

FSO USL-F type seal - internal diaphragm flanged type

Design description

The FSO USL-F construction is designed for those applications where the existing process connection is too small to use a flush diaphragm seal. The FSO USL-F is a variant on the standard USL-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 |
| 1.5" & 2" | cl. 300 - cl. 600 | 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 |
| DN45 to DN50 | PN40-100 | 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 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 USL-F can be executed with:

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

The lower part of the FSO USL-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. Alternatively, the capillary can be placed at the side of the seal (radial). 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^{-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.

Retaining bolts & nuts

The retaining bolts between upper part are not in the scope of supply and is depending on the applications.

Gaskets

For the FSO USL-F a gasket is supplied for the closing between the upper and the lower part of the FSO USL-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 ¹ | -73 / +343°C |
| Camprofile | -200 / + 500°C |

1: Garfite cannot be used on steam applications

Pressure

The maximum working pressure of the FSO USL 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. 300 | A182 AISI 316(L) | 49.6 bar | 29.4 bar |
| Cl. 600 | A182 AISI 316(L) | 99.3 bar | 58.9 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.

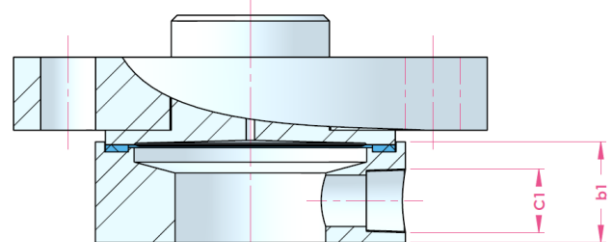
Flushing ports

The FSO USL-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

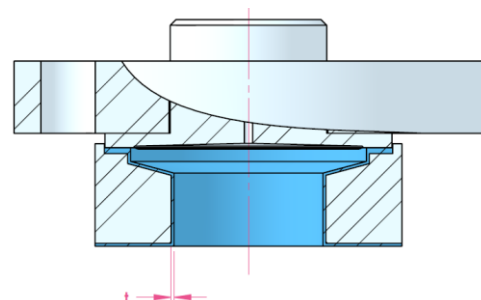
FSO USL-F lower parts are perfectly suitable for flush connections. However some sizes will need extra thickness of the lower part. Below a table with a "rule of thumb" to determine the new thickness of the lower part. The flush channel to the chamber is 6mm. The b1 of lower parts without flush ports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

PTFE lined lower part

The lower part of the FSO USL-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.

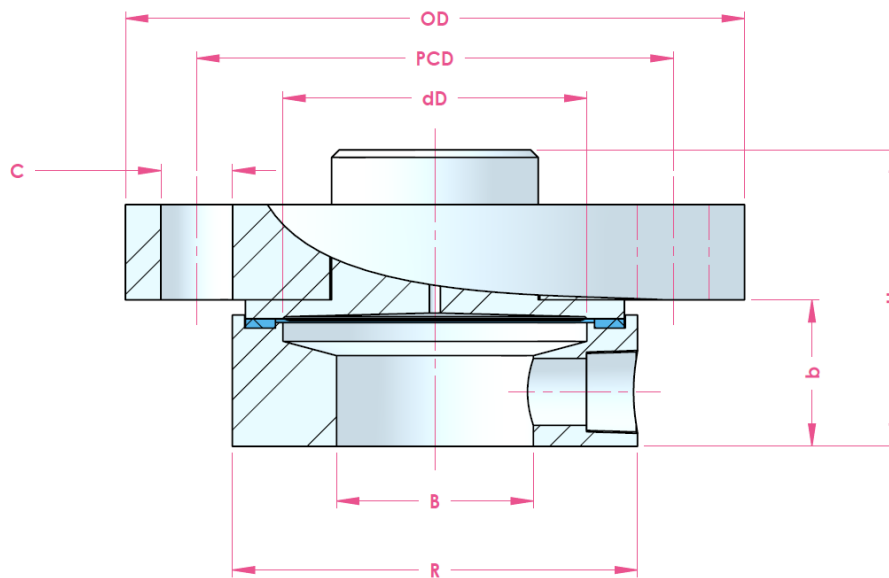
Minimum span table

| dD | AP/GP | DP |
|------|----------|---------|
| 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.

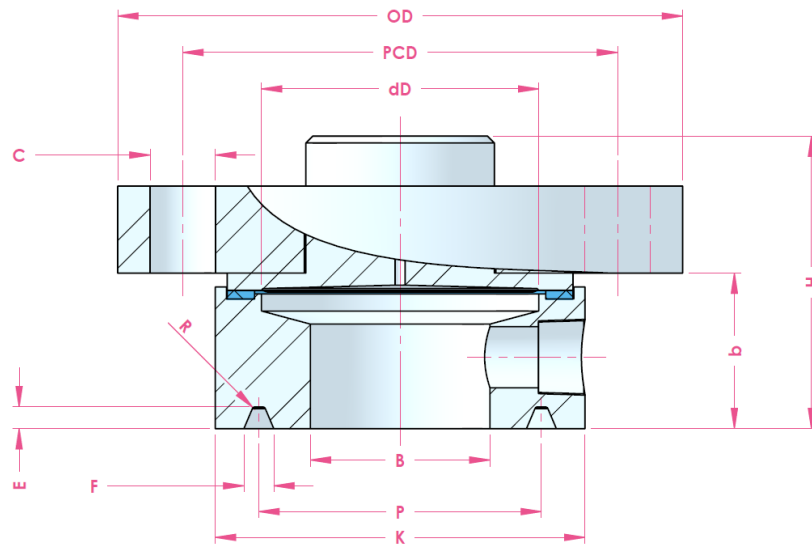
Dimensions table: ASME 16.5 RF facing



| size | rating | dD | OD | PCD | C | H | R | B | b |
|------|-------------|------|-------|-------|------|------|-------|------|------|
| 1,5" | cl. 300 | 81.0 | 155.0 | 114.3 | 22.2 | 42.1 | 108.0 | 40.9 | 23.0 |
| | cl. 400-600 | | | | | 45.3 | | | |
| 2" | cl. 300 | | 165.0 | 127.0 | 19.5 | 43.7 | | | |
| | cl. 400-600 | | | | | 48.4 | | | |

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

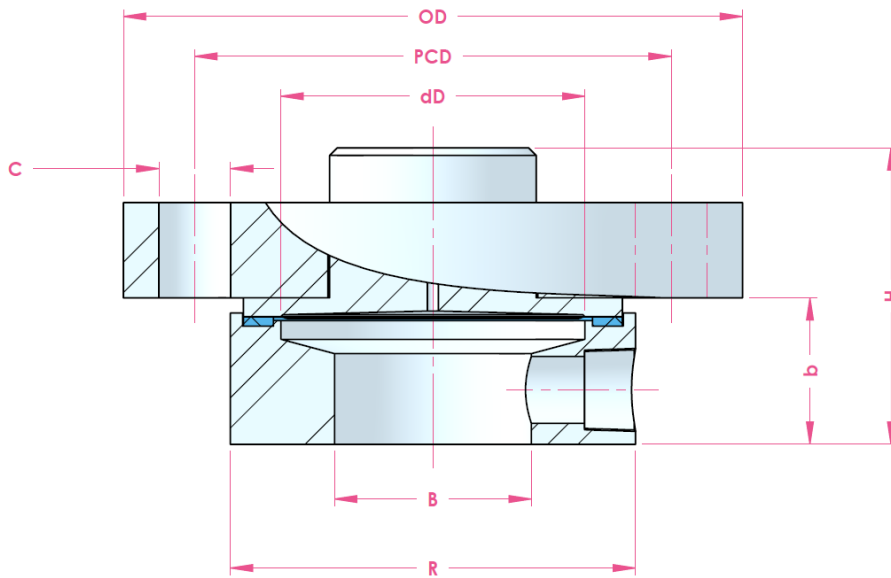
Dimensions table: ASME 16.5 RJF facing



| size | rating | dD | OD | PCD | C | H | K | B | b | P | E | F | R |
|------|-------------|------|-------|-------|------|------|-------|------|------|------|-----|-----|-----|
| 1.5" | cl. 300 | 81.0 | 155.0 | 114.3 | 22.2 | 52.1 | 108.0 | 40.9 | 33.0 | 68.3 | 6.4 | 8.7 | 0.8 |
| | cl. 400-600 | | | | | 55.3 | | | | | | | |
| 2" | cl. 300 | | 165.0 | 127.0 | 19.5 | 53.7 | | 58.4 | | | | | |
| | cl. 400-600 | | | | | 58.4 | | | | | | | |

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 | H | K | B | b |
|------|----------|------|-------|-------|------|------|-------|------|------|
| DN40 | PN63-100 | 81.0 | 170.0 | 125.0 | 22.0 | 51.0 | 108.0 | 43.1 | 23.0 |
| DN50 | PN40 | | 165.0 | | 18.0 | 43.0 | | 54.5 | |
| DN50 | PN63 | | 180.0 | 22.0 | 49.0 | 54.5 | | | |
| DN50 | PN100 | | 195.0 | 26.0 | 51.0 | 54.5 | | | |

b size is based on lower part without flush

Change log

| Date | Change |
|------|--------|
| - | |

Holland – United Kingdom – Romania – India – Thailand – Dubai – USA

To our knowledge, the information contained herein is accurate as of the date of this document. However neither Badotherm, nor its affiliates makes any warranty, express or limited, or accepts any liability in connection with this information or its use. This information is for technical skilled persons at their own discretion and risk and does not relate to the use of this product in combination with any other product. The user alone finally determines suitability of any information or material in contemplated use, the manner of use and whether any patents are infringed. This information gives typical properties only. Badotherm reserves the right to make changes to the specifications any materials without prior notice. The latest version of the datasheet can be found on www.badotherm.com.

© 2015 Badotherm, all rights reserved. Trademarks and/or other products referenced herein are either trademarks or registered trademarks of Badotherm.

DSS 7010
1 February 2019