Siargo Ltd.

Mass Flow Controller VA.2

MFC4000 SERIES

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Gas Mass Flow Controller

With proprietary MEMS *Thermal-D* sensing technologies

MFC4000 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 MFC4000 series of gas mass flow controllers for non-corrosive gas flow control applications with the full-scale mass flow rate of 50 mLn/min up to 500 mLn/min, and both analog set point and RS485 Modbus interface for the mass flow control. This product is specially designed for instrumentation applications with a tiny form factor. The product performance, maintenance, and troubleshooting, as well as the information for product orders, technical support, and repair, are also included. Other standard communication options can be further customized upon request.

The MFC4000 mass flow controller features a 100:1 dynamic range, operating within a pressure range of 0.1 to 0.8 MPa (15 to 120 PSI) and a compensated temperature range of 0 to 50°C.

The products are designed with an easy change of mechanical connectors. The standard connectors are UNF 10-32-female, and other customized ones are available upon request.

The products are operated with Siargo's proprietary MEMS ***Thermal-D*** ® sensing technology together with intelligent control electronics. Compared to conventional calorimetric flow sensing technology, this unique mass flow sensing technology eliminates gas sensitivity for gases with similar diffusivity, enabling gas identification once programmed. The sensor surface is passivated with silicon nitride ceramic materials together with water/oilproof nano-coating for performance and reliability. This technology also offers better linearity and improves temperature performance. 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 allows high precision for gas process control with air calibration.

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 (MFC4010 / MFC4020 or MFC4090). The power and data cable (part number: M8-5F-100 or DB9-2-100), as shown below, may also be found if it is included in the manufacturer's order.

MFC4010 / MFC4020

MFC4010 / MFC4020
Power and data cable:
M8-5F-100

MFC4090

MFC4090
Power and data cable:
DB9-2-100

Figure 2.1: MFC4000 and cable

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 be included in the packing box or provided electronically upon request. In most cases, this manual shall be made available to the customer before the actual order.

The MFC4010 / MFC4020 cable (part number: M8-5F-100) has an M8 male connector with a length of 1.0 m. The MFC4090 cable (part number: DB9-2-100) has a DB9 connector with a length of 1.0 m. If another interface is ordered, the cable will be altered accordingly.

3. Knowing the products

3.1. Product description

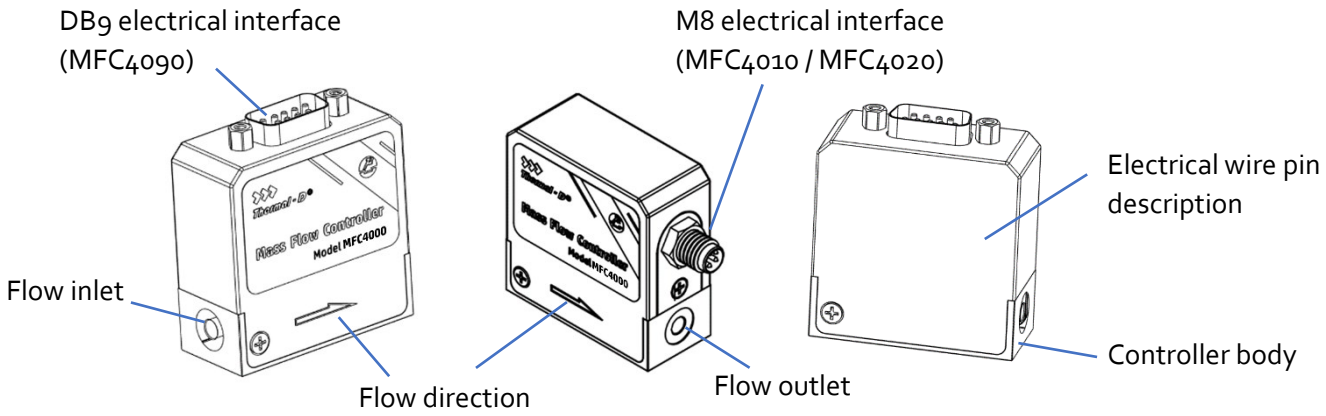


Figure 3.1: MFC4000 product description

3.2. Power and data cable description

MFC4010 / MFC4020 Cable

Figure 3.2: MFC4010 / MFC4020 socket and cable

Table 3.1: MFC4010 M8 pin/wire assignments.

Wire	Color	Definition
1	Brown	Power supply, 8 ~ 24 Vdc
2	White	RS485B (-)
3	Blue	Common
4	Black	RS485A (+)
5	Gray	Flow rate output, 0 ~ 5 Vdc or 4 ~ 20 mA

Table 3.2: MFC4020 M8 pin/wire assignments.

Wire	Color	Definition
1	Brown	Power supply, 8 ~ 24 Vdc
2	White	Common
3	Blue	Common
4	Black	Setpoint, analog 0 ~ 5 Vdc or 4 ~ 20 mA
5	Gray	Flow rate output, 0 ~ 5 Vdc or 4 ~ 20 mA

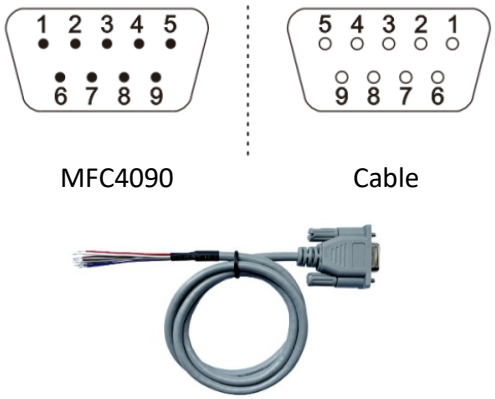


Figure 3.3: MFC4090 DB9 connection and cable

Table 3.3: MFC4090 DB9 pin/wire assignments.

Wire	Color	Definition
1	Purple	n/c
2	Red	n/c
3	White	RS485B (-)
4	Yellow	Setpoint, analog 0 ~ 5 Vdc or 4 ~ 20 mA
5	Black	RS485A (+)
6	Gray	Flow rate output, 0 ~ 5 Vdc or 4 ~ 20 mA
7	Brown	Power supply, 8 ~ 24 Vdc
8	Blue	Common
9	Green	Common

Note 1. The standard cable (part number: DB9-2-100) has a DB9 connector with a length of 1.0 meters. The other end for customer connection is open wires.

3.3. Mechanical dimensions

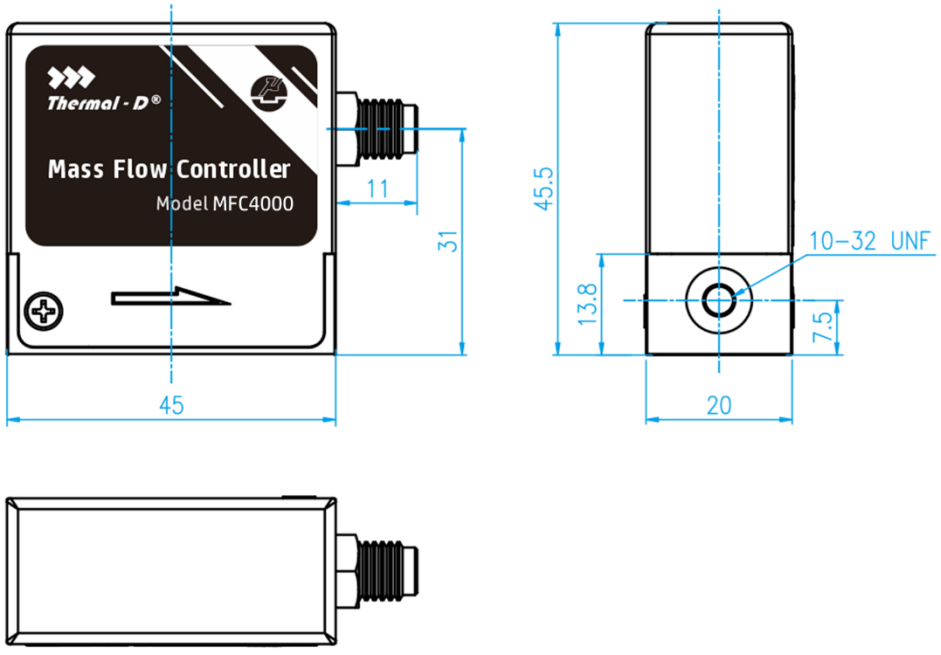


Figure 3.4: MFC4010 / MFC4020 dimensions

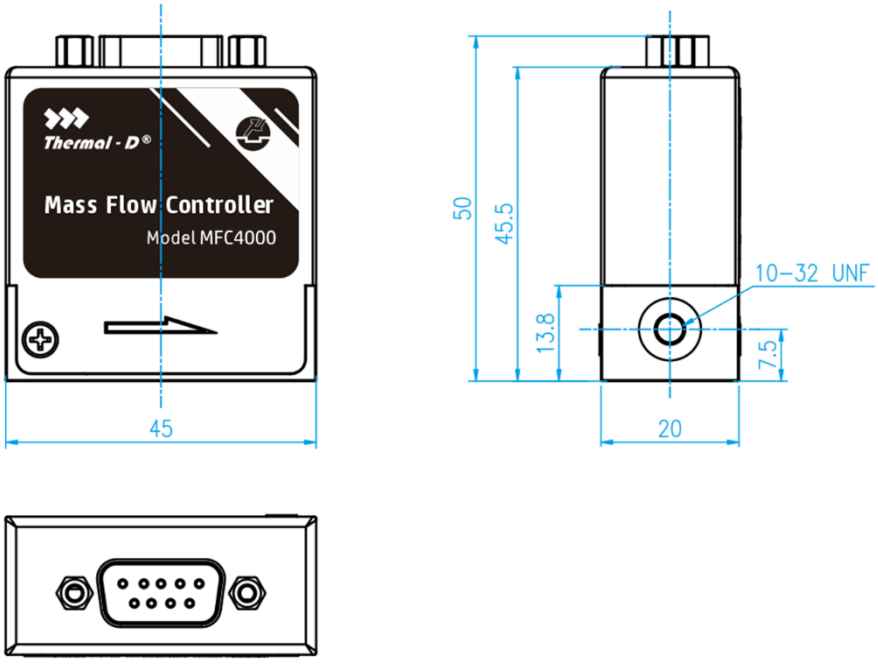


Figure 3.5: MFC4090 dimensions

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. Check the application requirements and verify whether they match the product specifications, in particular, the gas compatibility and pressure/temperature ratings for safety reasons.

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. However, since the products are calibrated at the horizontal installation, vertical placement of the product may incur some minor offset if the products are calibrated with an extensive dynamic range. When this happens, please apply the reset offset function described in this manual (Section 5) to ensure the offset is zeroed correctly. 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.

The connection pipes or tubes should be clean and free of foreign materials. Gas compatibility must be observed for the proper performance of the products. To ensure there is no gas instability, the pipe or tube diameter should match that of the product. Avoid installing pipes or tubes with a smaller diameter than that of the products; otherwise, it may create a strong flow instability, particularly at the laminar flow range, and result in significant inaccuracy of the measurements.

If another valve or pressure regulator must be installed closer to the products, please keep them at a distance of at least 15 times the pipe diameter from the products.

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) Do not install this product in an environment with excessive vibration, noise, and or

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

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

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

f) Make sure the power source is in the off status before connecting 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.

g) 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.

h) Before starting the flow control process, make sure no leakage is present after the installation.

i) 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 be higher than the system pressure to be measured, and the flow range should also be 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 of the specified ones in Section 7. Be cautious that standard electrical device precautions, such as EDS (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.

5.4 RS485 Modbus communication protocol (MFC4010 / MFC4090)

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 3.1 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 (MFC4000) is a slave.

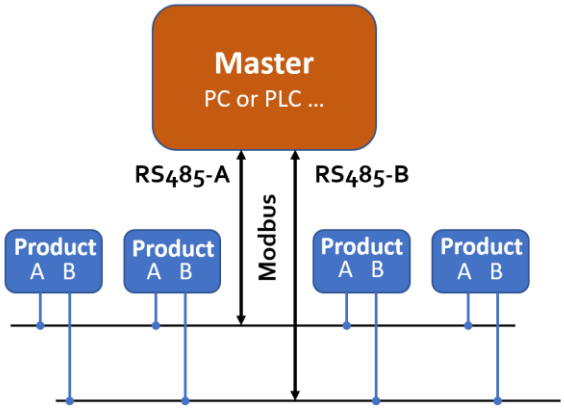


Figure 5.1: RS485 hardware

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 of a 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. The BYTE_L will come first in the framing, followed by the BYTE_H. The last one is the STOP signal.

Stop_bits: 4 periods of a 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 (MFC4000) 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 enabled again 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 ~ 0x0035	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)
Setpoint source	Set the setpoint source (R/W)	0x00BA	40187 (0x00BA)
Setpoint (flow code)	Set the flow rate in percentage of the full-scale flow (R/W)	0x00BB	40188 (0x00BB)
Setpoint flow	Read the current flow rate set by the user. (R)	0x00BC ~ 0x00BD	40189 (0x00BC)
P Gain	PD proportional control of the valve/flow rate. (R/W)	0x00BE	40191 (0x00BE)
D Gain	PD differential control of the valve/flow rate. (R/W)	0x00BF	40192 (0x00BF)
Valve preload offset	Default or preloaded valve opening. (R/W)	0x00C0	40193 (0x00C0)
Exhaust mode	Set the exhaust mode (R/W)	0x00C1	40194 (0x00C1)
Exhaust value	The value provides the setting percentage of the opened valve. This option is for open-loop control only. (R/W)	0x00C2	40195 (0x00C2)
Valve status	The value provides the percentage of the opened valve (R)	0x00C3	40196 (0x00C3)
Offset calibration	Offset reset or calibration (W)	0x00F0	40241 (0x00F0)
Write protection	Write protection of selected parameters (W)	0x00FF	40256 (0x00FF)

Notes: 1, R - Read-only, W - Write only, R/W - Read and write.

2, For the * marked functions, please disable the write protection before executing the command.

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 disabled, and the default address is 1.		

SN, Serial number	0x0030	Write	N
		Read	Y
Description	Series Number of the product, SN		
Value type	ASCII		
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 **Note: The unit is mLn/min.** For example, when the user reads "0" from register 0x003A and "20340" from register 0x003B, the current flow rate is calculated as follows: (0 * 65536 + 20340) / 1000 = 20.340 mLn/min.		

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; 4: baud rate=57600; 5: baud rate=115200; The default value is 3, baud rate=38400 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 application gas differs from that of the calibration gas.		
Value type	UINT 16		
Notes	The GCF of air is 1000 (default); it can be 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 the GCF values, please contact the manufacturer. **Notes: Please disable the write protection before executing this command.**		

Digital filter depth	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. **Notes: Please disable the write protection before executing this command.**		

Setpoint source	0x00BA	Write	Y
		Read	Y
Description	Set the setpoint source.		
Value type	UINT 16		
Notes	Available valve modes: 0 and 1. 0 - analog control; 1 - digital control.		

Setpoint	0x00BB	Write	Y
		Read	Y
Description	Set the flow rate as a percentage of the full-scale flow, where 0 represents zero flow or 0%, and 64000 corresponds to the full scale of 100%. The default value is 0, or zero flow.		
Value type	UINT 16		
Notes	Available valve parameters: 0 ~ 65535. 0 ~ 64000 corresponding to 0% ~ 100%. 0 - 0%; 64000 - 100%.		

Setpoint flow	0x00BC ~ 0x00BD	Write	N
		Read	Y
Description	Read the current flow rate that the user sets. The default value is 0.000 mLn/min with a resolution of 0.001 mLn/min.		
Value type	UINT 32		
Notes	Flow rate = [Value (0x00BC) * 65536 + value (0x00BD)] / 1000 e.g., When the user reads "1 (0x0001)" from register 0x003A and "44464 (0Xadb0)" from register 0x003B, the current flow rate = (1 * 65536 + 44464) / 1000 = 100.000 mLn/min		

P Gain	0x00BE	Write	Y
		Read	Y
Description	PLD proportional control of the valve/flow rate		
Value type	UINT 16		
Notes	Available valve parameters: 0 ~ 9999.		

G Gain	0x00BF	Write	Y
		Read	Y
Description	PLD differential control of the valve/flow rate		
Value type	UINT 16		
Notes	Available valve parameters: 0 ~ 9999.		

Valve preload offset	0x00C0	Write	Y
		Read	Y
Description	Default or preloaded valve opening.		
Value type	UINT 16		
Notes	Available valve parameters: 0 ~ 9999.		

Exhaust mode	0x00C1	Write	Y
		Read	Y
Description	Set the exhaust mode.		
Value type	UINT 16		
Notes	Available valve control modes: 0 and 1. 0 - Valve in PD control 1 - Valve in open-loop control		

Exhaust value	0x00C2	Write	Y
		Read	Y
Description	The value provides the setting percentage of the opened valve This option is for open-loop control only.		
Value type	UINT 16		
Notes	Available valve parameters: 0 ~ 10000. 0 ~ 10000 corresponding to 0% ~ 100%. 0 - fully closed or 0%; 10000 - fully open or 100%. The default value is 10000, i.e., fully open.		

Valve status	0x00C3	Write	N
		Read	Y
Description	This option is for open-loop control The value provides the percentage of the opened valve		
Value type	UINT 16		
Notes	Available valve parameters: 0 ~ 65535. 0 ~ 65535 corresponding to 0% ~ 100%. 0 - fully closed or 0%; 65535 - fully open or 100%.		

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.		

5.5 Analog voltage (0 ~ 5 Vdc) output (MFC4020 / MFC4090)

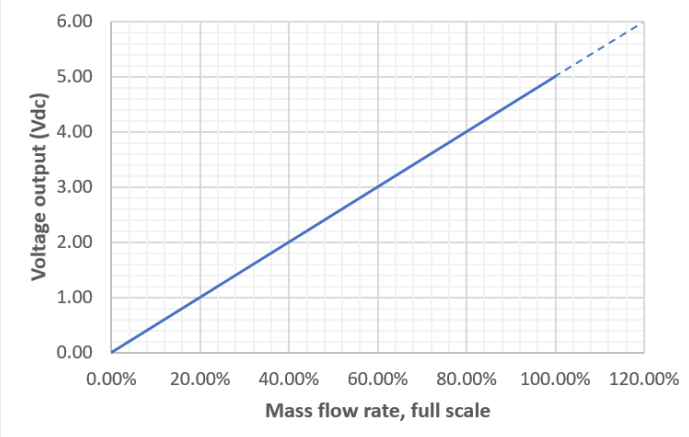
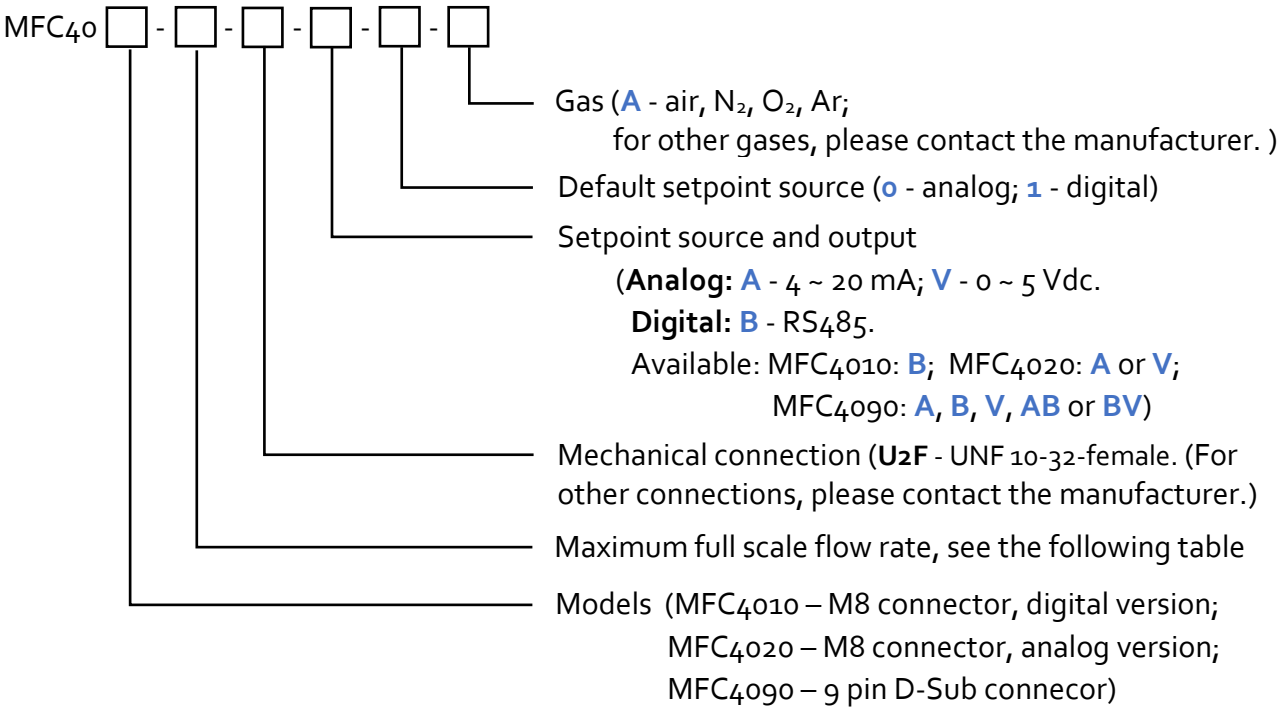


Figure 5.2: Analog output.

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 a flow range in mLn/min (**MFC4000** is the model number):

Maximum full-scale flow rate		Mechanical connection
0050	0…50 mLn/min	**U2F** - UNF 10-32-female
0100	0…100 mLn/min	
0200	0…200 mLn/min	
0500	0…500 mLn/min	

For example, MFC4090-0100-U2F-BV-0-A is a model for 0…100 mLn/min, with UNF 10-32-female connector, setpoint source, and output analog 0 ~ 5 Vdc and digital RS485 Modbus, default setpoint source analog (0 ~ 5 Vdc), and applicable for air, nitrogen, oxygen, or argon.

For other interfaces, such as DeviceNet, ProfiNet, IO-Link, etc., please contact the manufacturer. These interfaces will be the standard offer in due course. Please check back at www.Siargo.com for updates and additional information.

7. Technical specifications

7.1 Specifications

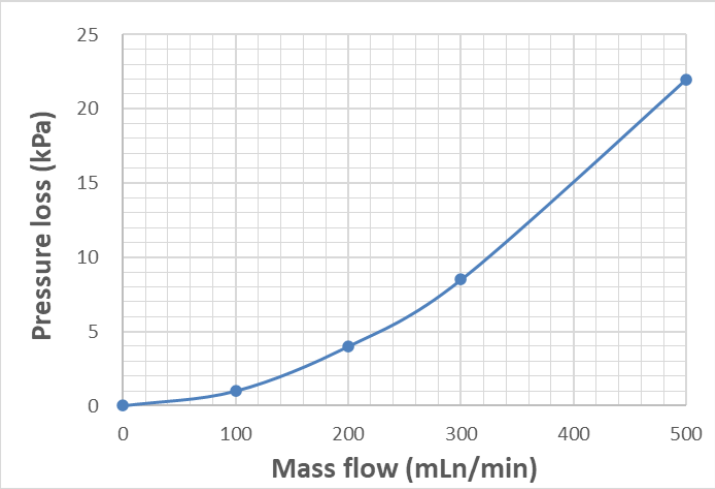
All specifications listed in the following table, unless otherwise noted, apply for calibration conditions at 0 °C and 101.325 kPa absolute pressure with air. The product is horizontally mounted during calibration.

	Value	Unit
Full-scale range	0 ~ 50 mLn/min ... 0 ~ 500 mLn/min	
Accuracy	± 1.0% r.d. (20 ~ 100% of full scale) ±0.2% f.s. (<20% of full scale)	
Repeatability	± 0.3% r.d. (20 ~ 100% of full scale) ±0.06% f.s. (<20% of full scale)	
Turn-down ratio	100:1	
Max control range	102	%FS
Control pressure range	0.1 ~ 0.8	MPa
Maximum operating differential pressure	0.4	MPa
Setpoint source (input signal)	Analog: 0 ~ 5 Vdc or 4 ~ 20 mA Digital: RS485	
Settling time	100	msec
Working temperature	0 ~ 55	°C
Humidity	<95, no condensation	%RH
Burst pressure	1.5	MPa
Max pressure loss	22 (500 mLn/min models)	kPa
External leakage rate (He)	≤1 * 10^{-9}	Pa·m^3 /s
Power supply	8 ~ 24	Vdc
Output signal	Analog: 0 ~ 5 Vdc or 4 ~ 20 mA Digital: RS485	
Max null shift (analog)	±30	mVdc
Control valve	Normally Closed (NC)	
Electrical connector	DB9	
Mechanical connection	UNF 10-32-female	
Protection	IP40	
Storage temperature	-20 ~ 70	°C
Reference conditions	0 °C, 101.325 kPa, air	
Fluid compatibility	Non-corrosive	
CE	EN61000-2; -3; -4	
Environmental	RoHS, REACH	

*For the other digital interface, please get in touch with the manufacturer.

7.2 Pressure loss

Flow rate (mLn/min)	Pressure loss (kPa)
0	0.0
100	1.0
200	4.0
300	8.5
500	22.0



8. Technical notes for the product performance

8.1 Measurement principle

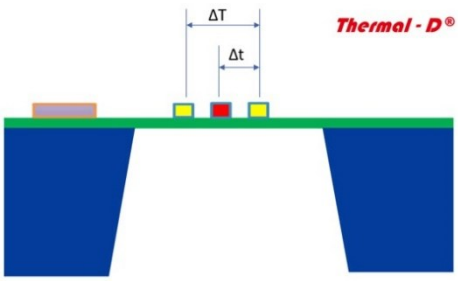


Figure 8.1: Measurement approach illustration.

The products utilize the Company's proprietary micro-machined (MEMS) thermal calorimetric sensing with time-domain data 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 amplitude, time, and temperature differences, calculating the thermal diffusivity and further correlating it to the fluid mass flow rate via the calibration process.

This unique thermal sensing approach offers an extensive dynamic range with better performance against environmental parameter alternations. It is the first of its kind in the industry that provides gas property independent mass flow measurements for gases with similar thermal diffusivities. It significantly simplifies process control with high precision and easy maintenance. Please refer to the company's 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 that of 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 could have large deviations due to the different measurement principles, in particular, as 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 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, which could bring 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 product can be applied to measure and control 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, CH_4, and CO.

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. Please contact your sales or manufacturer for additional information.

Under normal operation conditions, the wetted materials are fully compatible with common gases, such as air, oxygen, nitrogen, argon, and carbon dioxide. If a special gas is to be applied, please check back with the manufacturer for gas compatibility analysis. In some cases, some package materials may need to be changed for gas compatibility, or additional hazardous zone certification will be required before the products can be used.

8.2.4 Recalibration and maintenance

The re-calibration of the controller will be dependent on the usage and application requirements, and therefore, it is more of a decision by the applications.

If preferred, Siargo can offer free calibration software or a user application kit to facilitate the customer's calibration requirements. Alternatively, please contact your sales representative or directly contact the manufacturer for assistance. Siargo calibrates all products with NIST (National Institute of Standards and Technology, USA) traceable calibrators.

For maintenance, the services must be performed by trained or certified technicians by Siargo. Any arbitrary changes to the products will nullify the warranty of the products. It could lead to irreparable damage to the products and could even lead to unexpected injuries.

The products do not require regular maintenance if the specified application conditions are exactly observed. Only if there are clear indications of contamination and/or malfunctions would maintenance be required. Once this happens, don't hesitate to get in touch with your sales or directly contact customer support (information available on the Company's webpage) to obtain an RMA (Return Materials Authorization) before shipping the products back to the Company's support center. Siargo commits to respond as quickly as possible, and regular service will be completed within five business days if no major parts changes are required.

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 the cable.
	No flow or clogging	Check flow and contamination.
	Power regulator failure	Return to the factory.
	Sensor failure	Return to the factory.
Significant errors or unexpected flow rate	Particles, fluid type	Check the system.
Erroneous or large noise	Vibration, unstable flow	Check the system.
Valve not work	Wire connection, valve	Return to the factory.
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 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 contact 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 contact the local sales representatives or distributors that can be found 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 contact 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 95054-1857, USA
Phone: +01(408)969-0368
Email: info@Siargo.com

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

Appendix: Document history

Revision VA.2 (May 2026)

- Update the maximum full-scale flow rate to 500 mLn/min;
- Update the cable of MFC4090.

Revision VA.1.04 (August 2025)

- Corrections.

Revision VA.1.03 (October 2024)

- RS485 Modbus communication protocol corrections;
- Add external leakage rate (He).

Revision A.1.02 (July 2024)

- Minor corrections.

Revision A.1.01 (May 2024)

- Minor corrections.

Revision A.1 (December 2023)

- Set MFC4010, MFC4020, and MFC4090 via different electrical connectors.

Revision A.0 (November 2023)

- First release.