Datasheet SFM3000

Low Pressure Drop Digital Flow Meter

- Low pressure drop
- Flow range: +/- 200 slm (bidirectional)
- Accuracy 1.5% m.v. (typical)
- Very fast update time (0.5ms)
- Fully calibrated & temperature compensated
- Zero offset, no drift



Product Summary

The SFM3000 sensor is Sensirion's digital flow meter designed for high-volume 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 the very low pressure drop through the flow body of the sensor making it extremely suitable for very demanding applications, such as medical ventilation and respiratory applications.

The SFM3000 operates from a 5 Volt supply voltage and features a digital 2-wire I²C interface. The measurement results are internally **linearized** and **temperature compensated**.

The outstanding performance of this sensor 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 the gas is measured by a thermal sensor element which assures **very fast signal processing time and bi-directional measurement with best-in-class accuracy**.

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

- Medical
- Process automation
- Burner control
- Fuel cell control
- Spectroscopy
- Environment monitoring
- Laboratory

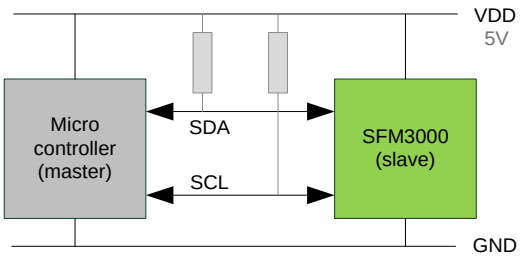
OEM options

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 SFM3000 flow meter features a fifth-generation silicon sensor chip SF05. 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.

Connection diagram



SFM3000 with bidirectional digital communication (I²C bus)

1. Sensor Performance

1.1 Physical specifications [1]

Parameter	Condition	Value		Unit
Flow Ranges	Air/N_2/O_2	-200 … +200 [2]		slm [3]
Update Time	14 bit	0.5		ms
		Max.	Typ.	
Accuracy [4,5,6,7]	span offset	±2.5 ± 0.1	±1.5 ± 0.05	% m.v. [8] slm
Repeatability [4,7]	span offset	±1 ± 0.05	±0.5 ± 0.02	% m.v. slm
Noise Level [4,7]	span offset	±1 ± 0.1	±0.5 ± 0.05	% m.v. slm
Accuracy Shift Due to Temperature Variation [9]	span offset	± 0.75 ± 0.0	± 0.25 ± 0.0	% m.v./10°C slm
Position sensitivity [10]	non-horizontal position	< 0.05		slm
Pressure Drop	@60slm @200slm	< 100 / < 0.4 < 600 / < 2.4		Pa / inH_2O

1.2 Media compatibility

Parameter	Value
Calibration [11]	Air, N_2, O_2
Media Compatibility	Air, N_2, O_2, other non- aggressive gases
Wetted Materials	PPE+PS blend (Noryl HN731SE, medical grade: biocompatible; ISO 10993 or USP Class VI), Si, Si_3N_4, SiO_x, Gold, Epoxy (FR04, FP4401), , Polyurethane, stainless steel (DIN 1.4301/AISI 304, annealed),
RoHS, REACH, WEEE	RoHS, REACH and WEEE compliant

1.3 Ambient conditions

Parameter	Condition	Value	Unit
Calibrated Temperature Range	15-95% rel. hum. (non cond.)	-20 … +85	°C
Operating Temperature Range	15-95% rel. hum. (non cond.)	-40 … +85	°C
Storage Temperature	10-95% rel. hum. (non cond.)	-40 … +85	°C
Operating Pressure Range	absolute	0.7 – 1.3	bar
Burst Overpressure	gauge	> 1	bar

[1] Unless otherwise noted, all sensor specifications are valid at 25°C with Vdd = 5V and absolute pressure = 966 mbar.
[2] Optional calibration up to ±300 slm range is available for large volume projects
[3] In standard liter per minute at 20°C and 1013 mbar
[4] With ideal inlet and outlet conditions, at VDD = 5V, 25°C, absolute pressure = 966 mbar
[5] Including offset, non-linearity, hysteresis
[6] Sensor position horizontal (see Section 4.1)
[7] Span or offset value, whichever is larger
[8] In % of measured value (m.v.) = of rate = of reading
[9] Shift due to temperature variation compared to calibration temperature
[10] See Section 4.1
[11] Contact Sensirion for information about other gases, wider calibrated temperature ranges and higher storage temperatures.

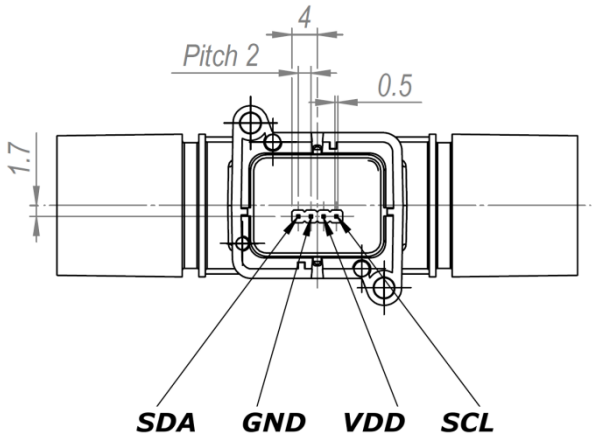
2. Electrical Specifications

2.1 Electrical characteristics

Electrical properties	Condition	Value		Unit
Interface		I^2C		
Default Sensor Address		64 (h40)		
Soft Reset Time		80		ms
Start-up Time [12]	Max.	100		ms
Supply Voltage (VDD)		5V +/-5%		V
Communication Level		Min.	Max.	V
	High	2.5	VDD	
	Low	GND	1.1	
Power Consumption		< 50		mW
Electrical Connector		2 mm pitch, 4 pins in a row		
Output signal resolution		14[13]		bit
Scale Factor Flow	Air, N2	140		1/slm
	O2	142.8		
Offset Flow		32'000		

[12] After 4.75V is reached
[13] 16 bit with two least significant bits always zero

2.2 Pin layout and mechanical concept of the electrical connection



Positive flow direction
(as marked on the sensor body)

The SFM3000 is designed for both connector attachment and through-hole technology hand-soldering to a PCB.

2.2.1 Connector attachment

The SFM3000 sensor's 4-pin 2 mm pitch electrical connector is compatible with Molex DuraClik™ socket (Molex product number: 502351-0400). For this type of connection please order the SFM3000 with a cap (according to the ordering information in Chapter 5). Diverse 4-core flat ribbon cables with crimp fittings can be used for electrical connection.

2.2.2 PCB soldering

Standard selective soldering systems may be used for soldering SFM3000 sensors. Reflow soldering is not feasible and may damage the sensor. The sensor ports must be protected from solder splash and flux during soldering. The characteristics of selective soldering machines vary, so any soldering setup must be tested before production use.

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:

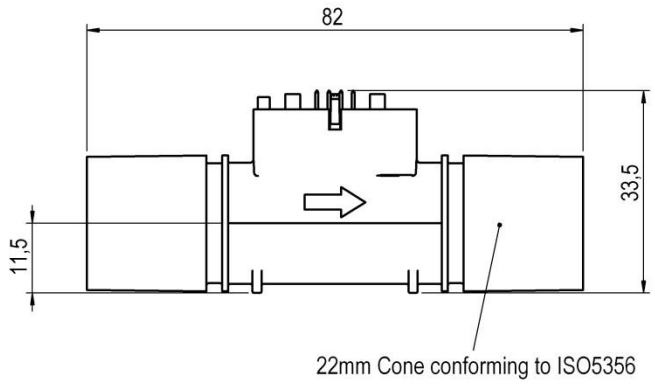
$$flow\ [\mathrm{slm}] = \frac{measured\ value - offset\ flow}{scale\ factor\ flow}$$

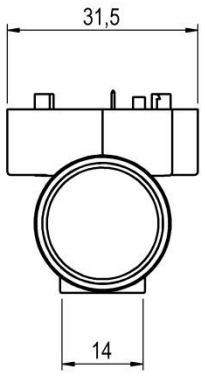
Please note that the first measurement performed directly after chip initialization is not valid.

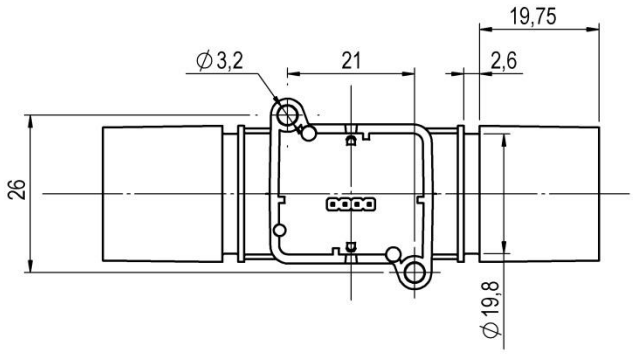
3. Mechanical Specifications

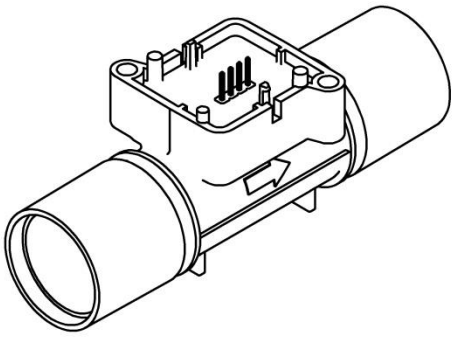
All dimensions are in millimeters (mm).

3.1 SFM3000 without cover (PCB mount version)



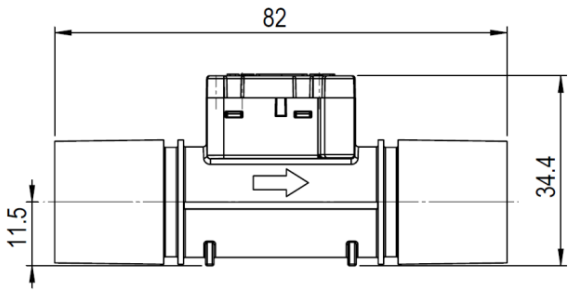






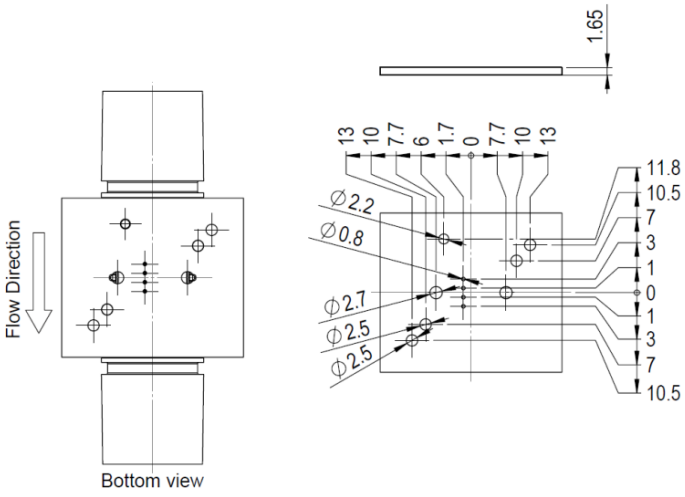
3.2 SFM3000 with cover

If used with cover, sensor height is 34.4 mm instead of 33 mm. All the other dimensions remain the same



3.3 Footprint

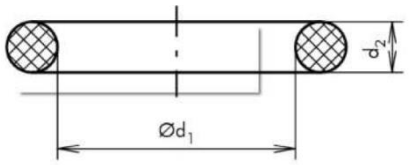
Please refer to the mask given below for reliable PCB attachment using the dedicated snap-in feet.



3.4 Mechanical fitting

Fittings of the SFM3000 sensor correspond to the international standard ISO5356-1:2004. Details about this type of connection can be found in the description of the standard. To minimize the risk of connectors being accidentally disconnected, latching connectors can be suggested.

It is also possible to insert O-rings in the grooves and attach tubes with an inner diameter of 23 mm to the SFM3000.



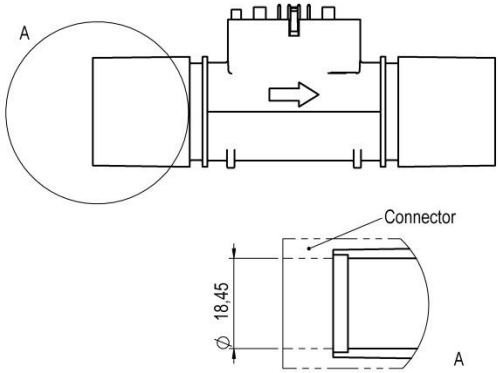
d_1 = 19mm
d_2 = 2mm

Cross section of recommended O-ring

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 SFM3000 main flow channel. The inlet tube has to be straight and at least 10 cm in length. The SFM3000 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 SFM3000 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 SFM3000 sensor is designed to be robust and shock resistant. Nevertheless, the accuracy of the high-precision SFM3000 can be degraded by rough handling. Sensirion does not guarantee proper operation in case of improper handling. **Note:** avoid applying any mechanical stress to the solder joints of the sensor during or as a result of PCB assembly.

4.5 ESD

The electronics of the SFM3000 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”.

5. Ordering Information

Use the part names and product numbers shown in the table below when ordering SFM3000 sensors. For the latest product information and local distributors, visit www.sensirion.com.

Part name	Cap	Product Number 1-100xxx-xx
SFM3000-200-C	With	932-01
SFM3000-200	Without	934-01

Packaging units: 20 items/tray.
Every sensor is traceable by a unique Serial Number.

Revision history

Date	Author	Version	Changes
July 2013	ANB	1	First release
February 2014	ANB	2	Updated material to Noryl

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.

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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REACH, RoHS and WEE Statement

The SFM3000 sensor complies with requirements of the following directives:

- EU Directive 1907/2006/EC concerning Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)
- EU Directive 2002/96/EC on waste electrical and electronic equipment (WEEE), OJ13.02.2003; esp. its Article 6 (1) with Annex II.
- EU Directive 2002/65/EC on the restriction of certain hazardous substances in electric and electronic equipment (RoHS), OJ01.01.2011

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