

Datasheet SFC5300 / SFM5300, SFC5330 / SFM5330 mass flow controller / meter for gases
August 2021 – V3

- Small form factor and footprint
- Full scale flows between 0.05 ... 5 slm/min
- Excellent accuracy / repeatability of 2% / 0.2% set point respectively
- Very wide control range (better than 1000:1)
- Ultra-fast settling time down to 50 ms
- Digital RS485 interface with temperature-compensated output
- NIST traceable calibration
- Mean Time Between Failures (MTBF) 169 years
- No drift and no re-calibration required in the field



SFX5300
long footprint



SFC5330
short footprint

Unsurpassed CMOSens® Technology

The SFX53x0 series continues Sensirion's pioneering work in MEMS-based mass flow controllers and meters: The heart of this 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 SFX53x0 achieves unmatched ratings for speed, accuracy and repeatability. In addition, no recalibration is needed due to the inherent longterm stability of the CMOSens® technology.

The SFX53x0 series is optimized for small form factors and an attractive cost structure, which makes it the first choice for instrument manufacturers in analytical, medical and process industry. As all Sensirion flow controllers, SFC53x0 offers fastest settling times and a high control range. Optional smart features like multiple gases and ranges, gas recognition and self-test capability are available on request. SFX53x0 is available in two

versions: SFX5300, with a larger body and D-sub connector and SFX5330 – with a smaller body and a compact 4-pin connector. Both are available with longer and shorter base (footprint).

The SFM53x0 is the valve-free flow meter based on the SFC53x0 mass flow controller. It features the same performance advantages and configurations as the MFC counterpart without providing the controller functionality.

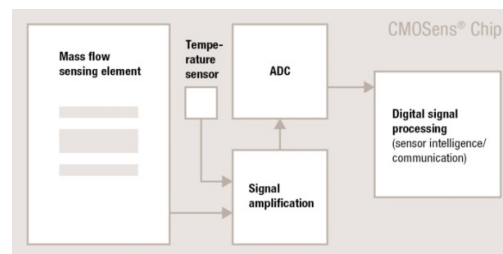


Figure 1: CMOSens® flow sensor diagram.

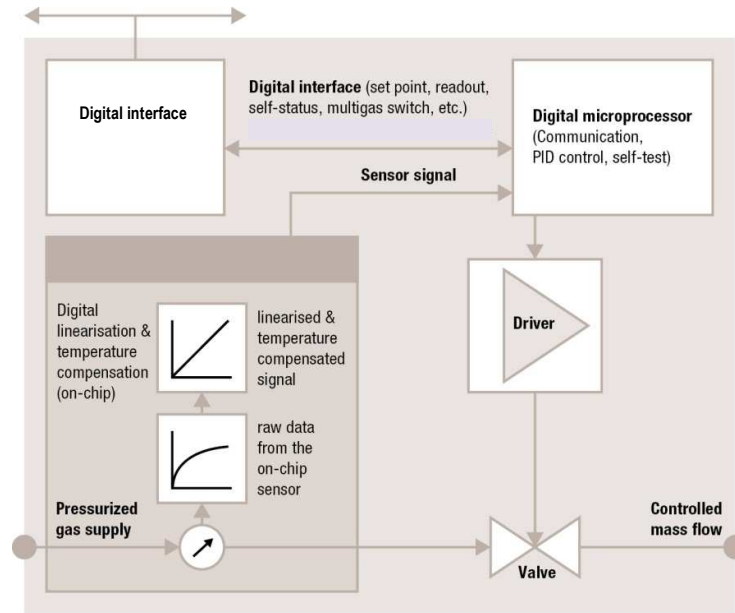


Figure 2: Block Diagram CMOSens® SFC53x0 mass flow controller.

Introductory Description

The CMOSens® based SFX53x0 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 SFC53x0 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 SFX53x0 mass flow controllers / meters show zero-drift performance and control / measure true mass flow independently of the ambient temperature and pressure changes.

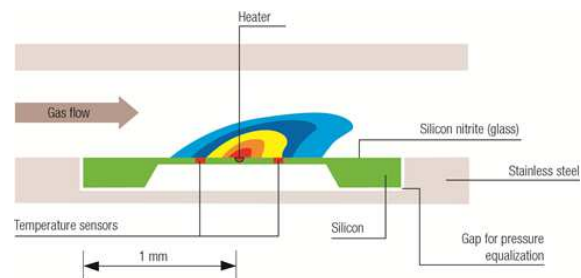


Figure 3: Cross-sectional view of gas channel.

1 CMOSens® SFC53x0 / SFM53x0 mass flow controller / meter performance

Table 1: Overview of CMOSens® SFC53x0 / SFM53x0 Mass Flow Controller / Meter Specifications

All data, unless otherwise noted, apply for the following calibration conditions: Temperature 20°C, Nitrogen (N₂), horizontal mounting position (electric connector on top), downmount connection, 3.0 bar overpressure (inlet: 4.0 bar absolute) against atmosphere (outlet: 1.0 bar absolute) for SFC53x0 and <0.1 bar for SFM53x0.

Specification	Value	Unit
Full scale flow (N ₂ equivalent)	0.05, 0.1, 0.2, 0.5, 1, 2, (5) ¹ , (10)	l _n /min or slm
Accuracy ²	2	% s.p. ³
whichever is greater	0.2	% FS
Repeatability	0.1	% s.p.
whichever is greater	0.01	% FS
Typical settling time ⁴	100 (50 on request)	ms
Measurement frequency	1000	Hz
Control range ⁵	Better than 1000:1	
Standard calibration gases	Air/N ₂ , H ₂ , O ₂ , He, Ar, CO ₂	
Calibrations using gas conversion ⁶ (on request)	SF ₆ , C ₄ F ₈ , CF ₄ , NH ₃ , SiH ₄ , N ₂ O, O ₃ , CO, CH ₄ , CH ₃ F, Xe, Ne, Kr + other gases and 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		
SFC53x0	< 2.0 / 29	bar / psig
SFM53x0	< 0.1 / 1.5	
Maximum input pressure ⁷	10 / 145	bar / psig
Maximum differential pressure ⁸	5 / 73	bar / psig
Leak integrity MFC external	9 x 10 ⁻⁹	mbar l/s He
Warming up time ⁹	1	sec
Weight	95 – 171 (depending on variant)	g

1.1 Accuracy

Figure 4 compares the set point accuracy of a conventional mass flow controller / meter with a CMOSens® SFC53x0. Typically, an accuracy of 2% FS (full scale) is stated for mass flow controllers using conventional sensor technology. The graph shows this

in relation to the accuracy of the SFC53x0 mass flow controller. It can be seen that especially at low flow rates the CMOSens® technology reaches superior performance.

¹ 5 slm and 10 slm variants are only available for Air/N₂ and with reduced performance compared to lower-flow versions. It is recommended to use SFC5400 for flow ranges >2 slm.

² Including offset, non-linearity and hysteresis. Measured against NIST traceable reference

³ in % of set point (s.p.) = measured value (m.v.) = rate = reading

⁴ Step answer from 10% to 100% of full scale within ±5% of set point

⁵ Specification is valid 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

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

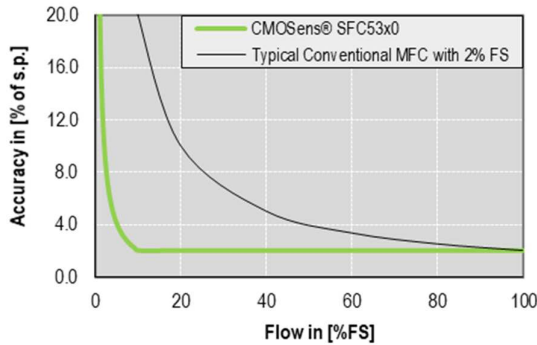


Figure 4: Accuracy comparison of the CMOSens® SFC53x0 / SFM53x0 device compared to a typical thermal mass flow controller / meter.

1.2 Repeatability

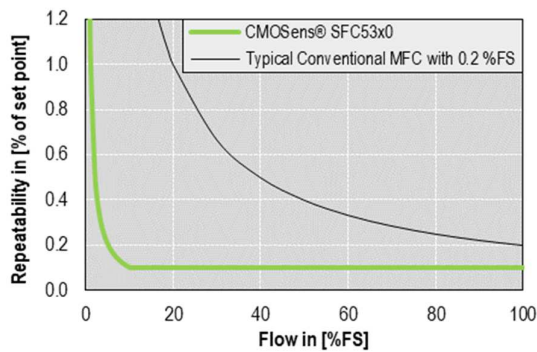


Figure 5: Repeatability comparison of the CMOSens® SFC53x0 / SFM53x0 device compared to a typical thermal mass flow controller/meter.

1.3 Settling time

The CMOSens® SFC53x0 mass flow controller has an ultra-fast settling time. Figure 6 shows the typical response time of the SFC53x0 in comparison to a

mass flow controller using conventional sensor technology.

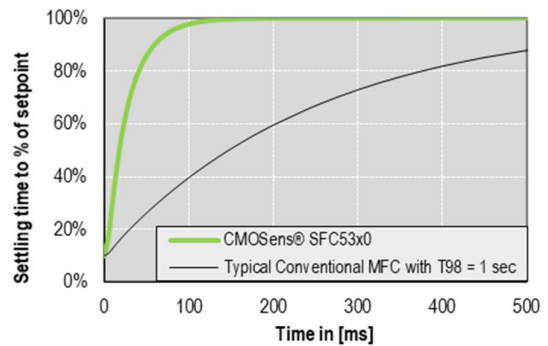


Figure 6: Settling time of the SFC53x0 vs. typical thermal mass flow controller.

1.4 Wide control range

Ultra-wide control range of the SFC53x0 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 SFC53x0 device can efficiently cover a flow range of three orders of magnitude.

1.5 Multiple gases, ranges & gas recognition

SFX53x0 can be equipped with multigas feature allowing switching between a set of gas calibrations saved in the device memory. Similarly, different ranges for the same gas can be stored. Another interesting feature is gas recognition. It 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.

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 aluminium body. The packaging allows the SFX53x0 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 is realized using vacuum tight glass feed through pins. This chosen packaging method ensures high reliability and tightness for all kinds of gases (see Figure 7 below).

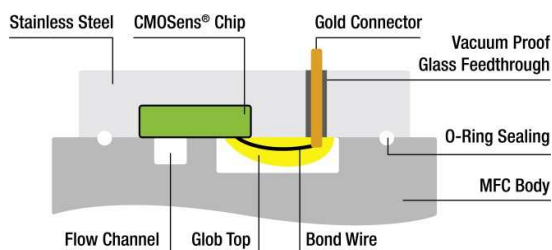


Figure 7: Vacuum tight glass feed through (longitudinal view)

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 applications different specialized materials for body, valve and sealing can be used.

Table 2: Overview of Wetted Materials. Standard configuration materials are shown in bold text. Optional materials are provided for large projects only.

Part	Wetted Material
Body	Aluminum Stainless steel or plastic on request
Sensor element	Silicon (Si) Silicon oxide (SiOx) Silicon nitride (Si₃N₄) Stainless steel Glass Glob top
Sealing	FKM EPDM / FFKM on request
Valve	Brass, FKM Stainless steel, EPDM / FFKM on request

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.

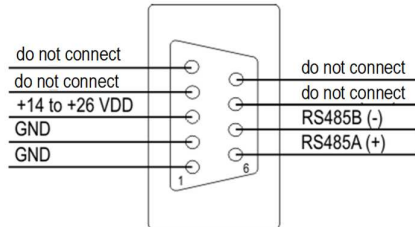
2.3.3 Explosive gases

The maximum heating energy of the sensor is limited to 12 mW in every circumstance, even in the case of a failure. 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 SFC53x0 / SFM53x0 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

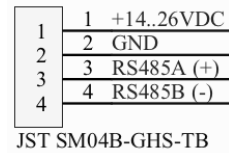
3.1 Connector & pin layout SFC5300

SFC5300 / SFM5300 feature a digital RS485 interface with detailed specifications of the protocol given on the Sensirion website. The electrical connector is a standard Sub-D 9pin which provides an easy and robust connection. The pin layout is shown below:



3.2 Connector & pin layout SFC5330

SFC5330 / SFM5330 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 is shown below:



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 SFC5300 / SFM5300	D-Sub 9pin (male on device)	
Electrical Connector SFC5330 / SFM5330	JST SM04B-GHS-TB	

Table 4: Current consumption

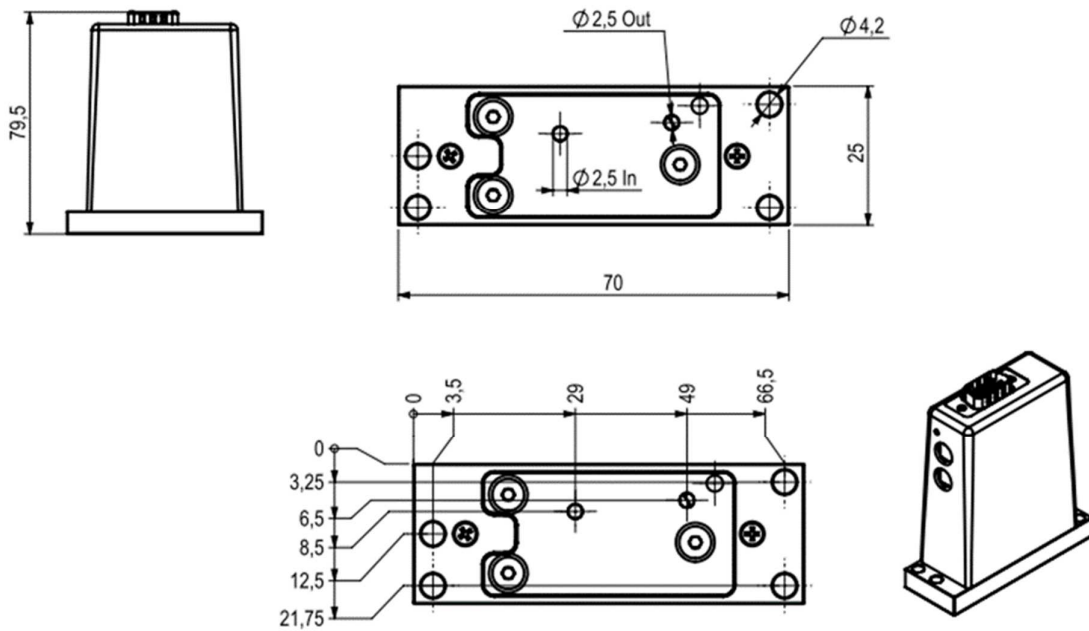
Parameter	Conditions	Typical value (within +/- 5%)	Units
Minimal supply current: standby, valve closed	VDD = 15 / 24 VDC	50 / 35	mA
Maximal supply current: small valve, fully opened, Flow range ≤ 500 sccm N2 equivalent	VDD = 15 / 24 VDC	120 / 75	mA
Maximal supply current: big valve, fully opened, Flow range > 500 sccm N2 equivalent	VDD = 15 / 24 VDC	320 / 200	mA

Table 5: Electromagnetic compatibility. Only valid for SFC/SFM5300, not for SFC/SFM5330

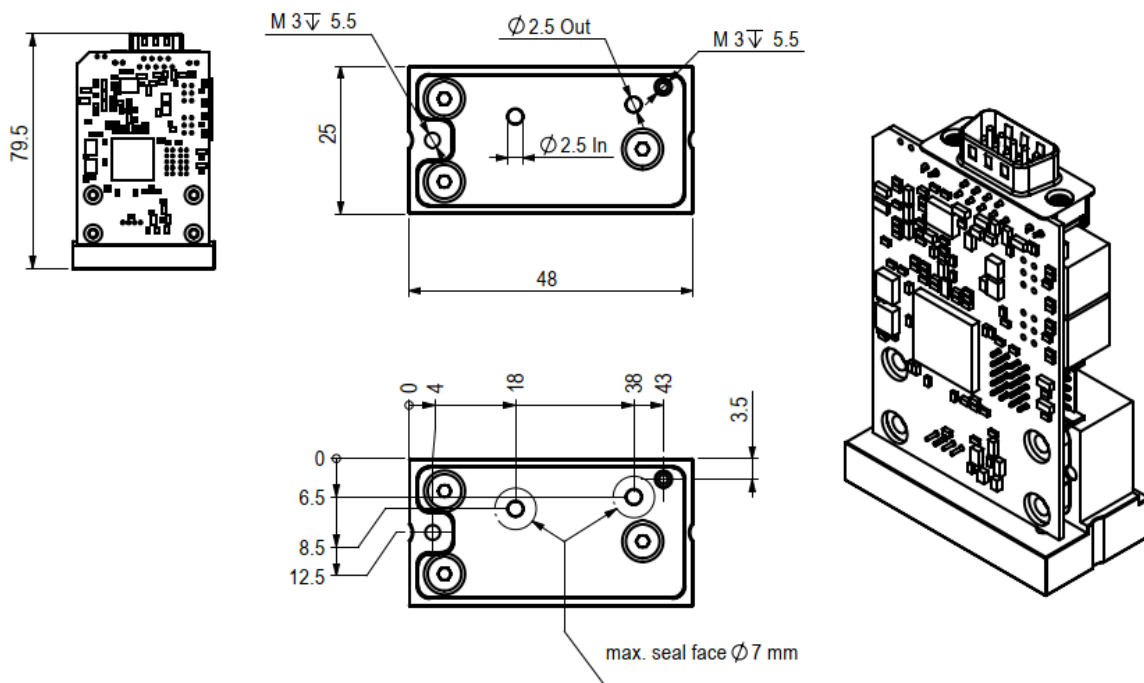
Parameter	Hall mark	Notes	Applied values
Electromagnetic Compatibility / Immunity in Industrial Environment: (EN 61000-6-2)	EN 61000-4-2	Air discharge (ESD)	± 8 kV (air) ± 4 kV (contact)
	EN 61000-4-6	High frequency electromagnetic radiation (HF)	10 V _{eff}
	EN 61000-4-4	Fast transients (burst)	± 4 kV

4 Physical dimensions and mounting information for SFC53x0 / SFM53x0

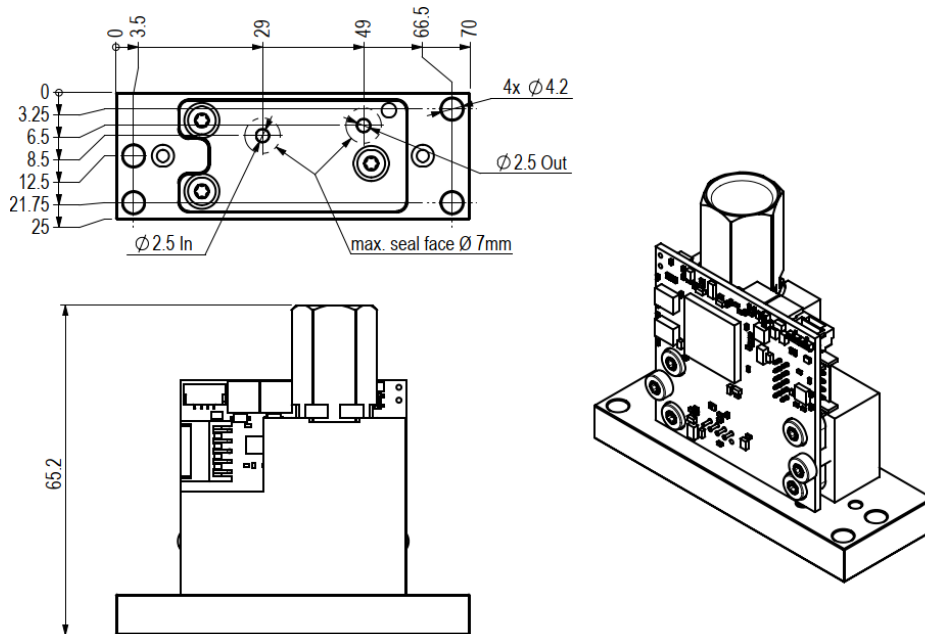
SFC5300 / SFM5300, long footprint with 4 screw holes (K variant). Here shown with the optional cap::



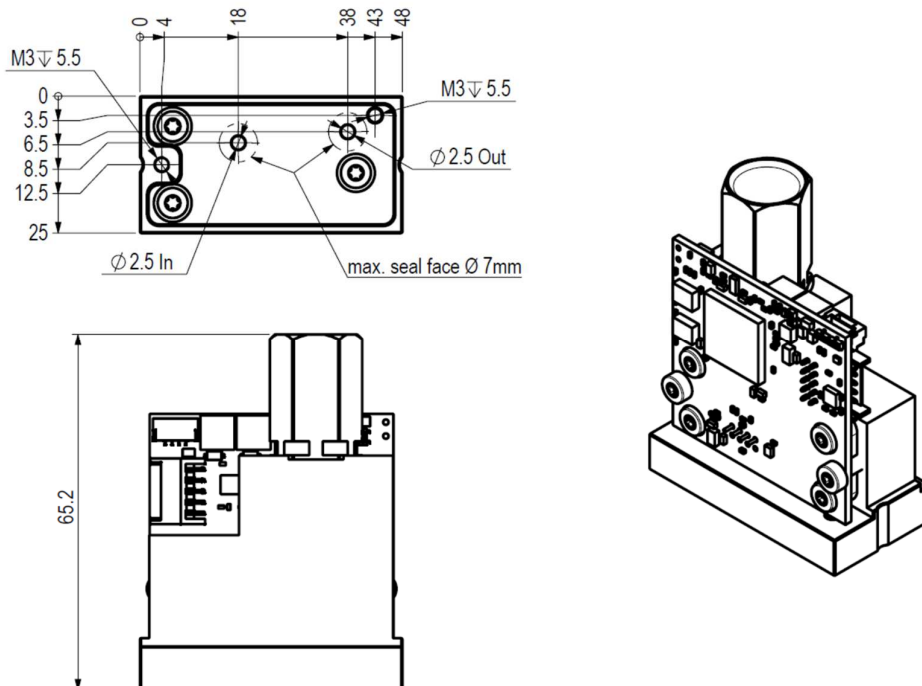
SFC5300 / SFM5300, short footprint with 2 downward facing screw threads (G variant). Here shown without the cap:



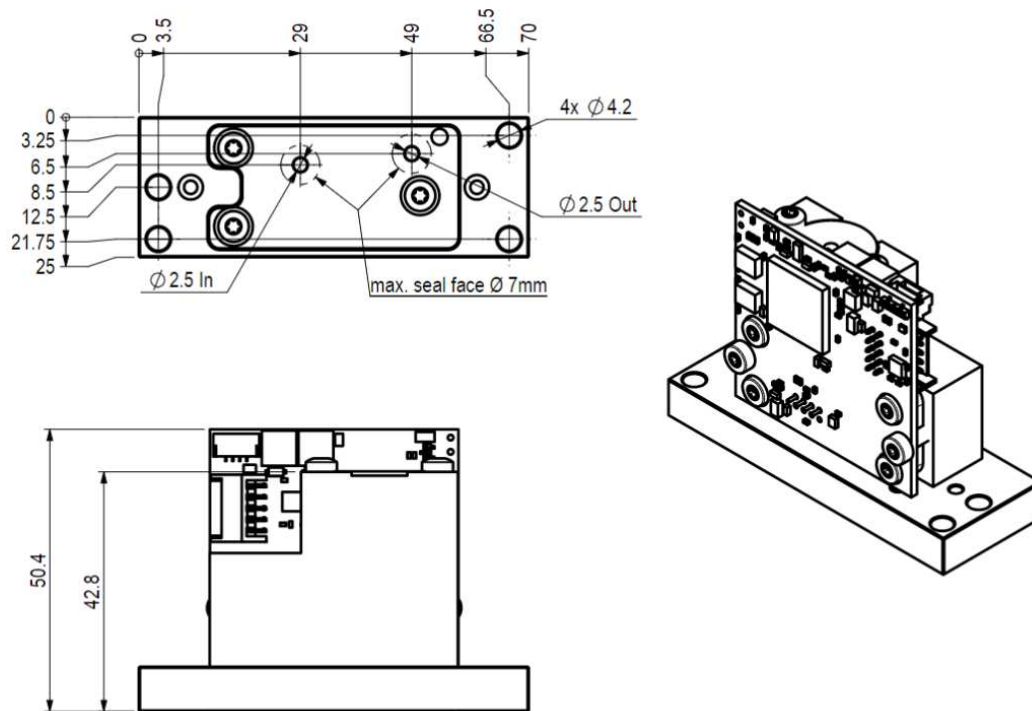
SFC5330, long footprint with 4 screw holes (K variant):



SFC5330 short footprint with 2 downward facing screw threads (G variant):



SFM5330, long footprint with 4 screw holes (K variant; the short variant is also available – no drawing shown):



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 Ordering information

SFC53x0 / SFM53x0 can be ordered by a product specific ordering code.

Example: SFC5300 LAG N2 500 mln/min

Code structure: Product XAZ Gas Range Unit (see Table 6 for explanation)

Table 7: Description and values for SFC53x0 / SFM53x0 ordering codes

Parameter	Value	Description	Where to look in this document
Product Plug / cap	SFC5300	Massflow controller, Sub-D 9pin, green cap by default	Page 1
	SFM5300	Massflow meter, Sub-D 9pin, green cap by default	
	SFC5330	Massflow controller, JST SM04B-GHS-TB, no cap	
	SFM5330	Massflow meter, JST SM04B-GHS-TB, no cap	
X – Electrical Interface	L	Digital RS485 SHDLC	Section 3.1
A – Material Body	A	Aluminum	Table 2
Z – Fitting	G	Downmount, short footprint with two downward facing screw threads	Chapter 4
	K	Downmount, long footprint with four screw holes	
Gas		Air/N ₂ , H ₂ , O ₂ , He, Ar, CO ₂ , SF ₆ , C ₄ F ₈	Table 1
Range		0.05, 0.1, 0.2, 0.5, 1, 2, (5), (10) slm	Table 1
Unit	mln/min	Norm milliliter per minute	Table 6
	ln/min	Norm liter per minute	
	sccm	Standard cubic centimeter per minute	
	slm	Standard liter per minute	

7 Revision history

Date	Version	Page(s)	Changes
September 2016	1	All	
July 2017	2	various	Introducing new Variant SFC5330
August 2021	3	various	Added drawings of more variants. Added notice about reduce performance of 5 and 10 slm variants. Corrected DB9 connector gender specification.

Important notices

Warning, personal injury

Do not use this product as safety or emergency stop device 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.

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.

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FCC and CE statement – SFC/SFM5300 only

The SFC5300 and SFM5300 products have been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules (FCC CFR 47).



The CMOSens® SFC53x0 / SFM53x0 devices fully comply with norm EN 61000-6-1 to EN 61000-6-4 (Immunity and Emission Test Series).



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