

## MEMS mass flow sensor

model FS4001

### characteristic

- Quality flow detection range low, 0 ~ 30 sccm to 0 ~ 1000 sccm
- High accuracy  $\pm 1.5\%$
- Quick response (4ms optional)
- Rated pressure up to 5bar (73 psi)
- Analog and digital user interfaces
- Easy to install

### description

The FS4001 mass flow sensor is manufactured using Siargo's patented MEMS flow sensor and packaging technology, specifically designed for low-flow applications ranging from 0-30 sccm to 0-1000 sccm. Featuring a specially engineered housing and smart electronics, this sensor achieves maximum flow rate while maintaining optimal sensitivity.

The component's housing is constructed from chemically inert and thermally stable poly carbonate material. Thanks to Siargo's unique MEMS sensor chip technology, specialized packaging techniques, and robust sensor casing, the device achieves a maximum pressure resistance of 5bar (73 psi).

The FS4001 sensor has a wide range of applications, including instrumentation (chromatography/mass spectrometry), leak detection, process control, gas flow measurement, and medical applications. It operates on a 8-18V DC power supply and provides both digital and analog user interfaces. The analog output maintains linearity at 0.5~4.5VDC, corresponding to flow rates from 0% to full scale. Digital outputs are transmitted via RS232. The latter part of this manual details the communication protocol RS232.

The calibration of the sensor is generally carried out with pure nitrogen at a temperature of 20°C and a pressure of 101.325 kPa, but other gases can also be used under other conditions as required by customers.

### operational principle

The MEMS sensor chip operates on a thermal measurement principle. It is mounted on a substrate embedded within the flow channel, which features boundary layer configurations to provide precise flow regulation and create laminar flow. The mass flow measurement is achieved when gas removes heat from the heater, causing redistribution of the temperature field. To ensure maximum accuracy in flow rate determination, the components must be calibrated using standard gas under predefined environmental conditions.

flow direction

Time-averaged velocity profile boundary layer

free stream

laminar flow

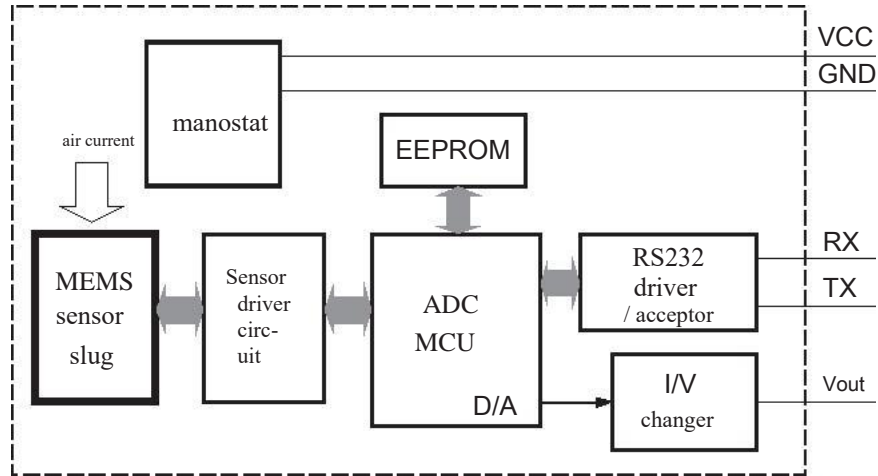
turbulence

sensor

Module diagram

The following figure shows the functional module diagram of the sensor. The MEMS sensor chip is powered by the sensor driver circuit and sends the voltage related to flow rate to the ADC. The microcontroller processes (amplify, filter) the voltage and then converts it into flow rate.

The sensor sends the flow rate signal in analog or analog and digital formats (RS232).



Functional module diagram of FS4001

# 1. Sensor Performance

## 1.1 Performance Parameter

Unless otherwise stated, all the following parameters apply to the calibration conditions: nitrogen, 20°C, 101.25kPa absolute pressure, horizontal installation.

model	FS4001	
range	0 ~ 30,100,200,500,1000, or customer defined	sccm
turn-down ratio	>100:1	
Accuracy <sup>1</sup>	$\pm(1.5 + 0.5 \text{ FS})$	%
repeatability	$\pm 0.25$	% indication
drift	$\pm 30$	mV
Output drift	$\pm 0.2$	%/°C
response time <sup>2</sup>	65 (Default, 4, 8, 16,33,131 optional)	
output	Linear: RS232, analog 0.5 ~ 4.5 Vdc	
pressure drop <sup>3</sup>	< 350	
pressure limit	-0.08 ~ +0.5	
supply electricity <sup>4</sup>	8 ~ 18 Vdc, 50 mA	
working current	The typical value is 20 when RS232 is not connected The typical value for PC communication is 25	
power dissipation	<200	
working temperature	-5 ~ +55	

1 Indicates  $\pm(1.5\% \text{ reading} + 0.5\% \text{ full scale})$ . To obtain the best measurement accuracy, the sensor should be preheated for at least one minute after being powered on;

2 The response time is determined by the ADC sampling rate and data processing algorithm. The default response time is 65ms. It can be programmed through RS232 communication.

3 The maximum pressure drop is measured at a flow rate of 1000 sccm. For sensors with a lower flow rate range, the pressure drop will be smaller.

4 A DC current source is required. The minimum output current required is 50mA. In practice, the sensor consumes less current than this.

## 1.2 Other parameters

Output pins	5 Jacks, 2.54 mm center, 0.635 mm square	
Calibration options <sup>1</sup>	Air, CO2, He, H <sub>2</sub> , N <sub>2</sub> , O <sub>2</sub> , Ar @ 20. C, 101.325 kPa	
Encapsulation materials	Carbonated polyester	
size	62 x 54 x 12.8	mm <sup>3</sup>
weight	15	g
Storage temperature	-20 ~ +65	
humidity	<95%RH (no icing or condensation)	

1 It can be calibrated with other gases and under other environmental conditions as required by customers

**Declaration of Conformity:** All components of the product comply with RoHS requirements. The sensor fully complies with CE standards EN61000-6-1 to 61000-6-4, EN50081-2 to 50082-2 and EMC Directive 89/336/EEC.

1.3 Discharge Characteristic

1.3.1 Simulated output characteristics

The analog output range of FS4001 is 0.5 ~ 4.5Vdc, corresponding to the flow rate from 0 to full scale. Taking 100sccm as an example, Table 1.1 and Figure 1.1 show the typical analog output v.s. flow rate.

Table 1.1: Typical output voltage vs. flow rate

velocity of flow (sccm)	Typical pressure (Vdc)
0	0.5
20	1.3
40	2.1
60	2.9
80	3.7
100	4.5
110	4.9
120	4.9

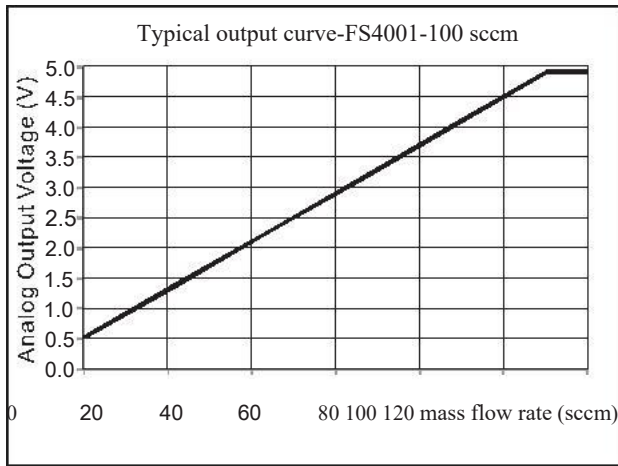


Table 1.1: Typical analog output curves.

To ensure product accuracy remains within specified parameters during interpolation, the calibration sensor is calibrated to a range exceeding the rated flow rate by 10%. For example, when calibrated for a 100sccm range, it is actually set to 110 sccm. Consequently, even when flow rates exceed the rated range, analog output continues to be generated, though its precision cannot be guaranteed.

1.3.2 Digital output characteristics

The digital output is carried out through RS232. Figure 1.2 shows the digital output of mass flow rate v.s.1000sccm. As with the analog output, if the flow rate exceeds the specified range, the output accuracy cannot be guaranteed.

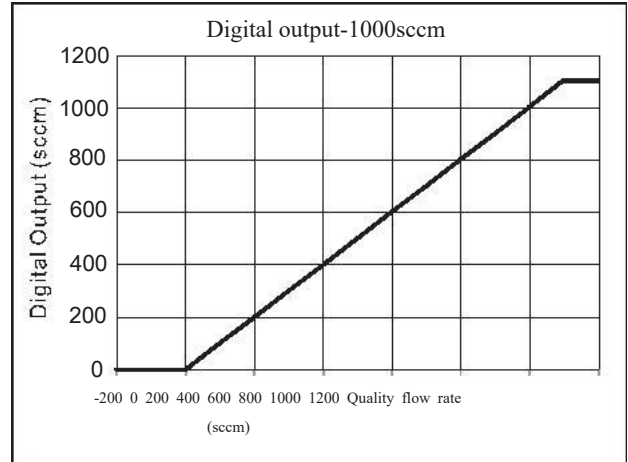


Figure 1.2: Typical Digital Transmission Characteristics

## 2. Ports and Interfaces

### 2.1 Definition of Pins

The FS4001 has 5 pins. Figure 2.1 and Table 2.1 show the sensor pin allocation and definition.

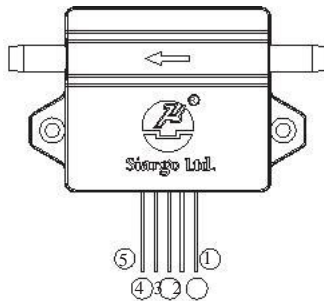


Figure 2.1: FS4001 Pin Configuration

Table 2.1: FS4001 Pin Definitions

number	definition
1	RX (RS232)
2	GND, the earth
3	VCC, source
4	Vout, analog output
5	TX (RS232)

### 2.2 Description of the Port

**VCC and GND:** The FS4001 requires a power supply of 8-18 Vdc. The component will internally adjust the voltage to power the circuit system. Therefore, there are no strict requirements for accuracy, stability, or external power supply ripple.

**Vout:** The analog output range is 0.5-4.5 Vdc, corresponding to the defined flow range of 0 to full scale. Beyond this range, there will still be a voltage reading, but the accuracy cannot be guaranteed.

**TX and RX:** Digital communication is bidirectional. TX serves as the transmission pin for RS232, sending signals from the sensor; RX acts as the receiving pin for signal acquisition. By simultaneously using these two pins along with GND, users can configure the sensor's operating mode and obtain voltage and flow rate data.

### 2.3 RS232 Communication Protocol

The preferred setting is:

Bit rate (bits/second):	38400
data bit :	8
stop bit :	1
Odd偶验证:	not have
flow control :	not have

The FS4001 has a variety of working modes for customers to choose from, so that they can obtain the required data in different ways. The following describes each mode:

operator schema :

- Send 0x9d to the sensor and receive 0x9d from the sensor
- Send 0x54 to the sensor and receive 0x54 from the sensor

The time interval between sending the previous and next bytes to the sensor is at least 5ms, and the sensor will send the following data:

IN OPERATION MODE ..... \n\r

After that, the sensor will enter operation mode. In this mode, the sensor data will be sent through RS232 interface at 200ms interval.

The data is formatted as follows:

V=vvvvvv\nF=ffffff\nA=0\n; \n

Among them, "V=vvvvvv" is the voltage code and "F=ffffff" is the flow rate, equal to ffff.fff

Sccm user mode:

- Send 0x9d to the sensor and receive 0x9d from the sensor
- Send 0x00 to the sensor and receive 0x00 from the sensor

The time interval between sending the previous and next bytes to the sensor is at least 5ms, and the sensor will send the following data:

IN USER MODE..... \n\r

After that, the sensor will enter user mode, in which no data will be sent through the RS232 interface.

Customer model:

- Send 0x9d to the sensor and receive 0x9d from the sensor
- Send 0x56 to the sensor and receive 0x56 from the sensor. The sensor will send the following data:

IN CUSTOMER MODE..... \n\r

After that, the sensor will enter customer mode. In this mode, the sensor data will be sent through RS232 interface at 200ms interval. The data format is:

F= fffffff\n; \n

It represents the instantaneous flow rate in ffff.fff sccm.

~~View instantaneous flow rate:~~

- Send 0x9d to the sensor and receive 0x9d from the sensor
- Send 0x55 to the sensor and receive 0x55 from the sensor

The sensor will return the instantaneous flow rate value through RS 232, and then enter the communication mode. The data format is:

ffffff IN USER MODE..... \n It represents the instantaneous flow rate in ffff.fff sccm.

Where "IN USER MODE \n\r!".indicates that the sensor will enter user mode.

### 3. Mechanical Dimensions and Installation

The FS4001 measures 62 x 54 x 12.8 mm, as shown in Figure 3.1:

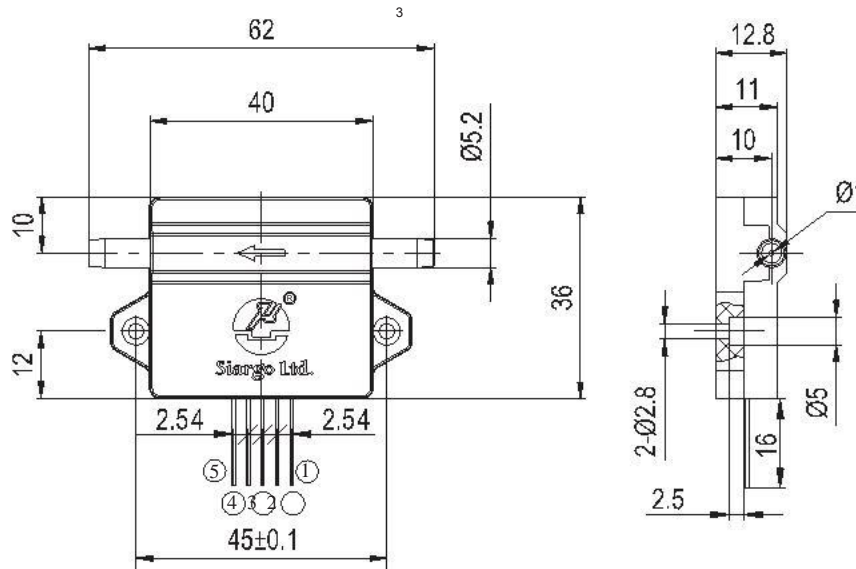
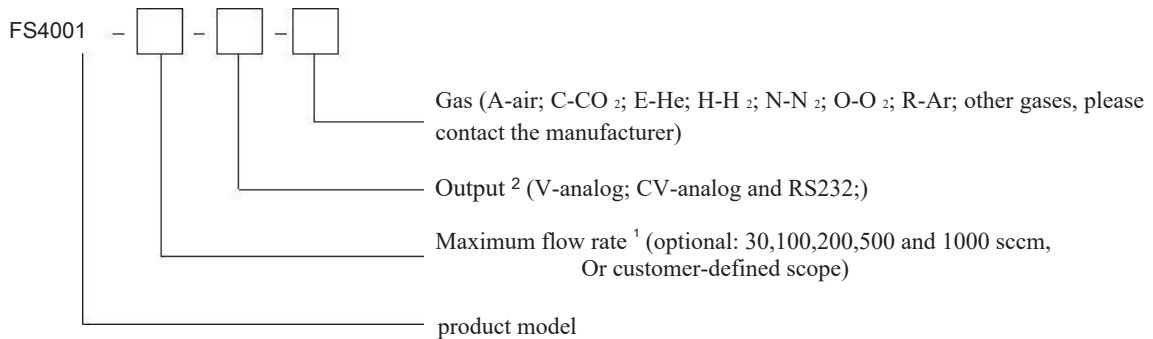


Figure 3.1: Mechanical Dimensions of FS4001

### 4. Ordering Guide

#### 4.1 Sensor Selection

The sensor material number is composed of the model plus the suffix indicating the flow rate range, output format and standard gas. The specific information is as follows:



<sup>1</sup> Only the maximum flow rate number is shown, for example, 100 indicates that the maximum flow rate is 100 sccm;

<sup>2</sup> The sensor is normally an analog output; digital output is optional.

#### 4.2 Order Contact and Customer Support

The list of sales offices is provided at the end of this document. For small quantities, you can order directly through the Siargo website [www.siargo.com](http://www.siargo.com) or contact a sales office; for large quantities, please order through a sales office, distributor, or sales representative.

Siargo is committed to delivering quality products. For product-related inquiries or support, please contact our customer service team at the end of this article. We will promptly address your needs and work closely with you until you are fully satisfied.

## important information

### Waterproofing materials and compatibility

The sensor body is made of medical-grade plastic. The sensor chip consists of silicon, silicon nitride, and silicon oxide, with surface passivation using silicon nitride and silicon oxide. The gasket is sealed with RTV(room temperature curing) silicone sealant composed of  $\text{HOCH}_3(\text{SiO})_n\text{CH}_3\text{H}$ .

### Installation and operation precautions

Prior to shipment, all products undergo comprehensive testing to ensure compliance with quality standards and meet all safety requirements. However, additional safety measures must be implemented during operation and installation. To prevent electrostatic discharge (ESD) damage and/or performance degradation, standard ESD prevention protocols should be followed during handling. When powering the equipment, supply it with the correct voltage and current, and never reverse the electrodes. All precautions and measures concerning electrical voltage must be strictly observed. Before leaving the factory, manufacturers ensure product sealing quality to guarantee sensors can operate effectively in environments up to 0.5MPa while preventing leaks. Since any leakage could lead to severe consequences, extreme caution must be exercised during installation and thorough leak testing must be conducted.

This product contains no user-maintainable components. Do not attempt to disassemble, replace parts, or modify the product without authorization. Such actions will void the warranty and result in liability for product damage. Only authorized personnel from the original manufacturer may perform repairs. At the customer's request, Siargo will provide necessary technical support and/or staff training.

### Product application precautions

Designed for general-purpose gases such as air and nitrogen, this product is recommended for use in non-explosive clean gases. Do not apply to fluorinated or fluorine-containing gas metering instruments. For certification details, contact the manufacturer. Using it with extreme corrosive or toxic gases may cause malfunction or even severe damage.

Do not expose the sensor housing to any liquid, this part is not waterproof.

When ventilating, it is necessary to avoid the condensation of water vapor in the components, otherwise the accuracy of the sensor will be greatly affected.

It is recommended that the application be designed so that its rated flow rate is approximately the full range of the sensor

70%. Do not use the sensor at extreme flow rates, such as 1000 sccm in an application of 10sccm.

### Warranty and liability (effective March 2009)

Siargo warrants that the products sold below are properly installed and used in accordance with the description details in the user manual under normal conditions without material or process defects. The warranty for OEM products is 180 days and for non-OEM products is 365 days from the date of shipment.

This warranty includes any legal warranty. Any repairs or returns should be made in accordance with

### This warranty clause.

Siargo disclaims all warranties, express or implied, and shall not be liable for any special or incidental damages or expenses, including but not limited to losses arising from installation, disassembly, reinstallation, or any form of direct or indirect damage. To the extent permitted by law, the user's or purchaser's remedies and Siargo's limitation of liability for any and all losses, injuries, or product-related damages—whether based on contractual claims, negligence, torts, strict liability, or other grounds—require the return of the product to Siargo. Upon verification of defects, the manufacturer may choose to refund, repair, or replace the product at its discretion. Siargo will not accept any warranty claims after the 365-day warranty period has expired. For products returned during the warranty period, the user or purchaser assumes the risk of loss, and the product will be returned to the buyer or customer. By purchasing this product, the buyer or user is deemed to have accepted these limited warranties and liabilities, which constitute the manufacturer's complete and exclusive responsibility without modification, correction, or exemption, except as expressly excluded by the manufacturer. The warranty terms are subject to the following exclusions:

- (1) Products that have been modified or modified, or subjected to unconventional physical or electrical conditions, not limited to those described in this document or other conditions that cannot be considered normal use of the product;
- (2) Siargo does not provide any warranty for products that are not manufactured by it. The warranty is only applicable to the original manufacturer.

## 深圳市杰晟兴电子有限公司 JM Components Limited

地址：深圳市福田区中航路7号鼎诚国际大厦南座2007室

手机：13662266995 马少良 电话：0755-83951311

官网：cn-sensor.com

邮编：518031

传真：0755-83952401

电邮：jackson@jmcomponents.com