HYBRID GAS DENSITY MONITOR WITH SWITCHING CONTACTS AND MODBUS OUTPUT

Swiss based Trafag offers precise, reliable and maintenance-free instruments, developed for density monitoring of SF_6 and alternative gases. Measurement is based on the gas density reference principle or the patented quartz tuning fork technology. Hybrid monitors combine both principles in one instrument. Thus offering the most reliable solution on the market by directly measuring the gas density.

Applications

- High voltage technology
- Medium voltage technology
- SF_6 and variety of alternative mixed gases

Features

- Exact switching output at all temperatures
- No contact bouncing
- Continuous density measurement
- Long term drift free sensor output signal
- Maintenance free indoor and outdoor use

11/2022
Data sheet H725170
Subject to change

Technical Data			
Measuring principle	• Monitor: Absolute pressure reference gas measuring system • Sensor: Oscillating quartz	Quantity of switchpoints	1 ... 3 microswitches
Measuring range	• Monitor: 0 …1100 kPa abs. @ 20°C • Sensor: 0 ... 60 kg/m³ 0 ... 1100 kPa abs. @ 20°C	Dial	Scale and units selectable
Output signal	• Monitor: Floating change-over contact (SPDT) • Sensor: RS485/Modbus (RTU)	Ambient temperature	-40°C ... +80°C

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trafag sensors controls

Ordering information/type code

		XXXX	XX	XXXX	XX	XX	XX	XX
Custom build code	**Hybrid gas density monitor with microswitches and RS485/modbus output**	**879X**						
	One microswitch	**8791**						
	Two microswitches	**8792**						
	Three microswitches	**8793**						
Wire terminal block	Standard wire terminal		**21**					
	Wire terminal (old version, do not use for new installations)		**22**					
Pressure connection	Threaded, axial and radial types			**1XXX**				
	Flanged and cap nut, axial and radial types			**2XXX**				
	Compartment immersion types [1]			**5XXX**				
Code number	Determined by Trafag				**XX**			
Options	Basic density indicator dial with two colour sectors without markings					**60**		
	Density indicator dial with scale according to customer specification					**61**		
	Low pressure indicator					**66**		
	Process gas wetted O-rings composed of IIR					**C2**		
	Microswitch outlet							
	EMC-cable gland M20x1.5, brass nickel-plated, for cable-ø 7 ... 12.5 [mm]					**10**		
	EMC-cable gland M20x1.5, brass nickel-plated, for cable-ø 8 ... 11 [mm]					**07**		
	EMC-cable gland M20x1.5, brass nickel-plated, for cable-ø 11 ... 14 [mm]					**08**		
	EMC-cable gland M25x1.5, brass nickel-plated, for cable-ø 8 ... 16 [mm]					**11**		
	EMC-cable gland M25x1.5, brass nickel-plated, for cable-ø 12.5 ... 20.5 [mm]					**17**		
	ITT Cannon connector					**12**		
	Blank plug M20x1.5, brass nickel-plated [2]					**13**		
	Blank plug M25x1.5, brass nickel-plated [2]					**04**		
	Blank plug M25x1.5, PA [2] [3]					**05**		
	Sensor outlet							
	EMC-cable gland M20x1.5, brass nickel-plated, for cable-ø 4 … 10 [mm]					**U8**		
	EMC-cable gland M20x1.5, brass nickel-plated, for cable-ø 7 … 12.5 [mm]					**U1**		
	EMC-cable gland M20x1.5, brass nickel-plated, for cable-ø 8 … 11 [mm]					**U6**		
	EMC-cable gland M20x1.5, brass nickel-plated, for cable-ø 11 … 14 [mm]					**U3**		
	Male electrical connector M12x1, 5-pole, A-coding					**U5**		
	Blank plug M20x1.5, brass nickel-plated [2]					**U2**		
	Integrated densitiy monitor test valve for DN8 coupling with M26x1.5 protective cap							
	Standard test port orientation					**W3**		
	Test port orientation 180°					**W0**		
	Test port orientation 270°					**W1**		
	Test port orientation 90°					**W2**		
	Integrated process gas test and re-filling valve for DN8 coupling with M26x1.5 protective cap							
	Standard filling port orientation					**F3**		
	Filling port orientation 180°					**F0**		
	Filling port orientation 270°					**F1**		
	Filling port orientation 90°					**F2**		

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Modbus settings	Baudrate and parity fixed	
	Baudrate 9600 and parity even (1 stop bit)	**76**
	Baudrate 19200 and parity even (1 stop bit)	**77**
	Baudrate and parity customised [4]	**78**
	Baudrate and parity open configurable	
	Default baudrate 19200, parity even (1 stop bit)	**79**
	Default settings customised [4]	**80**
	Server-ID	
	Open configurable (default ID = 1)	**95**
	Increasing number per order, start-ID selectable from 1 ... 247	**96**
	Fixed, customised per order, selectable from 1 ... 247	**97**

Accessories	Female electrical plugs	
	M12x1, 5-pole, A-coding, PA	**33**
	M12x1, 5-pole, A-coding, brass nickel-plated	**35**
	Thermal insulation ring for probe housing	**06**
	Thermal foam cover with drain holes	**37**
	Weather protection cover	**46**
	Pressure connection adapter 2300 - G1/2" male	**N1**

[1] Requires single-cable connection by microswitch outlet
[2] Select if EMC-cable gland is procured locally
[3] Without IP compatibility, not for use in operation
[4] Selectable baudrate: 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 56000, 57600
Selectable parity: none (2 stop bits), odd (1 stop bit), even (1 stop bit)

Further customised parameterisation to be indicated	
Process gas	SF_6, SF_6- based mixed gas, customer specific alternative gas
Variety of units for density dial	kPa, bar, MPa (abs., rel.[1]), psi (a., g.[1]), kg/m^2, kg/cm^2, also dual units available
Switchpoint @ 20°C [2]	Microswitch 1, p= xxx
	Microswitch 2, p= xxx
	Microswitch 3, p= xxx
Gas pressure @ 20°C	Requirement for specific process gas if other than 100 % SF_6

[1] Monitoring principle is based on absolute pressure reference system and is accordingly calibrated. While using relative dial units, local ambient pressure (e.g. altitude or weather derivations) has to be considered if comparing to local installed relative pressure gauges

[2] Factory setting for decreasing or increasing pressure available

Specifications		
Mechanical density monitoring	Monitoring principle	Absolute pressure measuring system with sealed reference gas chamber, fully temperature compensated by design [3]
	Monitoring range	0 ... 1100 kPa abs. @ 20°C
	Monitoring output	Floating change-over contact (SPDT)
	Quantity of switchpoints	1 ... 3 microswitches
	Monitoring accuracy	Refer to density indicator and microswitch sections
Electronical density measuring	Measuring principle	Oscillating quartz sensor
	Density measuring range [1]	0 ... 60 kg / m^3 0 ... 1100 kPa abs. @ 20°C
	Temperature measuring range	-40°C ... +80°C
	Sensor output	RS485/Modbus (RTU)
	Output parameter	Gas density [kg/m^3], gas pressure [kPa abs.] @ 20°C, gas temperature [K], gas pressure [kPa abs.] @ temperature variable [K]
Environmental conditions	Ambient temperature	-40°C ... +80°C [4]
	Protection [2]	IP65 and IP67
	Humidity	IEC 60068-2-30 (damp heat, cyclic, 100 % RH @ +55°C), membrane provides condensation compensation
	Overpressure	1300 kPa abs.
	Shock	70 g / 3 ms / 10'000 times at all axes excited on process connection without damage to instrument
	Routine inspection of gas tightness	Integral pressure testing with 6 bar rel. helium, SF_6 leakage rate less than $1 \cdot 10^{-8}$ mbar · l/s
Mechanical data	Process gas wetted material	Process connection and measuring system: 1.4404, 1.4435, 1.4571 (AISI316L, AISI316Ti) Test and re-filling valve: 1.4404 (AISI316L), CuZn39Pb3 (C38500) Sealing: EPDM [5], IIR as option
	Housing	AlSi10Mg, powder coated
	Screwed cable gland	Brass nickel plated, PA as option
	Dial	Dial face and pointer: Aluminium sheet Window: PMMA
	Weight	Hybrid density monitor: ~1000 g Hybrid density monitor with integrated test or re-filling valve ~ 1100 ... 1300 g

[1] The oscillating quartz sensor principle is a direct density measurement. Shown density / pressure @ 20°C correlation corresponds to 100 % SF_6 gas. Maximum value is either 60 kg/m^3 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_6

[2] While using appropriate cable gland and/or mating connector mounted according to instruction

[3] Depending on process gas requirements, the fully sealed reference gas chamber contains up to 0.001kg of SF_6. The relevant national regulations governing the disposal of hazardous waste apply and must be followed. Decommissioned or defective monitors can be returned to the manufacturer for disposal in a safe and environmentally appropriate manner

[4] Approved for extended temperature range –55°C … +80°C for 200h max. per year

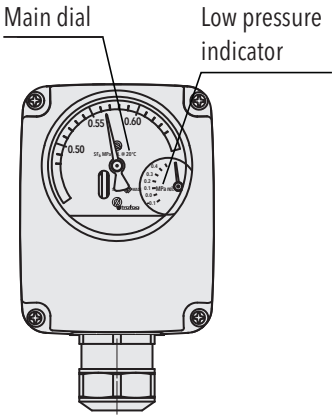
[5] SF_6 qualified

Density indicator		
	Main dial	**Low pressure indication option**
Indicator principle	Absolute pressure, fully temperature compensated by means of sealed reference gas chamber	Indication of relative pressure, for safety reason it is not temperature compensated
Scale	Colour sectors (standard red/yellow/green or red/green), switchpoint markings, single or dual units	Single unit, graduated range
Unit	Optional kPa, bar, MPa (abs., rel.[1]), psi (a., g.[1]), kg/m², kg/cm², customer specific units available	According to main dial unit (rel., g.)
Numbered range	Up to 180 kPa @ 20°C between lowest and highest indicated value [2]	Vacuum up to lowest switchpoint, 500 kPa rel. max.
Accuracy within numbered range	± 10 kPa @ 20°C	Up to 200 kPa rel.: ± 20 kPa Up to 500 kPa rel.: ± 10% MV

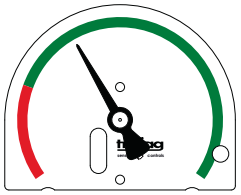
[1] Monitoring principle is based on absolute pressure reference system and is accordingly calibrated. While using relative dial units, local ambient pressure (e.g. altitude or weather derivations) has to be considered if comparing to local installed relative pressure gauges

[2] Typically ranges are from lock-out switchpoint to filling pressure (no high-alarm), or from lock-out switchpoint to high-alarm switchpoint

Hybrid density monitor with main dial and low pressure indicator in standard orientation
(electrical connection in 6 o'clock position).



Density indicator dial according to customer specification
Availabilty of a full variety of units including dual range indication, this also includes dial rotated by 90°/180°/270°.



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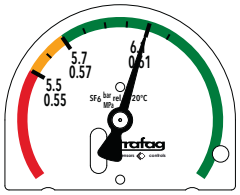

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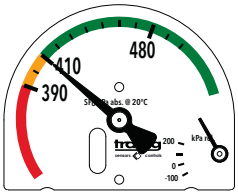

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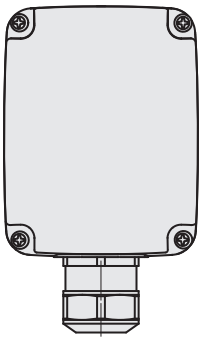
Hybrid monitor without indication dial



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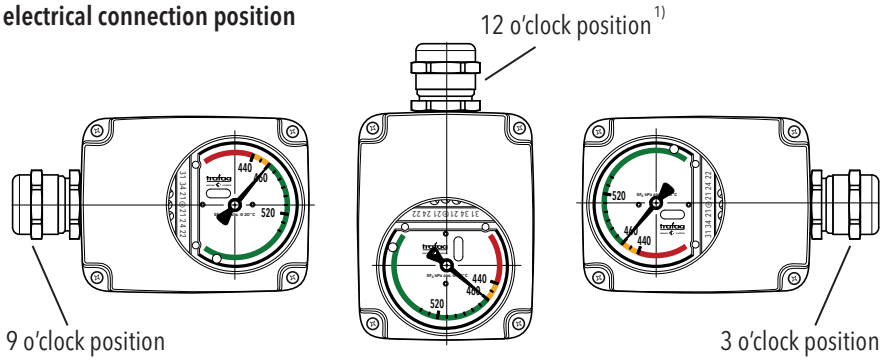
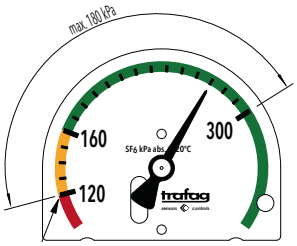
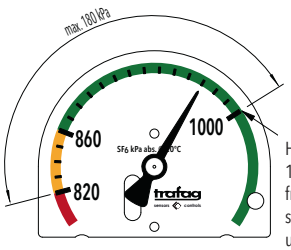
Customised dial orientation based on electrical connection position





Lowest switchpoint setting:
120 kPa abs. @ 20°C,
Distance from lowest to highest switchpoint:
up to 180 kPa @ 20°C



Highest switchpoint setting:
1000 kPa abs. @ 20°C, Distance from lowest to highest switchpoint:
up to 180 kPa @ 20°C

[1] Should only be used for indoor applications while using neither a weather protection cover nor a thermal foam cover

Microswitch and switchpoint		
Microswitch	Output signal	Floating change-over contact (SPDT)
	Resistive load (Inductive load)	AC - 250 V/10 (1.5) A DC - 250 V/0.1 (0.05) A, 220 V/0.25 (0.2) A, 110 V/0.5 (0.3) A, 24 V/2 (1) A
	Resistance of insulation	>100 MΩ, 500 VDC, ex factory
	Dielectric strength	2 kVAC, 50Hz, terminal to ground (earth)
	Switching cycle capacity	Up to 1 Mio. mechanical, more than 10'000 with maximum load
	Effect of vibration	4 g / 20…100 Hz effects no contact bounce at 5 kPa minimum distance from set switchpoint
Switchpoint setting	Factory adjustment	According to customer specification, [1] standard setting is for decreasing pressure
	Lowest switchpoint setting	120 kPa abs. @ 20°C
	Highest switchpoint setting	1000 kPa abs. @ 20°C
	Distance from the lowest to the highest switchpoint [2]	Up to 180 kPa @ 20°C
	Switching differential	3 ... 7 kPa typ. (15 kPa max.) if lowest to highest switchpoint distance is up to 130 kPa 5 ... 10 kPa typ. (20 kPa max.) if lowest to highest switchpoint distance is 130 ... 180 kPa

[1] Especially in areas with high daily temperature fluctuations it is recommended to maintain a minimum switchpoint distance of 40-60 kPa from filling pressure to surrounding switchpoint(s). Please contact us for more information

[2] Distance from lock-out to high-alarm pressure, or from lock-out to filling pressure (no high-alarm)

Switchpoint accuracy				
		+20°C	**-30°C ... +50°C**	**-40°C ... +60°C**
First alarm switchpoint setting pressure abs. @ 20°C [1]				
≤ 650 kPa	[kPa max.]	± 8	± 10	± 12
> 650 kPa	[kPa max.]	± 8	± 12	± 14
High pressure alarm [1] [2]	[kPa max.]	± 10	± 16	± 20

[1] While no liquefaction occurs and the insulation gas is completely gaseous

[2] Only applicable if factory adjustment includes high-alarm switchpoint above filling pressure

Additional information		
Documents	Data sheet	www.trafag.com/H72517
	Instructions	www.trafag.com/H73520
	Flyer	www.trafag.com/H71106

Density sensor		
Electrical data	Supply voltage	11 ... 32 VDC
	Current consumption	@ 24 VDC: 22 mA typ. / 40 mA max. @ 11 VDC: 47 mA typ. @ 32 VDC: 18 mA typ.
	Earthing	Via process connection or wire terminal
	Resistance of insulation	>100 MΩ, 500 VDC, ex factory
	Dielectric strength	500 VAC, 50 Hz, terminal to ground (earth)
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
Modbus settings	Baudrate	Default 9600 or 19200, optional selectable from 1200 ... 57600 [1)]
	Parity	Default even (1 stop bit), optional selectable odd (1 stop bit) or none (2 stop bits)
	Server-ID	Selectable from 1 … 247
	Devices in one bus	Up to 64
Accuracy	Density measurement [2)]	± 1.0 % FS typ. ± 1.8 % FS max.
	Temperature measurement	± 1.0 % FS typ. ± 3.0 % FS max.
	Resolution density output	13 bit
	Resolution temperature output	10 bit
	Repeatability density measurement	± 0.2 % FS
	Repeatability temperature measurement	± 0.1 % FS
	Transient response time required for signal output to reach accuracy tolerance band	Less than 1 h after connecting monitor to pressurised compartment Less than 1 min. when monitor is vacuumised together with compartment before gas filling
	Measurement output signal refresh time [3)]	Less than 40 ms

[1)] See ordering information

[2)] Total error band (TEB) for defined ambient temperature range while the insulation gas is completely gaseous

[3)] The refresh time mainly depends on the density been measured as the oscillating quartz sensor generates a basic frequency signal. A typical refresh time for a density of 40 kg/m³ is 7 ms, for a density of 10 kg/m³ it is 20 ms.

Electrical connections

Standard wiring terminal is divided into microswitch (X1) and density sensor (X2) block by default
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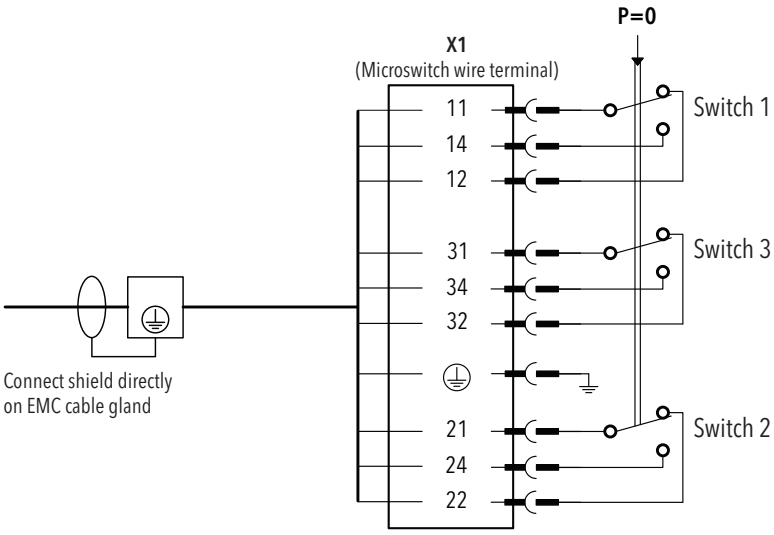
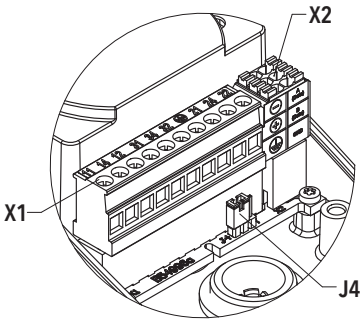
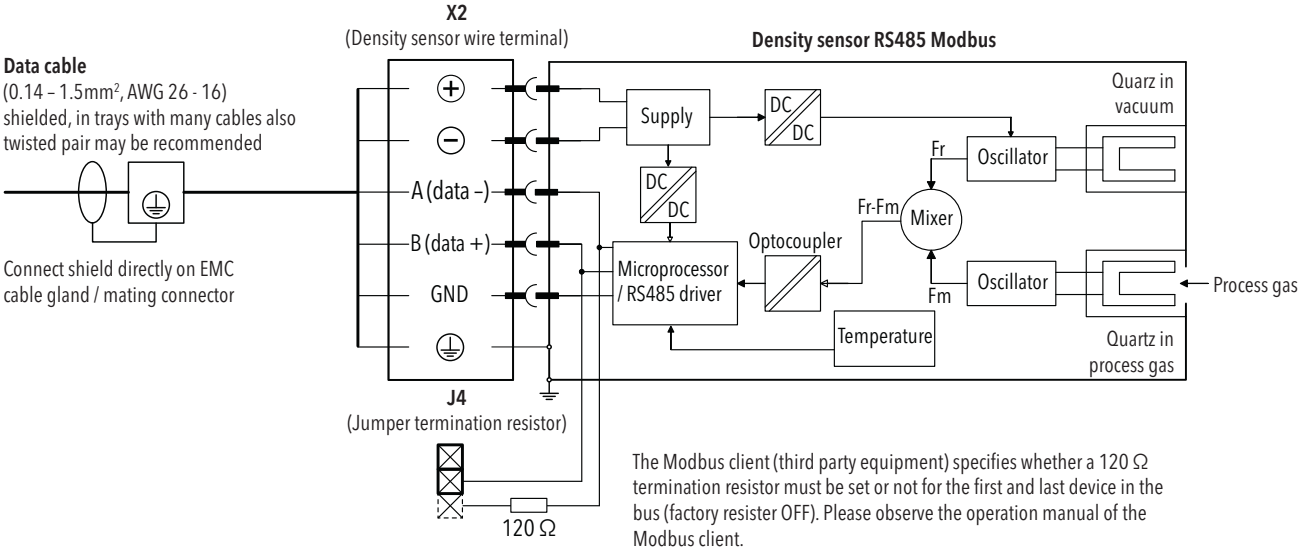
Number of microswitches according to customer application

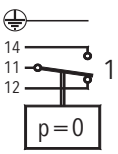






The Modbus client (third party equipment) specifies whether a 120 Ω termination resistor must be set or not for the first and last device in the bus (factory resister OFF). Please observe the operation manual of the Modbus client.

Microswitch in non-pressurised condition (p=0)



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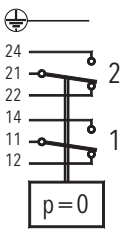

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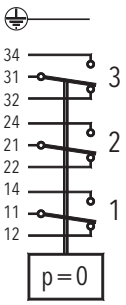

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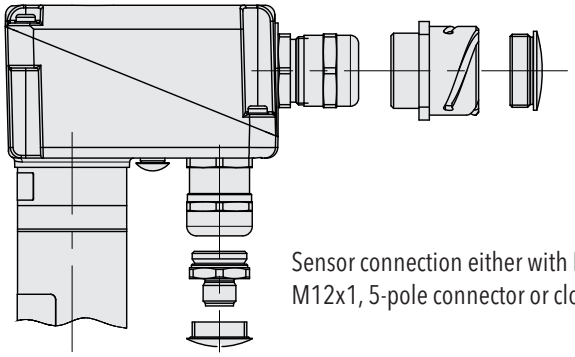
Connected with all electrically conductive elements of the density monitor

Instruction: www.trafag.com/ H73520

Electrical connections

Connections for microswitch and density sensor		
	Microswitch connection	**Density sensor connection**
EMC-cable gland	See ordering information	See ordering information
Wire terminal	Plugable, 0.2 ... 2.5 mm², 10-pins	Plugable, 0.14 ... 1.5 mm², 6-pins
Connector option	ITT Cannon	M12x1, 5-pole, A-coding

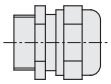


Microswitch connection either with EMC-cable gland, ITT Cannon connector or closed with blank plug.

Sensor connection either with EMC-cable gland, M12x1, 5-pole connector or closed with blank plug

Electrical connection

EMC-cable gland [1]



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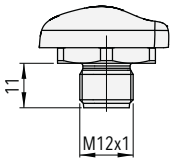
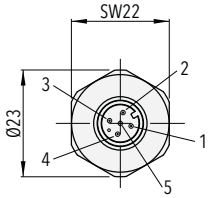
Type code 07 ... U8,
see ordering information

Male electrical connector M12x1, 5-pole, A-coding [2] [3] [4]

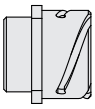


Material: Thread 1.4435 with PA contact holder



PIN 1: ⊕ PIN 4: B (data +)
PIN 2: GND PIN 5: A (data –)
PIN 3: ⊖

ITT Cannon connector [2] [4] [5]



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Blank plug [1]

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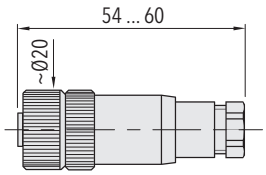
Type code 04 ... 02,
see ordering information

Accessories

Female electrical plug M12x1, 5-pole, A-coding [6]

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



For cable-Ø 4 ... 6 mm, max. 0.75 mm²

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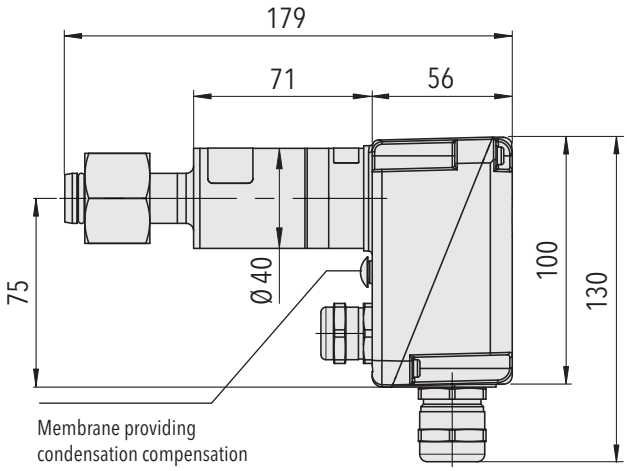
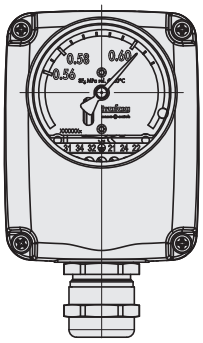
[1] IP 65 and IP 67 protection, exceptions are indicated in ordering information/type code
[2] Monitor internal wiring provided
[3] Space recommendation when connecting a T-piece connector: Use of a > 0.25 m shielded cable with female to male straight connectors between density sensor connection and T-piece to avoid orientation restriction due to connector coding
[4] IP 65 and IP 67 protection while using an equivalent mating connector mounted according to instruction
[5] Please contact us for standard pin-out and more details. Monitor internal wiring provided.
Sheltering options are limited to weather protection cover (46) and/or thermal insulation ring (06) for probe housing.
[6] IP 67 protection while connector and plug are mounted according to instruction

Typical dimensions of hybrid density monitor

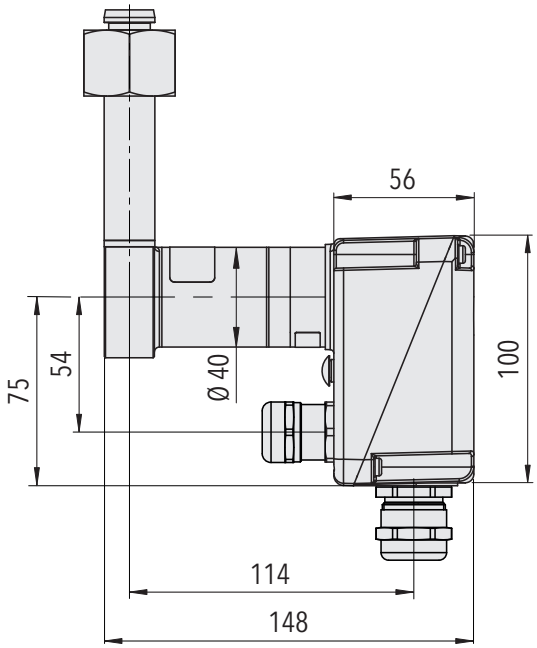
Example model with axial process connection and cap nut

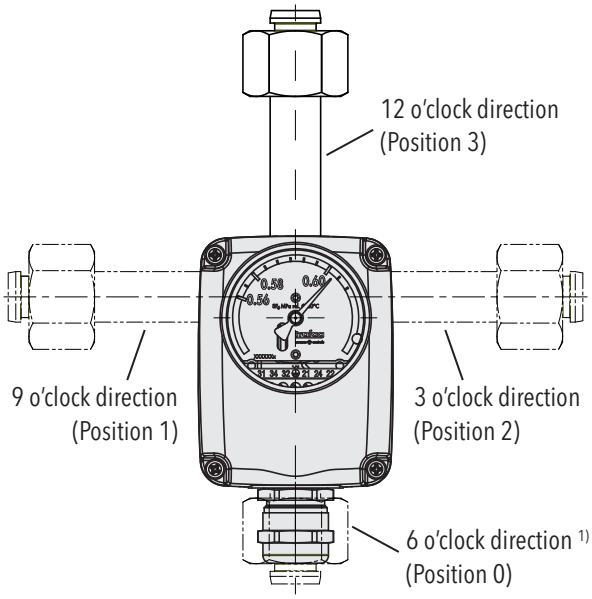




879x.21.2XXX.XX.XX.XX.XX

Example model with radial process connection





Radial process connection is configurable for 12/3/6/9 o'clock direction

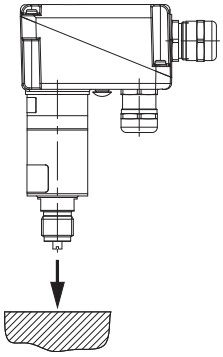
879x.21.2XXX.XX.XX.XX.XX

[1] Limited while using density sensor connection. Please contact us for more details.

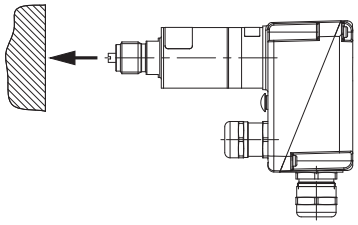
Installation and sheltering options

Installation			
	Indoor application	**Outdoor application**	**Outdoor application with rapidly changing or extreme weather conditions**
Installation orientation	No limitations, any orientation possible	A, B, C [1]	A, B, C [1]
Recommended option	None	■ Weather protection cover (46) ■ Thermal insulation for probe housing (06)	■ Thermal foam cover (37) ■ Compartment immersion type process connection (5XXX)

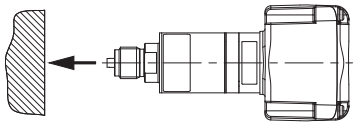
A



B

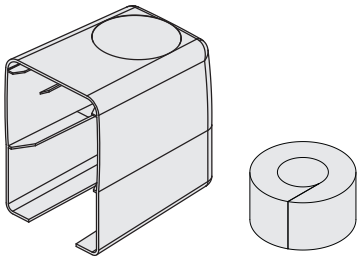


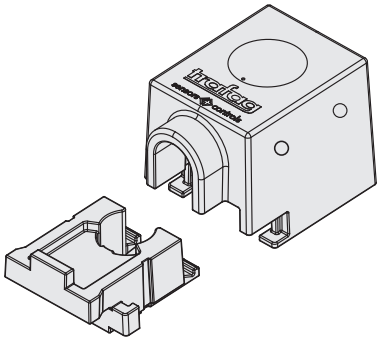
C

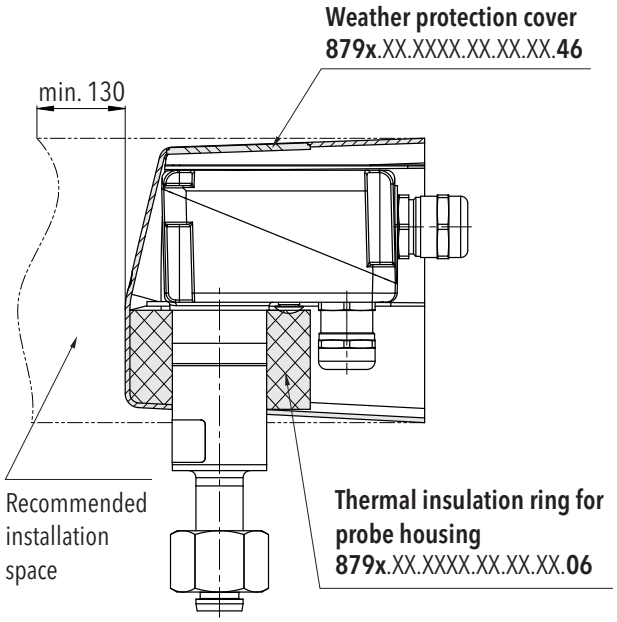


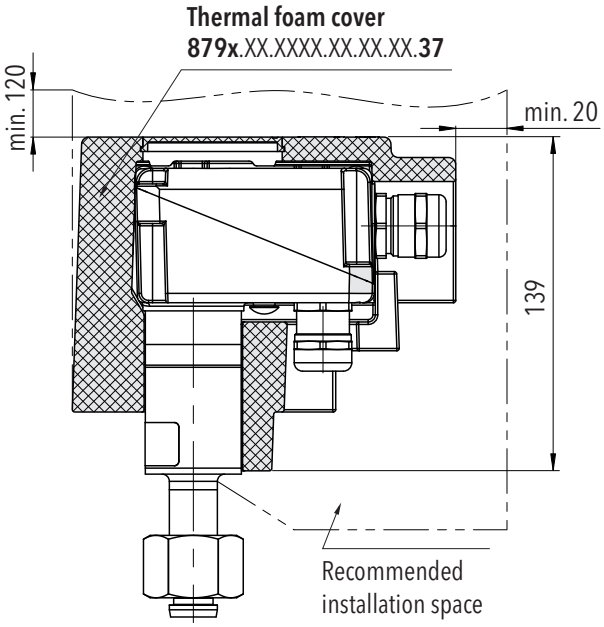
[1] Or any orientation in between. A vertical upside down installation shall be avoided.

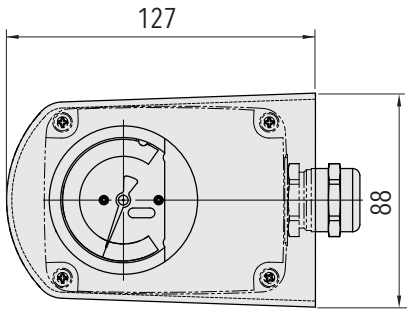
Installation and sheltering options

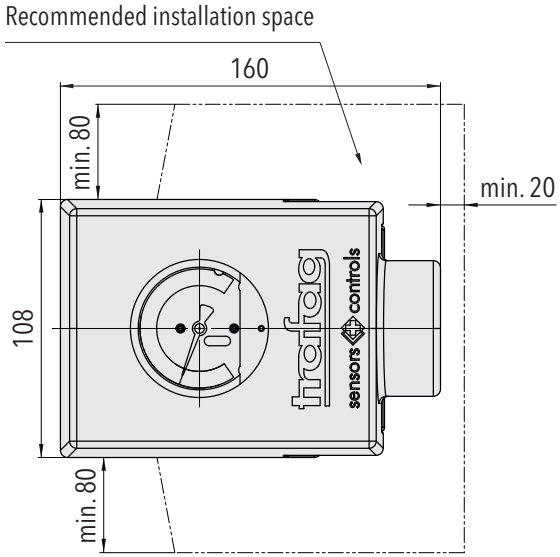










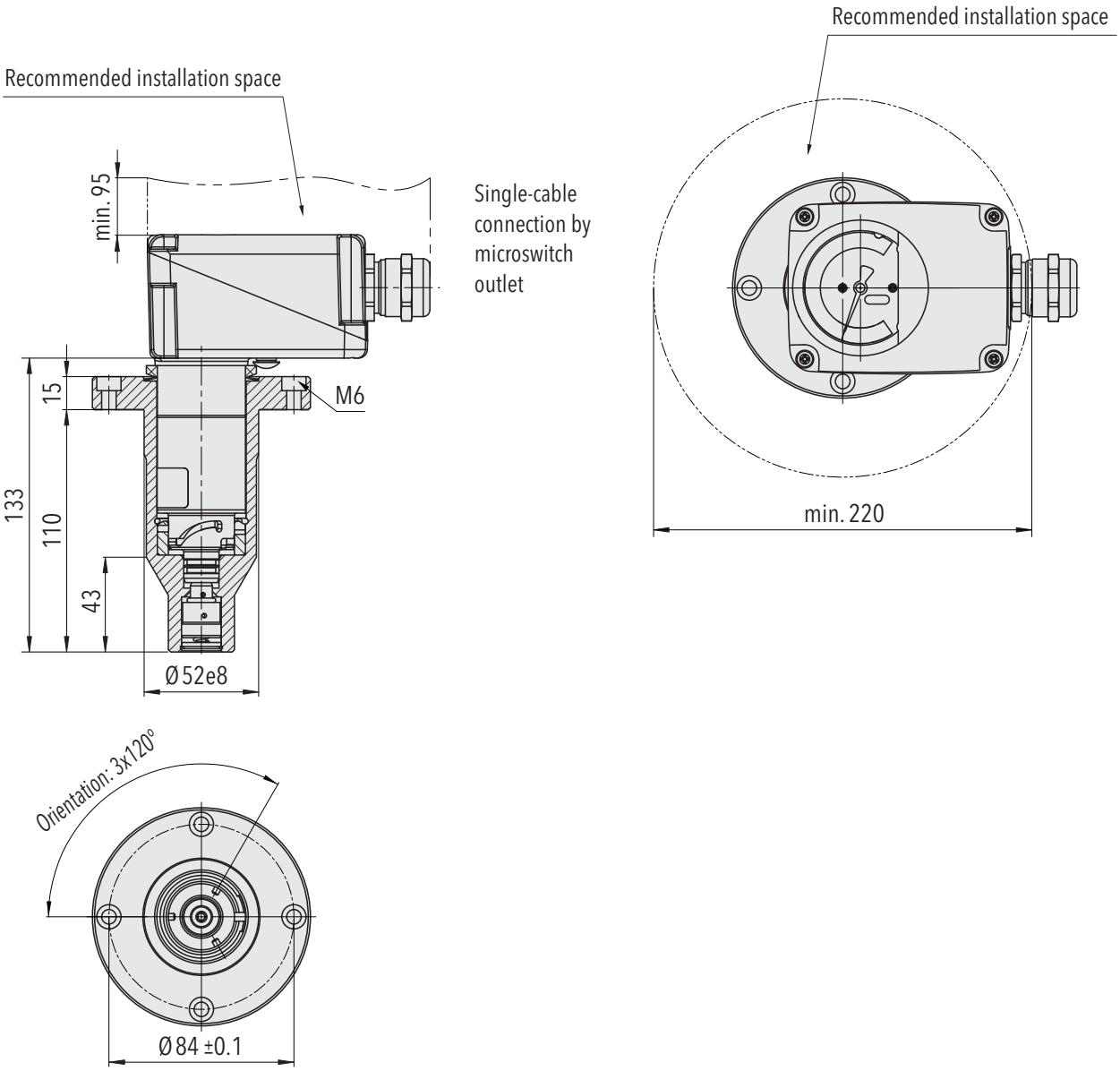


Weather protection cover (46) is aimed for long-term element protection. Insulation ring (06) for probe housing increases thermal inertia in moderate climates. Probe housing refers to the lower part of the monitor where reference chamber and oscillating quartz sensor are located.

Foam cover (37) increases thermal inertia of the hybrid density monitor. It is recommended in locations with high solar radiation or daily temperature fluctuations (high altitude, arctic, desert).

Installation and sheltering options

Compartment immersion process connection



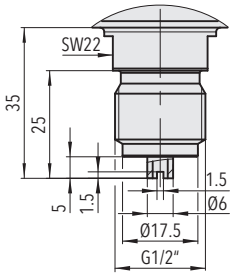
879x.XX.**5XXX**.XX.XX.XX.XX

The in-compartment installation (5xxx) is aimed to match process gas and monitor probe temperature.
Bayonet fitting allows installation while process is pressurised.

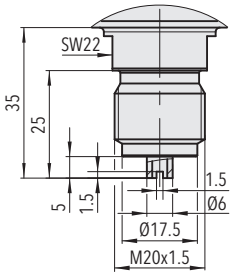
Further details see datasheet www.trafag.com/H72502

Process connections

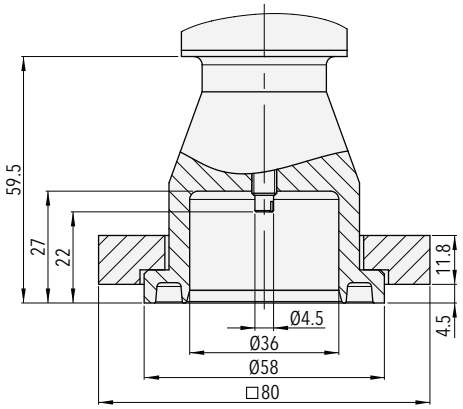
Axial process connections



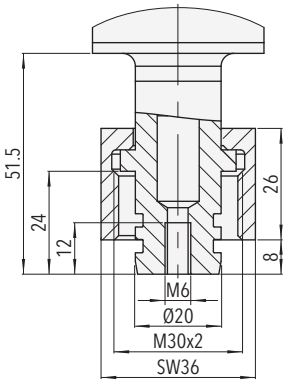
879x.XX.**1000**.XX.XX.XX.XX
Axial threaded connection G1/2"



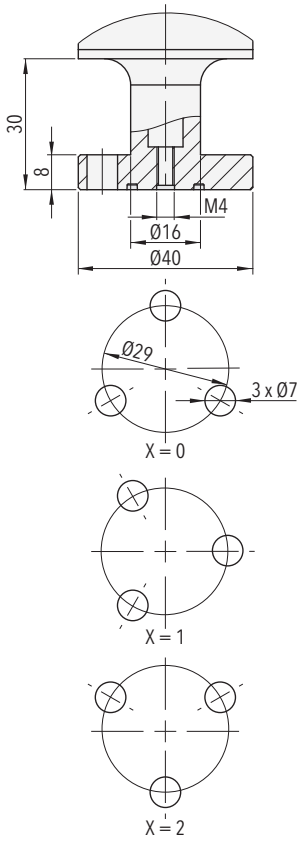
879x.XX.**1120**.XX.XX.XX.XX
Axial threaded connection M20x1.5



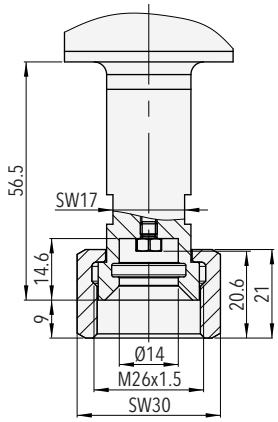
879x.XX.**2002**.XX.XX.XX.XX
Axial flanged connection



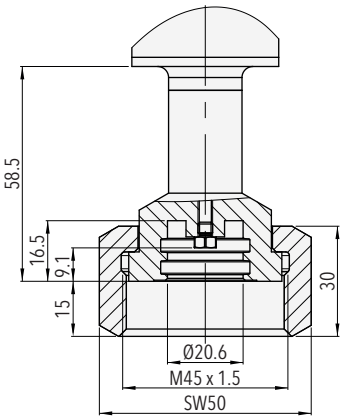
879x.XX.**2300**.XX.XX.XX.XX
Axial cap nut connection



879x.XX.**220x**.XX.XX.XX.XX
Axial flanged connection



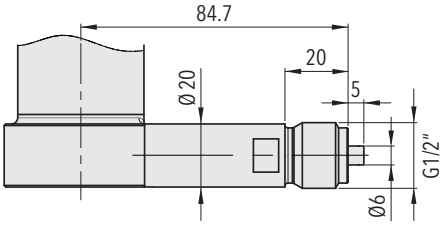
879x.XX.**2551**.XX.XX.XX.XX
Axial connection DN8



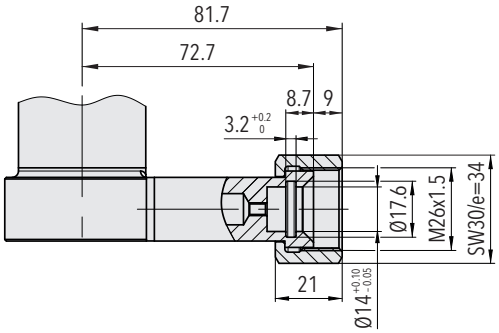
879x.XX.**2571**.XX.XX.XX.XX
Axial connection DN20

Process connections

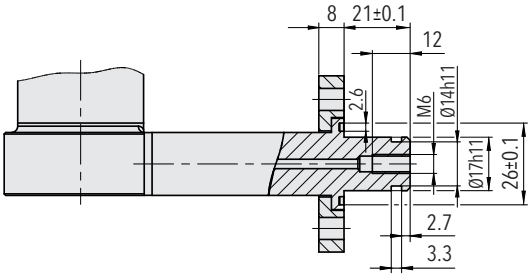
Radial process connections

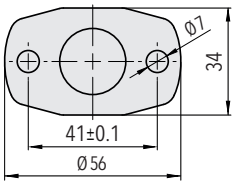


879x.XX.**1030**.XX.XX.XX.XX
Radial threaded connection G1/2"



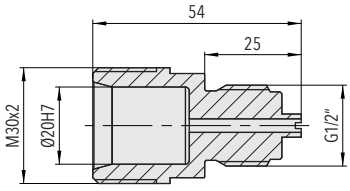
879x.XX.**2XE2**.XX.XX.XX.XX
Radial connection DN8





879x.XX.**2XP2**.XX.XX.XX.XX
Radial for two-hole flange connection

Adapter

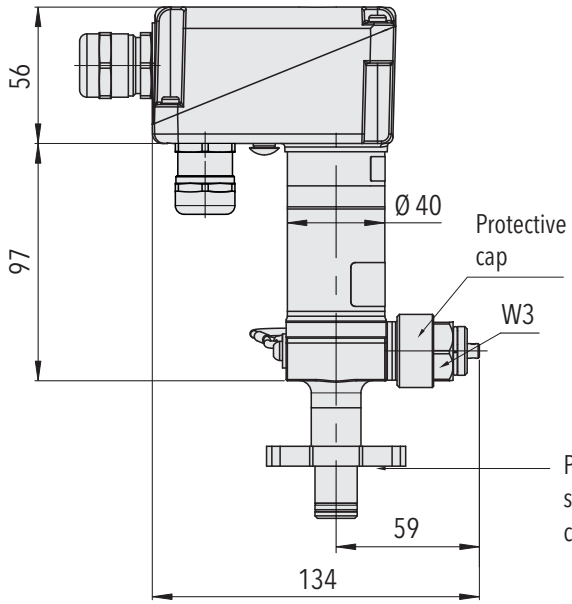


879x.XX.**2300**.XX.XX.XX.**N1**
Adapter 2300 - G1/2" male for rotatable G1/2" pressure connection

Delivery includes assembly kit and O-Ring set where applicable.
For full range of process connections and more details see data sheet www.trafag.com/H72502.

Valve options

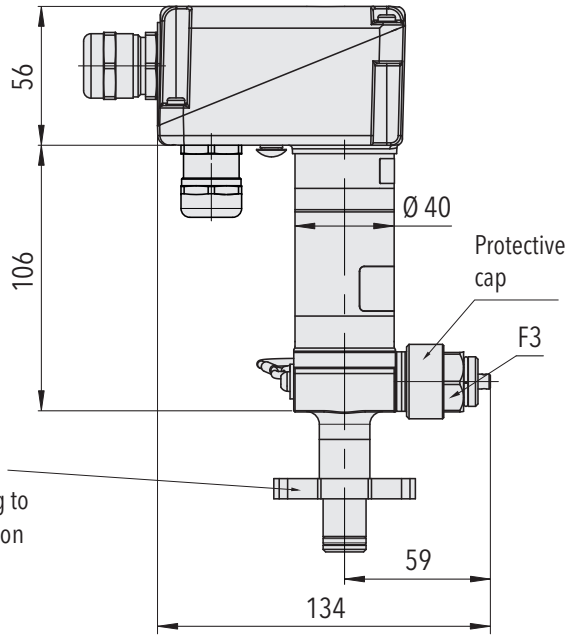
Integrated density monitor test valve



879x.XX.XXXX.XX.**W0/W1/W2/W3**.XX.XX

Test valve allows in-situ monitor and sensor verification without dismounting from pressure compartment. Test equipment is connected via DN8 port. Connection is configurable for direction W0/W1/W2/W3.

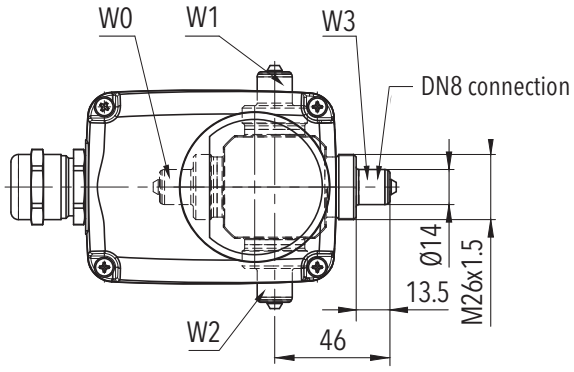
Integrated process gas test and re-filling valve

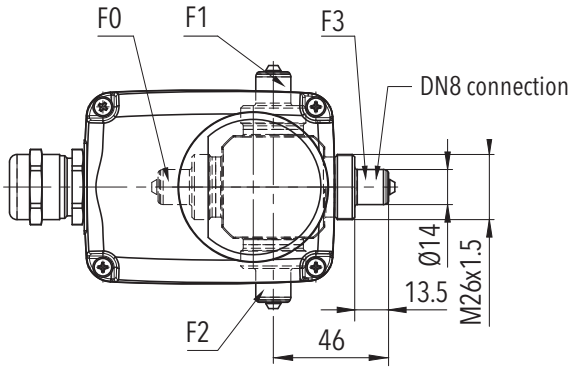


879x.XX.XXXX.XX.**F0/F1/F2/F3**.XX.XX

Valve allows in-situ analyzing of gas quality and direct insulating gas replenishment of pressure compartment via DN8 port on re-filling valve. Connection is configurable for direction F0/F1/F2/F3.

Orientation service connection (top view) [1)]
please specify when ordering



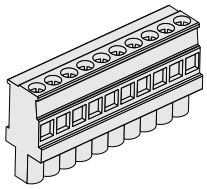


[1)] While using weather protection cover or thermal foam cover, the indicated installation spaces should be followed. See section installation and sheltering options.

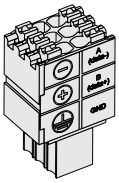
Operating specification for test and re-filling valve:
Opening and closing shall be limited to temperature range of -25°C ... +50°C.
Mechanical lifetime min. 250 actuation cycles.

For more details see instruction: www.trafag.com/H73521

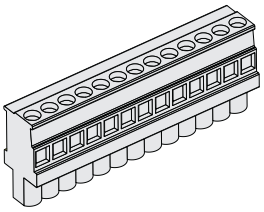
Spare parts



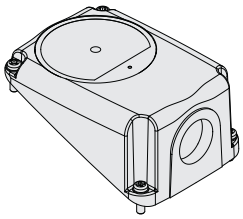
Standard microswitch wire terminal
(block X1, 10 pins) [1)]



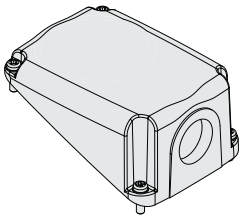
PCB Connector for RS485
(block X2, 6 pins)
(Trafag part no.: E00692 with D70290)



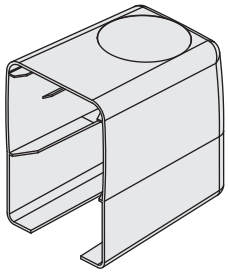
Wire terminal
(old version, 13-pins) [1)]



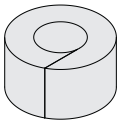
Housing cover with dial window [2)]



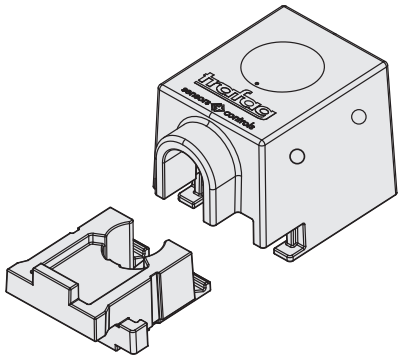
Housing cover without dial window [2)]



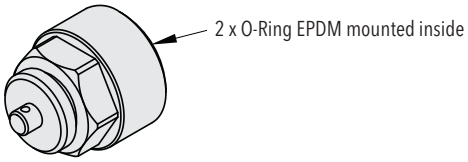
Weather protection cover
(Trafag part no.: C16354)



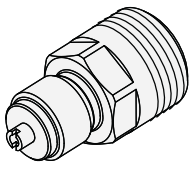
Thermal insulation ring for probe housing
(Trafag part no.: D34570)



Thermal foam cover with drain holes
(Trafag part no.: C23322)



M26x1.5 protective cap for test and re-filling valve
(Trafag part no.: C30645)



Pressure connection adapter 2300 - G1/2″ male
(Trafag part no.: C30931)

[1)] Please contact us for more details.
[2)] Please identify if microswitch cable outlet is required. For options see ordering information.