

TOOLS FOR

Titanium, Steel & High-Temp Alloys



Titanium Machining at 75 ipm!

Scan this code to:

- See How to Cut Titanium at 75 ipm
- Watch Videos
- See How to High-Speed Machine Steel
- And More...

Featured Tools:

NS Series – Machine Steel with Ease!

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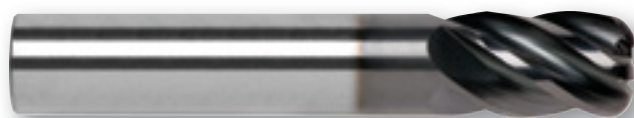
Variable Helix
Offset Fluting

- **500% Increase** in Metal Removal Rates
- **Reduced Cycle Time** from 45 minutes to 9 minutes
- **Speeds and Feeds up to 5X** Those of Traditional Steel Cutting Tools
- Available in **Inch and Metric Sizes**



XG Series – The Highest Performing Tool in Steel, Stainless & Other Difficult Alloys

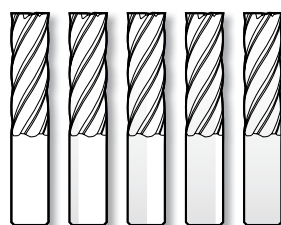
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*304 SS
Slotting &
Profiling
400sfm
24ipm

XF Series – Best Tool for High-Speed Machining

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Other High-Performance Tools



6Al4V Titanium Flap Trac
for Airplane Wing

VS.



6Al4V Titanium Flap Trac
for Airplane Wing

RJ XF-Series

RJ
XF-Series

**15X
LIFE!**

of Comparable
Tools!



Titanium, Steel & High-Temp Alloys Tools

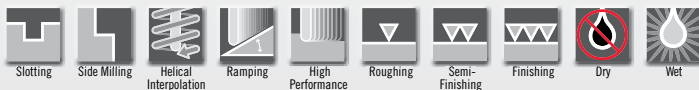
NS / MNS 402	4 Flute Tuffy Grade			44
XG / MXG 400/402	4 Flute Tuffy Grade			46
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NS/MNS Tuffy Grade Carbide End Mills

Characteristics



Applications



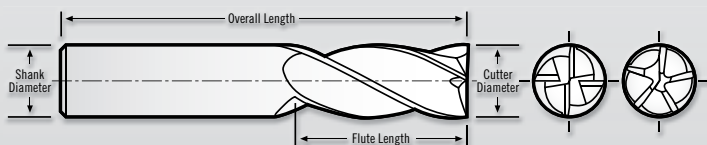
Materials



Coatings



NEW

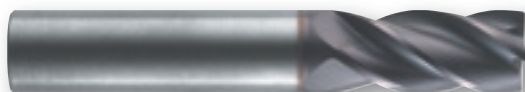


NS Tolerances

Cutting Dia. = $-.001/-0.002$ "
Shank Dia. = $-.0001/-0.0002$ "
Flute Length = $+.060/-0.000$ "
OAL = $+/-0.060$ "

MNS Tolerances

Cutting Dia. = $-0.025/-0.050$ mm
Shank Dia. = $-0.002/-0.005$ mm
Flute Length = $+0.50/+1.50$ mm
OAL = $+/-1.00$ mm



Add Flats for High Torque Cuts!

NS-401 4 Flute Stub Length

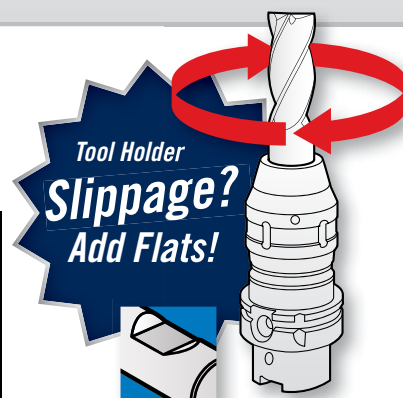
Cutting Diameter	Chamfer	Shank Diameter	Flute Length	Overall Length	Tool number Flats, AlTiN Coated	Tool number No Flats, AlTiN Coated
3/16"	0.008	3/16"	3/8"	2-1/2"	NS-401-06-FL	NS-401-06
1/4"	0.008	1/4"	1/2"	2-1/2"	NS-401-08-FL	NS-401-08
5/16"	0.01	5/16"	1/2"	2-1/2"	NS-401-10-FL	NS-401-10
3/8"	0.01	3/8"	5/8"	2-1/2"	NS-401-12-FL	NS-401-12
1/2"	0.01	1/2"	3/4"	3"	NS-401-16-FL	NS-401-16
5/8"	0.015	5/8"	7/8"	3-1/2"	NS-401-20-FL	NS-401-20
3/4"	0.015	3/4"	1"	4"	NS-401-24-FL	NS-401-24
1"	0.02	1"	1"	5"	NS-401-32-FL	NS-401-32

NS-402 4 Flute Standard Length

Cutting Diameter	Chamfer	Shank Diameter	Flute Length	Overall Length	Tool number Flats, AlTiN Coated	Tool number No Flats, AlTiN Coated
3/16"	0.008	3/16"	5/8"	2-1/2"	NS-402-06-FL	NS-402-06
1/4"	0.008	1/4"	3/4"	2-1/2"	NS-402-08-FL	NS-402-08
5/16"	0.01	5/16"	7/8"	2-1/2"	NS-402-10-FL	NS-402-10
3/8"	0.01	3/8"	1"	2-1/2"	NS-402-12-FL	NS-402-12
1/2"	0.01	1/2"	1-1/8"	3"	NS-402-16-FL	NS-402-16
5/8"	0.015	5/8"	1-1/4"	3-1/2"	NS-402-20-FL	NS-402-20
3/4"	0.015	3/4"	1-1/2"	4"	NS-402-24-FL	NS-402-24
1"	0.02	1"	1-3/4"	5"	NS-402-32-FL	NS-402-32

NS-403 4 Flute Long Length

Cutting Diameter	Chamfer	Shank Diameter	Flute Length	Overall Length	Tool number Flats, AlTiN Coated	Tool number No Flats, AlTiN Coated
3/16"	0.008	3/16"	7/8"	2-1/2"	NS-403-06-FL	NS-403-06
1/4"	0.008	1/4"	1"	2-1/2"	NS-403-08-FL	NS-403-08
5/16"	0.01	5/16"	1-1/8"	2-1/2"	NS-403-10-FL	NS-403-10
3/8"	0.01	3/8"	1-1/4"	3"	NS-403-12-FL	NS-403-12
1/2"	0.01	1/2"	1-1/2"	4"	NS-403-16-FL	NS-403-16
5/8"	0.015	5/8"	1-3/4"	4"	NS-403-20-FL	NS-403-20
3/4"	0.015	3/4"	2"	5"	NS-403-24-FL	NS-403-24
1"	0.02	1"	2-1/2"	6"	NS-403-32-FL	NS-403-32



Tuffy Grade Carbide End Mills **NS/MNS**



Add Flats for High Torque Cuts!

MNS-402 4 Flute Standard Length **METRIC**

AlTiN

Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Flats, AlTiN Coated	Tool Number No Flats, AlTiN Coated
6mm	6mm	14mm	58mm	MNS-402-06-FL	MNS-402-06
8mm	8mm	16mm	64mm	MNS-402-08-FL	MNS-402-08
10mm	10mm	20mm	73mm	MNS-402-10-FL	MNS-402-10
12mm	12mm	25mm	84mm	MNS-402-12-FL	MNS-402-12
16mm	16mm	32mm	93mm	MNS-402-16-FL	MNS-402-16
20mm	20mm	38mm	105mm	MNS-402-20-FL	MNS-402-20
25mm	25mm	45mm	121mm	MNS-402-25-FL	MNS-402-25

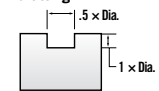
NS SERIES SPEEDS & FEEDS

Material	Surface Footage	3/16"		1/4"		5/16"		3/8"		1/2"		5/8"		3/4"		1"	
		RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
CAST IRON																	
Ductile	400	8149	20	6112	20	4890	24	4075	28	3056	31	2445	28	2037	24	1528	21
Gray	525	10696	42	8022	42	6418	51	5348	58	4011	64	3209	58	2674	51	2006	45
STEEL																	
1018/1020	500	10187	32	7640	32	6112	39	5093	44	3820	49	3056	44	2547	39	1910	34
4130	400	8149	20	6112	20	4890	24	4075	28	3056	31	2445	28	2037	24	1528	21
4140	400	8149	20	6112	20	4890	24	4075	28	3056	31	2445	28	2037	24	1528	21
4340	415	8455	21	6341	21	5073	25	4227	29	3171	32	2536	29	2114	25	1585	22
TOOL STEEL (ANNEALED)																	
A2	400	8149	17	6112	17	4890	22	4075	24	3056	27	2445	24	2037	22	1528	19
D2	360	7334	16	5501	16	4401	19	3667	22	2750	24	2200	22	1834	19	1375	17
H13	400	8149	17	6112	17	4890	22	4075	24	3056	27	2445	24	2037	22	1528	19
P20	400	8149	23	6112	23	4890	28	4075	31	3056	35	2445	31	2037	28	1528	24

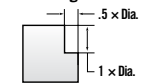
Speeds and feeds are based on applications with very rigid machine tools, toolholders, and fixturing. Speeds and feeds will vary dramatically depending on the application. Extreme forces can be generated and can cause damage, if not appropriate for the cutting conditions.

Helical interpolation or ramping should be used to enter pockets. For the highest material removal rates and longest tool life profile milling is preferred over slotting. (See diagrams below)

Slotting



Profiling



MNS SERIES SPEEDS & FEEDS **METRIC**

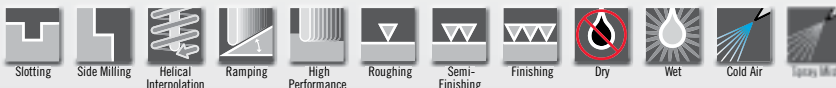
Material	Surface Meters/ min	6mm		8mm		10mm		12mm		16mm		20mm		25mm	
		RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min
CAST IRON															
Ductile	400	6475	505	4851	505	3881	621	3234	699	2426	776	1941	699	1552	543
Gray	525	8498	1060	6367	1060	5094	1304	4245	1467	3184	1630	2547	1467	2038	1141
STEEL															
1018/1020	500	8093	807	6064	807	4851	994	4043	1118	3032	1242	2426	1118	1941	869
4130	400	6475	505	4851	505	3881	621	3234	699	2426	776	1941	699	1552	543
4140	400	6475	505	4851	505	3881	621	3234	699	2426	776	1941	699	1552	543
4340	415	6717	523	5033	523	4027	644	3356	725	2517	805	2013	725	1611	564
TOOL STEEL (ANNEALED)															
A2	400	6475	444	4851	444	3881	546	3234	615	2426	683	1941	615	1552	478
D2	360	5827	400	4366	400	3493	492	2911	553	2183	615	1747	553	1397	430
H13	400	6475	444	4851	444	3881	546	3234	615	2426	683	1941	615	1552	478
P20	400	6475	575	4851	575	3881	708	3234	796	2426	885	1941	796	1552	619

XG/MXG Tuffy Grade Carbide End Mills

Characteristics



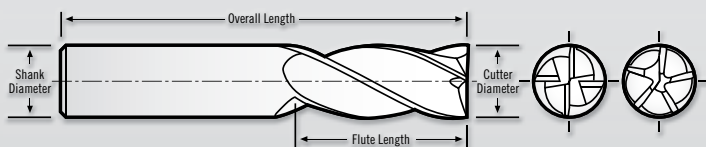
Applications



Materials



Coatings



XG Tolerances

Cutting Dia. = $-.001/-0.002$ "
Shank Dia. = $-.0001/-0.0002$ "
Flute Length = $+0.060/-0.000$ "
OAL = $+/-0.060$ "

MXG Tolerances

Cutting Dia. = $-.025/-0.050$ mm
Shank Dia. = $-.002/-0.005$ mm
Flute Length = $+0.50/+1.50$ mm
OAL = $+/-1.00$ mm

Variable Helix

a ≠ b



Add Flats for High Torque Cuts!

XG-400 4 Flute Stub Length

Cutting Diameter	Corner Radius	Shank Diameter	Flute Length	Overall Length	Tool Number Flats, AITiN Coated	Tool Number No Flats, AITiN Coated
1/4"	.017-.019"	1/4"	3/8"	2-1/2"	XG-400-08-FL	XG-400-08
5/16"	.020-.022"	5/16"	7/16"	2-1/2"	XG-400-10-FL	XG-400-10
3/8"	.023-.025"	3/8"	1/2"	2-1/2"	XG-400-12-FL	XG-400-12
1/2"	.025-.027"	1/2"	5/8"	3"	XG-400-16-FL	XG-400-16
5/8"	.027-.029"	5/8"	3/4"	3-1/2"	XG-400-20-FL	XG-400-20
3/4"	.028-.030"	3/4"	1"	4"	XG-400-24-FL	XG-400-24
1"	.028-.030"	1"	1-1/8"	5"	XG-400-32-FL	XG-400-32

Eliminate Tool Pull Out!

1/4"-5/16" h5 Shank Tolerance
3/8"-1" h4 Shank Tolerance

Tightest in the Industry!

XG-402 4 Flute Standard Length

Cutting Diameter	Corner Radius	Shank Diameter	Flute Length	Overall Length	Tool Number Flats, AITiN Coated	Tool Number No Flats, AITiN Coated
1/4"	.017-.019"	1/4"	3/4"	2-1/2"	XG-402-08-FL	XG-402-08
5/16"	.020-.022"	5/16"	13/16"	2-1/2"	XG-402-10-FL	XG-402-10
3/8"	.023-.025"	3/8"	7/8"	2-1/2"	XG-402-12-FL	XG-402-12
1/2"	.025-.027"	1/2"	1"	3"	XG-402-16-FL	XG-402-16
5/8"	.027-.029"	5/8"	1-1/4"	3-1/2"	XG-402-20-FL	XG-402-20
3/4"	.028-.030"	3/4"	1-1/2"	4"	XG-402-24-FL	XG-402-24
1"	.028-.030"	1"	2"	5"	XG-402-32-FL	XG-402-32



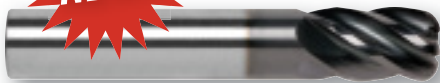
MXG-402 Metric 4 Flute Standard Length

METRIC

Cutting Diameter	Corner Radius	Shank Diameter	Flute Length	Overall Length	Tool Number Flats, AITiN Coated	Tool Number No Flats, AITiN Coated
6mm	.50-.55mm	6mm	14mm	57mm	MXG-402-06-FL	MXG-402-06
8mm	.55-.60mm	8mm	16mm	63mm	MXG-402-08-FL	MXG-402-08
10mm	.60-.65mm	10mm	20mm	72mm	MXG-402-10-FL	MXG-402-10
12mm	.65-.70mm	12mm	25mm	83mm	MXG-402-12-FL	MXG-402-12
16mm	.70-.75mm	16mm	32mm	92mm	MXG-402-16-FL	MXG-402-16
20mm	.90-1.0mm	20mm	38mm	104mm	MXG-402-20-FL	MXG-402-20

NOTE: Metric tools do not have flats.

Tuffy Grade Carbide End Mills **XG/MXG**



Add Flats for High Torque Cuts!



XG-500 5 Flute Stub Length

Cutting Diameter	Corner Radius	Shank Diameter	Flute Length	Overall Length	Tool Number Flats, AlTiN Coated	Tool Number No Flats, AlTiN Coated
1/4"	.017-.019"	1/4"	3/8"	2-1/2"	XG-500-08-FL	XG-500-08
5/16"	.020-.022"	5/16"	7/16"	2-1/2"	XG-500-10-FL	XG-500-10
3/8"	.023-.025"	3/8"	1/2"	2-1/2"	XG-500-12-FL	XG-500-12
1/2"	.025-.027"	1/2"	5/8"	3"	XG-500-16-FL	XG-500-16
5/8"	.027-.029"	5/8"	3/4"	3-1/2"	XG-500-20-FL	XG-500-20
3/4"	.028-.030"	3/4"	1"	4"	XG-500-24-FL	XG-500-24
1"	.028-.030"	1"	1-1/8"	5"	XG-500-32-FL	XG-500-32

XG-502 5 Flute Standard Length

Cutting Diameter	Corner Radius	Shank Diameter	Flute Length	Overall Length	Tool Number Flats, AlTiN Coated	Tool Number No Flats, AlTiN Coated
1/4"	.017-.019"	1/4"	3/4"	2-1/2"	XG-502-08-FL	XG-502-08
5/16"	.020-.022"	5/16"	13/16"	2-1/2"	XG-502-10-FL	XG-502-10
3/8"	.023-.025"	3/8"	7/8"	2-1/2"	XG-502-12-FL	XG-502-12
1/2"	.025-.027"	1/2"	1"	3"	XG-502-16-FL	XG-502-16
5/8"	.027-.029"	5/8"	1-1/4"	3-1/2"	XG-502-20-FL	XG-502-20
3/4"	.028-.030"	3/4"	1-1/2"	4"	XG-502-24-FL	XG-502-24
1"	.028-.030"	1"	2"	5"	XG-502-32-FL	XG-502-32



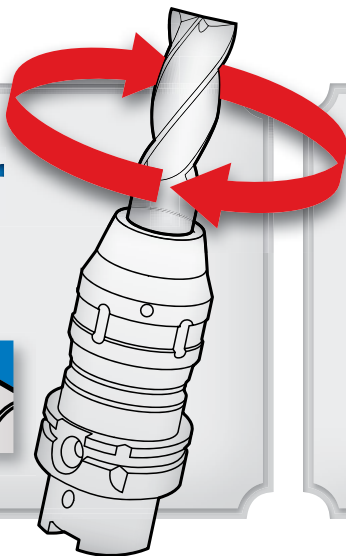
MXG-502 Metric 5 Flute Standard Length **METRIC**

Cutting Diameter	Corner Radius	Shank Diameter	Flute Length	Overall Length	Tool Number Flats, AlTiN Coated	Tool Number No Flats, AlTiN Coated
6mm	.50-.55mm	6mm	14mm	57mm	MXG-502-06-FL	MXG-502-06
8mm	.55-.60mm	8mm	16mm	63mm	MXG-502-08-FL	MXG-502-08
10mm	.60-.65mm	10mm	20mm	72mm	MXG-502-10-FL	MXG-502-10
12mm	.65-.70mm	12mm	25mm	83mm	MXG-502-12-FL	MXG-502-12
16mm	.70-.75mm	16mm	32mm	92mm	MXG-502-16-FL	MXG-502-16
20mm	.90-1.0mm	20mm	38mm	104mm	MXG-502-20-FL	MXG-502-20

NOTE: Metric tools do not have flats.

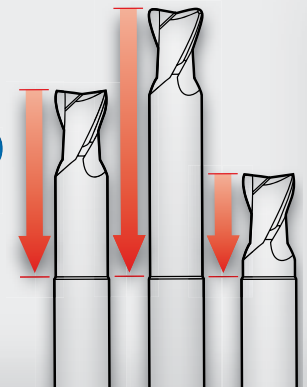
Tool Holder Slippage?

Add Flats! Use shrink fit or equivalent gripping force. If not, use flats.



Need Reach?

See End Mill Modifications (page 14)

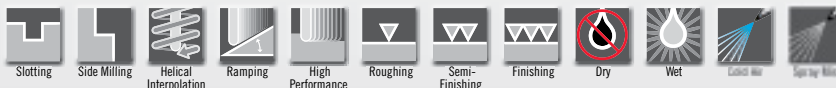


XG/MXG Tuffy Grade Carbide End Mills

Characteristics



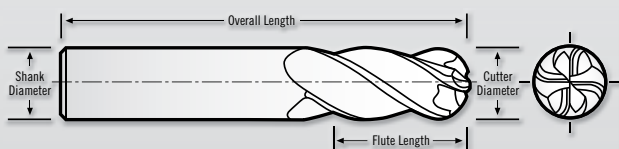
Applications



Materials



Coatings



XG-BN Tolerances

Cutting Dia. = $-.001/-0.002$ "
Shank Dia. = $-.0001/-0.0002$ "
Flute Length = $+0.060/-0.000$ "
OAL = $+/-0.060$ "

MXG-BN Tolerances

Cutting Dia. = $-.025/-0.050$ mm
Shank Dia. = $-.002/-0.005$ mm
Flute Length = $+0.50/+1.50$ mm
OAL = $+/-1.00$ mm



XG-402BN 4 Flute Ball End Standard Length

Cutting Diameter	Corner Radius	Shank Diameter	Flute Length	Overall Length	AITiN	
					Tool Number Flats, AITiN Coated	Tool Number No Flats, AITiN Coated
1/4"	—	1/4"	3/4"	2-1/2"	XG-402-08-BN-FL	XG-402-08-BN
5/16"	—	5/16"	13/16"	2-1/2"	XG-402-10-BN-FL	XG-402-10-BN
3/8"	—	3/8"	7/8"	2-1/2"	XG-402-12-BN-FL	XG-402-12-BN
1/2"	—	1/2"	1"	3"	XG-402-16-BN-FL	XG-402-16-BN
5/8"	—	5/8"	1-1/4"	3-1/2"	XG-402-20-BN-FL	XG-402-20-BN
3/4"	—	3/4"	1-1/2"	4"	XG-402-24-BN-FL	XG-402-24-BN
1"	—	1"	2"	5"	XG-402-32-BN-FL	XG-402-32-BN



MXG-402BN Metric 4 Flute Ball End Standard Length

Cutting Diameter	Corner Radius	Shank Diameter	Flute Length	Overall Length	METRIC	
					Tool Number Flats, AITiN Coated	Tool Number No Flats, AITiN Coated
6mm	—	6mm	14mm	57mm	MXG-402-06-BN-FL	MXG-402-06-BN
8mm	—	8mm	16mm	63mm	MXG-402-08-BN-FL	MXG-402-08-BN
10mm	—	10mm	20mm	72mm	MXG-402-10-BN-FL	MXG-402-10-BN
12mm	—	12mm	25mm	83mm	MXG-402-12-BN-FL	MXG-402-12-BN
16mm	—	16mm	32mm	92mm	MXG-402-16-BN-FL	MXG-402-16-BN
20mm	—	20mm	38mm	104mm	MXG-402-20-BN-FL	MXG-402-20-BN

NOTE: Metric tools do not have flats.

Variable Helix

a ≠ b

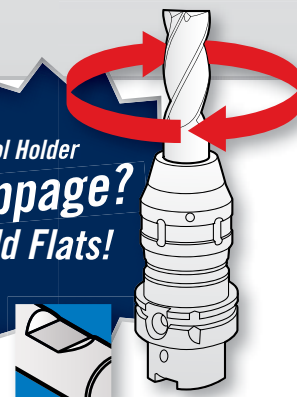
Add Flats for High Torque Cuts!

AITiN

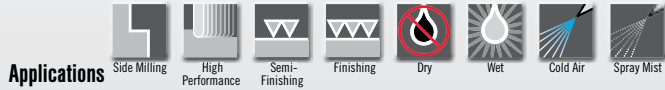
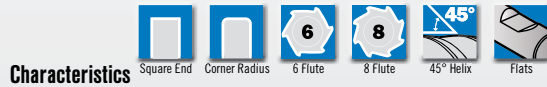
Add Flats for High Torque Cuts!

AITiN

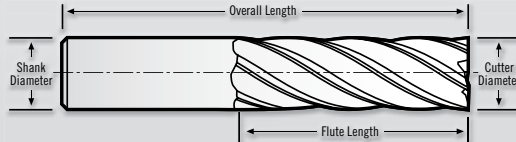
Tool Holder
Slippage?
Add Flats!



Tuffy Grade Carbide End Mills **XF/MXF**



Eliminate Tool Pull Out!
 1/4"-5/16" h5 Shank Tolerance
 3/8"-1" h4 Shank Tolerance
Tightest in the Industry!



XF Tolerances
 Cutting Dia. = $-.001/-0.002$ "
 Shank Dia. = $-.0001/-0.0002$ "
 Flute Length = $+.060/-0.000$ "
 OAL = $+/-0.060$ "

MXF Tolerances
 Cutting Dia. = $-.025/-0.050$ mm
 Shank Dia. = $-.002/-0.005$ mm
 Flute Length = $+0.500/+1.500$ mm
 OAL = ± 1.000 mm



XF-602/802 6/8 Flute Standard Length

Cutting Diameter	Corner Radius	Shank Diameter	Flute Length	Overall Length	Tool Number Flats, AITiN Coated	Tool Number No Flats, AITiN Coated
3/8"	0.030"	3/8"	7/8"	2-1/2"	XF-602-12-030-FL	XF-602-12-030
3/8"	0.060"	3/8"	7/8"	2-1/2"	XF-602-12-060-FL	XF-602-12-060
3/8"	0.090"	3/8"	7/8"	2-1/2"	XF-602-12-090-FL	XF-602-12-090
1/2"	0.030"	1/2"	1"	3"	XF-602-16-030-FL	XF-602-16-030
1/2"	0.060"	1/2"	1"	3"	XF-602-16-060-FL	XF-602-16-060
1/2"	0.090"	1/2"	1"	3"	XF-602-16-090-FL	XF-602-16-090
1/2"	0.120"	1/2"	1"	3"	XF-602-16-120-FL	XF-602-16-120
5/8"	0.030"	5/8"	1-1/4"	3-1/2"	XF-602-20-030-FL	XF-602-20-030
5/8"	0.060"	5/8"	1-1/4"	3-1/2"	XF-602-20-060-FL	XF-602-20-060
5/8"	0.090"	5/8"	1-1/4"	3-1/2"	XF-602-20-090-FL	XF-602-20-090
5/8"	0.120"	5/8"	1-1/4"	3-1/2"	XF-602-20-120-FL	XF-602-20-120
3/4"	0.060"	3/4"	1-1/2"	4"	XF-802-24-060-FL	XF-802-24-060
3/4"	0.090"	3/4"	1-1/2"	4"	XF-802-24-090-FL	XF-802-24-090
3/4"	0.120"	3/4"	1-1/2"	4"	XF-802-24-120-FL	XF-802-24-120
1"	0.060"	1"	2"	5"	XF-802-32-060-FL	XF-802-32-060
1"	0.090"	1"	2"	5"	XF-802-32-090-FL	XF-802-32-090
1"	0.120"	1"	2"	5"	XF-802-32-120-FL	XF-802-32-120

MXF-602/802 6/8 Flute Standard Length **METRIC**

Cutting Diameter	Corner Radius	Shank Diameter	Flute Length	Overall Length	Tool Number Flats, AITiN Coated	Tool Number No Flats, AITiN Coated
10mm	2.0mm	10mm	20mm	72mm	MXF-602-10-020-FL	MXF-602-10-020
10mm	2.5mm	10mm	20mm	72mm	MXF-602-10-025-FL	MXF-602-10-025
10mm	3.0mm	10mm	20mm	72mm	MXF-602-10-030-FL	MXF-602-10-030
12mm	2.0mm	12mm	25mm	83mm	MXF-602-12-020-FL	MXF-602-12-020
12mm	2.5mm	12mm	25mm	83mm	MXF-602-12-025-FL	MXF-602-12-025
12mm	3.0mm	12mm	25mm	83mm	MXF-602-12-030-FL	MXF-602-12-030
16mm	2.0mm	16mm	32mm	92mm	MXF-602-16-020-FL	MXF-602-16-020
16mm	2.5mm	16mm	32mm	92mm	MXF-602-16-025-FL	MXF-602-16-025
16mm	3.0mm	16mm	32mm	92mm	MXF-602-16-030-FL	MXF-602-16-030
20mm	2.0mm	20mm	38mm	104mm	MXF-802-20-020-FL	MXF-802-20-020
20mm	2.5mm	20mm	38mm	104mm	MXF-802-20-025-FL	MXF-802-20-025
20mm	3.0mm	20mm	38mm	104mm	MXF-802-20-030-FL	MXF-802-20-030
25mm	2.0mm	25mm	38mm	104mm	MXF-802-25-020-FL	MXF-802-25-020
25mm	2.5mm	25mm	38mm	104mm	MXF-802-25-025-FL	MXF-802-25-025
25mm	3.0mm	25mm	38mm	104mm	MXF-802-25-030-FL	MXF-802-25-030

NOTE: Metric tools do not have flats.

See New Trochoidal Tool Paths
www.robjack.com/videos

**Cut Titanium up to
 75 inches/minute
 1905 mm/minute**



Eliminate Tool Pull Out!
 6-8mm h5 Shank Tolerances
 10-25mm h4 Shank Tolerances
Tightest in the Industry!



XG/MXG Speeds & Feeds

XG-402 SPEEDS & FEEDS

Material	Surface Feet	1/4"		5/16"		3/8"		1/2"		5/8"		3/4"		1"	
		RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
CAST IRON															
Ductile	400	6112	28	4890	34	4075	39	3056	43	2445	39	2037	34	1528	30
Gray	525	8022	42	6418	51	5348	58	4011	64	3209	58	2674	51	2006	45
INCONEL															
625/718	100	1528	4	1222	5	1019	6	764	7	611	6	509	5	382	5
STEEL															
1018/1020	500	7640	32	6112	39	5093	44	3820	49	3056	44	2547	39	1910	34
4130	400	6112	20	4890	24	4075	28	3056	31	2445	28	2037	24	1528	21
4140	400	6112	20	4890	24	4075	28	3056	31	2445	28	2037	24	1528	21
4340	415	6341	21	5073	25	4227	29	3171	32	2536	29	2114	25	1585	22
STAINLESS STEEL															
303	550	8404	31	6723	38	5603	43	4202	48	3362	43	2801	38	2101	34
304	400	6112	17	4890	22	4075	24	3056	27	2445	24	2037	22	1528	19
316	400	6112	17	4890	22	4075	24	3056	27	2445	24	2037	22	1528	19
15-5/17-4	300	4584	13	3667	16	3056	18	2292	20	1834	18	1528	16	1146	14
13-8	300	4584	13	3667	16	3056	18	2292	20	1834	18	1528	16	1146	14
440C	300	4584	13	3667	16	3056	18	2292	20	1834	18	1528	16	1146	14
TOOL STEEL (ANNEALED)															
A2	400	6112	17	4890	22	4075	24	3056	27	2445	24	2037	22	1528	19
D2	360	5501	16	4401	19	3667	22	2750	24	2200	22	1834	19	1375	17
H13	400	6112	17	4890	22	4075	24	3056	27	2445	24	2037	22	1528	19
P20	400	6112	23	4890	28	4075	31	3056	35	2445	31	2037	28	1528	24
TITANIUM															
Com. pure	300	4584	17	3667	21	3056	24	2292	26	1834	24	1528	21	1146	18
6AL-4V	200	3056	9	2445	11	2037	12	1528	13	1222	12	1019	11	764	9
6AL-6V	175	2674	8	2139	9	1783	11	1337	12	1070	11	891	9	669	8

MXG-402 SPEEDS & FEEDS METRIC

Material	Surface Meters	6 mm		8 mm		10 mm		12 mm		16 mm		20 mm	
		RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min
CAST IRON													
Ductile	122	6475	706	4851	869	3881	978	3235	1087	2426	978	1941	869
Gray	160	8498	1060	6367	1304	5094	1467	4245	1630	3184	1467	2547	1304
INCONEL													
625/718	30	1619	108	1213	134	970	150	809	167	606	150	485	134
STEEL													
1018/1020	152	8093	807	6063	994	4851	1118	4043	1242	3032	1118	2426	994
4130	122	6475	505	4851	621	3881	699	3235	776	2426	699	1941	621
4140	122	6475	505	4851	621	3881	699	3235	776	2426	699	1941	621
4340	126	6717	523	5033	644	4027	725	3356	805	2517	725	2013	644
STAINLESS STEEL													
303	168	8903	791	6670	973	5337	1095	4448	1217	3335	1095	2668	973
304	122	6475	444	4851	546	3881	615	3235	683	2426	615	1941	546
316	122	6475	444	4851	546	3881	615	3235	683	2426	615	1941	546
15-5/17-4	91	4856	333	3638	410	2911	461	2426	512	1819	461	1455	410
13-8	91	4856	333	3638	410	2911	461	2426	512	1819	461	1455	410
440C	91	4856	333	3638	410	2911	461	2426	512	1819	461	1455	410

CONTINUED ON NEXT PAGE—

Speeds & Feeds **MXG/XF**

MXG-402 SPEEDS & FEEDS **METRIC** —CONTINUED FROM PREVIOUS

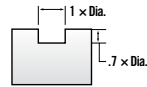
Material	Surface Meters	6 mm		8 mm		10 mm		12 mm		16 mm		20 mm	
		RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min	RPM	mm/min
TOOL STEEL (ANNEALED)													
A2	122	6475	444	4851	546	3881	615	3235	683	2426	615	1941	546
D2	110	5827	400	4366	492	3493	553	2911	615	2183	553	1747	492
H13	122	6475	444	4851	546	3881	615	3235	683	2426	615	1941	546
P20	122	6475	575	4851	708	3881	796	3235	885	2426	796	1941	708
TITANIUM													
Com. pure	91	4856	431	3638	531	2911	597	2426	664	1819	597	1455	531
6AL-4V	61	3237	222	2425	273	1941	307	1617	342	1213	307	970	273
6AL-6V	53	2833	194	2122	239	1698	269	1415	299	1061	269	849	239

General Guidelines for XG-402 and MXG-402

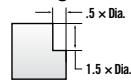
- Speeds and feeds are based on applications with very rigid machine tools, toolholders, and fixturing. Speeds and feeds will vary dramatically depending on the application. Extreme forces can be generated and can cause damage, if not appropriate for the cutting conditions.

- Helical interpolation or ramping should be used to enter pockets.
- For the highest material removal rates and longest tool life profile milling is preferred over slotting (See diagrams at right).
- Use shrink fit or equivalent tool holder. If not, use flats to eliminate slippage in the tool holder!
- Climb milling is recommended.
- For ball end tools reduce feed rate by 10%.

Slotting



Profiling



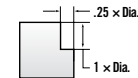
XG-502 AND XF SERIES SPEEDS & FEEDS

Material	Surface Feet	3/8"		1/2"		5/8"		3/4"		1"	
		RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min	RPM	in/min
CAST IRON											
Ductile	400	4075	58	3056	64	2445	58	2037	68	1528	60
Gray	525	5348	86	4011	96	3209	86	2674	102	2006	90
INCONEL											
625/718	150	1528	12	1146	14	917	12	764	16	573	14
STEEL											
1018/1020	500	5093	62	3820	68	3056	62	2547	74	1910	32
4130	400	4075	42	3056	46	2445	42	2037	48	1528	42
4140	400	4075	42	3056	46	2445	42	2037	48	1528	42
4340	415	4227	42	3171	48	2536	42	2114	50	1585	44
STAINLESS STEEL											
303	550	5603	62	4202	68	3362	62	2801	72	2101	64
304	400	4075	36	3056	40	2445	36	2037	44	1528	38
316	400	4075	36	3056	40	2445	36	2037	44	1528	38
15-5/17-4	300	3056	28	2292	30	1834	28	1528	32	1146	28
13-8	300	3056	28	2292	30	1834	28	1528	32	1146	28
440C	300	3056	28	2292	30	1834	28	1528	32	1146	28
TOOL STEEL (ANNEALED)											
A2	400	4075	36	3056	40	2445	36	2037	44	1528	38
D2	360	3667	32	2750	36	2200	32	1834	38	1375	34
H13	400	4075	36	3056	40	2445	36	2037	44	1528	38
P20	400	4075	44	3056	50	2445	44	2037	52	1528	46
TITANIUM											
Com. pure	300	3056	34	2292	38	1834	34	1528	40	1146	34
6AL-4V	380	3871	42	2903	48	2323	42	1935	50	1452	44
6AL-6V	175	1783	20	1337	22	1070	20	891	24	669	20

XF Finish Profiling

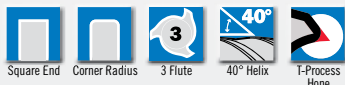


XG-502 Profiling

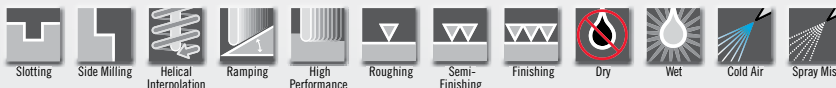


ST/MST Super Tuffy Grade Carbide End Mills

Characteristics



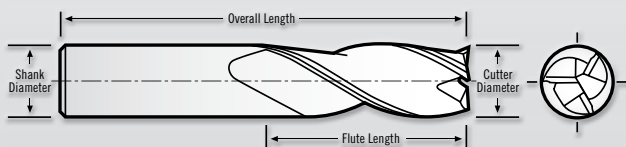
Applications



Materials



Coatings



ST-341 and ST-343 Tolerances

Cutting Dia. (1/8" to 1/4") = $+0.000/-0.002$ "
 (5/16" to 3/4") = $+0.000/-0.003$ "
 Shank Dia. = $-0.0001/-0.0002$ "
 Flute Length (1/8" to 5/16") = $+0.030/-0.000$ "
 (3/8" to 3/4") = $+0.060/-0.000$ "
 OAL = ± 0.060 "

MST-341 Tolerances

Cutting Dia. = $+0.000/-0.075$ mm
 Shank Dia. = $-0.002/-0.005$ mm
 Flute Length = $+0.500/+1.500$ mm
 OAL = ± 1.000 mm



**HONED
EDGE!**

ST-341 3 Flute Super Tuffy Carbide Stub Length



Cutting Diameter	Shank Diameter	Flute Length	Corner Break Size	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/8"	1/8"	1/4"	.003"/.005"	1-1/2"	ST-341-04	ST-341-04-T	ST-341-04-C	ST-341-04-A
3/16"	3/16"	3/8"	.003"/.005"	2"	ST-341-06	ST-341-06-T	ST-341-06-C	ST-341-06-A
1/4"	1/4"	1/2"	.003"/.005"	2-1/2"	ST-341-08	ST-341-08-T	ST-341-08-C	ST-341-08-A
5/16"	5/16"	1/2"	.004"/.006"	2-1/2"	ST-341-10	ST-341-10-T	ST-341-10-C	ST-341-10-A
3/8"	3/8"	5/8"	.005"/.007"	2-1/2"	ST-341-12	ST-341-12-T	ST-341-12-C	ST-341-12-A
1/2"	1/2"	5/8"	.006"/.009"	3"	ST-341-16	ST-341-16-T	ST-341-16-C	ST-341-16-A
5/8"	5/8"	3/4"	.009"/.011"	3-1/2"	ST-341-20	ST-341-20-T	ST-341-20-C	ST-341-20-A
3/4"	3/4"	1"	.011"/.014"	4"	ST-341-24	ST-341-24-T	ST-341-24-C	ST-341-24-A



MST-341 Metric 3 Flute Super Tuffy Carbide Stub Length METRIC



Cutting Diameter	Shank Diameter	Flute Length	Corner Break Size	Overall Length	Tool Number Uncoated	Tool Number Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
3mm	3mm	6mm	.075/.125mm	38mm	MST-341-03	MST-341-03-T	MST-341-03-C	MST-341-03-A
4mm	4mm	8mm	.075/.125mm	50mm	MST-341-04	MST-341-04-T	MST-341-04-C	MST-341-04-A
5mm	5mm	8mm	.075/.125mm	50mm	MST-341-05	MST-341-05-T	MST-341-05-C	MST-341-05-A
6mm	6mm	8mm	.075/.125mm	57mm	MST-341-06	MST-341-06-T	MST-341-06-C	MST-341-06-A
8mm	8mm	12mm	.100/.150mm	63mm	MST-341-08	MST-341-08-T	MST-341-08-C	MST-341-08-A
10mm	10mm	14mm	.125/.175mm	72mm	MST-341-10	MST-341-10-T	MST-341-10-C	MST-341-10-A
12mm	12mm	16mm	.150/.130mm	83mm	MST-341-12	MST-341-12-T	MST-341-12-C	MST-341-12-A
16mm	16mm	20mm	.230/.280mm	92mm	MST-341-16	MST-341-16-T	MST-341-16-C	MST-341-16-A
20mm	20mm	25mm	.280/.360mm	104mm	MST-341-20	MST-341-20-T	MST-341-20-C	MST-341-20-A

Super Tuffy Grade Carbide End Mills **ST**

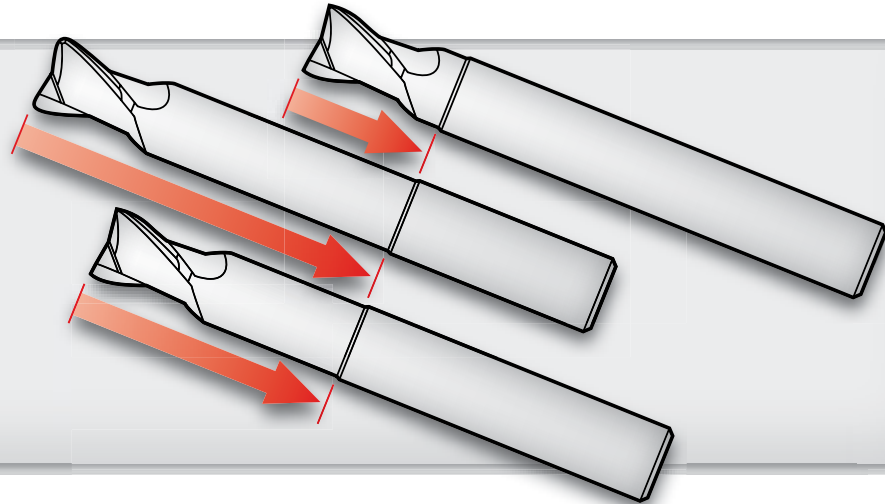


ST-343 3 Flute Super Tuffy Carbide Standard Length

Cutting Diameter	Shank Diameter	Flute Length	Corner Break Size	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/8"	1/8"	1/2"	.003"/.005"	1-1/2"	ST-343-04	ST-343-04-T	ST-343-04-C	ST-343-04-A
3/16"	3/16"	5/8"	.003"/.005"	2"	ST-343-06	ST-343-06-T	ST-343-06-C	ST-343-06-A
1/4"	1/4"	3/4"	.003"/.005"	2-1/2"	ST-343-08	ST-343-08-T	ST-343-08-C	ST-343-08-A
5/16"	5/16"	13/16"	.004"/.006"	2-1/2"	ST-343-10	ST-343-10-T	ST-343-10-C	ST-343-10-A
3/8"	3/8"	7/8"	.005"/.007"	2-1/2"	ST-343-12	ST-343-12-T	ST-343-12-C	ST-343-12-A
1/2"	1/2"	1"	.006"/.009"	3"	ST-343-16	ST-343-16-T	ST-343-16-C	ST-343-16-A
5/8"	5/8"	1-1/4"	.009"/.011"	3-1/2"	ST-343-20	ST-343-20-T	ST-343-20-C	ST-343-20-A
3/4"	3/4"	1-1/2"	.011"/.014"	4"	ST-343-24	ST-343-24-T	ST-343-24-C	ST-343-24-A

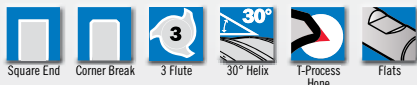
Need Reach?

See End Mill
Modifications (page 14)

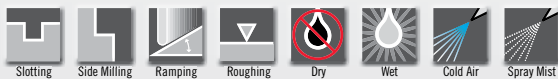


STR/MSTR 3 Flute Super Tuffy Grade Carbide Ruffers

Characteristics



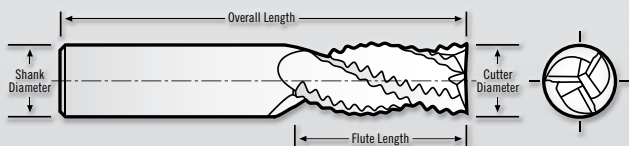
Applications



Materials



Coatings



STR Series Tolerances

Cutting Dia. = $-.003/-0.007$ "
 Shank Dia. = $-.0001/-0.0002$ "
 Flute Length (1/4" to 5/16") = $+.030/-0.000$ "
 (3/8" to 3/4") = $+.060/-0.000$ "
 OAL = $\pm .060$ "

MSTR Tolerances

Cutting Dia. = $-.075/-0.180$ mm
 Shank Dia. = $-.002/-0.005$ mm
 Flute Length = $+0.500/+1.500$ mm
 OAL = ± 1.000 mm



**HONED
EDGE!**

STR-301 3 Flute Super Tuffy Carbide Ruffer Stub Length



Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/4"	1/4"	1/2"	2-1/2"	STR-301-08*	STR-301-08-T*	STR-301-08-C*	STR-301-08-A*
5/16"	5/16"	1/2"	2-1/2"	STR-301-10*	STR-301-10-T*	STR-301-10-C*	STR-301-10-A*
3/8"	3/8"	5/8"	2-1/2"	STR-301-12	STR-301-12-T	STR-301-12-C	STR-301-12-A
7/16"	7/16"	5/8"	2-3/4"	STR-301-14*	STR-301-14-T*	STR-301-14-C*	STR-301-14-A*
1/2"	1/2"	5/8"	3"	STR-301-16	STR-301-16-T	STR-301-16-C	STR-301-16-A
5/8"	5/8"	7/8"	3-1/2"	STR-301-20	STR-301-20-T	STR-301-20-C	STR-301-20-A
3/4"	3/4"	1"	4"	STR-301-24	STR-301-24-T	STR-301-24-C	STR-301-24-A

*Does not come with flats.



MSTR-301 3 Flute Super Tuffy Carbide Ruffer Stub Length

METRIC



Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
6mm	6mm	8mm	57mm	MSTR-301-06	MSTR-301-06-T	MSTR-301-06-C	MSTR-301-06-A
8mm	8mm	12mm	63mm	MSTR-301-08	MSTR-301-08-T	MSTR-301-08-C	MSTR-301-08-A
10mm	10mm	14mm	72mm	MSTR-301-10	MSTR-301-10-T	MSTR-301-10-C	MSTR-301-10-A
12mm	12mm	16mm	83mm	MSTR-301-12	MSTR-301-12-T	MSTR-301-12-C	MSTR-301-12-A
16mm	16mm	20mm	92mm	MSTR-301-16	MSTR-301-16-T	MSTR-301-16-C	MSTR-301-16-A
20mm	20mm	25mm	104mm	MSTR-301-20	MSTR-301-20-T	MSTR-301-20-C	MSTR-301-20-A

NOTE: Metric tools do not have flats.

3 Flute Super Tuffy Grade Carbide Ruffers **STR/MSTR**



STR-303 3 Flute Super Tuffy Carbide Ruffer Standard Length

Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number Coated
1/4"	1/4"	3/4"	2-1/2"	STR-303-08*	STR-303-08-T*	STR-303-08-C*	STR-303-08-A*
9/32"	5/16"	3/4"	2-1/2"	STR-303-09*	STR-303-09-T*	STR-303-09-C*	STR-303-09-A*
5/16"	5/16"	13/16"	2-1/2"	STR-303-10*	STR-303-10-T*	STR-303-10-C*	STR-303-10-A*
3/8"	3/8"	7/8"	2-1/2"	STR-303-12	STR-303-12-T	STR-303-12-C	STR-303-12-A
7/16"	7/16"	1"	2-3/4"	STR-303-14*	STR-303-14-T*	STR-303-14-C*	STR-303-14-A*
1/2"	1/2"	1"	3"	STR-303-16	STR-303-16-T	STR-303-16-C	STR-303-16-A
9/16"	9/16"	1-1/4"	3-1/2"	STR-303-18*	STR-303-18-T*	STR-303-18-C*	STR-303-18-A*
5/8"	5/8"	1-1/4"	3-1/2"	STR-303-20	STR-303-20-T	STR-303-20-C	STR-303-20-A
3/4"	3/4"	1-1/2"	4"	STR-303-24	STR-303-24-T	STR-303-24-C	STR-303-24-A
1"	1"	2-1/2"	5"	STR-303-32	STR-303-32-T	STR-303-32-C	STR-303-32-A

*Does not come with flats.



MSTR-303 Flute Super Tuffy Carbide Ruffer Standard Length

METRIC



Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
6mm	6mm	14mm	57mm	MSTR-303-06	MSTR-303-06-T	MSTR-303-06-C	MSTR-303-06-A
8mm	8mm	16mm	63mm	MSTR-303-08	MSTR-303-08-T	MSTR-303-08-C	MSTR-303-08-A
10mm	10mm	20mm	72mm	MSTR-303-10	MSTR-303-10-T	MSTR-303-10-C	MSTR-303-10-A
12mm	12mm	25mm	83mm	MSTR-303-12	MSTR-303-12-T	MSTR-303-12-C	MSTR-303-12-A
16mm	16mm	32mm	92mm	MSTR-303-16	MSTR-303-16-T	MSTR-303-16-C	MSTR-303-16-A
20mm	20mm	38mm	104mm	MSTR-303-20	MSTR-303-20-T	MSTR-303-20-C	MSTR-303-20-A

NOTE: Metric tools do not have flats.

Need Without Flats?

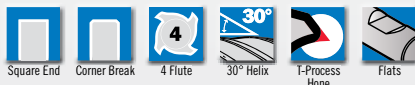
Order any tool without flats by adding
"-NF" to end of Tool Number!

NOTE: Metric sizes do not come with flats.



STR/MSTR 4 Flute Super Tuffy Grade Carbide Ruffers

Characteristics



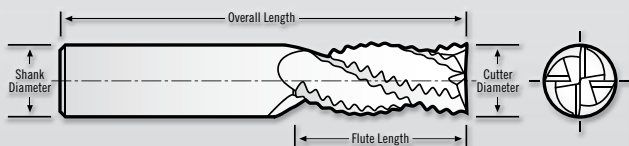
Applications



Materials



Coatings



STR Series Tolerances

Cutting Dia. = $-.003/-0.007$ "
 Shank Dia. = $-.0001/-0.0002$ "
 Flute Length (1/4" to 5/16") = $+.030/-0.000$ "
 (3/8" to 3/4") = $+.060/-0.000$ "
 OAL = ± 0.060 "

MSTR Tolerances

Cutting Dia. = $-.075/-0.180$ mm
 Shank Dia. = $-.002/-0.005$ mm
 Flute Length = $+0.500/+1.500$ mm
 OAL = ± 1.000 mm



STR-401 4 Flute Super Tuffy Carbide Ruffer Stub Length



Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/4"	1/4"	1/2"	2-1/2"	STR-401-08*	STR-401-08-T*	STR-401-08-C*	STR-401-08-A*
5/16"	5/16"	1/2"	2-1/2"	STR-401-10*	STR-401-10-T*	STR-401-10-C*	STR-401-10-A*
3/8"	3/8"	5/8"	2-1/2"	STR-401-12	STR-401-12-T	STR-401-12-C	STR-401-12-A
7/16"	7/16"	5/8"	2-3/4"	STR-401-14*	STR-401-14-T*	STR-401-14-C*	STR-401-14-A*
1/2"	1/2"	5/8"	3"	STR-401-16	STR-401-16-T	STR-401-16-C	STR-401-16-A
5/8"	5/8"	7/8"	3-1/2"	STR-401-20	STR-401-20-T	STR-401-20-C	STR-401-20-A
3/4"	3/4"	1"	4"	STR-401-24	STR-401-24-T	STR-401-24-C	STR-401-24-A
1"	1"	1-1/2"	5"	STR-401-32	STR-401-32-T	STR-401-32-C	STR-401-32-A

*Does not come with flats.



MSTR-401 4 Flute Super Tuffy Carbide Ruffer Stub Length

METRIC



Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
6mm	6mm	8mm	57mm	MSTR-401-06	MSTR-401-06-T	MSTR-401-06-C	MSTR-401-06-A
8mm	8mm	12mm	63mm	MSTR-401-08	MSTR-401-08-T	MSTR-401-08-C	MSTR-401-08-A
10mm	10mm	14mm	72mm	MSTR-401-10	MSTR-401-10-T	MSTR-401-10-C	MSTR-401-10-A
12mm	12mm	16mm	83mm	MSTR-401-12	MSTR-401-12-T	MSTR-401-12-C	MSTR-401-12-A
16mm	16mm	20mm	92mm	MSTR-401-16	MSTR-401-16-T	MSTR-401-16-C	MSTR-401-16-A
20mm	20mm	25mm	104mm	MSTR-401-20	MSTR-401-20-T	MSTR-401-20-C	MSTR-401-20-A

NOTE: Metric tools do not have flats.

4 Flute Super Tuffy Grade Carbide Ruffers **STR/MSTR**



STR-404 4 Flute Super Tuffy Carbide Ruffer Standard Length

Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/4"	1/4"	3/4"	2-1/2"	STR-404-08*	STR-404-08-T*	STR-404-08-C*	STR-404-08-A*
9/32"	5/16"	3/4"	2-1/2"	STR-404-09*	STR-404-09-T*	STR-404-09-C*	STR-404-09-A*
5/16"	5/16"	13/16"	2-1/2"	STR-404-10*	STR-404-10-T*	STR-404-10-C*	STR-404-10-A*
3/8"	3/8"	7/8"	2-1/2"	STR-404-12	STR-404-12-T	STR-404-12-C	STR-404-12-A
7/16"	7/16"	1"	2-3/4"	STR-404-14*	STR-404-14-T*	STR-404-14-C*	STR-404-14-A*
1/2"	1/2"	1"	3"	STR-404-16	STR-404-16-T	STR-404-16-C	STR-404-16-A
9/16"	9/16"	1-1/4"	3-1/2"	STR-404-18*	STR-404-18-T*	STR-404-18-C*	STR-404-18-A*
5/8"	5/8"	1-1/4"	3-1/2"	STR-404-20	STR-404-20-T	STR-404-20-C	STR-404-20-A
3/4"	3/4"	1-1/2"	4"	STR-404-24	STR-404-24-T	STR-404-24-C	STR-404-24-A
1"	1"	2-1/2"	5"	STR-404-32	STR-404-32-T	STR-404-32-C	STR-404-32-A

*Does not come with flats.



MSTR-404 4 Flute Super Tuffy Carbide Ruffer Standard Length

METRIC



Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
6mm	6mm	14mm	57mm	MSTR-404-06	MSTR-404-06-T	MSTR-404-06-C	MSTR-404-06-A
8mm	8mm	16mm	63mm	MSTR-404-08	MSTR-404-08-T	MSTR-404-08-C	MSTR-404-08-A
10mm	10mm	20mm	72mm	MSTR-404-10	MSTR-404-10-T	MSTR-404-10-C	MSTR-404-10-A
12mm	12mm	25mm	83mm	MSTR-404-12	MSTR-404-12-T	MSTR-404-12-C	MSTR-404-12-A
16mm	16mm	32mm	92mm	MSTR-404-16	MSTR-404-16-T	MSTR-404-16-C	MSTR-404-16-A
20mm	20mm	38mm	104mm	MSTR-404-20	MSTR-404-20-T	MSTR-404-20-C	MSTR-404-20-A

NOTE: Metric tools do not have flats.

Need Without Flats?

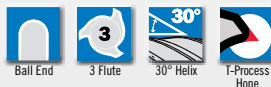
Order any tool without flats by adding
"-NF" to end of Tool Number!

NOTE: Metric sizes do not come with flats.

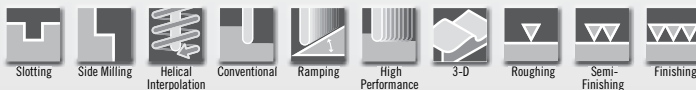


B 3 Flute Tuffy Grade Carbide Ball End Mills

Characteristics



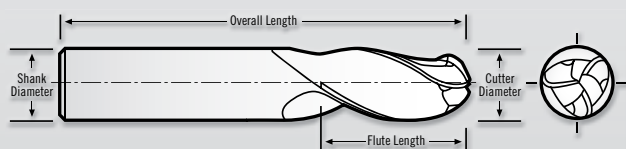
Applications



Materials



Coatings



B Series Tolerances

Cutting Dia. (1/16" to 1/4") = $\pm .000/- .002$
 (9/32" to 3/4") = $\pm .000/- .003$
 Shank Dia. = $\pm .0001/- .0002$
 Flute Length (1/16" to 5/16") = $\pm .030/- .000$
 (3/8" to 1") = $\pm .060/- .000$
 OAL = $\pm .060$ "



**HONED
EDGE!**



B-300 3 Flute Tuffy Ball End Stub Length

Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/8"	1/8"	1/4"	1-1/2"	B-300-04	B-300-04-T	B-300-04-C	B-300-04-A
3/16"	3/16"	5/16"	2"	B-300-06	B-300-06-T	B-300-06-C	B-300-06-A
1/4"	1/4"	5/16"	2-1/2"	B-300-08	B-300-08-T	B-300-08-C	B-300-08-A
5/16"	5/16"	7/16"	2-1/2"	B-300-10	B-300-10-T	B-300-10-C	B-300-10-A
3/8"	3/8"	1/2"	2-1/2"	B-300-12	B-300-12-T	B-300-12-C	B-300-12-A
1/2"	1/2"	5/8"	3"	B-300-16	B-300-16-T	B-300-16-C	B-300-16-A
5/8"	5/8"	7/8"	3-1/2"	B-300-20	B-300-20-T	B-300-20-C	B-300-20-A
3/4"	3/4"	1"	4"	B-300-24	B-300-24-T	B-300-24-C	B-300-24-A



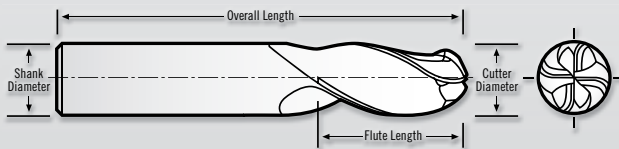
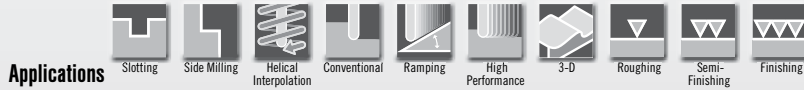
**HONED
EDGE!**



B-330 3 Flute Tuffy Ball End Standard Length

Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/8"	1/8"	1/2"	1-1/2"	B-330-04	B-330-04-T	B-330-04-C	B-330-04-A
3/16"	3/16"	5/8"	2"	B-330-06	B-330-06-T	B-330-06-C	B-330-06-A
1/4"	1/4"	3/4"	2-1/2"	B-330-08	B-330-08-T	B-330-08-C	B-330-08-A
5/16"	5/16"	13/16"	2-1/2"	B-330-10	B-330-10-T	B-330-10-C	B-330-10-A
3/8"	3/8"	7/8"	2-1/2"	B-330-12	B-330-12-T	B-330-12-C	B-330-12-A
1/2"	1/2"	1"	3"	B-330-16	B-330-16-T	B-330-16-C	B-330-16-A
5/8"	5/8"	1-1/4"	3-1/2"	B-330-20	B-330-20-T	B-330-20-C	B-330-20-A
3/4"	3/4"	1-1/2"	4"	B-330-24	B-330-24-T	B-330-24-C	B-330-24-A

4 Flute Tuffy Grade Carbide Ball End Mills **B/MB**



B Series Tolerances

Cutting Dia. (1/16" to 1/4") = $+0.000/-0.002$ "
 (9/32" to 3/4") = $+0.000/-0.003$ "
 Shank Dia. = $-0.0001/-0.0002$ "
 Flute Length (1/16" to 5/16") = $+0.030/-0.000$ "
 (3/8" to 1") = $+0.060/-0.000$ "
 OAL = ± 0.060 "

MB Tolerances

Cutting Dia. = $+0.000/-0.075$ mm
 Shank Dia. = $-0.002/-0.005$ mm
 Flute Length = $+0.500/+1.500$ mm
 OAL = ± 1.000 mm



B-440 4 Flute Tuffy Ball End Standard Length 40° Helix



Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/8"	1/8"	1/2"	1-1/2"	B-440-04	B-440-04-T	B-440-04-C	B-440-04-A
3/16"	3/16"	5/8"	2"	B-440-06	B-440-06-T	B-440-06-C	B-440-06-A
1/4"	1/4"	3/4"	2-1/2"	B-440-08	B-440-08-T	B-440-08-C	B-440-08-A
5/16"	5/16"	13/16"	2-1/2"	B-440-10	B-440-10-T	B-440-10-C	B-440-10-A
3/8"	3/8"	7/8"	2-1/2"	B-440-12	B-440-12-T	B-440-12-C	B-440-12-A
1/2"	1/2"	1"	3"	B-440-16	B-440-16-T	B-440-16-C	B-440-16-A
5/8"	5/8"	1-1/4"	3-1/2"	B-440-20	B-440-20-T	B-440-20-C	B-440-20-A
3/4"	3/4"	1-1/2"	4"	B-440-24	B-440-24-T	B-440-24-C	B-440-24-A



MB-440

4 Flute Tuffy Ball End Standard Length 40° Helix **METRIC**



Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
3mm	3mm	12mm	38mm	MB-440-03	MB-440-03-T	MB-440-03-C	MB-440-03-A
4mm	4mm	12mm	50mm	MB-440-04	MB-440-04-T	MB-440-04-C	MB-440-04-A
5mm	5mm	14mm	50mm	MB-440-05	MB-440-05-T	MB-440-05-C	MB-440-05-A
6mm	6mm	14mm	57mm	MB-440-06	MB-440-06-T	MB-440-06-C	MB-440-06-A
8mm	8mm	16mm	63mm	MB-440-08	MB-440-08-T	MB-440-08-C	MB-440-08-A
10mm	10mm	20mm	72mm	MB-440-10	MB-440-10-T	MB-440-10-C	MB-440-10-A
12mm	12mm	25mm	83mm	MB-440-12	MB-440-12-T	MB-440-12-C	MB-440-12-A
16mm	16mm	32mm	92mm	MB-440-16	MB-440-16-T	MB-440-16-C	MB-440-16-A
20mm	20mm	38mm	104mm	MB-440-20	MB-440-20-T	MB-440-20-C	MB-440-20-A

ST/MST 3 Flute Super Tuffy Grade Carbide End Mills

Characteristics



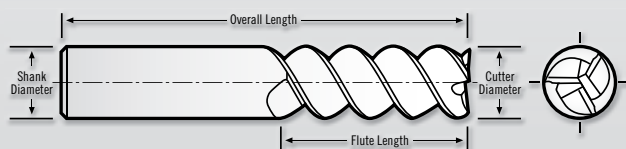
Applications



Materials



Coatings



ST-360 Tolerances

Cutting Dia. = $+0.000/-0.003$ "
 Shank Dia. = $-0.0001/-0.0002$ "
 Flute Length (1/8" to 1/4") = $+0.030/-0.002$ "
 (5/16" to 3/4") = $+0.060/-0.003$ "
 OAL = ± 0.060 "

MST-360 Tolerances

Cutting Dia. = $+0.000/-0.075$ mm
 Shank Dia. = $-0.002/-0.005$ mm
 Flute Length = $+0.500/+1.500$ mm
 OAL = ± 1.000 mm



ST-360 3 Flute Super Tuffy Carbide Standard Length

Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/8"	1/8"	1/2"	1-1/2"	ST-360-04	ST-360-04-T	ST-360-04-C	ST-360-04-A
3/16"	3/16"	5/8"	2"	ST-360-06	ST-360-06-T	ST-360-06-C	ST-360-06-A
1/4"	1/4"	3/4"	2-1/2"	ST-360-08	ST-360-08-T	ST-360-08-C	ST-360-08-A
5/16"	5/16"	13/16"	2-1/2"	ST-360-10	ST-360-10-T	ST-360-10-C	ST-360-10-A
3/8"	3/8"	7/8"	2-1/2"	ST-360-12	ST-360-12-T	ST-360-12-C	ST-360-12-A
7/16"	7/16"	1"	2-3/4"	ST-360-14	ST-360-14-T	ST-360-14-C	ST-360-14-A
1/2"	1/2"	1"	3"	ST-360-16	ST-360-16-T	ST-360-16-C	ST-360-16-A
9/16"	9/16"	1-1/4"	3-1/2"	ST-360-18	ST-360-18-T	ST-360-18-C	ST-360-18-A
5/8"	5/8"	1-1/4"	3-1/2"	ST-360-20	ST-360-20-T	ST-360-20-C	ST-360-20-A
3/4"	3/4"	1-1/2"	4"	ST-360-24	ST-360-24-T	ST-360-24-C	ST-360-24-A



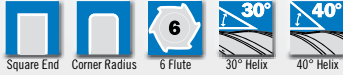
MST-360 3 Flute Super Tuffy Carbide Standard Length

METRIC

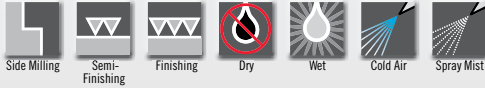
Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
3mm	3mm	12mm	38mm	MST-360-03	MST-360-03-T	MST-360-03-C	MST-360-03-A
4mm	4mm	12mm	50mm	MST-360-04	MST-360-04-T	MST-360-04-C	MST-360-04-A
5mm	5mm	14mm	50mm	MST-360-05	MST-360-05-T	MST-360-05-C	MST-360-05-A
6mm	6mm	14mm	57mm	MST-360-06	MST-360-06-T	MST-360-06-C	MST-360-06-A
8mm	8mm	16mm	63mm	MST-360-08	MST-360-08-T	MST-360-08-C	MST-360-08-A
10mm	10mm	20mm	72mm	MST-360-10	MST-360-10-T	MST-360-10-C	MST-360-10-A
12mm	12mm	25mm	83mm	MST-360-12	MST-360-12-T	MST-360-12-C	MST-360-12-A
16mm	16mm	32mm	92mm	MST-360-16	MST-360-16-T	MST-360-16-C	MST-360-16-A
20mm	20mm	38mm	104mm	MST-360-20	MST-360-20-T	MST-360-20-C	MST-360-20-A

6 Flute Super Tuffy Grade Carbide End Mills **ST/MST**

Characteristics



Applications



Materials

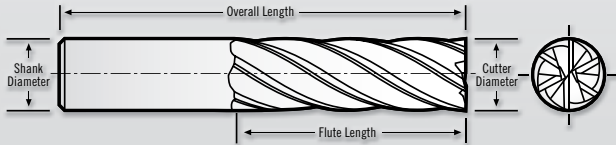


Coatings



Available with
Coolant Grooves

See Page 13



ST-630/ST-646 Tolerances

Cutting Dia. = $+0.001/-0.000$ "
Shank Dia. = $-0.0001/-0.0002$ "
Flute Length = $+0.060/-0.000$ "
OAL = ± 0.060 "

MST-646 Tolerances

Cutting Dia. = $+0.025/-0.000$ mm
Shank Dia. = $-0.002/-0.005$ mm
Flute Length = $+0.500/+1.500$ mm
OAL = ± 1.000 mm



+ Tolerances

Honed Radius



ST-646 6 Flute Super Tuffy Carbide Standard Length

Cutting Diameter	Shank Diameter	Flute Length	Corner Radius	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
3/8"	3/8"	7/8"	.005"/.007"	2-1/2"	ST-646-12	ST-646-12-T	ST-646-12-C	ST-646-12-A
1/2"	1/2"	1"	.006"/.009"	3"	ST-646-16	ST-646-16-T	ST-646-16-C	ST-646-16-A
5/8"	5/8"	1-1/4"	.009"/.011"	3-1/2"	ST-646-20	ST-646-20-T	ST-646-20-C	ST-646-20-A
3/4"	3/4"	1-1/2"	.011"/.014"	4"	ST-646-24	ST-646-24-T	ST-646-24-C	ST-646-24-A
1"	1"	2-1/2"	.012"/.015"	5"	ST-646-32	ST-646-32-T	ST-646-32-C	ST-646-32-A



MST-646 6 Flute Super Tuffy Carbide Standard Length **METRIC**

Cutting Diameter	Shank Diameter	Flute Length	Corner Radius	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
10mm	10mm	20mm	.125/.180mm	72mm	MST-646-10	MST-646-10-T	MST-646-10-C	MST-646-10-A
12mm	12mm	25mm	.150/.230mm	83mm	MST-646-12	MST-646-12-T	MST-646-12-C	MST-646-12-A
16mm	16mm	32mm	.230/.280mm	92mm	MST-646-16	MST-646-16-T	MST-646-16-C	MST-646-16-A
20mm	20mm	38mm	.280/.355mm	104mm	MST-646-20	MST-646-20-T	MST-646-20-C	MST-646-20-A



+ Tolerances



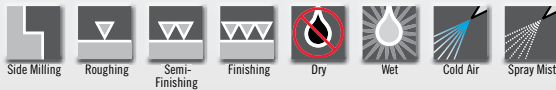
ST-630 6 Flute Super Tuffy Carbide Standard Length

Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
3/8"	3/8"	7/8"	2-1/2"	ST-630-12	ST-630-12-T	ST-630-12-C	ST-630-12-A
1/2"	1/2"	1"	3"	ST-630-16	ST-630-16-T	ST-630-16-C	ST-630-16-A
5/8"	5/8"	1-1/4"	3-1/2"	ST-630-20	ST-630-20-T	ST-630-20-C	ST-630-20-A
3/4"	3/4"	1-1/2"	4"	ST-630-24	ST-630-24-T	ST-630-24-C	ST-630-24-A
1"	1"	2-1/2"	5"	ST-630-32	ST-630-32-T	ST-630-32-C	ST-630-32-A

ST/MST 4 Flute Super Tuffy Grade Carbide End Mills



Characteristics



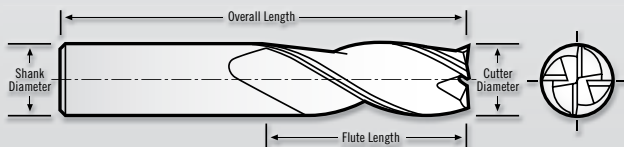
Applications



Materials



Coatings



ST-430/434 Tolerances

Cutting Dia. = $\pm .001/- .000$ "

Shank Dia. = $- .0001/- .0002$ "

Flute Length (1/8" to 5/16") = $\pm .030/- .000$ "
(3/8" to 1") = $\pm .060/- .000$ "

OAL = $\pm .060$ "

MST-430 and MST-434 Tolerances

Cutting Dia. = $\pm .025/- .000$ mm

Shank Dia. = $- .002/- .005$ mm

Flute Length = $\pm 0.500/\pm 1.500$ mm
OAL = ± 1.000 mm



ST-430 4 Flute Super Tuffy Carbide Standard Length



Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/8"	1/8"	1/2"	1-1/2"	ST-430-04	ST-430-04-T	ST-430-04-C	ST-430-04-A
5/32"	3/16"	9/16"	2"	ST-430-05	ST-430-05-T	ST-430-05-C	ST-430-05-A
3/16"	3/16"	5/8"	2"	ST-430-06	ST-430-06-T	ST-430-06-C	ST-430-06-A
7/32"	1/4"	5/8"	2-1/2"	ST-430-07	ST-430-07-T	ST-430-07-C	ST-430-07-A
1/4"	1/4"	3/4"	2-1/2"	ST-430-08	ST-430-08-T	ST-430-08-C	ST-430-08-A
9/32"	5/16"	3/4"	2-1/2"	ST-430-09	ST-430-09-T	ST-430-09-C	ST-430-09-A
5/16"	5/16"	13/16"	2-1/2"	ST-430-10	ST-430-10-T	ST-430-10-C	ST-430-10-A
3/8"	3/8"	7/8"	2-1/2"	ST-430-12	ST-430-12-T	ST-430-12-C	ST-430-12-A
7/16"	7/16"	1"	2-3/4"	ST-430-14	ST-430-14-T	ST-430-14-C	ST-430-14-A
1/2"	1/2"	1"	3"	ST-430-16	ST-430-16-T	ST-430-16-C	ST-430-16-A
9/16"	9/16"	1-1/4"	3-1/2"	ST-430-18	ST-430-18-T	ST-430-18-C	ST-430-18-A
5/8"	5/8"	1-1/4"	3-1/2"	ST-430-20	ST-430-20-T	ST-430-20-C	ST-430-20-A
3/4"	3/4"	1-1/2"	4"	ST-430-24	ST-430-24-T	ST-430-24-C	ST-430-24-A

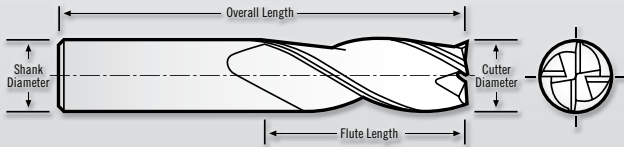
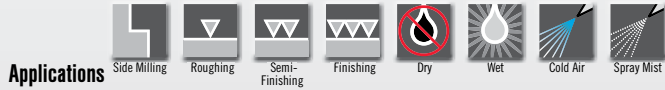


MST-430 4 Flute Super Tuffy Carbide Standard Length METRIC



Cutting Diameter	Shank Diameter	Flute Length	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
3mm	3mm	12mm	38mm	MST-430-03	MST-430-03-T	MST-430-03-C	MST-430-03-A
4mm	4mm	12mm	50mm	MST-430-04	MST-430-04-T	MST-430-04-C	MST-430-04-A
5mm	5mm	14mm	50mm	MST-430-05	MST-430-05-T	MST-430-05-C	MST-430-05-A
6mm	6mm	14mm	57mm	MST-430-06	MST-430-06-T	MST-430-06-C	MST-430-06-A
8mm	8mm	16mm	63mm	MST-430-08	MST-430-08-T	MST-430-08-C	MST-430-08-A
10mm	10mm	20mm	72mm	MST-430-10	MST-430-10-T	MST-430-10-C	MST-430-10-A
12mm	12mm	25mm	83mm	MST-430-12	MST-430-12-T	MST-430-12-C	MST-430-12-A
16mm	16mm	32mm	92mm	MST-430-16	MST-430-16-T	MST-430-16-C	MST-430-16-A
20mm	20mm	38mm	104mm	MST-430-20	MST-430-20-T	MST-430-20-C	MST-430-20-A

4 Flute Super Tuffy Grade Carbide End Mills **ST/MST**



ST-430/434 Tolerances

Cutting Dia. = $+0.001/-0.000$ "
 Shank Dia. = $-0.0001/-0.0002$ "
 Flute Length (1/8" to 5/16") = $+0.030/-0.000$ "
 (3/8" to 1") = $+0.060/-0.000$ "
 OAL = ± 0.060 "

MST-430 and MST-434 Tolerances

Cutting Dia. = $+0.025/-0.000$ mm
 Shank Dia. = $-0.002/-0.005$ mm
 Flute Length = $+0.500/+1.500$ mm
 OAL = ± 1.000 mm



ST-434 4 Flute Super Tuffy Carbide Standard Length



Cutting Diameter	Shank Diameter	Flute Length	Corner Break Size	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
1/8"	1/8"	1/2"	.003"/.005"	1-1/2"	ST-434-04	ST-434-04-T	ST-434-04-C	ST-434-04-A
3/16"	3/16"	5/8"	.003"/.005"	2"	ST-434-06	ST-434-06-T	ST-434-06-C	ST-434-06-A
1/4"	1/4"	3/4"	.003"/.005"	2-1/2"	ST-434-08	ST-434-08-T	ST-434-08-C	ST-434-08-A
5/16"	5/16"	13/16"	.004"/.006"	2-1/2"	ST-434-10	ST-434-10-T	ST-434-10-C	ST-434-10-A
3/8"	3/8"	7/8"	.005"/.007"	2-1/2"	ST-434-12	ST-434-12-T	ST-434-12-C	ST-434-12-A
1/2"	1/2"	1"	.006"/.009"	3"	ST-434-16	ST-434-16-T	ST-434-16-C	ST-434-16-A
5/8"	5/8"	1-1/4"	.009"/.011"	3-1/2"	ST-434-20	ST-434-20-T	ST-434-20-C	ST-434-20-A
3/4"	3/4"	1-1/2"	.011"/.014"	4"	ST-434-24	ST-434-24-T	ST-434-24-C	ST-434-24-A



MST-434 4 Flute Super Tuffy Carbide Standard Length **METRIC**



Cutting Diameter	Shank Diameter	Flute Length	Corner Break Size	Overall Length	Tool Number Uncoated	Tool Number TiN Coated	Tool Number TiCN Coated	Tool Number AlTiN Coated
3mm	3mm	12mm	.075/.125mm	38mm	MST-434-03	MST-434-03-T	MST-434-03-C	MST-434-03-A
4mm	4mm	12mm	.075/.125mm	50mm	MST-434-04	MST-434-04-T	MST-434-04-C	MST-434-04-A
5mm	5mm	14mm	.075/.125mm	50mm	MST-434-05	MST-434-05-T	MST-434-05-C	MST-434-05-A
6mm	6mm	14mm	.075/.125mm	57mm	MST-434-06	MST-434-06-T	MST-434-06-C	MST-434-06-A
8mm	8mm	16mm	.100/.150mm	63mm	MST-434-08	MST-434-08-T	MST-434-08-C	MST-434-08-A
10mm	10mm	20mm	.125/.175mm	72mm	MST-434-10	MST-434-10-T	MST-434-10-C	MST-434-10-A
12mm	12mm	25mm	.150/.130mm	83mm	MST-434-12	MST-434-12-T	MST-434-12-C	MST-434-12-A
16mm	16mm	32mm	.230/.280mm	92mm	MST-434-16	MST-434-16-T	MST-434-16-C	MST-434-16-A
20mm	20mm	38mm	.280/.360mm	104mm	MST-434-20	MST-434-20-T	MST-434-20-C	MST-434-20-A

Hi-Temp Alloys Tools in Other Sections

TS / MTS
201/301/401

(See Multiple Applications)



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TR
303/404/606

(See Multiple Applications)



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MINIATURES

(See Miniatures Applications)



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SAWS

(See Saws Applications)



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