

Flexim PIOX R532/R500 Process Refractometer



Transmitted Light Process Refractometer - Hygiene Design

Features

- Unique transmitted light refractometer for process analysis
- High accuracy and drift-free due to difference measurement
- Integrated fluid temperature measurement
- Internal self-diagnosis and detection of errors
- Optical system insensitive to deposits
- Use in food industry to determine the Brix value

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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

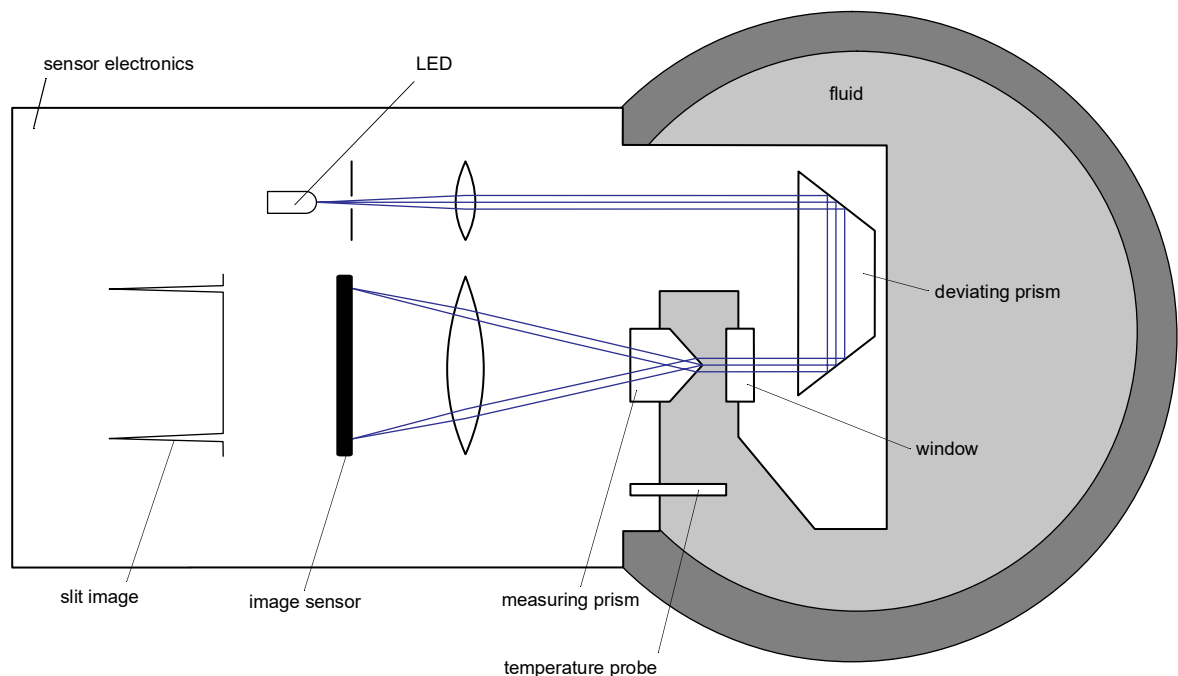
A special LED with a wave length $\lambda = 590$ nm (sodium D line) is used as the light source. The light passes through a slit, is parallelised by a lens and reversed by a deviating prism. Then it enters the fluid through a window in the sensor head. When the light beam re-enters the sensor, it is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

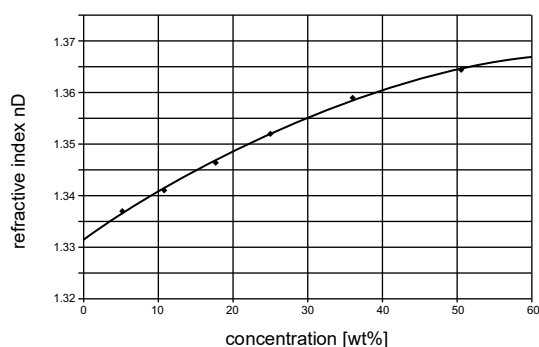
The transmitter calculates application-specific analysis quantity such as M%, Vol%, g/l, nDT (temperature-compensated refractive index), operating density, laboratory density, Brix value either with standardised fluid data sets from the library or with customised ones.

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.

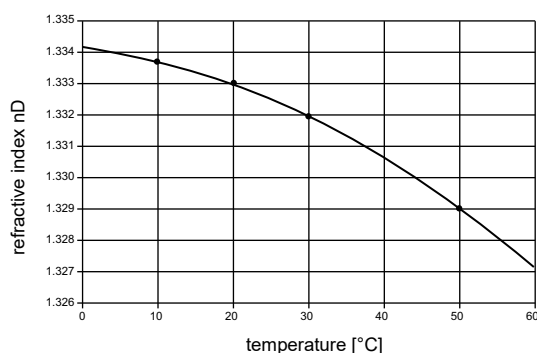
Dependence on temperature and concentration

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).

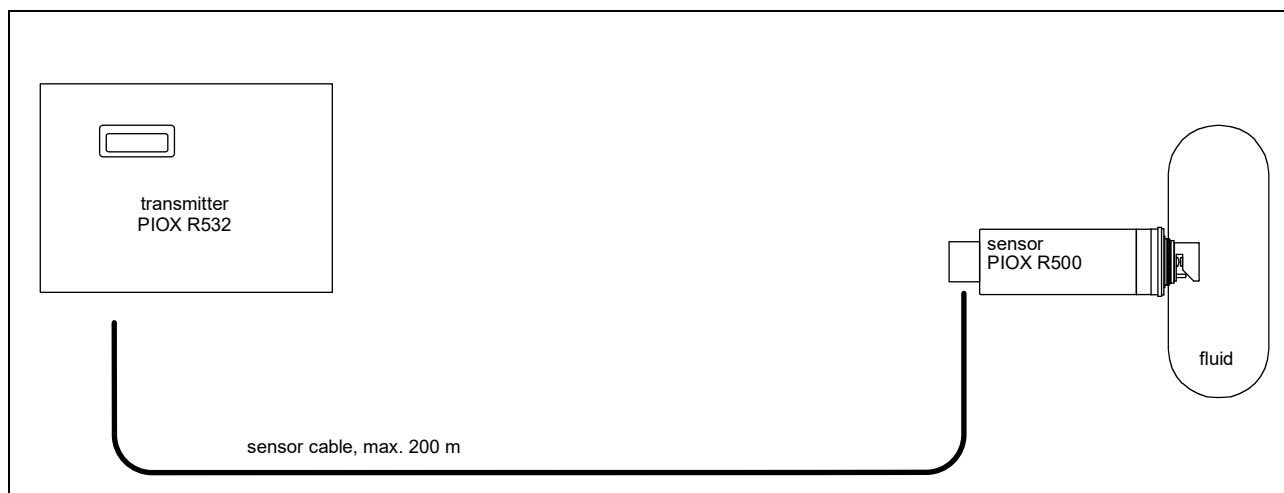
Dependence of the refractive index on the concentration (temperature = constant)



Dependence of the refractive index on the temperature (concentration = constant)




Measuring setup



Transmitter

Technical data

PIOX R532		
		
design		field device with 1 measuring channel
transmitter		
power supply		<ul style="list-style-type: none"> • 90...250 V/50...60 Hz or • 11...32 V DC
power consumption	W	< 10
number of measuring channels		1
damping	s	0...100 (adjustable)
response time	s	1
housing material		aluminum, powder coated
degree of protection		IP66
dimensions	mm	see dimensional drawing
weight	kg	2.25
fixation		wall mounting, optional: 2" pipe mounting
ambient temperature	°C	-20...+60
display		128 x 64 pixels, backlight
menu language		English, German, French, Spanish, Dutch, Russian, Polish, Turkish, Italian, Chinese
measuring functions		
physical quantities		see table below
diagnostic functions		signal amplitude, sensor humidity, sensor temperature
communication interfaces		
service interfaces		measured value transmission, parametrisation of the transmitter: <ul style="list-style-type: none"> • USB • LAN
process interfaces		max. 1 option: <ul style="list-style-type: none"> • Modbus RTU • HART
accessories		
data transmission kit		USB cable
software		<ul style="list-style-type: none"> • FluxDiagReader: reading of measured values and parameters, graphical representation • FluxDiag (optional): reading of measurement data, graphical representation, report generation, parametrisation of the transmitter
data logger		
loggable values		all physical quantities and totalised physical quantities
capacity		max. 800 000 measured values

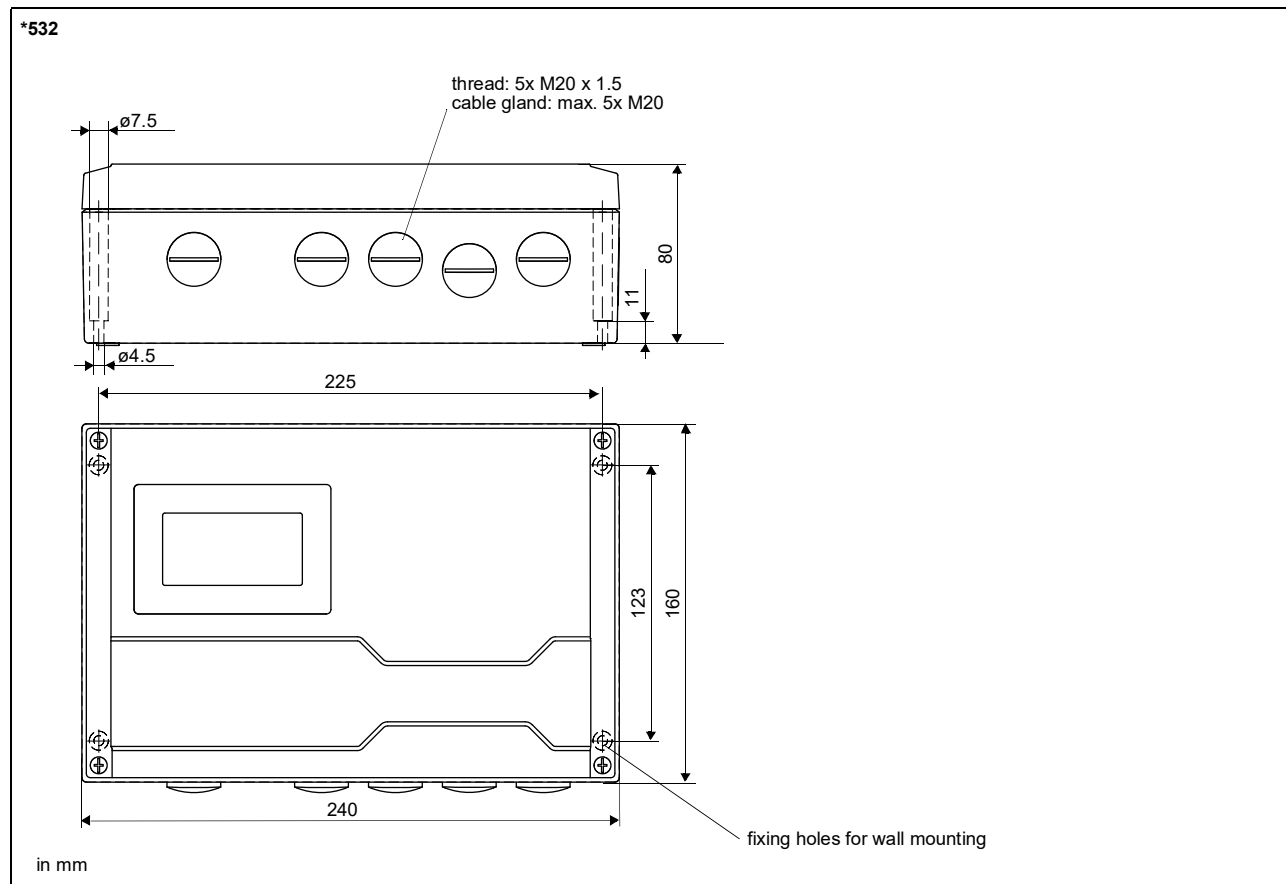
PIOX R532		
outputs		
The outputs are galvanically isolated from the transmitter.		
• switchable current output		
		configurable according to NAMUR NE 43
number		1 and optional: 1 (HART)
range	mA	4...20 (alarm current: 3.2...3.99, 20.01...24, hardware fault current: 3.2)
uncertainty		0.04 % of output value $\pm 3 \mu\text{A}$
active output		$R_{\text{ext}} = 250...530 \Omega$, $U_{\text{opencircuit}} = 28 \text{ V DC}$
passive output		$U_{\text{ext}} = 9...30 \text{ V DC}$, depending on R_{ext} ($R_{\text{ext}} < 458 \Omega$ at 20 V)
current output in HART mode		
• range	mA	4...20 (alarm current: 3.5...3.99, 20.01...22, hardware fault current: 3.2)
• active output		$R_{\text{ext}} = 250...530 \Omega$, $U_{\text{opencircuit}} = 28 \text{ V DC}$
• passive output		$U_{\text{ext}} = 9...30 \text{ V DC}$, depending on R_{ext} ($R_{\text{ext}} = 250...458 \Omega$ at 20 V)
• digital output		
number		2
functions		<ul style="list-style-type: none"> • frequency output • binary output • pulse output
type		open collector (passive)
operating parameters		$5...30 \text{ V}$, $I_{\text{max}} = 100 \text{ mA}$, $R_{\text{int}} = 20 \Omega$ Low: $U < 2 \text{ V}$ at $I_{\text{loop}} = 2 \text{ mA}$ ($R_{\text{ext}} = 12 \text{ k}\Omega$ at $U_{\text{ext}} = 24 \text{ V}$) High: $U > 15 \text{ V}$ ($R_{\text{ext}} = 12 \text{ k}\Omega$ at $U_{\text{ext}} = 24 \text{ V}$)
frequency output		
• range	kHz	0.002...10
• damping	s	0...999.9 (adjustable)
• pulse-to-pause ratio		1:1
binary output		
• binary output as alarm output		limit, change of flow direction or error
pulse output		
• pulse value	units	0.01...1000
• pulse width	ms	0.05...1000
• pulse rate		max. 10 000 pulses

Physical quantities

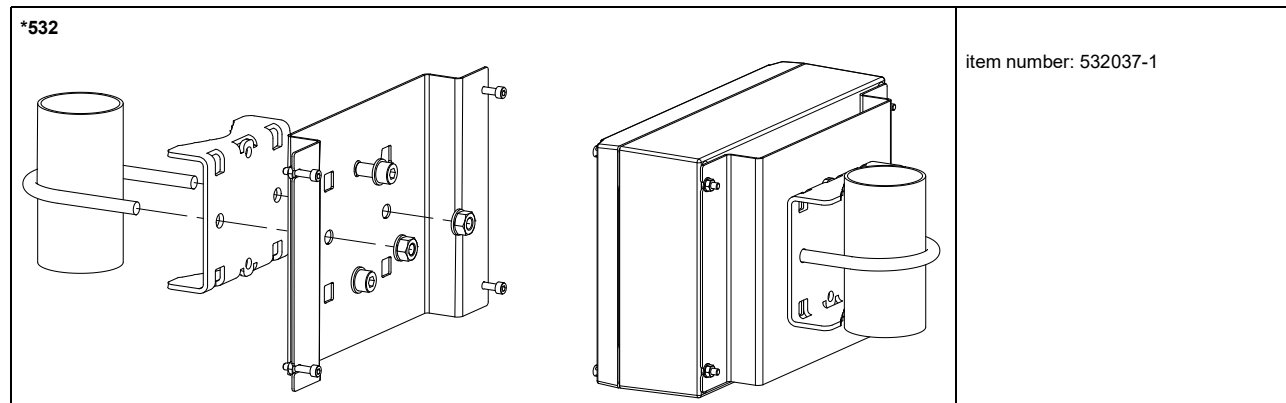
The available physical quantities depend on the fluid data set in the transmitter.

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

Dimensions



2" pipe mounting kit (optional)

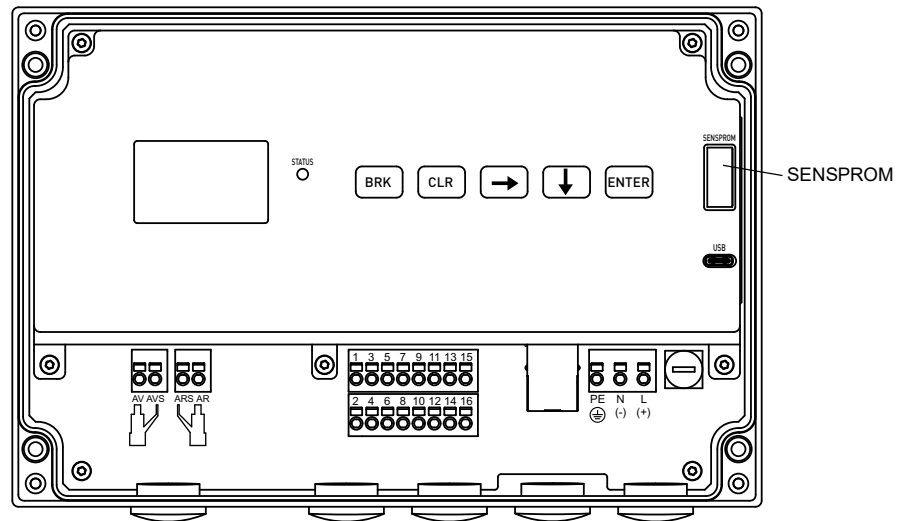


Storage

- do not store outdoors
- store within the original package
- store in a dry and dust-free place
- protect against sunlight
- keep all openings closed
- storing temperature: -20...+60 °C

Terminal assignment

*532



power supply¹

terminal	connection (AC)	terminal	connection (DC)
PE	protective conductor	PE	protective conductor
N	neutral conductor	(-)	-
L	outer conductor	(+)	+

transducers

terminal	transducer cable
4	yellow
3	green
1	brown
2	white

outputs^{1, 2}

terminal	connection
13+, 14-	passive current output
13-, 14+	active current output
9+, 10-	digital output
11+, 12-	
15+, 16-	passive current output/HART
15-, 16+	active current output/HART

communication interfaces

terminal	connection	communication interface
15	signal +	Modbus RTU ¹
16	signal -	
USB	type C Hi-Speed USB 2.0 Device	service (FluxDiag/FluxDiagReader)
LAN	RJ45 10/100 Mbps Ethernet	service (FluxDiag/FluxDiagReader)

¹ cable (by customer): e.g. flexible wires, with insulated wire ferrules, wire cross-section: 0.25...2.5 mm²

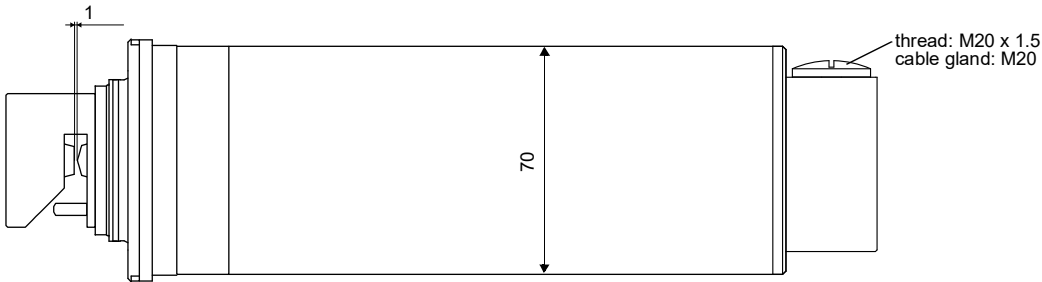
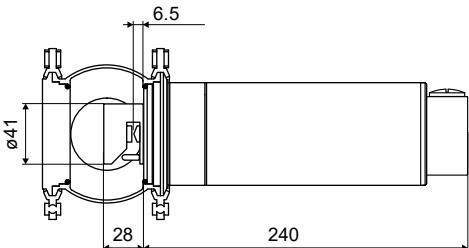
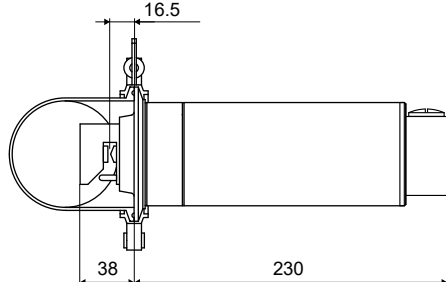
² The number, type and terminal assignment are customised.

Sensor

Technical data

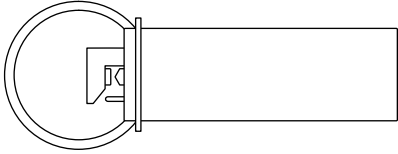
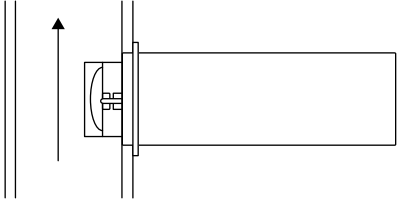
		R500
order code		RS1-R500-MHV4EP-NN
process parameters		
fluid		all liquids with a turbidity < 10 000 FAU
fluid temperature (depending on ambient temperature)	°C	-20...+150 (150 °C at an ambient temperature of 20 °C)
fluid pressure		PN 10
measurement		
measurement principle		transmitted light refractometry
measuring range		nD: 1.3...1.7 °Brix: 0...100
accuracy (absolute)		nD: 0.000 2 (corresponds to 0.1 °Brix, typically 0.1 wt%)
repeatability		nD: 0.000 02 (corresponds to 0.01 °Brix, typically 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		IP54, wetted parts: IP67
flange		for Varivent (N) or Tri-Clamp 3"
dimensions		see dimensional drawing
weight	kg	min. 2
ambient temperature	°C	-40...+70
temperature probe		
type		Pt1000
resolution	K	0.01
accuracy at 20 °C	K	0.15
response time	s	5

Dimensions

 <p>roughness (wetted metal parts): Ra 6.3</p>	
R500-MH, Varivent connection  <p>process gasket: O-ring 60 x 3 EPDM (item number: AN 2673)</p>	R500-MH, Tri-Clamp connection  <p>process gasket: O-ring DN 3" EPDM (item number: AN 3364)</p>

in mm

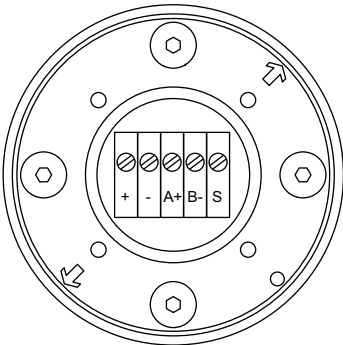
Sensor mounting positions

R500-M	
horizontal pipe	vertical pipe ¹
	

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

Sensor order code

1, 2	3...5	6	7	8, 9	10, 11	12, 13	14, 15	16...18	19	no. of character			
measurement principle	type	-	type of construction	design	material (wetted parts)	gaskets	-	explosion protection	certification	-	process pressure	flange	description
R	500		M	H	V4	EP		NN	NN		P10		transmitted light refractometer
											A15		standard sensor
													hygiene design
													stainless steel 316L (1.4404)
													EPDM
													not explosion-proof
													-
													PN 10
													150 psi
												V	flange, compatible with Varivent N ¹
												T	flange, compatible with Tri-Clamp 3" ⁱ

¹ process connection by customer

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