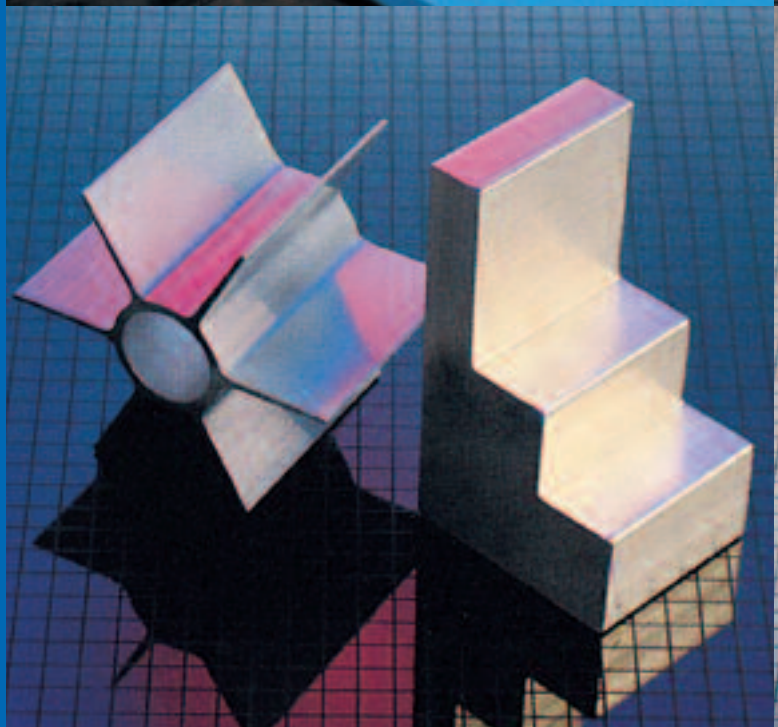
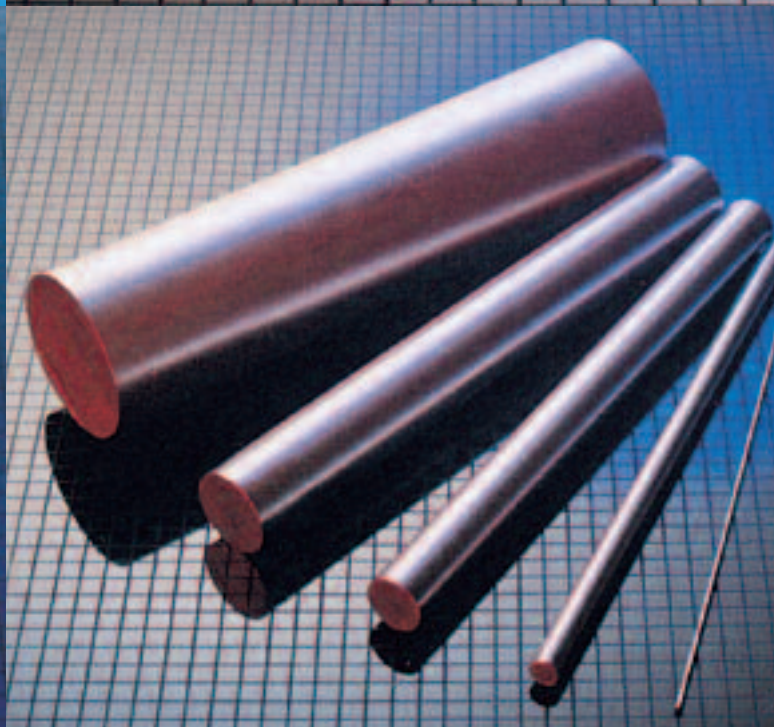
Castle Metals®

Aluminum Cold Finished & Extruded Rod & Bar

Quik Guide





Machining Guide for High-Speed Tooling

Aluminum Alloys		2011-T3 2011-T8 AND 2111-T8 6262-T8/T9 6262-T651/T6511			2014-T651 2017-T451 2024-T351		6061-T651/T6511 7075-T651	
MACHINING OPERATIONS		**SURFACE RPM**		**FEED IN/REV**	**SURFACE FPM**	**FEED IN/REV**	**SURFACE FPM**	**FEED IN/REV**
Threading	PITCH OF THREADS							
	3-8	200			150		100	
	9-15	250			200		150	
	15-20	325			250		200	
	21 & up	450			300		250	
Cutoff	WIDTH OF CUT-INCHES							
	1/8	700		.0035	450	.0030	300	.0025
	3/16	to		.0040	to	.0035	to	.0030
	1/4	1100		.0040	550	.0040	450	.0040
Turret Knurling 1/4 Inch Width Knurl Double All Feeds for Knurl Back Off	STOCK DIAMETER INCHES	MULTI-SPINDLE	SINGLE SPINDLE					
	1/4	700 to 1100	700 to 1100	.0125	450	.0125	300	.0125
	3/8			.0145	to	.0145	to	.0145
	1/2			.0190	550	.0190	450	.0190
	3/4	500 to 700		.0195		.0195		.0195
	1			.0205		.0205		.0205
	1 1/4			.0215		.0215		.0215
Cross Slide Knurling 1/4 Inch Width Knurl	STOCK DIAMETER INCHES	MULTI-SPINDLE	SINGLE SPINDLE					
	1/4	700 to 1100	700 to 1100	.0025	450	.0025	300	.0025
	3/8			.0033	to	.0033	to	.0033
	1/2			.0045	550	.0045	450	.0045
	3/4	500 to 700		.0060		.0060		.0060
	1			.0075		.0075		.0075
	1 1/4			.0095		.0095		.0095
Counter-Boring and Trepanning	WIDTH OF CUT-INCHES	MULTI-SPINDLE	SINGLE SPINDLE					
	3/8	700 to 800	700 to 1100	.0050	450	.0040	300	.003
	1/2			.0075	to	.0050	to	.004
	3/4			.0090	550	.0060	450	.005
	1	500 to 700		.0100		.0075		.006
	1 1/4			.0110		.0090		.007
Thread Rolling Cross Slide Tools	ALL SIZES			**SPINDLE REV**		**SPINDLE REV**		**SPINDLE REV**
9 Pitch + Coarser		500* to 600		20 to 29	500* to 600	20 to 29	500* to 600	20 to 29
9 to 14 Pitch				13 to 24		13 to 24		13 to 24
14 to 18 Pitch				12 to 22		12 to 22		12 to 22
18 Pitch + Finer				10 to 18		10 to 18		10 to 18

*Speed of rolls is determining factor. Refer to thread roll vendor.

[1] Deltalloy is a registered trademark of ALCOA.

[2] This column is provided for your convenience. A. M. Castle & Co. cannot and does not make recommendations of type or grade of material for end use. Proper selection of material for proposed end use is our customer's responsibility.

[3] Castle's aluminum is ordered to these specifications, however there are some restrictions by size, shape and availability. Give us your specifications to properly service your needs.

[4] **Typical properties shown are averages of various sizes for comparison purposes only. NOT FOR DESIGN.**

[5] Ratings for wrought aluminum alloys "A", "B", "C", and "D" are relative ratings in decreasing order of merit. An "A" rating is highest. Ratings are based on aluminum based alloys and are not to be used in comparison with other metals.

[6] Sizes greater than 2 inches will have slightly lower strength values.

[7] Sizes greater than 1-1/2 inch will have strengths lower than these values.

[8] Sizes larger than 3.25 inches diameter or 3 inches square would be somewhat lower.

[9] "A" rating indicates paint protection not generally required. Paint protectin advisable or necessary in corrossive atmospheres for "C" or lower ratings.

[10] In larger sizes this rating would be somewhat lower.

[11] Hot forming permissible for some materials under carefully controlled conditions. Consult your Sales Representative for additional information.

[12] "A", "B", "C", are relative ratings in increasing order of chip size and decreasing order of quality of finish, defined as follows:

A-Free-cutting, very small broken chips and excellent finish.

B-Curled or easily broken chips and good to excellent finish.

C-Continuous chips and good finish.

[13] 500 Kg load 10mm ball.

[14] Based on 500,000,000 cycles of completely reversed stress using the RR Moore machine and specimen.

[15] Average coefficient of thermal expansion x 10^{-6} per °F for temperature range of 68° to 212°F.

[16] In BTU per inch per square foot.

[17] SCC resistance ratings "A", "B", and "C" are relative ratings based on stress applied transversely with respect to the direction of fabrication after controlled exposure to sodium chloride solution by alternate immersion. The ratings are defined as follows:

A-No known instances of failure in service or laboratory tests

B-No known instances of failure in service, laboratory failures only

C-Service and laboratory failures under special conditions

[18] Density in lb./in.^{3} - NOT FOR DESIGN

[19] Electrical conductivity is % IACS @ 68°F - NOT FOR DESIGN

[20] Weldability ratings, "A", "B", "C", and "D" are relative ratings as follows:

A-Generally weldable by all commercial procedures and methods.

B-Weldable with special technique or in specific applications which justify preliminary trials or testing to develop welding procedure and performance.

C-Limited weldability because of crack sensitivity or loss in resistance of corrosion and mechanical properties.

D-No commonly used welding methods have so far been developed.

Machining Guide for High-Speed Tooling

Aluminum Alloys		2011-T3 2011-T8 AND 2111-T8 6262-T8/T9 6262-T651/T6511			2014-T651 2017-T451 2024-T351			6061-T651/T6511 7075-T651		
Turning Box Tools, Knee and Hollow Mills	DEPTH OF CUT-INCHES	MULTI-SPINDLE	SINGLE SPINDLE		MULTI-SPINDLE	SINGLE SPINDLE		MULTI-SPINDLE	SINGLE SPINDLE	
	⅛ ¼ ⅜	600	600 TO 1100 DEPENDING ON SHAPE; ROUND, HEX, OR SQUARE	.012 .010 .008	300 to 550	300 to 550	.010 .008 .006	300 to 550	300 to 550	.008 .006 .006
Forming Circular, Flat or Dove Tail	WIDTH OF CUT-INCHES	MULTI-SPINDLE	SINGLE SPINDLE		450 to 550		.0030 .0025 .0015 .0010	300 to 450		.002 .002 .001 .001
	⅛ to ¼ ¼ to ½ ½ to ¾ ¾ to 1 1 to 1½	700 to 800 500 to 600	700 to 1100	.0035 .0030 .0025 .0020 .0015						
Shaving	DEPTH OF CUT-INCHES	700 to 1100		.003 .002 .001	450 to 550		.0025 .0010 .0005	300 to 450		.0015 .001 .0005
	.005 .010 .015									
Twist Drilling Standard and Fast Spiral	DIAMETER INCHES	MULTI-SPINDLE	SINGLE SPINDLE		MULTI-SPINDLE	SINGLE SPINDLE				
	1/32 1/16 ⅛ ¼ ⅜ ½ ¾ 1 1¼ 1½ 1¾ 2	400	LESS THAN 1 INCH 600	.002 .004 .009 .014 .016 .016 .016 .016 .016 .016 .016 .016	350	LESS THAN 1½ INCHES 500	.002 .004 .008 .011 .013 .013 .013 .013 .013 .013 .013 .013	300		.0015 .0030 .0050 .0070 .0090 .0100 .0100 .0100 .0100 .0100 .0100 .0100
		1 to 1½ 550				OVER 1½ INCHES 450				
		OVER 1½ INCHES 450								
Half Round Drilling	DIAMETER INCHES	600 600 550		.005-.008 .008-.012 .012-.020	450 to 550		.004-.007 .008-.010 .012-.014	250 to 350		.003-.006 .007-.009 .010-.012
	3/32-⅜ ⅜-¾ ¾-1¼									
Reaming	DIAMETER INCHES	600 to 450		.007 to .010 .010 to .020	500 to 450		.007 to .010 .010 to .020	300 to 250		.007 to .010 .010 to .020
	−⅛ +⅛									
Taper Reaming	ALL SIZES	300 to 500		.002 to .005	300 to 500		.002 to .005	300 to 450		.002 to .005
Tapping	PITCH OF THREADS	50-75 90-125 125-150 150-200			50-75 90-125 125-150 150-200			50-75 90-125 125-150 150-200		
	3 to 8 9 to 15 16 to 24 25 & up									

Aluminum Cold Finished &

ALLOY	CHARACTERISTICS[2]	SPECIFICATION[3]			TYPICAL PROPERTIES[4,5] "NOT FOR									
		QQ-A	AMS	ASTM	Temper	Tensile Strength (KSI)	Yield Strength (KSI)	Elongation (%)	Corrosion[9] Resistance	Cold Forming[16]	Machinability[12]	Brinell Hardness[13] (BHN)	Shear Strength (KSI)	Fatigue Strength[14] (KSI)
2011 CF Cold Drawn	Excellent machinability, unexcelled for free cutting qualities, good mechanical properties. Excellent machined surface finish capability. The T451 and T8 tempers offer good deep drilling characteristics.	225/3 225/3 225/3	— — —	B211 B211 B211	T451 T3 T8	45 55[5] 59	26 43[5] 45	25 15 12	D[10] D[10] C	C C D	A A A	95 95 100	32 30 35	18 14 18
2017 CF Cold Drawn	Like 2011, this is a general purpose screw machine alloy. Higher strength than 2011-T3.	225/5	4118	B221	T451	62	40	22	D	C	B	105	38	18
2024 CF Cold Drawn	Good machinability and machined surface finish capability. A high-strength material of adequate workability. Has largely superseded 2017 for structural applications. Comparable strength to some mild steels.	225/6 225/6 225/6 225/6 225/6	— 4120 4120 4112 —	B211 B211 B211 B211 B211	T3 T351 T4 T6 T851	70 68 68 69 70	50 47 47 57 65	 19 19 10 7	D[10] D[10] D D D	C C C D D	B B B B B	 120 120 125 128	 41 41 43 43	 20 20 18 18
Deltalloy®[1] 4032 CF Cold Drawn	Good machinability and drilling characteristics when using single-point or multi-spindle screw machines. Excellent surface finish using polycrystalline or carbide tooling. Superior wear resistance, may eliminate the need for hard coat anodizing. High strength, low coefficient of thermal expansion.		4319		T651 T86	55 54	47 5I	8 7	B B	D D	B A	121 121	32	
6013 CF Cold Drawn	High strength, good machinability and good corrosion resistance. Easily joined by all welding and brazing methods. Excellent compresssive properties. Good applied coating acceptance.				T8	65[8]	62[8]	11	B	D	B	130	36	
6020 Lead Free	A lead free 6XXX series alloy with great machinability, excellent corrosion resistance and anodizing response, with superior surface finish.				T8 T9 T651	42 52 40	39 51 37	12 9 12	A A A	D D C	A A A			
6061 CF Cold Drawn	Excellent joining characteristics, good acceptance of applied coatings. Combines relatively high strength, good workability and high resistance to corrosion, widely available.	225/8 225/8 225/8 225/8	4116 4117 4117 —	B211 B211 B211 B211	T4 T6 T651 T8	35 45 45 50	21 40 40 48	25 17 17 16	A A A A	B C C C	C C C C	65 95 95	24 30 30	13 14 14
6061 Extruded	Same as 6061 CF Cold Drawn	—		B221 B221	T6511 T6	45 45	40 40	17 17	A A	C C	C C		30 30	14 14
6262 CF Cold Drawn	Good machinability with high strength; high corrosion resistance and applied coating acceptance. The T8 temper offers excellent residual stress control. Excellent surface finish.	225/10 225/10	— — — —	B211 B211 B211 B211	T6 T651 T8 T9[6]	45 45 51 58	40 40 49 55	17 17 15 10	A A A A	D C D D	B B B B	95 95 120	30 30 35	14 14 13
7068 Extruded	Significantly higher strength than 7075 with comparable corrosion resistance; higher strength allows for use of a lighter product in many applications.	—	— 4331	—	T6511	103	99	9	C	D	C	190	53	—
7075 CF Cold Drawn	Very high strength material used for highly stressed structural parts. The T7351 temper offers improved stress-corrosion cracking resistance. Strength level equal to or exceeding mild steels.	225/9 225/9 225/9	4122 4123 4124	B211 B211 B211	T6 T651 T7351	83 83 72	73 73 62	11 11 13	C C C	D D D	B B B	150 150	48 48	23 23 22

& Extruded Rod & Bar

R DESIGN"						JOINING						SIZE RANGE - INCHES				
Anodize Response	Coefficient of Thermal Expansion[15]	Thermal Conductivity at 75° F[16]	Stress Corrosion Cracking Resistance[17]	Density[18]	Electrical Conductivity[19]	Gas Welding	Inert Gas Arc Welding[20]	Resistance Welding	Brazing	Soldering	X Cold Finished O Extruded	Rounds	Hexagons	Squares	Flats	ALLOY
C C C	13.0 13.0 13.0	1060 1060 1190	C C A	.102	39 45	D D D	D D D	B B B	D D D	D D D	X X X	1/8″– 4″	1/4″– 2-3/4″			2011 CF Cold Drawn
C			C			D	B	B	D		X	1/2″– 7″				2017 CF Cold Drawn
C C C C C	12.8 12.8 12.8 12.8 12.8	840 840 840 1030 1030	C C C B A	.101	30 30 30 38 38	D D D D D	B B C C C	B B B B B	D D D D D	D D C C C	X X X X X	1/2″– 8″ 1/8″– 7/16″	5/8″– 2-3/4″ 1/4″– 9/16″	1/2″– 4″ 1/4″– 3/8″	1/2″ x 3/4″– 4″ x 6″ 1/8″ x 1″– 3/8″ x 6″	2024 CF Cold Drawn
C C	10.8 10.8	960 960	B B	.097	35	B B	B B	B B	C C	B B	X X					Deltalloy®[1] 4032 CF Cold Drawn
B+	13.0		A	.098	38	A	A	A	A	A	X					6013 CF®[1] Cold Drawn
A A A			A A A								X X X	1/2″– 2″		3″– 5″	2″ x 4″– 4″ x 6″	6020®[1] Lead Free
A A A A	13.2 13.2 13.2 13.2	1160 1160	A A A A	.098	40 43 43	A A A A	A A A A	A A A A	A A A A	B B B B	X X X X	1/8″– 7/16″ 1/2″– 8″	1/4″– 1/2″ 5/8″– 2″			6061 CF Cold Drawn
A A			A A	.098	43 43	A A	A A	A A	A A	B B	O O	3/8″– 8-1/2″ 9″– 15″	1/2″– 1-1/4″	3/8″– 6″ 1/4″	1/8″ x 1/2″– 4″ x 6″	6061 Extruded
A A A A	13.2 13.2 13.2 13.2	1180 1180 1180 1180	A A A A	.098	44	C C C B	A A A A	B B B A	A A A A	C C C C	X X X X					6262 CF Cold Drawn
B	13.0	—	C	.103	31	D	D	—	—	—	O	3/4″–2-1/2″				7068 Extruded
B B B	13.1 13.1 13.1	900 900 900	C C B	.101	33 33	D D D	C C C	B B B	D D D		X X X	3/8″– 1/2″ 9/16″– 8″		3/4″– 4″		7075 CF Cold Drawn

Tolerances–Aluminum Bars

Cold Finished

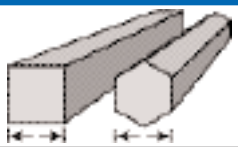
CF Rounds

SPECIFIED DIAMETER IN.	Tolerance – in. plus and minus except as noted		
	Allowable Deviation from Specified Diameter		
	cold finished rod	rolled rod	
		plus	minus
0.125 - 0.500	.0015	…	…
0.501 - 1.000	.002	…	…
1.001 - 1.500	.0025	…	…
1.501 - 2.000	.004	.006	.006
2.001 - 3.000	.006	.008	.008
3.001 - 3.499	.008	.012	.012
3.500 - 5.000	.012	.031	.016
5.001 - 8.000	…	.062	.031

CF Flats

Thickness or Width, In.	Tolerance	
	Thickness	Width
0.065″ - 0.500″	±.002	±.002
0.501″ - 0.750″	±.0025	±.0025
0.751″ - 1.000″	±.0025	±.0025
1.001″ - 1.500″	±.003	±.003
1.501″ - 2.000″	±.005	±.005
2.001″ - 3.000″	±.008	±.008
3.001″ - 4.000″	±.010	±.010
4.001″ - 6.000″	±.015	±.020

CF Squares, Hexagons, Octagons

DISTANCE ACROSS FLATS		
Specified Distance Across Flats (in.)	Tolerance in. plus and minus	
	ALLOWABLE DEVIATION FROM DISTANCE SPECIFIED ACROSSS FLATS	
	cold finished bar	rolled bar
0.125 - 0.500	.002	…
0.501 - 1.000	.0025	…
1.001 - 1.500	.003	…
1.501 - 2.000	.005	.016
2.001 - 3.000	.008	.020
3.001 - 4.000	…	.020

Extruded Rounds, Hexagons, Squares & Flats

Rounds

Size	Tolerance
.375″ - 1.000″	±.005
1.001″ - 1.938″	±.006
1.939″ - 3.000″	±.008
3.001″ - 3.750″	±.012
3.751″ - 5.000″	±.017
5.001″ - 6.500″	±.022
6.501″ - 7.999″	±.044
8.000″ - 9.999″	±.054
10.000″ - 11.000″	±.074
11.001″ - 12.000″	±.084

Hexagons

Size	Tolerance
.500″ - .941″	±.005
.942″ - 1.440″	±.006
1.441″ - 1.875″	±.007
1.876″ - 2.000″	±.008
2.001″ - 3.250″	±.012

Squares & Flats

Thickness or Width In.	Tolerance
Under.125	±.006
.125″ - .249″	±.007
.250″ - .499″	±.008
.500″ - .749″	±.009
.750″ - .999″	±.010
1.0″ - 1.49″	±.012
1.5″ - 1.99″	±.014
2.0″ - 3.99″	±.024
4.0″ - 7.99″	±.034
8.0″ - 9.99″	±.054

These tolerances are closer than Aluminum Association Standards.
Check with your Castle Metals representative for actual tolerances as these are for reference purposes only.

CALL 800.BUY.CSTL (289-2785) FOR THE CASTLE LOCATION NEAR YOU

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