Siargo Ltd.

AM1000 User Manual VB.0.05

Insertion MEMS flow, temperature and humidity sensors

MEMS Flow, Temperature, and Humidity Sensors

with integrated MEMS sensing technology

AM1000 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, as light particles may be accumulated inside the tiny pressure port that may result in inaccuracy in metrology, clogging, or other irrecoverable damage.
- Do not apply for any unknown or non-specified gases that may damage the product.

Table of Contents

1. Overview

All contact information can be found at the end of this manual.

This manual provides essential information for the AM1000 series of integrated MEMS sensors of mass flow (flow speed), temperature, and humidity. It can be readily applied for environmental monitoring as well as an insertion flow meter. The product performance, maintenance, and troubleshooting, as well as the information for product order, technical support, and repair, are also included.

The AM1000 sensors are manufactured with the company's proprietary MEMS (micro-electro-mechanical systems) sensing technology and package technology that offers programmable flow speed data with a dynamic range of 100:1, as well as local temperature and humidity.

The RS485 (Modbus), I^2C, and Bluetooth LE (reserved) options are ready for networking or remote communication. The formality is particularly suited for residential HVAC smart home applications, as well as industrial processes or environmental monitoring, such as in a cleanroom.

The product is fully customizable for the flow speed range and features an additional desirable user interface. It can be further packaged into a complete meter with a local display or with standalone battery-powered options.

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 informed. 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 sensor formality per the actual order), along with any accessories ordered.

Figure 2.1: AM1000 or AM1100

Note: Evaluation kit or any other accessories must be ordered separately.

Please check immediately for the integrity of the product and the accessories; if any abnormality is identified, please notify the distributor/sales representative or manufacturer as soon as you can. If any defects are confirmed, an exchange shall be arranged immediately via the original sales channel. This user manual shall also be included in the packing box or via an online link for an electronic version, which your sales agent should send. In most cases, this manual shall be made available to the customer before the actual order.

Please note that the sensor has the standard 1.0-meter data and power cable directly attached to the product; therefore, no separate cable is needed for the operation. Please follow the instructions in the subsequent section for the correct connections for the exact model you ordered.

3. Knowing the products

3.1 Product selection

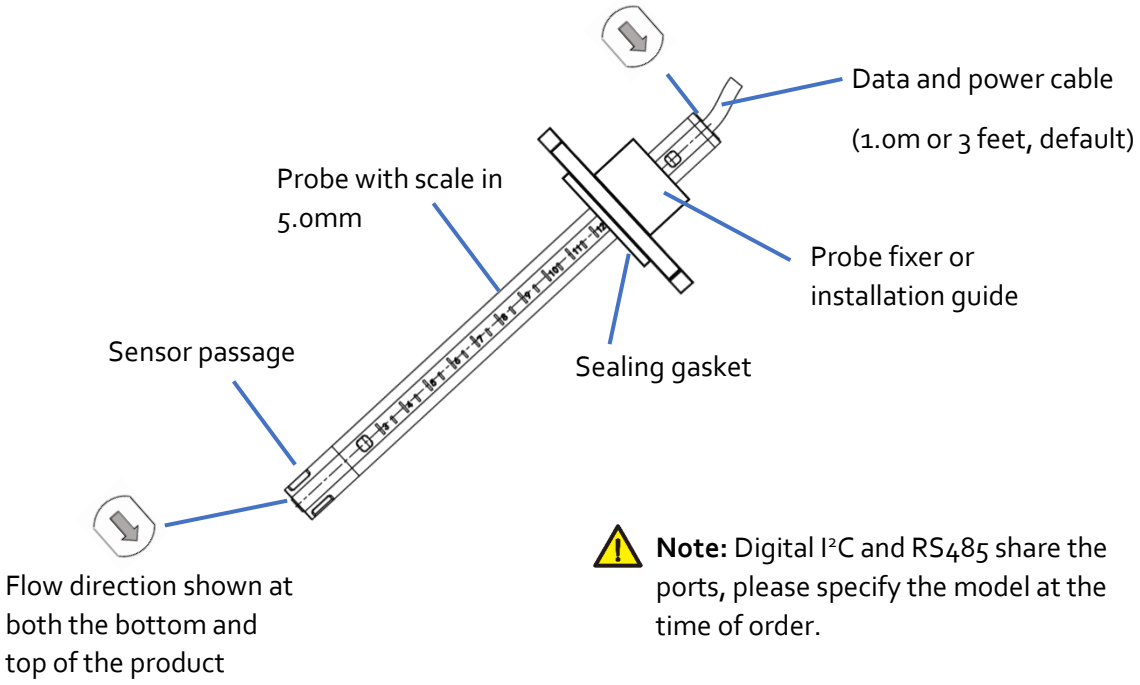


Figure 3.1: AM1000/1100 parts description

3.2 Power and data pinout description

Table 3.1: AM1000/1100 wire code assignment.

WIRE COLOR	DEFINITION
Red	VCC, power supply, 8~24Vdc
Black	GND, ground
Yellow	SCL, I²C clock / RS485 A (+)
Blue	SDA, I²C data / RS485 B (-)
Green	Analog output, 0.5~4.5 Vdc

Note: The product offers two digital communication options: I2C or RS485 Modbus Halfplex, which can be selected at the time of order. These two communication protocols share the ports as defined in Table 3.1. For the detailed protocols of the corresponding option, please refer to Section 5.

3.3 Mechanical dimensions

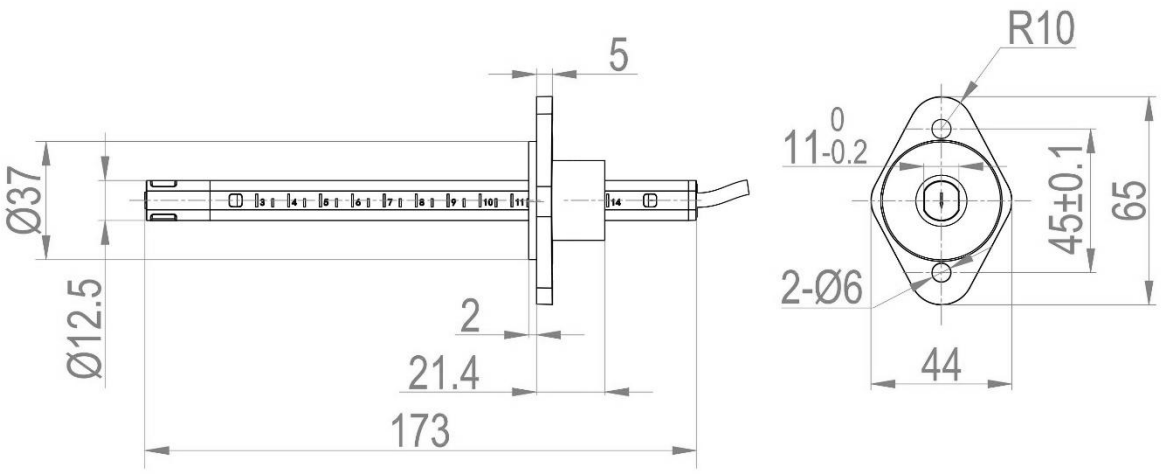


Figure 3.2: AM1000/1100 mechanical dimensions.

4. Installation

Do not open or alter any part of the product, which would lead to malfunction and irrecoverable damage.

Depending on the applications, the products can be used for open-space environmental data collection or as an insertion meter for inline gas flow measurement.

1. For the open space airspeed, temperature, and humidity measurement. Please note that the flow speed measurement is unidirectional; follow the arrow at the bottom of the probe to properly install it according to the application requirements. For open space measurement applications, there are no requirements for probe positioning. However, the flow data are relevant only to the probe's placement and are directionally defined by the arrow direction.

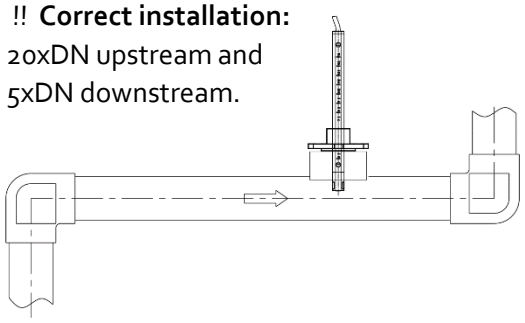
2. For the inline flow measurement, the product will be used as an insertion meter. The installation hole on the pipe where the product is to be inserted should be as close as possible to the probe's diameter, Φ12.5 mm. A flat, hard material surface should be prepared on the pipe to secure the probe. Refer to the following graphs. The fixtures should be leakage-proof tested before the installation of the product. An illustration sketch is shown below:

Figure 4.1: Preparation for the insertion fixture.

Ensure that no debris or excessive particles remain in the pipe during the preparation of the product fixtures.

Refer to the graphs below. According to OIML R137 recommendations, the upstream of the meter should have a 20xDN straight pipe length, and the downstream should have a 5xDN straight pipe length.

!! **Correct installation:**
20xDN upstream and
5xDN downstream.



!! **Incorrect installation**:
insufficient straight pipe
length

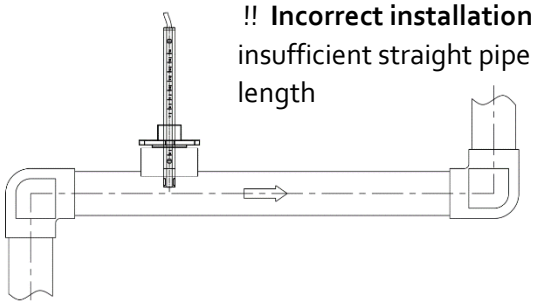
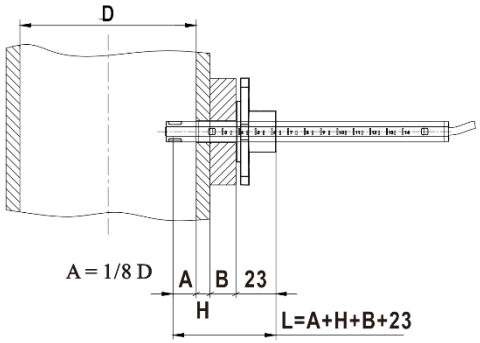


Figure 4.2: Installation with correct upstream and downstream space.



$$L = 1/8D+H+B+23$$

where *D* is the flow channel diameter

H is the flow channel wall thickness

B is the fixture base height.

Figure 4.3: Insertion probe length calculation.

Please note: a. The product is not designed for hazardous zone applications or exposure to corrosive gases.

b. The installation should also be at locations where it is away from valves, sharp turns, and other cases as described in OIML R137, as those would generate flow instability and cause unstable outputs.

c. The flow direction should be aligned as close as possible with the arrow on the product.

d. The product outputs the flow speed. To calculate the flow rate, it is necessary to know the depth of the product inside the flow channel. Please refer to the above graph for the calculations.

5. Digital communication descriptions

5.1 I²C interface

5.1.1 I²C interface connection diagram

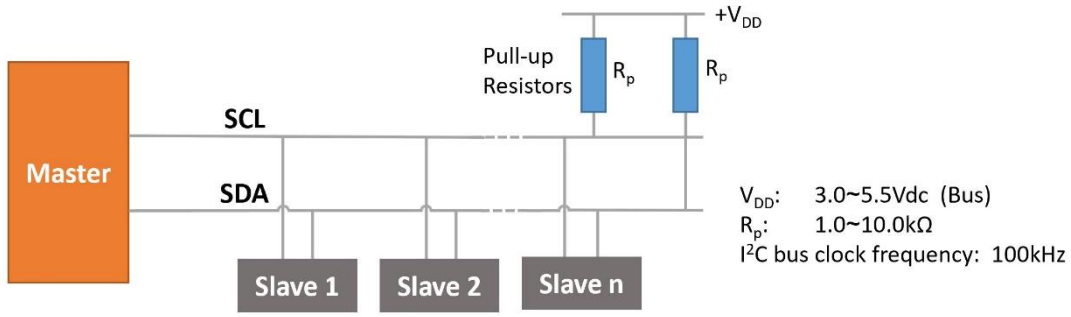


Figure 5.1: I²C connection

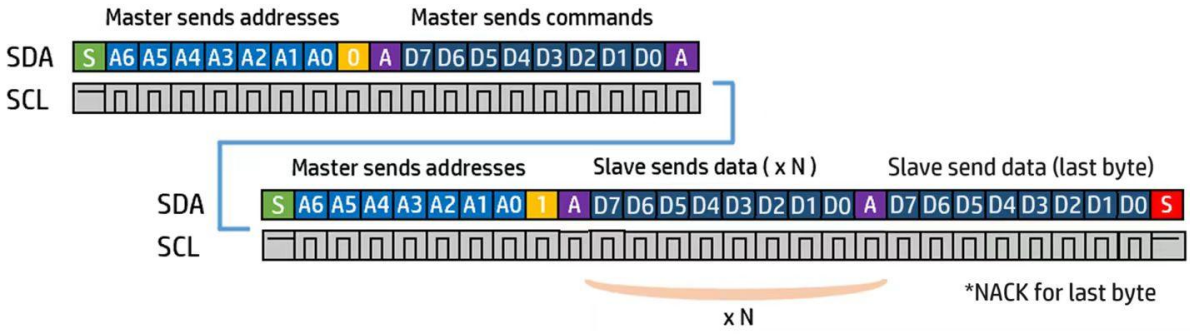
5.1.2 I²C interface command description

Command Byte (Hex)	Length (int 8)	Command Name	Read/Write	Notes
05H	1	I²C address	Write	Bit 0 is the R/W flag bit; Bits 1~ through 7 are available.
82H	12	Serial number	Read	ASCII
83H	4	Flow speed	Read	Int32/1000 in m/sec
85H	1	I²C address	Read	Bit 7 ~ Bit 1
BEH	1	Temperature	Read	Int8/100 in °C
BFH	1	Humidity	Read	Int8/100 in %RH

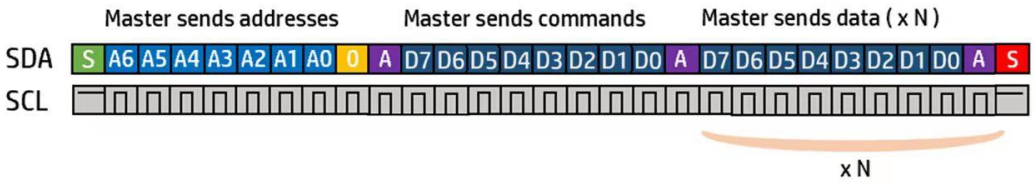
Note: 1. The I²C address is set to Bit 7~Bit 1. e.g., if the I²C address is 4 (0000 100x), the write address will be 0x08 (0000 1000) and the read address will be 0x09 (0000 1001).

5.1.3 I²C interface read/write sequences

I²C reads:



I²C writes:



Note:

bit		
S	Start bit	Master pulls SDA from HIGH to LOW while SCL remains HIGH.
S	Stop bit	Master allows SDA to float from LOW to HIGH while SCL remains HIGH.
A	ACK	Acknowledgement
1	Read	1 bit
0	Write	1 bit
A6	Address	7 bits, Default address: 1 (0000 001X)
D7	Data bit	8 bits

5.2 RS485 Modbus communication protocol

The RS485 hardware layer is TIA/EIA-485-A, as illustrated below. In this configuration, the product (AM1000/1100) is a slave.

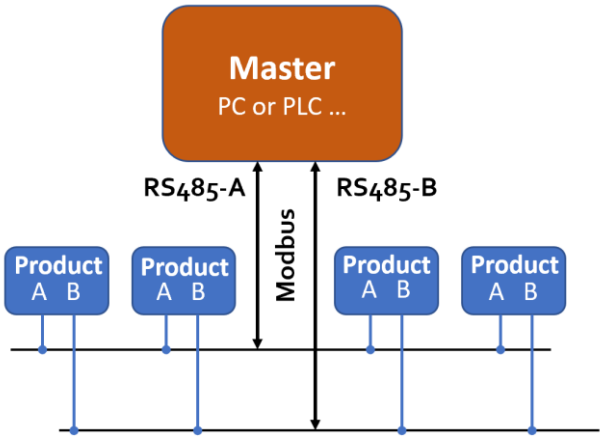


Figure 5.2: RS485 hardware

5.2.1 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

5.2.2 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 bit time, for a new frame.

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

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

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

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

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

5.2.3 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

5.2.4 Registers

The product (AM1000/1100) has multiple registers available for the assignment of the various functions. With these functions, the user can obtain data from products, such as product addresses and flow rates from the registers, or set product functions by writing the corresponding parameters.

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

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

Table 5.4: Registers

Functions	Description	Register	Modbus reference
Address	Product address (R/W)	0x0001	40002 (0x0001)
Flow speed	Current flow speed (R)	0x0002 ~ 0x0003	40003 (0x0002)
Baud rate	Communication baud rate (R/W)	0x0015	40022 (0x0015)
Temperature	Temperature (R)	0x0025	40038 (0x0025)
Humidity	Humidity (R)	0x0026	40039 (0x0026)

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

Address	**0X0001**	**Write**	Y
		Read	Y
Description	Address of the product		
Value type	UINT 16		
Notes	Values range from 1 to 247, with 0 being the broadcast address; the default value is 1.		

Flow speed	**0X0002 ~ 0X0003**	**Write**	N
		Read	Y
Description	Current flow speed		
Value type	UINT 32		
Notes	Flow speed = [Value (0x0002)*65536 + value (0x0003)]/1000 e.g.: for a flow speed of 20.34 m/sec, the user will read "0" from register 0x0002 and "20340" from register 0x0003, therefore Current flow speed = (0*65536+20340)/1000 = 20.34 m/sec		

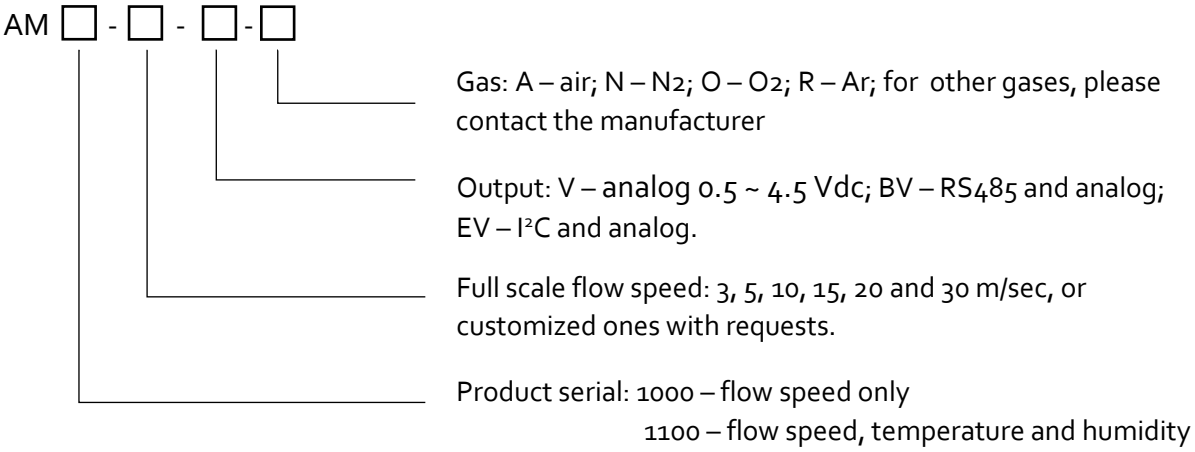
Baud rate	**0X0015**	**Write**	Y
		Read	Y
Description	Communication baud rate		
Value type	UINT 16		
Notes	Value=0: 4800; 1: 9600; 2: 19200; 3: 38400. The default value is 3.		

Temperature	**0X0025**	**Write**	N
		Read	Y
Description	Measured temperature data		
Value type	UINT 16		
Notes	Temperature = value (0x0025) /100 °C		

Humidity	**0X0026**	**Write**	N
		Read	Y
Description	Measured humidity data		
Value type	UINT 16		
Notes	Humidity = value (0x0026) /100 %RH.		

6. Product selection

The product part number is composed of the product model number and suffixes, indicating each of the selectable parameters. Refer to the following for details.



7. Product performance

All specifications listed in the following table, unless otherwise noted, apply for calibration conditions at 20°C and 101.325 kPa absolute pressure with air.

	Value	Unit
Flow speed range	0...3, 5, 10, 15, 20, 30	m/sec
Accuracy (total error band)	±2.5	%FS
Repeatability	0.8	%
Turn-down ratio	100:1	
Flow speed response time	10	msec
Working temperature	-10 ~ +65	°C
Temperature coefficient	±0.12	%/°C
Temperature accuracy	±0.5	°C
Temperature resolution	0.04	°C
Humidity accuracy	±2.0 (20~80%RH), otherwise ±5.0 max	%RH
Humidity resolution	0.04	%RH
Humidity response time	5.0	sec
Power supply	8~24	Vdc
Working current	<50	mA
Output*	Linear, I²C / RS485; Analog: 0.5~4.5Vdc	
Cable	5 color-coded, 1.0m	
Storage temperature	-20 ~ +70	°C
Calibration	Air @ 20°C, 101.325kPa	
Compliance	RoHS	
CE	IEC 61326-1;-2;-3	

***Note:** 1. Analog output only applies to flow speed. Temperature and humidity data are obtained via a digital interface.

7.1 Wetted materials and compatibility

The product flow channel 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 principles

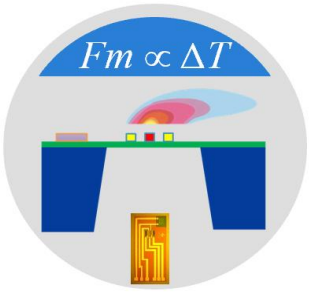


Figure 8.1: Measurement approach illustration.

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

The calorimetric sensing approach offers an extensive dynamic range with better performance against environmental parameter alternations. Please refer to the company's US patents and other publications made available to the public for additional information.

The temperature sensor is made on a silicon substrate and fully compensated.

The humidity sensor is also made on a silicon substrate with the principle of change in dielectric constant in a capacitor that occurs because of the amount of water vapor present.

8.2 Precautions for the best performance of the product

8.2.1 Altitude changes

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

8.2.2 Excessive humidity or condensation

The humidity change will not alter the performance of the sensor. However, if excessive humidity is present, resulting in condensation, the measurement channel could be blocked or changed. This

would result in a very unreliable data output. Please use a filter or other tools to prevent this situation from occurring when using this product.

8.2.3 Metrology verification

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

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

For the mass flow rate comparison, however, in addition to the flow system setup conditions recommended by OIML R137, a stable flow system must be ensured. This is because the current product is designed for a slight pressure loss; therefore, the sensor lacks a strong flow restrictor or conditioners to handle the flow instability that may exist in the system. Thus, to compare the metrology data, the user should ensure the system is stable; otherwise, the output could be noisy, and metrology deviations would be inevitable. If such cases are present, please get in touch with the manufacturer for further solutions.

For temperature and humidity measurement, due to the limited space in the package, the response time for humidity measurement may be slower than specified. For additional information, please get in touch with the manufacturer.

8.2.4. Blockage effect for an insertion meter

As the product probe has a specific size, when the probe is inserted into a flow channel and its size is no longer small enough compared with the flow channel size, the blockage effect has to be taken into account when calculating the mass flow rate that the insertion meter measures. For detailed information, please contact the manufacturer for the technical paper.

9. 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 any other consequential or indirect damages of any kind. To the extent permitted by law, the exclusive remedy of the user or purchaser, and the limit of Siargo's liability for any 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.

10. Service/order contact and other information

Siargo Ltd. is making every effort to ensure the quality of its products. For questions or product support, please get in touch with your direct sales representative. If you need additional assistance, please reach out to customer service at the address listed below. We will respond to your request in a timely fashion and work with you toward your complete satisfaction.

For sales or product orders, please get in touch with the local sales representatives or distributors listed on the company's webpage: www.Siargo.com.

For any returns, please get in touch with your direct sales representative to obtain an RMA. If you require further assistance, please 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 the product's status as clearly as possible, indicating your intention to return it 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

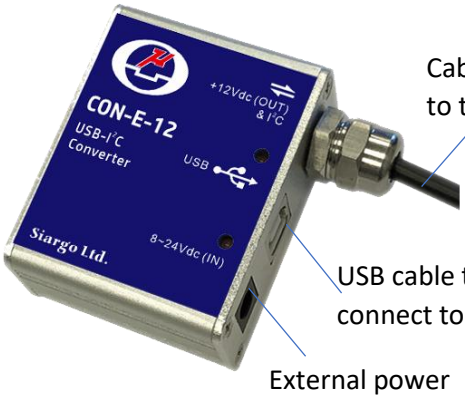
Siargo Ltd.
4677 Old Ironsides Drive, Suite 310,
Santa Clara, California 95054-1857, USA
Tel: +1(408)969-0368
Email: Info@Siargo.com

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

Appendix I: Sensor evaluation kit

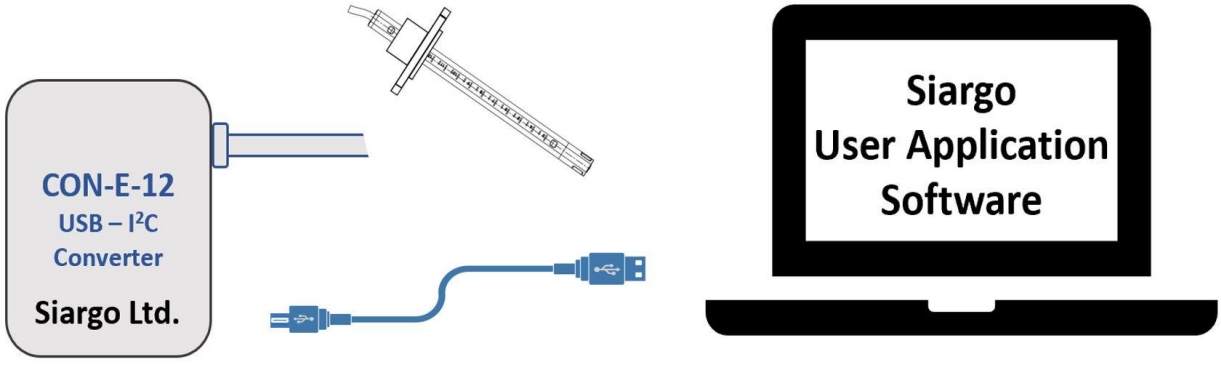
Siargo offers a sensor evaluation kit, including a digital data converter, USB data cable, and User Application software, that allows the user to evaluate the product performance on a Microsoft Windows-based computer. The user can read and visualize the flow rate of the product, obtain the totalized values, and save the data for further analysis. It can read from up to 128 sensors with the I²C interface in serial.

For further information and purchase of the evaluation kit, please get in touch with the manufacturer or the sales representative.



Each converter has a fixed cable that can be directly connected to the product. The USB cable connected to the PC is also included.

For most of the products, the power from the PC via the USB cable will be sufficient to power the sensor product; no external power will be required. However, for multiple sensors in serial, the power via the USB cable may not be enough; an external power adapter with 8~24Vdc will be necessary.



Appendix II: Document history

Revision VB.0.05 (August 2025)

- Corrections.

Revision VB.0.04 (July 2024)

- Correct the repeatability.

Revision VB.0.03 (July 2023)

- Update contact address and corrections.

Revision VB.0.02 (July 2022)

- Update service and sales contact.

Revision VB.0.01 (May 2022)

- Minor revisions.

Revision VB.0 (July 2021)

- The new format, additions.

Revision VA.14 (June 2020)

- RS485 communication protocol update.

Revision VA.13 (May 2020)

- RS485 communication protocol update.

Revision VA.12 (January 2020)

- RS485 communication protocol update.

Revision VA.11 (September 2019)

- Update the output definition and product selection code.

Revision VA.10 (April 2019)

- Update temperature range.

Revision VA.9 (November 2018)

- Calibration condition update.

Revision VA.8 (July 2018)

- I^2C communication update: temperature and humidity.

Revision VA.7 (May 2018)

- I²C communication update: sequences.