

GAS DENSITY SENSOR WITH ANALOG OUTPUT

Swiss based Trafag offers precise, reliable and maintenance-free instruments developed for density measuring of SF₆ 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
- SF₆ 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 output signal

03/2021

Data sheet H72507x

Technical Data

Measuring principle	Oscillating quartz	Supply voltage	<ul style="list-style-type: none"> • Pulse-width: 10 ... 20 VDC • Current loop: 10 ... 32 VDC
Measuring range	<ul style="list-style-type: none"> • Pulse-width: 0 ... 60 kg/m³ • Current loop: 0 ... 56.1 kg/m³ 	Ambient temperature	-40°C ... +80°C
Output signal	<ul style="list-style-type: none"> • Pulse-width: 10 ... 292 Hz • Current loop: 6.5 ... 20 mA 		

Subject to change

Ordering information/type code

		8774.	XX	XX	XX	XX	XX
Density measuring range	0...60 kg/m ³ for pulse-width output						
	0...56.1 kg/m ³ for current loop output	50					
Process connections	G3/8" male			11			
	2-hole flange 2800 series			28			
Sensor outputs	Pulse-width modulation				00		
	Current loop				04		
Electrical connections	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 ²					51	
Options	Female electrical plugs						
	EN 175301-803-A (DIN 43650-A), 4-pole						58
	M12x1, 5-pole, A-coding						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						25

Further customised parameterisation to be indicated

Process gas	SF ₆ , SF ₆ mixed gas, customer specific alternative gas
Gas pressure @ 20°C	Requirement for SF ₆ mixed gas or customer specific alternative gas
Length of shielded Radox cable	Length in mm

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

Specifications		
Electronical density measuring	Measuring principle	Oscillating quartz sensor ⁴⁾
	Density measuring range ¹⁾	<ul style="list-style-type: none"> • Pulse-width: 0 ... 60 kg/m³ 0 ... 1100 kPa abs. @ 20°C • Current loop: 0 ... 56.1 kg/m³ 0 ... 1100 kPa abs. @ 20°C
	Temperature measuring range ²⁾	-40°C ... +80°C
	Sensor output	<ul style="list-style-type: none"> • Pulse-width: 10 ... 292 Hz • Current loop: 6.5 ... 20 mA
	Output parameter	<ul style="list-style-type: none"> • Pulse-width: Gas density [kg/m³], gas temperature [°C] • Current loop: Gas density [kg/m³]
Electrical data	Supply voltage	<ul style="list-style-type: none"> • Pulse-width: 10 ... 20 VDC • Current loop: 10 ... 32 VDC
	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)
Environmental conditions	Ambient temperature	-40°C ... +80°C ⁵⁾
	Protection ³⁾	IP65 / 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 ₆ leakage rate less than 1·10 ⁻⁸ mbar · l/s
EMC protection	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
Mechanical data	Process gas wetted material	Process connection and measuring system: 1.4435 (AISI316L) Sealing: EPDM ⁶⁾
	Housing	1.4301 (AISI304)
	Weight	~ 200 ... 400 g

¹⁾ Shown density pressure correlation corresponds to 100 % SF₆ gas. Maximum value is either 60 kg/m³ (pulse-width) respectively 56.1 kg/m³ (current loop) or 1100 kPa abs. @ 20°C, whichever is reached first.

²⁾ Temperature measurement for sensor with pulse-width output only

³⁾ While using an appropriate female electrical plug

⁴⁾ The oscillating quartz sensor principle is a direct density measurement and is fully independent from the process gas composition. Measuring range is based on density pressure correlation which is defined by the particular gas isochores and is specifically fitted. Please contact us for process gases other than 100 % SF₆.

⁵⁾ Approved for extended temperature range -60°C ... +80°C for 200h max. per year

⁶⁾ SF₆ qualified

Accuracy	
Density measurement	± 1.0 % FS typ. ± 1.8 % FS max.
Temperature measurement ¹⁾	± 1.0 % FS typ. ± 3.0 % FS max.
Repeatability density measurement	± 0.2 % FS
Repeatability temperature measurement ¹⁾	± 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

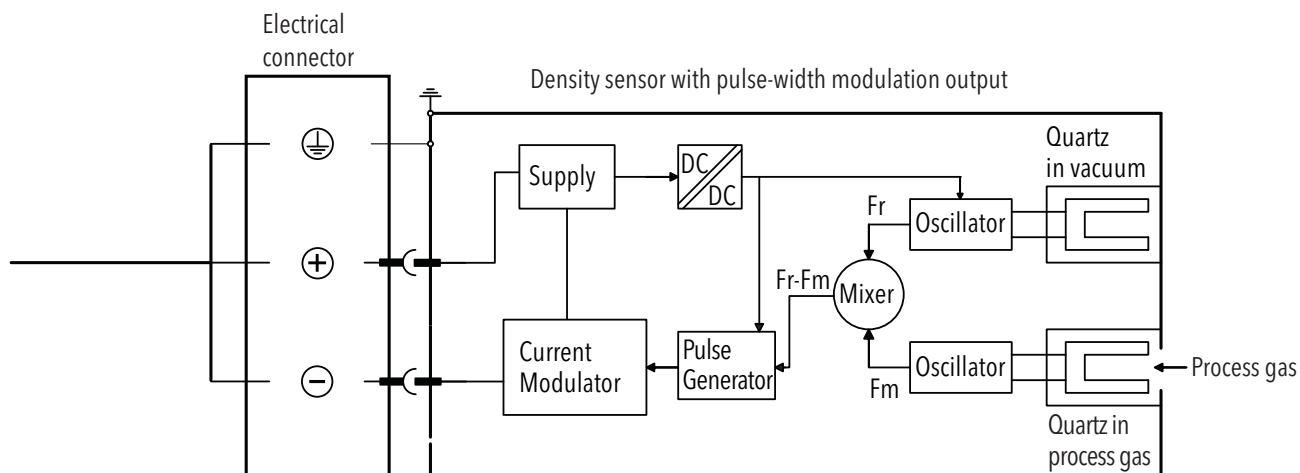
¹⁾ Temperature measurement for sensor with pulse-width output only

Additional information		
Documents	Data sheet	www.trafag.com/H72507
	Instructions	www.trafag.com/H73507
	Flyer	www.trafag.com/H71108

Electrical connections and options

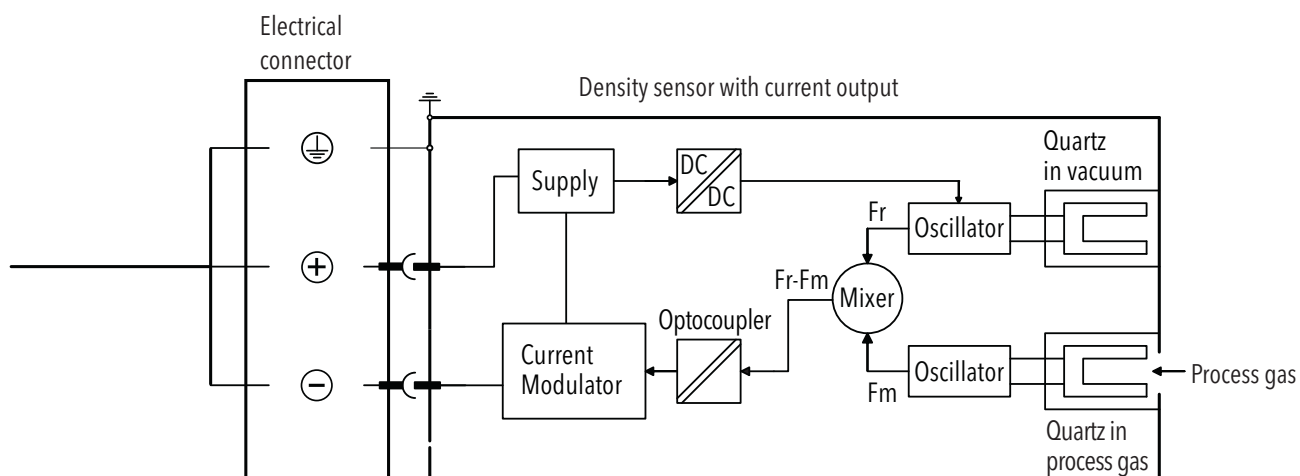
Wiring diagram pulse-width modulation

8774.50.XX.00.XX.XX.XX



Wiring diagram current loop

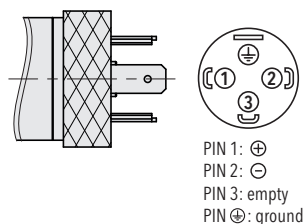
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Electrical connections and options

Male electrical connector

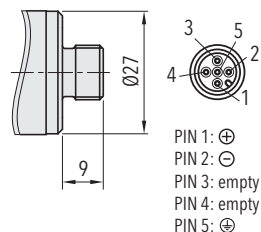
EN 175301-083-A (DIN43650-A), 4-pole ¹⁾



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Material: Collar nut 1.4305 with PA contact holder

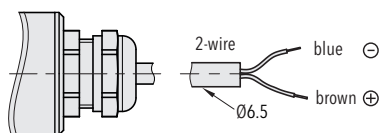
Male electrical connector M12x1, 5-pole, A-coding ²⁾



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Material: Thread 1.4435 with PA contact holder

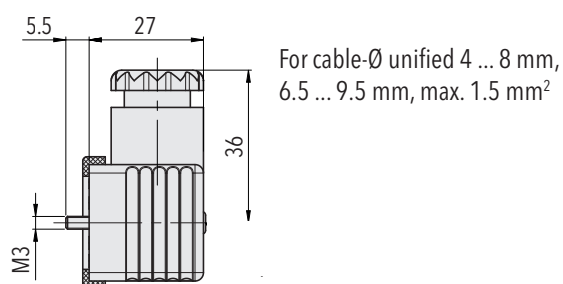
Shielded cable Radox 125, 2 x 0.5 mm² ³⁾



8774.50.XX.XX.51.XX.XX

Material: EMC-cable gland brass nickel-plated

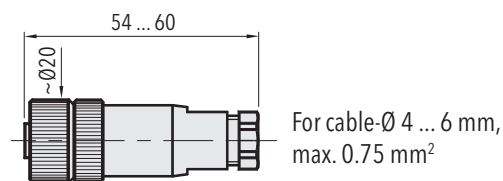
Female electrical plug EN 175301-803-A (DIN 43650-A), 4-pole ¹⁾



8774.50.XX.XX.04.58.XX

Material: Polyamide (PA)

Female electrical plug M12x1, 5-pole, A-coding ²⁾



8774.50.XX.XX.35.33/35.XX

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

¹⁾ IP65 protection in combination with plug while mounted according to instructions

²⁾ IP67 protection in combination with plug while mounted according to instructions

³⁾ IP 67 protection

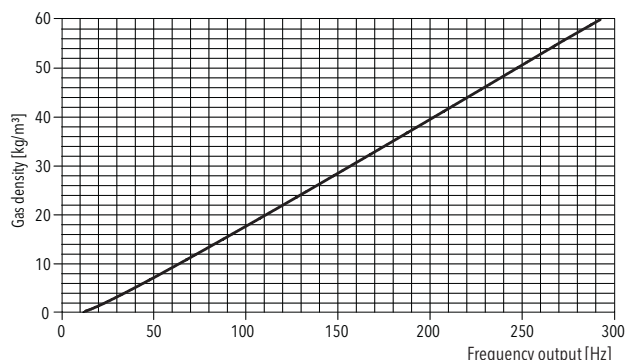


Instruction www.trafag.com/H73507

Conversion of output signal

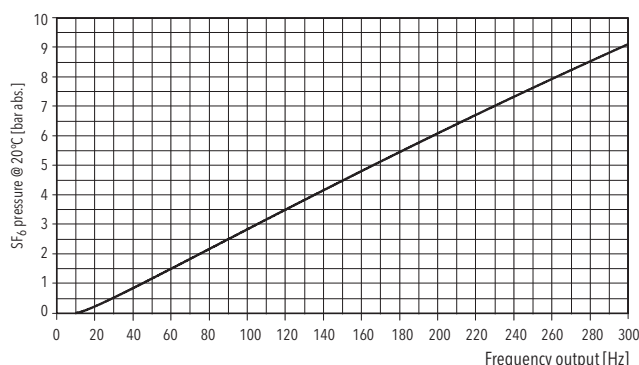
Gas density sensor with pulse-width modulation output signal

Relation of frequency output to gas density



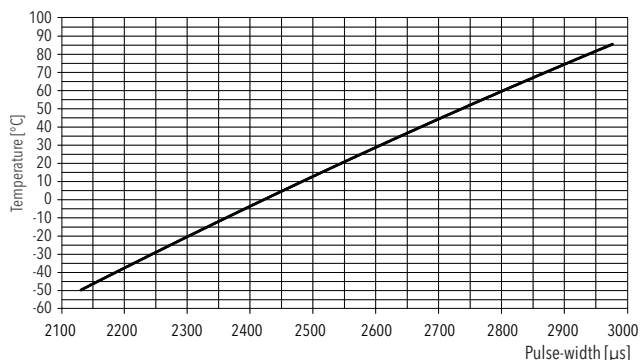
$$\text{Gas density [kg/m}^3] = \{\sqrt{(0,237 * F [\text{Hz}]) - 2,182 - 0,44}^2$$

Relation of frequency output to SF₆ 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



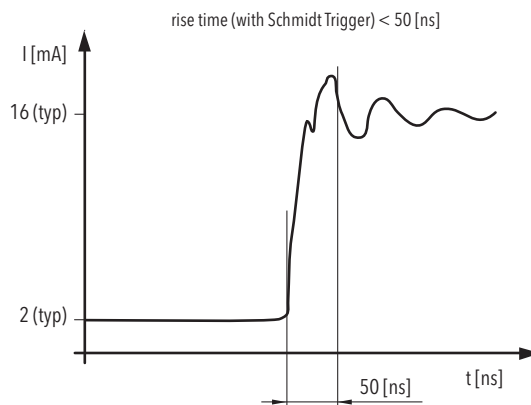
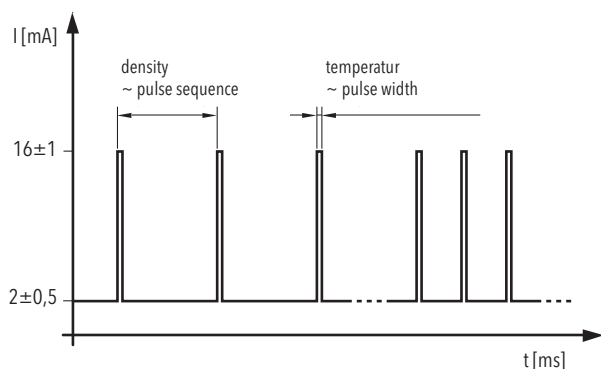
$$\text{Temperature [}^\circ\text{C]} = -1,951 * 10^{-5} * \text{PW} [\mu\text{s}]^2 + 0,2595 * \text{PW} [\mu\text{s}] - 514,3$$

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

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

The relation of frequency output to SF₆ pressure @20°C above applies only if 100 % SF₆ gas is used. Frequency to pressure @ 20°C correlation is defined by specific isochores. Please contact us for process gases other than 100% SF₆.

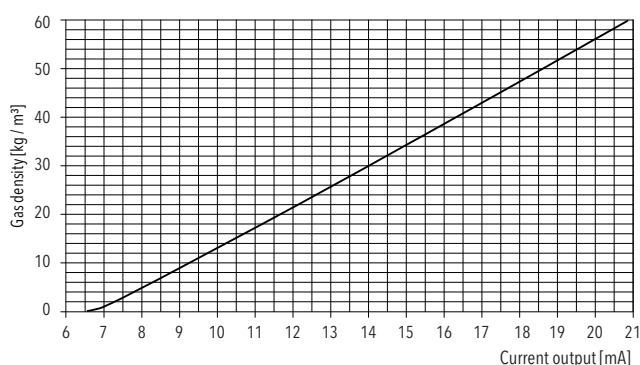
Current pulses, height typical 12-14 mA; power consumption electronics, without pulses typical 2 mA



Conversion of output signal

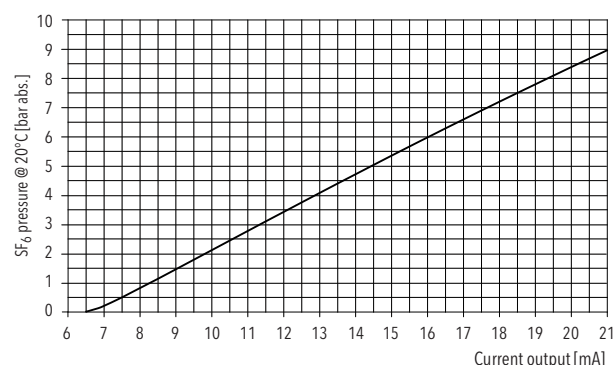
Gas density sensor with current loop output signal

Relation of current output to gas density



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

Relation of current output to SF₆ pressure @ 20°C



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

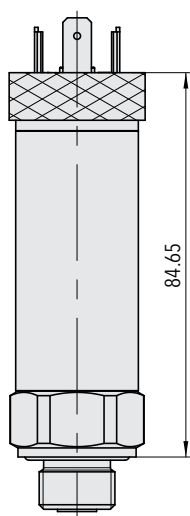
$$\text{SF}_6 \text{ pressure @ 20°C [bar abs.]} \approx 0.6303 * I [\text{mA}] - 4.1419$$

(add. non-linearity ± 0.3 FS between 9.5 and 19.25 mA)

The relation of current output to SF₆ pressure @20°C above applies only if 100 % SF₆ gas is used. Current to pressure @ 20°C correlation is defined by specific isochores. Please contact us for process gases other than 100% SF₆.

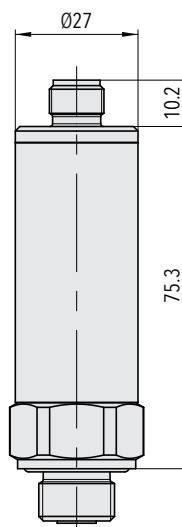
Dimensions and process connections

Sensor with G3/8" male process connection



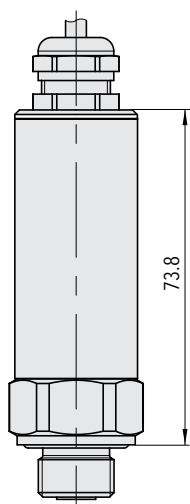
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Sensor with EN 175301-803-A (DIN 43650-A) electrical connector and G3/8" male process connection



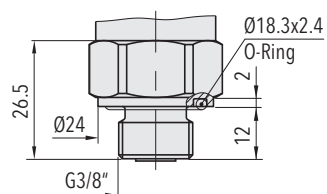
8774.50.11.XX.35.XX.XX.XX

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



8774.50.11.XX.51.XX.XX.XX

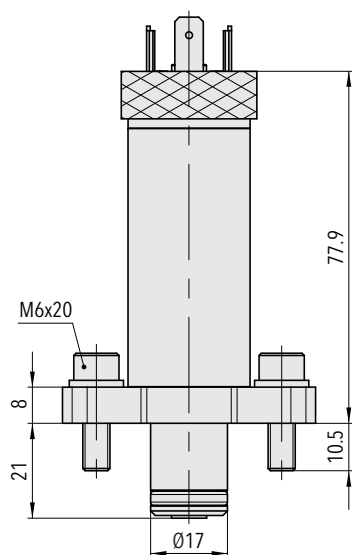
Sensor with Radox cable and G3/8" male process connection



G3/8" male process connection

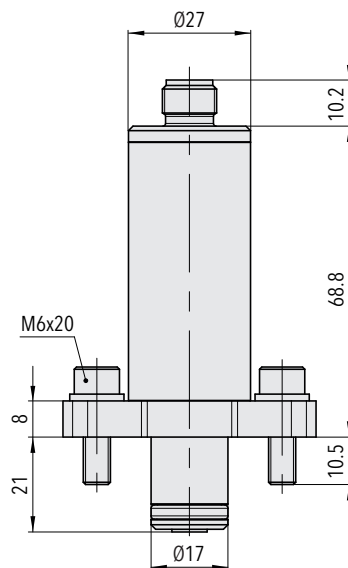
Dimensions and process connections

Sensor with 2-hole flange 2800 series



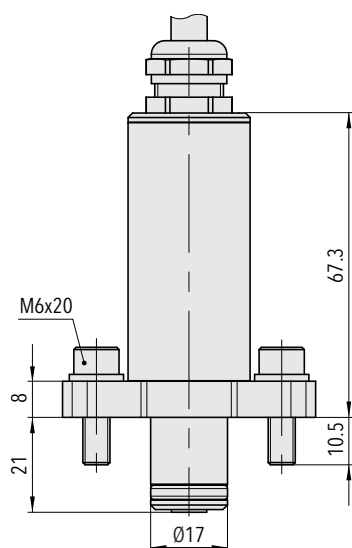
8774.50.28.XX.04.XX.XX

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



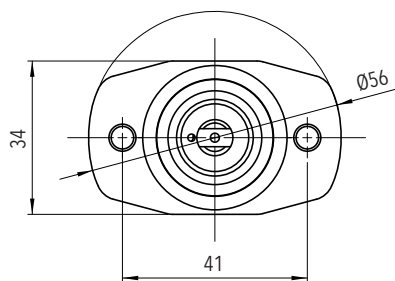
8774.50.28.XX.35.XX.XX.XX

Sensor with M12x1 electrical connector and 2-hole flange 2800



8774.50.28.0.X.51.XX.XX

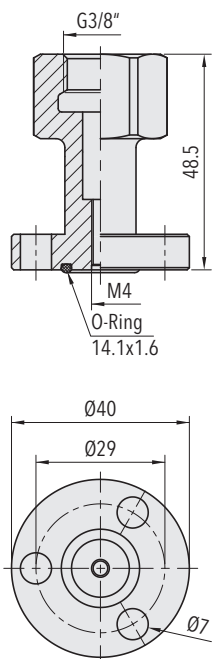
Sensor with Radox cable and 2-hole flange 2800



2-hole flange 2800

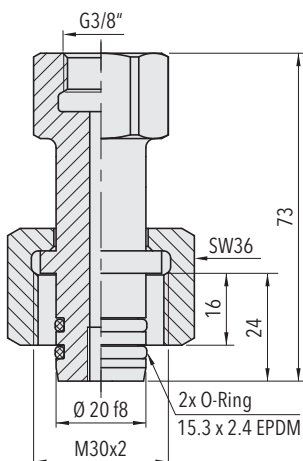
Dimensions and process connections

Process connection adapters



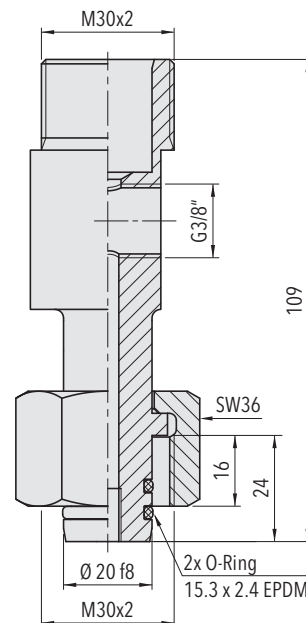
8774.50.11.XX.35.XX.XX.22

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



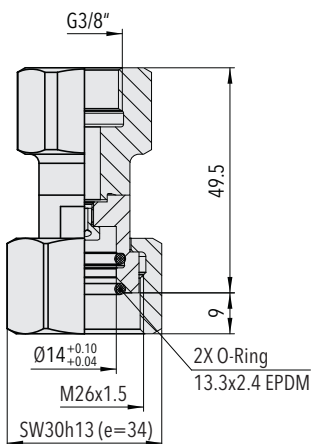
8774.50.11.XX.35.XX.XX.23

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



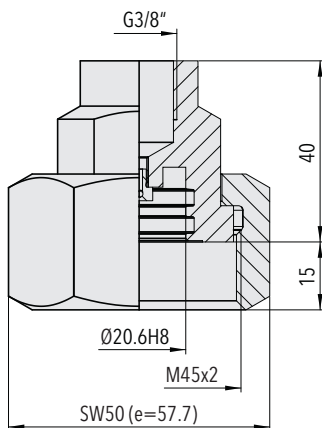
8774.50.11.XX.35.XX.XX.25

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



8774.50.11.XX.35.XX.XX.27

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



8774.50.11.XX.35.XX.XX.28

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