

PFLOW9022 User Manual vc.0.02

Integrated flow, pressure & temperature sensors



MEMS Flow, Pressure, and Temperature Sensors

with thermal and piezo sensing technology

PFLOW9022 Series

User Manual

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PFLOW9022 User Manual



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.

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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 PFLOW9022 series of combo sensors for medical ventilator or CPAP (Continuous Positive Airway Pressure) equipment applications. The product performance, maintenance, and troubleshooting, as well as the information for product order, technical support, and repair, are also included.

The PFLOW9022 sensors are manufactured with the company's proprietary MEMS (micro-electro-mechanical systems) sensing and package technology that offers primarily the mass flow and gauge pressure with optional temperature and humidity sensing in a compact design without the need for additional calibrations, which significantly reduces cost for the equipment manufacturers.

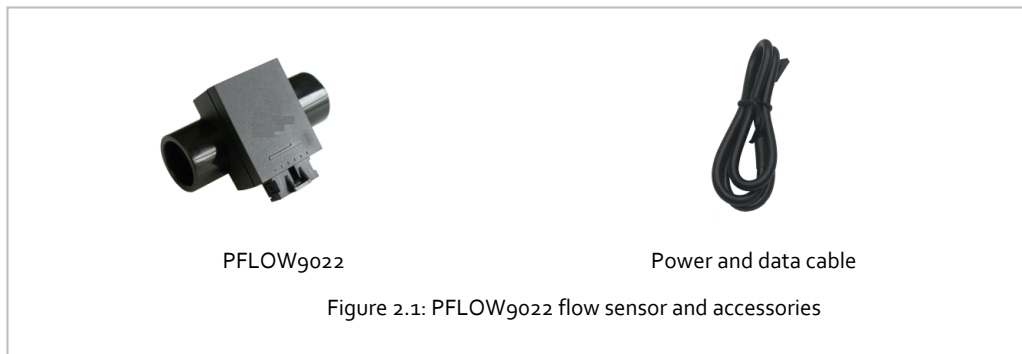
While the current packages are best for medical applications, the manufacturer also offers alternative customized packages with customized adapters. Please get in touch with the manufacturer for additional information.

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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 the power and data cable if included, as shown below.

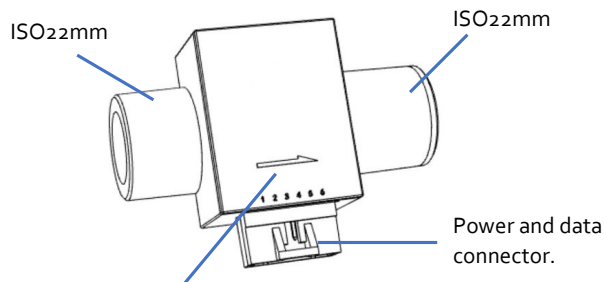


Please check immediately for the integrity of the product and the power and data cable; if any abnormality is identified, please notify the distributor/sales representative or manufacturer as soon as you can. If any defects are confirmed, an exchange shall be arranged immediately via the original sales channel. This user manual 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 a pinout that is designed to be directly placed onto a printed circuit board. Therefore, the power and data cable is an option that will not come with the order automatically.

3. Knowing the products

3.1 Product description



Direction for flow measurement.
For dual directional model, the
arrow does not apply.



Note: Analog outputs only apply for flow
and gauge pressure.

Figure 3.1: PFLOW9022 parts description

3.2 Power and data pinout description

Table 3.1: PFLOW9022 pin assignment.

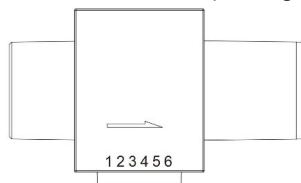


Figure 3.2: PFLOW9022 pinout
2.54mm centers; 0.635mm square

PIN	COLOR	DEFINITION
1	White ⁽¹⁾	Analog, pressure data
2	Green ⁽²⁾	Analog, Flow data
3	Black	GND, ground
4	Red ⁽³⁾	VCC, power supply, 5 ± 5% Vdc
5	Yellow ⁽⁴⁾	SCL, I ² C clock
6	Blue ⁽⁴⁾	SDA, I ² C data

Note: (1) The pressure analog output can be optional. The pin provides 0.5 ~ 4.5 Vdc corresponding to the specified pressure full-scale range. If the pressure option is not selected, this pin output is NULL.

(2) The flow rate analog outputs 0.5 ~ 4.5 Vdc corresponding with the specified flow full-scale range.

(3) Power supply: The PFLOW9022 requires a power supply of 5±5% Vdc. The sensor consumes less than 20 mA normally, and the minimum supply current must be larger than 15 mA.

(4) SDA and SCL are the I²C serial data line and serial clock line.

3.3 Mechanical dimensions

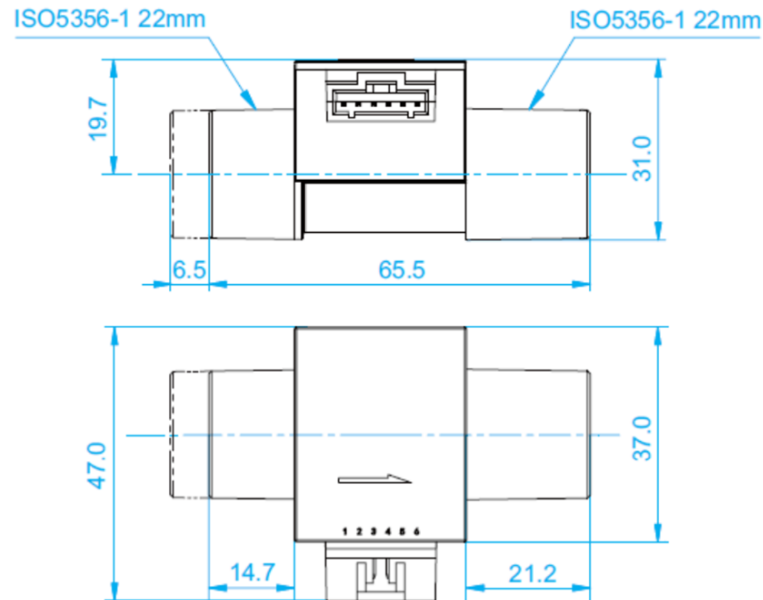


Figure 3.3: PFLOW9022 mechanical dimensions.

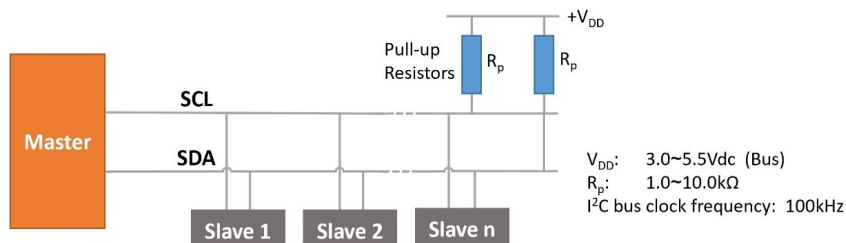
4. Installation

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

For the installation, ensure that the connections are properly leakage-proofed and that all necessary electrical precautions are taken. Please make sure the electrical pins are properly engaged. It should be noted that the sensor is designed for extremely low pressure per the applications; therefore, the system design would be necessary for the flow stability and related flow noises.

5. Basic operation

5.1 I²C interface connection diagram

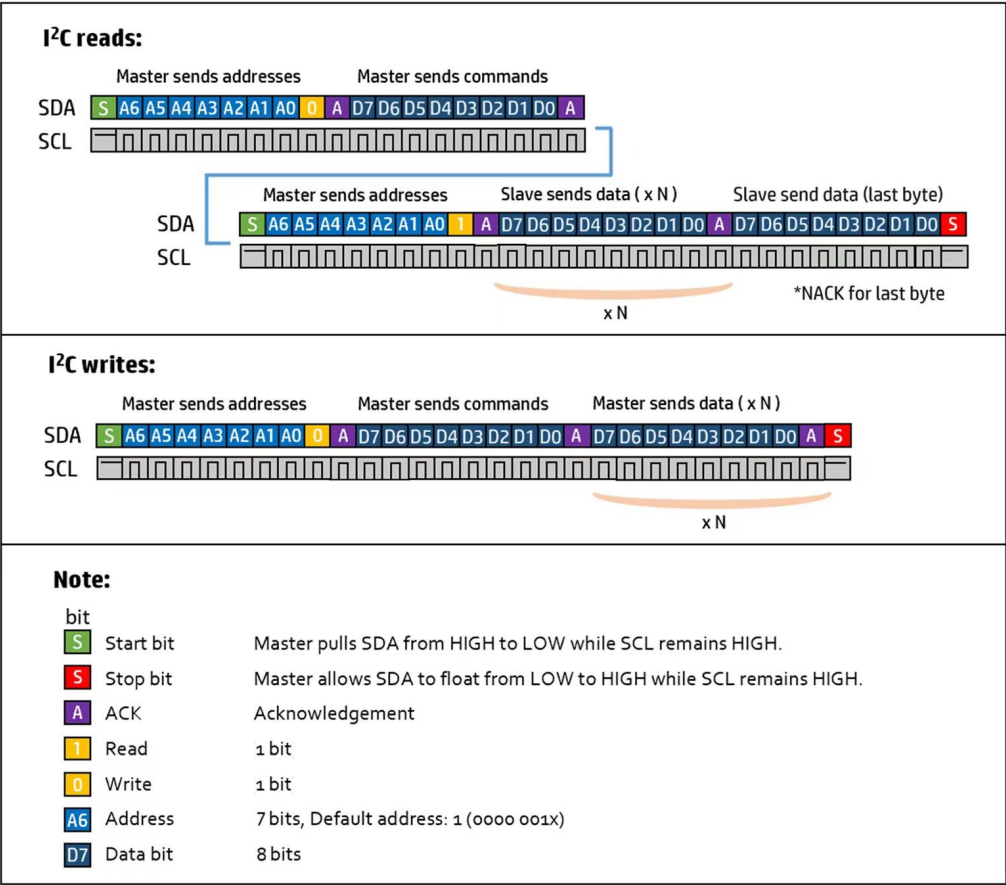


5.2 I²C interface command description

Command Byte (Hex)	Length (int 8)	Command Name	Read/Write	Notes
05H	1	I ² C address	Write	Bit 0 is the R/W flag bit; Bits 1 ~ through 7 are available.
0BH	1	Filter depth	Write	Int 8, 0 ~ 254
1CH	1	Flowrate offset reset	Write	1 byte, ensure no-flow conditions. Fixed value, 0x55.
24H	1	Pressure offset reset	Write	1 byte, ensure no-flow conditions. Fixed value, 0x55.
9DH	4	Write protection	Write	4 bytes, 0x53, 0x49, 0x41, 0x52. One-time effective.
82H	12	Serial number	Read	ASCII
83H	5	Flowrate	Read	Int32(/1000 SLPM)+CRC CRC=(Byte1)XOR(Byte2)XOR(Byte3)XOR(Byte4)
84H	9	Flowrate & Pressure	Read	Int32(/1000 SLPM), INT32(/1000 cmH ₂ O)+CRC CRC=(Byte1)XOR(Byte2)XOR(Byte3)XOR(Byte4)
85H	1	I ² C address	Read	Bit 7 ~ Bit 1
8BH	1	Filter depth	Read	Int 8, 0 ~ 254
A3H	5	Pressure	Read	Int32(/1000 cmH ₂ O)+CRC CRC=(Byte1)XOR(Byte2)XOR(Byte3)XOR(Byte4)
B2H	3	Temperature	Read	Int16(/100 °C) + CRC CRC=(Byte1)XOR(Byte2)
B3H	3	Humidity	Read	Int16(/100 %RH) + CRC CRC=(Byte1)XOR(Byte2)

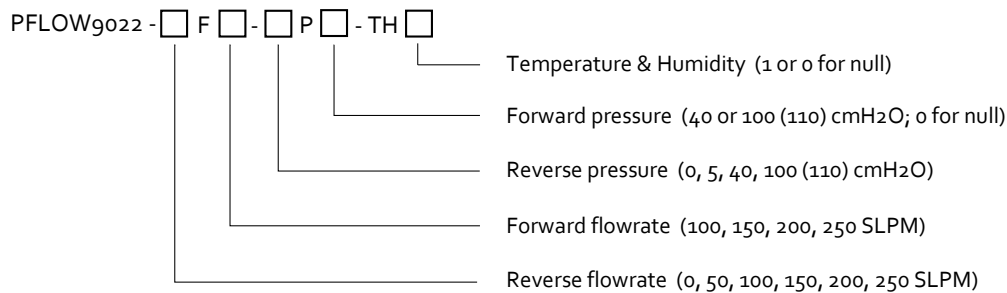
- Note:**
- 1. Before writing to the register, please ensure the write protection is disabled.
 - 2. The I²C address is set to Bit 7 ~ Bit 1. E.g., if the I²C address is 1 (0000 001x), the write address will be 0x02 (0000 0010) and the read address will be 0x03 (0000 0011).
 - 3. Write protection is a one-time practical function.

5.3 I²C interface read/write sequences



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.



Note:

1. Except for the temperature/humidity option, the numbers are designated for full-scale value.
2. Except for flow rate, 0 stands for null or without the corresponding sensing option.
3. Example: PFLOW9022-50-F200-5P40-TH1 is a sensor that measures mass flow rate from reverse 50 to forward 200SLPM; gauge pressure from -5 to 40 cmH₂O, temperature, and relative humidity.
4. The current configuration would not guarantee the response time for humidity; the humidity value could take additional and unspecified time to reach the real value.

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 range	-250 ... +250	SLPM
Accuracy (total error band)	$\pm(2.5+0.5FS)$	%
Output	Linear, analog 0.5 ~ 4.5Vdc / I ² C (14bit)	
Response time	1.8	msec
Gauge pressure	-5, -40, -100, 0 ... 40, 100 (110)	cmH ₂ O
Accuracy (total error band)	± 1.0	%FS
Output	Linear, analog 0.5 ~ 4.5Vdc / I ² C (14bit)	
Response time	1.8	msec
Temperature	-10 ~ +60	°C
Accuracy	± 0.5	°C
Humidity	0 ~ 100 (no condensation)	%RH
Accuracy	± 2.0 (20 ~ 80%RH); ± 5.0 (other ranges)	%
Resolution	0.7	%RH
Response time (63%)	5.0 (25 ~ 75%)	sec
Gas compatibility	Air, O ₂ , N ₂	
Supply voltage	5.0 $\pm$ 5%	Vdc
Power consumption	<60	mA
Warm-up time	<50	msec
Temperature compensation	-5 ~ +65	°C
Altitude compensation	-400 ~ +3000 (700 ~ 1060)	m (hPa)
Storage temperature	-20 ~ +70	°C
Compliance	RoHS; REACH	
CE	IEC 61000-4-2;4;8	

Note:

1. The analog output is correlated to the full-scale, whatever it is specified.
2. Burst pressure for pressure range: ± 40 kPa (-5 ~ 40 cmH₂O) and ± 100 kPa (-5 ~ 100 cmH₂O).
3. The data and power cable connector is supplied with the product. It is compatible with AMPMODU MAT 6 positions. (e.g., TE 5-103956-5 <https://www.te.com/usa-en/product-5-103956-5.html>)

7.2 Typical (analog) output

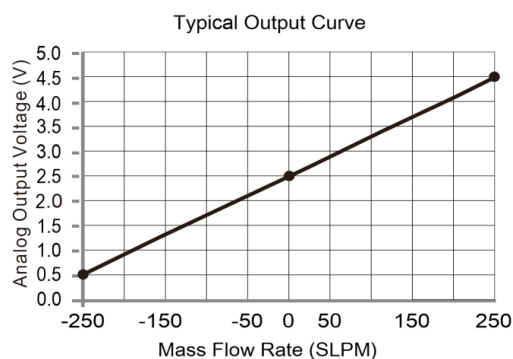


Figure 7.1: Typical analog output

Flow rate, -250 ~ +250 SLPM

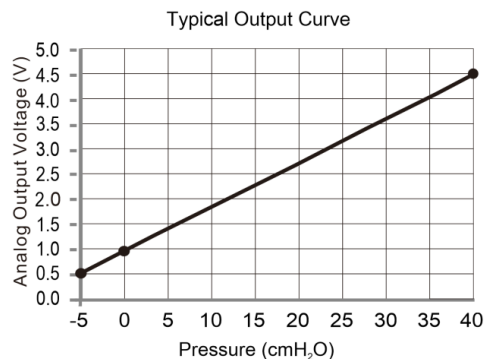
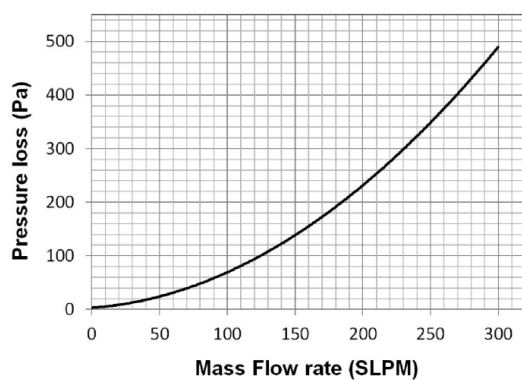


Figure 7.2: Typical analog output (pressure)

Pressure -5 ~ +40 cmH₂O

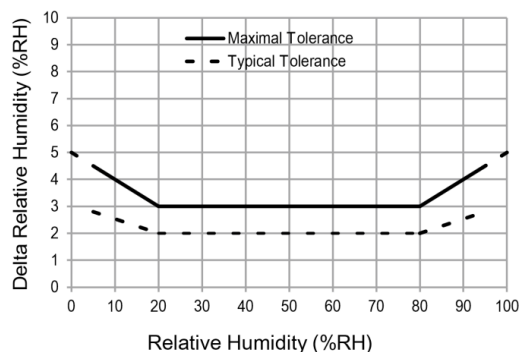
7.3 Pressure loss



The pressure loss shown in the graph is one-directional. The reverse direction will have an identical loss value.

Figure 7.3: Typical pressure loss

7.4 Relative humidity tolerance



The temperature and humidity data can only be accessed via the I²C interface due to the limited analog ports.

Figure 7.4: Relative humidity tolerance

7.5 Wetted materials

The product body is made of medical-grade plastics (polycarbonate, Makrolon₂₄₅₈). 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

The products utilize the Company's proprietary micro-machined (MEMS) sensing technology. The mass flow sensing is via calorimetry with temperature compensation. The gauge pressure is realized via piezoresistive sensing, while the temperature sensor is a micromachined platinum thermistor, and the humidity sensor is again micromachined with the capacitive sensing principle. The MEMS sensors allow the integration in a small footprint while offering multiparameter sensing.

8.2 Precautions for the best performance of the product

8.2.1 Contamination and sterilization

It is critical to have the measurements performed in a contamination-free environment for data accuracy. Excessive contaminants, such as vapors, will lead to data deviation or even product malfunctions in severe cases.

For medical applications, it may be desired to have the product sterilized from time to time. The Standard EtO sterilization process is recommended. For the detailed procedure, please consult your local experts or contact the manufacturer.

8.2.2 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. The specified altitude in Sec 7.1 has been thoroughly tested.

8.2.3 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 port or channel could be blocked or changed.

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

8.2.4 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 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.

9. Warranty and Liability

(Effective January 2018)

APSP 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.

APSP 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 APSP 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.

APSP 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 APSP'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 APSP, and upon verification of APSP 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 APSP more than 365 days after a cause of action has accrued. The products returned under warranty to APSP shall be at the user or purchaser's risk of loss and will be returned, if at all, at APSP'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 APSP. It shall not be amended, modified, or its terms waived except by APSP'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, APSP 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) APSP 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.

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Appendix II: Document history

Revision VC.o.02 (November 2025)

- Corrections.

Revision VC.o.01 (August 2025)

- Corrections.

Revision VC.o (January 2024)

- MEMS chip change to Dg.
- No spec changed.

Revision VB.1.01 (November 2023)

- Update contact address.

Revision VB.1 (September 2022)

- Correct the mechanical dimensions.

Revision VB.o.02 (August 2022)

- Minor correction.

Revision VB.o.01 (July 2022)

- Service and order information update.

Revision VB.o (June 2021)

- Reformatted and updated.

Revision VA.14 (October 2020)

- Revised ISO45001.

Revision VA.13 (July 2020)

- I²C communication protocol update.

Revision VA.12 (June 2020)

- I²C communication protocol update.

Revision VA.11 (October 2019)

- Output pin assignment update.

Revision VA.10 (October 2018)

- Add gauge pressure range.

Revision VA.9 (April 2018)

- I²C communication protocol update.

Revision VA.8 (July 2017)

- Response time update;
- build materials update;
- Application notes update;
- Added document history tracking.

We are here for you. Addresses and Contacts.

Headquarter Switzerland:

Angst+Pfister Sensors and Power AG
Thurgauerstrasse 66
CH-8050 Zurich
Phone +41 44 877 35 00
sensorsandpower@angst-pfister.com

Office Germany:

Angst+Pfister Sensors and Power Deutschland GmbH
Edisonstraße 16
D-85716 Unterschleißheim
Phone +49 89 374 288 87 00
sensorsandpower.de@angst-pfister.com

Office North America:

Angst+Pfister North America Inc.
10391 Brecksville Rd.
US-Brecksville, OH 44141
Phone +1 440 375-5212
info.apus@angst-pfister.com

Scan here and get an overview of personal contacts!



<https://sensorsandpower.angst-pfister.com/en/>

Experts on Design-In
for sensors and power solutions

We are here for you. Addresses and Contacts.

Headquarter Switzerland:

Angst+Pfister Sensors and Power AG
Thurgauerstrasse 66
CH-8050 Zurich
Phone +41 44 877 35 00
sensorsandpower@angst-pfister.com

Office Germany:

Angst+Pfister Sensors and Power Deutschland GmbH
Edisonstraße 16
D-85716 Unterschleißheim
Phone +49 89 374 288 87 00
sensorsandpower.de@angst-pfister.com

Office North America:

Angst+Pfister North America Inc.
10391 Brecksville Rd.
US-Brecksville, OH 44141
Phone +1 440 375-5212
info.apus@angst-pfister.com

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