Flexim PIOX R532/R500
Process Refractometer

Transmitted Light Process Refractometer - Chemistry 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
- Stainless steel and carbon-fiber reinforced PTFE sensors available
- Use in chemical processes to determine the concentration and density of liquid mixtures
- Library for approx. 50 typical analysis applications available, customized fluid data sets can also be provided
- Typical analysis outputs like M%, Vol%, g/l, operating density, laboratory density selectable

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 λ = 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.

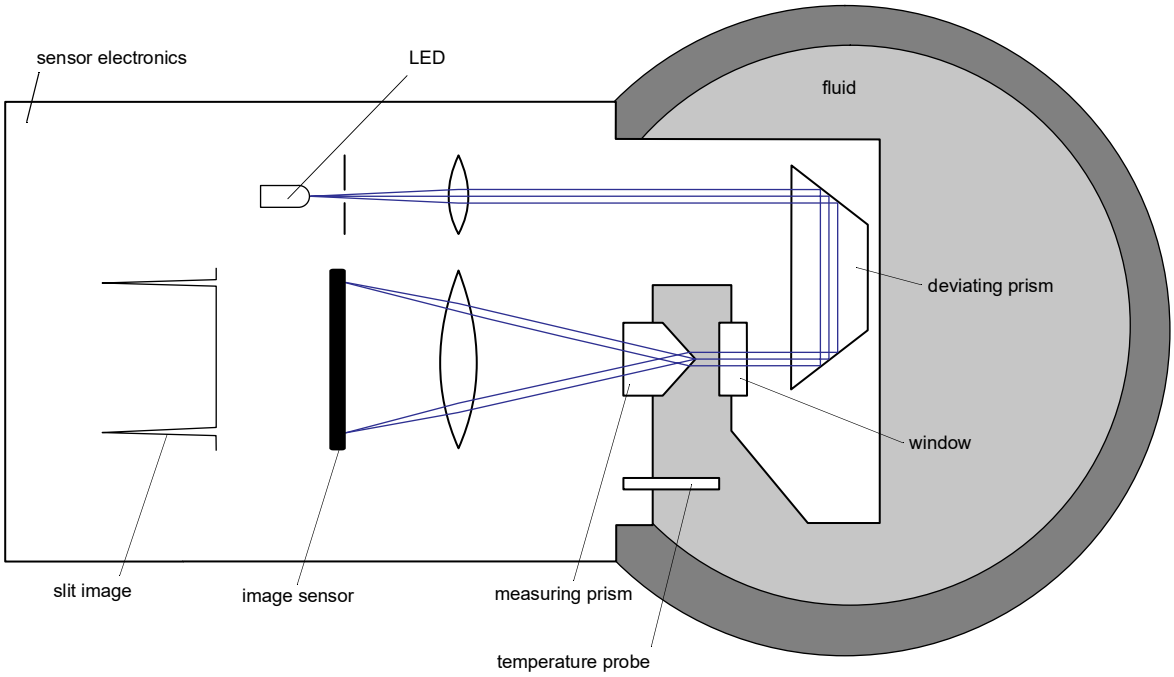
The angle of refraction is determined from the difference between the two images of the slit. The zero point is calculated continuously in order to compensate for the influences of the process pressure and temperature.

The refractive index nD 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

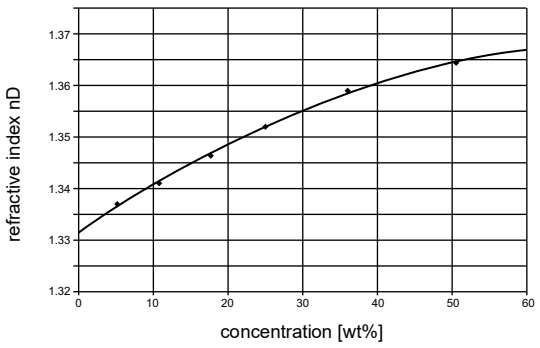
The transmitter calculates application-specific analysis quantity such as M%, Vol%, g/l, nDT (temperature-compensated refractive index), operating density, laboratory density, Brix value either with standardised fluid data sets from the library or with customised ones.

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.

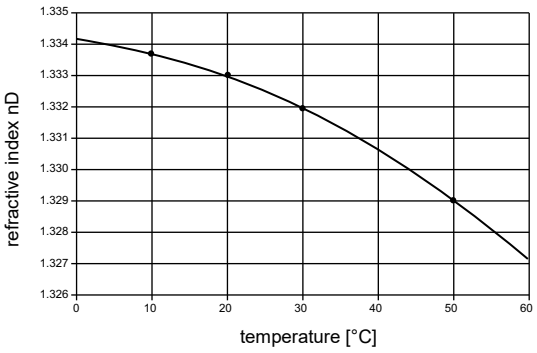
Dependence on temperature and concentration

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).

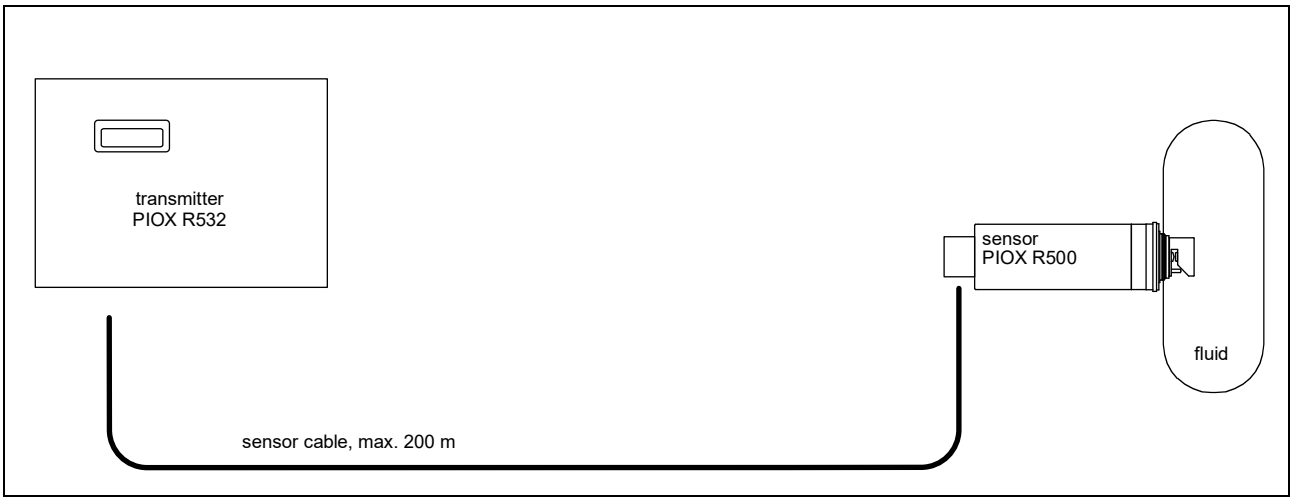
Dependence of the refractive index on the concentration (temperature = constant)



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		• 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: • USB • LAN
process interfaces		max. 1 option: • Modbus RTU • HART
accessories		
data transmission kit		USB cable
software		• 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 ±3 µA
active output		R_{ext} = 250...530 Ω, $U_{opencircuit}$ = 28 V DC
passive output		U_{ext} = 9...30 V DC, depending on R_{ext} (R_{ext} < 458 Ω at 20 V)
current output in HART mode • range • active output • passive output	 mA	 4...20 (alarm current: 3.5...3.99, 20.01...22, hardware fault current: 3.2) R_{ext} = 250...530 Ω, $U_{opencircuit}$ = 28 V DC U_{ext} = 9...30 V DC, depending on R_{ext} (R_{ext} = 250...458 Ω at 20 V)
• **digital output**		
number		2
functions		• frequency output • binary output • pulse output
type		open collector (passive)
operating parameters		5...30 V, I_{max} = 100 mA, R_{int} = 20 Ω Low: U < 2 V at I_{loop} = 2 mA (R_{ext} = 12 kΩ at U_{ext} = 24 V) High: U > 15 V (R_{ext} = 12 kΩ at U_{ext} = 24 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

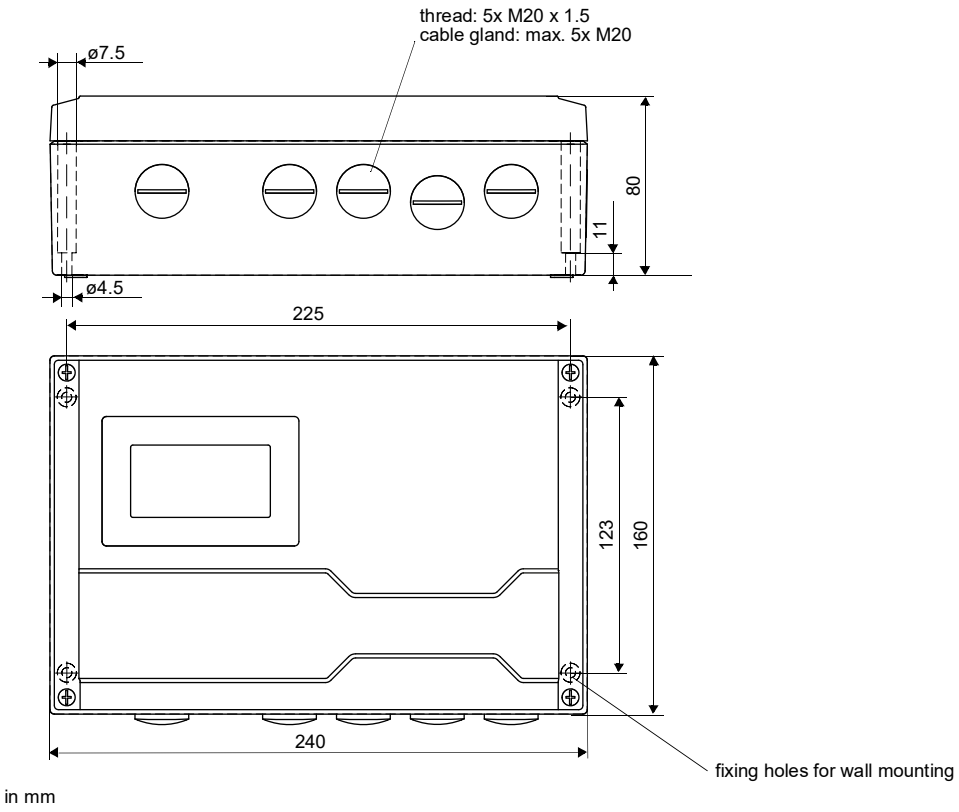
Physical quantities

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	
SSF	standard fluid data set	refractive index, fluid temperature, °Brix, concentration	application-specific fluid data set from FLEXIM database
SCF	customised fluid data set	refractive index, fluid temperature, °Brix, further customised physical quantities	data set developed by FLEXIM in cooperation with the customer

Dimensions

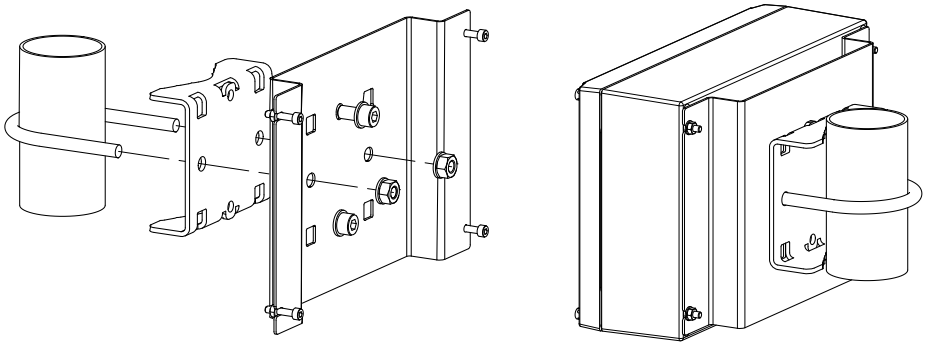
***532**



in mm

2" pipe mounting kit (optional)

***532**



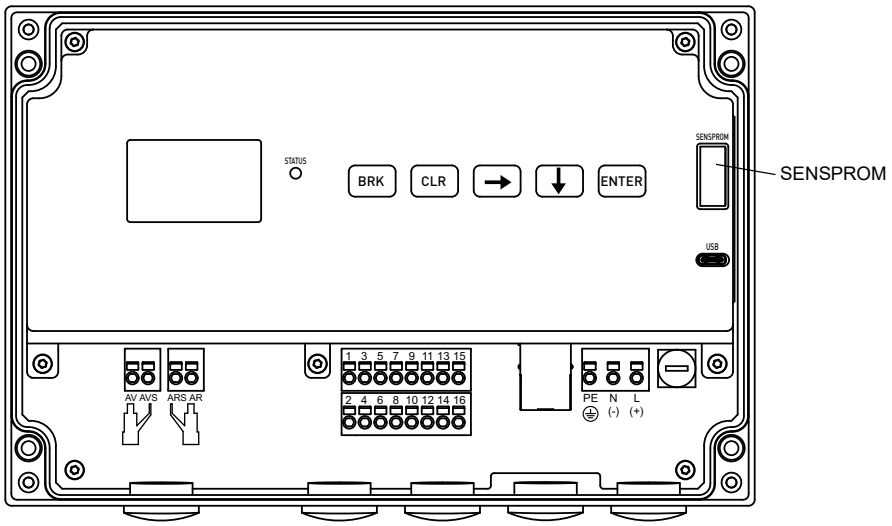
item number: 532037-1

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 supply[1]			
terminal	**connection (AC)**	**terminal**	**connection (DC)**
PE	protective conductor	PE	protective conductor
N	neutral conductor	(-)	-
L	line 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- 11+, 12-	digital output
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 mm^2

[2] The number, type and terminal assignment are customised.

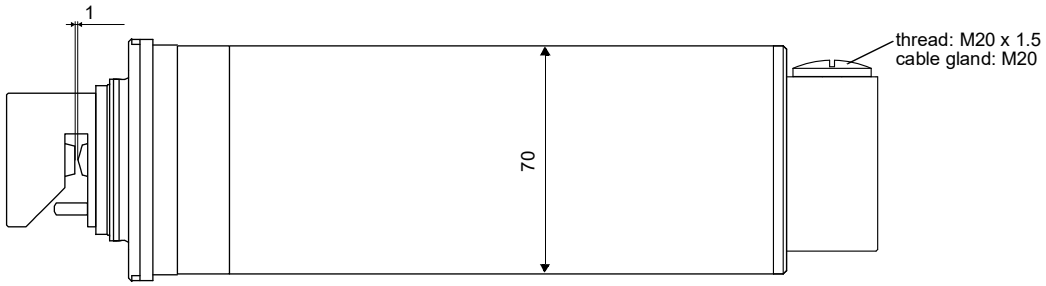
Sensor

Technical data

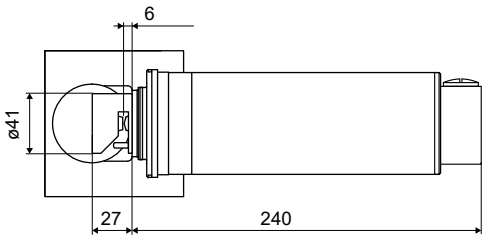
		R500	R500
order code		RS1-R500-*CS4KR-NN	RS1-R500-*CTFKR-NN
process parameters			
fluid		all liquids with a turbidity < 10 000 FAU	all liquids with a turbidity < 10 000 FAU
fluid temperature (depending on ambient temperature)	°C	-20...+150 (150 °C at an ambient temperature of 20 °C)	-20...+120
fluid pressure		PN 10, PN 16, PN 40 (on request, depending on process connection)	PN 10
measurement			
measurement principle		transmitted light refractometry	transmitted light refractometry
measuring range		nD: 1.3…1.7	nD: 1.3…1.7
accuracy (absolute)		nD: 0.000 2 (typically 0.1 wt%)	nD: 0.000 2 (typically 0.1 wt%)[1]
repeatability		nD: 0.000 02 (typically 0.01 wt%)	nD: 0.000 02 (typically 0.01 wt%)
resolution (display)		nD: 0.000 001	nD: 0.000 001
material			
housing		stainless steel 304 (1.4301)	stainless steel 304 (1.4301), epoxy-powder coated
wetted parts		stainless steel 316Ti (1.4571) (others on request)	PTFE/carbon 25 %
gaskets		FFKM	FFKM
prism		sapphire, nD ≈ 1.76	sapphire, nD ≈ 1.76
degree of protection		IP54, wetted parts: IP67	IP54, wetted parts: IP67
flange		depending on type of construction (see sensor order code)	depending on type of construction (see sensor order code)
dimensions		see dimensional drawing	see dimensional drawing
weight	kg	min. 2	see dimensional drawing
ambient temperature	°C	-40...+70	-40...+70
temperature probe			
type		Pt1000	Pt1000
resolution	K	0.01	0.01
accuracy at 20 °C	K	0.15	0.15
response time	s	5	20

[1] R500-LCTF: depending on temperature and flow velocity:
max. 2.5 m/s at 20 °C
max. 1 m/s at 80 °C

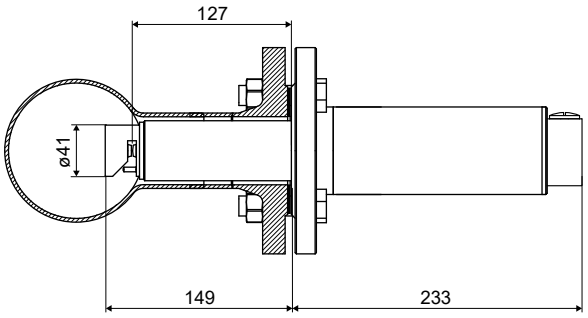
Dimensions



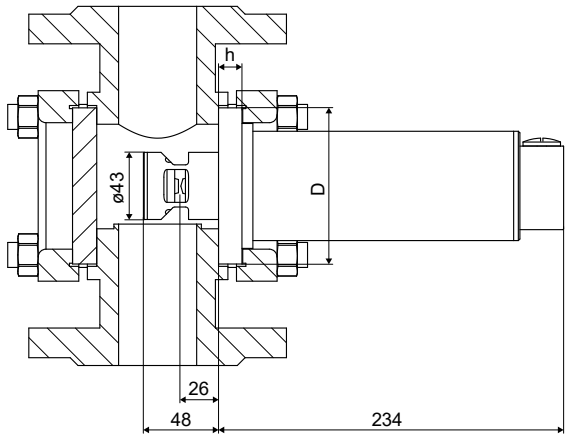
R500-MCS4, FLEXIM flange



R500-LCS4, direct flange

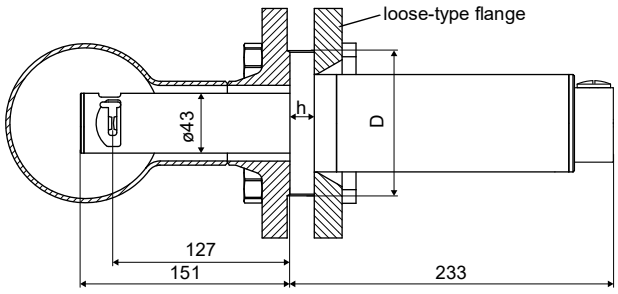


R500-MCTF



pipe diameter	D mm	h mm	weight kg
DN 50, 2"	Ø100	15	1.84
DN 80, 3"	Ø122	20	2.04

R500-LCTF



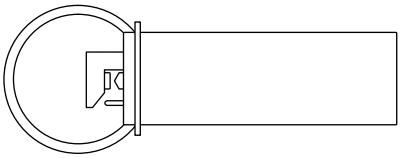
pipe diameter	D mm	h mm	weight kg	connecting dimensions according to
DN 50	Ø102	17	2.19	ISO 7005 EN 1092 BS 4504 DIN 2501
DN 80	Ø124	17	2.5	
2"	Ø102	17	2.19	ANSI/ASME B 16.5 class 150 ASTM D 4024 BS 1560 BS EN 1759
3"	Ø124	17	2.5	

in mm

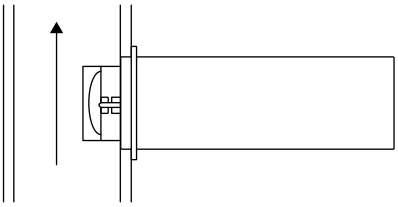
Sensor mounting positions

R500-M

horizontal pipe

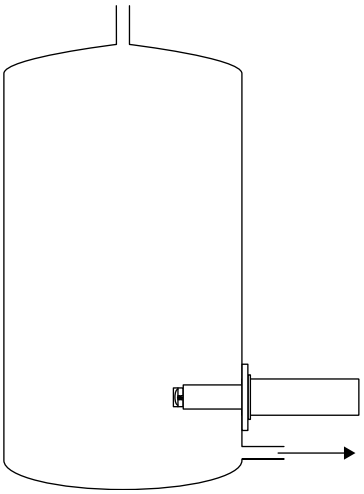


vertical pipe[1]



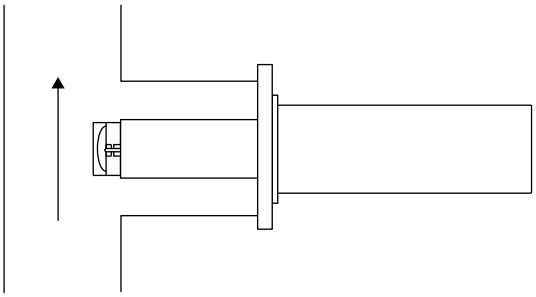
R500-L

vessel



installation close to the outlet

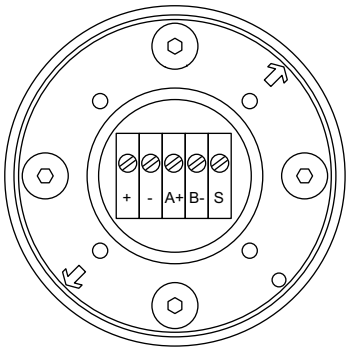
T-piece[1]



[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

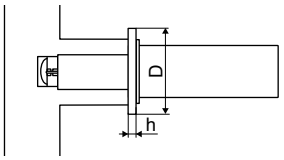
Sensor order code

1, 2	3...5		6	7	8, 9	10, 11		12, 13	14, 15		16...18	19	20...22	no. of character
measurement principle	**type**	**-**	**type of construction**	**design**	**material (wetted parts)**	**gaskets**	**-**	**explosion protection**	**certification**	**-**	**process pressure**	**flange**	**flange size (flange = D)**	**description**
R														transmitted light refractometer
	500													
			M											standard sensor
			L											long sensor
				C										chemistry design
					S4									stainless steel 316Ti (1.4571)
					TF									PTFE
						KR								FFKM (standard)
						KA								FFKM (oleum specialised)
								NN						not explosion-proof
									NN					-
											P10			PN 10
											A15			150 psi
											P16			PN 16
											A30			300 psi
											P40			PN 40 (on request)
												F		FLEXIM flange (R500-MC)
												D		direct flange (R500-LCS4, R500-*CTF)
													050	DN 50 (R500-LCS4)
													080	DN 80 (R500-LCS4)
													002	2" (R500-LCS4)
													003	3" (R500-LCS4)
													H50	DN 50 (loose-type flange (R500-LCTF) or sight glass fitting (R500-MCTF))
													H80	DN 80 (loose-type flange (R500-LCTF) or sight glass fitting (R500-MCTF))
													H02	2" (loose-type flange (R500-LCTF) or sight glass fitting (R500-MCTF))
													H03	3" (loose-type flange (R500-LCTF) or sight glass fitting (R500-MCTF))

Process connection

Direct flange for PIOX R500-LCS4K*-****-***D

The sensor is welded to the direct flange (EN 1092-1 type 05 or ASME B16.5 150/300 psi).

description		sensor order code	pressure rating (flange)	pipe diameter	dimensions [mm]		dimensional drawing
					D	h	
direct flange	D050	R500-LCS4K*-****-P**D050	PN 16 optional: PN 40	DN 50	ø165	18	
	D080	R500-LCS4K*-****-P16D080	PN 16	DN 80	ø200	20	
	D002	R500-LCS4K*-****-A15D002 R500-LCS4K*-****-A30D002	150 psi 300 psi	2"	ø6"	19.1	
	D003	R500-LCS4K*-****-A15D003 R500-LCS4K*-****-A30D003		3"	ø7.5"	23.9	

special materials on request

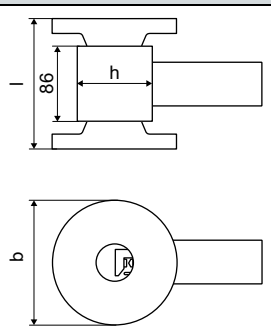
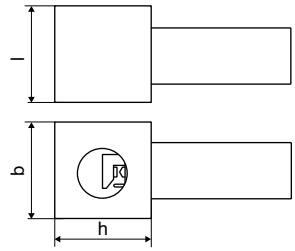
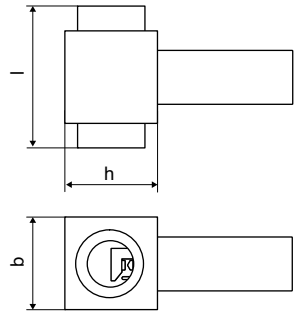
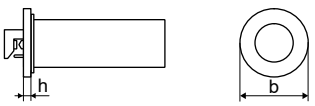
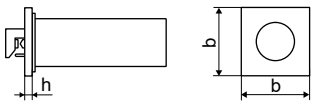
Process connection for PIOX R500-MCS4K*-****-***F

Order code

process connection	-	connection type	pipe diameter	-	explosion protection	-	material[1]	gaskets	-	pressure rating (flange)[1]	/	option	description
PCR													process connection
		FD											flow chamber with flanges according to EN 1092-1 type 11
		FA											flow chamber with flanges according to ASME B 16.5 150/ 300 psi
		FT											flow chamber with screwed connection
		FW											flow chamber with welded connection to the process pipe
		WR											round welding plate for vessel installation
		WS											square welding plate for vessel installation
			xxx										DN xxx (xxx = 015, 025, 050, 080) 1" (xxx = 001), 2" (xxx = 002), 3" (xxx = 003), 3/8" (xxx = G38), 1/2" (xxx = G12), 3/4" (xxx = G34) welding plate (xxx = T00)
					NN								not explosion-proof, zone 0/1
							S4						stainless steel 316Ti (1.4571)
								FE					FPM with FEP coating
										Pyy			pressure rating PN yy in bar (yy = 10, 16, on request: 40)
										Ayy			150 psi (yy = 15), 300 psi (yy = 30)
												HCL	cleaning line (PCR-F*)

[1] possible pipe diameters/materials/pressure ratings to be selected from table on page 16. Observe national regulations when selecting the flange size depending on the pressure rating.

Technical data

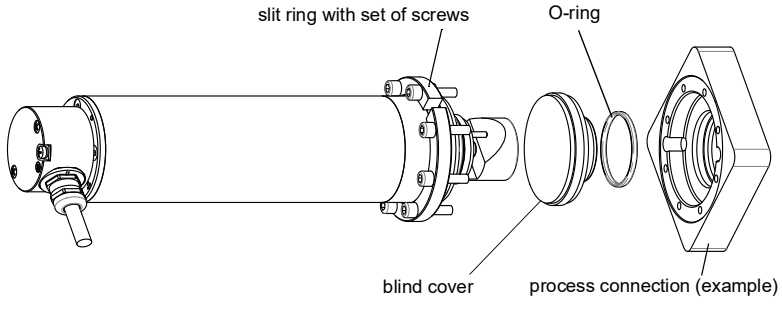
description	order code	pressure rating (flange) Pyy	pipe diameter xxx	dimensions [mm]			weight [kg]	dimensional drawing
				l	b	h		
flow chamber with flanges accessories: blind cover, sensor mounting kit optional: cleaning line[1]	PCR-FDxxx-**-S4FE-P16	PN 16	DN 15	170	ø95	58	4.3	
			DN 25	176	ø115	58	5	
			DN 50	190	ø165	80	8.3	
			DN 80	200	ø200	107	11.9	
	PCR-FAxxx-**-S4FE-Ayy	150 psi 300 psi	ANSI 1"	8.32“	ø4.25“	2.3“	5.1	
			ANSI 2"	8.94“	ø6“	3.15“	8.8	
			ANSI 3"	9.69“	ø7.48“	4.21“	13.4	
flow chamber with screwed connection accessories: blind cover, sensor mounting kit optional: cleaning line[1]	PCR-FTxxx-**-S4FE-Pyy		G 3/8"	100	100	100	3.3	
			G 1/2"				3.2	
			G 3/4"				3.2	
flow chamber with welded connection to the process pipe accessories: blind cover, sensor mounting kit optional: cleaning line[1]	PCR-FWxxx-**-S4FE-Pyy		DN 15	100	100	58	2.8	
			DN 25	100	100	58	2.7	
			DN 50	100	100	80	4.2	
			DN 80	100	100	107	3.1	
			1"	3.94"	3.94"	2.3"	2.7	
			2"	3.94"	3.94"	3.15"	4.2	
			3"	3.94"	3.94"	4.21"	3.1	
round welding plate for vessel installation accessories: blind cover, sensor mounting kit	PCR-WRT00-**-S4FE-Pyy				ø100	20		
square welding plate for vessel installation accessories: blind cover, sensor mounting kit	PCR-WST00-**-S4FE-Pyy			100	100	20		

xxx, yy - see order code
PN 40 on request

[1] cleaning connection:
- thread: G1/4"
- cable gland
- stainless steel pipe 6 x 1 mm, length: 150 mm

Accessories

sensor mounting kit

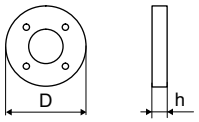


sensor mounting kit	item number
slit ring	TR4492-SP
set of screws	8x TR4214-SP
O-ring	TR2661-SP
blind cover	TR4494-SP

included in supply

Direct flange for PIOX R500-LCTFKR-****-***D

The sensor is connected to the direct flange. It is fixed with a loose-type flange.

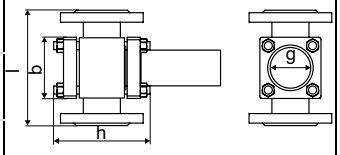
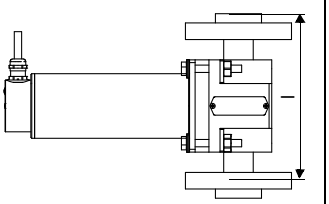
description		sensor order code	pressure rating (flange)	pipe diameter	dimensions [mm]		dimensional drawing
					D	h	
loose-type flange	DH50	R500-LCTFKR-****-P10DH50	PN 10	DN 50	165	20	
	DH80	R500-LCTFKR-****-P10DH80		DN 80	200	20	
	DH02	R500-LCTFKR-****-A15DH02	150 psi	2"	165	24	
	DH03	R500-LCTFKR-****-A15DH03		3"	200	27	

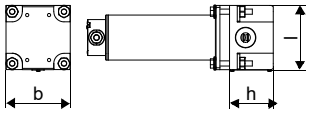
included in supply

Process connection for PIOX R500-MCTFKR-****-***D

Order code

process connection	-	connection type	pipe diameter	-	explosion protection	-	material (wetted parts)	gaskets	-	pressure rating (flange)	description
PCR											process connection
		FH									sight glass fitting
		PH									flow chamber PVDF
			xxx								DN xxx (xxx = 025, 050, 080) 1" (xxx = 001), 2" (xxx = 002), 3" (xxx = 003), 4" (xxx = 004) 3/8" (xxx = G38), 1/2" (xxx = G12), 3/4" (xxx = G34)
					NN						not explosion-proof, zone 0/1
							PF				sight glass fitting with PFA liner
							PV				PVDF
								FE			FPM with FEP coating
								NN			without gasket (self-sealing)
										Pyy	pressure rating PN yy in bar (yy = 10)
										Ayy	150 psi (yy = 15)

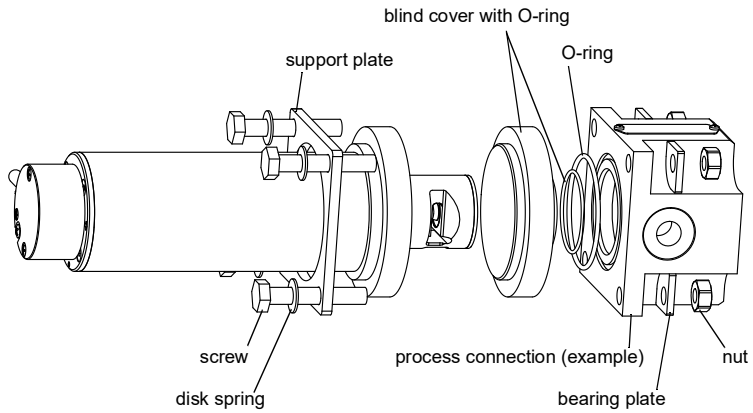
description	order code	pressure rating (flange)	pipe diameter	dimensions [mm]				dimensional drawing
				l	b	g	h	
sight glass fitting with PFA liner (self-sealing) • sensor: PIOX R500-MCTFKR-****-P10DH** (pipe diameter of sight glass fitting and sensor flange size must match each other)	PCR-FH050-**-PFNN-P10	PN 10	DN 50	230	120	ø80	185	
	PCR-FH080-**-PFNN-P10		DN 80	310	ø190	ø100	246	
	PCR-FH002-**-PFNN-A15	150 psi	2"	230	120	ø80	185	
	PCR-FH003-**-PFNN-A15		3"	310	ø190	ø100	246	
flow chamber with flanges (PVDF) • sensor: PIOX R500-MCTFKR-****-P10DH50 • gasket: TR2644-SP[1]	PCR-PH025-**-PVFE-P10	PN 10	DN 25	200				
	PCR-PH001-**-PVFE-A15	150 psi	1 "	200				

description	order code	pressure rating (flange)	pipe diameter	dimensions [mm]				dimensional drawing
				l	b	g	h	
flow chamber with screwed connection (PVDF) • sensor: PIOX R500-MCTFKR-****-P10DH50 • gasket: TR2644-SP[1]	PCR-PHG38-**-PVFE-A15	150 psi	NPT 3/8"	100	100		68	
	PCR-PHG12-**-PVFE-A15		NPT 1/2"					
	PCR-PHG34-**-PVFE-A15		NPT 3/4"					

[1] gasket TR2644-SP: 63.17 x 2.62 FEP (FPM), included in supply

Accessories

sensor mounting kit



sensor mounting kit	item number
support plate	TR2013-SP
bearing plate	4x TR2014-SP
screw	4x TR9180-SP
nut	4x TR4294-SP
disk spring	4x TR4209-SP
O-ring	TR2644-SP
blind cover O-ring	TR3922-SP TR2646-SP

included in supply

For more information: **Emerson.com**

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