

► A SUPERIOR WAY TO FASTEN ROTATING COMPONENTS:

Excelling because of its simplicity, it contains all structural features in only two parts. This new development is the Shaftloc® - a patented device (United States Patent No. 5,067,846), - manufactured and marketed exclusively by SDP/SI.

► SHAFTLOC® HAS ONLY TWO PARTS:

A slotted outer sleeve and a slotted inner sleeve, both of which have hexagonal heads. The outer sleeve is cylindrical on its outside diameter, and threaded on its inside diameter. Conversely, the inner sleeve is threaded on its outside diameter, and cylindrical on its inside diameter. The thread is unique in that it is not symmetrical and that it creates a continuous inclined surface.

► HOW SHAFTLOC® WORKS:

The shallow angle of the thread produces large amplifications of forces, resulting in substantial torque transmission capability between the component and the shaft.

Style 1:

Double-Ended, when the two sleeves are threaded into each other with a component placed between them, tightening the sleeves will cause the outer one to expand and the inner one to contract.

Style 2:

Single-Ended, when the two sleeves are threaded into each other and slipped into the component, tightening the sleeves will cause the outer one to expand and the inner one to contract.

► DISTINCT ADVANTAGES OF SHAFTLOC® OVER OTHER FASTENING DEVICES:

- Ability to be used for stationary breadboard or production structures
- Simplicity of design - few parts
- Easy repositioning or synchronizing of rotating components
- Ease of assembly
- Applicability to small shaft diameters
- Availability in all stainless construction
- No marring of shafts
- Low cost

► LEARN MORE ABOUT SHAFTLOC® AT:

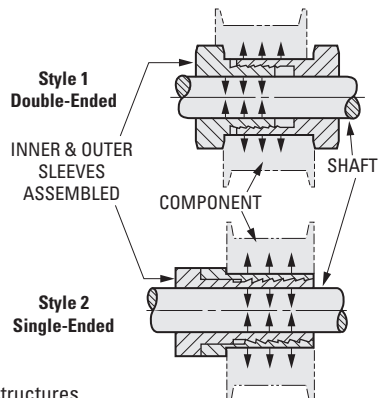
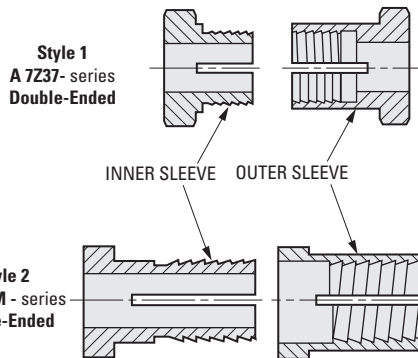
<http://www.sdp-si.com/products/Shaftloc-and-Accessories/index.php>

► FOR ALL THE SHAFTLOC® FASTENERS, GO TO:

Shaftloc® Styles	Inch Sizes	Metric Sizes
A-Type	A 7Z38-...	A 7Z38M...
M-Type	A 7Z36-...	A 7Z36M...
Double-Ended Type	A 7Z37-...	—
Single-Ended Type	A 7Z39-...	A 7Z39M...

► FOR SHAFTLOC® PULLEYS:

- XL: A 6T 3-H...
- L: A 6T 4-H...
- HTD 3 mm: A 6T23-H...
- HTD 5 mm: A 6T25-H...



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› **THE QUESTION:**

I'm not able to get a good connection between the pulley and shaft in my drive assembly. Could you explain the various ways of connecting a pulley to a shaft to prevent the pulley from slipping?

› **THE RESPONSE BY SDP/SI ENGINEERING:**

There are a variety of methods used to attach pulleys to shafts. Knowing the advantages and disadvantages of each one will help you make a better choice when installing drive components into your assembly. Using the appropriate method for your application can go a long way in preventing damage and possible equipment failure. Consideration should also be given to field service needs.

Controlled tolerances between the shaft and pulley prevent slipping and can be achieved through various mounting devices or fastening methods.

Types of connections between shaft and pulley:

- Set-screw
- Fairloc®
- Press-fit
- Shaftloc®
- Shaft extenders
- Clamp

Structure: advantages and disadvantages of each:

Set-screw type connection is a simple, inexpensive way to connect a pulley to a shaft. The pulley requires an additional extension (Hub) on which, perpendicular to the direction of the shaft, a hole or holes are drilled and tapped.

Drilling and tapping can be performed on any type of material the pulley is made of, most common are aluminum, stainless steel, steel, and plastics with a metal or reinforced hub.

Disadvantages: requires additional axial space because of the hub's projection; torque transmission is limited in comparison to press-fit and Shaftloc® types. In addition, different types of set screw tips can damage the surface of the shaft.



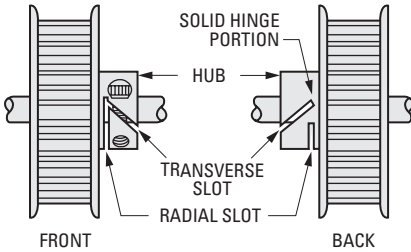
The Fairloc® Integral Fastener solves phasing, timing, positioning and frequent removal problems. The Fairloc® hub is featured on many of our standard components.

Fairloc® type is an easy way to connect the pulley to the shaft.

Two slots are machined into the hub — one oriented radially, the other angularly — to create a transverse wedge which remains attached to the solid portion of the hub on one side. The resultant cantilevered clamping section has a tapped hole to accept a cap screw which passes through a clearance hole in the solid portion of the hub, and into a threaded hole in the transverse wedge section. As the screw is tightened, the cantilevered section clamps the shaft securely.

The compact, self-contained design reduces misalignment and can be tightened and released repeatedly without marring the shaft. Produced in stainless steel, aluminum and brass, it is well suited for applications that require moderate torque and speed. For optimal performance Fairloc® hubs require controlled tolerances between the shaft and pulley (suggested clearance fit .0001"/.0008"). For high-torque/high-speed applications, shaft locks are a better option.

Fairloc® and Shaftloc® are registered trademarks of Designatronics (SDP/SI).



The Fairloc® type is an easy way to connect a pulley to a shaft.

Press fit type, especially for metal on metal, is a good option for applications requiring tight concentricity/runout. This method performs well in low/moderate torque (20-30 lbs x in.) applications, even for high rotational speeds. Good for devices where space constraint is a concern.

Disadvantages: requires very precise tolerances on the bore of the pulley and on the pilot surface of the shaft. Not all combinations of materials provide the same torque capacity of the press fit.

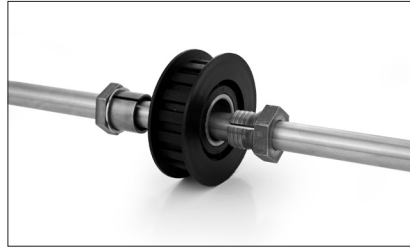
Shaftloc® is a very robust way to connect a pulley to a shaft, good for high-speed applications as well. It is recommended for mechanisms where axial space is of concern; doesn't require extremely precise tolerances on the pilot surfaces. These devices are made of various types of metals (steel is preferred).

Disadvantages: a more expensive option (requires additional component, the Shaftloc®).

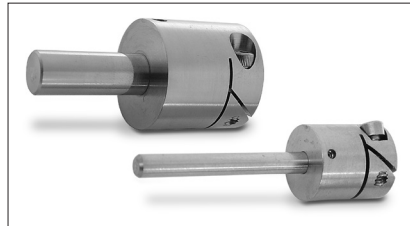
Shaft extenders are used where large axial distances between components need to be compensated. When produced in stainless steel, they provide the best performance for high-torque (70-80 lbs x in.) and high-speed applications.

Disadvantages: requires high precision shafting and very tight concentricity between bore and the shaft O.D.

Clamp type requires additional clamp to connect a split hub pulley and a shaft. Clamps come in a variety of configurations; balanced clamps are used for high-torque applications.



Shaftloc® is a robust way to connect a pulley to a shaft, and good for high-speed applications as well.



Shaft extenders are used where large axial distances between components need to be compensated.

Disadvantage: additional components - the clamp. Requires controlled tolerances on pilot surfaces, some of the constructions are difficult to assemble. Usage of clamps has declined as easier to use connecting methods have been developed.

Applications:

Set-screw: in mechanisms used for shop manual tools

Fairloc®: aerospace, avionics, medical, printing, scanning devices

Shaftloc®: power tools, oil industry

Shaft extenders: drilling devices

When attaching the pulley to the shaft, you have a number of choices; one method may work better in your applications than another. It is important to have a basic understanding of your drive system and keep the following points in mind: torque and speed requirements, accessibility, material, and cost.

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THE BETTER WAY TO FASTEN ROTATING COMPONENTS.

Solves...Phasing, Timing, Positioning and Frequent Removal Problems

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› HERE'S HOW IT WORKS:

Two slots are machined into the hub, one oriented radially, the other angularly, to create a transverse wedge which remains attached to the solid portion of the hub on one side. The resultant cantilevered clamping section has a tapped hole to accept a cap screw which passes through a clearance hole in the solid portion of the hub, and into a threaded hole in the transverse wedge section. As the screw is tightened, the cantilevered section clamps the shaft securely. The screw can be tightened and released repeatedly without marring the shaft or affecting its torque transmitting abilities.

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› PROVED MOST EFFECTIVE:

For precision application – Lab tests proved Fairloc® to be superior to all other comparable fasteners. For high torque application – Torques up to 400 lbf in. are obtained with a 5/8" bore Fairloc® hub.

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› TYPICAL APPLICATION AREAS FOR FAIRLOC® INCLUDE:

Computer Tape Drives, Aerospace Components, Aircraft Instrumentation, Aircraft Fuel Control Systems, Machine Tools, N/C Machines, Computer Input / Output Systems, Military Fire Control Systems, Medical Equipment, Business Machines, Optical Equipment, Power Drives.

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› FEATURES:

Full Use Of The Bore - Gives maximum support to the component, reduces wobble or misalignment.

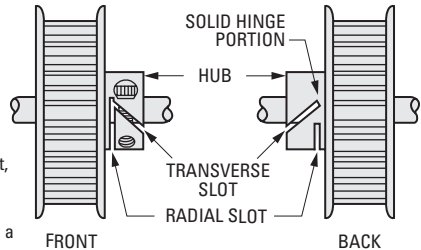
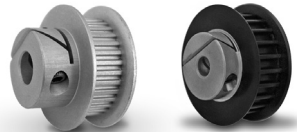
Easy Adjustment - Fairloc® replaces set screws and clamps, eliminates marred shafts; components can be repositioned with a single hex key adjustment.

Compact, Self-Contained Design - When available space or access is limited, Fairloc's® small hub envelope is a distinct advantage.

Very High Reliability

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Call on our Engineering Department to discuss the advantages of applying the Fairloc® concept to your designs.

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Fairloc® Hub Pulleys

Pitch	Page #
.080	2-44
1/5	2-90
3 mm HTD®	2-133
5 mm HTD®	2-158
2 mm GT®2/GT®3	2-179
3 mm GT®2/GT®3	2-198

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FASTENER SELECTOR GUIDE

Fastening Method	FASTENER SELECTOR GUIDE					Legend
	A	B	C	D	E	
Clamps	Yes	No	No	Yes	No	A – Shaft remains smooth B – Self-contained (no additional inventory) C – Component is fully supported D – Easy adjustment E – Can be pinned if desired
*Fairloc®	Yes	Yes	Yes	Yes	Yes	
Keys	No	No	No	No	No	
Pins	No	No	No	No	Yes	
Set Screws	No	No	No	No	Yes	

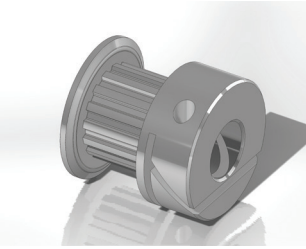
* Patented

® Registered trademark

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Figures 1, 2 and 3 shows the torque at which the sample Fairloc® pulleys started to slip on the shaft. All pulleys were made of aluminum. Clamping screw had Moly Grease on threads and under head.

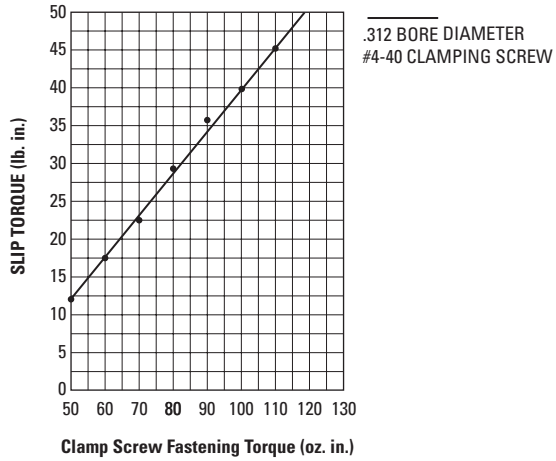


Figure 1.

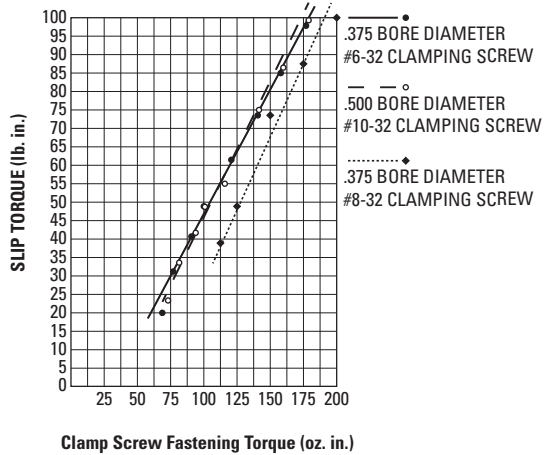


Figure 2.

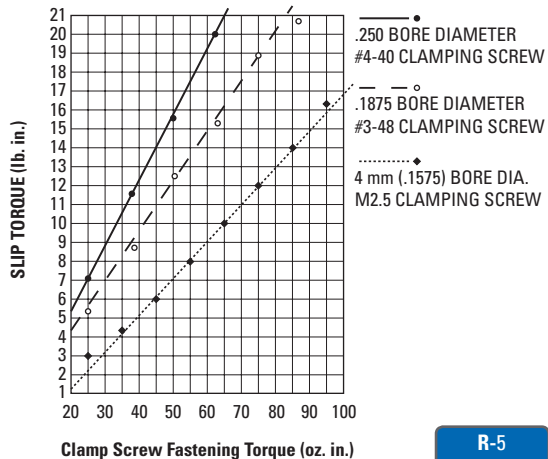


Figure 3.



Minimum Pulley Diameters

Belt Type	Pitch		rpm Max.	Suggested Minimum*		
	Inch	mm		No. of Grooves	Pitch Diameter	
					Inch	mm
MXL	.080	2.03	10000	14	.357	9.07
			7500	12	.306	7.77
			5000	11	.280	7.11
			3500	10	.255	6.48
XL	.200	5.08	3500	12	.764	19.41
			1750	11	.700	17.78
			1160	10	.637	16.18
L	.375	9.525	3500	16	1.910	48.51
			1750	14	1.671	42.44
			1160	12	1.432	36.37
H	.500	12.7	3500	20	3.182	80.82
			1750	18	2.865	72.77
			1160	16	2.546	64.67
HTD®	.118	3	3500	20	.752	19.1
			1750	18	.677	17.2
			1160	17	.639	16.23
	.197	5	3500	30	1.880	47.75
			1750	26	1.629	41.38
			1160	22	1.379	35.03
	.315	8	3500	32	3.208	81.48
			1750	28	2.807	71.3
			1160	24	2.406	61.11
			14000	16	.401	10.19
GT®2/GT®3	.079	2	7500	14	.351	8.92
			5000	12	.301	7.65
			2800	18	.677	17.2
	.118	3	5000	20	.752	19.1
			2800	18	.677	17.2
			1600	16	.602	15.29
	.197	5	2000	22	1.379	35.03
			1400	20	1.253	31.83
			1000	18	1.128	28.65
			3600	14	.417	10.6
T	.098	2.5	1800	14	.417	10.6
			1200	14	.417	10.6
			<1200	16	.480	12.2
			3600	14	.844	21.45
	.197	5	1800	14	.844	21.45
			1200	14	.844	21.45
			<1200	16	.969	24.6
			3600	16	1.931	49.05
	.394	10	1800	16	1.931	49.05
			1200	16	1.931	49.05
<1200			18	2.183	55.45	

*Smaller pulleys than shown under "Suggested Minimum" may be used if a corresponding reduction in belt life is satisfactory. Use of pulleys smaller than those shown will be at customers' own responsibility for performance and belt life.



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INCH		METRIC	
Fractional	Decimal	mm	
	.00394	0.1	
	.00787	0.2	
	.01181	0.3	
1/64	.015625	0.3969	
	.01575	0.4	
	.01969	0.5	
	.02362	0.6	
	.02756	0.7	
1/32	.03125	0.7938	
	.0315	0.8	
	.03543	0.9	
	.03937	1.00	
1/16	.046875	1.1906	
	.0625	1.5875	
5/64	.078125	1.9844	
	.07874	2.00	
3/32	.09375	2.3813	
7/64	.109375	2.7781	
1/8	.11811	3.00	
	.125	3.175	
9/64	.140625	3.5719	
5/32	.15625	3.9688	
	.15748	4.00	
11/64	.171875	4.3656	
	.1875	4.7625	
3/16	.19685	5.00	
	.203125	5.1594	
7/32	.21875	5.5563	
15/64	.234375	5.9531	
1/4	.23622	6.00	
	.2500	6.35	
17/64	.265625	6.7469	
	.27559	7.00	
9/32	.28125	7.1438	
19/64	.296875	7.5406	
5/16	.3125	7.9375	
	.31496	8.00	
21/64	.328125	8.3344	
11/32	.34375	8.7313	
	.35433	9.00	
23/64	.359375	9.1281	
3/8	.375	9.525	
25/64	.390625	9.9219	
	.3937	10.00	
13/32	.40625	10.3188	
27/64	.421875	10.7156	
7/16	.43307	11.00	
	.4375	11.1125	
29/64	.453125	11.5094	

INCH		METRIC	
Fractional	Decimal	mm	
	.46875	11.9063	
1/2	.47244	12.00	
31/64	.484374	12.3031	
	.5000	12.70	
	.51181	13.00	
33/64	.515625	13.0969	
17/32	.53125	13.4938	
35/64	.546875	13.8907	
	.55118	14.00	
9/16	.5625	14.2875	
	.578125	14.6844	
37/64	.59055	15.00	
19/32	.59375	15.0813	
39/64	.609375	15.4782	
5/8	.625	15.875	
	.62992	16.00	
41/64	.640625	16.2719	
21/32	.65625	16.6688	
	.66929	17.00	
43/64	.671875	17.0657	
11/16	.6875	17.4625	
	.703125	17.8594	
45/64	.70866	18.00	
23/32	.71875	18.2563	
47/64	.734375	18.6532	
3/4	.74803	19.00	
	.7500	19.05	
49/64	.765625	19.4469	
25/32	.78125	19.8438	
13/16	.7874	20.00	
51/64	.796875	20.2407	
	.8125	20.6375	
53/64	.82677	21.00	
27/32	.828125	21.0344	
55/64	.84375	21.4313	
	.859375	21.8282	
7/8	.86614	22.00	
	.875	22.225	
57/64	.890625	22.6219	
29/32	.90551	23.00	
59/64	.90625	23.0188	
15/16	.921875	23.4157	
	.9375	23.8125	
61/64	.94488	24.00	
31/32	.953125	24.2094	
	.96875	24.6063	
63/64	.98425	25.00	
1	.984375	25.0032	
	1.0000	25.4000	

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	METRIC to U.S.			U.S. to METRIC		
LENGTH	Millimeters	x 0.0394	= Inches	Inches	x 25.4000	= Millimeters
	Meters	x 39.3701	= Inches	Inches	x 0.0254	= Meters
	Meters	x 3.2808	= Feet	Feet	x 0.3048	= Meters
	Meters	x 1.0936	= Yards	Yards	x 0.9144	= Meters
	Kilometers	x 3280.84	= Feet	Feet	x 0.0003048	= Kilometers
	Kilometers	x 0.6214	= Statute Miles	Statute Miles	x 1.6093	= Kilometers
	Kilometers	x 0.5396	= Nautical Miles	Nautical Miles	x 1.8532	= Kilometers
AREA	Square mm	x 0.0016	= Square Inches	Square Inches	x 645.160	= Square mm
	Square cm	x 0.1550	= Square Inches	Square Inches	x 6.4516	= Square cm
	Square Meters	x 10.7639	= Square Feet	Square Feet	x 0.0929	= Square Meters
	Square Meters	x 1.1960	= Square Yards	Square Yards	x 0.8361	= Square Meters
	Hectares	x 2.4711	= Acres	Acres	x 0.4047	= Hectares
	Square km	x 247.105	= Acres	Acres	x 0.004047	= Square km
	Square km	x 0.3861	= Square Miles	Square Miles	x 2.5900	= Square km
WEIGHT	Grams	x 15.4324	= Grains	Grains	x 0.0648	= Grams
	Grams	x 0.0353	= Ounces (Avd.)	Ounces (Avd.)	x 28.3495	= Grams
	Grams	x 0.0338	= Fluid oz. (water)	Fluid oz. (water)	x 29.5735	= Grams
	Kilograms	x 35.2740	= Ounces (Avd.)	Ounces (Avd.)	x 0.0283	= Kilograms
	Kilograms	x 2.2046	= Pounds (Avd.)	Pounds (Avd.)	x 0.4536	= Kilograms
	Metric Tons (1000 kg)	x 1.1023	= Net Ton (2000 lbs.)	Net Ton (2000 lbs.)	x 0.9072	= Metric Tons (1000 kg)
	Metric Tons (1000 kg)	x 0.9842	= Gross Ton (2240 lbs.)	Gross Ton (2240 lbs.)	x 1.0160	= Metric Tons (1000 kg)
FORCE	Newtons	x 3.5969	= Ounces force	Ounces force	x 0.2780	= Newtons
	Newtons	x 0.2248	= Pounds force	Pounds force	x 4.4482	= Newtons
	Kilograms force	x 2.2046	= Pounds force	Pounds force	x 0.4536	= Kilograms force
TORQUE	Newton Meters	x 141.6119	= Ounce force Inches	Ounce force Inches	x 0.0071	= Newton Meters
	Newton Meters	x 8.8508	= Pound force Inches	Pound force Inches	x 0.1130	= Newton Meters
	Newton Meters	x 0.7376	= Pound force Feet	Pound force Feet	x 1.3558	= Newton Meters
POWER	Kilowatt	x 1.3410	= Horsepower	Horsepower	x 0.7457	= Kilowatt
	Watt	x 0.0013	= Horsepower	Horsepower	x 745.7122	= Watt

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inches	mm	inches	mm	inches	mm
0.001	0.0254	0.01	0.254	0.1	2.54
0.002	0.0508	0.02	0.508	0.2	5.08
0.003	0.0762	0.03	0.762	0.3	7.62
0.004	0.1016	0.04	1.016	0.4	10.16
0.005	0.1270	0.05	1.270	0.5	12.70
0.006	0.1524	0.06	1.524	0.6	15.24
0.007	0.1778	0.07	1.778	0.7	17.78
0.008	0.2032	0.08	2.032	0.8	20.32
0.009	0.2286	0.09	2.286	0.9	22.86

inches	inches									
	0.0000	0.0001	0.0002	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009
	millimeters (mm)									
0.000	.00000	.00254	.00508	.00762	.01016	.01270	.01524	.01778	.02032	.02286
0.001	.02540	.02794	.03048	.03302	.03556	.03810	.04064	.04318	.04572	.04826
0.002	.05080	.05334	.05588	.05842	.06096	.06350	.06604	.06858	.07112	.07366
0.003	.07620	.07874	.08128	.08382	.08636	.08890	.09144	.09398	.09652	.09906
0.004	.10160	.10414	.10668	.10922	.11176	.11430	.11684	.11938	.12192	.12446
0.005	.12700	.12954	.13208	.13462	.13716	.13970	.14224	.14478	.14732	.14986
0.006	.15240	.15494	.15748	.16002	.16256	.16510	.16764	.17018	.17272	.17526
0.007	.17780	.18034	.18288	.18542	.18796	.19050	.19304	.19558	.19812	.20066
0.008	.20320	.20574	.20828	.21082	.21336	.21590	.21844	.22098	.22352	.22606
0.009	.22860	.23114	.23368	.23622	.23876	.24130	.24384	.24638	.24892	.25146
0.010	.25400	.25654	.25908	.26162	.26416	.26670	.26924	.27178	.27432	.27686
0.011	.27940	.28194	.28448	.28702	.28956	.29210	.29464	.29718	.29972	.30226
0.012	.30480	.30734	.30988	.31242	.31496	.31750	.32004	.32258	.32512	.32766
0.013	.33020	.33274	.33528	.33782	.34036	.34290	.34544	.34798	.35052	.35306
0.014	.35560	.35814	.36068	.36322	.36576	.36830	.37084	.37338	.37592	.37846
0.015	.38100	.38354	.38608	.38862	.39116	.39370	.39624	.39878	.40132	.40386
0.016	.40640	.40894	.41148	.41402	.41656	.41910	.42164	.42418	.42672	.42926
0.017	.43180	.43434	.43688	.43942	.44196	.44450	.44704	.44958	.45212	.45466
0.018	.45720	.45974	.46228	.46482	.46736	.46990	.47244	.47498	.47752	.48006
0.019	.48260	.48514	.48768	.49022	.49276	.49530	.49784	.50038	.50292	.50546
0.020	.50800	.51054	.51308	.51562	.51816	.52070	.52324	.52578	.52832	.53086

CONVERSION OF SMALL mm TO INCH



PHONE: 516.328.3300 • FAX: 516.326.8827 • WWW.SDP-SI.COM

mm	inches	mm	inches	mm	inches
0.01	0.00039	0.1	0.00394	1	0.03937
0.02	0.00079	0.2	0.00787	2	0.07874
0.03	0.00118	0.3	0.01181	3	0.11811
0.04	0.00157	0.4	0.01575	4	0.15748
0.05	0.00197	0.5	0.01969	5	0.19685
0.06	0.00236	0.6	0.02362	6	0.23622
0.07	0.00276	0.7	0.02756	7	0.27559
0.08	0.00315	0.8	0.03150	8	0.31496
0.09	0.00354	0.9	0.03543	9	0.35433

mm	millimeters (mm)									
	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009
	inches									
0.00	.00000	.00004	.00008	.00012	.00016	.00020	.00024	.00028	.00031	.00035
0.01	.00039	.00043	.00047	.00051	.00055	.00059	.00063	.00067	.00071	.00075
0.02	.00079	.00083	.00087	.00091	.00094	.00098	.00102	.00106	.00110	.00114
0.03	.00118	.00122	.00126	.00130	.00134	.00138	.00142	.00146	.00150	.00154
0.04	.00157	.00161	.00165	.00169	.00173	.00177	.00181	.00185	.00189	.00193
0.05	.00197	.00201	.00205	.00209	.00213	.00217	.00220	.00224	.00228	.00232
0.06	.00236	.00240	.00244	.00248	.00252	.00256	.00260	.00264	.00268	.00272
0.07	.00276	.00280	.00283	.00287	.00291	.00295	.00299	.00303	.00307	.00311
0.08	.00315	.00319	.00323	.00327	.00331	.00335	.00339	.00343	.00346	.00350
0.09	.00354	.00358	.00362	.00366	.00370	.00374	.00378	.00382	.00386	.00390
0.10	.00394	.00398	.00402	.00406	.00409	.00413	.00417	.00421	.00425	.00429
0.11	.00433	.00437	.00441	.00445	.00449	.00453	.00457	.00461	.00465	.00469
0.12	.00472	.00476	.00480	.00484	.00488	.00492	.00496	.00500	.00504	.00508
0.13	.00512	.00516	.00520	.00524	.00528	.00531	.00535	.00539	.00543	.00547
0.14	.00551	.00555	.00559	.00563	.00567	.00571	.00575	.00579	.00583	.00587
0.15	.00591	.00594	.00598	.00602	.00606	.00610	.00614	.00618	.00622	.00626
0.16	.00630	.00634	.00638	.00642	.00646	.00650	.00654	.00657	.00661	.00665
0.17	.00669	.00673	.00677	.00681	.00685	.00689	.00693	.00697	.00701	.00705
0.18	.00709	.00713	.00717	.00720	.00724	.00728	.00732	.00736	.00740	.00744
0.19	.00748	.00752	.00756	.00760	.00764	.00768	.00772	.00776	.00780	.00783
0.20	.00787	.00791	.00795	.00799	.00803	.00807	.00811	.00815	.00819	.00823

TORQUE

Multiply By							To Obtain
dy • cm	g • cm	N • m x 10 ⁻⁴	N • m	oz. • in.	lb. • in.	lb. • ft.	
1	980.7	1000	10 ⁷	7.062 x 10 ⁴	1.130 x 10 ⁸	1.356 x 10 ⁷	dy • cm
1.020 x 10 ⁻³	1	1.020	1.020 x 10 ⁴	72.01	1.152 x 10 ³	1.383 x 10 ⁴	g • cm
10 ⁻³	9.807 x 10 ⁻¹	1	10 ⁴	70.62	1.130 x 10 ³	1.356 x 10 ⁴	N • m x 10 ⁻⁴
10 ⁻⁷	9.807 x 10 ⁻⁵	10 ⁻⁴	1	7.062 x 10 ⁻³	0.1130	1.356	N • m
1.416 x 10 ⁻⁵	1.389 x 10 ⁻²	1.416 x 10 ⁻²	141.6	1	16	192	oz. • in.
8.850 x 10 ⁻⁷	8.681 x 10 ⁻⁴	8.850 x 10 ⁻⁴	8.850	6.250 x 10 ⁻²	1	12	lb. • in.
7.375 x 10 ⁻⁸	7.234 x 10 ⁻⁵	7.375 x 10 ⁻⁵	0.7375	5.208 x 10 ⁻³	8.333 x 10 ⁻²	1	lb. • ft.

PREFIXES FOR SI UNITS

Multiple and Submultiple	Prefix	Symbol
1,000,000,000,000 = 10 ¹²	tera	T
1,000,000,000 = 10 ⁹	giga	G
1,000,000 = 10 ⁶	mega	M
1,000 = 10 ³	kilo	k
100 = 10 ²	hecto	h
10 = 10	deka	da
0.1 = 10 ⁻¹	deci	d
0.01 = 10 ⁻²	centi	c
0.001 = 10 ⁻³	milli	m
0.000 001 = 10 ⁻⁶	micro	μ
0.000 000 001 = 10 ⁻⁹	nano	n
0.000 000 000 001 = 10 ⁻¹²	pico	p
0.000 000 000 000 001 = 10 ⁻¹⁵	femto	f
0.000 000 000 000 000 001 = 10 ⁻¹⁸	atto	a

GREEK ALPHABET

A	α	Alpha
B	β	Beta
Γ	γ	Gamma
Δ	δ	Delta
E	ε	Epsilon
Z	ζ	Zeta
H	η	Eta
Θ	θ	Theta
I	ι	Iota
K	κ	Kappa
Λ	λ	Lambda
M	μ	Mu
N	ν	Nu
Ξ	ξ	Xi
O	ο	Omicron
Π	π	Pi
P	ρ	Rho
Σ	ς	Sigma
T	τ	Tau
Υ	υ	Upsilon
Φ	φ	Phi
X	χ	Chi
Ψ	ψ	Psi
Ω	ω	Omega

POWER

Multiply By			To Obtain
oz. • in. • rpm	watts	hp	
1	1352	1.008 x 10 ⁶	oz. • in. • rpm
7.345 x 10 ⁻⁴	1	745.7	watts
9.917 x 10 ⁻⁷	1.341 x 10 ⁻³	1	hp

INERTIA

Multiply By				To Obtain
g • cm ²	kg • m ²	oz. • in. • s ²	oz. • in. ²	
1	10 ⁷	7.062 x 10 ⁴	182.9	g • cm ²
10 ⁻⁷	1	7.062 x 10 ⁻³	1.829 x 10 ⁻⁵	kg • m ²
1.416 x 10 ⁻⁵	141.6	1	2.590 x 10 ⁻³	oz. • in. • s ²
5.467 x 10 ⁻³	5.467 x 10 ⁴	386.09	1	oz. • in. ²

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Quantity	Conventional		SI Unit	Conversion Factors
	Inch Unit	Metric Unit		
Length	Inch in.	Meter m	Metre m	1 in. = 25.4 mm 1 mm = 0.03937 in. 1 m = 3.2808 ft. 1 ft. = 0.3048 m
Area	Square Inch in. ²	Square Centimeter cm ²	Square Metre m ²	1 in. ² = 6.4516 cm ² 1 cm ² = 0.155 in. ² 1 m ² = 10.764 ft. ² 1 ft. ² = 0.092903 m ²
Mass	Pound Mass lb.	Kilogram Mass kg	Kilogram Mass kg	1 lb. = 0.45359237 kg 1 kg = 2.2046 lb.
Force	Pound Force lbf	Kilogram Force kgf	Newton N	1 lbf = 0.45359237 kgf 1 lbf = 4.44822 N 1 kgf = 2.2046 lbf 1 kgf = 9.80665 N 1 N = 0.1019716 kgf 1 N = 0.224809 lbf
Stress Pressure	Pounds Per Square Inch lbf/in. ²	Kilogram Per Square Centimeter kgf/cm ²	Pascal N/m ² (Pa)	1 MPa (megapascal) = 10 ⁶ N/m ² = N/mm ² 1 kPa (kilopascal) = 10 ³ N/m ² 1 lbf/in. ² = 0.070307 kgf/cm ² 1 lbf/in. ² = 7.0307 • 10 ⁻⁴ kgf/mm ² 1 lbf/in. ² = 6.8947 • 10 ⁻³ N/mm ² (MPa) 1 kgf/cm ² = 14.2233 lbf/in. ² 1 kgf/cm ² = 9.80665 • 10 ⁻² N/mm ² (MPa)
Torque Work	Inch • Pounds lbf • in.	Kilogram Meters kgf • m	Newton Metres N • m	1 lbf • in. = 1.1521 kgf • cm 1 kgf • cm = 0.8679 lbf • in. 1 lbf • in. = 0.1129848 N • m 1 kgf • m = 9.80665 N • m 1 kgf • cm = 9.80665 • 10 ⁻² N • m 1 N • m = 8.85 lbf • in. 1 N • m = 10.19716 kgf • cm
Power	Pound Feet Per Minute lbf • ft./min.	Kilogram Meters Per Second kgf • m/s	Newton Meters Per Second N • m/s	1 kW = 1000 N • m/s 1 kW = 60,000 N • m/min. 1 kW = 44,220 lbf • ft./min. 1 kW = 1.34 hp 1 hp = 75 kgf • m/s 1 hp = 44,741 N • m/min. 1 hp = 33,000 lbf • ft./min. 1 hp = 0.7457 kW
Velocity	Feet Per Second ft./sec.	Meters Per Second m/sec.	Metres Per Second m/sec.	1 ft./sec. = 0.3048 m/sec. 1 in./sec. = 2.54 cm/sec. 1 ft./min. = 0.00508 m/sec. 1 mph = 0.44704 m/sec. 1 km/hr = 0.27777 m/sec. 1 mph = 1.609344 km/hr
Acceleration	Feet Per Second Square ft./sec. ²	Meters Per Second Square m/sec. ²	Metres Per Second Square m/sec. ²	1 ft./sec. ² = 0.3048 m/sec. ²

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Linear	1 inch	25.400 millimeters (mm)	1 millimeter	0.03937 inches (in.)
	1 inch	2.54 centimeters (cm)	1 centimeter	0.3937 inches (in.)
	1 foot	12 inches (in.)	1 inch	0.08333 feet (ft.)
	1 foot	0.333 yards (yd.)	1 yard	3 feet (ft.)
	1 foot	0.3048 meters (m)	1 meter	3.2808 feet (ft.)
	1 yard	36 inches (in.)	1 inch	0.02778 yards (yd.)
	1 yard	3 feet (ft.)	1 foot	0.333 yards (yd.)
	1 yard	91.44 centimeters (cm)	1 centimeter	0.01094 yards (yd.)
	1 yard	0.9144 meters (m)	1 meter	1.0936 yards (yd.)
	1 statute mile	5280 feet (ft.)	1 kilometer	3281 feet (ft.)
	1 statute mile	1760 yards (yd.)	1 kilometer	1094 yards (yd.)
	1 statute mile	1.6093 kilometers (km)	1 kilometer	0.6214 statute mile
Area	1 sq. inch	6.4516 sq. centimeters	1 sq. centimeter	0.15500 sq. inch
	1 sq. foot	144 sq. inches	1 sq. inch	0.00694 sq. feet
	1 sq. foot	929.03 sq. centimeters	1 sq. centimeter	0.00108 sq. feet
	1 sq. foot	0.092903 sq. meters	1 sq. meter	10.764 sq. feet
	1 sq. yard	9 sq. feet	1 sq. foot	0.1111 sq. yards
	1 sq. yard	0.83612 sq. meters	1 sq. meter	1.196 sq. yards
Volume	1 cu. inch	0.0005787 cu. feet	1 cu. foot	1728 cu. inches
	1 cu. inch	0.004329 gallons (gal.)	1 gallon	231 cu. inches
	1 cu. inch	16.39 cu. centimeters	1 cu. centimeter	0.06102 cu. inches
	1 cu. inch	0.00001639 cu. meters	1 cu. meter	61023 cu. inches
	1 cu. inch	0.0164 liters (l)	1 liter	61.017 cu. inches
	1 cu. foot	1728 cu. inches	1 cu. inch	0.0005787 cu. feet
	1 cu. foot	7.481 gallons (gal.)	1 gallon	0.1337 cu. feet
	1 cu. foot	0.0283 cu. meters	1 cu. meter	35.31 cu. feet
	1 cu. foot	28.32 liters (l)	1 liter	0.03531 cu. feet
	1 cu. yard	27 cu. feet	1 cu. foot	0.0370 cu. yards
	1 cu. yard	0.76410 cu. meters	1 cu. meter	1.30873 cu. yards
	1 pint	0.4732 liters (l)	1 liter	2.11327 pints (pt.)
	1 quart	2 pints (pt.)	1 pint	0.50 quarts (qt.)
	1 quart	0.25 gallons (gal.)	1 gallon	4 quarts (qt.)
	1 quart	57.75 cu. inches	1 cu. inch	0.017316 quarts (qt.)
	1 quart	0.03342 cu. feet	1 cu. foot	29.9222 quarts (qt.)
	1 quart	0.9464 liters (l)	1 liter	1.057 quarts (qt.)
	1 gallon	231 cu. inches	1 cu. inch	0.004329 gallons (gal.)
1 gallon	0.1337 cu. feet	1 cu. foot	7.481 gallons (gal.)	
1 gallon	3.785 liters (l)	1 liter	0.2642 gallons (gal.)	
Weight	1 ounce	28.35 grams (g)	1 gram	0.03527 ounces (oz.)
	1 ounce	0.02835 kilograms (kg)	1 kilogram	35.274 ounces (oz.)
	1 pound	16 ounces (oz.)	1 ounce	0.0625 pounds (lb.)
	1 pound	453.6 grams (g)	1 gram	0.002205 pounds (lb.)
	1 pound	0.4536 kilograms (kg)	1 kilogram	2.2046 pounds (lb.)
Pressure	1 pound/sq. inch	0.070307 kg/sq. cm	1 kilogram/sq. cm	14.223 pounds/sq. in.
	1 pound/sq. foot	4.8824 kilograms/sq. m	1 kilogram/sq. meter	0.2048 pounds/sq. ft.
	1 pound/sq. yard	0.54249 kilograms/sq. m	1 kilogram/sq. meter	1.8433 pounds/sq. yd.
	1 ounce/cu. inch	1.7300 grams/cu. cm	1 gram/cu. cm	0.57803 ounce/cu. in.
	1 pound/cu. foot	16.019 kilograms/cu. m	1 kilogram/cu. meter	0.062428 pounds/cu. ft.

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To Convert	Into	Multiply By
Amperes/sq. cm	Amperes/sq. in.	6.452
Amperes/sq. in.	Amperes/sq. cm	0.1550
Ampere-hours	Coulombs	3600
Ampere-turns	Gilberts	1.257
Ampere-turns/cm	Ampere-turns/in.	2.540
Ampere-turns/cm	Gilberts/cm	1.257
Ampere-turns/in.	Ampere-turns/cm	0.3937
Ampere-turns/in.	Gilberts/cm	0.4950
Angstrom unit	Inches	3937×10^{-9}
Angstrom unit	Microns (mus)	10^{-4}
Atmospheres	Cms of mercury	76
Atmospheres	Ft. of water (4°C)	33.90
Atmospheres	In. of mercury (0°C)	29.92
Atmospheres	Pounds/sq. in.	14.70
Bars	Atmospheres	0.9869
Bars	Dynes/sq. cm	10^6
Bars	Pounds/sq. in.	14.50
Btu	Ergs	1.0550×10^{10}
Btu	Foot-pounds	778.3
Btu	Gram-calories	252
Btu	Horsepower-hrs.	3.931×10^{-4}
Btu	Joules	1054.8
Btu	Kilowatt-hrs.	2.928×10^{-4}
Btu/hr.	Foot-pounds/sec.	0.2162
Btu/hr.	Gram-cal./sec.	0.0700
Btu/hr.	Horsepower-hrs.	3.929×10^{-4}
Btu/hr.	Watts	0.2931
Btu/min.	Foot-pounds/sec.	12.96
Btu/min.	Horsepower	0.02356
Btu/min.	Kilowatts	0.01757
Btu/min.	Watts	17.57
Calories, gram (mean)	Btu (mean)	3.9685×10^{-3}
Candle/sq. in.	Lamberts	0.4870
Centigrade	Fahrenheit	$(^{\circ}\text{C} \times 9/5) + 32^{\circ}$
Centiliters	Liters	0.01
Centimeters	Feet	3.281×10^{-2}
Centimeters	Meters	0.01
Centimeters	Inches	0.3937
Centimeters	Millimeters	10
Centimeter-dynes	Centimeter-grams	1.020×10^{-3}
Centimeter-dynes	Pound-feet	7.376×10^{-8}
Centimeters/sec.	Feet/sec.	0.03281
Centimeters/sec. ²	Feet/sec. ²	0.03281
Circular mils	Sq. centimeters	5.067×10^{-6}
Circular mils	Sq. mils	0.7854
Circular mils	Sq. inches	7.854×10^{-7}
Circumference	Radians	6.283
Coulombs	Faradays	1.036×10^{-5}
Coulombs/sq. cm	Coulombs/sq. in.	64.52
Coulombs/sq. in.	Coulombs/sq. cm	0.1550
Cubic centimeters	Cu. inches	0.06102
Cubic centimeters	Gallons (U.S. liquid)	2.642×10^{-4}
Cubic centimeters	Liters	0.001
Cubic centimeters	Quarts (U.S. liquid)	1.057×10^{-3}
Cubic feet	Cu. Inches	1728

To Convert	Into	Multiply By
Cubic feet	Cu. meters	0.02832
Cubic feet	Cu. yards	0.03704
Cubic feet	Gallons (U.S. liq.)	7.48052
Cubic feet	Liters	28.32
Cubic feet/min.	Cu. cms/sec.	472
Cubic inches	Cu. centimeters	16.39
Cubic inches	Cu. feet	5.787×10^{-4}
Cubic inches	Gallons (U.S. liq.)	4.329×10^{-3}
Cubic inches	Liters	0.01639
Cubic inches	Quarts (U.S. liq.)	0.01732
Cubic meters	Gallons (U.S. liq.)	264.2
Cubic meters	Liters	1000
Cubic meters	Pints (U.S. liq.)	2113
Days	Seconds	86400
Degrees/sec.	Radians/sec.	0.01745
Degree/sec.	Revolutions/min.	0.1667
Degrees/sec.	Revolutions/sec.	2.778×10^{-3}
Degrees (angle)	Quadrants	0.01111
Degrees (angle)	Radians	0.01745
Degrees (angle)	Seconds	3600
Dynes/cm	Erg/sq. millimeter	0.01
Dynes/sq. cm	Atmospheres	9.869×10^{-7}
Dynes/sq. cm	In. of mercury (0°C)	2.953×10^{-5}
Dynes	Grams	1.020×10^{-3}
Dynes	Joules/cm	10^{-7}
Dynes	Joules/m (Newtons)	10^{-5}
Dynes	Pounds	2.248×10^{-6}
Dynes/sq. cm	Bars	10^{-6}
Erg/sec.	Dyne-cm/sec.	1.0
Ergs	Btu	9.480×10^{-11}
Ergs	Dyne-centimeters	1.0
Ergs	Foot-pounds	7.367×10^{-8}
Ergs	Grams-calories	0.2389×10^{-7}
Ergs	Grams-cms	1.020×10^{-3}
Ergs	Joules	10^{-7}
Ergs	Watt-hours	0.2778×10^{-10}
Ergs/sec.	Btu/min.	5.688×10^{-9}
Ergs/sec.	Foot-pounds/sec.	7.3756×10^{-8}
Ergs/sec.	Horsepower	1.341×10^{-10}
Ergs/sec.	Kilowatts	10^{-10}
Farads	Microfarads	10^6
Faradays	Ampere-hours	26.80
Faradays	Coulombs	9.649×10^4
Feet	Centimeters	30.48
Feet	Meters	0.3048
Feet	Millimeters	304.8
Feet of water	Atmospheres	0.02950
Feet of water	Inches of mercury	0.8826
Feet of water	Kilograms/sq. cm	0.03048
Feet of water	Pounds/sq. in.	0.4335
Feet/min.	Centimeters/sec.	0.5080
Feet/min.	Miles/hr.	0.01136
Feet/sec.	Centimeters/sec.	30.48
Feet/sec. ²	Meters/sec. ²	0.3048
Feet/sec. ²	Miles/hrs	0.6818

To Convert	Into	Multiply By
Foot-candles	Lumens/sq. meter	10.764
Foot-pounds	Btu	1.286×10^{-3}
Foot-pounds	Ergs	1.356×10^{-7}
Foot-pounds	Gram-calories	0.3238
Foot-pounds	Joules	1.356
Foot-pounds/min.	Btu/min.	1.286×10^{-3}
Foot-pounds/min.	Foot-pounds/sec.	0.01667
Foot-pounds/min.	Horsepower	3.030×10^{-5}
Foot-pounds/min.	Kg-calories/min.	3.24×10^{-4}
Foot-pounds/min.	Kilowatts	2.260×10^{-5}
Foot-pounds/sec.	Btu/min.	0.07717
Foot-pounds/sec.	Horsepower	1.818×10^{-3}
Foot-pounds/sec.	Kilowatts	1.356×10^{-3}
Gallons	Cu. feet	0.1337
Gallons	Cu. inches	231
Gallons	Liters	3.785
Gallons of water	Pounds of water	8.3453
Gausses	Lines/sq. in.	6.452
Gausses	Webers/sq. cm	10^{-8}
Gausses	Webers/sq. in.	6.452×10^{-8}
Gilberts	Ampere-turns	0.7958
Gilberts/cm	Ampere-turns/cm	0.7958
Gilberts/cm	Ampere-turns/in.	2.021
Grams	Dynes	980.7
Grams	Joules/cm	9.807×10^{-5}
Grams	Kilograms	0.001
Grams	Milligrams	1000
Grams	Ounces (avd.)	0.03527
Grams	Pounds	2.205×10^{-3}
Grams/cu. cm	Pounds/cu. ft.	62.43
Grams/cu. cm	Pounds/cu. in.	0.03613
Gram-calories	Btu	3.9683×10^{-3}
Gram-calories	Ergs	4.1868×10^7
Gram-calories	Foot-pounds	3.0880
Gram-calories	Horsepower-hrs.	1.5596×10^{-6}
Gram-calories	Watt-hrs.	1.1630×10^{-3}
Gram-calories/sec.	Btu-hr.	14.286
Gram-centimeters	Btu	9.297×10^{-8}
Gram-centimeters	Ergs	980.7
Gram-centimeters	Joules	9.807×10^{-5}
Henries	Millihenries	1000
Horsepower	Btu/min.	42.44
Horsepower	Foot-pounds/min.	33000
Horsepower	Foot-pounds/sec.	550
Horsepower	Kg-calories/min.	10.68
Horsepower	Watts	745.7
Horsepower-hrs.	Btu	2547
Horsepower-hrs.	Ergs	2.6845×10^{13}
Horsepower-hrs.	Foot-pounds	1.98×10^6
Horsepower-hrs.	Gram-calories	641190
Horsepower-hrs.	Joules	2.684×10^6
Horsepower-hrs.	Kilowatt-hrs.	0.7457
Hours	Weeks	5.952×10^{-3}
Inches	Centimeters	2.540
Inches	Millimeters	25.40
Inches	Mils	1000
Inches of mercury	Atmospheres	0.03342
Inches of mercury	Feet of water	1.133

To Convert	Into	Multiply By
Inches of mercury	Pounds/sq. in.	0.4912
Joules	Btu	9480×10^{-4}
Joules	Ergs	10^7
Joules	Foot-pounds	0.7376
Joules	Kilogram-calories	2.389×10^{-4}
Joules	Watt-hrs.	2.778×10^{-4}
Kilograms	Grams	1000
Kilograms	Pounds	2.205
Kilograms	Tons (short)	1.102×10^{-3}
Kilograms/sq. cm	Pounds/sq. in.	14.22
Kilogram-calories	Btu	3.968
Kilogram-calories	Foot-pounds	3088
Kilogram-calories	Joules	4186
Kilogram-calories	Kilowatt-hrs.	1.163×10^{-3}
Kilolines	Maxwells	1000
Kilometers	Meters	1000
Kilometers	Miles	0.6214
Kilometers/hr.	Feet/sec.	0.9113
Kilometers/hr.	Miles/hr.	0.6214
Kilometers/hr. ²	Centimeters/sec. ²	27.78
Kilometers/hr. ²	Feet/sec. ²	0.9113
Kilometers/hr. ²	Miles/hr. ²	0.6214
Kilowatts	Btu/min.	56.92
Kilowatts	Foot-pounds/sec.	737.6
Kilowatts	Horsepower	1.341
Kilowatts	Kg-calories/min.	14.34
Kilowatts	Watts	1000
Kilowatt-hrs.	Btu	3413
Kilowatt-hrs.	Foot-pounds	2.655×10^6
Kilowatt-hrs.	Gram-calories	859850
Kilowatt-hrs.	Horsepower-hrs.	1.341
Kilowatt-hrs.	Joules	3.6×10^6
Lines/sq. cm	Gausses	1.0
Lines/sq. in.	Gausses	0.1550
Lines/sq. in.	Webers/sq. in.	10^{-8}
Liters	Cu. centimeters	1000
Liters	Cu. feet	0.03531
Liters	Cu. inches	61.02
Liters	Gallons (U.S. liq.)	0.2642
Lumens	Spher. candle power	0.07958
Lumens	Watts	0.001496
Lumens/sq. ft.	Foot-candles	1.0
Lumens/sq. ft.	Lumens/sq. meter	10.76
Maxwells	Kilolines	0.001
Maxwells	Webers	10^{-8}
Megohms	Ohms	10^6
Meters	Centimeters	100
Meters	Feet	3.281
Meters	Inches	39.37
Meters	Kilometers	0.001
Meters	Yards	1.094
Meters/min.	Feet/sec.	0.05468
Meters/sec.	Feet/sec.	3.281
Meters/sec.	Kilometers/hr.	3.6
Meters/sec.	Miles/hr.	2.237
Meters/sec. ²	Feet/sec. ²	3.281
Meters/sec. ²	Kilometers/hr. ²	3.6
Meters/sec. ²	Miles/hr. ²	2.237

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To Convert	Into	Multiply By
Microfarads	Farads	10 ⁻⁶
Microhms	Megohms	10 ⁻¹²
Microhms	Ohms	10 ⁻⁶
Microns	Meters	10 ⁻⁶
Miles (statute)	Centimeters	1.609 x 10 ⁵
Miles (statute)	Feet	5280
Miles (statute)	Inches	6.336 x 10 ⁴
Miles (statute)	Kilometers	1.609
Miles/hr.	Feet/min.	88
Miles/hr.	Feet/sec.	1.467
Miles/hr.	Meters/min.	26.82
Miles/h • s	Centimeters/sec. ²	44.70
Miles/h • s	Feet/sec. ²	1.467
Miles/h • s	Kilometers/h • s	1.609
Millimicrons	Meters	10 ⁻⁹
Milligrams	Grams	0.001
Millihenries	Henries	0.001
Milliliters	Liters	0.001
Millimeters	Centimeters	0.1
Millimeters	Inches	0.03937
Millimeters	Mils	39.37
Mils	Centimeters	2.540 x 10 ⁻³
Mils	Inches	0.001
Minutes (angles)	Degrees	0.01667
Minutes (angles)	Radians	2.909 x 10 ⁻⁴
Ohms	Megohms	10 ⁶
Ounces	Grams	28.349527
Ounces	Pounds	0.0625
Ounces (fluid)	Cu. inches	1.805
Ounces (fluid)	Liters	0.02957
Pints (liquid)	Cu. centimeters	473.2
Pints (liquid)	Cu. feet	0.01671
Pints (liquid)	Cu. inches	28.87
Pints (liquid)	Gallons	0.125
Pints (liquid)	Liters	0.4732
Pints (liquid)	Quarts (liquid)	0.5
Poise	Grams/cm. sec.	1.00
Pounds	Dynes	44.4823 x 10 ⁴
Pounds	Grams	453.5924
Pounds	Kilograms	0.4536
Pounds	Ounces	16
Pounds of water	Cu. feet	0.01602
Pounds of water	Cu. inches	27.68
Pounds of water	Gallons	0.1198
Pound-feet	Centimeter-dynes	1.356 x 10 ⁷
Pound-feet	Centimeter-grams	13825
Pound-feet	Meter-kilograms	0.1383
Pounds/cu. in.	Grams/cu. cm	27.68
Pounds/cu. in.	Pounds/cu. ft.	1728
Pounds/sq. in.	Atmospheres	0.06804
Pounds/sq. in.	Feet of water	2.307
Pounds/sq. in.	Inches of mercury	2.036
Pounds/sq. in.	Pounds/sq. ft.	144
Quarts (liquid)	Gallons	0.25
Quarts (liquid)	Liters	0.9463
Radians	Degrees	57.30
Radians/sec.	Degrees/sec.	57.30
Radians/sec. ²	Revs./sec. ²	0.1592
Revolutions	Degrees	360

To Convert	Into	Multiply By
Revolutions	Radians	6.283
Revolutions/min.	Degrees/sec.	6
Revolutions/min.	Radians/sec.	0.1047
Revolutions/min. ²	Radians/sec. ²	1.745 x 10 ⁻³
Revolutions/min. ²	Revolutions/sec. ²	2.778 x 10 ⁻⁴
Revolutions/sec.	Degrees/sec.	360
Revolutions/sec.	Radians/sec.	6.283
Revolutions/sec. ²	Radians/sec. ²	6.283
Seconds (angles)	Degrees	2.778 x 10 ⁻⁴
Seconds (angles)	Minutes	0.01667
Slugs	Pounds	32.17
Square centimeters	Circular mils	1.973 x 10 ⁵
Square centimeters	Sq. inches	0.1550
Square centimeters	Sq. meters	0.0001
Square centimeters	Sq. millimeters	100
Square feet	Circular mils	1.833 x 10 ⁸
Square feet	Sq. centimeters	929
Square feet	Sq. inches	144
Square inches	Circular mils	1.273 x 10 ⁶
Square inches	Sq. centimeters	6.452
Square inches	Sq. millimeters	645.2
Square inches	Sq. mils	10 ⁶
Square meters	Sq. centimeters	10 ⁴
Square meters	Sq. feet	10.76
Square meters	Sq. inches	1550
Square meters	Sq. millimeters	10 ⁶
Square millimeters	Circular mils	1973
Square millimeters	Sq. centimeters	0.01
Square millimeters	Sq. inches	1.550 x 10 ⁻³
Square mils	Circular mils	1.273
Square mils	Sq. centimeters	6.452 x 10 ⁻⁶
Square mils	Sq. inches	10 ⁻⁶
Temp. (°C) + 273°	Absolute temp. (°C)	1.0
Temp. (°C) + 17.78°	Temperature (°F)	1.8
Temp. (°F) + 460°	Absolute temp. (°F)	1.0
Temp. (°F) - 32°	Temperature (°C)	5/9
Tons (short)	Ounces	32000
Tons (short)	Pounds	2000
Volts/inch	Volts/cm	0.39370
Watts	Btu/hr.	3.4129
Watts	Btu/min.	0.05688
Watts	Ergs/sec.	107
Watts	Foot-pounds/sec.	0.7378
Watts	Horsepower	1.341 x 10 ⁻³
Watts	Kg-calories/min.	0.01433
Watts	Kilowatts	0.001
Watt-hours	Btu	3.413
Watt-hours	Ergs	3.60 x 10 ¹⁰
Watt-hours	Foot-pounds	2656
Watt-hours	Gram-calories	859.85
Watt-hours	Horsepower-hrs.	1.341 x 10 ⁻³
Watt-hours	Kilogram-calories	0.8605
Watt-hours	Kilowatt-hrs.	0.001
Webers	Maxwells	10 ⁸
Webers	Kilolines	10 ⁵
Webers/sq. in.	Gausses	1.550 x 10 ⁷
Webers/sq. in.	Lines/sq. in.	10 ⁸
Webers/sq. in.	Webers/sq. cm	0.1550
Yards	Meters	0.9144

P Diametral Pitch	m Module	Circular Pitch		Circular Tooth Thickness		Addendum	
		inches	millimeters	inches	millimeters	inches	millimeters
.5000	50.8	6.2832	159.593	3.1416	79.796	2.0000	50.800
.5080	50	6.1842	157.080	3.0921	78.540	1.9685	50.000
.5644	45	5.5658	141.372	2.7829	70.686	1.7717	45.000
.6048	42	5.1948	131.947	2.5974	65.973	1.6535	42.000
.6350	40	4.9474	125.664	2.4737	62.832	1.5748	40.000
.6513	39	4.8237	122.522	2.4119	61.261	1.5354	39.000
.7056	36	4.4527	113.097	2.2263	56.549	1.4173	36.000
.7500	33.8667	4.1888	106.395	2.0944	53.198	1.3333	33.867
.7697	33	4.0816	103.673	2.0408	51.836	1.2992	33.000
.7938	32	3.9579	100.531	1.9790	50.265	1.2598	32.000
.8467	30	3.7105	94.248	1.8553	47.124	1.1811	30.000
.9071	28	3.4632	87.965	1.7316	43.982	1.1024	28.000
.9407	27	3.3395	84.823	1.6697	42.412	1.0630	27.000
1	25.4000	3.1416	79.796	1.5708	39.898	1.0000	25.400
1.0160	25	3.0921	78.540	1.5461	39.270	.9843	25.000
1.0583	24	2.9684	75.398	1.4842	37.699	.9449	24.000
1.1545	22	2.7211	69.115	1.3605	34.558	.8661	22.000
1.2700	20	2.4737	62.832	1.2368	31.416	.7874	20.000
1.4111	18	2.2263	56.549	1.1132	28.274	.7087	18.000
1.5000	16.9333	2.0944	53.198	1.0472	26.599	.6667	16.933
1.5875	16	1.9790	50.265	.9895	25.133	.6299	16.000
1.8143	14	1.7316	43.982	.8658	21.991	.5512	14.000
2	12.7000	1.5708	39.898	.7854	19.949	.5000	12.700
2.1167	12	1.4842	37.699	.7421	18.850	.4724	12.000
2.3091	11	1.3605	34.558	.6803	17.279	.4331	11.000
2.5000	10.1600	1.2566	31.919	.6283	15.959	.4000	10.160
2.5400	10	1.2368	31.416	.6184	15.708	.3937	10.000
2.8222	9	1.1132	28.274	.5566	14.137	.3543	9.000
3	8.4667	1.0472	26.599	.5236	13.299	.3333	8.467
3.1416	8.0851	1.0000	25.400	.5000	12.700	.3183	8.085
3.1750	8	.9895	25.133	.4947	12.566	.3150	8.000
3.5000	7.2571	.8976	22.799	.4488	11.399	.2857	7.257
3.6286	7	.8658	21.991	.4329	10.996	.2756	7.000
3.9077	6.5000	.8040	20.420	.4020	10.210	.2559	6.500
4	6.3500	.7854	19.949	.3927	9.975	.2500	6.350
4.2333	6	.7421	18.850	.3711	9.425	.2362	6.000
4.6182	5.5000	.6803	17.279	.3401	8.639	.2165	5.500
5	5.08	.6283	15.959	.3142	7.980	.2000	5.080
5.0800	5	.6184	15.708	.3092	7.854	.1969	5.000
5.3474	4.75	.5875	14.923	.2938	7.461	.1870	4.750
5.6444	4.5	.5566	14.137	.2783	7.069	.1772	4.500
6	4.2333	.5236	13.299	.2618	6.650	.1667	4.233
6.3500	4	.4947	12.566	.2474	6.283	.1575	4.000
6.7733	3.75	.4638	11.781	.2319	5.890	.1476	3.750
7	3.6286	.4488	11.399	.2244	5.700	.1429	3.629
7.2571	3.5	.4329	10.996	.2164	5.498	.1378	3.500
7.8154	3.25	.4020	10.210	.2010	5.105	.1280	3.250
8	3.1750	.3927	9.975	.1963	4.987	.1250	3.175
8.4667	3	.3711	9.425	.1855	4.712	.1181	3.000
9	2.8222	.3491	8.866	.1745	4.433	.1111	2.822
9.2364	2.75	.3401	8.639	.1701	4.320	.1083	2.750

NOTE: Bold face diametral pitches and modules designate preferred values.

Continued on the next page

DIAMETRAL PITCH TO METRIC GEAR EQUIVALENCE



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P Diametral Pitch	m Module	Circular Pitch		Circular Tooth Thickness		Addendum	
		inches	millimeters	inches	millimeters	inches	millimeters
10	2.5400	.3142	7.980	.1571	3.990	.1000	2.540
10.1600	2.50	.3092	7.854	.1546	3.927	.0984	2.500
11	2.3091	.2856	7.254	.1428	3.627	.0909	2.309
11.2889	2.25	.2783	7.069	.1391	3.534	.0886	2.250
12	2.1167	.2618	6.650	.1309	3.325	.0833	2.117
12.7000	2	.2474	6.283	.1237	3.142	.0787	2.000
13	1.9538	.2417	6.138	.1208	3.069	.0769	1.954
14	1.8143	.2244	5.700	.1122	2.850	.0714	1.814
14.5143	1.75	.2164	5.498	.1082	2.749	.0689	1.750
15	1.6933	.2094	5.320	.1047	2.660	.0667	1.693
16	1.5875	.1963	4.987	.0982	2.494	.0625	1.588
16.9333	1.5	.1855	4.712	.0928	2.356	.0591	1.500
18	1.4111	.1745	4.433	.0873	2.217	.0556	1.411
20	1.2700	.1571	3.990	.0785	1.995	.0500	1.270
20.3200	1.25	.1546	3.927	.0773	1.963	.0492	1.250
22	1.1545	.1428	3.627	.0714	1.814	.0455	1.155
24	1.05833	.1309	3.325	.0654	1.662	.0417	1.058
25.4000	1	.1237	3.142	.0618	1.571	.0394	1.000
28	0.90714	.1122	2.850	.0561	1.425	.0357	.907
28.2222	0.9	.1113	2.827	.0557	1.414	.0354	.900
30	0.84667	.1047	2.660	.0524	1.330	.0333	.847
31.7500	0.8	.0989	2.513	.0495	1.257	.0315	.800
32	0.79375	.0982	2.494	.0491	1.247	.0313	.794
33.8667	0.75	.0928	2.356	.0464	1.178	.0295	.750
36	0.70556	.0873	2.217	.0436	1.108	.0278	.706
36.2857	0.7	.0866	2.199	.0433	1.100	.0276	.700
40	0.63500	.0785	1.995	.0393	.997	.0250	.635
42.333	0.6	.0742	1.885	.0371	.942	.0236	.600
44	0.57727	.0714	1.814	.0357	.907	.0227	.577
48	0.52917	.0654	1.662	.0327	.831	.0208	.529
50	0.5080	.0628	1.596	.0314	.798	.0200	.508
50.800	0.5	.0618	1.571	.0309	.785	.0197	.500
63.500	0.4	.0495	1.257	.0247	.628	.0157	.400
64	0.39688	.0491	1.247	.0245	.623	.0156	.397
67.733	0.375	.0464	1.178	.0232	.589	.0148	.375
72	0.35278	.0436	1.108	.0218	.554	.0139	.353
72.5714	0.35	.0433	1.100	.0216	.550	.0138	.350
78.1538	0.325	.0402	1.021	.0201	.511	.0128	.325
80	0.31750	.0393	.997	.0196	.499	.0125	.318
84.6667	0.3	.0371	.942	.0186	.471	.0118	.300
92.3636	0.275	.0340	.864	.0170	.432	.0108	.275
96	0.26458	.0327	.831	.0164	.416	.0104	.265
101.600	0.25	.0309	.785	.0155	.393	.0098	.250
120	0.21167	.0262	.665	.0131	.332	.0083	.212
125	0.20320	.0251	.638	.0126	.319	.0080	.203
127.000	0.2	.0247	.628	.0124	.314	.0079	.200
150	0.16933	.0209	.532	.0105	.266	.0067	.169
169.333	0.15	.0186	.471	.0093	.236	.0059	.150
180	0.14111	.0175	.443	.0087	.222	.0056	.141
200	0.12700	.0157	.399	.0079	.199	.0050	.127
203.200	0.125	.0155	.393	.0077	.196	.0049	.125

NOTE: Bold face diametral pitches and modules designate preferred values.

Continued from the previous page



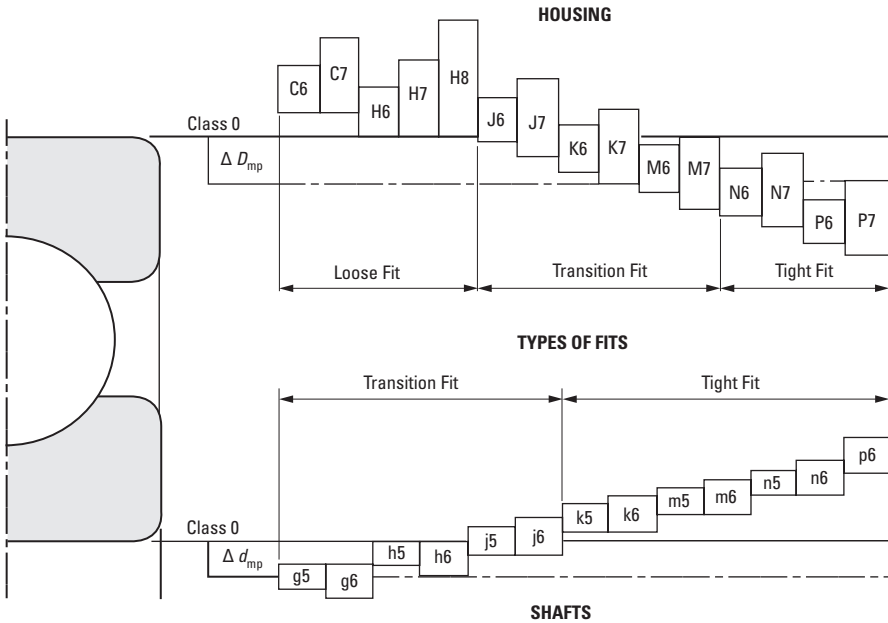
Comparison of Tolerance Classifications of Various National Standards

Standard		Tolerance Class				
International Organization for Standardization	ISO 492	Normal class Class 6X	Class 6	Class 5	Class 4	Class 2
American National Standards Institute (ANSI)	ANSI/AFBMA Std.20*	ABEC-1 RBEC-1	ABEC-3 RBEC-3	ABEC-5 RBEC-5	ABEC-7	ABEC-9
Deutsches Institut für Normung	DIN 620	P0	P6	P5	P4	P2
Japanese Industrial Standard	JIS B 1514	Class 0 Class 6X	Class 6	Class 5	Class 4	Class 2

* "ABEC" is applied for ball bearings and "RBEC" for roller bearings.

NOTES: 1. ISO 492 and 199, DIN 620 and JIS B 1514 have the same specification level.

2. The tolerance and allowance of JIS B 1514 are a little different from those of AFBMA standards.



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Many components such as clutches, brakes, couplings, drive belts, etc. are used in applications where starting, stopping or reversing of a load is involved. Factors and formulas needed to establish the power requirements are given here.

Kinetic Energy of Rotation

Starting from basic equation

$$E = \frac{mV^2}{2} \dots\dots \text{ft.} \cdot \text{lb.} \tag{1}$$

where

m is mass = $\frac{W}{G}$ is slugs i.e. $\frac{\text{lb.} \cdot \text{sec.}^2}{\text{ft.}}$ W = weight in lbs
 G = gravitational acceleration in ft./sec.²
 (G = 32.2 ft./sec.² = 386 in./sec.²)

V is velocity in $\frac{\text{ft.}}{\text{sec.}}$

If we assume that the entire mass is concentrated at the radius of gyration k, then we can substitute

$$V = \frac{2k\pi N}{60} \dots \frac{\text{ft.}}{\text{sec.}} \text{ where } N \text{ is in rpm; } k \text{ is in feet}$$

Substituting values for V and G in the basic equation, we obtain

$$E = \frac{Wk^2}{G} \cdot \frac{N^2}{182.5} = \frac{Wk^2N^2}{5878} \dots\dots \text{ft.} \cdot \text{lb.} \tag{2}$$

Inertia

In simple terms, Inertia is the property of a body at rest to stay at rest, or in motion to remain in motion.

Expression $\frac{Wk^2}{G} = I_G$ is known as mass moment of inertia and is given in ft. • lb. • sec.²

Often, expression $Wk^2 = I$ in lb. • ft.² is used as "moment of inertia in weight units". It is proportional to I_G and its proportionality factor G = 32.2 is often lumped with other constants.

Table below tabulates the values of Wk^2 for commonly used cross sections.

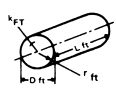
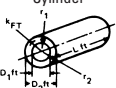
Part	Radius Of Gyration K (Feet)	K^2 (Feet ²)	W (Weight In lb.) w = Density Of Material In lb./cu. in.	$I = wk^2$ (lb. • ft. ²)	$I_G = \frac{WK^2}{G}$ (lb. • ft. • sec. ²)
Circular Cylinder 	0.354 D	$K^2 = \frac{r^2}{2}$	1.360wLD ²	170.4wLD ⁴	5.279wLD ⁴
Hollow Circular Cylinder 	$0.354 \sqrt{D_2^2 + D_1^2}$	$K^2 = \frac{r_1^2 + r_2^2}{2}$	1.360wL(D ₂ ² - D ₁ ²)	170.4wL(D ₂ ⁴ - D ₁ ⁴)	5.279wL(D ₂ ⁴ - D ₁ ⁴)

Table compiled based on References 1 and 2.

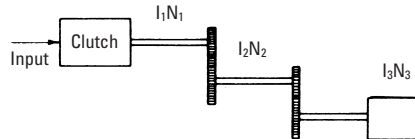
Nomographs on subsequent pages facilitate conversion of different units of inertia. A table shows actual inertia values for discs of different diameters.

Equivalent Inertia

Must be considered when inertia has to be reflected to a shaft which rotates at a different speed.

$$(I_2)_{EQ\ at\ 1} = I_2 \left(\frac{N_2}{N_1} \right)^2 \tag{7}$$

Example: Inertia at the clutch output:



$$I_{CL} = I_1 + I_2 \left(\frac{N_2}{N_1} \right)^2 + I_3 \left(\frac{N_3}{N_1} \right)^2$$

Torque

If a body of inertia I_G is accelerated at a constant angular acceleration θ (radians/sec.²), the necessary constant torque is

$$T = I_G \cdot \theta \dots\dots \text{lb.} \cdot \text{ft.} \tag{3}$$

If the acceleration speeds up the load ΔN (rpm) within t (seconds), then the angular acceleration can be expressed as:

$$\theta = \frac{\Delta\omega}{t} = \frac{2\pi\Delta N}{60t} \dots\dots \text{rad./sec.}^2 \tag{4}$$

where $\Delta\omega$ is the change of angular velocity in radians/sec. Substitution into (3) yields

$$T = \frac{Wk^2}{32.2} \cdot \frac{2\pi\Delta N}{60t} = \frac{Wk^2\Delta N}{308t} \dots\dots \text{ft.} \cdot \text{lb.} \tag{5}$$

R

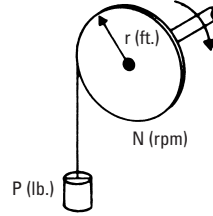
Work and Power

Work is the product of the magnitude of a force and the distance over which the force is applied. Power is the time rate at which the work is performed. Unit of power is

1 HP = 550 ft. lb./sec. = 33,000 ft. lb./min.

Hence,

$$HP = \frac{P \cdot 2\pi r \bar{N}}{33,000} = \frac{P \cdot r \cdot \bar{N}}{5252} = \frac{T \cdot \bar{N}}{5252} \tag{6}$$



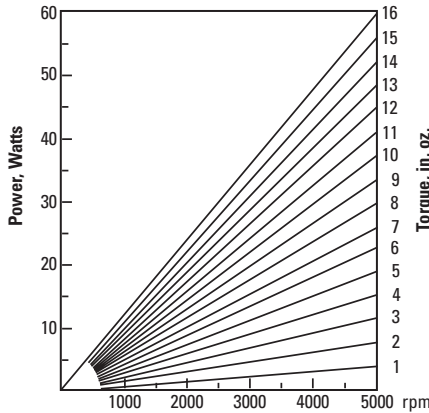
Since torque $T = P \cdot r$. The following table can be constructed. (Note that 1HP = 745.7 watts.)

HORSEPOWER equals	WATTS equals	When T given in
$\frac{T \cdot N}{5252} = 1.9 \cdot T \cdot N \cdot 10^{-4}$	$\frac{T \cdot N}{7.043} = 0.142 \cdot T \cdot N$	ft. lb.
$\frac{T \cdot N}{63024} = 1.586 \cdot T \cdot N \cdot 10^{-5}$	$\frac{T \cdot N}{84.51} = 1.183 \cdot T \cdot N \cdot 10^{-2}$	in. lb.
$\frac{T \cdot N}{10.08} \cdot 10^{-5} = 0.0992 \cdot T \cdot N \cdot 10^{-5}$	$\frac{T \cdot N}{1.351} \cdot 10^{-3} = 0.739 \cdot T \cdot N \cdot 10^{-3}$	in. oz.

N = rpm

REFERENCES:

1. "The Significance of WK² and How to Calculate It", Product Engineering June 27, 1960 page 39
2. ASME Handbook, Engineering Tables, McGraw Hill Co., 1956
3. "Calculating Mass Moments of Inertia" Product Engineering, Jan. 1956 page 215



POWER AS FUNCTION OF T AND N

To determine WR^2 of a shaft or disc, multiply numbers given in the table by the length of shaft or thickness of disc in inches.

For hollow shafts or rings, subtract WR^2 of the I.D. from the WR^2 of the O.D., and then multiply by length or thickness in inches.

Per Inch of Length or Thickness					
Dia. (in.)	WR^2 (lb. x ft. ²)	Dia. (in.)	WR^2 (lb. x ft. ²)	Dia. (in.)	WR^2 (lb. x ft. ²)
3/4	.00006	10-3/4	2.58	34	257.2
1	.0002	11	2.83	35	288.8
1-1/4	.0005	11-1/4	3.09	36	323.2
1-1/2	.001	11-1/2	3.38	37	360.7
1-3/4	.002	11-3/4	3.68	38	401.3
2	.003	12	4	39	445.3
2-1/4	.005	12-1/4	4.35	40	492.8
2-1/2	.008	12-1/2	4.72	41	543.9
2-3/4	.011	12-3/4	5.11	42	598.8
3	.016	13	5.58	43	658.1
3-1/2	.029	13-1/4	5.96	44	721.4
3-3/4	.038	13-1/2	6.42	45	789.3
4	.049	13-3/4	6.91	46	861.8
4-1/4	.063	14	7.42	47	939.3
4-1/2	.079	14-1/4	7.97	48	1021.8
5	.120	14-1/2	8.54	49	1109.6
5-1/2	.177	14-3/4	9.15	50	1203.1
6	.250	15	9.75	51	1302.2
6-1/4	.296	16	12.61	52	1407.4
6-1/2	.345	17	16.07	53	1518.8
6-3/4	.402	18	20.21	54	1636.7
7	.464	19	25.08	55	1761.4
7-1/4	.535	20	30.79	56	1893.1
7-1/2	.611	21	37.43	57	2031.9
7-3/4	.699	22	45.09	58	2178.3
8	.791	23	53.87	59	2332.5
8-1/4	.895	24	63.86	60	2494.7
8-1/2	1	25	75.19	66	3652.5
8-3/4	1.13	26	87.96	72	5172
9	1.27	27	102.3	78	7125
9-1/4	1.41	28	118.31	84	9584
9-1/2	1.55	29	136.14	90	12629
9-3/4	1.75	30	155.92	96	16349
10	1.93	31	177.77	102	20836
10-1/4	2.13	32	201.8		
10-1/2	2.35	33	228.2		

Power Conversion Equivalents

Horsepower Equals	42.44	BTU/min.
	33.000	ft. • lbs/min.
	550.00	ft. • lbs/sec.
	0.7457	kilowatts
	745.7	watts

Kilowatt Equals	56.92	BTU/min.
	44,260	ft. • lbs/min.
	737.6	ft. • lbs/sec.
	1.341	horsepower
	1000	watts

INERTIA CONVERSION TABLE

B A	lb • ft²	lb • ft • s² or slug • ft²	lb • in²	lb • in • s²	oz • in²	oz • in • s²	kg • cm²	kg • cm • s²	g • cm²	g • cm • s²
lb • ft²	1	3.108 x 10 ⁻²	144	.373	2.304 x 10 ³	5.968	421.40	0.4297	4.214 x 10 ⁵	429.71
lb • ft • s²	32.174	1	4.633 x 10 ³	12	7.413 x 10 ⁴	192	1.356 x 10 ⁴	13.825	1.356 x 10 ⁷	1.383 x 10 ⁴
lb • in²	6.944 x 10 ⁻³	2.158 x 10 ⁻⁴	1	2.590 x 10 ⁻³	16	4.144 x 10 ⁻²	2.926	2.984 x 10 ⁻³	2.926 x 10 ³	2.984
lb • in • s²	2.681	8.333 x 10 ⁻²	386.1	1	6.177 x 10 ³	16	1.130 x 10 ³	1.152	1.130 x 10 ⁶	1.152 x 10 ³
oz • in²	4.34 x 10 ⁻⁴	1.349 x 10 ⁻⁵	6.25 x 10 ⁻²	1.619 x 10 ⁻⁴	1	2.59 x 10 ⁻³	0.183	1.865 x 10 ⁻⁴	182.901	0.186
oz • in • s²	0.168	5.208 x 10 ⁻³	24.13	6.25 x 10 ⁻²	386.088	1	70.616	7.201 x 10 ⁻²	7.0616 x 10 ⁴	72.008
kg • cm²	2.373 x 10 ⁻³	7.376 x 10 ⁻⁵	0.3417	8.851 x 10 ⁻⁴	5.467	1.416 x 10 ⁻²	1	1.0197 x 10 ⁻³	1000	1.0197
kg • cm • s²	2.327	7.233 x 10 ⁻²	335.109	0.8679	5.362 x 10 ³	13.887	980.665	1	9.807 x 10 ⁵	1000
g • cm²	2.373 x 10 ⁻⁶	7.376 x 10 ⁻⁸	3.417 x 10 ⁻⁴	8.851 x 10 ⁻⁷	5.467 x 10 ⁻³	1.416 x 10 ⁻⁵	10 ⁻³	1.0197 x 10 ⁻⁶	1	1.0197 x 10 ⁻³
g • cm • s²	2.327 x 10 ⁻³	7.233 x 10 ⁻⁵	0.3351	8.680 x 10 ⁻⁴	5.362	1.389 x 10 ⁻²	.9807	10 ⁻³	980.667	1

NOTE: To convert from A to B multiply by entry in table.

Example: Convert a rotor inertia of 90 g • cm² to oz • in • sec.²
 The multiplier from the table above is 1.416 x 10⁻⁵
 The new inertia = 90 x 1.416 x 10⁻⁵ = 1.27 x 10³ oz • in • sec.²

COMPOSITE OF INCH AND METRIC DRILL SIZES



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I

R

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A

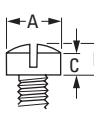
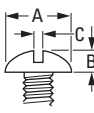
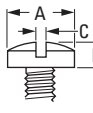
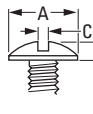
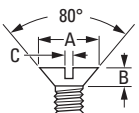
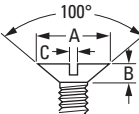
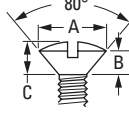
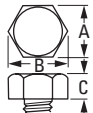

Drill Designation			Size		Drill Designation			Size		Drill Designation			Size	
Inch Series		Metric Series	Inches Dec. Equiv.	mm	Inch Series		Metric Series	Inches Dec. Equiv.	mm	Inch Series		Metric Series	Inches Dec. Equiv.	mm
Number or Letter Size	Fraction				Number or Letter Size	Fraction				Number or Letter Size	Fraction			
80	—	—	.0135	0.343	—	1/16	—	.0625	1.587	28	—	3.50	.1378	3.500
	—	0.35	.0138	0.350	—	—	1.60	.0630	1.600		—	—	.1405	3.569
79	—	—	.0145	0.368	52	—	—	.0635	1.613	9/64	—	—	.1406	3.571
	1/64	—	.0156	0.396	—	—	1.65	.0650	1.650	—	—	3.60	.1417	3.600
	—	0.40	.0158	0.400	—	—	1.70	.0669	1.700	27	—	—	.1440	3.658
78	—	—	.0160	0.406	51	—	—	.0670	1.702	—	—	3.70	.1457	3.700
	—	0.45	.0177	0.450	—	—	1.75	.0689	1.750	26	—	—	.1470	3.734
77	—	—	.0180	0.457	50	—	—	.0700	1.778	—	—	3.75	.1476	3.750
	—	0.50	.0197	0.500	—	—	1.80	.0709	1.800	25	—	—	.1495	3.797
76	—	—	.0200	0.508	—	—	1.85	.0728	1.850	—	—	3.80	.1496	3.800
	—	0.52	.0205	0.520	49	—	—	.0730	1.854	24	—	—	.1520	3.861
75	—	—	.0210	0.533	—	—	1.90	.0748	1.900	—	—	3.90	.1535	3.900
	—	0.55	.0217	0.550	48	—	—	.0760	1.930	23	—	—	.1540	3.912
74	—	—	.0225	0.572	—	—	1.95	.0768	1.950	5/32	—	—	.1562	3.967
	—	0.58	.0228	0.580	5/64	—	—	.0781	1.984	22	—	—	.1570	3.988
	—	0.60	.0236	0.600	47	—	—	.0785	1.994	—	—	4.00	.1575	4.000
73	—	—	.0240	0.610	—	—	2.00	.0787	2.000	21	—	—	.1590	4.039
	—	0.62	.0244	0.620	—	—	2.05	.0807	2.050	20	—	—	.1610	4.089
72	—	—	.0250	0.635	46	—	—	.0810	2.057	—	—	4.10	.1614	4.100
	—	0.65	.0256	0.650	45	—	—	.0820	2.083	—	—	4.20	.1654	4.200
	—	0.70	.0260	0.660	—	—	2.10	.0827	2.100	19	—	—	.1660	4.216
71	—	—	.0276	0.700	—	—	2.15	.0846	2.150	—	—	4.25	.1673	4.250
70	—	—	.0280	0.711	44	—	—	.0860	2.184	—	—	4.30	.1693	4.300
69	—	—	.0292	0.742	—	—	2.20	.0866	2.200	18	—	—	.1695	4.305
	—	0.75	.0295	0.750	—	—	2.25	.0886	2.250	11/64	—	—	.1719	4.366
68	—	—	.0310	0.787	43	—	—	.0890	2.261	17	—	—	.1730	4.394
	1/32	—	.0312	0.792	—	—	2.30	.0906	2.300	—	—	4.40	.1732	4.400
	—	0.80	.0315	0.800	—	—	2.35	.0925	2.350	16	—	—	.1770	4.496
67	—	—	.0320	0.813	42	—	—	.0935	2.375	—	—	4.50	.1772	4.500
66	—	—	.0330	0.838	3/32	—	—	.0937	2.380	15	—	—	.1800	4.572
	—	0.85	.0335	0.850	—	—	2.40	.0945	2.400	—	—	4.60	.1811	4.600
65	—	—	.0350	0.889	41	—	—	.0960	2.438	14	—	—	.1820	4.623
	—	0.90	.0354	0.900	—	—	2.45	.0965	2.450	13	—	—	.1850	4.700
64	—	—	.0360	0.914	40	—	—	.0980	2.489	—	—	4.70	.1850	4.700
63	—	—	.0370	0.940	—	—	2.50	.0984	2.500	—	—	4.75	.1870	4.750
	—	0.95	.0374	0.950	39	—	—	.0995	2.527	12	3/16	—	.1875	4.762
62	—	—	.0380	0.965	38	—	—	.1015	2.578	—	—	—	.1890	4.800
61	—	—	.0390	0.991	—	—	2.60	.1024	2.600	11	—	—	.1890	4.800
	—	1.00	.0394	1.000	37	—	—	.1040	2.642	—	—	4.80	.1910	4.851
60	—	—	.0400	1.016	—	—	2.70	.1063	2.700	—	—	4.90	.1929	4.900
	—	1.05	.0410	1.041	36	—	—	.1065	2.705	10	—	—	.1935	4.915
59	—	—	.0413	1.050	—	—	2.75	.1083	2.750	9	—	—	.1960	4.978
58	—	—	.0420	1.069	—	7/64	—	.1094	2.779	—	—	5.00	.1968	5.000
57	—	—	.0430	1.092	35	—	—	.1100	2.794	—	—	5.05	.1990	5.050
	—	1.10	.0433	1.100	—	—	2.80	.1102	2.800	8	—	—	.2000	5.080
	—	1.15	.0453	1.150	34	—	—	.1110	2.819	—	—	5.10	.2008	5.100
56	—	—	.0465	1.181	33	—	—	.1130	2.870	7	—	—	.2010	5.105
	3/64	—	.0469	1.191	—	—	2.90	.1142	2.900	—	13/64	—	.2031	5.159
	—	1.20	.0472	1.200	32	—	—	.1160	2.946	6	—	—	.2040	5.182
	—	1.25	.0492	1.250	—	—	3.00	.1181	3.000	—	—	5.20	.2047	5.200
	—	1.30	.0512	1.300	31	—	—	.1200	3.048	5	—	—	.2055	5.220
	—	0.520	.0520	1.321	—	—	3.10	.1220	3.100	—	—	5.25	.2067	5.250
	—	1.35	.0531	1.350	—	1/8	—	.1250	3.175	—	—	5.30	.2087	5.300
54	—	—	.0550	1.397	—	—	3.20	.1260	3.200	4	—	—	.2090	5.309
	—	1.40	.0551	1.400	—	—	3.25	.1280	3.250	—	—	5.40	.2126	5.400
	—	1.45	.0571	1.450	30	—	—	.1285	3.264	3	—	—	.2130	5.410
	—	1.50	.0591	1.500	—	—	3.30	.1299	3.300	—	—	5.50	.2165	5.500
53	—	—	.0595	1.511	—	—	3.40	.1339	3.400	—	7/32	—	.2187	5.555
	—	1.55	.0610	1.550	29	—	—	.1360	3.454	—	—	5.60	.2205	5.600

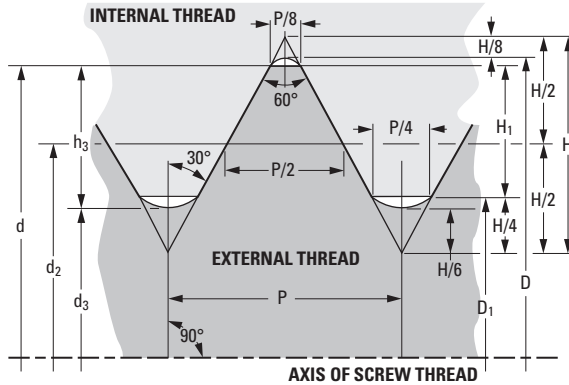
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Drill Designation			Size		Drill Designation			Size		Drill Designation			Size	
Inch Series		Metric Series	Inches Dec. Equiv.	mm	Inch Series		Metric Series	Inches Dec. Equiv.	mm	Inch Series		Metric Series	Inches Dec. Equiv.	mm
Number or Letter Size	Fraction				Number or Letter Size	Fraction				Number or Letter Size	Fraction			
2	—	—	.2210	5.613	R	—	—	.3390	8.611		37/64	—	.5781	14.684
	—	5.70	.2244	5.700		—	8.70	.3425	8.700		—	14.75	.5807	14.750
	—	5.75	.2264	5.750		11/32	—	.3437	8.730		—	15.00	.5906	15.000
1	—	—	.2280	5.791		—	8.75	.3445	8.750		19/32	—	.5937	15.080
	—	5.80	.2283	5.800		—	8.80	.3165	8.800		—	15.25	.6004	15.250
	—	5.90	.2323	5.900	S	—	—	.3480	8.839		39/64	—	.6094	15.479
A	—	—	.2340	5.944		—	8.90	.3504	8.900		—	15.50	.6102	15.500
	15/64	—	.2344	5.954		—	9.00	.3543	9.000		—	15.75	.6201	15.750
	—	6.00	.2362	6.000	T	—	—	.3580	9.093		5/8	—	.6250	15.875
B	—	—	.2380	6.045		—	9.10	.3583	9.100		—	16.00	.6299	16.000
	—	6.10	.2402	6.100		23/64	—	.3594	9.129		—	16.25	.6398	16.250
C	—	—	.2420	6.147		—	9.20	.3622	9.200		41/64	—	.6406	16.271
	—	6.20	.2441	6.200		—	9.25	.3642	9.250		—	16.50	.6496	16.500
D	—	—	.2460	6.248		—	9.30	.3661	9.300		21/32	—	.6562	16.667
	—	6.25	.2461	6.250	U	—	—	.3680	9.347		—	16.75	.6595	16.750
	—	6.30	.2480	6.300		—	9.40	.3701	9.400		—	17.00	.6693	17.000
E	1/4	—	.2500	6.350		—	9.50	.3740	9.500		43/64	—	.6719	17.066
	—	6.40	.2520	6.400		3/8	—	.3750	9.525		—	17.25	.6791	17.250
	—	6.50	.2559	6.500	V	—	—	.3770	9.576		11/16	—	.6875	17.462
F	—	—	.2570	6.528		—	9.60	.3780	9.600		—	17.50	.6890	17.500
	—	6.60	.2598	6.600		—	9.70	.3819	9.700		—	17.75	.6988	17.750
G	—	—	.2610	6.629		—	9.75	.3839	9.750		45/64	—	.7031	17.859
	—	6.70	.2638	6.700		—	9.80	.3858	9.800		—	18.00	.7087	18.000
	17/64	—	.2656	6.746		—	—	.3860	9.804		—	18.25	.7185	18.250
	—	6.75	.2657	6.750	W	—	9.90	.3898	9.900		23/32	—	.7187	18.255
H	—	—	.2660	6.756		25/64	—	.3906	9.921		—	18.50	.7283	18.500
	—	6.80	.2677	6.800		—	10.00	.3937	10.000		47/64	—	.7344	18.654
	—	6.90	.2717	6.900	X	—	—	.3970	10.084		—	18.75	.7382	18.750
I	—	—	.2720	6.909		—	10.10	.3976	10.100		—	19.00	.7480	19.000
	—	7.00	.2756	7.000		—	10.25	.4035	10.250		3/4	—	.7500	19.050
J	—	—	.2770	7.036	Y	—	—	.4040	10.262		—	19.25	.7579	19.250
	—	7.10	.2795	7.100		13/32	—	.4062	10.317		49/64	—	.7656	19.446
	—	—	.2810	7.137	Z	—	—	.4130	10.490		—	19.50	.7677	19.500
K	9/32	—	.2812	7.142		—	10.50	.4134	10.500		—	19.75	.7776	19.750
	—	7.20	.2835	7.200		27/64	—	.4219	10.716		25/32	—	.7812	19.842
	—	7.25	.2854	7.250		—	10.75	.4232	10.750		—	20.00	.7874	20.000
	—	7.30	.2874	7.300		—	11.00	.4331	11.000		51/64	—	.7969	20.241
L	—	—	.2900	7.366		7/16	—	.4375	11.112		—	20.50	.8071	20.500
	—	7.40	.2913	7.400		—	11.25	.4429	11.250		13/16	—	.8125	20.637
M	—	—	.2950	7.493		—	11.50	.4528	11.500		—	21.00	.8268	21.000
	—	7.50	.2953	7.500		29/64	—	.4531	11.509		53/64	—	.8281	21.034
	19/64	—	.2969	7.541		—	11.75	.4626	11.750		27/32	—	.8437	21.430
	—	7.60	.2992	7.600		15/32	—	.4687	11.905		—	21.50	.8465	21.500
N	—	—	.3020	7.671		—	12.00	.4724	12.000		55/64	—	.8594	21.829
	—	7.70	.3031	7.700		—	12.25	.4823	12.250		—	22.00	.8661	22.000
	—	7.75	.3051	7.750		31/64	—	.4844	12.304		7/8	—	.8750	22.225
	—	7.80	.3071	7.800		—	12.50	.4921	12.500		—	22.50	.8858	22.500
	—	7.90	.3110	7.900		1/2	—	.5000	12.700		57/64	—	.8906	22.621
	5/16	—	.3125	7.937		—	12.75	.5020	12.750		—	23.00	.9055	23.000
	—	8.00	.3150	8.000		—	13.00	.5118	13.000		29/32	—	.9062	23.017
	—	—	.3160	8.026		33/64	—	.5156	13.096		59/64	—	.9219	23.416
	—	8.10	.3189	8.100		—	13.25	.5217	13.250		—	23.50	.9250	23.500
	—	8.20	.3228	8.200		17/32	—	.5312	13.492		15/16	—	.9375	23.812
P	—	—	.3230	8.204		—	13.50	.5315	13.500		—	24.00	.9449	24.000
	—	8.25	.3248	8.250		—	13.75	.5413	13.750		61/64	—	.9531	24.209
	—	8.30	.3268	8.300		35/64	—	.5469	13.891		—	24.50	.9646	24.500
	21/64	—	.3281	8.334		—	14.00	.5512	14.000		31/32	—	.9687	24.605
	—	8.40	.3307	8.400		—	14.25	.5610	14.250		—	25.00	.9843	25.000
	—	—	.3320	8.433		9/16	—	.5625	14.287		63/64	—	.9844	25.004
Q	—	—	.3346	8.500		—	14.50	.5709	14.500		1	25.40	1.0000	25.400
	—	8.60	.3386	8.600		—	—	—	—		—	—	—	—

Screw Head Type	Screw Size		2	4	6	8	10	1/4"	5/16"	3/8"
	A	min.								
Fillister Head 	A	max.	.140	.183	.226	.270	.313	.414	.518	.622
		min.	.124	.166	.208	.250	.292	.389	.490	.590
	B	max.	.083	.107	.132	.156	.180	.237	.295	.355
		min.	.070	.094	.118	.141	.165	.219	.276	.333
	C	max.	.062	.079	.096	.113	.130	.170	.211	.253
		min.	.055	.072	.089	.106	.123	.161	.201	.242
Round Head 	A	max.	.162	.211	.260	.309	.359	.472	.590	.708
		min.	.146	.193	.240	.287	.334	.443	.557	.670
	B	max.	.069	.086	.103	.120	.137	.175	.216	.256
		min.	.059	.075	.091	.107	.123	.160	.198	.237
	C	max.	.031	.039	.048	.054	.060	.075	.084	.094
		min.	.023	.031	.039	.045	.050	.064	.072	.081
Pan Head (Binding) 	A	max.	.167	.219	.270	.322	.373	.492	.615	.740
		min.	.155	.205	.256	.306	.357	.473	.594	.716
	B	max.	.053	.068	.082	.096	.110	.144	.178	.212
		min.	.045	.058	.072	.085	.099	.130	.162	.195
	C	max.	.031	.039	.048	.054	.060	.075	.084	.094
		min.	.023	.031	.039	.045	.050	.064	.072	.081
Truss Head 	A	max.	.194	.257	.321	.384	.448	.573	.698	.823
		min.	.180	.241	.303	.364	.425	.546	.668	.787
	B	max.	.053	.069	.086	.102	.118	.150	.183	.215
		min.	.044	.059	.074	.088	.103	.133	.162	.191
	C	max.	.031	.039	.048	.054	.060	.075	.084	.094
		min.	.023	.031	.039	.045	.050	.064	.072	.081
Flat Head 	A	max.	.172	.225	.279	.332	.385	.507	.635	.762
		min.	.156	.207	.257	.308	.359	.477	.600	.722
	B	max.	.051	.067	.083	.100	.116	.153	.191	.230
		min.	.040	.055	.069	.084	.098	.131	.165	.200
	C	max.	.031	.039	.048	.054	.060	.075	.084	.094
		min.	.023	.031	.039	.045	.050	.064	.072	.081
Flat Head 	A	max.	.172	.225	.279	.332	.385	.507	.635	.762
		min.	.156	.207	.257	.308	.359	.477	.600	.722
	B	max.	.036	.048	.060	.072	.083	.110	.138	.165
		min.	.029	.040	.051	.062	.072	.097	.123	.148
	C	max.	.031	.039	.048	.054	.060	.075	.084	.094
		min.	.023	.031	.039	.045	.050	.064	.072	.081
Oval Head 	A	max.	.172	.225	.279	.332	.385	.507	.635	.762
		min.	.156	.207	.257	.308	.359	.477	.600	.722
	B	max.	.051	.067	.083	.100	.116	.153	.191	.230
		min.	.040	.055	.069	.084	.098	.131	.165	.200
	C	max.	.080	.104	.128	.152	.176	.232	.290	.347
		min.	.063	.084	.105	.126	.148	.187	.249	.300
Hex Head 	A	max.	.125	.187	.250	.250	.312	.375	.500	.562
		min.	.120	.181	.244	.244	.305	.367	.491	.552
	B	max.	.144	.217	.289	.289	.361	.433	.577	.650
		min.	.134	.205	.275	.275	.344	.413	.557	.621
	C	max.	.050	.060	.080	.110	.120	.190	.230	.295
		min.	.040	.049	.067	.096	.105	.172	.208	.270
Hex Socket Head 	A	max.	.140	.183	.226	.270	.312	.375	.468	.562
		min.	.136	.178	.221	.265	.306	.367	.457	.553
	B	max.	.086	.112	.138	.164	.190	.250	.312	.375
		min.	.083	.109	.134	.160	.185	.244	.306	.368



$$H = 0.86603P$$

$$h_3 = 0.61343P$$

$$H_1 = 0.54127P$$

$$r = \frac{H}{6} = 0.14434P$$

$$d_2 = d - 0.64953P \text{ (Effective Pitch Diameter)}$$

$$D_1 = d - 2H_1 \text{ (Minor Diameter – Internal)}$$

$$d_3 = d - 2h_3 \text{ (Minor Diameter – External)}$$

$$D = \text{(Major Diameter)}$$

d Basic Thread Designation	P Pitch mm	Threads Per Inch	Tap Drill mm	d ₂ Basic Pitch Diameter	Minor Diameter Limits			
					d ₃ – External		D ₁ – Internal	
					Min.	Max.	Min.	Max.
M1	0.25	101.6	0.75	0.83762	0.622	0.693	0.729	0.785
M1.6	0.35	72.6	1.25	1.37267	1.063	1.151	1.221	1.321
M2	0.4	63.5	1.6	1.74019	1.394	1.430	1.567	1.679
M2.5	0.45	56.5	2.05	2.20772	1.825	1.928	2.013	2.138
M3	0.5	50.8	2.5	2.67524	2.256	2.367	2.453	2.599
M3.5	0.6	42.3	2.9	3.11029	2.615	2.743	2.850	3.010
M4	0.7	36.3	3.3	3.54534	2.979	3.119	3.242	3.422
M5	0.8	31.8	4.2	4.01286	3.842	3.995	4.134	4.334
M6	1	25.4	5	5.35048	4.563	4.747	4.917	5.153
M8	1.25	20.3	6.75	7.18810	6.230	6.438	6.647	6.912
M10	1.5	16.9	8.5	9.02572	7.888	8.128	8.376	8.676

NOTE: Above limits are based on DIN 13 Sheet 13 for medium tolerance class.

For external threads:
 M1 – Tolerance 6h
 M1.6 and up – Tolerance 6g

For internal threads:
 M1 – Tolerance 5H
 M1.6 and up – Tolerance 6H