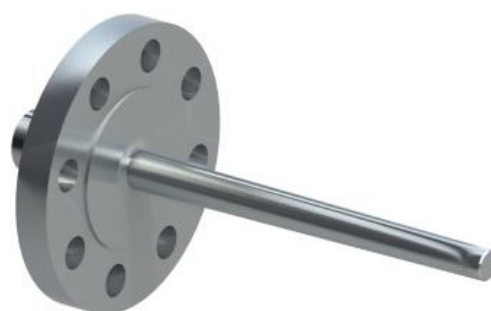


# Flanged thermowell bar stock design

## Design description

Badotherm thermowell model TW2x2 is a bar stock type thermowell with a flanged process connection. The construction is available with straight, stepped, or tapered stem. The standard material is AISI 316(L) and optionally various exotic materials are available. Thermowells are designed to protect the temperature gauge stem from corrosive effect, extreme pressure, or other process conditions. It also allows replacing the temperature instrument without disturbing the process.



## Wetted part materials

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

1: Solid machined version only

## Flange standard, size, rating and facings

ASME B16.5			
Size	Rating	Facing	Roughness
1" 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

EN 1092-1			
Size	Rating	Type	Roughness
DN20 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

## Bore sizes

Standard bore size	Fast response bore size <sup>1</sup>
6.5	6.2
8.5	8.2
10.5	10.2
12.5	12.2

1) in combination with matching stem (6, 8, 10, or 12mm)

## 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 thermowells seals are:

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

-> See datasheet “Polymer solutions”

## Polymer Lining

Straight version thermowell can be supplied with a PTFE sleeve. The wetted parts of the thermowell are covered with the sleeve with a minimum thickness of 1mm.

## 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, heat number of the stem and the manufacturers name to the flange for traceability purposes.

## Flanges and origin

The flanged 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 flanged thermowells are tested by means of an external pressure test of 1.5x the maximum allowed working pressure of the flange taking the material into account. The test media of with which the thermowell is pressure tested is water with a chloride level <30 ppm. Internal testing is optionally available.

## 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.

## Thermocal performance calculation

For critical applications it is recommended to perform a performance calculation for the thermowell. The in-house developed Wake Frequency Calculator “Thermocal” gives the result according to the calculations of the ASME PTC 19.3 TW-2016 including engineering recommendations when the thermowell exceeds the allowed stress.

## Dimensional limits

The ASME PTC 19.3 TW-2016 prescribes several limits. Outside these limits the WFC can not be generated. Thermowells outside restriction from below tables can be supplied without WFC calculation.

### Straight and tapered thermowells

Description	Symbol	Minimum	Maximum
Unsupported length	U	63.5	610
Bore diameter	d	6.2	12.2
Tip diameter	B	12.6	46.5
Taper ratio	B/A	0.6	1.0
Bore ratio	d/B	0.16	0.71
Minimum wall thickness	(B-d)/2	3	
Tip Thickness	t	3	

All dimensions in mm (except ratio)  
For tapered executions L>240 of max 240mm. Rest of stem is straight (L=240)

### Stepped thermowells

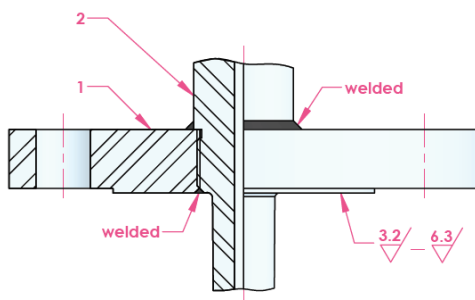
Description	Symbol	Minimum	Maximum
Unsupported length	U	127.0	610
Bore diameter	d	6.1	21.0
Step diameter ratio	B=12.70	0.5	0.8
	B=22.23	0.583	0.875
Length ratio	Ls/L	0	0.6
Minimum wall thickness	(B-d)/2	3	
Tip Thickness	t	3	

All dimensions in mm (except ratio)

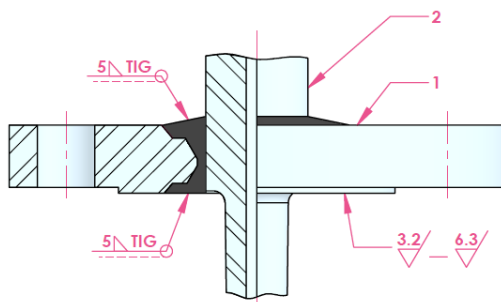
## Variants of construction

There are three variants of construction for the flange to the thermowell insert. The standard is a combination of a straight pipe thread welded on both the process side and the outside of the flange. The two options are a full penetration weld between well and flange, or a bar stock machined thermowell.

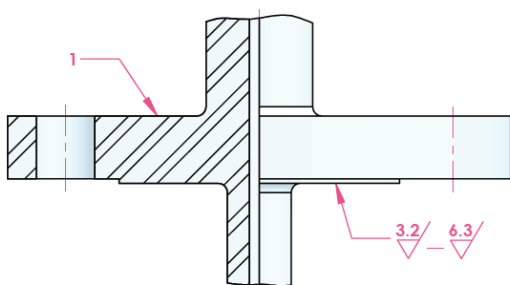
### Standard execution



### Penetration welded execution



### Solid machined execution



## 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
ASME PTC 19.3 TW - 2016	Performance Test Code on Thermowells

### Test Standards

Standard	Description
ASME B31.3	Process Piping

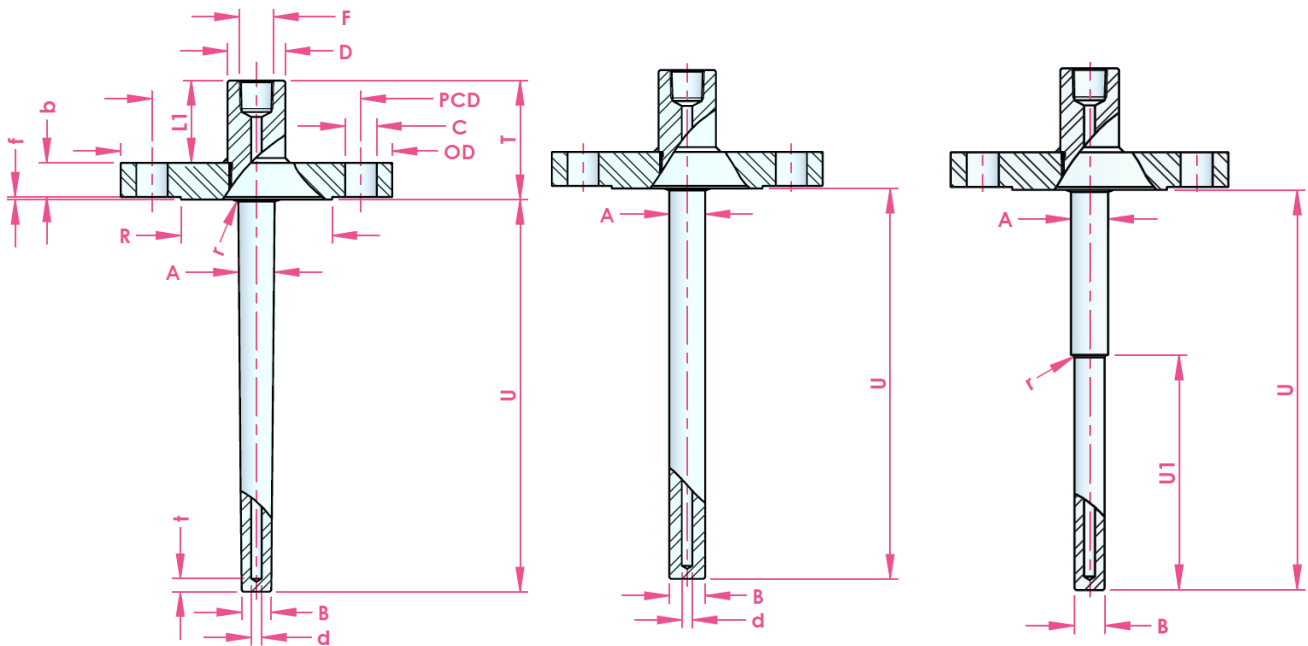
### Material Standards

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
ASME IX	Welding, Brazing, and Fusing Qualifications
ISO 15610	Specification and qualification of welding procedures for metallic materials

### Dimensions table: ASME 16.5 RF facing



	rating	OD	b	PCD	C / pcs	R	f	L1	T	D	t		
1"	cl. 150	110.0	14.7	79.4	15.9 / 4x	50.8	2.0	50	66.7	35	5.5		
	cl. 300	125.0	17.9	88.9	19.1 / 4x				69.9				
	cl. 400-600		24.5				81.5						
	cl. 900-1500	150.0	35.6	101.6	25.4 / 4x		7.0		92.6				
1.25"	cl. 150	115.0	17.9	88.9	15.9 / 4x	63.5	2.0		71.5			35	5.5
	cl. 300	135.0	19.5	98.4	19.1 / 4x				71.5				
	cl. 400-600		27.7				84.7						
	cl. 900-1500	160.0	35.6	111.1	25.4 / 4x		7.0		92.6				
1.5"	cl. 150	125.0	17.9	98.4	15.9 / 4x	73.0	2.0	69.9	35	5.5			
	cl. 300	155.0	21.1	114.3	22.3 / 4x			73.1					
	cl. 400-600		29.3				86.3						
	cl. 900-1500	180.0	38.8	123.8	28.6 / 4x		7.0	95.9					
2"	cl. 2500	205.0	51.5	146.0	31.8 / 4x	91.9	2.0	108.5			35	5.5	
	cl. 150	150.0	19.5	120.7	19.1 / 4x			71.5					
	cl. 300	165.0	22.7	127.0	19.1 / 8x		74.7						
	cl. 400-600		32.4				89.4						
3"	cl. 900-1500	215.0	45.1	165.1	25.4 / 8x	127.0	7.0	102.1	35	5.5			
	cl. 2500	235.0	57.9	171.4	28.6 / 8x			114.9					
	cl. 150	190.0	24.3	152.4	19.1 / 4x		2.0	76.3					
	cl. 300	210.0	29.0	168.3	22.3 / 8x			81.0					
cl. 400-600	38.8		95.8										
4"	cl. 900	240.0	45.1	190.5	25.4 / 8x	157.2	7.0	102.1			35	5.5	
	cl. 1500	265.0	54.7	203.2	31.9 / 8x			111.7					
	cl. 2500	305.0	73.7	228.6	35.0 / 8x		130.7						
	cl. 150	230.0	24.3	190.5	19.1 / 8x		2.0	76.3					
	cl. 300	255.0	32.2	200.0	22.3 / 8x	84.2							
	cl. 400		42.0			99.0							
	cl. 600	275.0	45.1	215.9	25.5 / 8x	7.0	102.1						
	cl. 900	290.0	51.5	235.0	31.8 / 8x		108.5						
cl. 1500	310.0	61.0	241.3	34.9 / 8x	118.0								
cl. 2500	355.0	83.2	273.0	41.3 / 8x	140.2								

All dimensions in mm, weight in kg

size	rating	OD	b	PCD	C / pcs	R	f	L1	T	D	t	Max A
DN20	PN10-40	105.0	18.0	75.0	14.0 / 4x	58.0	2.0	50.0	70.0	35	5.5	28
	PN63-100	130.0	22.0	90.0	18.0 / 4x				74.0			
DN25	PN10-40	115.0	18.0	85.0	14.0 / 4x	68.0	2.0		70.0			33
	PN63-100	140.0	24.0	100.0	18.0 / 4x				76.0			
	PN160								80.0			
	PN250	150.0	28.0	105.0	22.0 / 4x				86.0			
	PN320	160.0	34.0	115.0					90.0			
PN400	180.0	38.0	130.0	26.0 / 4x		70.0						
DN32	PN10-40	140.0	18.0	100.0	18.0 / 4x	78.0	2.0		76.0			43
	PN63-100	155.0	24.0	110.0	22.0 / 4x				71.0			
DN40	PN10-40	150.0	18.0		125.0	18.0 / 4x	88.0		3.0			79.0
	PN63-100	170.0	26.0	22.0 / 4x		81.0						
	PN160		28.0	26.0 / 4x	87.0							
	PN250	185.0	34.0		135.0	91.0						
	PN320	195.0	38.0	145.0	101.0							
	PN400	220.0	48.0	165.0	30.0 / 4x	730.0						
DN50	PN10-40	165.0	20.0	125.0	18.0 / 4x	102.0	3.0	79.0				
	PN63	180.0	26.0	135.0	22.0 / 4x			81.0				
	PN100	195.0	28.0	145.0	26.0 / 4x			83.0				
	PN160		30.0					26.0 / 8x	91.0			
	PN250	200.0	38.0	150.0	95.0							
PN320	210.0	42.0	160.0	30.0 / 8x	105.0							
DN80	PN10-40	200.0	24.0	160.0	18.0 / 8x	138.0	3.0	77.0				
	PN63	215.0	28.0	170.0	22.0 / 8x			81.0				
	PN100	230.0	32.0	180.0	26.0 / 8x			85.0				
	PN160	230.0	36.0					89.0				
	PN250	255.0	46.0	200.0	30.0 / 8x			99.0				
	PN320	275.0	55.0	220.0				108.0				
PN400	305.0	68.0	240.0	33.0 / 8x	121.0							
DN100	PN10-16	220.0	20.0	180.0	18.0 / 8x	158.0	3.0	73.0				
	PN25-40	235.0	24.0	190.0	22.0 / 8x	162.0		77.0				
	PN63	250.0	30.0	200.0	26.0 / 8x			83.0				
	PN100	265.0	36.0	210.0	30.0 / 8x			89.0				
	PN160		40.0					93.0				
	PN250	300.0	54.0	235.0	33.0 / 8x			107.0				
	PN320	335.0	65.0	265.0	36.0 / 8x			118.0				
PN400	370.0	80.0	295.0	39.0 / 8x	133.0							

Max A size is based on the EN 1514 kammprofil gasket minus 3mm.

## ASME Thermowell selection

Selection	Suffix	Description	
Thermowell type	BDTW212	Straight stem - Flanged bar stock thermowell	
	BDTW222	Stepped stem - Flanged bar stock thermowell	
	BDTW232	Tapered stem - Flanged bar stock thermowell	
Flange standard	A	ASME B16.5 sizing	
Size	02	1"	
	04	1.5"	
	05	2"	
	08	3"	
	10	4"	
Class	A1	cl. 150	
	A2	cl. 300	
	A3	cl. 400 <sup>*1</sup>	
	A4	cl. 600	
	A5	cl. 900 <sup>*1</sup>	
	A6	cl. 1500	
	A7	cl. 2500	
Facing type	RF	Raised Face ◀	
	RJF	Ring Joint Face	
	LMF	Large Male Face	
	SMF	Small Male Face	
	FF	Flat Face	
	LTF	Large Tongue Face	
	STF	Small Tongue Face	
	LGF	Large Groove Face	
	SGF	Small Groove Face	
	LFF	Large Female Face	
	SFF	Small Female Face	
Instrument connection	N12F	½" NPT female	
	M20F	M20 female	
	G12F	G ½" female	
Insertion length	U...	U length followed by U length in mm	
	U#...mm	U1 length for stepped executions only	
Bore diameter	B62	6.2mm	
	B65	6.5mm	
	B82	8.2mm	
	B85	8.5mm	
	B85	8.5mm	
	B02	10.2mm	
	B05	10.5mm	
	B12	12.2mm	
	B15	12.5mm	
		Bore diameter may be selected in all dimensions. Please check if the ratio's for wall thickness and bore ratio are in line with the tables for dimensional limits.	
Root diameter	...mm	Diameter of the thermowell on the root of the thermowell	
Tip diameter	...mm	Diameter of the thermowell on the tip of the thermowell	
Radius at root	R3 R..	3mm default radius from root to facing of the flange R followed by customized root in mm.	
Material selection of wetted parts	S316	AISI 316(L)	S31600/S31603
	S304	AISI 304L	S30403
	S310	AISI 310 MoLn	S31050
	U316	AISI 316 UG	S31603 (mod)
	S321	AISI 321	S32100
	S904	AISI 904(L)	S08904
	A020	Alloy 20	S 08020
	A400	Alloy 400	S04400
	A600	Alloy 600	S06600
	A625	Alloy 625	S06625
	A825	Alloy 825	S08825
	AB02	Alloy B2	S10665
	AC22	Alloy C-22	S06022
	A276	Alloy C-276	S10276
	DF44	Duplex F44	S31254
	DF51	Duplex F51/F60	S31803/S32205
	DF53	Duplex F53	S32750
DF55	Duplex F55	S32760	
N201	Nickel 201	N02201	
TG02	Titanium Gr. 2 <sup>*2</sup>	S R50400	
Z702	Zirconium 702 <sup>*2</sup>	S R60702	

\*1: For size ≥3"

\*2: solid machined bar stock execution only. Optionally the Lap Joint (Van Stone) execution.

## EN Thermowell selection

Selection	Suffix	Description	
Thermowell type	BDTW212	Straight stem - Flanged bar stock thermowell	
	BDTW222	Stepped stem - Flanged bar stock thermowell	
	BDTW232	Tapered stem - Flanged bar stock thermowell	
Flange standard	E	EN 1092-1	
Size	23	DN25	
	26	DN40	
	27	DN50	
	29	DN80	
	30	DN100	
Class	D4	PN10-40	
	D5	PN63	
	D6	PN100	
	D7	PN250	
	D8	PN400	
Facing type	A	Flat face	
	B1	Raised face standard finish ◀	
	B2	Raised face smooth finish	
	C	Tongue	
	D	Groove	
	E	Spigot	
F	Recess		
Instrument connection	N12F	½" NPT female	
	M20F	M20 female	
	G12F	G1/2 female	
Insertion length	U...	U length followed by U length in mm	
	U#...mm	U1 length for stepped executions only	
Bore diameter	B62	6.2mm	
	B65	6.5mm	
	B66	6.6mm	
	B70	7.0mm	
	B80	8.0mm	
	B85	8.5mm	
	B90	9.0mm	
	B10	10.0mm	
	B05	10.5mm	
	B11	11.0mm	
	B12	12.0mm	
	B25	12.5mm	
Bore diameter may be selected in all dimensions. Please check if the ratio's for wall thickness and bore ratio are in line with the tables for dimensional limits.			
Root diameter	...mm	Diameter of the thermowell on the root of the thermowell	
Tip diameter	...mm	Diameter of the thermowell on the tip of the thermowell	
Radius at root	R3	3mm default radius from root to facing of the flange	
	R..	R followed by customized root in mm.	
Material selection of wetted parts	S316	AISI 316(L)	S31600/S31603
	S304	AISI 304L	S30403
	S310	AISI 310 MoLn	S31050
	U316	AISI 316 UG	S31603 (mod)
	S321	AISI 321	S32100
	S904	AISI 904(L)	S08904
	A020	Alloy 20	S 08020
	A400	Alloy 400	S04400
	A600	Alloy 600	S06600
	A625	Alloy 625	S06625
	A825	Alloy 825	S08825
	AB02	Alloy B2	S10665
	AC22	Alloy C-22	S06022
	A276	Alloy C-276	S10276
	DF44	Duplex F44	S31254
	DF51	Duplex F51/F60	S31803/S32205
	DF53	Duplex F53	S32750
	DF55	Duplex F55	S32760
N201	Nickel 201	N02201	
TG02	Titanium Gr. 2 <sup>*2</sup>	S R50400	
Z702	Zirconium 702 <sup>*2</sup>	S R60702	

\*1: For size ≥3"

\*2: solid machined bar stock execution only. Optionally the Lap Joint (Van Stone) execution.

## option selection

Options		
Accessory	PCH	Plug and chain mounted to the thermowell
Coating and treatments	K1	Cleaned from oil and grease
	CPTS	PTFE Coating of $\pm 30\mu\text{m}$ thickness
	CPTT	PTFE Coating of $\pm 80\mu\text{m}$ thickness
	CPFS	PFA Coating $\pm 35\mu\text{m}$ thickness
	CPFS	PFA Coating $\pm 90\mu\text{m}$ thickness
	CHAL	ECTFE Coating $\pm 600\mu\text{m}$ thickness
	CFEP	FEP Coating $\pm 35\mu\text{m}$ thickness
Certificates and testing <sup>6</sup>	N75	2.1 NACE ISO 15156 (MR 01 75)
	LTPA	2.1 Static pressure leak test certificate acc ASME B16.5 (1.5 x MWP) <sup>5</sup>
	LTCE	2.1 Static pressure leak test certificate acc PED 2014/68/EU (1.43 x MWP) <sup>5</sup>
	PT1	2.1 Penetrant test certificate level 1 acc ISO 9712
	PT2	2.2 Penetrant test certificate level 2 acc ISO 9712
	PMI	2.2 Positive Material Identification
	WPS	2.2 Welding documents (WPS/PQR)
	IC32	3.2 Material certificate on materials
Special options	RD	Rush Delivery
	EU	European Origen materials

<sup>5</sup>:MWP is limited by flange rating, MWP pressure instrument, and MWP seal construction. Lowest value is used in order to prevent permanent damage.

<sup>6</sup>: Test report and 3.1 certificate on wetted parts is standard part of supply.

## Order related options

Options on complete order		
Certificates and testing	PMI	2.2 Positive Material Identification
	3PI	Third party inspection of goods
Packing	SW	Seaworthy packing



## Change log

Date	Change

Holland – Romania – India – Thailand – Dubai – USA

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