Siargo Ltd.

FS1015E User Manual VD.1

MEMS mass flow sensors

MEMS Mass Flow Sensors

with thermal calorimetric sensing technology

FS1015E 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 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 FS1015E series of mass flow sensors, designed primarily for medical applications such as ventilators, anesthesia equipment, and endoscopes with ISO 15mm adapters. These sensors feature a fast response time and very low-pressure loss. The sensor can also be used for other gas flow measurements, and different threaded connectors can be made available via an adaptor. The product performance, maintenance, and troubleshooting, as well as the information for product order, technical support, and repair, are also included.

The FS1015E sensors are manufactured with the company's proprietary MEMS (micro-electro-mechanical systems) sensing and package technology that offers primarily the mass flow rate measurements of a full scale up to 150 SLPM with a dynamic range of 100:1, and the maximum pressure rating of 2 bar (30 psi).

The sensor can be sterilized via a medical cleanse agent that is compatible with the wetted materials of polycarbonate, silicon nitride, and medical-grade epoxy LOCTITE 84-3J. Some types of alcohol may react with polycarbonate and are not recommended for use. An alternative standard dry EtO sterilization process would be highly recommended.

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: FS1015E

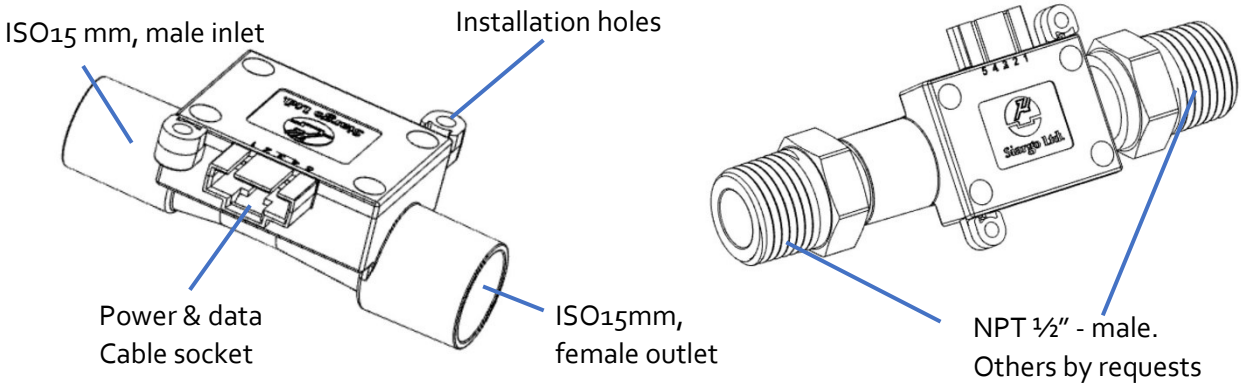
Figure 2.2: Optional power and data cable

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.

Please note that one end of the data cable is to be plugged into the sensor, and the other end is connected to the colored wire terminals. Please read Section 3 carefully before connecting to the power and your data terminals.

3. Knowing the products

3.1 Product description



Note: The standard products come with ISO-15mm connectors. For other types of connectors, a metal adapter can be added upon request.

Figure 3.1: FS1015E parts description

3.2 Power and data pinout description

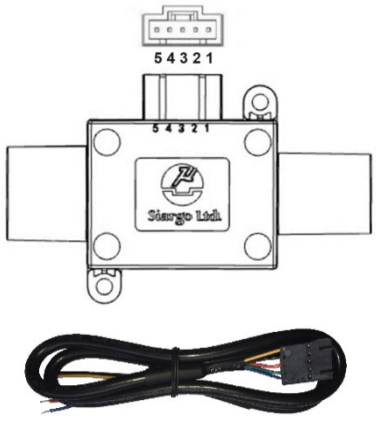


Table 3.1: FS1015E pin assignment.

PIN	COLOR	DEFINITION
1	Blue	SDA, I²C data
2	Green	Analog output, 0.5 ~ 4.5 Vdc
3	Red	VCC, power 5 ±5% Vdc
4	Black	GND, ground
5	Yellow	SCL, I²C clock

Figure 3.2: FS1015E pinout and cable
Connector: AMPMODU MTE 5 position; cable length: 50 cm.

Note: The product requires a power supply of 5 ± 5% Vdc. This voltage is internally filtered and regulated. However, the analog output might be influenced if the supply voltage has large deviations. It is advised to turn off the power when plugging in or unplugging the cable to avoid any damage.

3.3 Mechanical dimensions

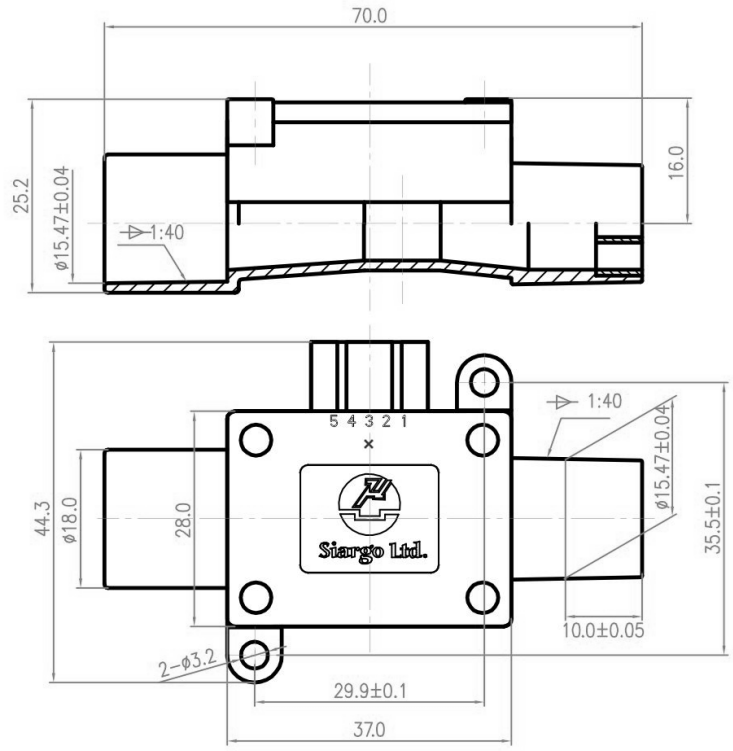


Figure 3.3: FS1015E mechanical dimensions with ISO15mm connectors.

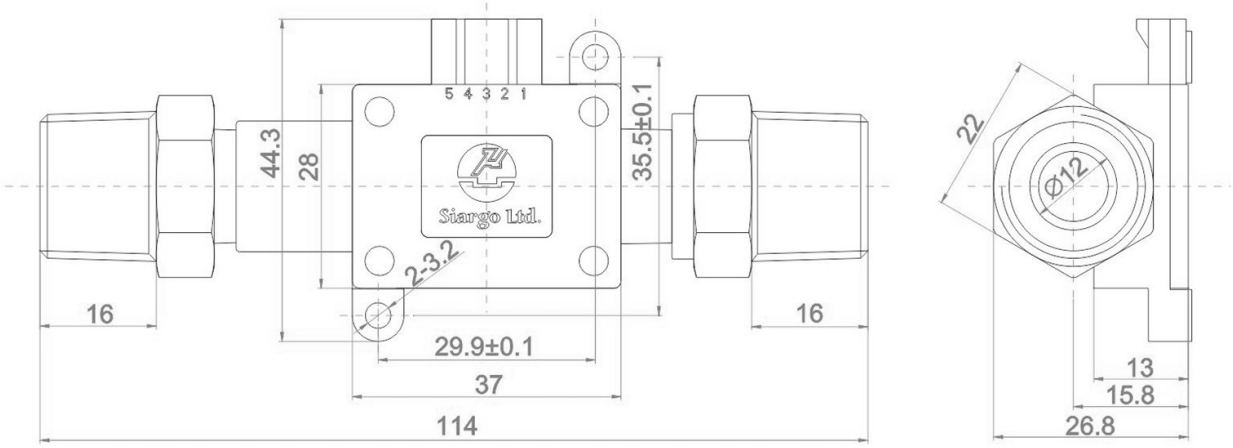


Figure 3.4: FS1015E mechanical dimensions with ½" NPT connectors.

Note: Other types of connectors could be possible upon request.

4. Wetted materials and compatibility

The product body is made of medical-compatible plastics (polycarbonate). 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.

5. Installation

The product at the time of shipment is fully inspected for product quality and meets all safety requirements. Additional safety measures during handling and installation should be applied. To prevent ESD (electrostatic discharge) damage and /or degradation, take customary and statutory ESD precautions when handling. Do not open or alter any part of the product, which would lead to malfunction and irrecoverable damage.

For the installation, the product comes with standard ISO15mm connectors, where the gas inlet is the male and the outlet is the female connector. The data and power cable are usually shipped with the product; otherwise, they can be obtained from the manufacturer. One end of the cable can be directly plugged into the sensor socket. In contrast, the other end has colored wire terminals, which need to be connected correspondingly to the power supply and data-receiving terminals. Make sure to refer to Sec 3.2 and double-check the connection before powering on. Before supplying the gas to the sensor, ensure that the mechanical leakage-proof connections and all electrical precautions are in place. 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.

It is advised that the products are best used for non-explosive and non-corrosive clean gases. The sensors cannot be used for gas metrology of fluoride or fluoride-containing gases. The use of these gases may cause the product to malfunction or even severe damage.

Avoid exposing the product's electronics, except for the inner flow channel, to any liquids, as the unit does not have waterproof electronics. Avoid flowing gas in conditions that could trap condensing water vapor inside the unit during operation, as this may significantly affect accuracy.

It is suggested to design your application so that the nominal flow rate is approximately 70% of the full-scale flow rating of the sensor. Avoid using a sensor with an extreme flow range; for example, a 150 SLPM sensor is not suitable for a 1.5 SLPM application.

6. Operation and MENU description

6.1 Check the product specifications

Before starting to use this product, check the product specifications that can be found in this manual or the basic information from the datasheet on the company's website www.Siargo.com.

The detailed product technical specifications can be found in Section 7. For a specific application, the pressure rating must not be higher than the system pressure to be measured, and the flow range should also be within the specified range. In most cases, the use of a high full-scale range meter for the very low flow rate measurement often results in erroneous data. The gas to be measured must also be consistent with that specified by the product. Be particularly cautious about the supplied voltage indicated in the specification. A higher voltage may lead to irrecoverable damage, and a lower voltage will not power the product for any desired functions.

For optimal product performance, it is recommended that the gas to be measured be clean and free of particles or other foreign materials.

6.2 Check the leakage

Check for gas leakage before any measurement. If necessary, pressurized nitrogen or air can be used for the leakage check.

6.3 Power the product and digital data connection

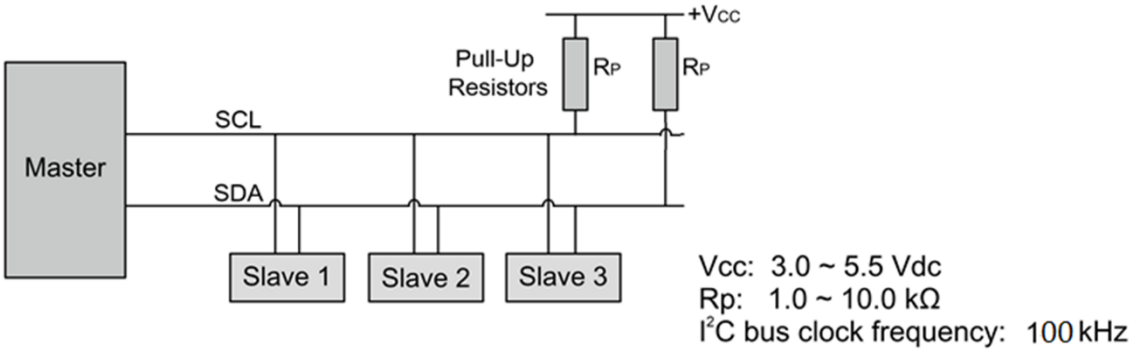
Although this product complies with the CE-required EMC regulations, it also requires the product to be used according to the standard electrical device practice. Before connecting the product with external DC power or an AC-DC adapter, make sure the supply voltage is within the range specified in Section 7. Be cautious that standard electrical device precautions, such as ESD (electrostatic discharge) and DC voltage, are observed. Excessive electrostatic discharge may damage the product.

The manufacturer-supplied power and data cable has a locking fixture. Lock the cable and ensure it is properly engaged to prevent accidental unplugging.

I^2C is used for digital data communication. Make sure the wires are correctly connected to the receiver side.

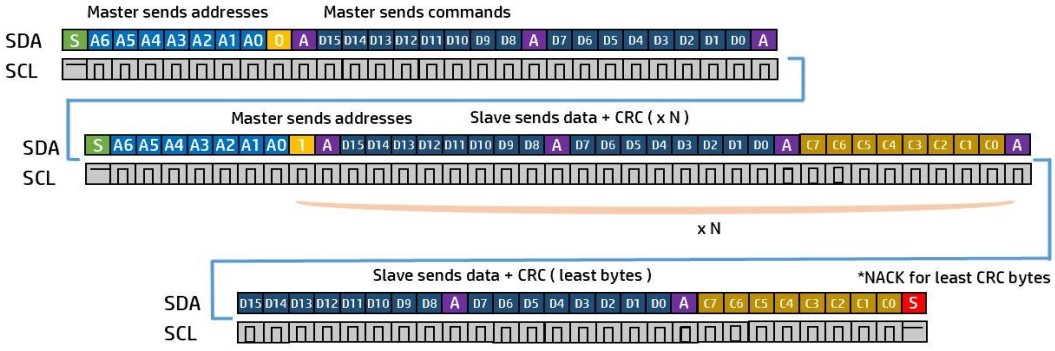
6.4 I²C communication protocol

6.4.1 I²C interface connection diagram

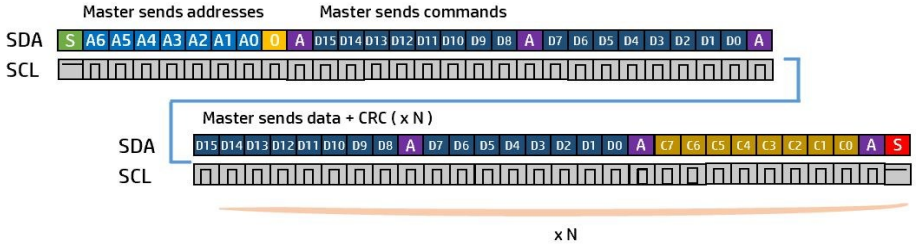


6.4.2 I²C interface read/write sequences

I²C reads:



I²C writes:



Note:

bit		
S	Start bit	Master pulls SDA from HIGH to LOW while SCL remains HIGH.
S	Stop bit	Master allows SDA to float from LOW to HIGH while SCL remains HIGH.
A	ACK	Acknowledgement
1	Read	(1 bit)
0	Write	(1 bit)
A6	Address	7 bits, the 7 most significant bits of the first transmitted byte. Default address: 1 (0000 001x)
D15	Data bit	16 bits
C7	CRC bit	8 bits

6.4.3 I²C interface command description

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 SLPM
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 flow rate	Write	Fixed value, 0xAA55

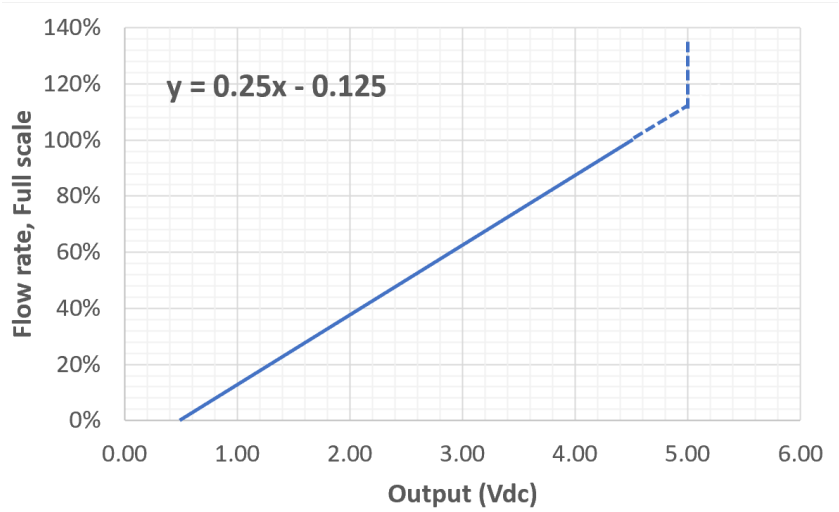
Note: The I²C address is set to bits 7 ~1, e.g., if the I²C address is 1 (0000 001x), the write address will be 0x02 (0000 0010) and the read address will be 0x03 (0000 0011).

6.4.4 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, only these two previously transmitted data bytes are used.

Property	Value
Name	CRC-8
Protected data	I²C 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

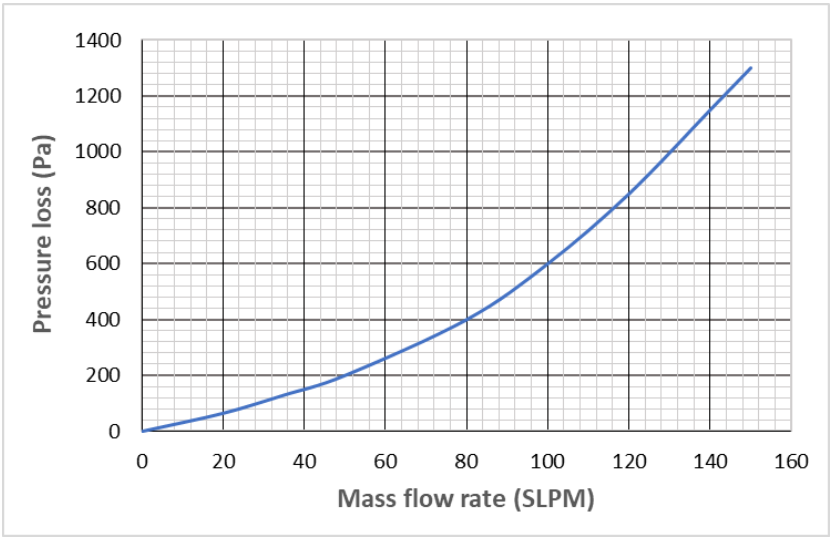
6.5 Analog output



Flow rate (SLPM)	Analog output (Vdc)
0.0	0.500
20.0	1.300
40.0	2.100
60.0	2.900
80.0	3.700
100.0	4.500
110.0	4.900
120.0	4.900

Figure 6.1: Typical analog output.

6.6 Pressure loss

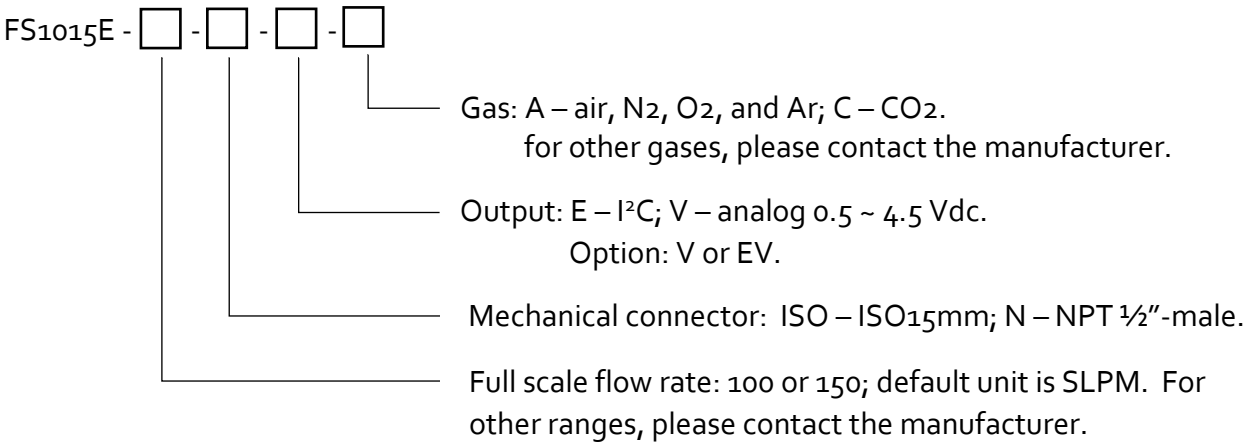


Flow rate (SLPM)	Pressure loss (Pa)
0	0
20	55
40	170
60	250
80	400
100	600
120	840
150	1300

Figure 6.2: Typical pressure loss

7. 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.



Note: For CO_2, the maximum flow rate is 100 SLPM.

8. 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 ~ 100, 0 ~ 150	SLPM
Accuracy (total error band)	±(2.0+0.5FS)	%
Repeatability	(0.5+0.15FS)	%
Turn-down ratio	100:1	
Response time	8	msec
Working temperature	-10 ~ +55	°C
Temperature coefficient	±0.12	%/°C
Maximum pressure	0.2	MPa
Pressure drop at full scale	1300 (150 SLPM)	Pa
Humidity	<95 (no condensation)	%RH
Analog null shift	±30	mVdc
Power supply	5±5%	Vdc
Working current	~10 (no output load)	mA
Output	Linear, Analog: 0.5 ~ 4.5 Vdc, I^2C	
Analog output load	Sourcing: 25; Sinking: 15	mA
Maximum overflow	300	SLPM
Maximum flow change	40	SLPM/sec
Storage temperature	-20 ~ +70	°C
Weight	21.5 g with ISO connector	
Calibration	Air @ 20°C, 101.325kPa	
Compliance	RoHS; REACH	
CE	IEC 61000-4-2;4;8	

Note: 1. Calibration with real gas is optional. Please get in touch with the manufacturer for further information.

9. Technical notes for the product performance

9.1 Measurement principles

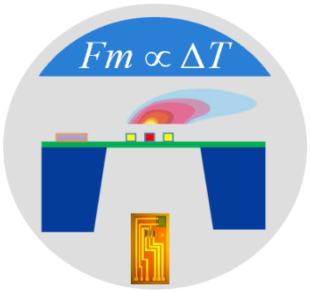


Figure 9.1: Measurement approach illustration.

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.

9.2 Precautions for the best performance of the product

9.2.1 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.

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

9.2.3 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.

9.2.4 Cleaning and sterilization

In case the product is required to be sterilized, it is recommended to use the standard dry EtO sterilization process.

Alternatively, the product can be sterilized with medical-grade cleansing liquid. For example, first, make sure the sensor is not powered on, and then prepare a clean medical liquid carrier and immerse only the FLOW CHANNEL of the sensor into the sterilizing solution. Ensure the entire sensor body is submerged in the solution, excluding the electronic cover, for 30 minutes. Then rinse the sensor by immersing it in the DI water for 30 min. Repeat this process with clean DI water for another 30 min. Then, dry the sensor in an oven at 65 °C for 120 min, preferably with clean air or nitrogen.

Avoid applying any alcohol that may interact with the polycarbonate, as the reaction could damage the sensor.

Be careful that this product does not have a liquid-proof design. Avoid the liquid attack on the electronic compartment.

10.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.

11. 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 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: Document history

Revision VD.1 (March 2026)

- Corrected the power supply.

Revision VD.0.01 (August 2025)

- Corrections.

Revision VD.0 (May 2024)

- FS1015CL has been upgraded; the new part number is FS1015E.
- MEMS chip changed to 4th GEN MEMS chip with Thermal-D technology, and circuit altered to match the 4th GEN MEMS chip.
- I²C communication protocol updated.

Revision VC.0 (August 2023)

- Added I²C communication.

Revision VB.0.03 (July 2023)

- Updated contact address.

Revision VB.0.02 (July 2022)

- Updated service and sales contact.

Revision VB.0.01 (May 2022)

- Minor revisions.

Revision VB.0 (September 2021)

- The new format, additions.

Revision VA.13 (October 2020)

- Revised ISO 45001.

Revision VA.12 (December 2017)

- Added mechanical dimensions for the product with NPT adapters.

Revision VA.11 (November 2017)

- Updated wetted materials information.

Revision VA.10 (September 2017)

- Added maximum overflow and maximum flow change (Additional Specifications);
- Added the revision history (Appendix).