

FSO-EXT type seal – flange type, extended diaphragm

Design description

The FSO-EXT construction has a seal body that is made of bar stock or forged material. The weld between the seal body and the diaphragm is a wetted part and therefore diaphragm materials are mostly chosen the same as the body material. The FSO-EXT is recommended when special body or flange material grades are required. FSO-EXT is typically used in combination with (differential) pressure transmitters for applications such as level, flow and (absolute) pressure measurement.



Flange diaphragm combinations

The diaphragm is TIG-welded to the flange and is designed to have the best performance for the specific size. This means that the flexibility and shape is carefully tested and measured. The standard thickness of diaphragm foil is 0.075mm

Body Material	Diaphragm material		
	General name	UNS	Wst.
AISI 316(L)	AISI 316L	S31603	1.4404
	AISI 304L	S30400	1.4306
	AISI 321	S32100	1.4541
	AISI 316 UG	S31603	1.4435
	Alloy C276	N27600	2.4810
AISI 304L	AISI 304L	S30400	1.4306
AISI 310 MoLn	25-22-2 LMN	S31050	1.4466
AISI 316 UG	AISI 316 UG	S31600	1.4435
AISI 321	AISI 321	S32100	1.4541
AISI 904(L)	AISI 904L	N08904	1.4539
Alloy 20	Alloy 20	N08020	2.4660
Alloy 400	Alloy 400	N04400	2.4360
Alloy 600	Alloy 600	N06600	2.4816
Alloy 625	Alloy 625	N06625	2.4856
Alloy 825	Alloy 825	N08825	2.4858
Alloy B2	Alloy B2	N10665	2.4617
Alloy C-22	Alloy C-22	N06022	2.4602
Alloy C-276	Alloy C-276	N10276	2.4810
Duplex F44	254 SMO (6Mo)	S31254	1.4547
Duplex F51/F60	Duplex 2205	S32205	1.4462
Duplex F53	Super Duplex 2507	S32750	1.4410
Duplex F55	Super Duplex 2507	S32750	1.4410
Nickel 201	Nickel 201	N02201	2.4068
Titanium Gr. 2	Titanium Gr. 1	R50250	2.7025
Zirconium 702	Zirconium 702	R60702	-

Flange size, rating and facings - ASME B16.5

ASME B16.5			
Size	Rating	Facing	Roughness
1.5" to 4"	cl. 150 - cl. 2500	RF, LMF, FF, SGF	Ra 3.2-6.3 µm
		RJF, SFF	Ra <1.6 µm
		SMF, LTF, STF, LGF, LFF	Ra <3.2 µm

Flange size, rating and facings - EN 1092-1

EN 1092-1			
Size	Rating	Type	Roughness
DN40 to DN100	PN10-400	A, B1, E, F	Ra 3.2-12.5 µm
		B2, C, D, G, H	Ra <0.8-3.2 µm

Flange size, rating and facings - DIN 2696

DIN 2696			
Size	Rating	Type	Roughness
DN50 to DN100	PN63-400	Form L (lens)	Ra <6.3 µm

Gold coatings

Several types of gold coating can be applied on the seals. The selection possibilities are:

- 25 µm Hydrogen protection (diaphragm only)
- 40 µm Hydrogen protection (diaphragm only)

-> See datasheet "Gold coatings"

Polymer coatings

Polymer coatings come in several types. The technical data on thickness and temperature limitation can be found in datasheet "polymer solutions" The applicable selection on BF seals are:

- PTFE coating
- ECTFE (Halar®) coating
- PFA coating
- FEP coating
- PTFE sheet

-> See datasheet "Polymer solutions"

Capillary tube and armor (protection)

The standard capillary mounting position is top side (axial) of the seal. The standard tube material is TP316 (316SS), optionally available in Alloy 400. There are three options in ID of the capillary; 2mm, 1mm, and 0.7mm. Badotherm capillaries are always protected against mechanical forces by armor. This doubled shielded armor consist is standard AISI 304, and optionally AISI 316. Additionally, the armor could be protected with a PVC sleeve in white, black, optionally with ATEX114 approval to protect against dust and water ingress and possibly corrosive ambient atmosphere.

-> See datasheet "Capillary lines"

Tapered execution

In some cases extended seals get stuck in the nozzle by the crystalized or hardened surrounding process media. A tapered extension from tip to flange and jacket holes. The tapered version is reducing the diameter 0.7mm/100mm of extension length

Limitations

There are some limitations in mounting the FSO-EXT to pressure instruments.

- ≤1.5" (DN25) can have maximum capillary length 6 mtr
- Direct mount is always with 80mm extension tube.

Lifting handles

Larger sizes and ratings of diaphragm seals can weigh up to 50 kg. Handling and installation can become a challenge. As from 15kg it is recommended to apply a set of lifting handles, welded on the sides of the flange of the seal. This can be used to handle it easier and install it in a safer way or have attach lifting tools to it.

-> See datasheet "diaphragm seal accessories"

Material Certification

Material traceability and related certification are applicable for all process wetted parts. Material certification possibilities depend on the type of seal, the assembly construction and the materials used. Material certification is in accordance with EN10204 3.1.

Additional material certification and testing can be provided on request, such as Positive Material Identification (PMI), Intergranular corrosion (IGC) testing, material certification in accordance with EN10204 3.2, NACE conformity for ISO-15156 (MR-0175) and/or ISO-17945 (MR-0103), NORSOK M-630 and many more.

-> Please note that the responsibility for material selection always rests with the user.

Flange Marking & Traceability

All flanges are marked by the forging shop with heat number, material designation, size, and rating. Badotherm adds a Badotherm reference number and the manufacturers name to the flange for traceability purposes.

Flanges and origin

The seal parts are made from forged materials according to the applicable standards. The standard sourcing of flanges is of international origin. Optionally regional preference can be requested, for example materials from EU origin.

Testing

All seals are helium tested according the ISO 20485 test procedure A.3 up to 10^{-9} mbar l/s before used on a diaphragm seal application.

-> See datasheet "Diaphragm Seal testing"

Cleanliness of the wetted parts

All parts are standard cleaned from excessive oil and grease. When additional requirements are needed, the parts can be cleaned according customer requirements and cleaning specifications.

Gaskets

Sizes of the diaphragm area are designed to match the gaskets used between the process and seal or flush ring. For the ASME B16.5 RF flanges the ASME B16.20 is used for dimension restriction to ensure both the spiral and grooved gaskets are fully supported by the serrated area. For the EN type B1 flanges the gasket dimensions are matching the sizes of the EN 1514-2. The size "G" in the tables refer to the start of the gasket surface.

Example performance calculation

Whether a diaphragm seal can be used for a specific measurement, depends on the size of the diaphragm. That size is restricted by the size of the diaphragm seal.

For pressure transmitters, Badotherm offers an online performance calculation tool to calculate its performance and to ensure that the diaphragm size is suitable for your measurement.

The table below presents the minimum span of the respective diaphragm sizes with standard process conditions. As rule of thumb, a TPE of max 5% is often considered acceptable, but it depends per situation.

Minimum span table

dD	AP/GP	DP
23.5mm	17.5 bar	na
32mm	11 bar	1850 mbar
44mm	1575 mbar	255 mbar
57mm	415 mbar	70 mbar
72mm	155 mbar	30 mbar
81mm	110 mbar	20 mbar

Pressure transmitter; ambient temperature -10...+30°C; process temperature 100°C with BSO 22 fill fluid; 3 meter capillary; ID 1mm, DP both sides mounted with seal

See the general overview of all diaphragm sizes with several standard situations and in combination with Badotherm pressure gauges.

Retaining screws

The cover flange and the seal part are fixed together hexagon socket cap screws. The length of the screws depends on the thickness of the cover flange.

Grade bolt	Type	Size
A2-70 (ISO 3506-1)	ISO 4762	M6

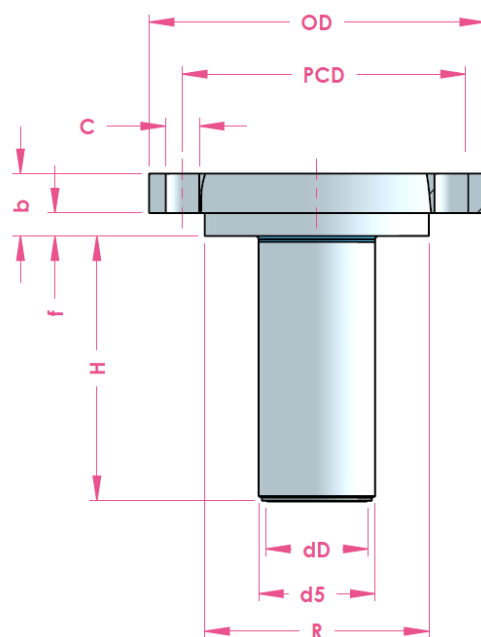
Extension length and diameter

Length and diameter can be selected in random dimensions. In the dimension tables the standard diameters are given, however variation can be made upon request. The length of the extension is always customer selected. Most common length of extensions are 50mm, 100mm, and 150mm.

Heavy duty execution

The normal extended seal is made from a blind flange, tube and a tip made from bar. For higher pressures, non-standard diameters and exotic materials the extension are made from solid bar stock material. The positive effect is that the extension can withstand higher loads. The negative influence is that the extensions has more weight compared to the tube version. The weight can be calculated according to the rule mentioned in the dimension table.

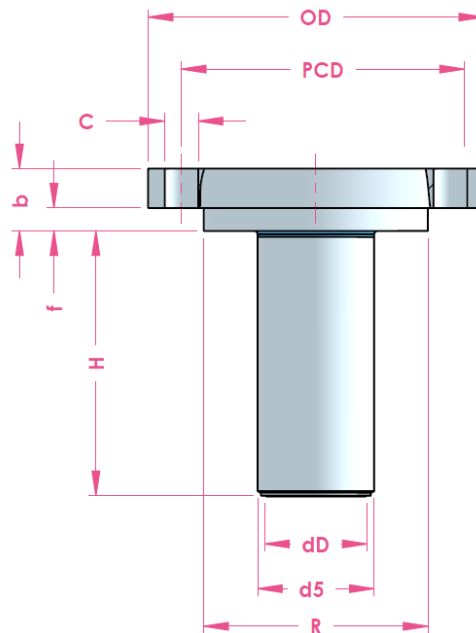
Dimensions table: ASME 16.5 RF facing



size	rating	OD	b	f	PCD	C / pcs	dD	d5	R	weight	EXT weight ¹
1.5"	cl. 150	127.0	35.9	18.0	98.6	15.9 / 4x	32.0	38.0	73.0	1.5	+ 0.09 x H*
	cl. 300	155.0	39.1		114.3	22.3 / 4x				2.7	
	cl. 400-600		47.3		124.0	28.6 / 4x				3.3	
	cl. 900-1500		56.8		146.0	31.8 / 4x				5.8	
	cl. 2500		69.5		120.6	19.1 / 4x				10.4	
2"	cl. 150	152.0	32.5	13.0	120.6	19.1 / 8x	44.0	48.0	91.9	2.4	+ 0.004 x H
	cl. 300	165.0	35.7		127.0	19.1 / 8x				3.2	
	cl. 400-600		45.4		165.1	25.4 / 8x				4.2	
	cl. 900-1500		58.1		171.4	28.6 / 8x				10.1	
	cl. 2500		70.9		152.4	19.1 / 4x				15.6	
3"	cl. 150	190.0	37.3	13.0	152.4	19.1 / 4x	72.0	76.0	127.0	4.9	+ 0.010 x H
	cl. 300	210.0	42.0		168.1	22.3 / 8x				6.8	
	cl. 400-600		51.8		190.5	25.4 / 8x				8.4	
	cl. 900		58.1		203.2	31.9 / 8x				13.1	
	cl. 1500		67.7		228.6	35.0 / 8x				19.1	
4"	cl. 2500	305.0	86.7	13.0	228.6	35.0 / 8x	81.0	93.0	157.2	34.8	+ 0.035 x H*
	cl. 150	229.0	37.3		190.5	19.1 / 8x				7.0	
	cl. 300		45.2		200.2	22.3 / 8x				11.5	
	cl. 400		55.0		215.9	25.5 / 8x				14.8	
	cl. 600		58.1		235.0	31.8 / 8x				17.3	
	cl. 900		64.5		241.3	34.9 / 8x				26.9	
	cl. 1500		74.0		273.0	41.3 / 8x				29.9	
cl. 2500	356.0	96.2	273.0	41.3 / 8x	53.9	+ 0.055x H*					

All dimensions in mm, weight in kg
 1) Weights marked with * are based on bar stock material. This weight should be taken for exotics as well.

Dimensions table: EN 1092-1 B1 type

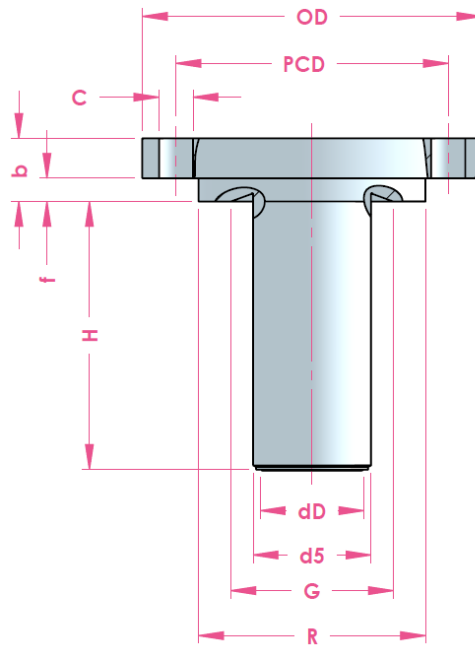


size	rating	OD	b	f	PCD	C / pcs	dD	d5	R	Weight	EXT weight ¹		
DN40	PN10-40	150.0	36.0	18.0	110.0	18.0 / 4x	32.0	38.0	88.0	2.0	+ 0.09 x H*		
	PN63-100	170.0	44.0		125.0	22.0 / 4x				4.0			
	PN160		46.0		135.0	26.0 / 4x				4.4			
	PN250	185.0	52.0		145.0	165.0				30.0 / 4x		6.7	8.7
	PN320	195.0	56.0		165.0	30.0 / 4x				14.1			
PN400	220.0	66.0	165.0	30.0 / 4x	14.1								
DN50	PN10-40	165.0	33.0	13.0	125.0	18.0 / 4x	44.0	48.0	102.0	3.0	+ 0.004 x H		
	PN63	180.0	39.0		135.0	22.0 / 4x				4.5			
	PN100	195.0	41.0		145.0	26.0 / 4x				6.0			
	PN160		43.0		150.0	26.0 / 8x				6.4			
	PN250	200.0	51.0		160.0	26.0 / 8x				8.2	+ 0.014 x H*		
	PN320	210.0	55.0		160.0	30.0 / 8x				10.7			
PN400	235.0	65.0	180.0	30.0 / 8x	16.7								
DN80	PN10-40	215.0	37.0	13.0	160.0	18.0 / 8x	72.0	76.0	138.0	5.0	+ 0.010 x H		
	PN63		41.0		170.0	22.0 / 8x				6.5			
	PN100	230.0	45.0		180.0	26.0 / 8x				9.0			
	PN160	230.0	49.0		200.0	30.0 / 8x				10.3	+ 0.035 x H*		
	PN250	255.0	59.0		220.0	33.0 / 8x				16.5			
	PN320	275.0	68.0		240.0	33.0 / 8x				25.4			
PN400	305.0	81.0	240.0	33.0 / 8x	38.4								
DN100	PN10-16	220.0	33.0	13.0	180.0	18.0 / 8x	81.0	93.0	158.0	4.5	+ 0.029 x H		
	PN25-40	235.0	37.0		190.0	22.0 / 8x				6.5			
	PN63	250.0	43.0		200.0	26.0 / 8x				9.0			
	PN100	265.0	49.0		210.0	30.0 / 8x				13.0			
	PN160		53.0		210.0	30.0 / 8x			15.3				
	PN250	300.0	67.0		235.0	33.0 / 8x			27.2	+ 0.055 x H*			
	PN320	335.0	78.0		265.0	36.0 / 8x			42.5				
	PN400	370.0	93.0		295.0	39.0 / 8x			67.3				

All dimensions in mm, weight in kg

1) Weights marked with * are based on bar stock material. This weight should be taken for exotics as well.

Dimensions table: DIN 2696 Form L



size	rating	OD	b	f	PCD	C / pcs	dD	d5 ²	R	G	Weight	EXT weight ¹	
DN50	PN63	180.0	33.0	13.0	135.0	22.0 / 4x	44.0	48.0	102.0	68.0	4.5	+ 0.014 x H	
	PN100	195.0	39.0		145.0	26.0 / 4x					6.0		
	PN160		41.0		150.0	26.0 / 8x					6.4		
	PN250	200.0	43.0		160.0	26.0 / 8x					8.2		
	PN320	210.0	51.0		180.0	30.0 / 8x					10.7		
PN400	235.0	55.0	180.0		30.0 / 8x	16.7							
DN80	PN63	215.0	65.0		170.0	22.0 / 8x	6.5	72.0	76.0	138.0	97.0	9.0	+ 0.035 x H
	PN100	230.0	37.0		180.0	26.0 / 8x	9.0						
	PN160	230.0	41.0		200.0	30.0 / 8x	10.3						
	PN250	255.0	45.0		220.0	30.0 / 8x	16.5						
	PN320	275.0	49.0		240.0	33.0 / 8x	25.4						
DN100	PN400	305.0	59.0		240.0	33.0 / 8x	38.4	81.0	93.0	162.0	127.0	9.0	+ 0.055x H*
	PN63	250.0	68.0		200.0	26.0 / 8x	13.0						
	PN100	265.0	81.0		210.0	30.0 / 8x	15.3						
	PN160		33.0		235.0	33.0 / 8x	27.2						
	PN250	300.0	37.0	295.0	39.0 / 8x	67.3							

All dimensions in mm, weight in kg

*1 Weights are based on bar stock material. This weight should be taken for exotics as well.

*2 Based on series 1 gaskets

Change log

Date	Change
7-5-2020	Removed cap side (Radial) from capillary paragraph
8-3-2021	Updated dimension table ASME B16.5:2020

Holland – Romania – India – Thailand – Dubai – USA

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