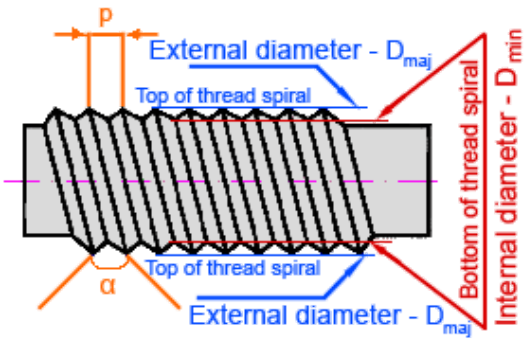
The thread

A **screw thread** is a helical structure wrapped around a cylindrical or cone. In case of screws this surface is external, and in case of nuts it is internal. There is a particular case when the sprial thread is disposed on a flat surface. Geometrically speaking, the thread can be generated by a square, triangular, trapezoidal or semi-circle figure, which has a spiral motion around the axis of the surface of rotation.



p = pitch of thread
α (alpha) = angle of thread

External thread carried on a cylindrical surface

The helical part described by a point on the surface line making a complete rotation is called spiral. The pitch (**p**) of the helical (thread) is the distance between two spirals which are measured on the same surface line. The thread angle **α (alpha)**, is the angle between the flanks and is the same with the inclination angle of the helical. Dmin is the diameter of the bottom of the thread and Dmaj is the external diameter of the thread which is measured at the peak tangential. At a 360 ° rotation, a spiral is gone through, and the screw or nut is moving forward or backward along the axis with a distance equal to the length of pitch p.

Thread classification

Thread classification is made taking the following characteristics in consideration:

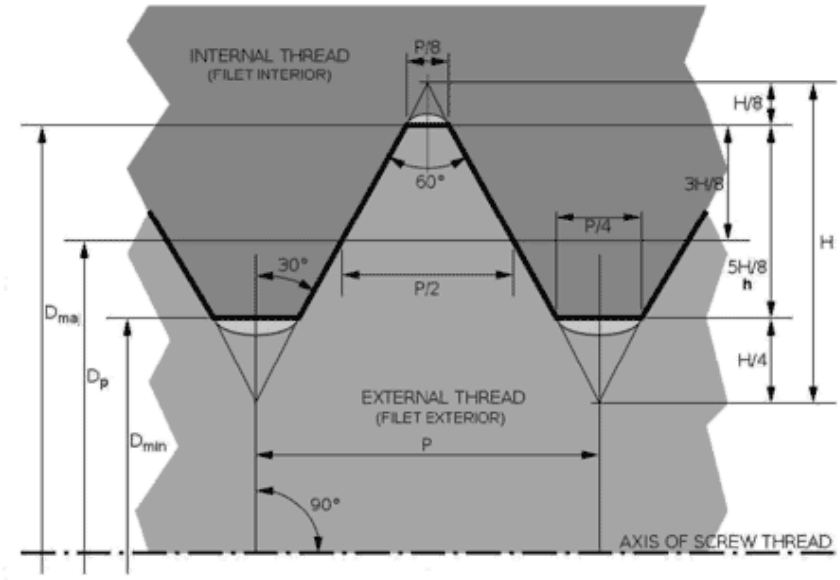
- after the thread profile: triangular, square, trapezoidal, saw, rectangular, round
- after the revolution surface on which is achieved: cylindrical or taper
- after the number of beginnings: one start point(simple thread), several start points (multiple thread)
- after the measuring unit: metric thread (mm), imperial thread (inch)

Types of threads

ISO Metric Thread (M)	**National Pipe Taper Thread (NPT)**
UNIFIED Thread (UN)	**ACME Thread**
British Association Thread (BA)	**STUB ACME Thread**
British Standard Cycle Thread (BSC)	**Buttress Thread (BUTT)**
Whitworth (W) and BSW Thread	**Round Thread (Rd)**
Gas Thread (G)	**Panzer-Gewinde Thread (PG)**

1. The ISO Metric Thread (M) - ISO 723-1993, ISO 965/1-1998, STAS 6371-73, STAS 510-74, STAS 981-74

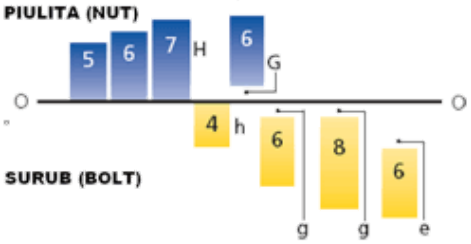
The metric thread is the most common type of thread around the world, used for joining various components. This was one of the first international standards agreed when the International Organization for Standardization (ISO) was set up in 1947.



- P: Pitch
- H: Thread height
- h: Thread depth
- Dmaj: Major diameter (the largest diameter of the screw)
- Dmin: Minor diameter (the smallest diameter of the screw, Dmin= Dmaj – 2xh)
- Dp: Effective pitch diameter (the thread diameter where the thickness is equal to the space between the spirals, Dp = Dmaj – h)

Metric thread properties:
- thread angle: 60°;
- H = 0.866025 x P;

Metric thread classes:



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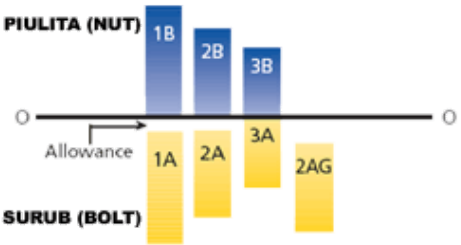
2. The UNIFIED Thread (UN) - ANSI B1.1-1982
- UNC (coarse pitch) de la 1/4" la 4" dia.
- UNF (fine pitch) de la 1/4" la 11/2" dia.
- UNEF (extra fine pitch) de la 1/4" la 111/16" dia.
- UNS (unified national special)
- UN (constant pitch) pentru 4,6,8,12,16,20,28, 32 TPI

The UNIFIED thread has the same 60° profile as the ISO metric screw thread but the characteristic dimensions of each UTS thread (Unified Thread Standard) were chosen in inch fraction rather than a round millimeter value. The UTS thread is most commonly used in USA and Canada.

UN thread properties:
- thread angle: 60°;
- H = 0.866025 x P;

UN thread classes:



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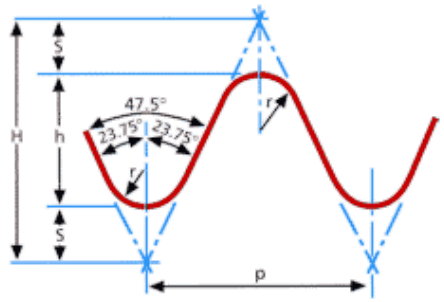
3. Filetul BA (British Association) - BS 93: 1951

The BA thread was formulated in 1884 and standardised in 1903 (England) with the use in electrical fittings and accessories. It is slowly being replaced by the ISO metric thread and now is mainly used for fine threaded connections especially in instruments.

BA thread properties:
- thread angle: 47.5°
- H = 1.13634 x p
- h = 0.60000 x p
- r = 0.18083 x p
- s = 0.26817 x p



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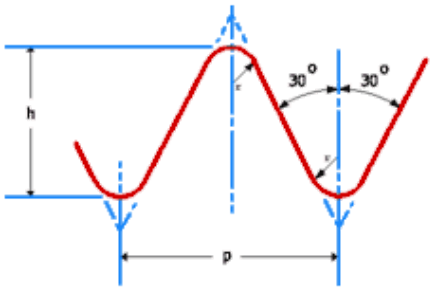
4. The BSC thread (British Standard Cycle)

- BSC (BSCy) - British Standard Cycle
- CEI - Cycle Engineers Institute - replaced by BSC

The BSC thread is a fine thread well suited to cycle and motorcycle applications because it allows high torque settings and resists the tendancy to loosen under vibration. Also, the larger core diameter gives greater shear strength. The most popular sizes are with a pitch of 26 TPI although other pitches are also possible 24, 32 and 40 TPI.



BSC thread properties:

- thread angle: 60°
- h = 0.5327 x p
- r = P/6

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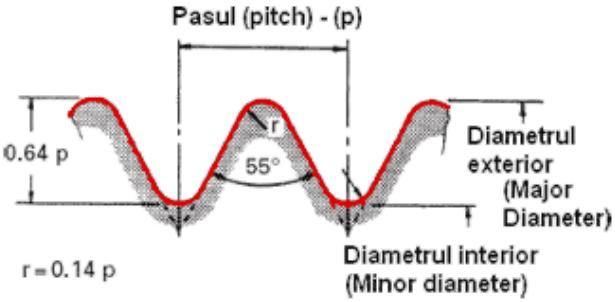
5. Whitworth (W) and British Standard Whitworth (BSW) thread

- W - Whitworth
- BSW – British Standard Whitworth
- BSF - British Standard Fine
- BSC - British Standard Cycle - used for motorcycles because of high torque and vibration resitance

The Whitworth thread is used especially in USA and England, being devised by Sir Joseph Whitworth in 1841. It is marked with the letter 'W' followed by a number expressed as a fraction: W 1 1/2". This means that the diameter is expressed in inches and the pitch in number of threads per inch (TPI) - 1 inch = 25.4 mm. Because of the more inclined flank angle, it loosens much more difficult under vibrations.



Whitworth thread properties:

- thread angle: 55°
- H = 0.960491 x p
- h = 0.640327 x p
- r = 0.137329 x p

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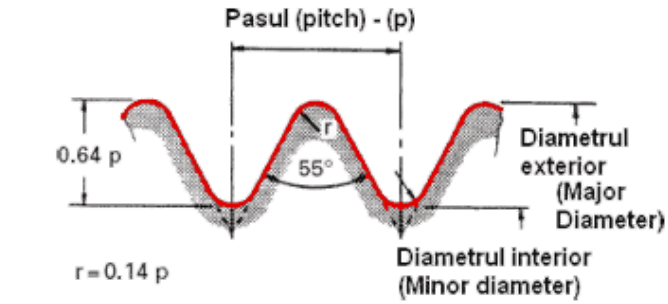
6. The Gas thread (G) - ISO-228 Part I-1996 (E)

- BSPP (G) - British Standard Pipe Parallel Thread
- BSPF - British Standard Pipe Fastening Thread
- BSPT – British Standard Pipe Taper Thread

The Gas thread (G) is a straight thread used for interconnecting pipes, also known in the trade as BSPP, NPS or G. It is technically a Whitworth thread which is actually a British Standard Pipe Parallel (BSPP) thread known as "G". Per the ISO standard, the proper designation is "G" in front of the fraction.

Whitworth thread properties:

- thread angle: 55°
- H = 0.960491 x p
- h = 0.640327 x p
- r = 0.137329 x p



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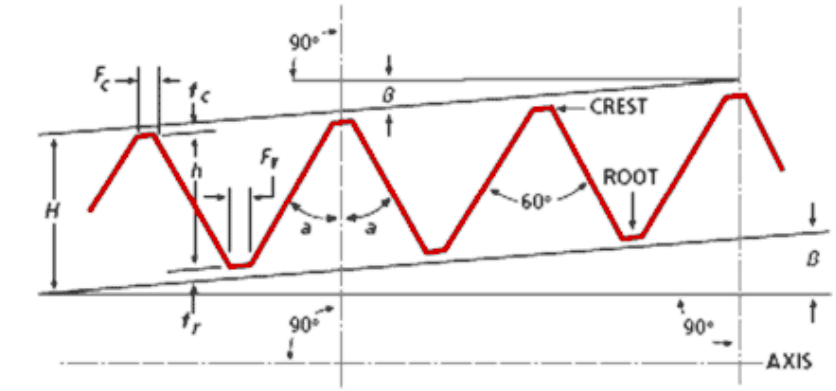
7. The National Pipe Thread Taper (NPT) thread - ANSI/ASME B1.20.1-1993

- NPT – National Pipe Thread Taper
- FPT – female (internal) National Pipe Taper threads
- MPT – male (external) National Pipe Taper threads
- PTF – SAE short tape pipe thread
- NPTF – Dryseal American National Standard Taper Pipe Thread (ANSI B1.20.3)
- NPSM – American National straight pipe thread for mechanical joints
- NPSI – American National straight intermediate pipe thread
- NPSF – American Standard National Pipe Straight Fuel (Dryseal)
- NPSL – American Standard Straight Locknut Pipe Thread

The NPT thread is a U.S. standard for tapered threads used on threaded pipes and fittings. The ANSI/ASME B.1.20.1 standard includes thread angles of 60° and sizes from 1/16" to 24" nominal pipe diameter.



- H = 0.866025p = height of 60° sharp V thread
- h = 0.800000p = height of thread on product
- p = 1/n = pitch (measured parallel to axis)
- n = number of threads per inch
- a = 30° = thread flank angle
- β = 1° 47' = thread taper angle for 1/16 taper
- fc = depth of truncation at crest
- fr = depth of truncation at root
- Fc = width of flat at crest
- Fr = width of flat at root

NPT thread properties:

- tapered thread 1° 47'
- truncation of roots and crests are flat
- thread angle: 60°
- pitch is measured in threads per inch (TPI)

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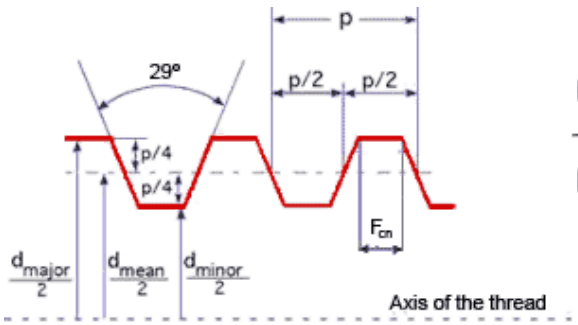
8. The ACME thread - ANSI/ASME B1.5

The ACME thread is a parallel thread most commonly used for transversal motion on industrial machines. The trapezoidal thread form provide high strength and ease of manufacture. The ACME thread is similar to the trapezoidal thread, the only difference being the reference system (ACME - imperial and Trapezoidal - metric 30°).



ACME thread properties:

- thread angle: 29°
- H = 1.93335 x p
- h = p/2
- Fcn = 0.3707 x p

'G' is the most commonly used tolerance class. Many times class 'C' is also used as per designer's requirement. '3G' class is used for general purpose assemblies while classes above 3 have progressively closer tolerances.

2G class = $0.030\sqrt{P} + 0.006\sqrt{D}$
3G class = $0.014\sqrt{P} + 0.0028\sqrt{D}$
4G class = $0.010\sqrt{P} + 0.002\sqrt{D}$

D = major diameter
P = pitch

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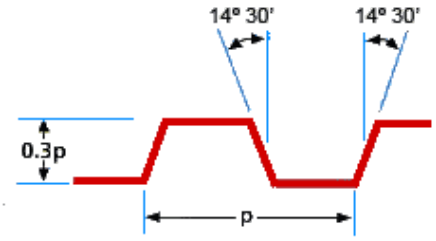
9. The STUB ACME thread - ANSI/ASME B1.8

The STUB ACME thread came into being early in the 1900's and it's use has been generally confined to those unusual applications where a coarse-pitch thread of shallow depth is required.



STUB ACME thread properties:
- thread angle: 29°
- H = 1.93335 x p
- h = 0.3 x p
- Fcn = 0.4224 x p

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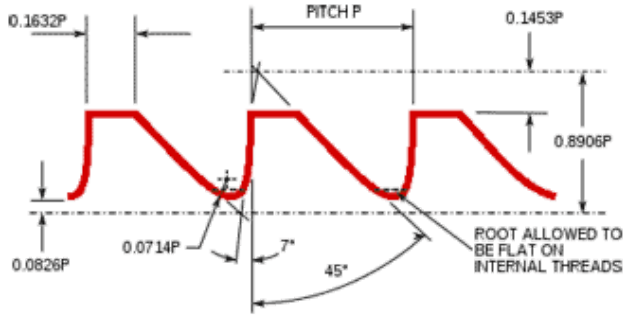
10. The BUTTRESS thread - ANSI B1.9 - 1973

The BUTTRESS thread has a saw tooth shaped profile and is basically used on transversal motion of industrial machines, hydraulic sealings (oil fields) or gun barrels so that it can withstand recoiled impact.



BUTTRESS thread profile:
- thread angle: 7°/45°
- H = 0.89064 x p
- h = 0.6627 x p
- Fcn = 0.1632 x p

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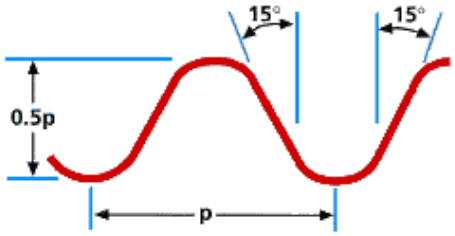
11. The round thread (Knuckle - Rd) - DIN 405, DIN 15403, DIN 20400

The round thread (Rd) is insensitive to dirt and damage due to the round profile and is used on clutches, train braking systems and gate valves.



Round thread properties:
- thread ange: 30°
- h = 0.5 x p

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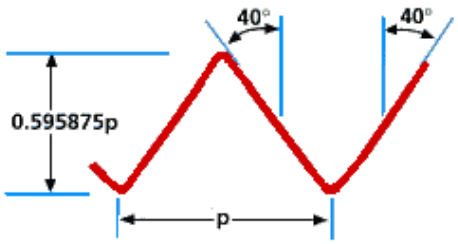
12. The PG thread (Panzer-Gewinde) - DIN 40430-1971 & DIN 40431-1972

The PG thread - is a thread as per German standards used mainly for electrical connections instead of the B.S. Conduit thread. The depth of the thread is smaller than NPT or Metric but larger flank angle.



PG thread properties:
- thread angle: 80°
- h = 0.595875 x p

Standard PG Steel Conduit sizes per DIN 40430:
- Pg7: Dmaj = 12.5mm; TPI = 20
- Pg9: Dmaj = 15.2mm; TPI = 18
- Pg11: Dmaj = 18.6mm; TPI = 18
- Pg13.5: Dmaj = 20.4mm; TPI = 18
- Pg16: Dmaj = 22.5mm; TPI = 18
- Pg21: Dmaj = 28.3mm; TPI = 16
- Pg29: Dmaj = 37mm; TPI = 16
- Pg36: Dmaj = 47mm; TPI = 16
- Pg42: Dmaj = 54mm; TPI = 16
- Pg48: Dmaj = 59.3mm; TPI = 16

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Tapping size holes for thread cutting

ISO METRIC threads - DIN 336

Thread type x Pitch [mm]	Hole size [mm]	Internal thread diam. (Dmin) min. [mm]	Internal thread diam. (Dmin) max. [mm]	Thread type x Pitch [mm]	Hole size [mm]	Internal thread diam. (Dmin) min. [mm]	Internal thread diam. (Dmin) max. [mm]
M1 x 0.25	0.75	0.729	-	M11 x 1.50	9.50	9.376	9.676
M1.1 x 0.25	0.85	0.829	-	M12 x 1.75	10.20	10.106	10.441
M1.2 x 0.25	0.95	0.929	-	M14 x 2.00	12.00	11.835	12.210
M1.3 x 0.30	1.10	1.075	-	M16 x 2.00	14.00	13.835	14.210
M1.6 x 0.35	1.25	1.221	1.321	M18 x 2.50	15.50	15.294	15.744
M1.8 x 0.35	1.45	1.421	1.521	M20 x 2.50	17.50	17.294	17.744
M2 x 0.40	1.60	1.567	1.679	M22 x 2.50	19.50	19.294	19.744
M2.2 x 0.45	1.75	1.713	1.838	M24 x 3.00	21.00	20.752	21.252
M2.5 x 0.45	2.05	2.013	2.138	M27 x 3.00	24.00	23.752	24.252
M3 x 0.50	2.50	2.459	2.599	M30 x 3.50	26.50	26.211	26.771
M3.5 x 0.60	2.90	2.850	3.010	M33 x 3.50	29.50	29.211	29.771
M4 x 0.70	3.30	3.242	3.422	M36 x 4.00	32.00	31.670	32.270
M4.5 x 0.75	3.70	3.688	3.878	M39 x 4.00	35.00	34.670	35.270
M5 x 0.80	4.20	4.134	4.334	M42 x 4.50	37.50	37.129	37.799
M6 x 1.00	5.00	4.917	5.153	M45 x 4.50	40.50	40.129	40.799
M7 x 1.00	6.00	5.917	6.153	M48 x 5.00	43.00	42.587	43.297
M8 x 1.25	6.80	6.647	6.912	M52 x 5.00	47.00	46.587	47.287
M9 x 1.25	7.80	7.647	7.912	M56 x 5.50	50.50	50.046	50.796
M10 x 1.50	8.50	8.376	8.676				

ISO METRIC FINE threads - DIN 336

Thread type x Pitch [mm]	Hole size [mm]	Internal thread diam. (Dmin) min. [mm]	Internal thread diam. (Dmin) max. [mm]	Thread type x Pitch [mm]	Hole size [mm]	Internal thread diam. (Dmin) min. [mm]	Internal thread diam. (Dmin) max. [mm]
MF2.5 x 0.35	2.15	2.121	2.221	MF18 x 1.00	17.00	16.917	17.153
MF3.0 x 0.35	2.65	2.621	2.721	MF18 x 1.50	16.50	16.376	16.676
MF3.5 x 0.35	3.15	3.121	3.221	MF18 x 2.00	16.00	15.835	16.210
MF4.0 x 0.50	3.50	3.459	3.599	MF20 x 1.00	19.00	18.917	19.153
MF4.5 x 0.50	4.00	3.959	4.099	MF20 x 1.50	18.50	18.376	18.676
MF5.0 x 0.50	4.50	4.459	4.599	MF20 x 2.00	18.00	17.835	18.210
MF5.5 x 0.50	5.00	4.959	5.099	MF22 x 1.00	21.00	20.917	21.153
MF6.0 x 0.75	5.20	5.188	5.378	MF22 x 1.50	20.50	20.376	20.676
MF7.0 x 0.75	6.20	6.188	6.378	MF22 x 2.00	20.00	19.835	20.210
MF8.0 x 0.50	7.50	7.459	7.599	MF24 x 1.00	23.00	22.917	23.153
MF8.0 x 0.75	7.20	7.188	7.378	MF24 x 1.50	22.50	22.376	22.676
MF8.0 x 1.00	7.00	6.917	7.153	MF24 x 2.00	22.00	21.835	22.210
MF9.0 x 0.75	8.20	8.188	8.378	MF25 x 1.00	24.00	23.917	24.153
MF9.0 x 1.00	8.00	7.917	8.153	MF25 x 1.50	23.50	23.376	23.676
MF10 x 0.75	9.20	9.188	9.378	MF25 x 2.00	23.00	22.835	23.210
MF10 x 1.00	9.00	8.917	9.153	MF27 x 1.00	26.00	25.917	26.153
MF10 x 1.25	8.80	8.647	8.912	MF27 x 1.50	25.50	25.376	25.676
MF11 x 0.75	10.20	10.188	10.378	MF27 x 2.00	25.00	24.835	25.210
MF11 x 1.00	10.00	9.917	10.153	MF28 x 1.00	27.00	26.917	27.153
MF12 x 1.00	11.00	10.917	11.153	MF28 x 1.50	26.50	26.376	26.676
MF12 x 1.25	10.80	10.647	10.912	MF28 x 2.00	26.00	25.853	26.210
MF12 x 1.50	10.50	10.376	10.676	MF30 x 1.00	29.00	28.917	29.153
MF14 x 1.00	13.00	12.917	13.153	MF30 x 1.50	28.50	26.376	28.676
MF14 x 1.25	12.80	12.647	12.912	MF30 x 2.00	28.00	27.835	28.210
MF14 x 1.50	12.50	12.376	12.676	MF30 x 3.00	27.00	26.752	27.252
MF15 x 1.00	14.00	13.917	14.153	MF32 x 1.50	30.50	30.376	30.676
MF15 x 1.50	13.50	13.376	13.676	MF32 x 2.00	30.00	29.835	30.210

MF16 x 1.00	15.00	14.197	15.153	MF33 x 1.50	31.50	31.376	31.676
MF16 x 1.25	14.75	14.647	14.912	MF33 x 2.00	31.00	30.835	31.210
MF16 x 1.50	14.50	14.376	14.676	MF33 x 3.00	30.00	29.752	30.252
MF17 x 1.00	16.00	15.917	16.153	MF35 x 1.50	33.50	33.376	33.676
MF17 x 1.50	15.50	15.376	15.676	MF36 x 1.50	34.50	34.376	34.676

UNIFIED threads - DIN 336 (ISO 5864)

Thread size - TPI (threads/inch)	Hole size [mm]	Internal thread diam. (Dmin) min. [mm]	Internal thread diam. (Dmin) max. [mm]	Thread size - TPI (threads/inch)	Hole size [mm]	Internal thread diam. (Dmin) min. [mm]	Internal thread diam. (Dmin) max. [mm]
Nr. 1 - 64 UNC	1.50	1.425	1.582	7/16" - 14 UNC	9.40	9.149	9.550
Nr. 1 - 72 UNF	1.55	1.473	1.613	7/16" - 20 UNF	9.90	9.739	10.030
Nr. 2 - 56 UNC	1.85	1.694	1.872	1/2" - 13 UNC	10.80	10.584	11.013
Nr. 2 - 64 UNF	1.90	1.755	1.913	1/2" - 20 UNF	11.50	11.326	11.618
Nr. 3 - 48 UNC	2.10	1.941	2.146	9/16" - 12 UNC	12.20	11.996	12.456
Nr. 3 - 56 UNF	2.15	2.024	2.197	9/16" - 18 UNF	12.90	12.761	13.084
Nr. 4 - 40 UNC	2.35	2.385	2.156	5/8" - 11 UNC	13.50	13.376	13.868
Nr. 4 - 48 UNF	2.40	2.271	2.459	5/8" - 18 UNF	14.50	14.348	14.671
Nr. 5 - 40 UNC	2.65	2.697	2.487	3/4" - 10 UNC	16.50	16.299	16.833
Nr. 5 - 44 UNF	2.70	2.550	2.741	3/4" - 16 UNF	17.50	17.330	17.689
Nr. 6 - 32 UNC	2.85	2.642	2.896	7/8" - 9 UNC	19.50	19.169	19.748
Nr. 6 - 40 UNF	2.95	2.819	3.023	7/8" - 14 UNF	20.40	20.262	20.663
Nr. 8 - 32 UNC	3.50	3.302	3.531	1" - 8 UNC	22.25	21.963	22.598
Nr. 8 - 36 UNF	3.50	3.404	3.607	1" - 12 UNF	23.25	23.109	23.569
Nr. 10 - 24 UNC	3.90	3.683	3.962	1.1/8" - 7 UNC	25.00	24.648	25.349
Nr. 10 - 32 UNF	4.10	3.962	4.166	1.1/8" - 12 UNF	26.50	26.284	26.744
Nr. 12 - 24 UNC	4.50	4.343	4.597	1.1/4" - 7 UNC	28.00	27.823	28.524
Nr. 12 - 28 UNF	4.70	4.496	4.724	1.1/4" - 12 UNF	29.50	29.459	29.919
1/4" - 20 UNC	5.10	4.976	5.268	1.3/8" - 6 UNC	30.75	30.343	31.120
1/4" - 28 UNF	5.50	5.367	5.580	1.3/8" - 12 UNF	32.75	32.634	33.094
5/16" - 18 UNC	6.60	6.411	6.734	1.1/2" - 6 UNC	34.00	33.518	34.295
5/16" - 24 UNF	6.90	6.792	7.038	1.1/2" - 12 UNF	36.00	35.809	36.269
3/8" - 16 UNC	8.00	7.805	8.164	1.3/4" - 5 UNC	39.50	38.951	39.814
3/8" - 24 UNF	8.50	8.379	8.626	2" - 4.5 UNC	45.00	44.689	45.598

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