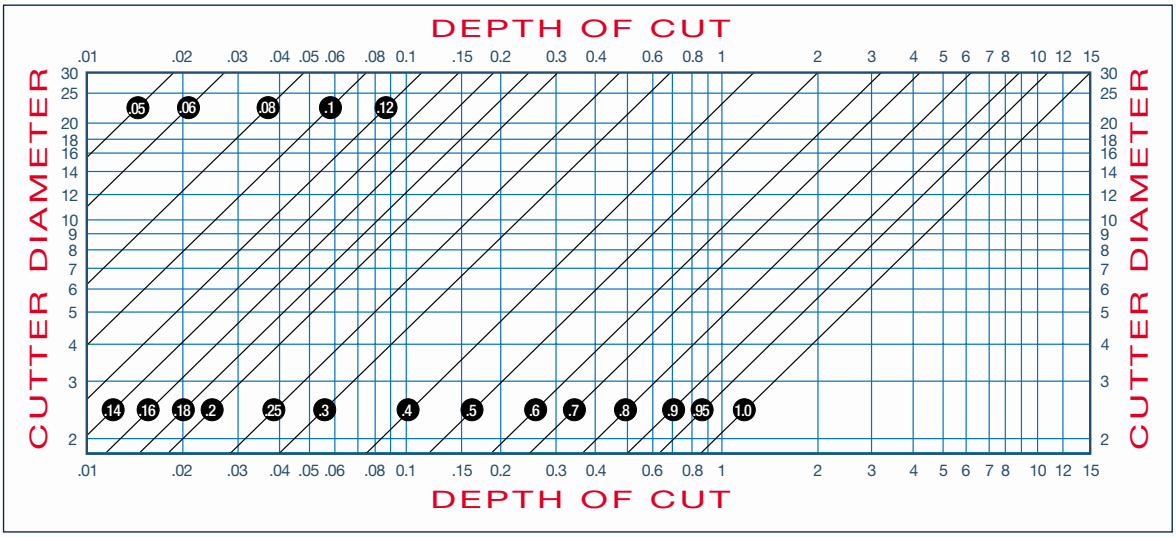
CHIP THINNING (SLOTTING)



To find the Radial Chip Thinning Factor for a slotting cut:

1. Find the Depth of Cut on the horizontal scale.
2. Locate the nominal diameter of the cutter on the vertical axis.
3. Cross-reference the two figures.
4. Locate the diagonal line closest to the intersection of the vertical and horizontal axes. The value of this diagonal is the Radial Chip Thinning Factor for your specific application.
5. Multiply this radial chip thinning factor with the calculated chip thickness to get the actual chip thickness.

VoMAX™ OPERATING PARAMETERS

Material		Brinell Hardness	SFM	Feed per Insert	Grades* IN1530	IN6515	IN2015/IN2010	IN2030	IN2040	IN2005	IN15K (Polished)	IN70N	Coolant
Aluminum	6061-T6, 7075-T6, 2024	-	1500-3000	.004-.015							1		Yes
Cast Iron	Gray	150-280	400-750	.005-.012		2	1						No
	Nodular		300-650										
			1500+	.004-.007								1	
Steel	Low Carbon 1018, 8620	150-250	250-500	.005-.010									No
	High Carbon F-6180, Nitralloy 52100	250-400	200-350	.005-.008									
	Alloyed Steel 4140, 4340, 6150	150-300	250-400	.005-.010				2	1	3			
	Tool Steel A-6, D-1, D-2, P-20	Up to 300											
Stainless Steel	300 Series, 304, 316	-	250-400	.003-.006									May not be required at high speeds
	400 Series, 15-5 PH, 17-4 PH	Up to 320	300-600		1			2		3			
	13-8 PH	-	200-250	.004-.008									Yes
Nickel Alloys	Inconel 600, 706, 718, 903, Hastelloy, Waspalloy	-	75-120	.003-.006	1			3		2			Yes
Titanium	6AL-4V	-	100-150	.003-.006	2			3		1			Yes

*In order of preference.

Operating Parameters

INSERT SERIES: DPM314/DPM324

Material		Brinell Hardness	SFM	Feed per Insert	Grades* IN2015	IN2040	IN2005	Coolant
Cast Iron	Gray	150-280	400-750	.005-.012	1		2	No
	Nodular		300-650					
Steel	Low Carbon 1018, 8620	150-250	250-500	.005-.010		1	2	No
	High Carbon F-6180 Nitralloy 52100	250-400	200-350	.005-.008				
	Alloyed Steel 4140, 4340, 6150	150-300	250-400	.005-.010				
	Tool Steel A-6, D-1, D-2, P-20	Up to 300						
Stainless Steel	300 Series 304, 316	-	250-400	.003-.006	2		1	May not be required at high speeds
	400 series, 15-5 PH, 17-4 PH	Up to 300	300-600					
	13-8 PH	-	200-250	.004-.008				Yes
Nickel Alloys	Inconel 600, 706, 718 903, Hastelloy, Waspalloy	-	75-120	.003-.006	2		1	Yes
Titanium	6AL-4V	-	100-150	.003-.006	2		1	Yes

INSERT SERIES: DPM424/DPM434

Material		Brinell Hardness	SFM	Feed per Insert	Grades* IN2015	IN2040	IN2005	IN1530	IN6515	Coolant
Cast Iron	Gray	150-280	400-750	.007-.018	1		3		2	No
	Nodular		300-650							
Steel	Low Carbon 1018, 8620	150-250	250-500	.005-.015		1	2	3		No
	High Carbon F-6180 Nitralloy 52100	250-400	200-350	.006-.013						
	Alloyed Steel 4140, 4340, 6150	150-300	250-400	.006-.015						
	Tool Steel A-6, D-1, D-2, P-20	Up to 300								
Stainless Steel	300 Series 304, 316	-	250-400	.005-.010			2	1		May not be required at high speeds
	400 series, 15-5 PH, 17-4 PH	Up to 300	300-600							
	13-8 PH	-	200-250	.006-.012						Yes
Nickel Alloys	Inconel 600, 706, 718 903, Hastelloy, Waspalloy	-	75-120	.004-.007			2	1		Yes
Titanium	6AL-4V	-	100-150	.004-.007			1	2		Yes

Grade and Carbide Selection

CHOOSING A GRADE

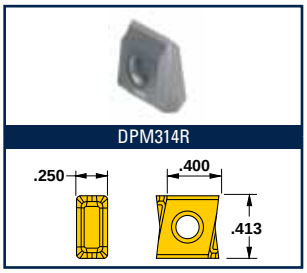
Grade	Material
IN2015 / IN2010	Grey, ductile, nodular iron dry or wet, low to medium cutting speed, low to medium chip thickness.
IN6515	Grey, ductile, nodular iron dry, medium to high cutting speed, medium to high chip thickness. Heavily interrupted cuts.
IN1530	General purpose mild steel, hi-temp alloys, or stainless steel. Interrupted cuts. Wet.
IN2030 / IN2005	Hi-temp alloys. Poor set-up rigidity. Wet or dry.
IN2040	General purpose mild steel and steel alloys, ductile and nodular iron (dry only), when set-up rigidity is good.
IN6542 / IN6510	Grey, ductile, nodular iron dry or wet, non-interrupted milling, low to medium cutting speed, medium to high chip thickness.
IN15K (w/polish)	Non-ferrous materials. Wet.
IN70N	Grey, ductile, nodular iron dry only, very high speed, low to medium chip thickness.

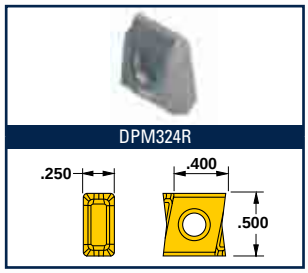
CARBIDE SELECTION GUIDE

Direction of Use	Wear Resistance → / ← Toughness / ← Increase Feed / Increase Speed →	Wear Resistance → / ← Toughness / ← Increase Feed / Increase Speed →	Wear Resistance → / ← Toughness / ← Increase Feed / Increase Speed →
Material	Short Chipping Malleable Iron, Non-Ferrous Metal, Hardened Iron, Chilled Iron, Cast Iron	High-Temp Alloys, Alloy Iron, Steel Casting, Manganese	Free Cutting Steels, Malleable Iron, Steel Casting, Steel

New CL	Coating	C1						C2		C3		C4						C5						C6		C7		C8		
		K50	K45	K40	K35	K30	K25	K20	K15	K10	K05	K01	M50	M40	M30	M20	M10	P50	P45	P40	P35	P30	P25	P20	P15	P10	P05	P01		
IN15K	Uncoated		IN15K																											
IN6510	CVD							IN6510																						
IN6515	CVD				IN6515																	IN6515								
IN1530	PVD	IN1530												IN1530					IN1530											
IN2005	PVD													IN2005							IN2005									
IN2010	PVD				IN2010																									
IN2015	PVD			IN2015										IN2015							IN2015									
IN2030	PVD		IN2030											IN2030					IN2030											
IN2040	PVD																			IN2040										
N70N	Non-Carbide							IN70N																						

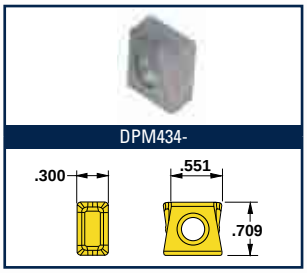
INSERTS: 0° LEAD RH ONLY





Insert Color Code	Insert Number	Corner IN	Grades 2015	2040	2005
	DPM314R001	.031	■	■	■
	DPM324R001	.031	■	■	■
	DPM424R001	.031	■	■	■

INSERTS: SLOTTING RH/LH



Insert Color Code	Insert Number	Corner IN	Grades 2015	2040	2005	1530
	DPM434-001	.031	■	■	■	■
	DPM434-002	.062	■	■	■	

General Application Information

APPLYING BASIC PRINCIPLES OF MACHINING WITH INDEXABLES CAN IMPROVE PERFORMANCE

The following information is directed toward indexable carbide tools but it can be applied to many other cutting tools, as well. It provides some basic guidelines designed to serve as a starting point for safe and reliable performance. Contact your Ingersoll Cutting Tool Company sales engineer or distributor for specific application assistance.

Rigidity. Use the most rigid cutter possible. This usually means the cutter with the largest diameter and shortest length. Use the best adaption possible. Integral tapers, such as a 50 V-flange, are better than straight shanks. When selecting straight shank tools, use a cutter with the largest diameter shank possible and a holder with the shortest length possible.

Effective cutting edges. When calculating feed rate, use the effective number of inserts. In extended flute cutters, the effective number of inserts is not the number of rows. Use the effective number listed with the specifications for each series of tools.

Chip load. Carbide cutting tools have to take a "bite" to cut. Be sure to cut with an adequate chip load. Light chip loads can contribute to chatter, causing a cutter to "rub" instead of "bite." This can also result in poor tool life. As a general rule, chip loads should not be less than .004". Also, be sure to use Radial Chip Thinning Factors (RCTF) when calculating feed rates.

Chip recutting. Unlike HSS, carbide cutting tools cannot recut chips. Recutting chips will damage carbide. To evacuate chips, use air or coolant depending on the material being cut.

Coolant. Generous amounts of coolant are required when low thermal conductivity, work hardening, and chip welding tendencies are evident.

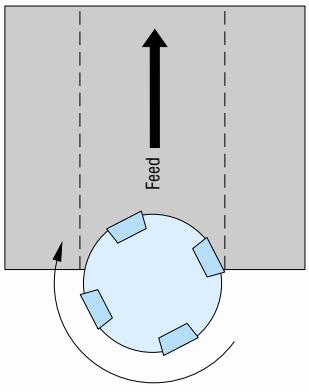
Use coolant only when necessary. Some materials cut better dry. In some applications, coolant causes thermal cracking of inserts and poor tool life.

Feed rates. Reduce feed rates by 50 percent when entering or exiting a cut. Since fewer inserts are engaged in the work, pounding can occur. Reducing feed rates will reduce the shock of the interrupted cut and contribute to longer tool life.

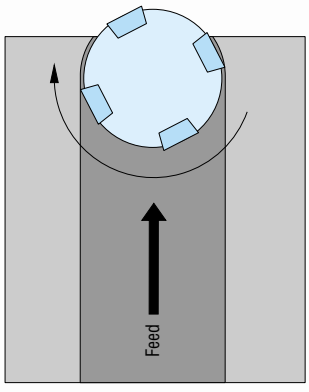
When entering a corner during pocket milling, a larger portion of the cutter's diameter is engaged. Power requirements and tool deflection increase. To compensate, program a reduced interpolated feed rate. Alternately, drill or plunge the corner prior to milling.

Cutter rotation. Climb cut whenever possible. Carbide is designed for climb milling and will not generally perform as well when conventional cutting.

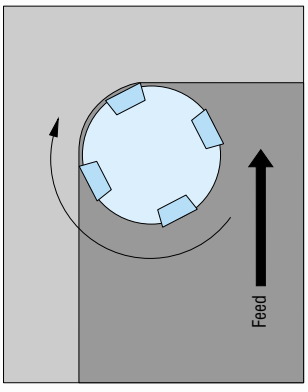
Conventional cutting may be employed on older machines to minimize backlash. It can also extend tool life in sandy, scaly, or torch-cut surfaces as the cutting edge enters into cleaner, softer material.



Entering a Cut



Exiting a Cut



Corner Cutting

Reduce feed rates by 50% when entering a cut, exiting a cut, or entering a corner. This reduces pounding and cutting forces and can extend the life of your indexable carbide tool.

Standard Milling Formulas

Surface Speed per Minute

$$SFM = .26 \times Diameter \times RPM$$

Revolutions per Minute

$$RPM = \frac{3.82 \times SFM}{Diameter}$$

Feed per Revolution

$$FPR = \frac{IPM}{RPM}$$

Inches per Minute

$$IPM = RPM \times FPR$$

Feed per Insert

$$FPI = \frac{FPR}{No.\ Eff.\ Insert}$$

Horsepower equals Material Removal Rate divided by the "K" Factor

Horsepower

$$HP = \frac{WOC \times DOC \times IPM}{K}$$

Material	"K" Factors
Aluminum	3.0 - 4.0
Brass-Soft	3.0
Brass-Hard	2.0
Bronze-Hard	1.4
Bronze-VH	.5 - .7
Cast Iron 200 Bhn	1.5 - 2.0
Cast Iron > 200 Bhn	1,3 - 1.8
Steel 100 Bhn	1.5
Steel 150 Bhn	.9
Steel 200 Bhn	.7
Steel 250 Bhn	.6
Steel 400 Bhn	.5
Stainless Steel	.5 - 1.0
High Temp Alloys	.3 - .8

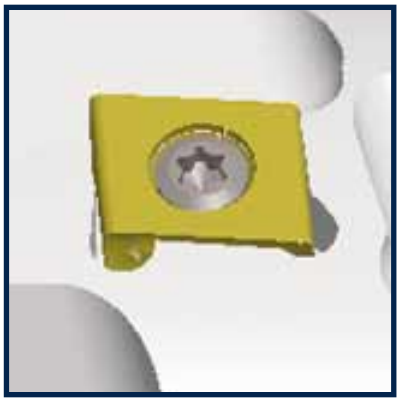
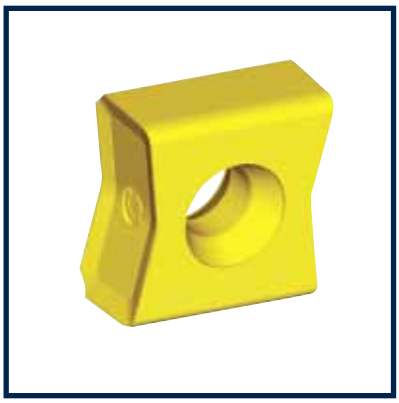
MODIFIED STANDARDS AND SPECIALS

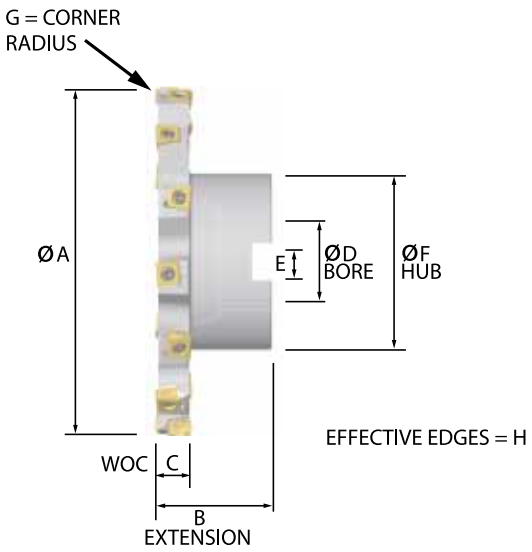
PRODUCT WORKSHEETS

- APPENDIX -







SUGGESTED DIAMETER 4.00"+

VARIABLE FEATURES

A:_____

B:_____

C:_____

D:_____

E:_____

F:_____

G:_____

H:_____

MEASUREMENT UNITS USED

☐ INCH ☐ MM

SLOTTING/SLABBING AND T-SLOTTING

APPLICATION DATA

WORKPIECE MATERIAL

AVG. RADIAL DOC

RPM

FEED RATE

MACHINE TYPE

MACHINE H.P.

MAX. TOOL ASSY. WEIGHT

REMARKS

THIS PAGE MAY BE COPIED AND VARIABLES FILLED IN TO COMMUNICATE BASIC DESIGN REQUIREMENTS

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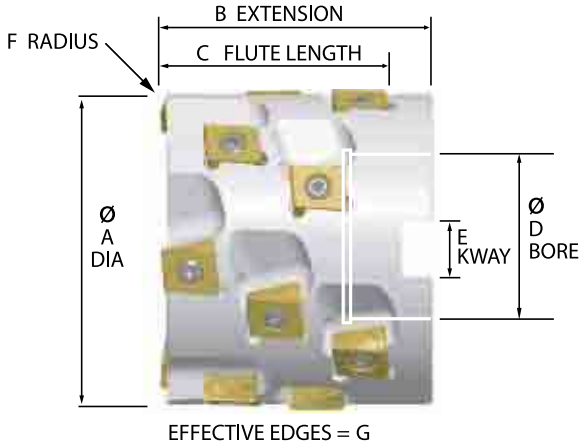

SUGGESTED DIAMETER 2.00"+

VARIABLE FEATURES

A:_____

B:_____

C:_____

D:_____

E:_____

F:_____

G:_____

MEASUREMENT UNITS USED
☐ INCH ☐ MM

HEAVY-DUTY SHELL MILL

COOLANT THRU: YES NO

APPLICATION DATA

WORKPIECE MATERIAL

AVG. RADIAL DOC

RPM

FEED RATE

MACHINE TYPE

MACHINE H.P.

MAX. TOOL ASSY. WEIGHT

REMARKS

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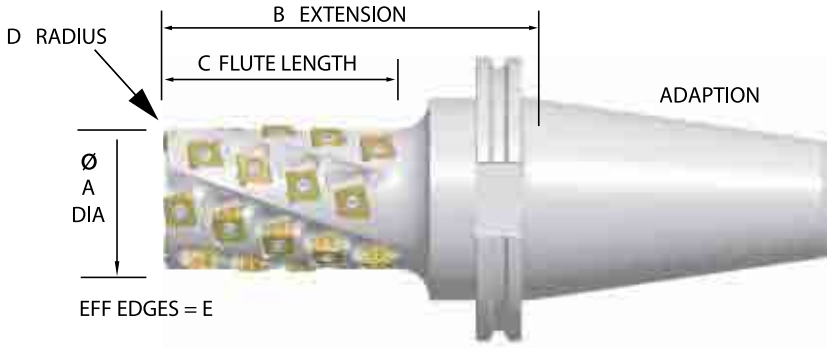

SUGGESTED DIAMETER 1.50"+

VARIABLE FEATURES

A:_____

B:_____

C:_____

D:_____

E:_____

MEASUREMENT UNITS USED

☐ INCH ☐ MM

HEAVY-DUTY ENDMILLING

COOLANT THRU: YES NO

ADAPTION STYLE:_____

APPLICATION DATA

WORKPIECE MATERIAL

AVG. RADIAL DOC

RPM

FEED RATE

MACHINE TYPE

MACHINE H.P.

MAX. TOOL ASSY. WEIGHT

REMARKS

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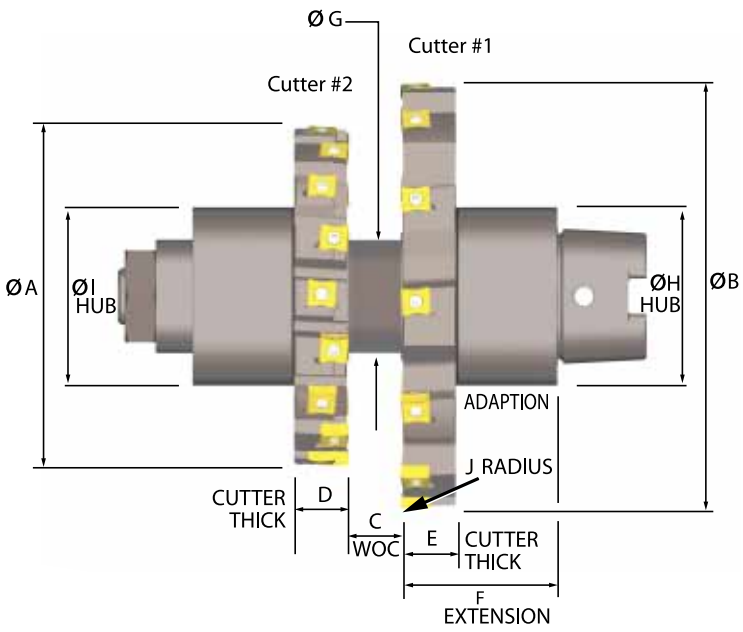

Optional
PA-0613 Anvil

VARIABLE FEATURES

A:_____

B:_____

C:_____

D:_____

E:_____

F:_____

G:_____

H:_____

I:_____

J:_____

MEASUREMENT UNITS USED

☐ INCH ☐ MM

STRADDLE MILLING
FULL SIDE MILLING

CUTTER #1 QUANTITY OF INSERTS:_____

CUTTER # 2 QUANTITY OF INSERTS:_____

ADAPTION STYLE:_____

APPLICATION DATA

WORKPIECE MATERIAL_____

AVG. AXIAL DOC_____

RPM_____

FEED RATE_____

MACHINE TYPE_____

MACHINE H.P._____

MAX. TOOL ASSY. WEIGHT_____

REMARKS

_____

_____

_____

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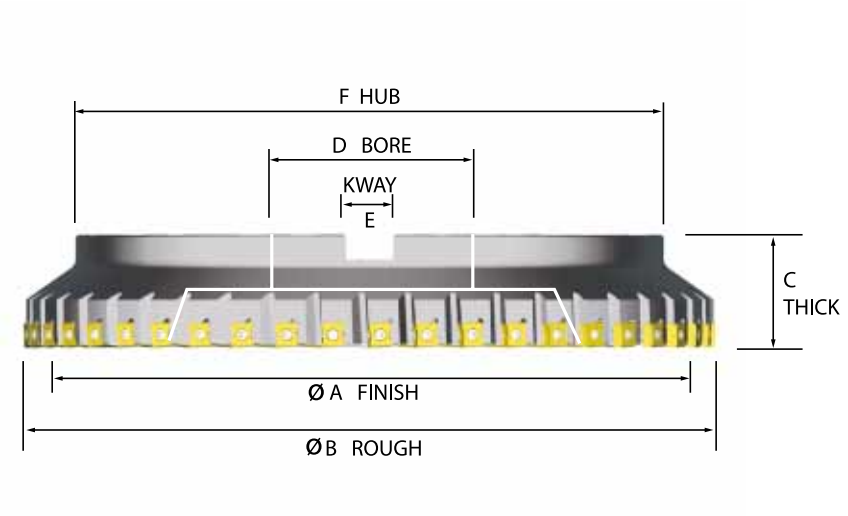

VARIABLE FEATURES

A:_____

B:_____

C:_____

D:_____

E:_____

F:_____

MEASUREMENT UNITS USED

☐ INCH ☐ MM

COMBINATION FINISH FACE MILL

PROPOSED QUANTITY OF ROUGHER INSERTS:_____

PROPOSED QUANTITY OF FINISHER INSERTS:_____

ROUGHER L-NEST PROTECTION/ ADJUSTMENT REQUESTED: . . . . . YES NO

COOLANT MANIFOLD REQUESTED: . .YES NO

APPLICATION DATA

WORKPIECE MATERIAL _____

AVG. AXIAL DOC _____

RPM _____

FEED RATE _____

MACHINE TYPE _____

MACHINE H.P. _____

MAX. TOOL ASSY. WEIGHT _____

REMARKS

_____

_____

_____

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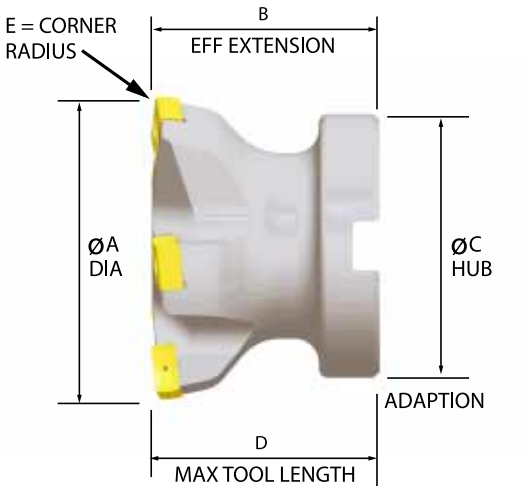

OPTIONAL
PAR0615/PAL0615
NEST

SUGGESTED DIAMETER 2.50"+

VARIABLE FEATURES

A:_____

B:_____

C:_____

D:_____

E:_____

MEASUREMENT UNITS USED
☐ INCH ☐ MM

BORING

QUANTITY OF INSERTS:_____

ADAPTION STYLE:_____

COOLANT THRU: . . . . . YES NO

L-NEST POCKET PROTECTION/
ADJUSTMENT REQUESTED . . . . . .YES NO

APPLICATION DATA

WORKPIECE MATERIAL

AVG. RADIAL DOC

RPM

FEED RATE

MACHINE TYPE

MACHINE H.P.

MAX. TOOL ASSY. WEIGHT

REMARKS

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