HARMONY Ni SERIES

DYNAMIC & TROCHOIDAL MACHINING

AUSTRALIAN MADE

suttontools

suttontools HARMONY Ni SERIES

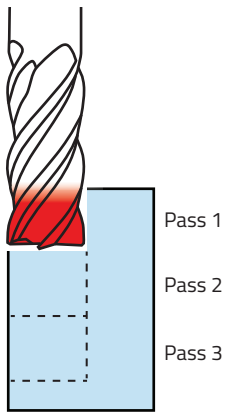
Dynamic & Trochoidal Milling

Dynamic/Trochoidal Milling strategies provide a tool engagement angle with the workpiece that utilises more of the cutting edge of the tool, ensuring a stable process, shorter machining times & longer tool life.

Dynamic & Trochoidal method - Applies a lower radial step-over (ae) & a higher depth of cut (ap), spreading the wear, loads & heat across the entire cutting edge.

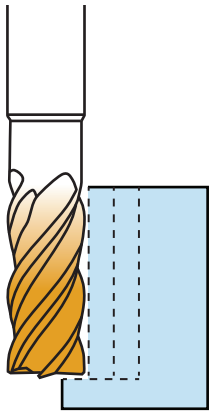
- Dynamic & Trochoidal milling, adjusts the parameters to maintain a constant load on the tool, providing more aggressive metal material rates (MRR)
- Dynamic & Trochoidal milling, requires a CAM package to generate the tool path & virtually any CNC machine.

Traditional



Traditional methods are typically higher step-over & lower depth of cut.

Trochoidal



Dynamic & Trochoidal is mostly based on the theory of radial chip thinning that occurs with varying ae which relates to chip thickness and feed per tooth.

Advantages of Dynamic & Trochoidal Milling

- Decreased cutting forces
- Reduced heat
- Reduced tool wear
- Suitable for lower power machines
- Greater machining accuracy
- Spindle & machine friendly
- Improved tool life
- Faster cycle time
- One tool for multiple slot sizes (trochoidal)
- Thin wall applications

● Optimal ○ Effective

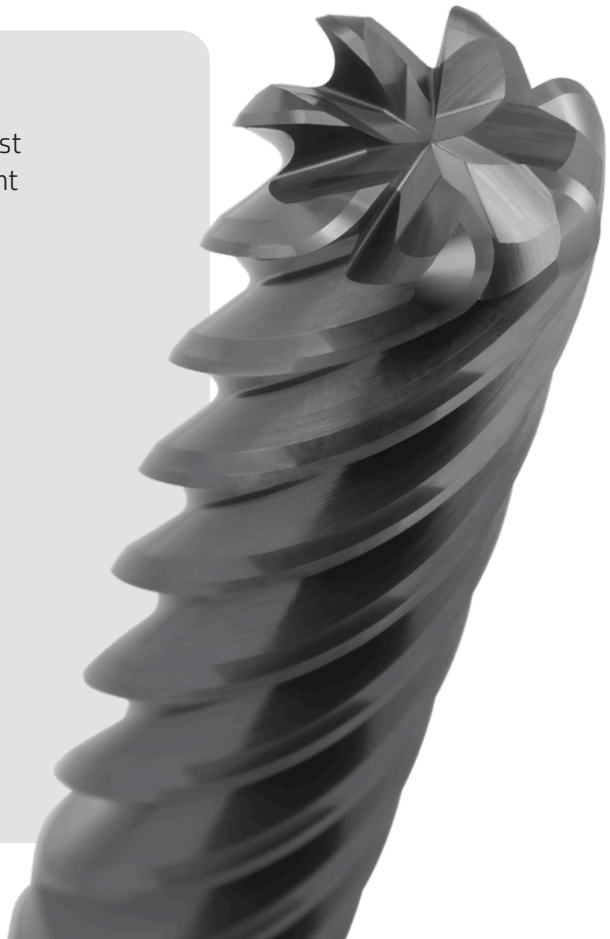
Page	Item Code	Tool	Diameter range	Type	Shank Type	No. of Flutes	Geometry	Tool Material	Coating	Standard	P	P	M	S
											Steel 1-5	Steel 6-13	Stainless Steel	Titanium & Super Alloys
4	E472		6mm – 20mm	Square End	DIN6535 HA	5	R40/42 Ni	VHM-Ultra	X.Ceed	DIN6527 L	●	○	●	●
4	E473				DIN6535 HB						●	○	●	●
5	E474			Corner Radius	DIN6535 HA						●	○	●	●
5	E475				DIN6535 HB						●	○	●	●
6	E486		10-20mm	Square/Corner Radius	DIN6535 HA	7				3XL	●	○	●	●
7	E487				DIN6535 HA	9				4XL	●	○	●	●

Tool Design & Geometry

Harmony Ni series is designed with machining the most difficult of materials in mind, such as the heat resistant Ni based alloy material group. Although optimised for this low machinability material group, it has many advantages in the other material groups, such as Stainless Steels & Alloyed Steels.

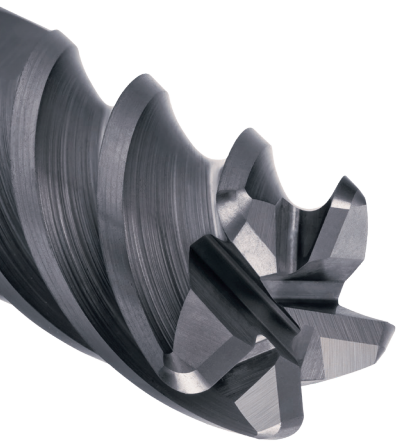
Features & Benefits

- Higher flute count than standard endmills for higher productivity
- Variable helix design to suppress chatter for smoother/stable machining
- Xceed coating for longer tool life
- Optimised carbide grade, offering higher cutting edge strength
- Also available in Square End & multiple Corner radius sizes per diameter



Performance Comparison - Ni

Application 1 - Roughing



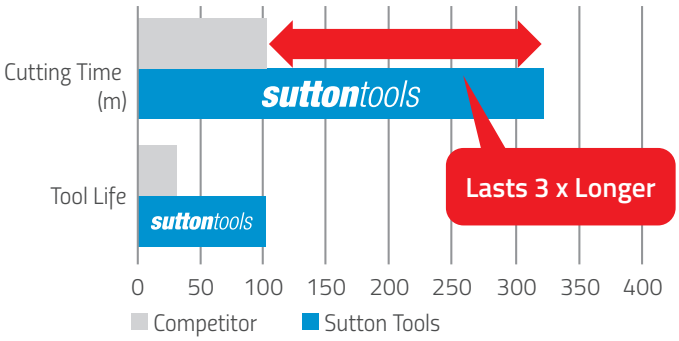
Set up

Part No	E4741640
Standard	DIN6527L
Coolant	External
Major Diameter	16mm
Material	Inconel 718
Machine type	HAAS VMC

Test Data

Tool Material Grade	VHM
Tool Diameter (mm)	16
z (teeth number)	5
ae (mm)	7.5
ap (mm) / depth	12
Cutting Speed V(m/min)	58
RPM	1153
Feed Rate (mm/min)	323
Feed f(mm/flute)	0.056

Results	Sutton Tools	Competitor
Cutting Time (min)	320	105
Tool life (m)	103.3	33.9



Application 2 - Tool Wear Comparison

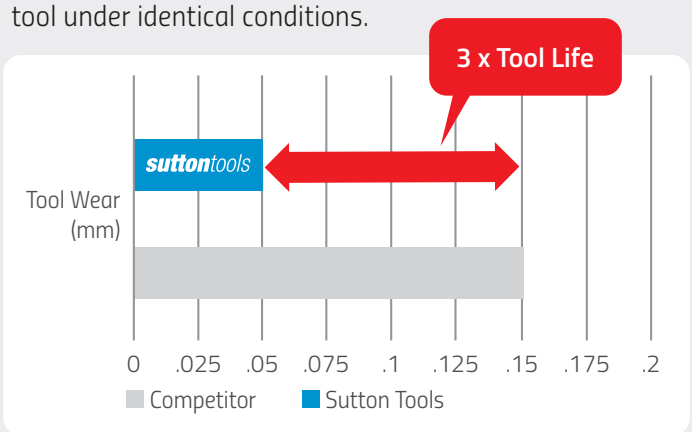
Set up

Part No	E4741210
Standard	DIN6527L
Coolant	External
Material	Inconel 718
Machine type	HAAS VF2 SS

Test Data

Tool Diameter (mm)	12
z (teeth number)	5
ae (mm)	3.8
ap (mm) / depth	6
Cutting Speed V(m/min)	33
Feed f(mm/flute)	0.035

Wear measured after 7 minutes of machining with each tool under identical conditions.

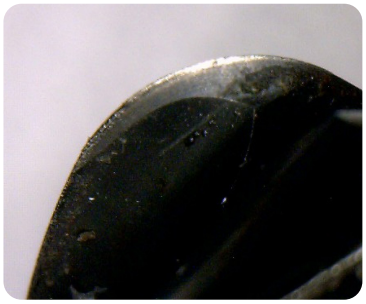


Application 3 - Dynamic Milling

Edge Condition after 23 blades

Set up

Part No	E4741225
Standard	DIN6527L
Workpiece	Turbine Blades
Material	**3D Print. Ti**
Coolant	External

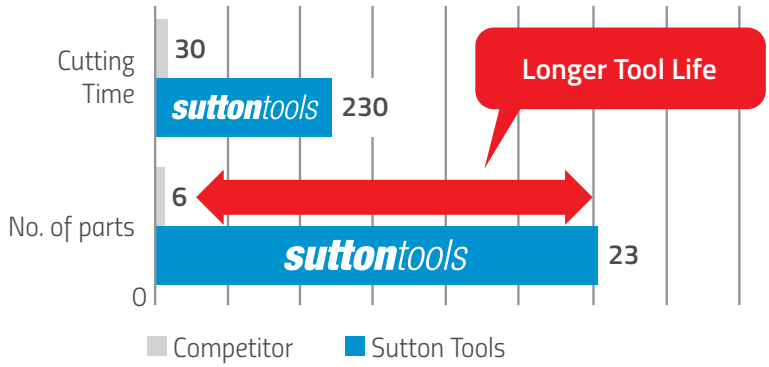


Close up of tool wear

Test Data	Sutton	Competitor
z (teeth number)	5	6
ae (mm)	12	3
ap (mm) / depth	6	6
Cutting Speed V(m/min)	83	65
RPM	2200	1723
Feed Rate (mm/min)	1320	517
Feed f(mm/flute)	0.12	0.05

Results

Cutting Time (min)	230	30
MRR (cm3/min)	95.0	9.3
Tool life (m)	303.5	15.5
No. of parts	23	6



Application 4 - Tool Life vs Parts

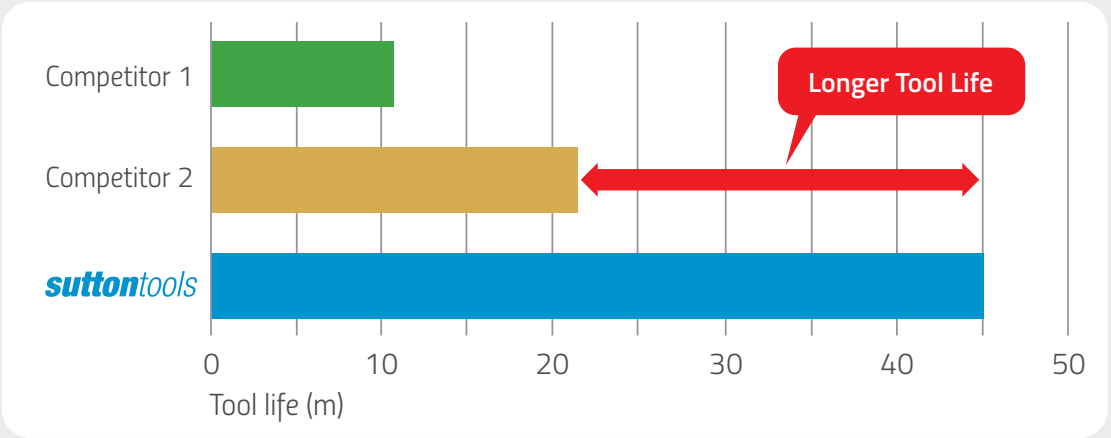
Set up

Part No	E4741010
Workpiece	Bracket
Material	Inconel 625
Coolant	External

Test Data	Competitor 1	Competitor 2	Sutton Tools
z (teeth number)	4	4	5
ae (mm)	0.4	0.4	0.5
ap (mm) / depth	22	22	22
Cutting Speed V(m/min)	45	45	45
RPM	1431	1431	1431
Feed Rate (mm/min)	343	343	500
Feed f(mm/flute)	0.06	0.06	0.07

Results

MRR (cm3/min)	12.6	12.6	15.7
Material Volume (cm3)	403	806	1417
Tool life (m)	11.0	22.0	45.0
No. of parts	2	4	10



Endmills Carbide, 5 Flute, R40/42 Ni, DIN6527L, *Harmony*

suttontools

HARMONY Ni SERIES

- Excellent solution for stainless steels and super alloy
- Optimised geometry with variable helix design
- XCeed for outstanding oxidation resistance and hot hardness

Fraise 5 dents carbure, R40°/42° Ni, DIN6527L, HARMONY, Torique

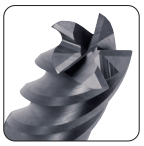
- Optimisée pour les bases Nickel, Duplex et Super-Duplex
- Hélice variable pour supprimer les vibrations
- Revêtement Xceed pour une bonne résistance à l'oxidation et à les hautes températures.

Frese metallo duro, 5 Taglienti, R40/42 Ni, Toriche, DIN6527L, Harmony

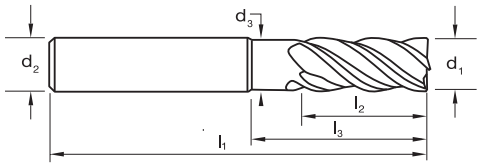
- Fresa torica il cui raggio di testa viene interamente rettificato in un unica volta senza riprese
- Ottimizzata per una vita utensile maggiore su leghe di inconel, acciaio inossidabile
- Elica variabile per eliminare le vibrazioni
- Web rastremato per aumetare rigidità
- Xceed per un eccezionale resistenza all'ossidazione e alle alte temperature

Fresas de MD, 5 Ranuras, R40/42 Ni, DIN6527L, Harmony

- Filo facetado para aplicaciones de acabado
- Optimizado para una mayor vida útil de la herramienta en aleaciones de inconel, acero inoxidable
- Diseño de hélice variable para suprimir vivraciones
- Núcleo cónico para aumentar la rigidez
- Xceed para una excelente resistencia a la oxidación y dureza en caliente



DIN 6527L | MICRO | 12° | 45°



	E472	E473
Catalogue Code	E472	E473
Product Group	B0210	B0210
Material	VHM-ULTRA	VHM-ULTRA
Surface Finish	*Xceed*	*Xceed*
Sutton Designation	**Ni**	**Ni**
Geometry	R40/42 Ni	R40/42 Ni
Shank Form (DIN 6535)	HA	HA
Shank Tolerance	h6	h6

Size Ref.	d_1 (e8)	l_1	l_2	l_3	d_2	d_3	z	chf	rad	Item #	Item #
0600	**6.0**	57	13	21	6	5.7	5	0.20	-	E472 0600	E473 0600
0800	**8.0**	63	19	27	8	7.6	5	0.20	-	E472 0800	E473 0800
1000	**10.0**	72	22	32	10	9.5	5	0.25	-	E472 1000	E473 1000
1200	**12.0**	83	26	38	12	11.5	5	0.25	-	E472 1200	E473 1200
1600	**16.0**	92	32	44	16	15.5	5	0.35	-	E472 1600	E473 1600
2000	**20.0**	104	38	54	20	19.5	5	0.35	-	E472 2000	E473 2000

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
E472	●	●	●	●	●	○	○	○	○	○	○	○	○	●	●	●																●	●	●	●	●													
E473	●	●	●	●	●	○	○	○	○	○	○	○	○	●	●	●																●	●	●	●	●													

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 Ni, Cnr Rad, DIN6527L, *Harmony*

suttontools

HARMONY Ni SERIES

- Excellent solution for stainless steels and super alloy
- Optimised geometry with variable helix design
- XCeed for outstanding oxidation resistance and hot hardness

Fraise 5 dents carbure, R40°/42° Ni, DIN6527L, HARMONY, Torique

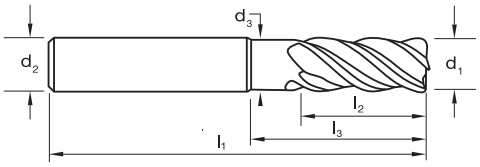
- Optimisée pour les bases Nickel, Duplex et Super-Duplex
- Hélice variable pour supprimer les vibrations
- Revêtement Xceed pour une bonne résistance à l'oxidation et à les hautes températures.

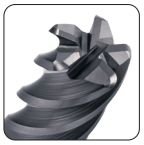
Frese metallo duro, 5 Taglienti, R40/42 Ni, Toriche, DIN6527L, Harmony

- Fresa torica il cui raggio di testa viene interamente rettificato in un unica volta senza riprese
- Ottimizzata per una vita utensile maggiore su leghe di inconel, acciaio inossidabile
- Elica variabile per eliminare le vibrazioni
- Web rastremato per aumetare rigidità
- Xceed per un eccezionale resistenza all'ossidazione e alle alte temperature

Fresas de MD, 5 Ranuras, R40/42 Ni, DIN6527L, Harmony

- Filo facetado para aplicaciones de acabado
- Optimizado para una mayor vida útil de la herramienta en aleaciones de inconel, acero inoxidable
- Diseño de hélice variable para suprimir vivraciones
- Núcleo cónico para aumentar la rigidez
- Xceed para una excelente resistencia a la oxidación y dureza en caliente





	E474	E475
Catalogue Code	E474	E475
Product Group	B0210	B0210
Material	VHM-ULTRA	VHM-ULTRA
Surface Finish	*Xceed*	*Xceed*
Sutton Designation	**Ni**	**Ni**
Geometry	R40/42 Ni	R40/42 Ni
Shank Form (DIN 6535)	HA	HA
Shank Tolerance	h6	h6

Size Ref.	d_1 (e8)	l_1	l_2	l_3	d_2	d_3	z	chf	rad	Item #	Item #
0605	**6.0**	57	13	21	6	5.7	5	-	0.5	E474 0605	E475 0605
0610		57	13	21	6	5.7	5	-	1.0	E474 0610	E475 0610
0805	**8.0**	63	19	27	8	7.6	5	-	0.5	E474 0805	E475 0805
0810		63	19	27	8	7.6	5	-	1.0	E474 0810	E475 0810
1005	**10.0**	72	22	32	10	9.5	5	-	0.5	E474 1005	E475 1005
1010		72	22	32	10	9.5	5	-	1.0	E474 1010	E475 1010
1210	**12.0**	83	26	38	12	11.5	5	-	1.0	E474 1210	E475 1210
1215		83	26	38	12	11.5	5	-	1.5	E474 1215	E475 1215
1225		83	26	38	12	11.5	5	-	2.5	E474 1225	E475 1225
1240		83	26	38	12	11.5	5	-	4.0	E474 1240	E475 1240
1610	**16.0**	92	32	44	16	15.5	5	-	1.0	E474 1610	E475 1610
1615		92	32	44	16	15.5	5	-	1.5	E474 1615	E475 1615
1625		92	32	44	16	15.5	5	-	2.5	E474 1625	E475 1625
1640		92	32	44	16	15.5	5	-	4.0	E474 1640	E475 1640
2010	**20.0**	104	38	54	20	19.5	5	-	1.0	E474 2010	E475 2010
2015		104	38	54	20	19.5	5	-	1.5	E474 2015	E475 2015
2025		104	38	54	20	19.5	5	-	2.5	E474 2025	E475 2025
2040		104	38	54	20	19.5	5	-	4.0	E474 2040	E475 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
E474	●	●	●	●	●	○	○	○	○	○	○	○	○	●	●	●																	●	●	●	●	●											
E475	●	●	●	●	●	○	○	○	○	○	○	○	○	●	●	●																	●	●	●	●	●											

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

● Optimal ○ Effective

Endmills Carbide, 7 Flute, R40/42 Ni, Extra Long

suttontools

HARMONY Ni SERIES

- Excellent solution for stainless steels and super alloy
- Optimised geometry with variable helix design
- XCeed for outstanding oxidation resistance and hot hardness

Fraise 7 dents carbure, R40°/42° Ni, DIN6527L, HARMONY, Torique

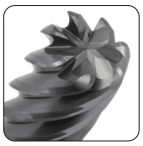
- Optimisée pour les bases Nickel, Duplex et Super-Duplex
- Hélice variable pour supprimer les vibrations
- Revêtement Xceed pour une bonne résistance à l'oxidation et à les hautes températures.

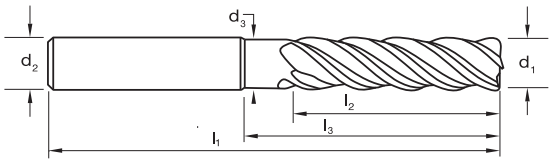
Frese metallo duro, 7 Taglienti, R40/42 Ni, Toriche, DIN6527L, Harmony

- Fresa torica il cui raggio di testa viene interamente rettificato in un unica volta senza riprese
- Ottimizzata per una vita utensile maggiore su leghe di inconel, acciaio inossidabile
- Elica variabile per eliminare le vibrazioni
- Web rastremato per aumetare rigidità
- Xceed per un eccezionale resistenza all'ossidazione e alle alte temperature

Fresas de MD, 7 Ranuras, R40/42 Ni, DIN6527L, Harmony

- Filo facetado para aplicaciones de acabado
- Optimizado para una mayor vida útil de la herramienta en aleaciones de inconel, acero inoxidable
- Diseño de hélice variable para suprimir vivraciones
- Núcleo cónico para aumentar la rigidez
- Xceed para una excelente resistencia a la oxidación y dureza en caliente





Catalogue Code	E486
Product Group	B0210
Material	VHM-ULTRA
Surface Finish	*Xceed*
Sutton Designation	Ni-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	
	SUTTON STD - 3XL								
1000	10	85	34	44	10	95	7	-	E486 1000
1020	10	85	34	44	10	95	7	2	E486 1020
1025	10	85	34	44	10	95	7	2.5	E486 1025
1040	10	85	34	44	10	95	7	4	E486 1040
1200	12	96	40	51	12	11.5	7	-	E486 1200
1210	12	96	40	51	12	11.5	7	1	E486 1210
1215	12	96	40	51	12	11.5	7	1.5	E486 1215
1220	12	96	40	51	12	11.5	7	2	E486 1220
1225	12	96	40	51	12	11.5	7	2.5	E486 1225
1230	12	96	40	51	12	11.5	7	3	E486 1230
1240	12	96	40	51	12	11.5	7	4	E486 1240
1600	16	105	52	57	16	15.5	7	-	E486 1600
1610	16	105	52	57	16	15.5	7	1	E486 1610
1615	16	105	52	57	16	15.5	7	1.5	E486 1615
1620	16	105	52	57	16	15.5	7	2	E486 1620
1625	16	105	52	57	16	15.5	7	2.5	E486 1625
1630	16	105	52	57	16	15.5	7	3	E486 1630
1640	16	105	52	57	16	15.5	7	4	E486 1640
2000	20	140	64	80	20	19.5	7	-	E486 2000
2010	20	140	64	80	20	19.5	7	1	E486 2010
2015	20	140	64	80	20	19.5	7	1.5	E486 2015
2020	20	140	64	80	20	19.5	7	2	E486 2020
2025	20	140	64	80	20	19.5	7	2.5	E486 2025
2030	20	140	64	80	20	19.5	7	3	E486 2030
2040	20	140	64	80	20	19.5	7	4	E486 2040
2050	20	140	64	80	20	19.5	7	5	E486 2050

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
E486	●	●	●	●	●	○	○	○	○	○	○	○	○	●	●	●																	●	●	●	●	●												

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

● Optimal ○ Effective

Endmills Carbide, 9 Flute, R40/42 Ni, Extra Long

suttontools

HARMONY Ni SERIES

- Excellent solution for stainless steels and super alloy
- Optimised geometry with variable helix design
- XCeed for outstanding oxidation resistance and hot hardness

Fraise 7 dents carbure, R40°/42° Ni, DIN6527L, HARMONY, Torique

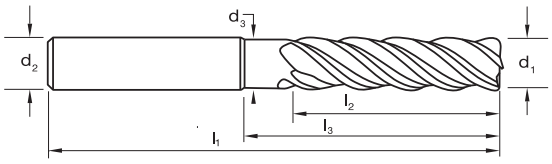
- Optimisée pour les bases Nickel, Duplex et Super-Duplex
- Hélice variable pour supprimer les vibrations
- Revêtement Xceed pour une bonne résistance à l'oxidation et à les hautes températures.

Frese metallo duro, 7 Taglienti, R40/42 Ni, Toriche, DIN6527L, Harmony

- Fresa torica il cui raggio di testa viene interamente rettificato in un unica volta senza riprese
- Ottimizzata per una vita utensile maggiore su leghe di inconel, acciaio inossidabile
- Elica variabile per eliminare le vibrazioni
- Web rastremato per aumetare rigidità
- Xceed per un eccezionale resistenza all'ossidazione e alle alte temperature

Fresas de MD, 7 Ranuras, R40/42 Ni, DIN6527L, Harmony

- Filo facetado para aplicaciones de acabado
- Optimizado para una mayor vida útil de la herramienta en aleaciones de inconel, acero inoxidable
- Diseño de hélice variable para suprimir vivraciones
- Núcleo cónico para aumentar la rigidez
- Xceed para una excelente resistencia a la oxidación y dureza en caliente



Catalogue Code	E487
Product Group	B0210
Material	VHM-ULTRA
Surface Finish	*Xceed*
Sutton Designation	Ni-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	9	-	E487 1000
1020	**10**	93	42	52	10	9.5	9	2	E487 1020
1025	**10**	93	42	52	10	9.5	9	2.5	E487 1025
1040	**10**	93	42	52	10	9.5	9	4	E487 1040
1200	**12**	110	50	65	12	11.5	9	-	E487 1200
1210	**12**	110	50	65	12	11.5	9	1	E487 1210
1215	**12**	110	50	65	12	11.5	9	1.5	E487 1215
1220	**12**	110	50	65	12	11.5	9	2	E487 1220
1225	**12**	110	50	65	12	11.5	9	2.5	E487 1225
1230	**12**	110	50	65	12	11.5	9	3	E487 1230
1240	**12**	110	50	65	12	11.5	9	4	E487 1240
1600	**16**	130	66	82	16	15.5	9	-	E487 1600
1610	**16**	130	66	82	16	15.5	9	1	E487 1610
1615	**16**	130	66	82	16	15.5	9	1.5	E487 1615
1620	**16**	130	66	82	16	15.5	9	2	E487 1620
1625	**16**	130	66	82	16	15.5	9	2.5	E487 1625
1630	**16**	130	66	82	16	15.5	9	3	E487 1630
1640	**16**	130	66	82	16	15.5	9	4	E487 1640
2000	**20**	160	82	100	20	19.5	9	-	E487 2000
2010	**20**	160	82	100	20	19.5	9	1	E487 2010
2015	**20**	160	82	100	20	19.5	9	1.5	E487 2015
2020	**20**	160	82	100	20	19.5	9	2	E487 2020
2025	**20**	160	82	100	20	19.5	9	2.5	E487 2025
2030	**20**	160	82	100	20	19.5	9	3	E487 2030
2040	**20**	160	82	100	20	19.5	9	4	E487 2040
2050	**20**	160	82	100	20	19.5	9	5	E487 2050

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
E487	●	●	●	●	●	○	○	○	○	○	○	○	○	●	●	●																	●	●	●	●	●											

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

● Optimal ○ Effective

Guide to the cutting conditions

CAM programming software is required to control the cycle/toolpaths, with different information needed to suit the various conditions, such as material type.

These cutting conditions are a guide for Dynamic & Trochoidal applications & will vary subject to the users own machine conditions & set-up variables.

Careful consideration has been given to chip loads based on the step over (ae) size of cut to ensure chip thinning is eliminated, with deflection kept to a minimum.

Workpiece Material

- LOW MACHINEABILITY / HARDER TO MACHINE = increase in process reliability
- HIGH MACHINABILITY / EASY TO MACHINE = increase in productivity

Machine Size

- Larger Machines = high spindle torque, stable feed, ideal for medium & larger tools
- Smaller Machines = higher spindle speed, shorter acceleration & deceleration, ideal for small to medium tools

Workpiece Clamping

- Stable = optimised metal removal rate can be achieved
- Unstable = reduce feed for increased process reliability

Tool Clamping

- HA shank style = higher concentricity aids in longer tool life, but with increased pull out in extremely tough materials when heavy cuts are taken.
- HB shank style = lower concentricity but eliminates pull out, ideal for larger machines & tool diameters.

Tool engagement angle

- For Concave milling paths, engagement angle increases, therefore tool stress increases - ae & fz must be reduced by 20%
- 90 deg Corner radius milling paths = tool radius, conditions affected dramatically – vc & fz must be reduced by 70%.
- 90 deg Corner radius milling paths < tool radius, condition is stable - ae & fz must be reduced by 30%
- For Convex milling paths, engagement angle decreases, therefore tool stress decreases - ae & fz can be increased.

Dynamic & Trochoidal Cutting parameters

Standard Length – E472-E475

ROUGHING

ISO	VDI^ 3323	Material		Condition	HB	N/mm²	Common Grades	Vc (m/min)	Tool Engagement Angle	Recommended ae	Max ap	6mm	8mm	10mm	12mm	16mm	20mm
P	1	Steel - Non-alloy, cast & free cutting	~ 0.15 %C	A	125	440	1020, S1214L	270	53°	0.2x d1	l2	0.044	0.070	0.088	0.106	0.140	0.176
	2		~ 0.45 %C	A	190	640	1045	270				0.044	0.070	0.088	0.106	0.140	0.176
	3			QT	250	840		270				0.044	0.070	0.088	0.106	0.140	0.176
	4		~ 0.75 %C	A	270	910	1055, 1060	270				0.044	0.070	0.088	0.106	0.140	0.176
	5			QT	300	1010		210				0.042	0.063	0.081	0.096	0.129	0.159
	6	Steel - Low alloy & cast < 5% of alloying elements		A	180	610	4140, 4340	270				0.044	0.070	0.088	0.106	0.140	0.176
	7			QT	275	930		270				0.044	0.070	0.088	0.106	0.140	0.176
	8			QT	300	1010		210				0.042	0.063	0.081	0.096	0.129	0.159
	9			QT	350	1180		210				0.042	0.063	0.081	0.096	0.129	0.159
	10	Steel - High alloy, cast & tool		A	200	680	A2, H13 (SKD61), D2	270				0.044	0.070	0.088	0.106	0.140	0.176
	11			HT	325	1100		210				0.042	0.063	0.081	0.096	0.129	0.159
	12	Steel - Corrosion resistant & cast	Ferritic / Martensitic	A	200	680	SS430, 431, 440C	210				0.042	0.063	0.081	0.096	0.129	0.159
	13		Martensitic	QT	240	810		210				0.042	0.063	0.081	0.096	0.129	0.159
M	14.1	Stainless Steel	Austenitic	AH	180	610	303, 304, 316	150	46°	0.15 x d1	l2	0.039	0.054	0.066	0.081	0.105	0.132
	14.2		Duplex		250	840	321, 341	100	37°	0.1 x d1		0.048	0.063	0.081	0.096	0.129	0.162
	14.3		Precipitation Hardening		250	840	15-5Ph, 17-4Ph	100				0.048	0.063	0.081	0.096	0.129	0.162
S	31	High temp. alloys	Fe based	A	200	680		60	31°	0.08 x d1	l2	0.045	0.060	0.075	0.090	0.120	0.150
	32			AH	280	950		50				0.045	0.060	0.075	0.090	0.120	0.150
	33		Ni / Co based	A	250	840	Inconel 625	50				0.045	0.060	0.075	0.090	0.120	0.150
	34			AH	350	1180	Inconel 718	40				0.045	0.060	0.075	0.090	0.120	0.150
	35			C	320	1080	Inconel 718	30				0.045	0.060	0.075	0.090	0.120	0.150

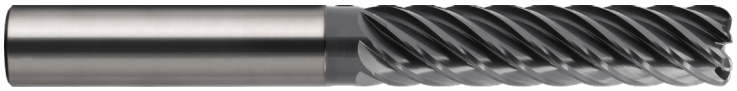
UNIVERSAL

ISO	VDI^ 3323	Material		Condition	HB	N/mm²	Common Grades	Vc (m/min)	Tool Engagement Angle	Recommended ae	Max ap	6mm	8mm	10mm	12mm	16mm	20mm
P	1	Steel - Non-alloy, cast & free cutting	~ 0.15 %C	A	125	440	1020, S1214L	290	46°	0.15x d1	l2	0.051	0.084	0.105	0.126	0.168	0.210
	2		~ 0.45 %C	A	190	640	1045	290				0.051	0.084	0.105	0.126	0.168	0.210
	3			QT	250	840		290				0.051	0.084	0.105	0.126	0.168	0.210
	4		~ 0.75 %C	A	270	910	1055, 1060	290				0.051	0.084	0.105	0.126	0.168	0.210
	5			QT	300	1010		230				0.051	0.075	0.096	0.114	0.153	0.189
	6	Steel - Low alloy & cast < 5% of alloying elements		A	180	610	4140, 4340	290				0.051	0.084	0.105	0.126	0.168	0.210
	7			QT	275	930		290				0.051	0.084	0.105	0.126	0.168	0.210
	8			QT	300	1010		230				0.051	0.075	0.096	0.114	0.153	0.189
	9			QT	350	1180		230				0.051	0.075	0.096	0.114	0.153	0.189
	10	Steel - High alloy, cast & tool		A	200	680	A2, H13 (SKD61), D2	290				0.051	0.084	0.105	0.126	0.168	0.210
	11			HT	325	1100		230				0.051	0.075	0.096	0.114	0.153	0.189
	12	Steel - Corrosion resistant & cast	Ferritic / Martensitic	A	200	680	SS430, 431, 440C	230				0.051	0.075	0.096	0.114	0.153	0.189
	13		Martensitic	QT	240	810		230				0.051	0.075	0.096	0.114	0.153	0.189
M	14.1	Stainless Steel	Austenitic	AH	180	610	303, 304, 316	170	37°	0.10 x d1	l2	0.048	0.063	0.081	0.096	0.129	0.162
	14.2		Duplex		250	840	321, 341	110	31°	0.08 x d1		0.054	0.069	0.087	0.105	0.141	0.174
	14.3		Precipitation Hardening		250	840	15-5Ph, 17-4Ph	110				0.054	0.069	0.087	0.105	0.141	0.174
S	31	High temp. alloys	Fe based	A	200	680		60	26°	0.05 x d1	l2	0.045	0.060	0.075	0.090	0.120	0.150
	32			AH	280	950		50				0.045	0.060	0.075	0.090	0.120	0.150
	33		Ni / Co based	A	250	840	Inconel 625	50				0.045	0.060	0.075	0.090	0.120	0.150
	34			AH	350	1180	Inconel 718	40				0.045	0.060	0.075	0.090	0.120	0.150
	35			C	320	1080	Inconel 718	30				0.045	0.060	0.075	0.090	0.120	0.150

FINISHING

ISO	VDI^ 3323	Material		Condition	HB	N/mm²	Common Grades	Vc (m/min)	Tool Engagement Angle	Recommended ae	Max ap	6mm	8mm	10mm	12mm	16mm	20mm
P	1	Steel - Non-alloy, cast & free cutting	~ 0.15 %C	A	125	440	1020, S1214L	300	18°	0.02x d1	l2	0.039	0.063	0.078	0.093	0.123	0.153
	2		~ 0.45 %C	A	190	640	1045	300				0.039	0.063	0.078	0.093	0.123	0.153
	3			QT	250	840		300				0.039	0.063	0.078	0.093	0.123	0.153
	4		~ 0.75 %C	A	270	910	1055, 1060	300				0.039	0.063	0.078	0.093	0.123	0.153
	5			QT	300	1010		250				0.039	0.057	0.069	0.084	0.111	0.141
	6	Steel - Low alloy & cast < 5% of alloying elements		A	180	610	4140, 4340	300				0.039	0.063	0.078	0.093	0.123	0.153
	7			QT	275	930		300				0.039	0.063	0.078	0.093	0.123	0.153
	8			QT	300	1010		250				0.039	0.057	0.069	0.084	0.111	0.141
	9			QT	350	1180		250				0.039	0.057	0.069	0.084	0.111	0.141
	10	Steel - High alloy, cast & tool		A	200	680	A2, H13 (SKD61), D2	300				0.039	0.063	0.078	0.093	0.123	0.153
	11			HT	325	1100		250				0.039	0.057	0.069	0.084	0.111	0.141
	12	Steel - Corrosion resistant & cast	Ferritic / Martensitic	A	200	680	SS430, 431, 440C	250				0.039	0.057	0.069	0.084	0.111	0.141
	13		Martensitic	QT	240	810		250				0.039	0.057	0.069	0.084	0.111	0.141
M	14.1	Stainless Steel	Austenitic	AH	180	610	303, 304, 316	170	18°	0.02 x d1	l2	0.030	0.039	0.048	0.060	0.078	0.099
	14.2		Duplex		250	840	321, 341	120	11°	0.01 x d1		0.039	0.051	0.063	0.075	0.102	0.126
	14.3		Precipitation Hardening		250	840	15-5Ph, 17-4Ph	120				0.039	0.051	0.063	0.075	0.102	0.126
S	31	High temp. alloys	Fe based	A	200	680		70	11°	0.01 x d1	l2	0.033	0.042	0.054	0.066	0.087	0.108
	32			AH	280	950		60				0.033	0.042	0.054	0.066	0.087	0.108
	33		Ni / Co based	A	250	840	Inconel 625	60				0.033	0.042	0.054	0.066	0.087	0.108
	34			AH	350	1180	Inconel 718	50				0.033	0.042	0.054	0.066	0.087	0.108
	35			C	320	1080	Inconel 718	40				0.033	0.042	0.054	0.066	0.087	0.108

Dynamic & Trochoidal Cutting parameters



Extra Length – E486 & E487 Series

ROUGHING

ISO	VDI^ 3323	Material		Condition	HB	N/mm²	Common Grades	Vc (m/min)	Tool Engagement Angle	Recommended ae	Max ap	6mm	8mm	10mm	12mm	16mm	20mm
P	1	Steel - Non-alloy, cast & free cutting	~ 0.15 %C	A	125	440	1020, S1214L	270	53°	0.2x d1	l2	0.044	0.070	0.088	0.106	0.140	0.176
	2		~ 0.45 %C	A	190	640	1045	270				0.044	0.070	0.088	0.106	0.140	0.176
	3			QT	250	840		270				0.044	0.070	0.088	0.106	0.140	0.176
	4		~ 0.75 %C	A	270	910	1055, 1060	270				0.044	0.070	0.088	0.106	0.140	0.176
	5			QT	300	1010		210				0.042	0.063	0.081	0.096	0.129	0.159
	6	Steel - Low alloy & cast < 5% of alloying elements		A	180	610	4140, 4340	270				0.044	0.070	0.088	0.106	0.140	0.176
	7			QT	275	930		270				0.044	0.070	0.088	0.106	0.140	0.176
	8			QT	300	1010		210				0.042	0.063	0.081	0.096	0.129	0.159
	9			QT	350	1180		210				0.042	0.063	0.081	0.096	0.129	0.159
	10	Steel - High alloy, cast & tool		A	200	680	A2, H13 (SKD61), D2	270				0.044	0.070	0.088	0.106	0.140	0.176
	11			HT	325	1100		210				0.042	0.063	0.081	0.096	0.129	0.159
	12	Steel - Corrosion resistant & cast	Ferritic / Martensitic	A	200	680	SS430, 431, 440C	210				0.042	0.063	0.081	0.096	0.129	0.159
	13		Martensitic	QT	240	810		210				0.042	0.063	0.081	0.096	0.129	0.159
M	14.1	Stainless Steel	Austenitic	AH	180	610	303, 304, 316	150	46°	0.15 x d1	l2	0.039	0.054	0.066	0.081	0.105	0.132
	14.2		Duplex		250	840	321, 341	100	37°	0.1 x d1		0.048	0.063	0.081	0.096	0.129	0.162
	14.3		Precipitation Hardening		250	840	15-5Ph, 17-4Ph	100				0.048	0.063	0.081	0.096	0.129	0.162
S	31	High temp. alloys	Fe based	A	200	680		60	31°	0.08 x d1	l2	0.045	0.060	0.075	0.090	0.120	0.150
	32			AH	280	950		50				0.045	0.060	0.075	0.090	0.120	0.150
	33		Ni / Co based	A	250	840	Inconel 625	50				0.045	0.060	0.075	0.090	0.120	0.150
	34			AH	350	1180	Inconel 718	40				0.045	0.060	0.075	0.090	0.120	0.150
	35			C	320	1080	Inconel 718	30				0.045	0.060	0.075	0.090	0.120	0.150

UNIVERSAL

ISO	VDI^ 3323	Material		Condition	HB	N/mm²	Common Grades	Vc (m/min)	Tool Engagement Angle	Recommended ae	Max ap	6mm	8mm	10mm	12mm	16mm	20mm
P	1	Steel - Non-alloy, cast & free cutting	~ 0.15 %C	A	125	440	1020, S1214L	290	46°	0.15x d1	l2	0.051	0.084	0.105	0.126	0.168	0.210
	2		~ 0.45 %C	A	190	640	1045	290				0.051	0.084	0.105	0.126	0.168	0.210
	3			QT	250	840		290				0.051	0.084	0.105	0.126	0.168	0.210
	4		~ 0.75 %C	A	270	910	1055, 1060	290				0.051	0.084	0.105	0.126	0.168	0.210
	5			QT	300	1010		230				0.051	0.075	0.096	0.114	0.153	0.189
	6	Steel - Low alloy & cast < 5% of alloying elements		A	180	610	4140, 4340	290				0.051	0.084	0.105	0.126	0.168	0.210
	7			QT	275	930		290				0.051	0.084	0.105	0.126	0.168	0.210
	8			QT	300	1010		230				0.051	0.075	0.096	0.114	0.153	0.189
	9			QT	350	1180		230				0.051	0.075	0.096	0.114	0.153	0.189
	10	Steel - High alloy, cast & tool		A	200	680	A2, H13 (SKD61), D2	290				0.051	0.084	0.105	0.126	0.168	0.210
	11			HT	325	1100		230				0.051	0.075	0.096	0.114	0.153	0.189
	12	Steel - Corrosion resistant & cast	Ferritic / Martensitic	A	200	680	SS430, 431, 440C	230				0.051	0.075	0.096	0.114	0.153	0.189
	13		Martensitic	QT	240	810		230				0.051	0.075	0.096	0.114	0.153	0.189
M	14.1	Stainless Steel	Austenitic	AH	180	610	303, 304, 316	170	37°	0.10 x d1	l2	0.048	0.063	0.081	0.096	0.129	0.162
	14.2		Duplex		250	840	321, 341	110	31°	0.08 x d1		0.054	0.069	0.087	0.105	0.141	0.174
	14.3		Precipitation Hardening		250	840	15-5Ph, 17-4Ph	110				0.054	0.069	0.087	0.105	0.141	0.174
S	31	High temp. alloys	Fe based	A	200	680		60	26°	0.05 x d1	l2	0.045	0.060	0.075	0.090	0.120	0.150
	32			AH	280	950		50				0.045	0.060	0.075	0.090	0.120	0.150
	33		Ni / Co based	A	250	840	Inconel 625	50				0.045	0.060	0.075	0.090	0.120	0.150
	34			AH	350	1180	Inconel 718	40				0.045	0.060	0.075	0.090	0.120	0.150
	35			C	320	1080	Inconel 718	30				0.045	0.060	0.075	0.090	0.120	0.150

FINISHING

ISO	VDI^ 3323	Material		Condition	HB	N/mm²	Common Grades	Vc (m/min)	Tool Engagement Angle	Recommended ae	Max ap	6mm	8mm	10mm	12mm	16mm	20mm
P	1	Steel - Non-alloy, cast & free cutting	~ 0.15 %C	A	125	440	1020, S1214L	300	18°	0.02x d1	l2	0.039	0.063	0.078	0.093	0.123	0.153
	2		~ 0.45 %C	A	190	640	1045	300				0.039	0.063	0.078	0.093	0.123	0.153
	3			QT	250	840		300				0.039	0.063	0.078	0.093	0.123	0.153
	4		~ 0.75 %C	A	270	910	1055, 1060	300				0.039	0.063	0.078	0.093	0.123	0.153
	5			QT	300	1010		250				0.039	0.057	0.069	0.084	0.111	0.141
	6	Steel - Low alloy & cast < 5% of alloying elements		A	180	610	4140, 4340	300				0.039	0.063	0.078	0.093	0.123	0.153
	7			QT	275	930		300				0.039	0.063	0.078	0.093	0.123	0.153
	8			QT	300	1010		250				0.039	0.057	0.069	0.084	0.111	0.141
	9			QT	350	1180		250				0.039	0.057	0.069	0.084	0.111	0.141
	10	Steel - High alloy, cast & tool		A	200	680	A2, H13 (SKD61), D2	300				0.039	0.063	0.078	0.093	0.123	0.153
	11			HT	325	1100		250				0.039	0.057	0.069	0.084	0.111	0.141
	12	Steel - Corrosion resistant & cast	Ferritic / Martensitic	A	200	680	SS430, 431, 440C	250				0.039	0.057	0.069	0.084	0.111	0.141
	13		Martensitic	QT	240	810		250				0.039	0.057	0.069	0.084	0.111	0.141
M	14.1	Stainless Steel	Austenitic	AH	180	610	303, 304, 316	170	18°	0.02 x d1	l2	0.030	0.039	0.048	0.060	0.078	0.099
	14.2		Duplex		250	840	321, 341	120	11°	0.01 x d1		0.039	0.051	0.063	0.075	0.102	0.126
	14.3		Precipitation Hardening		250	840	15-5Ph, 17-4Ph	120				0.039	0.051	0.063	0.075	0.102	0.126
S	31	High temp. alloys	Fe based	A	200	680		70	11°	0.01 x d1	l2	0.033	0.042	0.054	0.066	0.087	0.108
	32			AH	280	950		60				0.033	0.042	0.054	0.066	0.087	0.108
	33		Ni / Co based	A	250	840	Inconel 625	60				0.033	0.042	0.054	0.066	0.087	0.108
	34			AH	350	1180	Inconel 718	50				0.033	0.042	0.054	0.066	0.087	0.108
	35			C	320	1080	Inconel 718	40				0.033	0.042	0.054	0.066	0.087	0.108

Sutton Tools Europe Cooperatie U.A. TVA/VAT No. NL 821219674B01

Australia (Head Office) 378 Settlement Road, Thomastown 3074, Victoria Australia
T +61 3 9280 0800 **F** +61 3 9464 0015 **E** cservice@sutton.com.au

The Netherlands (Europe Head Office) Bruijellestraat 4, 5048 Ae Tilburg, Nederland
T +31 13 220 1480 **E** suttontools.eu@sutton.com.au

www.suttontools.com

499980587_0121