

## SFC4000

### Ultra-Fast CMOSens® Mass Flow Controller for Gases

- High accuracy Mass Flow Controller (0.8% of set point for 10 – 100% FS)
- Ultra fast settling time (<100ms to within 2% of setpoint)
- CMOSens technology
- Analog interface (0-5Vdc)
- Unipolar Power Supply (14 to 24 Vdc)
- Down-mount, VCR, VCO fittings
- Digitally calibrated & temperature compensated
- NIST traceable calibration

Product Information March 2009 – v25



Swagelok fittings



Downmount fittings

## CMOSens® SFC4000 Product Summary

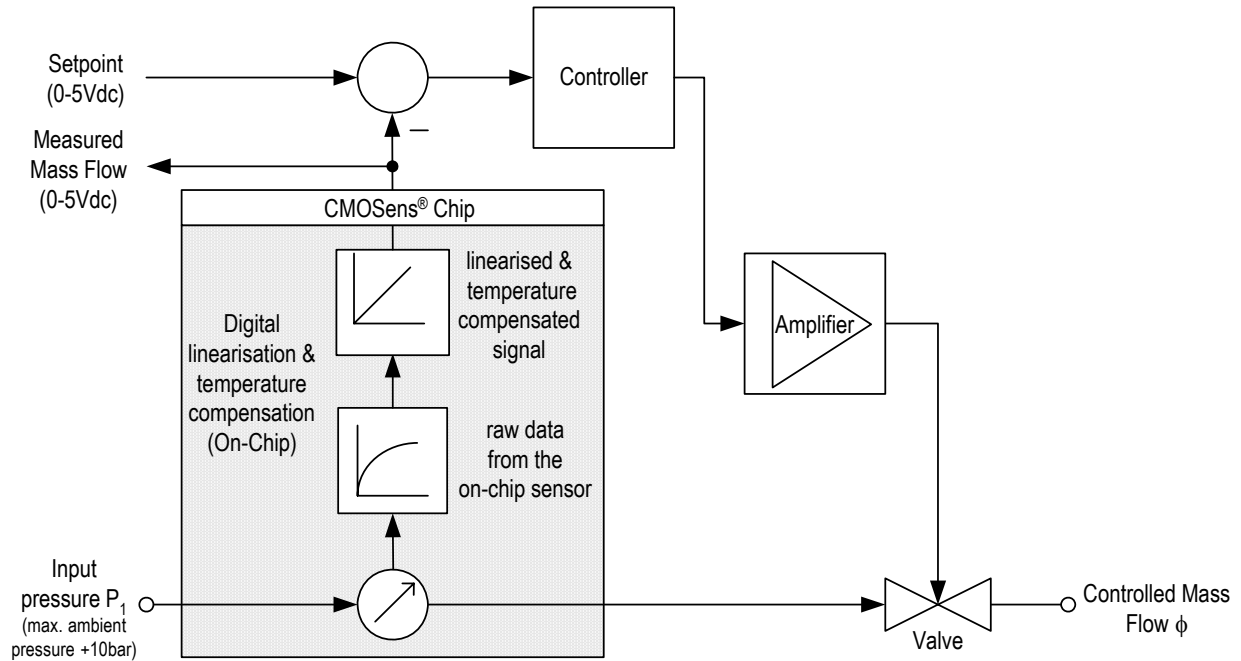
The CMOSens® SFC4000 mass flow controller enables the very fast and accurate control of gas flows over a very wide range. Its leading performance is based on Sensirion's unsurpassed CMOSens® sensor technology which combines a high precision sensor element with the amplification and A/D converter circuit on one single CMOS chip. The digital calibrated and temperature compensated sensor signal is converted directly on the CMOSens® chip into a PWM signal which is used in a fast analog controlling circuit to control the valve. This results in very high accuracy, fast settling time and large dynamic range.

The CMOSens® sensor is packed in a vacuum tight stainless steel package which is mounted on a rugged

aluminum housing. This makes the SFC4000 mass flow controller the best choice for a wide range of applications, such as mass flow controlling in process control, analytical instrumentation, medical applications, fuel cells, as well as gas flow metrology.

The SFC4000 provides analog electrical interfaces for input and output signals (0 – 5 V) and requires a standard supply voltage between 14 and 24 VDC. It can be operated at input pressures of up to 10 bar (145 psi).

The SFC4000 is the result of intensive optimizations of the Sensirion PC1 mass flow controller. The new SFC4000 is highly compatible to the PC1 and offers even better specifications and a simpler power supply concept.


 Figure 1: Block Diagram CMOSens<sup>®</sup> SFC4000 Mass Flow Controller.

## Introductory Description

The overall performance of a mass flow controller depends mainly on the mass flow sensor used in it. The heart of the SFC4000 Mass Flow Controller is powered by Sensirion's unsurpassed CMOSens<sup>®</sup> sensor technology. The SFC4000 Mass Flow Controller therefore provides very high performance and accuracy at very attractive system cost.

A CMOSens<sup>®</sup> flow sensor comprises the sensing element on a miniaturized membrane and complete signal processing for linearization and temperature compensation on a silicon chip and is manufactured using CMOS standard processes.

Due to the symmetrical arrangement of the two temperature sensors on this membrane, an additional temperature sensor for the temperature compensation data and the high end A/D conversion and amplification on the same chip the unbeatable performance with regard to repeatability and accuracy is achieved.

The minimal thermal mass of the membrane results in a sensor response time of 1.7 ms only. Since the whole design of the amplification, A/D conversion, digital linearization and temperature compensation are matched to that sensor speed, a fully compensated flow measurement value is delivered every 0.7 milliseconds.

These key advantages of the CMOSens<sup>®</sup> technology allow very fast and very stable and accurate flow control using conservative and stable control algorithms.

Another advantage of the CMOSens<sup>®</sup> technology is its resistance to electromagnetic disturbances (EMC). The CMOSens<sup>®</sup> sensor itself is packed in a vacuum tight stainless steel package which is mounted on a rugged aluminum housing. This allows the use of the SFC4000 Mass Flow Controller for a wide range of applications.

The SFC4000 device controls true mass flow independent of the ambient temperature and pressure changes. You simply connect the gas supply of the gas to be controlled to the SFC4000 device, set the flow value via the analog interface and get additional feedback via the analog output signal. The analog interface allows an easy connection to the SFC4000 device.

The standard calibration gas is nitrogen, or Air. Calibration with other gases such as O<sub>2</sub>, He, H<sub>2</sub> are available of the shelf. Calibrations for SF<sub>6</sub>, C<sub>4</sub>F<sub>8</sub> and several other gas types are available for large volume OEM customers.

## 1 CMOSens® SFC4000 Mass Flow Controller Performance

Table 1: Overview of CMOSens® SFC4000 Mass Flow Controller Specifications

All data, unless otherwise noted, apply for calibration conditions and refer to the setpoint: 20°C, Nitrogen (N<sub>2</sub>), 2.0 bar overpressure (inlet, 3.0 bar absolute) against atmosphere (outlet, 1.0 bar absolute), horizontal mounting position, straight VCR inlet fitting (length min. 5 x ∅) or down-mount.

Specification	Condition	Value				Unit
<b>Range:</b>						
Model Number		SFC4100		SFC4200		
Full Scale Flow (Air equivalent)		0.05	0.5	2 , 5	20	l <sub>n</sub> /min
<b>Performance:</b>						
Accuracy <sup>1, 2</sup>	10 - 100% FS <sup>3</sup>	0.8	0.8	0.8	1	% s.p. <sup>4</sup>
	<10% FS	0.08	0.08	0.08	0.1 <sup>5</sup>	% FS
Repeatability	10-100% FS	0.1	0.1	0.1	0.2	% s.p.
	<10% FS	0.01	0.01	0.01	0.02	% FS
Typical Settling Time <sup>6</sup>	10-100% FS	< 100	< 100	< 100	< 250	ms
Offset <sup>7</sup>		< 0.08	< 0.08	< 0.08	< 0.1	% FS
Standard Calibration Gas <sup>8</sup>		N <sub>2</sub>		Air		
Other gases		See paragraph Ordering Information at end of this data sheet				
Control Range		≥ 1:1'000				
Operating Temperature (Ambient and Gas)		0 – 50 / 32 – 122				°C / °F
Temp. Coeff. Zero		0.005				% FS / °C
Temp. Coeff. Span		0.06				% s.p. / °C
Position Sensitivity correction <sup>9</sup>		on request				% FS
Pressure Coefficient		< -0.15 / 1 bar				% s.p.
Pressure Drop at Full Flow <sup>10</sup>	p <sub>abs.</sub> = 1 bar gas: air	<0.5 / 22	<2.0 / 29	<2.0 / 29	<3.0 / 43	bar / psig
Maximum Input Pressure <sup>11</sup>		10 / 145	10 / 145	10 / 145	10 / 145	bar / psig
Maximum Differential Pressure <sup>12</sup>		5 / 73	5 / 73	5 / 73	4 / 58	bar / psig
Leak Integrity MFC external		1 x 10 <sup>-6</sup>				mbar l/s He
Leak Integrity through closed Valve		1 x 10 <sup>-6</sup>				mbar l/s He
Wetted Materials		Si, Si <sub>3</sub> N <sub>4</sub> , SiOx, Viton®, SSL316L, Glob Top, Glass, Al, Brass				
Warming Up time <sup>13</sup>		5				sec.

<sup>1</sup> Including Offset, Non-Linearity, Hysteresis

<sup>2</sup> Specification (%s.p.) for 0.05l<sub>n</sub>/min version valid from 20% to 100% of full scale.

<sup>3</sup> in % of full scale (FS)

<sup>4</sup> in % of setpoint (s.p.) = measured value (m.v.) = of rate = of reading

<sup>5</sup> For Setpoints <4%FS (0-0.2V) the Accuracy is 0.3%FS

<sup>6</sup> Step answer within 10% and 100% of full scale to within ±2% of setpoint. 3.0bar input pressure, 1.0bar ambient/outlet pressure. Gas type: N<sub>2</sub>. (Depending on gas type, this specification may vary from 30 to 300 ms).

<sup>7</sup> Output at 0.00V setpoint

<sup>8</sup> Other gases for volume applications on request

<sup>9</sup> For any other position than horizontal flow path mounting, electrical connector on top, value given applicable for N<sub>2</sub> only, may vary with gas

<sup>10</sup> 1 bar = 100 000 Pa = 0.9869 atm = 401.9 inch H<sub>2</sub>O = 14.5 psi. For availability of lower pressure drop option, contact Sensirion AG

<sup>11</sup> Pressure between flow inlet and ambient

<sup>12</sup> Pressure between flow inlet and flow outlet. For availability of higher differential pressure option, contact Sensirion AG

<sup>13</sup> up to within ±2 % of setpoint (s.p.)

### 1.1 Accuracy

Figure 2 compares the setpoint accuracy of a conventional mass flow controller with a CMOSens<sup>®</sup> SFC4000. Typically an accuracy of 1% FS (full scale) is stated for mass flow controllers using conventional sensor technology. The graph shows this in relation to the accuracy of the SFC4000 mass flow controller. It can be seen that especially at low flow rates the CMOSens<sup>®</sup> technology reaches superior performance.

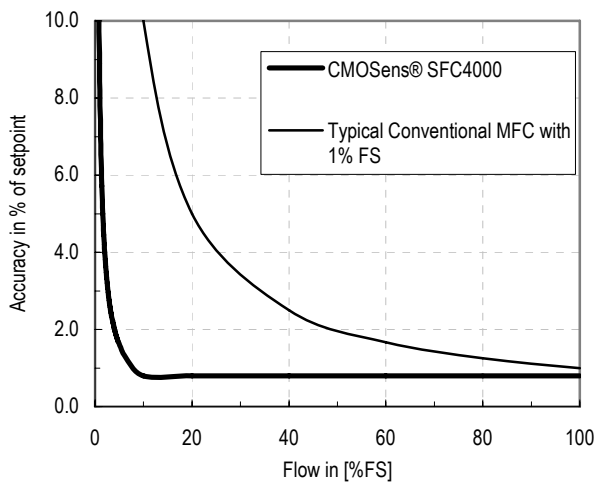


Figure 2: Comparison of typical accuracies

### 1.2 Repeatability

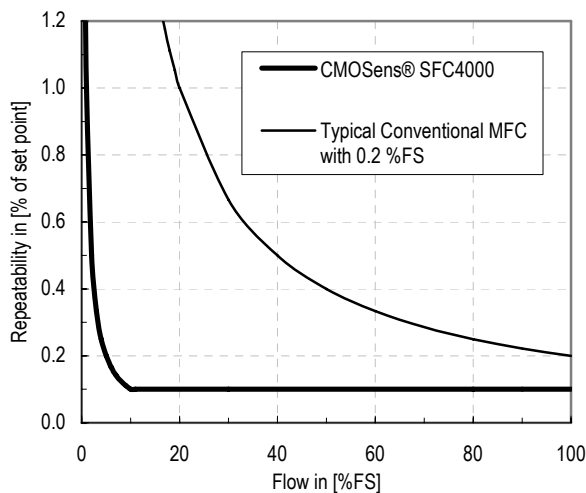


Figure 3: Comparison of the repeatability of the CMOSens<sup>®</sup> SFC4000 device compared to a typical mass flow controller (MFC).

In Figure 3 the repeatability of the SFC4000 devices is compared with the repeatability of a typical mass flow controller (MFC). It emphasizes the superior performance of the SFC4000 device.

### 1.3 Settling Time

The CMOSens<sup>®</sup> SFC4000 Mass Flow Controller has a ultra-fast settling time<sup>14</sup> of less than 100 ms only. Figure 4 shows the typical response time of the SFC4000 in comparison to a mass flow controller using conventional sensor technology.

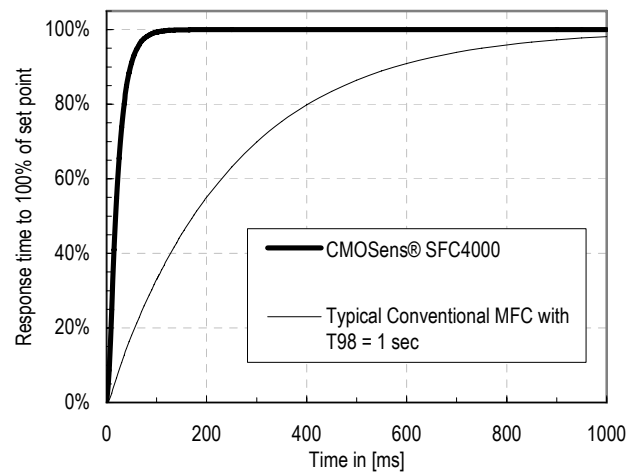


Figure 4: Settling time of the SFC4000 to 100% of set point

<sup>14</sup> Settling time: Time the controller needs to be within 2% of his new setpoint after a change.

## 2 Working Principle of the CMOSens<sup>®</sup> Mass Flow Controller

### 2.1 Calorimetric Principle for Mass Flow Measurement

The CMOSens<sup>®</sup> SFC4000 measures the mass gas flow using the calorimetric principle of measuring heat transfer. A heating element on a thermally insulated membrane is kept above ambient temperature. In the presence of gas flow, the temperature distribution up- and downstream is disturbed. This asymmetry is then measured. The whole arrangement is carried out on a silicon chip using CMOS standard processes. Due to the minimal thermal mass of the membrane, symmetrical arrangement, and accurate temperature measurement, the revolutionary specifications of the SFC4000 devices are achieved.

The arrangement on a CMOSens<sup>®</sup> chip also allows the cross sectional diameter of the sensor channel to be 0.9 x 1.5 mm, which is much larger than structures in conventional mass flow controllers (i.e. 0.3 – 0.5 mm diameter). This channel design makes the technology more robust against i.e. particle polluted or humidified gasses.

In Figure 7 the cross sectional view of the sensor itself sitting in its stainless steel package is shown (see section 2.4 for packaging details).

### 2.2 CMOSens<sup>®</sup> sensor technology

CMOSens<sup>®</sup> is the base technology for all Sensirion sensor modules and sensor systems. The unification of semiconductor chip and sensor technology serves as a platform for highly integrated system solutions with excellent sensor precision and reliability. With CMOSens<sup>®</sup>, the on-chip sensor element forms an integrated whole with a high-end amplification and A/D converter circuit. Due to the compact single-chip design, CMOSens<sup>®</sup> based sensors are very resistant to electromagnetic disturbances (EMC). This is another important technical advantage of this state of the art sensor technology. As a result, CMOSens<sup>®</sup> based multi sensor modules offer excellent sensor precision, fast response time and a very large dynamic measurement range.

In addition to the flow sensor, the CMOSens<sup>®</sup> chip also incorporates a temperature sensor which constantly measures the temperature of the chip and due to the small thermal mass also the temperature of the gas. This temperature information is used directly for the temperature compensation.

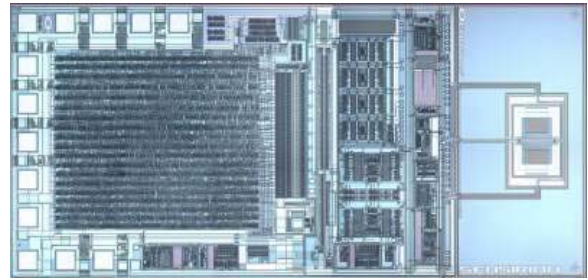


Figure 5: Picture of a CMOSens<sup>®</sup> chip

### 2.3 Signal processing

The CMOSens<sup>®</sup> chip used in the SFC4000 Mass Flow Controller is able to communicate directly with an external EEPROM.

In combination with on-chip intelligence the output signal of the chip can be linearized, temperature compensated and calibrated using the calibration data stored in the EEPROM. The generated PWM output signal of the CMOSens<sup>®</sup> chip is then directly used in the controller circuit for the control of the valve and subsequently the mass flow.

With its internal clock rate of several hundred kHz the CMOSens<sup>®</sup> chip measures the flow very rapidly and precisely. The generated flow signal is then processed by the on-chip A/D and linearization and temperature compensation is calculated. The final PWM signal of the CMOSens<sup>®</sup> sensor chip is ready to use for the controller circuit of the valve.

The complete layout of the CMOSens<sup>®</sup> flow chip is strictly designed for best performance of each element and for fast and effective interaction between each other. This ensures optimal signal processing at very high precision and speed.

Since the produced PWM signal is very fast, accurate flow control can be reached by using conservative and stable control algorithms.

Based on the high integration on the CMOSens<sup>®</sup> chip, excellent sensor precision is reached resulting in high performance of the whole CMOSens<sup>®</sup> SFC4000 Mass Flow Controller at very attractive system cost.

Figure 6 shows the typical flow and temperature signal path of a CMOSens<sup>®</sup> flow chip as it is also used in the SFC4000 series.

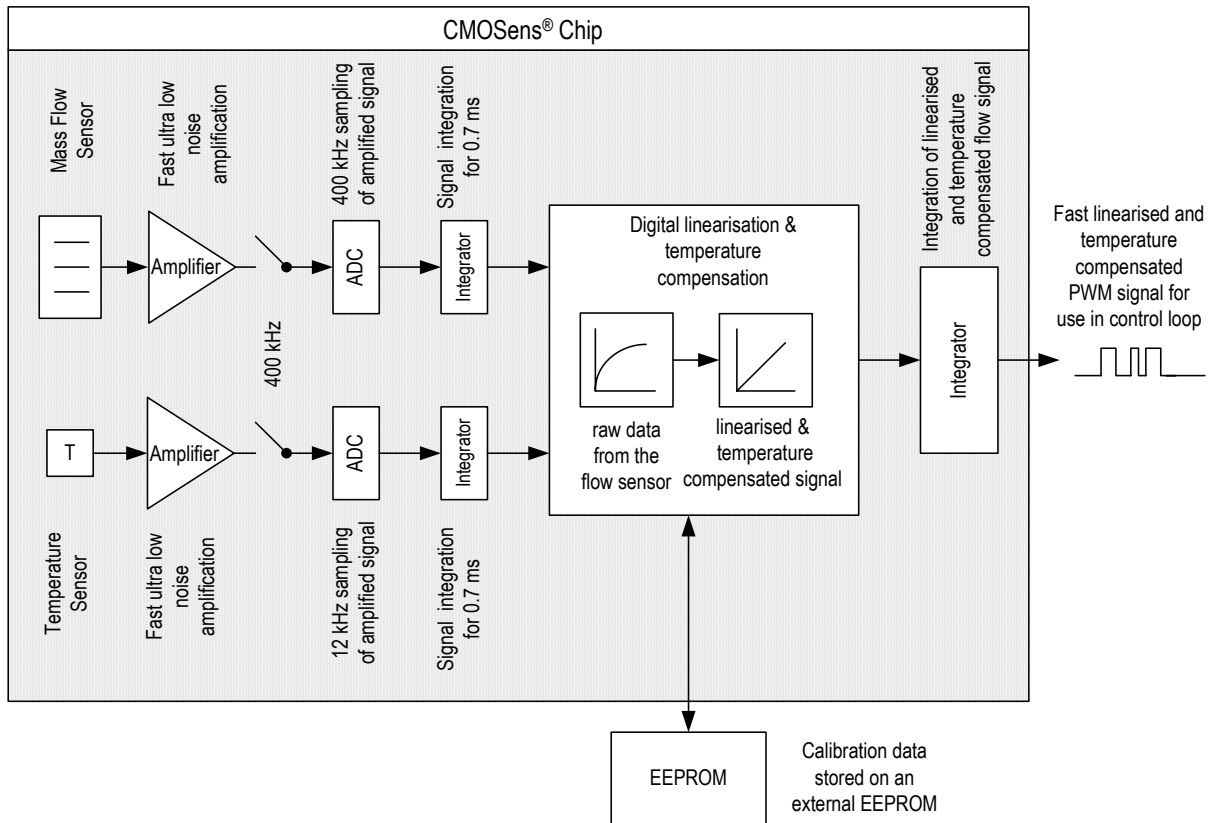


Figure 6: Flow signal processing diagram of a typical CMOSens<sup>®</sup> mass flow sensor chip

## 2.4 Packaging principle and sealing

To guarantee a vacuum proof housing of the sensor and the flow path, several patented technologies are used. The CMOSens<sup>®</sup> chip itself is placed vacuum tight in a stainless steel (316SSL) package that is connected via O-ring sealing to the aluminum body. The packaging allows the SFC4000 Mass Flow Controller to operate under high input pressure conditions (10 bar/145 psi standard, higher ratings for volume applications on request).

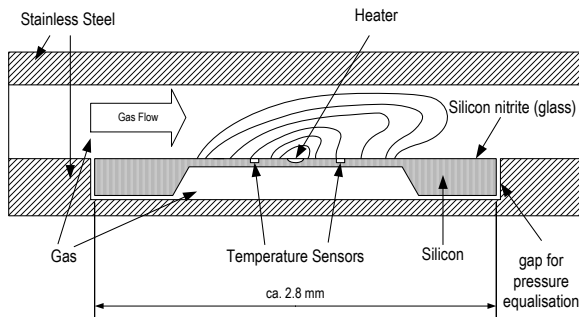


Figure 7: Cross sectional view of vacuum tight stainless steel package with sensor part

The electrical connection from the chip to the main controller board is carried out using vacuum tight glass feed through pins. This chosen packaging method ensures high reliability and tightness for all kinds of gases (Figure 8).

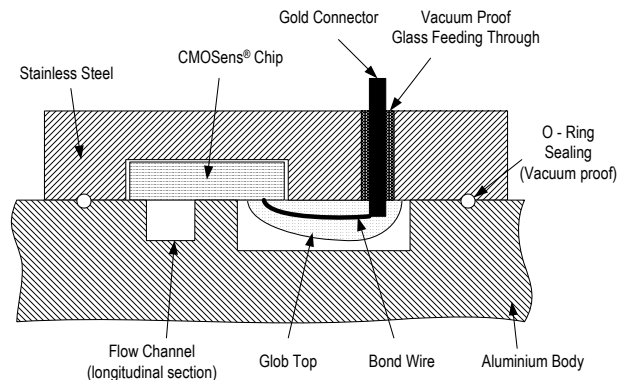


Figure 8: Vacuum Tight Glass Feed Through (Longitudinal View)

## 2.5 Wetted Materials & Compatibility

The packaging method ensures that a minimum number of inert materials only is wetted by the gas which is controlled by the SFC4000 MFC.

The following Table 2 gives an overview of the materials wetted by the gas.

Table 2: Overview of Wetted Materials

PC Part	Wetted Material
Body	Aluminium
Sensor element	Silicon (Si) Silicon oxide (SiO <sub>x</sub> ) Silicon nitride (Si <sub>3</sub> N <sub>4</sub> ) Stainless Steel Glass Glob Top
Sealing	Viton <sup>®</sup>
Valve <sup>15</sup>	Brass Viton <sup>®</sup>

For high volume OEM applications also different specialized materials for the body, the valve and the sealing can be configured.

## 2.6 Operation with different gas types

The CMOSens<sup>®</sup> SFC4000 Mass Flow Controller is available in different versions. For all versions the safety instructions in chapter 2.7 must be observed.

For standard applications a cost effective off-the-shelf version calibrated with Nitrogen (N<sub>2</sub>) respectively Air is the best choice. This also ensures short lead times at comparably low costs.

For volume customers other gas type calibrations are available on request and availability. Please contact Sensirion for further details if this option is applicable to you.

## 2.7 Safety Instructions

The CMOSens<sup>®</sup> SFC4000 is designed for the use of a wide range of various types of gases. The vacuum tight stainless steel packaging of the CMOSens<sup>®</sup> chip together with the housing and sealing materials

ensure a tight and highly resistant sealing of the controller. Furthermore each controller is thoroughly leak tested during the manufacturing process.

In addition the electronic circuit is designed in such a way that the maximum heating energy of the sensor is limited to 12 mW in every circumstance (even in the case of a failure).

For safety reasons however Sensirion strongly recommends to maintain also the following instructions:

### *Toxic gases*

The whole gas assembly must be checked for leakage before applying toxic gas to the device.

### *Explosive gases*

The CMOSens<sup>®</sup> sensor element is tested according to EN 50020 chapter 6.2.4 b). Sensirion guarantees the safe use of gases of the classes T1 or T2 (ignition temperature  $\geq 300$  °C). This includes also mixtures of air or oxygen with hydrogen or hydrocarbons. However the SFC4000 is not designed for the use in hazardous areas (EN 6079-10) where explosive gases can occur outside of the controller.

### *Aggressive or corrosive gases*

Please make sure that the gases you use are compatible with the wetted materials listed in Table 2, chapter 2.5. In case of doubt please contact Sensirion for further advice.

<sup>15</sup> valve for volume OEM applications also available with Stainless Steel body instead of brass body and Kalrez<sup>®</sup> instead of Viton.

### 3 Electrical Connection

#### 3.1 Connector and Pin Layout

The electrical connector of the SFC4000 is a standard Sub-D 9pin connector. This enables an easy and reliable universal connection.

Please refer to the CMOSens® SFC4000 Installation Instruction Manual for the correct electrical connection diagram including instructions for grounding of the device.

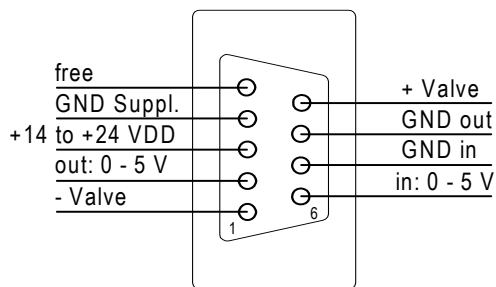


Figure 9: CMOSens® SFC4000 Pin Layout

#### 3.2 Power supply

The SFC4000 Mass Flow Controller requires a standard voltage supply of +14 to +24 VDC. Since this voltage is internally regulated, there are no stringent requirements as far as ripple and stability are concerned.

#### 3.3 Analog Interfaces

The SFC4000 has two interfaces: For input and output both a standard 0 – 5 VDC interface is used.

#### 3.4 Digital Interfaces (Valve Override)

The valve of the SFC4000 Mass Flow Controller is a “normally closed” type. For security reasons the SFC4000 Mass Flow Controller is equipped with two valve override functions:

*Purge Mode:* Setting 5Vdc to +Valve (pin9) will fully open the control valve ignoring any setpoint.

*Shut Mode:* Setting 5Vdc to -Valve (pin1) will fully close the control valve ignoring any setpoint.

## 4 Ratings and Electrical Specifications

#### 4.1 Absolute Maximum Ratings

Ambient operating temperature	0°C to 50°C / 32 °F to 122°F
Max. operating pressure	10 bar / 145 psi
Supply voltage	14.0 to 26.4 Vdc

#### 4.2 Electrical Specifications

Table 3: Interface Characteristics of SFC4000

Parameter	Conditions	Min.	Typ.	Max.	Units
<b>Input (set point)</b>					
Input Voltage	DC	0		5	V
Input Resistance		300			kΩ
<b>Output</b>					
Output Voltage	DC	0		5	V
Minimum Load Resistance		10			kΩ
<b>Digital Input for Valve Override</b>					
Purge Mode (fully open)	DC	4.5	5.0	30	V
Shut Mode (fully closed)	DC	4.5	5.0	30	V

Table 4: Powersupply Characteristics of SFC4000

Parameter	Conditions	Min.	Typ.	Max.	Units
Power Supply DC	DC	14.0	15.0...24.0	26.4	V

Table 5: Current and Power Dissipation Characteristics of SFC4000

Parameter	Conditions	Typical <sup>16</sup>		Units
<b>SFC4100</b>				
Max. Supply Current	Setpoint = don't care + Valve = 5Vdc - Valve = nc	VDD = 15VDC	120	mA
		VDD = 24VDC	75	
Power Dissipation (control mode)	Setpoint = 5Vdc + Valve = nc - Valve = nc	VDD = 15VDC	1.7	W
		VDD = 24VDC	1.7	
Power Dissipation (purge mode)	Setpoint = don't care + Valve = 5Vdc - Valve = nc	VDD = 15VDC	1.8	W
		VDD = 24VDC	1.8	
Power Dissipation (shut mode)	Setpoint = don't care + Valve = nc - Valve = 5Vdc	VDD = 15VDC	0.8	W
		VDD = 24VDC	0.7	
<b>SFC4200</b>				
Max. Supply Current	Setpoint = don't care + Valve = 5Vdc - Valve = nc	VDD = 15VDC	320	mA
		VDD = 24VDC	200	
Power Dissipation (control mode)	Setpoint = 5Vdc + Valve = nc - Valve = nc	VDD = 15VDC	4.1	W
		VDD = 24VDC	4.0	
Power Dissipation (purge mode)	Setpoint = don't care + Valve = 5Vdc - Valve = nc	VDD = 15VDC	4.9	W
		VDD = 24VDC	4.8	
Power Dissipation (shut mode)	Setpoint = don't care + Valve = nc - Valve = 5Vdc	VDD = 15VDC	0.8	W
		VDD = 24VDC	0.7	

Table 6: Electrical Characteristics and Weight of SFC4000

Parameter	Conditions	Value	Units
<b>Electrical</b>			
Input Set Point		0 – 5.0	VDC
Output		0 – 5.0	VDC
+Valve, -Valve		0 or 5.0	VDC
Supply Voltage (nominal)		15.0 – 24.0	VDC
Supply Voltage (maximum rating)		14.0 – 26.4	VDC
Electrical Connector		Sub-D 9pin	
<b>Mechanical</b>			
Weight (without fittings)		230	g
Weight (down mount)		270	g
Weight (VCR/VCO)		310	g

Table 7: Electromagnetic compatibility of SFC4000

Parameter	Hall mark	Notes	Applied values
Electromagnetic Compatibility / Immunity in Industrial Environment: (EN 61000-6-2)	EN 61000-4-2	Air discharge (ESD)	± 8 kV (air) ± 4 kV (contact)
	EN 61000-4-6	High frequency electromagnetic radiation (HF)	10 Veff
	EN 61000-4-4	Fast transients (burst)	± 4 kV

<sup>16</sup> Specification may vary by +/- 5%

## 5 Physical Dimensions and Mounting Information

The SFC4000 is mounted in chemically inert aluminum housing. The rugged package has been designed to withstand an operating pressure of up to 10 bars/ 145 psi.

Physical dimensions and mounting information for the down mount and ¼" VCR/VCO version are provided in Figure 10 and Figure 12.

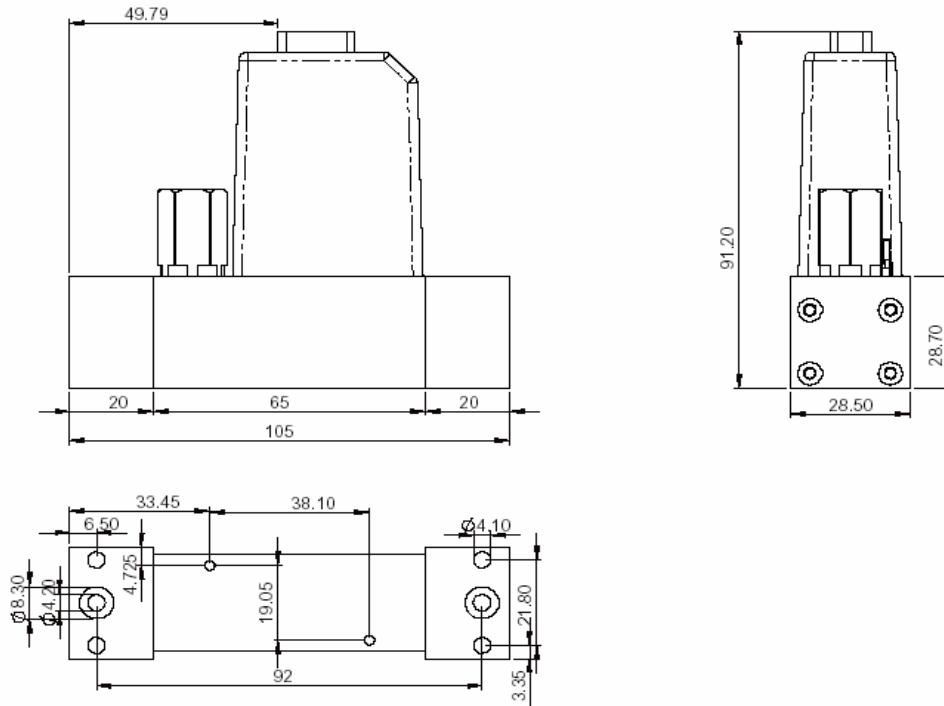


Figure 10: Physical dimensions and mounting information for the down mount version. All units are in [mm]

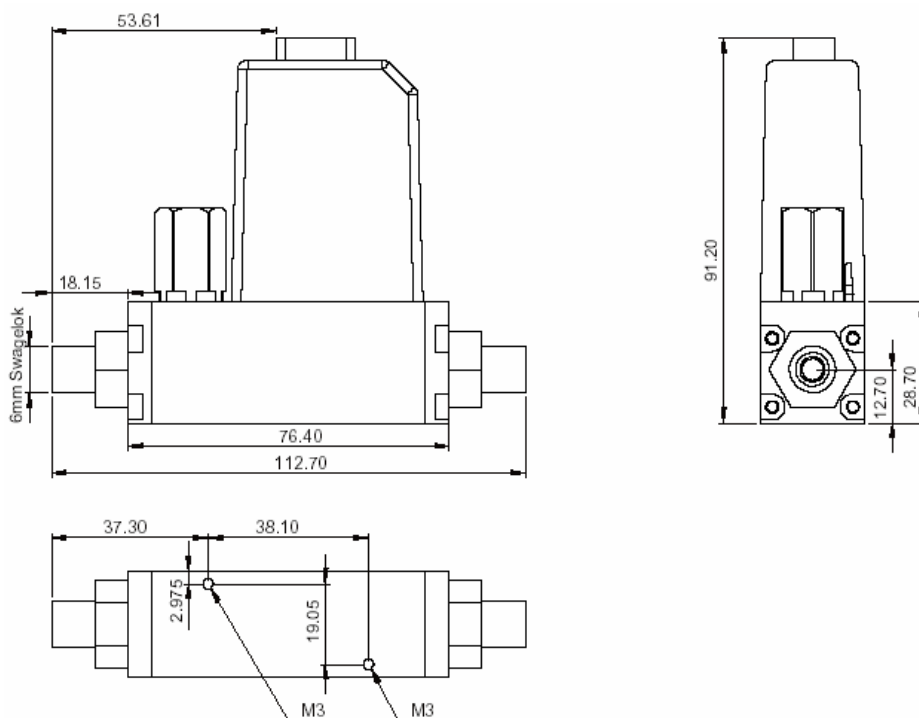


Figure 11: Physical dimensions and mounting information for the 6mm Swagelok fitting version. All units are in [mm]

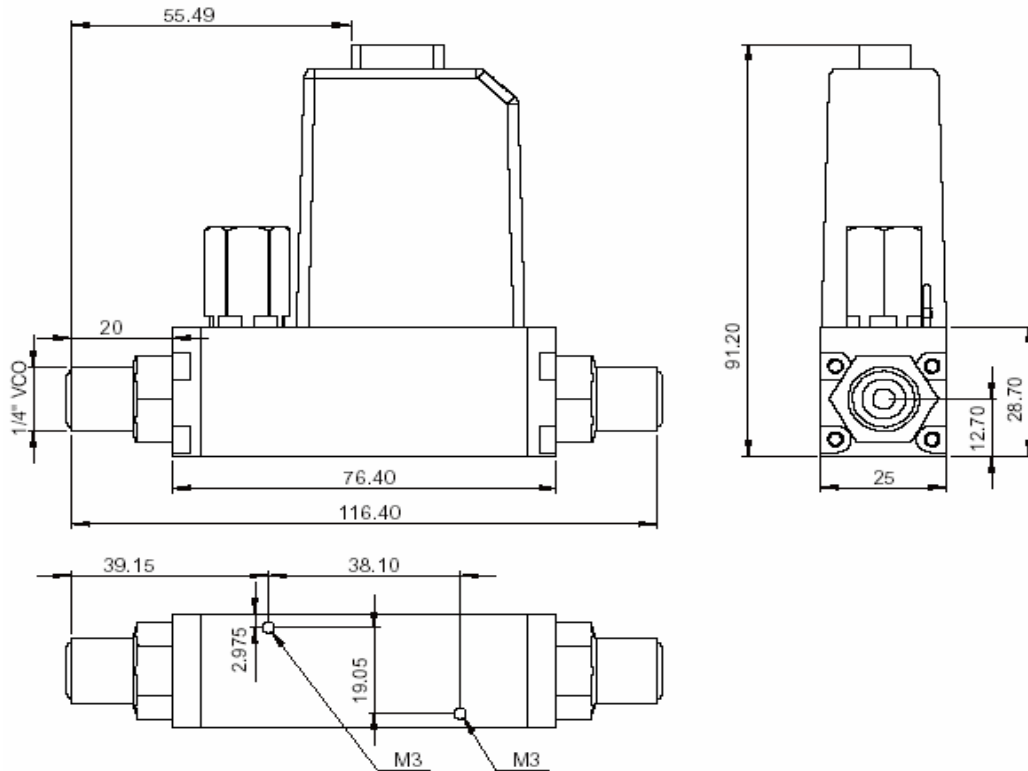


Figure 12 : Physical dimensions and mounting information for the 1/4" VCO fitting version. All units are in [mm]

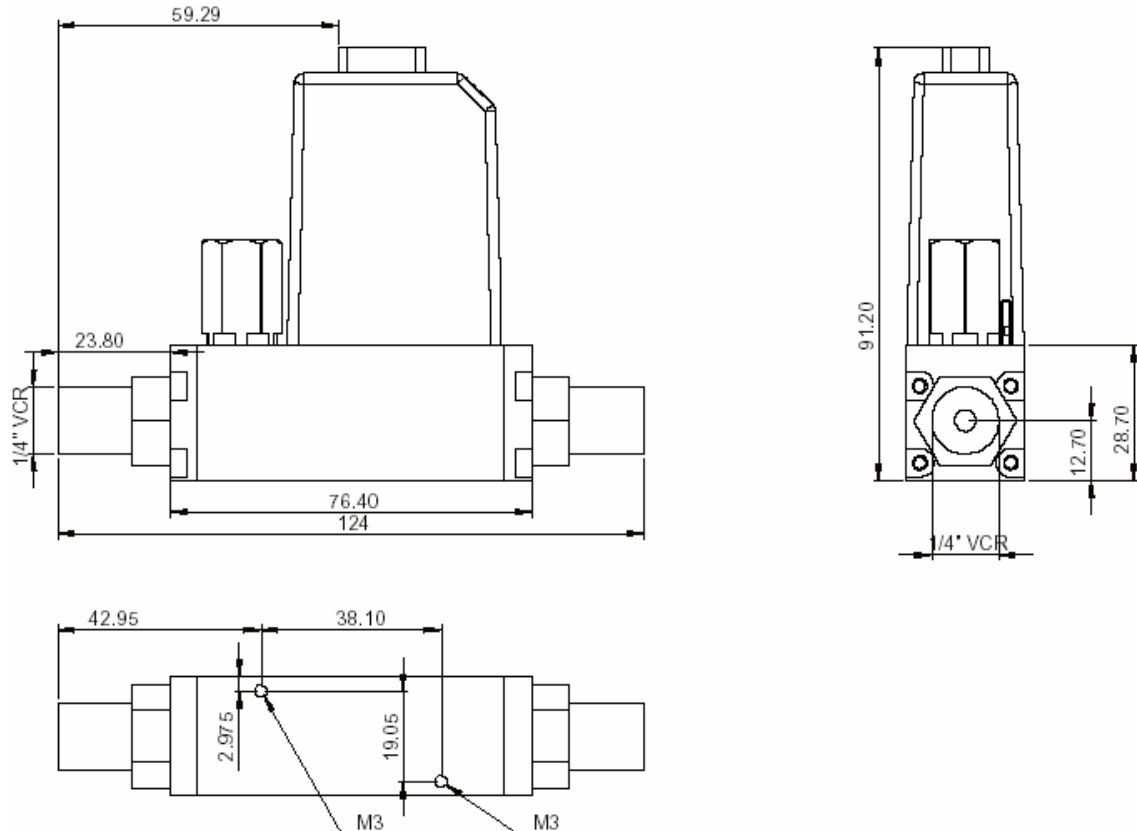


Figure 13: Physical dimensions and mounting information for the 1/4" VCR fitting version. All units are in [mm]

## 6 Ordering Information

The SFC4000 is the succeeding model to the discontinued Sensirion PC1 mass flow controller. The SFC4000 is highly compatible to the PC1 while offering even better specifications and a simpler power supply concept.

### 6.1 Order code for SFC4000 Mass Flow Controllers:

If available provide the complete product code as written on product label:

e.g. SFC4100 UAGUCV N2 500mln/min

If the product code is not available, provide the following information:

1. Product family code (e.g. SFC4000 – Your Sensirion contact will find out for you if SFC4100 or SFC4200 will be required)

2. Mechanical code UA<sub>x</sub> (replace *x* with the letter corresponding to the required mechanical interface, as defined in Table 8)
3. Gas type (for available gas types see Table 8). If your requested gas type or range is not mentioned please ask your Sensirion contact for availability.
4. max. flow range with required flow unit (for available flow units see Table 9)

### 6.2 Available Delivery Options

All combinations of gas types, flow ranges and units listed in Table 8 are standard and available.

For availability of other MFC configurations for OEM volume applications contact Sensirion AG.

For the latest product information please visit Sensirion's website on <http://www.sensirion.com>.

Table 8: Available Versions of CMOSens® SFC4000 Mass Flow Controller

Product family / Base code	Available mechanical Flow Connectors						Calibration Gas <sup>17</sup>	Max. Flow Full Scale Flow in l/min	Unit
	Down mount	6 mm Swagelok	¼" Swagelok	1/8" Swagelok	¼" VCO	¼" VCR			
SFC4100 UA <sub>x</sub>	<i>x</i> =G	<i>x</i> =5	<i>x</i> =6	<i>x</i> =7	<i>x</i> =H	<i>x</i> =I	Air, N <sub>2</sub> , O <sub>2</sub>	0.05 / 0.10 / 0.20 / 0.50	mln/min l/min sccm slm
	<i>x</i> =G	<i>x</i> =5	<i>x</i> =6	<i>x</i> =7	<i>x</i> =H	<i>x</i> =I	He	0.50 / 2.0	
	<i>x</i> =G	<i>x</i> =5	<i>x</i> =6	<i>x</i> =7	<i>x</i> =H	<i>x</i> =I	H <sub>2</sub>	0.50 / 2.0	
SFC4200 UA <sub>x</sub>	<i>x</i> =G	<i>x</i> =5	<i>x</i> =6	<i>x</i> =7	<i>x</i> =H	<i>x</i> =I	Air, N <sub>2</sub>	2.0 / 5.0 / 20.0	mln/min l/min sccm slm
	<i>x</i> =G	<i>x</i> =5	<i>x</i> =6	<i>x</i> =7	<i>x</i> =H	<i>x</i> =I	SF <sub>6</sub> <sup>18</sup>	0.3 / 0.6 / 1.0 / 1.2	
	<i>x</i> =G	<i>x</i> =5	<i>x</i> =6	<i>x</i> =7	<i>x</i> =H	<i>x</i> =I	C <sub>4</sub> F <sub>8</sub>	0.2 / 0.3 / 0.4	

*Example 1:* SFC4100 UAG Air 0.05 l/min

This order code corresponds to: SFC4000 with down mount connector, calibrated for 0.05 l/min full scale. Air, norm liter per minute i.e. liter per minute at 0 °C / 32° F and 1013 mbar / 14.69 psi.

*Example 2:* SFC4200 UA5 SF<sub>6</sub> 1200 sccm

This order code corresponds to: SFC4000 with 6 mm Swagelok connector, calibrated for 1200 sccm full scale. SF<sub>6</sub>, standard cubic centimeter per minute i.e. at 20 °C / 68° F, and 1013 mbar / 14.69 psi.

<sup>17</sup> Contact Sensirion AG for availability of other gases for volume applications.

<sup>18</sup> Available for order quantities of 10 and more. For detailed accuracy and settling time specifications contact Sensirion AG.

## 6.3 Supported Flow Units

Table 9: Units for gas flow rates

Typical flow unit	Reference condition	
	Gas Temperature	Gas Pressure
mln/min (norm milliliter per minute)	0 °C / 32° F	1013 mbar / 14.69 psi
ln/min (norm liter per minute)		
sccm (standard cubic centimeter per minute)	20 °C / 68° F	
slm (standard liter per minute)		

Example: Relationship for N<sub>2</sub> between:

ln/min (0°C, 1013 mbar)	and	slm (20°C / 68°F, 1013 mbar / 14.69)
1 ln/min	=	1.073 slm
10 ln/min	=	10.73 slm

Notes:

## 7 Revision history

Date	Version	Page(s)	Changes
November 2005	Preliminary	1-13	First public release
January 2006	Preliminary v1.4	1-16	Specifications, typos, various small modifications, ordering Information
February 2006	Preliminary v1.5	1-16	Updated images and layout, disclaimer updated
February 2006	v2.0	1-16	Typos, updated specifications.
February 2006	V2.1	1-16	Error in ordering information corrected, power specification enhanced
March 2006	V2.2	1-16	Order information updated, several layout changes
April 2008	v2.3	1-15	T-Coefficient Span, Ordering information
October 2008	V2.4	3	Added lowest flow accuracy for 20ln/min flow controllers
March 2009	V2.5	12, 15	Ordering Information

## 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. 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 data sheet 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 "ESD, Latchup and EMC" 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 data sheet 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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### RoHS and WEEE Statement

The SFC4x00 family complies with requirements of the following directives:

- 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 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS), OJ 13.02.2003; esp. its Article 4.

## FCC and CE Statement

The SFC4000 product has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules (FCC CFR 47). These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult a dealer or an experienced radio/TV technician for help.



The CMOSens® SFC4000 device fully complies with norm EN 61000-6-1 to EN 61000-6-4 (Immunity and Emission Test Series).

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