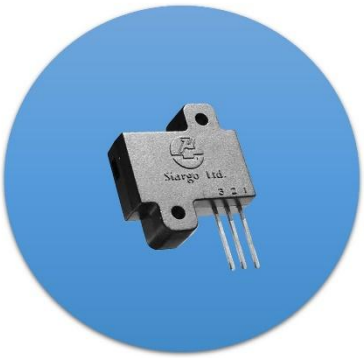
Siargo Ltd.

FS7002 User Manual VD.1.04

MEMS mass flow sensors



MEMS Mass Flow Sensors

with thermal calorimetric sensing technology

FS7002 Series

User Manual

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Siargo Ltd.
4677 Old Ironsides Drive, Suite 310,
Santa Clara, California 95054-1857,
USA

Tel: +1(408)969-0368
Email: Info@Siargo.com

Attention!

- Please carefully read this manual before operating this product.
- Do not open or modify any hardware that may lead to irrecoverable damage.
- Do not use this product if you suspect any malfunctions or defects.
- Do not use this product for corrosive media or in a strong vibrational 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 of electrical safety, even if it operates at a low voltage; any electrical shock might lead to some unexpected damage.
- 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

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 outputs of a gas flow speed, with a maximum flow speed detection range of 0 ~ 15 m/sec, and selectable 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, and 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 dismantling the packing materials. Ensure no damage 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, open it to find the product (either the sensor formality per the actual order), along with the power and data cable if included, as shown below.

Figure 2.1: FS7002

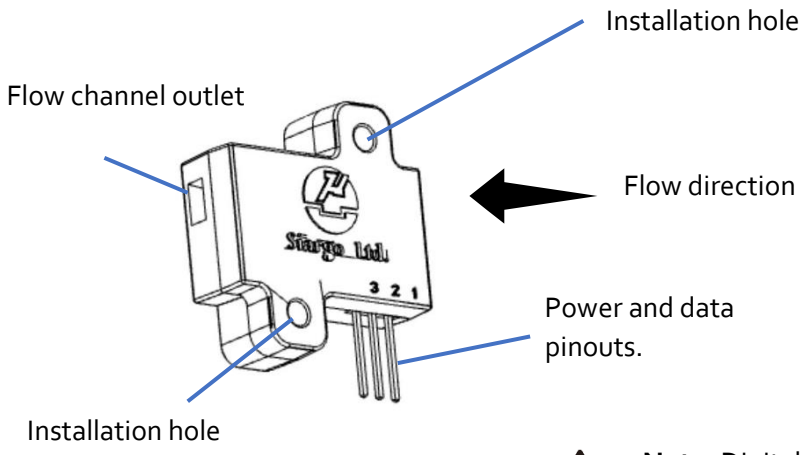
Figure 2.2: FS7002L

Please check immediately for the integrity of the product. The FS7002 analog option will have three pins, while the I²C digital version will have four 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 your sales agent should send. In most cases, this manual shall be made available to the customer before the actual order, or by direct email to info@siargo.com.

Please note that the sensor has a pinout that is designed to be directly placed onto a printed circuit 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 I²C 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

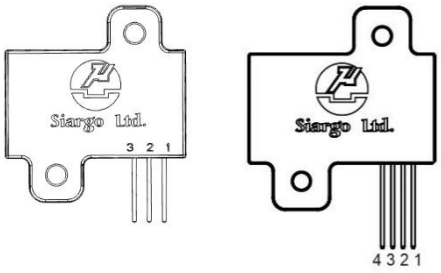


Figure 3.2: FS7002 / FS7002L pinout
FS7002 pins: 2.54 mm centers, 0.635 mm square
FS7002L pins: 1.27 mm centers, 0.5 mm square

Table 3.1: FS7002 pin assignment.

PIN	DEFINITION	
	FS7002	**FS7002L**
1	VCC	SCL, I²C clock
2	Vout	GND
3	GND	Power supply
4		SDA, I²C data

Note 1. FS7002 requires a power supply of 5.0±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 a stable output.

3.3 Mechanical dimensions

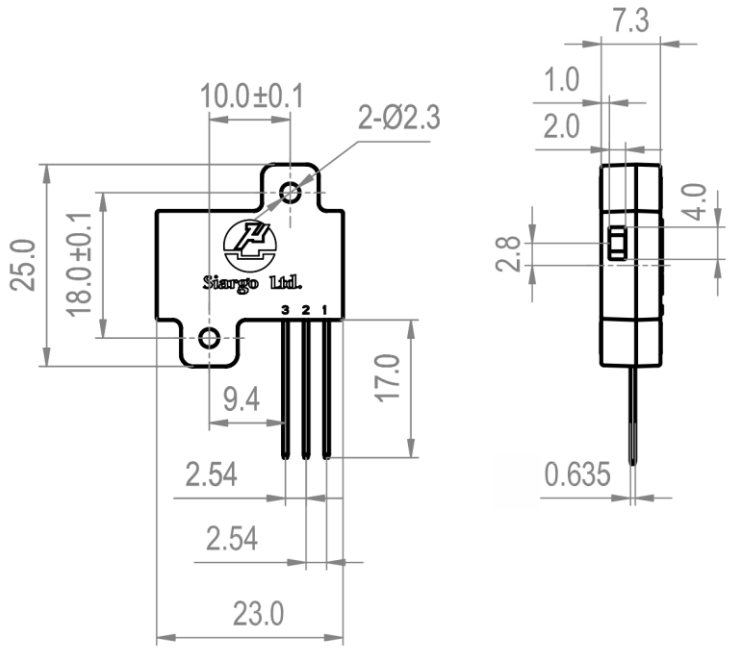


Figure 3.3: FS7002 mechanical dimensions.

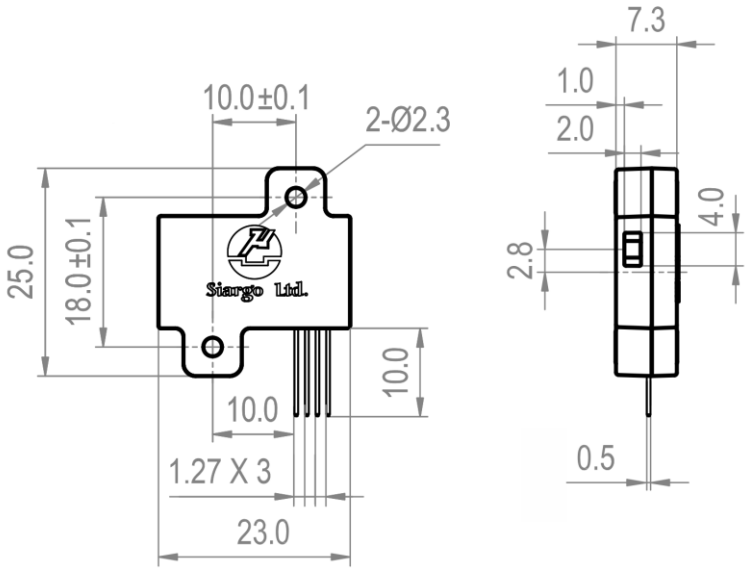


Figure 3.4: FS7002L mechanical dimensions.

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 liability for 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 in the direction where the application is required. Either fix the sensor directly on a printed circuit 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 to apply the appropriate torque or force.

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. 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 get in touch with the manufacturer. The use of other gases, such as highly corrosive and toxic gases, may cause the product to malfunction or even severe damage.

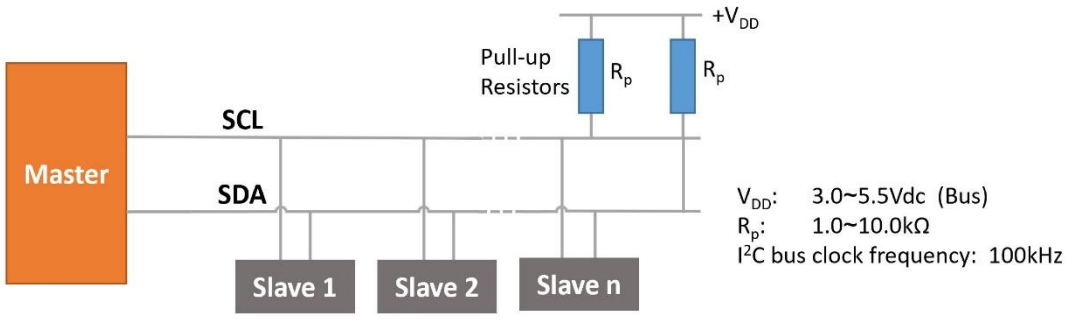
Don't expose the product's outer surface to any liquids; the unit does not have a water-resistant electronics package.

Avoid flowing gas in conditions that could trap condensing water vapor inside the unit, as this could significantly alter the accuracy.

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. Avoid using a sensor with an extreme flow range; for example, a 10 m/s full-scale model is not suitable for a 0.2 m/s application.

5. I²C interface (for FS7002L)

5.1 I²C interface connection diagram

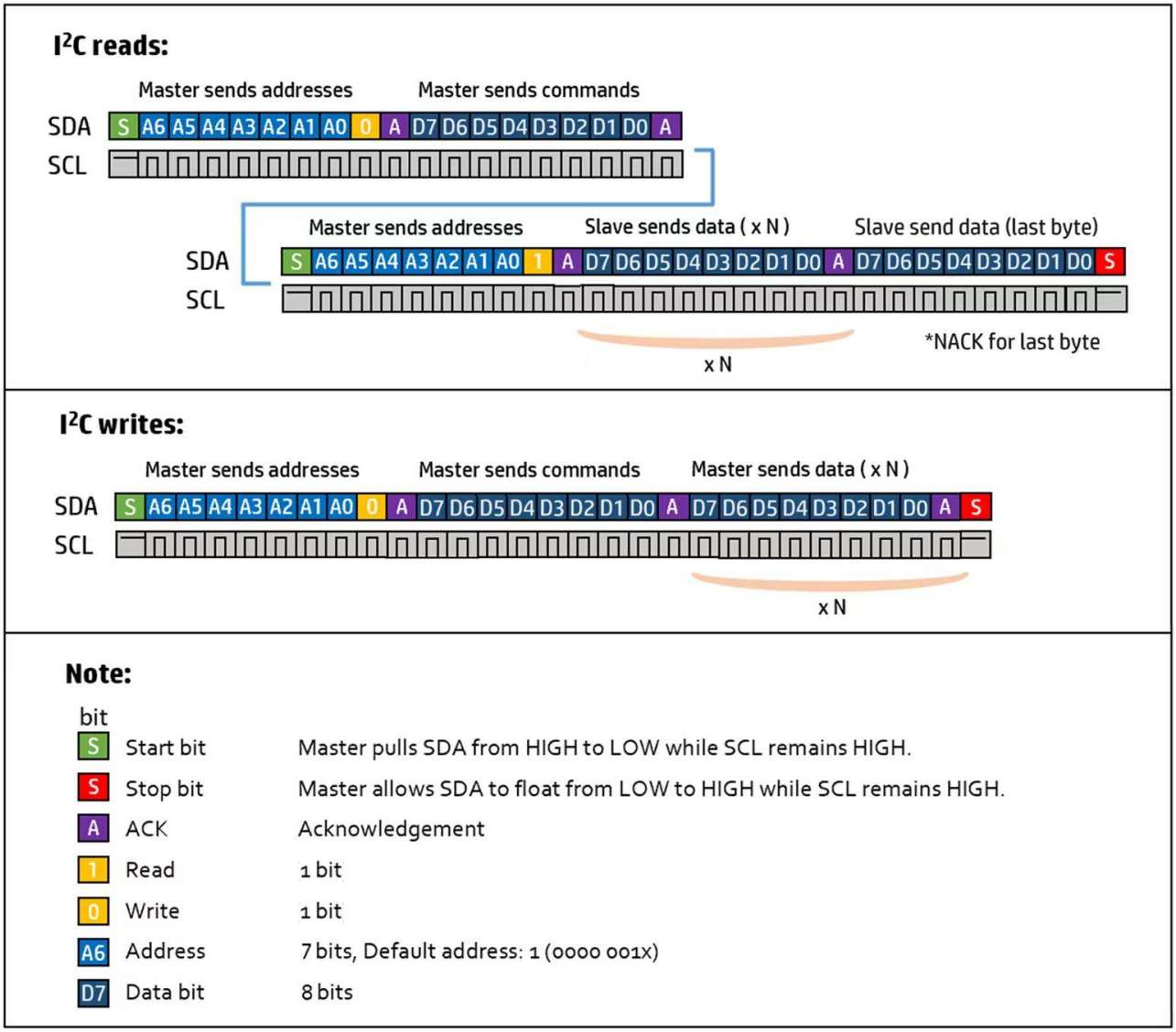


5.2 I²C interface command description

Command Byte (Hex)	Length (int 8)	Command Name	Read/Write	Notes
05H	1	I²C address	Write	Bit 0 is the R/W flag bit. Bits 7 through 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	5	Flow rate	Read	Int32(/1000 m/sec) + CRC CRC=(Byte1)xOR(Byte2)x(OR(Byte3)XOR(byte4)
85H	1	I²C address	Read	Bit 7 ~ Bit 1
8BH	1	Filter depth	Read	Int 8, 0 ~ 254

Note 1. The I²C address is set to Bit 7 ~ Bit 1. E.g., if the I²C address is 1 (0000 001x), the write address will be 0x02 (0000 0010) and the read address will be 0x03 (0000 0011).

5.3 I²C interface read/write sequences



6. Product selection

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

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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[1]	200 ~ 800			mVdc
Full-scale output[1]	2500 ~ 3300			mVdc
Power supply	5.0 ± 5%			Vdc
Working current[2]	~ 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 a 5.0 Vdc supply without a 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^2C) 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^2C, linear		
Power supply	3.0 ~ 3.6		Vdc
Working current[2]	~ 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 a 3.3 Vdc supply without a load.

7.2 Wetted materials

The wetted materials of the FS7002 series include polycarbonate (sensor body and flow channel); silicon nitride, FR4, and Ablestik 84-3J.

7.3 Output characteristics

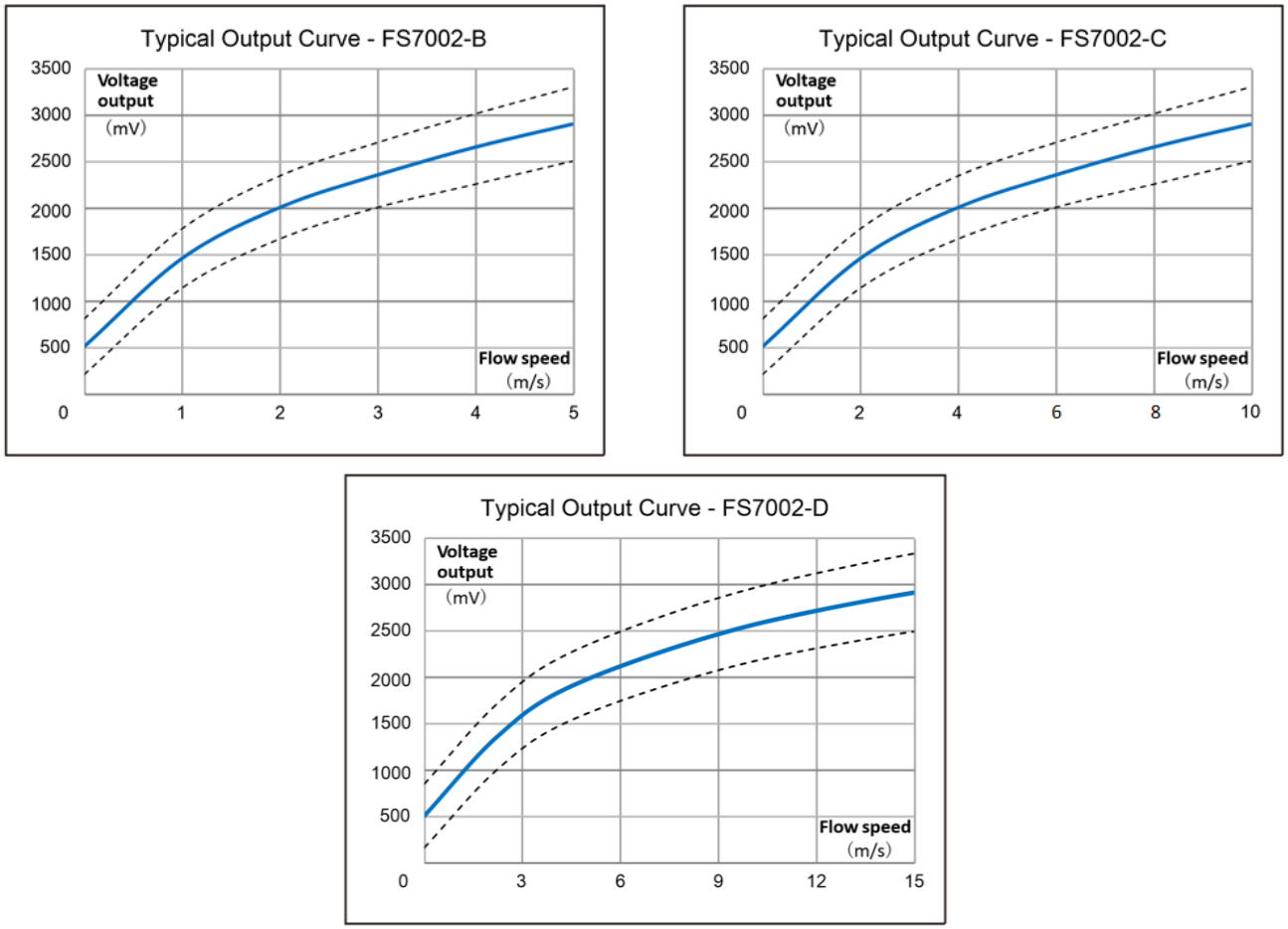


Figure 7.1: Typical output of FS7002

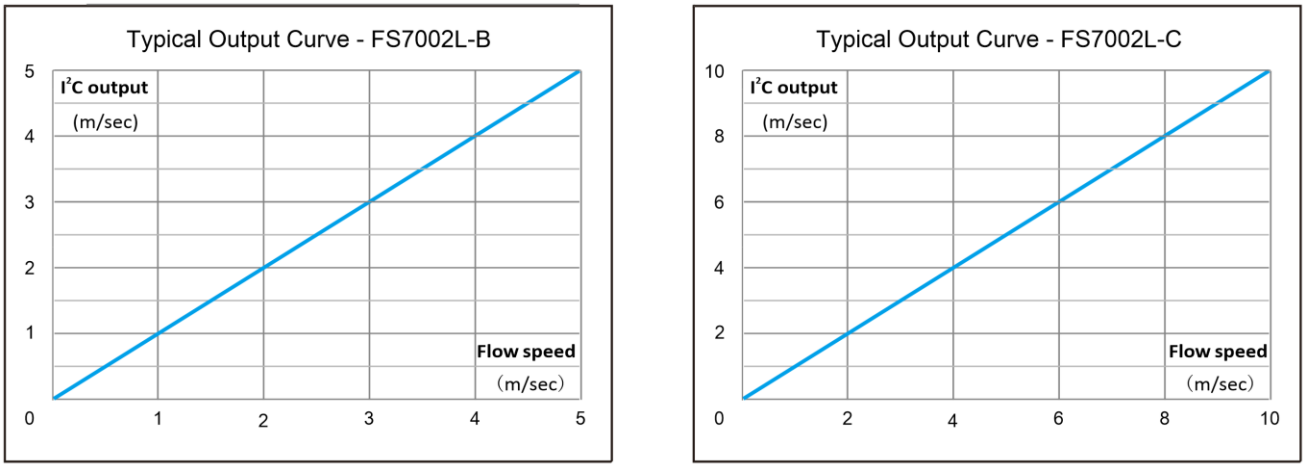


Figure 7.2: Typical output of FS7002L

8 Technical notes for the product performance

8.1 Measurement principles

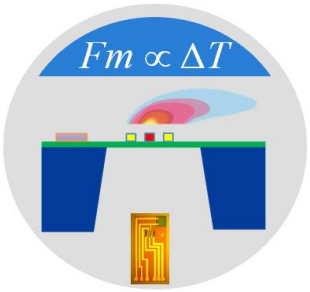


Figure 8.1: Measurement approach illustration.

The products utilize the Company's proprietary micro-machined (MEMS) calorimetric sensing and data processing technology. A thermal signal generator with a pair of sensing elements upstream 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, which are then correlated with the fluid mass flow rate via the calibration process.

The calorimetric sensing approach offers an extensive dynamic range with better performance against 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 the 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 altitude change-induced errors. The specified altitude in Sec 7.1 has been thoroughly 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 changed. This would result in very unreliable data output. Please use other tools to prevent this situation from occurring 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 taken while performing such a task.

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

For the mass flow rate 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 slight pressure loss; therefore, the sensor lacks a strong flow restrictor or conditioners to handle the flow instability that may exist in the system. Thus, 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 get in touch with the manufacturer for further solutions.

For temperature and humidity measurement, due to the limited space in the package, the response time for humidity measurement may be slower than specified. For additional information, please get in touch with the manufacturer.

9 Warranty and Liability

(Effective January 2018)

Siargo warrants that the products sold hereunder will be used appropriately and installed correctly under normal circumstances and service conditions. 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 of a 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 fully responsible for validating the performance and suitability of the products for their particular design and applications. For any 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 expenses or reasonable attorney fees 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., or 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 when 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, as 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 damage;
(3) Products that have been opened or dismantled for whatever reason;
(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 unauthorized dealers or any third parties resell.

10 Service/Order contact and other information

Siargo Ltd. is making every effort to ensure the quality of its products. For questions or product support, please get in touch with your direct sales representative. If you need additional assistance, please get in touch with 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.

For sales or product orders, please get in touch with the local sales representatives or distributors listed on the company's webpage: www.Siargo.com.

For any returns, please get in touch with your direct sales representative to obtain an RMA. If you require further assistance, please get in touch with info@siargo.com for additional information or a Return Materials Authorization (RMA) before returning the product to the factory for servicing, including calibration. Please specify in your email message that you intend to return the product to the factory and include your shipping address. Be sure to write the RMA on the returned package or include a letter with the RMA information.

Direct customer service request(s) should be addressed to

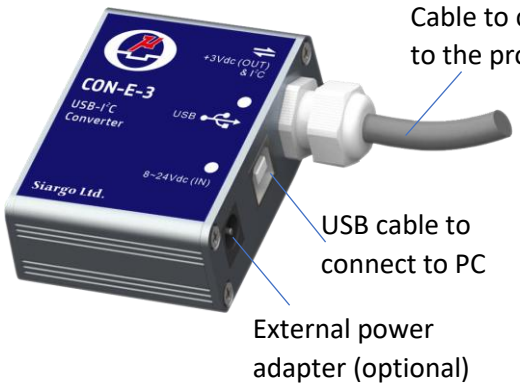
Siargo Ltd.
4677 Old Ironsides Drive, Suite 310,
Santa Clara, California 95054-1857, USA
Tel: +1(408)969-0368
Email: Info@Siargo.com

For further information and updates, please visit www.Siargo.com.

Appendix I: Sensor evaluation kit

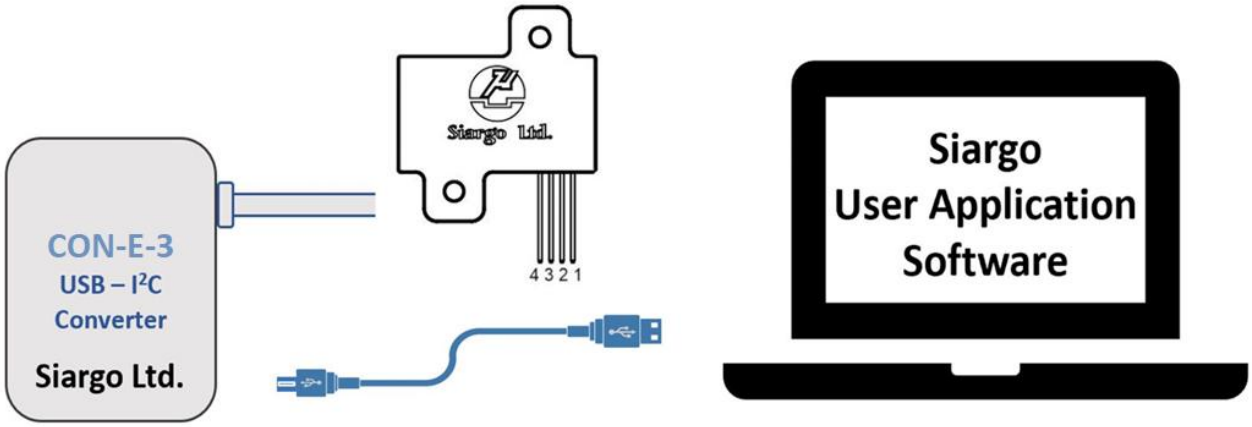
Siargo offers a sensor evaluation kit, including a digital data converter, USB data cable, and User Application software, that allows the user to evaluate the product performance on a Microsoft Windows-based computer. The user can read and visualize the flow rate of the product, obtain the totalized values, and save the data for further analysis. It can read from up to 128 sensors with the I²C interface in serial.

For further information and the purchase of the evaluation kit, please get in touch with 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 necessary.



Appendix II: Document history

Revision VD.1.04 (August 2025)

- Corrections.

Revision VD.1.03 (June 2023)

- Update contact address.

Revision VD.1.02 (August 2022)

- Minor corrections.

Revision VD.1.01 (July 2022)

- Minor corrections.

Revision VD.1 (September 2021)

- Combined FS7002 and FS7002L user manual;
- Re-format with additions.

FS7002: Revision VC.7 (October 2020)

- ISO 45001 addition.

FS7002: Revision VC.6 (February 2018)

- Add the model FS7002D.

FS7002: Revision VC.5 (July 2017)

- Add revision history;
- Contact information update.

FS7002L: Revision VA.0 (August 2018)

- First release.