

GÜHRING

GÜHRING HIGH-PERFORMANCE TOOLS FOR
MACHINING FIBRE COMPOSITE MATERIALS

- without fraying of fibres and delamination
- for optimal component surface finish quality



Machining modern composite materials

GÜHRING – YOUR WORLDWIDE PARTNER

Pictograms

Tool material	VHM	PKD							
	Solid carbide	Polycrystalline diamond							
Surface finish		C	D						
	bright	TiCN	Cristall						
Ø-tolerance	e10	h6	h7	h8	m7				
Shank form	HA	Cyl							
	to DIN 6535								
Standard	DIN 6539	~DIN 371	DIN 371	WN					
	to Guhring std.								
Type	H	N	NR15	W	FK	CR 100	FR 100	TM SP	MTM3 SP
Form	C	D							
Hole type									
	Through holes and blind holes								
Cutting direction	R								
	right-hand								
Applications									
	slotting	roughing	ramping	Helix	drilling	finishing	copying		
Lenght									
	long (DIN)	medium length							
No. of cutting edges	2	3	4	4-8					
	no. of cutting lips								
Web thinning									
Helix angle	0°	2-4°	4°	10°	30°				
	size of helix angle / no. of different helix angles								
Rake angle	10°	15°	25°						
	rake angle of circumferential cutting edges								
Infeed									
	for lateral infeed	for lateral infeed and ramping		for lateral infeed, ramping and drilling					
Point angle	90°	120°							

MACHINING MODERN COMPOSITE MATERIALS

Modern fibre reinforced plastics (FRP's) are making an entry into a broad range of industrial applications for reasons of efficiency, weight reduction, strength and dynamics. With their specific properties they extend the group of conventional metal lightweight construction materials such as aluminium- and titanium-alloys. FRP's or multi-material combinations, ie. a mixture of FRP and metallic materials, are therefore no longer exclusively retained for the aerospace industry, motorsport and other high-end applications. It is especially worth highlighting the great growth in the general automotive and commercial vehicle technology.

FRP's are applied where high specific strength and low weight as well as high dynamic or energy efficient processes can be found. For the machining of CFRP, GFRP and stacks (FRP-metal-layer composite) without component damage, cutting edge quality and wear resistance of the tool material are of absolute importance. Guhring provides special solid carbide, coated carbide and PCD tooling solutions for these demanding materials. They are specially adapted to the respective material structure and ensure optimum chip evacuation as well as uniform hole diameters across all materials.

CHALLENGES

- components without fraying of fibres
- delamination-free component surface finish
- no component damage through "peel-up" or "push-out"
- prevention of split fibres on component
- minimising burr development
- prevention of thermal damage

TOOLS

FOR THE MACHINING OF MODERN COMPOSITE MATERIALS



SOLID CARBIDE DRILLS

from Ø2.50 mm to Ø12.70 mm
see pages 7–8

Solid carbide



END MILLS

from Ø8.00 mm to Ø12.70 mm
see page 26

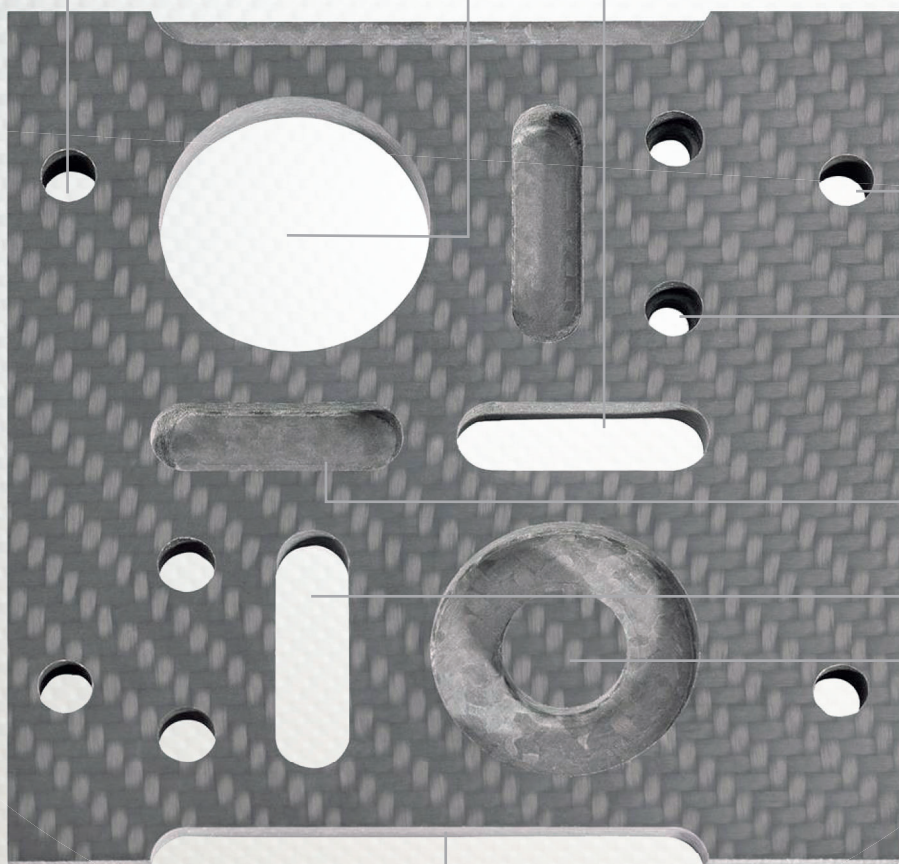
PCD



END MILLS Z=1

from Ø2.00 mm to Ø16.00 mm
see page 9

Solid carbide





PCD DRILLS

from Ø2.70 mm to Ø12.70 mm
see pages 20-21

PCD



TAPS

from M3 mm to M16 mm
see page 16-17

Solid carbide



THREAD MILLING CUTTERS

from M1.6 mm to M20x1.5 mm
see page 18-19

Solid carbide



KEVLAR END MILLS FR 100

from Ø4.00 mm to Ø12.70 mm
see pages 13-14

Solid carbide



KEVLAR END MILLS CR 100

from Ø4.00 mm to Ø16.00 mm
see pages 10-12

Solid carbide



SLOT DRILLS Z=2

from Ø4.00 mm to Ø20.00 mm
see page 22-23

PCD



SLOT DRILLS Z=3

from Ø14.00 mm to Ø20.00 mm
see page 24-25

PCD



PCD COMPRESSION MILLING CUTTERS

from Ø12.70 mm to Ø16.00 mm
see page 27

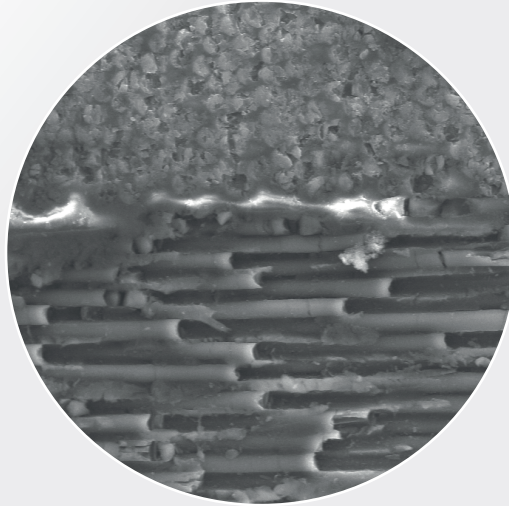
PCD



RESULT OF A DRILLING OPERATION WITH SPECIALISED GUHRING TOOLING SOLUTIONS



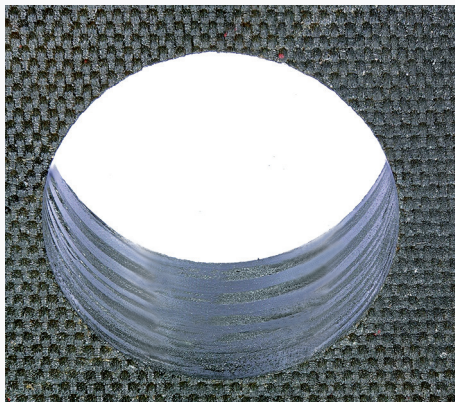
Machining with a Guhring tool retains the structure and direction of the fibres in the component, as the REM examination shows. The fibres are neither pressed into the matrix nor ripped out of the composite.



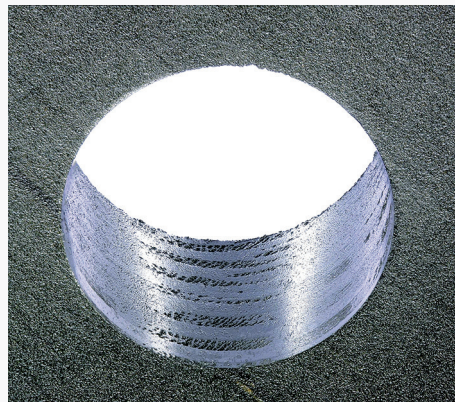
CFRP cut surface with 500-fold magnification

Optimal machining results in CFRP

no peel-up – no push-out



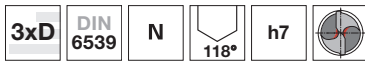
hole exit in CFRP
with woven cover layer
hole $d = 6.35$ mm



hole exit in
unidirectional CFRP
hole $d = 6.35$ mm



Stub drills



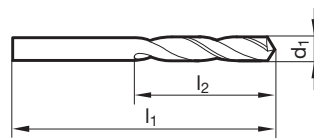
Tool material

solid carbide

Surface finish



Cutting direction



Article no.

730

d1	d1	l1	l2	Availability
mm	inch	mm	mm	
2.500		43.00	14.00	●
3.000		46.00	16.00	●
3.200		49.00	18.00	●
3.260		49.00	18.00	●
3.300		49.00	18.00	●
3.500		52.00	20.00	●
3.570	9/64	52.00	20.00	●
3.600		52.00	20.00	●
4.000		55.00	22.00	●
4.100		55.00	22.00	●
4.500		58.00	24.00	●
4.760	3/16	62.00	26.00	●
4.800		62.00	26.00	●
5.000		62.00	26.00	●
5.500		66.00	28.00	●
6.000		66.00	28.00	●
6.350	1/4	70.00	31.00	●
6.400		70.00	31.00	●
6.500		70.00	31.00	●
7.000		74.00	34.00	●
7.500		74.00	34.00	●
8.000		79.00	37.00	●
8.500		79.00	37.00	●
9.000		84.00	40.00	●
9.500		84.00	40.00	●
10.000		89.00	43.00	●
12.700	1/2	102.00	51.00	●

Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		40-130 m/min	0.03 - 0.15 f (mm/rev)



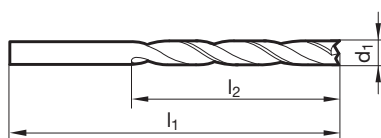
Kevlar drills



Tool material **solid carbide**

Surface finish

Cutting direction



Article no.

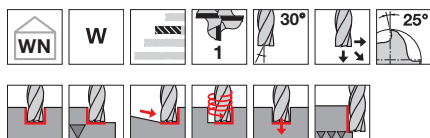
1149

d1	d1	l1	l2	Availability
mm	inch	mm	mm	
2.500	9/64	43.00	14.00	●
3.200		49.00	18.00	●
3.570		52.00	20.00	●
4.000	3/16	55.00	22.00	●
4.760		62.00	26.00	●
5.000		62.00	26.00	●
6.000		66.00	28.00	●
8.000		79.00	37.00	●
10.000		89.00	43.00	●

Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		40-130 m/min	0.03 - 0.15 f (mm/rev.)



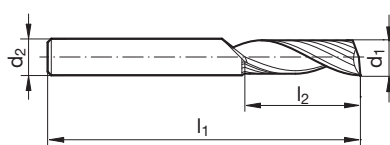
End mills Z=1

Tool material **solid carbide**

Surface finish

Cutting direction

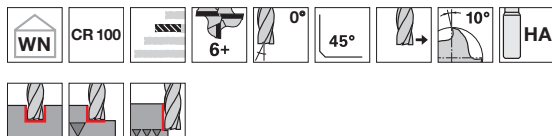
polished flutes, centre cutting

Article no. **6793**

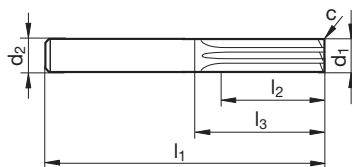
d1 h10 mm	d2 h6 mm	l1 mm	l2 mm	Z	Availability
2.000	2.00	38	10.0	1	●
3.000	3.00	39	12.0	1	●
4.000	4.00	40	15.0	1	●
5.000	5.00	50	16.0	1	●
6.000	6.00	57	20.0	1	●
8.000	8.00	63	22.0	1	●
10.000	10.00	73	25.0	1	●
12.000	12.00	83	30.0	1	●
16.000	16.00	92	35.0	1	●

Material	Process	Cutting speed	Feed rate
CFK GFK aramid		100-250 m/min	0,03 - 0,12 f _z (mm/z)
CFK GFK aramid		80-150 m/min	0,03 - 0,2 f (mm/rev.)

Kevlar CR 100 end mills

Tool material **solid carbide**Surface finish **(D)**Cutting direction **(R)**

Solid carbide ultra-fine grain, diamond-coated,
without face cutting, for slotting and trimming



Article no.

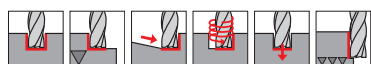
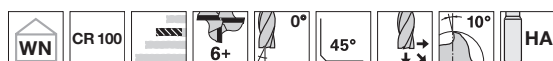
6717

d1 e10	d2 h6	l1	l2	l3	c	Z	Availability
mm	mm	mm	mm	mm	mm x 45°		
4.000	6.00	57.00	10.00	19.40	0.10	6	●
6.000	6.00	65.00	15.00	29.00	0.15	8	●
8.000	8.00	75.00	20.00	39.00	0.15	10	●
10.000	10.00	80.00	25.00	40.00	0.15	12	●
12.000	12.00	93.00	32.00	48.00	0.15	14	●
16.000	16.00	108.00	34.00	60.00	0.15	14	●

Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		250-500 m/min	0.03 - 0.12 f _z (mm/z)



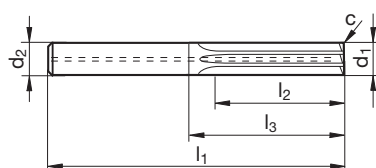
CR 100 Kevlar end mills

Tool material **solid carbide**

Surface finish

Cutting direction

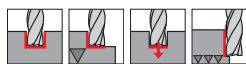
Solid carbide ultra-fine grain, diamond-coated,
with centre cutting, for slotting and trimming as well as oblique plunging

Article no. **6719**

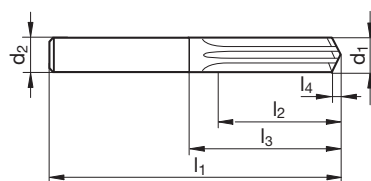
d1 e10	d2 h6	l1	l2	l3	c	Z	Availability
mm	mm	mm	mm	mm	mm x 45°		
4.000	6.00	57.00	10.00	19.40	0.32	6	●
6.000	6.00	65.00	15.00	29.00	0.48	8	●
8.000	8.00	75.00	20.00	39.00	0.64	10	●
10.000	10.00	80.00	25.00	40.00	0.80	12	●
12.000	12.00	93.00	32.00	48.00	0.96	14	●
16.000	16.00	108.00	34.00	60.00	1.28	14	●

Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		250-500 m/min	0.03 - 0.12 f _z (mm/z)
CFRP GFRP aramid		100-250 m/min	0.05 - 0.2 f (mm/rev.)

CR 100 Kevlar end mills

Tool material **solid carbide**Surface finish **(D)**Cutting direction **(R)**

Solid carbide ultra-fine grain, diamond-coated,
with drill point, especially for plunging and subsequent milling

Article no. **6720**

d1 (e10)	d2 (h6)	l1	l2	l3	l4	Z	Availability
mm	mm	mm	mm	mm	mm		
4.000	6.00	57.00	10.00	27.00	1.3	6	●
6.000	6.00	65.00	15.00	29.00	1.9	8	●
8.000	8.00	75.00	20.00	39.00	2.5	10	●
10.000	10.00	80.00	25.00	40.00	3.1	12	●
12.000	12.00	93.00	32.00	48.00	3.7	14	●
16.000	16.00	108.00	34.00	60.00	4.9	14	●

Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		250-500 m/min	0.03 - 0.12 f _z (mm/z)
CFRP GFRP aramid		100-250 m/min	0.05 - 0.20 f (mm/rev.)



FR 100 Kevlar end mills

Tool material **solid carbide**

Surface finish

D

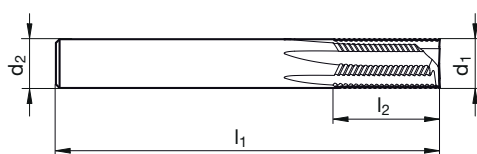
O

Cutting direction

R

R

Solid carbide ultra-fine grain, diamond-coated,
with drill centre cutting, for slotting and trimming as well as oblique plunging



Article no.

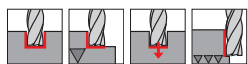
6769

6805

Code no.	d1 (e10)	d1 (e10)	d2 (h6)	l1	l1	l2	l2	Z	Availability	
	mm	inch	mm	mm	inch	mm	inch			
4.000	4.000		6.000	66.00		15.00		4	●	●
4.762	4.762	3/16	4.762	63.50	2.5	15.00	37/64	4	●	●
4.763	4.762	3/16	4.762	63.50	2.5	15.80	5/8	4	●	●
6.000	6.000		6.000	70.00		20.00		4	●	●
6.350	6.350	1/4	6.350	63.50	2.5	15.00	37/64	4	●	●
6.351	6.350	1/4	6.350	63.50	2.5	19.05	3/4	4	●	●
8.000	8.000		8.000	75.00		25.00		6	●	●
9.525	9.525	3/8	9.525	76.20	3.0	18.00	45/64	6	●	●
9.526	9.525	3/8	9.525	76.20	3.0	25.40	1	6	●	●
10.000	10.000		10.000	72.00		15.00		6	●	●
12.000	12.000		12.000	83.00		20.00		6	●	●
12.700	12.700	1/2	12.700	88.90	3.5	25.40	1	8	●	●
12.701	12.707	1/2	12.700	88.90	3.5	31.75	1.25	8	●	●

Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		150-450 m/min	0.03 - 0.12 f _z (mm/z)
CFRP GFRP aramid		125-150 m/min	0.05 - 0.20 f (mm/rev.)

FR 100 Kevlar end mills



Solid carbide ultra-fine grain, diamond-coated,
with drill point, specially for plunging and subsequent milling

Tool material **solid carbide**

Surface finish

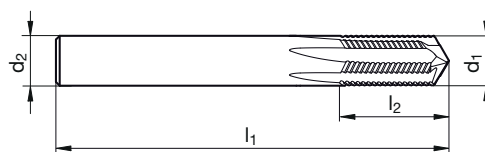
D

O

Cutting direction

R

R



Article no.

6770

6806

Code no.	d1 (e10)	d1 (e10)	d2 (h6)	l1	l1	l2	l2	Z	Availability
	mm	inch	mm	mm	inch	mm	inch		
4.000	4.000		6.000	66.00		15.00		4	● ●
4.762	4.762	3/16	4.762	63.50	2.5	15.00	37/64	4	● ●
4.763	4.762	3/16	4.762	63.50	2.5	15.80	5/8	4	● ●
6.000	6.000		6.000	70.00		20.00		4	● ●
6.350	6.350	1/4	6.350	63.50	2.5	15.00	37/64	4	● ●
6.351	6.350	1/4	6.350	63.50	2.5	19.05	3/4	4	● ●
8.000	8.000		8.000	75.00		25.00		6	● ●
9.525	9.525	3/8	9.525	76.20	3.0	18.00	45/64	6	● ●
9.526	9.525	3/8	9.525	76.20	3.0	25.40	1	6	● ●
10.000	10.000		10.000	72.00		15.00		6	● ●
12.000	12.000		12.000	83.00		20.00		6	● ●
12.700	12.700	1/2	12.700	88.90	3.5	25.40	1	8	● ●
12.701	12.707	1/2	12.700	88.90	3.5	31.75	1.25	8	● ●

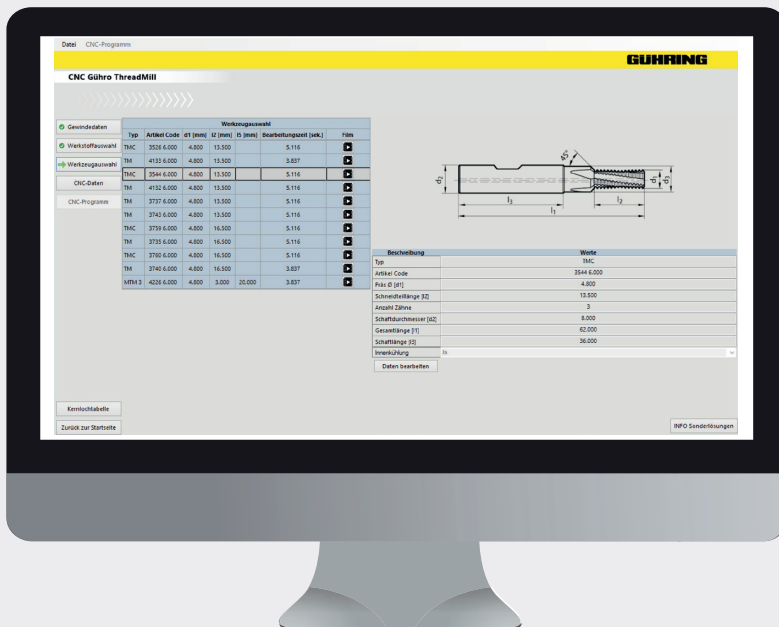
Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		150-450 m/min	0.03 - 0.12 f _z (mm/z)
CFRP GFRP aramid		125-150 m/min	0.05 - 0.18 f (mm/rev.)

CNC Gührö ThreadMill



Free programming software

for thread milling cutters and drill thread milling cutters



In order to make the machining with Gühring thread milling cutters even more user friendly, we have developed the intuitive "CNC Gührö Thread Mill".

"CNC Gührö Thread Mill" is available free-of-charge. Simply download it from our homepage www.guehring.de.



To the optimal CNC programme in five steps

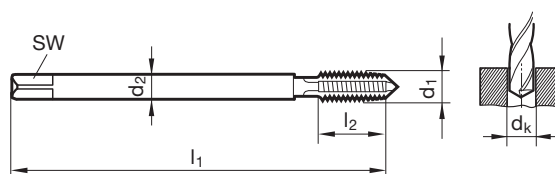
1. Specify the thread data
Select from all current thread standards
2. Select the material
You are always referred to the optimal parameters
3. Select the tool
Technical data, drawing, machining time and video simplify selection
4. Record CNC data
Enter required milling strategy and parameters
5. Receive CNC programme with code and data sheet
Programming data (Sinumerik, Haidenhain, Fanuc, Philips, Mazatrol or Hurco) are imported and automatically recognised

Machine taps for ISO metric threads

Tool material **solid carbide**

Surface finish

Tolerance on Ø ISO2/6H

Article no. **2944**

d1	P	d2	SW	dk	l1	l2	Availability
	mm	mm	mm	mm	mm	mm	
M3	0.500	3.50	2.700	2.60	56.00	12.00	●
M4	0.700	4.50	3.400	3.40	63.00	14.00	●
M5	0.800	6.00	4.900	4.30	70.00	17.00	●
M6	1.000	6.00	4.900	5.10	80.00	20.00	●
M8	1.250	8.00	6.200	6.90	90.00	20.00	●
M10	1.500	10.00	8.000	8.60	100.00	24.00	●
M12	1.750	12.00	9.000	10.40	110.00	28.00	●
M16	2.000	16.00	12.000	14.10	110.00	40.00	●

Material	Process	Cutting speed
CFK GFK	blind hole through hole	10 - 20 m/min



Taps for ISO metric threads with internal cooling



≥ M5 with internal cooling

Tool material

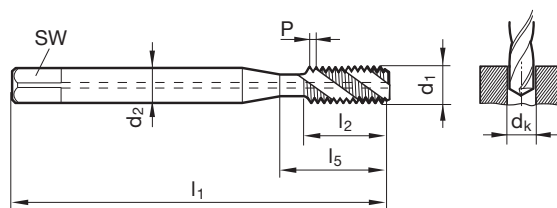
solid carbide

Surface finish



Tolerance on Ø

6HX



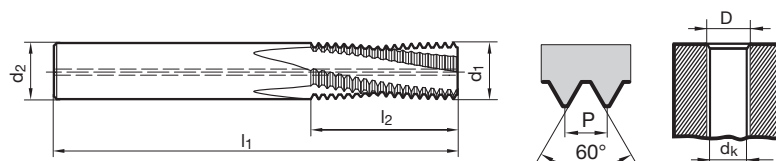
Article no.

971

d1	P	d2	SW	dk	l1	l2	l5	Availability
	mm	mm	mm	mm	mm	mm	mm	
M3	0.500	3.500	2.700	2.50	56.000	8.000	18.000	●
M4	0.700	4.500	3.400	3.30	63.000	10.000	21.000	●
M5	0.800	6.000	4.900	4.20	70.000	10.000	25.000	●
M6	1.000	6.000	4.900	5.00	80.000	12.000	30.000	●
M8	1.250	8.000	6.200	6.80	90.000	16.000	35.000	●
M10	1.500	10.000	8.000	8.50	100.000	18.000	39.000	●

Material	Process	Cutting speed
CFK GFK	blind hole through hole	10 - 20 m/min

Thread milling cutters without chamfer for ISO metric threads

Tool material **solid carbide**Surface finish **C**Cutting direction **HA**Article no. **3737**

D	P	d1	d2	dk	l1	l2	Z	Code no.	Availability
	mm	mm	mm	mm	mm	mm			
M6	1.000	4.800	6.000	5.00	54.000	13.500	3	6.000	●
M8	1.250	6.400	8.000	6.80	62.000	18.100	3	8.000	●
M8 x 1	1.000	6.400	8.000	7.00	62.000	17.500	3	8.005	●
M10	1.500	7.950	10.000	8.50	74.000	21.800	3	10.000	●
M10 x 1	1.000	7.950	10.000	9.00	74.000	21.500	3	10.005	●
M10 x 1.25	1.250	7.950	10.000	8.80	74.000	21.900	3	10.006	●
M12	1.750	9.950	10.000	10.20	74.000	25.400	4	12.000	●
M12 x 1.5	1.500	9.950	10.000	10.50	74.000	26.300	4	12.007	●
M14	2.000	11.200	12.000	12.00	90.000	31.000	4	14.000	●
M14 x 1.5	1.500	11.200	12.000	12.50	90.000	30.800	4	14.007	●
M16	2.000	12.800	14.000	14.00	90.000	35.000	4	16.000	●
M16 x 1.5	1.500	12.800	14.000	14.50	90.000	33.800	4	16.007	●
M20	2.500	14.950	16.000	17.50	102.000	41.300	4	20.000	●
M20 x 1.5	1.500	14.950	16.000	18.50	102.000	42.800	4	20.007	●

Material	Process	Cutting speed	Feed rate
CFK GFK	blind hole through hole	50-80m/min	0.01 - 0.10 f _z (mm/z)

The appropriate CNC programme with code and data sheet for the tool you can get for free with the free programming software CNC Gührö Thread Mill.



Micro thread milling cutters



Tool material

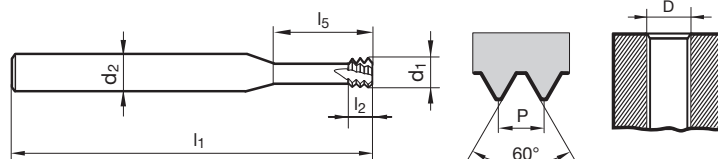
solid carbide

Surface finish



Cutting direction

HA



Article no.

4226

D	P	d1	d2	l1	l2	l5	Z	Code no.	Availability
	mm	mm	mm	mm	mm	mm			
M1.6	0.350	1.200	3.000	39.000	1.100	4.800	3	1.600	●
M1.8	0.350	1.400	3.000	39.000	1.100	5.400	3	1.800	●
M2	0.400	1.550	3.000	39.000	1.200	6.000	4	2.000	●
M2.5	0.450	1.950	3.000	39.000	1.400	7.500	4	2.500	●
M3	0.500	2.400	6.000	58.000	1.500	9.500	4	3.000	●
M3.5	0.600	2.800	6.000	58.000	1.800	11.000	4	3.500	●
M4	0.700	3.200	6.000	58.000	2.100	12.500	4	4.000	●
M5	0.800	4.000	6.000	58.000	2.400	16.000	4	5.000	●
M6	1.000	4.800	6.000	58.000	3.000	20.000	4	6.000	●
M8	1.250	5.950	6.000	58.000	3.800	24.000	4	8.000	●
M10	1.500	7.800	8.000	73.000	4.500	33.000	4	10.000	●
M12	1.750	9.000	10.000	84.000	5.300	38.000	4	12.000	●
M16	2.000	11.800	12.000	84.000	6.000	35.000	5	16.000	●

Material	Process	Cutting speed	Feed rate
CFK GFK	blind hole through hole	50-80m/min	0.01 - 0.10 f _z (mm/z)

The appropriate CNC programme with code and data sheet for the tool you can get for free with the free programming software CNC Gührö Thread Mill.



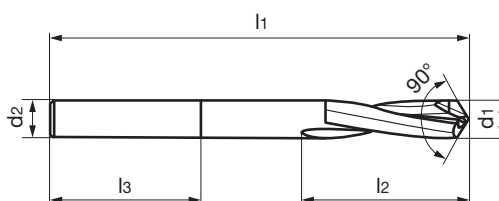
90° PCD drills



Tool material

PCD

Cutting direction



d1	d1	d2 h6	l1	l2	l3	Material number
mm	inch	mm	mm	mm	mm	
2.700		4.00	60.00	18.00	28.00	303 209 684
3.000		4.00	60.00	18.00	28.00	303 209 685
3.250		4.00	60.00	18.00	28.00	303 420 038
3.572	9/64	4.00	60.00	18.00	28.00	303 209 686
4.000		5.00	60.00	20.00	28.00	303 209 802
4.170		5.00	75.00	25.00	28.00	303 420 039
4.762	3/16	5.00	75.00	25.00	28.00	303 209 803
4.830		5.00	75.00	25.00	28.00	303 420 040
5.000		6.00	75.00	25.00	36.00	303 209 804
6.000		8.00	75.00	30.00	36.00	303 209 805
6.350	1/4	8.00	75.00	35.00	36.00	303 209 806
7.937	5/16	10.00	75.00	30.00	40.00	303 209 807
8.000		10.00	75.00	30.00	40.00	303 209 808
9.525	3/8	10.00	100.00	50.00	40.00	303 209 809
10.000		12.00	125.00	50.00	45.00	303 209 810
12.000		14.00	125.00	60.00	45.00	303 209 811
12.700	1/2	14.00	150.00	65.00	45.00	303 209 812

Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		75-200m/min	0.05 - 0.2 f (mm/rev.)



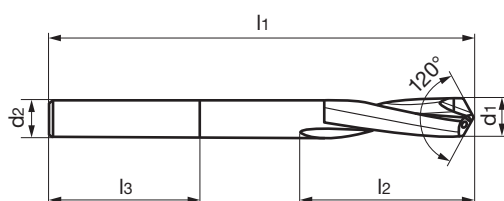
120° PCD drills



Tool material

PCD

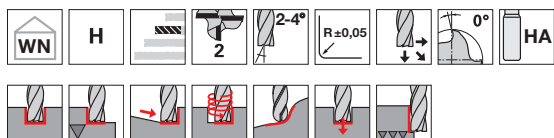
Cutting direction



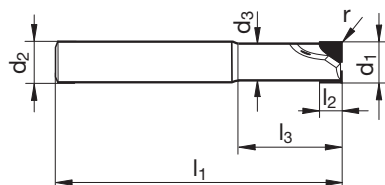
d1	d1	d2 h6	l1	l2	l3	Material number
mm	inch	mm	mm	mm	mm	
2.700		4.00	60.00	18.00	28.00	303 209 813
3.000		4.00	60.00	18.00	28.00	303 209 814
3.250		4.00	60.00	18.00	28.00	303 420 041
3.572	9/64	4.00	60.00	18.00	28.00	303 209 815
4.000		5.00	60.00	20.00	28.00	303 209 816
4.170		5.00	75.00	25.00	28.00	303 420 047
4.762	3/16	5.00	75.00	25.00	28.00	303 209 817
4.830		5.00	75.00	25.00	28.00	303 420 048
5.000		6.00	75.00	25.00	36.00	303 209 818
6.000		8.00	75.00	30.00	36.00	303 209 819
6.350	1/4	8.00	75.00	35.00	36.00	303 209 820
7.937	5/16	10.00	75.00	30.00	40.00	303 209 821
8.000		10.00	75.00	30.00	40.00	303 209 822
9.525	3/8	10.00	100.00	50.00	40.00	303 209 823
10.000		12.00	125.00	50.00	45.00	303 209 824
12.000		14.00	125.00	60.00	45.00	303 209 825
12.700	1/2	14.00	150.00	65.00	45.00	303 209 826

Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		100-250 m/min	0.05 - 0.20 f (mm/rev.)

PCD slot drills Z=2



Tool material	PCD
Surface finish	○
Cutting direction	Ⓜ



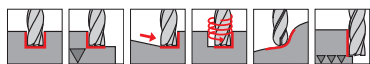
Article no. 5492

Code no.	d1	d1	d2 h6	d3	l1	l2	l3	r	Z	Availability
	mm		mm	mm	mm	mm	mm	mm		
4.000	4.000	± 0.02	6.00	3.70	51	6.0	14.0	0.1	2	●
5.000	5.000	± 0.02	6.00	4.70	51	8.0	14.5	0.1	2	●
6.000	6.000	± 0.02	6.00	5.70	57	8.0	20.0	0.1	2	●
8.000	8.000	± 0.02	8.00	7.40	63	8.0	26.0	0.1	2	●
8.001	8.000	± 0.02	8.00	7.40	63	12.0	26.0	0.1	2	●
10.000	10.000	± 0.02	10.00	9.40	72	8.0	30.0	0.1	2	●
10.001	10.000	± 0.02	10.00	9.40	72	16.0	30.0	0.1	2	●
12.000	12.000	± 0.02	12.00	11.20	83	8.0	36.0	0.1	2	●
12.001	12.000	± 0.02	12.00	11.20	83	16.0	36.0	0.1	2	●
14.000	14.000	± 0.02	14.00	13.00	83	8.0	36.0	0.1	2	●
14.001	14.000	± 0.02	14.00	13.00	83	16.0	36.0	0.1	2	●
16.000	16.000	± 0.02	16.00	15.00	100	12.0	50.0	0.1	2	●
16.001	16.000	± 0.02	16.00	15.00	100	20.0	50.0	0.1	2	●
18.000	18.000	± 0.02	18.00	17.00	100	12.0	50.0	0.1	2	●
18.001	18.000	± 0.02	18.00	17.00	100	20.0	50.0	0.1	2	●
20.000	20.000	± 0.02	20.00	19.00	100	12.0	48.0	0.1	2	●
20.001	20.000	± 0.02	20.00	19.00	100	20.0	48.0	0.1	2	●

Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		150-450 m/min	0.03 - 0.12 f _z (mm/z)
CFRP GFRP aramid		125-150 m/min	0.05 - 0.18 f (mm/rev.)



PCD slot drills Z=2



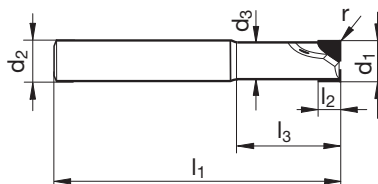
Tool material

PCD

Surface finish



Cutting direction



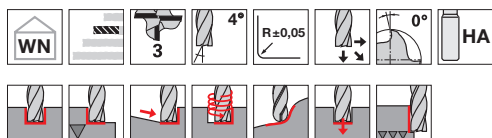
Article no.

5493

Code no.	d1	d1	d2 h6	d3	l1	l2	l3	r	Z	Availability
	mm		mm	mm	mm	mm	mm	mm		
4.000	4.000	± 0.02	6.00	3.70	70	6.0	14.0	0.1	2	●
5.000	5.000	± 0.02	6.00	4.70	70	8.0	14.5	0.1	2	●
6.000	6.000	± 0.02	6.00	5.70	75	8.0	20.0	0.1	2	●
8.000	8.000	± 0.02	8.00	7.40	100	8.0	26.0	0.1	2	●
8.001	8.000	± 0.02	8.00	7.40	100	12.0	26.0	0.1	2	●
10.000	10.000	± 0.02	10.00	9.40	100	8.0	30.0	0.1	2	●
10.001	10.000	± 0.02	10.00	9.40	100	16.0	30.0	0.1	2	●
12.000	12.000	± 0.02	12.00	11.20	100	8.0	36.0	0.1	2	●
12.001	12.000	± 0.02	12.00	11.20	100	16.0	36.0	0.1	2	●
14.000	14.000	± 0.02	14.00	13.00	100	8.0	36.0	0.1	2	●
14.001	14.000	± 0.02	14.00	13.00	100	16.0	36.0	0.1	2	●
16.000	16.000	± 0.02	16.00	15.00	150	12.0	50.0	0.1	2	●
16.001	16.000	± 0.02	16.00	15.00	150	20.0	50.0	0.1	2	●
18.000	18.000	± 0.02	18.00	17.00	125	12.0	50.0	0.1	2	●
18.001	18.000	± 0.02	18.00	17.00	125	20.0	50.0	0.1	2	●
18.002	18.000	± 0.02	18.00	17.00	150	12.0	50.0	0.1	2	●
18.003	18.000	± 0.02	18.00	17.00	150	20.0	50.0	0.1	2	●
20.000	20.000	± 0.02	20.00	19.00	150	12.0	48.0	0.1	2	●
20.001	20.000	± 0.02	20.00	19.00	150	20.0	48.0	0.1	2	●

Material	Process	Cutting speed	Feed rate
CFK GFK aramid		150-450 m/min	0.03 - 0.12 f _z (mm/z)
CFK GFK aramid		125-150 m/min	0.05 - 0.18 f (mm/rev.)

PCD slot drills Z=3



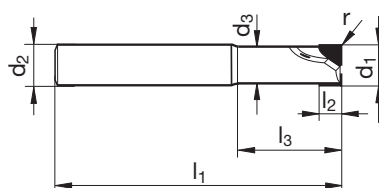
Tool material

PCD

Surface finish



Cutting direction



Article no.

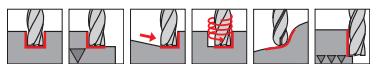
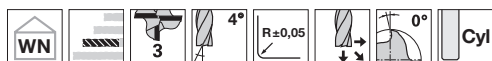
5495

Code no.	d1	d1	d2 h6	d3	l1	l2	l3	r	Z	Availability
	mm		mm	mm	mm	mm	mm	mm		
14.000	14.000	± 0.02	14.00	13.00	83	8.0	38.0	0.1	3	●
14.001	14.000	± 0.02	14.00	13.00	83	16.0	38.0	0.1	3	●
16.000	16.000	± 0.02	16.00	15.00	100	12.0	52.0	0.1	3	●
16.001	16.000	± 0.02	16.00	15.00	100	20.0	52.0	0.1	3	●
18.000	18.000	± 0.02	18.00	17.00	100	12.0	52.0	0.1	3	●
18.001	18.000	± 0.02	18.00	17.00	100	20.0	52.0	0.1	3	●
20.000	20.000	± 0.02	20.00	19.00	100	12.0	50.0	0.1	3	●
20.001	20.000	± 0.02	20.00	19.00	100	20.0	50.0	0.1	3	●

Material	Process	Cutting speed	Feed rate
CFK GFK aramid		150-450 m/min	0.03 - 0.12 f _z (mm/z)
CFK GFK aramid		125-150 m/min	0.05 - 0.18 f (mm/rev.)



PCD Slot drills Z=3



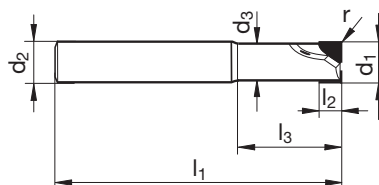
Tool material

PCD

Surface finish



Cutting direction



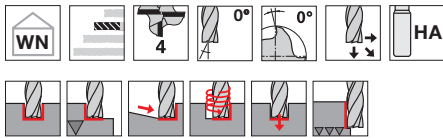
Article no.

5496

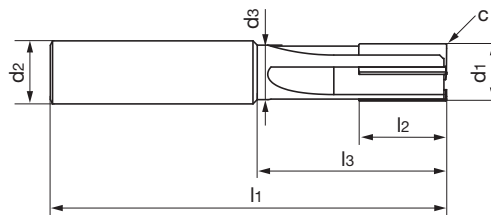
Code no.	d1	d1	d2 h6	d3	l1	l2	l3	r	Z	Availability
	mm		mm	mm	mm	mm	mm	mm		
14.000	14.000	± 0.02	14.00	13.00	100	8.0	38.0	0.1	3	●
14.001	14.000	± 0.02	14.00	13.00	100	16.0	38.0	0.1	3	●
16.000	16.000	± 0.02	16.00	15.00	150	12.0	52.0	0.1	3	●
16.001	16.000	± 0.02	16.00	15.00	150	20.0	52.0	0.1	3	●
18.000	18.000	± 0.02	18.00	17.00	150	12.0	52.0	0.1	3	●
18.001	18.000	± 0.02	18.00	17.00	150	20.0	52.0	0.1	3	●
20.000	20.000	± 0.02	20.00	19.00	150	12.0	50.0	0.1	3	●
20.001	20.000	± 0.02	20.00	19.00	150	20.0	50.0	0.1	3	●

Material	Process	Cutting speed	Feed rate
CFK GFK aramid		150-450 m/min	0.03 - 0.12 f _z (mm/z)
CFK GFK aramid		125-150 m/min	0.05 - 0.18 f (mm/rev.)

PCD End mills Z=4



Tool material	PCD
Surface finish	○
Cutting direction	Ⓜ

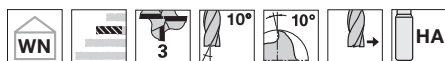


d1	d1	d2 h6	d3	l1	l2	l3	c	Z	Material number
mm	inch	mm	mm	mm	mm	mm	mm x 45°		
8.000		8.00	7.40	75.00	19.50	38.50	0.20	4	303 206 512
9.525	3/8	10.00	8.92	80.00	19.50	39.26	0.20	4	303 206 513
10.000		10.00	9.40	80.00	19.50	39.50	0.20	4	303 206 514
12.000		12.00	11.40	88.00	19.50	42.50	0.20	4	303 206 515
12.700	1/2	14.00	12.10	88.00	19.50	41.85	0.20	4	303 211 229
12.700	1/2	14.00	11.10	88.00	19.50	41.35	0.20	2+1	303 211 230

Material	Process	Cutting speed	Feed rate
CFK GFK aramid		150-500 m/min	0.03 - 0.12 f _z (mm/z)
CFK GFK aramid		125-200 m/min	0.05 - 0.20 f (mm/rev.)



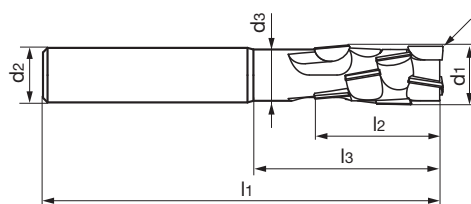
PCD Compression milling cutters Z=3



Tool material

PCD

Cutting direction



d1	d1	d2 h6	d3	l1	l2	l3	r	Material number
mm	inch	mm	mm	mm	mm	mm	mm	
12.700	1/2	12.00	11.30	88.00	28.00	41.49	0.10	303 211 231
14.000		14.00	12.60	88.00	28.00	40.19	0.10	303 211 257
16.000		16.00	14.60	91.00	28.00	40.19	0.10	303 211 258

Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		150-500 m/min	0.03 - 0.12 f _z (mm/z)

Tapping size holes for thread cutting/thread milling

Standard ISO metric threads DIN 13					ISO metric fine threads DIN 13										UNC threads ASME B1.1				
Nom. Ø	Pitch P	Tapping size hole Ø	Core diameter of int. thread 6H*		Nom. Ø	Pitch P	Tapping size hole Ø	Core diameter of int. thread 6H		Nom. Ø	Pitch P	Tapping size hole Ø	Core diameter of int. thread 6H		Nom. Ø	Thread	Tapping size hole Ø	Core diameter of int. thread 2B	
	mm	DIN 336 mm	min. mm	max. mm		mm	DIN 336 mm	min. mm	max. mm		mm	DIN 336 mm	min. mm	max. mm		per inch	DIN 336 mm	min. mm	max. mm
M 1	0.25	0.75	0.729	0.785	M 2.5 x 0.35	2.15	2.121	2.221		M 22 x 1.00	21.00	20.917	21.153		No. 1 - 64	1.55	1.425	1.580	
M 1.1	0.25	0.85	0.829	0.885	M 3.0 x 0.35	2.65	2.621	2.721		M 22 x 1.50	20.50	20.376	20.676		No. 2 - 56	1.85	1.694	1.872	
M 1.2	0.25	0.95	0.929	0.985	M 3.5 x 0.35	3.15	3.121	3.221		M 22 x 2.00	20.00	19.835	20.210		No. 3 - 48	2.10	1.941	2.146	
M 1.4	0.30	1.10	1.075	1.142	M 4.0 x 0.50	3.50	3.459	3.599		M 24 x 1.00	23.00	22.917	23.153		No. 4 - 40	2.35	2.157	2.385	
M 1.6	0.35	1.25	1.221	1.321	M 4.5 x 0.50	4.00	3.959	4.099		M 24 x 1.50	22.50	22.376	22.676		No. 5 - 40	2.65	2.487	2.698	
M 1.8	0.35	1.45	1.421	1.521	M 5.0 x 0.50	4.50	4.459	4.599		M 24 x 2.00	22.00	21.835	22.210		No. 6 - 32	2.85	2.642	2.896	
M 2	0.40	1.60	1.567	1.679	M 5.5 x 0.50	5.00	4.959	5.099		M 25 x 1.00	24.00	23.917	24.153		No. 8 - 32	3.50	3.302	3.531	
M 2.2	0.45	1.75	1.713	1.838	M 6.0 x 0.75	5.20	5.188	5.378		M 25 x 1.50	23.50	23.376	23.676		No. 10 - 24	3.90	3.683	3.937	
M 2.5	0.45	2.05	2.013	2.138	M 7.0 x 0.75	6.20	6.188	6.378		M 25 x 2.00	23.00	22.835	23.210		No. 12 - 24	4.50	4.343	4.597	
M 3	0.50	2.50	2.459	2.599	M 8.0 x 0.50	7.50	7.459	7.599		M 27 x 1.00	26.00	25.917	26.153		1/4 - 20	5.10	4.978	5.258	
M 3.5	0.60	2.90	2.850	3.010	M 8.0 x 0.75	7.20	7.188	7.378		M 27 x 1.50	25.50	25.376	25.676		5/16 - 18	6.60	6.401	6.731	
M 4	0.70	3.30	3.242	3.422	M 8.0 x 1.00	7.00	6.917	7.153		M 27 x 2.00	25.00	24.835	25.210		3/8 - 16	8.00	7.798	8.153	
M 4.5	0.75	3.70	3.688	3.878	M 9.0 x 0.75	8.20	8.188	8.378		M 28 x 1.00	27.00	26.917	27.153		7/16 - 14	9.40	9.144	9.550	
M 5	0.80	4.20	4.134	4.334	M 9.0 x 1.00	8.00	7.917	8.153		M 28 x 1.50	26.50	26.376	26.676		1/2 - 13	10.80	10.592	11.024	
M 6	1.00	5.00	4.917	5.153	M 10 x 0.75	9.20	9.188	9.378		M 28 x 2.00	26.00	25.835	26.210		9/16 - 12	12.20	11.989	12.446	
M 7	1.00	6.00	5.917	6.153	M 10 x 1.00	9.00	8.917	9.153		M 30 x 1.00	29.00	28.917	29.153		5/8 - 11	13.50	13.386	13.868	
M 8	1.25	6.80	6.647	6.912	M 10 x 1.25	8.80	8.647	8.912		M 30 x 1.50	28.50	28.376	28.676		3/4 - 10	16.50	16.307	16.840	
M 9	1.25	7.80	7.647	7.912	M 11 x 0.75	10.20	10.188	10.378		M 30 x 2.00	28.00	27.835	28.210		7/8 - 9	19.50	19.177	19.761	
M 10	1.50	8.50	8.376	8.676	M 11 x 1.00	10.00	9.917	10.153		M 30 x 3.00	27.00	26.752	27.252		1 - 8	22.25	21.971	22.606	
M 11	1.50	9.50	9.376	9.676	M 12 x 1.00	11.00	10.917	11.153		M 32 x 1.50	30.50	30.376	30.676		1 1/8 - 7	25.00	24.638	25.349	
M 12	1.75	10.20	10.106	10.441	M 12 x 1.25	10.80	10.647	10.912		M 32 x 2.00	30.00	29.835	30.210		1 1/4 - 7	28.00	27.813	28.524	
M 14	2.00	12.00	11.835	12.210	M 12 x 1.50	10.50	10.376	10.676		M 33 x 1.50	31.50	31.376	31.676		1 3/8 - 6	30.75	30.353	31.115	
M 16	2.00	14.00	13.835	14.210	M 14 x 1.00	13.00	12.917	13.153		M 33 x 2.00	31.00	30.835	31.210		1 1/2 - 6	34.00	33.528	34.290	
M 18	2.50	15.50	15.294	15.744	M 14 x 1.25	12.80	12.647	12.912		M 33 x 3.00	30.00	29.752	30.252		1 3/4 - 5	39.50	38.938	39.802	
M 20	2.50	17.50	17.294	17.744	M 14 x 1.50	12.50	12.376	12.676		M 35 x 1.50	33.50	33.376	33.676		2 - 4.5	45.00	44.679	45.593	
M 22	2.50	19.50	19.294	19.744	M 15 x 1.00	14.00	13.917	14.153		M 36 x 1.50	34.50	34.376	34.676						
M 24	3.00	21.00	20.752	21.252	M 15 x 1.50	13.50	13.376	13.676											
M 27	3.00	24.00	23.752	24.252	M 16 x 1.00	15.00	14.917	15.153		* M 1.1 up to M 1.4 tapping size hole of internal thread 5H									
M 30	3.50	26.50	26.211	26.771	M 16 x 1.25	14.80	14.647	14.912											
M 33	3.50	29.50	29.211	29.771	M 16 x 1.50	14.50	14.376	14.676											
M 36	4.00	32.00	31.670	32.270	M 17 x 1.00	16.00	15.917	16.153											
M 39	4.00	35.00	34.670	35.270	M 17 x 1.50	15.50	15.376	15.676											
M 42	4.50	37.50	37.129	37.799	M 18 x 1.00	17.00	16.917	17.153											
M 45	4.50	40.50	40.129	40.799	M 18 x 1.50	16.50	16.376	16.676											
M 48	5.00	43.00	42.587	43.297	M 20 x 1.00	19.00	18.917	19.153											
M 52	5.00	47.00	46.587	47.297	M 20 x 1.50	18.50	18.376	18.676											
M 56	5.50	50.50	50.046	50.796	M 20 x 2.00	18.00	17.835	18.210											

* M 1.1 up to M 1.4 tapping size hole of internal thread 5H

MJ threads DIN ISO 5855				
Nom. Ø	x	Pitch P	Tapping size hole Ø	Core diameter of int. thread 5H*
		mm	mm	min. mm max. mm
MJ 3	x	0.50	2.60	2.513 2.653
MJ 4	x	0.70	3.40	3.318 3.498
MJ 5	x	0.80	4.30	4.221 4.421
MJ 6	x	0.50	5.55	5.513 5.625
MJ 6	x	0.75	5.35	5.269 5.419
MJ 6	x	1.00	5.10	5.026 5.216
MJ 8	x	0.50	7.55	7.513 7.625
MJ 8	x	0.75	7.35	7.269 7.419
MJ 8	x	1.00	7.10	7.026 7.216
MJ 8	x	1.25	6.90	6.782 6.994
MJ 10	x	1.00	9.10	9.026 9.216
MJ 10	x	1.25	8.90	8.782 8.994
MJ 10	x	1.50	8.60	8.539 8.775
MJ 12	x	1.75	10.40	10.295 10.560
MJ 16	x	2.00	14.20	14.051 14.351

UNJC threads ISO 3161				
Nom. Ø	Thread	Tapping size hole Ø	Core diameter of int. thread 3B	
	per inch	mm	min. mm	max. mm
No. 6	- 32	2.85	2.733	2.939
No. 8	- 32	3.55	3.393	3.599
No. 10	- 24	4.00	3.795	4.064
No. 12	- 24	4.60	4.455	4.704
1/4	- 20	5.30	5.113	5.387
5/16	- 18	6.75	6.563	6.833
3/8	- 16	8.20	7.978	8.255
7/16	- 14	9.60	9.346	9.639
1/2	- 13	11.00	10.798	11.095
9/16	- 12	12.40	12.228	12.482
5/8	- 11	13.80	13.627	13.904

* MJ3 x 0.50 up to MJ 5 x 0.80 tapping size hole of internal thread 6H

UNJF threads ISO 3161				
Nom. Ø	Thread	Tapping size hole Ø	Core diameter of int. thread 3B	
	per inch	mm	min. mm	max. mm
No. 6	- 40	3.00	2.888	3.053
No. 8	- 36	3.60	3.480	3.663
No. 10	- 32	4.20	4.054	4.255
No. 12	- 28	4.75	4.602	4.816
1/4	- 28	5.60	5.466	5.662
5/16	- 24	7.00	6.906	7.109
3/8	- 24	8.60	8.494	8.679
7/16	- 20	10.00	9.876	10.084
1/2	- 20	11.60	11.463	11.661
9/16	- 18	13.00	12.913	13.122
5/8	- 18	14.60	14.501	14.702

Tapping size holes for thread cutting/thread milling

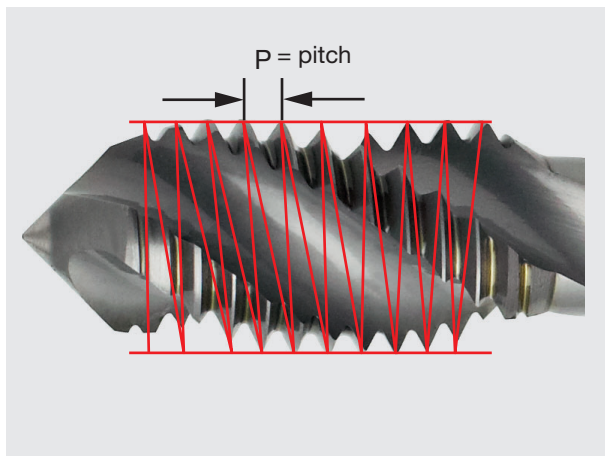
UNF threads ASME B1.1					BSW threads BS84					BSP threads (DIN-ISO 228-1)					Steel armoured conduit threads to DIN 40430				
Nom. Ø	Thre- ad	Tapping size hole Ø	Core diameter of int. thread 2B		Nom. Ø	Thre- ad	Tapping size hole Ø	Core diameter of int. thread		Nom. Ø	Thre- ad	Tapping size hole Ø	Core diameter of int. thread		Nom. Ø	Thre- ad	Tapping size hole Ø	Core diameter of int. thread	
	per inch	DIN 336 mm	min. mm	max. mm		per inch	mm	min. mm	max. mm		per inch	DIN 336 mm	min. mm	max. mm		per inch	mm	min. mm	max. mm
No. 1 - 72		1.55	1.473	1.610	W 1/16	60	1.20	1.045	1.230	G 1/16	28	6.80	6.561	6.843	Pg 7	20	11.40	11.280	11.430
No. 2 - 64		1.85	1.755	1.910	W 3/32	48	1.80	1.704	1.912	G 1/8	28	8.80	8.566	8.848	Pg 9	18	14.00	13.860	14.010
No. 3 - 56		2.15	2.024	2.197	W 1/8	40	2.50	2.362	2.591	G 1/4	19	11.80	11.445	11.890	Pg 11	18	17.30	17.260	17.410
No. 4 - 48		2.40	2.271	2.459	W 5/32	32	3.20	2.952	3.214	G 3/8	19	15.25	14.950	15.395	Pg 13.5	18	19.00	19.060	19.210
No. 5 - 44		2.70	2.550	2.741	W 3/16	24	3.60	3.407	3.745	G 1/2	14	19.00	18.631	19.172	Pg 16	18	21.30	21.160	21.310
No. 6 - 40		2.95	2.819	3.023	W 7/32	24	4.50	4.201	4.539	G 5/8	14	21.00	20.587	21.128	Pg 21	16	26.90	26.780	27.030
No. 8 - 36		3.50	3.404	3.607	W 1/4	20	5.10	4.724	5.156	G 3/4	14	24.50	24.117	24.658	Pg 29	16	35.50	35.480	35.730
No. 10 - 32		4.10	3.962	4.166	W 5/16	18	6.50	6.130	6.590	G 7/8	14	28.25	27.877	28.418	Pg 36	16	45.50	45.480	45.730
No. 12 - 28		4.60	4.496	4.724	W 3/8	16	7.90	7.492	7.987	G 1	11	30.75	30.291	30.931	Pg 42	16	52.50	52.480	52.730
1/4 - 28		5.50	5.359	5.588	W 7/16	14	9.20	8.789	9.330	G 1 1/8	11	35.50	34.939	35.579	Pg 48	16	57.80	57.780	58.030
5/16 - 24		6.90	6.782	7.036	W 1/2	12	10.50	9.989	10.591	G 1 1/4	11	39.50	38.952	39.592					
3/8 - 24		8.50	8.382	8.636	W 9/16	12	12.00	11.577	12.179	G 1 1/2	11	45.25	44.845	45.485					
7/16 - 20		9.90	9.728	10.033	W 5/8	11	13.50	12.918	13.558	G 1 3/4	11	51.00	50.788	51.428					
1/2 - 20		11.50	11.328	11.608	W 3/4	10	16.25	15.797	16.483	G 2	11	57.00	56.656	57.296					
9/16 - 18		12.90	12.751	13.081	W 7/8	9	19.25	18.611	19.353										
5/8 - 18		14.50	14.351	14.681	W 1	8	22.00	21.334	22.147										
3/4 - 16		17.50	17.323	17.678	W 1 1/8	7	24.50	23.928	24.832										
7/8 - 14		20.40	20.269	20.650	W 1 1/4	7	27.75	27.103	28.007										
1 - 12		23.25	23.114	23.571	W 1 3/8	6	30.50	29.504	30.528										
1 1/8 - 12		26.50	26.289	26.746	W 1 1/2	6	33.50	32.679	33.703										
1 1/4 - 12		29.50	29.464	29.921	W 1 5/8	5	35.50	34.769	35.963										
1 3/8 - 12		32.75	32.639	33.096	W 1 3/4	5	39.00	37.944	39.138										
1 1/2 - 12		36.00	35.814	36.271	W 2	4.5	44.50	43.571	44.877										

NPT ANSI B 2.1 American tapered pipe thread 1:16						
Version A (avoid if possible)	Version B	Nom. Ø	Thread per inch	Tapp. size hole Ø cylindrical (A) d1	Tapp. size hole Ø conical (B) D1	Cutting depth ET mm
		1/16	- 27	6.15	6.39	9.29
		1/8	- 27	8.40	8.74	9.32
		1/4	- 18	11.10	11.36	13.52
		3/8	- 18	14.30	14.80	13.83
		1/2	- 14	17.90	18.32	18.07
		3/4	- 14	23.30	23.67	18.55
		1	- 11,5	29.00	29.69	22.29
		1 1/4	- 11,5	37.70	38.45	22.80
		1 1/2	- 11,5	43.70	44.52	22.80
		2	- 11,5	55.60	56.56	23.20
		2 1/2	- 8	66.30	67.62	31.75
		3	- 8	82.30	83.52	33.74

Metric/metric fine EG-threads (EG M14 x 1.25) for wire thread inserts DIN 8140					UNC (UNC-STI) EG-threads for wire thread inserts ASME B18.29.1					UNF (UNF-STI) EG-threads for wire thread inserts ASME B18.29.1				
Nom. Ø	Pitch P	Tapping size hole Ø	Core diameter of int. thread		Nom. Ø	Thread per inch	Tapping size hole Ø	Core diameter of int. thread		Nom. Ø	Thread per inch	Tapping size hole Ø	Core diameter of int. thread	
	mm	mm	min. mm	max. mm			mm	min. mm	max. mm			mm	min. mm	max. mm
EG M 4 x	0.70	4.20	4.152	4.292	EG No. 6 -	32	3.80	3.678	3.879	EG No. 6 -	40	3.70	3.644	3.818
EG M 5 x	0.80	5.25	5.174	5.334	EG No. 8 -	32	4.40	4.338	4.524	EG No. 8 -	36	4.40	4.321	4.498
EG M 6 x	1.00	6.30	6.217	6.407	EG No. 10 -	24	5.20	5.055	5.283	EG No. 10 -	32	5.10	4.999	5.184
EG M 8 x	1.25	8.40	8.271	8.483	EG No. 12 -	24	5.80	5.715	5.944	EG No. 12 -	28	5.70	5.682	5.809
EG M10 x	1.50	10.50	10.324	10.560	EG 1/4 -	20	6.70	6.624	6.868	EG 1/4 -	28	6.60	6.546	6.721
EG M12 x	1.75	12.50	12.379	12.644	EG 5/16 -	18	8.40	8.242	8.489	EG 5/16 -	24	8.25	8.166	8.352
EG M14 x	1.25	14.40	14.271	14.483	EG 3/8 -	16	10.00	9.868	10.127	EG 3/8 -	24	9.80	9.754	9.931
EG M16 x	2.00	16.50	16.433	16.733	EG 7/16 -	14	11.60	11.506	11.783	EG 7/16 -	20	11.50	11.389	11.585
					EG 1/2 -	13	13.30	13.122	13.393	EG 1/2 -	20	13.10	12.974	13.172
					EG 9/16 -	12	14.90	14.747	15.032	EG 9/16 -	18	14.70	14.592	14.798
					EG 5/8 -	11	16.50	16.375	16.673	EG 5/8 -	18	16.25	16.180	16.386

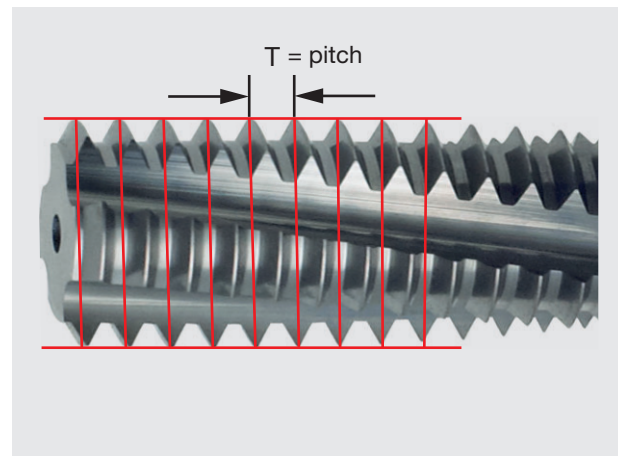
Difference between taps/fluteless taps and thread milling cutters

Taps/fluteless taps



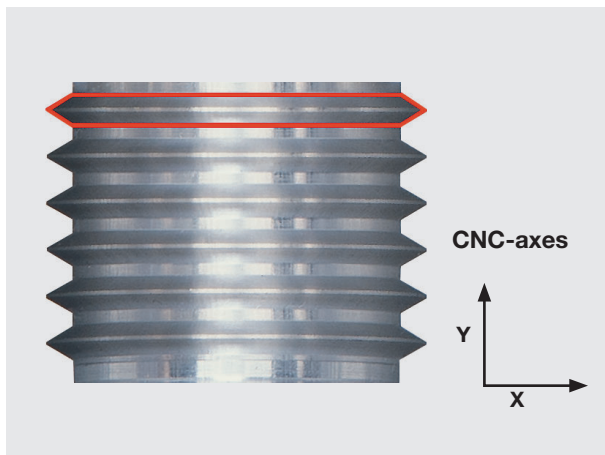
The red lines show the pitch angle of the thread that is ground into the tool. This means the pitch is cut into the workpiece by the tool.

Thread milling cutter

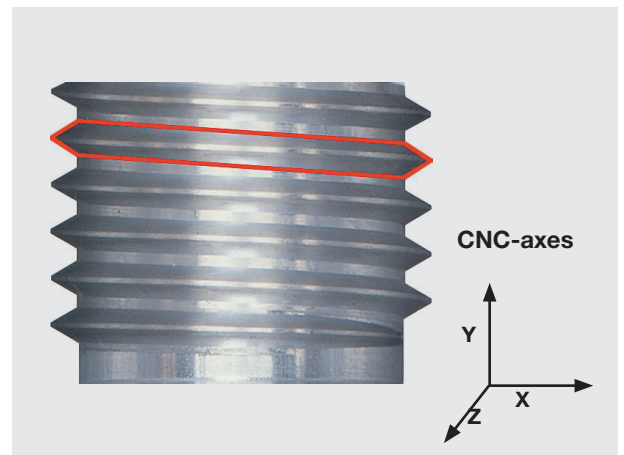


The red lines show that the tool does not possess a pitch angle. The pitch is produced by the Z-axis of a CNC machine.

Creation of the thread with thread milling



Thread profile without axial feed (Z-axis) of the machine. A groove profile is created without pitch. A functioning thread is not created.



Through the additional programming of the Z-axis the necessary pitch is produced.

Note:

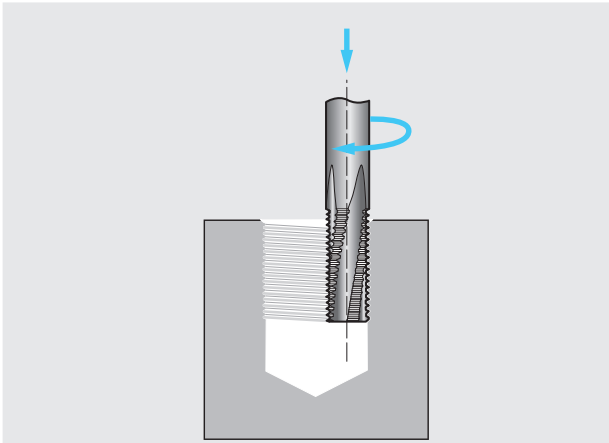
Due to diagonal milling in the pitch angle (**Z-axis**) the thread profile of the tool is **transferred onto the component distorted**.

The more the milling cutter diameter (80 % of nom. Ø) approaches the nominal thread diameter and the higher the thread pitch the more pronounced the profile distortion is.

Differentiating between two milling processes

Reverse rotation milling

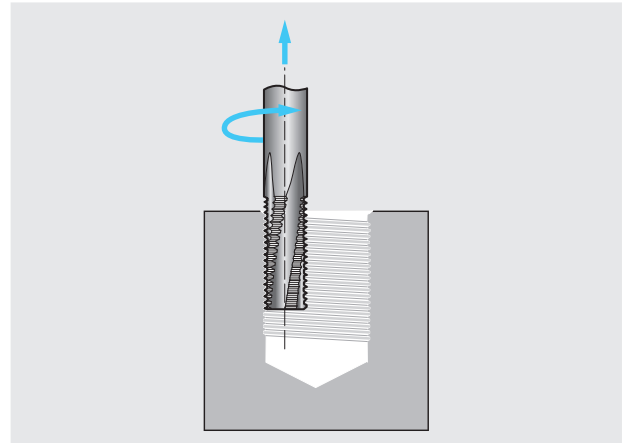
clockwise, with G02



Reverse rotation milling is preferentially applied for the machining of harder materials or to remedy taper threads.

Synchronous milling

anticlockwise, with G03

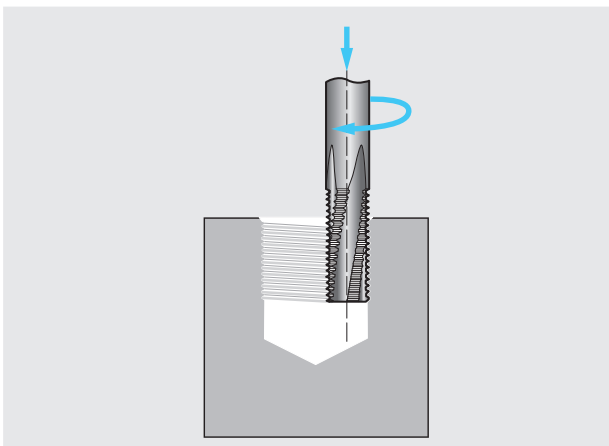


Synchronous milling is applied with thread depths smaller than $1.5 \times D$.
Advantage: A better surface finish is achieved.

Thread production with one tool

Right-hand thread

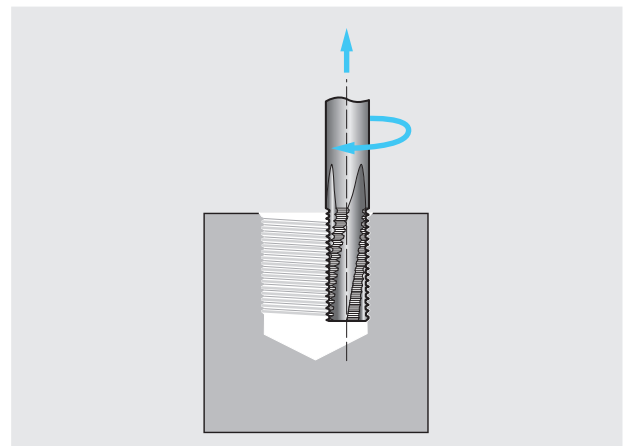
Reverse rotation milling



Tool rotates clockwise from top to bottom

Left-hand thread

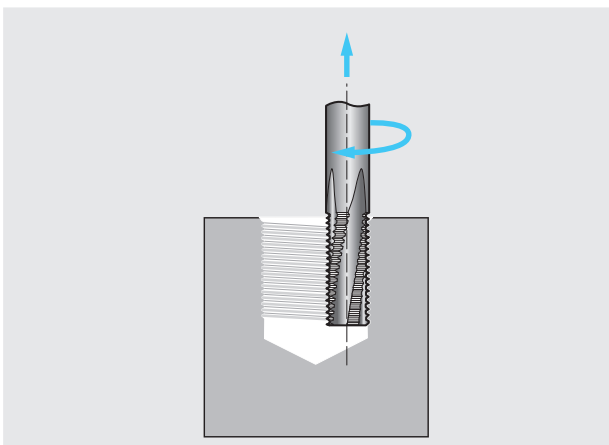
Reverse rotation milling



Tool rotates clockwise from bottom to top

Right-hand thread

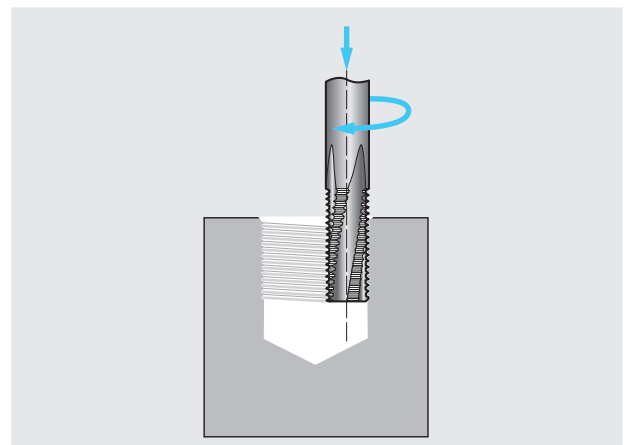
Synchronous milling



Tool rotates clockwise from bottom to top

Left-hand thread

Synchronous milling



Tool rotates clockwise from top to bottom

Thread milling programming

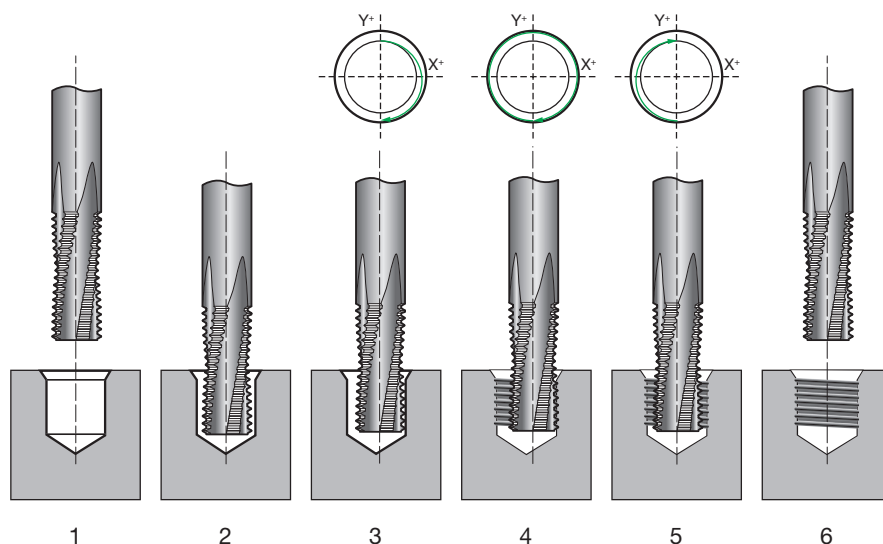
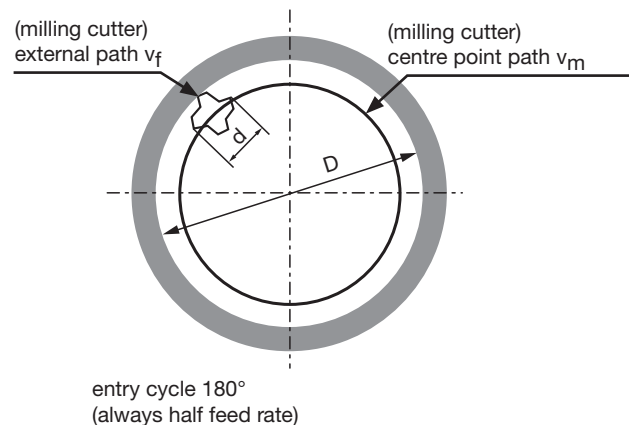
Program specifications

Thread milling functions

G00 Rapid movement	G90 Absolute dimension
G01 Feed	G91 Incremental dimension
G02 Circular interpolation (clockwise)	M03 Spindle on (clockwise rotation)
G03 Circular interpolation (anti-clockwise)	M05 Spindle stop
G17 Layer selection x-y axis	M08 Coolant on
G18 Layer selection z-x axis	X Axis
G19 Layer selection y-z axis	Y Axis
G40 Cancel tool correction	Z Axis
G41 Tool path correction (left of contour)	I Thread pitch parallel to X-axis
G42 Tool path correction (right of contour)	J Thread pitch parallel to Y-axis
G43 Tool length compensation (call-up)	S Spindle speed
G49 Tool length compensation (deselect)	F Feed
G54 Work offset	

CNC internal thread milling

1. Moving to start position
2. Moving to thread depth in bore
3. 180° descending loop to contour
4. 360° full circular movement of thread milling cutter
5. 180° exit loop to centre of bore
6. Rapid movement from bore to start position



Formula of calculation

$$v_c = \frac{d \cdot \pi \cdot n}{1000}$$

$$n = \frac{v_c \cdot 1000}{d \cdot \pi}$$

$$v_f = n \cdot z \cdot f_z$$

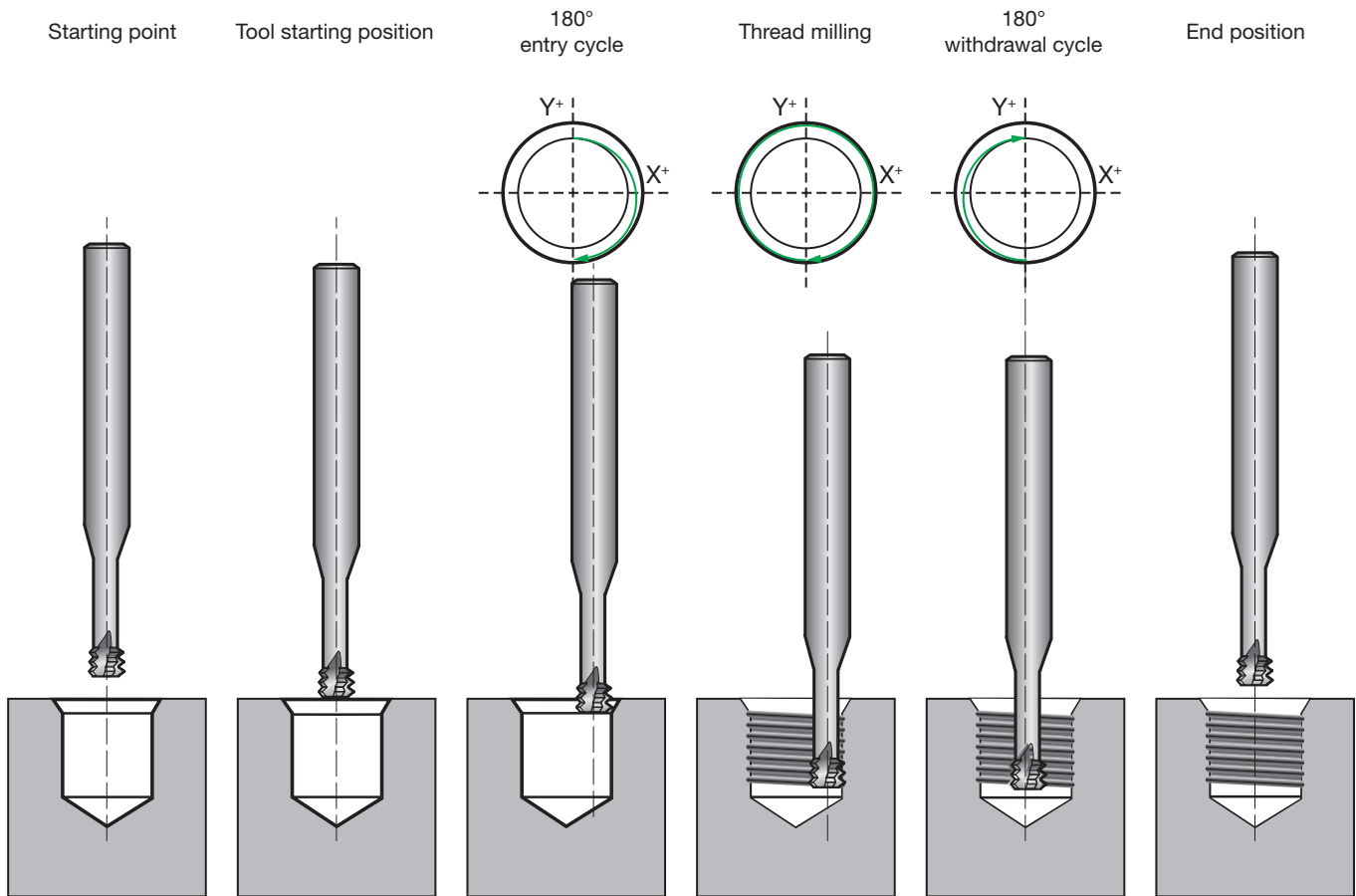
$$v_m = \frac{v_f \cdot (D - d)}{D}$$

$$v_b = n \cdot f_b$$

v_c = cutting speed
 v_f = contour feed
 v_m = centre point path feed
 n = revolutions
 z = number of teeth
 f_z = feed per tooth
 f_b = feed per drill per revolution*
 v_b = drill feed rate*
 D = Ø nom. of thread [mm]
 d = milling cutter nom. Ø [mm]
 * for drill/thread milling

Thread milling programming

Programming process for micro-thread milling (right-hand thread in reverse rotation)



Possibilities to reduce radial forces

To reduce radial forces cut distribution can be undertaken:

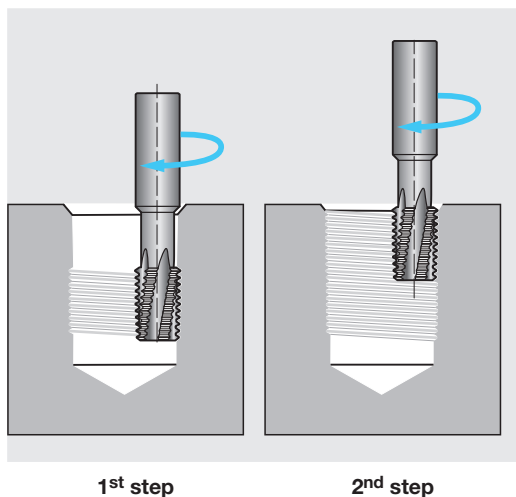
Advantage:

- for larger thread depths
- counteracts taper threads
- for unstable clamping conditions

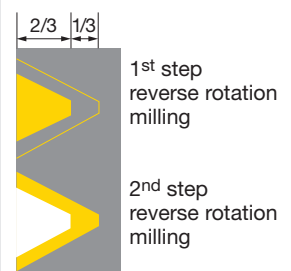
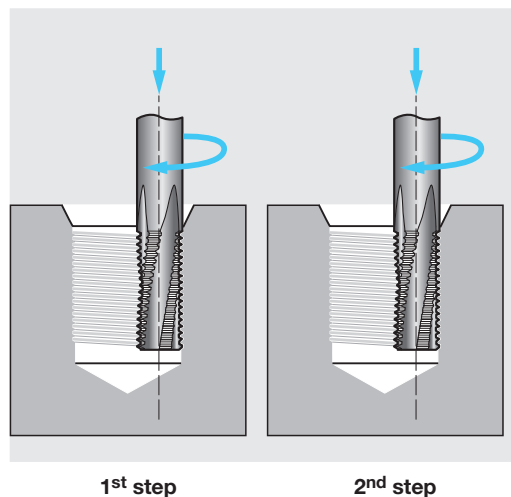
Disadvantage:

- increased tool wear
- longer production time

Axial distribution of cut



Radial distribution of cut



Practical application of thread milling cutters

1.) Tool clamping:

good concentricity is important, therefore clamping as short and rigid as possible

2.) Enter tool data in machine memory

- 1.) Tool length from the front face, take drill/thread milling cutters (DTMC) from point.
- 2.) Measure tool radius with tool pre-setting equipment. General rule:
measured radius - $0.022 \times \text{pitch}$ provides the input value in machine memory.

3.) Input of CNC program in control

(preferably integrated as sub-program at corresponding positions)

- a.) Call-up of a self-controlling cycle (procedures should be known)
- b.) Integration of data file from our threadmill-software (DIN or Haidenhain).

4.) Trial run over workpiece

- a) Tool length dimension in memory extending by an approximate value dependent on contact length (i.e. 30 mm) or offset zero point.
- b) Run program in single set, visual check of travel path.
- c) Allow program to run in automatic mode.

Attention:

With controls where it is not definitely clear what milling path is assigned it must be clarified if the feed is positioned on the external path v_f or at the centre path v_m . As a rule we specify the milling centre point path v_m .

5.) Application in workpiece

Re-set the tool extension or the zero point. Then allow the program to run in the workpiece the feed regulation must be 100 % selected. Should the thread not be true to gauge, the tool radius requires correction in the tool memory:

Example:

- thread too tight: Radius correction - input
- thread too large: Radius correction + input



Notes

This image shows a full page of blank graph paper. The grid consists of thin, light gray horizontal and vertical lines that intersect to form small squares across the entire surface. There are no margins, text, or other markings on the paper.



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