



## THREAD MILLING CUTTERS

### Thread milling cutters without chamfer - NPT threads

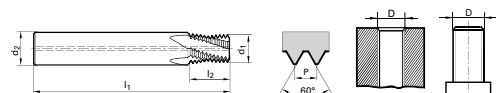
Series 3753 3754



|                  |               |       |
|------------------|---------------|-------|
| Tool material    | Solid Carbide |       |
| Coating          | TiCN*         | TiCN* |
| Type             | TM SP         | TM SP |
| Shank            | HA            | HB    |
| Coolant delivery | axial         | axial |

| Material              |                 | Suitability |
|-----------------------|-----------------|-------------|
| <b>P</b>              | Steel           | ●           |
| <b>M</b>              | Stainless steel | ●           |
| <b>K</b>              | Cast iron       | ●           |
| <b>N</b>              | Aluminum        | ●           |
| <b>S</b>              | Ni / Ti alloys  | ●           |
| <b>H</b>              | Hardened steel  | ○           |
| ●=Optimal ○=Secondary |                 |             |

For internal and external threading



\* TiCN coated thread mills will transition to Sirius coating as stock is replenished

| D<br>Ø | TPI | d1<br>mm | d2<br>mm | l1<br>mm | l2<br>mm | No. of<br>flutes | Code no. | EDP Number    | EDP Number    |
|--------|-----|----------|----------|----------|----------|------------------|----------|---------------|---------------|
| 1/16   | 27  | 5.90     | 8.00     | 54.00    | 9.90     | 3                | 8.190    | 9037530081900 | 9037540081900 |
| 1/8    | 27  | 7.30     | 8.00     | 64.00    | 9.90     | 3                | 10.620   | 9037530106200 | 9037540106200 |
| 1/4    | 18  | 9.95     | 12.00    | 72.00    | 19.05    | 4                | 14.140   | 9037530141400 | 9037540141400 |
| 3/8    | 18  | 12.20    | 14.00    | 80.00    | 14.82    | 4                | 17.570   | 9037530175700 | 9037540175700 |

See page 84 for machining parameters

See page 74 for tap/drill size info

## THREAD MILLING CUTTERS



### Thread milling cutters without chamfer - NPTF threads

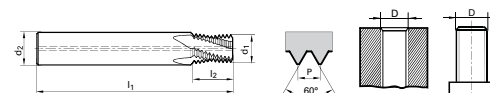
Series 3756 3757



|                  |               |       |
|------------------|---------------|-------|
| Tool material    | Solid Carbide |       |
| Coating          | TiCN*         | TiCN* |
| Type             | TM SP         | TM SP |
| Shank            | HA            | HB    |
| Coolant delivery | axial         | axial |

| Material              |                 | Suitability |
|-----------------------|-----------------|-------------|
| <b>P</b>              | Steel           | ●           |
| <b>M</b>              | Stainless steel | ●           |
| <b>K</b>              | Cast iron       | ●           |
| <b>N</b>              | Aluminum        | ●           |
| <b>S</b>              | Ni / Ti alloys  | ●           |
| <b>H</b>              | Hardened steel  | ○           |
| ●=Optimal ○=Secondary |                 |             |

For internal and external threading



\* TiCN coated thread mills will transition to Sirius coating as stock is replenished

| D<br>Ø | TPI | d1<br>mm | d2<br>mm | l1<br>mm | l2<br>mm | No. of<br>flutes | Code no. | EDP Number    | EDP Number    |
|--------|-----|----------|----------|----------|----------|------------------|----------|---------------|---------------|
| 1/16   | 27  | 5.90     | 8.00     | 54.00    | 9.90     | 3                | 8.190    | 9037560081900 | 9037570081900 |
| 1/8    | 27  | 7.30     | 8.00     | 64.00    | 9.90     | 3                | 10.620   | 9037560106200 | 9037570106200 |
| 1/4    | 18  | 9.95     | 12.00    | 72.00    | 19.05    | 4                | 14.140   | 9037560141400 | 9037570141400 |
| 3/8    | 18  | 12.20    | 14.00    | 80.00    | 14.82    | 4                | 17.570   | 9037560175700 | 9037570175700 |

See page 84 for machining parameters

See page 74 for tap/drill size info

### Application recommendations thread milling cutters and micro thread milling cutters

| ISO      |                                                                                 | Hardness HRC           | Hardness Brinell | Cutting speed SFM | Milling part diameter [d1] / feed per tooth [IPT] |        |        |        |        |        |        |        |        |
|----------|---------------------------------------------------------------------------------|------------------------|------------------|-------------------|---------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|
|          |                                                                                 |                        |                  |                   | Ø1 mm                                             | Ø2 mm  | Ø3 mm  | Ø4 mm  | Ø5 mm  | Ø6 mm  | Ø7 mm  | Ø8 mm  | Ø9 mm  |
| <b>P</b> | Structural/free-cutting steels, Unalloyed heat-treatable-/ case hardened steels | < 22                   | < 220            | 300               | 0,0004                                            | 0,0008 | 0,0008 | 0,0010 | 0,0012 | 0,0014 | 0,0018 | 0,0020 | 0,0022 |
|          | Free-cutting steels, unalloyed case hardened steels, nitriding steels           | < 30                   | < 290            | 260               | 0,0004                                            | 0,0008 | 0,0008 | 0,0010 | 0,0012 | 0,0014 | 0,0018 | 0,0020 | 0,0022 |
|          | Alloyed heat-treatable steels, heat-treatable steels, high speed steels         | < 38                   | < 350            | 230               | 0,0004                                            | 0,0008 | 0,0008 | 0,0010 | 0,0012 | 0,0014 | 0,0018 | 0,0020 | 0,0022 |
| <b>M</b> | Stainless steel sulfured, austenitic                                            | < 30                   | < 290            | 180               | 0,0004                                            | 0,0008 | 0,0010 | 0,0012 | 0,0012 | 0,0012 | 0,0014 | 0,0016 | 0,0020 |
|          | Stainless and acid-resist. steel steels, martensitic                            | < 30                   | < 290            | 165               | 0,0004                                            | 0,0008 | 0,0010 | 0,0012 | 0,0012 | 0,0012 | 0,0014 | 0,0016 | 0,0020 |
|          | duplex and super duplex                                                         | < 40                   | < 375            | 150               | 0,0004                                            | 0,0008 | 0,0010 | 0,0012 | 0,0012 | 0,0012 | 0,0014 | 0,0016 | 0,0020 |
| <b>K</b> | cast iron                                                                       |                        | < 300            | 400               | 0,0004                                            | 0,0008 | 0,0010 | 0,0012 | 0,0014 | 0,0016 | 0,0018 | 0,002  | 0,0024 |
|          | Spher. graph. iron and mall. cast iron                                          |                        | < 350            | 330               | 0,0004                                            | 0,0008 | 0,0010 | 0,0012 | 0,0014 | 0,0016 | 0,0018 | 0,002  | 0,0024 |
|          | ADI, GGV                                                                        |                        | < 350            | 260               | 0,0004                                            | 0,0008 | 0,0010 | 0,0012 | 0,0014 | 0,0016 | 0,0018 | 0,002  | 0,0024 |
| <b>N</b> | Aluminium and wrought alloys                                                    |                        | 30 - 150         | 820               | 0,0008                                            | 0,0012 | 0,0014 | 0,0016 | 0,0018 | 0,0020 | 0,0022 | 0,0024 | 0,0026 |
|          | Aluminium- cast alloys                                                          | 6-12 % silicon content | --               | 750               | 0,0008                                            | 0,0012 | 0,0014 | 0,0016 | 0,0018 | 0,0020 | 0,0022 | 0,0024 | 0,0026 |
|          | Magnesium alloys                                                                |                        | < 150            | 600               | 0,0008                                            | 0,0012 | 0,0014 | 0,0016 | 0,0018 | 0,0020 | 0,0022 | 0,0024 | 0,0026 |
|          | Copper and copper alloys                                                        |                        | ≤ 120            | 425               | 0,0004                                            | 0,0008 | 0,0010 | 0,0012 | 0,0014 | 0,0016 | 0,0018 | 0,0020 | 0,0022 |
|          | Copper special alloys                                                           |                        | < 410            | 525               | 0,0004                                            | 0,0008 | 0,0010 | 0,0012 | 0,0014 | 0,0016 | 0,0018 | 0,0020 | 0,0022 |
|          | Plastics (thermoplastics, duroplastics)                                         |                        | --               | 1000              | 0,0008                                            | 0,0012 | 0,0016 | 0,0018 | 0,0020 | 0,0022 | 0,0024 | 0,0028 | 0,0031 |
| <b>S</b> | Titanium and titanium alloys                                                    |                        | < 350            | 130               | 0,0004                                            | 0,0004 | 0,0006 | 0,0008 | 0,0010 | 0,0012 | 0,0014 | 0,0016 | 0,0016 |
|          | Nickel, cobalt, iron alloys                                                     |                        | < 410            | 100               | 0,0004                                            | 0,0004 | 0,0006 | 0,0008 | 0,0010 | 0,0012 | 0,0014 | 0,0016 | 0,0016 |
| <b>H</b> | High tensile steels, hardened steels                                            | < 55                   | 150              | x                 | 0,0004                                            | 0,0006 | 0,0008 | 0,001  | 0,0012 | 0,0012 | 0,0014 | 0,0016 |        |
|          |                                                                                 | < 62                   | 165              | x                 | 0,0004                                            | 0,0006 | 0,0008 | 0,001  | 0,0012 | 0,0012 | 0,0014 | 0,0016 |        |

| TM                                                                                  | TMC                                                                                 | TMU                                                                                 | MTM3                                                                                | MTM1                                                                                | MTMH3                                                                               |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|  |  |  |  |  |  |

|  | Ø10 mm | Ø12 mm | Ø14 mm | Ø16 mm | Ø18 mm | Ø20 mm |   |   |   |   |   |   |   |
|--|--------|--------|--------|--------|--------|--------|---|---|---|---|---|---|---|
|  | 0,0024 | 0,0024 | 0,0026 | 0,0026 | 0,0028 | 0,0031 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0024 | 0,0024 | 0,0026 | 0,0026 | 0,0028 | 0,0031 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0024 | 0,0024 | 0,0026 | 0,0026 | 0,0028 | 0,0031 | ○ | ● | ● | ● | ● | ● | ● |
|  | 0,0022 | 0,0024 | 0,0026 | 0,0026 | 0,0028 | 0,0030 | ○ | ● | ● | ● | ● | ● | ● |
|  | 0,0022 | 0,0024 | 0,0026 | 0,0026 | 0,0028 | 0,0030 | ○ | ● | ● | ● | ● | ● | ● |
|  | 0,0022 | 0,0024 | 0,0026 | 0,0026 | 0,0028 | 0,0030 | ○ | ● | ● | ● | ● | ● | ● |
|  | 0,0026 | 0,0028 | 0,0031 | 0,0035 | 0,0039 | 0,0047 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0026 | 0,0028 | 0,0031 | 0,0035 | 0,0039 | 0,0047 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0026 | 0,0028 | 0,0031 | 0,0035 | 0,0039 | 0,0047 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0028 | 0,0031 | 0,0033 | 0,0035 | 0,0039 | 0,0047 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0028 | 0,0031 | 0,0033 | 0,0035 | 0,0039 | 0,0047 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0028 | 0,0031 | 0,0033 | 0,0035 | 0,0039 | 0,0047 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0024 | 0,0026 | 0,0028 | 0,0030 | 0,0031 | 0,0035 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0024 | 0,0024 | 0,0026 | 0,0028 | 0,0030 | 0,0031 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0035 | 0,0035 | 0,0039 | 0,0047 | 0,0051 | 0,0059 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0018 | 0,0020 | 0,0022 | 0,0024 | 0,0026 | 0,0028 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0018 | 0,0020 | 0,0022 | 0,0024 | 0,0026 | 0,0028 | ● | ● | ● | ● | ● | ● | ● |
|  | 0,0018 | 0,002  | 0,0022 | 0,0024 | 0,0026 | 0,0028 | ○ | ● | ○ | ● | ○ | ● | ● |
|  | 0,0018 | 0,002  | 0,0022 | 0,0024 | 0,0026 | 0,0028 | ○ | ● | ○ | ● | ○ | ● | ● |

- Optimal
- Secondary



## TM SP – Thread milling cutters without chamfer

# GUHRING

### CNC Data Sheet



Date 12.11.2019

| Machining Task                  |                  | Material                                       |
|---------------------------------|------------------|------------------------------------------------|
| Thread Dimension                | 3/8-16 UNC right | Structural- and free cutting steels, unalloyed |
| Length                          | 0.50 Inch        | tempered-/case hardened steels                 |
| countersink $\alpha = 90^\circ$ | No               |                                                |

| Tool                    |                         | Cutting Values                     |
|-------------------------|-------------------------|------------------------------------|
| Description             | TM SP 2xD ohne Senkfase | Milling                            |
| Milling cutter diameter | d1 = 0.301 Inch         | Vc 3543 Inch/min n 3747 1/min      |
| Programmed Radius       | 0.149 Inch              | fz 0.002 Inch/tooth                |
| Order-No                | 4128_9.525              | Vf 22.00 Inch/min Vm 4.37 Inch/min |

| NC-Options      |                                | Cycle Time           |
|-----------------|--------------------------------|----------------------|
| Machine Control | Sinumerik [DIN]                | Total Time 5.59 sec. |
| Cutting Path    | Center point path, incremental |                      |
| Milling process | Conventional milling           |                      |
| No. of passes   | One cut                        |                      |

**Note** CNC-program serves as a programming example and should be tested by simulation before use on component.

#### CNC-Code

; Tool= TM SP 2xD ohne Senkfase 3/8-16 UNC right  
; Material= P1  
; Vc=3543 Inch/min  
; fz=0.002 Inch/tooth  
; Conventional milling  
; One cut  
; Thread Type= Internal Right-Hand Thread

Attention, for controls that refer to outer path, values in brackets to be used!

EXAMPLE



#### CNC-Code

```
N10 M6 T1
N20 G90 G54 G00 X0.0000 Y0.0000
N30 Z0.0787 S3747 M3 M8
N40 Z-0.4187
N50 G91
N60 G42 G01 X0.0000 Y0.1505 F2.18 ;(F11.06)
N70 G02 X0.0000 Y-0.3380 I0.0000 J-0.1690 Z-0.0094
N80 G02 X0.0000 Y0.0000 I0.0000 J0.1875 Z-0.0625 F4.37 ;(F22.13)
N90 G02 X0.0000 Y0.3380 I0.0000 J0.1690 Z-0.0094
N100 G40 G01 X0.0000 Y-0.1505
N110 G90
N120 G00 Z0.0787 M9
N130 M30
```

Attention, for controls that refer to outer path, values in brackets to be used!



## Drill size for thread milling cutters

| Std. ISO metric threads<br>DIN 13 |            |                                   |                                     |        |
|-----------------------------------|------------|-----------------------------------|-------------------------------------|--------|
| nom. Ø                            | pitch<br>p | tapping<br>size hole Ø<br>DIN 336 | core diameter<br>of int. thread 6H* |        |
| mm                                | mm         | mm                                | min.                                | max.   |
| M 1                               | 0,25       | <b>0,75</b>                       | 0,729                               | 0,785  |
| M 1,1                             | 0,25       | <b>0,85</b>                       | 0,829                               | 0,885  |
| M 1,2                             | 0,25       | <b>0,95</b>                       | 0,929                               | 0,985  |
| M 1,4                             | 0,30       | <b>1,10</b>                       | 1,075                               | 1,142  |
| M 1,6                             | 0,35       | <b>1,25</b>                       | 1,221                               | 1,321  |
| M 1,8                             | 0,35       | <b>1,45</b>                       | 1,421                               | 1,521  |
| M 2                               | 0,40       | <b>1,60</b>                       | 1,567                               | 1,679  |
| M 2,2                             | 0,45       | <b>1,75</b>                       | 1,713                               | 1,838  |
| M 2,5                             | 0,45       | <b>2,05</b>                       | 2,013                               | 2,138  |
| M 3                               | 0,50       | <b>2,50</b>                       | 2,459                               | 2,599  |
| M 3,5                             | 0,60       | <b>2,90</b>                       | 2,850                               | 3,010  |
| M 4                               | 0,70       | <b>3,30</b>                       | 3,242                               | 3,422  |
| M 4,5                             | 0,75       | <b>3,70</b>                       | 3,688                               | 3,878  |
| M 5                               | 0,80       | <b>4,20</b>                       | 4,134                               | 4,334  |
| M 6                               | 1,00       | <b>5,00</b>                       | 4,917                               | 5,153  |
| M 7                               | 1,00       | <b>6,00</b>                       | 5,917                               | 6,153  |
| M 8                               | 1,25       | <b>6,80</b>                       | 6,647                               | 6,912  |
| M 9                               | 1,25       | <b>7,80</b>                       | 7,647                               | 7,912  |
| M 10                              | 1,50       | <b>8,50</b>                       | 8,376                               | 8,676  |
| M 11                              | 1,50       | <b>9,50</b>                       | 9,376                               | 9,676  |
| M 12                              | 1,75       | <b>10,20</b>                      | 10,106                              | 10,441 |
| M 14                              | 2,00       | <b>12,00</b>                      | 11,835                              | 12,210 |
| M 16                              | 2,00       | <b>14,00</b>                      | 13,835                              | 14,210 |
| M 18                              | 2,50       | <b>15,50</b>                      | 15,294                              | 15,744 |
| M 20                              | 2,50       | <b>17,50</b>                      | 17,294                              | 17,744 |
| M 22                              | 2,50       | <b>19,50</b>                      | 19,294                              | 19,744 |
| M 24                              | 3,00       | <b>21,00</b>                      | 20,752                              | 21,252 |
| M 27                              | 3,00       | <b>24,00</b>                      | 23,752                              | 24,252 |
| M 30                              | 3,50       | <b>26,50</b>                      | 26,211                              | 26,771 |
| M 33                              | 3,50       | <b>29,50</b>                      | 29,211                              | 29,771 |
| M 36                              | 4,00       | <b>32,00</b>                      | 31,670                              | 32,270 |
| M 39                              | 4,00       | <b>35,00</b>                      | 34,670                              | 35,270 |
| M 42                              | 4,50       | <b>37,50</b>                      | 37,129                              | 37,799 |
| M 45                              | 4,50       | <b>40,50</b>                      | 40,129                              | 40,799 |
| M 48                              | 5,00       | <b>43,00</b>                      | 42,587                              | 43,297 |
| M 52                              | 5,00       | <b>47,00</b>                      | 46,587                              | 47,297 |
| M 56                              | 5,50       | <b>50,50</b>                      | 50,046                              | 50,796 |

\* M 1,1 up to M 1,4 tapping size hole of int. thread 5H

| (Whitworth - BSPP) threads<br>(DIN-ISO 228-1) |                     |                        |                                 |        |
|-----------------------------------------------|---------------------|------------------------|---------------------------------|--------|
| nom. Ø                                        | threads<br>per inch | tapping<br>size hole Ø | core diameter<br>of int. thread |        |
| inch                                          |                     | mm                     | min.                            | max.   |
| G 1/16                                        | 28                  | <b>6,80</b>            | 6,561                           | 6,843  |
| G 1/8                                         | 28                  | <b>8,80</b>            | 8,566                           | 8,848  |
| G 1/4                                         | 19                  | <b>11,80</b>           | 11,445                          | 11,890 |
| G 3/8                                         | 19                  | <b>15,25</b>           | 14,950                          | 15,395 |
| G 1/2                                         | 14                  | <b>19,00</b>           | 18,631                          | 19,172 |
| G 5/8                                         | 14                  | <b>21,00</b>           | 20,587                          | 21,128 |
| G 3/4                                         | 14                  | <b>24,50</b>           | 24,117                          | 24,658 |
| G 1 1/4                                       | 11                  | <b>30,75</b>           | 30,291                          | 30,931 |
| G 1 1/8                                       | 11                  | <b>35,50</b>           | 34,939                          | 35,579 |
| G 1 1/2                                       | 11                  | <b>39,50</b>           | 38,952                          | 39,592 |
| G 1 3/4                                       | 11                  | <b>45,25</b>           | 44,845                          | 45,485 |
| G 1 7/8                                       | 11                  | <b>51,00</b>           | 50,788                          | 51,428 |
| G 2                                           | 11                  | <b>57,00</b>           | 56,656                          | 57,296 |

| ISO metric fine threads<br>DIN 13 |              |                                   |                                    |      |
|-----------------------------------|--------------|-----------------------------------|------------------------------------|------|
| nom. Ø                            | x pitch<br>p | tapping<br>size hole Ø<br>DIN 336 | core diameter<br>of int. thread 6H |      |
| mm                                | mm           | mm                                | min.                               | max. |
| M 2,5 x 0,35                      | <b>2,15</b>  | 2,121                             | 2,221                              |      |
| M 3,0 x 0,35                      | <b>2,65</b>  | 2,621                             | 2,721                              |      |
| M 3,5 x 0,35                      | <b>3,15</b>  | 3,121                             | 3,221                              |      |
| M 4,0 x 0,50                      | <b>3,50</b>  | 3,459                             | 3,599                              |      |
| M 4,5 x 0,50                      | <b>4,00</b>  | 3,959                             | 4,099                              |      |
| M 5,0 x 0,50                      | <b>4,50</b>  | 4,459                             | 4,599                              |      |
| M 5,5 x 0,50                      | <b>5,00</b>  | 4,959                             | 5,099                              |      |
| M 6,0 x 0,75                      | <b>5,20</b>  | 5,188                             | 5,378                              |      |
| M 7,0 x 0,75                      | <b>6,20</b>  | 6,188                             | 6,378                              |      |
| M 8,0 x 0,50                      | <b>7,50</b>  | 7,459                             | 7,599                              |      |
| M 8,0 x 0,75                      | <b>7,20</b>  | 7,188                             | 7,378                              |      |
| M 8,0 x 1,00                      | <b>7,00</b>  | 6,917                             | 7,153                              |      |
| M 9,0 x 0,75                      | <b>8,20</b>  | 8,188                             | 8,378                              |      |
| M 9,0 x 1,00                      | <b>8,00</b>  | 7,917                             | 8,153                              |      |
| M 10 x 0,75                       | <b>9,20</b>  | 9,188                             | 9,378                              |      |
| M 10 x 1,00                       | <b>9,00</b>  | 8,917                             | 9,153                              |      |
| M 10 x 1,25                       | <b>8,80</b>  | 8,647                             | 8,912                              |      |
| M 11 x 0,75                       | <b>10,20</b> | 10,188                            | 10,378                             |      |
| M 11 x 1,00                       | <b>10,00</b> | 9,917                             | 10,153                             |      |
| M 12 x 1,00                       | <b>11,00</b> | 10,917                            | 11,153                             |      |
| M 12 x 1,25                       | <b>10,80</b> | 10,647                            | 10,912                             |      |
| M 12 x 1,50                       | <b>10,50</b> | 10,376                            | 10,676                             |      |
| M 14 x 1,00                       | <b>12,00</b> | 12,917                            | 13,153                             |      |
| M 14 x 1,25                       | <b>12,80</b> | 12,647                            | 12,912                             |      |
| M 14 x 1,50                       | <b>12,50</b> | 12,376                            | 12,676                             |      |
| M 15 x 1,00                       | <b>14,00</b> | 13,917                            | 14,153                             |      |
| M 15 x 1,50                       | <b>13,50</b> | 13,376                            | 13,676                             |      |
| M 16 x 1,00                       | <b>15,00</b> | 14,917                            | 15,153                             |      |
| M 16 x 1,25                       | <b>14,80</b> | 14,647                            | 14,912                             |      |
| M 16 x 1,50                       | <b>14,50</b> | 14,376                            | 14,676                             |      |
| M 17 x 1,00                       | <b>16,00</b> | 15,917                            | 16,153                             |      |
| M 17 x 1,50                       | <b>15,50</b> | 15,376                            | 15,676                             |      |
| M 18 x 1,00                       | <b>17,00</b> | 16,917                            | 17,153                             |      |
| M 18 x 1,50                       | <b>16,50</b> | 16,376                            | 16,676                             |      |
| M 20 x 1,00                       | <b>19,00</b> | 18,917                            | 19,153                             |      |
| M 20 x 1,50                       | <b>18,50</b> | 18,376                            | 18,676                             |      |
| M 20 x 2,00                       | <b>18,00</b> | 17,835                            | 18,210                             |      |
| M 22 x 1,00                       | <b>21,00</b> | 20,917                            | 21,153                             |      |

| MJ threads<br>DIN ISO 5855 |              |                        |                                      |      |
|----------------------------|--------------|------------------------|--------------------------------------|------|
| nom. Ø                     | x pitch<br>p | tapping<br>size hole Ø | core diameter<br>of int. threads 5H* |      |
| mm                         | mm           | mm                     | min.                                 | max. |
| MJ 3 x 0,50                | <b>2,60</b>  | 2,513                  | 2,653                                |      |
| MJ 4 x 0,70                | <b>3,40</b>  | 3,318                  | 3,498                                |      |
| MJ 5 x 0,80                | <b>4,30</b>  | 4,221                  | 4,421                                |      |
| MJ 6 x 0,50                | <b>5,55</b>  | 5,513                  | 5,825                                |      |
| MJ 6 x 0,75                | <b>5,35</b>  | 5,269                  | 5,419                                |      |
| MJ 6 x 1,00                | <b>5,10</b>  | 5,026                  | 5,216                                |      |
| MJ 8 x 0,50                | <b>7,55</b>  | 7,513                  | 7,825                                |      |
| MJ 8 x 0,75                | <b>7,35</b>  | 7,269                  | 7,419                                |      |
| MJ 8 x 1,00                | <b>7,10</b>  | 7,026                  | 7,216                                |      |
| MJ 8 x 1,25                | <b>6,90</b>  | 6,782                  | 6,994                                |      |
| MJ 10 x 1,00               | <b>9,10</b>  | 9,026                  | 9,216                                |      |
| MJ 10 x 1,25               | <b>8,90</b>  | 8,782                  | 8,994                                |      |
| MJ 10 x 1,50               | <b>8,60</b>  | 8,539                  | 8,775                                |      |
| MJ 12 x 1,75               | <b>10,40</b> | 10,295                 | 10,560                               |      |
| MJ 16 x 2,00               | <b>14,20</b> | 14,051                 | 14,351                               |      |

| UNC-threads<br>ASME B1.1 |                     |                                   |                                    |      |
|--------------------------|---------------------|-----------------------------------|------------------------------------|------|
| nom. Ø                   | threads<br>per inch | tapping<br>size hole Ø<br>DIN 336 | core diameter<br>of int. thread 2B |      |
| inch                     |                     | mm                                | min.                               | max. |
| Nr. 1 - 64               | <b>1,55</b>         | 1,425                             | 1,580                              |      |
| Nr. 2 - 56               | <b>1,85</b>         | 1,694                             | 1,872                              |      |
| Nr. 3 - 48               | <b>2,10</b>         | 1,941                             | 2,146                              |      |
| Nr. 4 - 40               | <b>2,35</b>         | 2,157                             | 2,385                              |      |
| Nr. 5 - 40               | <b>2,65</b>         | 2,487                             | 2,698                              |      |
| Nr. 6 - 32               | <b>2,85</b>         | 2,642                             | 2,896                              |      |
| Nr. 8 - 32               | <b>3,50</b>         | 3,302                             | 3,531                              |      |
| Nr. 10 - 24              | <b>3,90</b>         | 3,683                             | 3,937                              |      |
| Nr. 12 - 24              | <b>4,50</b>         | 4,343                             | 4,597                              |      |
| 1/4 - 20                 | <b>5,10</b>         | 4,978                             | 5,258                              |      |
| 1/2 - 18                 | <b>6,60</b>         | 6,401                             | 6,731                              |      |
| 3/4 - 16                 | <b>8,00</b>         | 7,798                             | 8,153                              |      |
| 1 1/4 - 14               | <b>9,40</b>         | 9,144                             | 9,550                              |      |
| 1 1/2 - 13               | <b>10,80</b>        | 10,592                            | 11,024                             |      |
| 1 3/4 - 12               | <b>12,20</b>        | 11,989                            | 12,446                             |      |
| 2 - 11                   | <b>13,50</b>        | 13,386                            | 13,868                             |      |
| 2 1/4 - 10               | <b>16,50</b>        | 16,307                            | 16,840                             |      |
| 2 1/2 - 9                | <b>19,50</b>        | 19,177                            | 19,761                             |      |
| 3 - 8                    | <b>22,25</b>        | 21,971                            | 22,606                             |      |
| 3 1/4 - 7                | <b>25,00</b>        | 24,638                            | 25,349                             |      |
| 3 1/2 - 7                | <b>28,00</b>        | 27,813                            | 28,524                             |      |
| 4 - 6                    | <b>30,75</b>        | 30,353                            | 31,115                             |      |
| 4 1/4 - 6                | <b>34,00</b>        | 33,528                            | 34,290                             |      |
| 4 1/2 - 5                | <b>39,50</b>        | 38,938                            | 39,802                             |      |
| 5 - 4                    | <b>45,00</b>        | 44,679                            | 45,593                             |      |

| UNJC-threads<br>ISO 3161 |                     |                        |                                     |      |
|--------------------------|---------------------|------------------------|-------------------------------------|------|
| nom. Ø                   | threads<br>per inch | tapping<br>size hole Ø | core diameter<br>of int. threads 3B |      |
| inch                     |                     | mm                     | min.                                | max. |
| Nr. 6 - 32               | <b>2,85</b>         | 2,733                  | 2,939                               |      |
| Nr. 8 - 32               | <b>3,55</b>         | 3,393                  | 3,599                               |      |
| Nr. 10 - 24              | <b>4,00</b>         | 3,795                  | 4,064                               |      |
| Nr. 12 - 24              | <b>4,60</b>         | 4,455                  | 4,704                               |      |
| 1/4 - 20                 | <b>5,30</b>         | 5,113                  | 5,387                               |      |
| 1/2 - 18                 | <b>6,75</b>         | 6,563                  | 6,833                               |      |
| 3/4 - 16                 | <b>8,20</b>         | 7,978                  | 8,255                               |      |
| 1 1/4 - 14               | <b>9,60</b>         | 9,346                  | 9,639                               |      |
| 1 1/2 - 13               | <b>11,00</b>        | 10,798                 | 11,095                              |      |
| 1 3/4 - 12               | <b>12,40</b>        | 12,228                 | 12,482                              |      |
| 2 - 11                   | <b>13,80</b>        | 13,627                 | 13,904                              |      |

| UNJF-Threads<br>ISO 3161 |                     |                        |                           |      |
|--------------------------|---------------------|------------------------|---------------------------|------|
| nom. Ø                   | threads<br>per inch | tapping<br>size hole Ø | Kern-Ø<br>Innengewinde 3B |      |
| inch                     |                     | mm                     | min.                      | max. |
| Nr. 6 - 40               | <b>3,00</b>         | 2,888                  | 3,053                     |      |
| Nr. 8 - 36               | <b>3,60</b>         | 3,480                  | 3,663                     |      |
| Nr. 10 - 32              | <b>4,20</b>         | 4,054                  | 4,255                     |      |
| Nr. 12 - 28              | <b>4,75</b>         | 4,602                  | 4,816                     |      |
| 1/4 - 28                 | <b>5,60</b>         | 5,466                  | 5,662                     |      |
| 1/2 - 24                 | <b>7,00</b>         | 6,906                  | 7,109                     |      |
| 3/4 - 24                 | <b>8,60</b>         | 8,494                  | 8,679                     |      |
| 1 - 20                   | <b>10,00</b>        | 9,876                  | 10,084                    |      |
| 1 1/4 - 20               | <b>11,60</b>        | 11,463                 | 11,661                    |      |
| 1 1/2 - 18               | <b>13,00</b>        | 12,913                 | 13,122                    |      |
| 1 3/4 - 18               | <b>14,60</b>        | 14,501                 | 14,702                    |      |

## Drill size for thread milling cutters

| UNF-threads<br>ASME B1.1 |                     |                                    |
|--------------------------|---------------------|------------------------------------|
| nom. Ø                   | threads<br>per inch | core diameter<br>of int. thread 2B |
| inch                     |                     | mm                                 |
| Nr. 1 - 72               | <b>1,55</b>         | 1,473                              |
| Nr. 2 - 64               | <b>1,85</b>         | 1,755                              |
| Nr. 3 - 56               | <b>2,15</b>         | 2,024                              |
| Nr. 4 - 48               | <b>2,40</b>         | 2,271                              |
| Nr. 5 - 44               | <b>2,70</b>         | 2,550                              |
| Nr. 6 - 40               | <b>2,95</b>         | 2,819                              |
| Nr. 8 - 36               | <b>3,50</b>         | 3,404                              |
| Nr. 10 - 32              | <b>4,10</b>         | 3,962                              |
| Nr. 12 - 28              | <b>4,60</b>         | 4,496                              |
| 1/4 - 28                 | <b>5,50</b>         | 5,359                              |
| 1/2 - 24                 | <b>6,90</b>         | 6,782                              |
| 3/4 - 24                 | <b>8,50</b>         | 8,382                              |
| 1 - 20                   | <b>9,90</b>         | 9,728                              |
| 1 1/4 - 20               | <b>11,50</b>        | 11,328                             |
| 1 1/2 - 18               | <b>12,90</b>        | 12,751                             |
| 1 3/4 - 18               | <b>14,50</b>        | 14,351                             |
| 2 - 16                   | <b>17,50</b>        | 17,323                             |
| 2 1/4 - 14               | <b>20,40</b>        | 20,269                             |
| 2 1/2 - 12               | <b>23,25</b>        | 23,114                             |
| 2 3/4 - 12               | <b>26,50</b>        | 26,299                             |
| 3 - 12                   | <b>29,50</b>        | 29,464                             |
| 3 1/4 - 12               | <b>32,75</b>        | 32,639                             |
| 3 1/2 - 12               | <b>36,00</b>        | 35,814                             |

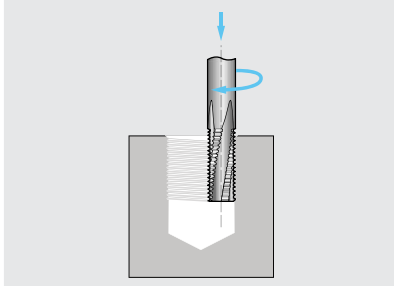
| UNC (UNC-STI) EG-threads<br>for wire thread inserts ASME B18.29.1 |                     |                        |                                 |
|-------------------------------------------------------------------|---------------------|------------------------|---------------------------------|
| nom. Ø                                                            | threads<br>per inch | tapping<br>size hole Ø | core diameter<br>of int. thread |
| inch                                                              |                     | mm                     | min. max.                       |
| EG Nr. 6 - 32                                                     | <b>3,80</b>         | 3,678                  | 3,879                           |
| EG Nr. 8 - 32                                                     | <b>4,40</b>         | 4,338                  | 4,524                           |
| EG Nr. 10 - 24                                                    | <b>5,20</b>         | 5,055                  | 5,283                           |
| EG Nr. 12 - 24                                                    | <b>5,80</b>         | 5,715                  | 5,944                           |
| EG 1/4 - 20                                                       | <b>6,70</b>         | 6,624                  | 6,868                           |
| EG 1/2 - 18                                                       | <b>8,40</b>         | 8,242                  | 8,489                           |
| EG 3/4 - 16                                                       | <b>10,00</b>        | 9,868                  | 10,127                          |
| EG 1 - 14                                                         | <b>11,60</b>        | 11,506                 | 11,783                          |
| EG 1 1/4 - 13                                                     | <b>13,30</b>        | 13,122                 | 13,393                          |
| EG 1 1/2 - 12                                                     | <b>14,90</b>        | 14,747                 | 15,032                          |
| EG 1 3/4 - 11                                                     | <b>16,50</b>        | 16,375                 | 16,673                          |

| EG UNF (UNF-STI) threads<br>for wire thread inserts ASME B18.29.1 |                        |                              |                                 |            |
|-------------------------------------------------------------------|------------------------|------------------------------|---------------------------------|------------|
| nom.<br>Ø                                                         | threads<br>per<br>inch | tapping<br>size hole Ø<br>mm | core diameter<br>of int. thread |            |
|                                                                   |                        |                              | min,<br>mm                      | max,<br>mm |
| EG Nr. 6 - 40                                                     |                        | <b>3.70</b>                  | 3.644                           | 3.818      |
| EG Nr. 8 - 36                                                     |                        | <b>4.40</b>                  | 4.321                           | 4.498      |
| EG Nr. 10 - 32                                                    |                        | <b>5.10</b>                  | 4.999                           | 5.184      |
| EG Nr. 12 - 28                                                    |                        | <b>5.70</b>                  | 5.682                           | 5.809      |
| EG 1/4 - 28                                                       |                        | <b>6.60</b>                  | 6.546                           | 6.721      |
| EG 1/2 - 24                                                       |                        | <b>8.25</b>                  | 8.166                           | 8.352      |
| EG 3/4 - 24                                                       |                        | <b>9.80</b>                  | 9.754                           | 9.931      |
| EG 1 - 20                                                         |                        | <b>11.50</b>                 | 11.389                          | 11.585     |
| EG 1 1/4 - 20                                                     |                        | <b>13.10</b>                 | 12.974                          | 13.172     |
| EG 1 1/2 - 18                                                     |                        | <b>14.70</b>                 | 14.592                          | 14.798     |
| EG 2 - 18                                                         |                        | <b>16.25</b>                 | 16.180                          | 16.386     |



### Reverse rotation milling

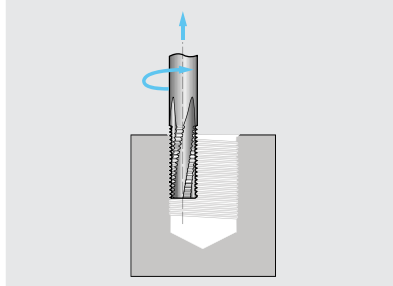
clockwise, with G02



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

### Synchronous milling

counter clockwise, with G03

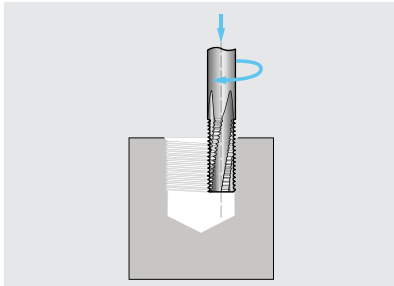


Synchronous milling is applied with thread depths smaller than 1.5xD.  
Advantage: A better surface finish is achieved.

### Thread production with one tool

#### Right-hand thread

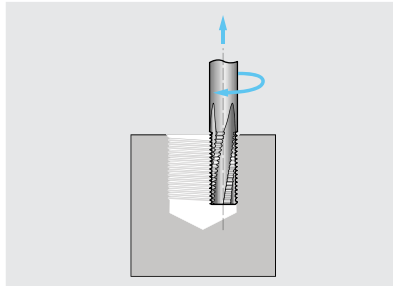
Reverse rotation milling



Tool rotates clockwise from top to bottom

#### Left-hand thread

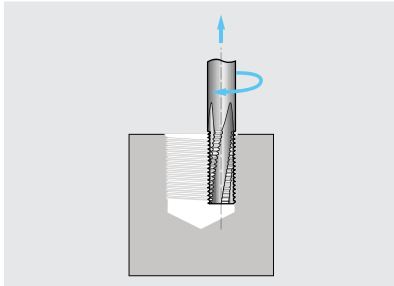
Reverse rotation milling



Tool rotates clockwise from bottom to top

#### Right-hand thread

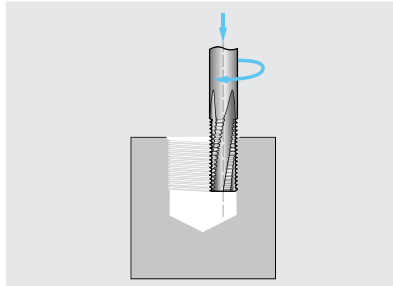
Synchronous milling



Tool rotates clockwise from bottom to top

#### Left-hand thread

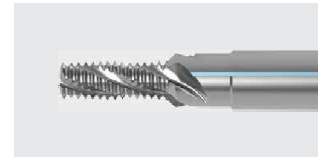
Synchronous milling



Tool rotates clockwise from top to bottom



### Illustration

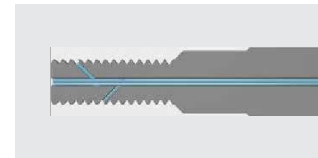


### Modification

Cooling slots on shank

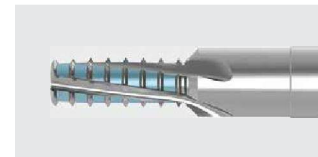
### Effect

Targeted cooling, without weakening the tool cross-section in the cutting edge area



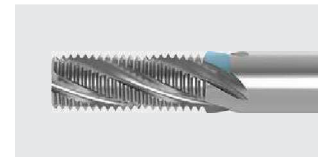
Radial coolant exits

Targeted cooling with through hole threads



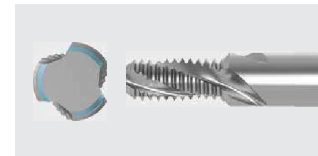
Threads removed

Reduced cutting forces but longer machining time because two cycles are required



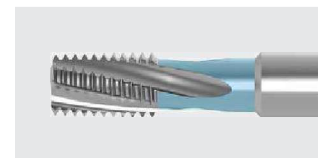
De-burring cutting edge

Removing the incomplete threads at the thread run-in without additional operating step



First thread profile lengthened at the face

Chamfering a tapping size hole



Grinding collar

Enables axial distribution of cuts – useful for deep threads

## Thread milling programming

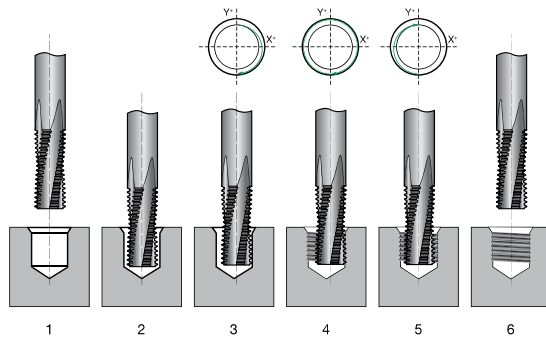
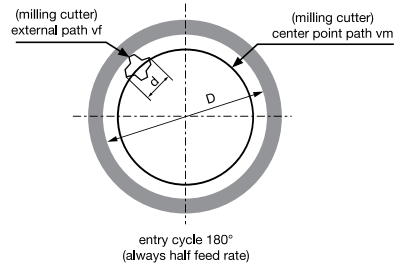
### Program specifications

Thread milling functions

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



### Formula of calculation

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

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

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

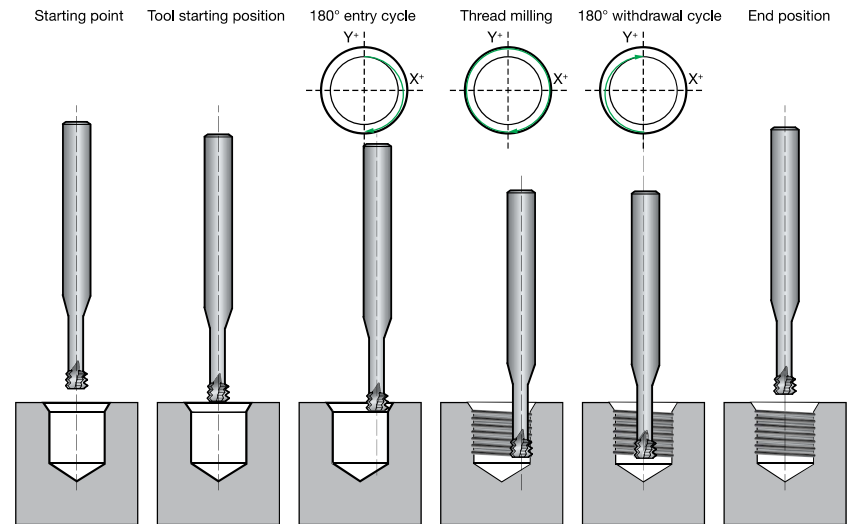
$$v_m = v_f \cdot \frac{(D - d)}{D}$$

$$v_b = n \cdot f_b$$

vc = cutting speed  
vf = contour feed  
vm = centre point path feed  
n = revolutions  
z = number of teeth  
fz = feed per tooth  
fb = feed per drill per revolution\* vb = 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:

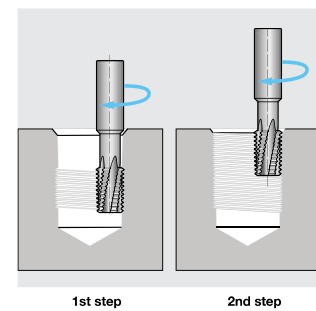
#### Advantage:

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

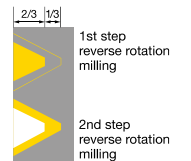
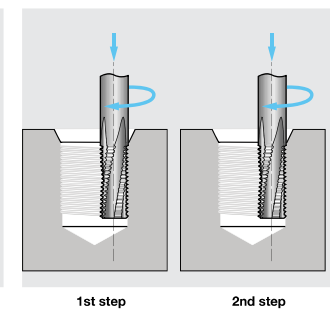
#### Disadvantage:

- increased tool wear
- longer production time

### Axial distribution of cut



### Radial distribution of cut



## Selecting the correct clamping chuck

Correct tool clamping also plays an essential role with thread milling. Thread milling cutters should as a rule be clamped as short as possible. A compact and mechanical clamping force is preferable. The error in concentricity should not exceed 0.02 millimeters.

### Power chucks



A power chuck excels thanks to extremely accurate concentricity. The high clamping forces and optimal smooth running are a perfect prerequisite for the production of threads in all materials including a high pitch.

max. permissible error in concentricity: 0.003 mm

### Side lock holders



A side lock holder for HB and HE shanks is a robust, cost-efficient clamping chuck with a maximum clamping force. The clamping surface prevents the tool twisting or being pulled out during machining. Therefore, side lock holders are suitable for the production in all materials including a high pitch.

max. permissible error in concentricity: 0.002 mm

### Shrink fit chucks



A shrink fit chuck creates a rigid connection with the shrink fitted tool. Incorrect shrink fitting or older shrink fit chucks can result in the pulling out of the tool. Tool breakage and possible loss of the component would be the consequence. Therefore, the shrink fit chuck is only suitable for a thread pitch  $< P=1.5$  mm.

max. permissible error in concentricity: 0.005 mm

### Hydraulic chucks



A hydraulic chuck, similar to the shrink fit chuck, has only limited suitability for thread milling. Especially with high radial forces this clamping chuck reaches its limits. Therefore, the hydraulic chuck is recommended for softer materials such as aluminum and a thread pitch  $< P=1.5$  mm.

max. permissible error in concentricity: 0.005 mm

### Collet holders



Collet chucks are very well suited for micro-thread milling because only axial stresses are created. The low clamping forces only permit the milling of softer materials. Consequently, collet holders are not suitable for conventional thread milling.

max. permissible error in concentricity: 0.01 mm

## 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 center path  $v_m$ . As a rule we specify the milling center 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





|          | Material group                                   | Examples                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>P</b> | Common structural steels                         | A283, A516, Gr50, 30, 35, 42, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 100, 110, 135, 140, 145, 150, 160                                                                                                                                                                                                                                                                                                                            |
|          | Free-cutting steels                              | 1151, 1215, L10, 10L10, 10L15, 10L17, 10L20, 10L23, 10L25, 10L30, 10L35, 10L40, 10L42, 10L45, 10L49, 10L50, 10L55, 11L15, 11L16, 11L17, 11L37, 11L38, 11L39, 11L41, 11L44, 11L46, 12L11, 12L12, 12L13, 12L14, 12L15, 41L25, 41L30, 41L35, 41L40, 41L42, 41L47, 41L50 51L15, 51L17, 51L20, 86L20, 86L40                                                                                                                             |
|          | Unalloyed heat-treatable steels                  | 1005, 1006, 1008, 1009, 1010, 1011, 1012, 1013, 1015, 1016, 1017, 1018, 1019, 1020, 1021, 1022, 1023, 1025, 1026, 1029, 1030, 1033, 1035, 1037, 1038, 1039, 1040, 1042, 1043, 1044, 1045, 1046, 1049, 1050, 1053, 1055, 1059, 1060, 1064, 1065, 1069, 1070, 1071, 1074, 1075, 1078, 1080, 1084, 1085, 1086, 1090, 1095                                                                                                             |
|          | Alloyed heat-treatable steels                    | 1330, 1335, 1340, 1345, 2340, 3140, 3145, 3150, 3230, 3240, 3335, 3340, 3435, 3450, 4032, 4037, 4063, 4130, 4135, 4137, 4140, 4142, 4145, 4147, 4150, 4161, 4337, 4340, 4640, 5045, 5046, 5060, 5130, 5132, 5135, 5140, 5145, 5157, 5150, 5155, 5160, 6130, 6135, 6140, 6145, 6150, 7140, 8145, 8150, 7140, 8630, 8632, 8635, 8637, 8640, 8642, 8645, 8650, 8650, 8660, 8735, 8740, 8742, 9250, 9254, 9255, 9260, 9262, 9840, 9850 |
|          | Unalloyed case hardened steels                   | 1005, 1006, 1008, 1009, 1010, 1011, 1012, 1013, 1015, 1016, 1017, 1018, 1019, 1020, 1021, 1022, 1023, 1025, 1026, 1029, 1030, 1033, 1035, 1037, 1038, 1039, 1040, 1042, 1043, 1044, 1045, 1046, 1049, 1050, 1053, 1055, 1059, 1060, 1064, 1065, 1069, 1070, 1071, 1074, 1075, 1078, 1080, 1084, 1085, 1086, 1090, 1095                                                                                                             |
|          | Alloyed case hardened steels                     | 2317, 2512, 2515, 2517, 3115, 3120, 3215, 3220, 3312, 3316, 3325, 4012, 4023, 4024, 4027, 4028, 4119, 4119, 4125, 4317, 4320, 4419, 4422, 4427, 4608, 4615, 4617, 4620, 4621, 4626, 4718, 4720, 4815, 4817, 4820, 5015, 5115, 5117, 5120, 6115, 6118, 6120, 6125, 8115, 8615, 8617, 8620, 8622, 8625, 8627, 8720, 8822, 9310, 9315, 9317                                                                                           |
|          | Nitriding steels                                 | 1132, 1137, 1138, 1139, 1140, 1141, 1144, 1145, 1146, 1151                                                                                                                                                                                                                                                                                                                                                                         |
|          | Tool steels                                      | A2, A3, A4, A5, A6, A8, A9, A10, O1, O2, O6, O7, A7, D2, D3, D4, D5, D7, H10, H11, H12, H13, H14, H19, H20, H21, H22, H23, H24, H25, H26, H41, H42, H43, L1, L3, W1, W2, W5                                                                                                                                                                                                                                                        |
|          | High speed steels                                | M1, M2, M3-1, M3-2, M4, M6, M7, M10, M30, M33, M34, M36, M41, M42, M43, M44, M46, M47, T1, T2, T4, T5, T6, T8, T15                                                                                                                                                                                                                                                                                                                 |
|          | Spring steels                                    | 5150, 5155, 6145, 6150, 9255                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>H</b> | Hardened steels >48-60 Rc                        | Heat Treated Steels                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>M</b> | Stainless steels, sulphured                      | 203 Ez, 303 Se, 303 Ma, 303 Pb, 303 PlusX, 430F Se, 416 Se, 416 PlusX, 420F, 420F Se, 440F, 440F Se                                                                                                                                                                                                                                                                                                                                |
|          | austenitic                                       | 201, 202, 301, 302B, 303, 304, 304L, 305, 308, 309, 309S, 310, 310S, 314, 316, 316L, 317, 321, 330, 347, 348, 384, 385, Nitronic 32, Nitronic 33, Nitronic 40, Nitronic 50, Nitronic 60, 17-7PH                                                                                                                                                                                                                                    |
|          | martensitic                                      | 403, 405, 410, 414, 416, 420, 422, 430, 431, 440A, 440B, 440C, 446, 501, 502, 630, Greek Ascoloy                                                                                                                                                                                                                                                                                                                                   |
| <b>K</b> | Cast iron                                        | A48-20 B, A48-30 B, A48-40 B, A48-50B, A159G1800, A159G2500, A159G3000, A159G3500, A159G4000                                                                                                                                                                                                                                                                                                                                       |
|          | Spheroidal graphite iron and malleable cast iron | 60-10-18, 60-40-18, 65-45-12, 80-55-06, 100-70-03, 120-90-02, 32510, 35018, 40010, 50005, 60004, 70003, 80002, 90001, A220-70003, A220-8002, A536                                                                                                                                                                                                                                                                                  |
|          | Chilled cast iron                                |                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>S</b> | Special alloys                                   | Inconel, Hastelloy, Monel, Nimonic, MAR-M246, DS-Ni, Waspalloy, Rene41                                                                                                                                                                                                                                                                                                                                                             |
|          | Ti and Ti-alloys                                 | Ti6AL4V, 5390A, TiCu2                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>N</b> | Aluminium and Al-alloys                          | EC 1060, 1100, 1145, 1175, 1235, 2011, 2014, 2017, 2018, 2021, 2024, 2025, 2117, 2218, 2219, 2618, 3003, 3004, 3005, 4032, 4032-T6, 5005, 5050, 5052, 5056, 5083, 5086, 5154, 5252, 5254, 5454, 5456, 5457, 5652, 5657, 6053, 6061, 6061-T6, 6063, 6066, 6070, 6101, 6151, 6253, 6262, 6463, 6951, 7001, 7004, 7005, 7039, 7049, 7050, 7075, 7075-T6, 7079, 7175, 7178                                                             |
|          | Al wrought alloys                                | 1100-0, 3003-H18, 5056-0, 2024-T4, 4043-H18                                                                                                                                                                                                                                                                                                                                                                                        |
|          | Al cast alloys                                   | 295-T6, 319-F, 356-T6, 380-F, 384-F, 390-F, 443-F, 413-F, 518-F, 713-TS, 850-TS                                                                                                                                                                                                                                                                                                                                                    |
|          | Magnesium alloys                                 | AZ31B, AZ63A, AZ80A, AZ91C, EZ33A, HK31A, QE22A, ZK60A                                                                                                                                                                                                                                                                                                                                                                             |
|          | Copper, low-alloyed                              | C10100, C27000, C71500, C52400, C77000, C17200, C71500, C95500, C86500                                                                                                                                                                                                                                                                                                                                                             |
|          | Brass, short-chipping                            | CUZn10, CUZn20                                                                                                                                                                                                                                                                                                                                                                                                                     |