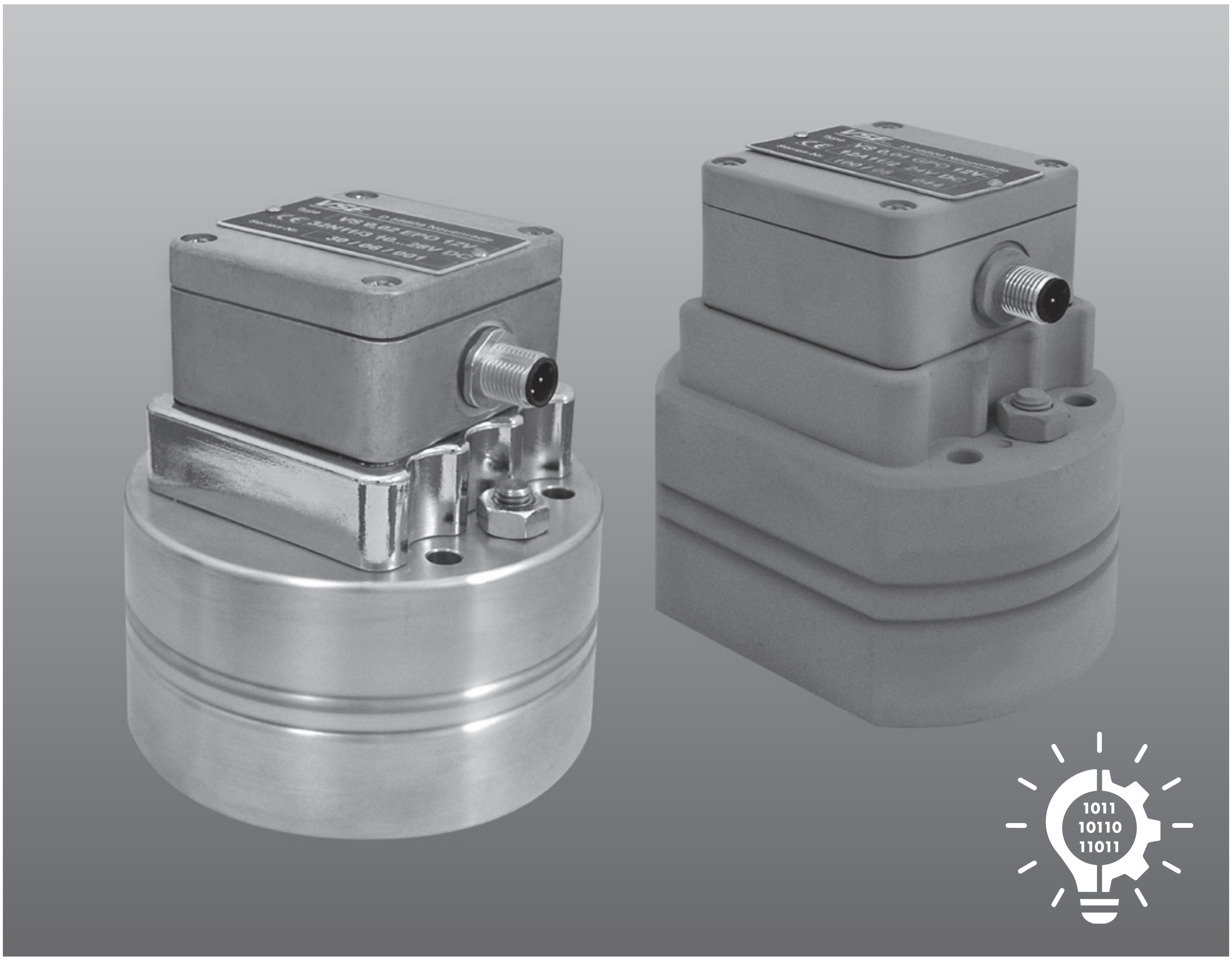
Solutions for Fluid Technology



OPERATING MANUAL

for flow meters of the product line "VSI+ High Definition Flow Meter"

TABLE OF CONTENTS

1. IMPORTANT INFORMATION AND LEGAL NOTICES

Dear customer, dear user,

This operating instruction for volume sensors of the **"VSI+ High Definition Flow Meter"** series by VSE Volumentechnik GmbH (VSE) contains information required to properly install and commission the flow meter for the intended purpose.

Any installation, commissioning, operation, maintenance and testing may only be carried out by trained and authorized personnel. The operating instructions must be read and followed carefully to ensure a trouble-free, proper and safe operation of the flow meter. In particular, the safety instructions are essential.

These operating instructions must be kept safe and accessible for the authorized personnel at all times. At no time should contents of the operating instructions be removed. A missing manual or missing pages must be replaced immediately if lost. The operating instructions can be requested at any time from VSE or downloaded from our website www.vse-flow.com. The operating instructions must be passed on to each subsequent user of the flow meter.

This operating instruction is not subject to any modification service by VSE. VSE reserves the right to make technical changes at any time without notice.

VSE makes no warranties, express or implied, with respect to commercial qualities and suitability for a particular purpose.

VSE accepts no liability for damage and malfunctions resulting from operating errors, failure to observe these operating instructions, improper installation, commissioning or maintenance as well as improper use of the flow meter.

The opening of the flow meter is absolutely not permitted. After an unauthorized opening or rebuilding as well as after a single, incorrect connection of the flow circuits of the flow meter, the warranty as well as the product liability by VSE expire.

2. GENERAL FUNCTION DESCRIPTION OF FLOW METER

Flow meters made by VSE Volumentechnik GmbH measure the volume flow of liquids according to the toothed wheel principle. A pair of very precisely adjusted toothed wheels in the housing constitutes the meter. A signal pick-up system registers meter rotation free of contact and tooth by tooth. In flow meters of high resolution (VSI), each tooth is output as a multiple of digital pulses, depending on interpolation setting.

The gaps within the teeth of the meter wheels, form meter chambers in the areas, in which they are completely enclosed by the housing walls; these chambers digitalise liquid flow depending on their chamber volume.

The liquid flow within one meter rotation of a tooth division is divided by the set interpolation factor. This gives the volume measurement per pulse (Vm) and is defined in cm3/pulse. It identifies the constructional size of a flow meter (e.g. VSI 1/16).

3. GENERAL DISCRIPTION

Please follow all instructions in this operating manual; only this ensures trouble-free operation of the flow meters. VSE is not liable for any damage ensuing from not following of these instructions.

Opening the devices during the term of warranty is only authorised after consultation and approval of VSE.

4. FLOW METER SELECTION

The correct selection (version) of type and constructional size is crucial for a trouble-free and safe operation of the flow meters. Owing to the great number of various applications and flow meter versions, the technical specifications in the VSE catalogue material are of a general nature. Performance of the flow meter depends on type, size and meter range and on the liquid that is to be measured. Please consult VSE for an exact description..

5. DECLARATION OF CONFORMITY

Flow meters of the "VSI" product line are tested for their electromagnetic compatibility and interference transmission in terms of the law on electromagnetic compatibility and correspond to the legal prescriptions enforced by EMC directives. They may not be operated independently and are to be connected via cable to a power source and supply digital electric signals for electronic evaluation. A declaration of conformity is submitted for all flow meters, which you can request if you require.

Since the electromagnetic compatibility of the total measuring system depends on cable layout, correct connection of protective shielding and each single connected device. You must ensure that all components correspond to the electromagnetic compatibility directives and that the electromagnetic compatibility of the total system, machine or plant is assured.

All flow meters are tested according to the valid, legally prescribed electromagnetic compatibility directives and possess the CE-certification. The EC-declaration of conformity is the CE-label attached to all flow meters.

6. GENERAL CONDITIONS FOR INITIAL START-UP

Before assembly and before initial start-up, you have to note the following properties and aspects of the corresponding characteristics of your system, so that a trouble-free and safe operation is possible.

1. The process fluid

- ➞ Is the flow meter **suitable for the medium**?
- ➞ Is the fluid **viscous or abrasive**?
- ➞ Is the fluid **contaminated** or is there **solid matter** in **the fluid**?
- ➞ Which **granular size** does the solid matter possess and can it block the meter?
- ➞ Does the fluid have **fillers** or other **additional material**?
- ➞ Is it necessary to install a pre-switched **hydraulic filter**?
- ➞ Are the **pipe lines clean** and free of assembly residues such as swarf, weld chips?
- ➞ Is the **tank clean** and is it ensured that **no extraneous materials** can get into the pipe line system from the tank?
- ➞ Is the fluid often changed and is **sufficient flushing performed in this case**?
- ➞ Are the pipe lines and the entire system completely **deaerated**?
- ➞ Are the fluid and the cleaning agent compatible with the **seals**?

2. The hydraulic properties of the system

- Is the **max. operating pressure of the system** lower than the max. permitted operating pressure of the flow meter?
- Is the **max. fall of pressure Δp** (on flow meter) below the max. permitted fall of pressure?
- Does an excessively **great fall in pressure Δp** occur on the flow meter at max. flow (e.g. with higher viscosity)?
- Does the flow range of the flow meter (depending on viscosity) correspond to the **provided flow**?
- Note that flow range decreases the **greater the viscosity**!
- Does the temperature range of the flow meter correspond to the **provided max. temperature** of the medium?
- Is the **cross section** of the pipe line large enough and are the falls in pressure in the system not excessive?
- Is the **hydraulic connection** (supply and reverse flow) correctly connected and leak-proof?
- Has the **pump** sufficient power to operate the system?
- A blocking flow meter can stop the whole flow. Is a **pressure control valve / bypass** provided in the system?

3. Electronic evaluation and electrical safety

- Have you selected the optimal flow meter and is this equipped with the **appropriate preamplifier**?
- Does the **power supply voltage** of the flow meter correspond to the provided voltage?
- Is the power supply voltage supplied by the mains or evaluation device sufficiently **steady**?
- Does the **output** of the power supply voltage correspond to the required power output?
- Has the electric connection been installed based on the enclosed **connection plan**?
- Is the cable protected by a shield?
- Is there a **connection** of the cable protective shielding via the round plug to the housing of the flow meter?
- Is the flow meter connected firmly to the **earth conductor PE** or is the cable protective shield connected to ground GND?
- Is the cable laid interference-free and is the installation secured from input of **interference pulses**?
- Is the **round plug** of the connection cable firmly screwed together with the plug of the flow meter?
- Are the wires on the **evaluation device** correctly and properly connected?
- Is there a **potential difference** between the earth conductor PE on the flow meter and the earth conductor PE on the evaluation device?
- Does a correcting lead have to be laid to eliminate the **potential difference** between the flow meter and the evaluation device?
- Does the entire system correspond to the directives of the electromagnetic compatibility laws (**EMC**)?
- Have all local valid regulations, **applicable directives**, guidelines and background conditions of the **electromagnetic compatibility laws** been maintained and observed?
- Systems that can lead to personal injury through malfunction or failure are to be equipped with the **appropriate safety devices**. The functioning of these safety devices is to be checked at regular intervals!

7. MAXIMUM OPERATING PRESSURE

Before assembling the flow meter, you have to test that the max. operating pressure of the system does not exceed the max. permitted opera-ting pressure of the flow meter. Meanwhile, observe the top pressures that can occur, when operating the system.

The following operating pressures are permitted depending on flow meter version:

- Flow meter in grey cast iron version p_{max} = 315 bar/4500 psi
- Flow meter in stainless steel version p_{max} = 450 bar/6500 psi
- Flow meter in special version p_{max} = 700 bar/10100 psi

Important:
Please consult VSE for all operating pressures > 450 bar / 6500 psi and for special versions.

8. INFORMATION ON EU DIRECTIVE 2014/68/EU ON PRESSURE EQUIPMENT

In terms of Article 2, No. 5 of the directive named above, VSE volume sensors are so-called "pressuremaintaining components" and this directive thereby relates to them. VSE volume sensors must thereby comply with the technical requirements named in Section 4 of the directive in accordance with Article 4, Paragraph (1d), Piping according to Paragraph (1c). Typically, the fluids measured fall into Group 2 in accordance with Article 13, Paragraph (1b). The volume sensors sold by VSE do not comply with the limit values defined under Article 4, Paragraph (1a). The technical requirements on volume sensors from VSE are therefore limited to the criteria defined in Article 4, Paragraph (3). That means that the devices must be designed and manufactured in accordance with the good engineering practices prevailing in the member state. We hereby confirm this. The paragraph also states that these units may not bear the CE label named in Article 18. A CE declaration of conformity is therefore not issued in accordance with 2014/68/EU. The CE label of our volume sensors refers to Directive 2014/30/EU.

9. FLOW METER RANGE

The flow meter range specified in the flow meter data sheet (Q_{min} – Q_{max}) refers to the testing fluid "hydraulic oil" with a viscosity of 21 mm²/s at a temperature of 20°C. For this flow meter range, VSE specifies measurement accuracy of up to 0.3 % of the measurement value and a repetition accuracy of 0.05 %.

For fluids of lower viscosity (< 21 mm²/s) measurement accuracy deteriorates, while for fluids of higher viscosity (> 21 mm²/s) it can improve. Also note, however, that the flow meter range is restricted in case of higher viscosity (see "Technical specifications").

Important:
Make sure that the specified maximum permitted operating pressure of the flow meter cannot be exceeded, whatever the operating mode of the system. Note the flow meter range that is dependent on the viscosity of the fluid to be measured.

10. ASSEMBLY OF THE FLOW METER

The flow meter should be mounted on an easily accessible location, so that dismantling for cleaning the meter presents no problem. Since flow meters can work in any installation position and flow direction, you can mount it on any location of your system. Take care, when installing the flow meter that liquid always remains in the flow meter, even at system standstill and that it can never run empty. The outflow of the flow meter should therefore always show a certain back pressure, since this clamps the flow meter firmly in the liquid column (the meter supports itself through this on the liquid column) and the pipe line cannot run empty. In critical cases or when the pipe line is at standstill or standby and can run empty, we recommend installing an extra non-return valve in the outflow line.

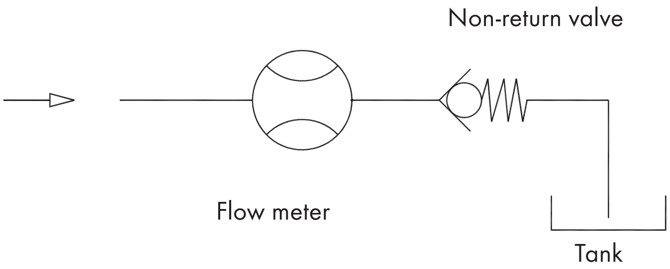


Fig. 1: Flow meter installation with non-return valve

Important:
Make sure that the flow meter is always completely filled both in inflow and outflow and that the outflow has a little back pressure. This prevents the meter being damaged by a sudden and steep increase of flow and at the same time improves measurement accuracy.

Flow meters of the "VSI" product line can be mounted directly onto a block or into the pipe line using four screws. Always select large cross sections for the hydraulic supply and return flow respectively for the entire pipe line system (if possible). This lowers the fall in pressure and the flow rate in the total system.

VSE supplies subplates for all flow meters of the "VSI" product line; they have various pipe threads and side or rearside connection. Depending on the provided conditions, the installed pipe line, the pipe cross section or pipe thread, the operator can choose the suitable sub-plate and incorporate this into the system or machine without additional reductions.

The flow meter is screwed onto the block or subplate with four DIN 912 cheese head screws. The screws are to be evenly pretensed crosswise with the following torques.

When changing the fastening screws you must take great care that the screws are of property class 10.9 and 12.9.

Table 1: Torque of fastening screws

Flow meter size (cast iron and 1.4305)	Torque
VSI 0.04; VSI 0.1; VSI 0.2	15 Nm
VSI 0.4; VSI 1; VSI 2	35 Nm

Please note the special instructions for mounting sizes VSI 4 and VSI 10 (see appendix)

Important:
When mounting the flow meter, you must take great care that the seals are not damaged and correctly placed in the hydraulic connections oft the flow meter. Wrongly installed or damaged seals lead to leakage and to a leaky system, which may have dire consequences. Please make sure that flow meters with EPDM seals do not come into contact with oil and greases on a mineral oil basis. These fluids can decompose the seals. The yellow plastic plugs in the hydraulic connections of the flow meter protect the meter against dirt and contamination during storage and shipping. Before mounting the flow meter you have to remove these plugs so that in- and outflow is free and open.

11. CLEANING AND FLUSHING OF PIPE LINES BEFORE INITIAL START-UP

Before initial start-up of the flow meter, you must flush and clean the whole system. Contaminated fluid can effect the correct function of the flow meter or seriously damage the meter.

After preparing and connecting up the system pipes, you must first carefully flush and clean the whole pipe line system and the tank. To do this, you have to mount a diversion plate onto the block or subplate instead of the flow meter, so that the fluid can flow through the diversion plate and all extraneous material (e.g. swarf, metal chips, etc.) can be flushed out without obstruction. Use a fluid as cleansing agent, which is compatible with the fluid being used later and which does not cause un-desirable reactions. You can consult the suppliers and manufacturers of the fluid or contact VSE for the corresponding information.

VSE supplies bypass plates for all VSI-flow meter sizes. Flow meters are measurement pick-up systems made with high-level precision. They have a mechanical meter consisting of two toothed wheels, which is adapted to the housing with narrow slots. Even the tiniest damage to the toothed wheels and bearings can cause a measurement error. So always make sure that no extraneous material gets into the meter and that the fluid flowing through is always free from dirt and contamination. After the system has been carefully flushed out and no extraneous material is in the pipe line, you can mount the flow meter and commence the initial start-up.

Important:
Please flush out the pipe lines and the tank thoroughly, to prevent contamination within the flow meter.

12. FILTERING OF LIQUID

Strongly contaminated fluids or extraneous material in the fluid can block, damage or even destroy the flow meter. Always install a sufficiently large filter for these cases in front of the flow meter to prevent damage to the flow meter. The necessary filtering depends on size, bearing system and model of flow meter.

Table 2: Pre-switched Filter

Flow meter size	Filter meter size for ball bearings
VSI 0.04 / 0.1	10 µm
VSI 0.2 / 0.4	20 µm
VSI 1 / 2	50 µm

For information on filter size for flow meters with plain bearings, in special version, or with specially adjusted meter tolerances, please consult ***VSE Volumentechnik GmbH****.*

Important:
A blocking flow meter can stop the whole flow. You have to provide a control valve / bypass for the system.

13. FLOW METERS WITH HIGH DEFINITION

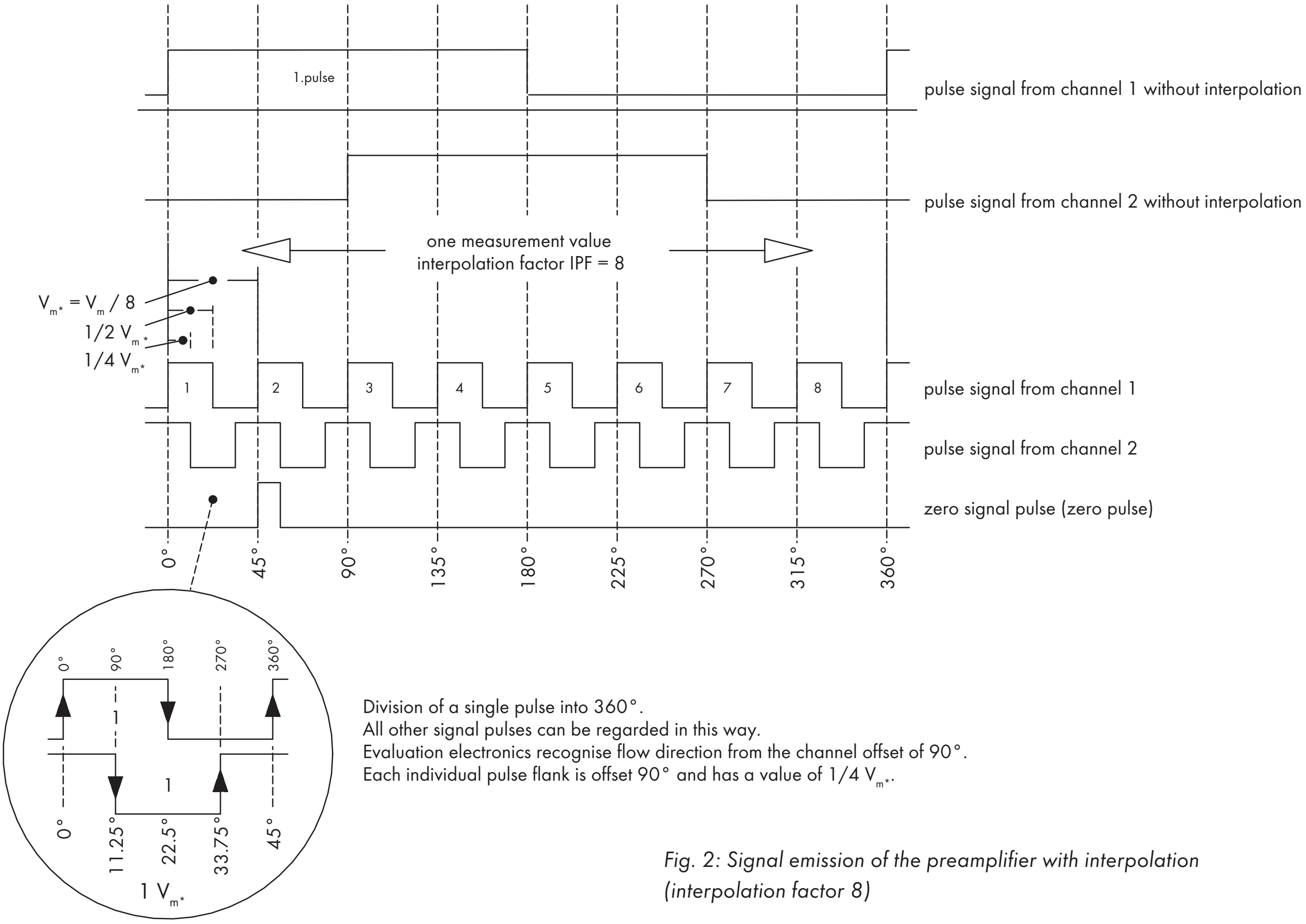
The measuring volume of the flow meter is determined by the mechanically displaced liquid volume within a tooth gap and the set interpolation. It is calculated from the size of the flowmeter and the set division factor or interpolation factor IPF. Vm = Vm*/ IPF (see Figure 2)

The IPF is selectable in different steps up to a maximum of 128, whereby the resolution is adapted to the specific application in order to achieve the most precise flow or volume measurements (see table 3).

The output of the two 90° phase-shifted pulse signals via two channels also enables an edge evaluation (see figure 3).

With this feature the following applications in particular can be realized:

- ➞ Measuring, controlling and regulating in the lower flow range
- ➞ Measuring controlling and regulating in zero flow
- ➞ Measuring, controlling and regulating in both flow directions
- ➞ Measuring, controlling, dosing and filling of small volume



Division of a single pulse into 360°.
All other signal pulses can be regarded in this way.
Evaluation electronics recognise flow direction from the channel offset of 90°.
Each individual pulse flank is offset 90° and has a value of 1/4 V_{m*}.

Fig. 2: Signal emission of the preamplifier with interpolation (interpolation factor 8)

Fig. 2 shows the resolution of the volume measurement Vm with an interpolation factor of 8. This resolves each volume measurement into eight individual part volumes. A pulse on the signal output of channel 1 or channel 2 thus has a value of $V_m{}^* = V_m / 8 = 1/8\ V_m$ per pulse. In double evaluation (flank evaluation of one channel) this results in a value of $1/2\ V_m{}^* = V_m / 16 = 1/16\ V_m$ and for quadruple evaluation (flank evaluation of both channels) the result is a value of $1/4\ V_m{}^* = V_m / 32 = 1/32\ V_m$ per flank.

Evaluation electronics can recognise flow direction from signals offset 90°. Hence you can program a resolution of 4 to 64 angular steps per volume measurement V_m(see fig. 3). The frequency multiplication “f*” lies between 1 and 16 (see table 3).

Table 3: Interpolation factor and resolution

Interpolation factor	Imp/V_m	Max. resolution (evaluation of signal flanks)	Resolution V_m* (volume measurement V_m*) [ml]	Max. resolution (angle degrees)	Frequency f_{max}*
1	1	4	V_m / 4	90°	f_{max} x 1
4	4	16	V_m /16	22,5°	f_{max} x 4
8	8	32	V_m /32	11,25°	f_{max} x 8
10	10	40	V_m /40	9°	f_{max} x 10
16	16	64	V_m /64	5,625°	f_{max} x 16
32	32	128	V_m /128	2,8125°	f_{max} x 32
64	64	256	V_m /256	1,40625°	f_{max} x 64
128	128	512	V_m /512	0,703125°	f_{max} x 128

Only the marked lines are illustrated in the diagram of fig. 3

Column 1: Selectable interpolation factor IPF.
Column 2: Pulses per volume measurement V_m.
Column 3: Maximum resolution of the signal flanks. The signal flanks of channels 1 and 2 are evaluated.
Column 4: Volume measurement V_m* resulting from the maximum resolution of the signal flanks.
Column 5: Maximum resolution in angle degrees at resolution of signal flanks.
Column 6: Maximum frequency f_{max}* at maximum flow Q_{max} and programmed interpolation factor IPF

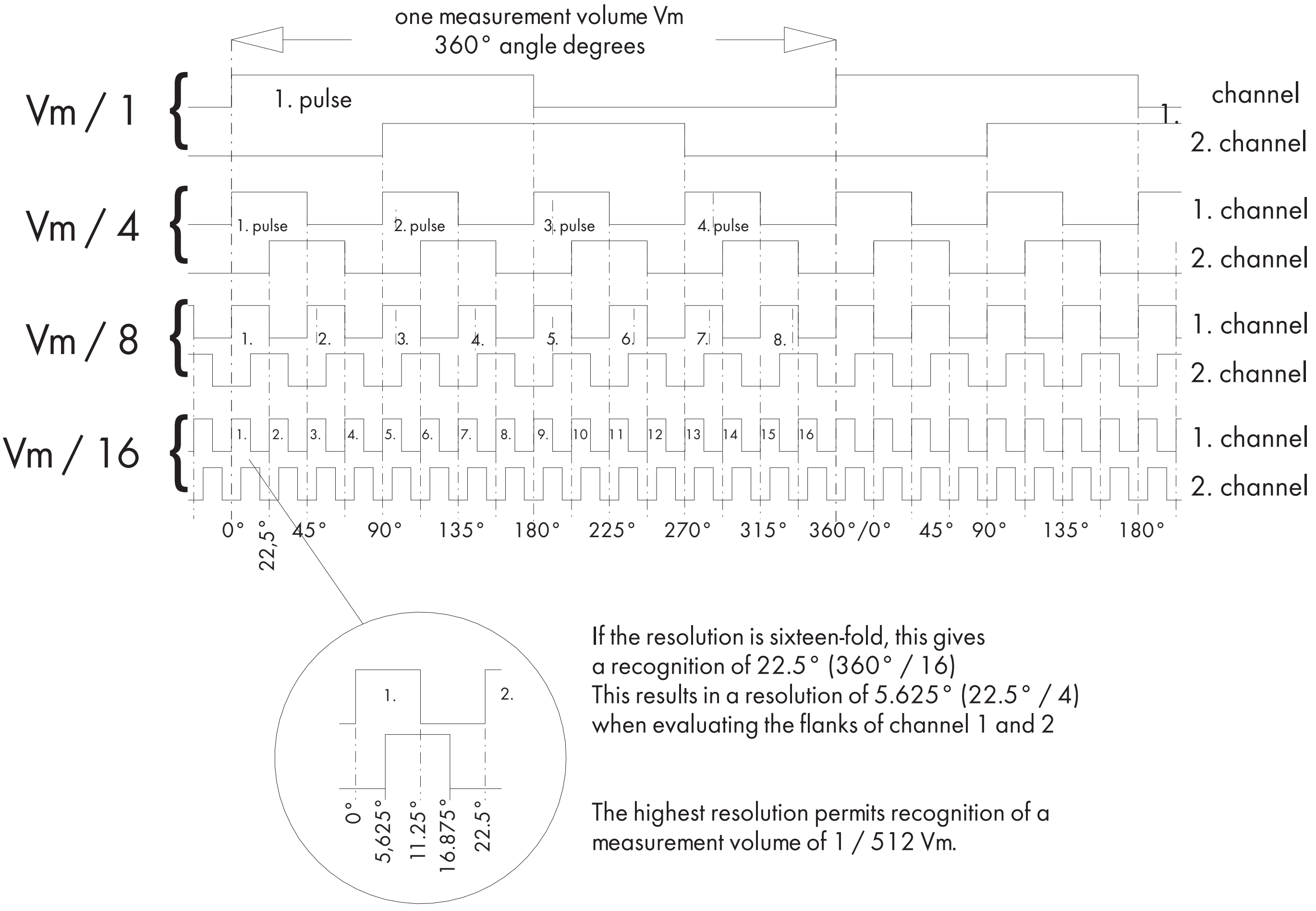
In practice, the maximum flow Q_{max} of the flow meter is seldom run, so that a lower frequency can be calculated. The maximum frequency is then calculated according to the following formula:

$$f_{max}\hat{} = \frac{(Q_{max}\hat{})\cdot IPF}{V_m} \qquad \textbf{Formula 1}$$

$f_{max}\hat{}$	Maximum frequency of the flow meter signals
$Q_{max}\hat{}$	Maximum flow attained in the case of application described here
IPF	Programmed interpolation factor
V_m	Volume measurement of the flow meter

Example: Flow meter VSI 1/10... max. flow the system can be run on at a maximum
$Q_{max}\hat{}$ = 40 l/min = 666.667 ml/sec; IPF = 10; V_m = 1 ml/pulse; $f_{max}\hat{}$ = 6666.67 Hz = 6.66667 kHz

At max. flow $Q_{max}\hat{}$ = 40 l/min, the flow meter VSI 1/10... outputs a frequency of $f_{max}\hat{}$ = 6666.67 Hz.



If the resolution is sixteen-fold, this gives
a recognition of 22.5° (360° / 16)
This results in a resolution of 5.625° (22.5° / 4)
when evaluating the flanks of channel 1 and 2

The highest resolution permits recognition of a
measurement volume of 1 / 512 Vm.

Fig. 3: Interpolation of the volume measurement V_m

At initial start-up of the system, you have to program the volume measurement V_m* or the correct K-factor (see table 4, column 4) in your evaluation electronics as parameter value (e.g. multiplier). The evaluation electronics then multiply every pulse the flow meter outputs by the volume measurement V_m* and thus calculates the flow and the volume. For flow meters with high resolution, the parameter value volume measurement V_m* is dependent on volume measurement Vm (see table 4, column 2) and on the programmed interpolation factor IPF (see table 4, column 3). Please consult this first of all for the volume measurement V_m* or the K-factor and program this value as parameter into your evaluation electronics.

The maximum flow rates with the corresponding frequencies are listed in columns 4 and 8 of table 4.

Important:
Test the connected evaluation electronic system as to whether it can process the maximum frequency f_{max}* of the flow meter. Check the data from the following table for the relevant flow meter, or calculate the maximum frequency data f_{max}° with formula 1.

Table 4: Volume measurement and max. frequency at high resolution

Flow meter	Vol. measurement V_m	Interpol. IPF*	Vol. measurement V_m* (ml/pulse)	K-Faktor* (Imp/l)	Q_{max}	f_{max}	f_{max}* (Hz)
VSI 0.04...	**0.04 ml/Imp**	1	0.04	25000	**4 l/min (= 4 000 ml/min = 66.67 ml/s)**	**1,666.7 Hz**	1666.7
		4	0.01	100000			6666.8
		8	0.005	200000			13333.6
		10	0.004	250000			16667
		16	0.0025	400000			26667.2
		32	0.00125	800000			53334.4
		64	0.000625	1600000			106668.8
		128	0.0003125	3200000			120000 (2.25l/min)*
VSI 0.1...	**0.1 ml/Imp**	1	0.1	10000	**10 l/min (= 10 000 ml/min = 166.67 ml/s)**	**1,666.7 Hz**	1666.7
		4	0.025	40000			6666.8
		8	0.0125	80000			13333.6
		10	0.01	100000			16667
		16	0.00625	160000			26667.2
		32	0.003125	320000			53334.4
		64	0.0015625	640000			106668.8
		128	0.00078125	1280000			120000 (5.625l/min)*
VSI 0.2...	**0.2 ml/Imp**	1	0.2	5000	**18 l/min (= 18 000 ml/min = 300 ml/s)**	**1,500 Hz**	1500
		4	0.05	20000			6000
		8	0.025	40000			12000
		10	0.02	50000			15000
		16	0.0125	80000			24000
		32	0.00625	160000			48000
		64	0.003125	320000			96000
		128	0.0015625	640000			120000 (11.25l/min)*
VSI 0.4...	**0.4 ml/Imp**	1	0.4	2500	**40 l/min (= 40 000 ml/min = 666.7 ml/s)**	**1,666.7 Hz**	1666.7
		4	0.1	10000			6666.8
		8	0.05	20000			13333.6
		10	0.04	25000			16667
		16	0.025	40000			26667.2
		32	0.0125	80000			53334.4
		64	0.00625	160000			106668.8
		128	0.003125	320000			120000 (22.5l/min)*
VSI 1...	**1 ml/Imp**	1	1	1000	**80 l/min (= 80 000 ml/min = 1 333.3 ml/s)**	**1.333,3 Hz**	1333.3
		4	0.25	4000			5333.2
		8	0.125	8000			10666.4
		10	0.1	10000			13333
		16	0.0625	16000			21332.8
		32	0.03125	32000			42665.6
		64	0.015625	64000			85331.2
		128	0.0078125	128000			120000 (56.25l/min)*
VSI 2...	**2 ml/Imp**	1	2	500	**150 l/min (= 150 000 ml/min = 2 500 ml/s)**	**1, 250 Hz**	1250
		4	0.5	2000			5000
		8	0.25	4000			10000
		10	0.2	5000			12500
		16	0.125	8000			20000
		32	0.0625	16000			40000
		64	0.03125	32000			80000
		128	0.015625	64000			120000 (112.5l/min)*

** The maximum output frequency is limited at 120,000 Hz.*

Table 4: Volume measurement and max. frequency at high resolution

V_m = physical volume measurement (size) of the flow meter (volume per tooth and per tooth gap)
Q_{max} = max. flow (test conditions)
f_{max} = max. frequency at Q_{max} $f_{max} = Q_{max} / V_m$
IPF* = programmable interpolation factor
* = all characters marked with * refer to IPF*
V_m* = interpolated volume measurement $V_m* = V_m$ / IPF* ; K-factor* = $1 / V_m*$
f_{max}* = max. interpolated frequency at Q_{max} $f_{max}* = Q_{max} / V_m*$

Example of flow meter "VSI 0.1/10 ..."

1. Column	Flow meter, version VSI and size 0.1	VSI 0.1...
2. Column	Physical volume measurement V_m (corresponds to the volume measurement Vm at interpolation factor IPF* = 1)	V_m = 0.1 ml/Imp
3. Column	Interpolation factor IPF* = hardware programmed	IPF* = 10
4. Column	Volume measurement V_m*	V_m* = 0.01 ml/Imp
5. Column	K-factor*; reciprocal value of volume measurement V_m*	K-factor* = 100,000 Imp/l
6. Column	Maximum flow Q_{max} of the flow meter	Q_{max} = 10 l/min
7. Column	Maximum frequency f_{max} at interpolation factor IPF = 1 (see column 2) (corresponds to the volume measurement V_m at interpolation factor IPF = 1)	f_{max} = 1,666.7 Hz
8. Column	Maximum frequency f_{max}* at programmed interpolation factor (see column 3)	f_{max}* = 16,666.7 Hz

14. SETTINGS OF THE PREAMPLIFIER

The settings are made with the DIP switches located in the lower right corner of the preamplifier housing (see Figure 4). With the-se the corresponding interpolation factor IPF (bit 1 to 3) can be selected, the direction inversion (bit 4) and the activation/deactiva-tion of the pulse filter (bit 5). A description of the settings is shown in figure 5. The settings can be modified at any time during operation.

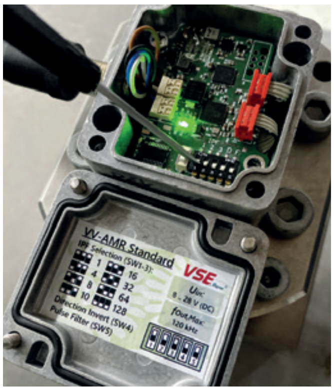


Fig. 4: Preamplifer electronics

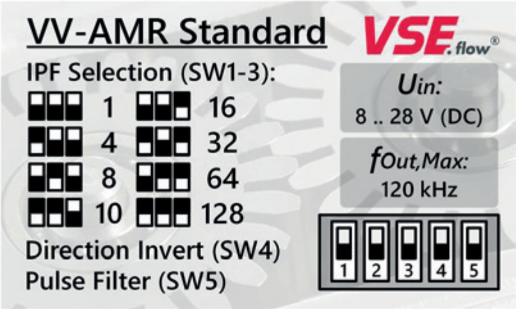


Fig. 5: Settings

The discription is also located in the lid of the preamplifier housing so that the settings can be changed directly on site.

Important:
Take ESD preventive measures to prevent electrostatic discharge while working on the preamplifier electronics.

15. PULSE FILTERING

Oscillations in fluid systems manifest themselves through constant forward and backward movements of the li-quid column, which is also detected by the pair of toothed wheels or meter and converted into proportional electronic pulses or edge sequences. Depending on the application, oscillations or vibrations can occur during the flow rest phases or discontinuous flows. The pulses generated during the oscialtion phase can be incorrectly interpreted by the downstream evaluating unit or controller, which can be very distracting for the respective operating process.

The signal filtering function of the internal electronics continuously offsets these generated edges during the rapid forward and backward movements of the meter measuring unit. The signals at the channel outputs are also suppressed at the same time until the internal offset is equalized or the initial position of the meter measuring unit has been reached again (see Fig. 6).

The filter memory contains a rotational movement over 8 teeth of the meter.

If this movement of 8 teeth is exceeded, the pulses are output in the corresponding direction, which is then automatically stored as preferred direction.

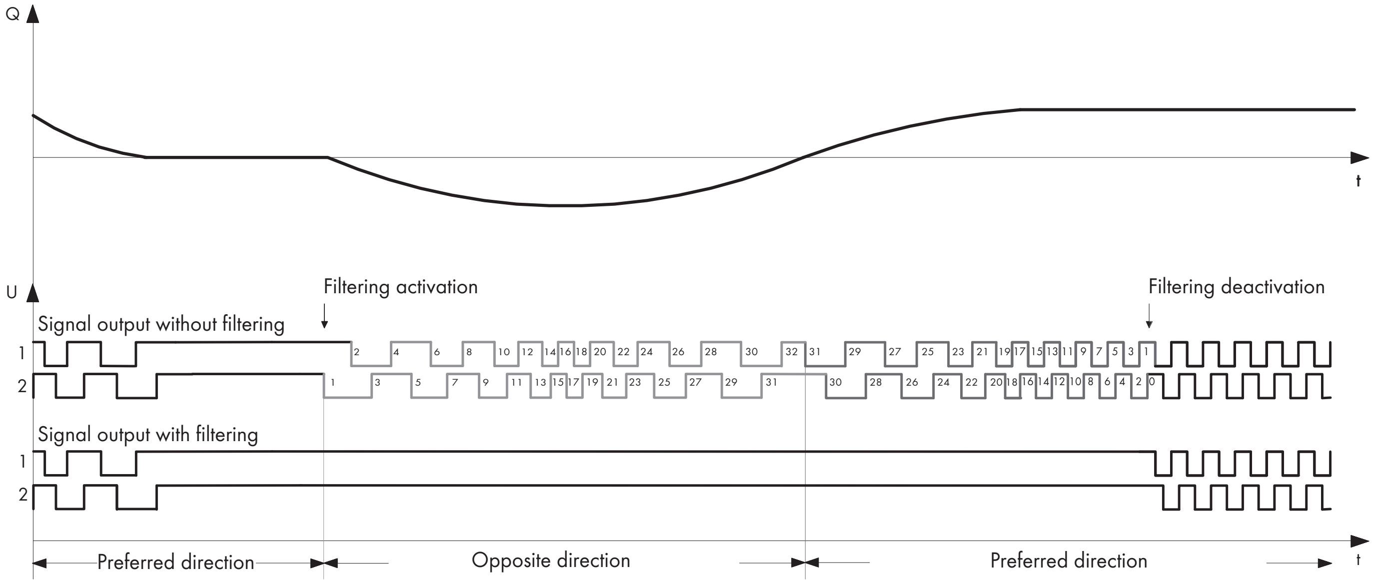


Fig. 6: Pulse filtering principle

16. INDICATING LEDS

The LEDs of the electronics give information about the corresponding states of the outputs and . This includes certain operating and error conditions (see table 6 and 7).

The LEDs provide information about the corresponding status of the outputs (high / low) and indicate operating and error conditions (see tables 6 and 7).

The two orange LEDs near to the wire connections indicate the states of the outputs, which can be used to check the activity flow / standstill. The green LED signals the general ON/OFF operating status and the red LED signals an error (see Figure 7).

Operating status	🟢	○	🟠	Operation ON /Output activ
	🟢	🔴 / 🔴	🟠	Signal error, Sensor error

Fig. 7: Indicating LEDs of the preamplifier board

17. TECHNICAL SPECIFICATIONS OF PREAMPLIFIER

Pickup sensor	2 x AMR-sensor (sine and cosine signals)
Configuration	automatically via peripheral board
Resolution	selectable 1, 4, 8, 10, 16, 32, 64, 128
Frequency	up to 120kHz
Signal outputs	Channel A, Channel B
Channel A and B	Two signal outputs for emitting the digital flow sensor signals; between channel A and channel B there is a channel offset of 90°
Flow direction	Recognition of flow direction from channel offset of the signals from channel A to channel B. On request also available with separate direction signal,direction can be changed by a switch of the preamplifier electronics
Outputs	3 current limiting and short-circuit-proof push-pull output stages (channel A, channel B); driver current approx. 200 mA at 24 V power supply; small saturation voltage up to 30 mA load current; short switching times; reverse voltage protection by integrated free-run diodes against V_b and GND; temperature protection switching with hysteresis; outputs are of high impedance in case of error; ESD protected
Error messages	Electronics error (e.g. defective interpolator); sensor error(e.g. sensor break-off); configuration necessary
Operating voltage	V_b= 8 . . . 28 VDC
Current comsumption	$I_{\text{no load}}$ = approx. 40 mA (@24V DC); total current consumption depending on loading of outputs

18. PLUG ASSIGNMENT OF PREAMPLIFIER

Fig. 8 shows the plug assignment of the preamplifier.

The pin assignment of the connector pins is compatible with all VS(I) preamplifier versions. The common 4 or 5-wired connection cables can still be used to connect the volume sensor.

Please note that the shielding of the cable on the connector side is connected to the metal housing of the connector.

The cable shielding should always be laid continuously as far as the flow meter and not interrupted in cross connectors or branch sockets. Lay the connection cable as directly as possible from the evaluating device to the flow meter, since interruptions are always a potential source of error.

In order to prevent interference either the shield should be connected to ground GND or to a protective earth conductor (PE). Alternatively the flow meter must be connected electrically to earth (PE). This is generally ensured with the grounded pipelines. This is normally secured by the earthed pipe lines.

If there are potential differences between the preamplifier housing and the earth conductor PE of the evaluating electronics, you have to lay a correcting earth.

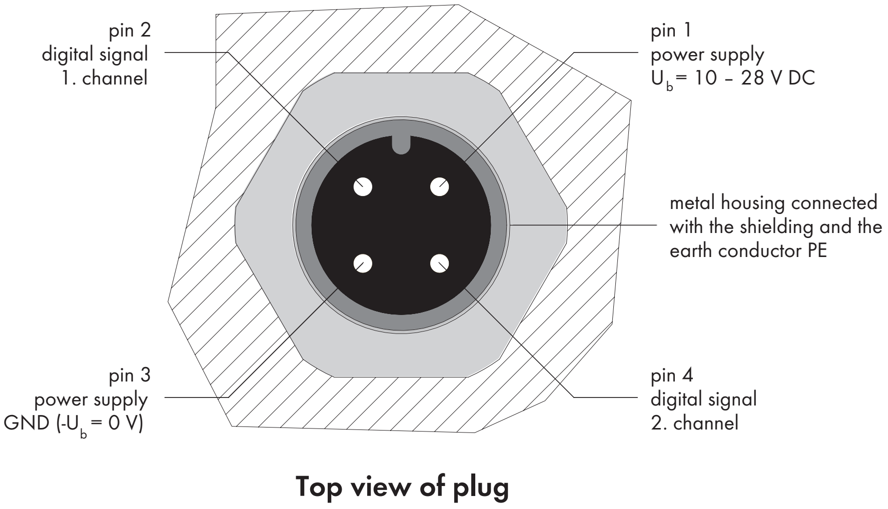


Fig. 8: Flange plug installed in the preamplifier housing of the flow meter

Important:
Only use well-shielded cables for the connection cable, with a wire cross section of ≥ 4 x 0.25 mm^2.
Please make sure that the housing of the round plug is metallic and that it has a connection to the shielding.

Important:
Please make sure that no extra inductive elements are connected in the power supply of the flow meter, such as contactors, relays, valves etc. These components are potential sources of interference which generate high interference pulses, when switched and can interfere with the functioning of the flow meter, although this complies with the electromagnetic compatibility directives (especially if the inductive elements are not provided with an adequate protective circuit).

19. MAINTENANCE

Working life is dependent on operating conditions and thus the specific properties of the devices, limited through wear, corrosion, deposits or age. The operator is responsible for regular control, maintenance and recalibration. Any indication of a malfunction or damage prohibits any further use.
On request, we can supply you with a borrowed device for the duration of repair or overhauling.
We advice to a yearly control and recalibration.

20. SENDING BACK OF REPAIRS AND SAMPLE DEVICES

It is imperative that you enclose an exact description of the complaint, objection or fault, when returning the device so as to ensure a rapid and economic repair of the flow meters and other components. Furthermore, you must include a security sheet, which informs unambiguously, which fluid was run with the flow meter and how dangerous this fluid is. The maintenance of legal regulations as regards work safety, such as workplace regulations, accident prevention regulations, and stipulations on environmental protection, waste disposal and the water management law, obliges industrial corporations to protect their employees and other persons and environment against harmful effects, when handling hazardous materials. If further safety precautions are still necessary despite careful emptying and cleaning of the flow meter, information on this is imperative and must be included with the returned despatch.

When returning flow meters to VSE Volumentechnik GmbH, please note that inspection and repair will only be performed if the safety specifications sheet of the utilised fluid is enclosed and the flow meters completely cleaned and flushed. This protects our employees and simplifies our work.

If this is not observed, the despatch will be returned, chargeable to the recipient.

21. TECHNICAL SPECIFICATIONS VSI 0.04 / IPF – VSI 2 / IPF

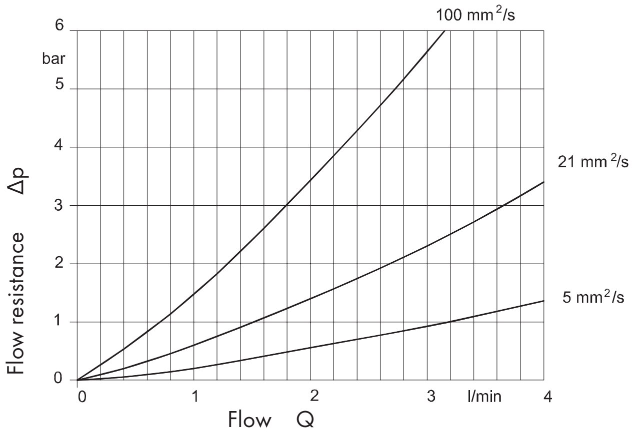
Size	Measuring range l/min	Frequency Hz	Pulse value cm^3/pulse	K-factor Imp/liter
VSI 0.04	0.004 ... 4	1.667 * IPF ... 1,666.67 * IPF	0.04 / IPF	25,000 * IPF
VSI 0.1	0.01 ... 10	1.667 * IPF ... 1,666.67 * IPF	0.1 / IPF	10,000 * IPF
VSI 0.2	0.02 ... 18	1.667 * IPF ... 1,500.00 * IPF	0.2 / IPF	5,000 * IPF
VSI 0.4	0.03 ... 40	1.250 * IPF ... 1,666.67 * IPF	0.4 / IPF	2,500 * IPF
VSI 1	0.05 ... 80	0.833 * IPF ... 1,333.33 * IPF	1 / IPF	1,000 * IPF
VSI 2	0.1 ... 120	0.833 * IPF ... 1,000.00 * IPF	2 / IPF	500 * IPF

Adjustable interpolation factors IPF: 1; 4; 8; 10; 16; 32; 64; 128

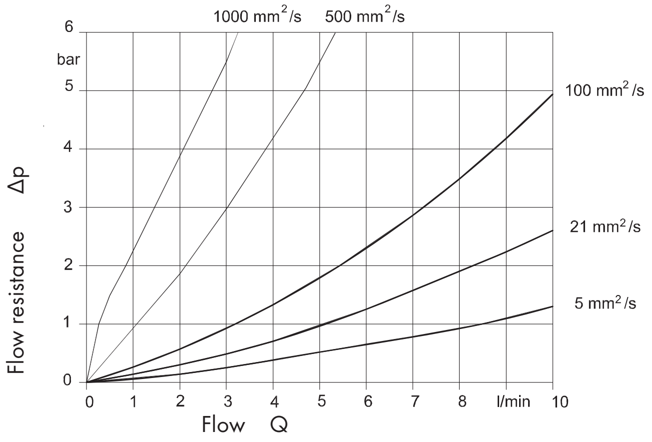
Measurement accuracy	up to 0.3 % of measurement value (with viscosity > 20 mm^2/s)
Repetition accuracy	± 0.05 % under the same operating conditions
Material	Cast iron EN-GJS-400-15 (EN 1563) or Stainless steel 1.4305
Meter bearing	Ball bearings or steel plain bearings (medium-dependent)
Seals	FPM (standard), NBR, PTFE, EPDM, silicon, FVMQ
Max. operating pressure	Cast iron EN-GJS-400-15 (EN 1563) 315 bar / 4500psi Stainless steel 1.4305 450 bar / 6500 psi
Medium temperature	–40°C ... + 120°C (–40°F ... 248°F)
Ambient temperature	–20°C ... + 50°C (–4°F ... 122°F)
Viscosity range	1 ... 100,000 mm^2/s
Installation position	any
Flow direction	any
Running noise	max. 72 db(A)
Power supply voltage	8 up to 28 volts/DC
Pulse output	2 current limiting and short-circuit-proof output stages low signal: 0 = GND; high signal: 1 = U_b -1
Channel offset	90° ± 5° max.
Pulse-width repetition rate	1/1 ± 5% max.
Preamplifier housing	Aluminium
Protection type	IP 65

22. FLOW RESPONSE CURVES VSI 0.04 – VSI 2

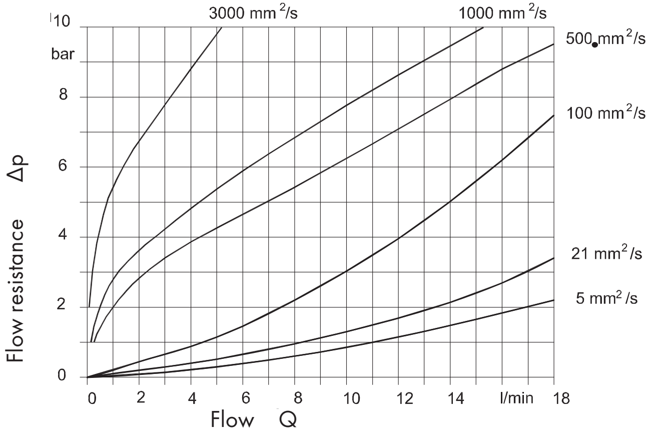
VSI 0.04



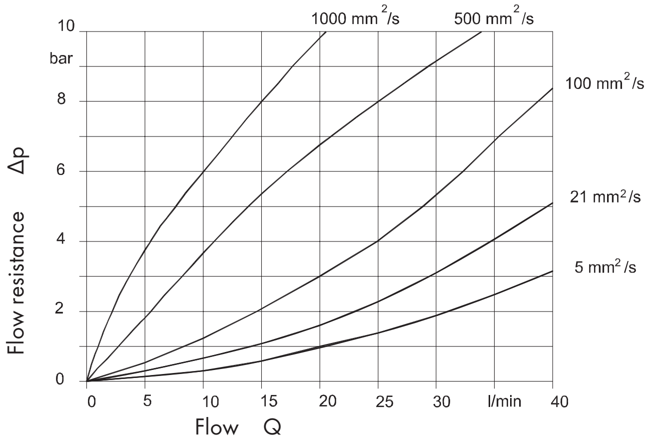
VSI 0.1



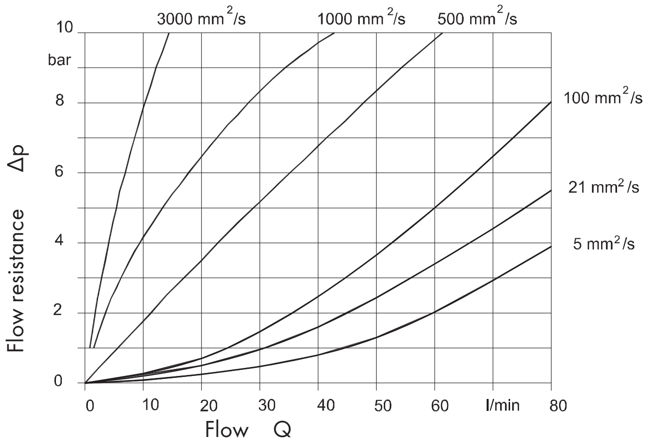
VSI 0.2



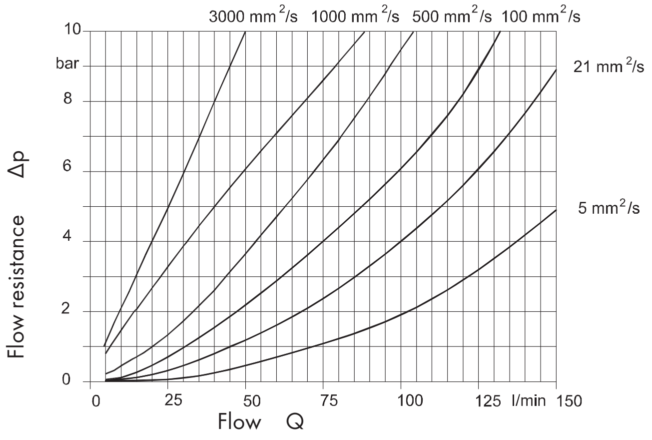
VSI 0.4



VSI 1

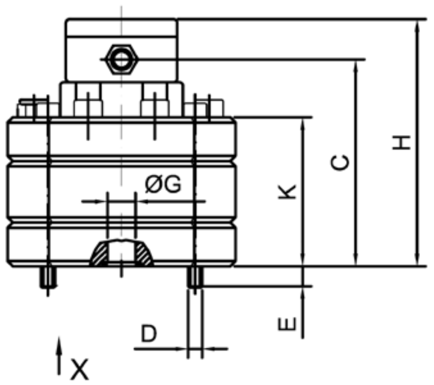


VSI 2



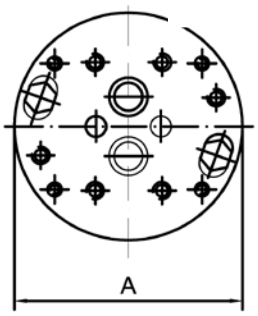
23. DIMENSIONS VSI 0.04 – VSI 2

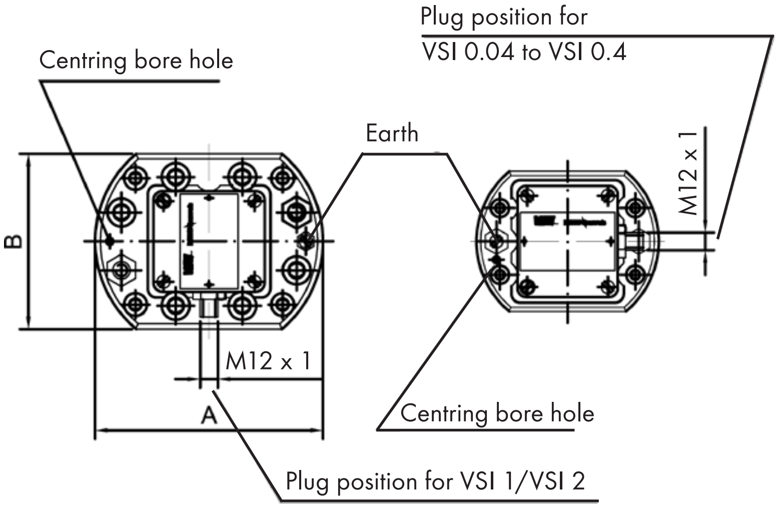
Cast iron version



View X

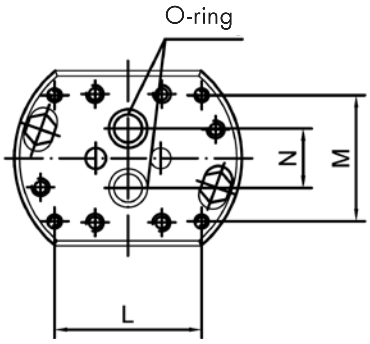
Stainless steel version
Connection diagram
Housing without milled edge





View X

Cast iron version
Connection diagram

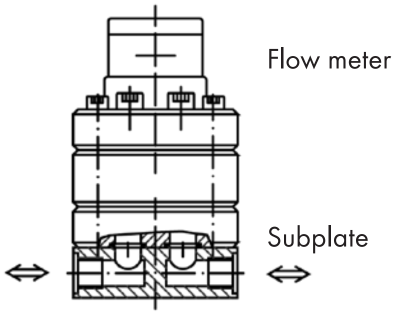


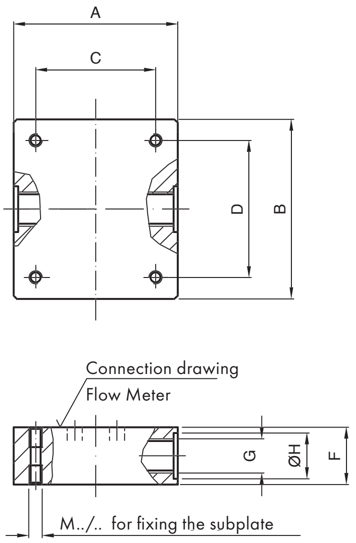
Size VSI	A	B	C	D	E	øG	H	K	L	M	N	O-ring	Weight GG kg	E kg
0.04	100	80	83	M6	11.5	9	106.5	59	70	40	20	11 x 2	2.8	3.4
0.1	100	80	85	M6	9	9	108.5	61	70	40	20	11 x 2	2.8	3.4
0.2	100	80	85	M6	9.5	9	108.5	61	70	40	20	11 x 2	3.0	3.7
0.4	115	90	87.5	M8	11.5	16	111.5	63.5	80	38	34	17.96 x 2.62	4.0	5.0
1	130	100	92	M8	12.5	16	115.5	68	84	72	34	17.96 x 2.62	5.3	6.8
2	130	100	109	M8	15	16	132.5	85	84	72	34	17.96 x 2.62	6.7	8.4

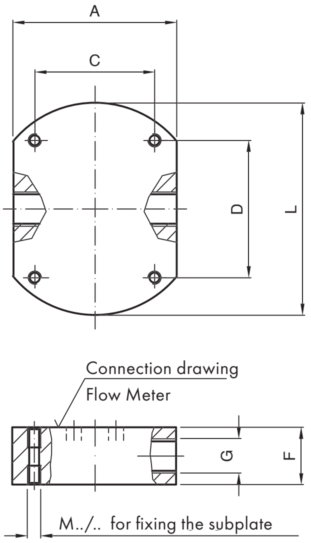
Dimensions in mm

24. DIMENSIONS SUPPLATES AP.0.2 – 1

Connection position, side



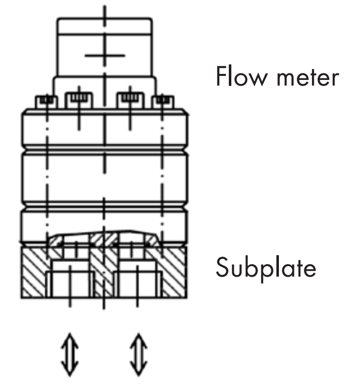


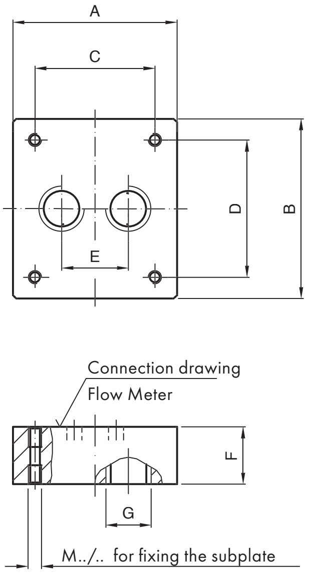


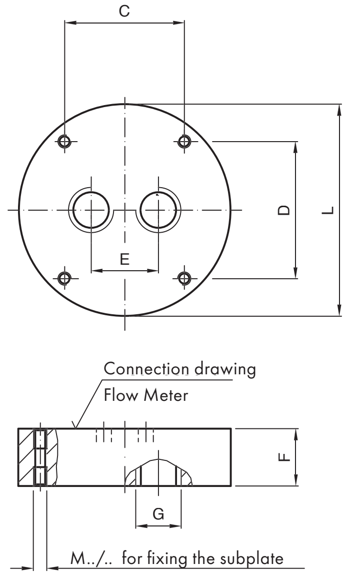
Size VSI	Connection thread G	F	øH	A	B	C	D	E	L	Thread / depth M	Weight kg
0.04	G 1/4"	35	20	80	90	40	70	26	100	M6/12	1.8
0.1	G 3/8"		23					30			
0.2	G 1/2"		28					38			
0.4	G 1/2"	35	28	90	100	38	80	46	115	M8/15	2.7
	G 3/4"	40	33					52			
1 **2**	G 1/2"	35	28	100	110	72	84	46	130	M8/15	3.6
	G 3/4"	40	33					52			
	G 1"	55	41					55			

only for AP . 4 U...

Connection position below







25. TYPE KEY

Example

VSI 0,2	/	.	.	.	.	G	P	O	1	2	V	-	4	2	R	1	1	/	X

Series

X	Change code, factory definition

Connection

1	4 pin M12-connector
5	5 pin. M12-connector

Preamplifier

1	integrated

Signal output

R	8...28V DC (VV - AMR standard)

No. of pick-up

2	2 pick-ups

Pick-up system

4	AMR - sensor

Type of seal

V	FPM (Viton) standard
P	NBR (Perbunan)
T	PTFE (Teflon)
E	EPDM
B	EPDM-41B8
S	silicon
Q	FVMQ

Instrument toleranz (factory-set to the application)

1	reduced tolerances
2	normal tolerances (standard)
3	increased tolerances
4	tolerance steel-sleeve bearing
5	increased tolerance steel-sleeve bearing

Instruments bearing (factory-set to the application)

1	ball bearing
2	spindle bearing
3	bronze sleeve bearing
5	steel sleeve bearing
6	hard metal sleeve bearing
7	angular ball bearing
9	sleeve bearing plasma nitrided

Gear surface coating

O	without surface coating (standard)
C	dynamant- surface coating (C-surface coating)

Type of connection

P	Subplate
R	pipe connection

Material

G	EN GJS-400-15 (GGG40)
E	stainless steel 1.4301 / 1.4305 (V2A)
X	stainless steel 1.4404 / 1.4571 (V4A)
A	aluminium
H	EN GJS-600-3 (GGG60) (high-pressure)

Interpolation (not applicable for VS series)

*	n impulses per tooth gap volume	$V_m = V_z / n$
	example: VS 0.2 imp. 16	$V_m = 0.2cm^3 / 16 = 0.0125cm^3$

Size

VSI 0.04	tooth gap volumeVz = 0.04ml
VSI 0.1	tooth gap volumeVz = 0.1ml
VSI 0.2	tooth gap volumeVz = 0.2ml
VSI 0.4	tooth gap volumeVz = 0.4ml
VSI 1	tooth gap volumeVz = 1ml
VSI 2	tooth gap volumeVz = 2ml

Vm = measuring volume
Vz = tooth gap volume

Subplates AP ...

Example

AP G1 S C 0 N /1

Product line (Modification id. no.)

Version

N	Standard version
S	Special version

Accessory connection

0	without rinse connection

Connection thread

A	G 1/4	**J**	1/4 NPT	**S**	SAE 1/2
B	G 3/8	**K**	3/8 NPT	**T**	SAE 3/4
C	G 1/2	**L**	1/2 NPT	**U**	SAE 1
D	G 3/4	**M**	3/4 NPT	**V**	SAE 1 1/4
E	G1	**N**	1 NPT	**W**	SAE 1 1/2
F	G1 1/4	**O**	1 1/4 NPT	**X**	SAE 2
G	G1 1/2	**P**	1 1/2 NPT		

Connection position side

S	Connection position side
U	Connection below

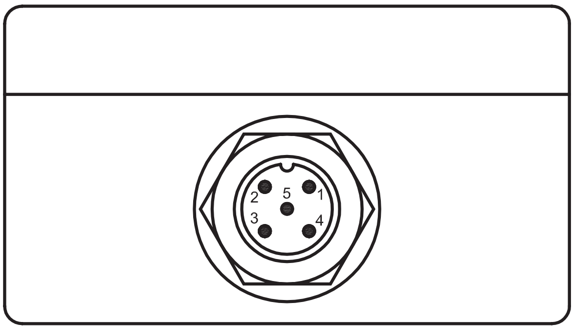
Size

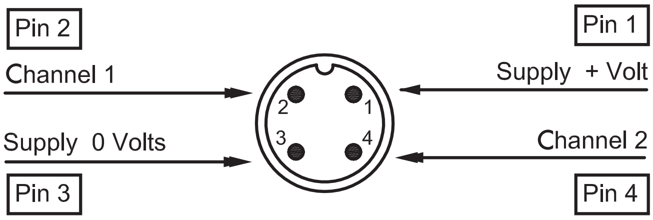
0.2	VSI 0.04 VSI 0.1 VSI 0.2
0.4	VSI 0.4
1	VSI 1 VSI 2

Material

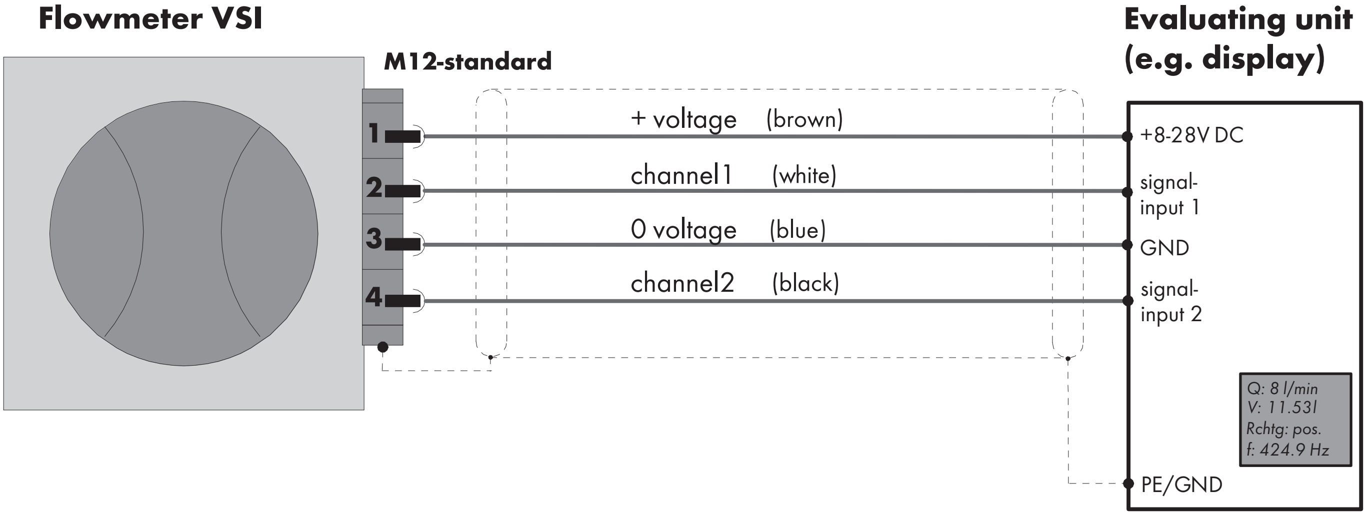
G	EN-GJL-250, EN-GJS-400-15 (DIN EN 1561/1563)
E	Stainless steel 1.4305

26. PLUG ASSIGNMENT





27. CONNECTION DIAGRAM



NOTES

VSE Volumentechnik GmbH
Hönnestraße 49
58809 Neuenrade / Germany

Phone +49 (0) 23 94 / 6 16-30
Fax +49 (0) 23 94 / 6 16-33
info@vse-flow.com
www.vse-flow.com

e.holding
FLUID TECHNOLOGY GROUP
www.e-holding.de

E04-07-69-002 11/20 www.plakart.de