HARMONY

Ti MACHINING

suttontools

Aviation

Medical

Machining Titanium

TiAl6V4, Grade 5 alloy is the commonly used titanium grade. Some applications include: compressor blades, discs, and rings for jet engines; airframe and space capsule components, pressure vessels, rocket engine cases, helicopter rotor hubs, fasteners, critical forgings requiring high strength-to-weight ratios.

Machining TiAl6V4, Grade 5 alloy is often a similar practice to austenitic stainless steels. Best results are usually achieved with slower speeds, heavy feeds, rigid tooling, and large amounts of non-chlorinated cutting fluid.

The chip thickness is really paramount when machining titanium, getting this right, will have the biggest effect on your productivity.

However, in application the optimal chip thickness will have a tendency to pull the tool from its holder when in cut. By using Hi-Grip type tool holding systems, it allows to apply the optimal chip thickness, resulting in excellent Metal Removal Rate (MRR), tool life and providing a stable metal-cutting process.

A relatively increased f_z (mm/tooth) and moderately slower V_c (m/min) when compared to machining general steels, provides the best MRR, whereas higher speeds and lighter feeds will lead to premature tool wear, shorter tool life and potential distortion or poor surface finish on the component.

The Harmony Ti series, provides the ideal solution for high-quality milling of titanium. Designed for use in CNC machines with trochoidal toolpath strategies, the Harmony Ti series improves the productivity where the optimal metal removal rates are required, whilst suppressing any chatter, leading to longer tool life.

HARMONY
Ti Series


Universal

5 Flute R40/42 Ti VHM Series

This is the best solution for trochoidal milling strategies, as the 5 flute design provides the optimal productivity when considering Metal Removal Rates (min/cm^3).

Longest tool life is through a combination of specialised carbide grade, geometry that suppresses chatter, ultra smooth surface finish for cleaner cutting of the material and a specific PVD coating developed to resist wear in machining titanium.

The component quality is very high without burrs, even when taking semi-roughing type cuts.


Universal


Finishing

6 Flute R40/42 Ti VHM Series

Careful post-grinding edge treatment is applied to this range, that ensures the finest surface finish, whilst the 6 flute design provides an opportunity for higher feedrate.

Excellent solution when optimal surface finish is required. Lighter spindle loads, means good MRR can be achieved in smaller spindle machines due to the extra cutting edges.


Slotting


Universal

4 Flute R40/42 VA VHM Series

If helical plunging/ramping and side milling is required with one tool, then this is the ideal design. The endteeth geometry has high relief and chip space to enable an efficient process, without the need to drill a hole.


Roughing

R30VA-R SPM Roughing Series

The chip breaking design, HSS-SPM substrate and AlCrN coating enables a superior toughness for stable process milling applications.

Ideal for less than perfect clamping situations of the work-piece, where large amounts of metal removal is required.

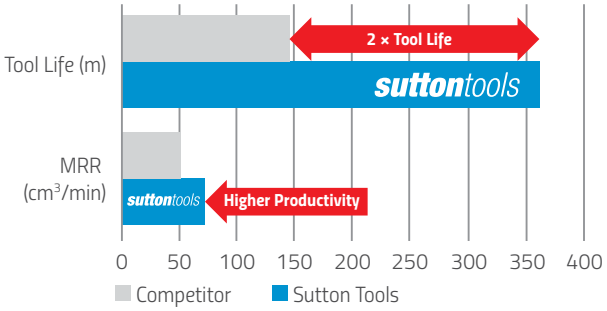
Often used in lights-out production due to its stable machining characteristic.

Performance Comparison - Ti

Test Data

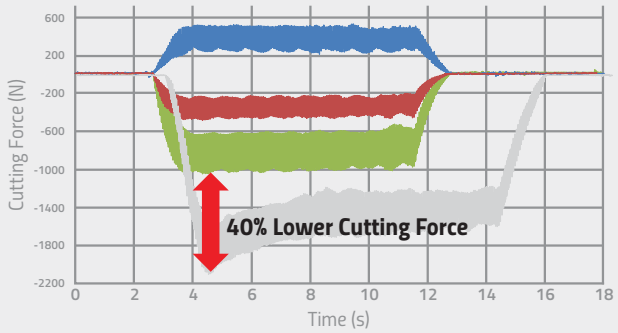
Material	TiAl6V4
Tool	E466 1640
Tool Holder	Collet Chuck (Big Dashowa)
Size	ø16 x 4 Corner Radius
Cutting Speed Vc (m/min)	90
RPM	1430
Feed Rate (mm/min)	572
Feed f (mm/flute)	0.08
ae (mm)	4
ap (mm) / depth	30

Results

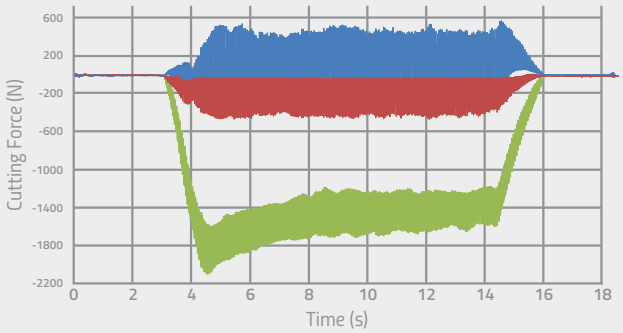


Comparison

Sutton Tools



Competitor



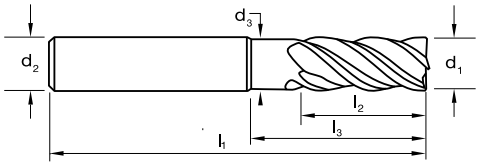
Key: YN XN ZN

Endmills Carbide, 5 Flute, R40/42 Ti

suttontools HARMONY

- Optimised design for trochoidal milling strategies in titanium alloys
- Variable helix design to suppress vibration
- Web taper to increase rigidity
- AlNova for outstanding oxidation resistance and hot hardness
- Carefully selected carbide grade for Ti machining

DIN 6527L | r | MICRO | 2°



Catalogue Code	E464	E465
Product Group	B0210	B0210
Material	VHM-ULTRA	VHM-ULTRA
Surface Finish	AlNova	AlNova
Sutton Designation	Ti	Ti
Geometry	R40/42	R40/42
Shank Form (DIN 6535)	HA	HB
Shank Tolerance	h6	h6

Size Ref.	d_1 (e8)	l_1	l_2	l_3	d_2	d_3	z	rad	Item #	Item #
DIN6527L - Square End										
0600	**6.0**	83	26	38	12	11.5	5		E464 0600	
0800	**8.0**	63	19	27	8	7.6	5		E464 0800	
1000	**10.0**	72	22	32	10	9.5	5		E464 2000	
1200	**12.0**	83	26	38	12	11.5	5		E464 1200	E465 1200
1600	**16.0**	92	32	44	16	15.5	5		E464 1600	E465 1600
2000	**20.0**	104	38	54	20	19.5	5		E464 2000	E465 2000
2500	**25.0**	125	45	64	25	24	5		E464 2500	
DIN6527L - Corner Rad									E466	E467
0605	**6.0**	57	13	21	6	5.5	5	0.5	E466 0605	
0610		57	13	21	6	5.5	5	1.0	E466 0610	
0805	**8.0**	63	19	27	8	7.5	5	0.5	E466 0805	
0810		63	19	27	8	7.5	5	1.0	E466 0810	
1005	**10.0**	72	22	32	10	9.5	5	0.5	E466 1005	
1010		72	22	32	10	9.5	5	1.0	E466 1010	
1210	**12.0**	83	26	38	12	11.2	5	1.0	E466 1210	E467 1210
1225		83	26	38	12	11.2	5	2.5	E466 1225	E467 1225
1240		83	26	38	12	11.2	5	4.0	E466 1240	E467 1240
1610	**16.0**	92	32	44	16	15	5	1.0	E466 1610	E467 1610
1625		92	32	44	16	15	5	2.5	E466 1625	E467 1625
1630		92	32	44	16	15	5	3.0		E467 1630
1640		92	32	44	16	15	5	4.0	E466 1640	E467 1640
2010	**20.0**	104	38	54	20	19	5	1.0	E466 2010	E467 2010
2025		104	38	54	20	19	5	2.5	E466 2025	E467 2025
2030		104	38	54	20	19	5	3.0	E466 2030	
2040		104	38	54	20	19	5	4.0	E466 2040	E467 2040
2050		104	38	54	20	19	5	5.0	E466 2050	E467 2050
2060		104	38	54	20	19	5	6.0	E466 2060	E467 2060
2510	**25.0**	120	45	64	25	24	5	1.0	E466 2510	
2525		120	45	64	25	24	5	2.5	E466 2525	
2530		120	45	64	25	24	5	3.0	E466 2530	
2540		120	45	64	25	24	5	4.0	E466 2540	
2550		120	45	64	25	24	5	5.0	E466 2550	

ISO	P													M			K							N											S												H					
VDI 3323	1	2	3	4	5	6	7	8	9	10	11	12	13	14.1	14.2	14.3	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37.1	37.2	37.3	37.4	37.5	38.1	38.2	39.1	39.2	40	41
E464 / E465																																						●	●	●	●	●	●							
E466 / E467																																						●	●	●	●	●	●							

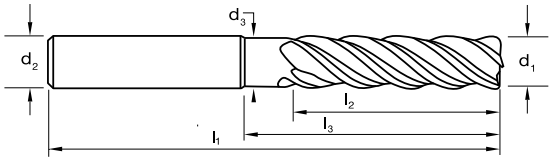
P Steel | M Stainless Steel | K Cast Iron | N Non-Ferrous Metals | S Titanium & Super Alloys | H Hard Materials

● Optimal ○ Effective

Endmills Carbide, 5 Flute, R40/42 Ti, Extra Long

suttontools HARMONY

- Optimised design for trochoidal and HSM milling strategies in titanium alloys
- For extra deep pocket milling in typically thin wall components
- Variable helix design to suppress vibration
- AlNova for outstanding oxidation resistance and hot hardness



Catalogue Code	E476
Product Group	B0210
Material	VHM-ULTRA
Surface Finish	AlNova
Sutton Designation	Ti-3XL
Geometry	R40/42
Shank Form (DIN 6535)	HA
Shank Tolerance	h6

Size Ref.	d_1 (e8)	l_1	l_2	l_3	d_2	d_3	z	rad	Item #
	SUTTON STD - 3XL								
1000	**10**	85	34	44	10	9.5	5	-	E476 1000
1020	**10**	85	34	44	10	9.5	5	2	E476 1020
1025	**10**	85	34	44	10	9.5	5	2.5	E476 1025
1040	**10**	85	34	44	10	9.5	5	4	E476 1040
1200	**12**	96	40	51	12	11.5	5	-	E476 1200
1210	**12**	96	40	51	12	11.5	5	1	E476 1210
1215	**12**	96	40	51	12	11.5	5	1.5	E476 1215
1220	**12**	96	40	51	12	11.5	5	2	E476 1220
1225	**12**	96	40	51	12	11.5	5	2.5	E476 1225
1230	**12**	96	40	51	12	11.5	5	3	E476 1230
1240	**12**	96	40	51	12	11.5	5	4	E476 1240
1600	**16**	105	52	57	16	15.5	5	-	E476 1600
1610	**16**	105	52	57	16	15.5	5	1	E476 1610
1615	**16**	105	52	57	16	15.5	5	1.5	E476 1615
1620	**16**	105	52	57	16	15.5	5	2	E476 1620
1625	**16**	105	52	57	16	15.5	5	2.5	E476 1625
1630	**16**	105	52	57	16	15.5	5	3	E476 1630
1640	**16**	105	52	57	16	15.5	5	4	E476 1640
2000	**20**	140	64	80	20	19.5	5	-	E476 2000
2010	**20**	140	64	80	20	19.5	5	1	E476 2010
2015	**20**	140	64	80	20	19.5	5	1.5	E476 2015
2020	**20**	140	64	80	20	19.5	5	2	E476 2020
2025	**20**	140	64	80	20	19.5	5	2.5	E476 2025
2030	**20**	140	64	80	20	19.5	5	3	E476 2030
2040	**20**	140	64	80	20	19.5	5	4	E476 2040
2050	**20**	140	64	80	20	19.5	5	5	E476 2050
2060	**20**	140	64	80	20	19.5	5	6	E476 2060

ISO	P												M			K						N										S							H					
VDI 3323	1	2	3	4	5	6	7	8	9	10	11	12	13	14.1	14.2	14.3	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37.1	37.2	37.3	37.4	37.5	38.1	38.2	39.1	39.2	40	41
E476																																						●	●	●	●	●	●						

P Steel M Stainless Steel K Cast Iron N Non-Ferrous Metals S Titanium & Super Alloys H Hard Materials

● Optimal ○ Effective

Endmills Carbide, 5 Flute, R40/42 Ti, Extra Long

suttontools HARMONY

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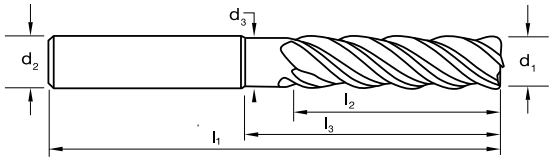


Catalogue Code	E477
Product Group	B0210
Material	VHM-ULTRA
Surface Finish	AlNova
Sutton Designation	Ti-4XL
Geometry	R40/42
Shank Form (DIN 6535)	HA
Shank Tolerance	h6

Size Ref.	d_1 (e8)	l_1	l_2	l_3	d_2	d_3	z	rad	Item #
	SUTTON STD - 4XL								
1000	**10**	93	42	52	10	9.5	5	-	E477 1000
1020	**10**	93	42	52	10	9.5	5	2	E477 1020
1025	**10**	93	42	52	10	9.5	5	2.5	E477 1025
1040	**10**	93	42	52	10	9.5	5	4	E477 1040
1200	**12**	110	50	65	12	11.5	5	-	E477 1200
1210	**12**	110	50	65	12	11.5	5	1	E477 1210
1215	**12**	110	50	65	12	11.5	5	1.5	E477 1215
1220	**12**	110	50	65	12	11.5	5	2	E477 1220
1225	**12**	110	50	65	12	11.5	5	2.5	E477 1225
1230	**12**	110	50	65	12	11.5	5	3	E477 1230
1240	**12**	110	50	65	12	11.5	5	4	E477 1240
1600	**16**	130	66	82	16	15.5	5	-	E477 1600
1610	**16**	130	66	82	16	15.5	5	1	E477 1610
1615	**16**	130	66	82	16	15.5	5	1.5	E477 1615
1620	**16**	130	66	82	16	15.5	5	2	E477 1620
1625	**16**	130	66	82	16	15.5	5	2.5	E477 1625
1630	**16**	130	66	82	16	15.5	5	3	E477 1630
1640	**16**	130	66	82	16	15.5	5	4	E477 1640
2000	**20**	160	82	100	20	19.5	5	-	E477 2000
2010	**20**	160	82	100	20	19.5	5	1	E477 2010
2015	**20**	160	82	100	20	19.5	5	1.5	E477 2015
2020	**20**	160	82	100	20	19.5	5	2	E477 2020
2025	**20**	160	82	100	20	19.5	5	2.5	E477 2025
2030	**20**	160	82	100	20	19.5	5	3	E477 2030
2040	**20**	160	82	100	20	19.5	5	4	E477 2040
2050	**20**	160	82	100	20	19.5	5	5	E477 2050
2060	**20**	160	82	100	20	19.5	5	6	E477 2060

ISO	P													M			K							N									S												H					
VDI 3323	1	2	3	4	5	6	7	8	9	10	11	12	13	14.1	14.2	14.3	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37.1	37.2	37.3	37.4	37.5	38.1	38.2	39.1	39.2	40	41
E477																																						●	●	●	●	●	●							

P Steel M Stainless Steel K Cast Iron N Non-Ferrous Metals S Titanium & Super Alloys H Hard Materials

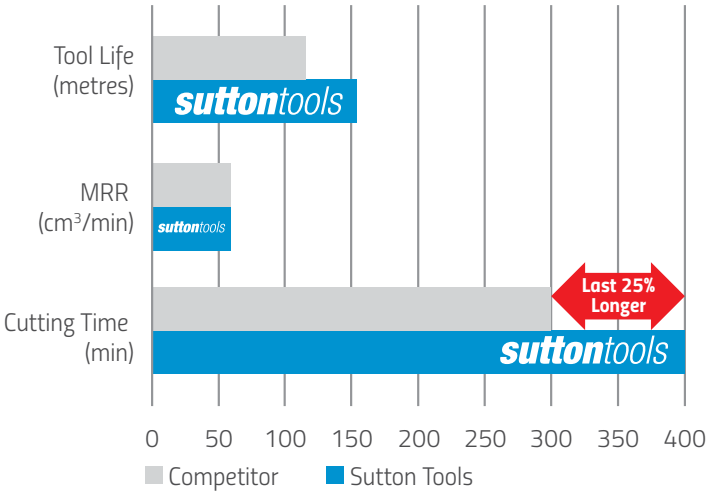
● Optimal ○ Effective

Performance Comparison - Ti

Test Data

Material	TiAl6V4	
Tool Holder	HSK63 Shrink Fit (HAIMER)	
Size	ø20 x R1	
ae (mm) / depth	26	
	Sutton Tools	**Competitor A**
Tool	E470 2010	6 Flute, Variable Helix
Cutting Speed Vc (m/min)	80	80
RPM	1272	1272
Feed Rate (mm/min)	382	382
Feed f (mm/flute)	0.06	0.06

Comparison



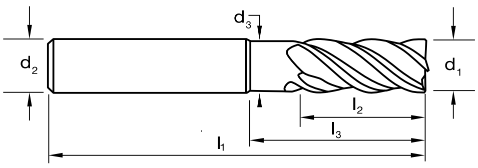
Edge Condition after 400 mins.

Endmills Carbide, 6 Flute, R40/42 Ti

suttontools HARMONY

- Optimised design for finishing in titanium alloys
- Variable helix design to suppress vibration
- Web taper to increase rigidity
- AlNova for outstanding oxidation resistance and hot hardness
- Carefully selected carbide grade for Ti machining

DIN 6527L | MICRO | 2°



Catalogue Code	E468	E469
Product Group	B0210	B0210
Material	VHM-ULTRA	VHM-ULTRA
Surface Finish	*AlNova*	*AlNova*
Sutton Designation	Ti	Ti
Geometry	R40/42	R40/42
Shank Form (DIN 6535)	HA	HB
Shank Tolerance	h6	h6

Size Ref.	d_1 (e8)	l_1	l_2	l_3	d_2	d_3	z	rad	Item #	Item #
	DIN6527L - Square End									
1200	**12.0**	83	26	38	12	11.5	6		E468 1200	E469 1200
1600	**16.0**	92	32	44	16	15.5	6		E468 1600	E469 1600
2000	**20.0**	104	38	54	20	19.5	6		E468 2000	E469 2000
	DIN6527L - Corner Rad								**E470**	**E471**
1210	**12.0**	83	26	38	12	11.5	6	1.0	E470 1210	E471 1210
1225		83	26	38	12	11.5	6	2.5	E470 1225	E471 1225
1240		83	26	38	12	11.5	6	4.0	E470 1240	E471 1240
1610	**16.0**	92	32	44	16	15.5	6	1.0	E470 1610	E471 1610
1625		92	32	44	16	15.5	6	2.5	E470 1625	E471 1625
1640		92	32	44	16	15.5	6	4.0	E470 1640	E471 1640
2010	**20.0**	104	38	54	20	19.5	6	1.0	E470 2010	E471 2010
2025		104	38	54	20	19.5	6	2.5	E470 2025	E471 2025
2040		104	38	54	20	19.5	6	4.0	E470 2040	E471 2040
2050		104	38	54	20	19.5	6	5.0	E470 2050	E471 2050
2060		104	38	54	20	19.5	6	6.0	E470 2060	E471 2060

ISO	P													M			K						N										S											H					
VDI 3323	1	2	3	4	5	6	7	8	9	10	11	12	13	14.1	14.2	14.3	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37.1	37.2	37.3	37.4	37.5	38.1	38.2	39.1	39.2	40	41
E468 / E469																																						●	●	●	●	●	●						
E470 / E471																																						●	●	●	●	●	●						

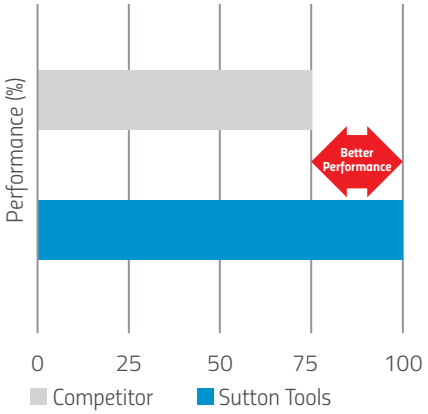
P Steel M Stainless Steel K Cast Iron N Non-Ferrous Metals S Titanium & Super Alloys H Hard Materials ● Optimal ○ Effective

Performance Comparison - VA

Test Data

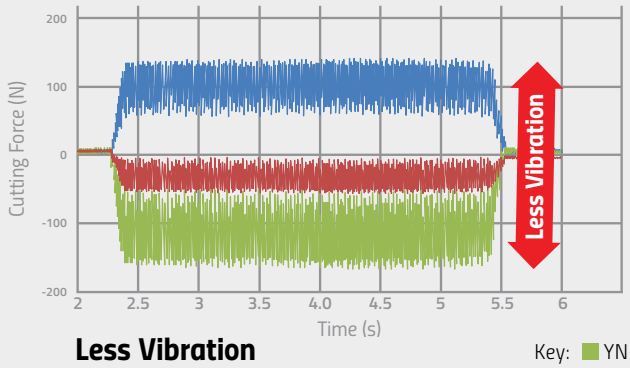
Material	AISI 304 / 1.4301 / AS 304
Tool	E462 1610
Tool Holder	Collet Chuck
Size	ø16 x 4 Corner Radius
Cutting Speed Vc (m/min)	120
RPM	3185
Feed Rate (mm/min)	828
Feed f (mm/flute)	0.065
ae (mm)	0.24
ap (mm) / depth	18

Results



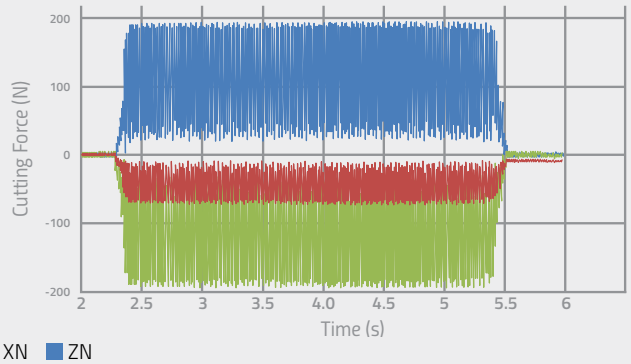
Comparison

Sutton Tools



Less Vibration

Competitor



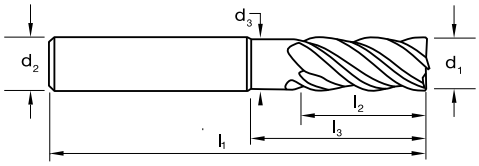
Key: YN XN ZN

Endmills Carbide, 4 Flute, R40/42 VA

suttontools HARMONY

- Excellent solution for stainless steels and super alloy type materials
- Optimised geometry with variable helix design ensures high productivity
- Suitable for slotting, side cutting and finishing applications with the one tool
- HELICA for outstanding oxidation resistance and hot hardness
- VHM-ULTRA grade of carbide for high performance

DIN 6527L | MICRO



Corner Rad

	E459	E460
Catalogue Code	E459	E460
Product Group	B0210	B0210
Material	VHM-ULTRA	VHM-ULTRA
Surface Finish	*HELICA*	*HELICA*
Sutton Designation	VA	VA
Geometry	R40/42	R40/42
Shank Form (DIN 6535)	HA	HB
Shank Tolerance	h6	h6

Size Ref.	d_1 (e8)	l_1	l_2	l_3	d_2	d_3	z	rad	Item #	Item #
	DIN6527L - Square End									
0300	**3.0**	57	8	14	6	2.8	4		E459 0300	E460 0300
0400	**4.0**	57	11	16	6	3.8	4	1.0	E459 0400	E460 0400
0500	**5.0**	57	13	18	6	4.8	4	2.5	E459 0500	E460 0500
0600	**6.0**	57	13	21	6	5.7	4	4.0	E459 0600	E460 0600
0800	**8.0**	63	19	27	8	7.6	4		E459 0800	E460 0800
1000	**10.0**	72	22	32	10	9.5	4	1.0	E459 1000	E460 1000
1200	**12.0**	83	26	38	12	11.5	4	2.5	E459 1200	E460 1200
1400	**14.0**	83	26	38	14	13.5	4	4.0	E459 1400	E460 1400
1600	**16.0**	92	32	44	16	15.5	4		E459 1600	E460 1600
1800	**18.0**	92	32	44	18	17.5	4	1.0	E459 1800	E460 1800
2000	**20.0**	104	38	54	20	19.5	4	2.5	E459 2000	E460 2000
	DIN6527L - Corner Rad								**E462**	**E463**
0603	**6.0**	57	13	21	6	5.5	4	0.3	E462 0603	E463 0603
0605		57	13	21	6	5.5	4	0.5	E462 0605	E463 0605
0610		57	13	21	6	5.5	4	1.0	E462 0610	E463 0610
0803	**8.0**	63	19	27	8	7.5	4	0.3	E462 0803	E463 0803
0805		63	19	27	8	7.5	4	0.5	E462 0805	E463 0805
0810		63	19	27	8	7.5	4	1.0	E462 0810	E463 0810
0815		63	19	27	8	7.5	4	1.5	E462 0815	E463 0815
0820		63	19	27	8	7.5	4	2.0	E462 0820	E463 0820
1003	**10.0**	72	22	32	10	9.5	4	0.3	E462 1003	E463 1003
1005		72	22	32	10	9.5	4	0.5	E462 1005	E463 1005
1010		72	22	32	10	9.5	4	1.0	E462 1010	E463 1010
1015		72	22	32	10	9.5	4	1.5	E462 1015	E463 1015
1020		72	22	32	10	9.5	4	2.0	E462 1020	E463 1020
1203	**12.0**	83	26	38	12	11.5	4	0.3	E462 1203	E463 1203
1205		83	26	38	12	11.5	4	0.5	E462 1205	E463 1205
1210		83	26	38	12	11.5	4	1.0	E462 1210	E463 1210
1215		83	26	38	12	11.5	4	1.5	E462 1215	E463 1215
1220		83	26	38	12	11.5	4	2.0	E462 1220	E463 1220
1230		83	26	38	12	11.5	4	3.0	E462 1230	E463 1230
1605	**16.0**	92	32	44	16	15.5	4	0.5	E462 1605	E463 1605
1610		92	32	44	16	15.5	4	1.0	E462 1610	E463 1610
1615		92	32	44	16	15.5	4	1.5	E462 1615	E463 1615
1620		92	32	44	16	15.5	4	2.0	E462 1620	E463 1620
1630		92	32	44	16	15.5	4	3.0	E462 1630	E463 1630
1640		92	32	44	16	15.5	4	4.0	E462 1640	E463 1640
2005	**20.0**	104	38	54	20	19.5	4	0.5	E462 2005	E463 2005
2010		104	38	54	20	19.5	4	1.0	E462 2010	E463 2010
2015		104	38	54	20	19.5	4	1.5	E462 2015	E463 2015
2020		104	38	54	20	19.5	4	2.0	E462 2020	E463 2020
2030		104	38	54	20	19.5	4	3.0	E462 2030	E463 2030
2040		104	38	54	20	19.5	4	4.0	E462 2040	E463 2040

ISO	P												M			K						N									S												H					
VDI 3323	1	2	3	4	5	6	7	8	9	10	11	12	13	14.1	14.2	14.3	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37.1	37.2	37.3	37.4	37.5	38.1	38.2	39.1	39.2	40	41
E459 / E460						○	○	○	○	○	○	○	○	●	●	●							○	○	○	○	○	○	○				○	○	○	○	○	○	○	○		○	○							
E462 / E463						○	○	○	○	○	○	○	○	●	●	●							○	○	○	○	○	○	○				○	○	○	○	○	○	○	○		○	○							

P Steel | M Stainless Steel | K Cast Iron | N Non-Ferrous Metals | S Titanium & Super Alloys | H Hard Materials

● Optimal ○ Effective

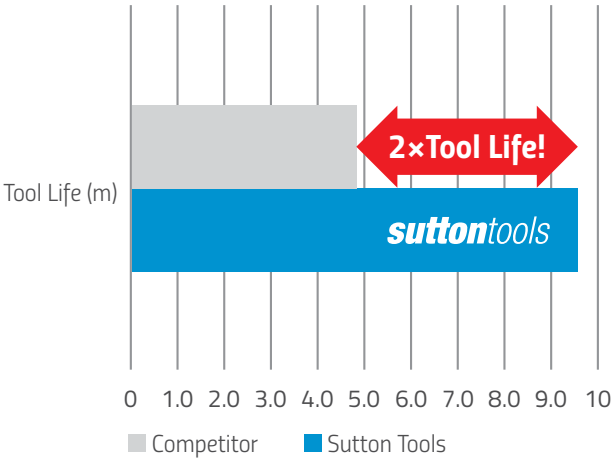
Performance Comparison - VA-R

Comparison 1

Test Data

Material	TiAl6V4
Tool	E255 1640
Tool Holder	Collet Chuck (Big Dashowa)
Size	16mm
Cutting Speed Vc (m/min)	20
RPM	398
Feed Rate (mm/min)	119
Feed f (mm/flute)	0.06
ae (mm)	10
ap (mm) / depth	20

Results

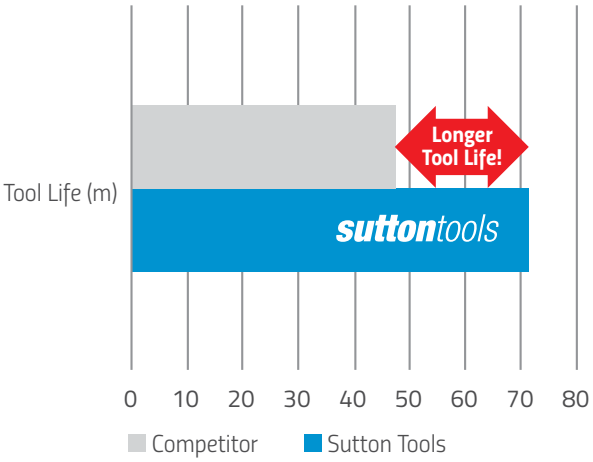


Comparison 2

Test Data

Material	TiAl6V4
Tool	Special Custom Make
Tool Holder	Collet Chuck
Size	31.75mm (1-1/4")
Cutting Speed Vc (m/min)	23
RPM	230
Feed Rate (mm/min)	79
Feed f (mm/flute)	0.057
ae (mm)	16
ap (mm) / depth	48

Results

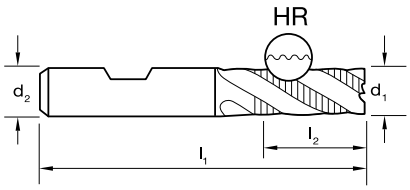


Roughers SPM, R30 VA-R, Regular

suttontools

- HSS-SPM
- Unique HR geometry offers stable performance in difficult to machine materials for roughing applications
- Ideal for large volume metal removal

DIN 844K | B | HR | 45° | r



Catalogue Code	E251	E255	E252
Discount Group	B0408	B0408	B0408
Material	SPM	SPM	SPM
Surface Finish	AlCrN	AlCrN	AlCrN
Sutton Designation	VA	VA	VA
Geometry	R30 VA-R	R30 VA-R Corner Rad	R30 VA-R
Shank Form (DIN 1835)	B	B	B
Shank Tolerance	h6	h6	h6

Size Ref.	d_1 (js14)	l_1	l_2	d_2	z	rad	Item #	Item #	Item #
0600	6.0	57	13	6	4		E251 0600		
0800	8.0	69	19	10	4		E251 0800		
1000	10.0	72	22	10	4		E251 1000		
1025	10.0	72	22	10	4	2.5		E255 1025	
1040	10.0	72	22	10	4	4		E255 1040	
1200	12.0	83	26	12	4		E251 1200		
1225		83	26	12	4	2.5		E255 1225	
1240		83	26	12	4	4		E255 1240	
1600	16.0	92	32	16	4		E251 1600		
1605		92	32	16	5		E251 1605		
1625		92	32	16	5	2.5		E255 1625	
1640		92	32	16	5	4		E255 1640	
2000	20.0	104	38	20	4		E251 2000		
2005		104	38	20	5		E251 2005		
2025		104	38	20	5	2.5		E255 2025	
2040		104	38	20	5	4		E255 2040	
2050		104	38	20	5	5		E255 2050	
2060		104	38	20	5	6		E255 2060	
2500	25.0	121	45	25	5		E251 2500		
2525		121	45	25	5	2.5		E255 2525	
2540		121	45	25	5	4		E255 2540	
2550		121	45	25	5	5		E255 2550	
2560		121	45	25	5	6		E255 2560	
3040	30.0	121	45	25	6	4		E255 3040	
3200	32.0	133	53	32	6		E251 3200		
3240	32.0	133	53	32	6	4		E255 3240	
0600	6.0	68	24	6	3				E252 0600
0800	8.0	88	38	10	3				E252 0800
1000	10.0	95	45	10	4				E252 1000
1200	12.0	110	53	12	4				E252 1200
1600	16.0	123	63	16	4				E252 1600
2000	20.0	141	75	20	4				E252 2000
2500	25.0	166	90	25	5				E252 2500

ISO	P													M			K						N										S												H					
VDI 3323	1	2	3	4	5	6	7	8	9	10	11	12	13	14.1	14.2	14.3	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37.1	37.2	37.3	37.4	37.5	38.1	38.2	39.1	39.2	40	41
E251	○	○	○	○	●	○	●	●		●		○	●	●	●	○																	○	○	○	○	○	○	●	●	●	●	○	○					
E255	○	○	○	○	●	○	●	●		●		○	●	●	●	○																	○	○	○	○	○	○	●	●	●	●	○	○					
E252	○	○	○	○	●	○	●	●		●		○	●	●	●	○																	○	○	○	○	○	○	●	●	●	●	○	○					

P Steel | M Stainless Steel | K Cast Iron | N Non-Ferrous Metals | S Titanium & Super Alloys | H Hard Materials

● Optimal ○ Effective

ISO	VDI	Material Group	Sutton	
P	A	Steel	N	UNI
M	R	Stainless Steel	VA	
K	F	Cast Iron	GG	
N	N	Non-Ferrous Metals, Aluminiums & Coppers	Al | W	
S	S	Titaniums & Super Alloys	Ti	Ni
H	H	Hard Materials (≥ 45 HRC)	H	

^ VDI 3323 material groups can also be determined by referring to the workpiece material cross reference listing. Refer to main index of this section.



Catalogue Code	E464	E466		E468	E470		E476		
Material	VHM-ULTRA			VHM-ULTRA			VHM-ULTRA		
Surface Finish	*AlNova*			*AlNova*			*AlNova*		
Sutton Designation	Ti			Ti			Ti-3XL		
Geometry									
Type of Cut: *Slotting*							●		
Finishing		●			●				
Universal			●			●			●
Roughing									
Profiling									
↑↓ ap × Ø			1.5		1.5	1.0		3.0	3.0
←→ ae × Ø			0.05		0.05	0.2		0.05	0.2

ISO	VDI^ 3323	Material		Condition	HB	N/mm²	Vc	Feed #		Vc	Feed #		Vc	Feed #	Vc	Feed #
P	1	Steel - Non-alloy, cast & free cutting	~ 0.15 %C	A	125	440	-	-	-	-	-	-	-	-	-	-
	2		~ 0.45 %C	A	190	640	-	-	-	-	-	-	-	-	-	-
	3			QT	250	840	-	-	-	-	-	-	-	-	-	-
	4		~ 0.75 %C	A	270	910	-	-	-	-	-	-	-	-	-	-
	5			QT	300	1010	-	-	-	-	-	-	-	-	-	-
	6	Steel - Low alloy & cast < 5% of alloying elements		A	180	610	-	-	-	-	-	-	-	-	-	-
	7			QT	275	930	-	-	-	-	-	-	-	-	-	-
	8			QT	300	1010	-	-	-	-	-	-	-	-	-	-
	9			QT	350	1180	-	-	-	-	-	-	-	-	-	-
	10	Steel - High alloy, cast & tool		A	200	680	-	-	-	-	-	-	-	-	-	-
	11			HT	325	1100	-	-	-	-	-	-	-	-	-	-
	12	Steel - Corrosion resistant & cast	Ferritic / Martensitic	A	200	680	-	-	-	-	-	-	-	-	-	-
	13		Martensitic	QT	240	810	-	-	-	-	-	-	-	-	-	-
M	14.1	Stainless Steel	Austenitic	AH	180	610	-	-	-	-	-	-	-	-	-	-
	14.2		Duplex		250	840	-	-	-	-	-	-	-	-	-	-
	14.3		Precipitation Hardening		250	840	-	-	-	-	-	-	-	-	-	-
K	15	Cast Iron - Grey (GG)	Ferritic / Pearlitic		180	610	-	-	-	-	-	-	-	-	-	-
	16		Pearlitic		260	880	-	-	-	-	-	-	-	-	-	-
	17	Cast Iron - Nodular (GGG)	Ferritic		160	570	-	-	-	-	-	-	-	-	-	-
	18		Pearlitic		250	840	-	-	-	-	-	-	-	-	-	-
	19	Cast Iron - Malleable	Ferritic		130	460	-	-	-	-	-	-	-	-	-	-
	20		Pearlitic		230	780	-	-	-	-	-	-	-	-	-	-
N	21	Aluminum & Magnesium - wrought alloy	Non Heat Treatable		60	210	-	-	-	-	-	-	-	-	-	-
	22		Heat Treatable	AH	100	360	-	-	-	-	-	-	-	-	-	-
	23	Aluminum & Magnesium - cast alloy ≤12% Si	Non Heat Treatable		75	270	-	-	-	-	-	-	-	-	-	-
	24		Heat Treatable	AH	90	320	-	-	-	-	-	-	-	-	-	-
	25	Al & Mg - cast alloy >12% Si	Non Heat Treatable		130	460	-	-	-	-	-	-	-	-	-	-
	26	Copper & Cu alloys (Brass/Bronze)	Free cutting, Pb > 1%		110	390	-	-	-	-	-	-	-	-	-	-
	27		Brass (CuZn, CuSnZn)		90	320	-	-	-	-	-	-	-	-	-	-
	28		Bronze (CuSn)		100	360	-	-	-	-	-	-	-	-	-	-
	29	Non-metallic - Thermosetting & fiber-reinforced plastics					-	-	-	-	-	-	-	-	-	-
	30	Non-metallic - Hard rubber, wood etc.					-	-	-	-	-	-	-	-	-	-
S	31	High temp. alloys	Fe based	A	200	680	-	-	-	-	-	-	-	-	-	-
	32			AH	280	950	-	-	-	-	-	-	-	-	-	-
	33		Ni / Co based	A	250	840	-	-	-	-	-	-	-	-	-	-
	34			AH	350	1180	-	-	-	-	-	-	-	-	-	-
	35			C	320	1080	-	-	-	-	-	-	-	-	-	-
	36	Titanium & Ti alloys	CP Titanium		400 MPa		**85**	**17**	**14**	**85**	**17**	**14**	**70**	**7**	**70**	**10**
	37.1		Alpha alloys		860 MPa		**80**	**17**	**14**	**80**	**17**	**14**	**65**	**7**	**55**	**10**
	37.2		Alpha / Beta alloys	A	960 MPa		**80**	**17**	**14**	**80**	**17**	**14**	**65**	**7**	**50**	**10**
	37.3			AH	1170 MPa		**80**	**17**	**14**	**80**	**17**	**14**	**50**	**7**	**40**	**10**
	37.4		Beta alloys	A	830 MPa		**80**	**17**	**14**	**80**	**17**	**14**	**65**	**7**	**55**	**10**
	37.5			AH	1400 MPa		**80**	**17**	**14**	**80**	**17**	**14**	**50**	**7**	**40**	**10**
H	38.1	Hardened steel		HT	45 HRC		-	-	-	-	-	-	-	-	-	-
	38.2			HT	55 HRC		-	-	-	-	-	-	-	-	-	-
	39.1			HT	58 HRC		-	-	-	-	-	-	-	-	-	-
	39.2			HT	62 HRC		-	-	-	-	-	-	-	-	-	-
	40	Cast Iron	Chilled	C	400	1350	-	-	-	-	-	-	-	-	-	-
	41			HT	55 HRC		-	-	-	-	-	-	-	-	-	-

Condition: **A** (Annealed), **AH** (Age Hardened), **C** (Cast), **HT** (Hardened & Tempered), **QT** (Quenched & Tempered)

Bold = Optimal | Regular = Effective

Feed Table (f_z) (mm/tooth)

Ø	Feed #																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2	0.001	0.002	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.010	0.011	0.013	0.014	0.016	0.018	0.020	0.022	0.024	0.026	0.030
3	0.002	0.003	0.004	0.005	0.006	0.008	0.009	0.010	0.012	0.014	0.016	0.018	0.020	0.023	0.025	0.028	0.032	0.034	0.038	0.042
4	0.004	0.005	0.006	0.007	0.009	0.010	0.012	0.014	0.016	0.018	0.021	0.023	0.026	0.030	0.032	0.036	0.040	0.044	0.045	0.050
5	0.005	0.006	0.008	0.009	0.011	0.013	0.015	0.017	0.020	0.023	0.025	0.030	0.032	0.036	0.040	0.044	0.050	0.055	0.060	0.065
6	0.006	0.008	0.009	0.011	0.013	0.016	0.018	0.021	0.024	0.028	0.030	0.034	0.038	0.042	0.045	0.050	0.055	0.060	0.070	0.075
8	0.010	0.012	0.014	0.017	0.019	0.022	0.025	0.028	0.032	0.036	0.040	0.045	0.050	0.055	0.060	0.065	0.075	0.080	0.085	0.095
10	0.013	0.015	0.018	0.021	0.024	0.028	0.032	0.036	0.040	0.045	0.050	0.055	0.060	0.070	0.075	0.085	0.090	0.100	0.11	0.12
12	0.016	0.019	0.022	0.026	0.030	0.034	0.038	0.044	0.050	0.055	0.060	0.065	0.075	0.080	0.090	0.100	0.11	0.12	0.13	0.14
16	0.020	0.024	0.028	0.034	0.038	0.044	0.050	0.055	0.060	0.070	0.080	0.085	0.095	0.11	0.12	0.13	0.14	0.16	0.17	0.18
20	0.022	0.028	0.032	0.038	0.044	0.050	0.060	0.065	0.075	0.085	0.095	0.11	0.12	0.13	0.15	0.16	0.18	0.19	0.21	0.23
25	0.025	0.032	0.038	0.045	0.055	0.060	0.070	0.080	0.090	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.22	0.24	0.26	0.29

Notes on Milling

1. Above values are guidelines for the size and type of cut nominated.
2. For long series tools, reduce speed by 40% and feed by 20%.





E477				E459			E462			E251	E255	E252			
VHM-ULTRA				VHM-ULTRA			VHM-ULTRA			SPM		SPM			
AlNova				*HELICA*			*HELICA*			*AlCrN*		*AlCrN*			
Ti-4XL				VA			VA			VA		VA			
										R30 VA-R		R30 VA-R (Long)			
	●				●			●							*Slotting*
															Finishing
			●			●			●						*Universal*
										●		●			*Roughing*
															Profiling
	4.0		4.0		1.0	1.0		1.0	1.0	1.0		1.0			ap
	0.05		0.2		1.0	0.3		1.0	0.3	0.5		0.5			ae
Vc	Feed #	Vc	Feed #	Vc	Feed #		Vc	Feed #		Vc	Feed #	Vc	Feed #	VDI 3323	ISO
-	-	-	-	-	-	-	-	-	-	40	4	40	4	1	P
-	-	-	-	-	-	-	-	-	-	40	4	40	4	2	
-	-	-	-	-	-	-	-	-	-	40	4	40	4	3	
-	-	-	-	-	-	-	-	-	-	40	4	40	4	4	
-	-	-	-	-	-	-	-	-	-	**40**	**4**	**40**	**4**	5	
-	-	-	-	210	12	9	210	12	9	40	4	40	4	6	
-	-	-	-	175	12	9	175	12	9	**40**	**4**	**40**	**4**	7	
-	-	-	-	175	12	9	175	12	9	**40**	**4**	**40**	**4**	8	
-	-	-	-	120	12	9	120	12	9	-	-	-	-	9	
-	-	-	-	175	12	9	175	12	9	**40**	**4**	**40**	**4**	10	
-	-	-	-	120	12	9	120	12	9	-	-	-	-	11	
-	-	-	-	120	12	9	120	12	9	25	6	25	6	12	
-	-	-	-	100	12	9	100	12	9	**30**	**4**	**30**	**4**	13	
-	-	-	-	**120**	**12**	**9**	**120**	**12**	**9**	**40**	**10**	**40**	**10**	14.1	M
-	-	-	-	**120**	**12**	**9**	**120**	**12**	**9**	**40**	**10**	**40**	**10**	14.2	
-	-	-	-	**100**	**12**	**9**	**100**	**12**	**9**	25	6	25	6	14.3	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	K
-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	
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-	-	-	-	200	11	8	200	11	8	-	-	-	-	23	
-	-	-	-	200	11	8	200	11	8	-	-	-	-	24	
-	-	-	-	200	11	8	200	11	8	-	-	-	-	25	
-	-	-	-	200	11	8	200	11	8	-	-	-	-	26	
-	-	-	-	200	11	8	200	11	8	-	-	-	-	27	
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-	-	-	-	70	11	8	70	11	8	25	4	25	4	31	S
-	-	-	-	**70**	11	8	**70**	11	8	15	4	15	4	32	
-	-	-	-	70	11	8	70	11	8	25	4	25	4	33	
-	-	-	-	**70**	11	8	**70**	11	8	10	4	10	4	34	
-	-	-	-	**70**	11	8	**70**	11	8	15	4	15	4	35	
65	**7**	**65**	**10**	90	11	8	90	11	8	30	5	30	5	36	
60	**7**	**50**	**10**	**90**	11	8	**90**	11	8	15	4	15	4	37.1	
60	**7**	**45**	**10**	**90**	11	8	**90**	11	8	15	4	15	4	37.2	
45	**7**	**35**	**10**	-	-	-	-	-	-	12	4	12	4	37.3	
60	**7**	**50**	**10**	**90**	11	8	**90**	11	8	15	4	15	4	37.4	
45	**7**	**35**	**10**	90	11	8	90	11	8	12	4	12	4	37.5	
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	41	

METRIC ENDMILLS (mm size)

Ø = nominal tool diameter (mm)
n = Spindel speed (RPM)
vc = Cutting speed (m/min)
fz = Feed rate per tooth (mm/tooth)
vf = Feed rate (mm/min)
z = No. cutting edges
Q = Metal removal rate (cm^3/min)
ap = Cutting depth (mm)
ae = Cutting width (mm)

$$n = \frac{v_c \times 1000}{Ø \times \pi} \simeq \frac{v_c}{Ø} \times 318$$

$$v_c = \frac{n \times Ø \times \pi}{1000} \simeq \frac{n \times Ø}{318}$$

$$f_z = \frac{V_f}{z \times n} \qquad v_f = f_z \times z \times n$$

$$Q = \frac{a_p \times a_e \times v_f}{1000}$$

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