

Transmitted light process refractometer

For a wide range of applications in the field of hygiene

Features

- Unique transmitted light refractometer for process analysis
- High accuracy and drift-free due to difference measurement
- Immune to pressure and temperature fluctuations
- Integrated fluid temperature measurement
- Sapphire optics with high chemical resistance and mechanical durability
- Optical system insensitive to deposits
- Internal self-diagnosis and detection of errors
- Stainless steel and no dead space sensors for one-sided pipe access
- Use in explosive atmospheres feasible
- Sensor calibration microcontroller-controlled and independent of the transmitter
- Digital data transmission between transmitter and sensor
- Configurable data logger
- Remote parameterizing via USB/LAN
- Support of numerous fieldbus systems
- Process connections Varivent and Tri-Clamp are compatible for a wide range of pipe and vessel dimensions
- Library for approx. 50 typical analysis applications available, customized fluid data sets can also be provided
- Typical analysis outputs like Brix, M%, Vol%, g/l, operating density, laboratory density selectable
- Analysis of multi-component mixtures possible using additional measurement parameter, e.g. density, conductance, sound speed



Sensor PIOX R500-MH, Varivent connection



Sensor PIOX R500-MH, Tri-Clamp connection



PIOX R721**-*A



PIOX R721**-*S

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Measurement principle

Refractive index

The refractive index n of a solution is determined using transmitted light refractometry. A light beam propagates through the solution and is refracted at the interface of a prism. The angle of refraction is measured by a detector. The refractive index n of the solution is calculated from the angle of refraction using Snell's law of refraction:

$$n_i \cdot \sin\theta_i = n_t \cdot \sin\theta_t$$

where

- n_i - refractive index of fluid
- θ_i - angle of incidence
- n_t - refractive index of prism
- θ_t - angle of refraction

Measurement with refractometer PIOX R

Sensor

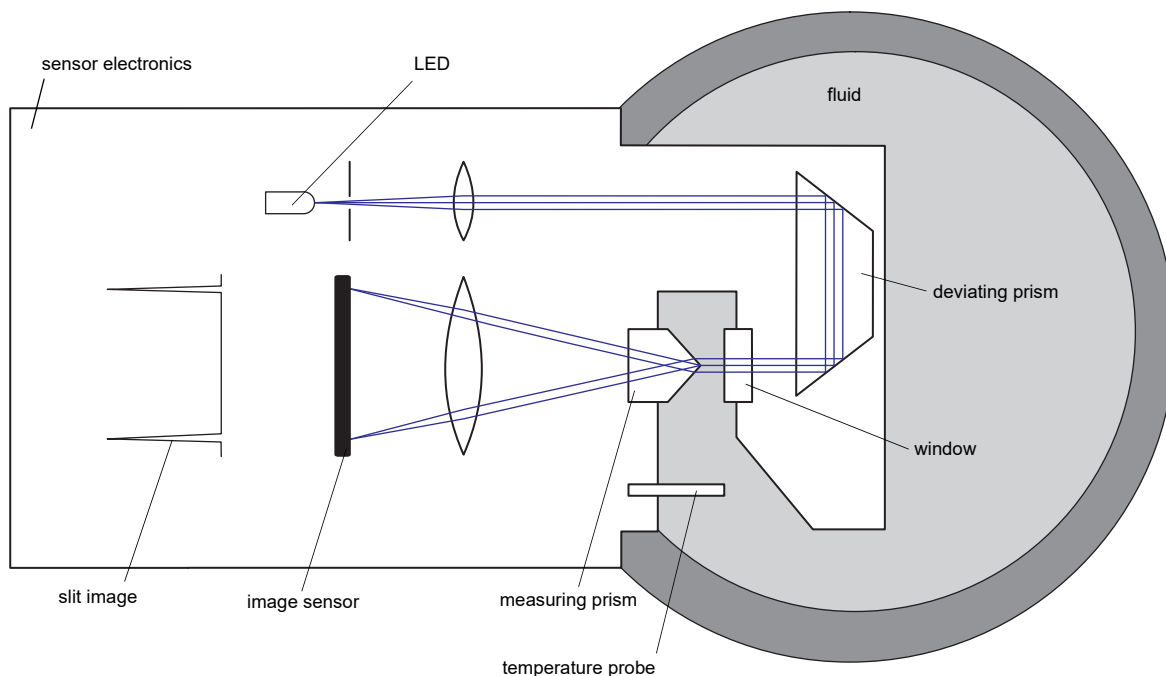
A special LED with a wave length $\lambda = 590 \text{ nm}$ (sodium D line) is used as the light source. The light passes through a slit, is parallelized by a lens and reversed by a deviating prism. Then it enters the fluid through a window in the sensor head. When the light beam re-enters the sensor, it is split at the apex of a measuring prism and refracted at its lateral surfaces.

The two resulting measuring beams are focused by a lens, generating sharp slit images on the image sensor.

The angle of refraction is determined from the difference between the two images of the slit. The zero point is calculated continuously in order to compensate for the influences of the process pressure and temperature.

The refractive index n_{DT} is calculated from the angle of refraction between the measuring prism and the fluid. Furthermore, the following values can be measured:

- fluid temperature measured by the integrated temperature probe Pt1000
- diagnostic values (e.g. gain, amplitude, quality, symmetry) resulting from extended signal processing
- sensor humidity and temperature



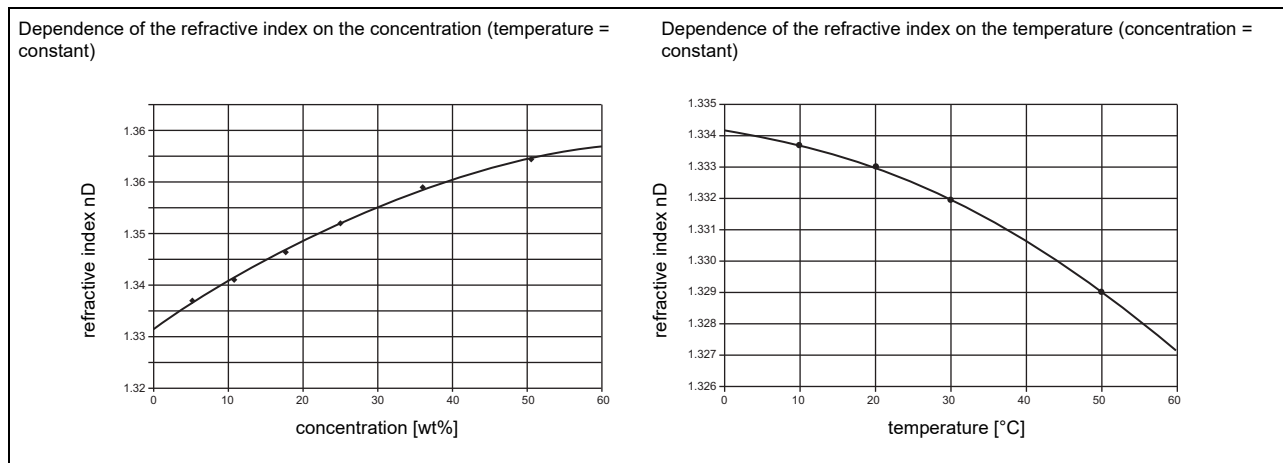
Processing in the transmitter

The transmitter calculates application-specific analysis quantity such as M%, Vol%, g/l, nDT (temperature-compensated refractive index), operating density, laboratory density, Brix value either with standardized fluid data sets from the library or with customized ones.

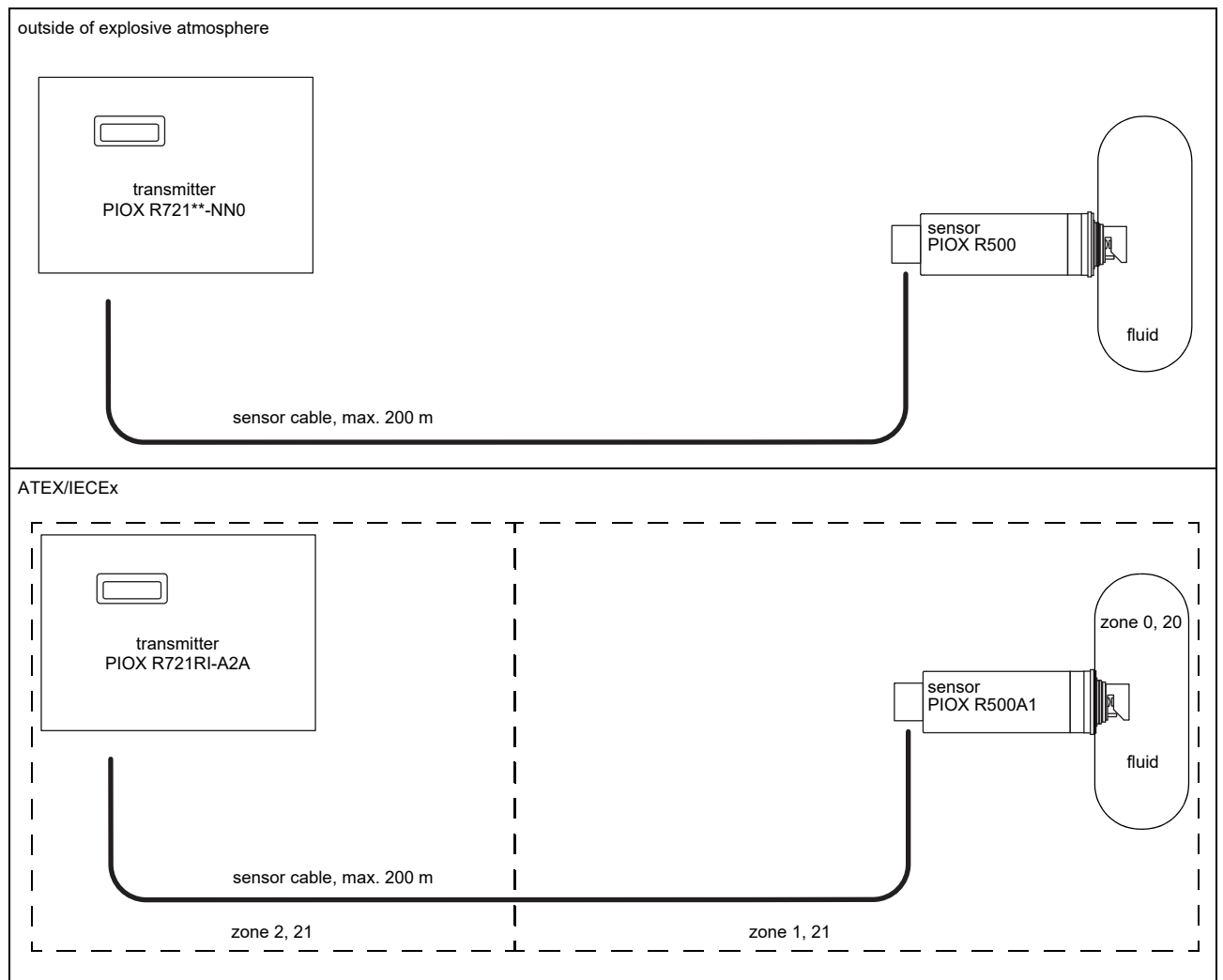
The transmitter can be equipped with electrical inputs, allowing for the input of additional available fluid quantities, e.g. sound speed, density or conductance, and using them for the measurement of three-component mixtures.

Dependence on temperature and concentration

As well as the density, the refractive index of a fluid depends on the temperature and concentration. In the majority of aqueous solutions, the refractive index increases with rising concentration (temperature = constant) and decreases with rising temperature (concentration = constant).





Measuring setups



Transmitter

Technical data

	PIOX R721**-NN01A	PIOX R721**-NN01S	PIOX R721RI-A2A1S
			
design	standard field device nonEx	field device with stainless steel housing nonEx	field device with stainless steel housing zone 2
transmitter			
power supply	<ul style="list-style-type: none"> • 100...230 V/50...60 Hz or • 20...32 V DC 		<ul style="list-style-type: none"> • 20...32 V DC
power consumption	W < 15		
number of measuring channels	1		
damping	s 0...100 (adjustable)		
response time	s 1		
housing material	aluminum, powder coated	stainless steel 316L (1.4404)	
degree of protection	IP66	IP66	IP66
dimensions	mm see dimensional drawing		
weight	kg 5.4	5.1	
fixation	wall mounting, optional: 2" pipe mounting		
ambient temperature	°C -40...+60 (< -20 °C without operation of the display)	-40...+60 (< -20 °C without operation of the display)	-40...+60 (< -20 °C without operation of the display)
display	128 x 64 dots, backlight		
menu language	English, German, French, Spanish, Dutch, Russian, Polish		
explosion protection			
• ATEX/IECEX			
marking	-	-	II(1)3G CE 0637 Ex I(M1) II(1)2D Ex ec nC ic [ia Ga] IIC T4 Gc [Ex ia I Ma] Ex tb [ia Da] IIIC T120 °C Db T _a -40...+60 °C
certification ATEX	-	-	IBExU06ATEX1075 X
certification IECEX	-	-	IECEX IBE 10.0003X
intrinsic safety parameters	-	-	U _m = 120 V
measuring functions			
physical quantities	refractive index, fluid temperature, °Brix, wt% (saccharose), more with application specific output parameters		
diagnostic functions	signal amplitude, sensor humidity, sensor temperature		
communication interfaces			
service interfaces	measured value transmission, parametrization of the transmitter: <ul style="list-style-type: none"> • USB¹ • LAN¹ 		
process interfaces	max. 1 option ² : <ul style="list-style-type: none"> • Modbus RTU • HART • Profibus PA • FF H1 • Modbus TCP 		
accessories			
serial data kit	USB cable		
software	<ul style="list-style-type: none"> • FluxDiagReader: download of measured values and parameters, graphical presentation • FluxDiag (optional): download of measurement data, graphical presentation, report generation, parametrization of the transmitter 		
data logger			
loggable values	all physical quantities, totalized values and diagnostic values		
capacity	max. 800 000 measured values		

¹ outside of explosive atmosphere (housing cover open)

² with inputs and including parametrization of the transmitter

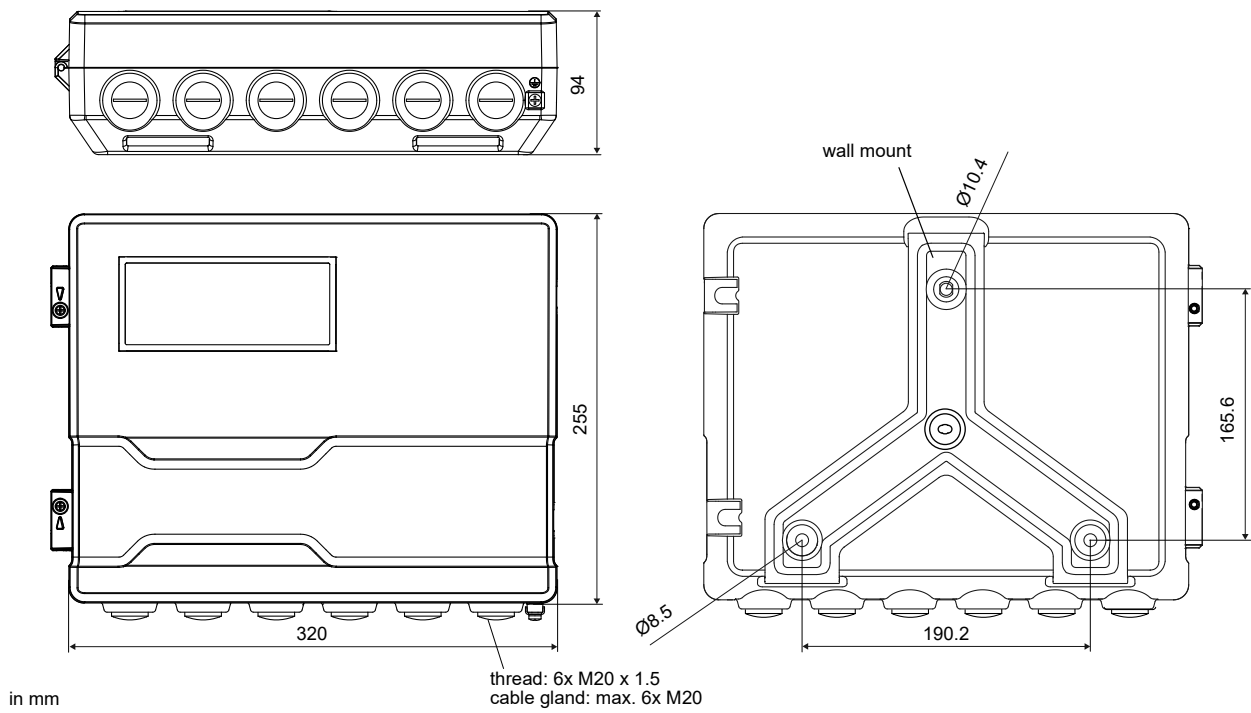
		PIOX R721**-NN01A	PIOX R721**-NN01S	PIOX R721RI-A2A1S
outputs				
The outputs are galvanically isolated from the transmitter.				
number		on request		
• switchable current output				
The switchable current outputs are menu selectable all together as passive or active.				
range	mA	4...20 (3.2...22)		
accuracy		0.04 % of reading $\pm 3 \mu\text{A}$		
active output		$R_{\text{ext}} < 350 \Omega$		
passive output		$U_{\text{ext}} = 8...30 \text{ V}$, depending on R_{ext} ($R_{\text{ext}} < 1 \text{ k}\Omega$ at 30 V)		
• voltage output				
range	V	0...1 or 0...10		
accuracy		0...1 V: 0.1 % of reading $\pm 1 \text{ mV}$ 0...10 V: 0.1 % of reading $\pm 10 \text{ mV}$		
internal resistance		$R_{\text{int}} = 500 \Omega$		
• binary output				
optorelay		26 V/100 mA		
binary output as alarm output				
• functions		limit		
inputs				
The inputs are galvanically isolated from the transmitter.				
number		max. 4, on request		
• temperature input				
type		Pt100/Pt1000		
connection		4-wire		
range	$^{\circ}\text{C}$	-150...+560		
resolution	K	0.01		
accuracy		$\pm 0.01 \%$ of reading $\pm 0.03 \text{ K}$		
• current input				
accuracy		0.1 % of reading $\pm 10 \mu\text{A}$		
active input		$U_{\text{int}} = 24 \text{ V}$, $R_{\text{int}} = 50 \Omega$, $P_{\text{int}} < 0.5 \text{ W}$, not short-circuit proof		
• range	mA	0...20		
passive input		$R_{\text{int}} = 50 \Omega$, $P_{\text{int}} < 0.3 \text{ W}$		
• range	mA	-20...+20		
• voltage input				
range	V	0...1		
accuracy		0.1 % of reading $\pm 1 \text{ mV}$		
internal resistance		$R_{\text{int}} = 1 \text{ M}\Omega$		

¹ outside of explosive atmosphere (housing cover open)

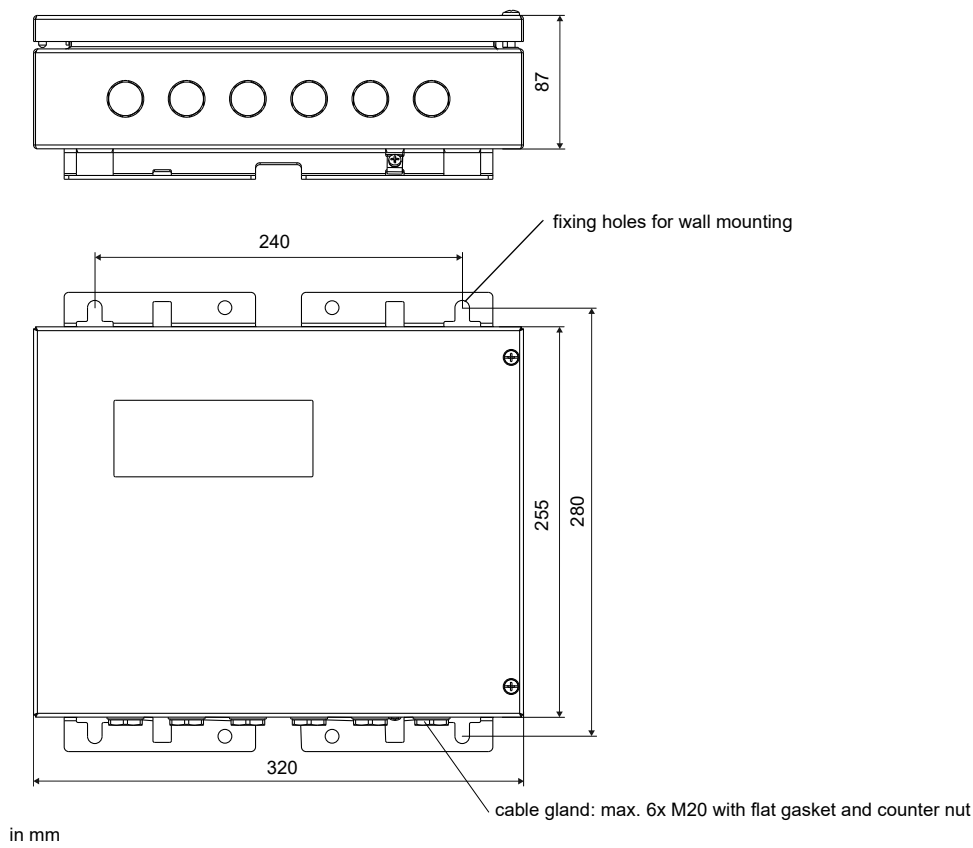
² with inputs and including parametrization of the transmitter

Dimensions

*721**_****A

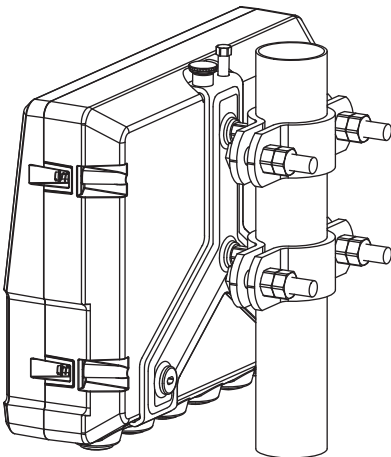


*721**_****S

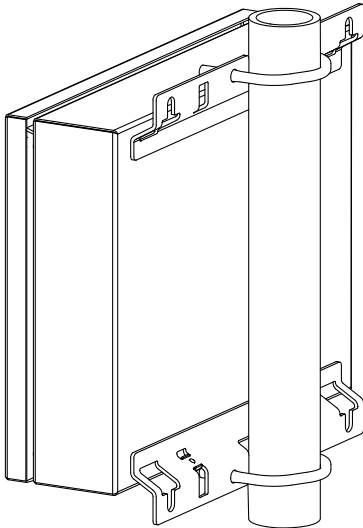


2" pipe mounting kit

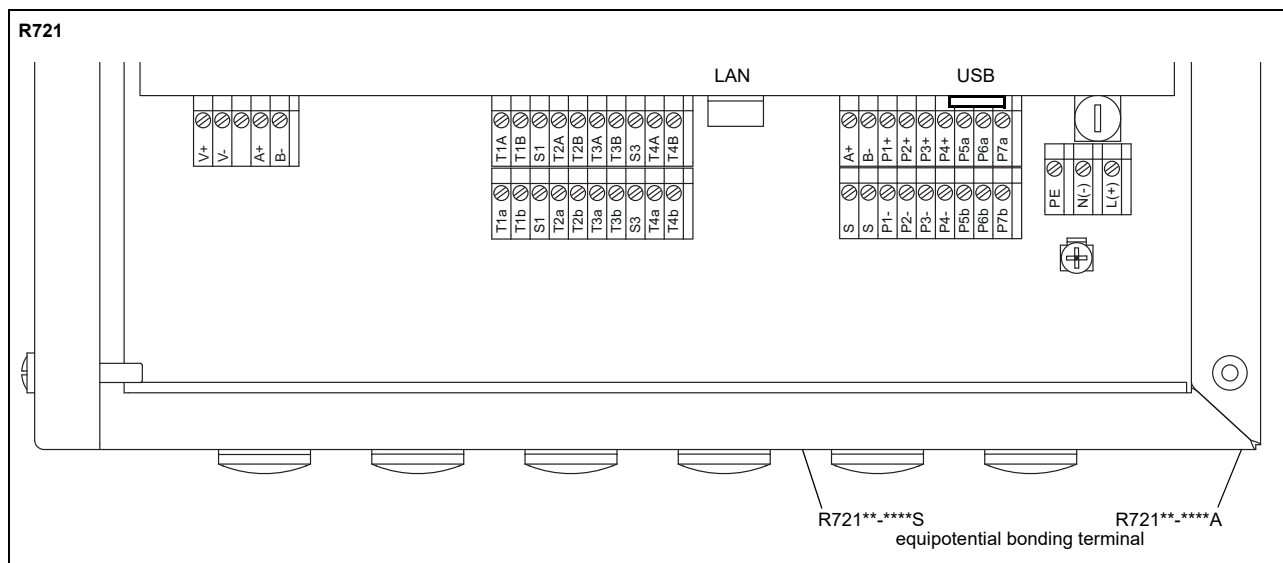
*721**_****A



*721**_****S



Terminal assignment



power supply ¹				
terminal	connection (AC)		connection (DC)	
PE	earth		earth	
N(-)	neutral		-	
L(+)	phase		+	
transducers				
terminal	transducer cable			
V+	yellow			
V-	green			
A+	brown			
B-	white			
outputs ^{1, 2}				
terminal	connection	terminal	connection	communication interface
P1+...P4+ P1-...P4-	current output, voltage output	A+	signal +	<ul style="list-style-type: none"> • Modbus RTU¹ • HART¹ • Profibus PA¹ • FF H1¹
		B-	signal -	
P5a...P7a P5b...P7b	binary output	S	shield	
		USB	type B	<ul style="list-style-type: none"> • service (FluxDiag/FluxDiagReader)
		LAN	RJ45	<ul style="list-style-type: none"> • service (FluxDiag/FluxDiagReader) • Modbus TCP
analog inputs ^{1, 2}				
terminal	temperature probe	passive sensor	active sensor	
T1a...T4a		not connected	not connected	
T1A...T4A		-	+	
T1b...T4b		+	not connected	
T1B...T4B'		not connected	-	
S1, S3		not connected	not connected	

¹ cable (by customer): e.g. flexible leads, with insulated wire end ferrules, lead cross sectional area: 0.25...2.5 mm²

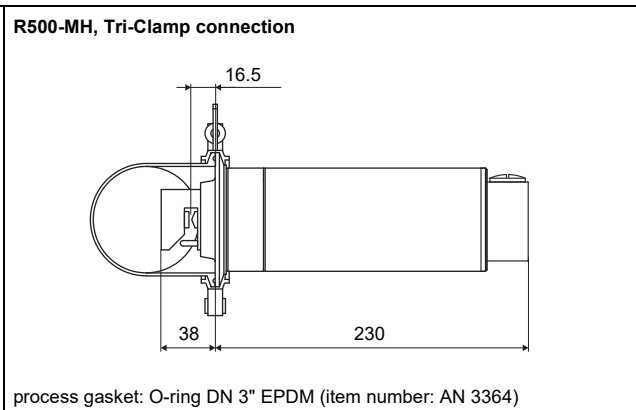
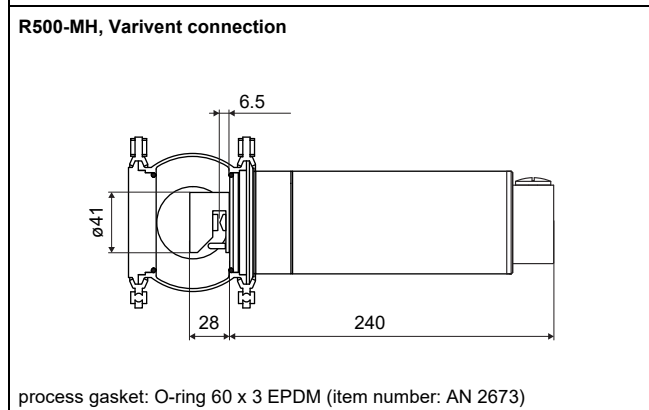
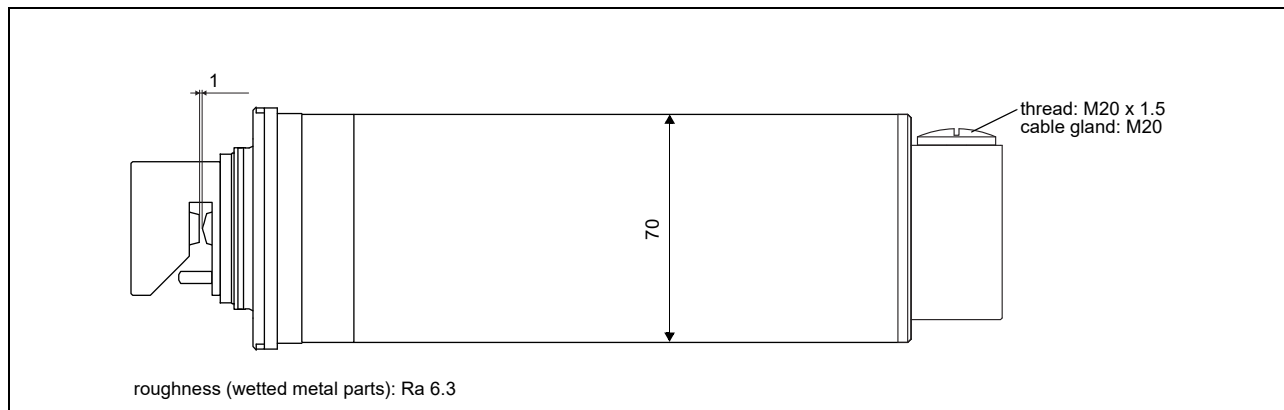
² The number, type and terminal assignment will be customized.

Sensor

Technical data

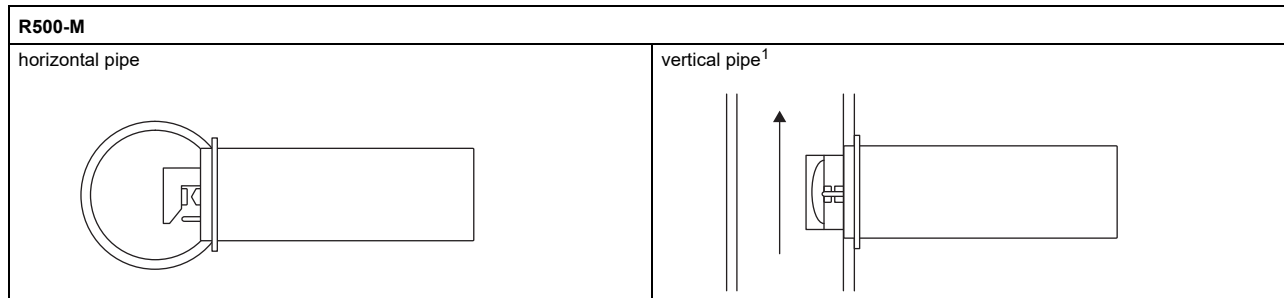
		R500	R500A1
order code		R500-MHV4EPNN	R500-MHV4EPA1
process parameters			
fluid		all liquids with a turbidity < 10 000 FAU	
fluid temperature (depending on ambient temperature)	°C	-20...+150 (150 °C at an ambient temperature of 20 °C)	-20...+130
fluid pressure		PN 10	
measurement			
measurement principle		transmitted light refractometry	
measuring range		nD: 1.3...1.7 °Brix: 0...100	
accuracy (absolute)		nD: 0.000 2 (corresponds to 0.1°Brix, typical 0.1 wt%)	
repeatability		nD: 0.000 02 (corresponds to 0.01 °Brix, typical 0.01 wt%)	
resolution (display)		nD: 0.000 001	
material			
housing		stainless steel 304 (1.4301)	
wetted parts		stainless steel 316L (1.4404)	
gaskets		EPDM	
prism		sapphire, nD ≈ 1.76	
degree of protection according to IEC/EN 60529		IP67	
flange		for Varivent (N) or Tri-Clamp 3"	
dimensions		see dimensional drawing	
weight	kg	min. 2	
ambient temperature	°C	-20...+60	
explosion protection			
• ATEX/IECEx			
marking		-	II1G CE 0637 Ex IM1 II1D Ex ia op is IIC T4 Ga Ex ia op is I Ma Ex ia op is IIIC T120 °C Da Ta -40...+60 °C Tm -20...+130 °C
certification ATEX		-	IBExU06ATEX1075 X
certification IECEx		-	IECEx IBE 10.0003X
temperature probe			
type		Pt1000	
resolution	K	0.01	
accuracy at 20 °C	K	0.15	
response time	s	5	

Dimensions



in mm

Mounting positions of sensor



¹ The pipe always has to be completely filled. The preferred flow direction is upward, in exceptional cases downward.

Connection

Terminal assignment

terminal	connection
+	yellow
-	green
A+	brown
B-	white
S	shield

equipotential bonding terminal on housing cover

Sensor cable

		R500	R500A1
item number		TR10126	TR10125
type		LIYCY 2 x 2 x 0.75 grey	EB CY 2x2x0.75
length	m	max. 200	max. 200
weight	kg/m	approx. 0.106	approx. 0.106
ambient temperature	°C	-40...+80	-40...+80
properties		flame retardant according to IEC 60332-1-2	flame retardant according to IEC 60332-1-2
cable jacket			
material		PVC	PVC
outer diameter	mm	8.5	8.7
colour		grey	blue
shield		x	x

Sensor order code

1, 2	3...5	6	7	8, 9	10, 11	12, 13	14...16	17	18...20	no. of character	
measurement principle	type	-	type of construction	design	material (wetted parts)	gaskets	explosion protection	process pressure	flange	cable length	description
R	500		M								transmitted light refractometer
				H							standard sensor
					V4						hygiene design
						EP					stainless steel 316L (1.4404)
							A1				EPDM
								NN			zone 0/1
											not explosion proof
									P10		PN 10
										V	flange, compatible with Varivent N ¹
										T	flange, compatible with Tri-Clamp 3" ¹
										XXX	in m

¹ process connection by customer

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