Carbide Modular Shrink System

Millstar's Carbide Modular Shrink System offers versatility, strength and accuracy. The carbide shank offers strength and rigidity and the shrink tolerances offer better accuracy than screw on type systems. These tools are designed for high speed machining and hard metal machining and will allow for better tool life as well as better surface finishes.

MILLSTAR

Carbide Modular Shrink System

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Shrink System Identification

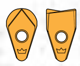
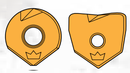
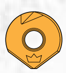
Head, Steel

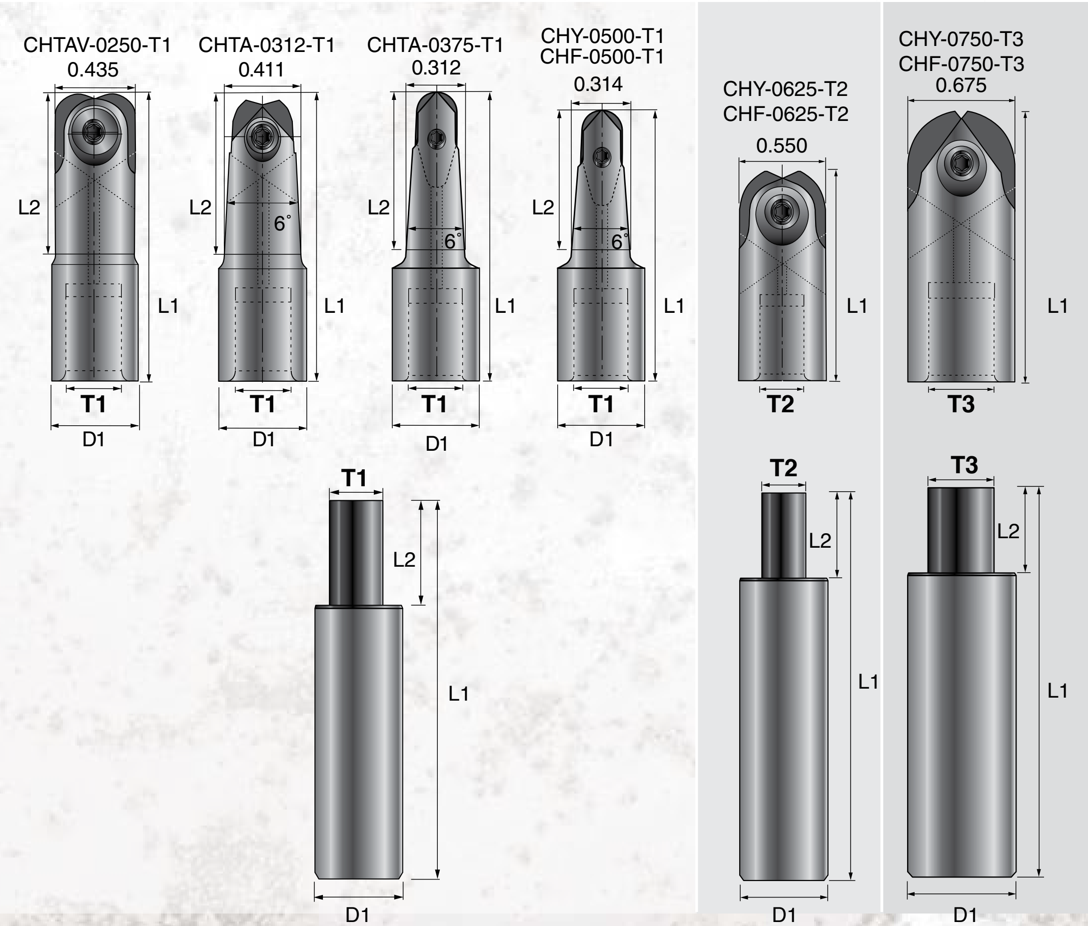
Measurement System	Denotes Type	Diameter Size	Connection Compatability
Imperial	CHY	500	T1
Metric	CHY	12	T1

Shank, Carbide

Measurement System	Denotes Type	Diameter Size	Overall Length	Connection Compatability
Imperial	CSS	500	2.29	T1
Metric	CSS	12	75	T1
	"CHTA" or "CHTAV" = Taper Neck Head "CHY" = Straight Head for Ball Insert "CHF" = Straight Head for Flat Type Insert	Imperial = Hundredths of an Inch Metric = Millimeters		

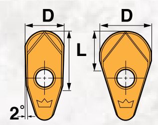
Carbide Modular Shrink System

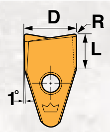
Insert		Shrink Fit HEAD				Shrink Fit SHANK			
			Dimensions				Dimensions		
Type	Code	Tool Number	ØD1	L1	L2	Tool Number	ØD1	L1	L2
	VBD, VRBS	CHTAV-0250-T1	0.460	1.700	0.879	CSS-0500-2.9-T1 CSS-0500-4.9-T1	0.500 0.500	2.900 4.900	0.600 0.600
		CHTAV-0312-T1	0.460	1.700	0.827				
	TO, HF, FB, BDS, MB,MBT, BD, TOBD-NF, RBT	CHTA-0375-T1	0.460	1.700	0.845				
	RB, MB, MBT, BS, RBT	CHY-0500-T1	0.460	1.700	0.857				
	FB, BD, BDS, HF, TO, TOBD-NF	CHF-0500-T1	0.460	1.700	0.857				
	BS, RB, MB, MBT, RBT	CHY-0625-T2	0.550	1.500		CSS-0625-4.1-T2 CSS-0625-7.1-T2	0.625 0.625	4.100 7.100	0.650 0.650
	FB, BD, BDS, HF, TO, TOBD-NF	CHF-0625-T2	0.550	1.500					
	RB, BS, MB, MBT, RBT	CHY-0750-T3	0.675	1.900		CSS-0750-3.8-T3 CSS-0750-6.8-T3 CSS-18-150-T3	0.750 0.750 18mm	3.800 6.800 6.000	0.700 0.700 0.700
	FB, BD, BDS, HF, TO, TOBD-NF	CHF-0750-T3	0.675	1.900					



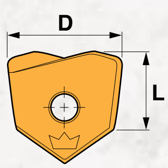
Profile Milling Program Tools

Small Ball Nose & Back Draft Inserts

VRBS	Tool Ordering Number	Dimensions D	Dimensions L	Dimensions R	Grade XRN	Grade TLN	Grade HSN	Description
	VRBS-0250	0.250	0.294	0.125	•	•	•	Used for semi and finish-milling small radius or detail work, and surface milling in soft and hard steel, cast iron, aerospace and non-ferrous alloys, graphite, etc. Suitable for high speed and hard milling.
	VRBS-0312	0.312	0.184	0.156	•	•	•	

VBD	Tool Ordering Number	Dimensions D	Dimensions L	Dimensions R	Grade XRN	Grade TLN	Grade HSN	
	VBD-0250-R01	0.250	0.313	0.015	•	•	•	Used for semi and finish-milling small radius or detail work, and surface milling in soft and hard steel, cast iron, aerospace and non-ferrous alloys, graphite, etc. Suitable for high speed and hard milling.
	VBD-0312-R01	0.312	0.215	0.015	•	•	•	

High Feed Inserts

HF	Tool Ordering Number	Dimensions D	Dimensions L	Dimensions PR	Grade XRN	Grade TLN	Grade HSN	Description
	HF-0375...	0.375	0.0125	0.028	•	•	•	Millstar HF insert is designed for High feed and High speed machining. It runs at high cutting speed and feed rates with shallow depth of cut. It allows the chip to flow up and out of the cut quickly. It allows heavy chip loads.
	HF-0500...	0.500	0.0203	0.052	•	•	•	
	HF-0625...	0.625	0.0235	0.071	•	•	•	
	HF-0750...	0.750	0.0315	0.094	•	•	•	
	HF-1000...	1.000	0.0345	0.111	•	•	•	

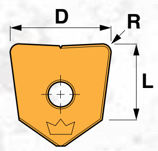
Cutting Recommendations for High Feed Inserts

Work Material	Material Hardness	Cutting Depth at Diameter ap max					Cutting Width	Insert	Coating Type Recom.	Cut speed at D	Max feed per tooth fz at cutting insert diameter D				
USA/W.-Nr./JIS	Hrc	0.375	0.500	0.625	0.750	1.000	Ae max			sfm/min	0.375	0.500	0.625	0.750	1.000
H13/1,2344/ SKD61	<41	0,014	0,019	0,023	0,028	0,037	60 - 75%	HF	XRN/HSN	515 - 715	0,012~0,016	0,017~0,021	0,021~0,025	0,026~0,030	0,035~0,039
H13/1,2344/ SKD61	41-50	0,012	0,016	0,019	0,023	0,031	60 - 75%	HF	XRN/HSN	415 - 615	0,010~0,014	0,014~0,018	0,017~0,021	0,021~0,025	0,029~0,033
H13/1,2344/ SKD61	51+	0,009	0,013	0,016	0,019	0,025	60 - 75%	HF	HSN	315 - 515	0,007~0,011	0,011~0,015	0,014~0,018	0,017~0,021	0,023~0,027
A2/1,2363/ SKD12	<41	0,014	0,019	0,023	0,028	0,037	60 - 75%	HF	XRN/HSN	515 - 715	0.,012~0,016	0,017~0,021	0,021~0,025	0,026~0,030	0,035~0,039
A2/1,2363/ SKD12	14-50	0,012	0,016	0,019	0,023	0,0319	60 - 75%	HF	XRN/HSN	415 - 615	0,010~0,014	0,014~0,018	0,017~0,021	0,021~0,025	0,029~0,033
A2/1,2363/ SKD12	51+	0,009	0,013	0,016	0,019	0,025	60 - 75%	HF	HSN	315 - 515	0,007~0,011	0,011~0,015	0,014~0,018	0,017~0,021	0,023~0,027
P20/1,2330	<41	0,014	0,019	0,023	0,028	0,037	60 - 75%	HF	XRN/HSN	515 - 715	0,012~0,016	0,017~0,021	0,021~0,025	0,026~0,030	0,035~0,039
P20/1,2330	14-50	0,012	0,016	0,019	0,023	0,031	60 - 75%	HF	XRN/HSN	415 - 615	0,010~0,014	0,014~0,018	0,017~0,021	0,021~0,025	0,029~0,033
D2/1,2379/ SKD11	<41	0,014	0,019	0,023	0,028	0,037	60 - 75%	HF	XRN/HSN	515 - 715	0,012~0,016	0,017~0,021	0,021~0,025	0,026~0,030	0,035~0,039
D2/1,2379/ SKD11	14-50	0,012	0,016	0,019	0,023	0,031	60 - 75%	HF	XRN/HSN	415 - 615	0,010~0,014	0,014~0,018	0,017~0,021	0,021~0,025	0,029~0,033
D2/1,2379/ SKD11	51+	0,009	0,013	0,016	0,019	0,025	60 - 75%	HF	HSN	315 - 515	0,007~0,011	0,011~0,015	0,014~0,018	0,017~0,021	0,023~0,027
Grey Cast Iron/ GG	<41	0,014	0,019	0,023	0,028	0,037	60 - 75%	HF	XRN/HSN	515 - 715	0,012~0,016	0,017~0,021	0,021~0,025	0,026~0,030	0,035~0,039
Cast Iron/GGG	41+	0,012	0,016	0,019	0,023	0,031	60 - 75%	HF	XRN/HSN	515 - 715	0,012~0,016	0,017~0,021	0,021~0,025	0,026~0,030	0,035~0,039

Copy Milling Program Tools

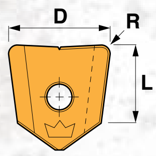
Flat Bottom, Back Draft, Toroid

BD-N



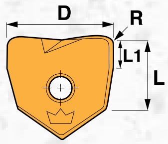
Tool Ordering Number	D	L	R	XRN	TLN	HSN	Description
BD-0375-N	0.375	0.357	1/32,1/16	•	•	•	Precision ground with 7º back taper. Used for milling of cores, cavities, fillets with straight or very steep walls of harder materials.
BD-0500-N	0.500	0.380	1/32,1/16	•	•	•	
BD-0625-N	0.625	0.457	1/32,1/16	•	•	•	
BD-0750-N	0.750	0.540	1/32,1/16,1/8	•	•	•	
BD-1000-N	1.000	0.740	1/32,1/16,1/8	•	•	•	
BD-1250-N	1.250	0.919	1/32,1/16,1/8	•	•	•	

BD-R



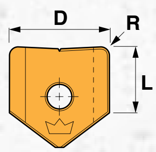
Number	D	L	R	XRN	TLN	HSN	Description
BD-0375-R	0.375	0.340	1/32	•	•	•	Precision ground with positive ground chip-breaker and 7º back taper. Used for milling of cores, cavities, fillets with straight or very steep walls of softer materials.
BD-0500-R	0.500	0.380	1/32,1/16,1/8	•	•	•	
BD-0625-R	0.625	0.457	1/32,1/16	•	•	•	
BD-0750-R	0.750	0.540	1/32,1/16,1/8	•	•	•	
BD-1000-R	1.000	0.740	1/32,1/16,1/8	•	•	•	
BD-1250-R	1.250	0.919	1/32,1/16,1/8	•	•	•	

BDS



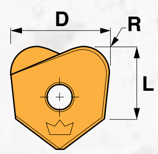
Number	D	L	R	L1	XRN	TLN	HSN	Description
BDS-0375-N	0.375	0.340	1/32,1/16	0.125	•	•	•	Precision ground with unique crossover design between flat bottom FB and back draft DB inserts. Allows straight walls with a larger step down than BD. Allows higher cutting speeds and feeds.
BDS-0500-N	0.500	0.380	015,1/32,1/16	0.125	•	•	•	
BDS-0625-N	0.625	0.457	1/32,1/16	0.125	•	•	•	
BDS-0750-N	0.750	0.540	1/32,1/16,1/8	0.125	•	•	•	
BDS-1000-N	1.000	0.740	1/32,1/16,1/8	0.125	•	•	•	
BDS-1250-N	1.250	0.919	1/16	0.125	•	•	•	

FB-R



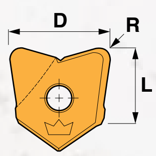
Number	D	L	R	XRN	TLN	HSN	Description
FB-0375-R	0.375	0.341	1/32	•	•	•	Precision ground with positive ground chip-breaker. Flat bottom inserts for shoulder milling, fillet finishing and long reach angular wall finishing of softer materials.
FB-0500-R	0.500	0.350	1/32,1/16,1/8	•	•	•	
FB-0625-R	0.625	0.421	1/32,1/16	•	•	•	
FB-0750-R	0.750	0.496	1/32,1/16,1/8	•	•	•	
FB-1000-R	1.000	0.679	1/32,1/16,1/8	•	•	•	
FB-1250-R	1.250	0.843	1/32,1/16,1/8	•	•	•	

TO



Number	D	L	R	XRN	TLN	HSN	Description
TO-0375	0.375	0.349	0.125	•	•	•	Precision ground large corner radius & back taper for spiral and pocket milling. Milling of pre-hard and hardened flat surfaces at higher speeds than tools with smaller corner radii. Good choice for HS milling of Aluminum.
TO-0500	0.500	0.377	0.125	•	•	•	
TO-0625	0.625	0.433	0.156	•	•	•	
TO-0750	0.750	0.518	0.187	•	•	•	
TO-1000	1.000	0.716	0.250	•	•	•	
TO-1250	1.250	0.865	0.312	•	•	•	

TOBD-NF



Number	D	L	R	XRN	TLN	HSN	Description
TOBD-0500-NF	0.500	0.377	0.125				Millstar inserts designed for high seed high feed roughing of Aluminum, but also has the versatility to be used for fine finishing as well.
TOBD-0625-NF	0.625	0.433	0.125				
TOBD-0750-NF	0.750	0.518	0.125				
TOBD-1000-NF	1.000	0.716	0.125				

Radius Ordering Numbers:

For .015 use ordering # .015 • For 1/32" use ordering # 02 1/16" use ordering # 04
For 1/8" use ordering # 08

Example: 1/2" BDS-0500N-04-HSN

NA
Non-coated grade.

XRN
Multi-layer hybrid coating of AlCrN. This coating has very good heat resistance and also a low friction coefficient. The XRN coating is designed for use in HSM of un-heat treated softer materials such as Titanium, Inconel, Stainless Steels and other gummy materials that require the use of liquid coolant.

HSN
Millstar's new coating is a multi-layer hybrid Nano coating. This new coating has very good heat resistance and high hardness. The HSN coating is designed for use in HSM of Heat Treated materials up to 72 HRc.

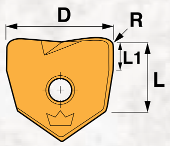
ALTiN-EXALON (TLN)
Titanium Aluminum Nitride advanced PVD coating. A special, improved ALTiN coating approaching surface hardness of CBN on a tough substrate. Recommended for tough and hard metal machining applications.

DMD
Diamond coating. Custom coating for cutting non-ferrous, non-metallic and very abrasive materials at highly elevated speeds. Use on copper, bronze, brass, aluminum-silicon alloys, carbon graphite, solid and fiber-reinforced plastics, ceramics and composite materials.

Custom tool coatings for specific applications are available by request.

BDS Series in PCD and CBN Tipped

Back Draft

BDS	Tool Ordering Number	Dimensions				Grade			Description
		D	L	R	L1	XRN	TLN	HSN	
	BDS-0375-N	0.375	0.340	1/32,1/16	0.125	•	•	•	Precision ground with unique crossover design between flat bottom FB and back draft BD inserts. Allows straight walls with a larger step down than BD. Allows higher cutting speeds and feeds.
	BDS-0500-N	0.500	0.380	015,1/32,1/16	0.125	•	•	•	
	BDS-0625-N	0.625	0.457	1/32,1/16	0.125	•	•	•	
	BDS-0750-N	0.750	0.540	1/32,1/16,1/8	0.125	•	•	•	
	BDS-1000-N	1.000	0.740	1/32,1/16,1/8	0.125	•	•	•	

PCD Tipped
For carbon milling with longer tool life

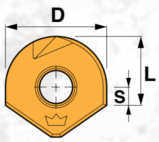
CBN Tipped
For high speed machining or milling of high hardness materials with longer tool life and superior finishes.

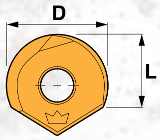
Radius Ordering Numbers:

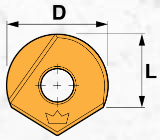
For .015 use ordering # .015 • For 1/32" use ordering # 02 1/16" use ordering # 04
For 1/8" use ordering # 08
Example: 1/2" BDS-0500N-04-PCD or CBN

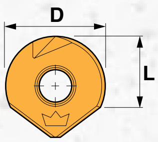
Copy Milling Program Tools

Ball Nose Inserts

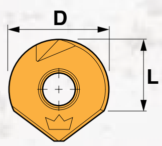
BS-N	Tool Ordering Number	Dimensions D	Dimensions L	Dimensions S	Grade XRN	Grade TLN	Grade HSN	Description
	BS-0375-N	0.375	0.390	0.154	•	•	•	Sidecutting, non-chipbreaker. Side cutting insert used in cavity and core profiling, for blending of fillets on medium and hard materials.
	BS-0500-N	0.500	0.350	0.100	•	•	•	
	BS-0625-N	0.625	0.421	0.109	•	•	•	
	BS-0750-N	0.750	0.496	0.121	•	•	•	
	BS-1000-N	1.000	0.679	0.179	•	•	•	
	BS-1250-N	1.250	0.828	0.203	•	•	•	

MB	Number	D	L	XRN	TLN	HSN	Description
	MB-0375	0.375	0.349	•	•	•	Unique cutting edge allows performance in all operations in material below 42 HRc; in semi, & finishing operations above. Significant benefits in chip evacuation. Insert geometry allows smoother cutting motion-diminishing heat build up & tool deflection, reduces vibration caused by cutting action.
	MB-0500	0.500	0.377	•	•	•	
	MB-0625	0.625	0.443	•	•	•	
	MB-0750	0.750	0.518	•	•	•	
	MB-1000	1.000	0.716	•	•	•	
	MB-1250	1.250	0.865	•	•	•	

MBT	Number	D	L	XRN	TLN	HSN	Description
	MBT-0375	0.375	0.349	•	•	•	Precision ground, harder grade, for semi-finish and finish milling. Excellent choice for unattended finish milling at small depth and high speeds and feed rates.
	MBT-0500	0.500	0.377	•	•	•	
	MBT-0625	0.625	0.443	•	•	•	
	MBT-0750	0.750	0.518	•	•	•	
	MBT-1000	1.000	0.716	•	•	•	
	MBT-1250	1.250	0.865	•	•	•	

RB-N	Number	D	L	XRN	TLN	HSN	Description
	RB-0375-N	0.375	0.390	•	•	•	Precision ground, non-chipbreaker. Best choice for cavity, core and profile milling of pre-hard and fully hard die/mold steels, cast steels and cast iron. Strongest cutting edge design.
	RB-0500-N	0.500	0.377	•	•	•	
	RB-0625-N	0.625	0.443	•	•	•	
	RB-0750-N	0.750	0.518	•	•	•	
	RB-1000-N	1.000	0.716	•	•	•	
	RB-1250-N	1.250	0.865	•	•	•	

RBT

RBT	Number	D	L	XRN	TLN	HSN	Description
	RB-0375-T	0.375	0.349	•	•	•	Precision ground for semi-finish and finish milling. Excellent choice for unattended finish milling at small depth and high speed and feed rates.
	RB-0500-T	0.500	0.377	•	•	•	
	RB-0625-T	0.625	0.443	•	•	•	
	RB-0750-T	0.750	0.518	•	•	•	
	RB-1000-T	1.000	0.716	•	•	•	
	RB-1250-T	1.250	0.865	•	•	•	

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Non-coated grade.

XRN
Multi-layer hybrid coating of AlCrN. This coating has very good heat resistance and also a low friction coefficient. The XRN coating is designed for use in HSM of un-heat treated softer materials such as Titanium, Inconel, Stainless Steels and other gummy materials that require the use of liquid coolant.

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Diamond coating. Custom coating for cutting non-ferrous, non-metallic and very abrasive materials at highly elevated speeds. Use on copper, bronze, brass, aluminum-silicon alloys, carbon graphite, solid and fiber-reinforced plastics, ceramics and composite materials.

Custom tool coatings for specific applications are available by request.

MILLSTAR

Choosing Cutting Parameters/Calculating Cutting Speed and Feed – INCH For Ball Nose Inserts

Table 1 - Cutting Conditions for Using Steel Shank Holders

Working Material	Hardness	Grade	SFM	Feed fn (inch/Rev) Insert Diameter (inch) 0.250	0.312	0.375	0.500	0.625	0.750	1.000	1.250	Ap Max	Ae Max
Low Alloy Steel (1.7225)	200-280HB	TLN, HSN	450-1200	0.008	0.012	0.016	0.016	0.020	0.020	0.020	0.020	.10 x D	.40 x D
Alloy & Die Steel (1.2311, P20, DME2/3/5)	32-42HRC	TLN, HSN	300-800	0.006	0.010	0.012	0.016	0.016	0.016	0.020	0.020	.8 x D	.35 x D
Tool Steel (1.2344, 1.2379)	42-52HRC	TLN, HSN	300-700	0.006	0.010	0.012	0.016	0.020	0.020	0.020	0.020	.6 x D	.30 x D
Stainless Steel (1.4301, 1.4401)	200-350HB	XRN, TLN, HSN	250-400	0.006	0.010	0.012	0.016	0.016	0.016	0.020	0.020	.10 x D	.40 x D
Gray Cast Iron (GG25-GG30)	160-260HB	TLN, HSN	600-1200	0.008	0.012	0.016	0.020	0.023	0.023	0.028	0.028	.10 x D	.50 x D
Nodular Cast Iron (GGG60-GGG70)	180-300HB	TLN, HSN	450-1200	0.008	0.012	0.016	0.020	0.023	0.023	0.028	0.028	.15 x D	.50 x D
Copper Alloy	80-150HB	XRN	450-1500	0.010	0.016	0.020	0.023	0.028	0.028	0.028	0.028	.10 x D	.40 x D
Aluminum Alloys	30-120HB	XRN	1000-3000	0.010	0.016	0.020	0.023	0.028	0.028	0.028	0.028	.10 x D	.50 x D
Graphite		TLN, HSN	600-2000	0.012	0.020	0.023	0.028	0.030	0.030	0.030	0.030	.20 x D	.50 x D
Ni & Co Based Alloy	250-320HB	XRN, HSN	100-300	0.006	0.008	0.012	0.016	0.016	0.020	0.020	0.020	.8 x D	.50 x D
Titanium Alloy (Annealed)	<350HB	XRN, HSN	150-400	0.006	0.008	0.010	0.012	0.012	0.016	0.020	0.020	.8 x D	.33 x D
Titanium Alloy (Sol. Treated/Aged)	<380HB	XRN, HSN	120-300	0.004	0.006	0.008	0.012	0.012	0.012	0.016	0.016	.8 x D	.35 x D

Table 2 - Cutting Conditions for Using Carbide Shank Holders

Working Material	Hardness	Grade	SFM	Feed fn (inch/Rev) Insert Diameter (inch) 0.250	0.312	0.375	0.500	0.625	0.750	1.000	1.250	Ap Max	Ae Max
Low Alloy Steel (1.7225)	200-280HB	TLN, HSN	450-1200	0.012	0.016	0.016	0.02	0.023	0.023	0.028	0.028	.10 x D	.50 x D
Alloy & Die Steel (1.2311, P20, DME2/3/5)	32-42HRC	TLN, HSN	300-1200	0.012	0.012	0.012	0.016	0.02	0.02	0.023	0.023	.8 x D	.40 x D
Tool Steel (1.2344, 1.2379)	42-52HRC	TLN, HSN	300-800	0.012	0.012	0.012	0.016	0.02	0.02	0.023	0.023	.6 x D	.35 x D
Stainless Steel (1.4301, 1.4401)	200-350HB	XRN, TLN, HSN	250-400	0.012	0.012	0.016	0.02	0.023	0.028	0.028	0.03	.10 x D	.50 x D
Gray Cast Iron (GG25-GG30)	160-260HB	TLN, HSN	600-1200	0.012	0.016	0.02	0.02	0.023	0.028	0,8	0.04	.10 x D	.40 x D
Nodular Cast Iron (GGG60-GGG70)	180-300HB	TLN, HSN	450-1200	0.012	0.016	0.016	0.02	0.023	0.023	0.028	0.03	.10 x D	.40 x D
Copper Alloy	80-150HB	XRN	450-1500	0.012	0.016	0.016	0.02	0.023	0.023	0.028	0.028	.10 x D	.40 x D
Aluminum Alloys	30-120HB	XRN	1000-3000	0.012	0.016	0.02	0.023	0.028	0.028	0.03	0.03	.10 x D	.40 x D
Graphite		TLN, HSN	600-2000	0.012	0.02	0.023	0.028	0.03	0.03	0.03	0.03	.20 x D	.40 x D
Ni & Co Based Alloy	250-320HB	XRN, HSN	100-300	0.012	0.012	0.016	0.016	0.02	0.023	0.023	0.028	.8 x D	.50 x D
Titanium Alloy (Annealed)	<350HB	XRN, HSN	150-400	0.006	0.008	0.012	0.012	0.012	0.016	0.02	0.02	.8 x D	.50 x D
Titanium Alloy (Sol. Treated/Aged)	<380HB	XRN, HSN	120-300	0.004	0.006	0.008	0.012	0.012	0.016	0.016	0.02	.8 x D	.50 x D
Harden Steel (1.2344, 1.2379)	45-55HRC	TLN, HSN	300-1200	0.008	0.01	0.012	0.016	0.02	0.02	0.023	0.023	.8 x D	.35 x D

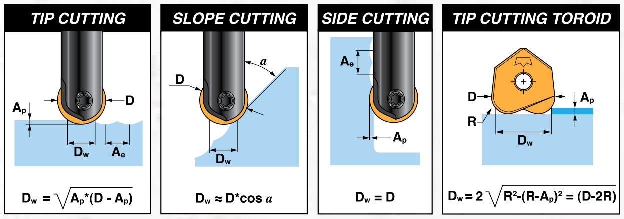
Choosing Cutting Parameters/Calculating Cutting Speed and Feed – INCH

1. Find the Cutting Speed & Feed fn

Find SFM and fn range in Table 1 or Table 2 at left. Choose the average value for SFM and the lower value for feed in the range.

2. Compute the Dw

In order to compute the RPM value of the spindle it is necessary to determine the Dw which is the effective engaged tool diameter. The Dw depends on the geometry of the inserts (ball nose or toroid) and the relative position of the tool against the working piece surface. Example calculation is of Dw is presented to the right.



3. Calculate Spindle Speed

Use the formula: N = SFM x 3.82 (÷Dw)

Table 3 - Working Diameter For Ball Nose Tools

ØD	0.250	0.312	0.375	0.500	0.625	0.750	1.000	1.250
Depth of cut	Dw Working Diameter (inch) Actual effective cutting diameter							
0.020	0.135	0.153	0.169	0.196	0.220	0.242	0.280	0.314
0.050	0.200	0.229	0.255	0.300	0.339	0.374	0.436	0.490
0.075	0.229	0.267	0.300	0.357	0.406	0.450	0.527	0.594
0.100	0.245	0.292	0.332	0.400	0.458	0.510	0.600	0.678
0.125	0.250	0.306	0.345	0.433	0.500	0.559	0.661	0.750
0.156		0.312	0.370	0.464	0.541	0.609	0.726	0.827
0.188			0.375	0.484	0.573	0.650	0.781	0.893
0.250				0.500	0.612	0.707	0.866	1.000
0.312					0.625	0.739	0.927	1.082
0.375						0.750	0.968	1.146
0.500							1.000	1.225
0.625								1.250

Table 4 - Working Diameter For Toroid Tools

Insert Diameter "D"	0.375	0.500	0.625	0.750	1.000	1.250
Depth of cut	Dw Working Diameter (inch) Actual cutting diameter of toroid inserts					
0.020	0.260	0.385	0.465	0.544	0.696	0.845
0.050	0.325	0.450	0.541	0.630	0.800	0.964
0.075	0.354	0.479	0.579	0.675	0.867	1.031
0.100	0.370	0.495	0.604	0.707	0.900	1.083
0.125	0.375	0.500	0.618	0.720	0.933	1.125
0.156			0.625	0.745	0.964	1.166
0.188				0.750	0.984	1.198
0.250					1.000	1.237
0.312						1.250

4. Calculate the Table Feed V_f (m/min)

Use the formula: $V_f = N * f_n * K_f$. K_f is the feed rate multiplier coefficient taking into consideration that chip load is less than theoretical value. Take the value of K_f from Table 5 or Table 6.

Table 5 - Feed Rate Multiplier For Ball Nose Inserts

Insert Diameter "D"	0.250	0.312	0.375	0.500	0.625	0.750	1.000	1.250
Depth of cut	Feedrate Multiplier Factors (for Working Diameters Dw)							
0.020	1.850	2.040	2.220	2.550	2.840	3.000	3.750	4.000
0.050	1.250	1.360	1.470	1.670	1.840	2.000	2.290	2.550
0.075	1.090	1.170	1.250	1.400	1.540	1.670	1.900	2.100
0.100	1.020	1.070	1.130	1.250	1.370	1.470	1.670	1.840
0.125	1.000	1.020	1.060	1.150	1.250	1.340	1.510	1.660
0.156		1.000	1.010	1.080	1.160	1.230	1.380	1.510
0.188			1.000	1.030	1.090	1.150	1.280	1.400
0.250				1.000	1.020	1.060	1.150	1.250
0.312					1.000	1.020	1.080	1.150
0.375						1.000	1.030	1.090
0.500							1.000	1.020
0.625								1.000

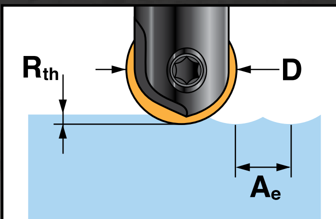
Table 6 - Feed Rate Multiplier For Toroid Tools

Insert Diameter "D"	0.375	0.500	0.625	0.750	1.000	1.250
Depth of cut	FEEDRATE MULTIPLIER FACTORS (inch) (for Toroid Working Diameters Dw)					
0.020	1.850	1.850	2.040	2.220	2.550	2.840
0.050	1.250	1.250	1.360	1.470	1.670	1.840
0.075	1.090	1.090	1.170	1.250	1.400	1.540
0.100	1.020	1.020	1.070	1.130	1.250	1.370
0.125	1.000	1.000	1.020	1.060	1.150	1.250
0.156			1.000	1.010	1.080	1.160
0.188				1.000	1.030	1.090
0.250					1.000	1.020
0.312						1.000

Verify Surface Roughness (R_{th})

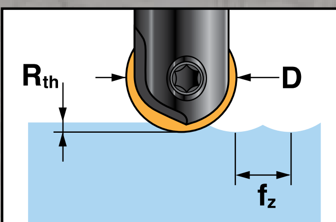
1. Decreasing the A_e and feed by half will improve surface roughness by 4 times.
2. Using $f_z = A_e$ in most cases is the best option.

Surface Roughness Step-Over



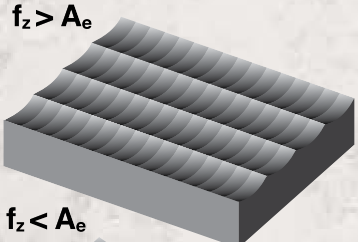
$$R_{th}, A_e = \frac{D}{2} - \sqrt{\frac{D^2 - A_e^2}{4}}$$

Surface Roughness Feed Dir

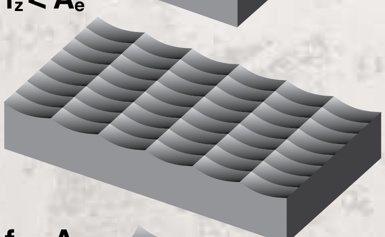


$$R_{th}, A_e = \frac{D}{2} - \sqrt{\frac{D^2 - f_z^2}{4}}$$

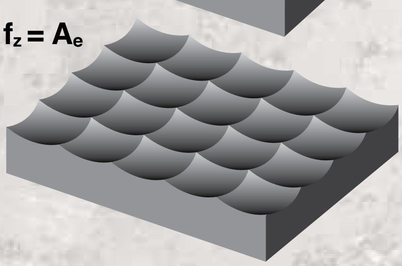
$f_z > A_e$



$f_z < A_e$



$f_z = A_e$



Feed & Speed Calculations

Nomenclature

- D = cutter/insert diameter
- Dw = effective cutter diameter
- z = number of teeth
- Vc = cutting speed
- n = number of revolutions per minute
- Vf = feed rate, or table feed
- f = feed per revolution
- fz = feed per tooth
- Fzcor = feed/tooth, chip thinning corrected
- CF = centerline feed, helical interpolation
- x = multiplier symbol (inch)
- • = multiplier symbol (metric)
- ap = axial depth of cut
- ae = width of cut, step-over
- R = insert radius
- SFM = surface feet per minute
- RPM = revolutions per minute
- IPM = inch per minute, feed rate
- π = 3.14159...circle, circumference:dia. ratio
- Rth,ae = theoretical surface roughness in step-over direction
- Rth,fz = theoretical surface roughness in feed direction
- B = bore dia., helical interpolation
- IC = inscribed circle (2 x R)
- Q = metal removal rate

Cutting Speed

To find the SFM of a cutter:

$$SFM = \frac{\varpi \times D \times RPM}{12} = 0.262 \times D \times RPM$$

Example:
To find the SFM of a 3/4" Ø cutter rotating at 6000 RPM:

$$.262 \times D \times RPM = 0.262 \times 0.75 \times 6000 = 1179\ SFM$$

Metric Formula:

$$v_c = \frac{n \bullet \pi \bullet Dw}{1000} = m / minute$$

Spindle Speed

To find the RPM of a cutter:

$$RPM = \frac{12 \times SFM}{\varpi \times D} = \frac{3.82 \times SFM}{D}$$

Example
To find the RPM of a 1/2" Ø cutter rotating at 800 SFM:

$$RPM = \frac{3.82 \times 800}{.500} = 6112\ RPM$$

Metric Formula:

$$n = \frac{v_c \bullet 1000}{\varpi \bullet Dw} = min^{-1}$$

Feed Per Tooth

To find the feed per tooth of a cutter:

$$FZ = \frac{IPM}{z \times RPM}$$

Example
To find the feed per tooth of a two flute cutter rotating at 10000 RPM with a table travel of 240 inches per minute:

$$FZ = \frac{240}{2 \times 10\,000} = 0.012\ FZ$$

Metric Formula:

$$f = \frac{v_f}{n \bullet z} = mm / tooth$$

Feed Rate or Table Feed

To find the feed (table feed) in inches per minute:

$$IPM = RPM \times f_z \times z$$

Example
To find the feed per tooth of a two flute cutter rotating at 5000 RPM with a feed per tooth of 0.006:

$$IPM = 5000 \times 0.006 \times 2 = 60\ IPM$$

Metric Formula:

$$v_f = n \bullet f_z \bullet z = mm / minute$$

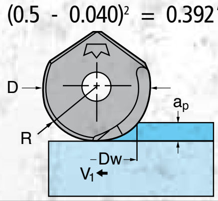
Effective Cutting Diameter, Ball Nose

To find the effective cutter Ø of a ball nose tool:

$$Dw = 2 \times \sqrt{R^2 - (R - a_p)^2}$$

Example
To find the effective cutter diameter engaged of a 1.0" Ø ball nose tool cutting at 0.040" depth of cut:

$$Dw = 2 \times \sqrt{0.5^2 - (0.5 - 0.040)^2} = 0.392''$$



Metric Formula:
use same formula in mm.

Effective Cutting Diameter, Toroid

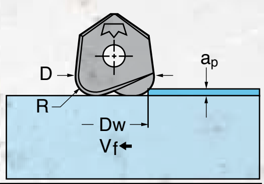
To find the effective cutter Ø of a Toroid bull nose tool:

$$Dw = 2 \times \sqrt{R^2 - (R - a_p)^2} + (D - 2R)$$

Example

$$Dw = 2 \times \sqrt{.1875^2 - (.1875 - .1)^2} + (.75 - (2 \times .1875)) = .707$$

To find the effective cutter diameter engaged of a 3/4" Ø Toroid bull nose tool cutting at 0.100" depth of cut:



Metric Formula: use same formula in mm.

Surface Roughness, Step-Over

To find the surface roughness in step-over direction:

$$R_{th,ae} = \frac{D}{2} - \sqrt{\frac{D^2 - a_e^2}{4}}$$

Example
To find the theoretical roughness of a 3/4" Ø ball nose tool in step-over direction of the cut (peak-to-valley or cusp height), with a 0.030 step-over value:

$$R_{th,ae} = \frac{.75}{2} - \sqrt{\frac{.75^2 - .03^2}{4}} = 0.0003''$$

Metric Formula: use same formula in mm.

Surface Roughness, Feed Direction

To find the surface roughness in feed direction:

$$R_{th,fz} = \frac{D}{2} - \sqrt{\frac{D^2 - f_z^2}{4}}$$

Example
To find the theoretical roughness of a 3/4" Ø ball nose tool in feed direction of the cut (peak-to-valley or cusp height), with a 0.005 feed per tooth value:

$$R_{th,fz} = \frac{.75}{2} - \sqrt{\frac{.75^2 - .005^2}{4}} = 0.000008''$$

Metric Formula: use same formula in mm.

Carbide Modular Shrink System

Millstar's Carbide Modular Shrink System offers versatility, strength and accuracy. The carbide shank offers strength and rigidity and the shrink tolerances offer better accuracy than screw on type systems. These tools are designed for high speed machining and hard metal machining and will allow for better tool life as well as better surface finishes.

Carbide Modular Shrink System

Click here to go to main table of contents

Shrink System Identification

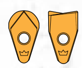
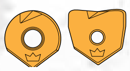
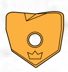
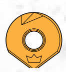
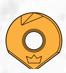
Head, Steel

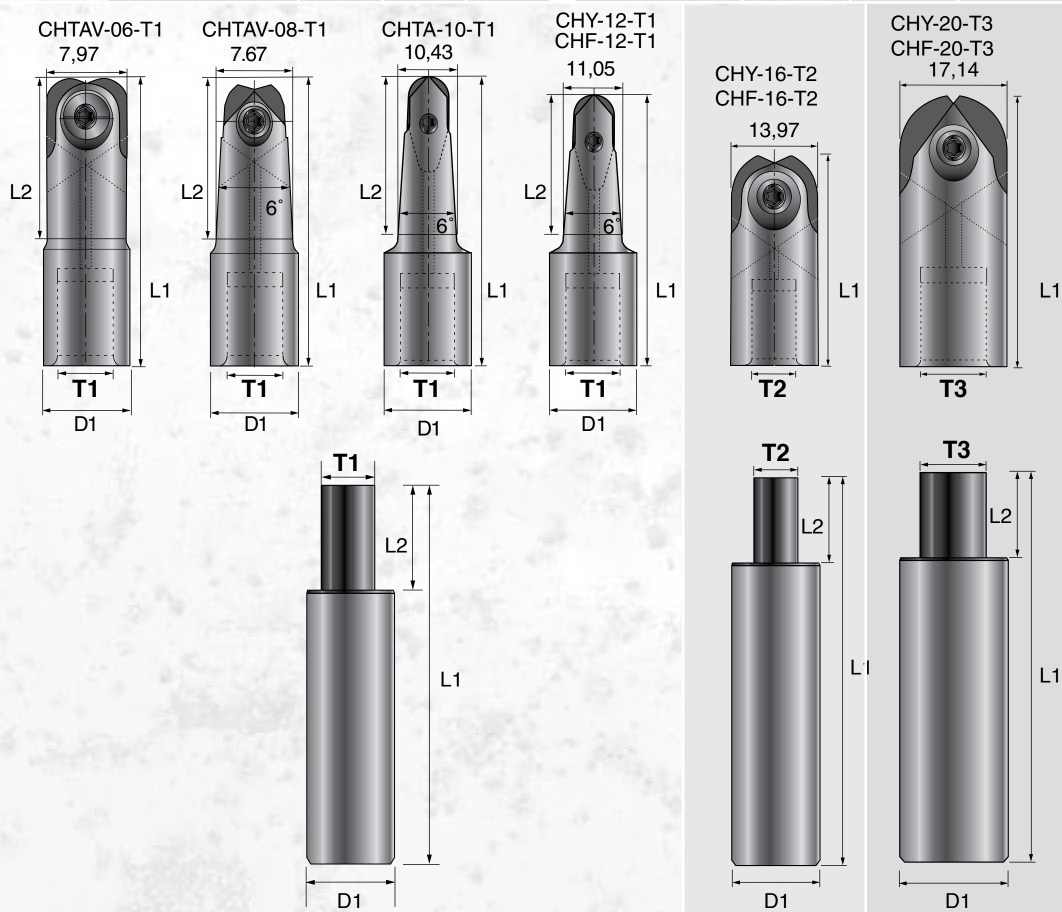
Measurement System	Denotes Type	Diameter Size	Connection Compatability
Imperial	CHY	500	T1
Metric	CHY	12	T1

Shank, Carbide

Measurement System	Denotes Type	Diameter Size	Overall Length	Connection Compatability
Imperial	CSS	500	2.29	T1
Metric	CSS	12	75	T1
	"CHTA" or "CHTAV" = Taper Neck Head "CHY" = Straight Head for Ball Insert "CHF" = Straight Head for Flat Type Insert	Imperial = Hundredths of an Inch Metric = Millimeters		

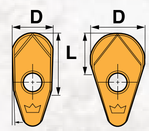
Carbide Modular Shrink System, Metric

Insert		Shrink Fit HEAD				Shrink Fit SHANK			
			Dimensions				Dimensions		
Type	Code	Tool Number	ØD1	L1	L2	Tool Number	ØD1	L1	L2
	VBD, VRBS	CHTAV-06-T1	11,7	43,2	22,3	CSS-12-75-T1 CSS-12-125-T1	12 12	73,60 124,40	15,24 15,24
		CHTAV-08-T1	11,7	43,2	20,9				
	TO, HF, FB, BDS, MB,MBT, BD, TOBD-NF, RBT	CHTA-10-T1	11,7	43,2	21,5				
	RB, MB, MBT, BS, RBT	CHY-12-T1	11,7	43,2	21,5				
	FB, BD, BDS, HF, TO, TOBD-NF	CHF-12-T1	11,7	43,2	21,5				
	BS, RB, MB, MBT, RBT	CHY-16-T2	14,0	38,2		CSS-16-105-T2 CSS-16-180-T2	16 16	104,80 180,80	16,51 16,51
	FB, BD, BDS, HF, TO, TOBD-NF	CHF-16-T2	14,0	38,2					
	RB, BS, MB, MBT, RBT	CHY-20-T3	17,1	48,3		CSS-20-95-T3 CSS-20-175-T3 CSS-18-150-T3	20 20 18	96,50 172,70 150	17,78 17,78 17,78
	FB, BD, BDS, HF, TO, TOBD-NF	CHF-20-T3	17,1	48,3					

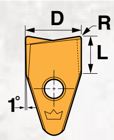


Profile Milling Program Tools

Small Ball Nose & Back Draft Inserts

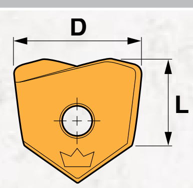


VRBS	Tool Ordering Number	Dimensions D	Dimensions L	Dimensions R	Grade XRN	Grade TLN	Grade HSN	Description
	VRBS-6	6	8,10	3	•	•	•	Used for semi and finish-milling small radius or detail work, and surface milling in soft and hard steel, cast iron, aerospace and non-ferrous alloys, graphite, etc. Suitable for high speed and hard milling.
	VRBS-8	8	4,50	4	•	•	•	



VBD	Tool Ordering Number	Dimensions D	Dimensions L	Dimensions R	Grade XRN	Grade TLN	Grade HSN	
	VBD-06	6	8,6	0,1/0,4	•	•	•	Used for semi and finish-milling small radius or detail work, and surface milling in soft and hard steel, cast iron, aerospace and non-ferrous alloys, graphite, etc. Suitable for high speed and hard milling
	VBD-08	8	5	0,1/0,4	•	•	•	

Metric High Feed Inserts



HF	Tool Ordering Number	Dimensions D	Dimensions L	Dimensions PR	Grade XRN	Grade TLN	Grade HSN	Description
	HF-10	10	3	1,00	•	•	•	Millstar HF insert is designed for High feed and High speed machining. It runs at high cutting speed and feed rates with shallow depth of cut. It allows the chip to flow up and out of the cut quickly. It allows heavy chip loads.
	HF-12	12	4	1,43	•	•	•	
	HF-16	16	5	1,94	•	•	•	
	HF-20	20	6	2,26	•	•	•	
	HF-25	25	7	2,82	•	•	•	

Cutting Recommendations for High Feed Inserts

Work Material	Material Hardness	Cutting Depth at Diameter ap max					Cutting Width	Insert	Coating Type Recom.	Cut speed at D	Max feed per tooth fz at cutting insert diameter D				
USA/W.-Nr./JIS	Hrc	10	12	16	20	25	Ae max			sfm/min	10	12	16	20	25
H13/1,2344/ SKD61	<41	0,38	0,46	0,61	0,76	0,95	60 - 75%	HF	XRN/HSN	157 - 218	0,28~0,48	0,36~0,56	0,051~0,71	0,66~0,86	0,85~1,05
H13/1,2344/ SKD61	41-50	0,32	0,38	0,51	0,64	0,80	60 - 75%	HF	XRN/HSN	126 - 187	0,22~0,42	0,28~0,48	0,41~0,61	0,54~0,74	0,70~0,90
H13/1,2344/ SKD61	51+	0,26	0,31	0,42	0,52	0,65	60 - 75%	HF	HSN	96 - 157	0,16~0,36	0,21~0,41	0,32~0,52	0,42~0,62	0,55~0,75
A2/1,2363/ SKD12	<41	0,38	0,46	0,61	0,76	0,95	60 - 75%	HF	XRN/HSN	157 - 218	0,28~0,48	0,36~0,56	0,51~0,71	0,66~0,86	0,85~1,05
A2/1,2363/ SKD12	14-50	0,32	0,38	0,51	0,64	0,80	60 - 75%	HF	XRN/HSN	126 - 187	0,220~0,42	0,28~0,48	0,32~0,52	0,54~0,74	0,70~0,90
A2/1,2363/ SKD12	51+	0,26	0,31	0,42	0,52	0,65	60 - 75%	HF	HSN	96 - 157	0,16~0,36	0,21~0,41	0,51~0,71	0,42~0,62	0,55~0,75
P20/1,2330	<41	0,38	0,46	0,61	0,76	0,95	60 - 75%	HF	XRN/HSN	157 - 218	0,28~0,48	0,36~0,56	0,41~0,61	0,66~0,86	0,85~1,05
P20/1,2330	14-50	0,32	0,38	0,51	0,64	0,80	60 - 75%	HF	XRN/HSN	126 - 187	0,22~0,42	0,28~0,48	0,51~0,71	0,54~0,74	0,70~0,90
D2/1,2379/ SKD11	<41	0,38	0,46	0,61	0,76	0,95	60 - 75%	HF	XRN/HSN	157 - 218	0,28~0,48	0,36~0,56	0,41~0,71	0,66~0,86	0,85~1,05
D2/1,2379/ SKD11	14-50	0,32	0,38	0,51	0,64	0,80	60 - 75%	HF	XRN/HSN	126 - 187	0,22~0,42	0,28~0,48	0,41~0,61	0,54~0,744	0,70~0,90
D2/1,2379/ SKD11	51+	0,26	0,31	0,42	0,52	0,65	60 - 75%	HF	HSN	96 - 157	0,16~0,36	0,21~0,41	0,32~052	0,42~0,62	0,55~0,75
Grey Cast Iron/ GG	<41	0,38	0,46	0,61	0,76	0,95	60 - 75%	HF	XRN/HSN	157 - 218	0,282~0,48	0,36~0,56	0,51~0,71	0,66~0,86	0,85~1,05
Cast Iron/GGG	41+	0,38	0,46	0,61	0,76	0,95	60 - 75%	HF	XRN/HSN	157 - 218	0,28~0,48	0,36~0,56	0,51~0,71	0,66~0,86	0,85~1,05

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NA
Non-coated grade.

XRN
Multi-layer hybrid coating of AlCrN. This coating has very good heat resistance and also a low friction coefficient. The XRN coating is designed for use in HSM of un-heat treated softer materials such as Titanium, Inconel, Stainless Steels and other gummy materials that require the use of liquid coolant.

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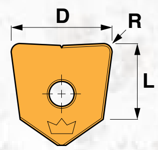
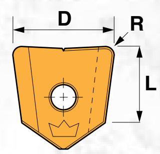
Flat Bottom, Back Draft, Toroid

BD-N



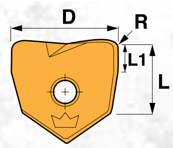
Tool Ordering Number	D	L	R	XRN	TLN	HSN	Description
BD-10-N	10	8,5	0,5/0,8/1,0	•	•	•	Precision ground with 7º back taper. Used for milling of cores, cavities, fillets with straight or very steep walls of harder materials.
BD-12-N	12	9,95	0,5/1,0/2,0	•	•	•	
BD-16-N	16	11,55	0,5/1,0/1,3/2,0/3,0	•	•	•	
BD-20-N	20	13,35	0,5/1,0/1,6/2,0/3,0	•	•	•	
BD-25-N	25	19,95	1,0/2,0	•	•	•	
BD-32-N	32	8,5	1,0/2,6	•	•	•	

BD-R



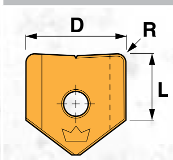
Number	D	L	R	XRN	TLN	HSN	Description
BD-10-R	10	8,5	0,5/0,8/1,0	•	•	•	Precision ground with positive ground chip-breaker and 7º back taper. Used for milling of cores, cavities, fillets with straight or very steep walls of softer materials.
BD-12-R	12	9,95	0,5/1,0	•	•	•	
BD-16-R	16	11,55	0,5/1,0/1,3	•	•	•	
BD-20-R	20	13,35	0,5/1,0/1,6	•	•	•	
BD-25-R	25	19,95	1,0/2,0	•	•	•	
BD-32-R	32	23,35	2,6	•	•	•	

BDS



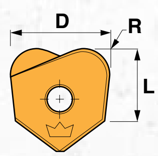
Number	D	L	R	L1	XRN	TLN	HSN	Description
BDS-10-N	10	8,5	0,1/0,8/1,0	3	•	•	•	Precision ground with unique crossover design between flat bottom FB and back draft DB inserts. Allows straight walls with a larger step down than BD. Allows higher cutting speeds and feeds.
BDS-12-N	12	9,95	0,1/1,0	3	•	•	•	
BDS-16-N	16	11,55	0,1/1,0/1,3	3	•	•	•	
BDS-20-N	20	13,35	0,1/1,0/1,6	3	•	•	•	
BDS-25-N	25	19,95	1,0/2,0	3	•	•	•	
BDS-32-N	32	23,35	1,0/2,0	3	•	•	•	

FB-R



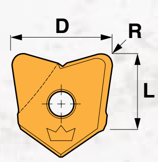
Number	D	L	R	XRN	TLN	HSN	Description
FB-10-R	10	8,5	0,8	•	•	•	Precision ground with positive ground chip-breaker. Flat bottom inserts for shoulder milling, fillet finishing and long reach angular wall finishing of softer materials.
FB-12-R	12	9,15	1,0	•	•	•	
FB-16-R	16	10,65	0,5/1,3	•	•	•	
FB-20-R	20	12,25	1,6	•	•	•	
FB-25-R	25	16,35	2,0	•	•	•	
FB-32-R	32	21,3	2,6	•	•	•	

TO



Number	D	L	R	XRN	TLN	HSN	Description
TO-10	10	8,65	3,0	•	•	•	Precision ground large corner radius & back taper for spiral and pocket milling. Milling of pre-hard and hardened flat surfaces at higher speeds than tools with smaller corner radii. Good choice for HS milling of Aluminum.
TO-12	12	9,20	3,0	•	•	•	
TO-16	16	11,25	4,0	•	•	•	
TO-20	20	13,15	5,0	•	•	•	
TO-25	25	18,25	6,0	•	•	•	
TO-30	30	22,15	7,5	•	•	•	
TO-32	32	21,95	8,0	•	•	•	

TOBD-NF

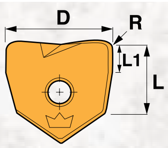


Number	D	L	R	XRN	TLN	HSN	Description
TOBD-12-NF	12	9,2	3,0	•	•	•	Millstar inserts designed for high seed high feed roughing of Aluminum, but also has the versatility to be used for fine finishing as well.
TOBD-16-NF	16	11,25	3,0	•	•	•	
TOBD-20-NF	20	13,15	3,0	•	•	•	
TOBD-25-NF	25	18,25	3,0	•	•	•	

MILLSTAR

BDS Series in PCD and CBN Tipped

Back Draft

BDS	Tool Ordering Number	Dimensions: D	Dimensions: L	Dimensions: R	Dimensions: L1	Grade: XRN	Grade: TLN	Grade: HSN	Description
	BDS-10-N	10	8,5	0,1/0,8/1,0	3	•	•	•	Precision ground with unique crossover design between flat bottom FB and back draft BD inserts. Allows straight walls with a larger step down than BD. Allows higher cutting speeds and feeds.
	BDS-12-N	12	9,95	0,1/1	3	•	•	•	
	BDS-16-N	16	11,55	0,1/1/1,3	3	•	•	•	
	BDS-20-N	20	13,35	0,1/1/1,6	3	•	•	•	
	BDS-25-N	25	19,95	1/2	3	•	•	•	

PCD Tipped
For carbon milling with longer tool life

CBN Tipped
For high speed machining or milling of high hardness materials with longer tool life and superior finishes.

NEW!
Higher cutting speeds and feeds with new Back Draft Tools

Radius Ordering Numbers:

For .015 use ordering # .015 • For 1/32" use ordering # 02 1/16" use ordering # 04
For 1/8" use ordering # 08
Example: 1/2" BDS-0500N-04-PCD or CBN

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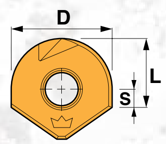
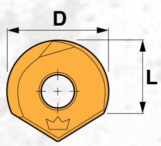
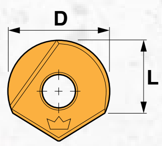
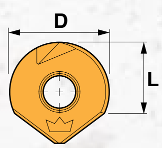
Ball Nose Inserts

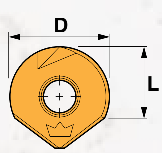
BS-N	Tool Ordering Number	Dimensions D	Dimensions L	Dimensions S	Grade XRN	Grade TLN	Grade HSN	Description
	BS-10-N	10	9,50	3,65	•	•	•	Sidecutting, non-chipbreaker. Side cutting insert used in cavity and core profiling, for blending of fillets on medium and hard materials.
	BS-12-N	12	8,80	2,90	•	•	•	
	BS-16-N	16	10,70	2,85	•	•	•	
	BS-20-N	20	12,75	2,85	•	•	•	
	BS-25-N	25	17,20	4,85	•	•	•	
	BS-30-N	30	20,00	5,10	•	•	•	
	BS-32-N	32	21,00	5,30	•	•	•	

MB	Number	D	L	XRN	TLN	HSN	Description
	MB-10	10	8,65	•	•	•	Unique cutting edge allows performance in all operations in material below 42 HRc; in semi, & finishing operations above. Significant benefits in chip evacuation. Insert geometry allows smoother cutting motion-diminishing heat build up & tool deflection, reduces vibration caused by cutting action.
	MB-12	12	9,20	•	•	•	
	MB-16	16	11,25	•	•	•	
	MB-20	20	13,15	•	•	•	
	MB-25	25	18,25	•	•	•	
	MB-30	30	22,15	•	•	•	
	MB-32	32	21,95	•	•	•	

MBT	Number	D	L	XRN	TLN	HSN	Description
	MBT-10	10	8,65	•	•	•	Precision ground, harder grade, for semi-finish and finish milling. Excellent choice for unattended finish milling at small depth and high speeds and feed rates.
	MBT-12	12	9,20	•	•	•	
	MBT-16	16	11,25	•	•	•	
	MBT-20	20	13,15	•	•	•	
	MBT-25	25	18,25	•	•	•	
	MBT-30	30	22,15	•	•	•	
	MBT-32	32	21,95	•	•	•	

RB-N	Number	D	L	XRN	TLN	HSN	Description
	RB-10-N	10	9,50	•	•	•	Precision ground, non-chipbreaker. Best choice for cavity, core and profile milling of pre-hard and fully hard die/mold steels, cast steels and cast iron. Strongest cutting edge design.
	RB-12-N	12	9,20	•	•	•	
	RB-14-N	14	9,45	•	•	•	
	RB-16-N	16	11,25	•	•	•	
	RB-20-N	20	13,15	•	•	•	
	RB-22-N	22	17,45	•	•	•	
	RB-25-N	25	18,25	•	•	•	
	RB-30-N	30	22,15	•	•	•	
	RB-32-N	32	21,95	•	•	•	

RBT

RBT	Number	D	L	XRN	TLN	HSN	Description
	RB-10-T	10	8,65	•	•	•	Precision ground for semi-finish and finish milling. Excellent choice for unattended finish milling at small depth and high speed and feed rates.
	RB-12-T	12	9,20	•	•	•	
	RB-16-T	16	11,25	•	•	•	
	RB-20-T	20	13,15	•	•	•	
	RB-25-T	25	18,25	•	•	•	
	RB-30-T	30	22,15	•	•	•	
	RB-32-T	32	21,95	•	•	•	

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Choosing Cutting Parameters/Calculating Cutting Speed and Feed – METRIC For Ball Nose Inserts

Table 1 - Cutting Conditions for Using Steel Shank Holders

Working Material	Hardness	Grade	Vc m/min	Feed fn (mm/Rev) Insert Diameter (mm)									Ap Max	Ae Max
				6	8	10	12	16	20	25	30	32		
Low Alloy Steel(1.7225)	200-280HB	TLN, HSN	150-200	0,2	0,3	0,4	0,4	0,5	0,5	0,6	0,6	0,6	.15 x D	.15 x D
Alloy & Die Steel (1.2311, P20, DME2/3/5)	32-42HRC	TLN, HSN	100-150	0,15	0,25	0,3	0,4	0,4	0,4	0,5	0,5	0,5	.20 x D	.20 x D
Tool Steel (1.2344, 1.2379)	42-52HRC	TLN, HSN	120-160	0,15	0,25	0,3	0,4	0,5	0,5	0,6	0,6	0,6	.20 x D	.20 x D
Stainless Steel (1.4301, 1.4401)	200-350HB	XRN, TLN, HSN	90-120	0,15	0,25	0,3	0,4	0,4	0,4	0,5	0,5	0,5	.20 x D	.20 x D
Gray Cast Iron (GG25-GG30)	160-260HB	TLN, HSN	200-360	0,2	0,3	0,4	0,5	0,6	0,6	0,7	0,7	0,7	.10 x D	.10 x D
Nodular Cast Iron (GGG60-GGG70)	180-300HB	TLN, HSN, HSN	150-300	0,2	0,3	0,4	0,5	0,6	0,6	0,7	0,7	0,7	.15 x D	.15 x D
Copper Alloy	80-150HB	XRN	150-200	0,25	0,4	0,5	0,6	0,7	0,7	0,8	0,8	0,8	.10 x D	.10 x D
Aluminum Alloys	30-120HB	XRN	200-300	0,25	0,4	0,5	0,6	0,7	0,7	0,8	0,8	0,8	.6 x D	.6 x D
Graphite		TLN	200-400	0,3	0,5	0,6	0,7	0,8	0,8	0,9	0,9	0,9	.5 x D	.5 x D
Ni & Co Based Alloy	250-320HB	XRN, HSN	30-70	0,15	0,2	0,3	0,4	0,4	0,5	0,5	0,6	0,6	.30 x D	.30 x D
Titanium Alloy (Annealed)	<350HB	XRN, HSN	50-120	0,15	0,2	0,25	0,35	0,35	0,4	0,45	0,5	0,5	.33 x D	.33 x D
Titanium Alloy (Sol. Treated/Aged)	<380HB	XRN, HSN	40-90	0,1	0,15	0,2	0,3	0,3	0,35	0,4	0,45	0,45	.35 x D	.35 x D
Harden Steel (1.2344, 1.2379)	45-55HRC	TLN, HSN	70-90	0,15	0,25	0,3	0,4	0,5	0,5	0,6	0,6	0,6	.30 x D	.30 x D

Table 2 - Cutting Conditions for Using Carbide Shank Holders

Working Material	Hardness	Grade	Vc m/min	Feed fn (mm/Rev) Insert Diameter (mm)									Ap Max	Ae Max
				6	8	10	12	16	20	25	30	32		
Low Alloy Steel (1.7225)	200-280HB	TLN, HSN	260-380	0,3	0,4	0,4	0,5	0,6	0,6	0,7	0,7	0,7	.15 x D	.50 x D
Alloy & Die Steel (1.2311, P20, DME2/3/5)	32-42HRC	TLN, HSN	250-330	0,25	0,3	0,3	0,4	0,5	0,5	0,6	0,6	0,6	.20 x D	.50 x D
Tool Steel (1.2344, 1.2379)	42-52HRC	TLN, HSN	240-320	0,25	0,3	0,3	0,4	0,5	0,5	0,6	0,6	0,6	.20 x D	.50 x D
Stainless Steel (1.4301, 1.4401)	200-350HB	XRN, TLN, HSN	200-260	0,25	0,3	0,4	0,5	0,6	0,65	0,7	0,8	0,8	.20 x D	.50 x D
Gray Cast Iron (GG25-GG30)	160-260HB	TLN, HSN	360-450	0,35	0,45	0,5	0,5	0,6	0,7	0,8	1,0	1,0	.10 x D	.40 x D
Nodular Cast Iron (GGG60-GGG70)	180-300HB	TLN, HSN	300-400	0,3	0,4	0,4	0,5	0,6	0,6	0,7	0,8	0,8	.15 x D	.15 x D
Copper Alloy	80-150HB	XRN	300-400	0,3	0,4	0,4	0,5	0,6	0,6	0,7	0,7	0,7	.10 x D	.40 x D
Aluminum Alloys	30-120HB	XRN	400-500	0,3	0,4	0,5	0,6	0,7	0,7	0,8	0,8	0,8	.6 x D	.40 x D
Graphite		TLN, HSN	600-800	0,3	0,5	0,6	0,7	0,8	0,8	0,9	0,9	0,9	.5 x D	.40 x D
Ni & Co Based Alloy	250-320HB	XRN, HSN	80-110	0,25	0,3	0,4	0,4	0,5	0,6	0,6	0,7	0,7	.30 x D	.50 x D
Titanium Alloy (Annealed)	<350HB	XRN, HSN	150-230	0,15	0,2	0,25	0,35	0,35	0,4	0,45	0,5	0,5	.33 x D	.50 x D
Titanium Alloy (Sol. Treated/Aged)	<380HB	XRN, HSN	110-220	0,1	0,15	0,2	0,3	0,3	0,35	0,4	0,45	0,45	.35 x D	.50 x D
Harden Steel (1.2344, 1.2379)	45-55HRC	TLN, HSN	120-220	0,2	0,25	0,3	0,4	0,5	0,5	0,6	0,6	0,6	.30 x D	.30 x D

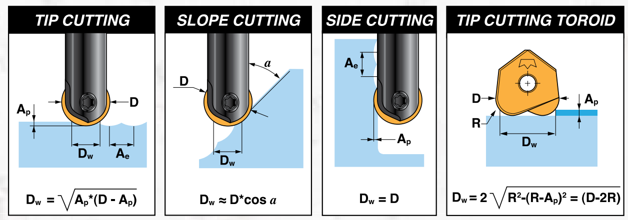
Choosing Cutting Parameters/Calculating Cutting Speed and Feed – METRIC

1. Find the Cutting Speed V_c (m/min) & Feed f_n (mm/n^{-1})

Find Vc and fn range in Table 1 or Table 2 above. Choose the average value for Vc and the lower value for feed in the range.

2. Compute the Dw

In order to compute the RPM value of the spindle it is necessary to determine the Dw which is the effective engaged tool diameter. The Dw depends on the geometry of the inserts (ball nose or toroid) and the relative position of the tool against the working piece surface. Example calculation is of Dw is presented to the right.



3. Calculate Spindle Speed N(n/min)

Use the formula: $N = (V_c * 1{,}000)/\prod * Dw$

Table 3 - Working Diameter For Ball Nose Tools (tip cutting)

ØD	Ap																	
	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1	1,5	2	2,5	3	3,5	4	5	6	7
6	1,5	2,2	2,6	3	3,3	3,6	3,9	4,1	4,3	4,5	5,2	5,7	5,9	6,0					
8	1,8	2,5	3	3,5	3,9	4,2	4,5	4,8	5,1	5,3	6,2	6,9	7,4	7,7					
10	2	2,8	3,4	3,9	4,4	4,7	5,1	5,4	5,7	6,0	7,1	8,0	8,7	9,2	9,5				
12	2,2	3,1	3,7	4,3	4,8	5,2	5,6	6,0	6,3	6,6	7,9	8,9	9,7	10,4	10,9	11,3	11,8		
14	2,4	3,3	4,1	4,7	5,2	5,7	6,1	6,5	6,9	7,2	8,7	9,8	10,7	11,5	12,1	12,6	13,4	13,9	
16	2,5	3,6	4,3	5	5,6	6,1	6,5	7,0	7,4	7,7	9,3	10,6	11,6	12,5	13,2	13,9	14,8	15,5	15,9
20	2,8	4	4,9	5,6	6,2	6,8	7,4	7,8	8,3	8,7	10,5	12,0	13,2	14,3	15,2	16,0	17,3	18,3	19,1
25		4,5	5,4	6,3	7,0	7,7	8,2	8,8	9,3	9,8	11,9	13,6	15,0	16,2	17,3	18,3	20,0	21,4	22,4
30			6	6,9	7,7	8,4	9,1	9,7	10,2	10,8	13,1	15,0	16,6	18,0	19,3	20,4	22,4	24,0	25,4
32				7,1	7,9	8,7	9,4	10,0	10,6	11,1	13,5	15,5	17,2	18,7	20	21,2	23,2	25,0	26,5

Table 4 - Working Diameter For Toroid Tools (tip cutting)

Insert Diameter "D"	10	12	16	20	25	30	32
Depth of Cut	Dw Working Diameter (metric) Actual cutting diameter of toroid inserts						
0,5	7,3	9,3	11,9	14,3	17,8	20,4	21,6
1,0	8,5	10,5	13,3	16,0	19,6	22,5	23,8
2,0	9,7	11,7	14,9	18,0	22,0	25,2	26,6
3,0	10,0	12,0	15,8	19,2	23,4	27,0	28,5
4,0			16,0	19,8	24,3	28,3	29,9
5,0				20,0	24,9	29,2	30,8
6,0					25,0	29,7	31,5
8,.0						30,0	32,0

4. Calculate the Table Feed V_f (m/min)

Use the formula: $V_f = N * f_n * K_f$. K_f is the feed rate multiplier coefficient taking into consideration that chip load is less than theoretical value. Take the value of K_f from Table 5 or Table 6.

Table 5 - Feed Rate Multiplier For Ball Nose Inserts

Insert Diameter "D"	6	8	10	12	16	20	25	30	32
Depth of Cut	Feedrate Multiplier Factors (for working diameters Dw)								
0,5	1,8	2,0	2,2	2,5	2,8	3,2	3,5	3,8	4,0
1,0	1,2	1,5	1,6	1,8	2,0	2,2	2,5	2,6	2,8
2,0	1,0	1,1	1,2	1,3	1,5	1,6	1,8	1,9	2,0
3,0	0,0	1,0	1,1	1,1	1,2	1,4	1,5	1,6	1,7
4,0		1,0	1,0	1,1	1,2	1,2	1,3	1,4	1,5
5,0			1,0	1,0	1,1	1,1	1,2	1,3	1,4
6,0				1,0	1,0	1,1	1,2	1,2	1,3
8,0					1,0	1,0	1,1	1,1	1,2
10,0						1.,0	1,0	1,1	1,1
12,5							1,0	1,0	1,0
16,0								1,0	1,0

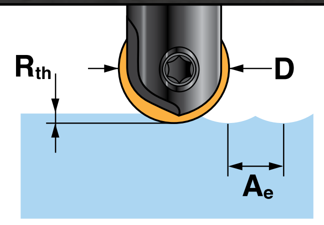
Table 6 - Feed Rate Multiplier For Toroid Tools

Insert Diameter "D"	10	12	16	20	25	30	32
Depth of Cut	Feedrate Multiplier Factors (for Toroid working diameters Dw)						
0,5	1,8	1,8	2,0	2,2	2,5	2,6	2,8
1,0	1,2	1,2	1,5	1,6	1,8	1,9	2,0
2,0	1,0	1,0	1,1	1,2	1,3	1,4	1,5
3,0	1,0	1,0	1,0	1,1	1,1	1,2	1,2
4,0			1,0	1,0	1,1	1,2	1,2
5,0				1,0	1,0	1,1	1,1
6,0					1,0	1,0	1,0
8,0						1,0	1,0

Verify Surface Roughness (R_{th})

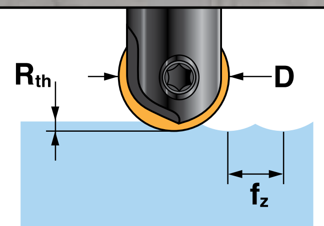
1. Decreasing the A_e and feed by half will improve surface roughness by 4 times.
2. Using $f_z = A_e$ in most cases is the best option.

Surface Roughness Step-Over



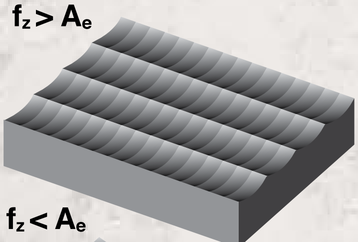
$$R_{th}, A_e = \frac{D}{2} - \sqrt{\frac{D^2 - A_e^2}{4}}$$

Surface Roughness Feed Dir

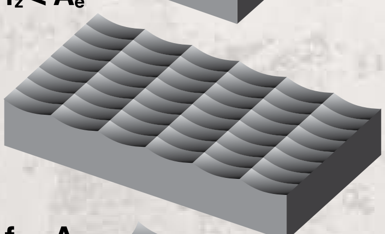


$$R_{th}, A_e = \frac{D}{2} - \sqrt{\frac{D^2 - f_z^2}{4}}$$

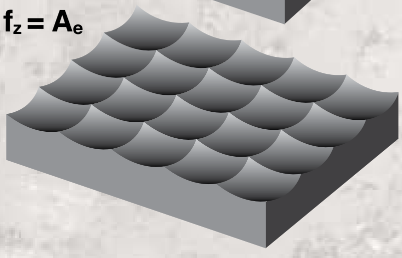
$f_z > A_e$



$f_z < A_e$



$f_z = A_e$



Normal Cutting Parameter Recommendations for BDS, BD and FB inserts

For typical mold steels (1.2311, 1.2344, 1.2711, 1.2714, etc.)

The following parameters are ONLY if cutting a flat surface with the bottom of the tool. For finish machining using only the side of the tool, use the cutting parameters for Ball Inserts.

1. Spindle speed: n(s) (min^{-1})

FB or BD Ø==>	6	8	10	12	16	20	25	32
Material hardness	Spindle speed n(s)							
< 40 HRc	8000	5600	4600	3600	2800	2250	1800	1500
40-54 HRc	7000	4900	3850	2800	2400	1960	1540	1350
55-64 HRc	6000	4200	3100	2200	1800	1500	1350	1200

2. Feed per tooth: fz (mm/tooth)

FB or BD Ø ==>	6	8	10	12	16	20	25	32
Material hardness	Feed per tooth f_z							
< 40 HRc	0.15	0.15	0.2	0.25	0.3	0.35	0.35	0.4
40-54 HRc	0.15	0.15	0.2	0.25	0.3	0.35	0.35	0.4
55-64 HRc	0.1	0.12	0.15	0.20	0.25	0.25	0.25	.25

3. Cutting depth: ap (mm)

FB or BD Ø ==>	6	8	10	12	16	20	25	32
Material hardness	Maximum Cutting depth a_p							
< 40 HRc	0.3	0.35	0.5	0.6	0.8	1.0	1.25	1.6
40-54 HRc	0.2	0.25	0.5	0.6	0.8	1.0	1.25	1.6
55-64 HRc	0.1	0.12	0.4	0.45	0.65	0.8	1.0	1.25

4. Maximum Cutting width / step-over: ae (mm)

FB or BD Ø ==>	6	8	10	12	16	20	25	32
Material hardness	Cutting width a_e							
< 40 HRc	4	6	8	9	13	17	20	26
40-54 HRc	4	6	8	9	13	17	20	26
55-64 HRc	4	6	8	9	13	17	20	26

Additional recommendations and conditions which make it necessary to modify normal cutting parameters

1. Always use climb cutting in roughing operation.
2. Enter the material with the cutter by straight ramping or helical interpolation ramping. A 2° ramp angle will achieve best results.
3. When roughing a cavity level by level (Z-level) it is best to start in the center and work outward in a square, rectangular or round spiral depending on the shape of the work piece. Use climb cutting.
4. Long tool body extension from the spindle or tool adapter will make it necessary to decrease the recommended parameters above:
   - If the tool body extension is 3 times the ball insert diameter or less, use the recommendations on page 1.
   - If the tool body extension is 4 times the ball insert diameter, multiply the cutting parameters by 0.9 (90 %).
   - If the tool body extension is 5 times the ball insert diameter, multiply the cutting parameters by 0.75 (75 %). Use a tapered tool body for additional strength.
   - If the tool body extension is 6 times the ball insert diameter, multiply the cutting parameters by 0.6 (60 %). Use a tapered tool body for additional strength.
   - If the tool extension is greater than 6 times the ball insert diameter, it is recommended to use a carbide tool body instead of a steel body for additional rigidity.
5. If the spindle speed recommended is higher than the spindle speed available on the machine, use the highest spindle speed available. You may use the same recommended feed per tooth, cutting depth and cutting width as shown above. We do not recommend reducing the feed per tooth.