

## Transmitted light process refractometer

For a wide range of applications in the field of hygiene

### Features

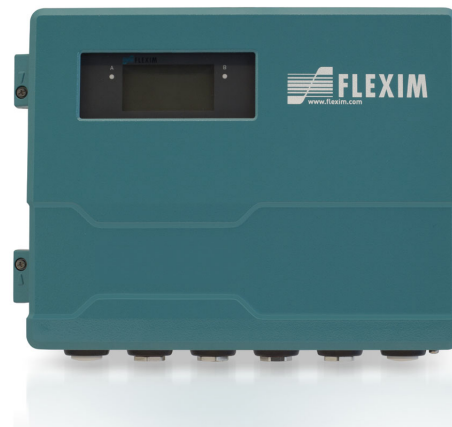
- Unique transmitted light refractometer for process analysis
- High accuracy and drift-free due to difference measurement
- No minimum flow velocity required for reliable measurement
- Immune to pressure and temperature fluctuations
- Integrated fluid temperature measurement
- Sapphire optics with high 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
- $\theta_i$  - angle of incidence
- $n_t$  - refractive index of prism
- $\theta_t$  - angle of refraction

### Measurement with refractometer PIOX R

#### Sensor

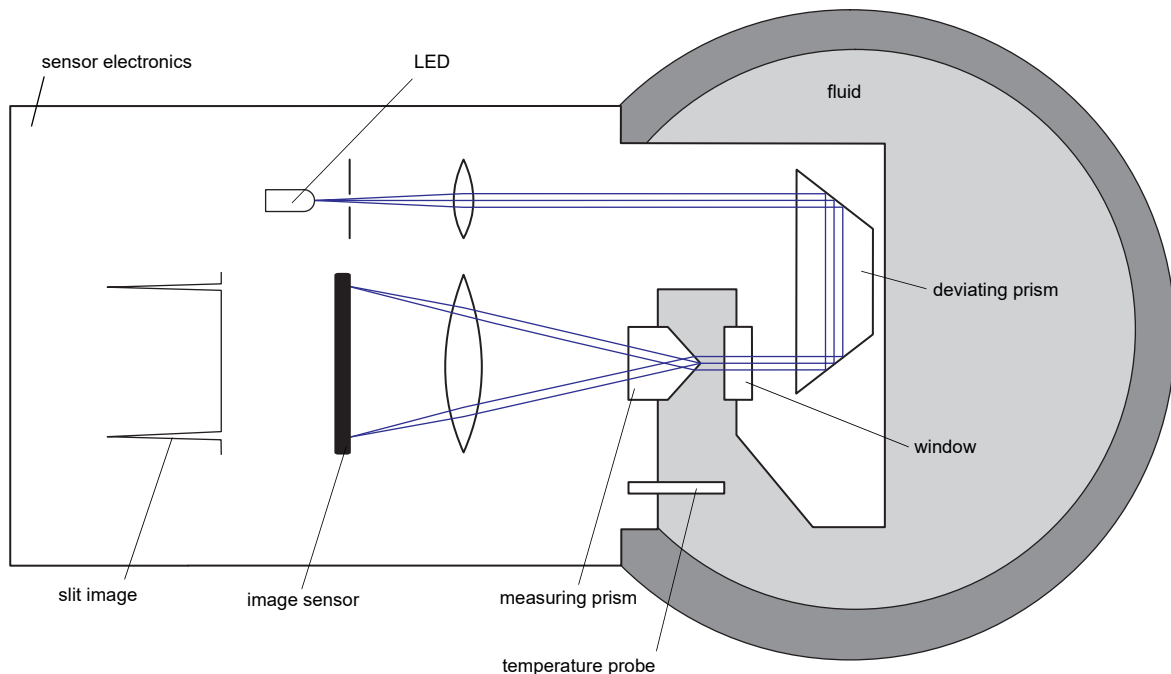
A special LED with a wave length  $\lambda = 590$  nm (sodium D line) is used as the light source. The light passes through a slit, is parallelised by a lens and reversed by a deviating prism. Then it enters the fluid through a window in the sensor head. When the light beam re-enters the sensor, it is 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  $n_D$  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



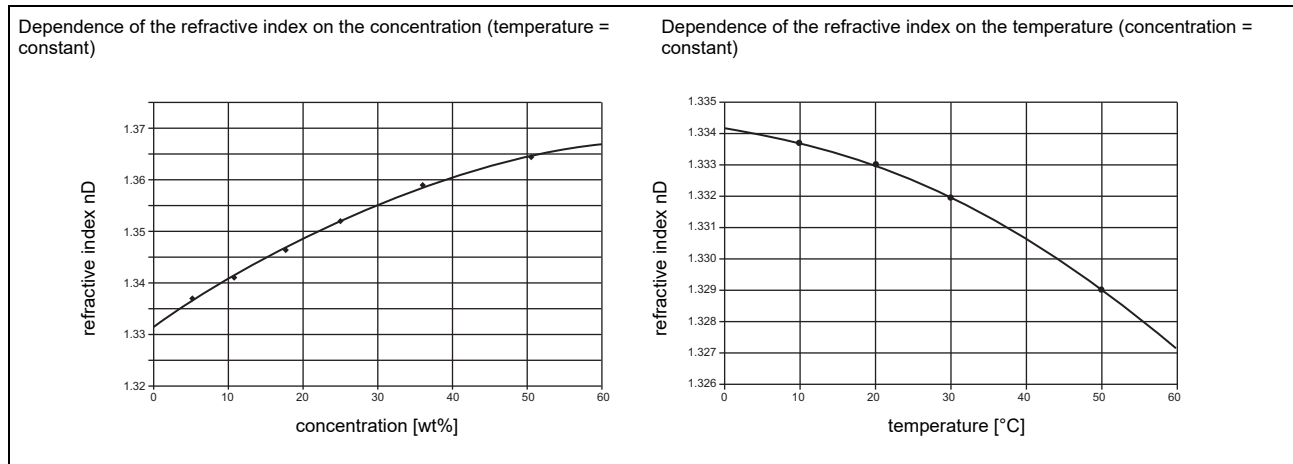
### Processing in the transmitter

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 standardised fluid data sets from the library or with customised ones.

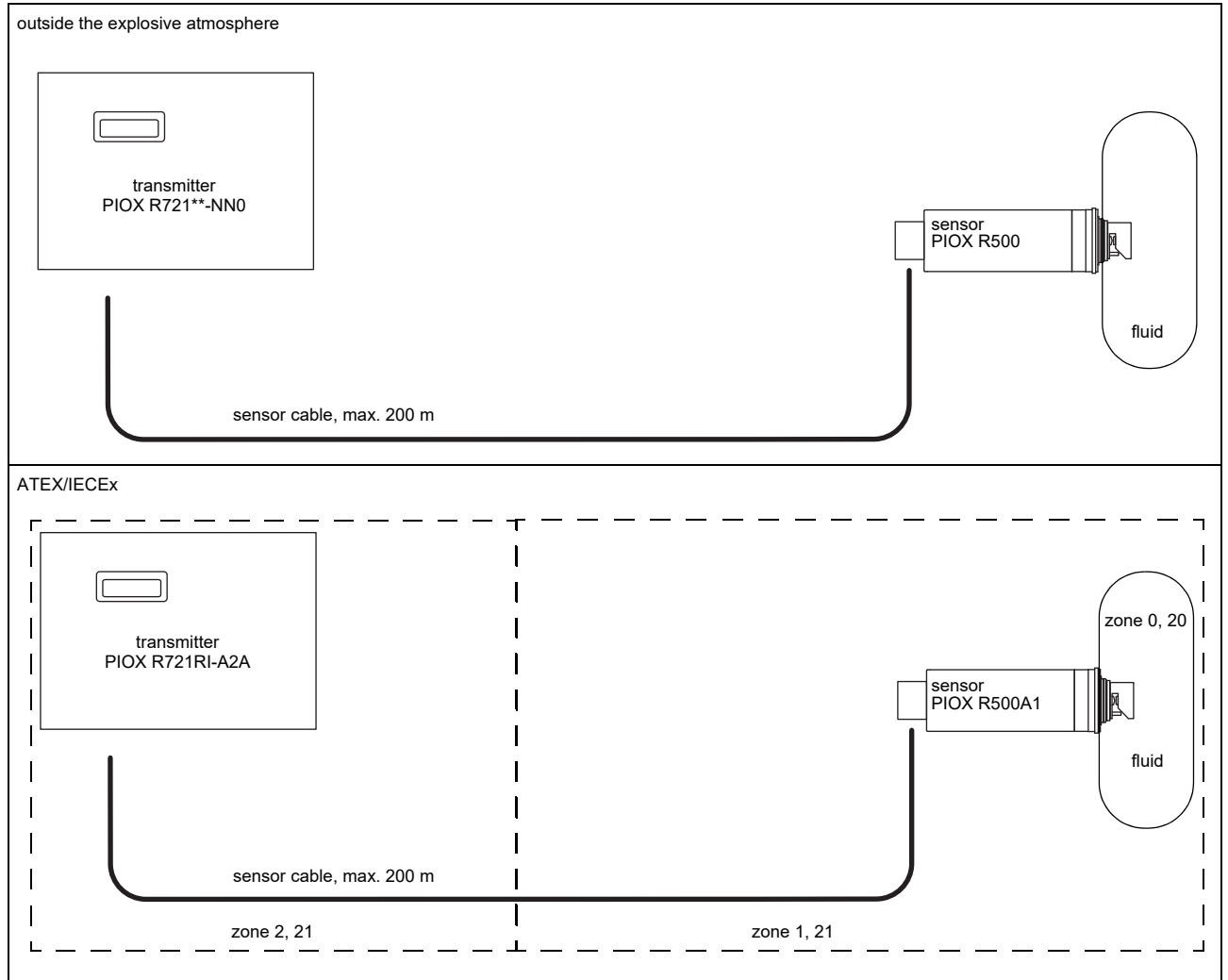
The transmitter can be equipped with electrical inputs, allowing for the input of additional available fluid quantities, e.g. sound speed, density or conductance, and using them for the measurement of three-component mixtures.

### 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 setup



# Transmitter

## Technical data

	PIOX R721**-NN01A	PIOX R721**-NN01S	PIOX R721RI-A2A1S
			
design	standard field device	field device with stainless steel housing	field device with stainless steel housing zone 2
<b>transmitter</b>			
power supply	<ul style="list-style-type: none"> <li>• 100...230 V/50...60 Hz or</li> <li>• 20...32 V DC</li> </ul>		<ul style="list-style-type: none"> <li>• 20...32 V DC</li> </ul>
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
dimensions	mm	see dimensional drawing	
weight	kg	5.4	5.1
fixation		wall mounting, optional: 2" pipe mounting	
ambient temperature	°C	-40...+60 (< -20 without operation of the display)	-40...+60 (< -20 without operation of the display)
display		128 x 64 dots, backlight	
menu language		English, German, French, Spanish, Dutch, Russian, Polish	
<b>explosion protection</b>			
• ATEX/IECEX			
marking			II(1)3G CE 0637 I(M1) II(1)2D Ex ec nC ic [ia Ga] IIC T4 Gc [Ex ia I Ma] Ex tb [ia Da] IIC T120 °C Db T <sub>a</sub> -40...+60 °C
certification ATEX	-	-	IBExU06ATEX1075 X
certification IECEx	-	-	IECEX IBE 10.0003X
intrinsic safety parameters	-	-	U <sub>m</sub> = 120 V
<b>measuring functions</b>			
physical quantities		see table below	
diagnostic functions		signal amplitude, sensor humidity, sensor temperature	
<b>communication interfaces</b>			
service interfaces		measured value transmission, parametrisation of the transmitter: <ul style="list-style-type: none"> <li>• USB<sup>1</sup></li> <li>• LAN<sup>1</sup></li> </ul>	
process interfaces		max. 1 option: <ul style="list-style-type: none"> <li>• Modbus RTU</li> <li>• HART</li> <li>• Profibus PA</li> <li>• FF H1</li> <li>• Modbus TCP</li> </ul>	
<b>accessories</b>			
data transmission kit		USB cable	
software		<ul style="list-style-type: none"> <li>• FluxDiagReader: reading of measured values and parameters, graphical presentation</li> <li>• FluxDiag (optional): reading of measurement data, graphical presentation, report generation, parametrisation of the transmitter</li> </ul>	
<b>data logger</b>			
loggable values		all physical quantities, totalised physical quantities and diagnostic values	
capacity		max. 800 000 measured values	

<sup>1</sup> outside the explosive atmosphere (housing cover open)

		PIOX R721**-NN01A	PIOX R721**-NN01S	PIOX R721RI-A2A1S
<b>outputs</b>				
		The outputs are galvanically isolated from the transmitter.		
number		on request		
<b>• switchable current output</b>				
		All switchable current outputs are jointly switched to active or passive.		
range	mA	4...20 (3.2...22)		
accuracy		0.04 % MV ±3 µA		
active output		$R_{ext} < 350 \Omega$		
passive output		$U_{ext} = 8...30 \text{ V}$ , depending on $R_{ext}$ ( $R_{ext} < 1 \text{ k}\Omega$ at 30 V)		
<b>• voltage output</b>				
range	V	0...1 or 0...10		
accuracy		0...1 V: 0.1 % MV ±1 mV 0...10 V: 0.1 % MV ±10 mV		
internal resistance		$R_{int} = 500 \Omega$		
<b>• digital output</b>				
functions		<ul style="list-style-type: none"> <li>• frequency output</li> <li>• binary output</li> <li>• pulse output</li> </ul>		
number		3		
		5...30 V / < 100 mA		
<b>frequency output</b>				
• range	kHz	0...5		
<b>binary output</b>				
• binary output as alarm output		limit, change of flow direction or error		
<b>pulse output</b>				
• functions				
• pulse value	units	0.01...1000		
• pulse width	ms	0.05...1000		
<b>inputs</b>				
		The inputs are galvanically isolated from the transmitter.		
number		max. 4, on request		
<b>• temperature input</b>				
type		Pt100/Pt1000		
connection		4-wire		
range	°C	-150...+560		
resolution	K	0.01		
accuracy		±0.01 % MV ±0.03 K		
<b>• current input</b>				
accuracy		0.1 % MV ±10 µA		
active input		$U_{int} = 24 \text{ V}$ , $R_{int} = 50 \Omega$ , $P_{int} < 0.5 \text{ W}$ , not short-circuit proof		
• range	mA	0...20		
passive input		$R_{int} = 50 \Omega$ , $P_{int} < 0.3 \text{ W}$		
• range	mA	-20...+20		
<b>• voltage input</b>				
range	V	0...1		
accuracy		0.1 % MV ±1 mV		
internal resistance		$R_{int} = 1 \text{ M}\Omega$		

<sup>1</sup> outside the explosive atmosphere (housing cover open)

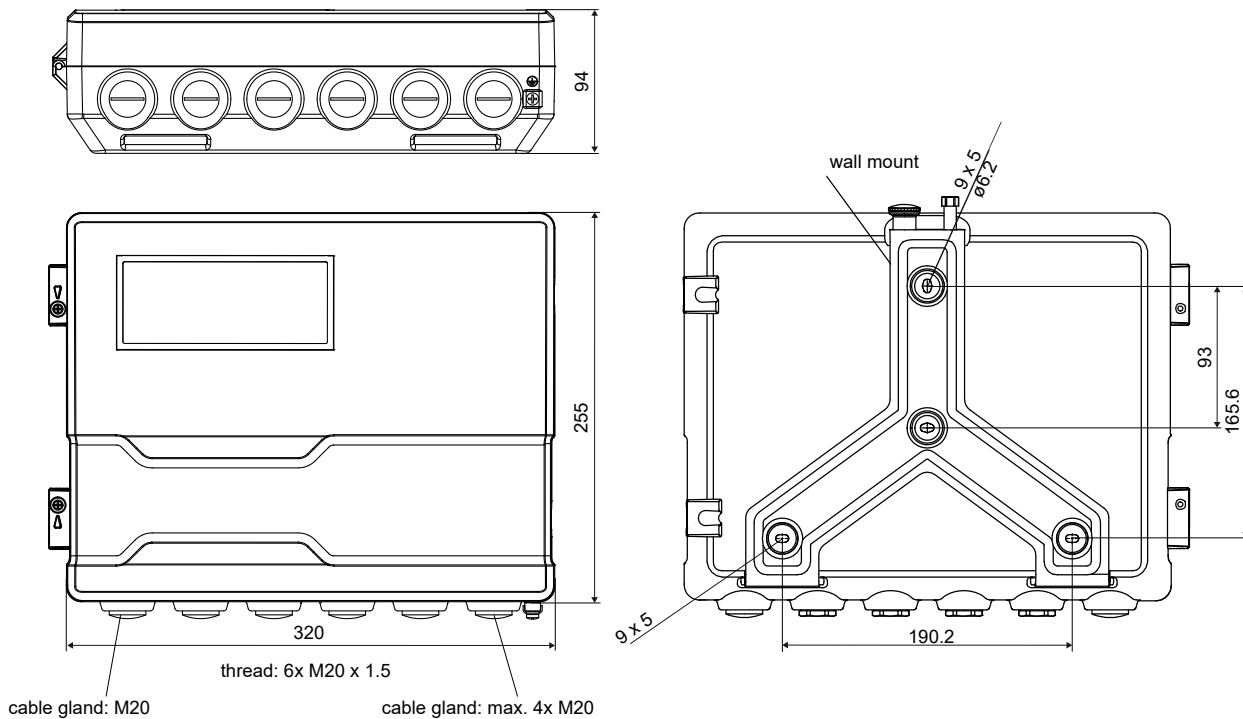
## Physical quantities

The available physical quantities depend on the fluid data set in the transmitter.

fluid data set	physical quantities	remark
NN	no fluid data set	refractive index, fluid temperature, °Brix, wt% (saccharose)
MD	standard fluid data set	refractive index, fluid temperature, °Brix, wt% (saccharose), concentration
CU	customised fluid data set	refractive index, fluid temperature, °Brix, wt% (saccharose), further customised physical quantities
		application-specific fluid data set from FLEXIM database
		data set developed by FLEXIM in cooperation with the customer

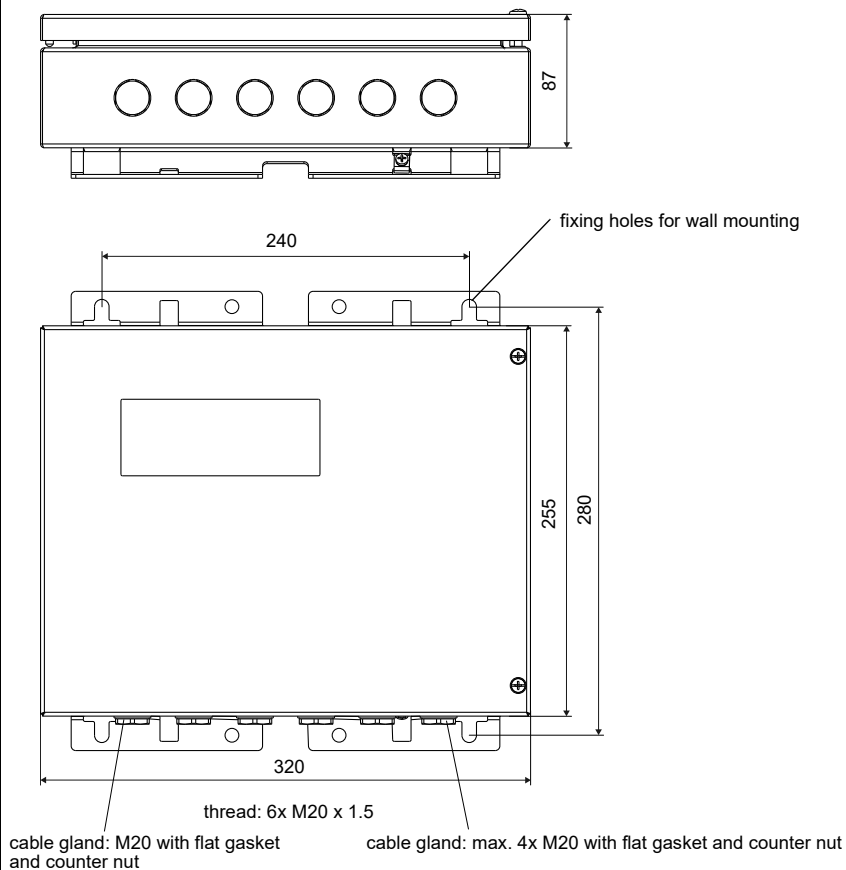
### Dimensions

R721\*\*\_\*\*\*\*A



in mm

R721\*\*\_\*\*\*\*S

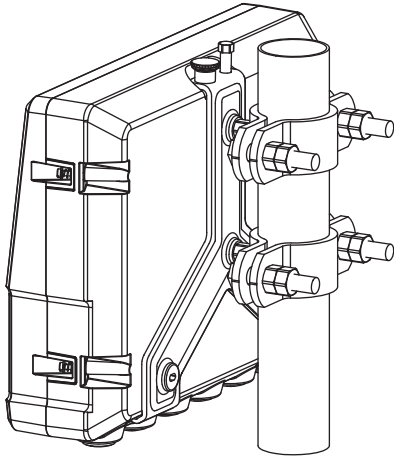


in mm



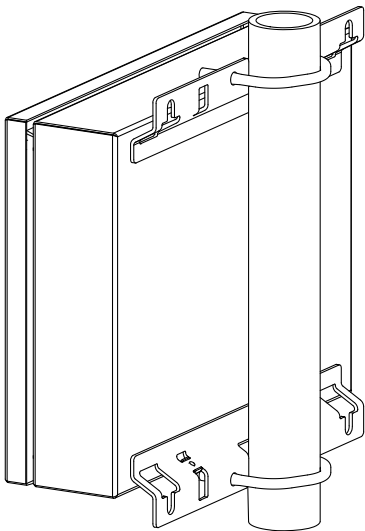
## 2" pipe mounting kit

\*72\*\*\*-\*\*\*\*A



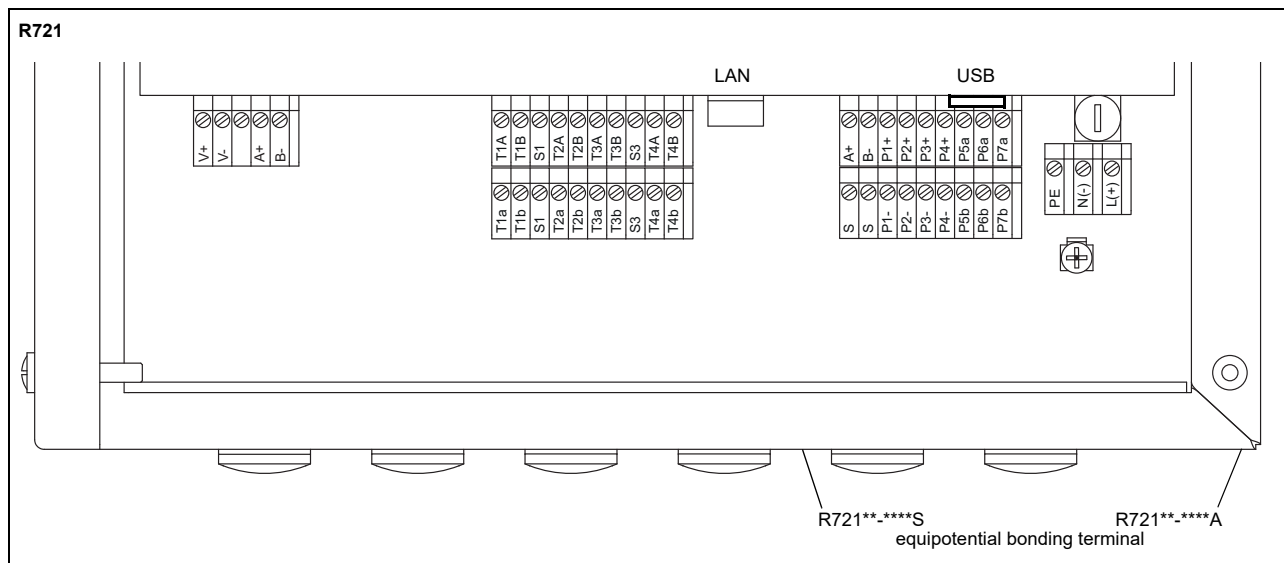
order code:  
ACC-PE-\*721-/PMK4

\*72\*\*\*-\*\*\*\*S



order code:  
ACC-PE-\*721-/PMK6

### Terminal assignment



power supply <sup>1</sup>				
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 <sup>1, 2</sup>				
terminal	connection	terminal	connection	communication interface
P1+...P4+ P1-...P4-	current output, voltage output	A+	signal +	<ul style="list-style-type: none"> <li>• Modbus RTU<sup>1</sup></li> <li>• HART<sup>1</sup></li> <li>• Profibus PA<sup>1</sup></li> <li>• FF H1<sup>1</sup></li> </ul>
		B-	signal -	
P5a...P7a P5b...P7b	digital output	S	shield	
		USB	type B Hi-Speed USB 2.0 Device	<ul style="list-style-type: none"> <li>• service (FluxDiag/ FluxDiagReader)</li> </ul>
		LAN	RJ45 10/100 Mbps Ethernet	<ul style="list-style-type: none"> <li>• service (FluxDiag/ FluxDiagReader)</li> <li>• Modbus TCP</li> </ul>
analog inputs <sup>1, 2</sup>				
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	

<sup>1</sup> cable (by customer): e.g. flexible wires, with insulated wire ferrules, wire cross-section: 0.25...2.5 mm<sup>2</sup>

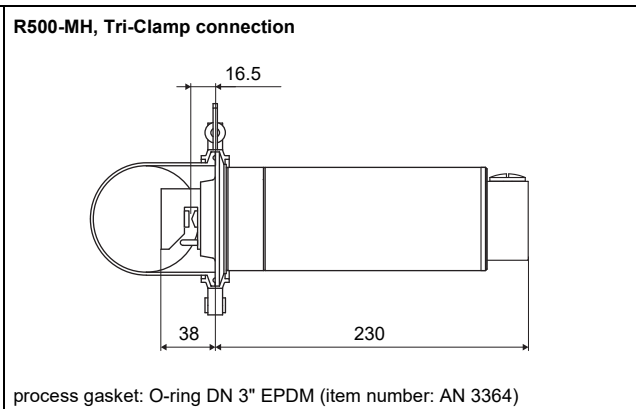
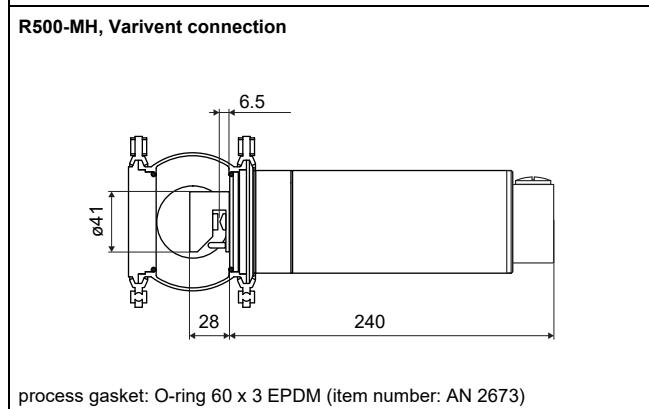
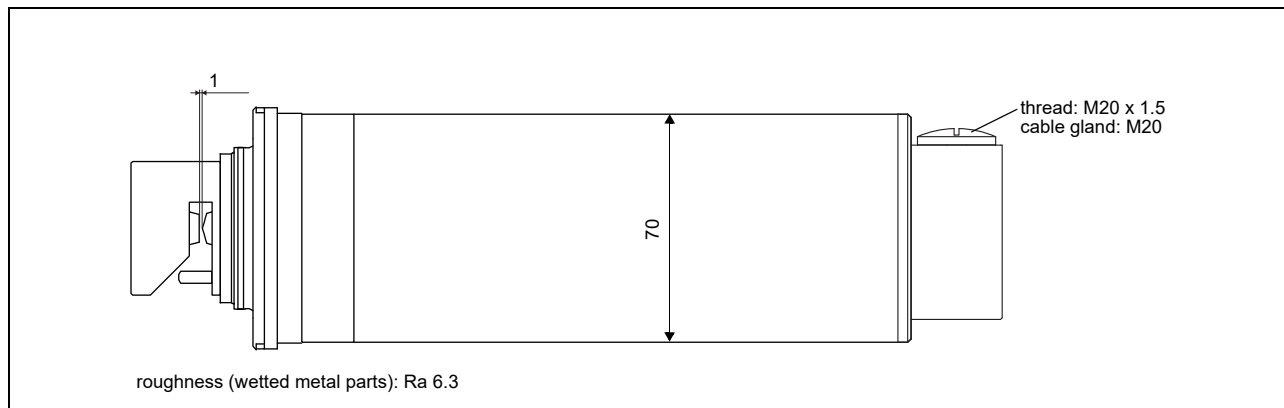
<sup>2</sup> The number, type and terminal assignment are customised.

# Sensor

## Technical data

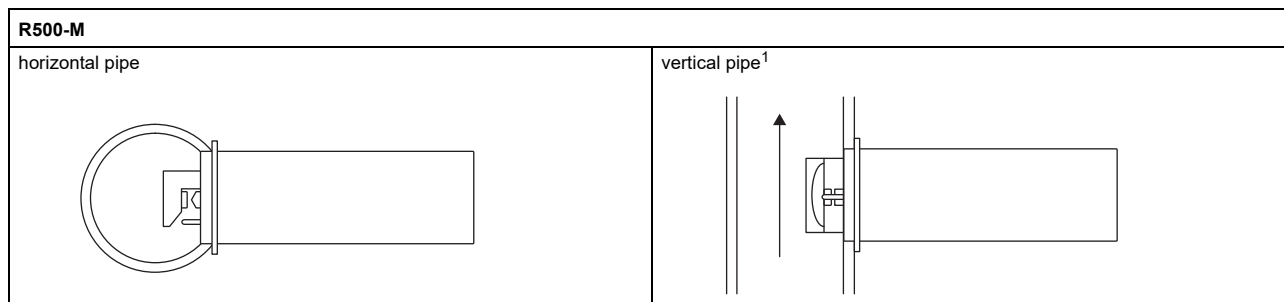
		R500	R500A1
order code		R500-MHV4EPNN	R500-MHV4EPA1
<b>process parameters</b>			
fluid		all liquids with a turbidity < 10 000 FAU	
fluid temperature (depending on ambient temperature)	°C	-20...+150 (150 °C at an ambient temperature of 20 °C)	-20...+130
fluid pressure		PN 10	
<b>measurement</b>			
measurement 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, typically 0.1 wt%)	
repeatability		nD: 0.000 02 (corresponds to 0.01 °Brix, typically 0.01 wt%)	
resolution (display)		nD: 0.000 001	
<b>material</b>			
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	
<b>explosion protection</b>			
• ATEX/IECEx			
marking		-	II1G 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
<b>temperature probe</b>			
type		Pt1000	
resolution	K	0.01	
accuracy at 20 °C	K	0.15	
response time	s	5	

### Dimensions



in mm

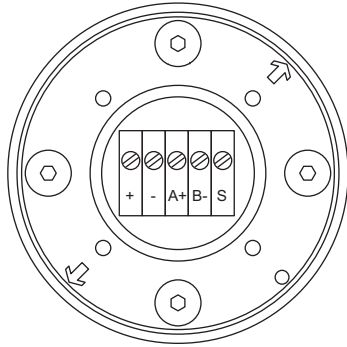
### Sensor mounting positions



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

## Connection

### Terminal assignment

	<table border="1"> <thead> <tr> <th>terminal</th> <th>connection</th> </tr> </thead> <tbody> <tr> <td>+</td> <td>yellow</td> </tr> <tr> <td>-</td> <td>green</td> </tr> <tr> <td>A+</td> <td>brown</td> </tr> <tr> <td>B-</td> <td>white</td> </tr> <tr> <td>S</td> <td>shield</td> </tr> </tbody> </table> <p>equipotential bonding terminal on housing cover</p>	terminal	connection	+	yellow	-	green	A+	brown	B-	white	S	shield
terminal	connection												
+	yellow												
-	green												
A+	brown												
B-	white												
S	shield												

### 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
<b>cable jacket</b>			
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											transmitted light refractometer
	500										standard sensor
		M									hygiene design
			H								stainless steel 316L (1.4404)
				V4							EPDM
					EP						zone 0/1
						A1					not explosion-proof
						NN					PN 10
							P10				flange, compatible with Varivent N <sup>1</sup>
								V			flange, compatible with Tri-Clamp 3" <sup>1</sup>
								T			in m
									XXX		

<sup>1</sup> process connection by customer

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