The firm ELETTA Flow AB

The differential pressure Flow Monitors FM

Operation manual

Control unit

M **S** **D**

+ Pipe section with the orifice plate

GL **FA** **GSS** **FSS**

= the unified design

for the countries of the Customs Union

Please note that this manual is available as a PDF-file on our website www.eletta.com along with other information such as technical leaflets and application reports about the applications areas of Flow Monitors FM (hereinafter – Flow Monitors).

This gives you the option either to print out the desired publications or watch it on the screen. Of course this also enables you to benefit from the use of modern software. For instance you can adjust the size of the image to suit your specific need.

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As we have tried to write this manual as carefully and comprehensive as possible from the beginning, we understand that you can still run into problems, which are not clearly described in this manual. In the unlikely event of such an incident, we kindly ask you to make sure that you go through the manual carefully, before contacting our Distributors or Eletta Flow AB in Sweden. This is to save valuable time for any of us involved in the Eletta Products, as it is sometimes easy to overlook a specific sentence in the manual. If you after doing this still are not able to solve the problem, our Customer Service staff, at the below numbers and addresses, are more than happy to help you.

You will also find useful information about our Products and organization on our homepage, which you can find at the address below.

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CONTENTS

1 General information

1.1 Description

The differential pressure Flow Monitors FM (hereinafter – Flow Monitors) are designed to measure volumetric flow of liquids (water, industrial oil up to 550 cSt, antifreeze).

They have been manufactured in Sweden since 1947 and are well known for its reliability. They are used where operational safety demands, efficient supervision and rugged installation is needed, all over the world. Eletta AB in Sweden is certified according to ISO9001 and ISO14001.

The differential pressure Flow Monitors FM are based on the proven and dependable differential pressure principle, using orifice plates for different measuring ranges.

Due to the working principle of the Flow Monitor, it is of utmost importance that the installation instructions (chapter 2.3) are followed carefully in order to get the proper function of the Flow Monitor.

The Flow Monitors consists of two parts mainly i.e. the Pipe Section (PS) with the orifice plate and the Control Unit (CU). PS is the part that is to be mounted in the process pipe and CU is mounted on the PS.

The Flow Monitors are working with the next differential pressure ranges:

50 – 200 mbar	(5 – 20 kPa)	for executions CU: S2, S02, D2, R2;
22 – 550 mbar	(2,2 – 55 kPa)	for executions CU: S25, S05, D5, R5;
5 – 500 mbar	(0,5 – 50 kPa)	for executions CU: M310;
12,5 – 1250 mbar	(1,25 – 125 kPa)	for executions CU: M325;
25 – 2500 mbar	(2,5 – 250 kPa)	for executions CU: M350.

The operating principle of Flow Monitors based on the measurement of differential pressure proportional to the liquid volume of the measuring PS.

Fluid from the PS, through the channels of the pressure before and after the orifice plate, enters the CU.

The CU executions D2 and D5 contains the electrical circuit board which is giving you the flow information via the LCD-display on the front side of the Flow Monitor, and through the output 4…20 mA and a frequency output from 200 to 1000 Hz. Indication of the two independent settable relays (max.30W) for high/low alarm positions is displayed on the LCD display.

The CU executions M310, M325 and M350 contains the two pressure sensors, RS485 interface, the circuit board and the electrical connector. The circuit board outputs 4-20 mA analog signal and flow alarm through the output connector.

The CU executions S02 and S05 have a local readout, and S2 and S25 are also equipped with two independent adjustable alarms (micro switches). The readout has a scale, which shows you the ordered flow range with a multiplier as a standard. The standard scales have the following designations; for S2/S02 the scale goes from the number 4 to 8 (1:2 turndown). This is the value that you have to multiply the small multiplier (MC-measuring constant) figure at the bottom of the scale with, in order to read the actual flow in the values you have ordered.

For the executions S25 and S05 the scale goes from 1 to 5 and hence, this is the value you use together with the multiplier (MC) at the bottom of the scale, to read the actual Flow through the Monitor.

The Control Unit can also be fitted with a special ordered scale (direct reading scales) as an option, for example, lit/min, m3/h etc. for easy reading and then you have no multiplier at the bottom of the scale.

Flow Monitors are installed in the pipeline with the nominal diameters (DN) from 15 to 300 mm. PS are available in different process connections with the following standards:
1. Threaded connections from DN15 mm (1/2") to DN40 mm (1 1/2").
2. Flanged (wafer) connections from DN15 mm to DN300 mm (12").

1.2 Specifications

The only flow difference between the S2 and S25 is the turndown of the flow range i.e. the S2 has a 1:2 turndown (for example; 50 –100 l/min) and the S25 has a turn down of 1:5 (for example; 20 – 100 l/min).
The same applies to executions S02 and S05, D2 and D5. The executions M310, M325 and M350 have the turndown 1:10 (e.g., 10-100 l/min).

Accuracy:

Modification **S**:
±5 % F.S (full scale) within 20-80 % of the chosen Flow range
±10 % F.S.(full scale) within 0-20 % and 80-100 % of the chosen Flow range

Modifications **D** and **M**:
±2 % F.S (full scale) of the chosen flow range.

The accuracy stated is achievable if the installation instruction is followed given in this manual. It is recommended, that you always chose the flow range of the Flow Monitor so that the normal flow is in the middle of the Monitor Flow range. Make sure that the expected alarm set points are within the chosen flow range. For example: if you have a flow of 110 l/min maximum and the normal Flow is at 90 l/min, chose the Eletta Flow Monitor S2 with a flow range of 60-120 l/min.
This will give you the highest accuracy since your flow is in the middle of the Monitor Flow Range and give you a lower pressure loss.

Repeatability:

< 2 % on actual value modifications **S** and **D**;
<0,5 % on actual value modification **M**.

Pressure:

Max. PN:1,6 MPa (16 bar) – modifications **S** and **D**.
Min. PN: a line pressure of apx.: 0,07 – 0,1 MPa (0,7 – 1 bar) is required for proper operation.

Max. PN: 1,0 MPa (10 bar) – execution M310.
Min PN: 0,1 MPa (1 bar).

Max. PN: 2,5 MPa (25 bar) – execution M325.
Min PN: 0,175 MPa (1,75 bar).

Max. PN: 5,0 MPa (50 bar) – execution M350.
Min PN: 0,3 MPa (3 bar).

Temperature of medium:

Control Unit
Modification **D** temperature range + 5 °C to + 65 °C.
Modification **M**: +5 **°C** to +80 **°C**.
Modification **S**: +5 °C to +90 °C.

Ambient temperature:	All modifications: +5 °C to +60 °C.
Display:	Modification **S**: 120 mm diameter with mechanical pointer and a linear scale. Modification **D**: LCD- display with the actual value of volumetric flow. Modification **M**: not included.
Sight front glass:	Modifications **S** and **D**: Acrylic glass. Modification **M**: not included.
Process connection:	DN 15-40 (0,5 – 1,5") modification GL; DN 15-25 (0,5 – 1") modification GSS; DN 15-300 (0,5 – 12") modification FA; DN 15-300 (0,5 – 12") modification FSS.
Alarm contacts:	Executions S2 and S25 have 2 (two) micro switch SPDT contacts, independently adjustable within the ordered Flow range. Executions S02 and S05 has no micro switch contacts included; only a dial for local indication of Flow. Executions D2 and D5 contains 2 (two) alarm contacts with maximum load capacity of 30 Watts and independently adjustable within the chosen Flow range. Executions M310, M325 и M350 has no alarm contacts included.
Specifications of switches:	**Executions S2 and S25:** SPDT-micro switches; Voltage: max. 460 V AC; Current: max.15 A; Hysteresis: ±10 %; Contact surfaces are silver plated as standard; As an option, micro switches are available with gold plated contact surface. **Executions D2 and D5:** Two independent relays, user settable over the whole flow range; Max 50 V AC/DC; Min. 1 mA, 5 VDC; Max switching capacity: 30 W; Changeable hysteresis is separate for each alarm between 2,5 and 10%.
Power supply:	**Executions D2 and D5:** 22 to 26 VDC; power consumption: up to 2,6 W. **Executions M310, M325 and M350:** 8 to 28 VDC; power consumption: up to 0,560 W.

Protection Class:	**Ingress protection (IP)** **for executions S2 and S25:** IP43 (NEMA 3R), standard, IP65 (NEMA 4x), optional; **for executions D2, D5, R2, R5:** IP65 (NEMA 4), standard; **for executions M310, M325 and M350:** IP67 (NEMA 6) as standard
Material Pipe Section:	Modification GL: copper alloy. Modification GSS: stainless steel SS 2564 (SS 316) Modification FA: up to DN40 mm (1 1/2") – copper alloy. from DN50 mm (2") – cast iron with epoxy coating. Modification FSS; stainless steel SS2343 (SS316).
Material Membrane:	Textile reinforced Hydrated Nitrile rubber (HNBR), standard on all models except stainless steel. Textile reinforced EPDM rubber, optional for all models Textile reinforced Fluorinated rubber, FPM, standard in stainless steel models, optional for others.
Material O-rings and other soft parts:	Follows the Membrane materials.

1.3 Completeness of delivery

The completeness of delivery consists of a Flow monitor, operation manual, document about methods of verification (DMV) and passport. Thus for each delivery of identical Flow Monitors to one customer shall be issued one copy of DMV and manual.

When ordering the Flow Monitor with PS modifications FA and FSS, package includes two gaskets.

All Flow Monitors with CU modifications M are supplied with a connecting cable PUR Standard cable 2,5 m, with a cross section of 8 x 0,25 mm^2. If You want to lengthen the cable, use a three-core cable for the output section of each core at least 0,25 mm^2.

1.4 Software

Flow Monitors, except the modification S have the firmware, that is installed in the integrated memory of CU in the manufacture. In the process of operation cannot be changed, because the user does not have access to it. Protection from unauthorized access to the settings and measurement data is provided by mechanical sealing.

The software is intended for the collection, conversion, processing, display (modification D) on the display unit and transmission of measurement results to the external measuring system.

Rationing of metrological characteristics of the Flow Monitor was performed with the effects. The protection level is "high" in accordance with the rules P50.2.077-2014.
Identification data are shown in table 1.

Table 1 – Identification data of software

Identification data (features)	Setting	
	For modification	
	M	D
Identification name of the software	Class: 5.20	D-METER
The version number (identification number) of the software	13.xx	2.xx
Digital identifier of the software	-*	-*
where x takes values from 0 to 9. * – Data not available because this software may not be modified, downloaded or read via some kind of interface		

1.5 Marking and sealing places

On CU of each flow monitor is applied label with the following technical parameters: type, execution, measurement range, medium, serial number, ambient temperature, maximum pressure, ingress protection, year of production.

An example plate is shown in figure 1.

Figure 1 – An example of the type plate

To protect the diaphragm from changes of the metrological characteristics, on PS is applied engraved or by laser, unique number specified in the passport data. Scheme of seal for protection from unauthorized access with the designation of the place for a verification mark is shown in figure 2.

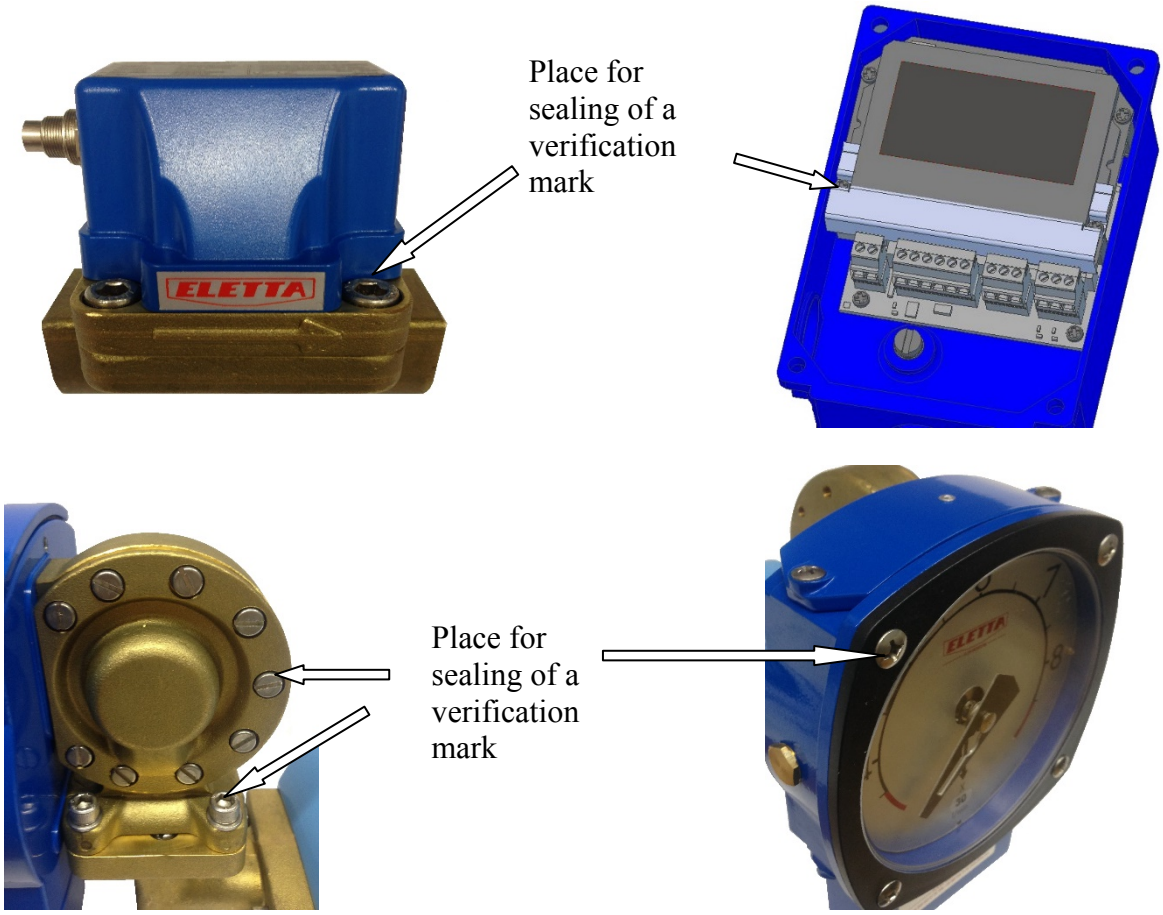


Figure 2 - Scheme of seal for protection from unauthorized access
with the designation of the place for a verification mark

2 Installation

2.1 Unpacking

We appreciate that you have decided to purchase our Products and we would like to ask you to begin the installation by checking your delivery against the Packing List. Please make sure to check the box for external damages before opening. If you find external damages, which have also led to damages to the Flow Monitor inside, you should contact the forwarder/shipper to claim replacement (or the cost of replacement). Check the Monitors' identification tag against your purchase order to make sure you have got the right articles with the right specifications.

All Monitors are individually packed in plastic bags and put into the box either two by two or individually in each box. The plastic bag is to prevent foreign particles to get inside the Pipe Section, which could prevent proper function of the Flow Monitor after the installation.

The box is made from recycled environmental friendly material and we kindly ask you to deal with the waste material in a way that will have as little impact on the environment as possible.

2.2 Procedures before Installation

N o t e - Before any installation or maintenance work, disconnect all electrical power.

Please check that you are going to mount the Monitor at the lowest point in the piping system if you are measuring liquids. Also check if the planned flow direction in the system matches the one indicated on the Monitor. There is a flow direction arrow on the outside of the pipe section.

Check that the pipe section has the right threads or the right flange standard to match your piping or counter flange.

2.3 Installation of the Pipe Section

Note!!! Before starting to install the Pipe Section, please make sure that the piping is not under pressure from flow of liquid.

The PS can be installed in any desired direction, vertically or horizontally or angular and the direction arrow on the PS denote the direction of the flow. It is very important that the PS is mounted with the correct direction, as the function of the Flow Monitor otherwise will be prevented. The piping shall be rigid and free from vibrations and hoses connected directly into the Monitors should be avoided as much as possible. If you have weak piping we advise you to use the M6 mounting holes (only on GL - series) on the backside of the pipe section, to fasten the pipe section to a wall or a rigid bracket. The straight runs before and after the Monitor should not be too short, in order to avoid disturbances, which can cause the Monitor to show incorrect values. We recommend giving at least 10 - 15 diameters upstream and 5 diameters downstream (Figure 3).

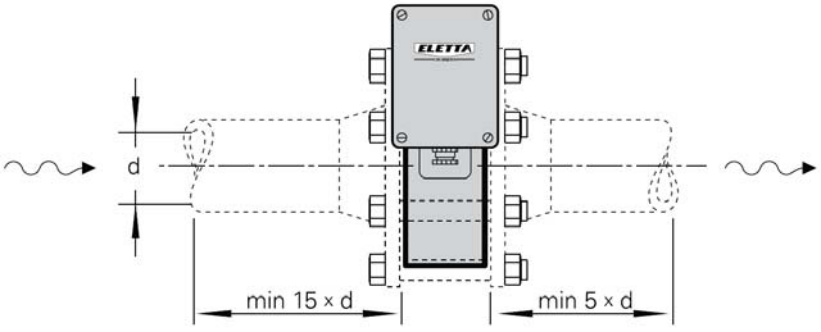


Figure 3 - Recommended installation of Pipe Section

The reasons for this procedure is to achieve a stable flow profile inside the pipe and by doing so, get a true reading. Please be aware of the fact that it is practically impossible to predict when the flow is stable after disturbances in the piping, so this must serve as a guideline only.

The straight runs must be free from valves, bends or in/decreasing diameters. Any of these disturbances must be placed **before** and preferably **after** you start counting the straight runs.

If you are installing the threaded versions, GL and GSS-versions, please make sure that you are not using so called ”tube fittings”. We have often seen them to have a much smaller inside diameter than the pipe section, even though the size of the thread match. This can create a jet stream of the fluid, which will cause the differential pressure to be to low and you, will not get a good or accurate reading.

The following inside diameters apply for the threaded Pipe Sections:
GL and GSS 15 = **16 mm**
GL and GSS 20 = **21 mm**
GL and GSS 25 = **26 mm**
GL 40 = **41 mm**

Make sure that the CU, if mounted directly on the PS, is placed on top of the PS and not under to prevent particles in the fluid to collect in the diaphragm housing. Please use a filter in the pipeline if you suspect the fluid to contain particles.

When choosing the place of installation of the Flow Monitor it is necessary to consider that the pipeline in this place was completely filled with liquid during operation.

The flanged modifications FA and FSS, must be aligned with the counter flange and not placed in stress by tightening the bolts uneven. The flanged models come with a gasket and we recommend using this, as it is dimensioned to suit the installation.

Please see to that the gasket is properly aligned and not disturbing the flow. It is also of utmost importance that the connecting pipe and flange is of the same diameter (inside) and standard as the PS.

A mismatch can cause an erratic or incorrect reading of the flow. If needed, please support the Flow Monitors with rigid brackets. There is no problem in attaching the brackets directly to the Flow Monitor, but we recommend mounting them in the pipeline downstream and upstream to avoid unnecessary stress in the installation area.

2.4 Pressure Drop

The Eletta Flow Monitor is a differential pressure measuring device and therefore it creates a certain pressure drop when in function. There are two different types of Pressure Drop’s involved, actual pressure drop and permanent pressure drop. Below we will explain the difference between these two: actual pressure drop and permanent pressure drop. When the orifice plate mounted in the Eletta Flow Monitor reduces the flow area inside the pipe system, a pressure drop over the orifice is created. This is what we call actual pressure drop.

The calculation of the flow is using this pressure drop to calculate the actual flow value (see calculation below).

The actual pressure drop is a temporary pressure state and the Eletta Flow Monitors are working within this differential pressure created within the Flow range of the Monitor.

When the flow has passed the Monitor, the pressure is then trying to get back to its original pressure and normally after 15 times the inner diameter of the pipe, the flow becomes linear and fully developed. This is a normalized flow but due to friction losses over our Flow Monitor, the pressure will not be able to reclaim all the energy (pressure). This is what we call permanent pressure drop.

The permanent pressure drop can be calculated approximately by:

$$\Delta\rho_{(ppd)} = \Delta\rho_{(apd)} \bullet (1- \beta^2), \qquad (1)$$

where the symbols represent:

$\Delta\rho_{(ppd)}$ - permanent pressure drop;
$\Delta\rho_{(apd)}$ - actual pressure drop (see formula below "actual pressure drop graph" for calculation);
β - d/D ratio (ratio between bore and inner diameter of the pipe).

This means that for the normal range $\beta = (0.2 – 0.7)$ a typical permanent pressure drop ranges from $0.96\Delta\rho$ and $0.51\Delta\rho$ can be expected.

Example:
For the Eletta Flow Monitor execution S2 with PS execution GL15 with a flow range of 10 - 20 l/min, the following example can be used for how to calculate the $\Delta\rho_{(ppd)}$ permanent pressure drop at 15 l/min for the said Monitor.

d = 10,2 mm
D = 16,0 mm

This gives $\beta = 10,2/16,00 \Rightarrow \beta = 0,6375$ and $(1- \beta^2)= 0,594$

Furthermore, in order to use this β-value in the above formula, we need to determine the $\Delta\rho_{(apd)}$. We can either use the "Actual Pressure Drop Graph" (figure 4) for an approximate value or for intermediate values we can use the formula below the graph (figure 4). If we use the formula for calculate the $\Delta\rho_{(apd)}$ at 15 l/min we will get:

$\Delta\rho_{(apd)} = (15/20)^2 \bullet 200$ mbar $\Rightarrow$ 112,5 mbar

In order to finally get the permanent pressure drop, we use the above described formula: $\Delta\rho_{(ppd)} = \Delta\rho_{(apd)} \bullet (1- \beta^2)$, and put in the values we have:

$\Delta\rho_{(ppd)} = 112,5 \bullet 0,594$ mbar $\Rightarrow$ 66,82 mbar

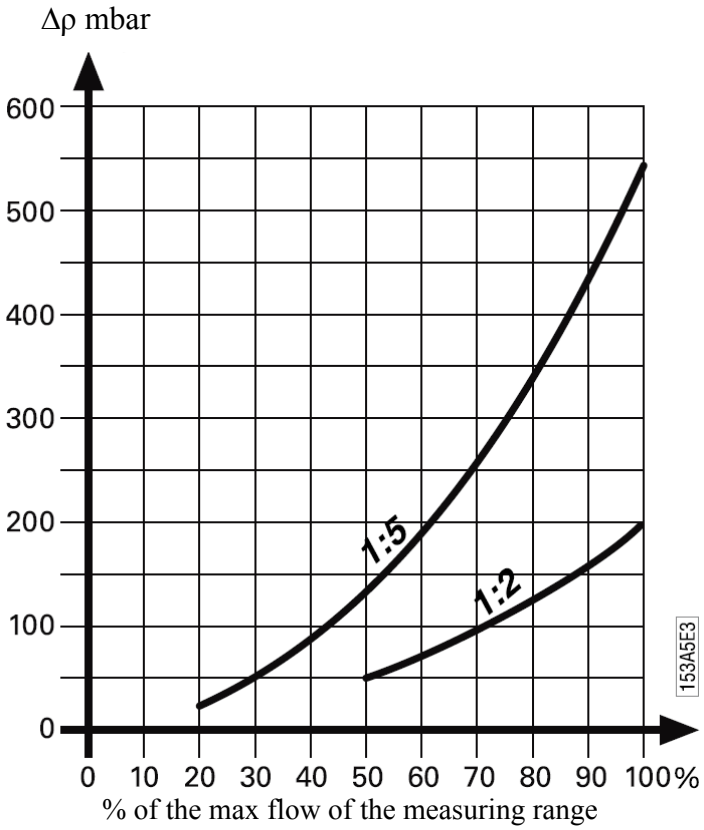


Figure 4 - Actual Pressure Drop Graph

$\Delta\rho_{(apd)} = (Q/Q_{max})^2 \cdot$ **200 mbar** - for turn down ratio of 1:2;
$\Delta\rho_{(apd)} = (Q/Q_{max})^2 \cdot$ **550 mbar** - for turn down ratio of 1:5,
где **Q** – actual flow
Q_{max} - maximum flow of the Flow Monitor (according to the installed orifice plate).
The Pressure loss curves in the graph (figure 4) must serve as a guideline.

2.5 Electrical Installation

Note – Only an authorized professional person should make all electrical installations!

This section is not valid for the models S02 and S05 as these are Flow Monitors without any micro switches installed and work without the need of electrical power.

Before you connect any cables, please make sure that you have the right power supply within the specifications (see section 1.2).

The executions of S2 and S25 has 2 (two) SPDT micro switches operating in two directions and independently adjustable within a chosen range. Below is the scheme of setting of high/low micro switches for the executions S2 and S25 (figure 5).

Before any circuit is connected/disconnected, make sure that all power is off!

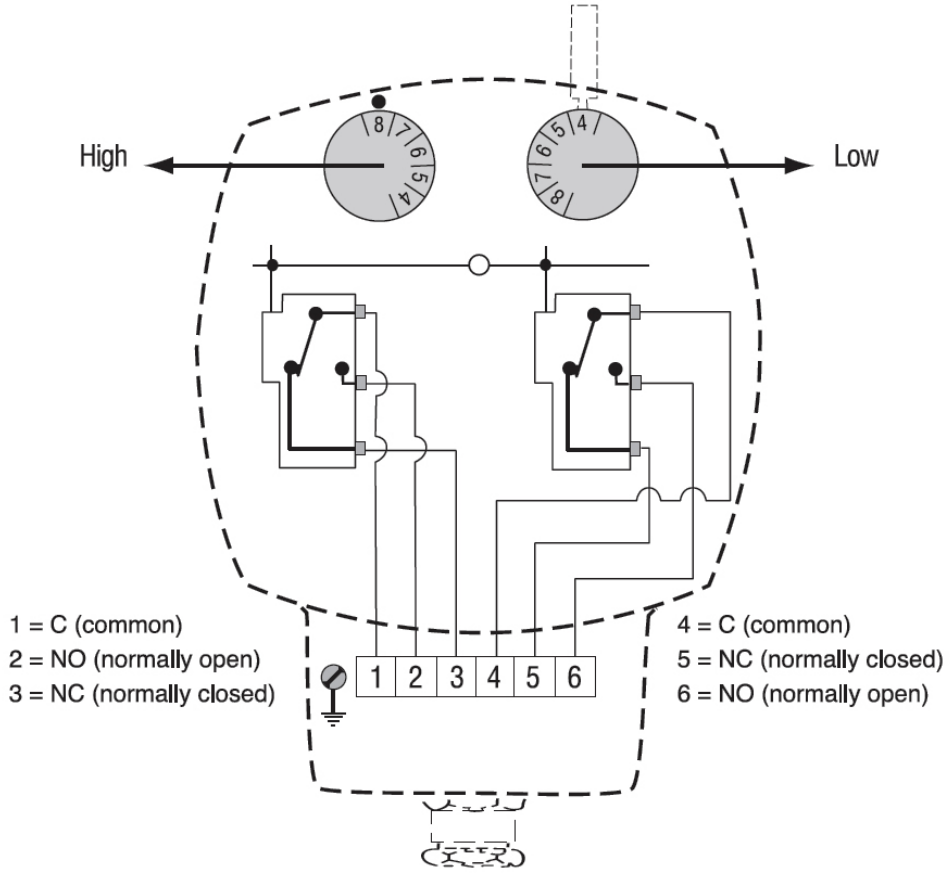


Figure 5 - Setting of high/low micro switches for the executions S2 and S25

The wiring diagram on figure 5 shows the switching function, when the flow is zero or below the lower set point.

Executions D2 and D5

Before you connect any cables, please make sure that you have the right power supply which is within the specifications (see section 1.2 ”Specifications”). Our recommendations for the analog output signal cable is shielded twisted pair with an area of minimum 0,2 mm^2. Only connect the shield in one end (instrument) to avoid ground loops. The instrument will drive the analog output and you must not connect a two-wire circuit into these terminals.

The analog output signal is pre-calibrated in our flow rig, to give you a zero based signal. This means that you will get a 4 mA reading when the flow is between zero (0) and up to the minimum possible chosen range and when the flow hits the minimum value of chosen range, the signal will jump to the linear part of the signal. For example: an D2 Flow Monitor with a turn down of 1:2 in flow will have the output signal showing 4 mA between 0 and 50% of the maximum value of chosen range and then jump up to 12 mA when it hits 50% of the possible flow range and then be linear up to 100% flow. This means that the used milliampere signal within the flow range, goes from 12 mA to 20 mA.

The D5 Flow Monitor will then go from 7,2 mA to 20 mA within the possible flow range (20% - 100% flow range). The frequency output of executions D2 and D5 works on the same principle.

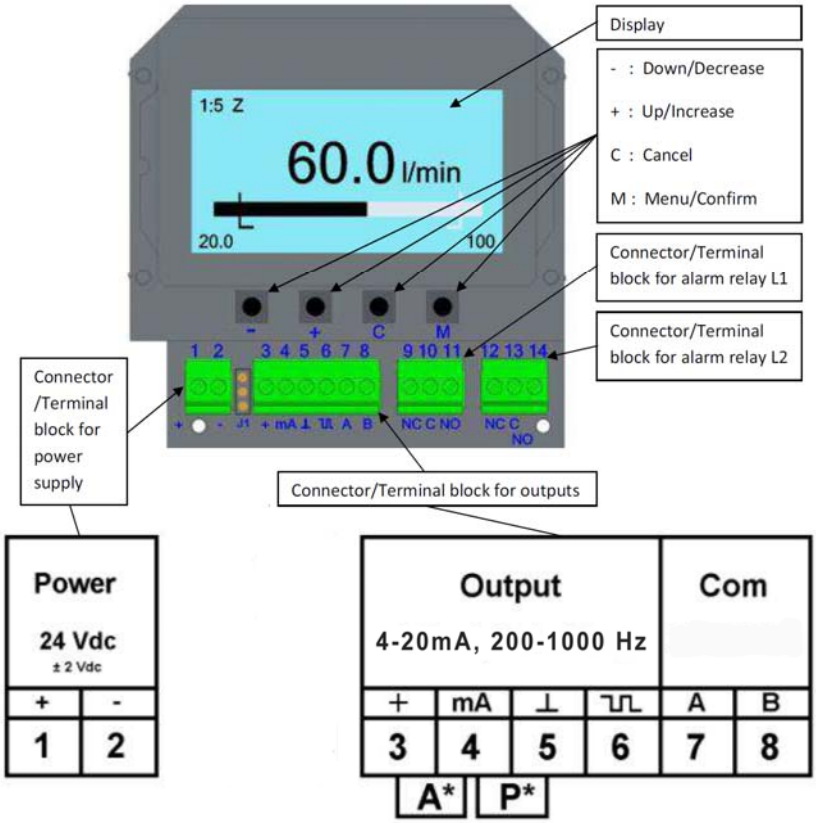
The reason for our standard calibration of the output signals as per above is the fact that most customers have a receiving instrument (digital display or analog readout) which is capable of showing 0-100%. Our execution will show him zero flow until the actual flow reaches our Flow Monitors

lowest possible flow indication and then the receiving instrument will jump up to, and immediately show, the correct and actual flow.

All terminal block connections are to be made through the included cable glands. Please note that you can have two alternative mountings of the cable gland, depending on what side you want to enter with the cable. We recommend the entry of the cables into the enclosure to be placed in a downward or sideways direction, to avoid moisture and water to collect in the enclosure.

The terminal block connections are described in figure 6. The ground screw is located next to the terminal block in the lower part of the Control unit.

It is not allowed to install the Flow Monitor modification D in an Ex-hazardous area.



№№	Purpose
1	Power supply +
2	Power supply -
3	+24 V OUT
4	Signal mA*
5	Signal ground
6	Frequency signal
7	Not active
8	Not active
9	Alarm relay L1 (wiring diagram in fig.7)
10	
11	
12	Alarm relay L2 (wiring diagram in fig.7)
13	
14	

A* Active mA drive (Max external load 1000 Ohms)

P* Passive mA load (Max external voltage 25 V)

Figure 6 – Wiring diagram with terminal block connections for Flow Monitors modification D

Power supply for CU modifications D

Make sure that you use the correct power supply voltage, the allowed range is +22 to +26 VDC.

Alarm relays

N o t e – Before any circuit is connected/disconnected make sure, that all power is off!

The Eletta Flow Monitors modification D have the possibility to give two independent flow alarms to a supervising system when for example the flow is below or higher than a predetermined value. The two relays used for this purpose are independent of the analog output signal and can be adjusted in the factory during manufacture or in the Centre of Certification and Metrology over the whole chosen range individually. Below you can find the wiring diagram (figure 7) for connecting the relays.

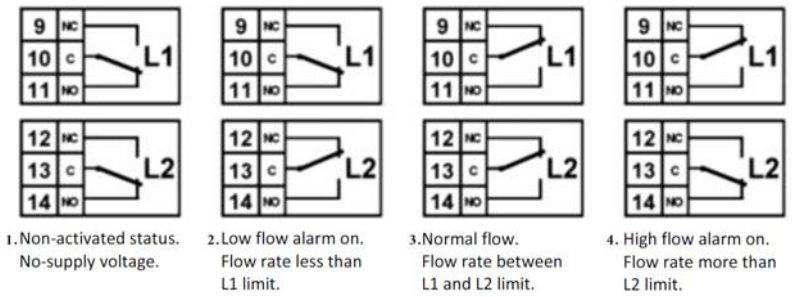
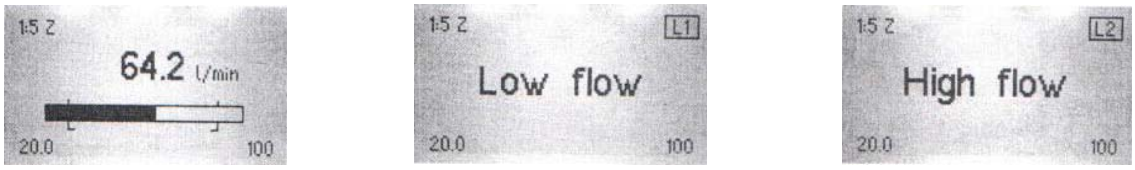


Figure 7 – Wiring diagram with alarm relays for Flow Monitors modification D

The flow value shows constantly as long as the flow is within the flow range (figure 8, variant 1).



Variant 1 Variant 2 Variant 3

Variant 1. The value is within the flow range.
Variant 2. Within 2% below Q min the value will flash before it goes over to show "Low flow".
Variant 3. Within 2% above Q max, the value will flash before it goes over to show "High flow".

Figure 8 – Variants display data of the flow range on the LCD-display

If the actual value of the flow falls below the minimum value of the chosen range more than 2 %, the display shows "Low flow" (figure 8, variant 2), informing about too low value of flow. Also this message will appear, when you connect the Flow Monitor to the power supply and in the absence of flow in the pipe. If the actual value of the flow is above the maximum value of the measuring range, the display appears "High flow" (figure 8, variant 3) to inform about the inflated flow in the pipeline.

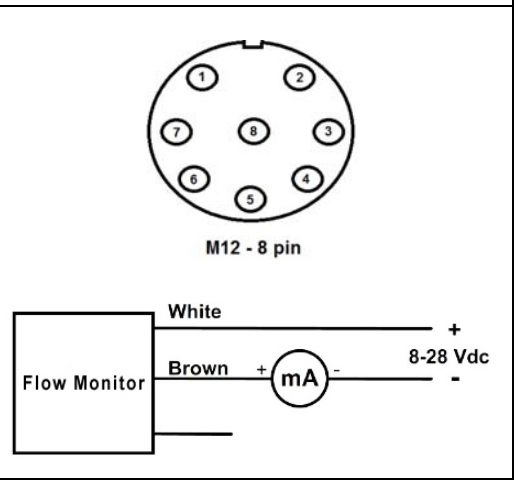
Executions M310, M325 and M350

Before you connect any cables, please make sure that you have the right power supply which is within the specifications (see section 1.2 "Specifications").

The connection cable with PUR coating is found in the delivery box together with the Flow Monitor modification M. The cable is 2,5 m with cross-section 8x0,25 мм^2 having a circular connector with screw locking. If you want to extend the cable which comes with the flow meter, then use a cable for the output signals, each lead having a conductive area of at least 0,25 мм^2.

In the table below refer to what purpose have wires of the supplied cable.

Table 2 – The purpose of the wires of the cable supplied for Flow Monitors modification M

№	Wire color	Purpose	Additional information	Graphic image
1	White	Power supply (+)	+8 up to +28 VDC	
2	Brown	- (mA)	Analog output signal	
3	Green	RS485A		
4	Yellow	RS485B		
5	Grey	Not active	Not used	
6	Pink	Not active	Not used	
7	Blue	Not active	Not used	
8	Red	Not active	Not used	

How to connect?

Connect the connection cable like this:

1) Turn the cable connector to the right position.
2) Push the cable connector against the connector of the Control unit.
3) Lock it by screwing the locking ring.

The analog output signal is pre-calibrated in our flow rig, to give you a zero based signal. This means that you will get a 4 mA reading when the flow is between zero (0) and up to the minimum possible chosen range and when the flow hits the minimum value of chosen range, the signal will jump to the linear part of the signal. For example: an M310 Flow Monitor with a turn down of 1:10 in flow will have the output signal showing 4 mA between 0 and 10% of the maximum value of chosen range and then jump up to 5,6 mA when it hits 10% of the possible flow range and then be linear up to 100% flow. This means that the used milliampere signal within the flow range, goes from 5,6 mA to 20 mA.

Power supply for CU modifications M

Make sure that you use the correct power supply voltage, the allowed range is +8 to +28 VDC.

3 Operation

3.1 Principle of operation, DP-Flow Measurement

The Eletta Flow Monitor's function is based on the proven and dependable differential pressure principal, using interchangeable sharp-edge orifice plates for different measuring ranges. This is perhaps the oldest and most widely used principle for flow metering, mainly because of its simplicity, its relatively low cost and high volume of research data available for predicting the Flow Monitors behavior. In the Pipe Section, a fixed area flow restriction (the orifice plate) causes a pressure drop, which varies with the flow rate. This pressure drop has a high and a low pressure, which is lead through two channels from each side of the orifice plate, to the Control Unit. By measure the pressure drop allows flow rate measurement by means of a mathematical formula. A short form of the calculation can be described as: $Q = \sqrt{\Delta\rho}$.

In most Eletta Flow Monitors, the differential pressure is sensed and measured mechanically via a rubber diaphragm and linked to an outside of the process liquid/gas, mechanism. This mechanism transforms the movement into a Flow rate value shown on the dial.

3.2 Adjustment of switch points (executions S2, S25, D2 and D5)

All the Eletta Flow Monitors are tested and calibrated according to the customer's orders before shipping.

Executions S2, S25

If the customer does not specify a desired switch point for the flow alarm, the modification S Flow Monitor's micro switches are preset to trip at the min- and max flow value.

There is a possibility to adjust the switch points in the field by adjusting the micro switches' position mechanically. To readjust, remove the two screws that hold the cover at the top of the blue housing. The two adjusting dials are then visible through the opening. Underneath the removed cover, you will find a small tool necessary to use in order to change the adjusting dials position.

The adjusting dials are marked the same as the scale in the front and this marking can be used to approximately find the right switch point for the actual application. Put the tool inside the drilled hole on the top of the adjusting dial and gently move the dial sideways to the desired position. If the two adjusting dials are set to the same position, the micro switches will trip at the same time. If possible, use the left adjusting dial for the high flow alarm (higher end of the scale) and the right for the min. flow alarm (the lower end of the scale), in order to get the best accuracy. If you use the alarms the other way around, the spring mechanism inside the diaphragm housing will be affected with lower accuracy as a result, so please try to avoid that.

Repeat the procedure for the next adjusting dial and then put the tool back in its bracket at the cover.

Reinstall the cover at the top with the two screws and start up the process again.

Please note!! We have calibrated each Flow Monitor in our flow rig and set the switches according to the Flow values we achieve in the rig under good conditions. We must stress that under actual field conditions, the flow profile can be different from the one in our flow rig depending on valves, hoses, bends or other obstructions and therefore the switching can be off from our preset values.

Executions D2, D5

Alarm relay execution D2 are pre-set as follows:
L1 – roughly 55 % of the chosen Flow range;
L2 – roughly 95 % of the chosen Flow range.
Сигнализирующие реле исполнений D5 установлены следующим образом:
L1 – roughly 30 % of the chosen Flow range;
L2 – roughly 90 % of the chosen Flow range.
Please remember, that calibration of Flow Monitors by the manufacturer are carried out in the test bench, respectively, the switches are set to the values of the volumetric flow rate, obtained under these optimum conditions.

3.3 The identification of the flow direction and the location of the pipeline

When ordering, You must specify the direction of the liquid in the pipe, i.e. which side the liquid will enter the pipe section, as well as the way the position of the pipeline for more convenient reading.

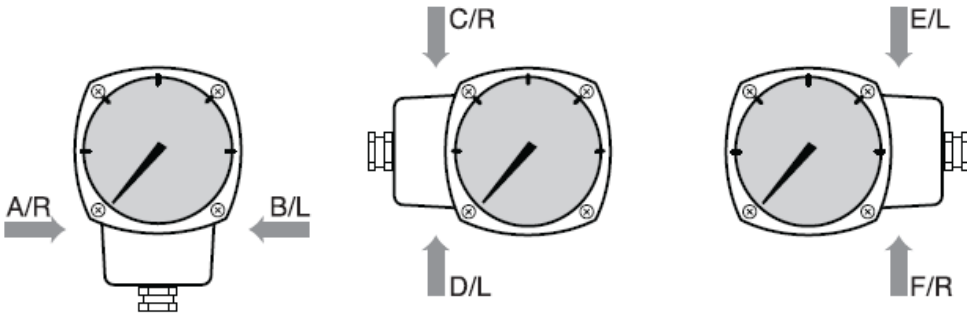


Figure 9 – The directions of the liquid in the pipe and the locations of the pipeline

4 Trouble shooting

4.1 Verification and calibration

We would like to stress the fact that all the Flow Monitors are calibrated and adjusted individually on water in a specially purpose built calibrated flow rig in our workshop. This means that we have calibrated and adjusted the Monitors under reference conditions with enough straight runs before and after, always the same liquid, temperature, flows and pressure. If you find our Monitors to show another value compared to a reference meter on site, it can well be due to the fact that the reference meter has been calibrated under other reference conditions and that our Monitor have other conditions on site in the actual application, than we used under the calibration prior to shipping.

The Flow Monitor is not showing any value or is showing the wrong value:

- Is the Monitor mounted correctly with respect to the flow direction? Please, check the arrow on the outside of the pipe section with the actual flow direction, check the flow direction selector inside the monitor. Make sure that it is corresponding to the true flow.
- Is there any flow in the pipe? And is it enough to create the needed Δρ?
- Do you have the right orifice plate for the application? Check the stamped values on the orifice plate (pipe section model number and flow).
- Are there enough straight runs upstream and downstream the Monitor? It must be 15 diameters upstream and 5 diameters downstream after the pipe section. Do you have valves or bends in more than one plane within the above straight runs? If so, move the Monitor further away to achieve enough straight runs.
- Under the above section 3.1 it is described how the Flow Monitor creates the differential pressure. The Flow Monitors work with different Δρ, i.e. on the executions S2, D2 the Δρ is always maximum 200 mbar and for the executions S25 and D5 the Δρ is always maximum 550 mbar, and for the executions M310, M325 and M350 - 500, 1250 and 2500 mbar, respectively. This means, that at maximum Δρ the flow range is always 100% in any Flow Monitor mounted on any pipe section.

To check if the Monitor is showing the right desired and ordered value, it is easy to remove the Flow Monitor from the pipe system and block the orifice plate and apply the correct maximum pressure at the inlet. If you apply for example 200 mbar on the executions S2 and S02 with a blocked orifice, the pointer should reach the last digit (8 for the executions S2 and S02) on the front scale and if you have a direct reading scale installed, the pointer should reach the end value.

The same goes for a S25 and S05 model, which should reach the digit 5 if you apply a pressure of 550 mbar.

On the execution D2 – we get 20 mA output signal and 1000 Hz on frequency output, on executions M310, M325 и M350 – 20 mA.

You can of course also verify the flow in the Eletta Flow Monitor versus another flow meter in the system or take the Flow Monitor out and put in a flow test rig, if you have the possibility.

If the above is not the case, there is a need to send the Flow Monitor to the Distributor of the Eletta Flow AB.

If you find process liquid coming out of the Control Unit:

Most probably you will find a broken lever, the small stainless steel shaft going through a rubber sealing and it is attached to the diaphragm in the end. If you have exposed the Flow Monitor to excessive pressure above the maximum allowable or if the process liquid is too aggressive to the rubber in the sealing, it can cause the sealing to break.

4.2 Electrical connections

Please always see to that you are using the right voltage and current (see section 1.2) and that you have connected all the leads in a proper way. If you open the cover on the Control Unit of the Monitors it is normally very easy to see, if a component is broken or burned.

If you need to order a complete Flow Monitor or a Control Unit for any reason, please check the identification plate and write down the serial number, flow range and liquid and order a new Unit from us. The manufacturer will ship you the complete Flow Monitor and you can then easily install the new Flow Monitor instead of existing unit.

5 Weight and Dimensions

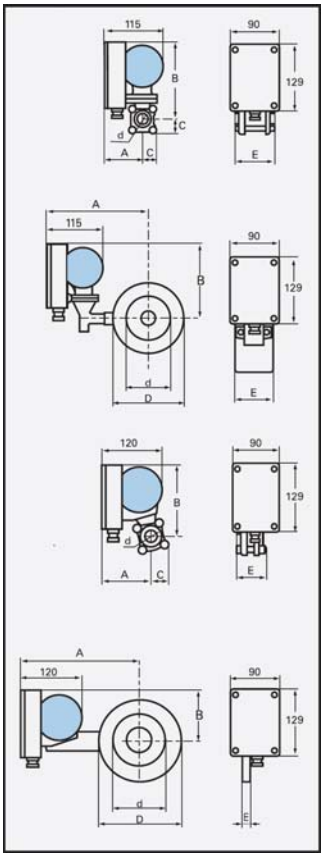
Table 3 – Weight and Dimensions

Control unit modification D with Pipe section modification GL						
DN, mm	A, mm	B, mm	C, mm	d, mm	E, mm	Weight, kg
15	75	150	30	16	80	3,0
20	75	150	30	21	80	3,0
25	75	150	30	26	80	3,0
40	85	160	40	41	90	4,0

Control unit modification D with Pipe section modification FA						
DN, mm	A, mm	B, mm	D, mm	d, mm	E, mm	Weight, kg
15	149	145	53	16	70	4,0
20	153	145	63	22	70	4,4
25	159	145	73	30	70	4,6
32	165	145	84	39	70	5,1
40	170	145	94	43	70	5,8
50	178	145	109	55	70	5,9
65	188	145	129	70	70	7,0
80	196	145	144	82	70	7,8
100	206	145	164	107	70	8,2
125	222	145	194	132	70	10,3
150	234	145	219	160	70	11,2
200	262	145	274	207	70	15,1
250	289	145	330	260	70	18,7
300	318	145	385	310	70	21,4

Control unit modification D with Pipe section modification GSS						
DN, mm	A, mm	B, mm	C, mm	d, mm	E, mm	Weight, kg
15	100	130	35	16	53	3,0
20	100	130	35	21	53	3,0
25	100	130	35	26	53	3,0

Control unit modification D with Pipe section modification FSS						
DN, mm	A, mm	B, mm	D, mm	d, mm	E, mm	Weight, kg
15	169	95	53	16	15	3,0
20	175	95	63	22	15	3,0
25	183	95	73	30	15	3,0
32	185	95	84	39	15	3,0
40	190	95	94	43	15	3,0
50	210	95	109	55	15	3,0
65	220	95	129	70	15	3,5
80	228	95	144	82	15	3,5
100	238	95	164	107	15	4,0
125	253	95	194	160	15	4,5
150	266	95	219	159	15	5,0
200	293	95	274	207	15	6,5
250	320	95	330	260	15	8,0
300	350	95	385	310	15	9,5

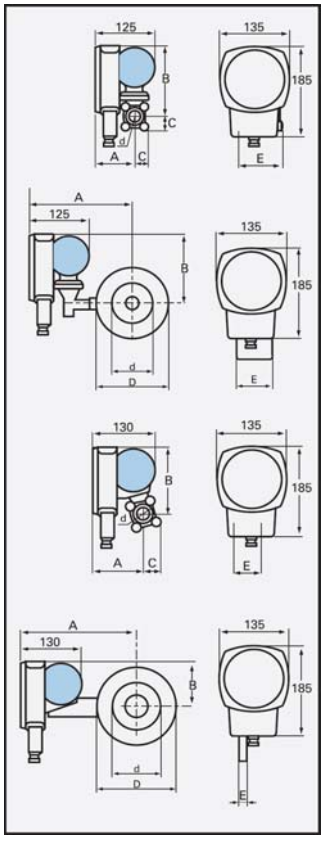


Control unit modification S with Pipe section modification GL						
DN, mm	A, mm	B, mm	C, mm	d, mm	E, mm	Weight, kg
15	85	150	30	16	80	3,5
20	85	150	30	21	80	3,5
25	85	150	30	26	80	3,5
40	95	160	40	41	90	4,5

Control unit modification S with Pipe section modification FA						
DN, mm	A, mm	B, mm	D, mm	d, mm	E, mm	Weight, kg
15	160	145	53	16	70	4,5
20	164	145	63	22	70	4,9
25	170	145	73	30	70	5,1
32	176	145	84	39	70	5,6
40	181	145	94	43	70	6,3
50	189	145	109	55	70	6,4
65	199	145	129	70	70	7,5
80	207	145	144	82	70	8,3
100	217	145	164	107	70	8,7
125	233	145	194	132	70	10,8
150	245	145	209	160	70	11,7
200	273	145	274	207	70	15,6
250	300	145	330	260	70	19,2
300	329	145	385	310	70	22,0

Control unit modification S with Pipe section modification GSS						
DN, mm	A, mm	B, mm	C, mm	d, mm	E, mm	Weight, kg
15	110	130	35	16	53	3,0
20	110	130	35	21	53	3,0
25	110	130	35	26	53	3,0

Control unit modification S with Pipe section modification FSS						
DN, mm	A, mm	B, mm	D, mm	d, mm	E, mm	Weight, kg
15	179	95	53	16	15	3,0
20	185	95	63	22	15	3,0
25	193	95	73	30	15	3,5
32	200	95	84	39	15	3,5
40	205	95	94	43	15	3,5
50	220	95	109	55	15	4,0
65	230	95	129	70	15	4,0
80	238	95	144	82	15	4,0
100	248	95	164	107	15	4,5
125	263	95	194	132	15	5,0
150	276	95	219	160	15	5,5
200	303	95	274	207	15	7,0
250	330	95	330	260	15	9,0
300	355	95	385	310	15	10,0



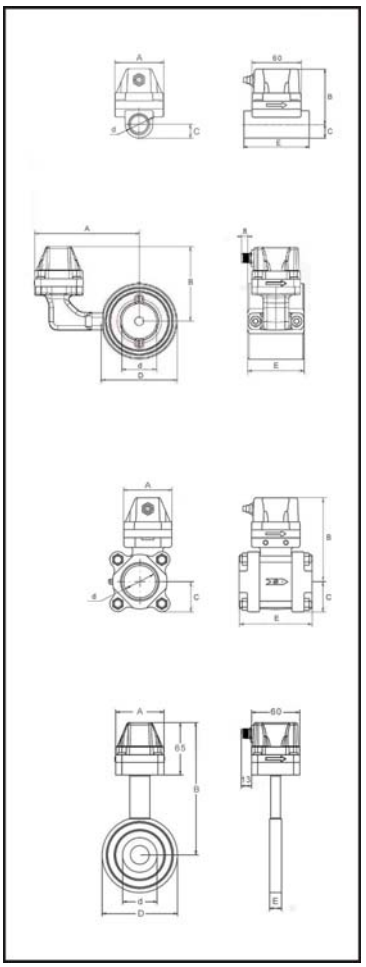
Continuation of table 3

Control unit modification M with Pipe section modification GL						
DN, mm	A, mm	B, mm	C, mm	d, mm	E, mm	Weight, kg
15	60	66	14	16	80	0,8
20	60	69	17	21	80	0,9
25	60	73	21	26	80	1,0
40	60	105	38	41	90	2,6

Control unit modification M with Pipe section modification FA						
DN, mm	A, mm	B, mm	D, mm	d, mm	E, mm	Weight, kg
15	108	93	53	16	70	2,6
20	112	93	63	22	70	3,0
25	118	93	73	30	70	3,2
32	124	93	84	39	70	3,7
40	129	93	94	43	70	4,4
50	137	93	109	55	70	4,5
65	147	93	129	70	70	5,6
80	155	93	144	82	70	6,4
100	165	93	164	107	70	6,8
125	181	93	194	132	70	8,9
150	193	93	219	160	70	9,8
200	220	93	274	207	70	13,7
250	248	93	330	260	70	17,3
300	277	93	385	310	70	20,0

Control unit modification M with Pipe section modification GSS						
DN, mm	A, mm	B, mm	C, mm	d, mm	E, mm	Weight, kg
15	60	66	14	16	53	0,7
20	60	69	17	21	53	0,8
25	60	73	21	26	53	0,9

Control unit modification M with Pipe section modification FSS						
DN, mm	A, mm	B, mm	D, mm	d, mm	E, mm	Weight, kg
15	60	143	53	17	15	1,6
20	60	149	63	22	15	1,7
25	60	154	73	29	15	1,8
32	60	160	84	39	15	1,9
40	60	165	94	43	15	2,0
50	60	173	109	55	15	2,2
65	60	183	129	70	15	2,5
80	60	191	144	82	15	2,6
100	60	201	164	107	15	3,0
125	60	216	194	160	15	3,6
150	60	239	219	159	15	4,1
200	60	266	274	207	15	5,5
250	60	295	330	260	15	7,5
300	60	322	385	310	15	8,5



6 Measuring Ranges Table

Table 4 - Standard Measuring Ranges

DN	Value for CU executions				
	S02, S2, D2	S05, S25, D5	M310	M325	M350
	dm^3/min (l/min)	dm^3/min (l/min)	dm^3/min (l/min)	dm^3/min (l/min)	dm^3/min (l/min)
1	2	3	4	5	6
15	0,4-0,8	0,4-2	0,2-2	0,5-5	1-10
	0,6-1,2	1-5	0,5-5	1-10	5-50
	1-2	2-10	1-10	5-50	7,5-75
	1,6-3,2	4-20	5-50	7,5-75	10-100
	2-4	6-30	-	-	-
	2,4-4,8	8-40	-	-	-
	3,2-6,4	-	-	-	-
	4-8	-	-	-	-
	6-12	-	-	-	-
	8-16	-	-	-	-
	10-20	-	-	-	-
	12-24	-	-	-	-
	16-32	-	-	-	-
20	4-8	4-20	1-10	1-10	2-20
	6-12	6-30	5-50	5-50	5-50
	8-16	8-40	8-80	12-120	12-120
	10-20	15-75	-	-	15-150
	12-24	-	-	-	-
	16-32	-	-	-	-
	20-40	-	-	-	-
25	8-16	6-30	1-10	5-50	5-50
	10-20	12-60	5-50	10-100	10-100
	12-24	16-80	17,5-175	25-250	25-250
	16-32	24-120	-	-	-
	24-48	30-150*	-	-	-
	36-72	-	-	-	-
	40-80	-	-	-	-
	50-100*	-	-	-	-
32	20-40	8-40	5-50	10-100	10-100
	28-56	20-100	8-80	20-200	20-200
	40-80	40-200	10-100	40-400	40-400
	60-120	50-250	30-300	-	60-600
	80-160	-	-	-	-
40	20-40	8-40	5-50	10-100	10-100
	28-56	20-100	10-100	25-250	25-250
	40-80	40-200	30-300	50-500	50-500
	60-120	60-300	-	-	60-600
	80-160	-	-	-	-
	100-200	-	-	-	-
50	40-80	20-100	10-100	20-200	20-200
	60-120	40-200	25-250	50-500	50-500
	80-160	70-350	50-500	80-800	80-800
	120-240	100-500	-	-	100-1000
	160-320	-	-	-	-

Continuation of table 4

1	2	3	4	5	6
65	60-120	20-100	25-250	30-300	30-300
	80-160	50-250	50-500	60-600	60-600
	120-240	100-500	80-800	120-1200	120-1200
	160-320	160-800	-	-	200-2000
	240-480	-	-	-	-
	280-560	-	-	-	-
80	120-240	40-200	25-250	50-500	50-500
	160-320	80-400	50-500	100-1000	100-1000
	240-480	160-800	100-1000	200-2000	200-2000
	320-640	240-1200	-	-	250-2500
	400-800	-	-	-	-
100	160-320	80-400	50-500	50-500	50-500
	280-560	160-800	100-1000	100-1000	100-1000
	400-800	250-1250	200-2000	300-3000	300-3000
	600-1200	400-2000	-	-	-
	700-1400	-	-	-	-
125	400-800	100-500	100-1000	100-1000	100-1000
	600-1200	200-1000	200-2000	200-2000	200-2000
	800-1600	400-2000	300-3000	300-3000	300-3000
	1000-2000	600-3000	-	-	-
150	600-1200	200-1000	100-1000	100-1000	100-1000
	800-1600	400-2000	200-2000	200-2000	200-2000
	1200-2400	600-3000	300-3000	300-3000	300-3000
	1400-2800	900-4500	-	-	-
	1500-3000	-	-	-	-
200	800-1600	400-2000	200-2000	200-2000	200-2000
	1200-2400	500-2500	250-2500	250-2500	250-2500
	1400-2800	600-3000	300-3000	300-3000	300-3000
	1500-3000	-	-	-	-
250	1200-2400	400-2000	200-2000	200-2000	200-2000
	1400-2800	500-2500	250-2500	250-2500	250-2500
	1500-3000	600-3000	300-3000	300-3000	300-3000
300	1200-2400	400-2000	200-2000	200-2000	240-2400
	1400-2800	500-2500	250-2500	250-2500	250-2500
	1500-3000	600-3000	300-3000	300-3000	300-3000

* - For pipe sections modifications FA and FSS only

Note – On request it is possible to produce the Flow Monitors with a lower measuring range than indicated in the table, but not higher, than the maximum range for each of the relevant pipeline (DN). For example, the pipe section for DN65 for the execution D2 may have on request a range of less than 60...120 dm^3/min (l/min), but may not have the maximum range of more than 280...560 dm^3/min (l/min).

7 The structure of the code and an example entry for order

Code		Designation
Type of Flow Monitor		
FM		the differential pressure Flow Monitor
Execution of Control unit		
S02		mechanical display with the arrow, no output signal, no signal contacts, turndown 1:2, PN16 bar
S05		mechanical display with the arrow, no output signal, no signal contacts, turndown 1:5, PN16 bar
S2		mechanical display with the arrow, no output signal, with two signal contacts, turndown 1:2, PN16 bar
S25		mechanical display with the arrow, no output signal, with two signal contacts, turndown 1:5, PN16 bar
D2		LCD-display, with output signal 4…20 mA and with frequency output of 200...1000 Hz, with two signal contacts, turndown 1:2, PN16 bar
D5		LCD-display, with output signal 4…20 mA and with frequency output of 200...1000 Hz, with two signal contacts, turndown 1:5, PN16 bar
M310		without display, with output signal 4…20 mA and with RS485 interface, turndown 1:10, PN10 bar
M325		without display, with output signal 4…20 mA and with RS485 interface, turndown 1:10, PN25 bar
M350		without display, with output signal 4…20 mA and with RS485 interface, turndown 1:10, PN50 bar
Execution of Pipe section		
GLX		threaded, material copper alloy, X is the nominal diameter, specify in accordance with table 4 of this Manual
GSSX		threaded, material stainless steel, X is the nominal diameter, specify in accordance with table 4 of this Manual
FAX		flanged (wafer), material to DN40 mm inclusive – copper alloy, and from DN50 mm – cast iron with epoxy coating, X is the nominal diameter, specify in accordance with table 4 of this Manual
FSSX		flanged (wafer), material stainless steel, X nominal diameter, specify in accordance with table 4 of this Manual
Measuring range		
T(*)		* – the range specified in accordance with table 4 of this Manual
The name of the measured medium		
W		water
X		industrial oil
Y		antifreeze
The direction of the liquid in the pipe and the location of the pipeline		
A/R		horizontal pipeline, liquid direction: from left to right
B/L		horizontal pipeline, liquid direction: from right to left
C/R		vertical pipline, liquid direction: from top to down, CU is the right of the pipeline
D/L		vertical pipline, liquid direction: from the bottom up, CU is the right of the pipeline
E/L		vertical pipline, liquid direction: from top to down, CU is the left of the pipeline
F/R		vertical pipline, liquid direction: from the bottom up, CU is the left of the pipeline

Example entry for order (order's key): FM-S25-FA150-T(400-2000 l/min)-W-A/R

8 Example of passport

The differential pressure Flow Monitor FM
Execution _____
Passport № _____

General information

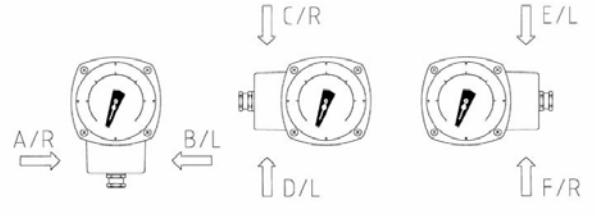
The differential pressure Flow Monitors FM are used to measure flows of liquids (water, industrial oil up to 550 cSt, antifreeze).

Serial number CU / PS: [number CU] / [number PS]

Specifications

Flow range:	[Measuring flow range]
Medium:	[The name of the medium]
Sealing gasket:	[Seal material]
Maximum pressure:	[The maximum pressure in MPa]
The temperature of medium:	[The temperature of medium in °C]
Ambient temperature:	[The ambient temperature in °C]
Ingress protection:	[Class of ingress protection]
Process connection:	[Execution of pipe section]
Flow direction:	[The direction of the liquid in the pipe and the location of the pipeline]
Power supply:	[The power supply in VDC for modifications D and M]
Power consumption:	[Power consumption in Watts for modifications D and M]
Signal contacts:	[The parameters of the signal contacts]
The output signal:	[The parameters of the output signal]
Accuracy:	[Reduced error in %]
Name of software:	[Indicates the name of software]
The software version number:	[Indicates the number of software version]
Order code:	[Code entry for order]

The direction of the liquid in the pipe and the location of the pipeline:



Sign and stamp of trading organization:

Date _____ Name, surname.

Warranty

1. The manufacturer guarantees the conformity of the instrument with the technical requirements provided the customer terms and conditions of use, storage, transportation and installation.
2. Warranty period of operation of the Flow Monitor is 12 months from date of shipment to the consumer.
3. Warranty period of storage of the Flow Monitor is 6 months from date of shipment to the consumer.

9 Notes