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better measurement



SCHMIDT® Flow Sensor
SS 20.250
Instructions for Use

SCHMIDT® Flow Sensor SS 20.250

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Subject to modifications

1 Important Information

The instructions for use contain all required information for a fast commissioning and a safe operation of **SCHMIDT®** flow sensors:

- 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 (refer to chapter 2). In particular, it is not designed for direct or indirect protection of personal or machinery.
- **SCHMIDT Technology** cannot give any warranty as to its suitability for certain purpose and cannot be held liable 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!

Non-observance of these instructions may lead to injury of the personnel or malfunction of the device.

General note

All dimensions are indicated in mm.

2 Application range

The **SCHMIDT® Flow Sensor SS 20.250** (article number: 526 340) is designed for stationary measurement of the flow velocity as well as the temperature of air and gas at atmospheric pressure conditions.

The sensor is based on the measuring principle of a thermal anemometer. It measures the mass flow of the measuring medium as flow velocity which is output in a linear way as standard velocity¹ w_N based on standard conditions of 1013.25 hPa and 20 °C. Thus, the resulting output signal is independent from pressure and temperature of the medium to be measured. The sensor is designed for the use inside closed rooms and is not suitable for outdoor use.



When using the sensor outdoors, it must be protected against direct exposure to the weather.

3 Mounting instructions

General information on handling

The flow sensor **SS 20.250** is a sensitive measuring instrument. Therefore, avoid applying mechanical force onto the sensor tip.



The head of the sensor probe can be damaged irreversibly due to mechanical loads.

Leave the protective cap during mounting as long as possible attached and handle the sensor with care.

Flow characteristics

To avoid any distortion of the measurement results, appropriate installation conditions must be guaranteed to ensure that the gas flow is supplied to the sensor in a quiet (low in turbulence) state. The corresponding measures depend on the flow-determining system properties (pipe, flow box, outdoor environment etc.), they are described in the following sub-chapters for different mounting variants.



Correct measurements require a (laminar) flow low in turbulence.

Because the sensor has to measure the temperature of the medium also, the temperature measuring sleeve must be in direct contact with the measured medium. That means that a minimum immersion depth (MID) of 58 mm is required (see Figure 3-1).

¹ Corresponds to the actual velocity under standard conditions.

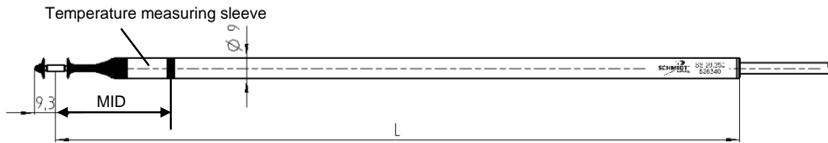


Figure 3-1

Installation in pipes or channels

The central installation of the sensor over the pipe cross-section must be realized on a point where the flow is quiet. The simplest method² for obtaining a quiet flow is to provide a sufficiently long distance in front of the sensor (run-in distance) and behind the sensor (run-out distance) straight without disturbances (such as edges, seams, bend etc., refer to installation drawing Figure 3-2).

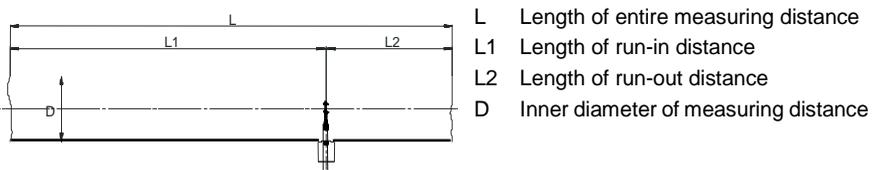


Figure 3-2

The required abatement distances (in relation to the pipe's inner diameter D) in case of different fault causes are listed in Table 1.

Flow obstacle upstream of measuring distance	Minimum length of distance	
	Run-in (L1)	Run-out (L2)
Light bend ($< 90^\circ$)	10 x D	5 x D
Reduction / expansion / 90° bend of 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 (3-dimensional change in direction)	35 x D	5 x D
Shut-off valve	45 x D	5 x D

Table 1

This table lists the minimum values required in each case. If the listed straight conduit lengths cannot be achieved, the measurement accuracy may be impaired.

Under the conditions mentioned above, a flattened, parabolic velocity profile is produced over the pipe cross-section which reaches its maximum

² Alternatively flow rectifiers, e.g. honeycomb ceramics, can be used.

w_N in the middle of the pipe (optimum measuring point). This measuring value can be converted to an average flow velocity \overline{w}_N constant over the cross-section by means of a so called profile factor PF. This profile factor depends on the pipe diameter and is shown in Table 2.

Thus, it is possible to calculate the standard volumetric flow using the measured standard flow velocity in a pipe with known inner diameter:

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

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

$$\dot{V}_N = \overline{w}_N \cdot A \cdot 3600$$

D Inner diameter of pipe [m]
 A Cross-section area of pipe [m²]
 w_N Standard flow velocity in pipe centre [m/s]
 \overline{w}_N Average standard flow velocity in tube [m/s]
 PF Profile factor (for pipes with circular cross-sections)
 \dot{V}_N Standard volumetric flow [m³/h]

PF	Tube Ø		Measuring range of volumetric flow [m ³ /h]			
	Inside [mm]	Outside [mm]	for sensor measuring range			
			1 m/s	2.5 m/s	10 m/s	20 m/s
0.710	70.3	76.1	10	25	99	198
0.720	82.5	88.9	14	35	139	277
0.740	100.8	108.0	21	53	213	425
0.760	125.0	133.0	34	84	336	672
0.795	150.0	159.0	51	126	506	1,012
0.820	182.5	193.7	77	193	772	1,544
0.840	206.5	219.1	101	253	1,013	2,026
0.845	309.7	323.9	229	573	2,292	4,583
0.850	631.6	660.0	959	2,397	9,587	19,175

Table 2

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

www.schmidt-sensors.com or www.schmidttechnology.de

Since the situation is similar to that in a pipe, the volumetric flow in a square chamber can be calculated in the same way, i.e. by equating the hydraulic diameters of both cross-section forms (see Figure 3-3). The result for a rectangle is a “diameter” D_R equivalent to a circular pipe:

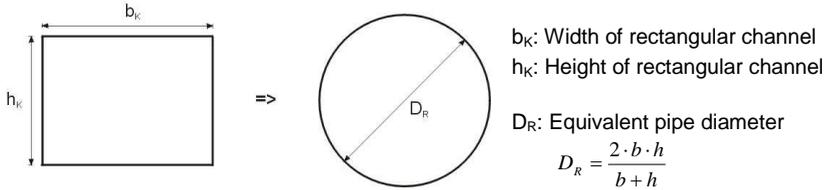


Figure 3-3

According to this the volumetric flow in a chamber is calculated:

$$A_R = \frac{\pi}{4} \cdot D_R^2 = \frac{\pi}{4} \cdot \left(\frac{2 \cdot b_K \cdot h_K}{b_K + h_K} \right)^2$$

b_K / h_K Width / height of square chamber [m]
 D_R Inner diameter of equivalent pipe [m]
 A_R Cross-section area of equivalent pipe [m²]
 w_N Flow velocity in the middle of duct / pipe [m/s]
 \bar{w}_N Average flow velocity in equivalent pipe [m/s]
 PF Profile factor of pipe³ with inner diameter D_R
 \dot{V}_N Standard volumetric flow [m³/s]

$$A_R = \pi \cdot \left(\frac{b_K \cdot h_K}{b_K + h_K} \right)^2$$

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

$$\dot{V}_N = \bar{w}_N \cdot A_R$$

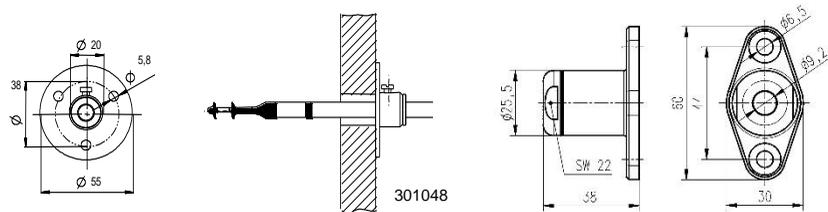
$$\dot{V}_N = PF \cdot \pi \cdot \left(\frac{b_K \cdot h_K}{b_K + h_K} \right)^2 \cdot w_N$$

Wall installation

In general there are two options available for sensor installation on or (directly) in a wall:

Installation with a flange

SCHMIDT Technology offers two types of flanges.



Mounting flange 301048

Wall mounting flange 520181

Figure 3-4

The simple mounting flange (see Figure 3-4, left side) fixes the sensor by means of a locking screw and is not pressure-tight.

The wall mounting flange (Figure 3-4, right), suitable for clean rooms, is pressure tight up to 500 mbar, made of stainless steel and uses an O-ring

³ The profile factors are equal for both cross-section forms.

on the contact surface to separate the medium to be measured from the environment.

Assembly:

- Drill a bushing bore with 10 ... 12 mm diameter in the wall.
- Align and drill bore pattern for fastening screws according to the required position of the locking screw (mounting flange 301048) or mounting plate (wall mounting flange 520181).
- Screw down the flange.
- Remove protective cap and insert sensor probe carefully in coaxial direction into flange.
- Adjust immersion depth of the probe and fasten sensor by means of the locking screw (mounting flange 301046) or lock nut (wall mounting flange 520181).

Mounting with compression fitting

SCHMIDT Technology offers two compression fittings that differ in material (brass or stainless steel; for details refer to subchapter *Accessories*).

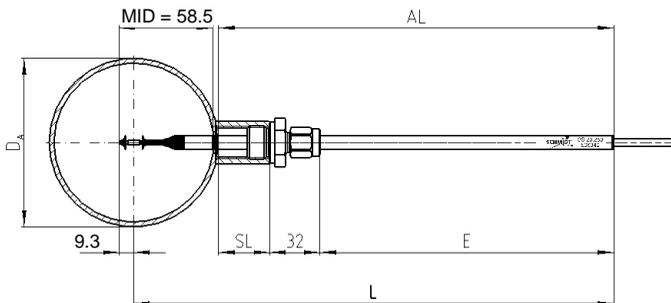


Figure 3-5

L	Sensor length [mm]	D_A	Outer diameter of the pipe [mm]
SL	Length of the weld-in sleeve [mm]	E	Sensor tube setting length [mm]
AL	Projecting length [mm]	MID	Minimum immersion depth [mm]

The compression fittings are mounted using their external thread $G\frac{1}{2}$. Normally, a clamp with internal thread $G\frac{1}{2}$ resp. $Rp\frac{1}{2}$ (for details refer to subchapter *Accessories*) is welded as a connecting piece onto the bore in the medium-transporting system wall and the fitting is screwed in.

The further assembly is carried out as described in the previous subchapter.

Accessories

The following accessories are available for mounting the **SCHMIDT® Flow Sensor SS 20.250**.

Type / art. no.	Drawing	Assembly
Mounting flange 301048		<ul style="list-style-type: none"> - Immersion sensor - Wall (planar surface) - Attachment with: 3 screws ($\varnothing < 5$ mm) - Material: Aluminium anodized Steel gal. (lock screw) PTFE (clamping ring) - Atmospheric pressure use
Wall mounting flange 520181		<ul style="list-style-type: none"> - Immersion sensor - Wall (planar surface) - Attachment with: 2 screws M5⁴ - Material: Stainless steel 1.4404 PTFE (clamping ring) Viton (O-Ring) - Atmospheric pressure use (pressure tight ≤ 500 mbar)
Compression fitting 532160		<ul style="list-style-type: none"> - Immersion sensor - Pipe (typ.); wall - Screwing into a clamp - Material: Stainless steel 1.4571 PTFE (clamping ring) - Atmospheric pressure use
Compression fitting 517206		<ul style="list-style-type: none"> - Immersion sensor - Pipe (typ.); wall - Screwing into a clamp - Material: Brass PTFE (clamping ring⁵) NBR (O-Ring) - Atmospheric pressure use
Clamp a.) 524916 b.) 524882		<ul style="list-style-type: none"> - Internal thread Rp$\frac{1}{2}$ - Material: a.) Steel, black b.) Stainless steel 1.4571

Table 3

⁴ Countersunk head, not included in the delivery

⁵ Sealing ring splitted (in half)

4 Electrical connection

The sensor is equipped with a 5-pin cable firmly fixed to the housing pipe with open cable ends (pin assignment refers to Table 4).

Designation	Function	Wire color of cable
Power	Operating voltage: $\pm U_B$ in DC mode Operating voltage: $U\sim$ in AC mode	Brown
Analog w_N	Output signal: Flow velocity	Yellow
Analog T_M	Output signal: Temperature of medium	Green
GND	Operating voltage: $\pm U_B$ in DC mode Operating voltage: $U\sim$ in AC mode	White
AGND	Reference ground of analog outputs	Gray

Table 4

The cable has a standard length of 2 m; further lengths from 3 ... 100 m can be ordered optionally.

Electrical assembly



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

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



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

Operating voltage

For proper operation the sensor requires DC or AC voltage with a nominal value of 24 V_(eff) with permitted tolerance of $\pm 10\%$. Typical operating current is approx. 60 mA and at maximum 100 mA⁶.



Only operate sensor within the defined range of operating voltage (24 V DC / AC_{eff} $\pm 10\%$).

Undervoltage may result in malfunction; overvoltage may lead to irreversible damages.

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

⁶ Both signal outputs 22 mA (maximum measuring values), minimum operating voltage.

Analog outputs

Both analog outputs for flow and temperature are equipped with an "Auto-U/I" feature, that means that the signal electronics switches automatically between operation as voltage (U) or current interface (I) depending on the value of the load resistance R_L (switching threshold: $R_L = 500 / 550 \Omega$; for details refer to chapter 5 *Signalizations*).



For voltage mode a load resistance of at least $10 \text{ k}\Omega$ is recommended.

It is recommended to connect the same resistance value (e.g. 300Ω each for I mode or $10 \text{ k}\Omega$ each for U mode) to both analog outputs (even if one of them is not used).

The apparent resistance R_L must be connected between the corresponding signal output and the electronic reference potential for the sensor outputs (refer to Figure 4-1).

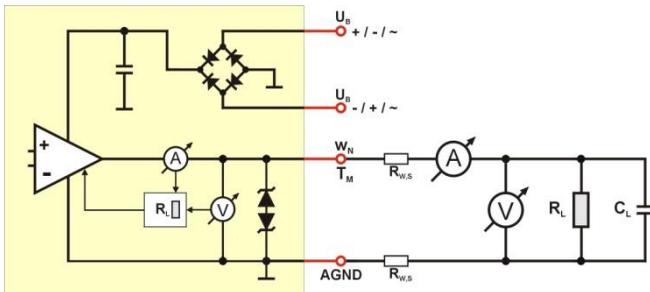


Figure 4-1

With alternating operating voltage, AGND has to be selected as measuring reference potential.

If the sensor is used with direct voltage, also the mass of the supply voltage can be used as reference potential as long as it is short-circuited with AGND. This procedure is not recommended because mass offset and noise may interfere the output signal in voltage mode.



With alternating operating voltage, AGND must be selected as measuring reference potential for the signal output.

Otherwise, AGND should be selected as measuring reference potential for the signal output.

The signal outputs have a permanent short-circuit protection against both rails of the operating voltage.

The maximum load capacity is 10 nF .

5 Signalizations

Optical

The **SCHMIDT® Flow Sensor SS 20.250** is equipped with a light ring on its cable exit that signals the current sensor state (refer to Table 5).

Symbol	Light	Sensor state
○	Off	Supply voltage: none, wrong polarity, too low
●	Green (permanently)	Sensor ready for operation
◐	Flashes green	Supply voltage too high or Medium temperature beyond specification range
◑	Flashes red	Sensor defective

Table 5

Analog outputs

- Switching characteristic Auto-U/I

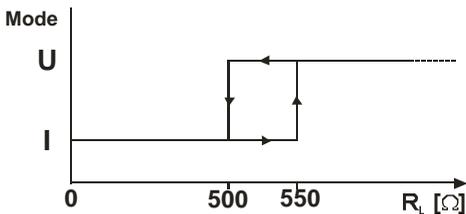


Figure 5-1

Depending on the signal value, the accuracy of the mode switching point detection can be reduced. Therefore, it is recommended to select the resistance in such a way that a secure detection can be maintained (< 300 Ω for current mode and > 10 kΩ for voltage mode).

With a zero signal in voltage mode, the electronic system generates test pulses that correspond to an effective value of approx. 1 mV. The latest measuring devices may trigger in response to such a pulse and display short-term measuring values of up to 20 mV. In this case it is recommended to install an RC filter before the measuring input with a time constant of 20 ... 100 ms.

- Representation of measuring range
The measuring range of the corresponding measuring value is mapped in a linear way to the signaling range of its associated analog output. For flow measurement the measuring ranges from zero flow up to the selectable end of the measuring range $w_{N,max}$ (refer to Table 6). The measuring range of the medium temperature T_M is specified from -20 ... +70 °C (refer to Table 7) and is output in a linear way.

Voltage mode (U)	Current mode (I)
$w_N = \frac{w_{N,max}}{10 V} \cdot U_{Out}$	$w_N = \frac{w_{N,max}}{16 mA} \cdot (I_{Out} - 4 mA)$

Table 6

Voltage mode (U)	Current mode (I)
$T_M = \left(\frac{90}{10 V} \cdot U_{Out} - 20 \right) ^\circ C$	$T_M = \left[\frac{90}{16 mA} \cdot (I_{Out} - 4 mA) - 20 \right] ^\circ C$

Table 7

Note regarding commissioning:

Normally the temperature output provides approx. 5 V or 12 mA because the typical prevailing room temperature of approx. 25 °C corresponds to half of the measuring range.

- Error signaling
In current mode the interface outputs 2 mA.
In voltage mode the output switches to 0 V.
- Exceeding measuring range for flow
Measuring values larger than $w_{N,max}$ are output in a linear way up to 110 % of the signaling range (11 V or 21.6 mA). For higher values of w_N the output signals stays constant.
- Medium temperature beyond specification range
Operation beyond the specified limits may damage the sensor and is displayed as follows (also refer to images in Table 7):
 - Medium temperature below -20 °C
The analog output for T_M switches to error (0 V or 2 mA).
The analog output for w_N switches to error (0 V or 2 mA).

- Medium temperature above +70 °C (at approx. 75 °C)⁷
The analog output for w_N switches to error (0 V or 2 mA).
The analog output for T_M switches directly to the maximum output values of 11 V or 22 mA.

6 Startup

Before switching on the **SCHMIDT® Flow Sensor SS 20.250**, it must be checked if the sensor is installed correctly, both mechanically and electrically.

If the sensor is in the correct operational state, it is ready for measurement approx. 10 s after switching on the supply voltage.

7 Information concerning operation

Environmental condition Temperature

The **SCHMIDT® Flow Sensor SS 20.250** monitors both medium and operating temperature of the electronics. As soon as one limit of the specified temperature range is exceeded, the sensor switches off flow measurement and reports a corresponding error. As soon as proper operational conditions are restored, the sensor resumes measuring mode.



Even leaving the specified operating temperature range for a short period can cause an irreversible sensor damage.

Environmental condition Medium

The **SS 20.250** is designed for the use in clean to slightly soiled media.



Soiling or other gratings on the sensor cause distortions of measurements.

Therefore, the sensor must be checked for soiling at regular intervals and cleaned if necessary.

The coated versions exhibit a particularly high chemical media resistance against organic solvents, acids and caustics in liquid or gaseous state, e.g.:

Acetone, ethyl acetate, methyl ethyl ketone, perchlorethylene, peracetic acid, xylene, alcohols, ammonia, petrol, motor oil (50 °C), cutting oil (50 °C), sodium hydroxide, acetic acid, hydrochloric acid, sulphuric acid.

The suitability of the above mentioned or other similar chemicals must be checked for every individual case due to different ambient conditions.

⁷ The switching hysteresis of the threshold is approx. 2 K.



(Condensating) liquid on the sensor causes serious measurement deviations.

After drying the correct measuring function is restored (as long as the condensate has not damaged it by corrosion or similar).

Sterilization

Both uncoated and coated sensor can be sterilized during operation.

Alcohols (drying without leaving residues) and hydrogen peroxide (uncoated version only) are approved and certified as disinfectants.

Other disinfectants must be checked by the customer if necessary.

8 Service information

Maintenance

Heavy soiling of the sensor tip may distort the measured value. Therefore, the sensor tip must be checked for soiling at regular intervals. If soiling is visible, the sensor can be cleaned as described below.

Cleaning of the sensor tip

To clean the sensor tip from dust or soiling move it carefully in warm water containing a washing-up liquid or other permitted cleaning fluid (e.g. Iso-propanol)⁸. Persistent incrustations or gratings can be previously softened by prolonged immersion and then removed by means of a soft brush or cloth. Avoid applying force to the sensitive sensor tip.



The sensor tip is a sensitive measuring system.
During manual cleaning proceed with great care.

Before putting the sensor again into operation, wait until the sensor tip is completely dry.

Eliminating malfunctions

The following table lists possible errors (error images) and a description to detect errors. Furthermore, possible causes and measures to be taken to eliminate errors are listed.

⁸ Other cleaning fluids on request.

Error image		Possible causes	Troubleshooting
	$A_{Out} = 0 \text{ V} / 0 \text{ mA}$	Supply voltage U_B : ➤ No U_B available ➤ $U_{B,DC}, \bar{U}_{B,AC} < 15 \text{ V}$	Supply voltage: ➤ Check if connected correctly to control unit ➤ Check voltage value Send in sensor for repair
Signal light off Both signal outputs at zero		Sensor defective	
	$A_{Out} = 0 \text{ V} / 2 \text{ mA}$	Sensor element defective	Send in sensor for repair
	$A_{Out} = 0 \text{ V} / 2 \text{ mA}$ $A_{Out} = 0 \text{ V} / 22 \text{ mA}$	Temperature too low / high	Increase / reduce temperature
	$A_{Out} = 0 \text{ V} / 2 \text{ mA}$	Operating voltage too high	Reduce operating voltage
Flow signal w_N is too large / small		Measuring range too small / large	Check sensor configuration
		I-mode instead of U-mode or vice versa	Check measuring resistance
		Medium to be measured is not air	Gas correction considered?
		Sensor tip soiled	Clean sensor tip
Flow signal w_N is fluctuating		U_B unstable	Check the voltage stability
		Sensor head is not in optimum position Run-in / run-out distance is too short	Check mounting conditions
		Strong fluctuations of pressure or temperature	Check operating parameters
Analog signal in U-mode has offset or is noisy		Measuring resistance of signal output is at GND	Connect measuring resistance to AGND
Analog signal permanently at maximum		Measuring resistance of signal output is at $+U_{B,DC}$	Connect measuring resistance to AGND
Analog signal switches between min. and max.		Measuring resistance of signal output is at GND ($U_{B,AC}$)	Connect measuring resistance to AGND

Table 8

Transport / Shipment of the sensor

Before transportation or shipment of the sensor, the delivered protective cap must be placed onto the sensor tip. Avoid soiling or mechanical stress.

Calibration

If the customer has made no other provisions, we recommend repeating the calibration at a 12-month interval. For this purpose, the sensor must be returned to the manufacturer.

Spare parts or repair

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

- **A completed declaration of decontamination must be attached.**

The form "Declaration of decontamination" is enclosed with the sensor and can also be downloaded from

www.schmidt-sensors.com or www.schmidttechnology.de

under the heading "Service & Support", "Sensorics".

If the sensor is used in systems important for operation, we recommend you to keep a replacement sensor in stock.

Test certificates and material certificates

Every new sensor is accompanied by a certificate of compliance according to EN10204-2.1. 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 parameters	Standard velocity w_N of air, based on standard conditions 20 °C and 1013.25 hPa Medium temperature T_M
Medium to be measured	Air or nitrogen, other gases on request
Measuring range w_N	0 ... 1 / 10 / 20 m/s Special measuring range: 1 ... 20 m/s (in steps of 0.1 m/s)
Lower detection limit w_N	0.06 m/s
Measuring accuracy ⁹ w_N - Standard - Precision (optional)	$\pm(5\% \text{ of meas. value} + [0.4\% \text{ of final value; min. } \pm 0.02 \text{ m/s}])$ $\pm(3\% \text{ of meas. value} + [0.4\% \text{ of final value; min. } \pm 0.02 \text{ m/s}])$
Reproducibility w_N	$\pm 1.5\%$ of measured value
Response time (t_{90}) w_N	3 s (jump from 0 to 5 m/s)
Measuring range T_M	-20 ... +70 °C
Measuring accuracy T_M ($w_N > 2$ m/s)	± 1 K (10 ... 30 °C); ± 2 K (remaining measuring range)
Storage temperature	-20 ... +85 °C
Humidity range	0 ... 95 % rel. humidity (RH), non-condensing
Operating pressure	Atmospheric (700 ... 1,300 hPa)
Coatings (optional)	Sensor head: Polyurethan derivative (black) Probe: Parylene (transparent)
Operating voltage U_B	24 V _{DC/ACeff} $\pm 10\%$
Current consumption	Typ. < 60 mA, max. 100 mA
Analog outputs - Type: Auto-U/I Switching Auto-U/I - Voltage output - Current output - Switching hysteresis Maximum load capacity	Flow velocity, medium temperature Automatic switching of signal mode on base of load R_L 0 ... 10 V for $R_L \geq 550 \Omega$ 4 ... 20 mA for $R_L \leq 500 \Omega$ $\Delta R_L = 50 \Omega$ 10 nF
Electrical connection	Non-detachable connecting cable, pigtail ¹⁰ , 5-pin, length 2m Special lengths: 3 ... 100 m (in steps of 1 m)
Maximum cable length	Voltage signal: 15 m, current signal: 100 m
Type of protection	IP65
Protection class	III (SELV) or PELV (EN 50178)
Min. immersion depth	58 mm
Probe length L	300 / 500 mm
Weight	200 g max. (with 2 m cable)

⁹ Under conditions of the reference.

¹⁰ With cable end sleeves

10 Declarations of conformity

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

SCHMIDT® Flow Sensor SS 20.250

Part-No. **526 340**

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

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