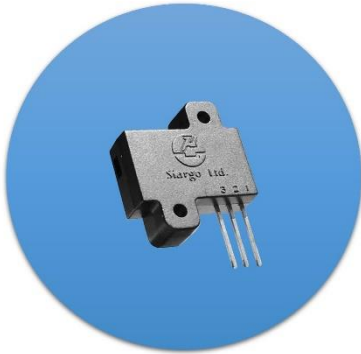




# FS7002 User Manual VD.1

MEMS mass flow sensors



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# **MEMS Mass Flow Sensors**

**with thermal calorimetric sensing technology**

FS7002 Series

## **User Manual**

Document No. 11-2021-FS11 EN

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## Attention !

- Please carefully read this manual prior to operating this product.
- Do not open or modify any hardware which may lead to irrecoverable damage.
- Do not use this product if you suspect any malfunctions or defection.
- Do not use this product for corrosive media or in a strong vibration environment.
- Use this product according to the specified parameters.
- Only the trained or qualified personnel shall be allowed to perform product services.



## Use with caution !

- Be cautious for electrical safety, and even it operates at a low voltage, any electrical shock might lead to some unexpected damages.
- The gas to be measured should be clean and free of particles, as even light particles may be accumulated inside the tiny pressure port that may result in inaccuracy in metrology, clogging, or other irrecoverable damage.
- Do not apply for any unknown or non-specified gases that may damage the product.

## Table of Contents

<b>1. Overview</b> .....	<b>5</b>
<b>2. Receipt / unpack of the products</b> .....	<b>6</b>
<b>3. Knowing the products</b> .....	<b>7</b>
3.1 Product description .....	7
3.2 Power and data pinout description .....	7
3.3 Mechanical dimensions.....	8
<b>4. Installation</b> .....	<b>9</b>
<b>5. I<sup>2</sup>C interface (for FS7002L)</b> .....	<b>10</b>
5.1 I <sup>2</sup> C interface connection diagram.....	10
5.2 I <sup>2</sup> C interface command description .....	10
5.3 I <sup>2</sup> C interface read/write sequences .....	11
<b>6. Product selection and order information</b> .....	<b>12</b>
6.1 Product selection .....	12
6.2 Order contact and customer support .....	12
<b>7. Product performance</b> .....	<b>13</b>
7.1 Technical specifications .....	13
7.1.1 Technical specifications for FS7002.....	13
7.1.2 Technical specifications for FS7002L.....	14
7.2 Output characteristics .....	15
<b>8. Technical notes for the product performance</b> .....	<b>16</b>
8.1 Measurement principles.....	16
8.2 Precautions for the best performance of the product .....	16
8.2.1 Altitude changes.....	16
8.2.2 Excessive humidity or condensation .....	16
8.2.3 Metrology verification .....	17
<b>9. Warranty and Liability</b> .....	<b>18</b>
<b>10. Service contact and information</b> .....	<b>20</b>
<b>Appendix I: Sensor evaluation kit</b> .....	<b>21</b>
<b>Appendix II: Document history</b> .....	<b>22</b>

## 1. Overview

All contact information can be found at the end of this manual.

This manual provides essential information for the FS7002 series of mass flow sensors. The sensor is packaged with a small footprint, offering both nonlinear and linear output of a gas flow speed, with the maximum flow speed detection range of 0 ~ 15 m/sec, selectable of the full-scale speed at the time of order. Applications include gas flow path or filter clogging control, oxygen flow delivery, fan monitoring in a cleanroom or similar conditions, leakage detection, instrumentation as well as medical applications. The product performance, maintenance, and troubleshooting, as well as the information for product order, technical support, and repair, are also included.

The FS7002 sensors are manufactured with the company's proprietary MEMS (micro-electro-mechanical systems) sensing and package technology.

## 2. Receipt / unpack of the products

Upon receipt of the products, please check the packing box before the dismantlement of the packing materials. Ensure no damages during shipping. If any abnormality is observed, please contact and notify the carrier who shipped the product and inform the distributors or sales representatives if the order is not placed directly with the manufacturer; otherwise, the manufacturer should be informed. For any further actions, please refer to the return and repair section in this manual.

If the packing box is intact, proceed to open the packing box, and you shall find the product (either the sensor formality per the actual order), together with the power and data cable if the order is included as shown below.

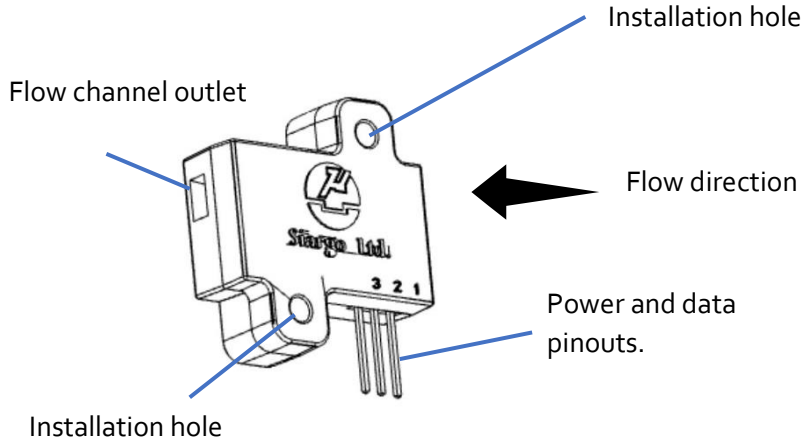


Please check immediately for the integrity of the product. FS7002 analog option will have 3 pins while the I<sup>2</sup>C digital version will have 4 pins. If any abnormality is identified, please notify the distributor/sales representative or manufacturer as soon as you can. If any defects are confirmed, an exchange shall be arranged immediately via the original sales channel. This user manual shall also be included in the packing box or via an online link for an electronic version which should be sent by your sales agent. In most cases, this manual shall be made available to the customer before the actual order, or by direct email to [info@siargo.com](mailto:info@siargo.com).

Please note that the sensor has a pinout that is designed to be directly placed onto a printed circuitry board. Therefore, the power and data cable is an option that will not come with the order automatically.

### 3. Knowing the products

#### 3.1 Product description



**Note:** Digital I<sup>2</sup>C will have 4 pins, please specify the model at the time of order.

Figure 3.1. FS7002 / FS7002L parts description

#### 3.2 Power and data pinout description

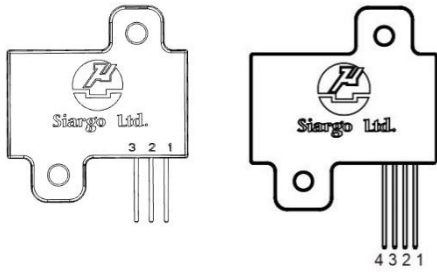


Table 3.1: FS7002 pin assignment.

PIN	DEFINITION	
	FS7002	FS7002L
1	VCC	SCL, I <sup>2</sup> C clock
2	Vout	GND
3	GND	Power supply
4		SDA, I <sup>2</sup> C data

Figure 3.2. FS7002 / FS7002L pinout

FS7002 pins: 2.54 mm centers, 0.635 mm square

FS7002L pins: 1.27 mm centers, 0.5 mm square

**Note:** 1. FS7002 requires a power supply of  $5.0 \pm 5\%$  Vdc, and FS7002L requires a power supply of 3.0 ~ 3.6 Vdc. For the FS7002 analog model, although the circuitry is internally regulated and filtered, the output will depend on the accuracy of the power supply.

2. The minimal current shall be larger than 10mA for the stable output.

### 3.3 Mechanical dimensions

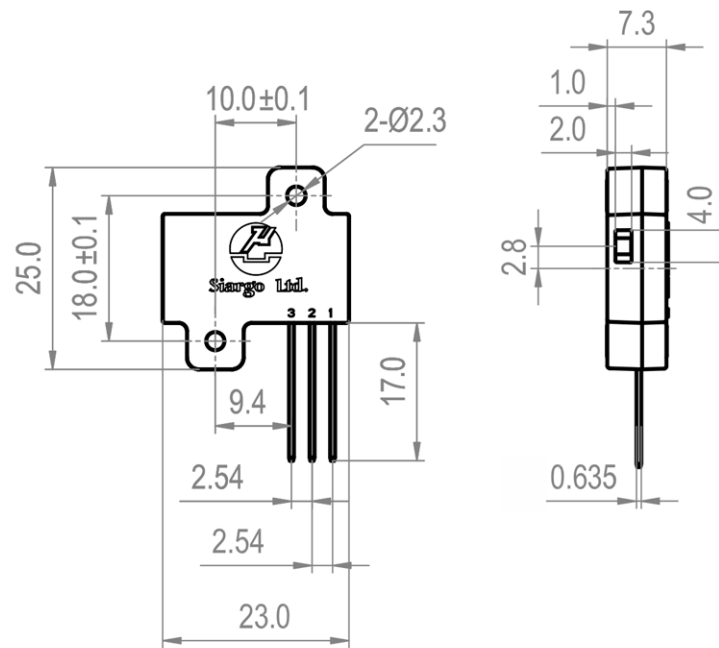


Figure 3.3. FS7002 mechanical dimensions.

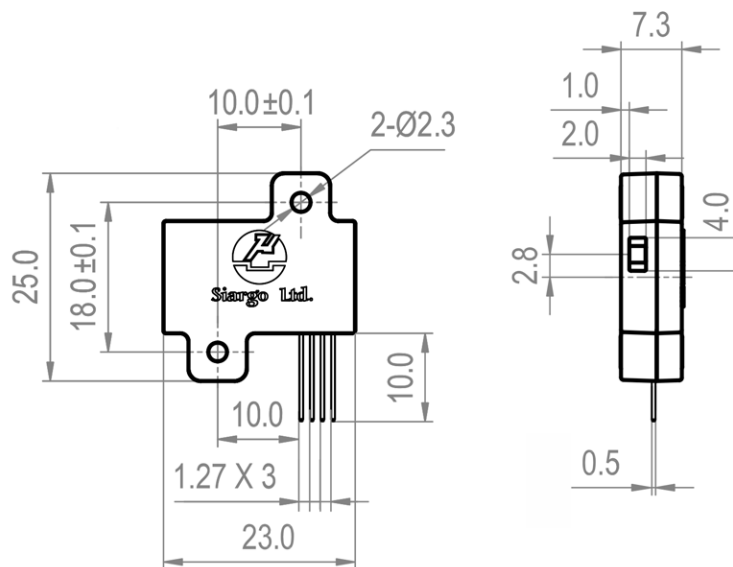


Figure 3.4. FS7002L mechanical dimensions.



## 4. Installation

This product contains no user-serviceable components. Do not attempt to disassemble, substitute parts or perform unauthorized modifications to the product. Doing so will forfeit the terms of the warranty and cause the liability to any damages thereafter. It should only be serviced by authorized personnel. Upon request, Siargo will provide necessary technical support and/or training of the personnel.

The product is designed for an open space measurement of the flow speed. Therefore aim the flow inlet to the direction where the application is required. Either fix the sensor directly on a printed circuitry board or fix the sensor with a proper cable. The two installation holes allow the user to attach the sensor to a solid base. When tightening the screw, be careful of the proper torque or force applied.

The product at the time of shipment is fully inspected for product quality and meets all safety requirements. Additional safety measures during installation should be applied. To prevent ESD (electrostatic discharge) damage and /or degradation, take customary and statutory ESD precautions when handling. Do power the product with the correct polarity, voltage, and amperage. All precautions and measures for electrical voltage handling must apply.

The product is designed for use with general-purpose gases such as air and nitrogen. It is advised that the products should be used for non-corrosive and non-explosive clean gases. The sensors cannot be used for gas metrology of fluoride or fluoride-containing gases. For updates on the product certification information, please contact the manufacturer. Use for other gases such as extreme corrosive and toxic gases may cause the product malfunctioning or even severe damages.

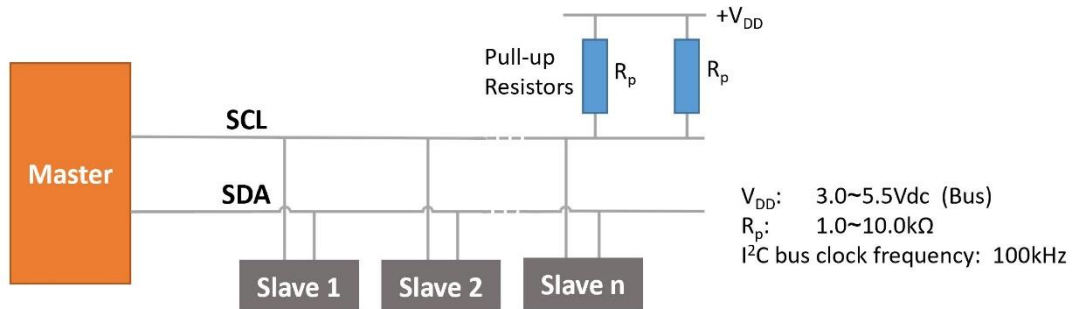
Don't expose the product's outer surface to any liquids, the unit does not have a water-resistive electronics package.

Don't flow gas in conditions that can cause condensing water vapor to be trapped inside the unit as the accuracy could be significantly altered.

It is suggested to design your application so that the nominal flow rate is approximately 70% of the full-scale flow rate of the sensor. Don't use a sensor with an extreme flow range, for instance, don't use a sensor with a 10 m/s full-scale model for a 0.2 m/s application.

## 5. I<sup>2</sup>C interface (for FS7002L)

### 5.1 I<sup>2</sup>C interface connection diagram

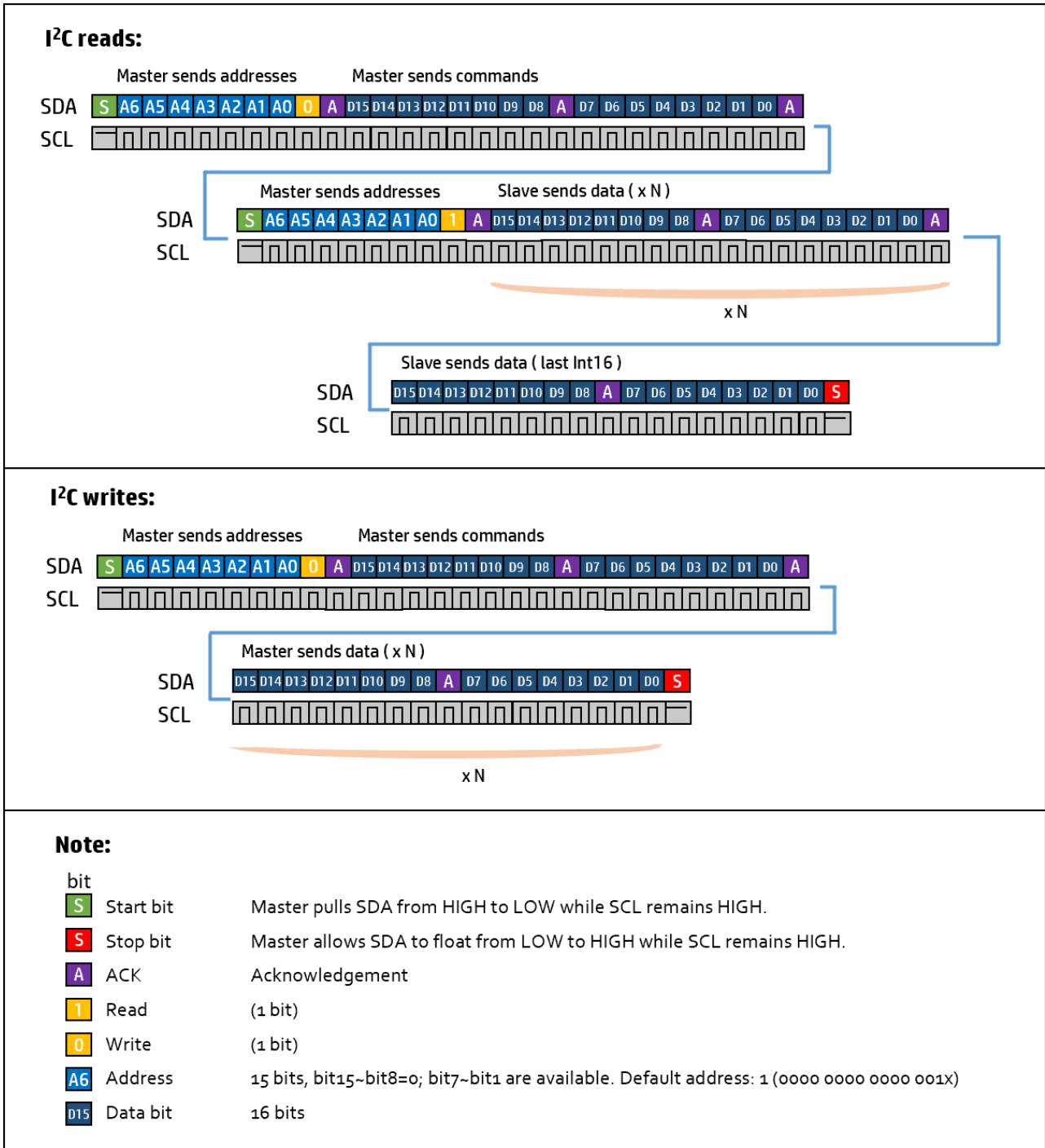


### 5.2 I<sup>2</sup>C interface command description

Command Byte (Hex)	Length (int 16)	Command Name	Read/Write	Notes
05H	1	I <sup>2</sup> C address	Write	Bit 0 is R/W flag bit; Bit 7 ~ Bit 1 are available.
0BH	1	Filter depth	Write	Int 8, 0 ~ 254
1CH	1	Flowrate offset reset	Write	1 byte, ensure no-flow conditions
82H	12	Serial number	Read	ASCII
83H	4	Flow rate	Read	Int32(/1000 SLPM)+CRC CRC=(Byte1)XOR(Byte2)XOR(Byte3)XOR(byte4)
85H	1	I <sup>2</sup> C address	Read	Bit 7 ~ Bit 1
8BH	1	Filter depth	Read	Int 8, 0 ~ 254

**Note:** 1. The I<sup>2</sup>C address is set to Bit 7 ~ Bit 1. E.g. if the I<sup>2</sup>C address is 1 (0000 001x), the write address will be 0x02 (0000 0010) and the read address will be 0x03 (0000 0011).

### 5.3 I<sup>2</sup>C interface read/write sequences



## **6. Product selection and order information**

### **6.1 Product selection**

The product models are defined in the specification table. Please refer to the specification tables in Sec. 7 to select the product models for all orders.

### **6.2 Order contact and customer support**

The sales offices and the sales distributors/representatives are listed at the end of this document. For small quantities, the order can be placed either through the Siargo website: [www.siargo.com](http://www.siargo.com) or the sales office. For large quantities, please contact the sales office, distributors, or sales representatives.

Siargo is making every effort to ensure the quality of the products. In case of questions and/or product supports, please contact the customer service listed at the end of the document.

## 7. Product performance

### 7.1 Technical specifications

#### 7.1.1 Technical specifications for FS7002

All specifications listed in the following table, unless otherwise noted, apply for calibration conditions at 20°C and 101.325 kPa absolute pressure with air.

The following specifications are for the FS7002 series, which is an analog output version.

	FS7002-B	FS7002-C	FS7002-D	Unit
Flow range	0 ~ 5	0 ~ 10	0 ~ 15	m/sec
Repeatability	±3.0	±2.0	±2.0	%FS
Response time	20			msec
Output	analog, nonlinear			
Null output <sup>1</sup>	200 ~ 800			mVdc
Full scale output <sup>1</sup>	2500 ~ 3300			mVdc
Power supply	5.0 ± 5%			Vdc
Working current <sup>2</sup>	~ 10			mA
Power consumption	<50			mW
Output load	Sourcing: 14; Sinking: 11			mA
Working temperature	-10 ~ 70			°C
Humidity range	<95 (no icing or condensation)			%RH
Storage temperature	-20 ~ 80			°C
Compliance	RoHS			

- Note:**
1. Before taking data, warm up the sensor for 1 minute.
  2. The working current is taken at 5.0 Vdc supply without load.

### 7.1.2 Technical specifications for FS7002L

All specifications listed in the following table, unless otherwise noted, apply for calibration conditions at 20°C and 101.325 kPa absolute pressure with air.

The following specifications are for the FS7002L series, which is a digital (I<sup>2</sup>C) output version.

	FS7002L-B	FS7002L-C	Unit
Flow range	0 ~ 5	0 ~ 10	m/sec
Repeatability	±3.0	±2.0	%FS
Response time	20		msec
Output	I <sup>2</sup> C, linear		
Power supply	3.0 ~ 3.6		Vdc
Working current <sup>2</sup>	~10		mA
Power consumption	<50		mW
Working temperature	-10 ~ 70		°C
Humidity range	<95 (no icing or condensation)		%RH
Storage temperature	-20 ~ 80		°C
Compliance	RoHS		

- Note:**
1. Before taking data, warm up the sensor for 1 minute.
  2. The working current is taken at 3.3 Vdc supply without load.

## 7.2 Output characteristics

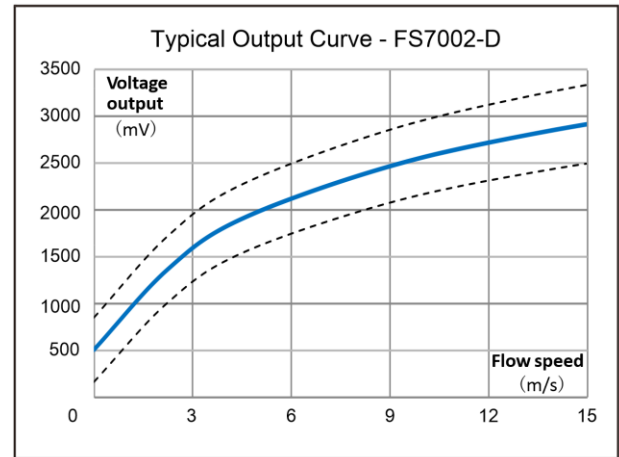
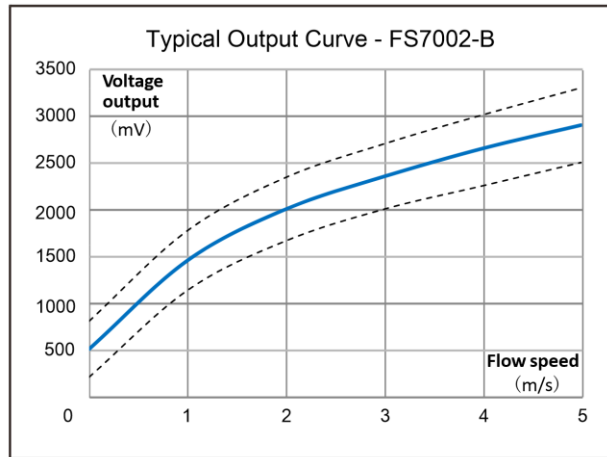


Figure 7.1. Typical output of FS7002

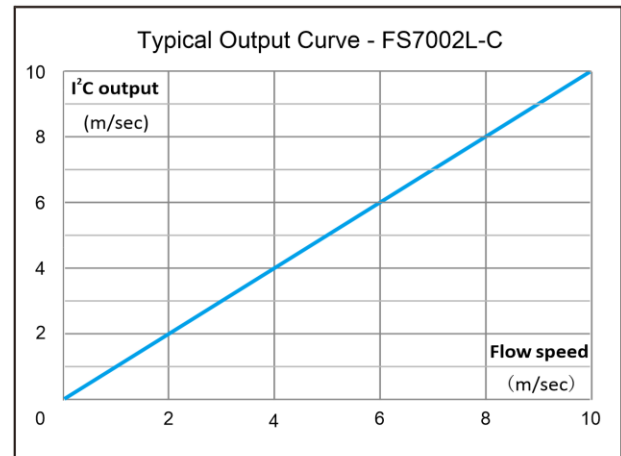
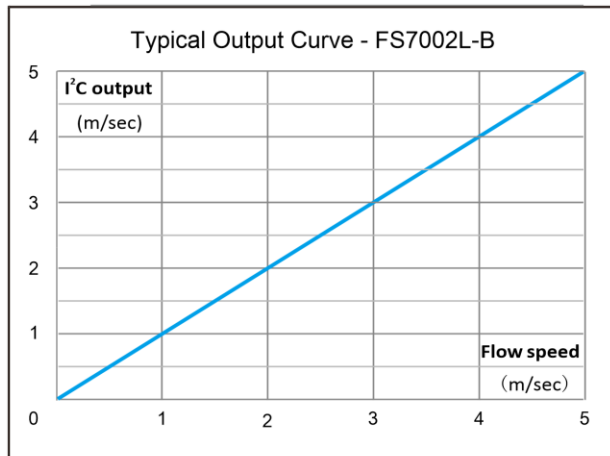


Figure 7.2. Typical output of FS7002L

## 8. Technical notes for the product performance

### 8.1 Measurement principles

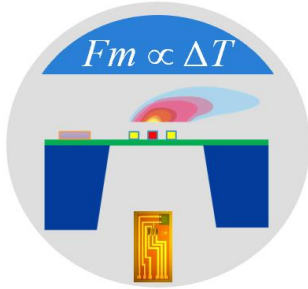


Figure 8.1. Measurement approach illustration.

The products utilize the Company's proprietary micro-machined (MEMS) calorimetric sensing and data process technology. A thermal signal generator with a pair of sensing elements at the up and downstream of the microheater is precisely manufactured and separated at predefined micrometer distances on a chip surface with excellent thermal isolation. When a fluid is flowing through the sensing chip, the fluid carries the thermal signal downstream. The sensing elements register the temperature differences, further correlated to the fluid mass flow rate via the calibration process.

The calorimetric sensing approach offers a large dynamic range with a better performance against the environmental parameter alternations.

Please refer to the company's US patents and other publications made available to the public for additional information.

### 8.2 Precautions for the best performance of the product

#### 8.2.1 Altitude changes

Unlike some other products on market, the design of the sensor has a built-in pressure balancer that prevents membrane deformation due to altitude changes. Therefore, the sensor is intrinsically insensitive to the altitude change-induced errors. The specified altitude in Sec 7.1 has been fully tested.

#### 8.2.2 Excessive humidity or condensation

The humidity change will not alter the performance of the sensor. However, if excessive humidity is present resulting in condensation, the measurement port or channel could be blocked or altered. This would result in a very unreliable data output. Please filter or other tools to prevent this situation to occur when using this product.



### 8.2.3 Metrology verification

Testing the products with local metrology tools will be performed in almost all cases. It should be noted that for this particular sensor, special care should be applied while performing such a task.

The gauge pressure tests are relatively simple, as long as the pressure is tested under a stable media condition, the metrology data should be well reproduced.

For the mass flowrate comparison, however, in addition to the flow system setup conditions recommended by OIML R137, a stable flow system must be ensured. This is because the current product is designed for a small pressure loss, therefore the sensor does not have a strong flow restrictor or conditioners to handle the flow instability that may exist in the system. Therefore to compare the metrology data, the user should ensure the system is stable, otherwise, the output could be noisy and metrology deviations would be inevitable. If such cases are present, please contact the manufacturer for further solutions.

For temperature and humidity measurement, because of the small package space, the response of the humidity could be slower than the specified. For additional information, please contact the manufacturer.

## 9. Warranty and Liability

(Effective January 2018)

Siargo warrants the products sold hereunder, properly used, and properly installed under normal circumstances and service. As described in this user manual, it shall be free from faulty materials or workmanship for 180 days for OEM products and 365 days for non-OEM products from the date of shipment. This warranty period is inclusive of any statutory warranty. Any repair or replacement serviced product shall bear the same terms in this warranty.

Siargo makes no warranty, representation, or guarantee and shall not assume any liability regarding the suitability of the products described in this manual for any purposes that are not specified in this manual. The users shall be held for full responsibility for validating the performance and suitability of the products for their particular design and applications. For any of the misuse of the products out of the scope described herein, the user shall indemnify and hold Siargo and its officers, employees, subsidiaries, affiliates, and sales channels harmless against all claims, costs, damages, and expense or reasonable attorney fee from direct or indirect sources.

Siargo makes no other warranty, express or implied, and assumes no liability for any special or incidental damage or charges, including but not limited to any damages or charges due to installation, dismantling, reinstallation, etc. other consequential or indirect damages of any kind. To the extent permitted by law, the exclusive remedy of the user or purchaser, and the limit of Siargo's liability for any and all losses, injuries, or damages concerning the products, including claims based on contract, negligence, tort, strict liability, or otherwise shall be the return of products to Siargo, and upon verification of Siargo to prove to be defective, at its sole option, to refund, repair or replacement of the products. Regardless of form, no action may be brought against Siargo more than 365 days after a cause of action has accrued. The products returned under warranty to Siargo shall be at the user or purchaser's risk of loss and will be returned, if at all, at Siargo's risk of loss. Purchasers or users are deemed to have accepted this limitation of warranty and liability, which contains the complete and exclusive limited warranty of Siargo. It shall not be amended, modified, or its terms waived except by Siargo's sole action.

This manual's product information is believed to be accurate and reliable at the time of release or made available to the users. However, Siargo shall assume no responsibility for any inaccuracies and/or errors and reserves the right to make changes without further notice for the relevant information herein.

This warranty is subject to the following exclusions:

- (1) Products that have been altered, modified, or have been subject to unusual physical or electrical circumstances indicated but not limited to those stated in this document or any other actions which cannot be deemed as proper use of the products;

- (2) Products that have been subject to chemical attacks, including exposure to corrosive substances or contaminants. In the case of battery usage, long term discharge or leakage induced damages;
- (3) Products that have been opened or dismantled for whatever reasons;
- (4) Products that have been subject to working conditions beyond the technical specification as described by this manual or related datasheet published by the manufacturer;
- (5) Any damages incurred by the incorrect usage of the products;
- (6) Siargo does not provide any warranty on finished goods manufactured by others. Only the original manufacturer's warranty applies;
- (7) Products that are re-sold by unauthorized dealers or any third parties.

## 10. Service contact and information

Siargo Ltd. is making every effort to ensure the quality of the products. In case of questions and or product supports, please contact customer service at the address listed below. We will respond to your request in a timely fashion and work with you toward your complete satisfaction.

Customer service and all orders should be addressed to

Siargo Ltd.  
3100 De La Cruz Boulevard, Suite 210,  
Santa Clara, California 95054, USA  
Phone: +01(408)969-0368  
Email: [info@Siargo.com](mailto:info@Siargo.com)

For orders, please provide an accurate and full postal address. Siargo will not ship to P.O. Boxes or via a third party.

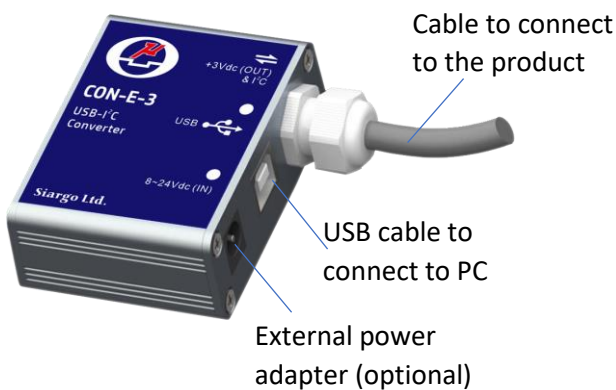
Please contact [info@siargo.com](mailto:info@siargo.com) to obtain a Return Materials Authorization (RMA) before shipping the product back to the factory for returns or factory services such as calibration. Please specify as clear and detailed as possible in your email message the product's status that you intend to ship back to the factory. Be sure to write the RMA on the returned package or include a letter with the RMA information.

For further information and updates, please visit [www.Siargo.com](http://www.Siargo.com).

## Appendix I: Sensor evaluation kit

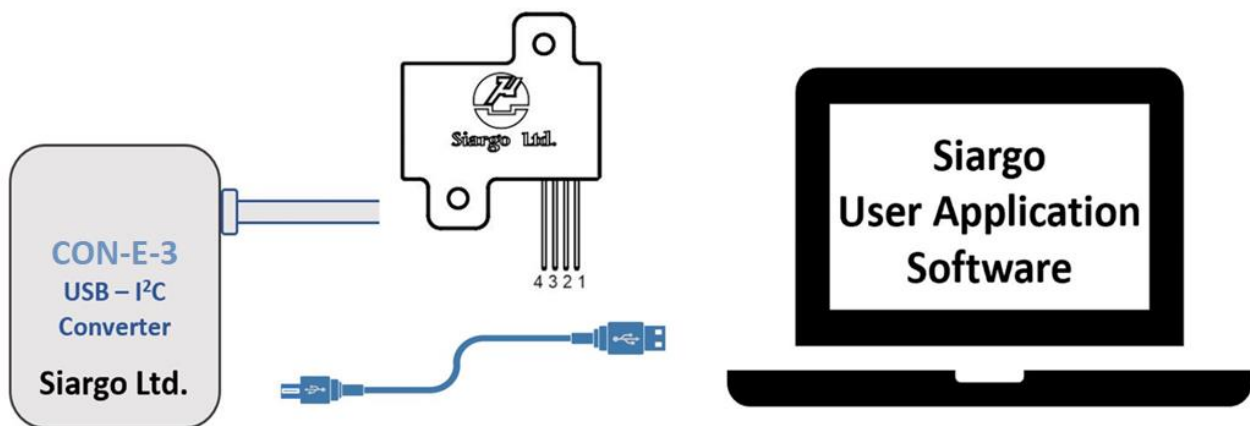
Siargo offers a sensor evaluation kit, including a digital data converter, USB data cable, and User Application software, that allows the user to evaluate the product performance on a Microsoft Windows-based computer. The user can read and visualize the flow rate of the product, obtain the totalized values, and save the data for further analysis. It can read from up to 128 sensors with the I<sup>2</sup>C interface in serial.

For further information and purchase of the evaluation kit, please contact the manufacturer or the sales representative.



Each converter has a fixed cable that can be directly connected to the product. The USB cable connected to the PC is also included.

For most of the products, the power from the PC via the USB cable will be sufficient to power the sensor product, no external power will be required. However, for multiple sensors in serial, the power via the USB cable may not be enough, an external power adapter with 8 ~ 24Vdc will be required.



## Appendix II: Document history

- Revision D.1 (September 2021)
  - Combined FS7002 and FS7002L user manual.
  - Re-format with additions.
  
- Revision C.7: FS7002 (October 2020):
  - ISO 45001 addition.
  
- Revision C.6 (February 2018):
  - Add the model FS7002D.
  
- Revision C.5 (July 2017):
  - Add revision history
  - Contact information update
  
- Revision A.0 FS7002L (August 2018):
  - First release.