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

Solid carbide — Polycrystalline diamond

Surface finish

bright — TiCN — Cristall

Ø-tolerance

Shank form

to DIN 6535

Standard

to Guhring std.

Type

Form

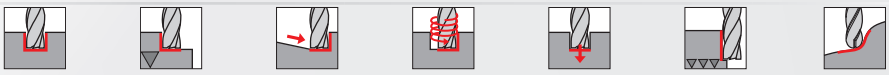
Hole type

Through holes and blind holes

Cutting direction

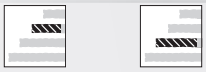
right-hand

Applications



slotting — roughing — ramping — Helix — drilling — finishing — copying

Lenght



long (DIN) — medium length

No. of cutting edges

no. of cutting lips

Web thinning

Helix angle

size of helix angle / no. of different helix angles

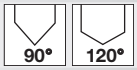
Rake angle

rake angle of circumferential cutting edges

Infeed

for lateral infeed — for lateral infeed and ramping — for lateral infeed, ramping and drilling

Point angle



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 high-lighting 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

END MILLS

from Ø 8.00 mm to Ø 12.70 mm

see page 26

PCD

SOLID CARBIDE DRILLS

from Ø 2.50 mm to Ø 12.70 mm

see pages 7 – 8

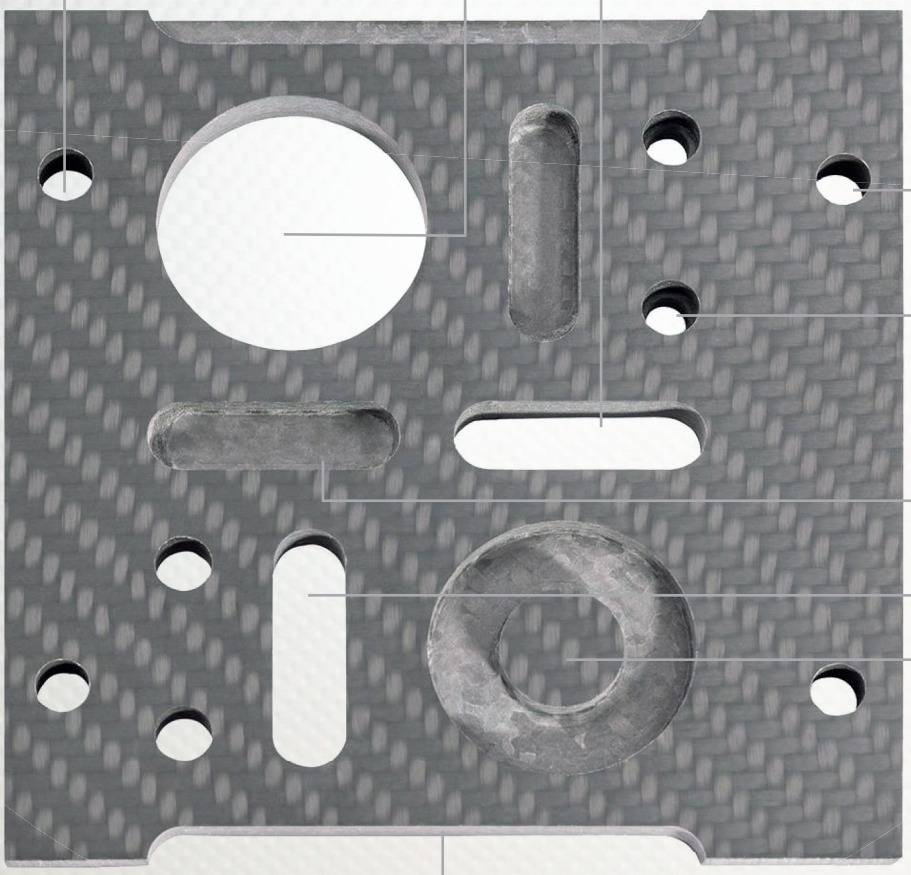
Solid carbide

END MILLS Z=1

from Ø 2.00 mm to Ø 16.00 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

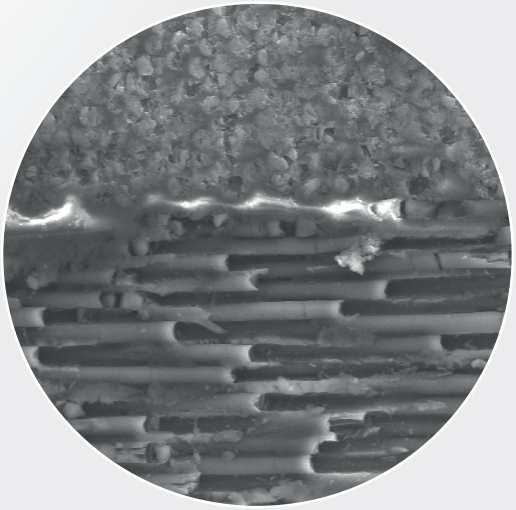
SLOT DRILLS Z=2
from Ø4.00 mm to Ø20.00 mm
see page 22-23
PCD

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

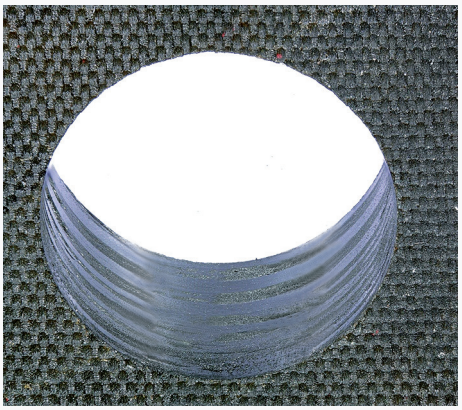
Machining with a Guhring tool retains the structure and direction of the fibres in the component, as the REM examination shows. The fibres are neither pressed into the matrix or ripped out of the composite.



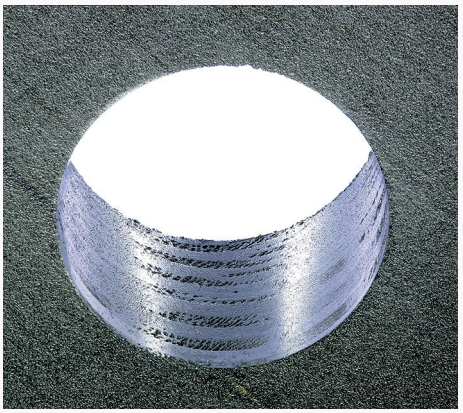
CRFP cut surface with 500-fold magnification

Optimal machining results in CFRP

no peel-up – no push-out



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

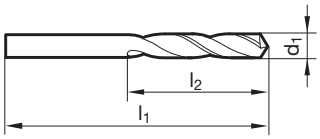


hole exit in
unidirectional CFRP
hole d = 6.35 mm

Stub drills

3xD | DIN 6539 | N | 118° | h7

Tool material	**solid carbide**
Surface finish	◯
Cutting direction	R



Article no. 730

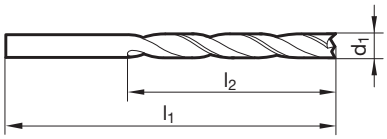
d1 mm	d1 inch	l1 mm	l2 mm	Availability
2.500		43.00	14.00	●
3.000		46.00	16.00	●
3.200		49.00	18.00	●
3.260		49.00	18.00	●
3.300		49.00	18.00	●
3.500		52.00	20.00	●
3.570	9/64	52.00	20.00	●
3.600		52.00	20.00	●
4.000		55.00	22.00	●
4.100		55.00	22.00	●
4.500		58.00	24.00	●
4.760	3/16	62.00	26.00	●
4.800		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

WN | FK | h8

Tool material	solid carbide
Surface finish	○
Cutting direction	R

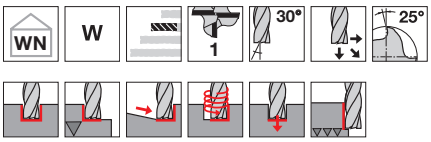


Article no. 1149

d1 mm	d1 inch	l1 mm	l2 mm	Availability
2.500		43.00	14.00	●
3.200		49.00	18.00	●
3.570	9/64	52.00	20.00	●
4.000		55.00	22.00	●
4.760	3/16	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	●

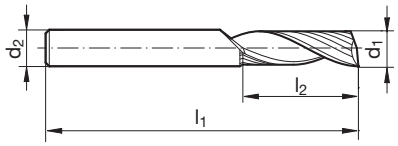
Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		40-130 m/min	0.03 - 0.15 f (mm/rev.)

End mills Z=1



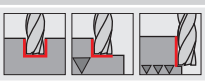
Tool material	**solid carbide**
Surface finish	D
Cutting direction	R

polished flutes, centre cutting

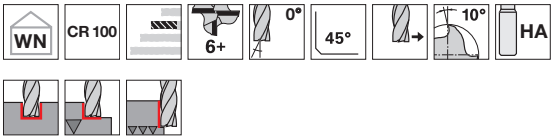


Article no. 6793

d1 h10	d2 h6	l1	l2	Z	Availability
mm	mm	mm	mm		
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	●

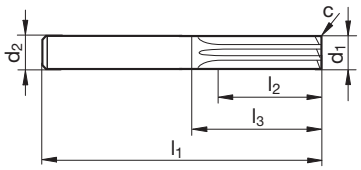
Material	Process	Cutting speed	Feed rate
CFK GFK aramid		100-250 m/min	0,03 - 0,12 f_z (mm/z)
CFK GFK aramid		80-150 m/min	0,03 - 0,2 f (mm/rev.)

Kevlar CR 100 end mills



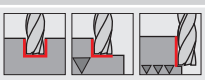
Tool material	**solid carbide**
Surface finish	D
Cutting direction	R

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

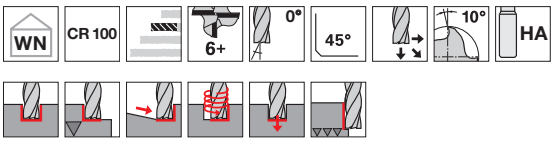


Article no. 6717

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	●

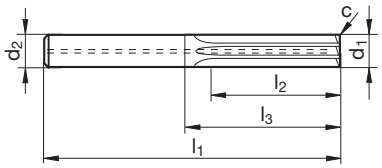
Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		250-500 m/min	0.03 - 0.12 f_z (mm/z)

CR 100 Kevlar end mills



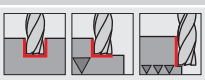
Tool material	**solid carbide**
Surface finish	D
Cutting direction	R

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

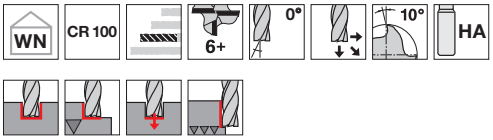


Article no. 6719

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	●

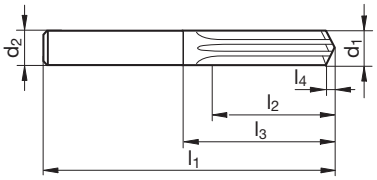
Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		250-500 m/min	0.03 - 0.12 f_z (mm/z)
CFRP GFRP aramid		100-250 m/min	0.05 - 0.2 f (mm/rev.)

CR 100 Kevlar end mills



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

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

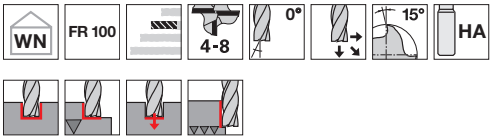


Article no. 6720

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	●

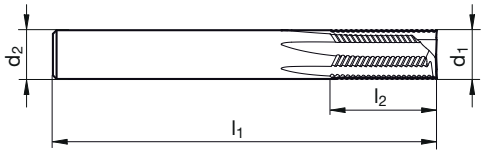
Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		250-500 m/min	0.03 - 0.12 f_z (mm/z)
CFRP GFRP aramid		100-250 m/min	0.05 - 0.20 f (mm/rev.)

FR 100 Kevlar end mills



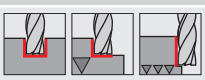
Tool material	solid carbide	
Surface finish	D	○
Cutting direction	R	R

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

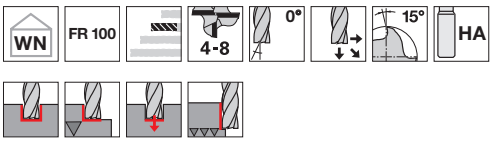


Article no.	6769	6805

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	●	●

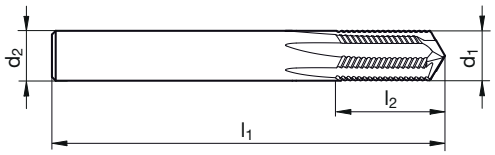
Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		150-450 m/min	0.03 - 0.12 f_z (mm/z)
CFRP GFRP aramid		125-150 m/min	0.05 - 0.20 f (mm/rev.)

FR 100 Kevlar end mills



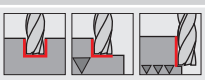
Tool material	solid carbide	
Surface finish	D	○
Cutting direction	R	R

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



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	●	●

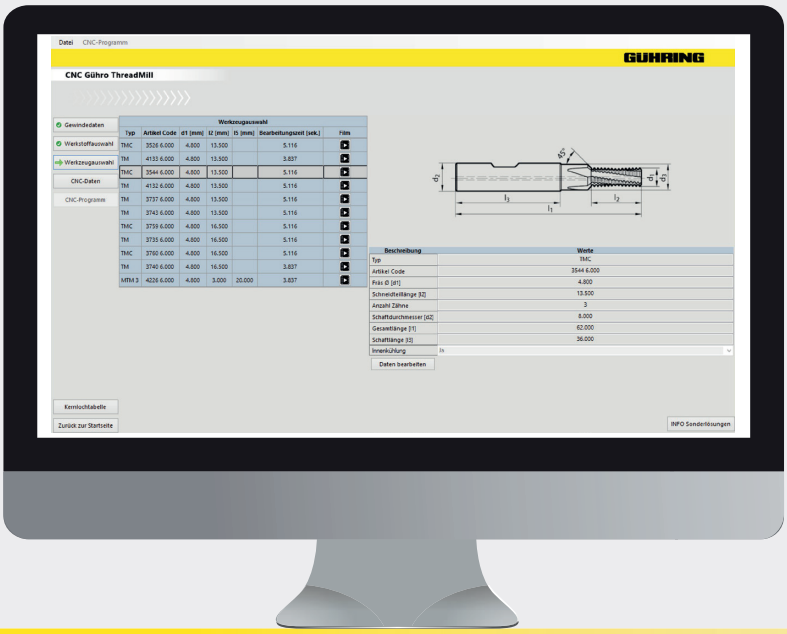
Material	Process	Cutting speed	Feed rate
CFRP GFRP aramid		150-450 m/min	0.03 - 0.12 f_z (mm/z)
CFRP GFRP aramid		125-150 m/min	0.05 - 0.18 f (mm/rev.)

CNC Gühro ThreadMill

NEW VERSION v 2.0

Free programming software

for thread milling cutters and drill thread milling cutters



In order to make the machining with Guhring thread milling cutters even more user friendly, we have developed the intuitive “CNC Gühro Thread Mill”.

“CNC Gühro Thread Mill” is available free-of-charge. Simply download it from our homepage www.guehring.de.

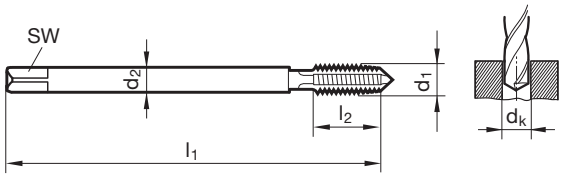
To the optimal CNC programme in five steps

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

~DIN 371 | R | H | D

Tool material	**solid carbide**
Surface finish	C
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	●

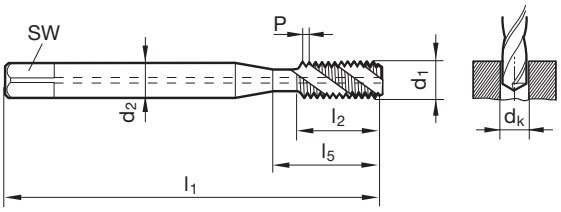
Material	Process	Cutting speed
CFK GFK	blind hole through hole	10 - 20 m/min

Taps for ISO metric threads with internal cooling

DIN 371 | R | N R15 | C

≥ M5 with internal cooling

Tool material	**solid carbide**
Surface finish	◯
Tolerance on Ø	6HX



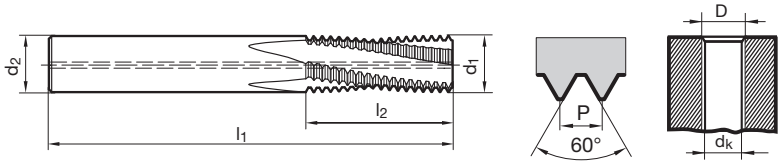
Article no. **971**

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

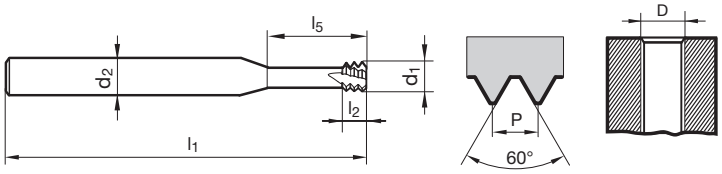
D	P	d1	d2	dk	l1	l2	Z	Code no.	Availability
	mm	mm	mm	mm	mm	mm			
M6	1.000	4.800	6.000	5.00	54.000	13.500	3	6.000	●
M8	1.250	6.400	8.000	6.80	62.000	18.100	3	8.000	●
M8 x 1	1.000	6.400	8.000	7.00	62.000	17.500	3	8.005	●
M10	1.500	7.950	10.000	8.50	74.000	21.800	3	10.000	●
M10 x 1	1.000	7.950	10.000	9.00	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	50-80 m/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 Gühro Thread Mill.

Micro thread milling cutters

Tool material	**solid carbide**
Surface finish	C
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	●

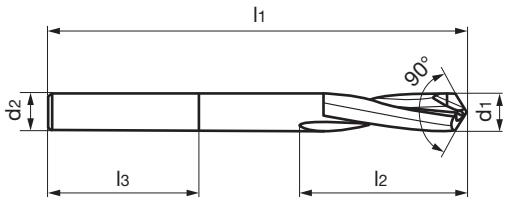
Material	Process	Cutting speed	Feed rate
CFK GFK	blind hole through hole	50-80 m/min	0.01 - 0.10 f_z (mm/z)

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

90° PCD drills

N | 3xD | m7 | 90°

Tool material	PCD
Cutting direction	R



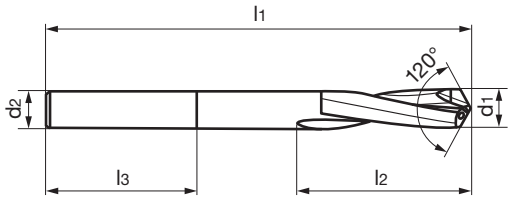
d1 mm	d1 inch	d2 h6 mm	l1 mm	l2 mm	l3 mm	Material number
2.700		4.00	60.00	18.00	28.00	303 209 684
3.000		4.00	60.00	18.00	28.00	303 209 685
3.250		4.00	60.00	18.00	28.00	303 420 038
3.572	9/64	4.00	60.00	18.00	28.00	303 209 686
4.000		5.00	60.00	20.00	28.00	303 209 802
4.170		5.00	75.00	25.00	28.00	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		75-200 m/min	0.05 - 0.2 f (mm/rev.)

120° PCD drills

N | 3xD | m7 | 120°

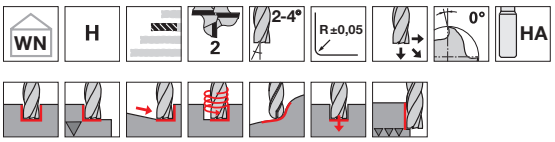
Tool material	PCD
Cutting direction	R



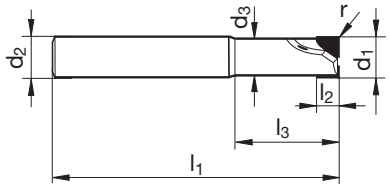
d1	d1	d2 h6	l1	l2	l3	Material number
mm	inch	mm	mm	mm	mm	
2.700		4.00	60.00	18.00	28.00	303 209 813
3.000		4.00	60.00	18.00	28.00	303 209 814
3.250		4.00	60.00	18.00	28.00	303 420 041
3.572	9/64	4.00	60.00	18.00	28.00	303 209 815
4.000		5.00	60.00	20.00	28.00	303 209 816
4.170		5.00	75.00	25.00	28.00	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

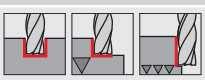


Tool material	PCD
Surface finish	◯
Cutting direction	(R)

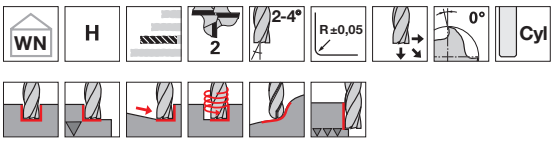


Article no. 5492

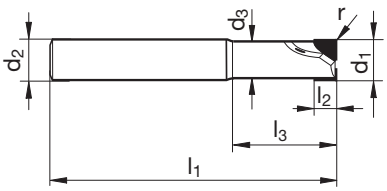
Code no.	d1	d1	d2 h6	d3	l1	l2	l3	r	Z	Availability
	mm		mm	mm	mm	mm	mm	mm		
4.000	4.000	± 0.02	6.00	3.70	51	6.0	14.0	0.1	2	●
5.000	5.000	± 0.02	6.00	4.70	51	8.0	14.5	0.1	2	●
6.000	6.000	± 0.02	6.00	5.70	57	8.0	20.0	0.1	2	●
8.000	8.000	± 0.02	8.00	7.40	63	8.0	26.0	0.1	2	●
8.001	8.000	± 0.02	8.00	7.40	63	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

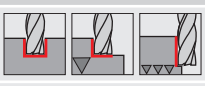


Tool material	PCD
Surface finish	◯
Cutting direction	(R)

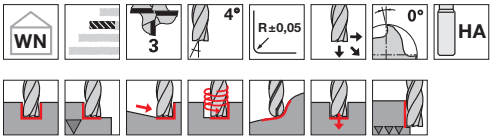


Article no. 5493

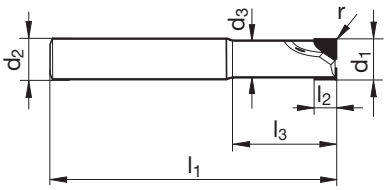
Code no.	d1	d1	d2 h6	d3	l1	l2	l3	r	Z	Availability
	mm		mm	mm	mm	mm	mm	mm		
4.000	4.000	± 0.02	6.00	3.70	70	6.0	14.0	0.1	2	●
5.000	5.000	± 0.02	6.00	4.70	70	8.0	14.5	0.1	2	●
6.000	6.000	± 0.02	6.00	5.70	75	8.0	20.0	0.1	2	●
8.000	8.000	± 0.02	8.00	7.40	100	8.0	26.0	0.1	2	●
8.001	8.000	± 0.02	8.00	7.40	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

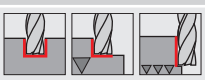


Tool material	PCD
Surface finish	◯
Cutting direction	Ⓡ

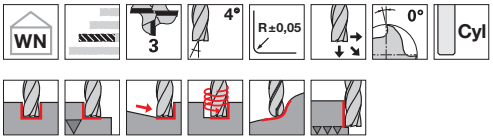


Article no. 5495

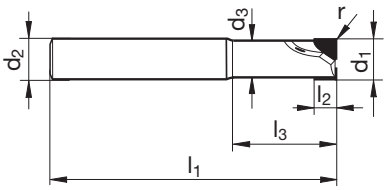
Code no.	d1	d1	d2 h6	d3	l1	l2	l3	r	Z	Availability
	mm		mm	mm	mm	mm	mm	mm		
14.000	14.000	± 0.02	14.00	13.00	83	8.0	38.0	0.1	3	●
14.001	14.000	± 0.02	14.00	13.00	83	16.0	38.0	0.1	3	●
16.000	16.000	± 0.02	16.00	15.00	100	12.0	52.0	0.1	3	●
16.001	16.000	± 0.02	16.00	15.00	100	20.0	52.0	0.1	3	●
18.000	18.000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

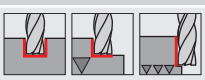


Tool material	PCD
Surface finish	◯
Cutting direction	R

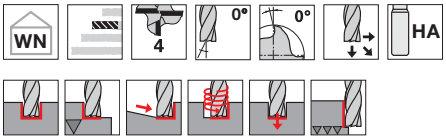


Article no. 5496

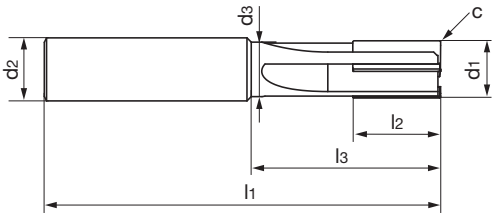
Code no.	d1	d1	d2 h6	d3	l1	l2	l3	r	Z	Availability
	mm		mm	mm	mm	mm	mm	mm		
14.000	14.000	± 0.02	14.00	13.00	100	8.0	38.0	0.1	3	●
14.001	14.000	± 0.02	14.00	13.00	100	16.0	38.0	0.1	3	●
16.000	16.000	± 0.02	16.00	15.00	150	12.0	52.0	0.1	3	●
16.001	16.000	± 0.02	16.00	15.00	150	20.0	52.0	0.1	3	●
18.000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

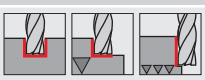
PCD End mills Z=4



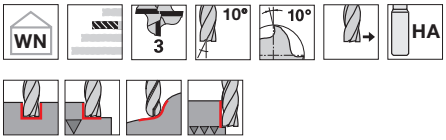
Tool material	PCD
Surface finish	◯
Cutting direction	Ⓡ



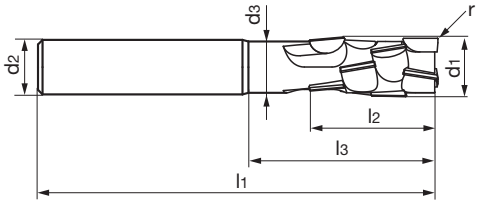
d1 mm	d1 inch	d2 h6 mm	d3 mm	l1 mm	l2 mm	l3 mm	c mm x 45°	Z	Material number
8.000		8.00	7.40	75.00	19.50	38.50	0.20	4	303 206 512
9.525	3/8	10.00	8.92	80.00	19.50	39.26	0.20	4	303 206 513
10.000		10.00	9.40	80.00	19.50	39.50	0.20	4	303 206 514
12.000		12.00	11.40	88.00	19.50	42.50	0.20	4	303 206 515
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.)

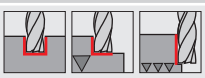
PCD Compression milling cutters Z=3



Tool material	PCD
Cutting direction	R



d1 mm	d1 inch	d2 h6 mm	d3 mm	l1 mm	l2 mm	l3 mm	r mm	Material number
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				
Nom. Ø	Pitch P	Tapping size hole Ø	Core diameter of int. thread 6H*	
	mm	DIN 336 mm	min. mm	max. mm
M 1	0.25	**0.75**	0.729	0.785
M 1.1	0.25	**0.85**	0.829	0.885
M 1.2	0.25	**0.95**	0.929	0.985
M 1.4	0.30	**1.10**	1.075	1.142
M 1.6	0.35	**1.25**	1.221	1.321
M 1.8	0.35	**1.45**	1.421	1.521
M 2	0.40	**1.60**	1.567	1.679
M 2.2	0.45	**1.75**	1.713	1.838
M 2.5	0.45	**2.05**	2.013	2.138
M 3	0.50	**2.50**	2.459	2.599
M 3.5	0.60	**2.90**	2.850	3.010
M 4	0.70	**3.30**	3.242	3.422
M 4.5	0.75	**3.70**	3.688	3.878
M 5	0.80	**4.20**	4.134	4.334
M 6	1.00	**5.00**	4.917	5.153
M 7	1.00	**6.00**	5.917	6.153
M 8	1.25	**6.80**	6.647	6.912
M 9	1.25	**7.80**	7.647	7.912
M 10	1.50	**8.50**	8.376	8.676
M 11	1.50	**9.50**	9.376	9.676
M 12	1.75	**10.20**	10.106	10.441
M 14	2.00	**12.00**	11.835	12.210
M 16	2.00	**14.00**	13.835	14.210
M 18	2.50	**15.50**	15.294	15.744
M 20	2.50	**17.50**	17.294	17.744
M 22	2.50	**19.50**	19.294	19.744
M 24	3.00	**21.00**	20.752	21.252
M 27	3.00	**24.00**	23.752	24.252
M 30	3.50	**26.50**	26.211	26.771
M 33	3.50	**29.50**	29.211	29.771
M 36	4.00	**32.00**	31.670	32.270
M 39	4.00	**35.00**	34.670	35.270
M 42	4.50	**37.50**	37.129	37.799
M 45	4.50	**40.50**	40.129	40.799
M 48	5.00	**43.00**	42.587	43.297
M 52	5.00	**47.00**	46.587	47.297
M 56	5.50	**50.50**	50.046	50.796

ISO metric fine threads DIN 13				
Nom. Ø x Pitch P	Tapping size hole Ø	Core diameter of int. thread 6H		
mm	DIN 336 mm	min. mm	max. mm	
M 2.5 x 0.35	**2.15**	2.121	2.221	
M 3.0 x 0.35	**2.65**	2.621	2.721	
M 3.5 x 0.35	**3.15**	3.121	3.221	
M 4.0 x 0.50	**3.50**	3.459	3.599	
M 4.5 x 0.50	**4.00**	3.959	4.099	
M 5.0 x 0.50	**4.50**	4.459	4.599	
M 5.5 x 0.50	**5.00**	4.959	5.099	
M 6.0 x 0.75	**5.20**	5.188	5.378	
M 7.0 x 0.75	**6.20**	6.188	6.378	
M 8.0 x 0.50	**7.50**	7.459	7.599	
M 8.0 x 0.75	**7.20**	7.188	7.378	
M 8.0 x 1.00	**7.00**	6.917	7.153	
M 9.0 x 0.75	**8.20**	8.188	8.378	
M 9.0 x 1.00	**8.00**	7.917	8.153	
M 10 x 0.75	**9.20**	9.188	9.378	
M 10 x 1.00	**9.00**	8.917	9.153	
M 10 x 1.25	**8.80**	8.647	8.912	
M 11 x 0.75	**10.20**	10.188	10.378	
M 11 x 1.00	**10.00**	9.917	10.153	
M 12 x 1.00	**11.00**	10.917	11.153	
M 12 x 1.25	**10.80**	10.647	10.912	
M 12 x 1.50	**10.50**	10.376	10.676	
M 14 x 1.00	**13.00**	12.917	13.153	
M 14 x 1.25	**12.80**	12.647	12.912	
M 14 x 1.50	**12.50**	12.376	12.676	
M 15 x 1.00	**14.00**	13.917	14.153	
M 15 x 1.50	**13.50**	13.376	13.676	
M 16 x 1.00	**15.00**	14.917	15.153	
M 16 x 1.25	**14.80**	14.647	14.912	
M 16 x 1.50	**14.50**	14.376	14.676	
M 17 x 1.00	**16.00**	15.917	16.153	
M 17 x 1.50	**15.50**	15.376	15.676	
M 18 x 1.00	**17.00**	16.917	17.153	
M 18 x 1.50	**16.50**	16.376	16.676	
M 20 x 1.00	**19.00**	18.917	19.153	
M 20 x 1.50	**18.50**	18.376	18.676	
M 20 x 2.00	**18.00**	17.835	18.210	
M 22 x 1.00	**21.00**	20.917	21.153	
M 22 x 1.50	**20.50**	20.376	20.676	
M 22 x 2.00	**20.00**	19.835	20.210	
M 24 x 1.00	**23.00**	22.917	23.153	
M 24 x 1.50	**22.50**	22.376	22.676	
M 24 x 2.00	**22.00**	21.835	22.210	
M 25 x 1.00	**24.00**	23.917	24.153	
M 25 x 1.50	**23.50**	23.376	23.676	
M 25 x 2.00	**23.00**	22.835	23.210	
M 27 x 1.00	**26.00**	25.917	26.153	
M 27 x 1.50	**25.50**	25.376	25.676	
M 27 x 2.00	**25.00**	24.835	25.210	
M 28 x 1.00	**27.00**	26.917	27.153	
M 28 x 1.50	**26.50**	26.376	26.676	
M 28 x 2.00	**26.00**	25.835	26.210	
M 30 x 1.00	**29.00**	28.917	29.153	
M 30 x 1.50	**28.50**	28.376	28.676	
M 30 x 2.00	**28.00**	27.835	28.210	
M 30 x 3.00	**27.00**	26.752	27.252	
M 32 x 1.50	**30.50**	30.376	30.676	
M 32 x 2.00	**30.00**	29.835	30.210	
M 33 x 1.50	**31.50**	31.376	31.676	
M 33 x 2.00	**31.00**	30.835	31.210	
M 33 x 3.00	**30.00**	29.752	30.252	
M 35 x 1.50	**33.50**	33.376	33.676	
M 36 x 1.50	**34.50**	34.376	34.676	

UNC threads ASME B1.1				
Nom. Ø	Thread	Tapping size hole Ø	Core diameter of int. thread 2B	
	per inch	DIN 336 mm	min. mm	max. mm
No. 1 -	64	**1.55**	1.425	1.580
No. 2 -	56	**1.85**	1.694	1.872
No. 3 -	48	**2.10**	1.941	2.146
No. 4 -	40	**2.35**	2.157	2.385
No. 5 -	40	**2.65**	2.487	2.698
No. 6 -	32	**2.85**	2.642	2.896
No. 8 -	32	**3.50**	3.302	3.531
No. 10 -	24	**3.90**	3.683	3.937
No. 12 -	24	**4.50**	4.343	4.597
1/4 -	20	**5.10**	4.978	5.258
5/16 -	18	**6.60**	6.401	6.731
3/8 -	16	**8.00**	7.798	8.153
7/16 -	14	**9.40**	9.144	9.550
1/2 -	13	**10.80**	10.592	11.024
9/16 -	12	**12.20**	11.989	12.446
5/8 -	11	**13.50**	13.386	13.868
3/4 -	10	**16.50**	16.307	16.840
7/8 -	9	**19.50**	19.177	19.761
1 -	8	**22.25**	21.971	22.606
1 1/8 -	7	**25.00**	24.638	25.349
1 1/4 -	7	**28.00**	27.813	28.524
1 3/8 -	6	**30.75**	30.353	31.115
1 1/2 -	6	**34.00**	33.528	34.290
1 3/4 -	5	**39.50**	38.938	39.802
2 -	4.5	**45.00**	44.679	45.593

* 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				
Nom. Ø	Thread per inch	Tapping size hole Ø DIN 336 mm	Core diameter of int. thread 2B min. mm	Core diameter of int. thread 2B max. mm
No. 1 -	72	**1.55**	1.473	1.610
No. 2 -	64	**1.85**	1.755	1.910
No. 3 -	56	**2.15**	2.024	2.197
No. 4 -	48	**2.40**	2.271	2.459
No. 5 -	44	**2.70**	2.550	2.741
No. 6 -	40	**2.95**	2.819	3.023
No. 8 -	36	**3.50**	3.404	3.607
No. 10 -	32	**4.10**	3.962	4.166
No. 12 -	28	**4.60**	4.496	4.724
1/4 -	28	**5.50**	5.359	5.588
5/16 -	24	**6.90**	6.782	7.036
3/8 -	24	**8.50**	8.382	8.636
7/16 -	20	**9.90**	9.728	10.033
1/2 -	20	**11.50**	11.328	11.608
9/16 -	18	**12.90**	12.751	13.081
5/8 -	18	**14.50**	14.351	14.681
3/4 -	16	**17.50**	17.323	17.678
7/8 -	14	**20.40**	20.269	20.650
1 -	12	**23.25**	23.114	23.571
1 1/8 -	12	**26.50**	26.289	26.746
1 1/4 -	12	**29.50**	29.464	29.921
1 3/8 -	12	**32.75**	32.639	33.096
1 1/2 -	12	**36.00**	35.814	36.271

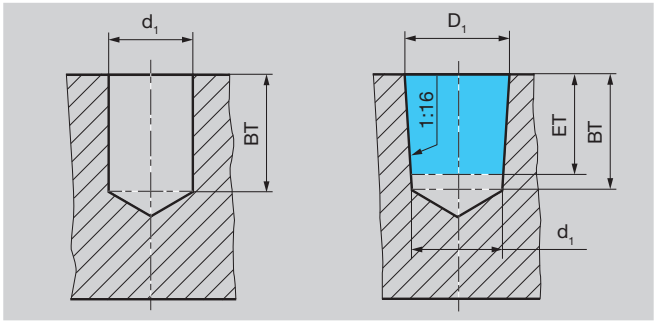
BSW threads BS84				
Nom. Ø	Thread per inch	Tapping size hole Ø mm	Core diameter of int. thread min. mm	Core diameter of int. thread max. mm
W 1/16	60	**1.20**	1.045	1.230
W 3/32	48	**1.80**	1.704	1.912
W 1/8	40	**2.50**	2.362	2.591
W 5/32	32	**3.20**	2.952	3.214
W 3/16	24	**3.60**	3.407	3.745
W 7/32	24	**4.50**	4.201	4.539
W 1/4	20	**5.10**	4.724	5.156
W 5/16	18	**6.50**	6.130	6.590
W 3/8	16	**7.90**	7.492	7.987
W 7/16	14	**9.20**	8.789	9.330
W 1/2	12	**10.50**	9.989	10.591
W 9/16	12	**12.00**	11.577	12.179
W 5/8	11	**13.50**	12.918	13.558
W 3/4	10	**16.25**	15.797	16.483
W 7/8	9	**19.25**	18.611	19.353
W 1	8	**22.00**	21.334	22.147
W 1 1/8	7	**24.50**	23.928	24.832
W 1 1/4	7	**27.75**	27.103	28.007
W 1 3/8	6	**30.50**	29.504	30.528
W 1 1/2	6	**33.50**	32.679	33.703
W 1 5/8	5	**35.50**	34.769	35.963
W 1 3/4	5	**39.00**	37.944	39.138
W 2	4.5	**44.50**	43.571	44.877

BSP threads (DIN-ISO 228-1)				
Nom. Ø	Thread per inch	Tapping size hole Ø DIN 336 mm	Core diameter of int. thread min. mm	Core diameter of int. thread max. mm
G 1/16	28	**6.80**	6.561	6.843
G 1/8	28	**8.80**	8.566	8.848
G 1/4	19	**11.80**	11.445	11.890
G 3/8	19	**15.25**	14.950	15.395
G 1/2	14	**19.00**	18.631	19.172
G 5/8	14	**21.00**	20.587	21.128
G 3/4	14	**24.50**	24.117	24.658
G 7/8	14	**28.25**	27.877	28.418
G 1	11	**30.75**	30.291	30.931
G 1 1/8	11	**35.50**	34.939	35.579
G 1 1/4	11	**39.50**	38.952	39.592
G 1 1/2	11	**45.25**	44.845	45.485
G 1 3/4	11	**51.00**	50.788	51.428
G 2	11	**57.00**	56.656	57.296

Steel armoured conduit threads to DIN 40430				
Nom. Ø	Thread per inch	Tapping size hole Ø mm	Core diameter of int. thread min. mm	Core diameter of int. thread max. mm
Pg 7	20	**11.40**	11.280	11.430
Pg 9	18	**14.00**	13.860	14.010
Pg 11	18	**17.30**	17.260	17.410
Pg 13.5	18	**19.00**	19.060	19.210
Pg 16	18	**21.30**	21.160	21.310
Pg 21	16	**26.90**	26.780	27.030
Pg 29	16	**35.50**	35.480	35.730
Pg 36	16	**45.50**	45.480	45.730
Pg 42	16	**52.50**	52.480	52.730
Pg 48	16	**57.80**	57.780	58.030

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	Cutting depth BT (min) mm
1/16	- 27	**6.15**	6.39	9.29	10.7
1/8	- 27	**8.40**	8.74	9.32	10.8
1/4	- 18	**11.10**	**11.36**	13.52	15.6
3/8	- 18	**14.30**	**14.80**	13.83	16.0
1/2	- 14	**17.90**	**18.32**	18.07	20.8
3/4	- 14	**23.30**	**23.67**	18.55	21.3
1	- 11,5	**29.00**	**29.69**	22.29	25.6
1 1/4	- 11,5	**37.70**	**38.45**	22.80	26.1
1 1/2	- 11,5	**43.70**	**44.52**	22.80	26.1
2	- 11,5	**55.60**	**56.56**	23.20	26.5
2 1/2	- 8	**66.30**	**67.62**	31.75	36.3
3	- 8	**82.30**	**83.52**	33.74	38.5

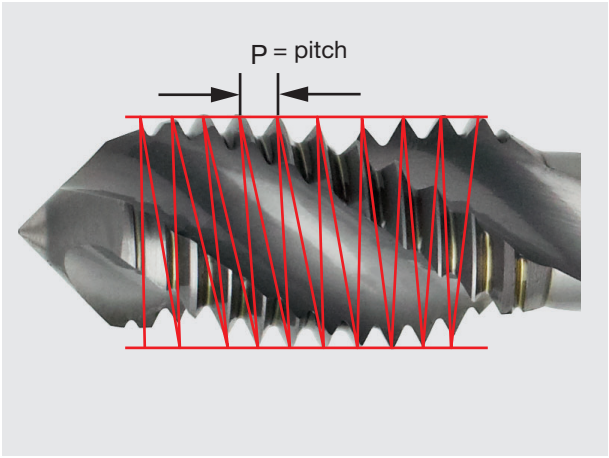
Metric/metric fine EG-threads (EG M14 x 1.25) for wire thread inserts DIN 8140				
Nom. Ø x Pitch P	Tapping size hole Ø mm	Core diameter of int. thread min. mm	Core diameter of int. thread max. mm	
EG M 4 x 0.70	**4.20**	4.152	4.292	
EG M 5 x 0.80	**5.25**	5.174	5.334	
EG M 6 x 1.00	**6.30**	6.217	6.407	
EG M 8 x 1.25	**8.40**	8.271	8.483	
EG M10 x 1.50	**10.50**	10.324	10.560	
EG M12 x 1.75	**12.50**	12.379	12.644	
EG M14 x 1.25	**14.40**	14.271	14.483	
EG M16 x 2.00	**16.50**	16.433	16.733	

UNC (UNC-STI) EG-threads for wire thread inserts ASME B18.29.1				
Nom. Ø	Thread per inch	Tapping size hole Ø mm	Core diameter of int. thread min. mm	Core diameter of int. thread max. mm
EG No. 6 -	32	**3.80**	3.678	3.879
EG No. 8 -	32	**4.40**	4.338	4.524
EG No. 10 -	24	**5.20**	5.055	5.283
EG No. 12 -	24	**5.80**	5.715	5.944
EG 1/4 -	20	**6.70**	6.624	6.868
EG 5/16 -	18	**8.40**	8.242	8.489
EG 3/8 -	16	**10.00**	9.868	10.127
EG 7/16 -	14	**11.60**	11.506	11.783
EG 1/2 -	13	**13.30**	13.122	13.393
EG 9/16 -	12	**14.90**	14.747	15.032
EG 5/8 -	11	**16.50**	16.375	16.673

UNF (UNF-STI) EG-threads for wire thread inserts ASME B18.29.1				
Nom. Ø	Thread per inch	Tapping size hole Ø mm	Core diameter of int. thread min. mm	Core diameter of int. thread max. mm
EG No. 6 -	40	**3.70**	3.644	3.818
EG No. 8 -	36	**4.40**	4.321	4.498
EG No. 10 -	32	**5.10**	4.999	5.184
EG No. 12 -	28	**5.70**	5.682	5.809
EG 1/4 -	28	**6.60**	6.546	6.721
EG 5/16 -	24	**8.25**	8.166	8.352
EG 3/8 -	24	**9.80**	9.754	9.931
EG 7/16 -	20	**11.50**	11.389	11.585
EG 1/2 -	20	**13.10**	12.974	13.172
EG 9/16 -	18	**14.70**	14.592	14.798
EG 5/8 -	18	**16.25**	16.180	16.386

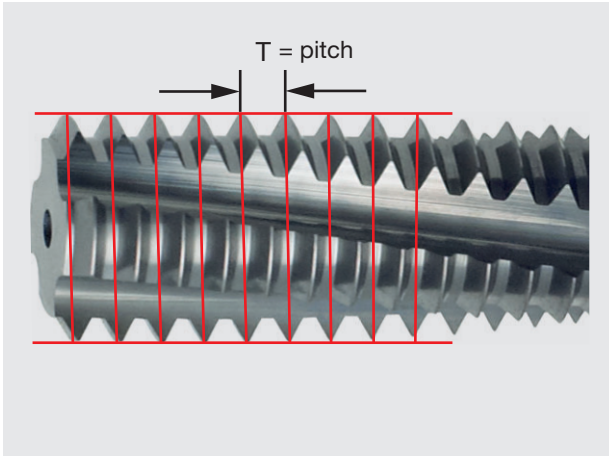
Difference between taps/fluteless taps and thread milling cutters

Taps/fluteless taps



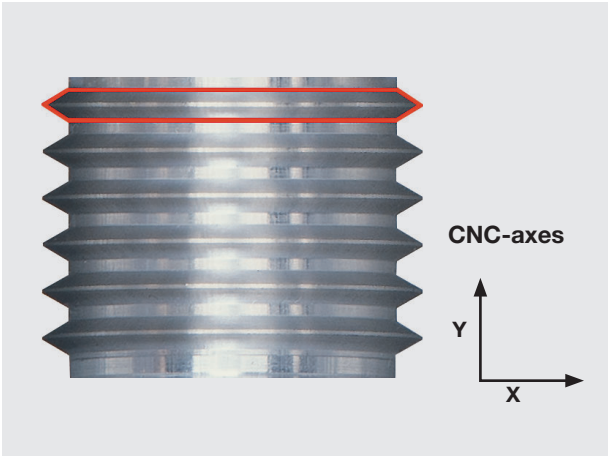
The red lines show the pitch angle of the thread that is ground into the tool. This means the pitch is cut into the workpiece by the tool.

Thread milling cutter

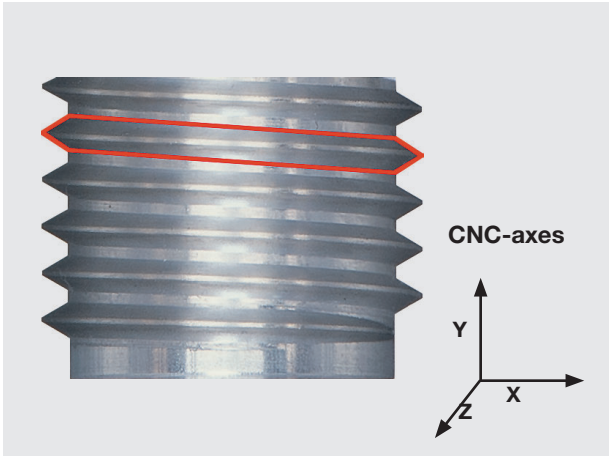


The red lines show that the tool does not possess a pitch angle. The pitch is produced by the Z-axis of a CNC machine.

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.



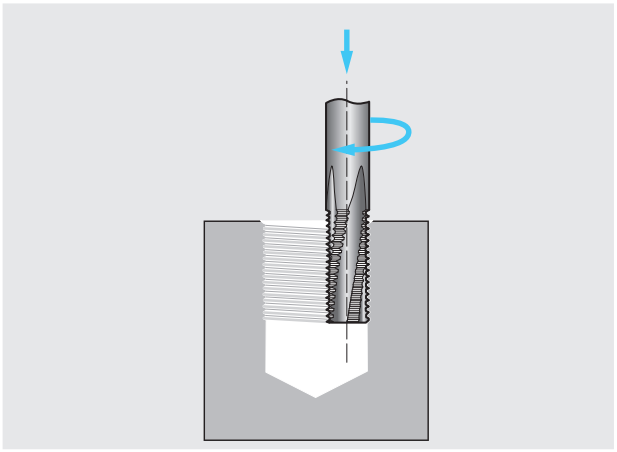
Through the additional programming of the Z-axis the necessary pitch is produced.

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

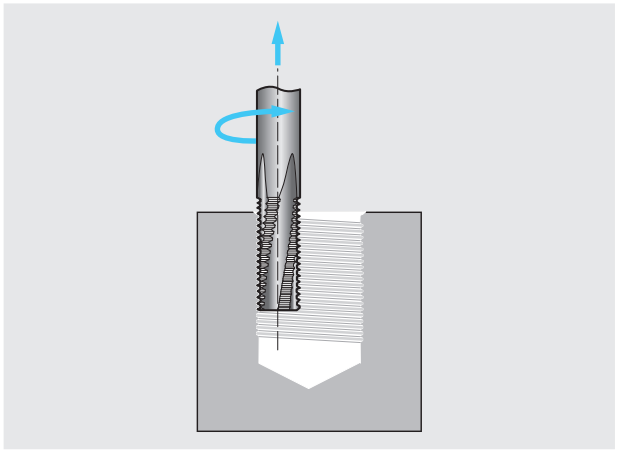
clockwise, with G02



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

Synchronous milling

anticlockwise, with G03

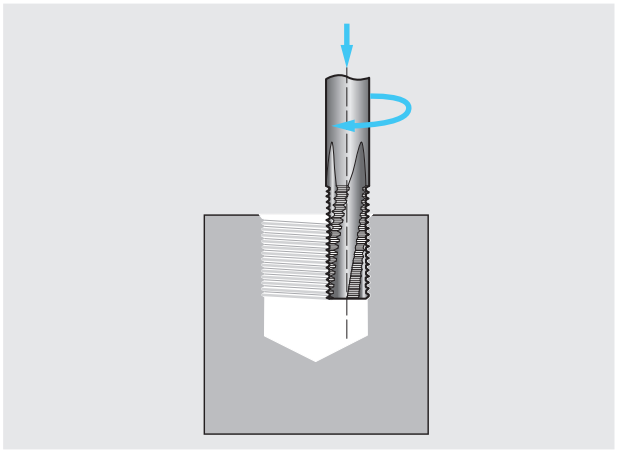


Synchronous milling is applied with thread depths smaller than 1.5xD.
Advantage: A better surface finish is achieved.

Thread production with one tool

Right-hand thread

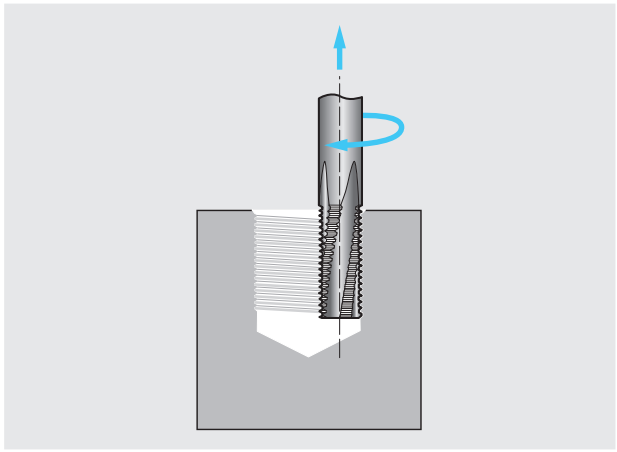
Reverse rotation milling



Tool rotates clockwise from top to bottom

Left-hand thread

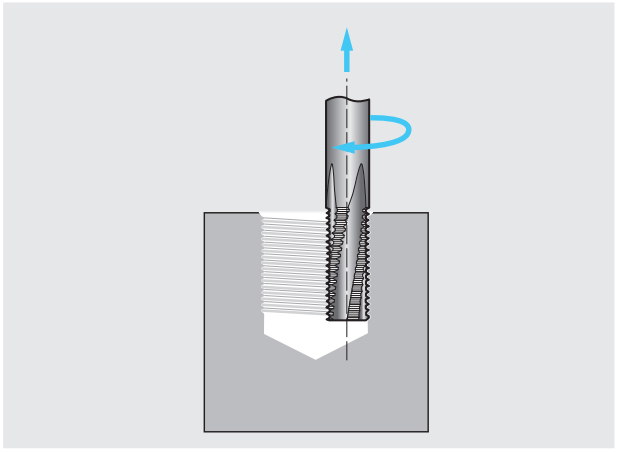
Reverse rotation milling



Tool rotates clockwise from bottom to top

Right-hand thread

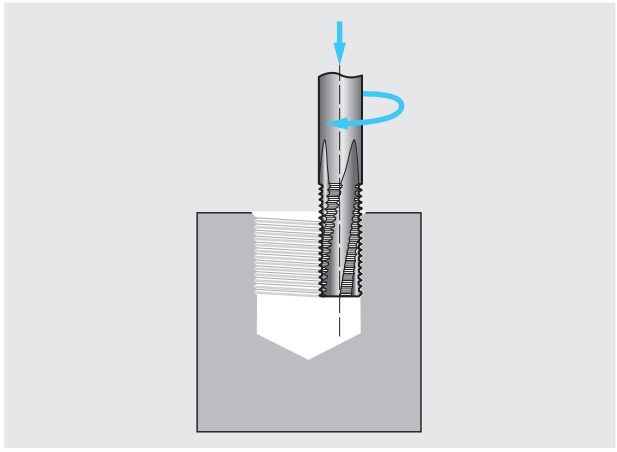
Synchronous milling



Tool rotates clockwise from bottom to top

Left-hand thread

Synchronous milling



Tool rotates clockwise from top to bottom

Thread milling programming

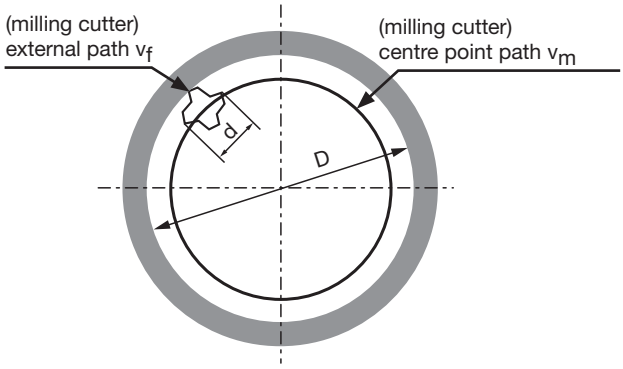
Program specifications

Thread milling functions

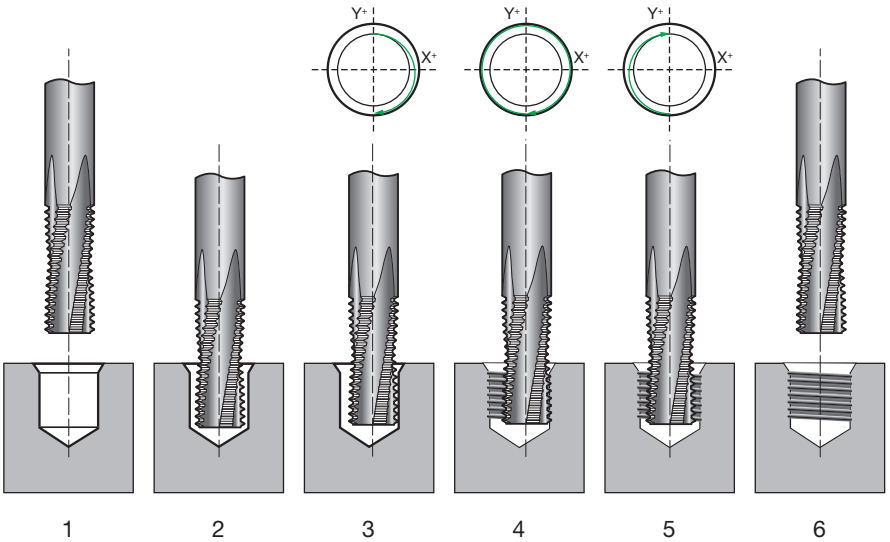
G00	Rapid movement	**G90**	Absolute dimension
G01	Feed	**G91**	Incremental dimension
G02	Circular interpolation (clockwise)	**M03**	Spindle on (clockwise rotation)
G03	Circular interpolation (anti-clockwise)	**M05**	Spindle stop
G17	Layer selection x-y axis	**M08**	Coolant on
G18	Layer selection z-x 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



entry cycle 180°
(always half feed rate)



Formula of calculation

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

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

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

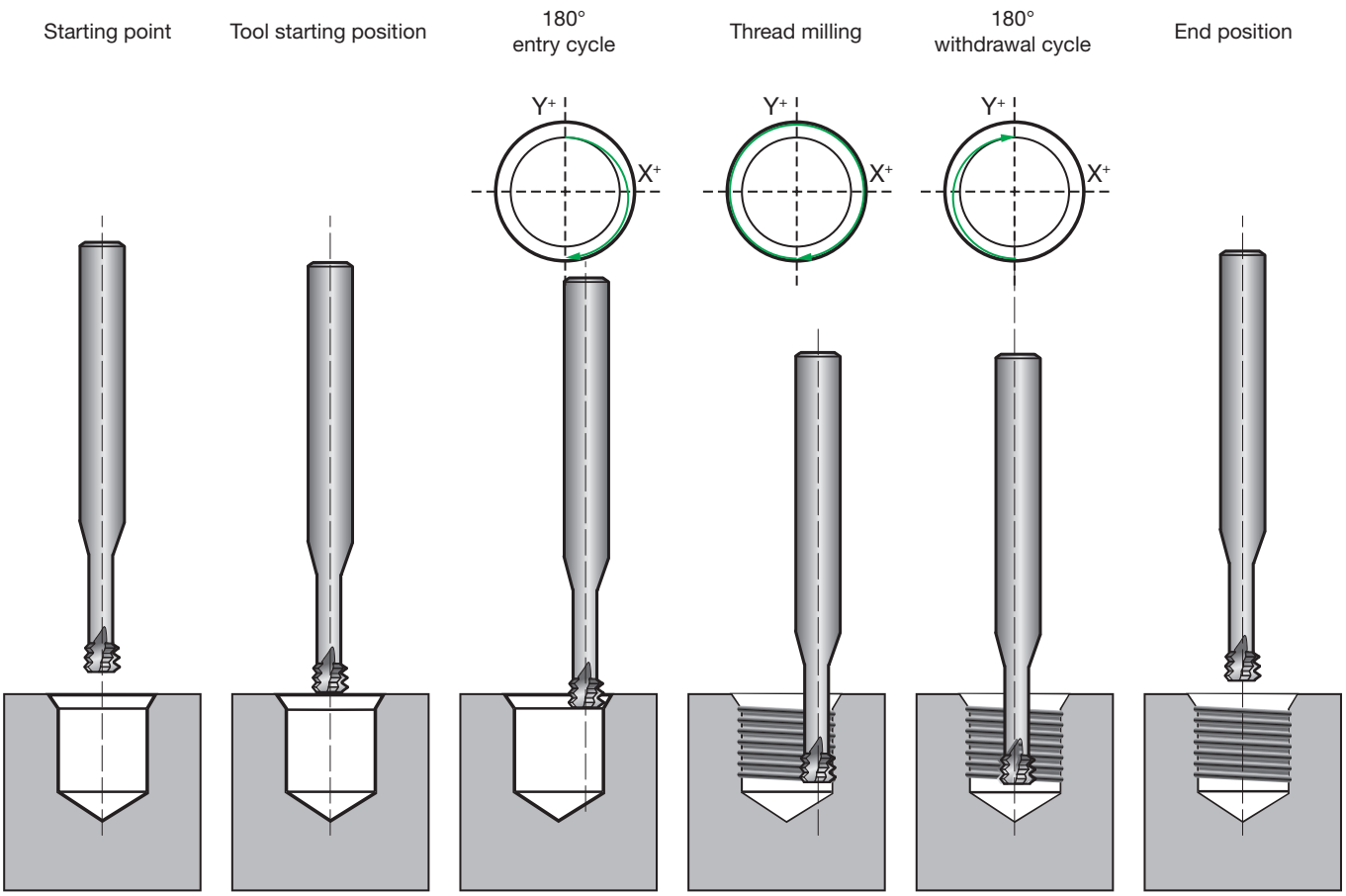
$$v_m = \frac{v_f \cdot (D - d)}{D}$$

$$v_b = n \cdot f_b$$

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)



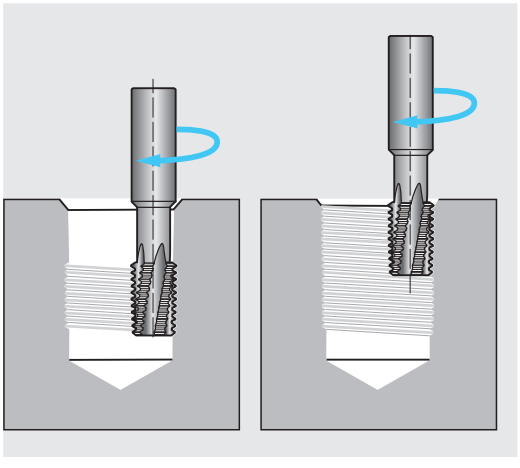
Possibilities to reduce radial forces

To reduce radial forces cut distribution can be undertaken:

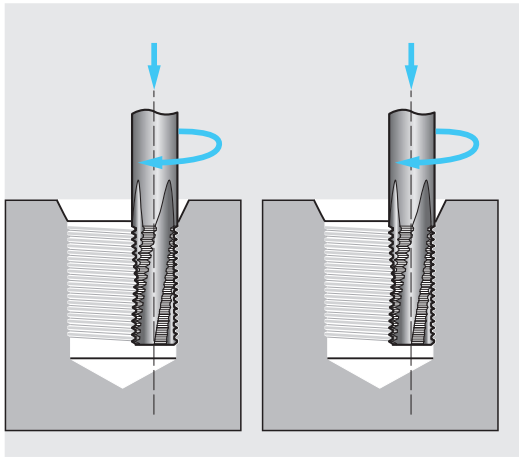
Advantage:
- for larger thread depths
- counteracts taper threads
- for unstable clamping conditions

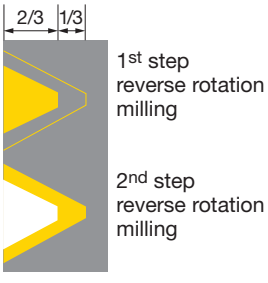
Disadvantage:
- increased tool wear
- longer production time

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) rom point.
2.) Measure tool radius with tool pre-setting equipment. General rule: measured radius - 0.022 x 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 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

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