Siargo Ltd.

FS1100 User Manual VA.1.03

MEMS mass flow sensors



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MEMS Mass Flow Sensors

With proprietary thermal-D® sensing technology

FS1100 Series

User Manual

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Attention!

- Please carefully read this manual prior to 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 for 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.

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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 FS1100 series of mass flow sensors that are designed primarily for medical applications, such as ventilators, with a fast response time and 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 sensing elements are manufactured with Siargo's proprietary MEMS (micro-electro-mechanical systems) thermal mass flow sensing technologies (***Thermal-D*** ®) that measure the calorimetry and diffusivity of the flow medium. This technology, compared to conventional calorimetric sensing, offers much better linearity in the full dynamic range, removes gas sensitivities for gases that have similar thermal diffusivities, and increases the measurement accuracy when used with a gas conversion factor. It also simultaneously outputs the instant flow medium temperature data and improves the temperature performance of the thermal sensing approach.

The FS1100 sensors measure primarily the mass flow rate measurements of a full scale up to 250 SLPM with a dynamic range of 100:1, and a temperature measurement of -20 to 85 °C. It has a 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.

Thermal-D ® is a trademark of Siargo's thermal sensing 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) as shown below.



Figure 2.1: FS1100

Please check immediately for the integrity of the product. 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 the data and power cable socket is a standard Molex 87831-1041 (THT). According to the application requirements for cable length and connectors, the user can obtain the corresponding cable from Molex's webpage:

https://www.molex.com

3. Knowing the products

3.1 Product description

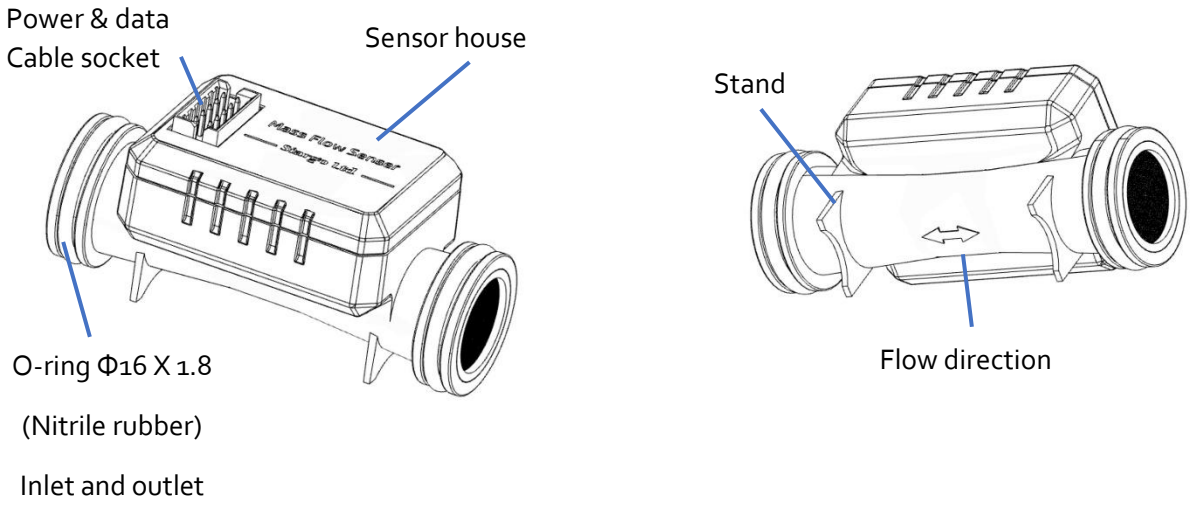


Figure 3.1: FS1100 product description

3.2 Power and data pinout description

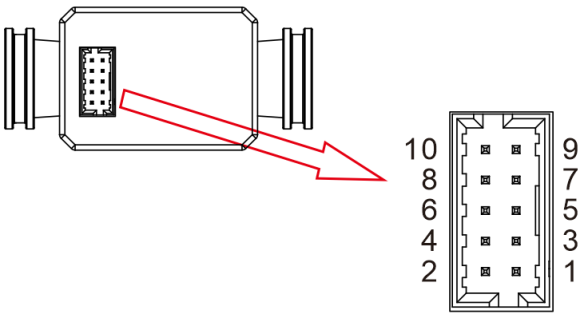


Figure 3.2: FS1100 pinout

Connector: Molex 87831-1041 (THT), the user can Obtain the cable from www.molex.com according to the application requirements.

Table 3.1: FS1100 pin assignment.

PIN	DEFINITION
1	Fout, analog output, flow data
2, 4, 9	GND, ground
3	Tout, analog output, temperature
5	SCL, I²C clock
6	SDA, I²C data
7, 10	N.C.
8	VCC, power supply 5 (±5%) Vdc

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 that the power be off when plugging in or unplugging the cable to avoid any damage.

3.3 Mechanical dimensions

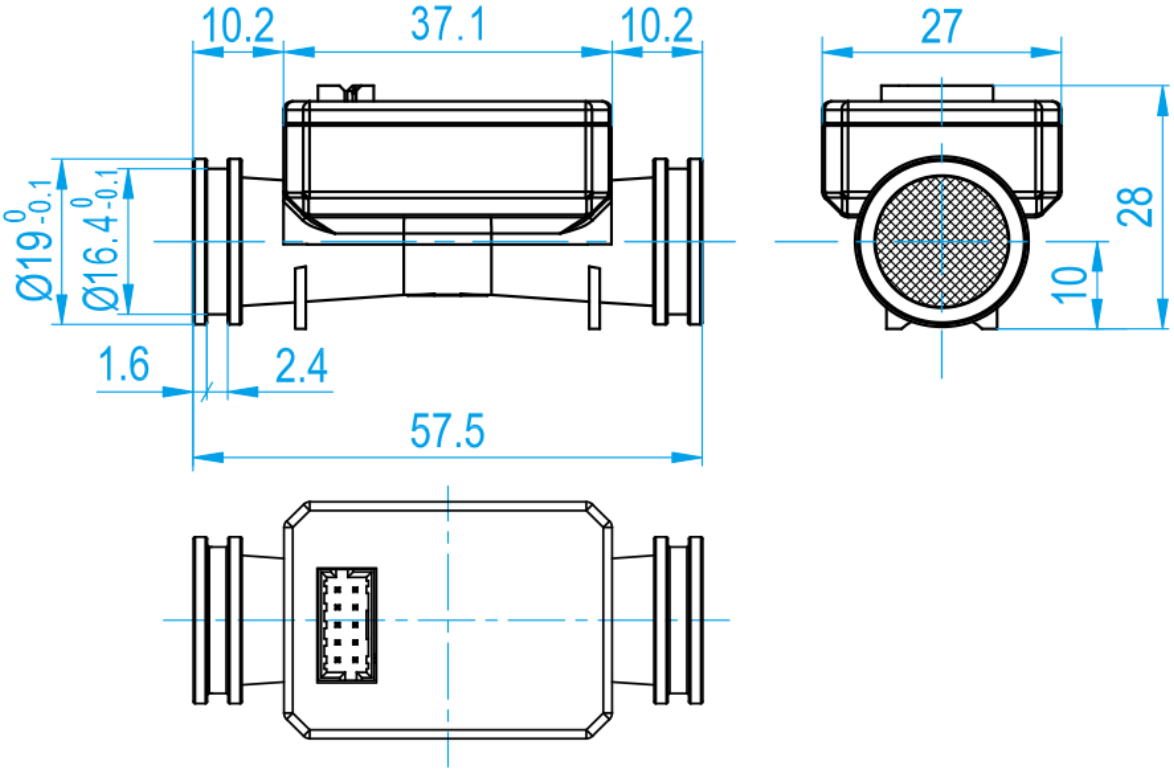


Figure 3.3: FS1100 mechanical dimensions.

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. Operation

5.1 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 8. 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.

5.2 Check the leakage

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

5.3 Power the product and digital data connection

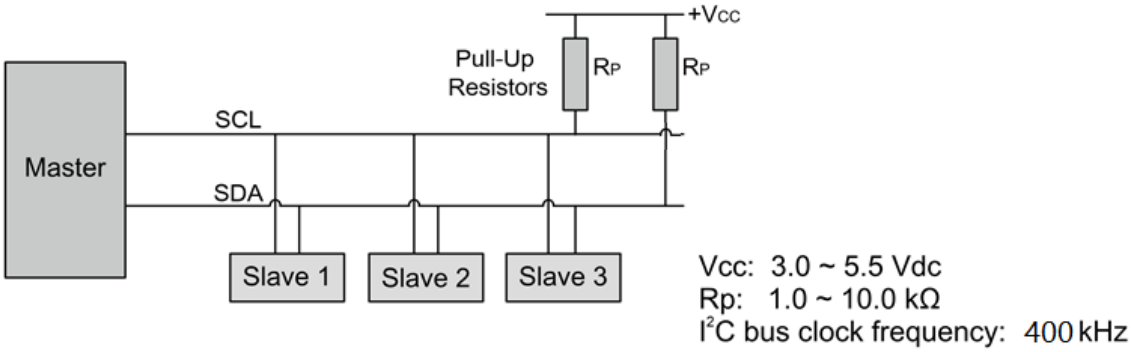
Although this product complies with the CE-required EMC regulations, it also requires the product to be used according to the standard electrical device practice. Before connecting the product with external DC power or an AC-DC adapter, make sure the supply voltage is within the range specified in Section 8. 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 protocol is used for digital data communication. Refer to Table 3.1 and make sure the wires are correctly connected to the receiver side.

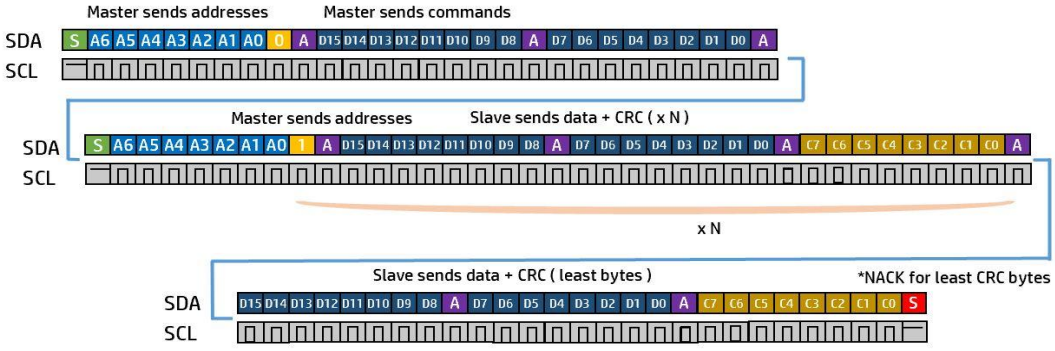
5.4 I²C communication protocol

5.4.1 I²C interface connection diagram

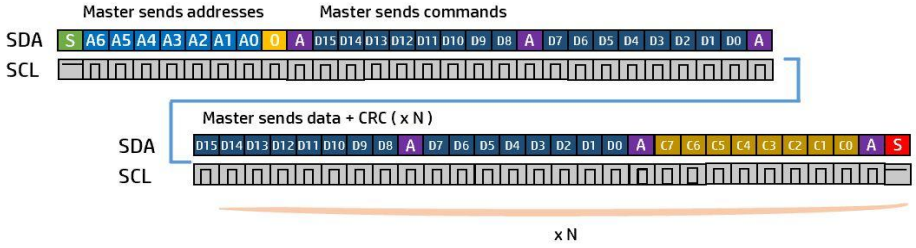


5.4.2 I²C interface read/write sequences

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

5.4.3 I²C interface command description

Command Byte	Length (int 16)	Command Name	Read/Write	Notes
0x00A4 (1)	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
0x0040	1	Temperature	Read	Int 16/100 °C
0x008C (2)	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
0x00FF	1	Write protection disabler for a write function.	Write	Fixed value, 0xAA55 Write protection is a one-time effective function. This function is enabled at the time of product shipment. To enable the write function of a specific parameter, such as filter depth, the user needs to send 0xAA55 to the register 0x00FF, and then the write function will be enabled (write protection is disabled). After the write execution is completed, the firmware will automatically re-enable the write protection.

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).

(2) Need to disable the write protection before the write function.

5.4.4 CRC checksum calculation

The 8-bit CRC checksum transmitted after each 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	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. Installation

Do not open or alter any part of the product that would lead to malfunction and irrecoverable damage. It will also forfeit the terms of the warranty and cause liability.

The product at the time of shipment is fully inspected for its quality and meets all safety requirements. Additional safety measures during the installation should be applied. This includes, but is not limited to, the leakage verification procedures, standard ESD (electrostatic discharge) precautions, and DC voltage precautions. Other tasks, such as calibration, part replacement, repair, and maintenance, must only be performed by trained personnel. Upon request, the manufacturer will provide necessary technical support and/or training for the personnel.

There are no preferred space directions for the installation. The flow direction should be aligned with the arrow mark on the meter body. If the flowing fluid may have particles or debris, a filter is strongly recommended to be installed upstream of the meter.

Please follow the following steps to complete the installation:

a) Upon opening the package, the product's physical integrity should be inspected to ensure no visual damage.

b) Before installation of the product, please ensure that the pipe debris, particles, or any other foreign materials are completely removed.

c) Close the upstream valve, if any, completely.

d) During installation, please make sure no foreign materials (such as water, oil, dirt, particles, etc.) enter the installation pipeline.

e) Connect electrical wires per the wire definition in Table 3.1. Please ensure the power supply range is 5 (±5%) Vdc and the power supply polarization. If an adapter is used, ensure it meets industrial standards and has all necessary safety certifications.

f) For the data communication wire connection, please follow the description in Table 3.1 and make sure that the wires are correctly connected to the proper ports on your data device/equipment. Please make sure the data cable meets industrial standards with appropriate shielding.

g) Slowly open the valve(s) of the gas supply, if any, upstream or downstream, or both of the pipeline. The product should then start to measure the flow in the pipeline.

Note: Because the meter has an extensive dynamic measurement range, it is normal to see a small instant flow rate even if there is "no flow" in the pipeline. If the value is consistently present, double-check the pipe leakage and then reset the offset if you are sure there is no leakage or flow.

h) This will conclude the installation.

Cautions

a) Don't alter any parts of the product.

b) Ensure the electrical connection is done correctly per the instructions.

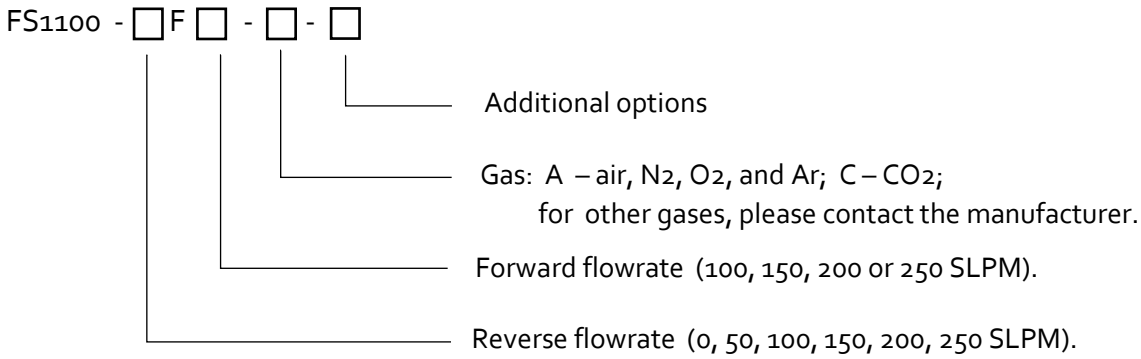
c) Make sure no mechanical stresses in the connections.

d) The strong electromagnetic interference sources close by or any mechanical shocks at the pipeline may also create malfunctioning of the product.

e) Slowly open/close valves at the gas supply piping to prevent abrupt pulse flow impact.

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:

1. The default unit of the flow rate is SLPM. For other ranges, please get in touch with the manufacturer.
2. Example: FS1100-50F250-A is a sensor that measures mass flow rate from reverse 50 to forward 250SLPM, air.

8. Product performance

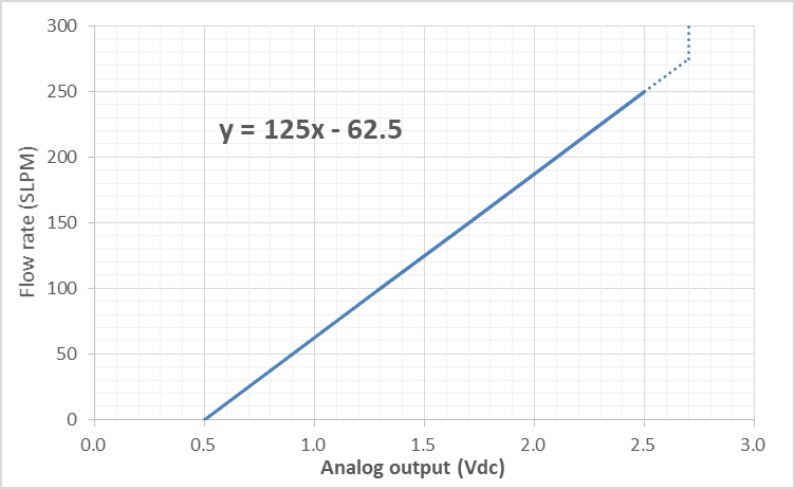
8.1 Technical specifications

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	-250 ... +250	SLPM
Accuracy (total error band)	±(2.0+0.5FS)	%
Repeatability	(0.5+0.15FS)	%
Turn-down ratio	100:1	
Response time	5	msec
Temperature range	-20 ~ +80	°C
Temperature accuracy (0~50°C)	±2.5	°C
Working temperature	-10 ~ +55	°C
Temperature coefficient	±0.12	%/°C
Maximum pressure	0.2	MPa
Warm-up time	500	msec
Humidity	<95 (no condensation)	%RH
Analog null shift	±30	mVdc
Power supply	5 (± 5%)	Vdc
Working current	~15 (no output load)	mA
Output	Linear, Analog: 0.5 ~ 2.5Vdc / Digital: I²C	
Resolution	16 bit	
Maximum overflow	300	SLPM
Maximum flow change	40	SLPM/sec
Storage temperature	-20 ~ +65	°C
Weight	23	g
Calibration	Air @ 20°C, 101.325kPa	
Compliance	RoHS; REACH	
CE	IEC 61000-4-2; 4; 8	

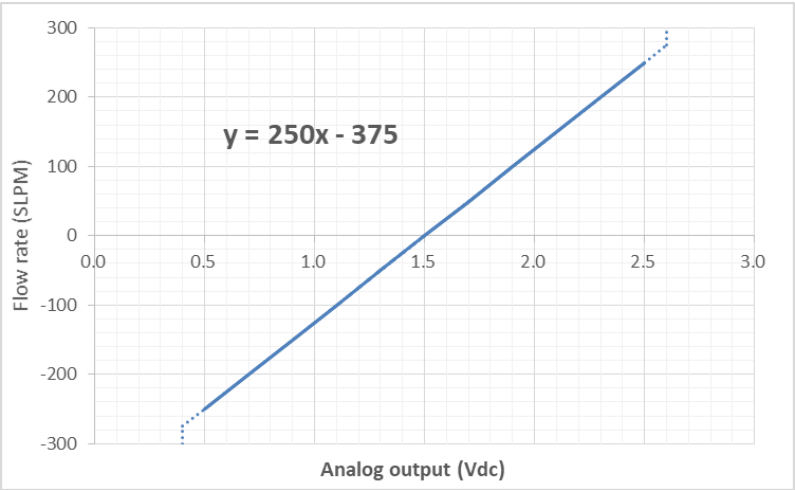
Note: 1. Calibration with real gas is optional. Please get in touch with the manufacturer for further information.

8.2 The analog output of the flow rate



Flow rate (SLPM)	Analog output (Vdc)
0	**0.500**
+50	0.900
+100	1.300
+150	1.700
+200	2.100
+250	**2.500**
+275	2.700
+300	2.700

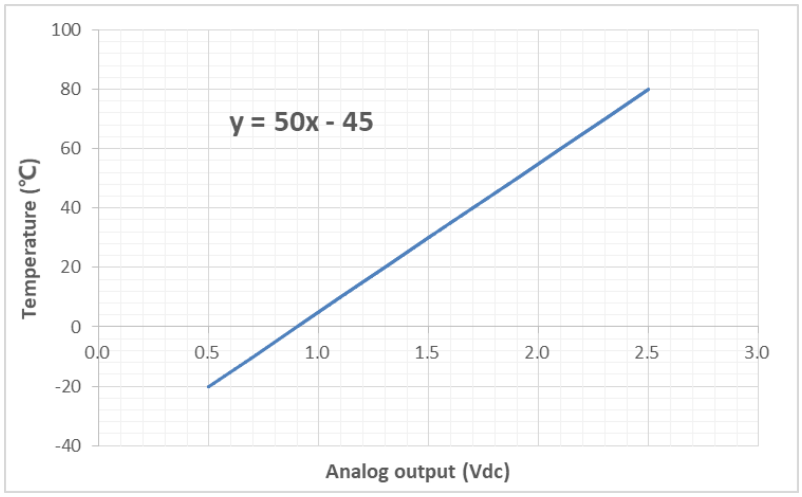
Figure 8.1: Typical analog output of flow rate (0 ~ 250 SLPM)



Flow rate (SLPM)	Analog output (Vdc)
-300	0.400
-275	0.400
-250	**0.500**
-200	0.700
-150	0.900
-100	1.100
-50	1.300
0	**1.500**
+50	1.700
+100	1.900
+150	2.100
+200	2.300
+250	**2.500**
+275	2.600
+300	2.600

Figure 8.2: Typical analog output of flow rate (-250 ~ +250 SLPM)

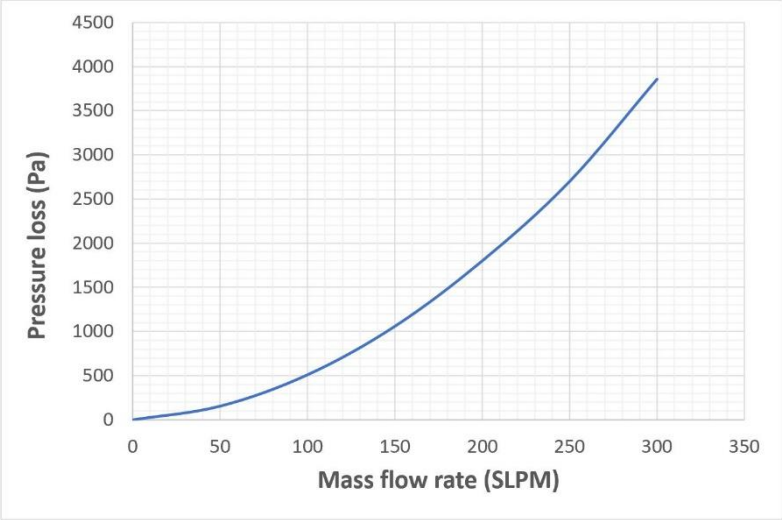
8.3 The analog output of the temperature



Temperature (°C)	Analog output (Vdc)
-20	**0.500**
-10	0.700
0	**0.900**
10	1.100
20	1.300
30	1.500
40	1.700
50	1.900
60	2.100
70	2.300
80	**2.500**

Figure 8.3: Typical analog output of the temperature

8.4 Pressure loss



Flow rate (SLPM)	Pressure loss (Pa/psi)
0	0 / 0
50	150 / 0.02
100	510 / 0.07
150	1050 / 0.15
200	1800 / 0.26
250	2700 / 0.39

Figure 8.4: Typical pressure loss

9. Technical notes for the product performance

9.1 Measurement principles

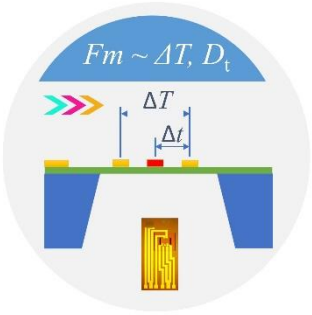


Figure 9.1: Measurement principle illustration.

The products utilize the Company's proprietary micro-machined (MEMS) calorimetric sensing with thermal diffusivity detection 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 and measure the fluidic thermal diffusivity, further correlated to the fluid mass flow rate via the calibration process.

Compared to the calorimetric sensing products offered by other manufacturers on the market, the ***Thermal-D*** ® sensing approach provides an extensive dynamic range with better performance against environmental parameter alternations. It removes some gas sensitivities for gases with the same diffusivity and dramatically improves the linearity when a gas conversion factor is used for metering the non-calibration gases. 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 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. In case you need any further assistance, please get in touch with info@siargo.com to obtain additional information or a Return Materials Authorization (RMA) before shipping the product back to the factory for factory services such as 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

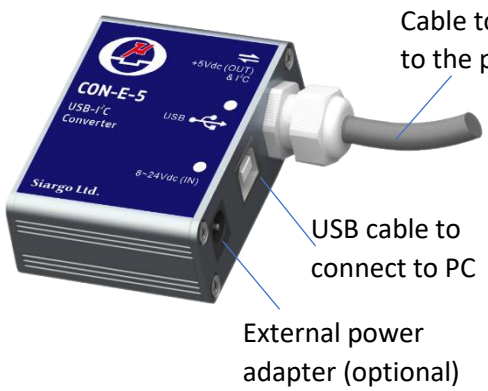
Siargo Ltd.
4677 Old Ironsides Drive, Suite 310,
Santa Clara, California 95054-1857, USA
Tel: +1(408)969-0368
Email: Info@Siargo.com

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

Appendix I: Sensor evaluation kit

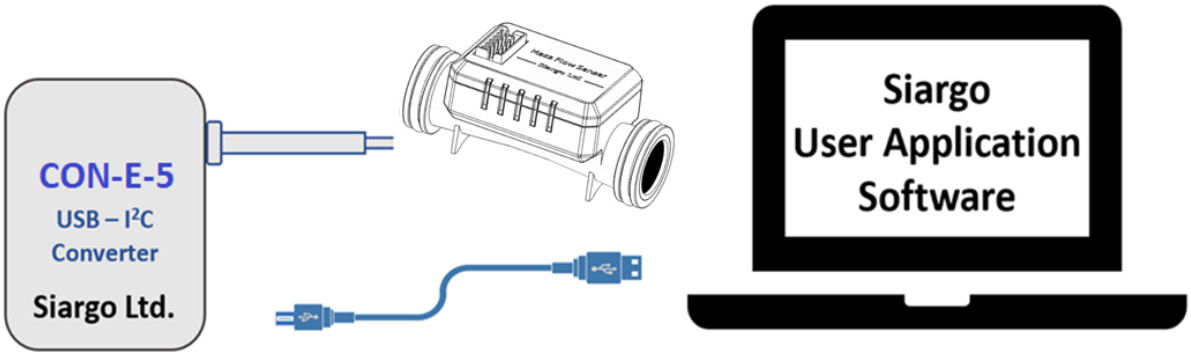
Siargo offers a sensor evaluation kit, including a digital data converter, USB data cable, and User Application software, that allows the user to evaluate the product performance on a Microsoft Windows-based computer. The user can read and visualize the flow rate of the product, obtain the totalized 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 8~24Vdc will be necessary.



Appendix II: Document history

Revision VA.1.03 (August 2025)

- Update the repeatability.

Revision VA.1.02 (May 2024)

- Update the repeatability.

Revision VA.1.01 (September 2023)

- Update contact address and corrections.

Revision VA.1 (June 2023)

- Corrections.

Revision VA.0 (August 2022)

- First release.