Data Sheet – SFM3200

Digital Flow Meter for medical applications

- Superior performance at very low flows
- Low pressure drop
- Inspiratory flow sensor
- Flow range: up to 250 slm

Product Summary

The SFM3200 sensor is Sensirion's digital flow meter designed for high-volume applications. The SFM3200 measures the flow rate of **air, oxygen and other non-aggressive gases** with superb accuracy. A special design of the flow channel results in the very low pressure drop through the flow body of the sensor making it extremely suitable for medical ventilation and respiratory applications.

The SFM3200 is designed to be resilient to rough handling and performs **reliably at variable inlet conditions**. The outstanding performance of these sensors is based on Sensirion's **patented CMOSens® sensor technology**, which combines the sensor element, signal processing and digital calibration on a single microchip. The flow rate of a gas is measured by a thermal sensor element which assures **very fast signal processing time and bidirectional measurement mode with best in class accuracy**. The signal is internally **linearized** and **temperature compensated**.

The well-proven CMOS technology is perfectly suited for high-quality mass production and is the ideal choice for demanding and cost-sensitive OEM applications.

Applications

- Ventilation
- Anesthesia
- Respiratory measurements
- Inspiratory flow measurement
- Drug delivery

OEM options

A variety of custom options can be implemented for high-volume OEM applications (custom flow rates, calibration for other gases, different body form factor etc.).

For a reusable version of this sensor see the SFM3200-AW datasheet.

Contact us for more information.

Sensor chip

The SFM3200 flow meter features a fifth-generation silicon sensor chip. In addition to a thermal mass flow sensor element, the chip contains an amplifier, A/D converter, EEPROM memory, digital signal processing circuitry, and interface. Due to seamless integration of signal acquisition and processing on the single silicon die significant performance and cost benefits are achieved.

1. Sensor Performance

1.1 Physical specifications[1]

Parameter	Condition	Value		Unit
Flow range		-100 … +250		slm[2]
		Typ. [3]	Max [4]	
Accuracy[5]	span (-40 to +80) slm	2	3	% m.v.[6]
	span (-60 to +100) slm	3	5	% m.v[6]
	span whole range	7	10	% m.v[6]
	offset	0.05	0.1	slm[2]
Noise Level[5,7,8]	span <50 slm	0.6	1.0	% m.v[6]
	span >50 slm	1.0	2.0	% m.v[6]
	span >100 slm	1.5	4.5	% m.v[6]
	offset	0.034	0.07	slm[2]
Accuracy Shift Due to Temperature Variation[5,9]	span	0.4	0.5	% m.v./10˚C
	offset	0.015	0.02	slm[2]/10°C
Resolution (14 bit)[5]	span		0.07	% m.v. [6]
	offset		0.034	slm[2]
Pressure drop	@ 60 slm	100 / 0.41	150 / 0.62	Pa / inH_2O
	@ 100 slm	250 / 0.81	300 / 0.97	
	@ 200 slm	750 / 3.02	1100 / 4.44	

1.2 Ambient Conditions

Parameter	Condition	Value	Unit
Calibrated Temperature Range	T(environment)=T(gas); 15% rel. hum.	+10 … +50	°C
Operating Temperature Range	10-95% rel. hum. (non cond.)	+10 … +50	°C
Storage Temperature	10-95% rel. hum. (non cond.)	-25 … +70	°C
Operating Pressure Range	absolute	0.60 – 1.07	bar
Burst Overpressure	gauge	0.78	bar

[1] Unless otherwise noted, all sensor specifications are valid at 25°C with Vdd = 5V and absolute pressure = 966 mbar and horizontal flow direction
[2] slm: mass flow measured in liters per minute at standard conditions (T = 20 °C, p = 1013.25 mbar)
[3] for "Typ" a CpK of 0.67 is targeted (95% of sensors within the Typ limit)
[4] for "Max" no sensor measured outside of this limits will be shipped and a CpK of 1.33 is targeted
[5] Total accuracy/noise level/resolution is a sum of zero-point and span accuracy/noise level/resolution.
[6] %m.v. = % measured value = % of reading
[7] one standard deviation, measured at full sampling rate without averaging
[8] noise level defined as standard deviation of individual sensor readings, measured at full sampling rate (typ: average of noise level ; max: at least 99.99% of sensors have a noise level below indicated value)
[9] these effects need to be added to the initial values if applicable

1.3 Media compatibility

Parameter	Value
Calibration	Air
Media Compatibility	Air (non-condensing), N_2, O_2, other non- aggressive gases
Wetted Materials	Si, Si_3N_4, SiO_x, Gold, Epoxy, Glob Top, PPSU, Polyurethane, stainless steel
RoHS, REACH	RoHS and REACH

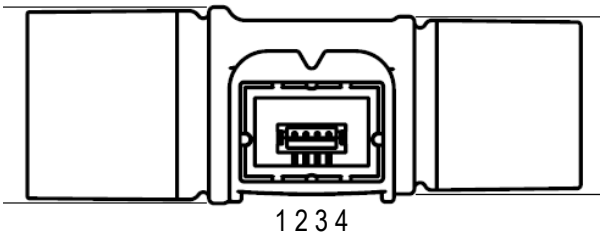
The sensor can be used with gas mixtures, such as O2 and air. Please see application note: "GF_AN_SFM3200_SFM3300_Effects_Humidity_Gas_mixtures" for details.

2. Electrical Specifications

2.1 Electrical characteristics

Electrical properties	Condition	Value		Unit
Interface		I²C		
Default Sensor Address		64 (h40)		
Update Time	14 bit	0.5		ms
Soft Reset Time		80		ms
Start-up Time [10]	Max.	100		ms
I²C bus Clock Frequency	Max.	400		kHz
Supply Voltage		5V +/-5%		V
Communication Level		Min	Max	V
	High	2.5	VDD	
	Low	GND	1.1	
Power Consumption		< 50		mW
Electrical Connector		JST B4B-ZR-SM4-TF (Male)		
Output signal resolution		14		bit
Scale Factor Flow	Air[11]	120		1/slm
Offset Flow		32'768 (h8000)		

2.2 Pin layout



1 2 3 4

Pin	Function
1	SDA
2	GND
3	VCC
4	SCK

2.3 Conversion to Physical Values

In order to obtain the measured flow in [slm], the measured value needs to be converted using the following formula:

$$flow\ [slm] = \frac{measured\ value - offset\ flow}{scale\ factor\ flow}$$

Please note that the first measurement performed directly after chip initialization is not valid.

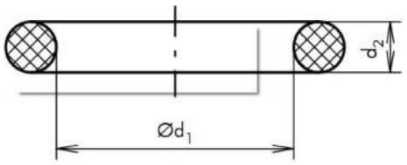
[10] After 4.75V is reached
[11] For compensation for O2 and humidity see application note: "GF_AN_SFM3200_SFM3300_Effects_Humidity_Gas_mixtures".

3. Mechanical Specifications

3.1 Connection with medical cones

Fittings of the SFM3200 sensor correspond to the international standard ISO5356-1:2004. Details about this type of connection can be found in the description of the standard.

3.2 Connection with O-ring



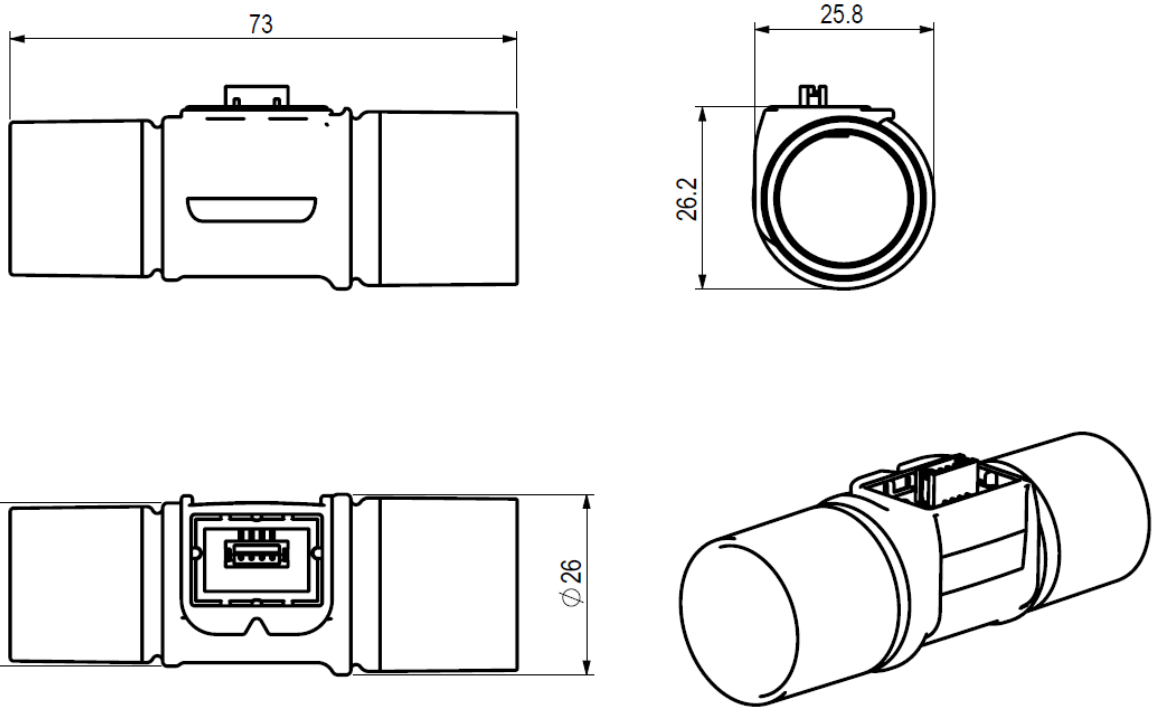
Cross section of recommended O-ring 1

O-ring socket: d_1 = 22 mm, d_2 = 1.5 mm
O-ring cone: d_1 = 20 mm, d_2 = 1.5 mm

3.3 Dimensions

Parameter	Value	Unit
Length	73.0	mm
Inner diameter	19	mm
Downstream conical cone[12]	22	mm
Upstream conical socket[12]	22	mm
Additional connection with O-rings possible (see above)	-	-
Weight	<30	g

All dimensions are in millimetres (mm).

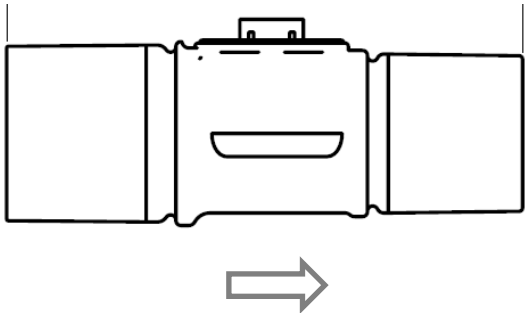


[12] According to ISO5356-1:2004

4. Instructions for Use

4.1 Calibration orientation

The sensors are calibrated horizontally as depicted in the following graph:



Positive flow direction (as marked on the sensor)

4.2 Design guidelines

In order to provide good flow conditions, the inner diameter of the connecting tube has to be approximately the same as the inner diameter of the SFM3200 main flow channel. The inlet tube has to be straight and at least 10 cm in length. The SFM3200 is equipped with meshes on the in- and outlets of the flow channel to reduce turbulences and thus improve the stability.
Please refer to the application note “Inlet conditions for the SFM3000 Mass flow meters” for more information.
Additionally, it is recommended to avoid placing the sensor such that the sensing element is at the bottom. This helps prevent deposition of matter (such as dust particles or water droplets) on the sensing element.

4.3 Temperature compensation

The SFM3200 sensor features digital temperature compensation. The temperature is measured on the CMOSens® chip by an on-chip temperature sensor. This data is fed to a compensation circuit that is also integrated on the CMOSens® sensor chip. Thus, no external temperature compensation is necessary.

4.4 Sensor handling

The packaging method of the CMOSens chip together with the inert housing and the sealing materials ensure a tight and highly resistant sealing of the device. Please be aware that aggressive and corrosive gases can influence the sensor element and may even destroy the sealing or the plastics body.
Please also be careful with the use of explosive or toxic gases. Any leakage even outside the controller can be dangerous.

For the above reasons, Sensirion guarantees the safe use of the CMOSens® Mass Flow Meter for inert, in-explosive and non-toxic gases only.

The SFM3200 sensor is designed to be robust and shock resistant. Nevertheless, the accuracy of the high-precision SFM3200 can be degraded by rough handling. Sensirion does not guarantee proper operation in case of improper handling. **Note:** avoid applying mechanical stress.

4.5 ESD

The electronics of the SFM3200 sensor consist of a single automotive qualified chip. It complies with the following ESD norms:

- AEC Q 100 002 (4kV HBM)
- AEC Q 100 003 (200V MM)

Although the sensor complies with these norms, it does not mean the sensor is immune against ESD.
The sensor is shipped in an antistatic tray to prevent electrostatic discharge. To avoid damage to the sensor, ground yourself using a grounding strap or by touching a grounded object before touching the sensor. Furthermore, store the parts in an antistatic package when not in use.

4.6 I²C Interface and communication

Due to I²C interface restrictions, the cable length from the sensor to the microprocessor is recommended to be as short as possible and certainly not above 30 cm. For wires longer than 10 cm it is mandatory to shield the SDA and SCL.
In case data is read from the sensor, the first data byte of the transaction must always be acknowledged by the master.
It must be possible to reset the sensor through a hard reset, i.e. powering off and on the sensor, in case the sensor freezes.

I²C Communication details are given in the application note “I²C Functional Description for SFM3000 series”.

5. Ordering Information

Use the part names and product numbers shown in the table below when ordering SFM3200 sensors. For the latest product information and local distributors, visit www.sensirion.com.

Part name	Product Number
SFM3200	1-101051-01

Packaging units: 30 items/tray.
Every sensor is traceable by a unique Serial Number.

Revision history

Date	Author	Version	Changes
July 2016	DAT	1	Release
May 2017	SAW	1.1	Changed max storage temperature from 65°C to 70°C

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 (including death). 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 datasheet 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 "Handling Instructions" 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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SENSIRION reserves the right, without further notice, (i) to change the product specifications and/or the information in this document and (ii) to improve reliability, functions and design of this product.

Headquarters and Subsidiaries

SENSIRION AG
Laubisruetistr. 50
CH-8712 Staefa ZH
Switzerland

phone: +41 44 306 40 00
fax: +41 44 306 40 30
info@sensirion.com
www.sensirion.com

Sensirion AG (Germany)
phone: +41 44 927 11 66
info@sensirion.com
www.sensirion.com

Sensirion Inc., USA
phone: +1 805 409 4900
info_us@sensirion.com
www.sensirion.com

Sensirion Japan Co. Ltd.
phone: +81 3 3444 4940
info-jp@sensirion.com
www.sensirion.co.jp

Sensirion Korea Co. Ltd.
phone: +82 31 337 7700~3
info-kr@sensirion.com
www.sensirion.co.kr

Sensirion China Co. Ltd.
phone: +86 755 8252 1501
info-cn@sensirion.com
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