



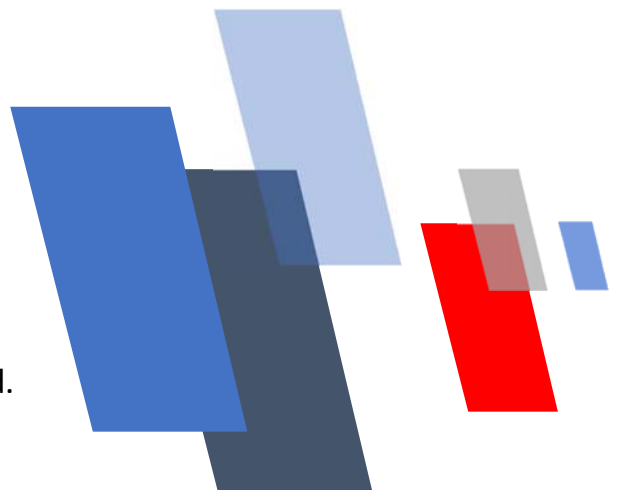
FS1015CL User Manual VB.2

MEMS mass flow sensors



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MEMS Mass Flow Sensors

with thermal calorimetric sensing technology

FS1015CL 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 which may lead to irrecoverable damage.
- Do not use this product if you suspect any malfunctions or deflection.
- 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 FS1015CL series of mass flow sensors that are designed primarily for medical applications such as ventilators, anesthesia equipment, and endoscope with the ISO 15mm adapters with a fast response time and a 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 FS1015CL 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 alcohol may react with polycarbonate and is 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 the dismantlement of the packing materials. Ensure no damages during shipping. If any abnormality is observed, please contact and notify the carrier who shipped the product and inform the distributors or sales representatives if the order is not placed directly with the manufacturer; otherwise, the manufacturer should be informed. For any further actions, please refer to the return and repair section in this manual.

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



Figure 2.1: FS1015CL



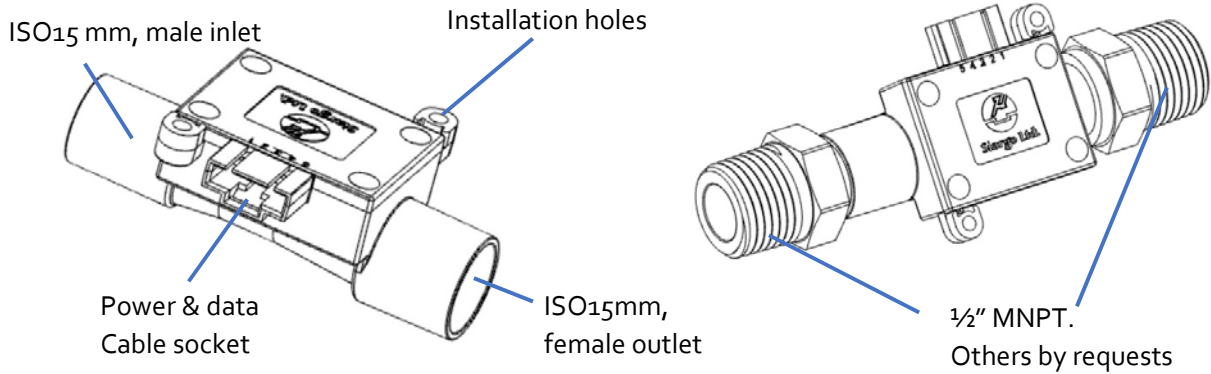
Figure 2.2: Optional power and data

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 should be sent by your sales agent. 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 another end is colored wire terminals. Please read Sec. 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: FS1015CL parts description

3.2 Power and data pinout description

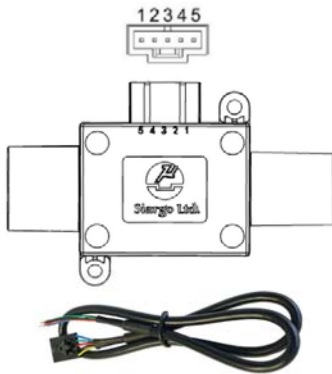


Table 3.1: FS1015CL pin assignment.

PIN	COLOR	DEFINITION
1	Blue	SDA, I ² C data
2	Green	Analog output, 0.5~4.5 Vdc
3	Red	VCC, power 8~24Vdc
4	Black	GND, ground
5	Yellow	SCL, I ² C clock

Figure 3.2: FS1015CL pinout and cable
Connector: AMPMODU MTE 5 position; cable length: 50 cm.

Note: The product requires a power supply of $5 \pm 5\%$ Vdc. This voltage is internally filtered and regulated. However, the analog output might be influenced if the supply voltage would have large deviations. It is advised that the power should be off when plugging in or out the cable to avoid any damages.

3.3 Mechanical dimensions

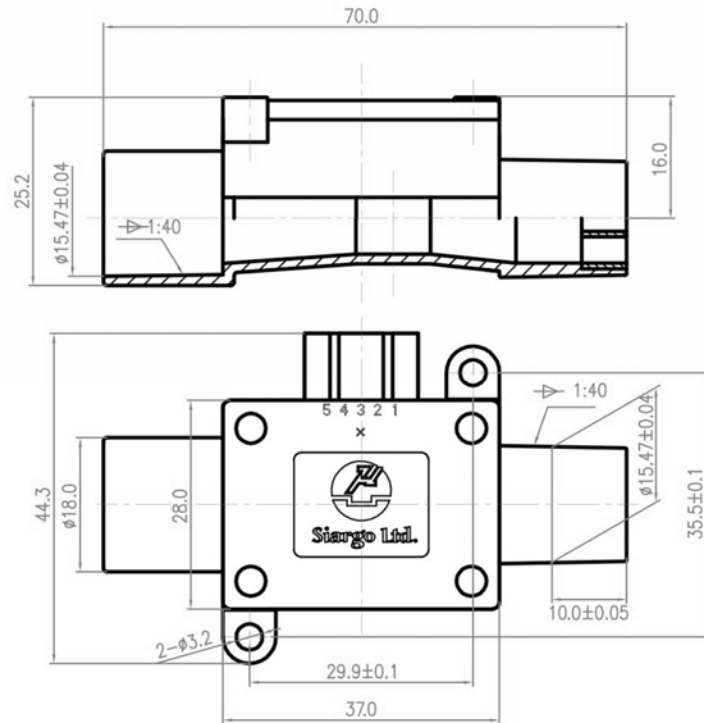


Figure 3.3: FS1015CL mechanical dimensions with ISO15mm connectors.

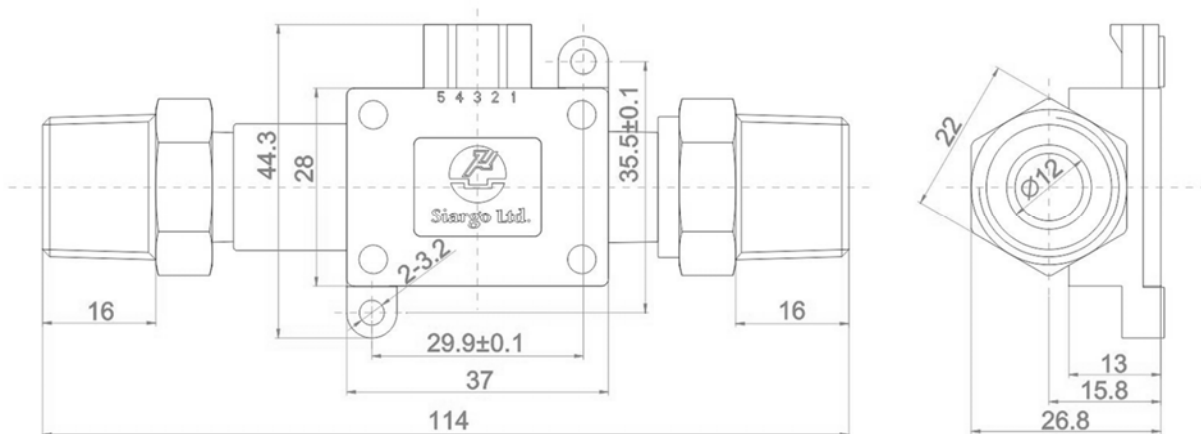


Figure 3.4: FS1015CL mechanical dimensions with 1/2" NPT connectors.

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 is normally shipped with the product, otherwise, it can be obtained from the manufacturer. One end of the cable can be directly plugged into the sensor socket while another end is the 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 power on. Before supplying the gas to the sensor, make sure to the mechanical leakage proof of the connections and all electrical precautions are applied. It should be noted that the sensor is designed for medium to low pressure per the applications, therefore, the system design would be important 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 damages.

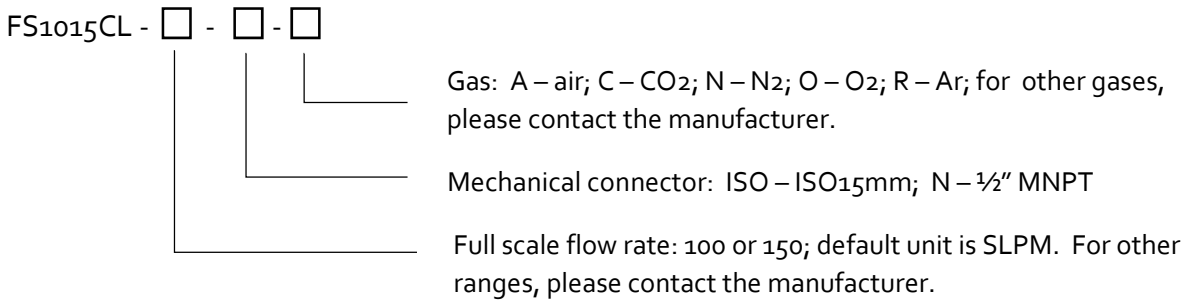
Don't expose the product's electronics other than the inner flow channel to any liquids, the unit does not have waterproof electronics. Don't flow gas in conditions that can cause condensing water vapor to be trapped inside the unit during operation as the accuracy could be significantly influenced.

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. Don't use a sensor with a flow range in extreme cases, for instance, don't use a 150 SLPM sensor for a 1.5 SLPM application.

6. Product selection and order information

6.1 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 CO₂, the maximum flow rate is 100 SLPM.

6.2 Order contact and customer support

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

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

7. Product performance

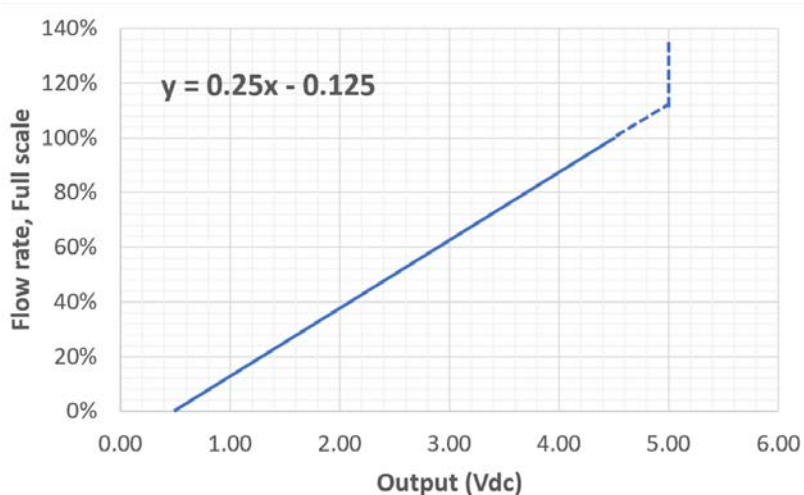
7.1 Technical specifications

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)	$\pm(2.0 + 0.5FS)$	%
Repeatability	0.5	%
Turn-down ratio	100:1	
Response time	8	msec
Working temperature	-10~ 55	°C
Temperature coefficient	± 0.12	%/°C
Maximal 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	$5 \pm 5\%$	Vdc
Working current	~10 (no output load)	mA
Output	Linear, I ² C Analog: 0.5 ~ 4.5 Vdc	
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 with ISO connector	g
Calibration	Air @ 20 °C, 101.325 kPa	
Compliance	RoHS; REACH	
CE	IEC 61000-4-2;4;8	

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

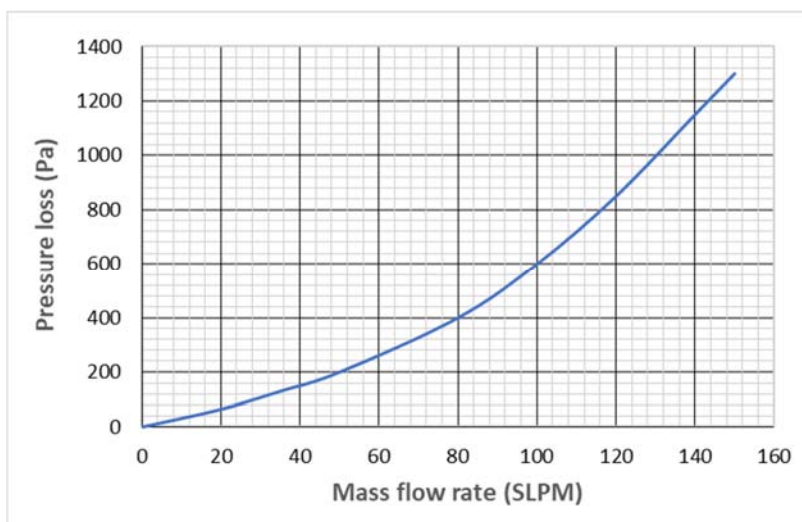
7.2 Analog output



Flow rate (SLPM)	Analog output (Vdc)
0	0.500
20	1.300
40	2.100
60	2.900
80	3.700
100	4.500
110	4.900
120	4.900

Figure 7.1. Typical analog output.

7.3 Pressure loss with ISO15 mm connector



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

Figure 7.2. Typical pressure loss

8. Technical notes for the product performance

8.1 Measurement principles

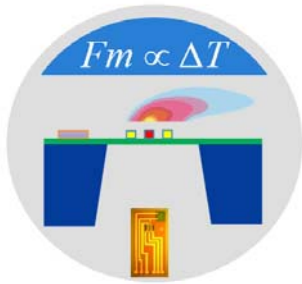


Figure 8.1: Measurement approach illustration.

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

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

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

8.2 Precautions for the best performance of the product

8.2.1 Altitude changes

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

8.2.2 Excessive humidity or condensation

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

8.2.3 Metrology verification

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

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

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

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

8.2.4 Cleaning and sterilization

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

Alternatively, the product can be sterilized with medical-grade cleanse liquid. For example, first, make sure the sensor is not powered on, and then prepare a clean medical liquid carried and immerse only the FLOW CHANNEL of the sensor into the sterilizing solution. Make sure the entire sensor body is within the solution but not the electronic cover for 30 min. 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 of the electronic compartment.

9. Warranty and Liability

(Effective January 2018)

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

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

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

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

This warranty is subject to the following exclusions:

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

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

10. Service contact and information

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

Customer service and all orders should be addressed to

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

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

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

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

Appendix: Document history

- Revision B.2 (March 2022)
 - Corrections.
- Revision B.1 (September 2021)
 - The new format, additions.
- Revision A.13 (October 2020):
 - Revised ISO 45001.
- Revision A.12 (December 2017):
 - Add mechanical dimensions for the product with NPT adapters.
- Revision A.11 (November 2017):
 - Update wetted materials information.
- Revision A.10 (September 2017):
 - Added maximum overflow and maximum flow change (Additional Specifications).
 - Added the revision history (Appendix).