

SDP1108/SDP2108

Low Differential Pressure Sensor
with fast response time

- For medical ventilators (ICU and home care)
- High sensitivity below 10 Pa to measure small volume flow (neonatal)
- Fast response time for efficient trigger function
- Unsurpassed performance thanks to CMOSens® technology
- Offset and hysteresis free
- Fully calibrated and temperature compensated
- Not sensitive to the mounting orientation and vibrations



SDPx108 Product Summary

The SDPx108 sensor family is a differential pressure sensor for air based on the successful SDP1000/SDP2000 sensor from Sensirion AG. The response time of the SDPx108 has been optimized for medical ventilation applications.

Mounted in a rugged, chemically inert PPS housing the SDPx108 differential pressure sensors feature a unique dynamic range, zero offset and unsurpassed **long term stability**. This makes it an ideal fit for demanding yet cost sensitive OEM applications in medical and HVAC equipment.

The SDPx108 is fully RoHS compliant.

The SDPx108 is supplied with **5.0 V** and provides a **0.25...4.0 V output**. Although the output of the sensor is analog, the internal linearization and **temperature**

compensation is performed digitally. This results in a superior accuracy, outstanding resolution (up to 0.05 Pa), and lowest temperature dependence.

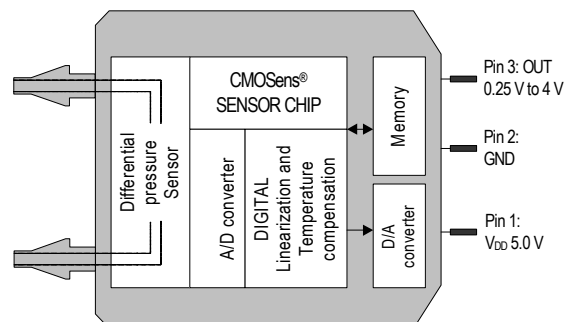
Its leading performance is based on Sensirion's proprietary CMOSens® sensor technology which combines the sensor element with amplification and A/D conversion on one single silicon chip. The differential pressure is measured by a thermal sensing element. In contrast to other thermal differential pressure sensors only a very small amount of air is required. This leads to a reliable operation even under harsh conditions. In comparison to membrane and piezo-resistive based sensors the SDPx108 differential pressure sensors show an extended measurement range, better **offset stability** and improved reproducibility even at lowest pressure ranges. In addition the SDPx108 is robust against pressure bursts and shows no sensitivity to the mounting orientation.

Applications

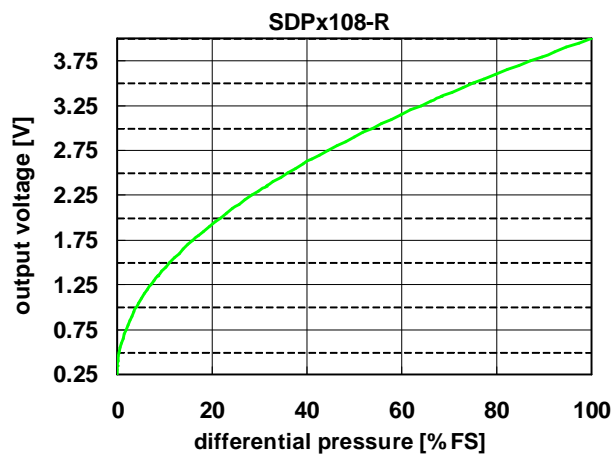
Medical applications:

- Homecare ventilation
- Intensive care ventilation (ICU)
- Other

Block Diagram



1 Sensor Output Characteristics¹



The SDPx108-R provides a fully calibrated voltage output. To enhance resolution and accuracy at very low differential pressures, the SDPx108 standard version (SDPx108-R) comes with a root-square output characteristics.

For high-quantity OEM applications, other ranges and output characteristics can be realized. E.g. linear output and a bidirectional measurement range is possible. Please contact Sensirion for further information.

$$\text{Diff. Press. [Pa]} = \left(\frac{\text{Output Voltage} - 0.25\text{V}}{3.75\text{V}} \right)^2 \cdot \text{FS [Pa]}$$

Use this formula to convert the sensor output into physical value.

¹Calibration conditions apply unless otherwise noted: 23°C and $p_{\text{absolute}} = 966 \text{ mbar}$, dry air, $V_{\text{DD}} = 5.000 \text{ V}$. FS is 500Pa for the SDP1108 and 3500 Pa for the SDP2108.

2 Specifications

Table 1: SDPx108-R Sensor specifications¹

| Parameter | | SDP1108-R | | | SDP2108-R | | | Unit |
|-----------------------------------------------------------|-------------------|-----------|------------|------------|-----------|-----------|-----------|------------------------------------|
| | | Min | Typ | Max | Min | Typ | Max | |
| Measurement range | | 0.25 | - | 4 | 0.25 | | 4 | Volts |
| | | 0 | - | 500 | 0 | | 3500 | Pa |
| | | 0 | - | 2 | 0 | | 14 | Inch water |
| Accuracy ³ | 20% FS to 100% FS | - | 1.0 | 2.0 | - | 1 | 2 | % Measured Value ⁴ |
| | 0 to 20% FS | - | 0.2 | 0.4 | - | 0.2 | 0.4 | % Full Span ⁵ |
| | zero ² | - | 15 0.01 | 40 0.06 | - | 20 0.1 | 50 0.6 | mV Pa |
| Repeatability | 100 to 500 Pa | - | 0.3 | 1.0 | - | 0.3 | 1.0 | % Measured Value |
| | 0 to 100 Pa | - | 0.05 | 0.2 | - | 0.06 | 0.2 | % Full Span ⁵ |
| Null drift per year ⁶ | | - | 0 | 0.1 | - | 0 | 0.3 | Pa / year |
| Additional error over temperature ⁷ (T ≠ 23°C) | 0 to 100 % FS | - | 0.03 | 0.05 | - | 0.03 | 0.05 | % Measured Value ⁴ / °C |
| | zero | - | 1 | 2 | - | 1 | 3 | mV/°C |
| Response time ⁽⁸⁾ | | 6.6 | 8.0 | 10.1 | 6.6 | 8.0 | 10.1 | ms |
| Cut off frequency of internal filter | | 17 | 20 | 24 | 17 | 20 | 24 | Hz |

¹ Calibration conditions apply unless otherwise noted: 23°C and $p_{\text{absolute}} = 966 \text{ mbar}$, dry air, $V_{\text{DD}} = 5.000 \text{ V}$

² Variance between the zero point (offset) of different sensors measured under the same conditions (e.g. same supply voltage, temperature, ...)

³ Include deviations due to linearity, hysteresis, and repeatability

⁴ % Measured value = (SDPx108 output [Pa] - output of reference instrument [Pa]) / output of reference instrument [Pa].

⁵ Full span is defined as 3750 mV / 500 Pa for SDP1108 and 3750 mV / 3500 Pa for the SDP2108.

⁶ Drift over time due to aging, pressure cycles... Test results can be provided.

⁷ The additional error due to temperature variation is temporary. Once the sensor is back to the calibration temperature, the shift disappears (no hysteresis).

⁸ Tau= 0 to 63%, filter response time = 8ms. For faster response time, contact Sensirion.

Table 2: Additional sensor specifications.

| Parameter | | | |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------|
| Media Calibration ¹ | Air, N ₂ – for other gases contact Sensirion AG. | | |
| Media Compatibility | Air, N ₂ , O ₂ | | |
| Operating Conditions ² : - Temperature - Humidity | -10 °C ... +60 °C / 14°F ... 140 °F non-condensing | | |
| Ambient storage conditions ³ | -40 °C ... +80 °C / -40°F ... 176 °F | | |
| Orientation sensitivity | below zero point accuracy | | |
| Admissible overpressure (short term) | 1 bar (14.5 PSI) | | |
| Burst Pressure Capability | 2 bar (29 PSI) | | |
| Weight | 14 g | | |
| Protection Class | IP 20 | | |
| Wetted materials | Glass (silicon nitride, silicon oxide), Silicon, PPS (Polyphenylene Sulfide), PEEK (Polyetheretherketone), FR4, Silicone as static sealing, Epoxy, Gold | | |
| Electromagnetic compatibility | EN 61000-4-2 | Air discharge (ESD) | ± 2 kV |
| Lead free | ROHS compliant. | | |

¹ Sensors are calibrated for a specific gas, please contact Sensirion when you employ different gases than the specified.

² Condensation of liquids or dust on the sensor membrane might lead to sensor offset. Please consult our application notes on www.sensirion.com.

³ For maximum 2 weeks

2.1 Temperature Compensation

The SDPx108 differential pressure sensors feature a sophisticated built-in temperature compensation circuit. The temperature is measured on the CMOSens[®] chip by means of a PTAT bandgap reference temperature sensor. Its data is fed into a compensation circuit which is also integrated on the CMOSens[®] sensor chip. No external temperature compensation is therefore required.

2.2 Altitude Correction

The SDPx108 differential pressure transducers achieve their unsurpassed performance by using a dynamic measurement principle: An applied differential pressure forces a small air flow through the SDPx108, which measures this air flow.

The sensor signal is dependant on the ambient air density. The temperature effect on density is compensated by internal intelligence (see Paragraph 2.3). Effects on density due to a change of ambient pressure, typically a change of altitude above sea level, can be compensated using a correction factor according to the following equation:

$$Dp_{\text{eff}} = Dp_{\text{sensor}} \cdot P_{\text{cal}} / P_{\text{amb}}$$

Where Dp_{eff} is the effective differential pressure, Dp_{sensor} the differential pressure indicated by the SDPx108, P_{cal} the absolute pressure during calibration (966 mbar) and P_{amb} the actual ambient absolute pressure.

This leads to the following correction factors:

Table 3: Altitude correction factors.

| Altitude [meter] | Ambient Pressure (P_{amb}) [mbar] | Correction Factor $P_{\text{cal}} / P_{\text{amb}}$ |
|------------------|----------------------------------------------|-----------------------------------------------------|
| 0 | 1013 | 0.95 |
| 250 | 984 | 0.98 |
| 425 | 966 | 1.00 |
| 500 | 958 | 1.01 |
| 750 | 925 | 1.04 |
| 1500 | 842 | 1.15 |
| 2250 | 766 | 1.26 |
| 3000 | 697 | 1.38 |

Example:

The SDP1108 is used at 750 m above sea level. The output of the SDP1108 shows 0.5 V, which corresponds to $Dp_{\text{sensor}} = 33.3 \text{ Pa}$. Taking into account the correction factor $P_{\text{cal}} / P_{\text{amb}} = 1.04$ the effective differential pressure Dp_{eff} is $33.3 \text{ Pa} \cdot 1.04 = 34.6 \text{ Pa}$.

Note:

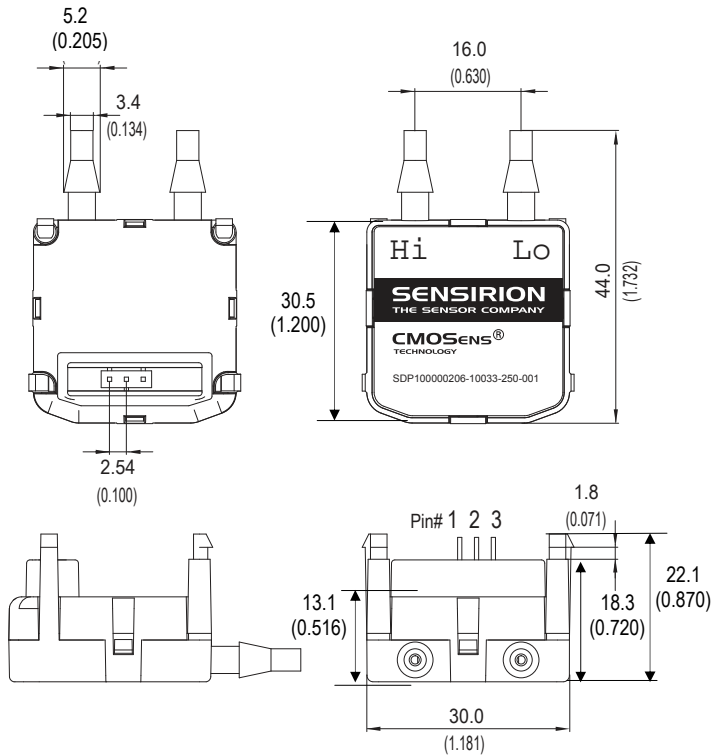
In many medical and HVAC applications such as filter monitoring, fan/ventilator control or air flow measurement the described effect is actually welcome since at the end the mass flow and not volume flow is the effective value to control.

3 Physical Dimensions and Mounting Information

3.1 Housing

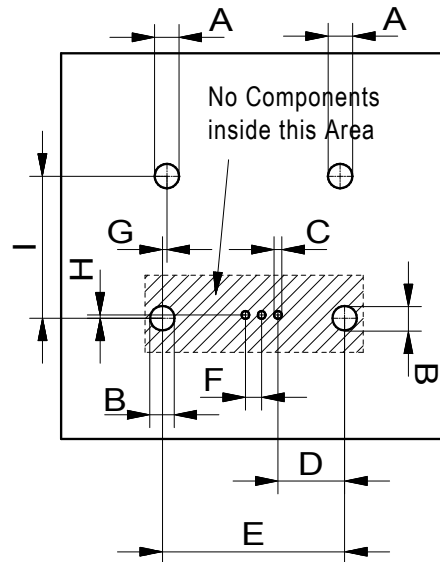
The SDPx108 differential pressure transducers are mounted in chemically inert PPS housing. The rugged package has been designed to withstand continuous overpressures of at least 1 bar (14.5 PSI). Burst pressure is > 2 bar (29 PSI)

The physical dimensions and mounting information is given in Figure 1 and 2.



| Pin# | Function |
|------|--------------------|
| 1 | VDD (5 Vdc) |
| 2 | Ground |
| 3 | OUT (0.25...4 Vdc) |

Figure 1: Pin out and physical dimensions in mm (inch). The drawing is not to scale.



| Dim. | [mm] | [inch] | [mil] |
|------|-------|--------|-------|
| A | 3.00 | 0.118 | 118 |
| B | 3.30 | 0.130 | 130 |
| C | 1.20 | 0.047 | 47 |
| D | 10.20 | 0.402 | 402 |
| E | 28.20 | 1.110 | 1110 |
| F | 2.54 | 0.100 | 100 |
| G | 0.60 | 0.024 | 24 |
| H | 0.50 | 0.020 | 20 |
| I | 22.70 | 0.894 | 894 |

Figure 2: SDPx108 PCB footprint. The drawing is not to scale.

3.2 Soldering Instructions

The SDPx108 differential pressure sensors can be wave soldered. Direct reflow soldering is not recommended since it may affect the accuracy.

If reflow soldering is required Sensirion recommends to use an SMD connector (e.g. type Samtec SSM-103-L-SV) and to mount the SDPx108 after soldering.

3.3 Connecting Hose

Sensirion recommends a hose with an inner diameter of 3.18 to 3.8mm (1/8 to 3/20 inch). Due to the dynamic measurement principle, a small air flow is required (Figure 3) which leads to a dependence on the length

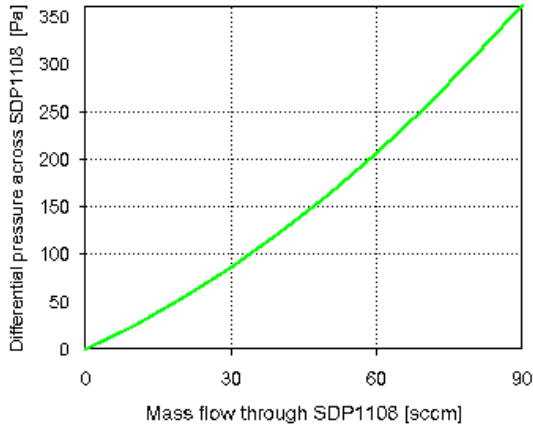


Figure 3: Typical air flow through the SDP1108. Please note: 1 scc/min = 1 cm³/min at 0°C and 1013 mbar pressure (1 sccm = 0.001 norm liter).

of the hose (Table 4). Tubes up to 1 m show less than 2 % error of the measured value (Table 4).

Table 4: Influence of the length of the connecting hose on the accuracy (using 4 mm inner diameter). Deviation is given in % of the measured value. Example SDP1108: a 500 Pa difference pressure is shown as 492.5 Pa when using 1 m tube with 4 mm inner diameter.

| Hose length | SDP1108 | | SDP2108 | |
|-----------------|---------|---------|---------|--------|
| | @FS | @0.5 FS | @FS | @0.5FS |
| 0.5 m (20 inch) | -0.75% | -0.95% | -0.06% | -0.07% |
| 1.0 m (40 inch) | -1.5% | -1.9% | -0.12% | -0.14% |
| 2.0 m (80 inch) | -3.0% | -3.8% | -0.24% | -0.28% |

Table 5: Maximum flow through the sensor element.

| Mass flow through sensor element: | SDP1108-R | SDP2108-R |
|-----------------------------------|---------------------|--------------------|
| | 123 sccm (@ 500 Pa) | 66 sccm (@3500 Pa) |

4 Electrical Specifications

4.1 Power Supply

The SDPx108 differential pressure sensors require a stable voltage supply of 5.0 V. The requirements for the electrical supply are specified in Table 5.

The resistive load at the output pin should be larger than 20 kOhm. The capacitive load at the output pin must not be larger than 200 pF. If the design shows a larger capacity at the output pin an additional resistor is required in series at the output (e.g. 620 Ohm).

4.2 Voltage Output

The SDP1108 features a voltage output from 0.25 V to 4.0 V. An output voltage below 0.25 V indicates a negative differential pressure (not calibrated).

Table 6: SDPx108 electrical characteristics.

| Parameter | Conditions | Min. | Typ. | Max. | Units |
|------------------------------------------|-------------------------|------|------|------|-------|
| Power Supply Voltage V _{DD} | | 4.75 | 5.0 | 5.25 | VDC |
| Operating Current | 5 V, no load, zero flow | | 5.1 | 6 | mA |
| Output capacitive load C _{load} | | | 20 | 200 | pF |
| Recommended load R _{load} | | 20 | 100 | ∞ | kΩ |

5 Ordering Information

When ordering please refer to the following part names and article numbers. For the latest product information and local distributor check out Sensirion's website on <http://www.sensirion.com>

| Part Name | Article Number |
|-----------|----------------|
| SDP1108-R | 1-100339-03 |
| SDP2108-R | 1-100729-03 |

Revision history

| Date | Revision | Author | Changes |
|---------------|----------|--------|-----------------------------------------------------------------------------------------------------------------------|
| October 2008 | V1.0 | PHA | Initial release |
| June 2010 | V1.1 | DAT | SDP2108 launched, New Item Number (see product change notification PCN 081015), block diagram (page 1), minor changes |
| February 2013 | V2 | ANB | Updated product number. Minor layout updates. |

Important Notices

Warning, personal injury

Do not use this product as safety or emergency stop devices or in any other application where failure of the product could result in personal injury (including death). Do not use this product for applications other than its intended and authorized use. Before installing, handling, using or servicing this product, please consult the data sheet and application notes. Failure to comply with these instructions could result in death or serious injury.

If the Buyer shall purchase or use SENSIRION products for any unintended or unauthorized application, Buyer shall defend, indemnify and hold harmless SENSIRION and its officers, employees, subsidiaries, affiliates and distributors against all claims, costs, damages and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if SENSIRION shall be allegedly negligent with respect to the design or the manufacture of the product.

ESD Precautions

The inherent design of this component causes it to be sensitive to electrostatic discharge (ESD). To prevent ESD-induced damage and/or degradation, take customary and statutory ESD precautions when handling this product.

See application note "ESD, Latchup and EMC" for more information.

Warranty

SENSIRION warrants solely to the original purchaser of this product for a period of 12 months (one year) from the date of delivery that this product shall be of the quality, material and workmanship defined in SENSIRION's published specifications of the product. Within such period, if proven to be defective, SENSIRION shall repair and/or replace this product, in SENSIRION's discretion, free of charge to the Buyer, provided that:

- notice in writing describing the defects shall be given to SENSIRION within fourteen (14) days after their appearance;
- such defects shall be found, to SENSIRION's reasonable satisfaction, to have arisen from SENSIRION's faulty design, material, or workmanship;
- the defective product shall be returned to SENSIRION's factory at the Buyer's expense; and
- the warranty period for any repaired or replaced product shall be limited to the unexpired portion of the original period.

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RoHS and WEEE Statement

The SDPx108 Series complies with requirements of the following directives:

- EU Directive 2002/96/EC on waste electrical and electronic equipment (WEEE), OJ13.02.2003; esp. its Article 6 (1) with Annex II.
- EU Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS), OJ 13.02.2003; esp. its Article 4.



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