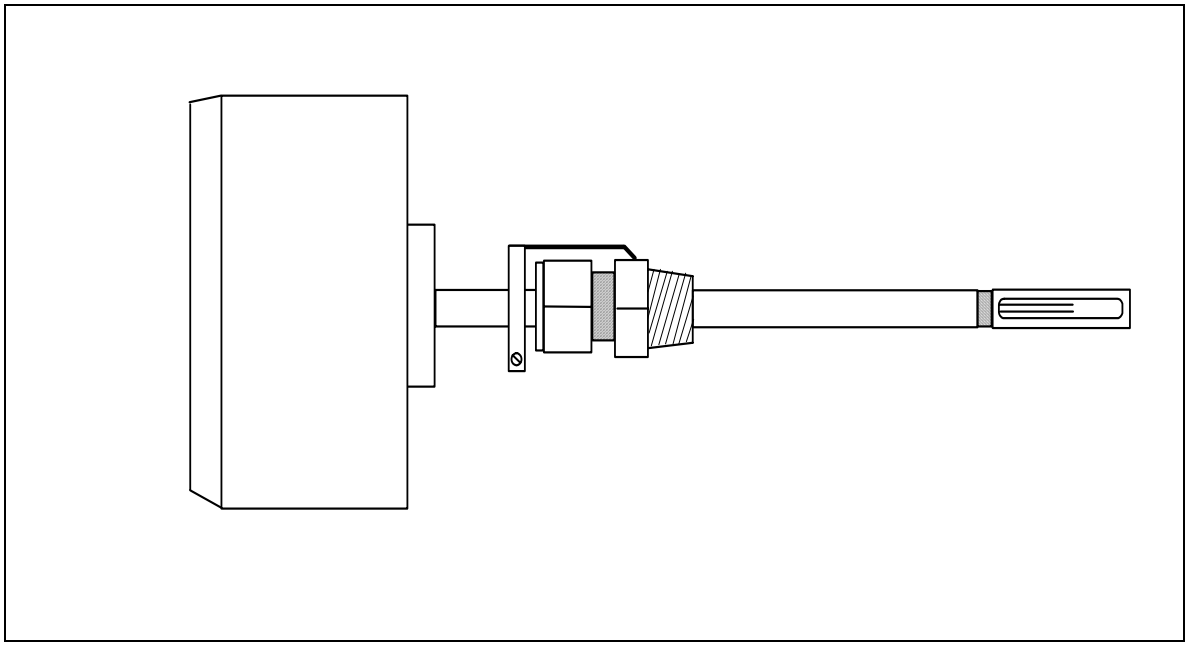
Installation- and Instruction manual

Mass flow meter for compressed air

VARIOMASS LC



Version: 02/10a

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Introduction

This manual is valid for all *VARIOMASS* LC IN-LINE sensor with nominal pipe sizes from 1/2" (12 mm) up to 2" (50 mm) and for all *VARIOMASS* LC insertion meters with nominal pipe sizes from 2.5” (65 mm) up to 20” (500 mm).

Included in delivery by default are:

The sensor with integrated evaluation electronics and with the insertion sensor additionally a Swagelok fitting bored through with welded on adjusting nuts or optional a BVR ½” ball valve retractable assembly.

Moreover there are optional a 8-pin mating plugs (round and made out of metal with an O-ring seal for IP 65 / NEMA 4X) for the electric pin. They can come with or without a connection cable in different lengths (2 / 5 / 10 or 20 meters long).

Please check the appendix from the model number key for further options.

Please handle every part with care, seeing that every violence done to the equipment can lead to a destruction of the measurement system.

1. Technical data

1.1 Electronics

Power supply:	24 VDC (min. 250 mA) +/- 20%
Ambient temperature range:	-10°C to + 45°C
Protection class:	IP 65 (only with cable gland)
Output signal:	0.. 20 mA or 4..20 mA linear (max. 500 Ohm U=12 VDC) pulse output signal for external counter (35 VDC 80 mA)
Flow units:	Nm³/h, Nm³/min., Nl/min., Nl/sec., SCFH, SCFM, kg/min., kg/h or Nm/sec.
Standard condition (N):	according to ISO 1217: 20°C & 1 bar abs. (others on request)
Media:	Air at 4 to 12 bar g (different ranges on request)
Media temperature:	20°C (+/- 20°C) (Standard) Optional up to + 200°C
Max. Media temperature:	+ 200°C
Process pressure:	maximum 16 bar g (Optional up to 40 bar g)
Process connection:	R ½" with Insertion meters ½“ to 2“ NPT or R thread with In-Line Sensor optional flange connection
Accuracy	+/- 3% of reading plus 1% of full scale (FS) and a turn down ratio 100:1
Turn down ratio:	1:10 up to 1:100 (Standard 1:100)
Repeatability:	0.5% of reading
Display:	2 x 16 alphanumeric display LC Display
Optional:	USB Interface for PC Software WIN-LC

1.2 Sensor

The insertion meters can be used according to the possible measuring range in reference with the nominal pipe sizes, which can be found in table 1.1

Model No.	Pipe size	max. Flow range:	min. Flow range:	First value:
L-0	DN 65	0 - 900 Nm³/h	0 – 90 Nm³/h	1 Nm³/h
L-0	DN 80	0 - 1.400 Nm³/h	0 – 140 Nm³/h	2 Nm³/h
L-0	DN 100	0 - 2.300 Nm³/h	0 – 230 Nm³/h	3 Nm³/h
L-0	DN 125	0 - 3.500 Nm³/h	0 – 350 Nm³/h	4 Nm³/h
L-1	DN 150	0 - 5.000 Nm³/h	0 – 500 Nm³/h	6 Nm³/h
L-1	DN 200	0 - 9.000 Nm³/h	0 – 900 Nm³/h	11 Nm³/h
L-1	DN 250	0 - 14.000 Nm³/h	0 – 1.400 Nm³/h	18 Nm³/h
L-1	DN 300	0 - 20.000 Nm³/h	0 – 2.000 Nm³/h	25 Nm³/h
L-1	DN 350	0 - 27.000 Nm³/h	0 – 2.700 Nm³/h	35 Nm³/h
L-1	DN 400	0 - 36.000 Nm³/h	0 – 3.600 Nm³/h	45 Nm³/h
L-1	DN 450	0 - 45.000 Nm³/h	0 – 4.500 Nm³/h	57 Nm³/h
L-1	DN 500	0 - 55.000 Nm³/h	0 – 5.500 Nm³/h	71 Nm³/h

Table 1.1. Standard conditions of measurement range as function of the pipe sizes

The In-Line flow meter are designed for flow ranges and pipe sizes listed in table 1.2

Model No.	Pipe size	Pipe inside diameter	Flow body lenght "L"	Process thread "N"	Max. Flow range
L-2	½ " (DN 15)	15,8 mm	7" (178 mm)	½" NPT	0 - 20 Nm³/h
L-3*	¾ " (DN 20)	20,9 mm	11,8" (300 mm)	R ¾"	0 - 100 Nm³/h
L-4*	1" (DN 25)	26,6 mm	11.8" (300 mm)	R 1“	0 - 150 Nm³/h
L-5	1 ¼ " (DN 32)	35,1 mm	10" (254 mm)	1 ¼" NPT	0 - 250 Nm³/h
L-6*	1 ½ " (DN 40)	40,9 mm	23,6" (600 mm)	R 1 ½"	0 - 350 Nm³/h
L-7*	2" (DN 50)	52,5 mm	29,5" (750 mm)	R 2"	0 - 600 Nm³/h

Table 1.2. Standard conditions of measurement range as function of the pipe sizes

* Values (Sensor lenght and thread type) are only accountable for the In-Line Sensors without the optional flow straightener.

Non Standard calibration

With a non standard calibration with high speed, e.g. 0-200 Nm/sec., the flow range full scales can be multiplied with a factor, e.g. 2.5. There of results, for example for a DN 100 pipe a maximum flow range of 0 – 5750 Nm³/h instead of 0 – 2300 Nm³/h. The standard flow ranges are based on a flow velocity of 0 – 80 Nm/sec.

Different gases (e.g. N2, O2, CO2, or Argon) as well as different ranges of pressure (e.g. 0-3 bar 12-20 bar or 40 bar) are possible on request.

2 Mounting

2.1 Checking sensor probe length

2.1.1. Insertion meters

The probe length of the shaft "L" of an insertion meter was chosen in a way that allows the flow range window to dig in at least to the middle of the processing pipe.

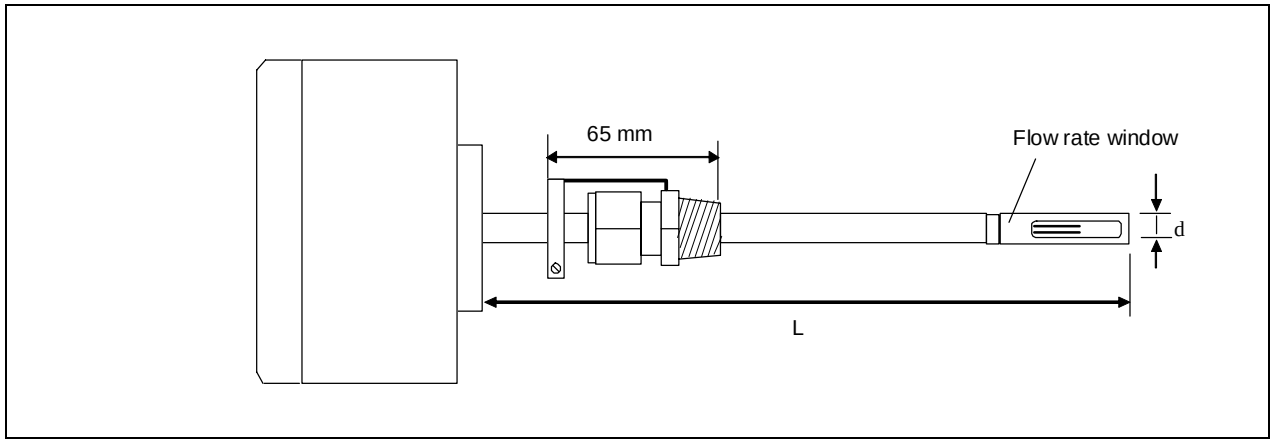


Table 1a) Dimensions of an Insertion meter

The probe shaft length "L" is for pipe sizes from 65 mm to 300 mm about 300 mm (12”) and for 65 mm to 500 mm about 400 mm (16”) long and the probe shaft diameter is d" = ½" (12,7 mm).

By using the option “K” BVR ½” (Ball valve retractor assembly) the max. pipe size for the length L = 300 mm (12”) with a nominal pipe size of DN 65 to DN 125 and with the sensor probe length L= 400 mm (16”) with a nominal pipe size of DN 65 to DN 300 is possible.

Concerning bigger nominal pipe sizes than 300 mm (12”) in connection with the option BVR ½“ a sensor probe length from > 400 mm is possible on request. Optional special length (L = 500 mm, 600 mm or 650 mm) are available.

2.1.2 **In-Line sensor**

The length of a sensor measuring tube “L” of an IN-LINE sensor adjusts to the ordered nominal size of the chosen equipment (see table 1b). The nominal size of the sensor measuring tube ranges from ½” to 2” (see table 1.2). Those values are partly only for measurement sections without flow straightener. The flow body length and pipe thread for In-Line meter with flow conditioner are in table 1.3 to find.

Modell No	Pipe size	Inside diameter	Flow body length "L"	Processs thread "N"	max.	Flow range
L-2	½“ (DN 15)	15,8 mm	7" (178 mm)	½“ NPT	0 -	20 Nm³/h
L-3	¾ " (DN 20)	20,9 mm	7" (178 mm)	¾" NPT	0 -	100 Nm³/h
L-4	1" (DN 25)	26,6 mm	8" (203 mm)	1" NPT	0 -	150 Nm³/h
L-5	1 ¼ " (DN 32)	35,1 mm	10" (254 mm)	1 ¼ " NPT	0 -	250 Nm³/h
L-6	1 ½ " (DN 40)	40,9 mm	15" (331 mm)	1 ½ " NPT	0 -	350 Nm³/h
L-7	2" (DN 50)	52,5 mm	20" (508 mm)	2" NPT	0 -	600 Nm³/h

Table 1.3.flow body length of In-Line meter with flow condioner

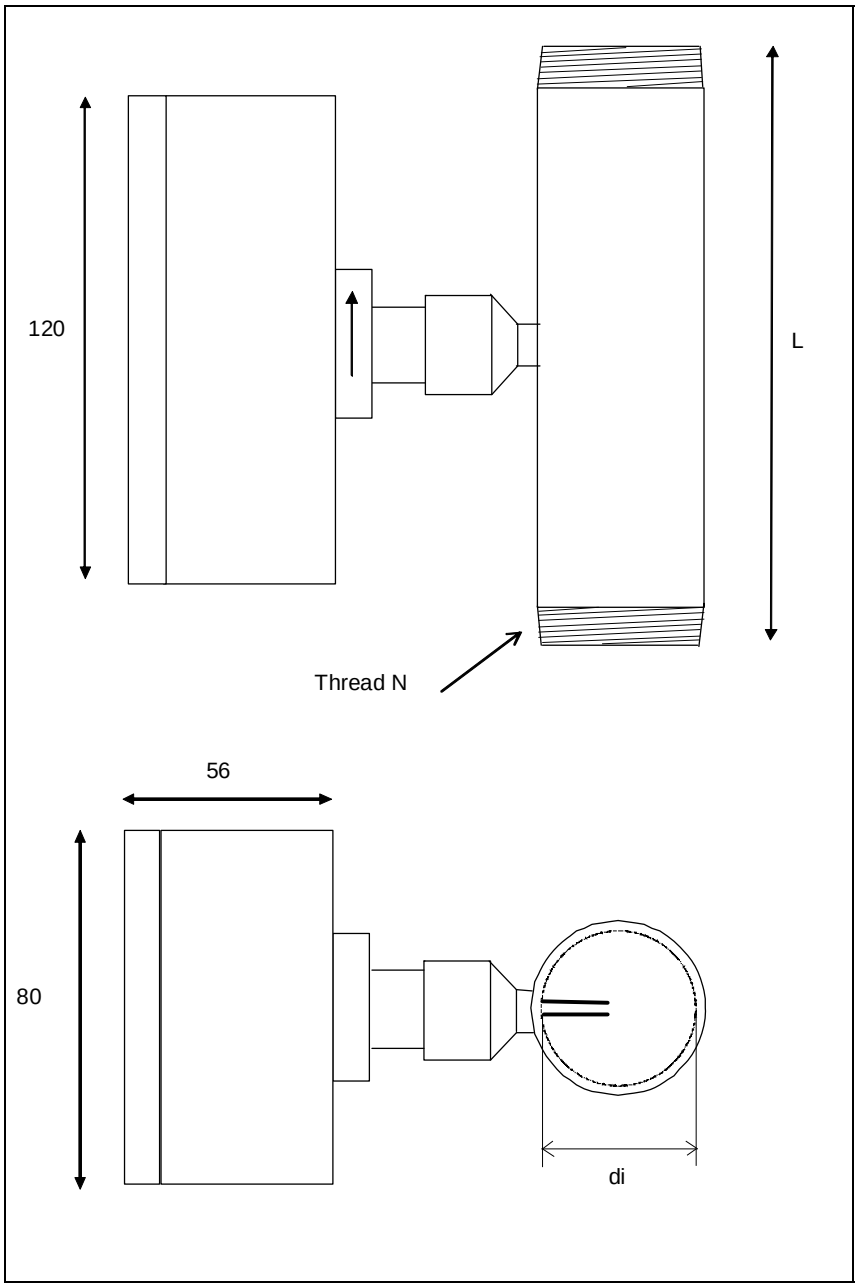


Table 1b) Dimensions of an In-Line Sensor

2.2. Installation of the Sensor

2.2.1 Installation of the Sensors without flow straightener

Proper installation of the flow section assembly is of great importance. It is important to install the flow meter at a position where an uninterrupted, straight measuring section from 10xD up- and 5xD down-stream section minimum is provided (D = pipe inside diameter).

With a strong flow velocity at the upstream section of the sensor caused by openings, actuator or changing of the pipe nominal size, there should at least be 20xD up- and 10xD downstream section available.

The available, straight measuring section of the processing pipe should be separated into 2/3 up- and 1/3 downstream sections (see table 2a).

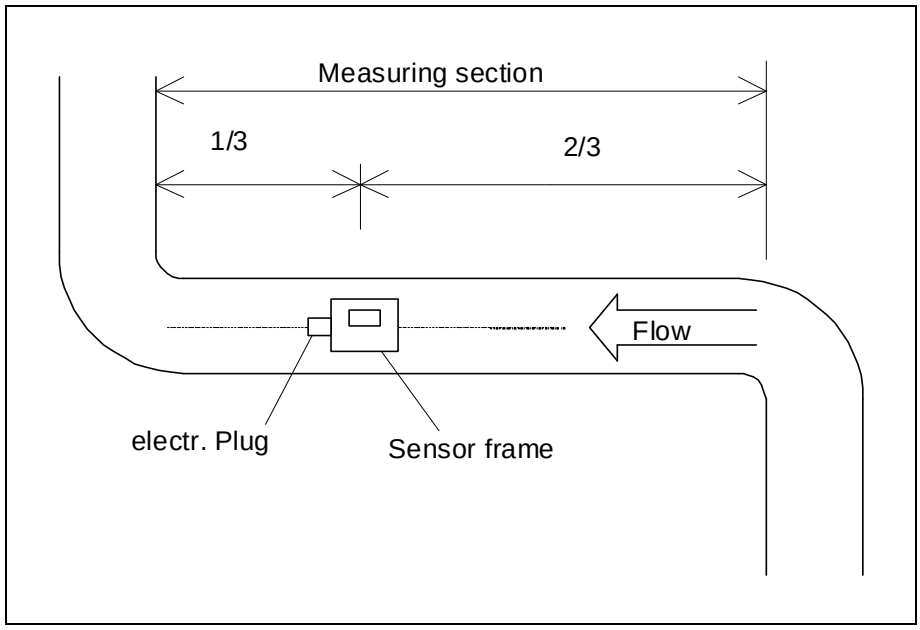


Table 2a) In-Line sensor: Measuring section with two 90°-elbow

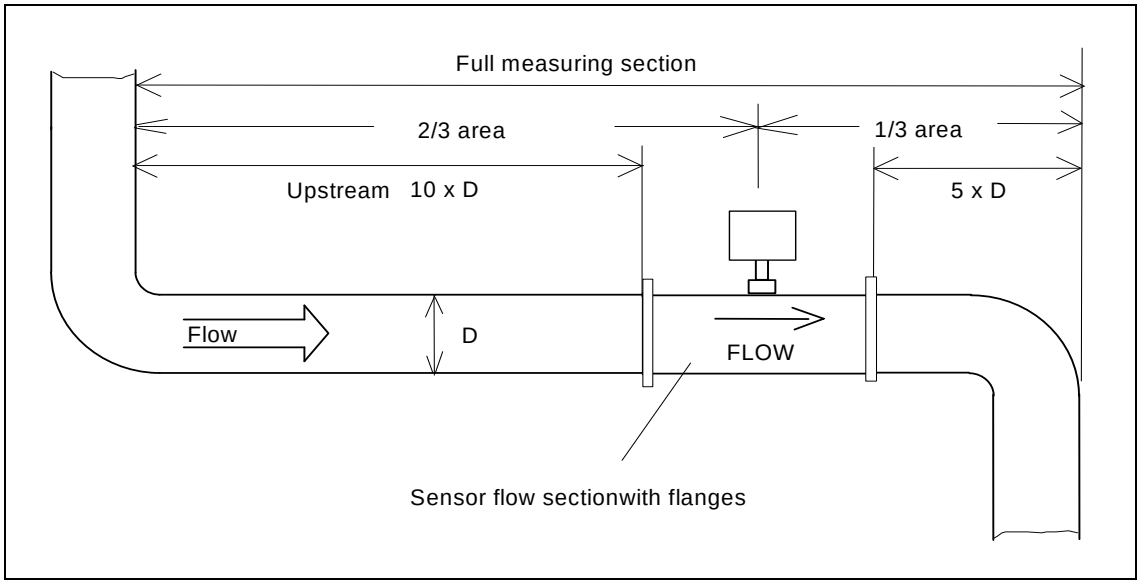


Table 2b) In-Line Sensor: Measuring section with two 90°-elbow

The pipeline channel (horizontal or vertical) is meaningless for the measuring system. With Insertion meters with a horizontal pipeline channel, a sideways or the from above immersed installation is recommended.

Important:
The instrument has to be installed at one place of the process control, where the measured amount of compressed air is dry (< 95% rel. humidity) and is above its temperature of dew point (always install behind the drywer). Dew drops or too high humidity lead to high measurement errors (up to 100% deviations).

The instrument shouldn't be installed in a closed circular pipeline, where reflow can't be excluded, seeing that otherwise the sensor measures the flow in both flow directions. Relief produces an, in the closed circular pipeline installed, non-return valve which allows the media only to flow in one direction. The valve isn't allowed to be in or close by the measurement section though.

2.2.2 Installation of the Sensors with flow straightener

2.2.2.1 In-Line Sensor

A free, undisturbed straight measuring section of at least 3xD up- and 2xD downstream section should be available for the In-Line sensor with flow straightener.

With a strong flow velocity at the upstream section of the sensor, caused by openings, actuator or changing of the pipe nominal size, there should at least be 10xD up- and 5xD downstream section available.

The available, straight measuring section of the processing pipe should be separated into 2/3 up- and 1/3 downstream sections (see table 2c).

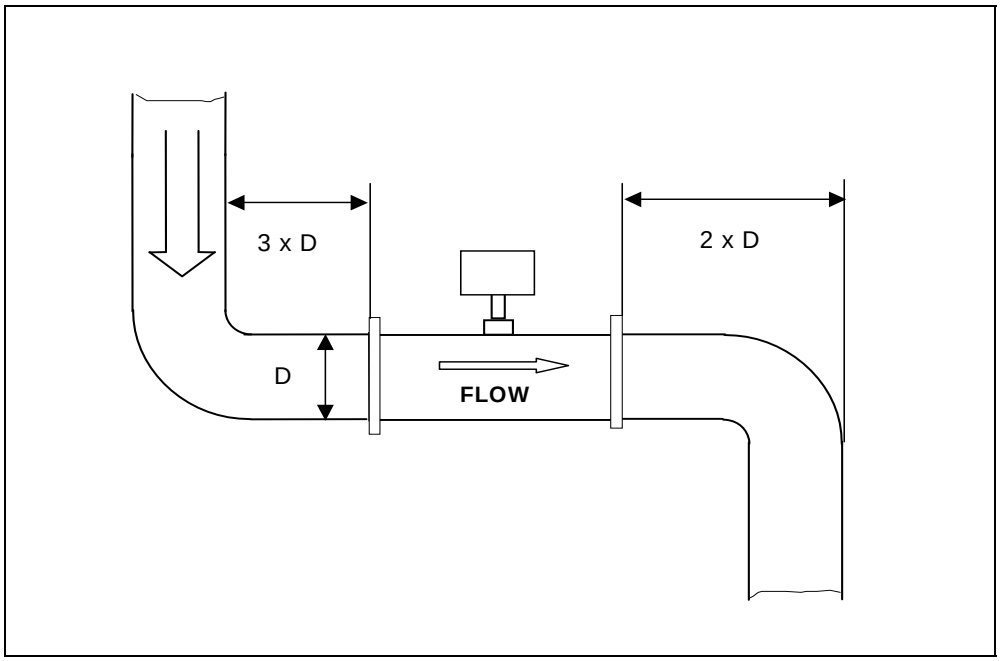


Table 2c) In-Line Sensor with flow straightener in a measuring section with two 90°-elbow

2.2.2.2 Insertion meters

Proper installation of the flow section assembly is of great importance.

The flow straightener with the nominal sizes DN 65 to DN 300 is delivered as perforated plate for mounting at intermediate flange and has to be placed at the upstream section at circa 3xD.

It is important to install the insertion meters with flow straightener at a position where there is an uninterrupted, straight measuring section from 5xD up- and 2xD downstream section minimum.

With a strong flow velocity at the upstream section of the sensor, caused by openings, actuator or changing of the pipe nominal size, there should at least be 15xD up- and 5xD downstream section available

The available, straight measuring section of the processing pipe should be separated into 2/3 up- and 1/3 downstream sections.

2.3. Installation of the sensor

2.3.1 Installation of the insertion meters

2.3.1.1 Installation of welding socket

The process connection should be a welding socket with a ½" inside thread or optional a counter flange for the flange version. The welding process connection should be in a right angle to the pipe and should match the center of the pipe.

The welding socket “M” should be between 20 and 60mm long and the hole inside diameter arranged at the welding process connection should be at least 15mm diameter in order to enter the probe (“d” = 13 mm) without problems. The imaginary extension line of the center line has to meet the pipe’s center. (See table 3)

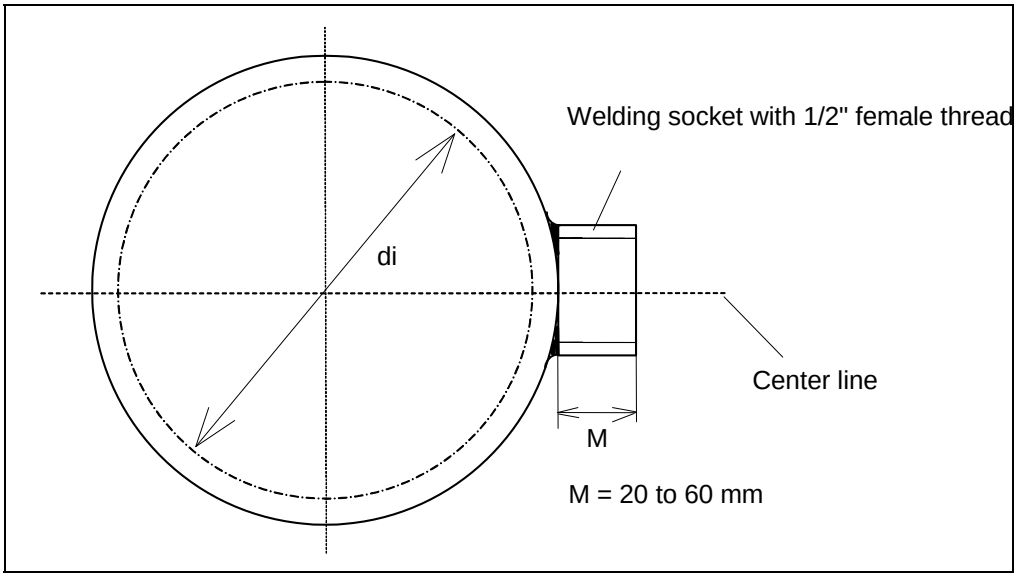


Table 3) Process connection welded on a pipe

2.3.1.2 Tube fitting

The standard process connection for the insertion flow meter is a Swagelok 1/2” bored through tube fitting. This fitting has a thread of R 1/2" for the process connection. Use Teflon band to fix the tube fitting with the pipe welding socket. This fitting has a Teflon ferrules which allows retracting the probe shaft without any deformation on the stainless steel probe shaft. For low pressure the nut can be hand tight and for higher pressure turn the nut additional 1/2 round against the direction of the twist. Use an „Inbus“screw driver on the external adjustment for proper tight (see table 4).

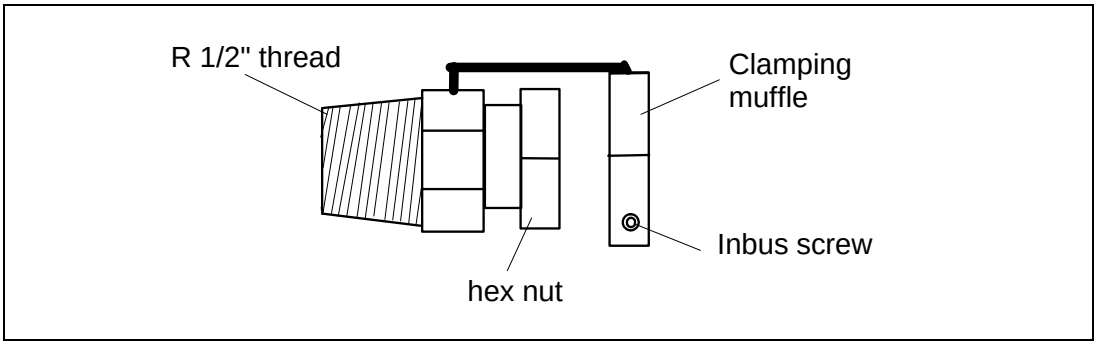


Table 4) Shaft mounted tube fitting with welded clamping muffle

The disassembling of the shaft mounted tube fitting should be at unpressurised process control for reasons of safety.

2.3.1.3 Flow direction specification

The window of the sensor has to be open in the flow direction. The sensor has to be installed in a way, that the flow direction mark “arrow” with FLOW on the sensor flange is the same as the flow direction of the media. The standard flow direction is defined from left to right, if looking at the sensor housing cover. A derivation from +/-5° is allowable, without having to sacrifice any exactness. The UPSTREAM mark on the sensor probe defines the side where the flow is coming from (See table 5)

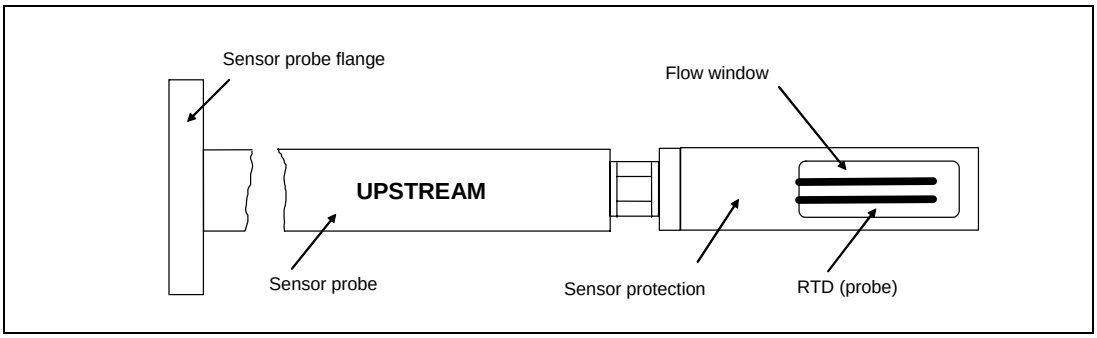


Table 5) Flow window open in the direction of flow

When having a reversed flow direction (in this case from left to right), the sensor has to be turned around its axis for 180°, so that the arrow marking “FLOW” on the sensor flange is coherent with the actual flow direction. The 8-pole DIN bushing attached to the sensor protection sleeve, points by a horizontal process run to the left and can be turned if needed (see chapter 2.3.1.3.1). Therefore it is important that the flow direction is mentioned correctly by the order entry before production of the flow meter.

2.3.1.3.1 Turning the sensor probe

The sensor probe can be turned carefully (!) around 180° to locate the display in the right position. To turn the probe the 4 attachment screws (Inbus) at the sensor flange have to be loosened. It is vital to take care that none of the inner sensor cables are destroyed and that the probe will only be turned one twist in one direction (clockwise or not). After loosening the screws, don’t remove the sensor probe from the frame floor for more than 2 cm. Before tightening the screws, please make sure that the o-ring gasket sits well.

The sensors have to be installed in a way that the flow window is arranged to the maximum flow velocity, which is situated in the pipe inside (see table 6a and 6b). The middle of the flow window is coherent with the pipes center line.

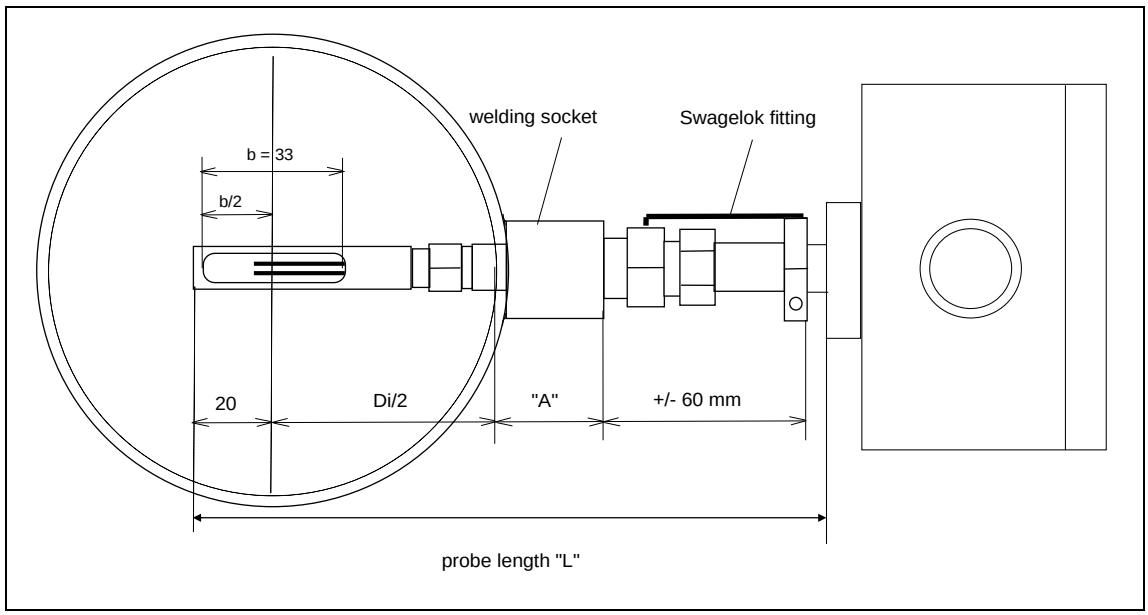


Table 6 a) Correct position of the flow window with clamping collar connection

Die minimum probe length (L_{min}) for standard process connection is (see Table 6a):

$$L_{min} = 20\ mm + D_i / 2 + A + 60\ mm$$

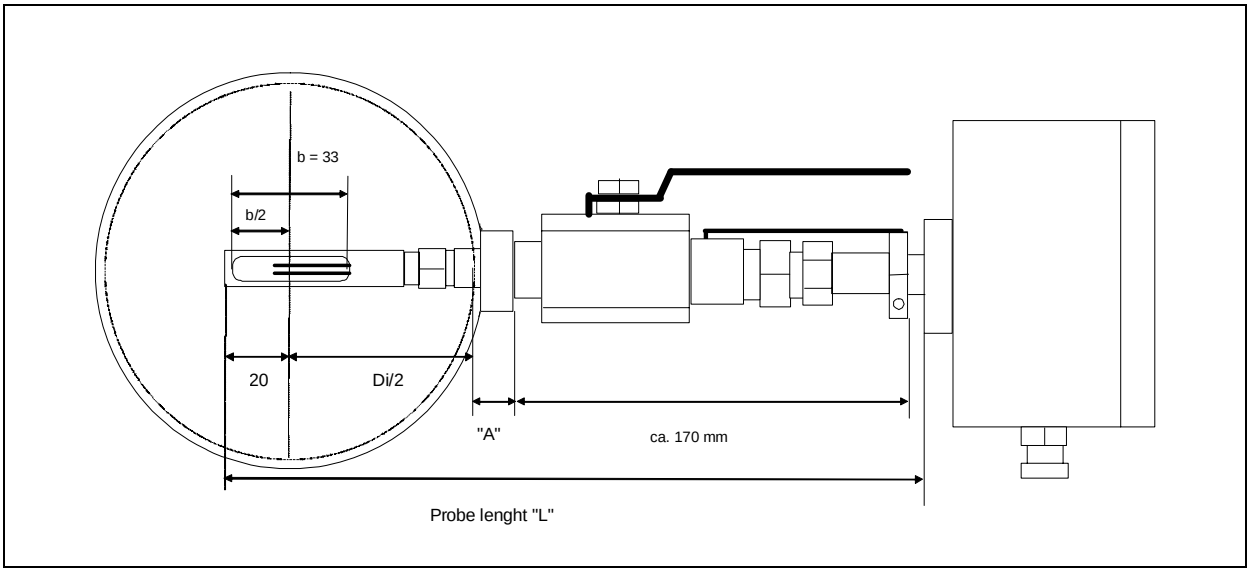


Table 6b) Correct position of flow window with probe unit with ball valve

Die minimum probe length (L_{min}) for Option K (BVR ½) is (see Table 6b):

$$L_{min} = 20\ mm + D_i / 2 + A + 170\ mm$$

The sensor probe can be pushed until the opposite pipe side and has to be dragged out again for the length of D_i /2 - 20 mm.

Example for optimized positioning of sensor window:

The pipe inside diameter (D_i) is 100 mm and the sensor probe is pushed to the opposite pipe side, then the probe has to dragged out again for the length of 30 mm (100/2 mm - 20 mm) to have a middle positioning of the sensor window.

2.3.1.4 Advice for demounting of the sensor:

The sensor probe has to be dragged out by opened clamping collar screwing and locking sleeve until behind the ball valve, before closing the exact one. As a general rule one can say, that only when the sensor probe window can be seen while dragging out, the ball valve can be closed. Do not ever use violence.

2.3.2 Mounting of In-Line Meters

The standard process connection for the In-Line Meters is either NPT - M thread or metric R and the thread size is depending on the pipe size of the flow body.

Note:
No elbow or reduction is allowed within the flow section area. (See chapter 2.2)

As an Option DIN-flanges are available.

The flow direction (example from left to right or right to left) on the flow body (see the arrow) must be the same as the flow direction of the gas (see table 7).

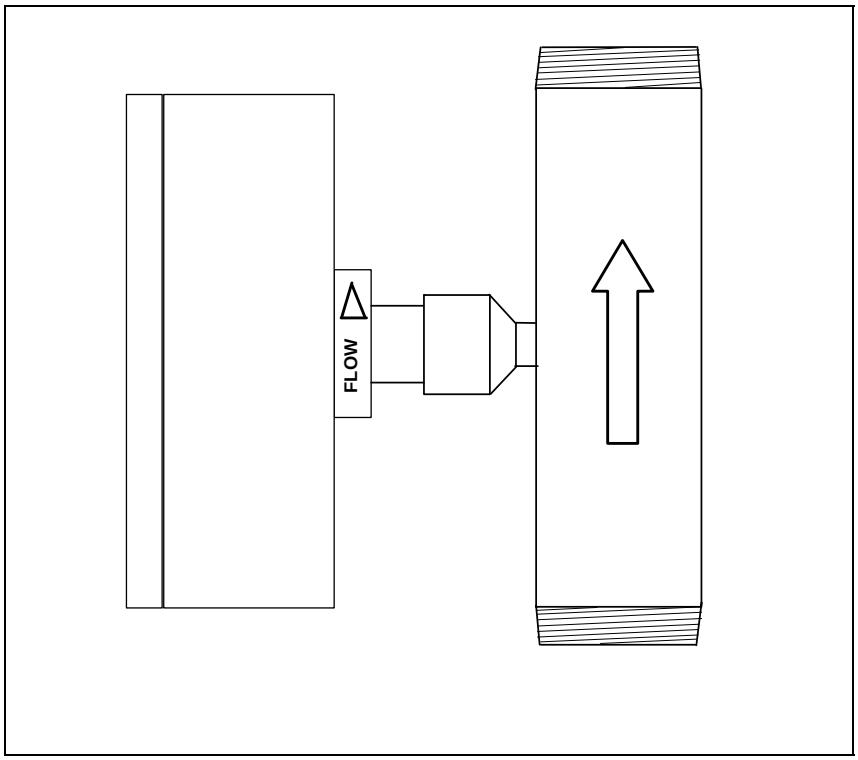


Table 7) In-Line Sensor with NPT-Thread

With the new In-Line sensor with “R” thread the inlet zone is marked through a 2/3 separation.

3. Electrical connection

Note:
Please keep the electronic dry and clean and install all wiring without power supply. Please take care, that the enclosure lit is always sealed and that the 8-pole plug with o-ring is attached tightly. All wiring has to be done with electricity shut off.

3.1 Power supply

The power supply for the transmitter electronic is 24 VDC with a maximum of 8 Watts and a current of maximum 250 mA. All electrical connection can be handled through the 8-pole plug connector. Please use only external wires with a min. of 0.35 mm² profile and max. of 0.75 mm²

The power supply (24 VDC) has to be separated from the analog output (0/4-20 mA), seeing that they are not separated galvanic outputs.

Connections plug arrangement and flex color (with delivery of LIYCY cable):

Plug 1: (-)	Power supply mass	(Color: white)
Plug 2: (+)	Pulse output	(Color: brown)
Plug 3: (-)	Analog Output (0/4..20 mA) mass	(Color: green)
Plug 4: (-)	Pulse Output mass	(Color: yellow)
Plug 5: (EXT)	external voltage for pulse output	(Color: grey)
Plug 6: (+)	Power supply (24VDC)	(Color: pink)
Plug 7: (+)	Analog Output (0/4..20 mA)	(Color: blue)
Plug 8: (-)	Power Supply Mass (same as # 1)	(Color: red)

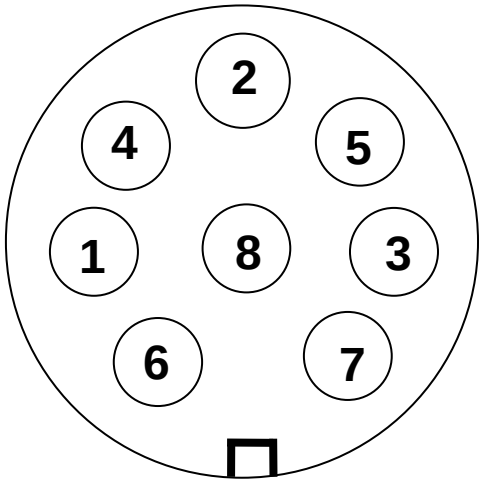


Table 8) Mating plug

The Power supply of 24 VDC has to be connected to the 8-pole mating plug, where the following allocation has to be considered:

Connection 1: (-)	Supply Voltage mass
Connection 6: (+)	Supply voltage (24VDC)
Connection 8: (-)	Supply Voltage mass

The mass is named twice (Connection 1 and 8) and can therefore be used parallel.

3.2 LCD Display

The 2 x 16 letter LC Display at the cover lit shows the flow value in the upper part (e.g. 1234 Nm³/h) related to standard conditions (N) according to ISO 1217 (or optional other) and the lowest line shows the total usage since initiation. The total usage meter can not be reseted. The flow units (Nm³/h, Nm³/min., Nl/min., Nl/sec., SCFH, SCFM, kg/min., kg/h or Nm/sec.) can only be changed with the optional software WIN-LC. The total usage meter has 12 digits and can show max. 999.999.999.999 Nm³.

3.3 Analog output

The analog outputs are on the 8-pole plug and have to be allocated like this:

Connection 3 (-)	Mass electricity output 0/4 to 20 mA (minus Pole) (Color: green)
Connection 7 (+)	Electricity Output 0/4 to 20 mA (plus Pole) (Color: blue)

The maximum burden of the resistivity shouldn't over exceed 500 Ohm. The analog outputs are not potential free, this means with same potential like the feeding voltage of 24 VDC, there has to be an external buffer amplifier between electronics and the signal processing.

The pre-settings are on 4..20 mA or 0..20 mA. A change of the analog output can be executed with the optional software WIN-LC.

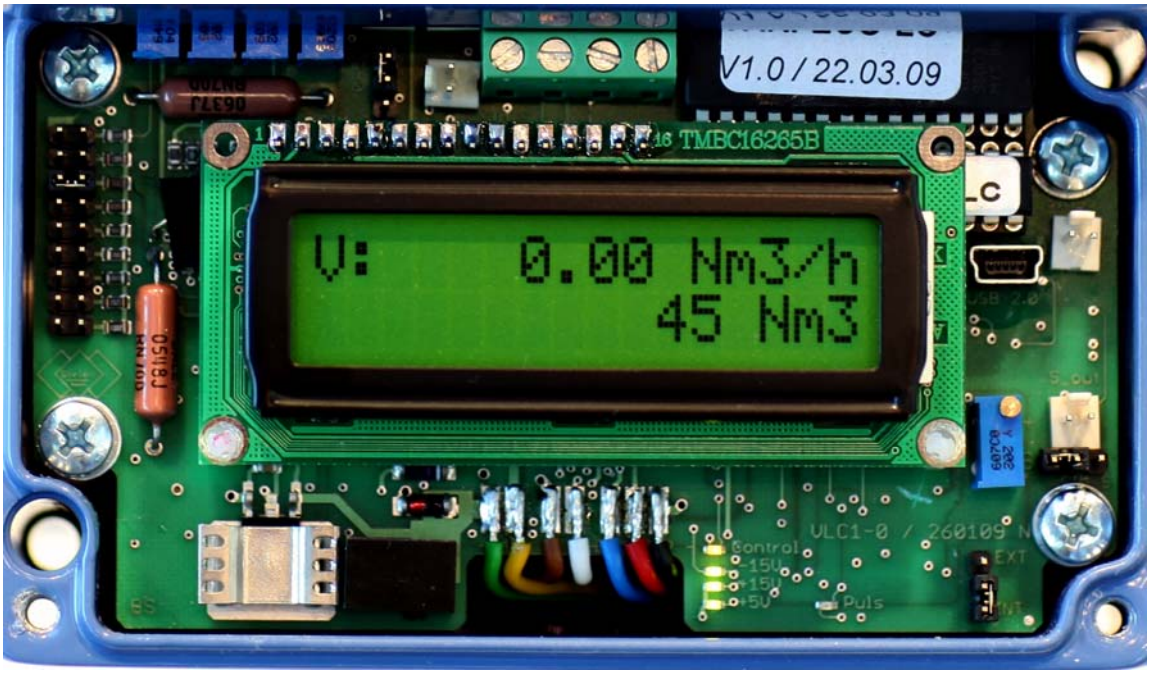


Table 9) VARIOMASS LC Electronic board with LCD Display

3.4 Puls output

The flow rate per pulse can be determined trough the software WIN-LC. It is recommended with low flow rates to set 1 m³ per ulse and with high flow rates (> 10.000 m³/h) to set the value on 10 m³/pulse or 100 m³/pulse. The maximum output is 5 pulses per second. Through hardware there is the possibility to choose between an internal (INT) and an external power supply. The internal power supply of 24 VDC can be chosen through the Jumper, by putting the Jumper on the lower position (see table 10), otherwise on the upper position (EXT). The Jumper is situated low right on the electronic board (see table 10).

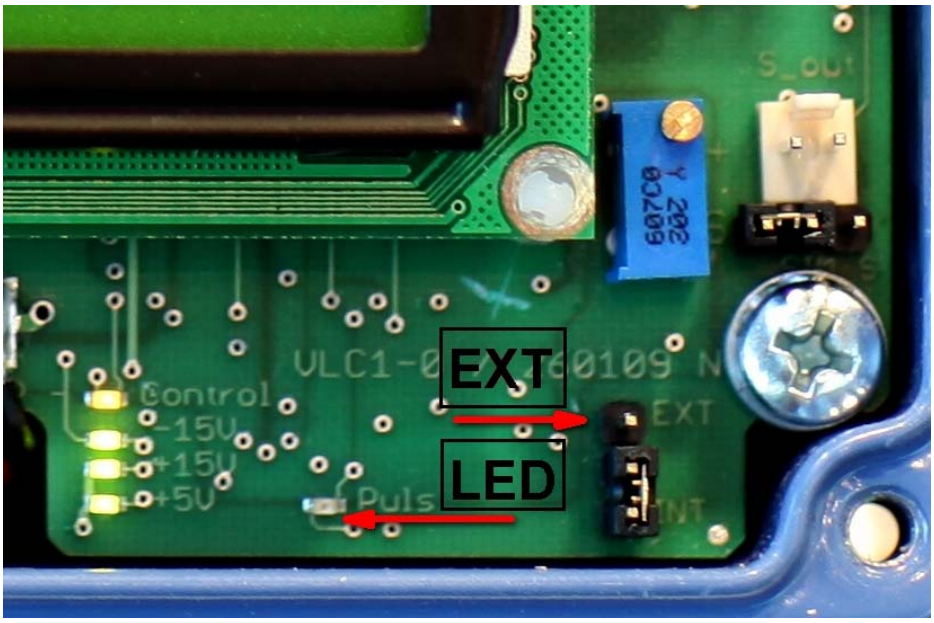


Table 10) Jumper in position for 24 VDC internal power supply

The pulse output can be gripped as follows:

Connection 2 (+)	Impulse output (+24 VDC) (Color: brown)
Connection 4 (-)	Impulse output mass (intern) (Color: yellow)
Connection 5 (Ext)	External power to be set (Color: grey)

The impulse output is a Darlington Optokoppler set for max. 35 VDC and 80 mA.
On the left side in Table 10 you find the yellow LED named Puls. This LED blinks when a puls signal is sending out via the puls output.

3.5. USB Interface (Option):

The serial interface (option V) of the VARIOMASS LC is here a USB interface and serves for communication purposes between the evaluation electronics and a PC with the software WIN-LC. Therefore the USB 2.0 cable has to be connected with the electronics and the PC. On the VARIOMASS LC board is a MINI USB-plug (right next to the display – see table 11).

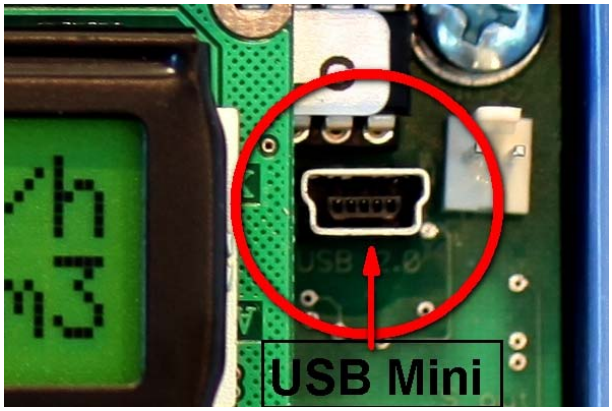


Table 11) USB interface on the VARIOMASS LC board

4. Starting

Before starting the following should be checked:

1) Check if the sensor probe is directed right.

2) Make sure that the Process connection is sealed.

3) Check if the wires are coherent with the wiring diagram.

4) Make sure that the power supply is 24 VDC and that the electric mating plug are connected to connection nr. 1 and / or nr. 8 and nr. 6.

After switching on the power supply, there will be a short test-run. After successfully completing the test-run, the following LED lights on the board should be blink or glow (see table 10):

- 3 green LEDs on the lower site of the board for the right power supply (intern + 5 VDC + 15 VDC and - 15 VDC)
- 1 yellow LED (CONTROL) on the lower sit of the board for process control (blinks approx. once per second)
- 1 further green LED on the right lower site for the pulse output that blinks when the preset consumption rate is reached.

To make the LEDs visible the case lit has to be removed first. For this you have to loosen 4 screws.

ATTENTION ! No changes to the Jumper or trimmers on the board can be made (except for the pulse output).

5. Debugging

Debugging and reparations are only allowed from qualified experts, with respective education.

Damages through unqualified use or handle exclude from warranty.

It is recommended to check the pipes, the evaluation electronics and the sensor elements regularly.

The pipes and electronics should be checked for signs of corrosion.

The sensorelements and the flowpipe should be checked for humidity.

The sensorelements should not show accumulated scalings or contamination and should, depending on contamination of the air flow, be cleaned regularly.

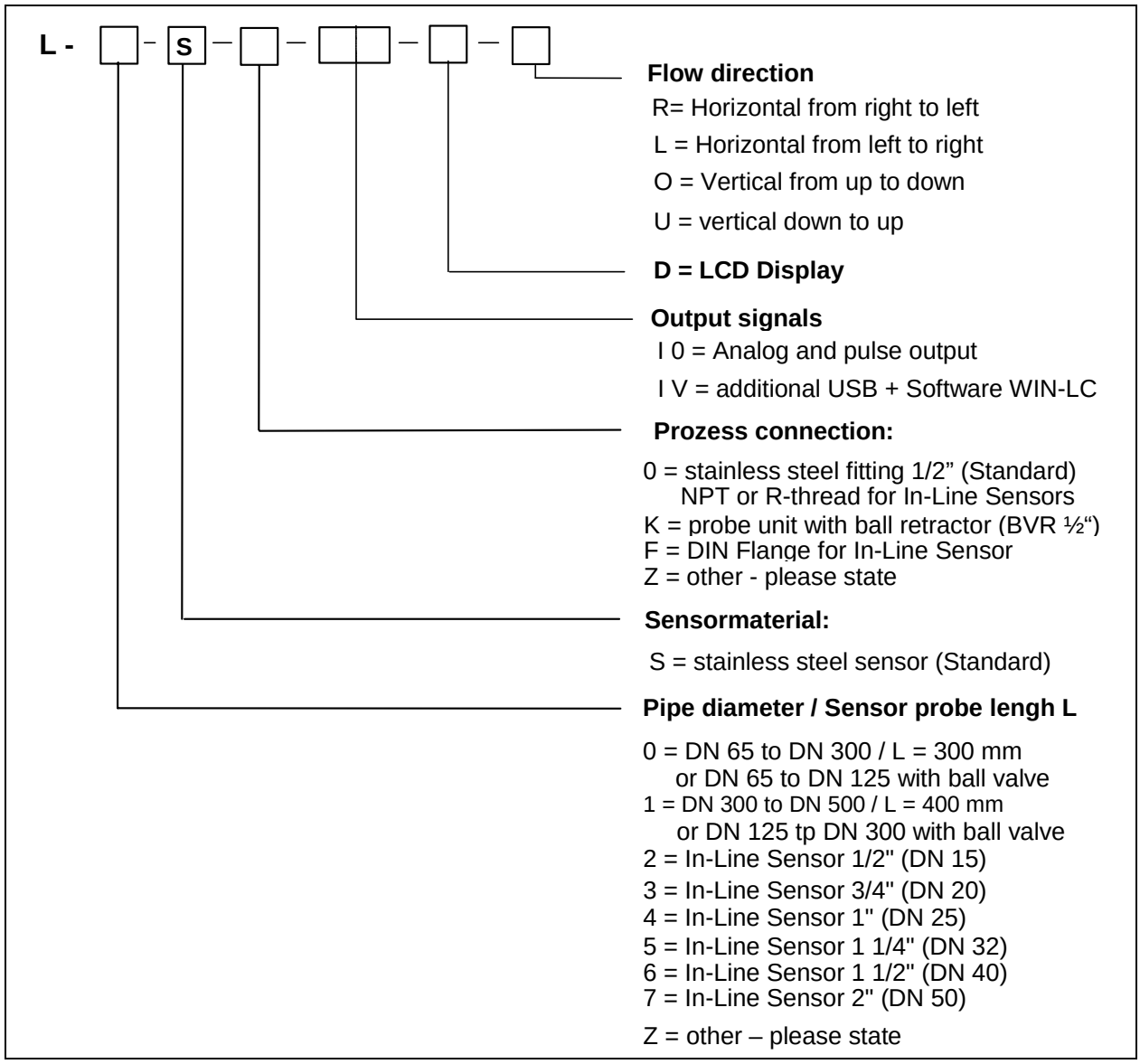
The analog output (4-20 mA) is zero, so make sure if the feeding voltage of 24 VDC is on the same potential as the signal processing. In this case an external buffer amplifier has to be used between electronics and the signal processing or the power supply has to be run by a separate stabilized power pack (230VAC / 24 VDC).

When experiencing problems with the software, switch evaluation electronics out and on again.

If one of the green LEDs for the power supply does not glow, the device has to be sent to repair.

By any questions with debugging please contact
DIELEN GmbH Tel.: +49 2834 7575-0 Fax: +49 2834 7575-10 e-mail: info@dielen-gmbh.de.

6. Model number:



We reserve the right for changes for all information made in this manual.