

Data Sheet – SFM3200-AW

Digital Flow Meter for medical applications

- Low pressure drop
- Expiratory flow sensor
- Flow range: -100 slm to +250 slm (bi-directional)
- Superior performance at low flows
- Autoclavable & cleanable



Product Summary

The SFM3200-AW sensor is Sensirion's digital flow meter designed for medical applications. It measures the flow rate of air, oxygen and other non-aggressive gases with superb accuracy. A special design of the flow channel results in a very **low pressure drop** through the flow body of the sensor. Combined with its **ability to withstand autoclave procedures**, the SFM3200-AW is extremely suited to expiratory flow measurements in medical ventilation and other respiratory applications.

The SFM3200 has been designed with the medical professionals in mind. It features medical cones for

pneumatic connection to standard breathing circuits and a mechanical interface for an **easy and reliable electrical reconnection**. The sensor element, signal processing and digital calibration are on a single microchip assuring **very fast signal processing time, best-in-class accuracy** and **superior robustness** to rough handling and adverse conditions.

The well-proven and patented **CMOSens® sensor 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
- Expiratory flow measurement
- Metabolic Measurements

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.). 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 specifications¹

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 full range	7	10	slm ²
	offset	0.05	0.1	
Noise Level ⁷	span <50 slm	0.6	1.0	% m.v. ⁶
	span >50 slm	1.0	2.0	% m.v. ⁶
	span > 100slm	2	4.5	slm ²
	offset	0.034	0.07	
Accuracy Shift Due to Temperature Variation ^{5,8}	span	0.4	0.5	% m.v./10°C
	offset	0.015	0.02	slm/10°C
Resolution (14bit)	span		0.07	% m.v. ⁶
	offset		0.04	slm ²
Pressure drop	@ 60 slm	100 / 0.41	150 / 0.62	Pa / inH ₂ O
	@ 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 ⁹	10-95% rel. hum. (non cond.)	+10 ... +50	°C
Storage Temperature	10-95% rel. hum. (non cond.)	-25 ... +65	°C
Operating Pressure Range	absolute	0.66 – 1.07	bar
Burst Overpressure	gauge	0.25	bar

¹ Unless otherwise noted, all sensor specifications are valid at 25°C with Vdd = 5V and absolute pressure = 966 mbar and horizontal flow.

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/repeatability is a sum of zero-point and span accuracy/repeatability.

⁶ %m.v. = % measured value = % of reading

⁷ 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)

⁸ these effects need to be added to the initial values if applicable

⁹ Do not exceed these operating conditions by heating the sensor excessively with the external heater, see section 4.4.

1.3 Media compatibility

Parameter	Value
Calibration ¹⁰	Air
Media Compatibility	Air, N ₂ , O ₂ , other non- aggressive gases
Wetted Materials	Si, Si ₃ N ₄ , SiO _x , Gold, Epoxy, Glob Top, PPSU, Silicone
RoHS, REACH	RoHS and REACH compliant

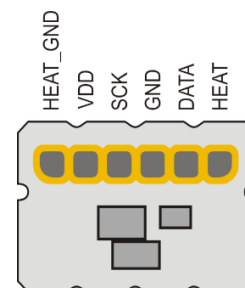
The sensor can be used with gas mixtures, such as breath gas with typically 4% CO₂ and 100% high humidity. Please ask Sensirion for details and error estimates.

2. Electrical Specifications

2.1 Electrical characteristics

Electrical properties	Condition	Value	Unit
Interface		I ² C	
Default Sensor Address		64 (h40)	
Update Time	14 bit	0.5	ms
Soft Reset Time		80	ms
Start-up Time ¹¹	Max.	100	ms
I ² C bus Clock Frequency	Max.	400	kHz
Supply Voltage		5V +/-5%	V
Communication Level	High Low	Min	Max
		2.5 GND	VDD 1.1
Power Consumption ¹²		< 50	mW
Electrical Connector		See section 2.2 and 3.2	
External Heater Power Rating	Max.	0.5	W
External Heater Resistance ¹³	Typ.	51	Ω
Output signal resolution		14	bit
Scale Factor Flow	Air	120	1/slm
Offset Flow		32'768 (h8000)	
Scale Factor Temperature		100	1/°C
Offset Temperature		20'000	

2.2 Pad layout



2.3 Conversion to Physical Values

¹⁰ Contact Sensirion for information about other gases, wider calibrated temperature ranges and higher storage temperatures.

¹¹ After 4.75V is reached

¹² When the external heater resistor is not in operation

¹³ The heater's purpose is to avoid condensation or icing. One should only apply sufficient power to achieve this purpose. See section 4.4 for more details.

In order to obtain the measured flow/temperature in [slm]/[°C], 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.

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.

SFM3200-AW has been designed for use in an expiratory environment. Therefore the sensor has been designed for a connector that can be easily connected and disconnected. The connector itself is not provided by Sensirion as a standard product but Sensirion can help with design recommendations.

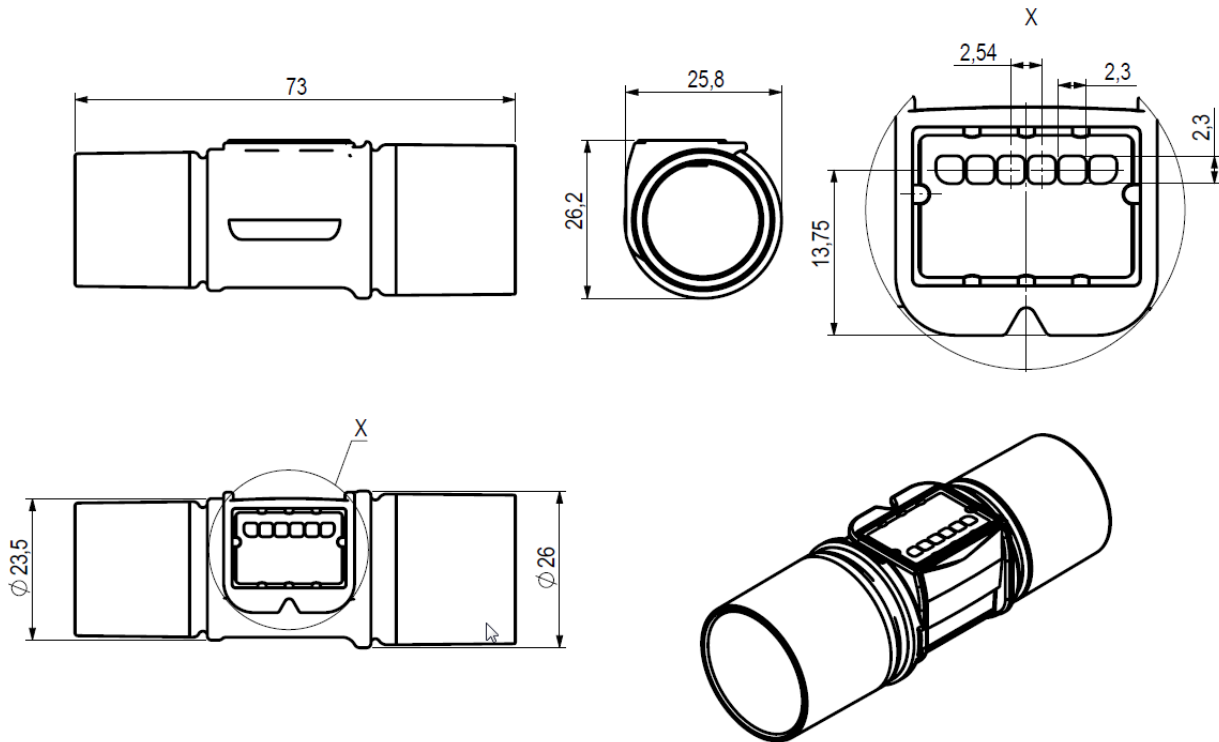
3.2 Mechanical/Electrical Interface

3.1 Dimensions

Parameter	Value	Unit
Length	73.0	mm
Inner diameter	19	mm
Downstream conical cone ¹⁴	22	mm
Upstream conical socket ⁹	22	mm
Weight	<30	g

All dimensions are in millimetres (mm).

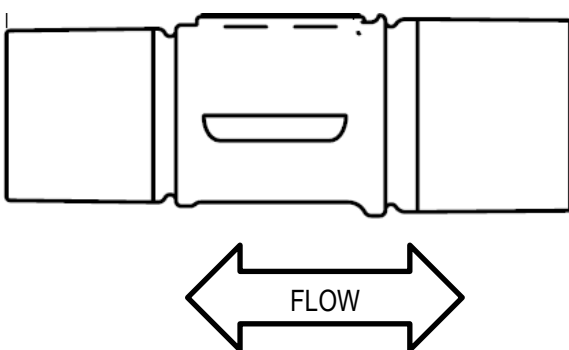
¹⁴ According to ISO5356-1:2004



4. Instructions for Use

4.1 Calibration orientation

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



4.2 Inlet flow conditions

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.

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 Heater operation

The sensor has an external heater for cases where the gas flowing through the sensor contains high humidity and is warmer than the ambient temperature. In such cases, heating the sensor can help to avoid condensation or icing. Sufficient power should be provided for this purpose, but excessive power must be avoided for two reasons:

- 1) to stay within the operating temperature range,
- 2) to maintain the best accuracy.

Reading out the chip temperature can be used as feedback on the current sensor temperature.

4.5 Sensor handling

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: never connect the sensor while connecting part is wet. Especially after cleaning specially care is needed to dry the sensor.

Please be aware that the SFM3200 has been designed for usage with air and other non-corrosive and toxic gases. 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.

4.6 Cleaning (SFM3200-AW version)

The SFM3200-AW has been designed to withstand medical cleaning procedures.

For details of the cleaning tests performed please contact Sensirion.

Sensirion AG does not guarantee the stability of the flow sensor using arbitrary methods and/or equipment for autoclaving. Validation of the flow sensor stability for a specific type of procedure and/or equipment is the sole responsibility of the customer.

4.7 ESD

The electronics of the SFM3200-AW flow sensor chip has been tested for ESD and passed an 8kV contact test.

4.8 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 "GF_AN_SFM3xxx_I²C Functional Description".

There is an additional EEPROM on the SFM3200-AW to allow storage of customer-specific data (like for example usage hours). Please see all details in the datasheet of the EEPROM. The EEPROM is of type 24LC01BT-I/MC. No additional validation or modification of EEPROM settings has been performed by Sensirion.

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-AW	1-101050-01

Packaging units: 30 items/tray.

Every sensor is traceable by a unique Serial Number.

Revision history

Date	Author	Version	Changes
December 2015	DAT	0.5	Changed status to D1
January 2018	DAT	1	Full release
March 2022	PSIM	1.1	Added section 4.4 and footnotes about heater operation

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.

SENSIRION is only liable for defects of this product arising under the conditions of operation provided for in the datasheet and proper use of the goods. SENSIRION explicitly disclaims all warranties, express or implied, for any period during which the goods are operated or stored not in accordance with the technical specifications.

SENSIRION does not assume any liability arising out of any application or use of any product or circuit and specifically disclaims any and all liability, including without limitation consequential or incidental damages. All operating parameters, including without limitation recommended parameters, must be validated for each customer's applications by customer's technical experts. Recommended parameters can and do vary in different applications.

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.

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