

## Datasheet SFM3300-D Datasheet SFM3300-AW Digital Flow Meter for medical applications

- Flow range:  $\pm 250$  slm, bidirectional
- Small dead space < 10ml
- Single use (-D) version
- Re-use (-AW) version
- Very fast update time (0.5ms)



### Product Summary

The SFM3300 series is Sensirion's digital flow meter series designed for medical applications. It measures the flow rate of **air, oxygen and other non-aggressive gases** with superb accuracy. The special design of the flow channel results in a **very small dead space**.

The SFM3300-D is the disposable single-use Version. The re-use version SFM3300-AW **withstands washing and autoclaving procedures**. Both versions are extremely well suited for proximal flow measurements in medical ventilation and other respiratory applications.

The SFM3300 series has been designed with the use by medical professionals in mind. It features **medical cones** for pneumatic connection to standard breathing circuits and a mechanical interface for **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

- Proximal Flow measurement
- Expiratory flow measurement
- For Ventilation & Anesthesia
- Respiratory measurements
- Metabolic Measurements

### OEM options

A variety of custom options can be implemented for high-volume OEM applications (custom flow rates, calibration for other gases etc.). Contact us for more information.

### Sensor chip

The SFM3300 series 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.

## 1.1 Physical specifications <sup>1</sup>

| Parameter                                                    | Condition     | Value                    |                  | Unit                    |
|--------------------------------------------------------------|---------------|--------------------------|------------------|-------------------------|
| Flow range                                                   |               | -250 ... +250            |                  | slm <sup>2</sup>        |
|                                                              |               | Typical                  | Max <sup>3</sup> |                         |
| Accuracy <sup>4</sup>                                        | span <100 slm | 3 <sup>5</sup>           | 5                | % m.v. <sup>6</sup>     |
|                                                              | span >100 slm | 7 <sup>5</sup>           | 10               | % m.v. <sup>6</sup>     |
|                                                              | offset        | 0.1 <sup>5</sup>         | 0.2              | slm <sup>2</sup>        |
| Noise Level <sup>4,7</sup>                                   | span <25slm   | 2.0 <sup>8</sup>         | 2.5              | % m.v. <sup>6</sup>     |
|                                                              | span >25slm   | 3 <sup>8</sup>           | 5                | % m.v. <sup>6</sup>     |
|                                                              | offset        | 0.1 <sup>8</sup>         | 0.2              | slm <sup>2</sup>        |
| Accuracy shift for deviation from Reference temperature 25°C | span          | 0.4 <sup>8</sup>         | 0.5              | % m.v./10°C             |
|                                                              | offset        | 0.015 <sup>8</sup>       | 0.02             | % m.v./10°C             |
| Resolution (14bit)                                           | span          |                          | 0.07             | % m.v. <sup>6</sup>     |
|                                                              | offset        |                          | 0.034            | slm <sup>2</sup>        |
| Pressure drop                                                | @ 60 slm      | 180 / 0.73 <sup>8</sup>  | 230 / 0.93       | Pa / inH <sub>2</sub> O |
|                                                              | @ 100 slm     | 380 / 1.53 <sup>8</sup>  | 550 / 2.21       | Pa / inH <sub>2</sub> O |
|                                                              | @ 200 slm     | 1400 / 5.62 <sup>8</sup> | 1900 / 7.63      | Pa / inH <sub>2</sub> O |

## 1.2 Ambient conditions

| Parameter                                | Condition                                                         | Value       | Unit  |
|------------------------------------------|-------------------------------------------------------------------|-------------|-------|
| Calibrated Temperature Range             | Dry gas                                                           | +10 ... +50 | °C    |
| Operating Temperature Range <sup>9</sup> | 10-95% rel. hum. (non cond.)                                      | +5 ... +50  | °C    |
| Extended Operating Range                 | Recommended to use on-sensor heater                               | -20...+5    | °C    |
| Storage Temperature                      | 10-95% rel. hum. (non cond.)                                      | -40 ... +70 | °C    |
| Shelf Life for SFM3300-D                 | 15°C - 35°C; 30 - 70 % rel. hum.<br>storage in original packaging | 3           | years |
| Operating Pressure Range                 | absolute                                                          | 0.54 – 1.1  | bar   |
| Burst Overpressure                       | gauge                                                             | 0.3         | bar   |

<sup>1</sup> Reference conditions are temperature = 25°C, absolute pressure = 966 mbar, horizontal flow and Vdd = 5V

<sup>2</sup> slm: mass flow measured in liters per minute at standard conditions (T = 20 °C, p = 1013.25 mbar)

<sup>3</sup> for "Max" no sensor measured outside of this limits will be shipped and a CpK of 1.33 is targeted

<sup>4</sup> For accuracy, noise level or resolution the total value is the sum of offset and span values

<sup>5</sup> This value corresponds to a CpK of 0.67 (95% of sensors within the "Typical" limit)

<sup>6</sup> %m.v. = % measured value = % of reading

<sup>7</sup> Noise level defined as standard deviation of individual sensor readings, measured at full sampling rate

<sup>8</sup> Average value

<sup>9</sup> 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 <sup>10</sup>    | Air                                                                                                  |
| Media Compatibility          | Air (non-condensing), N <sub>2</sub> , O <sub>2</sub> , other non- aggressive gases                  |
| Wetted Materials –AW version | Si, Si <sub>3</sub> N <sub>4</sub> , SiO <sub>x</sub> , Gold, Epoxy, PPSU, silicone, stainless steel |
| Wetted Materials –D version  | Si, Si <sub>3</sub> N <sub>4</sub> , SiO <sub>x</sub> , Gold, Epoxy, MABS, silicone                  |
| RoHS, REACH                  | RoHS and REACH compliant                                                                             |

## 2. Electrical Specifications

### 2.1 Electrical characteristics

| Electrical properties                      | Condition   | Value                 |                    | Unit  |
|--------------------------------------------|-------------|-----------------------|--------------------|-------|
| Interface                                  |             | I <sup>2</sup> C      |                    |       |
| Default Sensor Address                     |             | 64 (h40)              |                    |       |
| Update Time                                | 14 bit      | 0.5                   |                    | ms    |
| Soft Reset Time                            |             | 80                    |                    | ms    |
| Start-up Time <sup>11</sup>                | Max.        | 100                   |                    | ms    |
| I2C bus Clock Frequency                    | Max.        | 400                   |                    | kHz   |
| Supply Voltage                             |             | 5V±5%                 |                    | V     |
| Communication Level                        | High<br>Low | Min.<br>2.5<br>GND    | Max.<br>VDD<br>1.1 | V     |
|                                            |             |                       |                    |       |
| Power Consumption <sup>12</sup>            |             | < 50                  |                    | mW    |
| Electrical Connector                       |             | See section 0 and 3.2 |                    |       |
| External Heater Power Rating <sup>13</sup> | Max.        | 0.5                   |                    | W     |
| External Heater Resistance                 | Typ.        | 51                    |                    | Ω     |
| Output signal resolution <sup>14</sup>     |             | 14                    |                    | bit   |
| Scale Factor Flow                          | Air, N2     | 120                   |                    | 1/slm |
| Offset Flow                                |             | 32768                 |                    |       |

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

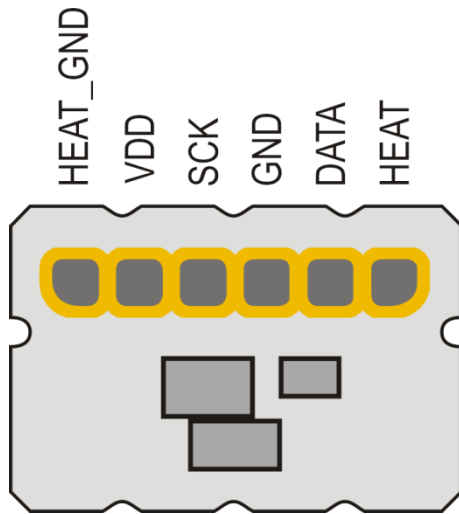
<sup>11</sup> After 4.75V is reached

<sup>12</sup> When the heater resistor on the PCB is not in operation

<sup>13</sup> 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.

<sup>14</sup> 16 bit with two least significant bits always zero

## 2.2 Pad layout



## 2.3 Conversion to Physical Values

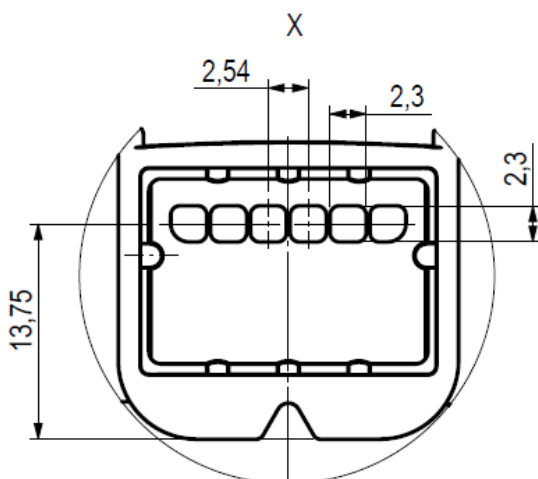
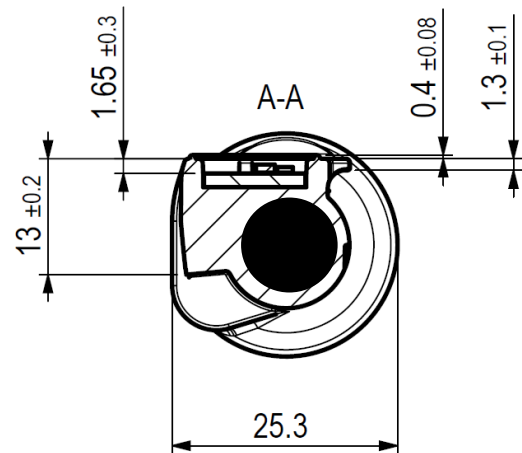
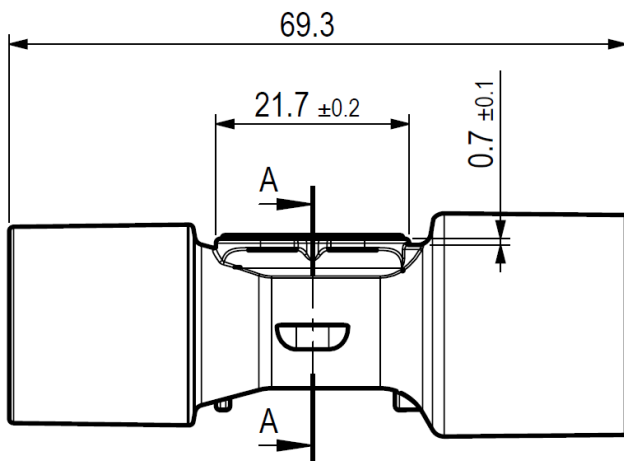
In order to obtain the measured flow in [slm], the measured value needs to be converted using the following formula:

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

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

## 3. Mechanical Specifications

All dimensions are in millimeters (mm).



### 3.1 Mechanical fitting

Fittings of the SFM3300 series sensors 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

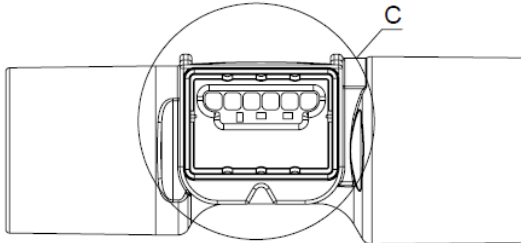
SFM3300 series sensors have been designed for use in an proximal/expiratory environment. Therefore the sensor connector has been designed for an easy and reliable connection and disconnection. The connector itself is not provided as a standard product by Sensirion but Sensirion can help with an application note including design recommendations.

| Dimension               | Condition | Value | Unit |
|-------------------------|-----------|-------|------|
| Length                  |           | 69.3  | mm   |
| Diameter Flow channel   |           | 11.25 | mm   |
| Proximal medical cone   | Inner     | 15    | mm   |
| Proximal medical socket | Outer     | 22    | mm   |
| Distal medical socket   | Inner     | 22    | mm   |
| Distal medical cone     | Outer     | 15    | mm   |
| Dead space              |           | <10   | ml   |
| Weight                  |           | <20   | g    |

## 4. Instructions for Use

### 4.1 Calibration orientation

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



← Positive flow direction  
(also marked on the sensor body)

Positive flow direction is from the female 22 mm cone to the male 22 mm medical cone, so that inspiratory flows are positive and expiratory flows negative.

### 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 SFM3300 main flow channel. The SFM3300-AW is equipped with meshes on the in- and outlets of the flow channel to reduce turbulences and thus improve the stability. In contrast the SFM3300-D has been designed without meshes as stability after re-use is not needed for a single use sensor.

### 4.3 Temperature compensation

The SFM3300 series sensors feature 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 Reprocessing (applies only to SFM3300-AW version)

The SFM3300-AW has been designed to withstand medical cleaning procedures. For details of the test and the results 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 SFM3300 flow sensor chip has been tested for ESD and passed an 8kV contact test. For ESD information about the additional EEPROM available on the SFM3300-AW version (type: 24LC01BT-I/MC) please consult the datasheet of the EEPROM.

### 4.7 Sensor handling

The SFM3300 series sensors have been designed to be robust and shock resistant. Nevertheless, the accuracy of the high-precision SFM3300 sensors 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 procedure special care is needed to dry the sensor.

Please be aware that SFM3300 has been designed for usage with air and other non-corrosive and non-toxic gases.

If leak tightness is critical in customer application it remains customer's sole responsibility to leak-test the sensor before usage.

### 4.8 I<sup>2</sup>C Interface and communication

Due to I<sup>2</sup>C 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.

I<sup>2</sup>C Communication details are given in the application note "GF\_AN\_SFM3xxx\_I<sup>2</sup>C Functional Description".

**SFM3300-AW only:**

There is an additional EEPROM on the SFM3300-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 SFM3300 series sensors. For the latest product information and local distributors, visit [www.sensirion.com](http://www.sensirion.com).

| Part name      | Product Number |
|----------------|----------------|
| SFM3300-250-AW | 1-101052-01    |
| SFM3300-250-D  | 1-101053-01    |

Packaging units: 30 items/tray.

Every sensor is traceable by a unique Serial Number.

## Revision history

| Date         | Author | Version | Changes                                                                                   |
|--------------|--------|---------|-------------------------------------------------------------------------------------------|
| July 2017    | SAW    | 1.0     | Release SFM3300-D                                                                         |
| Sep 2018     | DAT    | 1.1     | Added shelf life for SFM3300-D version on page 2; Removed rev history before version 1.0; |
| January 2019 | DAT    | 1.2     | Fully released also –AW version                                                           |
| January 2022 | PSIM   | 1.3     | Note on operating temperature conditions and heater's operation                           |
| March 2022   | PSIM   | 1.4     | Added section 4.4                                                                         |

## 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.

### 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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