

US-FH type seal - internal diaphragm flanged neck type

Design description

The US-FH construction is designed for those applications where the existing process connection is too small to use a flush mounted diaphragm seal mainly because of a too small diaphragm. The US-FH consists of an upper and lower housing. The lower housing creates the transition from the diaphragm size to the actual small 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 |
| | | 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 |
| 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 |
| NS10 to NS50 | 10-20K | RF | Ra 3.2-6.3 µm |

Gold coatings

Two types of gold coating thickness can be applied on the US-FH 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 US-FH can be executed with:

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

The lower part of the 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. 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 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.

Retaining bolts & nuts

The retaining bolts between upper and lower part can be selected in different materials and are in the size ANSI B1.1 3/8" UNC.

| Grade bolt | Grade nut | Material |
|---------------|--------------|--------------|
| ASTM F593C | ASTM F594C | AISI 304 |
| ASTM F593G | ASTM F594G | AISI 316 |
| ASTM A192 B7 | ASTM A192 2H | Carbon steel |
| ASTM A192 B8M | ASTM A192 8M | AISI 316 |

Torque

The closing between upper part and lower part is done with 4, or 8 bolts, depending on the pressure rating. The torque of the bolts is 35 Nm (25.81 ft-lb).

Gaskets

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

1: Garfite N cannot be used on steam applications

Pressure

The maximum working pressure of the US is limited. The maximum allowed operating pressure (MAOP) of the upper and lower construction is limited to 300 bar at 20°C. The maximum pressure of the assembly is depending on the selection and quantity of bolts and gasket and lower part pressure class.

| Size | Grade | 20°C | 400°C |
|----------|------------------|---------|---------|
| 4 x 3/8" | ASTM F593C/G | 125 bar | 80 bar |
| 8 x 3/8" | ASTM F593C/G | 250 bar | 155 bar |
| 4 x 3/8" | ASTM A192 B7/B8M | 150 bar | 100 bar |
| 8 x 3/8" | ASTM A192 B7/B8M | 300 bar | 190 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 US-FH 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-FH 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) | H |
|------------------|----------|
| 1/4" G/NPT | H+3mm |
| 3/8" G/NPT | H+9mm |
| 1/2" G/NPT | H+16mm |
| 1/2" butt weld | H+5mm |
| 3/4" butt weld | H+11mm |
| 1/2" socket weld | H+14.5mm |
| 3/4" socket weld | H+22mm |

All dimensions in mm.

PTFE lined lower part

The lower part of the US-FH 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

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 ₂ S-containing environments in oil and gas production |
| NORSOK M-630 - 2010 | specification for use in pipelines |
| ASTM standards | Material specific standards |

Certification Standards

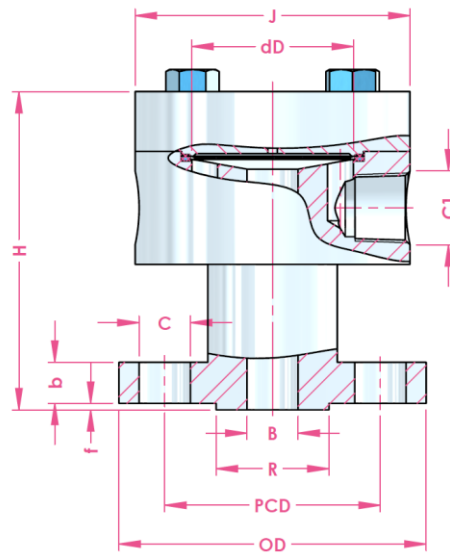
| Standard | Description |
|-----------------|----------------------|
| EN 10204 - 2017 | Inspection documents |

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 micrometres (µm) and microinch (µin)

| µm | µin |
|-----|-----|
| 0.8 | 32 |
| 1.6 | 63 |
| 3.2 | 125 |
| 6.3 | 250 |

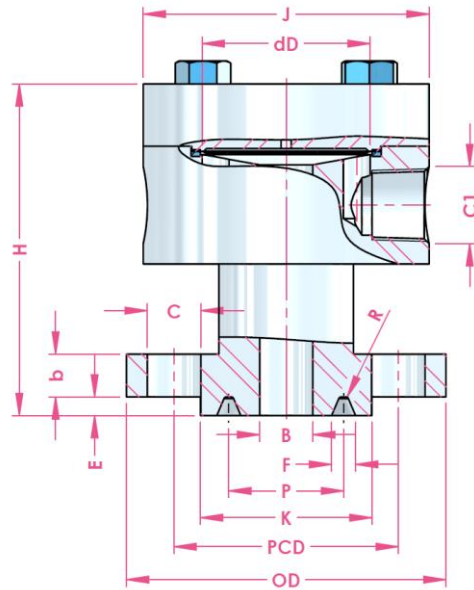
Dimensions table: ASME 16.5 RF facing



| size | rating | OD | J | B | R | b | f | H | PCD | C / pcs |
|----------------|----------------|---------|------|-------|-------|-------|-------|-------|-----------|-----------|
| 1/2" | cl. 150 | 89.0 | 85.0 | 15.8 | 34.9 | 9.7 | 1.5 | 79.0 | 60.5 | 15.9 / 4x |
| | cl. 300 | 95.0 | | | | 12.7 | | 82.1 | | |
| | cl. 400 - 600 | | | | | 14.2 | 88.7 | 66.5 | | |
| | cl. 900 - 1500 | 121.0 | | | | 22.4 | 92.5 | | 82.6 | |
| 3/4" | cl. 150 | 99.0 | | 21.0 | 42.9 | 11.2 | 1.5 | 80.6 | 69.8 | 15.9 / 4x |
| | cl. 300 | 117.0 | | | | 14.2 | | 91.2 | | |
| | cl. 400 - 600 | | | | | 15.7 | 97.8 | 82.6 | | |
| | cl. 900 - 1500 | | | | | 130.0 | 17.5 | | 114.8 | |
| | 1" | cl. 150 | | | | 108.0 | 26.6 | 50.8 | 12.7 | |
| cl. 300 | | 124.0 | | 15.7 | 92.8 | | | | | |
| cl. 400 - 600 | | | | 17.5 | 99.4 | 88.9 | | | | |
| cl. 900 - 1500 | | | | 149.0 | 28.4 | | | | 125.5 | 101.6 |
| 1.25" | cl. 150 | 117.0 | | 35.1 | 63.5 | 14.2 | 1.5 | 85.3 | 88.9 | 15.9 / 4x |
| | cl. 300 | 133.0 | | | | 17.5 | | 94.4 | | |
| | cl. 400 - 600 | | | | | 20.6 | 102.6 | 98.6 | | |
| | cl. 900 - 1500 | | | | | 159.0 | 28.4 | | 125.5 | |
| 1.5" | cl. 150 | 127.0 | 40.9 | 73.0 | 15.9 | 1.5 | 85.3 | 98.6 | 15.9 / 4x | |
| | cl. 300 | 155.0 | | | 19.0 | | 103.5 | | | |
| | cl. 400 - 600 | | | | 22.4 | 111.7 | 114.3 | | | |
| | cl. 900 - 1500 | | | | 178.0 | 31.8 | | 136.2 | | 124.0 |
| 2" | cl. 150 | 152.0 | 47.0 | 91.9 | 17.5 | 1.5 | 78.4 | 120.6 | 19.1 / 4x | |
| | cl. 300 | 165.0 | | | 20.6 | | 81.6 | | | |
| | cl. 400 - 600 | | | | 25.4 | 91.3 | 127.0 | | | |
| | cl. 900 - 1500 | | | | 216.0 | 38.1 | | 112.5 | | 165.1 |

All dimensions in mm.
Dimension H based on thickness without flush holes. Refer to table "thickness with flush ports" for additional thickness.

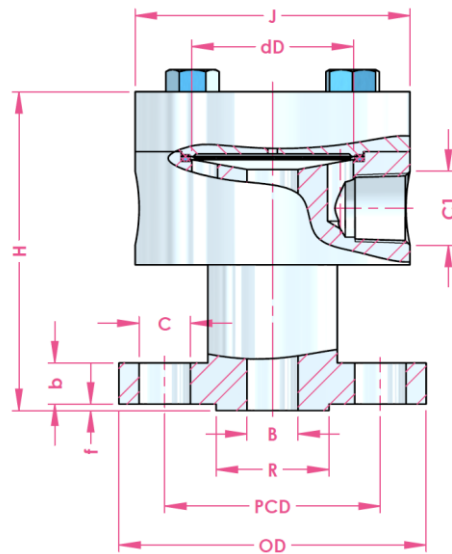
Dimensions table: ASME 16.5 RJF facing



| size | rating | OD | J | B | b | H | K | E | F | P | R | Ring# | PCD | C / pcs | | | | | | | | | | | |
|-------|----------------|-------|-------|------|-------|-------|-------|-------|-------|-----------|-------|-------|-----------|-----------|-----------|-----|-------|-----------|------|-------|-----------|-----|----|-------|-----------|
| 1/2" | cl. 300 | 95.0 | 85.0 | 15.8 | 12.7 | 85.6 | 51.0 | 5.54 | 7.14 | 34.14 | 0.8 | 11 | 66.7 | 15.9 / 4x | | | | | | | | | | | |
| | cl. 400 - 600 | | | | 14.2 | 98.7 | | | | | | 12 | 22.3 / 4x | | | | | | | | | | | | |
| | cl. 900 - 1500 | 22.4 | | | 124.9 | 60.5 | | | | | | 13 | 82.6 | 19.1 / 4x | | | | | | | | | | | |
| 3/4" | cl. 300 | 117.0 | | 21.0 | 26.6 | 14.2 | 95.5 | | | 63.5 | | 6.35 | 8.7 | 42.88 | 0.8 | 14 | 88.9 | 22.3 / 4x | | | | | | | |
| | cl. 400 - 600 | 15.7 | | | | 97.1 | 66.5 | | | | | | | | | 15 | 79.2 | 15.9 / 4x | | | | | | | |
| | cl. 900 - 1500 | 17.5 | | | | 114.2 | 66.5 | | | | | | | | | 16 | 88.9 | 19.1 / 4x | | | | | | | |
| 1" | cl. 150 | 99.0 | | 35.1 | 26.6 | 12.7 | 86.4 | | | 70.0 | | | | 6.35 | | 8.7 | 50.80 | 0.8 | 17 | 101.6 | 25.4 / 4x | | | | |
| | cl. 300 | 15.9 | | | | 89.6 | 73.2 | | | | | | | | | | | | 18 | 98.6 | 19.1 / 4x | | | | |
| | cl. 400 - 600 | 19.0 | | | | 98.7 | 79.5 | | | | | | | | | | | | 19 | 98.4 | 15.9 / 4x | | | | |
| | cl. 900 - 1500 | 22.4 | | | | 101.9 | 81.0 | | | | | | | | | | | | 20 | 114.3 | 22.3 / 4x | | | | |
| 1.25" | cl. 150 | 108.0 | | | 40.9 | 26.6 | 31.8 | | | 102.4 | | | | | | | 82.6 | | 6.35 | 8.7 | 65.07 | 0.8 | 21 | 111.1 | 25.4 / 4x |
| | cl. 300 | 17.5 | | | | | 89.6 | | | 82.6 | | | | | | | | | | | | | 22 | 120.6 | 19.1 / 4x |
| | cl. 400 - 600 | 20.6 | 107.9 | | | | 90.5 | 23 | 127.0 | 19.1 / 8x | | | | | | | | | | | | | | | |
| | cl. 900 - 1500 | 25.4 | 111.1 | | | | 92.0 | 24 | 165.1 | 25.4 / 4x | | | | | | | | | | | | | | | |
| 1.5" | cl. 150 | 127.0 | 47.0 | | | 26.6 | 28.4 | 124.9 | 71.5 | 7.92 | 11.91 | | | | | | 82.55 | | | | 0.8 | | 22 | 120.6 | 19.1 / 4x |
| | cl. 300 | 15.9 | | | | | 89.6 | 82.6 | | | | 23 | 127.0 | | 19.1 / 8x | | | | | | | | | | |
| | cl. 400 - 600 | 17.5 | | | | | 92.2 | 108.0 | | | | 24 | 165.1 | | 25.4 / 4x | | | | | | | | | | |
| | cl. 900 - 1500 | 28.4 | | | | | 113.5 | 124.0 | | | | 24 | 165.1 | | 25.4 / 4x | | | | | | | | | | |
| 2" | cl. 150 | 152.0 | | 47.0 | | 26.6 | 12.7 | 82.7 | 102.0 | | | 7.92 | 11.91 | 82.55 | 0.8 | 22 | 120.6 | 19.1 / 4x | | | | | | | |
| | cl. 300 | 15.7 | | | | | 87.5 | 108.0 | | | | | | | | 23 | 127.0 | 19.1 / 8x | | | | | | | |
| | cl. 400 - 600 | 17.5 | | | | | 92.2 | 108.0 | | | | | | | | 24 | 165.1 | 25.4 / 4x | | | | | | | |
| | cl. 900 - 1500 | 28.4 | | | | | 113.5 | 124.0 | | | | | | | | 24 | 165.1 | 25.4 / 4x | | | | | | | |

All dimensions in mm.
Dimension H based on thickness without flush holes. Refer to table "thickness with flush ports" for additional thickness.

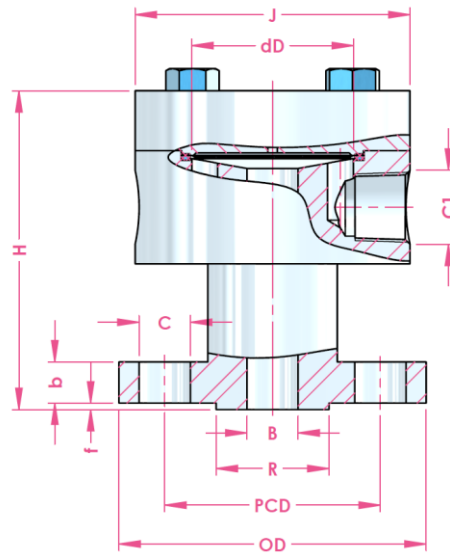
Dimensions table: EN 1092-1 B1 type



| size | rating | OD | J | B | b | R | f | H | PCD | C / pcs |
|------|----------|-------|------|------|------|-------|-------|-----------|-----------|-----------|
| DN15 | PN10-40 | 95.0 | 85.0 | 15.0 | 14.0 | 45.0 | 2.0 | 79.5 | 65.0 | 14.0 / 4x |
| | PN63-100 | 105.0 | | | 18.0 | | | 83.5 | | |
| DN20 | PN10-40 | 105.0 | | 20.0 | 16.0 | 58.0 | | 81.5 | 75.0 | |
| | PN63-100 | 130.0 | | | 20.0 | | | 94.9 | 90.0 | |
| DN25 | PN10-40 | 115.0 | | 25.0 | 16.0 | 68.0 | | 81.5 | 85.0 | 14.0 / 4x |
| | PN63-100 | 140.0 | | | 22.0 | | | 96.9 | 100.0 | 18.0 / 4x |
| DN32 | PN10-40 | 140.0 | | 32.0 | 16.0 | 78.0 | 90.9 | 100.0 | 18.0 / 4x | |
| | PN63-100 | 155.0 | | | 22.0 | | 106.2 | 110.0 | 22.0 / 4x | |
| DN40 | PN10-40 | 150.0 | | 40.0 | 16.0 | 88.0 | 89.9 | 110.0 | 18.0 / 4x | |
| | PN63-100 | 170.0 | | | 24.0 | | 87.2 | 125.0 | 22.0 / 4x | |
| | PN160 | 170.0 | | | 26.0 | | 89.2 | 125.0 | 22.0 / 4x | |
| DN50 | PN10-40 | 165.0 | | 47.0 | 18.0 | 102.0 | 75.9 | 125.0 | 18.0 / 4x | |
| | PN63 | 180.0 | 24.0 | | 87.2 | | 135.0 | 22.0 / 4x | | |
| | PN100 | 180.0 | 26.0 | | 94.5 | | 145.0 | 26.0 / 4x | | |
| | PN160 | 195.0 | 28.0 | | 96.5 | | 145.0 | 26.0 / 4x | | |

All dimensions in mm.
Dimension H based on thickness without flush holes. Refer to table "thickness with flush ports" for additional thickness.

Dimensions table: JIS 2220 B type



| size | rating | OD | B | b | R | f | H | PCD | C / pcs |
|------|--------|-------|------|------|------|-----|------|-------|-----------|
| NS10 | 10K | 90.0 | 12.7 | 11.0 | 46.0 | 1.0 | 80.0 | 65.0 | 15mm / 4x |
| | 16K | | | 13.0 | | | 82.0 | | |
| | 20K | | | 11.0 | | | 80.0 | | |
| NS15 | 10K | 95.0 | 16.1 | 11.0 | 51.0 | 1.0 | 80.0 | 70.0 | |
| | 16K | | | 13.0 | | | 82.0 | | |
| | 20K | | | 13.0 | | | 82.0 | | |
| NS20 | 10K | 100.0 | 21.6 | 13.0 | 56.0 | 1.0 | 82.0 | 75.0 | |
| | 16K | | | 15.0 | | | 84.0 | | |
| | 20K | | | 13.0 | | | 82.0 | | |
| NS25 | 10K | 125.0 | 27.6 | 13.0 | 67.0 | 1.0 | 91.3 | 90.0 | |
| | 16K | | | 15.0 | | | 93.3 | | |
| | 20K | | | 15.0 | | | 93.3 | | |
| NS32 | 10K | 135.0 | 35.7 | 15.0 | 76.0 | 2.0 | 93.3 | 100.0 | |
| | 16K | | | 17.0 | | | 95.3 | | |
| | 20K | | | 15.0 | | | 93.3 | | |
| NS40 | 10K | 140.0 | 41.6 | 15.0 | 81.0 | 2.0 | 93.3 | 105.0 | |
| | 16K | | | 17.0 | | | 95.3 | | |
| | 20K | | | 15.0 | | | 93.3 | | |
| NS50 | 10K | 155.0 | 47.0 | 15.0 | 96.0 | 2.0 | 93.3 | 120.0 | |
| | 16K | | | 17.0 | | | 95.3 | | |
| | 20K | | | 15.0 | | | 93.3 | | |

All dimensions in mm.

Dimension H based on thickness without flush holes. Refer to table "thickness with flush ports" for additional thickness.

Change log

| Date | Change |
|------------|---|
| 23-10-2020 | Bolt hole sizes C are changed due to incorrect dimensions |
| 17-11-2020 | Added RJF size table |
| | Update the H dimension and the thickness table for flush holes. |
| 8-3-2021 | Added tables for standards and roughness conversion |
| | Updated dimension tables to ASME B16.5:2020 |
| 5-5-2021 | Added JIS dimension table |

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