Dimensions
Mechanical and Performance Requirements

Tooth Lock Washers
- External, Steel & Stainless 154
- Internal, Steel & Stainless 155
- Countersunk External 156
- Combination External-Internal 157

Helical Spring Lock Washers
- High Alloy Split 158
- Regular Split, Carbon Steel 158
- Regular Split, Stainless 158
- Hi-Collar Split 159
- Heavy Split 160

Beveled Washers 161

Round Structural 162

Tension Indicating for Structural 163

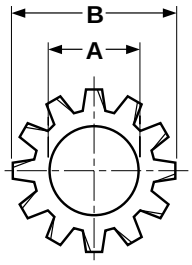
Tension Indicating for Grade 5 & 8 164

Dock Washers 165

Flat Washers
- USS, Low Carbon 166
- SAE, Low Carbon 167
- USS, Through-Hardened 168
- SAE, Through-Hardened 169
- USS, Extra Thick 170
- SAE, Extra Thick 171
- Fender 172
- Machine Screw 173
- Standard Flat, 18-8 Stainless Steel 174
- Standard Flat, 316 Stainless Steel 175

Countersunk Finishing Washers 176

External Tooth



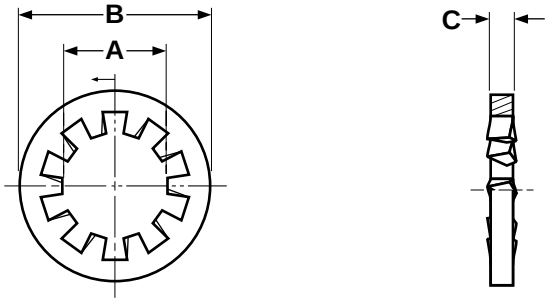
External Tooth Lock Washers

ASME B18.21.1-1999

Nominal Washer Size		A Inside Diameter		B Outside Diameter		C Thickness	
		Max	Min	Max	Min	Max	Min
#2	0.086	0.095	0.086	0.189	0.177	0.013	0.010
#3	0.099	0.109	0.102	0.235	0.220	0.016	0.010
#4	0.112	0.123	0.115	0.260	0.245	0.018	0.012
#5	0.125	0.136	0.129	0.285	0.270	0.020	0.014
#6	0.138	0.150	0.141	0.320	0.305	0.022	0.016
#8	0.164	0.176	0.168	0.381	0.365	0.023	0.018
#10	0.190	0.204	0.195	0.410	0.395	0.024	0.018
#12	0.216	0.231	0.221	0.475	0.460	0.027	0.020
1/4	0.250	0.267	0.256	0.510	0.494	0.028	0.023
5/16	0.3125	0.332	0.320	0.610	0.588	0.034	0.028
3/8	0.375	0.398	0.384	0.694	0.670	0.040	0.032
7/16	0.438	0.464	0.448	0.760	0.740	0.040	0.032
1/2	0.500	0.530	0.513	0.900	0.880	0.045	0.037
9/16	0.5625	0.596	0.576	0.985	0.960	0.045	0.037
5/8	0.625	0.663	0.641	1.070	1.045	0.050	0.042
3/4	0.750	0.795	0.768	1.260	1.220	0.055	0.047
7/8	0.875	0.927	0.897	1.410	1.380	0.060	0.052
1	1.000	1.060	1.025	1.620	1.590	0.067	0.059

Description	A hardened circular washer with twisted prongs or "teeth" which extend out from the outer edge of the washer.
Applications/ Advantages	This is the most preferable of all tooth-lock washers. It offers the greatest locking efficiency since the teeth are on the largest radius and provide greater torsional resistance.
Material	**Steel:** SAE 1050 - 1065 spring steel. **18-8 Stainless:** SAE 301 - 305 stainless steel. **316 Stainless:** SAE 316 stainless steel. **410 Stainless:** SAE 410 stainless steel.
Hardness	**Steel:** Rockwell C40 - 50 **18-8 Stainless:** Rockwell C20 - 45 **410 Stainless:** Rockwell C40 - 50
Plating	See Appendix-A for information on the plating of steel lock washers.

Internal Tooth Washers



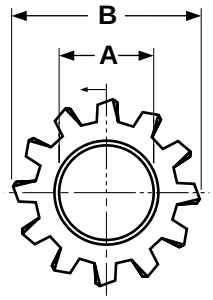
Internal Tooth Lock Washers

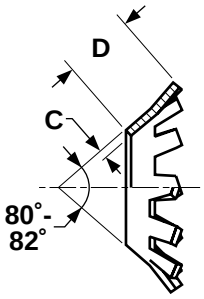
ASME B18.21.1-1999

Nominal Washer Size		A Inside Diameter		B Outside Diameter		C Thickness	
		Max	Min	Max	Min	Max	Min
#2	0.086	0.095	0.089	0.200	0.175	0.016	0.010
#3	0.099	0.109	0.102	0.232	0.215	0.016	0.010
#4	0.112	0.123	0.115	0.270	0.245	0.018	0.012
#5	0.125	0.136	0.129	0.280	0.255	0.020	0.014
#6	0.138	0.150	0.141	0.295	0.275	0.022	0.016
#8	0.164	0.176	0.168	0.340	0.325	0.023	0.018
#10	0.190	0.204	0.195	0.381	0.365	0.024	0.018
#12	0.216	0.231	0.221	0.410	0.394	0.027	0.020
1/4	0.250	0.267	0.256	0.478	0.460	0.028	0.023
5/16	0.312	0.332	0.320	0.610	0.594	0.034	0.028
3/8	0.375	0.398	0.384	0.692	0.670	0.040	0.032
7/16	0.438	0.464	0.448	0.789	0.740	0.040	0.032
1/2	0.500	0.530	0.512	0.900	0.867	0.045	0.037
9/16	0.5625	0.596	0.576	0.985	0.957	0.045	0.037
5/8	0.625	0.663	0.640	1.071	1.045	0.050	0.042
3/4	0.750	0.795	0.769	1.245	1.220	0.055	0.047
7/8	0.875	0.927	0.894	1.410	1.364	0.060	0.052
1	1.000	1.060	1.019	1.637	1.590	0.067	0.059
1/8	Pipe	0.425	0.410	0.615	0.595	0.022	0.017

Description	A hardened circular washer with twisted prongs or "teeth" which extend inward from the inside edge of the washer.
Applications/ Advantages	This is preferred when finished appearance is crucial and the teeth must be hidden under the head of the screw; also recommended for use with small heads such as fillisters.
Material	**Steel:** SAE 1050 - 1065 spring steel. **18-8 Stainless:** SAE 301 - 305 stainless steel. **316 Stainless:** SAE 316 stainless steel. **410 Stainless:** SAE 410 stainless steel.
Hardness	**Steel:** Rockwell C40 - 50 **18-8 Stainless:** Rockwell C20 - 45 **410 Stainless:** Rockwell C40 - 50
Plating	See Appendix-A for information on the plating of steel lock washers.

Countersunk External Tooth





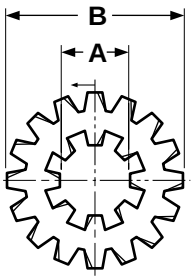
Countersunk External Tooth Lockwashers

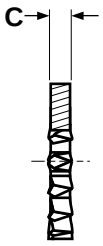
ASME B18.21.1-1999

Nominal Washer Size		A		B	C		D	
		Inside Diameter		Outside Diameter	Thickness		Length	
		Max	Min	Approx	Max	Min	Max	Min
4	0.112	0.123	0.113	0.213	0.019	0.015	0.065	0.050
6	0.138	0.150	0.140	0.289	0.021	0.017	0.092	0.082
8	0.164	0.177	0.167	0.322	0.021	0.017	0.099	0.083
10	0.190	0.205	0.195	0.354	0.025	0.020	0.105	0.088
12	0.216	0.231	0.220	0.421	0.025	0.020	0.128	0.118
1/4	0.250	0.267	0.255	0.454	0.025	0.020	0.128	0.113
5/16	0.3125	0.333	0.318	0.599	0.028	0.023	0.192	0.165
3/8	0.375	0.398	0.383	0.765	0.034	0.028	0.255	0.242
1/2	0.500	0.529	0.512	0.976	0.045	0.037	0.304	0.294

Description	An external tooth lock washer with a conical shaped bearing surface.
Applications/ Advantages	Designed for use with flat or oval head screws with countersunk angles of 82° or 100°.
Material	SAE 1050 - 1065 or equivalent spring steel
Hardness	Rockwell C40 - 50
Plating	See Appendix-A for information on the plating of steel lock washers.

Combination Tooth Washers





INTERNAL-EXTERNAL TOOTH LOCK WASHERS

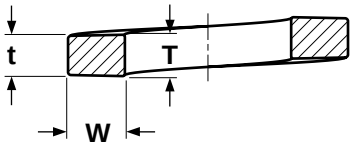
ASME B18.21.1 1999

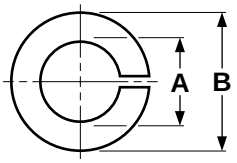
Nominal Washer Size		A		B		C	
		Inside Diameter		Outside Diameter *		Thickness	
		Max	Min	Max	Min	Max	Min
6	0.138	0.150	0.141	0.510	0.495	0.028	0.023
8	0.164	0.176	0.168	0.610	0.580	0.034	0.028
10	0.190	0.204	0.195	0.610	0.580	0.034	0.028
1/4	0.250	0.267	0.256	0.760	0.725	0.040	0.032
5/16	0.312	0.332	0.320	0.900	0.865	0.040	0.032
3/8	0.375	0.398	0.384	0.985	0.965	0.045	0.037
7/16	0.438	0.464	0.448	1.070	1.045	0.050	0.042
1/2	0.500	0.530	0.512	1.260	1.220	0.055	0.047
5/8	0.625	0.663	0.640	1.410	1.380	0.060	0.052

*Industry standards allow for washers with larger outside diameter dimensions.

Description	A hardened circular washer with twisted prongs or teeth protruding from both the inside and outer edges of the washer.
Applications/ Advantages	Preferred lockwasher in the following situations: (1) where a larger bearing surface is desired; (2) for an optimum electrical connection; (3) where the hole is oversized or out of round; (4) as an insert between two adjustable pieces where a longitudinal or rotational adjustment must be maintained.
Material	SAE 1050 - 1065 or equivalent spring steel
Hardness	Rockwell C40 - 50
Plating	See Appendix-A for information about the plating of steel lock washers.

Regular & High-Alloy Split





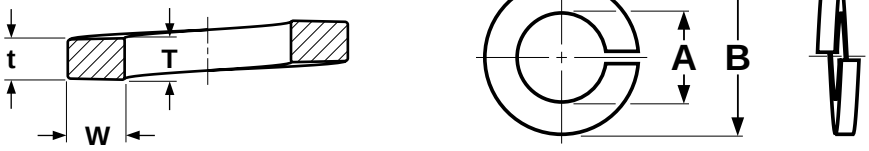
Regular & High Alloy Helical Spring Lockwashers

ASME B18.21.1-1999

Nominal Washer Size		A		B	(T+t)/2	W
		Inside Diameter		Outside Diameter	Mean Section Thickness	Section Width
		Max	Min	Max	Min	Min
#2	0.086	0.094	0.088	0.172	0.020	0.035
#3	0.099	0.107	0.101	0.195	0.025	0.040
#4	0.112	0.120	0.114	0.209	0.025	0.040
#5	0.125	0.133	0.127	0.236	0.031	0.047
#6	0.138	0.148	0.141	0.250	0.031	0.047
#8	0.164	0.174	0.167	0.293	0.040	0.055
#10	0.190	0.200	0.193	0.334	0.047	0.062
#12	0.216	0.227	0.220	0.377	0.056	0.070
1/4	0.250	0.260	0.252	0.487	0.062	0.109
5/16	0.312	0.322	0.314	0.583	0.078	0.125
3/8	0.375	0.385	0.377	0.680	0.094	0.141
7/16	0.438	0.450	0.440	0.776	0.109	0.156
1/2	0.500	0.512	0.502	0.869	0.125	0.171
9/16	0.562	0.574	0.564	0.965	0.141	0.188
5/8	0.625	0.641	0.628	1.073	0.156	0.203
3/4	0.750	0.766	0.753	1.265	0.188	0.234
7/8	0.875	0.894	0.878	1.459	0.219	0.266
1	1.000	1.024	1.003	1.656	0.250	0.297
1-1/8	1.125	1.153	1.129	1.847	0.281	0.328
1-1/4	1.250	1.280	1.254	2.036	0.312	0.359
1-3/8	1.375	1.408	1.379	2.219	0.344	0.391
1-1/2	1.500	1.534	1.504	2.419	0.375	0.422
1-3/4	1.750	1.789	1.758	2.679	0.389	0.424
2	2.000	2.039	2.008	2.936	0.422	0.427

Description	**Regular:** A coiled, hardened, split circular washer with a slightly trapezoidal wire section. **High-Alloy:** Dimensionally identical to a regular split lock washer but made from 4037 alloy steel (sizes over 1" are equivalent to heavy split lockwashers in size and material). **Stainless:** A regular split lock washer made from austenitic stainless steel.
Applications/ Advantages	**Regular:** (A) Applies greater bolt tension per unit of applied torque; (B) Provides a hardened bearing surface, creating more uniform torque control; (C) Provides more uniform load distribution; (D) Resists loosening caused by vibration and corrosion; (E) Is preferred lockwasher for use with hardened bearing surfaces. **High-Alloy:** Designed for use with Grade-5 & Grade-8 bolts and nuts. **Stainless:** For use with stainless nuts and screws of a similar stainless alloy in corrosive environments.
Material	**Carbon Steel:** SAE J403 1055 - 1065 carbon steel. **High-Alloy Steel:** 1/4 thru 1": SAE J404 4037 alloy steel; 1-1/8 thru 1-1/2": SAE J403 1055 - 1065 carbon steel **18-8 Stainless:** SAE J405 302 - 305 stainless steel. **316 Stainless:** SAE J405 316 stainless steel.
Hardness	**Carbon & High-Alloy Steel:** Rockwell C38 - 46 **Stainless:** Thru 5/8": Rockwell C35 - 43; Sizes over 5/8": Rockwell C32 - 43
Twist Test	With the washer in a vice with the split ends free and straight above the vice jaws, a 90° segment of the free end is gripped with a wrench and bent. Washers are to withstand being twisted through a 90° angle without signs of fracture. When the washer ultimately fractures beyond the prescribed 90° limit, the structure at the breaking point shall show a fine grain.
Plating	See Appendix-A for information about the plating of carbon steel and alloy steel lock washers.

Hi-Collar Helical Spring Washers

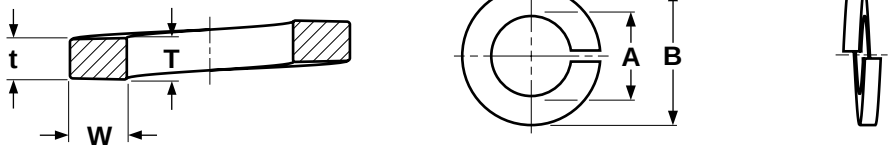


Hi-Collar Helical Spring Lock Washers

ASME B18.21.1-1999

Nominal Washer Size		A		B	W	$\frac{T+t}{2}$
		Inside Diameter		Outside Diameter	Washer Section	
					Width	Thickness
		Max	Min	Max	Min	Min
#4	0.112	0.120	0.114	0.173	0.022	0.022
#6	0.138	0.148	0.141	0.216	0.030	0.030
#8	0.164	0.174	0.167	0.267	0.042	0.047
#10	0.190	0.200	0.193	0.294	0.042	0.047
1/4	0.250	0.260	0.252	0.363	0.047	0.078
5/16	0.312	0.322	0.314	0.457	0.062	0.093
3/8	0.375	0.385	0.377	0.550	0.076	0.125
7/16	0.4375	0.450	0.440	0.644	0.090	0.140
1/2	0.500	0.512	0.502	0.733	0.103	0.172
9/16	0.5625	0.574	0.564	0.819	0.116	0.187
5/8	0.625	0.641	0.628	0.917	0.125	0.203
3/4	0.750	0.766	0.753	1.105	0.154	0.218
7/8	0.875	0.894	0.878	1.291	0.182	0.234
1	1.000	1.024	1.003	1.478	0.208	0.250
1 1/8	1.125	1.153	1.129	1.663	0.236	0.313
1 1/4	1.250	1.280	1.254	1.790	0.236	0.313
1 1/2	1.500	1.534	1.504	2.159	0.292	0.375

Description	A Hi-Collar washer is thicker and has a smaller outside diameter than a regular split lock washer.
Applications/ Advantages	Designed for use with smaller head screws, particularly sockets. Performs comparably to a regular split lock washer as a greater thickness compensates for smaller outside diameter.
Material	SAE 1055 - 1065 carbon steel
Hardness	Rockwell C38 - 46
Twist Test	With the washer in a vice with the split ends free and straight above the vice jaws, a 90° segment of the free end is gripped with a wrench and bent. Washers are to withstand being twisted through a 90° angle without signs of fracture. When the washer ultimately fractures beyond the prescribed 90° limit, the structure at the breaking point shall show a fine grain.
Plating	See Appendix-A for information about the plating of Hi-Collar split lock washers.



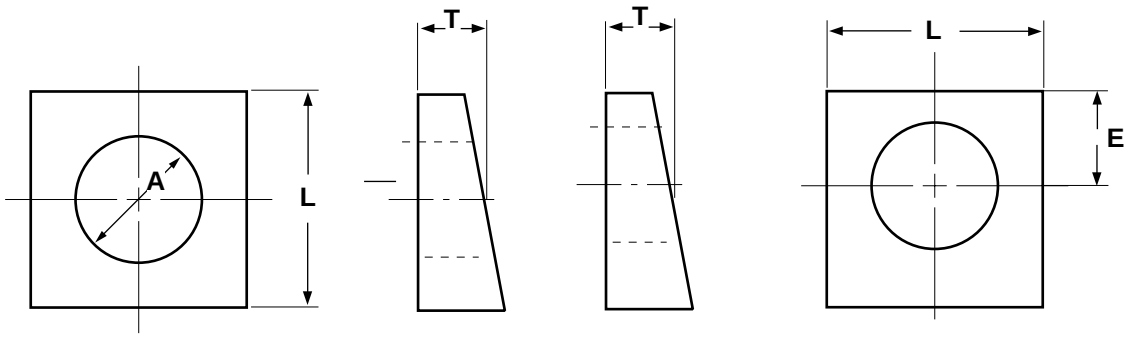
HEAVY SPLIT HELICAL SPRING LOCK WASHERS

ASME B18.21.1-1999

Nominal Washer Size		A		B	(T+t)/2	W
		Inside Diameter		Outside Diameter	Mean Section Thickness	Section Width
		Max	Min		Min	Min
#10	0.190	0.200	0.193	0.350	0.056	0.070
1/4	0.250	0.260	0.252	0.489	0.077	0.110
5/16	0.312	0.322	0.314	0.593	0.097	0.130
3/8	0.375	0.385	0.377	0.688	0.115	0.145
7/16	0.438	0.450	0.440	0.784	0.133	0.160
1/2	0.500	0.512	0.502	0.879	0.151	0.176
9/16	0.562	0.574	0.564	0.975	0.170	0.193
5/8	0.625	0.641	0.628	1.087	0.189	0.210
3/4	0.750	0.766	0.753	1.285	0.226	0.244
7/8	0.875	0.894	0.878	1.489	0.266	0.281
1	1.000	1.024	1.003	1.700	0.306	0.319
1-1/4	1.250	1.280	1.254	2.104	0.384	0.393

Description	Similar to a regular split lock washer, but with a greater outside diameter and thickness.
Applications/ Advantages	The increased bearing area makes this suitable for applications involving higher tightening torques.
Material	SAE 1055 - 1065 carbon steel.
Hardness	Rockwell C38 - 46
Twist Test	With the washer in a vice with the split ends free and straight above the vice jaws, a 90° segment of the free end is gripped with a wrench and bent. Washers are to withstand being twisted through a 90° angle without signs of fracture. When the washer ultimately fractures beyond the prescribed 90° limit, the structure at the breaking point shall show a fine grain.
Plating	See Appendix-A for information about plating heavy split lock washers.

Steel *Beveled* Washers



Square Beveled **Clipped Square Beveled**

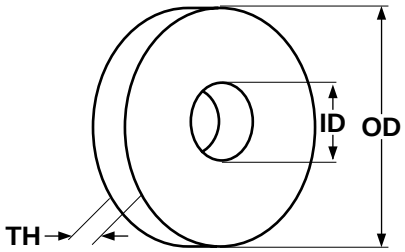
HARDENED BEVELED WASHERS

ASME B18.2.6-1996

Nominal Washer Size		Inside Diameter - A			L	T	E
		Basic	Tolerance		Minimum Side Length	Thickness	Minimum Edge Distance
			Plus	Minus			
1/2	0.500	0.531	0.0313	0	1.750	0.313	0.438
5/8	0.625	0.688	0.0313	0	1.750	0.313	0.547
3/4	0.750	0.813	0.0313	0	1.750	0.313	0.656
7/8	0.875	0.938	0.0313	0	1.750	0.313	0.766
1	1.000	1.125	0.0313	0	1.750	0.313	0.875
1-1/8	1.125	1.250	0.0313	0	2.250	0.313	0.984
1-1/4	1.250	1.375	0.0313	0	2.250	0.313	1.094
1-3/8	1.375	1.500	0.0313	0	2.250	0.313	1.203
1-1/2	1.500	1.625	0.0313	0	2.250	0.313	1.313

Description	A flat washer which can be square or circular, with one bearing surface having an oblique angle.
Applications/ Advantages	Commonly used when fastening bolts through the flanges of "I" beams.
Material	Washers shall be made from a carbon steel which conforms to the following chemical composition requirements (heat analysis): *Phosphorus:* 0.040% maximum; *Sulfur:* 0.050% maximum
Hardness	Plain or Zinc-plated - Rockwell C 38 - 45 Hot-Dip Galvanized - Rockwell C 26 - 45
Plating	See Appendix-A for plating information.

Round, Structural ASTM F436



ASTM F436 Round Structural Washers

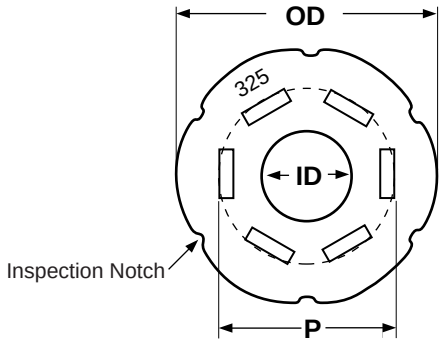
ASTM F436

Bolt Size	OD		ID		TH	
	Outside Diameter		Inside Diameter		Thickness	
	Max	Min	Max	Min	Max	Min
1/2	1.094	1.031	.562	.531	.177	.097
5/8	1.344	1.281	.719	.687	.177	.122
3/4	1.500	1.438	.843	.812	.177	.122
7/8	1.781	1.719	.969	.938	.177	.136
1	2.031	1.969	1.156	1.125	.177	.136

Description	Dimensionally comparable to the USS plain washer, but with a smaller outside diameter, manufactured from a higher grade of steel and heat-treated.
Applications/ Advantages	Designed to be used with A325 & A490 structural bolts.
Material	Structural washers shall be manufactured from a steel which conforms to the following chemical composition requirements: *Phosphorous*- 0.050%; *Sulfur*- 0.060%
Hardness	Rockwell C38 - 45
Plating	Structural washers are usually supplied plain or with a galvanized finish.

For Use with Structural Fasteners

Tension Indicating Washers



ASTM F959 Direct Tension Indicator Washers - used w/type 325 Structural Fasteners — ASTM F959

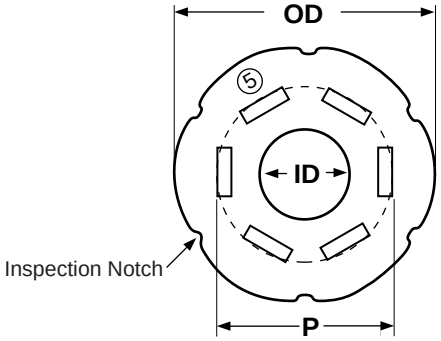
Nominal Size	OD		ID		TH		P	Number of Protrusions (equally spaced)	Compression Load Range (lbs.)	
	Outside Diameter		Inside Diameter		Thickness		Protrusion Tangential Diameter			
	Max	Min	Max	Min	With Protrusion Max	Without Protrusion Min	Max		Max	Min
1/2	1.187	1.167	0.527	0.523	0.180	0.104	0.788	4	14,000	12,000
5/8	1.375	1.355	0.658	0.654	0.220	0.126	0.956	4	23,000	19,000
3/4	1.625	1.605	0.790	0.786	0.230	0.126	1.125	5	34,000	28,000
7/8	1.875	1.855	0.921	0.917	0.240	0.142	1.294	5	47,000	39,000
1	2.000	1.980	1.052	1.048	0.270	0.158	1.463	6	61,000	51,000
1 1/8	2.250	2.230	1.183	1.179	0.270	0.158	1.631	6	67,000	56,000
1 1/4	2.500	2.480	1.315	1.311	0.270	0.158	1.800	7	85,000	71,000
1 3/8	2.750	2.730	1.446	1.442	0.270	0.158	1.969	7	102,000	85,000
1 1/2	3.000	2.980	1.577	1.573	0.270	0.158	2.138	8	124,000	103,000

Description	A round washer with notches formed into its outer edge, protrusions equally spaced from each other on the top face and corresponding pockets on the bottom face.
Applications/ Advantages	These washers are designed to be used with A325 structural bolts. The washer is placed beneath the head of the bolt and as the bolt is tightened, the protrusions compress. When the protrusions have been flattened a sufficient amount the fastening has achieved the proper tension. Direct tension indicators are not affected by the presence of oil or other lubricants, and they measure tension regardless of surface condition. They help ensure proper tension is achieved even when a simple box wrench or socket wrench are the only tools that can be used to tighten the screw.
Material	Direct tension indicator washers shall be manufactured from a steel which conforms to the following chemical composition requirements (product analysis): *Carbon*- 0.27-0.53%; *Manganese*- 0.47-0.93%; *Phosphorous*- 0.043% maximum; *Sulfur*- 0.048% maximum; *Silicon*- 0.13-0.37%
Heat Treatment	Parts shall be through hardened by heating to a temperature above the upper transformation temperature, quenched in liquid, then retempered by reheating to a suitable temperature to achieve the listed mechanical and performance requirements.
Hardness	Rockwell C35 maximum
Plating	Direct tension indicator washers are usually supplied plain or zinc plated.

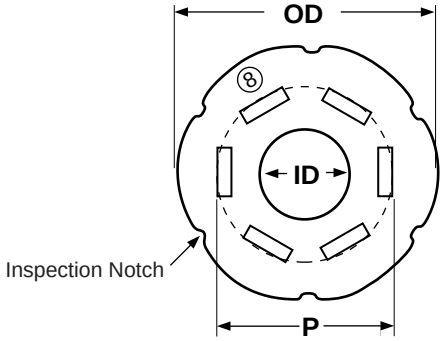
Washers

Tension Indicating

For Use with Grades 5 & 8 Fasteners



GRADE 5



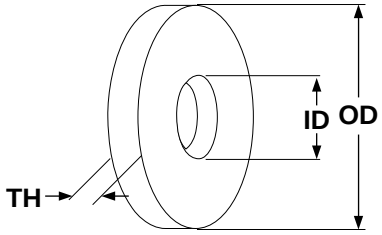
GRADE 8

DIRECT TENSION INDICATOR WASHERS - USED W/ GRADES 5 & 8 FASTENERS — SAE J 2486

Nominal Size	OD	ID		TH	P	Grade 5 Loads		Grade 8 Loads	
	Outside Diameter	Inside Diameter		Thickness	Protrusion Bearing Diameter	Target Clamp Load	Proof Load	Target Clamp Load	Proof Load
	Max	Max	Min	Min	Max		Min		Min
1/2	0.970	0.527	0.523	0.104	0.675	10,197	12,100	14,396	17,000
5/8	1.224	0.658	0.654	0.126	0.844	16,317	19,200	23,036	27,100
3/4	1.494	0.790	0.786	0.142	1.012	23,776	28,400	33,567	40,100
7/8	1.650	0.921	0.917	0.158	1.181	32,449	39,300	45,825	55,400
1	1.866	1.052	1.048	0.158	1.350	42,269	51,500	59,674	72,700
1 1/8	2.083	1.183	1.179	0.158	1.519	47,508	56,500	77,040	91,600
1 1/4	2.299	1.315	1.311	0.193	1.688	59,552	71,700	96,570	116,300
1 1/2	2.732	1.577	1.573	0.193	2.025	87,746	104,000	142,290	169,200

Description	A round washer with notches formed into its outer edge, protrusions on the top face equally spaced from each other, and corresponding pockets on the bottom face.
Applications/ Advantages	These washers are designed to be used with grade 5 and grade 8 cap screws. The washer is placed beneath the head of the cap screw and as the screw is tightened, the protrusions compress. When the protrusions have been flattened a sufficient amount the fastening has achieved the proper tension. Direct tension indicators are not affected by the presence of oil or other lubricants, and they measure tension regardless of surface condition. They help ensure proper tension is achieved even when a simple box wrench or socket wrench are the only tools that can be used to tighten the screw. They are used in the fleet industry, off-highway vehicles, construction, mining, and other heavy industrial equipment.
Material	Direct tension indicator washers shall be manufactured from a steel which conforms to the following chemical composition requirements (product analysis): *Carbon*- 0.27-0.53%; *Manganese*- 0.47-0.93%; *Phosphorous*- 0.043% maximum; *Sulfur*- 0.048% maximum; *Silicon*- 0.13-0.37%
Heat Treatment	Parts shall be through hardened by heating to a temperature above the upper transformation temperature, quenched in liquid, then retempered by reheating to a suitable temperature to achieve the listed mechanical and performance requirements.
Hardness	Rockwell C35 maximum
Plating	Direct tension indicator washers are usually supplied plain or zinc plated.

Steel *Dock* Washers



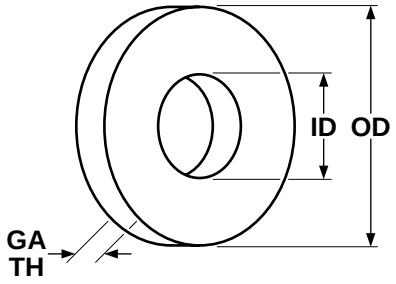
Dock Washers						
Bolt Size (In.)	ID		OD		TH	
	Inside Diameter		Outside Diameter		Thickness	
	Max	Min	Max	Min	Max	Min
1/2	.578	.558	3.020	2.993	.280	.230
5/8	.718	.681	3.020	2.993	.280	.230
3/4	.843	.806	3.020	2.993	.280	.230
7/8	.968	.931	3.020	2.993	.280	.230
1	1.093	1.056	3.280	3.240	.280	.230

Description	A circular flat washer that is significantly thicker than most other washers and has greater surface area than even fender washers.
Applications/ Advantages	Commonly used in dock and construction applications where thicker washers are required but a low carbon part is acceptable.
Material	Washers are punched from hot-rolled or hot-rolled and pickled steel.
Plating	Dock washers are provided in both plain and hot-dip galvanized finishes.

Washers

USS Flat

Low Carbon Steel



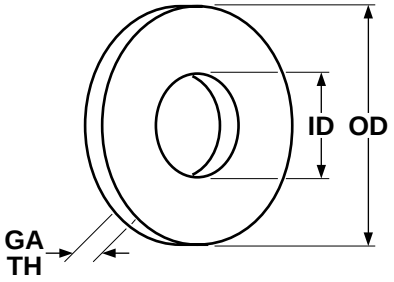
USS Low Carbon Washers

ANSI B18.22.1

Bolt Size	Outside Diameter			Inside Diameter			Thickness			Approximate Number per 50 Pounds
	Nominal	Max	Min	Nominal	Max	Min	American Standard (Gauge)	Max	Min	
3/16	9/16	0.577	0.557	1/4	0.265	0.245	18 (3/64)	.065	.036	18050
1/4	3/4	0.749	0.727	5/16	0.327	0.307	16 (1/16)	.080	.051	7450
5/16	7/8	0.905	0.868	3/8	0.390	0.370	14 (5/64)	.104	.064	4350
3/8	1	1.030	0.993	7/16	0.453	0.433	14 (5/64)	.104	.064	3350
7/16	1-1/4	1.280	1.243	1/2	0.515	0.495	14 (5/64)	.104	.064	2050
1/2	1-3/8	1.405	1.368	9/16	0.577	0.557	12 (7/64)	.132	.086	1300
9/16	1-1/2	1.499	1.462	5/8	0.640	0.620	21 (7/64)	.132	.086	1100
5/8	1-3/4	1.780	1.743	11/16	0.718	0.681	10 (9/64)	.160	.108	650
3/4	2	2.030	1.993	13/16	0.842	0.805	9 (5/32)	.177	.122	455
7/8	2-1/4	2.280	2.243	15/16	0.968	0.931	8 (11/64)	.192	.136	325
1	2-1/2	2.530	2.493	1-1/16	1.092	1.055	8 (11/64)	.192	.136	265
1-1/8	2-3/4	2.780	2.743	1-1/4	1.280	1.243	8 (11/64)	.192	.136	225
1-1/4	3	3.030	2.993	1-3/8	1.405	1.368	8 (11/64)	.192	.136	190
1-3/8	3-1/4	3.295	3.240	1-1/2	1.545	1.490	7 (3/16)	.213	.153	150
1-1/2	3-1/2	3.545	3.490	1-5/8	1.670	1.615	7 (3/16)	.213	.153	130
1-5/8	3-3/4	3.795	3.740	1-3/4	1.795	1.740	7 (3/16)	.213	.153	115
1-3/4	4	4.045	3.990	1-7/8	1.920	1.865	7 (3/16)	.213	.153	100
1-7/8	4-1/4	4.295	4.240	2	2.045	1.990	7 (3/16)	.213	.153	90
2	4-1/2	4.545	4.490	2-1/8	2.170	2.115	7 (3/16)	.213	.153	79
2-1/4	4-3/4	4.795	4.740	2-3/8	2.420	2.365	5 (7/32)	.248	.193	60
2-1/2	5	5.045	4.990	2-5/8	2.670	2.615	4 (15/64)	.280	.210	52
2-3/4	5-1/4	5.315	5.240	2-7/8	2.940	2.865	3 (1/4)	.310	.228	45
3	5-1/2	5.565	5.490	3-1/8	3.190	3.115	2 (5/32)	.327	.249	43

Description	A thin, flat, circular steel part with a centrally located hole.
Applications/ Advantages	Washers are designed for assembly around a bolt or screw, between the bearing surface of the fastener and the part to which it is attached. Flat washers are used to improve stress distribution, and to span large clearance holes. USS washers are designed to meet the majority of industrial applications in manufacturing, maintenance and repair.
Material	Plain washers shall be punched from hot-rolled, hot-rolled and pickled, or cold-rolled steel, or shall be machined from bar stock or tubing, or may be forged at the manufacturer's option.
Plating	See Appendix-A for information about the plating of low carbon flat washers.

Low Carbon Steel *SAE Flat* Washers



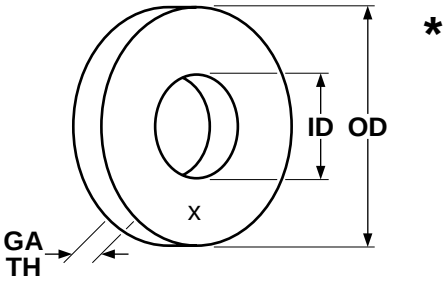
SAE Low Carbon Washers

ANSI B18.22.1

Bolt Size	Outside Diameter			Inside Diameter			Thickness			Approximate Number per 50 Pounds
	Nominal	Max	Min	Nominal	Max	Min	American Standard (Gauge)	Max	Min	
4	5/16	0.320	0.307	1/8	0.133	0.120	(1/32)	.040	.025	83300
6	3/8	0.390	0.370	5/32	0.164	0.151	18 (3/64)	.065	.036	39500
8	7/16	0.453	0.433	3/16	0.196	0.183	18 (3/64)	.065	.036	29500
10	1/2	0.515	0.495	7/32	0.227	0.214	18 (3/64)	.065	.036	22750
3/16	9/16	0.577	0.557	1/4	0.265	0.245	18 (3/64)	.065	.036	
12	9/16	0.577	0.557	1/4	0.265	0.245	16 (1/16)	.080	.051	14700
1/4	5/8	0.640	0.620	9/32	0.296	0.276	16 (1/16)	.080	.051	11100
5/16	11/16	0.703	0.681	11/32	0.359	0.339	16 (1/16)	.080	.051	9750
3/8	13/16	0.827	0.805	13/32	0.419	0.401	16 (1/16)	.080	.051	7000
7/16	59/64	0.937	0.915	15/32	0.484	0.464	16 (1/16)	.080	.051	5500
1/2	1-1/16	1.092	1.055	17/32	0.546	0.526	13 (3/32)	.121	.074	2800
9/16	1-3/16	1.186	1.149	19/32	0.609	0.589	13 (3/32)	.121	.074	2250
5/8	1-5/16	1.342	1.305	21/32	0.686	0.649	13 (3/32)	.121	.074	1850
3/4	1-1/2	1.499	1.462	13/16	0.842	0.805	10 (9/64)	.160	.108	1050
7/8	1-3/4	1.780	1.743	15/16	0.968	0.931	10 (9/64)	.160	.108	775
1	2	2.030	1.993	1-1/16	1.092	1.055	10 (9/64)	.160	.108	585
1-1/8	2-1/4	2.280	2.243	1-3/16	1.280	1.243	10 (9/64)	.160	.108	460
1-1/4	2-1/2	2.530	2.493	1-5/16	1.405	1.368	9 (5/32)	.192	.136	335
1-3/8	2-3/4	2.780	2.743	1-7/16	1.530	1.493	9 (5/32)	.213	.136	275
1-1/2	3	3.030	2.993	1-9/16	1.655	1.618	9 (5/32)	.213	.153	230

Description	Similar to a USS washer, but with slightly smaller inside and outside diameters. Also, most but not all SAE washers are made from thinner materials than USS washers.
Applications/ Advantages	SAE washers were designed to serve similar purposes as the USS washers, but specifically to meet the requirements in the field of automotive engineering.
Material	Plain washers shall be punched from hot-rolled, hot-rolled and pickled, or cold-rolled steel, or shall be machined from bar stock or tubing, or may be forged at the manufacturer's option.
Plating	See Appendix-A for information about the plating of steel flat washers.

USS Through-Hardened Flat



USS Through-Hardened Flat Washers

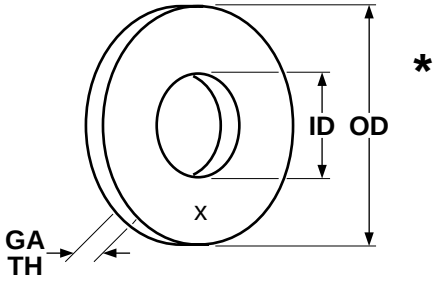
ANSI B18.22.1, Wrought Washer

Bolt Size	Outside Diameter			Inside Diameter			Thickness		Approximate Number per 50 Pounds
	Nominal	Max	Min	Nominal	Max	Min	Max	Min	
1/4	3/4	0.749	0.727	5/16	0.327	0.307	.072	.055	7500
5/16	7/8	0.905	0.868	3/8	0.390	0.370	.080	.064	5000
3/8	1	1.030	0.993	7/16	0.453	0.433	.080	.064	3500
7/16	1-1/4	1.280	1.243	1/2	0.515	0.495	.080	.064	2500
1/2	1-3/8	1.405	1.368	9/16	0.577	0.557	.121	.097	1500
9/16	1-1/2	1.499	1.462	5/8	0.640	0.620	.121	.097	1100
5/8	1-3/4	1.780	1.743	21/32	0.687	0.649	.146	.122	700
3/4	2	2.030	1.993	13/16	0.842	0.805	.146	.122	500
7/8	2-1/4	2.280	2.243	15/16	0.968	0.931	.160	.136	350
1	2-1/2	2.530	2.493	1-1/16	1.092	1.055	.160	.136	300
1-1/8	2-3/4	2.780	2.743	1-1/4	1.280	1.243	.160	.136	250
1-1/4	3	3.030	2.993	1-3/8	1.405	1.368	.160	.136	200
1-1/2	3-1/2	3.545	3.490	1-5/8	1.670	1.615	.160	.136	150

Description	Dimensionally similar to the USS plain washer counterparts, but with tighter tolerances on thickness, manufactured from a higher grade of steel and heat-treated.
Applications/ Advantages	Designed to perform the same functions as USS plain washers, but for use specifically with high-strength hardened steel bolts.
Material	SAE 1035 - 1050 steel
Hardness	Rockwell C38 - 45
Plating	See Appendix-A for information about the plating of through-hardened flat washers.

*Product standards require all through-hardened washers 1/4" diameter and larger to bear the insignia identifying its manufacturer. "X" represents one location such an insignia may appear.

Flat *SAE Through-Hardened* Washers



SAE Through-Hardened Flat Washers

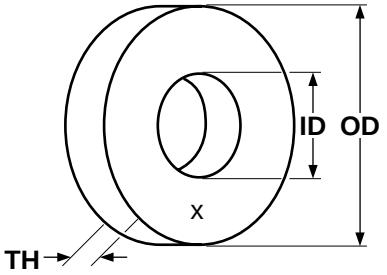
ANSI B18.22.1, Wrought Washer

Bolt Size	Outside Diameter			Inside Diameter			Thickness		Approximate Number per 50 Pounds
	Nominal	Max	Min	Nominal	Max	Min	Max	Min	
6	3/8	0.390	0.370	5/32	0.164	0.151	.065	.036	39500
8	7/16	0.453	0.433	3/16	0.196	0.183	.065	.036	29500
10	1/2	0.515	0.495	7/32	0.227	0.214	.065	.036	22750
12	9/16	0.577	0.557	1/4	0.265	0.245	.080	.051	14700
1/4	5/8	0.640	0.620	9/32	0.296	0.276	.072	.055	10000
5/16	11/16	0.703	0.681	11/32	0.359	0.339	.072	.055	10000
3/8	13/16	0.827	0.805	13/32	0.419	0.401	.072	.055	7000
7/16	59/64	0.937	0.915	15/32	0.484	0.464	.072	.055	5000
1/2	1-1/16	1.092	1.055	17/32	0.546	0.526	.121	.097	2425
9/16	1-3/16	1.186	1.149	19/32	0.609	0.589	.121	.097	2250
5/8	1-5/16	1.342	1.305	21/32	0.686	0.649	.146	.122	1340
3/4	1-15/32	1.499	1.462	13/16	0.842	0.805	.146	.122	1120
7/8	1-3/4	1.780	1.743	15/16	0.968	0.931	.160	.136	695
1	2	2.030	1.993	1-1/16	1.092	1.055	.160	.136	555
1-1/8	2-1/4	2.280	2.243	1-1/4	1.280	1.243	.160	.136	435
1-1/4	2-1/2	2.530	2.493	1-3/8	1.405	1.368	.160	.136	350
1-1/2	3	3.030	2.993	1-5/8	1.655	1.618	.160	.136	240
1-3/4	3-3/8	3.405	3.368	1-7/8	1.905	1.868	.201	.178	150
2	3-3/4	3.780	3.748	2-1/8	2.155	2.118	.201	.178	125

Description	Dimensionally equivalent to the low carbon SAE flat washer counterparts, but with tighter tolerances on thickness, manufactured from a higher grade of steel and heat-treated.
Applications/ Advantages	Designed to perform the same functions as low carbon SAE flat washers, but for use specifically with high-strength hardened steel bolts.
Material	SAE 1035 - 1050 steel
Hardness	Rockwell C38 - 45
Plating	See Appendix-A for information about the plating of through-hardened flat washers.

*Product standards require all through-hardened washers 1/4" diameter and larger to bear the insignia identifying its manufacturer. "X" represents one location such an insignia may appear.

USS Through-Hardened Extra Thick



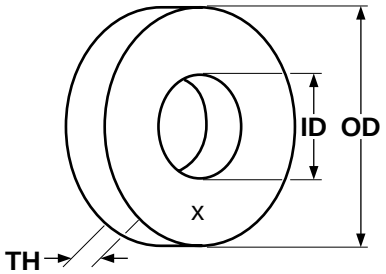
USS Through-Hardened Flat Washers-Extra Thick

ANSI B18.22.1, Wrought Washer

Bolt Size	Outside Diameter			Inside Diameter			Thickness		Approximate Number per 50 Pounds
	Nominal	Max	Min	Nominal	Max	Min	Max	Min	
1/4	3/4	0.749	0.727	5/16	0.327	0.307	.080	.064	6600
5/16	7/8	0.905	0.868	3/8	0.390	0.370	.093	.079	4200
3/8	1	1.030	0.993	7/16	0.453	0.433	.093	.079	3250
7/16	1-1/4	1.280	1.243	1/2	0.515	0.495	.106	.090	1750
1/2	1-3/8	1.405	1.368	9/16	0.577	0.557	.146	.122	1100
9/16	1-1/2	1.499	1.462	5/8	0.640	0.620	.146	.122	950
5/8	1-3/4	1.780	1.743	21/32	0.687	0.649	.160	.136	550
3/4	2	2.030	1.993	13/16	0.842	0.805	.160	.136	450
7/8	2-1/4	2.280	2.243	15/16	0.968	0.931	.160	.136	375
1	2-1/2	2.530	2.493	1-1/16	1.092	1.055	.160	.136	300

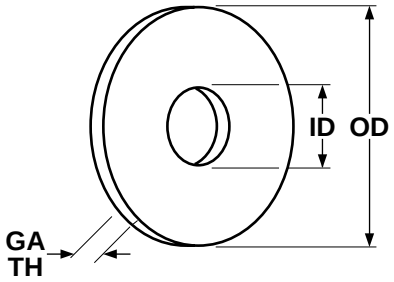
Description	Has identical inside and outside diameters as USS thru-hardened washer, but can be as much as 50% thicker. They are manufactured from a medium grade of steel and heat-treated.
Applications/ Advantages	Designed for heavy duty use in machinery construction, assembly, in-plant maintenance and building construction
Material	SAE 1035 - 1050 steel
Hardness	Rockwell C38 - 45
Plating	Parts are mechanically zinc yellow plated.

Extra Thick *SAE Through-Hardened* Washers



SAE THROUGH-HARDENED FLAT WASHERS - EXTRA THICK									ASME B18.22.1, Wrought Washer
Bolt Size	Outside Diameter			Inside Diameter			Thickness		Approximate Number per 50 Pounds
	Nominal	Max	Min	Nominal	Max	Min	Max	Min	
1/4	5/8	0.640	0.620	9/32	0.296	0.276	.080	.064	9400
5/16	11/16	0.703	0.681	11/32	0.359	0.339	.093	.079	8000
3/8	13/16	0.827	0.805	13/32	0.419	0.401	.093	.079	5300
7/16	59/64	0.937	0.915	15/32	0.484	0.464	.106	.090	3600
1/2	1-1/16	1.092	1.055	17/32	0.546	0.526	.146	.122	2000
9/16	1-3/16	1.186	1.149	19/32	0.609	0.589	.146	.122	1600
5/8	1-5/16	1.342	1.305	21/32	0.686	0.649	.160	.136	1150
3/4	1-15/32	1.499	1.462	13/16	0.842	0.805	.160	.136	950
7/8	1-3/4	1.780	1.743	15/16	0.968	0.931	.160	.136	650
1	2	2.030	1.993	1-1/16	1.092	1.055	.160	.136	500

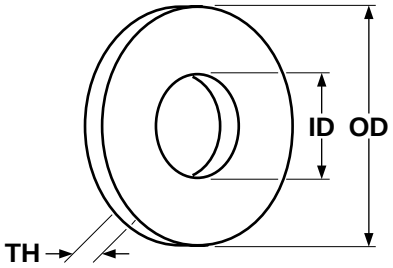
Description	Has identical inside and outside diameters as SAE thru-hardened washer, but can be as much as 50% thicker. They are manufactured from a medium grade of steel and heat-treated.
Applications/ Advantages	Designed for heavy duty use in machinery construction, assembly, in-plant maintenance and building construction
Material	SAE 1035 - 1050 steel
Hardness	Rockwell C38 - 45
Plating	Parts are mechanically zinc yellow plated.



Fender Washers

Bolt Size	Inside Diameter (+0, -.010)	Outside Diameter (+0, -.010)	Thickness		Approximate Number in 50 Pounds (Steel)
			Max	Min	
10	7/32	11/16	.080	.051	
10	7/32	3/4	.080	.051	
10	7/32	7/8	.080	.051	5000
10	7/32	1	.080	.051	3500
10	7/32	1-1/4	.080	.051	3000
1/4	9/32	1	.080	.051	3750
1/4	9/32	1-1/4	.080	.051	2300
1/4	9/32	1-1/2	.080	.051	1550
5/16	11/32	1-1/4	.080	.051	2400
5/16	11/32	1-1/2	.080	.051	1600
3/8	13/32	1-1/4	.080	.051	2350
3/8	13/32	1-1/2	.080	.051	1650
3/8	13/32	2	.08.	.051	1000
1/2	17/32	1-1/4	.080	.051	3000
1/2	17/32	1-1/2	.080	.051	2000
1/2	17/32	2	.080	.051	950

Description	A flat washer with significantly more surface area than a USS or SAE washer. They are also made from a thinner gauge metal than most flat washers.	
Applications/ Advantages	Used where an extra wide bearing surface is required. Originally designed for auto body repair work, they are also used in sheet metal, plumbing, and electrical work. Also used to attach signs to posts, to install drywall and wood paneling.	
Material	Steel	Stainless
	Washers shall be punched from hot-rolled, hot-rolled and pickled or cold-rolled steel, or shall be machined from bar stock or tubing, or may be forged at the manufacturer's option.	18-8 Stainless steel
Plating	Fender washers are usually provided zinc plated or with no finish.	Parts are usually supplied with no additional finish.



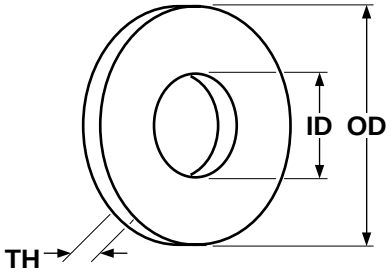
Machine Screw Washers

Washer Size	Inside Diameter		Outside Diameter		Thickness	
	Max	Min	Max	Min	Max	Min
2	0.097	0.087	0.224	0.214	0.022	0.014
3	0.114	0.104	0.255	0.245	0.023	0.018
4	0.130	0.120	0.286	0.276	0.030	0.022
5	0.145	0.135	0.286	0.276	0.030	0.022
6	0.155	0.145	0.380	0.370	0.036	0.028
8	0.175	0.165	0.380	0.370	0.036	0.028
10	0.209	0.199	0.443	0.433	0.036	0.028
12	0.232	0.222	0.505	0.495	0.052	0.044
14	0.270	0.260	0.567	0.557	0.052	0.044
5/16	0.335	0.325	0.630	0.620	0.054	0.046
3/8	0.397	0.387	0.693	0.683	0.054	0.046

Description	The smallest type of flat washer with an outside diameter equal to slightly twice the size of the inside diameter.	
Applications/ Advantages	Designed for use with machine screws in general industrial applications.	
Material	*Steel*	*Stainless*
	Washers are punched from cold-rolled steel.	18-8 Stainless steel
Plating	See Appendix-A for plating information.	Stainless machine screw washers are usually furnished without any additional coating.

Standard Flat

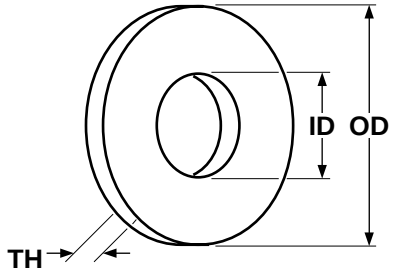
18-8 Stainless Steel



Standard Flat Washers - 18-8 Stainless Steel			
Size	OD	ID	TH
	Outside Diameter	Inside Diameter	Thickness
	Nominal	Nominal	Nominal
4	.312	.125	.031
6	.375	.156	.031
8	.375	.172	.031
10	.438	.203	.031
1/4	.625	.281	.050
5/16	.750	.344	.050
3/8	.875	.391	.050
3/8	1.000	.391	.062
7/16	1.125	.500	.050
1/2	1.250	.562	.055 - .062
5/8	1.500	.688	.062
3/4	1.750	.812	.075
7/8	2.000	.938	.095 - .109
1	2.000	1.062	.095 - .109

Description	A thin, flat, circular stamping with a centrally located hole, made from an 18-8 austenitic stainless steel.
Applications/ Advantages	Designed for use with 18-8 stainless steel screws and nuts in general industrial applications where parts are subject to corrosion.
Material	18-8 stainless steel

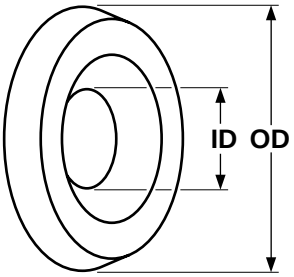
316 Stainless Steel *Standard Flat* Washers

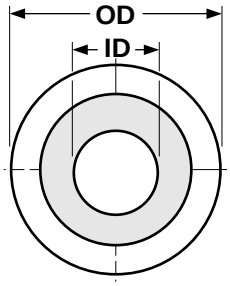


COMMERCIAL FLAT WASHERS - 316 STAINLESS STEEL			
Size	OD	ID	TH
	Outside Diameter	Inside Diameter	Thickness
	Nominal	Nominal	Nominal
1/4	.625	.281	.045
1/4	.688	.281	.045
5/16	.750	.344	.045
3/8	.875	.406	.045
3/8	1.000	.406	.045
1/2	1.250	.531	.055
5/8	1.500	.688	.075
3/4	1.750	.812	.075
7/8	2.000	.938	.095
7/8	2.250	.938	.105
1	2.000	1.062	.095
1	2.500	1.062	.105

Description	A thin, flat, circular stamping with a centrally located hole, made from a 316 austenitic stainless steel.
Applications/ Advantages	Designed for use with 316 stainless steel screws and nuts in general industrial applications where parts are subject to corrosion.
Material	316 stainless steel

Countersunk Finishing





Countersunk Finishing Washers

Screw Size	Outside Diameter	Inside Diameter		Overall Height
	Nominal	Max	Min	
#4	3/8	.150	.120	3/32
#6	15/32	.200	.170	5/64
#8	17/32	.210	.180	7/64
#10	19/32	.265	.235	7/64
#12	21/32	.289	.259	1/8
1/4	25/32	.335	.305	5/32
5/16	15/16	.409	.373	3/16
3/8	1 1/8	.460	.425	1/4

Description	A formed circular washer designed for use with flat or oval head screws. This is a raised type of finishing washer which is convex shaped. For use with 82° countersunk flat and oval head screws.
Applications/ Advantages	Designed for accommodating the heads of countersunk screws. It provides additional bearing area on the material being fastened and can be used to give a neat, finished appearance.
Material	Washers shall be punched from hot-rolled, hot-rolled and pickled or cold-rolled steel, or shall be machined from bar stock or tubing, or may be forged at the manufacturer's option.
Plating	Countersunk finishing washers are typically supplied with a nickel plating. Other coatings such as black oxide are also popular.