

# GAS DENSITY SENSOR WITH CURRENT OUTPUT

Swiss based Trafag offers precise, reliable and maintenance-free instruments developed for density measuring of SF<sub>6</sub> and related alternative gases. Measurement is based on the patented quartz tuning fork technology. Thus offering the most reliable and long term drift free solution on the market by directly measuring the insulating gas density.



## Applications

- Density monitoring in insulating and quenching gas
- High voltage technology
- Medium voltage technology
- SF<sub>6</sub> and variety of alternative mixed gases

## Features

- Continuous current loop output
- Optional pulse-width modulation output
- Temperature signal via pulse-width output
- Suitable for outdoor and indoor applications
- Long term drift free sensor output signal

01/2024

Data sheet H72507aa

## Technical Data

Measuring principle	Oscillating quartz	Supply voltage	<ul style="list-style-type: none"> <li>• Pulse-width: 10 ... 20 VDC</li> <li>• Current loop: 10 ... 32 VDC</li> </ul>
Measuring range	<ul style="list-style-type: none"> <li>• Pulse-width: 0 ... 60 kg/m<sup>3</sup></li> <li>• Current loop: 0 ... 56.1 kg/m<sup>3</sup></li> </ul>	Ambient temperature	-40°C ... +80°C
Output signal	<ul style="list-style-type: none"> <li>• Pulse-width: 10 ... 292 Hz</li> <li>• Current loop: 6.5 ... 20 mA</li> </ul>		

Subject to change

## Ordering information/type code

		8774 .	XX	XX	XX	XX	XX
<b>Density measuring range</b>	0...60 kg/m <sup>3</sup> for pulse-width output						
	0...56.1 kg/m <sup>3</sup> for current loop output	50					
<b>Process connection</b>	G3/8" male			11			
	2-hole flange 2800 series			28			
<b>Sensor output</b>	Pulse-width modulation				00		
	Current loop				04		
<b>Electrical connection</b>	Male electrical connector EN 175301-803-A (DIN 43650-A), 4-pole					04	
	Male electrical connector M12x1, 5-pole, A-coding					35	
	Shielded cable Radox 125, 2x0.5mm <sup>2</sup>					51	
<b>Accessories</b>	Female electrical plugs						
	EN 175301-803-A (DIN 43650-A), 4-pole						58
	M12x1, 5-pole, A-coding, PA						33
	M12x1, 5-pole, A-coding, brass nickel-plated						35
	Pressure connection adapters						
	G3/8" female - 2200						22
	G3/8" female - 2300						23
	G3/8" female - 2550						27
	G3/8" female - 2570						28
	T-adapter M30x2 male - G3/8" female - 2300						

## Further customised parameterisation to be indicated

Process gas	SF <sub>6</sub> , SF <sub>6</sub> - based mixed gas, customer specific alternative gas
Gas pressure @ 20°C	Requirement for specific process gas if other than 100 % SF <sub>6</sub>
Length of shielded Radox cable	Length in mm



Trafag develops and manufactures customised products according to your specifications to meet your specific requirements. Please contact us for further details.

Specifications		
<b>Electronical density measuring</b>	Measuring principle	Oscillating quartz sensor
	Density measuring range <sup>1)</sup>	<ul style="list-style-type: none"> <li>• Pulse-width: 0 ... 60 kg/m<sup>3</sup> 0 ... 1100 kPa abs. @ 20°C</li> <li>• Current loop: 0 ... 56.1 kg/m<sup>3</sup> 0 ... 1100 kPa abs. @ 20°C</li> </ul>
	Temperature measuring range <sup>2)</sup>	-40°C ... +80°C
	Sensor output	<ul style="list-style-type: none"> <li>• Pulse-width: 10 ... 292 Hz</li> <li>• Current loop: 6.5 ... 20 mA</li> </ul>
	Output parameter	<ul style="list-style-type: none"> <li>• Pulse-width: Gas density [kg/m<sup>3</sup>], gas temperature [°C]</li> <li>• Current loop: Gas density [kg/m<sup>3</sup>]</li> </ul>
<b>Electrical data</b>	Supply voltage	<ul style="list-style-type: none"> <li>• Pulse-width: 10 ... 20 VDC</li> <li>• Current loop: 10 ... 32 VDC</li> </ul>
	Current consumption	Pulse-width @ 20 VDC: Pulse height 16 mA max. / 12-14 mA typ., without pulses 2 mA
	Earthing	Via process connection or plug
	Resistance of insulation	>100 MΩ, 500 VDC, ex factory
	Dielectric strength	250 VAC, 50 Hz, terminal to ground (earth)
<b>Environmental conditions</b>	Ambient temperature	-40°C ... +80°C <sup>4)</sup>
	Protection <sup>3)</sup>	IP65 and IP67
	Humidity	IEC 60068-2-30 (damp heat, cyclic, 100 % RH @ +55°C)
	Overpressure	1500 kPa abs.
	Vibration	15 g / 5 ... 2000 Hz
	Shock	100 g / 6 ms / 10'000 times at all axes excited on process connection without damage to sensor
	Routine inspection of gas tightness	Integral pressure testing with 6 bar rel. helium, SF <sub>6</sub> leakage rate less than 1·10 <sup>-8</sup> mbar · l/s
<b>EMC protection</b>	ESD	15 kV air, 8 kV contact, EN/IEC 61000-4-2
	Radiated immunity	10 V/m, 80 ... 6000 MHz, EN/IEC 61000-4-3
	Burst	2 kV, EN/IEC 61000-4-4
	Surge	2 kV, EN/IEC 61000-4-5
	Conducted immunity	10 Vrms, EN/IEC 61000-4-6
<b>Mechanical data</b>	Process gas wetted material	Process connection and measuring system: 1.4435 (AISI316L) Sealing: EPDM <sup>5)</sup>
	Housing	1.4301 (AISI304)
	Weight	~ 200 ... 400 g

<sup>1)</sup> The oscillating quartz sensor principle is a direct density measurement. Shown density / pressure @ 20°C correlation corresponds to 100 % SF<sub>6</sub> gas. Maximum value is either 60 kg/m<sup>3</sup> (pulse-width) respectively 56.1 kg/m<sup>3</sup> (current loop) or 1100 kPa abs. @ 20°C, whichever is reached first. Density / pressure @ 20°C correlation is defined by particular gas isochores and is specifically fitted. Please contact us for process gases other than 100 % SF<sub>6</sub>.

<sup>2)</sup> Temperature measurement for sensor with pulse-width output only

<sup>3)</sup> While using an appropriate mating connector mounted according to instruction

<sup>4)</sup> Approved for extended temperature range -55°C ... +80°C for 200h max. per year

<sup>5)</sup> SF<sub>6</sub> qualified

Accuracy	
Density measurement <sup>1)</sup>	± 1.0 % FS typ. ± 1.8 % FS max.
Temperature measurement <sup>2)</sup>	± 1.0 % FS typ. ± 3.0 % FS max.
Repeatability density measurement	± 0.2 % FS
Repeatability temperature measurement <sup>2)</sup>	± 0.1 % FS
Transient response time required for signal output to reach accuracy tolerance band	Less than 1 h after connecting sensor to pressurised compartment Less than 1 min. when sensor is vacuumised together with compartment before gas filling
Response time density changes to signal output	Less than 20 ms

<sup>1)</sup> Total error band (TEB) for defined ambient temperature range while the insulation gas is completely gaseous

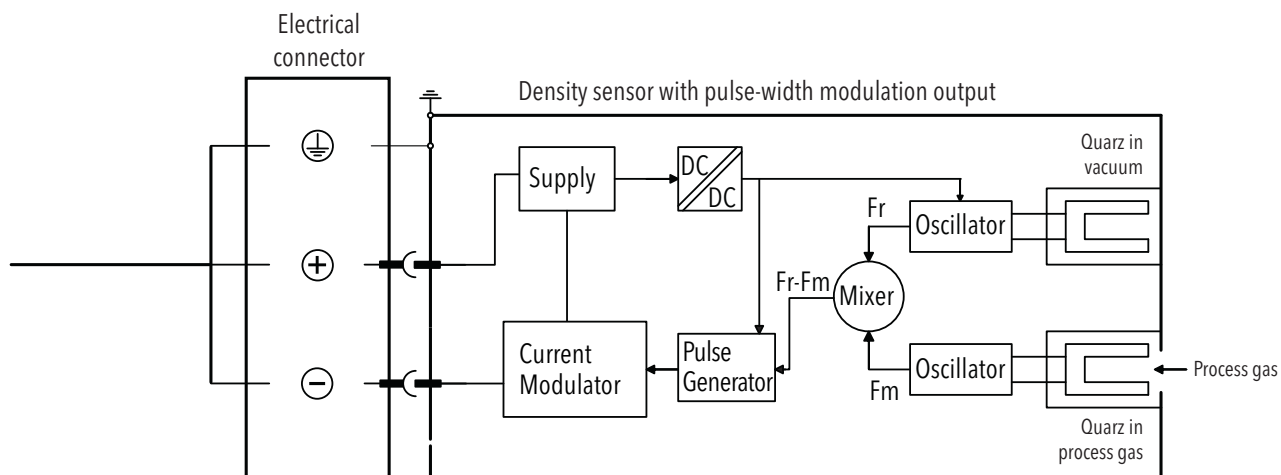
<sup>2)</sup> Temperature measurement for sensor with pulse-width output only

Additional information		
<b>Documents</b>	Data sheet	<a href="http://www.trafag.com/H72507">www.trafag.com/H72507</a>
	Instructions	<a href="http://www.trafag.com/H73507">www.trafag.com/H73507</a>
	Flyer	<a href="http://www.trafag.com/H71108">www.trafag.com/H71108</a>

## Electrical connections and options

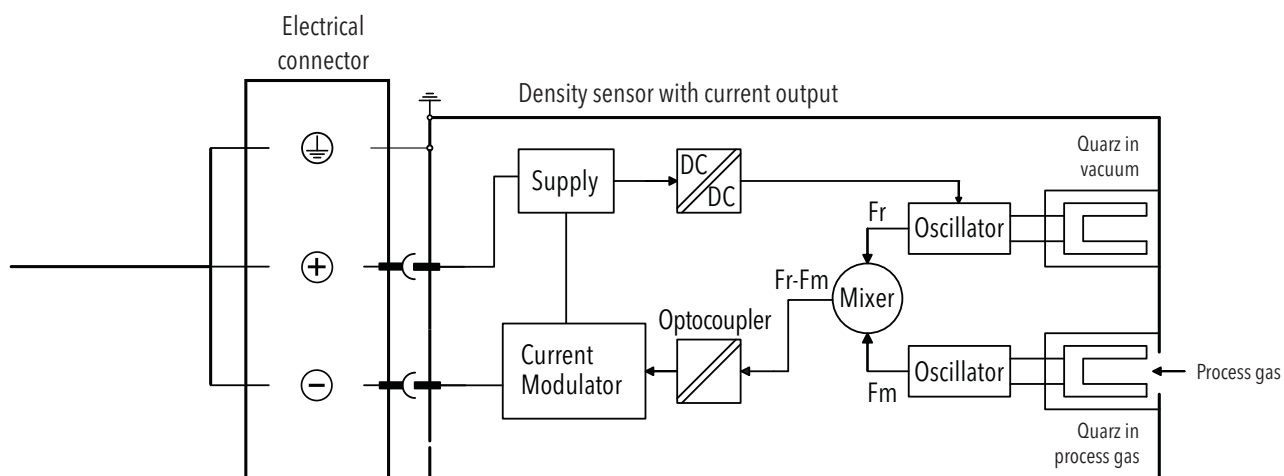
### Wiring diagram pulse-width modulation

8774.50.XX.00.XX.XX.XX



### Wiring diagram current loop

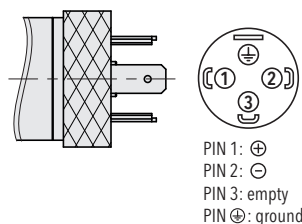
8774.50.XX.04.XX.XX.XX



## Electrical connections and options

### Male electrical connector

EN 175301-083-A (DIN43650-A), 4-pole <sup>1)</sup>

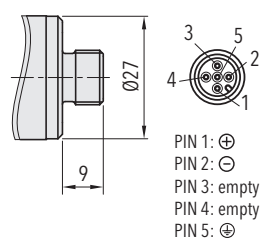


8774.50.XX.XX.04.XX.XX

Material: Collar nut 1.4305 with PA contact holder

### Male electrical connector

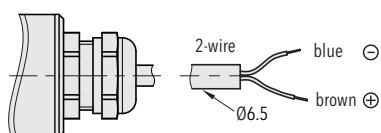
M12x1, 5-pole, A-coding <sup>2)</sup>



8774.50.XX.XX.35.XX.XX

Material: Thread 1.4435 with PA contact holder

### Shielded cable Radox 125, 2 x 0.5 mm<sup>2</sup> <sup>3)</sup>

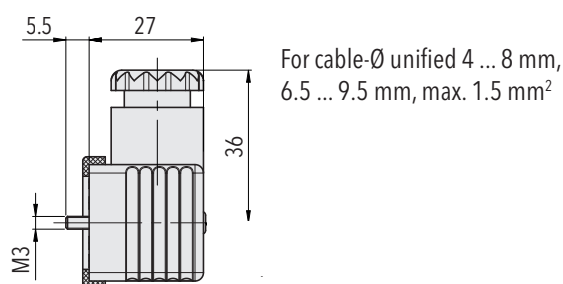


8774.50.XX.XX.51.XX.XX

Material: EMC-cable gland brass, nickel-plated

### Female electrical plug

EN 175301-803-A (DIN 43650-A), 4-pole <sup>4)</sup>

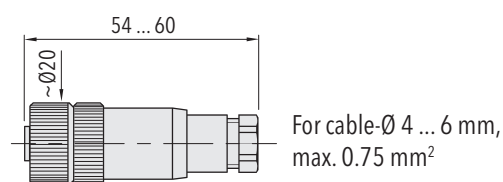


8774.50.XX.XX.04.58.XX

Material: Polyamide (PA)

### Female electrical plug

M12x1, 5-pole, A-coding <sup>5)</sup>



8774.50.XX.XX.35.33/35.XX

Material:  
Type code 33: Polyamide (PA)  
Type code 35: Brass, nickel-plated

<sup>1)</sup> IP 65 protection while using an equivalent mating connector mounted according to instruction

<sup>2)</sup> IP 65 and IP 67 protection while using an equivalent mating connector mounted according to instruction

<sup>3)</sup> IP 65 and IP 67 protection

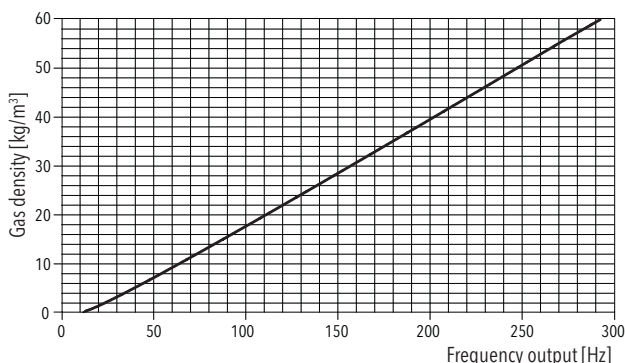
<sup>4)</sup> IP 65 protection while connector and plug are mounted according to instruction

<sup>5)</sup> IP 67 protection while connector and plug are mounted according to instruction

## Conversion of output signal

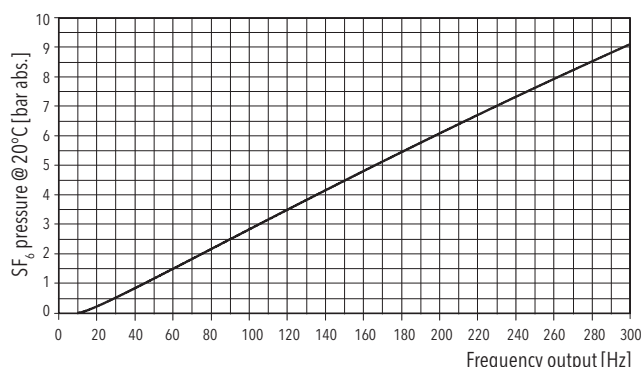
Gas density sensor with pulse-width modulation output signal

### Relation of frequency output to gas density



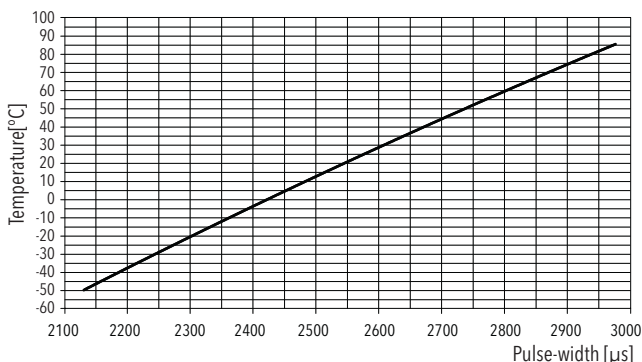
$$\text{Gas density [kg/m}^3] = \sqrt{(0,237 * F [\text{Hz}]) - 2,182 - 0,44}^2$$

### Relation of frequency output to SF<sub>6</sub> pressure @ 20°C



$$\begin{aligned} \text{SF}_6 \text{ pressure @ T [K] [kg/m}^3] = & \\ & \{0,000569502 * T [\text{K}] * \text{Density [kg/m}^3] + \\ & (0,00250695 * 0,000569502 * T [\text{K}] - \\ & 0,00073822) * \text{Density [kg/m}^3]^2 - \\ & (0,00000212238 * 0,000569502 * T [\text{K}] - \\ & 0,000000513) * \text{Density [kg/m}^3]^3 \} \end{aligned}$$

### Relation of pulse-width to temperature



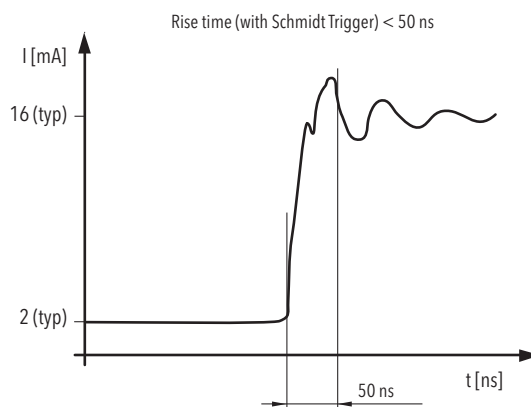
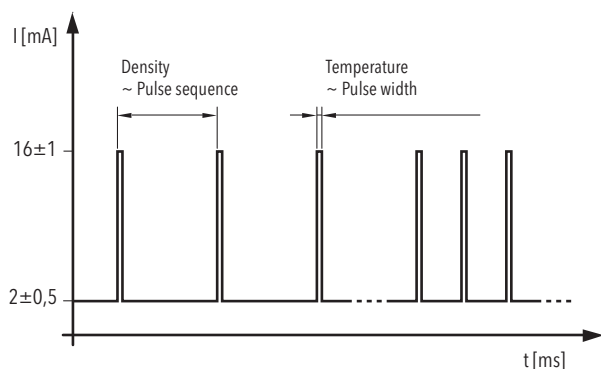
$$\text{Temperature [}^\circ\text{C]} = -1,951 * 10^{-5} * \text{PW} [\mu\text{s}]^2 + 0,2595 * \text{PW} [\mu\text{s}] - 514,3$$

$$\text{SF}_6 \text{ Pressure @ 20}^\circ\text{C [bar abs.]} \approx 0.032 * F [\text{Hz}] - 0.32$$

(linearized approximation with additional error of  $\pm 0.3\%$  FS within 100 ... 250 Hz)

The relation of frequency output to SF<sub>6</sub> pressure @20°C above applies only if 100 % SF<sub>6</sub> gas is used. Density and frequency to pressure @ 20°C correlations are defined by specific isochores. Please contact us for process gases other than 100% SF<sub>6</sub>.

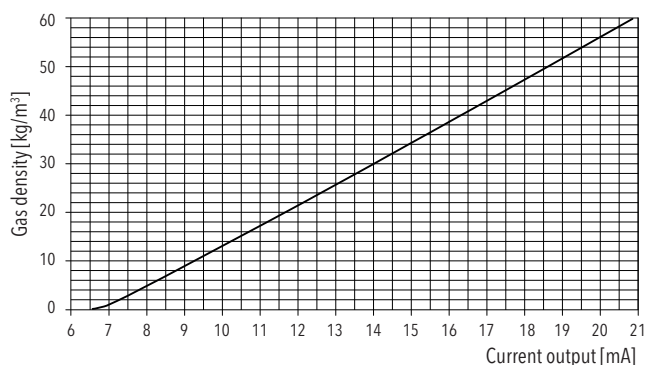
Current pulses, height typical 12-14 mA; power consumption electronics, without pulses typical 2 mA



## Conversion of output signal

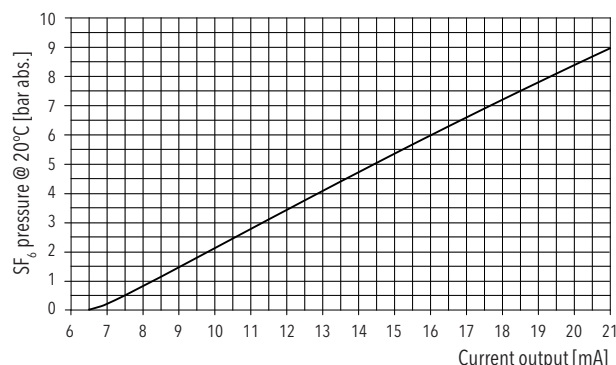
### Gas density sensor with current loop output signal

#### Relation of current output to gas density



$$\text{Gas density [kg/m}^3\text{]} = \{\sqrt{4,651 * (I [\text{mA}] - 6,005) - 2,185 - 0,44}\}^2$$

#### Relation of current output to SF<sub>6</sub> pressure @ 20°C



$$\begin{aligned} \text{SF}_6 \text{ pressure @ T [K] [kg/m}^3\text{]} = & \\ & \{0,000569502 * T [\text{K}] * \text{Density [kg/m}^3\text{]} + \\ & (0,00250695 * 0,000569502 * T [\text{K}] - \\ & 0,00073822) * \text{Density [kg/m}^3\text{]}^2 - \\ & (0,00000212238 * 0,000569502 * T [\text{K}] - \\ & 0,000000513) * \text{Density [kg/m}^3\text{]}^3\} \end{aligned}$$

$$\text{SF}_6 \text{ pressure @ 20°C [bar abs.]} \approx 0.6303 * I [\text{mA}] - 4.1419$$

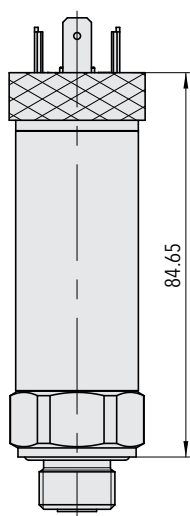
(add. non-linearity  $\pm 0.3$  FS between 9.5 and 19.25 mA)

The relation of current output to SF<sub>6</sub> pressure @20°C above applies only if 100 % SF<sub>6</sub> gas is used. Density and current to pressure @ 20°C correlations are defined by specific isochores. Please contact us for process gases other than 100% SF<sub>6</sub>.



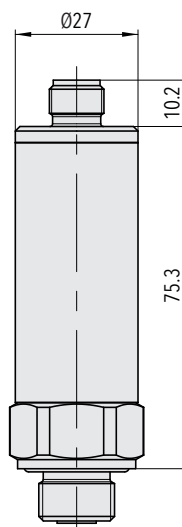
## Dimensions and process connections

### Sensor with G3/8" male process connection



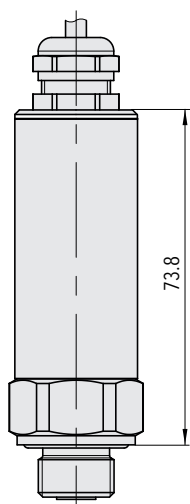
**8774.50.11.XX.04.XX.XX**

Sensor with EN 175301-803-A (DIN 43650-A) electrical connector and G3/8" male process connection



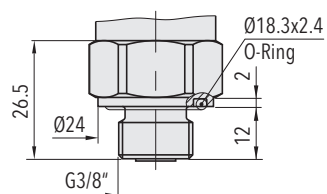
**8774.50.11.XX.35.XX.XX.XX**

Sensor with M12x1 electrical connector and G3/8" male process connection



**8774.50.11.XX.51.XX.XX.XX**

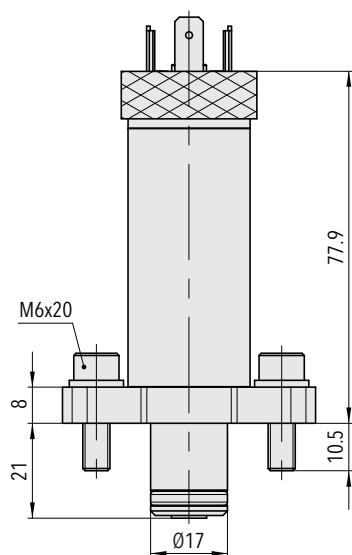
Sensor with Radox cable and G3/8" male process connection



G3/8" male process connection

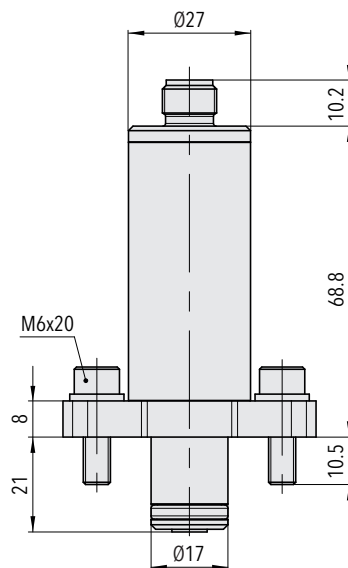
## Dimensions and process connections

### Sensor with 2-hole flange 2800 series



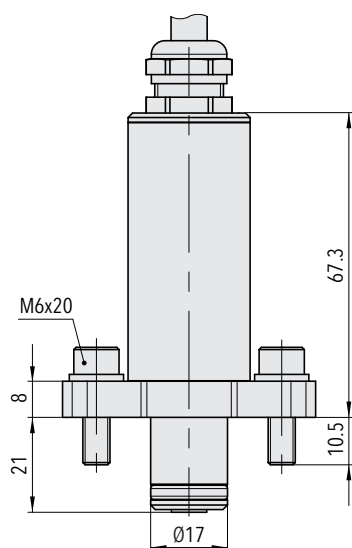
**8774.50.28.XX.04.XX.XX**

Sensor with EN 175301-803-A (DIN 43650-A) electrical connector and 2-hole flange 2800



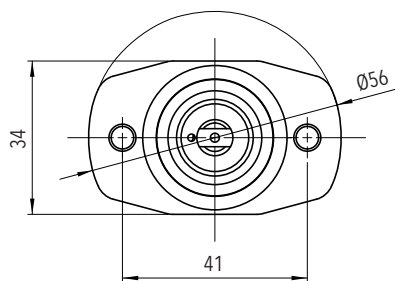
**8774.50.28.XX.35.XX.XX.XX**

Sensor with M12x1 electrical connector and 2-hole flange 2800



**8774.50.28.0.X.51.XX.XX**

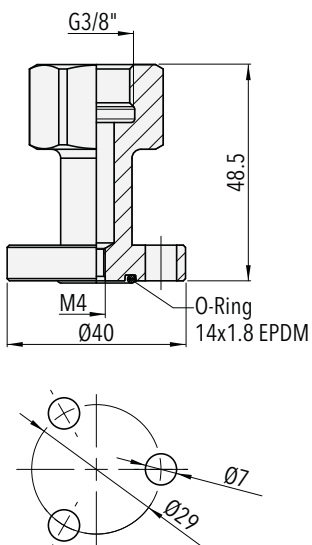
Sensor with Radox cable and 2-hole flange 2800



2-hole flange 2800

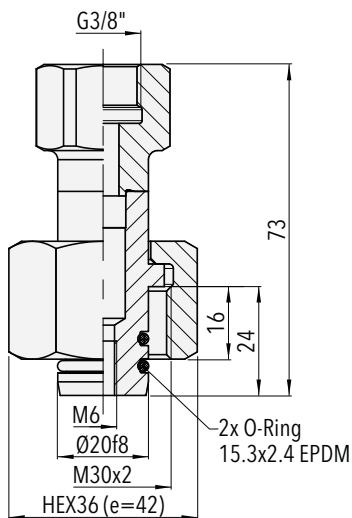
## Dimensions and process connections

### Process connection adapters



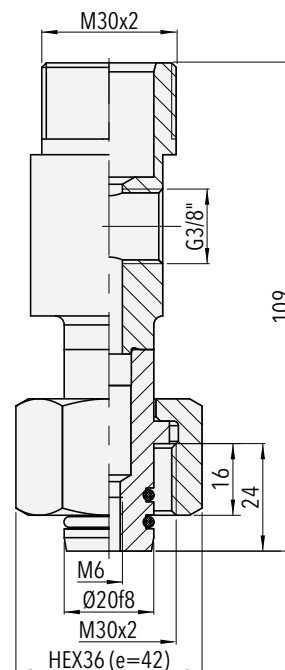
#### 8774.50.11.XX.35.XX.XX.22

Adapter G3/8" female -  
3-hole flange 2200 series  
Material: 1.4435 (AISI316L)



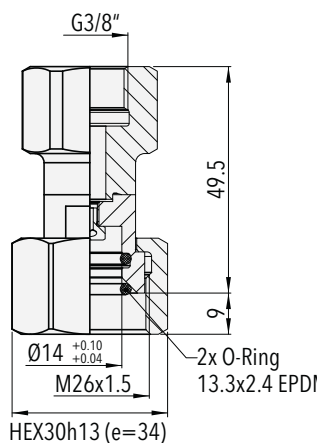
#### 8774.50.11.XX.35.XX.XX.23

Adapter G3/8" female - 2300  
Material: 1.4435 (AISI316L)  
with nickel-plated brass nut



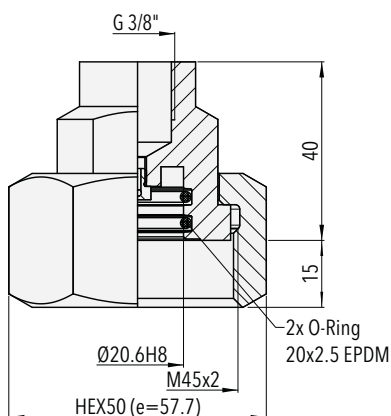
#### 8774.50.11.XX.35.XX.XX.25

T-adapter M30x2 male -  
G3/8" female - 2300  
Material: 1.4435 (AISI316L)  
with nickel-plated brass nut



#### 8774.50.11.XX.35.XX.XX.27

Adapter G3/8" female - 2550 for DN8  
Material: 1.4404 (AISI316L)  
with nickel-plated brass nut



#### 8774.50.11.XX.35.XX.XX.28

Adapter G3/8" female - 2570 for DN20  
Material: 1.4435 (AISI316L)  
with nickel-plated brass nut