DORMER PRAMET

# HEAVY MACHINING

2023



DORMER PRAMET

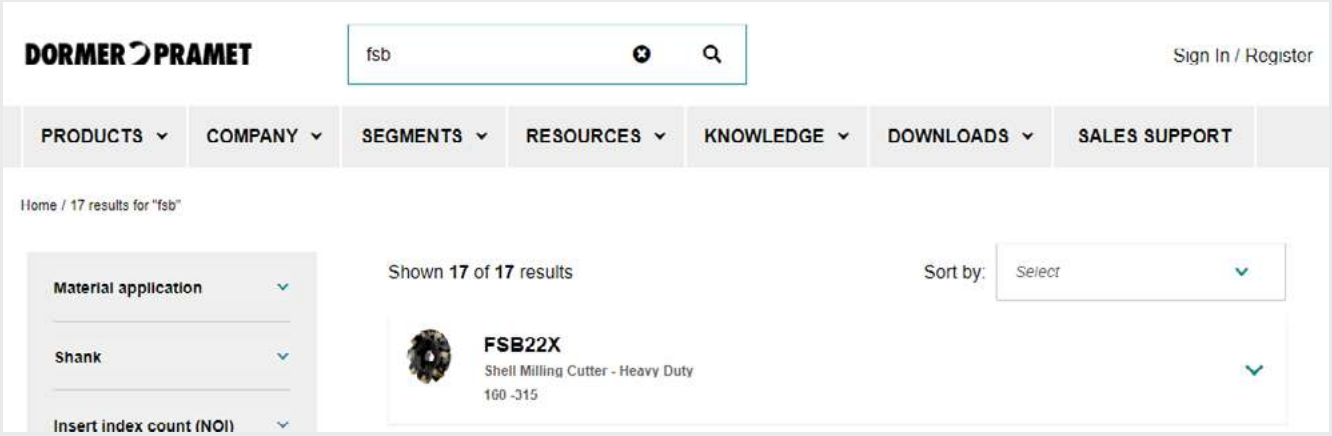
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## INTRODUCTION

This catalogue presents a selection of Dormer Pramet products most suitable for the machining of large-scale components, which require high levels of material to be removed. These applications require tools with high performance and operational reliability. Included are turning, milling, hole making and threading tools for machining large shafts, forgings, castings, and bright steel round bars.
Also included are special cutters for machining specimens with groove shape U or V for Charpy impact testing.
Technical section including the relevant information to help optimize the machining processes for each group of tools is a part of this catalogue as well.
The catalogue is designed as an interactive navigator through the roughing assortment, where by clicking on the image of the tool you will be directed to the webpage of the tool, which provides detailed information about the tool and the associated inserts and accessories.



Home / FSB22X / 250C09R F60SB22X



PRAMET

## 250C09R-F60SB22X

Shell Milling Cutter - Heavy Duty
Material ID: 6759710

Face mill with positve/negative geometry which utilises 9 off SBKX 2207DZ.. or SBMR 2207DZ.. single sided inserts, cutting diameter 250 to maximum 267.4mm with 60° approach angle and 60mm connection bore according to DIN 8030-C, 63mm protrusion length and differential pitch for face milling with a maximum depth of cut of 15.0mm

If you want to see the prices or stock information, please sign in or request access.

Contact Sales

## Related Parts

INSERT | SPARE PART

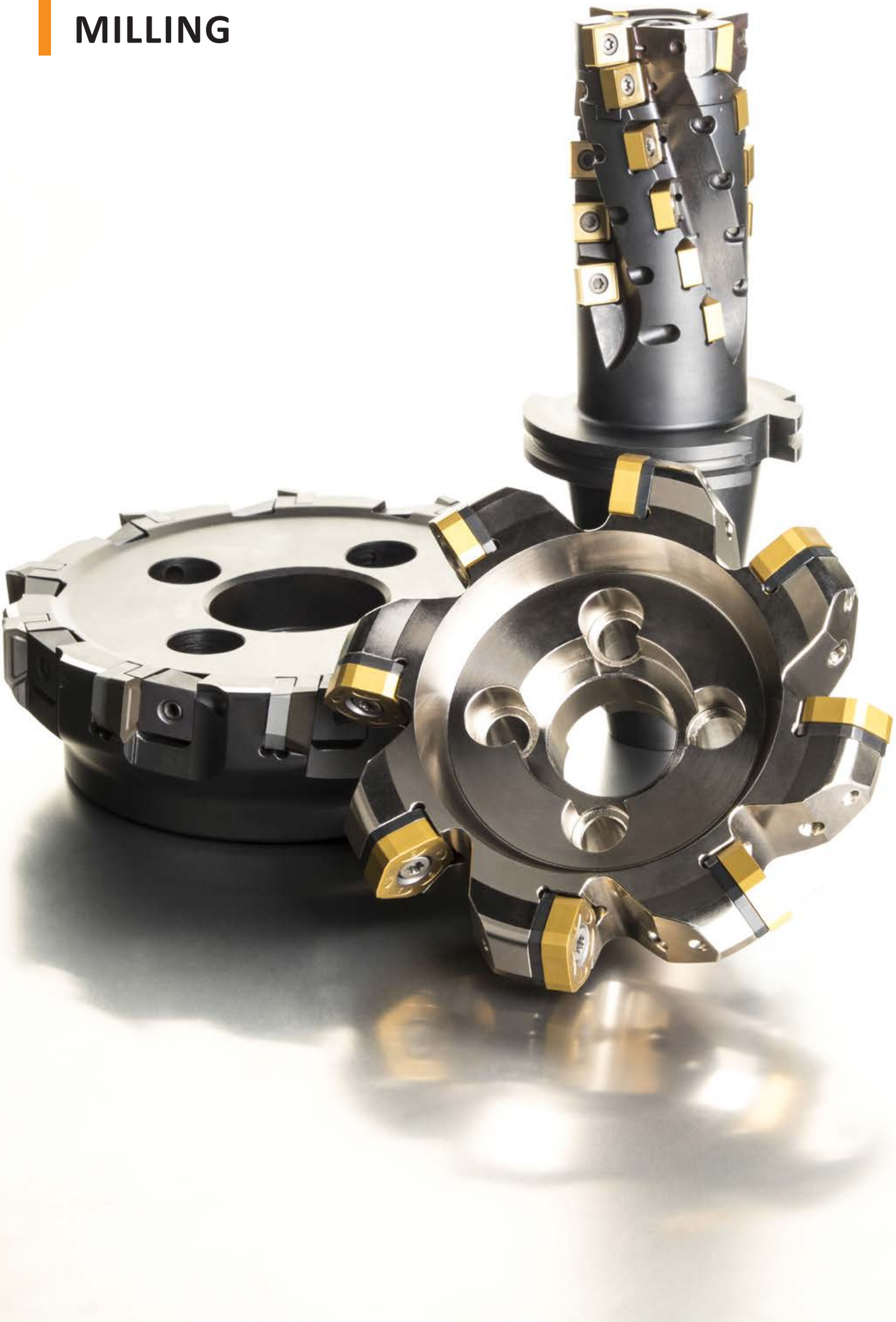
Grade: Select | Chipbreaker manufacturer: Select | Material application: Select

**SBKX 22**
Milling Insert - Heavy Duty

**SBMR 22**
Milling Insert - Heavy Duty

## Downloads

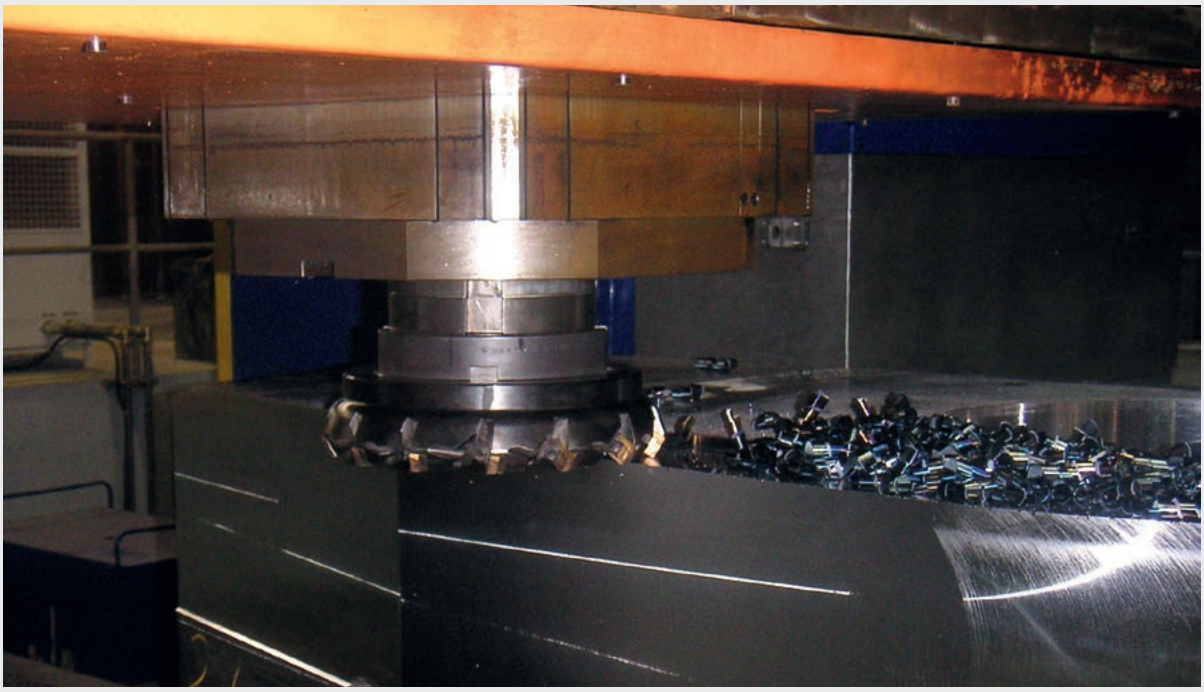
# HEAVY MILLING



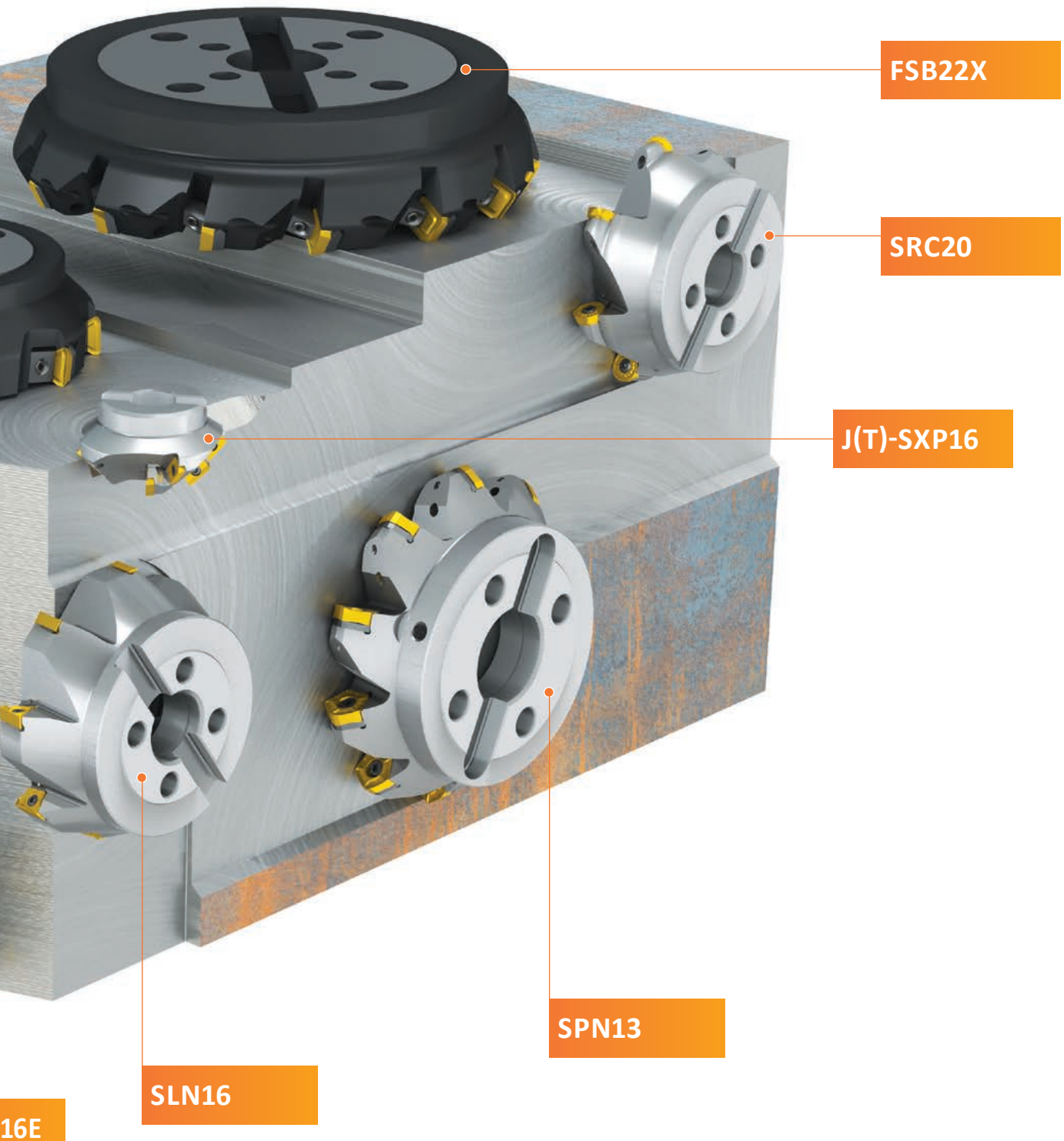
# HEAVY MILLING

Milling large-size components is inherently associated with the removal of large material allowances. These are often castings with inclusions of molding sand or free-forged steel forgings with a thick layer of scale. These are extremely unfavorable conditions for the operation of cutting tools. Therefore, our indexable inserts and tool bodies are particularly wear-resistant and operationally reliable and withstand those conditions. The Dormer Pramet range of dedicated tools for heavy milling ensure effective milling of surfaces, offsets, grooves, chamfers, edge rounding and multi-axis shaping. The standard range is complemented by tools made to order.





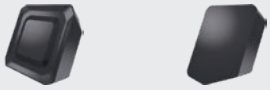

J(T)-SLSN
FTB27X
L2-SZP
S90CN(XN)
F-SCC
J(T)-SSAP
J(T)-SAD


FSB22X
SRC20
J(T)-SXP16
SPN13
SLN16
16E



# INDEXABLE FACE MILLS

## FACE MILLING

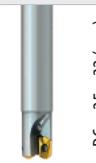
| | SPN13 | | FSB22X | | |
|---|---|---|---|---|---|
| | 57° | | 60° | | |
| | APMX (mm) | 10.0 | APMX (mm) | 15.0 | |
| | DC (mm) | 100 – 315 | DC (mm) | 125 – 250 | |
| **Cylindrical shank** | | | | | |
| **Weldon** | | | | | |
| **Shell mill** (≤ 125 mm) |  DC = 100 – 125 (mm) | |  DC = 125 (mm) | | |
| **Shell mill** (> 125 mm) |  DC = 160 – 315 (mm) | |  DC = 160 – 250 (mm) | | |
| **Page** | | | | | |
| **ISO** | P M K S H | | P M K | | |
| **Insert shape** |  | |  | | |
| **Inserts** | PNM. 1308 / PNMQ 13 / XN.. 1308 | | SB.. 2207 / SB.. 2207 | | |
| **No. of cutting edges** | 10 / 1 | | 4 / 1 | | |
| **Face milling** | ■ | | ■ | | |
| **Chamfer milling** | | | | | |
| **Helical interpolation** | | | | | |
| **Progressive plunging** | | | | | |
| **Ramping** | | | | | |
| **Shape surfaces milling (copy milling)** | | | | | |
| **Shallow shoulder milling** | | | | | |
| **Shallow slot milling** | | | | | |
| **Plunge milling** | | | | | |

■ Primary use ◪ Possible use



# INDEXABLE SQUARE SHOULDER MILLS

## SQUARE SHOULDER MILLING

| | SAD16E | SLN16 | FTB27X |
|---|---|---|---|
| | 90° | 90° | 90° |
| | APMX (mm) 13.0 | APMX (mm) 13.0 | APMX (mm) 18.0 |
| | DC (mm) 25 – 175 | DC (mm) 63 – 175 | DC (mm) 140 – 260 |
| **Cylindrical / Weldon** |  DC = 25 – 32 (mm)  DC = 25 – 40 (mm) | | |
| **Modular / Morse** |  DC = 32 – 40 (mm)  DC = 25 – 40 (mm) | | |
| **Shell mill** (≤ 140 mm) |  40 – 140 (mm) |  DC = 63 – 140 (mm) |  DC = 140 (mm) |
| **Shell mill** |  DC = 160 – 175 (mm) |  DC = 160 – 175 (mm) |  DC = 175 – 260 (mm) |
| **Page** | | | |
| **ISO** | P M K N S H | P K N H | P M K |
| **Insert shape** |  |   |  |
| **Inserts** | AD.X 1606 | LN.U 1607 / LNGU 16 | TBMR 2707 |
| **No. of cutting edges** | 2 | 4 | 3 |
| **Shallow shoulder milling** | ■ | ■ | ■ |
| **Helical interpolation** | ■ | | |
| **Shallow slot milling** | ■ | ■ | ◪ |
| **Plunge milling** | ■ | ■ | |
| **Progressive plunging** | ■ | | |
| **Ramping** | ■ | | |
| **Face milling** | ◪ | | ◪ |
| **Shape surfaces milling (copy milling)** | ■ | ◪ | |

■ Primary use ◪ Possible use



# INDEXABLE DEEP SHOULDER MILLS

## DEEP SHOULDER MILLING

| | J(T)-SAD16E | J(T)-SLSN | J(T)-SSAP |
|---|---|---|---|
| | 90° | 90° | 90° |
| | APMX (mm) 40.0 – 108.0 | APMX (mm) 104.0 – 134.0 | APMX (mm) 58.0 – 95.0 |
| | DC (mm) 50 – 100 | DC (mm) 63 – 80 | DC (mm) 50 – 80 |
| **Arbor** (ISO/DIS 7388-1) (DIN 69871-1) |  DC = 50 – 80 (mm) |  DC = 63 – 80 (mm) |  DC = 50 – 80 (mm) |
| **Arbor** (ISO 297) (DIN 2080) |  DC = 50 – 80 (mm) |  DC = 63 – 80 (mm) | |
| **Arbor** (JIS B 6339) |  DC = 50 – 80 (mm) |  DC = 50 – 80 (mm) |  DC = 50 – 80 (mm) |
| **Shell mill** |  DC = 50 – 100 (mm) | | |
| **Page** | | | |
| **ISO** | P M K N S H | P K | P M K N S H |
| **Insert shape** |  |  |  |
| **Inserts** | AD.. 1606 | LNET 1606 / SN.. 1305 / SNET 13 | APEW 15 / APET 15 / SPET 12 / SPEW 12 AD / SPET 12 AD |
| **No. of cutting edges** | 2 | 2 / 8 | 2 / 4 |
| **Deep shoulder milling**  | ■ | ■ | ■ |
| **Deep slot milling**  | ■ | ■ | ■ |
| **Face milling**  | ◪ | ◪ | ◪ |
| **Plunge milling**  | ◪ | ◪ | ◪ |

■ Primary use ◪ Possible use



# INDEXABLE SLOT MILLS

## SLOT MILLING

| | S90CN(XN) | | | |
|---|---|---|---|---|
| | 90° | | | |
| | APMX (mm) | 14.0 – 30.5 | | |
| | DC (mm) | 125 – 315 | | |
| **Disc** |  DC = 125 – 315 (mm) | | | |
| **Disc** (200 mm) |  DC = 200 (mm) | | | |
| **Shell mill** |  DC = 125 – 200 (mm) | | | |
| **Page** | | | | |
| **ISO** | P M K | | | |
| **Insert shape** |  |  | | |
| **Inserts** | CNHQ 1005 | XNHQ 1205 XNHQ 1606 | | |
| **No. of cutting edges** | 2 | | | |
| **Deep slot milling**  | ■ | | | |
| **Deep shoulder milling**  | ◪ | | | |
| **Face milling**  | ◪ | | | |
| **Rear face milling**  | ◪ | | | |

■ Primary use ◪ Possible use



# INDEXABLE COPY MILLS

## COPY MILLING

| | SRC20 | L2-SZP | | | |
|---|---|---|---|---|---|
| | – | – | – | – | – |
| | APMX (mm) 10.0 | APMX (mm) 8.9 – 44.7 | APMX (mm) 8.9 – 44.7 | APMX (mm) 8.9 – 44.7 | APMX (mm) 8.9 – 44.7 |
| | DCX (mm) 80 – 125 | DCX (mm) 25 | DCX (mm) 32 | DCX (mm) 40 | DCX (mm) 50 |
| **Cylindrical shank** | |  |  | | |
| **Weldon** | |  |  |  |  |
| **Morse** | |  |  | |  |
| **Shell mill / Modular** |  |  |  | | |
| **Page** | | | | | |
| | P M K S H | P M K S H | P M K S H | P M K S H | P M K S H |
| **Insert shape** |  |  |  |  |  |
| **Inserts** | RC 2006 | ZP | ZP | ZP | ZP |
| **No. of cutting edges** | – | 2 | 2 | 2 | 2 |
| **Shape surfaces milling (copy milling)** | ■ | ■ | ■ | ■ | ■ |
| **Face milling** | ■ | | | | |
| **Helical interpolation** | ■ | | | | |
| **Progressive plunging** | ■ | | | | |
| **Ramping** | ■ | | | | |
| **Shallow slot milling** | | | | | |
| **Deep shoulder milling** | | | | | |
| **Chamfer milling** | | | | | |
| **Plunge milling** | | | | | |

■ Primary use ◪ Possible use



# INDEXABLE CHAMFER & T-SLOTS MILLS

## CHAMFER, T-SLOT MILLING

| | J(T)-SXP16 | SSD09 | 2516 | F-SCC |
|---|---|---|---|---|
| | 15°– 75° | 45° | 45° | 90° |
| | APMX (mm) 7.0– 28.0 | APMX (mm) 4.5 | APMX (mm) 8.5 | APMX (mm) 11.0 – 18.0 |
| | DC (mm) 35 – 45 | DC (mm) 10 – 25 | DC (mm) 11 – 19 | DC (mm) 25 – 40 |
| **Cylindrical shank** | |  | | |
| **Weldon** | |  |  |  |
| **Morse** | |  | | |
| **Shell mill** |  | | | |
| **Page** | | | | |
| **ISO** | P M K N | P M K S H | P M K S | P M K |
| **Insert shape** |  |   |  |  |
| **Inserts** | XPHT 1604 | SDE. 0903 / SDE. 0903 | TCMT 16T3 | CCMX |
| **No. of cutting edges** | 2 | 4 | 3 | 2 |
| **Chamfer milling**  | ■ | ■ | ■ | |
| **Rear face milling**  | | | | ■ |
| **T-slot milling**  | | | | ■ |
| **Shallow shoulder milling**  | | | | ◪ |
| **Shallow slot milling**  | | | | ◪ |

■ Primary use ◪ Possible use



# OTHER MILLING INSERTS

## OTHER MILLING INSERTS – NAVIGATOR

| CNM 563 | RDHX 20 | SPGN 25 DZ | SPKN 15 | SPKR 15 |
|---|---|---|---|---|
|  |  |  |  |  |

| SPUN 25 | TPKN 22 | TPKR 22 | TPUN 22 |
|---|---|---|---|
|  |  |  |  |

## TOOLS MADE ON REQUEST

Dormer Pramet also offers specialized tools for heavy machining. We understand that fabricating pieces occasionally requires a specialized tool configuration. Or you might need a very limited number of tools for a specific purpose. This section highlights our Heavy Machining tools that are less common, but no less important, to your heavy machining needs.

Some of our tools are already available in various models including left-handed cutting configuration or custom cutter bodies. Please contact your local Dormer Pramet sales office for further information and advice.

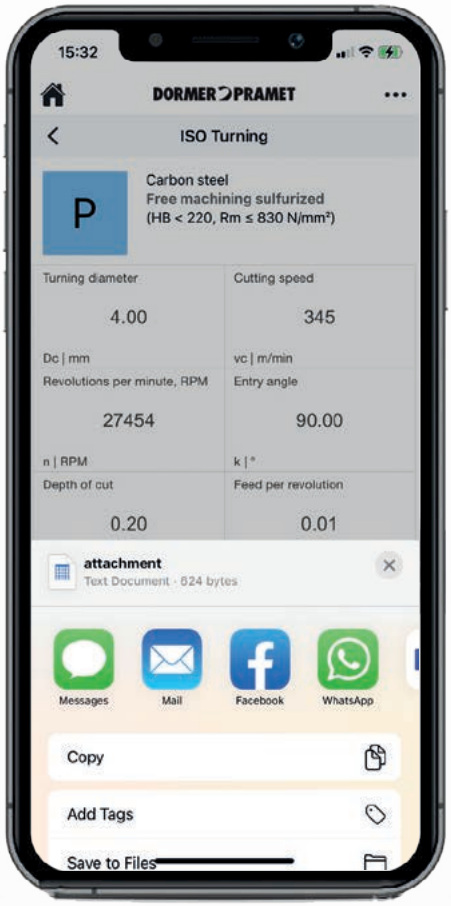
## EXAMPLES OF TOOLS MADE ON REQUEST



DORMER PRAMET

# ALWAYS CONNECT

No wifi or internet connection? The machining calculator works perfectly even when you are offline, making sure it's always available when you need it. **Simply Reliable.**



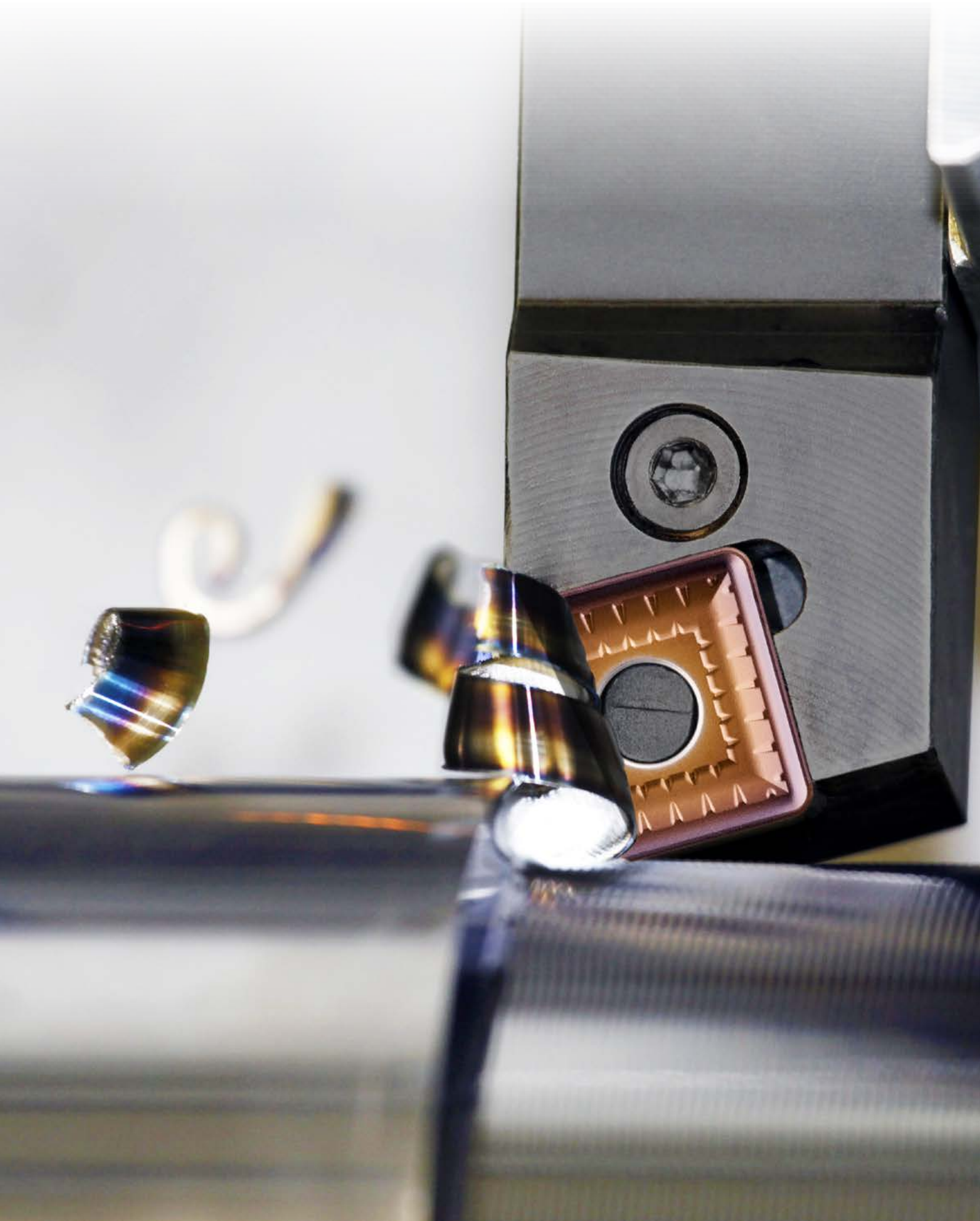



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# HEAVY TURNING



# HEAVY TURNING

Heavy Turning of large shafts with scale from the forging or casting processes with interrupted cutting caused by uneven surfaces require extremely strong and operationally reliable tools. Within the range of Dormer Pramet indexable tools are inserts with cutting edge lengths from 25 – 50 mm and tool holders which cover all common applications and are available in sizes that ensure the required stability of the cutting process. Cutting efficiency is achieved by applying modern and reliable grades and insert geometries designed to withstand heavy cutting loads. To support quick tool change we offer the unique exchangeable cassettes system KH which allows the user to replace the head of the tool within 30 seconds.

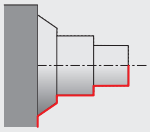



KHP-LBN(RL)
KHP-RSC(RL)
KHS-SBC(RL)
KHP-SBN(RL)
PLBN(RL) EXT
PRSC(RL) EXT
PSBN(RL) EXT
SSBC(RL) EXT


DKH(RL)
KHP-SSN(RL)
KHP-CBN(RL)
KHP-CLN(RL)
KHP-SSN(RL)
DWLN(RL) EXT
PCBN(RL) EXT
PSKN(RL) EXT
DSDNN EXT
PCLN(RL) EXT

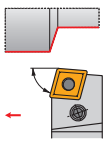
# ISO TURNING – HEAVY ROUGHING – EXTERNAL

FIXED TOOL HOLDERS (NEGATIVE INSERTS)



## PCBN(RL) EXT

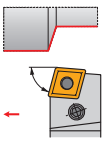
| 75° | CN.. |
|---|---|
| | 19<br>25 |



| | |
|---|---|
| | 40×40 |

## PCBN(RL) EXT

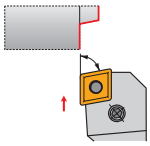
| 75° | CN.. |
|---|---|
| | 25 |



| | |
|---|---|
| | 50×50 |

## PCKN(RL) EXT

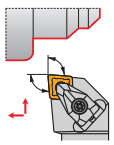
| 75° | CN.. |
|---|---|
| | 19 |



| | |
|---|---|
| | 40×40 |

## DCLN(RL) EXT

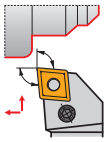
| 95° | CN.. |
|---|---|
| | 19 |



| | |
|---|---|
| | 40×40 |

## PCLN(RL) EXT

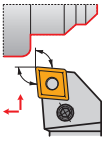
| 95° | CN.. |
|---|---|
| | 19<br>25 |



| | |
|---|---|
| | 40×40 |

## PCLN(RL) EXT

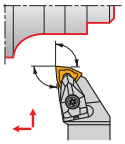
| 95° | CN.. |
|---|---|
| | 25 |



| | |
|---|---|
| | 50×50 |

## DWLN(RL) EXT

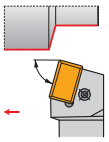
| 95° | WN.. |
|---|---|
| | 13 |



| | |
|---|---|
| | 40×40 |

## PLBN(RL) EXT

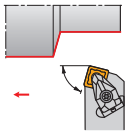
| 75° | LN.. |
|---|---|
| | 40<br>50 |



| | |
|---|---|
| | 60×60 |

## DSBN(RL) EXT

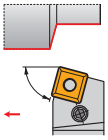
| 75° | SN.. |
|---|---|
| | 19 |



| | |
|---|---|
| | 40×40 |

## PSBN(RL) EXT

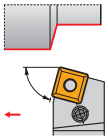
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|---|---|
| | 19<br>25 |



| | |
|---|---|
| | 40×40 |

## PSBN(RL) EXT

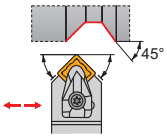
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| | 19<br>25 |



| | |
|---|---|
| | 50×50 |

## DSDNN EXT

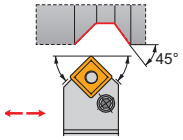
| 45° | SN.. |
|---|---|
| | 19<br>25 |




| | |
|---|---|
| | 40×40 |

## PSDNN EXT

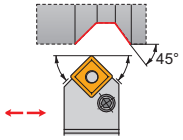
| 45° | SN.. |
|---|---|
| | 19<br>25 |




| | |
|---|---|
| | 40×40 |

## PSDNN EXT

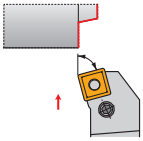
| 45° | SN.. |
|---|---|
| | 25 |




| | |
|---|---|
| | 50×50 |

## PSKN(RL) EXT

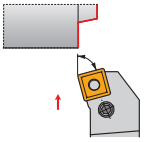
| 75° | SN.. |
|---|---|
| | 19<br>25 |



| | |
|---|---|
| | 40×40 |

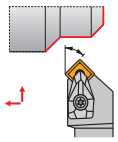
## PSKN(RL) EXT

| 75° | SN.. |
|---|---|
| | 19<br>25 |

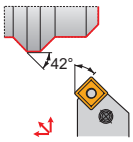


| | |
|---|---|
| | 50×50 |

## DSSN(RL) EXT

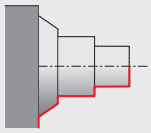
| 45° | SN.. |
|---|---|
|  | 19 |
| 40×40 | |

## PSSN(RL) EXT

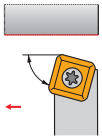
| 45° | SN.. |
|---|---|
|  | 25 |
| 50×50 | |

## ISO TURNING – HEAVY ROUGHING – EXTERNAL

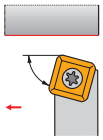
**FIXED TOOL HOLDERS (POSITIVE INSERTS)**



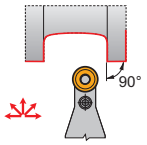
## SSBC(RL) EXT

| 75° | SC.. |
|---|---|
|  | 25<br>38 |
| 40×40 | |

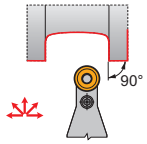
## SSBC(RL) EXT

| 75° | SC.. |
|---|---|
|  | 25<br>38 |
| 60×60 | |

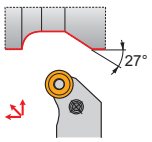
## PRDCN EXT

| | RC.. |
|---|---|
|  | 20<br>25 |
| 40×40 | |

## PRDCN EXT

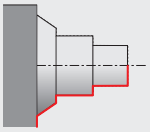
| | RC.. |
|---|---|
|  | 20<br>25 |
| 50×50 | |

## PRSC(RL) EXT

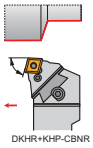
| | RC.. |
|---|---|
|  | 20<br>25 |
| 40×40 | |

# ISO TURNING – HEAVY ROUGHING – EXTERNAL

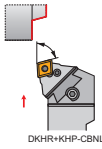
**HEAD (KH)**



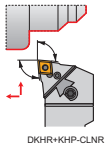
## KHP-CBNR + DKH(RL)

| 75° | CN.. |
|---|---|
|  DKHR+KHP-CBNR | 25 |
| 40×50 / 60×80 | |

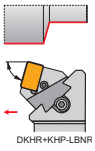
## KHP-CBNL + DKH(RL)

| 75° | CN.. |
|---|---|
|  DKHR+KHP-CBNL | 25 |
| 40×50 / 60×80 | |

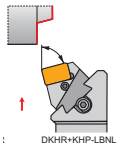
## KHP-CLNR/L + DKH(RL)

| 95° | CN.. |
|---|---|
|  DKHR+KHP-CLNR | 19<br>25 |
| 40×50 / 60×80 | |

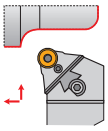
## KHP-LBNR + DKH(RL)

| 75° | LN.. |
|---|---|
|  DKHR+KHP-LBNR | 40 |
| 40×50 / 60×80 | |

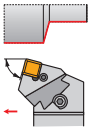
## KHP-LBNL + DKH(RL)

| 75° | LN.. |
|---|---|
|  DKHR+KHP-LBNL | 40 |
| 40×50 / 60×80 | |

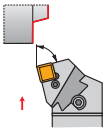
## KHP-RSCR/L + DKH(RL)

| | RC.. |
|---|---|
|  DKHR+KHP-RSCR | 20 |
| 40×50 / 60×80 | |

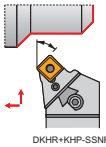
## KHP-SBNR + DKH(RL)

| 75° | SN.. |
|---|---|
|  DKHR+KHP-SBNR | 19<br>25 |
| 40×50 / 60×80 | |

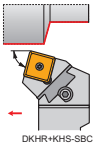
## KHP-SBNL + DKH(RL)

| 75° | SN.. |
|---|---|
|  DKHR+KHP-SBNL | 25 |
| 40×50 / 60×80 | |

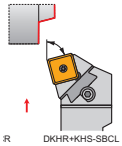
## KHP-SSNR/L + DKH(RL)

| 45° | SN.. |
|---|---|
|  DKHR+KHP-SSNR | 25 |
| 40×50 / 60×80 | |

## KHS-SBCR + DKH(RL)

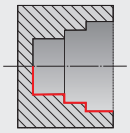
| 75° | SC.. |
|---|---|
|  DKHR+KHS-SBC | 25<br>38 |
| 40×50 / 60×80 | |

## KHS-SBCL + DKH(RL)

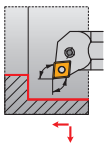
| 75° | SC.. |
|---|---|
|  DKHR+KHS-SBCL | 25<br>38 |
| 40×50 / 60×80 | |

## ISO TURNING – INTERNAL

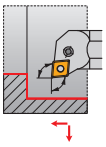
**SHORT AND STABLE COMPONENTS (NEGATIVE INSERTS)**



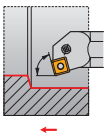
### PCLN(RL) INT

| 95° | CN.. |
|---|---|
|  | 19 |
|  50 | |

### PCLN(RL) INT

| 95° | CN.. |
|---|---|
|  | 19 |
|  60 | |

### PSKN(RL) INT

| 93° | SN.. |
|---|---|
|  | 19 |
|  50 | |

## P

1st choice for stable working conditions
Variants for different working conditions

Very unstable working conditions
Unstable working conditions
Stable working conditions

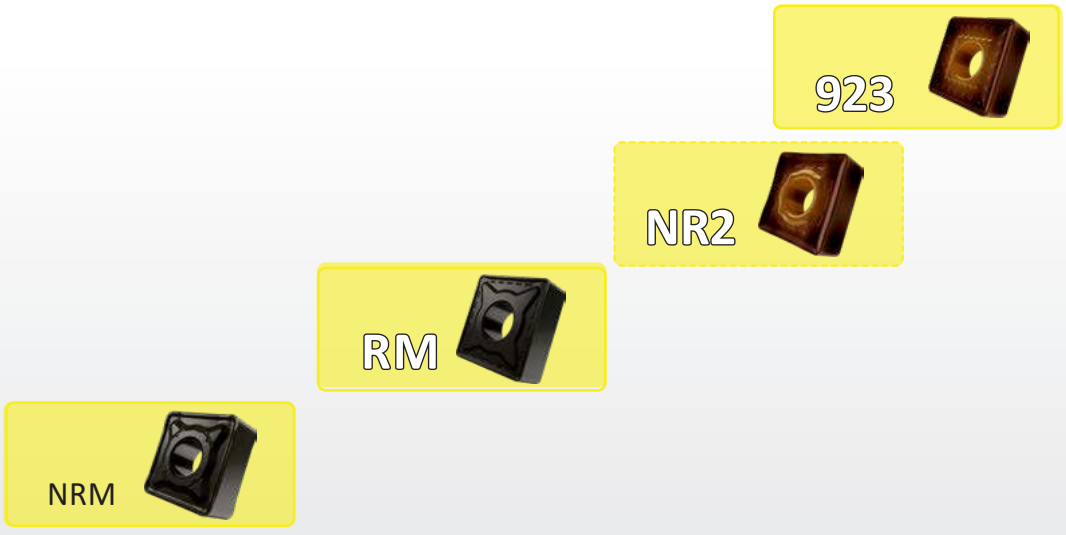



| | R | HR | HR | HR |
|---|---|---|---|---|
| f ⇨ | 0.35 – 1.2 mm/rev | 0.40 – 1.3 mm/rev | 0.7 – 1.5 mm/rev | 1.2 – 2.6 mm/rev |
| $a_p$ | 2.4 – 15 mm | 3.0 – 16 mm | 5.0 – 16 mm | 10.0 – 36 mm |

## M

1st choice for stable working conditions
Variants for different working conditions

Very unstable working conditions
Unstable working conditions
Stable working conditions

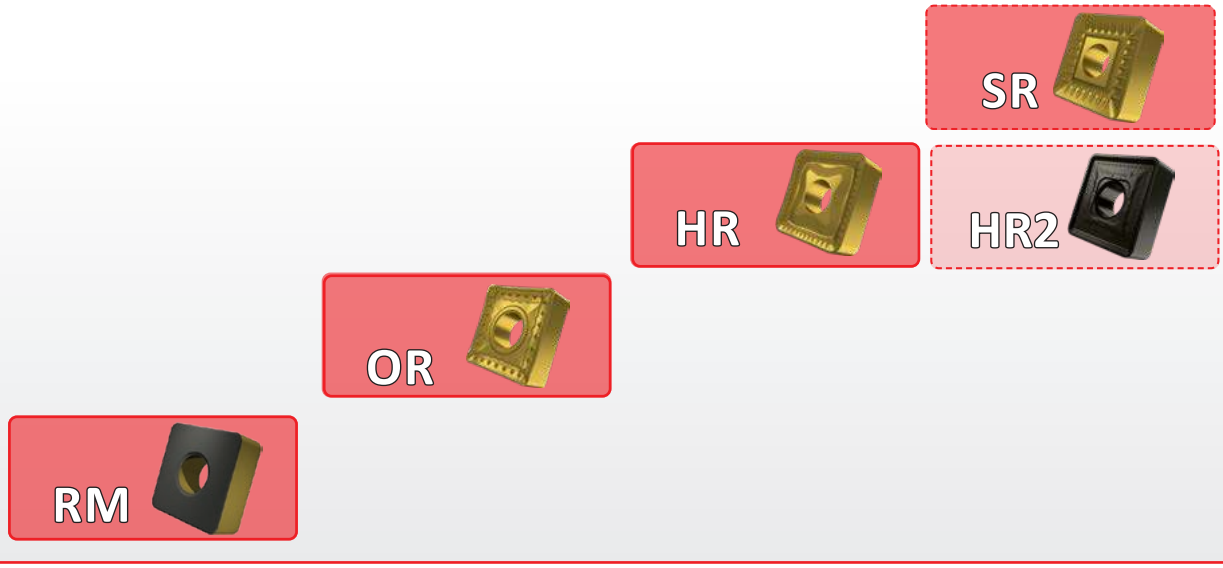



| | R | R | HR | |
|---|---|---|---|---|
| f ⇨ | 0.4 – 1.0 mm/rev | 0.40 – 1.0 mm/rev | 0.5 – 1.2 mm/rev | |
| $a_p$ | 2.4 – 15 mm | 3.0 – 13 mm | 3.0 – 16 mm | |

## K

1st choice for stable working conditions
Variants for different working conditions

Very unstable working conditions
Unstable working conditions
Stable working conditions

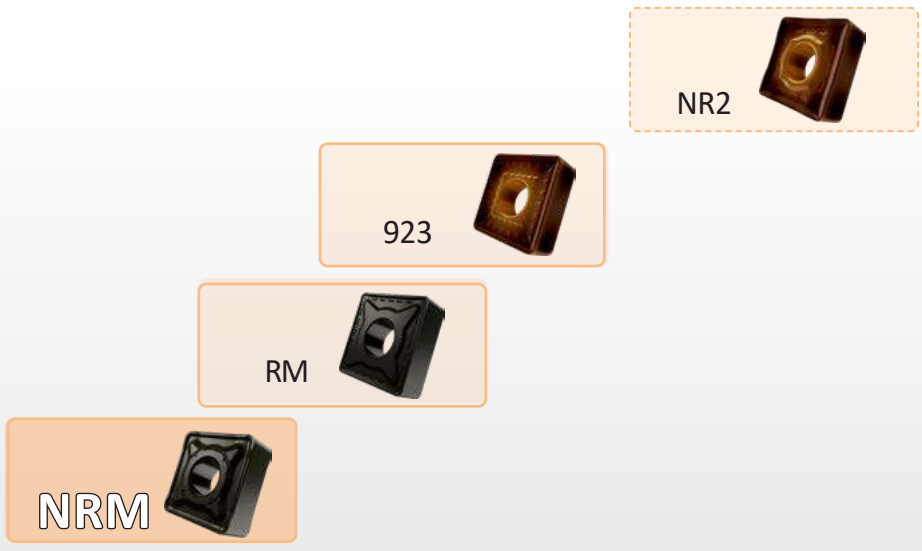



| | R | R | HR | HR |
|---|---|---|---|---|
| f | 0.1 – 1.1 mm/rev | 0.40 – 1.3 mm/rev | 0.5 – 1.4 mm/rev | 0.7 – 1.3 mm/rev |
| $a_p$ | 2.4 – 12 mm | 4.0 – 16 mm | 5.0 – 16 mm | 10.0 – 36 mm |

## S

1st choice for stable working conditions
Variants for different working conditions

Very unstable working conditions
Unstable working conditions
Stable working conditions




| | R | R | HR | |
|---|---|---|---|---|
| f | 0.35 – 0.8mm/rev | 0.40 – 1.0 mm/rev | 0.5 – 1.5 mm/rev | |
| $a_p$ | 2.4 – 12 mm | 3.0 – 11 mm | 3.0 – 13 mm | |

## P

1st choice
Possible use

Very unstable working conditions

Unstable working conditions

Stable working conditions







| | | | HR | HR |
|---|---|---|---|---|
| f ⇨ | | | 0.7 – 1.4 mm/rev | 1.0 – 1.8 mm/rev |
| $a_p$ | | | 4.0 – 18 mm | 4.0 – 24 mm |

## M

1st choice
Possible use

Very unstable working conditions

Unstable working conditions

Stable working conditions







| | | | HR | HR |
|---|---|---|---|---|
| f ⇨ | | | 0.7 – 1.3 mm/rev | 1.0 – 1.6 mm/rev |
| $a_p$ | | | 4.0 – 18 mm | 4.0 – 24 mm |

## S

1st choice
Possible use

Very unstable working conditions

Unstable working conditions

Stable working conditions




| | | | | |
|---|---|---|---|---|
| | | | | HR |
| f | | | | 1.1 – 1.6 mm/rev |
| $a_p$ | | | | 4.0 – 13 mm |



# NEGATIVE INSERTS

CNMA 19



CNMG 19



CNMG 25



CNMM 19



CNMM 25



LNUX 40, LN.X 50



RNMG 19



RNMG 25



SNMA 19



SNMA 25



SNMG 19



SNMG 25



SNMM 19



SNMM 25



SNMX 25



TNMG 27



TNMG 33



TNMM 27



WNMM 13





# POSITIVE INSERTS

**RCMX 20**



**RCMX 25**



**RCMX 32**



**SCMT 25**



**SCMT 38**



**SPUN-IT 25**



**TPUN-IT 27**

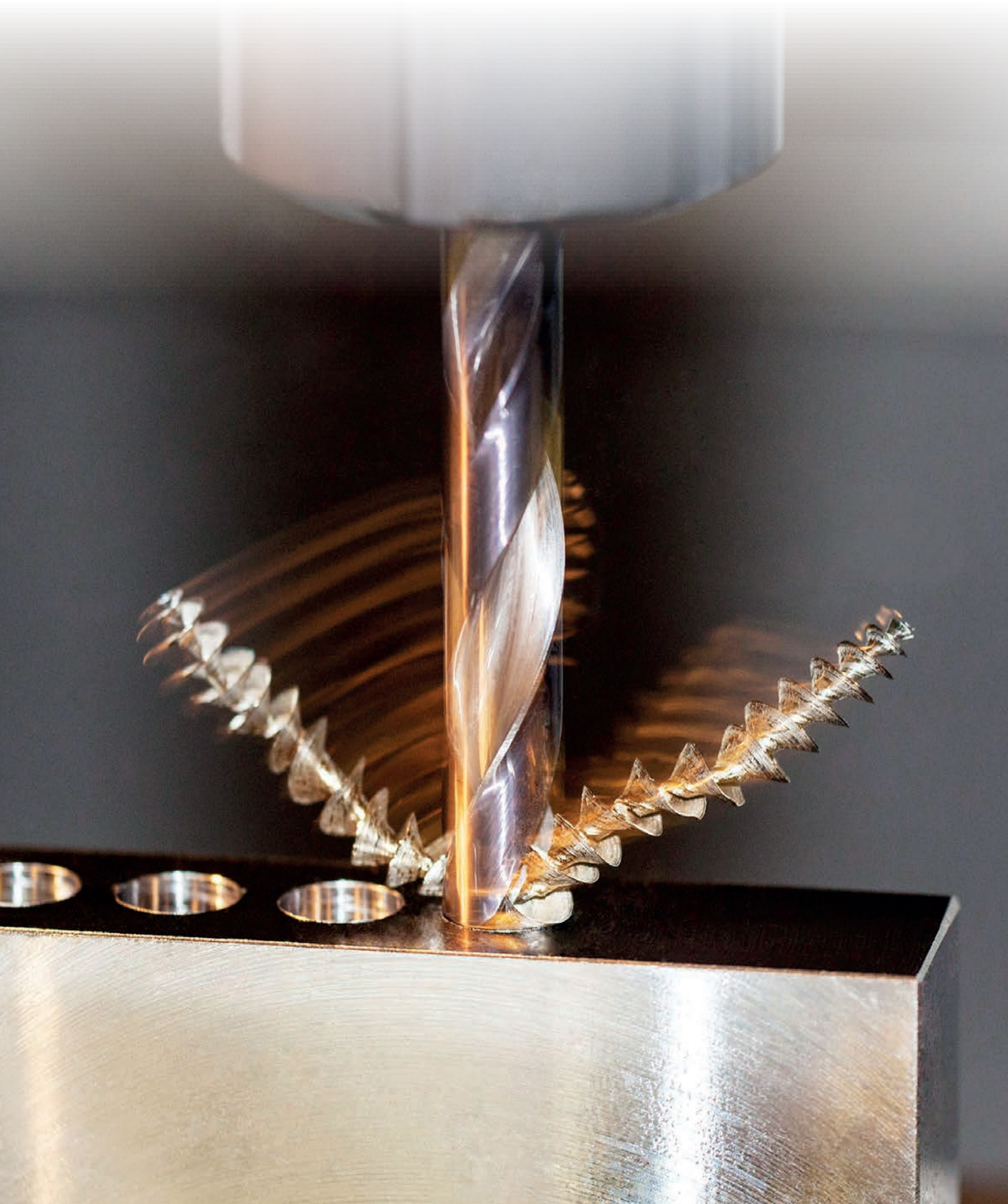


**TPUN-IT 33**





# HOLEMAKING





# HSS DRILLS

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Material code (BMC) | | HSS | HSS | | | | | | | | | | | |
| Basic standard group (BSG) | | DIN 345 | DIN 1870(2) | | | | | | | | | | | |
| Usable length (ULDR) | | 4×D | 20×D | | | | | | | | | | | |
| Application angle | | 118° | 130° | | | | | | | | | | | |
| Coating | | ST | Bright ST | | | | | | | | | | | |
| Shank | | | | | | | | | | | | | | |
| Spiral form | | λ 20-35° | λ >35° | | | | | | | | | | | |
| Hand (Cutting direction) | | R | R | | | | | | | | | | | |
| Cooling (CSP) | | | | | | | | | | | | | | |
| | |  |  | | | | | | | | | | | |
| Product Family Code | | A130 | A952 | | | | | | | | | | | |
| | | 3.00 – 50.80 | 8.00 – 40.00 | | | | | | | | | | | |
| P | P1 | ■ | ■ | | | | | | | | | | | |
| | P2 | ■ | ■ | | | | | | | | | | | |
| | P3 | ■ | ◪ | | | | | | | | | | | |
| | P4 | ◪ | ◪ | | | | | | | | | | | |
| M | M1 | ◪ | ◪ | | | | | | | | | | | |
| | M2 | ◪ | ◪ | | | | | | | | | | | |
| | M3 | ◪ | ◪ | | | | | | | | | | | |
| | M4 | ◪ | ◪ | | | | | | | | | | | |
| K | K1 | ■ | ◪ | | | | | | | | | | | |
| | K2 | ◪ | ◪ | | | | | | | | | | | |
| | K3 | ◪ | ◪ | | | | | | | | | | | |
| | K4 | ◪ | ◪ | | | | | | | | | | | |
| | K5 | ◪ | ◪ | | | | | | | | | | | |
| N | N1 | ◪ | ◪ | | | | | | | | | | | |
| | N2 | ◪ | ◪ | | | | | | | | | | | |
| | N3 | ◪ | ◪ | | | | | | | | | | | |
| | N4 | ◪ | ◪ | | | | | | | | | | | |
| | N5 | | | | | | | | | | | | | |
| S | S1 | ◪ | ◪ | | | | | | | | | | | |
| | S2 | ◪ | ◪ | | | | | | | | | | | |
| | S3 | ◪ | ◪ | | | | | | | | | | | |
| | S4 | ◪ | ◪ | | | | | | | | | | | |
| H | H1 | | | | | | | | | | | | | |
| | H2 | | | | | | | | | | | | | |
| | H3 | | | | | | | | | | | | | |
| | H4 | | | | | | | | | | | | | |

■ Primary use ◪ Possible use



# HYDRA DRILLS

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Material code (BMC) | | HM | HM | HSS | HSS | HSS | HSS | HSS | | | | | | |
| Basic standard group (BSG) | | DORMER | DORMER | DORMER | DORMER | DORMER | DORMER | DORMER | | | | | | |
| Usable length (ULDR) | | | | 1.5×D | 3×D | 5×D | 8×D | 12×D | | | | | | |
| Application angle | | 140° | 140° | | | | | | | | | | | |
| Coating | | Ti-phon | Ti-phon | Bright Ni | Bright Ni | Bright Ni | Bright Ni | Bright Ni | | | | | | |
| Shank | | | | DIN 6535HB DIN 6535HE ISO 9766 | DIN 6535HB DIN 6535HE | DIN 6535HB DIN 6535HE | DIN 6535HB DIN 6535HE | | | | | | | |
| Hand (Cutting direction) | | R | R | R | R | R | R | R | | | | | | |
| Cooling (CSP) | | | | | | | | | | | | | | |
| | | HYDRA | HYDRA | HYDRA NEW | HYDRA | HYDRA | HYDRA | HYDRA NEW | HYDRA | HYDRA | | | | |
| Product Family Code | | R950 | R960 | H851 | H853 | H855 | H858 | H8512 | H860 | H861 | | | | |
| | | 12.00 – 42.00, 15/32 – 1.5/8 | 12.00 – 30.50, 15/32 – 1.3/16 | 12.00 – 30.50, 15/32 – 1.3/16 | 12.00 – 42.50, 15/32 – 1.5/8 | 12.00 – 42.50, 15/32 – 1.5/8 | 13.50 – 42.50, 35/64 – 1.5/8 | 13.50 – 25.65, 35/64 – 1.1/64 | N1 - N7 | N1 - N6 | | | | |
| P | P1 | ◪ | ■ | | | | | | | | | | | |
| | P2 | ■ | ◪ | | | | | | | | | | | |
| | P3 | ■ | | | | | | | | | | | | |
| | P4 | ■ | | | | | | | | | | | | |
| M | M1 | | ■ | | | | | | | | | | | |
| | M2 | | ■ | | | | | | | | | | | |
| | M3 | | ■ | | | | | | | | | | | |
| | M4 | | ■ | | | | | | | | | | | |
| K | K1 | | ■ | ■ | | | | | | | | | | |
| | K2 | ■ | ◪ | ■ | | | | | | | | | | |
| | K3 | ■ | ◪ | ■ | | | | | | | | | | |
| | K4 | ■ | ◪ | ■ | | | | | | | | | | |
| | K5 | ■ | ◪ | ■ | | | | | | | | | | |
| N | N1 | | | | | | | | | | | | | |
| | N2 | | | | | | | | | | | | | |
| | N3 | | | | | | | | | | | | | |
| | N4 | | | | | | | | | | | | | |
| | N5 | | | | | | | | | | | | | |
| S | S1 | | ◪ | | | | | | | | | | | |
| | S2 | | ◪ | | | | | | | | | | | |
| | S3 | | ◪ | | | | | | | | | | | |
| | S4 | | ◪ | | | | | | | | | | | |
| H | H1 | | | | | | | | | | | | | |
| | H2 | | | | | | | | | | | | | |
| | H3 | | | | | | | | | | | | | |
| | H4 | | | | | | | | | | | | | |

■ Primary use ◪ Possible use



# INDEXABLE DRILLS

| Working length | 2×D | 3×D | 4×D | 5×D | XPET..AP | SCET..-UD | XPET..AP-SD | SCET..-SD |
|---|---|---|---|---|---|---|---|---|
| Picture |  |  |  |  |  |  |  |  |
| Coolant |  |  |  |  | – | – | – | – |
| | | | | | | | | |
| Drill type | 802D | 803D | 804D | 805D | – | – | – | – |
| Drill tolerance | ± 0.05 | ± 0.05 | ± 0.05 | ± 0.05 | – | – | – | – |
| Hole tolerance * | 0 /+0.2 | 0 /+0.3 | 0 /+0.4 | 0 /+0.5 | – | – | – | – |
| Surface finish * | $R_a$ 2 – 6 µm | $R_a$ 2 – 6 µm | $R_a$ 2 – 6 µm | $R_a$ 2 – 6 µm | – | – | – | – |
| Diameter range | 15.0 – 40.0 | 15.0 – 58.0 | 17.0 – 58.0 | 19.0 – 31.0 | – | – | – | – |
| P | P1 | | | | ■ | ■ | ■ | ■ |
| | P2 | | | | ■ | ■ | ■ | ■ |
| | P3 | | | | ■ | ■ | ■ | ■ |
| | P4 | | | | ■ | ■ | ■ | ■ |
| M | M1 | | | | | | ■ | ■ |
| | M2 | | | | | | ■ | ■ |
| | M3 | | | | | | ■ | ■ |
| | M4 | | | | | | ■ | ■ |
| K | K1 | | | | ◪ | ■ | ◪ | ◪ |
| | K2 | | | | ◪ | ■ | ◪ | ◪ |
| | K3 | | | | ◪ | ■ | ◪ | ◪ |
| | K4 | | | | ◪ | ■ | ◪ | ◪ |
| | K5 | | | | ◪ | ■ | ◪ | ◪ |
| S | S1 | | | | | | ◪ | ◪ |
| | S2 | | | | | | ◪ | ◪ |
| | S3 | | | | | | ◪ | ◪ |
| | S4 | | | | | | ◪ | ◪ |

* The tolerance of drilled hole and surface finish are heavily dependent on machining conditions.

# REAMERS AND COUNTERSINKS



| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Material code (BMC) | | HSS-E | HSS | HSS | HSS | | | | | | | | | |
| Coating | | Bright ST | Bright ST | Bright | TiN | | | | | | | | | |
| Basic standard group (BSG) | | BS 328 | DIN 311 | DIN 335D | DIN 335D | | | | | | | | | |
| Hand (Cutting direction) | | R | R | R | R | | | | | | | | | |
| Shank | | | | | | | | | | | | | | |
| Application angle | | | | 90° | 90° | | | | | | | | | |
| Reamer form | | B | | | | | | | | | | | | |
| Achievable hole tolerance (TCHA) | | H7 | k11 | | | | | | | | | | | |
| Taper gradient - millimeter (Rate of taper) | | | | | | | | | | | | | | |
| | |  |  |  |  | | | | | | | | | |
| Product Family Code | | B101 | B121 | G138 | G338 | | | | | | | | | |
| | | 3.00 – 2" | 10.00 – 30.00 | 25.00 – 80.00 | 25.00 – 63.00 | | | | | | | | | |
| P | P1 | ■ | ■ | ■ | ■ | | | | | | | | | |
| | P2 | ■ | ■ | ■ | ■ | | | | | | | | | |
| | P3 | ■ | ■ | ◪ | ■ | | | | | | | | | |
| | P4 | ◪ | ◪ | ◪ | ■ | | | | | | | | | |
| M | M1 | ◪ | | ◪ | ◪ | | | | | | | | | |
| | M2 | | | ◪ | ◪ | | | | | | | | | |
| | M3 | | | | | | | | | | | | | |
| | M4 | | | | | | | | | | | | | |
| K | K1 | ■ | ■ | ◪ | ■ | | | | | | | | | |
| | K2 | ■ | ■ | ◪ | ■ | | | | | | | | | |
| | K3 | ◪ | ◪ | ◪ | ■ | | | | | | | | | |
| | K4 | | | | ◪ | | | | | | | | | |
| | K5 | | | ◪ | ■ | | | | | | | | | |
| N | N1 | ■ | ■ | ◪ | ■ | | | | | | | | | |
| | N2 | ■ | ■ | ◪ | ■ | | | | | | | | | |
| | N3 | ■ | ■ | ■ | ■ | | | | | | | | | |
| | N4 | ◪ | ◪ | ◪ | ◪ | | | | | | | | | |
| | N5 | | | | | | | | | | | | | |
| S | S1 | | | | | | | | | | | | | |
| | S2 | | | | | | | | | | | | | |
| | S3 | | | | | | | | | | | | | |
| | S4 | | | | | | | | | | | | | |
| H | H1 | | | | | | | | | | | | | |
| | H2 | | | | | | | | | | | | | |
| | H3 | | | | | | | | | | | | | |
| | H4 | | | | | | | | | | | | | |

■ Primary use ◪ Possible use

# THREADING
# HSS TAPS



| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thread form (THFT) | | M | MF | UNC | UNF | M | MF | UNC | UNF | M | MF | UNC | UNF | M |
| Basic standard group (BSG) | | DIN 352 | DIN 2181 | DIN 352 | DIN 2181 | ISO 529 | ISO 529 | ISO 529 | ISO 529 | DIN 371/376 | DIN 374 | DIN 2184-1 | DIN 2184-1 | DIN 371/376 |
| Thread tolerance class (TCTR) | | 6H | 6H | 2B | 2B | 6H | 6H | 2B | 2B | 6H | 6H | 2B | 2B | 6H |
| Threading application | | | | | | | | | | | | | | |
| Usable length (ULDR) | | 1.5×D | 1.5×D | 1.5×D | 1.5×D | 1.5×D | 1.5×D | 1.5×D | 1.5×D | 2.5×D | 2.5×D | 2.5×D | 2.5×D | 2.5×D |
| Material code (BMC) | | HSS | HSS | HSS | HSS | HSS | HSS | HSS | HSS | HSS-E PM | HSS-E PM | HSS-E PM | HSS-E PM | HSS-E PM |
| Tap chamfer style (TCS) | | C 2-3 | C 2-3 | C 2-3 | C 2-3 | | | | | B 3.5-5 | B 3.5-5 | B 3.5-5 | C 2-3 | C 2-3 |
| Flute Geometry (FDC) | | | | | | | | | | | | | | |
| Flute helix angle (FHA) | | | | | | | | | | | | | | λ 45° |
| Hand (Cutting direction) | | R | R | R | R | R | R | R | R | R | R | R | R | R |
| Coating | | Bright | Bright | Bright | Bright | Bright | Bright | Bright | Bright | ST | ST | ST | ST | ST |
| Coolant exit style (CXSC) | | | | | | | | | | | | | | |
| Product Family Code | | E100 | E105 | E108 | E111 | E500 | E513 | E515 | E524 | EP016H | EP11 | EP21 | EP31 | EX016H |
| | | M1.6 – M52 | M2.5 – M50 | No.5 – 1" | No.5 – 1" | M1 – M56 | M3 – M50 | No.1 – 2" | No.0 – 1.1/2 | M2 – M30 | M4 – M30 | No.4 – 1" | No.8 – 1" | M2 – M64 |
| P | P1 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ◪ | ◪ | ◪ | ◪ | ◪ |
| | P2 | ■ | ■ | ■ | ◪ | ■ | ■ | ■ | ■ | ■ | ◪ | ■ | ■ | ■ |
| | P3 | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ■ | ■ | ■ | ■ | ■ |
| | P4 | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | | ◪ | ■ | ■ | ■ |
| M | M1 | | | | | | | | | ◪ | ◪ | ◪ | ◪ | ◪ |
| | M2 | | | | | | | | | ◪ | ◪ | ◪ | ◪ | ◪ |
| | M3 | | | | | | | | | ◪ | ◪ | ◪ | ◪ | ◪ |
| | M4 | | | | | | | | | ◪ | ◪ | ◪ | ◪ | ◪ |
| K | K1 | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | |
| | K2 | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | |
| | K3 | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | |
| | K4 | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | |
| | K5 | | | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | ◪ | |
| N | N1 | ■ | ■ | ■ | ■ | ◪ | ◪ | ◪ | ◪ | | | | | |
| | N2 | ■ | ■ | ■ | ■ | ◪ | ◪ | ◪ | ◪ | | | | | |
| | N3 | ■ | ■ | ■ | ■ | ◪ | ■ | ■ | ■ | | | | | |
| | N4 | ■ | ■ | ◪ | ■ | ◪ | ◪ | ◪ | ◪ | | | | | |
| | N5 | | | | | | | | | | | | | |
| S | S1 | | | | | | | | | | | | | |
| | S2 | | | | | | | | | | | | | |
| | S3 | | | | | | | | | | | | | |
| | S4 | | | | | | | | | | | | | |
| H | H1 | | | | | | | | | | | | | |
| | H2 | | | | | | | | | | | | | |
| | H3 | | | | | | | | | | | | | |
| | H4 | | | | | | | | | | | | | |

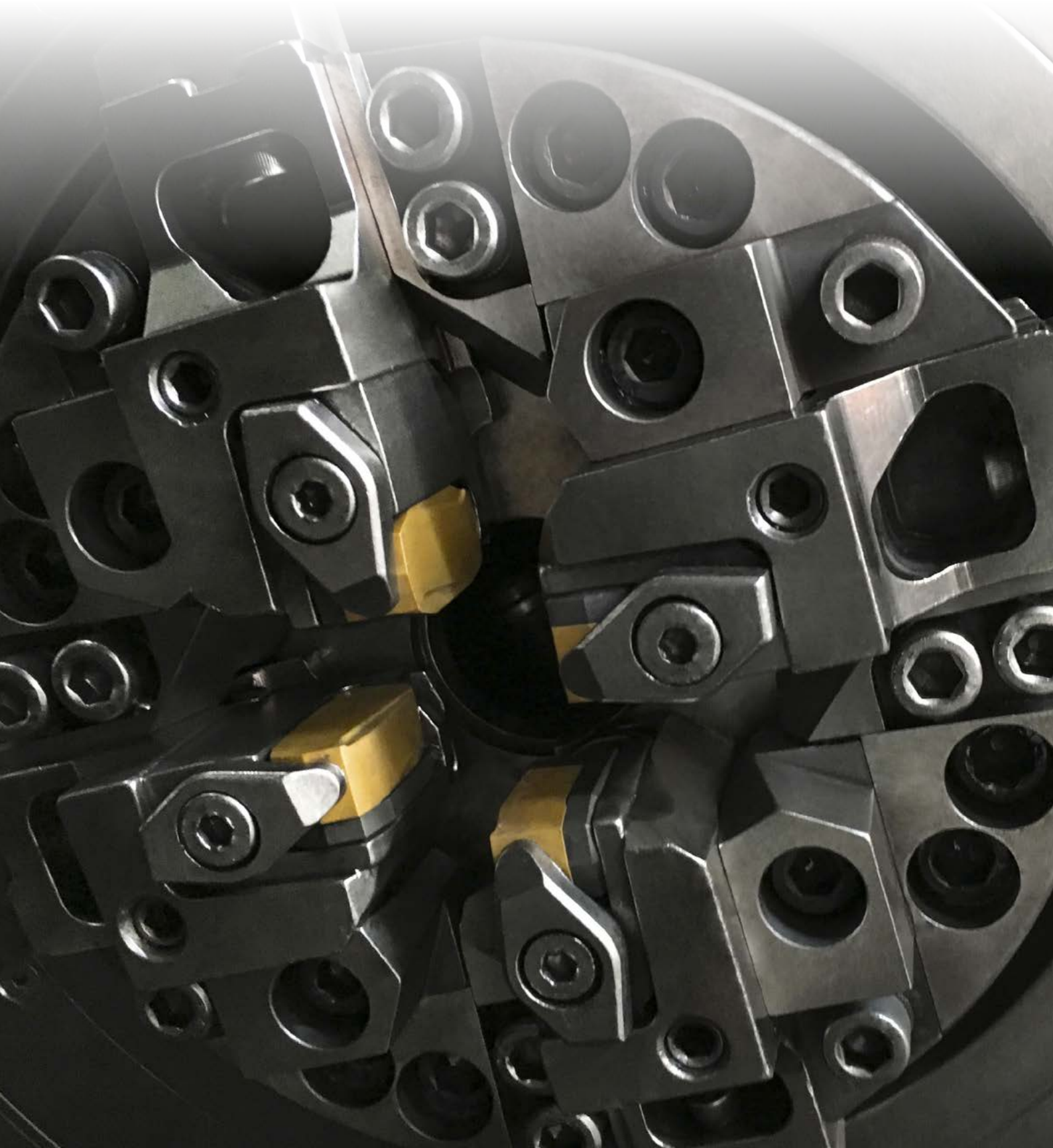
■ Primary use ◪ Possible use

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thread form (THFT) | | MF | UNC | UNF | | | | | | | | | | | |
| Basic standard group (BSG) | | DIN 374 | DIN 2184-1 | DIN 2184-1 | | | | | | | | | | | |
| Thread tolerance class (TCTR) | | 6H | 2B | 2B | | | | | | | | | | | |
| Threading application | | | | | | | | | | | | | | | |
| Usable length (ULDR) | | 2.5×D | 2.5×D | 2.5×D | | | | | | | | | | | |
| Material code (BMC) | | HSS-E PM | HSS-E PM | HSS-E PM | | | | | | | | | | | |
| Tap chamfer style (TCS) | | C 2-3 | C 2-3 | C 2-3 | | | | | | | | | | | |
| Flute Geometry (FDC) | | | | | | | | | | | | | | | |
| Flute helix angle (FHA) | | λ 45° | λ 45° | λ 45° | | | | | | | | | | | |
| Hand (Cutting direction) | | R | R | R | | | | | | | | | | | |
| Coating | | ST | ST | ST | | | | | | | | | | | |
| Coolant exit style (CXSC) | | | | | | | | | | | | | | | |
| | |  |  |  | | | | | | | | | | | |
| Product Family Code | | EX11 | EX21 | EX31 | | | | | | | | | | | |
| | | M4 – M30 | No.4 – 1" | No.8 – 1" | | | | | | | | | | | |
| P | P1 | ◪ | ◪ | ◪ | | | | | | | | | | | |
| | P2 | ■ | ■ | ■ | | | | | | | | | | | |
| | P3 | ■ | ■ | ■ | | | | | | | | | | | |
| | P4 | ■ | ■ | ■ | | | | | | | | | | | |
| M | M1 | ◪ | ◪ | ◪ | | | | | | | | | | | |
| | M2 | ◪ | ◪ | ◪ | | | | | | | | | | | |
| | M3 | ◪ | ◪ | ◪ | | | | | | | | | | | |
| | M4 | ◪ | ◪ | ◪ | | | | | | | | | | | |
| K | K1 | | | ◪ | | | | | | | | | | | |
| | K2 | | | ◪ | | | | | | | | | | | |
| | K3 | | | ◪ | | | | | | | | | | | |
| | K4 | | | ◪ | | | | | | | | | | | |
| | K5 | | | ◪ | | | | | | | | | | | |
| N | N1 | | | | | | | | | | | | | | |
| | N2 | | | | | | | | | | | | | | |
| | N3 | | | | | | | | | | | | | | |
| | N4 | | | | | | | | | | | | | | |
| | N5 | | | | | | | | | | | | | | |
| S | S1 | | | | | | | | | | | | | | |
| | S2 | | | | | | | | | | | | | | |
| | S3 | | | | | | | | | | | | | | |
| | S4 | | | | | | | | | | | | | | |
| H | H1 | | | | | | | | | | | | | | |
| | H2 | | | | | | | | | | | | | | |
| | H3 | | | | | | | | | | | | | | |
| | H4 | | | | | | | | | | | | | | |

■ Primary use ◪ Possible use

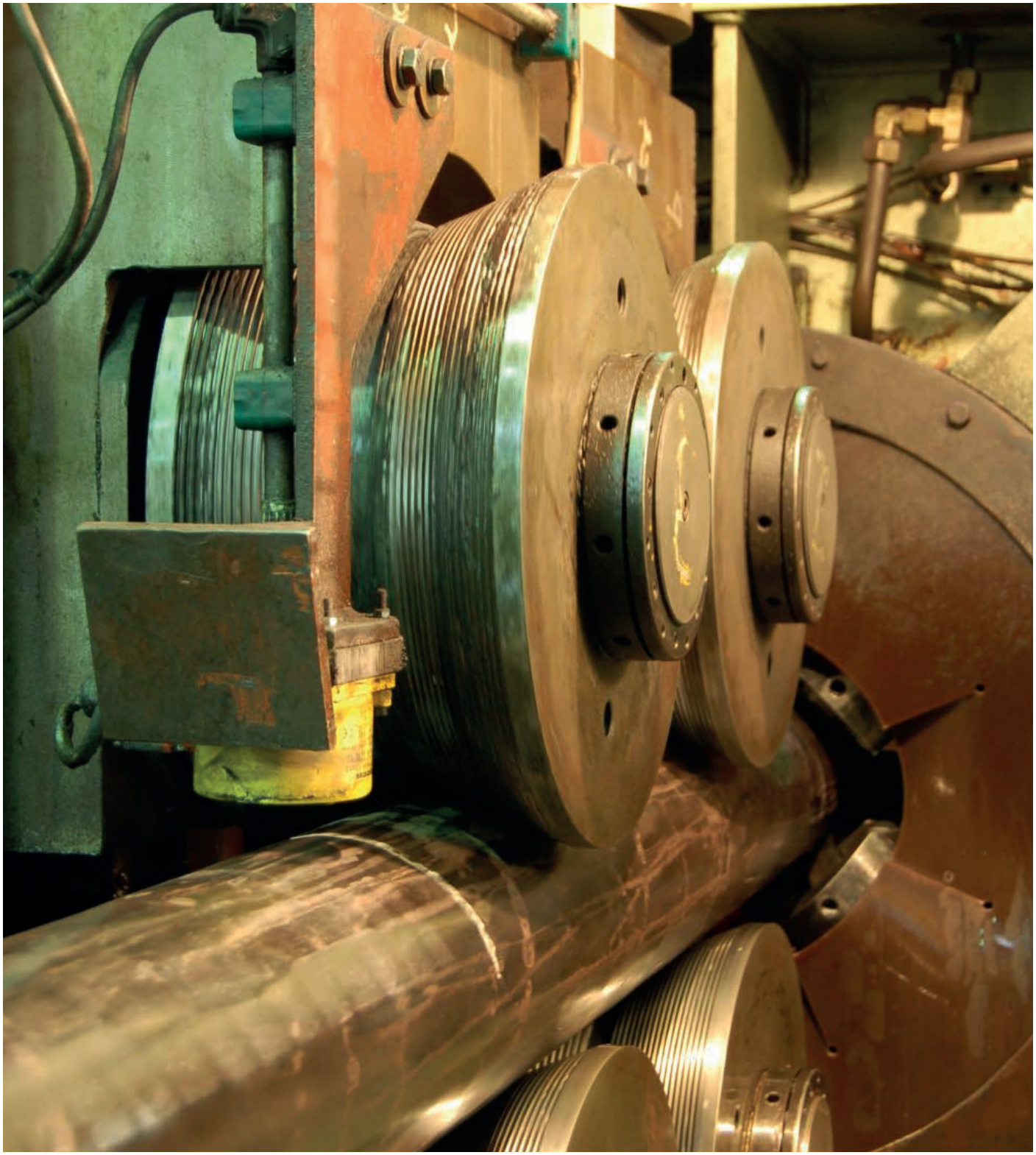


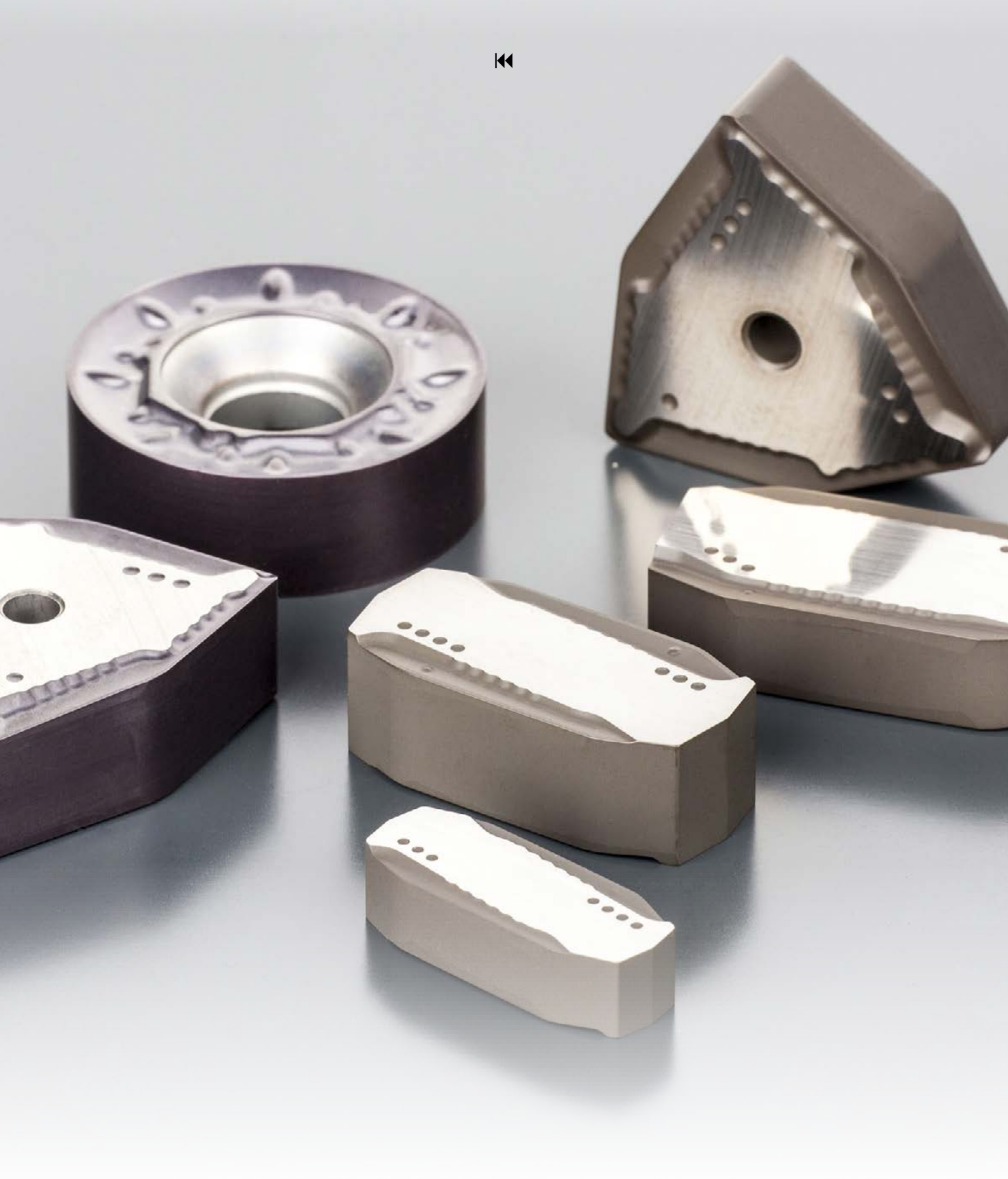
# BAR PEELING



# INTRODUCTION

In Bar Peeling applications, the most important criteria are process stability, high productivity, dimensional accuracy of machined bars, and excellent surface quality. With many years of experience, we can offer a wide range of inserts with specific geometries suitable for steel and stainless steel as well as difficult to machine materials. Dormer Pramet state-of-the-art production methods for cemented carbide grades and MT-CVD and PVD coating layers ensures our peeling inserts provide the required tool life to meet customer expectation. Specific cassettes that are used on different manufacturers machine tools can be provided on request.





# BAR PEELING INSERTS

**LNGF 30**



12

**LNGF 36**



12

**LNGF 40**



13

**LNXR**



14

**RNGH 38**



15

**RNGH 50**



15

**TNGJ 22**



16

**TNGJ 28**



16

**WNGF**



17

**WNGU**



17

**WNMF**



18

**WNMJ**



18

**WNXJ**



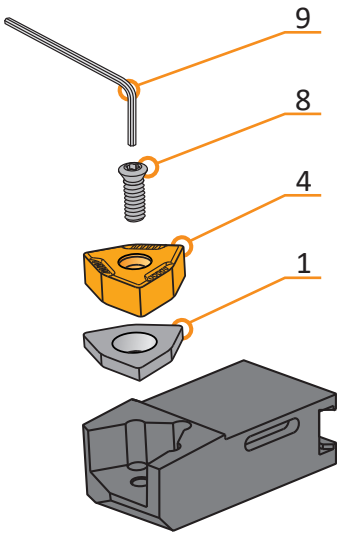
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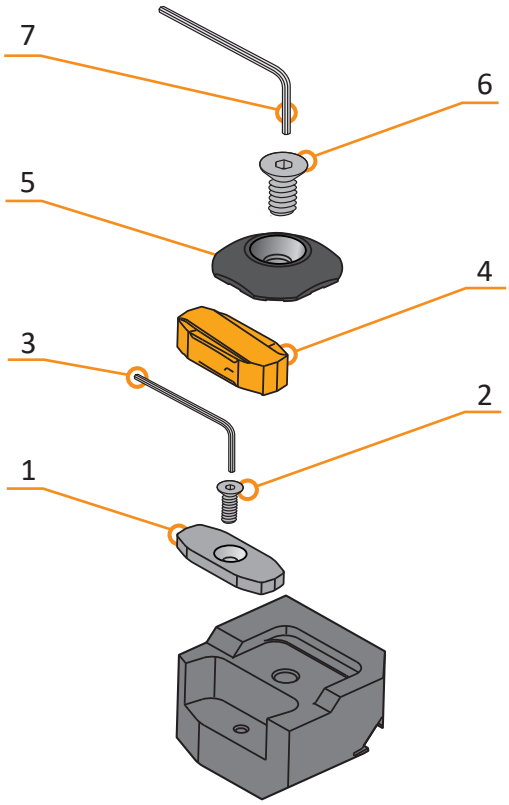


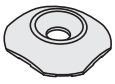
# ACCESSORIES AND SPECIAL PRODUCTS

Bar Peeling inserts are generally mounted in two ways, either using a screw through the centre hole of the indexable insert or via a top clamp mechanism.

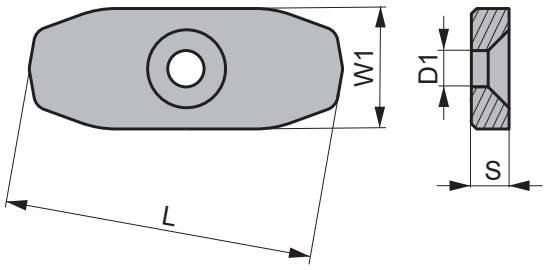
Most of our cassettes are equipped with a cemented carbide shim (washer) to protect the pocket and extend the life of the cassettes. The spare parts list for individual fastening systems is shown in the diagrams below and in the table of individual components.



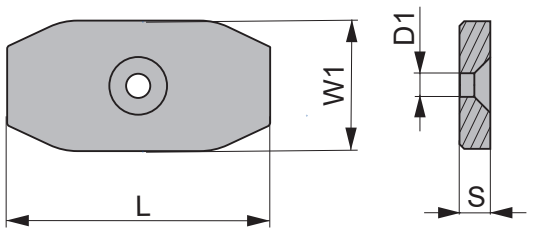




| 4 | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |
| **LNGF 3007..** | LNW 300310 | HCS 0308 | HXK 2 | UP 3005 | HCS 0612 | HXK 4 | – | – |
| **LNGF 3612..** | LNW 360310 | HCS 0308 | HXK 2 | UP 3005 | HCS 0612 | HXK 4 | – | – |
| **LNGF 4010..** | LNW 400410 | HCS 0310 | HXK 2 | UP 3005 | HCS 0612 | HXK 4 | – | – |
| **RNGH 3812..** | RNX 380700 | – | – | – | – | – | HCS 1030 | HXK 6 |
| **WN.J 2013..** | WNW 200615 | – | – | – | – | – | US 8025-T30P | SDR T30P |
| **WN.F 2013..** | WNW 200615 | HCS 0816 | HXK 5 | UP 4107 | HCS 0820 | HXK 5 | | – |

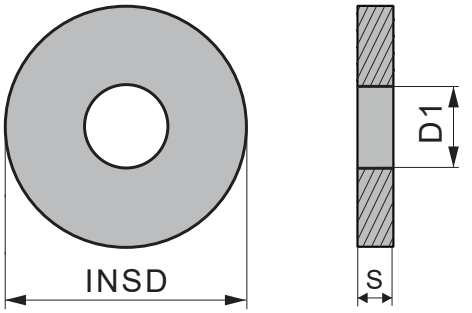
**LNW 300310**
**LNW 360310**



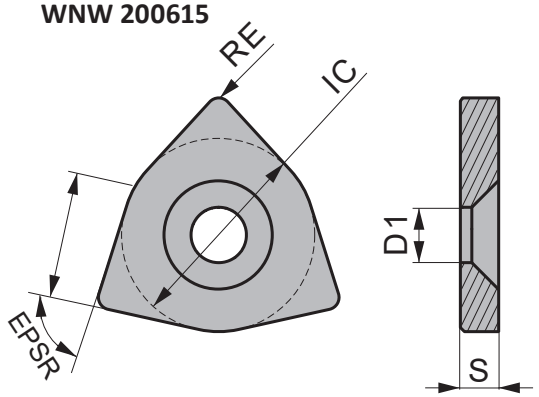

**LNW 400410**



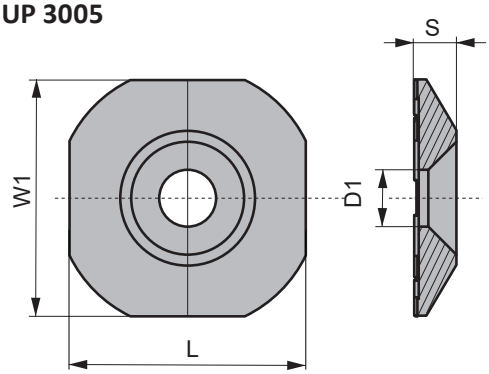

**RNW 380700**



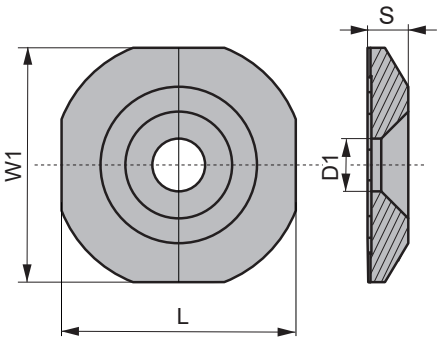

**WNW 200615**




**UP 3005**




**UP 4107**




| | L | W1 | S | D1 | IC / INSD | EPSR |
|---|---|---|---|---|---|---|
| **LNW 300310** | 29.75 | 11.60 | 3.50 | 3.50 | – | – |
| **LNW 360310** | 36.10 | 17.60 | 3.50 | 3.50 | – | – |
| **LNW 400410** | 39.70 | 19.70 | 4.75 | 3.50 | – | – |
| **WNW 200615** | 20.00 | – | 6.00 | 9.00 | 31.40 | 85 |
| **RNW 380700** | – | – | 7.00 | 11.15 | 37.75 | – |
| **UP 3005** | 27.00 | 27.00 | 4.70 | 6.50 | – | – |
| **UP 4107** | 38.20 | 38.20 | 6.40 | 8.60 | – | – |

# SPECIAL TOOLS
# FOR SPECIMENS IN CHARPY TESTS



# ST22N-1517-U+V

P M K

PRAMET

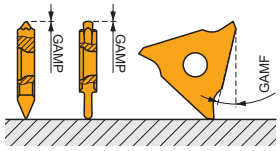
S

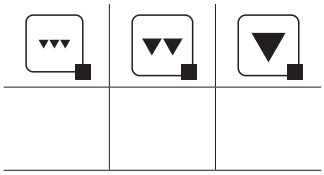


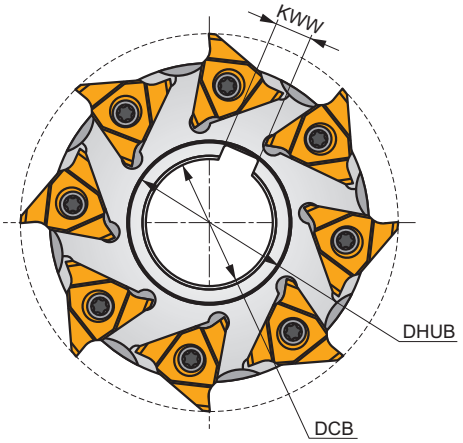
## Special Milling Cutter

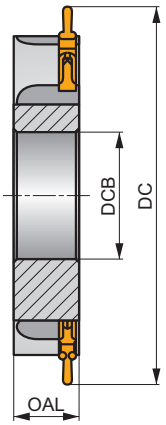
Disc cutter utilizing tangentially clamped special inserts S-TNEW22- for machining specimens with groove shape U or V for Charpy impact testing. Available as a made-on request product.

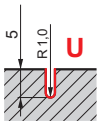
| KAPR | 90° |
|---|---|

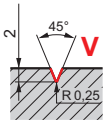





$h_m$ 0.03 - 0.05

| | | DC (mm) | OAL (mm) | DCB (mm) | DHUB (mm) | DCX (mm) | KWW (mm) | (mm) | GAMF (°) | GAMP (°) | | | max. | | kg | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ISO 6462 DIN 8030 | **80X08R-STN22-1517** | 80 | 14.2 | 27 | 34 | 5 | 8 | – | - 11 | 0 | 8 | – | 9000 | – | 0.28 | S-TNEW 22-2501812<br>S-TNEW22-2501813 | SPEC | – |

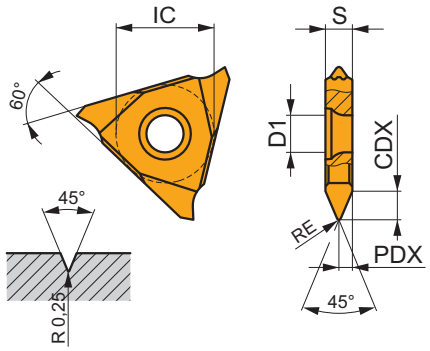
| | V | U |
|---|---|---|
| | S-TNEW 22-2501812 | S-TNEW22-2501813 |

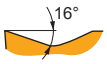
| | | Nm | | | |
|---|---|---|---|---|---|
| | US 4011-T15P | 3.5 | M 4 | 10.6 | SDR T15P |

# S-TNEW 22-V

PRAMET

| | IC (mm) | D1 (mm) | S (mm) | RE (mm) | CDX (mm) | PDX (mm) |
|---|---|---|---|---|---|---|
| 22 | 12.700 | 4.90 | 3.50 | 0.25 | 2.3 | 1.75 |



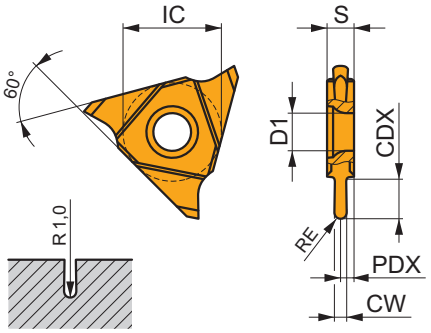

| | RE (mm) | P vc (m/min) | P f (mm/tooth) | P ap (mm) | M vc (m/min) | M f (mm/tooth) | M ap (mm) | K vc (m/min) | K f (mm/tooth) | K ap (mm) | N vc (m/min) | N f (mm/tooth) | N ap (mm) | S vc (m/min) | S f (mm/tooth) | S ap (mm) | H vc (m/min) | H f (mm/tooth) | H ap (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | | |
| S-TNEW 22-2501812 | 0.25 | ■ 210 | 0.20 | – | ■ 125 | 0.20 | – | ■ 195 | 0.20 | – | – | – | – | – | – | – | – | – | – |
| M8330 | | | | | | | | | | | | | | | | | | | |

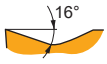
Geometry dedicated for V shape of groove in specimens for Charpy impact tests.

# S-TNEW 22-U

PRAMET

| | IC (mm) | D1 (mm) | S (mm) | RE (mm) | CW (mm) | CDX (mm) | PDX (mm) |
|---|---|---|---|---|---|---|---|
| 22 | 12.700 | 4.90 | 3.50 | 1.00 | 2.00 | 5.10 | 1.75 |




| | RE (mm) | P vc (m/min) | P f (mm/tooth) | P ap (mm) | M vc (m/min) | M f (mm/tooth) | M ap (mm) | K vc (m/min) | K f (mm/tooth) | K ap (mm) | N vc (m/min) | N f (mm/tooth) | N ap (mm) | S vc (m/min) | S f (mm/tooth) | S ap (mm) | H vc (m/min) | H f (mm/tooth) | H ap (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | | |
| S-TNEW22-2501813 | 1.00 | ■ 210 | 0.15 | – | ■ 125 | 0.15 | – | ■ 195 | 0.15 | – | – | – | – | – | – | – | – | – | – |
| M8330 | | | | | | | | | | | | | | | | | | | |

Geometry dedicated for U shape of groove in specimens for Charpy impact tests.

# ST22N-1504-U+V

P M K

PRAMET

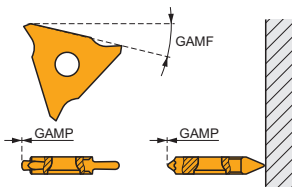
S

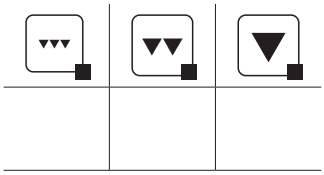


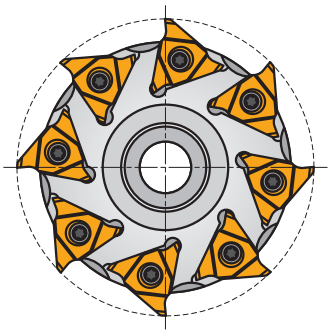
## Special Milling Cutter

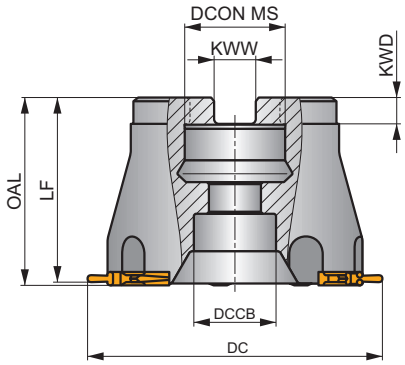
Arbor style cutter utilizing tangentially clamped special inserts S-TNEW22- for machining specimens with groove shape U or V for Charpy impact testing. Available as a made-on request product.

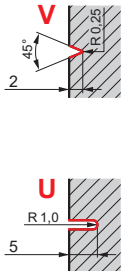
| KAPR | 90° |
|---|---|








$h_m$ 0.03 - 0.05



| | | DC (mm) | OAL (mm) | DCON MS (mm) | DCCB (mm) | LF (mm) | KWW | KWD | GAMF (°) | GAMP (°) | | | max. | | kg | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **80A08R-STN22-1504** | 80 | 50 | 27 | 38 | 49.2 | 12.4 | 7 | -11 | 0 | 8 | – | 9000 | | 0.99 | S-TNEW 22-2501812<br>S-TNEW22-2501813 | SPEC | AC001 |

| | V | U |
|---|---|---|
| | S-TNEW 22-2501812 | S-TNEW22-2501813 |

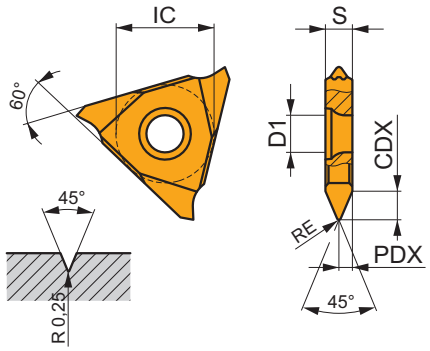
| | | Nm | | | |
|---|---|---|---|---|---|
| | US 4011-T15P | 3.5 | M 4 | 10.6 | SDR T15P |

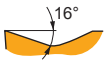
| | | |
|---|---|---|
| AC001 | KS 1230 | K.FMH27 |

# S-TNEW 22-V

PRAMET

| | IC (mm) | D1 (mm) | S (mm) | RE (mm) | CDX (mm) | PDX (mm) |
|---|---|---|---|---|---|---|
| 22 | 12.700 | 4.90 | 3.50 | 0.25 | 2.3 | 1.75 |



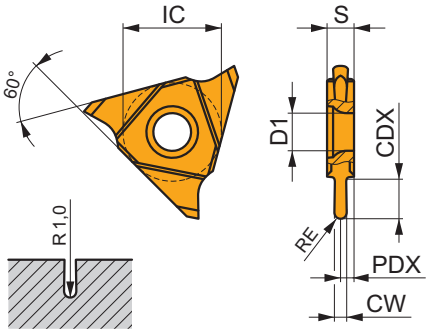

| | RE (mm) | P vc (m/min) | P f (mm/tooth) | P ap (mm) | M vc (m/min) | M f (mm/tooth) | M ap (mm) | K vc (m/min) | K f (mm/tooth) | K ap (mm) | N vc (m/min) | N f (mm/tooth) | N ap (mm) | S vc (m/min) | S f (mm/tooth) | S ap (mm) | H vc (m/min) | H f (mm/tooth) | H ap (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | | |
| S-TNEW 22-2501812 | 0.25 | ■ 210 | 0.20 | – | ■ 125 | 0.20 | – | ■ 195 | 0.20 | – | – | – | – | – | – | – | – | – | – |
| M8330 | | | | | | | | | | | | | | | | | | | |

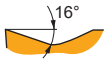
Geometry dedicated for V shape of groove in specimens for Charpy impact tests.

# S-TNEW 22-U

PRAMET

| | IC (mm) | D1 (mm) | S (mm) | RE (mm) | CW (mm) | CDX (mm) | PDX (mm) |
|---|---|---|---|---|---|---|---|
| 22 | 12.700 | 4.90 | 3.50 | 1.00 | 2.00 | 5.10 | 1.75 |




| | RE (mm) | P vc (m/min) | P f (mm/tooth) | P ap (mm) | M vc (m/min) | M f (mm/tooth) | M ap (mm) | K vc (m/min) | K f (mm/tooth) | K ap (mm) | N vc (m/min) | N f (mm/tooth) | N ap (mm) | S vc (m/min) | S f (mm/tooth) | S ap (mm) | H vc (m/min) | H f (mm/tooth) | H ap (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | | | | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | | | |
| S-TNEW22-2501813 | 1.00 | ■ 210 | 0.15 | – | ■ 125 | 0.15 | – | ■ 195 | 0.15 | – | – | – | – | – | – | – | – | – | – |
| M8330 | | | | | | | | | | | | | | | | | | | |

Geometry dedicated for U shape of groove in specimens for Charpy impact tests.

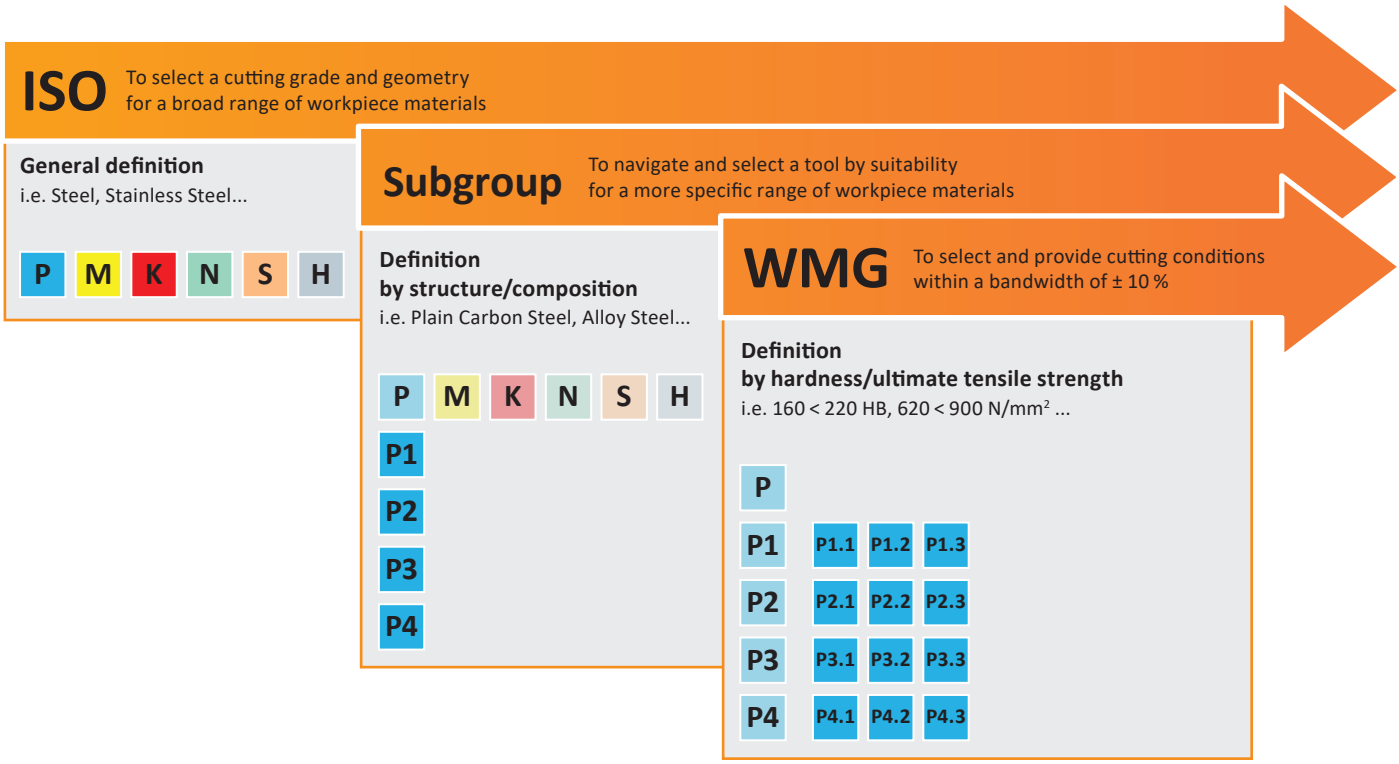
# TECHNICAL INFORMATION



## CONTENT OF TECHNICAL INFORMATION


| | |
|---|---|
| 📖 68 | WMG |
| 📖 76 | INDEXABLE MILLS |
| 📖 95 | HEAVY TURNING |
| 📖 118 | HOLEMAKING |
| 📖 139 | REAMERS AND COUTERSINKS |
| 📖 148 | THREADING |
| 📖 166 | RECOMMENDED SCREWS TORQUE AND USEFUL TABLES |
| 📖 173 | TECHNICAL INFORMATION ON INSERT BOX |

## Workpiece material groups (WMG)




## About Dormer Pramet's workpiece material classification

**W**orkpiece **M**aterial **G**roups (**WMG**) are used to support easy and reliable selection of the right cutting tool and starting values for machining conditions in particular applications.

Dormer Pramet classifies workpiece materials into six different coloured groups;

- **Blue**: Steel and cast steel (P-group)
- **Yellow**: Stainless steel (M-group)
- **Red**: Cast iron (K-group)
- **Green**: Non-ferrous metals (N-group)
- **Brown**: High-temperature alloys (S-group)
- **Grey**: Hardened materials (H-group)

Each of these are divided into subgroups on the basis of their structure and/or composition. For example, P-group steel and cast steel is split into four subgroups, namely;

- **P1** – Free machining steel
- **P2** – Plain carbon steel
- **P3** – Alloy steel
- **P4** – Tool steel

A final division includes material properties, such as hardness and ultimate tensile strength. This is to provide our customers with a complete tool recommendation, including starting values for cutting speed and feed.

The table on the next page includes a description of each workpiece material group, as well as examples of commonly used designations.

## WMG (Work Material Group)

| ISO group | | WMG (Work Material Group) | | | Hardness (HB or HRC) | Ultimate Tensile Strength (MPa) |
|---|---|---|---|---|---|---|
| P | P1 | P1.1 | Free machining steel (carbon steels with increased machinability) | Sulfurized | < 240 HB | ≤ 830 |
| | | P1.2 | | Sulfurized and phosphorized | < 180 HB | ≤ 620 |
| | | P1.3 | | Sulfurized/phosphorized and leaded | < 180 HB | ≤ 620 |
| | P2 | P2.1 | Plain carbon steel (steels comprised of mainly iron and carbon) | Containing <0.25 % C | < 180 HB | ≤ 620 |
| | | P2.2 | | Containing <0.55 % C | < 240 HB | ≤ 830 |
| | | P2.3 | | Containing >0.55 % C | < 300 HB | ≤ 1030 |
| | P3 | P3.1 | Alloy steel (carbon steels with an alloying content ≤ 10%) | Annealed | < 180 HB | ≤ 620 |
| | | P3.2 | | Hardened and tempered | 180 – 260 HB | > 620 ≤ 900 |
| | | P3.3 | | | 260 – 360 HB | > 900 ≤ 1240 |
| | P4 | P4.1 | Tool steel (special alloy steel for tools, dies and molds) | Annealed | < 26 HRC | ≤ 900 |
| | | P4.2 | | Hardened and tempered | 26 – 39 HRC | > 900 ≤ 1240 |
| | | P4.3 | | | 39 – 45 HRC | > 1240 ≤ 1450 |
| M | M1 | M1.1 | Ferritic stainless steel (straight chromium non-hardenable alloys) | | < 160 HB | ≤ 520 |
| | | M1.2 | | | 160 – 220 HB | > 520 ≤ 700 |
| | M2 | M2.1 | Martensitic stainless steel (straight chromium hardenable alloys) | Annealed | < 200 HB | ≤ 670 |
| | | M2.2 | | Quenched and tempered | 200 – 280 HB | > 670 ≤ 950 |
| | | M2.3 | | Precipitation-hardened | 280 – 380 HB | > 950 ≤ 1300 |
| | M3 | M3.1 | Austenitic stainless steel (chromium-nickel and chromium-nickel-manganese alloys) | | < 200 HB | ≤ 750 |
| | | M3.2 | | | 200 – 260 HB | > 750 ≤ 870 |
| | | M3.3 | | | 260 – 300 HB | > 870 ≤ 1040 |
| | M4 | M4.1 | Austenitic-ferritic (DUPLEX) or super-austenitic stainless steel | | < 300 HB | ≤ 990 |
| | | M4.2 | Precipitation hardening austenitic stainless steel | | 300 – 380 HB | ≤ 1320 |
| K | K1 | K1.1 | Gray iron or Automotive Gray iron (GG) (iron-carbon castings with a lamellar graphite microstructure) | Ferritic or ferritic-pearlitic | < 180 HB | ≤ 190 |
| | | K1.2 | | Ferritic-pearlictic or pearlitic | 180 – 240 HB | > 190 ≤ 310 |
| | | K1.3 | | Pearlitic | 240 – 280 HB | > 310 ≤ 390 |
| | K2 | K2.1 | Malleable iron (GTS/GTW) (iron-carbon castings with a graphite-free microstructure) | Ferritic | < 160 HB | ≤ 400 |
| | | K2.2 | | Ferritic or pearlitic | 160 – 200 HB | > 400 ≤ 550 |
| | | K2.3 | | Pearlitic | 200 – 240 HB | > 550 ≤ 660 |
| | K3 | K3.1 | Ductile iron (GGG) (iron-carbon castings with a nodular graphite microstructure) | Ferritic | < 180 HB | ≤ 560 |
| | | K3.2 | | Ferritic or pearlitic | 180 – 220 HB | > 560 ≤ 680 |
| | | K3.3 | | Pearlitic | 220 – 260 HB | > 680 ≤ 800 |
| | K4 | K4.1 | Austenitic gray iron (ASTM A436) (iron-carbon alloy castings with an austenitic lamellar graphite microstructure) | | < 180 HB | ≤ 190 |
| | | K4.2 | Austenitic ductile iron (ASTM A439 or ASTM A571) (iron-carbon alloy castings with an austenitic nodular graphite microstructure) | | < 240 HB | ≤ 740 |
| | | K4.3 | Austempered ductile iron (ASTM A897) (iron-carbon alloy castings with an ausferrite microstructure) | | < 280 HB | > 840 ≤ 980 |
| | | K4.4 | | | 280 – 320 HB | > 980 ≤ 1130 |
| | | K4.5 | | | 320 – 360 HB | > 1130 ≤ 1280 |
| | K5 | K5.1 | Compacted graphite iron CGI (ASTM A842) (iron-carbon castings with a vermicular graphite structure) | Ferritic | < 180 HB | ≤ 400 |
| | | K5.2 | | Ferritic-pearlitic | 180 – 220 HB | > 400 ≤ 450 |
| | | K5.3 | | Pearlitic | 220 – 260 HB | > 450 ≤ 500 |
| N | N1 | N1.1 | Commercially pure wrought aluminium | | < 60 HB | ≤ 240 |
| | | N1.2 | Wrought aluminium alloys | Half hard tempered | 60 – 100 HB | > 240 ≤ 400 |
| | | N1.3 | | Full hard tempered | 100 – 150 HB | > 400 ≤ 590 |
| | N2 | N2.1 | Cast aluminium alloys | | < 75 HB | ≤ 240 |
| | | N2.2 | | | 75 – 90 HB | > 240 ≤ 270 |
| | | N2.3 | | | 90 – 140 HB | > 270 ≤ 440 |
| | N3 | N3.1 | Free-cutting copper-alloys materials with excellent machining properties | | – | – |
| | | N3.2 | Short-chip copper-alloys with good to moderate machining properties | | – | – |
| | | N3.3 | Electrolytic copper and long-chip copper-alloys with moderate to poor machining properties | | – | – |
| | N4 | N4.1 | Thermoplastic polymers | | – | – |
| | | N4.2 | Thermosetting polymers | | – | – |
| | | N4.3 | Reinforced polymers or composites | | – | – |
| | N5 | N5.1 | Graphite | | – | – |
| S | S1 | S1.1 | Titanium or titanium alloys | | < 200 HB | ≤ 660 |
| | | S1.2 | | | 200 – 280 HB | > 660 ≤ 950 |
| | | S1.3 | | | 280 – 360 HB | > 950 ≤ 1200 |
| | S2 | S2.1 | Fe-based high-temperature alloys | | < 200 HB | ≤ 690 |
| | | S2.2 | | | 200 – 280 HB | > 690 ≤ 970 |
| | S3 | S3.1 | Ni-based high-temperature alloys | | < 280 HB | ≤ 940 |
| | | S3.2 | | | 280 – 360 HB | > 940 ≤ 1200 |
| | S4 | S4.1 | Co-based high-temperature alloys | | < 240 HB | ≤ 800 |
| | | S4.2 | | | 240 – 320 HB | > 800 ≤ 1070 |
| H | H1 | H1.1 | Chilled cast iron | | < 440 HB | – |
| | H2 | H2.1 | Hardened cast iron | | < 55 HRC | – |
| | | H2.2 | | | > 55 HRC | – |
| | H3 | H3.1 | Hardened steel < 55 HRC | | < 51 HRC | – |
| | | H3.2 | | | 51 – 55 HRC | – |
| | H4 | H4.1 | Hardened steel > 55 HRC | | 55 – 59 HRC | – |
| | | H4.2 | | | > 59 HRC | – |

| ISO group | | Subgroup | | WMG (Work Material Group) | | $k_{vG}$ | Examples of material (AISI, EN, DIN, ČSN, GB, SS, STN, BS, UNE, AFNOR, ASTM, GOST, UNS, UNI, ...) |
|---|---|---|---|---|---|---|---|
| P | **Steel and cast steel** (steels with alloy content ≤ 10 % and a hardness of < 45HRC) | P1 | Free machining steel (carbon steels with increased machinability) | P1.1 | Free machining sulfurized carbon steel with a hardness of < 240 HB | 1.33 | AISI **1108,** EN **15S22,** DIN **1.0723,** SS **1922,** ČSN **11120,** BS **210A15,** UNE **F.210F,** GB **Y15,** AFNOR **10F1,** GOST **A30,** UNI **CF10S20** |
| | | | | P1.2 | Free machining sulfurized and phosphorized carbon steel with a hardness of < 180 HB | 1.49 | AISI **1211,** EN **11SMn30,** DIN **1.0715,** SS **1912,** ČSN **11109,** BS **230M7,** UNE **F.2111,** GB **Y15,** AFNOR **S250,** GOST **A40G,** UNI **CF9SMn28** |
| | | | | P1.3 | Free machining sulfurized/phosphorized and leaded carbon steel with a hardness of < 180 HB | 1.53 | AISI **12L13,** EN **11SMnPb30,** DIN **1.0718,** SS **1914,** ČSN **12110,** BS **210M16,** UNE **F.2114,** GB **Y15Pb,** AFNOR **S250Pb,** GOST **AS35G2,** UNI **CF10SPb20** |
| | | P2 | Plain carbon steel (steels comprised of mainly iron and carbon) | P2.1 | Plain low carbon steel containing < 0.25 % C with a hardness of < 180 HB | 1.14 | AISI **1015,** EN **C15,** DIN **1.0401,** SS **1350,** ČSN **11301 ,** BS **080A15,** UNE **F.111,** GB **15,** AFNOR **C18RR,** GOST **St2ps,** UNI **Fe360** |
| | | | | P2.2 | Plain medium carbon steel containing < 0.55 %C with a hardness of < 240 HB | 1.00 | AISI **1030,** EN **C30,** DIN **1.0528,** SS **1550,** ČSN **12031,** BS **080M32,** UNE **F.1130,** GB **30,** AFNOR **AF50C30,** GOST **30G,** UNI **Fe590** |
| | | | | P2.3 | Plain high carbon steel containing > 0.55 % C, with a hardness of < 300 HB | 0.89 | AISI **1060,** EN **C60,** DIN **1.0601,** SS **1655,** ČSN **12061,** BS **080A62,** UNE **F513,** GB **60,** AFNOR **1C60,** GOST **60G,** UNI **C60** |
| | | P3 | Alloy steel (carbon steels with an alloying content ≤ 10 %) | P3.1 | Alloy steel with a hardness of < 180 HB | 0.92 | AISI **5015,** EN **16Mo3,** DIN **1.5415,** SS **2912,** ČSN **15020,** BS **1501-240,** UNE **F.2601,** GB **16Mo,** AFNOR **15D3,** GOST **15M,** UNI **16Mo3KW** |
| | | | | P3.2 | Alloy steel with a hardness of 180 – 260 HB | 0.74 | AISI **4140,** EN **42CrMo4,** DIN **1.7225,** SS **2244,** ČSN **15142,** BS **708M40,** UNE **F.8232,** GB **42CrMo,** AFNOR **42CD4,** GOST **40ChFA,** UNI **42CrMo4** |
| | | | | P3.3 | Alloy steel with a hardness of 260 – 360 HB | 0.63 | AISI **4140,** EN **42CrMo4,** DIN **1.7225,** SS **2244,** ČSN **15142,** BS **708M40,** UNE **F.8232,** GB **42CrMo,** AFNOR **42CD4,** GOST **40ChFA,** UNI **42CrMo4** |
| | | P4 | Tool steel (special alloy steel for tools, dies and molds) | P4.1 | Tool steel with a hardness of < 26 HRC | 0.55 | AISI **D2,** EN **X155CrVMo12-1,** DIN **1.2370,** SS **2736,** ČSN **19573,** BS **BD2,** UNE **F.520A,** GB **Cr12Mo1V1,** AFNOR **Z160CDV12,** GOST **Ch12MF,** UNI **X155CrVMo121KU** |
| | | | | P4.2 | Tool steel with a hardness of 26 – 39 HRC | 0.47 | AISI **D2,** EN **X155CrVMo12-1,** DIN **1.2370,** SS **2736,** ČSN **19573,** BS **BD2,** UNE **F.520A,** GB **Cr12Mo1V1,** AFNOR **Z160CDV12,** GOST **Ch12MF,** UNI **X155CrVMo121KU** |
| | | | | P4.3 | Tool steel with a hardness of 39 – 45 HRC | 0.38 | AISI **D2,** EN **X155CrVMo12-1,** DIN **1.2370,** SS **2736,** ČSN **19573,** BS **BD2,** UNE **F.520A,** GB **Cr12Mo1V1,** AFNOR **Z160CDV12,** GOST **Ch12MF,** UNI **X155CrVMo121KU** |

| ISO group | | Subgroup | | WMG (Work Material Group) | | $k_{vG}$ | Examples of material (AISI, EN, DIN, ČSN, GB, SS, STN, BS, UNE, AFNOR, ASTM, GOST, UNS, UNI, ...) |
|---|---|---|---|---|---|---|---|
| **M** | **Stainless steel** (corrosion resistant steels with ≥ 11 % chromium content) | **M1** | Ferritic stainless steel (straight chromium non-hardenable alloys) | **M1.1** | Stainless steel, ferritic with a hardness of < 160 HB | **1.22** | AISI **S429,** EN **X7Cr14,** DIN **1.4001,** SS **2326,** BS **434S17,** UNE **F.3401,** AFNOR **Z8C12,** GOST **08Ch13,** UNI **X6CrTi12** |
| | | | | **M1.2** | Stainless steel, ferritic with a hardness of 160 – 220 HB | **1.03** | AISI **446,** EN **X10CrAl24,** DIN **1.4762,** SS **2322,** ČSN **17113,** BS **430S17,** UNE **F.3154,** GB **10Cr17,** AFNOR **Z10CAS24,** GOST **12Ch17,** UNI **X16Cr26** |
| | | **M2** | Martensitic stainless steel (straight chromium hardenable alloys) | **M2.1** | Stainless steel, martensitic with a hardness of < 200 HB | **1.08** | AISI **430F,** EN **X14CrMoS17,** DIN **1.4104,** SS **2383,** ČSN **17140,** BS **410S21,** UNE **F.3117,** AFNOR **Z10CF17,** UNI **X10CrS17** |
| | | | | **M2.2** | Stainless steel, martensitic with a hardness of 200 – 280 HB | **0.89** | AISI **440C,** EN **X105CrMo17,** DIN **1.4125,** SS **2385,** ČSN **17023,** BS **425C11,** UNE **F.3402,** GB **102Cr17Mo,** AFNOR **Z100CD17,** GOST **95Ch18,** UNI **GX6CrNi 13 04** |
| | | | | **M2.3** | Stainless steel, martensitic with a hardness of 280 – 380 HB | **0.75** | AISI **420,** EN **X45Cr13,** DIN **1.4034,** ČSN **17029,** BS **425C11,** UNE **F.3405,** AFNOR **Z44C14,** GOST **20X17H12,** UNI **X30Cr13** |
| | | **M3** | Austenitic stainless steel (chromium-nickel and chromium-nickel-manganese alloys) | **M3.1** | Stainless steel, austenitic with a hardness of < 200 HB | **1.00** | AISI **304,** EN **X5CrNi18-12,** DIN **1.4303,** SS **2352,** ČSN **17249,** BS **305S17,** UNE **F.3513,** GB **10Cr18Ni12,** AFNOR **Z8CN18.12,** UNI **X7CrNi18 10** |
| | | | | **M3.2** | Stainless steel, austenitic with a hardness of 200 – 260 HB | **0.86** | AISI **309,** EN **X15CrNiSi20-12,** DIN **1.4828,** ČSN **17251,** BS **309S24,** UNE **F.3312,** GB **1Cr23Ni13,** AFNOR **Z15CNS20.12,** GOST **20Ch20N14S2,** UNI **16CrNi23 14** |
| | | | | **M3.3** | Stainless steel, austenitic with a hardness of 260 – 300 HB | **0.77** | AISI **5848,** EN **X45CrNiW18-9,** DIN **1.4873,** BS **331S40,** UNE **F.3211,** AFNOR **Z35CNWS14-4,** UNI **X45CrNiW 18 9** |
| | | **M4** | Super-austenitic, Duplex or Precipitation Hardening stainless steel (austenitic alloys with > 20 % Ni, austenitic-ferritic microstructure or precipitation hardened) | **M4.1** | Stainless steel, austenitic-ferritic or super-austenitic with a hardness of < 300 HB | **0.75** | AISI **329,** EN **X1-NiCrMoCU25-20-5,** DIN **1.4539,** SS **2562,** ČSN **17265,** BS **318S13,** UNE **F.3552,** GB **022Cr25NiMo2N,** AFNOR **Z1NCDU25.20** |
| | | | | **M4.2** | Stainless steel, precipitation hardening austenitic with a hardness of 300 – 380 HB | **0.64** | AISI **631 (17-7PH),** EN **X7CrNiAL17-7,** DIN **1.4568,** SS **2388,** ČSN **17465 ,** BS **301S13,** UNE **F.3217,** GB **07Cr17Ni7Al,** AFNOR **29CNA17-07,** GOST **09Ch17N7Ju1,** UNI **X53CrMnNiN21 9** |

| ISO group | | Subgroup | | WMG (Work Material Group) | | $k_{vG}$ | Examples of material (AISI, EN, DIN, ČSN, GB, SS, STN, BS, UNE, AFNOR, ASTM, GOST, UNS, UNI, ...) |
|---|---|---|---|---|---|---|---|
| K | **Cast Iron** (castings of iron and carbon alloys with > 2 % carbon content) | K1 | Gray iron (GG) (iron-carbon castings with a lamellar graphite microstructure) | K1.1 | Gray iron, ferritic or ferritic-pearlitic with a hardness of < 180 HB | 1.35 | ASTM **A48 Grade 20 (F11401),** EN-**JL-100,** DIN **GG-10 (0.6010),** SS **0110,** STN **422410,** BS **Grade 150,** UNE **FG10,** GB **HAT 100,** AFNOR **Ft10D,** GOST **SC 10,** UNI **G10** |
| | | | | K1.2 | Gray iron, ferritic-pearlitic or pearlitic with a hardness of 180 – 240 HB | 1.00 | ASTM **A48 Grade 30 (F12101),** EN-**JL-1030,** DIN **GG-20 (0.6020),** SS **0120,** STN **422420,** BS **Grade 220,** UNE **FG20,** GB **HT200,** AFNOR **Ft20D,** GOST **СЧ20,** UNI **G20** |
| | | | | K1.3 | Gray iron, pearlitic with a hardness of 240 – 280 HB | 0.75 | ASTM **A48 Grade 50 (F13501),** EN-**JL-1060,** DIN **GG-35 (0.6035),** SS **0135,** STN **422435,** BS **Grade 350,** UNE **FG35,** GB **HAT300,** AFNOR **Ft35D,** GOST **SC35,** UNI **G35** |
| | | K2 | Malleable iron (GTS/GTW) (heat-treated iron-carbon castings with a graphite-free microstructure) | K2.1 | Malleable iron, ferritic with a hardness of < 160 HB | 1.39 | ASTM **A602 Grade M3210 (F20000),** EN-**JM-1130,** DIN **GTS-35 (0.8135),** SS **0815,** BS **B340/12,** UNE **Type A,** AFNOR **MN 35-10,** GOST **КЧ35-10** |
| | | | | K2.2 | Malleable iron, ferritic or pearlitic with a hardness of 160 – 200 HB | 1.13 | ASTM **A602 Grade M4504 (F20001),** EN-**JM-1040,** DIN **GTS-50-05 (0.8045),** BS **P50-05,** AFNOR **MB 45-7** |
| | | | | K2.3 | Malleable iron, pearlitic with a hardness of 200 – 240 HB | 0.90 | ASTM **A602 Grade M7002 (F20004),** EN-**JM-1140,** DIN **GTS-45 (0.8145),** SS **0854,** STN **422540,** BS **P 45-06,** UNE **Typ B,** AFNOR **MP 50-5,** GOST **КЧ45-7,** UNI **GMN 45** |
| | | K3 | Ductile iron (GGG) (iron-carbon castings with a nodular graphite microsturcture) | K3.1 | Ductile (nodular/spheriodal) iron, ferritic with a hardness of < 180 HB | 1.23 | ASTM **A536 Grade 60-40-18 (F32800),** EN-**JS-1030,** DIN **GGG-40 (0.7040),** SS **0717,** STN **422304,** BS **420/12,** UNE **FGE 42-12,** GB **QT 400,** AFNOR **FGS 400-12,** GOST **ВЧ40** |
| | | | | K3.2 | Ductile (nodular/spheriodal) iron, ferritic or pearlitic with a hardness of 180 – 220 HB | 0.94 | ASTM **A536 Grade 80-55-06 (F33800),** EN-**JS-1050,** DIN **GGG-50 (0.7050),** SS **0727,** STN **422305,** BS **500/7,** UNE **FGE 50-7,** GB **QT 500-7,** AFNOR **FGS 500-7,** GOST **ВЧ50** |
| | | | | K3.3 | Ductile (nodular/spheriodal) iron, pearlitic with a hardness of 220 – 260 HB | 0.76 | ASTM **A536 Grade 100-70-03 (F34800),** EN-**JS-1060,** DIN **GGG-60 (0.7060),** SS **0732,** STN **422306,** BS **600/3,** UNE **FG70-2,** GB **QT 600-3,** AFNOR **FGS 600-3,** GOST **ВЧ60** |
| | | K4 | Austenitic or austempered ductile iron (Ni-Resist/ADI) (iron-carbon alloy castings with an austenitic or ausferrite microstructure) | K4.1 | Austenitic cast iron with a hardness of < 180 HB | 1.14 | ASTM **A436 Type 1 (L-NiCuCr 15 6 2, F41000),** EN-**JL-3011,** DIN **GGL-NiMn 13 7 (0.6652),** SS **0523,** BS **Grade F1,** AFNOR **FGL-Ni13Mn7,** GOST **S-NiMn 13 7** |
| | | | | K4.2 | Austenitic cast iron with a hardness of 180 – 240 HB | 0.86 | ASTM **A439 Type D-2B (S-NiCr 20 3, F43001),** EN-**JS-3021,** DIN **GGG-NiMn 23 4,** SS **0776,** BS **Grade S2M,** AFNOR **FGS Ni23 Mn4,** GOST **ЧН19Х3Ш** |
| | | | | K4.3 | Austempered ductile iron with a hardness of 240 – 280 HB | 0.63 | ASTM **A897 Grade 110-70-11** |
| | | | | K4.4 | Austempered ductile iron with a hardness of 280 – 320 HB | 0.54 | ASTM **A897 Grade 125-80-10,** EN-**JS-1100,** DIN **GGG-90 (5.3400)** |
| | | | | K4.5 | Austempered ductile iron with a hardness of 320 – 360 HB | 0.45 | ASTM **A897 Grade 2 (150-110-07),** EN-**JS-1110,** DIN **GGG-100 (5.3403)** |
| | | K5 | Compacted graphite iron (CGI) (iron-carbon castings with a vermicular graphite structure) | K5.1 | Vermicular, compacted graphite iron with a hardness of < 180 HB | 1.29 | ASTM **A842 Grade 300,** EN-**GJV-300,** DIN **GGV 30,** GOST **ЧВГ30,** |
| | | | | K5.2 | Vermicular, compacted graphite iron with a hardness of 180 – 220 HB | 0.97 | ASTM **A842 Grade 350,** EN-**GJV-350,** DIN **GGV 35 (5.2200),** GOST **ЧВГ30,** |
| | | | | K5.3 | Vermicular, compacted graphite iron with a hardness of 220 – 260 HB | 0.75 | ASTM **A842 Grade 450,** EN-**GJV-450,** DIN **GGV 45,** GOST **ЧВГ45,** |

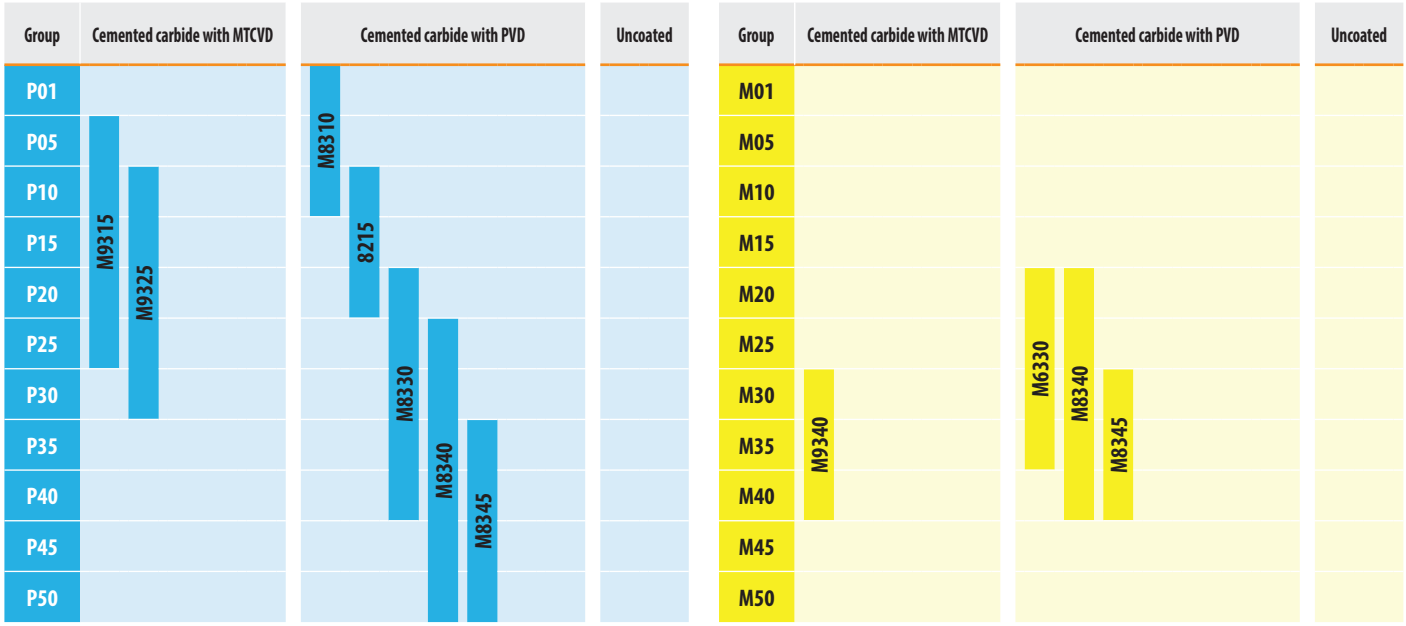
| ISO group | | Subgroup | | WMG (Work Material Group) | | $k_{vg}$ | Examples of material (AISI, EN, DIN, ČSN, GB, SS, STN, BS, UNE, AFNOR, ASTM, GOST, UNS, UNI, ...) |
|---|---|---|---|---|---|---|---|
| N | **Non-ferrous metals** (metals including alloys without an appreciable amount of iron) | **N1** | Wrought aluminium | **N1.1** | Pure aluminium and wrought aluminium alloys with a hardness of < 60 HB | 1.33 | UNS **A91200,** EN **AL99.6,** DIN **3.0205,** SS **4010,** STN **424009,** BS **1C,** UNE **L-3001,** GB **L5,** AFNOR **A4,** GOST **АДС,** UNI **3567** |
| | | | | **N1.2** | Wrought aluminium alloys with a hardness of 60 – 100 HB | 1.00 | UNS **A93004,** EN **AlMn0.5Mg0.5,** DIN **3.0505,** SS **4054,** STN **424432,** BS **N31,** UNE **L-3831,** GB **LF2,** AFNOR **A-M1,** GOST **АМц,** UNI **3568** |
| | | | | **N1.3** | Wrought aluminium alloys with a hardness of 100 – 150 HB | 0.67 | UNS **A95083,** EN **AlMg4.5Mn0.7,** DIN **3.3547,** SS **4140,** STN **424415,** BS **N8,** UNE **L-3321,** GB **AlMg4.5Mn,** AFNOR **A-G4.5Mn,** GOST **Amg 4.5,** UNI **P-AlMg4.4** |
| | | **N2** | Cast aluminium | **N2.1** | Cast aluminium alloys with a hardness of < 75 HB | 0.67 | UNS **A02080,** EN **AlCu4S,** BS **LM11,** STN **424331,** UNE **Al Si1Cu,** GOST **AMg5K,** UNI **G-AlSi7Mg** |
| | | | | **N2.2** | Cast aluminium alloys with a hardness of 75 – 90 HB | 0.60 | UNS **A02420,** EN **AlCu4Ni2Mg2,** SS **AlSi7MgFe,** BS **LM6,** STN **424519,** UNE **Al-7SiMg,** AFNOR **A-S7G,** GOST **AK7,** UNI **G-AlSi7Mg** |
| | | | | **N2.3** | Cast aluminium alloys with a hardness of 90 < 140 HB | 0.43 | UNS **A03360,** EN **G-ALCu4NiMg2,** SS **ALSi10Mg,** STN **424336,** BS **LM 30,** AFNOR **A-S10G,** UNI **G-AlSi9Mg** |
| | | **N3** | Copper or copper alloys | **N3.1** | Free-cutting copper-alloys materials with excellent machining properties | 0.70 | UNS **C14700,** EN **CuPb1P,** DIN **2.1498,** STN **423214,** BS **C111,** AFNOR **CuZn35Pb2,** GOST **L63-3,** UNI **CuS(P0.01)** |
| | | | | **N3.2** | Short-chip copper-alloys with good to moderate machining properties | 0.41 | UNS **C81540,** EN **CuNi2SiCr,** DIN **2.0857,** STN **423220,** BS **NS113,** UNE **CuSn12,** AFNOR **CuZn40,** GOST **L60,** UNI **P-CuZn-40** |
| | | | | **N3.3** | Electrolytic copper and long-chip copper-alloys with moderate to poor machining properties | 0.21 | UNS **C10100,** EN **CuAg0.1,** DIN **2.1203,** SS **5010,** UNE **CUSi3Mn1,** AFNOR **Cu-C2,** GOST **M1f,** UNI **Cu-0F** |
| | | **N4** | Polymers (synthetic or semi-synthetic materials) | **N4.1** | Thermoplastic polymers | 0.70 | ABS, Acryl, Duraplast, Elastomer, EP, Epoxid, FEP, Fluor, Gummi, Kautschuk, Latex, MF, MPF, PA, PAI, PC, PE, PEEK, PEI, PES, PET, PF, Phenolharze, PI, PMMA, Polyamide, Polyester, Polyolefine, Polysulfon, POM, PP, PPE, PPS, PS, PSU, PTFE, PU, PUR, PVDF, SAN, SI, Styrol, UF, Ureol |
| | | | | **N4.2** | Thermosetting polymers | 0.27 | Aramid, Epoxy, Fluoropolymer, Mehacrylate, Melamine, Phenolic, Polyester, Polyimide, Polymethacrylimide, Polyurethane |
| | | | | **N4.3** | Reinforced polymers or composites | 0.29 | CFK, GFK, GMT, Honeycomb, Kevlar, LFT, Organo, SMC |
| | | **N5** | Graphite | **N5.1** | | 1.0 | CGM-1, CM-00, GM-10, GM-11, GR030, GR030PI, GR060, GR060PI, GR125, MC-01, MC-01RO, MC-03, MC-03M, IG11, IG-15, IG-32, IG-43, IG-45, IG-70, ISEM-1, ISEM-2, ISEM-3, R8340, R8500X, Technograph 15, Technograph 30, ISO-63, EDM C-3, EDM1, EDM3, ISO-90, ISO-93, ISO-95, R8510, R8650, |

| ISO group | | Subgroup | | WMG (Work Material Group) | | $k_{vG}$ | Examples of material (AISI, EN, DIN, ČSN, GB, SS, STN, BS, UNE, AFNOR, ASTM, GOST, UNS, UNI, ...) |
|---|---|---|---|---|---|---|---|
| S | **High-temperature alloys** (superalloys with high temperature stength and corrosion resistant surpassing that of stainless steel) | S1 | Titanium or titanium alloys | S1.1 | Titanium or titanium alloys, with a hardness of <200 HB | 1.94 | UNS **R50250 (Grade 1),** EN **Ti 99.6,** DIN **3.7035,** BS **TA.2,** UNE **Ti-Po2,** AFNOR **T-40,** GOST **BT1-00,** AISI **R50250, 3.7025, T35, 2TA1, R50400, 3.7035, 2TA2,** |
| | | | | S1.2 | Titanium alloys, with a hardness of 200 – 280 HB | 1.72 | UNS **R56404 (Grade 29),** EN **Ti2Cu,** DIN **3.7124,** BS **TA.21,** UNE **Ti-P11,** AFNOR **T-U2 ,** AISI **TA6V, Ti-6Al-4V, Ti 10.2.3, Ti5553** |
| | | | | S1.3 | Titanium alloys, a hardness of 280 – 360 HB | 1.44 | UNS **R54250 (Grade 38),** EN **TiAl6V4,** DIN **3.7165,** ČSN **TiAl6VELI,** BS **TA. 13,** UNE **Ti-P63,** AFNOR **T-A6V,** GOST **BT6,** AISI **TA6V, Ti-6Al-4V, Ti 10.2.3, Ti5553** |
| | | S2 | Fe-based high-temperature alloys | S2.1 | High-temperature Fe-based alloys with a hardness of <200 HB | 1.33 | UNS **N08801 (Incoloy 801),** EN **X8 NiCrAlTi31-21,** DIN **1.4959,** BS **NA 15,** AFNOR **Z8NC33-21,** AISI **A-286, Discaloy, Haynes 556, Iconel 909, Greek Ascolloy** |
| | | | | S2.2 | High-temperature Fe-based alloys with a hardness of 200 – 280 HB | 1.17 | UNS **N19907,** EN **X6NiCrTiMoVB25-15-2,** DIN **1.4980,** SS **2570,** BS **HR52,** AFNOR **Z6NCTDV25.15B,** GOST **36HXTЮ,** AISI **A-286, Discaloy, Haynes 556, Iconel 909, Greek Ascolloy** |
| | | S3 | Ni-based high-temperature alloys | S3.1 | High-temperature Ni-based alloys with a hardness of <280 HB | 1.00 | UNS **A09706 (Inconel 706),** EN **NiCr25FeAl,** DIN **2.4856,** BS **HR 6,** ČSN **Inconel 625,** UNE **F.3313,** GB **1Cr16Ni35,** AFNOR **NC22FeDNB,** GOST **XH38BT,** AISI **Inconel 718, 706 Waspalloy, Udimet 720, Inconel 625** |
| | | | | S3.2 | High-temperature Ni-based alloys with a hardness of 280 – 360 HB | 0.83 | UNS **N07001,** EN **NiCr20Co13Mo4Ti3Al,** DIN **2.4654,** BS **HR 2,** ČSN **Waspaloy,** AFNOR **NCKD 20ATV,** GOST **XH80TБЮ,** AISI **Inconel 718, 706 Waspalloy, Udimet 720, Inconel 625** |
| | | S4 | Co-based high-temperature alloys | S4.1 | High-temperature Co-based alloys with a hardness of <240 HB | 0.78 | UNS **R30016 (Stellite 6b),** EN **CoCr20W15Ni,** DIN **2.4964,** AFNOR **KC 20 WN,** GOST **ЛК52,** AISI **Haynes 25, Stellite 21, 31** |
| | | | | S4.2 | High-temperature Co-based alloys with a hardness of 240 – 320 HB | 0.67 | UNS **R30016 (Stellite 6b),** EN **CoCr20W15Ni,** DIN **2.4964,** AFNOR **KC 20 WN,** GOST **ЛК52,** AISI **Haynes 25, Stellite 21, 31** |

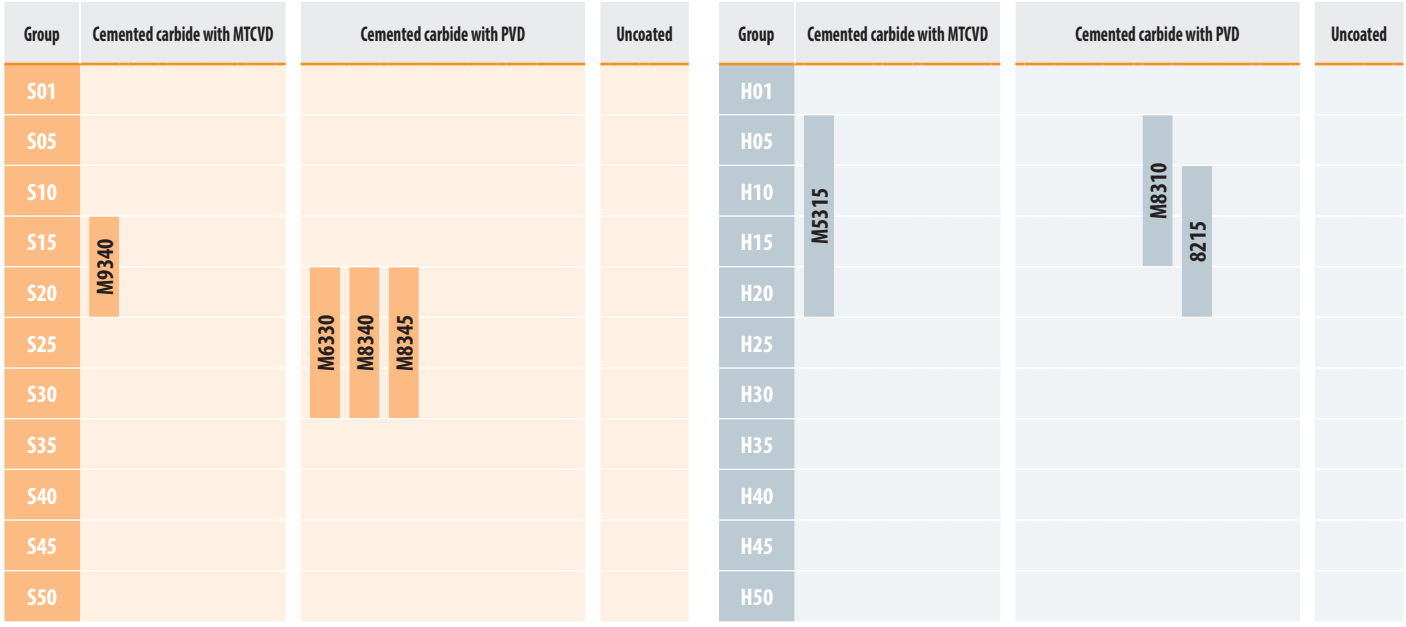
| ISO group | | Subgroup | | WMG (Work Material Group) | | $k_{vG}$ | Examples of material (AISI, EN, DIN, ČSN, GB, SS, STN, BS, UNE, AFNOR, ASTM, GOST, UNS, UNI, ...) |
|---|---|---|---|---|---|---|---|
| **H** | **Hardened materials** (any engineering metal with a hardness > 45 HRC) | **H1** | Chilled cast iron | **H1.1** | Chilled cast iron with a hardness of < 440 HB | 1.52 | UNS **F45001,** EN-**GJS-1050-6,** DIN **5.3406,** SS **0512,** BS **Grade 2A** |
| | | **H2** | Hardened cast iron | **H2.1** | Hardened cast iron with a hardness < 55 HRC | 0.90 | UNS **F45003,** EN-**GJS-1400-1,** DIN **5.3405,** SS **0457,** BS **Grade 3D** |
| | | | | **H2.2** | Hardened cast iron with a hardness > 55 HRC | 0.77 | UNS **F45003,** EN **G-X260NiCr4-2,** DIN **0.9620,** SS **0466,** BS **Grade S** |
| | | **H3** | Hardened steel < 55 HRC | **H3.1** | Hardened steel with a hardness of < 51 HRC | 1.00 | AISI **4135,** EN **34CrMo4,** DIN **1.7220,** SS **2234,** STN **415131,** BS **198,** UNE **F.1250,** GB **35CrMo,** AFNOR **35CD4,** GOST **АС38ХГМ,** UNI **35CrMo4KB** |
| | | | | **H3.2** | Hardened steel with a hardness of 51 – 55 HRC | 0.82 | AISI **4135,** EN **34CrMo4,** DIN **1.7220,** SS **2234,** STN **415131,** BS **198,** UNE **F.1250,** GB **35CrMo,** AFNOR **35CD4,** GOST **АС38ХГМ,** UNI **35CrMo4KB** |
| | | **H4** | Hardened steel > 55 HRC | **H4.1** | Hardened steel with a hardness of 55 – 59 HRC | 0.64 | UNS **T31501,** EN **100MnCrW4,** DIN **1.2510,** SS **2140,** STN **419413,** BS **B01,** UNE **F.5220,** GB **9CrWMn,** AFNOR **90MWCrV5,** GOST **9ХВГ,** UNI **95MNWCr5KU** |
| | | | | **H4.2** | Hardened steel with a hardness of > 59 HRC | 0.54 | UNS **T31501,** EN **100MnCrW4,** DIN **1.2510,** SS **2140,** STN **419413,** BS **B01,** UNE **F.5220,** GB **9CrWMn,** AFNOR **90MWCrV5,** GOST **9ХВГ,** UNI **95MNWCr5KU** |



# INDEXABLE MILLS – TECHNICAL INFO


Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Uncoated
P01
P05
P10
P15
P20
P25
P30
P35
P40
P45
P50
M9315
M9325
M8310
8215
M8330
M8340
M8345
Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Uncoated
M01
M05
M10
M15
M20
M25
M30
M35
M40
M45
M50
M9340
M6330
M8340
M8345


Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Uncoated
K01
K05
K10
K15
K20
K25
K30
K35
K40
K45
K50
M5315
M8310
8215
M8330
Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Uncoated
N01
N05
N10
N15
N20
N25
N30
N35
N40
N45
N50
8215


Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Uncoated
S01
S05
S10
S15
S20
S25
S30
S35
S40
S45
S50
M9340
M6330
M8340
M8345
Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Uncoated
H01
H05
H10
H15
H20
H25
H30
H35
H40
H45
H50
M5315
M8310
8215

| Grade Identification | Area of Application | Application | Feed | Cutting speed | Resistance to adverse Working Conditions | Coating | Colour | Substrate | Coolant benefit | Grade description |
|---|---|---|---|---|---|---|---|---|---|---|
| M5315 | P05 – P20<br>K05 – K25<br>H05 – H20 | ◪<br>■<br>■ | | | | MT-CVD | | H | --- | One of the most abrasion-resistant milling grades which should be used under stable conditions. Its main advantage is the extremely high resistance to thermal stress and abrasive K05 – K25 wear. It is mainly used for machining hard and very hard materials, particularly cast iron. |
| M5326 | P05 – P25<br>K10 – K30<br>H10 – H20 | ◪<br>■<br>◪ | | | | MT-CVD | | H | --- | Milling grade with high abrasion resistance even at high thermal loads, main application area is grey and ductile cast iron with relatively high cutting speeds with medium depths of cut. |
| M9315 | P05 – P25<br>K10 – K30<br>H10 – H20 | ■<br>■<br>◪ | | | | MT-CVD | | H | --- | Milling grade with high abrasion resistance even at high thermal loads, main application area is higher cutting speeds with medium or small depths of cut. |
| M9325 | P10 – P30<br>K10 – K30<br>H15 – H20 | ■<br>■<br>◪ | | | | MT-CVD | | H | --- | This grade has an ideal balance between wear resistance and toughness, it is mainly designed for roughing operations. Advantages are excellent wear resistance even at relatively high cutting speeds with excellent reliability, this grade is more suitable for applications using higher speeds and lower feed rates. |
| M9340 | P35 – P50<br>M30 – M40<br>S15 – S20 | ■<br>■<br>■ | | | | MT-CVD | | H | --- | A very tough grade, where the main advantage is the high strength of the cutting edge and resistance to adverse cutting conditions. Although this material has an MT-CVD M30 – M40 coating, it is possible to use emulsion cooling for its application, especially in optimum cutting conditions. |
| M6330 | P20 – P35<br>M20 – M35<br>S20 – S30 | ■<br>■<br>■ | | | | PVD | | H | + / - | Milling grade with extraordinary service reliability. Especially suitable for machining of hard to machine materials. Powerful in applications where unfavourable conditions and heavy cuts dominate. |
| M8310 | P01 – P10<br>M01 – M10<br>K01 – K10<br>H05 – H15 | ■<br>◪<br>■<br>◪ | | | | PVD | | ultra submicron H | - | Grade specially developed for copy milling, featuring high resistance to abrasion. It is suitable for machining at higher cutting speeds under stable cutting conditions, and for machining virtually all groups of machined materials (particularly stronger and harder materials). |
| 8215 | P10 – P20<br>M10 – M20<br>K10 – K25<br>N10 – N25<br>S10 – S15<br>H10 – H15 | ■<br>◪<br>■<br>■<br>◪<br>■ | | | | PVD | | submicron H | + / - | One of the most versatile milling grades, in terms of both the range of workpiece materials and the range of possible applications. It is characterised by high wear resistance and operational reliability. Its other advantages include excellent resistance to cracking induced by temperature shock. With its unique properties, this material is undoubtedly one of the pillars of the milling range. |
| M8325 | P20 – P40<br>M15 – M30 | ■<br>◪ | | | | PVD | | S | - | The main application area of this grade is machining all kinds of steels (including stainless) in the "soft state". It can also be used for machining softer cast irons. Suitable for M15 – M30 machining at medium speeds under average cutting conditions. |
| M8326 | P20 – P40<br>M15 – M30 | ■<br>◪ | | | | PVD | | H | - | Special grade for heavy duty. The main application area of this grade is machining all kinds of steels (including stainless) in the „soft state". It can also be used for machining softer cast irons. Suitable for M15 – M30 machining at medium speeds under average cutting conditions. |
| M8330 | P20 – P40<br>M20 – M35<br>K20 – K40<br>N15 – N30<br>S15 – S25<br>H15 – H25 | ■<br>■<br>■<br>◪<br>◪<br>◪ | | | | PVD | | submicron H | + / - | This grade is universal and can be used for machining various types of materials. However, it's priority application area lies within steels and ductile cast irons. It is recommended for milling at medium speeds under unstable cutting conditions. |

| Grade Identification | Area of Application | Application | Feed | Cutting speed | Resistance to adverse Working Conditions | Coating | Colour | Substrate | Coolant benefit | Grade description |
|---|---|---|---|---|---|---|---|---|---|---|
| M8340 | P25 – P50<br>M20 – M40<br>K20 – K40<br>S20 – S30 | ■<br>■<br>◪<br>■ | | | | PVD | | submicron H | + / - | One of the toughest grade dedicated for machining with lower cutting speed and unfavorable conditions. This grade is ideal for all operations where the main requirement is for a tough cutting edge. |
| M8345 | P30 – P50<br>M30 – M40 | ■<br>■ | | | | PVD | | H | - | This grade has exceptional operational reliability and is designed for heavy cuts in unfavourable conditions in difficult and tough materials. |
| M8346 | P30 – P50<br>M30 – M40 | ■<br>◪ | | | | PVD | | H | - | This grade has exceptional operational reliability and is designed for heavy cuts in unfavourable conditions in difficult and tough materials with low to medium cutting speed |
| S26 | P15 – P30 | ■ | | | | – | | S | + + | Uncoated milling grade with excellent resistance to erosion of the cutting face. It is intended solely for machining carbon and alloy steels at low cutting speeds. |

| Substrate | |
|---|---|
| **H** | WC-Co based substrate |
| **submicron H** | WC-Co based substrate, fine-grained (< 1 µm) |
| **ultra submicron H** | WC-Co based substrate, very fine-grained (< 0.5 µm) |
| **S** | Substrate with cubic carbides |

| Coating | |
|---|---|
| **MT-CVD** | Medium-temperature chemical method of coating |
| **PVD** | Low-temperature physical method of coating |
| **-** | Uncoated grade |

| Coolant Benefit | |
|---|---|
| **- - -** | Very negative effect on tool life – cooling is not recommended |
| **-** | Slightly negative effect on tool life |
| **+ / -** | Influence of cooling may be both positive and negative – decisive factor is specific working conditions |
| **+ +** | Positive effect on tool life – cooling is recommended |

| Level of influence | |
|---|---|
| | Level 1 – 5 |

### Correction factors for specific type of cutter and operation $C_{VcO}$

| X.V | ● | ◖ | ✖ |
|---|---|---|---|
| **Face mills with *KAPR* 45° – 60° and negative inserts (SHN06C, SHN09C, CHN09, …)** | 1.15 | 1.00 | 0.85 |
| **Face mills with *KAPR* 45° and positive inserts (SOE06Z, SOE09Z, SOD05,...)** | 1.15 | 1.00 | 0.85 |
| **Shoulder mills with *KAPR* 90° (SAD07D, SAD11E, SAD16E, SLN12, SLN16..)** | 1.10 | 1.00 | 0.90 |
| **Copy face mills (SRC10 – SRC20, SRD05 – SRD16, …)** | 1.10 | 1.00 | 0.90 |
| **Copy end mills (K2-PPH, K2-SLC, K2-SRC, K3-CXP…)** | 1.10 | 1.00 | 0.90 |
| **Disc mills (S90CN(XN), S90SN...)** | 1.10 | 1.00 | 0.90 |
| **Shoulder mills with extended flute J(T)-CSD12X, J(T)-SAD11E, J(T)-SAD16E...)** | 1.25 | 1.00 | 0.80 |
| **Face mills for heavy duty (FSB22X, SPN13..)** | 1.30 | 1.00 | 0.85 |
| **Shoulder mills for heavy duty (FTB27X..)** | 1.25 | 1.00 | 0.85 |

### Correction factors for required durability $C_{VcT}$

| minutes | 15 | 20 | 30 | 45 | 60 | 90 | 120 |
|---|---|---|---|---|---|---|---|
| **General machining operations (fine finishing up to roughing)** | 1.23 | 1.13 | 1.00 | 0.89 | 0.81 | 0.72 | – |
| **Heavy machining operations (heavy roughing)** | – | – | 1.23 | 1.13 | 1.00 | 0.89 | 0.81 |

### Additional correction factors $C_{VcA}$

| Machining environment | $C_{VcA}$ |
|---|---|
| **Condition of the work-material (hard skin due to forging or casting)** | 0.70 |
| **Unstable machining conditions** | 0.85 |
| **Common machining conditions** | 1.00 |
| **Stable machining conditions** | 1.20 |

### Correction factors for cutting speed when face and shoulder milling with < 100 % radial immersion $C_{VcRCT}$

| $a_e$/DC | 5 % | 10 % | 15 % | 20 % | 25 % | 30 % | 40 % | 50 % | 60 % | 70 % | 75 % | 80 % | 90 % | 100 % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X.V | **1.48** | **1.35** | **1.27** | **1.22** | **1.19** | **1.16** | 1.11 | 1.08 | 1.05 | 1.03 | **1.00** | **1.00** | **1.00** | **1.00** |

### Correction factors to compensate for chip-thinning when face and shoulder milling with < 100 % radial immersion $Cf_{zRCT}$

| $a_e$/DC | 5 % | 10 % | 15 % | 20 % | 25 % | 30 % | 40 % | 50 % | 60 % | 70 % | 75 % | 80 % | 90 % | 100 % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ⇨x.f | **2.20** | **1.60** | **1.35** | **1.20** | **1.10** | 0.95 | 0.85 | 0.75 | 0.85 | 0.95 | **1.00** | **1.00** | **1.00** | **1.00** |
| ⇨x.f | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | 0.65 | 0.65 | 0.67 | **0.68** | **0.71** | **0.72** | **0.74** | **0.79** | **1.00** |

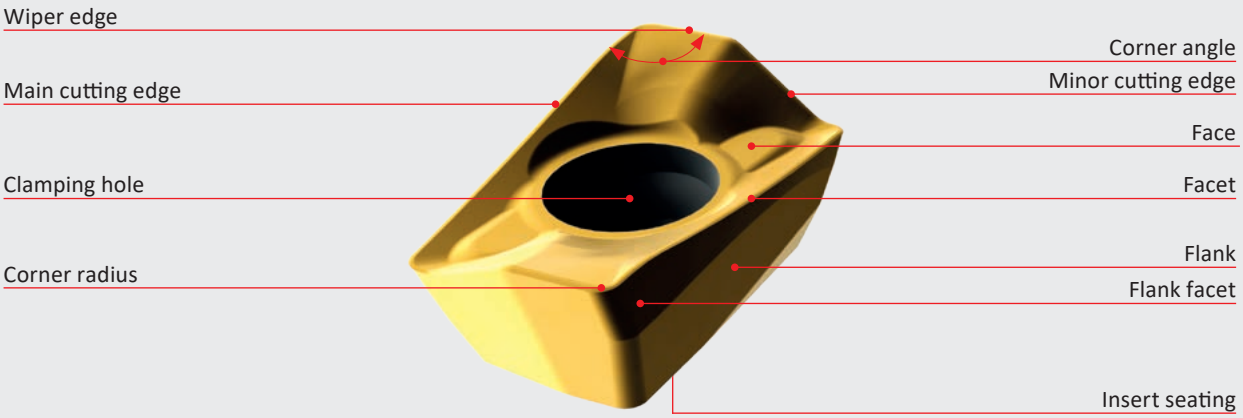
**Resulting corrected cutting speed *vcc***

$vcc = v_c \times kvG \times C_{VcO} \times CvcT \times C_{VcA} \times C_{VcRCT} \times Cf_{zRCT}$

$k_{vG}$ – coefficient of used material

$v_c$ – starting speed from catalogue page

**Parts of an Indexable Insert**



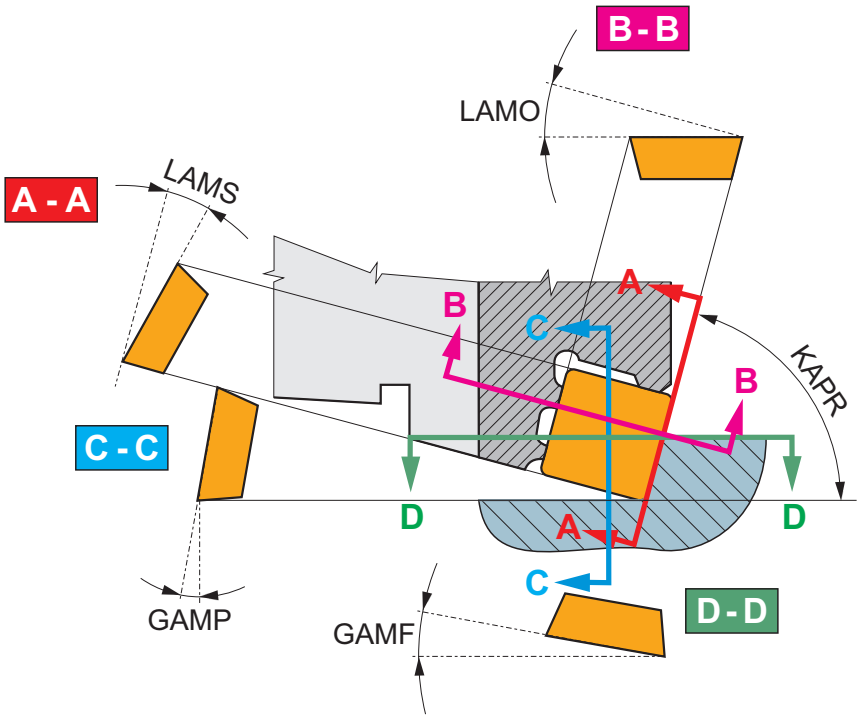

**Geometry of milling tool**

Constructional angles determine the basic orientation of the seat position that the cutting insert is clamped in and are therefore important for the design of the milling cutter body. There are two angles: axial face angle *GAMP* – $\gamma_p$ (tool back rake) and radial face angle *GAMF* – $\gamma_f$ (tool side rake) – see picture below.
Working angles are the setting angle *KAPR* – $\kappa_r$, the orthogonal face angle *GAMO* $\gamma_o$ and the rake angle of the cutting edge *LAMS* – $\lambda_s$.

- **Orthogonal face angle** *GAMO* – $\gamma_o$ affects not only the extent of plastic deformation of the cut chip but also the cutting force and temperature. The bigger the rake angle *GAMO* – $\gamma_o$, the lower the cutting force and power demand of the spindle motor (and vice versa).
- **Setting angle** *KAPR* – $\kappa_r$ determines the thickness of the chip at a specific feed per tooth $f_z$ and axial depth of cut $a_p$. It therefore affects cutting forces, specifically load, wear and tool service life. Reducing the setting angle *KAPR* – $\kappa_r$ at a constant feed $f_z$ causes a decrease in the chip thickness h.
- **Rake angle of cutting edge** *LAMS* – $\lambda_s$ together with setting angle *KAPR* – $\kappa_r$ and face angle *GAMO* – $\gamma_o$, this determines the point of first contact between the edge and work piece. That is why it affects the resistance of the edge to chipping during interrupted cut. At the same time, it affects the direction of chip evacuation.

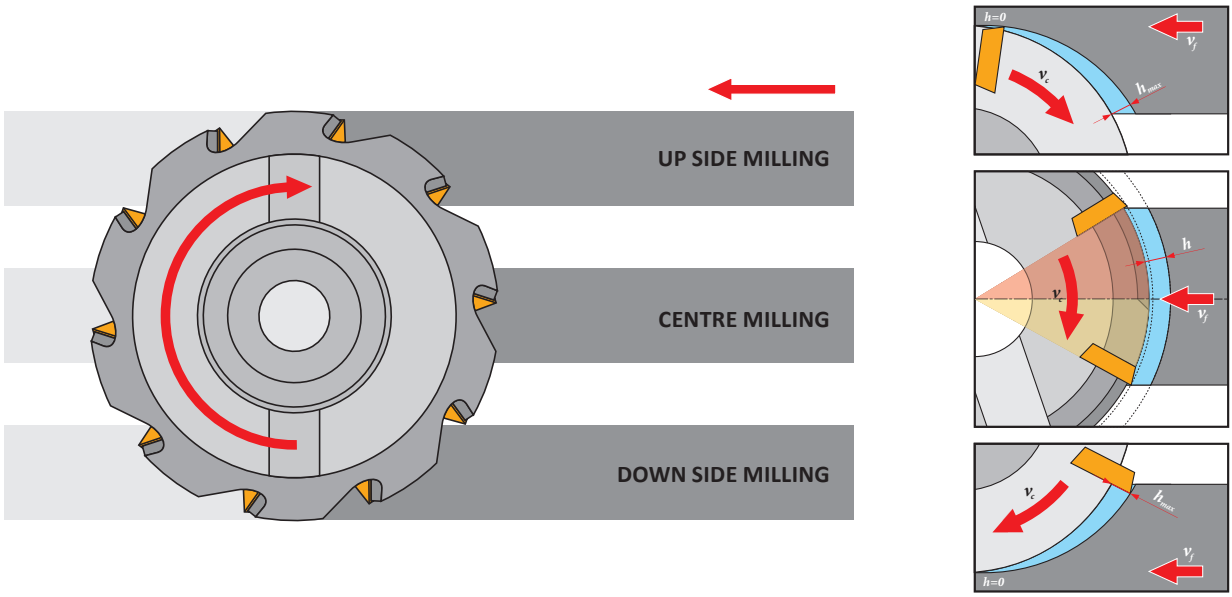
Working angles of the tool you can determine the bed using the formulas or diagrams below.

**Working and constructional angles of milling tool**

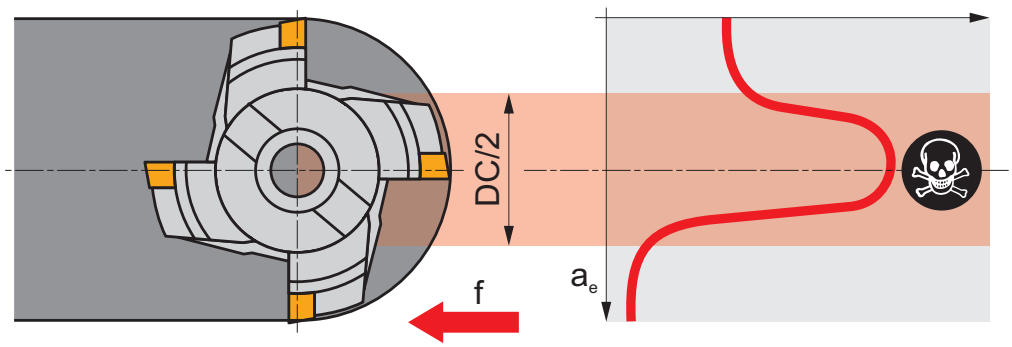


When performing a milling operation, the edge of the milling cutter almost always makes interrupted (intermittent) cuts. Each edge enters and exits the workpiece at least once within a single revolution of the tool.
In addition, a periodic change in chip thickness takes place during each revolution of the milling cutter. This results in fluctuations in the size and direction of the tangential component of the cutting force. The edge of the milling cutter is thus subjected to cyclic stress which results in specific wear. The durability of the milling cutter edge is therefore dependent on the conditions in which the edge enters and exits the workpiece. Proper choice of these conditions significantly affects the milling process and its results in terms of cutting power and quality of the machined surface.

At the moment the edge enters or exits the workpiece, the edge is subjected to more or less intense mechanical shock which causes mechanical stress in the immediate vicinity of the cutting edge. If engagement conditions are chosen incorrectly, this shock can cause brittle damage to the edge, in the form of either fracturing or crumbling of the edge.
Position of the milling cutter relative to the workpiece is thus a very important factor. There are essentially three possible milling cutter positions: side up milling, centre milling and side down milling. For indexable tools, we recommend using co-directional engagement (so that the cutter forms thick chips on entry and thin chips on exit). However, there are notable exceptions (workpieces with surface skin, machines with worn feed screws...).

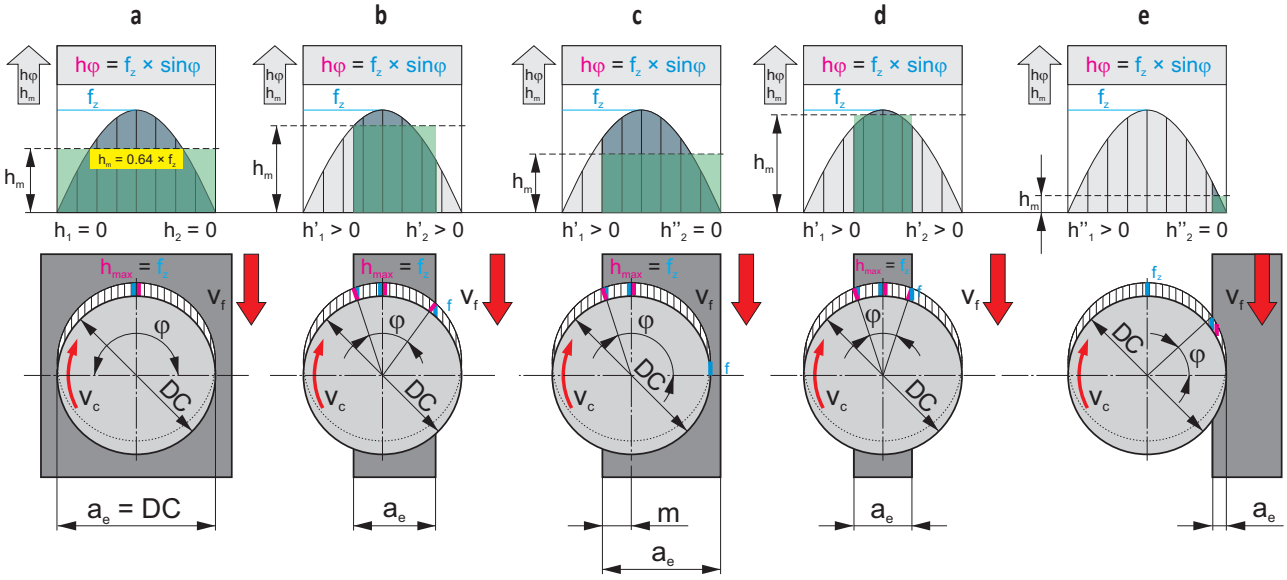



During face milling, where the width of the milled surface $a_e$ is equal to the diameter of the milling cutter, follow the values recommended specifically for the inserts. If the engagement width is less than the diameter of the milling cutter, then the key factor is whether we machine with the centre or the side of the milling cutter, as mentioned above. In both cases, corrections in feed and cutting speed should be made (see correction tables on page XXX). Either way, we should try to ensure that the tool does not enter or exit the cut in an area close to the centre of the milling cutter (so-called dead zone).




When the edge exits from the cut, this is accompanied by both stressing of the edge due to rapid cooling of the surface layers of the insert near the cutting edge and by mechanical shock caused by the release of flexible deformations, particularly in the surface layers of the workpiece after a rapid decrease in cutting force.

As stated above, chip thickness *h* changes during a single revolution depending on the angle φ in line with the formula $h\varphi = f_z \times sin\varphi$. Maximum chip thickness with steady $f_z$ is reached within the axis of the milling cutter. The average thickness of a chip $h_m$ removed by one tooth during one revolution is calculated as the height of a rectangle with the same area as the area under a sine curve relative to the radial depth of cut $a_e$. Average chip thickness $h_m$ is dependent on the type of milling cutter and on engagement conditions, particularly the ratio of $a_e/DC$, feed per tooth $f_z$ and naturally also on the entering angle *KAPR* – $\kappa_r$. The following figure shows illustrative examples.




Average chip thickness $h_m$ for milling (with the centre) in accordance with figure a, b, d is calculated based on the formula:

$$h_m = f_z \times \sin\kappa_r \times \left( 57.3 \frac{a_e}{DC \times \arcsin \times \left( \frac{a_e}{DC} \right)} \right)$$

Average chip thickness $h_m$ for machining with the side of the milling cutter (figure c, e) is calculated based on the formula:

$$h_m = f_z \times \sin\kappa_r \times 114.6 \times \left( \frac{a_e}{DC \times \arccos \times \left( 1 - \frac{2a_e}{DC} \right)} \right)$$

For milling with the side of the cutter in line with figure e, where the $a_e/DC$ ratio is very low (< 0.2), average chip thickness $h_m$ can be calculated using the simplified formula:

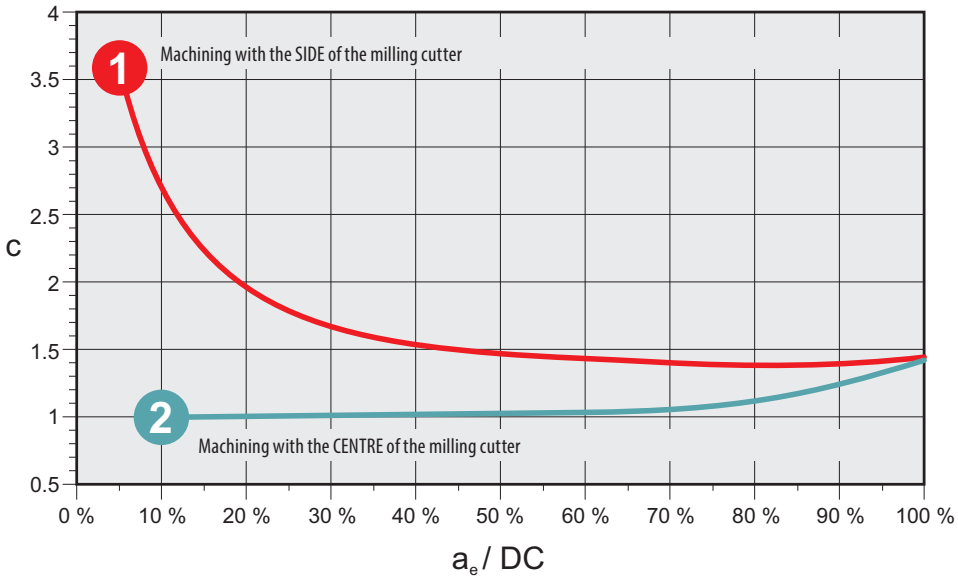
$$h_m = f_z \times \sin\kappa_r \times \sqrt{\frac{a_e}{DC}}$$

Where:

| | |
|---|---|
| $h_m$ | Is average chip thickness (mm) |
| $f_z$ | Feed per tooth (mm/tooth) |
| $a_e$ | Radial depth of cut (mm) |
| *DC* | Diameter of the milling cutter (mm) |
| $\kappa_r$ | Entering angle of the main cutting edge *KAPR* (°) |

For optimal application of any milling tool, we recommend checking chip thickness, or rather, using the recommended $h_m$ range to choose (calculate) the proper feed rate.
It is, of course, also necessary to take into account the geometry of the indexable insert itself. To calculate $f_z$, you can use the formulae provided above or use the following formula. The values of coefficient $c$ can be derived from the following chart:

$$f_z = \frac{h_m}{sin \times \kappa_r} \times c$$




Each tool type listed in this catalogue has its own optimum range of average chip thickness. Using values lower than listed in this range may prevent the tool from cutting or, rather, may subject the insert to excessive wear and, in extreme cases, may even destroy it in the process. Similarly, exceeding the recommended values may destroy the insert by overloading the tool. The ranges of recommended average chip thickness are listed directly by each tool family.
**The full range of chip thickness can only be used for groups P and K. The lower limit of chip thickness must be adjusted (taken as higher than listed) for groups M and S and for tougher materials from group N. The upper limit must be lowered for groups H, S and slightly also for tougher materials from group M. On the contrary, it is possible to increase the upper limit of recommended average chip thickness by approx. 10 – 15 % when machining soft materials from group N.**

**SHN06C**

P M K H

PRAMET

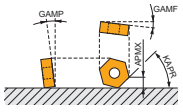
S

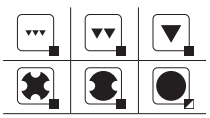


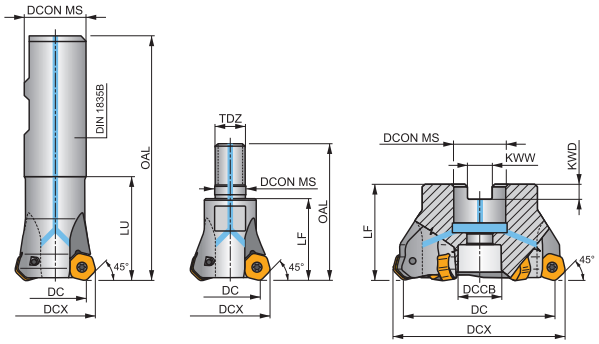
**ECON HN06 45° Face Mill with Double Negative Design and Internal Coolant**

Highly productive 45° face mill utilising double sided HN.. 06 style inserts with APMX of 3 mm. Roughing, finishing and chamfering. Economical insert with 12 cutting edges. Differential tooth pitch. Weldon, modular and arbor style available in range from Ø25 up to Ø125 mm. Body treated for longer tool life.

| | |
|---|---|
| KAPR | 45° |
| APMX | 3.0 mm |






Optimum range of average chip thickness (mm)

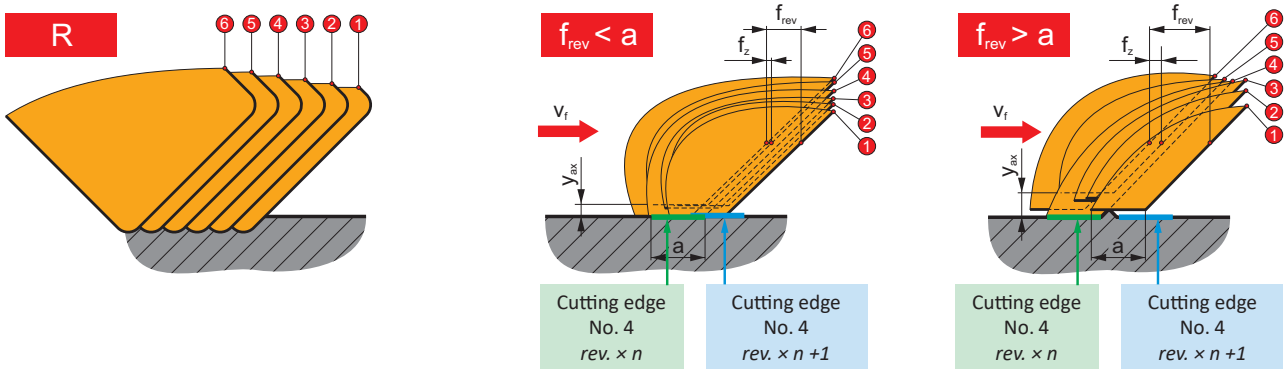
| | |
|---|---|
| $h_m$ | 0.06 – 0.15 |
| $h_m$ | 0.06 – 0.15 |

| Product | DC | DCX | OAL | DCON MS | DCCB | LU | LF | TDZ | KWW | KWD | GAMF | GAMP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

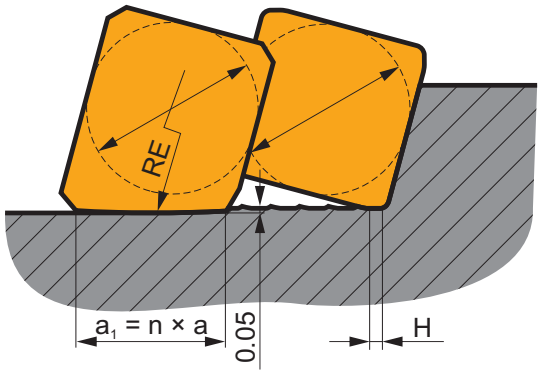
One of the key criteria in finishing operations is the resulting roughness of the machined surface. The following article will therefore provide several tips on how to approach this issue.

**Face Milling**

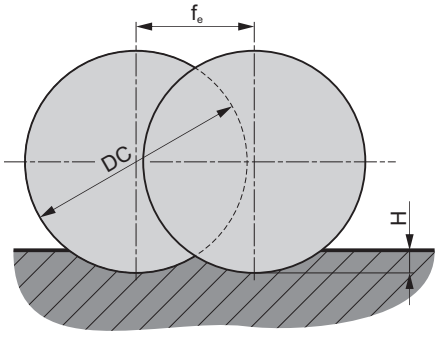
When performing any milling operation, the machined surface is shaped by multiple edges. The microgeometry of the surface is thus dependent on the axial runout of the individual edges of the milling cutter. The most axially protruding edges are the ones that shape the machined surface. The resulting roughness of the milled surface is, to a large extent, influenced by the design of the tip of the indexable insert. If the tip of the indexable insert has a radius, it creates imperfections on the surface. The size of these imperfections is dependent on the corner radius and feed speed. For inserts with smoothing segments, the rule of thumb is that the feed per revolution must be less than 80 % of the size of the smoothing segment. In larger (multi-tooth) cutters, fulfilling this condition can sometimes be problematic, since the maximum feed value $f_z = 0.8 \times a / z$ may approach the lower limit recommended for certain types of insert geometry (the feed speed is lower than the width of the facet in the feed direction). Using lower feed speeds usually results in an increase in cutting resistance, leading to reduced tool life.




In that case, the best solution is to use a milling cutter with fewer teeth or to reduce the number of teeth on the milling cutter (only fitting an insert onto every other tooth of milling cutters with an even number of teeth). There is, however, a risk of reduced productivity. Another alternative is the use of so-called wiper inserts (if such inserts are available for the given type of tool). Even this solution has its drawbacks, however. For milling cutters with a small diameter (approx. 63 mm and less) the speed gradient is too high and there is a risk of tearing or smearing of the surface (edge build-up) towards the centre of the milling cutter when machining tough materials.
Information about the size of smoothing segments can be found at the beginning of technical information in the catalogue section.



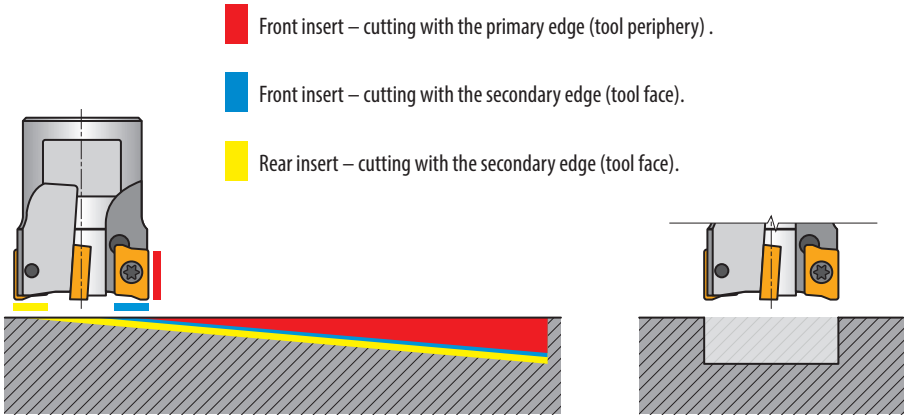

As regards the majority of other types of milling operations, the approximate maximum surface roughness can again be calculated. To do so, we can use the following formula, here accompanied by a graphical explanation.



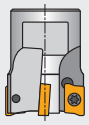

$$H = \frac{f_e^2}{4 \times DC} \rightarrow f_e = \sqrt{4 \times DC \times H}$$

**Ramping**

Ramping is a technology that simultaneously applies three different cutting methods:




An important parameter here is the ramp angle, i.e. the descent in the Z axis across the given stretch. Some tools (HFC) allow descending at a lower angle but with a higher feed, or allow a higher ramp angle with lower feed to be used. These angles or descents across the given section are listed in technical recommendations.

| | |
|---|---|
|  | |
|  | Down at max. angle and horizontally back and down again at max. angle and horizontally back... |
|  | There and back at a smaller (half) angle and last exit horizontally. |
|  | Down at max. angle, back horizontally by length *DC* and then down at max. angle, repeat straight... |
|  | Down at max. angle, then up by length *X* and down again at max. angle. $X = tg\ \alpha\ (DC - W1)$ |

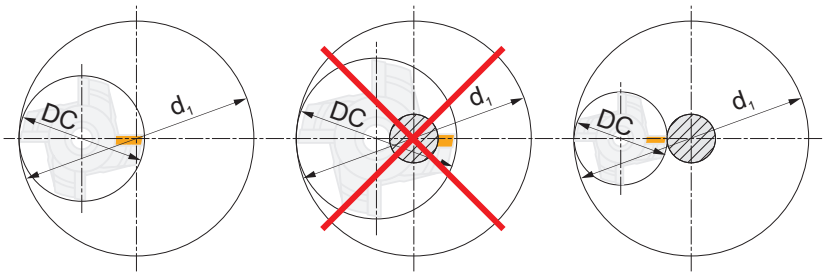
When choosing the feed speed, we advise following the recommendation given for slot milling. If the slot is deeper (i.e. first pass at an angle, second to level off), you must select one of four basic programme variants for the consecutive steps.

Where:

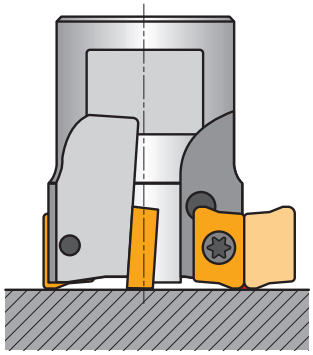
| | |
|---|---|
| *X* | Offset (mm) |
| $\alpha$ | Ramp angle (°) |
| *DC* | Diameter of the milling cutter (mm) |
| *W1* | Insert width (mm) |

**Milling using Circular or Helical Interpolation**

This method is analogous to ramping, except it is performed along a circular path. In this case, one of the most important factors is the milling cutter diameter or minimum and maximum diameter of the hole we are able to machine with the given milling cutter type (this information is vital only when using milling cutters without central cutting edges). If the milling cutter diameter is too large, the path of the insert will not pass through the axis of the hole, resulting in a protrusion which will collide with the face of the tool and may potentially destroy the tool completely. On the other hand, if the diameter of the milling cutter is too small, the core will remain inside the hole axis and must then be milled off separately.




DC = cca 0.5 × $d_1$ | DC > 0.5 × $d_1$ | DC < 0.5 × $d_1$



$D_{max}$ – Hole diameter

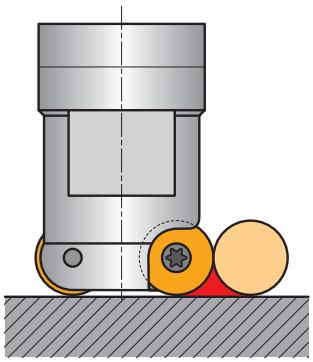
*DC* – Milling cutter diameter

*INSD* – Insert diameter

*RE* – Insert corner radius

*BS* – WIPER edge length

*b* – Max. $a_e$ for grooving



**Maximum hole diameter**

For blind holes, you can achieve a flat bottom by having the tool pass over the bottom's centre.

| | | |
|---|---|---|
| For through hole: $D_{max} = 2 \times DC$ | | For through hole: $D_{max} = 2 \times DC$ |

**Minimum hole diameter**

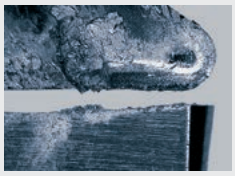
| | | |
|---|---|---|
| For through hole: $D_{min} = (DC - b) \times 2$ | | For through hole: $D_{min} = (DC - 0.8\,INSD) \times 2$ |
| For flat bottom: $D_{min} = (DC - (RE + BS)) \times 2$ | | For flat bottom: $D_{min} = (DC - 0.5\,INSD) \times 2$ |

Recommendations include tables listing the minimum hole diameter, maximum hole diameter and in-axis descent angle values for these diameters (in some cases there will be two tables: one for standard insert geometry and another for HFC).

# TYPES OF WEAR ON MILLING INSERTS

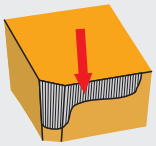
## BUILT–UP EDGE

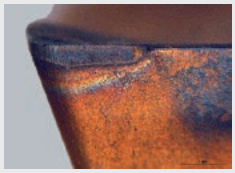




| | | |
|---|---|---|
| | | It has no influence. |
| (MT)CVD / PVD | ++ | Any coating (decisive factor is anti-adhesion effect). |
| f | ↑ | The higher the feed rate the less probability of built-up edge creation. |
| v | ↓↑ | Change (generally increase) the cutting speed. |
| $a_p$ | | It has no influence. |
| | ↓↑ | Use more positive geometry (built up edge is not created when the rake angle is more than 40°). |
| | - | Use a coolant with more effective anti-sticking properties (we do not recommend to use coolant for milling). |

## FLANK WEAR





| | | |
|---|---|---|
| | ↑ | Use a more wear resistant substrate (H). |
| (MT)CVD / PVD | ++ | Any coating (decisive factor is hardness – TiC, TiCN). |
| f | ↑ | Increase feed (especially if it is under 0.1 mm). |
| v | ↓ | Decrease cutting speed. |
| $a_p$ | | It has no influence. |
| | ↑ | Increase the clearance angle. |
| | + | It can help, but only with ideal working conditions. |

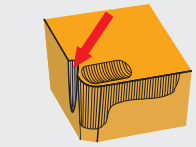
## CRATERING





| | | |
|---|---|---|
| | ↑ | Use a more wear resistant substrate (S). |
| (MT)CVD / PVD | ++ | CVD coating (decisive factor is oxidation resistance – $\alpha$ $Al_2O_3$). |
| f | ↑ | Feed has infuence on shape and position of crater. |
| v | ↓ | Decrease cutting speed. |
| $a_p$ | ↓ | Minimal effect. |
| | ↑ | Use more positive cutting geometry. |
| | ++ | It can help, but only with ideal working conditions. |

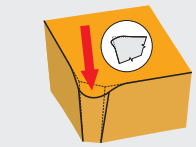
## OXIDATION GROOVE ON THE MINOR EDGE

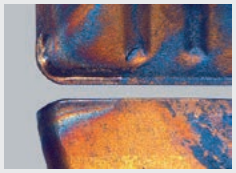




| | | |
|---|---|---|
| | ↑ | Use a more wear resistant substrate (S). |
| (MT)CVD PVD | ++ | CVD coating (decisive factor is oxidation resistance – α $Al_2O_3$). |
| f | ↓ | Feed has infuence on shape and position of groove. |
| V | ↓ | Decrease cutting speed. |
| $a_p$ | ↓ | Minimal effect. |
| | ↑ | Use another (more positive) cutting geometry. |
| | ++ | It can help, but only with ideal working conditions. |

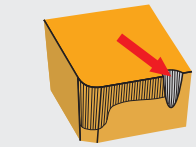
## PLASTIC DEFORMATION





| | | |
|---|---|---|
| | ↑ | Using a more wear resistant substrate (decisive factor is content of Co). |
| (MT)CVD PVD | + | Any coating (decisive factor is friction). |
| f | ↓ | Decrease feed rate. |
| V | ↓ | Decrease cutting speed. |
| $a_p$ | ↓ | Minimal effect. |
| | ↑ | Use another (more positive) cutting geometry. |
| | ++ | It can help, but only with ideal working conditions. |

## NOTCH WEAR

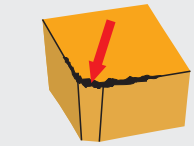


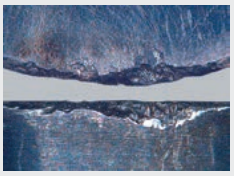


| | | |
|---|---|---|
| | ↑↓ | It depends on the character of the damage (abrasive – use more wear resistant substrate; breaking – use tougher substrate). |
| (MT)CVD PVD | ++ | CVD coating (decisive factor is oxidation resistance – α $Al_2O_3$). |
| f | ↓ | Feed has infuence on intensity, but less than the cutting speed. |
| V | ↓ | Decrease cutting speed. |
| $a_p$ | ↑↓ | Use unequal depth of cut. |
| | ↓ | Use less positive cutting geometry. |
| | + | It can help, but only with ideal working conditions. |
| | | Use tool with smaller setting angle. |

# TYPES OF WEAR ON MILLING INSERTS

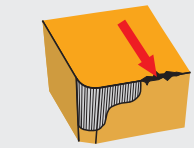
## BRITTLE CRACKS AT THE CUTTING EDGE





| | | |
|---|---|---|
| | ↓ | (H) grain has a great influence. |
| (MT)CVD / PVD | + | PVD coating recommended. |
| f | ↓ | Feed has infuence on intensity, but less than the cutting speed. |
| v | ↑↓ | It is about vibrations. |
| $a_p$ | | It has no influence. |
| | ↑ | Increase the rake angle to reduce cutting forces. |
| | - | No coolant (it is possible to use air to remove chips from cutting area). |
| | | Use better working condition ($a_e$ / DC). |

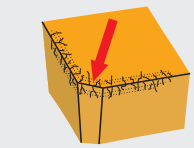
## FAILURE OF CUTTING EDGE

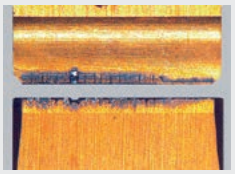




| | | |
|---|---|---|
| | ↓ | (H) grain has a great influence. |
| (MT)CVD / PVD | + | PVD coating recommended. |
| f | ↑↓ | Good swarf control is very important. |
| v | ↑↓ | It is about swarf control and vibration. |
| $a_p$ | ↑↓ | Reduces the force load (important for machining with long overhangs). |
| | ↓ | Use less positive cutting geometry. |
| | | It has no influence. |
| | | Use better working conditions, reduce feed rate until insert is in cut. |

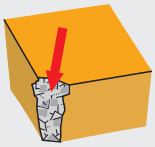
## CREATION OF RACK CRACKS

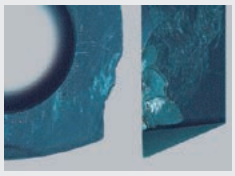




| | | |
|---|---|---|
| | ↓ | (H) grain has a great influence. |
| (MT)CVD / PVD | + + | PVD coating recommended. |
| f | ↓ | Feed has infuence on intensity, but less than the cutting speed. |
| v | ↓ | Lower speed means lower temperature. |
| $a_p$ | | It has no influence. |
| | ↑ | Use another (more positive) cutting geometry. |
| | - - - | No coolant (it is possible to use air to remove chips from cutting area). |
| | | Use better working condition ($a_e$ / DC). |

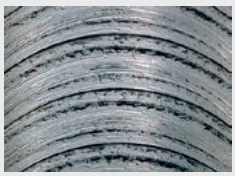
## INSERT FRACTURE





| | | |
|---|---|---|
|  | ↓ | (H) grain has a great influence. |
|  | + | PVD coating recommended. |
|  | ↓ | Very important to reduce cutting force. |
|  | ↑↓ | It is about swarf control and vibration. |
|  | ↓ | Reduces the force load. |
|  | ↓ | Use less positive cutting geometry. |
|  | | It has no influence. |
| | | Use better working conditions ($a_e$ / DC). |

## POOR SURFACE QUALITY



**Description and cause:**

Numerous causes depending on the workpiece material, cutting conditons (feed rate and cutting speed), the condition of the cutting edge, the extent and type of wear, and the condition and rigidity of the machine – tool – workpiece assembly.

- Incorrect tool chosen
- Incorrect chip thickness
- Incorrect cutting speed
- Coolant is needed
- High feed rate

**Corrective measures:**

- Use a finishing insert, or an insert with finishing segment
- Use an insert with suitable cutting geometry
- Reduce the feed rate
- Adjust (usually increase) the cutting speed
- Use coolant or lubrication (MQL)
- Eliminate vibrations
- Use a tool with which the position of the individual inserts can be adjusted more accurately
- Change the chip thickness (modify the machining conditions)

## VIBRATIONS

**Description and cause:**

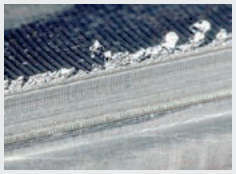
This is a very common problem, which is mainly caused by an unbalanced workpiece or tool, unstable fixing of the machined part and high cutting forces.

- Low rigidity of machine-tool-workpiece assembly
- Excessive chip depth (both axial and radial)
- Run-out – poor workpiece or tool balance
- Large tool overhang

**Corrective measures:**

- Check the stability of the workpiece fixing
- Check the stability of the tool fixing
- Reduce the cutting depth
- Use a tool with smaller overhang
- Modify the cutting speed
- Reduce the chip thickness (change the cutting or machining conditions)
- Choose a suitable cutting geometry and tool material to minimize the cutting process force balance (as sharp and as positive as possible), i.e. use a tool with a lower cutting resistance
- When milling, use a tool with a smaller setting angle

## BURRS



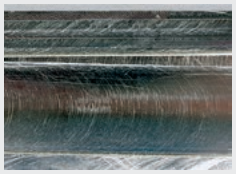
**Description and cause:**

This usually occurs on soft steels and plastic materials.

**Corrective measures:**

- Use a cutting insert with a sharp cutting edge
- Use a cutting insert with positive geometry
- Use a tool with a smaller setting angle

## ERRORS IN DIMENSIONS AND SHAPE OF WORKPIECE



**Description and cause:**

Depends on a number of factors.

**Corrective measures:**

- Use a wear-resistant cutting insert
- Improve the stability of the cutter and workpiece
- Minimize tool overhang
- Use a workpiece with a suitable machining allowance

## INADEQUATE CHIP FORMATION



**Description and cause:**

Producing a chip with a suitable shape is very important to insert durability and service life of the tool. The workpiece material, the feed rate, the depth of cut and the cutting geometry all have an effect on chip forming. A chip that is too long is unacceptable for various reasons, while a chip that is too short is undesirable as it overloads the cutting edge and causes vibrations.

**Corrective measures:**

- Change the feed rate and depth of cut
- Use a more suitable cutting geometry
- Change the cutting conditions

## CHECK THE SEAT CONDITION OF THE CUTTING INSERT

Before clamping a new cutting insert or changing the edge, it is necessary to clean the seat and check its condition or the condition of the anvil and wedge (especially the damage under the corner of the cutting insert).

## CHECK AND SERVICE THE CLAMPING PARTS

It is also important to check the clamping parts, including clamping levers, screws, wedges and clamps. Only use original, undamaged parts (found in the catalogue). Regularly lubricate the threads and the binding surface of screws using, for example, heat-resistant lubricant (MOLYKOTE). For assembly and disassembly, only use screwdrivers and wrenches specified in our catalogue or recommended by the tool manufacturer. Be careful not to over-tighten. To avoid this, we advise using a pre-set torque wrench.

## CHECK THE TIGHTENING

Before tightening, check the fit of the cutting insert on the whole of the binding surface and in the radial and axial directions. Cutting inserts and tools must always be clean and undamaged.

| Value | Unit | Formula |
|---|---|---|
| **Number of revolutions** | (rev/min) | $n = \frac{v_c \times 1000}{DC \times \pi}$ |
| **Cutting speed** | (m/min) | $v_c = \frac{\pi \times DC \times n}{1000}$ |
| **Feed per revolution** | (mm/rev) | $f_{rev} = \frac{f_{min}}{n} = f_z \times z$ |
| **Feed per minute (speed of feed)** | (mm/min) | $f_{min} = v_f = f_{rev} \times n = f_z \times z \times n$ |
| **Feed per tooth** | (mm/tooth) | $f_z = \frac{f_{rev}}{z} = \frac{f_{min}}{n \times z}$ |
| **Chip cross section** | ($mm^2$) | $A = f_z \times a_p$ |
| **Chip thickness (for inserts with a straight edge)** | (mm) | $h = f_z \times \sin KAPR$ |
| **Chip thickness (for round cutting inserts)** | (mm) | $h = f_z \times \sqrt{\frac{a_p}{INSD}}$ |
| **Metal removal rate** | ($cm^3$/min) | $Q = \frac{a_p \times a_e \times f_{min}}{1000}$ |
| **Power demand** | (kW) | $P_c = \frac{a_p \times a_e \times f_{min}}{60 \times 10^6 \times \eta} \times k_c \times k_\gamma$ |
| **Approximate power demand** | (kW) | $P_c = \frac{a_p \times a_e \times f_{min}}{x}$ |

**Note:**

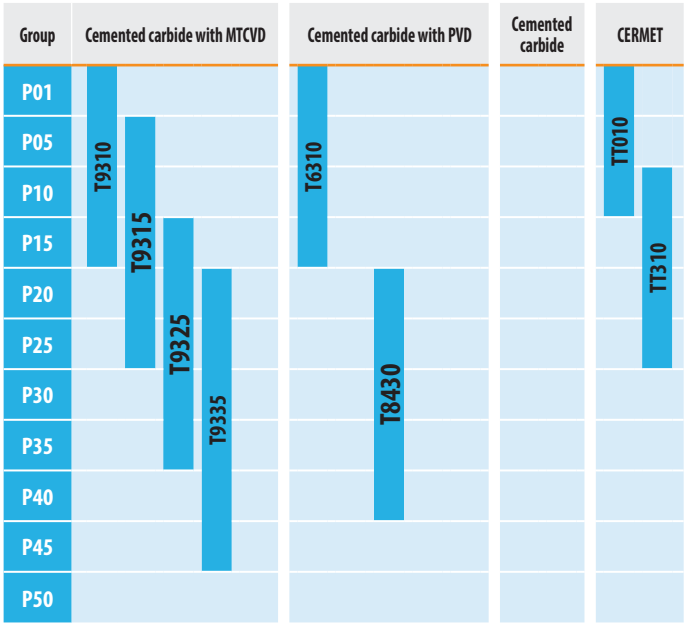
| | Quantity | Unit |
|---|---|---|
| $n$ | Number of revolutions | (rev/min) |
| $DC$ | Diameter (of tool or work piece) | (mm) |
| $v_c$ | Cutting speed | (m/min) |
| $f_{rev}$ | Feed per revolution | (mm/rev) |
| $A$ | Chip cross section | ($mm^2$) |
| $a_p$ | Axial depth of cut (depth of cut) | (mm) |
| $a_e$ | Radial depth of cut (width of cut) | (mm) |
| $KAPR$ | Setting angle | (°) |
| $f_{min}$ | Feed per minute (sometimes called speed of feed) | (mm/min) |
| $f_z$ | Feed per tooth | (mm/tooth) |
| $z$ | Number of teeth | (-) |
| $INSD$ | Diameter of insert | (mm) |

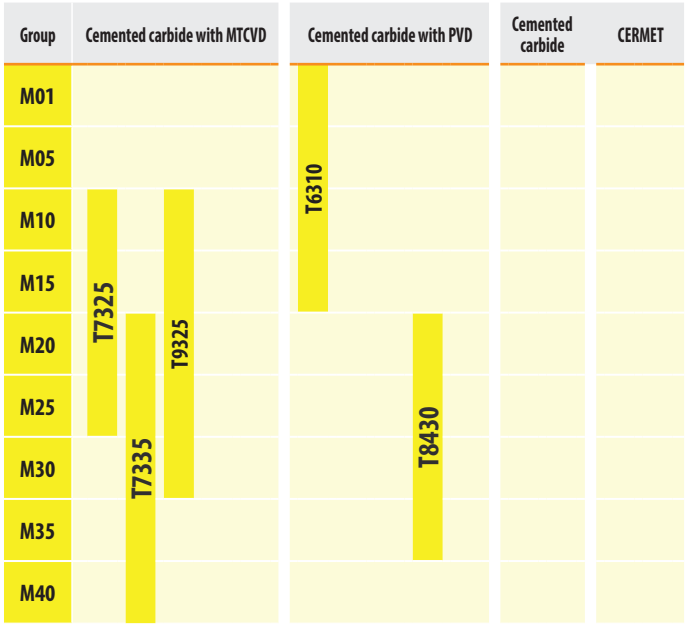
| | Quantity | Unit |
|---|---|---|
| $h$ | Chip thickness | (mm) |
| $Q$ | Material removal rate per minute | ($cm^3$/min) |
| $P_c$ | Power demand | (kW) |
| $k_c$ | Cutting force per $mm^2$ | (MPa) |
| $k_\gamma$ | Coefficient of influence of angle $\gamma_0$ | (°) |
| $\eta$ | Machine efficiency usually $\eta = 0.75$ | (-) |
| $x$ | Coefficient of influence of work piece material | (-) |

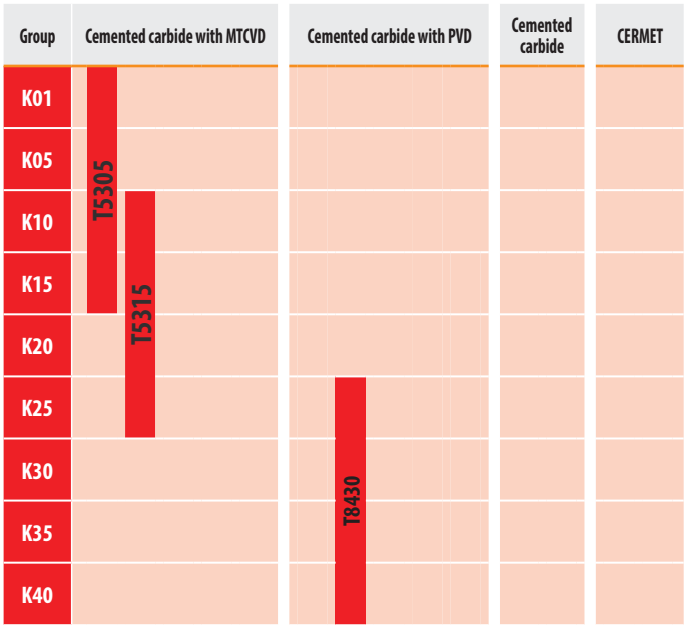
| Material | Steel | Cast iron | Al |
|---|---|---|---|
| Coefficient $x$ | 24 000 | 30 000 | 120 000 |

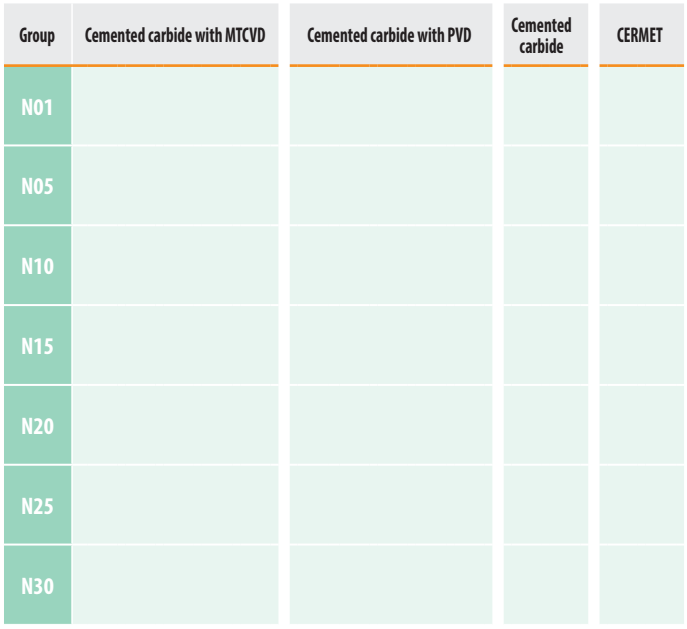


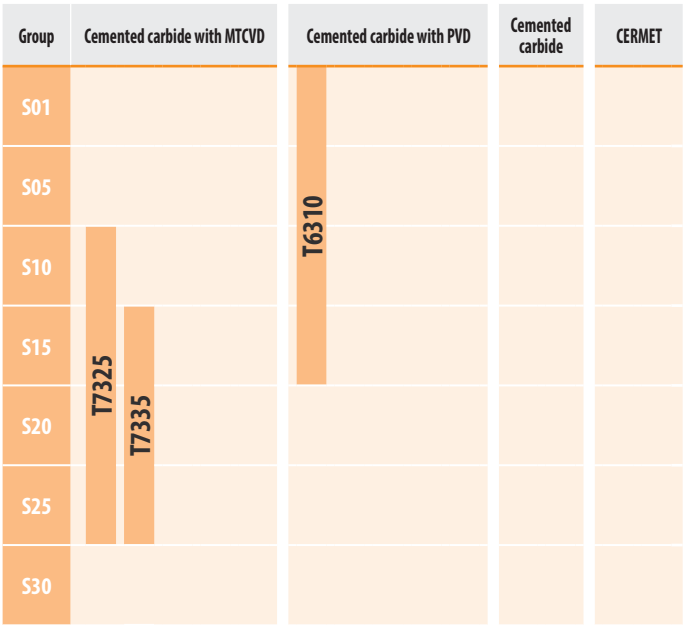
# INDEXABLE TURNING – TECHNICAL INFO

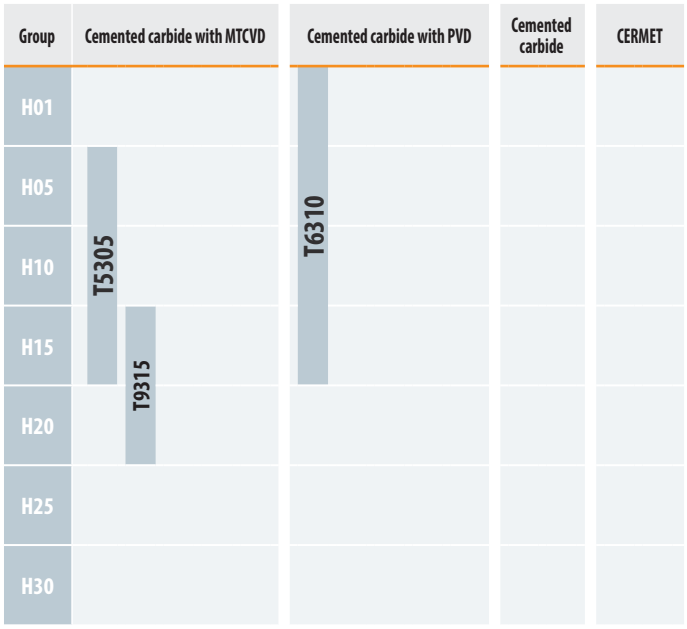

Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Cemented carbide
CERMET
P01
P05
P10
P15
P20
P25
P30
P35
P40
P45
P50
T9310
T9315
T9325
T9335
T6310
T8430
TT010
TT310


Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Cemented carbide
CERMET
M01
M05
M10
M15
M20
M25
M30
M35
M40
T7325
T7335
T9325
T6310
T8430


Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Cemented carbide
CERMET
K01
K05
K10
K15
K20
K25
K30
K35
K40
T5305
T5315
T8430


Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Cemented carbide
CERMET
N01
N05
N10
N15
N20
N25
N30


Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Cemented carbide
CERMET
S01
S05
S10
S15
S20
S25
S30
T7325
T7335
T6310


Group
Cemented carbide with MTCVD
Cemented carbide with PVD
Cemented carbide
CERMET
H01
H05
H10
H15
H20
H25
H30
T5305
T9315
T6310

| Grade Identification | Area of Application | Application | Feed | Cutting speed | Resistance to adverse Working Conditions | Coating | Colour | Substrate | Coolant benefit | Grade description |
|---|---|---|---|---|---|---|---|---|---|---|
| **T9226** | P15 - P35<br>M10 - M30<br>K15 - K25<br>S15 - S25 | ■<br>■<br>◪<br>◪ | | | | MT-CVD | | FGM | + + + | Grade designed for heave roughing applications. A versatile grade with high resistance to mechanical damage and retains very good wear resistance. Usable at lower cutting speeds. |
| **T9310** | P01 - P15<br>K05 - K20<br>H10 - H20 | ■<br>◪<br>◪ | | | | MT-CVD | | FGM | + + | Grade with high abrasion resistance which can be used for slightly interrupted cutting. It will be used for finishing or semi-roughing operations. This material can also be used for roughing operations provided the machine-tool-workpiece configuration is sufficiently rigid. |
| **T9315** | P05 - P25<br>K05 - K25<br>H10 - H20 | ■<br>◪<br>◪ | | | | MT-CVD | | FGM | + + | A versatile grade with excellent wear resistance properties even under intense cutting conditions. It can also be used for operations with interrupted cuts. With it's well balanced properties this grade can be first choice for a wide range of turning operations. Not suited to low cutting speeds. |
| **T9316** | P10 - P20<br>M05 - M15<br>K10 - K30<br>H15 - H25 | ■<br>◪<br>■<br>◪ | | | | MT-CVD | | FGM | + + + | Grade designed for railway applications. A versatile grade with excellent wear resistance properties. Usable at lower and high cutting speeds. |
| **T9325** | P15 - P35<br>M10 - M30<br>K15 - K35<br>S10 - S20 | ■<br>■<br>◪<br>◪ | | | | MT-CVD | | FGM | + + | From a technological perspective this is an extremely versatile grade with high resistance to mechanical damage in adverse cutting conditions and retains excellent wear resistance. The correct application of this material requires high cutting speeds. |
| **T9415** NEW | P05 - P30<br>K05 - K25<br>H10 - H20 | ■<br>◪<br>◪ | | | | MT-CVD | | M | + + | Highly wear-resistant material designed primarily for finish turning of common carbon and alloy steels. Despite its high abrasion resistance, it is also suitable for interrupted cutting operations. We recommend this material as the first choice for most turning operations, especially in high production applications. |
| **T9335** | P20 - P45<br>M15 - M40<br>S15 - S25 | ■<br>■<br>◪ | | | | MT-CVD | | FGM | + + + | One of the toughest grades which is especially suitable for adverse cutting conditions at medium to high feed rates and medium cutting speeds. Compared to its predecessors, M15 – M40 it is not only tougher, but also more abrasion resistant which will be useful when using intensive cutting conditions. |
| **T7325** | P15 - P35<br>M10 - M25<br>S10 - S25 | ◪<br>■<br>■ | | | | MT-CVD | | FGM | + + + | One of the most universal turning grades. Especially designed for stainless steel machining. Optimal balance between wear resistance and performance reliability. Suitable for broad variety of application in turning operations. |
| **T7335** | P20 - P40<br>M20 - M40<br>S15 - S25 | ◪<br>■<br>■ | | | | MT-CVD | | FGM | + + + | Grade with functionally graded substrate, featuring very high operational reliability and very good wear-resistance. It is best suited to use in the machining of very tough M20 – M40 materials. |
| **T5305** | P05 - P15<br>K01 - K15<br>H05 - H15 | ◪<br>■<br>◪ | | | | MT-CVD | | H | + | Grade with very high resistance to chemical wear; suitable for finishing operations using high cutting speeds. With its high abrasion resistance, it is also suitable for productive K01 – K15, machining of hardened and treated materials. |
| **T5315** | P10 - P25<br>K10 - K25<br>H15 - H25 | ◪<br>■<br>◪ | | | | MT-CVD | | H | + | Grade intended primarily for productive machining which has high abrasion resistance and good operational reliability. Due to its properties, this material is particularly suitable for roughing and finishing operations for good or slightly adverse cutting conditions. |

| Grade Identification | Area of Application | Application | Feed | Cutting speed | Resistance to adverse Working Conditions | Coating | Colour | Substrate | Coolant benefit | Grade description |
|---|---|---|---|---|---|---|---|---|---|---|
| **6630** | P15 - P35<br>M10 - M30<br>K20 - K30<br>S15 - S25 | ■<br>■<br>◪<br>□ | | | | MT-CVD | | FMG | + + + | A versatile grade with high resistance to mechanical damage and retains very good wear resistance. Usable at lower cutting speeds for heavy roughing applications. |
| **6640** | P20 - P40<br>M20 - M35<br>K25 - K40 | ■<br>■<br>■ | | | | MT-CVD | | H | + + + | One of the toughest turning materials which can be used especially in roughing operations, or where operational reliability under adverse cutting conditions is a priority. Another ideal choice for machines working with low to medium cutting speeds and medium to high feed rates. |
| **T6310** | P01 - P15<br>M01 - M15<br>K05 - K20<br>N05 - N20<br>S01 - S15<br>H01 - H15 | ■<br>■<br>■<br>■<br>■<br>■ | | | | PVD | | ultra submicron H | + + + | High wear resistant turning grade with top PVD coating. Suitable for finishing operation and applications, where sharp cutting edge together with high flank wear resistance is of high importance |
| **T8330** | P25 - P40<br>M20 - M35<br>K20 - K40<br>N15 - N30<br>S15 - S25<br>H15 - H25 | ■<br>■<br>■<br>◪<br>◪<br>◪ | | | | PVD | | submicron H | + + + | Undoubtedly the most versatile grade it is suitable for machining all types of materials and can be applied in almost all turning operations. It's main benefits are high operational reliability and excellent frictional properties; it is therefore suited to applications at medium to low cutting speeds. |
| **T8345** | P30 - P50<br>M20 - M40<br>K30 - K40<br>S20 - S30 | ■<br>◪<br>◪<br>◪ | | | | PVD | | submicron H | + + + | This is the toughest turning grade, which is intended mainly for machining under the worst cutting conditions and in applications with the highest requirements for operating reliability. Because of these properties, this material is recommended for lower cutting speeds. |
| **T8430** NEW | P20 - P40<br>M20 - M35<br>K25 - K40<br>N15 - N30<br>S15 - S25<br>H15 - H25 | ■<br>■<br>◪<br>◪<br>◪<br>◪ | | | | PVD | | submicron H | + + + | Undoubtedly the most versatile cutting material, this is useful for machining of all types of machined materials and is practically applicable in almost all types of turning operations. Its main benefits are its high operational reliability and very good frictional properties; it is therefore suitable for applications at medium and lower cutting speeds. |

| Substrat | |
|---|---|
| **H** | WC-Co based substrate |
| **submicron H** | WC-Co based substrate fine grained (< 1 µm) |
| **ultra submicron H** | WC-Co based substrate very fine grained (< 0,5 µm) |
| **FGM** | Functionally graded substrate |
| **Cermet** | Cemented carbide without WC |
| **ceramics** | Cutting ceramics |
| **PCD** | Polycrystalline Diamond |
| **CBN** | Cubic Boron Nitride |
| **HSS** | High speed steel |

| Coating | |
|---|---|
| **MT-CVD** | Medium-temperature chemical method of coating |
| **PVD** | Low-temperature physical method of coating |
| × | Uncoated grade |

| Benefits of cutting fluid | |
|---|---|
| + + + | Use of coolant is essential |
| + + | Highly recommended |
| + | Recommended |
| + / – | Optional |
| – - | Do not use coolant |
| – | Coolant not recommended |

### Correction factors for specific type of operation $C_{VcO}$

| | FF | | | F | | | M | | | R | | | HR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $a_p$ | 0.5 | | | 1.5 | | | 2.5 | | | 5.0 | | | 12.0 | | |
| | I | II | III | I | II | III | I | II | III | I | II | III | I | II | III |
| f | 0.05 | 0.08 | 0.10 | 0.10 | 0.15 | 0.20 | 0.20 | 0.30 | 0.40 | 0.40 | 0.60 | 0.80 | 0.80 | 1.00 | 1.30 |
| **Chip-breakers for fine finishing** (FF, FF2…) | 1.15 | 1.00 | 0.95 | 0.85 | 0.80 | – | – | – | – | – | – | – | – | – | – |
| **Chip-breakers for finishing** (NF, SF..) | – | – | 1.20 | 1.05 | 1.00 | 1.05 | 1.00 | 0.90 | – | – | – | – | – | – | – |
| **Chip-breakers for medium machining** (FM, M, NM, NMR, SM…) | – | – | – | – | – | 1.15 | 1.10 | 1.00 | 0.95 | 0.85 | – | – | – | – | – |
| **Chip-breakers for roughing** (RM, NRM, NR, R…) | – | – | – | – | – | – | – | – | 1.25 | 1.10 | 1.00 | 0.95 | 0.65 | – | – |
| **Chip-breakers for heavy roughing** (HR, HR2, NR2, OR…) for 45 min durability | – | – | – | – | – | – | – | – | – | 1.25 | 1.20 | 1.15 | 1.05 | 1.00 | 0.95 |

### Correction factors for required durability $C_{VcT}$

| minutes | 10 | 15 | 20 | 30 | 45 | 60 |
|---|---|---|---|---|---|---|
| **General machining operations** (fine finishing up to roughing) | 1.13 | 1.00 | 0.93 | 0.84 | 0.76 | 0.71 |
| **Heavy machining operations** (heavy roughing) | – | – | – | 1.10 | 1.00 | 0.93 |

### Additional correction factors $C_{VcA}$

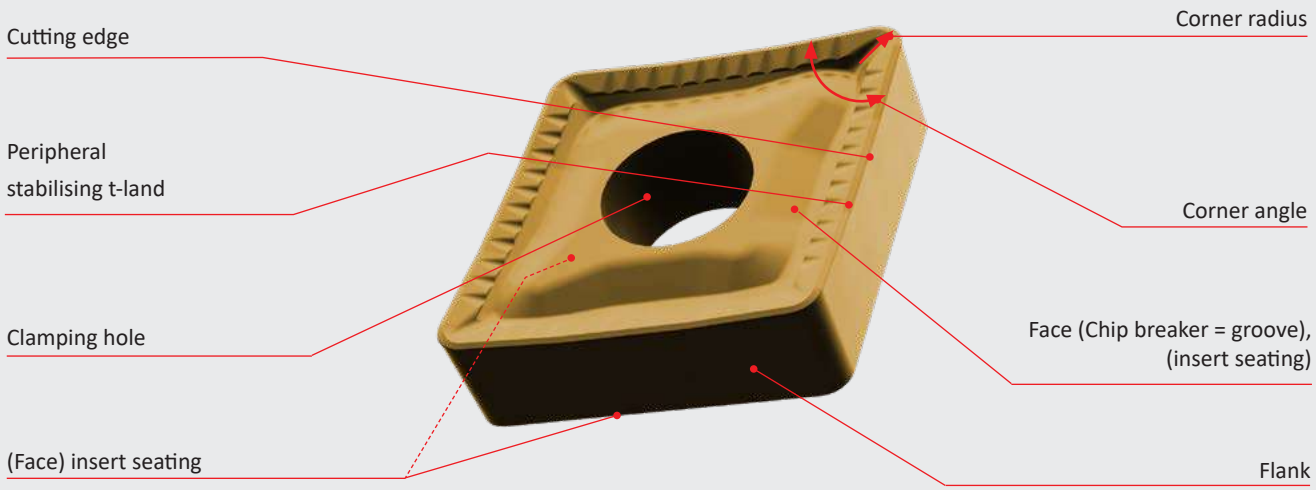
| Machining environment | $C_{VcA}$ |
|---|---|
| **Condition of the work-material** (hard skin due to forging or casting) | 0.70 |
| **Internal turning** | 0.75 |
| **Parting and grooving (radial)** | 0.88 |
| **Face grooving** | 0.80 |
| **Interrupted cut** | 0.80 |
| **Unstable machining conditions** | 0.85 |
| **Common machining conditions** | 1.00 |
| **Stable machining conditions** | 1.20 |

### Resulting corrected cutting speed $v_{cC}$

$$v_{cC} = v_c \cdot k_{vG} \cdot C_{VcO} \cdot C_{VcT} \cdot C_{VcA}$$

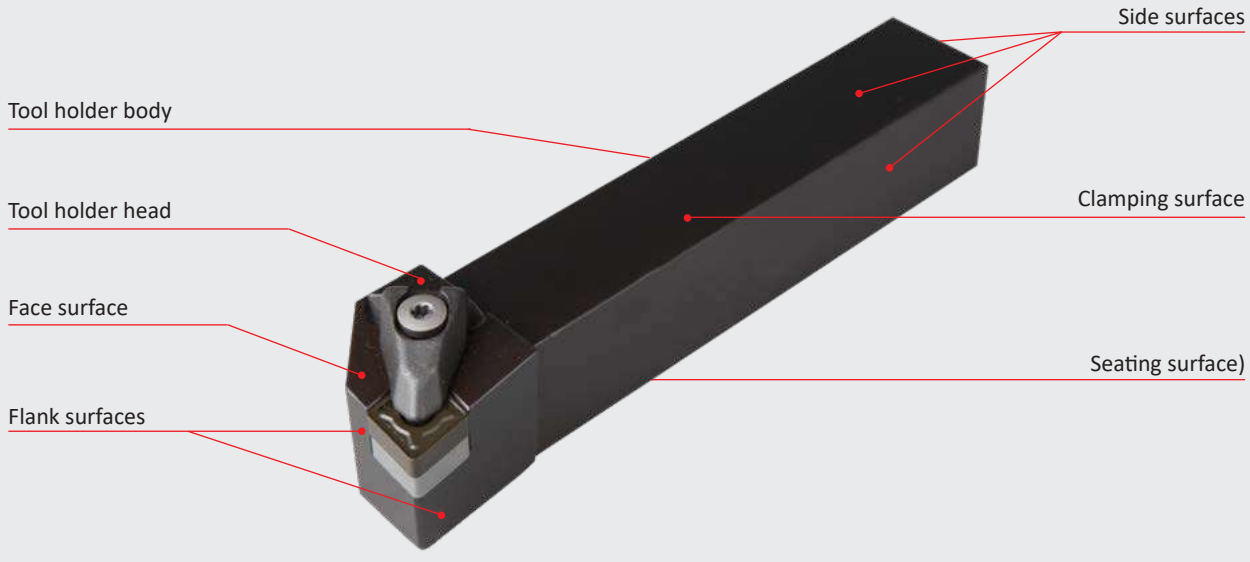
$k_{vG}$ – coefficient of used material
$v_c$ – starting speed from catalogue page

**Insert parts**




**Corner radius** – determines in most cases the recommended minimum depth of cut and, together with the feed, also determines the achieved roughness.
The **Cutting edge** is the intersection of face and flank surfaces. Its longitudinal roughness is one of the first evaluation criteria when assessing an insert.
The **insert corner angle** is very important with regard to the usable cutting edge length, resistance in the interrupted cut, heat dissipation from the cutting point, etc.
The **peripheral stabilising t-land** is an area located after the cutting edge. Its width is very often variable and its angle also changes regularly. In most cases, the width of the t-land, together with the adjustment angle at which the insert works, is a limiting factor for specifying the minimum feed.
The **chip breaker** – together with the t-land determines the application area (narrow grooves – finishing and materials with short chip, wide grooves – mostly roughing operations and tough materials).
The **clamping hole** – if there is no hole, the insert will definitely be designed for the ISO C clamping system. If the hole is cylindrical, the insert is designed for the ISO P, M, D + clamping systems (in nearly all cases the flank angle is 0°. If the hole is trumpet-shaped and the flank angle is positive, the insert is single-sided and is designed for the ISO S clamping system. If the hole is conical and is the same on both sides of the insert, then it is most likely a tangential insert (double-sided).
The **insert seating** – if it is formed by the same relief as the face surface, the insert is double-sided, if it is different, the insert is single-sided. It must be assessed with regard to the planned load or the type of cut. (the size and distance of the radius and the cutting edges).

**Tool holder parts**



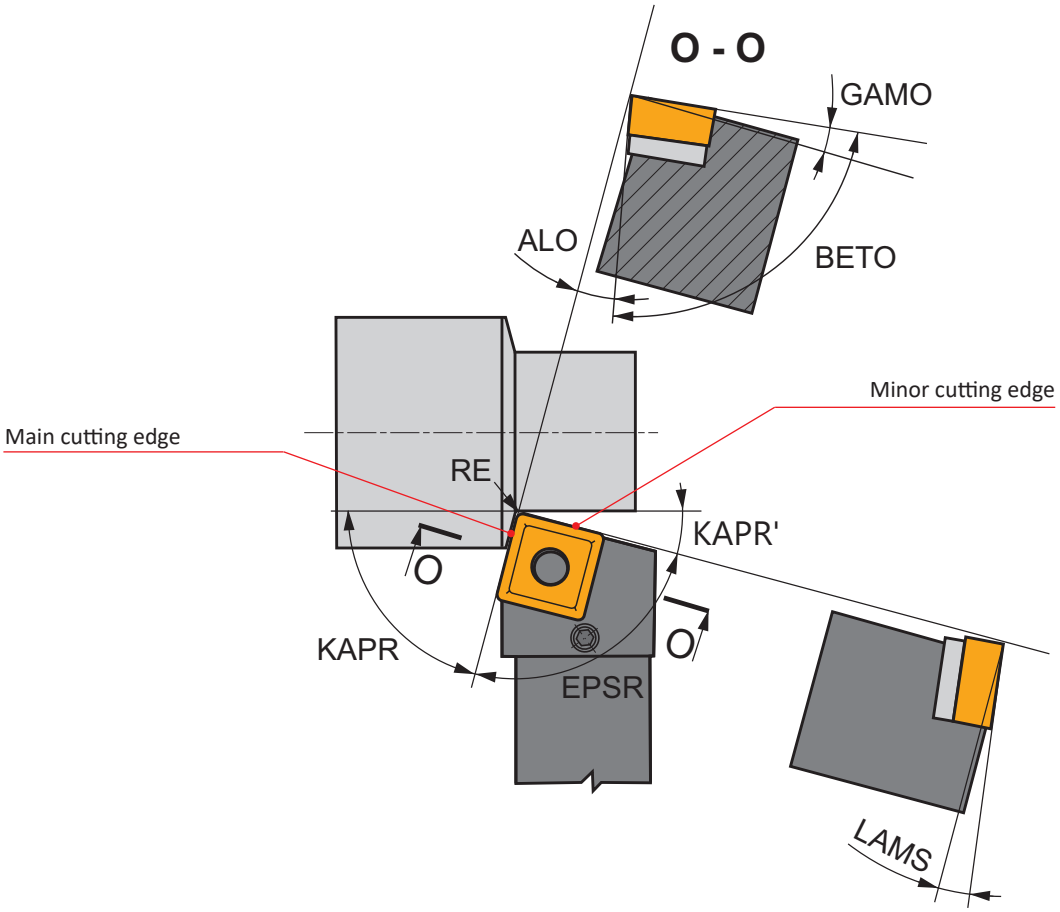
The turning tool consists of two basic parts:
**1) the body consisting of:**
seating surface
clamping surface
side surfaces (which can further be provided with adjusting screws)
**Note:** For external turning, the tool holder body is usually a square cross section (square or rectangle). For internal turning, the cross section of the holder body is circular and, for larger cross sections, it is provided with adjusting surfaces. But the holder body can also be formed by a special type of shank, such as CAPTO (PSC) or HSK

**2) the head with:**
face
flank surfaces
The tool holder head also includes a clamping system into which the inserts are inserted
From the face side (for radial inserts) or from the flank surface side (for tangential inserts)
**Note: the types of heads are:**
straight – allows turning in both directions
side – distinguish between right and left design
bent – distinguish between right and left design (allows better access when turning more complex surfaces)

**Working and construction angles of turning tools**

The position and orientation of the cutting edge in relation to the workpiece and its geometric shape determine the cutting angle characteristics.
The angles on the cutting edge are determined by a two coordinate system:
a) design
b) working

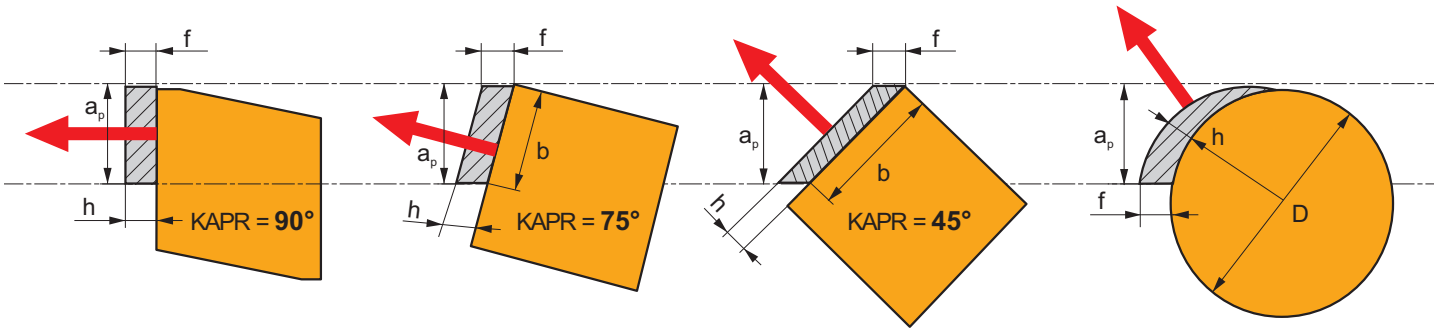
**a) tool coordinate system** (stationary), which is used to determine the cutting edge geometry during design, production and checking. All angles defined in this system are called tool cutting angles. All angles defined by ISO standards according to the insert shape belong in this group.



**b) working coordinate system,** used to determine the cutting edge geometry during the machining process. These angles are called working angles and they depend on the position of the insert clamped into the tool holder. For example, the cutting insert SNUN ..... has a tool clearance angle *AN* = 0° and a rake angle *GAMP* = 0°, however the insert is clamped in the tool holder to give a working clearance angle *ALO* = 6° and a working rake angle *GAMO* = -6°. The working angles affect the tool angles with pre-formed chip breakers. However the most important are the working angles for the cutting process.

The basic tool angles are indicated in the picture in the basic tool plane (interlaid by the bearing surface of the tool holder) and in the normal tool plane (interlaid across to cutting edge – cut O-O).
We are concerned with the following angles:
**The rake angle** *GAMO* – substantially affects the cutting process. Its size determines the progress and the intensity of plastic deformation during chip forming; it also determines the value of the cutting forces and the thermal stress on the cutting edge. The range of rake angles is wide, from *GAMO* = +25° to -15° for cutting tools with indexable cutting inserts for milling and turning. A positive rake angle improves the chip forming conditions, reduces the cutting forces and reduces the cutting temperature level. A negative rake angle improves the strength of the cutting edge, however it increases plastic deformation during chip forming and thereby also the cutting forces and temperatures.

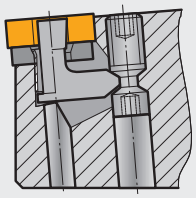
**Clearance angle** *ALO* affects the value of friction between the flank and the machined surface. Increasing the clearance angle *ALO* reduces this friction and thereby flank wear as well.
**Wedge angle** *BETO* is the angle of the cutting insert's wedge. Increasing angle *BETO* increases the strength of the cutting edge (resistance against shock), however it also increases the cutting resistance.
**Inclination angle of main cutting edge** *LAMS* – determines the point of first contact between the cutting edge and the workpiece, which is important for interrupted cut. If *LAMS* is positive, the point of contact is close to the nose of the cutting insert. The negative angle *LAMS* moves the point of first contact far from the nose and thereby affects the resistance of the cutting edge against mechanical stress. Furthermore, *LAMS* affects the direction of chip evacuation. If *LAMS* is negative, the direction of chip evacuation is towards the machined surface. Whereas if *LAMS* is positive, the direction of chip evacuation is away from the machined surface.
**Setting angle of main cutting edge** *KAPR* has main influence on the values of cutting forces and the cross section shape of the chip. Reducing angle *KAPR* makes the chip thinner at a given feed $f$ and depth of cut $a_p$. Whereas if *KAPR* = 90° the chip thickness $h = f$ and the chip width $b = a_p$ becomes wider. Regarding the decreasing setting angle the function width of the T-land is increasing and the rake angle of insert is decreasing.
**Setting angle of minor cutting edge** *KAPR´* together with corner radius *RE* define the final surface quality.




$h = f$ | $h = 0{,}96\ f$ | $h = 0{,}71\ f$ | $h = 0 \div f$

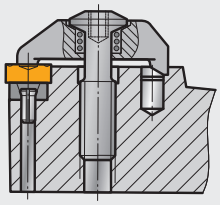
**Tool holder choice with regard to the clamping technique**

The PRAMET TOOLS offer includes tool holders, adjustable holders, turret heads and adjustable holders for external longitudinal, facing, copy turning, and naturally also for internal turning. Tool holders are classified according to the inserts clamping system into six groups that are schematically illustrated in the following passage.



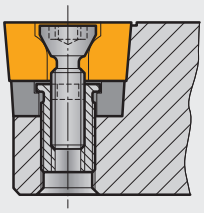
## ISO P

This system serves for the clamping of negative inserts with cylindrical hole, both with chip formers and/or without them. The insert clamping is achieved as a result of an angle lever that after tightening the screw presses the insert down to the holder bed. Tool holders with this clamping system of inserts ensure a reliable and exact clamping of an insert. They perform the best and also the most frequent use at external turning operations, namely both finishing and roughing ones. Alternatively this type of clamping can be also used for holders intended for internal turning of holes with larger diameters.



## ISO D

This system serves for the clamping of both negative and positive inserts without holes, namely with both chip formers (pre-pressed, ground and side-pressed ones) and without them. The insert is fixed in the bed of a tool holder by a screw-held clamp, under which there is still embedded a side-pressed chip former at some insert types. Holders with this clamping system are used for both the external and internal surface machining. At present the clamping system C loses its importance. Especially at tools for internal turning it is replaced by the system S with benefit.

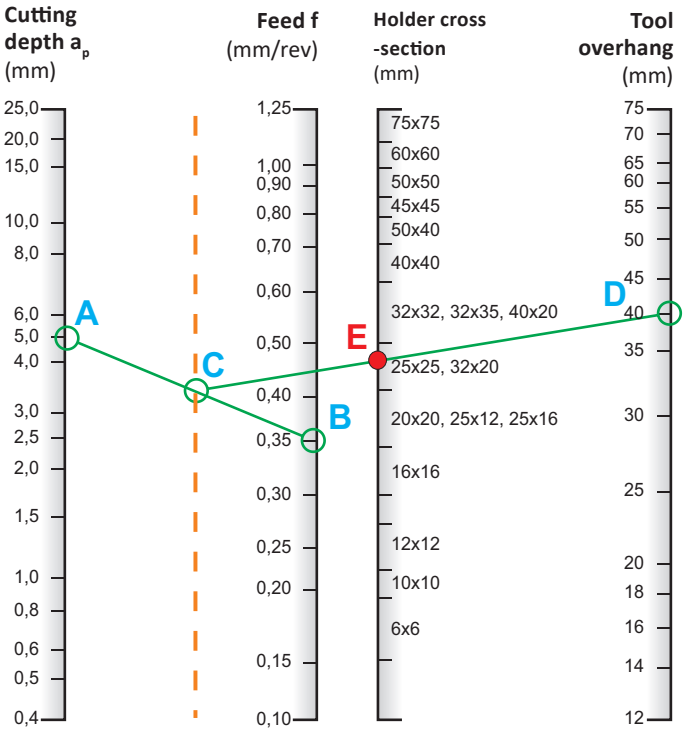


## ISO S

This clamping system is mainly used for small cross-section tools, designed for both external and internal turning (drilling). In this case a special screw, going through an insert cone hole, achieves the clamping. By tightening this screw an insert is fixed in the tool bed. This solution is especially convenient because there is no obstacle for chip flow.

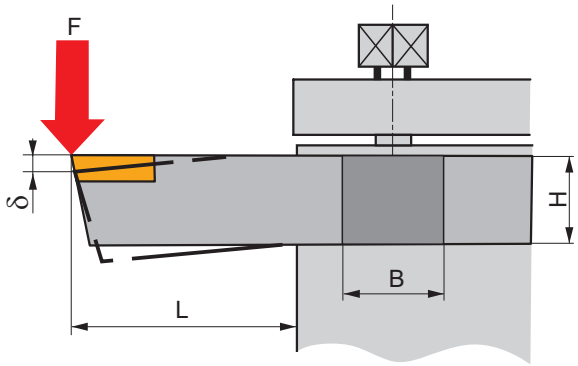
**With reference to square cutting tool**

External cutting tools (square cross section)




Unfortunately, we cannot offer you a similar diagram for choosing the diameter of the inner cutting tool as the situation in internal turning is complicated by the chip. Due to the larger overhang, a holder with the largest possible diameter should be chosen, but if the diameter of the holder is close to the diameter of the hole to be machined, problems can occur with the chip evacuation. It usually gets between the hole wall and the holder body damaging the surface being formed.
In general, if you use tools with a steel body, the overhang should not exceed 4xD, and if you have tools with a carbide or heavy metal body, the maximum overhang should be 6xD. Remember that for both types of tools, the portion for clamping the tool should be at least 3xD.

Use the **maximum possible cross section** with regard to clamping options and process limitations.

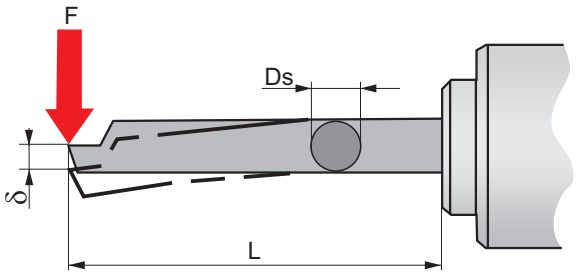



Bending stress

$$\sigma = \frac{6 . F . L}{B . H^2} \quad (\text{MPa})$$

Tool holder deflection

$$\delta = \frac{4 . F . L^3}{E . B . H^3} \quad (\text{mm})$$




Bending stress

$$\sigma = \frac{32 . F . L}{\pi . D_s^3} \quad (\text{MPa})$$

Tool holder deflection

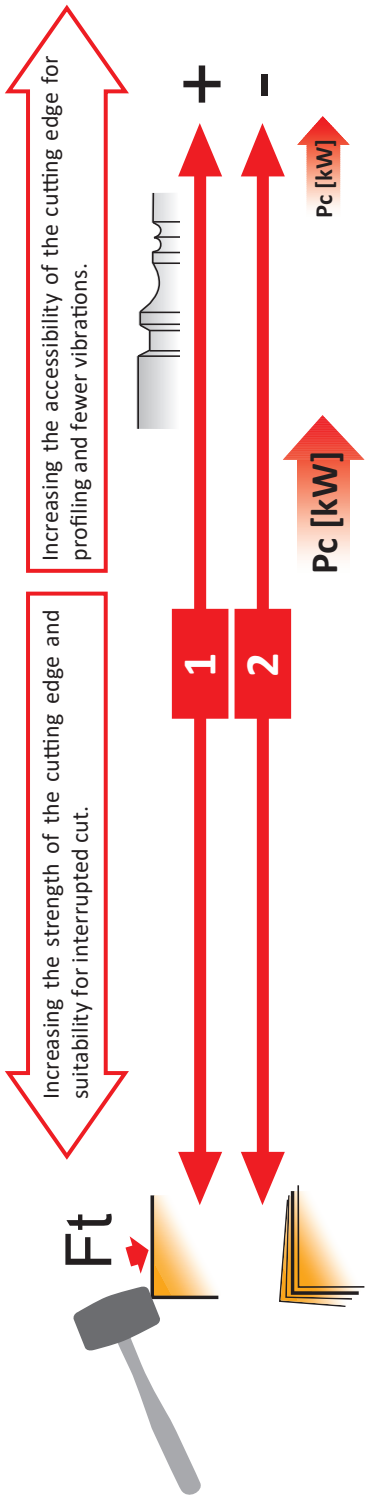
$$\delta = \frac{64 . F . L^3}{3 . \pi . E . D_s^3} \quad (\text{mm})$$

| | |
|---|---|
| σ | Bending stress in the body (MPa) |
| **F** | Cutting force (N) |
| **L** | Tool overhang (mm) |
| **B** | Body width (mm) |
| **H** | Body height (mm) |
| **Ds** | Body diameter (mm) |
| **E** | Body material elastic modulus (MPa) |

| Material | MPa (N/mm²) | (kgf/mm²) |
|---|---|---|
| **Steel** | 210.000 | 21.000 |
| **Sintered carbide** | 560.000 – 620.00 | 56.000 – 62.00 |

**50%** reduction in overhang reduces deflection by **88%.**
**1/3** increase in cross section reduces bending by **68%.**

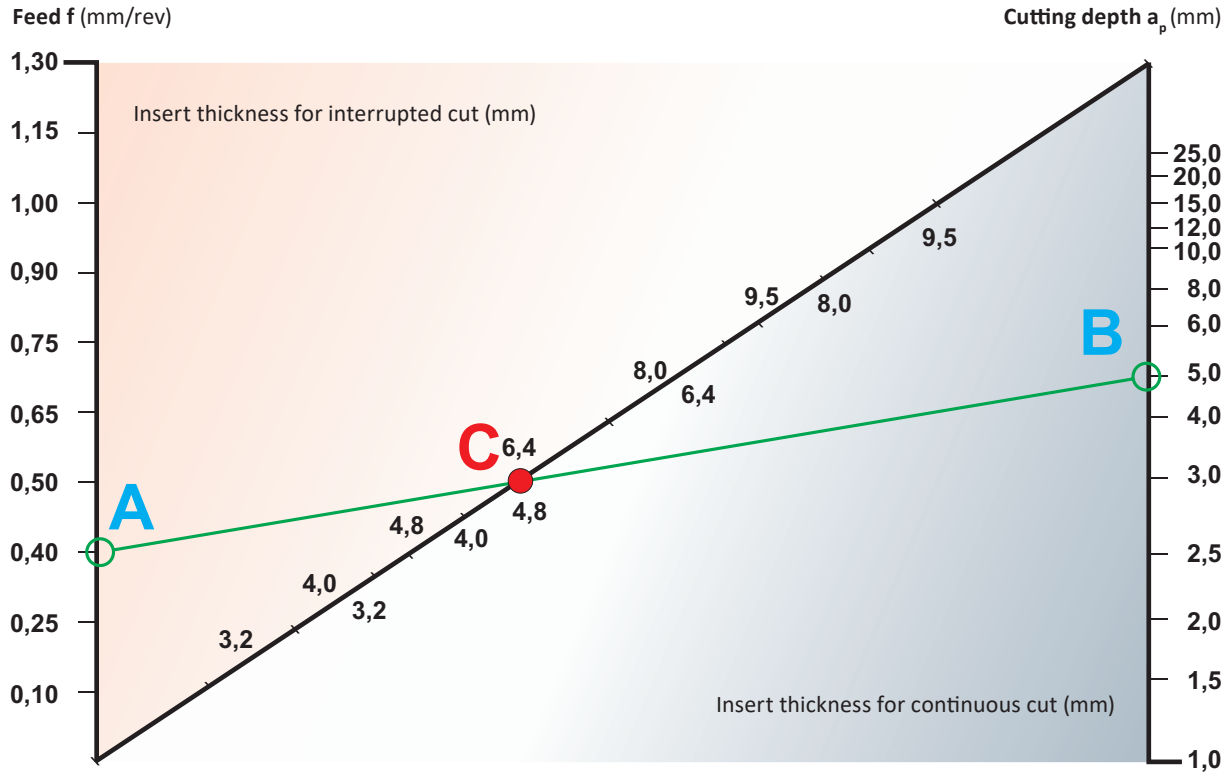
## Choosing the shape and size of the insert




| Priority of choice | Insert shape | | Nose angle | Insert size | | Maximum length of cutting edge Lmax | | | Roughing | Light roughing | Finishing | Profile turning | Face turning | Versatile applications | Tendency to vibrate | Hard material | Interrupted cut |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ISO | ANSI | | (mm) | (″) | | | | | | | | | |
| | | V | 35° | 11 | 2 | 0.25L | 2.80 | .110″ | | | | | | | | | |
| | | | | 13 | | | 3.30 | .130″ | | | ■ | ■ | | ◪ | ■ | | |
| | | | | 16 | 3 | | 4.20 | .165″ | | | | | | | | | |
| | | D | 55° | 07 | 2 | 0.25L | 2.00 | .078″ | | | | | | | | | |
| | | | | 11 | 3 | | 2.90 | .114″ | | ■ | ■ | ■ | ◪ | ■ | ■ | | |
| | | | | 15 | 4 | | 3.90 | .153″ | | | | | | | | | |
| | | T | 60° | 11 | 2 | 0.33L | 3.60 | .141″ | | | | | | | | | |
| | | | | 16 | 3 | | 5.50 | .216″ | | | | | | | | | |
| | | | | 22 | 4 | | 7.30 | .287″ | ◪ | ■ | ■ | ◪ | ◪ | ◪ | ■ | ◪ | |
| | | | | 27 | 5 | | 9.10 | .358″ | | | | | | | | | |
| | | W | 80° | 06 | 3 | 0.50L | 3.30 | .129″ | ◪ | ■ | ■ | ◪ | ■ | ◪ | ◪ | ◪ | ◪ |
| | | | | 08 | 4 | | 4.40 | .173″ | | | | | | | | | |
| | | C | 80° | 06 | 2 | 0.66L | 4.20 | .165″ | | | | | | | | | |
| | | | | 09 | 3 | | 6.40 | .251″ | | | | | | | | | |
| | | | | 12 | 4 | | 8.50 | .334″ | | | | | | | | | |
| | | | | 16 | 5 | | 10.60 | .417″ | ■ | ■ | ◪ | ◪ | ■ | ■ | ◪ | ■ | ■ |
| | | | | 19 | 6 | | 12.70 | .500″ | | | | | | | | | |
| | | | | 25 | 8 | | 16.50 | .649″ | | | | | | | | | |
| | | S | 90° | 09 | 3 | 0.66L | 6.30 | .248″ | | | | | | | | | |
| | | | | 12 | 4 | | 8.40 | .330″ | | | | | | | | | |
| | | | | 15 | 5 | | 10.40 | .409″ | ■ | ◪ | | | ■ | | | ■ | ■ |
| | | | | 19 | 6 | | 12.60 | .496″ | | | | | | | | | |
| | | | | 25 | 8 | | 16.80 | .661″ | | | | | | | | | |
| | | C | 100° | 12 | 4 | 0.66L | 8.50 | .334″ | | | | | | | | | |
| | | | | 19 | 6 | | 12.70 | .500″ | ■ | | | | ■ | | | ■ | ■ |
| | | | | 25 | 8 | | 16.50 | .649″ | | | | | | | | | |
| | | R | | 06 | | 0.40D | 2.40 | .094″ | | | | | | | | | |
| | | | | 08 | | | 3.20 | .125″ | | | | | | | | | |
| | | | | 10 | | | 4.00 | .157″ | | | | | | | | | |
| | | | | 12 | | | 4.80 | .188″ | | | | | | | | | |
| | | | | 15 | | | 6.00 | .236″ | ■ | | | | ◪ | ◪ | | ■ | ■ |
| | | | | 16 | | | 6.40 | .251″ | | | | | | | | | |
| | | | | 19 | | | 7.60 | .299″ | | | | | | | | | |
| | | | | 20 | | | 8.00 | .315″ | | | | | | | | | |
| | | | | 25 | | | 10.00 | .393″ | | | | | | | | | |
| | | | | 32 | | | 12.80 | .503″ | | | | | | | | | |

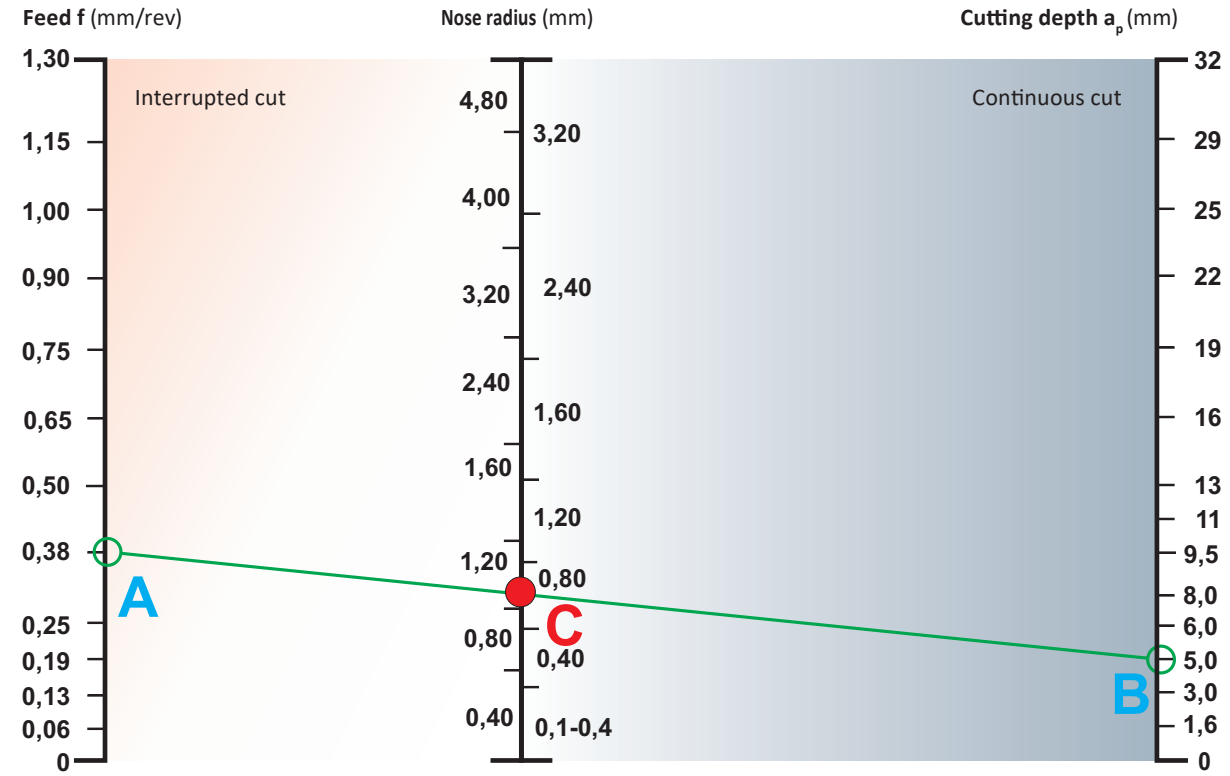
**Choosing the optimum thickness of the insert**

Based on practice, we recommend performing this only for interrupted cut and at a maximum load of inserts.




**Choosing the nose radius of the insert**

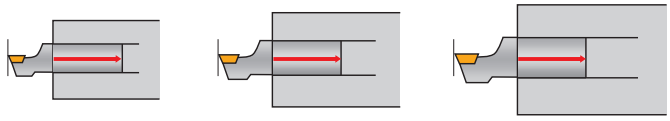
Based on practice, we recommend performing this only for interrupted cut and at a maximum load of inserts.



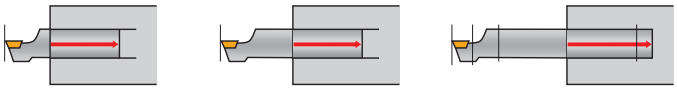




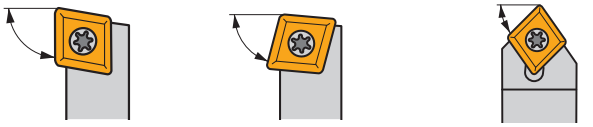
**Hardness of chip formation** – great attention must be paid to proper chip formation (the chip must be easily transportable from the cutting point and, at the same time, it should have the smallest possible plastic deformation, i.e. the lowest possible cutting forces).



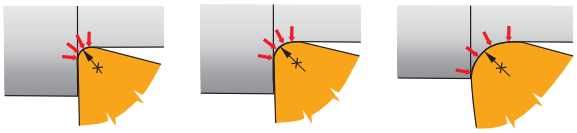
**Tool body cross section (clamping rigidity)** – the rigidity of the clamping itself is important. Therefore, we recommend using cutting tools with the largest possible body cross section that can be clamped. We also prefer to use monoblocks (PSC).



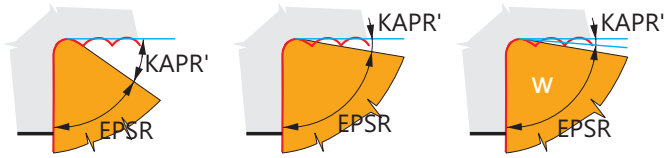
**Overhang (clamping rigidity)** – the tool overhang, or the rigidity of the clamping itself, is of great importance as well. Therefore, we recommend minimising the overhang.



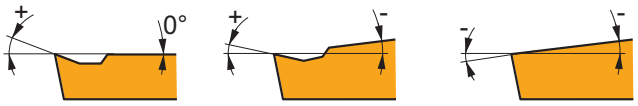
**Main cutting edge angle** – ideally, the tool adjustment angle should be close to 90°, i.e. the forces should be directed as much as possible to the axis of the machine spindle.



**Insert radius** – if there is a risk of vibration, we recommend selecting an insert with the smallest possible tip radius.



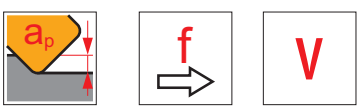

**Corner angle and minor cutting edge angle** – in this case it is recommended to choose an insert with the smallest possible tip angle, i.e. V (35°), D or K (55°), or T (60°).C or W shapes, or inserts with WIPER geometry, are not recommended. Please note this does not always apply (if torsional vibrations also occur, the application of these inserts can be beneficial).




**Geometry** – when turning thin-walled and slim parts, it is recommended to opt for positive inserts with positive geometry, then negative inserts with positive geometry, and only if there is no other choice, then negative inserts with neutral to negative geometry should be chosen.




**Micro-geometry (cutting edge design)** – to reduce the risk of vibration, it is necessary to select inserts with the sharpest possible cutting edge geometry. If you use inserts with t-landing, these should be as narrow and positive as possible. It is very important that the tool generates as little cutting resistance as possible.



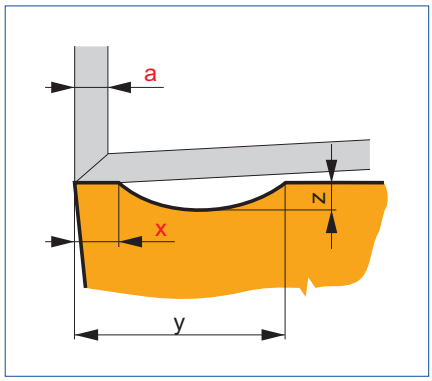

**Cutting conditions:**
1) When choosing the depth of cut, always make sure that the depth of cut is greater than the radius of the insert.
2) When choosing the feed, take into account that the specific cutting resistance increases with decreasing chip thickness, i.e. do not use extremely low feeds (below 0.1 mm).
3) If there are vibrations, cutting speed change (+/-) can also help – this is related to the inherent frequency of the machine.
NOTE: It is often advantageous to reduce the depth of cut (not below the radius) and increase the feed.



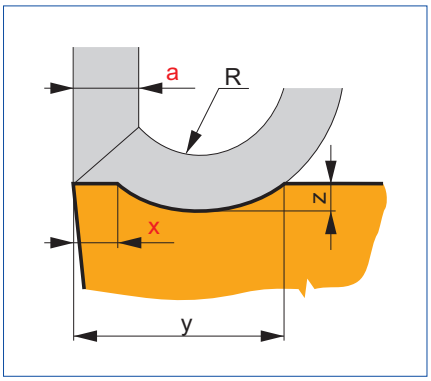
**Do not use worn inserts** – abrasion of the flank causes an increase in cutting forces, and thus the risk of vibration.
If tool clamping allows it, move the cutting edge above the axis (in external turning) by approx. 2% of the diameter.

**Choosing the chip breaker**

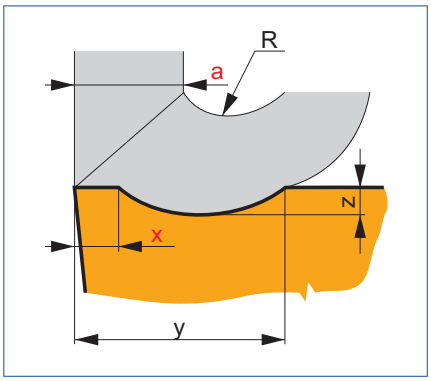
The shape of the chip depends on several factors – the properties of the machined component, material strength, toughness and microstructure, properties of the insert grade, especially the frictional properties (on the rake face), geometry of cutting edge, cutting conditions and the type of chip breaker, also static and dynamic properties of the machine.
Virtually all of these factors in the cutting process work to combine and determine the shape of the chip (shearing action, flow of the chip, or curled chip – which can gather and clog the machining area). Each chip breaker works in a defined range of feed and depth of cut.
The minimum feed at which the chip breaker functions depends on the width of Top Land „*x*“ and it's angle. The maximum feed depends on the distance from the cutting edge to the end of the chip breaker *y* and the depth of the chip breaker *z*.




If the thickness of layer „*a*“ cut away (at setting angle *KAPR* = 90°, equal to the feed) is significantly smaller than the T–land „*x*“, the chip is only in contact with the chamfer. It cannot enter the chip breaker and therefore it cannot be broken (see picture).

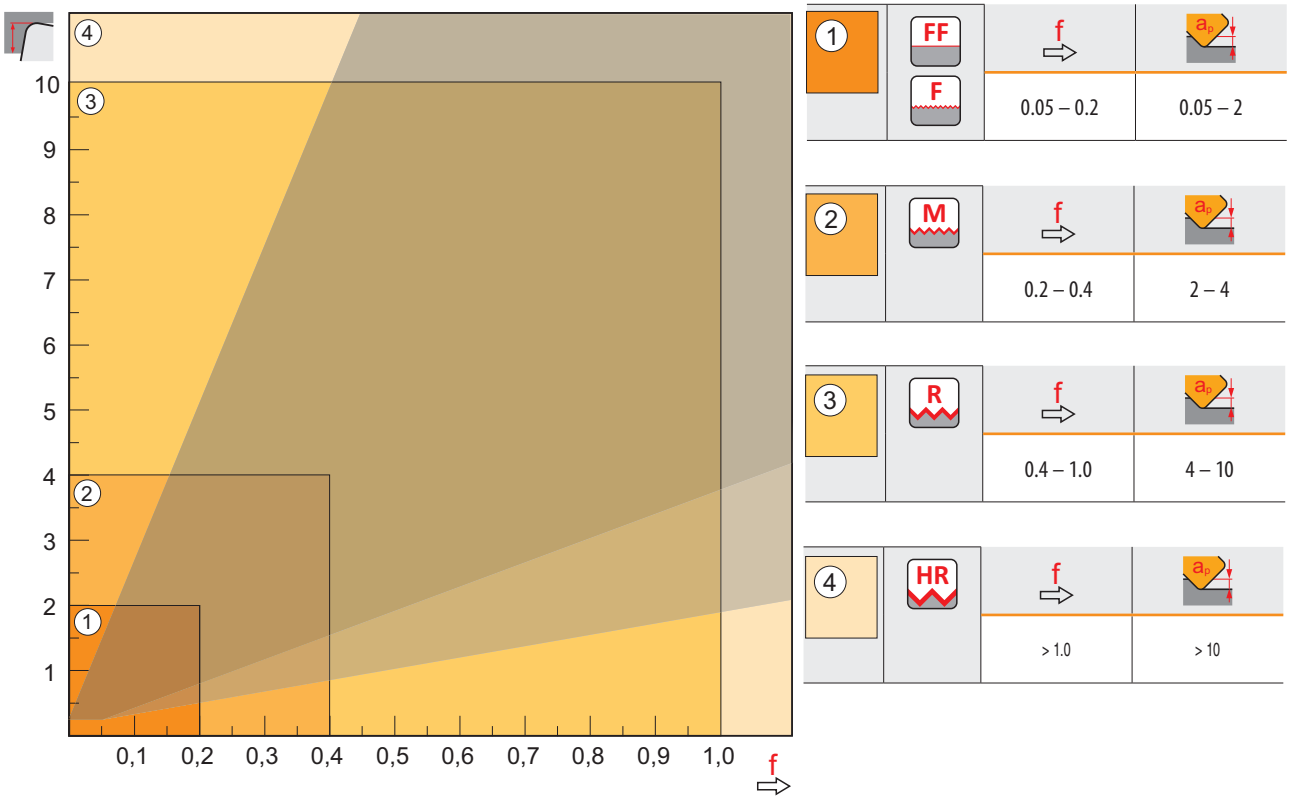


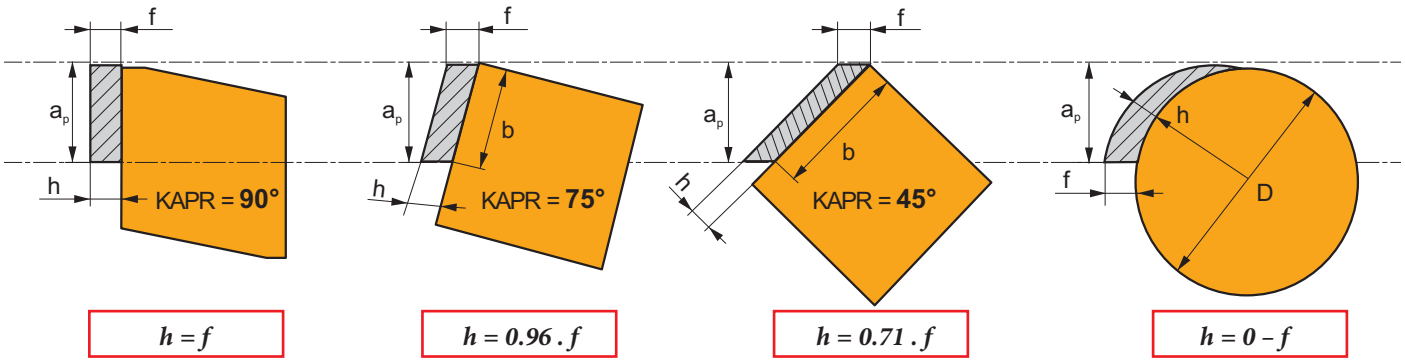

If the feed „*f*“ is greater (thickness greater than the depth of „*a*“ and *x* < *a* (*f* ), the chip enters the chip breaker and is curved at specific values of radius *R* (see picture).




If *x* << *a* (see picture) the chip is excessively deformed (chip is crushed). If the chip misses the chip breaker it will not be broken.

All chip breakers work in a defined range of cutting conditions. This is why the chip breaking area is shown as a continuous range in order to define the most commonly used depth of cut and feed combinations (see following picture). The chip breaker application ranges also overlap.





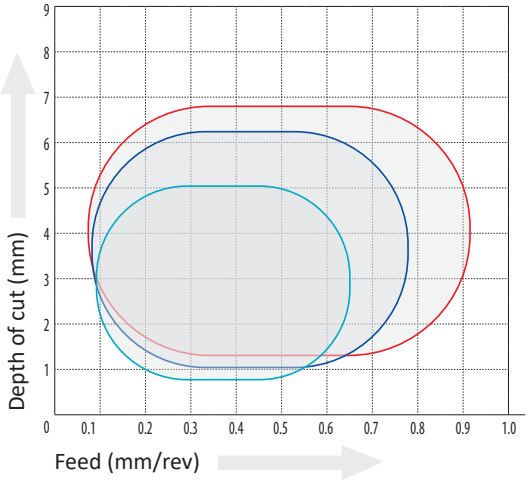

$h = f$ | $h = 0.96 \cdot f$ | $h = 0.71 \cdot f$ | $h = 0 - f$

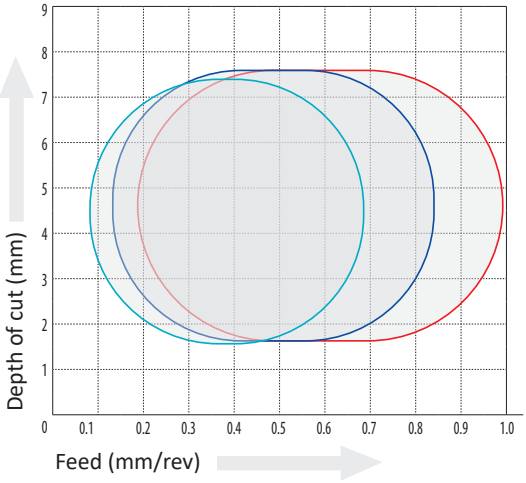
Optimal combination of depth of cut and feed varies for each material. The following table shows ranges of the optimal ratios $b$ (chip width) to $h$ (chip thickness). For adjustment angles close to 90°, this is essentially the ratio of depth of cut to feed. See picture.

| Material | | min b/h | max b/h | |
|---|---|---|---|---|
| P |  | 5 | 15 |  |
| M | | 8 | 12 | |
| K | | 3 | 30 | |
| N | | 9 | 11 | |
| S | Square chip b=h | 8 | 12 | Ribbon chip b/ h > 30 |
| H | | 5 | 20 | |

As follows from the table, when choosing cutting conditions, you should avoid the so-called square chip, i.e. values where the width is close to the thickness of the chip and, on the other hand, the ribbon chip, i.e. high depths of cut in combination with low feed.
The above table shows that the most problematic chip formation relates to non-ferrous metal alloys, in particular aluminium alloys with or without a low silicon content. This is followed by superalloys and stainless steels (especially austenitic and duplex steels). Next are steels, and the best situation is with hardened materials and cast irons.

Also, keep in mind that the chip formation diagram moves slightly towards higher depths of cut (up), with increasing cutting edge length (insert size), and towards higher feeds (to the right), with increasing radius.



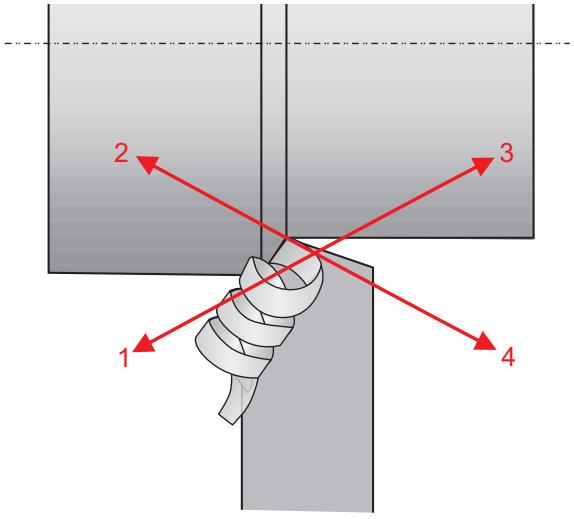



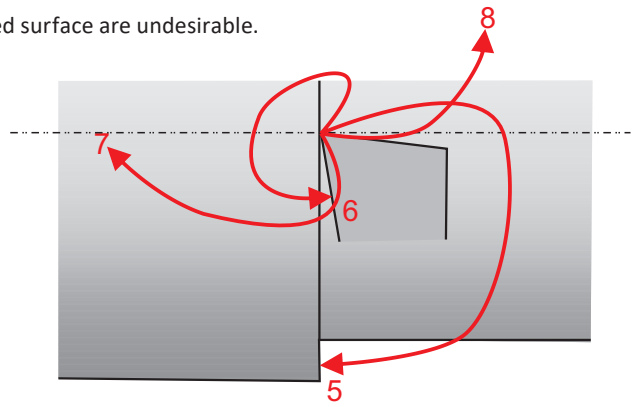

- An insert with the diameter of an inscribed circle IC = 19.050 (mm)
- An insert with the diameter of an inscribed circle IC = 15.875 (mm)
- An insert with the diameter of an inscribed circle IC = 12.700 (mm)
- An insert with the tip radius RE = 1.6 (mm)
- An insert with the tip radius RE = 1.2 (mm)
- An insert with the tip radius RE = 0.8 (mm)

Aside from shape of the chip, the direction of its evacuation is also very important. The following figure shows the basic directions of chip evacuation:

1 – from the workpiece in the feed direction,
2 – to the workpiece in the feed direction
3 – to the workpiece against the feed,
4 – from the workpiece against the feed,
5 – broken against the cutting area surface,
6 – broken against the side of the tool,
7 – broken against the surface being machined,
8 – broken against the machined surface,

Obviously, directions that can cause damage or scratching of the machined surface are undesirable.

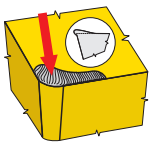


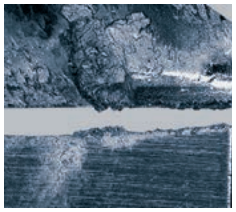




The following section clearly specifies all the geometries we offer you in structured groups. These tables should give you an optimal and more accurate choice.

# TYPES OF WEAR ON TURNING INSERTS

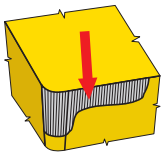
## BUILT–UP EDGE

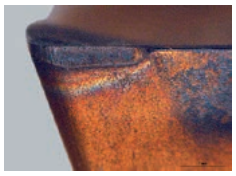




| | | |
|---|---|---|
| | | It has no influence |
| (MT)CVD PVD | + + | Any coating (decisive factor is anti-adhesion effect) |
| f | ↑ | The higher the feed rate the less probability of built-up edge creation |
| V | ↓↑ | Change (generally increase) the cutting speed |
| $a_p$ | | It has no influence |
| | ↓↑ | Use more positive geometry (built up edge is not created when the rake angle is more than 40°) |
| | - | Use a coolant with more effective anti-sticking properties (or no coolant at all) |

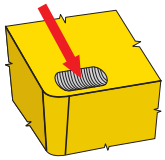
## FLANK WEAR





| | | |
|---|---|---|
| | ↑ | Use a more wear resistant substrate (S) |
| (MT)CVD PVD | + + | Any coating (decisive factor is oxidation resistance – $\alpha$ $Al_2O_3$) |
| f | ↑ | Feed has influence on shape and position of groove |
| V | ↓ | Decrease cutting speed |
| | ↑ | Minimal effect |
| $a_p$ | + | Use another (more positive) cutting geometry |
| | + | Use coolant or increase its intensity |

## CRATERING

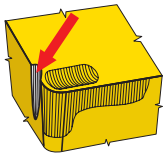




| | | |
|---|---|---|
| | ↑ | Use a more wear resistant substrate (S) |
| (MT)CVD PVD | + + | Any coating (decisive factor is thermal resistance – $\alpha$ $Al_2O_3$) |
| f | ↑ | Feed has influence on shape and position of crater |
| V | ↓ | Decrease cutting speed |
| $a_p$ | ↓ | Minimal effect |
| | ↑ | Use more positive cutting geometry |
| | + + | Use coolant or increase its intensity |

# TYPES OF WEAR ON TURNING INSERTS

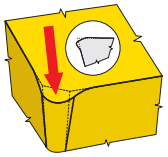
## OXIDATION GROOVE ON THE MINOR EDGE

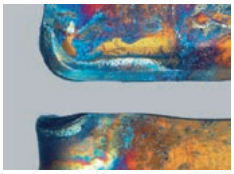




| | | |
|---|---|---|
| | ↑ | Use a more wear resistant substrate (H) |
| (MT)CVD PVD | ++ | Any coating (decisive factor is hardness – TIC, TICN) |
| f | ↓ | Increase feed (especially if it is under 0.1 mm) |
| v | ↓ | Decrease cutting speed |
| $a_p$ | ↓ | It has no influence |
| | ↑ | Increase the clearance angle |
| | ++ | Use a coolant or increase its intensity |

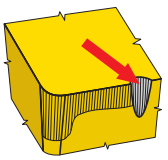
## PLASTIC DEFORMATION

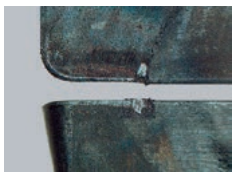




| | | |
|---|---|---|
| | ↑ | Use a more wear resistant grade (decisive factor is content of Co) |
| (MT)CVD PVD | + | Any coating (decisive factor is friction) |
| f | ↓ | Decrease feed rate |
| v | ↓ | Decrease cutting speed |
| $a_p$ | ↓ | Minimal effect |
| | ↑ | Use another (more positive) cutting geometry |
| | ++ | Use coolant or increase its intensity |

## SIDE FLANK NOTCH – REMEDY

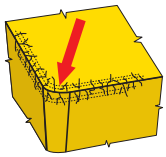


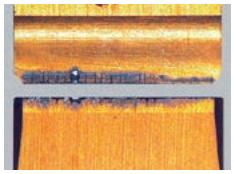


| | | |
|---|---|---|
| | ↑ ↓ | It depends on the character of the damage (abrasive – use more wear resistant substrate; breaking – use tougher substrate) |
| (MT)CVD PVD | ++ | CVD coating (decisive factor is oxidation resistance – $\alpha$ $Al_2O_3$) |
| f | ↓ | Feed has influence on intensity, but less than the cutting speed |
| v | ↓ | Decrease cutting speed |
| $a_p$ | ↑↓ | Use unequal depth of cut |
| | ↓ | Use less positive cutting geometry |
| | + | Use coolant or increase its intensity |
| | | Use tool with smaller setting angle |

# TYPES OF WEAR ON TURNING INSERTS

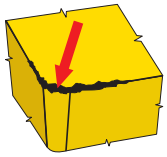
## CREATION OF RACK CRACKS

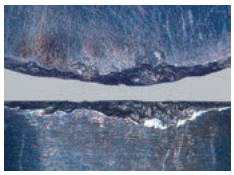




| | | |
|---|---|---|
| | ↓ | (H) grain has a great influence |
| (MT)CVD / PVD | ++ | PVD coating recommended |
| f | ↓ | Feed has influence on intensity, but less than the cutting speed |
| v | ↓ | Lower speed means lower temperature |
| $a_p$ | | It has no influence |
| | ↓ | Use less positive cutting geometry |
| | - - - | No coolant (it is possible to use air to remove chips from cutting area) |
| | | |

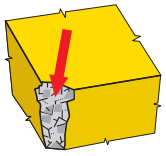
## BRITTLE CRACKS AT THE CUTTING EDGE

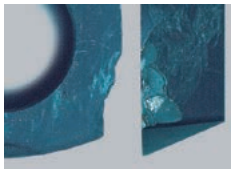




| | | |
|---|---|---|
| | ↓ | (H) grain has a great influence |
| (MT)CVD / PVD | + | PVD coating recommended |
| f | ↓ | Good swarf control is very important |
| v | ↑↓ | It is about swarf control and vibration |
| $a_p$ | ↓ | Reduces the force load (important for machining with long overhangs) |
| | ↓ | Use less positive cutting geometry |
| | | It has no influence |
| | | Use better working conditions, reduce feed rate until insert is in cut |

## INSERT FRACTURE

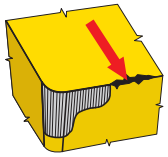




| | | |
|---|---|---|
| | ↓ | (H) grain has a great influence |
| (MT)CVD / PVD | + | PVD coating recommended |
| f | ↓ | Reduces the force load |
| v | ↑↓ | It is about swarf control and vibration |
| $a_p$ | ↓ | Reduces the force load |
| | ↓ | Use less positive cutting geometry |
| | | It has no influence |
| | | Use better working conditions |

# TYPES OF WEAR ON TURNING INSERTS

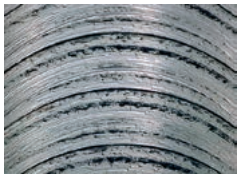
## FAILURE OF CUTTING EDGE





| | | |
|---|---|---|
|  | ↓ | (H) grain has a great influence |
|  | + | PVD coating recommended |
|  | ↑↓ | Good swarf control is very important |
|  | ↑↓ | It is about swarf control and vibration |
|  | ↑↓ | Good swarf control is very important |
|  | ↓ | Use less positive cutting geometry |
|  | | It has no influence |
| | | Problem is poor swarf control or evacuation of chips |

## POOR SURFACE QUALITY



**Description and cause:**

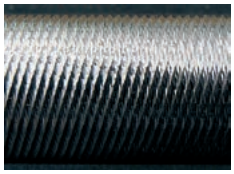
Numerous causes depending on the workpiece material, cutting conditions (feed rate and cutting speed), the condition of the cutting edge, the extent and type of wear, and the condition and rigidity of the machine–tool–workpiece assembly.

- incorrect tool chosen
- incorrect chip thickness
- incorrect cutting speed
- coolant is needed
- high feed rate

**Corrective measures:**

- use a wiper insert
- use a cutting insert with the right geometry
- reduce the feed rate
- change (usually increase) the cutting speed
- use a coolant
- improve the stability of the tool and workpiece
- change the chip cross section
- select a more easy–cutting chip breaker
- increase the nose radius

## VIBRATIONS



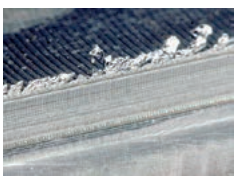
**Description and cause:**

This is a very common problem, which is mainly caused by an unbalanced workpiece or tool, unstable fixing of the workpiece, high cutting forces or tool overhang.

**Corrective measures:**

- improve the stability of the tool and workpiece
- reduce the depth of cut
- minimize tool overhang
- reduce the cutting speed
- use a tool with smaller setting angle
- reduce the chip cross section
- use a tool with a low cutting resistance
- increase the feed rate
- select a more easy–cutting chip breaker
- increase the nose radius

## BURRS



**Description and cause:**

This usually occurs on soft steels and plastic materials.

**Corrective measures:**

- use a cutting insert with a sharp cutting edge
- use a cutting insert with positive geometry
- use a tool with a smaller setting angle

## ERRORS IN DIMENSIONS AND SHAPE OF WORKPIECE



**Description and cause:**

Depends on a number of factors.

**Corrective measures:**

- use a wear–resistant cutting insert
- improve the stability of the cutter and workpiece
- minimize tool overhang
- use a workpiece with a suitable machining allowance

## INADEQUATE CHIP FORMATION



**Description and cause:**

Producing a chip with a suitable shape is very important to insert durability and service life of the tool. The workpiece material, the feed rate, the depth of cut and the cutting geometry all have an effect on chip forming. A chip that is too long is unacceptable for various reasons, while a chip that is too short is undesirable as it overloads the cutting edge and causes vibrations.

**Corrective measures:**

- change the feed rate and depth of cut
- use a more suitable cutting geometry
- change the cutting conditions

## CHECK THE SEAT CONDITION OF THE CUTTING INSERT

Before clamping a new cutting insert or changing the edge, it is necessary to clean the seat and check its condition or the condition of the anvil and wedge (especially the damage under the corner of the cutting insert).

## CHECK AND SERVICE THE CLAMPING PARTS

It is also important to check the clamping parts, including clamping levers, screws, wedges and clamps. Only use original, undamaged parts (found in the catalogue). Regularly lubricate the threads and the binding surface of screws, for example using heat–resistant lubricant (Molykote G.). For assembly and disassembly, only use screwdrivers and wrenches specified in our catalogue or recommended by the tool manufacturer. Pay attention to the correct tightening (proportional) – it is advisable to use a torque wrench.

## CHECK THE TIGHTENING

Before tightening, check the fit of the cutting insert on the whole of the binding surface and in the radial and axial directions. Cutting inserts and tools must always be clean and undamaged.

# TECHNICAL INFORMATION – INDEXABLE TURNING – FORMULA FOR CALCULATING CUTTING DATA

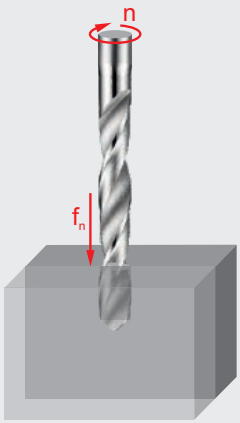
| Value | Formula | Unit | Note |
|---|---|---|---|
| **Number of revolutions** | $n = \frac{v_c \cdot 1000}{D \cdot \pi}$ | (1/min) | $n$ Number of revolutions (1/min)<br>$D$ Diameter (of tool or workpiece) (mm)<br>$v_c$ Cutting speed (m/min)<br>$f_{rev}$ Feed per revolution (mm/rev)<br>$f_{min}$ Feed per minute (Linear Feedrate) (mm/min) |
| **Cutting speed** | $v_c = \frac{\pi \cdot D \cdot n}{1000}$ | (m/min) | |
| **Feed per revolution** | $f_{rev} = \frac{f_{min}}{n}$ | (mm/rev) | |
| **Feed per minute (Linear Feedrate)** | $f_{min} = v_f = f_{rev} \cdot n$ | (mm/min) | |
| **Max. height of profile $R_{max}$** | $R_{max} = \frac{125 \cdot f_{rev}^{\ 2}}{RE}$ | (µm) | $R_{max}$ max. height of profile (mm)<br>$R_a$ surface finish (mm)<br>$f_{rev}$ feed per revolution (mm/rev)<br>$RE$ nose radius (mm) |
| **Surface finish $R_a$** | $R_a = \frac{43{,}9 \cdot f_{rev}^{\ 1{,}88}}{RE^{\ 0{,}97}}$ | (µm) | |
| **Chip cross section** | $A = f_{rev} \cdot a_p$ | ($mm^2$) | $A$ Chip cross section ($mm^2$)<br>$f_{rev}$ Feed per revolution (mm/rev)<br>$a_p$ Axial depth of cut (mm)<br>$\kappa_r$ Primary edge setting angle (°)<br>$h$ Chip thickness (mm)<br>$v_c$ Cutting speed (m/min)<br>$f_{min}$ Feed per minute (Linear Feedrate) (mm/min)<br>$Q$ Material removal rate per minute ($cm^3$/min)<br>$INSD$ Insert diameter (mm) |
| **Chip thickness (For insert with straight edge)** | $h = f_{rev} \cdot \sin \kappa_r$ | (mm) | |
| **Chip thickness (For round cutting insert)** | $h = f_{rev} \cdot \sqrt{\frac{a_p}{INSD}}$ | (mm) | |
| **Metal removal rate** | $Q = a_p \cdot f_{rev} \cdot v_c$ | ($cm^3$/min) | |
| **Power demand** | $P_c = \frac{a_p \cdot f_{rev}^{\ 1-c} \cdot k_{c1} \cdot v_c \cdot k\kappa_r}{6 \cdot 10^4 \cdot \eta}$ | (kW) | $P_c$ Power demand (kW)<br>$a_p$ Depth of cut (mm)<br>$f_{rev}$ Feed (mm/rev)<br>$c$ Constant KTV (1)<br>$k_c$ Specific cutting force (MPa)<br>$k_{\kappa_r}$ $\kappa_r$ angle constant (1)<br>$\eta$ Efficiency (usually $\eta = 0{,}75$) (1)<br>$x$ Machined material constant (1) |
| **Approximate power demand** | $P_c = \frac{a_p \cdot f_{rev} \cdot v_c}{x}$ | (kW) | |

| Material | Steel | Cast iron | Al |
|---|---|---|---|
| Coefficient $x$ | 20 | 25 | 100 |



# HOLEMAKING – TECHNICAL INFO

# TECHNICAL INFORMATION – DRILLING FEED RATE CHART



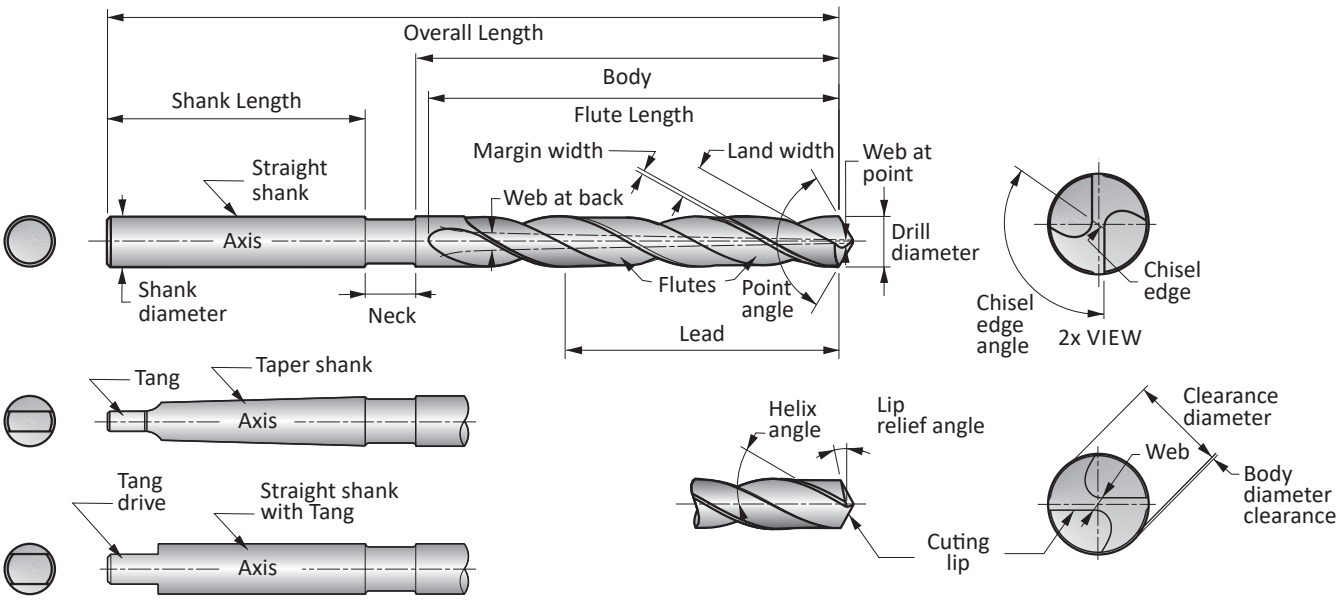

Feed per revolution ($f_n$ in mm/rev)
Depending on the working conditions it might be necessary to adjust these values ± 25 %.

**How to use this table to find the feed per revolution ($f_n$):**

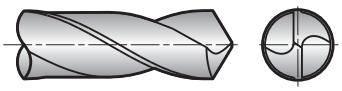
1. Find your Alpha Code on the product page (example: 46J, "J" is the Alpha Code).
2. Find the closest diameter for your cutting application in the top row of the table.
3. Find your Alpha Code in the left column of the table.
4. The intersection (cell) of the Diameter and Alpha Code is the feed per revolution ($f_n$).

| | | ø DC (mm) | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0.15 | 0.50 | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 8.00 | 10.00 | 12.00 | 15.00 | 16.00 | 20.00 | 25.00 | 30.00 | 40.00 | 50.00 | 100.00 |
| Feed rates | A | 0.003 | 0.006 | 0.012 | 0.023 | 0.029 | 0.032 | 0.036 | 0.042 | 0.054 | 0.062 | 0.069 | 0.082 | 0.086 | 0.110 | 0.125 | 0.135 | 0.155 | 0.175 | 0.263 |
| | B | 0.004 | 0.007 | 0.014 | 0.028 | 0.037 | 0.041 | 0.046 | 0.053 | 0.067 | 0.080 | 0.090 | 0.103 | 0.108 | 0.135 | 0.153 | 0.165 | 0.188 | 0.208 | 0.312 |
| | C | 0.004 | 0.008 | 0.015 | 0.032 | 0.044 | 0.050 | 0.056 | 0.064 | 0.080 | 0.098 | 0.110 | 0.125 | 0.130 | 0.160 | 0.180 | 0.195 | 0.220 | 0.240 | 0.360 |
| | D | 0.004 | 0.008 | 0.016 | 0.038 | 0.053 | 0.060 | 0.068 | 0.078 | 0.098 | 0.119 | 0.130 | 0.149 | 0.155 | 0.188 | 0.210 | 0.228 | 0.253 | 0.275 | 0.413 |
| | E | 0.004 | 0.009 | 0.017 | 0.043 | 0.062 | 0.071 | 0.080 | 0.092 | 0.115 | 0.140 | 0.150 | 0.173 | 0.180 | 0.215 | 0.240 | 0.260 | 0.285 | 0.310 | 0.465 |
| | F | 0.005 | 0.009 | 0.018 | 0.050 | 0.073 | 0.084 | 0.095 | 0.109 | 0.138 | 0.165 | 0.178 | 0.202 | 0.210 | 0.248 | 0.275 | 0.295 | 0.320 | 0.343 | 0.515 |
| | G | 0.005 | 0.010 | 0.019 | 0.056 | 0.084 | 0.096 | 0.109 | 0.126 | 0.160 | 0.190 | 0.205 | 0.231 | 0.240 | 0.280 | 0.310 | 0.330 | 0.355 | 0.375 | 0.563 |
| | H | 0.005 | 0.010 | 0.020 | 0.066 | 0.102 | 0.116 | 0.130 | 0.150 | 0.190 | 0.228 | 0.243 | 0.271 | 0.280 | 0.320 | 0.355 | 0.375 | 0.398 | 0.418 | 0.627 |
| | I | 0.005 | 0.011 | 0.021 | 0.076 | 0.119 | 0.134 | 0.150 | 0.173 | 0.220 | 0.265 | 0.280 | 0.310 | 0.320 | 0.360 | 0.400 | 0.420 | 0.440 | 0.460 | 0.690 |
| | J | 0.006 | 0.012 | 0.024 | 0.084 | 0.135 | 0.152 | 0.170 | 0.197 | 0.250 | 0.298 | 0.315 | 0.349 | 0.360 | 0.405 | 0.445 | 0.465 | 0.485 | 0.503 | 0.755 |
| | K | 0.007 | 0.013 | 0.026 | 0.092 | 0.150 | 0.170 | 0.190 | 0.220 | 0.280 | 0.330 | 0.350 | 0.388 | 0.400 | 0.450 | 0.490 | 0.510 | 0.530 | 0.545 | 0.818 |
| | L | 0.007 | 0.014 | 0.028 | 0.101 | 0.165 | 0.186 | 0.208 | 0.240 | 0.305 | 0.360 | 0.385 | 0.419 | 0.430 | 0.485 | 0.525 | 0.545 | 0.568 | 0.588 | 0.882 |
| | M | 0.008 | 0.015 | 0.030 | 0.110 | 0.180 | 0.202 | 0.225 | 0.260 | 0.330 | 0.390 | 0.420 | 0.450 | 0.460 | 0.520 | 0.560 | 0.580 | 0.605 | 0.630 | 0.945 |
| | N | 0.008 | 0.016 | 0.032 | 0.119 | 0.195 | 0.218 | 0.242 | 0.280 | 0.355 | 0.420 | 0.455 | 0.481 | 0.490 | 0.555 | 0.595 | 0.615 | 0.642 | 0.672 | 1.008 |
| | S | 0.002 | 0.004 | 0.008 | 0.014 | 0.020 | 0.025 | 0.030 | 0.037 | 0.050 | 0.080 | 0.100 | 0.123 | 0.130 | 0.150 | 0.170 | 0.190 | 0.220 | 0.240 | – |
| | T | 0.004 | 0.008 | 0.015 | 0.028 | 0.040 | 0.050 | 0.060 | 0.070 | 0.090 | 0.110 | 0.130 | 0.160 | 0.170 | 0.190 | 0.210 | 0.230 | 0.260 | 0.275 | – |
| | U | 0.007 | 0.013 | 0.026 | 0.048 | 0.070 | 0.080 | 0.090 | 0.107 | 0.140 | 0.170 | 0.200 | 0.223 | 0.230 | 0.240 | 0.270 | 0.300 | 0.360 | 0.375 | – |
| | V | 0.010 | 0.019 | 0.038 | 0.069 | 0.100 | 0.115 | 0.130 | 0.153 | 0.200 | 0.250 | 0.280 | 0.310 | 0.320 | 0.340 | 0.400 | 0.440 | 0.510 | 0.530 | – |
| | W | 0.012 | 0.025 | 0.049 | 0.089 | 0.130 | 0.150 | 0.170 | 0.200 | 0.260 | 0.330 | 0.380 | 0.418 | 0.430 | 0.450 | 0.470 | 0.490 | 0.520 | 0.540 | – |
| | X | 0.014 | 0.028 | 0.056 | 0.103 | 0.150 | 0.180 | 0.210 | 0.250 | 0.330 | 0.420 | 0.480 | 0.533 | 0.550 | 0.580 | – | – | – | – | – |
| | Y | 0.017 | 0.034 | 0.068 | 0.124 | 0.180 | 0.220 | 0.260 | 0.317 | 0.430 | 0.550 | 0.700 | 0.700 | 0.700 | 0.740 | – | – | – | – | – |
| | Z | 0.024 | 0.047 | 0.094 | 0.172 | 0.250 | 0.325 | 0.400 | 0.533 | 0.800 | 1.000 | 1.100 | 1.175 | 1.200 | 1.200 | – | – | – | – | – |

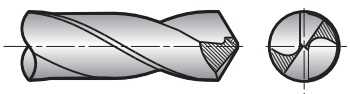
**Drill Nomenclature**



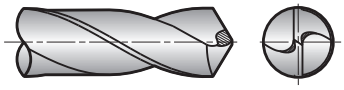

- **Axis** — The imaginary straight line which forms the longitudinal centre line of a drill.
- **Backtaper** — A slight decrease in diameter from front to back in the body of a drill.
- **Body** — The portion of a drill extending from the shank or neck to the outer corners of the cutting lips.
- **Body Clearance Diameter** — The portion of the land that has been cut away so it will not bind against the walls of the hole.
- **Chisel-Edge** — The edge at the end of the web that connects the cutting lips.
- **Chisel-Edge Angle** — The included angle between the chisel-edge and cutting lip, as viewed from the end of a drill.
- **Clearance Diameter** — The diameter over the cut away portion of the drill lands.
- **Drill** — A rotary end cutting tool having one or more cutting lips, and having one or more helical or straight flutes for the passage of chips and the admission of a cutting fluid.
- **Drill Diameter** — The diameter over the margins of a drill measured at the point.
- **Flute Length** — The length from the outer corners of the cutting lips to the extreme back of the flutes. Includes the sweep of the tool used to generate the flutes and therefore does not indicate the usable length of flutes.
- **Flutes** — Helical or straight grooves cut or formed in the body of a drill to provide cutting lips, permit removal of chips, and allow cutting fluid to reach the cutting lips.
- **Helix Angle** — The angle formed by the leading edge of the land with a plane containing the axis of a drill.
- **Land** — The peripheral portion of the body between adjacent flutes.
- **Land Width** — The distance between the leading edge and heel of the land; measured at a right angle to the leading edge.
- **Lead** — The axial advance of a leading edge of the land in one turn around the circumference.
- **Lip Relief Angle** — The axial relief angle at the outer corner of the lip; measured by projection to a plane tangent to the periphery at the outer corner of the lip.
- **Lips** — The cutting edges of a two flute drill extending from the chisel-edge to the periphery.
- **Margin** — The cylindrical portion of the land, which is not cut away, to provide clearance.
- **Neck** — The section of reduced diameter between the body and the shank of a drill.
- **Overall Length** — The length from the extreme end of the shank to the outer corners of the cutting lip. It does not include the conical shank end often used on straight shank drills, nor the conical cutting point used on both straight and taper shank drills.
- **Point** — The cutting end of a drill, made up of the ends of the lands and the web. In form, it resembles a cone, but departs from a true cone to furnish clearance behind the cutting lips.
- **Conventional** — Conventional Points with 118° included point angles are the most commonly used because they provide satisfactory results in a wide variety of materials. A possible limitation is that the straight chisel edge contributes to wandering at the drill point, often making it necessary to spot the hole for improved accuracy.



- **Split** — Split-Points (commonly called Crankshaft Points) were originally developed for use on drills designed for deep oil holes in automotive crankshafts. Since its inception, the split-point has gained widespread use and is applied to both 118° and 135° included point angles. Its main advantages are the ability to reduce thrust and eliminate wandering at the drill point. This is a distinct advantage when the drill is used in a portable drill or in drilling applications where bushings cannot be used. The split-point also has two positive rake cutting edges extending to the centre of the drill, which can assist as a chipbreaker to produce small chips which can readily be ejected.



- **Notched** — Notched Points were developed for drilling tough alloys. Commonly incorporated on heavy web drills, which allow the point to withstand the higher thrust loads required in drilling these materials. As with the split-point, the Notched Point contains two additional positive rake cutting edges extending toward the centre of the drill. These secondary cutting lips, which extend no further than half the original cutting lip, can assist in chip control and reduce the torque required in drilling tough materials. Notched Points can be incorporated on both 118° and 135° included point angles, making them suitable for drilling a wide variety of materials.



- **Point Angle** — The included angle between the cutting lips projected upon a plane parallel to the drill axis and parallel to the two cutting lips.
- **Relative Lip Height** — The difference in indicator reading between the cutting lips of a drill. Measured at a right angle to the cutting lip at a specific distance from the axis of the tool.
- **Shank** — The part of a drill by which it is held and driven.
- **Tang** — The flattened end of a taper shank, intended to fit into a driving slot in a socket.
- **Tang Drive** — Two opposite parallel driving flats on the extreme end of a straight shank.
- **Taper Shank** — Drills having conical shanks suitable for direct fitting in machine spindles, driving sleeves, or sockets. Tapered shanks generally have a tang.
- **Web** — The central portion of the body that joins the lands. The extreme end of the web forms the chisel-edge on a two flute drill.
- **Web Thickness** — The thickness of the web at the point, unless another specific location is indicated.

**General hints on drilling**

1. Select the most appropriate drill for the application, bearing in mind the material to be machined, the capability of the machine tool and the coolant to be used.

2. Flexibility within the component and machine tool spindle can cause damage to the drill as well as the component and machine - ensure maximum stability at all times. This can be improved by selecting the shortest possible drill for the application.

3. Tool holding is an important aspect of the drilling operation and the drill cannot be allowed to slip or move in the tool holder.

4. The correct use of Morse Taper Shank drills relies on an efficient fit between the taper surfaces of the tool and the tool holder. The use of a soft-faced hammer should be used to drive the drill into the holder.

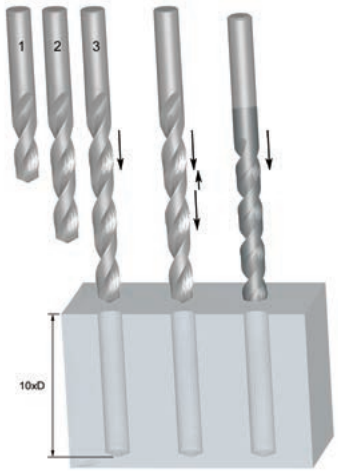
5. The use of suitable coolants and lubricants are recommended as required by the particular drilling operation. When using coolants and lubricants, ensure a copious supply, especially at the drill point.

6. Swarf evacuation whilst drilling is essential in ensuring the correct drilling procedure. Never allow the swarf to become stationary in the flute.

7. When regrinding a drill, always make sure that the correct point geometry is produced and that any wear has been removed.

### Deep hole drilling strategy

When drilling deep holes, several methods can be adopted to achieve the depth required. The example below shows four ways of drilling a hole with 10× the diameter of the drill.




| | Series Drilling | Series Drilling |
|---|---|---|
| **No of drills** | 3 (2.5×D, 6×D,10×D) | 2 (2.5×D,10×D) |
| **Type of drill** | Standard geometry, general purpose | Standard geometry, general purpose |
| **+ / -** | Expensive Time consuming | More cost effective Quick |

| | Peck Drilling | Single Pass Drilling |
|---|---|---|
| **No of drills** | 1 (10×D) | 1 (10×D) |
| **Type of drill** | Standard geometry, general purpose | Purpose specific tools |
| **+ / -** | Time consuming | Cost effective Fast |

### Trouble shooting when drilling

| Problem | Cause | Remedy |
|---|---|---|
| **Broken or twisted tangs** | Bad fit between shank and socket | Ensure the shank and socket are clean and free from damage |
| **Splitting of the web** | Feed too high | Reduce feed to optimum rate |
| | Insufficient initial clearance | Regrind to correct specification |
| | Excessive web thinning | Regrind to correct specification |
| | Heavy impact at point of drill | Avoid impact at the point of drill. Take care with taper shank drills when inserting/ ejecting from spindle |
| **Worn outer corner** | Excessive speed | Reduce speed to optimum – may be able to increase feed |
| **Broken outer corners** | Unstable component set up | Reduce movement in the component |
| **Chipped cutting lips** | Excessive initial clearance | Regrind to correct specification |
| **Breakage at flute run out** | Choking of flutes | Adopt a peck/series drilling concept |
| | Drill slipping | Ensure the drill is held securely in the chuck and spindle |
| **Spiral finish in hole** | Insufficient feed | Increase feed |
| | Bad positional accuracy | Use a spot drill before drilling |
| **Hole size too large** | Incorrect point geometry | Check point geometry |
| | Ineffective swarf clearance | Adjust speed, feed and peck length to achieve more manageable swarf |

**Hole Size / Achievable Hole Tolerances**

As geometric, substrate and coating configurations become more advanced, the ability of a drill to produce a more accurate hole size increases. In general, a standard geometry tool will achieve a hole size to H12. However as the configuration of the drill becomes more complex the achievable hole size, under favorable conditions, can be as good as H8.

To offer a better insight, listed below are the product types and their achievable hole tolerances:

HSS General Purpose drills – H12
HSS / HSCo Parabolic Flute Deep Hole Drills (PFX) – H10
HSS / HSCo High performance TiN/ TiALN coated (ADX) – H10
Solid Carbide High Performance TiN / TiALN coated (CDX, Force) – H8/H9

**Nominal Hole Diameter (mm)**

| ∅ (mm) | H8 | H9 | H10 | H12 |
|---|---|---|---|---|
| ≤ 3 | 0 / +0.014 | 0 / +0.025 | 0 / +0.040 | 0 / +0.100 |
| > 3 ≤ 6 | 0 / +0.018 | 0 / +0.030 | 0 / +0.048 | 0 / +0.120 |
| > 6 ≤ 10 | 0 / +0.022 | 0 / +0.036 | 0 / +0.058 | 0 / +0.150 |
| > 10 ≤ 18 | 0 / +0.027 | 0 / +0.043 | 0 / +0.070 | 0 / +0.180 |
| > 18 ≤ 30 | 0 / +0.033 | 0 / +0.052 | 0 / +0.084 | 0 / +0.210 |

**Nominal Hole Diameter (inches)**

| ∅ (inch) | H8 | H9 | H10 | H12 |
|---|---|---|---|---|
| ≤ .1181 | 0 / +0.0006“ | 0 / +0.0010“ | 0 / +0.0016“ | 0 / +0.0040“ |
| >.1181≤.2362 | 0 / +0.0007“ | 0 / +0.0012“ | 0 / +0.0019“ | 0 / +0.0048“ |
| >.2362 ≤.3937 | 0 / +0.0009“ | 0 / +0.0015“ | 0 / +0.0023“ | 0 / +0.0059“ |
| >.3937≤.7087 | 0 / +0.0011“ | 0 / +0.0017“ | 0 / +0.0028“ | 0 / +0.0071“ |
| >.7087≤1.1811 | 0 / +0.0013“ | 0 / +0.0021“ | 0 / +0.0033“ | 0 / +0.0083“ |

In view of the ability of some drills to produce a much tighter hole tolerance, due consideration should be given to drilled holes which are subject to secondary operations, eg. tapping, reaming. The diameter of the drill will need to be increased from what is recommended to account for the fact that the hole size produced will be smaller.

**Optimizing the Drilling Operation / Troubleshooting**

**Drill Selection**
Use the shortest drill the application will permit in order to achieve maximum tool rigidity.

**Holders**
Tool holders and collets must provide good concentricity between the drill and the machine spindle. Use a positive back stop to prevent the tool from backing up into the holder. Never clamp the tool over the flutes or over-tighten the holder. Static runout in the tool assembly must be accurately checked and maintained.

**Workpiece**
A secure and rigid workpiece to minimize deflection is needed, particularly on through-hole applications.

**Coolants**
Coolants are recommended when drilling mild steel and high temperature alloys. The purpose of the coolant media is to direct the chips away from the cutting tool and workpiece. Excessive coolant pressure and/or too much volume can negatively affect performance. When using coolant fed drills, the coolant pressure that is required should be higher than normal. Suggested pressure for coolant fed drills is minimally 10.3 bar or 150 PSI. As the diameter of the drill is reduced, the higher the pressure. This is to assist the chip in evacuating from a more confined area.

**Drilling Troubleshooting Guide**

| Problem | Solution |
|---|---|
| **Wear on Outer Corners** | Reduce cutting speed |
| | Increase feed (IPR) |
| | Improve direction of coolant flow |
| | Increase coolant pressure |
| | Add corner break |
| **Chipping of Chisel Edge** | Check accuracy of drill runout |
| | Check workpiece clamping accuracy and movement |
| | Check point centrality and lip height |
| | Increase feed rate |
| **Chipping of Cutting Lips** | Check accuracy of drill runout |
| | Check workpiece clamping accuracy and movement |
| | Reduce speed |
| | Reduce point clearance |
| | Increase hone |
| **Cracking of Lands** | Check movement of workpiece |
| | Increase back taper |
| | Check accuracy of drill runout |
| | Chip packing; increase flute form opening or peck drill (HSS or HSCO only) |
| | Slow down helix, horizontal drilling |
| | Increase feed |
| | When spot drilling, reduce feed |
| | Improve direction of coolant flow |
| | Increase coolant pressure |
| **Oversize Hole** | Increase speed, reduce feed |
| | Check workpiece clamping accuracy and movement |
| | Check accuracy of drill runout |
| | Chip packing, increase flute form opening or peck drill (HSS or HSCO only) |
| | Check point centrality and lip height |
| **Undersize Hole** | Improve direction of coolant flow |
| | Reduce cutting speed, increase feed |
| | Check drill diameter |
| **Hole Not Round** | Check accuracy of drill runout |
| | Check workpiece clamping accuracy and movement |
| | Check point centrality and lip height |
| | Chip packing, increase flute form opening or peck drill (HSS or HSCO only) |
| **Drill Breakage** | Chip packing, increase flute form opening or peck drill (HSS or HSCO only) |
| | Check workpiece clamping accuracy and movement |
| | Check accuracy of drill runout |
| | Reduce feed rate, increase feed rate |
| | Improve direction of coolant flow |
| | Increase coolant pressure |

| | Grade | Hardness (HV10) | C % | W % | Mo % | Cr % | V % | Co % | Tool Material |
|---|---|---|---|---|---|---|---|---|---|
| HSS | M2 | 810 – 850 | 0.9 | 6.4 | 5.0 | 4.2 | 1.8 | – | HSS |
| HSS-E | M35 | 830 – 870 | 0.93 | 6.4 | 5.0 | 4.2 | 1.8 | 4.8 | HSCO |
| | M42 | 870 – 960 | 1.08 | 1.5 | 9.4 | 3.9 | 1.2 | 8.0 | |

| Properties | HSS materials | Carbide materials | K10/30F (often used for solid tools) |
|---|---|---|---|
| Hardness (HV30) | 800-950 | 1300 – 1800 | 1600 |
| Density (g/cm³) | 8.0 – 9.0 | 7.2 – 15 | 14.45 |
| Compressive strength (N/mm²( | 3000 – 4000 | 3000 – 8000 | 6250 |
| Flexural strength, (bending) (N/mm²( | 2500 – 4000 | 1000 – 4700 | 4300 |
| Heat resistance (°C) | 550 | 1000 | 900 |
| E-module (KN/mm²) | 260 – 300 | 460 – 630 | 580 |
| Grain size (µm) | – | 0.2 – 10 | 0.8 |

The combination of hard particle (WC) and binder metal (Co) give the following changes in characteristics.

| Characteristic | Higher WC content give | Higher Co content give |
|---|---|---|
| Hardness | Higher hardness | Lower hardness |
| Compressive strength (CS) | Higher CS | Lower CS |
| Bending strength (BS) | Lower BS | Higher BS |

Grain size also influences the material properties. Small grain sizes means higher hardness and coarse grains give more toughness.

### Surface treatment / Coating properties examples

| Surface Treaments | Colour | Coating material | Hardness (HV) | Thickness (µm) | Coating structure | Frict. coeff. against steel | Max. appl. temp. (°C) |
|---|---|---|---|---|---|---|---|
| ST | Dark grey | $Fe_3O_4$ | 400 | Max. 5 | Conversion into the surface | – | 550 |
| Bronze | Bronze | $Fe_3O_4$ | 400 | Max. 5 | Conversion into the surface | – | 550 |
| TiN | Gold | TiN | 2300 | 1 – 4 | Mono-layer | 0.4 | 600 |
| TiAlN | Black grey | TiAlN | 3300 | 3 | Nano structured | 0.3 – 0.35 | 900 |

## Tool materials

| | | |
|---|---|---|
| **High Speed Steel** | HSS | A medium-alloyed high speed steel that has good machinability and good performance. HSS exhibits hardness, toughness and wear resistance characteristics that make it attractive in a wide range of applications, for example in drills and taps. |

## Carbide materials

| | | |
|---|---|---|
| **Carbide Materials (or Hard Materials)** | HM | A sintered powder metallurgy substrate, consisting of a metallic carbide composite with binder metal. The most central raw material is tungsten carbide (WC). Tungsten carbide contributes to the hardness of the material. Tantalum carbide (TaC), titanium carbide (TiC) and niobium carbide (NbC) complements WC and adjusts the properties to what is desired. These three materials are called cubic carbides. Cobalt (Co) acts as a binder and keeps the material together.<br><br>Carbide materials are often characterised by high compression strength, high hardness and therefore high wear resistance, but also by limited flexural strength and toughness. Carbide is used in taps, reamers, milling cutters, drills and thread milling cutters. |

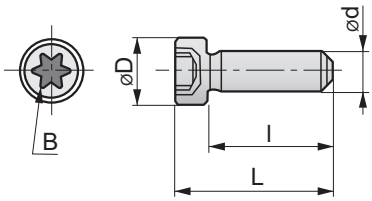
## Surface Coatings

| | | |
|---|---|---|
| **Bright Nickel Plating** |  | Bright Nickel Plated surface protects hardened steel body from rust, corrosion and also improves chip evacuation. |
| **Ti-phon (TiAlCrSiN)** |  | Ti-phon Coating is a coating similar to TiAlN but with the addition of Chromium (Cr) and Silicon (Si) which is specially formulated for Hydra Heads to prevent edge build-up and greatly improve chip flow. This coating exhibits high hot hardness, high oxidation resistance and superior lubricity when used on tools for machining applications involving heavy mechanical and thermal stresses, high speeds and high feed rates. These coating properties translate into superior wear resistance and edge strength. |

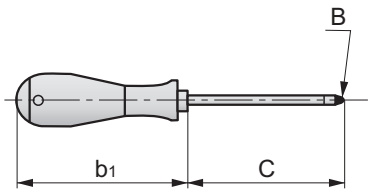
**Torque table**

|  H860 |  H861 |  Hydra Head ø Metric Range |  Hydra Head ø Fractional Range |  Hydra Head ø Decimal Size Range (min. / max.) | Torque Values Nm (Metric System) | Torque Values in/lbs (Inch System) |
|---|---|---|---|---|---|---|
| **H860N1** | **H861N1** | 12.0 mm – 15.5 mm | 15/32" – 39/64" | 0.4688" – 0.6102" | 0.75 – 0.99 | 6.6 – 8.8 |
| **H860N2** | **H861N2** | 15.6 mm – 18.5 mm | 5/8" – 23/32" | 0.6142" – 0.7283v | 0.93 – 1.24 | 8.2 – 11.0 |
| **H860N3** | **H861N3** | 18.6 mm – 21.5 mm | 47/64" – 27/32" | 0.7323" – 0.8465" | 1.84 – 2.44 | 16.3 – 21.6 |
| **H860N4** | **H861N3** | 22.0 mm – 24.5 mm | 55/64" – 31/32" | 0.8594" – 0.9688" | 2.73 – 3.72 | 24.2 – 32.9 |
| **H860N5** | **H861N4** | 25.0 mm – 27.5 mm | 63/64" – 1-3/32" | 0.9843" – 1.0938" | 4.14 – 5.52 | 36.6 – 48.8 |
| **H860N6** | **H861N5** | 28.0 mm – 33.5 mm | 1-7/64" – 1-19/64" | 1.1024" – 1.3189" | 4.97 – 6.63 | 44.0 – 58.7 |
| **H860N7** | **H861N6** | 34.0 mm – 42.0 mm | 1-11/32" – 1-5/8" | 1.3386" – 1.6535" | 7.2 | 63.7 |

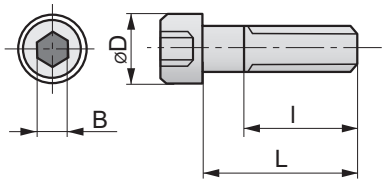
**Screws and screw-driver data**



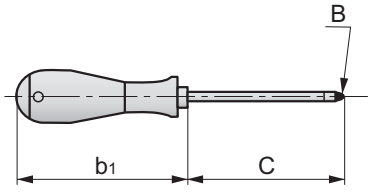

| e-code | d | Pitch | L (mm) | l (mm) | D (mm) | B |
|---|---|---|---|---|---|---|
| **H860N1** | M2.2 | 0.45 | 7.5 | 5.7 | 3.5 | 8IP |
| **H860N2** | M2.5 | 0.45 | 9.0 | 7.0 | 4.1 | 10IP |
| **H860N3** | M3.0 | 0.50 | 10.5 | 8.0 | 4.9 | 15IP |
| **H860N4** | M3.5 | 0.60 | 11.5 | 8.8 | 5.5 | 15IP |
| **H860N5** | M4.0 | 0.70 | 12.5 | 9.5 | 6.0 | 20IP |
| **H860N6** | M4.5 | 0.75 | 14.3 | 10.8 | 6.8 | 25IP |




| e-code | B | C | $b_1$ |
|---|---|---|---|
| **H861N1** | 8IP | 60 | 104 |
| **H861N2** | 10IP | 80 | 111 |
| **H861N3** | 15IP | 80 | 111 |
| **H861N4** | 20IP | 100 | 118 |
| **H861N5** | 25IP | 100 | 118 |

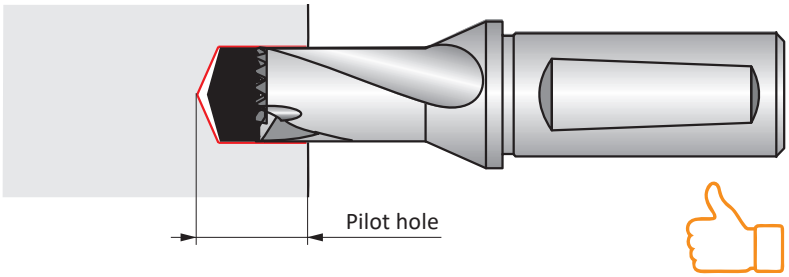



| e-code | d | Pitch | L (mm) | l (mm) | D (mm) | B |
|---|---|---|---|---|---|---|
| **H860N7** | M5.0 | 0.8 | 15 | full | 8.5 | 4 |

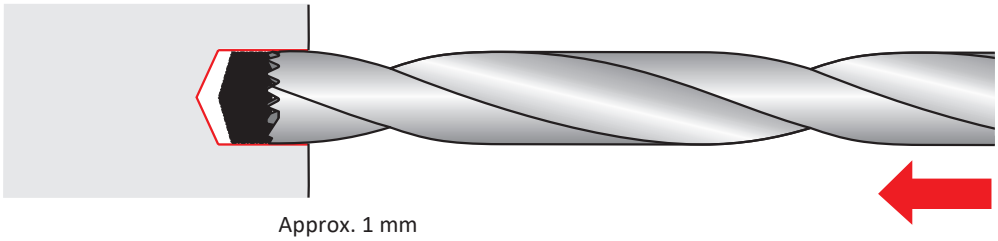



| e-code | B | C | $b_1$ |
|---|---|---|---|
| **H861N6** | 4 | 75 | 111 |

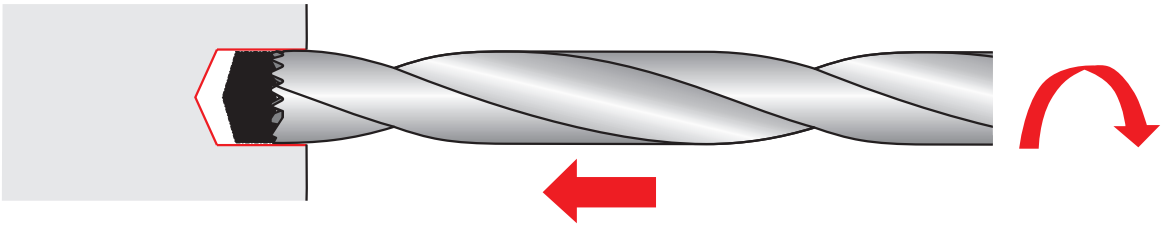
**Apply special programming for 8×D and 12xD drilling**




Drill a pilot hole (1.5×D to 3×D depth) with the same HYDRA head diameter (if needed check the runout of the drill max. +/ 0.05 mm).

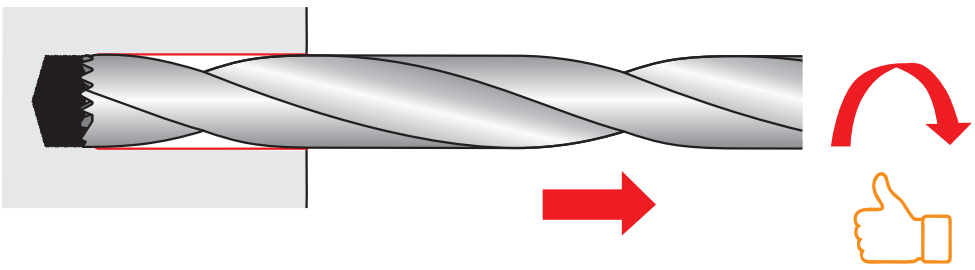



Enter the pilot hole with the 8×D or 12×D Body running a maximum of 500 rpm, to approximately 1mm above the pre-drilled pilot hole depth.



Start coolant flow and increase the rotational speed up to the recommended RPM.
**Note: Apply a short dwell time don't start the feed before recommended RPM is reached.**

Drill without pecking to the required depth.



When the required depth is reached, retract the drill by approximately 0.1 mm to 0.5 mm and reduce to 500 rpm followed by a complete retraction with normal feed.**Note: retracting the drill with a higher spindle speed may cause a shoulder damage from run out or destroy the hole surface and tolerance.**

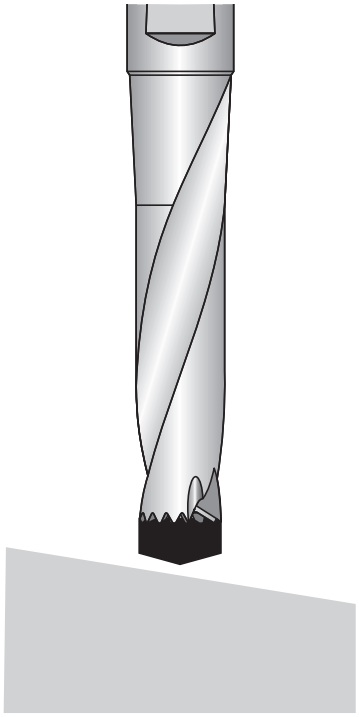
**Drilling hints & tips with the hydra drill**

**Coolants**
For maximum chip evacuation and tool performance, coolant use is recommended. Emulsion coolant concentration of 6 – 8% is recommended for most applications, with a coolant pressure of 20 bar (290 PSI) or higher. For high strength steel, stainless steels and tougher drilling applications, use a higher concentration of 10 – 12%. In these applications, particularly in stainless steels, it is recommended to use the maximum coolant pressure on the machine. The Hydradrill coolant holes provide improved web strength and reduce heat at the cutting edges for increased productivity and longer tool life.

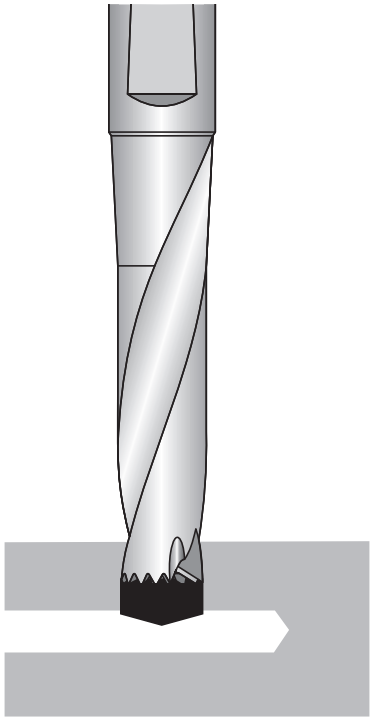
**Holders**
Always use tool holders and collets that provide good concentricity between the drill and the machine spindle. Use a positive stop to prevent the tool from backing up into the holder. Radial runout in the tool assembly must be accurately checked and maintained.

**Workpiece**
A secure and rigid workpiece will minimise deflection, and allow for better accuracy and true position of the hole.

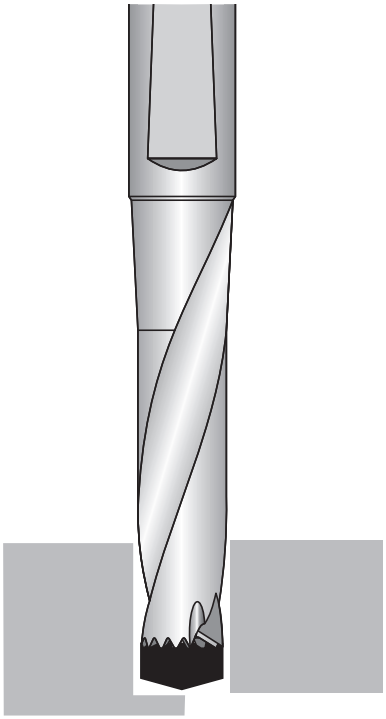
**Feeds**
It is important not to underfeed the drill which will cause it to dwell and dull. This is particularly true in work hardening materials. Feed rates should be high enough for proper chip formation.



Entrance or exit on an angular surface



Drilling through cross holes



Interrupted at exit

In these drilling scenarios, reducing feed rate to 1/3 (33%) is generally recommended. Drilling into an entry angle of more than 10° is NOT recommended – surface should be milled flat first.

| | Grade | Hardness (HV10) | C % | W % | Mo % | Cr % | V % | Co % | Tool Material |
|---|---|---|---|---|---|---|---|---|---|
| HSS | M2 | 810 – 850 | 0.9 | 6.4 | 5.0 | 4.2 | 1.8 | – | HSS |

| Properties | HSS materials | Carbide materials | K10/30F (often used for solid tools) |
|---|---|---|---|
| Hardness (HV30) | 800 – 950 | 1300 – 1800 | 1600 |
| Density (g/cm$^3$) | 8.0 – 9.0 | 7.2 – 15 | 14.45 |
| Compressive strength (N/mm$^2$) | 3000 – 4000 | 3000 – 8000 | 6250 |
| Flexural strength, (bending) (N/mm$^2$) | 2500 – 4000 | 1000 – 4700 | 4300 |
| Heat resistance (°C) | 550 | 1000 | 900 |
| E-module (KN/mm$^2$) | 260 – 300 | 460 – 630 | 580 |
| Grain size (µm) | – | 0.2 – 10 | 0.8 |

The combination of hard particle (WC) and binder metal (Co) give the following changes in characteristics.

| Characteristic | Higher WC content give | Higher Co content give |
|---|---|---|
| Hardness | Higher hardness | Lower hardness |
| Compressive strength (CS) | Higher CS | Lower CS |
| Bending strength (BS) | Lower BS | Higher BS |

Grain size also influences the material properties. Small grain sizes means higher hardness and coarse grains give more toughness.

## 802D, 803D (XPET..AP, SCET..-UD)

f ⇨

| | D9335 | D8330 | D8345 | ø 15 | ø 20 | ø 25 | ø 30 | ø 40 | ø 58 |
|---|---|---|---|---|---|---|---|---|---|
| P1 | ■ | ■ | ■ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| P2 | ■ | ■ | ■ | 0.11 | 0.13 | 0.15 | 0.17 | 0.21 | 0.28 |
| P3 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| P4 | ■ | ■ | ■ | 0.12 | 0.14 | 0.16 | 0.18 | 0.22 | 0.30 |
| K1 | ■ | ■ | ■ | 0.14 | 0.16 | 0.19 | 0.21 | 0.26 | 0.34 |
| K2 | ■ | ■ | ■ | 0.14 | 0.16 | 0.19 | 0.21 | 0.26 | 0.34 |
| K3 | ■ | ■ | ■ | 0.14 | 0.16 | 0.19 | 0.21 | 0.26 | 0.34 |
| K4 | ■ | ■ | ■ | 0.14 | 0.16 | 0.19 | 0.21 | 0.26 | 0.34 |
| K5 | ■ | ■ | ■ | 0.14 | 0.16 | 0.19 | 0.21 | 0.26 | 0.34 |

## 802D, 803D (XPET..AP-SD, SCET..-SD)

f ⇨

| | D9335 | D8330 | D8345 | ø 15 | ø 20 | ø 25 | ø 30 | ø 40 | ø 58 |
|---|---|---|---|---|---|---|---|---|---|
| P1 | ■ | ■ | ■ | 0.08 | 0.09 | 0.10 | 0.11 | 0.14 | 0.18 |
| P2 | ■ | ■ | ■ | 0.11 | 0.13 | 0.15 | 0.17 | 0.21 | 0.28 |
| P3 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| P4 | ■ | ■ | ■ | – | – | – | – | – | – |
| K1 | ◪ | ◪ | ◪ | 0.08 | 0.09 | 0.10 | 0.11 | 0.14 | 0.18 |
| K2 | ◪ | ◪ | ◪ | 0.11 | 0.13 | 0.15 | 0.17 | 0.21 | 0.28 |
| K3 | ◪ | ◪ | ◪ | 0.12 | 0.14 | 0.16 | 0.18 | 0.22 | 0.24 |
| K4 | ◪ | ◪ | ◪ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| K5 | ◪ | ◪ | ◪ | 0.14 | 0.16 | 0.19 | 0.21 | 0.25 | 0.33 |
| M1 | ■ | ■ | ■ | 0.12 | 0.14 | 0.16 | 0.18 | 0.22 | 0.30 |
| M2 | ■ | ■ | ■ | 0.11 | 0.13 | 0.15 | 0.17 | 0.21 | 0.28 |
| M3 | ■ | ■ | ■ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| M4 | ■ | ■ | ■ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| S1 | ◪ | ◪ | ◪ | 0.08 | 0.09 | 0.10 | 0.11 | 0.14 | 0.18 |
| S2 | ◪ | ◪ | ◪ | 0.08 | 0.09 | 0.10 | 0.11 | 0.14 | 0.18 |
| S3 | ◪ | ◪ | ◪ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| S4 | ◪ | ◪ | ◪ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |

## 804D (XPET..AP, SCET..-UD)

f ⇨

| | D9335 | D8330 | D8345 | ø 15 | ø 20 | ø 25 | ø 30 | ø 40 | ø 58 |
|---|---|---|---|---|---|---|---|---|---|
| P1 | ■ | ■ | ■ | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.14 |
| P2 | ■ | ■ | ■ | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.25 |
| P3 | ■ | ■ | ■ | 0.12 | 0.14 | 0.16 | 0.18 | 0.22 | 0.30 |
| P4 | ■ | ■ | ■ | 0.11 | 0.13 | 0.15 | 0.17 | 0.21 | 0.28 |
| K1 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| K2 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| K3 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| K4 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| K5 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |

## 804D (XPET..AP-SD, SCET..-SD)

f ⇨

| | D9335 | D8330 | D8345 | ø 15 | ø 20 | ø 25 | ø 30 | ø 40 | ø 58 |
|---|---|---|---|---|---|---|---|---|---|
| P1 | ■ | ■ | ■ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| P2 | ■ | ■ | ■ | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.25 |
| P3 | ■ | ■ | ■ | 0.12 | 0.14 | 0.16 | 0.18 | 0.22 | 0.30 |
| P4 | ■ | ■ | ■ | – | – | – | – | – | – |
| K1 | ◪ | ◪ | ◪ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| K2 | ◪ | ◪ | ◪ | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.25 |
| K3 | ◪ | ◪ | ◪ | 0.11 | 0.13 | 0.15 | 0.17 | 0.20 | 0.27 |
| K4 | ◪ | ◪ | ◪ | 0.12 | 0.14 | 0.16 | 0.18 | 0.22 | 0.30 |
| K5 | ◪ | ◪ | ◪ | 0.14 | 0.16 | 0.19 | 0.21 | 0.25 | 0.33 |
| M1 | ■ | ■ | ■ | 0.11 | 0.13 | 0.15 | 0.17 | 0.21 | 0.28 |
| M2 | ■ | ■ | ■ | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.25 |
| M3 | ■ | ■ | ■ | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.14 |
| M4 | ■ | ■ | ■ | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.14 |
| S1 | ◪ | ◪ | ◪ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| S2 | ◪ | ◪ | ◪ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| S3 | ◪ | ◪ | ◪ | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.14 |
| S4 | ◪ | ◪ | ◪ | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.14 |

## 805D (XPET..AP, SCET..-UD)

f ⇨

| | D9335 | D8330 | D8345 | ø 15 | ø 20 | ø 25 | ø 30 | ø 40 | ø 58 |
|---|---|---|---|---|---|---|---|---|---|
| P1 | ■ | ■ | ■ | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.14 |
| P2 | ■ | ■ | ■ | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.25 |
| P3 | ■ | ■ | ■ | 0.12 | 0.14 | 0.16 | 0.18 | 0.22 | 0.30 |
| P4 | ■ | ■ | ■ | 0.11 | 0.13 | 0.15 | 0.17 | 0.21 | 0.28 |
| K1 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| K2 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| K3 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| K4 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |
| K5 | ■ | ■ | ■ | 0.13 | 0.15 | 0.18 | 0.20 | 0.24 | 0.32 |

## 805D (XPET..AP-SD, SCET..-SD)

f ⇨

| | D9335 | D8330 | D8345 | ø 15 | ø 20 | ø 25 | ø 30 | ø 40 | ø 58 |
|---|---|---|---|---|---|---|---|---|---|
| P1 | ■ | ■ | ■ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| P2 | ■ | ■ | ■ | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.25 |
| P3 | ■ | ■ | ■ | 0.12 | 0.14 | 0.16 | 0.18 | 0.22 | 0.30 |
| P4 | ■ | ■ | ■ | – | – | – | – | – | – |
| K1 | ◪ | ◪ | ◪ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| K2 | ◪ | ◪ | ◪ | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.25 |
| K3 | ◪ | ◪ | ◪ | 0.11 | 0.13 | 0.15 | 0.17 | 0.20 | 0.27 |
| K4 | ◪ | ◪ | ◪ | 0.12 | 0.14 | 0.16 | 0.18 | 0.22 | 0.30 |
| K5 | ◪ | ◪ | ◪ | 0.12 | 0.14 | 0.16 | 0.18 | 0.22 | 0.30 |
| M1 | ■ | ■ | ■ | 0.11 | 0.13 | 0.15 | 0.17 | 0.21 | 0.28 |
| M2 | ■ | ■ | ■ | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.25 |
| M3 | ■ | ■ | ■ | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.14 |
| M4 | ■ | ■ | ■ | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.14 |
| S1 | ◪ | ◪ | ◪ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| S2 | ◪ | ◪ | ◪ | 0.07 | 0.08 | 0.09 | 0.10 | 0.12 | 0.16 |
| S3 | ◪ | ◪ | ◪ | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.14 |
| S4 | ◪ | ◪ | ◪ | 0.06 | 0.07 | 0.08 | 0.09 | 0.10 | 0.14 |

## FORMULA FOR CALCULATION OF CUTTING PARAMETERS

**Nomenclature and formula**

| Parameter | Formula | Unit |
|---|---|---|
| **RPM** | $n = \frac{v_c \cdot 1000}{DC \cdot \pi}$ | (rev/min) |
| **Cutting speed** | $v_c = \frac{\pi \cdot DC \cdot n}{1000}$ | (m/min) |
| **Table feed** | $v_f = n \cdot f$ | (mm/min) |
| **Cross section area of the hole** | $A = \frac{\pi \cdot DC^2}{4}$ | ($mm^2$) |
| **Metal removal rate** | $Q = \frac{v_f \cdot A}{1000}$ | ($cm^3$/min) |
| **Machining time** | $T_c = \frac{L + h}{v_f}$ | (min/pcs) |

| | | | | | |
|---|---|---|---|---|---|
| $DC$ | Diameter of drill | (mm) | $h$ | Distance from drill point to workpiece before feeding | (mm) |
| $f$ | Feed per revolution | (mm/rev) | $L$ | Depth of hole | (mm) |

## RECOMMENDED TIGHTENING TORQUES FOR SCREWS

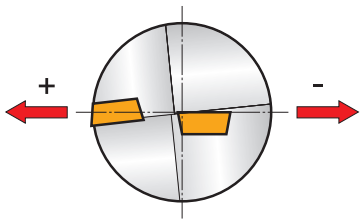
| | Nm | | | | | |
|---|---|---|---|---|---|---|
| **US 2245-T07P** | 0.9 | FLAG T07P | M 2.2 | 5.3 | D-T7P | MR-0.8-2.0 vario |
| **US 2205-T07P** | 0.9 | FLAG T07P | M2.2 | 5.4 | D-T7P | MR-0.8-2.0 vario |
| **US 2506-T07P** | 1.2 | FLAG T07P | M 2.5 | 6 | D-T7P | MR-0.8-2.0 vario |
| **US 2507-T08P** | 1.2 | FLAG T08P | M 2.5 | 7 | D-T8P | MR-0.8-2.0 vario |
| **US 3007-T08P** | 2.0 | FLAG T08P | M 3 | 7 | D-T8P | MR-1.0-5.0 vario |
| **US 3007-T09P** | 2.0 | FLAG T09P | M 3 | 7.4 | D-T9P | MR-1.0-5.0 vario |
| **US 3009-T09P** | 2.0 | FLAG T09P | M 3 | 8.7 | D-T9P | MR-1.0-5.0 vario |
| **US 3508-T15P** | 3.0 | FLAG T15P | M 3.5 | 8.3 | D-T15P | MR-1.0-5.0 vario |
| **US 3510-T15P** | 3.0 | FLAG T15P | M 3.5 | 10.6 | D-T15P | MR-1.0-5.0 vario |
| **US 4011-T15P** | 3.5 | FLAG T15P | M 4 | 10.7 | D-T15P | MR-1.0-5.0 vario |
| **US 5012-T15P** | 5.0 | FLAG T15P | M 5 | 12.2 | D-T15P | MR-1.0-5.0 vario |

**Radial adjustment**

**Hole diameter adjustment and set-up recommendation**
Radial adjustment is possible with indexable drills to achieve a smaller or larger hole diameter than the actual drill.
Radial adjustment values are available in the main drill data tables.

When mounting the drill make sure the drill centre line and workpiece centre are aligned. To achieve a larger hole diameter displace the drill so that the peripheral insert moves in a + away from the workpiece centre line (see diagram below).

**Rotating tool**
For drilling holes with accuracy IT10 and higher, adjustable holders are recommended when using 802D, 803D, 804D and 805D drills.
**Stationary tool**



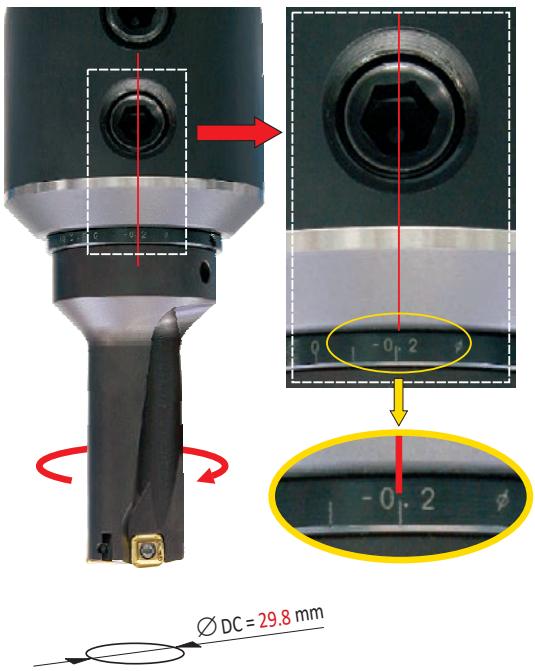

**Tool life**
Inserts should be changed when flank wear measures 0.2 – 0.4 mm at the largest point.
Cutting data recommendations in this catalogue are aimed at achieving tool life of 7 metres drilling depth on the peripheral insert. (20 – 30 mins contact).

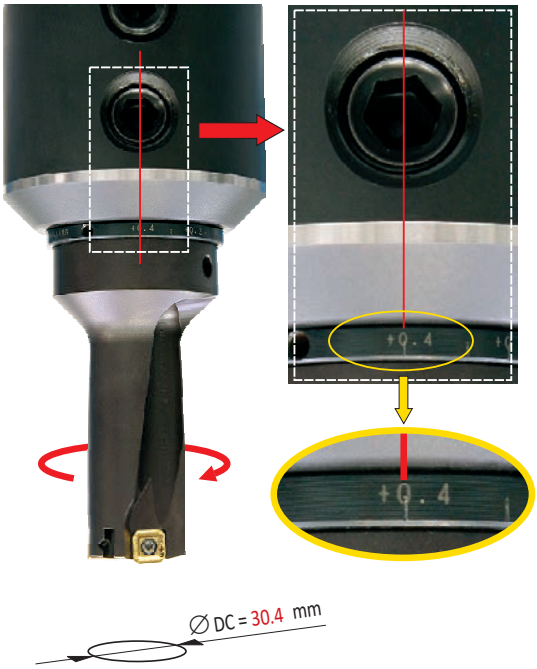
## EP — ADJUSTABLE SLEEVE

| Shank diameter | Drill diameter | Range |
|---|---|---|
| 25 | 15 – 24 | +0.4 – -0.2 |
| 32 | 24.5 – 40 | +0.4 – -0.2 |

**For Milling Machines**

Diameter adjustment range



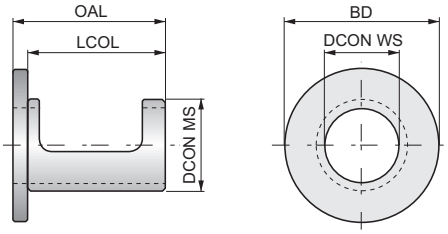



# EP



## EP - Indexable Insert Drill Adjustment Sleeve

Sleeve to adjust indexable insert drill diameter. Can be used in Ø32 or Ø40 mm weldon tool holders. The outside drill diameter is adjusted by rotating the sleeve.



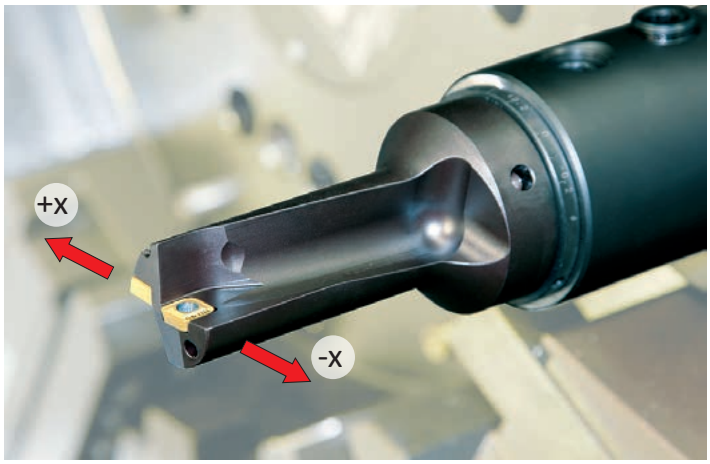

Diameter adjustment range is 0.4 – -0.2; center height adjustment range is 0.2 – -0.15.

| Product | DCON WS | DCON MS | BD | OAL | LCOL | kg |
|---|---|---|---|---|---|---|
| | (mm) | (mm) | (mm) | (mm) | (mm) | |
| **EP253253** | 25.00 | 32.00 | 53.00 | 53.0 | 48 | 0.15 |
| **EP324058** | 32.00 | 40.00 | 58.00 | 58.0 | 53 | 0.20 |

| Shank diameter | Drill diameter | Range |
|---|---|---|
| 25 | 15 – 24 | +0.2 – -0.15 |
| 32 | 24.5 – 40 | +0.2 – -0.15 |

**Centre height adjustment – for lathe operation**

Centre height adjustment range



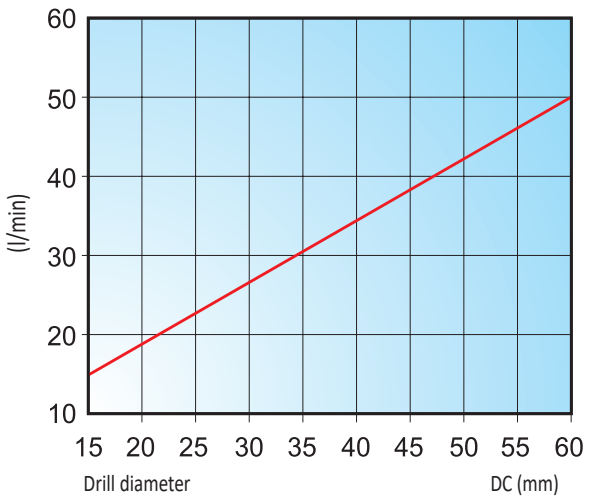

## MACHINING DATA FOR INDEXABLE DRILLS

**Recommended pressure of supplied cutting fluid**

| Drill diameter DC (mm) | Pressure of cutting fluid | |
|---|---|---|
| | Drill length | |
| | 2.0 – 2.5 DC | 3.0 – 5.0 DC |
| 15 – 25 | 6 bar | 12 bar |
| 26 – 40 | 4.5 bar | 9 bar |
| > 40 | 3 bar | 6 bar |

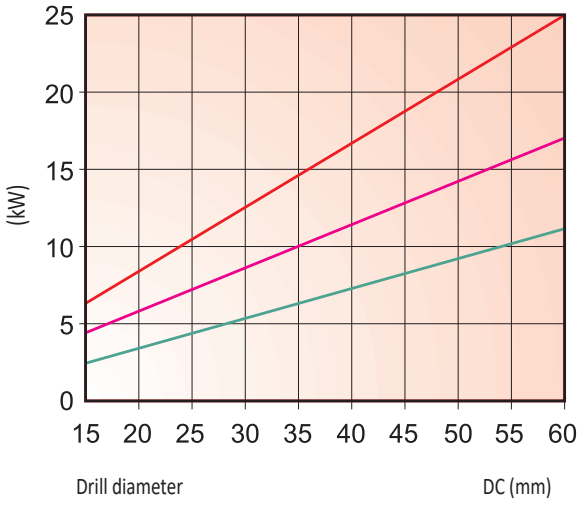
**Coolant volume requirement**

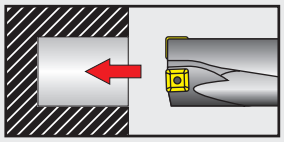
**DRY DRILLING**
Pressurised air through the drill is recommended when drilling without coolant in cast iron and steel



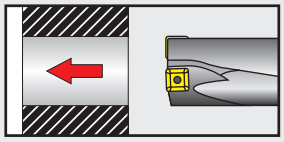

**Net power consumption**



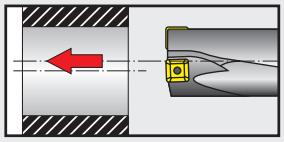





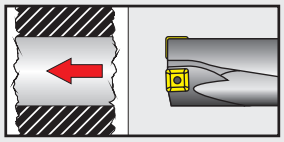
**BLIND HOLE DRILLING**
For drilling holes deeper than 1×DC internal cooling is necessary.



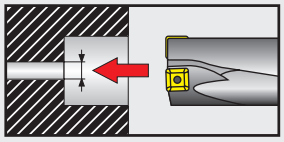
**THROUGH HOLE DRILLING**
A disc can be produced when the indexable drill exits the material. This disc can be ejected at high speed when the workpiece is rotating. It is essential that the machine is adequately guarded to ensure operator safety



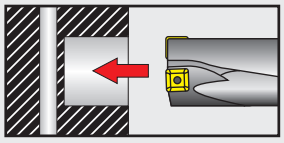
**OFF-CENTRE DRILLING**
Decrease the feed to lower recommended values for particular inserts. See inserts description pages for indexable drills.
Do not exceed radial adjustment values.



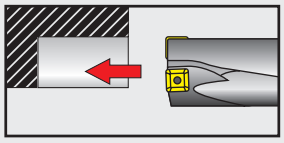
**STARTING ON UNEVEN AND CAST SURFACES**
Decrease the feed by 50% on entrance for indexable drills until both inserts are engaged.



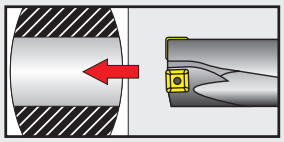
**BORING AND DRILLING INTO PILOT HOLES**
If a pre-drilled hole is larger than 1/4 drill diameter, decrease the feed.



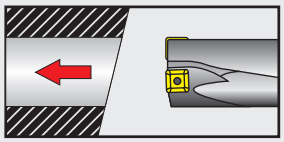
**DRILLING CROSS HOLES**
Decrease the feed by 50% when drilling across an existing hole.
The diameter of existing hole should not be larger than 0.25 x DC.



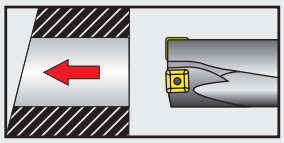
**INTERRUPTED CUT AND PLUNGING**
Decrease the feed to lower recommended feed values for particular insert. See inserts description site for indexable drills.



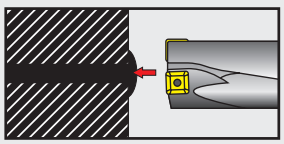
**DRILLING ON CURVED SURFACE**
Drilling on the centre line can be done with reduced feed rate down to 50 % during entrance and exit.



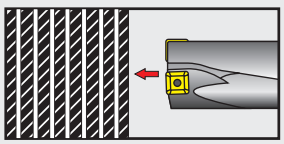
**DRILLING ON ANGLED SURFACES**
Decrease the feed by 50% on entrance for indexable drills until both inserts are engaged if the angle of entry is more than 5°.



**EXIT ON ANGLED SURFACE**
Decrease the feed by 50% on exit if angle of exit is more than 5°.



**STARTING ON A WELDED SEAM**
Facing is recommended before drilling.
Decrease the feed by 50 % during drilling of the welded material.



**DRILLING OF STACKED MATERIALS**
Avoid spaces larger than 0.2 mm between layers. The component must be securely fixed. If necessary reduce the feed.

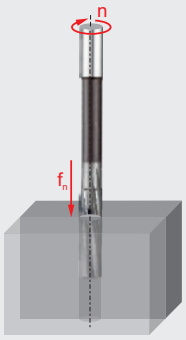
## TROUBLESHOOTING FOR INDEXABLE DRILLS

| | |
|---|---|
| **LOW PERFORMANCE OF DRIVING MOTOR (LOW SPINDLE POWER)** | a) reduce cutting speed = reduction of spindle RPM<br>b) reduce feed rate |
| **EXCESSIVE WEAR OF PERIPHERAL INSERT** | a) reduce cutting speed = reduction of spindle RPM<br>b) choose a more wear resistant grade<br>c) increase coolant volume and pressure |
| **CHIPPING OF PERIPHERAL INSERT** | a) reduce feed rate until peripheral insert is fully engaged<br>b) choose a tougher insert grade<br>c) reduce cutting speed |
| **CHIPPING OF CENTRE INSERT** | a) reduce feed rate during entry<br>b) check the drill and workpiece clamping |
| **CONTINUOUS, BADLY FORMED CHIP** | a) adjust feed rate<br>b) increase cutting speed and simultaneously reduce feed rate |
| **SWARF CONGESTION IN THE FLUTES** | a) increase coolant volume and pressure<br>b) reduce cutting speed<br>c) adjust feed rate |



# REAMERS – TECHNICAL INFO

# REAMERS FEED RATE CHART

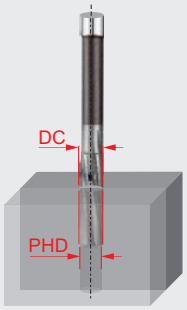



Feed per revolution ($f_n$ in mm/rev)
Depending on the working conditions it might be necessary to adjust these values ± 15 %.

**How to use this table to find the feed per revolution ($f_n$):**

1. Find your Alpha Code on the product page (example: 21C, "C" is the Alpha Code).
2. Find the closest diameter for your cutting application in the top row of the table.
3. Find your Alpha Code in the left column of the table.
4. The intersection (cell) of the Diameter and Alpha Code is the feed per revolution ($f_n$).

| | | ø DC (mm) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1.00 | 1.50 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 | 10.00 | 12.00 | 15.00 | 16.00 | 20.00 | 25.00 | 30.00 | 40.00 | 50.00 | 80.00 |
| Feed rates | A | 0.030 | 0.045 | 0.055 | 0.078 | 0.090 | 0.100 | 0.125 | 0.137 | 0.150 | 0.170 | 0.185 | 0.210 | 0.220 | 0.250 | 0.280 | 0.320 | 0.390 | 0.440 | 0.500 |
| | B | 0.035 | 0.055 | 0.072 | 0.110 | 0.130 | 0.150 | 0.165 | 0.172 | 0.180 | 0.210 | 0.240 | 0.270 | 0.280 | 0.310 | 0.360 | 0.400 | 0.500 | 0.550 | 0.600 |
| | C | 0.040 | 0.065 | 0.085 | 0.135 | 0.160 | 0.185 | 0.200 | 0.210 | 0.220 | 0.260 | 0.285 | 0.325 | 0.335 | 0.390 | 0.440 | 0.480 | 0.600 | 0.680 | 0.750 |
| | D | 0.050 | 0.080 | 0.110 | 0.160 | 0.180 | 0.200 | 0.235 | 0.253 | 0.270 | 0.320 | 0.360 | 0.400 | 0.410 | 0.470 | 0.540 | 0.600 | 0.730 | 0.850 | 0.950 |
| | E | 0.065 | 0.100 | 0.140 | 0.180 | 0.215 | 0.250 | 0.300 | 0.325 | 0.350 | 0.390 | 0.430 | 0.485 | 0.500 | 0.530 | 0.640 | 0.750 | 0.910 | 1.100 | 1.200 |
| | F | 0.090 | 0.140 | 0.180 | 0.260 | 0.305 | 0.350 | 0.395 | 0.417 | 0.440 | 0.500 | 0.550 | 0.610 | 0.630 | 0.700 | 0.800 | 0.930 | 1.200 | 1.500 | 1.650 |




Machining allowance when using a **machine reamer** (MA in mm)
Premachined hole diameter
PHD = DC – MA.

**How to use this table to get to the right premachined hole diameter (PHD):**

1. Find the diameter range for your cutting application in the top row of the table.
2. Find your ISO Group Code in the left column of the table (example: For Stainless Steel the ISO Group Code is "M")
3. The intersection (cell) of the Diameter Range and ISO Group Code is the Machining Allowance (MA)
4. Subtract the Machining Allowance from the reaming diameter to get to the premachined hole diameter (PHD).

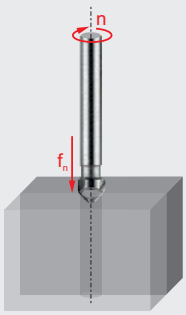
*(example: for a 6mm hole in steel (P) the PHD is 5.85mm)*

| | | ø DC (mm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1.00 | 5.00 | 5.00 | 8.00 | 8.00 | 12.00 | 12.00 | 16.00 | 16.00 | 30.00 | 30.00 | 80.00 |
| ISO group | P | 0.10 | | 0.15 | | 0.20 | | 0.20 | | 0.30 | | 0.30 | |
| | M | 0.08 | | 0.10 | | 0.10 | | 0.20 | | 0.20 | | 0.30 | |
| | K | 0.10 | | 0.15 | | 0.20 | | 0.20 | | 0.30 | | 0.30 | |
| | N | 0.10 | | 0.15 | | 0.20 | | 0.20 | | 0.30 | | 0.30 | |
| | S | 0.05 | | 0.10 | | 0.10 | | 0.15 | | 0.20 | | 0.20 | |
| | H | 0.05 | | 0.05 | | 0.10 | | 0.10 | | 0.15 | | 0.20 | |

Be cautious with the machining tolerances of drills, the tool diameter is not the same as the hole diameter produced!

Note: The recommended allowance when using a hand reamer is 0.05 to 0.10 mm.

# COUNTERSINKS FEED RATE CHART



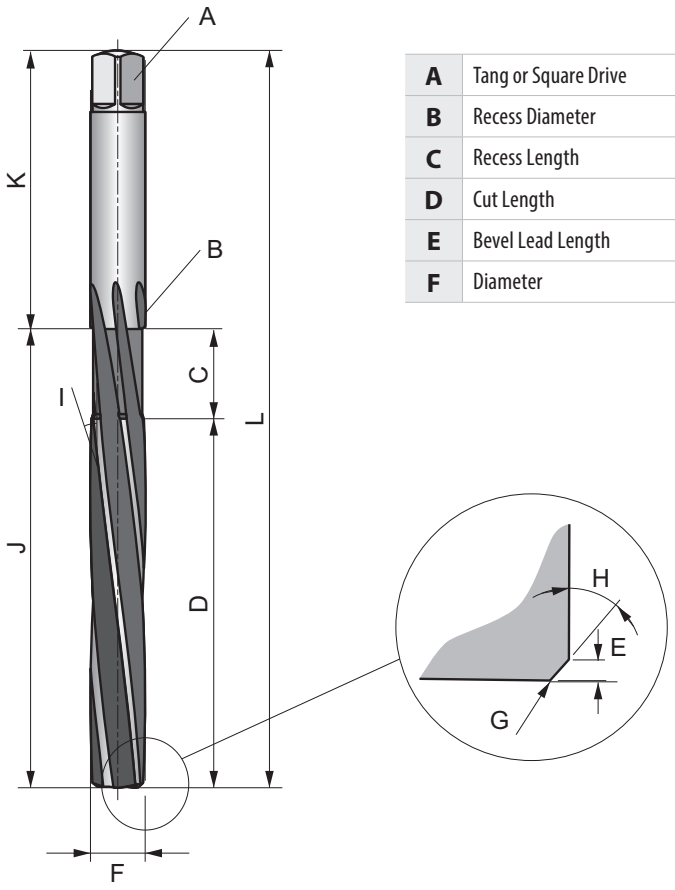

Feed per revolution ($f_n$ in mm/rev)
Depending on the working conditions it might be necessary to adjust these values ± 15 %.

**How to use this table to find the feed per revolution ($f_n$):**

1. Find your Alpha Code on the product page (example: 23E, "E" is the Alpha Code).
2. Find the closest diameter for your cutting application in the top row of the table.
3. Find your Alpha Code in the left column of the table.
4. The intersection (cell) of the Diameter and Alpha Code is the feed per revolution (fn).

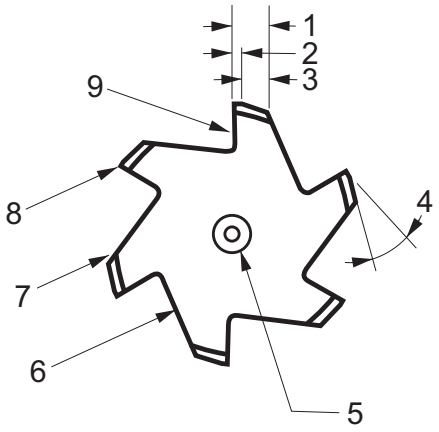
| | | ø DC (mm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **6.00** | **8.00** | **10.00** | **16.00** | **20.00** | **25.00** | **32.00** | **40.00** | **60.00** | **80.00** |
| **Feed rates** | **A** | 0.030 | 0.040 | 0.050 | 0.060 | 0.080 | 0.090 | 0.100 | 0.120 | 0.140 | 0.160 |
| | **B** | 0.040 | 0.050 | 0.060 | 0.080 | 0.100 | 0.120 | 0.140 | 0.160 | 0.180 | 0.200 |
| | **C** | 0.050 | 0.060 | 0.080 | 0.100 | 0.120 | 0.140 | 0.160 | 0.180 | 0.200 | 0.220 |
| | **D** | 0.060 | 0.080 | 0.100 | 0.120 | 0.150 | 0.180 | 0.200 | 0.220 | 0.250 | 0.280 |
| | **E** | 0.080 | 0.100 | 0.120 | 0.150 | 0.180 | 0.200 | 0.250 | 0.270 | 0.300 | 0.320 |
| | **F** | 0.090 | 0.110 | 0.130 | 0.160 | 0.190 | 0.210 | 0.260 | 0.290 | 0.330 | 0.360 |
| | **G** | 0.100 | 0.120 | 0.150 | 0.180 | 0.200 | 0.220 | 0.280 | 0.320 | 0.360 | 0.400 |
| | **H** | 0.120 | 0.150 | 0.180 | 0.200 | 0.220 | 0.250 | 0.300 | 0.350 | 0.400 | 0.450 |

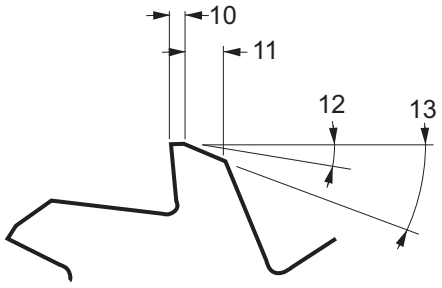
**Reamer Definitions / Nomenclature**




| | |
|---|---|
| **A** | Tang or Square Drive |
| **B** | Recess Diameter |
| **C** | Recess Length |
| **D** | Cut Length |
| **E** | Bevel Lead Length |
| **F** | Diameter |

| | |
|---|---|
| **G** | Bevel Lead |
| **H** | Bevel Lead Angle |
| **I** | Helix Angle |
| **J** | Body Length |
| **K** | Shank Length |
| **L** | Overall Length |




| | |
|---|---|
| **1** | Width of Land |
| **2** | Circular Land |
| **3** | Clearance |
| **4** | Clearance Angle |
| **5** | Centre Hole |
| **6** | Flute |
| **7** | Heel |
| **8** | Cutting Edge |
| **9** | Face |

| | |
|---|---|
| **10** | Width of Primary Clearance |
| **11** | Width of Secondary Clearance |
| **12** | Primary Clearance Angle |
| **13** | Secondary Clearance Angle |

**Reaming**

To obtain the best results when using reamers it is essential to make them 'work'. It is a common fault to prepare holes for reaming with too little stock left in the starting hole diameter. If insufficient stock is left in the hole before reaming, the reamer will rub, quickly show wear and will result in loss of diameter. It is equally important for performance not to leave too much stock in the hole. (See Stock removal below).

1. Select the optimum type of reamer and the optimum speeds and feeds for the application. Ensure that pre-drilled holes are the correct diameter.
2. The workpiece must be held rigid and the machine spindle should have no play.
3. The chuck for straight shank reamers must be of good quality and in good working condition. If the reamer slips in the chuck and the feed is automatic, breakage of the reamer may occur.
4. Keep tool overhang from machine spindle to a minimum.
5. Use recommended lubricants to enhance the life of the reamer and ensure the fluid reaches the cutting edges. As reaming is not a heavy cutting operation, soluble oil 40:1 dilution is normally satisfactory. Air blasting may be used with grey cast iron, if dry machining.
6. Do not allow the flutes of a reamer to become blocked with chips. Retract if necessary to empty the flutes, this can help to prevent poor hole quality and breakage of the tool.
7. Before the reamer is reground, check concentricity between centres. In most instances only the bevel lead will need regrinding.
8. Keep reamers sharp. Frequent regrinding is good economy, but it is important to understand that reamers cut only on the bevel and taper leads and not on the lands. Consequently only these leads need regrinding. Accuracy of regrinding is important to hole quality and tool life.

**Stock removal**

The recommended stock removal in reaming is dependent on the application material and the surface finish of the pre-drilled hole. General guidelines for stock removal are shown in the following tables:

| **Size of reamed hole** (mm) | **When pre-drilled** | **When pre-core-drilled** |
|---|---|---|
| **Below 4** | 0.1 | 0.1 |
| **Over 4 to 11** | 0.2 | 0.15 |
| **Over 11 to 39** | 0.3 | 0.2 |
| **Over 39 to 50** | 0.4 | 0.3 |

| **Size of reamed hole** (inches) | **When pre-drilled** | **When pre-core-drilled** |
|---|---|---|
| **Below 3/16"** | 0.004" | 0.004" |
| **3/16" to ½"** | 0.008" | 0.006" |
| **½" to 1.½"** | 0.010" | 0.008" |
| **1.½" to 2"** | 0.016" | 0.010" |

**Hand/Machine reaming**

Although both hand and machine reamers offer the same capability regarding finished hole size, the use of each must be considered according to the application. A hand reamer, for reasons of alignment, has a long taper lead, whereas a machine reamer has only a 45 degree bevel lead. A machine reamer cuts only on the bevel lead while a hand reamer cuts on the bevel lead as well as the taper lead.

**Tolerance limits**




1. On the cutting diameter of standard reamers
   The diameter (DC) is measured across the circular land immediately behind the bevel or taper lead. The tolerance is in accordance with DIN 1420 and is intended to produce H7 holes.

| **Reamer tolerance** | | | |
|---|---|---|---|
| **Diameter** (mm) | | **Tolerance Limit** (mm) | |
| Over | Up to and including | High + | Low + |
| – | 3 | 0.008 | 0.004 |
| 3 | 6 | 0.010 | 0.005 |
| 6 | 10 | 0.012 | 0.006 |
| 10 | 18 | 0.015 | 0.008 |

| **Reamer tolerance** | | | |
|---|---|---|---|
| **Diameter** (mm) | | **Tolerance Limit** (mm) | |
| Over | Up to and including | High + | Low + |
| 18 | 30 | 0.017 | 0.009 |
| 30 | 50 | 0.021 | 0.012 |
| 50 | 80 | 0.025 | 0.014 |

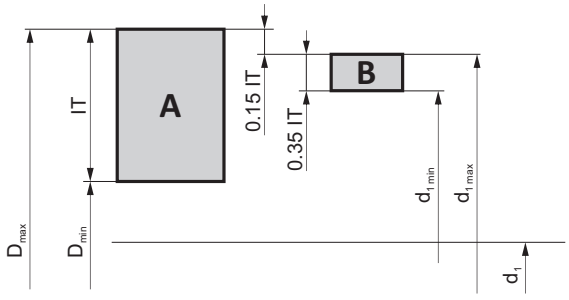
2. H7 hole tolerance
   The most common tolerance on a finished hole is H7 (see table below). For any other tolerance the figure and table below (in Note 3) can be used to calculate the reamers tolerance location and width

| **Hole tolerance** | | | |
|---|---|---|---|
| **Diameter** (mm) | | **Tolerance Limit** (mm) | |
| Over | Up to and including | High + | Low + |
| – | 3 | 0.010 | 0 |
| 3 | 6 | 0.012 | 0 |
| 6 | 10 | 0.015 | 0 |
| 10 | 18 | 0.018 | 0 |

| **Hole tolerance** | | | |
|---|---|---|---|
| **Diameter** (mm) | | **Tolerance Limit** (mm) | |
| Over | Up to and including | High + | Low + |
| 18 | 30 | 0.021 | 0 |
| 30 | 50 | 0.025 | 0 |
| 50 | 80 | 0.030 | 0 |

3. Other hole tolerances when it is necessary to define the dimensions of a special reamer intended to cut to a specific tolerance, e.g. D8, this well proven guide can be used.

| **Diameter tolerance width** (µm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Tolerance width (microns) | over 1 incl. 3 | over 3 incl. 6 | over 6 incl. 10 | over 10 incl. 18 | over 18 incl. 30 | over 30 incl. 50 | over 50 incl. 80 | over 80 incl. 120 |
| **IT5** | 4 | 5 | 6 | 8 | 9 | 11 | 13 | 15 |
| **IT6** | 6 | 8 | 9 | 11 | 13 | 16 | 19 | 22 |
| **IT7** | 10 | 12 | 15 | 18 | 21 | 25 | 30 | 35 |
| **IT8** | 14 | 18 | 22 | 27 | 33 | 39 | 46 | 54 |
| **IT9** | 25 | 30 | 36 | 43 | 52 | 62 | 74 | 87 |
| **IT10** | 40 | 48 | 58 | 70 | 84 | 100 | 120 | 140 |
| **IT11** | 60 | 75 | 90 | 110 | 130 | 160 | 190 | 220 |
| **IT12** | 100 | 120 | 150 | 180 | 210 | 250 | 300 | 350 |




$A =$ Hole tolerance
$B =$ Reamer tolerance
$IT =$ Tolerance width
$D_{max} =$ Max. diameter of hole
$D_{min} =$ Min. diameter of hole
$d_1 =$ Nominal diameter
$d_{1\,max} =$ Max. diameter of reamer
$d_{1\,min} =$ Min. diameter of reamer

e.g. 10 mm hole with tolerance D8, Max dia = 10.062, Min dia = 10.040, Hole tolerance (IT8) = 0.022

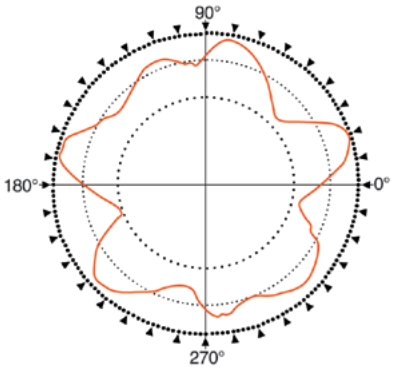
Maximum limit: 0.15 × hole tolerance (IT8) = 0.0033, rounded up = 0.004
Minimum limit: 0.35 × hole tolerance (IT8) = 0.0077, rounded up = 0.008
Maximum limit for reamer = 10.062 – 0.004 = 10.058
Minimum limit for reamer = 10.058 – 0.008 = 10.050

**Applications – Reamer Selection**

The most common types of reamers have a left-hand spiral because the main applications involve through holes requiring chips to be pushed forward. For blind holes, reamers with straight flutes or right hand spirals are recommended.
The most efficient reaming conditions depend on the application, material, quality of hole required, stock removal, lubrication and other factors. A general guide to surface speeds and feeds for machine reamers is shown in the reamer WMG and feed charts (see Product Selector) and stock removal tables.
Extremely unequal spacing on reamers means that the divide is not the same for each tooth. As there are no two teeth diametrically opposite each other, the reamer produces a hole with a roundness variance of between 1 and 2 µm. This compared with a variance of up to 10µm with conventional unequal spacing.

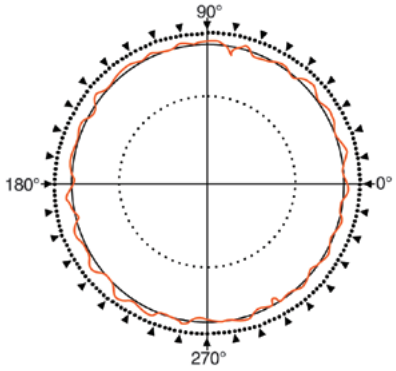
**Carbide Reamers – Comparison spacing / EU spacing**

Unequal spacing
Roundness error up to 10 µm




**Results of roundness**

Extremely unequal spacing
Roundness error up to 1 – 2 µm




**Results of roundness**

**Trouble shooting when reaming**

| Problem | Cause | Remedy |
|---|---|---|
| **Broken or twisted tangs** | Incorrect fit between shank and socket | Ensure the shank and socket are clean and free from damage |
| **Rapid tool wear** | Insufficient stock to remove | Increase the amount of stock to be removed (smaller hole) |
| **Oversize hole** | Excessive lip height variation | Regrind to correct specification |
| | Displacement in the machine spindle | Repair and rectify spindle displacement |
| | Defects on the tool holder | Replace tool holder |
| | Tool shank is damaged | Replace or regrind the shank |
| | Ovality of the tool | Replace or regrind the tool |
| | Asymmetric bevel lead angle | Regrind to correct specification |
| | Too high feed or cutting speed | Adjust cutting conditions in accordance with Catalogue |
| **Undersize hole** | Insufficient stock to remove | Increase the amount of stock to be removed (smaller hole) |
| | Too much heat generated while reaming. The hole widens and shrinks | Increase coolant flow |
| | The tool diameter is worn and is undersize | Regrind to correct specification or replace tool |
| | Too low feed or cutting speed | Adjust cutting conditions in accordance with the Catalogue |
| | Pre-drilled hole is too small | Decrease the amount of stock to be removed (larger hole) |
| **Oval and conical holes** | Displacement in the machine spindle | Repair and rectify spindle displacement |
| | Misalignment between tool and hole | Use a bridge reamer |
| | Asymmetric bevel lead angle | Regrind to correct specification |
| **Bad hole finish** | Excessive stock to remove | Decrease the amount of stock to be removed (larger hole) |
| | Worn out tool | Regind to correct specification |
| | Undersize cutting rake angle | Regind to correct specification |
| | Too diluted emulsion or cutting oil | Increase % concentration |
| | Feed and/or speed too low | Adjust cutting conditions in accordance with Catalogue |
| | Cutting speed too high | Adjust cutting conditions in accordance with Catalogue |
| **The tool clamps and breaks** | Worn out tool | Regind to correct specification |
| | Back taper of the tool is too small | Check and replace/modify the tool |
| | The width of the land is too wide | Check and replace/modify the tool |
| | Workpiece material tend to squeeze | Use an adjustable reamer to compensate for the displacement |
| | Pre-drilled hole is too small | Decrease the amount of stock to be removed (larger hole) |
| | Heterogeneous material with hard inclusions | Use solid carbide reamer |

| | Grade | Hardness (HV10) | C % | W % | Mo % | Cr % | V % | Co % | Tool Material |
|---|---|---|---|---|---|---|---|---|---|
| HSS | M2 | 810 – 850 | 0.9 | 6.4 | 5.0 | 4.2 | 1.8 | – | HSS |
| HSS-E | M35 | 830 – 870 | 0.93 | 6.4 | 5.0 | 4.2 | 1.8 | 4.8 | HSCO |
| | M42 | 870 – 960 | 1.08 | 1.5 | 9.4 | 3.9 | 1.2 | 8.0 | |

| Properties | HSS materials | Carbide materials | K10/30F (often used for solid tools) |
|---|---|---|---|
| Hardness (HV30) | 800-950 | 1300 – 1800 | 1600 |
| Density (g/cm³) | 8.0 – 9.0 | 7.2 – 15 | 14.45 |
| Compressive strength (N/mm²( | 3000 – 4000 | 3000 – 8000 | 6250 |
| Flexural strength, (bending) (N/mm²( | 2500 – 4000 | 1000 – 4700 | 4300 |
| Heat resistance (°C) | 550 | 1000 | 900 |
| E-module (KN/mm²) | 260 – 300 | 460 – 630 | 580 |
| Grain size (µm) | – | 0.2 – 10 | 0.8 |

The combination of hard particle (WC) and binder metal (Co) give the following changes in characteristics.

| Characteristic | Higher WC content give | Higher Co content give |
|---|---|---|
| Hardness | Higher hardness | Lower hardness |
| Compressive strength (CS) | Higher CS | Lower CS |
| Bending strength (BS) | Lower BS | Higher BS |

Grain size also influences the material properties. Small grain sizes means higher hardness and coarse grains give more toughness.

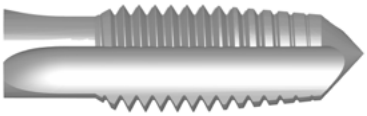
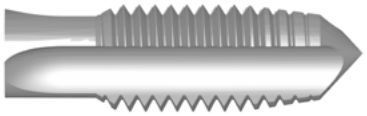
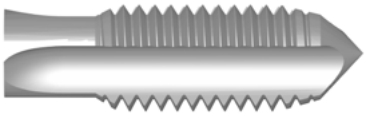
### Surface treatment / Coating properties examples

| Surface Treaments | Colour | Coating material | Hardness (HV) | Thickness (µm) | Coating structure | Frict. coeff. against steel | Max. appl. temp. (°C) |
|---|---|---|---|---|---|---|---|
| TiN | Gold | TiN | 2300 | 1-4 | Mono-layer | 0.4 | 600 |
| TiAlN | Black grey | TiAlN | 3300 | 3 | Nano structured | 0.3-0.35 | 900 |



# THREADING – TECHNICAL INFO

Hand taps (ISO standard) with different chamfer lengths each producing a full thread profile.

| | | | |
|---|---|---|---|
| **NO1 =** |  Taper lead | **A** 6-8 |  |
| **NO2 =** |  Plug lead | **B** 4-6 |  |
| **NO3 =** |  Bottoming lead | **C** 2-3 |  |

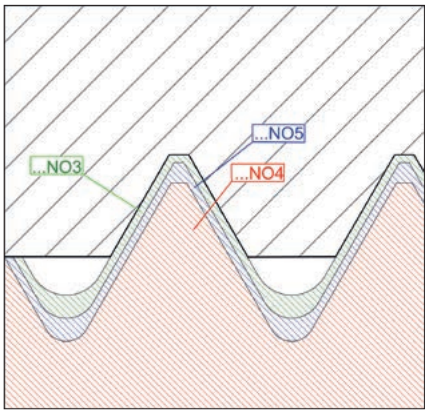
| | | |
|---|---|---|
| **ISO** | **NO6 =** | NO1 + NO2 + NO3 |
| | **NO7 =** | NO2 + NO3 * |

| | | |
|---|---|---|
| **ANSI** | **NO6 =** | NO1 (taper) + NO2 (plug) + NO3 (bottoming) |

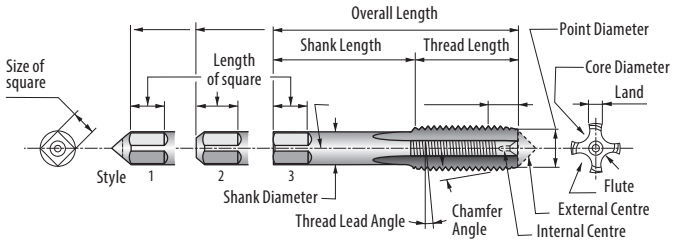
*** E550, E710** **NO7 =** NO3 (truncated) + NO3

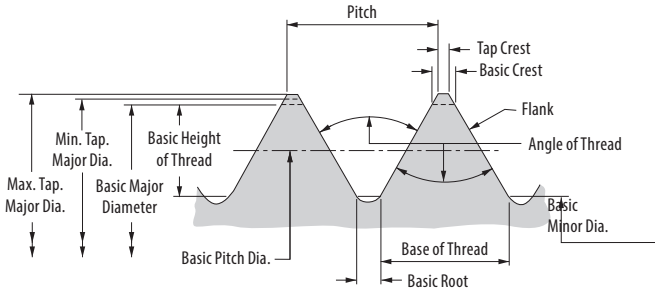
Serial taps (DIN standard) with each sequencing tap cutting a part of the profile, the NO3 tap is needed to complete a full thread profile.

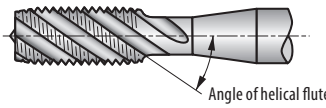
| | | |
|---|---|---|
| **NO4 =** |  Starter tap | **A** 6-8 |
| **NO5 =** |  Seconding tap | **B** 3.5-5 |
| **NO3 =** |  Finishing (bottoming lead) tap | **C** 2-3 |

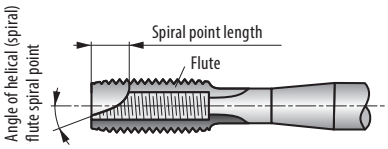


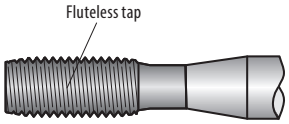

| | | |
|---|---|---|
| **DIN ISO** | **NO8 =** | NO3 + NO4 + NO5 |
| | **NO9 =** | NO3 + NO5 |

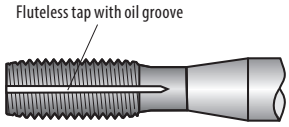



**Allowance:** The minimum clearance or maximum interference which is intended between mating parts.

**Angle of Thread:** The angle included between the flanks of a thread measured in an axial plane.

**Back Taper:** A slight taper on the threaded portion of the tap making the pitch diameter near the shank smaller than that at the chamfer.

**Basic:** The theoretical or nominal standard size from which all variations are made.

**Chamfer:** The tapered and relieved cutting teeth at the front end of the threaded section. Common types of chamfer are taper, 8 to 10 pitches long, plug, 3 to 5 pitches and bottoming, 1 to 2 pitches.

**Crest:** The top surface joining the two sides or flanks of a thread.

**Cutting Face:** The leading side of the land.

**Flute:** The longitudinal channels formed on a tap to create cutting edges on the thread profile.

**Heel:** The following side of the land.

**Height of Thread:** In profile, distance between crest and bottom section of thread measured normal to the axis.

**Hook Face:** A concave cutting face of the land. This may be varied for different materials and conditions.

**Interrupted Thread:** Alternate teeth are removed in the thread helix on a tap; usually restricted to those having an odd number of flutes.

**Land:** One of the threaded sections between the flutes of a tap.

**Lead of Thread:** The distance a screw thread advances axially in one turn.

**Major Diameter:** The largest diameter of the screw or nut on a straight screw thread.

**Minor Diameter:** The smallest diameter of the screw or nut on a straight screw thread.

**Neck:** The reduced diameter, on some taps, between the threaded portion and the shank.

**Pitch:** The distance from a point on one thread to a corresponding point on the next thread, measured parallel to the axis.

**Pitch Diameter:** On a straight screw thread, the diameter of an imaginary cylinder where the width of the thread and the width of the space between threads is equal.

**Point Diameter:** The diameter at the leading end of the chamfered portion.

**Radial:** The straight face of a land, the plane of which passes through the axis of the tap.

**Rake:** The angle of the cutting face of the land in relation to an axial plane intersecting the cutting face at the major diameter.

**Relief:** The removal of metal behind the cutting edge to provide clearance between the part being threaded and a portion of the threaded land. Also, see back taper.

**Chamfer relief:** The gradual decrease in land height from cutting edge to heel on the chamfered portion of the tap land to provide radial clearance for the cutting edge.

**Concentric relief:** Radial relief in the thread form starting at the back of a concentric margin.

**Eccentric thread relief:** Radial relief in the thread form starting at the cutting edge and continuing to the heel.

**Root:** The bottom surface joining the flanks of two adjacent threads.

**Side or flank of thread:** The surface of the thread which connects the crest with the root.

**Shank:** The portion of the tap by which it is held and driven.

**Spiral Point:** An oblique cutting edge ground into the lands to provide a shear cutting action on the first few threads.

**Square:** The squared end of the tap shank.

**Thread:** The helical formed tooth of the tap which produces the thread in a tapped hole.

**Thread Lead Angle:** The angle made by the helix of the thread at the pitch diameter, with a plane perpendicular to the axis.

**Threads Per Inch:** The number of threads in one inch of length.

**THREAD: Single:** A thread in which lead is equal to pitch.
**Double:** A thread in which lead is equal to twice the pitch.
**Triple:** A thread in which lead is equal to triple the pitch.

**General hints on tapping**

The success of any tapping operation depends on a number of factors, all of which affect the quality of the finished product.

1. Select the correct design of tap for the component material and type of hole, i.e. through or blind, from the Materials Classification chart.
2. Ensure the component is securely clamped – lateral movement may cause tap breakage or poor quality threads.
3. Select the correct size of drill from the relevant catalogue page. Always ensure that work hardening of the component material is kept to a minimum.
4. Select the correct cutting speed as shown on the catalogue product page.
5. Use appropriate cutting fluid for correct application.
6. In NC applications ensure that the feed value chosen for the program is correct. When using a tapping attachment, 95% to 97% of the pitch is recommended to allow the tap to generate its own pitch.
7. Where possible, hold the tap in a good quality torque limiting tapping attachment, which ensures free axial movement of the tap and presents it squarely to the hole. It also protects the tap from breakage if accidentally 'bottomed' in a blind hole.
8. Ensure smooth entry of the tap into the hole, as an uneven feed may cause 'bell mouthing'.

**Tap tolerance vs tolerance on internal thread (nut)**

| Tolerance class, Tap | | | Tolerance, Internal thread (Nut) | | | | | Application |
|---|---|---|---|---|---|---|---|---|
| ISO | DIN | ANSI BS | | | | | | |
| ISO 1 | 4 H | 3 B | 4 H | 5 H | – | – | – | Fit without allowance |
| ISO 2 | 6 H | 2 B | 4 G | 5 G | 6 H | – | – | Normal fit |
| ISO 3 | 6 G | 1 B | – | – | 6 G | 7 H | 8 H | Fit with large allowance |
| – | 7 G | – | – | – | – | 7 G | 8 G | Loose fit for following treatment or coating |

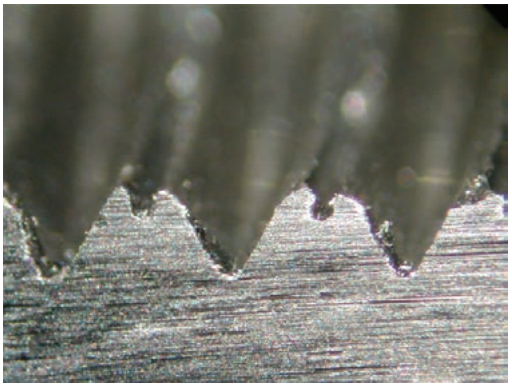
## Tap Geometries & Applications

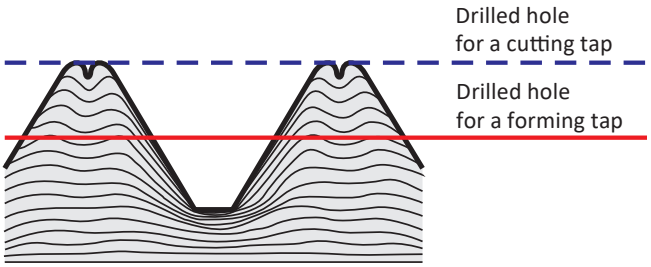
| Description | Chips |
|---|---|
| **Taps with straight flutes**<br>Straight flutes are the most commonly used type of tap. Suitable for use on most materials, mainly short chipping steel and cast iron, they form the basis of the program. |  |
| **Taps with interrupted thread**<br>The interrupted thread ensures less friction and therefore less resistance, which is particularly important when threading material which is resilient and difficult to machine (e.g. aluminium, bronze). It is also easier for lubricant to penetrate to the cutting edges, thus helping to minimize the torque generated. |  |
| **Spiral point taps**<br>The tap has a straight fairly shallow flute and is often referred to as a gun nose or spiral point tap. The gun nose or spiral point is designed to drive the chips forward. The relatively shallow flutes ensure that the sectional strength is maximised. They also act to allow lubricant to reach the cutting edges. This type of tap is recommended for threading through holes. |  |
| **Nut taps**<br>These taps are generally used to thread nuts but can be used also on deep through holes. They have a shank diameter smaller than the nominal and a longer overall length, because their function is to accumulate nuts.<br><br>They are used on special machines designed to thread huge amounts of nuts. They can work in steel and stainless steel.<br><br>The first serial tap has a very long chamfer, in order to spread the cutting load on almost two thirds of the thread length. |  |

| Description | Chips |
|---|---|
| **Taps with flutes only on the chamfer lead**<br>The cutting part of the tap is formed by gun nosing in the same manner as for a spiral point tap, the function being to drive the chips forward ahead of the cutting edges. This design is extremely rigid which facilitates good machining results. However, the short length of the gun nosing limits its application to a depth of hole less than about $1.5 \times TDZ$. |  |
| **Taps with spiral flutes**<br>Taps with spiral flutes are intended primarily for threading in blind holes. The helical flute transports the chips back away from the cutting edges and out of the hole, thus avoiding packing of chips in the flutes or at the bottom of the hole. In this way, danger of breaking the tap or damaging the thread is minimised. |  |
| **Cold forming taps**<br>Cold forming taps differ from cutting taps in that the thread is produced by plastic deformation of the component material rather than by the traditional cutting action. This means that no chips are produced by their action. The application range is materials with good formability. Tensile strength (*Rm*) should not exceed 1200 N/mm$^2$ and the elongation factor ($A_5$) should not be less than 10 %.<br><br>Cold forming taps without flutes are suitable for normal machining and are especially suitable when vertically tapping blind holes. They are also available with through coolant. |  |
| **Through coolant taps**<br>The performance of taps with through coolant holes is higher than the same taps used with external lubrication. These kinds of taps allow better evacuation of the chip, which is transported away from the cutting area itself. Wear on the cutting edge is reduced, since the cooling effect on the cutting zone is higher than the heat generation.<br><br>Lubrication can be oil, emulsion or air pressurised with oil mist. Working pressure not less then 15 bar is required, but good results can be obtained with minimal lubrication. |  |

**Flow Of Material When Forming A Thread**

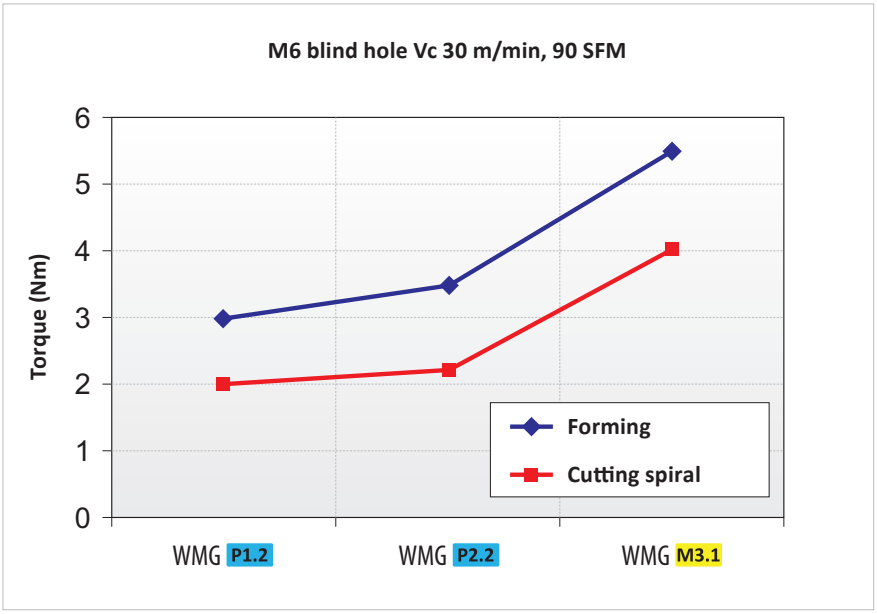
The tapping hole size depends upon the material being drilled, the cutting conditions selected and the condition of the equipment being used. If material is pushed up at the thread entry by the tap and/or the life of the tap is too short, select a slightly larger drill diameter. If on the other hand the profile of the thread formed is insufficient, then select a slightly smaller drill diameter.






Section of thread obtained by forming tap on steel C45˝.

Cold forming taps require more power on the spindle, compared to a cutting tap of the same size, since it generates higher torque.




Torque comparison between forming and cutting taps in different material groups.

**Trouble Shooting When Tapping**

| Problem | Cause | Remedy |
|---|---|---|
| **Oversize** | Incorrect tolerance. | Choose a tap with lower thread tolerance. |
| | Incorrect axial feed rate. | Reduce feed rate by 5 – 10 % or increase compression of tap holder. |
| | Wrong type of tap for application. | Use spiral point for through hole or spiral flute for blind hole. Use coated tool to prevent built up edge. Check Catalogue or Product Selector for correct tool alternative. |
| | Tap not centered on the hole. | Check tap holder and position tap centre on the hole. |
| | Lack of lubrication. | Use good lubrication in order to prevent built up edge. See lubricant section in technical handbook. |
| | Tap speed too slow . | Follow recommendation in Catalogue/Product Selector. |
| **Undersize** | Wrong type of tap for application. | Use spiral point for through hole or spiral flute for blind hole. Use coated tool to prevent built up edge. Use tap with higher rake angle. Check Catalogue or Product Selector for correct tool alternative. |
| | Incorrect tolerance. | Choose a tap with higher tolerance, especially on material with low oversize tendency, such as cast iron, stainless steel. |
| | Incorrect or lack of lubricant. | Use good lubrication in order to prevent chip blockage inside the hole. See lubricant section in technical handbook. |
| | Tap drill hole too small. | Increase drill diameter to the maximum value. Check tapping size drill. |
| | Material closing in after tapping. | See recommendation in Catalogue/Product Selector for correct tool alternative. |
| **Chipping** | Wrong type of tap for application. | Choose a tap with lower rake angle. Choose a tap with longer chamfer. Use spiral point taps for through hole and spiral flute for blind holes, in order to avoid chip blockage. Check Catalogue or Product Selector for correct tool alternative. |
| | Incorrect or lack of lubricant. | Use good lubrication in order to prevent built up edge. See lubricant section in technical handbook. |
| | Taps hit bottom of hole. | Increase depth of drilling or decrease depth of tapping. |
| | Work hardening surface. | Reduce speed, use coated tool, use good lubrication. See section for machining of stainless steel in technical handbook. |
| | Swarf trapping on reversal. | Avoid sudden return of tap on reversal motion. |
| | Chamfer hits hole entrance. | Check axial position and reduce axial error of tap point on hole centre |
| | Tap drill hole too small. | Increase drill diameter to maximum value. Check tapping size drill. |

**Trouble Shooting When Tapping**

| Problem | Cause | Remedy |
|---|---|---|
| **Breakage** | Tap worn out. | Use a new tap or regrind the old one. |
| | Lack of lubricant. | Use good lubrication in order to prevent built up edge and chip blockage. See lubricant section in technical handbook. |
| | Taps hit bottom of hole. | Increase depth of drilling or decrease depth of tapping. |
| | Tap speed too high. | Reduce cutting speed. Follow recommendation in Catalogue / Product Selector |
| | Work hardening surface. | Reduce speed. Use coated tool Use good lubrication. See section for machining of stainless steel in technical handbook. |
| | Tap drill hole too small. | Increase drill diameter up to maximum value. See tap drill tables. |
| | Too high torque. | Use tapping attachment with torque adjustment clutch. |
| | Material closing in after tapping. | See recommendation in Catalogue/Product Selector for correct tool alternative. |
| **Rapid wear** | Wrong type of tap for application. | Use tap with lower rake angle and/or higher relief and/or longer chamfer. Use coated tool. Check Catalogue or Product Selector for correct tool alternative. |
| | Lack of lubricant. | Use good lubrication in order to prevent built up edge and thermal stress on cutting edge. See lubricant section in technical handbook. |
| | Tap speed too high. | Reduce cutting speed. Follow recommendation in Catalogue/Product Selector. |
| **Built up edge** | Wrong type of tap for application. | Use tap with lower rake angle and/or higher relief. Check Catalogue or Product Selector for correct tool alternative. |
| | Lack of lubricant. | Use good lubrication in order to prevent built up edge. See lubricant section in technical handbook. |
| | Surface treatment not suitable. | Choose a tap with the recommended surface treatment. |
| | Tap speed too low. | Follow recommendation in Catalogue/Product Selector. |



# BAR PEELING – TECHNICAL INFO

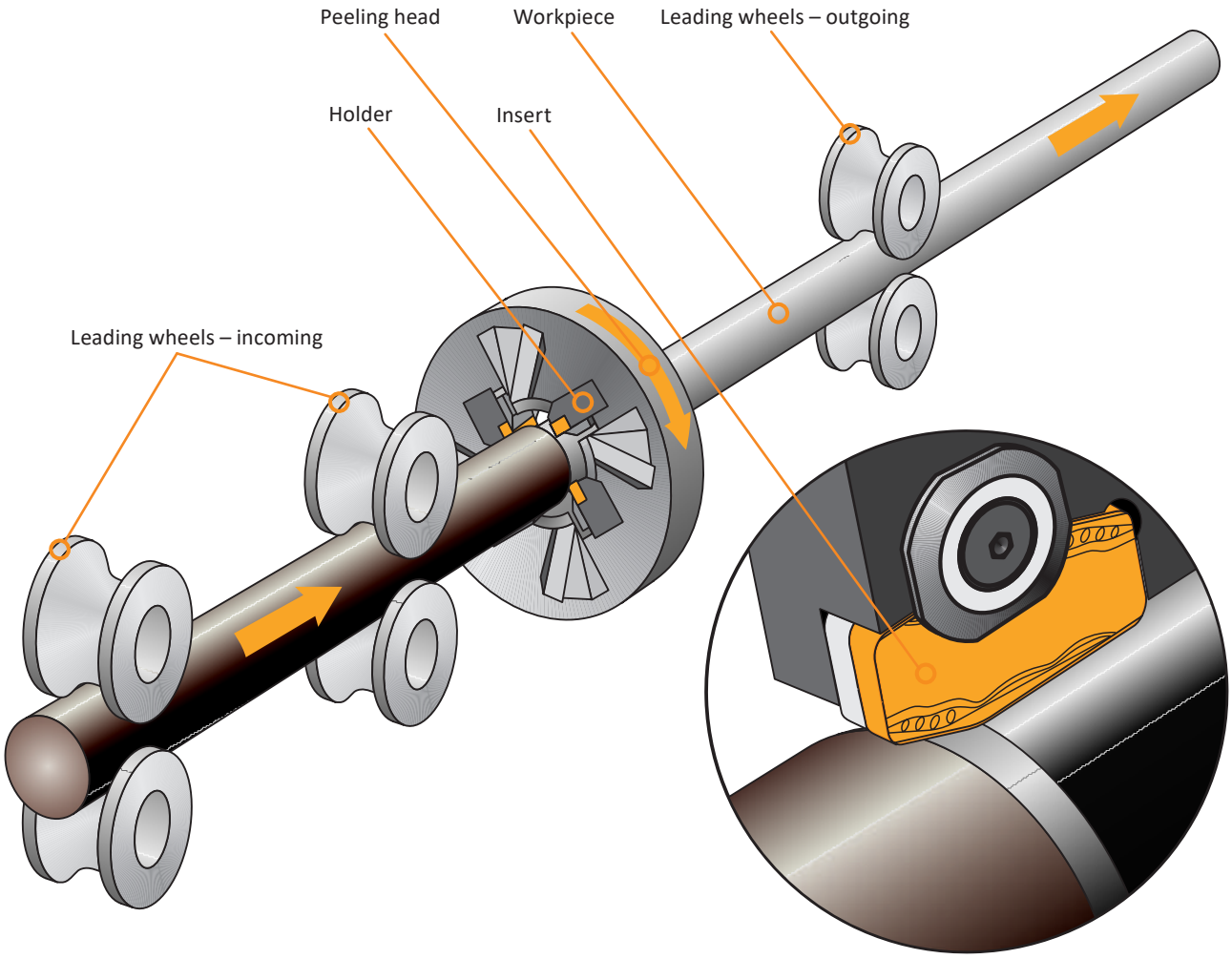
**BAR PEELING**

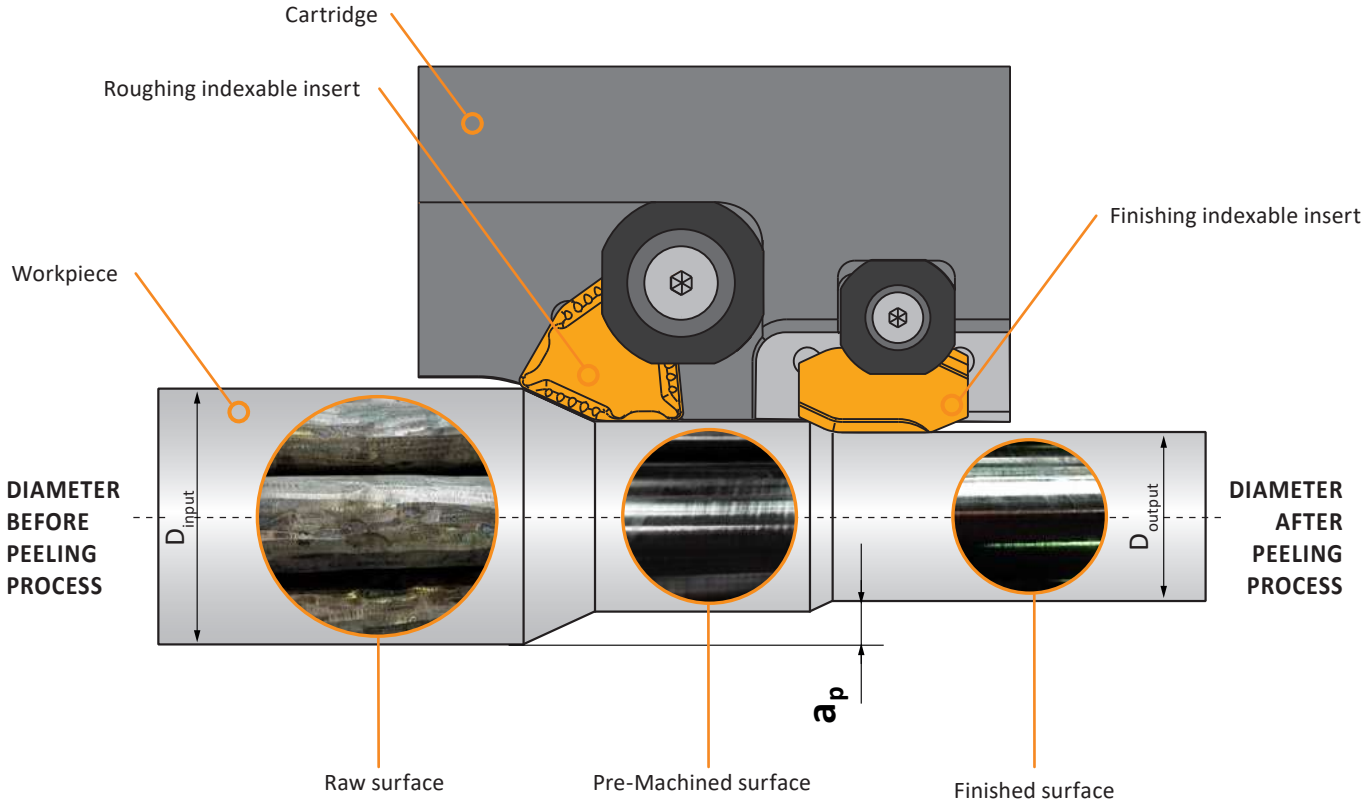
The outstanding feature of this specific operation is relatively high feed rates and small depth of cut applied to round bars and thick walled tubes. Peeling operations remove surface layers of oxides, rolled contaminants and cracks caused by hot forging or rolling.

Peeled materials are mostly carbon steel, alloy steel for heat treating, tool steel, stainless steel and also heat–resistant alloys based on Ni, Co, Fe and Ti.

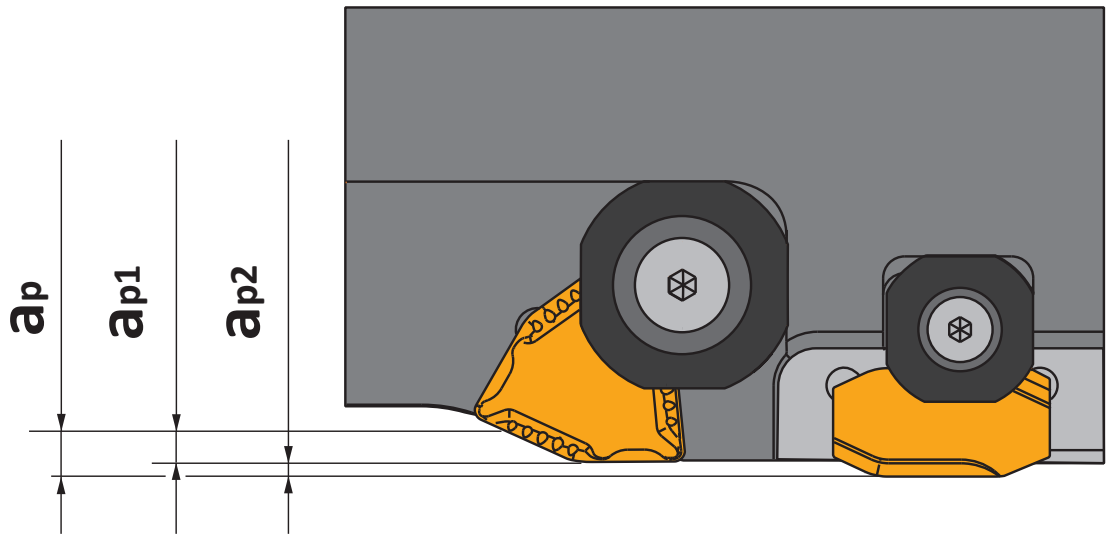
The advantages of peeling technology in comparison with turning are:

- Machining at higher feed rates
- Higher productivity
- Less inserts consumption
- Excellent roughness quality
- High dimensional accuracy



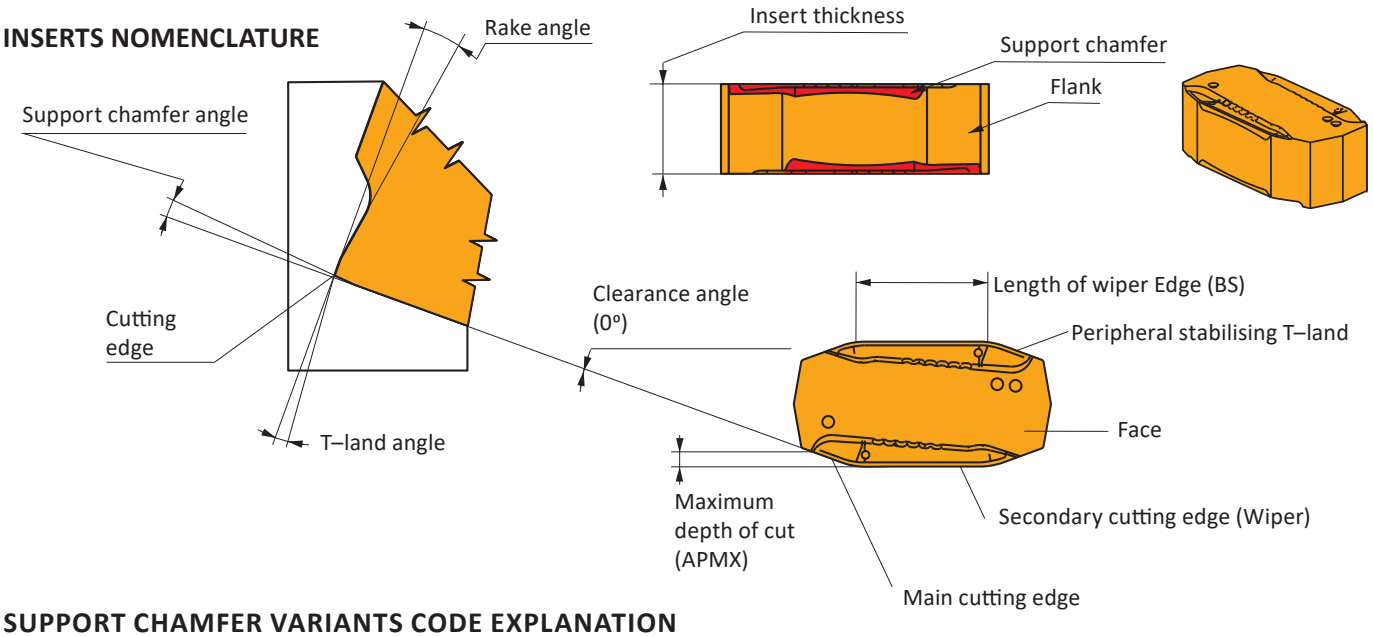



The total depth of cut $a_p$ is the difference between the input diameter and output diameter of the workpiece divided by two.



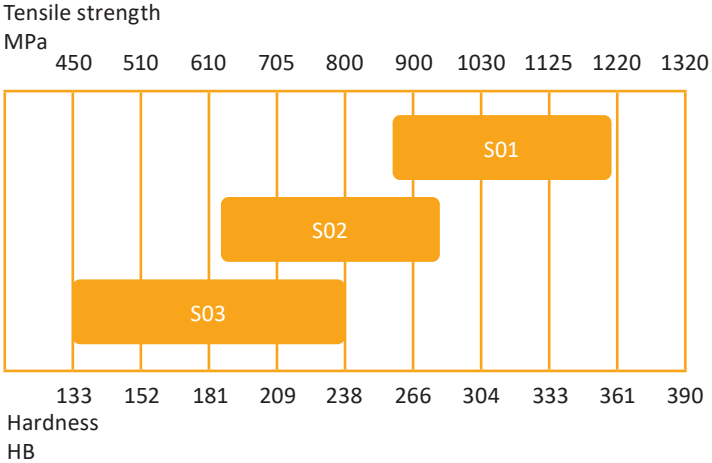

Depth of cut ap in cassettes with more than one insert is divided into the partial depths of cut for each insert ($a_{p1}$; $a_{p2}$). Those values should be taken into consideration during detailed analyses of the cutting conditions of the roughing and finishing inserts.

## INSERTS NOMENCLATURE



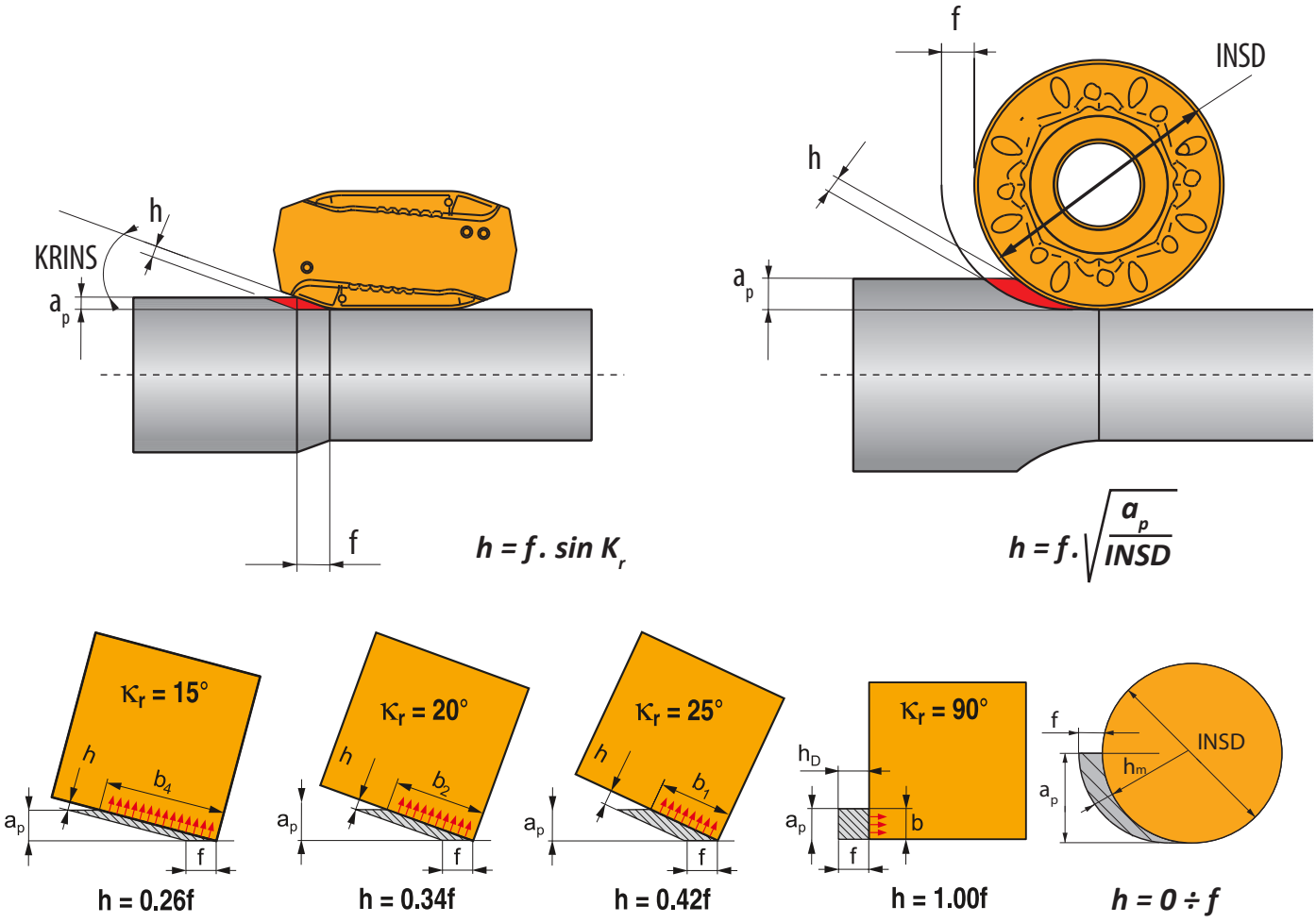

## SUPPORT CHAMFER VARIANTS CODE EXPLANATION

| Support chamfer variant | Sketch | Main cutting edge – angle | Wiper cutting edge – angle | Workpiece material properties |
|---|---|---|---|---|
| S01 |  | 0° | 5° | 850 — 1200 MPa<br>123 — 174 kPsi<br>250 — 360 HB<br>Tempered |
| S02 |  | 3° | 5° | 600 — 950 MPa<br>87 — 137 kPsi<br>180 — 260 HB<br>Basic hardness |
| S03 |  | 5° | 5° | 450 — 800 MPa<br>65 — 116 kPsi<br>150 — 230 HB<br>Annealed |

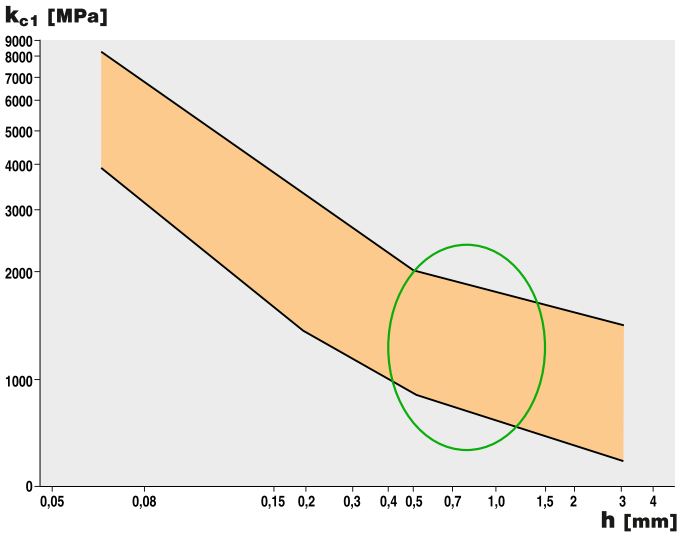





**The setting angle of the main cutting edge KRINS,** has the most influence on the cutting forces and cross-section shape of the chip. Reducing angle KRINS makes the chip thinner at a given feed ***f*** and depth of cut $a_p$. Whereas if KRINS = 90° the chip thickness ***h = f*** and the chip width ***b = $a_p$*** becomes wider. Regarding the decreasing setting angle, the function width of the T-land is increasing and the rake angle of insert is decreasing. For round inserts, the chip thickness **h** varies from **0** to ***f*** depending on the depth of cut $a_p$. For that reason we use the average chip thickness value **hm** which is based on the relation $a_p$/INSD, where **INSD** is the external diameter of the round insert.
Dependence of chip thickness **h** on setting angle **KRINS**



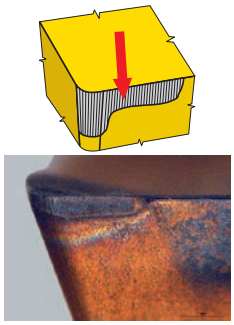

Dependence of specific cutting resistance kc1 on chip thickness




With decreasing chip thickness, the specific cutting resistance increases! Optimal chip thickness range is marked green on the graph.
We recommend using feeds in the range specified in the product section of this catalogue, which are also available on the insert box.
$K_{c1}$ values for various materials are listed in the table on page 47.

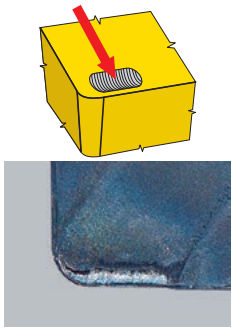
# TYPES OF WEAR ON PEELING INSERTS & TROUBLESHOOTING

## FLANK WEAR



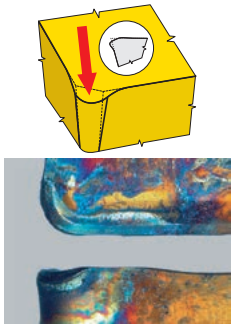
| | | |
|---|---|---|
| substrate | ↑ | Use a more wear resistant substrate (s) |
| (MT)CVD / PVD | ++ | Any coating (decisive factor is oxidation resistance – α $Al_2O_3$) |
| f | ↑ | Feed has influence on shape and position of groove |
| v | ↓ | Decrease cutting speed |
| $a_p$ | + | It has no influence |
| clearance angle | ↑ | Increase the clearance angle |
| coolant | | Use coolant or increase its intensity |

## CRATERING



| | | |
|---|---|---|
| substrate | ↑ | Use a more wear resistant substrate (s) |
| (MT)CVD / PVD | ++ | Any coating (decisive factor is thermal resistance – α $Al_2O_3$) |
| f | ↑ | Feed has influence on shape and position of crater |
| v | ↓ | Decrease cutting speed |
| $a_p$ | ↓ | Minimal effect |
| clearance angle | ↑ | Use more positive cutting geometry |
| coolant | ++ | Use coolant or increase its intensity |

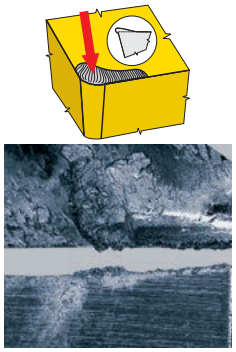
## PLASTIC DEFORMATION



| | | |
|---|---|---|
| substrate | ↑ | Use a more wear resistant grade (decisive factor is content of Co) |
| (MT)CVD / PVD | + | Any coating (decisive factor is friction) |
| f | ↓ | Decrease feed rate |
| v | ↓ | Decrease cutting speed |
| $a_p$ | ↓ | Minimal effect |
| clearance angle | ↑ | Use another (more positive) cutting geometry |
| coolant | ++ | Use coolant or increase its intensity |

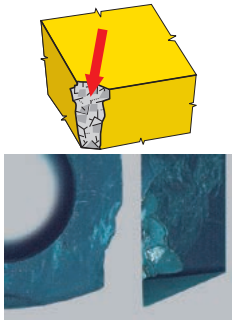
# TYPES OF WEAR ON PEELING INSERTS & TROUBLESHOOTING

## BUILT–UP EDGE



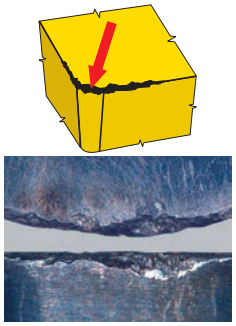
| | | |
|---|---|---|
| | | It has no influence |
| (MT)CVD / PVD | + + | Any coating (decisive factor is anti-adhesion effect) |
| f | ↑ | The higher the feed rate the less probability of built-up edge creation. |
| v | ↓↑ | Change (generally increase) the cutting speed. |
| $a_p$ | | It has no influence |
| | ↓↑ | Use more positive geometry |
| | - | Use a coolant with more effective anti-sticking properties (or no coolant at all) |

## INSERT FRACTURE



| | | |
|---|---|---|
| | ↓ | (H) grain has a great influence |
| (MT)CVD / PVD | + | PVD coating recommended |
| f | ↓ | Reduces the force load |
| v | ↑↓ | It is about swarf control and vibration |
| $a_p$ | ↓ | Reduces the force load |
| | ↓ | Use less positive cutting geometry |
| | | It has no influence |
| | | Use better working conditions |

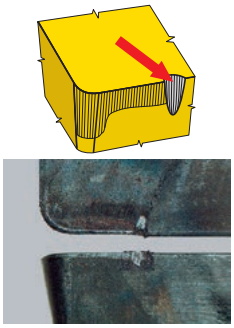
## BRITTLE CRACKS AT THE CUTTING EDGE



| | | |
|---|---|---|
| | ↓ | (H) grain has a great influence |
| (MT)CVD / PVD | + | PVD coating recommended |
| f | ↓ | Good swarf control is very important |
| v | ↑↓ | It is about swarf control and vibration |
| $a_p$ | ↓ | Reduces the force load (important for machining with long overhangs) |
| | ↓ | Use less positive cutting geometry; Use insert with wider T-land |
| | | It has no influence |

# TYPES OF WEAR ON PEELING INSERTS & TROUBLESHOOTING

## SIDE FLANK NOTCH – REMEDY



| | | |
|---|---|---|
| | ↑ ↓ | It depends on the character of the damage (abrasive – use more wear resistant substrate; breaking – use tougher substrate) |
| (MT)CVD PVD | + + | CVD coating (decisive factor is oxidation resistance – α $Al_2O_3$) |
| f | ↓ | Feed has influence on intensity, but less than the cutting speed |
| V | ↓ | Decrease cutting speed |
| | ↓ | Minimal effect |
| | + | Use another (more positive) cutting geometry |
| | | Use tool with smaller setting angle |

## NON – CIRCULAR BAR CROSS SECTION

Description:

- uneven bar surface (unstable depth of cut)
- non adjusted tool (incorrectly fixed inserts)
- bars are not brought into peeling head by coaxial way

Troubleshooting:

- check value of cutting depth–(noncircular raw) product = (noncircular final bar)
- check inserts clamping and slide of cartridge or toolholder
- check entry rollers adjustment
- check outgoing rollers adjustment

## VIBRATIONS

- guide rollers are adjusted incorrectly
- smoothing edge is too sharp
- small damping facet on smoothing edge
- cutting edge is under axis
- too thin chips (insufficient feed rate)
- uneven or too high wear of inserts
- check leading rollers adjustment
- increase cutting edge rounding
- increase support facet on flank surface facet
- check cutting edge position (to axis or above axis)
- increase feed rate „f" (mm/rev)
- check insert adjustment

## POOR SURFACE (HELICAL TRACE)

- insert clamping is incorrect, worn insert pocket
- feed „f" (mm/rev) is bigger than length of smoothing edge
- smoothing edge is not parallel to bar axis
- check adjustment and wear of insert (change insert)
- decrease feed rate „f" (mm/rev)
- check insert adjustment

## BAD CHIP FORMATION

- too low feed per insert
- not enough coolant
- incorrect geometry of insert
- increase the feed per insert
- increase coolant efficiency
- change insert geometry

## UNEVEN WEAR BETWEEN INDEXABLE INSERTS

- different depth of cut for each indexable insert
- tool holder with damaged insert pocket
- insert clamped incorrectly
- check the tool-holders pre-adjustment
- use only tool-holder in good condition (change the shims if applied)
- clean the inset pocket properly before clamping of new insert

| Value | Unit | Formula |
|---|---|---|
| **Number of revolutions** | [rev/min] | $n = \frac{v_c \,.\, 1000}{DC \,.\, p}$ |
| **Cutting speed** | [m/min] | $v_c = \frac{\pi \,.\, DC \,.\, n}{1000}$ |
| **Feed per revolution** | [mm/rev] | $f_{rev} = \frac{f_{min}}{n} = f_z \,.\, z$ |
| **Feed per minute (speed of feed)** | [mm/min] | $f_{min} = v_f = f_{rev} \,.\, n = f_z \,.\, z \,.n$ |
| **Feed per one tool-holder in peeling head** | [mm/tooth] | $f_z = \frac{f_{rev}}{z} = \frac{f_{min}}{n \,.\, z}$ |
| **Chip cross section** | [mm$^2$] | $A = f_z \,.\, a_p$ |
| **Chip thickness (for inserts with a straight cutting edge)** | [mm] | $h = f_z \,.\, \sin k_r$ |
| **Chip thickness (for round cutting inserts)** | [mm] | $h = f_z \,.\, \sqrt{\frac{a_p}{INSD}}$ |
| **Metal removal rate** | [cm$^3$/min] | $Q = a_p \,.\, f_{rev} \,.\, v_c$ |
| **Power demand** | [kW] | $P_c = \frac{a_p \,.\, f_z \,.\, v_c \,.\, \frac{k_{c1}}{h^{mc}}}{60000\,\eta} \,.\, Z$ |

**Note:**

| | Quantity | Unit |
|---|---|---|
| n | Number of revolutions | [rev/min] |
| DC | Diameter (of work piece) | [mm] |
| $v_c$ | Cutting speed | [m/min] |
| $f_{rev}$ | Feed per revolution of peeling head | [mm/rev] |
| A | Chip cross section (per one tool-holder / cassette) | [mm$^2$] |
| $a_p$ | Axial depth of cut (depth of cut) | [mm] |
| KRINS | Setting angle of insert main cutting edge | [°] |
| $f_{min}$ | Feed per minute (sometimes called speed of feed) | [mm/min] |
| $f_z$ | Feed per tooth (one tool-holder) | [mm/tooth] |
| z | Number of teeth (tool-holder) | [-] |
| INSD | Diameter of insert | [mm] |

| | Quantity | Unit |
|---|---|---|
| h | Chip thickness | [mm] |
| Q | Material removal rate per minute | [cm$^3$/min] |
| Pc | Power demand | [kW] |
| kc1 | Specific cutting force per 1 mm2 chip cross-section ( see the table at page 47) | [MPa] |
| kc | Specific cutting force according to chip cross-section and thickness | [MPa] |
| η | Machine efficiency usually η = 0,65 | [-] |
| mc | Exponent related to work piece material – (see the table at page 47) | [-] |

## BAR PEELING – TECHNICAL INFO – SPECIFIC CUTTING FORCE TABLE

TABLE

| | | | | Ultimate tensile strength Mpa ($N/mm^2$) | Specific Cutting force kc1 N/mm2 | Increase Value mc |
|---|---|---|---|---|---|---|
| P | P1 | P1.1 | Free machining sulfurized carbon steel with a hardness of < 240 HB | ≤ 830 | 1500 | 0.24 |
| | | P1.2 | Free machining sulfurized and phosphorized carbon steel with a hardness of < 180 HB | ≤ 620 | 1250 | 0.24 |
| | | P1.3 | Free machining sulfurized/phosphorized and leaded carbon steel with a hardness of <180 HB | ≤ 620 | 1250 | 0.24 |
| | P2 | P2.1 | Plain low carbon steel containing < 0.25 %C with a hardness of < 180 HB | ≤ 620 | 1250 | 0.24 |
| | | P2.2 | Plain medium carbon steel containing < 0.55%C with a hardness of < 240 HB | ≤ 830 | 1500 | 0.24 |
| | | P2.3 | Plain high carbon steel containing > 0.55%C, with a hardness of < 300HB | ≤ 1030 | 1650 | 0.24 |
| | P3 | P3.1 | Alloy steel with a hardness of < 190 HB | ≤ 620 | 1550 | 0.24 |
| | | P3.2 | Alloy steel with a hardness of 180–260 HB | > 620 ≤ 900 | 1650 | 0.24 |
| | | P3.3 | Alloy steel with a hardness of 260–360 HB | > 900 ≤ 1240 | 1750 | 0.24 |
| | P4 | P4.1 | Tool steel with a hardness of < 26 HRC | ≤ 900 | 1800 | 0.24 |
| | | P4.2 | Tool steel with a hardness of 26-39 RC | > 900 ≤ 1240 | 2000 | 0.24 |
| | | P4.3 | Tool steel with a hardness of 39-45 HRC | > 1250 ≤ 1450 | 2300 | 0.24 |
| M | M1 | M1.1 | Stainless steel, ferritic with a hardness of < 160 HB | ≤ 520 | 1750 | 0.20 |
| | | M1.2 | Staintess steel, ferritic with a hardness of 160–220 HB | > 520 ≤ 700 | 1950 | 0.20 |
| | M2 | M2.1 | Stainless steel, martensitic with a hardness of < 200 HB | > 670 | 2100 | 0.20 |
| | | M2.2 | Stainiess steel, martensitic with a hardness of 200–280 HB | > 670 ≤ 950 | 2200 | 0.20 |
| | | M2.3 | Stainless steel, martensitic with a hardness of 280–380 HB | > 950 ≤ 1300 | 2450 | 0.20 |
| | M3 | M3.1 | Stainless steel, austenitic with a hardness of < 200 HB | ≤ 730 | 1900 | 0.20 |
| | | M3.2 | Stainiess steel, austenitic with a hardness of 200–260 HB | > 750 ≤ 870 | 2100 | 0.20 |
| | | M3.3 | Stainiess steel, austenitic with a hardness of 260-300 HB | > 870 ≤ 1040 | 2200 | 0.20 |
| | M4 | M4.1 | Stainless steel, austenitic-ferritic or super-austenitic with a hardness of < 300 HB | ≤ 990 | 2350 | 0.20 |
| | | M4.2 | Stainless steel, precipitation hardening austenitic with a hardness of 300–380 HB | ≤ 1320 | 2500 | 0.20 |
| S | S1 | S1.1 | Titanium or titanium alloys, with a hardness of < 200 HB | ≤ 660 | 1400 | 0.22 |
| | | S1.2 | Titanium alloys, with a hardness of 200–280 HB | > 660 ≤ 950 | 1500 | 0.22 |
| | | S1.3 | Titanium alloys, a hardness of 280–360 HB | > 950 ≤ 1200 | 1600 | 0.22 |
| | S2 | S2.1 | High-temperature Fe-based alloys with a hardness of < 200 HB | ≤ 690 | 2450 | 0.24 |
| | | S2.2 | High-temperature Fe-based alloys with a hardness of 200–280 HB | > 690 ≤ 970 | 2550 | 0.24 |
| | S3 | S3.1 | High-temperature Ni-based alloys with a hardness of < 260 HB | ≤ 940 | 2850 | 0.24 |
| | | S3.2 | High-temperature Ni-based alloys with a hardness of 280–360 HB | > 940 ≤ 1200 | 3100 | 0.24 |
| | S4 | S4.1 | High-temperature Co-based alloys with a hardness of < 240HB | ≤ 800 | 2880 | 0.24 |
| | | S4.2 | High-temperature Co-based alloys with a hardness of 240–320 HB | >800 ≤ 1070 | 3100 | 0.24 |



# RECOMMENDED SCREWS TORQUE AND USEFUL TABLES

# RECOMMENDED TORQUE OF CLAMPING SCREWS

| Clamping screw | Torque | Thread | Length |
|---|---|---|---|
| | (Nm) | – | (mm) |
| US 20 | 0.9 | M 2 | 3 |
| US 2205-T07P | 0.9 | M 2.2 | 5 |
| US 25 | 1.2 | M 2.5 | 5 |
| US 2505-T08P | 1.2 | M 2.5 | 5 |
| US 2506-T07P | 1.2 | M 2.5 | 6 |
| US 3006-T09P | 2 | M 3 | 6 |
| US 3007-T09P | 2 | M 3 | 7 |
| US 3504-T09P | 3 | M 3.5 | 4 |
| US 3507-T15 | 3 | M 3.5 | 7 |
| US 3509-T15 | 3 | M 3.5 | 9 |
| US 3511-T15 | 3 | M 3.5 | 11 |
| US 3512-T15P | 3 | M 3.5 | 12 |
| US 4008-T15P | 3.5 | M 4 | 8 |
| US 4011-T15P | 3.5 | M 4 | 11 |
| US 4511-T20 | 5 | M 4.5 | 11 |
| US 5012-T15P | 5 | M 5 | 12 |
| US 70 | 5 | M 4 | 5 |
| US 71 | 5 | M 4 | 7 |
| US 72 | 5 | M 4 | 9 |
| US 73 | 5 | M 4 | 11 |
| CS 3007-T08P | 1.2 | M 3 | 7 |
| CS 4008-T15P | 3 | M 4 | 8 |
| CS 42506-T07P | 1 | M 2.5 | 6 |
| CS 43008-T08P | 1.2 | M 3 | 8 |
| CS 43509-T10P | 2 | M 3.5 | 9 |
| CS 44013-T15P | 3 | M 4 | 13 |
| CS 45016-T20P | 5 | M 5 | 16 |
| CS 46020-T25P | 7.5 | M 6 | 20 |
| CS 48025-T40P | 15 | M 8 | 25 |
| CS 5009-T20P | 5 | M 5 | 9 |
| CS 5013-T20P | 5 | M 5 | 13 |
| CS 5015-T20P | 5 | M 5 | 15 |
| CS 6020-T20P | 7.5 | M 6 | 20 |
| CS 8025-T30P | 15 | M 8 | 25 |
| US 2505-T07P | 1.2 | M 2.5 | 5 |
| US 2506-T07P | 1.2 | M 2.5 | 6 |
| US 3007-T09P | 2 | M 3 | 7 |
| US 3505-T09P | 3 | M 3.5 | 5 |
| US 4011A-T15P | 3.5 | M 4 | 11 |
| US 4011-T15P | 3.5 | M 4 | 11 |
| US 44010-T15P | 3.5 | M 4 | 10 |
| US 44012-T15P | 3.5 | M 4 | 12 |
| US 45011-T20P | 5 | M 5 | 11 |
| US 45012-T20P | 5 | M 5 | 12 |
| US 5011-T20P | 5 | M 5 | 11 |
| US 5018-T20P | 5 | M 5 | 18 |
| US 52506-T07P | 0.8 | M 2.5 | 6 |
| US 54511-T15P | 5 | M 4.5 | 11 |
| US 62003A-T06P | 0.6 | M 2 | 3 |
| US 62004A-T06P | 0.6 | M 2 | 4 |
| US 62004-T06P | 0.6 | M 2 | 4 |
| US 62505-T07P | 1.2 | M 2.5 | 5 |
| US 62506-T07P | 1.2 | M 2.5 | 6 |
| US 62506-T08P | 1.2 | M 2.5 | 6 |
| US 62508-T08P | 1.2 | M 2.5 | 7 |
| US 63009-T09P | 1.2 | M 3 | 9 |
| US 63509-T15P | 3 | M 3.5 | 10 |
| US 63510-T10P | 2 | M 3.5 | 9 |
| US 63511D-T15P | 3 | M 3.5 | 11 |

| Clamping screw | Torque | Thread | Length |
|---|---|---|---|
| | (Nm) | – | (mm) |
| US 63513-T15P | 3 | M 3.5 | 12 |
| US 64014-T15P | 3.5 | M 4 | 14 |
| US 65013-T20 | 5 | M 5 | 13 |
| US 65014-T20P | 5 | M 5 | 14 |
| US 65017-T20P | 5 | M 5 | 17 |
| US 66015-T25P | 7.5 | M 6 | 15 |
| US 68020-T30P | 15 | M 8 | 20 |
| US 68026-T30P | 15 | M 8 | 26 |
| US 74016-T15P | 3.5 | M 4 | 16 |

## Torque screwdrivers

| Torque handle  | Torque (Nm) | Clamping screw thread |
|---|---|---|
| MR-0.8-2.0 Vario | 0.5 – 2.0 | M 2 – M 3 |
| MR-1.0-5.0 Vario | 0.8 – 5.0 | M 2.5 – M 5 |
| MR-0.9 fix | 0.9 | M 2 |
| MR-2.0 fix | 2.0 | M 3 |
| MR-3.0 fix | 3.0 | M 3.5 |
| MR-3.5 fix | 3.5 | M 4 |
| MR-5.0 fix | 5.0 | M 5 |

## Replaceable shanks

| Replaceable shanks  |
|---|
| D-T6 |
| D-T6P |
| D-T7 |
| D-T7P |
| D-T8 |
| D-T8P |
| D-T9 |
| D-T9P |
| D-T15 |
| D-T15P |
| D-T20 |
| D-T20P |

## Screw lubrication

Insert clamping screws are subject to high thermal stresses. It is recommended that all screws be lubricated with a high quality paste such as MOLYKOTE 1000.

# RECOMMENDED SCREW TORQUES

## CLAMPING SCREW

| Screw designation | Screwdriver | Torque (Nm) |
|---|---|---|
| **28588** | MA2-8304 | 0.8 |
| **28992** | MA2-8304 | 0.8 |
| **416.1-832** | PT-8002 | 3.6 |
| **5513 020-01** | PT-8004 | 3.6 |
| **5513 020-03** | PT-8001 | 0.8 |
| **5513 020-04** | PT-8003 | 1.5 |
| **5513 020-05** | PT-8001 | 0.8 |
| **5513 020-14** | TX 225PLUS | 8.5 |
| **5513 020-24** | PT-8002 | 1.5 |
| **5513 020-27** | PT-8000 | 0.6 |
| **5513 020-28** | PT-8000 | 0.6 |
| **5513 021-03** | DMN 3124 | 13 |
| **CS 8601-T09P** | SDR T09P | 1.7 |
| **CS 8601-T15P** | SDR T15P | 3.9 |
| **CS 8601-T20P** | SDR T20P | 6.4 |
| **CS 8601-T25P** | SDR T25P | 9.5 |
| **DVF 0573** | PT-8002 | 1.5 |
| **DVF 2260** | TX 215PLUS | 3.6 |
| **DVF 3584** | DMD 1650 | 0.6 |
| **DVF 3593** | TX 207PLUS | 0.8 |
| **HS 0408** | HXK 3 | 5 |
| **HS 0520C** | HXK 4 | 5 |
| **HS 0616C** | HXK 5 | 8 |
| **HS 0620** | HXK 5 | 6 |
| **HS 0620C** | HXK 5 | 6 |
| **HS 0625** | HXK 5 | 6 |
| **HS 0625C** | HXK 5 | 6 |
| **HS 0630** | HXK 5 | 6 |
| **HS 0825** | HXK 6 | 10 |
| **HS 0830** | HXK 6 | 10 |
| **HS 0835** | HXK 6 | 10 |
| **HS 0840** | HXK 8 | 11 |
| **HS 1030** | HXK 8 | 8 |
| **HS 1060** | HXK 6 | 10 |
| **HS 93** | HXK 5 | 8 |
| **HS 94** | HXK 5 | 8 |
| **HSI 1020** | HXK 6 | 8 |
| **PS 0512** | HXK 2 | 2 |
| **PS 0512-A** | HXK 2 | 2 |
| **PS 0616** | HXK 2,5 | 4 |
| **PS 12040** | HXK 5 | 8 |
| **PS 6026-709P** | SRD T09P | 2 |

## CLAMPING SCREW

| Screw designation | Screwdriver | Torque (Nm) |
|---|---|---|
| **PS 8290** | HXK 2 | 2 |
| **SR 14** | HXK 10 | 10 |
| **SR 85011-T15P** | SDR T15P | 5 |
| **SR 85017-T09P** | SDR T09P | 2 |
| **SR 85020-T15P** | SDR T15P | 3 |
| **SR 86025-T20P** | SRD T20P | 5 |
| **T20.037** | DMD 1650 | 0.6 |
| **UP 0909-T09P** | SRD T09P | 2 |
| **UP 1515-T15P** | SDR T15P | 8 |
| **US 2505-T07P** | SDR T07P | 0.9 |
| **US 2506-T07P** | SDR T07P | 0.9 |
| **US 3007-T09P** | SDR T09P | 2 |
| **US 34** | HXK 3 | 5 |
| **US 35** | HXK 4 | 6 |
| **US 3508-T15P** | SDR T15P | 3 |
| **US 3510A-T15P** | SDR T15P | 3 |
| **US 3510-T15P** | SDR T15P | 3 |
| **US 3512A-T15P** | SDR T15P | 3 |
| **US 3512-T15P** | SDR T15P | 3 |
| **US 36** | HXK 4 | 6 |
| **US 38** | HXK 5 | 8 |
| **US 39** | HXK 5 | 8 |
| **US 40** | HXK 4 | 6 |
| **US 4008-T15P** | SDR T15P | 3.5 |
| **US 4011-T15P** | SDR T15P | 3.5 |
| **US 41** | HXK 4 | 6 |
| **US 42** | HXK 4 | 6 |
| **US 45013-T20P** | SDR T20P | 5 |
| **US 4512-T15P** | SDR T15P | 5 |
| **US 4514A-T20** | SDR T20 | 5 |
| **US 46** | HXK 3 | 5 |
| **US 46017-T20P** | SDR T20P | 5 |
| **US 47** | HXK 5 | 8 |
| **US 5012-T15P** | SDR T15P | 5 |
| **US 5015-T20P** | SDR T20P | 5 |
| **US 5018-T20P** | SDR T20P | 5 |
| **US 6020-T25P** | SDR T25P | 6 |
| **US 64518-T15P** | SDR T15P | 5 |
| **US 8025-T30P** | SDR T20P | 13 |
| **US 83** | HXK 4 | 6 |
| **US 95** | HXK 4 | 10 |

## TORQUE SCREWDRIVERS

| Torque handle | Torque (Nm) | Clamping screw thread |
|---|---|---|
| **MR-0.8-2.0 vario** | 0.5 – 2.0 | M 2 – M 3 |
| **MR-1.0-5.0 vario** | 0.8 – 5.0 | M 2.5 – M 5 |
| | | |
| **MR-0.9 fix** | 0.9 | M 2 |
| **MR-2.0 fix** | 2.0 | M 3 |
| **MR-3.0 fix** | 3.0 | M 3.5 |
| **MR-3.5 fix** | 3.5 | M 4 |
| **MR-5.0 fix** | 5.0 | M 5 |

## REPLACEABLE SHANKS

| Replaceable shanks | | |
|---|---|---|
| **D-T6** | **D-T8** | **D-T15** |
| **D-T6P** | **D-T8P** | **D-T15P** |
| **D-T7** | **D-T9** | **D-T20** |
| **D-T7P** | **D-T9P** | **D-T20P** |

## SCREW LUBRICATION

Insert clamping screws are subject to high thermal stresses. It is recommended that all screws be lubricated with a high quality paste such as MOLYKOTE 1000.

## HARDNESS CONVERSION TABLE

| Strength (MPa) | Hardness | | | |
|---|---|---|---|---|
| | BRINELL | VICKERS | ROCKWELL | ROCKWELL |
| $R_m$ | HB | HV | HRB | HRC |
| 285 | 86 | **90** | 1190 | – |
| 320 | 95 | **100** | 56.2 | – |
| 350 | 105 | **110** | 62.3 | – |
| 385 | 114 | **120** | 66.7 | – |
| 415 | 124 | **130** | 71.2 | – |
| 450 | 133 | **140** | 75.0 | – |
| 480 | 143 | **150** | 78.7 | – |
| 510 | 152 | **160** | 81.7 | – |
| 545 | 162 | **170** | 85.8 | – |
| 575 | 171 | **180** | 87.1 | – |
| 610 | 181 | **190** | 89.5 | – |
| 640 | 190 | **200** | 91.5 | – |
| 675 | 199 | **210** | 93.5 | – |
| 705 | 209 | **220** | 95 | – |
| 740 | 219 | **230** | 96.7 | – |
| 770 | 228 | **240** | 98.1 | – |
| 800 | 238 | **250** | 99.5 | – |
| 820 | 242 | **255** | – | 23.1 |
| 850 | 252 | **265** | – | 24.8 |
| 880 | 261 | **275** | – | 26.4 |
| 900 | 266 | **280** | – | 27.1 |
| 930 | 276 | **290** | – | 28.5 |
| 950 | 280 | **295** | – | 29.2 |
| 995 | 295 | **310** | – | 31.0 |
| 1030 | 304 | **320** | – | 32.2 |
| 1060 | 314 | **330** | – | 33.3 |
| 1095 | 323 | **340** | – | 34.4 |
| 1125 | 333 | **350** | – | 35.5 |
| 1155 | 342 | **360** | – | 36.6 |

| Strength (MPa) | Hardness | | | |
|---|---|---|---|---|
| | BRINELL | VICKERS | ROCKWELL | ROCKWELL |
| $R_m$ | HB | HV | HRB | HRC |
| 1190 | 352 | **370** | – | 37.7 |
| 1220 | 361 | **380** | – | 38.8 |
| 1255 | 371 | **390** | – | 39.8 |
| 1290 | 380 | **400** | – | 40.8 |
| 1320 | 390 | **410** | – | 41.8 |
| 1350 | 399 | **420** | – | 42.7 |
| 1385 | 409 | **430** | – | 43.6 |
| 1420 | 418 | **440** | – | 44.5 |
| 1455 | 428 | **450** | – | 45.3 |
| 1485 | 437 | **460** | – | 46.1 |
| 1520 | 447 | **470** | – | 46.9 |
| 1555 | 456 | **480** | – | 47.7 |
| 1595 | 466 | **490** | – | 48.4 |
| 1630 | 475 | **500** | – | 49.1 |
| 1665 | 485 | **510** | – | 49.8 |
| 1700 | 494 | **520** | – | 50.5 |
| 1740 | 504 | **530** | – | 51.1 |
| 1775 | 513 | **540** | – | 51.7 |
| 1810 | 523 | **550** | – | 52.3 |
| 1845 | 532 | **560** | – | 53.0 |
| 1880 | 542 | **570** | – | 53.6 |
| 1920 | 551 | **580** | – | 54.1 |
| 1955 | 561 | **590** | – | 54.7 |
| 1995 | 570 | **600** | – | 55.2 |
| 2030 | 580 | **610** | – | 55.7 |
| 2070 | 589 | **620** | – | 56.3 |
| 2105 | 599 | **630** | – | 56.8 |
| 2145 | 608 | **640** | – | 57.3 |
| 2180 | 618 | **650** | – | 57.8 |

**Industry Standard tolerancess For Shafts & Holes**

Tolerance values are shown in Microns (µm)

Formula for Microns ...1 µm = 0.001 mm / 0.000039 "

| Tolerance | **Diameter** (mm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | > 1 ≤ 3 | > 3 ≤ 6 | > 6 ≤ 10 | > 10 ≤ 18 | > 18 ≤ 30 | > 30 ≤ 50 | > 50 ≤ 80 | > 80 ≤ 120 |
| | **Diameter** (inch) | | | | | | | |
| | > 0.039" ≤ 0.118" | > 0.118" ≤ 0.236" | > 0.236" ≤ 0.394" | > 0.394" ≤ 0.709" | > 0.709" ≤ 1.181" | > 1.181" ≤1.968" | >1.968" ≤ 3.149" | > 3.149" ≤ 4.724" |
| | **Tolerance values** (µm) | | | | | | | |
| **e8** | -14 / -28 | -20 / -38 | -25 / -47 | -32 / -59 | -40 / -73 | -50 / -89 | -60 / -106 | -72 / -126 |
| **f6** | -6 / -12 | -10 / -18 | -13 / -22 | -16 / -27 | -20 / -33 | -25 / -41 | -30 / -49 | -36 / -58 |
| **f7** | -6 / -16 | -10 / -22 | -13 / -28 | -16 / -34 | -20 / -41 | -25 / -50 | -30 / -60 | -36 / -71 |
| **h6** | 0 / -6 | 0 / -8 | 0 / -9 | 0 / -11 | 0 / -13 | 0 / -16 | 0 / -19 | 0 / -22 |
| **h7** | 0 / -10 | 0 / -12 | 0 / -15 | 0 / -18 | 0 / -21 | 0 / -25 | 0 / -30 | 0 / -35 |
| **h8** | 0 / -14 | 0 / -18 | 0 / -22 | 0 / -27 | 0 / -33 | 0 / -39 | 0 / -46 | 0 / -54 |
| **h9** | 0 / -25 | 0 / -30 | 0 / -36 | 0 / -43 | 0 / -52 | 0 / -62 | 0 / -74 | 0 / -87 |
| **h10** | 0 / -40 | 0 / -48 | 0 / -58 | 0 / -70 | 0 / -84 | 0 / -100 | 0 / -120 | 0 / -140 |
| **h11** | 0 / -60 | 0 / -75 | 0 / -90 | 0 / -110 | 0 / -130 | 0 / -160 | 0 / -190 | 0 / -220 |
| **h12** | 0 / -100 | 0 / -120 | 0 / -150 | 0 / -180 | 0 / -210 | 0 / -250 | 0 / -300 | 0 / -350 |
| **k10** | +40 / 0 | +48 / 0 | +58 / 0 | +70 / 0 | +84 / 0 | +100 / 0 | +120 / 0 | +140 / 0 |
| **k12** | +100 / 0 | +120 / 0 | +150 / 0 | +180 / 0 | +210 / 0 | +250 / 0 | +300 / 0 | +350 / 0 |
| **m7** | +2 / +12 | +4 / +16 | +6 / +21 | +7 / +25 | +8 / +29 | +9 / +34 | +11 / +41 | +13 / +48 |
| **js14** | +/ -125 | +/ -150 | +/ -180 | +/ -215 | +/ -260 | +/ -310 | +/ -370 | +/ -435 |
| **js16** | +/ -300 | +/ - 375 | +/ -450 | +/ -550 | +/ -650 | +/ -800 | +/ -950 | +/ -1100 |
| **H7** | +10 / 0 | +12 / 0 | +15 / 0 | +18 / 0 | +21 / 0 | +25 / 0 | +30 / 0 | +35 / 0 |
| **H8** | +14 / 0 | +18 / 0 | +22 / 0 | +27 / 0 | + 33 / 0 | +39 / 0 | +46 / 0 | +54 / 0 |
| **H9** | +25 / 0 | +30 / 0 | +36 / 0 | +43 / 0 | +52 / 0 | +62 / 0 | +74 / 0 | +87 / 0 |
| **H12** | +100 / 0 | +120 / 0 | +150 / 0 | +180 / 0 | +210 / 0 | +250 / 0 | +300 / 0 | +350 / 0 |
| **P9** | -6 / -31 | -12 / -42 | -15 / -51 | -18 / -61 | -22 / -74 | -26 / -86 | -32 / -106 | -37 / -124 |
| **S7** | -13 / -22 | -15 / -27 | -17 / -32 | -21 / -39 | -27 / -48 | -34 / -59 | -42 / -72 | -58 / -93 |

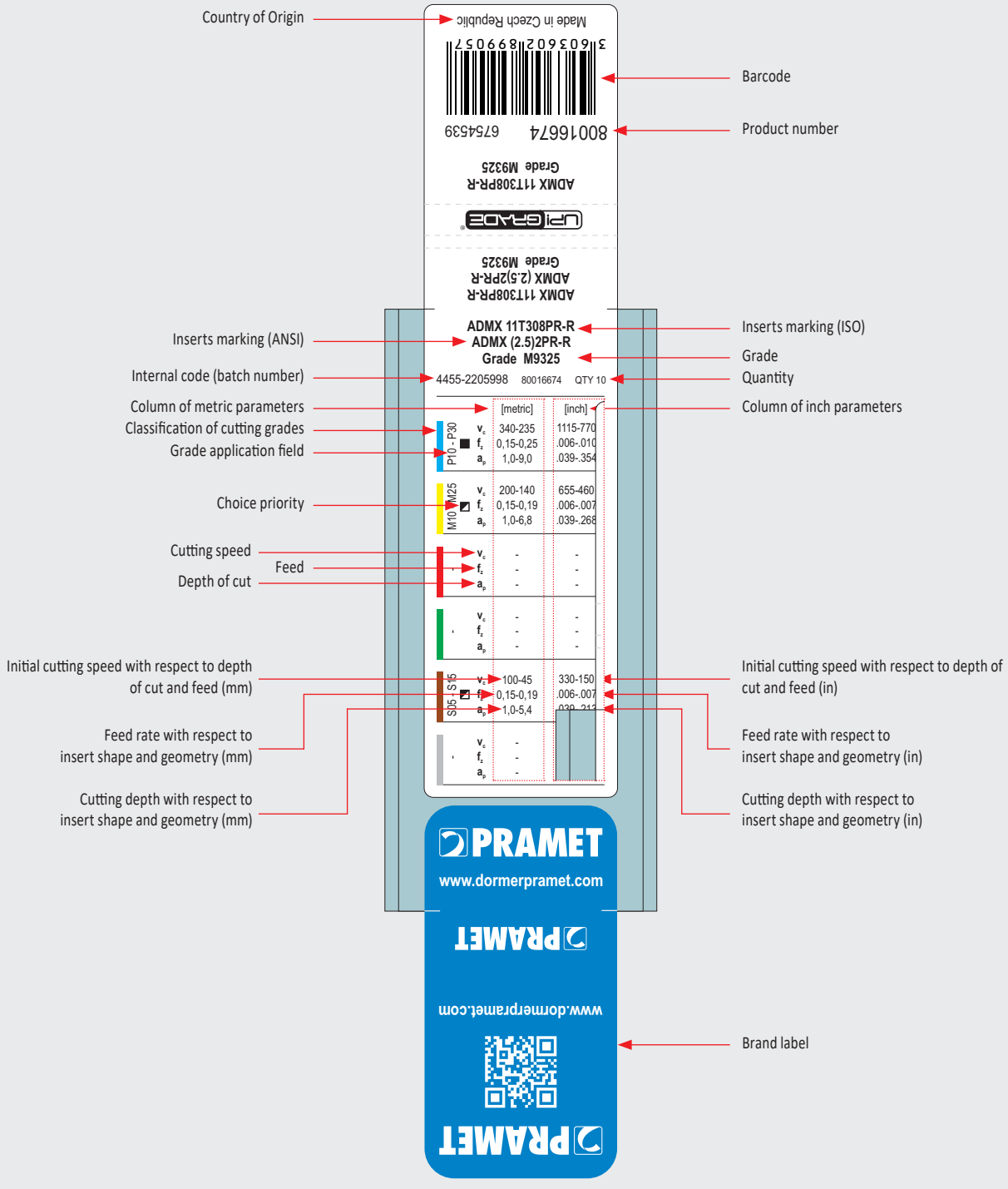
# RECOMMENDED DRILL SIZES FOR TAPPING

| Metric ISO threads | | Recommended drill diameter for | |
|---|---|---|---|
| **Thread** | Pitch | Cutting tap | Fluteless tap |
| **M16 × 1.0** | 1.00 | 15.0 | 15.5 |
| **M16 × 0.75** | 0.75 | 15.3 | – |
| **M17 × 1.0** | 1.00 | 16.0 | – |
| **M18** | 2.50 | 15.5 | 16.8 |
| **M18 × 2.0** | 2.00 | 16.0 | – |
| **M18 × 1.5** | 1.50 | 16.5 | 17.3 |
| **M18 × 1.0** | 1.00 | 17.0 | – |
| **M20** | 2.50 | 17.5 | 18.8 |
| **M20 × 2.0** | 2.00 | 18.0 | – |
| **M20 × 1.5** | 1.50 | 18.5 | 19.3 |
| **M20 × 1.0** | 1.00 | 19.0 | – |
| **M22** | 2.50 | 19.5 | 20.8 |
| **M22 × 2.0** | 2.00 | 20.0 | – |
| **M22 × 1.5** | 1.50 | 20.5 | 21.3 |
| **M22 × 1.0** | 1.00 | 21.0 | – |
| **M24** | 3.00 | 21.0 | 22.5 |
| **M24 × 2.0** | 2.00 | 22.0 | – |
| **M24 × 1.5** | 1.50 | 22.5 | 23.3 |
| **M27** | 3.00 | 24.0 | – |
| **M27 × 2.0** | 2.00 | 25.0 | – |
| **M30** | 3.50 | 26.5 | – |
| **M30 × 2.0** | 2.00 | 28.0 | – |
| **M33** | 3.50 | 29.5 | – |
| **M36** | 4.00 | 32.0 | – |
| **M36 × 3.0** | 3.00 | 33.0 | – |
| **M39** | 4.00 | 35.0 | – |
| **M42** | 4.50 | 37.5 | – |
| **M42 × 3.0** | 3.00 | 39.0 | – |
| **M45** | 4.50 | 40.5 | – |
| **M48** | 5.00 | 43.0 | – |
| **M48 × 3.0** | 3.00 | 45.0 | – |
| **M52** | 5.00 | 47.0 | – |
| **M52 × 3.0** | 3.00 | 48.0 | – |

| Inch threads UNF | | Recommended drill diameter for | |
|---|---|---|---|
| **Thread** | Pitch | Cutting tap | Fluteless tap |
| **3/4“** | 16 | 17.5 | 18.3 |
| **7/8“** | 14 | 20.5 | 21.3 |
| **1“** | 12 | 23.4 | 24.3 |
| **1 1/8“** | 12 | 26.5 | – |
| **1 1/4“** | 12 | 29.8 | – |
| **1 3/8“** | 12 | 33.0 | – |
| **1 1/2“** | 12 | 36.0 | – |

| Inch threads UNC | | Recommended drill diameter for | |
|---|---|---|---|
| **Thread** | Pitch | Cutting tap | Fluteless tap |
| **3/4“** | 10 | 16.7 | 17.8 |
| **7/8“** | 9 | 19.5 | 20.8 |
| **1“** | 8 | 22.2 | 23.8 |
| **1 1/8“** | 7 | 25.0 | – |
| **1 1/4“** | 7 | 28.2 | – |
| **1 3/8“** | 6 | 31.0 | – |
| **1 1/2“** | 6 | 34.0 | – |
| **1 3/4“** | 5 | 39.5 | – |
| **2“** | 4 1/2 | 45.2 | – |
| **2 1/4“** | 4 1/2 | 51.6 | – |
| **2 1/2“** | 4 | 57.2 | – |

| Whitworth pipe threads | | Recommended drill diameter for | |
|---|---|---|---|
| **Thread** | Pitch | Cutting tap | Fluteless tap |
| **G 3/8“** | 19 | 15.3 | 16.0 |
| **G 1/2“** | 14 | 19.0 | 20.0 |
| **G 5/8“** | 14 | 21.0 | 22.0 |
| **G 3/4“** | 14 | 24.5 | 25.5 |
| **G 7/8“** | 14 | 28.3 | 29.3 |
| **G 1“** | 11 | 30.8 | 32.0 |
| **G 1 1/8“** | 11 | 35.5 | – |
| **G 1 1/4“** | 11 | 39.5 | – |
| **G 1 3/8“** | 11 | 41.8 | – |
| **G 1 1/2“** | 11 | 45.3 | – |
| **G 1 3/4“** | 11 | 51.0 | – |
| **G 2“** | 11 | 57.0 | – |


Country of Origin
Made in Czech Republic
3 603602 899057
Barcode
80016674 6754539
Product number
ADMX 11T308PR-R
Grade M9325
UPI GRADE
ADMX 11T308PR-R
ADMX (2.5)2PR-R
Grade M9325
Inserts marking (ANSI)
Inserts marking (ISO)
ADMX 11T308PR-R
ADMX (2.5)2PR-R
Grade M9325
Grade
Internal code (batch number)
4455-2205998 80016674 QTY 10
Quantity
Column of metric parameters
Column of inch parameters
[metric] [inch]
Classification of cutting grades
Grade application field
P10 - P30
340-235 1115-770
0,15-0,25 .006-.010
1,0-9,0 .039-.354
Choice priority
M10 M25
200-140 655-460
0,15-0,19 .006-.007
1,0-6,8 .039-.268
Cutting speed
Feed
Depth of cut
Initial cutting speed with respect to depth of cut and feed (mm)
S05 - S15
100-45 330-150
0,15-0,19 .006-.007
1,0-5,4
Initial cutting speed with respect to depth of cut and feed (in)
Feed rate with respect to insert shape and geometry (mm)
Feed rate with respect to insert shape and geometry (in)
Cutting depth with respect to insert shape and geometry (mm)
Cutting depth with respect to insert shape and geometry (in)
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