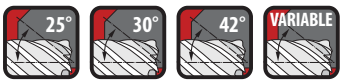
DYNAMIC. AMERICAN. CARBIDE.

ICON LEGEND

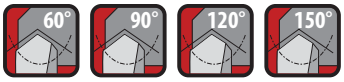
CENTER CUTTING

HELIX ANGLE

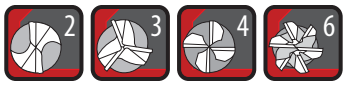


CUT/SPIRAL DIRECTION

DRILL POINT ANGLES



NUMBER OF FLUTES



FLUTE SPACING:

Equal Index

Unequal Index

FINISHES:

Coating		Recommended Materials	Benefits	Structure	Hardness	Oxidation Temp.	Friction Coefficient	Thickness (microns)	Color
TiN	Titanium Nitride	General Purpose	Increases tool longevity & productivity (higher feed rates)	Single-layer	81 Hrc	1100° F	0.5	1-2	Gold
ZrN	Zirconium Nitride	Non-ferrous	Lubricity & tool longevity	Single-layer	88 Hrc	1000° F	0.4	1-4	Canary Yellow
TiCN	Titanium Carbonitride	Carbon Steels, Alloy Steels, Cast Irons, Super Alloys, Copper, Bronze, Brass, High Silicon Aluminum Alloys	Increases edge retention and wear resistance	Single-layer	87 Hrc	750° F	0.45	2-4	Blue / Gray
AlTiN	Aluminum, Titanium Nitride	Alloy Steels, Stainless Steels, Tool Steels, Nickel Alloys & Titaniums	Excellent heat resistance is perfectly suited for dry machining	Multi-layer	90 Hrc	1650° F	0.45	1-4	Gray / Black
AlTiCrN	Aluminum Titanium Chromium Nitride	Cast Irons & Stainless Steels	Low friction	Nano Composite Multi-layer	88 Hrc	1500° F	0.4	1-4	Silver / Gray
nACRo	Chromium Aluminum Titanium Silicon Nitride	Carbon Steel, Stainless Steel, Hardened Steel, Nickel Alloys, Cast Irons, Titaniums & Super Alloys	Extreme heat resistance and edge retention	Nano Composite Multi-layer	89 Hrc	2100° F	0.35	1-7	Gray / Blue

Ground and polished

Unground with Grind Stock

CARBIDE SUBSTRATE:

- C-2 SM 10% — C-2 grade, Sub-Micron grain carbide with 10% cobalt
- PREM SM 12% — Hard metal grade, Sub-Micron grain with 12% cobalt
- C-5 MED 8% — C-5 grade, Medium grain carbide with 8% cobalt

PROFILES:

- FINE PITCH — Fine Pitch
- MED PITCH — Medium Pitch
- COARSE PITCH — Coarse Pitch
- CHIP BREAKER — Chipbreaker

END STYLES:

- SQ — Square Corner
- BN — Ball Nose
- RAD — Corner Radius
- CHAM — Corner Chamfer
- 45° CHAM — End Chamfer

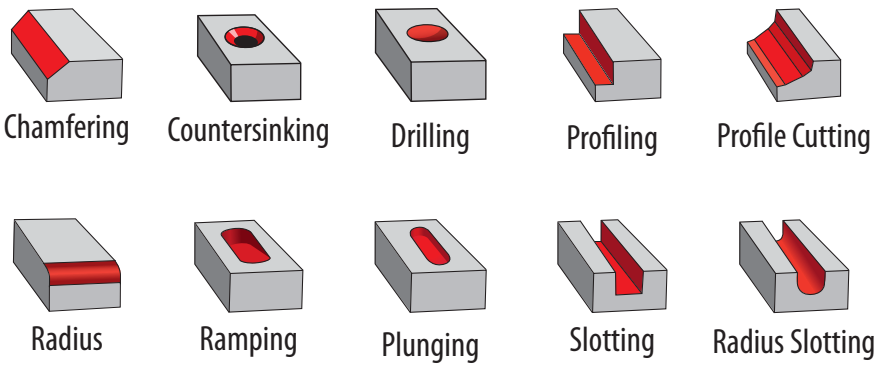
SHANK STYLES:

- STRAIGHT H6 — Straight - H6 Tolerances
- FLAT — Weldon Flat
- NECKED — Necked Shank

SPEEDS AND FEEDS:

- p. XXX — Speed and Feeds Page Location

TOOL APPLICATIONS:



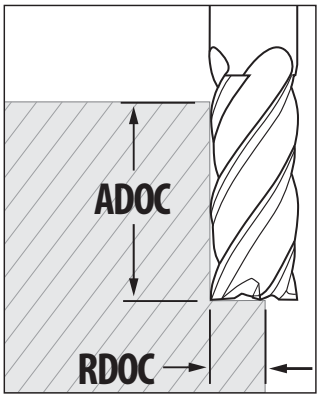
ISO MATERIAL GROUP:

- P — Steels
- M — Stainless Steels
- N — Non-Ferrous
- S — Super Alloys
- K — Cast Iron
- H — Hardened Materials

Formulas	
Inch	**Metric**
Inches Per Minute (***IPM***) = IPT x T x RPM	Millimeter per minute (***MMPM***) = RPM x MMPT x T
Inches Per Revolution (***IPR***) = IPM ÷ RPM	Millimeter per revolution (***MMPR***) = MMPM + RPM
Inches Per Tooth (***IPT***) = IPM ÷ (RPM x T)	Millimeter per Tooth (***MMPT***) = MMPM + RPM x T
Metal Removal Rate (***MRR***) = ADOC x RDOC x IPM	Metal Removal Rate (***MRR***) = ADOC x RDOC x MMPM x 1000

NOTE: ALL RECOMMENDATIONS ARE CONSIDERED AS STARTING PARAMETERS ONLY

END MILL CUTTING RECOMMENDATIONS



Axial Depth of Cut (ADOC) *Radial Depth of Cut (RDOC)*	Flute Count (*T*)		
Applications	**2 & 3 Flutes**	**4 & 5 Flutes**	**6 Flutes**
Slotting	ADOC: 100% DIA	ADOC: 50% DIA	
Light Roughing	ADOC: 100% LOC RDOC: 15-25% DIA	ADOC: 100% LOC RDOC: 15-25% DIA	ADOC: 100% LOC RDOC: 10-20% DIA
Heavy Roughing	ADOC: 150% DIA RDOC: 25-50% DIA	ADOC: 150% DIA RDOC: 25-50% DIA	
Finishing	ADOC: 100% LOC RDOC: 3-5% DIA	ADOC: 100% LOC RDOC: 3-5% DIA	ADOC: 100% LOC RDOC: 3-5% DIA

GENERAL GUIDELINES FOR MILLING

- SELECT THE SHORTEST FLUTE LENGTH POSSIBLE FOR BEST RIGIDITY AND MATERIAL REMOVAL
- CHOOSE THE LARGEST DIAMETER POSSIBLE FOR OPTIMUM STRENGTH
- SMALLER FLUTE LENGTH = LARGER SFM
- LARGER FLUTE LENGTH = SMALLER SFM

- COATINGS CAN ALLOW FASTER FEED RATES.

OPTIMAL ENVIRONMENTS SUPPORT THE FOLLOWING INCREASES IN SFM:

TIN: 20% ALTIN: 45%
TICN: 25% ZRN: 35%

CHIP THINNING

RDOC	Increase Feed Rate
30%	1.1 x IPT
25%	1.2 x IPT
20%	1.3 x IPT
15%	1.4 x IPT
10%	1.8 x IPT
7%	2 x IPT
5%	2.3 x IPT
3%	3 x IPT
2%	3.5 x IPT
1%	5 x IPT

Drill Troubleshooting

PROBLEM	Speeds & Feeds: Reduce Feed or Reduce at Exit	Speeds & Feeds: Reduce Feed at Entrance	Speeds & Feeds: Consistent Feed rate	Speeds & Feeds: Increase Feed	Speeds & Feeds: Reduce Speed	Speeds & Feeds: Increase Speed	Coolant: Coolant Mix	Coolant: Coolant Increase Flow	Coolant: Coolant Filter	Setup: Workpiece Clamp Rigid	Setup: Collet Accuracy	Setup: Tool Holder fit .0008	Setup: Alignment	Setup: Peck Drill	Setup: Concentricity	Setup: Do not Extract Tool During Peck
Flank Wear	◆			◆	◆			◆	◆							
Margin Wear					◆		◆			◆					◆	
Breakage	◆	◆	◆				◆	◆	◆	◆	◆	◆	◆	◆	◆	
Flaking							◆		◆						◆	
Creater Wear					◆											
Chisel Edge Wear	◆			◆				◆		◆						
Corner Chipping	◆			◆			◆		◆						◆	◆
Flute Chipping	◆														◆	
Cutting Edge Chipping	◆						◆	◆	◆	◆	◆	◆	◆			
Cutting Edge Wear				◆	◆											
Point Center Chipping	◆															
Rake Face	◆															
Scoring on Tool Body	◆						◆			◆					◆	
Long Stringy			◆	◆												
Varied Chip Form			◆													
Blue/Brown Chips								◆								
Tool Life	◆				◆		◆	◆	◆	◆						
≤ sized Hole	◆	◆		◆	◆		◆	◆	◆							
≥ sized Hole	◆			◆						◆	◆	◆	◆			
Poor Alignment										◆					◆	
Poor Surface Finish	◆	◆			◆	◆	◆	◆	◆						◆	
Heavy Burr Breakout	◆						◆	◆	◆	◆						
Retract Marks															◆	
Hole Location		◆								◆	◆	◆			◆	
Hole Straightness	◆									◆	◆	◆			◆	
Deflection		◆														
Point Deflection															◆	
Galling					◆											
Vibration			◆								◆	◆			◆	
Abnormal Noise					◆											
Chip Packing	◆	◆	◆		◆		◆	◆	◆							
No Drill Penetration										◆				◆		

Reamer Troubleshooting

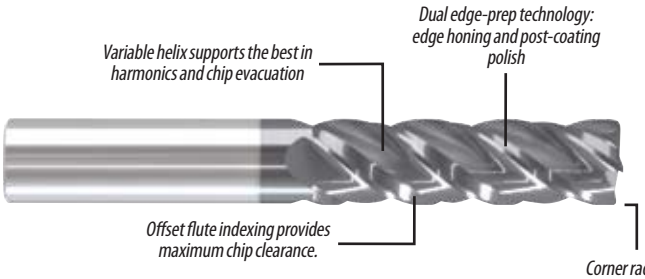
	POSSIBLE SOLUTIONS																			
	SPEEDS & FEEDS							TOOL GEOMETRY							COOLANT AND STOCK REMOVAL					
PROBLEM	Reduce Feed	Increase Feed	Reduce Feed	Increase Speed	Use Larger Reamer	Use Smaller Reamer	Bad Speed and Feed	Worn Tool Margin	Worn Cutting Edge	Uneven Lip Height	Chip Capacity of Reamer	Too Much Clearance	Grind Larger Back Taper	Bent Reamer	Insufficient Stock	Too Much Stock	Use Coolant	Run Dry	Poor Hole Prep
Burnishing		◆									◆				◆				
Reamer Wear	◆		◆				◆									◆	◆		◆
Hole Quality	◆		◆				◆	◆	◆	◆					◆	◆	◆		◆
Hole ≤size	◆		◆		◆			◆	◆	◆					◆	◆	◆		
Hole ≥ size		◆		◆		◆		◆	◆					◆		◆	◆	◆	◆
Accuracy	◆					◆				◆							◆		
Chatter		◆	◆							◆	◆	◆			◆		◆		
Out of Round Hole					◆			◆	◆	◆	◆				◆	◆	◆		
Hole Taper						◆		◆	◆	◆			◆			◆	◆		
Bell Mouth		◆					◆	◆	◆		◆		◆	◆			◆		
Reamer Life		◆	◆				◆			◆		◆					◆		
Scoring in Bore							◆	◆	◆	◆					◆	◆	◆		◆
Deflection																			

NOTE: All recommendations are considered as starting parameters only

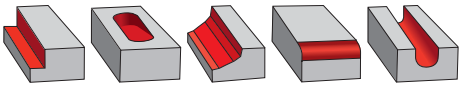
Consider the following variables when trying to diagnose tool failure:

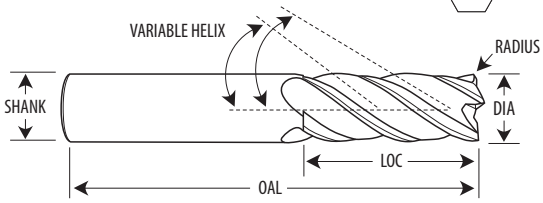
1) Machine rigidity
2) Concentricity at spindle
3) Work piece rigidity
4) coolant type
5) recommended feeds and speeds
6) Tool Selection

FUSION CR



p. 21





FUSING ADVANCED HP TECHNOLOGY WITH CLASSIC GP AFFORDABILITY

DIAMETER TOLERANCE: +0.000 / -0.002" SHANK TOLERANCE: +0.0000 / -0.0004"

DIA	DEC IN	LOC	SHANK	OAL	LENGTH	RADIUS	BRIGHT	ALTICRN
1/8	0.1250	1/4	1/8	1-1/2	Stub	0.010	284-000375	284-000376
						0.015	284-000377	284-000378
						0.020	284-000379	284-000380
						0.030	284-000381	284-000382
1/8	0.1250	1/2	1/8	1-1/2	Regular	0.010	284-000383	284-000384
						0.015	284-000385	284-000386
						0.020	284-000387	284-000388
						0.030	284-000389	284-000390
1/8	0.1250	3/4	1/8	2-1/4	Long	0.015	284-000391	284-000392
						0.020	284-000393	284-000394
						0.030	284-000395	284-000396
1/8	0.1250	1	1/8	3	X/Long	0.015	284-000397	284-000398
						0.020	284-000399	284-000400
						0.030	284-000401	284-000402
3/16	0.1875	3/8	3/16	2	Stub	0.010	284-000403	284-000404
						0.015	284-000405	284-000406
						0.020	284-000407	284-000408
						0.030	284-000409	284-000410
						0.045	284-000411	284-000412
3/16	0.1875	5/8	3/16	2	Regular	0.010	284-000413	284-000414
						0.015	284-000415	284-000416
						0.020	284-000417	284-000418
						0.030	284-000419	284-000420
						0.045	284-000421	284-000422
3/16	0.1875	3/4	3/16	2-1/2	Long	0.015	284-000423	284-000424
						0.020	284-000425	284-000426
						0.030	284-000427	284-000428
3/16	0.1875	1	3/16	4	Ext XX/Long	0.015	284-000435	284-000436
						0.020	284-000437	284-000438
						0.030	284-000439	284-000440
3/16	0.1875	1-1/8	3/16	3	X/Long	0.015	284-000429	284-000430
						0.020	284-000431	284-000432
						0.030	284-000433	284-000434
1/4	0.2500	1/2	1/4	2-1/2	Stub	0.015	284-000441	284-000442
						0.020	284-000443	284-000444
						0.030	284-000445	284-000446
						0.045	284-000447	284-000448
						0.060	284-000449	284-000450

FUSION CR CONTINUED

DIA	DEC IN	LOC	SHANK	OAL	LENGTH	RADIUS	BRIGHT	ALTICRN
1/4	0.2500	3/4	1/4	2-1/2	Regular	0.015	284-000451	284-000452
						0.020	284-000453	284-000454
						0.030	284-000455	284-000456
						0.045	284-000457	284-000458
						0.060	284-000459	284-000460
1/4	0.2500	1	1/4	4	X/Long	0.015	284-000471	284-000472
						0.020	284-000473	284-000474
						0.030	284-000475	284-000476
						0.045	284-000477	284-000478
						0.060	284-000479	284-000480
1/4	0.2500	1-1/8	1/4	3	Long	0.015	284-000461	284-000462
						0.020	284-000463	284-000464
						0.030	284-000465	284-000466
						0.045	284-000467	284-000468
						0.060	284-000469	284-000470
1/4	0.2500	1-1/2	1/4	4	X/Long	0.015	284-000481	284-000482
						0.020	284-000483	284-000484
						0.030	284-000485	284-000486
						0.045	284-000487	284-000488
						0.060	284-000489	284-000490
1/4	0.2500	1-1/2	1/4	6	Ext XX/Long	0.015	284-000491	284-000492
						0.020	284-000493	284-000494
						0.030	284-000495	284-000496
						0.045	284-000497	284-000498
						0.060	284-000499	284-000500
5/16	0.3125	1/2	5/16	2-1/2	Stub	0.015	284-000501	284-000502
						0.020	284-000503	284-000504
						0.030	284-000505	284-000506
						0.045	284-000507	284-000508
						0.060	284-000509	284-000510
						0.090	284-000511	284-000512
5/16	0.3125	13/16	5/16	2-1/2	Regular	0.015	284-000513	284-000514
						0.020	284-000515	284-000516
						0.030	284-000517	284-000518
						0.045	284-000519	284-000520
						0.060	284-000521	284-000522
						0.090	284-000523	284-000524
5/16	0.3125	1-1/8	5/16	3	Long	0.015	284-000525	284-000526
						0.020	284-000527	284-000528
						0.030	284-000529	284-000530
						0.045	284-000531	284-000532
						0.060	284-000533	284-000534
5/16	0.3125	1-1/2	5/16	6	Ext XX/Long	0.015	284-000545	284-000546
						0.020	284-000547	284-000548
						0.030	284-000549	284-000550
						0.045	284-000551	284-000552
						0.060	284-000553	284-000554

FUSION CR Continued

DIA	DEC IN	LOC	SHANK	OAL	LENGTH	RADIUS	BRIGHT	ALTICRN
5/16	0.3125	1-5/8	5/16	4	X/Long	0.015	284-000535	284-000536
						0.020	284-000537	284-000538
						0.030	284-000539	284-000540
						0.045	284-000541	284-000542
						0.060	284-000543	284-000544
3/8	0.3750	5/8	3/8	2-1/2	Stub	0.015	284-000555	284-000556
						0.020	284-000557	284-000558
						0.030	284-000559	284-000560
						0.045	284-000561	284-000562
						0.060	284-000563	284-000564
						0.090	284-000565	284-000566
3/8	0.3750	1	3/8	2-1/2	Regular	0.015	284-000567	284-000568
						0.020	284-000569	284-000570
						0.030	284-000571	284-000572
						0.045	284-000573	284-000574
						0.060	284-000575	284-000576
						0.090	284-000577	284-000578
3/8	0.3750	1	3/8	4	Ext X/Long	0.015	284-000589	284-000590
						0.020	284-000591	284-000592
						0.030	284-000593	284-000594
						0.045	284-000595	284-000596
						0.060	284-000597	284-000598
3/8	0.3750	1-1/8	3/8	3	Long	0.015	284-000579	284-000580
						0.020	284-000581	284-000582
						0.030	284-000583	284-000584
						0.045	284-000585	284-000586
						0.060	284-000587	284-000588
3/8	0.3750	1-1/2	3/8	6	Ext XX/Long	0.015	284-000609	284-000610
						0.020	284-000611	284-000612
						0.030	284-000613	284-000614
						0.045	284-000615	284-000616
						0.060	284-000617	284-000618
3/8	0.3750	1-3/4	3/8	4	X/Long	0.015	284-000599	284-000600
						0.020	284-000601	284-000602
						0.030	284-000603	284-000604
						0.045	284-000605	284-000606
						0.060	284-000607	284-000608
7/16	0.4375	1	7/16	2-3/4	Regular	0.030	284-000619	284-000620
						0.045	284-000621	284-000622
						0.060	284-000623	284-000624
						0.090	284-000625	284-000626
						0.125	284-000627	284-000628

FUSION CR CONTINUED

DIA	DEC IN	LOC	SHANK	OAL	LENGTH	RADIUS	BRIGHT	ALTICRN
1/2	0.5000	5/8	1/2	3	Stub	0.015	284-000629	284-000630
						0.020	284-000631	284-000632
						0.030	284-000633	284-000634
						0.045	284-000635	284-000636
						0.060	284-000637	284-000638
						0.090	284-000639	284-000640
						0.125	284-000641	284-000642
1/2	0.5000	1	1/2	4	Sm/Med	0.015	284-000657	284-000658
						0.020	284-000659	284-000660
						0.030	284-000661	284-000662
						0.045	284-000663	284-000664
						0.060	284-000665	284-000666
						0.090	284-000667	284-000668
						0.125	284-000669	284-000670
1/2	0.5000	1-1/4	1/2	3	Regular	0.015	284-000643	284-000644
						0.020	284-000645	284-000646
						0.030	284-000647	284-000648
						0.045	284-000649	284-000650
						0.060	284-000651	284-000652
						0.090	284-000653	284-000654
						0.125	284-000655	284-000656
1/2	0.5000	1-1/2	1/2	4	Medium	0.015	284-000671	284-000672
						0.020	284-000673	284-000674
						0.030	284-000675	284-000676
						0.045	284-000677	284-000678
						0.060	284-000679	284-000680
						0.090	284-000681	284-000682
						0.125	284-000683	284-000684
1/2	0.5000	1-1/2	1/2	6	Ext X/Long	0.015	284-000699	284-000700
						0.020	284-000701	284-000702
						0.030	284-000703	284-000704
						0.045	284-000705	284-000706
						0.060	284-000707	284-000708
						0.090	284-000709	284-000710
						0.125	284-000711	284-000712
1/2	0.5000	2	1/2	4	Long	0.015	284-000685	284-000686
						0.020	284-000687	284-000688
						0.030	284-000689	284-000690
						0.045	284-000691	284-000692
						0.060	284-000693	284-000694
						0.090	284-000695	284-000696
						0.125	284-000697	284-000698
1/2	0.5000	3	1/2	6	X/Long	0.015	284-000713	284-000714
						0.020	284-000715	284-000716
						0.030	284-000717	284-000718
						0.045	284-000719	284-000720
						0.060	284-000721	284-000722
						0.090	284-000723	284-000724
						0.125	284-000725	284-000726

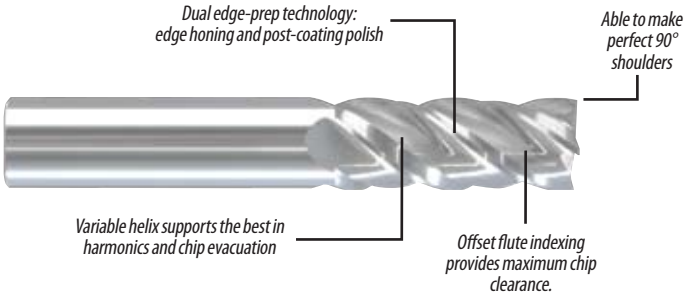
FUSION CRN CONTINUED

DIA	DEC IN	LOC	SHANK	OAL	LENGTH	RADIUS	BRIGHT	ALTICRN
5/8	0.6250	3/4	5/8	3-1/2	Stub	0.015	284-000727	284-000728
						0.020	284-000729	284-000730
						0.030	284-000731	284-000732
						0.045	284-000733	284-000734
						0.060	284-000735	284-000736
						0.090	284-000737	284-000738
						0.125	284-000739	284-000740
5/8	0.6250	1-1/4	5/8	3-1/2	Regular	0.015	284-000741	284-000742
						0.020	284-000743	284-000744
						0.030	284-000745	284-000746
						0.045	284-000747	284-000748
						0.060	284-000749	284-000750
						0.090	284-000751	284-000752
						0.125	284-000753	284-000754
5/8	0.6250	1-1/2	5/8	6	Ext X/Long	0.030	284-000765	284-000766
						0.045	284-000767	284-000768
						0.060	284-000769	284-000770
						0.090	284-000771	284-000772
						0.125	284-000773	284-000774
5/8	0.6250	2-1/4	5/8	5	Long	0.030	284-000755	284-000756
						0.045	284-000757	284-000758
						0.060	284-000759	284-000760
						0.090	284-000761	284-000762
						0.125	284-000763	284-000764
5/8	0.6250	3	5/8	6	X/Long	0.030	284-000775	284-000776
						0.045	284-000777	284-000778
						0.060	284-000779	284-000780
						0.090	284-000781	284-000782
						0.125	284-000783	284-000784
3/4	0.7500	1	3/4	4	Stub	0.030	284-000785	284-000786
						0.045	284-000787	284-000788
						0.060	284-000789	284-000790
						0.090	284-000791	284-000792
						0.125	284-000793	284-000794
						0.190	284-000795	284-000796
						0.250	284-000797	284-000798
3/4	0.7500	1-1/2	3/4	4	Regular	0.030	284-000799	284-000800
						0.045	284-000801	284-000802
						0.060	284-000803	284-000804
						0.090	284-000805	284-000806
						0.125	284-000807	284-000808
						0.190	284-000809	284-000810
						0.250	284-000811	284-000812
3/4	0.7500	1-1/2	3/4	6	Ext X/Long	0.030	284-000825	284-000826
						0.045	284-000827	284-000828
						0.060	284-000829	284-000830
						0.090	284-000831	284-000832
						0.125	284-000833	284-000834
						0.250	284-000835	284-000836

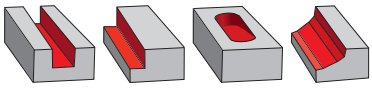
FUSION CR CONTINUED

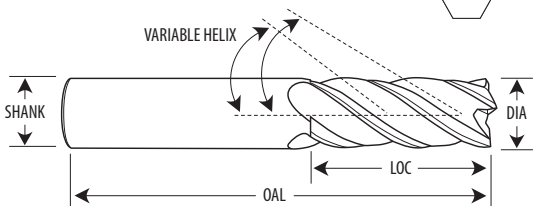
DIA	DEC IN	LOC	SHANK	OAL	LENGTH	RADIUS	BRIGHT	ALTICRN
3/4	0.7500	2-1/4	3/4	5	Long	0.030	284-000813	284-000814
						0.045	284-000815	284-000816
						0.060	284-000817	284-000818
						0.090	284-000819	284-000820
						0.125	284-000821	284-000822
						0.250	284-000823	284-000824
3/4	0.7500	3	3/4	6	X/Long	0.030	284-000837	284-000838
						0.045	284-000839	284-000840
						0.060	284-000841	284-000842
						0.090	284-000843	284-000844
						0.125	284-000845	284-000846
						0.250	284-000847	284-000848
3/4	0.7500	4	3/4	7	XX/Long	0.030	284-000849	284-000850
						0.045	284-000851	284-000852
						0.060	284-000853	284-000854
						0.090	284-000855	284-000856
						0.125	284-000857	284-000858
						0.250	284-000859	284-000860
1	1.0000	1-1/2	1	4	Regular	0.030	284-000861	284-000862
						0.045	284-000863	284-000864
						0.060	284-000865	284-000866
						0.090	284-000867	284-000868
						0.125	284-000869	284-000870
						0.190	284-000871	284-000872
						0.250	284-000873	284-000874
1	1.0000	1-1/2	1	6	Ext X/Long	0.030	284-000887	284-000888
						0.045	284-000889	284-000890
						0.060	284-000891	284-000892
						0.090	284-000893	284-000894
						0.125	284-000895	284-000896
						0.250	284-000897	284-000898
1	1.0000	2-1/4	1	5	Long	0.030	284-000875	284-000876
						0.045	284-000877	284-000878
						0.060	284-000879	284-000880
						0.090	284-000881	284-000882
						0.125	284-000883	284-000884
						0.250	284-000885	284-000886
1	1.0000	3	1	6	X/Long	0.030	284-000899	284-000900
						0.045	284-000901	284-000902
						0.060	284-000903	284-000904
						0.090	284-000905	284-000906
						0.125	284-000907	284-000908
						0.250	284-000909	284-000910
1	1.0000	4	1	7	XX/Long	0.030	284-000911	284-000912
						0.045	284-000913	284-000914
						0.060	284-000915	284-000916
						0.090	284-000917	284-000918
						0.125	284-000919	284-000920
						0.250	284-000921	284-000922

FUSION SQ



p. 21





FUSING ADVANCED HP TECHNOLOGY WITH CLASSIC GP AFFORDABILITY

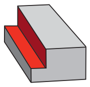
DIAMETER TOLERANCE: +0.000 / -0.002" SHANK TOLERANCE: +0.0000 / -0.0004"

DIA	DEC IN	LOC	SHANK	OAL	LENGTH	BRIGHT	ALTICRN
1/8	0.1250	1/4	1/8	1-1/2	Stub	284-000058	284-000059
		1/2	1/8	1-1/2	Regular	284-000060	284-000061
		3/4	1/8	2-1/4	Long	284-000062	284-000063
		1	1/8	3	X/Long	284-000064	284-000065
3/16	0.1875	3/8	3/16	2	Stub	284-000088	284-000089
		5/8	3/16	2	Regular	284-000090	284-000091
		3/4	3/16	2-1/2	Long	284-000092	284-000093
		1-1/8	3/16	3	X/Long	284-000094	284-000095
1/4	0.2500	1/2	1/4	2-1/2	Stub	284-000118	284-000119
		3/4	1/4	2-1/2	Regular	284-000120	284-000121
		1-1/8	1/4	3	Long	284-000122	284-000123
		1-1/2	1/4	4	X/Long	284-000124	284-000125
5/16	0.3125	1/2	5/16	2-1/2	Stub	284-000148	284-000149
		13/16	5/16	2-1/2	Regular	284-000150	284-000151
		1-1/8	5/16	3	Long	284-000152	284-000153
		1-5/8	5/16	4	X/Long	284-000154	284-000155
3/8	0.3750	5/8	3/8	2-1/2	Stub	284-000178	284-000179
		1	3/8	2-1/2	Regular	284-000180	284-000181
		1-1/8	3/8	3	Long	284-000182	284-000183
		1-3/4	3/8	4	X/Long	284-000184	284-000185
7/16	0.4375	1	7/16	2-3/4	Regular	284-000210	284-000211
		2	7/16	4	Long	284-000212	284-000213
		3	7/16	6	X/Long	284-000214	284-000215
1/2	0.5000	5/8	1/2	3	Stub	284-000238	284-000239
		1	1/2	3	Regular	284-000240	284-000241
		1-1/4	1/2	3	Regular	284-000242	284-000243
		1-1/2	1/2	4	Medium	284-000244	284-000245
		2	1/2	4	Long	284-000246	284-000247
		3	1/2	6	X/Long	284-000248	284-000249
5/8	0.6250	3/4	5/8	3-1/2	Stub	284-000268	284-000269
		1-1/4	5/8	3-1/2	Regular	284-000270	284-000271
		2-1/4	5/8	5	Long	284-000272	284-000273
		3	5/8	6	X/Long	284-000274	284-000275
3/4	0.7500	1	3/4	4	Stub	284-000298	284-000299
		1-1/2	3/4	4	Regular	284-000300	284-000301
		2-1/4	3/4	5	Long	284-000302	284-000303
		3	3/4	6	X/Long	284-000304	284-000305
		4	3/4	7	XX/Long	284-000306	284-000307
1	1.0000	1-1/2	1	4	Regular	284-000330	284-000331
		2-1/4	1	5	Long	284-000332	284-000333
		3	1	6	X/Long	284-000334	284-000335
		4	1	7	XX/Long	284-000336	284-000337

MILLING RECOMMENDATIONS

FUSION

PROFILING



Surface Feet Per Minute (SFM)
Radial Depth of Cut (RDOC)
Inches Per Tooth (IPT)

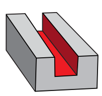
Workpiece Material Group			Hardness	SFM based on RDOC: Cutting Diameter Engaged 5%	10%	20%	30%	50%	IPT* (BASELINE): Cutting Diameter 1/8†	3/16†	1/4†	5/16	3/8	1/2	5/8	3/4	1
Steels	Free Machining & Low Carbon: 10XX, 11XX, 12XX 12LXX, ASTM A27 ASTM A36	P	≤ 28 Rc	1050	700	385	375	350	0.00065	0.00097	0.00120	0.0032	0.0038	0.0054	0.0065	0.0076	0.0108
Steels	Medium Carbon, High Carbon Steels, Alloy Steels & Easy to Machine Tool: 13XX, 41XX, 43XX 51XX, 86XX, 93XX	P	28 - 38 Rc	630	420	320	250	210	0.00065	0.00097	0.00120	0.0032	0.0038	0.0054	0.0065	0.0076	0.0108
Tool & Die Steels	A2, H13, L6, P20, S7	P	28 - 44 Rc	525	350	300	275	250	0.00065	0.00097	0.00120	0.0032	0.0038	0.0054	0.0065	0.0076	0.0108
Stainless Steel	Easy to Machine, 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	≤ 28 Rc	650	600	550	500	450	0.00065	0.00097	0.00120	0.0032	0.0038	0.0054	0.0065	0.0076	0.0108
Stainless Steel	Moderately Difficult to Machine, Nitronic 50, Nitronic 60 , 301, 303 304, 304L Incoloy 27-7MO, 316 316L, 321, 347	M	≤ 28 Rc	525	400	350	300	250	0.00065	0.00097	0.00120	0.0032	0.0038	0.0054	0.0065	0.0076	0.0108
Stainless Steel	Difficult to Machine, 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	> 28 Rc	525	400	350	300	250	0.00065	0.00097	0.00120	0.0032	0.0038	0.0054	0.0065	0.0076	0.0108
Super Alloys	High Temp, Nimonics, Inconel, Monel, Hastelloy	S	≤ 42 Rc	265	200	175	150	100	0.00048	0.00065	0.00096	0.0017	0.0019	0.0028	0.0032	0.0038	0.0054
Super Alloys	Titanium: Ti 3Al-2.5V, Ti 6Al-4V Ti 10V-2Fe-3Al	S	≤ 42 Rc	230	200	175	150	125	0.00048	0.00065	0.00096	0.0017	0.0019	0.0028	0.0032	0.0038	0.0054
Hardened Materials		H	45-55 Rc	250	240	230	210	200	0.00360	0.00432	0.00504	0.0022	0.0025	0.0036	0.0043	0.0050	0.0072
Cast-Iron	Gray: SAE J431, ASTM A48	K	≤ 240 HB	425	400	375	350	300	0.00065	0.00097	0.00120	0.0032	0.0038	0.0054	0.0065	0.0076	0.0108
Cast-Iron	Ductile & Malleable: ASTM A536, ASTM 897, ASTM A47, ASTM A220 ASTM A602	K	> 240 HB	320	300	250	225	200	0.00065	0.00097	0.00120	0.0032	0.0038	0.0054	0.0065	0.0076	0.0108
Non-Ferrous	Aluminum, Brass, Bronze, Copper, Plastics, Graphite	N		1000	960	920	880	840	0.00048	0.00065	0.00096	0.0032	0.0038	0.0054	0.0065	0.0076	0.0108

***CHIP THINNING Adjustments**

RDOC	Increase IPT
50%	None
30%	1.1 x
25%	1.2 x
20%	1.3 x
15%	1.4 x
10%	1.8 x
7%	2.0 x
5%	2.3 x
3%	3.0 x
2%	3.5 x
1%	5.0 x

†1/4" AND SMALLER DIAMETERS: Use caution when Profiling more than 50% or Slotting more than 25%

SLOTTING



Surface Feet Per Minute (SFM)
Radial Depth of Cut (RDOC)
Inches Per Tooth (IPT)

Workpiece Material Group			Hardness	SFM: Cutting Diameter Engaged 25%	50%	100%	IPT* (BASELINE): Cutting Diameter 1/8†	3/16†	1/4†	5/16	3/8	1/2	5/8	3/4	1
Steels	Free Machining & Low Carbon: 10XX, 11XX, 12XX 12LXX, ASTM A27 ASTM A36	P	≤ 28 Rc	462	444	420	0.00060	0.00084	0.00120	0.0019	0.0023	0.0030	0.0037	0.0046	0.0060
Steels	Medium Carbon, High Carbon Steels, Alloy Steels & Easy to Machine Tool: 13XX, 41XX, 43XX 51XX, 86XX, 93XX	P	28 - 38 Rc	294	276	2652	0.00048	0.00084	0.00108	0.0019	0.0023	0.0030	0.0037	0.0046	0.0060
Tool & Die Steels	A2, H13, L6, P20, S7	P	28 - 44 Rc	252	234	210	0.00048	0.00072	0.00096	0.0019	0.0023	0.0030	0.0037	0.0046	0.0060
Stainless Steel	Easy to Machine, 430F, 301, 303, 410, 416 Annealed, 420F, 430, 430F	M	≤ 28 Rc	462	444	420	0.00060	0.00084	0.00120	0.0019	0.0023	0.0030	0.0037	0.0046	0.0060
Stainless Steel	Moderately Difficult to Machine, Nitronic 50, Nitronic 60 , 301, 303 304, 304L Incoloy 27-7MO, 316 316L, 321, 347	M	≤ 28 Rc	294	252	210	0.00048	0.00084	0.00108	0.0019	0.0023	0.0030	0.0037	0.0046	0.0060
Stainless Steel	Difficult to Machine, 302B, 304B, 309, 310, 316, 316B, 316L, 316Ti, 317, 317L, 321, PH13-8Mo, Nitronics	M	> 28 Rc	252	234	210	0.00036	0.00048	0.00060	0.0019	0.0023	0.0030	0.0037	0.0046	0.0060
Super Alloys	High Temp, Nimonics, Inconel, Monel, Hastelloy	S	≤ 42 Rc	150	126	108	0.00036	0.00048	0.00060	0.0010	0.0012	0.0016	0.0019	0.0020	0.0031
Super Alloys	Titanium: Ti 3Al-2.5V, Ti 6Al-4V Ti 10V-2Fe-3Al	S	≤ 42 Rc	120	108	96	0.00036	0.00048	0.00060	0.0010	0.0012	0.0016	0.0019	0.0020	0.0031
Hardened Materials		H	34-45 Rc	294	276	252	0.00024	0.00036	0.00048	0.0019	0.0023	0.0030	0.0037	0.0046	0.0060
Cast-Iron	Gray: SAE J431, ASTM A48	K	≤ 240 HB	540	480	420	0.00060	0.00084	0.00120	0.0019	0.0023	0.0030	0.0037	0.0046	0.0060
Cast-Iron	Ductile & Malleable: ASTM A536, ASTM 897, ASTM A47, ASTM A220 ASTM A602	K	> 240 HB	360	300	270	0.00048	0.00084	0.00108	0.0019	0.0023	0.0030	0.0037	0.0046	0.0060
Non-Ferrous	Aluminum, Brass, Bronze, Copper, Plastics, Graphite	N		900	720	540	0.00132	0.00204	0.00264	0.0019	0.0023	0.0030	0.0037	0.0046	0.0060

HIGH PERFORMANCE ENDMILL SETS

- *Five Piece Sets - 1/8, 3/16, 1/4, 3/8, & 1/2 sizes*
- *Regular/standard flute and overall lengths*
- *Engineered nano-foam cushioning for ultimate tool protection*
- *Rugged plastic index can be reused to house future tooling*
- *Uncoated and coated options offered*

AVALANCHE

FLUTES	END STYLE	Bright	ZrN
2	Corner Radius	282-888881	282-888882
3	Square	273-888881	273-888882
3	Corner Radius	283-888881	283-888882

FUSION SQ

FLUTES	END STYLE	Bright	AlTiCrN
4	Square	284-888881	284-888882

ALPHA

FLUTES	END STYLE	nACRo®
4	Corner Radius	294-888881
5	Corner Radius	295-888881

ATTACKER

FLUTES	END STYLE	Bright	AlTiN
3	Corner Radius	267-888881	267-888882
4	Corner Radius	257-888881	257-888882

AGGRESSOR

FLUTES	PROFILE	Bright	ZrN	AlTiCrN
4	Fine Pitch	255-888811	—	255-888812
4	Medium Pitch	256-888881	—	256-888882
3	Coarse Pitch	255-888801	255-888802	—

TERMS AND CONDITIONS

Acceptance of Terms
By purchasing products from Monster Tool Company, you agree that you have read, understand and agree to be bound by all of the provisions set forth herein and below (collectively, the "Terms and Conditions"), all of which constitute an agreement between you and Monster Tool Company. The unenforceability of any one of the Terms and Conditions shall not affect the enforceability of any other of the Terms and Conditions. The terms and conditions on any proposal, quotation, order acknowledgement, invoice or other form you receive from Monster Tool Company are incorporated under these Terms and Conditions. These Terms and Conditions constitute the exclusive agreement between you and Monster Tool Company, except as otherwise agreed by a mutually signed document. Our failure to assert a right or insist upon compliance with any term and condition shall not constitute a waiver of that right or justify any subsequent noncompliance. Monster Tool Company reserves the right to change these terms and conditions by posting a revision on our website or by mailing, faxing or emailing said notification.

Distributor Discount
See current price supplemental for list pricing and please contact us for discount schedule, terms & conditions.

Terms of Order
All orders are shipped with Net 30 day terms (delinquent at 45 days). No shipment to delinquent accounts. Any account paid after 30 days may become COD on future orders. All orders are subject to credit approval. In the event any legal action or proceeding is brought by any party under this Agreement, the prevailing party shall be entitled to recover the reasonable fees of its attorneys and any costs incurred in such action or proceeding, including costs of appeal, if any, in such amount that the court or administrative body having jurisdiction over such action or proceeding may award.

Ordering Information
All items in the Monster Tool Company catalog carry unique item numbers. Using these numbers will keep ordering errors to a minimum and assure that you will receive exactly what you order. Orders will be accepted by phone, fax, EDI, and email. All orders under $50 will be subject to a $7.50 processing fee.

Drop Shipping
All drop ship orders must be faxed or emailed to Monster Tool Company. Monster Tool Company will not assume responsibility for any incorrect shipping information. Monster Tool Company will assess a $20 fee to any drop ship order that is either returned or re-routed by the shipping company. Failure to provide proper and complete information that results in any additional shipping penalties or fees from UPS will be billed to the distributor.

Shipping / Freight Collect – Discrepancies / Late or Lost Delivery
Same day shipping is available for stocked items ordered before 3:30pm Pacific Time Monday through Friday. UPS is the preferred method of shipping for same day shipping. FEDEX or USPS could be delayed up to one business day from date of order. We accept freight collect numbers or can prepay and add the freight charges to any order. Any freight collect charges that are noncollectable by UPS, or any penalties or fees incurred for errant billing information or wrong address that are re-billed to Monster Tool Company will be billed back to customer issuing the purchase order. In the event that the freight carrier does not deliver your order on time or loses the order, Monster Tool Company will file a claim on your behalf. Claims can take up to 30 days to be processed and refunded by the freight carrier, which is at their full discretion. Monster Tool cannot be held accountable for any late or lost orders. All prepay and add freight services are billed with insurance for this reason and any freight collect accounts assume full responsibility at the time a tracking number is issued by freight carrier. Any lost package that was insured by Monster Tool through our prepay and add freight services will be immediately replaced. Claims for shortages must be made within 3 days of receipt of tools.

UPS Expedited Freight Program
Monster Tool offers a prepaid freight program for faster delivery and cost savings to our customers. We offer the following freight programs for your consideration:
- UPS Red (Next Day Air) service billed at UPS Blue (2-day) published rates.
- UPS Blue (2-day) service billed at UPS Ground published rates.
- Free UPS Ground freight on orders over $1000

Product Warranty
Monster Tool Company assures that all products sold shall be free from manufacturing and material defects. Monster Tool Company will repair, replace, or issue credit on any product that does not conform with this warranty. Any product that has been altered, used, marked or damaged voids this warranty. This warranty is in lieu of all other warranties, expressed or implied including any warranty of merchantability or fitness for a particular purpose and is also in lieu of all other obligations or liabilities, including any obligation or liability arising from contract, or otherwise for damages whether direct, indirect or consequential. There are no other warranties except the warranty against defects in material and workmanship set forth above, and we neither assume nor authorize any other person or firm to assume for it any other obligation or liability in connection with our products.

Product Return Policy
Prior to acceptance of any returned products, a Returned Authorization (RA) number must be issued from our Returns Department by calling 888-227-2433 or emailing returns@monstertool.com. A list of returned products accompanied with purchase order numbers is required for review and approval prior to issuance of a RA. Only current EDP numbers are considered for return, any discontinued products are non-returnable. All specials, modified tooling, or altered tools cannot be returned for credit unless tools were manufactured incorrectly per the customer's specifications provided. Only tools purchased within 6 months from date of order will be eligible for return. Returned products for credit will be valued at purchase price regardless of current price. All returned products must pass Quality Assurance inspection, be undamaged, unaltered, unused, resalable, manufactured according to current tooling specifications, and in original packaging. No credit will be issued if tools do not pass QA inspection or meet the aforementioned criteria. All products must be received within 21-days of RA issuance. A restocking charge of 20% will apply or an offsetting order of two times (200%) the value of the returned product will apply to all products returned for any reason other than a manufacturer error or defect. Freight charges will be assumed by the customer unless the return is due to manufacturer error or defect. The RA number must be clearly visible on the outside of the box and on the enclosed packing list. Any items shipped and not approved for return will either be returned to the customer or scrapped at the customer's expense. Please return product with approved RA number to: Monster Tool Company, 2470 Ash Street, Bay #2, Vista, CA 92081

Monster Tool Blanket Order Policy
Blanket orders are extremely beneficial for high volume consumers of cutting tools. This order option enables all parties to maximize their logistical planning increasing efficiencies, price security and cost savings for all parties. All blanket orders must be taken within the agreed upon term not to exceed 12-months from date of order. Blanket order releases can be released on a scheduled timely basis or released as needed. No cancellations or returns will be allowed on blanket orders regardless if the products sold are standard catalog items or specials.

Technical Assistance
Any technical assistance or application suggestions made by Monster Tool Company personnel or website tech data information and online calculators are only to assist the customer and in all cases use of such information is solely the customer's responsibility.

Safety Precautions when using Cutting Tools
Monster Tool Company is committed to manufacturing products that can be used safely as directed under recommended machining parameters. Cutting tools can break or shatter when in use due to the extreme forces of the machining environment. Cutting tools will generate chips while engaged in the work piece and can produce dust, swarf, gases and potentially sparks or fire. Caution and safety must be taken into account at all times to include the use of protective eye wear, machine safety guard barriers, proper ventilation, quick access to fire suppression equipment and other safeguards. In no way shall Monster Tool Company be held accountable or liable for any costs, machine down time, injuries, or deaths resulting from cutting tool breakage or emissions.

Limitation of Liability
Under no circumstance shall Monster tool Company be held liable in contract, warranty, tort or otherwise for any special, exemplary, incidental or consequential damages that result from your purchase or use of any Monster Tool Company products. In no event shall our liability exceed the purchase price of the products from Monster Tool Company. It is the customer's responsibility to inspect all products to determine if they are suitable and per specification required by the end user.

Revisions to Marketing Avenues
Monster Tool Company reserves the right to revise listings and specifications in our catalog and website without notice. Monster Tool Company is not responsible for any typographical errors. Please verify the current data at the time of your order.

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MONSTER TOOL COMPANY
888-227-2433
WWW.MONSTERTOOL.COM
SALES@MONSTERTOOL.COM
2470 ASH STREET, VISTA, CA 92081