# *DIJET CARBIDE TOOLS*

## Technical Information

*Technical Information*

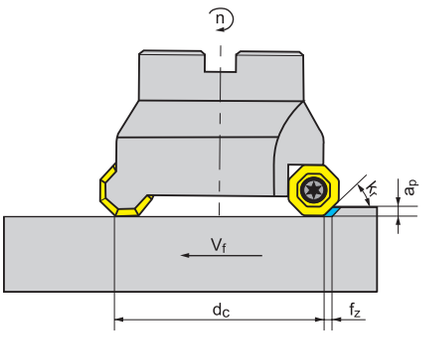
# Technical Information

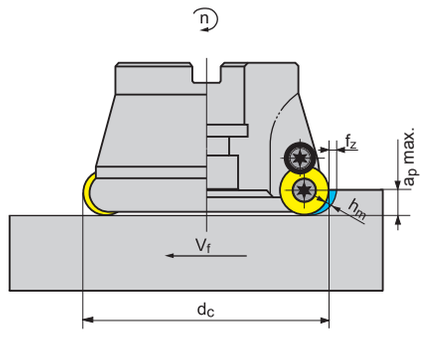
## Terminology and Formulas (for milling)

| | | | | | |
|---|---|---|---|---|---|
| $D_c$ | = Cutting diameter | mm. | $Z_c$ | = Effective number of teeth | |
| $a_e$ | = Cutting width (step) | mm. | $h_{ex}$ | = Max chip thickness | mm. |
| $a_p$ | = Depth of cut | mm. | $h_m$ | = Average chip thickness | mm. |
| $f_n$ | = Feed rate per revolution | mm. | $k_{c1}$ | = Specific cutting force ($h_{ex}$ = 1mm) | $N/mm^2$. |
| $f_z$ | = Feed rate per tooth | mm. | $P_c$ | = Net cutting power | KW. |
| $D_e$ | = Effective cutting diameter | mm. | $k_r$ | = Major cutting edge angle | deg. |
| $V_c$ | = Cutting speed | m/mm. | $V_{co}$ | = Constant for cutting speed | |
| Q | = Metal removal rate | cm3/min. | $C_{vc}$ | = Correction factor for cutting speed | |
| l | = Machined length | mm. | n | = Spindle speed | rev/min. |
| $V_f$ | = Table feed (feed rate) | mm/min. | $n_{mt}$ | = Efficiency | KW |
| $Da_p$ | = Max cutting diameter at specific depth | mm. | $m_c$ | = Rise in specific cuting force ($k_c$) as a function of chip thickness | |
| $Z_n$ | = Total number of edges in the tool | | | | |

### General formulas

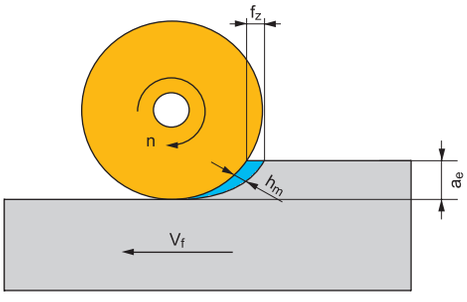
| | | | |
|---|---|---|---|
| Cutting speed | $V_c = \frac{\pi \times D_c \times n}{1000}$ = m/min. | Spindle speed | $n = \frac{V_c \times 1000}{\pi \times D_c}$ = rev/min. |
| Table feed (feed speed) | $V_f = f_z \times n \times z_n$ = mm/min. | Feed per tooth | $f_z = \frac{V_f}{n \times z_n}$ = mm. |
| Feed per revolution | $f_n = \frac{V_f}{n}$ = mm/rev. | Removal rate | $Q = \frac{a_p \times a_e \times V_f}{1000}$ = $cm^3$. |
| Specific cutting force | $k_c = k_{c1} \times h_{nm}^{-mc}$ = mm/min. | Effective cutting diameter | $D_e = 2 \times \sqrt{a_p \times (D_c - a_p)}$ = mm. |
| Average chip thickness (side & facemilling) when $a_e / D_c \leq 0.1$ | $h_m = f_z \sqrt{\frac{a_e}{D_c}}$ = mm. | Net power | $P_c = \frac{a_p \times a_e \times V_f \times k_c}{60 \times 10^6 \times n_{mt}}$ = KW |
| Average chip thickness when $a_e / D_c \geq 0.1$ | $h_m = \frac{\sin k_r \times 180 \times a_e \times f_z}{\pi \times D_c \times \arcsin\left(\frac{a_e}{D_c}\right)}$ = mm. | Cutting time | $T_c = \frac{l}{V_f}$ = min. |

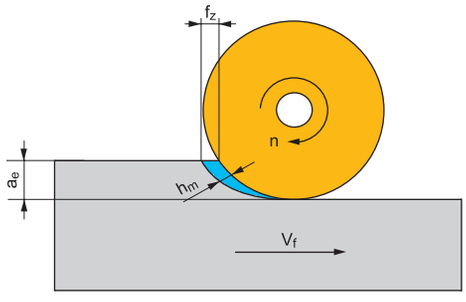


# Technical Information

## Up Cut and Down Cut




***Down Milling:***

- same workpiece direction, feed rate and rotation of milling cutter.
- chip cross-section start on the strongest point.

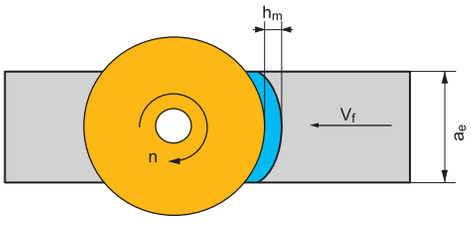
**Generally down milling should be prefered if rigid machine is available.**

***Up Milling:***

- the feed rate of workpiece is counter-clockwise to the sense of milling cutter rotation.
- chip cross-section starts on the weakest point.

**Up milling should be applied on instable milling machine and workpiece materials with higher hardness.**

## Tool with central work piece

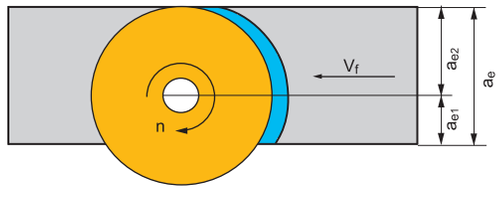



***Formulas:***

$$h_m = \frac{\sin(k_r) \times 180 \times a_e \times f_z}{\pi \times d_c \times \arcsin\left(\frac{a_e}{d_c}\right)}$$

$$f_z = \frac{h_m \times \pi \times \arcsin\left(\frac{a_e}{d_c}\right)}{\sin(k_r) \times 180 \times a_e}$$

## Tool with outside center work piece



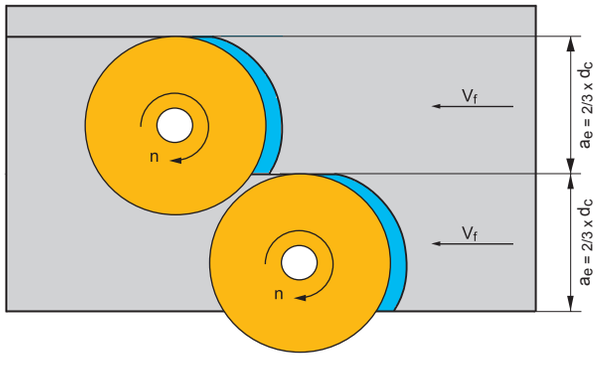

***Formulas:***

$$h_m = \frac{\sin(k_r) \times 360 \times a_e \times f_z}{\pi \times d_c \times \left[\arcsin\left(\frac{2xa_{e1}}{d_c}\right) + \arcsin\left(\frac{2xa_{e2}}{d_c}\right)\right]}$$

$$f_z = \frac{h_m \times \pi \times d_c \times \left[\arcsin\left(\frac{2xa_{e1}}{d_c}\right) + \arcsin\left(\frac{2xa_{e2}}{d_c}\right)\right]}{\sin(k_r) \times 360 \times a_e}$$

## Suggested milling operation

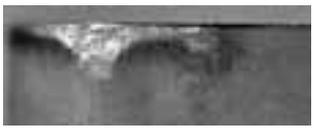
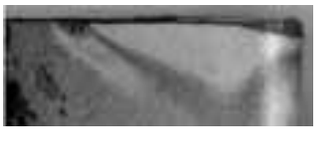
***We suggest to work like this when possible or in any case work with tangential tool exit. Up cut and down cut is possible with Ae Max. 2/3 of tool diameter.***



# Technical Information

| APPLICATIONS |
| --- |
| Turning |

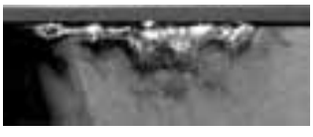
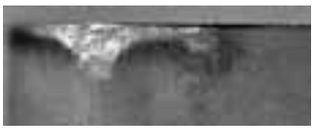
## *Troubleshooting*

| PROBLEM | CAUSE | RECOMMENDED ACTION |
| --- | --- | --- |
| **Chipping** | • insert grade<br>• speeds & feeds<br>• others | • Change to tougher grade<br>• Increase SFM if chipping is on trailing edge<br>• Decrease SFM if chipping is on leading edge<br>• Adjust chip load<br>• Minimize tool overhang<br>• Check for insert movement/check clamp |
| **Flank Wear**  | • insert grade<br>• speeds & feeds | • Change to more wear-resistant grade<br>• Decrease SFM |
| **Crater Wear** | • insert grade<br>• insert shape<br>• speeds & feeds<br>• others | • Change to more crater wear-resistant grade<br>• Change breaker<br>• Use positive rake insert<br>• Decrease SFM<br>• Adjust chip load |
| **Broken Nose** | • insert grade<br>• insert shape<br>• others | • Change to tougher grade<br>• Use larger nose radius if allowable<br>• Increase hone size<br>• Adjust chip load |
| **Built-up Edge** | • insert grade<br>• insert shape<br>• speeds & feeds<br>• others | • Change to tougher grade<br>• Adjust hone size<br>• Increase SFM<br>• Adjust depth of cut per pass<br>• Increase coolant concentration and/or flow |
| **Deformation**  | • insert grade<br>• speeds & feeds | • Change more heat-resistant grade<br>• Decrease SFM |

# Technical Information

| APPLICATIONS |
| --- |
| Milling |

## *Troubleshooting*

| PROBLEM | CAUSE | RECOMMENDED ACTION |
| --- | --- | --- |
| **Chipping**  | • insert grade<br>• speeds & feeds | • Change to tougher grade<br>• Increase the cutting speed<br>• Reduce the feed/tooth |
| **Flank Wear**  | • insert grade<br>• speeds & feeds | • Use a more wear-resistant grade<br>• Reduce the cutting speed<br>• Increase the feed/tooth |
| **Crater Wear** | • insert grade<br>• speeds & feeds | • Use a more crater wear-resistant grade<br>• Reduce the cutting speed<br>• Reduce the feed/tooth |
| **Broken Nose** | • insert grade<br>• speeds & feeds<br>• insert shape | • Use a tougher grade<br>• Adjust the cutting speed<br>• Adjust the feed/tooth<br>• Use a thicker insert |
| **Poor Surface Finish** | • insert grade<br>• speeds & feeds<br>• insert shape<br>• tool shape | • Use a more wear-resistant grade<br>• Increase the cutting speed<br>• Use a polished insert<br>• Use a higher rake cutter |
| **Burrs, Chipping, etc.** | • insert grade<br>• tool shape | • Increase the cutting speed<br>• Reduce the feed/tooth<br>• Use a higher rake cutter |
| **Vibration** | • speeds & feeds | • Reduce the cutting speed<br>• Reduce the feed/tooth |

# Technical Information

| APPLICATIONS |
| --- |
| Drilling |

## *Troubleshooting*

| PROBLEM | CAUSE | RECOMMENDED ACTION |
| --- | --- | --- |
| **Drill Breakage** | • speeds & feeds<br>• cutting fluid<br>• others | • Maintain constant feed rate<br>• Reduce the cutting speed<br>• Reduce the feed rate<br>• Increase coolant flow<br>• Use a machine with sufficient horsepower<br>• Tighten workpiece clamping |
| **Center Point Breakage** | • tool<br>• speeds & feeds<br>• others | • Reduce drill overhang<br>• Maintain constant feed rate<br>• Reduce the feed rate when starting drill<br>• Use a machine with sufficient horsepower<br>• Tighten work piece clamping |
| **Peripheral Cutting Edge Breakage** | • tool<br>• speeds & feeds<br>• others | • Reduce drill overhang<br>• Maintain constant feed rate<br>• Reduce the cutting speed<br>• Use a machine with sufficient horsepower<br>• Tighten workpiece clamping |
| **Chipping** | • tool<br>• speeds & feeds<br>• cutting fluid<br>• others | • Reduce drill overhang<br>• Maintain constant feed rate<br>• Change the feed rate<br>• Increase coolant flow<br>• Use a machine with sufficient horsepower<br>• Tighten workpiece clamping |
| **Long Stringy Chips** | • tool<br>• speeds & feeds | • Less lead angle<br>• Increase hone<br>• Maintain constant feed rate<br>• Increase the feed rate |
| **Chip Form Varies** | • speeds & feeds<br>• cutting fluid<br>• others | • Maintain constant feed rate<br>• Maintain constant coolant flow<br>• Use a machine with sufficient horsepower |

# Technical Information

| APPLICATIONS |
| --- |
| Drilling |

## *Troubleshooting*

| PROBLEM | CAUSE | RECOMMENDED ACTION |
| --- | --- | --- |
| **Over Size or Out-of-Round** | • tool<br>• speeds & feeds<br>• others | • Reduce drill overhang<br>• Increase lead angle<br>• Increase the cutting speed<br>• Reduce the feed rate<br>• Use a machine with sufficient horsepower<br>• Tighten workpiece clamping |
| **Poor Surface Finish** | • speeds & feeds<br>• others | • Maintain constant feed rate<br>• Increase the cutting speed<br>• Reduce the feed rate<br>• Use low feed rate when starting drill<br>• Use a machine with sufficient horsepower<br>• Tighten workpiece clamping |
| **Galling on Drill Body** | • tool<br>• speeds & feeds<br>• others | • Reduce drill overhang<br>• Reduce the cutting speed<br>• Increase the feed rate<br>• Use a machine with sufficient horsepower<br>• Tighten workpiece clamping |
| **Vibration** | • tool<br>• speeds & feeds<br>• others | • Use light hone<br>• Reduce drill overhang<br>• Maintain constant feed rate<br>• Use a machine with sufficient horsepower<br>• Tighten workpiece clamping |

# Technical Information

## Material Cross Reference

### • Carbon Steel & Alloy Steel

| TYPE | | JIS | DIN |
|---|---|---|---|
| Carbon Steel | 1010 | S10C | C10 |
| | 1015 | S15C | C15 |
| | 1020 | S20C | C22 |
| | 1025 | S25C | C25 |
| | 1030 | S30C | C30 |
| | 1035 | S35C | C35 |
| | 1040 | S40C | C40 |
| | 1045 | S45C | C45 |
| | 1050 | S50C | C50 |
| | 1055 | S55C | C55 |
| | 1060 | S58C | C60 |
| | 1010 | S09CK | CK10 |
| | 1015 | S15CK | CK15 |
| | 1020 | S20CK | CK22 |
| Nickel Chromium Molybdenum Steel | 8620 | SNCM220 | |
| | 8640 | SNCM240 | |
| | 4320 | SNCM420 | |
| | 4340 | SNCM439 | |
| Chromium Steel | 5130 | SCr430 | |
| | 5135 | SCr435 | 34Cr4 |
| | 5140 | SCr440 | 42Cr4 |
| | 5147 | SCr445 | |
| Chromium Molybdenum Steel | 4130 | SCM430 | |
| | 4135 | SCM435 | 34CrMo4 |
| | 4140 | SCM440 | 42CrMo4 |
| | 4145 | SCM445 | |
| Manganese Steel and Manganese Chromium Steel | 1520 | SMn420 | |
| | 1536 | SMn433 | |
| | 1541 | SMn438 | |
| | | SMnC420 | |
| | | SMnC443 | |
| Structural Steel with Quenching Property Guaranteed (H Steel) | 1522H | SMn420H | |
| | 1541H | SMn438H | |
| | 5120H | SCr420H | |
| | 5130H | SCr430H | 34Cr4 |
| | 5135H | SCr435H | 37Cr4 |
| | 5140H | SCr440H | 41Cr4 |
| | 4135H | SCM435H | 34CrMo4 |
| | 4140H | SCM440H | 42CrMo4 |
| | 4145H | SCM445H | |
| | 8620H | SNCM220H | |
| | 4320H | SNCM420H | |

### • Tool Steel

| TYPE | | JIS | DIN |
|---|---|---|---|
| Carbon Tool Steel | W1-13 | SK1 | |
| | W1-11 1/2 | SK2 | |
| | W1-10 | SK2 | C105W1 |
| | W1-9 | SK4 | |
| | W1-8 | SK5 | C80W1 |
| | W1-7 | SK6 | C80W1 |
| | | SK7 | C70W2 |
| High Speed Steel | T1 | SKH2 | |
| | T4 | SKH3 | |
| | T15 | SKH10 | |
| | M2 | SKH51 | S6-5-2 |
| | M3-1 | SKH52 | |
| | M3-2 | SKH53 | S6-5-3 |
| | M4 | SKH54 | |
| | M36 | SKH56 | |
| | M7 | SKH58 | |
| | M42 | SKH59 | S2-10-1-8 |
| Alloy Tool Steel | F2 | SKS11 | 105WCr6 |
| | L6 | SKS51 | |
| | W2-9 1/2 | SKS43 | |
| | W2-8 1/2 | SKS44 | |
| | D3 | SKD1 | X210Cr12 |
| | D2 | SKD11 | |
| | A2 | SKD12 | |
| | H11 | SKD6 | 38CrMoV5 |
| | H13 | SKD61 | 40CrMoV5 |
| | P20 | | 40CrMnMo7 |

### • Stainless Steel

| TYPE | | JIS | DIN |
|---|---|---|---|
| Austenitic | AISI 201 | SUS 201 | |
| | AISI 202 | SUS 202 | |
| | AISI 301 | SUS 301 | |
| | AISI 302 | SUS 302 | |
| | AISI 302B | SUS 302B | |
| | AISI 303 | SUS 303 | DINX10 CrNiS189 |
| | AISI 303Se | SUS 303Se | |
| | AISI 304 | SUS 304 | DINX5 CrNi1810 |
| | AISI 304L | SUS 304L | DINX2 CrNi1911 |
| | AISI 304N | SUS 304N1 | |
| | AISI 305 | SUS 305 | DINX2 CrNi1812 |
| | AISI 308 | SUS 308 | |
| | AISI 309S | SUS 309S | |
| | AISI 310S | SUS 310S | |
| | AISI 316 | SUS 316 | DINX2 CrNiMo17122 |
| | AISI 316L | SUS 316L | DINX2 CrNiMo17132 |
| | AISI 316N | SUS 316N | |
| | AISI 317 | SUS 317 | |
| | AISI 317L | SUS 317L | DINX2 CrNiMo18164 |
| | AISI 321 | SUS 321 | DINX6 CrNiTi1810 |
| | AISI 347 | SUS 347 | DINX6 CrNiNb1810 |
| | AISI 384 | SUS 384 | |
| | ASTMXM7 | SUSXM7 | |
| | ASTMXM15 | SUSXM15J1 | |
| Ferritic | AISI 405 | SUS 405 | DINX6 CrAl13 |
| | AISI 429 | SUS 429 | |
| | AISI 430 | SUS 430 | DINX6 Cr17 |
| | AISI 430F | SUS 430F | DINX12 CrMoS17 |
| | AISI 434 | SUS 434 | DINX6 CrNb17 |
| | ASTMXM27 | SUS XM27 | |
| Martensitic | AISI 403 | SUS 403 | |
| | AISI 410 | SUS 410 | DINX10 Cr13 |
| | AISI 410S | SUS 410S | DINX6 Cr13 |
| | AISI 416 | SUS 416 | |
| | AISI 420 | SUS 420 | DINX20 Cr13 |
| | AISI 420F | SUS 420F | |
| | AISI 431 | SUS 431 | DINX20 CrNi172 |
| | AISI 440A | SUS 440A | |
| | AISI 440B | SUS 440B | |
| | AISI 440C | SUS 440C | |
| | ASTM440F | SUS 440F | |
| | ASTM 631 | SUS 631 | DINX7 CrNiA1177 |
| | AISI 632 | SUS 632 | |

# Material Cross Reference

### • Heat Resistant Steel

| TYPE | AISI ASTM | JIS | DIN |
|---|---|---|---|
| Austenitic | AISI 309 | SUH 309 | |
| | AISI 310 | SUH 310 | INCrNi252 |
| | AISI 330 | SUH 330 | |
| | ASTM660 | SUH 0 | |
| | ASTM661 | SUH 61 | |
| Ferritic | AISI 409 | SUH 409 | INX6CrTi1 |
| | AISI 446 | SUH 446 | |
| Martensitic | | SUH 1 | |
| | | SUH 3 | |
| | | SUH 4 | |
| | | SUH 11 | |
| | | SUH 600 | |
| | ASTM616 | SUH 616 | |

### • Cast Iron

| TYPE | AISI ASTM | JIS | DIN |
|---|---|---|---|
| Gray Cast Iron | A48-20B | FC100 | GG-10 |
| | A48-25B | FC150 | GG-15 |
| | A48-30B | FC200 | GG-20 |
| | A48-35B | FC250 | GG-25 |
| | A48-40B | FC300 | GG-30 |
| | A48-50B | FC350 | GG-35 |
| Ductile Cast Iron | 60-40-18 | FCD400 | GGG-40 |
| | 65-45-12 | FCD500 | GGG-50 |
| | 80-55-06 | FCD600 | GGG-60 |
| | 100-70-03 | FCD700 | GGG-70 |

# Technical Information

## Chemical Components

| | | MATERIAL | C | Mn | Si | Cr | Ni | Co | Mo | W | Cb | Ti | Al | B | Fe | OTHER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat-Resistant Alloys | Fe Base | A-286 | 0.05 | 1.40 | 0.99 | 15.00 | 26.00 | - | 1.30 | - | - | 2.00 | 0.20 | 0.003 | 54.00 | 0.30 V |
| | | M-308 (J-1300) | 0.08 | | | 14.00 | 33.00 | | 4.00 | 6.50 | | 2.00 | 0.25 | | 40.00 | 0.25 ZR |
| | | 16-25-6 (Timkin) | 0.10 | 1.40 | 0.77 | 16.00 | 25.00 | | 6.00 | | | | | | 5.00 | 0.15 N |
| | | Chromalloy (Unitemp 14 CMV) | 0.20 | | | 1.00 | | | 1.00 | | | | | | 97.70 | 0.12 V |
| | | Lapelloy | 0.30 | | | 11.50 | 0.35 | | 2.75 | | | | | | 85.00 | 0.25 V |
| | | Am-355 | 0.13 | 0.75 | 0.35 | 15.50 | 4.50 | | 2.85 | | | | | | 75.80 | 0.11 N |
| | | Discaloy | 0.05 | 0.60 | 0.90 | 13.00 | 26.00 | | 3.00 | | | 1.80 | 0.20 | | 54.00 | |
| | | Tinadur | 0.08 | | | 15.00 | 30.00 | | | | | 1.75 | 0.40 | | 53.00 | 1.00 Ta |
| | | N-155 (Multimet) | 0.10 | 1.50 | 0.70 | 21.00 | 20.00 | 19.50 | 3.00 | 2.40 | 1.10 | 1.00 | | | 30.00 | 0.13 N |
| | | 19-9 DL | 0.30 | 1.00 | 0.60 | 19.00 | 9.00 | | 1.40 | 1.30 | 0.40 | 0.30 | | | 66.00 | |
| | | S-588 | 0.40 | 1.50 | 0.80 | 18.00 | 20.00 | | 4.00 | 4.00 | 4.00 | | | | 47.00 | |
| | | W545 | 0.04 | 1.50 | 0.40 | 13.00 | 26.00 | | 1.50 | | | 2.80 | 0.20 | 0.080 | 54.80 | |
| | | Unitemp 212 | 0.08 | | | 16.00 | 25.00 | | | | 0.50 | 4.00 | 0.35 | | 54.00 | 0.06 BR<br>0.05 ZR |
| | | S-590 | 0.45 | 1.50 | 1.00 | 20.00 | 20.00 | 20.00 | 4.00 | 4.00 | 4.00 | | | | 26.50 | |
| | | Unitemp 1415NW (Greek Ascoloy) | 0.18 | | | 13.00 | 2.00 | | | 3.00 | | | | | 81.80 | |
| | | V-57 | 0.08 | 0.25 | 0.55 | 14.75 | 25.50 | | 1.25 | | | 3.00 | 0.25 | 0.008 | 54.10 | 0.30 V |
| | | H46 | 0.17 | | | 12.00 | 0.45 | | 0.65 | | 0.40 | | | | 58.90 | 0.35 V<br>0.05 N |
| | | H53 | 0.08 | | | 10.50 | 0.25 | 7.00 | 0.80 | 0.80 | 0.45 | | | | 79.60 | 0.55 V |
| | | EME | 0.10 | 0.50 | 0.70 | 19.00 | 12.00 | | | 3.20 | 1.20 | | | | 63.00 | 0.15 N |
| | | Unimach #1 | 0.40 | | 0.90 | 5.00 | | | 1.30 | | | | | | 91.90 | 0.50 V |
| | | Almar 362 | 0.03 | 0.30 | 0.20 | 14.50 | 6.50 | | | | | 0.80 | | | 77.60 | |
| | | Custom 455 | 0.03 | 0.50 | 0.50 | 11.75 | 9.00 | | | | 0.30 | 1.20 | | | 74.40 | 2.25 Cu |
| | | Incoloy 800 | 0.04 | 0.75 | 0.35 | 21.00 | 32.50 | | | | | 0.37 | 0.37 | | 46.00 | 0.30 Cu |
| | | Incoloy 801 | 0.04 | 0.75 | 0.35 | 20.50 | 32.00 | | | | | 1.12 | | | 44.50 | 0.15 Cu |
| | Ni Base | Rene 41 | 0.10 | 0.30 | 0.30 | 19.00 | 53.00 | 11.00 | 10.00 | | | 32.00 | 1.60 | 0.005 | 2.00 | |
| | | M-452 (J-1500) | 0.10 | 1.00 | 0.70 | 19.00 | 54.00 | 10.00 | 10.00 | | | 2.50 | 0.80 | 0.005 | 2.00 | |
| | | Waspaloy | 0.05 | 0.70 | 0.40 | 19.00 | 58.00 | 14.00 | 4.50 | | | 2.50 | 1.20 | 0.005 | 2.00 | 0.06 ZR |
| | | Udimet 500 | 0.05 | 0.70 | 0.30 | 19.00 | 47.00 | 18.00 | 4.00 | | | 3.00 | 3.00 | 0.005 | 2.00 | 0.05 ZR |
| | | Inconel X | 0.04 | 0.70 | 0.30 | 15.00 | 73.00 | | | | 0.90 | 2.50 | 0.90 | | 7.00 | |
| | | Nimonic 80A | 0.05 | 0.70 | 0.50 | 20.00 | 76.00 | | | | | 2.30 | 1.00 | | 0.50 | |
| | | Nimonic 90 | 0.08 | 0.50 | 0.40 | 20.00 | 58.00 | 16.00 | | | | 2.30 | 1.40 | | 0.50 | |
| | | DCM | 0.05 | | | 14.30 | 61.00 | | 5.30 | | | 3.40 | 4.30 | 0.080 | 4.60 | |
| | | Hastelloy B | 0.05 | 1.00 | 1.00 | 1.00 | 60.00 | 2.50 | 28.00 | | | | | | 5.50 | 0.40 V |
| | | Hastelloy C | 0.08 | 1.00 | 1.00 | 15.50 | 54.00 | 2.50 | 16.00 | 3.75 | | | | | 5.50 | 0.35 V |
| | | Hastelloy R-235 | 0.15 | | | 15.50 | 62.00 | 2.50 | 5.50 | | | 2.50 | 2.00 | | 10.00 | |
| | | Hastelloy X | 0.10 | 1.00 | 1.00 | 22.00 | 36.00 | 1.50 | 9.00 | 0.60 | | | | | 18.50 | |
| | | Hastelloy W | 0.15 | | | 22.00 | 45.00 | | 9.00 | | | | | | 24.00 | 0.30 V |
| | | Inconel (600) | 0.04 | 0.40 | 0.20 | 15.50 | 76.00 | | | | | | | | 7.00 | |
| | | Incoloy 901 | 0.05 | 0.48 | 0.22 | 12.80 | 43.00 | | 5.70 | | | 2.50 | | | 35.30 | |
| | | Nimonic 75 | 0.12 | 0.40 | 0.60 | 20.00 | 76.00 | | | | | 0.40 | 0.06 | | 2.40 | 0.05 Cu |
| | | Nimonic 80A | 0.05 | 0.70 | 0.50 | 20.00 | 76.00 | | | | | 2.30 | 1.00 | | 0.50 | 0.05 Cu |
| | | Inconel 700 | 0.13 | 0.08 | 0.25 | 15.00 | 46.00 | 29.00 | 3.00 | | | 2.20 | 3.20 | | 0.80 | |
| | | K-42-B | 0.05 | 0.70 | 0.70 | 18.00 | 43.00 | 22.00 | | | | 2.50 | 0.20 | | 13.00 | |
| | | Inconel 713C | 0.12 | 0.15 | 0.40 | 13.00 | 72.00 | | 4.50 | | 2.25 | 0.60 | 6.00 | | 1.00 | |
| | | Inconel 718 | 0.04 | 0.20 | 0.30 | 19.00 | 52.00 | | 3.00 | | 5.20 | 0.90 | 0.50 | | 18.50 | 0.05 Cu<br>5.02 Ta |
| | | Allvac 620 | 0.05 | | | 19.00 | 57.00 | 12.00 | 6.00 | 1.00 | | 3.00 | 2.00 | 0.010 | | |
| | | Pyromet 860 | 0.10 | 1.00 | 1.00 | 16.00 | 48.00 | 4.00 | 9.00 | 0.60 | | 3.00 | 1.30 | 0.010 | 18.50 | |
| | | Inconel X-750 | 0.04 | 0.70 | 0.25 | 15.50 | 73.00 | | | | 0.95 | 2.50 | 0.70 | | 7.00 | 0.50 Cu |
| | | Astroloy | 0.06 | | | 15.00 | 54.60 | 18.00 | 3.30 | | | 3.50 | 4.50 | 0.050 | | |
| | | Inconel 713 | 0.13 | | | 12.00 | 75.00 | | 5.50 | | 2.00 | 0.60 | 6.00 | | | |
| | | Monel 713y 400 | 0.12 | 0.90 | 0.15 | | 66.00 | | | | | | | | 1.35 | 31.50 Cu |
| | | Monel Alloy R405 | 0.18 | 0.90 | 0.15 | | 66.00 | | | | | 0.50 | 2.75 | | 1.35 | 31.50 Cu |
| | | Monel Alloy K-500 | 0.15 | 0.60 | 0.15 | | 65.00 | | | | | 0.50 | 2.80 | | 1.00 | 29.50 Cu |
| | | Monel Alloy K-500 (aged) | 0.15 | 0.60 | 0.15 | | 65.00 | | | | | 0.50 | 2.80 | | 1.00 | 29.50 Cu |
| | | Inconel 625 | 0.05 | 0.15 | 0.30 | 22.00 | 61.00 | | 9.00 | | 4.00 | 0.20 | 0.20 | | 3.00 | 3.65 Ta<br>0.10 Cu |
| | | Permanickel Alloy 300 | 0.25 | 0.10 | 0.06 | | 98.60 | | | | | 0.50 | | | 0.10 | 0.02 Cu<br>0.35 Mg |
| | | Duranickel Alloy 301 | 0.15 | 0.25 | 0.55 | | 94.00 | | | | | 0.50 | 4.50 | | 0.15 | 0.05 Cu |
| | | Refractaloy 26 | 0.03 | 0.80 | 1.00 | 18.00 | 38.00 | 30.00 | 3.20 | | | 2.60 | 0.20 | | 6.17 | |
| | | Udimet 700 | 0.06 | 1.00 | 0.10 | 15.00 | 56.40 | 18.45 | 5.25 | | | 3.50 | 4.25 | 0.030 | 0.50 | |
| | | Colmonoy 4 | 0.45 | | 2.25 | 10.00 | 82.80 | | | | | | | 2.000 | 2.50 | |
| | | Colmonoy 5 | 0.65 | | 3.75 | 11.50 | 80.00 | | | | | | | 2.500 | 4.25 | |
| | | Colmonoy 20 | 0.25 | | 3.00 | 5.00 | 88.25 | | | | | | | 1.000 | 3.50 | |
| | | Colmonoy 21 | 0.25 | | 3.25 | 5.00 | 90.50 | | | | | | | 1.250 | 1.00 | |
| | | Colmonoy 22 | 0.12 | | 3.40 | | 95.50 | | | | | | | 1.350 | 1.00 | |

# Chemical Components

| | MATERIAL | C | Mn | Si | Cr | Ni | Co | Mo | W | Cb | Ti | Al | B | Fe | OTHER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co Base | J-1570 | 0.20 | 5.00 | | 20.00 | 30.00 | 39.00 | | 6.50 | | 4.10 | | | | |
| | J-1650 | 0.20 | | | 19.00 | 27.00 | 36.00 | | 12.00 | | 3.80 | | 0.020 | | 2.00 Ta |
| | S-816 | 0.38 | 1.50 | 0.70 | 20.00 | 20.00 | 43.00 | 4.00 | 4.00 | 4.00 | | | | 3.00 | |
| | L-605(HS-25) | 0.12 | 1.50 | 1.00 | 20.00 | 10.00 | 51.00 | | 15.00 | | | | | 1.00 | |
| | HS-21 (Vitallium) | 0.25 | 0.60 | 0.60 | 27.00 | 3.00 | 62.00 | 5.00 | | | | | | 1.00 | |
| | HS-31 (X-40) | 0.40 | 0.60 | 0.60 | 25.00 | 10.00 | 55.00 | | 8.00 | | | | | 1.00 | |
| | HS-30 (422-19) | 0.40 | 0.60 | 0.60 | 24.00 | 16.00 | 51.00 | 6.00 | | | | | | 1.00 | |
| | HS-27 | 0.40 | | 0.60 | 23.00 | 2.00 | 67.00 | 6.00 | | | | | | 1.00 | |
| | WI 52 | 0.45 | 5.00 | 0.50 | 21.00 | 1.00 | 61.70 | | 11.00 | 2.00 | | | | 1.70 | 0.04 P<br>0.04 S |
| | Wallex #6 (Colmonoy) | 1.00 | | 1.25 | 29.00 | | 64.30 | | 4.50 | | | | | | |
| | Jetalloy 209 | 0.02 | | | 20.00 | 10.00 | 50.00 | | 15.00 | | 2.00 | | | 1.00 | |
| | Nivco | 0.02 | 0.35 | 0.15 | 0.50 | 22.50 | 73.50 | | | | 1.80 | 0.22 | | 0.30 | 1.10 ZR<br>0.01 S |
| | Stellite J | 2.20 | 1.00 | 1.00 | 31.00 | 2.50 | 43.30 | | 16.00 | | | | | 3.00 | |
| Titanium Alloys | Commercially Pure (annealed) | | | | | | | | | | | | | | |
| | 110-170 BHN | | | | | | | | | | 99.50 | | | | |
| | 140-200 BHN | | | | | | | | | | 99.20 | | | | |
| | 200-275 BHN | | | | | | | | | | 99.00 | | | | |
| | ALPHA | | | | | | | | | | | | | | |
| | Ti-5AL-2.5 Sn (annealed) | | | | | | | | | | 92.50 | 5.00 | | | 2.50 Sn |
| | Ti-6AL-1V-4Zr (annealed) | | | | | | | | | | 89.00 | 6.00 | | | 4.00 Zr<br>1.00 V |
| | Ti-7AL-2Cb-1Ta (annealed) | | | | | | | | | | 90.00 | 7.00 | | | 2.00 Cb<br>1.00 Ta |
| | Ti-8AL-1Mo-1V (heat treated) | | | | | | | | | | 90.00 | 8.00 | | | 1.00 Mo<br>1.00 V |
| | 290-335-BHN | | | | | | | | | | | | | | |
| | Alpha-bata | | | | | | | | | | | | | | |
| | Ti-6AL-4V (annealed) | | | | | | | | | | 90.00 | 6.00 | | | 4.00 V |
| | Ti-4AL-4Mn (annealed) | | 4.00 | | | | | | | | 92.00 | 4.00 | | | |
| | Ti-2Fe-1Cr-2Mo (annealed) | | | | 2.00 | | | 2.00 | | | 94.00 | | | 2.00 | |
| | Ti-7AL-4Mo (annealed) | | | | | | | 4.00 | | | 89.00 | 7.00 | | | |
| | Ti-1Al-8V-5Fe (annealed) | | | | | | | | | | 86.00 | 1.00 | | 5.00 | 8.00 V |
| | Alpha-bete | | | | | | | | | | | | | | |
| | Ti-6AL-6V-25M-1 (Fe, Cu) (Annealed) | | | | | | | | | | 87.00 | 6.00 | | | 1.00 Fe<br>Cu<br>6.00 V |
| | Ti-8AL-1Mo-1v | | | | | | | 1.00 | | | 90.00 | 8.00 | | | |
| | Beta | | | | | | | | | | | | | | |
| | Ti-13V-11Cr-3AL (solution treated) | | | | 11.00 | | | | | | 73.00 | 3.00 | | | 13.00 V |
| Other Cut Resistant Materials | COLUMBIUM (Cb) | | | | | | | | | | | | | | |
| | D-31 | | | | | | | 10.00 | 15.00 | 80.00 | 10.00 | | | | 1.00 Zr |
| | F-48 | | | | | | | 5.00 | 10.00 | 79.00 | | | | | 5.00 Zr |
| | Cb-74 | | | | | | | | 10.00 | 85.00 | | | | | 10.00 Hf |
| | Cb-129 | | | | | | | | 15.00 | 80.00 | | | | | 2.00 Ta |
| | Cb-132M | 0.001 | | | | | | 5.00 | 15.00 | 58.50 | | | | | 1.50 Zr<br>2.50 Zr |
| | Cb-752 | | | | | | | | 10.00 | 87.50 | | | | | 1.00 Zr |
| | 1% Zr | | | | | | | | | 99.00 | | | | | |
| | TUNGSTEN (W) | | | | | | | | | | | | | | |
| | W-Forged Rolled | | | | | | | | 99.90 | | | | | | |
| | W-Sintered (28-35 Rc) | | | | | | | | 99.90 | | | | | | |
| | W-10 | | | | | 7.50 | | | 90.00 | | | | | | |
| | W-2 | | | | | 2.50 | | | 97.50 | | | | | | 2.50 Cu |
| | TANTALUM (Ta) | | | | | | | | | | | | | | |
| | Ta-10W | | | | | | | | 10.00 | | | | | | 90.00 Ta |
| | T-111 | | | | | | | | 8.00 | | | | | | 90.00 Ta<br>2.00 Hf |
| | T-222 | | | | | | | | 10.00 | | | | | | 87.50 Ta<br>2.50 Hf |
| | Ta | 0.01 | | | | | | | | | | | | | 99.80 |
| | MOLYBDENUM (Mo) | | | | | | | | | | | | | | |
| | Molybdenum | 0.15 | | | | | | 99.80 | | | | | | | |
| | TZM | | | | | | | 99.40 | | | 0.50 | | | | 0.08 Zr |
| | TZC | 0.12 | | | | | | 98.40 | | | 1.25 | | | | 0.15 Zr |
| | 70 Mo-30W | 0.15 | | | | | | 69.80 | 30.00 | | | | | | |

# Technical Information

## Conversion Table Reference - Hardness Scales

| Brinell, 10mm Ball, Load 3000kg, Standard Ball | Vickers | Rockwell | | Shore |
|---|---|---|---|---|
| | | B Scale, Load 100kg, Diameter 1/16 in. Steel Ball | C Scale, Load 150kg, 120° Diamond Cone | |
| **HB** | **HV** | **HRB** | **HRC** | **HS** |
| - | 940 | - | 68.0 | 97 |
| - | 920 | - | 67.5 | 96 |
| - | 900 | - | 67.0 | 95 |
| (767) | 880 | - | 66.4 | 93 |
| (757) | 860 | - | 65.9 | 92 |
| | | | | |
| (745) | 840 | - | 65.3 | 91 |
| (733) | 820 | - | 64.7 | 90 |
| (722) | 800 | - | 64.0 | 88 |
| (712) | - | - | - | - |
| (710) | 780 | - | 63.3 | 87 |
| (698) | 760 | - | 62.5 | 86 |
| | | | | |
| (684) | 740 | - | 61.8 | - |
| (682) | 737 | - | 61.7 | 84 |
| (670) | 720 | - | 61.0 | 83 |
| (656) | 700 | - | 60.1 | - |
| (653) | 697 | - | 60.0 | 81 |
| | | | | |
| (647) | 690 | - | 59.7 | - |
| (638) | 680 | - | 59.2 | 80 |
| (630) | 670 | - | 58.8 | - |
| (627) | 667 | - | 58.7 | 79 |
| | | | | |
| - | 677 | - | 59.1 | - |
| (601) | 640 | - | 57.3 | 77 |
| | | | | |
| - | 640 | - | 57.3 | - |
| (578) | 615 | - | 56.0 | 75 |
| | | | | |
| - | 607 | - | 55.6 | - |
| (555) | 591 | - | 54.7 | 73 |
| | | | | |
| - | 579 | - | 54.0 | - |
| (534) | 569 | - | 53.5 | 71 |
| - | 553 | - | 52.5 | - |
| (514) | 547 | - | 52.1 | 70 |
| | | | | |
| 495 | 539 | - | 51.6 | - |
| - | 530 | - | 51.1 | - |
| - | 528 | - | 51.0 | 68 |
| | | | | |
| 477 | 516 | - | 50.3 | - |
| - | 508 | - | 49.6 | - |
| - | 508 | - | 49.6 | 66 |
| | | | | |
| 461 | 495 | - | 48.8 | - |
| - | 491 | - | 48.5 | - |
| - | 491 | - | 48.5 | 65 |
| | | | | |
| 444 | 474 | - | 47.2 | - |
| - | 472 | - | 47.1 | - |
| - | 472 | - | 47.1 | 63 |

| Brinell, 10mm Ball, Load 3000kg, Standard Ball | Vickers | Rockwell | | Shore |
|---|---|---|---|---|
| | | B Scale, Load 100kg, Diameter 1/16 in. Steel Ball | C Scale, Load 150kg, 120° Diamond Cone | |
| **HB** | **HV** | **HRB** | **HRC** | **HS** |
| 429 | 455 | - | 45.7 | 61 |
| 415 | 440 | - | 44.5 | 59 |
| 401 | 425 | - | 43.1 | 58 |
| 388 | 410 | - | 41.8 | 56 |
| 375 | 396 | - | 40.4 | 54 |
| | | | | |
| 363 | 383 | - | 39.1 | 52 |
| 352 | 372 | 110.0 | 37.9 | 51 |
| 341 | 360 | 109.0 | 36.6 | 50 |
| 331 | 350 | 108.5 | 35.5 | 48 |
| 321 | 339 | 108.0 | 34.3 | 47 |
| | | | | |
| 311 | 328 | 107.5 | 33.1 | 46 |
| 302 | 319 | 107.0 | 32.1 | 45 |
| 293 | 309 | 106.0 | 30.9 | 43 |
| 285 | 301 | 105.5 | 29.9 | - |
| 277 | 292 | 104.5 | 28.8 | 41 |
| | | | | |
| 269 | 284 | 104.0 | 27.6 | 40 |
| 262 | 276 | 103.0 | 26.6 | 39 |
| 255 | 269 | 102.0 | 25.4 | 38 |
| 248 | 261 | 101.0 | 24.2 | 37 |
| 241 | 253 | 100.0 | 22.8 | 36 |
| | | | | |
| 235 | 247 | 99.0 | 21.7 | 35 |
| 229 | 241 | 98.2 | 20.5 | 34 |
| 223 | 234 | 97.3 | 18.8 | - |
| 217 | 228 | 96.4 | 17.5 | 33 |
| 212 | 222 | 95.5 | 16.0 | - |
| | | | | |
| 207 | 218 | 94.6 | 15.2 | 32 |
| 201 | 212 | 93.8 | 13.8 | 31 |
| 197 | 207 | 92.8 | 12.7 | 30 |
| 192 | 202 | 91.9 | 11.5 | 29 |
| 187 | 196 | 90.7 | 10.0 | - |
| | | | | |
| 183 | 192 | 90.0 | 9.0 | 28 |
| 179 | 188 | 89.0 | 8.0 | 27 |
| 174 | 182 | 87.8 | 6.4 | - |
| 170 | 178 | 86.8 | 5.4 | 26 |
| 167 | 175 | 86.0 | 4.4 | - |
| | | | | |
| 163 | 171 | 85.0 | 3.3 | 25 |
| 156 | 163 | 82.9 | 0.9 | - |
| 149 | 156 | 80.8 | - | 23 |
| 143 | 150 | 78.7 | - | 22 |
| 137 | 143 | 76.4 | - | 21 |
| | | | | |
| 131 | 137 | 74.0 | - | - |
| 126 | 132 | 72.0 | - | 20 |
| 121 | 127 | 69.8 | - | 19 |
| 116 | 122 | 67.6 | - | 18 |
| 111 | 117 | 65.7 | - | 15 |

**Note:** Figures in parentheses under Brinell indicate values using tungsten carbide ball.

# SAFETY PAMPHLET

## 1. In using tungsten carbide tools.

As product liability (PL Law) has been enforced on 1st July 1995, Dijet Industrial Co., Ltd. (hereafter Dijet) started to append a warning or caution label on the package materials for pertinent products.

However, on the tool bodies, no warning or caution label is attached, and therefore, you should read this safety pamphlet before you use any kind of Dijet products or other tools made of our high hard materials.

You are also requested to make well known the contents of this pamphlet to every worker in your plant as a part of your plant safety education program.

## 2. Basic features of high hard tools materials.

The high hard tools material is a general term for the sintered material of tungsten carbide alloy, the chief ingredient of which is tungsten carbide (WC), cermet whose chief ingredients are titanium nitride, carbide, cubic boron nitride (CBN) and/or sintered diamond. These materials are sometimes called just “hard metal”.

### 2-1. Physical properties of hard metal.

| | |
|---|---|
| Appearance | : It differs according to the materials/<br>Exam: gray, dark gray, black, gold, etc. |
| Smell | : Odorless |
| Hardness | : Carbide & Cermet - HV500<br>Ceramics - HV1.000<br>CBN - HV2,500<br>Sintered diamond - HV8,000 |
| Density | : Carbide - 9 - 15<br>Cermet - 6 - 9<br>Ceramics & CBN - 3 - 5 |

### 2-2. Ingredients

Carbide, Nitride, Carbo-nitride and Oxide of W, Ti, Al, Ta or B and in addition, in some of them, metal ingredients like Co, Ni, Cr or Mo etc. are contained.

## 3. Precautions for handling hard metal tool materials.

- Hard metals have the feature of high hardness but are also brittle.
  Therefore, they will crack by strong impact or clamping too fast.
- Hard metals are very heavy. In case of large sized tools or big quantities, they need to be handled as weight cargo.
- The heat expansion rate of hard metal is different from that of steel materials.
  Therefore, shrink fitted or force fitted tools can break if they are in extremely high (or low) temperature than the designed value.

## 4. Precautions for processing of hard metal.

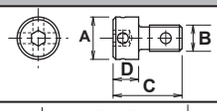
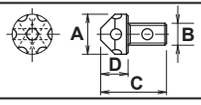
- When cooled by grinding solution or water the strength of the material can deteriorate.
  Special attention should be made for storage condition of these materials.
  According to the surface condition, the strength of materials will be greatly lowered.
  Use a diamond wheel for finishing of surface roughness.
- Dust will be generated in grinding operation.
  Chronic inhalation may cause “hard metal lung: and is dangerous to your health.
  Provide exhaust ventilation and wear appropriate protective equipment like dust mask, etc.
  When skin contact or eye contact occurs, wash thoroughly with water.
- In grinding of hard metals or brazed tools, heavy metal ingredient will remain in the waste fluid.
  Waste fluid must be completely disposed of in a safe way.
- After re-grinding of brazed tools, confirm that cracks on the surface of tools are completely eliminated.
- In marking on hard metal materials of finished goods with laser or electric pens, minute cracks bay be generated on the surfaces.
- Avoid marking on the position where stress will be imposed.
  In electric discharging process on hard metal, residue cracks will remain on the surfaces causing lowering of strength. These cracks must be completely ground off.

# Instructions For Using Cutting Tools

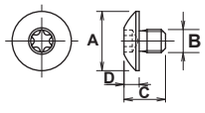
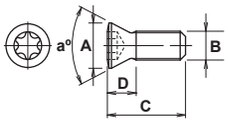
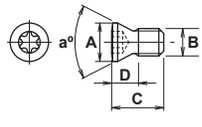
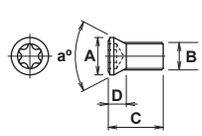
| ITEM | HAZARD | COUNTERMEASURE |
|---|---|---|
| General Cutting Tools | Direct contact to the sharp cutting edge may cause injury. | Wear protective gloves when taking out of box or mounting to the machine. |
| | Misuse or mismatch of working conditions may cause tool breakage or dispersion of broker pieces. | Provide safety covers, wear safety glasses and/or protective gloves. Read instruction manual before using. Refer to the recommended conditions in catalog. |
| | Excess impact or heavy wear will increase cutting resistance and may cause tool breakage and dispersion of broken pieces. | Change tools a little early.<br>Provide safety covers, wear safety glasses and protective gloves. |
| | Dispersion of heated or prolonged chips may cause injury or burn. | Provide safety covers, wear safety glasses and/or protective gloves.<br>Get rid of chips safely. |
| | During cutting operation, cutting tools get very hot. Direct contact to tools immediately after operation may cause burn. | Wear protective equipment like protective gloves. |
| | Sparks, generation of heat or chips in high temperature during operation may cause fire. | Avoid operation when ignition or explosion is expected. When insoluble coolant is used, enough fire fighting measure must be taken. |
| | Lack of dynamic balance in high speed rotation may cause runout and the tool may break by vibration. | Provide test run and confirm if vibration or chattering is observed. |
| | Direct contact to the burrs on the work part may cause injury. | Do not contact with bare hand. Wear protective gloves. |
| Indexable Cutting Tools | When inserts or parts are not clamped properly, falling off or dispersion may occur and cause injury. | Clean up the insert pocket or fastening parts before reloading.<br>Confirm if the inserts or parts are correctly clamped by the supplied wrench. |
| | When clamped too tight by supplementary tools like pipe etc., inserts or body may be broken and unusable. | Be sure to use supplied wrench. |
| | When indexable tools are used in high-speed rotation, insert or parts may burst out of the body due to antifugal force. | Use within the recommended cutting conditions.<br>Refer to the instruction manual on catalogs. |
| Milling Cutters and Other Rotating Tools | Since milling cutters have sharp edges, direct contact with bare hands may cause injury. | Wear protective gloves. |
| | If cutter lacks dynamic balance or rotates eccentrically, tool breakage or dispersion of broken pieces may occur by runout or vibration. | Use the cutter within the range of recommended working conditions.<br>Rotating portion and dynamic balancing should be periodically checked to prevent eccentric rotation or run out due to wear of bearing portion. |
| Drill | When drilling through hole on work piece, a disc of work material may fly out end of hole.<br>It is very dangerous since the disc has sharp edges. | Provide safety covers, wear safety glasses and/or protective gloves.<br>Also provide protective covers around drill holding. portion. |
| | Micro drills have sharp points, direct contact with fingers is dangerous.<br>If broken, small pieces may remain in the wound and disperse around the body. | Handle carefully with protective gloves and protective glasses. |
| Brazed Tools | Dispersion of broken tips by tool breakage or falling of tool may cause injury. | Confirm if tips are firmly brazed.<br>Avoid using in this condition, which requires generation of high cutting temperature. |
| Others | When brazing is carried out time and again, the strength of carbide tip is deteriorated and becomes easily broken during operation. | Carbide tip which is brazed several times should not be used, its strength has deteriorated. |
| | It is dangerous to use tools other than the fixed application.<br>It may cause damage of tool and machine. | Use the tool as prescribed in the instruction manual. |

# Parts

## Adjustable Screws

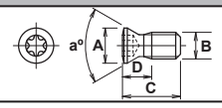
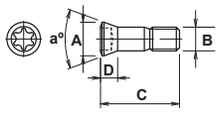
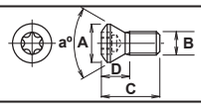
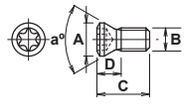
| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | Wrench |
|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | a° | |
|  | ASW-113 | 4.8 | No. 10-32UNF | 12.7 | 4.8 | - | - | AD-1845 |
| | ADS-513 | 7.8 | M5 x 0.5 | 13.0 | 5.0 | - | - | AD-2080 |
| | ADS-514 | 5.6 | M5 x 0.5 | 14.5 | 6.5 | - | - | AD-2080 |
|  | ASW-513 | 9.0 | M5 x 0.5 | 13.0 | 5.0 | - | - | AD-1845 |

## Clamp Screws

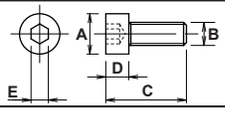
| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | Wrench | Torque Nm | Torque lbs./ft |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | a° | | | |
|  | CB3540 | 9.0 | M3.5 x 0.6 | 6.3 | 2.3 | - | - | T-15 | 2.1 | 1.55 |
|  | CSW-1838 | 2.7 | M1.8 x 0.35 | 3.7 | 1.8 | - | 55 | T-6 | 0.25 | .18 |
| | CSW-206 | 3.5 | M2.5 x 0.45 | 5.0 | 2.4 | - | 55 | T-8 | 0.9 | .66 |
| | CSW-2542 | 3.0 | M2.5 x 0.45 | 4.2 | 2.5 | - | 43 | T-7 | 0.9 | .66 |
| | CSW-2547 | 3.4 | M2.5 x 0.45 | 4.7 | 2.5 | - | 43 | T-7 | 0.9 | .66 |
| | CSW-3570 | 5.5 | M3.5 x 0.6 | 7.0 | 3.5 | - | 55 | T-15 | 2.1 | 1.55 |
| | CSW-3595 | 5.5 | M3.5 x 0.6 | 9.5 | 3.5 | - | 55 | T-15 | 2.1 | 1.55 |
| | CSW-406H | 5.0 | M4 x 0.7 | 6.0 | 3.6 | - | 43 | T-15 | 3.6 | 2.66 |
| | CSW-407 | 5.0 | M4 x 0.7 | 7.0 | 3.6 | - | 43 | T-15 | 3.6 | 2.66 |
| | CSW-408H | 5.0 | M4 x 0.7 | 8.0 | 3.6 | - | 43 | T-15 | 3.6 | 2.66 |
| | CSW-4510 | 6.6 | M4.5 x 0.75 | 10.0 | 4.0 | - | 57 | T-20 | 5.0 | 3.69 |
| | CSW-510 | 6.4 | M5 x 0.8 | 11.0 | 4.5 | - | 43 | T-20 | 5.5 | 4.06 |
|  | DSW-1838H | 2.5 | M1.8 x 0.35 | 3.8 | 2.0 | - | 55 | T-6 | 0.4 | - |
| | DSW-306H | 4.3 | M3 x 0.5 | 6.5 | 3.2 | - | 55 | T-10 | 1.8 | 1.33 |
| | DSW-307 | 4.3 | M3 x 0.5 | 7.5 | 2.8 | - | 55 | T-10 | 1.4 | 1.03 |
| | DSW-307H | 4.3 | M3 x 0.5 | 7.6 | 3.2 | - | 55 | T-10 | 1.8 | 1.33 |
| | DSW-4075 | 5.2 | M4 x 0.7 | 7.5 | 3.5 | - | 55 | T-15 | 3.6 | 2.66 |
| | DSW-408 | 6.0 | M4 x 0.7 | 8.5 | 3.6 | - | 55 | T-15 | 3.6 | 2.66 |
| | DSW-4085 | 5.3 | M4 x 0.7 | 8.6 | 3.5 | - | 55 | T-15 | 3.6 | 2.66 |
| | DSW-410H | 5.3 | M4 x 0.7 | 10.0 | 3.7 | - | 55 | T-15 | 3.6 | - |
| | DSW-4510H | 6.8 | M4.5 x 0.75 | 10.0 | 4.7 | - | 55 | T-20 | 6.0 | 4.43 |
| | DSW-4512H | 6.8 | M4.5 x 0.75 | 12.5 | 5.2 | - | 55 | T-20 | 6.0 | 4.43 |
| | DSW-4515H | 6.8 | M4.5 x 0.75 | 15.5 | 5.2 | - | 55 | T-20 | 6.0 | - |
| | DSW-509 | 7.0 | M5 x 0.8 | 9.5 | 4.9 | - | 55 | T-20 | 6.1 | 4.50 |
| | DSW-511H | 7.0 | M5 x 0.8 | 11.5 | 4.9 | - | 55 | T-20 | 6.1 | 4.50 |
| | DSW-512V | 7.2 | M5 x 0.8 | 12.5 | 6.0 | - | 55 | T-25 | 6.1 | 4.50 |
|  | ESW-205 | 3.6 | M2.5 x 0.45 | 5.5 | 2.0 | - | 60 | T-8 | 0.9 | .66 |
| | ESW-206 | 3.6 | M2.5 x 0.45 | 6.0 | 2.0 | - | 60 | T-8 | 0.9 | .66 |
| | ESW-304 | 4.0 | M3 x 0.5 | 4.5 | 2.0 | - | 55 | T-8 | 1.4 | 1.03 |
| | ESW-306 | 4.0 | M3 x 0.5 | 6.0 | 2.0 | - | 55 | T-8 | 1.4 | 1.03 |
| | ESW-307 | 4.0 | M3 x 0.5 | 7.5 | 2.0 | - | 55 | T-8 | 1.4 | 1.03 |
| | ESW-405 | 5.3 | M4 x 0.7 | 5.9 | 2.7 | - | 55 | T-15 | 3.1 | 2.29 |
| | ESW-406 | 5.3 | M4 x 0.7 | 6.6 | 2.7 | - | 55 | T-15 | 3.1 | 2.29 |
| | ESW-408 | 5.3 | M4 x 0.7 | 8.0 | 2.7 | - | 55 | T-15 | 3.1 | 2.29 |
| | ESW-410 | 5.3 | M4 x 0.7 | 10.0 | 2.7 | - | 55 | T-15 | 3.1 | 2.29 |
| | ESW-412 | 5.3 | M4 x 0.7 | 12.0 | 2.7 | - | 55 | T-15 | 3.1 | 2.29 |
| | ESW-507 | 6.8 | M5 x 0.8 | 7.5 | 3.4 | - | 55 | T-25 | 5.5 | 4.06 |
| | ESW-508 | 6.8 | M5 x 0.8 | 8.2 | 3.4 | - | 55 | T-25 | 5.5 | 4.06 |
| | ESW-510 | 6.8 | M5 x 0.8 | 10.0 | 3.4 | - | 55 | T-25 | 5.5 | 4.06 |

# Parts

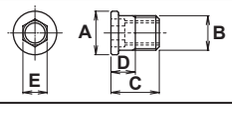
## Clamp Screws

| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | Wrench | Torque Nm | Torque lbs./ft |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | a° | | | |
|  | FS1030 | 6.6 | M5 x 0.8 | 10.9 | 5.5 | - | 60 | T-20 | 5.5 | 4.06 |
| | FS1030S | 6.6 | M5 x 0.8 | 9.5 | 5.5 | - | 60 | T-20 | 5.5 | 4.06 |
|  | FSW-2005H | 2.5 | M2 x 0.25 | 5.0 | 1.3 | - | 40 | T-06 | 0.5 | .37 |
| | FSW-2506H | 3.0 | M2.5 x 0.35 | 6.6 | 1.5 | - | 40 | T-07 | 0.9 | .66 |
| | FSW-3007H | 3.8 | M3 x 0.35 | 8.1 | 2.0 | - | 40 | T-08 | 1.2 | .89 |
| | FSW-3509 | 4.7 | M3.5 x 0.6 | 9.6 | 2.3 | - | 40 | T-10 | 2.0 | 1.48 |
| | FSW-4013 | 5.8 | M4 x 0.7 | 13.5 | 3.3 | - | 40 | T-15 | 3.0 | 2.21 |
| | FSW-5016 | 6.8 | M5 x 0.8 | 16.4 | 3.2 | - | 40 | T-20 | 4.0 | 2.95 |
| | FSW-6020 | 8.5 | M6 x 1.0 | 20.0 | 4.3 | - | 40 | T-30 | 5.0 | 3.69 |
| | FSW-8025 | 11.0 | M8 x 1.25 | 25.0 | 5.5 | - | 40 | T-40 | 6.0 | 4.43 |
|  | HSW-614H | 10.0 | M6 x 1.0 | 15.0 | 7.3 | - | 60 | T-30 | 7.5 | 5.53 |
|  | TSW-2250 | 3.1 | M2.2 x 0.45 | 5.0 | 2.3 | - | 60 | T-07 | 0.6 | .44 |
| | TSW-2556H | 3.6 | M2.5 x 0.45 | 5.6 | 2.7 | - | 60 | T-08 | 0.9 | .66 |
| | TSW-3512H | 5.3 | M3.5 x 0.6 | 11.5 | 4.5 | - | 60 | T-15 | 2.1 | - |
| | TSW-408 | 5.5 | M4 x 0.7 | 8.0 | 3.3 | - | 60 | T-15 | 3.1 | 2.29 |
| | TSW-511 | 7.0 | M5 x 0.8 | 11.0 | 5.0 | - | 60 | T-20 | 5.5 | 4.06 |
| | TSW-612 | 8.5 | M6 x 1.0 | 12.0 | 4.8 | - | 60 | T-25 | 7.5 | 5.53 |

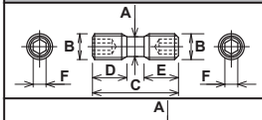
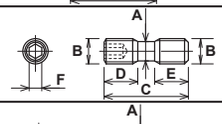
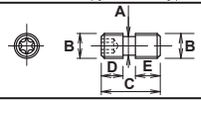
## Hexagon Socket Head Cap Screws

| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | Wrench | Torque |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | | |
|  | HCS4-10 | 7.0 | M4 x 0.7 | 14.0 | 4.0 | 3.0 | - | - | - |
| | HCS5-10 | 8.5 | M5 x 0.8 | 15.0 | 5.0 | 4.0 | - | - | - |

## Shim Screws

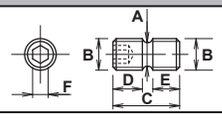
| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | Wrench | Torque Nm | Torque lbs./ft |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | a° | | | |
|  | SSW-535 | 6.3 | M5 x 0.5 | 7.0 | 3.1 | 3.5 | - | - | 6.5 | - |
| | SSW-745 | 8.4 | M7 x 0.5 | 8.0 | 2.9 | 4.5 | - | - | 8.0 | - |

## Wedge Screws

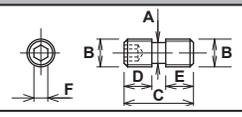
| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | Wrench | Torque Nm | Torque lbs./ft |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | | | |
|  | LS-1 | 4.6 | M6 x 1.0 | 22.0 | 8.5 | 8.5 | 3.0 | - | 6.0 | 4.43 |
|  | LS-101 | 4.6 | M6 x 1.0 | 16.0 | 6.5 | 6.5 | 3.0 | - | 6.0 | 4.43 |
| | LS-106 | 4.6 | M6 x 1.0 | 14.5 | 6.5 | 5.0 | 3.0 | - | 6.0 | 4.43 |
| | LS-107 | 4.6 | M6 x 1.0 | 13.0 | 5.0 | 5.0 | 3.0 | - | 6.0 | 4.43 |
|  | LS-109 | 5.5 | M7 x 0.75 | 19.0 | 7.5 | 8.0 | - | T-25 | 7.0 | 5.16 |
| | LS-110 | 4.8 | M6 x 0.75 | 22.0 | 8.0 | 8.0 | - | T-15 | 6.0 | - |
| | LS-180 | 6.0 | M8 x 1.0 | 19.0 | 7.0 | 8.0 | - | T-27 | 8.0 | 5.90 |

# Parts

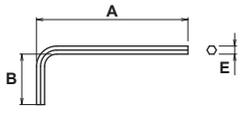
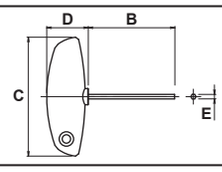
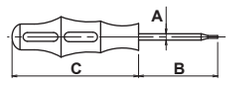
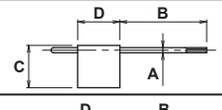
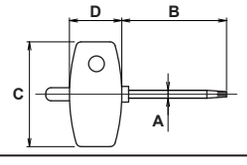
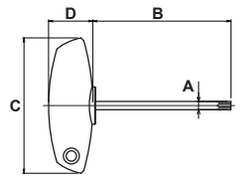
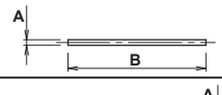
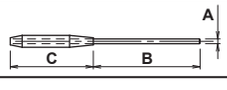
## Rest Button Screws

| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | Wrench | Torque |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | | |
|  | LS-113 | 3.7 | No. 10-32UNF | 10.2 | 4.5 | 4.1 | 2.4 | - | - |

## Clamp Screws

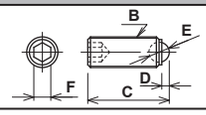
| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | Wrench | Torque Nm | Torque lbs./ft |
|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | | | |
|  | SLS-3 | 6.0 | M8 x 1.0 | 20.0 | 8.0 | 8.0 | 4.0 | - | 8.0 | 5.90 |

## Wrenches

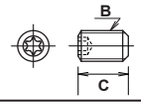
| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | Wrench Size |
|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | |
|  | LW-025 | 59.5 | 18.0 | - | - | 2.5 | - |
| | LW-030 | 67.0 | 20.0 | - | - | 3.0 | - |
| | LW-035 | 71.5 | 22.5 | - | - | 3.5 | - |
| | LW-040 | 75.0 | 25.0 | - | - | 4.0 | - |
| | LW-045 | 80.5 | 27 | - | - | 4.5 | - |
| | LW-050 | 80.0 | 28.0 | - | - | 5.0 | - |
|  | A-030 | - | 60.0 | 80.0 | 28.0 | 3.0 | - |
|  | A-07SD | 4.0 | 60.0 | 80.0 | - | - | T-7 |
| | A-08SD | 4.0 | 70.0 | 80.0 | - | - | T-8 |
| | A-10SD | 4.0 | 70.0 | 95.0 | - | - | T-10 |
| | A-20SD | 5.0 | 90.0 | 105.0 | - | - | T-20 |
| | A-25SD | 5.0 | 100.0 | 105.0 | - | - | T-25 |
|  | A-06 | 1.7 | 34.5 | 15.0 | 15.0 | - | T-6 |
| | A-07 | 2.0 | 34.5 | 15.0 | 15.9 | - | T-7 |
| | A-08 | 2.3 | 39.0 | 19.0 | 19.0 | - | T-8 |
|  | A-10 | 3.0 | 40.0 | 40.0 | 20.0 | - | T-10 |
| | A-15 | 3.5 | 45.0 | 40.0 | 20.0 | - | T-15 |
| | A-20W | 4.0 | 45.0 | 40.0 | 20.0 | - | T-20 |
|  | A-15T | 4.0 | 100.0 | 80.0 | 26.0 | - | T-15 |
| | A-20 | 4.0 | 100.0 | 100.0 | 32.0 | - | T-20 |
| | A-20L | 5.5 | 200.0 | 100.0 | 32.0 | - | T-20 |
| | A-25 | 4.5 | 100.0 | 100.0 | 32.0 | - | T-25 |
| | A-27 | 5.5 | 100.0 | 100.0 | 32.0 | - | T-27 |
| | A-30 | 6.0 | 100.0 | 100.0 | 32.0 | - | T-30 |
| | A-40 | 7.0 | 100.0 | 100.0 | 32.0 | - | T-40 |
|  | AD-1845 | 1.8 | 45.0 | - | - | - | - |
|  | AD-2080 | 2.0 | 45.0 | 35.0 | - | - | - |

# Parts

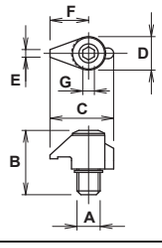
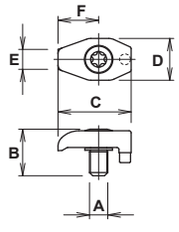
## Adjustable Screw

| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | Wrench | Torque |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | | |
|  | LSM-512 | - | M5 x 1.0 | 12.6 | 1.0 | 3.0 | 2.5 | - | - |

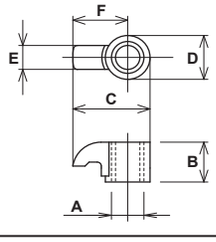
## Hexagon Socket Set Screw

| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | Wrench | Torque |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | | |
|  | RSW-05008 | - | M5 x 0.8 | 8.0 | - | - | - | T-10 | - |

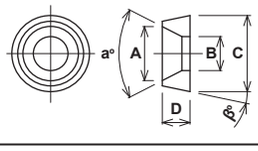
## Clamp Sets

| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | | | Wrench |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | |
|  | DCM-1 | M5 x 0.8 | 13.8 | 13.8 | 6.8 | 2.0 | 8.5 | 2.5 | - |
| | DCM-5 | M6 x 1.0 | 17.0 | 16.5 | 8.9 | 2.0 | 10.0 | 3.0 | - |
|  | DCM-17 | M4.5 x 0.75 | 11.7 | 18.0 | 10.5 | 5.0 | 10.0 | - | T-20 |
| | DCM-18 | M3.5 x 0.6 | 10.0 | 13.0 | 7.6 | 3.0 | 7.2 | - | T-15 |

## Clamp

| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | |
|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F |
|  | DCM-2 | M8 x 1.0 | 10.0 | 19.0 | 11.0 | 6.0 | 13.5 |

## Clamp Washer

| DRAWING | CATALOG NUMBER | DIMENSIONS | | | | | |
|---|---|---|---|---|---|---|---|
| | | A | B | C | D | a° | β° |
|  | CW-11 | 8.0 | 5.0 | 11.0 | 4.0 | 55 | 12 |