be set too. Hysteresis is a tolerance field on one side of flow limits PF1 and PF2. The output status changes (indicates crossing over pre-set limit), when the immediate flowrate crosses over the value PF2 (or goes below limit PF1). The output status comes back to the default status, when the immediate flowrate decreases under the value PF2-H (or increases over limit PF1+H) again.

Mode g) with non-zero hysteresis:

Mode h) with non-zero hysteresis:

Mode k) with non-zero hysteresis:

Mode l) with non-zero hysteresis:

Qp value represents volume for 1 impulse and can be set independently to the nominal diameter of sensor. Values PF1, PF2 and H are described in the chapter "LIMITS".

5.1.3.2   Pulse width

Item allows setting pulse width in [ms]. Available widths are 2.5, 5, 10, 25, 50, 100, 250 and 500 ms.

5.1.3.3   Volume for 1 impulse (Qp 1 pulse)

Item allows setting the Qp constant. Qp represents the volume for one impulse.

5.1.4   Status (relay) output

Status output is operated by a relay. Maximum switched voltage is 110 VAC or DC, maximum switched current is 1A, maximum switched power is 30W (whichever condition occurs first). Positive output is on terminal REL, negative output is on terminal COM. Current must be limited by an external circuit.

Note 1: Frequency, impulse and status outputs are galvanically connected to each other and galvanically isolated from other electronic circuits.

Note 2: Active status output uses the power supply of the current output. Total current consumption from this power supply must be less than 40 mA. Active frequency output is galvanically connected to current output.

Note 3: In case of using this output as a passive, external source and current limiting is necessary.
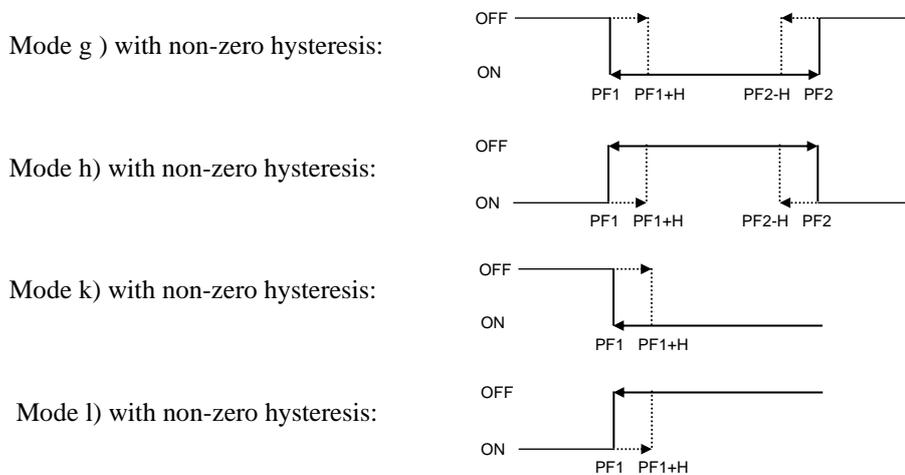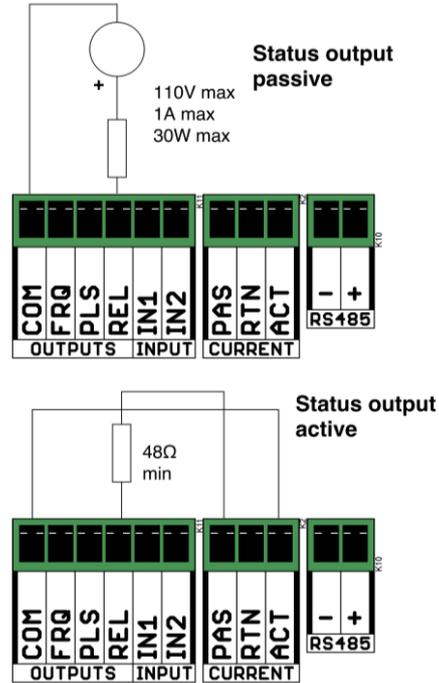
5.1.4.1 Mode

Status output can be programmed in one of the following modes:

a)	**Off**	output is not active (HI state).
b)	**On Positive**	output is HI in case of negative flow and LO in case of positive flow.
c)	**On Negative**	output is HI in case of positive flow and LO in case of negative flow.
d)	**On In**	output is LO, when flowrate is higher than PF1 and lower than PF2, otherwise it is HI.
e)	**On Out**	output is HI, when flowrate is higher than PF1 and lower than PF2, otherwise it is LO.
f)	**Dose On**	output is LO, when programmed dose is being measured and HI when the dose is out.
g)	**Dose Off**	output is HI, when programmed dose is being measured and LO when the dose is out.
h)	**On>F1**	output is LO, when flowrate is higher than PF1, otherwise it is HI.
i)	**On<F1**	output is LO, when flowrate is lower than PF1, otherwise it is HI.
j)	**Error On**	output is LO, when an error is indicated
k)	**Error Off**	output is HI, when an error is indicated

If setting of flow limit is chosen, hysteresis H can be set too. Hysteresis is a tolerance field on one side of flow limits PF1 and PF2. The output status changes (indicates crossing over pre-set limit), when the immediate flowrate crosses over the value PF2 (or goes below limit PF1). The output status comes back to the default status, when the immediate flowrate decreases under the value PF2-H (or increases over limit PF1+H) again.

Mode d) with non-zero hysteresis:

Mode e) with non-zero hysteresis:

Mode h) with non-zero hysteresis:
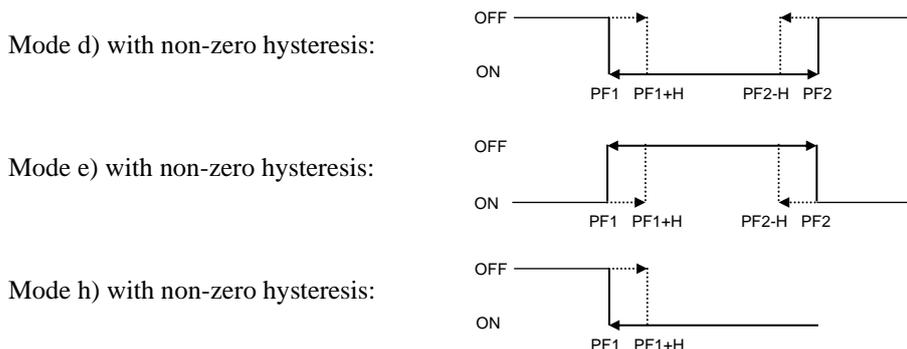
Mode i) with non-zero hysteresis:
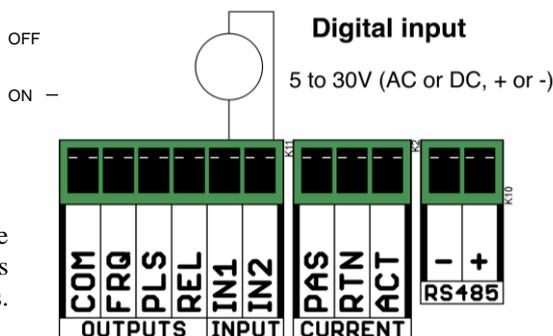
5.1.4.2 Error mask

The Mask allows selecting which errors will be reported via the Status Output. Mask value is calculated as sum of bit values all enabled errors. Bit value of available errors is in the table:

Bit	Bit value	Error
D0	1	Internal error
D1	2	Excitation overload
D2	4	Empty pipe
D3	8	Temperature out
D4	16	Frequency over
D5	32	Flowrate over
D6	64	Current open
D7	128	Datalogger full

Table 11 : Error mask

Note:
Error Mask should be set to value 255 to report all error messages. This is sum of all error's bit values. Error Mask 128 means that only the "Current open" error will be reported via the Status Output. The Status Output should be set to the mode j) "Error on" or mode k) "Error off".

5.1.5 PLC digital input

Digital input is activated with DC voltage between 5 and 30 V (positive or negative). Digital input should be connected between terminals IN1 and IN2.

Note: PLC digital input is galvanically isolated from other electronic circuits.

5.1.5.1 Mode

Digital input can be programmed in one of the following modes:

a) **Off** — input activation does nothing.
b) **Start dose** — input activation starts dose volume measuring. Dosing indication can be performed by one of outputs (frequency, impulse or status).
c) **Clear aux. volume** — input activation clears the Auxiliary volume.
d) **Clear all volumes** — input activation clears all volumes.
e) **State out on** — input sets status output to on state.
f) **State out off** — input sets status output to off state.
g) **State out toggle** — input toggles status output state.
h) **Empty Pipe** — input activation invokes error Empty Pipe. Flowrate is zeroed and volume counters are stopped in this state.

5.1.6 Limits

Function enables user to set values PF1, PF2 and H. These limits define basic conditions for all digital outputs. Values are common for Frequency, Pulse and Status outputs

5.1.6.1 Low flowrate limit (LIMIT PF1)

Value is flowrate expressed in selected flowrate units. Available range is according to the nominal diameter.

5.1.6.2   High flowrate limit (LIMIT PF2)

Value is flowrate expressed in selected flowrate units. Available range is according to the nominal diameter.

5.1.6.3   Hysteresis of flowrate limits (HYSTERESIS)

Value is flowrate hysteresis of limits expressed in selected flowrate units. Available range is according to the nominal diameter.

5.1.7   Dosing

The flowmeter is able to control dosing of measured liquid. For this function digital input (start of dosing) and one of digital outputs (end of dosing) are required.

5.1.7.1   Volume

Function enables user to set volume for dosing.

5.1.7.2   Actual

Function displays actual state of measured dose.

5.1.7.3   Stop dosing

Function enables user to stop dosing in progress.

Example setting 1

- Digital input mode: Start Dose
- State output mode: Dose On
- Dosing volume: 1m3

Active level on the digital input starts dosing. Flowmeter switches state output and counts the dose. As soon as measured dose is reached, flowmeter activates the State output to stop dosing. State output can control (through contractor) valve or pump.

5.1.8   RS485 interface

The serial port RS485 is designed for online communication between flowmeter and computer. It is suitable for real time flowmeter monitoring. In contrast to the RS232 serial port, which is suitable for one-shot configuration or calibration of the flowmeter. The RS485 can be connected to up to 16 flowmeters together and the total connection length of all wires can be up to 800 meters. Positive output (A) is on terminal 11, negative output (B) on terminal 12.

Example of three flowmeters and one computer interconnection:

All flowmeters and computer are connected parallel using twisted pair cable. At each end of the communications line should be 470 Ω terminations.
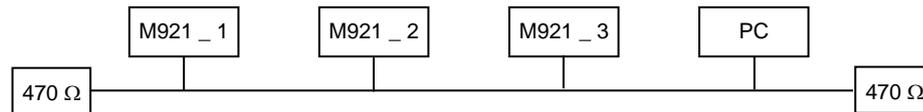
Interconnection of three flowmeters and computer using RS485 bus

Flowmeters are marked with numbers. These numbers are equal to flowmeter's RS485 address.

FlowAssistant software for PC is designed for flowmeter control using RS485 or RS232 serial bus

Note 1: Communication through the serial port RS485 is a half duplex type. The flowmeter is a listener and sends data only after a query from a computer. Each flowmeter has its own RS485 address. The range of addresses is 0 to 255. Factory setting of RS485 address is 0. Communication speed is selectable between 4800 and 115200 Bd. For cables over 100m or a noisy power supply voltage (especially peaks generated, usually by motors, etc.), select communication speed below 9600 Bd.

Note 2: Serial port RS485 is galvanically isolated from all the other electronic circuits.

5.1.8.1   RS485 bus properties

RS485 interface can work in three modes:

     a)   Normal – communication protocol ADAM compatible with flowmeter M910.

     b)   Modbus RTU – communication protocol Modbus, binary communication.

     c)   Modbus ASCII – communication protocol Modbus, ASCII communication.

To transfer the data using RS485 bus, 8N1 data format is used, i.e. each data word includes 8 bits, no parity and one stop bit.

5.1.9   USB/RSR232

USB/RS232 interface is intended for flowmeter configuration and calibration. It's not recommended to use this interface during general flowmeter operation, since IP protection is void as a result necessity of the case lid to be open. For communication during operation use of RS485 interface is recommended. Interface is galvanically isolated from all the other parts of flowmeter. Configuration or calibration data can be changed with remote commands, or using supplied software FlowAssistant.

5.1.9.1   USB connector

The connector is located on the top left corner of the bottom PCB. Flowmeter can be connected to computer with supplied USB A-B cable.

5.1.9.2 RS232 bus properties

To transfer the data using RS232 bus, 8N1 data format is used, i.e. each data word includes 8 bits, no parity and one stop bit. Communication speed can be set using menu. Address is not used in RS232 mode.

Baud rate	User setup	1200 to 115200 Bd
Data bits		8
Stop bit	Fixed	1
Parity		none

Table 12 : USB/RS232 properties

5.2 Command syntax

Communication between flowmeter and computer consists of a flow of periodically alternating commands type command-response or query-response. Command is always a text followed by parameter and ended by control sign <cr>. Response is always ended with control sign <cr>.

There are three types of responses:

1) Parameters value – response to a query

2) Ok – response to a command

3) ErrX – in case that command has wrong format. Where X is error code from the table below:

Error code	Meaning
1	Unknown command
2	Parameter out of range
3	Value cannot be set
4	Value cannot be read
5	Unknown parameter
6	Parameter too low
7	Parameter to high
8	Number as parameter is required
9	Access denied – use appropriate password
10	Wrong value of calibration point
11	Password locked – six unsuccessful attempts to enter password. Setup menu is blocked for 20 minutes.

Table 13 : RS232 error codes

Commands described in this chapter can be issued through both buses (RS485 and RS232). The only difference is, that before all commands for RS485 bus is identification in form "#00". Where '#' is the command prefix and "00" is flowmeters address 0 in hexadecimal form. For flowmeter with address 1 it's identification is "#01". Flowmeter answers are prefix in form ">00" for flowmeter 0, ">01" for flowmeter 1 etc.

Modbus protocol is explained in independent document.

5.2.1 Syntax description

<DNPD> =   Decimal Numeric Program Data, this format is used to express decimal number with or without the exponent.

<CPD> =   Character Program Data. Usually, it represents a group of alternative character parameters. e.g. {0 | 1 | 2 | 3}.

? =   A flag indicating a request for the value of the parameter specified by the command. No other parameter than the question mark can be used.

(?) =   A flag indicating a request for the parameter specified by the command. This command permits a value to be set as well as requested.

<cr> =   carriage return. ASCII code 13. This code executes the command or query.

5.2.2 Command list

5.2.2.1 Main menu

Flowrate reading

RFL?

Response contains actual "Flowrate" value in selected units.

Example:
If query „RFL?<cr>" is sent, flowmeter returns response in format „1.000000E+02<cr>".

Volume reading

RVO?

Response contains actual "Volume" counter value in selected units.

Example:
If query „RVO?<cr>" is sent, flowmeter returns response in format „1.000000E+02<cr>".

Positive volume reading

RVP?

Response contains actual Positive volume counter value.

Example:
If query „RVP?<cr>" is sent, flowmeter returns response in format „1.000000E+02<cr>".

Negative volume reading

RVN?

Response contains actual Negative volume counter value.

Example:
If query „RVN?<cr>" is sent, flowmeter returns response in format „-1.000000E+02<cr>".

Auxiliary volume reading

RVA?

Response contains actual Auxiliary volume counter value.

Example:
If query „RVA?<cr>" is sent, flowmeter returns response in format „1.000000E+02<cr>".

Maximum flowrate value reading

RMX?

Response contains maximum Flowrate value.

Example:
If query „RMX?<cr>" is sent, flowmeter returns response in format „1.000000E+02<cr>" (maximum flowrate value indicated since last reset – command CLRMM).

Date and time of maximum flowrate reading

RXD?

Response contains time & date of maximum flowrate.

Example:
If query „RXD?<cr>" is sent, flowmeter returns response in format „10:06 15/01/2009<cr>" (time & date of maximum flowrate value indicated since last reset – command CLRMM).

Minimum flowrate value reading

RMN?

Response contains minimum Flowrate value.

Example:
If query „RMN?<cr>" is sent, flowmeter returns response in format „0.000000E+00<cr>" (minimum flowrate value indicated since last reset – command CLRMM).

Flow unit resolution

FFR(?)<CPD> { 0 | 1 | 2 | 3 | 4 | 5 }

Following modes can be set:

- 0   none (0)
- 1   1 decimal
- 2   2 decimals
- 3   3 decimals
- 4   4 decimals
- 5   default

M921 confirms execution with string „Ok<cr>".

Example:
Command „FFR1<cr>" sets mode "1 decimal" for flowrate resolution. If query „FFR?<cr>" is sent, flowmeter returns response in format „1<cr>".

Volume unit resolution

FVR(?)<CPD> { 0 | 1 | 2 | 3 | 4 | 5 }

Following modes can be set:

- 0   none (0)
- 1   1 decimal
- 2   2 decimals
- 3   3 decimals
- 4   4 decimals
- 5   default

M921 confirms execution with string „Ok<cr>".

Example:
Command „FVR1<cr>" sets mode "1 decimal" for flowrate resolution. If query „FVR?<cr>" is sent, flowmeter returns response in format „1<cr>".

Actual dosing volume reading

RDO?

Response contains actual dosing volume value.

Example:
If query „RDO?<cr>" is sent, flowmeter returns response in format „1.000000E+02<cr>".

Dosing state reading

RDA?

Response contains dosing state.

Response is:

- 0   - dosing is not in progress (inactive)
- 1   - dosing is in progress (active)

Example:
If query „RDA?<cr>" is sent, flowmeter returns response in format „0<cr>" in case dosing is not in progress.

5.2.2.2   Error messages

Errors reading

IER?

Response contains list of all errors from the power on or from the last reading (query IER?).

The Mask allows selecting which errors will be reported via the State Output. Errors are expressed as sum of bit values of errors. Bit value of possible errors is in the table:

Bit	Bit value	Error
D0	1	Internal error
D1	2	Excitation overload
D2	4	Empty pipe
D3	8	Temperature out
D4	16	Frequency over
D5	32	Flowrate over
D6	64	Current open
D7	128	Datalogger full

Example:
Response „0<cr>" indicates that there was no error. Response "8<cr>" indicates that temperature of current excitation coils was (is) out of programmed limits. Value "6<cr>" (4+2) indicates that excitation circuit is open and there is no liquid in the pipe (empty pipe).

Flowmeter's state reading

RES?

Response contains flowmeter's state.

Response is:

- 0   - flowmeter functions properly
- 1   - flowmeter indicates error (in the last 3 seconds before the query was sent)

Example:
If query „RES?<cr>" is sent, flowmeter returns response in format „0<cr>"

5.2.2.3 Input/output

5.2.2.3.1 Current output

Current output mode setting

SCM(?)<CPD> { 0 | 1 | 2 | 3 | 4 | 5 }

Following modes can be set:

- 0   Off
- 1   Positive Flow
- 2   Negative Flow
- 3   Absolute Flow
- 4   Bipolar Flow
- 5   Fixed

M921 confirms execution with string „Ok<cr>".

Example:
Command „SCM1<cr>" sets mode "Positive flowrate" for current output. If query „SCM?<cr>" is sent, flowmeter returns response in format „1<cr>".

Current output constant Qi setting

SCO(?)<DNPD>

Command sets constant Qi, which represents flowrate value for current 20 mA.

<DNPD>

It represents required flowrate in actual units. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set value in actual units.

Example:
Command „SCO10.5<cr>" sets value Qi to 10.5 in actual units. After query „SCO?<cr>" flowmeter returns string „1.050000E+01<cr>".

Fixed current setting

SFC(?)<DNPD>

Command sets fixed current in range between 4 mA and 20 mA. Current output must be set to "Fixed" mode.

<DNPD>

It represents current for "Current output" in mA. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set value in mA.

Example:
Command „SFC10<cr>" sets current output to 10 mA (it must be set to "Fixed current" mode). After query „SFC?<cr>" flowmeter returns string „1.000000E+01<cr>".

Current loop test

FCE(?)<CPD> { 0 | 1 }

Internal current loop test can be switched:

- 0   Off
- 1   On

M921 confirms current loop test state with string „Ok<cr>".

Example:

Command „FCE0<cr>" switches current loop test "Off". If query „FCE?<cr>" is sent, flowmeter returns response in format „0<cr>".

Current loop state reading

RCE?

Response contains state of current loop.

Response is:

- 0   - current loop is closed
- 1   - current loop is disconnected

Example:
If query „RCE?<cr>" is sent, flowmeter returns response in format „0<cr>" for closed current loop.

5.2.2.3.2 Frequency output

Frequency output mode setting

SFM(?)<CPD> { 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 }

Following modes can be set:

- 0   Off
- 1   Positive Flow
- 2   Negative Flow
- 3   Absolute Flow
- 4   On Positive
- 5   On Negative
- 6   On In
- 7   On Out
- 8   Dose On
- 9   Dose Off
- 10 On<F2
- 11 On>F2
- 12 Fixed

M921 confirms execution with string „Ok<cr>".

Example:
Command „SFM1<cr>" sets mode "Positive flow" for frequency output. If query „SFM?<cr>" is sent, flowmeter returns response in format „1<cr>".

Frequency output constant Qf setting

SFO(?)<DNPD>

Command sets constant Qf, which represents flowrate value for frequency 1000 Hz.

<DNPD>

It represents required flowrate in actual units. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set value in actual units.

Example:
Command „SFO10.5<cr>" sets value Qf to 10.5. After query „SFO?<cr>" flowmeter returns string „1.050000E+01<cr>".

Fixed frequency setting

SFF(?)<DNPD>

Command sets fixed for frequency in range between 10 Hz and 12 kHz. Frequency output must be set to "Fixed" mode.

<DNPD>

It represents frequency for "Frequency output" in Hz. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set value in Hz.

Example:
Command „SFF1000<cr>" sets frequency output to 1000 Hz (it must be set to "Fixed frequency" mode). After query „SFF?<cr>" flowmeter returns string „1.000000E+03<cr>".

5.2.2.3.3 Pulse output

Impulse output mode setting

SPM(?)<CPD> { 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 }

Following modes can be set:

- 0   Off
- 1   Positive Flow
- 2   Negative Flow
- 3   Absolute Flow
- 4   On Positive
- 5   On Negative
- 6   On In
- 7   On Out
- 8   Dose On
- 9   Dose Off
- 10   On>F1
- 11   On<F1

M921 confirms execution with string „Ok<cr>".

Example RS232:
Command „SPM1<cr>" sets mode "Positive flowrate" for impulse output. If query „SPM?<cr>" is sent, flowmeter returns response in format „1<cr>".

Impulse output constant Qp setting

SPO(?)<DNPD>

Command sets constant Qp, which represents volume for 1 impulse.

<DNPD>

It represents volume for 1 impulse in actual units. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set value in actual units.

Example:
Command „SPO1.0<cr>" sets value Qp to 1.0. After query „SPO?<cr>" flowmeter returns string „1.000000E+00<cr>".

Impulse width setting

SPT(?)<CPD> { 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 }

Following widths can be set:

- 0   2.5 ms
- 1   5 ms
- 2   10 ms
- 3   25 ms
- 4   50 ms
- 5   100 ms
- 6   250 ms
- 7   500 ms

M921 confirms execution with string „Ok<cr>".

Example RS232:
Command „SPT5<cr>" sets 100 ms pulse width. If query „SPT?<cr>" is sent, flowmeter returns response in format „5<cr>".

5.2.2.3.4 State output

State output mode setting

SSM(?)<CPD> { 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 }

Following modes can be set:

- 0   Off
- 1   On Positive
- 2   On Negative
- 3   On In
- 4   On Out
- 5   Dose On
- 6   Dose Off
- 7   On>F1
- 8   On<F1
- 9   Error On
- 10   Error Off

M921 confirms execution with string „Ok<cr>".

Example:
Command „SSM1<cr>" sets mode "On for positive flowrate" for state output. If query „SSM?<cr>" is sent, flowmeter returns response in format „1<cr>".

Setting the mask for State Output error message (ERROR MASK)

SEM(?)<DNPD>

Command sets the mask that enables error message.

<DNPD>

It represents error mask.
The Mask allows selecting which errors will be reported via the State Output. Mask value is calculated as sum of bit values all enabled errors. Bit value of available errors is in the table:

Bit	Bit value	Error
D0	1	Internal error
D1	2	Excitation overload
D2	4	Empty pipe
D3	8	Temperature out
D4	16	Frequency over
D5	32	Flowrate over
D6	64	Current open
D7	128	Datalogger full

Table 14 : State output error mask

Note:
Error Mask should be set to value 255 to report all error messages. This is sum of all error's bit value. Error Mask 64 means that only the "Current open" error will be reported via the State Output. If query „SEM?<cr>" is sent, flowmeter returns response in format „64<cr>". The State Output should be set to the mode "Error On" or mode "Error Off" (see command SSM).

5.2.2.3.5 Digital input PLC

Digital input mode setting

SIM(?)<CPD> { 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 }

Following modes can be set:

- 0   Off
- 1   Start dose
- 2   Clear aux. volume
- 3   Clear all volumes
- 4   State output on
- 5   State output off
- 6   State output toggle
- 7   Empty Pipe

M921 confirms execution with string „Ok<cr>".

Example:
Command „SIM1<cr>" sets mode "Dose" for digital input. If query „SIM?<cr>" is sent, flowmeter returns response in format „1<cr>".

5.2.2.3.6 Limits setting

Low limit value (PF1)

SF1(?)<DNPD>

Command sets low limit value PF1.

<DNPD>

It represents flowrate for low limit value PF1 in actual unit. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set value in actual unit.

Example:
Command „SF1-10.5<cr>" sets low limit value to –10.5. After query „SF1?<cr>" flowmeter returns string „-1.050000E+01<cr>".

High limit value (PF2)

SF2(?)<DNPD>

Command sets low limit value PF2.

<DNPD>

It represents flowrate for high limit value PF2 in actual unit. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set value in actual unit.

Example:
Command „SF210.5<cr>" sets low limit value to 10.5. After query „SF2?<cr>" flowmeter returns string „1.050000E+01<cr>".

Hysteresis

SHY(?)<DNPD>

Command sets hysteresis H.

<DNPD>

It represents flowrate for hysteresis H in actual unit. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set value in actual unit.

Example:
Command „SHY1.05<cr>" sets hysteresis to 1.05. After query „SHY?<cr>" flowmeter returns string „1.050000E+00<cr>".

5.2.2.3.7 Dosing

Dosing volume (constant Qd)

SIO(?)<DNPD>

Command sets constant Qd, which represents volume for dosing.

<DNPD>

It represents volume for dosing in actual units. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set value in actual units.

Example:
Command „SIO1.0<cr>" sets value Qd to 1.0. After query „SIO?<cr>" flowmeter returns string „1.000000E+00<cr>".

Dosing volume Reset

CLRDO

Command clears volume for dosing.

M921 confirms execution with string „Ok<cr>".

Example:
Command „ CLRDO <cr>" clears dosing volume counter

Dosing volume Reset with restart

CLRDR

Command clears volume for dosing and starts new batch.

M921 confirms execution with string „Ok<cr>".

Example:
Command „ CLRDR <cr>" clears dosing volume counter and starts new batch.

5.2.2.3.8 RS485, RS232/USB, Modbus

RS485 address

PRA(?)<CPD>

Command sets RS485 address from 0 to 255.

<CPD>

M921 confirms execution with string „Ok<cr>". In case of query, M921 returns current address.

Example:
Command „PRA255<cr>" sets RS485 address to " 255 ". After query „PRA?<cr>" flowmeter returns „ 255 <cr>".

Modbus address

PMA(?)<CPD>

Command sets Modbus address from 1 to 247.

<CPD>

M921 confirms execution with string „Ok<cr>". In case of query, M921 returns current address.

Example:
Command „PMA255<cr>" sets modbus address to " 247 ". After query „PMA?<cr>" flowmeter returns „ 247 <cr>"

Modbus parity

PMP(?)<CPD> { 0 | 1 | 2 }

Modbus parity can be set to:

- 0   none
- 1   even
- 2   odd

M921 confirms execution with string „Ok<cr>".

Example:

Command „PMP0<cr>" sets pairty to "none". If query „PMP?<cr>" is sent, flowmeter returns response in format „0<cr>".

Baudrate

PSB(?)<CPD> { 0 | 1 | 2 | 3 | 4 }

Baudrate valid for both RS485 and RS232 (USB) can be set to:

- 0   1200
- 1   2400
- 2   4800
- 3   9600
- 4   19200
- 5   38400
- 6   57600
- 7   115200

M921 confirms execution with string „Ok<cr>".

Example:
Command „PSB4<cr>" sets baudrate to "19200". If query „PSB?<cr>" is sent, flowmeter returns response in format „4<cr>".

5.2.2.4   Flowrate parameters

Flowrate unit

FFS(?)<CPD> { 0 | 1 | 2 | 3 | 4 }

Following units can be set:

- 0   l/s
- 1   m3/h
- 2   UG/m
- 3   IG/m
- 4   "user"

M921 confirms execution with string „Ok<cr>".

Example:
Command „FFS0<cr>" sets flowrate unit "l/s". If query „FFS?<cr>" is sent, flowmeter returns response in format „0<cr>".

Flowrate user unit

FFU(?)<CPD>

Command sets text for flowrate user unit.

<CPD>

It represents user units expressed as 3 ASCII characters. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set user unit.

Example:
Command „FFU l/m <cr>" sets flowrate user unit " l/m ". After query „FFU?<cr>" flowmeter returns string „ l/m <cr>".

Conversion constant for flowrate user unit

FFC(?)<DNPD>

Command sets conversion constant for flowrate user unit with respect to [l/s].

<DNPD>

It represents a constant, which is calculated as a ratio between flowrate in user unit and flowrate in basic unit ([l/s]). For example constant for [m3/h] is 3.6. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set constant.

Example:
Command „FFC3.6<cr>" sets constant "3.6 ". After query „FFC?<cr>" flowmeter returns „3.600000E+00<cr>".

Flowrate direction

FFD(?)<CPD> { 0 | 1 }

Following directions can be set:

- 0   Positive
- 1   Negative

M921 confirms direction with string „Ok<cr>".

Example:
Command „FFD0<cr>" sets "Positive direction". If query „FFD?<cr>" is sent, flowmeter returns response in format „0<cr>".

Low flow cutoff

FLF(?)<DNPD>

Command sets flowrate limit for suppression low flowrates.

<DNPD>

It represents flowrate expressed in actual unit. All flowrates below this limit are displayed as 0. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set low flow cut-off.

Example:
Command „FLF0.2<cr>" sets low flow cut-off "0.2". After query „FLF?<cr>" flowmeter returns „2.000000E-01<cr>".

Moving average samples

FTC(?)<DNPD>

Command sets number of samples for moving average calculation.

<DNPD>

Value in range between 1 (no averaging) and 20 samples can be set. M921 confirms execution with string „Ok<cr>". In case of query M921 returns number of samples.

Example:
Command „FTC8<cr>" sets number of samples to 8. After query „FLF?<cr>" flowmeter returns „8<cr>".

Min. / Max. flowrates Reset

CLRMM

Command resets "Min. Flowrate" and "Min. Flowrate" values.

M921 confirms execution with string „Ok<cr>".

Example:
Command „CLRMM<cr>" resets both min/max values.

Nominal flowrate reading

RQN?

Response contains actual flowmeters Nominal flowrate (Q_N).

Example:
If query „RQN?<cr>" is sent, flowmeter returns response in format „8.000000E+01<cr>" for nominal flowrate 80 (m3/h…).

Empty pipe detection

FEP(?)<CPD> { 0 | 1 }

Empty pipe detection can be enabled (1) or disabled (0).

- 0   Disable
- 1   Enable

M921 confirms command with string „Ok<cr>".

Example:
Command „FEP0<cr>" disables empty pipe detection. User can disable this function in case user use external empty pipe detection connected to the flowmeter's digital input. If query „FEP?<cr>" is sent, flowmeter returns response in format „0<cr>".

5.2.2.5   Volume parameters

Volume unit

FVS(?)<CPD> { 0 | 1 | 2 | 3 | 4 }

Following units can be set:

- 0   m3
- 1   l
- 2   UG
- 3   IG
- 4   "user"

M921 confirms execution with string „Ok<cr>".

Example:
Command „FVS0<cr>" sets volume unit "m3". If query „FVS?<cr>" is sent, flowmeter returns response in format „0<cr>".

Volume user unit

FVU(?)<CPD>

Command sets text for volume user unit.

<CPD>

It represents user units expressed as 3 ASCII characters. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set user unit.

Example:
Command „FVU dm3 <cr>" sets volume user unit " dm3 ". After query „FVU?<cr>" flowmeter returns string „ dm3 <cr>".

Conversion constant for volume user unit

FVC(?)<DNPD>

Command sets conversion constant for volume user unit with respect to [l].

<DNPD>

It represents a constant, which is calculated as a ratio between volume in user unit and volume in basic unit ([l]). For example constant for [m3] is 0.001. M921 confirms execution with string „Ok<cr>". In case of query M921 returns set constant.

Example:
Command „FVC0.001<cr>" sets constant "0.001 ". After query „FVC?<cr>" flowmeter returns „1.000000E-03<cr>".

Total volume counter Reset

CLRVO

Command resets "Total volume counter" including the positive and negative volume counter.

M921 confirms execution with string „Ok<cr>".

Example:
Command „CLRVO<cr>" resets the *Total, positive and negative volume counters*.

Auxiliary volume counter Reset

CLRAV

Command resets "Auxiliary volume counter".

M921 confirms execution with string „Ok<cr>".

Example:
Command „CLRAV<cr>" resets the *Auxiliary volume counter*.

Timed volume counter Reset

CLRTV

Command resets "Timed volume counter".

M921 confirms execution with string „Ok<cr>".

Example:
Command „CLRTV<cr>" resets the *Timed volume counter*.

5.2.2.6   Datalogger parameters

Datalogger step

DST(?)<CPD> { 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 }

Datalogger can be set:

- 0   Datalogger is Off
- 1   Datalogger sampling rate is 5 minutes.
- 2   Datalogger sampling rate is 10 minutes.
- 3   Datalogger sampling rate is 15 minutes.
- 4   Datalogger sampling rate is 30 minutes.
- 5   Datalogger sampling rate is 45 minutes.
- 6   Datalogger sampling rate is 60 minutes.
- 7   Datalogger sampling rate is 120 minutes.
- 8   Datalogger sampling rate is 180 minutes.
- 9   Datalogger sampling rate is 240 minutes.

M921 confirms datalogger step with string „Ok<cr>".

Example RS232:
Command „DST0<cr>" switches datalogger "Off". If query „DST?<cr>" is sent, flowmeter returns response in format „0<cr>".

Datalogger number of samples

DNR?

Response contains number of flowrate samples stored in datalogger.

Example:
If query „DNR?<cr>" is sent, flowmeter returns response in format „252<cr>" for 252 samples in datalogger.

Datalogger filling (percentage)

DPC?

Response contains datalogger filling in percent.

Example:
If query „DPC?<cr>" is sent, flowmeter returns response in format „14<cr>" for 14% datalogger full.

Datalogger filling (bytes)

DBT?

Response contains datalogger filling in bytes.

Example:
If query „DBT?<cr>" is sent, flowmeter returns response in format „1850<cr>" for 1850 bytes used.

Datalogger reading (text format)

DRT?

Response contains all values stored in internal datalogger.

Example:
If query „DRT?<cr>" is sent, flowmeter returns response in format:

```
14:28       13.10.2003                                          5.820     l/s
14:33       13.10.2003                                          4.765     l/s
14:38       13.10.2003                                          4.712     l/s
14:43       13.10.2003                                          4.792     l/s
14:48       13.10.2003                                          4.760     l/s
No Record
```


Datalogger reading (hex format)

DRD?

Response contains all values stored in internal datalogger.

Example:
If query „DRD?<cr>" is sent, flowmeter returns response in intel hex format:

Datalogger clear

DCLR

Command clears all data stored in internal datalogger.

M921 confirms execution with string „Ok<cr>".

Example:
Command „DCLR<cr>" clears all data in datalogger.

5.2.2.7 Calibration

Number of calibration points

CPN(?) <CPD> { 2 | 3 | 4 }

M921 confirms completion with string „Ok<cr>".

Example:
Command „CPN2<cr>" sets mode 2 calibration points. If query „CPN?<cr>" is sent, flowmeter returns response in format „2<cr>".

Nominal value of calibration point 1

CX1(?)<DNPD>

Command sets constant CX1, which represents the nominal value of calibration point 1.

<DNPD>

It represents nominal value in selected units. M921 confirms completion with string „Ok<cr>". In case of a query the M921 returns the set value in the selected unit.
Example:

Command „CX110.5<cr>" sets value CX1 to 10.5. After query „CX1?<cr>" flowmeter returns string „1.050000E+01<cr>".

Nominal value of calibration points 2, 3 and 4

CX2, CX3, CX4

For explanation see command CX1.

Calibration constant for calibration point 1

CY1(?)<DNPD>

Command sets constant CY1, which represents the calibration constant for calibration point 1.

<DNPD>

It represents the calibration constant. M921 confirms completion with string „Ok<cr>". In case of a query the M921 returns the set value.
Example:

Command „CY110.5<cr>" sets value CY1 to 10.5. After query „CY1?<cr>" flowmeter returns string „1.050000E+01<cr>".

Calibration constants for calibration points 2, 3 and 4

CY2, CY3, CY4

For explanation see command CY1.

5.2.2.8 General

5.2.2.8.1 Display parameters

Contrast setting

FDC(?)<DNPD> { 0 | 1 | 2 | 3 | 4 }

User can select one of following modes:
- 0   LOWEST
- 1   LOW
- 2   MEDIUM
- 3   HIGH
- 4   HIGHEST

M921 confirms completion with string „Ok<cr>". In case of a query the M921 returns the contrast value.

Example:
Command „FDC2<cr>" sets the contrast to MEDIUM. If query „FDC?<cr>" is sent, flowmeter returns response in format „2<cr>".

Backlight mode setting

FDB(?)<CPD> { 0 | 1 | 2 }

User can select one of following modes:
- 0   Off - backlight is switched off

- 1   On (20s) - backlight is switched on after any key is pressed and after 20s is switched off
- 2   On - backlight is switched on

M921 confirms completion with string „Ok<cr>".

Example:
Command „FDB1<cr>" sets the backlight mode "On (20s)". If query „FDB?<cr>" is sent, flowmeter returns response in format „1<cr>".

5.2.2.8.2 Real time clock setting

Time setting

FTM(?)<CPD> HH:MM:SS

Command sets new time for internal Real Time Clock.

<CPD>

It represents new time in format HH:MM:SS. Any value in range between 00:00:00 and 23:59:59 can be set. M921 confirms execution with string „Ok<cr>". In case of query M921 returns real time.

Example:
Command „FTM14:25:00<cr>" sets new time (2:25:00 pm). After query „FTM?<cr>" flowmeter returns „14:25:00<cr>".

Date setting

FDT(?)<CPD> DD.MM.YYYY

Command sets new date for internal Real Time Clock.

<CPD>

It represents new date in format DD.MM.YYYY. Any value in range between 01.01.2000 and 31.12.2099 can be set. M921 confirms execution with string „Ok<cr>". In case of query M921 returns real date.

Example:
Command „FDT05.03.2002<cr>" sets new date (March 5, 2002). After query „FDT?<cr>" flowmeter returns „05.03.2002<cr>".

Date format setting

FDF(?)<CPD> { 0 | 1 | 2 | 3 | 4 | 5 | 6 }

User can select one of following items:

- 0   M/D/Y
- 1   M-D-Y
- 2   D/M/Y
- 3   D.M.Y
- 4   D-M-Y
- 5   Y/M/D
- 6   Y.M.D

M921 confirms completion with string „Ok<cr>".

Example:
Command „FDF0<cr>" sets the date format "D/M/Y". If query „FDF?<cr>" is sent, flowmeter returns response in format „0<cr>".

Firmware version

ISW?

Response contains version of flowmeter internal firmware version.

Example:
Response contains firmware version in format „1.01<cr>".

Pipe diameter

RND?

Response contains actual flowmeter's Nominal diameter (DN).

Example:
If query „RDN?<cr>" is sent, flowmeter returns response in format „50<cr>" for nominal diameter 50mm.

5.2.2.8.3 Temperature measuring

Excitation coils temperature

ICT?

Response contains excitation coils (measured liquid) temperature.

Example:
Response contains measured temperature in format „3.520000E+01<cr>" (for 35.2 °C).

Minimum allowed coil temperature setting

FTL(?)<DNPD>

Command sets low temperature limit in range -20 to +150°C.

<DNPD>
Presents low temperature limit. M921 confirms completion with string „Ok<cr>". In case of a query the M921 returns the temperature value.

Example:
Command „FTL-20<cr>" sets the low temperature limit to -20°C. If query „FTL?<cr>" is sent, flowmeter returns response in format „-20<cr>".

Maximum allowed coil temperature setting

FTH(?)<DNPD>

Command sets high temperature limit in range -20 to +150°C.

<DNPD>
Presents high temperature limit. M921 confirms completion with string „Ok<cr>". In case of a query the M921 returns the temperature value.

Example:
Command „FTH80<cr>" sets the low temperature limit to 80°C. If query „FTH?<cr>" is sent, flowmeter returns response in format „80<cr>".

Electronic unit temperature

IT?

Response contains temperature inside the electronic unit. This temperature should be in range -20 to +70°C.

Example:
Response contains measured temperature in format „3.520000E+01<cr>" (for 35.2 °C).

Temperature unit

IUT(?)<CPD> { 0 | 1 | 2 }

User can select one of following items:

- 0   °C
- 1   F
- 2   K

M921 confirms completion with string „Ok<cr>".

Example:
Command „IUT0<cr>" sets the temperature unit to "0". If query „IUT?<cr>" is sent, flowmeter returns response in format „0<cr>".

5.2.2.8.4 Password setting

Password

PSW<DNPD>

Command enters password, that enables access to flowmeter's settings. Password can be change with new command PSW.

Example:
Command „PSW12345<cr>" enters password 12345.

Actual access level

PAL(?)<CPD> { 0 | 1 | 2 | 3 }

Command can set the access level to 0. Query returns the actual access level.

Available levels:

- 0   Without access
- 1   Basic access level
- 2   Calibration access level
- 3   Service access level

Example:
If query „PAL? <cr>" is sent flowmeter returns response in format "2<cr>", for "Calibration access level". Command „PAL0<cr>" sets the flowmeter to access level 0 (without access).

Basic access password setting

FPB(?)<DNPD>

Command changes the password valid for access level "Basic".

<DNPD>
Presents new password in range 0 to 99999. M921 confirms completion with string „Ok<cr>".

Example:
Command „FPB520<cr>" sets basic password "520". If query „FPB?<cr>" is sent, flowmeter returns response in format „520<cr>".

Calibration access password setting

FPC(?)<DNPD>

Command changes the password valid for access level "Calibration".

<DNPD>
Presents new password in range 0 to 99999. M921 confirms completion with string „Ok<cr>".

Example:
Command „FPC520<cr>" sets calibration password "520". If query „FPC?<cr>" is sent, flowmeter returns response in format „520<cr>".

5.2.2.8.5 Service information

Device identification

IDN?

Response contains flowmeter's model type number.

Example:
If query „IDN?<cr>" is sent, flowmeter returns response in format „M921-Vxxxx<cr>".

Nominal diameter reading

RDN?

Response contains actual flowmeter's Nominal diameter (DN).

Example:
If query „RDN?<cr>" is sent, flowmeter returns response in format „50<cr>" for nominal diameter 50mm.

Power supply type

PPW(?)<CPD> { 0 | 1 | 2 | 3 }

Command sets the power supply type (frequency of excitation current):

- **0 - AC**
- **1 – 12VDC**
- **2 – 24VDC**
- **3 – 48VDC**

M921 confirms completion with string „Ok<cr>".

Example:
Command „PPW0<cr>" sets frequency selection to AC. If query „PPW?<cr>" is sent, flowmeter returns response in format „0<cr>".

+5V power supply

IU1?

Response contains measured value of +5V internal power supply. Accuracy is not guaranteed (value is informative).

Example:
If query „IU1?<cr>" is sent, flowmeter returns response in format „4.994000E+00<cr>" for voltage 4.994 V.

-5V power supply

IU2?

Response contains measured value of -5V internal power supply. Accuracy is not guaranteed (value is informative).

Example:
If query „IU2?<cr>" is sent, flowmeter returns response in format „4.994000E+00<cr>" for voltage 4.994 V.

+15V power supply

IU3?

Response contains measured value of +15V internal power supply. Accuracy is not guaranteed (value is informative).

Example:
If query „IU3?<cr>" is sent, flowmeter returns response in format „1.484000E+01<cr>" for voltage 14.84 V.

Coils voltage

IU4?

Response contains measured value of voltage on coils. Accuracy is not guaranteed (value is informative).

Example:
If query „IU4?<cr>" is sent, flowmeter returns response in format „1.012000E+01<cr>" for voltage 10.12 V.

+2.5V power supply

IU5?

Response contains measured value of +2.5V internal power supply. Accuracy is not guaranteed (value is informative).

Example:
If query „IU5?<cr>" is sent, flowmeter returns response in format „2.550000E+00<cr>" for voltage 2.55 V.

Coils current

IU6?

Response contains measured value of coils current (mA). Accuracy is not guaranteed (value is informative).

Example:
If query „IU6?<cr>" is sent, flowmeter returns response in format „9.985000E+01<cr>" for current 99.85 mA.

Excitation coils resistance

ICO?

Response contains measured value of excitation coil resistance. Accuracy is not guaranteed (value is informative).

Example:
If query „ICO?<cr>" is sent, flowmeter returns response in format „1.047000E+02<cr>" for resistance 104.7 Ω

6   Maintenance

The inductive flowmeter is an electronic device with circuits protected with built-in electronic fuses. These protect the instrument against damage caused by the user.

6.1 Recommendations for correct operation

The following principles should be consider during installation:

- *If there is a noisy power supply voltage (especially peaks generated, usually by motors, etc.), use an external power supply filter between the flowmeter and power supply.*

- *Protect the flowmeter and the internal lining of the sensor pipe from mechanical damage, especially during installation or cleaning.*

- *Protect the flowmeter from direct sunlight. Fit a sunshade if necessary.*

- *Do not expose the flowmeter to intense vibration.*

6.2 Periodical maintenance

The flowmeter does not require any special maintenance. Dependent on the media being measured it is recommended that approx. once a year, remove the sensor from the pipe and clean the liner. Method of cleaning consists of removing mechanical dirt and any non-conductive coating (like oil film) from the liner. A very dirty liner could cause inaccuracy of the measurement. Check mechanical state of the liner.

6.3 What to do in case of failure

If an **obvious failure** occurs during the operation (e.g. the display is not lit), the flowmeter must be switched off immediately. First, check the fuse located under the electronic board cover.

- Turn off the power to the flowmeter.

- Remove the cover from the transmitter

- The fuse from fuse holder. Replace it with a new fuse of   the same rating if necessary

- Replace the cover.

- Connect power supply again.

If an obvious fault is evident, e.g. a measurement range or an operating mode is not functional, the user cannot correct the fault.

Hidden faults can cause different symptoms. Usually, they cause instability of some parameters. Hidden defects can be caused by unacceptable distortion, degraded insulation etc. In this case contact Distributor.

The flowmeter can have "hidden defects", when correct operation rules are not applied. In this case, the fault can be caused by wrong installation. Most frequent cases of false "hidden defects":

- mains voltage out of tolerance limits or unstable

- poor grounding of the measuring circuit (bad connection of the ground terminal)

- large electrostatic or electromagnetic field.

6.4 Error messages

When any error occurs, the flowmeter will display an error message. Errors can arise because of:

- Incorrect control, i.e. faulty connection to the flowmeter, grounding, etc.,

- Flowmeter failure

In case of any error, the error message is displayed on the display for approx. 1 to 5 seconds. The same error message can be read by computer using RS232 or RS485 (command IER?).

After switching on, an internal test of the hardware is performed. If there were any error during the power on test, the flowmeter would display the appropriate error message.

Types of errors and methods of troubleshooting (if available) are in following table:

Error	Meaning	Troubleshooting
Internal error	Internal unit error.	Internal error. Turn the flowmeter off and after 5 s turn on. If the error will appear again, contact manufacturer.
Excitation overload	Resistance of excitation coils is higher than 250 Ohm.	Resistance of excitation coils is too high (open circuit). Check sensor connection.
Empty pipe	No liquid in pipe	Fill the pipe with liquid. In case there is liquid in the pipe, clean electrodes and check connection cables between sensor and electronic.
Temperature out	Temperature of excitation coils is out of limits.	Temperature of excitation coils (measured liquid) is out of limits. In case of need change the limits.
Frequency over	Incorrect setting of frequency output.	Generated frequency is over 12kHz. Correct the frequency output setting.
Flowrate over	Measured flowrate doesn't correspond with nominal diameter.	Check the nominal diameter setting.
Current open	Current loop is disconnected.	Generated current is over 20mA. Correct the current output setting.
Datalogger full	Memory of datalogger is full.	Read the datalogger using the FlowAssistant software.

Table 15 : Errors

Except of errors mentioned above the flowmeter reports also errors caused by incorrect communication with the computer. These errors are described in the chapter „Remote control".

7   Application information

7.1 Specifications

Nominal size	DN15 to DN800
Nominal pressure	PN10 to PN40
Flow range	0.03 to 12 m/s (0.01 to 6000 l/s) / (0.03 to 21000 m3/h)
Accuracy	• 0.25 % (0.5 to 12 m/s) of reading value • 0.003 m/s (0.03 to 0.5 m/s)
Maximum media temperature	80°C (176°F) for rubber liner 150°C (302°F) for PTFE liner in remote version
Medium minimum electrical conductivity	$\geq 5~\mu S / cm$
Ambient temperature	-20 to 70 °C (-4 to 140°F)
Excitation coils temperature	-20 to 150 °C (-4 to 302°F)
Power supply (nominal range, range, flowmeter version)	• **85 V to 264 V AC** (47-65 Hz) • M921-Vxx0x • **12V DC** (9 V to 18 V DC) • M921-Vxx1x • **24V DC** (18 V to 36 V DC) • M921-Vxx2x • **48V DC** (36 V to 75 V DC) • M921-Vxx3x
Power consumption	12 VA
Liner	• hard rubber • PTFE
Electrodes	• CrNi stainless steel 1.4571 • Hastelloy C276 • Tantalum
Measuring tube	Stainless steel 1.4201, dimensions according to DIN 17457
Flange	Carbon steel 1.0402 or higher Dimensions according to DIN2501 (=EN1092=BS 4504), ANSI B16.5, JIS B2220, Sanitary DIN11851, flangeless wafer style
Protection category	• Compact version: IP67 • Remote version: sensor IP68, converter IP65 (optionally IP67)
Outputs	• Frequency 0 to 12 kHz with programmable flowrate and function • Pulse 0 to 200 Hz with programmable volume, function and pulse width • Status (relay) output 110V/1A/30W with programmable function • Current loop 4 to 20 mA with programmable flowrate and function, error/alarm function.
Input	PLC digital input with programmable function
Communication	• USB/RS232, RS485 (Modbus)
Displayed values	• Flowrate (m3/h, l/s, US.Gal/min, Imperial.Gal/min, user) • Volume (m3, l, US.Gal, Imperial.Gal, user) • Positive, total, negative and auxiliary (clearable, daily) volume
Control	• Keyboard with 6 buttons, graphic display with backlight. • USB/RS232 and RS485
Other features	• Test of: excitation coils, electronic unit • Diagnostic of internal temperature and power supply voltages • Internal temperature and power supply diagnostic • Real time clock with maintenance-free backup power source • Empty pipe indication • Datalogger 900000 records (programmable sample rate) • Registration of min. and max. flowrate including date and time

7.2 Weight and dimensions

Flowmeter weight and dimensions depend mostly on the version (remote or compact) and diameter of the pipe.

7.2.1   Electronic unit

The pictures below show dimensions of the electronic unit. Dimensions are in millimeters.
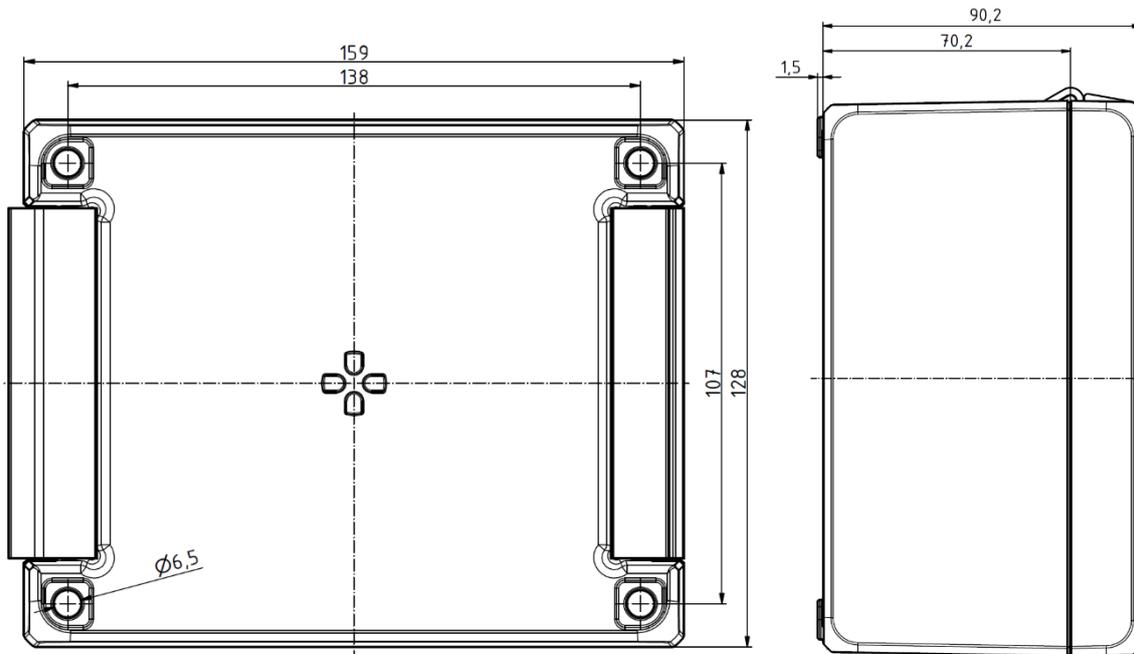
Weight: 1.8 kg

7.2.2   Electronic unit – remote version

Basic:

Electronic unit has standard four holes for installing the wall mounting.

Options (extra ordered) 921-10 wall brackets (BA WL 7035):

Scope of delivery: 2 wall brackets and 4 screws.

Dimensions are in millimeters.
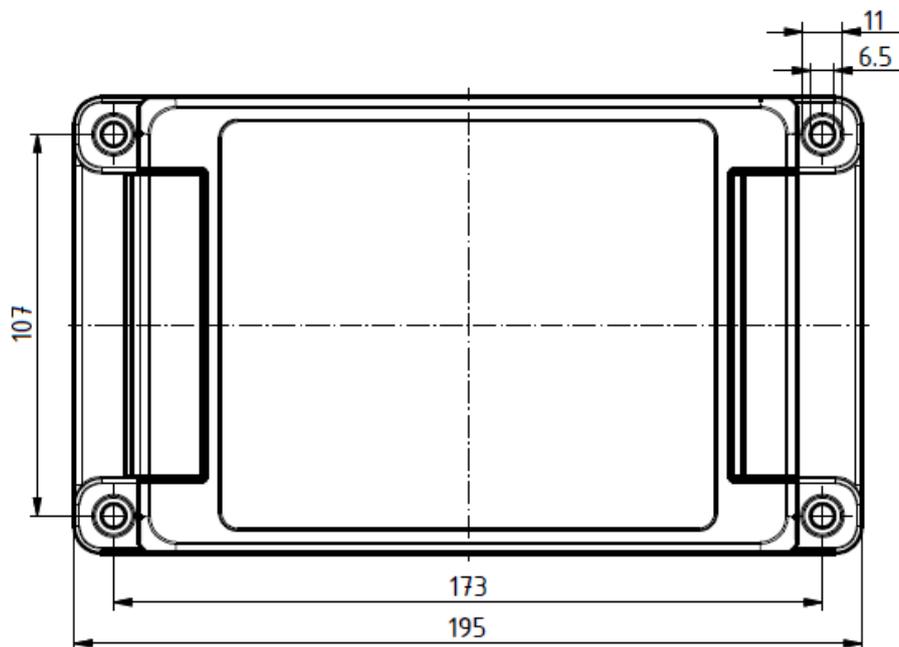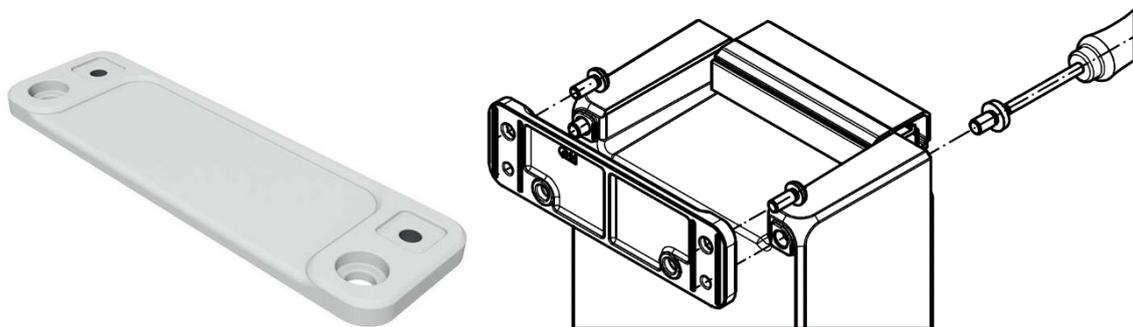
Options (extra ordered) 921-11 rail DIN EN 60715 TH 15 (TS 15):

Scope of delivery: 1 DIN rail, galvanised steel.

Options (extra ordered) 921-12 rail DIN EN 60715 G 32 (TS 32):

Scope of delivery: 1 DIN rail, galvanised steel.

Options (extra ordered) 921-13 rail DIN EN 60715 TH 35 (TS 35):

Scope of delivery: 1 DIN rail, galvanised steel.

7.2.3   Sensor

In the table below are the dimensions of the sensor for compact version. In case of remote version add 120 millimetres to dimension "A" for cable gland and cable. Flanges in DIN version meet standard EN1092. Flanges in ANSI version meet requirements of ANSI B 16.5 standard.
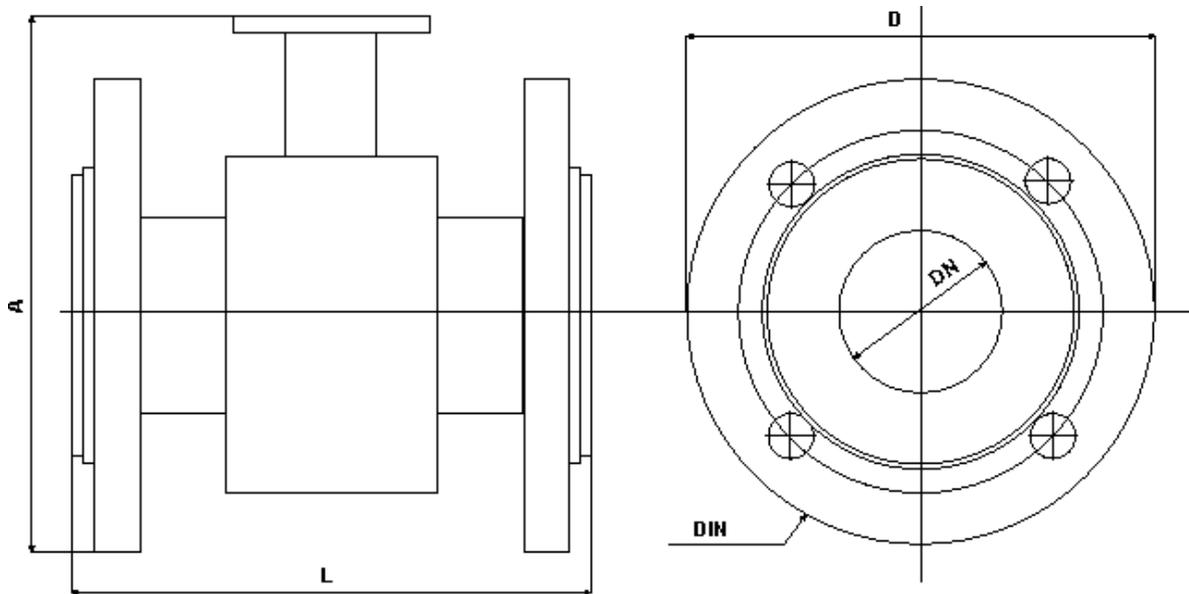

DN (mm)	PN (bar)	D (mm)	A (mm)	L (mm)	Weight (kg)
15	16	95	145	200	3
20	16	105	150	200	3,5
25	16	115	155	200	4
32	16	140	165	200	5
40	16	150	175	200	5
50	16	165	185	200	7
65	16	185	200	200	8,5
80	16	200	215	200	10
100	16	220	235	250	13
125	16	250	265	250	17
150	16	285	295	300	22
200	16	340	355	350	31
250	10	395	435	450	44
300	10	445	485	500	57
350	10	505	535	550	72
400	10	565	580	600	95
500	10	670	695	600	120
600	10	780	800	600	160
700	10	895	900	700	230
800	10	1015	1010	800	330

Table 16 : Dimensions and weights – DIN flanges

7.3 Used materials

Electromagnetic flowmeter is made from materials, which meet international standards and conventions.

Liner	Hard rubber Teflon - PTFE	as standard
Electrodes	CrNi stainless steel 1.4571 Hastelloy C276 Tantalum	as standard
Sensor tube	Stainless steel 1.4201,	dimensions according to DIN 17457
Flange	Carbon steel 1.0402 or higher	dimensions according to DIN2501 (=EN1092=BS 4504), ANSI B16.5, JIS B2220, Sanitary DIN11851, flangeless wafer style

Table 17 : Used materials

7.4 Used pluggable terminal block connectors

Specification of used connectors are listed in following table, in case of needing replacement of connectors or their pluggable counterparts.

Placement	Number of pins	Pitch [mm]	Manufacturer	PCB header (type or number)	Pluggable terminal counterpart (type or number)
Electrodes and coils	5	5.08	PTR Messtechnik GmbH	STLZ950/05G-5.08-V-GREEN	AKZ1100/05G-5.08-V-GREEN
Power supply	3 with flanges	5	Würth Elektronik	691318700003	691343710003
Input/outputs	6	3.81		691321300006	691361300006
	3			691321300003	691361300003
	2			691321300002	691361300002

Table 18 : Connector types

7.5 Flowrate versus diameter

The choice of flowrate for an electromagnetic flowmeter depends on the diameter of the sensor. The higher pipe diameter, the higher flowrate can be measured. A determining parameter for flowrate is maximum velocity of the liquid. Maximum velocity is the speed, where the flow of liquid inside pipe is still laminar. In M921 it is limited to 10m/s (with 125% overload). Speed over 10 m/s is usually too high for industrial applications. Such diameter of pipe is usually selected, where expected flowrate is between $Q_{5\%}$ and $Q_{50\%}$.

In the table below applicable flowrates for various diameters is displayed in units l/s and m^3/hr.

DN	Flowrates [l/s]						Flowrates [m3/h]					
	$Q_{0.3\%}$	$Q_{5\%}$	Q_N	$Q_{50\%}$	$Q_{100\%}$	Q_{MAX}	$Q_{0.3\%}$	$Q_{5\%}$	Q_N	$Q_{50\%}$	$Q_{100\%}$	Q_{MAX}
15	0,005	0,09	0,50	0,88	1,77	2,21	0,06	0,32	2,00	3,18	6,36	7,95
20	0,009	0,16	0,90	1,57	3,14	3,93	0,11	0,57	3,20	5,65	11,31	14,14
25	0,015	0,25	1,40	2,45	4,91	6,14	0,18	0,88	5,00	8,84	17,67	22,09
32	0,024	0,40	2,20	4,02	8,04	10,05	0,3	1,5	8,00	14,5	29,0	36,2
40	0,04	0,6	4,0	6,3	12,6	15,7	0,5	2,3	13,0	22,6	45,2	56,6
50	0,06	1,0	6,0	9,8	19,6	24,5	0,7	3,5	20,0	35,3	70,7	88,4
65	0,10	1,7	9,0	16,6	33,2	41,5	1,2	6,0	35,0	59,7	119,5	149,3
80	0,15	2,5	14,0	25,1	50,3	62,8	1,8	9,0	50,0	90,5	181,0	226,2
100	0,24	3,9	20,0	39,3	78,5	98,2	3	14	80	141	283	353
125	0,4	6	30,0	61	123	153	4	22	150	221	442	552
150	0,5	9	50,0	88	177	221	6	32	200	318	636	795
200	0,9	16	100	157	314	393	11	57	300	565	1131	1414
250	1,5	25	150	245	491	614	18	88	500	884	1767	2209
300	2,1	35	200	353	707	884	25	127	800	1272	2545	3181
350	2,9	48	300	481	962	1203	35	173	1000	1732	3464	4330
400	3,8	63	400	628	1257	1571	45	226	1300	2262	4524	5655
500	5,9	98	600	982	1963	2454	71	353	2000	3534	7069	8836
600	8,5	141	800	1414	2827	3534	102	509	3000	5089	10179	12723
700	12	192	1000	1924	3848	4811	139	693	4000	6927	13854	17318
800	15	251	1200	2513	5027	6283	181	905	5000	9048	18096	22620

Table 19 : Applicable flowrates for various diameters

$Q_{0.3\%}$ - minimum applicable flowrate (minimum flowrate with guaranteed accuracy)
$Q_{5\%}$ - recommended minimum flowrate (minimum flowrate with best accuracy)
Q_N - recommended nominal flowrate (expected working flowrate)
$Q_{50\%}$ - recommended maximum flowrate (maximum flowrate for industrial use)
$Q_{100\%}$ - maximum applicable flowrate (maximum flowrate with guaranteed accuracy)
Q_{MAX} - maximum applicable overload ($Q_{125\%}$) (flowmeter is still measuring)
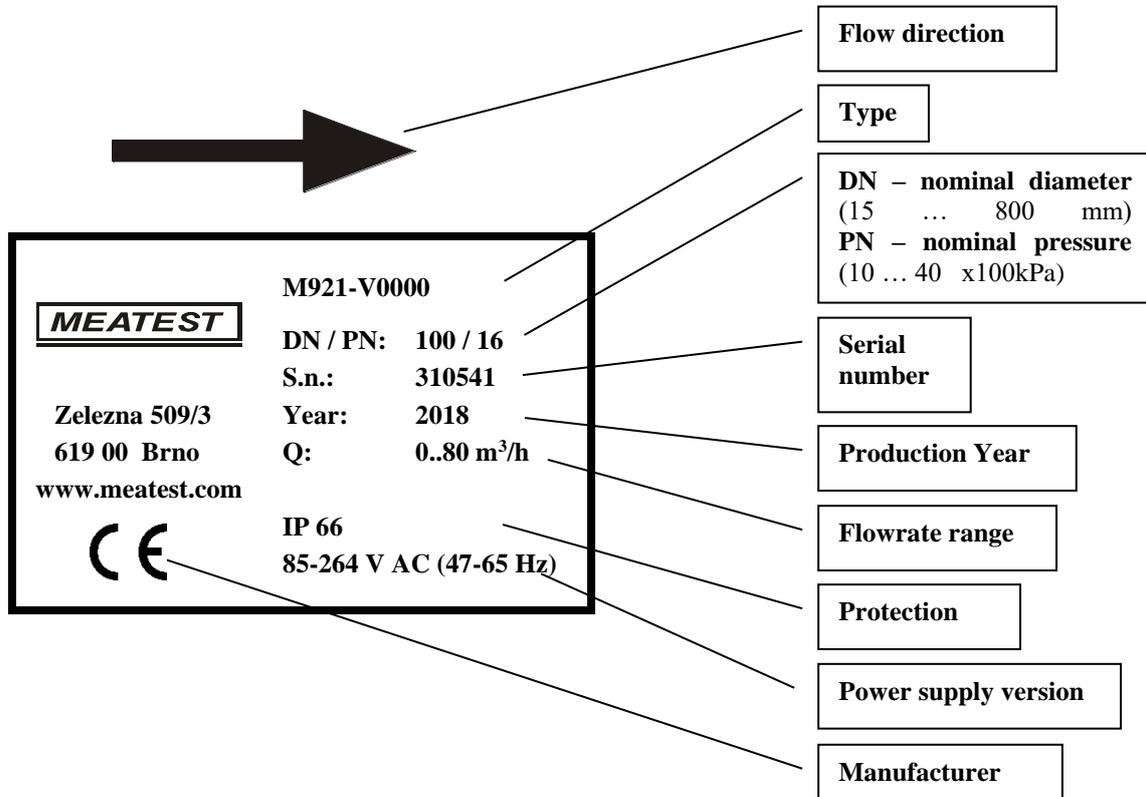
Table 2: M921 flowrates

A sensor diameter should be chosen to keep real flowrate between $Q_{5\%}$ and $Q_{50\%}$, because in this range the flowmeter has the best accuracy.
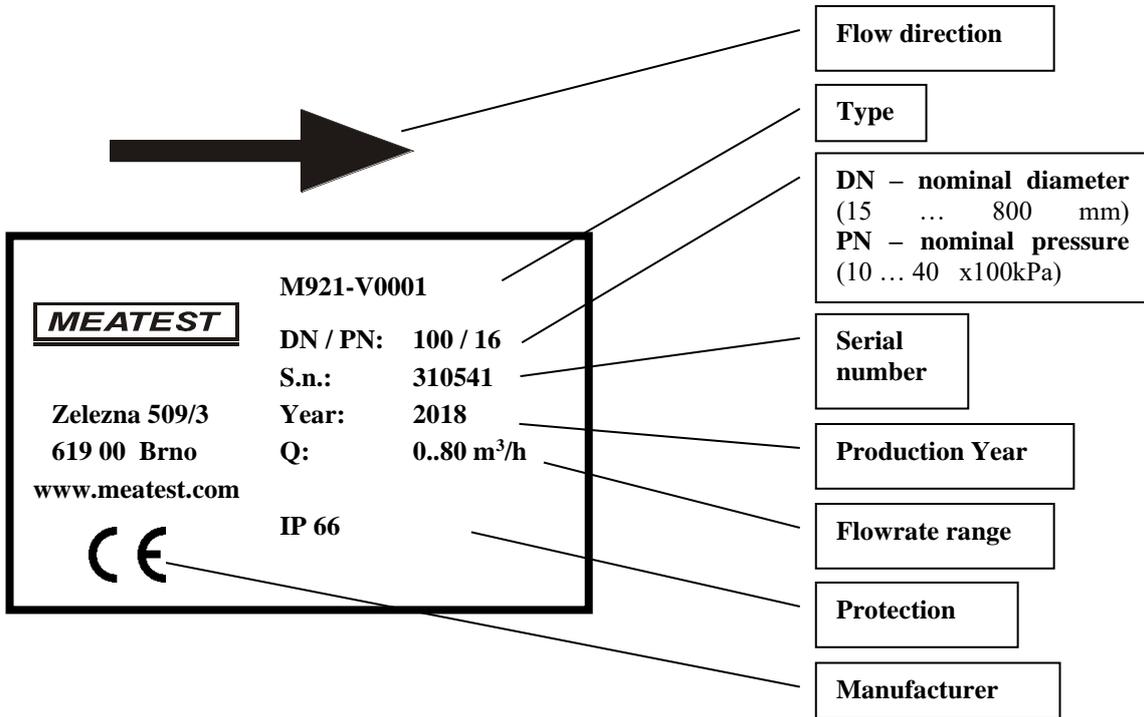
7.6 Type plate

Compact version

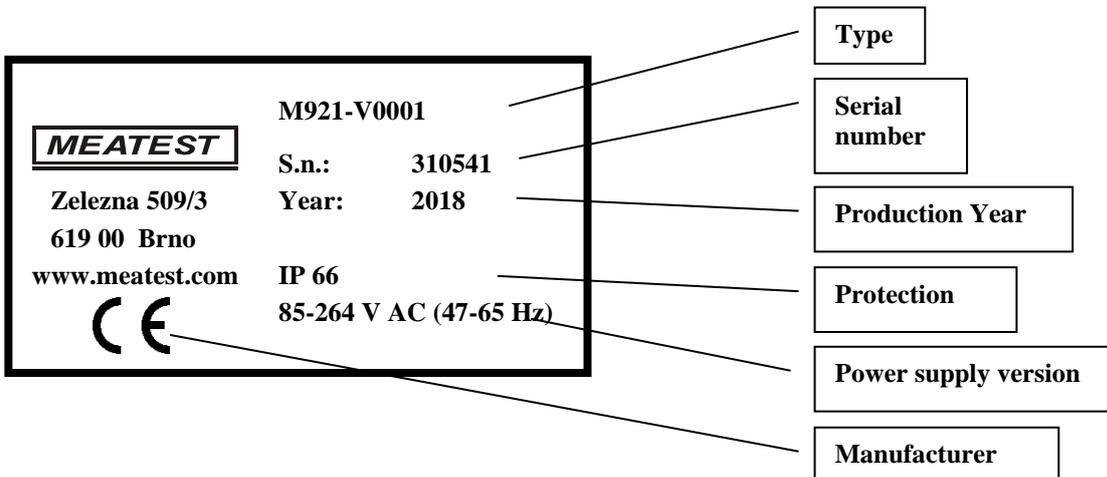The type plate is located on the sensor. The following information is on the plate:

Remote version

Type plate on the **flanged sensor**:

Type plate on the **converter**:

7.7 Terminology

Special symbols and terms.

Flowrates:

$Q_{1\%}$ - minimum applicable flowrate (the least flowrate which has guaranteed measuring accuracy – depends on diameter – see table 2 M921 flowrates).

$Q_{5\%}$ - recommended minimum flowrate (least flowrate which has the best measuring accuracy – depends on diameter – see table 2 M921 flowrates).

Q_N - recommended nominal flowrate (nominal flowrate in which is flowmeter usually calibrated – depends on diameter – see table 2 M921 flowrates). User can predetermine this nominal flowrate in userr order.

$Q_{50\%}$ - recommended maximum flowrate (maximum flowrate which is usually used in industrial applications – depends on diameter – see table 2 M921 flowrates).

$Q_{100\%}$ - maximum applicable flowrate (flowrate limit which has guaranteed measuring accuracy – depends on diameter – see table 2 M921 flowrates).

Q_{MAX} - maximum applicable overload ($Q_{125\%}$) (maximum flowrate which can be still measured – depends on diameter – see table 2 M921 flowrates).

Abbreviations:

Qi   - current output constant. It represents flowrate for current 20 mA.

Qf   - frequency output constant. It represents flowrate for frequency 1000 Hz.

Qp   - impulse output constant. It represents volume for 1 impulse.

Qd   - constant for dosing. It represents volume for 1 dose.

PF1   - flowrate limit constant. It represents low limit flowrate. Crossing this limit activates the appropriate digital output.

PF2   - flowrate limit constant. It represents high limit flowrate. Crossing this limit activates the appropriate digital output.

H   - flowrate limit constant. It represents hysteresis by evaluating limits PF1 and PF2.

Auxiliary volume counter – second Total Volume counter. It is usually used for measuring volume during day, month etc.

RS232 – serial bus. It enables remote control of instruments by a computer. Only one instrument can be connected to one RS232 bus. Cable length between PC and instrument is limited to app. 10 metres.

RS485 – serial bus. It enables remote control of instruments by a computer. To the RS485 can be connected more instruments (max. 16). Total cable length is limited to app. 800 metres.

7.8 Measuring principle

The flowmeter is designed for electrically conductive fluids. Measurement is based on Faraday's law of induction, according to which a voltage is induced in an electrically conductive body, which passes through a magnetic field. The following expression is applicable to the voltage:
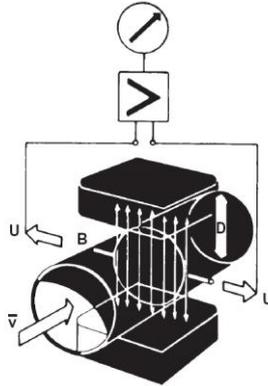
$U = K \times B \times v \times D$

where:

 U = induced voltage
 K = an instrument constant
 B = magnetic field strength
 v = mean velocity
 D = pipe diameter

Thus the induced voltage is proportional to the mean flow velocity, when the field strength is constant. Inside the electromagnetic flowmeter, the fluid passes through a magnetic field applied perpendicular to the direction of flow. An electric voltage is induced by the movement of the fluid (which must have a minimum electrical conductivity). This is proportional to the mean flow velocity and thus to the volume of flow. The induced voltage signal is picked up by two electrodes, which are in conductive contact with the fluid and transmitted to a signal converter for a standardized output signal. This method of measurement offers the following advantages:

- No pressure loss through pipe constriction or protruding parts.
- Since the magnetic field passes through the entire flow area, the signal represents a mean value over the pipe cross-section; therefore, only relatively short straight inlet pipes x DN from the electrode axis are required upstream of the primary head.
- Only the tube liner and the electrodes are in contact with the fluid.
- Already the original signal produced is an electrical voltage, which is an exact linear function of the mean flow velocity.
- Measurement is independent of the flow profile and other properties of the fluid.

The magnetic field of the primary head is generated by a square wave current fed from the signal converter to the field coils. This field current alternates between positive and negative values. Alternate positive and negative flowrate-proportional signal voltages are generated at the same frequency by the effect of the magnetic field, which is proportional to the current. The positive and negative voltages at the primary head electrodes are subtracted from one another in the signal converter. Subtraction always takes place when the field current has reached its stationary value, so that constant interference voltages or external or fault voltages changing slowly in relation to the measuring cycle are suppressed. Power line interference voltages coupled in the primary head or in the connecting cables are similarly suppressed.

8   Ordering information

8.1 Options

Liner	
M921-V**0**xxx	hard rubber
M921-V**2**xxx	teflon PTFE
Electrodes	
M921-Vx**0**xx	CrNi steel
M921-Vx**1**xx	hastelloy C276
M921-Vx**2**xx	tantalum
Power supply voltage/frequency	
M921-Vxx**0**x	85 V to 264 V AC (47-65 Hz)
M921-Vxx**1**x	12V DC
M921-Vxx**2**x	24V DC
M921-Vxx**3**x	48V DC
Construction	
M921-Vxxx**0**	compact version
M921-Vxxx**1**	remote version

Table 20 : Options

8.2 Extra ordered options

Option 921-10	wall brackets
Option 921-11	rail DIN EN 60715 TH 15
Option 921-12	rail DIN EN 60715 G 32
Option 921-13	rail DIN EN 60715 TH 35

8.3 Example of order

M921-V0000 DN50 PN16

Liner:	hard rubber
Electrodes:	CrNi steel
Power supply:	85 V to 264 V AC (47-65 Hz)
Construction:	compact version
Nominal diameter:	50 mm
Nominal pressure:	16 bar

M921-V2120 DN15 PN25

Liner:	PTFE
Electrodes:	hastelloy C276
Power supply:	24 V DC
Construction:	compact version
Nominal diameter:	15 mm
Nominal pressure:	25 bar

Manufacturer

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