

Transmitted light process refractometer

For a wide range of applications in the field of chemistry

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 carbon-fiber reinforced PTFE sensors available
- 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 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 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-°C



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

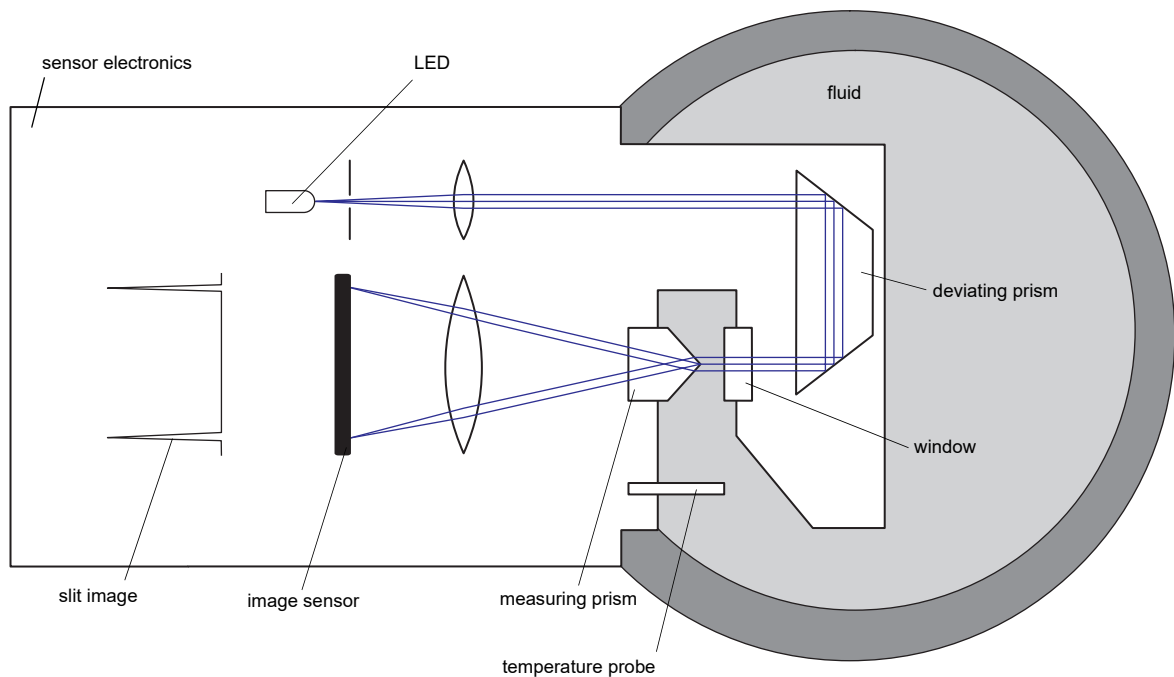
A special LED with a wave length $\lambda = 590$ nm (sodium D line) is used as the light source. The light passes through a slit, is parallelized by a lens and reversed by a deviating prism. Then it enters the fluid through a window in the sensor head. When the light beam re-enters the sensor, it is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



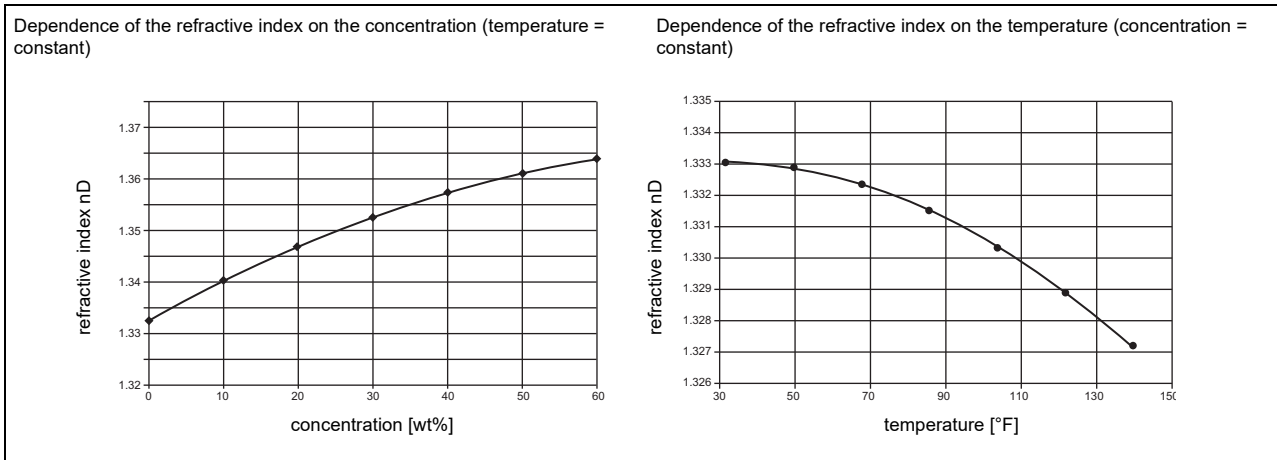
Processing in the transmitter

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.

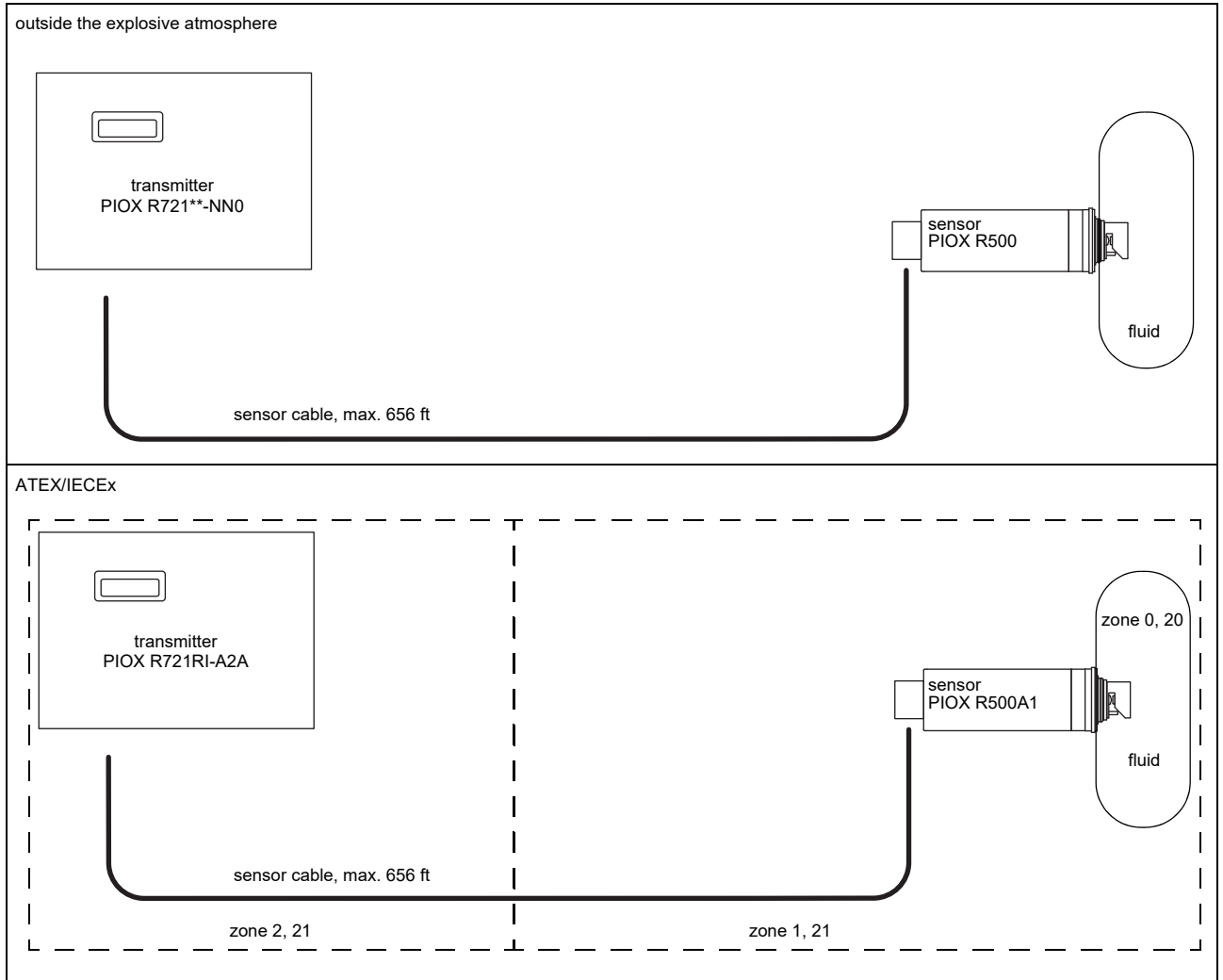
The transmitter can be equipped with electrical inputs, allowing for the input of additional available fluid quantities, e.g., sound speed, density or conductance, and using them for the measurement of three-component mixtures.

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).





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
transmitter			
power supply	<ul style="list-style-type: none"> • 100 to 230 V/50 to 60 Hz or • 20 to 32 V DC 		<ul style="list-style-type: none"> • 20 to 32 V DC
power consumption	W	< 15	
number of measuring channels		1	
damping	s	0 to 100 (adjustable)	
response time	s	1	
housing material		aluminum, powder coated	stainless steel 316L
degree of protection		IP65	IP65
dimensions	inch	see dimensional drawing	
weight	lb	11.9	11.2
fixation		wall mounting, optional: 2" pipe mounting	
ambient temperature	°F	-4 to +131/140	-4 to +131/140
display		128 x 64 dots, backlight	
menu language		English, German, French, Spanish, Dutch, Russian, Polish	
explosion protection			
• ATEX/IECEX			
marking	-	-	II(1)3G 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 IBExU06ATEX1075 X IECEx IBE 10.0003X U _m = 120 V
certification ATEX	-	-	
certification IECEx	-	-	
intrinsic safety parameters	-	-	
measuring functions			
physical quantities		see table below	
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: <ul style="list-style-type: none"> • Modbus RTU • HART • Profibus PA • FF H1 • Modbus TCP 	
accessories			
data transmission kit		USB cable	
software		<ul style="list-style-type: none"> • FluxDiagReader: reading of measured values and parameters, graphical presentation • FluxDiag (optional): reading of measurement data, graphical presentation, report generation, parametrization of the transmitter 	
data logger			
loggable values		all physical quantities, totalized physical quantities and diagnostic values	
capacity		max. 800 000 measured values	

¹ outside the explosive atmosphere (housing cover open)

	PIOX R721**-NN01A	PIOX R721**-NN01S	PIOX R721RI-A2A1S
outputs			
	The outputs are galvanically isolated from the transmitter.		
number	on request		
• switchable current output			
	All switchable current outputs are jointly switched to active or passive.		
range	mA	4 to 20 (3.2 to 22)	
accuracy		0.04 % MV ±3 µA	
active output		$R_{ext} < 350 \Omega$	
passive output		$U_{ext} = 8 \text{ to } 30 \text{ V}$, depending on R_{ext} ($R_{ext} < 1 \text{ k}\Omega$ at 30 V)	
• voltage output			
range	V	0 to 1 or 0 to 10	
accuracy		0 to 1 V: 0.1 % MV ±1 mV 0 to 10 V: 0.1 % MV ±10 mV	
internal resistance		$R_{int} = 500 \Omega$	
• digital output			
functions		<ul style="list-style-type: none"> • frequency output • binary output • pulse output 	
number		3	
		5 to 30 V / < 100 mA	
frequency output			
• range	kHz	0 to 5	
binary output			
• binary output as alarm output		limit, change of flow direction or error	
pulse output			
• functions			
• pulse value	units	0.01 to 1000	
• pulse width	ms	0.05 to 1000	
inputs			
	The inputs are galvanically isolated from the transmitter.		
number	max. 4, on request		
• temperature input			
type		Pt100/Pt1000	
connection		4-wire	
range	°F	-238 to +1040	
resolution	K	0.01	
accuracy		±0.01 % MV ±0.03 K	
• current input			
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 to 20	
passive input		$R_{int} = 50 \Omega$, $P_{int} < 0.3 \text{ W}$	
• range	mA	-20 to +20	
• voltage input			
range	V	0 to 1	
accuracy		0.1 % MV ±1 mV	
internal resistance		$R_{int} = 1 \text{ M}\Omega$	

¹ outside the explosive atmosphere (housing cover open)

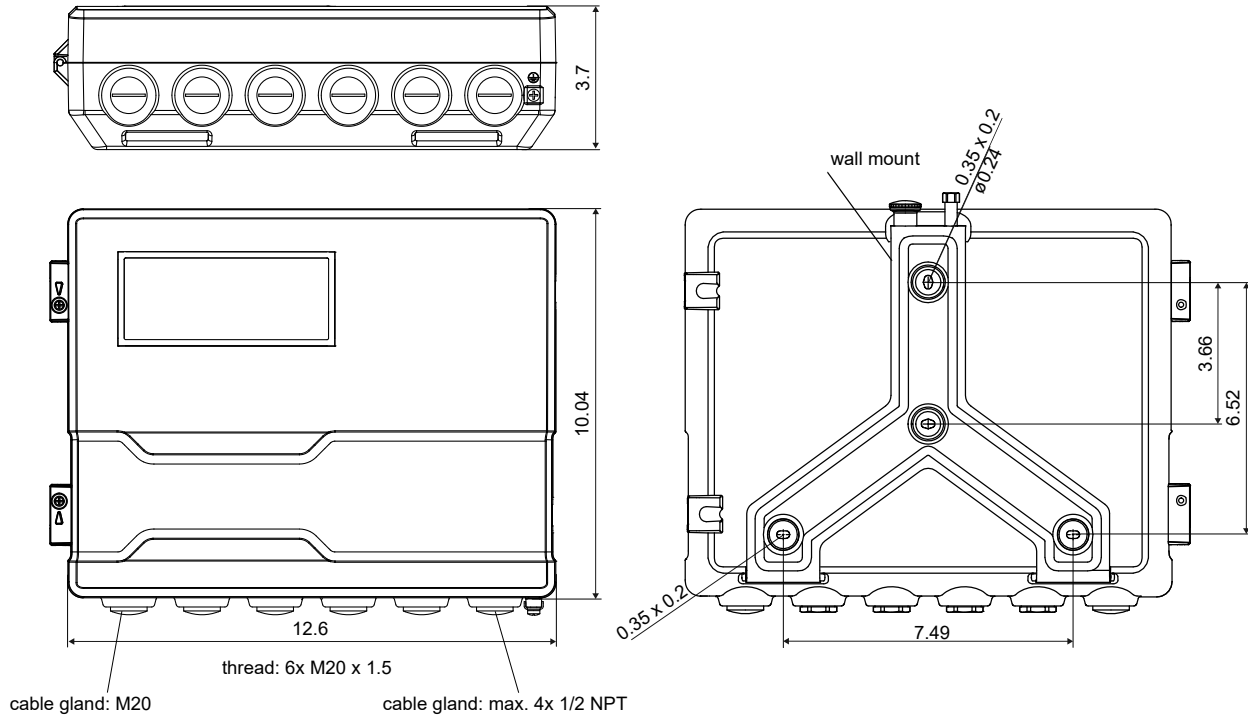
Physical quantities

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

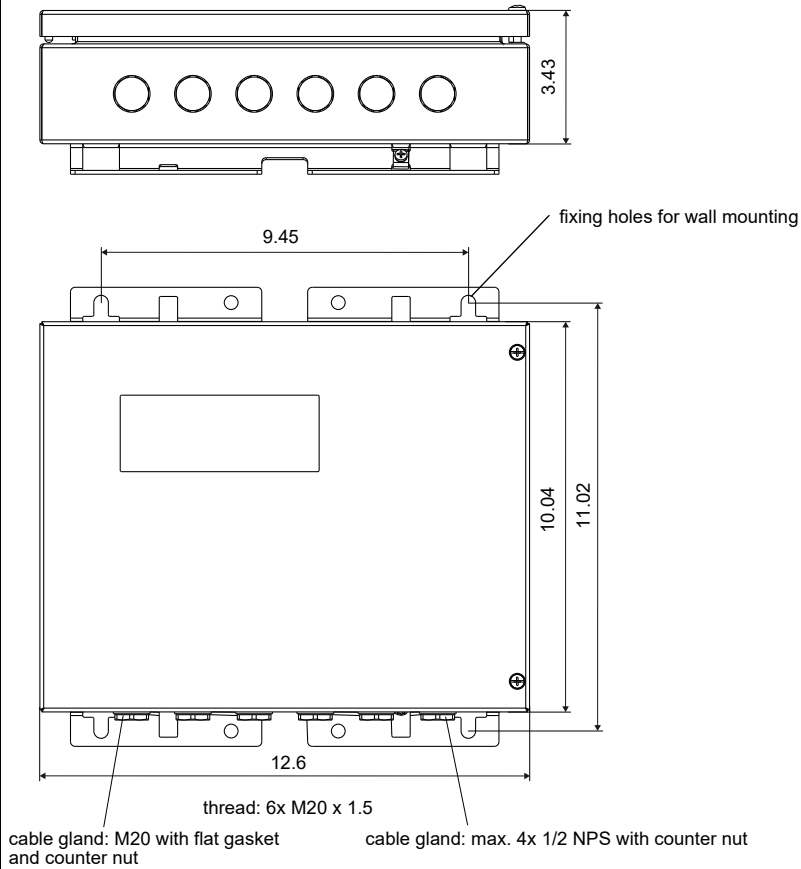
Dimensions

R721**..****A



in inch

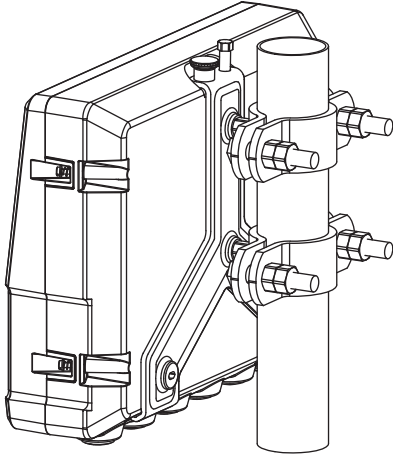
R721**..****S



in inch

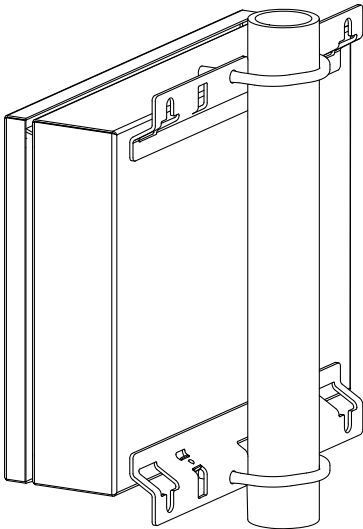
2" pipe mounting kit

*72***-****A



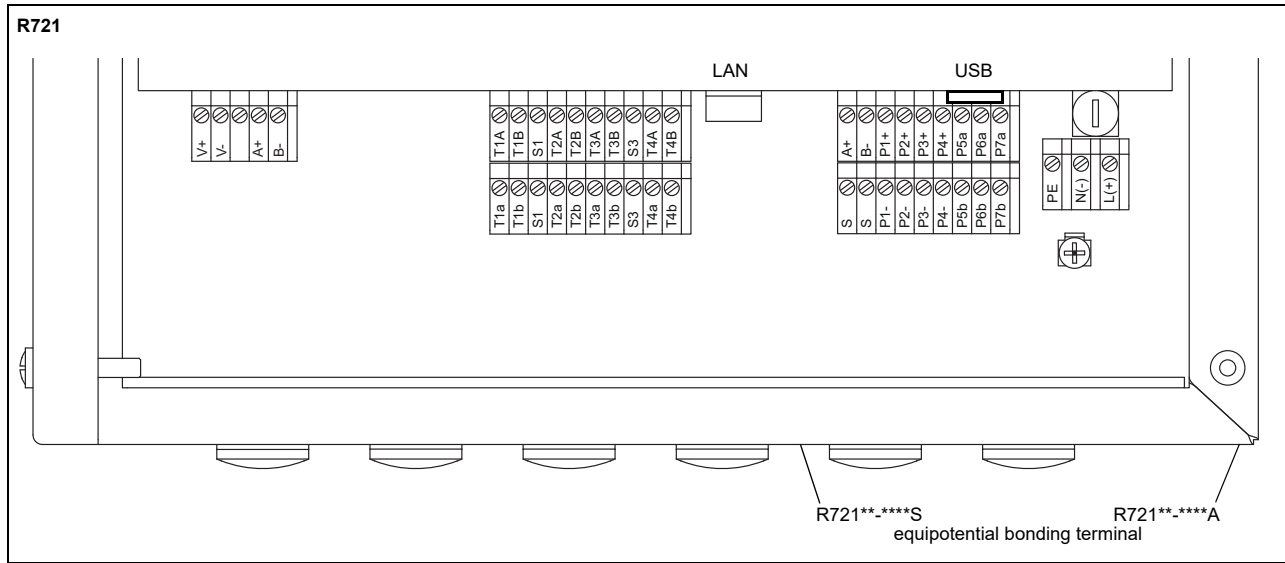
order code:
ACC-PE-*721-/PMK4

*72***-****S



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

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+ to P4+ P1- to P4-	current output, voltage output	A+	signal +	<ul style="list-style-type: none"> • Modbus RTU¹ • HART¹ • Profibus PA¹ • FF H1¹
		B-	signal -	
P5a to P7a P5b to P7b	digital output	S	shield	
		USB	type B Hi-Speed USB 2.0 Device	<ul style="list-style-type: none"> • service (FluxDiag/ FluxDiagReader)
		LAN	RJ45 10/100 Mbps Ethernet	<ul style="list-style-type: none"> • service (FluxDiag/ FluxDiagReader) • Modbus TCP
analog inputs ^{1, 2}				
terminal	temperature probe	passive sensor	active sensor	
T1a to T4a		not connected	not connected	
T1A to T4A		-	+	
T1b to T4b		+	not connected	
T1B to T4B'		not connected	-	
S1, S3		not connected	not connected	

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

² The number, type and terminal assignment are customized.

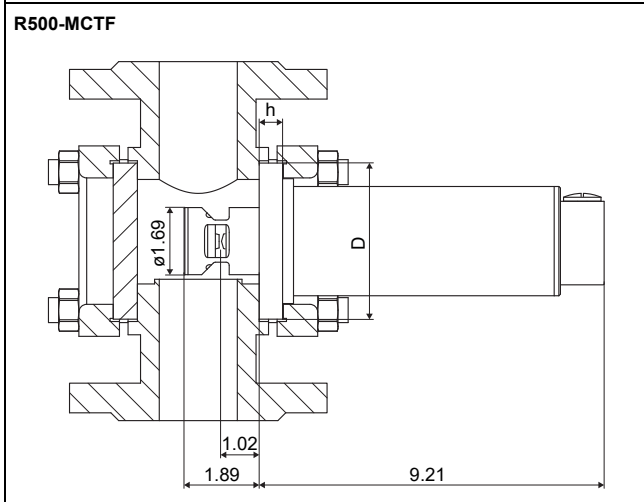
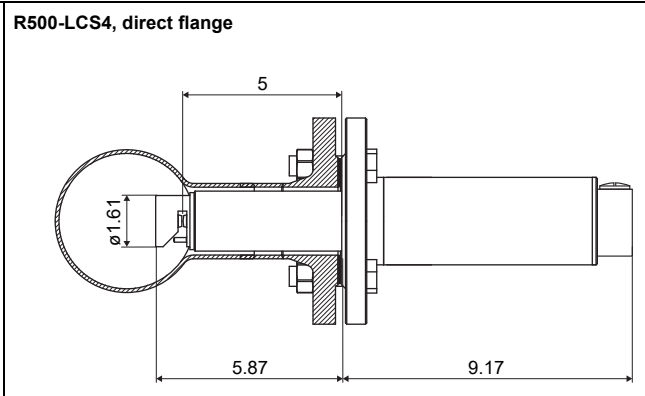
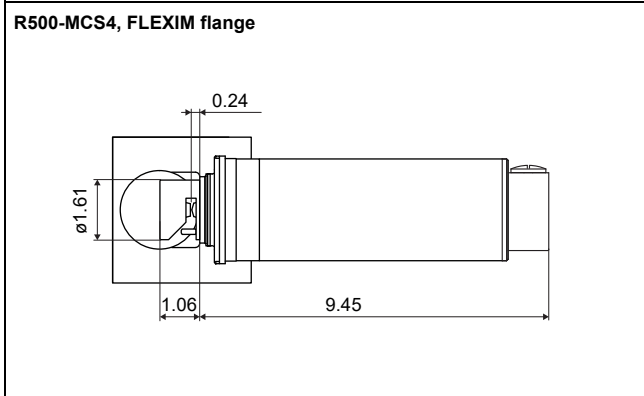
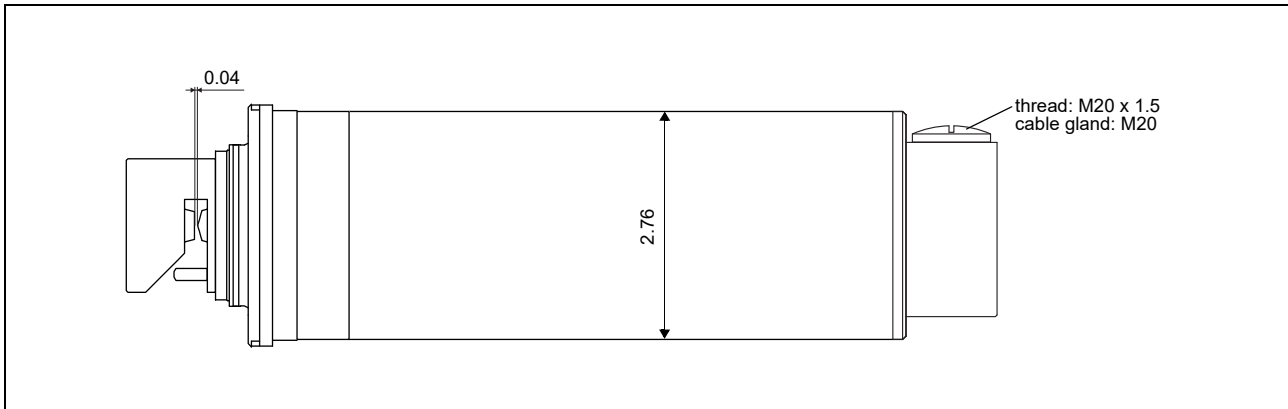
Sensor

Technical data

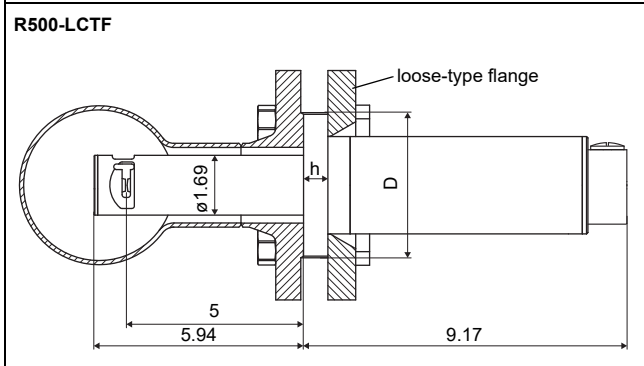
	R500	R500A1	R500	R500A1
order code	R500-*CS4KRNN	R500-*CS4KRA1	R500-*CTFKRNN	R500-*CTFKRA1
process parameters				
fluid	all liquids with a turbidity < 10 000 FAU		all liquids with a turbidity < 10 000 FAU	
fluid temperature (depending on ambient temperature)	°F	-4 to +302 (302 °F at an ambient temperature of 68 °F)	-4 to +266	-4 to +248
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 to 1.7	nD: 1.3 to 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	stainless steel 304, epoxy-powder coated	
wetted parts		stainless steel 316Ti (others on request)	PTFE/carbon 25 %	
gaskets		FFKM	FFKM	
prism		sapphire, nD ≈ 1.76	sapphire, nD ≈ 1.76	
degree of protection		IP67	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	lb	min. 4.4	see dimensional drawing	
ambient temperature	°F	-4 to +108	-4 to +108	
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	-	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...+120 °C
certification ATEX	-	IBExU06ATEX1075 X	-	IBExU06ATEX1075 X
certification IECEx	-	IECEX IBE 10.0003X	-	IECEX IBE 10.0003X
temperature probe				
type		Pt1000	Pt1000	
resolution	K	0.01	0.01	
accuracy at 68 °F	K	0.15	0.15	
response time	s	5	20	

¹ R500-LCTF: depending on temperature and flow velocity:
max. 8 ft/s at 68 °F
max. 3 ft/s at 176 °F

Dimensions



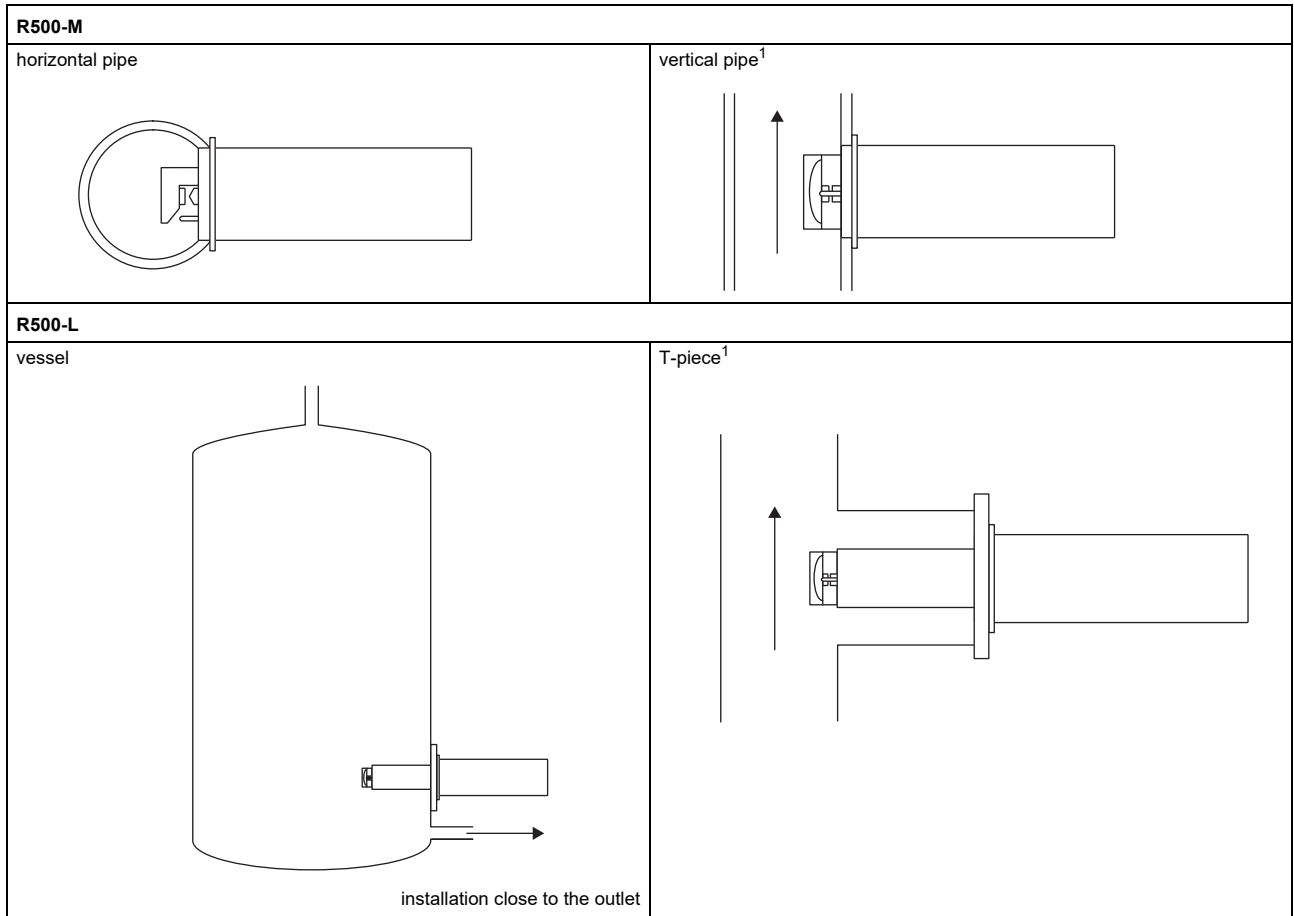
pipe diameter	D inch	h inch	weight lb
DN 50, 2"	Ø3.94	0.59	4.1
DN 80, 3"	Ø4.8	0.79	4.5



pipe diameter	D inch	h inch	weight lb	connecting dimensions according to
DN 50	Ø4.02	0.67	4.8	ISO 7005 EN 1092 BS 4504 DIN 2501
DN 80	Ø4.88	0.67	5.5	
2"	Ø4.02	0.67	4.8	ANSI/ASME B 16.5 class 150
3"	Ø4.88	0.67	5.5	ASTM D 4024 BS 1560 BS EN 1759

in inch

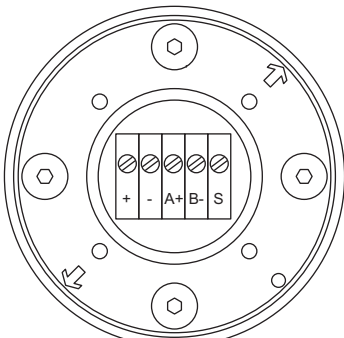
Sensor mounting positions



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

Connection

Terminal assignment

	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="background-color: #cccccc;">terminal</th> <th style="background-color: #cccccc;">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 gray	EB CY 2x2x0.75
length	ft	max. 656	max. 656
weight	lb/ft	approx. 0.07	approx. 0.07
ambient temperature	°F	-40 to +176	-40 to +176
properties		flame retardant according to IEC 60332-1-2	flame retardant according to IEC 60332-1-2
cable jacket			
material		PVC	PVC
outer diameter	inch	0.33	0.34
color		gray	blue
shield		x	x

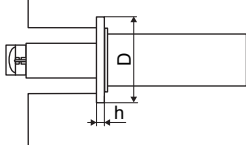
Sensor order code

1, 2	3 to 5	6	7	8, 9	10, 11	12, 13	14 to 16	17	18 to 20	21 to 23	no. of character	
measurement principle	type		type of construction	design	material (wetted parts)	gaskets	explosion protection	process pressure	flange	flange size (flange = D)	cable length	description
R	500											transmitted light refractometer
			M									standard sensor
			L									long sensor
				C								chemistry design
					S4							stainless steel 316Ti (1.4571)
					TF							PTFE
						KR						FFKM (Kalrez)
							A1					zone 0/1
							NN					not explosion-proof
								P10				PN 10
								P16				PN 16
								P40				PN 40
									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))
											XXX	in m

Process connection

Direct flange for PIOX R500-LCS4KR**D

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

description	sensor order code	pressure rating (flange)	pipe diameter	dimensions [inch]		dimensional drawing	
				D	h		
direct flange	D050	R500-LCS4****D050	PN 16 optional: PN 40	DN 50	ø6.5	0.71	
	D080	R500-LCS4****D080	PN 16	DN 80	ø7.87	0.79	
	D002	R500-LCS4****D002	150 lbs	2"	ø6	0.75	
	D003	R500-LCS4****D003		3"	ø7.5	0.94	

special materials on request

Process connection for PIOX R500-MCS4KR**F

Order code

process connection	connection type	pipe diameter	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 lbs
	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, 040, 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)
			S4				stainless steel 316Ti
				FE			FPM with FEP coating
					yy		pressure rating PN yy in bar (yy = 10, 16, on request: 40) 150 lbs (yy = 10)
						CL	cleaning line (PCR-F*)

¹ possible pipe diameters/materials/pressure ratings to be selected from table on page 17. Observe national regulations when selecting the flange size depending on the pressure rating.

Technical data

description	order code	pressure rating (flange) yy	pipe diameter xxx	dimensions [inch]			weight [lb]	dimensional drawing
				l	b	h		
flow chamber with flanges accessories: blind cover, sensor mounting kit optional: cleaning line ¹	PCR-FDxxxS4FEyy	PN 16	DN 15	6.69	ø3.74	2.28	9.5	
			DN 25	6.93	ø4.53	2.28	11	
			DN 40	7.48	ø5.91	2.76	16.4	
			DN 50	7.48	ø6.5	3.15	18.3	
			DN 80	7.87	ø7.87	4.21	26.2	
	PCR-FAxxxS4FE10	150 lbs	ANSI 1"	8.32	ø4.25	2.3	11.2	
			ANSI 2"	8.94	ø6	3.15	19.4	
ANSI 3"			9.69	ø7.48	4.21	29.5		
flow chamber with screwed connection accessories: blind cover, sensor mounting kit optional: cleaning line ¹	PCR-FTxxxS4FEyy		G 3/8"	3.94	3.94	3.94	7.3	
			G 1/2"				7.1	
			G 3/4"				7.1	
flow chamber with welded connection to the process pipe accessories: blind cover, sensor mounting kit optional: cleaning line ¹	PCR-FWxxxS4FEyy		DN 15	3.94	3.94	2.28	6.2	
			DN 25	3.94	3.94	2.28	6	
			DN 40	3.94	3.94	2.76	6.9	
			DN 50	3.94	3.94	3.15	9.3	
			DN 80	3.94	3.94	4.21	6.8	
			1"	3.94	3.94	2.3	6	
			2"	3.94	3.94	3.15	9.3	
			3"	3.94	3.94	4.21	6.8	
round welding plate for vessel installation accessories: blind cover, sensor mounting kit	PCR-WRT00S4FEyy				ø3.94	0.79		
square welding plate for vessel installation accessories: blind cover, sensor mounting kit	PCR-WST00S4FEyy			3.94	3.94	0.79		

xxx, yy - see order code
PN 40 on request

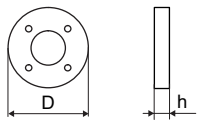
- ¹ cleaning connection:
- thread: G1/4"
 - cable gland
 - stainless steel pipe 0.24 x 0.04 inch, length: 5.91 inch

Accessories

<p>sensor mounting kit</p> <p>slit ring with set of screws</p> <p>O-ring</p> <p>blind cover</p> <p>process connection (example)</p>	<table border="1"> <thead> <tr> <th>sensor mounting kit</th> <th>item number</th> </tr> </thead> <tbody> <tr> <td>slit ring</td> <td>TR4492-SP</td> </tr> <tr> <td>set of screws</td> <td>8x TR4214-SP</td> </tr> <tr> <td>O-ring</td> <td>TR2661-SP</td> </tr> <tr> <td>blind cover</td> <td>TR4494-SP</td> </tr> </tbody> </table> <p>included in supply</p>	sensor mounting kit	item number	slit ring	TR4492-SP	set of screws	8x TR4214-SP	O-ring	TR2661-SP	blind cover	TR4494-SP
sensor mounting kit	item number										
slit ring	TR4492-SP										
set of screws	8x TR4214-SP										
O-ring	TR2661-SP										
blind cover	TR4494-SP										

Direct flange for PIOX R500-LCTFKR**D

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

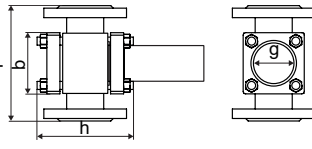
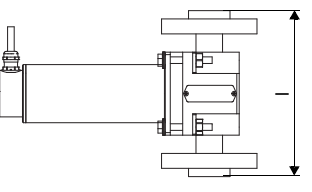
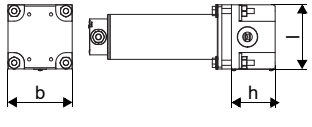
description	sensor order code	pressure rating (flange)	pipe diameter	dimensions [inch]		dimensional drawing	
				D	h		
loose-type flange	DH50	R500-LCTFKR**DH50	PN 10	DN 50	6.5	0.79	
	DH80	R500-LCTFKR**DH80		DN 80	7.87	0.79	
	DH02	R500-LCTFKR**DH02	150 lbs	2"	6.5	0.94	
	DH03	R500-LCTFKR**DH03		3"	7.87	1.06	

included in supply

Process connection for PIOX R500-MCTFKR**D

Order code

process connection	connection type	pipe diameter	wetted parts	gaskets	pressure rating (flange)	option	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)
			PF				sight glass fitting with PFA liner
			PV				PVDF
				FE			FPM with FEP coating
					yy		pressure rating PN yy in bar (yy = 10) 150 lbs (yy = 10)

description	order code	pressure rating (flange) yy	pipe diameter xxx	dimensions [inch]				dimensional drawing
				l	b	g	h	
sight glass fitting with PFA liner (self-sealing)	PCR-FH050PFFE10	PN 10	DN 50	9.06	4.72	ø3.15	7.28	
	PCR-FH080PFFE10		DN 80	12.2	ø7.48	ø3.94	9.69	
	PCR-FH002PFFE10	150 lbs	2"	9.06	4.72	ø3.15	7.28	
	PCR-FH003PFFE10		3"	12.2	ø7.48	ø3.94	9.69	
flow chamber with flanges (PVDF) gasket: TR2644-SP ¹	PCR-PH025PVFE10	PN 10	DN 25	7.87				
	PCR-PH001PVFE10	150 lbs	1 "	7.87				
flow chamber with screwed connection (PVDF) gasket: TR2644-SP ¹	PCR-PHG38PVFE10		NPT 3/8"	3.94	3.94		2.68	
	PCR-PHG12PVFE10		NPT 1/2"					
	PCR-PHG34PVFE10		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	TR3922-SP
O-ring	TR2646-SP

included in supply



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Subject to change without prior notice.

Errors excepted.

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