Simply a question of better measurement

SCHMIDT® Flow Sensor

SS 20.420

Instructions for Use

SCHMIDT® Flow Sensor
SS 20.420

Table of Contents

Impressum:

Revision: 538888.02E

Subject to modifications

1 Important Information

These instructions for use contain all required information for a fast commissioning and a safe operation of **SCHMIDT® Flow sensor SS20.420.**

- These instructions for use must be read completely and observed carefully, before putting the unit into operation.
- Any claims under the manufacturer's liability for damage resulting from non-observance or non-compliance with these instructions will become void.
- Tampering with the device in any way whatsoever - with the exception of the designated use and the operations described in these instructions for use - will forfeit any warranty and exclude any liability.
- The unit is designed exclusively for the use described below (see chapter *2*). In particular, it is not designed for direct or indirect protection of personal and machinery.
- **SCHMIDT Technology** cannot give any warranty as to its suitability for certain purpose and cannot be held liable for errors contained in these instructions for use or for accidental or sequential damage in connection with the delivery, performance or use of this unit.

Symbols used in this manual

The symbols used in this manual are explained in the following section.

Danger warnings and safety instructions - read carefully!

The non-observance of these instructions may lead to personal injury or malfunction of the device.

General information

All dimensions are indicated in millimeter.

2 Application Range

The **SCHMIDT® Flow sensor SS 20.420** (article number: 538045) is designed for stationary use in cleanrooms, air ducts or air shafts under atmospheric pressure conditions and clean environmental conditions. The sensor measures the flow velocity of the measuring medium as standard velocity[1] (unit: m/s) relative to standard pressure of 1,013.25 hPa and standard temperature of 20 °C. The output signal is linear and independent of pressure and temperature of the medium.
Optionally, the sensor can measure in both directions (see chapter *5*).

The decisive characteristics of the product are listed below:

- Measuring task
  - Measurement of flow velocity
  - Detection of flow direction (bidirectional version)
- Application examples
  - Laminar-flow monitoring in cleanrooms
  - Monitoring of room-to-room overflow
  - Cooling air monitoring
  - Flow measurement in test benches

Only suitable for the use in clean gases.
In particular, the medium to be measured must not contain oils, residue forming substances or abrasive particles.

When transporting the sensor or when carrying out not approved cleaning procedures, always place the protective cap on the head of the probe.

The **SCHMIDT® Flow sensor SS 20.420** is designed for the use inside closed rooms and is not suitable for outdoor use.

[1] Corresponds to the actual flow velocity under standard conditions.

3 Mounting Instructions

The following accessories are available for installation:

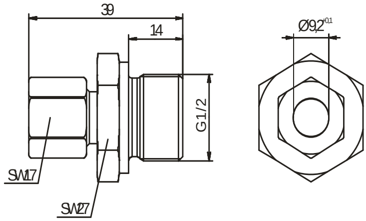
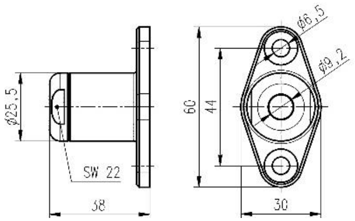
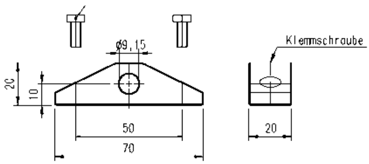
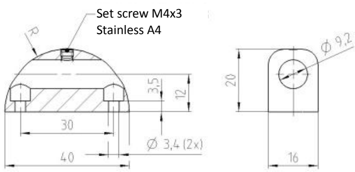
Type / art. no.	Drawing	Assembly
Compression fitting 532160		- Immersion sensor - Pipe (typ.) - Wall - Screwing into a clamp[2] - Material: Stainless steel 1.4571 Clamp collar PTFE
Wall mounting flange 520181		- Immersion sensor - Wall (plain surface) - To be fixed with: 2 screws M5[3] - Material: Stainless steel 1.4404 PTFE O-ring Viton
Wall mounting bracket (an. aluminum) 503895		- Room-to-room overflow - Wall (plain surface) - Attachment with: 2 screws M5 x 12 - Material: Aluminum, anodised
Wall mounting bracket (stainless steel) 551740		- Room-to-room overflow - Wall (plain surface) - Attachment with: 2 screws M5 x 12 - Material: Stainless steel 1.4404

Table 1

All mounting fixtures fasten the sensor by means of frictional clamping on the sensor tube. This enables stepless positioning of the sensor in the holder both axially in direction of the longitudinal sensor axis (immersion depth) as well as in rotational direction around the same axis (tilting).

- The angle of tilt[4] to flow direction should not exceed ±3° in order to avoid significant measuring errors (> 1 %).

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[2] Commercially available welding stud (not included in the delivery) must be welded.
[3] Countersunk head (not included in the delivery).
[4] Deviation between measuring direction of sensor head and flow direction.

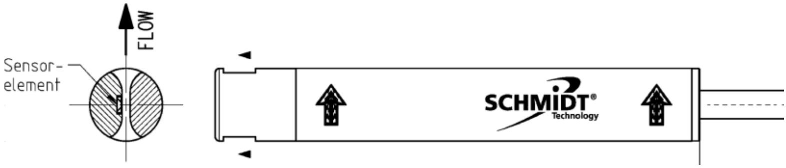


Figure 3-1

- In inhomogeneous, laminar flow fields (for example a quasi-parabolic speed profile in a tube), the sensor tip should be positioned at the place at which the highest speed occurs (adjustment of the immersion depth; see Figure 3-2) since this point has normally the largest distance to interfering elements such as boundary surfaces.
- If correctly mounted, both compression fitting as well as wall mounting flange are tight up to a gauge pressure of 500 mbar[5].

For measurements in media with overpressure, appropriate safety measures must be taken to prevent unintended dis-carding of the sensor.

Tube-related flow

Installation in a flow guiding tube is carried out by means of a compression fitting (532160, see Figure 3-2):

- Screw the threaded part of the compression fitting into the welded pipe union (hexagon AF 27) tightly. Unscrew the spigot nut (AF17) to such an extent that the sensor probe can be inserted without jamming.
- Introduce sensor into compression fitting until the sensor tip is located in the middle of the tube. Then tighten spigot nut slightly using a fork wrench AF17 to fix the sensor.

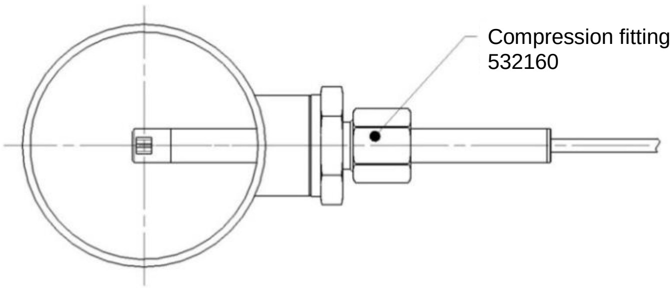


Figure 3-2

[5] The screw-in thread of the compression fitting must be sealed, e.g. with teflon tape.

- Align sensor to nominal flow direction (direction of arrow) considering that immersion depth must be maintained.

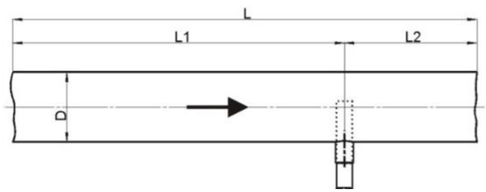
The angular deviation should not be greater than ±3° referenced to the ideal position. Otherwise measurement accuracy may be affected (deviation > 1 %).

- Tighten spigot nut by turning the fork wrench (AF17) by a quarter while maintaining the sensor in position.

To reach the accuracy specified in its data sheet, the **SS 20.420** has to be positioned in a straight pipe and at a place with undisturbed flow profile. An undisturbed flow profile can be achieved if a sufficiently long distance in front of the sensor (run-in distance) and behind the sensor (run-out distance) is held absolutely straight and without disturbances (such as edges, seams, bends, etc.).

Correct measurements require laminar[6] flow with as low turbulence as possible.

The design of the run-out distance is also important, since disturbances do not only act **in** direction of the airflow but also lead to turbulences **opposite** to flow direction.



L = Length of whole measuring distance
L1 = Length of run-in distance
L2 = Length of run-out distance
D = Inner diameter of measuring distance

Figure 3-3

The following Table 2 shows the required straight pipe lengths depending on the inner tube diameter D and different causes of disturbances.

This table lists the <u>minimum values</u> required in each case. If the listed straight pipe lengths cannot be achieved, measurement accuracy may be impaired or additional actions are required like the use of flow rectifiers[7].

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[6] The term “laminar” means here an air flow low in turbulence (not according to its physical definition saying that the Reynolds number is < 2300).

[7] E.g., honeycombs made of plastics or ceramics; profile factor may change therefore.

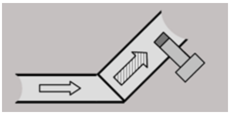
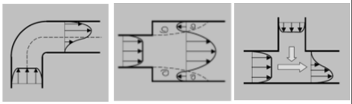
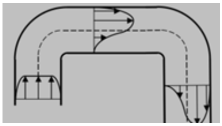
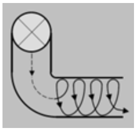
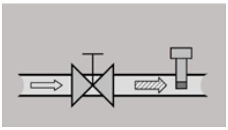
Flow obstacle upstream of measuring distance		Minimum distance length of	
		Run-in (L1)	**Run-out (L2)**
Light bend (< 90°)		**10 x D**	**5 x D**
Reduction, expansion, 90° bend or T-junction		**15 x D**	**5 x D**
Two 90° bends in one plane (2-dimensional)		**20 x D**	**5 x D**
Two 90° bends with 3-dimensional change in direction		**35 x D**	**5 x D**
Shut-off valve		**45 x D**	**5 x D**

Table 2

When mounting the sensor in a tube with a known cross section area, the output signal of the flow velocity can be used to calculate the standard volumetric flow of the medium.

$$A = \frac{\pi}{4} \cdot D^2$$

$$\overline{w}_N = PF \cdot w_N$$

$$\dot{V}_N = \overline{w}_N \cdot A$$

D	Inner diameter of tube [m]
A	Cross section area of tube [m^2]
w_N	Flow velocity in the middle of tube [m/s]
$\overline{w}_N$	Average flow velocity in tube [m/s]
PF	Profile factor (for tubes with a circular cross section A)
$\dot{V}_N$	Standard volumetric flow [m^3/s]

SCHMIDT Technology provides on its homepage a convenient calculation tool to compute flow velocity or volume flow in pipes (circular or rectangle) for all its sensor types and measuring ranges:

www.schmidt-sensors.com

www.schmidttechnology.de

Wall mounting

The wall mounting flange (520181) is designed for installation of the flow sensor **SS 22.420** as an immersion sensor through a wall (e.g. wall of a flow box). The threaded bush included in the delivery has a base provided with a plane contact surface and two holes which allow a fast and easy installation by means of two screws.

All advantages, requirements and installation instructions regarding the stepless sensor installation are applicable for the compression fitting (see subchapter: *Tube-related flow*).

Mounting for measuring room-to-room overflow

A room-to-room overflow sensor is fixed by means of a wall mounting bracket (503895 in anodized aluminum or 551740 in stainless steel). The sensor should be placed in flow direction behind the wall opening, whereas the sensor tip must be located in the middle of the opening (see Figure 3-4 for an example with 503895).

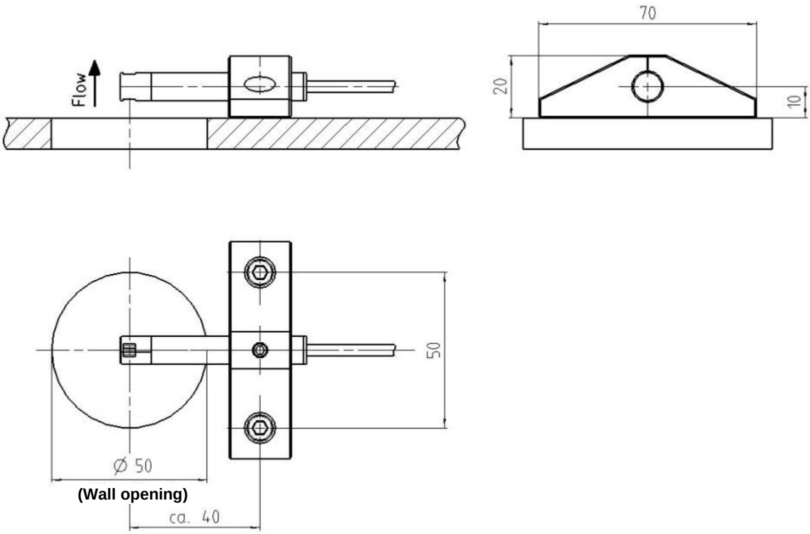


Figure 3-4

The application of a **SS 20.420** with bidirectional measurement capability allows the detection of backflow and is therefore able to signalize critical operating conditions.

4 Electrical Connection

During electrical installation ensure that no voltage is applied and inadvertent activation is not possible.

The sensor is equipped with a firmly attached connection cable (pin assignment see Table 3).

No.	Designation	Function	Wire colour
1	Power	Operating voltage: $+U_B$	Brown
2	Flow	Velocity signal w_N	Green
3	GND	Operating voltage: mass	White

Table 3

The metallic housing of the sensor is indirectly coupled to GND (VDR[8], in parallel with 100 nF) and should be connected to an anti-interference potential, e.g. GND (depending on the shielding concept).

The appropriate protection class III (SELV) respective PELV (EN 50178) has to be considered.

Operating voltage

The **SS 20.420** is protected against a polarity reversal of the operating voltage.

It has a nominal operating voltage range of U_B = 12 ... 26.4 V_{DC}.

Only operate sensor in the defined operating voltage range (12 ... 26.4 V_{DC}).
Undervoltage may result in malfunction. Overvoltage may lead to irreversible damage to the sensor.

The specifications for the operating voltage are valid for the connection at the sensor. Voltage drops generated due to line resistances must be considered by the customer.

Current consumption of the sensor is typical 6 mA, at maximum less than 10 mA (including signal output current).

[8] Voltage dependent resistor; breakdown voltage 27 V @ 1 mA

Analog signal output

The analog output utilizes a voltage interface featuring permanent short-circuit protection against both rails of the operating voltage U_B.

Signal range:	0 ... 10 V
Type:	High side driver, load resistance against GND
Minimum load resistance R_L:	10 kΩ
Maximum load capacity C_L:	1 nF
Maximum short-circuit current:	10 mA
Maximum cable length:	10 m
Wiring:	

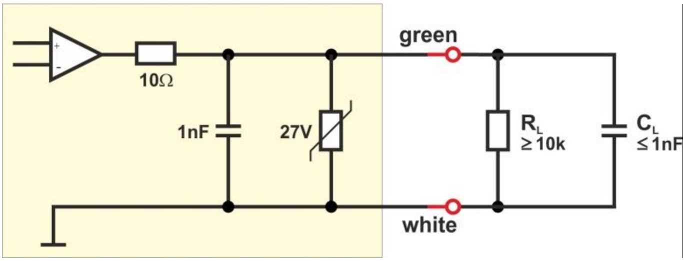


Figure 4-1

The voltage drop[9] in the GND wire of the connecting cable (mass offset) can significantly affect the analog signal of the voltage output.

[9] The specific resistance of the lead of the connecting cable (0.14 mm²) is 0.138 Ω/m (20 °C); at L = 10 m a current of $I_{B,max}$ = 10 mA can cause a voltage drop up to 14 mV.

5 Signalizing

Analog output

The **SS 20.420** measures flow speed either in one (unidirectional) or optionally in both directions (bidirectional).

- Representation of measuring range and flow direction:

  The measuring range (0 … $w_{N,max}$) of the unidirectional version is mapped proportionally to the whole signaling range (0 … 10 V; see Table 4, left column). This direction is defined as the nominal measuring direction and marked with two engraved arrows on the sensor tube.

  In case of a bidirectional version (measuring range: $-w_{N,max}$ … $+w_{N,max}$) the representation area of the analog signal output is spread symmetrically, that means a flow of zero complies with 50 % of the signal range (= 5 V; see Table 4, right column).

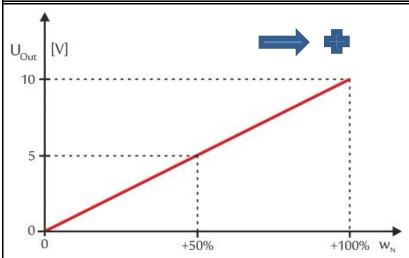
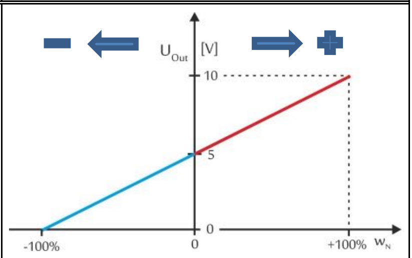
Unidirectional version	Bidirectional version
	
$w_N = \frac{w_{N,max}}{10\,V} \cdot U_{Out}$	$w_N = (\frac{U_{Out}}{5\,V} - 1) \cdot w_{N,max}$

Table 4

- Overflow:

  Flow speeds which exceed the positive measuring range are furthermore output in a linear way up to 110 % of the measuring range (end value + 10 %), to signalize clearly that there is an overflow. For higher values of flow the output signal remains constant.

- Error signaling:

  The signal output is set to 0 V.

6 Startup

Prior to turn on the **SCHMIDT® Flow sensor SS 20.420**, the following checks have to be carried out:

- Immersion depth of the sensor probe and its alignment to the flow direction.
- Tightening of fastening screw of the used mounting accessory.
- Correct electrical connection of connecting cable in the field.
- Correct operating voltage applied (value and polarity).

The sensor is ready for operation about five seconds after switch-on.
If the sensor has another temperature than the ambient, this time is prolonged until the sensor has reached ambient temperature.

In case of faults or other problems during installation, the fault table (see Table 5) can help to resolve the problem.

If the problems persist, please contact **SCHMIDT Technology**.

7 Information on Operation

Sterilization

The **SS 20.420** can be sterilized during operation.

Approved disinfectants are alcohol (drying without leaving residues). If too much cleaning agent is applied to the sensor, the "soiling detection" can be activated and the analog signal is set to error state (0 V). As soon as the sensor element is dried, the sensor is automatically reset to its normal function.

Due to its capillarity, the chamber head gap in the sensor tip can be filled completely with cleaning agent. In this case, it is possible that it will take **more than one hour** until the liquid is evaporated and the sensor works again without problems. To accelerate the drying process, the measuring gap can be cleaned carefully by means of a short compressed air blast or similar methods.

Cleaning of the system

If it is necessary to clean the system in which the sensor is installed, using another cleaning agent than mentioned above the sensor tip must be protected against the penetration of inappropriate cleaning agents by means of the protective cap, which is included in the delivery. This is especially important for cleaning agents which do not dry without leaving residues or cleaning processes during which may soil the sensor tip.

Prior to carry out problematic cleaning measures (e.g. using inadmissible cleaning agents), the protective cap (yellow, included in delivery) must be placed on the sensor head to protect its sensor element.

See also chapter *8 Service Information*, subchapter *Cleaning sensor tip*.

8 Service Informations

Maintenance

A soiled sensor tip may distort the measured value. Therefore, the sensor tip must be checked for soiling at regular intervals.

If it is soiled or wetted by a liquid, the sensor signal error (0 V) via the analog output. In this case, clean the sensor as described below.

If the error signal does not disappear after cleaning and drying, the sensor must be sent in to the manufacturer for repair.

Cleaning sensor tip

If the sensor tip is soiled or dusty, it must be carefully cleaned by means of compressed air (avoid strong pressure impulses!).

If this procedure is not successful, the sensor tip can be cleaned by immersing and washing it in alcohol, which dries without leaving residues (e.g. isopropyl alcohol). As soon as the alcohol has been evaporated, the sensor is again ready for operation.

- Do not shake or tap the wet sensor!
- Do not try to clean the sensor tip by any type of mechanical methods. Do not touch the sensor element located in the chamber head. This may irreversibly damage the sensor.
- Do not use strong cleaners, brush or other objects, fluffy cloths etc. to clean the sensor tip!
- Inappropriate cleaning agents may leave residues on the sensor element and therefore lead to faulty measurements or result in permanent damage to the sensor element.
- If the chamber head gap of the sensor tip is completely filled with cleaning agent, accelerate the drying process by blowing it out, if necessary.

Removing malfunctions

The following Table 5 lists possible errors with a description how to detect them. Furthermore, possible causes and measures to be taken to remove them are listed.

Error image	Possible cause	Remedy
No output signal A_{Out} = 0 V	Operating voltage (not / incorrectly connected)	Check operating voltage and wiring
	Sensor defective	Send in for repair
Error message of sensor A_{Out} = 0 V, although there is a flow	Sensor element wetted	Wait until element is dry
		Blow out sensor tip (if possible)
	Sensor element soiled	Clean sensor tip
	Sensor element defective	Send in for repair
Unexpected values of analog output Measured A_{Out} : Too high / low Strong noise or drift	Sensor configuration (measuring range / indication of direction)	Check order configuration and measurement settings
	Medium to be measured does not correspond to the calibration medium (Standard conditions: Air at 1013.25 hPa and 20 °C)	Check medium parameters
	Mounting conditions (tilting / immersion depth / distortion)	Check mounting conditions
	Irregular flow behaviour (turbulences / other disturbances)	Check run-in and run-out distances
	Sensor element soiled	Clean sensor top etc.
	Operating voltage not OK (DC / value / stability)	Check operating voltage
	Large / fast variations of pressure and temperature	Check medium parameters
	Improper electrical load	Load resistance $R_L < R_{L,min}$ Increase resistance ≥ 10 kΩ Load capacity $C_L > C_{L,max}$ Reduce capacity ≤ 1 nF Insert resistor in series to C_L

Table 5

Transport / dispatch of the sensor

Before transport or dispatch of the **SS 20.420**, the delivered protective cap must be put over the sensor head.
Avoid soiling or mechanical stress.

Calibration

If the customer has made no other provisions, we recommend repeating the calibration at a 12-month interval. To do so, the sensor must be sent in to the manufacturer.

Spare parts or repair

No spare parts are available, since a repair is only possible at the manufacturers. In case of defects, the sensors must be sent in to the supplier for repair.

When the sensor is used in systems important for operation, we recommend keeping a replacement sensor in stock.

Test certificates and material certificates

Every newly produced sensor is accompanied by a certificate of compliance according to EN 10204-2.1. Material certificates are not available.

Upon request, we shall prepare, at a charge, a factory calibration certificate, traceable to national standards.

9 Technical Data

Measuring quantity	Normal velocity w_N of air based on normal conditions of 20 °C and 1013.25 hPa
Medium to be measured	Clean air or nitrogen; more gases on request
Measuring range	(±) 0 ... 1 / 2.5 / 5 / 10 m/s Unidirectional or bidirectional
Lower detection limit	(±) 0.05 m/s
Measuring accuracy[10] - Standard - High precision	 ±(5 % of meas. value +[1 % of end value; min. ± 0.05 m/s]) ±(3 % of meas. value +[1 % of end value; min. ± 0.05 m/s])
Repeatability	±2 % of measured value
Response time (t_{90})	0.2 s
Analogue output - Type - Load	Short circuit protected Voltage (0 ... 10 V) R_L ≥ 10 kΩ, C_L ≤ 1 nF
Operating voltage	12 ... 26.4 V DC (reverse voltage protected)
Current consumption	Typ. 6 mA (max. 10 mA[11])
Humidity range	≤ 95 % RH (not condensing)
Operating pressure	Atmospheric (700 ... 1,300 hPa)
Mounting tolerance	±3° relative to nominal flow direction
Operating temperature	0 ... +60 °C
Storage temperature	-20 ... +85 °C
Connection cable	Fixed at housing, pigtail[12], 3 x 0.14 mm², 5 m, PVC
Protection class	III (SELV) or PELV (according EN 50178)
Protection type	IP65
Dimensions / material - Sensor head - Sensor tube - Total length of sensor	 Ø 9 mm x 10 mm Stainless steel 1.4404 Ø 9 mm x 50 / 100 mm Stainless steel 1.4404 60 / 110 mm
Weight	About 40 g

[10] Under reference condition
[11] Including signal output current
[12] Sheath approx. 50 mm stripped, stranded ends approx. 6 mm stripped and tinned

10 Declarations of Conformity

SCHMIDT Technology GmbH herewith declares in its sole responsibility, that the product

SCHMIDT® Flow Sensor SS 20.420

Part-No. **538 045**

is in compliance with the appropriate

European guidelines and standards

and

UK statutory requirements and designated standards.

The corresponding declarations of conformity can be download from **SCHMIDT®** homepage:

www.schmidt-sensors.com

www.schmidttechnology.de

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