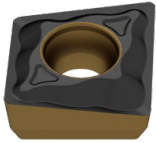


New products for machining technicians

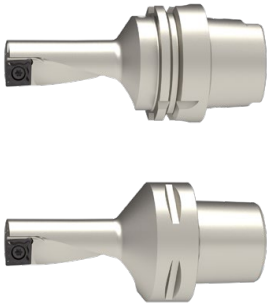
NEW ISO-P indexable inserts



Update of the reliable CVD EcoCut grades CTCP425 / CTCP435. With the update, the grades are more wear-resistant and have a wear-detection coating layer.

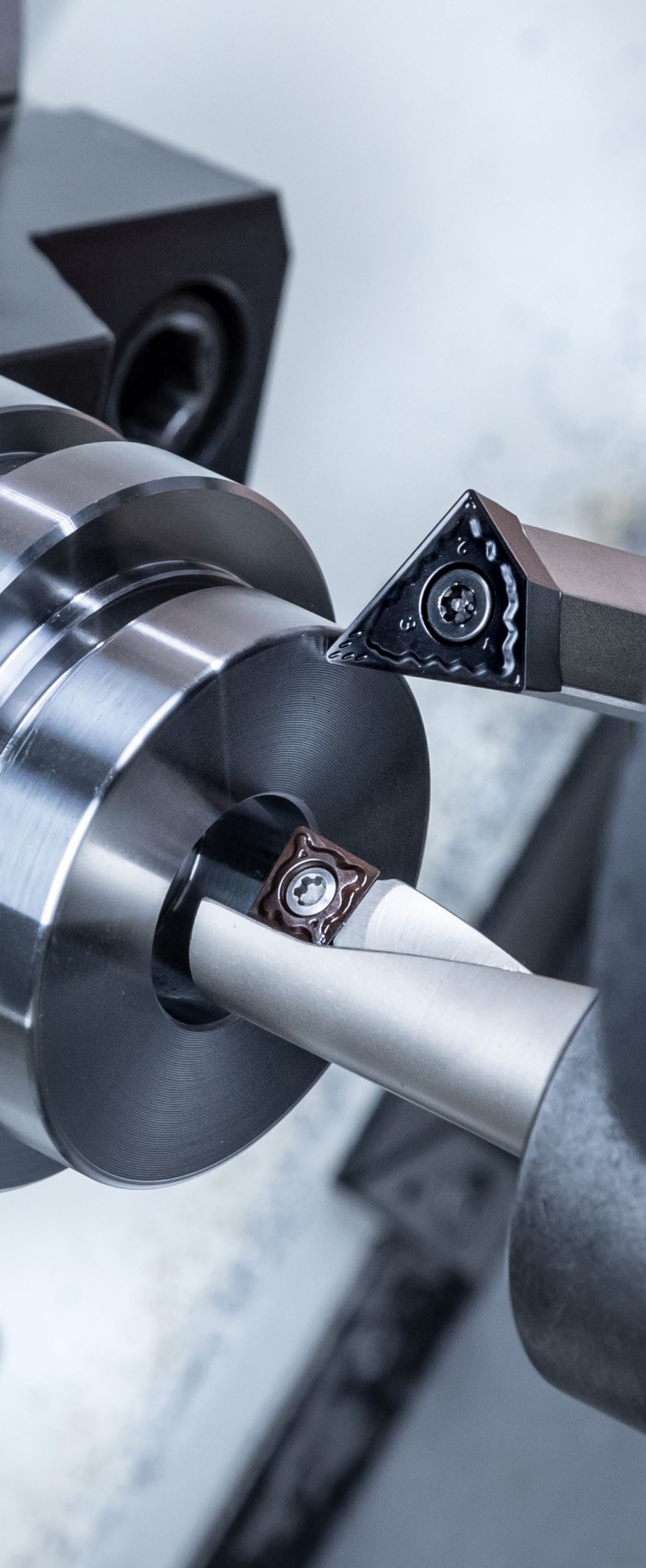
→ Page 11

NEW EcoCut Classic with direct machine interface



The new EcoCut Classic product range with direct machine interface performs the same application functions as all other EcoCut Classic tools, but the new monotools impress when it comes to stability – and therefore run quietly and very reliably. Furthermore, chip removal has been optimised thanks to the updated chip space, guaranteeing process security.

→ Page 15+16



Solid drilling and bore machining

- 1 HSS drilling
- 2 Solid carbide drilling
- 3 Indexable insert drilling
- 4 Reaming and Countersinking

Threading

- 5 Spindle Tooling
- 6 Taps and thread formers
- 7 Circular and Thread Milling
- 8 Thread turning

Turning

- 9 Turning Tools
- 10 Multifunctional Tools – EcoCut and FreeTurn
- 11 Grooving Tools
- 12 Miniature turning tools

Milling

- 13 HSS Milling Cutters
- 14 Solid Carbide milling cutters
- 15 Milling tools with indexable inserts

Clamping technology

- 16 Adaptors and Accessories
- 17 Workpiece clamping

- 18 Material examples

Table of contents

Advantages of FreeTurn / EcoCut	4+5
Example applications / explanation of symbols	5
Toolfinder	6+7
Product programme	8–26
Technical Information	
General cutting data	27–29
EcoCut Mini Cutting Data	30+31
EcoCut Classic Cutting Data	32+33
EcoCut ProfileMaster Cutting Data	34+35
FreeTurn cutting data	36
EcoCut chip breaker overview	37
FreeTurn chip breaker overview	38
Application information	39–47
Grade overview and application	48–50
FreeTurn / EcoCut design system	51+52

CERATIZIT \ Performance

Premium quality tools for high performance.

The premium quality tools from the **CERATIZIT Performance** product line have been designed for specific applications and are distinguished by their outstanding performance. If you make high demands on the performance of your production and want to achieve the very best results, we recommend the Premium tools in this product line.

Advantages of FreeTurn

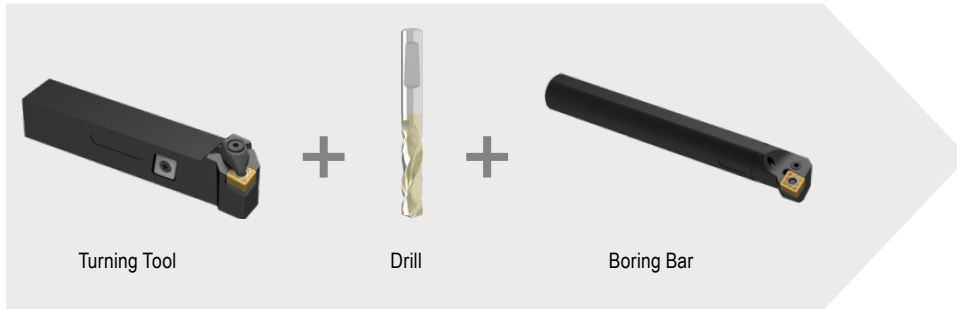
The diagram illustrates the advantages of FreeTurn through three horizontal panels, each showing a different aspect of the tool's performance:

- Flexibility:** Shows a tool with a 360-degree rotation arrow. It also displays three different tool geometries labeled 'Roughing', 'Roughing', and 'Finishing', indicating its versatility in different machining stages.
- Productivity:** Shows a tool cutting a part, with a red arrow pointing to a finished, polished part, highlighting the high quality and efficiency of the process.
- Stability:** Shows a tool cutting a part, with a red arrow indicating the cutting direction and a blue arrow indicating the tool's stability during the process.

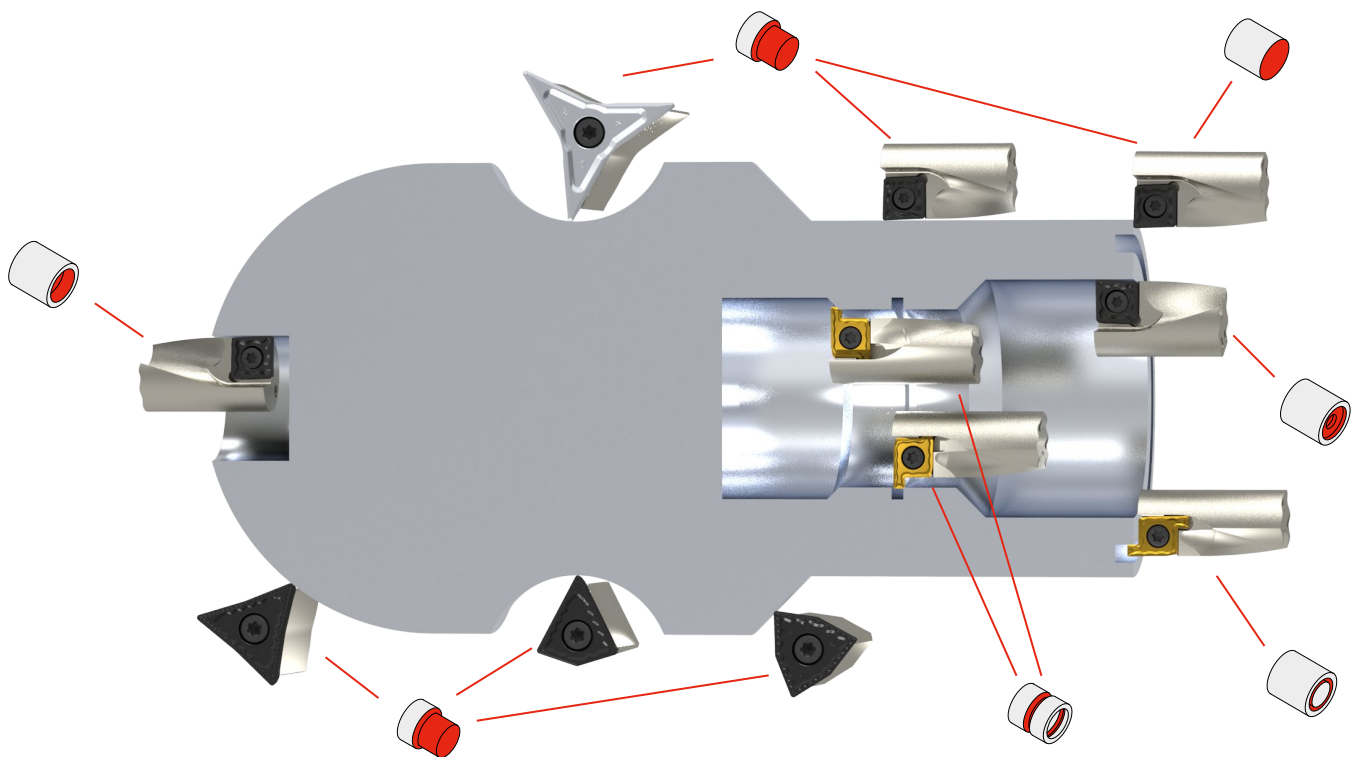
On the right side of the diagram, a large, detailed 3D rendering of the FreeTurn tool is shown, highlighting its complex, multi-faceted design.

Advantages of EcoCut

- ▲ reduced machining time
- ▲ reduced need for tool positions
- ▲ generates flat bottom of hole
- ▲ less programming
- ▲ lower set-up costs / reduced setting time
- ▲ time savings due to fewer tool changes



Application examples



10


Symbol explanation

Turning outside profiles	Face turning	Drilling into full material	Turning internal profiles	External / internal radial grooving	Axial grooving	Int. coolant supply

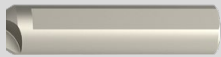
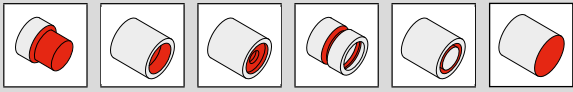
-28P Polished chip breaker	F Fine Machining	
H216T Carbide Grade	M Medium Machining	
	R Rough Machining	

Toolfinder

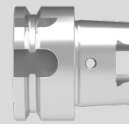
<p>Tool system</p>	<p>EcoCut Mini</p>	<p>EcoCut Classic</p>																																																												
<p>Application</p>																																																														
<p>Machine interface</p>	 <p>Adapter for EcoCut Mini → 9+10</p>	 <p>HSK-T 63 PSC 50 PSC 63</p>																																																												
<p>Lengths and diameters Versions</p>	<p>2,25xD Ø 2–8 → 8</p> <p>4,0xD Ø 2–8 → 8</p>	<p>1,5xD Ø 8–32 → 12</p> <p>2,25xD Ø 8–32 → 13</p> <p>3,0xD Ø 8–32 → 14</p> <p>2,25xD Ø 16–32 HSK-T → 15</p> <p>2,25xD Ø 16–32 PSC → 16</p>																																																												
<p>Cutting material designation</p>	<table border="1"> <tr> <td>CTPP435</td> <td>CTPP435</td> <td>CTWN425</td> <td>CTWN425</td> </tr> <tr> <td>DRAGONSKIN</td> <td>DRAGONSKIN</td> <td></td> <td></td> </tr> </table>	CTPP435	CTPP435	CTWN425	CTWN425	DRAGONSKIN	DRAGONSKIN			<table border="1"> <tr> <td>CTCP425-P</td> <td>-M50Q CTCP425-P</td> <td>CTCP435-P</td> <td>CTPP430</td> <td>-27P H216T</td> <td>-27Q H210T</td> </tr> <tr> <td>DRAGONSKIN</td> <td>DRAGONSKIN</td> <td>DRAGONSKIN</td> <td>DRAGONSKIN</td> <td></td> <td></td> </tr> </table>	CTCP425-P	-M50Q CTCP425-P	CTCP435-P	CTPP430	-27P H216T	-27Q H210T	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN																																										
CTPP435	CTPP435	CTWN425	CTWN425																																																											
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CTCP425-P	-M50Q CTCP425-P	CTCP435-P	CTPP430	-27P H216T	-27Q H210T																																																									
DRAGONSKIN	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN																																																											
<p>Cutting conditions</p>	 <p>Solid carbide Solid carbide Solid carbide Solid carbide</p> <p>Left-hand Right-hand Left-hand Right-hand</p>	 <p>M M M M M M</p> <p>XCNT XCNT XCNT XCNT XCET XCET</p>																																																												
<p>Application range</p>	<table border="1"> <tr><td>●</td><td>●</td><td></td><td></td></tr> <tr><td>●</td><td>●</td><td></td><td></td></tr> <tr><td>○</td><td>○</td><td>○</td><td>○</td></tr> <tr><td>○</td><td>○</td><td>●</td><td>●</td></tr> <tr><td>●</td><td>●</td><td>○</td><td>○</td></tr> <tr><td>○</td><td>○</td><td>○</td><td>○</td></tr> </table>	●	●			●	●			○	○	○	○	○	○	●	●	●	●	○	○	○	○	○	○	<table border="1"> <tr><td>●</td><td>●</td><td>●</td><td>●</td><td></td><td></td></tr> <tr><td>○</td><td>○</td><td>○</td><td>●</td><td></td><td></td></tr> <tr><td>○</td><td>○</td><td>○</td><td>○</td><td>●</td><td>○</td></tr> <tr><td>○</td><td>○</td><td></td><td>○</td><td>●</td><td>●</td></tr> <tr><td></td><td></td><td>○</td><td>○</td><td>○</td><td>●</td></tr> <tr><td>○</td><td>○</td><td>○</td><td>○</td><td>○</td><td>○</td></tr> </table>	●	●	●	●			○	○	○	●			○	○	○	○	●	○	○	○		○	●	●			○	○	○	●	○	○	○	○	○	○
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<p>Page No.</p>	<p>→ 8 → 8 → 8 → 8</p> <p>→ v_c Page 28</p>	<p>→ 11 → 11 → 11 → 11 → 11 → 11</p> <p>→ v_c Page 28</p>																																																												

 EcoCut tools are suitable for off-centre drilling. This permits certain deviations from the nominal tool diameter to be achieved
→ For details, see the technical information.

EcoCut ProfileMaster



FreeTurn



HSK-T 63



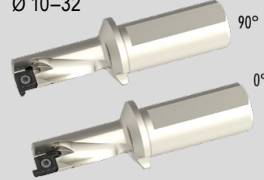
PSC 63

1,5xD
Ø 10–32



→ 18

2,25xD
Ø 10–32



→ 19

HSK-T

LPR = 100
LPR = 125



→ 23+26

PSC

LPR = 100
LPR = 125



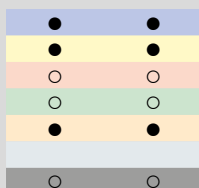
→ 24+26

10

-M20 CTPP430	-M20 CTPP430
DRAGONSKIN	DRAGONSKIN



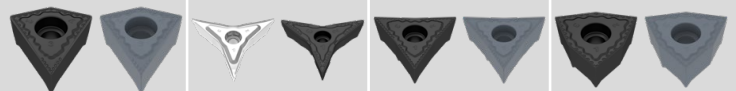
M	M
PM-R	PM-L



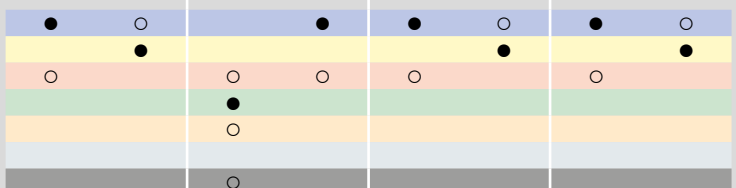
→ 17 → 17

→ v_c Page 28

CTCP125	CTPM125	-28P H216T	-F CTCP125	CTCP125	CTPM125	CTCP125	CTPM125
DRAGONSKIN	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN



M M F	F F F	F F F	M M M
FT15 . 808055...	FT15 . 353535...	FT15 . 555555...	FT17 . 808080...

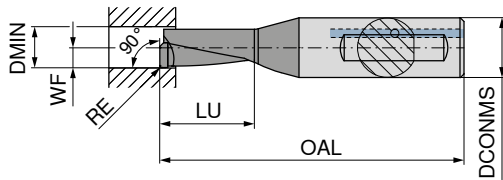
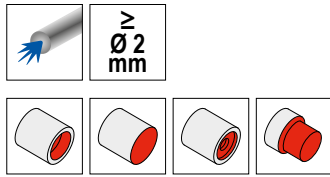


→ 20 → 20 → 21 → 21 → 22 → 22 → 25 → 25

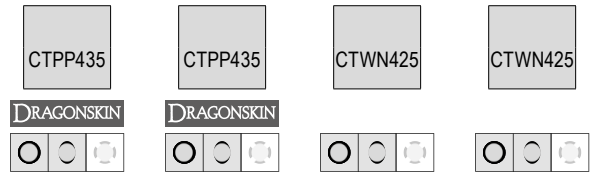
→ v_c Page 29

EcoCut – Mini

▲ Drilling and turning tool for small diameters



Illustrations show right-hand versions



Solid carbide Left-hand Solid carbide Right-hand Solid carbide Left-hand Solid carbide Right-hand

ISO designation	DMIN mm	DCONMS mm	OAL mm	LU mm	WF mm	RE mm
ECM 02 R/L 2,25D	2.0	4	28	4.50	1.00	0.1
ECM 02 R/L 2,25D AL	2.0	4	28	4.50	1.00	0.1
ECM 02 R/L 4,00D	2.0	4	31	8.00	1.00	0.1
ECM 02 R/L 4,00D AL	2.0	4	31	8.00	1.00	0.1
ECM 02,5 R/L 2,25D	2.5	4	29	5.63	1.25	0.1
ECM 02,5 R/L 2,25D AL	2.5	4	29	5.63	1.25	0.1
ECM 02,5 R/L 4,00D	2.5	4	33	10.00	1.25	0.1
ECM 02,5 R/L 4,00D AL	2.5	4	33	10.00	1.25	0.1
ECM 03 R/L 2,25D	3.0	4	31	6.75	1.50	0.1
ECM 03 R/L 2,25D AL	3.0	4	31	6.75	1.50	0.1
ECM 03 R/L 4,00D	3.0	4	35	12.00	1.50	0.1
ECM 03 R/L 4,00D AL	3.0	4	35	12.00	1.50	0.1
ECM 03,5 R/L 2,25D	3.5	4	32	7.88	1.75	0.1
ECM 03,5 R/L 2,25D AL	3.5	4	32	7.88	1.75	0.1
ECM 03,5 R/L 4,00D	3.5	4	37	14.00	1.75	0.1
ECM 03,5 R/L 4,00D AL	3.5	4	37	14.00	1.75	0.1
ECM 04 R/L 2,25D	4.0	6	35	9.00	2.00	0.2
ECM 04 R/L 2,25D AL	4.0	6	35	9.00	2.00	0.2
ECM 04 R/L 4,00D	4.0	6	41	16.00	2.00	0.2
ECM 04 R/L 4,00D AL	4.0	6	41	16.00	2.00	0.2
ECM 05 R/L 2,25D	5.0	6	37	11.25	2.50	0.2
ECM 05 R/L 2,25D AL	5.0	6	37	11.25	2.50	0.2
ECM 05 R/L 4,00D	5.0	6	45	20.00	2.50	0.2
ECM 05 R/L 4,00D AL	5.0	6	45	20.00	2.50	0.2
ECM 06 R/L 2,25D	6.0	8	38	13.50	3.00	0.2
ECM 06 R/L 2,25D AL	6.0	8	38	13.50	3.00	0.2
ECM 06 R/L 4,00D	6.0	8	49	24.00	3.00	0.2
ECM 06 R/L 4,00D AL	6.0	8	49	24.00	3.00	0.2
ECM 07 R/L 2,25D	7.0	8	42	15.75	3.50	0.2
ECM 07 R/L 2,25D AL	7.0	8	42	15.75	3.50	0.2
ECM 07 R/L 4,00D	7.0	8	53	28.00	3.50	0.2
ECM 07 R/L 4,00D AL	7.0	8	53	28.00	3.50	0.2
ECM 08 R/L 2,25D	8.0	8	45	18.00	4.00	0.2
ECM 08 R/L 2,25D AL	8.0	8	45	18.00	4.00	0.2
ECM 08 R/L 4,00D	8.0	8	57	32.00	4.00	0.2
ECM 08 R/L 4,00D AL	8.0	8	57	32.00	4.00	0.2

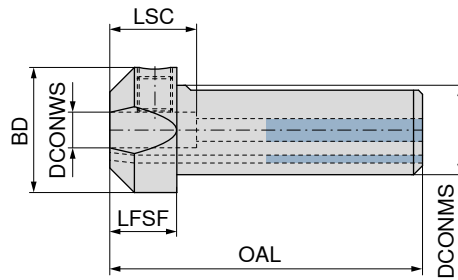
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£		£		£		£	
2B/20	320	2B/20	320	2B/20	420	2B/20	420
58.83		58.83		51.87		51.87	
61.72	321	61.72	321	54.38	421	54.38	421
60.64	325	60.64	325	53.42	425	53.42	425
63.64	326	63.64	326	56.07	426	56.07	426
62.54	330	62.54	330	55.11	430	55.11	430
65.68	331	65.68	331	57.86	431	57.86	431
64.96	335	64.96	335	57.28	435	57.28	435
68.20	336	68.20	336	60.15	436	60.15	436
68.98	300	68.98	300	60.75	450	60.75	450
72.40	301	72.40	301	63.80	451	63.80	451
71.37	302	71.37	302	62.48	452	62.48	452
74.67	303	74.67	303	65.53	453	65.53	453
73.20	306	73.20	306	64.60	456	64.60	456
76.90	312	76.90	312	67.52	462	67.52	462
75.47	308	75.47	308	66.58	458	66.58	458
79.43	314	79.43	314	69.64	464	69.64	464
77.97	310	77.97	310	68.45	460	68.45	460
81.69	316	81.69	316	71.75	466	71.75	466

P	●	●		
M	●	●		
K	○	○	○	○
N	○	○	●	●
S	●	●	○	○
H				
O	○	○	○	○

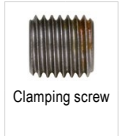
EcoCut – Adapter Mini

Scope of supply:

Toolholder with one clamping screw and one screwdriver



Designation	DCONWS mm	DCONMS mm	BD mm	OAL mm	LFSF mm	LSC mm	70 800 ...	
							£	
EC-ADX16-04	4	16	22	59	14	18	217.95	716
EC-ADX20-04	4	20	25	64	14	18	217.95	720
EC-ADX16-06	6	16	22	59	14	18	217.95	976
EC-ADX20-06	6	20	25	64	14	18	217.95	996
EC-ADX16-08	8	16	22	59	14	18	217.95	978
EC-ADX20-08	8	20	25	64	14	18	217.95	998



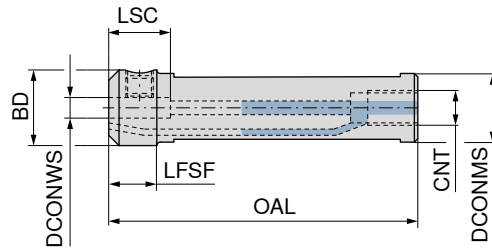
**Spare parts
for Article no.**

Article no.	Screw	70 950 ...	
		£	
70 800 716	M5x10 ISO 4026	3.61	867
70 800 720	M5x10 ISO 4026	3.61	867
70 800 976	M8x1x8 - SW4	3.61	123
70 800 996	M8x1x8 - SW4	3.61	123
70 800 978	M8x1x8 - SW4	3.61	123
70 800 998	M8x1x8 - SW4	3.61	123

EcoCut – Mini adapter with coolant connection thread

Scope of supply:

Toolholder with one clamping screw and one screwdriver



Designation	DCONWS mm	DCONMS mm	BD mm	OAL mm	LFSF mm	LSC mm	CNT	70 801 ...	
								£	
ECA 16-04	4	16	20.0	75	14	18	G 1/8	116.37	716
ECA 20-04	4	20	19.6	90	14	18	G 1/8	118.79	720
ECA 22-04	4	22	21.6	110	14	18	G 1/8	122.37	722
ECA 16-06	6	16	22.0	75	14	18	G 1/8	116.37	816
ECA 20-06	6	20	22.0	90	14	18	G 1/8	118.79	820
ECA 22-06	6	22	21.6	110	14	18	G 1/8	122.37	822
ECA 16-08	8	16	22.0	75	14	18	G 1/8	116.37	916
ECA 20-08	8	20	22.0	90	14	18	G 1/8	118.79	920
ECA 22-08	8	22	21.6	110	14	18	G 1/8	122.37	922

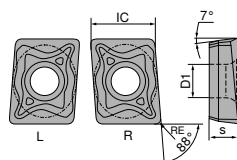


**Spare parts
for Article no.**

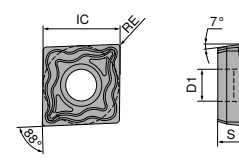
		70 950 ...	
		£	
70 801 716	M5X8 - DIN 913	1.72	13200
70 801 720	M5X8 - DIN 913	1.72	13200
70 801 722	M5X8 - DIN 913	1.72	13200
70 801 816	M8x1x8 - SW4	3.61	123
70 801 820	M8x1x8 - SW4	3.61	123
70 801 822	M8x1x8 - SW4	3.61	123
70 801 916	M8x1x8 - SW4	3.61	123
70 801 920	M8x1x8 - SW4	3.61	123
70 801 922	M8x1x8 - SW4	3.61	123

XCNT / XCET

Designation	S mm	D1 mm	IC mm
XC.T 0401..	1.80	2.10	4.5
XC.T 0502..	2.10	2.25	5.8
XC.T 0602..	2.38	2.50	6.5
XC.T 0703..	3.18	2.80	7.6
XC.T 0803..	3.18	3.40	8.5
XC.T 09T3..	3.97	3.40	9.6
XC.T 10T3..	3.97	4.40	10.6
XC.T 1304..	4.76	5.30	13.5
XC.T 1705..	5.56	5.30	17.5



XC. T 04..



XC. T 05../06../07../08../09../10../13../17..

XCNT / XCET

NEW	NEW	NEW			
-EN CTCP425-P	-M50Q CTCP425-P	-EN CTCP435-P	-EN CTPP430	-27P H216T	-27Q H210T
DRAGONSKIN	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN		
M XCNT	M XCNT	M XCNT	M XCNT	M XCET	M XCET
70 386 ...	70 386 ...	70 386 ...	70 386 ...	70 286 ...	70 286 ...

ISO	RE mm	£ 1D/19	72001	£ 1D/19	75001	£ 1D/19	82001	£ 1D/19	920	£ 1D/19	620	£ 1D/19	120
040102EL	0.2	18.40	72001			18.40	82001	17.86	920				
040102ER	0.2	18.40	72201			18.40	82201	17.86	922				
040102FL	0.2									20.01	620	20.79	120
040102FR	0.2									20.01	622	20.79	122
040104EL	0.4	18.40	70001	19.20	75001	18.40	80001	17.86	900				
040104ER	0.4	18.40	70201	19.20	75201	18.40	80201	17.86	902				
040104FL	0.4									20.01	600	20.79	100
040104FR	0.4									20.01	602	20.79	102
050202EN	0.2	18.40	72301			18.40	82301	17.86	923				
050202FN	0.2									20.01	623	20.79	123
050204EN	0.4	18.40	70301	19.20	75301	18.40	80301	17.86	903				
050204FN	0.4									20.01	603	20.79	103
060202EN	0.2	18.40	72401			18.40	82401	17.86	924				
060202FN	0.2									20.01	624	20.79	124
060204EN	0.4	18.40	70401	19.20	75401	18.40	80401	17.86	904				
060204FN	0.4									20.01	604	20.79	104
070304EN	0.4	18.40	70501	19.20	75501	18.40	80501	17.86	905				
070304FN	0.4									20.01	605	20.79	105
080304EN	0.4	18.69	70601	19.50	75601	18.69	80601	18.13	906				
080304FN	0.4									20.27	606	21.05	106
09T304EN	0.4	18.96	70701	19.92	75701	18.96	80701	18.39	907				
09T304FN	0.4									20.38	607	21.18	107
10T304EN	0.4	19.92	70801	20.73	75801	19.92	80801	19.32	908				
10T304FN	0.4									20.79	608	21.85	108
10T308EN	0.8	19.92	73801	20.73	78801	19.92	83801	19.32	938				
10T308FN	0.8									20.79	628	21.85	128
130404EN	0.4	22.77	71001	23.86	76001	22.77	81001	22.10	910				
130404FN	0.4									25.43	610	26.47	110
130408EN	0.8	22.77	74001	23.86	79001	22.77	84001	22.10	940				
130408FN	0.8									25.43	611	26.47	111
170508EN	0.8	24.01	71201	25.23	76201	24.01	81201	23.30	912				
170508FN	0.8									25.81	612	27.12	112

P	●	●	●	●									
M	○	○	○	○									
K	○	○	○	○	○	○	○	○	○	●	○	○	○
N										○	●	○	●
S							○	○	○	○			●
H													
O										○	○		○

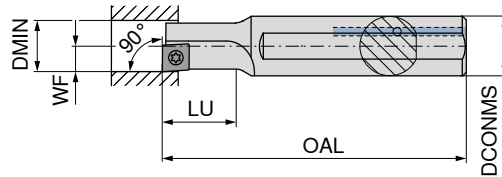
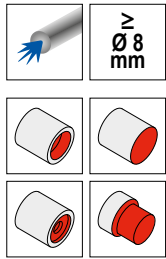
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EcoCut – Classic 1.5xD

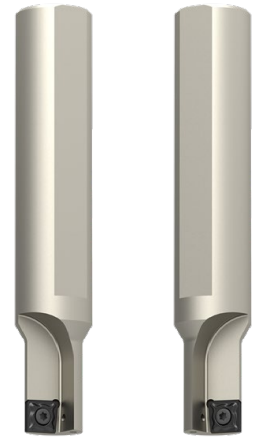
▲ Drilling and turning tool

Scope of supply:

Toolholder with 1 clamping screw + 2 spare screws and screwdriver



Illustrations show right-hand versions

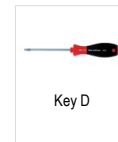


Left-hand

Right-hand

ISO designation	DMIN mm	DCONMS mm	OAL mm	LU mm	WF mm	torque moment Nm	Insert	70 805 ...		70 804 ...	
								£		£	
ECC 08 L 1,5D 04	8	12	80	12.0	4.0	0,4	XC.T 0401..EL	183.66	008 ²⁾	183.66	008 ¹⁾
ECC 08 R 1,5D 04	8	12	80	12.0	4.0	0,4	XC.T 0401..ER				
ECC 10 R/L 1,5D 05	10	12	90	15.0	5.0	0,7	XC.T 0502..	183.66	010	183.66	010
ECC 12 R/L 1,5D 06	12	16	100	18.0	6.0	1,0	XC.T 0602..	186.67	012	186.67	012
ECC 14 R/L 1,5D 07	14	16	110	21.0	7.0	1,2	XC.T 0703..	191.17	014	191.17	014
ECC 16 R/L 1,5D 08	16	20	125	24.0	8.0	2,2	XC.T 0803..	194.18	016	194.18	016
ECC 18 R/L 1,5D 09	18	25	135	27.0	9.0	2,2	XC.T 09T3..	223.96	018	223.96	018
ECC 20 R/L 1,5D 10	20	25	150	30.0	10.0	3,2	XC.T 10T3..	252.47	020	252.47	020
ECC 25 R/L 1,5D 13	25	32	180	37.5	12.5	5,0	XC.T 1304..	291.15	025	291.15	025
ECC 32 R/L 1,5D 17	32	40	200	48.0	16.0	5,0	XC.T 1705..	330.06	032	330.06	032

- 1) Note! Right-hand insert on right-hand tool
- 2) Note! Left-hand insert on left-hand tool



Key D



Clamping screw

Spare parts for Article no.

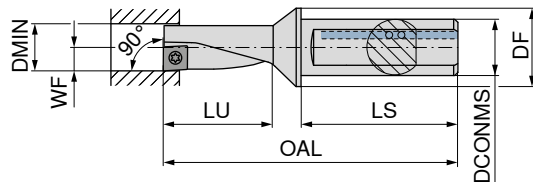
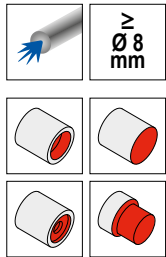
Article no.	Part	80 950 ...		70 950 ...	
		£		£	
70 805 008	T06 - IP	17.37	123	4.26	862
70 804 008	T06 - IP	17.37	123	4.26	862
70 805 010 / 70 804 010	T06 - IP	17.37	123	3.79	863
70 805 012 / 70 804 012	T07 - IP	17.13	124	3.67	856
70 805 014 / 70 804 014	T08 - IP	17.13	125	4.73	857
70 805 016 / 70 804 016	T09 - IP	18.76	126	3.61	819
70 805 018 / 70 804 018	T09 - IP	18.76	126	3.61	819
70 805 020 / 70 804 020	T15 - IP	20.03	128	3.61	859
70 805 025 / 70 804 025	T20 - IP	21.03	129	3.61	864
70 805 032 / 70 804 032	T20 - IP	21.03	129	3.61	864

EcoCut – Classic 2.25xD

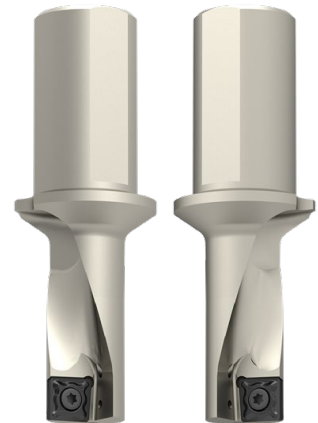
▲ Drilling and turning tool

Scope of supply:

Toolholder with 1 clamping screw + 2 spare screws and screwdriver



Illustrations show right-hand versions

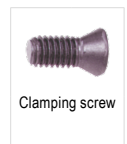
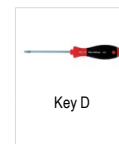


Left-hand **70 805 ...** Right-hand **70 804 ...**

ISO designation	DMIN mm	DCONMS mm	DF mm	OAL mm	LU mm	LS mm	WF mm	torque moment Nm	Insert	£ 2B/20		£ 2B/20	
ECC 08 L 2,25D 04	8	10	15	60.0	18.0	38	4.0	0.4	XC.T 0401..EL	273.25	108 ²⁾	273.25	108 ¹⁾
ECC 08 R 2,25D 04	8	10	15	60.0	18.0	38	4.0	0.4	XC.T 0401..ER			273.25	110
ECC 10 R/L 2,25D 05	10	12	18	69.5	22.5	42	5.0	0.7	XC.T 0502..	273.25	110	273.25	110
ECC 12 R/L 2,25D 06	12	16	22	78.0	27.0	45	6.0	1.0	XC.T 0602..	280.75	112	280.75	112
ECC 14 R/L 2,25D 07	14	16	23	83.5	31.5	45	7.0	1.2	XC.T 0703..	286.87	114	286.87	114
ECC 16 R/L 2,25D 08	16	20	28	94.0	36.0	50	8.0	2.2	XC.T 0803..	292.88	116	292.88	116
ECC 18 R/L 2,25D 09	18	25	36	109.5	40.5	56	9.0	2.2	XC.T 09T3..	322.66	118	322.66	118
ECC 20 R/L 2,25D 10	20	25	35	111.0	45.0	56	10.0	3.2	XC.T 10T3..	351.18	120	351.18	120
ECC 25 R/L 2,25D 13	25	32	44	129.0	56.5	60	12.5	5.0	XC.T 1304..	407.74	125	407.74	125
ECC 32 R/L 2,25D 17	32	40	54	158.0	72.0	70	16.0	5.0	XC.T 1705..	458.42	132	458.42	132

- 1) Note! Right-hand insert on right-hand tool
- 2) Note! Left-hand insert on left-hand tool

10



80 950 ...
£
Y7

70 950 ...
£
2A/28

Spare parts for Article no.

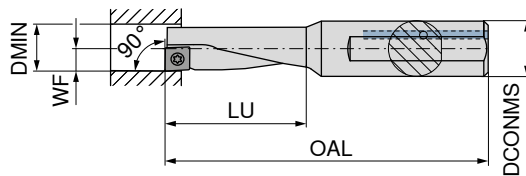
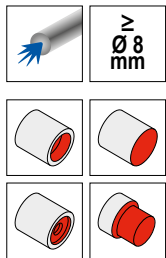
Article no.	Part	£	QTY	Part	£	QTY
70 805 108	T06 - IP	17.37	123	M1,8x3,6 - IP	4.26	862
70 804 108	T06 - IP	17.37	123	M1,8x3,6 - IP	4.26	862
70 805 110 / 70 804 110	T06 - IP	17.37	123	M2x4,3 - IP	3.79	863
70 805 112 / 70 804 112	T07 - IP	17.13	124	M2,2x5 - IP	3.67	856
70 805 114 / 70 804 114	T08 - IP	17.13	125	M2,5x6 - IP	4.73	857
70 805 116 / 70 804 116	T09 - IP	18.76	126	M3x7 - IP	3.61	819
70 805 118 / 70 804 118	T09 - IP	18.76	126	M3x7 - IP	3.61	819
70 805 120 / 70 804 120	T15 - IP	20.03	128	M3,5x8,6 - IP	3.61	859
70 805 125 / 70 804 125	T20 - IP	21.03	129	M4,5x10,5 - IP	3.61	864
70 805 132 / 70 804 132	T20 - IP	21.03	129	M4,5x10,5 - IP	3.61	864

EcoCut – Classic 3xD – Heavy metal

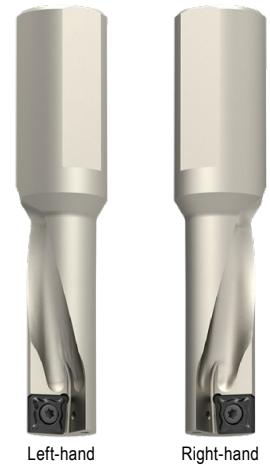
- ▲ Drilling and turning tool
- ▲ vibration-damped

Scope of supply:

Toolholder with 1 clamping screw + 2 spare screws and screwdriver



Illustrations show right-hand versions



ISO designation	DMIN mm	DCONMS mm	OAL mm	LU mm	WF mm	torque moment Nm	Insert	70 805 ...		70 804 ...	
								£		£	
ECC 08 L 3,00D 04 H	8	12	80	24	4.0	0,4	XC.T 0401..EL	2B/20	608 ²⁾	2B/20	608 ¹⁾
ECC 08 R 3,00D 04 H	8	12	80	24	4.0	0,4	XC.T 0401..ER	673.84		673.84	
ECC 10 R/L 3,00D 05 H	10	12	85	30	5.0	0,7	XC.T 0502..	676.83	610	676.83	610
ECC 12 R/L 3,00D 06 H	12	16	95	36	6.0	1,0	XC.T 0602..	730.51	612	730.51	612
ECC 14 R/L 3,00D 07 H	14	16	100	42	7.0	1,2	XC.T 0703..	747.49	614	747.49	614
ECC 16 R/L 3,00D 08 H	16	20	110	48	8.0	2,2	XC.T 0803..	819.64	616	819.64	616
ECC 18 R/L 3,00D 09 H	18	25	125	54	9.0	2,2	XC.T 09T3..	992.22	618	992.22	618
ECC 20 R/L 3,00D 10 H	20	25	130	60	10.0	3,2	XC.T 10T3..	1,012.31	620	1,012.31	620
ECC 25 R/L 3,00D 13 H	25	32	150	75	12.5	5,0	XC.T 1304..	1,289.48	625	1,289.48	625
ECC 32 R/L 3,00D 17 H	32	40	185	96	16.0	5,0	XC.T 1705..	1,687.76	632	1,687.76	632

- 1) Note! Right-hand insert on right-hand tool
- 2) Note! Left-hand insert on left-hand tool

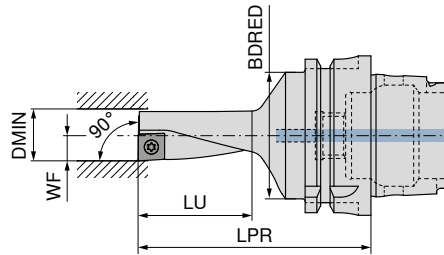
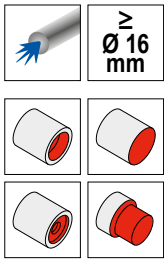


Spare parts for Article no.	80 950 ...		70 950 ...	
	£		£	
70 805 608	Y7	123	2A/28	862
70 804 608		123		862
70 805 610 / 70 804 610		123		863
70 805 612 / 70 804 612		124		856
70 805 614 / 70 804 614		125		857
70 805 616 / 70 804 616		126		819
70 805 618 / 70 804 618		126		819
70 805 620 / 70 804 620		128		859
70 805 625 / 70 804 625		129		864
70 805 632 / 70 804 632		129		864

EcoCut – HSK-T 2.25xD

Scope of supply:

Toolholder with 1 clamping screw + 2 spare screws and screwdriver

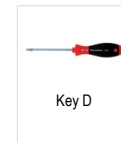


Illustrations show right-hand versions

NEW **NEW**



ISO designation	Adapter	LPR mm	LU mm	BDRED mm	WF mm	DMIN mm	torque moment Nm	Insert	Left-hand		Right-hand	
									£	...	£	...
HSK-T 63 ECC 16 R/L 2,25D 08	HSK-T 63	84	36.00	50	8.0	16	2,2	XC.T 0803..	£ 362.03	51637	£ 362.03	51637
HSK-T 63 ECC 20 R/L 2,25D 10	HSK-T 63	92	45.00	50	10.0	20	3,2	XC.T 10T3..	£ 434.06	52037	£ 434.06	52037
HSK-T 63 ECC 25 R/L 2,25D 13	HSK-T 63	104	56.25	50	12.5	25	5,0	XC.T 1304..	£ 504.05	52537	£ 504.05	52537
HSK-T 63 ECC 32 R/L 2,25D 17	HSK-T 63	120	72.00	50	16.0	32	5,0	XC.T 1705..	£ 566.71	53237	£ 566.71	53237



Key D



Clamping screw

Spare parts for Article no.

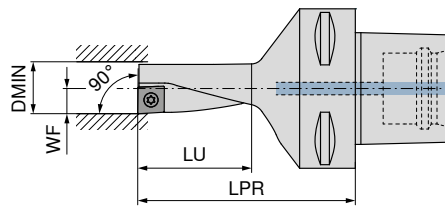
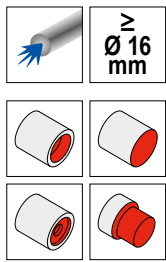
		80 950 ...		70 950 ...	
		£	...	£	...
74 590 51637 / 74 591 51637	T09 - IP	18.76	126	M3x7 - IP	3.61 819
74 590 52037 / 74 591 52037	T15 - IP	20.03	128	M3,5x8,6 - IP	3.61 859
74 590 52537 / 74 590 53237	T20 - IP	21.03	129	M4,5x10,5 - IP	3.61 864
74 591 52537 / 74 591 53237	T20 - IP	21.03	129	M4,5x10,5 - IP	3.61 864

10

EcoCut – Classic PSC 2,25xD

Scope of supply:

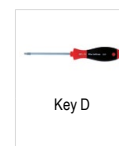
Toolholder with 1 clamping screw + 2 spare screws and screwdriver



Illustrations show right-hand versions



ISO designation	Adapter	LPR mm	LU mm	WF mm	DMIN mm	torque moment Nm	Insert	Left-hand 74 591 ...		Right-hand 74 590 ...	
								£	2D/80	£	2D/80
PSC 50 ECC 16 R/L 2,25D 08	PSC 50	70	36.00	8.0	16	2,2	XC.T 0803..	362.03	51694	362.03	51694
PSC 50 ECC 20 R/L 2,25D 10	PSC 50	81	45.00	10.0	20	3,2	XC.T 10T3..	434.06	52094	434.06	52094
PSC 50 ECC 25 R/L 2,25D 13	PSC 50	93	56.25	12.5	25	5,0	XC.T 1304..	504.05	52594	504.05	52594
PSC 50 ECC 32 R/L 2,25D 17	PSC 50	110	72.00	16.0	32	5,0	XC.T 1705..	566.71	53294	566.71	53294
PSC 63 ECC 16 R/L 2,25D 08	PSC 63	75	36.00	8.0	16	2,2	XC.T 0803..	362.03	51693	362.03	51693
PSC 63 ECC 20 R/L 2,25D 10	PSC 63	86	45.00	10.0	20	3,2	XC.T 10T3..	434.06	52093	434.06	52093
PSC 63 ECC 25 R/L 2,25D 13	PSC 63	97	56.25	12.5	25	5,0	XC.T 1304..	504.05	52593	504.05	52593
PSC 63 ECC 32 R/L 2,25D 17	PSC 63	114	72.00	16.0	32	5,0	XC.T 1705..	566.71	53293	566.71	53293

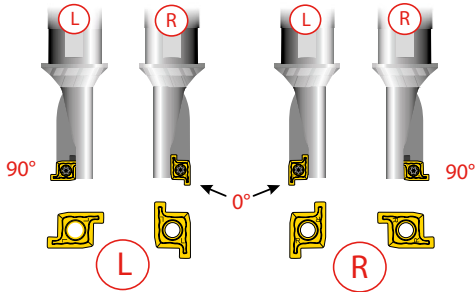
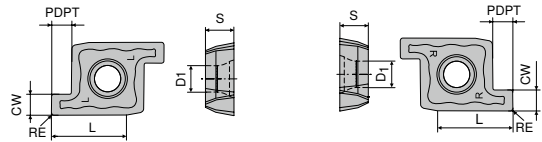


**Spare parts
for Article no.**

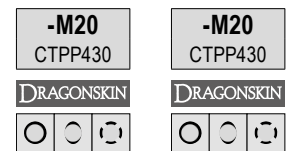
	80 950 ...		70 950 ...	
	£	Y7	£	2A/28
74 590 51694 / 74 590 51693	T09 - IP	18.76 126	M3x7 - IP	3.61 819
74 590 52094 / 74 590 52093	T15 - IP	20.03 128	M3,5x8,6 - IP	3.61 859
74 590 52594 / 74 590 53294	T20 - IP	21.03 129	M4,5x10,5 - IP	3.61 864
74 590 52593 / 74 590 53293	T20 - IP	21.03 129	M4,5x10,5 - IP	3.61 864
74 591 51694 / 74 591 51693	T09 - IP	18.76 126	M3x7 - IP	3.61 819
74 591 52094 / 74 591 52093	T15 - IP	20.03 128	M3,5x8,6 - IP	3.61 859
74 591 52594 / 74 591 53294	T20 - IP	21.03 129	M4,5x10,5 - IP	3.61 864
74 591 52593 / 74 591 53293	T20 - IP	21.03 129	M4,5x10,5 - IP	3.61 864

PM-R / PM-L

Designation	CW mm	PDPT mm	L mm	S mm	D1 mm
PM 10 G 201504	2.0	1.5	5.0	2.10	2.1
PM 12 G 201804	2.0	1.8	6.0	2.30	2.5
PM 16 G 252004	2.5	2.0	8.0	2.80	3.4
PM 20 G 302504	3.0	2.5	10.0	3.70	4.0
PM 25 G 353004	3.5	3.0	12.5	4.50	4.4
PM 32 G 404004	4.0	4.0	16.0	5.60	6.0



PM-L / PM-R



ISO	RE mm	M PM-L 70 289 ...		M PM-R 70 289 ...	
		£		£	
PM 10 G 201504	0.4	19.25	510	19.25	511
PM 12 G 201804	0.4	19.38	515	19.38	516
PM 16 G 252004	0.4	19.61	520	19.61	521
PM 20 G 302504	0.4	20.53	525	20.53	526
PM 25 G 353004	0.4	22.86	530	22.86	531
PM 32 G 404004	0.4	24.67	535	24.67	536
P		●		●	
M		●		●	
K		○		○	
N		○		○	
S		●		●	
H					
O		○		○	

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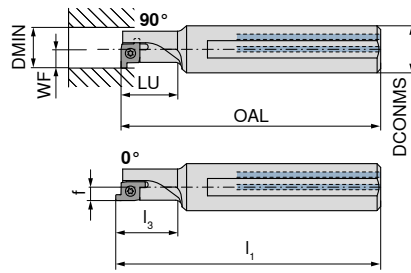
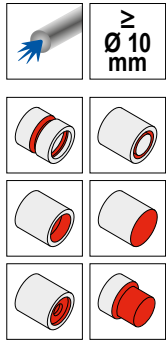
→ v_c Page 28

EcoCut – ProfileMaster 1.5xD

▲ Drilling, turning and grooving tool

Scope of supply:

Toolholder with one clamping screw and one screwdriver

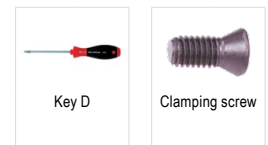


Illustrations show right-hand versions



ISO designation	DMIN mm	DCONMS mm	OAL mm	LU mm	WF mm	l ₁ mm	l ₃ mm	f mm	torque moment Nm	Insert	Left-hand		Right-hand	
											70 821 ...	70 820 ...	70 821 ...	70 820 ...
PMC 10 R/L 1,5D	10	12	80	15	5.0				0,4	PM 10R/L	£ 2G/P1 197.99	010 ¹⁾	£ 2G/P1 197.99	010 ¹⁾
PMC 12 R/L 1,5D	12	16	90	18	6.0				1,0	PM 12R/L	£ 205.26	012 ¹⁾	£ 205.26	012 ¹⁾
PMC 16 R/L 1,5D	16	20	125	24	8.0	127.3	26.3	5.7	2,2	PM 16R/L	£ 217.15	016	£ 217.15	016
PMC 20 R/L 1,5D	20	25	150	30	10.0	152.8	32.8	7.2	2,2	PM 20R/L	£ 267.94	020	£ 267.94	020
PMC 25 R/L 1,5D	25	32	180	38	12.5	183.3	40.8	9.2	3,2	PM 25R/L	£ 304.54	025	£ 304.54	025
PMC 32 R/L 1,5D	32	40	200	48	16.0	204.3	52.3	11.7	5,0	PM 32R/L	£ 348.29	032	£ 348.29	032

1) only usable as 90° version



Spare parts for Article no.

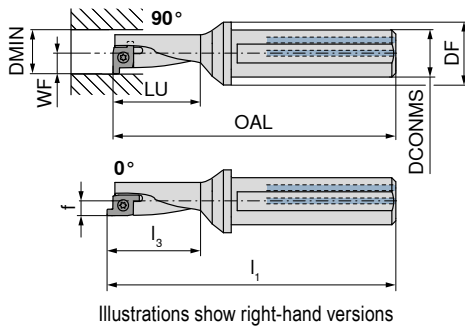
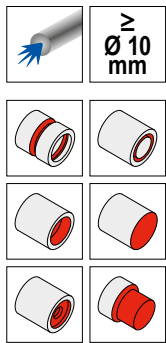
	80 950 ...		70 950 ...	
	£		£	
70 820 010 / 70 821 010	£ Y7 17.37	123	£ 2A/28 4.26	862
70 820 012 / 70 821 012	17.13	124	3.67	137
70 820 016 / 70 821 016	18.76	126	3.61	008
70 820 020 / 70 821 020	20.03	128	3.61	009
70 820 025 / 70 821 025	20.03	128	3.61	859
70 820 032 / 70 821 032	21.03	129	9.42	010

EcoCut – ProfileMaster 2.25xD

▲ Drilling, turning and grooving tool

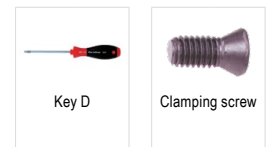
Scope of supply:

Toolholder with one clamping screw and one screwdriver



ISO designation	DMIN mm	DCONMS mm	DF mm	OAL mm	LU mm	WF mm	l ₁ mm	l ₃ mm	f mm	torque moment Nm	Insert	Left-hand 70 821 ...		Right-hand 70 820 ...	
												£ 2G/P1		£ 2G/P1	
PMC 10 R/L 2,25D	10	12	18	72.4	22.50	5.0				0,4	PM 10R/L	291.26	110 ¹⁾	291.26	110 ¹⁾
PMC 12 R/L 2,25D	12	16	22	78.0	27.00	6.0				1,0	PM 12R/L	297.37	112 ¹⁾	297.37	112 ¹⁾
PMC 16 R/L 2,25D	16	20	28	96.5	36.00	8.0	98.8	38.3	5.7	2,2	PM 16R/L	313.31	116	313.31	116
PMC 20 R/L 2,25D	20	25	32	111.0	45.00	10.0	113.8	47.8	7.2	2,2	PM 20R/L	374.39	120	374.39	120
PMC 25 R/L 2,25D	25	32	44	132.6	56.25	12.5	135.9	59.6	9.2	3,2	PM 25R/L	429.91	125	429.91	125
PMC 32 R/L 2,25D	32	40	54	158.0	72.00	16.0	162.3	76.3	11.7	5,0	PM 32R/L	482.32	132	482.32	132

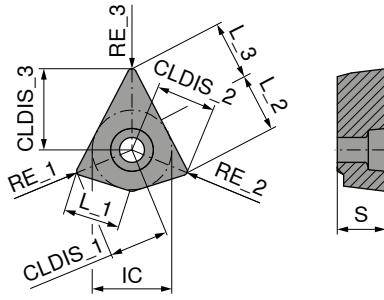
1) only usable as 90° version



Spare parts for Article no.

	80 950 ...		70 950 ...	
	£ Y7		£ 2A/28	
70 820 110 / 70 821 110	17.37	123	4.26	862
70 820 112 / 70 821 112	17.13	124	3.67	137
70 820 116 / 70 821 116	18.76	126	3.61	008
70 820 120 / 70 821 120	20.03	128	3.61	009
70 820 125 / 70 821 125	20.03	128	3.61	859
70 820 132 / 70 821 132	21.03	129	9.42	010

FT15 . 808055



Designation	IC mm	CLDIS_1 mm	L_1 mm	CLDIS_2 mm	L_2 mm	CLDIS_3 mm	L_3 mm	S mm
FT15 M 808055R080804-MMF	15	11.22	10.8	11.22	11.4	15.78	11.4	9.14
FT15 M 808055R08-MMF	15	11.22	10.8	11.22	11.2	15.31	11.2	9.14
FT15 M 808055R121208-MMF	15	11.00	10.7	11.00	11.2	15.31	11.2	9.14

ISO	RE_1 mm	RE_2 mm	RE_3 mm
FT15 M 808055R080804-MMF	0.8	0.8	0.4
FT15 M 808055R08-MMF	0.8	0.8	0.8
FT15 M 808055R121208-MMF	1.2	1.2	0.8

P			●	○
M				●
K			○	
N				
S				
H				
O				

CTCP125

DRAGONSKIN

M M F

FT15 . 808055...

74 003 ...

£ FW

24.86 00400

24.86 00200

24.86 00600

CTPM125

DRAGONSKIN

M M F

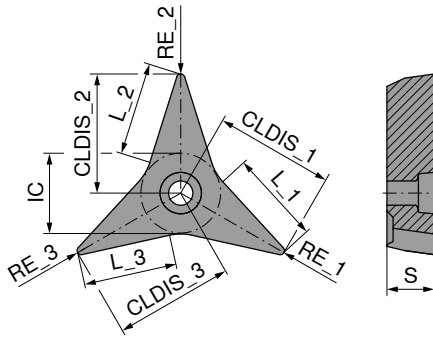
FT15 . 808055...

74 003 ...

£ FW

24.86 10200

FT15 . 353535



Designation	IC mm	CLDIS_1 mm	L_1 mm	CLDIS_2 mm	L_2 mm	CLDIS_3 mm	L_3 mm	S mm
FT15 G 353535R04-28P	15	24.01	16.10	24.01	16.10	24.01	16.10	9.14
FT15 G 353535R08-28P	15	23.08	15.20	23.08	15.20	23.08	15.20	9.14
FT15 G 353535R08-F	15	23.08	14.96	23.08	14.96	23.08	14.96	9.14

ISO	RE_1 mm	RE_2 mm	RE_3 mm
FT15 G 353535R04-28P	0.4	0.4	0.4
FT15 G 353535R08-28P	0.8	0.8	0.8
FT15 G 353535R08-F	0.8	0.8	0.8

P		●
M		
K	○	○
N		●
S		○
H		
O		○

NEW

-F
CTCP125

DRAGONSKIN

F F F
FT15 . 353535...

74 077 ...

£
FW

41.55 00400

-28P
H216T

DRAGONSKIN

F F F
FT15 . 353535...

74 001 ...

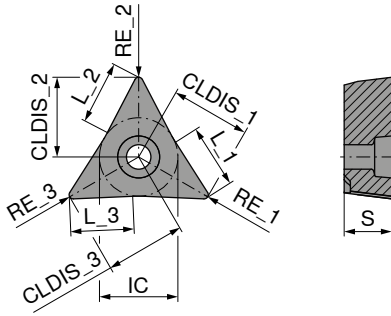
£
FW

41.55 20200
41.55 20400

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→ v. Page 29

FT15 . 555555



Designation	IC mm	CLDIS_1 mm	L_1 mm	CLDIS_2 mm	L_2 mm	CLDIS_3 mm	L_3 mm	S mm
FT15 M 555555R04-FFF	15	15.78	12.6	15.78	12.6	15.78	12.6	9.14
FT15 M 555555R08-FFF	15	15.31	12.3	15.31	12.3	15.31	12.3	9.14

ISO	RE_1 mm	RE_2 mm	RE_3 mm
FT15 M 555555R04-FFF	0.4	0.4	0.4
FT15 M 555555R08-FFF	0.8	0.8	0.8

CTCP125	CTPM125
DRAGONSKIN	DRAGONSKIN
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
F F F	F F F
FT15 . 555555...	FT15 . 555555...
74 002 ...	74 002 ...
£ FW	£ FW
21.38 00200	21.38 10400
21.38 00400	

P	●	○
M	●	●
K	○	●
N	○	○
S	○	○
H	○	○
O	○	○

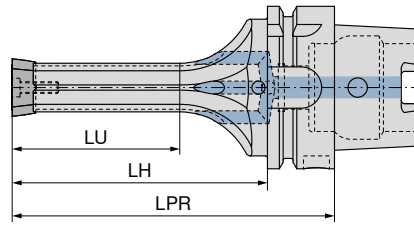
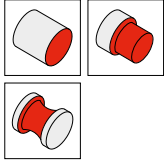
→ v. Page 29

FreeTurn – HSK-T tool holder FT15

- ▲ Tool holder for FreeTurn indexable insert
- ▲ DirectCooling coolant supply

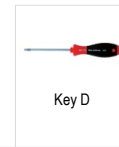
Scope of supply:

Toolholder with one clamping screw and one screwdriver

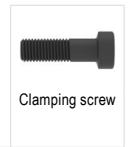


Figures show version FT15 . 808055...

ISO designation	Adapter	LPR mm	LH mm	LU mm	Insert	DirectCooling 74 700 ... £ FT
HSK-T63-100-FT15 353535	HSK-T 63	100	74	40	FT15 . 353535...	676.05 00137
HSK-T63-100-FT15 808055	HSK-T 63	100	74	40	FT15 . 808055...	676.05 00537
HSK-T63-100-FT15 555555	HSK-T 63	100	74	40	FT15 . 555555...	676.05 00337
HSK-T63-125-FT15 353535	HSK-T 63	125	99	65	FT15 . 353535...	688.15 00237
HSK-T63-125-FT15 808055	HSK-T 63	125	99	65	FT15 . 808055...	688.15 00637
HSK-T63-125-FT15 555555	HSK-T 63	125	99	65	FT15 . 555555...	688.15 00437



Key D



Clamping screw

Spare parts

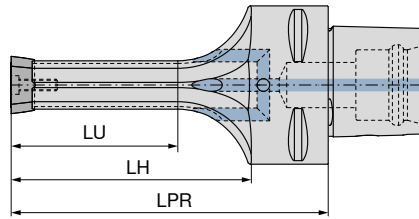
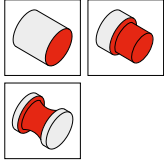
Adapter	Key D	Clamping screw
HSK-T 63	80 950 ... £ Y7	70 950 ... £ 2A/28
HSK-T 63	T20 - IP 16.39 121	M4,5x18 - IP 9.91 25900

FreeTurn – PSC tool holder FT15

- ▲ Tool holder for FreeTurn indexable insert
- ▲ DirectCooling coolant supply

Scope of supply:

Toolholder with one clamping screw and one screwdriver



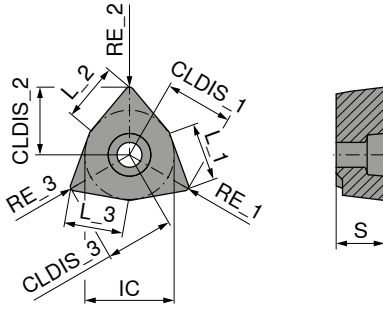
Figures show version FT15 . 808055...

ISO designation	Adapter	LPR mm	LH mm	LU mm	Insert	DirectCooling £ FT
PSC-63-100-FT15 353535	PSC 63	100	69.4	40	FT15 . 353535...	784.91 00193
PSC-63-100-FT15 808055	PSC 63	100	69.3	40	FT15 . 808055...	784.91 00593
PSC-63-100-FT15 555555	PSC 63	100	69.6	40	FT15 . 555555...	784.91 00393
PSC-63-125-FT15 353535	PSC 63	125	94.4	65	FT15 . 353535...	796.99 00293
PSC-63-125-FT15 808055	PSC 63	125	94.3	65	FT15 . 808055...	796.99 00693
PSC-63-125-FT15 555555	PSC 63	125	94.6	65	FT15 . 555555...	796.99 00493

Spare parts

Adapter	Key D	Clamping screw
PSC 63	80 950 ... £ Y7 16.39 121	70 950 ... £ 2A/28 9.91 25900

FT17 . 808080



Designation	IC mm	CLDIS_1 mm	L_1 mm	CLDIS_2 mm	L_2 mm	CLDIS_3 mm	L_3 mm	S mm
FT17 M 808080R04-MMM	17	13.00	11.3	13.00	11.3	13.00	11.3	9.14
FT17 M 808080R08-MMM	17	12.78	11.3	12.78	11.3	12.78	11.3	9.14
FT17 M 808080R12-MMM	17	12.56	11.2	12.56	11.2	12.56	11.2	9.14

ISO	RE_1 mm	RE_2 mm	RE_3 mm
FT17 M 808080R04-MMM	0.4	0.4	0.4
FT17 M 808080R08-MMM	0.8	0.8	0.8
FT17 M 808080R12-MMM	1.2	1.2	1.2

P		●	○
M			●
K		○	
N			
S			
H			
O			

CTCP125	CTPM125
DRAGONSKIN	DRAGONSKIN
M M M	M M M
FT17 . 808080...	FT17 . 808080...
74 000 ...	74 000 ...
£ FW	£ FW
28.69 00200	28.69 10400
28.69 00400	
28.69 00600	

10

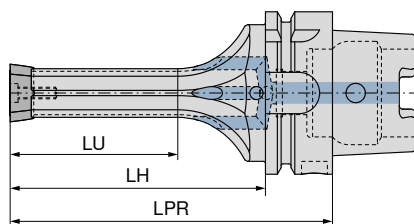
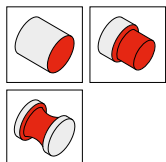
→ v. Page 29

FreeTurn – HSK-T tool holder FT17

- ▲ Tool holder for FreeTurn indexable insert
- ▲ DirectCooling coolant supply

Scope of supply:

Toolholder with one clamping screw and one screwdriver



DirectCooling
74 701 ...

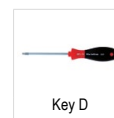
ISO designation	Adapter	LPR mm	LH mm	LU mm	Insert
HSK-T63-100-FT17 808080	HSK-T 63	100	74	40	FT17 . 808080...
HSK-T63-125-FT17 808080	HSK-T 63	125	99	65	FT17 . 808080...

£
FT
676.05 00737
688.15 00837

Spare parts

Adapter

HSK-T 63



Key D



Clamping screw

80 950 ...

£
Y7
16.39 121

70 950 ...

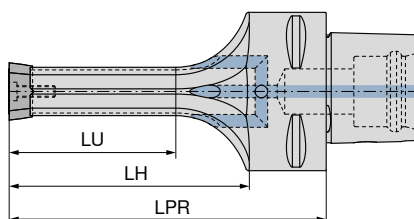
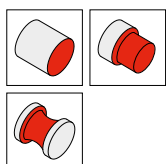
£
2A/28
9.91 25900

FreeTurn – PSC tool holder FT17

- ▲ Tool holder for FreeTurn indexable insert
- ▲ DirectCooling coolant supply

Scope of supply:

Toolholder with one clamping screw and one screwdriver



DirectCooling
74 701 ...

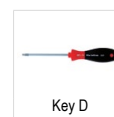
ISO designation	Adapter	LPR mm	LH mm	LU mm	Insert
PSC-63-100-FT17 808080	PSC 63	100	69.3	40	FT17 . 808080...
PSC-63-125-FT17 808080	PSC 63	125	94.3	65	FT17 . 808080...

£
FT
784.91 00793
796.99 00893

Spare parts

Adapter

PSC 63



Key D



Clamping screw

80 950 ...

£
Y7
16.39 121

70 950 ...

£
2A/28
9.91 25900

Material examples for cutting data tables


	Material sub-group	Index	Composition / Structure / Heat treatment	Tensile strength N/mm ² / HB / HRC	Material number	Material designation	Material number	Material designation
P	Unalloyed steel	P.1.1	< 0,15 % C Annealed	420 N/mm ² / 125 HB	1.0401	C15	1.1141	Ck15
		P.1.2	< 0,45 % C Annealed	640 N/mm ² / 190 HB	1.1191	C45E	1.0718	9SMnPb28
		P.1.3	< 0,45 % C Tempered	840 N/mm ² / 250 HB	1.1191	C45E	1.0535	C55
		P.1.4	< 0,75 % C Annealed	910 N/mm ² / 270 HB	1.1223	C60R	1.0535	C55
		P.1.5	< 0,75 % C Tempered	1010 N/mm ² / 300 HB	1.1223	C60R	1.0727	45S20
	Low-alloy steel	P.2.1	Annealed	610 N/mm ² / 180 HB	1.7131	16MnCr5	1.6587	17CrNiMo6
		P.2.2	Tempered	930 N/mm ² / 275 HB	1.7131	16MnCr5	1.6587	17CrNiMo6
		P.2.3	Tempered	1010 N/mm ² / 300 HB	1.7225	42CrMo4	1.3505	100Cr6
		P.2.4	Tempered	1200 N/mm ² / 375 HB	1.7225	42CrMo4	1.3505	100Cr6
	High-alloy steel and high-alloy tool steel	P.3.1	Annealed	680 N/mm ² / 200 HB	1.4021	X20Cr13	1.4034	X46Cr13
		P.3.2	Hardened and tempered	1100 N/mm ² / 300 HB	1.2343	X38CrMoV5-1	1.4034	X46Cr13
		P.3.3	Hardened and tempered	1300 N/mm ² / 400 HB	1.2343	X38CrMoV5-1	1.4034	X46Cr13
	Stainless steel	P.4.1	Ferritic / martensitic Annealed	680 N/mm ² / 200 HB	1.4016	X6Cr17	1.2316	X36CrMo16
		P.4.2	Martensitic Tempered	1010 N/mm ² / 300 HB	1.4112	X90CrMoV18	1.2316	X36CrMo16
M	Stainless steel	M.1.1	Austenitic / austenitic-ferritic Quenched	610 N/mm ² / 180 HB	1.4301	X5CrNi18-10	1.4571	X6CrNiMoTi17-12-2
		M.2.1	Austenitic Tempered	300 HB	1.4841	X15CrNiSi25-21	1.4539	X1NiCrMoCu25-20-5
		M.3.1	Austenitic / ferritic (Duplex)	780 N/mm ² / 230 HB	1.4462	X2CrNiMoN22-5-3	1.4501	X2CrNiMoCuWN25-7-4
K	Grey cast iron	K.1.1	Pearlitic / ferritic	350 N/mm ² / 180 HB	0.6010	GG-10	0.6025	GG-25
		K.1.2	Pearlitic (martensitic)	500 N/mm ² / 260 HB	0.6030	GG-30	0.6045	GG-45
	Spherulitic graphite cast iron	K.2.1	Ferritic	540 N/mm ² / 160 HB	0.7040	GGG-40	0.7060	GGG-60
		K.2.2	Pearlitic	845 N/mm ² / 250 HB	0.7070	GGG-70	0.7080	GGG-80
	Malleable iron	K.3.1	Ferritic	440 N/mm ² / 130 HB	0.8035	GTW-35-04	0.8045	GTW-45
		K.3.2	Pearlitic	780 N/mm ² / 230 HB	0.8165	GTS-65-02	0.8170	GTS-70-02
N	Aluminium wrought alloy	N.1.1	Non-hardenable	60 HB	3.0255	Al99,5	3.3315	AlMg1
		N.1.2	Hardenable Age-hardened	340 N/mm ² / 100 HB	3.1355	AlCuMg2	3.2315	AlMgSi1
	Cast aluminium alloy	N.2.1	≤ 12 % Si, non-hardenable	250 N/mm ² / 75 HB	3.2581	G-AlSi12	3.2163	G-AlSi9Cu3
		N.2.2	≤ 12 % Si, hardenable Age-hardened	300 N/mm ² / 90 HB	3.2134	G-AlSi5Cu1Mg	3.2373	G-AlSi9Mg
		N.2.3	> 12 % Si, non-hardenable	440 N/mm ² / 130 HB		G-AlSi17Cu4Mg		G-AlSi18CuNiMg
	Copper and copper alloys (bronze/brass)	N.3.1	Free-machining alloys, PB > 1 %	375 N/mm ² / 110 HB	2.0380	CuZn39Pb2 (Ms58)	2.0410	CuZn44Pb2
		N.3.2	CuZn, CuSnZn	300 N/mm ² / 90 HB	2.0331	CuZn15	2.4070	CuZn28Sn1As
		N.3.3	CuSn, lead-free copper and electrolytic copper	340 N/mm ² / 100 HB	2.0060	E-Cu57	2.0590	CuZn40Fe
	Magnesium alloys	N.4.1	Magnesium and magnesium alloys	70 HB	3.5612	MgAl6Zn	3.5312	MgAl3Zn
	S	Heat-resistant alloys	S.1.1	Fe - basis Annealed	680 N/mm ² / 200 HB	1.4864	X12NiCrSi 36-16	1.4865
S.1.2			Fe - basis Age-hardened	950 N/mm ² / 280 HB	1.4980	X6NiCrTiMoVB25-15-2	1.4876	X10NiCrAlTi32-20
S.2.1			Ni or Co basis Annealed	840 N/mm ² / 250 HB	2.4631	NiCr20TiAl (Nimonic80A)	3.4856	NiCr22Mo9Nb
S.2.2			Ni or Co basis Age-hardened	1180 N/mm ² / 350 HB	2.4668	NiCr19Nb5Mo3 (Inconel 718)	2.4955	NiFe25Cr20NbTi
S.2.3			Ni or Co basis Cast	1080 N/mm ² / 320 HB	2.4765	CoCr20W15Ni	1.3401	G-X120Mn12
Titanium alloys		S.3.1	Pure titanium	400 N/mm ²	3.7025	Ti99,8	3.7034	Ti99,7
		S.3.2	Alpha + beta alloys Age-hardened	1050 N/mm ² / 320 HB	3.7165	TiAl6V4	Ti-6246	Ti-6Al-2Sn-4Zr-6Mo
		S.3.3	Beta alloys	1400 N/mm ² / 410 HB	Ti555.3	Ti-5Al-5V-5Mo-3Cr	R56410	Ti-10V-2Fe-3Al
H	Hardened steel	H.1.1	Hardened and tempered	46–55 HRC				
		H.1.2	Hardened and tempered	56–60 HRC				
		H.1.3	Hardened and tempered	61–65 HRC				
		H.1.4	Hardened and tempered	66–70 HRC				
	Chilled iron	H.2.1	Cast	400 HB				
Hardened cast iron	H.3.1	Hardened and tempered	55 HRC					
O	Non-metal materials	O.1.1	Plastics, duroplastic	≤ 150 N/mm ²				
		O.1.2	Plastics, thermoplastic	≤ 100 N/mm ²				
		O.2.1	Aramid fibre-reinforced	≤ 1000 N/mm ²				
		O.2.2	Glass/carbon-fibre reinforced	≤ 1000 N/mm ²				
		O.3.1	Graphite					

* Tensile strength

10


Cutting data standard values for EcoCut

Index	DRAGONSKIN				DRAGONSKIN			DRAGONSKIN
	EcoCut Mini CTWN425	EcoCut Mini CTPP435	EcoCut Classic CTCP425-P	EcoCut Classic CTCP435-P	EcoCut Classic CTPP430	EcoCut Classic H210T	EcoCut Classic H216T	EcoCut ProfileMaster CTPP430
	v _c in m/min							
P.1.1		145	270	230	180			170
P.1.2		125	235	200	155			140
P.1.3		105	200	165	130			115
P.1.4		100	190	155	125			105
P.1.5		90	175	140	110			95
P.2.1		130	240	200	160			145
P.2.2		100	185	155	120			105
P.2.3		90	175	140	110			95
P.2.4		70	130	105	80			60
P.3.1		105	185	160	115			110
P.3.2		70	135	110	85			75
P.3.3		30	80	60	55			40
P.4.1		105	185	160	115			110
P.4.2		85	160	130	100			95
M.1.1		105	160	160	115			110
M.2.1		65			85			75
M.3.1		95			110			100
K.1.1	140	140	205	185	160	110	170	180
K.1.2	115	120	205	185	140	90	130	260
K.2.1	150	140	200	180	160	120	180	160
K.2.2	110	120	200	180	140	85	130	250
K.3.1	170	150	195	175	125	140	190	130
K.3.2	140	125	195	175	110	110	160	230
N.1.1	300	40			40	40	60	300
N.1.2	50	290			290	290	310	200
N.2.1	300	290			290	290	60	300
N.2.2	300	190			190	190	460	200
N.2.3	450	340			340	340	60	150
N.3.1	350	240			240	240	460	300
N.3.2	350	240			240	240	460	300
N.3.3	250	190			190	190	360	200
N.4.1	200	140			140	140	260	200
S.1.1	40	35		35	55	35	45	35
S.1.2	30	30		30	55	25	35	30
S.2.1	30	20		20	55	25	35	20
S.2.2	25	15		15	55	20	25	15
S.2.3	20	15		15	55	20	20	15
S.3.1	90	85		85	70	65	110	85
S.3.2	55	40		40	60	45	70	40
S.3.3	40	30		30	40	30	50	30
H.1.1								
H.1.2								
H.1.3								
H.1.4								
H.2.1								
H.3.1								
O.1.1	130	110			110	110	155	130
O.1.2								
O.2.1	105	95			95	95	140	105
O.2.2								
O.3.1								

 The cutting data is strongly influenced by external conditions, such as the stability of the tool and workpiece clamping, material and type of machine. The specified values represent guideline cutting data that can be adjusted by approx. ±20% according to the usage conditions.

Cutting data standard values for FreeTurn

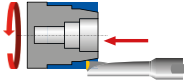
Index	F		M		-28P
	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN	DRAGONSKIN	
	CTCP125	CTPM125	CTCP125	CTPM125	H216T
	v _c in m/min		v _c in m/min		v _c in m/min
P.1.1	295	205	295	205	
P.1.2	255	170	255	170	
P.1.3	215	140	215	140	
P.1.4	200	130	200	130	
P.1.5	180	120	180	120	
P.2.1	260	175	260	175	
P.2.2	195	130	195	130	
P.2.3	180	120	180	120	
P.2.4	130	80	130	80	
P.3.1	170	140	170	140	
P.3.2	105	95	105	95	
P.3.3	45	50	45	50	
P.4.1	170	140	170	140	
P.4.2	140	120	140	120	
M.1.1		140		140	
M.2.1		100		100	
M.3.1		130		130	
K.1.1	170		170		170
K.1.2	160		160		130
K.2.1	180		180		180
K.2.2	160		160		130
K.3.1	200		200		190
K.3.2	160		160		160
N.1.1					1650
N.1.2					1350
N.2.1					1200
N.2.2					1100
N.2.3					600
N.3.1					525
N.3.2					500
N.3.3					375
N.4.1					275
S.1.1					45
S.1.2					35
S.2.1					35
S.2.2					25
S.2.3					20
S.3.1					110
S.3.2					70
S.3.3					50
H.1.1					
H.1.2					
H.1.3					
H.1.4					
H.2.1					
H.3.1					
O.1.1					160
O.1.2					
O.2.1					140
O.2.2					
O.3.1					

 The cutting data is strongly influenced by external conditions, such as the stability of the tool and workpiece clamping, material and type of machine. The specified values represent guideline cutting data that can be adjusted by approx. ±20% according to the usage conditions.

Depth of Cut and Feedrate for EcoCut Mini

Turning

2.25xD

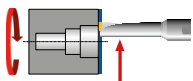


EcoCut Mini Size	Depth of Cut a_p in mm									
	0,25	0,5	0,75	1,0	1,5	2,0	2,5	3,0	3,5	4,0
	Feed rate f in mm/rev.									
ECM 02..	0,02–0,07	0,02–0,07								
ECM 02,5..	0,02–0,07	0,02–0,07	0,02–0,05							
ECM 03..	0,02–0,07	0,02–0,07	0,02–0,05	0,02–0,05						
ECM 03,5..	0,02–0,07	0,02–0,07	0,02–0,05	0,02–0,05	0,02–0,05					
ECM 04..	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,03–0,07	0,01–0,05				
ECM 05..	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,03–0,08	0,02–0,06	0,01–0,04			
ECM 06..	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,03–0,08	0,02–0,06	0,01–0,04		
ECM 07..	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,03–0,08	0,02–0,06	0,01–0,04	
ECM 08..	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,03–0,08	0,02–0,06	0,01–0,04

4xD

EcoCut Mini Size	Depth of Cut a_p in mm									
	0,25	0,5	0,75	1,0	1,5	2,0	2,5	3,0	3,5	4,0
	Feed rate f in mm/rev.									
ECM 02..	0,02–0,05	0,01–0,05								
ECM 02,5..	0,02–0,05	0,01–0,05								
ECM 03..	0,02–0,05	0,02–0,05	0,01–0,05							
ECM 03,5..	0,02–0,05	0,02–0,05	0,02–0,05	0,01–0,05						
ECM 04..	0,04–0,1	0,04–0,1	0,04–0,1	0,03–0,08	0,01–0,05					
ECM 05..	0,04–0,1	0,04–0,1	0,04–0,1	0,03–0,085	0,02–0,06	0,01–0,04				
ECM 06..	0,04–0,1	0,04–0,1	0,04–0,1	0,03–0,085	0,02–0,06	0,01–0,04				
ECM 07..	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,03–0,08	0,02–0,06	0,01–0,04			
ECM 08..	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,1	0,04–0,095	0,03–0,08	0,02–0,06	0,01–0,04		

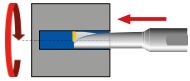
Face turning



EcoCut Mini Size	2,25xD		4xD	
	$a_{p\max}$ in mm	f in mm/rev.	$a_{p\max}$ in mm	f in mm/rev.
ECM 02..	0,30	0,01–0,05	0,30	0,01–0,03
ECM 02,5..	0,30	0,01–0,05	0,30	0,01–0,03
ECM 03..	0,50	0,01–0,06	0,50	0,01–0,04
ECM 03,5..	0,50	0,01–0,06	0,50	0,01–0,04
ECM 04..	0,70	0,03–0,07	0,70	0,02–0,05
ECM 05..	0,70	0,03–0,07	0,70	0,02–0,05
ECM 06..	0,70	0,03–0,07	0,70	0,02–0,05
ECM 07..	1,00	0,04–0,08	1,00	0,03–0,06
ECM 08..	1,00	0,04–0,08	1,00	0,03–0,06

Depth of Cut and Feedrate for EcoCut Mini

Drilling
Feed rate



EcoCut Mini Size	2,25xD	4xD
	f in mm/rev.	f in mm/rev.
ECM 02..	0,0025–0,0075	0,0025–0,005
ECM 02,5..	0,0025–0,010	0,0025–0,005
ECM 03..	0,0025–0,0125	0,0025–0,010
ECM 03,5..	0,0025–0,0150	0,0025–0,010
ECM 04..	0,005–0,030	0,005–0,0125
ECM 05..	0,005–0,030	0,005–0,015
ECM 06..	0,005–0,030	0,005–0,020
ECM 07..	0,005–0,035	0,005–0,025
ECM 08..	0,005–0,040	0,005–0,030

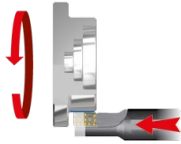
max. bore depth

EcoCut Mini Size	2,25xD	4xD
	Max. hole depth in mm	Max. hole depth in mm
ECM 02..	4,50	8,0
ECM 02,5..	5,63	10,0
ECM 03..	6,75	12,0
ECM 03,5..	7,88	14,0
ECM 04..	9,0	16,0
ECM 05..	11,25	20,0
ECM 06..	13,5	24,0
ECM 07..	15,75	28,0
ECM 08..	18,0	32,0


Depth of Cut and Feedrate for EcoCut Classic

Turning

1.5xD




EcoCut Classic Size	Depth of Cut a_p in mm											
	1	2	3	4	5	6	7	8	9	10	12	14
	Feed rate f in mm/rev.											
ECC 08	0,06–0,12	0,06–0,12	0,04–0,10	0,02–0,08								
ECC 10	0,07–0,15	0,07–0,15	0,05–0,13	0,04–0,11	0,02–0,09							
ECC 12	0,08–0,16	0,08–0,16	0,08–0,16	0,06–0,14	0,04–0,12	0,02–0,10						
ECC 14	0,09–0,18	0,09–0,18	0,09–0,18	0,09–0,18	0,07–0,16	0,05–0,14	0,02–0,11					
ECC 16	0,10–0,20	0,10–0,20	0,10–0,20	0,10–0,20	0,08–0,18	0,06–0,16	0,04–0,14	0,02–0,12				
ECC 18	0,11–0,22	0,11–0,22	0,11–0,22	0,11–0,22	0,11–0,22	0,09–0,20	0,07–0,18	0,05–0,16	0,03–0,13			
ECC 20	0,12–0,24	0,12–0,24	0,12–0,24	0,12–0,24	0,12–0,24	0,11–0,23	0,09–0,21	0,07–0,19	0,05–0,17	0,03–0,15		
ECC 25	0,13–0,26	0,13–0,26	0,13–0,26	0,13–0,26	0,13–0,26	0,13–0,26	0,13–0,26	0,11–0,24	0,09–0,22	0,07–0,20	0,03–0,16	
ECC 32	0,15–0,30	0,15–0,30	0,15–0,30	0,15–0,30	0,15–0,30	0,14–0,30	0,15–0,30	0,15–0,30	0,13–0,28	0,11–0,26	0,07–0,22	0,03–0,18

 Feed f may be increased by 50–75 % when using -M50Q and -27Q.

2.25xD

EcoCut Classic Size	Depth of Cut a_p in mm										
	1,0	2,0	2,5	3,0	3,5	4,0	4,5	5,0	5,5	6,0	7,0
	Feed rate f in mm/rev.										
ECC 08	0,06–0,12	0,04–0,10	0,02–0,08								
ECC 10	0,07–0,15	0,05–0,13	0,03–0,11	0,02–0,09							
ECC 12	0,08–0,16	0,08–0,16	0,06–0,14	0,04–0,12	0,02–0,10						
ECC 14	0,09–0,18	0,09–0,18	0,07–0,16	0,05–0,14	0,04–0,13	0,02–0,11					
ECC 16	0,10–0,20	0,10–0,20	0,09–0,19	0,07–0,17	0,05–0,15	0,03–0,13					
ECC 18	0,11–0,22	0,11–0,22	0,11–0,22	0,09–0,20	0,07–0,18	0,05–0,16	0,03–0,14				
ECC 20	0,12–0,24	0,12–0,24	0,12–0,24	0,12–0,24	0,10–0,22	0,08–0,20	0,06–0,18	0,04–0,16			
ECC 25	0,13–0,26	0,13–0,26	0,13–0,26	0,13–0,26	0,13–0,26	0,12–0,25	0,10–0,23	0,08–0,21	0,06–0,19	0,04–0,17	
ECC 32	0,15–0,30	0,15–0,30	0,15–0,30	0,15–0,30	0,15–0,30	0,15–0,30	0,14–0,29	0,12–0,27	0,10–0,25	0,08–0,23	0,05–0,20

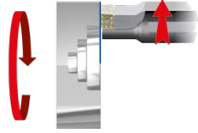
 Feed f may be increased by 50–75 % when using -M50Q and -27Q.

3xD

EcoCut Classic Size	Depth of Cut a_p in mm								
	1,0	2,0	2,5	3,0	3,5	4,0	5,0	6,0	7,0
	Feed rate f in mm/rev.								
ECC 08	0,05–0,10	0,02–0,06							
ECC 10	0,06–0,11	0,03–0,07							
ECC 12	0,06–0,12	0,04–0,10	0,02–0,08						
ECC 14	0,07–0,13	0,05–0,11	0,02–0,09						
ECC 16	0,07–0,15	0,06–0,14	0,04–0,12	0,02–0,09					
ECC 18	0,08–0,16	0,08–0,16	0,06–0,14	0,04–0,12					
ECC 20	0,09–0,18	0,09–0,18	0,09–0,18	0,07–0,16	0,05–0,14	0,03–0,12			
ECC 25	0,10–0,19	0,10–0,19	0,10–0,19	0,08–0,17	0,06–0,15	0,03–0,13			
ECC 32	0,11–0,22	0,11–0,22	0,11–0,22	0,11–0,22	0,09–0,20	0,07–0,18	0,03–0,14		

Depth of Cut and Feedrate for EcoCut Classic

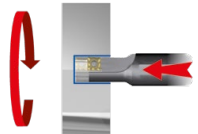
Face turning



EcoCut Classic Size	1,5xD		2,25xD		3xD	
	a _p in mm	f in mm/rev.	a _p in mm	f in mm/rev.	a _p in mm	f in mm/rev.
ECC 08	2,00	0,05–0,10	1,90	0,04–0,09	1,10	0,04–0,07
ECC 10	2,50	0,06–0,12	2,20	0,05–0,10	1,20	0,04–0,09
ECC 12	3,00	0,07–0,14	2,60	0,06–0,12	1,40	0,05–0,11
ECC 14	3,50	0,08–0,16	3,00	0,07–0,14	1,60	0,06–0,12
ECC 16	4,00	0,09–0,18	3,40	0,08–0,16	1,90	0,06–0,13
ECC 18	4,50	0,10–0,20	3,80	0,09–0,18	2,00	0,07–0,14
ECC 20	5,00	0,11–0,22	4,20	0,10–0,20	2,20	0,08–0,15
ECC 25	6,00	0,12–0,24	5,00	0,11–0,22	2,60	0,09–0,18
ECC 32	8,00	0,13–0,27	6,00	0,12–0,25	3,00	0,10–0,20

Drilling

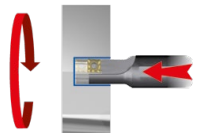
Feed rate



EcoCut Classic Size	1,5xD	2,25xD	3xD
	f in mm/rev.	f in mm/rev.	f in mm/rev.
ECC 08	0,01–0,04	0,01–0,04	0,01–0,02
ECC 10	0,01–0,05	0,01–0,05	0,01–0,03
ECC 12	0,01–0,05	0,01–0,05	0,01–0,04
ECC 14	0,01–0,07	0,01–0,07	0,01–0,05
ECC 16	0,02–0,08	0,02–0,08	0,02–0,06
ECC 18	0,03–0,09	0,03–0,09	0,03–0,07
ECC 20	0,03–0,10	0,03–0,10	0,03–0,08
ECC 25	0,03–0,12	0,03–0,12	0,04–0,09
ECC 32	0,05–0,15	0,05–0,15	0,05–0,11

10

max. bore depth

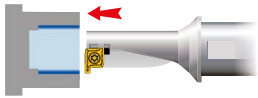


EcoCut Classic Size	1,5xD	2,25xD	3xD
	Max. hole depth in mm	Max. hole depth in mm	Max. hole depth in mm
ECC 08	12,0	18,0	24,0
ECC 10	15,0	22,5	30,0
ECC 12	18,0	27,0	36,0
ECC 14	21,0	31,5	42,0
ECC 16	24,0	36,0	48,0
ECC 18	27,0	40,5	54,0
ECC 20	30,0	45,0	60,0
ECC 25	37,5	56,5	75,0
ECC 32	48,0	72,0	96,0

Depth of Cut and Feedrate for EcoCut ProfileMaster 90°

Turning

1,5xD



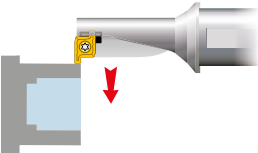
EcoCut ProfileMaster Size	Depth of Cut a_p in mm							
	1	2	3	4	5	6	7	8
	Feed rate f in mm/rev.							
EC PM 10	0,07–0,20	0,05–0,17	0,02–0,12					
EC PM 12	0,07–0,20	0,05–0,17	0,02–0,12					
EC PM 16	0,10–0,25	0,07–0,23	0,05–0,21	0,02–0,17				
EC PM 20	0,12–0,27	0,10–0,26	0,007–0,24	0,05–0,20	0,02–0,14			
EC PM 25	0,15–0,30	0,15–0,30	0,13–0,28	0,10–0,26	0,05–0,22	0,02–0,18		
EC PM 32	0,15–0,30	0,15–0,30	0,15–0,30	0,15–0,30	0,10–0,27	0,07–0,24	0,05–0,21	0,02–0,15

2,25xD

EcoCut ProfileMaster Size	Depth of Cut a_p in mm							
	1	2	3	4	5	6	7	8
	Feed rate f in mm/rev.							
EC PM 10	0,07–0,19	0,02–0,13						
EC PM 12	0,07–0,19	0,02–0,13						
EC PM 16	0,10–0,25	0,07–0,21	0,02–0,13					
EC PM 20	0,12–0,27	0,07–0,24	0,05–0,19					
EC PM 25	0,15–0,30	0,10–0,27	0,07–0,23	0,02–0,15				
EC PM 32	0,15–0,30	0,15–0,30	0,10–0,27	0,07–0,23	0,02–0,15			

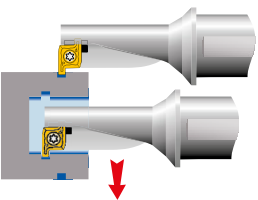
Face turning

1.5xD and 2.25xD



EcoCut ProfileMaster Size	Depth of Cut a_p in mm						
	1,0	1,5	2,0	2,5	3,0	3,5	
	Feed rate f in mm/rev.						
EC PM 10	0,02–0,15	0,02–0,15					
EC PM 12	0,02–0,15	0,02–0,15					
EC PM 16	0,05–0,20	0,05–0,20	0,05–0,20				
EC PM 20	0,08–0,22	0,08–0,22	0,08–0,22	0,08–0,22			
EC PM 25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25		
EC PM 32	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	

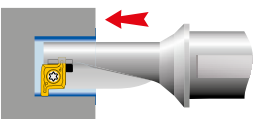
Internal + external – radial grooving



EcoCut ProfileMaster Size	1,5xD	EcoCut ProfileMaster Size	2,25xD
	f in mm/rev.		f in mm/rev.
EC PM 10	0,01–0,08	EC PM 10	0,01–0,08
EC PM 12	0,02–0,10	EC PM 12	0,02–0,10
EC PM 16	0,04–0,15	EC PM 16	0,04–0,15
EC PM 20	0,04–0,16	EC PM 20	0,04–0,16
EC PM 25	0,07–0,20	EC PM 25	0,07–0,20
EC PM 32	0,08–0,22	EC PM 32	0,08–0,22


Drilling

Feed and max. hole depth



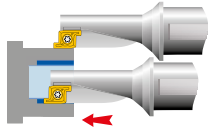
EcoCut ProfileMaster Size	1,5xD		EcoCut ProfileMaster Size	2,25xD	
	f in mm/rev.	Max. hole depth in mm		f in mm/rev.	Max. hole depth in mm
EC PM 10	0,01–0,05	15,0	EC PM 10	0,01–0,05	22,5
EC PM 12	0,01–0,06	18,0	EC PM 12	0,01–0,06	27,0
EC PM 16	0,02–0,09	24,0	EC PM 16	0,02–0,09	36,0
EC PM 20	0,03–0,10	30,0	EC PM 20	0,03–0,10	45,0
EC PM 25	0,04–0,12	37,5	EC PM 25	0,04–0,12	56,3
EC PM 32	0,04–0,14	48,0	EC PM 32	0,04–0,14	72,0

Depth of Cut and Feedrate for EcoCut ProfileMaster 0°

 EcoCut ProfileMaster Sizes 10 and 12 can not be used as 0° version.

Turning

1,5xD



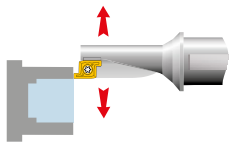
EcoCut ProfileMaster Size	Depth of cut a_p in mm					
	1,0	1,5	2,0	2,5	3,0	3,5
	Feed rate f in mm/rev.					
EC PM 16	0,04–0,20	0,04–0,20	0,04–0,20			
EC PM 20	0,06–0,22	0,06–0,22	0,06–0,22	0,06–0,22		
EC PM 25	0,08–0,25	0,08–0,25	0,08–0,25	0,08–0,25	0,08–0,25	
EC PM 32	0,10–0,28	0,10–0,28	0,10–0,28	0,10–0,28	0,10–0,28	0,10–0,28

2,25xD

EcoCut ProfileMaster Size	Depth of cut a_p in mm					
	1,0	1,5	2,0	2,5	3,0	3,5
	Feed rate f in mm/rev.					
EC PM 16	0,04–0,20	0,04–0,20	0,04–0,20			
EC PM 20	0,06–0,22	0,06–0,22	0,06–0,22	0,06–0,22		
EC PM 25	0,08–0,25	0,08–0,25	0,08–0,25	0,08–0,25	0,08–0,25	
EC PM 32	0,10–0,28	0,10–0,28	0,10–0,28	0,10–0,28	0,10–0,28	0,10–0,28

Face turning

1,5xD



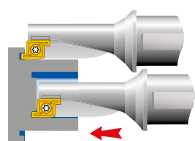
EcoCut ProfileMaster Size	Depth of cut a_p in mm						
	1,0	1,5	2,0	2,5	3,0	3,5	4,0
	Feed rate f in mm/rev.						
EC PM 16	0,05–0,20	0,05–0,20	0,05–0,20				
EC PM 20	0,05–0,20	0,05–0,20	0,05–0,20	0,05–0,20			
EC PM 25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25		
EC PM 32	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25

10

2,25xD

EcoCut ProfileMaster Size	Depth of cut a_p in mm						
	1,0	1,5	2,0	2,5	3,0	3,5	4,0
	Feed rate f in mm/rev.						
EC PM 16	0,05–0,20	0,05–0,20	0,05–0,20				
EC PM 20	0,05–0,20	0,05–0,20	0,05–0,20	0,05–0,20			
EC PM 25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25		
EC PM 32	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25	0,10–0,25

Axial grooving external + internal

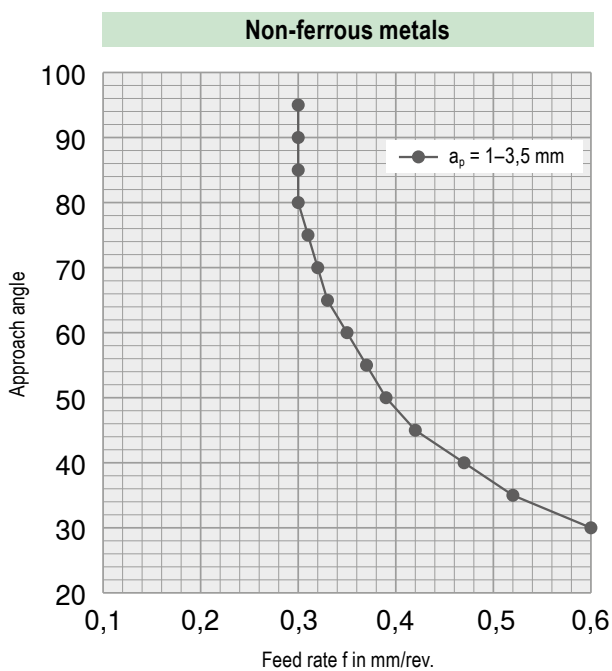
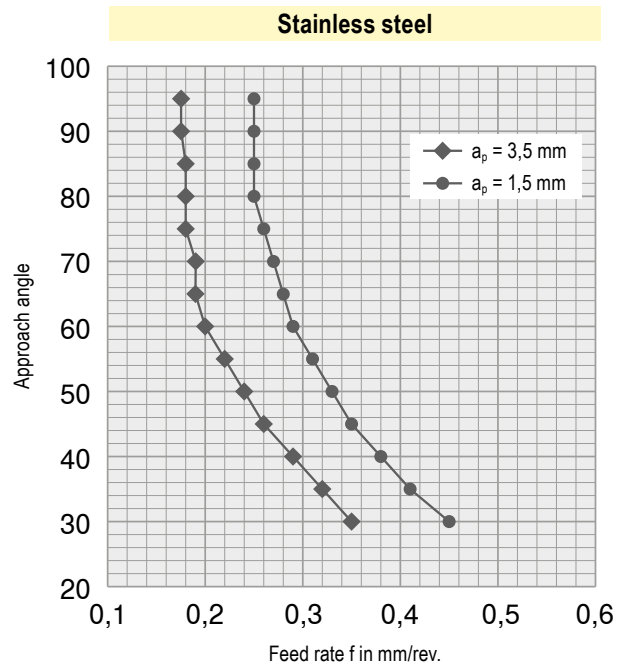
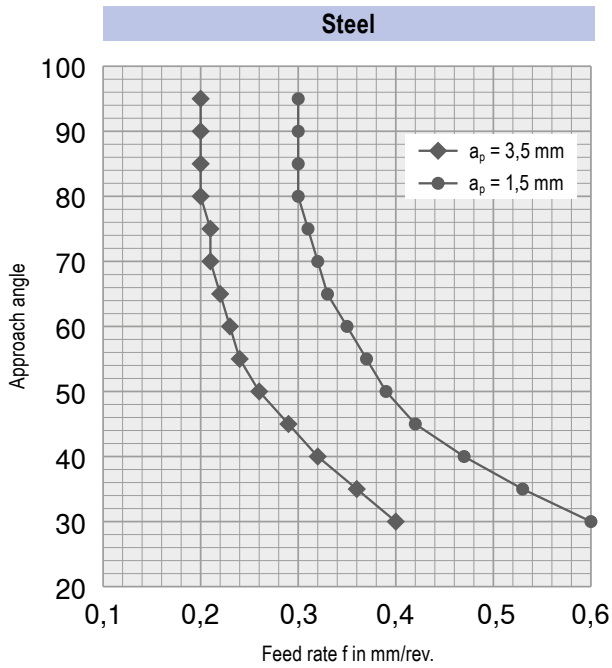


EcoCut ProfileMaster Size	1,5xD
	Feed rate f in mm/rev.
EC PM 16	0,02–0,12
EC PM 20	0,04–0,14
EC PM 25	0,06–0,18
EC PM 32	0,08–0,20

EcoCut ProfileMaster Size	2,25xD
	Feed rate f in mm/rev.
EC PM 16	0,02–0,12
EC PM 20	0,04–0,14
EC PM 25	0,06–0,18
EC PM 32	0,08–0,20

Initial curves for FreeTurn

	Material				Inserts		v_c in m/min	Cooling
Steel	1.7225	42CrMo4	1010 N/mm ²	P.2.3	FT1x M 80xxxxR08 -M	CTCP125	200	Emulsion
Stainless steel	1.4301	X5CrNi18-10	610 N/mm ²	M.1.1	FT1x M 80xxxxR08 -M	CTPM125	140	Emulsion
Non-ferrous metals	3.2341	G-AlSi 5 Mg	200 N/mm ²	N2.2	FT1x G 35xxxxR08-28P	H210T	1100	Emulsion



Chip Breakers Overview

EcoCut Classic

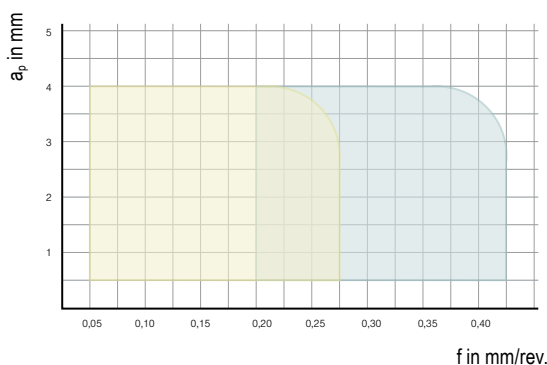
Model	Smooth cut	Irregular cutting depth	Interrupted cut	Sectional illustration	
				f mm	
-EN ▲ Universal geometry ▲ Excellent chip breakage ▲ Positive cutting edge ▲ Low to medium feeds		CTCP425-P	CTCP435-P / CTPP430	CTPP430 / CTCP435-P	
	CTCP425-P / CTPP430	CTPP430	CTPP430		
	CTCP425-P	CTCP435-P / CTPP430	CTCP435-P		
	CTPP430	CTPP430	CTPP430		
	CTCP435-P / CTPP430	CTCP435-P / CTPP430	CTCP435-P		
CTCP435-P / CTPP430	CTCP435-P / CTPP430	CTCP435-P		0,05–0,275	
-M50Q ▲ With wiper geometry ▲ Excellent surface qualities ▲ Good chip formation ▲ Medium to high feeds		CTCP425-P	CTCP425-P		
	CTCP425-P				
	CTCP425-P	CTCP425-P			
-27P ▲ Positive cutting edge ▲ Periphery ground ▲ Polished rake face ▲ First choice for non-ferrous metals					
		H216T	H216T	H216T	
		H216T	H216T	H216T	
		H216T	H216T	H216T	
		H216T	H216T	H216T	
-27Q ▲ With wiper geometry ▲ Extremely positive geometry ▲ Periphery ground ▲ Low adhesion					
		H210T	H210T	H210T	
		H210T	H210T	H210T	
		H210T	H210T	H210T	
		H210T	H210T	H210T	

10

EcoCut ProfileMaster

-M20 ▲ Positive geometry ▲ Universal application ▲ Low to medium feeds		CTPP430	CTPP430	CTPP40	
		CTPP430	CTPP430	CTPP430	
		CTPP430	CTPP430	CTPP430	
		CTPP430	CTPP430	CTPP430	
		CTPP430	CTPP430	CTPP430	
		CTPP430	CTPP430	CTPP430	0,05–0,25

Application area of -EN and -M50Q chip breakers




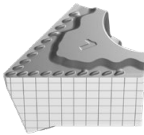
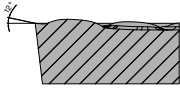
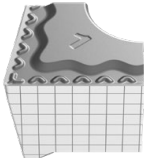
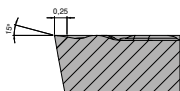

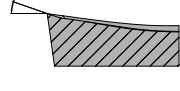


EcoCut Classic 2.25xD – ECC16 – XCNT 080304

- = -M50Q
- = Standard

Chip Breakers Overview

FreeTurn

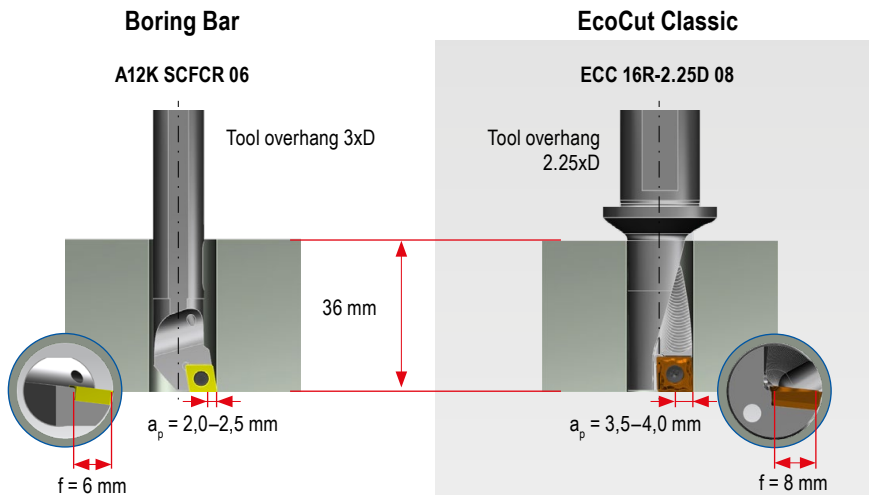
	Model	Smooth cut	Irregular cutting depth	Interrupted cut	Sectional illustration
					f mm
-F ▲ Traditional finishing geometry ▲ High surface quality ▲ First choice for finishing steel		CTCP125	CTCP125		 0-6
		CTCP125	CTCP125		
-M ▲ Average to rough machining ▲ Aggressive chip breaker		CTPM125	CTPM125		 0-6
		CTPM125	CTPM125		
-28P ▲ Traditional finishing geometry ▲ Sharp cutting edge ▲ First choice for aluminium					 0-1,8
		H216T	H216T	H216T	
		H216T	H216T	H216T	
		H216T	H216T	H216T	
		H216T	H216T	H216T	

EcoCut Classic – Application as the most stable boring tool

EcoCut can be used not only as a multifunctional tool. In comparison with a boring bar EcoCut used as a pure boring tool gives the user enormous benefits.

Example: machining bores, 16 mm diameter by 36 mm depth

Differences in the tool



Your Advantages

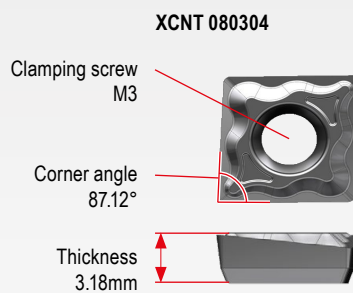
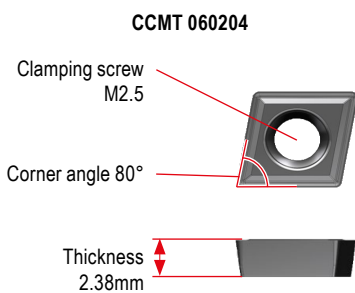
Large, stable toolholder

- ▲ Absorption of high cutting forces
- ▲ Low vibration
- ▲ Chip Booster for perfect cooling and chip evacuation

Benefits

- ▲ High surface quality
- ▲ Perfect chip control
- ▲ Max. process security

Differences in the insert



Large and stable insert

- ▲ Increased process security
- ▲ Enables large depths of cut
- ▲ Higher cutting data
- ▲ Higher tool life

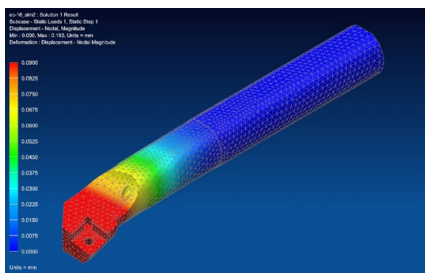
Benefits

- ▲ Reduction in machining time
- ▲ Increased productivity
- ▲ Reduced tooling costs

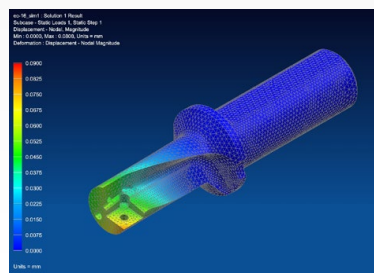
Stability Comparison

Calculation using FEM

A load of 1000 N on the insert seat corresponds to an approx. a_p of 2.0 mm and f of 0.2 mm



Deflection 0.19mm

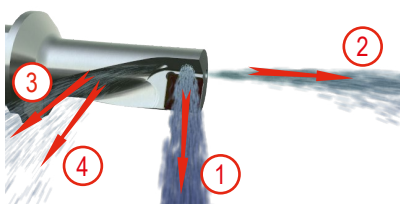


Deflection 0.08mm

Practical experience shows:

- ▲ Reduced machining time by up to 75 %
- ▲ Increase in tool life by 400 % possible

Innovative chip removal – Chip-Booster



EcoCut tools are equipped with a unique coolant and chip removal system.

1 Cooling of the indexable insert

2 General coolant stream

3 Chip booster for improved chip transport

4 Chip booster prevents chips from getting stuck between tool and workpiece

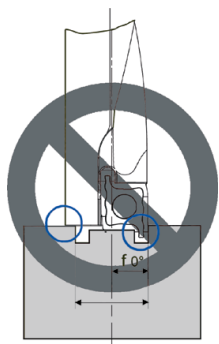
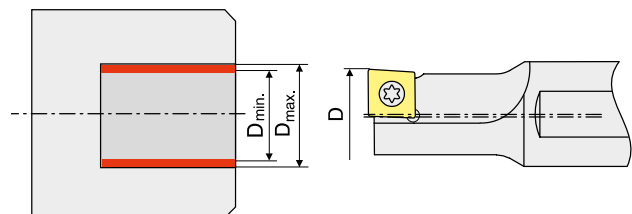
1 For maximum chip transport efficiency when drilling, coolant pressure must be 3–6 bar minimum (optimal 7–10 bar).

Application Tips

Drilling Off centre

Due to the special construction of the EcoCut tool and insert, off-centre drilling is possible.

Deviations from the tool nominal \varnothing , can be achieved (see adjacent table).



ProfileMaster 0°
Not suitable for drilling!

EcoCut Mini	Tool nominal- \varnothing	Work piece bore \varnothing	
	D in mm	D _{min.} in mm	D _{max.} in mm
ECM 02 L/R - ...D	2	1,95	2,1
ECM 02,5 L/R - ...D	2,5	2,45	2,6
ECM 03 L/R - ...D	3	2,95	3,15
ECM 03,5 L/R - ...D	3,5	3,45	3,65
ECM 04 R/L - ...D	4	3,90	4,20
ECM 05 R/L - ...D	5	4,90	5,20
ECM 06 R/L - ...D	6	5,90	6,20
ECM 07 R/L - ...D	7	6,90	7,20
ECM 08 R/L - ...D	8	7,90	8,20

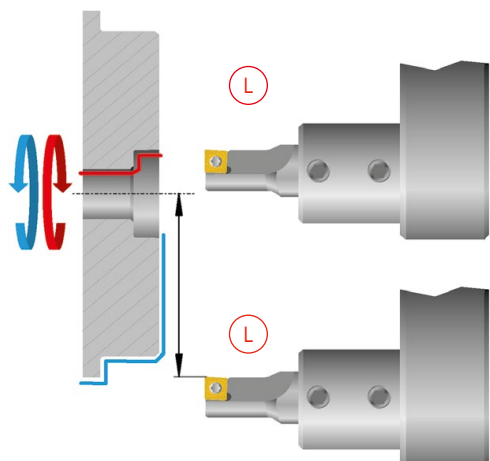
EcoCut Classic	Tool nominal- \varnothing	Work piece bore \varnothing	
	D in mm	D _{min.} in mm	D _{max.} in mm
ECC 08 R/L - ... 04	8	7,85	8,30
ECC 10 R/L - ... 05	10	9,85	10,50
ECC 12 R/L - ... 06	12	11,85	12,50
ECC 14 R/L - ... 07	14	13,85	14,50
ECC 16 R/L - ... 08	16	15,85	16,50
ECC 18 R/L - ... 09	18	17,85	18,50
ECC 20 R/L - ... 10	20	19,80	20,50
ECC 25 R/L - ... 13	25	24,80	25,80
ECC 32 R/L - ... 17	32	31,80	33,00

EcoCut ProfileMaster	Tool nominal- \varnothing	Work piece bore \varnothing	
	D in mm	D _{min.} in mm	D _{max.} in mm
PM 10R/L ...	10	9,85	12
PM 12R/L ...	12	11,85	15
PM 16R/L ...	16	15,85	19
PM 20R/L ...	20	19,80	24
PM 25R/L ...	25	24,80	29
PM 32R/L ...	32	31,80	38

Machining over centre

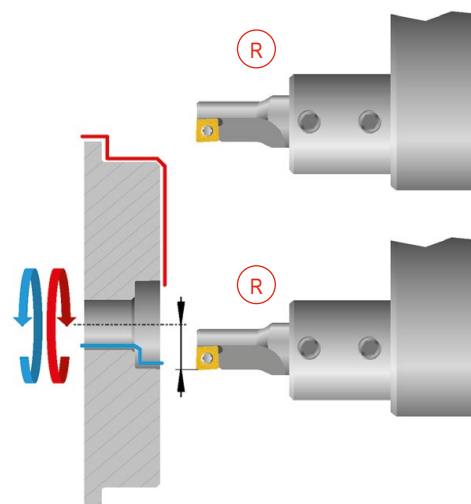
Problem

In case of insufficient movement of the machine across the centre line, the external diameter can not be machined with the same tool.



Solution

Use a right hand EcoCut tool.

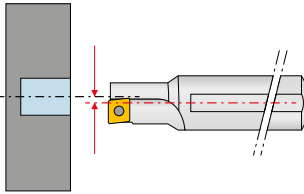


Application Tips

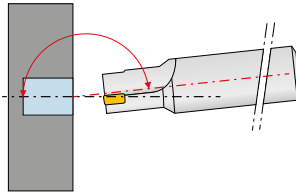
With axial displacement there is the danger of collision!

Problems

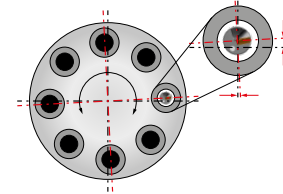
Displacement in x-direction:



Angular error:



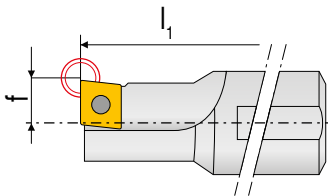
Turret position error:



Remedy

When pre-setting the tool:

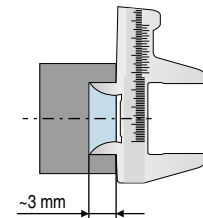
- ▲ Definition as an internal turning tool for programming



- ▲ Enter the tool nominal \varnothing as bore target \varnothing

At the machine:

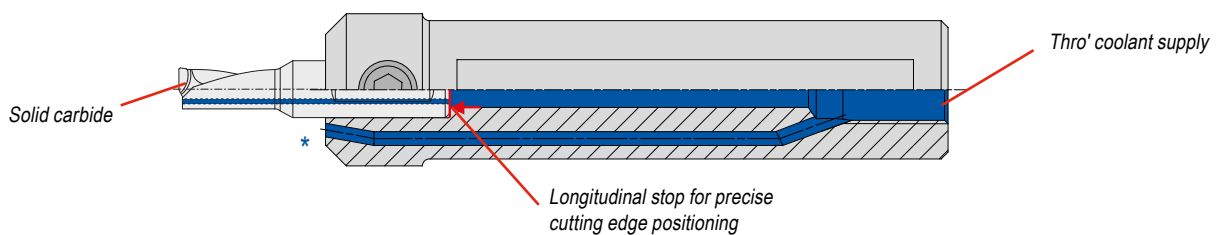
- ▲ Make measuring cut, approx. 3 mm deep
- ▲ Measure drilled diameter produced



- ▲ If necessary correct drilling \varnothing
- ▲ Start machining

10

EcoCut Mini adapter – Design

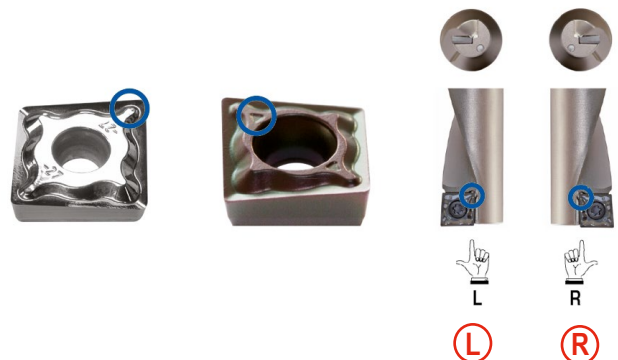


* Cross-section rotated by 90° for clarity

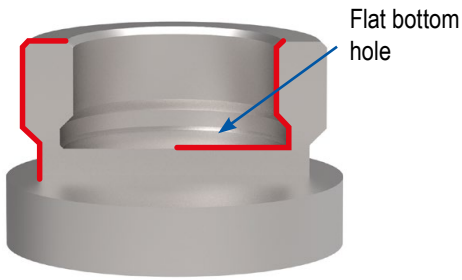
Mounting of the insert for EcoCut Classic

For tools up to \varnothing 8 mm right and left handed inserts are required.
From \varnothing 10-32 mm neutral inserts are used.

Note!
Ensure correct installation position.



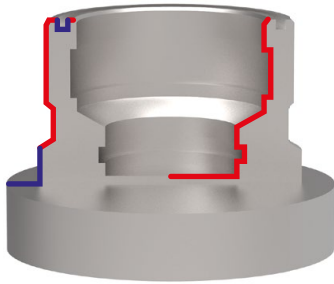
EcoCut ProfileMaster – the highlight with regard to efficiency



Right hand tool



right hand insert



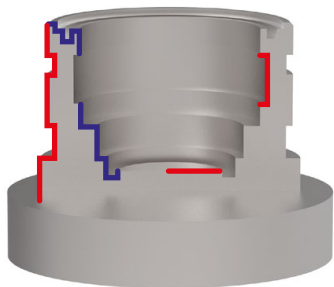
Right hand tool



left hand insert



right hand insert



Left hand tool

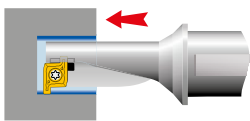
Right hand tool



right hand insert

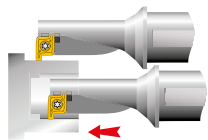


Version 90°

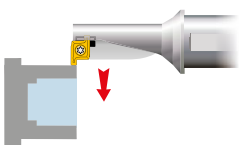


Drilling into solid material
with flat bottom hole

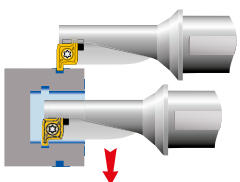
Boring



Turning External Diameters



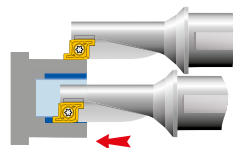
Turning Internal Diameters



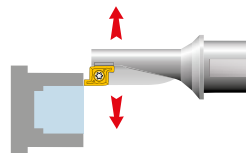
External radial grooving

Internal radial grooving

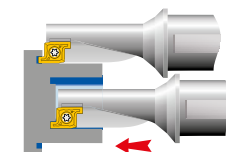
Version 0°



Turning External Diameters

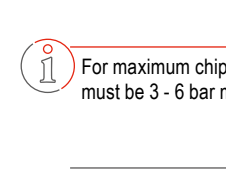


Turning Internal Diameters



Turning Profiles

Axial grooving external



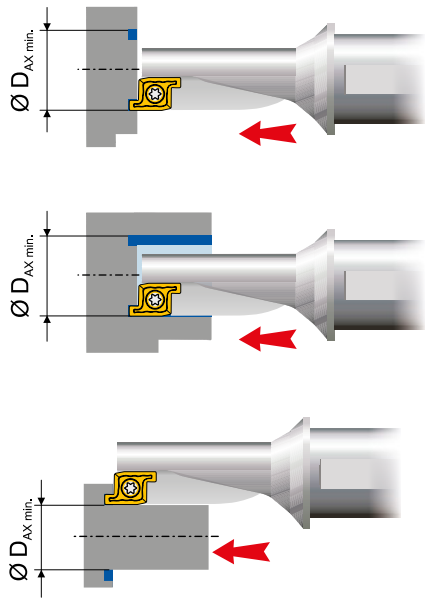
Axial grooving internal



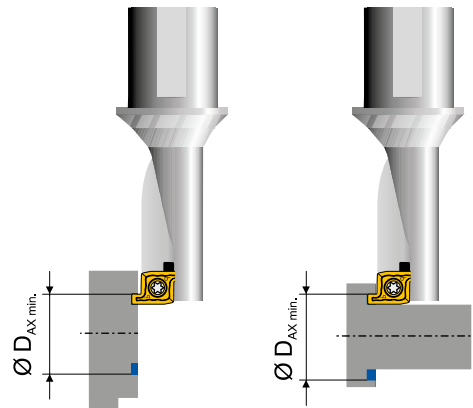
For maximum chip transport efficiency when drilling, coolant pressure must be 3 - 6 bar minimum (optimal 7 - 10 bar).

EcoCut ProfileMaster – Axial Grooving

0° (from Ø 16 mm)

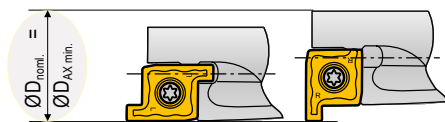


90°

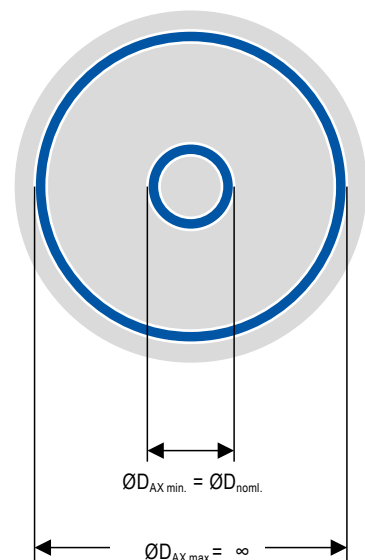


EcoCut ProfileMaster	ØD _{noml.} mm	ØD _{AX min.} mm	ØD _{AX max.} mm
PM 10R/L 1,5D	10	10	> 10
PM 10R/L 2,25D	10	10	> 10
PM 12R/L 1,5D	12	12	> 12
PM 12R/L 2,25D	12	12	> 12
PM 16R/L 1,5D	16	16	> 16
PM 16R/L 2,25D	16	16	> 16
PM 20R/L 1,5D	20	20	> 20
PM 20R/L 2,25D	20	20	> 20
PM 25R/L 1,5D	25	25	> 25
PM 25R/L 2,25D	25	25	> 25
PM 32R/L 1,5D	32	32	> 32
PM 32R/L 2,25D	32	32	> 32

$$\text{ØD}_{\text{AX min.}} = \text{ØD}_{\text{noml.}}$$



- ØD_{noml.} = Nominal tool diameter
- ØD_{AX min.} = smallest diameter for axial grooving
- ØD_{AX max.} = largest diameter for axial grooving



Application Tips

Recommendation for Optimum Results

Type of problem									Remedy measures
Type of wear				Work piece problems		Swarf control			
Edge breakage	Built-up edge	Wear on clearance face	Plastic deformation	Vibration	Surface quality	Chip too long (snarl chip)	Chip too short (fragmented chip)		
	▲	▼	▼	▼	▲	▼		Cutting data	Cutting speed
▼		~	▼	▲	▼	▲	▼		Feed rate
▲		▲	▲	▼	▲			Insert selection	Corner radius ▲ larger ▼ smaller
▼		▲	▲						Tool Material ▲ Wear resistance ▼ toughness
~				~	~			General criteria	Tool clamping
~				~	~				Work piece clamping
~				~	▼				Overhang
~		~		~	~				Tip height
	●	●	●		●	●			Cooling lubricant

▲ raise, increase large influence

↑ raise, increase small influence

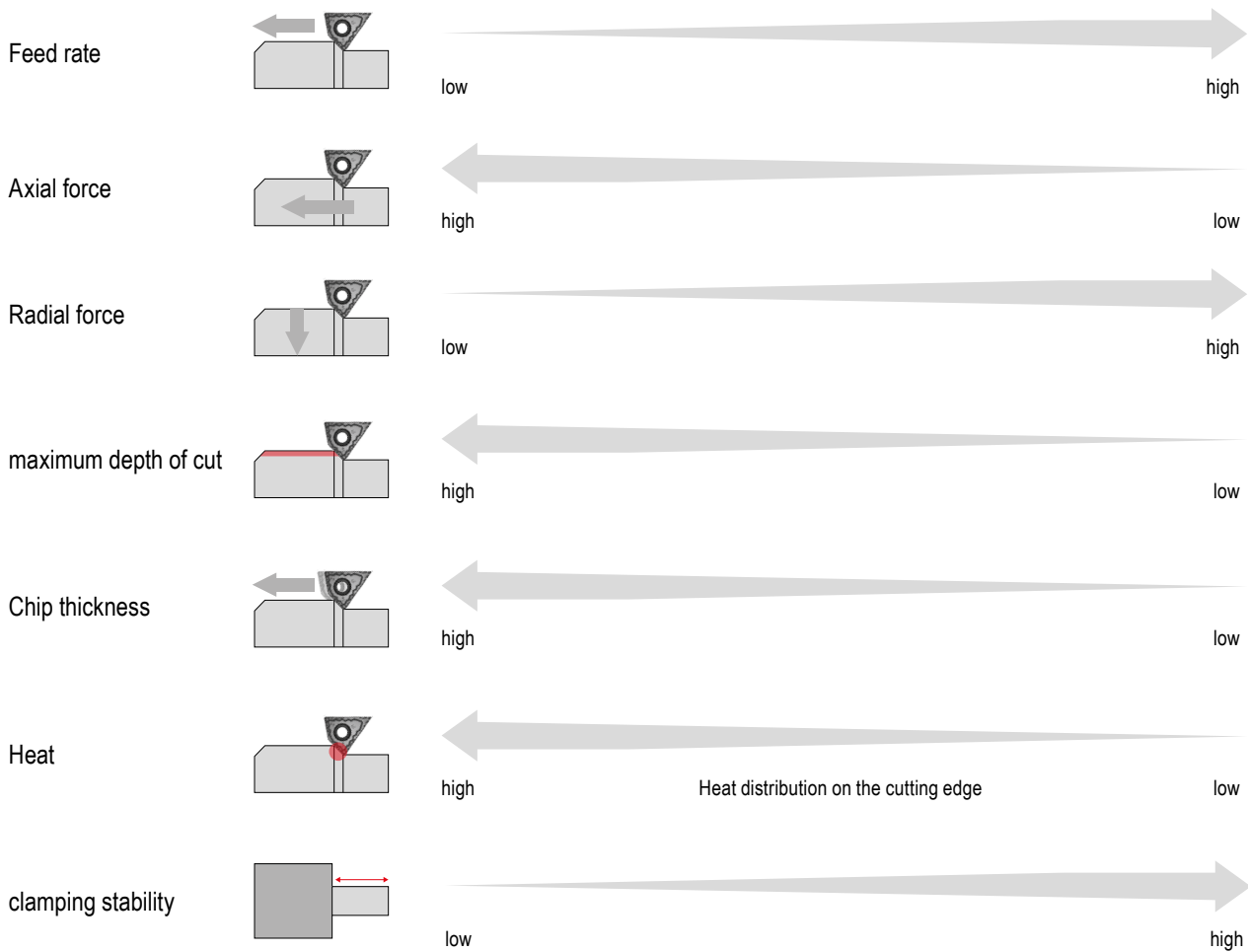
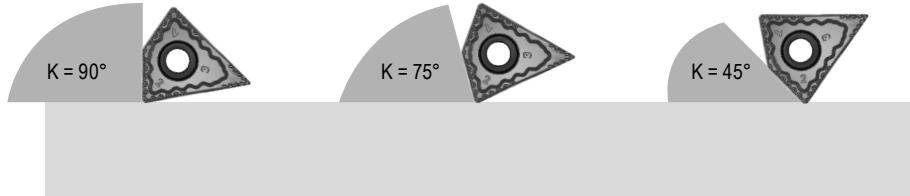
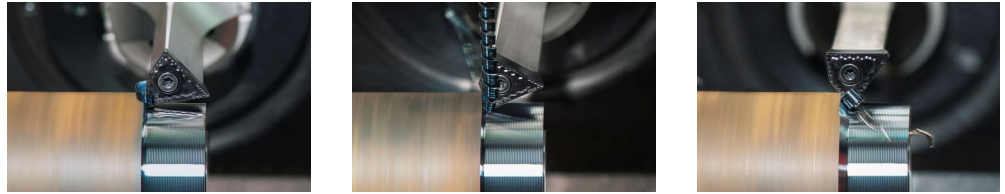
▼ avoid, reduce large influence

↓ avoid, reduce small influence

~ control, optimize

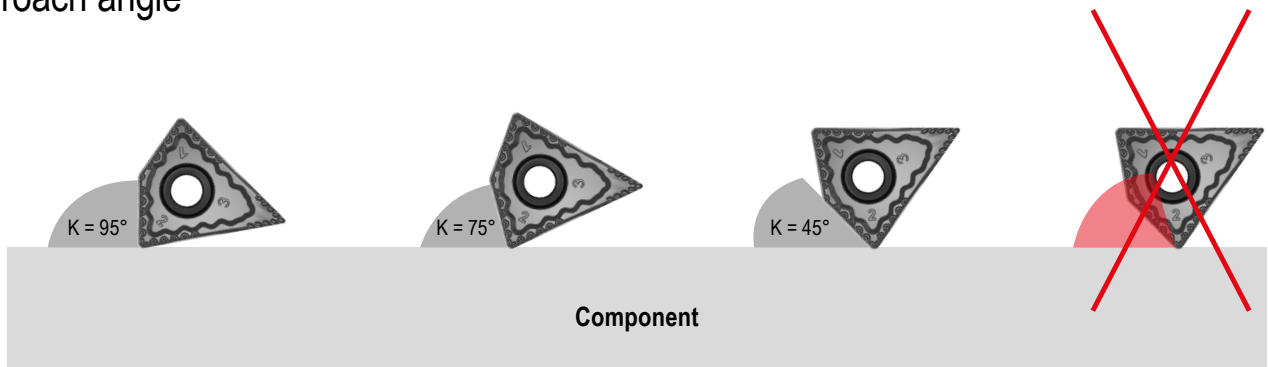
● use

Factors influencing the selection of the correct cutting angle



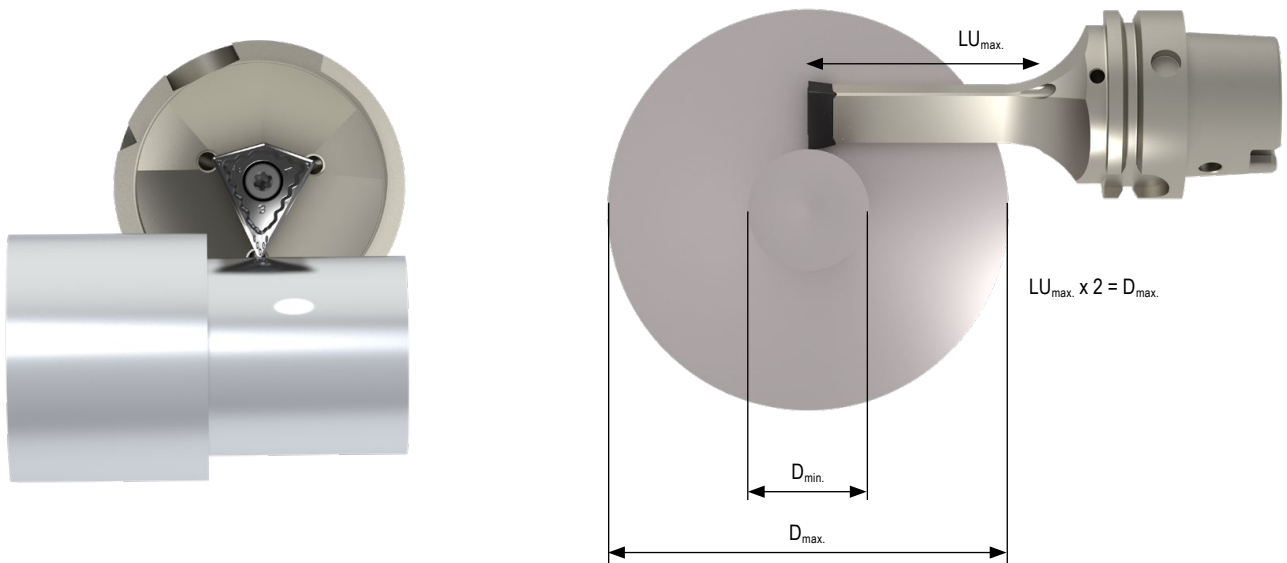
10

Approach angle



The approach angle always works from the edge of the component to the main cutting edge (tool).

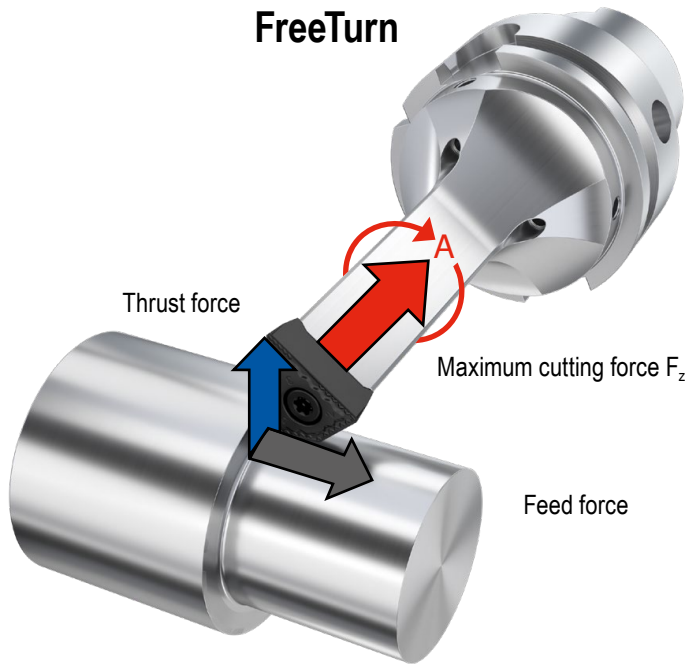
Tool / workpiece length ratio



This table shows the diameter ranges you can work in with the different tool lengths.

Tool	D _{max.} in mm	200	190	180	170	160	150	140	130	120	110	100	90	80
PSC-63-100-FT 808055	D _{min.} in mm					127	115	102	88	73	56	34	0	0
PSC-63-125-FT 808055	D _{min.} in mm	138	125	110	90	70	42	0	0	0	0	0	0	0

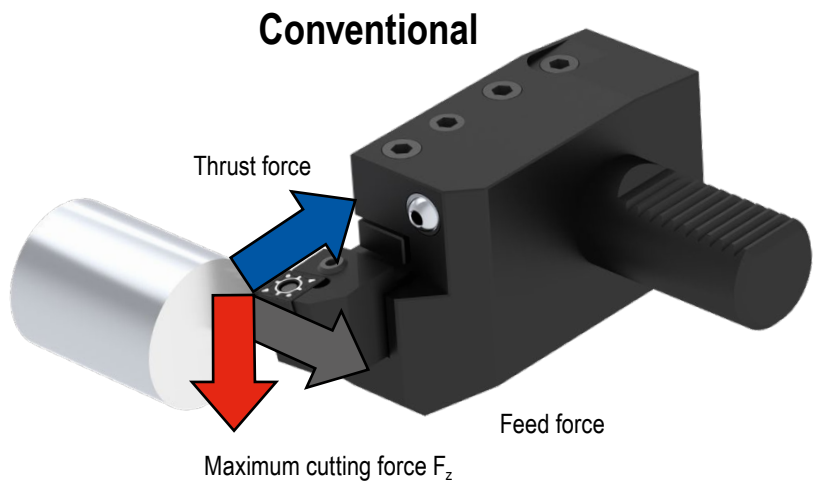
Force data from the process



Practical test

Steel machining
shaft \varnothing 60 mm
1.7227 / 42CrMoS4
 R_m 850 Nm

Cutting data:
 $v_c = 175$ m/min.
 $f = 0.3$ mm/rev.
 $a_p = 3.0$ mm
 $K = 95^\circ$



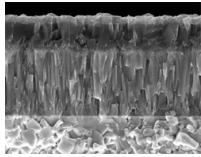
10

FreeTurn		Conventional
2136 N	F XYZ	2206 N
920 N	F XY (feed force)	2143 N
1928 N	Maximum cutting force F_z	526 N

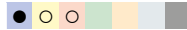
Grade description

EcoCut Classic

CTCP425-P



ISO P25 | M20 | K30



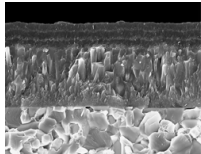
Specification:

Composition: Co 7.0%; mixed carbides 8.1%; WC balance | Grain size: 1-2 µm | Hardness: HV₃₀ 1470 | Coating specification: CVD Ti(CN) + Al₂O₃ multi-layer

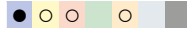
Recommended application:

The wear-resistant solution for steel and cast iron under stable conditions and with high cutting speed

CTCP435-P



ISO P35 | M30 | K40 | S25



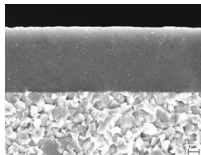
Specification:

Composition: Co 9.6%; mixed carbides 7.8%; others 0.4%; WC balance | Grain size: 1-2 µm | Hardness: HV₃₀ 1400 | Coating specification: CVD Ti(C,N) + Al₂O₃ multi-layer

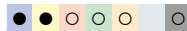
Recommended application:

The reliable choice when machining steel and cast iron under unstable conditions.

CTPP430



ISO | P30 | M25 | K30 | N25 | S25 | O25



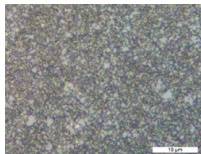
Specification:

Composition: Co 9.0%; others 0.75%; WC balance | Grain size: 0.85 µm | Hardness: HV₃₀ 1590 | Coating specification: PVD TiAlN

Recommended application:

The universal high-performance grade for steel, austenitic steel and heat-resistant alloys

H210T



ISO | K10 | N10 | S10 | O10



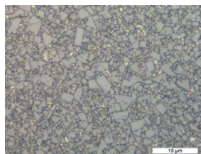
Specification:

Composition: Co 6.0%; WC balance | Grain size: 0.8 µm | Hardness: HV₃₀ 1850

Recommended application:

The wear-resistant uncoated carbide grade for the machining of aluminium and other non-ferrous metals.

H216T



ISO | K15 | N15 | S15 | O10



Specification:

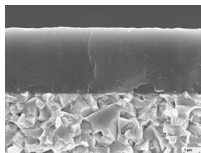
Composition: Co 6.0%; WC balance | Grain size: 1 µm | Hardness: HV₃₀ 1630

Recommended application:

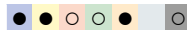
The uncoated carbide grade for the machining of aluminium and other non-ferrous metals

EcoCut Mini

CTPP435



ISO P35 | M30 | K30 | N30 | S30 | O30



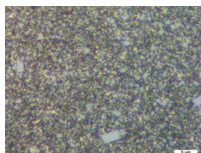
Specification:

Composition: Co 10.3%; others 1.2%; WC balance | Grain size: 0.7 µm | Hardness: HV₃₀ 1600 | Coating specification: PVD TiN / TiAlN

Recommended application:

The universal high-performance grade for steel, austenitic steel and heat-resistant alloys

CTWN425



ISO K20 | N25 | S25 | O25



Specification:

Composition: Co 10.3%; others 1.2%; WC balance | Grain size: 0.7 µm (submicron grade) | Hardness: HV₃₀ 1600

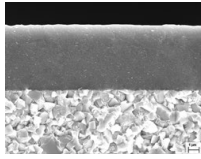
Recommended application:

The uncoated carbide grade for the machining of aluminium and other non-ferrous metals.

Grade description

EcoCut ProfileMaster

CTPP430



ISO | P30 | M25 | K30 | N25 | S25 | O25



Specification:

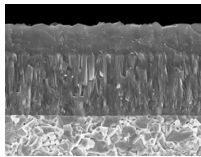
Composition: Co 9.0%; others 0.75%; WC balance | Grain size: 0.85 µm | Hardness: HV₃₀ 1590 | Coating specification: PVD TiAlN

Recommended application:

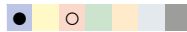
The universal high-performance grade for steel, austenitic steel and heat-resistant alloys

FreeTurn

CTCP125



ISO | P25 | K25



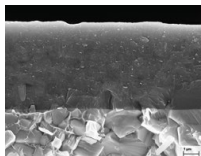
Specification:

Composition: Co 7.0%; mixed carbides 8.0%; WC balance | Grain size: 1 - 2 µm | Hardness: HV₃₀ 1450 | Coating specification: CVD TiCN-Al₂O₃

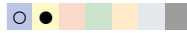
Recommended application:

The first choice for the universal machining of steel

CTPM125



ISO | P35 | M25



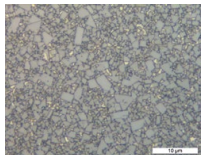
Specification:

Composition: Co 9.6%; mixed carbides 7.8%; others 0.4%; WC balance | Grain size: 1 - 2 µm | Hardness: HV₃₀ 1460 | Coating specification: PVD TiAlTaN

Recommended application:

The first choice for the machining of austenitic steels

H216T



ISO | K15 | N15 | S15 | O10



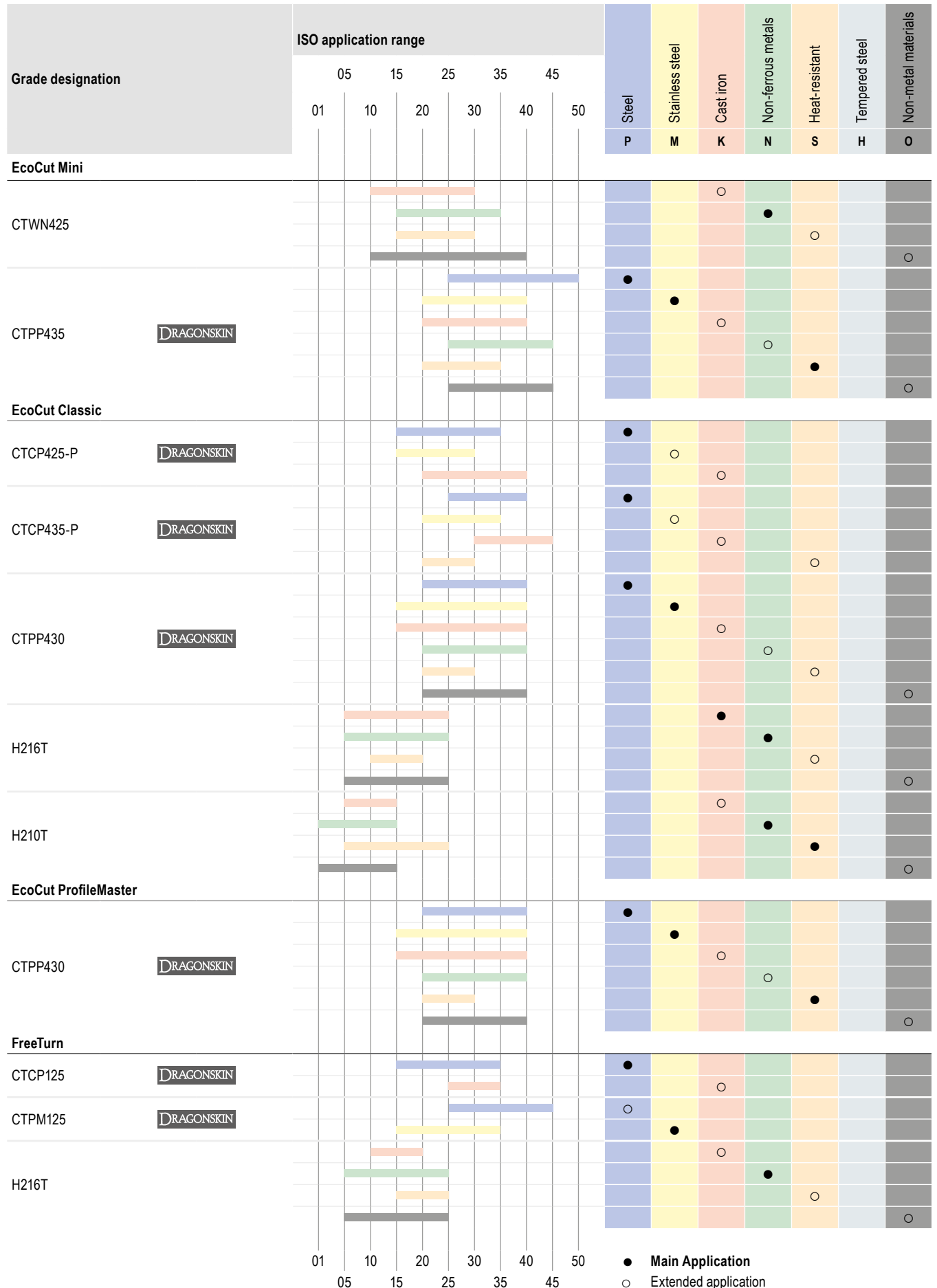
Specification:

Composition: Co 6.0%; WC balance | Grain size: 1 µm | Hardness: HV₃₀ 1630

Recommended application:

The uncoated carbide grade for the machining of aluminium and other non-ferrous metals

Application



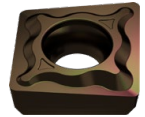
wear-resistant v_c+ v_c- tough

Designation System

EcoCut – indexable insert designation

X C E T 17 05 08 F N - 27P

1 2 3 4 5 6 7 8 9 10

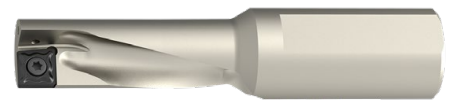


- 1 Insert shape
- 2 Clearance angle
- 3 Tolerances
- 4 Characteristics
- 5 Cutting length
- 6 Insert thickness
- 7 Corner radius
- 8 Cutting edge
- 9 Direction of cut
- 10 Chip groove

EcoCut – holder designation

ECC 32 R - 3.0D 17 H

1 2 3 4 5 6

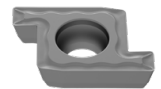


- 1 System
- 2 Nominal diameter in mm
- 3 Direction of cut
- 4 maximum hole depth
- 5 insert size
- 6 Tool holder version in Densimet

EcoCut ProfileMaster – indexable insert designation

PM 25 R G 35 30 04 - M20

1 2 3 4 5 6 7 8

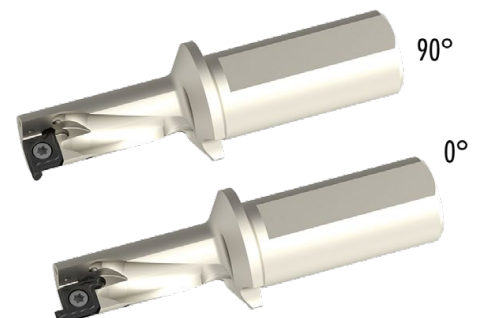


- 1 ProfileMaster
- 2 Nominal diameter in mm
- 3 Direction of cut
- 4 Version
- 5 Groove width in mm/10
- 6 Groove depth in mm/10
- 7 Corner radius
- 8 Chip groove

EcoCut ProfileMaster – holder designation

PMC 25 R - 2.25D

1 2 3 4

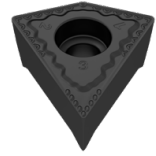


- 1 ProfileMaster
- 2 Nominal diameter in mm
- 3 Direction of cut
- 4 maximum hole depth

10

Designation System

FreeTurn – indexable insert designation



FT15 M/G 808055R080804 Q MMF CTCP125

1 2 3 4 5 6 7 8 9 10 11 12

- | | |
|---|---|
| 1 FreeTurn | 7 Corner radius 1 in mm |
| 2 Nominal diameter in mm | 8 Corner radius 2 in mm |
| 3 ISO tolerance (M = sintered, G = polished) | 9 Corner radius 3 in mm |
| 4 Cutter angle 1 in degrees | 10 Wiper geometry |
| 5 Cutter angle 2 in degrees | 11 Chip breaker (M = medium, F = fine) |
| 6 Cutter angle 3 in degrees | 12 Carbide Grade |

FreeTurn – holder designation

HSK - T63 - 100 - FT15 808055

1 2 3 4 5 6 7 8



- | | |
|--------------------------|------------------------------------|
| 1 System | 5 Nominal diameter in mm |
| 2 Size | 6 Cutter angle 1 in degrees |
| 3 Overhang length | 7 Cutter angle 2 in degrees |
| 4 FreeTurn | 8 Cutter angle 3 in degrees |

