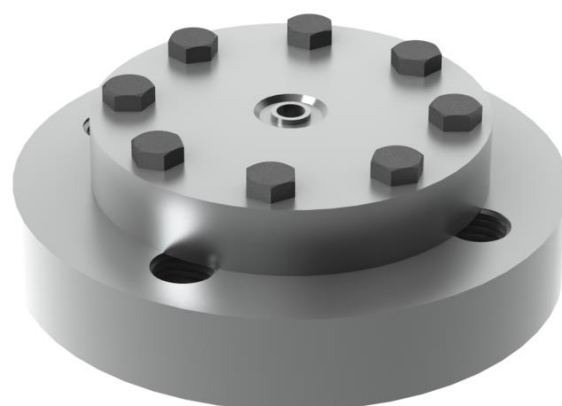


# USL-F type seal - internal diaphragm flanged type

## Design description

The USL-F construction is designed for those applications where the existing process connection is too small to use a flush diaphragm seal. The USL-F consists of an upper and lower housing, the upper is the actual seal part with a diaphragm size that allows for measurement of low ranges. The lower housing creates the transition from the diaphragm size to the smaller process connection.



## Housing / diaphragm combinations

Body Material	Diaphragm material		
(Lower part)	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
AISI 316(L) PTFE lined	Tantalum	R60702	-

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
1/2" to 2"	cl. 150 - cl. 1500	RF, LMF, FF, SGF	Ra 3.2-6.3 µm
		RJF	Ra <1.6 µm
		SMF, LTF, STF, LGF, LFF, SFF	Ra <3.2 µm

## Flange size, rating and facings - EN 1092-1

EN 1092-1			
Size	Rating	Type	Roughness
DN15 to DN50	PN10-160	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 – JIS B2220

JIS B2220			
Size	Rating	Type	Roughness
DN25 to DN50	10-20K	RF	Ra 3.2-12.5 µm

## Gold coatings

Two types of gold coating thickness can be applied on the USL-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 USL-F can be executed with:

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

The lower part of the 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 and lower part can be selected in different materials and are in the size M10 up to 600# (PN100) and 5/8" for 1500# (PN250).

Grade bolt	Grade nut	Material
ISO 3506-1 A2-70	ISO 3506-2 A2	AISI 304
ISO 3506-1 A4-70	ISO 3506-2 A4	AISI 316
ASTM A193 B7	ASTM A194 2H	Carbon steel
ASTM A193 B8M	ASTM A194 8M	AISI 316

## Torque

The closing between upper part and lower part is done with 8 bolts, depending on the pressure rating. The torque of the M10 bolts is 35 Nm (25.81 ft-lb) and for the 5/8" UNC bolt torque is 75Nm.

## Gaskets

For the USL-F a gasket is supplied for the closing between the upper and the lower part of the 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 <sup>1</sup>	-73 / +343°C
Camprofile <sup>2</sup>	-200 / + 500°C

1: Garfite N cannot be used on steam applications  
2: For >cl.900 Camprofile is required

## Pressure

The maximum working pressure of the USL is limited. The maximum allowed operating pressure (MAOP) of the upper and lower construction is depending on the type of bolts used. The maximum pressure of the assembly is depending on the selection and of bolts and gasket and lower part pressure class.

Size	Grade	MAOP @ 20°C	MAOP @ 400°C
8 x M10	ISO 3506-1 A2/A4-70	125 bar	66 bar
8 x 5/8"	ASTM F593C/G	248 bar	145 bar
8 x 5/8"	ASTM A193 B7/B8M	248 bar	145 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.

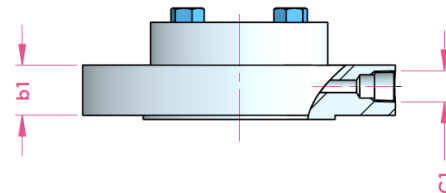
## Flushing ports

The 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

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.

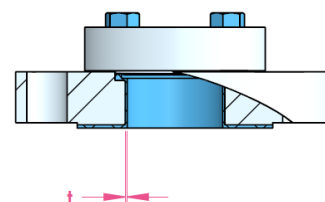


Flush size (C1)	b1
1/4" G/NPT	b<20 then b1=20
3/8" G/NPT	b<28 then b1=28
1/2" G/NPT	b<35 then b1=35
1/2" butt weld	b<24 then b1=24
3/4" butt weld	b<30 then b1=30
1/2" socket weld	b<33.5 then b1=33.5
3/4" socket weld	b<41 then b1=41

All dimensions in mm.

## PTFE lined lower part

The lower part of the USL-F can be 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. Lining is not possible for cl.900 and higher



## 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.

## Standards used

### Design Standards

Standard	Description
ASME B16.5 - 2020	Pipe flanges and flanged fittings
ASME B16.20 - 2017	Metalic gaskets for flanges
EN 1092-1 - 2018	Circular flanges for pipes
EN 1514-2 - 2021	Dimensions of gaskets
API ISO 10423 (API 6A) - 2010	International Standard for Petroleum and Natural Gas Industries
JIS B2220 - 2012	Japanese Flange Standard
GOST 33259 - 2015	Russian Flange Standard

### Test Standards

Standard	Description
ISO 20485 - 2018	Non-destructive testing - Leak testing - Tracer gas method

### Material Standards

Standard	Description
NACE MR0175/MR0103 ISO 15156 - 2020	use in H <sub>2</sub> S-containing environments in oil and gas production
NORSOK M-630 - 2010	specification for use in pipelines
ASTM standards	Material specific standards

### Certification Standards

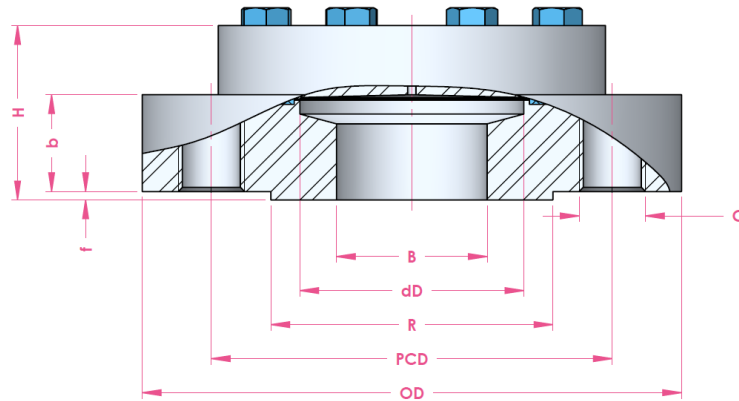
Standard	Description
EN 10204 - 2017	Inspection documents

## Roughness conversion

The specific flange norm all relate to specific roughness value for surface finish and flange finish. Below table can be used for conversion between the average roughness (Ra) in micrometers (µm) and microinch (µin)

µm	µin
0.8	32
1.6	63
3.2	125
6.3	250

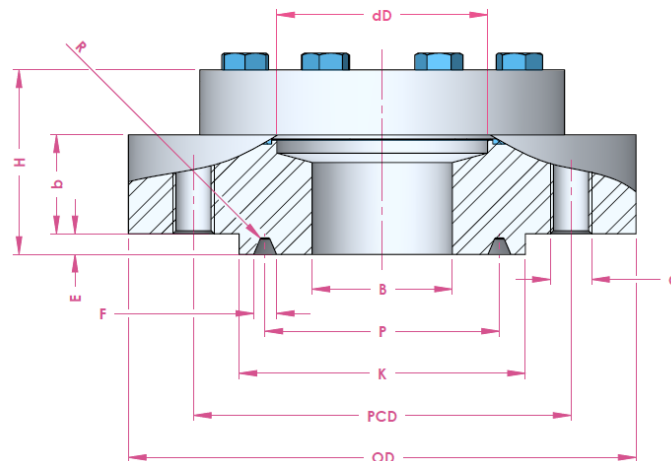
### Dimensions table: ASME 16.5 RF facing



size	rating	OD	B	b	R	f	H	PCD	C / pcs	Weight
1/2"	cl. 150	140.0	15.8	40.0	34.9	1.5	67.0	60.5	0.5" - 13 UNC / 4x	7.9 kg
	cl. 300			39.0				66.5		
	cl. 400 - 600	160.0		43.0	6.4	71.0	82.6	3/4" - 10 UNC / 4x		
	cl. 900 - 1500			39.0		68.0			69.8	
3/4"	cl. 150	140.0	21.0	44.0	42.9	1.5	71.0	82.6	5/8" - 11 UNC / 4x	7.9 kg
	cl. 300			43.0				82.6		
	cl. 400 - 600	160.0		43.0	6.4	76.0	88.9	3/4" - 10 UNC / 4x		
	cl. 900 - 1500			43.0		53.5			88.9	
1"	cl. 150	140.0	26.6	38.0	50.8	1.5	65.0	79.2	0.5" - 13 UNC / 4x	7.9 kg
	cl. 300			41.0				88.9		
	cl. 400 - 600	160.0		48.0	6.4	50.0	101.6	7/8" - 9 UNC / 4x		
	cl. 900 - 1500			48.0		80.0			101.6	
1.5"	cl. 150	140.0	40.9	38.0	73.0	1.5	65.0	98.6	0.5" - 13 UNC / 4x	7.9 kg
	cl. 300			44.0				114.3		
	cl. 400 - 600	155.0		45.0	6.4	77.0	124.0	3/4" - 10 UNC / 4x		
	cl. 900 - 1500	180.0		48.0		80.0			124.0	
2"	cl. 150	150.0	52.5	29.0	91.9	1.5	56.0	120.6	5/8"-11 UNC / 4x	7.0 kg
	cl. 300			30.0				127.0		
	cl. 400 - 600	165.0		29.0	6.4	61.0	165.1	25.4 / 8x		
	cl. 900 - 1500	215.0		50.0		82.0			165.1	

All dimensions in mm, weight in kg

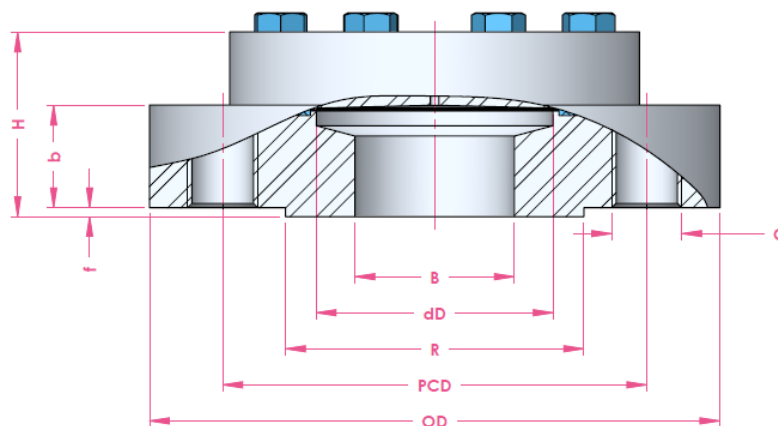
### Dimensions table: ASME 16.5 RJF facing



size	rating	OD	B	b	K	E	F	H	P	Ring#	PCD	C / pcs	Weight		
1/2"	cl. 300	140.0	15.8	40.0	51.0	5.56	8.7	70.5	34.1	11	66.7	1/2"-13 UNC / 4x	8.6 kg		
	cl. 400 - 600			39.0				69.5					8.5 kg		
	cl. 900 - 1500	160.0		43.0	60.5			74.4				39.7	12	9.0 kg	
3/4"	cl. 300	140.0	21.0	44.0	63.5	6.35	8.7	75.4	42.9	13	82.6	5/8"-11 UNC / 4x	9.0 kg		
	cl. 400 - 600			43.0	66.5			74.4				44.5	14	13.0 kg	
	cl. 900 - 1500	160.0		38.0	70.0			69.4				47.6	15	8.6 kg	
1"	cl. 150	140.0	26.6	41.0	71.5	6.35	8.7	72.4	50.8	16	88.9	5/8"-11 UNC / 4x	9.0 kg		
	cl. 300			48.0	82.5			88.0					101.6	7/8"-9 UNC / 4x	13.0 kg
	cl. 400 - 600	160.0		38.0	82.5			69.4				65.1	19	8.5 kg	
1.5"	cl. 150	140.0	40.9	44.0	90.5	6.35	8.7	75.4	68.3	20	114.3	3/4"-10 UNC / 4x	10.0 kg		
	cl. 300	159.0		48.0	92.0			79.4					123.8	1"-8 UNC / 4x	16.0 kg
	cl. 400 - 600	178.0		29.0	102.0			60.4					120.7	19.1mm / 4x	8.5 kg
2"	cl. 150	152.0	52.5	29.0	102.0	7.92	11.91	60.4	82.6	22	120.7	19.1mm / 4x	8.5 kg		
	cl. 300			30.0	108.0			62.9					127.0	19.1mm / 8x	9.6 kg
	cl. 400 - 600	165.0		29.0	108.0			61.9					127.0	19.1mm / 8x	9.6 kg
	cl. 900 - 1500	216.0		50.0	124.0			82.9				95.3	24	165.1	25.4mm / 4x

All dimensions in mm, weight in kg

### Dimensions table: EN 1092-1 B1 type



size	rating	OD	B	b	R	f	H	PCD	C / pcs	Weight (+/-)		
DN15	PN10-40	140.0	17.3	40.0	45.0	2.0	67.0	65.0	M12 / 4x	8 kg		
	PN63-100			65.0			75.0					
	PN160	160.0		70.0			90.0	M16 / 4x		12 kg		
	PN250			43.0			65.0	75.0				
DN20	PN10-40	140.0	22.3	38.0	58.0	2.0	65.0	75.0	M12 / 4x	9 kg		
	PN63-100		21.7	43.0			70.0	90.0				
DN25	PN10-40	140.0	28.5	35.5	68.0		3.0	62.5	85.0		M12 / 4x	9 kg
	PN63-100			43.5				70.5	100.0			
	PN160	160.0		49.5		76.5		105.0	M20 / 4x	12 kg		
	PN250			40.0		78.0		110.0	M16 / 4x			
DN40	PN10-40	150.0	43.1	40.0	88.0	3.0	78.0	110.0	M16 / 4x	8.5 kg		
	PN63-100	170.0	42.5	41.0			79.0	125.0			M20 / 4x	
DN50	PN10-40	165.0	54.5	30.0	102.0		3.0	58.0	135.0	M16 / 4x	7.0 kg	
	PN63	180.0						68.0	145.0			M24 / 4x
	PN100	195.0	53.9	43.0		71.0		150.0	M24 / 8x	15 kg		
	PN160					71.0		150.0	M24 / 8x			
PN250	200.0											

All dimensions in mm, weight in kg

## Change log

Date	Change
30-3-2020	Extra decimal in dimension "P", "E" and "F" in RJF table
15-10-2020	Added PN 160 for EN 1092-1 size DN15, DN25, DN40, and DN50
22-10-2020	Size 2" cl. 300 and cl 600 size was changed form 160mm tot 165mm
8-3-2021	Added table with standards and roughness values Updated dimension tables according ASME B16.5:2020

Holland – Romania – India – Thailand – Dubai – USA

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