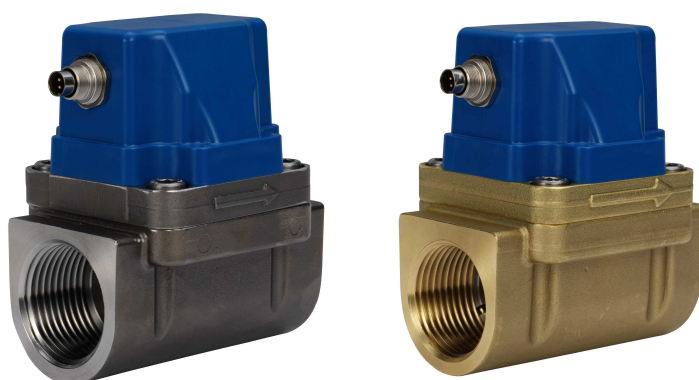


M-series Flow Meter Manual



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About this manual

- This manual relates to the M-series Flow Meter.
- Note that the latest version of this manual is always available as a PDF file on our web site www.eletta.com.
- **On our site you also find other interesting information such as leaflets, newsletters and application reports.**

Proprietary Rights

This manual contains confidential technical data, including trade secrets and proprietary information, that are the property of Eletta Flow AB, Sweden.

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These data are only disclosed to you under permission of limited use within your company. Use for manufacturing or processing is not permitted.

Any other use of data and information is strictly prohibited without prior written permission from Eletta Flow AB, Sweden.

Safety instructions



In this manual, this warning symbol is used to emphasize where you have to be particularly careful to avoid injury or damaging the product.



The M-series Flow Meter must not be installed in explosive environments. The product is not Ex-hazardous approved.



To prevent injury when installing the Flow Meter, make sure that the system is not pressurized from gas or liquid flow.



There are no serviceable parts inside the instrument. Eletta takes no responsibility for injury or damage caused by unauthorized disassembly.



Never open the instrument by unscrewing the four hexagon bolts at the top while the instrument is pressurized.



The electrical installation must only be made by authorized personnel.



Disconnect all power connections before installation or service.



Never exceed the maximum static pressure, which is specified on the product label, and in this manual.



Make sure that the correct electrical power is used.

Distributors

Eletta has appointed a number of distributors all over the world. You will find more information about your closest distributor at our web site www.eletta.com, or by contacting our Customer Service Center.

Customer Service

Our Customer Service Center is available during normal office hours 8.00 - 16.30 C.E.T., (8 am - 4.30 pm Central European Time).

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About Troubleshooting

Please refer to the trouble-shooting section 6.2 where we answer the most frequent questions. We have tried to make this manual as clear and comprehensive as possible, but we understand that you might run into problems which might not be described in this manual. In this case your local Distributor or Our Customer Service Center will be more than happy to answer any of your commercial or technical questions.

1 General Information

1.1 General Description

The M-series Eletta Flow Meters are used to measure and control flows of liquids and gases in threaded pipes with sizes DN15-DN40 and flange fitted pipe sizes DN15 to DN400.

Note that the M-series Flow Meters arrives factory calibrated and programmed at delivery. At the time of order, data for your specific application is used for configuration of the unit. This enables quick and easy installation by the user. Only mechanical assembly and electrical installation are needed. No further adjustments have to be done by the user.

However, it is possible to adjust most parameters in the field after installation using the Eletta Flow Center. You find more information about this in the manual of Eletta Flow Center.

1.2 The Differential Pressure Principle

The M-series Eletta Flow Meters are based on the proven and dependable differential pressure principle and use interchangeable orifice plates for different pipe dimensions and measuring ranges. See section 3 for more information about the measurement principle.

The M-series Flow Meter is factory calibrated for the differential pressure range of the unit. The range differs between our three different versions:

- M310, with standard pressure operating range of 5 – 500 mbar
- M325, with standard pressure operating range of 12,5 – 1250 mbar
- M350, with standard pressure operating range of 25 – 2500 mbar

The differential pressure range can be customized using Eletta Flow Center or specified at the time of ordering.

1.3 Accuracy

The M-series Flow Meter measures media pressure using two independent pressure transducers. The measurement values are then converted to a flow value by the microprocessor. The flow accuracy can be separated into:

The M-series pressure sensors have an accuracy of $\pm 0,05\%$ F.S.(Full Scale) of the measured differential pressure.

Our orifices are calculated based on ISO 5167-1:1999/AMD.1:1998. The measurement error related to the orifice calculation varies because it is dependent on the type of media, flow conditions and pipe dimension. At ideal conditions an accuracy within 0,5-1% FS of the calculated flow can be expected.

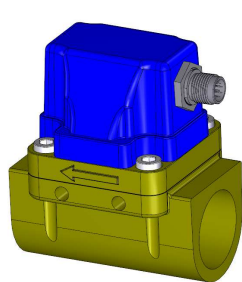
Tolerances pipe section and orifice bore diameter contribute to around 0,5-1% FS

Overall flow accuracy:

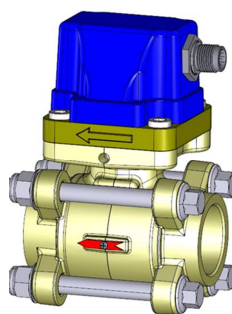
At ideal conditions $\pm 2\%$ FS can be expected.

1.4 Overview

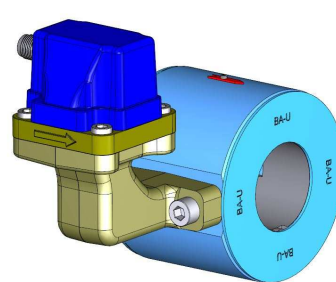
M-series is available with four different types of pipes; Threaded G-BR/G-SS and GL, as well as FA and FSS for flanged fitting. The flow monitor mainly consists of two parts, the Control Unit and the Pipe Section.



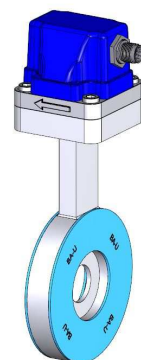
M-RR



M-GL



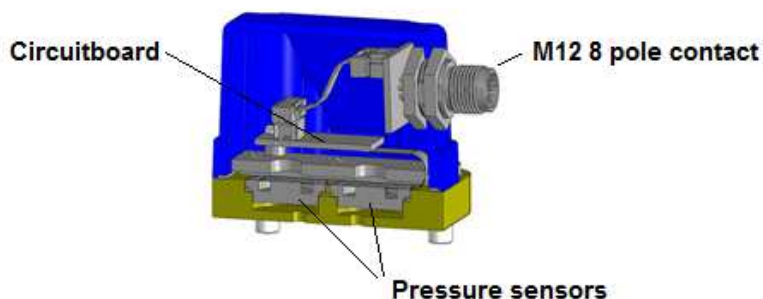
M-FA



M-FSS

Control unit

The Control Unit contains the two pressure sensors, the circuit board and the electrical connector with integrated filter. The circuit board outputs 4-20 mA through the output connector. The mA signal is changeable using Flow Center.

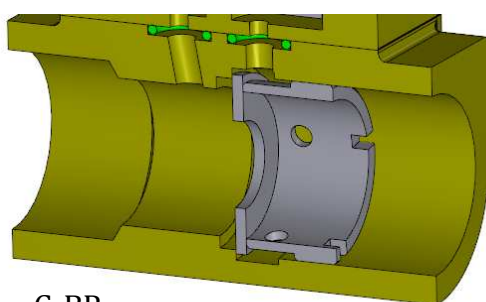


In order to get the unit to work properly with good accuracy, it is very important that the unit is installed correctly according to the installation instruction, see chapter 2.

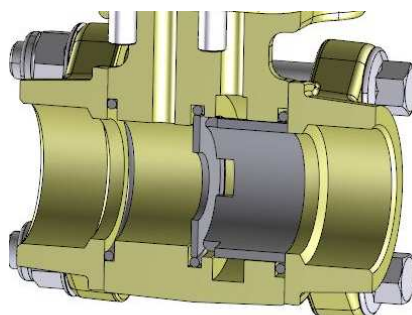
Pipe section

The Pipe Section is assembled in-line with the process pipe and the Control Unit is fitted on top of the Pipe Section. It is also possible, for example when measuring a too hot media, to install the Control Unit separated (using either steel pipes or tubes) from the Pipe Section. See section 2.4 Add-Ons, Options.

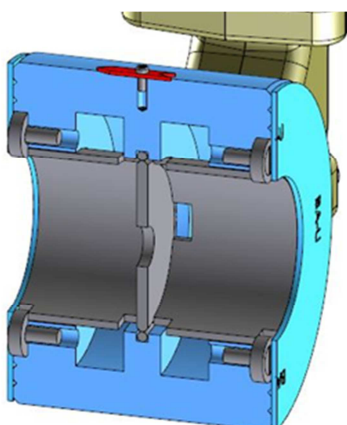
The Pipe Section contains of an exchangeable Orifice Plate and Plate Holder/Spacers. There are four different types of pipes; GBR, FA, GL and FSS. (FSS pipe sections contain no changeable orifice plate - pipe and orifice makes one integrated unit.)



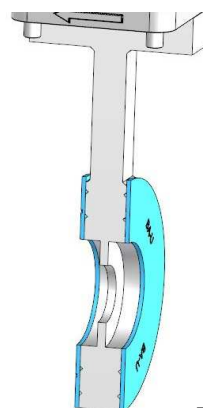
G-BR



-GL



-FA



-FSS

1.5 Pipe Dimensions

The Pipe Sections are available in various dimensions and materials to fit different requirements of various applications. Following tables provide a summary of our different materials and fittings.

Threaded (G)		
Pipe material	Type	Available dimensions
De-zincified Brass, CW602N, EN12420	M-G15BR	DN15 (1/2" BSPP*)
	M-G20BR	DN20 (3/4" BSPP*)
	M-G25BR	DN25 (1" BSPP*)
	M-GL40	DN40 (1 1/2" BSPP) DN40 (1 1/2" NPT)
Stainless steel 1.4409/EN10213	M-G15SS	DN15 (1/2" BSPP*)
	M-G20SS	DN20 (3/4" BSPP*)
	M-G25SS	DN25 (1" BSPP*)

* Use NPT adapters for NPT connection (adapters are not included) For GL version NPT threads are available.

Flange connections		
Pipe material	Type	Available dimensions
Bronze CC491K/493K-GC/GZ/1982	FA15 – FA25	DIN DN15 – DN25, PN16 DN15 – DN25, ANSI 150 lbs
Cast iron with Epoxi coating EN-GJL-250/EN1561	FA32 – FA400	DIN DN32 – DN400, PN16 DN32 – DN100, ANSI 150lbs DN125 - DN200, Suitable ANSI 150 lbs DN250 – DN300, ANSI 150 lbs
Stainless steel EN1.4435/EN1.4401/EN1.4404	F15SS-F400SS	DIN DN15 – DN400, PN16 DN15 – DN400, ANSI 150lbs
Stainless steel SMO254 EN1.4547	F15SS-F400SS	DIN DN15 – DN400, PN16 DN15 – DN400, ANSI 150 lbs
Bronze CC491K/493K-GC/GZ/1982		DIN DN32 – DN400, PN16 DN50 – DN100, ANSI 150lbs DN125 - DN200, Suitable ANSI 150 lbs DN250 – DN300, ANSI 150 lbs

1.7 PED Certification

M-series complies with applicable parts in Pressure Equipment Directive 97/23/EC. Conformity assessment has been performed according to module A. Internal production control combined with module A1. Internal manufacturing checks with monitoring of the final assessment, for category 2. Performed by Inspecta AB, Notified body No. 0409. PED Declaration of conformity will be sent to you upon request and are also available on www.eletta.com

1.8 EMC

M-series Flow monitors comply with the EMC directive 2004/108/EC through the following harmonized standards:

- EN 61 000 – 6 – 3:2007 Generic Emission – Residential, commercial and light industry.
- EN 61 000 – 6 - 2:2005 Generic Immunity - Industry

2 Installation

2.1 Unpacking

Before installation, we kindly ask you to perform the following steps:

- 1) Check that there are no external damages to the outer packaging. If there are damages, check if the Flow Meter has been damaged. If there is a transportation damage, contact your forwarder.
- 2) Check that the delivered parts corresponds to the Packing list. Note that the connection cable is also included in the package.

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

2.2 Preparations

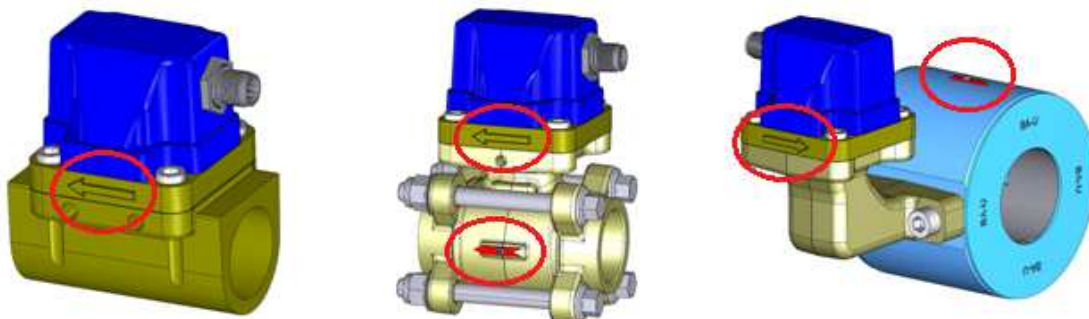
Before installation, we kindly ask you to perform the following steps:

- 1) Eletta recommends that you choose a correct position for the installation of the flow meter in your pipe system. The following table serves as a guideline.

Process Media	Correct installation
Liquid	Low level position of the system.
Gas	High level position of the system.

- 2) Check that the flow direction in your pipe corresponds to the direction of the Flow Meter. The flow direction is indicated by an engraved arrow on the Pressure Plate. Note that the cable connector shall always be located on the upstream side of the pipe section. See section 4.1 for further details on how to change the flow direction.

For a GL or FA pipe the engraved arrow on the M-unit should coincide with the red flow pointer on the pipe, see below pics.

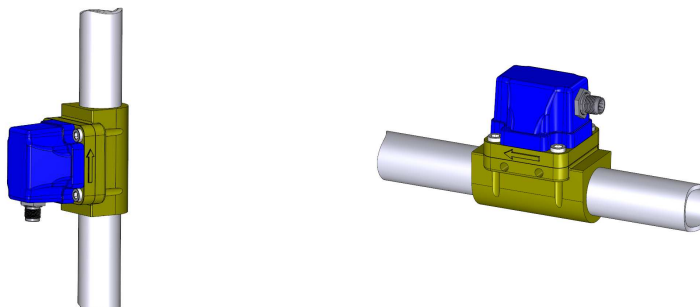


2.3 Installing the Flow Meter

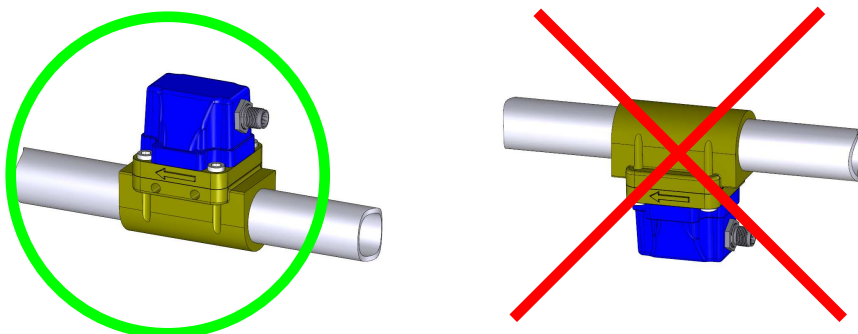


- Disconnect all electrical power before intallation!
- Make sure that the system is not pressurized!

1) Install the Flow Meter in any desired direction, vertical or horizontal.

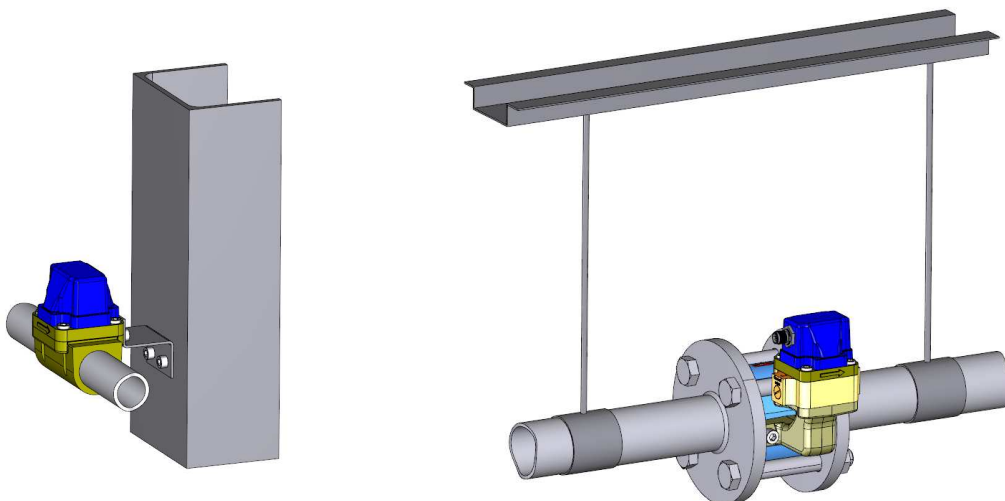


2) If you install the Flow Meter horizontally, make sure that the Control Unit always is oriented upwards, i.e. on top of the Pipe Section, and not up side down. The reason for this is to prevent particles in the fluid to collect in the chambers of the pressure sensors. Please use a filter in the pipeline if your system fluid contains particles.



3) Ensure that you install the Flow Meter according to the correct flow direction, which is indicated by an engraved arrow. Note that the cable connector shall always be located on the upstream side.

4) The installation location of the Flow Meter should be rigid and vibration free. On the rear side of the GBR pipe section there are threaded M6 holes which can be used to secure the flow meter on a wall or similar using an angle bracket. For FA and FSS pipe sections, please support the Flow Monitors with rigid brackets. We recommend installing them in the pipeline downstream and upstream to avoid unnecessary stress in the installation area.

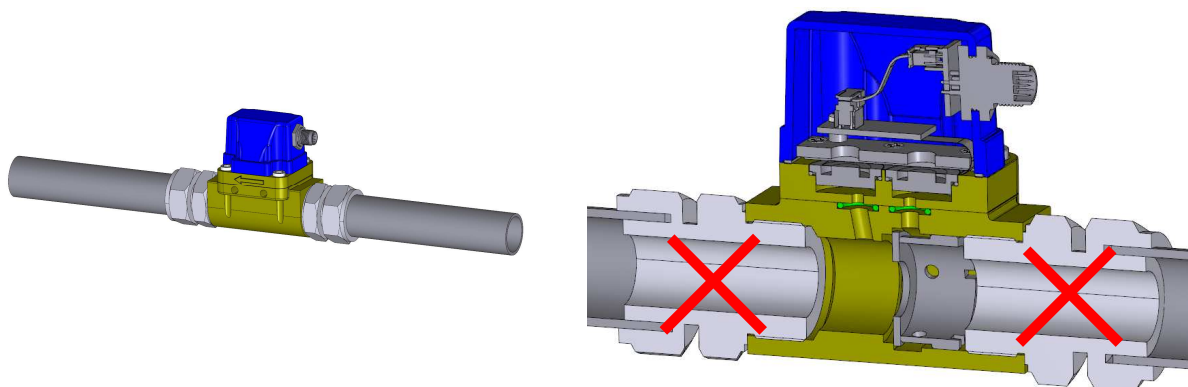


If your system still suffers from vibrations, we recommend separate mounting of the Pipe Section and Control Unit. See section 2.4

5) It is also of importance that the connecting pipes and flanges are of the same diameter (inside) and standard as the pipe section. Please refer to section 7. Technical specification for inside and outside diameters of our different pipes. A mismatch can cause an erratic or incorrect reading of the flow.

6) Threaded pipes

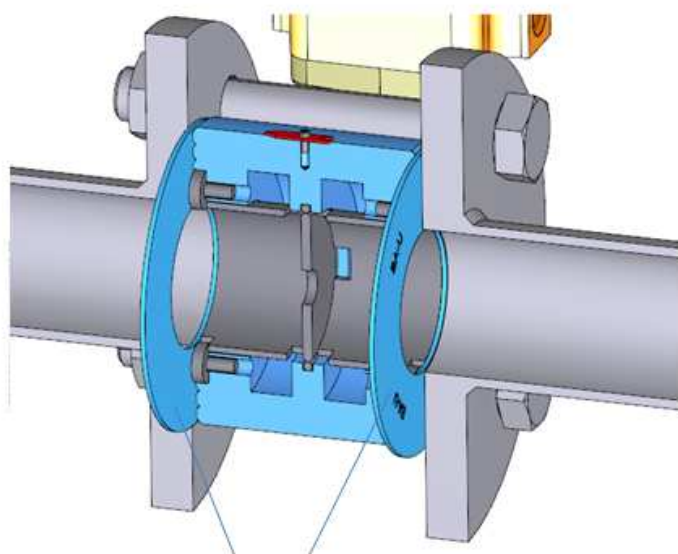
In the case that the inner diameter of your pipes, including fittings, does not correspond to the inside diameter of our pipes, inaccuracy may occur. The reason is that such fittings, with an inside diameter that is too small, will create a media jet stream, which results in a too low differential pressure, thereby causing measurement error.



If you have to use a tube fitting with too small inner diameter, make sure you locate them outside of the required straight runs upstream and downstream from the meter.

7) Pipes for flanged fittings

The flanged models, FA and FSS-versions, must be aligned with the counter flanges and should not be exposed to stress related to unevenly tightened bolts. The flanged models are delivered with two fiber gaskets and we recommend using these, as they are dimensioned according to our pipe dimensions. Please ensure that the gaskets are properly aligned and don't obstruct the flow.

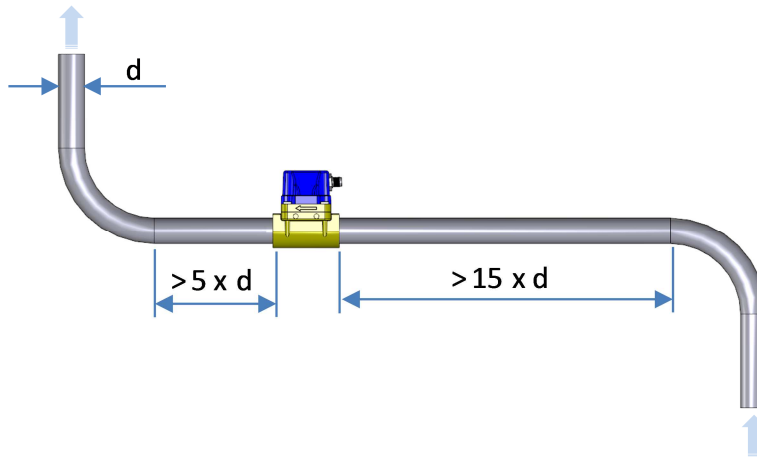


Fiber gaskets

8) To obtain maximum accuracy, make sure that the system pipe has sufficiently long straight run before the Flow Meter (upstream). We recommend that the straight run corresponds to at least 15 times the present inner diameter of the pipe.

Also make sure that the run after the Flow Meter (downstream) is at least 5 times the inner diameter of the pipe.

Also make sure that there are no valves, bends or diameter changes. This to avoid flow disturbances which might cause inaccurate reading of the flow.



Note

In applications where maximum accuracy is not necessary, the lengths of the runs can be reduced. Note that it is practically impossible to predict where and when a flow gets stable after a disturbance. Therefore, the recommendation above serves only as a guideline, i.e. a method that has proven to secure the measurement accuracy. If shorter runs are used, Elettta neither can guarantee the specified maximum accuracy, nor predict the flow in your specific application.

2.4 Electrical Installation



The electrical installation must only be made by authorized personnel!



Do not install the M-series flow meter in Ex-hazardous areas!

The connection cable is included in the purchase of your M-unit. The cable has eight wires and a M12-female connector with screw locking and one end open. The Standard cable length is 2,5 m. A 10 meter cable is available as an option.

In the case you want to splice the cable in order to extend the cable further than 10 meters, please make sure that the conductive area of the wires for the output signal is at least 0,25 mm² (0,00039 inch²). Maximum output load is 1 kΩ.

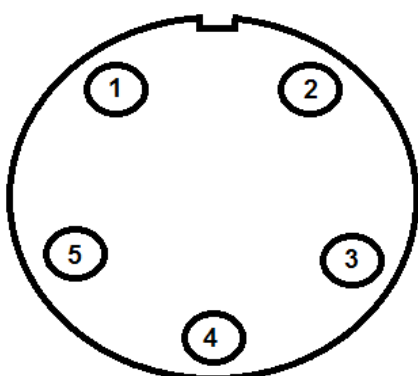
Make sure that you use the correct power supply, the allowed voltage range is between +8 to +28 VDC.

A wiring diagram is attached on the cable from factory.

Below is the wiring connection for the older M9 and current M12 M3XX unit. The configuration is referenced looking at the female of the cable connecting to M unit.

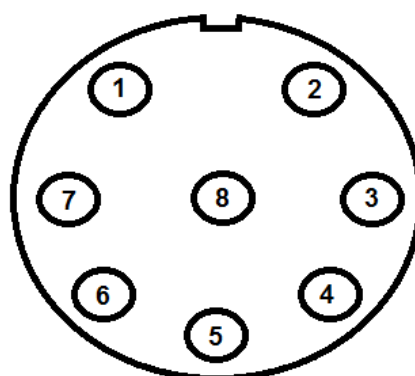


1	RS485B	White Green Brown
2	- (mA)	
3	Alarm (Special models)	
4	+ VDC	
5	RS485A	



M9 - 5 pin

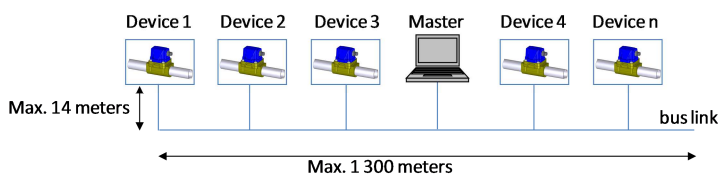
1	+ VDC	white
2	- (mA)	brown
3	RS485A	green
4	RS485B	yellow
5	Not active	grey
6	Alarm (Special models)	pink
7	Not active	blue
8	Not active	red



M12 - 8 pin

2.5 Modbus RS485 communication

The physical connection is provided by the RS485 serial interface. This guarantees good interference immunity and enables a flexible bus structure, i.e. several devices can be administrated as slaves by a single master. In order to minimise the scope of cabling, the RS485 is used in half-duplex mode. This means that 2 wires are required for communications and 2 wires for power in feed.



In order to operate several devices at one serial interface, they are simply all connected in parallel (RS485A, RS485B, GND and +Vcc). Before incorporating the devices into the bus, each device must be programmed with a different address. It is possible to configure a network up to a length of 1300 metres with a maximum of 128 devices. Each riser cable may be up to 14 m in length. The employed cable should correspond to specification EIA RS485.

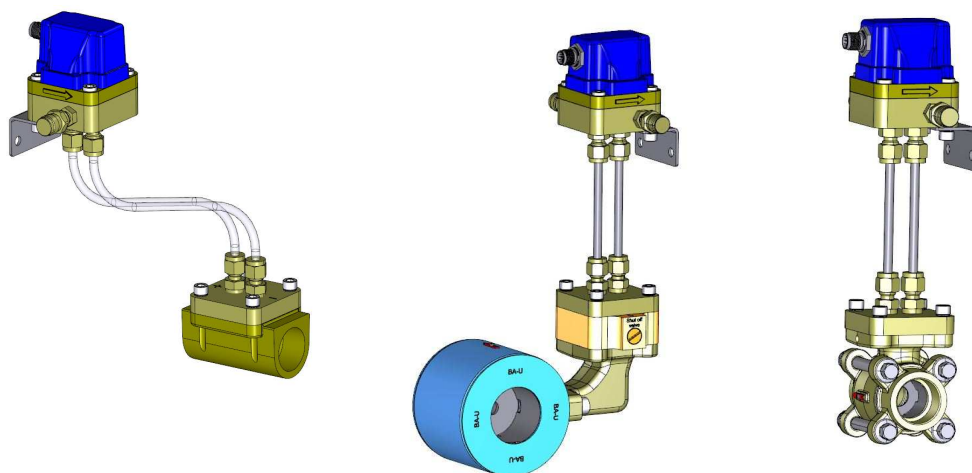
The Modbus RS485 Communication protocol is too extensive to describe in this manual. Please contact your local distributor or our Customer service department for further details.

3 Optional accessories

3.1 Separate Mounting

Sometimes, the pipe Section and the Control Unit need to be separately located from each other. The reasons could be lack of space, high system media temperature or vibrations. The following section explains our Separate Mounting kit.

The orifice plate creates two pressures, one on each side of the plate. These pressures are distributed to the two pressure sensors in the Control Unit through channels in the pressure plate and the pipe section. When installing the Pipe Section and the Control Unit separately, these channels are extended by using two plastic hoses. These hoses are fitted between the Pipe section and the Control Unit using two adapters.

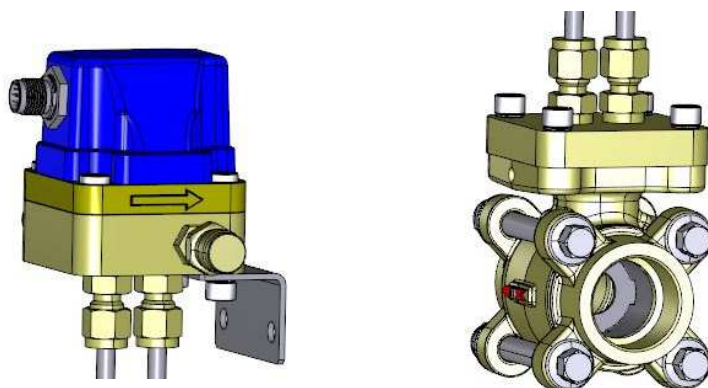


As a standard, two 1,75 m (5.74 feet) PA plastic hoses are delivered with the Separate mounting kit. The diameter is 6 mm (0,23 inch) and suitable for a maximum temperature of 90 °C (194 °F) and a maximum pressure of 10 bar (145 PSI).

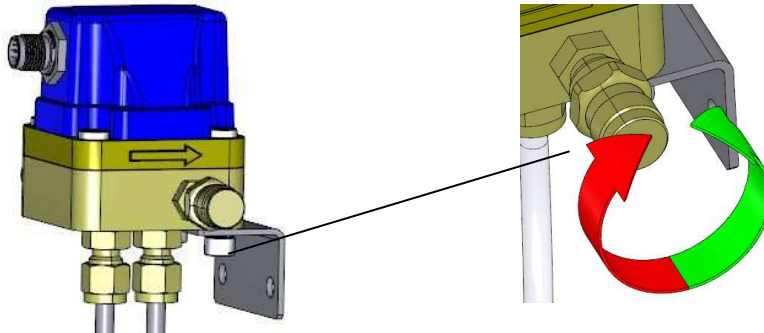


The plastic hoses shall not be used for temperatures higher than 90 °C (194 °F) or pressures higher than 10 bar (145 PSI). If your process temperature or pressure exceeds these levels, we recommend you to use copper or stainless steel pipes. Such pipes are not included with the product. Choose material with respect to the type of liquid or gas in your system. If you are using a chemical reactive media, check with your tubing supplier which is the most suitable material to use for your application.

For a separate mounting you need two different adapters. One that is installed on the Pipe Section and one for the Control Unit.



The Control Unit Adapter has valves for discharging entrapped air. There is also an angle bracket included for wall fitting.

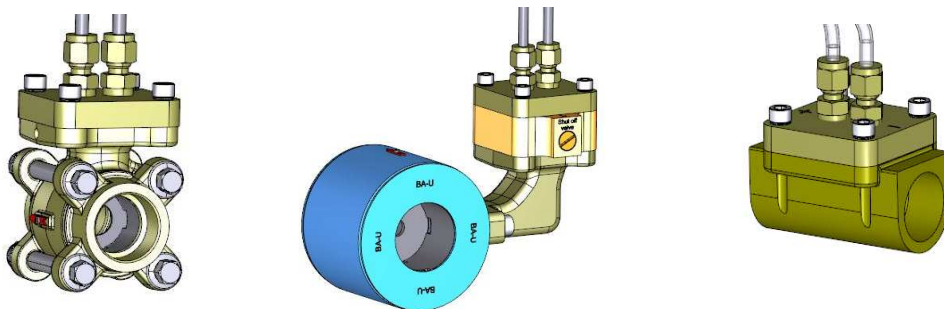


We recommend installing the Pipe Section and the Control Unit as close to each other as practically possible. This will facilitate future trouble-shooting and on-site calibration.

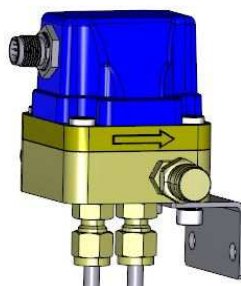
The plastic hoses can be replaced by 6 mm metal pipes (for instance copper or stainless steel) depending of the system media, pressure and temperature. Such pipes are not supplied by Eletta Flow, contact a local hardware store or plumber. If you are using a chemical reactive media, check with your tubing supplier which is the most suitable material to use for your application.

3.2 Separate Mounting – Installation

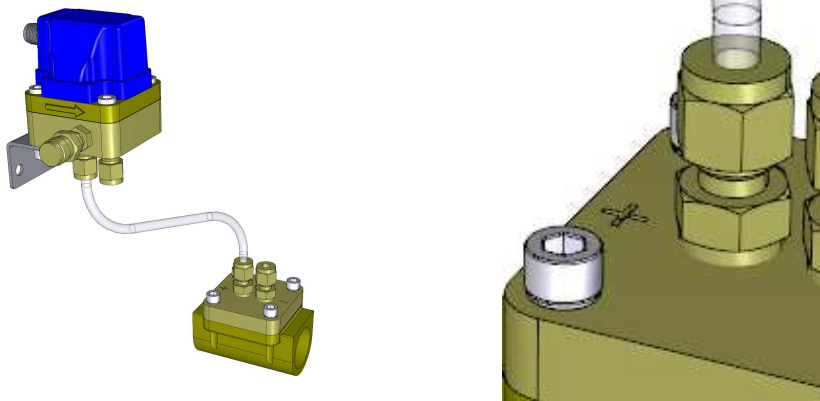
- 1) Install the Pipe Section according to the instruction in chapter 2.3. In this case you can mount the Pipe Section in any direction, vertically or horizontally, and with the pressure channels pointing upwards, downwards or sideways.
- 2) Assemble the Pipe Section Adapter to the Pipe Section. (If separate mounting is ordered together with control unit and pipe section the adapter is assembled from factory.)



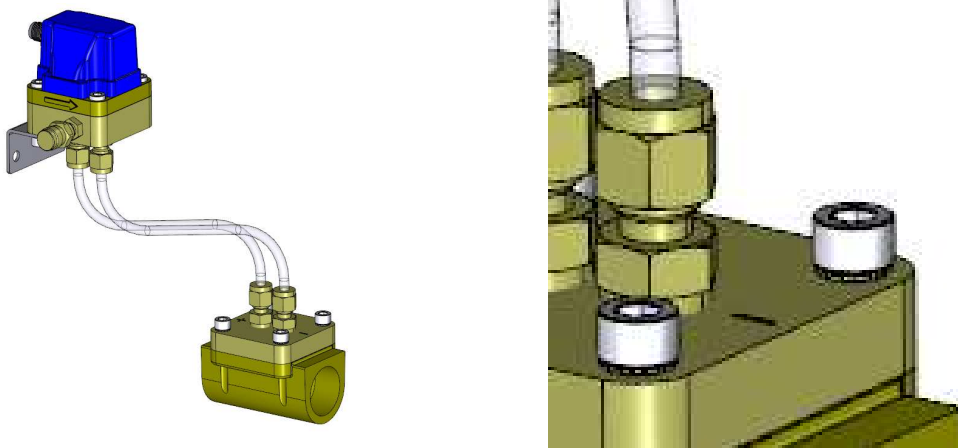
- 3) Find a suitable place for installing the Control Unit. We recommend that the Control Unit is installed where it is easily accessed with respect to maintenance.
- 4) Assemble the Control Unit Adapter to the Control Unit. (If separate mounting is ordered together with control unit and pipe section the adapter is assembled from factory.)



- 5) Install the Control Unit Adapter to a wall, a pipe or other rigid object.
- 6) Ensure that the hoses have the same length in order to avoid different pressures between the two channels, which will cause inaccurate flow reading.
- 7) Both adapters have engraved “+” and “-” signs. Connect one of the hoses between the respective “+” signs. The “+” sign represents the upstream side. Tighten with care.

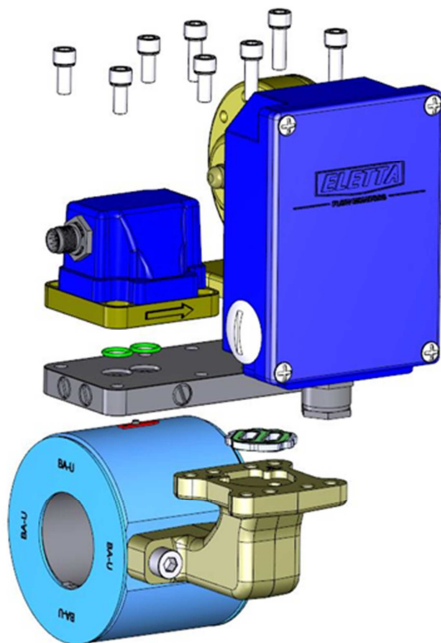


Connect the other hose between the respective “-” signs. The “-” sign represents the downstream side. Tighten with care.

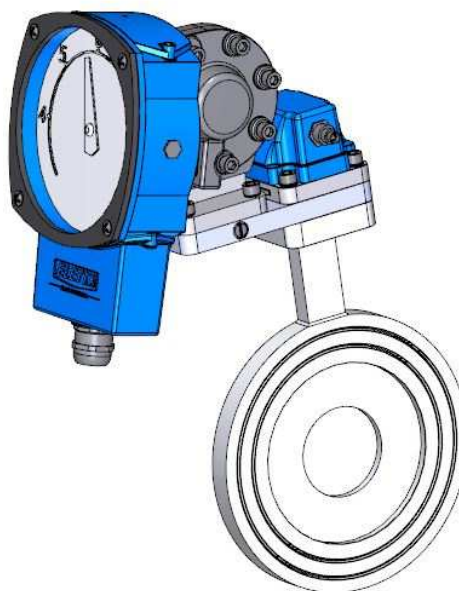


3.3 Combination instrument, Parallel connector M

With a parallel connector it is possible to connect a M-flow meter together with a V or S-series flow monitor on the same pipe section (GL, FA and F-SS type). This makes it possible to combine the reliable and capable switch functionality of the S and V-series with an analog mA-signal.



V- and M- series on
FA pipe section



S- and M- series on
F-SS pipe section

S and V-series works with pressures up to 16 bar (g). All three versions of our M-units can be used with the parallel connector but as a guideline we recommend that:

- M310 is used for static pressures up to 10 bar(g).
- M325 is used for static pressures between 10 bar(g) to 25 bar(g)
- M350 used in applications where there are risks for water hammer pulses which could damage pressure transmitters of lower pressure ranges.

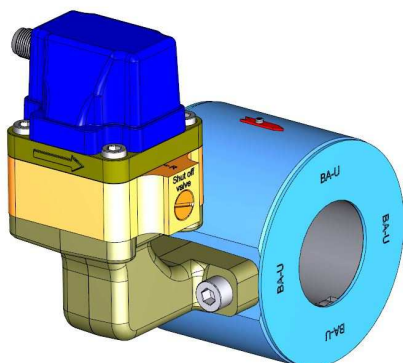
If you purchase a complete parallel unit; M-unit with S or V-series; it will arrive assembled into one unit from factory. For installation instructions of the pipe section, reference to section 2.3. For electrical installation of the M-unit refer to section 2.4 in this manual. For electrical installation instructions of the combination flow monitor, reference to the individual manual of that flow monitor (normally V- or S-series).

It is possible to upgrade an existing V or S-series flow monitor with a Parallel connector. When ordering the parallel connector and M-unit it is necessary to state which type of flow monitor the M-unit will be working together with; normally a V1, S2, V15 or S25 unit. The M-series will then be configured accordingly from factory. It is also possible to re-configure your M-unit with our configuration software Eletta Flow Center.

3.4 Cover in Stainless steel

The cover of the M-unit is manufactured in Polyamid plastic; PA12 (Grillamid 1kn-5h). It is known to be chemical resistant to most common fluids for which the M-series is used. But in rare cases with even tougher environments M-series is also available with a Stainless steel cover as an option. Our stainless steel cover is made in EN 1.4436 (grade 316).

3.5 Shut-off valve connecting block



The shut off block is only available for FA and GL15-40 pipe sections.

The shut off block is based upon a reliable solution. The shut off block closes the pressure channels between the control unit and the pipe section and allows disassembly of the control unit while the system is pressurized.

If there are no shut off valves in the system and there is maintenance on a regular basis (check or clean the pressure channels, inspection of orifice, calibrations etc.). Then it is a good idea to order the M-unit with a shut off block. With a shut off block you'll not require a separate shut off valve system and you don't need to de-pressurize the whole system.

There are two flow selectors, see below picture, when a shut off block is installed. Factory default will always be that both flow selectors are orientated in either –L- (Right to left flow) or –R- (Left to Right flow) according to the order information provided by the customer. But for M-series, none of the flow selectors will influence the flow direction. The two flow selectors only serve as sealings between the pipe section, the shut off block and the control unit.

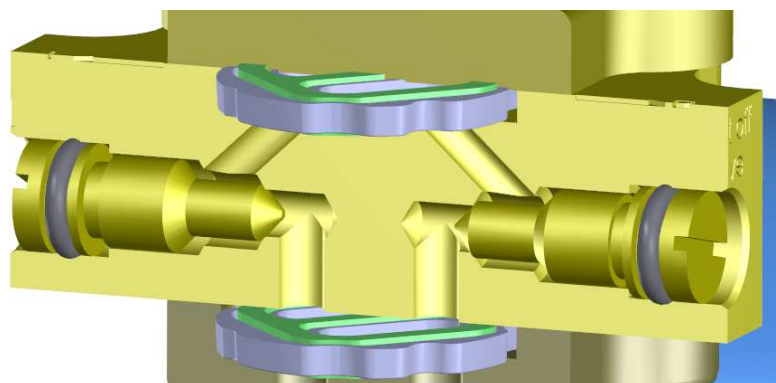
The two valves are operated as follows:

- To close the pressure channel, turn the valve Counter wise (CW) until bottom.
- To open the pressure channel, turn the valve Counter clockwise (CCW) until the top of the valve is flush the top plane.

Note!!! There is one individual valve for each pressure channel, two valves in total. It is important that both valves are closed in order to disconnect the control unit from the static pressure of the pipe system.

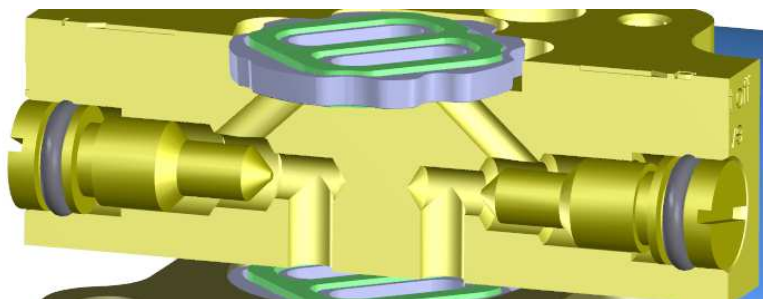
OFF-mode:

Both valves are turned so that they block the pressure channels. The control unit can be disassembled with the system running.



ON-mode:

Both valves are opened, the top off the screw is just level with the side of the block.

**3.6 Communication cable for Flow Center**

The M-series is always configured according to order information when delivered from our factory. But it is also possible to re-configure your M-unit with our configuration software Eletta Flow Center. Eletta Flow Center is available at our download page of our homepage together with the required drivers for the communication cable.

The Communication cable is not included with the purchase of the M-series, it is sold separately as an option.

Interface converter with Binder socket 713/8-pin:

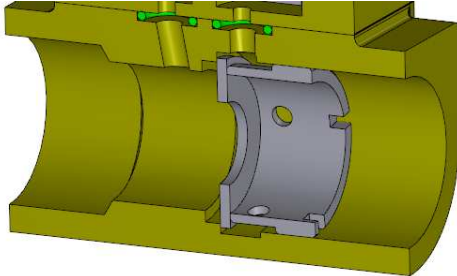
- Supply via USB for one connected final consumer (U-Out = 11,8 VDC / I-Outmax = 40 mA)
- Measuring channel: voltage input 0...12 VDC
- Visual status and configuration display (LED)
- Galvanic isolation
- Total length: 1,7 m

USB connection cable included in the scope of delivery



3.7 Tool kit for orifice exchange G-BR pipes.

The orifice is held in place by the plate holder. There are two slots in the plate holder which is used as tool grip when removing the plate holder. Easiest way to remove the plate holder is by using our Tool kit which ensures a firm grip. The tool kit consists of three wrenches, one for each pipe dimension.



4 Differential Pressure Measurements

4.1 The Differential Pressure Principle

The function of the Eletta Flow Meters and Flow Monitors is based on the proven and dependable differential pressure principle. The instruments use interchangeable sharp-edged orifice plates designed for different measurement ranges.

This is probably one of the oldest and most widely used principles for flow measurements. The principle benefits from simplicity and low cost. In addition, there exist a large amount of research data and experience, which is useful when predicting the behavior of a certain orifice plate.

Inserted into the Pipe Section of the Flow Meter, the orifice plate constitutes an area restriction that causes a pressure drop after the orifice plate. This pressure drop varies with the flow rate. This means that, in the flow direction, we will have one pressure before the orifice plate, and another after the plate. The first pressure will be slightly higher than the second.

The two pressures are lead through two separate channels to separate pressure sensors in the Control Unit. The two pressures are measured and the difference is calculated. This is called the *differential pressure*.

The flow (Q) and the differential pressure (ΔP) are proportional to each other. The relation can be approximated by the following formula.

$$Q = \sqrt{\Delta P}$$

4.2 Pressure Drop

Since the Eletta Flow Meter is based on the Differential Pressure Principle, it is inevitable that a small permanent system pressure drop is caused. The reason is that the orifice plate reduces the flow area inside the pipe, and this will effect the pressure.

In our discussion, it is important to fully understand two types of pressure drops. The first is the actual pressure drop created between the both sides of the orifice plate. The second is the permanent pressure drop that will slightly effect the system.

The actual pressure drop is a temporary state that occur over the orifice plate. On the downstream side of the Flow Meter the pressure will try go get back to the same conditions as on the upstream side. Normally, the flow profile will be recovered on the downstream side after approximately 10-15 times the inner diameter of the pipe. However, due to friction losses caused by the orifice plate, the system pressure will be somewhat less on the downstream side. The size of this loss, the permanent pressure drop, can be calculated using two mathematical formulas.

The permanent pressure drop and the actual pressure drop are related according to the formula

$$\Delta p_F = \Delta p_a (1 - \beta^2)$$

where

Δp_F = permanent pressure loss

Δp_a = actual pressure loss

$\beta = d/D$

d = the diameter of the bore in the orifice plate

D= the inside diameter of the pipe

Normally β is in the interval 0.2 – 0.7 resulting in a permanent pressure loss of $0.96 \Delta p_a - 0.51 \Delta p_a$.

The second formula approximates the relation between the actual pressure drop and the flow:

$$\Delta p_a = (Q/Q_{max})^2 * \Delta p_{MAX}$$

Δp_a = actual pressure loss in mbar

Δp_{MAX} = maximum allowed differential pressure, see "Flow conditions" on the type plate.

Q = actual flow

Q_{max} =maximum flow for the orifice plate, see "Flow conditions" on the type plate .

Example:

Let us assume the following:

Q range: 0-10 l/min

Q = 5 l/min

d = 5,9 mm

D = 16.00 mm

Media pressure = 5 bar

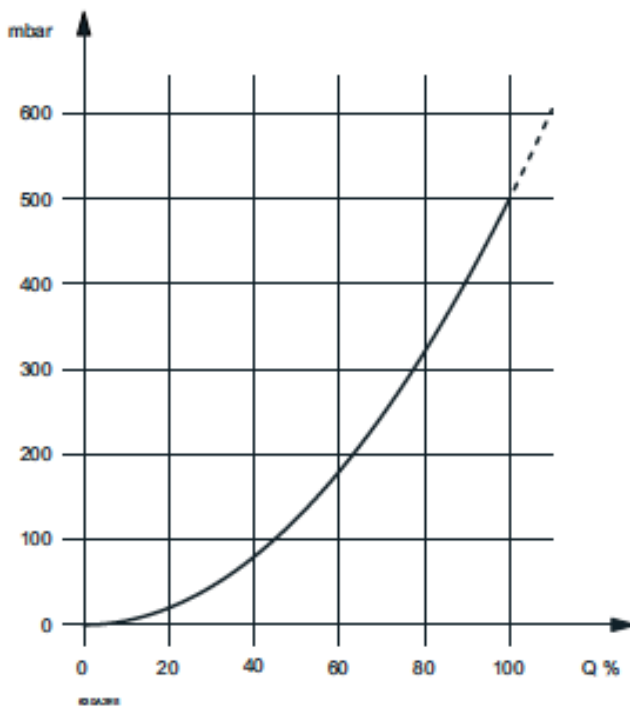
$\Delta p_{MAX} = 500 \text{ mbar}$

This gives a β of $5,9/16.00 = 0,36875$, which results in $(1-\beta^2) = 0,864$

Hence, $\Delta p_P = \Delta p_a * 0,864$

A flow of 5 l/min results in a actual pressure drop of $(5/10)^2 \times 500 = 125 \text{ mbar}$.

The curve below approximately shows the relation between the actual pressure loss and the flow percentage.



The permanent pressure drop will then be $0,864 * 125 = 108 \text{ mbar}$

If we now compare this drop with the system media pressure of 5 bar, we find that the efficiency η is almost 98%.

$$\eta = (5 - 0,108)/5 = 97,8\%$$

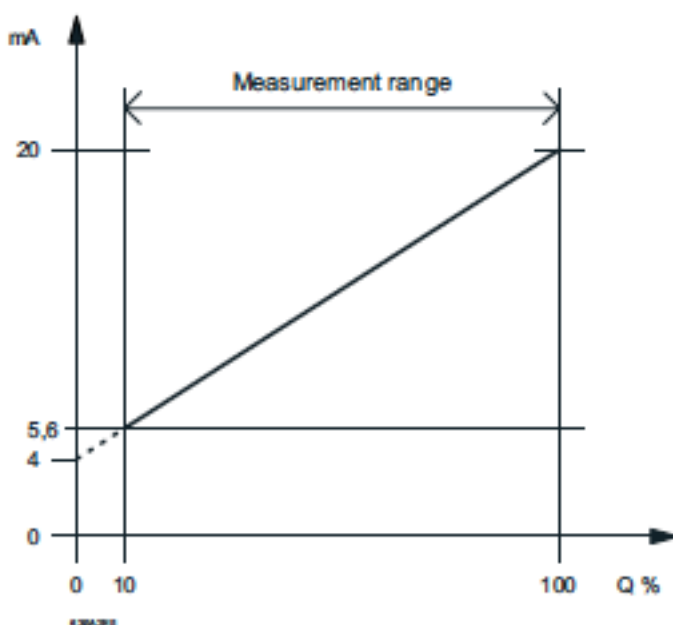
This means that mounting a Flow Meter with a bore, that temporarily decreases the flow area with as much as 86%, only decreases the static pressure with approximately 2 % at 50% flow.

5 The Output Signal

Each orifice plate is designed and optimized for a specific flow range and fluid. This means that there is a maximum flow value for a specific orifice plate. This value is represented by the flow percentage 100%. A flow value higher than the maximum flow value will not be measured with the same accuracy.

The analogue output signal from the Control Unit is always in the range 4-20 mA as default. This means that the maximum flow (100%), for a specific orifice plate, corresponds to the output level 20 mA.

However, the minimum flow 0% is merely theoretical since it is not possible to use the differential pressure principle if there is no flow at all. There has to be a certain minimum flow to create the different pressures on the upstream and downstream side of the orifice plate. Therefore, the Flow Meter is said to have a turn down of 1:10. In this very case, the lowest flow must be 10% of the maximum flow in order for the Flow Meter to be able to work properly.



For more information about the behaviour of the output signal, we refer to the Flow Center manual.

5.1 Customized range

Using our software Flow Center (option), it is possible to let the output signal range limits correspond to other values than 0% and 100 % flow.

In this way, if your application always has a flow of 40-60%, you can “zoom in” on this range and let 4 mA correspond to 40% flow, and 20 mA correspond to 60% flow.

6 Measurement modes

The M-series can be configured for three different measurement modes. Flow mode, Gas flow mode and Differential pressure mode. Either the unit is configured at the time of order or configured at any time by using our software tool Flow Center. The modes are more in detail described in the Flow Center manual.

6.1 Differential pressure mode

Differential pressure mode is used when an analogue output signal, proportional to the detected differential pressure, is to be measured.

6.2 Flow mode

Flow mode is used when measuring liquids (non compressible fluids). The analogue output of the unit provides a signal which is proportional to the flow rate. Normally 4 – 20 mA correspond to 0 - 100 % of the Flow range, but customization is possible.

6.3 Gas flow mode

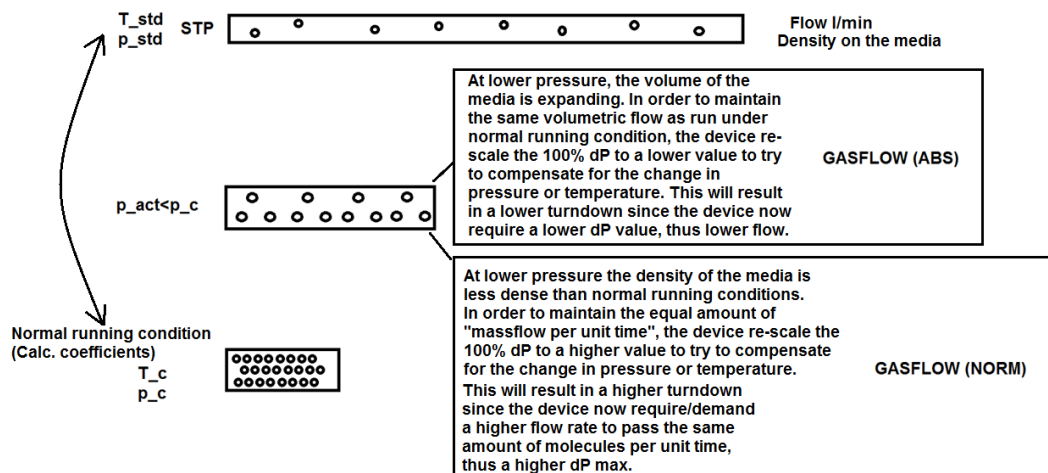
Gas flow mode is used when measuring gas (compressible fluids) flows. The analogue output of the unit provides a signal which is proportional to the flow rate. Normally 4 – 20 mA correspond to 0 - 100 % of the Flow range, but customization is possible.

The difference compared to flow mode is that the M-series utilizes an algorithm to compensate for the actual pressure and temperature conditions in the pipe. This means that the M-series will compensate for process changes. Although it is recommended to be as precise as possible when predicting the process condition because the compensation will affect measuring range and accuracy. Refer to the Flow Center manual for a more detailed description.

There are two different kinds of Gas flow modes: Normalized and actual/absolute flow. Standard or normalized flow is the equivalent flow rate the gas would be moving if the temperature and pressure were at standard conditions. It is usually the most useful measure of gas flow because it defines the mass flow, number of molecules and heat-carrying capacity of the gas. Volumetric flow rate or actual flow rate is the actual volume flow of the gas exiting the flow meter.

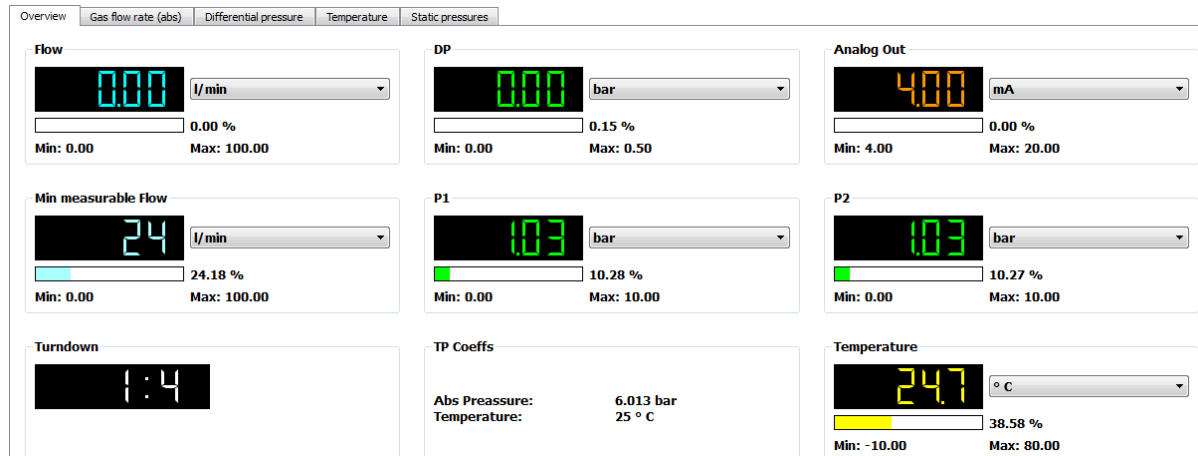
At normal running conditions, the actual and normalized flow rate will be exactly the same. It is only when P/T conditions vary from normal running conditions where they deviate from each other.

It is important to understand that these modes compensate inversely of each other.

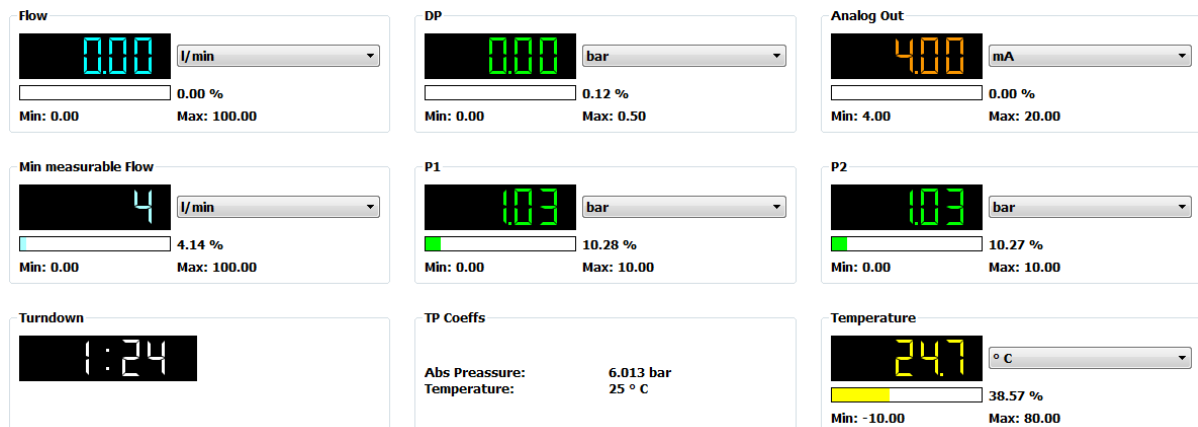


Assume a unit M310 set for normal running conditions at 5 bar (g), 25 deg C and 100 NI/min.

The following is the response from Flow Center at atmospheric condition for Gas flow (ABS). The gas will be expanded at this state and will only measure between 5 and around 80 mbar (Turndown 1:4 in Q). The device has been forced to re-scale itself in order to maintain the volumetric flow rate at this pressure to match it to the calculation coefficients or normal running conditions. This will affect the units ability to measure flow and the flow range from standard 10-100 NI/min is now 24-100 NI/min.



The following is the response from Flow Center at atmospheric condition for Gas flow (NORM). The gas has now become less dense and the device now demands a higher DP in order to maintain the same amount of "mass flow" per unit time. The device will now measure between 5 and 2900 mbar (Turndown 1:24 in Q). This will actually increase the units ability to measure the flow range since the range now is 4-100 NI/min and not 10-100 NI/min.



7 Installation Modifications

7.1 Change of Flow Direction



Make sure that the system is not pressurized!

After a Flow Meter has been installed in a pipe system, it is possible to swap the flow direction. To do this, always dismount the whole Control Unit including the pressure plate.

1. Unscrew the four hexagon bolts on the top side of the pressure plate.
2. Turn the Control Unit 180° so the arrow on the pressure plate corresponds to the correct flow direction.
3. Remount the hexagon bolts.

7.2 Change of Flow Range

The Eletta Flow Meters features an orifice design that does not require recalibration after exchanging the orifice plate. This can be used in-field for easy change of flow ranges. The orifice plate inside the Pipe Section is the only part that has to be changed.

You can use any flow range and orifice plate that suits your application, as long as the flow falls within the limits of the range for the Flow Meter.

In each case of changing the orifice plate in-field, we kindly ask you to first contact your distributor or Eletta for advise about the correct orifice plate. The properties of each orifice plate is carefully calculated and designed to match the specific conditions of your installation.

Proper tooling makes changing orifice much easier. A tool kit for orifice exchange is available as an option.

Perform the following steps for exchanging the orifice plate:

- 1) Dismount the whole Flow Meter.
- 2) Unscrew the orifice plate holder.
- 3) Take out the old orifice plate
- 4) Mount the new orifice plate.
- 5) Mount all removed parts in opposite order

8 Maintenance

Since Eletta can't predict the conditions and environmental circumstances of your installation, e.g. surroundings and process media, it is not possible for us to provide maintenance recommendations for any specific installation in this manual. We can only give a few general maintenance guidelines.

We recommend that you use your own experience with knowledge about the specific installation and environment to decide what periodical inspections might be needed.

8.1 Housing

Periodically check that the cover is undamaged and that all seals are tight. This is important to prevent moisture and dust to enter inside the housing.

8.2 Electrical wiring and connections

Periodically inspect the power and output wirings for signs of corrosion, cracks or deterioration. Check that the electrical connector to the instrument is tightly attached and shows no signs of corrosion.

8.3 Bolts and screws

Check that all four visible bolts are present and securely tightened to avoid leakage. Replace a bolt or screw if mechanically damaged.

8.4 Process connection

Periodically inspect the process pipe connections to verify that all seals are tight and that there are no leakages. Check that the Flow Meter isn't exposed to vibrations. Check that the temperature at the Control Unit doesn't exceed the max temp of 100° C.

8.5 Pipe Section

If necessary, periodically remove the Pipe Section and inspect the orifice plate for wear, debris or build-up of foreign matter. Any of these factors could cause inaccurate readings from the unit. If the orifice is dirty, clean the bore and the orifice using a brush or appropriate solvents (intended for brass or stainless steel). The sharp edge of the bore is absolutely necessary to provide proper and accurate flow reading. If the bore wear is excessive, please contact your local distributor or Eletta Flow for purchase of a replacement orifice. Check the Pipe Section body for signs of corrosion and fatigue fractures.

9 Trouble Shooting

9.1 Inaccurate flow prediction

If you find that a purchased Eletta Flow Meter does not show the same value as a reference meter on site, this could either be due to that the reference meter has been calibrated under other reference conditions, or that the Eletta Flow Meter now is used under other conditions than the Eletta factory reference conditions.

The accuracy stated is achievable only if the instrument is correctly installed according to this manual.

9.2 The Meter shows the wrong value or nothing at all

Check the following subjects to find out what is wrong.

- Is there any power supply?
- Does the power supply use the correct voltage?
- Is there any output signal, at least 4 mA?
- Is there any flow in the system pipe?
- Is the Control unit correctly mounted with respect to the flow direction? Check that the engraved arrow on the Pipe Section corresponds to the media flow of the system.
- Is the flow sufficient to generate a differential pressure? The Flow Meter is designed for a minimum flow. Check the flow range.
- **In Gas mode:** Check orifice calculation conditions correspond with the pressure and temperature of the system.
- **Oil applications:** Check that the orifice calculation conditions correspond with the oil used; viscosity, density and actual oil temperature.
- Do you use the correct orifice plate for the application? Check the information on the product label
- If you use "tube fittings" when connecting the system pipes to the Pipe Section, make sure that they do not have inside diameters that are too small.
- Verify that you are using the correct inner diameter and enough straight runs up-stream and down stream of the pipe section.

9.3 Liquid (or gas) is coming out of the Control Unit

- Turn the system flow off. Remove the Flow Meter and check that the Pipe Section and Control Unit have no cracks, and that all seal are undamaged.

10 Spare parts

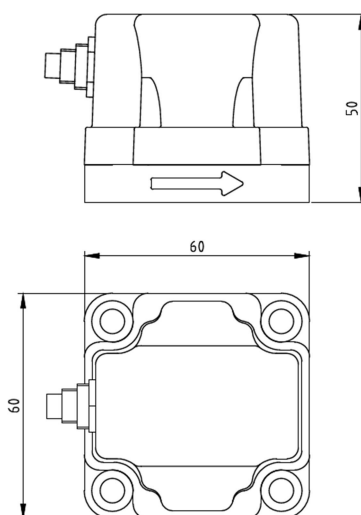
The Control unit of Elettta M-series contains no exchangeable parts

Do not try to repair the Flow Meter yourself. It is not possible to replace certain spare parts since the Flow Meter has to be calibrated as a whole. Contact your local distributor or Elettta Flow for advice.

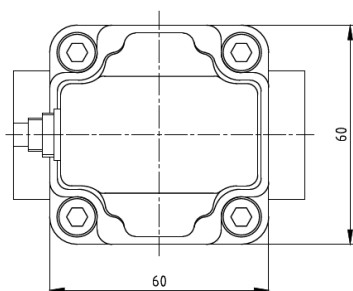
Contact your distributor for information about service. The product label specifies the serial number, the flow range and the media.

11 Technical Specifications

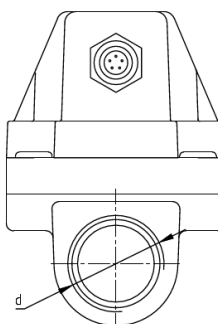
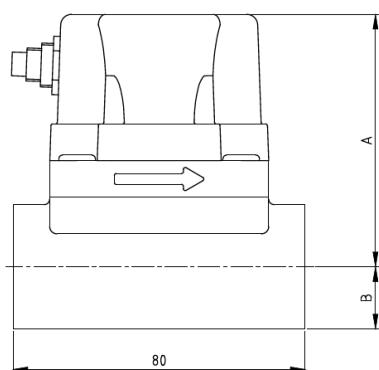
11.1 Dimensions unit



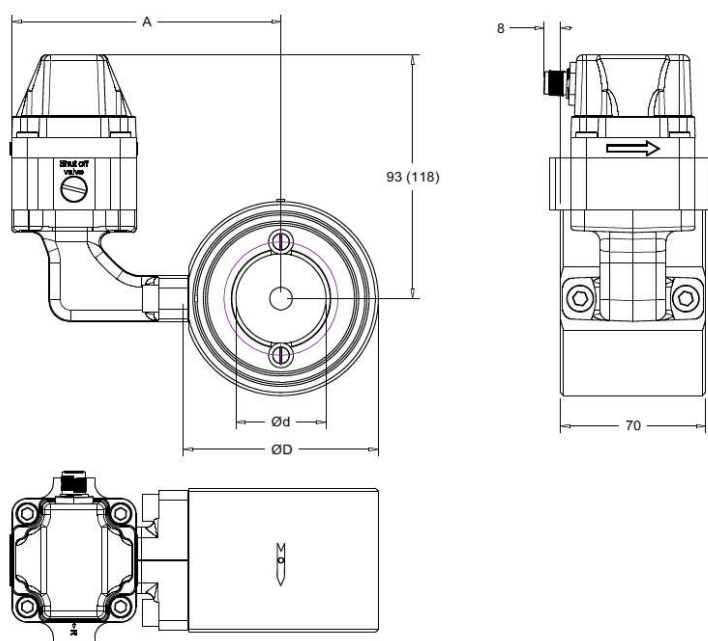
11.2 Dimensions threaded pipe



Type	d	A (mm)	B (mm)	Weight (kg)
M-G15	1/2" BSPP	66	14	0,8
M-G20	3/4" BSPP	69	17	0,9
M-G25	1" BSPP	73	21	1,0



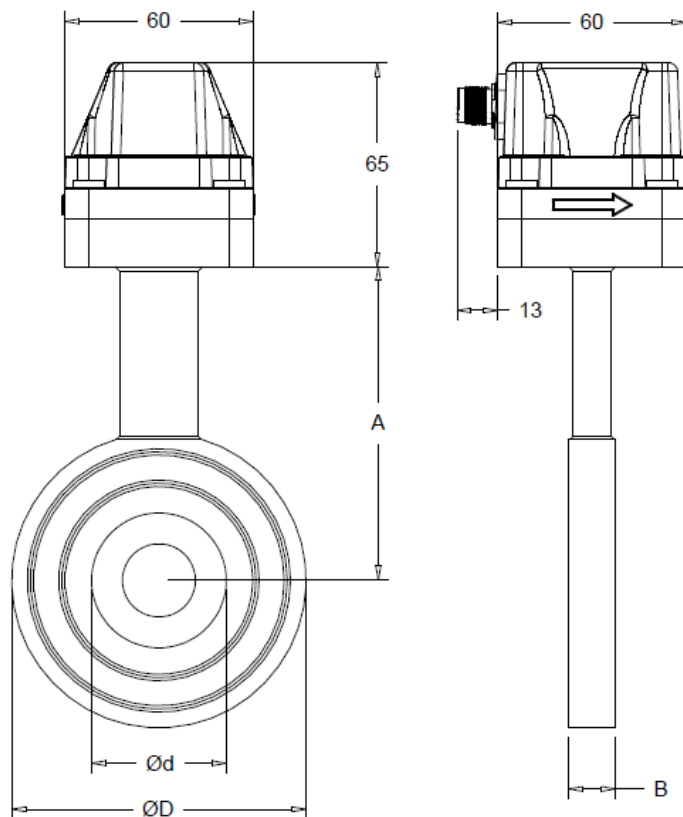
11.3 Flange fitted pipe sections, Cast Iron / Bronze metal with shut off block



Type DN size	Size	d	D	A
FA15	1/2 "	16	53	108
FA20	3/4 "	22	63	112
FA25	1 "	30	73	118
FA32	1 1/4 "	39	84	124
FA40	1 1/2 "	43	94	129
FA50	2 "	55	109	137
FA65	2 1/2 "	70	129	147
FA80	3 "	82	144	155
FA100	4 "	107	164	165
FA125	5 "	132	194	181
FA150	6 "	160	219	193
FA200	8 "	207	274	220
FA250	10 "	260	330	248
FA300	12 "	310	385	277
FA350	14 "	340	445	307
FA400	16 "	390	498	333

(Dimensions) are meter installation with shut off block

11.4 Flange fitted pipe sections, stainless steel



Type DN size	Size	d	D	A	B
F15SS	1/2 "	17	53	78	15
F20SS	3/4 "	22	63	84	15
F25SS	1 "	29	73	89	15
F32SS	1 1/4 "	39	84	95	15
F40SS	1 1/2 "	43	94	100	15
F50SS	2 "	55	109	108	15
F65SS	2 1/2 "	70	129	118	15
F80SS	3 "	82	144	126	15
F100SS	4 "	107	164	136	15
F125SS	5 "	132	194	151	15
F150SS	6 "	160	219	174	15
F200SS	8 "	207	274	201	15
F250SS	10 "	260	330	230	15
F300SS	12 "	310	385	257	15
F350SS	14 "	340	445	287	15
F400SS	16 "	390	498	324	18

11.5 Property - Specification

Property	Specification
Accuracy	+/- 1% FS of the default differential pressure. (M310: 500 mbar, M325: 1250 mbar, M350: 2500 mbar) This corresponds to +/- 2% F.S. of the flow during reference conditions with water and air.
Flow measuring range	Turn down of 1:10 for liquids as standard setting. For gases turn down changes according to the pressure and temperature compensation. It is possible to customize Turn down by changing the differential pressure.
Repeatability	Less than 0,5% of present value.
Max static pressure	-M310: 10 bar(g) (145 PSI) -M325: 25 bar(g) only for threaded pipes G15-25BR/SS and GL40. FA/FSS pipes 16 bar(g). -M350: 50 bar(g) only for threaded pipes G15-25BR/SS and GL40. FA/FSS pipes 16 bar(g).
Min static pressure*	- M310: 1 bar(g) (14,5 PSI) - M325: 1,75 bar(g) (25,4 PSI) - M350: 3 bar(g) (43,5 PSI) * Minimum pressure at to get a proper reading, provided there is a flow in the system.
Max over pressure	+ 50 % of Max static pressure
Temperature ranges	Control unit -10° C to +100° C (+14° F to 212° F) Higher process temperatures are achievable by remote installation of the Control unit, reference to section 2.4.1. Temperature compensation -10° C to +80° C (+14° F to 176° F) Pipe section GSS pipes -10° C to +200° C (+14° F to 392° F) GBR and GL pipes -10° C to +120° C (+14° F to 248° F) FA pipes -10° C to +100° C (+14° F to 212° F) FSS pipes -10° C to +100° C (+14° F to 212° F) Connector and included cable -20° C to +85° C
Pressure endurance	10 ⁷ pressure cycles from 0 to F.S. at 25° C
Vibration endurance	20 g, 20 to 5000 Hz
Shock endurance	20g, sinus 11 ms
Control unit	Housing Polyamide plastic with EMC shielding inside. Connector 8-poles LTW
Connection cable	PUR Standard cable 2,5 m (10 m cable available as option) 8 x 0,25 mm ²
Protection class	IP67 (NEMA 6)

Property	Specification
Process pipe dimensions	GBR DN15 - 25 (½" – 1" BSPP) GL DN15 – 40 (½" – 1 ½" BSPP or NPT) FA (Flanged) DN15 – 400, DIN PN16 DN50 – 100, ANSI 150lbs DN125 - 200, Suitable ANSI 150 lbs (actual DIN PN16) DN250 – DN300, ANSI 150 lbs FSS (Flanged) DN15 – 400, DIN PN16 DN15 – 400, ANSI 150 lbs
Power supply	+8 VDC to +28 VDC (2 wire loop feed)
Output	4 – 20 mA (Output update rate: 20 ms) Min Response time: 20 ms, with Filter setting min (0 s) Max response time 26 s, with Filter setting max (26s) RS485 for external communication Max output load is calculated with the following formula: $\text{Max } \Omega = \frac{\text{Supply voltage} - 8 \text{ V}}{0,02 \text{ A}}$ (Including connection cable)
Power consumption	In the range of 32 – 560 mW depending on the differential pressure and the supply voltage. Power supply of 8 VDC and 4mA output signal = 32 mW Power supply of 28 VDC and 20 mA output signal = 560 mW
O-ring materials	- GBR, GL and FA pipes: NBR (Nitrile rubber) as standard. - FSS pipes: FPM (Fluorinated rubber) as standard. - EPDM (Ethylene Propylene Diene)
Orifice plate holder / Spacer materials	GBR/GSS pipes: Stainless steel EN 1.4435 (ASTM 316L) GL pipes: Polyamide plastic FA pipes: DN15-100 Polyamide plastic DN125 – 400 Stainless steel EN 1.4404 (ASTM 316L)
Orifice material	Stainless steel EN 1.4435 (ASTM 316L)
CE approvals	Eletta Flow Meters conform with the following EU directives: - Low voltage. 72/33/EEC (EN 60 204-1 Part 1) - For electromagnetic compatibility, EMC directive 2004/108/EC (EN 61 000 – 6 – 3:2007 and EN 61 000 – 6 - 2:2005) - Pressure equipments, applicable parts in PED 97/23/EC

12 Measurement flow ranges, Water

The following table states the standard flow ranges for the M-series. The chart is a guideline of what flow ranges are achievable for different pipe sections. For other flow ranges and media (gases, oils etc.) consult your local distributor.

M310 (M10) dp-range: 0 - 500 mbar				M325 (M25) dp-range: 0 - 1250 mbar			
Dim.		Pipe	Measuring range l/min	Dim.		Pipe	Measuring range l/min
Thread	DN15 1/2"	G15 (GL15)	0,2 - 2	Thread	DN15 1/2"	G15 (GL15)	0,5 - 5
			0,5 - 5				1 - 10
			1 - 10				2,5 - 25
			2,5 - 25				5 - 50
			5 - 50				7,5 - 75
Thread	DN20 3/4"	G20 (GL20)	1 - 10	Thread	DN20 3/4"	G20 (GL20)	1 - 10
			2,5 - 25				2,5 - 25
			5 - 50				5 - 50
			8 - 80				12 - 120
Thread	DN25 1"	G25 (GL25)	1 - 10	Thread	DN25 1"	G25 (GL25)	5 - 50
			2,5 - 25				10 - 100
			5 - 50				20 - 200
			12 - 120	Thread	DN40 1 1/2"	GL40	10 - 100
Thread	DN40 1 1/2"	GL40	5 - 50				20 - 200
			10 - 100				40 - 400
			30 - 300	Flange	DN15 1/2"	FA15 F15SS	0,5 - 5
Flange	DN15 1/2"	FA15 F15SS	0,2 - 2				1 - 10
			0,5 - 5				5 - 50
			1 - 10				7,5 - 75
Flange	DN20 3/4"	FA20 F20SS	5 - 50	Flange	DN20 3/4"	FA20 F20SS	1 - 10
			0,5 - 5				5 - 50
			1 - 10				12 - 120
			5 - 50	Flange	DN25 1"	FA25 F25SS	5 - 50
Flange	DN25 1"	FA25 F25SS	8 - 80				10 - 100
			1 - 10				25 - 250*
			5 - 50	Flange	DN32 1 1/4"	FA32 F32SS	10 - 100
Flange	DN32 1 1/4"	FA32 F32SS	17,5 - 175*				20 - 200
			5 - 50				40 - 400**
Flange	DN40 1 1/2"	FA40 F40SS	10 - 100	Flange	DN40 1 1/2"	FA40 F40SS	10 - 100
			30 - 300				25 - 250
			5 - 50				50 - 500
Flange	DN50 2"	FA50 F50SS	10 - 100	Flange	DN50 2"	FA50 F50SS	20 - 200
			25 - 250				50 - 500
			50 - 500	Flange	DN65 2 1/2"	FA65 F65SS	30 - 300
Flange	DN65 2 1/2"	FA65 F65SS	25 - 250				60 - 600
			50 - 500				120 - 1200***
Flange	DN80 3"	FA80 F80SS	80 - 800***	Flange	DN80 3"	FA80 F80SS	50 - 500
			25 - 250				100 - 1000
			50 - 500	Flange	DN100 4"	FA100 F100SS	200 - 2000
Flange	DN100 4"	FA100 F100SS	100 - 1000				50 - 500
			200 - 2000				100 - 1000
Flange	DN125 5"	FA125 F125SS	300 - 3000	Flange	DN125 5"	FA125 F125SS	300 - 3000
			100 - 1000				500 - 5000
			200 - 2000	Flange	DN150 6"	FA150 F150SS	100 - 1000
Flange	DN150 6"	FA150 F150SS	400 - 4000				300 - 3000
			200 - 2000				700 - 7000
Flange	DN200 8"	FA200 F200SS	700 - 7000	Flange	DN200 8"	FA200 F200SS	200 - 2000
			200 - 2000				500 - 5000
			500 - 5000				110 - 11000
Flange	DN250 10"	FA250 F250SS	1200 - 12000	Flange	DN250 10"	FA250 F250SS	200 - 2000
			200 - 2000				500 - 5000
			500 - 5000				1700 - 17000

*For ANSI: Max.: 0-120 **For ANSI: Max.: 0-200

***For ANSI: Max.: 0-700

*For ANSI: Max.: 0-120 **For ANSI: Max.: 0-200

***For ANSI: Max.: 0-700

13 Type plates

On each flow meter you find two type plates stating technical data for your specific flow meter.

Examples of type plates are shown below.

The largest plate is the main type plate which states:

- Type
- Model
-
- Power supply range
- Output signal range
- Serial no.
- Temperature range
- Maximum pressure, pressure sensor
- Protection class
- Manufacturing year

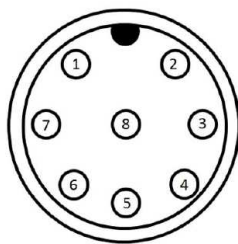
ELETTA		Phone +46(0)8 603 07 70
		www.eletta.com
Type: M310 - G15BR	Min/Max Temp:	-10-100°C
Model: 223021015	Max Pressure:	10 Bar
Supply: 8-28 Vdc	Protection class:	IP67
Output: 4-20 mA	CE 2014	
No: 123456		

The second plate states the flow conditions for the specific orifice⁻¹ plate:

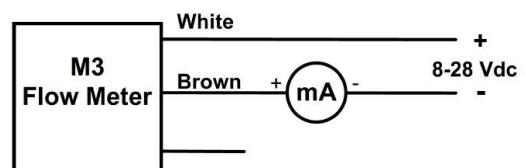
- Type of fluid
- Dynamic viscosity η
- Density ρ
- Temperature
- Pressure p
- Flow range Q
- Differential pressure range Δp

FLOW CONDITIONS	
Fluid: Air	
η : 0,018 cP ρ : 1,205 kg/m ³	
p: 8 bar(g)	T: 0°C
STP: 1 atm / 0°C	
Q: 0 - 5 Nm ³ /min	
Δp Range: 500 mbar	

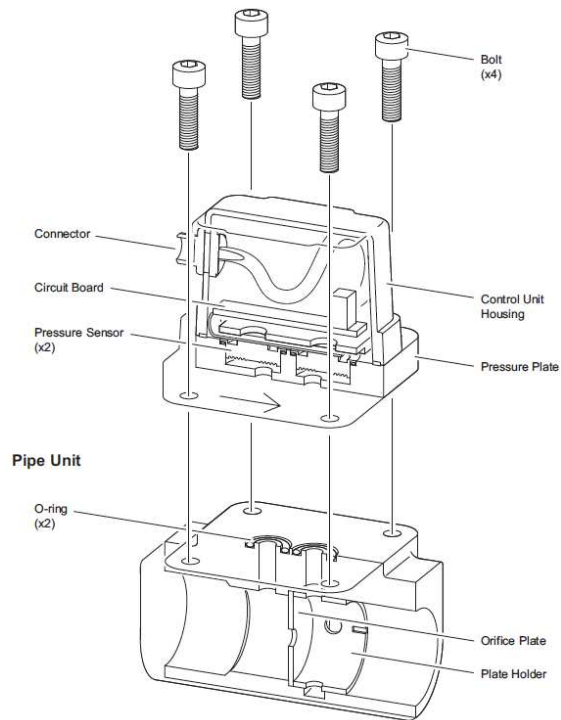
On the cable at the open end you find a sticker with the wiring diagram



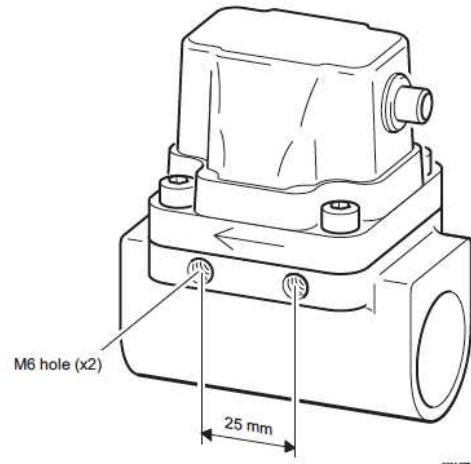
Function		Female connector	Wire color
8 - 28 VDC	+	Pole 1	WHITE
	-	Pole 2	BROWN
RS485A		Pole 3	GREEN
RS485B		Pole 4	YELLOW
Not active		Pole 5	GREY
Not active		Pole 6	PINK
Not active		Pole 7	BLUE
Not active		Pole 8	RED



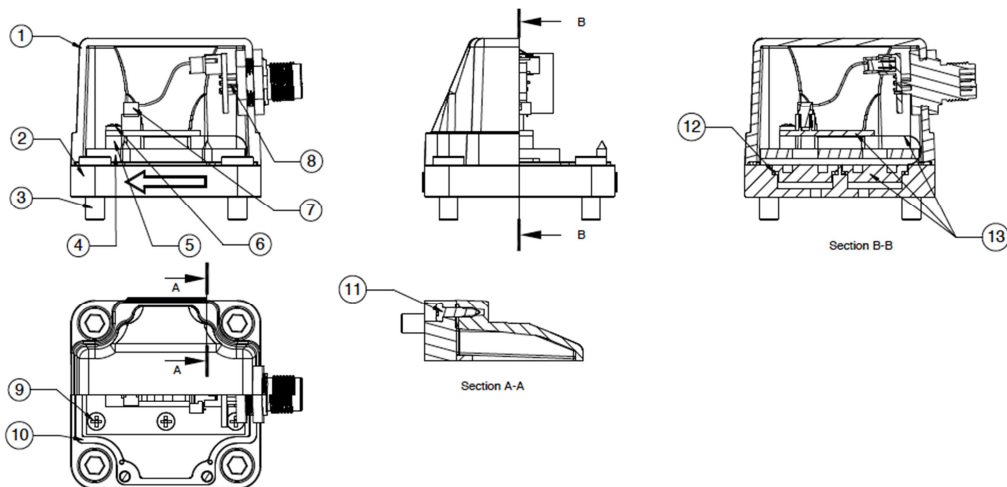
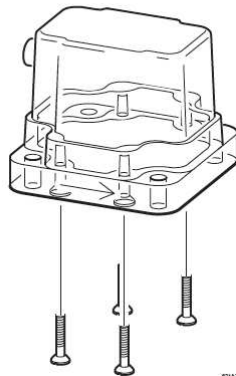
14 BOM



M6 holes for rigid mounting



Control Unit and Pressure Plate



Pos.	Qt.	Denomination	Material	Dimension	Art. no.	Remark
1	1	Cover M Cover M SS	PA12 Grlamid lkn-5h Stainless steel EN 1.4436		40-93192 40-93192-1	Inside is metalised with 5my aluminium for EMC protection
2	1	Baseplate M-HP BR Baseplate M-HP SS	CW602N EN12420 Forging EN 1.4436 precision casted		40-93193 40-93193-1	
3	4	Screw MC6S	1.4301	M6x14	40-90079	
4	1	Pressure plate M-BR Pressure plate M-SS	CW614N EN 1.4436		40-93191 40-93191-1	
5	1	Spacer	CW614N	2.5x5x4	40-90080	Nickel plated
6	1	Screw MRX	1.4301	M2.5x8	40-90005	
7	1	Flatcable with connectors	Connectors: High temp glass filled polyester Wire/flatcable: Pvc		40-93207	
8	1	RFI card with M12 contact	Nut: zinc alloy, nickel plated Male pin: copper alloy, gold plated O-ring: epdm Connector on card: pvc		40-93206	
9	6	Screw MFX	1.4301	M3x10	40-90076	
10	1	Sealing cover	Conductive TPE		40-94069	C3 6068
11	4	Screw ETPPH	1.4301	M3x12	40-90078	
12	2	Sealing	NBR - Nitrile rubber (STD for brass assembly) FPM - Fluorcarbon rubber (STD for SS assembly) EPDM - Synthetic rubber	18.1x1.6	40-94070 40-94070-1 40-94070-2	
13	1	Pressure transducer assy: Pressure transducers with communication wire to pcb card M310/V8.1 M325/V8.1 M350/V8.1 M 10/V5.5 M 25/V5.5 M 50/V5.5 M 100/V5.5	Pressure transducer: 1.4404 Oil filling: Silicone oil		40-91091-1 40-91096-1 40-91097-1 40-91091 40-91096 40-91097 40-91098	

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