Instruction and Operation Manual

S418-V

Compact Thermal Mass Flow Meter for Vacuum Application (Pro-Inline)

.SUTO

Dear Customer,

Thank you for choosing our product.

Before you start up the device please read this manual in full and carefully observe instructions stated in this manual. The manufacturer cannot be held liable for any damage which occurs as a result of non-observance or non-compliance with this manual.

Should the device be tampered with in any manner other than a procedure which is described and specified in the manual, the warranty is void and the manufacturer is exempt from liability.
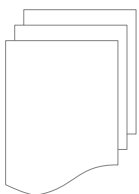
The device is designed exclusively for the described application.

SUTO offers no guarantee for the suitability for any other purpose. SUTO is also not liable for consequential damage resulting from the delivery, capability or use of this device.

Table of Contents

1 Safety instructions

Please check if this instruction manual matches with the product type.

Please observe all notes and instructions indicated in this manual. It contains essential information which must be observed before and during installation, operation and maintenance. Therefore this instruction manual must be read carefully by the technician as well as by the responsible user / qualified personnel.

This instruction manual must be available at the operation site of the flow sensor at any time. In case of any obscurities or questions, regarding this manual or the product, please contact the manufacturer.

WARNING!

Compressed air!

Any contact with quickly escaping air or bursting parts of the compressed air system can lead to serious injuries or even death!

- Do not exceed the maximum permitted pressure range (see sensors label).

- Only use pressure tight installation material.

- Avoid that persons get hit by escaping air or bursting parts of the instrument.

- The system must be pressureless during maintenance work.

WARNING!

Voltage used for supply!

Any contact with energized parts of the product, may lead to an electrical shock which can lead to serious injuries or even death!

- Consider all regulations for electrical installations.

- The system must be disconnected from any power supply during maintenance.

- Any electrical work on system is only allowed by authorized qualified personal.

> **ATTENTION!**
>
> **Permitted operating parameters!**
>
> **Observe the permitted operating parameters, any operation exceeding this parameters can lead to malfunctions and may lead to damage on the instrument or the system.**

- Do not exceed the permitted operating parameters.

- Make sure the product is operated in its permitted limitations.

- Do not exceed or undercut the permitted storage and operation temperature and pressure.

- The product should be maintained and calibrated frequently, at least annually.

General safety instructions

- It is not allowed to use the product in explosive areas.

- Please observe the national regulations before/during installation and operation.

Remarks

- It is not allowed to disassemble the product.

> **ATTENTION!**
>
> **Measurement values can be affected by malfunction!**
>
> **The product must be installed properly and frequently maintained, otherwise it may lead to wrong measurement values, which can lead to wrong results.**

- Always observe the direction of the flow when installing the sensor. The direction is indicated on the housing.

- Do not exceed the maximum operation temperature at the sensors tip.

- Avoid condensation on the sensor element as this will affect accuracy enormously.

Storage and transportation

- Make sure that the transportation temperature is between -30 ... +70°C.

- For storage and transportation it is recommended to use the packaging which comes with the sensor.

- Please make sure that storage temperature of the sensor is between -10 ... +50°C.

- Avoid direct UV and solar radiation during storage.

- For the storage the humidity must be <90%, no condensation.

2 Registered trademarks

Trademark	Trademark owner
SUTO®	SUTO iTEC
MODBUS®	Modbus Organization, Hopkinton, USA
Android™, Google Play	Google LLC

3 RF exposure information and statement

This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body.

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help

- This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter.

4 Application

The S418-V is a Compact Thermal Mass Flow Meter that is designed to measure the actual flow at the low pressure side of vacuum pumps within the permissible operating parameters (in chapter 6 Technical data).

The S418-V can measure the following values:

- Absolute volumetric flow (default unit: al/min)
- Total consumption (default unit: m^3)
- Absolute pressure (default unit: bar)

Other units are configurable using the service app S4C-FS, which can be downloaded from the Google Play store or our Website. For more information, see chapter 10.

5 Features

- Inline thermal mass flow sensor virtually independent of pressure and temperature changes.

- Process connection of G-type thread with DN8, DN15, DN20 and DN25 available

- Very short response time.

- Particularly suitable for measuring at the point-of-use at the low pressure side of vacuum pumps.

- Integrated display showing actual volumetric flow and absolute pressure.

- Options for output signals:

    - Analogue 4 … 20 mA and pulse output
    - Modbus interface
    - M-Bus interface

- Bluetooth interface for remote sensor settings

- Configurable through Android or iOS devices

- Embedded data logger capable of recording 5-million measurement samples

6 Technical data

6.1 General data

CE FC FCC ID: 2ASK2-SUTO-003	
Parameters	Flow: Actual volumetric flow: l/min, m^3/h, m^3/min, cfm Consumption: m^3, ft^3 Medium pressure: bar, psi
Principle of measurement	Thermal mass flow
Sensor	Glass coated resistive sensor
Measuring medium	Air
Ambient temperature /Transport temperature	0 ... +50°C / -30 ... +70°C
Medium conditions	0 ... +50°C, rH<90% no condensation
Pressure range	0.01 ... 1.60 bar(a)
Material	Process connection: aluminum alloy Wetted parts: aluminum alloy Top casing: PC + ABS
Protection class	IP54
Dimensions	See dimensional drawing on page 11.
Display	4-digit LED display
Tube diameter	DN8, DN15, DN20, DN25
Process connection:	G inner thread ISO 228-1
Weight	0.43 kg (DN8), 0.46 kg (DN15) 0.96 kg (DN20), 0.97 kg (DN25)

6.2 Electrical data

Power supply	15 ... 30 VDC, 120 mA @ 24 VDC

6.3 Data logger

Memory size	Up to 8,000,000 samples.
Recording channels	Up to 3 channels: Flow, consumption, and pressure.
Logger programming	Through mobile app S4C-FS (Free for download on Google Play Store and SUTO Website)
Logger readout	Through the software S4A via USB (Downloadable on the SUTO website)

6.4 Output signals

Analogue output	Signal: 4 … 20 mA, isolated Scaling: 0 to max flow Max load: 250R
Pulse output	1 pulse per consumption unit (m^3 or ft^3) isolated switch, max. 30 VDC, 200 mA (pulse length: 10 … 120 ms, depends on flow rate)
Modbus output	See section 9.3.

6.5 Accuracy of flow

Accuracy*	±(1.5% of reading + 0.3% FS)
Temperature coefficient	< 0.1%/K FS
Pressure coefficient	<0.5% / bar
Turndown ratio	100:1
Stated accuracy at	Ambient/process temperature 23 °C ± 3 °C Ambient/process humidity <90% Process pressure at 0.6 MPa(g)
Repeatability	± 0.5% of reading
Sampling rate	10 samples / second

* The specified accuracy is valid only within the minimum and maximum flow rates that are indicated in section 14.1.

6.6 Accuracy of pressure

Accuracy	± 0.5% FS
Parameters	Pressure: bar (default) or psi
Sensor	Piezzo-resistive sensor
Measuring range	0.01 … 1.60 bar(a)

Remark: The total consumption value is saved to the permanent memory every 5 minutes. If within these 5 minutes the device is powered off, it will restore the last consumption value which was saved in the last cycle.
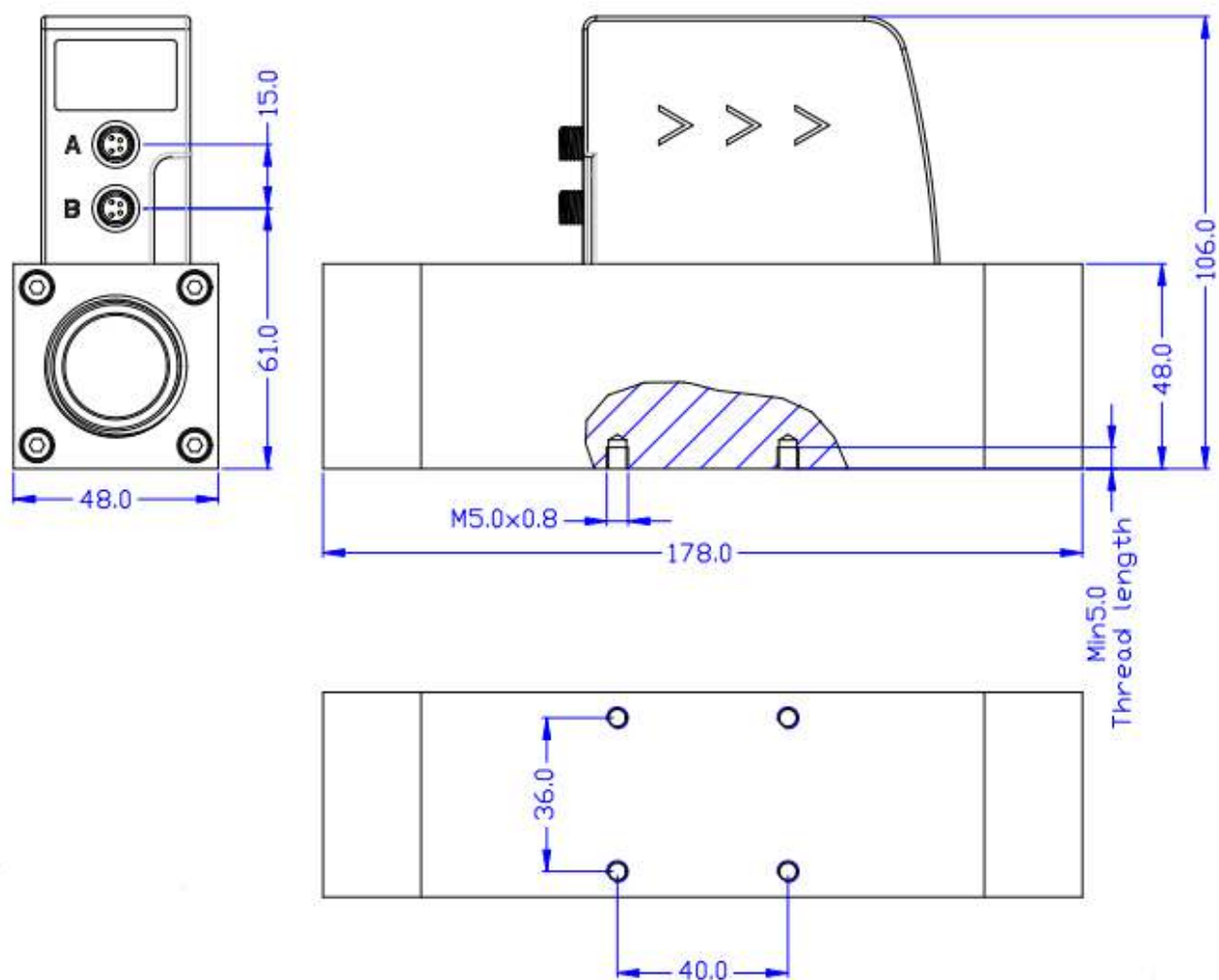
7 Dimensional drawing

Unit：mm

DN8/DN15
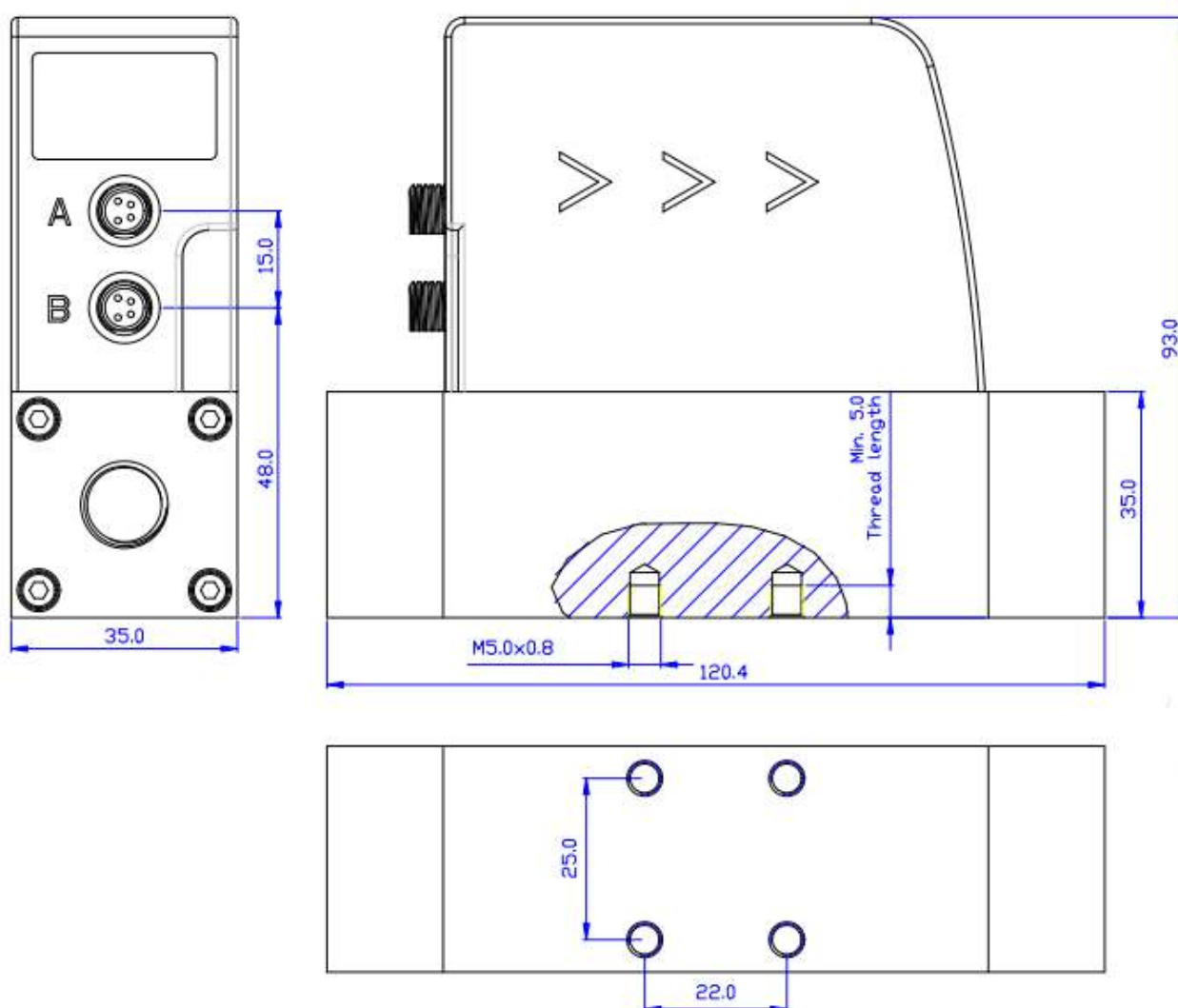
DN20/DN25

8 Installation

S418-V is delivered with following components:

Qty.	Description	Order no.
1	S418-V Compact Thermal Mass Flow Meter, DN8 / S418-V Compact Thermal Mass Flow Meter, DN15 / S418-V Compact Thermal Mass Flow Meter, DN20 / S418-V Compact Thermal Mass Flow Meter, DN25	S695 4190 S695 4191 S695 4192 S695 4193
1	5 m cable with M8 connector and open ends	A553 0136
1	USB cable	A553 0130
1	Instruction and operation manual	No
1	Calibration certificate	No

8.1 Installation Considerations

- When installing the flow meter, always observe the arrows on the housing showing the flow direction. The air/gas flow direction must always be in line with the arrows on the housing.


- Due to the integrated flow conditioner, there are no additional straight pipe requirements for good measurement. However for best measurement, it is recommended 3-5 times inner diameter straight pipe at the inlet.

Note:

- The device is for indoor use only! For outdoor applications, ensure a protection from solar radiation and rain. Always observe operating temperature and humidity as stated in the the technical data.

- It is strongly recommend not to install S415 permanently in wet air/gas conditions, which exists usually right after a compressor outlet.

- The S418-V can be installed in horizontal or vertical pipes.

8.2 LED indicators

The S418-V provides four LED indicators on the display panel, which indicate the status of the data logger, display, and Bluetooth connection separately.
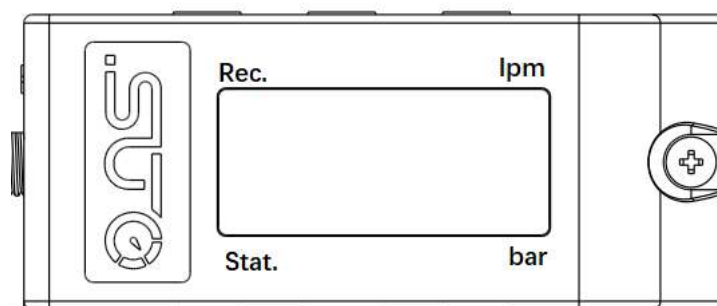

LED	Function	Status
Rec	Indicator for the logger state	On: NAND flash is formatting. Flashing: Data logger is working.
lpm	Indicator for the display state (volumetric flow)	On: The display is showing the volumetric flow rate. Flashing: N/A
stat.	Indicator for the Bluetooth state	On: Bluetooth is connected. Flashing: N/A
bar	Indicator for the display state (pressure)	On: The display is showing the pressure value. Flashing: N/A

8.3 Electrical connection

The flow sensor is equipped with two connectors "A" and "B". By default the sensor is delivered with one 5 m cable with a M8 connector on one side and open wires on the other side. To make the S418-V work, one

cable connection is sufficient. However, if the pulse output is to be used or the supply and the signal need to be on separate cables, a second connection cable must be ordered.
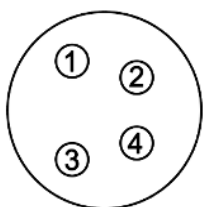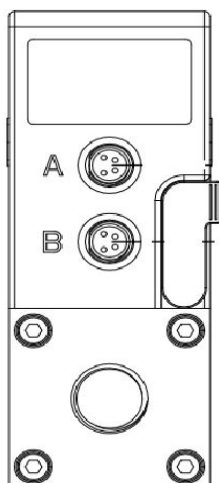
Legend to pin assignment

GND_M	Ground for Modbus
-VB	Negative supply voltage
+VB	Positive supply voltage
$+I_{isolated}$	Positive 4...20 mA signal (isolated)
$-I_{isolated}$	Negative 4... 20 mA signal (isolated)
D+	Modbus data +
D-	Modbus data -
SW	Isolated pulse output (switch)
M-Bus	M-Bus data
NA	Not Applicable

Pin assignment connector plug M8

Output type	Connector	Pin 1	Pin 2	Pin 3	Pin 4
Modbus	A	D-	-VB	+VB	D+
	B	D-	GND_M	NA	D+
Pulse and analog	A	$-I_{isolated}$	-VB	+VB	$+I_{isolated}$
	B	$-I_{isolated}$	SW	SW	$+I_{isolated}$
M-Bus	A	M-Bus	-VB	+VB	M-Bus
	B	M-Bus	NA	NA	M-Bus
Wire color		Brown	White	Blue	Black

ATTENTION!

**Do not screw the M8 plug using force. Otherwise, it may damage the connecting pins.**

9 Sensor signal outputs

9.1 Analog output

The sensor provides an analog output of 4 … 20 mA. This output can be scaled to match a desired measuring range. Standard scaling is from 0 to the max flow. The corresponding flow in different pipe sizes can be found in chapter 14.

9.2 Pulse output

The sensor outputs one pulse per consumption unit. This pulse output can be connected to an external pulse counter to count the total consumption. The number of m^3 per second are summed up and indicated after one second. Pulse length depends on flow rate.
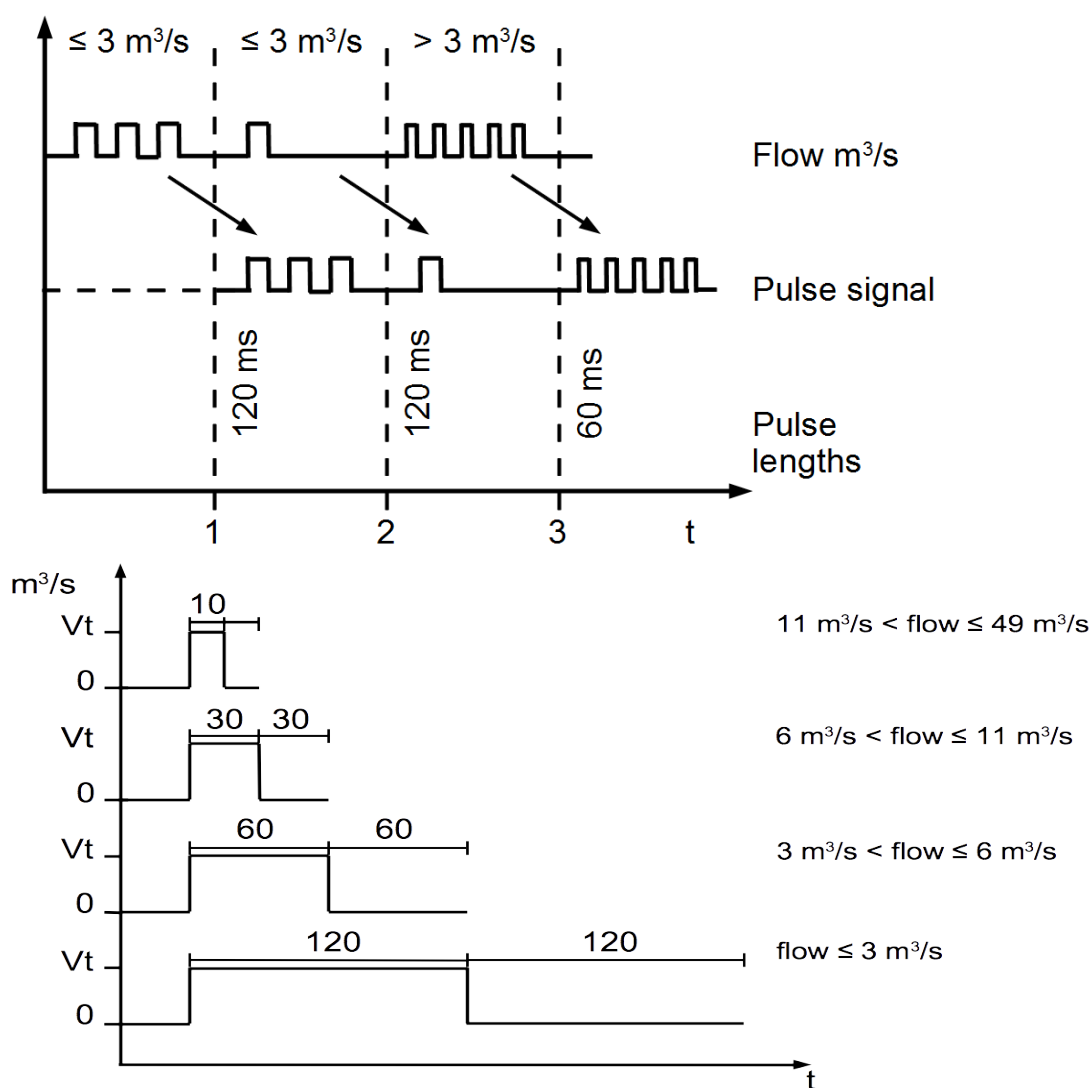
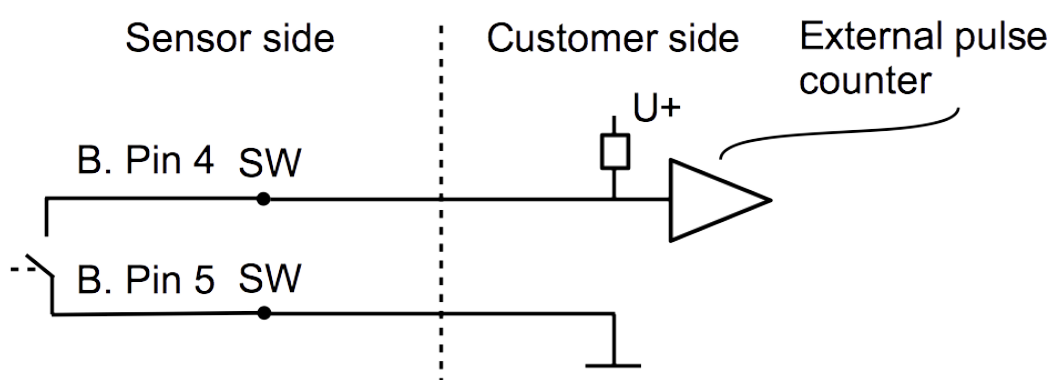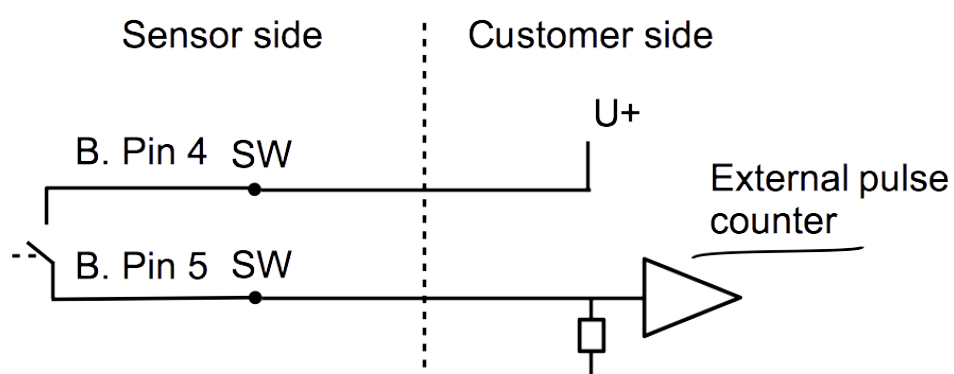| Volumetric flow [m³/s]	Volumetric flow [m³/h]	Pulse length [ms]	Max. pulse output per hour
≦ 3	≦ 10800	120	1080
> 3	> 10800	60	2880
> 6	> 21600	30	3960

Pulse connection diagram

Variant 1:

Variant 2:

9.3 Modbus Interface

9.3.1 Modbus Information

The default settings of the Modbus interface are as follows:

Mode	RTU
Baud rate	19200
Device address	Last two digits of the serial number
Framing / parity / stop bit	8, N, 1
Response timeout	1 second
Response delay	0 ms
Inter-frame spacing	7 char

Response message that the device returns to the master:

- Function code: 03

The information of the byte order is shown in the table below:

Byte Order	Sequence				Data Type
	1st	**2nd**	**3rd**	**4th**	
1-0-3-2	Byte 1 (MMMMMMMM*)	Byte 0 (MMMMMMMM *)	Byte 3 (SEEEEEEE)	Byte 2 (EMMMMMMM *)	FLOAT
1-0-3-2	Byte 1	Byte 0 LSB	Byte 3 MSB	Byte 2	UINT32 INT32
1-0	Byte 1 MSB	Byte 0 LSB	---	---	UINT16 INT16
1-0	Byte 1 XXX *	Byte 0 DATA	---	---	UINT8 INT8

* S: Sign, E: Exponent, M: Mantissa, XXX: no value

Explanations of MSB and LSB

MSB	MSB refers to Most Significant Byte first, which follows the Big-Endian byte order.
	For example, if the main system follows the MSB first order:
	When the 4-byte floating number, in the order of Byte1-Byte0-Byte3-Byte2, is received from the slave (sensor), the master must change the byte order to Byte3-Byte2-Byte1-Byte0 for the correct display of the value.
LSB	LSB refers to Least Significant Byte first, which follows the Little-

Endian byte order.

For example, if the main system follows the LSB first order: When the 4-byte floating number, in the order of Byte1-Byte0-Byte3-Byte2, is received from the slave (sensor), the master must change the byte order to Byte0-Byte1-Byte2-Byte3 for the correct display of the value.

Note: Modbus communication settings as well as other settings can be changed by the service App **S4C-FS** or through the windows based **Service Software**.

Available measurement channels

Channel name	Resolution	Format	Length	Register address
Flow	0.1	FLOAT	4-byte	6
Consumption	1	UNIT32	4-byte	8
Pressure	0.01	FLOAT	4-byte	2

9.3.2 Connect Several S418-V to Modbus Master

The S418-V with Modbus/RTU interface can be easily daisy-chained to a Modbus Master device. This master can be either SUTO displays and gateways or any third-party Modbus/RTU master.
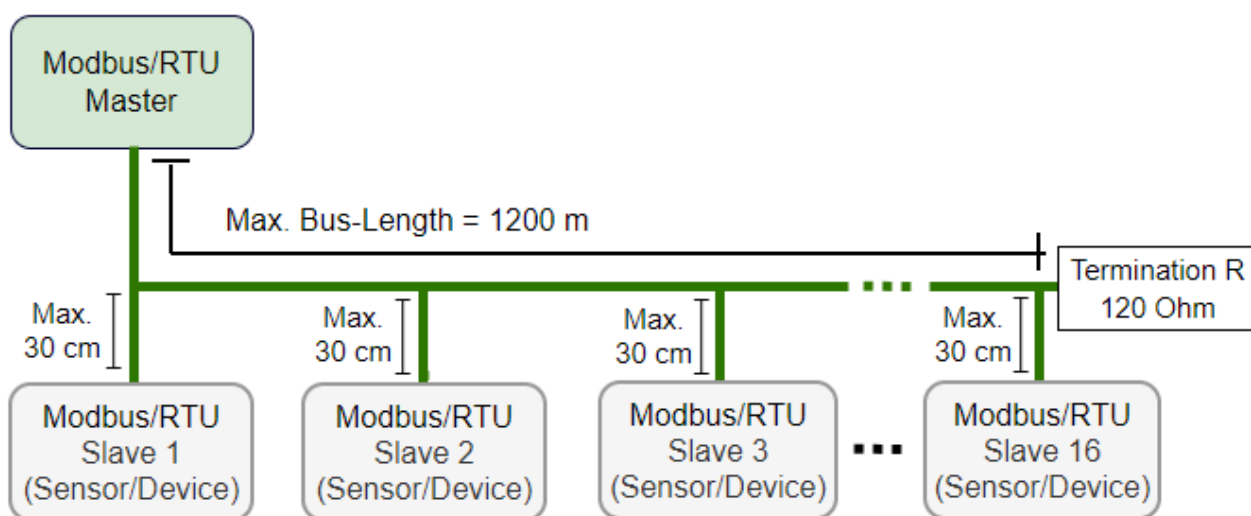
Through this method you can add up to 16 flow meters to the master device.

9.3.2.1 Modbus/RTU Cable Length

A Modbus/RTU bus line has limitations which shall not be exceeded, otherwise the communication might not be stable.

- The maximum total bus length must not exceed 1200 m.
- The stub length to each node must not exceed 30 cm.

See the picture below for details.

9.3.2.2 Modbus/RTU Wiring and Cable Type

To ensure a stable communication a twisted-pair bus cable must be chosen to set up the Modbus/RTU communication.

- Bus-cable specifications must follow the EIA485 Standard, must be twisted pair and shielded, for example 2 x 2 x 0.22 mm^2, Li-2YCY (A553 0123).

- The shield must be connected at one end to the master GND connection.

- At the end of the bus, a 120 Ohm resistor should be placed a termination resistor.

See the below picture for details.
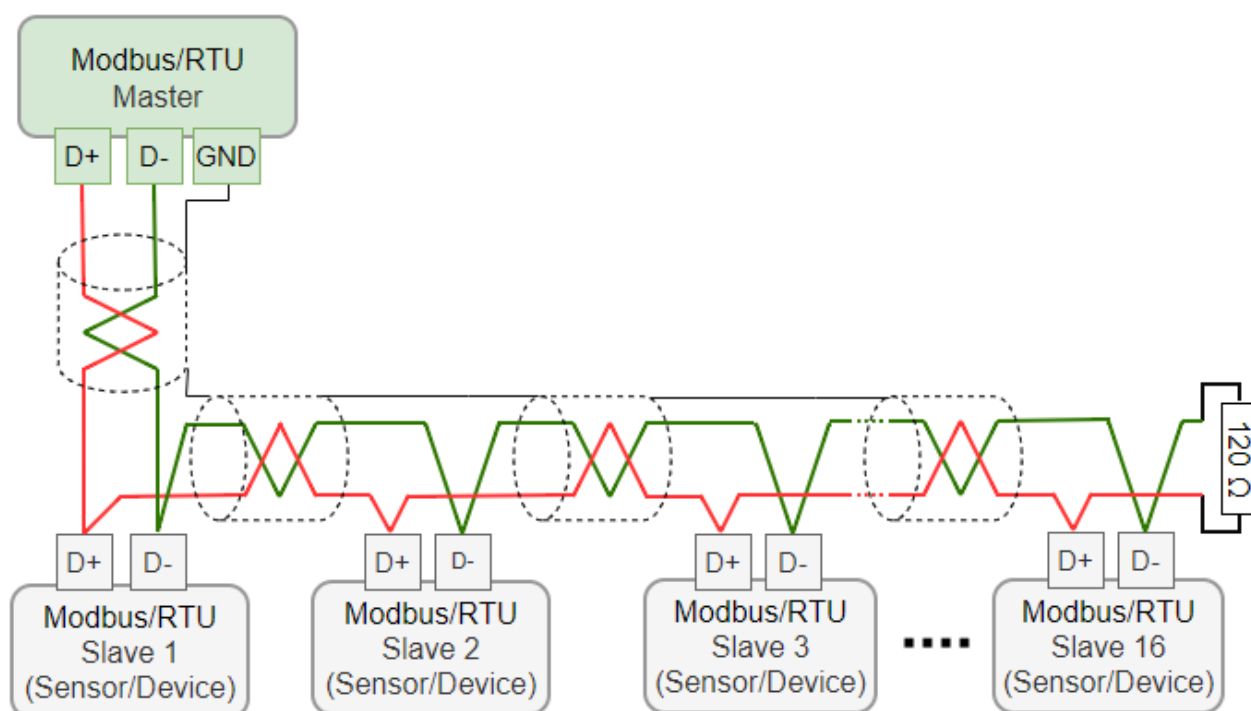
9.3.2.3 Create Daisy-Chain using RS-485 Splitter

To connect the S418-V to the daisy-chain, the RS-485 splitter (A554 3310) and the M8 to M12 converter cable (A553 0161) are needed.

Furthermore place a M12 termination resistor (C219 0055) at the last splitter in the daisy-chain, as show in the figure below.
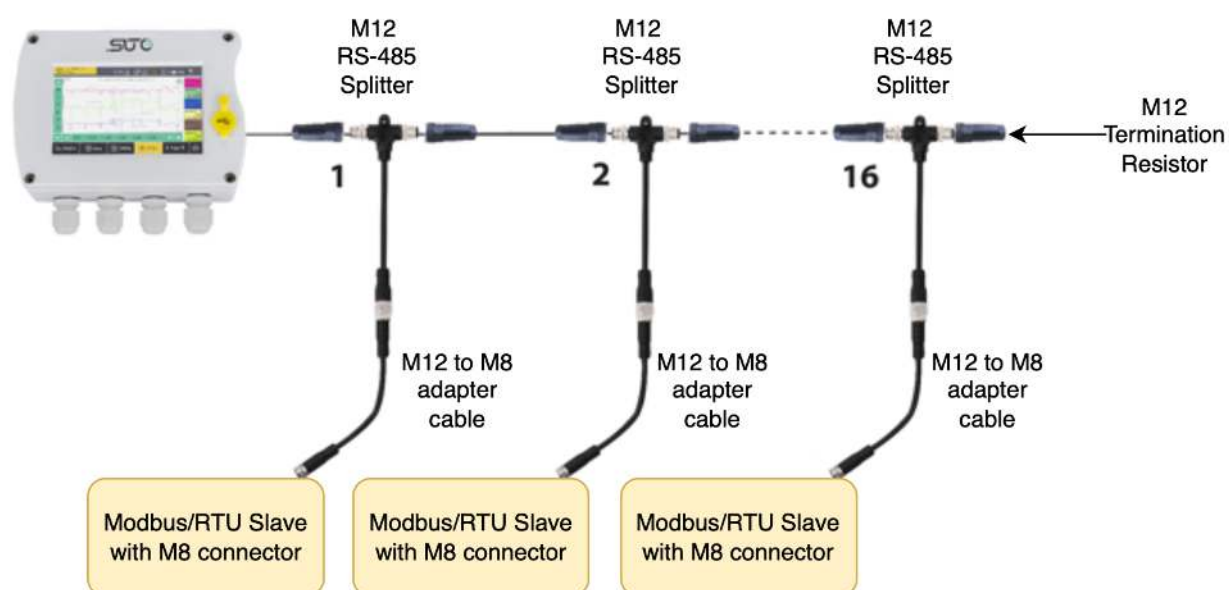
Note: The S331 can maximum provide 10 W power to the connected devices. If more power is required a separate power supply is needed.

9.3.2.4 Topology of Modbus/RTU Daisy-Chain

The recommended bus topology is to connect devices as a daisy-chain, as shown in the figure in section 9.3.2.1 Modbus/RTU Cable Length. Other connection topologies are not recommended and must be avoided.

Avoid a connection of Slaves to the master in ring or star topology.
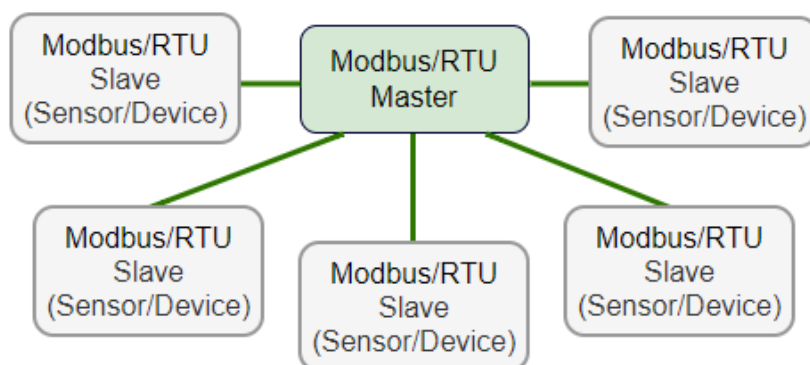
Avoid a star topology

Avoid a ring topology

10 Configuration

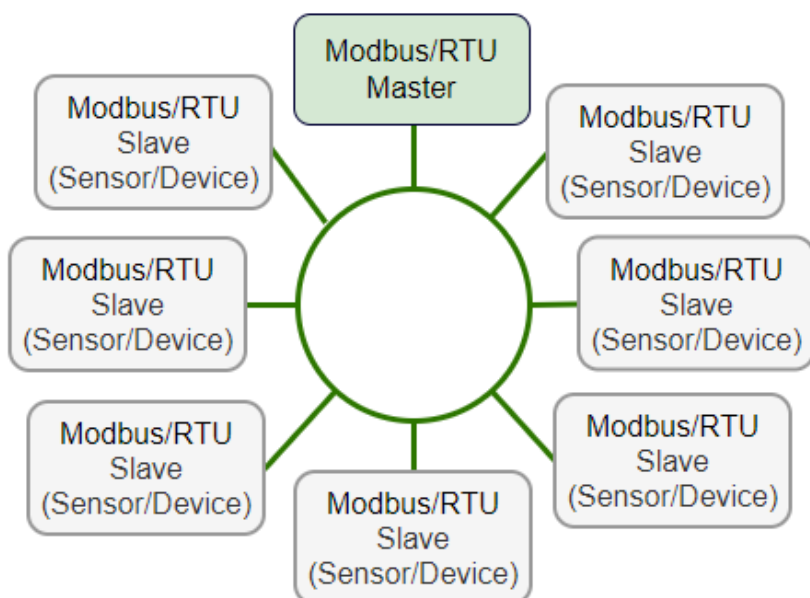To change any settings on the S418-V, download and install the service App **S4C-FS** from the Google Play store or SUTO Website. This App works on any Android or iOS system with Bluetooth supported.
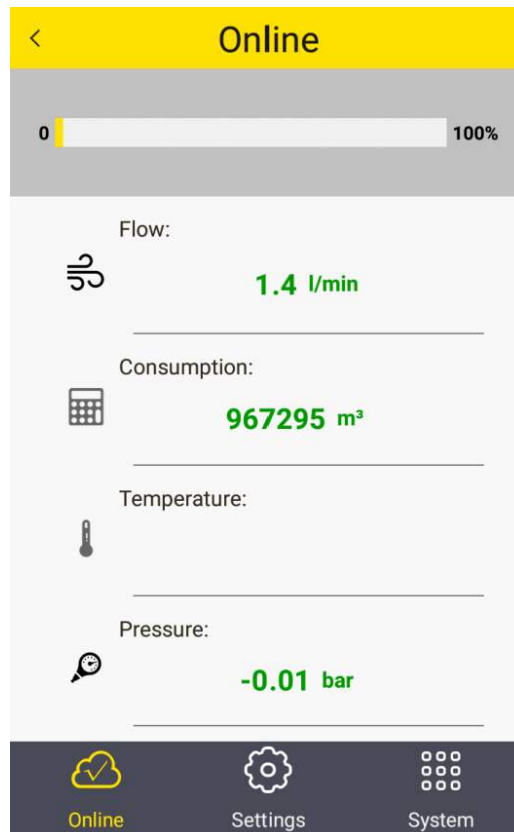
To be allowed to change settings, the App needs to scan the QR code on the calibration certificate. This ensures that only authorized users can access the sensor settings. For more information about instructions, see the S4C-FS Instruction and operation manual.

ATTENTION!

Changes on the settings may lead to wrong measurement results! Contact manufacturer in case you are not familiar with the settings.

11 Read and analysis of measurement data

The S418-V embeds the data logger to record measurement data. You can read out the data from the data logger, and analyze the data using the free analysis software S4A.

11.1 Features

Before you use the data logger, learn about how it works:

- You can use the S4C-FS App to enable or disable the data logger function and set a sampling rate as needed.

- By default the data logger is disabled. Once you enable the data logger, the S418-V starts logging data. Once you disable the data logger, the S418-V stops logging.

- The S418-V saves all sampled data records into one file. Each record includes a time stamp and all measurement data sampled at this time point, such as flow, consumption, and pressure.

- The S418-V log file supports up to 5.6 million records due to its memory size, which is equivalent to 64-day data at the one-second sampling rate.

- When the S418-V runs out of memory, the new record will replace the oldest one.

- To read out the logs recorded in the S418-V memory, install S4A (1.1.2 or later versions), which is a specialized log analysis software from SUTO, on a Windows-based computer. Meanwhile, connect the PC with the S418-V through the USB port.

- Data records are saved in one file in the S418-V, and usually S4A reads them out in one file. But in the following situations, S4A reads the records out into multiple log files :

  - When the sampling rate is changed, S4A reads out the data records into a different file.

  - When the S418-V stops logging (for example, when the power is shut off.) and resumes in less than 24 hours, S4A still reads out the data records into one file; However, if the time gap is larger than 24 hours, S4A reads out the new data records to a different file.

- S4A enables you to have a graphic view on measurement data recorded in a log file.

11.2 Operations

11.2.1 Logger configuration

You can control and configure the S418-V data logger using the S4C-FS App. Detailed steps are as follows.

1. Install and launch the **S4C-FS** App.

   For more information, see the *S4C-FS Instruction and Operation Manual*.

2. On the S4C-FS App, access **Settings** > **Logger Settings** and then perform all logger-related operations as described below.

Parameter	Description
Logger Status	To start or stop the logger.
Start Date & Time	To view the time stamp of the first log recorded.
Stop Date & Time	To view the time stamp of the last log recorded.
Number of Samples	To view the number of log records in the S418-V data logger.
Sampling Rate(mm:ss)	To specify the sampling rate.

11.2.2 Data read-out and analysis

To read, analyze and export the measurement data recorded in the S418-V, download and use the free data analysis software S4A:

1. Download the S4A software from **Support** > **Downloads** > **Apps** on the SUTO Website (http://www.suto-itec.com).

2. Install the software on your computer by double clicking the downloaded EXE file.

3. Launch the S4A software.

4. Click the **Detect** menu to detect and build the communication with the S418-V.

5. Click the **Read** menu to read out data records logged during a time period that you specify.

6. Click the **File** menu to have graphic views on measurement data in a log file; and if needed, to export this log file to the Excel or CSV format.

   For more information about operations on S4A, click the **Help** button on the top right corner.

12 Calibration

The sensor is calibrated ex work. The exact calibration date is printed on the certificate which is supplied together with the sensor. The accuracy of the sensor is regulated by the on site conditions, parameters like oil, high humidity or other impurities can affect the calibration and furthermore the accuracy. However we recommend to calibrate the instrument at least once per year. The calibration is excluded from the instruments warranty. For this please contact the manufacturer.

13 Disposal or waste

Electronic devices are recyclable material and do not belong in the household waste.
The sensor, the accessories and its packings must be disposed according to your local statutory requirements. The dispose can also be carried by the manufacturer of the product, for this please contact the manufacturer.

14 Appendix - Specifications

14.1 Vacuum flow ranges

Process connection	DN8	DN15	DN20	DN25	Absolute Pressure (hPa)
Standard flow in l/min	50	200	400	700	1000

The following table is used to find the appropriate flow meter size depending on the vacuum flow and absolute pressure.

Example:

If the actual situation is like this: absolution pressure = 300 hPa and vacuum flow = 750 l/min, the S418-V with DN20 will be the proper one.

Process connection	DN8	DN15	DN20	DN25	Absolute Pressure (hPa)
	56	222	444	778	900
	63	250	500	875	800
	71	286	571	1000	700
	83	333	667	1167	600
Vacuum flow in l/min	100	400	800	1400	500
	125	500	1000	1750	400
	167	557	1333	2333	300
	250	1000	2000	3500	200
	500	2000	4000	7000	100

Stated measuring ranges under the following conditions:

   Air at +20°C

14.2 Error codes

When an error code shows on the LED display, use the following table to identify the error cause.

Error code	Description
Er. 01	Real time clock failure
Er. 02	ADC failure
Er. 04	EEPROM failure
Er. 08	NAND flash failure
Er. 10	Pressure sensor failure
Er. 20	Flow sensor failure
Er. 30	Temperature sensor failure
Er. 40	Bluetooth failure
Er. 50	Logger failure

14.3 Order table

Order no.	Code	Description
S695 419	S418-V	S418-V Compact Thermal Mass Flow Meter, 1.5% o.RDG., 24 VDC

Connection thread

S695 419	0	DN8 G inner thread
	1	DN15 G inner thread
	2	DN20 G inner thread
	3	DN25 G inner thread

Output

A1455	A	Analogue 4 … 20 mA, pulse
A1456	B	Digital Modbus/RTU
A1457	C	Digital M-Bus

	A	With SI units
A1459	B	With imperial units instead of SI units

Display direction

	A	Standard display direction
A1460	B	Reverse display direction

Accessories

Order no.	Description
A554 3315	T-BOX for S418-V Modbus/M-Bus systems, including 2 m cable with a M8 connector
A554 0109	Main power supply 100-240 VAC / 24 VDC, 0.5 A, 2 m cable with M8 connector
A553 0137	Connection cable S418-V to S551, 5 m

.SUO

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