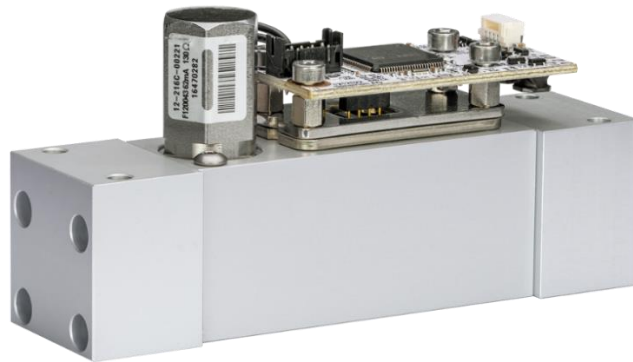


Datasheet SFC5460 / SFM5460 mass flow controller / meter for gases

Datasheet – V2

- Excellent accuracy/repeatability (0.8% / 0.1% of setpoint respectively)
- Wide control range (1000:1)
- Low profile of only 51 mm
- Digital RS485 interface
- Broad choice of connectors: Downmount, Swagelok, VCR, VCO, W-Seal
- Ultra-fast settling time (down to 50 ms)
- Multiple gases and gas recognition
- NIST traceable calibration
- Mean time between failures MTBF 169 years
- No drift and no re-calibration required in the field



SFC5460 with downmount option

Unsurpassed CMOSens® Technology

The heart of SFC5460 / SFM5460 product is the unsurpassed Sensirion CMOSens® technology. It combines a high precision sensor element with state of the art signal processing on a single chip and thereby providing an accurately calibrated and temperature compensated signal (see Figure 1). Thanks to this sensor technology, the SFC5460 / SFM5460 achieves unmatched ratings for speed, accuracy and repeatability at very attractive system cost. Due to the excellent long-term stability of SFC5460 / SFM5460, no recalibration is required.

The SFC5460 offers fastest settling time, high control range as well as high flexibility regarding mechanical connectors and communication interfaces. Digital versions also provide optional smart features like multiple gases and ranges, gas recognition and self-test capability.

The SFM5460 is the valve-free flow meter based on the SFC5460 mass flow controller. It features the same

performance advantages and configurations as the MFC counterpart without providing the controller functionality.

The brilliant performance of the SFC5460 / SFM5460 products makes them the best choice for a wide range of applications, such as analytical instrumentation, coating/etching equipment, medical equipment and process automation to name a few.

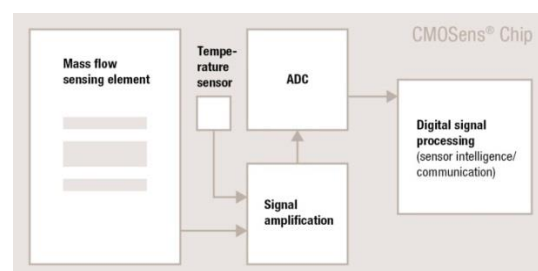


Figure 1: CMOSens® flow sensor diagram.

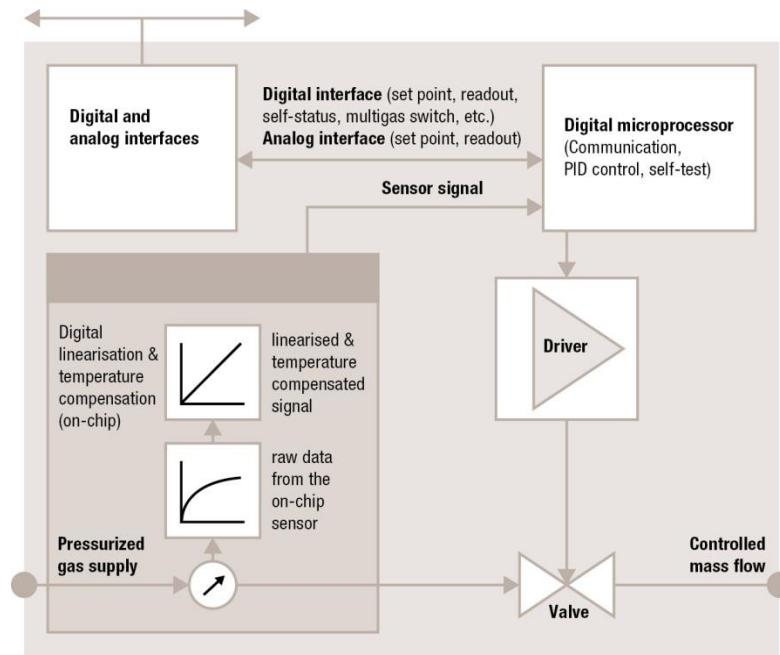


Figure 2: Block diagram CMOSens® SFC5460 mass flow controller.

Introductory Description

The CMOSens® based SFC5460 / SFM5460 measure the gas mass flow by the calorimetric principle based on heat transfer. A heater element on a thermally insulated membrane and two thermopiles up-stream and downstream are integrated on a single silicon chip. In the presence of gas flow, the temperature distribution up- and downstream is disturbed. This asymmetry is then measured. The measurement area as well as the A/D-converter and further signal processing are based on a single chip using CMOS standard processes (see Figure 3).

MEMS based CMOSens® technology enables a larger cross section (about 1.5x1 mm²) of the gas channel than bypass capillary diameter in conventional mass flow controllers (0.1 to 0.5 mm). This channel design makes the device more robust against particles, clogging and humidified gases. Due to the compact single-chip design and its mounting between metal parts, CMOSens® based sensors are very resistant to electromagnetic disturbances (EMC).

The minimal thermal mass of the membrane results in an ultra-fast sensor response time of 3-4 ms. Since the whole design of the amplification, A/D conversion, digital linearization and temperature compensation is matched to that sensor speed, a fully compensated flow measurement value can be delivered every millisecond.

Combined with advanced control algorithms running on an on-board microprocessor, the SFC5460 offers greatly reduced settling times compared to conventional mass flow controllers (see Figure 2).

Furthermore, a special arrangement of the two temperature sensors, the on-chip temperature compensation and the minimizing of noise sources lead to the unbeatable performance with regard to repeatability and accuracy over a large dynamic range. Thanks to its flawless design, the SFC5460 / SFM5460 mass flow controllers/meters show zero-drift performance and control/measure true mass flow independently of the ambient temperature and pressure changes.

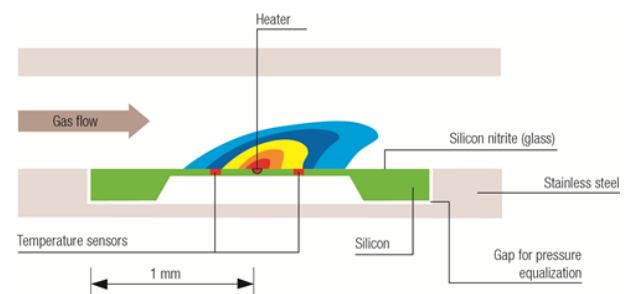


Figure 3: Cross-sectional view of gas channel.

1 CMOSens® SFC5460 / SFM5460 mass flow controller / meter performance

Table 1: Overview of CMOSens® SFC5460 / SFM5460 Mass Flow Controller / Meter Specifications

All data, unless otherwise noted, apply for the following calibration conditions: Temperature 20°C, Nitrogen (N₂), horizontal mounting position (el. connector on top), downmount connection, 3.0 bar overpressure (inlet: 4.0 bar absolute) against atmosphere (outlet: 1.0 bar absolute) for SFC5460 and <0.2 bar overpressure for SFM5460.

Specification	Value		Unit
Full scale flow	0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10	20, 50, 100	l/min or slm (or equivalent in ml/min or sccm)
Accuracy ¹ whichever is greater	0.8 0.08	1 0.1	% s.p. ² % FS
Repeatability whichever is greater	0.1 0.01	0.2 0.02	% s.p. % FS
Typical settling time ³	100 (50 for optimized OEM versions ⁴)		ms
Measurement frequency	1000		Hz
Control range ⁵ / Measurement range	Better than 1'000:1		
Standard calibration gases	Air/N ₂ , H ₂ , O ₂ , He, Ar, CO ₂	Air/N ₂ , O ₂	
Calibration using gas conversion ⁶	Standard: SF ₆ , C ₄ F ₈ OEM versions with other gases or mixtures on request (not compatible with aggressive gases, see wetted material list or contact Sensirion)		
Operating temperature (ambient and gas)	0 – 50 / 32 – 122		°C / °F
Temp. coeff. zero	0.005		% FS / °C
Temp. coeff. span	0.06		% s.p. / °C
Pressure drop at full flow SFC5460 SFM5460	< 2.0 / 29 < 0.1 / 1.5	< 3.0 / 43 < 0.2 / 3	bar / psig
Maximum input pressure ⁷	10 / 145		bar / psig
Maximum differential pressure ⁸	5 / 73	4 / 58	bar / psig
Leak integrity MFC external	9 x 10 ⁻⁹	9 x 10 ⁻⁶	mbar l/s He
Leak integrity through closed valve	1 x 10 ⁻⁶		mbar l/s He
Warming up time ⁹	1		sec

1.1 Accuracy

Figure 4 compares the set point accuracy of a conventional mass flow controller / meter with a CMOSens® SFC5460 / SFM5460. Typically, an accuracy of 1% FS (full scale) is stated for mass flow controllers using conventional sensor technology. The graph shows this in relation to the accuracy of the

SFC5460 mass flow controller. Especially at low flow rates the CMOSens® technology reaches superior performance.

¹ Including offset, non-linearity and hysteresis. Measured against NIST traceable reference

² in % of set point (s.p.) = measured value (m.v.) = rate = reading

³ Step answer from 10% to 100% of full scale within ±5% of set point.

⁴ Typically for large OEM projects (MOQ > 50 units per year).

⁵ Control range is relevant for mass flow controller only.

⁶ Gas conversion is generated from the real gas calibration data using the combination of standard gases. Typical accuracy is 2% m.v. / 0.2% FS (whichever is greater). Please contact Sensirion if better accuracy specification is required for your OEM project.

⁷ Pressure between flow inlet and ambient

⁸ Pressure between flow inlet and flow outlet. For availability of higher differential pressure option, contact Sensirion

⁹ to within ±2 % of set point

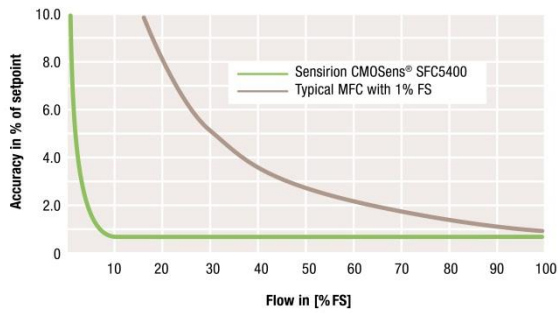


Figure 4: Accuracy comparison of the CMOSens® SFC54xx / SFM54xx device compared to a typical thermal mass flow controller / meter.

1.2 Repeatability

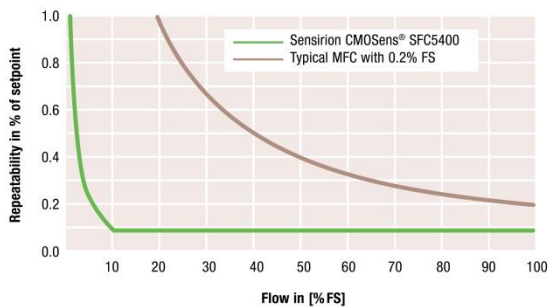


Figure 5: Repeatability comparison of the CMOSens® SFC54xx / SFM54xx device compared to a typical thermal mass flow controller / meter.

1.3 Settling time

The CMOSens® SFC5460 mass flow controller has an ultra-fast settling time. Figure 6 shows the typical response time of SFC5460 in comparison to a mass flow controller using conventional sensor technology.

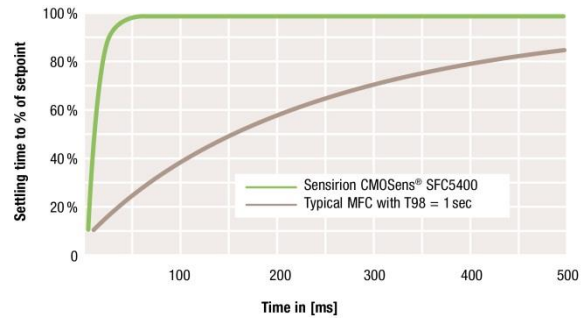


Figure 6: Settling time of the SFC54xx vs. typical thermal mass flow controller.

1.4 Wide control range

Ultra-wide control range of the SFC5460 brings a decisive benefit in applications with a wide dynamic range of gas flows. Instead of two devices used for high flow and low flow ranges, a single SFC5460 device can efficiently cover a flow range of three orders of magnitude.

2 Construction details

2.1 Packaging principle and sealing

To guarantee a vacuum proof housing of the sensor and the flow path, several patented technologies are used. The CMOSens® chip itself is placed vacuum tight in a stainless steel package that is connected via O-ring sealing to the aluminum body. The packaging allows the SFC5460 / SFM5460 mass flow controller / meter to operate under high input pressure conditions (up to 10 bar / 145 psi standard).

The electrical connection from the chip to the main controller board uses vacuum tight glass feed through pins. This packaging method ensures high reliability and tightness for all kinds of gases (see Figure 7 below).

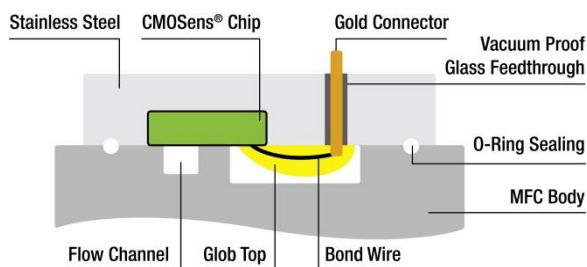


Figure 7: Vacuum tight glass feed through (longitudinal view)

2.2 Wetted materials & compatibility

The packaging method ensures that a minimum number of inert materials are wetted by the media. Table 2 gives an overview of the materials wetted by the gas. For high volume OEM applications different specialized materials for body, valve and sealing can be used.

Table 2: Overview of Wetted Materials.

Part	Wetted Material
Body	Aluminum
Sensor element	Silicon (Si) Silicon oxide (SiOx) Silicon nitride (Si ₃ N ₄) Stainless steel Glass Glob top
Sealing	FKM
Valve	Brass, FKM

2.3 Safety instructions

2.3.1 Toxic gases

The whole gas assembly must be checked for leakage before applying toxic gas to the device.

2.3.2 Aggressive or corrosive gases

Please make sure that the gases you use are compatible with the wetted materials listed in this chapter. In case of doubt, please contact Sensirion for further advice.

2.3.3 Explosive gases

The maximum heating energy of the sensor is limited to 12 mW. The CMOSens® sensor element is tested according to EN 50020 chapter 6.2.4 b). Sensirion guarantees the safe use of gases of the classes T1 or T2 (ignition temperature < 300 °C). This includes also mixtures of air or oxygen with hydrogen or hydrocarbons. However, the SFC5460 / SFM5460 are not designed for the use in hazardous areas (EN 60079-10) where explosive gases can occur outside of the device.

3 Electrical and communication specifications

3.1 Connector and pin layout

SFC5460 / SFM5460 feature a digital RS485 interface with detailed specifications of the protocol given on the Sensirion website. The electrical connector on the device is a JST SM04B-GHS-TB optimized for a small form factor.

It is best connected with a JST GHR-04V-S plug. The pin layout for JST SM04B-GHS-TB is shown below:

1	1 +14..26VDC
2	2 GND
3	3 RS485A (+)
4	4 RS485B (-)

JST SM04B-GHS-TB

Figure 8: Digital interface PIN layout (RS485)

3.2 Power supply

The SFC5460 / SFM5460 mass flow controller / meter requires a standard voltage supply of +14.0 to + 26.0 VDC. There are no stringent requirements for voltage ripple and stability because of the internal voltage regulation.

3.3 Electrical specifications

Table 3: Electrical characteristics

Parameter	Conditions	Units
Supply Voltage Range (VDD)	Typ. 15.0 – 24.0 Max. 14.0 – 26.4	VDC
Electrical Connector	JST SM04B-GHS-TB	

Table 4: Current consumption

Parameter	Conditions	Typical value (within +/- 5%)	Units
Max. Supply Current	VDD = 15 / 24 VDC	320 / 200	mA
Standby current	VDD = 15 / 24 VDC	50 / 35	mA

4 Physical dimensions and mounting information for SFC5460 / SFM5460

Physical dimensions and mounting information for the downmount and 1/4" VCR / VCO versions are provided below. All drawings are generated from SFC5460

models. SFM5460 has identical dimensions with the only difference of absent control valve (hexagonal-shaped element).

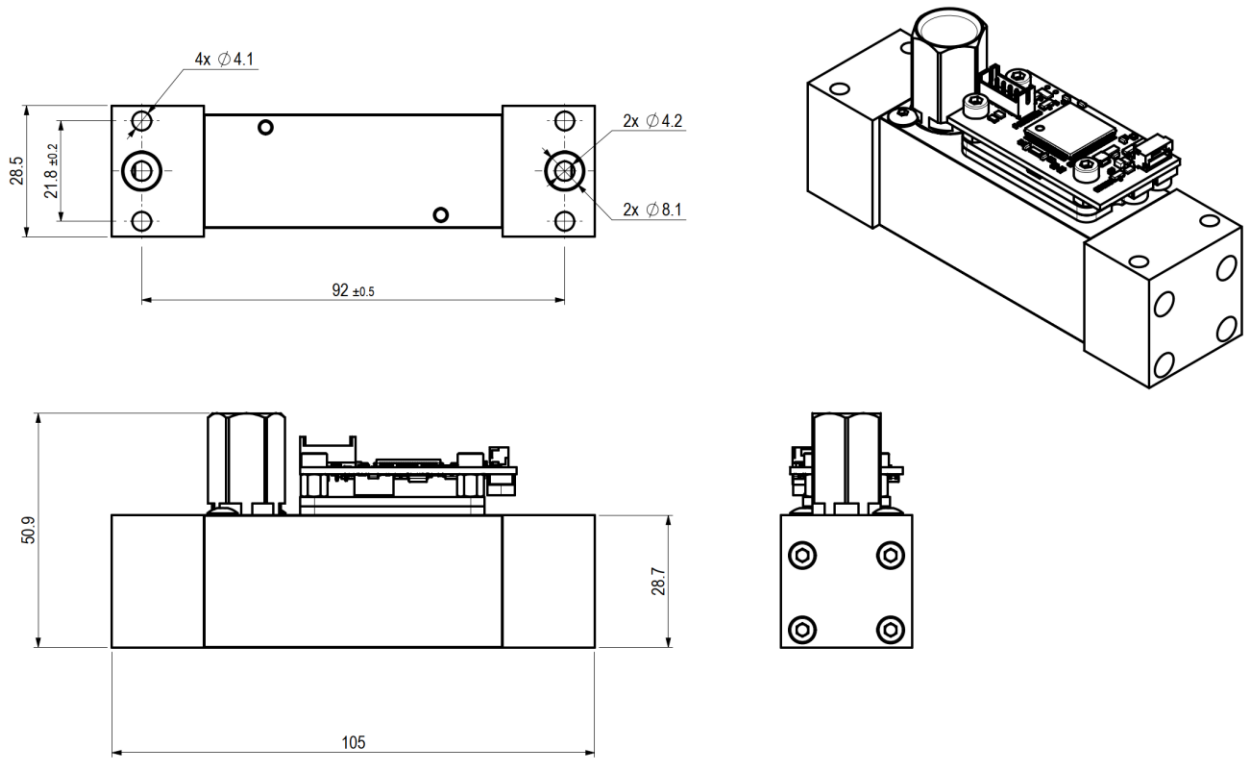


Figure 9: Physical dimensions and mounting information for downmount version. All units are in [mm].

Recommended O-ring: NORMATEC O-ring FKM NT 80.7/75 OR 2019 inner Ø 4,76 x 1,78 mm

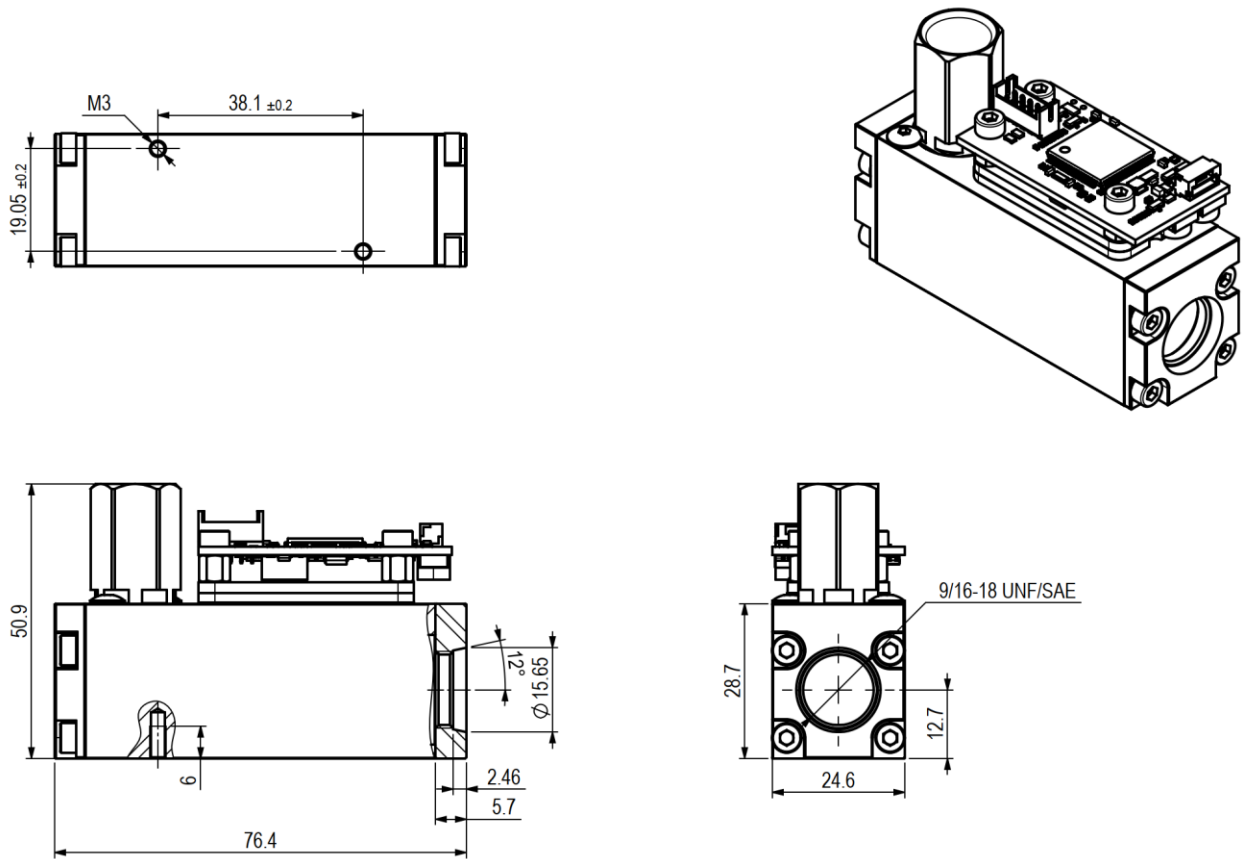


Figure 10: Physical dimensions and mounting information for the fitting versions. Specific dimensions for different types of fittings are shown in the next figure. All units are in [mm].

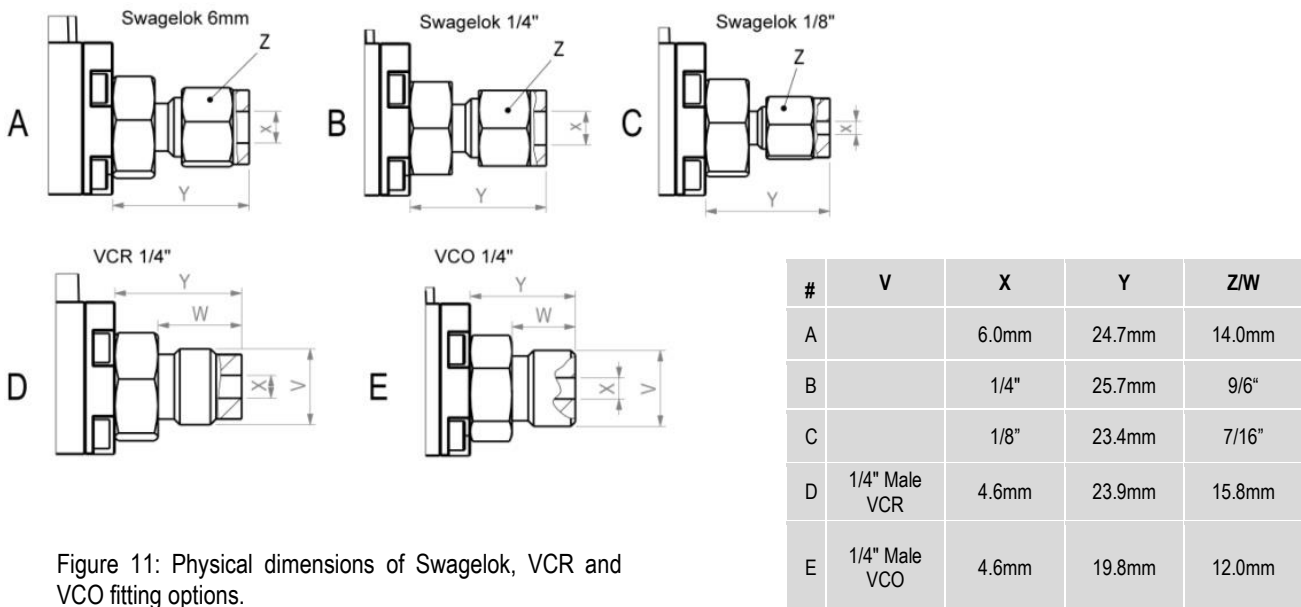


Figure 11: Physical dimensions of Swagelok, VCR and VCO fitting options.

Table 5: Weight

Parameter	Value	Units
Mechanical		
Weight (without fittings)	190	g
Weight (down mount)	255	g
Weight (VCR / VCO)	255	g

5 Supported flow units

Table 6: Units for gas flow rates

Typical flow unit	Reference condition	
	Gas Temperature	Gas Pressure
mln/min (norm milliliter per minute)	0 °C / 32° F	1013 mbar / 14.69 psi
ln/min (norm liter per minute)		
sccm (standard cubic centimeter per minute)	20 °C / 68° F	
slm (standard liter per minute)		

Example: Relationship for N₂ between:

ln/min (0°C, 1013 mbar)	and	slm (20°C / 68°F, 1013 mbar / 14.69)
1 ln/min	=	1.073 slm
10 ln/min	=	10.73 slm

6 OEM options

SFC5460 / SFM5460 is a platform that allows for OEM product developments in the context of high volume projects. Below a few OEM options are listed. Please do not hesitate to contact Sensirion AG to discuss your requirements.

OEM options for hardware (different wetted materials):

- Stainless steel body or other materials
- Sealing materials (e.g. EPDM / FFKM)
- Valve materials: Stainless steel, EPDM / FFKM on request

OEM options for calibration:

- Multigas calibration (allows switching between a set of gas calibrations saved in the device memory)
- Gas recognition¹
- Flow range extension above 100slm
- New gas calibrations

7 Ordering codes

SFC5460 / SFM54600 can be ordered by a product specific ordering code.

Example: SFC5460 LAG N2 500 mln/min
Code structure: Product XAZ Gas Range Unit (see Table 7 for explanation)

Table 7: Description and values for SFC5460 / SFM5460 ordering codes

Parameter	Value	Description	Where to look in this document
Product	SFC5460 SFM5460	Mass flow controller Mass flow meter	Page 1
X – Electrical Interface	L	Digital RS485	Section 3
A – Material Body	A	Aluminum (steel on request for OEM volumes)	Table 2
Z – Fitting	5 6 7 W G H I	Swagelok 6mm Swagelok 1/4" Swagelok 1/8" W-seal Downmount, Manifold VCO 1/4" VCR 1/4"	Section 4
Gas	Air/N ₂ , H ₂ , O ₂ , He, Ar, CO ₂ , SF ₆ , C ₄ F ₈		Table 1 & Table 8
Range	0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100 slm		Table 1 & Table 8
Unit	mln/min ln/min sccm slm	Norm milliliter per minute Norm liter per minute Standard cubic centimeter per minute Standard liter per minute	Table 6

Table 8: Availability of flow ranges for different gas calibrations

¹ Depending on the gas properties, gas recognition allows performing a check whether the activated gas calibration matches the media in the gas line. This is a safety feature, which prevents wrong operation due to mistake of user etc.

Gas	0.05 slm	0.1 slm	0.2 slm	0.5 slm	1 slm	2 slm	5 slm	10 slm	20 slm	50 slm	100 slm
N2	Available MOQ 1pc for Downmount, Swagelock 6mm and VCO1/4" Other fittings MOQ 5pcs										
Air											
O2	Available for OEM projects (MOQ >10 pcs)							On request for OEM projects only			
Ar											
H2											
He											
CO2											
SF6											
C4F8											

8 Revision history

Date	Version	Page(s)	Changes
Jan 2022	V1	all	First Release
September 2022	V2	10	Removed reference to Devicenet & IO-Link

Important Notices

Warning, Personal Injury

Do not use this product as safety or emergency stop devices or in any other application where failure of the product could result in personal injury. Do not use this product for applications other than its intended and authorized use. Before installing, handling, using or servicing this product, please consult the data sheet and application notes. Failure to comply with these instructions could result in death or serious injury.

If the Buyer shall purchase or use SENSIRION products for any unintended or unauthorized application, Buyer shall defend, indemnify and hold harmless SENSIRION and its officers, employees, subsidiaries, affiliates and distributors against all claims, costs, damages and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if SENSIRION shall be allegedly negligent with respect to the design or the manufacture of the product.

ESD Precautions

The inherent design of this component causes it to be sensitive to electrostatic discharge (ESD). To prevent ESD-induced damage and/or degradation, take customary and statutory ESD precautions when handling this product. See application note "ESD, Latchup and EMC" for more information.

Warranty

SENSIRION warrants solely to the original purchaser of this product for a period of 12 months (one year) from the date of delivery that this product shall be of the quality, material and workmanship defined in SENSIRION's published specifications of the product. Within such period, if proven to be defective, SENSIRION shall repair and/or replace this product, in SENSIRION's discretion, free of charge to the Buyer, provided that:

- notice in writing describing the defects shall be given to SENSIRION within fourteen (14) days after their appearance;
- such defects shall be found, to SENSIRION's reasonable satisfaction, to have arisen from SENSIRION's faulty design, material, or workmanship;
- the defective product shall be returned to SENSIRION's factory at the Buyer's expense; and
- the warranty period for any repaired or replaced product shall be limited to the unexpired portion of the original period.

This warranty does not apply to any equipment which has not been installed and used within the specifications recommended by SENSIRION for the intended and proper use of the equipment. EXCEPT FOR THE WARRANTIES EXPRESSLY SET FORTH HEREIN, SENSIRION MAKES NO WARRANTIES, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THE PRODUCT. ANY AND ALL WARRANTIES, INCLUDING WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY EXCLUDED AND DECLINED.

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