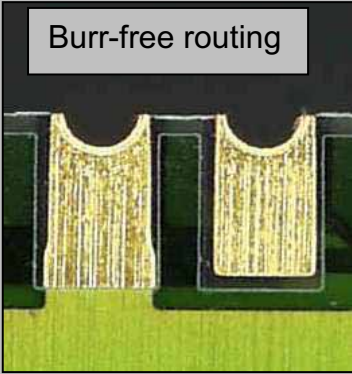
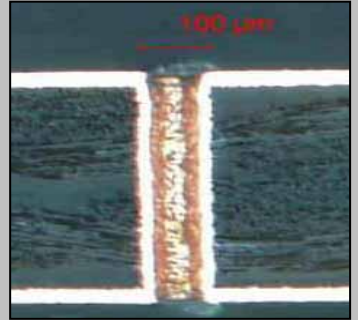


UMD
Ø 0,050 mm



Newest technology in the Application Centers of

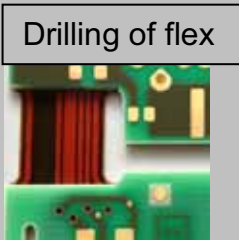
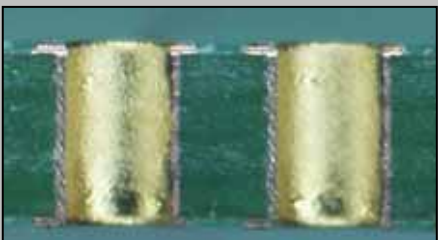
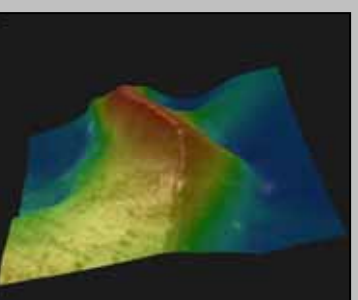
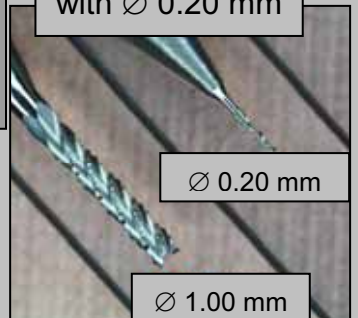
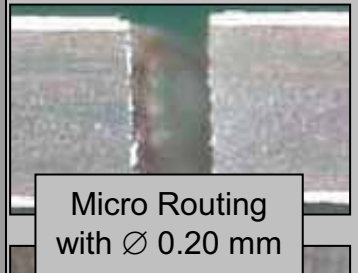
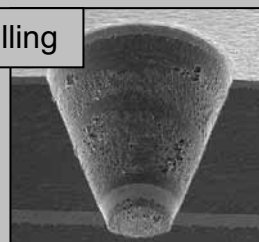
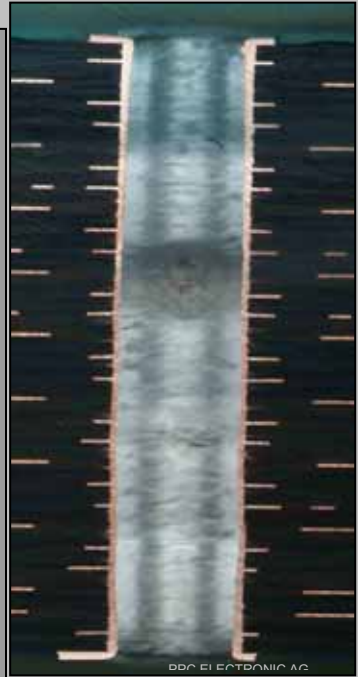
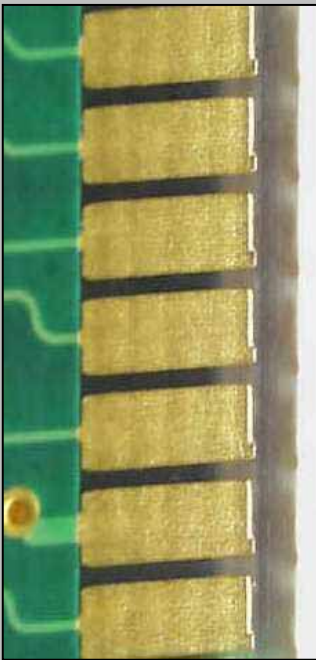


Application Center Ravensburg

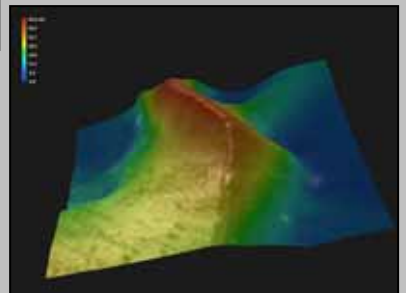
Drilling spindle	300.000 rpm
Routing spindle	125.000 rpm

Application Center China (Kunshan)

Drilling spindle	250.000 rpm
Routing spindle	125.000 rpm



Routing aluminium



Survey of HPTec drills / application fields drills

tool type	description	Ø range [mm]	DS - ML 4 layers	ML 6-8 layers	ML ≥ 10 layers	ML ≥ 70 µm copper	Filled / HTG	Back-panels	Flex / Flex-rigid	Polyimide	Teflon	Metal core ML	Copper / Brass	PMMA / Plexiglas	remark
530	Standard drill	0.30 - 0.50	●	●	●	●	○	●	○	●	●	●	●	●	Universal for all standard applications.
		0.55 - 1.95	●	●	●	●	●	○	●	○	○	○	●	○	
		2.00 - 6.35	●	●	●	●	●	●	●	●	●	●	●	●	
532	Chipbreaker / thinned web	3.175 - 6.35	●	●	●	●	●	●	●	●	●	●	●	●	Proved spade type drill for all multilayer boards.
230	Spade type drill	0.70 - 2.00	●	●	●	●	●	●	●	●	●	●	●	●	
218 212		Multilayer drill	0.105 - 0.15 0.20 - 0.65	●	●	●	●	●	●	●	●	●	●	●	
242 243			0.20 - 0.65	●	●	●	●	●	●	●	●	●	●	●	High performance drill. Excellent positioning accuracy and hole wall quality.
518 540	Standard	0.05 - 0.15 0.20 - 1.15	●	●	●	●	●	●	●	●	●	●	●	●	Highest demands on hole wall quality + chip transport.
250	Slot drill	0.50 - 2.50	●	●	●	●	●	●	●	●	●	●	●	●	Drilling slots
512	Flex drill	0.15 - 0.50	○	○	○	○	○	○	●	●	●	○	○	○	Excellent positioning accuracy, long tool life, more regrinding cycles possible.
596	Microvia drill	0.075 - 0.60	●	●	●	●	●	●	●	●	●	●	●	●	Drill for conical blind via holes.

Key:
 optimum = ●
 suitable = ○
 not recommendable = ◐

ULTRAMICROBOHRER Typen und Spirallängen
ULTRA MICRO DRILLS Types and Flute Lengths



Ø [mm]	512	518 / 418*	218 / 318*	596
	Flex- bohrer	Standard- bohrer	Kopf- bohrer	Microvia- Bohrer
	Flex Drill	Standard Drill	Spade Type Drill	Microvia Drill
0,050		0,6*		
0,075		1,0		
0,100		1,5		
0,105		1,8	1,6	
0,110		1,8	1,6	
0,120		2,0	2,0	0,5
0,150	2,5*	2,5	2,5	0,5*
0,20 / 0,25	3,5			1,0
0,30 / 0,35*	5,5			2,5
0,40	5,5*			2,5
0,45/0,50/0,60				2,5*

Ø > 0,15 mm siehe Übersicht Micro-/Standardbohrer

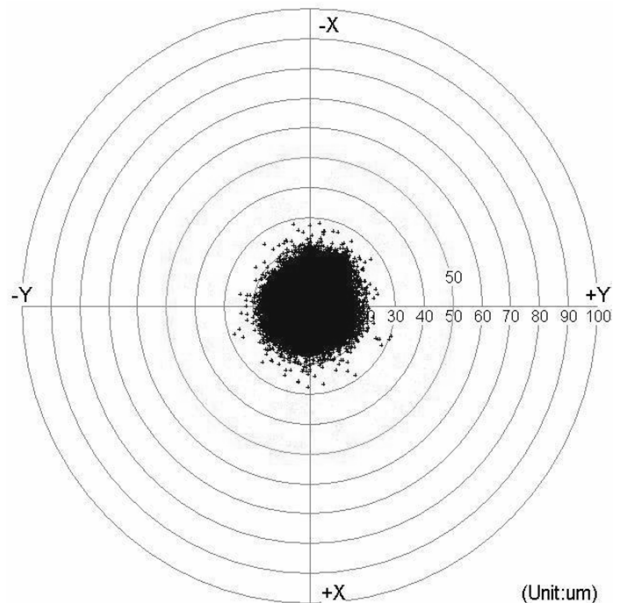
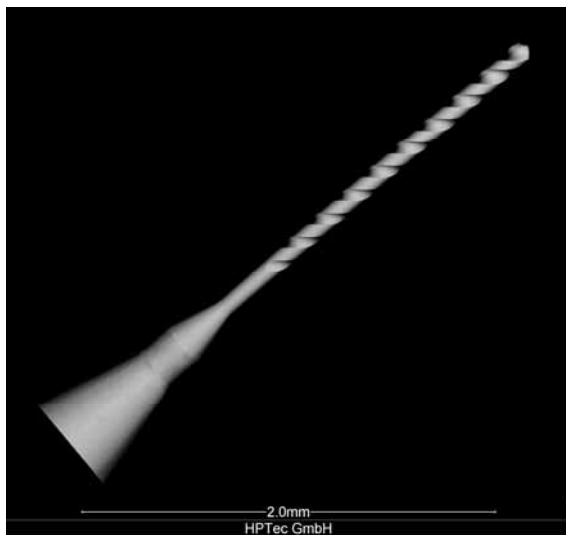
Ø > 0,15 mm see survey Micro/Standard Drills

* auf Anfrage

418 / 318 Schaftdurchmesser = 2 mm

* on request

418 / 318 shank diameter = 2 mm



BGA

BT-Material: 0.1 mm 2 x 6 µm Cu
Stack height: 6 up
Entry: LE-800
Backup: coated wood
Hits: 3000
Parameter: s = 200.000rpm
F = 35 mm/s
R = 250 mm/s

06.2016 - Technische Änderungen vorbehalten. / Subject to technical alterations.

Printed in Germany **HPTEC**

MICRO-/STANDARDBOHRER Typen und Spirallängen
MICRO / STANDARD DRILLS Types and Flute Lengths



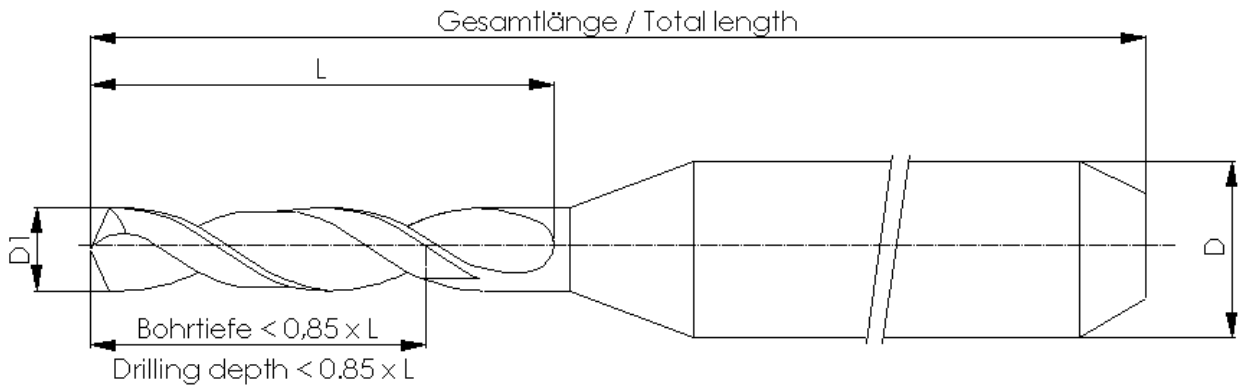
Ø [mm]	512	530	230	212	242	243	540	250
	Flex- bohrer	Standard- bohrer	Kopf- bohrer	Multilayer- bohrer			Langloch- bohrer	
	Flex Drill	Standard Drill	Spade Type Drill	Multilayer Drill				Slot Drill
Ø ≤ 0,2 mm siehe Übersicht ULTRAMICROBOHRER								
Ø ≤ 0,2 mm see survey ULTRA MICRO DRILLS								
* auf Anfrage * on request								
0,15	2,5*							
0,20	3,5	2,5*		3,5	3,5 / 4,0	3,5 / 4,0	3,2 / 4,0*	
0,25	3,5	2,5*		4	4,0 / 4,5	4,0 / 4,5 / 4,8*	3,2* / 4,0*	
0,30	5,5	3,5 / 5,5		5,5 / 6,5*	5,5 / 6,5*	5,5 / 6,5*	5,5*	1,8*
0,35	5,5*	3,5 / 5,5 / 7		5,5 / 7	5,5 / 6,5 / 7	5,5 / 6,5* / 7	5,5* / 7*	4,0*
0,40	5,5*	3,5 / 5,5 / 7		5,5 / 7 / 8,5*	7	5,5 / 7	5,5* / 7*	5,5*
0,45	7*	3,5 / 7		7 / 8,5*	7 / 8,5*	7 / 8,5*	7*	5,0*
0,50	7*	3,5 / 7 / 8,5		7 / 8,5	7 / 8,5*	7 / 8,5*	7*	5,5 / 7
0,55		7 / 8,5		8,5	7 / 8,5*	7 / 8,5*	7* / 8,5*	5,5 / 7
0,60		7 / 8,5		8,5	8,5	8,5*	7* / 8,5*	5,5 / 7
0,65		7* / 8,5		8,5	8,5	8,5*	7* / 8,5*	5,5 / 7
0,70		10,5	10				8,5* / 10,5*	5,5* / 7 / 8,5
0,75		10,5	10				8,5* / 10,5*	5,5* / 7 / 8,5
0,85		10,5	10				8,5* / 10,5*	5,5* / 7 / 8,5
0,90		10,5	10				9,5* / 10,5*	5,5* / 7 / 8,5
0,95		10,5	10				9,5* / 10,5*	5,5* / 7 / 8,5
1,00		10,5	10				10,5*	8,5
1,15		10,5	10				10,5*	8,5
1,20		10,5	10					8,5
1,25		10,5	10					8,5
1,60		10,5	10					8,5
1,65		10,5	10					8,5
2,00		10,5	10					8,5
2,05		10,5	10*					8,5
2,50		10,5	10*					8,5
3,00		10,5	10*					
3,175		10,5						
3,20		12						
6,35		12						

06.2016 - Technische Änderungen vorbehalten. / Subject to technical alterations.



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Spezifikation für Spiralbohrer
Specification for drills 212/218/230/242/243/250/512/518/530/532/540



	0,05 < D ₁ < D	D ₁ > D
Gesamtlänge / Total length	38,2 -0,2	38,2 -0,3
Spirallänge / Flute length		
L ≤ 2	+0,2 / -0,1	
2 < L < 10	+0,4 / -0,2	
L ≥ 10	+0,4 / -0,2	+0,5 / -0,3
Schneidenrauhtiefe R_t Roughness R_t	< 0,003	< 0,005
Schaft- / shank Ø D	-0,001 / -0,007	-0,001 / -0,01

Nenn- / Nominal-Ø D ₁	
0,05 ≤ 0,25	+0,000 / +0,008
0,26 ≤ 1,65	+0,000 / -0,008
1,66 - 3,175	+0,000 / -0,012
≥ 3,20	+0,000 / -0,015

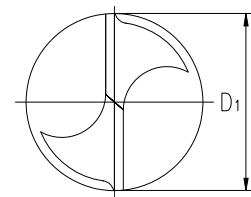
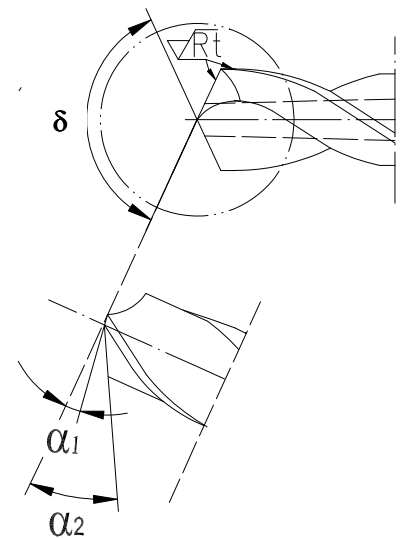
Angaben / Data in [mm]

Spitzenwinkel δ Point angle δ	
0,05 < D ₁ ≤ 0,12	130 -5
0,12 < D ₁ ≤ 0,20	120 -5
0,20 < D ₁ ≤ 3,175	130 -5
D ₁ > 3,175	165 -5
Typ 250	150 -5

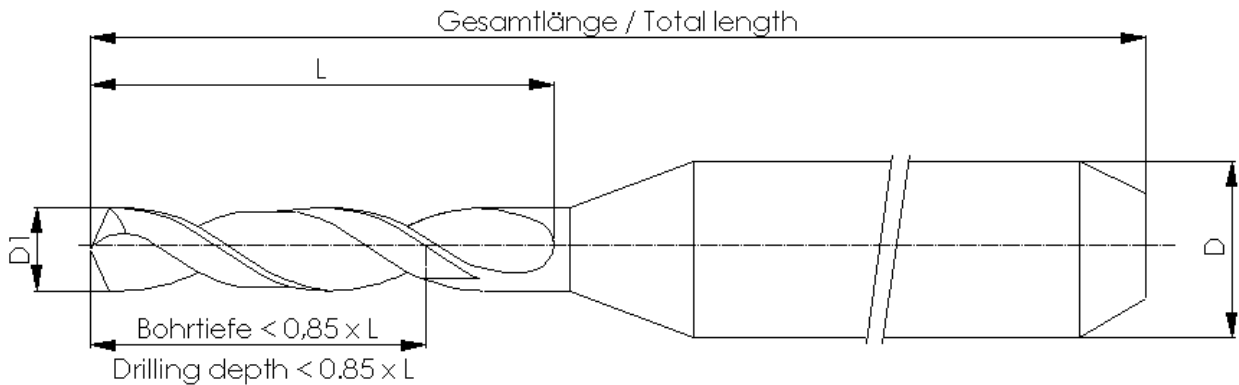
1. Freiwinkel α ₁ Primary face angle α ₁	
D ₁ 0,05 – 0,20	10 -3
0,21 – 6,50	15 -5

2. Freiwinkel α ₂ Secondary face angle α ₂	
D ₁ 0,05 – 6,50	30 -5

Angaben / Data in [°]



Spezifikation für Spiralbohrer 318/418
Specification for drills



	0,05 < D ₁ < D	D ₁ > D
Gesamtlänge / Total length	31,85 -0,2	31,85 -0,3
Spirallänge / Flute length		
L ≤ 2	+0,2 / -0,1	
2 < L < 10	+0,4 / -0,2	
L ≥ 10	+0,4 / -0,2	+0,5 / -0,3
Schneidenrauhtiefe R_t Roughness R_t	< 0,003	< 0,005
Schaft- / shank Ø D	-0,001 / -0,007	-0,001 / -0,01

Nenn- / Nominal-Ø D ₁	
0,05 ≤ 0,25	+0,000 / +0,008
0,26 ≤ 1,65	+0,000 / -0,008
1,66 – 1,99	+0,000 / -0,012
≥ 2,00	+0,000 / -0,015

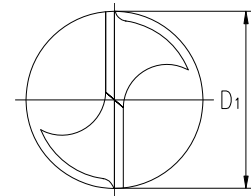
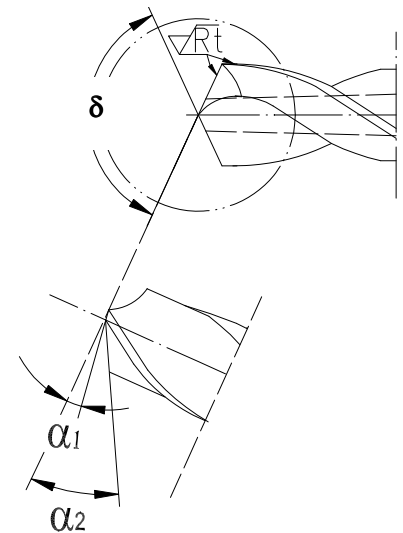
Angaben / Data in [mm]

Spitzenwinkel δ Point angle δ	
0,05 < D ₁ ≤ 0,12	130 -5
0,12 < D ₁ ≤ 0,20	120 -5
0,20 < D ₁ ≤ 3,175	130 -5
D ₁ > 3,175	165 -5

1. Freiwinkel α ₁ Primary face angle α ₁	
D ₁ 0,05 – 0,20	10 -3
0,21 – 6,50	15 -5

2. Freiwinkel α ₂ Secondary face angle α ₂	
D ₁ 0,05 – 6,50	30 -5

Angaben / Data in [°]





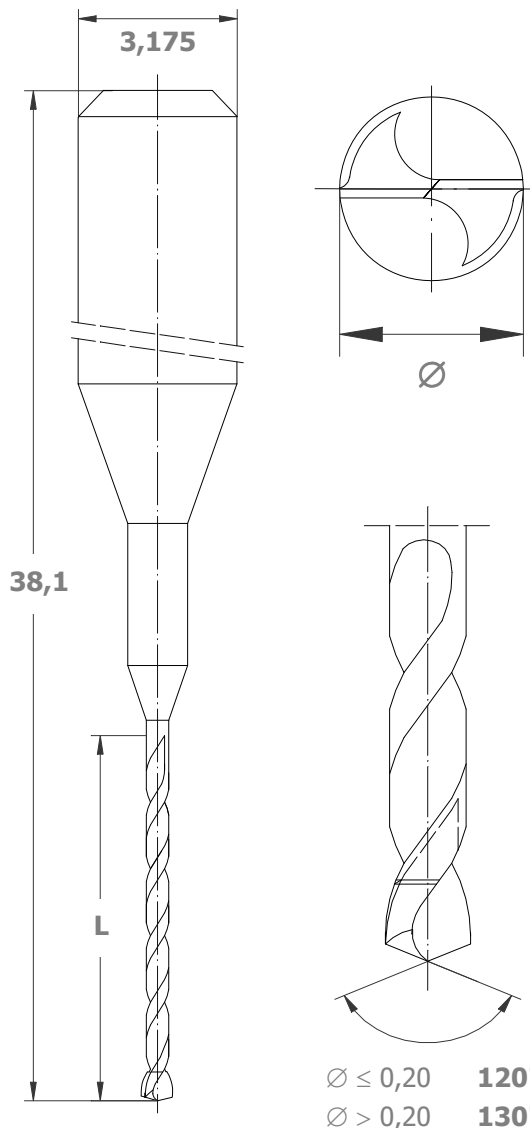
212

Multilayerbohrer, Kopfbohrergeometrie
Anwendung/Vorteile:

- Bohren von hochlagigen Multilayern
- Verbesserung der Lochqualität

Multilayer drill, spade type version
Application/Advantages:

- drilling of high layer boards
- improvement of hole quality



212						
Ø [mm]	L [mm]					
	3,5	4,0	5,5	6,5	7,0	8,5
0,20	x					
0,25	x					
0,30			x	x*		
0,35			x		x	
0,40			x		x	x*
0,45					x	x*
0,50					x	x
0,55						x
0,60						x
0,65						x

* auf Anfrage * on request



218

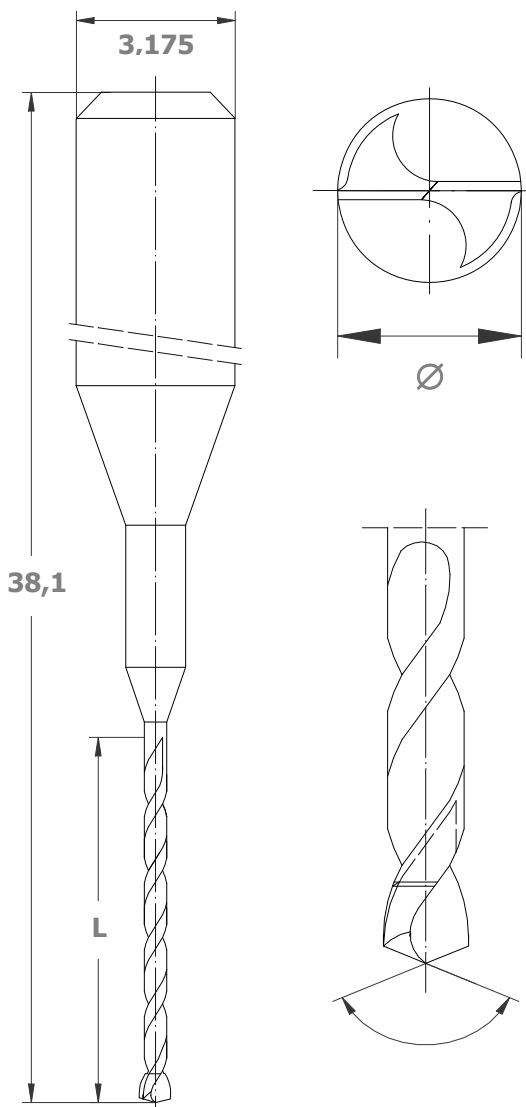
318

**Ultramicrobohrer,
Kopfbohrergeometrie
für hochdrehende Spindeln**
Anwendung/Vorteile:

- BGA / HDI
- höchste Stabilität
- höchste Bohrgenauigkeit

**Ultra micro drill,
spade type version
for high speed spindles**
Application/Advantages:

- BGA / HDI
- best stability
- best accuracy



218			
Ø [mm]	L [mm]		
	1,6	2,0	2,5
0,105	x		
0,110	x		
0,120		x	
0,150			x

**Auf Anfrage Typ 318 mit
Schaftdurchmesser 2,0 mm /
Gesamtlänge 32 mm erhältlich.**

**On request type 318 with
shank diameter 2,0 mm /
total length 32 mm available.**



230

Kopfbohrer

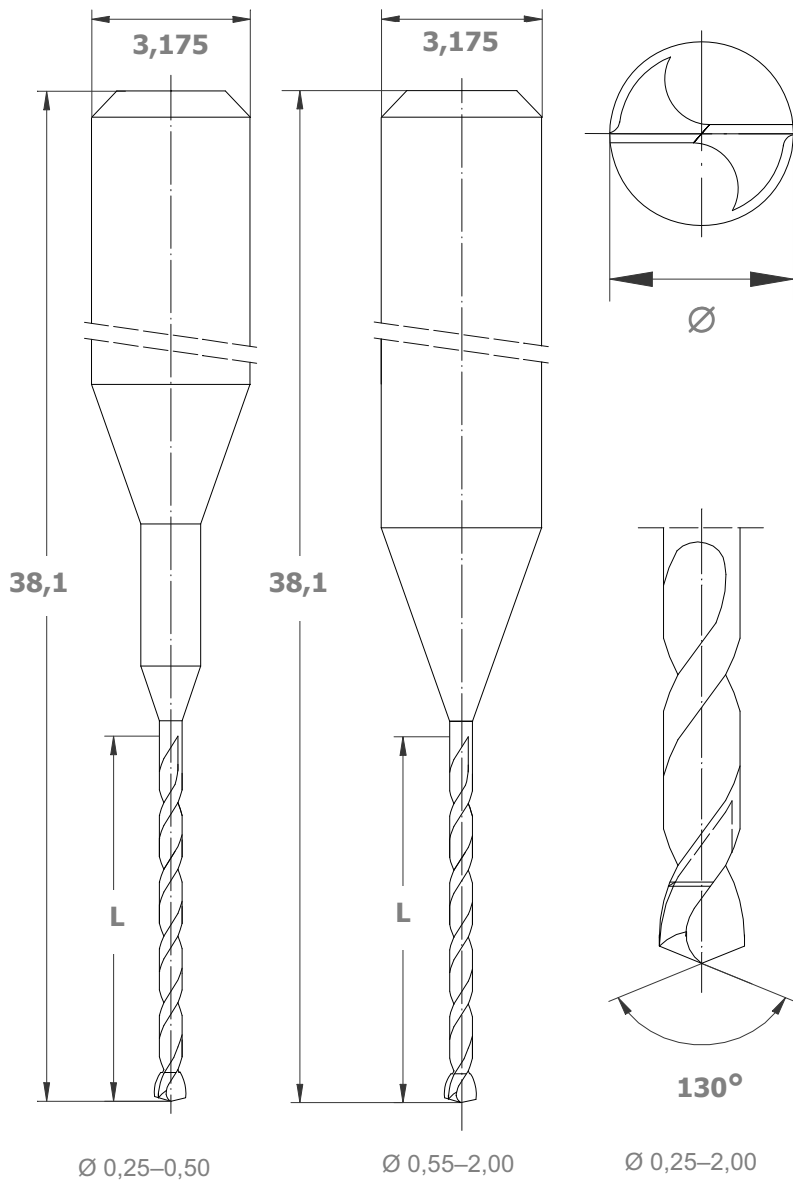
Anwendung/Vorteile:

- Bohren von anspruchsvollen Multilayern
- sehr gute Lochqualität bei geringem Bohrerverlauf durch optimierte Geometrie

Spade type drill

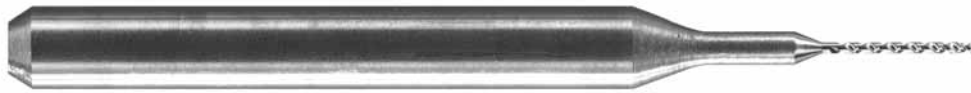
Application/Advantages:

- drilling of high-quality multilayer boards
- excellent hole quality by less drill deflection due to optimised undercut geometry



230	
Ø [mm]	L [mm] 10,0
0,70	x
0,75	x
0,80	x
:	:
1,60	x
1,65	x
:	:
2,00	x
2,05	x*
:	:*
3,00	x*

* auf Anfrage * on request



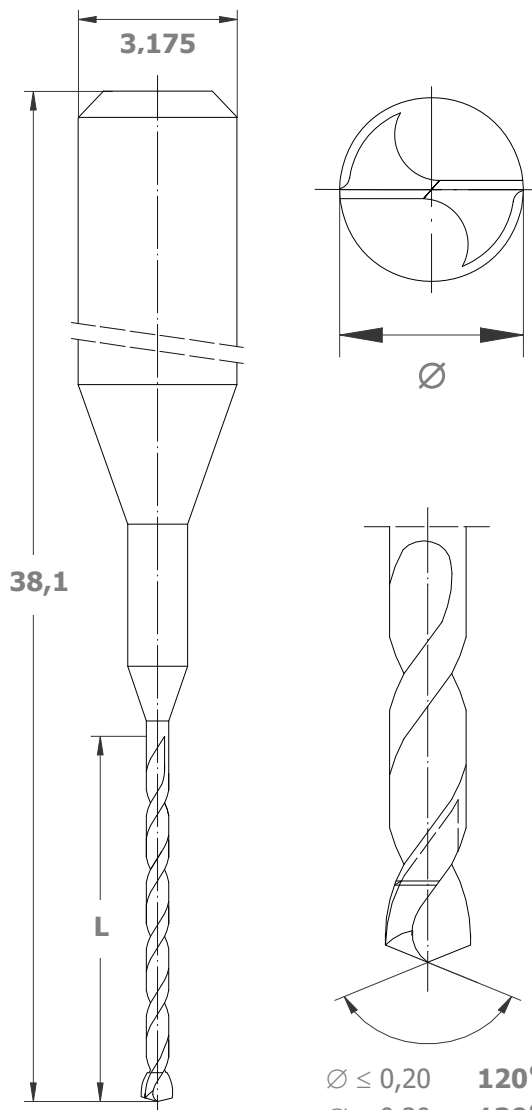
242

Multilayerbohrer, Kopfbohrergeometrie
Anwendung/Vorteile:

- maximale Stabilität
- verbesserter Bohrerlauf
- geringere Bohrkosten durch mehrmaliges Nachschleifen

Multilayer drill, spade type version
Application/Advantages:

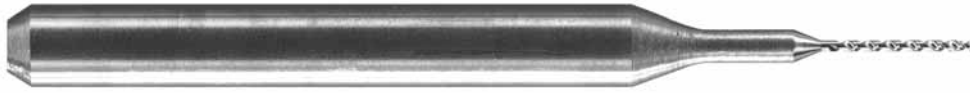
- maximum stability
- improved drill deviation
- less cost due to several regrinding cycles



$\varnothing \leq 0,20$ **120°**
 $\varnothing > 0,20$ **130°**

242							
Ø [mm]	L [mm]						
	3,5	4,0	4,5	5,5	6,5	7,0	8,5
0,20	x	x					
0,25		x	x				
0,30				x	x*		
0,35				x	x	x	
0,40						x	
0,45						x	x*
0,50						x	x*
0,55						x	x*
0,60							x
0,65							x

* auf Anfrage * on request



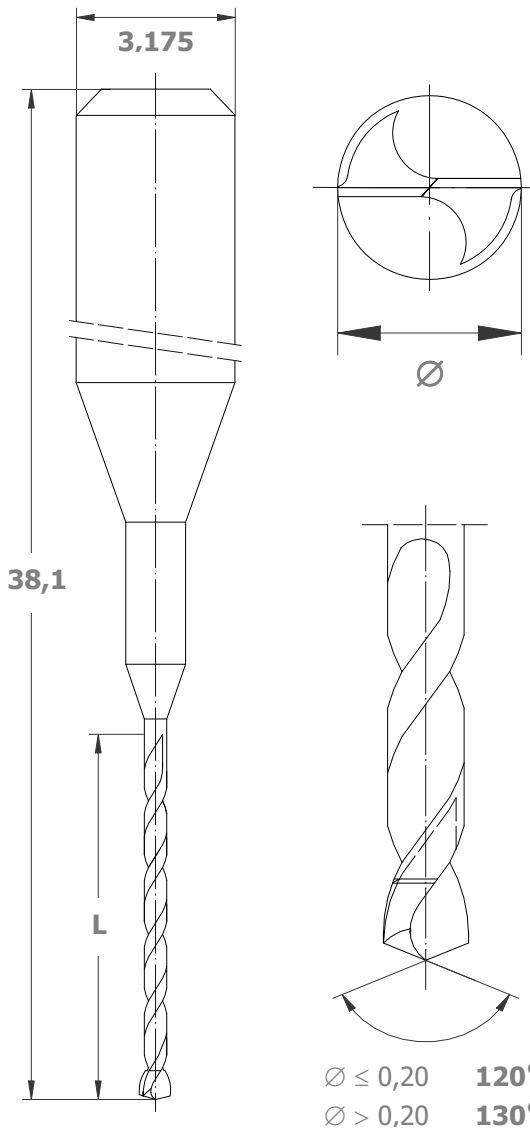
243

Multilayerbohrer, Kopfbohrergeometrie
Anwendung/Vorteile:

- Positioniergenauigkeit
- maximale Stabilität
- verbesserter Bohrerlauf
- geringere Bohrkosten durch mehrmaliges Nachschleifen

Multilayer drill, spade type version
Application/Advantages:

- positioning accuracy
- maximum stability
- improved drill deviation
- less cost due to several regrinding cycles



243								
Ø [mm]	L [mm]							
	3,5	4,0	4,5	4,8	5,5	6,5	7,0	8,5
0,20	x	x						
0,25		x	x	x*				
0,30					x	x*		
0,35					x	x*	x	
0,40					x		x	
0,45							x	x*
0,50							x	x*
0,55							x	x*
0,60								x*
0,65								x*

* auf Anfrage * on request



250

Langlochbohrer

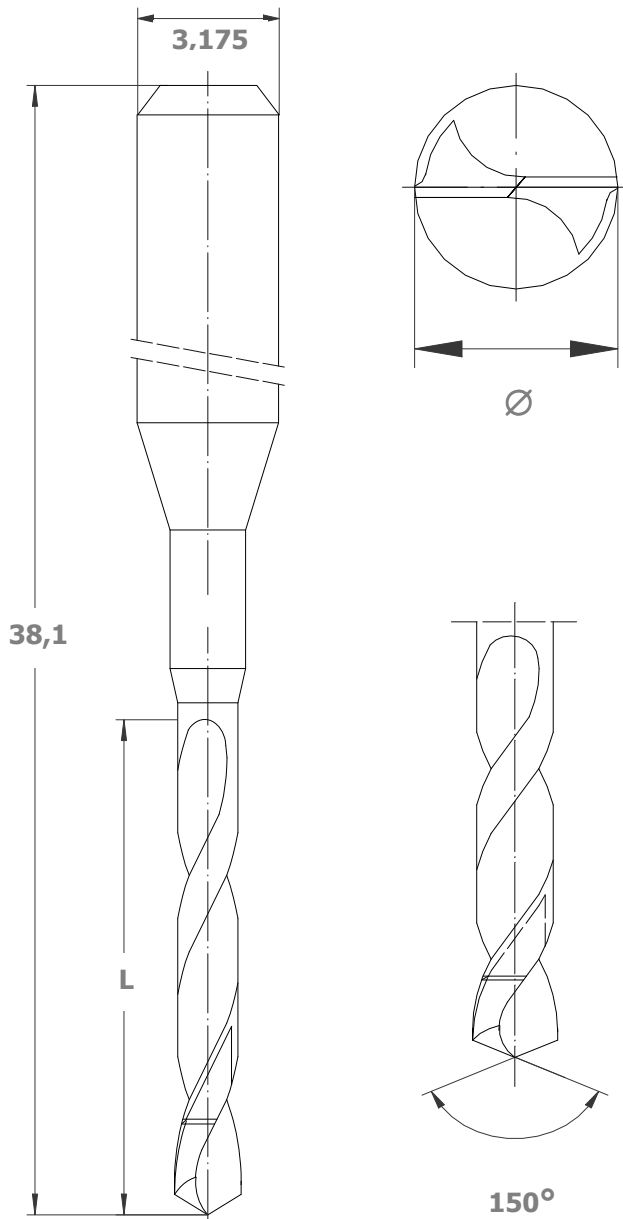
Anwendung/Vorteile:

- Bohren (Nippeln) von Langlöchern und Schlitzen
- Reduzierung Verlauf

Slot drill

Application/Advantages:

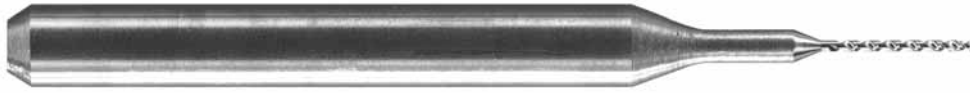
- drilling slots
- reduction of deviation



		250					
Ø [mm]	L [mm]						
	1,8	4,0	5,0	5,5	7,0	8,5	
0,30	x*						
0,35		x*					
0,40				x*			
0,45			x*				
0,50				x	x		
0,55				x	x		
0,60				x	x		
0,65				x	x		
0,70				x*	x	x	
0,75				x*	x	x	
0,80				x*	x	x	
0,85				x*	x	x	
0,90				x*	x	x	
0,95				x*	x	x	
1,00						x	
:						:	
1,25						x	
1,30						x	
:						:	
2,50						x	

* weitere Durchmesser und Spirallängen auf Anfrage

* other diameters and flute lengths on request



512

Flexbohrer

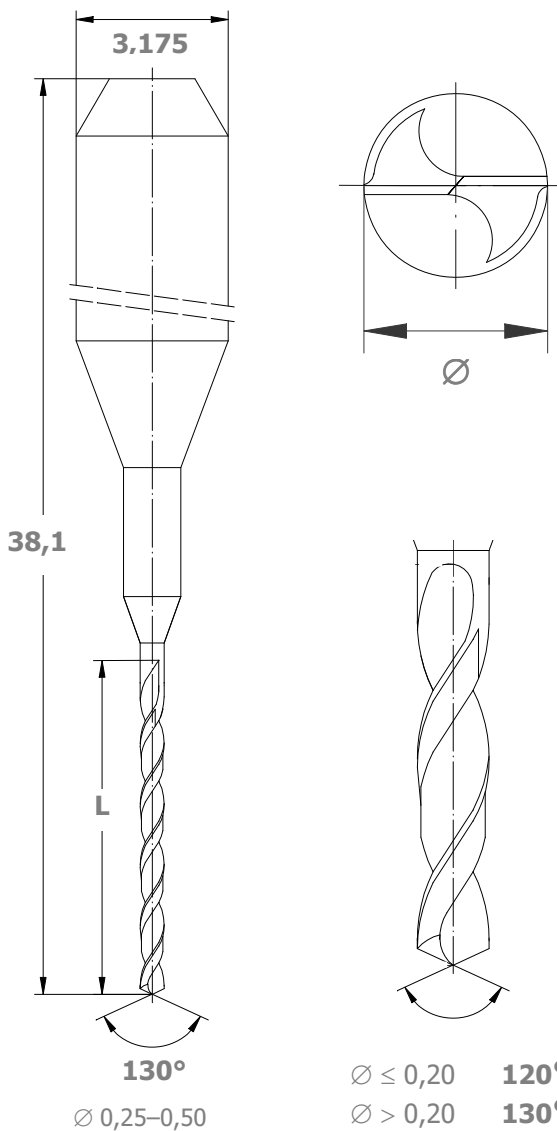
Anwendung/Vorteile:

- hoch produktive Bearbeitung von flexiblen und starr-flexiblen Multilayern
- optimale Bohrlochqualität
- Reduzierung von Nagelkopfbildung und Grat

Flex drill

Application/Advantages:

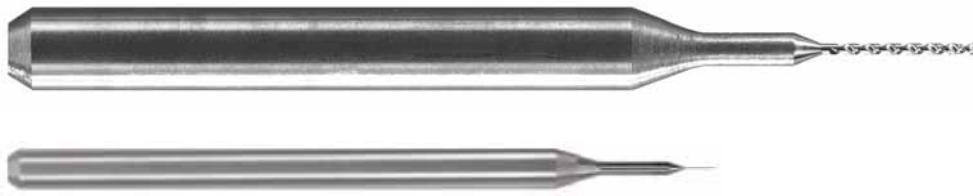
- drilling of flex and flex rigid boards
- improvement of hole quality
- reduction of nail heading



512	
Ø [mm]	L [mm]
	2,5 3,5 5,5 7,0
0,15	x*
0,20	x
0,25	x
0,30	x
0,35	x*
0,40	x*
0,45	x*
0,50	x*

* weitere Durchmesser und Spirallängen auf Anfrage

* other diameters and flute lengths on request



518

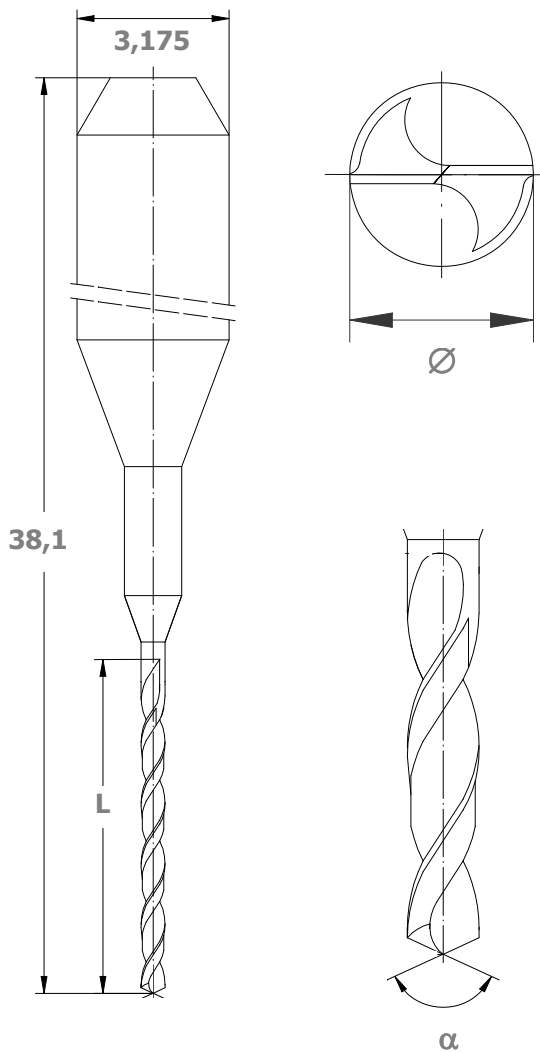
418

**Ultramicrobohrer,
Standardbohrergeometrie
für hochdrehende Spindeln
Anwendung/Vorteile:**

- BGA / HDI
- höchste Stabilität
- höchste Bohrgenauigkeit

**Ultra micro drill,
standard geometry
for high speed spindles
Application/Advantages:**

- BGA / HDI
- best stability
- best accuracy



518	
Ø [mm]	L [mm]
	0,6 1,0 1,5 1,8 2,0 2,5
0,050	x*
0,075	x
0,100	x
0,105	x
0,110	x
0,120	x
0,150	x

* auf Anfrage * on request

**Auf Anfrage Typ 418 mit
Schaftdurchmesser 2,0 mm /
Gesamtlänge 31,85 mm erhältlich.**

**On request type 418 with
shank diameter 2,0 mm /
total length 31.85 mm available.**



530

Spiralbohrer

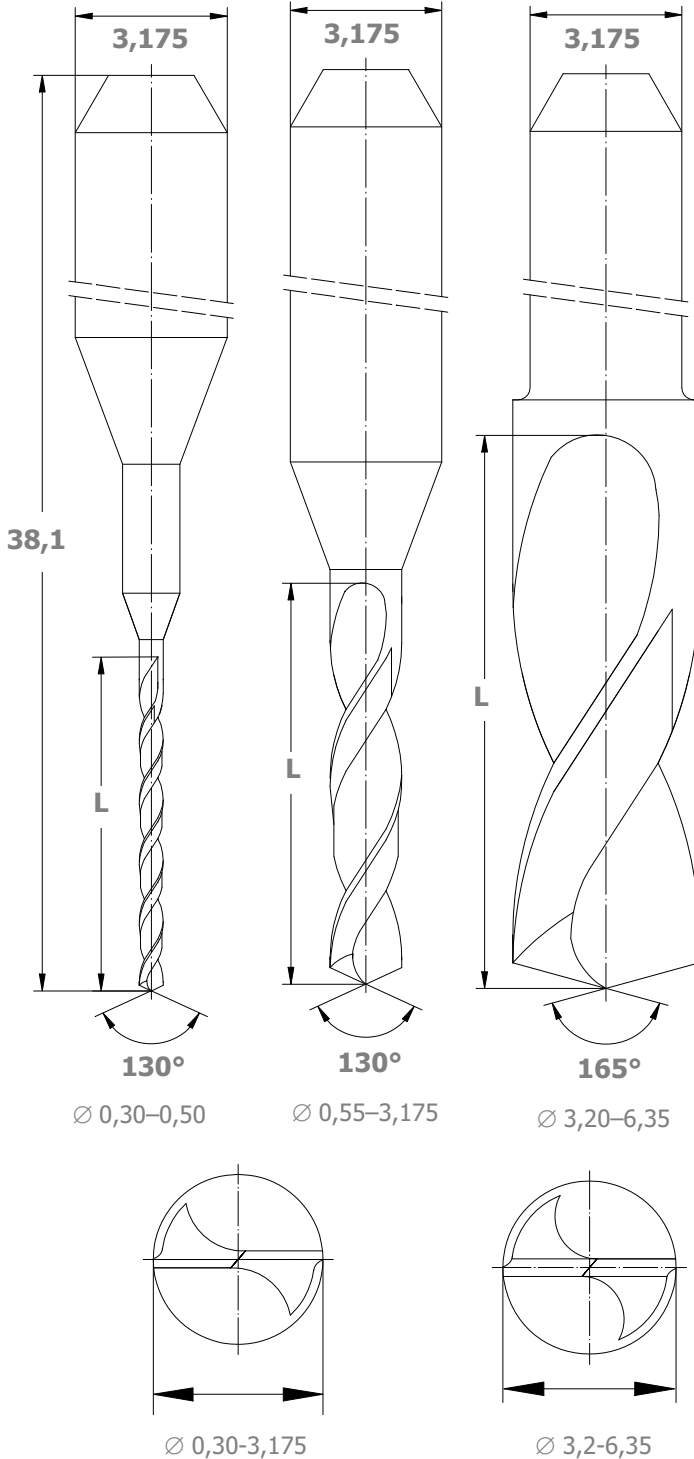
Anwendung:

- für alle Standardprodukte
- für Sacklochbohrungen (mit kurzer Spirallänge)

Standard drill

Application:

- for all standard products
- for blind via drilling (with short flute length)



530					
Ø [mm]	L [mm]				
	2,5	3,5	5,5	7,0	8,5
0,20	x*				
0,25	x*				
0,30		x	x		
0,35		x	x	x	
0,40		x	x	x	
0,45		x		x	
0,50		x		x	x
0,55				x	x
0,60				x	x
0,65				x*	x

Ø [mm]	L [mm]	
	10,5	12
0,70	x	
0,75	x	
0,80	x	
:	:	
3,15	x	
3,175	x	
3,20		x
3,25		x
:	:	
6,35		x

* auf Anfrage * on request



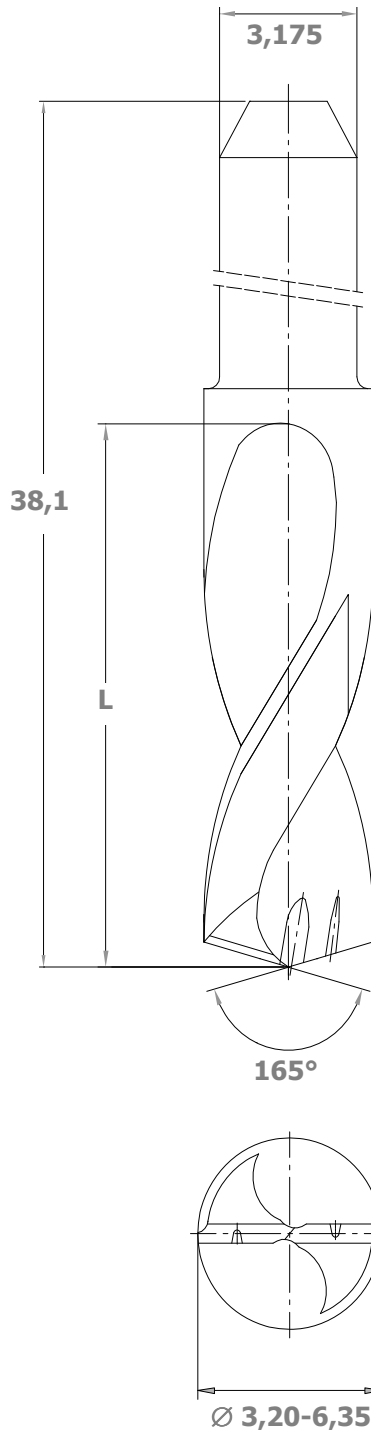
532

**Spiralbohrer mit ausgespitztem Kern,
Spanbrecher und Durchmesserverjüngung**
Anwendung/Vorteile:

- Dick-Kupferanwendungen
- für langspanende Werkstoffe
- erhebliche Reduzierung der Spindelkräfte

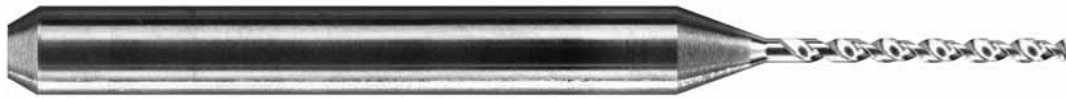
**Standard drill with thinned web, chip
breaker and back-tapered diameter**
Application/Advantages:

- thick copper applications
- long-chipping materials
- significant reduction of spindle forces



532	
Ø [mm]	L [mm]
	12
3,50	x
3,55	x
3,60	x
3,65	x
:	:
4,00	x
4,05	x
4,10	x
:	:
5,00	x
5,05	x
5,10	x
:	:
6,20	x
6,25	x
6,30	x
6,35	x*

Bemerkung:
Andere Durchmesser auf Anfrage.
Remark:
Other diameters on request.



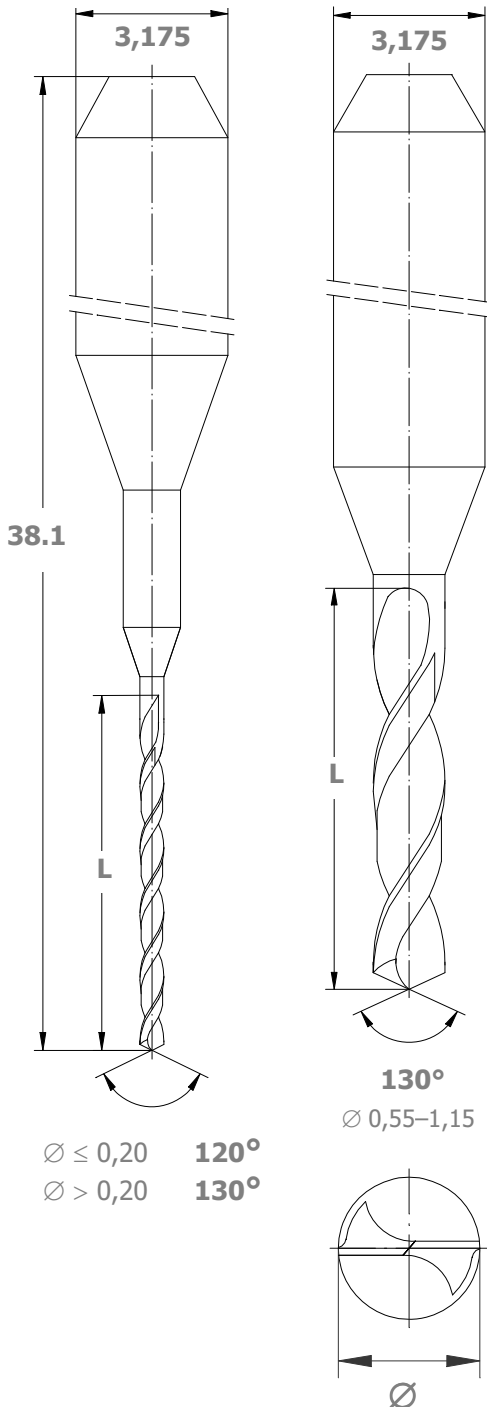
540

Multilayer-/ Dickkupferbohrer Anwendung/Vorteile:

- Bohren von hochlagigen / dicken Multilayern
- Bohren von Dickkupfer
- Verbesserung der Bohrlochqualität

Drill for multilayer and thick copper Application/Advantages:

- drilling of high layer boards / thick panels
- drilling of thick copper
- improvement of hole quality



$\varnothing \leq 0,20$ **120°**
 $\varnothing > 0,20$ **130°**

130°
 $\varnothing 0,55-1,15$

540	
Ø [mm]	L [mm]
	3,2 4,0 5,5 7,0
0,20	x x*
0,25	x* x*
0,30	x*
0,35	x* x*
0,40	x* x*
0,45	x*
0,50	x*

Ø [mm]	L [mm]			
	7,0	8,5	9,5	10,5
0,55	x*	x*		
0,60	x*	x*		
0,65	x*	x*		
0,70		x*		x*
0,75		x*		x*
0,80		x*		x*
0,85		x*		x*
0,90			x*	x*
0,95			x*	x*
1,00				x*
1,05				x*
1,10				x*
1,15				x*

* auf Anfrage * on request



596

Microvia-Bohrer mit konischem Außendurchmesser

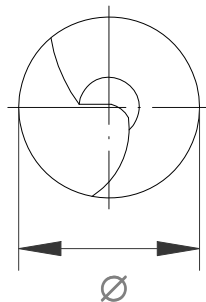
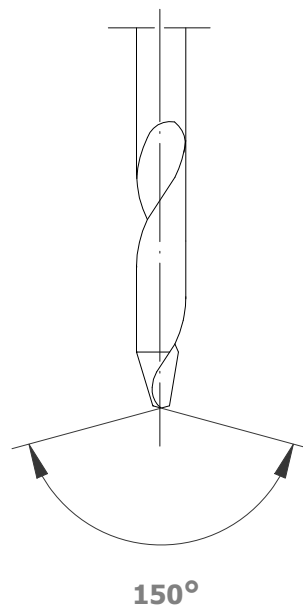
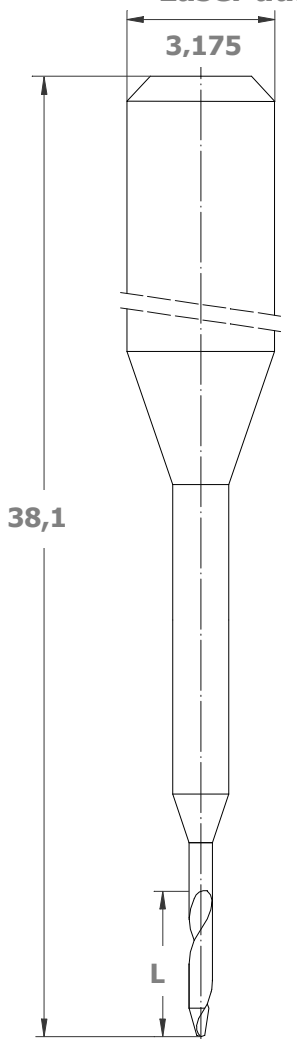
Anwendung/Vorteile:

- Bohren von Microvias (Sacklöchern)
- höchste Lochqualität und Positionsgenauigkeit
- Wirtschaftliches Bohren ggb. Laser auf Mehrspindel-Maschinen

Microvia drill with tapered outer diameter

Application/Advantages:

- drilling of microvias (blind holes)
- highest hole quality and high position accuracy
- economical drilling compared to laser on multispindle machines



Typ 596 Ø 0,12:
Maximale Bohrtiefe
120 µm

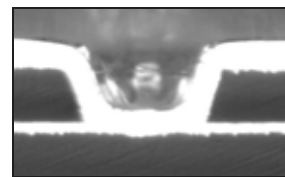
Type 596 Ø 0.12:
Maximum drilling
depth 120 µm

Typ 596 Ø 0,4:
Maximale Bohrtiefe
400 µm

Type 596 Ø 0.40:
Maximum drilling
depth 400 µm

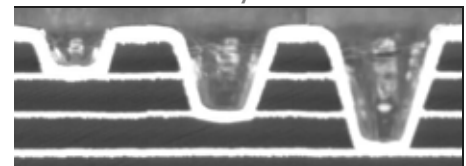
596			
Ø [mm]	L [mm]		
	0,5	1,0	2,5
0,12	x		
0,15	x*		
0,20		x	
0,25		x	
0,30			x
0,35			x
0,40			x
0,45			x*
0,50			x*
0,60			x*

Bemerkung: Andere Durchmesser auf Anfrage.
Remark: Other diameters on request.



Mechanisch gebohrtes Sackloch
auf die erste Innenlage.

Mechanical drilled microvia to
the first inner layer.



Mechanisch gebohrte Sacklöcher
auf drei Innenlagen.

Mechanical drilled microvias to
three inner layers.

HPTec GmbH
Im Karrer 6
D-88214 Ravensburg
Germany

Tel.: +49 (0)751-7669-0
Fax: +49 (0)751-7669-139
E-Mail: sales@hptec.de
www.hptec.de

HPTEC

Survey of HPTec routers / application fields routers

tool type	description	FR 4 oc ic	FR 2	CEM 1 CEM 3	Filled/HTG	PE	PTFE	PMMA	Polyimide	Flex / Rigid Flex	Al	Cu / brass	Metal composite laminates	remark
626	diamond-patterned teeth	● ●	●	●	○								○	standard contour router
726	spiral-patterned teeth	● ●	●	● ●	○ ● ●					○			○	standard contour router good chip transport and edge quality
756														
790														
817	1-flute	● ●	○	○		●	●	●	●	● ○	○ ●	●	○	very good edge quality, burr-free and for soft and flexible materials
818														
821	2-flute					●		●	●	○	●	●	○	excellent edge and surface quality
826	2-flute	● ●	○	○	○	●	●	●	●	○	○ ●	●	○	all-purpose tool for working with plastics and metals
827														
828														
836	3-flute	●	○	○	○	○	○	○	○	○		○	○	for metallised slots
80X	V-groove cutter	●	●	●	●	●	●	●	●	○	○	●	○	good chip transport and edge quality
850	Countersink	●	●	●	●	●	●	●	●		●	●	○	chamfering of PCBs
876	Contour finishing	○	○	○	○	○	○	○	○	○	○	○	●	burr free routing (goldfingers)
891	2-flute	○	○	○	○	○	○	○	○	○	●	○	○	good chip transport and edge quality

parameters

cutting speed v _s [m/min]	chip load [µm/1]										100-125			
	190-220	160-180	160-180	110-170	100-120	100-120	110-130	100-120	80-120	200-250		180-220		
Ø [mm]	oc	ic	oc	ic	oc	ic	oc	ic	oc	ic	oc	ic	oc	ic
1.0	8	8	10	8-12	10	10	10	20	10	8	3	3	2	
1.2	12	10	14	12-16	14	14	14	30	14	12	5	5	3	
1.6	20	15	25	22-26	25	25	40	40	25	23	8	8	4	
2.0	38	30	45	40-48	35	35	50	50	35	32	12	12	4	
2.4	48	34	55	50-60	40	40	60	60	40	35	15	15	5	

Cutting speed and chip load are basic recommendations depending on the material specification.
Parameters have to be adjusted accordingly.

Key:

optimal material = ●
possible alternative = ○

ic = inner contour
oc = outer contour

Formula: spindle speed n [rpm]

$$n = v_s * 1000 / (3.14 * \varnothing)$$

feed rate F [m/min]

$$F = f * n$$

$$f = F / n \text{ [µm/rev]}$$

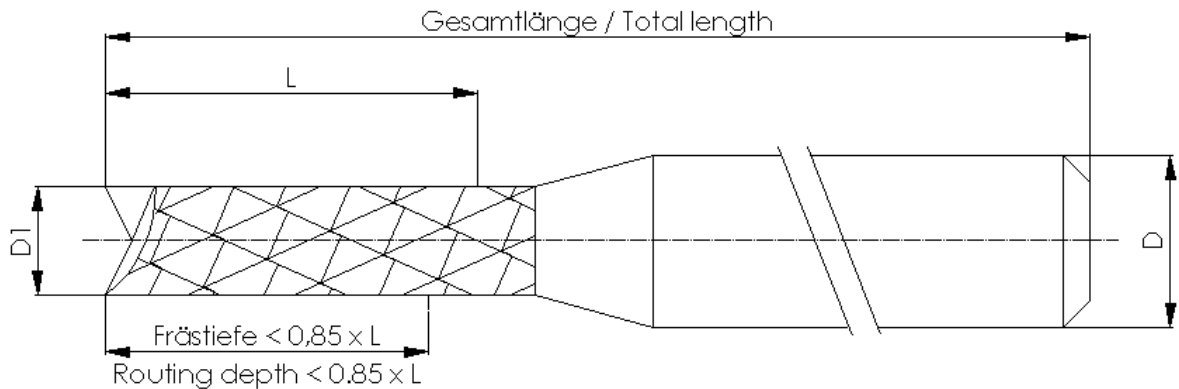
Standardfräser Übersicht / Survey of Standard Routers



Ø in [mm]	diamantverzahnt diamond-patterned teeth		spiralverzahnt spiral-patterned teeth		1-Schneider 1-flute		2-Schneider 2-flute			3-Schneider 3-flute		Schlichtfräser finishing router		Ritzstichel V-groove cutter		Kegelsenker Countersink						
	626	726	756	790	818	817	besch. coated	821	826	828	827	891	836	876	801	802	803	804	806	809	point angle	point angle
0,20								0,7*	0,7*						22°	30°	30°	45°	60°	90°	90°	120°/140°
0,25								1*	1*													
0,3								1*	1*													
0,4					1,5			1,5*	1,5*													
0,5					3			3	3													
0,6					3			3	3	3*												
0,7					3			3	3	3*												
0,8					3			5	5	5*												
0,9					3			5	5	5*												
1,0	7	7/8,5*	4*/5*/6,5*		3	3	3	5	5	5	5	3/4*	5*									
1,1	7	7/8,5*	6,5*		3*	3*	3*	5	5	5*	3*	3*	5*									
1,2	7	7/8,5*	4*/7*		4	4	4	5	5	5	3*/4*	5*										
1,3	7	7/8,5*	7*		4*	4*	4*	5	5	5*	3*	5*										
1,4	7	7/8,5*	4*/7*		4	4*	4*	5	5	5*	3*/4*	5*										
1,5	8	8,5	8,5	4*/8,5*	4	4*	4*	6	6	6*	4*/6	7*										
1,6	8	8,5	8,5	8,5	5	5	5	6	6	6	6	7*										
1,7	8	8,5	8,5*	8,5*	5*	5*	5*	6	6	6*	6*	7*										
1,8	8	8,5	4*/8,5*	4*/8,5*	5*	5*	5*	6	6	6*	4*/6*	7*										
1,9	8	8,5	8,5*	8,5*	5*	5*	5*	6	6	6*	6*	7*										
2,0	8/10	9	9	4*/9	8	8	8	6	8	8	4*/6	9*			X	X	X					
2,1	8	9	9*	9*				8	8	8*	6*	9*										
2,2	8	9	9*	9*				8	8	8*	6*	9*										
2,3	8	9	9*	9*				8	8	8*	6*	9*										
2,4	8/10	9	9	9	8	8	8	6	8	8	6	9*										
2,5	8	9	9*	9*				8	8	8*	6*	9*										
3,0	10	9	9	9	9	9	9	10	10	10	6	9*										
3,175	10*	9	9*	9*	9*	9*	9*	10	10	10*	6*	9*										
6,0																						X

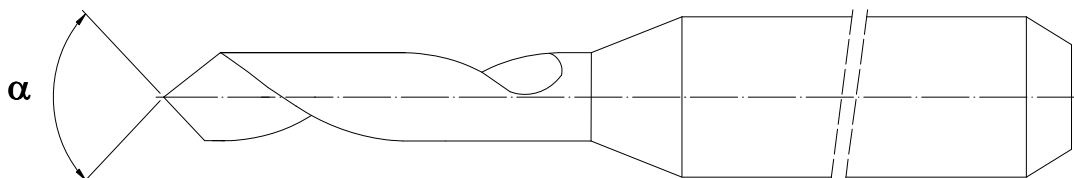
**Spezifikation für Fräser
Specification for routers**

**620/624/626
720/724/726/756/790
801/802/803/804/806/809
817/818/821/826/827/828/836/850/876/
891**

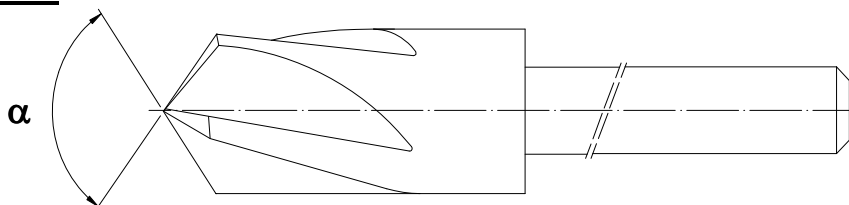


Gesamtlänge / Total Length		38,2 -0,4
Spirallänge / Flute Length	L	+0,6 / -0,1
Schaft- / Shank-Ø	D	-0,001/-0,007
Nenn- / Nominal-Ø	D₁	+0,01/-0,02
wenn / if D₁ = D		0/-0,04
Typ / Type 836		+0,01/-0,03
Schneidenschartigkeit / Roughness		≤ 0,006
Ausbrüche / Chips		≤ 0,030 max. 10 % der Einzelschneiden eines Fräasers / of the single cutting teeth of a router
		Angaben / Data in [mm]
Spitzenwinkel / Point Angle	α	±3
Typ / Type 801/802/803/804/806/809		Angaben / Data in [°]

Typ / Type 801/802/803/804/806/809:



Typ / Type 850:





626

Fräser mit Diamantverzahnung

Anwendungen:

- Standardfräser für Innen- und Außenkonturen
- alle Basismaterialien aus Glasgewebe

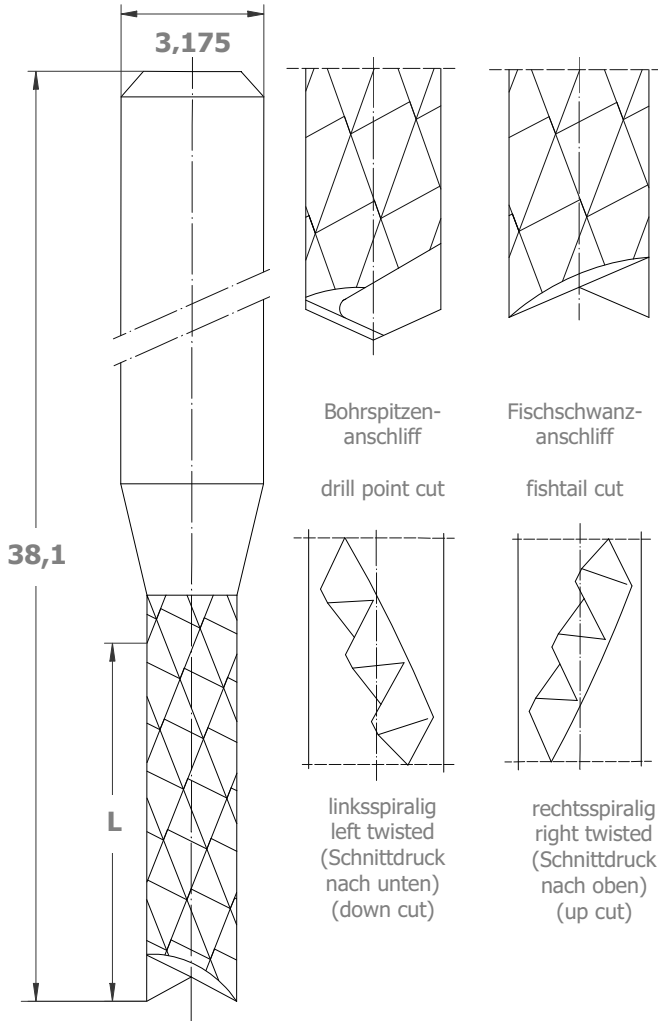
Router with diamond-patterned teeth

Applications:

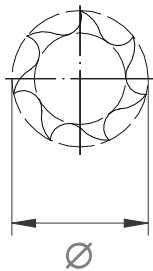
- standard router for inner and outer contours
- glass-epoxy based materials

624

620



626			
Ø [mm]	L [mm]		
	7,0	8,0	10,0
1,0	x		
1,1	x		
1,2	x		
1,3	x		
1,4	x		
1,5		x	
1,6		x	
1,7		x	
1,8		x	
1,9		x	
2,0		x	x
2,1		x	
2,2		x	
2,3		x	
2,4		x	x
2,5		x	
3,0			x
3,175			x*



626 Fischeschwanzanschliff
rechtsspiralig

fishtail cut
up cut (right twisted)

624* Bohrspitzenanschliff
rechtsspiralig

drill point cut
up cut (right twisted)

620* Fischeschwanzanschliff
linksspiralig
* auf Anfrage

fishtail cut
down cut (left twisted)
* on request

HPTec GmbH
Im Karrer 6
D-88214 Ravensburg
Germany

Tel.: +49 (0)751-7669-0
Fax: +49 (0)751-7669-139
E-Mail: sales@hptec.de
www.hptec.de

HPTEC



726

724

720

Fräser mit Spiralverzahnung

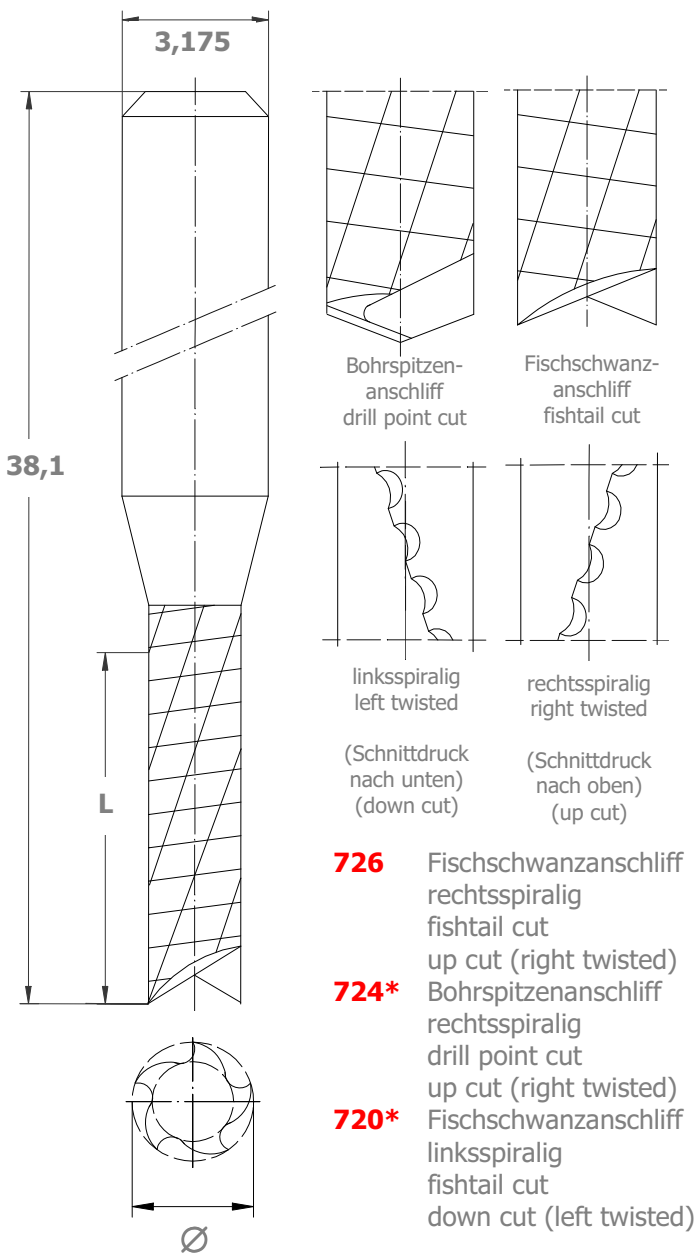
Anwendungen/Vorteile:

- Standardfräser für Innen- und Außenkonturen
- alle Basismaterialien aus Glasgewebe
- sehr guter Spantransport und sehr gute Oberflächenqualität

Router with spiral-patterned teeth

Applications/Advantages:

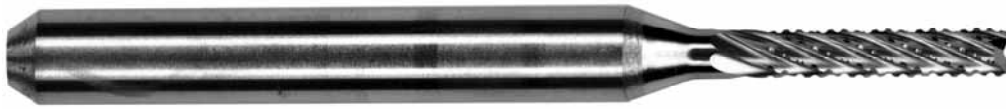
- standard router for inner and outer contours
- all kind of glass-epoxy based materials
- excellent chip transport and surface finish



- 726** Fischschwanzanschliff rechtsspiralig fishtail cut up cut (right twisted)
- 724*** Bohrspitzenanschliff rechtsspiralig drill point cut up cut (right twisted)
- 720*** Fischschwanzanschliff linksspiralig fishtail cut down cut (left twisted)

726						
\varnothing [mm]	L [mm]					
	3,0	3,5	5,0	7,0	8,5	9,0
0,5	x					
0,6	x					
0,7		x				
0,8			x			
0,9			x			
1,0				x	x*	
1,1				x	x*	
1,2				x	x*	
1,3				x	x*	
1,4				x	x*	
1,5					x	
1,6					x	
1,7					x	
1,8					x	
1,9					x	
2,0						x
2,1						x
2,2						x
2,3						x
2,4						x
2,5						x
3,0						x
3,175						x

* auf Anfrage * on request



756

Fräser mit Spiralverzahnung

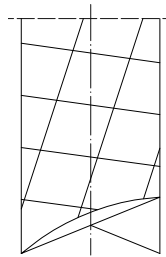
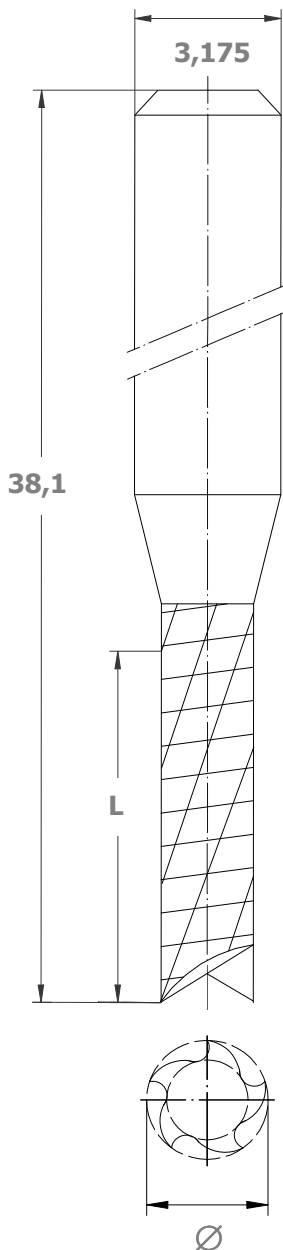
Anwendungen/Vorteile:

- Hochleistungsfräser für Innen- und Außenkonturen
- alle Basismaterialien aus Glasgewebe, Hoch Tg, gefüllte Materialien
- sehr guter Spantransport und sehr gute Oberflächenqualität

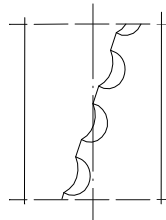
Router with spiral-patterned teeth

Applications/Advantages:

- high performance router for inner and outer contours
- all kind of glass-epoxy based materials, HTG, filled materials
- excellent chip transport and surface finish



Fischschwanz-
anschliff
fishtail cut



rechtsspiralig
right twisted

(Schnittdruck
nach oben)
(up cut)

756 Fischschwanzanschliff
rechtsspiralig
fishtail cut
up cut (right twisted)

756		
Ø [mm]	8,5	9,0
1,5	x	
1,6	x	
2,0		x
2,4		x

Bemerkung: weitere Durchmesser /
Spirallänge auf Anfrage
Remark: other diameters /
flute lengths on request



790

Diamantbeschichteter Fräser aus Vollhartmetall mit Spiralverzahnung

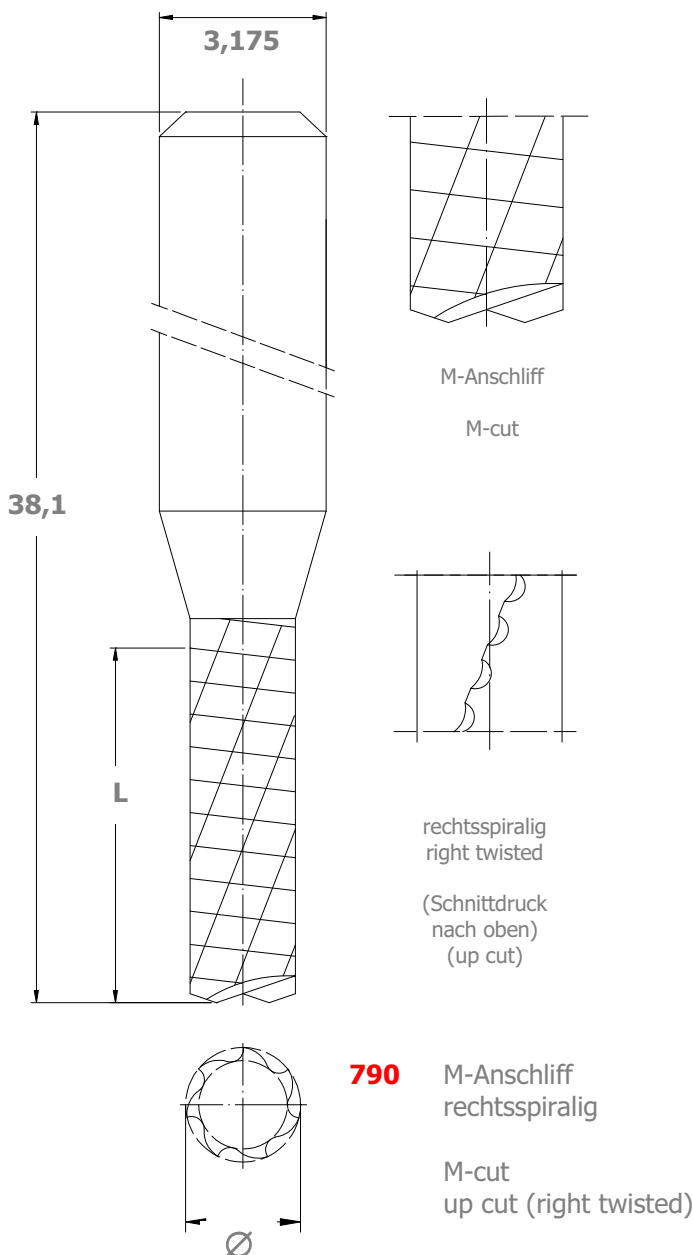
Anwendungen/Vorteile:

- Standardfräser für Innen- und Außenkonturen
- abrasive Basismaterialien
- guter Spantransport und sehr gute Oberflächenqualität
- engste Frästoleranzen

Diamond coated router made of solid carbide with spiral-patterned teeth

Applications/Advantages:

- standard router for inner and outer contours
- abrasive base materials
- good chip transport and excellent surface quality
- tightest routing tolerances



790	
Ø [mm]	L [mm]
	3,5 4,0 5,0 6,5 7,0 8,5 9,0
0,8	x*
0,9	x*
1,0	x* x* x*
1,1	x*
1,2	x* x*
1,3	x*
1,4	x* x*
1,5	x* x*
1,6	x
1,7	x*
1,8	x* x*
1,9	x*
2,0	x* x
2,1	x*
2,2	x*
2,3	x*
2,4	x
2,5	x*
3,0	x
3,175	x*

* auf Anfrage * on request



802

Frässtichel mit einer Spiralnute Anwendungen:

- Ritzen und Anfasen von Leiterplatten
- Fräsen von Isolationsabständen
- Ritzen von Bruchkanten
- Aluminium und Kupfer
- Kunststoffe
- Starrflex-Anwendungen

V-groove cutter with one spiral-twisted flute Applications:

- chamfering of circuit boards
- routing of dielectric spacing
- scribing of break-out edges
- aluminium and copper
- plastics
- flex rigid-applications

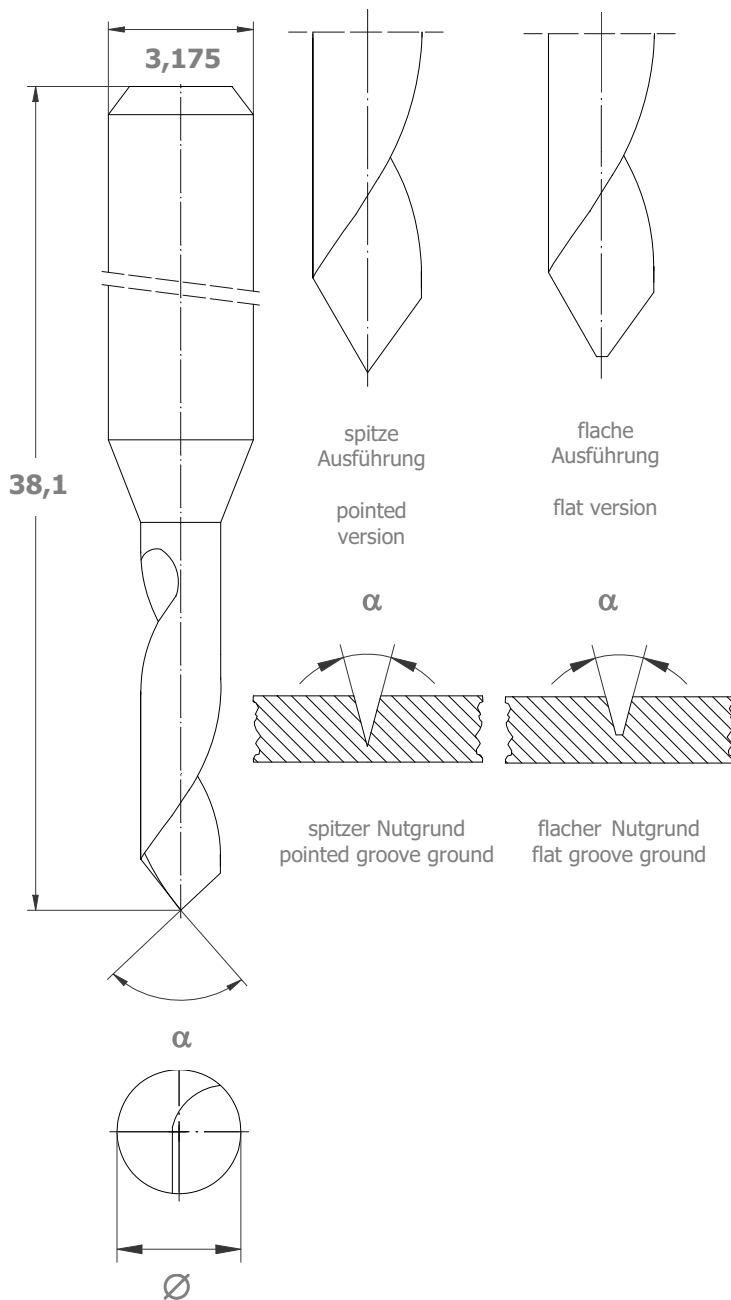
801

803

804

806

809



Ø [mm]	α				
	22°	30°	45°	60°	90°
2,0		x	x		
2,4				x	
3,175	x*				x
Standard	801	802 803	804	806	809

Bemerkung: andere Spitzenwinkel / Durchmesser auf Anfrage
Remark: other point angles / diameters on request

801 22° flache Ausführung
22° flat version

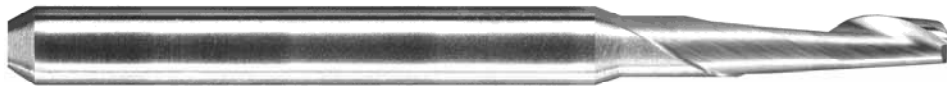
802 30° flache Ausführung
30° flat version

803 30° spitze Ausführung
30° pointed version

804 45° spitze Ausführung
45° pointed version

806 60° spitze Ausführung
60° pointed version

809 90° spitze Ausführung
90° pointed version



817

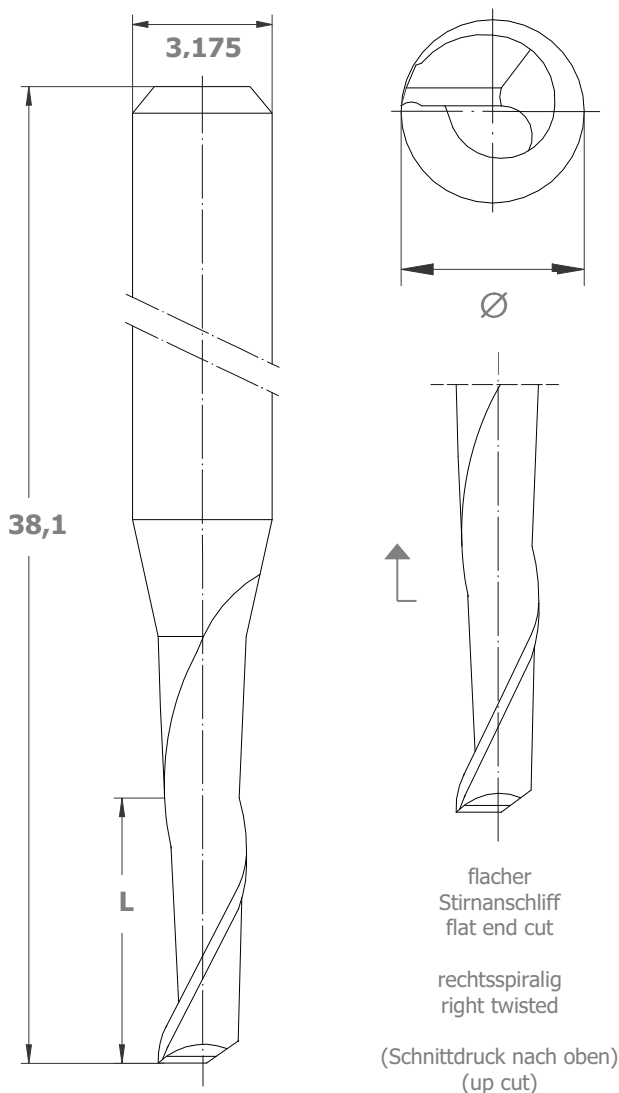
Fräser mit einer Hauptschneide Anwendungen/Vorteile:

- für Tiefenfräsen, Innenkonturen, Schlitze
- weiche Kunststoffe, Folien, PE, PTFE, PMMA, Polyimid
- Prepregs und FR4
- Flex-Anwendungen
- beste Oberflächen- und Kantenqualität

1-Flute router

Application/Advantages:

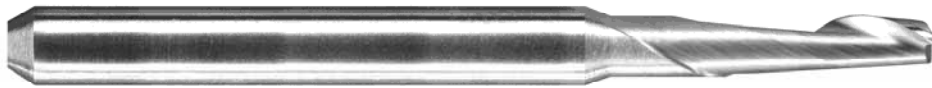
- for depth routing, inner contours, slots
- soft plastics, foils, PE, PTFE, PMMA, polyimide
- thin prepregs and FR4
- Flex-applications
- best surface and edge quality



817 flacher Stirnanschliff
rechtsspiralig (Schnittdruck nach oben)
flat end cut
up cut (right twisted)

817					
Ø [mm]	L [mm]				
	3,0	4,0	5,0	8,0	9,0
1,0	x				
1,1	x*				
1,2		x			
1,3		x*			
1,4		x*			
1,5		x*			
1,6			x		
1,7			x*		
1,8			x*		
1,9			x*		
2,0				x	
2,4				x	
3,0					x
3,175					x*

* auf Anfrage * on request



818

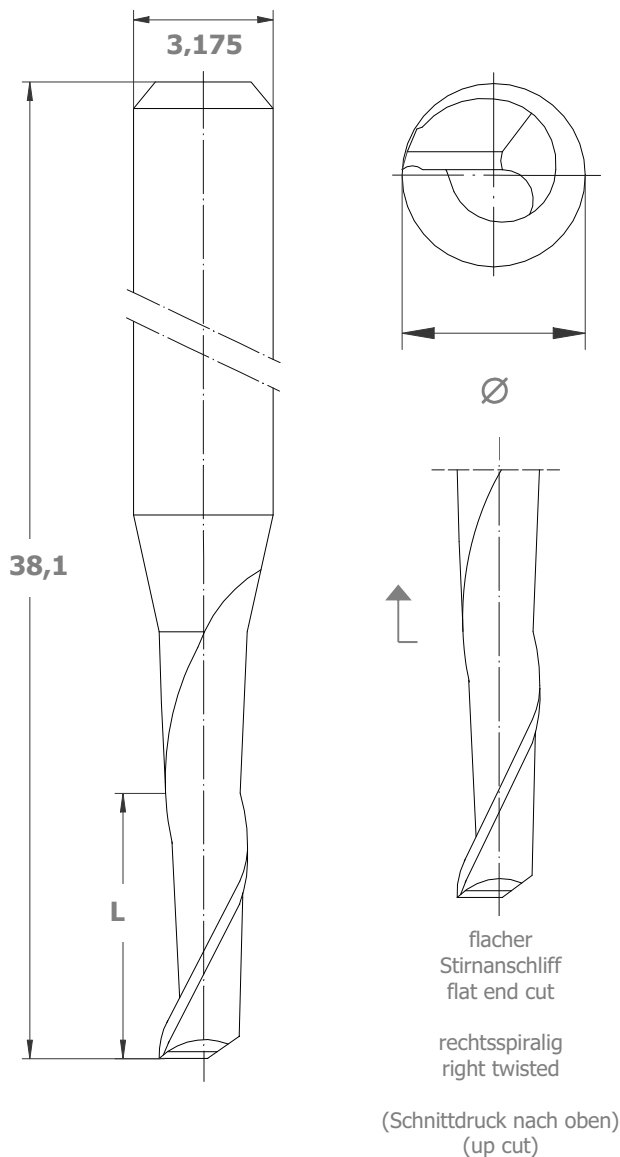
Fräser mit einer Hauptschneide Anwendungen/Vorteile:

- für Tiefenfräsen, Innenkonturen, Schlitze
- weiche Kunststoffe, Folien
- Al, Cu, Messing, Metalle
- beste Oberflächen- und Kantenqualität

1-Flute router

Application/Advantages:

- for depth routing, inner contours, slots
- soft plastics, foils
- Al, Cu, brass, metals
- best surface and edge quality



818 flacher Stirnanschliff
rechtsspiralig (Schnittdruck nach oben)
flat end cut
up cut (right twisted)

818						
Ø [mm]	L [mm]					
	1,5	3,0	4,0	5,0	8,0	9,0
0,4	x					
0,5		x				
0,6		x				
0,7		x				
0,8		x				
0,9		x				
1,0		x				
1,1		x*				
1,2			x			
1,3			x*			
1,4			x			
1,5			x			
1,6				x		
1,7				x*		
1,8				x*		
1,9				x*		
2,0					x	
2,4					x	
3,0						x
3,175						x*

* auf Anfrage * on request



821

Fräser mit 2 Hauptschneiden, beschichtet

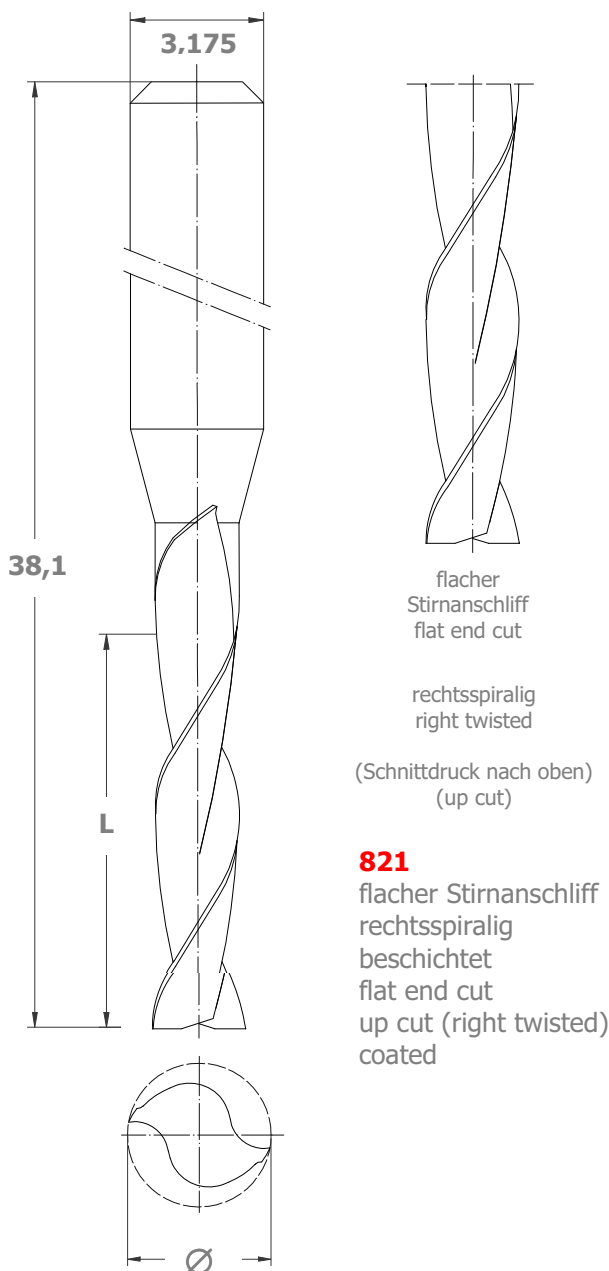
Anwendungen/Vorteile:

- Innenkonturen/Schlitze mit sehr hohen Qualitätsanforderungen
- Tiefenfräsungen möglich
- Al, Cu, Messing, Nichteisenmetalle
- Reduzierte Zerspanungskräfte
- Reduzierte Temperaturen beim Zerspanen

2-Flute router, coated

Applications/Advantages:

- inner contours/slots with very high quality demands
- depth routing possible
- routing Al, Cu, brass, metals
- reduced cutting forces
- reduced temperature during routing process



821
 flacher Stirnanschliff
 rechtsspiralig
 beschichtet
 flat end cut
 up cut (right twisted)
 coated

821		
Ø [mm]	L [mm]	
	3,0	6,0
1,00	x	
1,60		x
2,00		x
2,40		x

* weitere Durchmesser auf Anfrage
 * other diameters on request

Neu / New



826

828

Fräser mit 2 Hauptschneiden

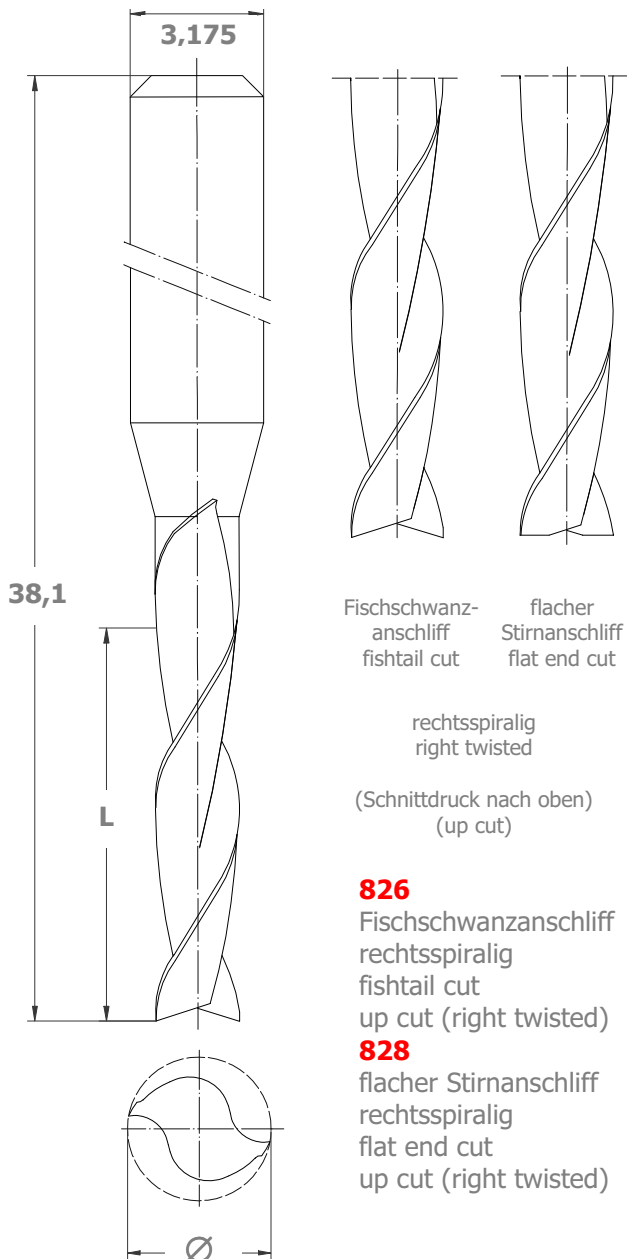
Anwendungen/Vorteile:

- für Tiefenfräsungen Typ 828
- Innenkonturen/Schlitze mit sehr hohen Qualitätsanforderungen
- Cu, Messing und Metalle
- beste Oberflächen- und Kantenqualität
- sehr guter Spantransport

2-Flute router

Applications/Advantages:

- for depth routing type 828
- inner contours/slots with high quality demands
- routing Cu, brass and metals
- best surface and edge quality
- excellent chip transport



826
Fischschwanzanschliff
rechtsspiralig
fishtail cut
up cut (right twisted)

828
flacher Stirnanschliff
rechtsspiralig
flat end cut
up cut (right twisted)

* auf Anfrage
* on request

HPTec GmbH
Im Karrer 6
D-88214 Ravensburg
Germany

Tel.: +49 (0)751-7669-0
Fax: +49 (0)751-7669-139
E-Mail: sales@hptec.de
www.hptec.de

826 828

Ø [mm]	L [mm]							
	0,7	1,0	1,5	3,0	5,0	6,0	8,0	10,0
0,20	x*							
0,25		x*						
0,30		x*						
0,40			x*					
0,50				x				
0,60				x				
0,70				x				
0,80					x			
0,90					x			
1,00					x			
1,10					x			
1,20					x			
1,30					x			
1,40					x			
1,50						x		
1,60						x		
1,70						x		
1,80						x		
1,90						x		
2,00							x	
2,10							x	
2,20							x	
2,30							x	
2,40							x	
2,50							x	
3,00								x
3,175								x



827

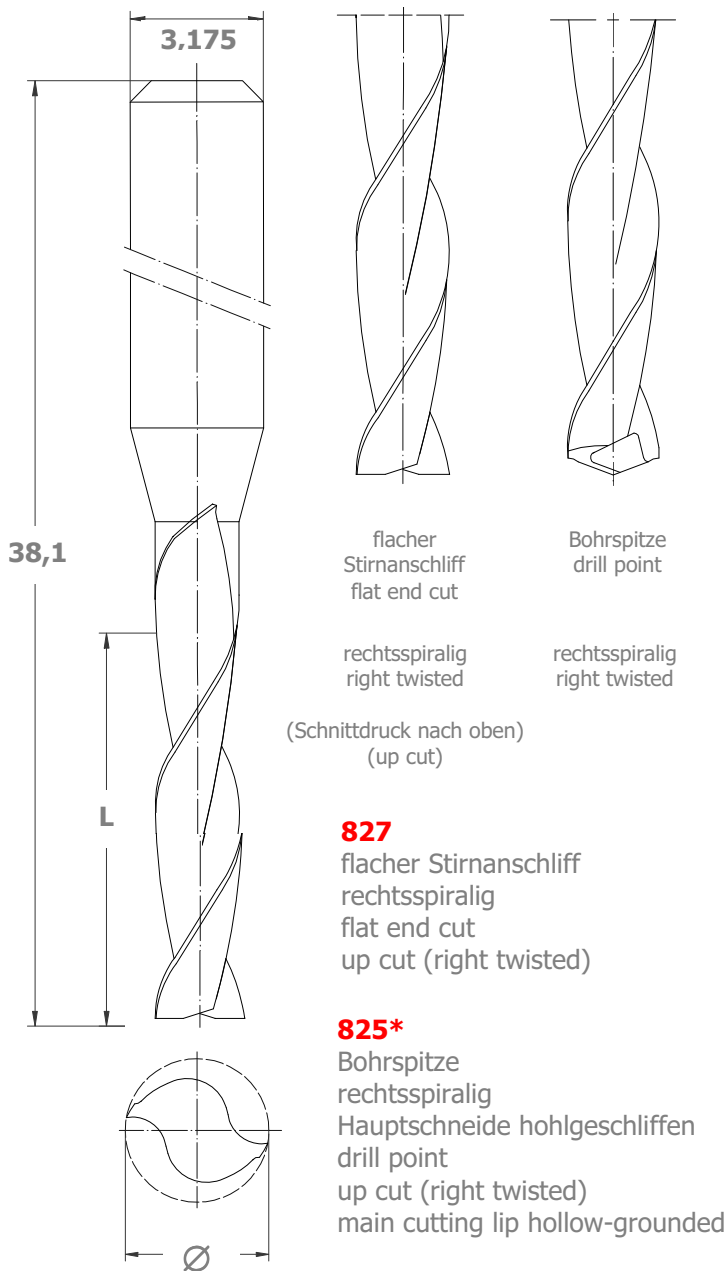
Fräser mit 2 Hauptschneiden Anwendungen/Vorteile:

- für die Leiterplatte
 - Tiefenfräsungen Typ 827
 - Innenkonturen/Schlitze mit sehr hohen Qualitätsanforderungen
 - weiche Kunststoffe, Folien, PE, PTFE, PMMA und Polyimid
 - Prepregs und FR4
 - Flex-Anwendungen
 - sehr guter Spantransport

2-Flute router Applications/Advantages:

- for PCB
 - depth routing type 827
 - inner contours/slots with high quality demands
 - routing plastics, foils, PE, PTFE, PMMA and polyimide
 - prepregs and FR4
 - flex-applications
 - excellent chip transport

825



		827				
Ø [mm]	L [mm]					
	3,0	5,0	6,0	8,0	10,0	
0,6	x*					
0,7	x*					
0,8		x*				
0,9		x*				
1,0		x				
1,1		x*				
1,2		x				
1,3		x*				
1,4		x*				
1,5			x*			
1,6			x			
1,7			x*			
1,8			x*			
1,9			x*			
2,0				x		
2,1				x*		
2,2				x*		
2,3				x*		
2,4				x		
2,5				x*		
3,0					x	
3,175					x*	

* auf Anfrage * on request

HPTec GmbH
Im Karrer 6
D-88214 Ravensburg
Germany

Tel.: +49 (0)751-7669-0
Fax: +49 (0)751-7669-139
E-Mail: sales@hptec.de
www.hptec.de

HPTEC



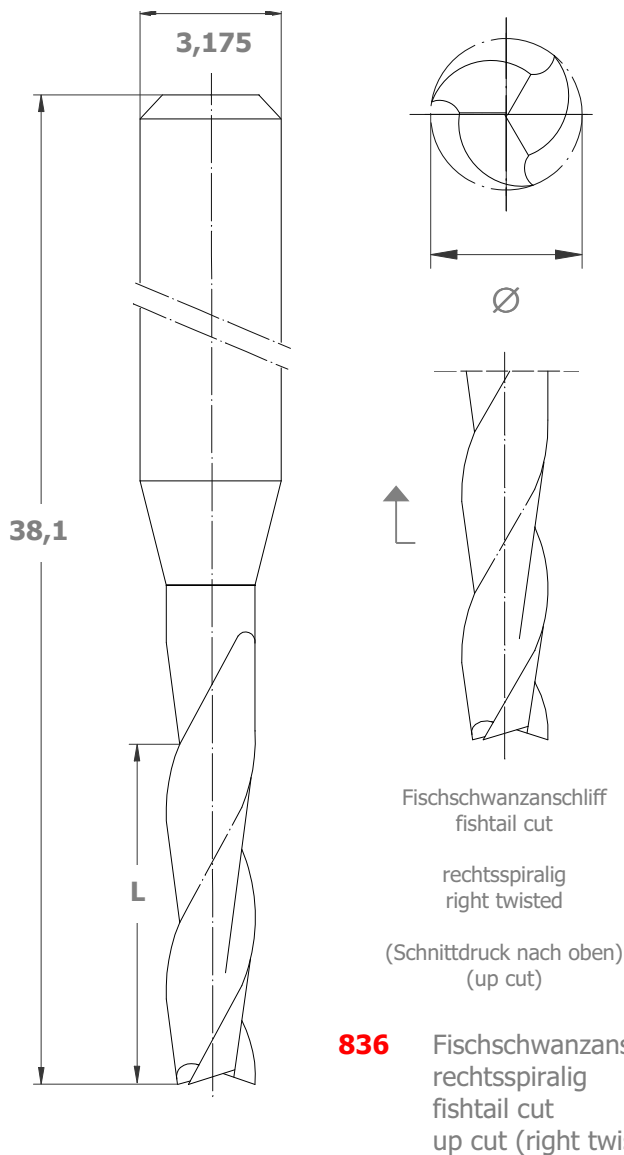
836

Fräser mit 3 Hauptschneiden Anwendungen:

- für Innenkonturen und metallisierte Schlitze
- Fräsen von Metalloberflächen
- weiche Kunststoffe, Folien, PE, PTFE, PMMA, Polyimid
- Prepregs und FR4
- Flex-Anwendungen
- beste Oberflächen- und Kantenqualität
- guter Spantransport

3-Flute router Applications:

- routing inner contours and slots
- routing metal surfaces
- soft plastics, foils, PE, PTFE, PMMA, polyimide
- thin prepregs and FR4
- flex-applications
- best surface and edge quality
- good chip transport



836			
Ø [mm]	L [mm]		
	5,0	7,0	9,0
1,0	x*		
1,1	x*		
1,2	x*		
1,3	x*		
1,4	x*		
1,5		x*	
1,6		x*	
1,7		x*	
1,8		x*	
1,9		x*	
2,0			x*
2,1			x*
2,2			x*
2,3			x*
2,4			x*
2,5			x*
3,0			x*
3,175			x*

* auf Anfrage * on request



850

Kegelsenker mit 5 Schneiden

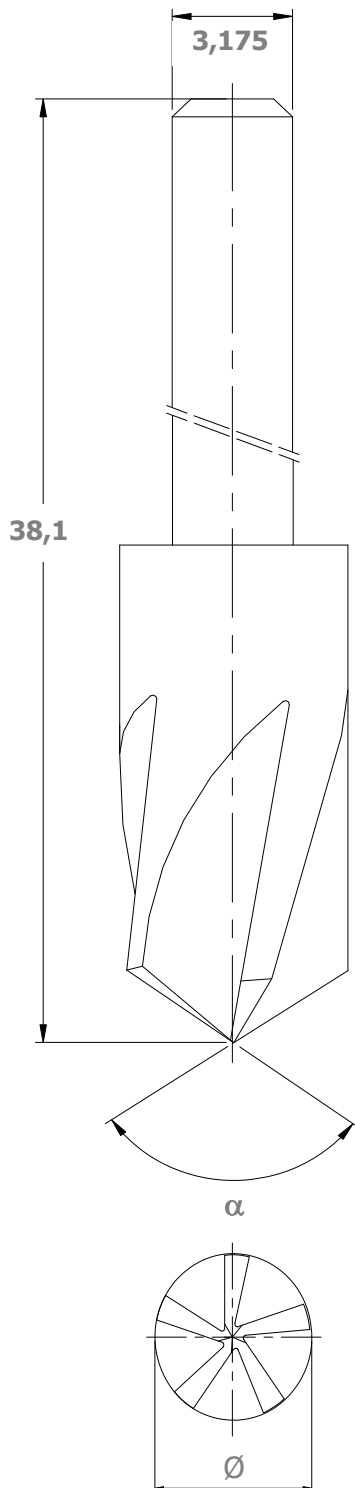
Countersink with 5 flutes

Anwendungen:

- Senken von Bohrungen
- Anfasen von Leiterplatten

Applications:

- countersinking of drill holes
- chamfering of circuit boards



850			
Ø	α		
[mm]	90°	120°	140°
6,0	x	x	x

Bemerkung:
Andere Spitzenwinkel / Durchmesser
auf Anfrage.
Remark:
Other point angles / diameters on
request.



876

Schlichtfräser

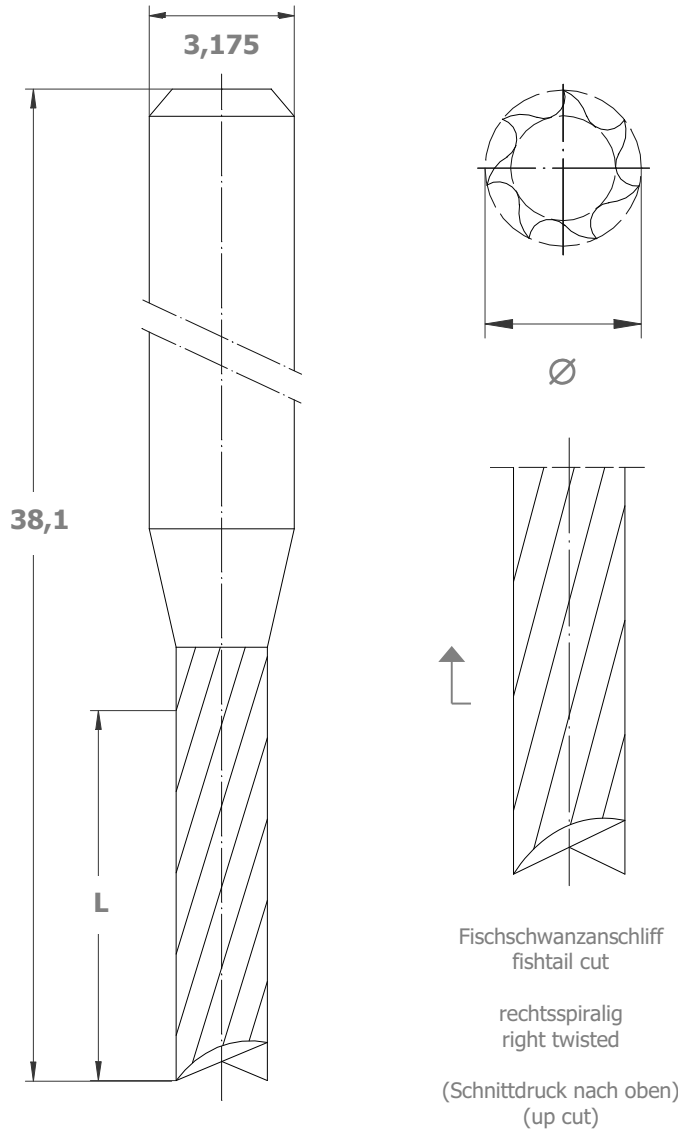
Anwendung:

- gratfreies Fräsen von Galvanoanbindungen (Goldfingers) und Metalloberflächen

Contour finishing router

Application:

- burr-free routing of metal surfaces (goldfingers) and metal composite laminates



876	
Ø [mm]	L [mm]
	7,0
1,6	x*
2,0	x*
2,4	x*

Bemerkung:

Andere Durchmesser auf Anfrage.

Remark:

Other diameters on request.

876 Fischschwanzanschliff
rechtsspiralig
fishtail cut
up cut (right twisted)



891

Diamantbeschichteter Fräser aus Vollhartmetall mit 2 Hauptschneiden

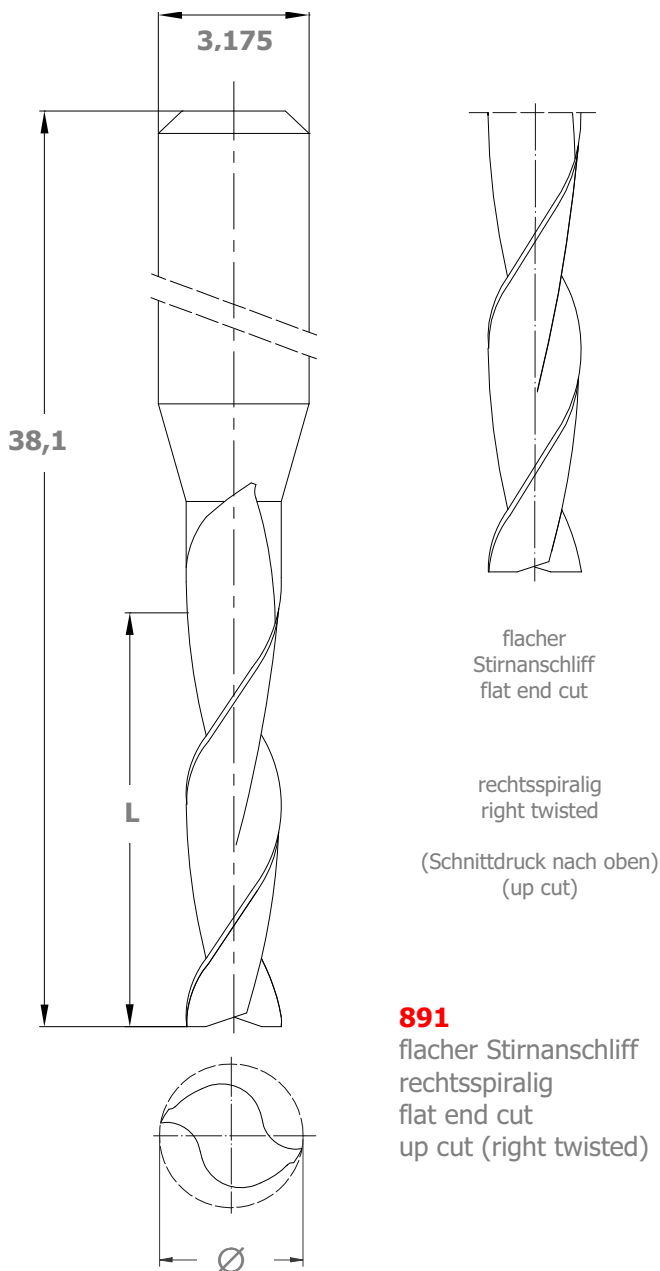
Anwendungen/Vorteile:

- Innenkonturen/Schlitze mit hohen Qualitätsanforderungen
- Geeignet zum Fräsen von Aluminium (trocken), Kupfer und GFK mit keramischen Füllstoffen
- sehr guter Spantransport
- Tiefenfräsungen möglich

Diamond coated 2-flute router made of solid carbide

Applications/Advantages:

- inner contours/slots with high quality demands
- routing aluminium (dry), copper and GRP with ceramic fillers
- excellent chip transport
- depth routing possible



891
 flacher Stirnanschliff
 rechtsspiralig
 flat end cut
 up cut (right twisted)

891			
Ø [mm]	L [mm]		
	3,0	4,0	6,0
0,9		x*	
1,0	x	x*	
1,1	x*		
1,2	x*	x*	
1,3	x*		
1,4	x*	x*	
1,5		x*	x
1,6			x*
1,7			x*
1,8		x*	x*
1,9			x*
2,0		x*	x
2,1			x*
2,2			x*
2,3			x*
2,4			x
2,5			x*
3,0			x
3,175			x*

* auf Anfrage * on request

Dienstleistungen / Service

Nachschleifen von Bohrern

Unser Service umfasst nicht nur das Neuwerkzeug, sondern auch das Nachschleifen von Gebrauchtwerkzeugen.

Regrinding of drills

Our service commitment does not only include new tools but also the regrinding of used tools.

Beringen von Werkzeugen

Alle von HPTec hergestellten Werkzeuge können nach Kundenspezifikation beringt werden.

Ring setting

All tools produced by HPTec can be set with rings acc. to customer's specification.

Toolmanagement

Level 1 – Terminalversion (Software STO)
PC mit Handscanner
Kapazität unbegrenzt
Lagerführung in Box und EM möglich

Level 2 – Small Tool Organizer (STO)
PC mit Handscanner und STO
Kombination von manueller und teilautomatischer Lagerführung
Kapazität von bis zu 15.600 Werkzeugen
bis zu 60 verschiedene Artikel

Level 3 – Tool Organizer (TO)
Vollautomatische Lagerverwaltung
Kapazität von mehr als 71.000 Werkzeugen
mehr als 7.100 verschiedene Artikel

Tool Management

Level 1 – Terminal Version
PC with hand scanner
Capacity unlimited
Boxes and EM can be stocked

Level 2 – Small Tool Organizer (STO)
PC with hand scanner
Combination of manual and semi-automatic stock management
Capacity up to 15.600 tools
up to 60 different articles

Level 3 – Tool Organizer (TO)
Fully automatic stock management
Capacity more than 71.000 tools
more than 7.100 different articles



Parameter Recommendation for Drills



Customer	HPTec Standard		
Material ¹ :	FR 4 ≤ 6 layers		
Spindle Type:	Air Bearing		
Cutting Speed	$v_s =$	150	[m/min]
Spindle Speed ¹	$n_{max} =$	125000	[rpm]

Diameter = D [mm]	Spindle Speed = n [rpm]
Chip Load = f [μm/1]	Retract Feed = R [m/min]
	Infeed = F [m/min]

D	f	F	n	R	D	f	F	n	R
0.10	6	0.7	125000	2.0	2.30	86	1.8	21000	25.0
0.15	10	1.2	125000	3.0	2.35	86	1.7	20000	25.0
0.20	13	1.7	125000	4.0	2.40	86	1.7	20000	25.0
0.25	18	2.3	125000	5.0	2.45	86	1.7	20000	25.0
0.30	22	2.7	125000	6.0	2.50	86	1.7	20000	25.0
0.35	25	3.1	125000	7.0	2.55	86	1.7	20000	25.0
0.40	28	3.3	119000	8.0	2.60	86	1.7	20000	25.0
0.45	31	3.3	106000	9.0	2.65	86	1.7	20000	25.0
0.50	35	3.3	95000	10.0	2.70	86	1.7	20000	25.0
0.55	40	3.5	87000	15.0	2.75	86	1.7	20000	25.0
0.60	44	3.5	80000	20.0	2.80	86	1.7	20000	25.0
0.65	48	3.5	73000	25.0	2.85	86	1.7	20000	25.0
0.70	52	3.6	68000	25.0	2.90	86	1.7	20000	25.0
0.75	57	3.6	64000	25.0	2.95	86	1.7	20000	25.0
0.80	62	3.7	60000	25.0	3.00	86	1.7	20000	25.0
0.85	67	3.7	56000	25.0	3.05	86	1.7	20000	25.0
0.90	71	3.8	53000	25.0	3.10	86	1.7	20000	25.0
0.95	76	3.8	50000	25.0	3.15	86	1.7	20000	25.0
1.00	81	3.9	48000	25.0	3.175	86	1.7	20000	25.0
1.05	86	3.8	45000	25.0	3.20	43	0.9	20000	25.0
1.10	86	3.7	43000	25.0	3.30	43	0.9	20000	25.0
1.15	86	3.6	42000	25.0	3.40	43	0.9	20000	25.0
1.20	86	3.4	40000	25.0	3.50	43	0.9	20000	25.0
1.25	86	3.2	38000	25.0	3.60	43	0.9	20000	25.0
1.30	86	3.2	37000	25.0	3.70	43	0.9	20000	25.0
1.35	86	3.0	35000	25.0	3.80	43	0.9	20000	25.0
1.40	86	2.9	34000	25.0	3.90	43	0.9	20000	25.0
1.45	86	2.8	33000	25.0	4.00	40	0.8	20000	25.0
1.50	86	2.7	32000	25.0	4.10	40	0.8	20000	25.0
1.55	86	2.7	31000	25.0	4.20	40	0.8	20000	25.0
1.60	86	2.6	30000	25.0	4.30	40	0.8	20000	25.0
1.65	86	2.5	29000	25.0	4.40	40	0.8	20000	25.0
1.70	86	2.4	28000	25.0	4.50	40	0.8	20000	25.0
1.75	86	2.3	27000	25.0	4.60	40	0.8	20000	25.0
1.80	86	2.3	27000	25.0	4.70	40	0.8	20000	25.0
1.85	86	2.2	26000	25.0	4.80	40	0.8	20000	25.0
1.90	86	2.1	25000	25.0	4.90	33	0.7	20000	25.0
1.95	86	2.1	24000	25.0	5.00	33	0.7	20000	25.0
2.00	86	2.1	24000	25.0	5.20	33	0.7	20000	25.0
2.05	86	2.0	23000	25.0	5.40	33	0.7	20000	25.0
2.10	86	2.0	23000	25.0	5.60	33	0.7	20000	25.0
2.15	86	1.9	22000	25.0	5.80	33	0.7	20000	25.0
2.20	86	1.9	22000	25.0	6.00	33	0.7	20000	25.0
2.25	86	1.8	21000	25.0	6.50	33	0.7	20000	25.0

¹ other materials and spindle speeds on request

Parameter Recommendation for Slot Drills



Customer	HPTec Standard	Cutting Speed $v_s = 150$ [m/min] Spindle Speed ¹ $n_{max} = 125000$ [rpm]
Material ¹ :	FR 4	
Spindle Type:	Air Bearing	

Diameter = D [mm] Spindle Speed = n [rpm]
Chip Load = f [$\mu\text{m}/1$] Infeed = F [m/min] Retract Feed = R [m/min]

D	f	F	n	R	D	f	F	n	R
0.50	10	1.1	108000	10.0	1.90	76	1.9	25000	25.0
0.55	17	1.7	98000	15.0	1.95	78	1.9	24000	25.0
0.60	20	1.8	90000	20.0	2.00	80	1.9	24000	25.0
0.65	27	2.2	83000	25.0	2.05	80	1.8	23000	25.0
0.70	33	2.5	77000	25.0	2.10	80	1.8	23000	25.0
0.75	35	2.5	72000	25.0	2.15	80	1.8	22000	25.0
0.80	38	2.6	68000	25.0	2.20	80	1.8	22000	25.0
0.85	40	2.6	64000	25.0	2.25	80	1.7	21000	25.0
0.90	43	2.6	60000	25.0	2.30	80	1.7	21000	25.0
0.95	47	2.7	57000	25.0	2.35	80	1.6	20000	25.0
1.00	50	2.7	54000	25.0	2.40	80	1.6	20000	25.0
1.05	52	2.3	45000	25.0	2.45	80	1.6	20000	25.0
1.10	53	2.3	43000	25.0	2.50	80	1.6	20000	25.0
1.15	55	2.3	42000	25.0	2.55	70	1.4	20000	25.0
1.20	56	2.2	40000	25.0	2.60	70	1.4	20000	25.0
1.25	58	2.2	38000	25.0	2.65	70	1.4	20000	25.0
1.30	59	2.2	37000	25.0	2.70	70	1.4	20000	25.0
1.35	61	2.1	35000	25.0	2.75	70	1.4	20000	25.0
1.40	62	2.1	34000	25.0	2.80	70	1.4	20000	25.0
1.45	63	2.1	33000	25.0	2.85	70	1.4	20000	25.0
1.50	64	2.0	32000	25.0	2.90	70	1.4	20000	25.0
1.55	66	2.0	31000	25.0	2.95	70	1.4	20000	25.0
1.60	67	2.0	30000	25.0	3.00	60	1.2	20000	25.0
1.65	68	2.0	29000	25.0	3.05	60	1.2	20000	25.0
1.70	69	1.9	28000	25.0	3.10	60	1.2	20000	25.0
1.75	70	1.9	27000	25.0	3.15	60	1.2	20000	25.0
1.80	72	1.9	27000	25.0	3.175	60	1.2	20000	25.0
1.85	74	1.9	26000	25.0					

¹ other materials and spindle speeds on request

Parameter Recommendation for Routers



Material¹: FR4
 Cutting Speed: 220 m/min
 Spindle type: Ball Bearing Spindle speed¹ n_{max.} = 60000 rpm
 Tool type: 726 / 756

Diameter = **D** [mm] Spindle speed = **n** [rpm]
 Chip load = **f** [μm/1] Table feed = **F(XY)** [m/min]
 Infeed with / without pre-drilling = **F(Z)** [m/min]
 max. stack height = **H** [mm]

D	f	F (XY)	n	F (Z) without	F (Z) with	H
			type 726	pre-drilling	pre-drilling	
[mm]	[μm/1]	[m/min]	rpm	[m/min]	[m/min]	[mm]
0.20	1	0.1	60000	0.1	0.2	0.5
0.30	2	0.1	60000	0.1	0.2	0.5
0.40	2	0.1	60000	0.1	0.5	1.0
0.50	3	0.2	60000	0.1	0.5	1.0
0.60	3	0.2	60000	0.1	0.5	1.6
0.70	4	0.2	60000	0.1	0.5	1.6
0.80	5	0.3	60000	0.2	0.5	3.5
0.90	6	0.4	60000	0.2	0.5	3.5
1.00	8	0.5	60000	0.4	2.0	5.0
1.10	9	0.5	60000	0.4	2.0	5.0
1.20	10	0.6	58000	0.4	2.0	5.0
1.30	12	0.6	54000	0.6	2.0	5.0
1.40	14	0.7	50000	0.6	2.0	5.0
1.50	16	0.8	47000	0.6	2.0	6.0
1.60	18	0.8	44000	0.8	5.0	6.0
1.70	22	0.9	41000	0.8	5.0	6.0
1.80	26	1.0	39000	0.8	5.0	6.0
1.90	30	1.1	37000	0.8	5.0	6.0
2.00	34	1.2	35000	1.3	5.0	6.5
2.10	38	1.3	33000	1.3	5.0	6.5
2.20	40	1.3	32000	1.3	5.0	6.5
2.30	42	1.3	30000	1.3	5.0	6.5
2.40	44	1.3	29000	1.3	5.0	6.5
2.50	46	1.3	28000	1.3	5.0	6.5
3.00	53	1.2	23000	1.3	5.0	6.5
3.175	55	1.2	22000	1.3	5.0	6.5

¹ other materials and spindle speeds on request

Formula for Cutting Parameters

Cutting Speed v_s :

$$V_s = \frac{n * D * \pi}{1000}$$

v_s = cutting speed [m/min]

n = spindle speed [rpm]

D = nominal diameter [mm]

π = 3,14

Chip load f :

(Feed per revolution)

$$f = \frac{F * 1000}{n}$$

f = chip load [mm/rev.]

F = feed rate [m/min]

n = spindle speed [1/min]

Conversion formula:

Feed rate F :

$$F = \frac{f * n}{1000}$$

Spindle speed n :

$$n = \frac{V_s * 1000}{D * \pi}$$

Example:

Given data: cutting speed v_s : 150 m/min
 chip load f : 0,055 mm/rev
 diameter D : 0,7 mm

$$\Rightarrow \text{spindle speed } n = \frac{150 \text{ m/min}}{(0,7 \text{ mm} * 3,14)} * 1000 = 68243 \text{ rpm}$$

\Rightarrow chosen spindle speed: **$n = 68000 \text{ rpm}$**

$$\Rightarrow \text{feed rate } F = \frac{(0,055 \text{ mm/rev} * 68000 \text{ rpm})}{1000} = 3,74 \text{ m/min}$$

\Rightarrow chosen feed rate: **$F = 3,7 \text{ m/min}$**

Trouble Shooting

Trouble shooting when drilling printed circuit boards:

Problem	Possible Causes	Remedy
drill breakage	<ul style="list-style-type: none"> - chips jam in flute space - cutting pressure too high - spindle run-out error - dirty/defect collet - drill deviation - chipping on cutting edges 	<ul style="list-style-type: none"> - use drills suitable for the specific cutting conditions (geometry), check extraction system/parameters - adapt feed rate - check spindle run-out - clean/replace collet - minimising of drill deviation - ensure correct tool handling
inaccurate drill hole positioning (drill deviation)	<ul style="list-style-type: none"> - flute length too long - spindle run-out error - dirty/defect collet - pin hole inaccurate - drill wear too high or chipping on cutting edges 	<ul style="list-style-type: none"> - adapt flute length - check spindle run-out - clean/replace collet - check pin hole - reduce hit counts/ no. of regrinding operations, check cutting conditions, check tool handling
poor surface quality of hole wall	<ul style="list-style-type: none"> - smear caused by inefficient chip removal - drill wear too high or chipping on cutting edges - board material insufficiently hardened 	<ul style="list-style-type: none"> - improve chip removal by <ul style="list-style-type: none"> a) improved extraction system b) use tools with suitable geometry (spade type drills) c) modification of parameters - reduce hit counts/ no. of regrinding operations, check cutting conditions, check tool handling - check quality of the laminate (multilayer pressing conditions)
nail heading	<ul style="list-style-type: none"> - feed rate/retraction rate too high or too low - wrong cutting parameters - drill wear too high or chipping on cutting edges - dwell time of drill at cusp too long 	<ul style="list-style-type: none"> - adapt feed rate/retraction rate - adapt cutting conditions to the laminate used - reduce hit count/ no. of regrinding operations, check cutting conditions, check tool handling - reduce dwell time

Trouble Shooting

Problem	Possible Causes	Remedy
smear of resin	<ul style="list-style-type: none"> - excessive drilling temperatures - laminate insufficiently hardened - drill wear too high or chipping on cutting edges - insufficient de-smear process 	<ul style="list-style-type: none"> - increase feed rate, reduce cutting speed - check laminate - reduce hit count/ no. of regrinding operations, check cutting conditions, check tool handling - check de-smear process
burr on entry and/or exit side	<ul style="list-style-type: none"> - drill wear too high or chipping on cutting edges - feed rate/retraction rate too high - entry/backup material too soft - pressure foot power insufficient 	<ul style="list-style-type: none"> - reduce hit count, check cutting conditions, check tool handling - reduce feed rate/retraction rate - use harder entry/backup material - check pressure and correct operation of pressure foot
contamination on the entry and/or exit side	<ul style="list-style-type: none"> - wrong cutting parameters - drill wear too high or chipping on cutting edges - pressure foot power insufficient - entry/backup material too soft - poor laminate bond 	<ul style="list-style-type: none"> - use recommended parameters - reduce hit count/ no. of regrinding operations, check cutting conditions, check tool handling - increase pressure foot power - use harder entry/backup material - check pressing procedure
deformation of inner layers	<ul style="list-style-type: none"> - chips jam in flute space - drill wear too high or chipping on cutting edges - poor laminate bond 	<ul style="list-style-type: none"> - use drills suitable for the specific cutting conditions (geometry), check extraction system/parameters - reduce hit count/no. of regrinding operations, check cutting conditions, check tool handling - check pressing procedure
winding of chips on drill	<ul style="list-style-type: none"> - insufficient chip extraction - feed rate too low (chips get too long) 	<ul style="list-style-type: none"> - clean and check extraction system, if necessary use more powerful extraction system - increase feed rate