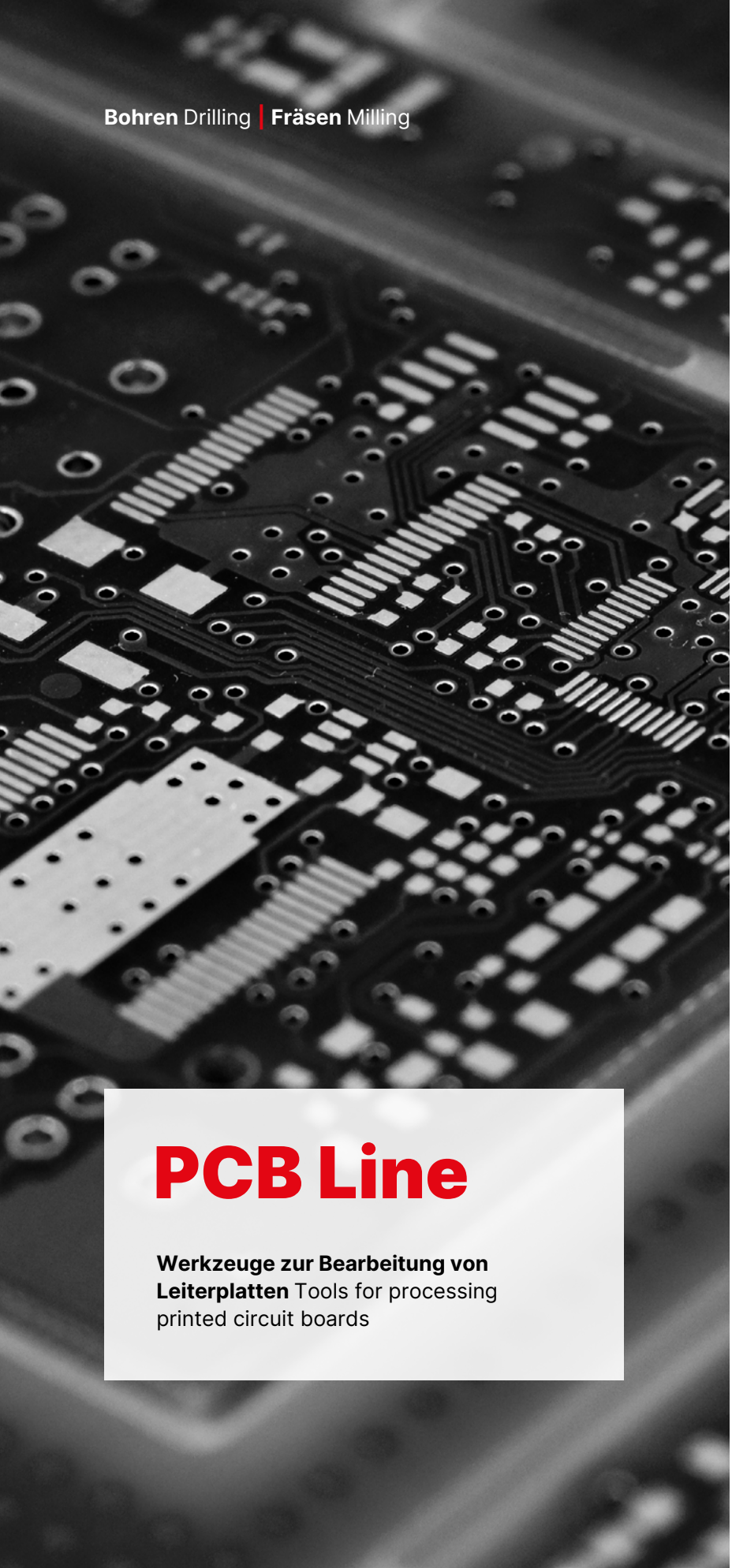
Bohren Drilling | **Fräsen** Milling

HPTEC



PCB Line

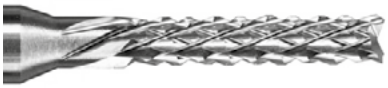
Werkzeuge zur Bearbeitung von Leiterplatten Tools for processing printed circuit boards



MORE THAN JUST TOOLS

Products PCB

Diamond-patterned
Types 620, 624, 626



Spiral-patterned
Types 720, 724, 726, 756, 790



Contour-finishing
Type 876



1-Flute router
Types 817, 818, 892



2-Flute router
Types 821, 826, 827, 828, 891



3-Flute router
Type 836



V-Groove cutter
Types 801, 802, 803, 804, 806, 809



Countersink
Type 850



Ultra micro drills
Types 518, 218, 318, 418



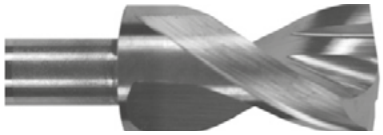
Standard drills



Type 530



Type 532



Spade drills
Type 230



Multilayer drills
Types 212, 242, 243, 272, 540

Type 271, 272



Type 543



Microvia drills
Type 596



Slot drills
Type 250



Flex drills
Type 512



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Survey of HPTec drills / application field drills

tool type	description		Ø range [mm]	DS - ML 4 layers	ML 6-8 layers	ML ≥ 10 layers	ML ≥ 70 µm copper	Filled / HTG	Backpanels	Flex / Flex-rigid	IC-Substr ABFM	Polyimide	Teflon	Metal core ML	Copper / Brass	Plexiglas	remark
530	Standard drill		0,20 - 0,50	●	◒	◒	◒	○	◒	○	●	◒	◒	◒	●	◒	Universal for all standard applications.
			0,55 - 1,95	●	◒	◒	◒	◒	○	◒	●	○	○	○	●	◒	
			2,00 - 6,35	●	●	●	◒	●	●	●	●	◒	◒	◒	●	◒	
532	Chipbreaker / thinned web		3,20 - 6,35	●	●	●	●	●	●	●	○	◒	◒	◒	●	◒	
543	Standard Drill		0,20 - 0,50	◒	●	●	●	●	●	●	○	●	●	◒	◒	●	Drill for high frequency applications
230	Multilayer drill	Spade type drill	0,70 - 2,00	●	●	●	◒	●	◒	◒	○	◒	●	◒	●	◒	Proved spade type drill for all multilayer boards.
218 212			0,105 - 0,15 0,20 - 0,65	●	●	●	●	◒	●	●	○	●	●	●	◒	●	Highest demands on hole wall quality + chip transport.
242 243 271 272			0,20 - 0,65 0,05 - 0,25	●	●	●	●	●	●	◒	●	●	●	◒	◒	◒	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	Spade type drill	0,50 - 3,00	●	●	●	◒	●	◒	◒	○	◒	◒	◒	◒	◒	Drilling slots
512	Flex drill	Standard	0,15 - 0,50	○	○	○	○	○	○	●	○	●	◒	○	○	○	Excellent positioning accuracy, long tool life, more regrinding cycles possible.
596	Micro-via drill	Conical	0,075 - 0,60	●	●	●	●	●	●	●	●	◒	◒	◒	◒	◒	Drill for conical blind via holes.

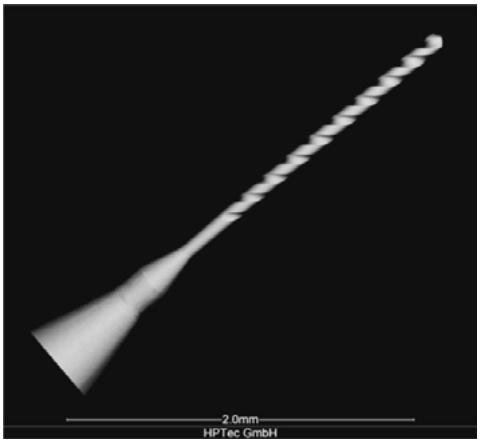
Key: ● optimum ◑ suitable ○ not recommendable

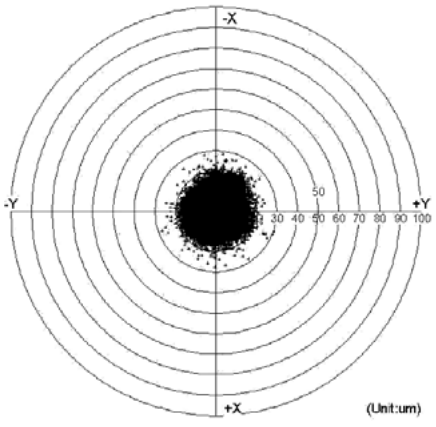
ULTRAMIKROBOHRER Typen und Spirallängen
ULTRA MICRO DRILLS Types and Flute Lengths

Ø [mm]	512	518 / 418*	218 / 318*	596
	Flexbohrer	Standard-bohrer	Kopfbohrer	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

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

Ø [mm]	212	512	530	532	543	230
	Multilayerbohrer	Flexbohrer	Standardbohrer	Spiral-bohrer	Standard-bohrer	Kopf-bohrer
		Flex Drill	Standard Drill	Standard Drill	Standard Drill	Spade Type Drill
		Ø ≤ 0,2 mm siehe Übersicht ULTRAMIKROBOHRER Ø ≤ 0,2 mm see survey ULTRA MICRO DRILLS				
		* auf Anfrage / * on request				
0,15		**2,5***				
0,20	**3,5**	**3,5**	**2,5***		**3,5***	
0,25	**4,0**	**3,5**	**2,5***		**4,5***	
0,30	**5,5 / 6,5***	**5,5**	**3,5 / 5,5**		**5,5***	
0,35	**5,5 / 7,0**	**5,5***	**3,5 / 5,5 / 7**		**6,5**	
0,40	**5,5 / 7,0 / 8,5***	**5,5***	**3,5 /5,5 / 7**		**7***	
0,45	**7,0 / 8,5***	**7***	**3,5 / 7**		**7***	
0,50	**7,0 / 8,5**	**7***	**3,5 / 7 / 8,5**		**7***	
0,55	**8,5**		**7 / 8,5**			
0,60	**8,5**		**7 / 8,5**			
0,65	**8,5**		**7* / 8,5**			
0,70			**10,5**			**10**
0,75			**10,5**			**10**
0,80			**10,5**			**10**
0,85			**10,5**			**10**
0,90			**10,5**			**10**
0,95			**10,5**			**10**
1,00			**10,5**			**10**
:			**:**			**:**
1,15			**10,5**			**10**
1,20			**10,5**			**10**
1,25			**10,5**			**10**
:			**:**			**:**
1,60			**10,5**			**10**
1,65			**10,5**			**10**
:			**:**			**:**
2,00			**10,5**			**10**
2,05			**10,5**			**10***
:			**:**			**:**
2,50			**10,5**			**10***
:			**:**			**:**
3,00			**10,5**			**10***
3,175			**10,5**			
3,20			**12**	**12**		
:			**:**	**:**		
6,35			**12**	**12**		

MICRO-/STANDARDBOHRER Typen und Spirallängen

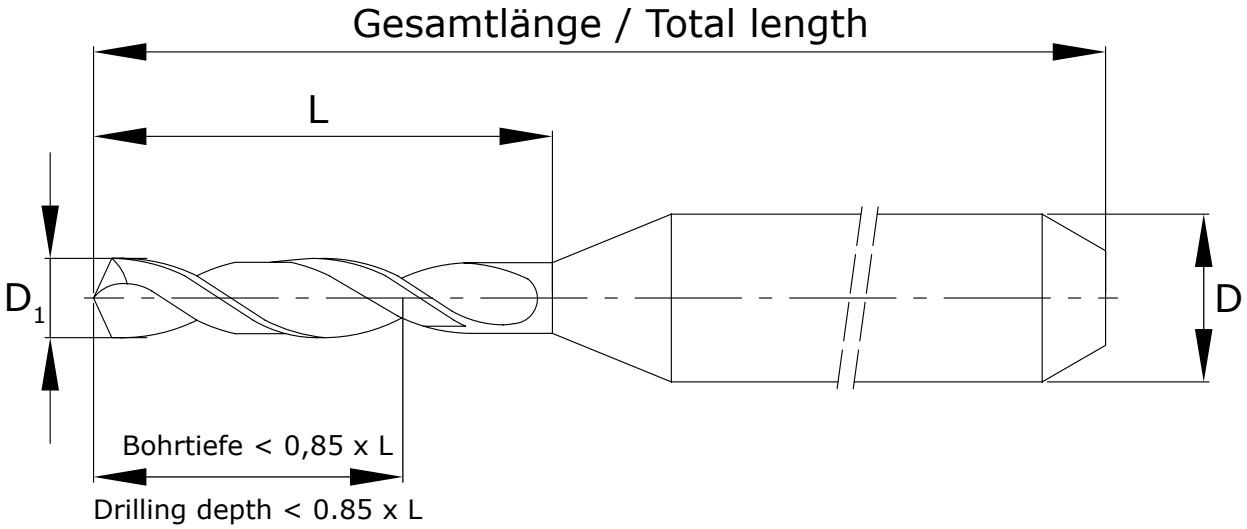
MICRO /STANDARD DRILLS Types and Flute Lengths

Ø [mm]	212	242	243	271	272	540	250
	Multilayerbohrer						Langlochbohrer
	Multilayer Drill						Slot Drill
0,050					0,9		
0,075				1,2*	1,2		
0,105				1,8	1,8		
0,11				1,8*	1,8		
0,12				1,8*/2,0/2,2*	1,8/2,0*		
0,15				2,5	2,5/3,5*		
0,20	3,5	3,5/4,0	3,5/4,0	3,5/4,0/4,5*	3,5	3,2/4,0*	
0,25	4,0	4,0/4,5	4,0/4,5/4,8*	4,0/4,5/5,5*	4,0	3,2*/4,0*	
0,30	5,5/6,5*	5,5/6,5*	5,5/6,5*	5,5/6,5*		5,5*	1,8*
0,35	5,5/7,0	5,5/6,5/7,0	5,5/6,5*/7,0	5,5/6,5/7,2*		5,5*/7,0*	4,0*
0,40	5,5/7/8,5*	7,0	5,5/7,0	6,5/7,0		5,5*/7,0*	5,5*
0,45	7,0/8,5*	7,0/8,5*	7,0/8,5*	7,0/8,5*		7,0*	5,0*
0,50	7,0/8,5	7,0/8,5*	7,0/8,5*	7,0/8,5		7,0*	5,5/7,0
0,55	8,5	7,0/8,5*	7,0/8,5*	7,0*/8,5		7,0*/8,5*	5,5/7,0
0,60	8,5	8,5	8,5*	7,0/8,5		7,0*/8,5*	5,5/7,0
0,65	8,5	8,5	8,5*	7,0/8,5		7,0*/8,5*	5,5/7,0
0,70						8,5*/10,5*	5,5*/7,0/8,5
0,75						8,5*/10,5*	5,5*/7,0/8,5
0,80						8,5*/10,5*	5,5*/7,0/8,5
0,85						8,5*/10,5*	5,5*/7,0/8,5
0,90						9,5*/10,5*	5,5*/7,0/8,5
0,95						9,5*/10,5*	5,5*/7,0/8,5
1,00						10,5*	8,5
1,15						10,5*	8,5
1,20							8,5
1,25							8,5
1,60							8,5
1,65							8,5
2,00							8,5
2,05							8,5
2,50							8,5
2,55							8,5*
3,00							8,5*

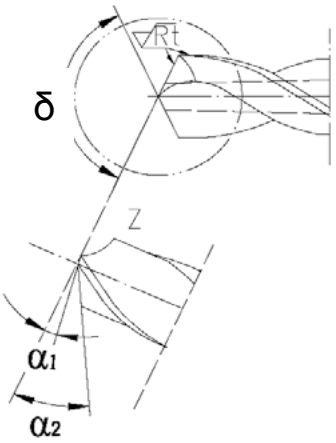
MICRO-/STANDARDBOHRER Typen und Spirallängen
MICRO /STANDARD DRILLS Types and Flute Lengths

Ø [mm]	212	242	243	271	272	540	250
	Multilayerbohrer						Langlochbohrer
	Multilayer Drill						Slot Drill
0,050					0,9		
0,075				1,2*	1,2		
0,105				1,8	1,8		
0,11				1,8*	1,8		
0,12				1,8*/2,0/2,2*	1,8/2,0*		
0,15				2,5	2,5/3,5*		
0,20	3,5	3,5/4,0	3,5/4,0	3,5/4,0/4,5*	3,5	3,2/4,0*	
0,25	4,0	4,0/4,5	4,0/4,5/4,8*	4,0/4,5/5,5*	4,0	3,2*/4,0*	
0,30	5,5/6,5*	5,5/6,5*	5,5/6,5*	5,5/6,5*		5,5*	1,8*
0,35	5,5/7,0	5,5/6,5/7,0	5,5/6,5*/7,0	5,5/6,5/7,2*		5,5*/7,0*	4,0*
0,40	5,5/7/8,5*	7,0	5,5/7,0	6,5/7,0		5,5*/7,0*	5,5*
0,45	7,0/8,5*	7,0/8,5*	7,0/8,5*	7,0/8,5*		7,0*	5,0*
0,50	7,0/8,5	7,0/8,5*	7,0/8,5*	7,0/8,5		7,0*	5,5/7,0
0,55	8,5	7,0/8,5*	7,0/8,5*	7,0*/8,5		7,0*/8,5*	5,5/7,0
0,60	8,5	8,5	8,5*	7,0/8,5		7,0*/8,5*	5,5/7,0
0,65	8,5	8,5	8,5*	7,0/8,5		7,0*/8,5*	5,5/7,0
0,70						8,5*/10,5*	5,5*/7,0/8,5
0,75						8,5*/10,5*	5,5*/7,0/8,5
0,80						8,5*/10,5*	5,5*/7,0/8,5
0,85						8,5*/10,5*	5,5*/7,0/8,5
0,90						9,5*/10,5*	5,5*/7,0/8,5
0,95						9,5*/10,5*	5,5*/7,0/8,5
1,00						10,5*	8,5
1,15						10,5*	8,5
1,20							8,5
1,25							8,5
1,60							8,5
1,65							8,5
2,00							8,5
2,05							8,5
2,50							8,5
2,55							8,5*
3,00							8,5*

Spezifikation für Spiralbohrer
Specification for drills
212/218/230/242/243/250/271/272
512/518/530/532/540/543



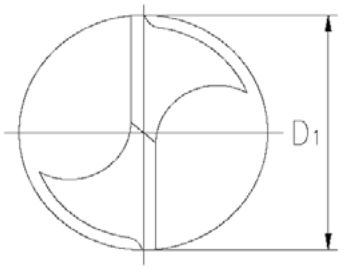
	$0,05 < D_1 < D$	$D_1 > D$
Gesamtlänge / Total length	**38,2 -0,2**	**38,2 -0,3**
Spirallänge / Flute length		
L ≤ 2 **2 < L < 10** **L ≥ 10**	**+0,2 / -0,1** **+0,4 / -0,2** **+0,4 / -0,2**	**+0,5 / -0,3**
Schneidenrauhtiefe R_t **Roughness R_t**	**< 0,003**	**< 0,005**
Schaft- / shank Ø D	**-0,001 / -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]

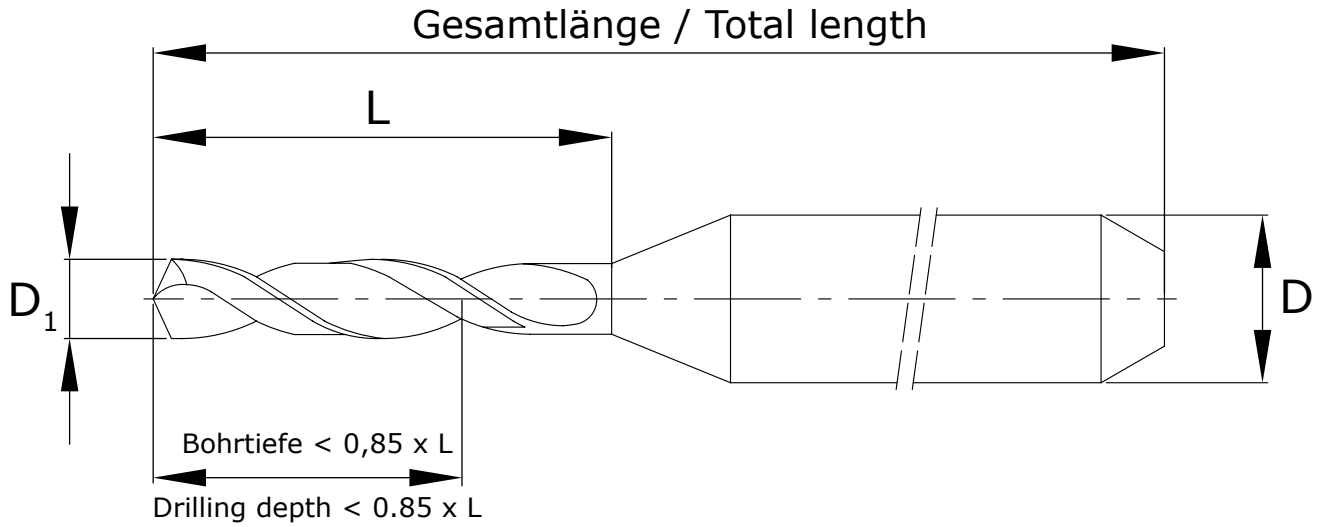
Spitzenwinkel δ **Point angle δ**	
0,05 > D1 ≤ 0,12	**130° -5°**
0,13 ≥ D1 ≤ 0,20	**120° -5°**
0,21 ≥ D1 ≤ 3,175	**130° -5°**
D1 > 3,175	**165° -5°**
Typ 250	**150° -5°**



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 [mm]

Spezifikation für Spiralbohrer
Specification for drills 318/418



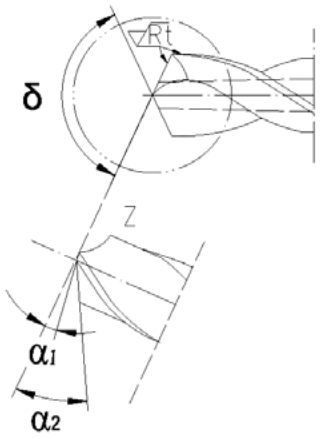
	$0,05 < D_1 < D$	$D_1 > D$
Gesamtlänge / Total length	**31,85 -0,2**	**31,85 -0,3**
Spirallänge / Flute length		
L ≤ 2	**+0,2 / -0,1**	**+0,5 / -0,3**
2 < L < 10	**+0,4 / -0,2**	
L ≥ 10	**+0,4 / -0,2**	
Schneidenrauhtiefe R_t Roughness R_t	**< 0,003**	**< 0,005**
Schaft- / shank Ø D	**-0,001 / -0,007**	**-0,001 / -0,01**

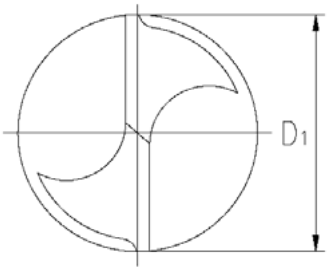
Nenn- / Nominal-Ø D_1	
0,05 ≤ 0,25	**+0,000 /+0,008**
0,26 ≤ 1,65	**+0,000 / -0,008**
1,66 - 1.99	**+0,000 / -0,012**
≥ 2.00	**+0,000 / -0,015**

Angaben / Data in [mm]

Spitzenwinkel δ Point angle δ	
0,05 > D1 ≤ 0,12	**130° -5°**
0,12 ≥ D1 ≤ 0,20	**120° -5°**
0,20 > D1 ≤ 3,175	**130° -5°**
D1 > 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 [mm]



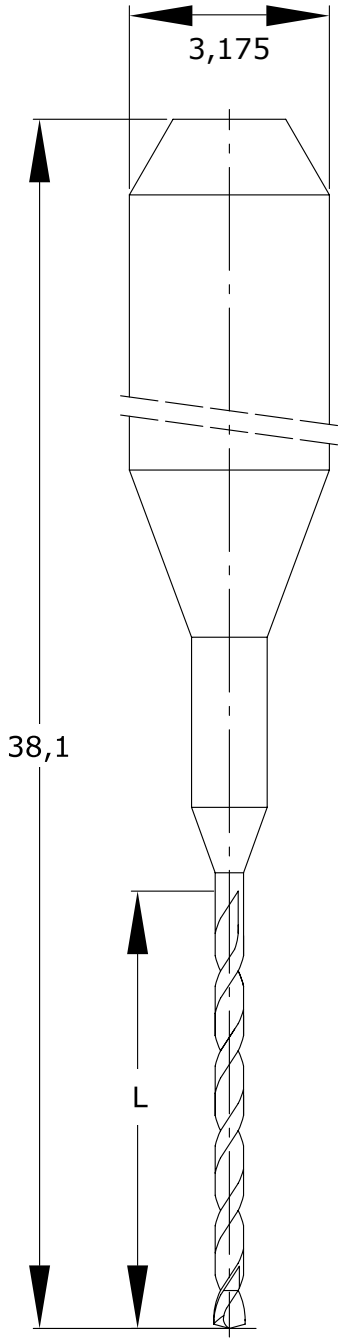


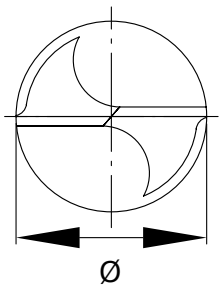


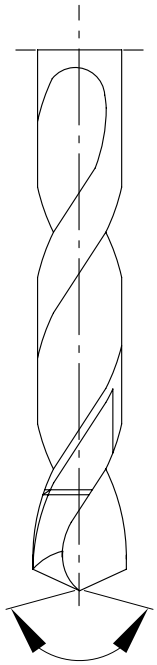
212

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**







Ø ≤ 0,20 **120°**
Ø > 0,20 **130°**

212	L [mm]					
Ø [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



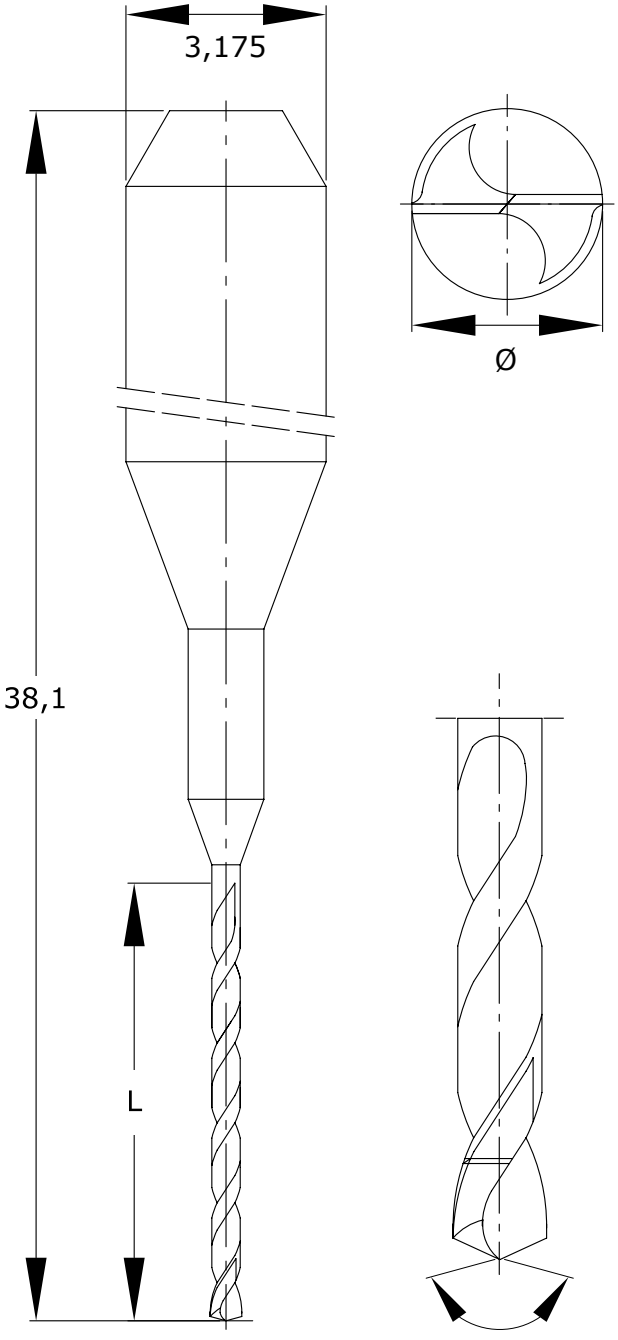
218
318

Ultramikrobohrer,
Kopfbohrergeometrie
für hochdrehende Spindeln
Anwendung/Vorteile:

- **BGA / HDI**
- **höchste Stabilität**
- **höchste Bohrgenauigkeit**

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

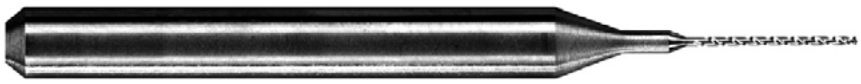
- **BGA / HDI**
- **best stability**
- **best accuracy**



218	L [mm]		
Ø [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.



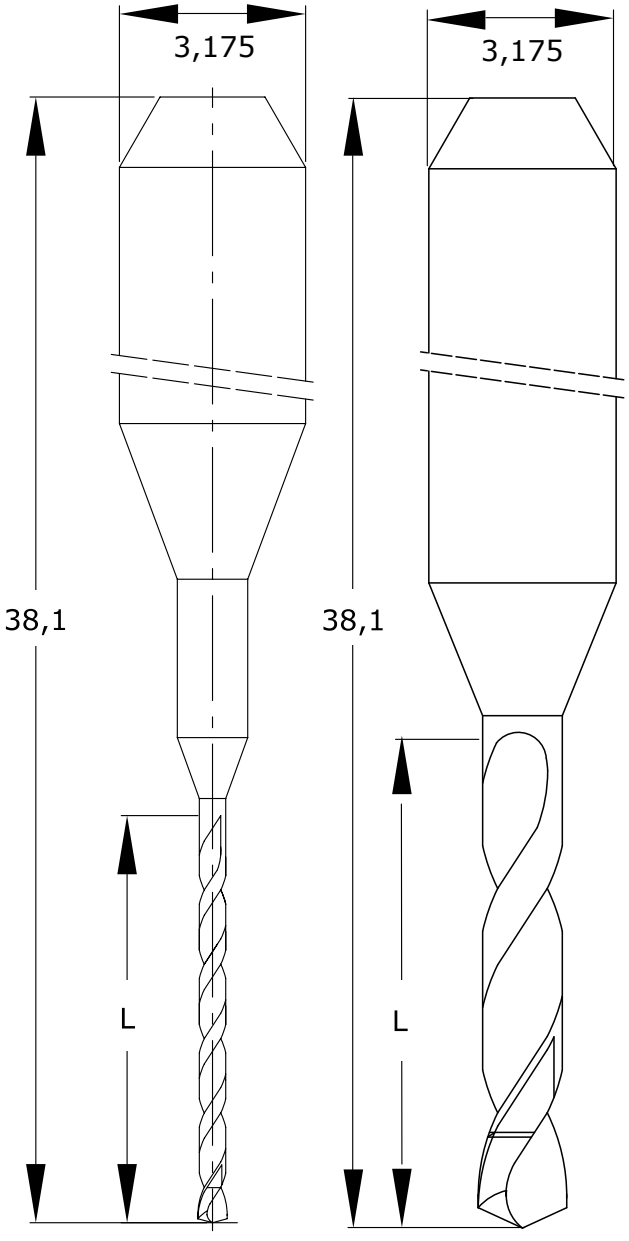
230

Kopfbohrer
Anwendung/Vorteile:

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

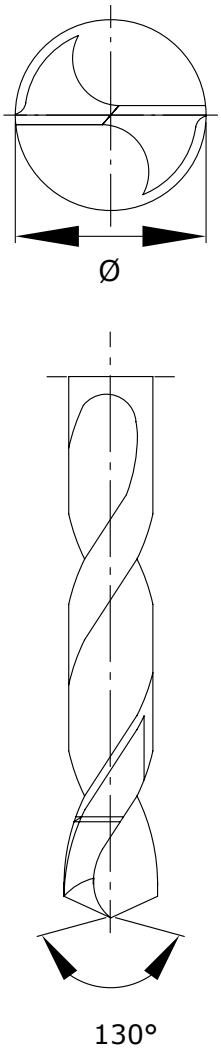
Spade type drill
Application/Advantages:

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



Ø 0,25-0,50

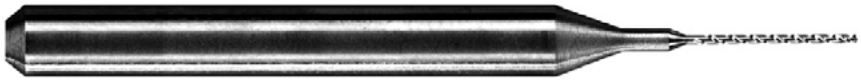
Ø 0,55-2,00



Ø 0,25-2,00

230	L [mm]
Ø [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



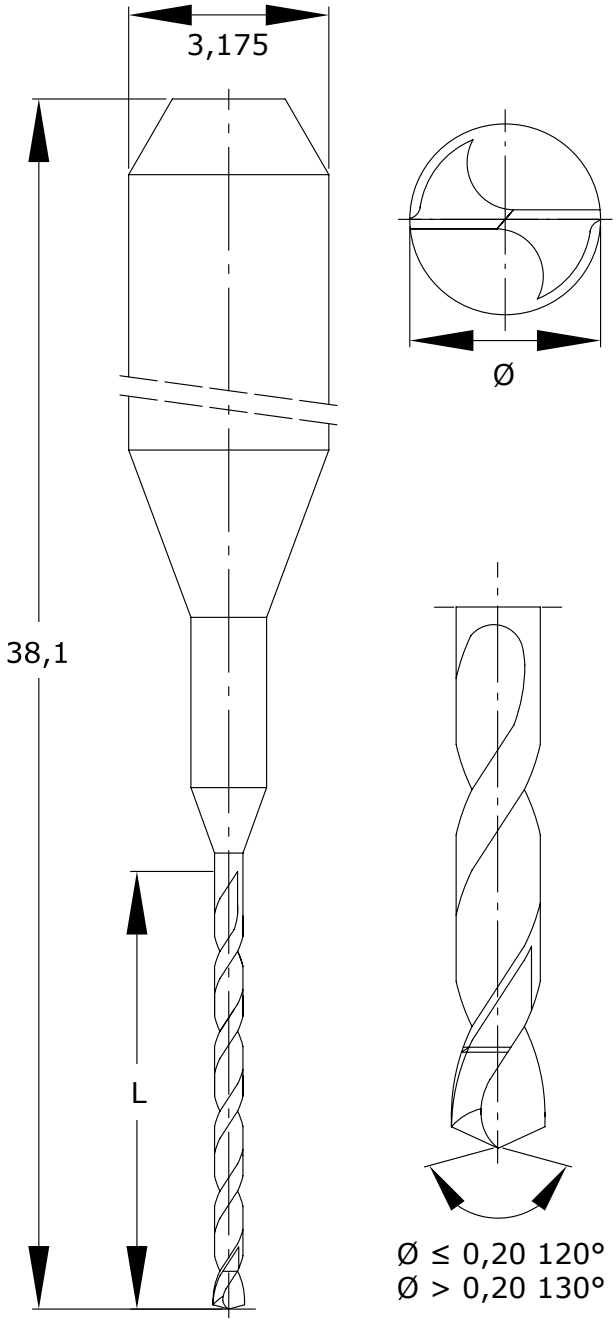
242

Multilayerbohrer, Kopfbohrergeometrie
Anwendung/Vorteile:

- **maximale Stabilität**
- **verbesserter Bohrerverlauf**
- **geringere Bohrkosten durch mehrmaliges Nachschleifen**

Multilayer drill, spade type version
Application/Advantages:

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



242	L [mm]						
Ø [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



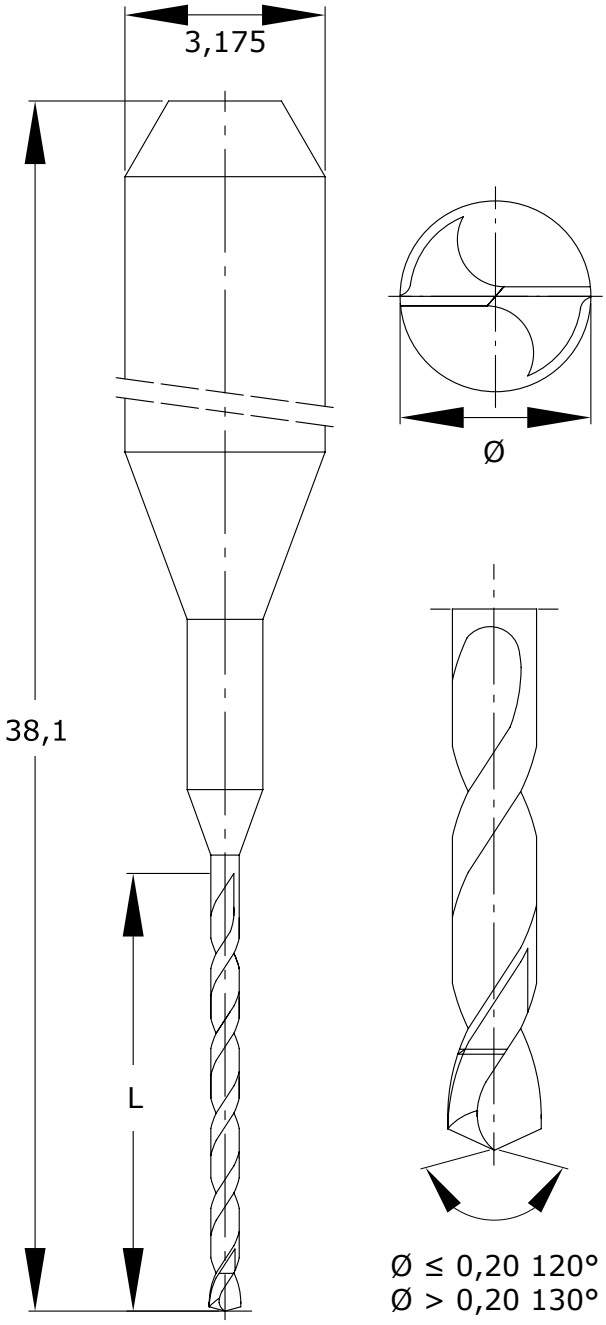
243

Multilayerbohrer, Kopfbohrergeometrie
Anwendung/Vorteile:

- **Positioniergenauigkeit**
- **maximale Stabilität**
- **verbesserter Bohrerverlauf**
- **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	L [mm]							
Ø [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



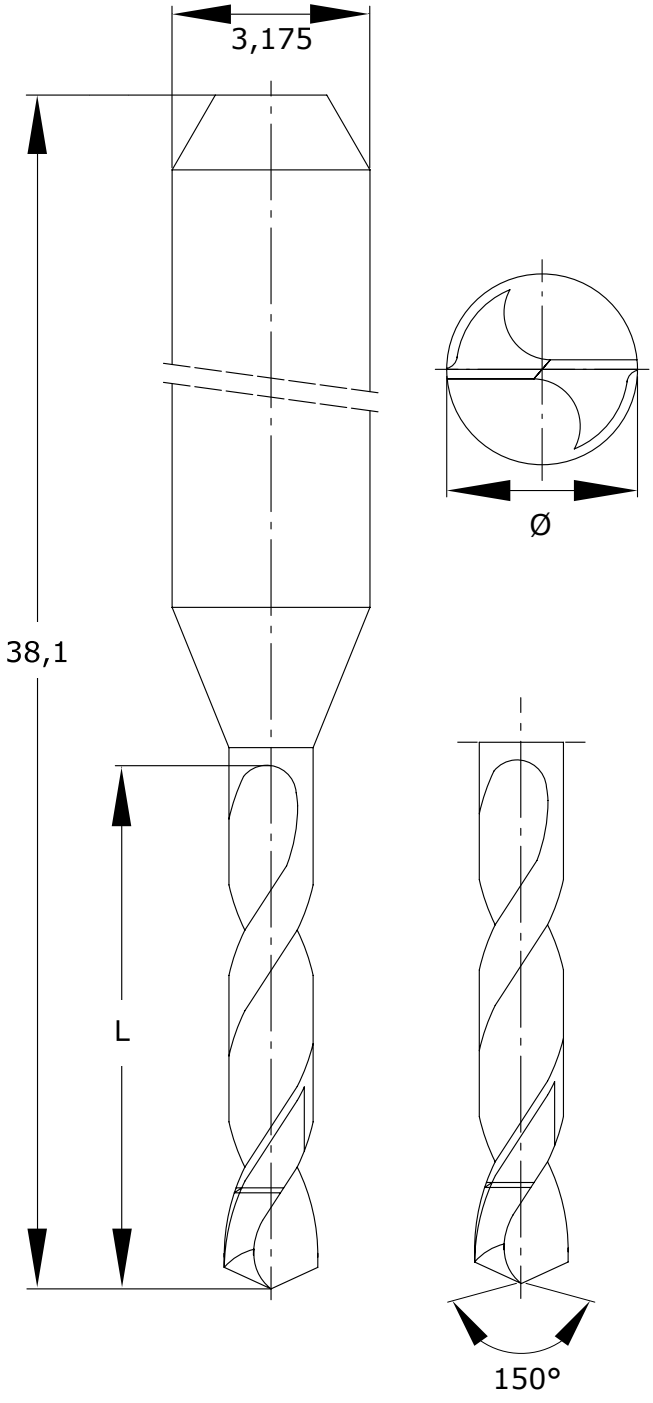
250

Langlochbohrer
Anwendung/Vorteile:

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

Slot drill
Application/Advantages:

- **drilling slots**
- **reduction of deviation**



250	L [mm]					
Ø [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
2,55						x*
:						:
3,00						x*

*weitere Durchmesser und Spirallängen auf Anfrage

*other diameters and flute lengths on request



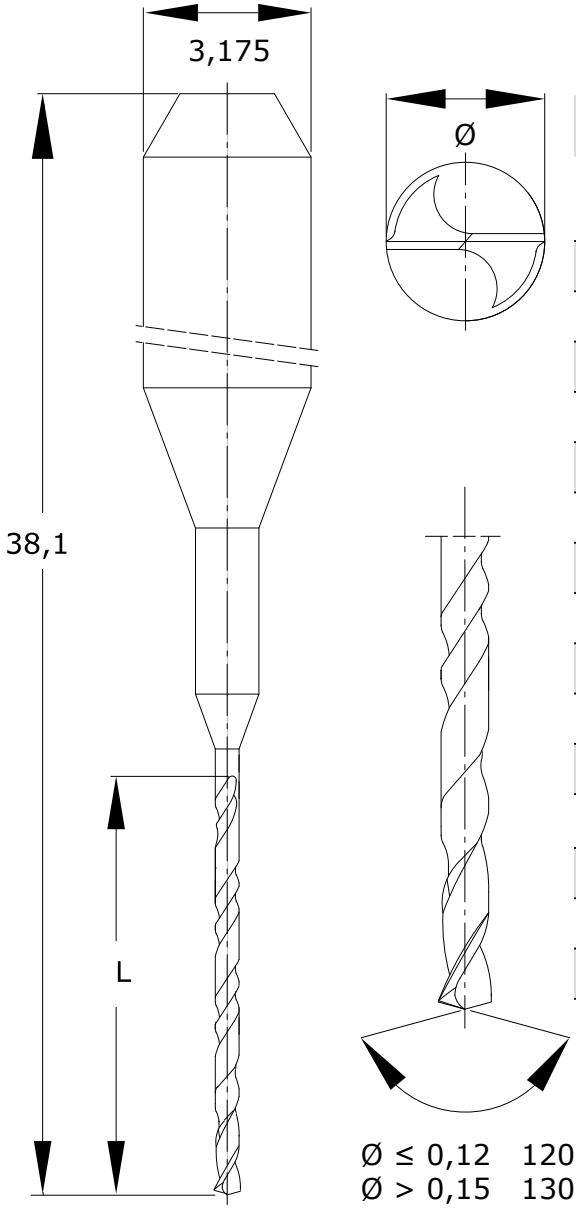
271

Multilayerbohrer, Kopfbohrergeometrie
2-in1-Schneider

Anwendung/Vorteile:
- **Reduzierter Bohrerbruch**
- **Verbesserter Bohrerverlauf**
- **Höchste Bohrlochqualität**
- **geringere Bohrkosten durch mehrmaliges Nachschleifen**

Multilayer drill, spade type version
2-in-1-flute

Application/Advantages:
- **reduce breakage**
- **improved drill deviation**
- **highest hole wall quality**
- **less cost due to several regrinding cycles**



271	L [mm]												
Ø [mm]	1,2	1,8	2,0	2,2	2,5	3,5	4,0	4,5	5,0	5,5	6,5	7,0	7,2	8,5
0,075	x*													
0,105		x												
0,11		x*												
0,12		x*	x	x*										
0,15					x									
0,20						x	x	x*						
0,25							x	x*						
0,30							x	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*		x
0,65												x*		x

* auf Anfrage * on request



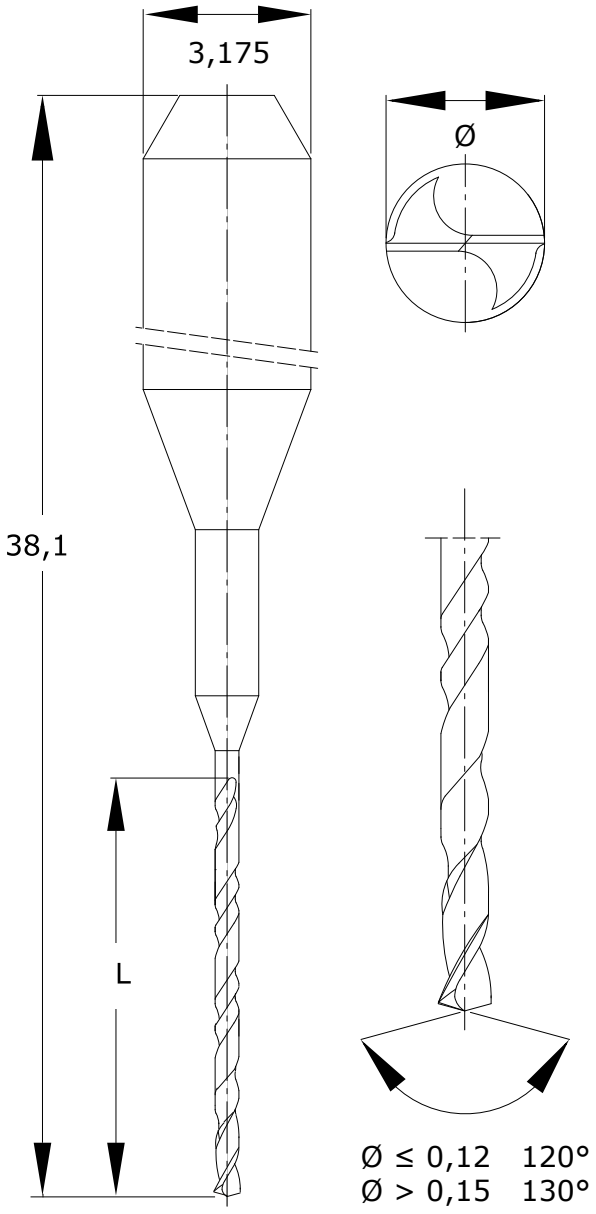
272

Multilayerbohrer, Kopfbohrergeometrie
2-in1-Schneider - beschichtet

Anwendung/Vorteile:
- **Reduzierter Bohrerbruch**
- **Verbesserter Bohrerverlauf**
- **Höchste Bohrlochqualität**
- **geringere Bohrkosten durch mehrmaliges Nachschleifen**

Multilayer drill, spade type version
2-in-1-flute - coated

Application/Advantages:
- **reduce breakage**
- **improved drill deviation**
- **highest hole wall quality**
- **less cost due to several regrinding cycles**



272	L [mm]						
Ø [mm]	0,9	1,2	1,8	2,0	2,5	3,5	4,0
0,050	x						
0,075		x					
0,105			x				
0,11			x				
0,12			x	x*			
0,15					x	x*	
0,20						x	
0,25							x

* auf Anfrage * on request

Neu / New



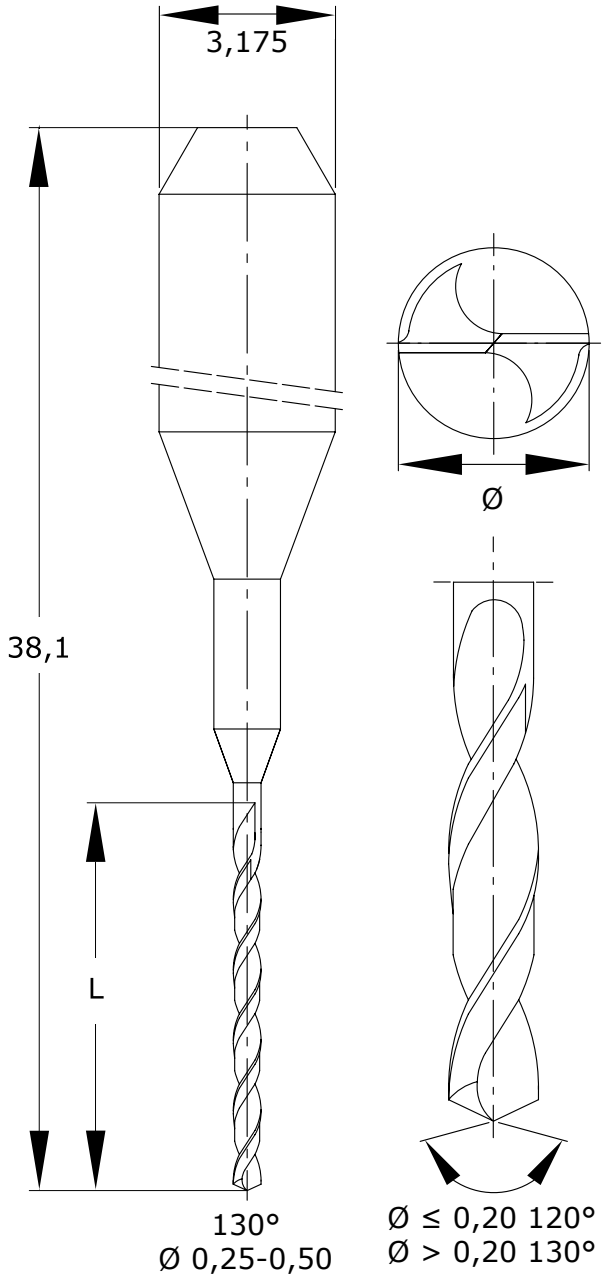
512

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 and burring**



512	L [mm]			
Ø [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



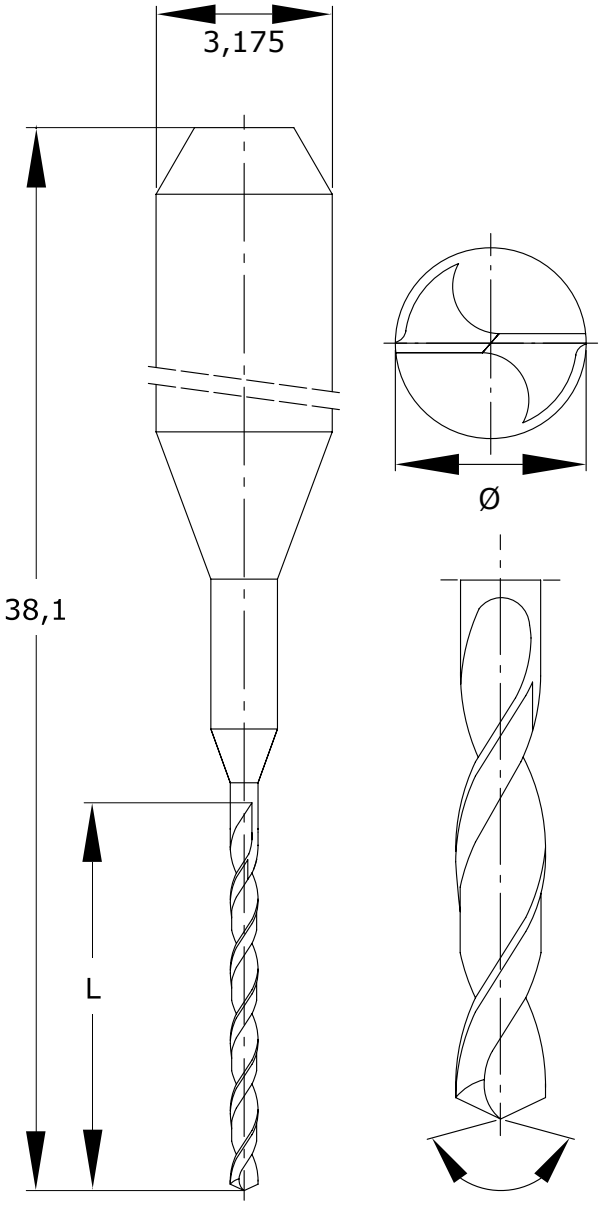
519

Ultramikrobohrer,
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**



519	L [mm]				
Ø [mm]	1,2	1,8	2,0	2,5	3,5
0,075	x				
0,105		x			
0,110		x			
0,120		x	x		
0,150				x	x

Neu / New

- **stabilerer Werkzeugkern**
- **optimierte Hartmetallspezifikation**
- **verbesserter Schleifprozess durch optimierte Schleifscheibenparameter**
- **höhere Bruchstabilität**

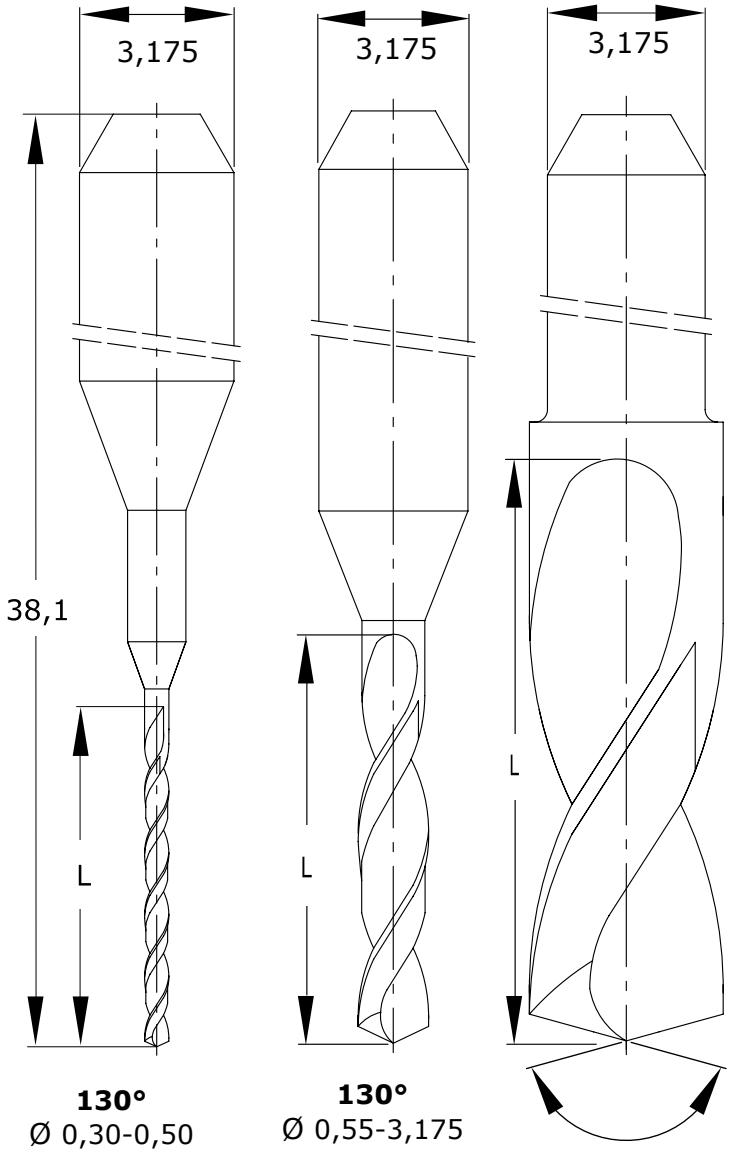
- **more stable tool core**
- **optimized carbide specification**
- **improved grinding process due to optimized grinding wheel parameters**
- **higher breaking strength**



530

Spiralbohrer
Anwendung:
- **für alle Standardprodukte**
- **für Sacklochbohrungen (mit kurzer Spirallänge)**

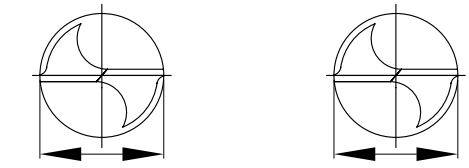
Standard drill
Application:
- **for all standard products**
- **for blind via drilling (with short flute length)**



130°
Ø 0,30-0,50

130°
Ø 0,55-3,175

165°
Ø 3,20-6,35



Ø 0,30-3,175

Ø 3,20-6,35

530	L [mm]				
Ø [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

	L [mm]	
Ø [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

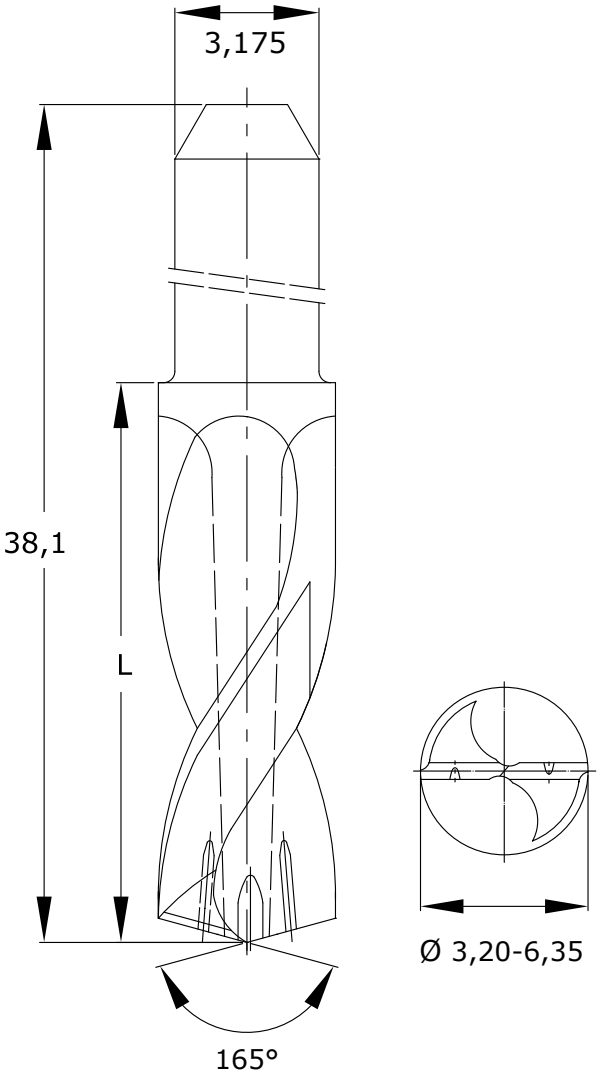
* auf Anfrage
* on request



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	L [mm]
Ø [mm]	12
3,20	x
3,25	x
3,30	x
3,35	x
3,40	x
3,45	x
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.



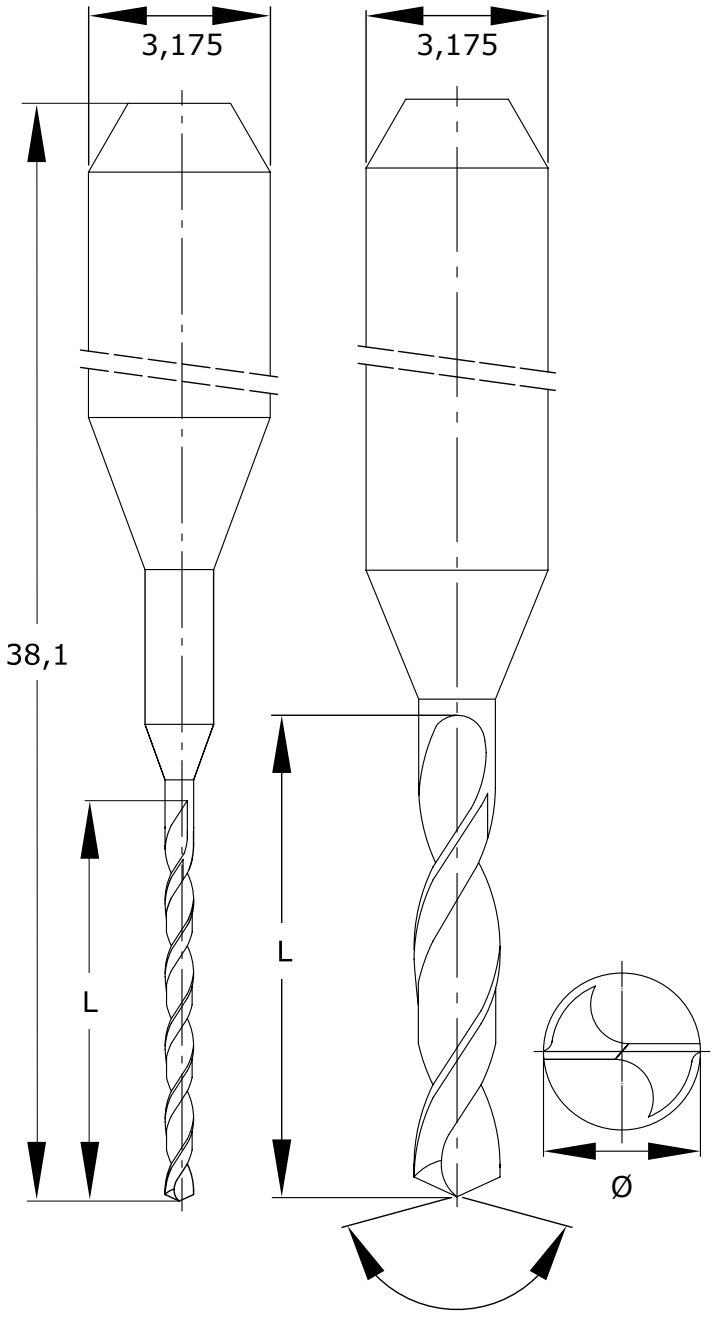
540

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**



Ø≤0,20 **120°**
Ø>0,20 **130°**

130°
Ø 0,55-1,15

540	L [mm]			
Ø [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*

	L [mm]			
Ø [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



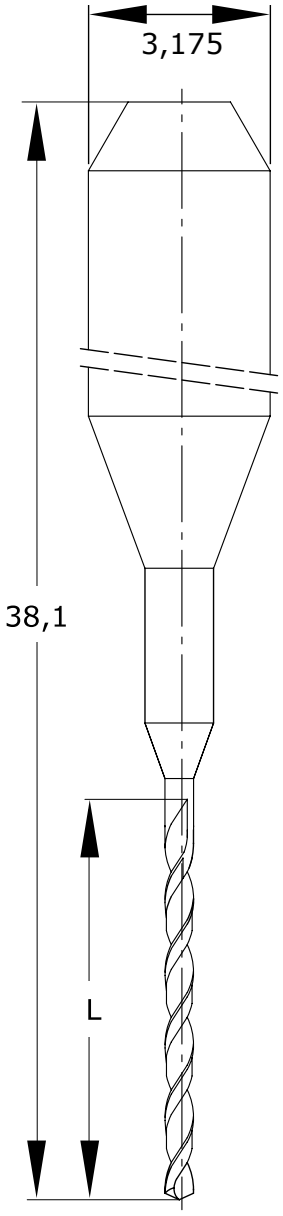
543

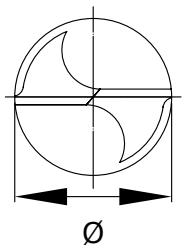
Standardbohrer für Hochfrequenz-anwendungen
Anwendung/Vorteile:

- **Bohren von Teflon, Polyimiden und Rogers-Anwendungen**
- **Verbesserung der Bohrlochqualität**
- **Reduzierung von Nagelkopf- und Gratbildung**
- **geringere Bohrkosten durch mehrmaliges Nachschleifen**

Standard drill for high frequency applications
Application/Advantages:

- **drilling of Teflon, polyimids and Rogers applications**
- **improvement of hole quality**
- **reduction of nail heading and burring**
- **less cost due to several regrinding cycles**





Ø≤0,20 **120°**
Ø>0,20 **130°**

543	L [mm]				
Ø [mm]	3,5	4,5	5,5	6,5	7,0
0,20	x*				
0,25		x*			
0,30			x*		
0,35				x	
0,40					x*
0,45					x*
0,50					x*

* auf Anfrage * on request



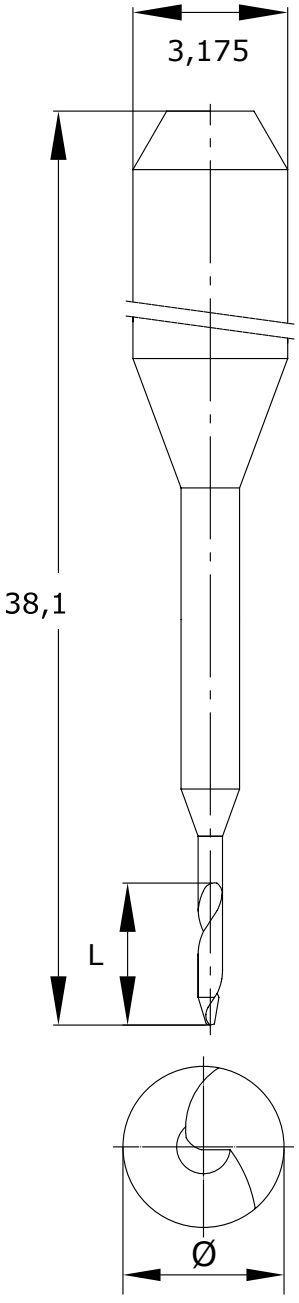
596

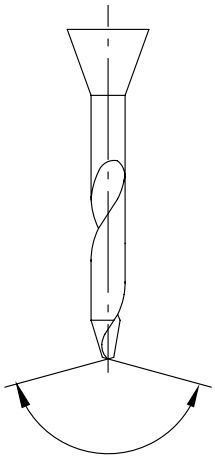
Microvia-Bohrer mit konischem Außendurchmesser
Anwendung/Vorteile:

- **Bohren von Microvias (Sacklöchern)**
- **höchste Lochqualität und Positionsgenauigkeit**
- **Wirtschaftliches Bohren ggü. 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**



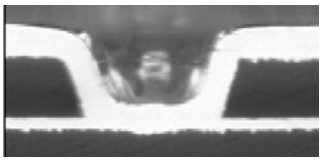


Typ 596 Ø 0,12:
Maximale Bohrtiefe 120 µm
Type 596 Ø 0.12:
Maximum drilling depth 120 µm

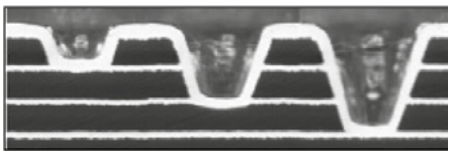
Typ 596 Ø 0,4:
Maximale Bohrtiefe 400 µm
Type 596 Ø 0.40:
Maximum drilling depth 400 µm

596	L [mm]		
Ø [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.

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Survey of HPTec routers / application fields routers

tool type	description	FR 4 oc	FR 4 ic	FR 2	CEM 1 CEM 3	Filled / HTG	Po-lyethy-lene	Teflon	Plexiglas	Polyimi-de	Flex / Rigid Flex	Al	Cu / brass	Metal compo-site laminates	remark
626	diamond-patterned teeth	●	●	●	●	O								O	standard contour router
726 756 790	spiral-patterned teeth	●	●	●	●	O ● ●					O			O	standard contour router good chip transport and edge quality
817 818	1-flute		●	O	O		●	●	●	●	● O	O ●	●	O	very good edge quality, burr-free and for soft and flexible materials
821	2-flute						●	●	●	●	O	○	●	O	excellent edge and surface quality
826 827 828	2-flute		●	O	O	O	●	●	●	●	●	● ● ●	● O ●	O	all-purpose tool for working with plastics and metals
836	3-flute		●	O	O	O	O	O	O	●	O		O	O	for metallised slots
80X	V-groove cutter	●		●	●	●	●	●	●	●	O	●	●	O	good chip transport and edge quality
850	Countersink	●		●	●	●	●	●	●	●		●	●	○	chamfering of PCBs
876	Contour finishing	O		O	O	O	O	O	O	O	O	O	O	●	burr free routing (goldfingers)
891	2-flute	O		O	O		O	O	O	O		●	O	O	good chip transport and edge quality
892	1-flute											O	●	O	good chip transport and edge quality
parameters															
cutting speed v_s [m/min]		190-220		160-180	160-180	110-170	100-120	100-120	110-130	100-120	80-120	200-250	180-220	100-125	Cutting speed and chip load are basic recommendations depending on the material specification. Parameters have to be adjusted accordingly.
Ø [mm]		**oc**	**ic**	**chip load [µm/1]**											
1,0		8	8	10	10	8-12	10	10	20	10	8	3	3	2	
1,2		12	10	14	14	12-16	14	14	30	14	12	5	5	3	
1,6		20	15	25	25	22-26	25	25	40	25	23	8	8	4	
2,0		38	30	45	45	40-48	35	35	50	35	32	12	12	4	
2,4		48	34	55	55	50-60	40	40	60	40	35	15	15	5	

Key:
optimal material = ●
possible alternative = O

ic = inner contour
oc = outer contour

Formula: spindle speed n [rpm]
$n = v_c * 1000 / (3.14 * Ø)$

feed rate F [m/min]
F = f * n
f = F / n [µm/rev]

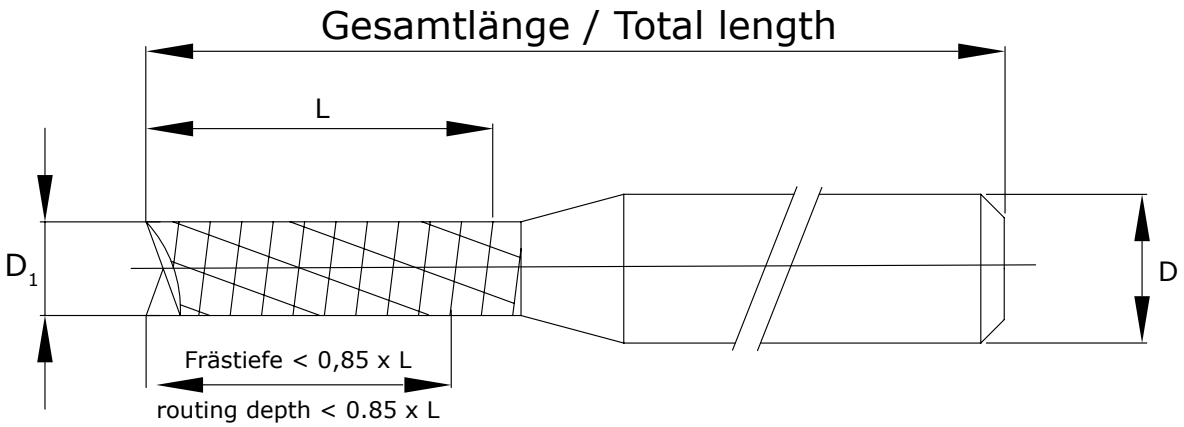
Standardfräser Übersicht / Survey of Standard Routers



	diamant-verzahnt	spiralverzahnt			1-Schneider			2-Schneider					3-Schnei-der	Schlicht-fräser	Ritzstichel						Kegelsenker
	diamond-patterned teeth	spiral-patterned teeth			1-flute			2-flute					3-flute	finishing router	V-groove cutter						Countersink
Ø	626	726	756	790	818	817	892	821	826	828	827	891	836	876	801	802	803	804	806	809	850
in [mm]				"besch. / coated"	"Tiefenfräser/ depth router"		"besch./ coated"	"besch./ coated"		"Tiefenfräser/ depth router"		"besch./ coated"									
0,20									0,7*	0,7*					point angle						point angle
0,25									1*	1*					22°	30°	30°	45°	60°	90°	90/120/140°
0,3									1*	1*											
0,4					1,5			1,5*	1,5*	1,5*											
0,5		3			3			3*	3	3											
0,6		3			3			3*	3	3	3*										
0,7		3,5			3			3*	3	3	3*										
0,8		5	5	3,5*	3			3	5	5	5*										
0,9		5		4*	3				5	5	5*										
1,0	7	7 / 8,5*	7	4*/ 5*/ 6,5*	3	3		3	5	5	5	3 / 4*	5*								
1,1	7	7 / 8,5*		6,5*	3*	3*			5	5	5*	3*	5*								
1,2	7	5*/7/8,5*	7	4* / 7*	4	4			5	5	5	3* / 4*	5*								
1,3	7	7 / 8,5*		7*	4*	4*			5	5	5*	3*	5*								
1,4	7	7 / 8,5*		4* / 7*	4	4*			5	5	5*	3* / 4*	5*								
1,5	8	8,5	8,5	4* / 8,5*	4	4*			6	6	6*	4* / 6	7*								
1,6	8	8,5	8,5	8,5	5	5	4	6	6	6	6	4/6	7*	7*							
1,7	8	8,5		8,5*	5*	5*			6	6	6*	6*	7*								
1,8	8	8,5		4* / 8,5*	5*	5*			6	6	6*	4* / 6*	7*								
1,9	8	8,5		8,5*	5*	5*			6	6	6*	6*	7*								
2,0	8 / 10	9	9	4* / 9	8	8	4	6	8	8	8	4 / 6	9*	7*		x	x	x			
2,1	8	9		9*					8	8	8*	6*	9*								
2,2	8	9		9*					8	8	8*	6*	9*								
2,3	8	9		9*					8	8	8*	6*	9*								
2,4	8 / 10	9	9	9	8	8	6	6	8	8	8	4* / 6	9*	7*	* auf Anfrage				x		
2,5	8	9		9*					8	8	8*	6*	9*		* on request						
3,0	10	9		9	9	9			10	10	10	4* / 6	9*								
3,175	10*	9		9*	9*	9*	6		10	10	10*	6*	9*		x*					x	
6,0																					x

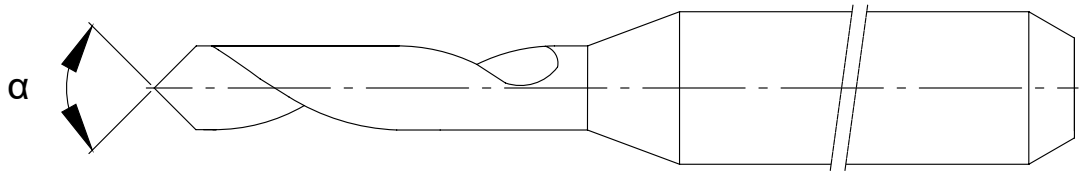
Spezifikation für Fräser 620/624/626

Specification for routers 720/724/726/756/790 801/802/803/804/806/809 817/818/821/826/827/828 836/850/876/891/892

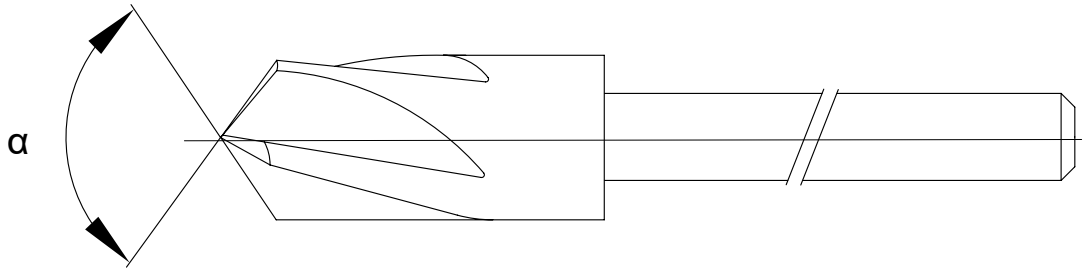


Gesamtlänge / Total Length	**38,2 –0,4**
Spirallänge / Flute Length L	**+0,6 / -0,1**
Schaft- / Shank-Ø D	**-0,001/-0,007**
Nenn- / Nominal-Ø D1 wenn / if D1 = D Typ / Type 836	**+0,01/-0,02 0/-0,04 +0,01/-0,03**
Schneidenschartigkeit / Roughness	**≤ 0,006**
Ausbrüche / Chips	**≤ 0,030 max. 10 % der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

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



Typ / Type 850:





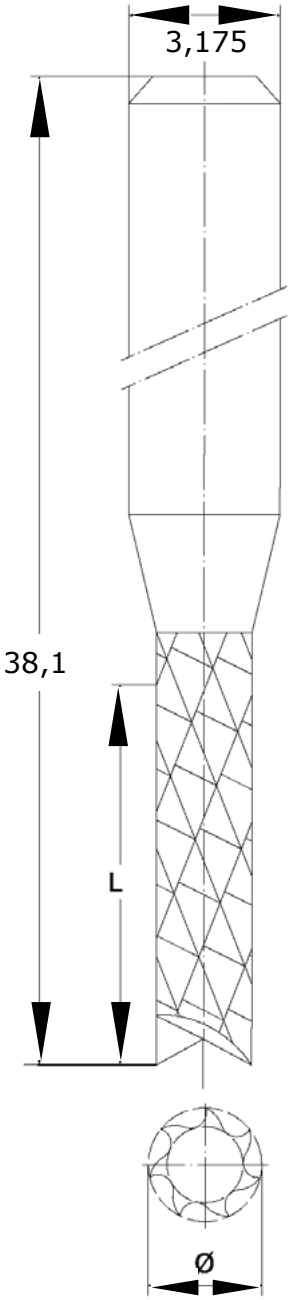
626
624
620

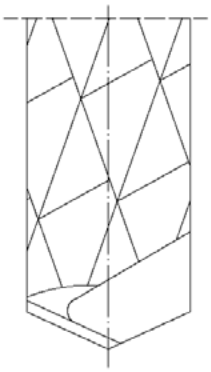
Fräser mit Diamantverzahnung
Anwendungen/Vorteile:

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

Router with diamond-patterned teeth
Applications/Advantages:

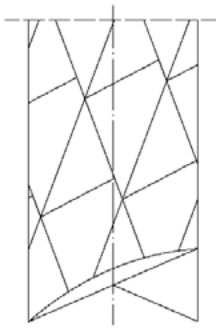
- **standard router for inner and outer contours**
- **glass-epoxy based materials**





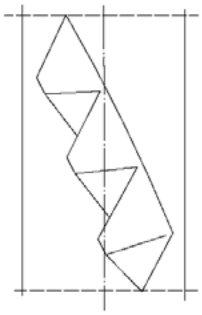
Bohrspitzen-anschliff

drill point cut

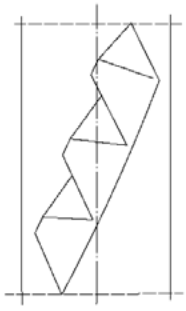


Fischschwanz-anschliff

fishtail cut



linksspiralig
left twisted
(Schnittdruck nach unten)
(down cut)



rechtsspiralig
right twisted
(Schnittdruck nach oben)
(up cut)

626	L [mm]		
Ø [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*

*auf Anfrage *on request

626 Fischschwanzanschliff rechtsspiralig — fishtail cut up cut (right twisted)

624 ***Bohrspitzenanschliff rechtsspiralig — drill point cut up cut (right twisted)

620 ***Fischschwanzanschliff linksspiralig — fishtail cut down cut (left twisted)



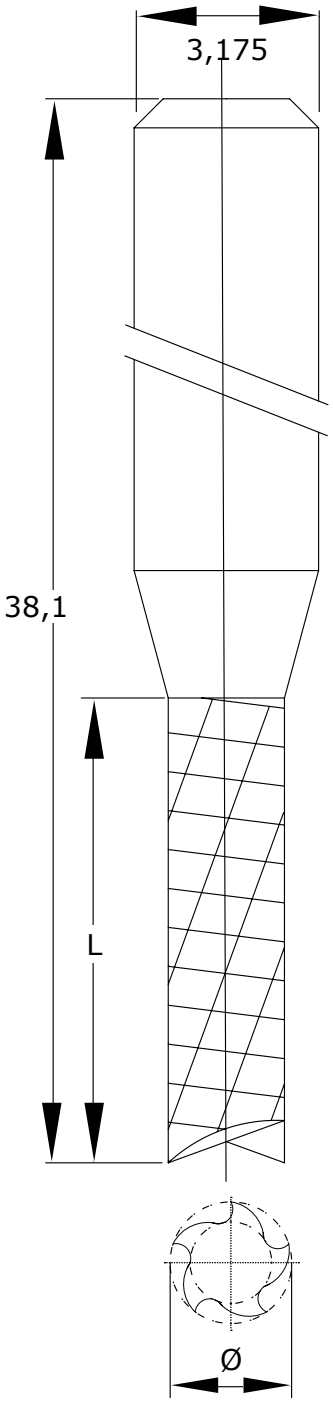
726
724
720

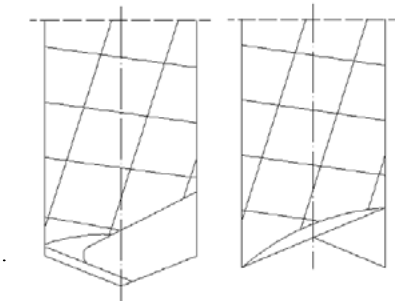
Fräser mit Spiralverzahnung
Anwendungen/Vorteile:

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

Router with spiral-patterned teeth
Applications/Advantages:

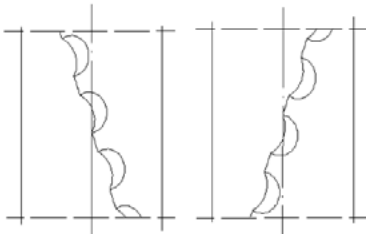
- **standard router for inner and outer contours**
- **all kind of glass-epoxy**
- **based materials**
- **excellent chip transport and surface finish**





Bohrspitzen-anschliff
drill point cut

Fischschwanz-anschliff
fishtail cut



linksspiralig
left twisted
(Schnittdruck nach unten)
(down cut)

rechtsspiralig
right twisted
(Schnittdruck nach oben)
(up cut)

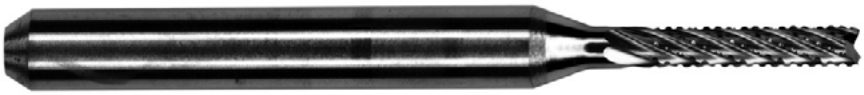
726 Fischschwanzanschliff
rechtsspiralig
fishtail cut
up cut (right twisted)

724* Bohrspitzenanschliff
rechtsspiralig
drill point cut
up cut (right twisted)

720* Fischschwanzanschliff
linksspiralig
fishtail cut
down cut (left twisted)

726	L [mm]					
Ø [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	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



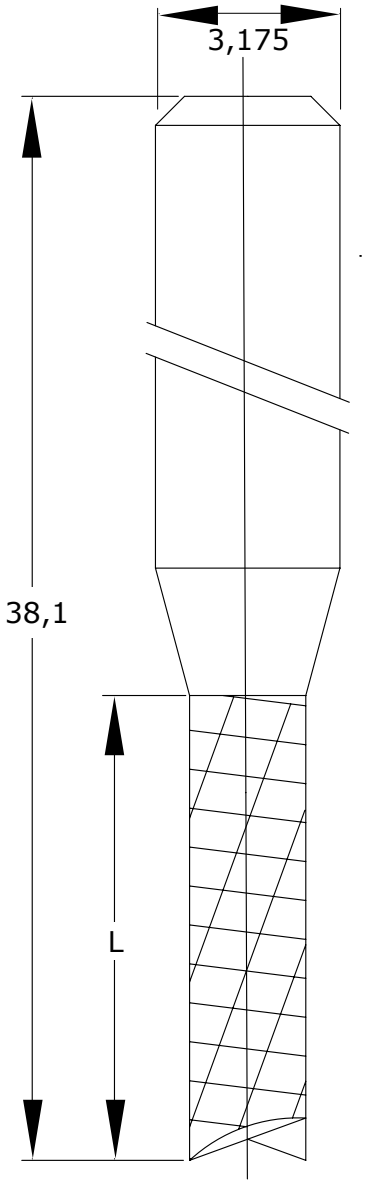
756

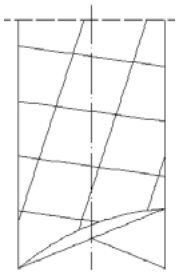
Fräser mit Spiralverzahnung
Anwendungen/Vorteile:

- **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:

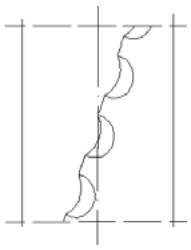
- **high performance router for inner and outer contours**
- **all kind of glass-epoxy based materials, HTG, filled materials**
- **excellent chip transport and surface finish**





756 Fisch-schwanz-anschliff

fishtail cut



rechtsspiralig
right twisted

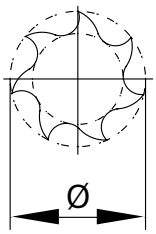
(Schnittdruck nach oben)

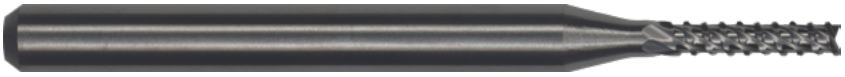
(up cut)

756 L [mm]				
Ø [mm]	5,0	7,0	8,5	9,0
0,8	x			
1,0		x		
1,2		x		
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





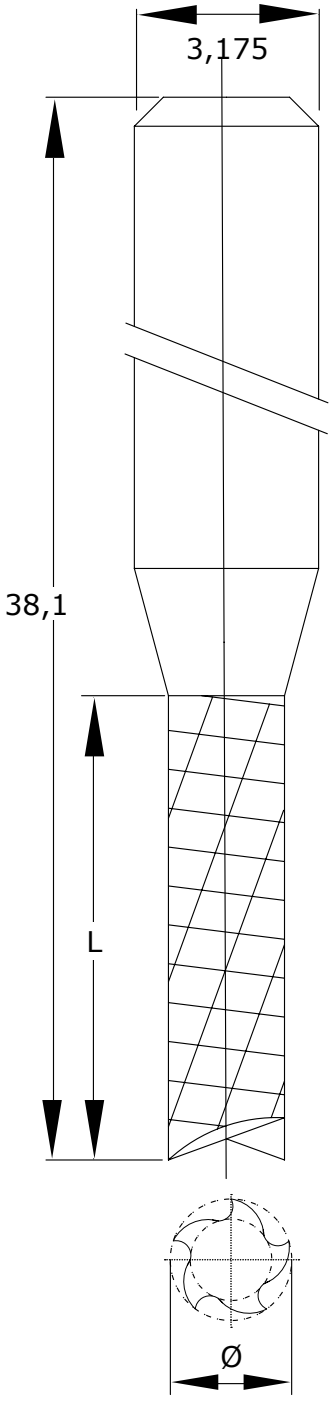
788

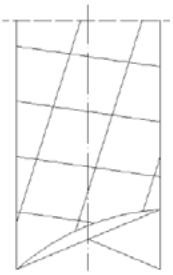
Fräser mit Spiralverzahnung und eckigen Spanbrecher
Anwendungen/Vorteile:

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

Router with spiral-patterned teeth and angular chip breaker
Applications/Advantages:

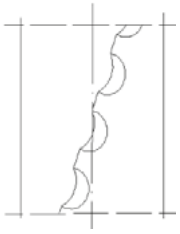
- **standard router for inner and outer contours**
- **all kind of glass-epoxy**
- **based materials**
- **excellent chip transport and surface finish**





Fischschwanz-anschliff

fishtail cut



rechtsspiralig
right twisted
(Schnittdruck nach oben)
(up cut)

788					
Ø [mm]	5,0	6,0	7,0	8,5	10,5
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	
2,0					x
2,1					x
2,2					x
2,3					x
2,4					x
2,5					x



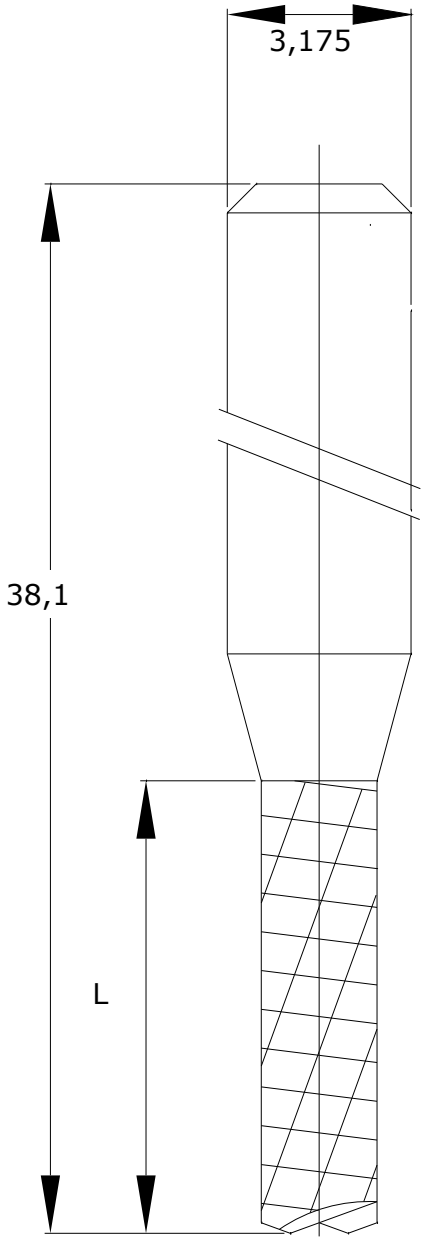
790

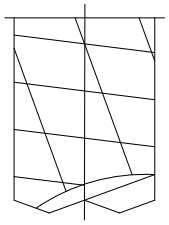
Diamantbeschichteter Fräser aus Vollhartmetall mit Spiralverzahnung
Anwendungen/Vorteile:

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

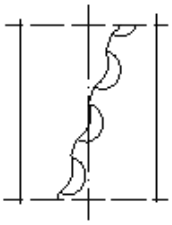
Diamond coated router made of solid carbide with spiral-patterned teeth
Applications/Advantages:

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



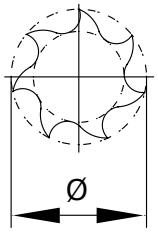


790
M-Anschliff
M-cut



rechtsspiralig
right twisted

(Schnittdruck nach oben)
(up cut)



790	L [mm]						
Ø [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

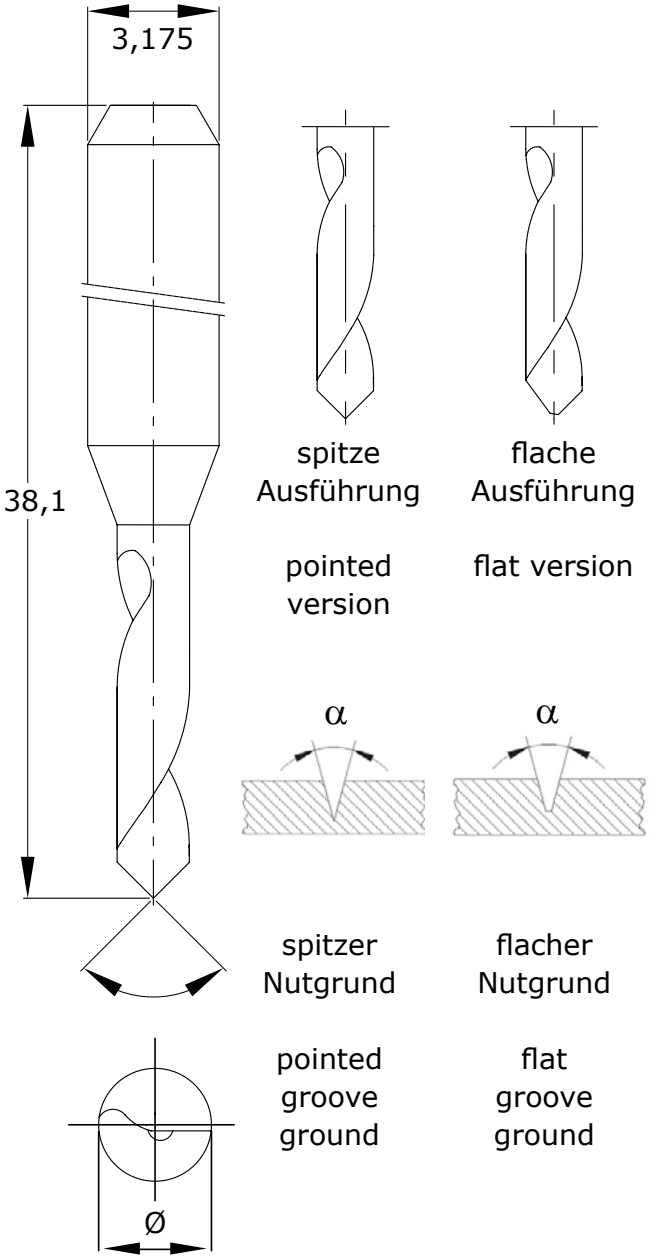
801
803
804
806
809

Frässtichel mit einer Spiralnut
Anwendungen/Vorteile:

- **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/Advantages:

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



	α				
Ø [mm]	22°	30°	45°	60°	90°
2,0		x	x		
2,4				x	
3,175	x*				x
Stan-dard	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



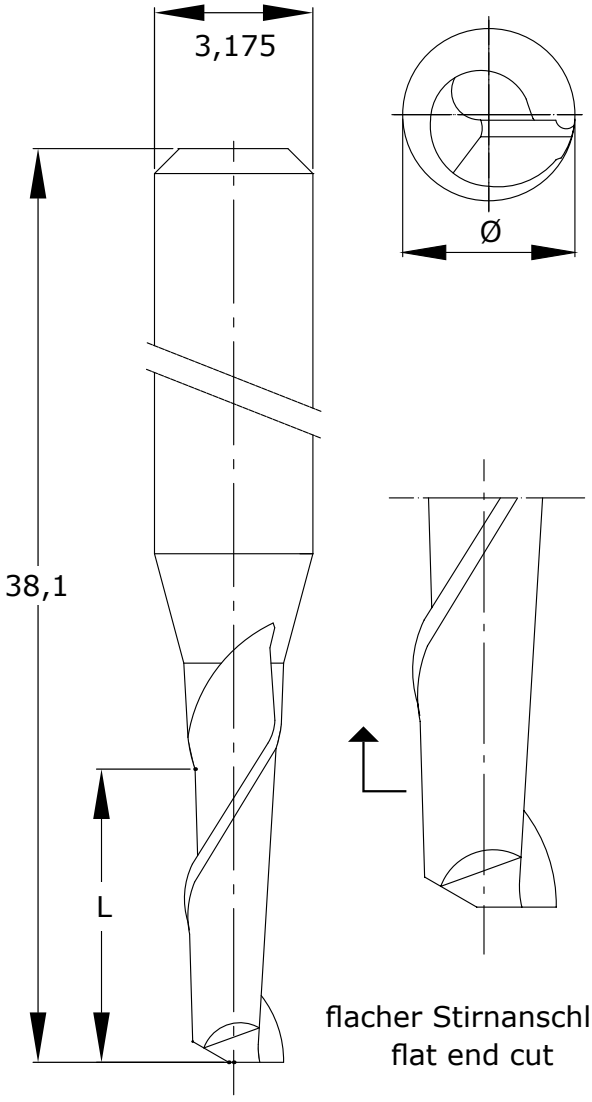
817

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**



flacher Stirnanschliff
flat end cut

rechtsspiralig
right twisted

(Schnittdruck nach oben)
(up cut)

817	L [mm]				
Ø [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

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



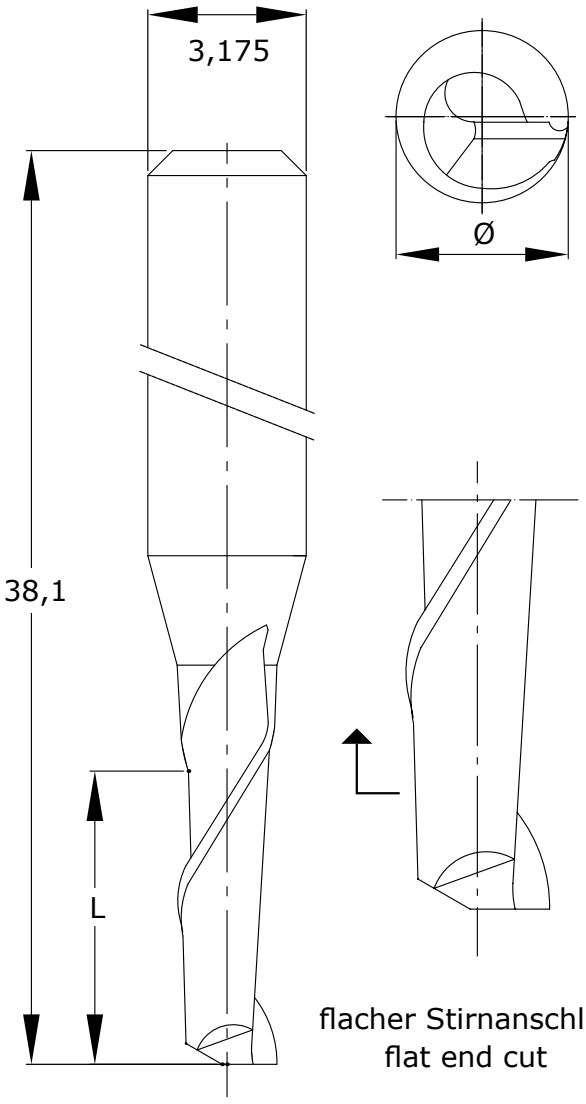
818

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**



flacher Stirnanschliff
flat end cut

rechtsspiralig
right twisted

(Schnittdruck nach oben)
(up cut)

818	L [mm]					
Ø [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

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



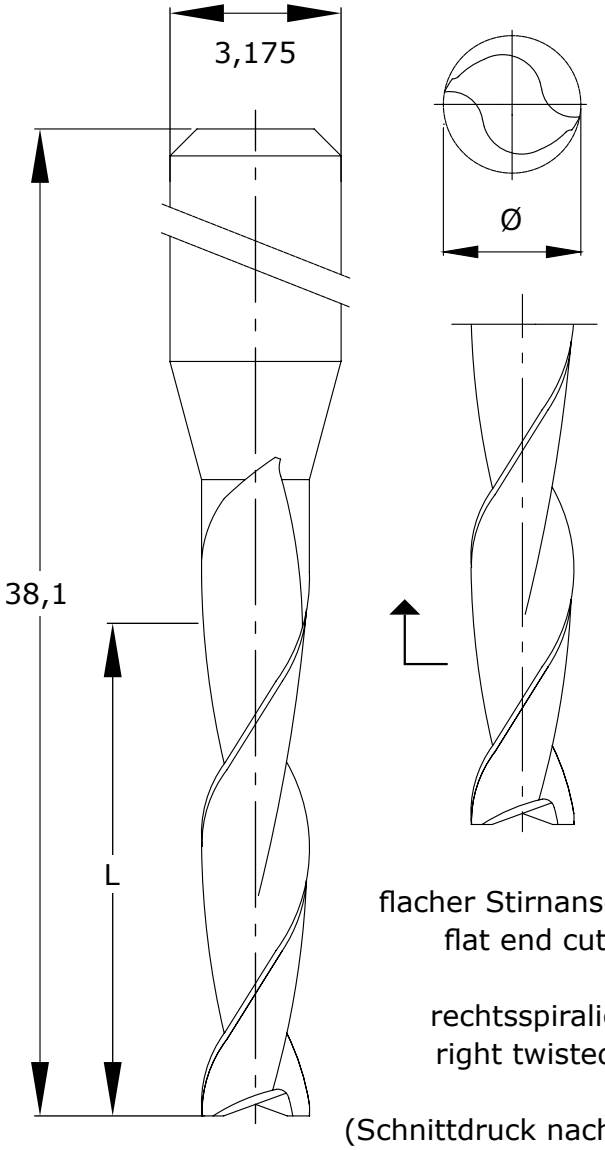
821

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	L [mm]		
Ø [mm]	1,5	3,0	6,0
0,40	x*		
0,50		x*	
0,60		x*	
0,70		x*	
0,80		x	
1,00		x	
1,60			x
2,00			x
2,40			x

*weitere Durchmesser auf Anfrage
*other diameters on request

flacher Stirnanschliff
flat end cut

rechtsspiralig
right twisted

(Schnittdruck nach oben)
(up cut)

821 flacher Stirnanschliff
rechtsspiralig
beschichtet

flat end cut
up cut (right twisted)
coated

status 10.2023 technische Änderungen vorbehalten | Subject to technical alterations



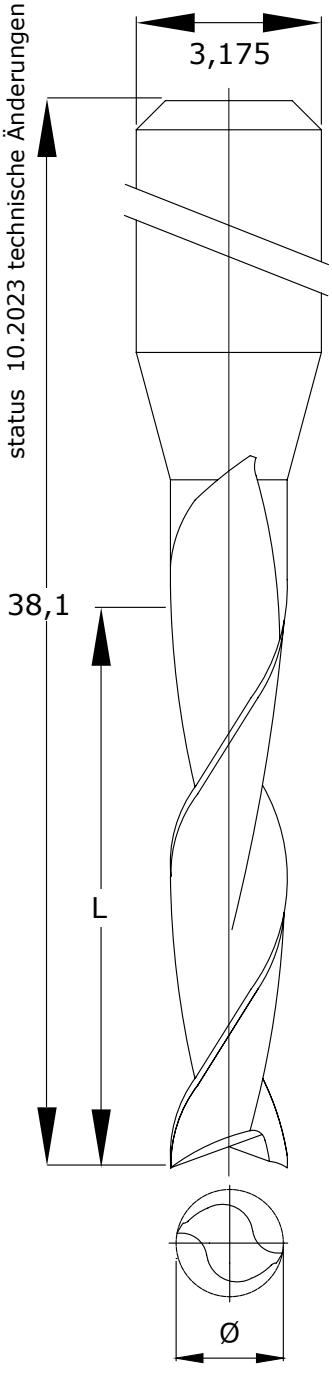
826
828

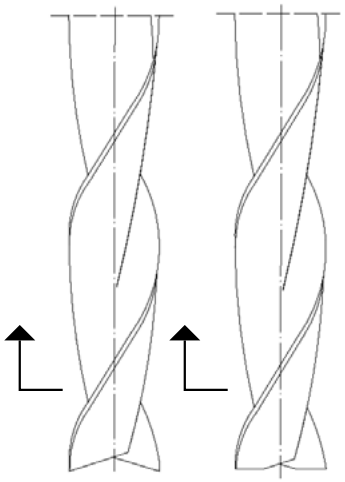
Fräser mit 2 Hauptschneiden
Anwendungen/Vorteile:

- **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**





Fisch-schwanz-anschliff
fishtail cut

flacher Stirn-anschliff
flat end cut

rechtsspiralig
right twisted

(Schnittdruck nach oben)
(up cut)

826
Fischschwanzanschliff
rechtsspiralig
fishtail cut
up cut (right twisted)

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

826	L [mm]							
Ø [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

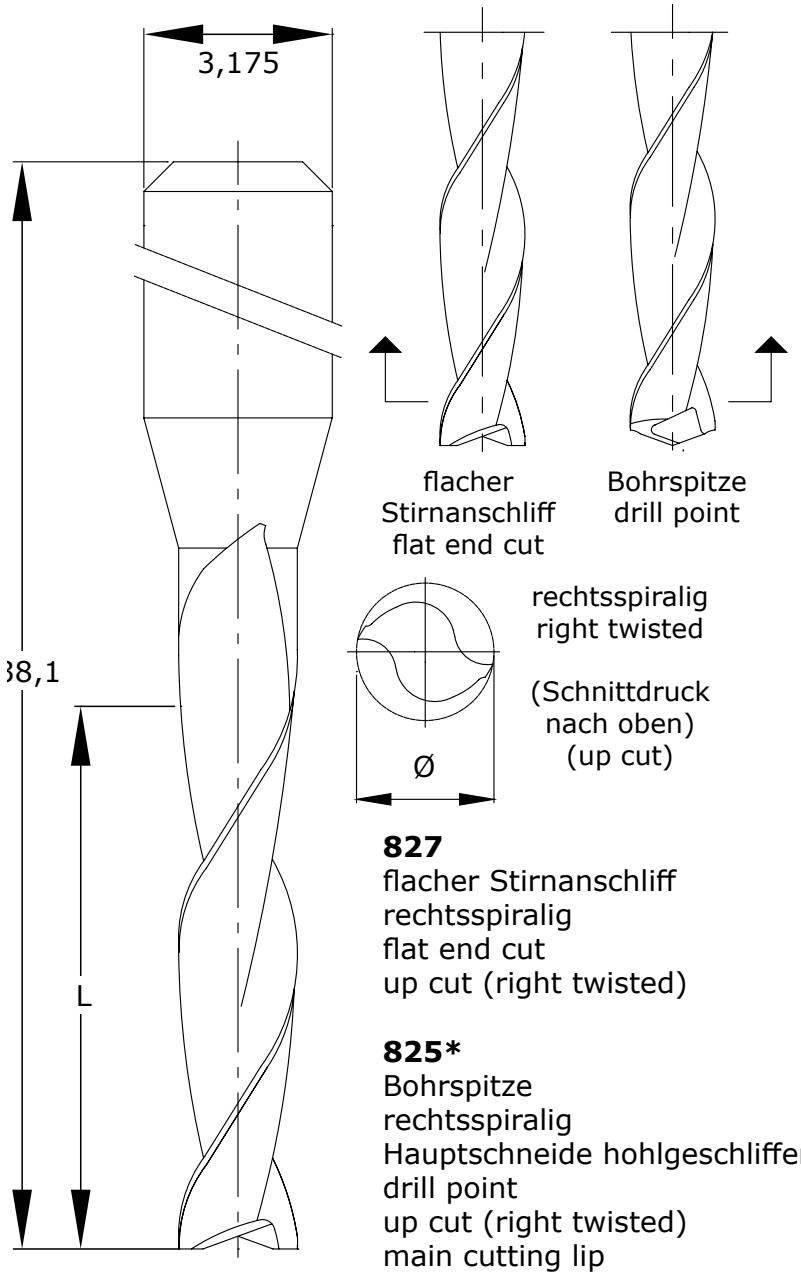
* auf Anfrage * on request



827
825

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**



827
flacher Stirnanschliff
rechtsspiralig
flat end cut
up cut (right twisted)

825*
Bohrspitze
rechtsspiralig
Hauptschneide hohlgeschliffen
drill point
up cut (right twisted)
main cutting lip
hollow-grounded

827	L [mm]				
Ø [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



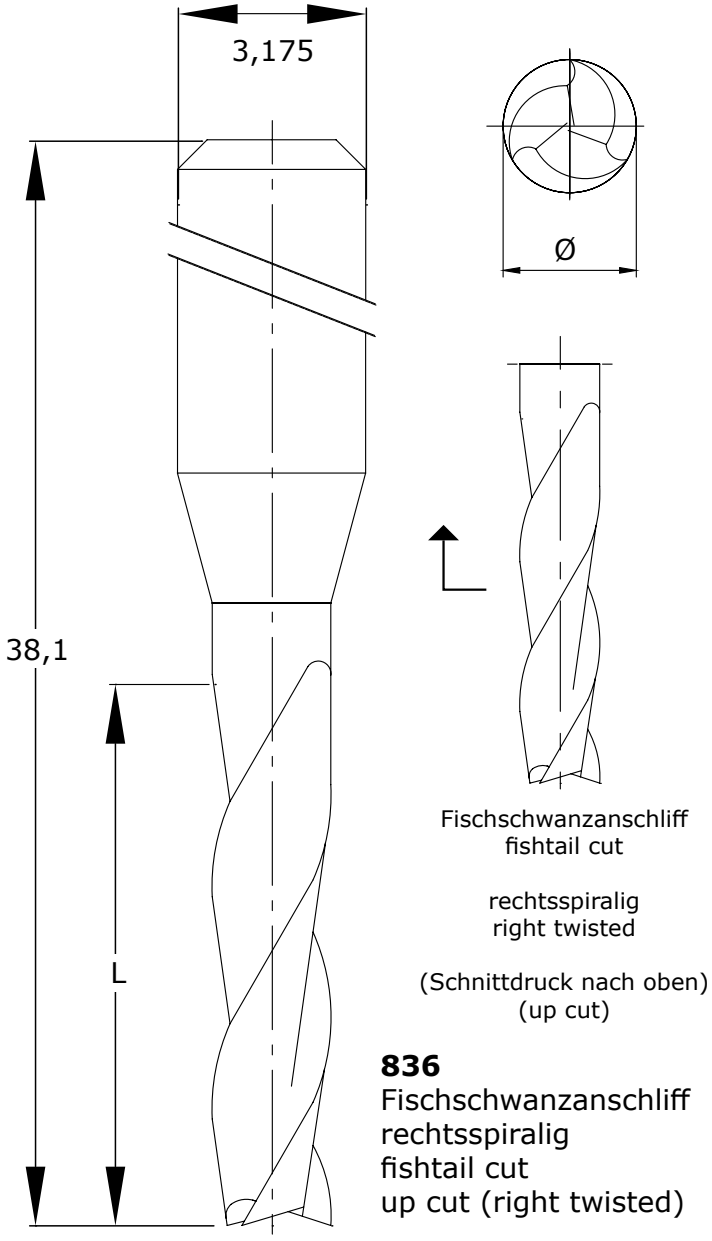
836

Fräser mit 3 Hauptschneiden
Anwendungen/Vorteile:

- **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/Advantages:
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**



Fischschwanzanschliff
fishtail cut

rechtsspiralig
right twisted

(Schnittdruck nach oben)
(up cut)

836
Fischschwanzanschliff
rechtsspiralig
fishtail cut
up cut (right twisted)

836	L [mm]		
Ø [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



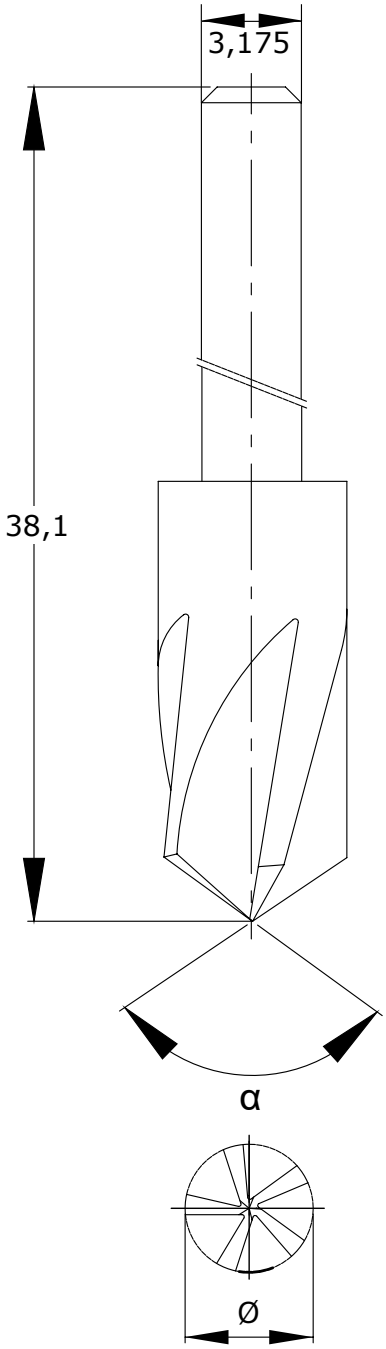
850

Kegelsenker mit 5 Schneiden

Anwendungen/Vorteile:
- **Senken von Bohrungen**
- **Anfasen von Leiterplatten**

Countersink with 5 flutes

Applications/Advantages:
- **countersinking of drill holes**
- **chamfering of circuit boards**



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

Bemerkung:
Andere Spitzenwinkel /
Durchmesser auf Anfrage.

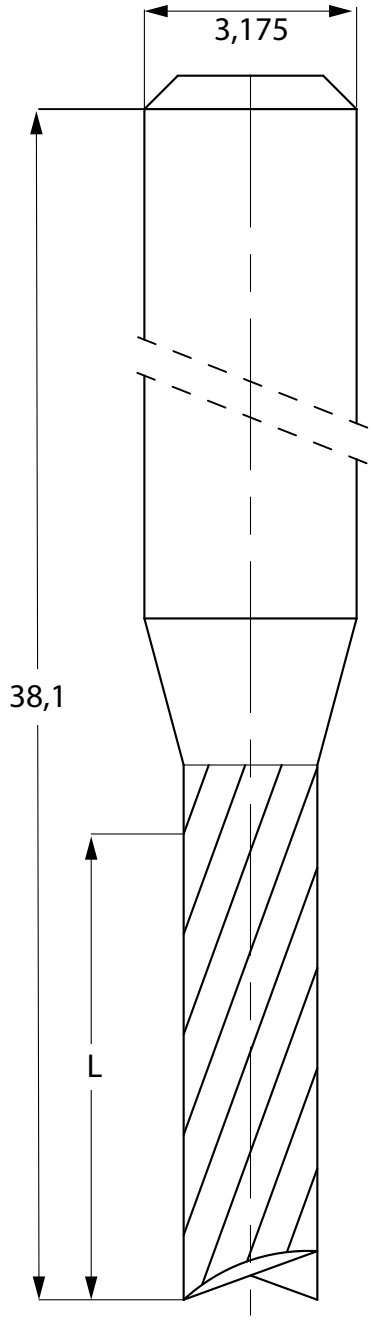
Remark:
Other point angles /
diameters on request.

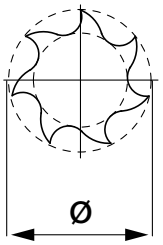


876
870

Schlichtfräser
Anwendungen/Vorteile:
- **gratfreies Fräsen von Galvanoanbindungen (Goldfingers) und Metalloberflächen**

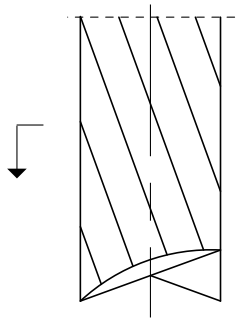
Contour finishing router
Applications/Advantages:
- **burr-free routing of metal surfaces (goldfingers) and metal composite laminates**



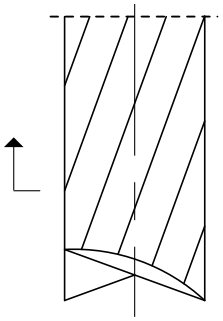


876	L [mm]
Ø [mm]	7,0
1,6	x*
2,0	x*
2,4	x*

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



870
Fischschwanzanschliff
linksspiralig
fishtail cut
down cut (left twisted)



876
Fischschwanzanschliff
rechtsspiralig
fishtail cut
up cut (right twisted)



891

Diamantbeschichteter Fräser aus Vollhartmetall mit 2 Hauptschneiden

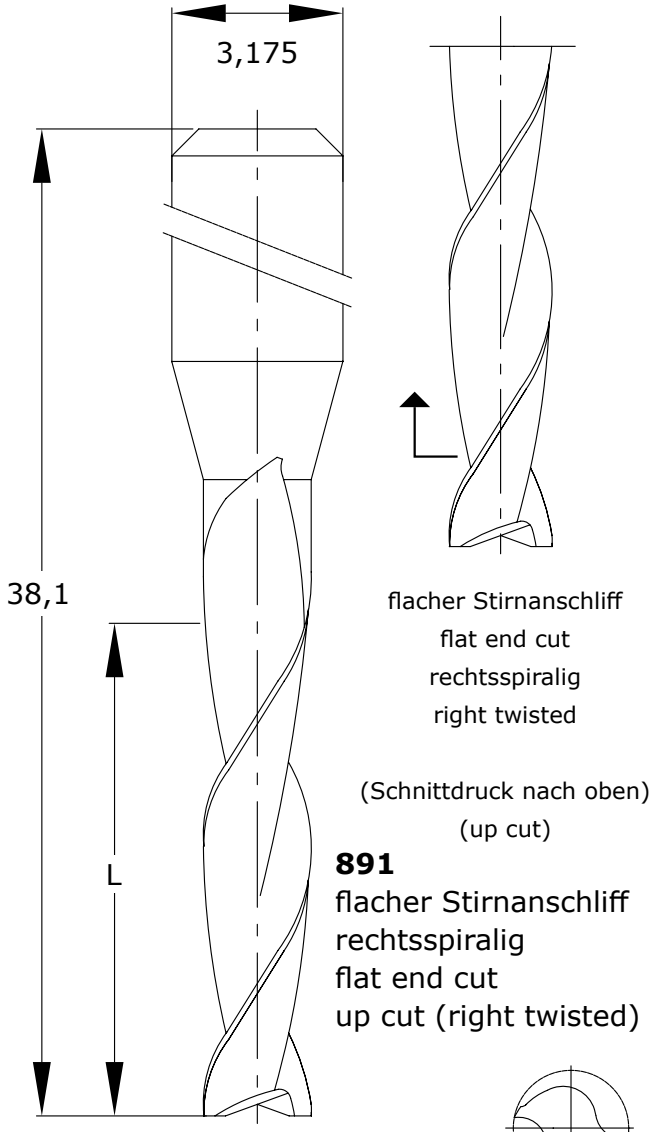
Anwendungen/Vorteile:

- **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:

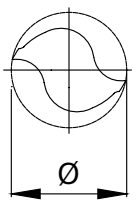
- **inner contours/slots with high quality demands**
- **routing aluminium (dry), copper and GRP with ceramic fillers**
- **excellent chip transport**
- **depth routing possible**



flacher Stirnanschliff
flat end cut
rechtsspiralig
right twisted

(Schnittdruck nach oben)
(up cut)

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



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

* auf Anfrage * on request



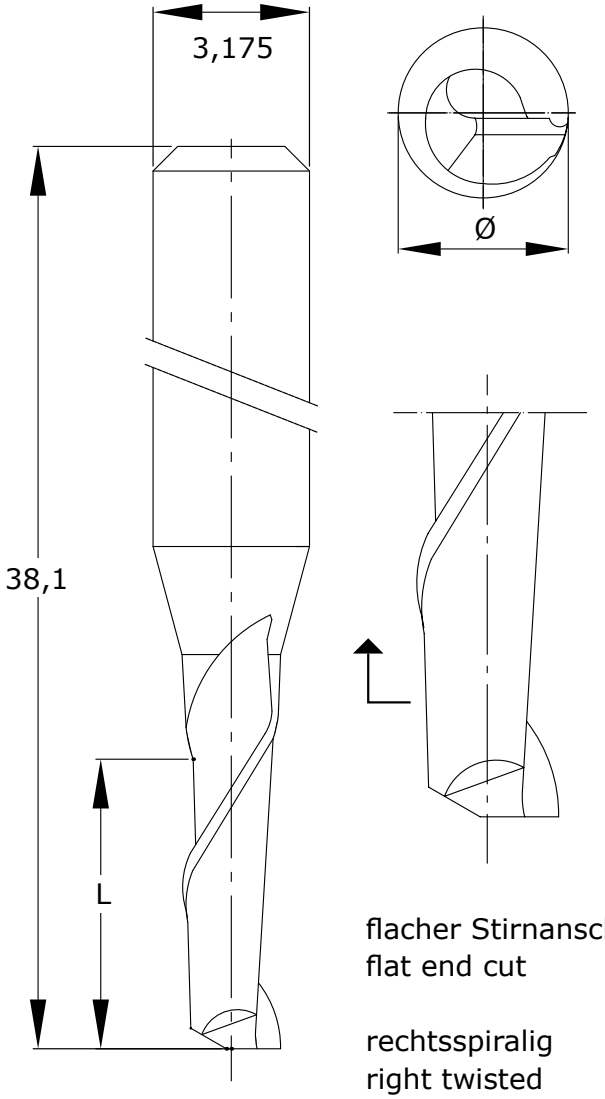
892

Diamantbeschichteter Fräser aus Vollhartmetall mit einer Hauptschneide
Anwendungen/Vorteile:

- **Innenkonturen,/Außenkonturen mit sehr hohen Qualitätsanforderungen**
- **Geeignet zum Fräsen von Kupfer, Kupfer mit keramischen Füllstoffen sowie weiteren Knetlegierungen**
- **sehr guter Spantransport**
- **Tiefenfräsungen möglich**

Diamond coated 1-flute router made of solid tungsten carbide
Application/Advantages:

- **inner and outer contours with very high quality demands**
- **routing copper and copper with ceramic fillers as well as wrought alloy**
- **excellent chip transport**
- **depth routing possible**



flacher Stirnanschliff
flat end cut

rechtsspiralig
right twisted

(Schnittdruck nach oben)
(up cut)

892	L [mm]	
Ø [mm]	4,0	6,0
1,6	x	
2,0	x	
2,4		x
3,175		x

* auf Anfrage * on request

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

Parameter Recommendation for Drills

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

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

Parameter Recommendation for Slot Drills

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

Diameter = D [mm]
Chip Load = f[µm/1]
Spindle Speed = n [rpm]
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

Customer HPTec Standard **Material[1]: FR 4** **Spindle Type: Air Bearing** **Tool Type: 726/756**	**Cutting Speed** v_C**=220[m/min]** **Spindle Speed[1]** n_{max}**=60000 [rpm]**

Diameter = **D**[mm]
Chip Load = **f**[µm/1]
Infeed with / without pre-drilling = **F(Z)** [m/min]
max. stack height = **H** [mm]

Table feed = **F(XY)** [m/min]
Spindle Speed = **n** [rpm]
Retract Feed = R [m/min]

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 vs:

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

v_c = 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: $n = \frac{v_c}{D * \pi} * 1000$

Example:

Given data:

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

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

> chosen spindle speed: n = 68000 rpm

> **feed rate** $F = \frac{(0,55mm/rev * 68000 rpm)}{1000} = 3,74$ m/min

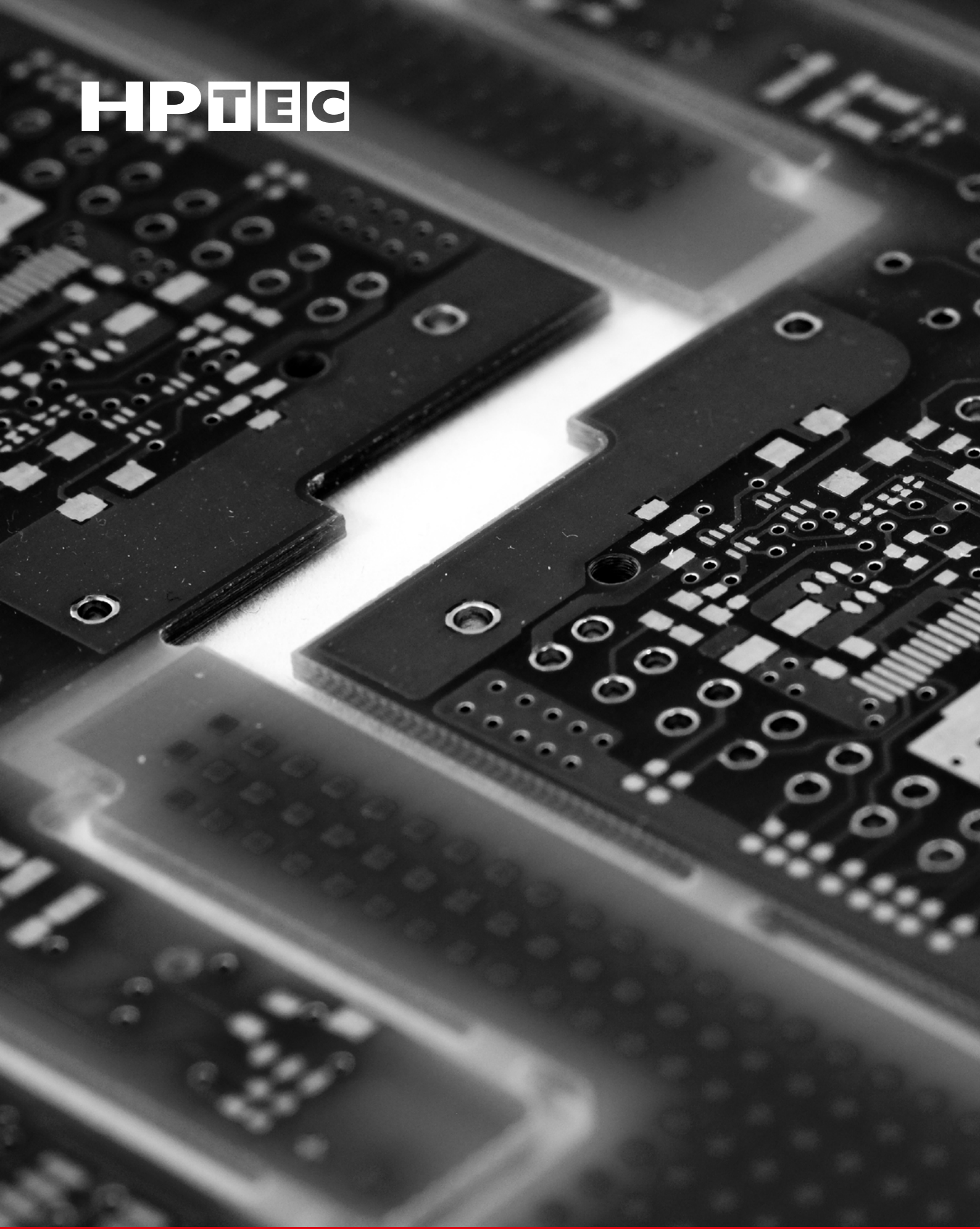
> chosen feed rate: F = 3,7 m/min

Trouble Shooting

Problem	Possible Causes	Remedy
drill breakage	- chips jam in flute space	- use drills suitable for the specific cutting conditions (geometry), check extraction system/parameters
	- cutting pressure too high	- adapt feed rate
	- spindle run-out error	- check spindle run-out
	- dirty/defect collet	- clean/replace collet
	- drill deviation	- minimising of drill deviation
	- chipping on cutting edges	- ensure correct tool handling
inaccurate drill hole positioning (drill deviation)	- flute length too long	- adapt flute length
	- spindle run-out error	- check spindle run-out
	- dirty/defect collet	- clean/replace collet
	- pin hole inaccurate	- check pin hole
	- drill wear too high or chipping on cutting edges	- reduce hit counts/ no. of regrinding operations, check cutting conditions, check tool handling
poor surface quality of hole wall	- smear caused by inefficient chip removal	- improve chip removal by a) improved extraction system b) use tools with suitable geometry (spade type drills) c) modification of parameters
	- drill wear too high or chipping on cutting edges	- reduce hit counts/ no. of regrinding operations, check cutting conditions, check tool handling
	- board material insufficiently hardened	- check quality of the laminate (multilayer pressing conditions)
nail heading	- feed rate/retraction rate too high or too low	- adapt feed rate/retraction rate
	- wrong cutting parameters	
	- drill wear too high or chipping on cutting edges	- adapt cutting conditions to the laminate used
		- reduce hit count/ no. of regrining operations, check cutting conditions, check tool handling
	- dwell time of drill at cusp too long	- reduce dwell time

Trouble Shooting

Problem	Possible Causes	Remedy
smear of resin	- excessive drilling temperatures - laminate insufficiently hardened - drill wear too high or chipping on cutting edges - insufficient de-smear process	- increase feed rate, reduce cutting speed - check laminate - reduce hit count/ no. of regrin ing operations, check cutting conditions, check tool handling - check de-smear process
burr on entry and/or exit side	- drill wear too high or chipping on cutting edges - feed rate/retraction rate too high - entry/backup material too soft - pressure foot power insufficient	- 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	- wrong cutting parameters - drill wear too high or chipping on cutting edges - pressure foot power insufficient - entry/backup material too soft - poor laminate bond	- use recommended parameters - reduce hit count/ no. of regrin- ing operations, check cutting conditions, check tool handling - increase pressure foot power - use harder entry/backup material - check pressing procedure
deformation of inner layers	- chips jam in flute space - drill wear too high or chipping on cutting edges - poor laminate bond	- use drills suitable for the speci fic cutting conditions (geome- try), check extraction system/ parameters - reduce hit count/no. of regrin- ding operations, check cutting conditions, check tool handling - check pressing procedure
winding of chips on drill	- insufficient chip extraction - feed rate too low (chips get too long)	- clean and check extraction system, if necessary use more powerful extraction system - increase feed rate



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