

# 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
- $\theta_i$  = angle of incidence
- $n_t$  = refractive index of prism
- $\theta_t$  = angle of refraction

### Measurement with refractometer PIOX R

#### Sensor

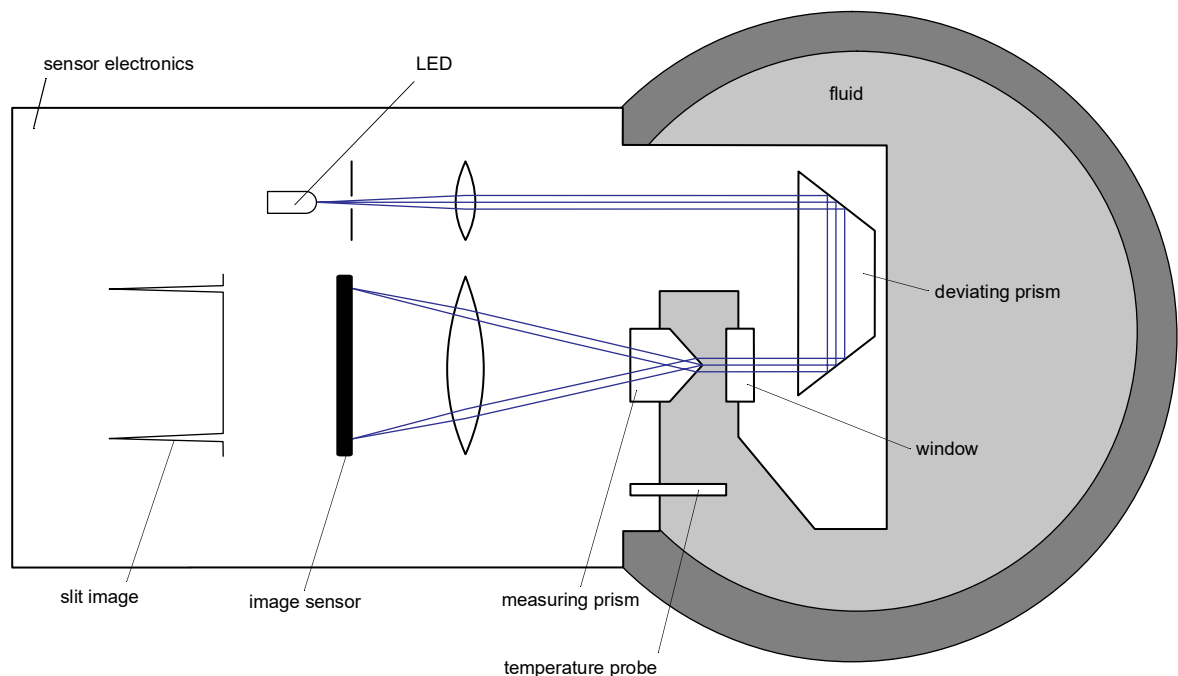
A special LED with a wave length  $\lambda = 590$  nm (sodium D line) is used as the light source. The light passes through a slit, is parallelized by a lens and reversed by a deviating prism. Then it enters the fluid through a window in the sensor head. When the light beam re-enters the sensor, it is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

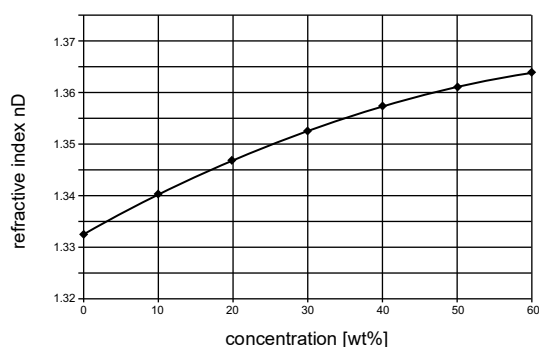
The transmitter calculates application-specific analysis quantity such as M%, Vol%, g/l, nDT (temperature-compensated refractive index), operating density, laboratory density, Brix value either with standardized fluid data sets from the library or with customized ones.

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.

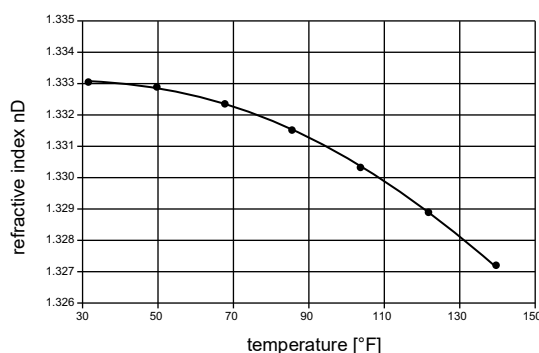
## Dependence on temperature and concentration

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).

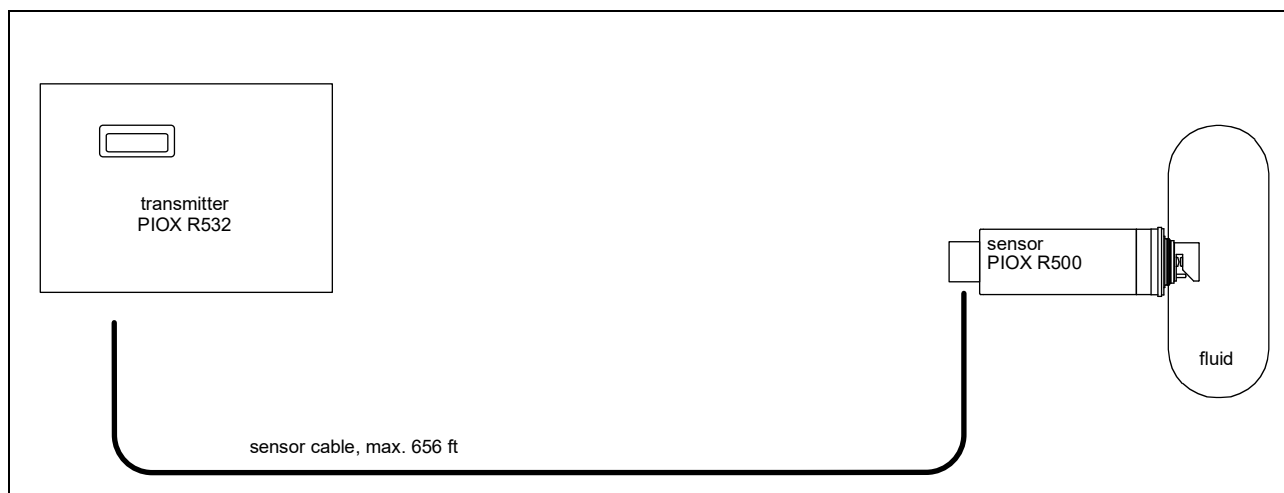
Dependence of the refractive index on the concentration (temperature = constant)



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




## Measuring setup



## Transmitter

### Technical data

		PIOX R532
		
design		field device with 1 measuring channel
<b>transmitter</b>		
power supply		<ul style="list-style-type: none"> <li>• 90 to 250 V/50 to 60 Hz or</li> <li>• 11 to 32 V DC</li> </ul>
power consumption	W	< 10
number of measuring channels		1
damping	s	0 to 100 (adjustable)
response time	s	1
housing material		aluminum, powder coated
degree of protection		IP66
dimensions	inch	see dimensional drawing
weight	lb	7
fixation		wall mounting, optional: 2" pipe mounting
ambient temperature	°F	-4 to +140
display		128 x 64 pixels, backlight
menu language		English, German, French, Spanish, Dutch, Russian, Polish, Turkish, Italian, Chinese
<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, parametrization of the transmitter: <ul style="list-style-type: none"> <li>• USB</li> <li>• LAN</li> </ul>
process interfaces		max. 1 option: <ul style="list-style-type: none"> <li>• Modbus RTU</li> <li>• HART</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 representation</li> <li>• FluxDiag (optional): reading of measurement data, graphical representation, report generation, parametrization of the transmitter</li> </ul>
<b>data logger</b>		
loggable values		all physical quantities and totalized physical quantities
capacity		max. 800 000 measured values

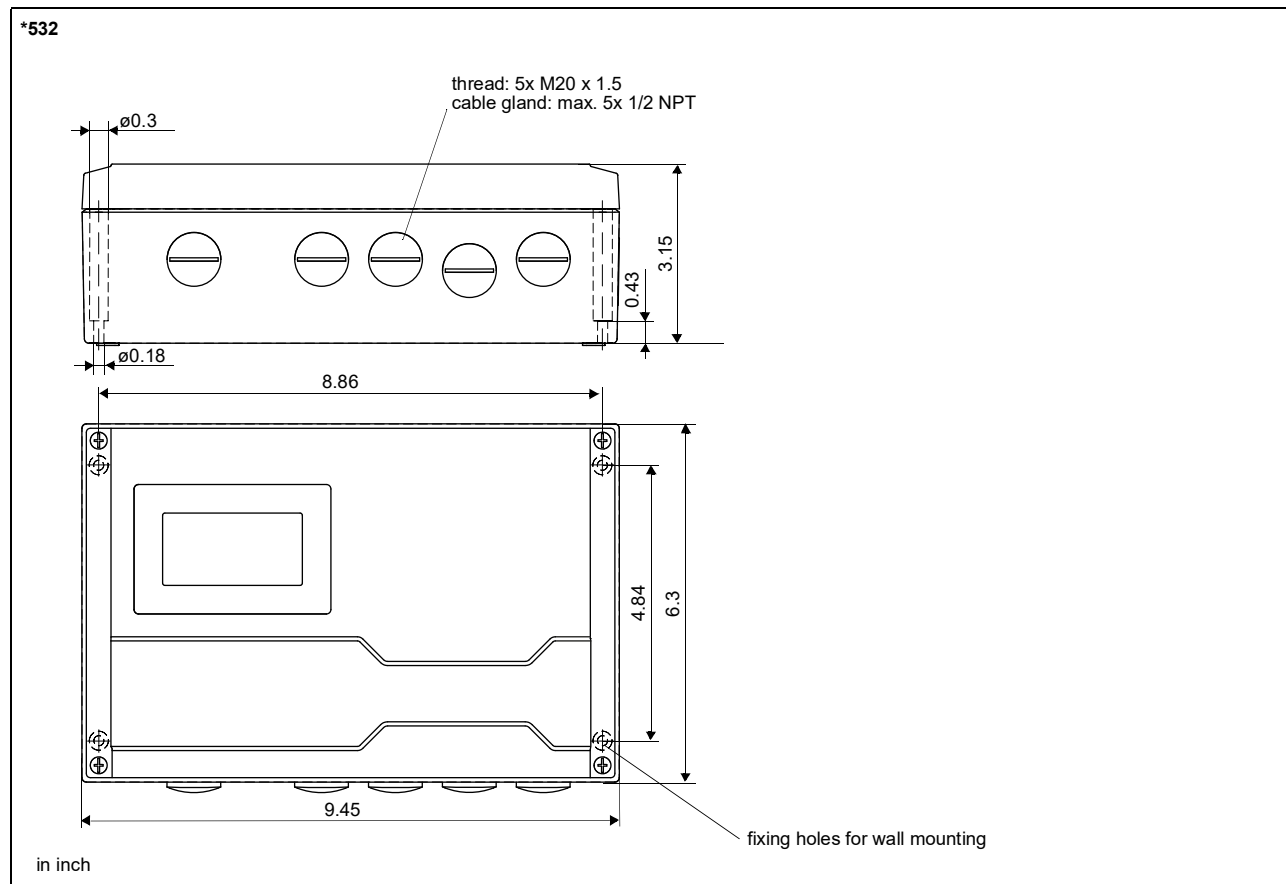
PIOX R532		
<b>outputs</b>		
The outputs are galvanically isolated from the transmitter.		
<b>• switchable current output</b>		
		configurable according to NAMUR NE 43
number		1 and optional: 1 (HART)
range	mA	4 to 20 (alarm current: 3.2 to 3.99, 20.01 to 24, hardware fault current: 3.2)
uncertainty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

## Physical quantities

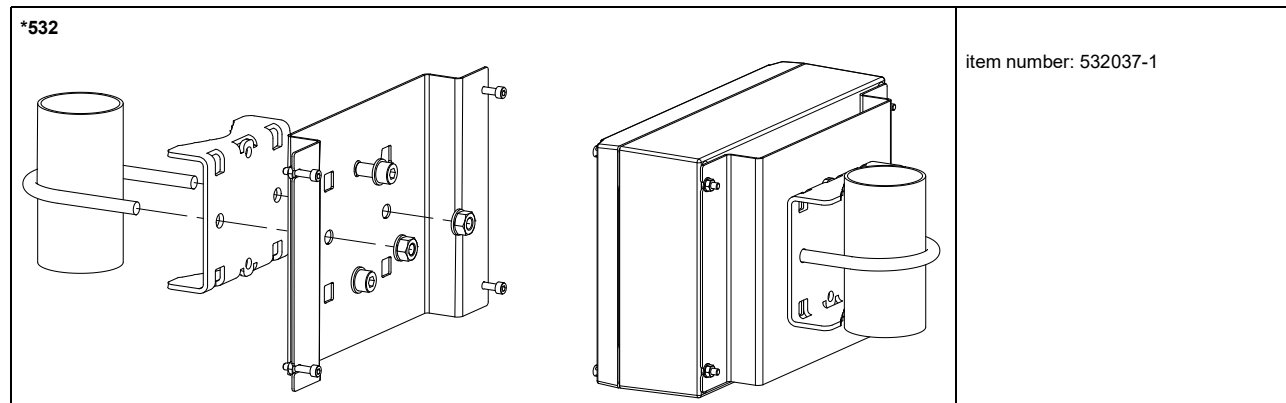
The available physical quantities depend on the fluid data set in the transmitter.

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	customized fluid data set	refractive index, fluid temperature, °Brix, wt% (saccharose), further customized physical quantities	data set developed by FLEXIM in cooperation with the customer

## Dimensions



## 2" pipe mounting kit (optional)



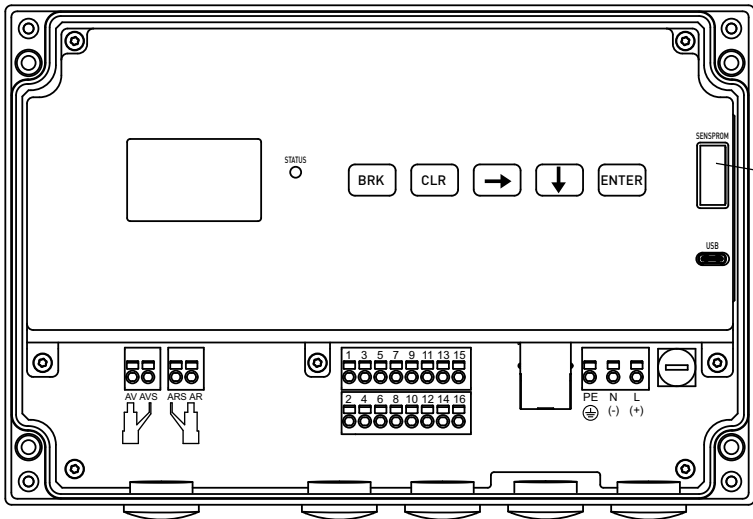
## Storage

- 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: -4...+140 °F



## Terminal assignment

\*532



The diagram shows the rear panel of a device with various connection points and labels. At the top, there is a 'STATUS' indicator, buttons for 'BRK', 'CLR', and navigation arrows, and an 'ENTER' button. To the right is a 'SENSPROM' label pointing to a component. Below these are two sets of screw terminals labeled 'AV AVS' and 'ARS AR'. In the center is a large terminal block with 16 numbered terminals (1-16) arranged in two rows. To the right of this block are terminals for 'PE', 'N', and 'L' with polarity symbols. At the bottom right is a 'USB' port.

power supply <sup>1</sup>			
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 <sup>1, 2</sup>			
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 <sup>1</sup>	
16	signal -		
USB	type C Hi-Speed USB 2.0 Device	service (FluxDiag/FluxDiagReader)	
LAN	RJ45 10/100 Mbps Ethernet	service (FluxDiag/FluxDiagReader)	

<sup>1</sup> cable (by customer): e.g., flexible wires, with insulated wire ferrules, wire cross-section: AWG14 to 24

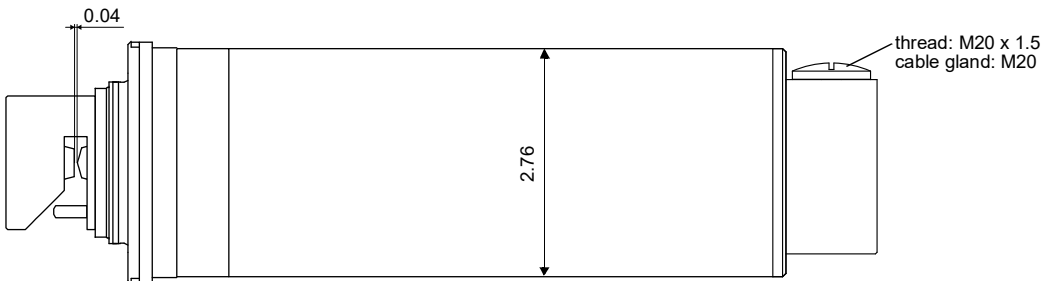
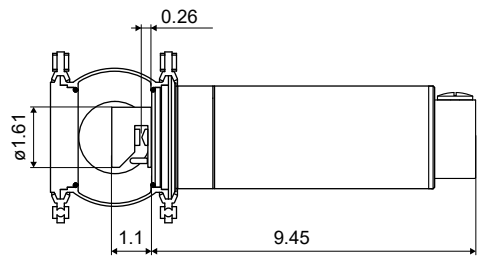
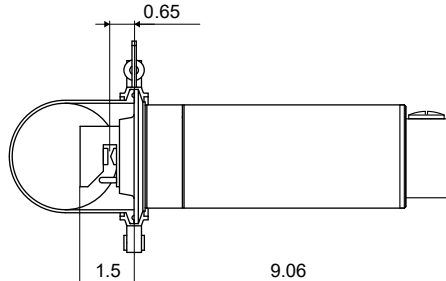
<sup>2</sup> The number, type and terminal assignment are customized.

## Sensor

### Technical data

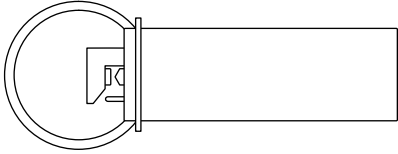
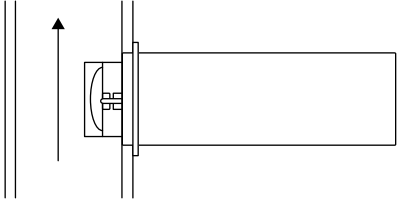
		<b>R500</b>
order code		RS1-R500-MHV4EP-NN
<b>process parameters</b>		
fluid		all liquids with a turbidity < 10 000 FAU
fluid temperature (depending on ambient temperature)	°F	-4 to +302 (302 °F at an ambient temperature of 68 °F)
fluid pressure		PN 10
<b>measurement</b>		
measurement principle		transmitted light refractometry
measuring range		nD: 1.3 to 1.7 °Brix: 0 to 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
wetted parts		stainless steel 316L
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	lb	min. 4.4
ambient temperature	°F	-40 to +158
<b>temperature probe</b>		
type		Pt1000
resolution	K	0.01
accuracy at 68 °F	K	0.15
response time	s	5

### Dimensions

 <p>roughness (wetted metal parts): 248 µinch</p>	
<p><b>R500-MH, Varivent connection</b></p>  <p>process gasket: O-ring 60 x 3 EPDM (item number: AN 2673)</p>	<p><b>R500-MH, Tri-Clamp connection</b></p>  <p>process gasket: O-ring DN 3" EPDM (item number: AN 3364)</p>

in inch

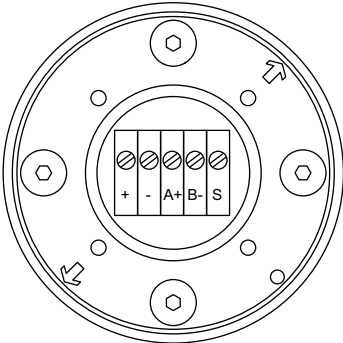
## Sensor mounting positions

R500-M	
horizontal pipe	vertical pipe <sup>1</sup>
	

<sup>1</sup> 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 gray
length	ft	max. 656
weight	lb/ft	approx. 0.07
ambient temperature	°F	-40 to +176
properties		flame retardant according to IEC 60332-1-2
cable jacket		
material		PVC
outer diameter	inch	0.33
color		gray
shield		x

## Sensor order code

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

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

For more information: **Emerson.com**

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