Siargo Ltd.



Gas Flow Meters VA.2.12

Model: MF-HD Series

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Gas Flow Meters

With MEMS Thermal Mass Flow Sensing

MF-HD Series

User Manual

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Siargo Ltd.
4677 Old Ironsides Drive, Suite 310,
Santa Clara, California 95054-1857,
USA

Tel: +1(408)969-0368
Email: Info@Siargo.com

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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 irreparable damage.
- Do not use this product if you suspect any malfunctions or defects.
- This product is designated for city natural gas metering at the applicable pressure.
- Cautions for the specified hazardous conditions. Do not weld online.
- 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 unexpected damage.
- The fluid 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 fluids that may damage the product.
- Do not force the connection. If the thread is not the same as the pipeline, use an adapter or contact the manufacturer for the correct model.

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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 MF-HD series of battery-powered gas flow meters for metering and management applications. The product performance, maintenance, troubleshooting, and information for product orders, technical support, and repair are also included.

In addition to general-purpose flow metering, the MF-HD series can be applied to utility gas metering (natural gas or liquid petroleum gas) that is designed and manufactured with Siargo's proprietary MEMS (micro-electro-mechanical systems) thermal (*Thermal-D*) sensing technology. The products offer mass flow metering for gases with large dynamic ranges while having a low-pressure drop.

One of the key applications is the IOT (Internet of Things) enabled management of LPG fuels for residential energy supply. The product offers improved management of the cylinders, which can inform users as well as suppliers' logistics and prevent supply shortages. The suppliers would better manage their manufacturing, inventory, and delivery schedules. The current products are designed for the North American market, where the LPG cylinders have a large capacity and the pressure regulators are pre-installed at the supply. The product will meter usage, detect leakages, and alert the user as well as the supplier via wireless cloud data management.

Certification by CSA for safety proof for hazardous gases is for Model MF19HD and MF25HD, which are portable battery-powered LPG or Natural Gas Meters assessed for the type of protection "intrinsic safety", Ex ib IIB T4 Gb; Class I, Zone 1, AEx ib IIB T4 Gb.

Alternatively, we also offer RS-485 Modbus communication. This digital interface is not certified for explosive gases.

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, contact 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. 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 meter or the sensor formality, as specified in your order). There are two models of serial products with different flow ranges. One is 1" in diameter, and another is ¾" in diameter. Ensure the product is what you have ordered.

Please immediately check 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 will also be included in the packing box or via an online request for an electronic version. In most cases, this manual will be made available to the customer before the actual order.



3. Knowing the Products

3.1 Product Description

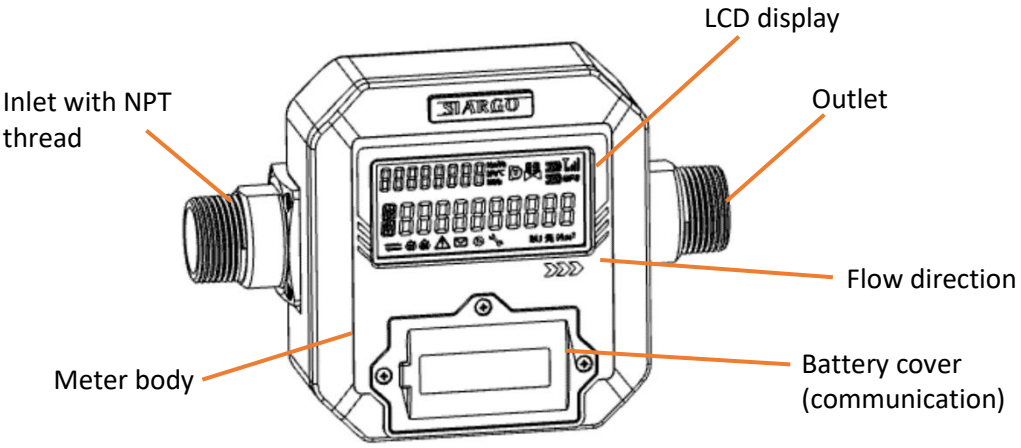


Figure 3.1: MF-HD part description

3.2 Power

The product is operated with a D-Cell (19AHr) lithium-ion battery. It must be fully safety-certified with a life guarantee. The capacity enables both performance and meter field operation. Currently, three battery models (Titus ER34615/ER26500, EVE Energy ER34615C) are CSA-approved and can be used with the meter. Other battery models can only be installed after obtaining CSA approval. As the lithium-ion battery is prohibited for air transportation, please purchase the recommended lithium-ion battery models locally. The battery lifetime will rely on the actual operation scenario. Normal usage of the meter (8 hours/day active time with gas flow) should allow the battery to power the meter for about 10 years.

The change of the battery for the communication operation would depend on the data transmission frequency. Consult the manufacturer or local dealer for recommendations.

3.3 Mechanical Dimensions

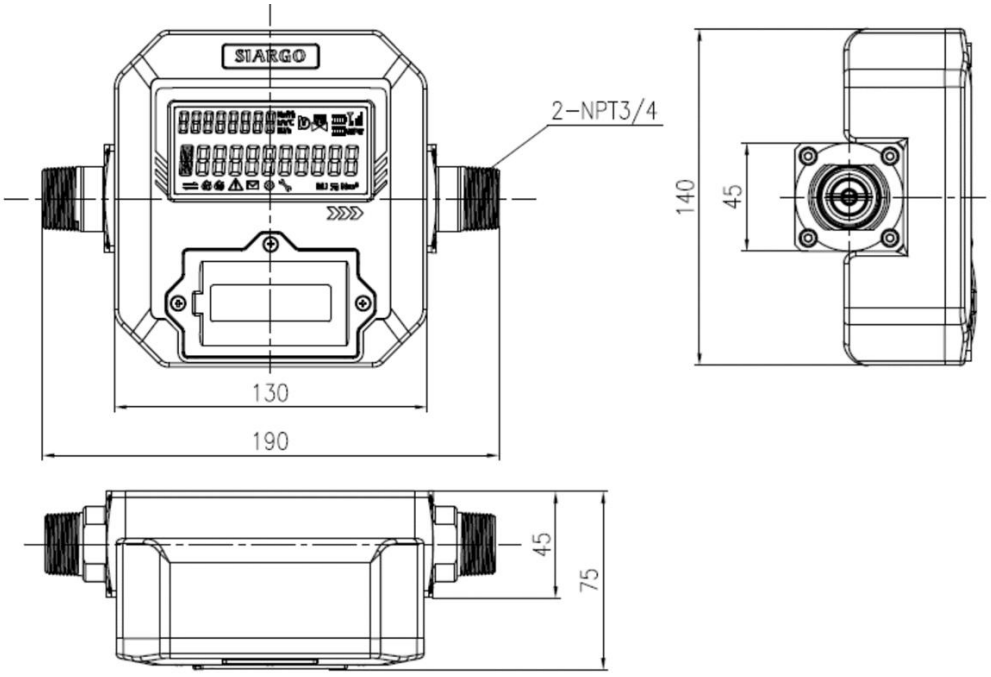


Figure 3.2: Dimensions of MF19HD

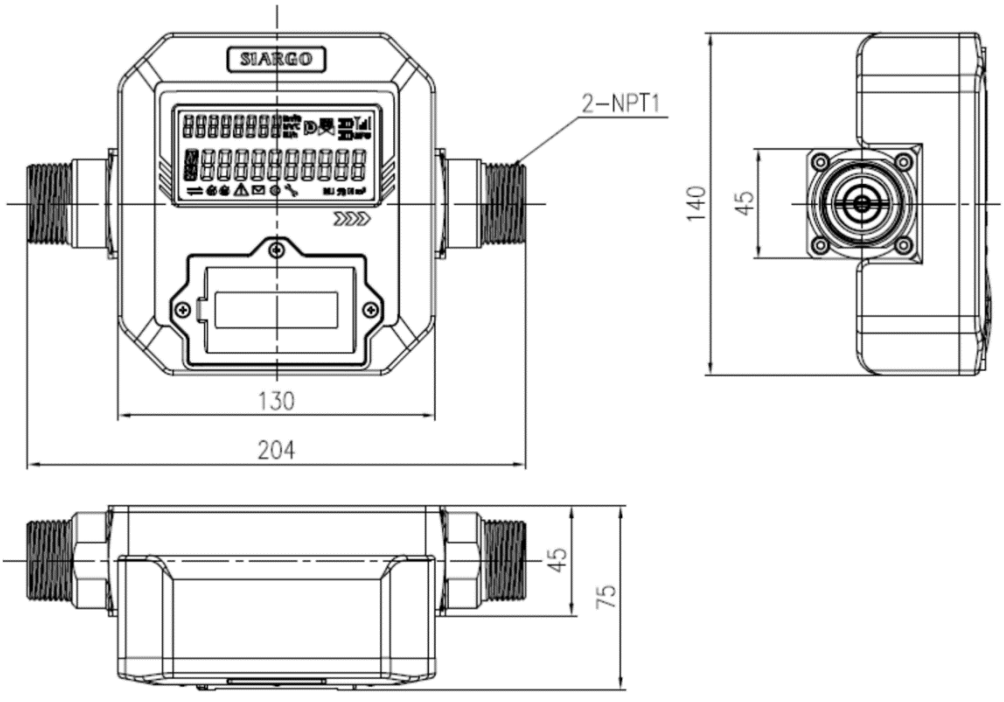
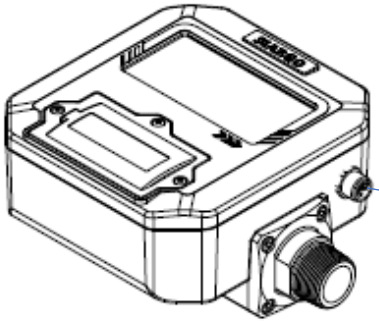


Figure 3.3: Dimensions of MF25HD



RS485 Modbus, M12

This model is not certified for Ex proof applications

Models with RS485 output.

4. Installation

4.1 Battery Installation

Remove the three screws on the battery chamber cover (Step 1). If the cover does not pop up, flip the meter or use a plastic or metal pin to hold the upper middle screw through-hole and lift-pull open the cover (Step 2). The battery chamber cover is engaged via the notches on its lower edge. Therefore, after lifting the top of the battery chamber cover, it will fall out of the notched engagement. Place the cover in a safe place. Install the battery into the chamber, and ensure the sealing rubber O-ring is in place. Then, put the battery chamber cover back and tighten it with the screws (Step 3).



Step 1: Open the battery chamber cover: remove the screws

Battery chamber cover tightened with three screws



Step 2: Pull-lift to remove the battery chamber cover.

Hold and lift to open



Cover engaging notches



Step 3: Install the battery, check the O-ring position, and re-engage the battery chamber cover. Finally tighten the three battery chamber screws.

O-ring

Battery chamber

4.2 Connection to Gas Supply Pipe

Do not open or alter any part of the product, except the battery chamber, which would lead to malfunction and irrecoverable damage that would forfeit the terms of the warranty.

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

Any actions that alter the physical integrity will void the warranty. It will also hold liability for any damages incurred thereafter.

The product is preferably to be installed horizontally. 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 installing the product, please ensure that the pipe debris or particles, or any other foreign materials, are completely removed.

c) Cautions during installation:

(i) It is preferable first to install the inlet end of the meter and then the outlet end of the meter; To ensure measurement accuracy, an upstream straight pipe of length no less than 10DN and a downstream straight pipe of length no less than 5DN should be in place.

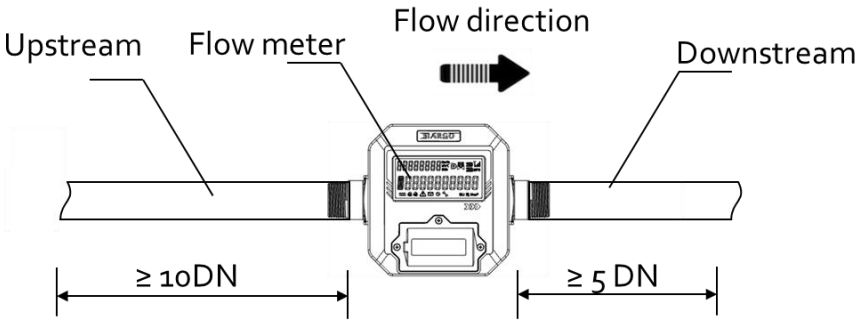
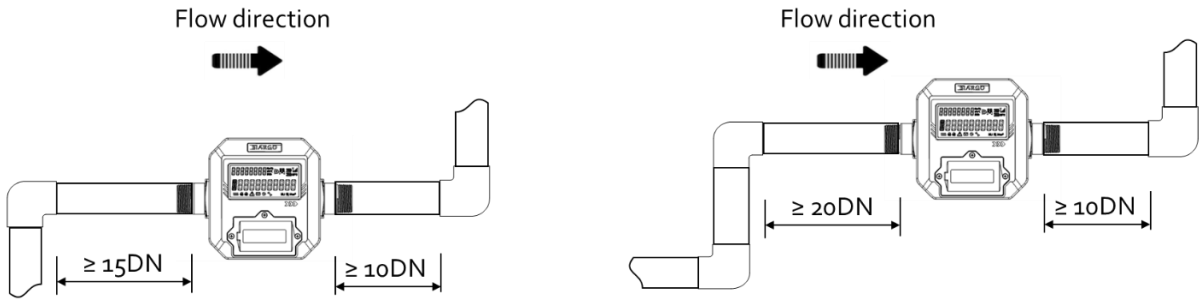


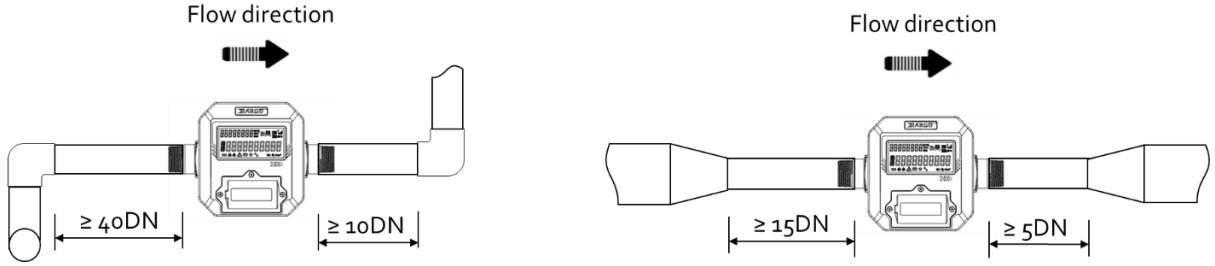
Figure 4.2: Installation recommendation



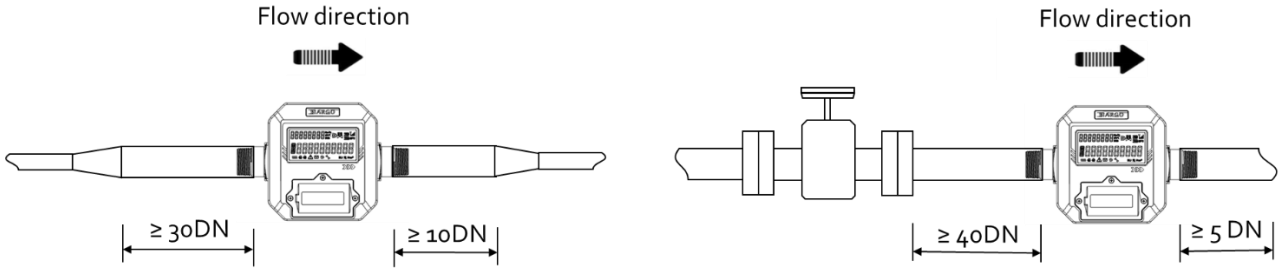
(a) 90-degree elbow or T-piece (b) 2x90-degree elbows

Figure 4.3: Installation recommendation

(ii) If there is a requirement for different pipe sizes, either upstream or downstream, the size of the pipe diameters should be larger than that of the selected meters. Please see the details below:



(c) 3x90 degree elbows, 3 dimensions (d) Pipe diameter reduction



(e) Pipe diameter expansion (f) with upstream control valve

(iii) During installation, please make sure no foreign materials (such as water, oil, dirt, particles, etc.) fall into the pipe.

d) Slowly open the valves at both ends of the pipeline, and the meter should then start to measure the flow in the pipeline.

e) Completion of the installation.

Cautions:

a) Don't try to alter any built-in part of the product.

b) Use only the battery with safety proof.

c) Release all the installation stresses so that no stresses will be exerted on the product.

d) The product should avoid strong electromagnetic interference sources nearby or periodic mechanical shocks to its body or pipeline.

e) Slowly open/close valves to prevent abrupt pulse flow impact, damaging the product.

5. Basic Operation

5.1 Check the Product Specifications

Before using this product, check the product specifications in this manual or the basic information located on the product's back panel.

The product information from this manual may be model-specified. In particular, the pressure rating must be lower than the system pressure of the gas. The flow range should also be within the specified range. In most cases, a high full-scale range meter for the low flow rate measurement often results in erroneous data. The gas to be measured must also be consistent with that specified by the product.

5.2 Check the Gas Supply System

For best performance, the gas to be measured must be clean and free of particles or other foreign materials. An upstream filter with a proper pore size would be an example of safe product usage for particle contamination. Please consider the actual application requirements for the filter specification, including pressure loss, gas conditions, and mechanical connections. Before releasing the gas to pass through the product, check the tubing to prevent any abnormalities, tighten the tubing fittings, and verify the gas flow direction.

5.3 Check the Leakage

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

5.4 Display

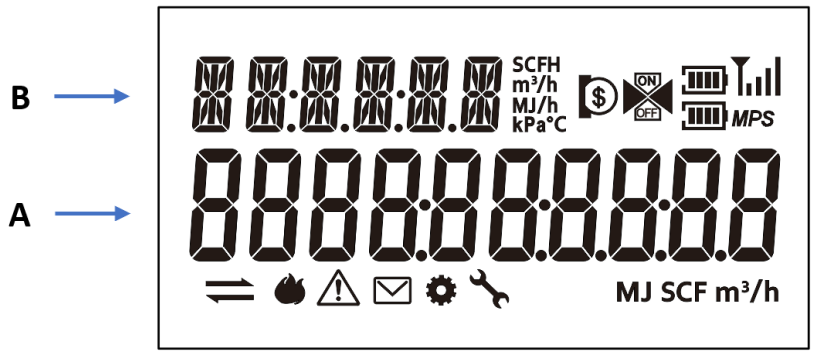


Figure 5.1: LCD symbol illustration.

Table 5.1: Symbol descriptions

Row A	Displays the totalized flow rate in m^3 or SCF. May display the gas tariff for pre-pay meters when the corresponding MENU is selected.
Row B	Displays instant flow rate in m^3/h or SCFH, pressure, temperature, date, and time.
	For a pre-pay meter or remote charge meter. When the balance is due, the symbol will flash. (reserved for future product upgrade)
	Valve status (reserved for future product upgrade).
	Battery status. MPS is the battery for communication.
	Communication signal indicator.
	Data transmission in progress.
	Indicate LPG gas is being metered. It turns off with airflow.
	Alarm indicator, when any alarms are triggered.
	User information. Enter the MENU to check. (Reserved for future product upgrade)
	Settings, when the corresponding MENU is entered. (Reserved for future product upgrade)
	Available tools. Enter the MENU to select. (reserved for future product upgrade)
MJ	Reserved for energy metering.

5.5 Remote Operation / Wireless Data

The meter supports BT LE, NB-IoT, or other remote data options.

The remote user can execute the following functions. This portion shall be updated with customer feedback.

- Read the meter data
- Setting the parameters
- Receive the alarms
- Others TBD

5.6 Pressure Loss in LPG

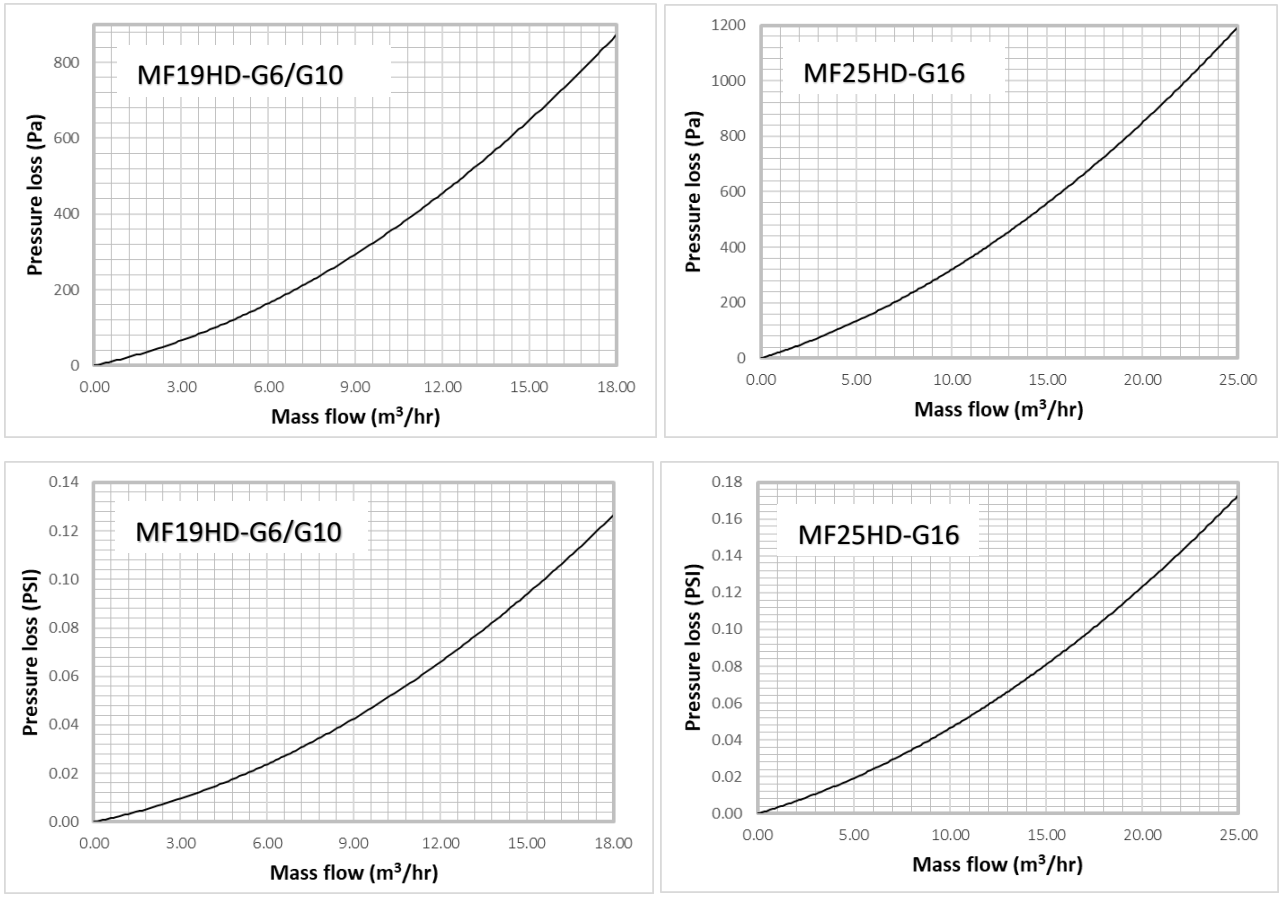


Figure 5.2: Pressure loss

5.7 Digital Communication (This option is not Ex-proof certified.)

5.7.1 Power and Data Cable Description

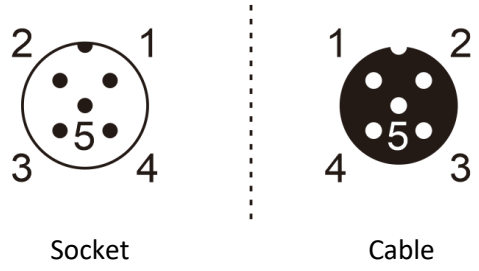


Figure 5.3: Socket and Cable

Table 5.2: Data wire assignment.

Wire	Color	Definition
1	Brown	Power supply (8 ~ 24 Vdc)
2	White	RS485B (-)
3	Blue	GND, ground
4	Black	RS485A (+)
5	Gray	N.C.

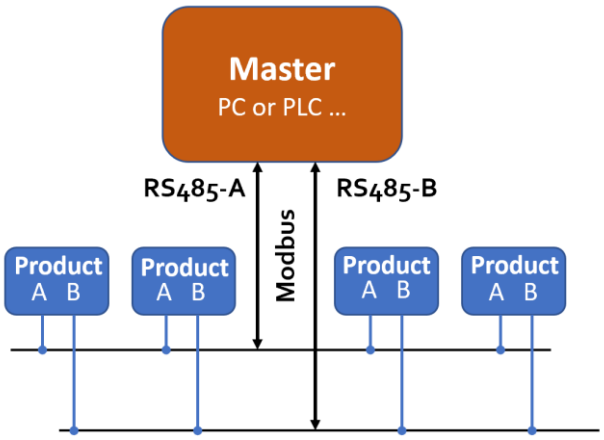
Note: The models with RS485 communication require an external power supply (8~24 Vdc).

5.7.2 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 configure communication parameters. Refer to Appendix I for the specific connection for the current product. The digital converter provided by Siargo allows you to plug and play with the meter for its basic functions. For experienced users, the following is an explanation of the digital interface.

5.7.2.1 Hardware connection

The hardware layer is TIA/EIA-485-A, shown below. The product (MF-HD) is a slave.



5.7.2.2 Communication parameters

The PC UART communication parameters are listed in the following table.

Parameters	Protocol
	RTU
Baud rate (Bits per second)	9600 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

5.7.2.3 Frame

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

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 157 (0x9d). 0 is the broadcast address.

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

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

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 of bit time, for ending the current frame.

5.7.2.4 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:

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

5.7.2.5 Registers

The product (MF-HD) has multiple registers for the various functions. Users can obtain data from the products, such as *product address* 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. 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, write protection will be automatically enabled to prevent incidental data loss.

Functions	Description	Register	Modbus reference
Address	Product address (R/W)	0x0081	40130 (0x0081)
Serial number	Serial number (R)	0x0030~0x0035	40049 (0x0030)
Alarm	Alarm events (R)	0x0036	40055 (0x0036)
Flow rate	Current flow rate (R)	0x003A~0x003B	40059 (0x003A)
Accumulated flow	Accumulated or totalized flow rate (R)	0x003C~0x003E	40061 (0x003C)
GCF *	Gas correction factor (R/W)	0x008B	40140 (0x008B)
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: A: available; N: not available

Flowmeter address	**0x0081**	**Write**	A
		Read	A
Description	Address of the product		
Value type	UINT 16		
Notes	Values from 1 to 247 except for 157 (0x9d). 0 is the broadcast address.		

SN, Serial number	**0x0030 ~ 0x0035**	**Write**	N
		Read	A
Description	Series Number of the product, SN		
Value type	ASCII		
Notes	SN= Value (0x0030), Value (0x0031), ..., Value (0x0035); Receiving 12 bytes as: 2A 47 37 41 45 49 30 32 30 35 38 2A, the corresponding Serial Number is **G7AEI02058**.		

Flowmeter address	**0x0036**	**Write**	N
		Read	A
Description	Alarm events		
Value type	UINT 16		
Notes	Bit0: battery low; Bit1: Flow rate out of range; Bit2: Hardware error; Bit3: Sensor polluted or reverse flow observed; Bit4: Sensor error; Bit5: BT checking error; Bit6: APP checking error; Bit7: Measured gas changed.		

Current flow rate	**0x003A ~ 0x003B**	**Write**	N
		Read	A
Description	Current flow rate		
Value type	UINT 32		

Notes	Flow rate = [Value (0x003A) * 65536 + value (0x003B)] / 1000 e.g., for a flow rate of 20.340 m^3/h, the user will read "0" from register 0x003A and "20340" from register 0x003B, therefore Current flow rate = (0*65536+20340)/1000 = 20.340

Accumulated flow rate	**0x003C ~ 0x003E**	**Write**	N
		Read	A
Description	Accumulated or totalized flow rate		
Value type	UINT 32 + UINT 16		
Notes	Accumulated flow rate = Value (0x003C) * 65536 + Value (0x003D) + Value (0x003E) /1000 e.g.: for an accumulated flow rate of 3452.245 SCF, the user will read "0" from register 0x003C; "3452" from register 0x003D, and "245" from register 0x003E. Then, the accumulated flow rate = 0 + 3425 + 245/1000=3425.245.		

GCF or K factor	**0x008B**	**Write**	A
		Read	A
Description	The gas conversion factor for use with gas is different from the calibration gas or when adjusting a system deviation.		
Value type	UINT 16		
Notes	The air (default) is 1000, normally read from register 0x008B. **The product will disable this function with write protection once the metering gas is confirmed with the proper GCF. For a specific GCF value, contact the manufacturer.**		

Offset calibration	**0x00Fo**	**Write**	A
		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. **When you execute this function, ensure there is NO flow in the flow channel.**		

Write protection	**0x00FF**	**Write**	A
		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, send 0xAA55 to 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.		

5.7.3 BT LE Communication Protocol

The current protocol is compatible with BT LE 5.0.

BT LE MAC address: 80:4B:50:9C:19:70

(The address is an example, will be different for each meter.)

Broadcast settings: Broadcasting 31000 msec (31 sec) per 10 minutes

During this period, in the first 29500 msec, the data will be updated every 1000 msec; in the last 500 msec, the data will not be updated.)

Contents of broadcasting: 02 01 06 11 FF B1 03 4F 54 4F 53 49 41 10 00 00 00 00 00 3E 34

HEX	Parsing	Note
02 01 06	AD1	
11 FF B1 03	AD2	
4F 54 4F 53 49 41	Otodata-Siargo Packet Header :"OTOSIA"	
10	Metering packet Type A version 1	
00	Trouble Status	
00 00 00 00	Incremental Count	
3E	BatteryLevel_64mV	Battery voltage equals 62*64=3968mV
34	DeviceTemperature_500mC	Temperature equals 52*0.5=26℃

The rest of the 500ms (in 31000 msec); data will be updated per 100ms, and the Contents of broadcasting:

02 01 06 1A FF B1 03 4F 54 4F 53 49 41 00 01 20 00 47 48 48 51 43 34 30 30 30 34 4D 46 19

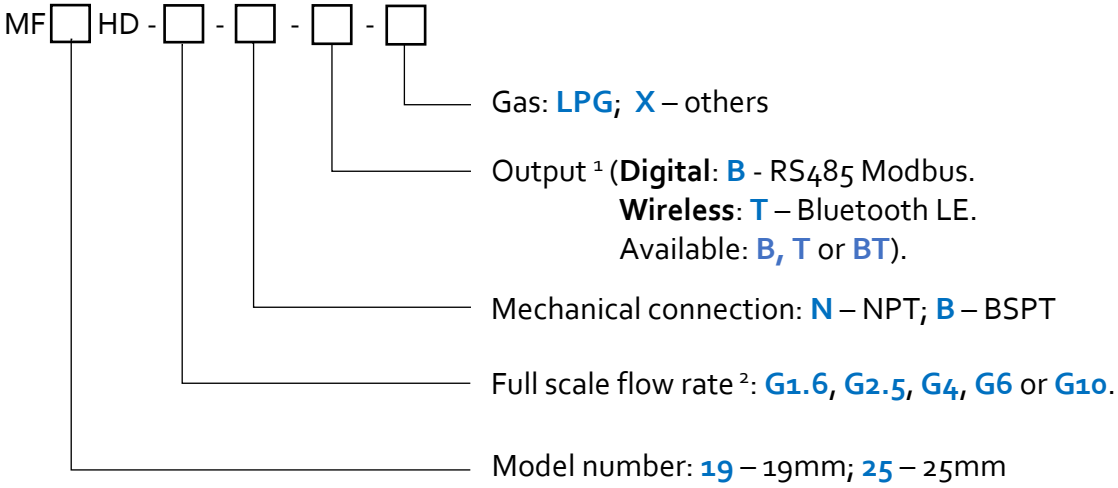
HEX	Parsing	Note
02 01 06	AD1	
1A FF B1 03	AD2	1A is the data bytes in the following, 0x1A = 26.

4F 54 4F 53 49 41	Otodata-Siargo Packet Header "OTOSIA"	
00	Identification packet version 1	
01	Hardware Version	
20 00	Firmware Version	
47 48 48 51 43 34 30 30 30 34	Device Serial Number GHHQC40004	The SN will be different for each meter.
4D 46 19	MF25 4D 46 = MF (ASCII), 0x19 =25	

6. Product Selection

Please refer to the following model guide for product selection and order.

6.1 LPG Application



Notes:

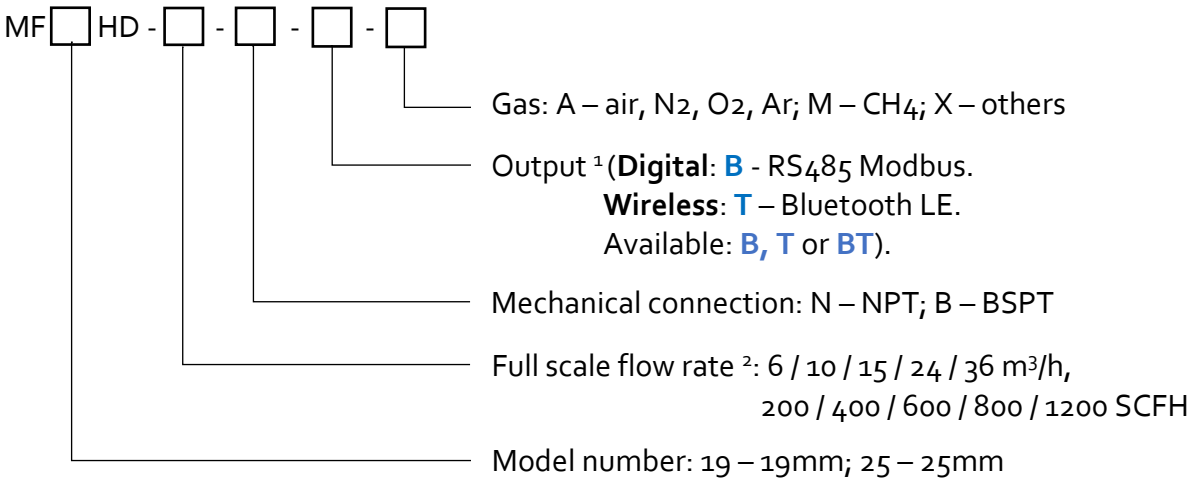
1. The battery chamber and socket/cable are selectable.

   - When RS485 is selected (Output code: B), the socket for RS485 communication is available. The battery power terminal is disabled.
   - When Bluetooth LE is selected (Output code: T), the battery power is enabled. The socket for RS485 communication is not available.
   - When both RS485 and Bluetooth LE are selected (Output code: BT), both sockets for RS485 communication and the battery chamber are available.

2. Flow range table.

	DN	Mechanical connection	Min flowrate		Max flowrate	
MF19HD-G1.6	19	NPT 3/4" or BSPT 3/4"	0.016 m³/h	0.5 SCFH	2.5 m³/h	90 SCFH
MF25HD-G2.5	25	NPT 1" or BSPT 1"	0.025 m³/h	0.8 SCFH	4.0 m³/h	142 SCFH
MF25HD-G4			0.04 m³/h	1.4 SCFH	6.0 m³/h	212 SCFH
MF25HD-G6			0.06 m³/h	2.5 SCFH	10 m³/h	400 SCFH
MF25HD-G10			0.10 m³/h	4.0 SCFH	16 m³/h	600 SCFH

6.2 Other Gases



Notes:

1. The battery chamber and socket/cable are selectable.

   - When RS485 is selected (Output code: B), the socket for RS485 communication is available. The battery power is disabled.
   - When Bluetooth LE is selected (Output code: T), the socket for RS485 communication is not available.
   - When both RS485 and Bluetooth LE are selected (Output code: BT), both sockets for RS485 communication and the battery chamber are available.

2. For the flow range, please consult the following table.

	DN	Mechanical connection	Min flowrate		Max flowrate	
MF19HD-6	19	NPT 3/4" or BSPT 3/4"	0.06 m³/h (=1.0 SLPM)	2 SCFH	6 m³/h (=100 SLPM)	200 SCFH
MF25HD-10	25	NPT 1" or BSPT 1"	0.10 m³/h (=1.6 SLPM)	4 SCFH	10 m³/h (=160 SLPM)	400 SCFH
MF25HD-15			0.15 m³/h (=2.5 SLPM)	6 SCFH	15 m³/h (=250 SLPM)	600 SCFH
MF25HD-24			0.24 m³/h (=4 SLPM)	8 SCFH	24 m³/h (=400 SLPM)	800 SCFH
MF25HD-36			0.36 m³/h (=6 SLPM)	12 SCFH	36 m³/h (=600 SLPM)	1200 SCFH

Note: Air, N2, O2, Ar, and CH4 have the same flow ranges.

7. 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. The product is horizontally mounted during calibration.

	LPG	Air, N_2, O_2, Ar, CH_4	Unit
Flow range	**MF19HD-G1.6** 0.016 ~ 2.5 m^3/h 0.5 ~ 90 SCFH	**MF19HD-6** 0.06 ~ 6 m^3/h (=1.0 ~ 100 SLPM) 2 ~ 200 SCFH	
	MF25HD-G2.5 0.025 ~ 4.0 m^3/h 0.8 ~ 142 SCFH	**MF25HD-10** 0.10 ~ 10 m^3/h (= 1.6 ~ 160 SLPM) 4.0 ~ 400 SCFH	
	MF25HD-G4 0.04 ~ 6.0 m^3/h 1.4 ~ 212 SCFH	**MF25HD-15** 0.15 ~ 15 m^3/h (= 2.5 ~ 250 SLPM) 6.0 ~ 600 SCFH	
	MF25HD-G6 0.06 ~ 10 m^3/h 2.5 ~ 400 SCFH	**MF25HD-24** 0.24 ~ 24 m^3/h (= 4 ~ 400 SLPM) 8.0 ~ 800 SCFH	
	MF25HD-G10 0.10 ~ 16 m^3/h 4.0 ~ 600 SCFH	**MF25HD-36** 0.36 ~ 36 m^3/h (= 6 ~ 600 SLPM) 12 ~ 1200 SCFH	
Turn-down ratio	160:1	100:1	
Accuracy	Class 1.5	±(1.5 r.d.+0.25 FS)%	
Working temperature	-40 ~ +60		°C
Working pressure	50 ~ 150		kPa
Burst pressure	300		kPa
Power supply*	Lithium-ion battery, 3.6V, 19AH ➢ Without communication, 5 years minimum. ➢ With Bluetooth LE, Beacon mode, 3 years. ➢ With Bluetooth LE, Master-slave mode, 6 months. External power supply 8~24Vdc ➢ RS485 and Bluetooth LE, Beacon mode or Master-slave mode		
Display resolution -Instant flow rate	**MF19HD-G1.6** 0.0001 m^3/h or 0.001SCFH **MF25HD-G2.5/G4** 0.0001 m^3/h or 0.01SCFH **MF25HD-G6/G10** 0.001 m^3/h or 0.01SCFH	**MF19HD-6** 0.0001 m^3/h or 0.01SCFH **MF25HD-10/15/24** 0.001 m^3/h or 0.01SCFH **MF25HD-36** 0.001 m^3/h or 0.1SCFH	

Display resolution -Totalized flow rate	0.001 m^3 or 0.01SCF	0.001 m^3 or 0.01SCF	
Data interface	RS485 Modbus, Bluetooth LE, or customized		
Reference conditions	20°C, 101.325 kPa, air		
Storage temperature	-30 ~ +70		°C
Hazardous rating	Ex ib IIB T4 Gb (battery-powered models)		
Protection	IP66		
Gas compatibility**	Noncorrosive		
CE	EN61326-1		

*Battery life depends on usage and environment. For standard LPG cylinder applications, battery life is about 10 years.

**For other gases, contact the manufacturer.

7.1 Wetted materials and compatibility

The product flow channel is made of anodized aluminum alloy. Flow conditioner is made of Acrylonitrile Butadiene Styrene (ABS). 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.

8. Technical Notes for the Product Performance

8.1 Measurement principle

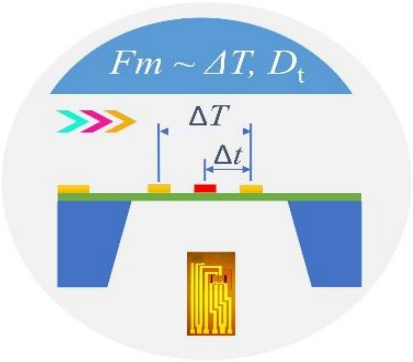


Figure 8.1: Measurement approach illustration.

The products utilize the Company's proprietary micro-machined (MEMS) thermal calorimetric sensing in time-domain data with a data processing algorithm. A thermal signal generator (microheater) with a pair of sensing elements is precisely manufactured upstream and downstream and separated at predefined micrometer distances on the chip surface under excellent thermal isolation. When a fluid flows through the sensing chip, the fluid carries the thermal signal downstream. The sensing elements register the amplitude, time, and temperature differences. It calculates the thermal diffusivity and further correlates with the fluid mass flow rate during 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, which allows 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 USA 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 to compare the data from the product with a third-party reference meter, and in many cases, discrepancies can occur.

When performing such a comparison, please note that the reference meter should have a better-specified accuracy (approximately one-third of that specified by 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, P1 is the pressure of the reference meter, P2 is the pressure at the test meter, v1 is the velocity of the reference meter, and v2 is the velocity of the test meter. h1 and h2 are the corresponding heights for the meters, which are often the same in the system. Therefore, it will be essential to ensure the system has no pressure variation. (This explains our recommendations for the installations in Section 4). In addition, the meter measurement principle is often the key to understanding any discrepancies.

Please note that for comparison with a rotameter, the reading can have large deviations due to differences in measurement principles. Particularly, 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 the meter's functionality. It is critical to ensure that the applied flow medium is clean and dry. If contamination is suspected, please allow experienced technical personnel to check and recondition it. Do not use foreign cleansers or other fluids to clean the flow path, as they could cause irreparable damage.

8.2.3 Apply to a different gas medium

The product is calibrated using a high-precision NIST-traceable metrological standard and clean and dry air. Thanks to the unique thermal sensing technology, the product can be applied to meters and control other clean and dry gases with similar thermal diffusivities without losing accuracy. It has effectively resolved the nonlinearity issues when applying to a gas conversion factor in calorimetric sensing, making the measurement highly accurate with an extensive dynamic range. Applicable gases 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. For more information, contact your sales representative or manufacturer.

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 applied, please check the

gas compatibility data with the manufacturer. In some cases, packing 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 recalibration of the controller depends on usage and application requirements. Therefore, it is 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, contact your sales representative or 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 changes to the products will void the product warranty. It could lead to irreparable damage to the products and could result in unexpected injuries.

The products do not require regular maintenance if the specified application conditions are exactly observed. Maintenance is required if indications of contamination or malfunctions are verified. In this case, contact your sales representative or directly contact customer support (information available on the Company's webpage) to obtain an RMA (Return Material Authorization) before shipping the products back to the Company's support center. Siargo commits to responding as fast as possible. Regular service will be performed within five business days if no major parts change is required.

9. Troubleshooting

Phenomena	Possible causes	Actions
No signal/display	The power is not connected; the battery is empty	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.
Offset unstable	Circuitry unstable	Check the system, power off
No digital interface	Wrong address, software	Check commands, connection
No wireless, BT cannot pair	Wrong model, data jam	Check the model, power off/on.

10.Warranty and Liability

(Effective January 2018)

Siargo warrants that the products sold hereunder, when used and installed properly under normal circumstances and services, will be free from defects. 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 repairs or replacement product shall bear the exact terms of 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. 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 beyond the scope described herein, the user shall indemnify and hold Siargo, its officers, employees, subsidiaries, affiliates, and sales channels harmless against all claims, costs, damages, expenses, and 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 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.

The product information in this manual is believed to be accurate and reliable at the time of release. They are made available to 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, but not limited to those stated in this document or any other actions that 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 resold by unauthorized dealers or any third parties.

11. Service/order Contact and Other Information

Siargo Ltd. is making every effort to ensure the quality of its products. For any questions or product support, contact your direct sales representative. If you require additional assistance, contact the customer service at the address listed below. We will respond quickly to your requests and work with you to your complete satisfaction.

For sales or product orders, contact the local sales representatives or distributors listed on the company's webpage www.Siargo.com.

For any returns, contact your direct sales representative to obtain an RMA. For any further assistance, contact 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. In your email messages, please specify the status of the product you intend to return 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: Meter Evaluation via RS485 Modbus

AI-1. Connect the Meter to a PC

The evaluation or tests of the meter are performed via the digital interface RS-485 Modbus. For the convenience of the application, Siargo offers user application software and a digital converter that can be used to connect the meter to a Microsoft Windows-compatible computer for digital data reading or acquisition.

For this purpose, connect the meter using the converter and the data cable provided by the manufacturer. One cable attached to the digital converter can be directly plugged into the meter, and another USB cable is used to connect to the computer, as shown below:



Note: Connect the cable to meter first, and then connect the USB cable provided to the digital converter and a PC USB port. If the PC is powered up at the connection, the LCD screen will light up.

AI-2. Software Description

The software is compatible with Microsoft Windows 8 and above. It allows for digital data collection and meter verification:

- Digital data interface via RS485 Modbus.
- Read and record the data.
- Set parameters.

Appendix II: Document History

Revision VA.2.12 (August 2025)

- Corrections.

Revision VA.2.11 (September 2024)

- Correct the product selection.

Revision VA.2.10 (June 2024)

- Add CH4 and corrections.

Revision VA.2.09 (May 2024)

- Correct the power supply.

Revision VA.2.08 (May 2024)

- Correct the product selection and flow ranges.

Revision VA.2.07 (March 2024)

- Correct the power supply.

Revision VA.2.06 (November 2023)

- Update contact address and corrections.

Revision VA.2.05 (June 2023)

- Minor corrections.

Revision VA.2.04 (April 2023)

- Correct the product selection for LPG.

Revision VA.2.03 (February 2023)

- Correct the flow range of MF25HD.

Revision VA.2.01 / VA.2.02 (October 2022 / December 2022)

- Minor corrections.

Revision VA.2 (July 2022)

- Minor corrections;
- Update service information.

Revision VA.1 (February 2022)

- Add additional gas options; minor addition.

Revision VA.0 (March 2021)

- First release.