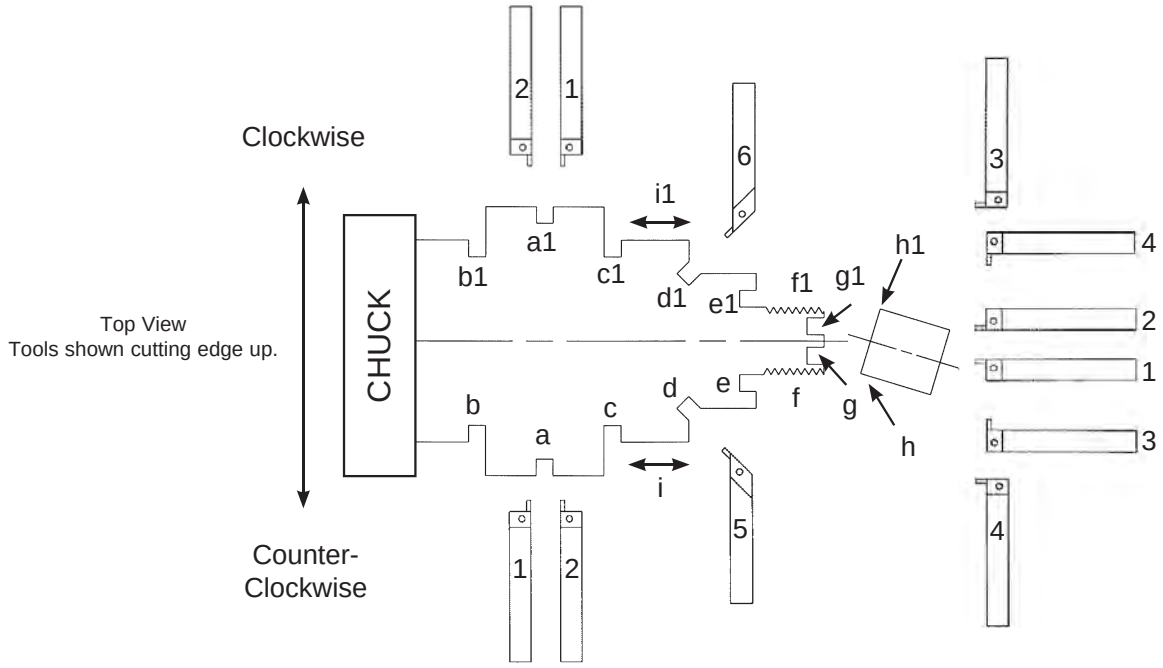

External Application Reference

Description	Specification	Operation	Insert Orientation	Insert Page	Toolholder Compatibility	Toolholder Page
OD Groove Reference: a,a1	.004" - .150" insert widths in .001" increments; Depths of cut 2.5 to 3 times width; For grooving, turning and generating profiles; Carbide and High Speed Steel.	a	Right Hand	1-10	2,3	7-1
		a1	Left Hand	1-10	1,4	7-1
	2,3,4,5 & 6mm insert widths; Depths of cut .5" to 1".	a	---	6-1	2,3	1-11
		a1	---	6-1	1,4	1-11
OD Groove at a shoulder Reference: b,b1,c,c1	.004" - .150" insert widths in .001" increments; Depths of cut 2.5 to 3 times width; For grooving, turning and generating profiles; Carbide and High Speed Steel.	b & c1	Left Hand	1-10	1,4	7-1
		b1 & c	Right Hand	1-10	2,3	7-1
	2,3,4,5 & 6mm insert widths; Depths of cut .5" to 1".	b & c1	---	6-1	1,4	1-11
		b1 & c	---	6-1	2,3	1-11
30°/45º/60° Undercut Reference: d,d1	.004" - .150" insert widths in .001" increments; Depths of cut 2.5 to 3 times width; .300", .750", 1.250" & 3" major diameters.	d	Counter-Clockwise	2-10	5	7-11
		d1	Clockwise	8-2	6	7-11
Face Groove Reference: e,e1,g,g1	.004" - .150" insert widths in .001" increments; Depths of cut 2.5 to 3 times width; For grooving, turning and generating profiles; Carbide and High Speed Steel.	e & g	Counter-Clockwise	2-10	1,4	7-1
		e1 & g1	Clockwise	8-2	2,3	7-1
	2,3,4,5 & 6mm insert widths; Depths of cut .5" to 1".	e & g	---	6-1	1,4	2-11
		e1 & g1	---	6-1	2,3	2-11
Threading Reference: f,f1	8 Threads Per Inch and greater Carbide and High Speed Steel.	f	Right Hand	4-10	2,3	7-1
		f1	Left Hand	4-10	1,4	7-1
	Acme threading 4 Threads Per Inch and greater Carbide and High Speed Steel.	f & f1	Right Hand	4-12	2,3	7-1
Parting Reference: h,h1	.025", .045", .062", .085" & .115" insert widths; Depths of cut .200" and .500"; Carbide and High Speed Steel.	h	---	5-4	2,3	7-1
		h1	---	5-4	1,4	7-1
Turning Reference: i,i1	TD and TP style inserts.	i	---	3-16,3-18	2,3	3-20
		i1	---	3-16,3-18	1,4	3-20

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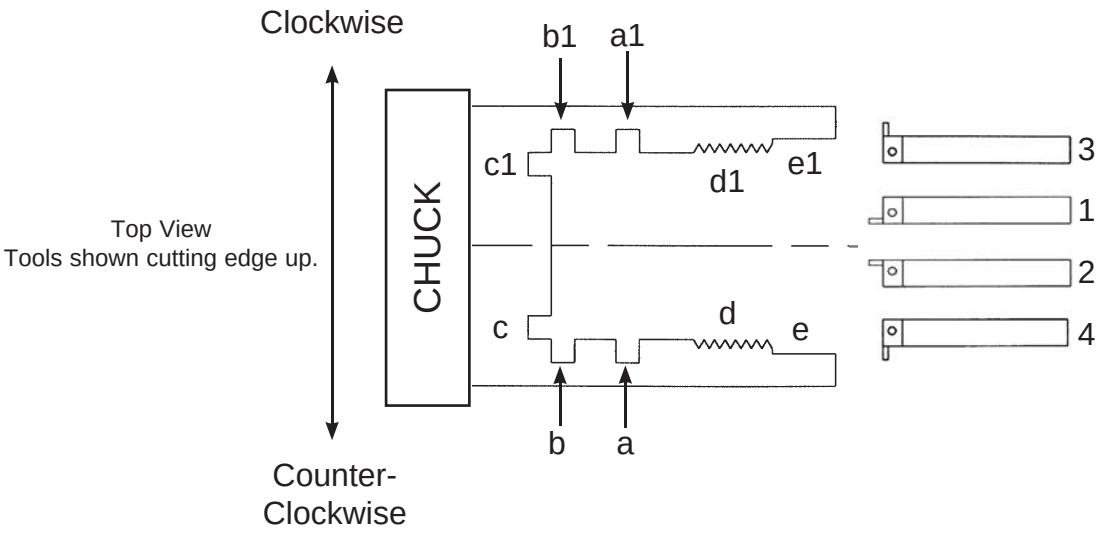

Internal Application Reference

Description	Specification	Operation	Insert Orientation	Insert Page	Toolholder Compatibility	Toolholder Page
Groove Reference: a,a1,b,b1	For internal diameters .125" and larger; .004" - .250" insert widths in .001" increments; Depths of cut to .150"; 1/8", 3/16", 1/4", 5/16",1/2" solid carbide shanks.	a,b	Left Hand	1-4	---	7-2
		a1 & b1	Right Hand	1-4	---	7-2
	For internal diameters .325" and larger; .004" - .125" insert widths in .001" increments; Depths of cut to .125"; For grooving, boring and generating profiles.	a & b	Left Hand	2-5	4	1-6
		a1 & b1	Right Hand	2-5	3	1-6
	For internal diameters 1" and larger; 2,3 & 4mm insert widths; Depths of cut .5".	a & b	---	6-1	4	1-8
		a1 & b1	---	6-1	3	1-8
	For internal diameters 1.250" and larger; .004" - .150" insert widths in .001" increments; Depths of cut 2.5 to 3 times width; For grooving, turning and generating profiles; Carbide and High Speed Steel.	a & b	Left Hand	1-10	4	7-1
		a1 & b1	Right Hand	1-10	3	7-1
Face Groove Reference: c,c1	For internal diameters .125" and larger; .004" - .250" insert widths in .001" increments; Depths of cut to .150"; 1/8", 3/16", 1/4", 5/16",1/2" solid carbide shanks.	c	Right Hand	2-4	---	7-2
		c1	Left Hand	2-4	---	7-2
	.004" - .150" insert widths in .001" increments; Depths of cut 2.5 to 3 times width; For grooving, turning and generating profiles; Carbide and High Speed Steel.	c	Counter-Clockwise	2-10	1,4	7-1
	For internal diameters .325" and larger; .004" - .125" insert widths in .001" increments; Depths of cut to .125"; For grooving, boring and generating profiles.	c	Right Hand	2-5	2	2-6
		c1	Left Hand	2-5	1	2-6
	For internal diameters 1.547" and larger; 2,3,4,5 & 6mm insert widths; Depths of cut .5" to 1".	c	---	6-1	2	2-8
		c1	---	6-1	1	2-8
Threading Reference: d,d1	For internal diameters .077" and larger; 4 Threads per Inch and greater; 1/8", 3/16", 1/4", 5/16",1/2" solid carbide shanks.	d	Right Hand	4-4	---	7-2
		d1	Left Hand	4-4	---	7-2
	For internal diameters .187" and larger 6 Threads per Inch and greater 3/16", 1/4", 5/16", 3/8" solid carbide shanks.	d	Right Hand	4-6	---	7-2
		d1	Left Hand	4-6	---	7-2
	For internal diameters .325" and larger; 9 Threads per Inch and greater.	d	Left Hand	4-8	4	1-6
		d1	Right Hand	4-8	3	1-6
	For internal diameters 1.250" and larger; 8 Threads per Inch and greater; Carbide and High Speed Steel.	d	Right Hand	4-10	4	7-1
		d1	Left Hand	4-10	3	7-1
	For internal Acme threading 1.250" and larger 4 Threads per Inch and greater Carbide and High Speed Steel.	d & d1	Right Hand	4-12	3,4	7-1
Boring Reference: e,e1	For internal diameters .073" and larger; 1/8", 3/16", 1/4", 5/16",1/2" solid carbide shanks.	e	Right Hand	3-4	---	7-2
		e1	Left Hand	3-4	---	7-2
	For internal diameters .165" and larger; WCGT, CD, TD and TP style inserts.	e	---	3-1	4	3-1
		e1	---	3-1	3	3-1

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DURA-MAX® 2000 CARBIDE	**DURA-MAX® 2000** is a versatile and tough sub-micron grain carbide. Because of its high transverse rupture strength and fine grain structure, **DURA-MAX® 2000** performs well with interrupted cuts. This grade is recommended for cutting steel, cast iron, stainless steel and applications where there are interrupted cuts. **DURA-MAX® 2000** approximates an ANSI C4/C5.
DURA-MAX® 3000 CARBIDE	**DURA-MAX® 3000** is a hard and wear resistant sub-micron grain carbide. **DURA-MAX® 3000** is designed for light finish cuts. This grade is recommended for cutting steels and applications where precision finish cuts are required. **DURA-MAX® 3000** approximates an ANSI C7/C8. **DURA-MAX® 3000 inserts are only available on MINI-BORE® style inserts. See Section 3 of this catalog for further detail.**
DURA-MAX® 4000 CARBIDE	**DURA-MAX® 4000** is a tough, general purpose sub-micron grain carbide. **DURA-MAX® 4000** is designed for roughing. This grade is recommended for cutting steels, stainless steel, nickel based alloys and applications where there are interrupted cuts. **DURA-MAX® 4000** approximates an ANSI C5/C6. **DURA-MAX® 4000 inserts are only available on MINI-BORE® style inserts. See Section 3 of this catalog for further detail.**
DURA-MAX® 5000 CARBIDE	**DURA-MAX® 5000** is a hard, abrasion resistant, sub-micron grain carbide. Because of its hardness and fine grain structure, **DURA-MAX® 5000** provides excellent edge and corner retention. This grade is recommended for cutting abrasive materials, non-ferrous alloys, aluminum, plastic and applications where there are no interrupted cuts. **DURA-MAX® 5000** approximates an ANSI C2/C3.
DURA-MAX® 8000 CBN	**DURA-MAX® 8000** is a **CBN** tipped insert which provides an increased production rate, improved surface finish and dimensional control when used on high-temperature alloys such as inconel, nickel base alloys and materials with a hardness of Rockwell C-35 or harder. **DURA-MAX® 8000 CBN tipped inserts are only available on MINI-BORE® style inserts. See Section 3 of this catalog for further detail.**
DURA-MAX® 9000 PCD	**DURA-MAX® 9000** is a **PCD** tipped insert which provides an increased production rate, improved surface finish and dimensional control when used on non-ferrous and abrasive metals such as aluminum, brass and copper. **DURA-MAX® 9000 PCD tipped inserts are only available on MINI-BORE® style inserts. See Section 3 of this catalog for further detail.**
HIGH SPEED STEEL	**High Speed Steel** will cut most materials. It will take considerable abuse. However, high speed steel will not wear as well as carbide. We suggest the use of high speed steel for jobs of 500 cuts or less. It also works well on older machines which do not have high enough spindle speeds to take advantage of carbide. **High Speed Steel** is an M42 grade.

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TiN (Titanium Nitride)	Excellent general purpose PVD coating for most applications. TiN offers excellent wear resistance and allows 10% - 30% increase in speeds and feeds. TiN also increases lubricity at cutting edge which reduces galling and welding. TiN is not recommended for Nickel alloys or Titanium. Color: Yellow/gold Thickness: 2-4 microns (.0001"-.0002")
TiCN (Titanium Carbonitride)	A multi-layer, PVD coating good for cutting Aluminum, Brass, Bronze, Copper and its alloys and Cast Iron. TiCN improves tool life and allows increased speeds and feeds. Should out-perform TiN in abrasive and difficult to machine materials. TiCN is harder and more impact resistant than TiN. Color: Gray/bronze Thickness: 2-6 microns (.0001"-.0004")
TiAlN (Titanium Aluminum Nitride)	A high performance PVD coating which excels in cutting abrasive or difficult-to-machine materials such as Titanium, Inconel, Waspaloy, Hastelloy, High Nickel Alloys, harder varieties of Stainless Steel. Good performance with interrupted cuts, high temperatures and dry machining. Color: Dark gray/black Thickness: 2-4 microns (.0001"-.0002")
DIAMOND	Works well in cutting Aircraft Aluminum, Automotive Cast Aluminum, Copper, Brass, Graphite, Carbon, Various Plastics, Nylon, Natural Wood, Composite Woods and Kurtzite. Diamond coating is not recommended for cutting steels or other ferrous metals. Color: Silver Thickness: 2-6 microns (.0001"-.0004")

Note on coolants:
THINBIT® inserts are compatible with all coolant types. Carbide and High Speed Steel give best performance on most materials when run flooded with coolant. Carbide does not perform well in thermal shock situations. Keep insert flooded or run dry.

Note on coatings:
Part numbers may not always include coating designation.

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THINBIT® TROUBLESHOOTING INFORMATION

It is critical for small tooling to have correct set ups. Speeds and feeds, condition of toolholder, insert and machine, centerline heights, squareness of cutting edge to machine, rigid machine to toolholder relationships are vital for proper performance in all applications. The items listed are general guides, but will not solve all problems. Please call our sales office for additional assistance.

Problem	Things to try
Grooving	
Cutting oversized; Groove walls not square	Check insert squareness; Check toolholder condition; Check insert centerline; Check machine alignment; Decrease IPR
Chatter; Poor finish	Increase speed; Reduce feed; Check toolholder condition; Check centerline; Stub toolholder and review toolholder size and machine set up for maximum rigidity; Add coating; Add top rake
Built up edge; Insert chipping	Increase feed; Increase speed; Run with coolant; Use coated insert; Check insert centerline
Burr on part	Add chamfer to insert; Turn or bore diameter after groove
Insert breaking	Check insert squareness; Check toolholder condition; Check insert centerline; Check machine condition; Decrease IPR; Review speeds and feeds; Verify insert grade
Chip control	Increase feed; Use peck cycle; Mount with cutting edge down; Flood with coolant; Add chip control to insert
Face Grooving	
Cutting oversized; Groove walls not square	Check insert squareness; Check toolholder condition; Check insert centerline; Check machine alignment; Decrease IPR
Chatter; Poor finish	Increase speed; Reduce feed; Check toolholder condition; Check centerline; Stub toolholder and review toolholder size and machine set up for maximum rigidity; Add coating; Add top rake
Built up edge; Insert chipping	Increase feed; Increase speed; Run with coolant; Use coated insert; Check insert centerline
Burr on part	Add chamfer to insert; Turn or bore diameter after groove
Insert breaking	Check insert squareness; Verify clearance diameter; Check insert centerline; Check toolholder condition; Check machine condition; Decrease IPR; Review speeds and feeds; Verify insert grade
Chip control	Increase feed; Use peck cycle; Mount with cutting edge down; Flood with coolant; Add chip control to insert
Boring/Turning	
Chatter; Poor Finish	Increase speed; Reduce feed; Check toolholder condition; Check centerline; Verify chip evacuation; Verify coolant reaching cutting edge; Stub toolholder and review toolholder size and machine set up for maximum rigidity; Add coating; Add top rake
Built up edge; Insert chipping	Increase feed; Increase speed; Increase corner radius; Run with coolant; Use coated insert; Check insert centerline
Insert breaking	Check squareness; Verify clearance diameter; Check centerline; Check toolholder condition; Check machine condition; Decrease IPR; Review speeds and feeds; Verify insert grade
Chip control	Increase feed; Mount with cutting edge down; Flood with coolant; Add chip control to insert
Threading	
Chatter; Poor finish	Increase speed; Reduce depth of cut per pass; Check toolholder condition; Check centerline; Verify chip evacuation; Verify coolant reaching cutting edge; Stub toolholder and review toolholder size and machine set up for maximum rigidity; Add coating
Built up edge; Insert chipping	Increase depth of cut per pass; Increase speed; Increase corner radius; Run with coolant; Use coated insert; Check insert centerline
Insert breaking	Check squareness; Check centerline; Check toolholder condition; Check machine condition; Decrease depth of cut per pass; Review speeds and feeds; Verify insert grade
Parting	
Insert leading; Faces not square	Check insert squareness; Check toolholder condition; Check insert centerline; Check machine alignment; Decrease IPR; Add lead angle
Chatter; Poor finish	Increase speed; Reduce feed; Check toolholder condition; Check centerline; Stub toolholder and review toolholder size and machine set up for maximum rigidity; Add coating; Add top rake
Built up edge; Insert chipping	Increase feed; Increase speed; Run with coolant; Use coated insert; Check insert centerline
Burr on part	Chamfer before parting; Add lead angle to drop side of insert
Insert breaking	Check insert squareness; Check toolholder condition; Check insert centerline; Check machine condition; Decrease IPR; Review speeds and feeds; Verify insert grade
Chip control	Increase feed; Use peck cycle; Mount with cutting edge down; Flood with coolant; Add chip control to insert

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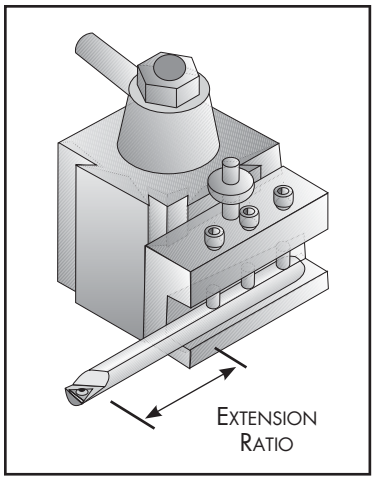


Extension Ratios

Bar Diameter	Steel 4 x ø	Heavy Metal 6 x ø	Carbide 8 x ø
.156"	.625"	.937"	1.250"
.187"	.750"	1.125"	1.500"
.250"	1.000"	1.500"	2.000"
.312"	1.250"	1.875"	2.500"
.375"	1.500"	2.250"	3.000"
.500"	2.000"	3.000"	4.000"
.625"	2.500"	3.750"	5.000"
.750"	3.000"		
1.000"	4.000"		

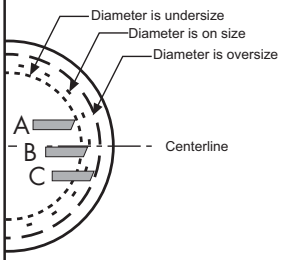
Shank Height	Steel
.312"	1.250"
.375"	1.500"
.500"	2.000"
.625"	2.500"
.750"	2.500"
1.000"	2.500"
1.250"	2.500"

Extending a toolholder beyond these recommendations can cause excessive deflection which will result in poor surface finish and reduced insert life. These recommendations may need to be reduced if cutting materials with low machinability, taking heavy cuts or using the tooling in non-rigid machine set-ups.

Toolholder Notes:

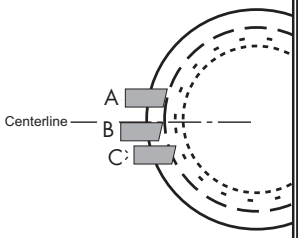
- To avoid burrs on your shanks, use only dog point screws. The use of cup point screws promotes burrs on the shanks and can result in problems removing or re-installing bars.
- Complete toolholders may be an assembly of several components each having an individual part number.
- Heavy Metal is a high density Tungsten based alloy that is very tough, stiff and vibration resistant.

Internal Tool & Face Grooving Cutting Heights



- Normal cutting forces cause tool deflection, therefore internal tools are manufactured to cut .002" to .010" above centerline.
- Setting tool above 'A' will cause diameter to be under desired size.
- Setting tool to cut at 'A' will cause insert to deflect to 'B' and cut desired diameter.
- Setting tool below 'A' will cause insert to deflect to 'C' and cause diameter to be oversized.
- Keep in mind if tools are mounted cutting edge toward floor, above center is toward floor.

External Tool Cutting Heights



- External tools are manufactured to cut on center to .005" below centerline.
- Setting tool to cut at 'A' can cause heel of insert to rub or cause failure.
- Setting tool to cut at 'B' will cause insert to deflect slightly and cut at 'C'.
- Setting tool below 'C' can cause insert to grab or fail.
- Keep in mind if tools are mounted cutting edge toward floor, below center is toward ceiling.

DEEPGROOVE® Head and Shank Compatibility Chart

Shank	Package	Page	Head	Clamp	Shank	Package	Page	Head	Clamp	Shank	Package	Page	Head	Clamp
DGS_ _XL	C	2-16	DGH4	DGC2	DGS_ _XR	B	2-16	DGH3	DGC1	DGS_ _ZR	N	2-8	DGH6	DGC6
	E	1-14	DGH2	DGC2		F	1-14	DGH1	DGC1		O	7-13	DGH3	DGC1
	S	7-14	DGH5	DGC5		T	7-14	DGH6	DGC6		Q	7-13	DGH1	DGC1
DGS_ _YR	D	2-16	DGH4	DGC2	DGS_ _YL	A	2-16	DGH3	DGC1	DGS_ _ZL	M	2-8	DGH5	DGC5
	G	1-14	DGH2	DGC2		H	1-14	DGH1	DGC1		P	7-13	DGH4	DGC2
	U	7-14	DGH5	DGC5		V	7-14	DGH6	DGC6		R	7-13	DGH2	DGC2

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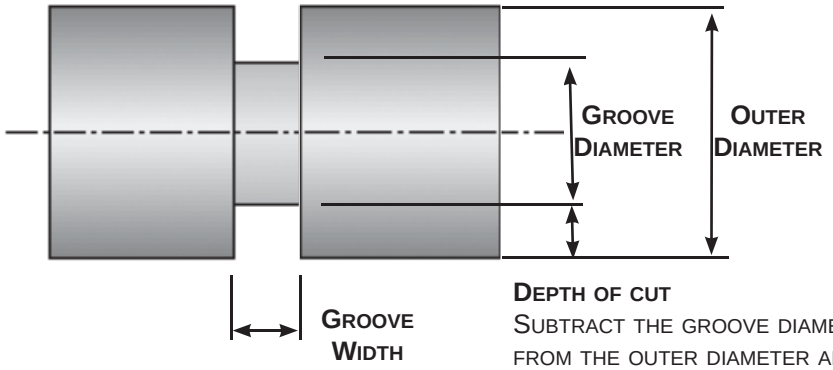


Depth of cut
Subtract the groove diameter from the outer diameter and divide by 2.

Example: 1" outer diameter with .75" groove diameter.

$\frac{1"-.75"}{2}$ = .125" depth of cut

Setup Guide

External Grooving Applications

Decrease surface speed (SFM)
Increase feed (IPR)
Set tool on center to .005" below center. Keep smaller inserts closer to center.

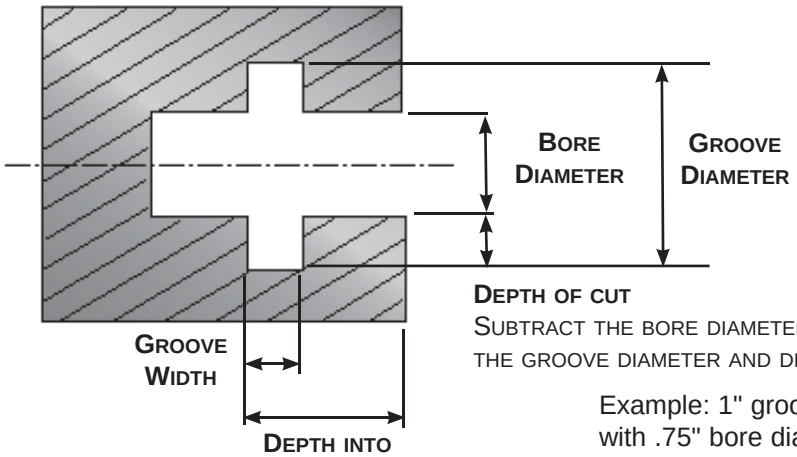
Modify Parameter →

Insert width:	.004"	.020"	.040"	.060"	.080"	.100"	.120"	.140"	.160"	.180"	.200"	.220"	.250"

← Modify Parameter

Internal Grooving Applications

Decrease surface speed (SFM)
Increase feed (IPR)
Set tool .002" to .010" above center. Keep smaller inserts closer to center.

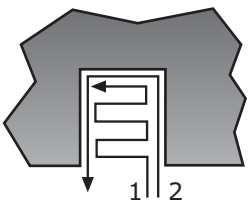


Depth of cut
Subtract the bore diameter from the groove diameter and divide by 2.

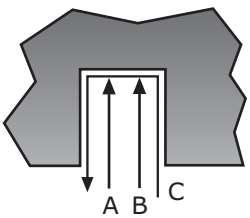
Example: 1" groove diameter with .75" bore diameter.

$\frac{1"-.75"}{2}$ = .125" depth of cut

Insert begins with: LGT, MGTI, GT



Insert begins with: DGI, DGMI



Cutting Paths
Use these diagrams for expanding the size of grooves.

Note: Side load on path 1 should be 10% to 30% of depth of cut on insert.

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Speeds & Feeds - Grooving

Material To Be Cut		Carbide			High Speed Steel	
		Carbide Grade	Speed (SFM)	Feed (IPR)	Speed (SFM)	Feed (IPR)
Aluminum	2021-6061	**DURA-MAX® 5000**	1000	.002	500	.002
Brass		**DURA-MAX® 5000**	250	.001	75	.001
Bronze		**DURA-MAX® 5000**	250	.001	70	.001
Cast Iron	Gray	**DURA-MAX® 5000**	120-345	.0015-.004	35-125	.0015-.004
	Ductile	**DURA-MAX® 2000**	70-345	.001-.004	15-125	.001-.004
	Malleable	**DURA-MAX® 2000**	75-525	.0015-.003	35-170	.0015-.003
Copper	101-757	**DURA-MAX® 5000**	150-170	.002	85-90	.002
	834-978	**DURA-MAX® 5000**	600	.003	340	.003
Magnesium	AZ, AM, EZ, ZE, HK Types	**DURA-MAX® 5000**	1000	.002	500	.002
Nickel	Nickel 200-230	**DURA-MAX® 5000**	225	.002	85	.002
	Monel	**DURA-MAX® 5000**	150	.001-.0015	15-60	.001-.0015
	Inconel, Waspaloy	**DURA-MAX® 5000**	45	.002	15	.002
	Hastelloy	**DURA-MAX® 5000**	75-95	.002	10-15	.002
Plastic	Teflon (TFE, CTFE)	**DURA-MAX® 5000**	400	.002	250	.002
	Nylon	**DURA-MAX® 5000**	350-600	.002-.003	350	.002-.003
	Phenolic	**DURA-MAX® 5000**	600	.003	350	.003
	Glass Filled	**DURA-MAX® 5000**	250	.002	NA	NA
Stainless Steels	201-385	**DURA-MAX® 5000**	225-275	.001-.0015	65-85	.001-.0015
	405-446	**DURA-MAX® 2000**	300	.0011	90	.0011
	14-4, 15-5, 16-6, 17-4 PH	**DURA-MAX® 2000**	110-205	.0006-.0012	30-60	.0006-.0012
Steel	1005-1029	**DURA-MAX® 2000**	255-450	.001-.002	80-140	.001-.002
	1030-1055	**DURA-MAX® 2000**	115-370	.0009-.0015	35-115	.0009-.0015
	1060-1095	**DURA-MAX® 2000**	95-255	.0007-.001	30-80	.0007-.001
	10L45-10L50	**DURA-MAX® 2000**	130-450	.0009-.0015	40-140	.0009-.0015
	12L13-12L15	**DURA-MAX® 2000**	550-600	.003-.0035	225-280	.003-.0035
	41L30-41L50	**DURA-MAX® 2000**	65-350	.0007-.0015	20-110	.0007-.0015
	4140-4150	**DURA-MAX® 2000**	65-370	.0007-.0015	20-115	.0007-.0015
	4140 (35 HRc)	**DURA-MAX® 2000**	200	.001	70	.001
	8617-8622	**DURA-MAX® 2000**	125-390	.001-.0016	40-120	.001-.0016
	M1-M6	**DURA-MAX® 2000**	190	.0013	60	.0013
	H10-H19	**DURA-MAX® 2000**	65-255	.0007-.0011	20-80	.007-.0011
	D2-D7	**DURA-MAX® 2000**	150-205	.001	45-60	.001
	A2-A9, 01-07	**DURA-MAX® 2000**	150-205	.001	45-60	.001
	W1, W2	**DURA-MAX® 2000**	375	.0015	110	.0015
	M-50, 52100	**DURA-MAX® 2000**	65-275	.0007-.0015	20-85	.0007-.0015
Titanium	Ti-6Al-6V	**DURA-MAX® 5000**	95	.001	45	.001

These speeds and feeds are given as a starting point only and may be adjusted up or down depending on conditions. Any time there is an interrupted cut in your operation, **DURA-MAX® 2000** carbide is recommended.

FORMULA FOR CONVERSION FROM SFM TO RPM

SFM = Surface Feet Per Minute RPM = Revolutions Per Minute IPR = Inches Per Revolution Diameter = Cutting Diameter $\pi = 3.14$

$$\text{RPM} = \frac{\text{SFM} \times 12}{(\pi) \times \text{Diameter}}$$

GROOVING

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