

Preliminary 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 | 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

1.3 Media compatibility

| Parameter | Value |
|--------------------------|---|
| Calibration ⁹ | 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

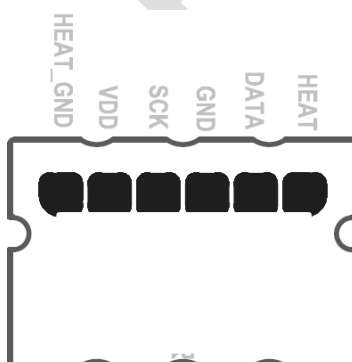
2.1 Electrical characteristics

| 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 ¹⁰ | Max. | 100 | ms |
| Supply Voltage | | 5V +/-5% | V |
| Communication Level | High | Min 2.5 | V |
| | Low | Max VDD 1.1 | |
| Power Consumption | | < 50 | mW |
| Electrical Connector | | See section 2.2 and 3.2 | |
| External Heater Power Rating | Max. | 0.5 | W |
| External Heater Resistance | 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 | |

⁹ Contact Sensirion for information about other gases, wider calibrated temperature ranges and higher storage temperatures.

¹⁰ After 4.75V is reached

2.2 Pin layout



2.3 Conversion to Physical Values

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.

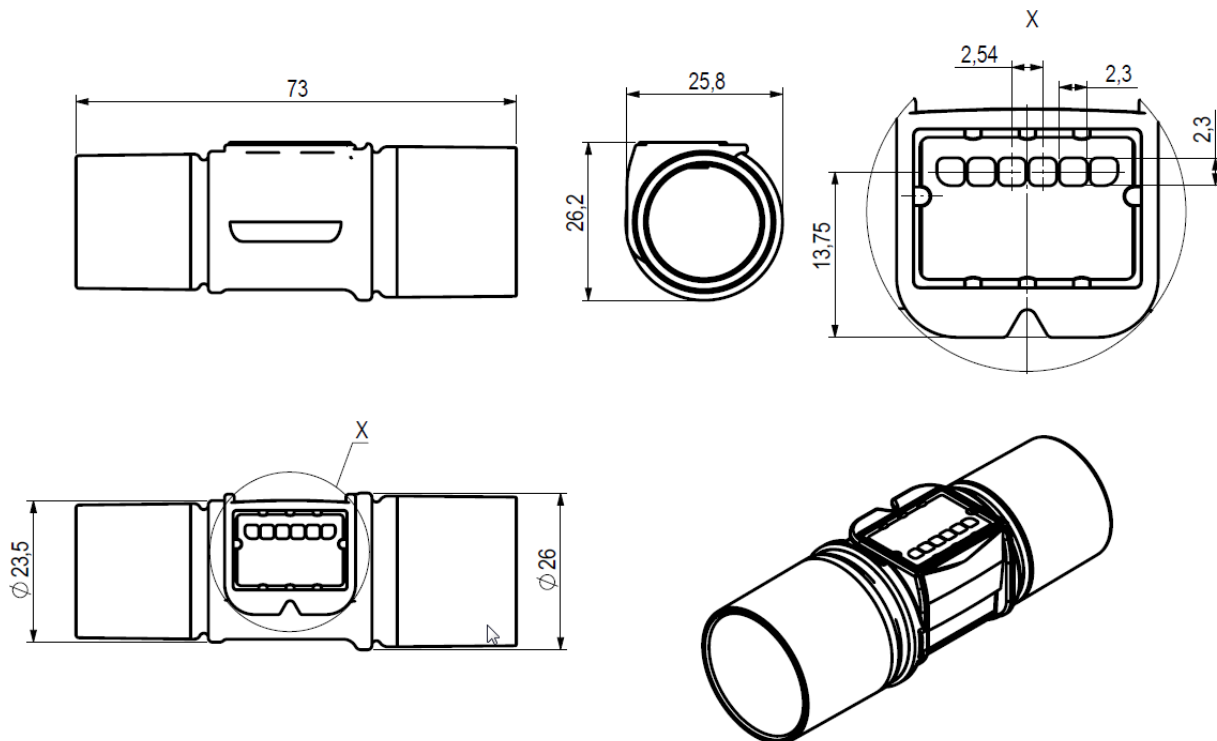
3.2 Mechanical/Electrical Interface

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.

3.1 Dimensions

| Parameter | Value | Unit |
|---------------------------------------|-------|------|
| Length | 73.0 | mm |
| Inner diameter | 19 | mm |
| Downstream conical cone ¹¹ | 22 | mm |
| Upstream conical socket ⁹ | 22 | mm |
| Weight | <30 | g |

All dimensions are in millimetres (mm).

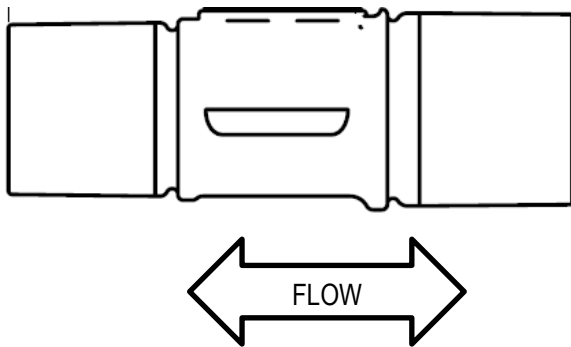


¹¹ According to ISO5356-1:2004

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 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 special 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.

4.5 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.

4.6 ESD

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

4.7 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".

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.

Preliminary

6. Disclaimer

This is a preliminary datasheet. All parameters are based on our best knowledge and understanding. These values are subject to change as the development and qualification of the sensor progresses. Therefore these values may differ from those of the final product.

Please contact Sensirion regarding any questions you have.

Please treat all information contained herein strictly confidential.

Revision history

| Date | Author | Version | Changes |
|---------------|--------|---------|--|
| March 2014 | DAT | 0.2 | First release |
| Nov 2014 | DAT | 0.31 | Preliminary datasheet release |
| May 2015 | DAT | 0.4 | Update after first qualification tests; released preliminary version |
| December 2015 | DAT | 0.5 | Changed status to D1 |

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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Headquarters and Subsidiaries

SENSIRION AG
Laubisruestr. 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@sensirion.co.jp
www.sensirion.co.jp

Sensirion Korea Co. Ltd.
phone: +82 31 345 0031 3
info@sensirion.co.kr
www.sensirion.co.kr

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

To find your local representative, please visit www.sensirion.com/contact