SDP1000 / SDP2000

Low Range Differential Pressure Transducer for Air and Non-Aggressive Gases

- For cost sensitive HVAC and medical OEM applications
- Unsurpassed performance thanks to CMOSens® technology
- Offset and hysteresis free
- Excellent accuracy and reproducibility even below 10 Pa
- Fully calibrated and temperature compensated
- Linear or square root extracted output characteristics available
- Not sensitive to the mounting orientation
- Direct PCB mounting with simple snap-on system

actual size

Data Sheet – June 2005 v2.7

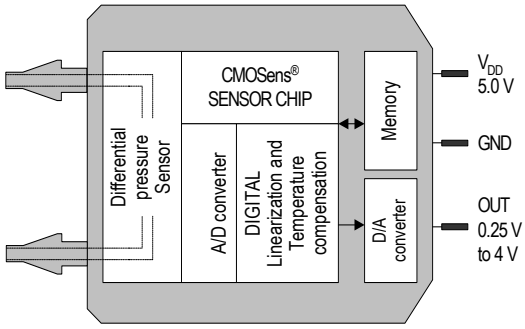
SDP1000 / SDP2000 Product Summary

The SDP1000 / SDP2000 differential pressure transducers for air cover the following measurement ranges: –5 to 125 Pa (0.5 inch H_2O), -20 to 500 Pa (2 inch H_2O), and -100 to 3500 Pa (14 inch H_2O).
Mounted in a rugged, chemically inert PPS housing the SDP1000 / SDP2000 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 HVAC and medical equipment.
The devices are supplied with 5.0 V and provide a 0.25…4.0 V output. Although the output of the SDP1000 / SDP2000 differential pressure transducer 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. The SDP1000 and the SDP2000 are available with a linear or square root extracted output characteristics at the same price. Since fully exchangeable just a few external electronic components around the SDP1000 / SDP2000 make a high quality differential sensor transmitter with e.g. an 0...10 V output or other interfaces (see Figure 8).
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 sensor element. In contrast to other thermal differential pressure sensors only a very small amount of air is required (see Figure 6). This leads to a reliable operation even under harsh conditions. In comparison to membrane based sensors the SDP1000 / SDP2000 differential pressure sensors show an extended measurement range, better offset stability and improved reproducibility even at lowest pressure ranges (see Figure 1 and 2). In addition the SDP1000 / SDP2000 is robust against pressure bursts and shows no sensitivity to the mounting orientation.

Applications

- Variable air volume systems (VAV)
- Filter pressure drop
- Fan/ventilator control
- Duct air flow measurements
- Room/cabin pressure control
- Burner control
- CPAP equipment
- Sleep apnea monitors

Block Diagram



1 Specifications

Table 1: Sensor specifications (at 22°C and $p_{absolute}$ = 966 mbar, V_{DD} = 5.0 V unless otherwise noted).

Parameter	SDP1000-L05			SDP1000-L			SDP1000-R			SDP2000-L			SDP2000-R			Unit
	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Measurement range	-5		125	- 20		500	- 20		500	-100		3500	-100		3500	Pa
	-0.02		0.5	-0.08		2	-0.08		2	-0.4		14	-0.4		14	Inch water
Full scale output (100 kΩ load)	3.94	4.00	4.06	3.94	4.00	4.06	3.94	4.00	4.06	3.94	4.00	4.06	3.94	4.00	4.06	V
Zero Pressure Output	0.247	0.250	0.253	0.247	0.250	0.253	0.238	0.250	0.262	0.247	0.250	0.253	0.238	0.250	0.262	V
Corresponding Offset	- 0.1	0	+ 0.1	- 0.4	0	+ 0.4				- 2.8	0	+ 2.8				Pa (3)
Power supply (see Tab 4)	4.75	5.00	5.25	4.75	5.00	5.25	4.75	5.00	5.25	4.75	5.00	5.25	4.75	5	5.25	V
Accuracy [0°C < T < 50°C] (also see Figure 1)		0.2	0.3		0.1	0.2		0.2	0.3		0.1	0.2		0.2	0.3	% FS (1)(2)
		1.5	2		1	1.5		1	1.5		1	1.5		1	1.5	% m.v. (1)
Repeatability		0.3	0.5		0.3	0.5		0.3	0.5		0.3	0.5		0.3	0.5	% m.v. (1)
Offset stability		0	±0.1		0	±0.1		0	±0.3		0	±0.3		0	±0.5	Pa / year
Temp. variation of zero pressure output [0°C < T < 50°C]	-3		+3	-3		+3	-30		+30	-3		+3	-30		+30	mV
	- 0.1		+ 0.1	- 0.4		+ 0.4				- 2.8		+ 2.8				Pa
Temperature error of span [T < 0°C or T > 50°C]		±0.8	±1.0		±0.2	±0.25		±0.30	±0.40		±0.2	± 0.25		±0.30	±0.40	% FS (1)(2)
		±1.50	±3.00		±1.50	±3.00		±1.50	±3.00		±1.50	± 3.00		±1.50	±3.00	% m.v. (1)
Resolution < 30% FS(1)	0.05	0.1	0.2	0.05	0.1	0.2	0.05	0.1	0.2	0.2	0.5	1	0.2	0.5	1	Pa
Resolution 30..70% FS(1)				0.2	0.5	1.5	0.2	0.5	1.5	1	2.5	8	1	2.5	8	Pa
Resolution > 70% FS(1)				1.5	2.2	3	1.5	2.2	3	8	11	14	8	11	14	Pa

(1) FS = full scale or span, m.v. = measured value, i.e. reading, whichever value is bigger
(2) FS = full scale or span, i.e. for the SDP1000 it is 500 Pa (2 "H2O), for the SDP2000 it is 3500 Pa (14 "H2O)
(3) See 2.2 Voltage Output formula for conversion

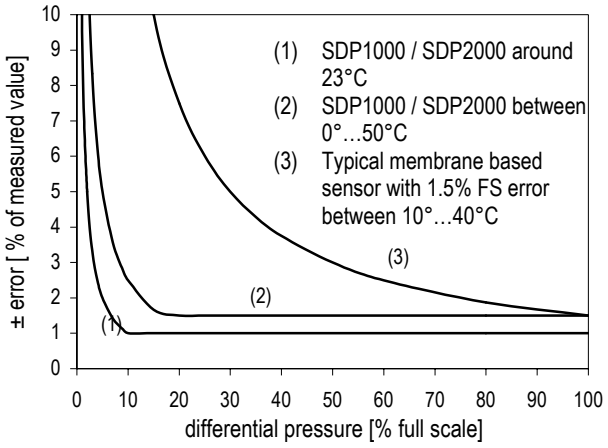


Figure 1: Accuracy (includes errors caused by offset, linearity, hysteresis and repeatability) of the SDP1000 -L (1), (2) compared with typical membrane sensors (3).

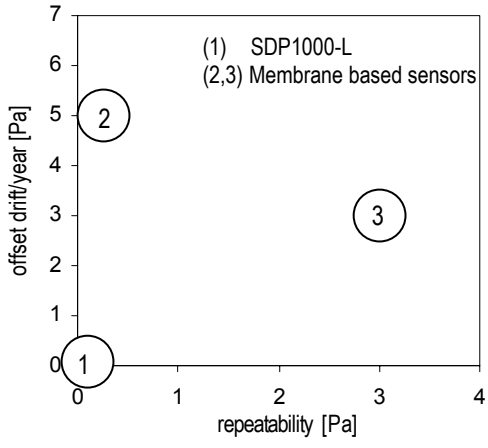


Figure 2: Max. repeatability and offset drift/year of the SDP1000-L (1) compared with two typical membrane based sensors (2,3).

Table 2: Additional sensor specifications.

Media	Air, N_2 – for other gases contact Sensirion AG.		
Operating Conditions: - Temperature - Humidity	-10 °C … +60 °C / 14°F … 140 °F non-condensing		
Ambient storage conditions[1]	-40 °C … +80 °C / -40°F … 176 °F		
Position sensitivity	below resolution		
Response time	40 ms (for faster response time contact Sensirion)		
Admissible overpressure (short term)	1 bar (14.5 PSI)		
Burst Pressure Capability	2 bar (29 PSI)		
Weight	14 g		
Protection Class	IP 00		
Wetted materials	Glass (silicon nitride, silicon oxide), Silicon, PPS (Polyphenylene Sulfide), PEEK (Polyetheretherketone), FR4, Silicone as static sealing, Epoxy		
Gas flow through sensor	see Figure 6.		
Electromagnetic compatibility	EN 61000-4-2	Air discharge (ESD)	± 2 kV
	EN 61000-4-3	High frequency electromagnetic radiation (HF)	3 V/m
	EN 61000-4-4	Fast transients (burst)	± 4 kV
Lead free	For lead free version, please contact Sensirion		

(1) For maximum 2 weeks

1.1 Temperature Compensation

The SDP1000 / SDP2000 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.

1.2 Altitude Correction

The SDP1000 / SDP2000 differential pressure transducers achieve their unsurpassed performance by using a dynamic measurement principle, i.e. an applied differential pressure forces a small air flow through the sensor. This results in a dependence of the indicated differential pressure on the ambient air density. While the temperature effect is compensated (see Paragraph 1.1) the altitude above sea level has an influence on the SDP1000 / SDP2000 output. If desired, this effect can be compensated by a correction factor according to the following equation:

$$Dp_{eff} = Dp_{sensor} * P_{cal} / P_{amb}$$

where Dp_{eff} is the effective differential pressure, Dp_{sensor} the differential pressure indicated by the SDP1000 / SDP2000, 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_{cal} / P_{amb}
0	1000	0.97
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 SDP1000 is used at 750 m above sea level. The output of the SDP1000 shows 0.5 V, which corresponds to Dp_{sensor} = 33.3 Pa. Taking into account the correction factor P_{cal} / P_{amb} = 1.04 the effective differential pressure Dp_{eff} is 33.3 Pa * 1.04 = 34.6 Pa.

Note:

In many 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.

2 Electrical Specifications

2.1 Power Supply

The SDP1000 / SDP2000 differential pressure sensors require a stable voltage supply of 5 V. Influence of the supply voltage variation on the offset and the sensitivity are given in Table 5.

2.2 Voltage Output

The SDP1000 / SDP2000 features a voltage output from 0.25 V to 4.0 V (Figure 2, 3). An output voltage below 0.25 V indicates a negative differential pressure. This range is not calibrated however.
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).

Linear output

Formula: P = lfactor * (voltage[(1)] – 0.250)/3.750

lfactor =	SDP1000-L05	SDP1000-L	SDP2000-L
Pascal	125	500	3500
Inch water	0.5	2	14

[(1)] voltage: measured output voltage in Volt.

Square Root output

Formula: P = rfactor * (voltage[(1)] -0.250)^2

rfactor =	SDP1000-L05	SDP1000-R	SDP2000-R
Pascal	na	35.55556	248.88889
Inch water	na	0.14222	0.99556

[(1)] voltage: measured output voltage in Volt.

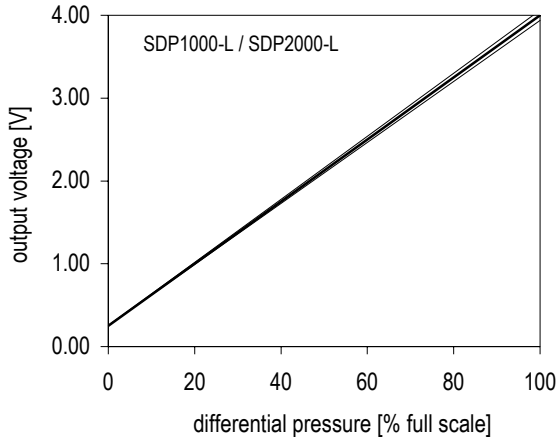


Figure 2: Linear output at 5 Vdc supply of the SDP1000-L and the SDP2000-L. The fine lines indicate the maximum tolerances including a temperature variation from 0 to 50°C.

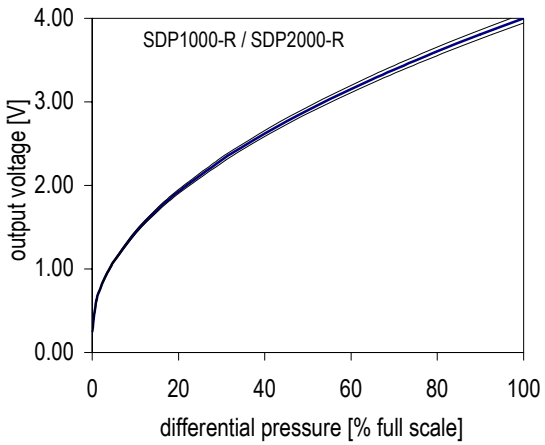


Figure 3: Square root extracted output of the SDP1000-R and the SDP2000-R at 5 Vdc supply. The fine lines indicate the maximum tolerances including a temperature variation from 0 to 50°C.

Table 4: SDP1000 / SDP200 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		3	5	mA
Output capacitive load C_{load}			20	200	pF
Recommended load R_{load}		20	100	∞	kΩ

Table 5: Power supply dependence of the offset and the sensitivity.

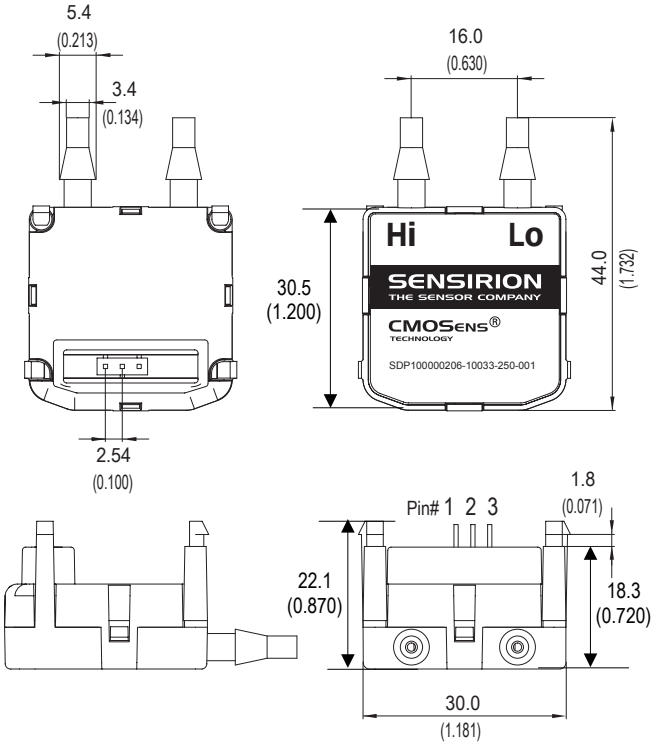
Parameter	Device	4.75 V	5.0 V	5.25 V	Units
Offset	SDP1000-L	- 1.2		+ 1.2	Pa
	SDP2000-L	- 8		+ 8	
Sensitivity	SDP1000-L	7.2	7.5	7.8	mV/Pa
	SDP2000-L	1.02	1.07	1.12	

3 Physical Dimensions and Mounting Information

3.1 Housing

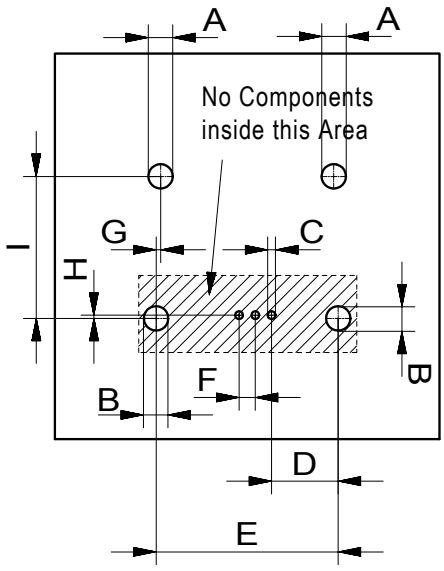
The SDP1000 / SDP2000 differential pressure transducer is mounted in chemically inert PPS housing. The rugged package has been designed to withstand continuous overpressures of at least 1 bar (14.5 PSI). Burst pressure is > 2 bar (29 PSI)

The physical dimensions and mounting information is given in Figure 4 and 5.



Pin#	Function
1	VDD (5 Vdc)
2	Ground
3	OUT (0.25…4 Vdc)

Figure 4: 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 5: SDP1000 / SDP2000 PCB footprint. The drawing is not to scale.

3.2 Soldering Instructions

The SDP1000 / SDP2000 differential pressure sensor 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 SDP1000 / SDP2000 after soldering.

3.3 Connecting Hose

Sensirion recommends a hose with an inner diameter of 3/16 inch. Due to the dynamic measurement principle, a small air flow is required (Figure 6) which leads to a dependence on the length of the hose (Figure 7). Tubes up to 1 m show less than 1 % error of the measured value (Figure 7).

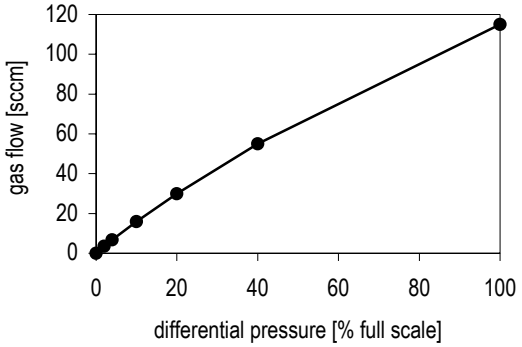
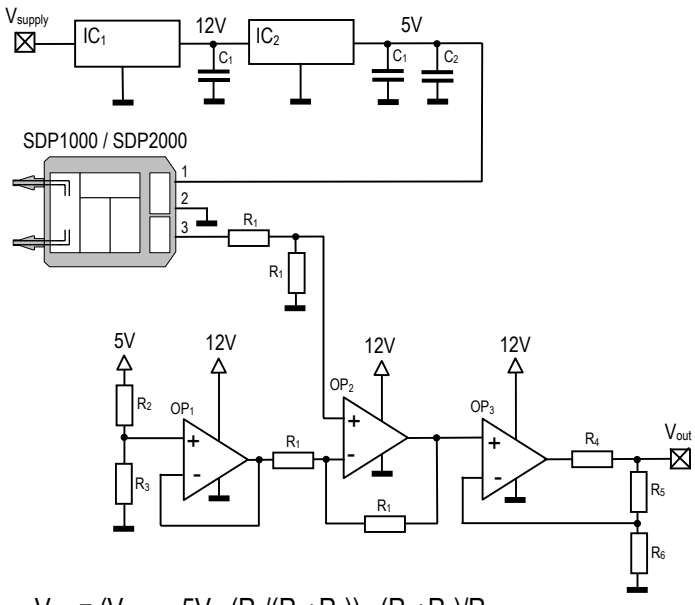


Figure 6: Typical air flow through the SDP1000 / SDP2000. Please note: 1 sccm = 1 cm³/min at 0°C and 1013 mbar pressure (1 sccm = 0.001 norm liter).

Length of the connecting hose	Deviation of Measured Value
0.5 m (20 inch)	- 0.4 %
1.0 m (40 inch)	- 0.8 %
2.0 m (80 inch)	- 1.6 %
4.0 m (160 inch)	- 3.2 %

Figure 7: Influence of the length of the connecting hose on the accuracy (using 3/16 inch inner diameter). Example: a 50 Pa difference pressure is shown as 49.8 Pa when using 0.5 m tube with 3/16 inch diameter.

4 Application Example: A High End Differential Pressure Transducer



$V_{out} = (V_{SDP} – 5V * (R_3/(R_2+R_3)) * (R_5+R_6)/R_5$

Example:

Output V_{out}: 0…10 Vdc
Range: 0…500 Pa, linear characteristics
Power supply V_{supply}: 14.5… 27 Vdc

Component	Value
IC_1	LM78L12
IC_2	LP2980
SDP	SDP1000
OP_1, OP_2, OP_3	LMC6044
C_1	200 nF
C_2	2.2 uF
R_1	10 kΩ (5%, 10 ppm)
R_2	18 kΩ (5%, 10 ppm)
R_3	1 kΩ (5%, 10 ppm)
R_4	100 Ω
R_5	6 kΩ (3x18 kΩ 5%, 10 ppm in parallel)
R_6	10 kΩ (5%, 10 ppm)

Figure 8: Schematic of a high-end differential pressure transmitter using the SDP1000 / SDP2000. With only a few external components and no additional calibration the transmitter features an accurate and temperature compensated 0…10 Vdc output signal.

5 Ordering Information

When ordering SDP1000 / SDP2000 differential pressure sensors 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	Output	Range (Full Scale)				Article Number
SDP1000-L05	Voltage 0.25 - 4.0 V, linear	125 Pa	1.25 mbar	0.5 "H_20	0.018 PSI	1-100235-01
SDP1000-L	Voltage 0.25 - 4.0 V, linear	500 Pa	5 mbar	2 "H_20	0.07 PSI	1-100110-01
SDP2000-L	Voltage 0.25 - 4.0 V, linear	3500 Pa	35 mbar	14 "H_20	0.50 PSI	1-100113-01
SDP1000-R	Voltage 0.25 - 4.0 V, square root	500 Pa	5 mbar	2 "H_20	0.07 PSI	1-100111-01
SDP2000-R	Voltage 0.25 - 4.0 V, square root	3500 Pa	35 mbar	14 "H_20	0.50 PSI	1-100112-01
SDPx000-OEM	Digital output on request	Other ranges on request				-

6 Important Notices

6.1 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. **Failure to comply with these instructions could result in death or serious injury.**
Should buyer purchase or use SENSIRION AG products for any such unintended or unauthorized application, buyer shall indemnify and hold SENSIRION AG and its officers, employees, subsidiaries, affiliates and distributors harmless 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 such claim alleges that SENSIRION AG was negligent regarding the design or manufacture of the part.

6.2 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 normal ESD precautions when handling this product.

6.3 Warranty

SENSIRION AG makes no warranty, representation or guarantee regarding the suitability of its product for any particular purpose, nor does SENSIRION AG assume any liability arising out of the application or use of any product or circuit and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters can and do vary in different applications. All operating parameters, including "Typical" must be validated for each customer applications by customer's technical experts.
SENSIRION AG reserves the right, without further notice, to change the product specifications and/or information in this document and to improve reliability, functions and design.

Headquarters and Sales Office

SENSIRION AG
Laubisrütistrasse 50
P.O. Box 235
CH-8712 Stäfa ZH
Switzerland

Phone: + 41 (0)44 306 40 00
Fax: + 41 (0)44 306 40 30
e-mail: info@sensirion.com
web: http://www.sensirion.com