MEMS Mass Flow Meters

Model MF4000

Contents

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Features

- Designed for gas flow in fixed flow channel of 3 mm and 8 mm, with accumulated flow
- Compact design ready for manifold applications
- Fast response time provides solutions for critical applications
- Excellent for electronic meters in anesthesia equipments
- Exchangeable mechanical connectors for easy installation at different applications
- Intrinsic safe enclosure for wide applications
- Low power consumption, can be operated by battery

Introduction

MF4000 Series mass flow meters are designed for applications in gas flow within a flow channel diameter of 3 mm and 8 mm, respectively. The compact design provides user friendly installation for multiple flow channel sensing requirements. Plastic finishing with an easy change of the mechanical adaptors enables applications with different connection thread requirements or one-touch approach. The meters can be used for electronic meters in anesthesia equipments, environmental samplers and many other industrial applications.

The meters can be customized with flow range, gas specific requirements, user interface and others upon requests to the manufacturer.

Applications

Environmental Monitoring
- Aeration cable
- Gas generated plasma monitor
- Vacuum applications
- Preservation of oxygen devices
- Anesthesia
- Ventilator
- Ventilation equipment detection devices
- Other industrial applications such as welding

Working Principle and Package

The MEMS calorimetric sensor is installed at the flow channel wall forming a plate that serves as an additional flow conditioner from the boundary layer configuration resulting in a laminar flow. The mass flow measurement is established as the fluid carries heat away from the heater causing the redistribution of the temperature field. Accurate flow rate is obtained by calibration with the standard fluid at the preset conditions.

Flow direction

Time-averaged velocity profile boundary layer

Free stream

Turbulent

Laminar

Sensor

Schematic of Electronics

(8-18)V$_{DC}$

(Pin3)VCC
(Pin4)GND
(Pin1)TX
(Pin5)RX
(Pin2)Vout
(Pin4)GND

Power Module

5V / 3.3V

5V Power Supply

Driving Circuit

MEMS Sensor Chip

Buffer

Amplifier

Filter

Signal Conditioning Circuit

∩ / #
x1   u1
A/D Converter

RS232

Analog Output

∩ / #
x1   u1
D/A Converter

EEPROM

Select

High-Speed 8-Bit Microcontroller

Test-Key Interface

Display and Key Driver

4-digit LED display
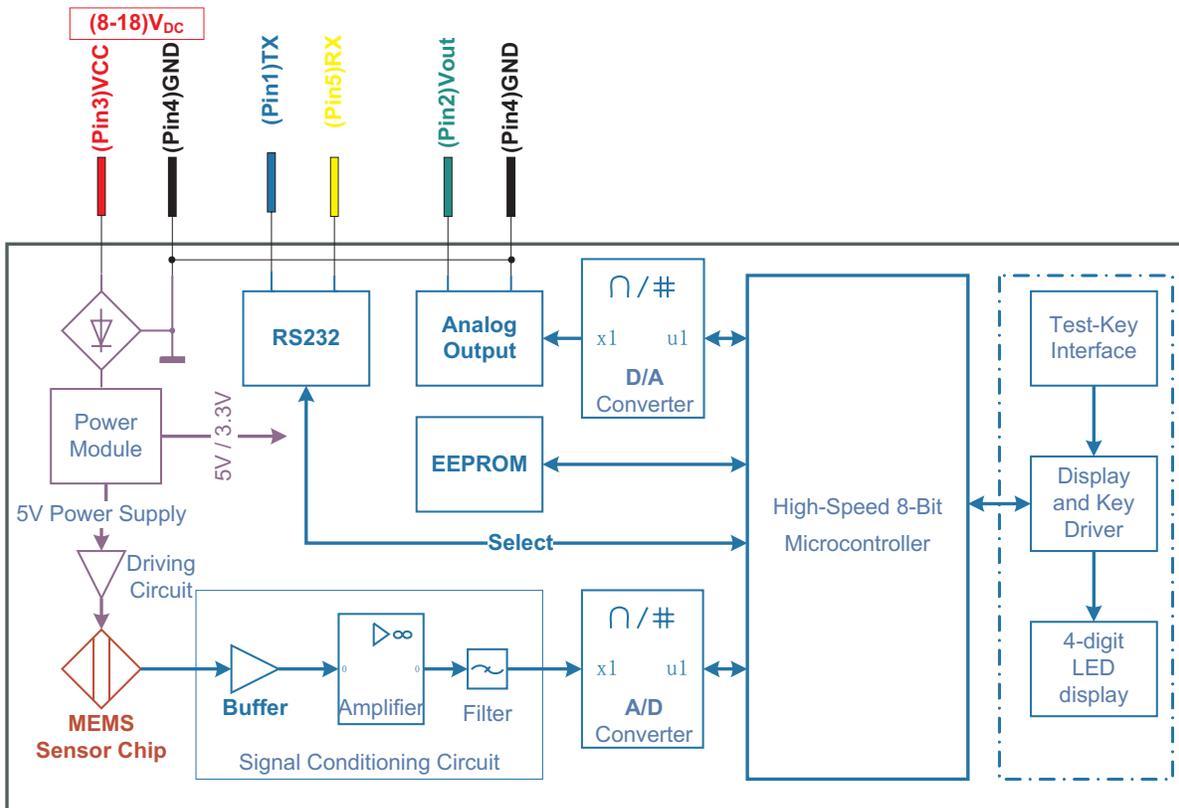
The Meters

The meters is packaged into the standard poly-carbonate enclosure with which the maximum detectable mass flow rate can be customized within 2SLPM to 50SLPM by modification of the circuitry so that the various flow can be achieved to meet customers' best requirements. The calibration is done with air at 20°C and 1 bar pressure. It can nonetheless be calibrated at other customer specific conditions upon requests.

Specifications

	MF4003	MF4008	
DN	3	8	mm
Max. Flowrate	2,3,4,5	10,20,30,40,50	SLPM
Turn-down	>100:1		
Accuracy	±(1.5±0.2FS)		%
Repeatability	±0.75		%
Null Shift	±30		mV
Output Shift	0.12		% / ℃
Response Time	100 (Default, 50, 100, 200 ,500, 1000 selectable)		ms
Power Supply	8~18Vdc, 100mA		
Output	RS232, Analog 0.5~4.5Vdc		
Display	4-digit, 7-segment LED，2 Status LED		
Units	Instant flow rate: SLPM; Flow accumlation: SL		
Display Resolution	0.001, 0.01, 0.1 selectable	0.01, 0.1 selectable	SLPM
Pressure Drop	100	600	Pa
Max. Pressure	0.5		MPa
Working Temperature	-10~+55		°C
Storage Temperature	-20~+65		°C
Humidity	<95		%RH
Mechanical Connection	BSPT 1/4 (R 1/4), 4mm / 6mm / 8mm One-touch		
Keyboard	3 keys		
Pins Out	5 Pins, 0.5m		
Calibration	Air, 20°C,101.325kPa		
Package	Polycarbonate		
Weight	57 (with BSPT 1/4 (R 1/4) connection) 76(with O4,O8 connection), 73(with O6 connection)		g

Description
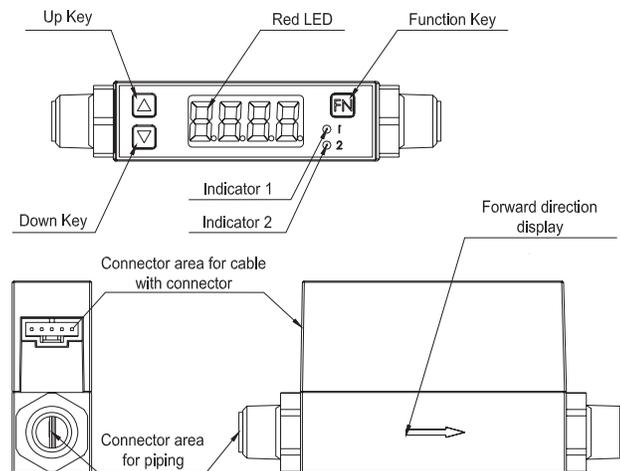
Dimensions

For R 1/4 connection

18.0±0.1
11.0±0.1
2-M3▽6.0

48.0
R 1/4
98.0
Ø3.0
20.0

MF4003

18.0±0.1
11.0±0.1
2-M3▽6.0

48.0
R 1/4
98.0
Ø8.0
20.0

MF4008
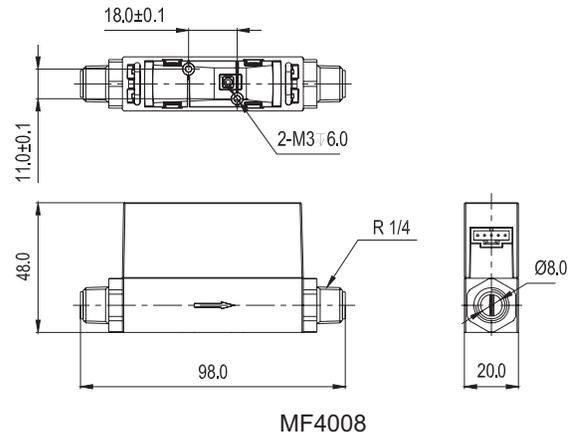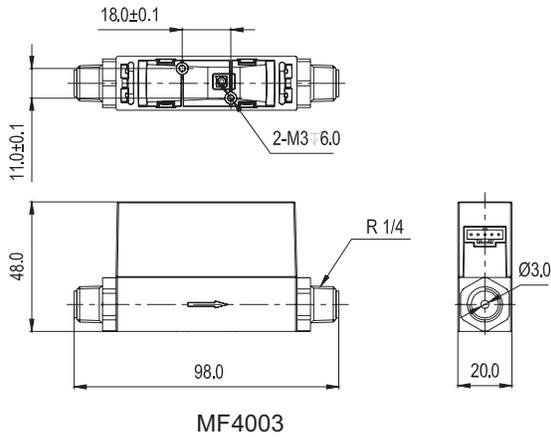
For One-touch connection

18.0±0.1
11.0±0.1
2-M3▽6.0

48.0
L
D
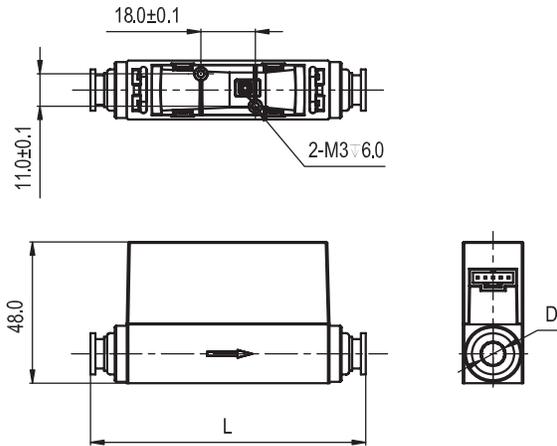
One-touch Connection	L	D
ID=8mm	91.0	Φ8.0
ID=6mm	83.0	Φ6.0
ID=4mm	80.0	Φ4.0

MF40 □ – □ – □ – □ – □

Gas (A-air; B-N_2O; C-carbon dioxide; N-nitrogen; O-oxygen; R-argon; for other gases, please contact manufacturer.)

Output (V - Analog, BV - Both analog and RS485, CV - Both analog and RS232);)

Connection (R-BSPT 1/4 (R 1/4); O4/O6/O8 – One-touch connection, DN=4mm/6mm/8mm;)

Max. Flowrate (selectable,MF4003 - 2,3,4,5SLPM; MF4008 - 10,20,30,40,50SLPM)

Product series name (03-DN3,08-DN8)
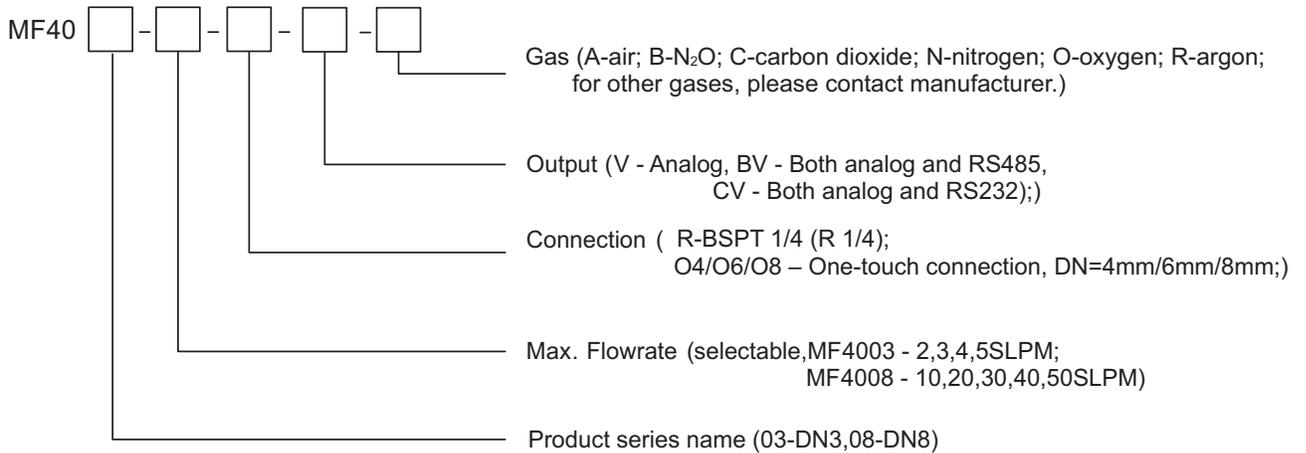
Installation and User Interface

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 if applicable, standard ESD (electrostatic discharge) precautions, and DC voltage precautions. Other tasks such as calibration, part replacement, repair, and maintenance must only be performed by trained personnel. Upon requests, manufacturer will provide necessary technical support and/or training of the personnel.

Do not open the product cover or alter any part of the product. Any such actions will forfeit the terms of the warranty and cause the liability to any damages thereafter.
The interface is defined in the table below:

Pin	Colour	Definition
1	Blue	TX, RS232 Transmit (output)
2	Green	Vout, Analog output
3	Red	VCC, Power supply (8 - 18 Vdc)
4	Black	GND, Ground
5	Yellow	RX, RS232 Receive (input)
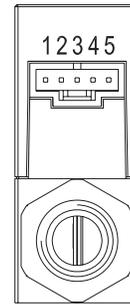
NOTE: Upon open the package, if any component listed above is missing or any visible mechanical damage is found, please contact supplier or distributors immediately. For additional assistance of installation, please contact supplier or customer service.

Running Mode

The display consists of a 4-digit LED panel and two LED indicators (i.e., I-LED and II-LED). Under the running mode, the 4-digit LED panel will show Instant flow rate, flow accumulation, or maximum/minimum flow rates. There are three different display modes: instant flow rate mode, flow accumulation mode, and maximum/minimum mode. The two LED indicators will illustrate which display mode is undergoing.
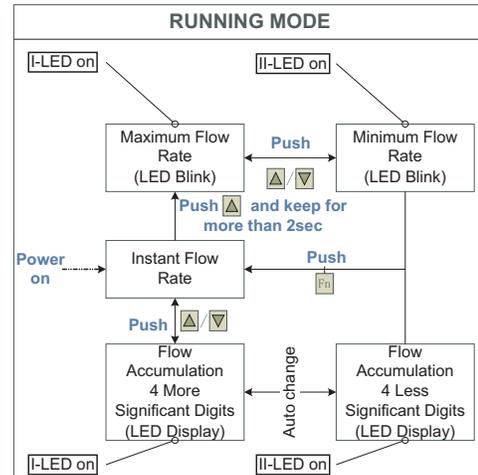
•**Instant flow rate mode:**

1. This is the default display mode, in which the two LED indicators are off.
2. The instant flow rate is displayed by the 4-digit LED panel with one decimal digit available. The flow rate unit is SLPM.
3. When the flow rate exceeds the maximum allowable flow rate, I-LED will blink.
4. When the flow rate exceeds the minimum allowable flow rate, II-LED will blink.

5. When the flow rate exceeds the maximum displayable reading, both I-LED and II-LED will blink simultaneously, which implies that the reading is incorrect (since the reading has been rounded off to fit the display, although the measurement may still be correct).

•**Flow accumulation mode:**
1. In this display mode, the two LED indicators are turned on.
2. The flow accumulation is displayed as an 8-digit numeric number in a time-division scheme. When the first LED indicator (I-LED) turns on, the 4-digit LED panel displays the more significant digits of the flow accumulation. After 1 second, the second LED indicator (II-LED) turns on and the 4-digit LED panel displays the less significant digits of the flow accumulation.
3. The flow accumulation unit is SL. The flow accumulation reading can be reset to zero by a key operation or by switching on/off the power supply.
   NOTE: The flow accumulation will not be saved after the meter is power off. Hence, the flow accumulation will always start from 0 SL when the meter is power on.

•**Maximum / minimum mode:**
1. In this mode, the maximum flow rate and the minimum flow rate (since the last power-on or the last maximum/minimum flow rate resetting) will be displayed.
2. When the maximum flow rate is shown, I-LED will turn on and the 4-digit LED panel will blink.
3. When the minimum flow rate is shown, II-LED will turn on and the 4-digit LED panel will blink.

Menu Setting Mode
Under the menu setting mode, various operations including keyboard lock/unlock, flow accumulation reset, automatic offset calibration, gas selection, response time setting, display refresh setting, maximum/minimum flow rate reset can be performed.

•**Keyboard lock:**
1. Prevent unintentional modifications of system parameters.
2. After the keyboard is locked, the user will be unable to perform any other menu settings unless the keyboard is unlocked by the user.

•**Flow accumulation reset:**
Reset the flow accumulation reading to 0 SL, and the flow accumulation counts re-starting at 0 SL.

•**Automatic offset calibration:**
Perform offset calibration, which is used for resolving the possible offset drifting after certain period of operation.
   NOTE: Before performing automatic offset calibration, please ensure that the gas in the pipe is static, i.e., at zero flow. Otherwise, it may cause inaccuracy during the measurement.

MENU SETTING MODE

Instant Flow Rate (LED Display)

Push Fn **and keep for more than 2 sec**

Push Fn

Keyboard Unlock 0.unL(Blink)

Push ▲/▼

Keyboard Locked 0.Loc(Blink)

Push Fn

Keep the Flow Accumulation 1.oFF(Blink)

Push ▲/▼

Clear the Flow Accumulation 1.on(Blink)

Push Fn

Flow accumulation Zeroing

Push Fn

Don't perform offset calibration 2.oFF(Blink)

Push ▲/▼

Perform Offset Calibration 2.on(Blink)

Push Fn

Automatic offset calibration

Push Fn

Push Fn

Push ▲ ▼

Response time=50ms 4.005(Blink)

Push ▲/▼

Response time=100ms 4.010(Blink)

Push ▲/▼

Response time=200ms 4.020(Blink)

Push ▲/▼

Response time=500ms 4.050(Blink)

按下 ▲/▼

Response time=1000ms 4.100(Blink)

Push Fn

Push Fn

Push ▲/▼

Display refresh time =250ms 5.025(Blink)

Push ▲/▼

Display refresh time =500ms 5.050(Blink)

Push ▲/▼

Display refresh time =1s 5.100(Blink)

Push ▲/▼

Display refresh time =2s 5.200(Blink)

Push Fn

Push Fn

Keep Max./Min. Flow Rate 6.oFF(Blink)

Push ▲/▼

Clear Max./Min. Flow Rate 6.on(Blink)

Push Fn

Clear Max./Min. Flow Rate

Push Fn

Push Fn

Keep current Setting 7.oFF(Blink)

Push ▲/▼

System default retrieval 7.on(Blink)

Push Fn

System default retrieval

Push Fn

Push Fn

Push ▲/▼

No decimal digits 8. 0(Blink)

Push ▲/▼

Decimal digits=1 8. 1(Blink)

Push ▲/▼

Decimal digits=2 8. 2(Blink)

Push ▲/▼

Decimal digits=3 8. 3(Blink)

Push Fn

Push Fn

Push Fn

Push Fn

• **Response time setting:**
  1. Set the response time of the analog output signal;
  2. Set the time interval for the digital output signal;
  3. After each setting is completed, it is in effect immediately. However, it is stored in the internal EEPROM only when a new menu operation is invoked. If the power is off before a new menu operation is invoked, the setting will be discarded without being stored.

Display	4.005	4.010	4.020	4.050	4.100
Response Time	50 ms	100 ms	200 ms	500 ms	1000 ms

• **Display refresh setting:**
  1. Set the time interval for the display refresh;
  2. After each setting is completed, it is in effect immediately. However, it is stored in the internal EEPROM only when a new menu operation is invoked. If the power is off before a new menu operation is invoked, the setting will be discarded without being stored.

Display	5.025	5.050	5.100	5.200
Refresh Time	250 ms	500 ms	1000 ms	2000 ms

• **Maximum / minimum flow rate record clearing:**
  1. Reset the maximum/minimum flow rate register, and the maximum/minimum flow rates will be re-starting from the initial state.
  2. The maximum/minimum flow rate record will be automatically reset when the meter is power off.

• **System default restore:**
  Reset all the system parameters to the default values specified in the factory.

• **Decimal setting:**
  Set the number of decimal digits.
  NOTE: The maximum number of decimal digits is depended on the maximum flow rate. For example, when the maximum flow rate is 10,20,30,40,50 L/min, the number of decimal digits can be at most 2, e.g., 49.99 L/min.

RS232 Data Communication Protocol

For purposes of computer control and networking, the RS232 is used for communication with the following preferred settings:

Baud rate (Bits per second):	38400
Date bits:	8
Stop bits:	1
Parity:	None
Flow control:	None

•**Operation mode:**
>   1. Send 0x9d to the meter and receive 0x9d from the meter;
>   2. Send 0x54 to the meter and receive 0x54 from the meter;

>   The time interval between two bytes sent to the meter must be longer than 5ms. The meter will be at Operation Mode in which the data from the meter will be sent via RS232 in an interval of 200ms.

>   The data are in the following format:
>>   V=vvvvvv\nF=ffffffff\nA=aaaaaaaa\n; \n
>>>   V=vvvvvv   Voltage code;
>>>   F=ffffffff   Instant flow rate; equals to *fffff.fff* SLPM
>>>   A=aaaaaaaa   Flow accumulation; equals to *aaaaa.aaa* SL

•**User mode:**
>   1. Send 0x9d to the meter and receive 0x9d from the meter;
>   2. Send 0x00 to the meter and receive 0x00 from the meter;
>   The time interval between two bytes sent to the meter must be longer than 5ms. Then the meter will be at User Mode in which none of the data will be sent via RS232 by the meter.

•**Continuous output mode setting:**
>   1. Send 0x9d to the meter and receive 0x9d from the meter;
>   2. Send 0x56 to the meter and receive 0x56 from the meter;
>   The meter enters the continuous output mode. In this mode, the meter will send out an instant flow rate measured value via RS232 periodically. The time interview can be set by the user through the menu setting operations. The output format is :
>>   "F= ffffffff\n;\n",   which represents an instant flow rate *fffff.fff* SLPM.

•**Lookup instant flow rate:**
>   1. Send 0x9d to the meter and receive 0x9d from the meter;
>   2. Send 0x55 to the meter and receive 0x55 from the meter;
>   The meter will return an instant flow rate value via RS232, and enter into the operation mode. The output format is: "ffffffff", which represents an instant flow rate *fffff.fff* SLPM.

Safety and Maintenance

•**Wetted materials and compatibility**

The meter body is made of medical compatible plastics. Sensor comprise of silicon, silicon nitride and silicon dioxide and the sensor surfaces are passivated with silicon nitride and silicon dioxide. The electronic sealing is provided by RTV (room temperature vulcanizing) silicone sealant WR-704 composed of HOCH3 (SiO) nCH3H.

•<u>Safety precautions</u>

The product is designed for use with general purpose gases such as air and nitrogen. It is advised that the products are best used for non-explosive clean gases. The sensors cannot be used for gas metrology of fluoride or fluoride containing gases. For updates of the product certification information, please contact manufacturer or visit www.Siargo.com. Use for other gases such as extreme corrosive and toxic may cause the product malfunctioning or even severe damages. The product sealing is ensured to work under working pressure of 1.0 Mpa and is leakage proof before the shipment. But cautions and further leakage test are important at installation as well since any leakage could cause severe safety issue. The power supply for this product is 8~18 VDC, all precautions and measures for electrical voltage handling must apply.

Attention: Any alternation and/or improper use of the product without the permission of the manufacturer can cause unpredicted damages and even injuries or other severe situations. Siargo Ltd or any of its employees, subsidiaries shall not be hold and indemnified against such consequences due to such circumstances via improper use of the product.

All maintenance of the meter should be done by trained and certified personnel by Siargo, Ltd. products.

Customer Service and Order

Siargo Ltd.
2041 Mission College Blvd, Ste 250, Santa Clara, California 95054 USA, info@Siargo.com; +01(408)969-0368

In Japan, please contact

Marubeni Information Systems Co., Ltd.
Device Solutions Department, 3-12-18 Shibuya, Shibuya-ku, Tokyo 150-0002; +81-3-5778-8661
Siargo@Marubeni-sys.com