Siargo Ltd.

Mass flow meters VA.1.2

MFS3000 SERIES

www.Siargo.com

Gas Mass Flow Meters

With proprietary MEMS flow sensing technology

MFS3000 Series

User Manual

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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. Do not apply this meter to a liquid medium.
- Do not apply for any unknown or non-specified gases that may damage the product.
- For remote data, please be sure the meter is configured correctly.

Table of Contents

1. Overview

This manual provides essential information for the operation of the MFS3000 series of gas mass flow meters for general-purpose gas flow monitor and control applications with a full-scale mass flow rate from 50 to 50000 sccm, and both analog and digital outputs. The series covers a wide dynamic flow range with a working pressure rating of up to 1.0 MPa (10 bar or 150 PSI), and a compensated temperature ranging from -10 to 55°C. 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. The sensor surface is passivated with silicon nitride ceramic materials together with water/oilproof nano-coating for performance and reliability. Compared to the conventional calorimetric flow sensing technology, this unique sensing approach offers better linearity, removes gas sensitivity for gases with similar thermal diffusivities, and improves temperature performance. It can also auto-recognize pre-programmed gases with significant differences in thermal diffusivity. It is the first of its kind in the industry that senses the mass flow with multiple gases without a manual gas conversion factor. As such, it ensures high precision for gas measurements with air calibration.

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 notified as well. 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 inside. The power and data cable (part number: DB9-3-100), as shown below, may also be found according to the same packing materials.

Figure 2.1: MFS3000 flow meter

Figure 2.2: power and data cable DB9-3-100

Please check immediately for the integrity of the product as well as 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 either be included in the packing box or be available via an online request for an electronic version. In most cases, this manual shall be made available to the customer before the actual order.

The standard cable (part number: DB9-3-100) has a DB9 connector with a length of 1.0 m.

3. Knowing the products

3.1. Product description

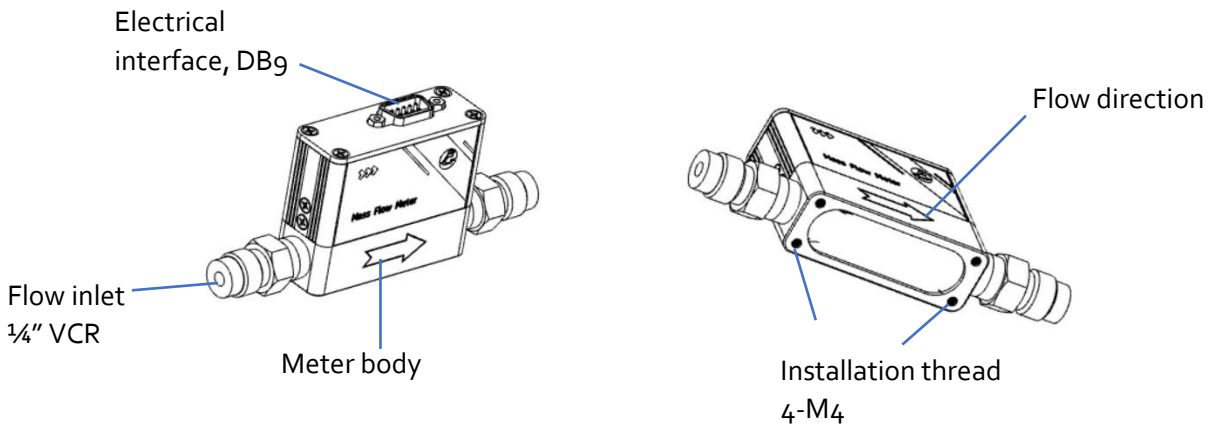


Figure 3.1: MFS3000 product with DB9 interface

3.2. Power and data cable description

Figure 3.2: MFS3000 connection and cable

Table 3.1: MFS3000 pin/wire assignments.

Wire	Color	Definition
1	Purple	n/c
2	Brown	n/c
3	Gray	RS485B (-)
4	Yellow	n/c
5	White	RS485A (+)
6	Blue	Flow output, 0 ~ 5 Vdc
7	Green	Power supply, 8 ~ 24 Vdc
8	Black	Common
9	Red	Common

Note: 1. The standard cable (part number: DB9-3-100) has a DB9 connector with a length of 1.0 meters. The other end for customer connection is open wires.

3.3. Mechanical dimensions

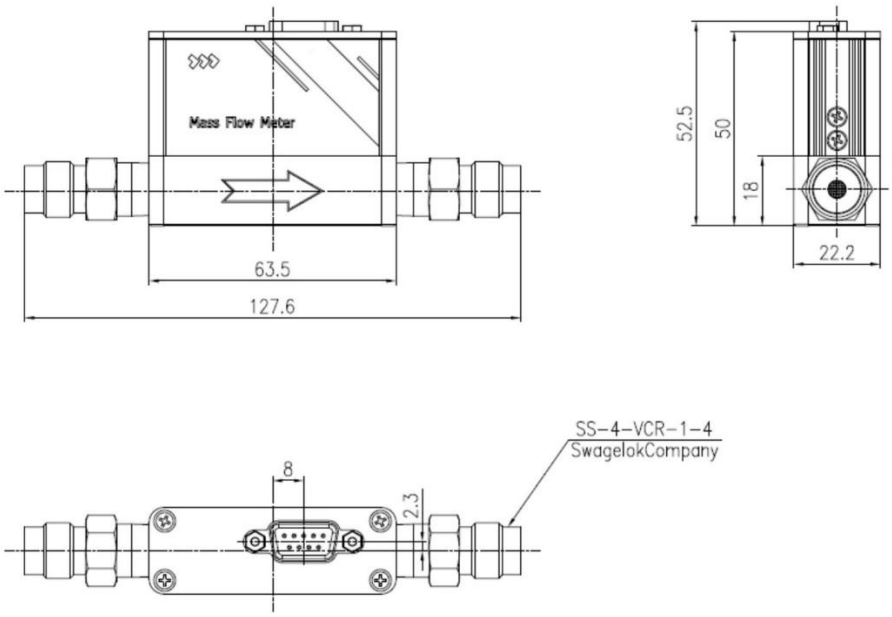


Figure 3.3.1: MFS3000 dimensions with VCR 1/4" connectors (<20SLPM).

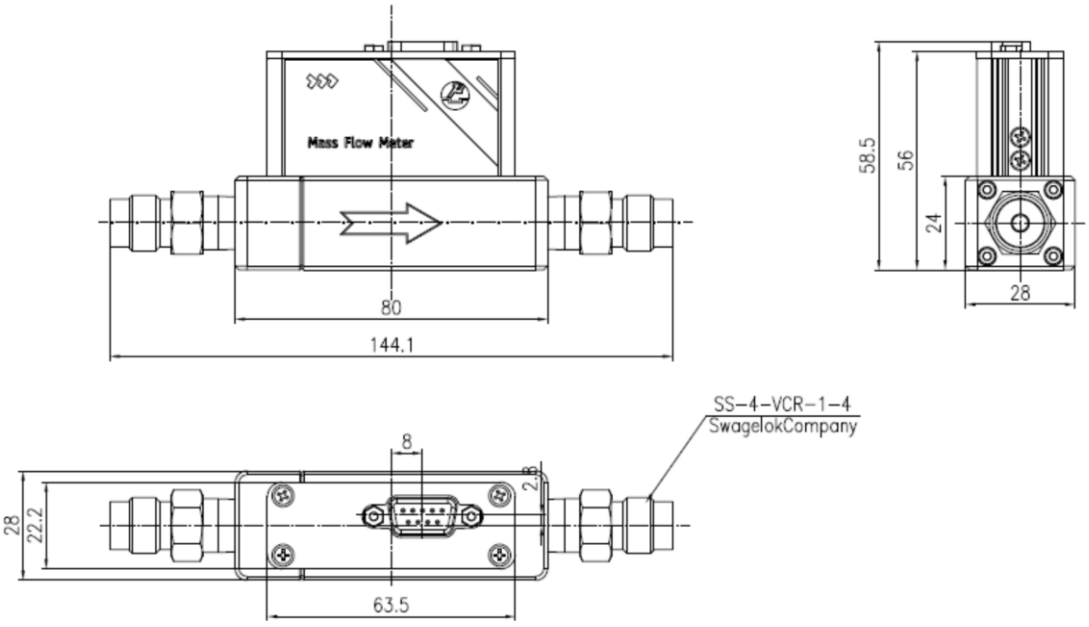


Figure 3.3.2: MFS3000 dimensions with VCR 1/4" connectors. (>20SLPM)

4. 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 EDS (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 be sure of the power supply range (i.e., 8 ~ 24 VDC) and power supply polarization. If an adapter is used, ensure it meets industrial standards and has all necessary safety certifications. Alternatively, this product can also be powered by a 9Vdc battery.

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) 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.

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 7. For a specific application, the pressure rating must not exceed the system pressure to be measured, and the flow range should also fall within the specified range. The gas medium for the controller 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 applied be clean and free of particles or other foreign materials.

5.2 Check the leakage

Check gas leakage in the pipe system before the operation. 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, 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.

IO-Link is used for digital data communication. Make sure the wires are correctly connected to your equipment side.

5.4 RS485 Modbus communication protocol

The digital communication protocol is based on standard Modbus RTU Half-plex mode. A master (PC or PLC) can communicate with multiple slaves (the current product) for data exchange and configuration of communication parameters. Refer to Table 3.2 for the cable connection.

5.4.1 Hardware connection

The RS485 hardware layer is TIA/EIA-485-A, as illustrated below. In this configuration, the product (FS4100) is a slave.

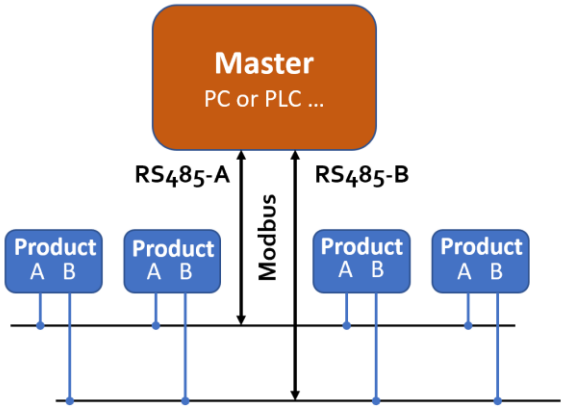


Figure 5.1: RS485 hardware

5.4.2 Communication parameters

The PC UART communication parameters are listed in Table 5.1.

Table 5.1: PC UART communication parameters

Parameters	Protocol
	RTU
Baud rate (Bits per second)	38400 bps
Start bits	1
Data bits	8
Stop bits	1
Even/Odd parity	None
Bits period	104.2 µsec
Bytes period	1.1458 msec
Maximum data length	20
Maximum nodes	247

5.4.3 Frame

The frame function is based on the standard Modbus RTU framing:

Table 5.2: frame function

Start_bits	Address	Function codes	Data	CRC	Stop_bits
T1-T2-T3-T4	8 bit	8 bit	N 8 bit (20≥n≥0)	16 bit	T1-T2-T3-T4

Start_bits: 4 periods bit time, for a new frame.

Address: The address can be set from 1 to 247 except for 157 (0x9d). 0 is the broadcast address.

Function codes: Define the product's functions/actions (slaves), either execution or response.

Data: The address of the register, the length of data, and the data themselves.

CRC: CRC verification code. The low byte is followed by the high byte. For example, a 16-bit CRC is divided into BYTE_H and BYTE_L. In the framing, the BYTE_L will come first, followed by the BYTE_H. The last one is the STOP signal.

Stop_bits: 4 periods bit time, for ending the current frame.

5.4.4 Function codes

The Modbus function codes applied for the product are a subclass of the standard Modbus function codes. These codes are used to set or read the registers of the product:

Table 5.3: function codes

Code	Name	Functions
0x03	Read register	Read register(s)
0x06	Set a single register	Write one single 16-bit register
0x10	Set multiple registers	Write multiple registers

5.4.5 Registers

The product (FS4100) has multiple registers available for the assignment of the various functions. With these functions, the user can obtain data from products, such as product addresses and flow rates from the registers, or set product functions by writing the corresponding parameters.

The currently available registers are listed in the following table, and the registers may be customized upon contacting the manufacturer. Where R: read; W: write-only; W/R: read and write.

Note: At the time of shipping, the write protection function is enabled except for the address and baud rate. Once the user completes the register value change, the write protection will be automatically re-enabled to prevent incidental data loss.

Table 5.4: Registers

Functions	Description	Register	Modbus
Address	Product address (R/W)	0x0081	40130 (0x0081)
Serial number	Serial number of the product (R)	0x0030	40049 (0x0030)
Flow rate	Current flow rate (R)	0x003A ~ 0x003B	40059 (0x003A)
Baud rate	Communication baud rate (R/W)	0x0082	40131 (0x0082)
GCF	Gas conversion factor (R/W)	0x008B	40140 (0x008B)
Digital filter depth	Response time or sampling time (R/W)	0x008C	40141 (0x008C)
Offset calibration	Offset reset or calibration (W)	0x00F0	40241 (0x00F0)
Write protection	Write protection of selected parameters (W)	0x00FF	40256 (0x00FF)

The detailed information of each register is described below: Y: enabled; N: disabled.

Address	**0x0081**	**Write**	Y
		Read	Y
Description	Address of the product		
Value type	UINT 16		
Notes	Values range from 1 to 247, excluding 157 (0x9d). The broadcast address is not enabled, and the default address is 1.		

SN, Serial number	**0x0030**	**Write**	N
		Read	Y
Description	Series Number of the product, SN		
Value type	UINT 8 (12 bits)		
Notes	SN= value(0x0030), value(0x0031),....,value (0x0035); Receiving 12 bits as 2A 41 31 42 32 33 34 35 36 2A , the corresponding Serial Number is **A1B23456**.		

Flow rate	**0x003A ~ 0x003B**	**Write**	N
		Read	Y
Description	Current flow rate		
Value type	UINT 16		
Notes	Flow rate = [Value (0x003A) * 65536 + value (0x003B)] / 1000 e.g.: When the user reads "0" from register 0x003A and "20340" from register 0x003B, the current flow rate = (0 * 65536 + 20340) / 1000 = 20.340 SLPM		

Baud rate	**0x0082**	**Write**	Y
		Read	Y
Description	Communication baud rate		
Value type	UINT 16		
Notes	0: baud rate=4800; 1: baud rate=9600; 2: baud rate=19200; 3 baud rate=38400. The default value is 3.		

	For example, when the user reads "3" from register 0x0082, the baud rate is 38400.		
GCF	**0x008B**	**Write**	Y
		Read	Y
Description	The gas conversion factor for the applicable gas differs from that of the calibration gas.		
Value type	UINT 16		
Notes	The GCF of air is 1000 (default), usually read from register 0x008B. **Note: The product will disable this function with write protection once the metering gas is confirmed with the proper GCF. For a specific GCF value, please get in touch with the manufacturer.**		

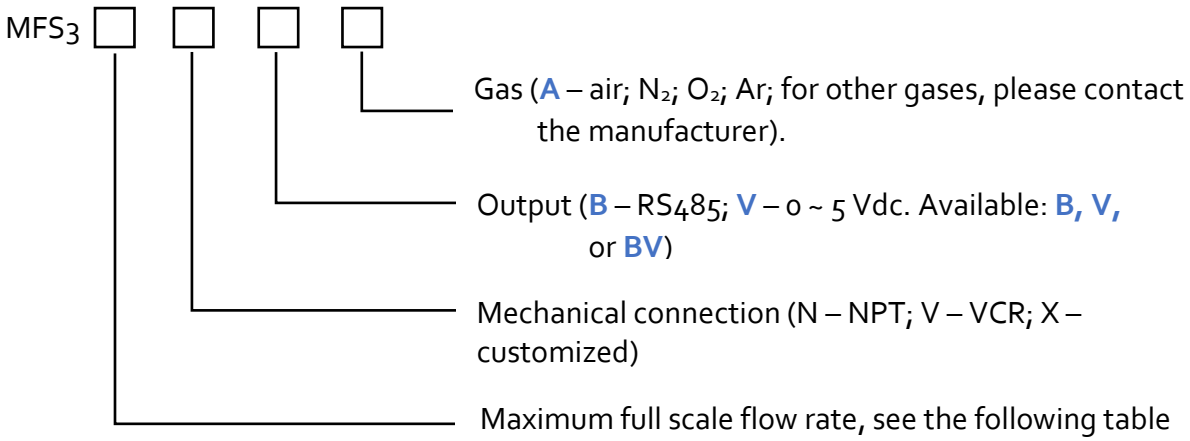
Response time	**0x008C**	**Write**	Y
		Read	Y
Description	Digital filter depth setting		
Value type	UINT 16		
Notes	0 ~ 9 programmable, corresponding to 2^0 ~ 2^9 data sampling in the software filter. The default value is 3, corresponding to 2^3 = 8 data sampling.		

Offset calibration	**0x00Fo**	**Write**	Y
		Read	N
Description	Reset or calibrate the offset.		
Value type	UINT 16, Fixed value 0xAA55		
Notes	To reset or calibrate the offset, write 0xAA55 to register 0x00Fo. **Note: When executing this function, ensure there is NO flow in the flow channel.**		

Write protection	**0x00FF**	**Write**	Y
		Read	N
Description	Write protection disabler for a set value to a specific register.		
Value type	UINT 16, Fixed value 0xAA55		
Notes	This function is enabled at the time of product shipment. To enable the write function of a specific parameter, such as GCF or offset, 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.		

6. Product selection

The product part number is composed of the product model number and suffixes indicating the full-scale flow rate, as well as the other parameters. Refer to the following for details.



For models with flow range in sccm or SLPM:

0050	0…50 sccm	005	0…5 SLPM
0100	0…100 sccm	010	0…10 SLPM
0200	0…200 sccm	015	0…15 SLPM
0500	0…500 sccm	020	0…20 SLPM
001	0…1000 sccm / 0…1 SLPM	030	0…30 SLPM
003	0…3000 sccm / 0…3 SLPM	050	0…50 SLPM

For other ranges, please specify, for example, 0…300 sccm, the model will be 0300; otherwise, please get in touch with the manufacturer.

For example, MFS3005-V-BV-A is a model for 0…5 SLPM, with a VCR connector, RS485 Modbus, and voltage output, and applicable for air, nitrogen, oxygen, or argon.

MFS30050-N-BV-A is a model for 0…50sccm, with NPT connector, RS485 Modbus, and voltage output, and applicable for air, nitrogen, oxygen, or argon.

Note: ***MFS3*** is the model number.

7. Technical specifications

Unless otherwise noted, all specifications listed in the following table apply for calibration conditions at 20°C and 101.325 kPa absolute pressure with air. The product is horizontally mounted at the time of calibration.

	Value	Unit
Full-scale range	0 ~ 50 sccm...0 ~ 1000 sccm 0 ~ 2 ... 0 ~ 50 SLPM	
Accuracy	± 1.0	%FS
Repeatability	0.50	%
Turn-down ratio	100:1	
Max pressure rating	1.0	MPa
Response time	20, programmable	msec
Working temperature	-5 ~ 55	°C
Humidity	<95, no condensation	%RH
Burst pressure	1.5	MPa
Power supply	8 ~ 24	Vdc
Analog output	0 ~ 5.0	Vdc
Max null shift (analog)	±30	mVdc
Digital output	RS485 Modbus	
Electrical connector	DB9	
Mechanical connection	1/8"... 1/4"	
Protection	IP40	
Storage temperature	-20 ~ 70	°C
Reference conditions	20°C, 101.325 kPa, air	
Fluid compatibility	Non-corrosive	
CE	EN61000-2; -3; -4	
Environmental	RoHS, REACH	

8. Technical notes for the product performance

8.1 Measurement principle

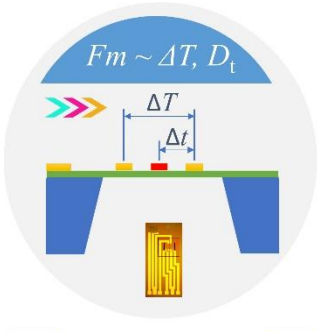


Figure 8.1: Illustration of the measurement principle.

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 proprietary 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 improves the linearity when a gas conversion factor is used for the metering of the non-calibration gases. 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 Comparison with a third-party reference meter

It is a general practice for users to compare the product's data with a third-party reference meter, which may reveal discrepancies in many cases.

When performing such a comparison, please note that the reference meter should have a better-specified accuracy (about 1/3 of the product), and pay special attention to the differences in the reading accuracy and full-scale accuracy.

A full-scale accuracy = reading accuracy x (full-scale flow rate/ set point (current) flow rate)

Another key point to comparing the different flow meters is that as long as the fluidic flow is a continuous flow without pulsation, then the fluid dynamics will have the system following the Bernoulli equation:

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

Where ρ is the fluid density, g is the acceleration due to gravity, P_1 is the pressure of the reference meter, P_2 is the pressure at the test meter, v_1 is the velocity of the reference meter, and v_2 is the velocity of the test meter. h_1 and h_2 are the corresponding heights for the meters, which are generally the same in the system. Therefore, it would be very critical for the system to have no pressure variation. (This explains our recommendations for the installations in Section 4). Also, the meter measurement principle is often very important for the understanding of any discrepancies.

Please note that for comparison with a rotameter, the reading may exhibit large deviations due to the different measurement principles, particularly because a rotameter is sensitive to pressure and temperature variations.

8.2.2 Particle contamination and fluidic cleanness

Any contamination, including particles and liquid vapors, would be detrimental to the accuracy of the flow measurement and also to the meter functionality. It is essential to ensure that the applied flow medium will be clean and dry. If any contamination is suspected, please allow experienced technical personnel to have it checked and reconditioned. Do not use a foreign cleanser or other fluids to clean the flow path, as this could cause irrecoverable damage.

8.2.3 Apply to a different gas medium

The product is calibrated with a high-precision NIST traceable metrological standard with clean and dry air. Thanks to the unique thermal sensing technology, the sensor can be applied to measure other clean and dry gases with similar thermal diffusivities without losing accuracy. It effectively solves the nonlinearity issues of using a gas conversion factor in calorimetric sensing, making the measurement highly accurate in an extensive dynamic range. Gases that can be applied include air, N_2, O_2, Ar, CO_2, and N_2O.

This innovative product also follows the basic sensing principle described in the international standard for thermal mass flow meters (ISO 14511:2001 - Measurement of fluid flow in closed conduits — Thermal mass flowmeters). For gases with different diffusivities, a gas conversion factor could be applied. However, due to the meter assembly procedure, the head loss value from the meter to the meter would not be 100% identical. At the extensive dynamic measurement range, the thermal response would also have some deviations and nonlinearity from gas to gas. Therefore, measurement by the sensor for a gas medium with substantially different diffusivities compared to that of the calibration gas would bear larger measurement errors, particularly at the low Reynolds number range, where the laminar flow has a sensitive flow profile.

9. Troubleshooting

Phenomena	Possible causes	Actions
No signal	The power is not connected.	Connect the power and then check the cable.
	Cable connection incorrect	Check cable
	No flow or clogging	Check flow and contamination.
	Power regulator failure	Return to factory
	Sensor failure	Return to factory
Significant errors or unexpected flow rate	Particles, fluid type	Check system
Erroneous or large noise	Vibration, unstable flow	Check system
Offset unstable	Circuitry instability	Check the system, power off
No digital interface	Wrong address, software	Check commands, connection

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 outside 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, including 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 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, 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 re-sold by unauthorized dealers or third parties.

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 that you intend to return the product to the factory and include your shipping address. Be sure to write the RMA on the returned package or include a letter with the RMA information.

Direct customer service request(s) should be addressed to

Siargo Ltd.
4677 Old Ironsides Drive, Suite 310,
Santa Clara, California 95054, USA
Phone: +01(408)969-0368
Email: info@Siargo.com

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

Appendix: Document history

Revision A.1.2.1 (September 2025)

- Corrections.

Revision A.1.2 (November 2022)

- Update model dimensions.

Revision A.1.1 (November 2022)

- Update model numbers and product selection.

Revision A.1.0 (July 2016)

- Update model numbers and product selection.