BANTAM TOOLS™ *professional reliability & precision*

CNC MACHINIST REFERENCE CHART

MATERIAL CONSIDERATIONS

ABS
Acrylonitrile butadiene styrene is a terpolymer, meaning a combination of three polymers. ABS is a versatile, impact-resistant material that is easy to add color to and construct things with.

Aluminum 6061
Aluminum is a lightweight, durable, and corrosion-resistant metal that is electrically conductive. The most commonly used, general-purpose alloy is 6061 aluminum, which offers a great blend of strength and machinability.

Carbon Steel
As defined by AISI, carbon steel contains a carbon content up to 2.1% by weight. Lower carbon steels suitable for machining include C1010 and C1018.

HDPE
HDPE stands for high-density polyethylene. It's an inexpensive, lightweight, chemical-resistant, food-safe plastic that has a high strength-to-density ratio, making it well suited for many applications.

Titanium
Titanium has a low density but high strength and can be alloyed with aluminum and iron among other elements. It has a low heat conductivity requiring lower cutting speeds in order to prolong tool life.

Acrylic
Acrylic is a transparent thermoplastic derived from natural gas, more brittle than polycarbonate but more scratch resistant and available in many colors and textures.

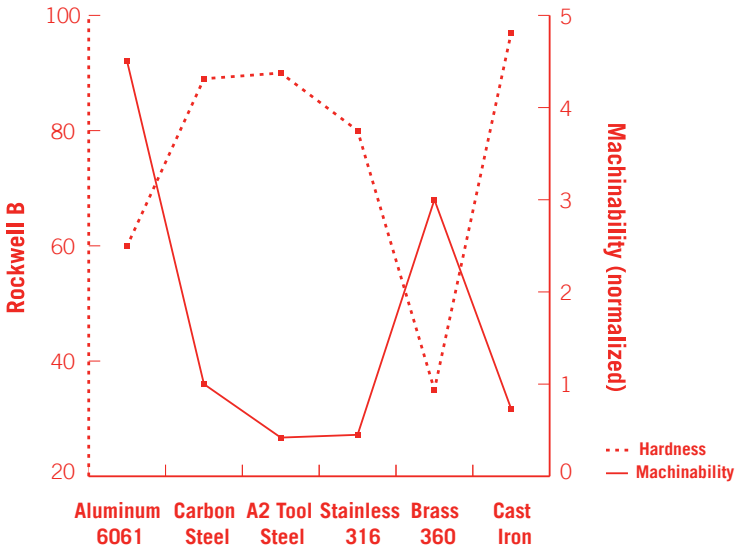
Brass
Brass is an alloy of primarily copper and zinc. It's often called free-machining brass because it's hard enough to hold its shape but soft enough to machine easily.

Delrin
Delrin is the brand name for acetal homopolymer resin, which is a very hard, high-strength engineering plastic. It can withstand temperatures from -40°F to 248°F and mills easily.

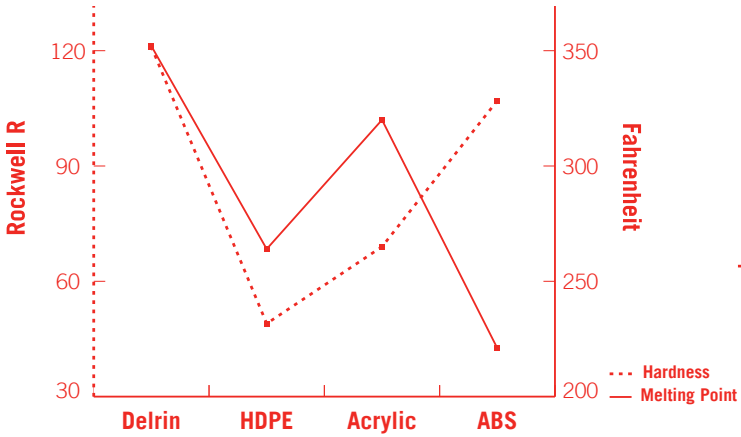
Stainless 316
Stainless steel is a steel alloy with a minimum of 10.5% chromium. The presence of chromium creates a thin, microscopic layer preventing corrosion and rust. Stainless 316 is more resistant to acids than its 304 counterpart.

Tool Steel
Tool steel contains a carbon content between .5% and 1.5%. The presence of carbides play a dominant role in the quality of tool steel, and the resistance to abrasion make it well suited for hand tools and machine dies.

Metal Machinability vs Hardness



Plastic Hardness vs Melting Point



"Take pride in your work and life. It's about the outcome, not the income."

— **John Saunders** *machinist & educator*

G-CODE REFERENCE

Gcode	Parameters	Command
G0	axes	Rapid traverse
G1	axes, F	Straight feed
G4	P	Dwell
G20		Inch unit mode
G21		mm unit mode
G28.3	axes	Select absolute position
G53		Select absolute coordinates
G54-G59		Select coordinate system 1—6
G90		Absolute positioning mode
G91		Incremental positioning mode

Gcode	Parameters	Command
M3	S	Spindle on CW
M4	S	Spindle on CCW
M5		Spindle off
M6		Tool change
M8		Coolant on
M9		Coolant off

Gcode	Parameters	Command
F	Feed rate	Specify feed rate
S	RPM	Set spindle speed
N	Line number	Label G-code block
P	Seconds	Specify dwell time

NUT SIZING CHART

SURFACE FEET PER MINUTE

Material	HSS	Carbide
Aluminum	600	800
Brass	175	175
Delrin	400	800
Polycarbonate	300	500
Stainless Steel (303)	80	300
Steel	70	350

COMMON CALCULATIONS

Surface Feet per min = Revolutions per min * .262 * Tool Diameter

Revolutions per min = Surface Feet per min * 3.82 / Tool Diameter

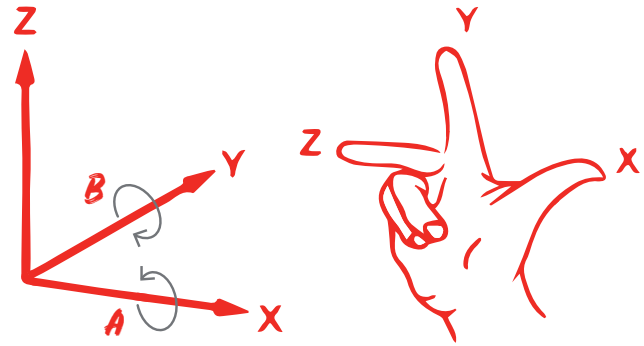
Feed Rate (inches per min) = Revolutions per min * Chip Load per tooth * Number of Flutes

Chip Load per tooth = Inches per min / Revolutions per min / Number of Flutes

Millimeter to inches = Multiply length by 25.4

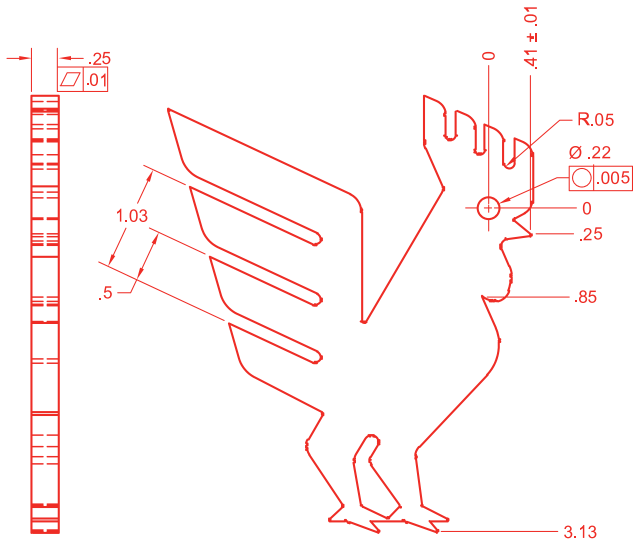
Inches to millimeter = Divide length by 25.4

RIGHT-HAND RULE



The right-hand rule is a simple method to identify the direction and orientation of the axis in three-dimensional systems, such as CAD programs and CNC machines. Each finger points in the positive direction of movement. On CNC machines, this is oriented in relation to the movement of the spindle.

DIMENSIONING BEST PRACTICES



This simple drawing highlights a few GD&T symbols in practice: flatness, circularity, and perpendicularity. When dimensioning a drawing, remember this essential rule: Avoid redundant dimensions and over-defining your part.

GEOMETRIC DIMENSIONING & TOLERANCING SYMBOLS

Symbol	Geometric Characteristic	Tolerance Type	Control Summary
▱	Flatness	**Form** (No Relation Between Features)	Controls form (shape) of surfaces and can also control form of an axis or median plane Datum reference not allowed
—	Straightness		
⌭	Cylindricity		
○	Circularity		
⊥	Perpendicularity	**Orientation** (No Relation Between Features)	Controls orientation (tilt) of surfaces, axes, or median planes for size and non-size features Datum reference required
//	Parallelism		
∠	Angularity		
⌖	Position	**Location**	Locates center points, axes, and median planes for size features Controls orientation
⌓	Profile of a Surface		Locates surfaces Controls size, form, and orientation of surfaces based on datum reference
⌒	Profile of a Line		
⌰	Total Runout	**Runout**	Controls surface coaxiality Controls form and orientation of surfaces
↗	Circular Runout		
◎	Concentricity	**Location** (Derived Median Points)	Locates derived median points of a feature Not common—consider using position, runout, or profile
⌯	Symmetry		

DRILL & TAP CHART (IN)

Tap Size	Tap Drills		Clearance Hole Drills	
Tap Size	Alum, Brass, Plastics 75% Thread	Stainless Steel, Steels, Iron 50% Thread	Close Fit	Free Fit
	Drill Size	Drill Size	Drill Size	Drill Size
0-80	3/64	55	52	50
1-64	53	1/16	48	46
1-72	53	52		
2-56	50	49	43	41
2-64	50	48		
3-48	47	44	37	35
3-56	45	43		
4-40	43	41	32	30
4-48	42	40		
5-40	38	7/64	30	29
5-44	37	35		
6-32	36	32	27	25
6-40	33	31		
8-32	29	27	18	16
8-36	29	26		
10-24	25	20	9	7
10-32	21	18		
12-24	16	12	2	1
12-28	14	10		
12-32	13	9		
1/4-20	7	7/32	F	H
1/4-28	3	1		
1/4-32	7/32	1		
5/16-18	F	J	P	Q
5/16-24	I	9/32		
5/16-32	9/32	L		
3/8-16	5/16	Q	W	X

Tap Size	Tap Drills		Clearance Hole Drills	
Tap Size	Alum, Brass, Plastics 75% Thread	Stainless Steel, Steels, Iron 50% Thread	Close Fit	Free Fit
	Drill Size	Drill Size	Drill Size	Drill Size
3/8-24	Q	S		
3/8-32	11/32	T		
7/16-14	U	25/64	29/64	15/32
7/16-20	25/64	13/32		
7/16-28	Y	Z		
1/2-13	27/64	29/64	33/64	17/32
1/2-20	29/64	15/32		
1/2-28	15/32	15/32		
9/16-12	31/64	33/64	37/64	19/32
9/16-18	33/64	17/32		
9/16-24	33/64	17/32		
5/8-11	17/32	9/16	41/64	21/32
5/8-18	37/64	19/32		
5/8-24	37/64	19/32		
11/16-24	41/64	21/32	45/64	23/32
3/4-10	21/32	11/16	49/64	25/32
3/4-16	11/16	45/64		
3/4-20	45/64	23/32		
13/16-20	49/64	25/32	53/64	27/32
7/8-9	49/64	51/64	57/64	29/32
7/8-14	13/16	53/64		m
7/8-20	53/64	27/32		
15/16-20	57/64	29/32	61/64	31/32
1-8	7/8	59/64	1 1/64	1 1/32
1-12	15/16	61/64		
1-20	61/64	31/32		

DRILL & TAP CHART (MM)

Tap Size	Tap Drills		Clearance Hole Drills	
Metric Tap Size	Tap Drill (mm)	Closest Drill (in)	Close Fit (mm)	Free Fit (mm)
M3 x 0.5	2.5	40	3.2	3.4
M4 x 0.7	3.3	30	4.2	4.4
M5 x 0.8	4.2	19	5.2	5.4
M6 x 1.0	5	9	6.2	6.4
M8 x 1.25	6.7	G	8.3	8.6
M10 x 1.5	8.5	Q	10.4	10.8
M12 x 1.75	10.2	X	12.4	12.8

"Make it good. Make it last."

— **CW&T** product design duo

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