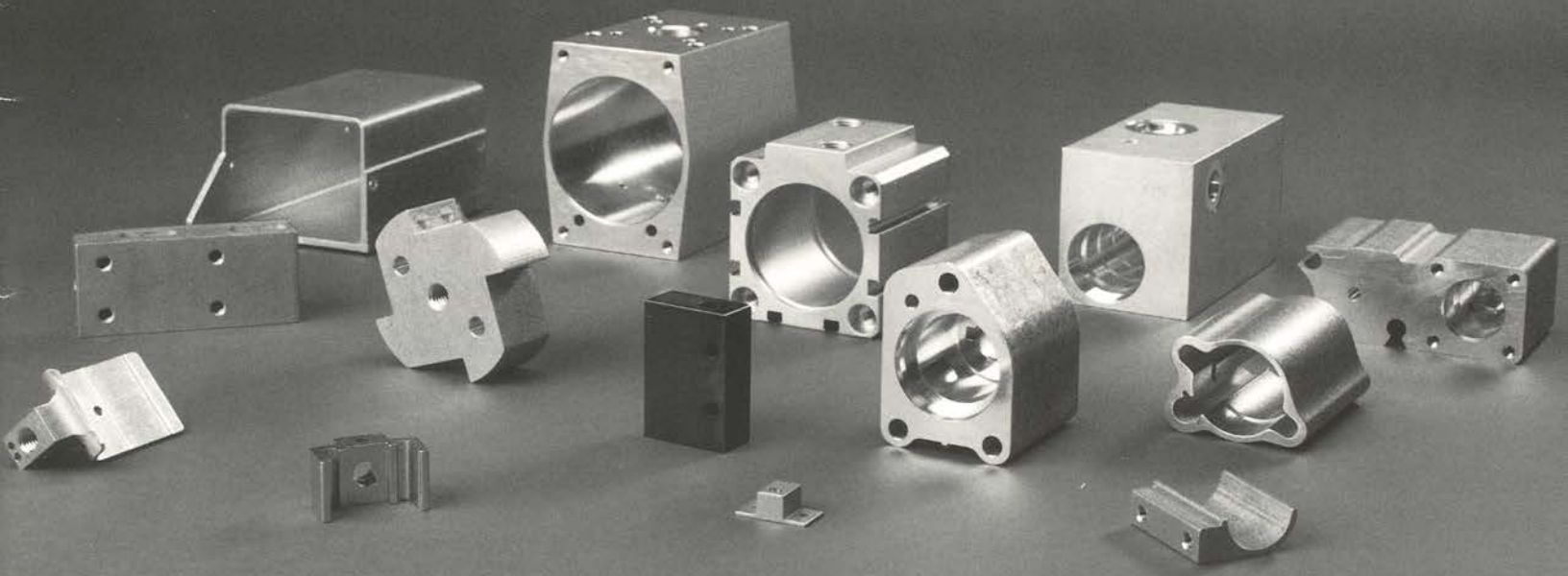
GENERAL EXTRUSIONS, INC.

Design Guide
ALUMINUM EXTRUSIONS



GENERAL EXTRUSIONS, INC.

Introduction

We're here to help . . .

Aluminum extrusions can reduce assembly time and improve component appearance and performance. Use these basic design considerations to convert from other processes or create a new aluminum component.

The push to combine higher quality with lower costs has never been stronger than today. But nowhere do those goals compete more aggressively than on the design engineer's desk.

At General Extrusions, we offer the engineering support you need to meet your performance and cost goals without sacrificing quality.

Many of the component parts now machined, cast, stamped, formed, and welded can be converted to extrusions, resulting in greater strength, dimensional stability, fewer assembly operations and the most efficient use of material.

Once your component is designed, General Extrusions can provide the extrusion, and the fabrication and finishing operations as well – for single-source convenience and quality assurance.

For more information or a quote, please call our sales department at (330) 783-0270, or send us a fax to (330) 788-1250.

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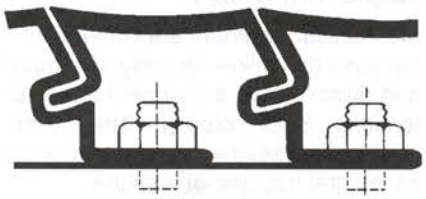
Quality is just the beginning.

Hinge Fit



A

Adjustable
Slip Fit Connection

B

Hinge and slip fit

A. Larger assembly can be made up by hinge fitting smaller extrusions together.

B. Adjustments can be made to counter tolerance accumulations.

Jointing components

Sliding dovetail gives a flat joint when connecting two parts.

Lap-Lock Joints

Side Entry

Edge Entry

Dovetail Sliding Fit

Lap Joints

Single

Double

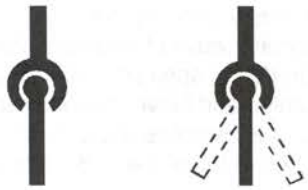
Held by Self-Threading Fastener

Some extrusion joining methods

Various examples of lap joints used for positioning or building larger enclosures.

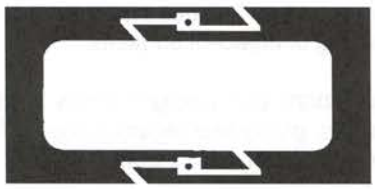
In Item 1, A is moved in and up. Then B is inserted to lock the joint.

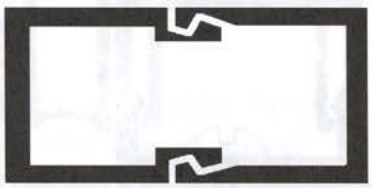
Cylindrical Sliding Fits



Sliding and hinge joints

For clearance tolerances, contact our engineering service department at AD.





Interlocking extrusions

The flat locking edges require less deflection for assembly.

GENERAL EXTRUSIONS, INC.

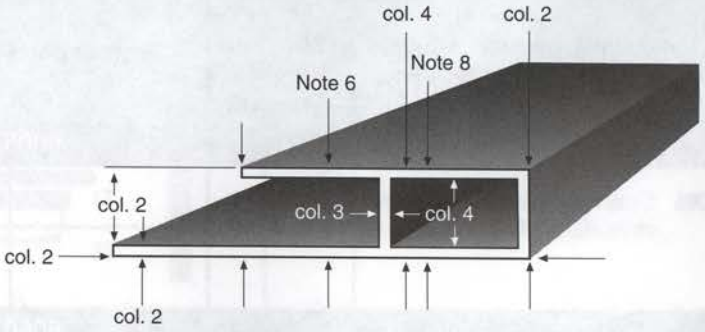
Alloy-Temper Specifications Chart

Aluminum Extrusion Alloys: Number and Characteristics	Major Alloying Elements (Percent)	Temper and Thickness-in.		Tensile Strength – ksi				Elongation percent min in 2 in. or 4D
				Ultimate		Yield		
				min.	max.	min.	max.	
6005								
6005 Similar to 6061 alloy. Used in structural applications.	Si .6-.9 Mg .40-.6	-T1	Up thru 0.500	25.0	. . .	15.0	. . .	16
		-T5	Up thru 0.124 0.125-1.000	38.0 38.0	. . . . . .	35.0 35.0	. . . . . .	8 10
6060								
6060 Improved Extrudability while maintaining 6063. Mechanical properties.	Mg .41 Si .45	-T4 and T42	Up thru 0.500 0.501-1.000	19.0 18.0	. . . . . .	10.0 9.0	. . . . . .	14 14
		-T5	Up thru 0.500 0.501-1.000	22.0 21.0	. . . . . .	16.0 15.0	. . . . . .	8 8
		-T6 and T62	Up thru 0.124 0.125-1.000	30.0 30.0	. . . . . .	25.0 25.0	. . . . . .	8 10
6061								
6061 Most versatile of heat treatable group. Will take considerable forming in T4. Good corrosion resistance. Used in transportation and structural applications.	Mg .8-1.2 Si .40-.8	-0 -T1 -T4, T4510 and T4511 -T42 -T51 -T6, T62,T6510 and T6511	All Up thru 0.625 All All Up thru 0.625 Up thru 0.249 0.250 and over	. . . 26.0 26.0 26.0 35.0 38.0 38.0	22.0	. . . 14.0 16.0 12.0 30.0 35.0 35.0	16.0	16 16 16 16 8 8 10
6063								
6063 The most popular extrusion alloy. Takes a good surface finish, is corrosion-resistant, and can be heat-treated for strength.	Mg .45-.9 Si .20-.6	-0	All	. . .	19.0	. . .	. . .	18
		-T1	Up thru 0.500 0.501-1.000	17.0 16.0	. . . . . .	9.0 8.0	. . . . . .	12 12
		-T4 and T42	Up thru 0.500 0.501-1.000	19.0 18.0	. . . . . .	10.0 9.0	. . . . . .	14 14
		-T5	Up thru 0.500 0.501-1.000	22.0 21.0	. . . . . .	16.0 15.0	. . . . . .	8 8
		-T6 and T62	Up thru 0.124 0.125-1.000	30.0 30.0	. . . . . .	25.0 25.0	. . . . . .	8 10
6463								
6463 Designed to accept a bright finish after anodizing.	Mg .45-.9 Si. .20-.6 Cu. .20 Fe15 max.	-T1	Up thru 0.500	17.0	. . .	9.0	. . .	12
		-T5	Up thru 0.500	22.0	. . .	16.0	. . .	8
		-T6 and T62	Up thru 0.124 0.125-0.500	30.0 30.0	. . . . . .	25.0 25.0	. . . . . .	10 10

NOTE: TOLERANCES SHOWN ARE ALUMINUM ASSOCIATION STANDARD. BETTER THAN STANDARD IS ACHIEVABLE. PLEASE CALL GEI SALES DEPT. FOR DESIGN INPUT.

Cross-Sectional Dimension Tolerances

Wire, Rod, Bar & Shapes[1]
Except for Shapes in T3510, T4510, T6510, T73510, T76510 and T8510 Tempers[7]

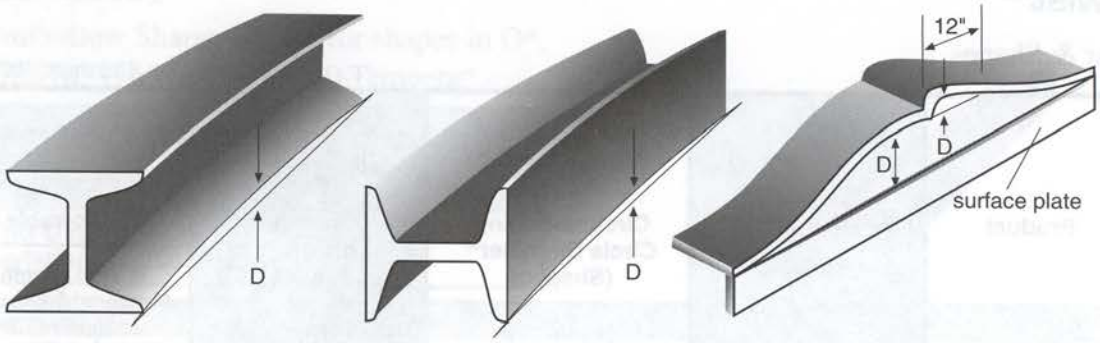


Specified Dimension In.	Tolerance[2,3] – in. plus and minus															
	Metal Dimensions						Space Dimensions									
	Allowable deviation from specified dimension where 75% or more of the dimension is metal[9,10]						Allowable deviation from specified dimension where more than 25% of the dimension is space[6,8]									
	All except those covered by Column 3		Wall thickness[4] Completely[5] enclosing space 0.11 sq. in. & over (Eccentricity)		At dimensioned points 0.250-0.624 inches from base of leg		At dimensioned points 0.625-1.249 inches from base of leg		At dimensioned points 1.250-2.499 inches from base of leg		At dimensioned points 2.500-3.999 inches from base of leg		At dimensioned points 4.000-5.999 inches from base of leg		At dimensioned points 6.000-8.000 inches from	
	Col. 2		Col. 3		Col. 4		Col. 5		Col. 6		Col. 7		Col. 8		Col. 9	
Col. 1	Alloys 5083 5086 5454	(11) Other Alloys	Alloys 5083 5086 5454	(11) Other Alloys	Alloys 5083 5086 5454	(11) Other Alloys	Alloys 5083 5086 5454	(11) Other Alloys	Alloys 5083 5086 5454	(11) Other Alloys	Alloys 5083 5086 5454	(11) Other Alloys	Alloys 5083 5086 5454	(11) Other Alloys	Alloys 5083 5086 5454	(11) Other Alloys
Circumscribing Circle Sizes Less Than 10 Inches in Diameter																
Up thru 0.124	.009	.006	±15% of specified dimension; ±.090 max. ±.015 min.	±10% of specified dimension; ±.060 max. ±.010 min.	.013	.010	.015	.012	..	..	..	..	..	..	..	..
0.125-0.249	.011	.007			.016	.012	.018	.014	.020	.016	..	..	..	..	..	..
0.250-0.499	.012	.008			.018	.014	.020	.016	.022	.018	.024	.020	..	..	..	..
0.500-0.749	.014	.009			.021	.016	.023	.018	.025	.020	.027	.022	..	..	..	..
0.750-0.999	.015	.010			.023	.018	.025	.020	.027	.022	.030	.025	.035	.030	..	..
1.000-1.499	.018	.012			.027	.021	.029	.023	.032	.026	.036	.030	.041	.035	..	..
1.500-1.999	.021	.014			.031	.024	.033	.026	.038	.031	.043	.036	.049	.042	.057	.050
2.000-3.999	.036	.024			.046	.034	.050	.038	.060	.048	.069	.057	.080	.068	.092	.080
4.000-5.999	.051	.034			.061	.044	.067	.050	.081	.064	.095	.078	.111	.094	.127	.110
6.000-7.999	.066	.044			.076	.054	.084	.062	.104	.082	.121	.099	.142	.120	.162	.140
8.000-9.999	.081	.054			.091	.064	.101	.074	.127	.100	.147	.120	.182	.145	.197	.170
Circumscribing Circle Sizes 10 inches in Diameter and Over																
Up thru 0.124	.021	.014	±15% of specified dimension; ±.090 max. ±.025 min.	±15% of specified dimension; ±.090 max. ±.015 min.	.025	.018	.027	.020	..	..	..	..	..	..	..	..
0.125-0.249	.022	.015			.026	.019	.029	.022	.035	.028	..	..	..	..	..	..
0.250-0.499	.024	.016			.028	.020	.032	.024	.038	.030	.058	.050	..	..	..	..
0.500-0.749	.025	.017			.030	.022	.035	.027	.049	.040	.068	.060	..	..	..	..
0.750-0.999	.027	.018			.031	.023	.039	.030	.057	.050	.079	.070	.099	.090	..	..
1.000-1.499	.028	.019			.033	.024	.043	.034	.069	.060	.089	.080	.109	.100	..	..
1.500-1.999	.036	.024			.046	.034	.056	.044	.082	.070	.102	.090	.122	.110	.182	.170
2.000-3.999	.051	.034			.061	.044	.071	.054	.097	.080	.117	.100	.137	.120	.197	.180
4.000-5.999	.066	.044			.076	.054	.086	.064	.112	.090	.132	.110	.152	.130	.212	.190
6.000-7.999	.081	.054			.091	.064	.101	.074	.127	.100	.147	.120	.167	.140	.227	.200
8.000-9.999	.096	.064			.106	.074	.116	.084	.142	.110	.162	.130	.182	.150	.242	.210
10.000-11.999	.111	.074			.121	.084	.131	.094	.157	.120	.177	.140	.197	.160	.257	.220
12.000-13.999	.126	.084			.136	.094	.146	.104	.172	.130	.192	.150	.212	.170	.272	.230
14.000-15.999	.141	.094			.151	.104	.161	.114	.187	.140	.207	.160	.227	.180	.287	.240
16.000-17.999	.159	.104			.166	.114	.176	.124	.202	.150	.222	.170	.242	.190	.302	.250
18.000-19.999	.171	.114			.181	.124	.191	.134	.217	.160	.237	.180	.257	.200	.317	.260
20.000-21.999	.186	.124			.196	.137	.206	.144	.232	.170	.252	.190	.272	.210	.332	.270
22.000-24.000	.201	.134			.211	.144	.221	.154	.247	.180	.267	.200	.287	.220	.347	.280

For all numbered footnotes, see page 14.

Straightness[1]

Rod, Bar and Shapes
(For edges in the longitudinal direction)



Product	Temper	Specified Diameter (Rod); Specified Width (Bar); Circumscribing Circle Diameter[4] (Shapes) in.	Specified Thickness (Rectangles) Minimum Thickness (Shapes) in.	Tolerance[3]–in. Allowable Deviation (D) from Straight In Total Length or in any Measured Segment of One Foot or More of Total Length
Rod and Square, Hexagonal and Octagonal Bar	All except O, TX510,[2] TX511[2]	All		.0125 X Measured length, ft.
	0	0.500 and over		.050 X Measured length, ft.
	TX511[2]	0.500 and over		.0125 X Measured length, ft.
Rectangular Bar	All except O, TX510,[2] TX511[2]	Up thru 1.499	Up thru 0.094[7]	.050 X Measured length, ft.
			0.095 and over	.0125 X Measured length, ft.
		1.500 and over	All	.0125 X Measured length, ft.
	O	Over 0.500	0.500 and over	.050 X Measured length, ft.
	TX511[2]	Over 0.500	0.500 and over	.0125 X Measured length, ft.
Shapes	All except.O, TX510,[2,5] TX511[2]	Up thru 1.499	Up thru 0.094[7]	.050 X Measured length, ft.
			0.095 and over	.0125 X Measured length, ft.
		1.500 and over	All	.0125 X Measured length, ft.
	O	Over 0.500	Up thru 0.094[7]	.200 X Measured length, ft.
			0.095 and over	.050 X Measured length, ft.

For all numbered footnotes, see next page.

(Extracted from Aluminum Standards and Data, 1993 Table 11.4)

Twist[1,6]

Bar & Shapes

(Extracted from Aluminum Standards and Data, 1993 Table 11.4)

Product	Temper	Specified Width (Bar); Circumscribing Circle Diameter[4] (Shapes) in.	Specified Thickness (Rectangles) Minimum Thickness (Shapes) in.	Tolerance[3]–Degrees Allowable Deviation from Straight: In Total Length or in any Measured Segment of One Ft or More of Total Length	Tolerance[3]–Degrees Allowable Deviation from Straight: Maximum For Total Length
Bar	All except O TX510,[2] TX511[2]	Up thru 1.499 1.500-2.999 3.00 and over	All 0.300 and over 0.300 and over	1 X Measured length, ft. 1/2 X Measured length, ft. 1/4 X Measured length, ft.	7 5 3
	TX510[2]	0.500-2.999 3.000 and over	0.500 and over 0.500 and over	1 1/2 X Measured length, ft. 1/2 X Measured length, ft.	7 5
	O TX511[2]	0.500-1.499 1.500-2.999 3.000 and over	0.500 and over 0.500 and over 0.500 and over	3 X Measured length, ft. 1 1/2 X Measured length, ft. 3/4 X Measured length, ft.	7 5 3
Shapes	All except O TX510,[2,5] TX511[2]	Up thru 1.499 1.500-2.999 3.000 and over	All All All	1 X Measured length, ft. 1/2 X Measured length, ft. 1/4 X Measured length, ft.	7 5 3
	O TX511[2]	0.500 and over 0.500-1.499 1.500-2.999	Up thru 0.094 0.095 and over 0.095 and over	3 X Measured length, ft. 3 X Measured length, ft. 1 1/2 X Measured length, ft.	7 7 5

Footnotes for pages 12-15

(1) These Standard Tolerances are applicable to the average shape; wider tolerances may be required for some shapes and closer tolerances may be possible for others.

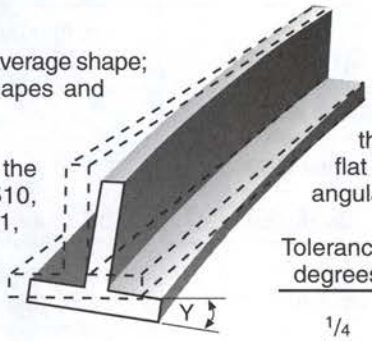
(2) TX510 and TX511 are general designations for the following stress relieved tempers: T3510, T4510, T6510, T8510, T73510, T76510, T3511, T4511, T6511, T8511, T73511, T76511, respectively.

(3) When weight of piece on flat surface minimizes deviation.

(4) The circumscribing circle diameter is the diameter of the smallest circle that will completely enclose the cross-section of the extruded product.

(5) Tolerances for T3510, T4510, T6510, T73510, T76510, and T8510 tempers shall be as agreed upon between purchaser and vendor at the time the contract or order is entered.

(6) Twist Limits
Twist is normally measured by placing the product on a flat surface and at any point along its length measuring the maximum distance between the bottom surface of the section and the flat surface. From this measurement, the actual deviation from straightness* of the section at that point is subtracted. The remainder is the twist. To convert the standard twist tolerance (degrees) to an equivalent linear value, the sine of the standard tolerance is multiplied by the width of the surface of the section that is on the flat surface. The following values are used to convert angular tolerance to linear deviation:



Tolerance, degrees	Maximum allowable linear deviation inch per inch of width
1/4	0.004
1/2	0.009
1	0.017
1 1/2	0.026
3	0.052
5	0.087
7	0.122

* See Table of Straightness Limits for product of interest to determine actual deviation from straightness.

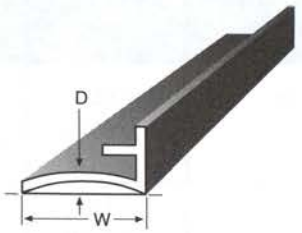
(7) Applies only if the thickness along at least 1/3 of the total perimeter is 0.095 and over.

(8) Tolerances for "O" temper material is four times the standard tolerances shown.

FLATNESS (Flat Surfaces)[1]

Bar, Solid Shapes and Semihollow Shapes except for shapes in O[8], T3510, T4510, T6510, T73510, T76510 and T8510 Tempers[4]

SURFACES WIDTHS UP THRU 1 INCH OR ANY 1 INCH INCREMENT OF WIDER SURFACES Maximum Allowable Deviation D = TOLERANCE (in.)
WIDTHS OVER 1 INCH Maximum Allowable Deviation D = TOLERANCE X W (in.)

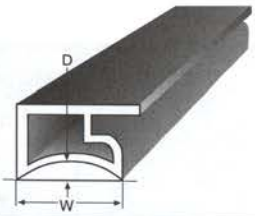


MINIMUM THICKNESS OF METAL FORMING THE SURFACE IN.	SURFACE WIDTH – IN.										
	UP TO 5.999	6.000 TO 7.999	8.000 TO 9.999	10.000 TO 11.999	12.000 TO 13.999	14.000 TO 15.999	16.000 TO 17.999	18.000 TO 19.999	20.000 TO 21.999	22.000 TO 23.999	24.000 AND UP
	TOLERANCE										
Up thru 0.124	.004	.006	.010	.014	–	–	–	–	–	–	–
0.125-0.187	.004	.006	.008	.012	.014	.014	.014	–	–	–	–
0.188-0.249	.004	.006	.008	.010	.012	.012	.012	.014	.014	–	–
0.250-0.374	.004	.006	.006	.008	.010	.010	.012	.012	.012	.014	–
0.375-0.499	.004	.004	.006	.088	.008	.008	.010	.010	.010	.012	.014
0.500-0.749	.004	.004	.006	.006	.008	.008	.008	.008	.010	.010	.012
0.750-0.999	.004	.004	.006	.006	.008	.008	.008	.008	.008	.008	.010
1.000-1.499	.004	.004	.004	.006	.006	.006	.008	.008	.008	.008	.008
1.500-1.999	.004	.004	.004	.004	.006	.006	.006	.006	.008	.008	.008
2.000 AND UP	.004	.004	.004	.004	.004	.006	.006	.006	.008	.008	.008

FLATNESS (Flat Surfaces)[1]

Hollow Shapes except for shapes in O[8], T3510, T4510, T6510, T73510, T76510 and T8510 Tempers[4]

SURFACES WIDTHS UP THRU 1 INCH OR ANY 1 INCH INCREMENT OF WIDER SURFACES Maximum Allowable Deviation D = TOLERANCE (in.)
WIDTHS OVER 1 INCH Maximum Allowable Deviation D = TOLERANCE X W (in.)



MINIMUM THICKNESS OF METAL FORMING THE SURFACE IN.	SURFACE WIDTH – IN.										
	UP TO 5.999	6.000 TO 7.999	8.000 TO 9.999	10.000 TO 11.999	12.000 TO 13.999	14.000 TO 15.999	16.000 TO 17.999	18.000 TO 19.999	20.000 TO 21.999	22.000 TO 23.999	24.000 AND UP
	TOLERANCE										
Up thru 0.124	.006	.008	.012	.016	–	–	–	–	–	–	–
0.125-0.187	.006	.008	.010	.014	.016	–	–	–	–	–	–
0.188-0.249	.004	.006	.010	.012	.014	.014	.014	.016	–	–	–
0.250-0.374	.004	.006	.008	.010	.012	.012	.012	.014	.014	.016	–
0.375-0.499	.004	.006	.008	.010	.010	.010	.012	.012	.012	.014	.016
0.500-0.749	.004	.004	.006	.008	.008	.008	.010	.010	–	.012	.014
0.750-0.999	.004	.004	.006	.006	.008	.008	.008	.008	–	.010	.012
1.000 AND UP	.004	.004	.004	.006	.006	.008	.008	.008	.008	.008	.008

GENERAL EXTRUSIONS, INC.

Tapping Specification

THREAD SIZE:	PERCENT THREAD – CUT TAP					PERCENT THREAD – ROLL FORM			
	60%	65%	70%	75%	80%	60%	65%	70%	75%
3-48	0.0828	0.0814	0.0801	0.0787	0.0774	0.0905	0.0898	0.0890	0.0884
4-40	0.0925	0.0909	0.0893	0.0876	0.0860	0.1018	0.1010	0.1000	0.0993
5-40	0.1055	0.1039	0.1023	0.1006	0.0990	0.1148	0.1140	0.1130	0.1123
6-32	0.1136	0.1116	0.1096	0.1076	0.1055	0.1252	0.1243	0.1230	0.1221
8-32	0.1396	0.1376	0.1356	0.1336	0.1315	0.1512	0.1503	0.1490	0.1481
10-24	0.1575	0.1548	0.1521	0.1494	0.1467	0.1729	0.1717	0.1700	0.1688
10-32	0.1656	0.1636	0.1616	0.1596	0.1575	0.1772	0.1763	0.1750	0.1741
12-24	0.1835	0.1808	0.1781	0.1754	0.1727	0.1989	0.1977	0.1960	0.1948
1/4-20	0.2110	0.2078	0.2045	0.2013	0.1980	0.2295	0.2280	0.2260	0.2245
1/4-28	0.2222	0.2198	0.2175	0.2152	0.2129	0.2354	0.2343	0.2329	0.2318
5/16-18	0.2692	0.2656	0.2620	0.2584	0.2548	0.2898	0.2879	0.2861	0.2842
5/16-24	0.2800	0.2773	0.2746	0.2719	0.2692	0.2955	0.2941	0.2927	0.2912
3/8-16	0.3263	0.3222	0.3182	0.3141	0.3101	0.3495	0.3474	0.3452	0.3431
3/8-24	0.3425	0.3398	0.3371	0.3344	0.3317	0.3580	0.3566	0.3552	0.3537

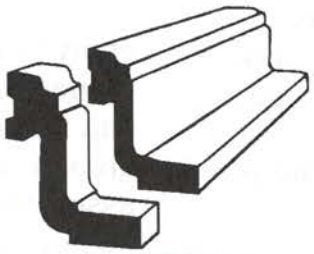
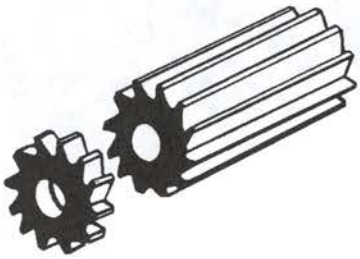
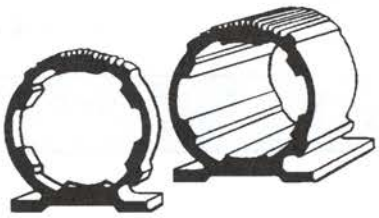
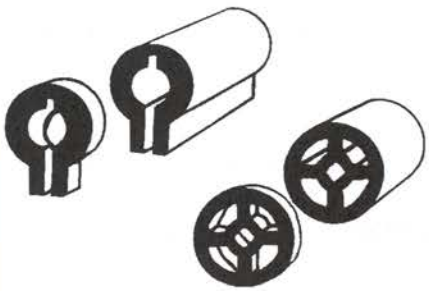
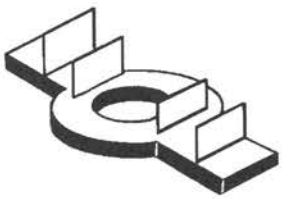
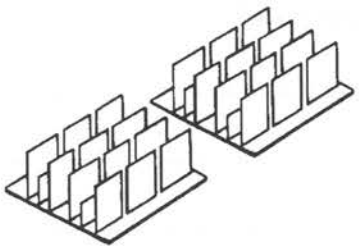
GENERAL EXTRUSIONS, INC.

Class of Fits

SIZE:	QUICK & EASY ASSEMBLY 1B			GENERAL 2B		CLOSE TOLERANCE ASSEMBLY 3B				
	60%	65%	70%	75%	80%	60%	65%	70%	75%	80%
M2 X 0.4	0.0665	0.0654	0.0644	0.0634	0.0624	0.0723	0.0718	0.0712	0.0707	0.0702
M2 X 0.5	0.1028	0.1015	0.1002	0.0989	0.0977	0.1101	0.1094	0.1087	0.1081	0.1074
M4 X 0.7	0.1360	0.1342	0.1324	0.1306	0.1288	0.1462	0.1453	0.1444	0.1434	0.1425
M5 X 0.8	0.1723	0.1703	0.1682	0.1662	0.1641	0.1840	0.1829	0.1819	0.1808	0.1797
M6 X 1.0	0.2055	0.2030	0.2004	0.1979	0.1953	0.2202	0.2188	0.2175	0.2161	0.2148
M7 X 1.0	0.2449	0.2423	0.2398	0.2372	0.2347	0.2595	0.2582	0.2568	0.2555	0.2542

GENERAL EXTRUSIONS, INC.

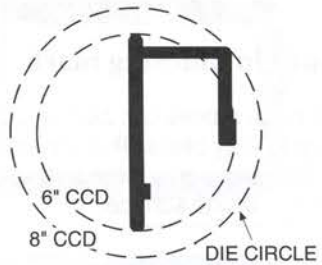
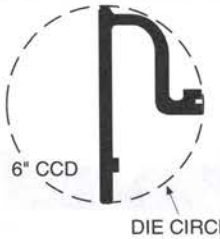
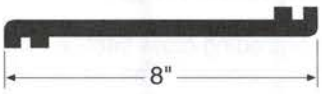
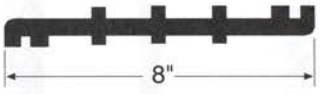
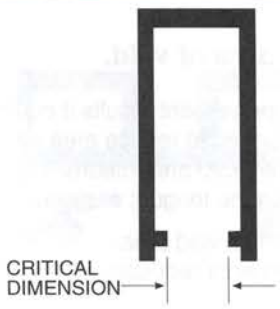
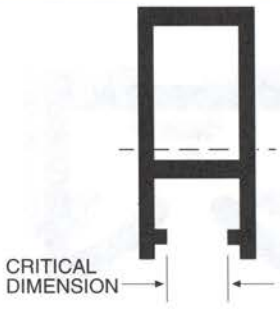
Design Pointers

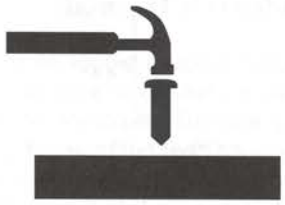
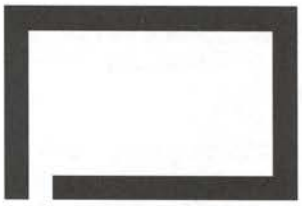
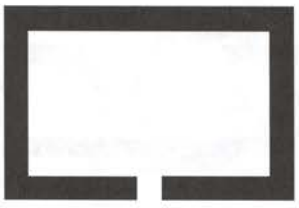
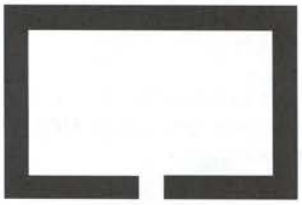
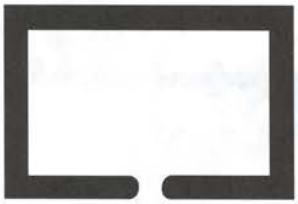
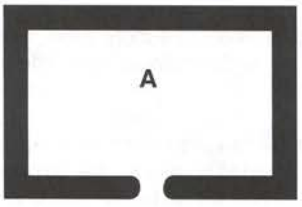
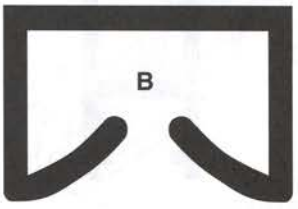
Instead of this . . .	. . . examine this	
		Convert a forging into a low-cost extrusion.
Machining from Bar Stock Sand Castings		Convert powdered metal gear into an extrusion.
Stampings Forming		Convert a die cast housing into an extrusion.
Weldments Hobbing		Convert a stamping into an extrusion.
		Convert a die sand casting into an extrusion.

Quality is just the beginning.

GENERAL EXTRUSIONS, INC.

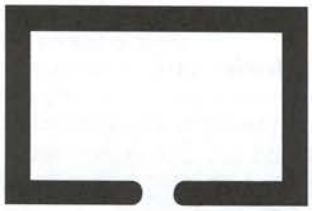
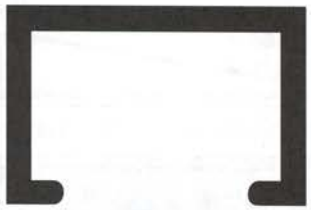
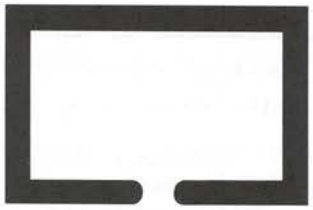
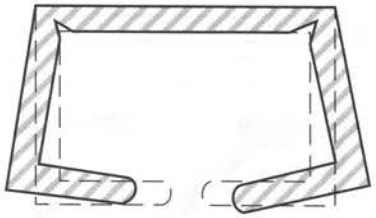
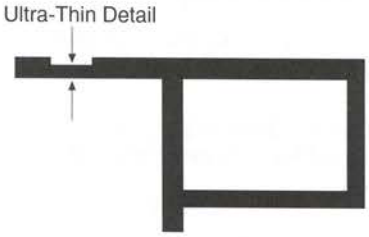
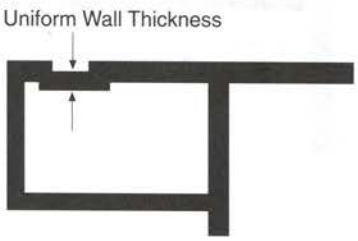
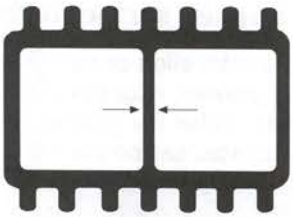
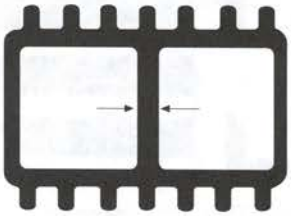
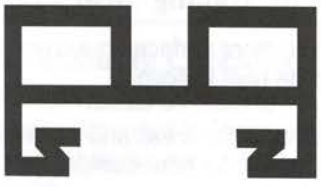
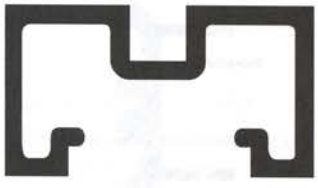
Design Pointers

Instead of this . . .	. . . do this	
		**Keep circumscribing circle diameter (CCD) small.** Large CCD requires bigger press, more care. Metals tend to flow slower as distance from the die center increases. Thin sections near periphery of a large die need special handling. Most aluminum extrusions are less than 6" CCD.
		**Smooth all transitions.** Transitions should be streamlined by a generous radius at any thick-thin junction.
		**Keep wall thickness uniform.** The preceding shape can be further improved by maintaining uniform wall thickness. In addition to using more metal, thick-thin junctions give rise to distortion, die breakage or surface defects on the extrusion.
		**Ribs help straightening operation.** Wide, thin sections can be hard to straighten after extruding. Ribs help prevent twisting.
		**Web gives better dimensional control.** Metal dimensions are more easily held than gap or angle dimensions. Web also allows thinner wall sections in this example. The hollow condition of the "redesigned" part can be avoided by making the component in two pieces as shown by the dotted line.

Instead of this . . .	. . . do this	
		**Built-in indexing mark.** An index groove can also be used to help identify pieces that are similar in appearance, or to distinguish an inside vs. an outside surface.
		**Avoid knife edges.** A knife edge is difficult to fill, and when extruded will appear wavy. Change the profile to blunt or rounded part.
		**Symmetry preferred in semi-hollow areas.** When designing, visualize the die that will be necessary to produce the shape. In this case, by keeping the void symmetrical about the throat opening, the pressure on the die "tongue" is balanced and die breakage is minimized.
		**Rounded corner strengthens tongue.** The preceding cross section has been further improved. The die tongue is now less likely to snap off.
		**Reduce area of void.** Further improvement results if outline can be changed to reduce area enclosed. Reduced area means less pressure on the tongue; easier extrusion. A. Original void area B. Void area reduced

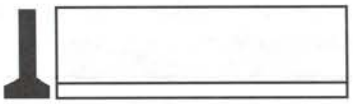
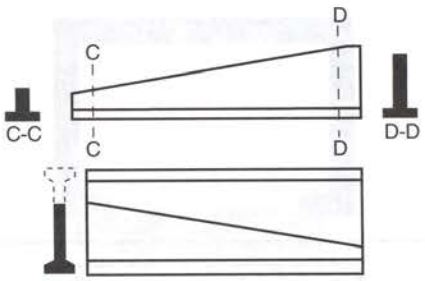
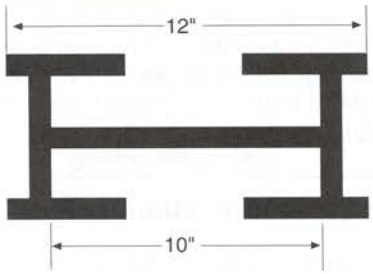
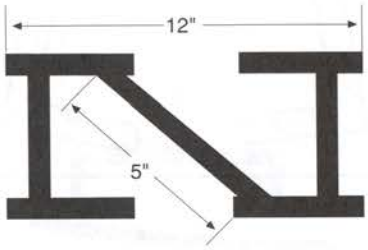
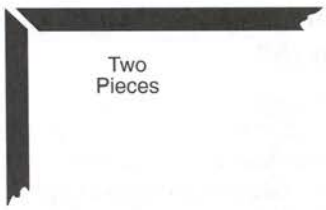
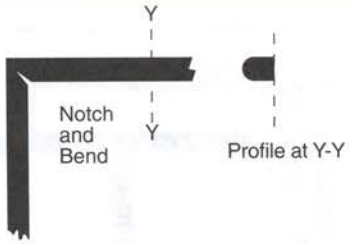
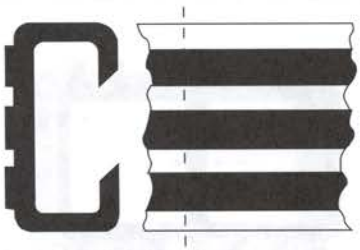
GENERAL EXTRUSIONS, INC.

Design Pointers

Instead of this . . .	. . . do this	
		**Semi-hollow changed to solid.** Better than the previous suggestions, widening the opening into the void puts this shape into the *solid* classification and cuts production costs measurably. The die, if you visualize it, no longer has a fragile tongue.
		**Extrude a modified shape.** If the design function prohibits any of the previous suggestions, it may be possible to strengthen the tongue by extruding a modified shape, then repositioning it before aging.
		**Shape Modification.** The technique of extruding a modified shape is also suitable for shapes that have deep, narrow grooves.
		**Avoid detail at the end of long, thin rail.** If thin detail is needed, such as the channel at the extreme left, you can 1) move the detail closer to a support; 2) increase wall thickness to prevent distortion; or 3) provide support at other end of the rail.
		**Thicker wall may be less expensive.** In a class 3 hollow extruded shape, such as this double-compartment heat exchanger, a thin wall between the two voids is very difficult and costly to extrude.
		**Avoid hollow shape.** Hollow and multi-hollow extruded shapes are usually much more costly than the simple solid shape. Also, less metal has been used. (**Note:** Extruded bar, rod or tubing of standard round, square, hex or octagonal shapes are not termed *hollow extruded shapes* and are generally less expensive than either solid or hollow extruded shapes.)

GENERAL EXTRUSIONS, INC.

Design Pointers

Instead of this . . .	. . . do this	
		**Lengthwise cut.** Tapering sections are obtained from this lengthwise cut. These may serve as stiffeners, permitting maximum weight economy.
		**Keep perimeter/cross-section area ratio as low as possible.** Extruders often measure complexity in terms of the amount of perimeter for a given weight (or cross-section area) of metal. In this example, the size of perimeter has been saved by reducing the length of the cross member.
		**Corner assemblies.** Notching permits unbroken outer edge, replaces two pieces with one. Simplifies assembly . . . parts can be shipped flat and assembled at your plant.
 Handrail or Escalator Component	 Handrail or Escalator Component	**Ribs disguise surface defects.** With little extra effort or cost, designers can add grooves, ridges or other decorative detail. Either the grooves or the raised surfaces can be colored to emphasize contrast.
		**Ribs for cooling (heat sinks).** Develop more surface area using fins to dissipate heat buildup. Redistribute the mass and increase the surface area for heat dissipation.

GENERAL EXTRUSIONS, INC.

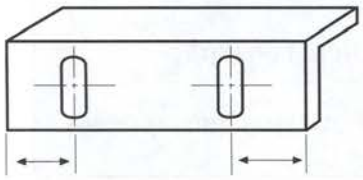
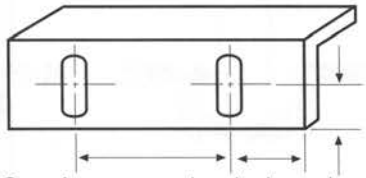
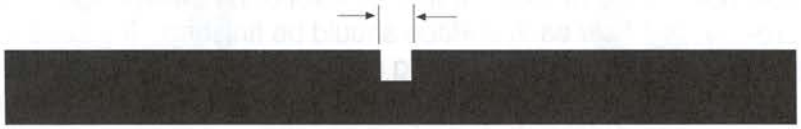
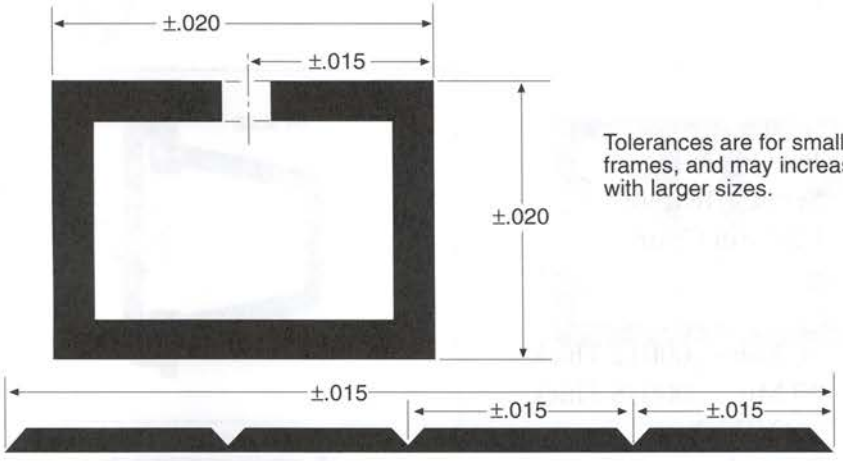
Dimensioning

Call us during the design stage at: (330) 783-0270.

For best results, begin working with GEI early in the design stage of your project. We will need the following information:

- sample or description of the part
- use length
- estimated annual quantity
- finishing requirements
- applicable government, engineering society or customer specifications
- end use
- purchase length
- exposed surface area
- special packaging
- alloy and temper
- order quantity
- what secondary operations are necessary
- marking
- delivery

Tolerances are based on industry standards. Please contact GEI's sales department with any questions you may have.

Instead of this . . .	. . . we recommend	
	 Spec from one end and edge only.	**Tolerance between holes.** Punched ±.005 Drilled ±.005 Reamed ±.005 From gauge end & edge ±.010
 A 1/16" groove can be used to separate surface finishes.		**Disguised joints.** Serrations, scalloping and embossing can camouflage joints on exposed surfaces, and can also add pleasing decorative effects. Emphasizing a joint can also be an effective decorative device. A slight groove (1/64") at the meeting edges of shapes can accomplish this.
 Tolerances are for smaller frames, and may increase with larger sizes.		**Frame Tolerances:** Height and width (±.020) Hole locations (±.015)

Dimensioning Checklist:

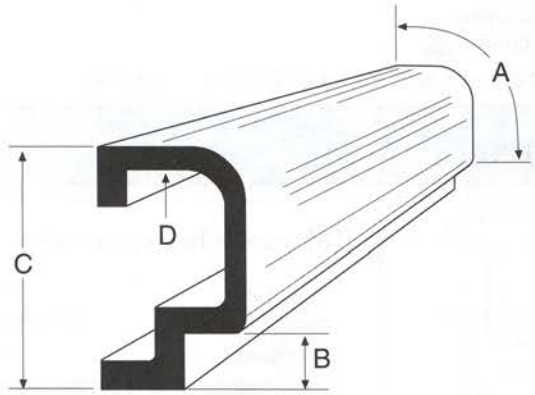
- ✔ A 1/64" radius on fillets and corners is recommended to improve extrudability as compared to sharp corners.
- ✔ Specify lengths needed.
- ✔ List special tolerances when they are required.
- ✔ Indicate all exposed surfaces on the drawing, as these require special attention.
- ✔ Specify finish required.

Quality is just the beginning.

GENERAL EXTRUSIONS, INC.

Appearance Considerations

Call GEI's Sales Department regarding special requirements or questions at: (330) 783-0270.



Surface Specifications

A	**Critically exposed**
B	**Partially exposed**
C	**Functional unexposed**
D	**Non-functional (unexposed)**

Appearance and finish have a significant impact on the cost of your component. When you are communicating with GEI, be sure to designate finish requirements, function and mating parts so that we can suggest cost-saving improvements.

When designing your component, consider how it will be viewed – from eye level or below eye level – and how each surface should be finished. If you have a question regarding special requirements or have some concerns call GEI's Engineering Department during the design stage.

FINISHES FOR EXTRUSIONS

■ As Extruded

Depending on section, 32 micro in.

■ Mechanical

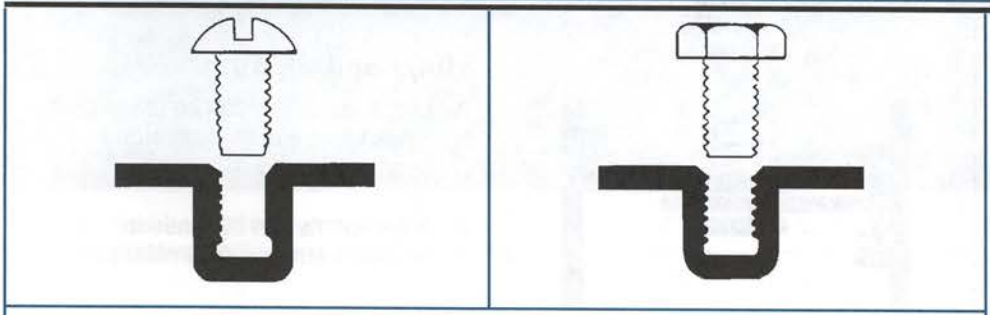
Buff	Jewelry & Luster
Brush	Scratch Texture
Sand	Uniform Grain

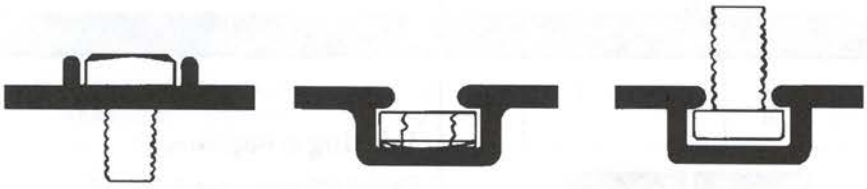
■ Chemical

Clear Anodize	10 Min – .00012 Thick
Color Anodize	40 Min – .00048 Thick
Hard Coat Anodize	.002 Thick
Etch	Frosted

■ Paint

Powder Coat	Enamel, Epoxy, Vinyl
Silkscreen	Inks, Enamel, Epoxy





Extruded screw thread single and double

Mechanical fasteners are convenient because they allow for easy assembly and disassembly, adjustment and maintenance. Slots, holes and threads for mechanical fasteners can be extruded as integral features of a shape.

When ordering a thread fit, supply complete fastener detail or a sample of the fastener itself for inspection purpose.

Nut retainers

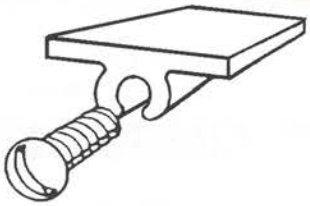
Nut retainers or T-Slots to retain nut or bolt heads.

Adjustable Locking Connection

Restrained Nut Connection

Connectors

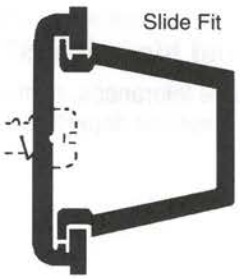
These two connectors give adjustment to the joining of parts.



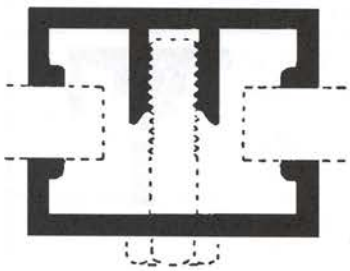
Extruded screw boss

This fastener can save a machining operation in connecting parts.

Slide Fit



Thread Fit



Concealed fasteners

Architects and designers have devised a great many ways of arranging fasteners in extruded shapes so that they are concealed and leave the exposed surfaces of assemblies uncluttered. A selection of these methods is illustrated here.

Exposed fasteners not only detract from a pleasing overall appearance, but also encourage localized buildup of dirt and grime, and sometimes cause unsightly staining of adjacent surfaces.

Incorporate concealing features in basic shapes, giving due regard to their effect on extrudability and surface finish.

Corner Snap Fit

Snap Fit