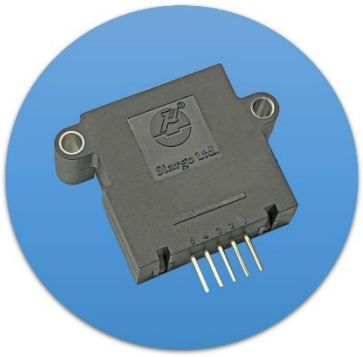
Siargo Ltd.

FS5001E User Manual VD.1

MEMS Mass flow sensors for manifold installation



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MEMS Mass Flow Sensors

with thermal sensing technology for manifold configuration

FS5001E 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

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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.

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1. Overview

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

This manual provides essential information for the FS5001E series of mass flow sensors for process control and instrumentation, including gas chromatography applications. The product performance, maintenance, and troubleshooting, as well as the information for product order, technical support, and repair, are also included.

The FS5001E sensors are manufactured with the company's proprietary MEMS (micro-electro-mechanical systems) sensing and package technology, providing the temperature and pressure-independent mass flow sensing for a full-scale range from 200 to 15000 sccm with a maximum pressure rating of 10 bar or 150 psi.

The product provides a manifold configuration for the mechanical connections. Optionally, it also opts for a stainless steel mechanical converter that offers the 4mm one-touch flexible piping.

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.



FS5001E



Power and data cable (optional)

Figure 2.1: FS5001E flow sensor and accessories

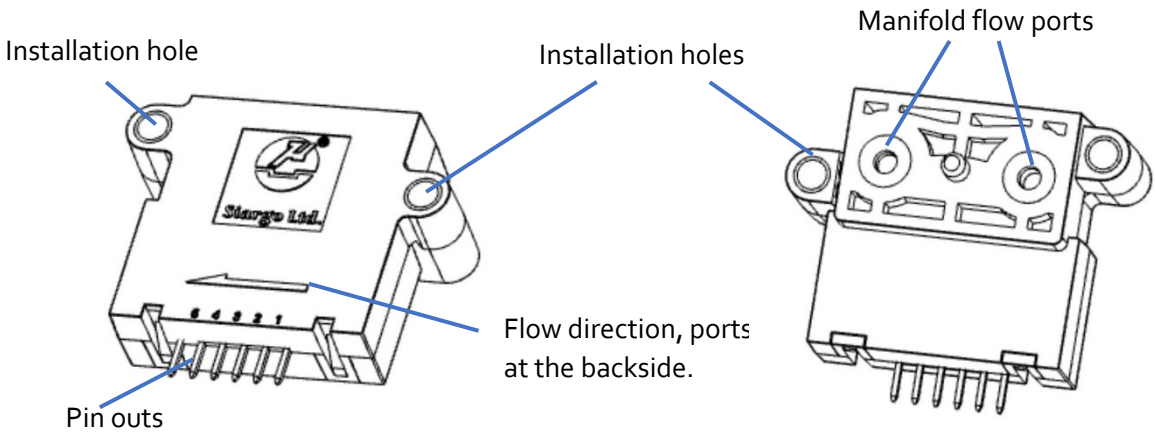
Please check immediately for the integrity of the product and the power and data cable; if any abnormality is identified, please notify the distributor/sales representative or manufacturer as soon as you can. If any defects are confirmed, an exchange shall be arranged immediately via the original sales 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.

To prevent the sensor from over-force-related damage or malfunctions during installation, the product comes with a stainless steel installation plate, two screws (M3x20), and 2 O-rings (2.5x1.8).

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. The product also includes a stainless steel accessory that allows the conversion of the manifold connection into 4mm one-touch connections for flexible piping.

3. Knowing the products

3.1 Product description



Note: The manifold base port size should not be smaller than those of the flow ports on the product.

Figure 3.1: FS5001E parts description

3.2 Power and data pinout description

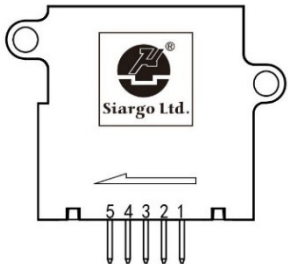


Figure 3.2: FS5001E pinout
2.54mm centers; 0.635mm square

Table 3.1: FS5001E pin assignment.

PIN	DEFINITION
1	SDA, I²C data
2	Analog output, 0.5 ~ 4.5 Vdc
3	VCC, power supply, 8 ~ 24Vdc
4	GND, ground
5	SCL, I²C clock

DO NOT connect or disconnect the sensor cable when the power is on!! It will damage the electronic chipsets inside the sensor module!

Note: 1. Power supply: The FS5001E requires a power supply of 8 ~ 24 Vdc. No particular requirements for the external power supply, but standard industrial power cautions should be applied.

2. The analog outputs 0.5 ~ 4.5 Vdc correspond to the specified full-scale flow range at the time of order. If the analog option is not selected, this pin output could be NULL.

3. SDA and SCL are the I²C serial data line and serial clock line, please refer to the information in the subsequent section.

3.3 Mechanical dimensions

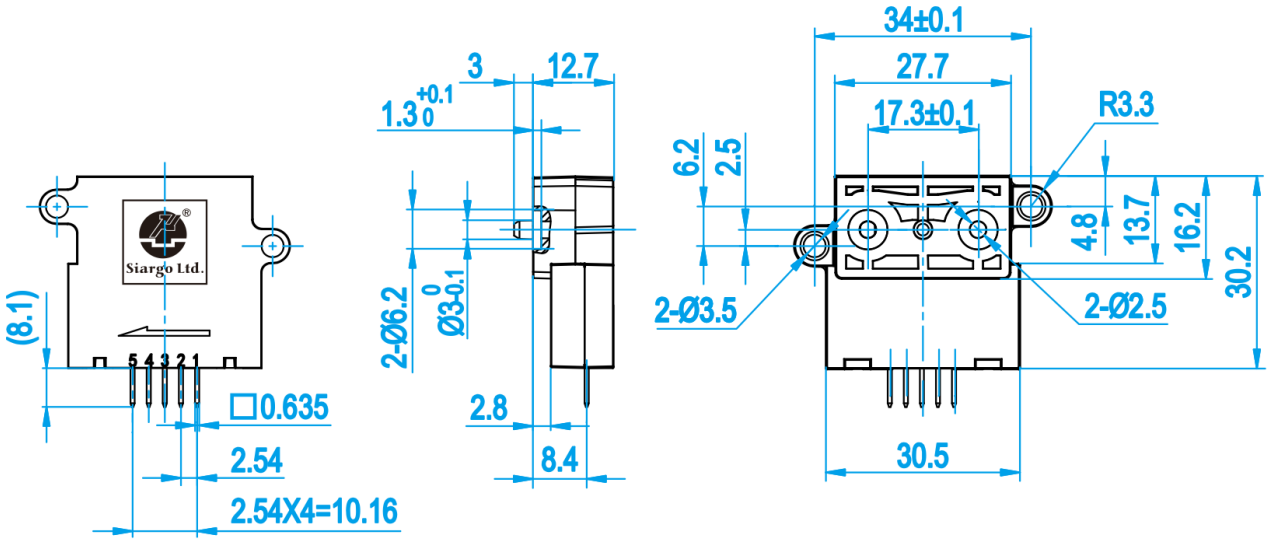


Figure 3.3: FS5001E: 0 ~ 200, 500, 1000, 2000, 4000, 6000 sccm models mechanical dimensions.

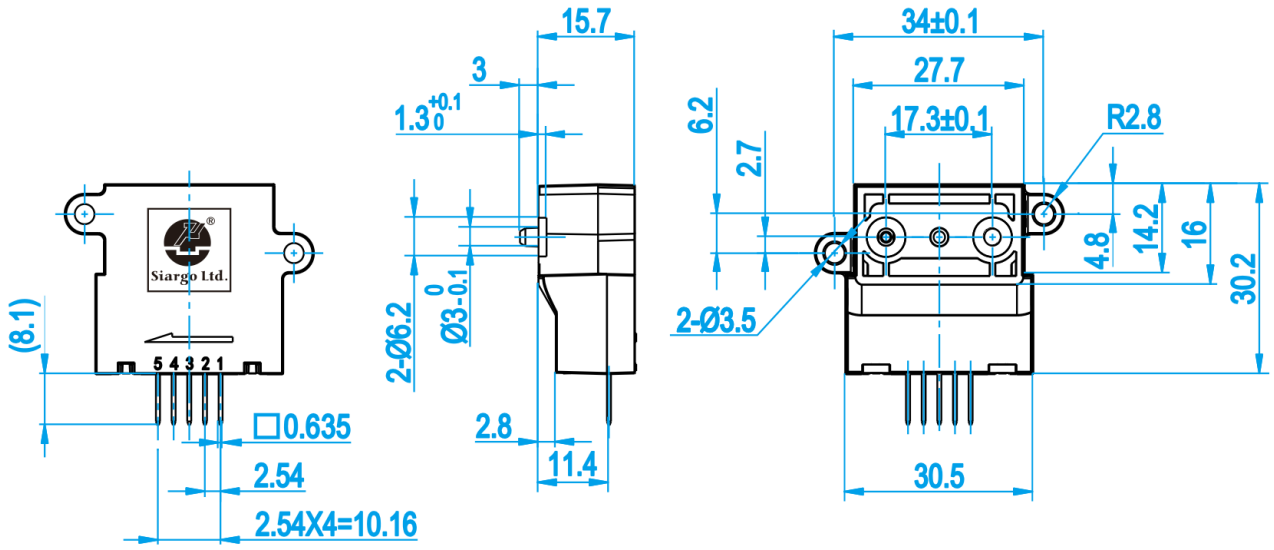


Figure 3.4: FS5001E: 0 ~ 10000, 15000 sccm models mechanical dimensions.

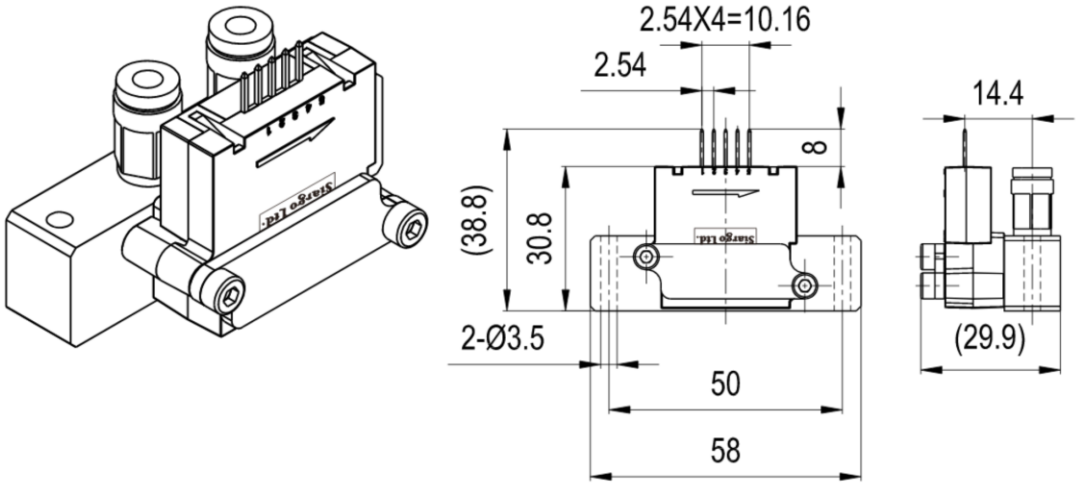


Figure 3.5: The mechanical dimensions for FS5001E with an optional Φ4 mm one-touch connection block.

4. Installation

Do not open or alter any part of the product, which would lead to malfunction and irrecoverable damage.

For the installation, ensure that the connections are properly leakage-proofed and that all necessary electrical precautions are taken. Please make sure the electrical pins are properly engaged. It should be noted that the sensor is designed for medium to low pressure per the applications; therefore, the system design would be necessary for the flow stability and related flow noises.

To prevent over-forced installation, the product comes with a stainless steel installation plate, two screws (M3x20), and 2 O-rings (2.5x1.8). The mounding torque applied should be within 0.35±0.03 N·m. Please follow the following graph for the installation of the stainless steel plate.

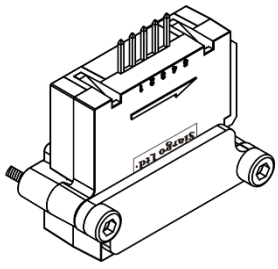
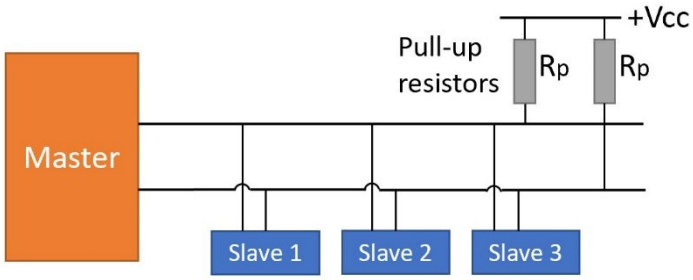


Figure 4.1: Illustration of the installation with the supplied metal plate.

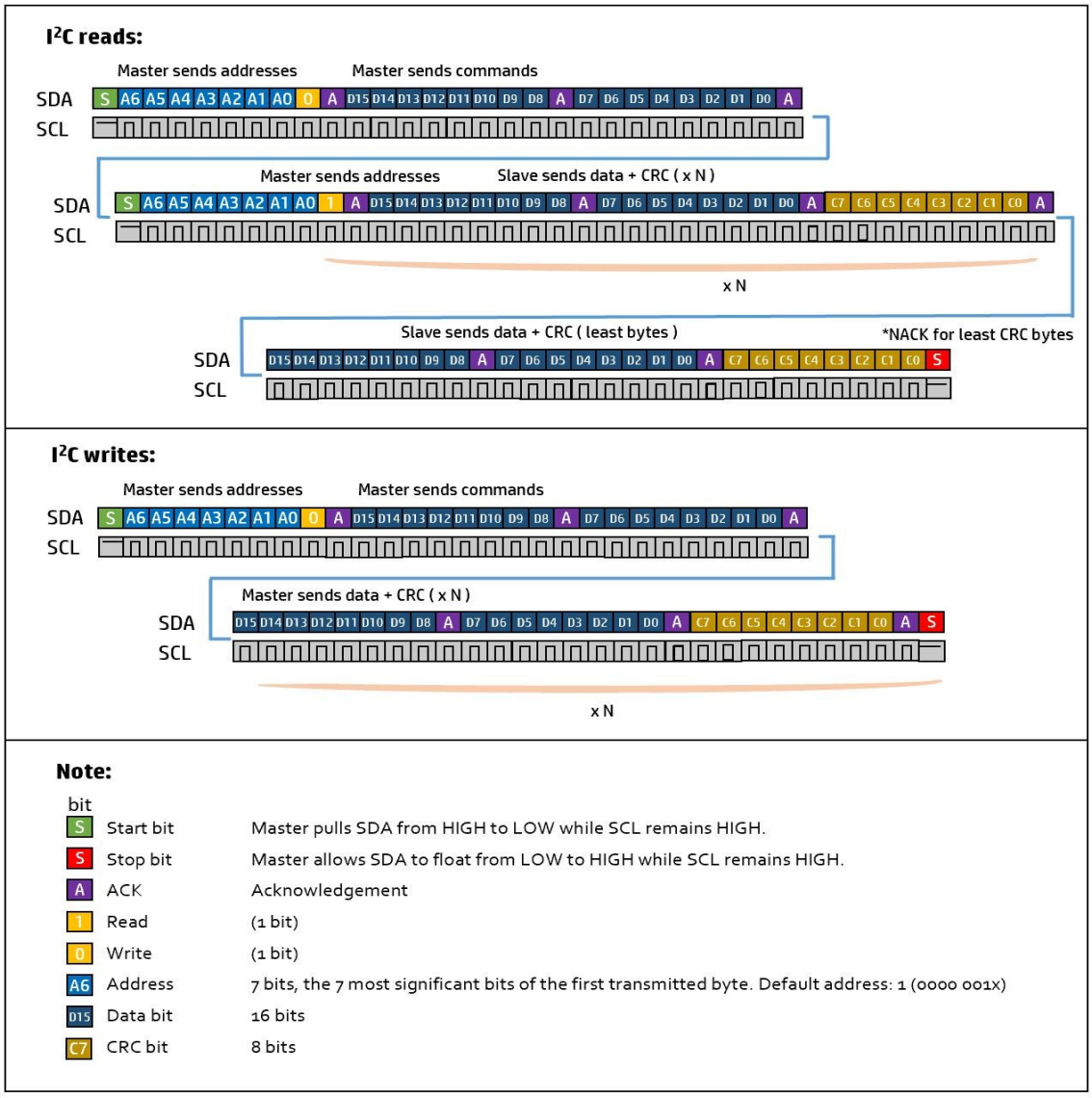
5. I²C communication protocol

5.1 I²C interface connection diagram



Vcc: 3.0 ~ 5.5 Vdc
Rp: 1.0 ~ 10.0 kΩ
I2C bus clock frequency: 100 kHz

5.2 I²C interface read/write sequences



5.3 I²C interface command description

Please note the addition of the CRC in the protocol. If you are using an older version, you may need to update your firmware for the current products.

Command Byte	Length (int 16)	Command Name	Read/Write	Notes
0x00A4	1	I²C address	Read/Write	Int 16. Bit 0 is the R/W flag bit. bits 1 ~ 7 are available; bit 8 ~ bit 15 = 0. The default I²C address is 1. Hex: 0x0002 (write) /0x0003 (read), Bin: 0000 0000 0000 0010 (write) 0000 0000 0000 0011 (read).
0x0030	6	Sensor serial number	Read	ASCII
0x003A	2	Flow rate	Read	Int 32/1000 sccm
0x0040	1	Gas temperature	Read	Int 16/100 °C
0x008B	1	Gas correction factor (GCF)	Read/Write	The gas conversion factor for the applicable gas differs from that of the calibration gas.
0x008C	1	Filter depth	Read/Write	Int 16, 0 ~ 9, corresponding to 2^0 ~ 2^9 data in the software filter. The default value is 3, corresponding to 2^3 = 8 data in the software filter.
0x00F0	1	Reset the offset of the differential pressure	Write	Fixed value, 0xAA55
0x00FF	1	Write protection	Write	Fixed value, 0xAA55 Write protection disabler for a set value to a specific register.

Note:

1. The I²C address is set to bits ~ 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).

2. GCF table

Gas type	Correction factor
Air	1000
Oxygen (O_2)	1000
Nitrogen (N_2)	1000
Argon (Ar)	1000
Carbon dioxide (CO_2)	540
Helium (He)	6700
Hydrogen (H_2)	5900

*: For Hydrogen/Helium application, the actual H_2/He calibration is performed whenever possible.

5.4 CRC checksum calculation

The 8-bit CRC checksum transmitted after every two data bytes (int 16) is generated by a CRC algorithm. Its properties are listed in the table below. To calculate the checksum, use only these two previously transmitted data bytes.

Property	Value
Name	CRC-8
Protected data	I^2C read and write
Width	8 bits
Polynomial	0x07 (x8 + x2 + x + 1)
Initialization	0x00
Reflect input	False
Reflect output	False
Final XOR	0x00
Example	CRC(0x4E20) = 0x6D

6. Product selection

The product part number is composed of the product model number and suffixes, indicating each of the selectable parameters. Refer to the following for details.

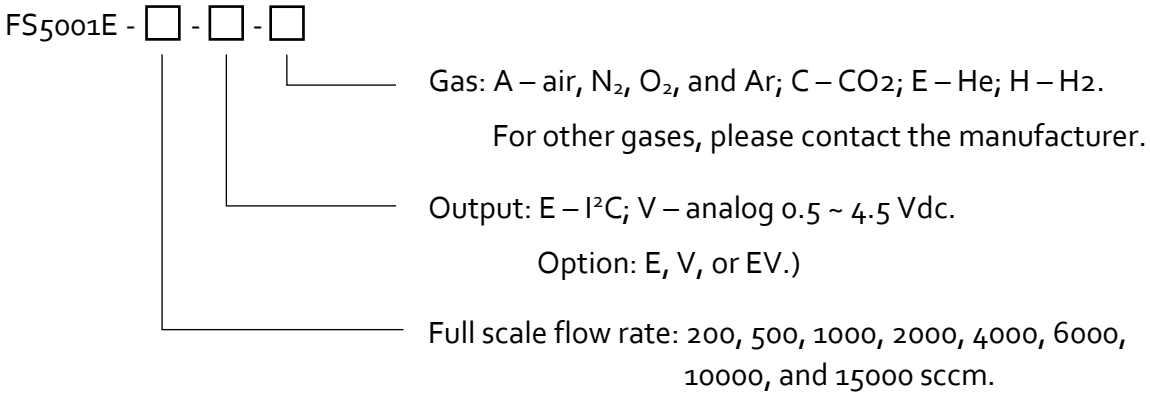


Table 6.1: Maximum full-scale flow rate selection

Gas	Connection Full-scale flow rate	Notes
Air, N_2, O_2, and Ar	200, 500, 1000, 2000, 4000, 6000, 10000, 15000	
CO_2	200, 500, 1000, 2000, 4000, 6000, 10000	
He	500, 1000, 2000, 4000, 6000, 10000, 15000	
H_2	500, 1000	

7. Product performance

7.1 Technical specifications

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.

	Value				Unit
Flow range	0 ~ 200	0 ~ 500, 1000	0 ~ 2000, 4000, 6000	0 ~ 10000, 15000	sccm
Accuracy	±(2.0+0.5FS)				%
Repeatability	(0.5+0.15FS)				%
Turn-down ratio	100:1				
Response time [2]	10				msec
Temperature range	-10 ~ +55				°C
Temperature coefficient [3]	±0.08				%/°C
Pressure range	-0.08 ~ 0.5				MPa
Burst pressure	1.0 (150)				MPa (psi)
Humidity	<95, no condensation				%RH
Analog null shift	±30				mV
Power supply	8 ~ 24				Vdc
Working current	50				mA
Output	Linear, analog 0.5 ~ 4.5 Vdc / I²C				
Analog load	Sourcing: 25 / Sinking: 15				mA
Maximum overflow	1	3	18	45	SLPM
Maximum flow change	150	500	3000	7500	sccm/sec
Calibration	Air @ 20°C, 101.325 kPa				
Storage temperature	-20 ~ +70				°C
Compliance	RoHS; REACH				
CE	IEC 61000-4-2; 4-8				

Note: 1. Allow the product to warm up for 60 seconds for the best performance.

2. Response time shown is the default. It can be programmed to the fastest <2 msec.

3. The temperature coefficient of ±0.08 %/°C is typical value.

7.2 Typical (analog) output

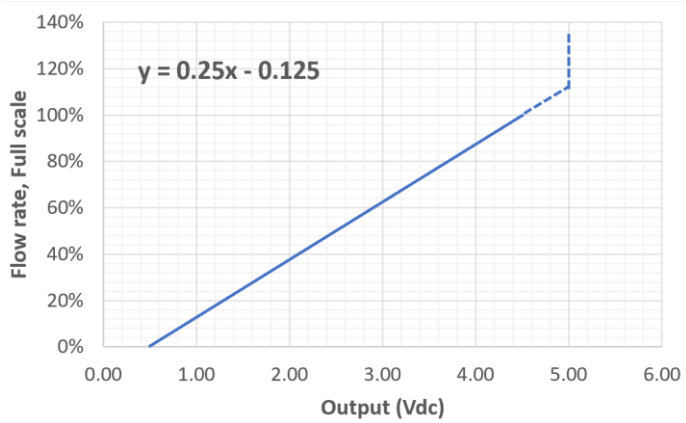


Figure 7.1: Typical analog output

7.3 Pressure loss

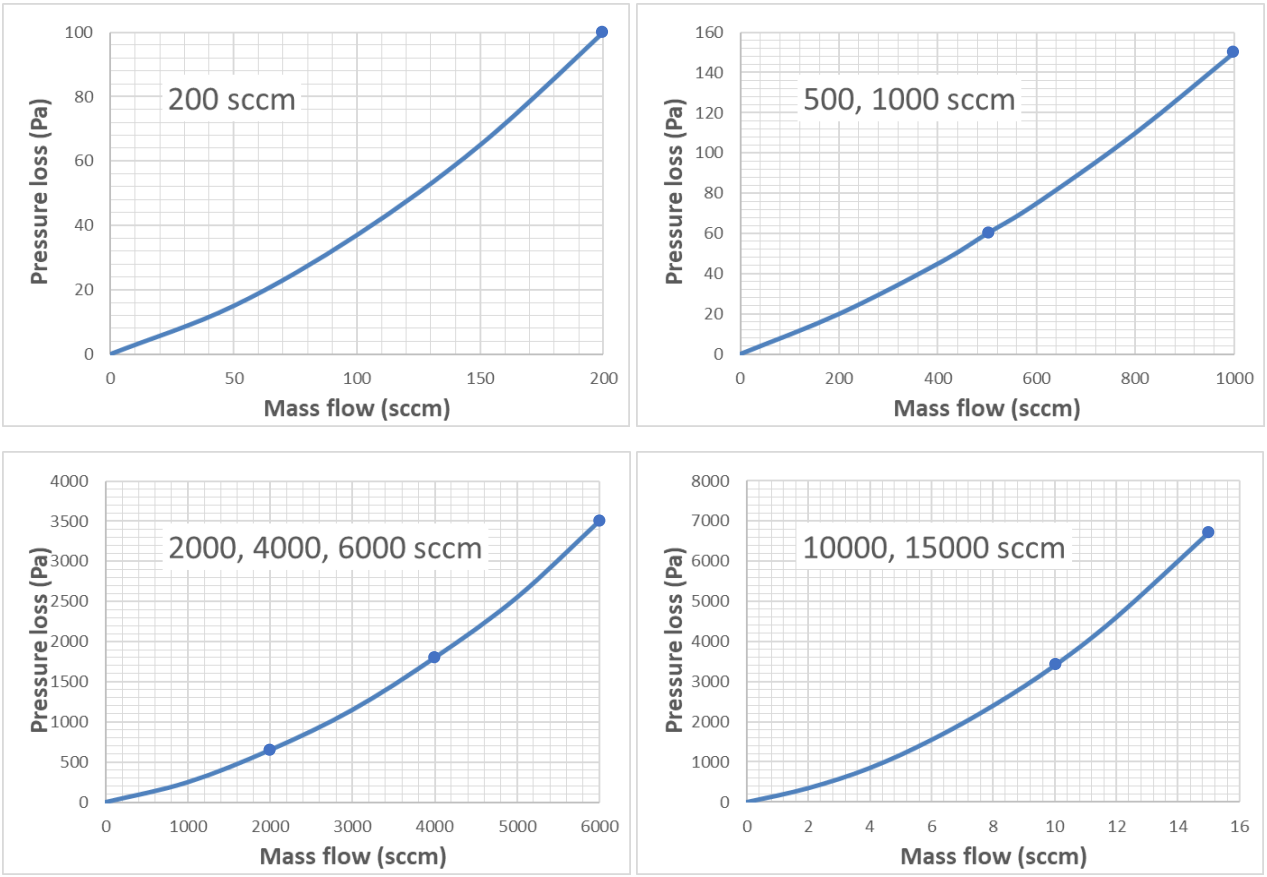


Figure 7.2: Upper row: from left to right, for models of full scale 200 sccm, and of full scale up to 1000 sccm; Lower row: from left to right, for models of full scale up to 6000 sccm, and of full scale up to 15000 sccm.

7.4 Wetted materials and compatibility

The product flow channel is made of Polybutylene terephthalate (PBT). The sensing element comprises silicon, silicon nitride, and silicon dioxide. The sensor chip surfaces are passivated with silicon nitride and silicon dioxide. The electronic sealing is provided by LOCTITE Ablestik 84-3J. Another wetted material that may be exposed is FR-4.

8. Technical notes for the product performance

8.1 Measurement principle

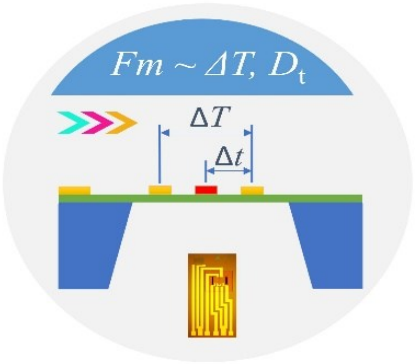


Figure 8.1: Measurement approach illustration

The products utilize the Company's proprietary micro-machined (MEMS) thermal calorimetric sensing in time-domain data with a data processing algorithm (Thermal-D sensing). A thermal signal generator (microheater) with a pair of sensing elements is precisely manufactured upstream and downstream and separated at predefined micrometer distances on the chip surface under excellent thermal isolation. When a fluid flows through the sensing chip, the fluid carries the thermal signal downstream. The sensing elements register the amplitude, time, and temperature differences. It calculates the thermal diffusivity and further correlates with the fluid mass flow rate during the calibration process.

This unique thermal sensing approach offers an extensive dynamic range with better performance against environmental parameter alternations. It is the first of its kind in the industry, which allows gas property-independent mass flow measurements for gases with similar thermal diffusivities. It significantly simplifies process control with high precision and easy maintenance. Please refer to the company's USA patents and other publications made available for additional information.

8.2 Precautions for the best performance of the product

8.2.1 Contamination and sterilization

It is critical to have the measurements performed in a contamination-free environment for data accuracy. Excessive contaminants, such as vapors, will lead to data deviation or even product malfunctions in severe cases.

For medical applications, it may be desired to have the product sterilized from time to time. A standard EtO sterilization process is recommended. For the detailed procedure, please consult your local experts or contact the manufacturer.

8.2.2 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.

8.2.3 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 a very unreliable data output. Please use other tools to prevent this situation from occurring when using this product.

8.2.4 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 any 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 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 contact and 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 reach out to 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 the product's status as clearly as possible, indicating your intention to return it 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

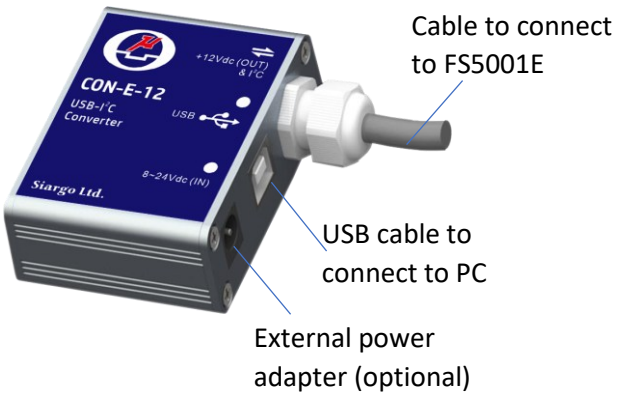
Siargo Ltd.
4677 Old Ironsides Drive, Suite 310,
Santa Clara, California 95054-1857, USA
Tel: +1(408)969-0368
Email: Info@Siargo.com

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

Appendix I: Sensor evaluation kit

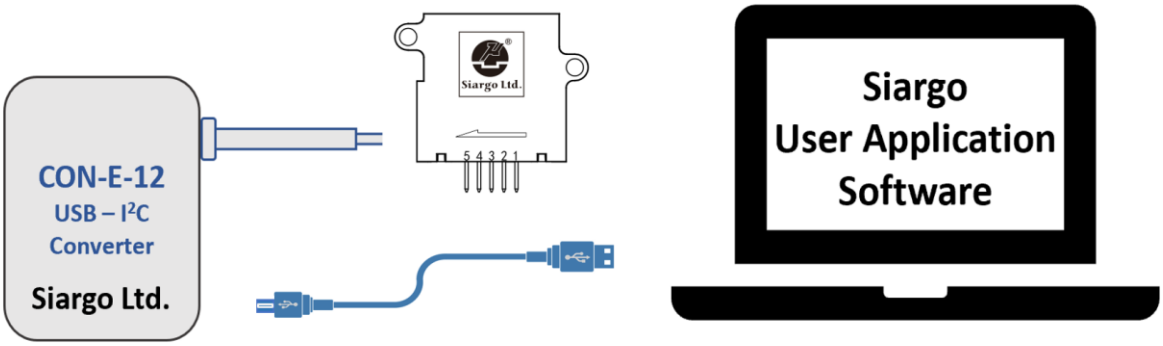
Siargo offers a sensor evaluation kit, including a digital data converter, USB data cable, and User Application software, that allows the user to evaluate the product performance on a Microsoft Windows-based computer. The user can read and visualize the flow rate of the product, obtain the totalized 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 purchase of the evaluation kit, please get in touch with the manufacturer or the sales representative.



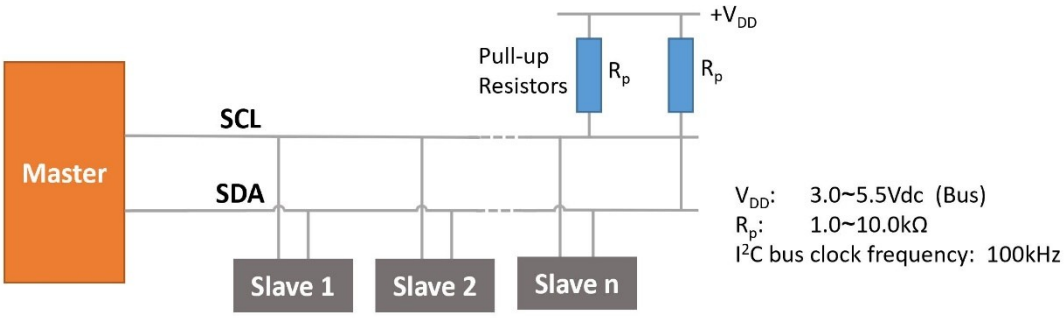
Each converter has a fixed cable that can be directly connected to the product. The USB cable connected to the PC is also included.

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 ~ 24 Vdc will be necessary.



Appendix II: I²C communication protocol of FS5001L

A-II.1 I²C interface connection diagram

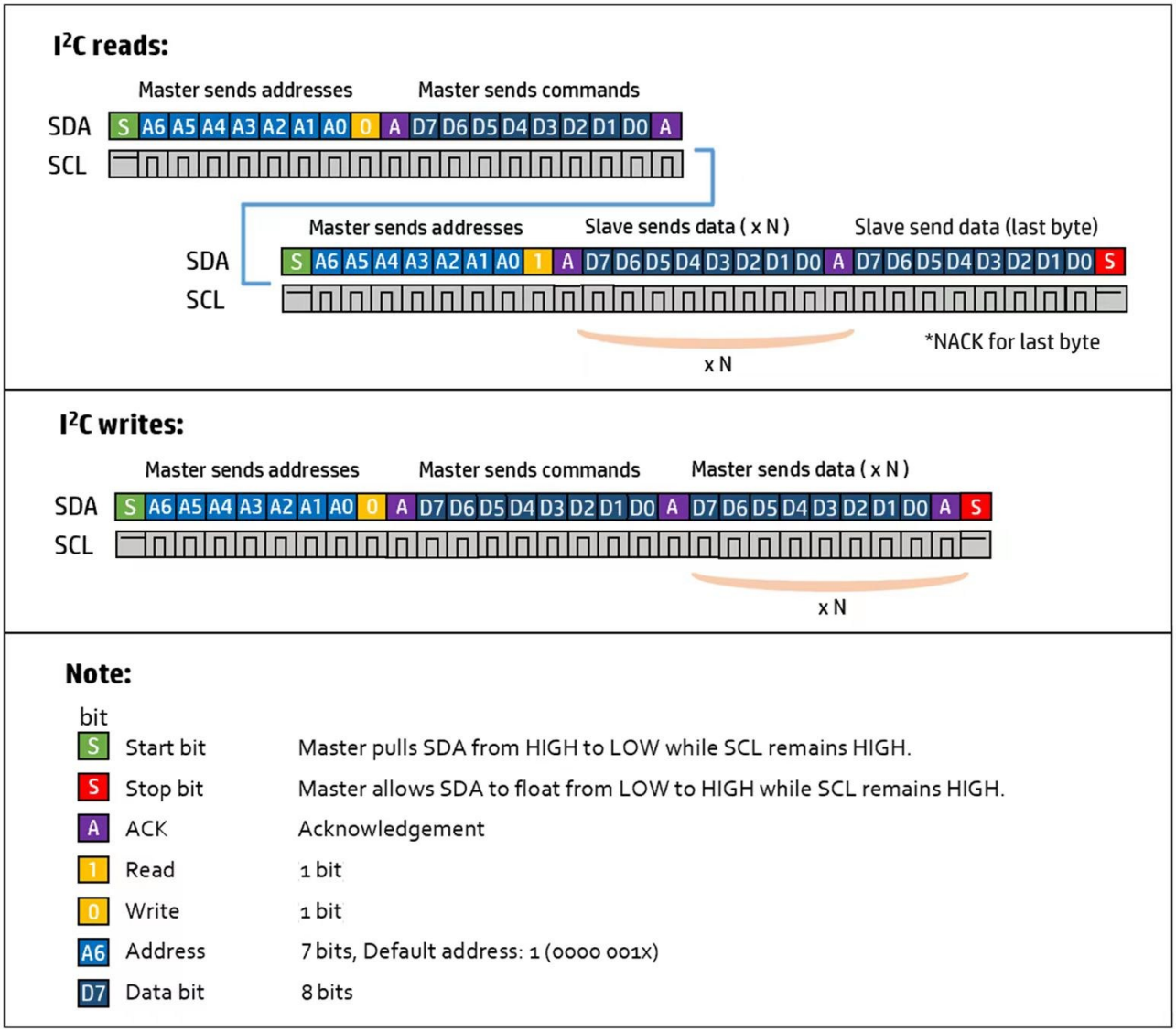


A-II.2 I²C interface command description

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.
1CH	1	Flowrate offset reset	Write	1 byte, ensure no-flow conditions
81H	2	Serial number	Read	Int 16
82H	12	Serial number	Read	ASCII
83H	5	Flow rate	Read	Int32(/1000 sccm)
85H	1	I²C address	Read	Bit 7 ~ Bit 1
8AH	2	Read the gas conversion factor	Read	Int16, the default value is 1000 for air
8BH	1	Filter depth	Read	Int 8, 0 ~ 254

Note: 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).

A-II.3 I²C interface read/write sequences



Appendix III: Document history

Revision VD.1 (February 2026)

- Added the GCF of He and H2 (*5.3 I²C interface command description, Note 2, GCF table*);
- Corrected the measurement principle (*8.1 Measurement principle*).

Revision VD.0.04 (August 2025)

- Corrections.

Revision VD.0.03 (November 2024)

- Corrected the FS5001L I²C protocol, which is listed in Appendix II.

Revision VD.0.02 (July 2024)

- Revised the temperature coefficient to 0.08%/°C.
- Corrections.

Revision VD.0.01 (July 2024)

- Revised the repeatability to (0.5+0.15FS)%.

Revision VD.0 (May 2024)

- FS5001L has been upgraded; the new part number is FS5001E.
- No spec changed. (MEMS chip change to 4th GEN MEMS chip with Thermal-D technology, and circuit altered to match the 4th GEN MEMS chip.)
- Updated the I²C command protocol. The sensor can communicate with the FS5001L I²C protocol, which is listed in Appendix II.

Revision VC.0.04 (March 2024)

- Corrected the I²C command description and sequences.

Revision VC.0.03 (December 2023)

- Corrected the I²C command description and sequences.

Revision VC.0.02 (July 2023)

- Updated contact address.

Revision VC.0.01 (July 2022)

- Updated service and sales contact.

Revision VC.0 (May 2022)

- Addition of a 15L/min model, and minor changes.

Revision VB.0 (July 2021)

- The new format, with additions.

Revision VA.8 (June 2021)

- Updated maximum pressure, and revise the I^2C voltage symbol.

Revision VA.7 (October 2020)

- Revised ISO 45001.

Revision VA.6 (June 2018)

- Revised the I^2C commands.

Revision VA.5 (December 2018)

- Revised the pressure drop.
- Revised the I^2C command description.

Revision VA.4 (June 2018)

- Corrected the features.

Revision VA.3 (April 2018)

- Added the mounting information.

Revision VA.2 (March 2018)

- Updated the photo.
- Revised the packaging material to PBT.
- Corrected the mechanical dimensions to 40.6 x 36.3 x 15.7 mm^3;
- Revised the I^2C command description;
- Revised the wetted materials.

Revision VA.1 (December 2017)

- Added the I^2C commands for response time.