

# FSO US-F type seal - internal diaphragm flanged type

## Design description

The FSO US-F construction is designed for those applications where the existing process connection is too small to use a flush diaphragm seal. The FSO US-F is a variant on the standard US-F and is using 3 instead of 2 components. The assembly consist out of an upper and lower housing. The upper part is retained by a cover flange made from a blind flange. This blind flange can be connected to the process flange by standard stud bolts. Because of interference of certain dimensions the executions are limited.



## Housing / diaphragm combinations

Housing materials		Diaphragm material		
Upper	Lower	General name	UNS	Wst.
AISI 316(L)	25-22-2 LMN	25-22-2 LMN	S31050	1.4466
	254 SMO (6Mo)	254 SMO (6Mo)	S31254	1.4547
	AISI 304L	AISI 304L	S30400	1.4400
	AISI 316(L)	AISI 316L	S31600	1.4404
	AISI 316 UG	AISI 316 UG	S31600	1.4435
	AISI 321	AISI 321	S32100	1.4400
	AISI 904L	AISI 904L	N08904	1.4539
	Alloy 20	Alloy 20	N08020	2.4660
	Duplex 2205	Duplex 2205	S32205	1.4462
	Alloy C-276	Alloy C-276	N10276	2.4810
	Alloy B2	Alloy B2	N10665	2.4617
	Alloy C22	Alloy C22	N06022	2.4602
	Alloy 600	Alloy 600	N06600	2.4816
	Alloy 625	Alloy 625	N06625	2.4856
	Alloy 825	Alloy 825	N08825	2.4810
	Alloy 400	Alloy 400	N04400	2.4375
	Nickel 201	Nickel 201	N02201	2.4068
	Super Duplex 2507	Super Duplex 2507	S32760	1.4501
	Tantalum	Tantalum	R05200	-
	Ti Gr2	Titanium Gr. 2	Titanium Gr. 1	R50250

All upper part materials are standard AISI 316(L) except for Titanium versions where the upper part is Titanium as well.

## Flange size, rating and facings - ASME B16.5

ASME B16.5			
Size	Rating	Facing	Roughness
0.75" to 1.5"	cl. 150 - cl. 1500	RF, LMF, FF, SGF	Ra 3.2-6.3 µm
		RFSF, 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
DN25 to DN40	PN10-250	A, B1, E, F	Ra 3.2-12.5 µm
		B2, C, D, G, H	Ra <0.8-3.2 µm

## Gold coatings

Two types of gold coating thickness can be applied on the FSO-US-F seals, both suitable for corrosion protection and hydrogen permeation. The selection possibilities are:

- 25 µm thickness
- 40 µm thickness

-> See datasheet "Gold coatings"

## Polymer solutions

Polymer solutions come in several executions and forms. The technical data on thickness and temperature limitation can be found in datasheet "polymer solutions". The upper part of the FSO US-F can be executed with:

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

The lower part of the FSO US-F can be executed with:

- PTFE coating
- PFA coating
- PTFE lining

-> 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"

## Cooling options

There are several ways to protect the instrument from elevated temperatures, such as the extended direct mount (EDM), a temperature reducer (TR) or by means of capillary.

-> See datasheet "cooling devices"

## 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 EN 13185 test procedure A.3 up to 10<sup>-9</sup> 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.

### Retaining bolts & nuts

The cover flange and seal are rotating and fixed by a stainless steel retaining ring.

### Gaskets

For the FSO US-F a gasket is supplied for the closing between the upper and the lower part of the FSO US-F. The gaskets are virgin PTFE, Garfite N, or camprofile stainless steel with graphite layer. The gasket area of the lower part is matching the process connection. The design has a matching ID of the lower part based on the S40 of the ASME 16.10.

Material	Operating temperature
Virgin PTFE	-200 / +260°C
Garfite N <sup>1</sup>	-73 / +343°C
Camprofile	-200 /+ 500°C

1: Garfite cannot be used on steam applications

### Pressure

The maximum working pressure of the FSO US is limited. The maximum allowed operating pressure (MAOP) of the upper and lower construction is depending on the type of bolts used and the cover flange pressure rating.

Rating	Material	MAOP @ 20°C	MAOP @ 400°C
Cl. 150	A182 AISI 316(L)	19.0 bar	6.5 bar
Cl. 300	A182 AISI 316(L)	49.6 bar	29.4 bar
Cl. 600	A182 AISI 316(L)	99.3 bar	58.9 bar
Cl. 1500	A182 AISI 316(L)	248.2 bar	147.2 bar

Based on the assumption bolts and body materials has same expansion coefficients. Some materials are limited by material specification and are not able to meet 400°C.

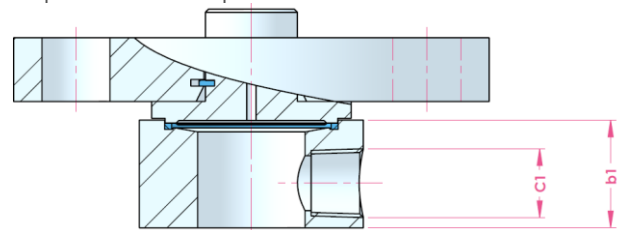
### Flushing ports

The FSO US-F diaphragm seal is suitable to be equipped with one or two flushing ports. This ports can be left open, or fitted with needle valves, blind plugs or vent plugs. The type and size of the port can be selected within below size.

Size	Standard	Sealant
1/4" NPT-f	ANSI B1.20.1	Tape or paste
1/2" NPT-f	ANSI B1.20.1	Tape or paste
G 1/4"	ISO 228-1	gasket ISO 1179
G 1/2"	ISO 228-1	gasket ISO 1179
1/2" Socket weld	ASME 16.9	weld
1/2" Butt weld	ASME 16.11	weld

### Thickness with flush ports

FSO-US lower parts are perfectly suitable for flush connections. However some sizes will need extra thickness of the lower part. Below a table with a "rule of thumb" to determine the new thickness of the lower part. The flush channel to the chamber is 6mm. The b1 of lower parts without flush ports is 20mm for RF and 30mm for RJF

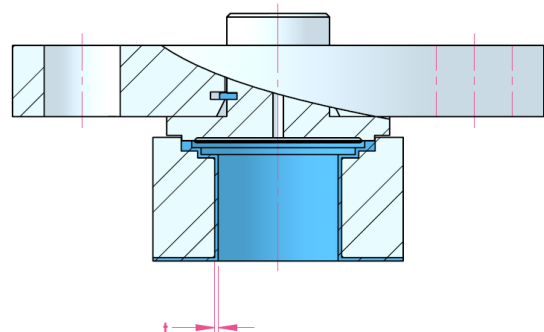


Flush size (C1)	b1
1/4" G/NPT	b<20 then b1=20
3/8" G/NPT	b<28 then b1=28
1/2" G/NPT	b<35 then b1=35
1/2" butt weld	b<24 then b1=24
3/4" butt weld	b<30 then b1=30
1/2" socket weld	b<33.5 then b1=3.5
3/4" socket weld	b<41 then b1=41

All dimensions in mm.

### PTFE lined lower part

The lower part of the FSO US-F can made with PTFE lining. The lower parts are designed in a way the sizes can be kept the same. The minimum thickness of the lining is t=1mm, and at some points thicker in order to give maximum chemical resistance.



## 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.

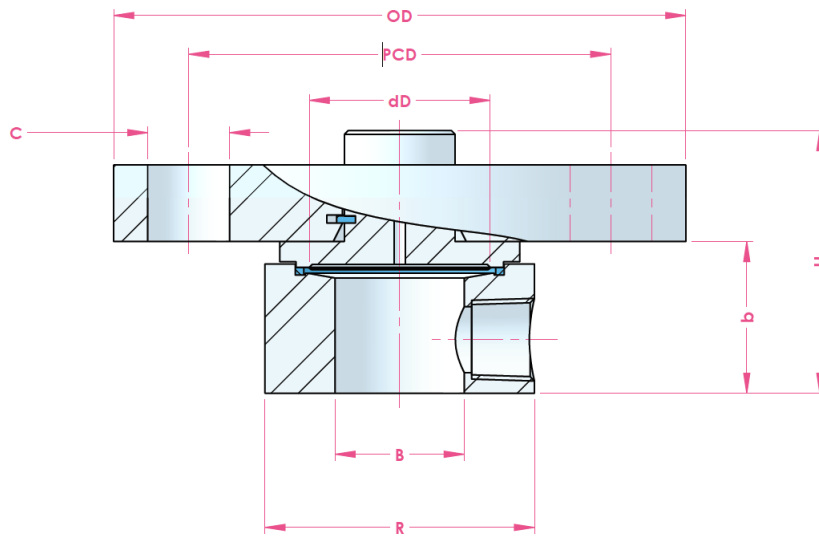
### Minimum span table

dD	AP/GP	DP
50mm	1200 mbar	205 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.

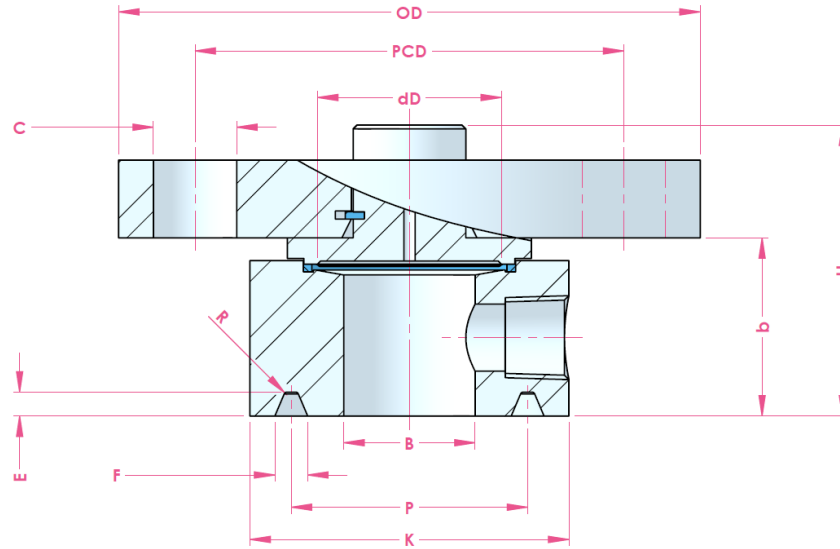
Dimensions table: ASME 16.5 RF facing



size	rating	dD	OD	PCD	C	H	R	B	b
3/4"	cl. 300	50.0	117.0	82.6	19.5	37.3	63.5	21.0	23.0
	cl. 400 - 600		130.0	88.9	22.2	38.9			
	cl. 900 - 1500				48.9				
1"	cl. 300		124.0	88.9	19.5	38.9	67.0	26.6	
	cl. 400 - 600		149.0	101.6	25.5	40.5			
	cl. 900 - 1500				51.6				
1.25"	cl. 150		117.0	88.9	16.0	27.3		35.1	
	cl. 300		133.0	98.6	19.5	40.1			
	cl. 400 - 600				43.7				
1.5"	cl. 900 - 1500		159.0	111.1	25.5	51.6	35.1		
	cl. 150		127.0	98.6	16.0	28.1			
	cl. 300		155.0	114.3	22.2	42.1	73.0	40.9	
	cl. 400 - 600	45.3							
	cl. 900 - 1500	54.8							

All sizes in mm; b size is based on lower part without flush

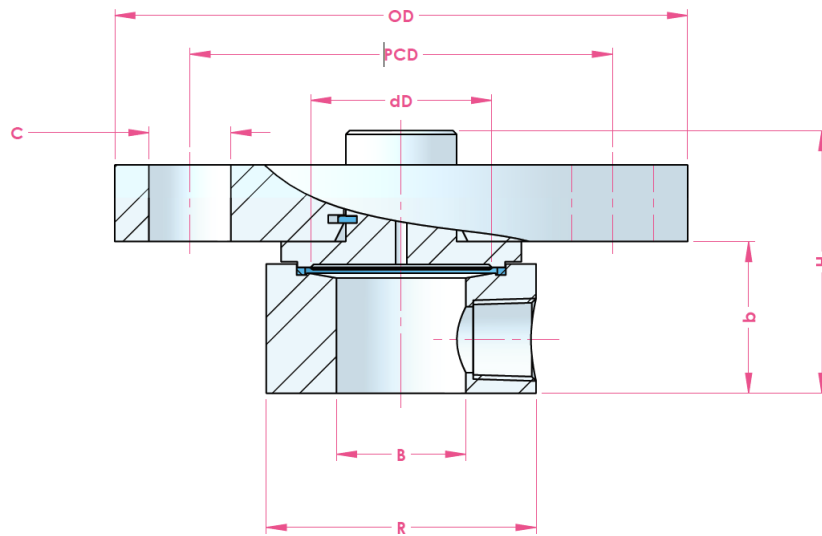
Dimensions table: ASME 16.5 RJF facing



size	rating	dD	OD	PCD	C	H	K	B	b	P	E	F	R		
3/4"	cl. 300	50.0	117.0	82.6	19.5	47.3	63.0	21.0	33.0	42.88	6.35	8.74	0.8		
	cl. 400-600		130.0	88.9	22.2	48.9								67.0	26.6
	cl. 900-1500		124.0	88.9	19.5	48.9									
1"	cl. 300		149.0	101.6	25.5	50.5	73.2	40.9							
	cl. 400-600		117.0	88.9	16.0	37.3				79.5				35.1	
	cl. 900-1500		133.0	98.6	19.5	53.7									83.0
1.25"	cl. 150		159.0	111.1	25.5	61.6	93.0	40.9							
	cl. 300		127.0	98.6	16.0	38.1				65.07				68.28	
	cl. 400-600		155.0	114.3	22.2	52.1									
1.5"	cl. 150		178.0	124.0	28.6	64.8									
	cl. 300														
	cl. 900-1500														

All sizes in mm; b size is based on lower part without flush

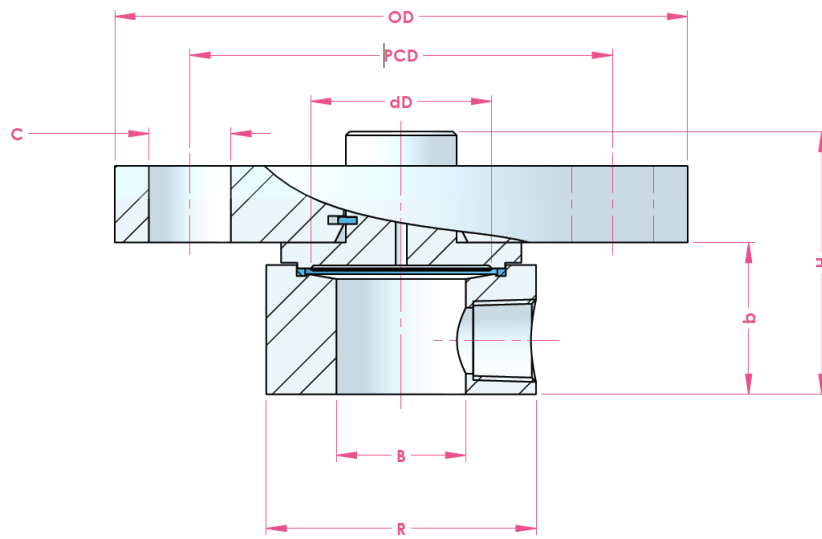
Dimensions table: EN 1092-1 B1 type



size	rating	dD	OD	PCD	C	b	H	R	B		
DN25	PN10-40	50.0	115.0	85.0	14.0	23.0	53.0	68.0	28.5		
	PN63-160		140.0	100.0	18.0						
	PN250		150.0	105.0	22.0						
DN32	PN10-40		140.0	100.0	18.0					78.0	37.2
	PN63-100		155.0	110.0	22.0						
DN40	PN10-40		150.0	145.0	18.0						
	PN63-160		170.0	125.0	22.0						
	PN250		185.0	135.0	26.0						

All sizes in mm; b size is based on lower part without flush

Dimensions table: JIS 2220 RF



size	rating	dD	OD	PCD	C	t	b	H	R	B
DN25	10K	50.0	125.0	90.0	19.0 / 4x	14.0	23.0	53.0	67.0	25.0
	16K					16.0				
	20K					18.0				
DN32	10K	50.0	135.0	100.0	19.0 / 4x	16.0	23.0	53.0	76.0	32.0
	16K					18.0				
	20K					16.0				
DN40	10K	50.0	140.0	105.0	19.0 / 4x	16.0	23.0	53.0	81.0	40.0
	16K					18.0				
	20K					16.0				

All sizes in mm; b size is based on lower part without flush



## Change log

Date	Change
7-5-2020	Removed cap side (Radial) from capillary paragraph
29-6-2020	Dimension R and K changed from 67.0 to 63.5mm
30-6-2020	New dimension drawings representing the retaining ring
8-3-2021	Updated ASME dimension table with the ASME B16.5:2020

Holland – Romania – India – Thailand – Dubai – USA

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