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 specifications[1]

Parameter	Condition	Value		Unit
Flow range		-100 … +250		slm[2]
		Typ. [3]	Max [4]	
Accuracy[5]	span (-40 to +80) slm span (-60 to +100) slm span full range offset	2 3 7 0.05	3 5 10 0.1	% m.v.[6] slm[2]
Noise Level[7]	span <50 slm span >50 slm span > 100slm offset	0.6 1.0 2 0.034	1.0 2.0 4.5 0.07	% m.v[6] % m.v[6] slm[2]
Accuracy Shift Due to Temperature Variation[5,8]	span offset	0.4 0.015	0.5 0.02	% m.v./10˚C slm/10˚C
Resolution (14bit)	span offset		0.07 0.04	% m.v. [6] slm[2]
Pressure drop	@ 60 slm @ 100 slm @ 200 slm	100 / 0.41 250 / 0.81 750 / 3.02	150 / 0.62 300 / 0.97 1100 / 4.44	Pa / inH_2O

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_3N_4, SiO_x, Gold, Epoxy, Glob Top, PPSU, Silicone
RoHS, REACH	RoHS and REACH compliant

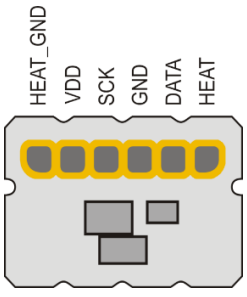
The sensor can be used with gas mixtures, such as breath gas with typically 4% CO_2 and 100% high humidity. Please ask Sensirion for details and error estimates.

2. Electrical Specifications

2.1 Electrical characteristics

Electrical properties	Condition	Value		Unit
Interface		I^2C		
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^2C 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 [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.

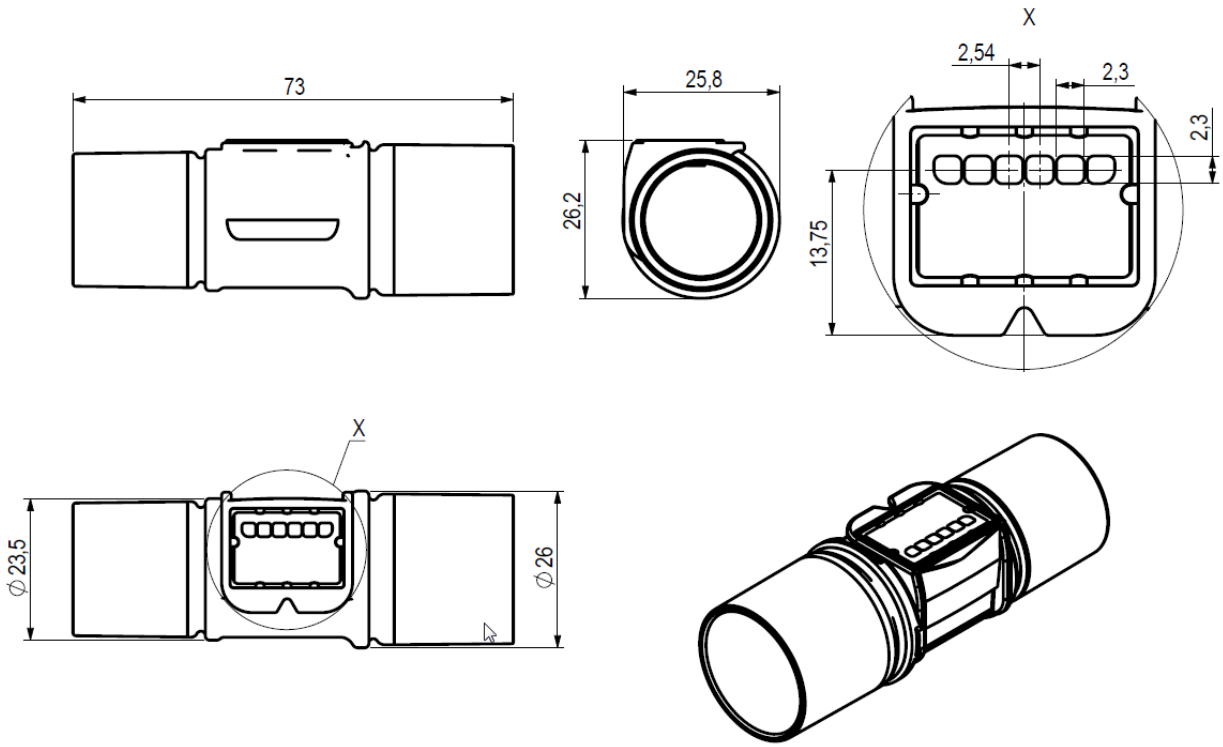
3.2 Mechanical/Electrical Interface

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).

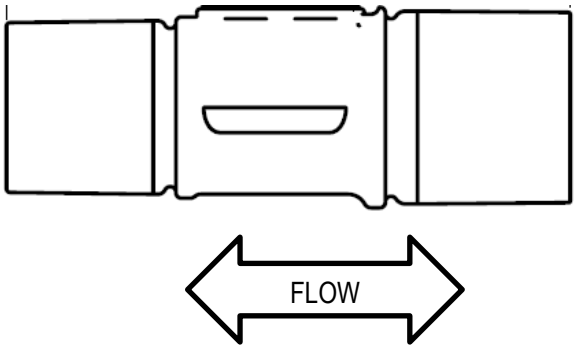
[14] According to ISO5356-1:2004



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 he 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