



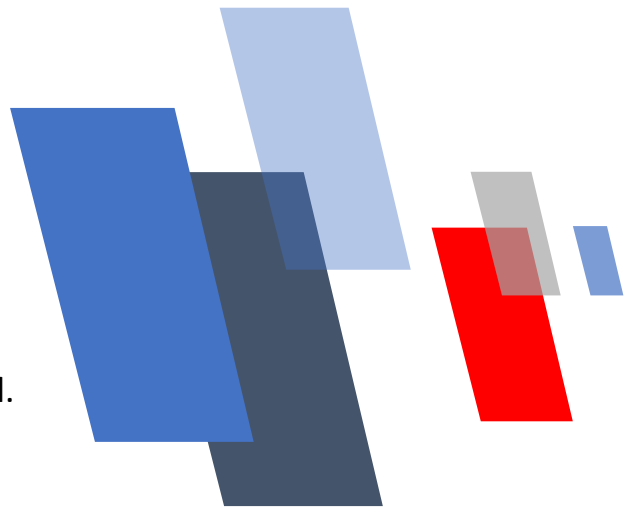
AM1000 User Manual VB.0.1

Insertion MEMS flow, temperature and humidity sensors



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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 prior to operating this product.
- Do not open or modify any hardware which may lead to irrecoverable damage.
- Do not use this product if you suspect any malfunctions or defection.
- Do not use this product for corrosive media or in a strong vibration 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 for electrical safety, and even it operates at a low voltage, any electrical shock might lead to some unexpected damages.
- The gas to be measured should be clean and free of particles, as even 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.

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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 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 the local temperature and humidity.

The RS485 (Modbus), I²C and Bluetooth LE (reserved) options are ready for networking or remote communication. The formality is particularly in favor of residential HVAC smart home applications; as well as the industrial process or environmental monitor such as in a cleanroom.

The product is fully customizable for the flow speed range and with another 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 the dismantlement of the packing materials. Ensure no damages 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, proceed to open the packing box, and you shall find the product (either the sensor formality per the actual order), together with any accessories if ordered together.



AM1000 or AM1100

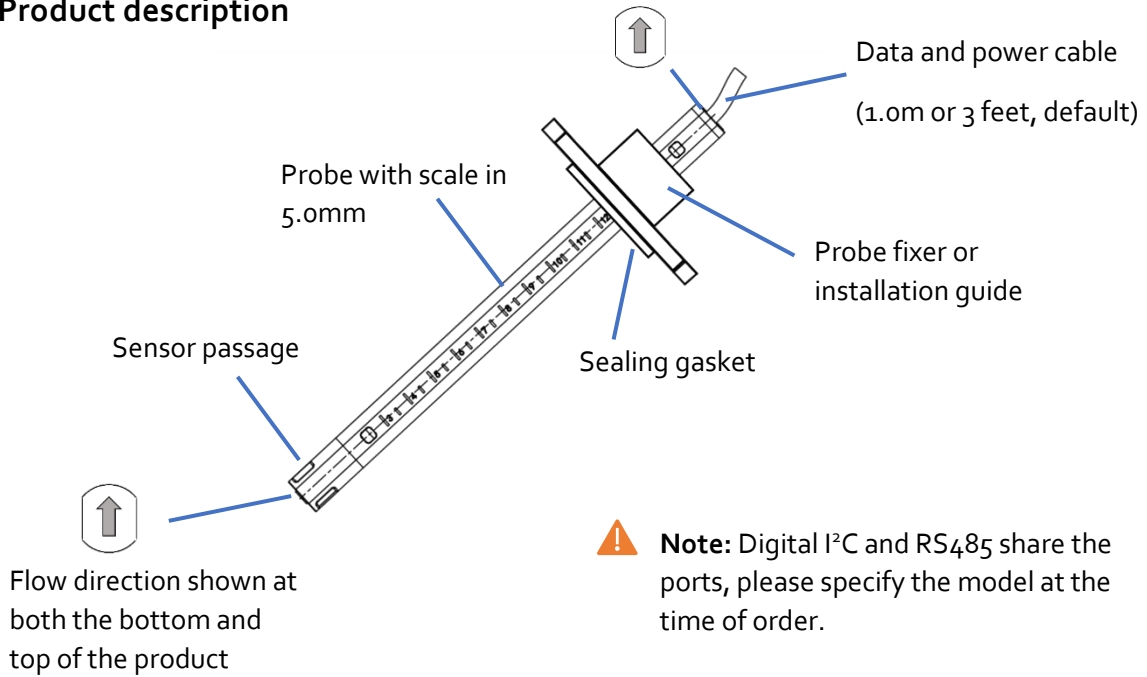
Note: Evaluation kit or any other accessories must be ordered separately.

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 should be sent by your sales agent. 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 description



3.2 Power and data pinout description

Table 3.2: AM1000/1100 wire code assignment.

WIRE COLOR	DEFINITION
Red	VCC, power supply, 8~24Vdc
Black	GND, ground
Yellow	SCL, I ² C clock / RS485 A (+)
Blue	SDA, I ² C data / RS485 B (-)
Green	Analog output, 0.5~4.5 Vdc

Note: The product offers two digital communications as options, I²C or RS85 Modbus Halfplex that can be selected at the time of order. These two communication protocols share the ports as defined in Table 3.2. For the detailed protocols of the corresponding option, please refer to Section 5.

3.3 Mechanical dimensions

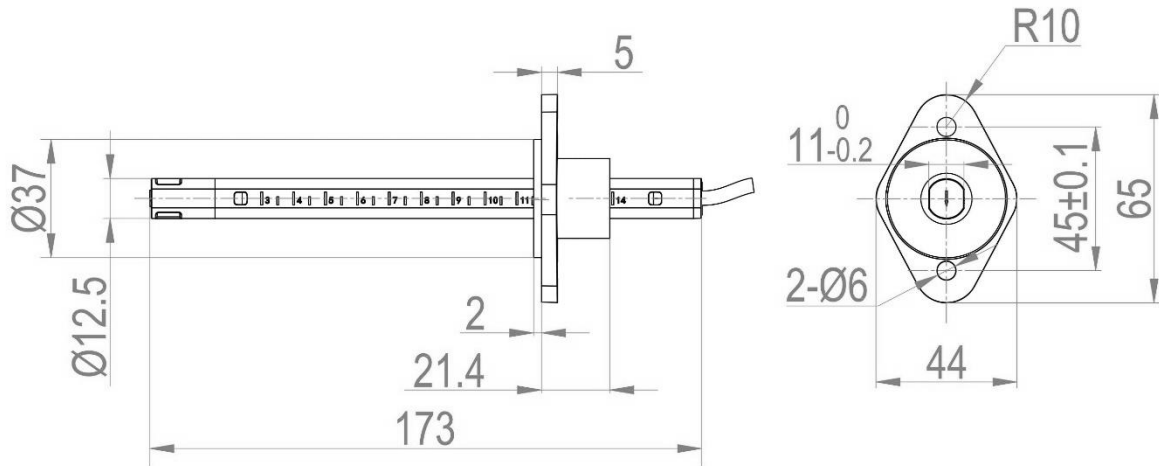


Figure 3.3.1. AM1000/1100 mechanical dimensions.

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 notice that the flow speed measurement is uni-direction, follow the arrow at the bottom of the probe to properly install the probe per the application requirements. For the open space measurement applications, no requirements for the probe positioning but the flow data are only relevant to where the probe is placed and the data 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, $\text{Ø}12.5$ mm. A flat plateau hard materials attached to the pipe should be prepared to fix the probe to the pipe, 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.

Make sure there is no debris or excessive particles left in the pipe during the preparation of the product fixtures on the pipe.

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

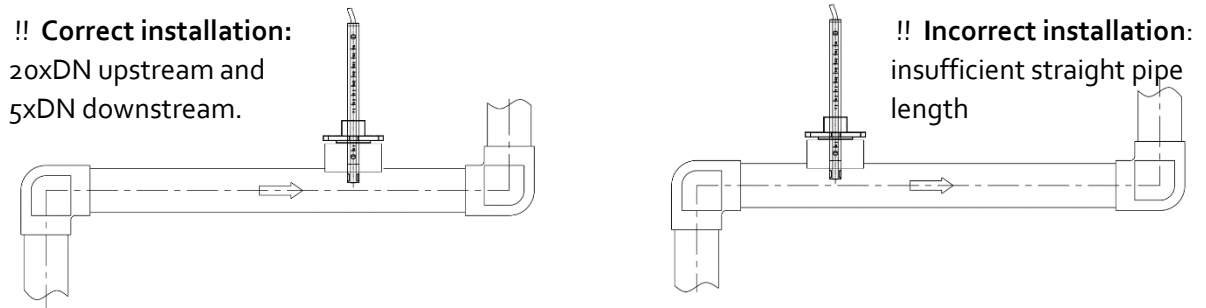
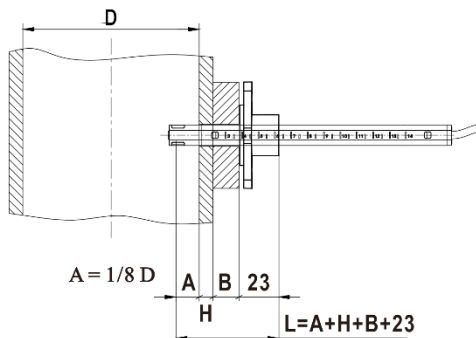


Figure 4-2. Installation with correct upstream and downstream space.



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

where D is the flow channel diameter

H is the flow channel wall thickness

B is the fixture base height.

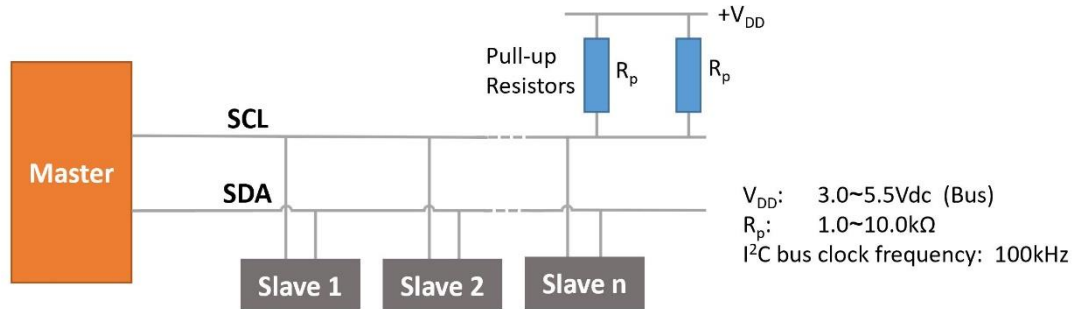
Figure 4-3. Insertion probe length calculation.

- Please note:**
- a. The product is not designed for hazardous zone applications, and not for 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 causing 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. In order to calculate the flow rate, it is necessary to know the depth that the product is 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

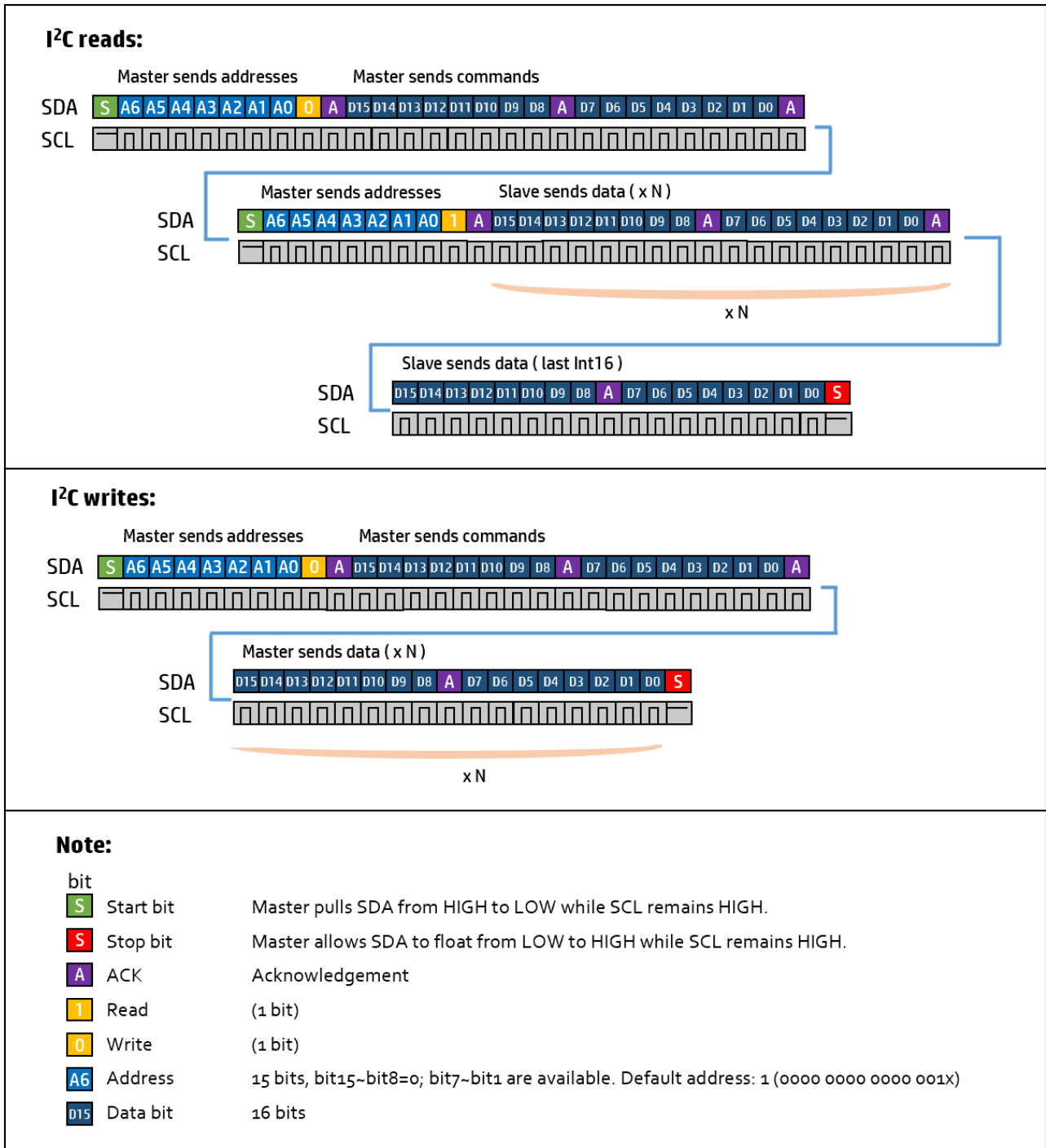


5.1.2 I²C interface command description

Command Byte (Hex)	Length (int 16)	Command Name	Read/Write	Notes
05H	1	I ² C address	Write	Bit 0 is R/W flag bit; Bit 1~ Bit 7 are available.
82H	12	Serial number	Read	ASCII
83H	4	Flow speed	Read	Int ₃₂ /1000 in m/sec
85H	1	I ² C address	Read	Bit 7 ~ Bit 1
BEH	1	Temperature	Read	Int ₁₆ /100 in °C
BFH	2	Humidity	Read	Int ₁₆ /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



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.

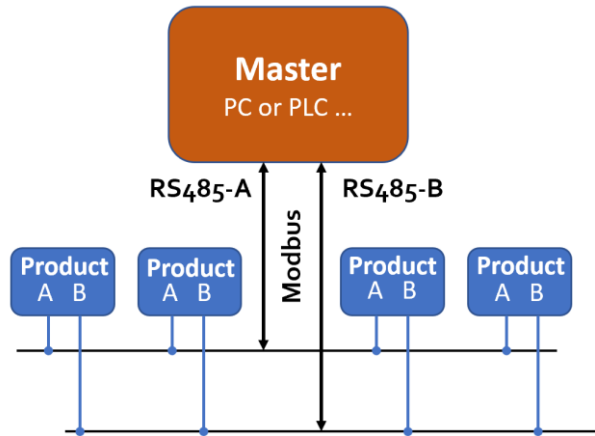


Figure 5.3: RS485 hardware

5.2.1. Communication parameters

The PC UART communication parameters are listed in table 5.2.1.

Table 5.2.1: 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 μ sec
Bytes period	1.1458 msec
Maximum data length	20
Maximum nodes	255

5.2.2. Frame

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

Table 5.2.2: frame function

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

- Start_bits:** 4 periods bit time, for a new frame.
- Address:** The address can be set from 1 to 255 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, 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, then followed by the BYTE_H. The last one is the STOP signal.
- Stop_bits:** 4 periods bit time, for ending the current frame.

5.2.3. Function codes

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

Table 5.2.3: function codes

Code	Name	Functions
0x03	Read register	Read register(s)
0x06	Set 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 the data from the products, such as *product address* and *flow rates* from the registers, or set the product functions by writing the corresponding parameters.

The currently available registers are listed in the following table, and the registers may be customized upon contact 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 address and baud rate. Once the user completes the register value change, the write protection will be automatically enabled once again to prevent incidental data loss.

Table 5.2.4: Registers

Functions	Description	Register	Modbus reference
Address	Product address (R/W)	0x0001	40002 (0x0001)
Flow speed	Current flow speed (R)	0x0002 ~ 0x0003	40003 (0x0003)
Baud rate	Communication baud rate (R/W)	0x0015	40022 (0x0015)
Temperature	Temperature (R)	0x0025	40038 (0x0025)
Humidity	Humidity (R)	0x0026	40038 (0x0039)

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 from 1 to 255; 0 is 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.		

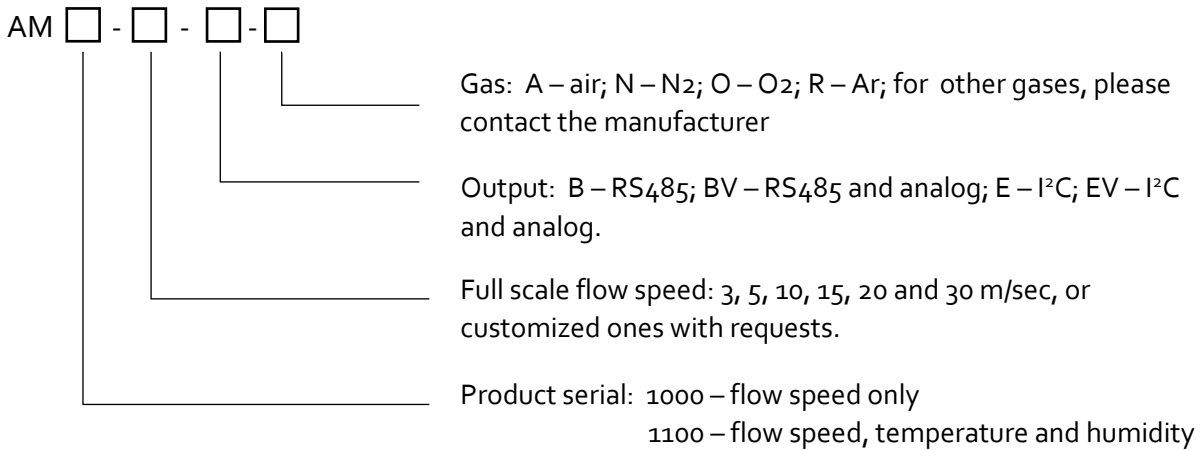
Temperature	0x0025	Write	N
		Read	Y
Description	Measured temperature data		
Value type	UINT 16		
Notes	Temperature = value (0x0025) /100 °C		

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

6. Product selection and order information

6.1. 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.



6.2. Order contact and customer support

The sales offices and the sales distributors/representatives are listed at the end of this document. For small quantities, the order can be placed either through the Siargo website: www.siargo.com or the sales office. For large quantities, please contact the sales office, distributors, or sales representatives.

Siargo is making every effort to ensure the quality of the products. In case of questions and/or product supports, please contact the customer service listed at the end of the document.

7. Product performance

7.1. 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 with air.

	Value	Unit
Flow speed range	0...3, 5, 10, 15, 20, 30	m/sec
Accuracy (total error band)	±2.5	%FS
Repeatability	1.0	%
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, I ² C / 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 via digital interface.

8. Technical notes for the product performance

8.1. Measurement principles

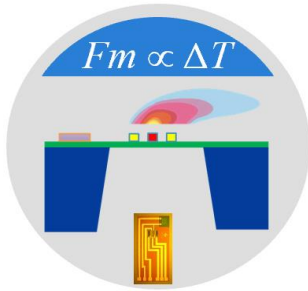


Figure 8.1. Measurement approach illustration.

The products utilize the Company's proprietary micro-machined (MEMS) calorimetric sensing and data process technology. A thermal signal generator with a pair of sensing elements at the up 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, further correlated to the fluid mass flow rate via the calibration process.

The calorimetric sensing approach offers a large dynamic range with a better performance against the 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 market, the design of the sensor has a built-in pressure balancer that preventing membrane deformation due to altitude changes. Therefore, the sensor is intrinsically insensitive to the 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 altered. This would

result in a very unreliable data output. Please filter or other tools to prevent this situation to occur 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 applied while performing such a task.

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

For the mass flowrate 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 small pressure loss, therefore the sensor does not have a strong flow restrictor or conditioners to handle the flow instability that may exist in the system. Therefore 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 contact the manufacturer for further solutions.

For temperature and humidity measurement, because of the small package space, the response of the humidity could be slower than the specified. For additional information, please contact the manufacturer.

8.2.4. Blockage effect for an insertion meter

As the product probe has a certain 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 the detailed information, please contact the manufacture for the technical while paper.

9. Warranty and Liability

(Effective January 2018)

Siargo warrants the products sold hereunder, properly used, and properly installed under normal circumstances and service. 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 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 for full responsibility for validating the performance and suitability of the products for their particular design and applications. For any of the 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 expense or reasonable attorney fee 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. 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 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 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 damages;
- (3) Products that have been opened or dismantled for whatever reasons;
- (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 are re-sold by unauthorized dealers or any third parties.

10. Service contact and information

Siargo Ltd. is making every effort to ensure the quality of the products. In case of questions and or product supports, please contact 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.

Customer service and all orders should be addressed to

Siargo Ltd.
3100 De La Cruz Boulevard, Suite 210,
Santa Clara, California 95054, USA
Phone: +01(408)969-0368
Email: info@Siargo.com

For orders, please provide an accurate and full postal address. Siargo will not ship to P.O. Boxes or via a third party.

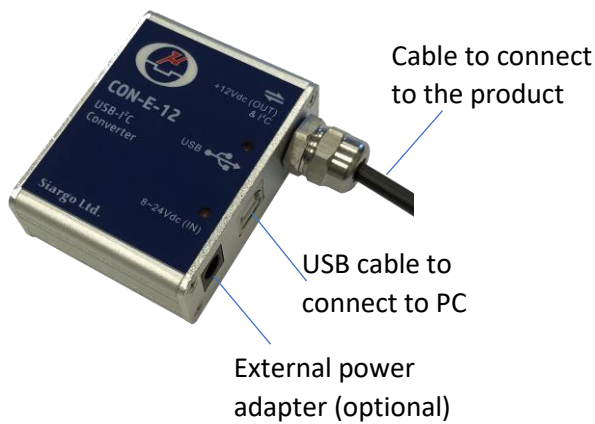
Please contact info@siargo.com to obtain a Return Materials Authorization (RMA) before shipping the product back to the factory for returns or factory services such as calibration. Please specify as clear and detailed as possible in your email message the product's status that you intend to ship back to the factory. Be sure to write the RMA on the returned package or include a letter with the RMA information.

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

Appendix I: Sensor evaluation kit

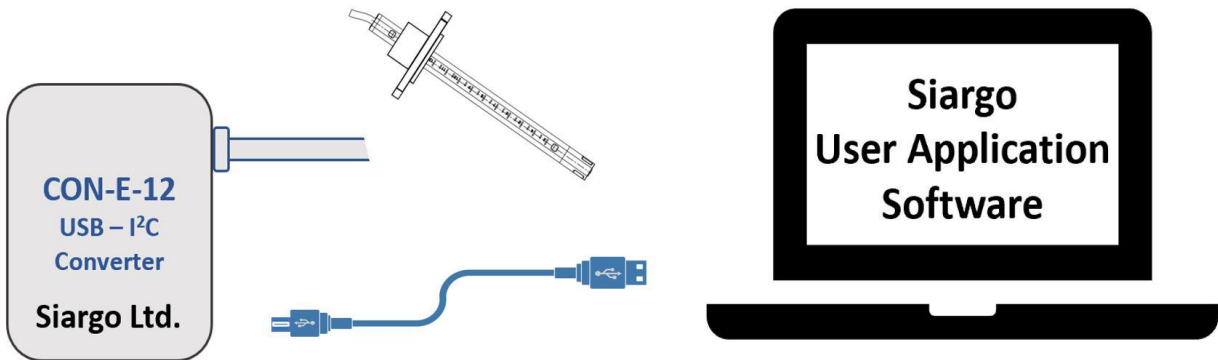
Siargo offers a sensor evaluation kit, including a digital data converter, USB data cable, and User Application software, that allows the user to evaluate the product performance on a Microsoft Windows-based computer. The user can read and visualize the flow rate of the product, obtain the totalized 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 contact 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 required.



Appendix II: Document history

- Revision B.0.1 (July 2021)
 - The new format, additions.
- Revision A.14 (June 2020):
 - RS485 communication protocol update.
- Revision A.13 (May 2020):
 - RS485 communication protocol update.
- Revision A.12 (January 2020):
 - RS485 communication protocol update.
- Revision A.11 (September 2019):
 - Output definition update, product selection code update.
- Revision A.10 (April 2019)
 - Update temperature range.
- Revision A.9 (November 2018):
 - Calibration condition update.
- Revision A.8 (July 2018):
 - I²C communication update: temperature and humidity.
- Revision A.7 (May 2018):
 - I²C communication update: sequences.