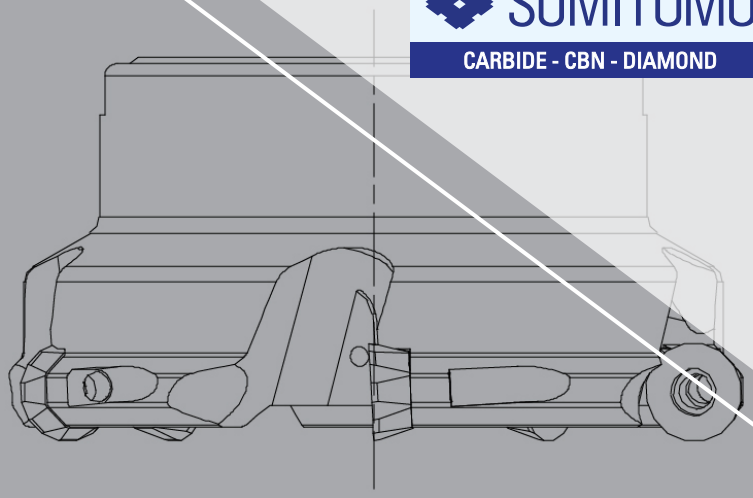
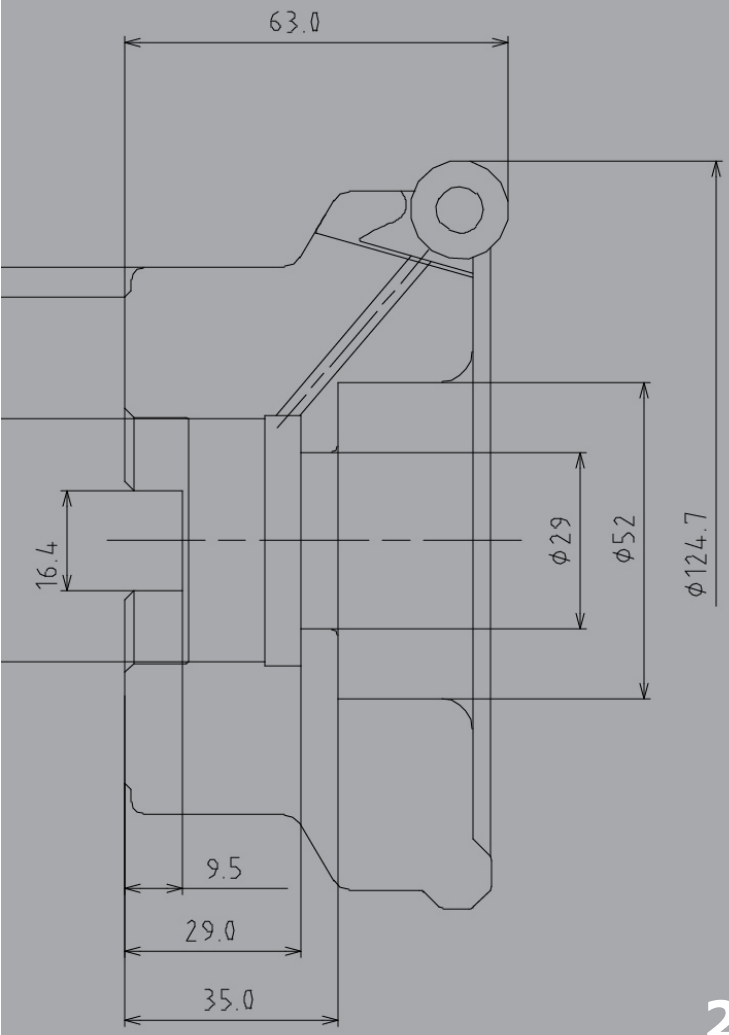
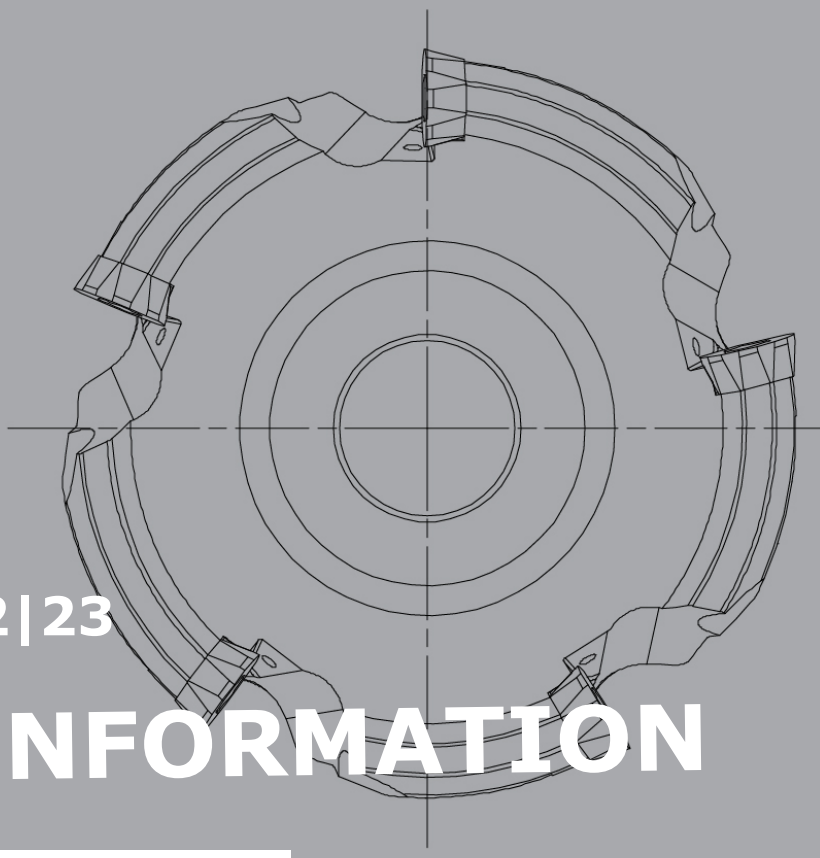
N-P

SUMITOMO
CARBIDE - CBN - DIAMOND

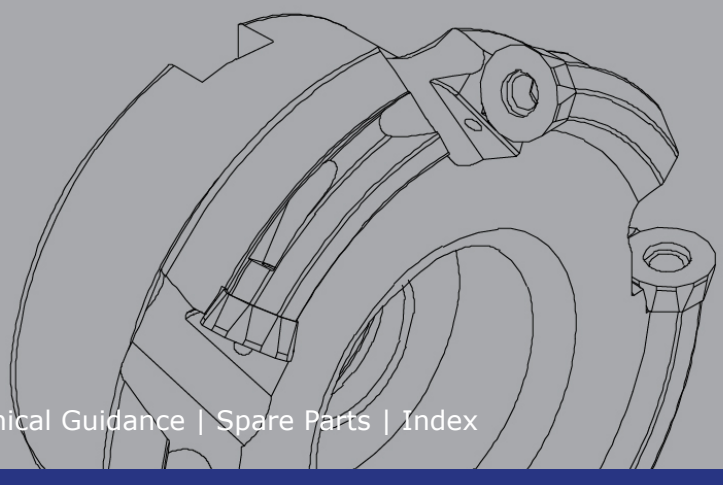






22|23

TECHNICAL INFORMATION



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SUMITOMO ELECTRIC GROUP

N

Technical Guidance References

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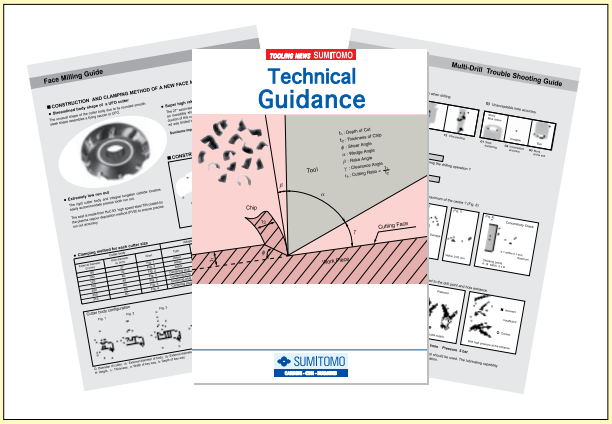

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Basics of Turning

■ Calculating Power Requirement

$$P_c = \frac{a_p \cdot f \cdot v_c \cdot K_c}{60 \times 10^3 \times \eta}$$

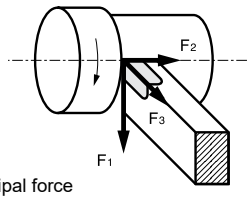
$$H = \frac{P_c}{0{,}75}$$

P_c : Net power requirement (KW)
v_c : Cutting speed (m/min)
f : Feed rate (mm/rev)
a_p : Depth of cut (mm)
η : Machine efficiency (0,70 ~ 0,85)
K_c : Specific cutting force (N/mm²)
H : Required horsepower (HP)

● Rough value of specific cutting force (K_c)

General steel :	2.500 ~ 3.000 N/mm²
Cast iron :	1.500 N/mm²
Aluminum :	800 N/mm²

■ Cutting Force



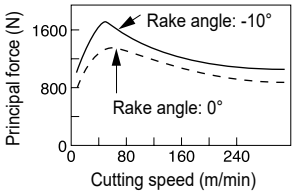
F_1 : Principal force
F_2 : Feed force
F_3 : Back force

● Calculating cutting force

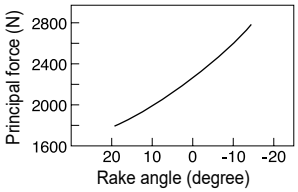
$$P = K_c \cdot q = \frac{k_c \times a_p \times f}{1000}$$

P : Cutting force (N)
K_c : Specific cutting force (N/mm²)
q : Chip area (mm²)
a_p : Depth of cut (mm)
f : Feed rate (mm/rev)

■ Cutting Speed and Cutting Force



■ Rake Angle and Cutting Force



■ Calculating Cutting Speed

① Calculating rotational speed from cutting speed

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

n : Spindle speed (min⁻¹)
v_c : Cutting speed (m/min)
D : Diameter of workpiece (mm)
$\pi \approx 3{,}14$

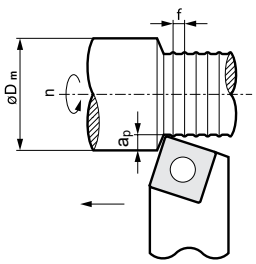
(Eg.) v_c = 150 m/min, D = 100 mm

$$n = \frac{1000 \times 150}{3{,}14 \times 100} = 478 \text{ (min}^{-1}\text{)}$$

② Calculating cutting speed from rotational speed

$$v_c = \frac{\pi \cdot D \cdot n}{1.000}$$

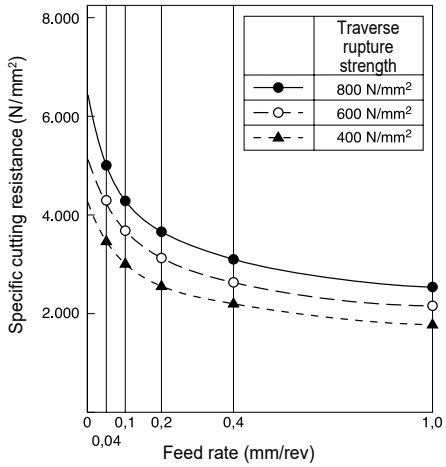
Refer to the above table



n : Spindle speed (min⁻¹)
v_c : Cutting speed (m/min)
f : Feed rate (mm/rev)
a_p : Depth of cut (mm)
D_m : Diameter of workpiece (mm)

■ Feed Rate and Specific Cutting Force

(For carbon steel)



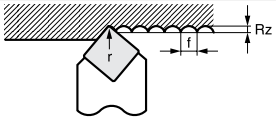
When feed rate decreases, specific cutting force increases.

■ Roughness

● Theoretical Surface Finish

$$Rz = \frac{f^2}{8 \times r}$$

Rz : Surface finish (mm)
f : Feed rate (mm/rev)
r : Nose radius (mm)



● Actual surface roughness

Steel :
Theoretical surface finish x 1,5–3
Cast iron :
Theoretical surface finish x 3–5

● Ways to Improve Surface Finish

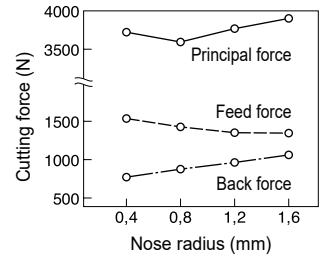
① Use an insert with a larger nose radius.

② Optimize the cutting speed and feed rate so that built-up edge does not occur.

③ Select an appropriate insert grade.

④ Use wiper insert.

■ Nose Radius and Cutting Force

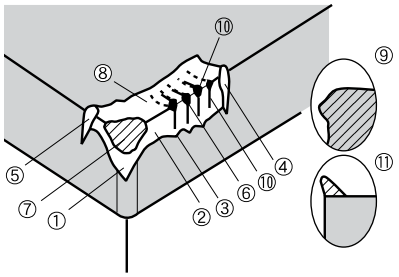


Large nose radius increases back force.

Work : 42CrMo4 (Hs38)
Inserts : TNGA2204○○
Holder : PTGNR2525-43
Condition : v_c = 100m/min
a_p = 4mm
f = 0,45 mm/rev

Tool Failures and Tool Life

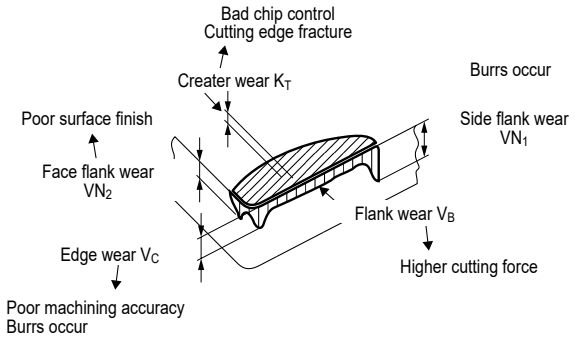
■ Forms of Tool Failures

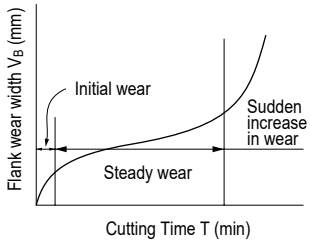
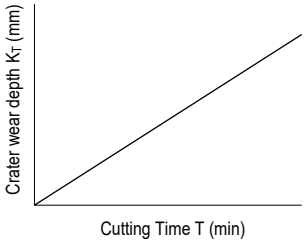


Cat.	No.	Name of Failure	Cause of Failure
Resulting from Mechanical causes	1~5	Flank Wear	Due to the scratching effect of hard grains contained in the work material.
	6	Chipping	Fine breakages caused by high cutting loads or chattering.
	7	Fracture	Due to the impact of an excessive mechanical force acting on the cutting edge.
Resulting from Chemical reactions	8	Crater Wear	Swaft chips removing tool material as it flow over the top face at high temperatures.
	9	Plastic Deformation	Cutting edge is depressed due to softening at high temperatures.
	10	Thermal Crack	Fatigue from rapid, repeated heating and cooling cycles during machining.
	11	Built-up Edge	Work material is pressure welded on the top face of the cutting edge.

■ Tool Wear

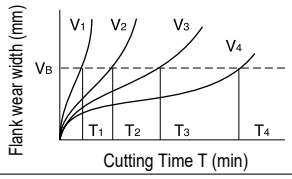
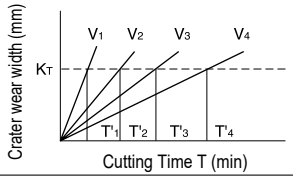
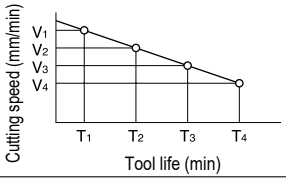
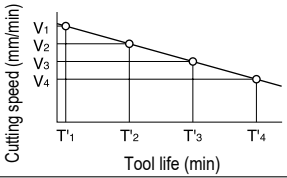
Forms of Tool Wear



Flank wear	Crater wear
	
Wear is rapid initially, then it proceeds more gradually in proportion with cutting time until a certain limit, beyond which it increases rapidly again.	Crater wear is more progressive with no sudden breakdown pattern.

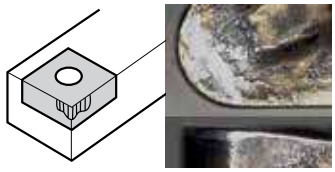
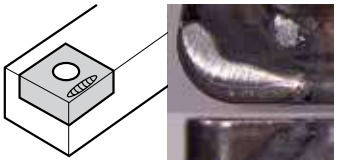
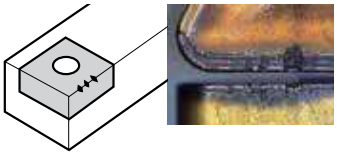
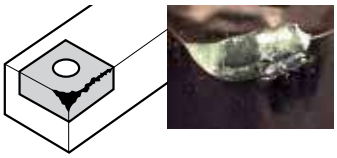
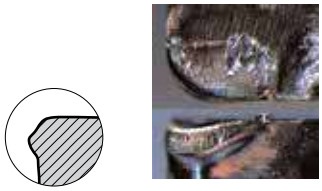
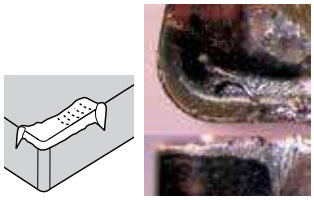
■ Tool Life (V-T)

Measure the relative tool lives of the specified wear, over a range of cutting speeds, then plot the tool life along the X-axis and the cutting speed along the Y-axis on a double logarithm graph.

	Flank wear	Crater wear
Tool wear		
Tool life		

Tool Failure and Remedies

■ Trouble Shooting Guide for Turning

	Damage	Cause	Countermeasures
Tool Edge Failure	Excessive flank wear 	- Grade lacks wear resistance. - Cutting speed ist too fast. - Feed rate ist far too slow.	- Select a wear resistant grade. P30 ⇨ P20 ⇨ P10 K20 ⇨ K10 ⇨ K01 - Use an insert with a larger rake angle. - Decrease the cutting speed. - Increase feed rates.
	Excessive crater wear 	- Grade lacks crater wear resistance. - Rake angle is too small. - Cutting speed is too fast. - Feed rate and depth of cut are too large.	- Select a more crater-resistant grade. - Use an insert with a larger rake angle. - Select an appropriate chipbreaker. - Decrease the cutting speed. - Decrease the D.O.C. and feed rate.
	Cutting edge chipping 	- Grade lacks toughness. - Insert falls off due to chip build-up. - Cutting edge lacks toughness. - Feed rate and depth of cut are too large.	- Change to tougher grades. P10 ⇨ P20 ⇨ P30 K01 ⇨ K10 ⇨ K20 - Increase amount of honing on cutting edge. - Reduce rake angle. - Reduce feed rates and depth of cut.
	Cutting edge fracture 	- Grades lacks toughness. - Cutting edge lacks toughness. - Holder lacks toughness. - Feed rarte is too fast. - Depth of cut is too large.	- Change to tougher grades. P10 ⇨ P20 ⇨ P30 K01 ⇨ K10 ⇨ K20 - Select a chipbreaker with a strong cutting edge. - Select a holder with a larger approach angle. - Select a holder with a larger shank size. - Decrease the D.O.C. and feed rate.
	Build-up edge 	- Inappropriate grade selection. - Dull cutting edge. - Cutting speed is too slow. - Feed rate ist too slow.	- Select a grade with less affinity to the work material. Coated carbide or cermet grades. - Select a grade with a smooth coating. - Use an insert with a larger rake angle. - Reduce amount of honing. - Increase cutting speeds. - Increase feed rates.
	Plastic deformation 	- Grade lacks thermal resistance. - Cutting speed is too fast. - Feed rate is too fast. - Depth of cut is too large. - Not enough cutting fluid.	- Select a more crater-wear-resistant grade. - Use an insert with a larger rake angle. - Decrease the cutting speed. - Reduce feed rates and depth of cut. - Supply a sufficient amount of coolant.
	Notch wear 	- Grade lacks wear resistance. - Rake angle is too small. - Cutting speed is too fast.	- Select a wear resistant grade. P30 ⇨ P20 ⇨ P10 K20 ⇨ K10 ⇨ K01 - Use an insert with a larger rake angle. - Alter depth of cutto shift the notch location.

Type of Chip Generation

	a	b	c	d
Shape				
Condition	Continuous chips with good surface finish.	Chip is sheared and separated by the shear angle.	Chips appear to be torn from the surface.	Chips crack before reaching the cutting point.
Application	Steel, Stainless steel	Steel, Stainless steel (Low speed)	Steel, Cast iron (Very low speed, very small feedrate)	Cast iron, Carbon
Influence factor	Easy ← Work deformation → Difficult Large ← Rake angle → Small Small ← D.O.C. → Large Fast ← Cutting speed → Slow			

Type of Chip Control

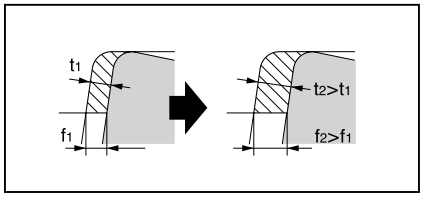
Feed rate	A	B	C	D	E
Large feed rate					
Small feed rate					
NC lathe (For automation)	×	×	○	○	△
General lathe (For safety)	×	○	○	○ ~ △	×

Good : C type, D type

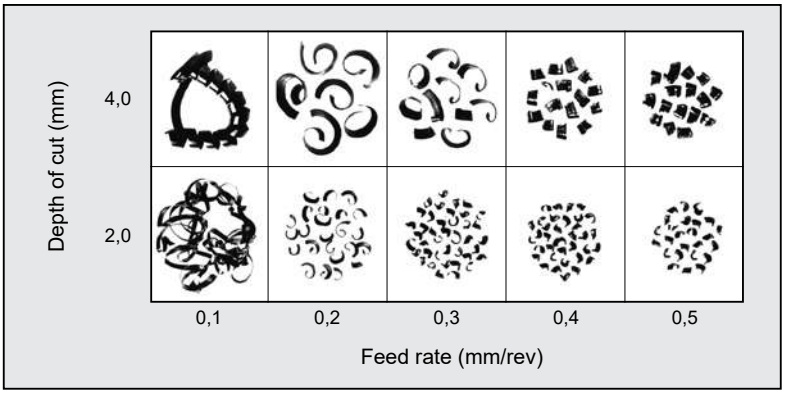
Poor
- A type : Twines around the tool or workpiece, damages the machined surface and affects safety.
- B type : Bulky, causes problems in the automatic chip conveyor and chipping occurs easily.
- E type : Causes spraying of chips, poor machined surface due to chattering, chipping, large cutting force and high temperatures.

Factor of Improvement Chip Control

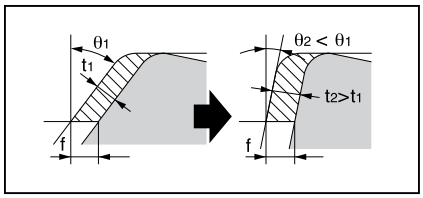
① Increase feed rate



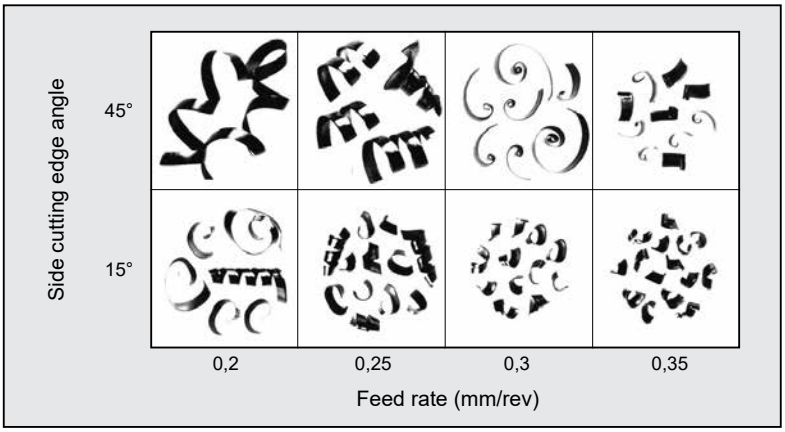
When feedrate increase, chips become thick and chip control improves.



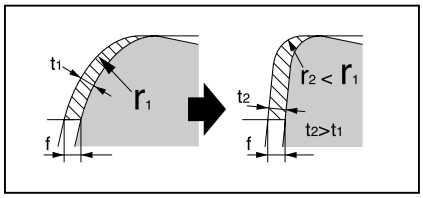
② Decrease side cutting edge



Even if feed rate is the same, smaller side cutting edge angle makes chips thick and chip control improves.

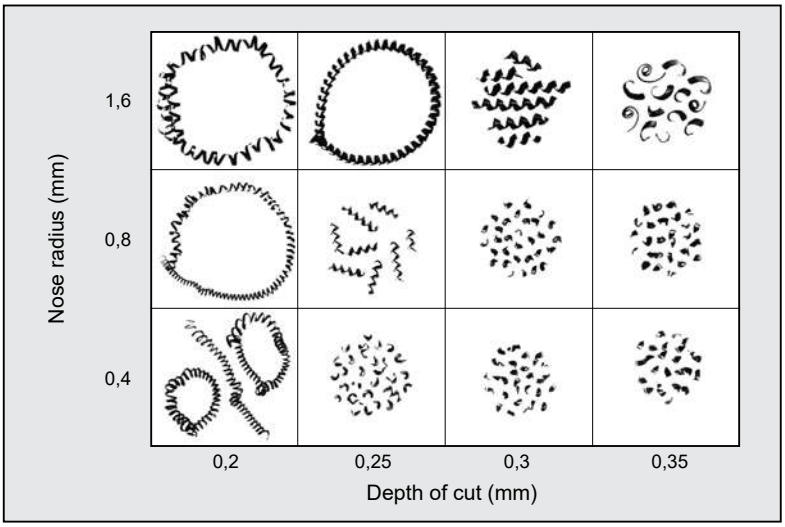


③ Decrease nose radius



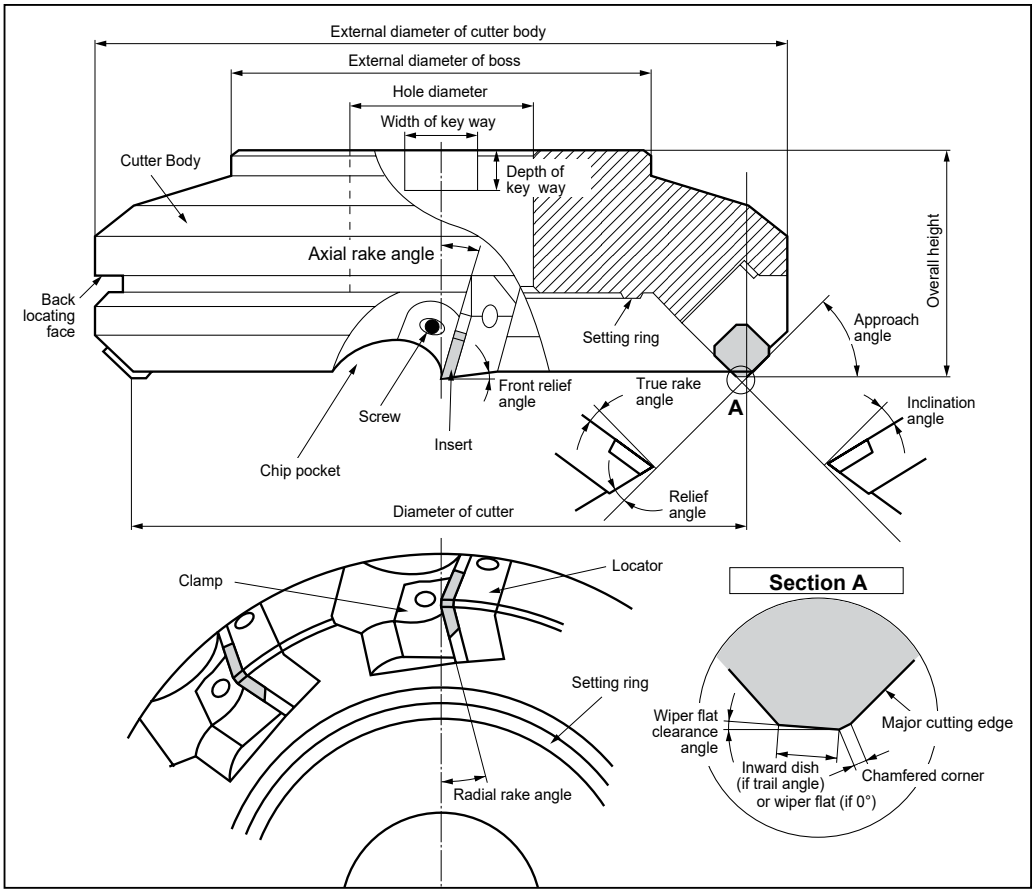
Even if depth of cut is the same, smaller nose radius makes chip thick and chip control improves.

* Cutting resistance increases in proportion with the width of the contact surface. Therefore, with a larger nose radius, cutting resistance and back force increases, chattering may also occur. However, with the same feedrate, a smaller nose radius would produce a poorer surface finish.



Basics of Milling

■ Parts of a Milling Cutter



■ Power Requirement

● Calculating cutting force

$$P_c = \frac{a_p \cdot a_e \cdot v_f \cdot K_c}{60 \times 10^6 \times \eta} \text{ (kW)}$$

● Horsepower

$$H = \frac{Pc}{0{,}75}$$

● Chip removal amount

$$Q = \frac{a_p \times a_e \times v_f}{1.000} \text{ (cm}^3\text{/min)}$$

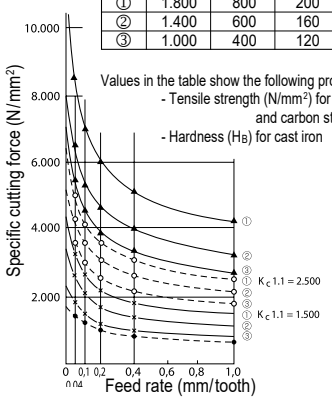
P_c : Net power requirement (kW)
H : Horsepower requirement (HP)
Q : Chip removal amount (cm^3/min)
a_e : Cutting width (mm)
v_f : Feed speed (mm/min)
a_p : Depth of cut (mm)
η : Machine efficiency (0,70 ~ 0,85)
K_c : Specific cutting forrce (N/mm^2)

Eg. rough value
(Steel : 2.500 ~ 3.000
Cast iron : 1.500)

● Relation between feed rate, work material, specific cutting force

Work-piece No.	Alloy steel	Carbon steel	Cast iron	Aluminum alloy
①	1.800	800	200	–
②	1.400	600	160	–
③	1.000	400	120	–

Values in the table show the following properties:
- Tensile strength (N/mm^2) for alloy steel and carbon steel
- Hardness (H_B) for cast iron



● Calculating cutting speed

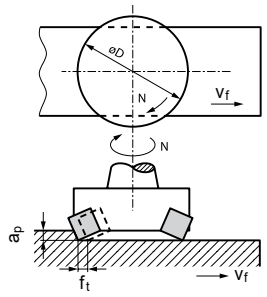
$$v_c = \frac{\pi \times D \times n}{1.000}$$

● Calculating feed rate

$$v_f = f_z \times z \times n$$

$$f_z = \frac{v_f}{z \times n}$$

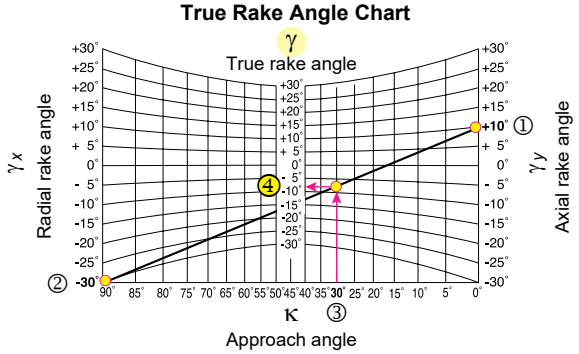
v_c : Cutting speed (m/min)
π ≈ 3,14
D : Cutter diameter (mm)
n : Rotation speed (rpm)
v_f : Feed speed (mm/min)
f_z : Feed rate (mm/tooth)
z : Number of teeth



■ Functions of the Various Cutting Angles

	Description	Code	Functions	Influences
① ②	Axial rake angle Radial rake angle	γ_y γ_x	Controls chip removal direction, effects adhesion of the chips and thrust force etc.	Rake angles can vary from positive to negative (large to small) with typical combinations of positive and negative, positive and positive or negative and negative configurations.
③	Approach angle	κ	Controls chip thickness and chip removal direction	The effect of the small approach angle is to reduce the chip thickness and cutting force.
④	True rake angle (Effective rake angle)	γ	Controls cutting performance and ability to retain a cutting edge	- With a positive (large) angle, cutting ability and adhesion resistance are improved but the strength of the cutting edge is weakened. - With negative (small) angle, the strength of the cutting edge is improved but chips will tend to adhere more easily.
⑤	Inclination angle	λ	Controls chip removal direction	- With a positive (large) angle, the chip removal is satisfactory with less cutting resistance but the strengh of the corner is weaker.
⑥	Wiper flat clearance angle	α_f	Controls surface finish	A smaller clearance angle will produce a better surface finish.
⑦	Clearance angle	α	Controls edge strength, tool life and chattering, etc	

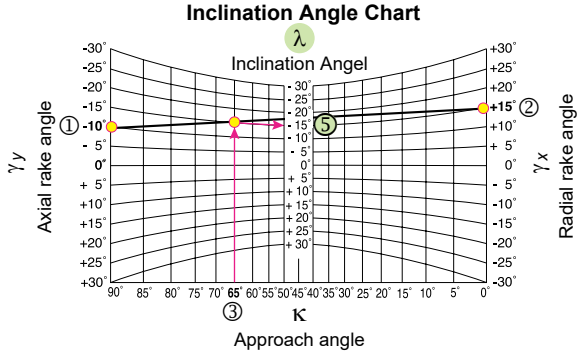
True Rake Angle Chart



Example in using the above chart:		Solution:
① γ_y :	Axial rake angle = +10°	True rake angle
② γ_x :	Radial rake angle = -30°	④ γ = - 8°
③ κ :	Approach angle = 30°	

Formula : $\tan\gamma = \tan\gamma_x \cdot \sin\kappa + \tan\gamma_y \cdot \cos\kappa$

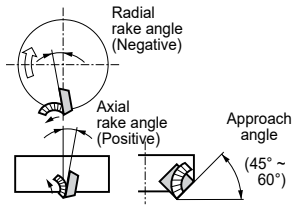
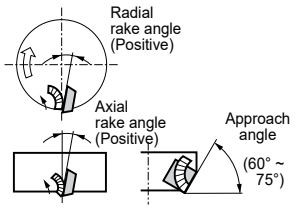
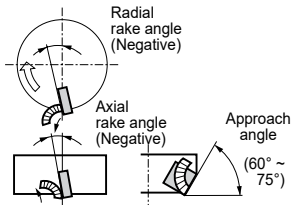
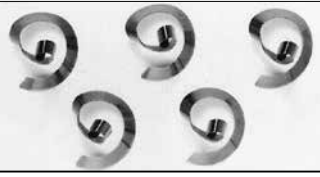
Inclination Angle Chart



Example in using the above chart :		Solution:
① γ_y :	Axial rake angle = -10°	Inclination angle
② γ_x :	Radial rake angle = +10°	⑤ λ = - 15°
③ κ :	Approach angle = 65°	

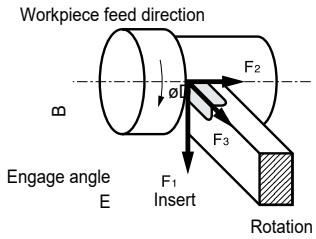
Formula : $\tan\lambda = \tan\gamma_y \cdot \sin\kappa - \tan\gamma_x \cdot \cos\kappa$

■ Rake Angle Combination

	Negative - Positive Type	Double Positive Type	Double Negative Type
The effects of the various angle configurations with relation to chip formation and chip removal. Chip removal direction Rotation			
Advantage	Excellent chip removal and good cutting action	Good cutting action	Double-sided inserts can be use and higher cutting edge strength
Disadvantage	Only single-sided inserts can be use	Lower cutting edge strength and only single-sided inserts can be use	Dull cutting action
Application	For Steel, Cast iron, Stainless steel, Alloy steel	For general milling of steel For low rigidly work piece	For light milling of cast iron and steel
Typical cutter	WGX, WGC, UFO	DPG	DNX, DGC, DNF
Chips (Eg.) Workpiece: 37Cr4 v_c = 130 m/min f_t = 0.23 mm/tooth a_p = 3 mm			

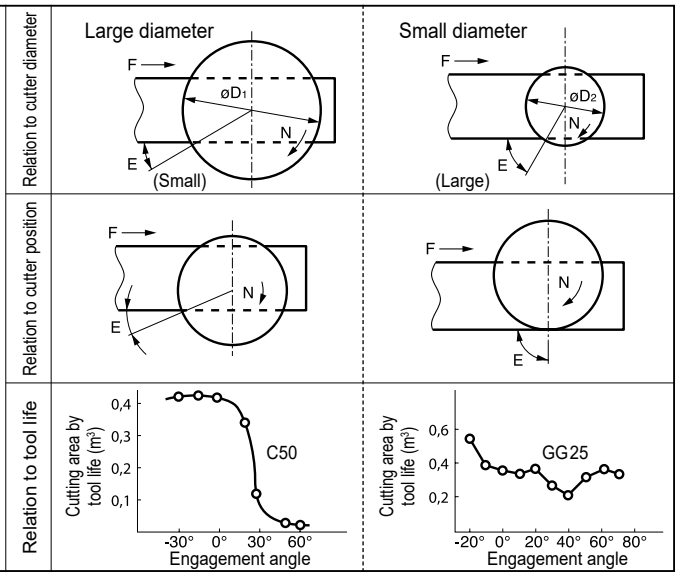
Basics of Milling

■ Relation Between Engage Angle and Tool Life

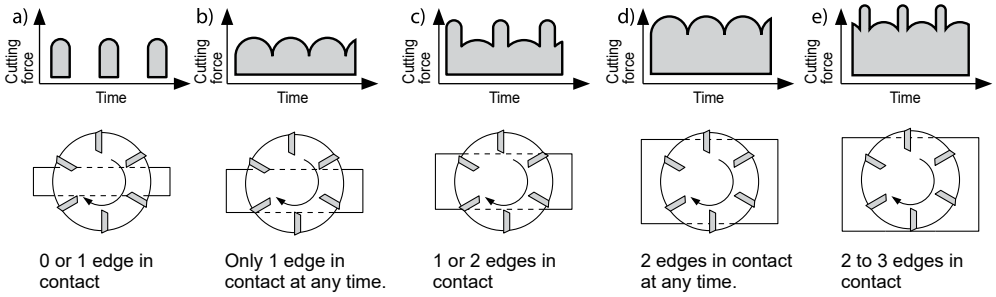


Engage angle denotes the angle by which the full length of the cutting edge comes in contact with the workpiece, with reference to the feed direction. The larger E is, the shorter the tool life.

To change the value of E:
1) Increase the cutter size
2) Shift the position of the cutter



● Relation between the number of simultaneously engaged cutting edges and cutting force:



■ To Improve Surface Roughness

① Milling inserts with wiper flat

When all the cutting edges have wiper flats, a few teeth are intentionally elevated to play the role of a wiper insert.

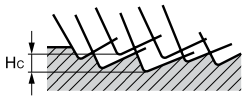
- Insert equipped with straight wiper flat (Face angle: Approx 15' - 1°)
- Insert equipped with curved wiper flat (Eg. curvature R500)

② Integral wiper insert system

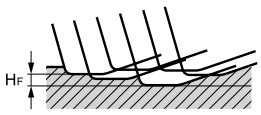
A system to protrude one or two inserts (wiper insert) with a smooth curved edge just a little beyond the other teeth to wipe the milled surface.

- (Applies to WGC, RF types etc.)

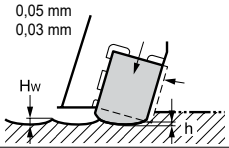
● Surface roughness without wiper flat



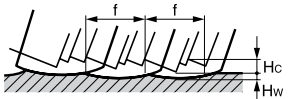
● Surface roughness with straight wiper flat



h : Projected value of wiper insert
Steels : 0,05 mm
Al : 0,03 mm

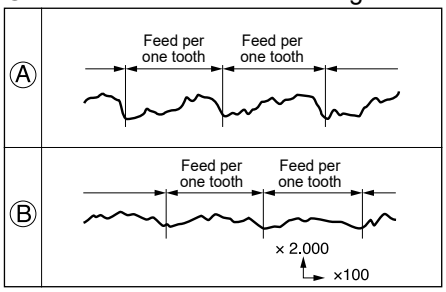


f : Feed rate per revolution



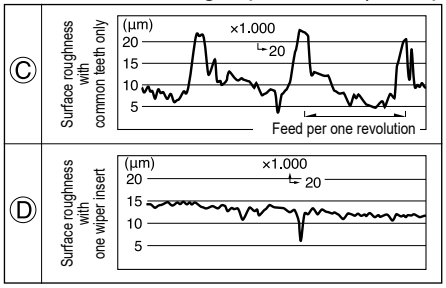
Hc : Surface roughness with only normal teeth
Hw : Surface roughness with wiper insert

● Influence of different face angles on surface finish



- Workpiece: 34CrMo4
- Cutter: DPG 5160 R (Single tooth)
- v_c = 154 m/min
  f_z = 0,234 mm/tooth
  a_p = 2 mm
- Face angle
  Ⓐ : 28'
  Ⓑ : 6'

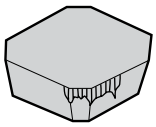
● Effects of having wiper insert (example)

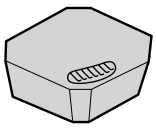


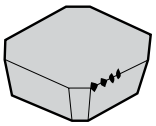
- Workpiece: GG25
- Cutter: DPG 4100 R
- Insert: SPKN 1203
- Axial run-out: 0,015 mm
- Radial run-out: 0,04 mm
- v_c = 105 m/min
- f_z = 0,29 mm/tooth (1,45 mm/rev)

Ⓒ : Only normal teeth
Ⓓ : with 1 wiper insert

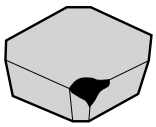
■ Trouble Shooting Guide for Milling

<table>
<tr><th colspan="2">Trouble</th><th colspan="2">Basic Remedies</th><th>Remedy Examples</th></tr>
<tr><td rowspan="4">Cutting Edge Failure</td><td>Excessive Flank Wear
  </td><td>Tool Material

Cutting Conditions</td><td>- Select a more wear resistant grade.
Carbide
P30 ⇨ P20
K20 ⇨ K10
⇨ { Coated / Cermet
- Reduce cutting speeds.
- Increase feedrate.</td><td>- Recommended insert grades
<table>
<tr><th></th><th>Steel</th><th>Cast Iron</th><th>Non-Ferrous Alloy</th></tr>
<tr><td>Finishing</td><td>T250A (Cermet)</td><td>ACK200 (Coated Carbide)
BN700 (SUMIBORON)</td><td>DA1000 (SUMIDIA)</td></tr>
<tr><td>Roughing</td><td>ACP100 (Coated Carbide)</td><td>ACK200 (Coated Carbide)</td><td>DL1000 (Coated Carbide)</td></tr>
</table></td></tr>
<tr><td>Excessive Crater Wear
  </td><td>Tool Material

Cutting Conditions</td><td>- Select a crater resistant grade.
- Reduce cutting speeds.
- Reduce depth-of-cut and feed rate.</td><td>- Recommended insert grades
<table>
<tr><th></th><th>Steel</th><th>Cast Iron</th><th>Non-Ferrous Alloy</th></tr>
<tr><td>Finishing</td><td>T250A (Cermet)</td><td>ACK200 (Coated Carbide)</td><td>DA1000 (SUMIDIA)</td></tr>
<tr><td>Roughing</td><td>ACP100 (Coated Carbide)</td><td>ACK200 (Coated Carbide)</td><td>DL1000 (Coated Carbide)</td></tr>
</table></td></tr>
<tr><td>Cutting Edge Chipping
  </td><td>Tool Material

Cutting Conditions

Tool Design</td><td>- Select tougher grade.
P10 ⇨ P20 ⇨ P30
K01 ⇨ K10 ⇨ K20
- Reduce feed rates.
- Select a negative-positive cutter configuration with a large approach angle.
- Reinforce the cutting edge (Honing).
- Select a strong edge insert (G → H).</td><td>- Recommended insert grades
<table>
<tr><th></th><th>Steel</th><th>Cast Iron</th></tr>
<tr><td>Finishing</td><td>ACP200 (Coated Carbide)</td><td>ACK200 (Coated Carbide)</td></tr>
<tr><td>Roughing</td><td>ACP300 (Coated Carbide)</td><td>ACK300 (Coated Carbide)</td></tr>
</table>
- Recommended cutter: WaveMill WGX type
- Cutting conditions:
Refer to recommended conditions listed in the general catalogue</td></tr>
<tr><td>Partial Fracture of Cutting Edges
  </td><td>Tool Material

Cutting Conditions

Tool Design</td><td>- If it is due to excessive low speeds or very low feed rates, select an adhesion resistant grade.
- If it is due to thermal cracking, select a thermal impact resistant grade.
- Select appropriate conditions with regards to the particular application.
- Select a negative-positive (or negative) cutter configuration with a large approach angle.
- Reinforce the cutting edge (Honing).
- Select a strong edge insert (G → H).
- Increase insert size -
(Thickness in particular).</td><td>- Recommended insert grades
<table>
<tr><th></th><th>Steel</th><th>Cast Iron</th></tr>
<tr><td>Roughing</td><td>ACP300
(Coated Carbide)</td><td>ACK300
(Coated Carbide)</td></tr>
</table>
- Recommended cutter: WaveMill WGX type
- Insert thickness: 3,18 → 4,76 mm
- Insert type: Standard → Strong edge type
- Cutting conditions:
Refer to recommended conditions listed in the general catalogue</td></tr>
<tr><td rowspan="5">Others</td><td>Unsatisfactory Machined Surface Finish</td><td>Tool Material

Cutting Conditions

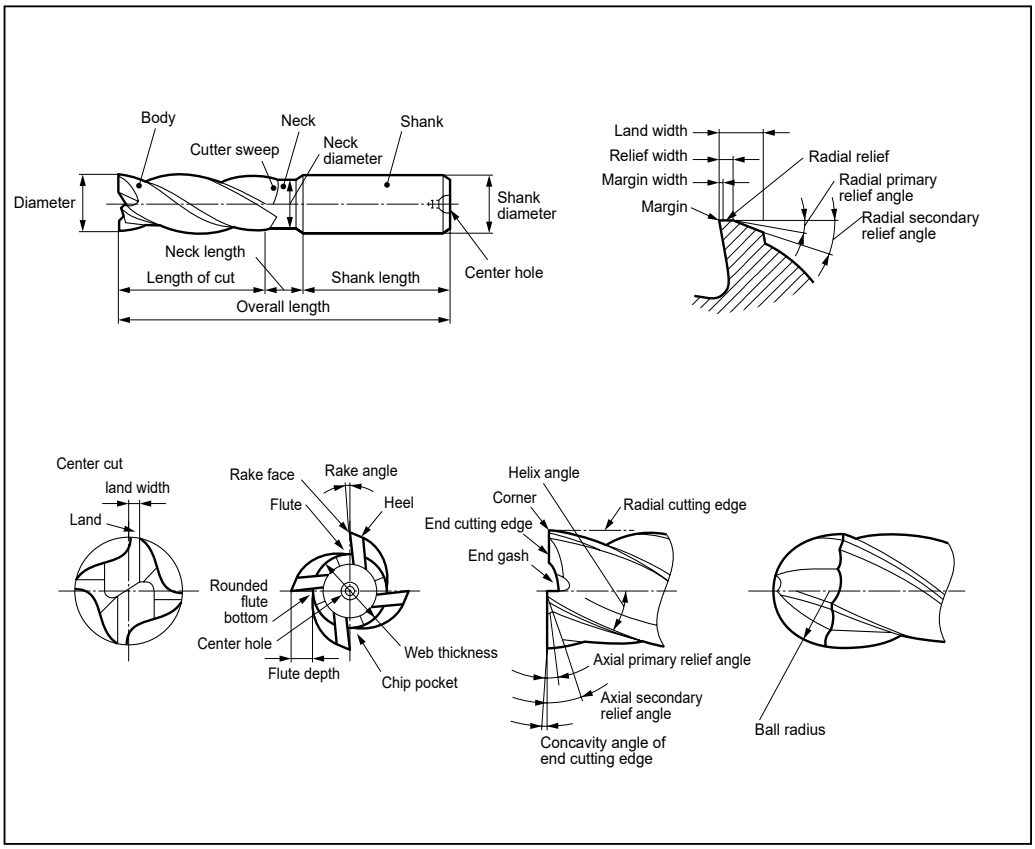
Tool Design</td><td>- Select an adhesion resistant grade.
Carbide → Cermet
- Increase cutting speeds.
- Improve axial run-out of cutting edges.
(Use a cutter with less run-out)
(Attach correct inserts)
- Use wiper inserts.
- Use special purpose cutters designed for finishing.</td><td>- Recommended insert grades
<table>
<tr><th></th><th></th><th>Steel</th><th>Cast Iron</th><th>Non-Ferrous Alloy</th></tr>
<tr><td>Roughing</td><td>Cutter Insert</td><td>WGX type*
ACP200
(Coated Carbide)</td><td>DGC type*
ACK200
(Coated Carbide)</td><td>FF type*
H1 (Carbide)
DL1000 (Coated Carbide)</td></tr>
<tr><td>Finishing</td><td>Cutter Insert</td><td>WGC type
T250A
(Cermet)</td><td>FMU type
BN700
(SUMIBORON)</td><td>RF type
DA1000
(SUMIDIA)</td></tr>
</table>
* marked cutters can be fitted with wiper inserts.</td></tr>
<tr><td>Chattering</td><td>Cutting Conditions
Tool Design

Others</td><td>- Reduce feed rates.
- Select a high rake cutter with sharp cutting edges
- Use an irregular pitched cutter.
- Improve workpiece and cutter clamp rigidity.</td><td>- Recommended cutters:
For steel: WaveMill WGX type
For cast iron: DNX type
For Non-ferrous alloy: High speed cutter for aluminium
RF type</td></tr>
<tr><td>Unsatisfactory Chip Control</td><td>Tool Design</td><td>- Select cutter with good chip removal features.
- Reduce number of teeth.
- Enlarge chip pocket.</td><td>- Recommended cutter: WaveMill WGX type</td></tr>
<tr><td>Edge Chipping on Workpiece</td><td>Tool Design

Cutting Conditions</td><td>- Select a large approach angle.
- Select a sharp cutting edge insert (G → L).
- Reduce feed rates.</td><td>- Recommended cutter: WaveMill WGX type</td></tr>
<tr><td>Burr on Workpiece</td><td>Tool Design
Cutting Conditions</td><td>- Select a cutter with sharp cutting edges.
- Increase feed rates.</td><td>- Recommended cutter: WaveMill WGX type + FG breaker
DGC type + FG breaker</td></tr>
</table>

Basics of Endmilling

Parts of an Endmill



Calculating Cutting Conditions

Cutting speed

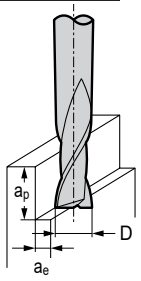
$$v_c = \frac{\pi \cdot D \cdot n}{1.000} \qquad n = \frac{1.000 \cdot v_c}{\pi \cdot D}$$

Feed rate

$$v_f = f \times n$$

$$v_f = f_z \times z \times n \qquad f_z = \frac{v_f}{z \times n}$$

Side milling

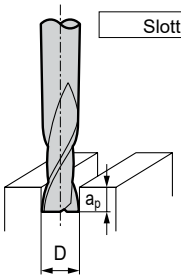


v_c : Cutting speed (m/min)
$\pi \approx 3{,}14$
D : Endmill diameter (mm)
n : Rotational speed (min^{-1})
v_f : Feed speed (mm/min)
f_r : Feed rate per revolution (mm/rev)
f_z : Feed rate per tooth (mm/tooth)
z : Number of teeth

Depth of cut (D.O.C)

a_p : Axial D.O.C. (depth)
a_e : Radial D.O.C. (width)

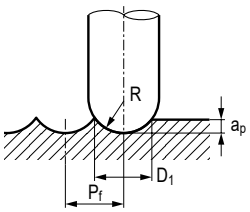
Slotting

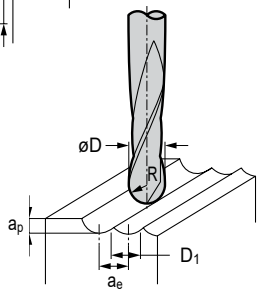


(Ball Endmill)

Notch width (D_1)

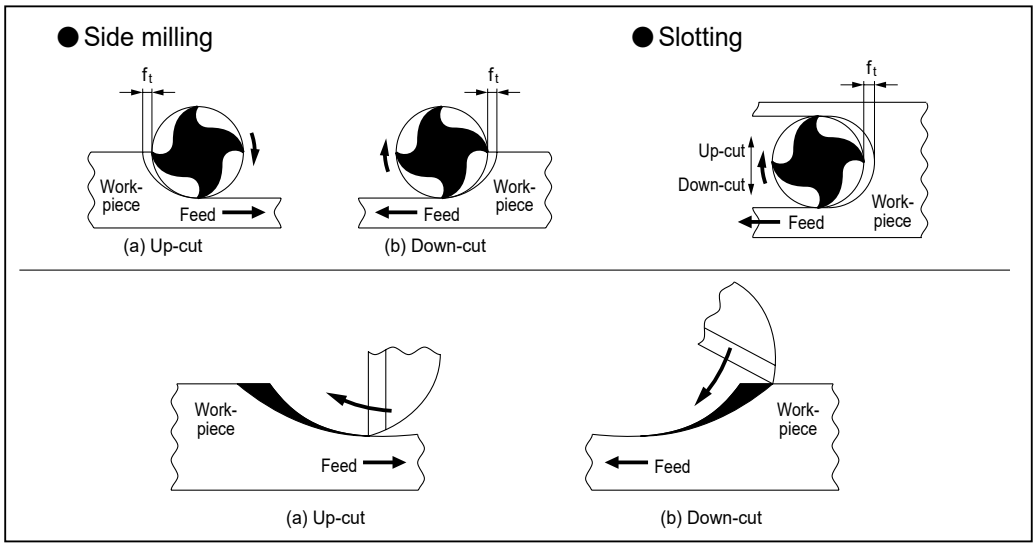
$$D1 = 2 \times \sqrt{2 \times R \times a_p - a_p^2}$$

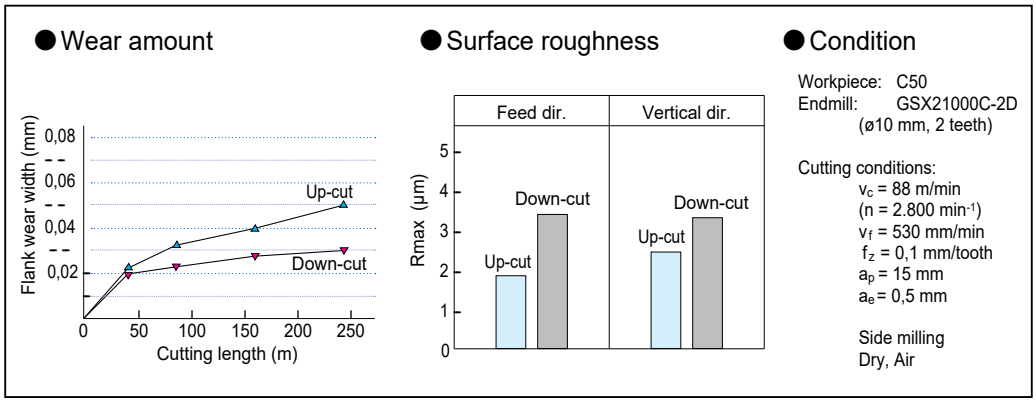




Cutting speed and feedrate are calculated using the same formula as square endmill.

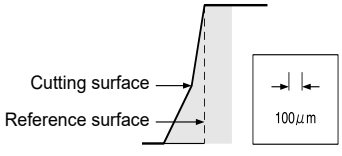
■ Up-cut and Dowm-cut





■ Relation Between Cutting Condition and Deflection

Endmill			Side milling: Work material: Pre-hardened steel (40HRC). Cutting data: v_c = 25 m/min, a_p = 12 mm, a_e = 0,8 mm				Slotting: Work material: Pre-hardened steel (40HRC). Cutting data: v_c = 25 m/min, a_p = 8 mm, a_e = 8 mm (Up-cut side / Down-cut side)			
Cat. No.	Number of teeth	Helix angle	Feed rate 0,16 mm/rev		Feed rate 0,11 mm/rev		Feed rate 0,05 mm/rev		Feed rate 0,03 mm/rev	
			Style		Style		Style		Style	
			Up-cut	Down-cut	Up-cut	Down-cut	Up-cut	Down-cut	Up-cut	Down-cut
SSM 2080	2	30°								
SSM 4080	4	30°								



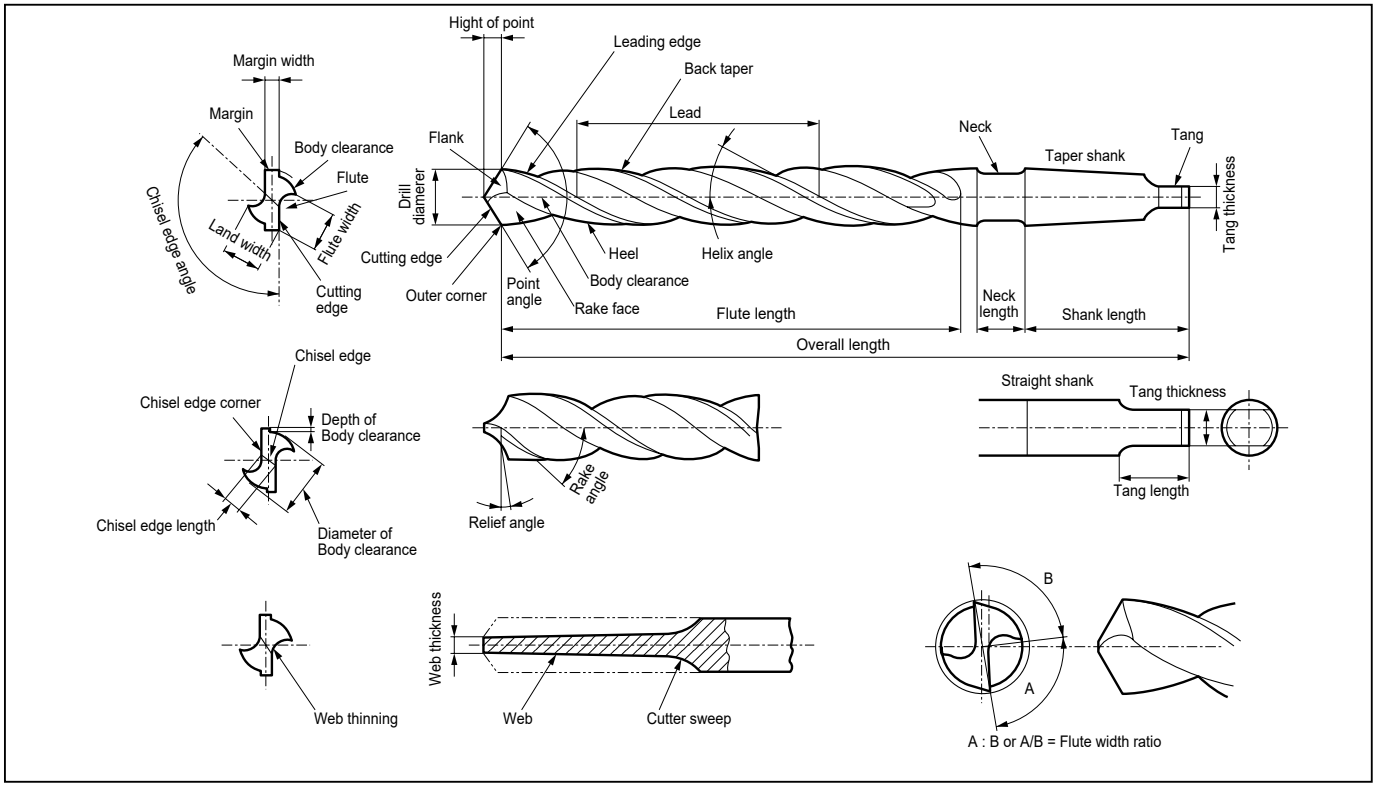
Tool Failure and Remedies

■ Trouble Shooting Guide for Endmilling

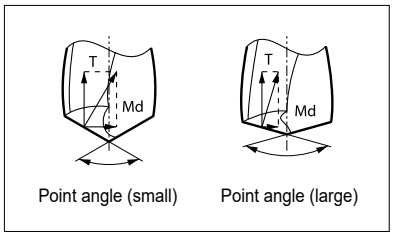
Failure		Cause		Remedies
Cutting Edge Failure	Excessive Wear	Cutting Conditions	- Cutting speed is too fast - Feed rate is too fast	- Decrease cutting speed and feed rate.
		Tool Shape	- The flank relief angle ist too small	- Change to an appropriate flank relief angle.
		Tool Material	- Insufficient wear resistance	- Select a substrate with more wear resistance - Use a coated tool
	Chipping	Cutting Conditions	- Feed rate ist too fast - Cutting depth is too deep - Tool overhang ist too long	- Decrease cutting speed. - Reduce depth of cut - Adjust tool overhang for correct length
		Machine Area	- Work clamps are weak - Tool is not firmly attached	- Clamp the work piece firmly - Make sure the tool is seated in the chuck properly
	Tool Fracture	Cutting Conditions	- Feed rate ist too fast - Cutting depth is too deep - Tool overhang ist too long - Cutting edge is too long	- Decrease cutting speed. - Reduce depth of cut - Reduce tool overhang as much as possible - Select a tool with a shorter cutting edge
Others	Shoulder Deflection	Cutting Conditions	- Feed rate is too fast - Cutting depth is too deep - Tool overhang is too long - Cutting on the down-cut	- Decrease cutting speed. - Reduce depth of cut - Adjust tool overhang for correct length - Change directions to up-cut
		Tool Shape	- Helix angle is large	- Use a tool with a smaller helix angle
	Unsatisfactory Machined Surface Finish	Cutting Conditions	- Feed rate is too fast	- Decrease cutting speed.
			- Packing of chips	- Use air blow - Use an insert with a larger relief pocket.
	Chattering	Cutting Conditions	- Cutting speed is too fast - Cutting on the up-cut - Tool overhang is too long	- Decrease cutting speed. - Change directions to down-cut - Adjust tool overhang for correct length
		Tool Shape	- Rake angle is large	- Use a tool with an appropriate rake angle
		Machine Area	- Work clamps are weak - Tool is not firmly attached	- Clamp the work piece firmly - Make sure the tool is seated in the chuck properly
	Packing of Chip	Cutting Conditions	- Feed rate is too fast - Cutting depth is too deep	- Decrease cutting speed. - Reduce depth of cut
		Tool Shape	- Too many teeth - Packing of chips	- Reduce number of teeth - Use air blow

Basics of Drilling

■ Parts of a Drill

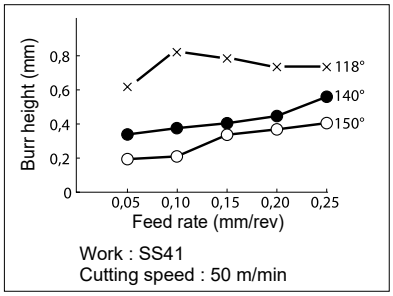


● Point Angle and Force



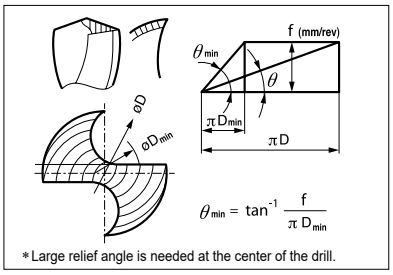
When point angle is large, thrust becomes large but torque becomes small.

● Point Angle and Burr



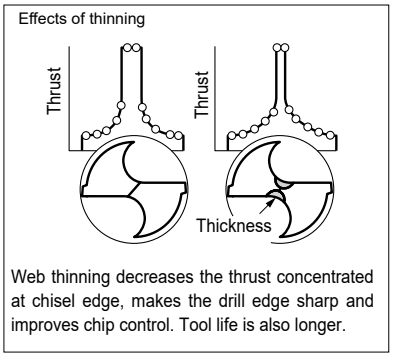
When point angle is large, burr height becomes low.

● Min. Requirement Relief Angle



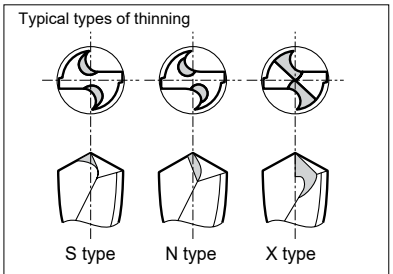
* Large relief angle is needed at the center of the drill.

● Web Thickness and Thrust



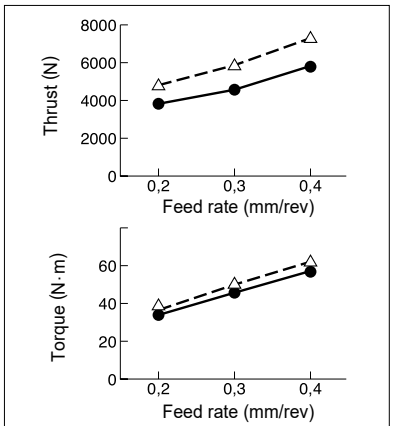
Web thinning decreases the thrust concentrated at chisel edge, makes the drill edge sharp and improves chip control. Tool life is also longer.

● Decrease Chisel Width by Thinning



S type : Standard type used generaly.
N type : Suitable for thin web drills.
X type : For hard-to-cut material or deep hole drilling.

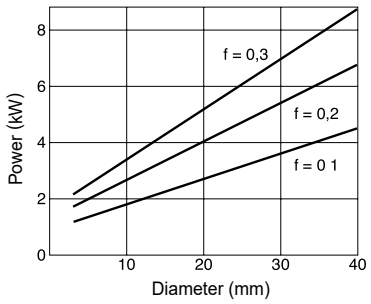
● Width of Edge Threatment and Cutting Force

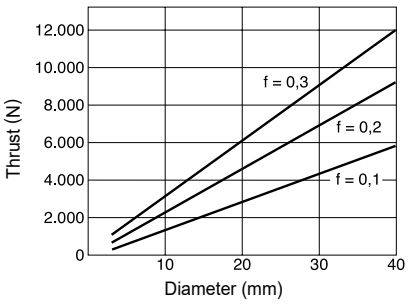


Drill: KDS 215 MAK
Work material: C50 (230HB)
Cutting conditions:
v_c = 50 m/min, Water soluble

Basics of Drilling

■ Reference of Power Requirement and Thrust





Work material:
C48 (220 HB)

■ Cutting Condition Selection

● Control cutting force for low rigid machine

The following table shows the relation between edge treatment width and cutting force. If a problem caused by cutting force occurs, reduce either the feedrate or the edge treatment width.

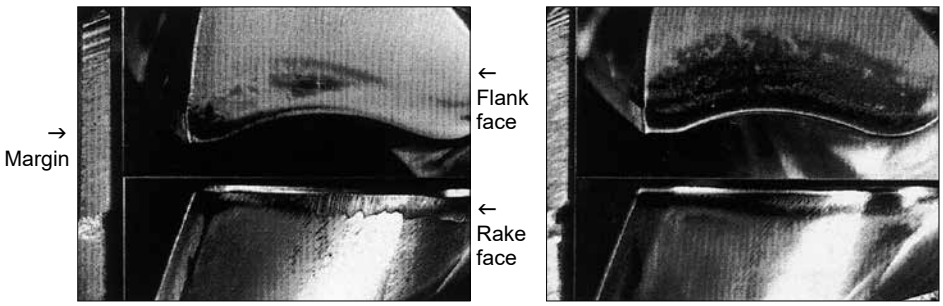
Condition		Edge treatment width			
		0,15 mm		0,05 mm	
v_c (m/min)	f (mm/rev)	Torque (N• m)	Thrust (N)	Torque (N• m)	Thrust (N)
40	0,38	12,8	2.820	12,0	2.520
50	0,30	10,8	2.520	9,4	1.920
60	0,25	9,2	2.320	7,6	1.640
60	0,15	6,4	1.640	5,2	1.100

Drill : ø10
Work material:
C50 (230 HB)

● High speed machining recommendation

When there is surplus capacity with enough machine power and rigidity drilling at normal recommended cutting conditions, we recommend higher drilling speeds.

Wear example

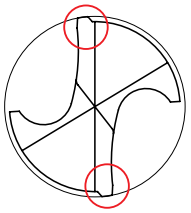


Vc = 60 m/min　　Vc = 120 m/min

Work material: C50 (230HB)
Cutting data: f = 0,3 mm/rev
a_p = 50 mm
Tool life: 600 holes (Cutting length : 30 m)

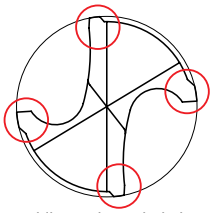
■ Explanation of Margins (Difference between single and double margins)

● Single Margin (2 guides: circled parts)



● Shape used on most drills

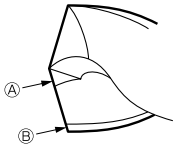
● D Double Margin (4 guides: circled parts)



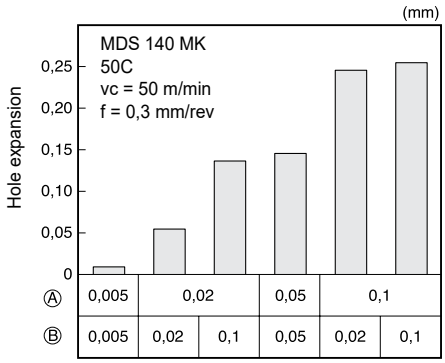
● 4-point guiding reduces hole bending and undulation for improved stability and accuracy during deep hole drilling.

■ Run-out Accuracy

Run-out of the lip height B and thinning point A are important.

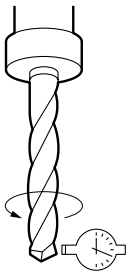


Ⓐ : The run-out accuracy of thinning point
Ⓑ : The difference of lip height

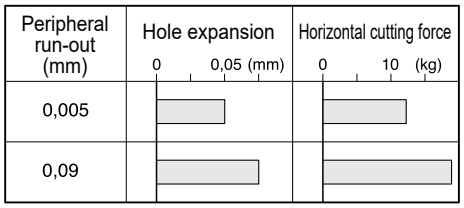


■ Peripheral Run-out Accuracy when Tool Rotates

Drill run-out when mounted on the machine spindle must be within 0,03 mm. If the run-out is large, the drilled hole will also be large causing an increase in the horizontal cutting force, which may result in drill breakage if the machine or work clamping is not rigid.



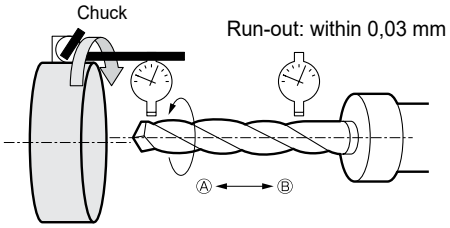
Run-out: within 0,03 mm



Drill: MDS120MK
Work material: C50 (230HB)
Cutting data: v_c =5 0 m/min, f = 0,3 mm/rev, a_p = 38mm
Water soluble

■ Peripheral Run-out Accuracy when Workpiece Rotates

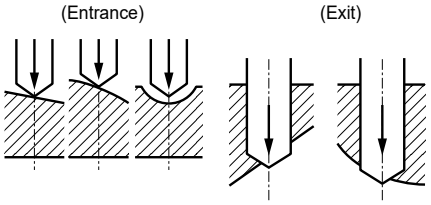
When use on a lathe, run-out at point A must be within 0,03 mm, this value must be similar when taken at position B.



■ Influence of Workpiece Surface

● Workpiece with slanted or uneven surface

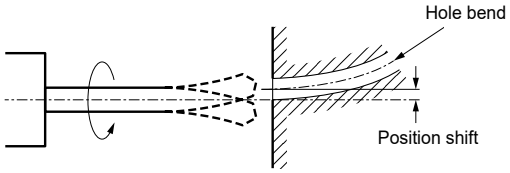
If the surface of the hole entrance or exit is slanted or uneven, decrease the feedrate to 0,1–0,15 mm/rev at these points.



■ How to Use Long Drill

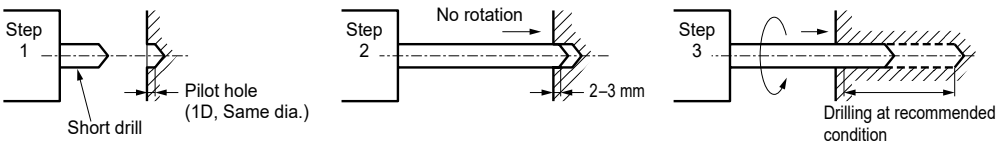
● Problem

When using a long drill (e.g. XHGS type and XHT type), DAK type or SMDH-D type drills at high rotational speeds, the run-out of the drill tip may cause a position shift at the entry point making the drill hole bent and resulting in drill breakage.

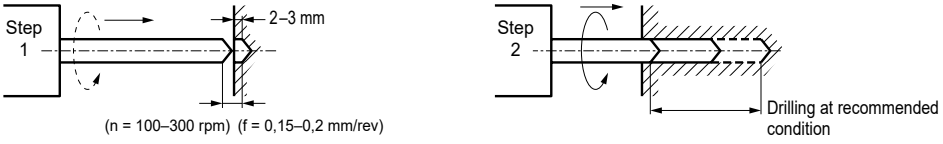


● Remedies

Method 1.



Method 2. Low rotational speed minimizes centrifugal forces and prevents drill bending.

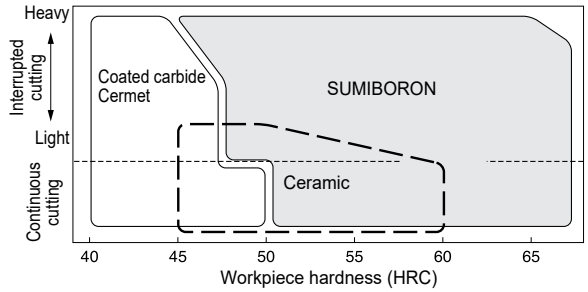


Tool Failure and Remedies

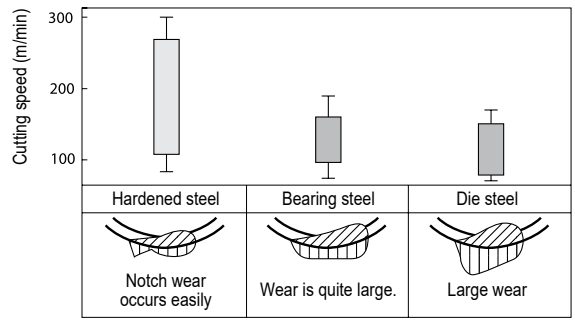
■ Trouble Shooting Guide for Drilling

Failure		Basic Remedies		Remedies Examples
Drill Failure	Excessive Wear on Cutting Edge	Cutting Conditions	- Use higher cutting speeds. - Increase feed rates.	- Vc = 80–100 m/min - Refer to rec ommended cutting conditions listed in the general catalogue.
		Cutting Fluid	- Reduce pressure if useing internal coolant. - Use cutting fluid with more lubricity.	- Below 1,5 MPa.
	Chisel Point Chipping	Tool Design	- Increase size of chisel width. - Increase amount of honing on cutting edge.	
		Cutting Conditions	- Reduce depth-of cut. - Reduce feed rate at entry point.	- f = 0,05–0,1 mm/rev .
		Others	- Improve workpiece clamping rigidity.	
	Chipping on Peripheral Cutting Edge	Tool Design	- Increase amount of honing on cutting edge. - Reduce the amount of front flank angle.	
		Cutting Conditions	- Reduce cutting speeds. - Increase feed rates.	- Refer to recommended cutting conditions listed in the general catalogue.
		Cutting Fluid Others	- Use cutting fluid with more lubricity. - Improve workpiece clamp rigidity.	
	Margin Wear	Tool Design	- Increase amount of back taper. - Reduce margin width.	
		Cutting Conditions	- Reduce cutting speeds. - Increase feed rates.	- Refer to recommended cutting conditions listed in the general catalogue.
		Cutting Fluid Others	- Use cutting fluid with more lubricity. - Schedule for earlier regrind.	
	Drill Breakage	Tool Design	- Increase amount of back taper. - Reduce margin width.	
		Cutting Conditions	- Reduce cutting speeds.	- Refer to recommended cutting conditions listed in the general catalogue.
		Cutting Fluid Others	- Use cutting fluid with more lubricity. - Improve workpiece clamp rigidity.	
Unsatisfactory Hole Accuracy	Oversized Holes	Tool Design	- Improve overall dril rigidity. (large web, small flute). - Reduce drill point angle.	- 130°–120°
		Cutting Conditions	- Reduce feed rate at entry phase. - Reduce cutting speeds.	- f = 0,05–0,1 mm/rev - Refer to recommended cutting conditions listed in the general catalogue.
		Cutting Fluid Others	- Improve workpiece clamp rigidity. - Improve drill clamp precision. - Improve drill clamp rigidity.	- Drill run-out below 0,02 mm
	Poor Surface Finish	Tool Design	- Increase amount of back taper.	
		Cutting Conditions	- Increase cutting speeds.	- Refer to recommended cutting conditions listed in the general catalogue.
		Cutting Fluid	- Use cutting fluid with more lubricity.	
	Holes are Not Straight	Tool Design	- Reduce amount of edge honing.	
		Cutting Conditions	- Reduce feedrates.	- Refer to recommended cutting conditions listed in the general catalogue.
		Others	- Improve workpiece clamp rigidity. - Improve drill clamp precision. - Improve drill clamp ridigity.	- Drill run-out below 0,02 mm
Unsatisfactory Chip Control	Packing of Chips	Cutting Conditions	- Increase cutting speeds. - Increase feed rates.	- Refer to recommended cutting conditions listed in the general catalogue.
		Cutting Fluid	- Reduce pressure if using internal coolant.	- Below 1,5 MPa.
	Long Stringy Chips	Tool Design	- Reduce amount of edge honing.	
		Cutting Conditions	- Increase feed rates.	- Refer to recommended cutting conditions listed in the general catalogue.
		Cutting Fluid	- Reduce pressure if using internal coolant.	- Below 1,5 MPa.

Application Map of the Various Tool Materials

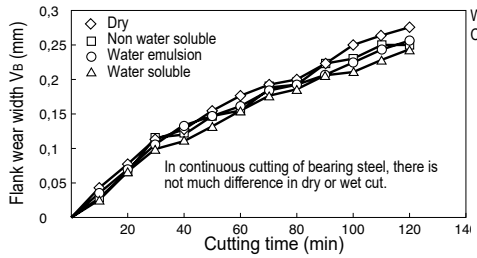


Work Materials and Cutting Speed Recommendations



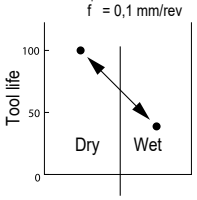
Influence of Coolant on Tool Life

● Continuous cutting



● Interrupted cutting

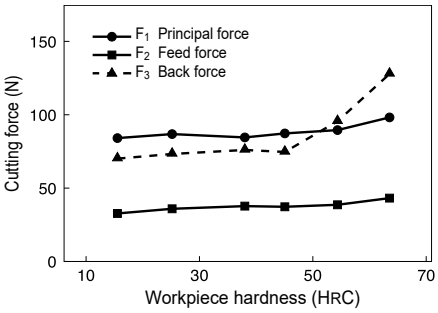
Work material: X155CrVMo12-1
Cutting data: v_c = 100 m/min
a_p = 0,2 mm
f = 0,1 mm/rev

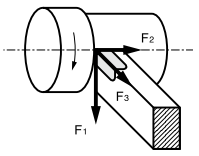


Work material: 100Cr6 (HRC58–62)
Insert: TPGN160304
Cutting data: v_c = 100 m/min
a_p = 0,15 mm
f = 0,1 mm/rev

For continuous cutting, the influence of coolant on tool life is minimal. However for interrupted cutting, coolant will shorten the tool life because of thermal cracking.

Relation Workpiece Hardness and Cutting Forces

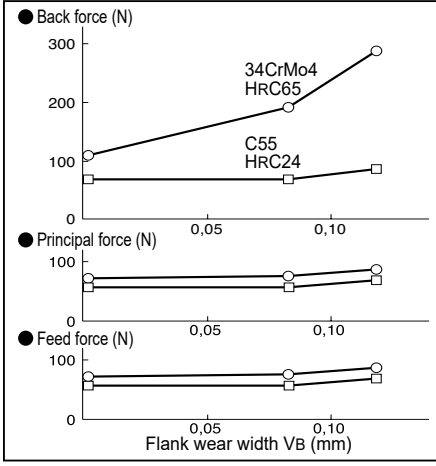




Work material: C105W1
Cutting data: v_c = 120 m/min
a_p = 0,2 mm
f = 0,1 mm/rev

Back force increases substantially for harder work materials.

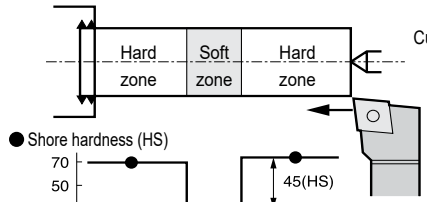
Relation between Flank Wear and Cutting Force



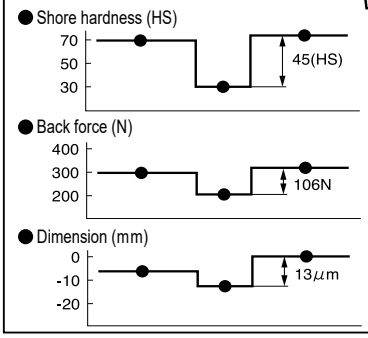
Cutting data: v_c = 80 m/min
a_p = 0,15 mm
f = 0,1 mm/rev

For hardened steel machining, back force increases substantially due to the expansion of flank wear.

Workpiece Hardness on Cutting Force and Accuracy

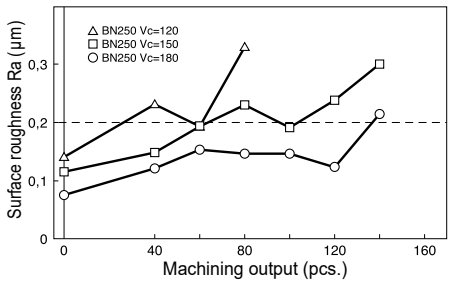


Cutting data: v_c = 120 m/min
a_p = 0,5 mm
f = 0,3 mm/rev
dry



External dimension at the soft zone is smaller due to lower cutting forces.

Relation Cutting Speed and Surface Roughness



Work material: 25CrMo4 (HRC58–62)
Holder: MTXNR2525
Insert: TNMA160408NU

Cutting data:
v_c= 120, 150, 180 m/min
a_p = 0,15 mm
f = 0,045 mm/rev
Wet

At high cutting speeds, surface roughness is more stable.

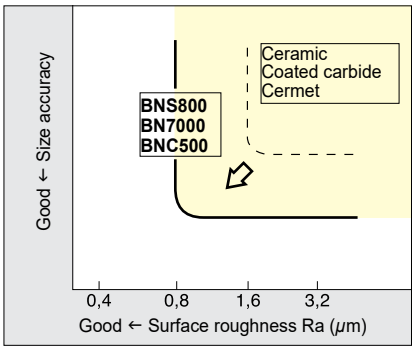
Improvement of Surface Roughness by Altering the Feedrate

Constant Feedrate	Variable Feedrate
Previous edge position f Stationary notch location	f Shifting notch location
	

Varying the feedrate spreads the notch location over a larger area, surface finish improves and notch wear decreases.

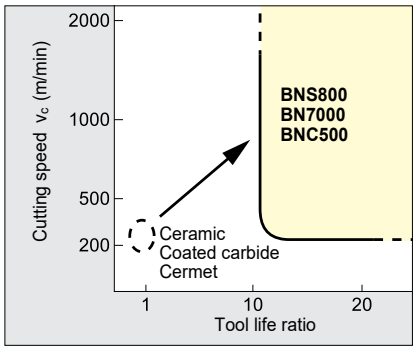
■ Advantages of Using SUMIBORON for Cast Iron Machining

● Higher accuracy

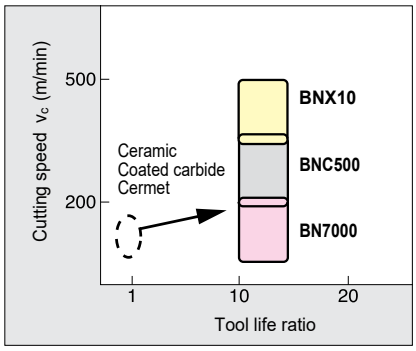


● Longer tool life at higher cutting speeds

GG: Grey cast iron

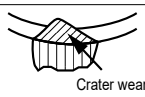
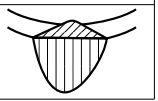


GGG: Ductile cast iron

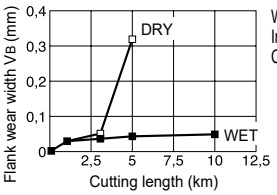


■ Turning

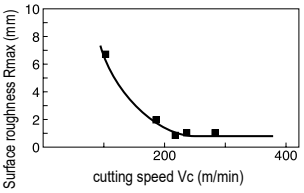
● Cast iron structure and wear shape examples

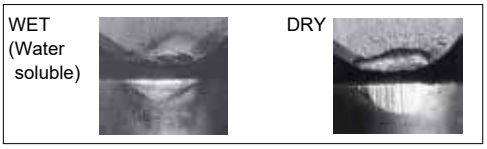
		GG	GGG
Structure			
	Matrix	Pearlite	Pearlite + Ferrite
Tool wear shape	Wet		
	Dry	 Crater wear	

($v_c \geq$ 200 m/min)



Work material: GG25
Insert: SNGN120408(BN500)
Cutting data: v_c = 450 m/min
a_p = 0,25 mm
f = 0,15 mm/rev
Continuous cutting





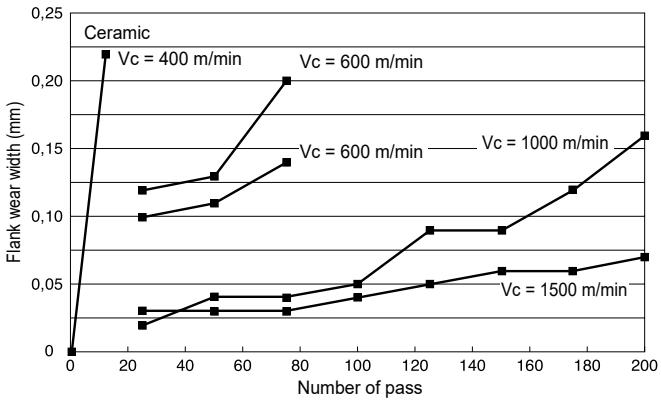
For machining cast iron with SUMIBORON, cutting speeds (Vc) should be 200m/min and above. WET cutting is recommended.

Machine: N/C lathe
Work material: GG25 (HB200)
Holder: MTJNP2525
Insert: TNMA160408(BN500)
Cutting data: v_c = 110–280 m/min
a_p = 0,1 mm
f = 0,1 mm/rev
WET

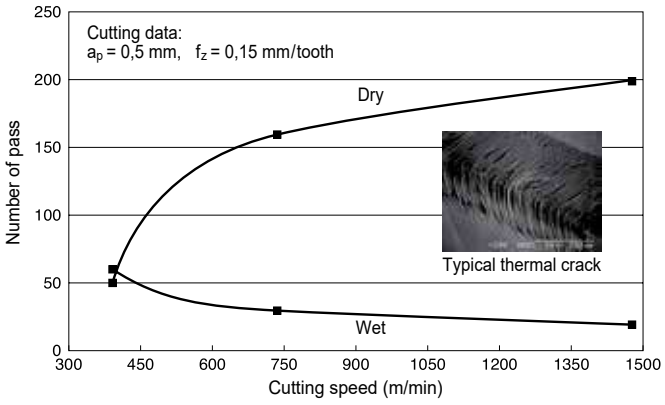
■ Milling

SUMIBORON BN Finish Mill EASY

- High speed machining Vc = 2000 m/min
- Surface Roughness Rz = 3,2 (Ra = 1,0)
- Running cost is reduced because of economical insert
- Easy insert setting with the aid of a setting gauge
- Safe, anti-centrifugal force construction for high speed conditions

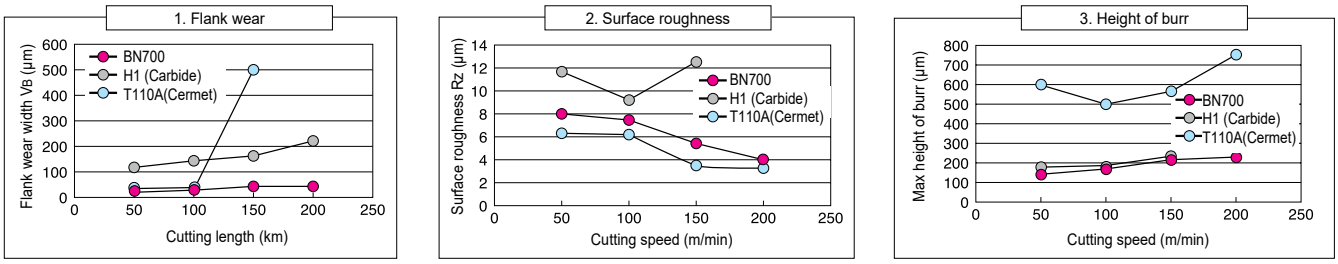


Work material: GG25
Tool material: BN700
Cutting data: a_p = 0,5 mm, f_z = 0,1 mm/tooth, DRY



Dry cutting is recommended for high speed milling of cast iron with SUMIBORON.

■ Powder Metal



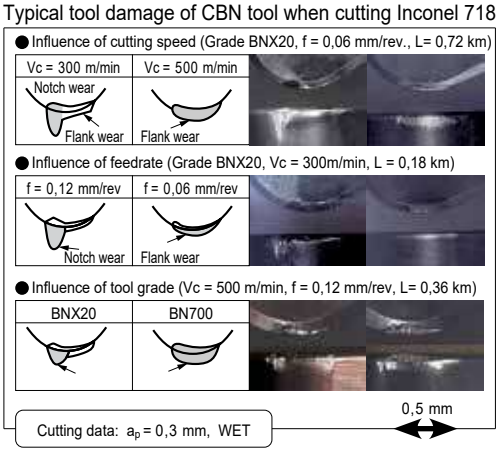
Work material: SMF4040 equivalent
Process details: ø100–300 mm heavy interrupted facing with grooves and drilled holes. (after 40 passes)
Insert: TNGA160404 Cutting data: f = 0.1 mm/rev, d = 0.1 mm, Wet

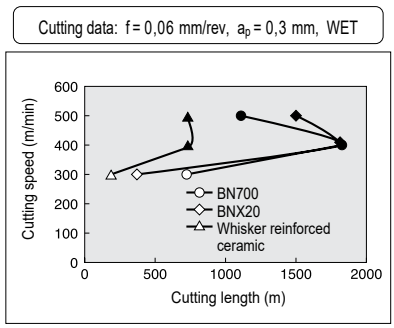
For general power metal components, carbide and cermet grades can perform up to Vc = 100 m/min. However, around Vc= 120 m/min, wear becomes rapid and surface roughness deteriorates with increased burrs.
SUMIBORON on the other hand, exhibits stability and superior wear resistance, burr prevention and surface roughness especially at high speeds.

■ Heat Resistive Alloy

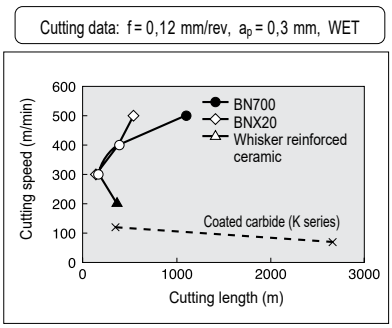
● Ni based alloy

Typical tool damage of CBN tool when cutting Inconel 718



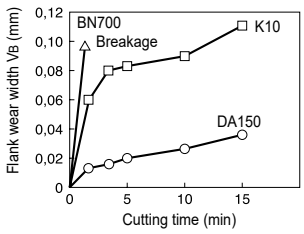


Tool life criteria
Notch wear = 0,25 mm
Or flank wear = 0,25 mm
BNX20 is recommended for high speed and low feedrate condition.
BN700 is recommended for cutting speeds below 240 m/min

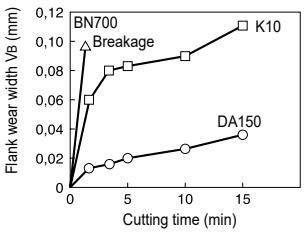


Tool life criteria
Notch wear = 0,25 mm
Or flank wear = 0,25 mm
BN700 is recommended for cutting at high feedrates.
(Over f = 0,1 mm/rev)

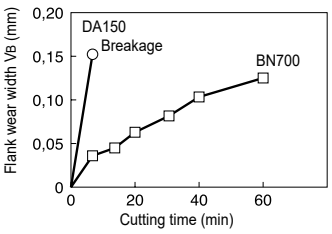
● Ti based alloy



Work Material: Ti-6Al-4V
Insert: DNM120404NF
Cutting data: v_c = 100 m/min, a_p = 0,1 mm, f = 0,05 mm/rev, WET
SUMIDIA positive type inserts are extremely good for Ti alloy, due to high cutting edge strength and high wear resistance.



Work Material: Ti-6Al-4V
Insert: DNM120404NF
Cutting data: v_c = 100 m/min, a_p = 0,1 mm, f = 0,05 mm/rev, WET
SUMIDIA positive type inserts are extremely good for Ti alloy, due to high cutting edge strength and high wear resistance.

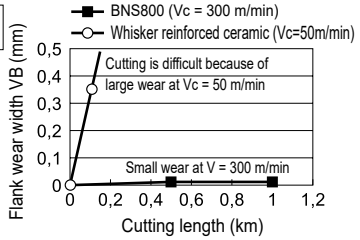


Work Material: Ti-6Al-4V
Insert: DNMA150412
Cutting data: Vc = 120 m/min, a_p = 0,3 mm, f = 0,25 mm/rev, WET
Negative type insert BN700 is excellent for high efficiency cutting. (For large depth of cut and high feedrates)

● Hard facing alloys

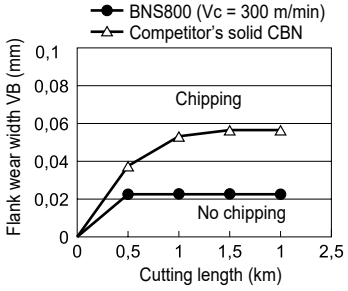
Work material: Colmonoy No.6 (Ni-based self fluxing alloy)

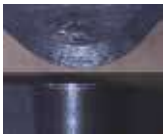
Insert: SNGN090308
Cutting data:
v_c = 50, 300 m/min
f = 0,1 mm/rev
a_p = 0,2 mm
Wet



Work material: Stellite SF-20 (Co-based Self-fluxing alloy)

Insert: SNGN090308
Cutting data:
v_c = 50 m/min
f = 0,1 mm/rev
a_p = 0,2 mm
Dry





BNS800
(Vc = 300 m/min, After 2 km Cutting)

Whisker reinforced ceramic
(Vc = 50 m/min, After 10 m Cutting)

BNS800
(After 2 km of cutting)

Competitor's solid CBN
(After 2 km of cutting)

Cutting Edge Failure

Damage	Remedies	
Large flank wear 	Tool material Tool design Cutting condition	- Select a more wear resistant grade. - Reduce the cutting force. - Reduce the NL width and angle. - Positive inserts preferred - Check the cutting speed. - Reduce the cutting speed to less than 200 m/min. - Higher feed rate reduces the overall tool-to-work contact time.
Large crater wear 	Tool material Tool design Cutting condition	- Crater wear resistant grades are recommended. - Continuous ~ Light interrupted cutting = BNC2010 - Light ~ Medium interrupted cutting = BNX20 - Medium ~ Heavy interrupted cutting = BNX25 - Determine the cutting edge geometry after inspecting the used inserts closely. - Sharpen the cutting edge to prevent crater wear. - Strengthen the cutting edge to prevent crater breakage. - Check the cutting speed. - Reduce the cutting speed to less than 200 m/min. - Higher feed rates are recommended.
Breakage at bottom of crater 		
Flaking 	Tool material Tool design Cutting condition	- Flaking is caused by high back forces and back force is related to flank wear. - Select a more wear resistant grade. - A sharper cutting edge helps prevent flaking. - Reduce the NL angle and width - Positive inserts preferred - Reduce flank wear with lower speed and higher feed rates. - Reducing tool-to-work contact time effectively reduces flank wear.
Chipping at notch position 	Cutting condition	- If surface finish is affected, consider using the “Variable Feed rate” method to improve finishing. - For other cases, use remedies similar to that for normal wear.
Chipping at notch position 	Tool material Tool design Cutting condition	- Caused by impact shocks to the cutting edge. - Chattering may also be a contributing factor. - Select a tougher grade. - Strengthen the cutting edge. - Large NL angle, Honing. - Higher feed rates are recommended to lessen the number of impacts.
Chipping at nose position 	Tool material Tool design Cutting condition	- Caused by impact shocks to the cutting edge. - Chattering may also be a contributing factor. - Select a tougher grade. - Strengthen the cutting edge. - Large NL angle, Honing. - Higher feedrates are recommended to lessen the number of impacts.
Thermal crack 	Cutting condition Tool design Tool material	- Thermal shocks generate vertical crack lines across the cutting edge. - Completely dry condition is recommended. - If dry condition machining is already observed, then reduction of cutting temperatures and cutting force is necessary. - Decrease cutting speed, feedrate, depth of cut. - Sharpen cutting edge. - Select more thermal conductivity grade.

■ Steel and Non-Ferrous Metal Symbols Chart

● Carbon Steels

JIS	AISI	DIN
S10C	1010	C10
S15C	1015	C15
S20C	1020	C22
S25C	1025	C25
S30C	1030	C30
S35C	1035	C35
S40C	1040	C40
S45C	1045	C45
S50C	1049	C50
S55C	1055	C55

● Ni-Cr-Mo Steels

SNCM220	8620	21NiCrMo2
SNCM240	8640	—
SNCM415	—	—
SNCM420	4320	—
SNCM439	4340	40NiCrMo6
SNCM447	—	34NiCrMo6

● Cr Steels

SCr415	—	15CrMo5
SCr420	5120	20Cr4
SCr430	5130	34Cr4
SCr435	5132	37Cr4
SCr440	5140	41Cr4
SCr445	5147	—

● Cr-Mo Steels

SCM415	—	15CrMo5
SCM420	—	20CrMo5
SCM430	4131	25CrMo4
SCM435	4137	34CrMo4
SCM440	4140	42CrMo4
SCM445	4145	—

● Mn Steels and Mn-Cr Steels for Structural Use

SMn420	1522	—
SMn433	1534	—
SMn438	1541	—
SMn443	1541	—
SMnC420	—	—
SMnC443	—	—

● Cr-Mo Steels

SK1	—	—
SK2	W1-11 1/2	—
SK3	W1-10	C105W1
SK4	W1-9	—
SK5	W1-8	C80W1
SK6	—	C80W1
SK7	—	C70W2

● High Speed Steels

JIS	AISI	DIN
SKH2	T1	—
SKH3	T4	S18-1-2-5
SKH10	T15	S12-1-4-5
SKH51	M2	S6-5-2
SKH52	M3–1	—
SKH53	M3–2	S6-5-3
SKH54	M4	—
SKH56	M36	—

● Alloy Tool Steels

SKS11	F2	—
SKS51	L6	—
SKS43	W2-9 1/2	—
SKD1	D3	X210Cr12
SKD11	D2	X155CrVMo12-1
SKD61	—	X40CrVMo5-1

● Grey Cast Iron

FC100	No 20B	GG-10
FC150	No 25B	GG-15
FC200	No 30B	GG-20
FC250	No 35B	GG-25
FC300	No 45B	GG-30
FC350	No 50B	GG-35

● Nodular Cast Iron

FCD400	60-40-18	GGG-40
FCD450	—	GGG-40.3
FCD500	80-55-06	GGG-50
FCD600	—	GGG-60
FCD700	100-70-03	GGG-70

● Ferritic Stainless Steels

SUS405	405	X10CrAl13
SUS429	429	—
SUS430	430	X6Cr17
SUS430F	430F	X7CrMo18
SUS434	434	X6CrMo17 1

● Martensitic Stainless Steels

SUS403	403	—
SUS410	410	X10Cr13
SUS416	416	—
SUS420JI	420	X20Cr13
SUS420F	420F	—
SUS431	431	X20CrNi17 2
SUS440A	440A	—
SUS440B	440B	—
SUS440C	440C	—

● Austenitic Stainless Steels

JIS	AISI	DIN
SUS201	201	—
SUS202	202	—
SUS301	301	X12CrNi17 7
SUS302	302	—
SUS302B	302B	—
SUS303	303	X10CrNiS18 9
SUS303Se	303Se	—
SUS304	304	X5CrNiS18 10
SUS304L	304L	X2CrNi19 11
SUS304NI	304N	—
SUS305	305	X5CrNi18 12
SUS308	308	—
SUS309S	309S	—
SUS310S	310S	—
SUS316	316	X5CrMo17 12 2
SUS316L	316L	X2CrNiMo17 13 2
SUS316N	316N	—
SUS317	317	—
SUS317L	317L	X2CrNiMo18 16 4
SUS321	321	X6CrNiTi18 10
SUS347	347	X6CrNiNb18 10
SUS384	384	—

● Heat Resisting Steels

SUH31	—	—
SUH35	—	—
SUH36	—	X53CrMnNi21 9
SUH37	—	—
SUH38	—	—
SUH309	309	—
SUH310	310	CrNi2520
SUH330	N08330	—

● Ferritic Heat Resisting Steels

SUH21	—	CrAl1205
SUH409	409	X6CrTi12
SUH446	446	—

● Martensitic Heat Resisting Steels

SUH1	—	X45CrSi9 3
SUH3	—	—
SUH4	—	—
SUH11	—	—
SUH600	—	—

References

■ Steel and Non-Ferrous Metal Symbols Chart

Expansion

P Carbon Steel for Structural Use

JIS	AISI/ASTM	DIN/EN	GB	BS	AFNOR	ГОСТ
S10C	1008 1010	C10E C10R 1.1122	08 10	040A10 045A10 045M10	XC10	08 10
S12C	1012	—	—	040A12	XC12	—
S15C	1015	C15E C15R 1.1132	15	055M15	—	15
S20C	1020	C22 CK22	20	070M20	—	20
S25C	1025	C25 C25E C25R C16D 1.0415	25	—	—	25
S30C	1030	C30 C30E C30R	30	080A30 080M30	—	30
S35C	1035	C35 C35E C35R 1.1172	35	080A35 080M36	—	35
S40C	1040 C40E	C40 C40E C40R 1.1186	40	060A40 080A40 080M40	—	40
S43C	1042 1043	—	—	080A42	XC42H1 XC42H2	40Г
S45C	1045 1045H	C45 C45E C45R 1.1191 1.1192	45	060A45 080M46	XC45	45
S50C	1049	C50 C50E C50R 1.1206	50	080M50	XC50	50
S53C	1050 1053	—	50Mn	080A52	XC54	—
S55C	1055	C55 C55E C55R 1.1203	55	070M55	XC55H1 XC55H2	55
S58C	1060	C60 C60E C60R	60	060A57 080A57	XC60	—
S60C	1059	C60E 1.1221	60 60Mn	—	—	60
S09CK	1010	C10E C10R	—	045A10 045M10	XC10	—
S15CK	1015	C15E C15R	—	—	XC12	—
S20CK	—	CK22	—	—	XC18	—

P Cr-Mo Steel

JIS	AISI/ASTM	DIN/EN	GB	BS	AFNOR	ГОСТ
SCM415	—	18CrMo4 1.7243	15CrMo	—	—	15ХМ
SCM420	—	20MoCr4 1.7321	20CrMo	708M20	—	20ХМ
SCM421	4121	18CrMo4 22CrMoS35 1.7243	20CrMn- Mo	—	—	25ХГМ
SCM425	—	25CrMo 1.7218	25CrMo	—	—	—
SCM430	4130	—	30CrMo	708A30	30CD4	30ХМ
SCM435	4135 4137	34CrMo4 1.7220	35CrMo	708A37 709A37	34CD4 38CD4 35CD4	35ХМ
SCM440	4142 4140	42CrMo4 42CrMoS4 1.7225	42CrMo	708M40 708A40 708A42 709A42 709M40	42CD4	38ХМ
SCM445	4145 4150	50CrMo4 1.7228	50CrMo	708A47	—	—

P Manganese Chromium Steel/Manganese Steel

SMn420	1522 1524	18Mn5 1.0436	20Mn2	150M19 120M19	20M5	20Г
SMn433	1330	28Mn6 1.1170	30Mn2	—	—	30Г2
SMn438	1335 1541	—	35Mn2	150M36	40M6	35Г2
SMn443	1340 1345 1541	—	40Mn2 45Mn2	135M40 150M36	35M5	35Г2 45Г2
SMnC420	5120	20MnCr5 1.7147	20CrMn	—	—	18ХГ
SMnC443	5140	41Cr4 1.7035	40CrMn	—	—	—

P Carbon Tool Steel

SK140 SK1	W2-13A W1-13	—	T13	—	$Y_2$140	—
SK120 SK2	W1-11 1/2	C120U 1.1555	T12	BW1C	$Y_2$120	y12
SK105 SK3	W1-10 W1-10 1/2	C105U 1.1545 C105W1	T11	BW1B	$Y_1$105	—
SK95 SK4	W1-9 W1-9 1/2	C105U 1.1545	T10	BW1A	$Y_1$90 $Y_1$80	y10
SK85 SK5	W1-8C W1-8	C80W1	T8Mn	BW1A	—	y8Г
SK80	W1-8A	C80U 1.1525	T8	—	—	y8
SK70	1070	C70U 1.1520	T7	—	—	y7

References

P Cr Steel

JIS	AISI/ASTM	DIN/EN	GB	BS	AFNOR	ГОСТ
SCr415	5115	17Cr3 1.7016	15Cr	—	—	15X
SCr420	5120	—	20Cr	—	20MC5	20X
SCr430	5130 5132	34Cr4 34CrS4 1.7033	30Cr	530A30 530A32	32C4	30X
SCr435	5135	37Cr4 1.7034	35Cr	530A36	38C4	35X
SCr440	5140	41Cr4 41CrS4 1.7035	40Cr	530M40 530A40	42C4	40X
SCr445	5147	—	45Cr	—	—	45X

P Nickel Chromium Steel

SNC415	4720 4715	20NiCrMo2-2 10NiCr5-4 17CrNi6-6 1.5918 1.5805 1.6523	20CrNi 12CrNi2 15CrNi6K	—	—	20XH 12XH
SNC236	3140 4337	41crCrMo7-3-2 34CrNiMo6	40CrNi 34CrNi2	—	—	40XH
SNC246	8645	—	45CrNi	—	—	45XH
SNC815	E3310	15NiCr13 1.5752	12CrNi3	—	—	12XH3A
SNC620	—	20NiCrMo13-4 1.6660	20CrNi3	—	—	20XH3A
SNC631	—	30NiCrMo16-6 1.6747	30CrNi3	—	—	30XH3A
SNC836	—	35NiCrMo16 1.6773	37CrNi3	—	—	—

P Ni-Cr-Mo Steel

SNCM220	8615 8617 8620 8622 4718	20NiCrMo2-2 20NiCrMoS2-2 17NiCrMo6 1.6566 1.6523	20CrNiMo 18CrMnNiMo 20NiCrMoK	805A20 805M20 805A22 805M22	20NCD 2	20XH2M 18ХНГМ
SNCM240	8637 8640	39NiCrMo3 1.6510	40CrNiMo	—	—	40XH2MA
SNCM415	—	—	—	—	—	
SNCM420	4320	17NiCrMo6-4	20CrNi2Mo	—	—	20XH2M (20XHM)
SNCM439	4340	41NiCrMo7-3-2 1.6563	40CrNi2Mo	—	—	40XH2MA
SNCM447	4340	41NiCrMo7-3-2 1.6563	45CrNiMoV	—	—	—

P High Speed Steel

JIS	AISI/ASTM	DIN/EN	GB	BS	AFNOR	ГОСТ
SKH2	T1	HS18-0-1 1.3355	W18Cr4V	BT1	Z80WCV 18-04-01	P18
SKH3	T4	S18-1-2-5	—	BT4	Z80WKCV 18-05-04-01	—
SKH4	T5	—	—	BT5	Z80WKCV 18-10-04-02	—
SKH10	T15	S12-1-4-5	W12Cr4V5Co5	BT15	Z160WKCV 12-05-05-04	P12K5V5
SKH51	M2	S6-5-2 1.3339	W6Mo5Cr4V2	BM2	Z160WDCV 06-05-04-02	P6M5ø2
SKH52	M3-1	HS6-6-2 1.3350	W6Mo6Cr4V2	—	—	—
SKH53	M3-2	S6-5-3 HS6-5-3 1.3344	W6Mo5Cr4V3	—	Z160WDCV 06-05-04-03	P6M5ø3
SKH54	M4	—	W6Mo5Cr4V4	BM4	Z130WDCV 06-05-04-04	—
SKH55	M35 M41	S6-5-2-5 HS6-5-2-5 1.3243	W6Mo5Cr4V2Co5	BM35	Z190WDCV 06-05-05-04-02	P6M5K5
SKH56	M36	—	—	—	—	—
SKH57	M48	HS10-4-3-10 1.3207	W10Mo4Cr4V3Co10	—	Z130WKCDV 10-10-04-04-03	—
SKH58	M7	HS2-8-2 1.3348	W2Mo9Cr4V2	—	Z100DCWV 09-04-02-02	—
SKH59	M42	HS2-10-1-8 1.3247	W2Mo9Cr4VCo8	BM42	Z130DKCWV 09-08-04-02-01	P2M9K8ø

P Alloy Tool Steel

SKS11	F2	—	—	—	—	—
SKS2	—	105WCr6	—	—	105WC13	—
SKS51	L6	—	—	—	—	—
SKS41	—	—	4CrW2Si	—	—	4XB2C
SKS43	W2-9 1/2	—	—	BW2	Y1105V	—
SKS44	W2-8 1/2	—	—	—	—	—
SKS3	O1	95MnWCr5 1.2825	9CrWMn	—	—	9ХВГ
SKS31	O7	105WCr6	CrWMn	—	105WC31	ХВГ
SKD1	D3	X210Cr12 1.2080	Cr12	BD3	X200Cr12	X12
SKD4	—	—	30W4Cr2V	BH21	Z32WCV5	—
SKD5	H21	X30WCrV9-3 1.2581	3Cr2W8V	BH21	Z30WCV9	3X2B8ø
SKD6	H11	X37CrMoV5-1 1.2343	4Cr5MoSiV	BH11	X38CrMoV5	4X5MøC
SKD61	H13	X40CrMoV5-1 1.2344	4Cr5MoSiV1	BH13	Z40CDV5	4X5Mø1C
SKD7	H10	X32CrMoV33 1.2365	3Cr3Mo3V	BH10	32DCV28	—
SKD8	H19	38CrCoWV18-17-17 1.2661	3Cr3Mo3VCo3	BH19	—	—
SKD10	D2	X153CrMoV12 1.2379	Cr12Mo1V1	—	—	X12M1ø1
SKD11	D2 D4	—	Cr12MoV	BD2	X160CrMoV12	X12Mø
SKD12	A2	X100CrMoV5 1.2363	Cr5Mo1V	BA2	Z100CDV5	—

References

Steel and Non-Ferrous Metal Symbols Chart

Expansion

Ferritic Stainless Steels

JIS	AISI/ASTM	DIN/EN	GB	BS	AFNOR	ГОСТ
SUS405	405 S40500	X10CrAl13 1.4002	0Cr13Al 06Cr13Al	405S17	26CA13	—
SUS429	429 S42900	—	1Cr15 10Cr15 022Cr15NbTi	—	—	—
SUS430	430 S43000	X6Cr17 1.4016	1Cr17 10Cr15 S11710	430S17	Z8C17	12X17
SUS430F	430F S43020	X12CrMoS17	Y1Cr17 Y10Cr17	—	210CF17	—
SUS434	434 S43400	X6CrMo17-1 1.4113	1Cr17Mo 10Cr17Mo	434S17	Z8CD17.01	—

Martensitic Stainless Steels

SUS410	410 S41010	X10Cr13 1.4006	12Cr13 1Cr13	410S21	Z13C13	12X13
SUS403	403 S40300	—	12Cr12 1Cr12	—	—	—
SUS444	444 S44400	X2CrMoTi18-2 1.4521	019Cr19Mo2NbTi 00Cr18Mo2	—	—	—
SUS416	416 S41600	X12CrS13 1.4005	Y12Cr13 Y1Cr13	416S21	Z12CF13	—
SUS420J1	420 S42000	X20Cr13 1.4021	20Cr13 2Cr13	420S29	Z20C13	20X13
SUS420J2	420 S42000	X30Cr13 1.4028	30Cr13 3Cr13	420S45	Z30C13	30X13
SUS420F	420G S42020	X29Cr13 1.4029	Y30Cr13 Y3Cr13	—	Z30CF13	—
SUS431	431 S43100	X17CrNi16-2	17Cr16Ni2	431S29	—	—
SUS440C	440C S44004	—	108Cr17 11Cr17	—	Z100CD17	—

Stainless Steel (Precipitation Hardened Structure)

SUS630	630 S17400	X5CrNiCuNb16-4 1.4542	0Cr17Ni4Cu4Nb 05Cr17Ni4Cu4Nb	—	Z6CNU17.04	—
SUS631	631 S17700	X7CrNiAl17-7 1.4568	0Cr17Ni7Al 07Cr17Ni7Al	—	Z8CNA17.07	09X17H7 Ю

Austenitic Stainless Steels

JIS	AISI/ASTM	DIN/EN	GB	BS	AFNOR	ГОСТ
SUS201	201 S20100	X12crMnNiN17-7-5 1.4372	1Cr17Mn6Ni5N 12Cr17Mn6Ni5N	—	Z12CMN17-07Az	—
SUS202	202 S20200	X12CrMnNiN18-9-5 1.4373	1Cr18Mn9Ni5N 12Cr18Mn9Ni5N	284S16	—	—
SUS301	301 S30100	X12CrNi17 7 1.4319 1.4310	1Cr17Ni7 12Cr17Ni7	—	Z12CN17.07	17X18H9
SUS302	302 S30200	X9CrNi18-9 1.4325	1Cr18Ni9 12Cr18Ni9	302S25	Z10CN18.09	12X18H9
SUS302B	302B S30215	—	1Cr18Ni9Si3 12Cr18Ni9Si3	—	—	—
SUS303	303 S30300	X8CrNiS18-9 X10CrNiS189 1.4305	Y1Cr18Ni9 Y12Cr18Ni9	303S21	Z10CNF18.09	—
SUS303Se	303Se S30323	—	Y12Cr18Ni9Se Y1Cr18Ni9Se	303S41	—	12X18H10E
SUS304	304 S30400	X5CrNi18-10 1.4301	0Cr18Ni9 06Cr19Ni10	304S31	Z6CN18.09	08X18H10
SUS304L	304L S30403	X2CrNi19-11 1.4306	00Cr19Ni10 022Cr19Ni10	304S11	Z2CN18.10	03X18H11
SUS304N1	304N S30451	X5CrNiN19-9 1.4315	06Cr19Ni10N 06Cr19Ni10NbN	—	Z6CN19-09Az	—
SUS305	305 S30500	X2CrNiN18-10 1.4311	1Cr18Ni12 10Cr18Ni12	305S19	Z8CN18.12	—
SUS309S	309S S30908	X6CrNi23-13 1.4950	0Cr23Ni13 06Cr23Ni13	—	—	0X23H12
SUS310S	310S S31008	X6CrNi25-20 1.4951	0Cr25Ni20 06Cr25Ni20	—	—	08X23H20
SUS316	316 S31600	X5CrNiMo17-12-2 1.4401	0Cr17Ni12Mo2 06Cr17Ni12Mo2	316S31	Z7CND17.12	—
SUS316L	316L S31603	X2CrNiMo17-12-2 1.4404	00Cr17Ni12Mo2 022Cr17Ni12Mo2	316S11	Z2CND17.12	03X17H14M2
SUS316N	316N S31651	—	0Cr17Ni12Mo2N 06Cr17Ni12Mo2N	—	—	—
SUS317	317 S31700	—	0Cr19Ni13Mo3 06Cr19Ni13Mo3	317S16	—	—
SUS317L	317L S31703	X2CrNiMo18-15-4 1.4438	00Cr19Ni13Mo3 022Cr19Ni13Mo3	317S12	Z2CND19.15	03X19H13M3
SUS321	321 S32100	X6CrNiTi18-10 1.4541	0Cr18Ni10Ti 06Cr18Ni1Ti	321S31	Z6CNT18.10	08X18H10T
SUS347	347 S34700	X6CrNiNb18-10 1.4550	0Cr18Ni11Nb 06Cr18Ni11Nb	347S31	Z6CNNb18.10	08X18H12Б

References

S Ferritic Heat Resistant Steels

JIS	AISI/ASTM	DIN/EN	GB	BS	AFNOR	ГОСТ
SUH409	409 S40900	X6CrTi12	06Cr11Ti 0Cr11T1	409S19	Z6CT12	—
SUH446	446 S44600	—	2Cr25N 16Cr25N	—	Z12C24	—

S Martensitic Heat Resistant Steel

SUH1	—	—	45Cr9Si3	401S45	Z45CS9	—
SUH3	—	—	4Cr10Si2Mo 40Cr10Si2Mo	—	Z40CSD10	40X10C2M
SUH4	—	—	8Cr20Si2Ni 80Cr20Si2Ni	443S65	Z80CSN20.02	—
SUH11	—	—	4Cr9Si2 42Cr9Si2	—	—	40X 9C2
SUH600	—	—	2Cr12MoVNbN 18Cr12MoVNbN	—	—	—
SUH616	616 S42200	—	2Cr12NiMoWV 22Cr12NiWMoV	—	—	—

S Austenitic Heat Resistant Steel

SUH31	—	—	4Cr14Ni14W2Mo	331S42	—	45X14H14B2M
SUH35	—	X53CrMnNiN21-9-4 1.4871	5Cr21Mn9Ni4N 53Cr21Mn9Ni4N	349S52	Z52CMN21.09	55X20Г9AH4
SUH36	—	X53CrMnNi21 9	—	349S54	Z55CMN21-09Az	55X20Г9AH4
SUH37	—	X15CrNiSi20-12 1.4828	22Cr21Ni12N 2Cr21Ni12N	381S34	—	—
SUH38	—	—	—	—	—	—
SUH309	309 S30900	X12CrNi23-13 1.4833	16Cr23Ni13 2Cr23Ni13	309S24	Z15CN24.13	20X23H12
SUH310	310 S31000	—	2Cr25Ni21 20Cr25Ni20	310S24	Z15CN25.20	—
SUH330	—	X12CrNiMnMoN25-18-6-5 1.4565	1Cr16Ni35 12Cr16Ni35	—	Z12NCS35.16	—

K Gray Cast Iron

FC100	No 20B	GG-10	HT100	100	—	Cy10
FC150	No 25B	GG-15	HT150	150	FGL150	Cy15
FC200	No 30B	GG-20	HT200	200	FGL200	Cy20
FC250	No 35B	GG-25	HT250	250	FGL250	Cy25
FC300	No 45B	GG-30	HT300	300	FGL300	Cy30
FC350	No 50B	GG-35	HT350	350	FGL350	Cy35

K Nodular Cast Iron

FCD400	60-40-18	GGG-40	QT400-18	400/17	FGS370-17	By40
FCD450	—	GGG-40.3	QT450-10	420/12	FGS400-12	By45
FCD500	80-55-06	GGG-50	QT500-7	500/7	FGS500-7	By50
FCD600	—	GGG-60	QT600-3	600/7	FGS600-2	By60
FCD700	100-70-03	GGG-70	QT700-2	700/2	FGS700-2	By70
FCD800	120-90-02	GGG-80	—	800/2	FGS800-2	By80

N Aluminum and Al Alloys - Sheets, plates and strips

JIS	AISI/ASTM	DIN/EN	GB	BS	AFNOR	ГОСТ
A1060P	1060	EN AW-1060	L2	—	—	—
A1050P	1050	A199.50	1A50	—	—	—
A1100P	1100	EN AW-1100	L5-1	—	—	—
A1200P	1200	EN AW-1200	L5	EN AW-1200	EN AW-1200	—
A2014P	2014	EN AW-2014	LD10	EN AW-2014	EN AW-2014	—
A2017P	2017	EN AW-2017	2A11(LY11)	EN AW-2017	EN AW-2017	—
A2219P	2219	EN AW-2219	2A16(LY16)	—	—	—
A2024P	2024	EN AW-2024	2A12(LY12)	EN AW-2024	EN AW-2024	—
A2124P	2124	EN AW-2124	2A12(LY12)	—	—	—
A3003P	3003	EN AW-3003	LF21	EN AW-3003	EN AW-3003	—
A3004P	3004	EN AW-3004	3004	—	—	—
A3005P	3005	EN AW-3005	3005	—	—	—
A3015P	3105	EN AW-3105	3105	—	—	—
A5005P	5005	EN AW-5005	5005	—	—	—
A5050P	5050	EN AW-5050	—	—	—	—
A5052P	5052	EN AW-5052	5A02	EN AW-5052	EN AW-5052	—
A5154P	5154	—	LF3	—	—	—
A5254P	5254	—	LF3	—	—	—
A5454P	5454	EN AW-5454	5454	EN AW-5454	EN AW-5454	—
A5456P	5456	EN AW-5456	—			
A6101P	6101	EN AW-6101	6101			
A6061P	6061	EN AW-6061	6061(LD30)	EN AW-6061	EN AW-6061	—
A7075P	7075	EN AW-7075	7A04	EN AW-7075	EN AW-7075	—
A7178P	7178	EN AW-7178	7A03(LC3)	—	—	—

N Aluminum Alloy Die Castings

ADC1	A413.0	EN AC-44300	YL102	—	—	—
ADC3	A360.0	EN AC-43400	YL104	EN AC-43400	EN AC-43400	—
ADC5	518.0	—	Al-Mg7	—	—	—
ADC10	—	EN AC-46000	YL112	—	—	—
ADC12	—	—	YL113	LM20	—	—
ADC14	B390.0	—	—	—	—	—
AC4C	357	G-AlSi7Mg	ZAlSi7Mg1A	LM25	A-S7G-03	—
AC4CH	356	G-AlSi7Mg	ZALSi7Mg	LM25	A-S7G	—
—	308	G-AlSi6Cu4	ZAlSi5Cu6Mg	LM21	—	—

H Hardened Steel

C4BS	440A	X100CrMo13	7Cr17	—	—	—
AC4A	610	X110CrMoV15	—	—	—	—
AC4A	0-2	X65CrMo14	—	—	—	—

References

Hardness Scale Comparision Chart

● Approx. metric value and Brinell hardness of steel

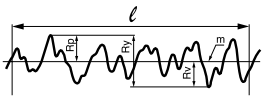
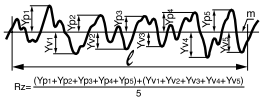
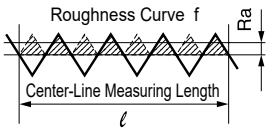
Brinell Hardness 10mm Ball 3.000kgf (HB)	Rockwell Hardness				Vickers Hardness 50kgf	Shore Hardness	Traverse Rupture Strength (N/mm^2)
	„A“ Scale Diamond, brale 60kgf (HRA)	„B“ Scale 100kgf 1/10“ Ball (HRB)	„C“ Scale Diamond, brale 150kgf (HRC)	„D“ Scale Diamond, brale 100kgf (HRD)	(HV)	(HS)	
—	85,6	—	68,0	76,9	940	97	—
—	85,3	—	67,5	76,5	920	96	—
—	85,0	—	67,0	76,1	900	95	—
767	84,7	—	66,4	75,7	880	93	—
757	84,4	—	65,9	75,3	860	92	—
745	84,1	—	65,3	74,8	840	91	—
733	83,8	—	64,7	74,3	820	90	—
722	83,4	—	64,0	73,8	800	88	—
712	—	—	—	—	—	—	—
710	83,0	—	63,3	73,3	780	87	—
698	82,6	—	62,5	72,6	760	86	—
684	82,2	—	61,8	72,1	740	—	—
682	82,2	—	61,7	72,0	737	84	—
670	81,8	—	61,0	71,5	720	83	—
656	81,3	—	60,1	70,8	700	—	—
653	81,2	—	60,0	70,7	697	81	—
647	81,1	—	59,7	70,5	690	—	—
638	80,8	—	59,2	70,1	680	80	—
630	80,6	—	58,8	69,8	670	—	—
627	80,5	—	58,7	69,8	667	79	—
601	79,8	—	57,3	68,7	640	77	—
578	79,1	—	56,0	67,7	615	75	—
555	78,4	—	54,7	66,7	591	73	2055
534	77,8	—	53,5	65,8	569	71	1985
514	76,9	—	52,1	64,7	547	70	1890
495	76,3	—	51,0	63,8	528	68	1820
477	75,6	—	49,6	62,7	508	66	1730
461	74,9	—	48,5	61,7	491	65	1670
444	74,2	—	47,1	60,8	472	63	1585
429	73,4	—	45,7	59,7	455	61	1510
415	72,8	—	44,5	58,8	440	59	1460
401	72,0	—	43,1	57,8	425	58	1390
388	71,4	—	41,8	56,8	410	56	1330
375	70,6	—	40,4	55,7	396	54	1270
363	70,0	—	39,1	54,6	383	52	1220
352	69,3	(110,0)	37,9	53,8	372	51	1180
341	68,7	(109,0)	36,6	52,8	360	50	1130
331	68,1	(108,5)	35,5	51,9	350	48	1095

Brinell Hardness 10mm Ball 3.000kgf (HB)	Rockwell Hardness				Vickers Hardness 50kgf	Shore Hardness	Traverse Rupture Strength (N/mm^2)
	„A“ Scale Diamond, brale 60kgf (HRA)	„B“ Scale 100kgf 1/10“ Ball (HRB)	„C“ Scale Diamond, brale 150kgf (HRC)	„D“ Scale Diamond, brale 100kgf (HRD)	(HV)	(HS)	
321	67,5	(108,0)	34,3	50,1	339	47	1060
311	66,9	(107,5)	33,1	50,0	328	46	1025
302	66,3	(107,0)	32,1	49,3	319	45	1005
293	65,7	(106,0)	30,9	48,3	309	43	970
285	65,3	(105,5)	29,9	47,6	301	—	950
277	64,6	(104,5)	28,8	46,7	292	41	925
269	64,1	(104,0)	27,6	45,9	284	40	895
262	63,6	(103,0)	26,6	45,0	276	39	875
255	63,0	(102,0)	25,4	44,2	269	38	850
248	62,6	(101,0)	24,2	43,2	261	37	825
241	61,8	100,0	22,8	42,0	253	36	800
235	61,4	99,0	21,7	41,4	247	35	785
229	60,8	98,2	20,5	40,5	241	34	765
223	—	97,3	(18,8)	—	234	—	—
217	—	96,4	(17,5)	—	228	33	725
212	—	95,5	(16,0)	—	222	—	705
207	—	94,6	(15,2)	—	218	32	690
201	—	93,8	(13,8)	—	212	31	675
197	—	92,8	(12,7)	—	207	30	655
192	—	91,9	(11,5)	—	202	29	640
187	—	90,7	(10,0)	—	196	—	620
183	—	90,0	(9,0)	—	192	28	615
179	—	89,0	(8,0)	—	188	27	600
174	—	87,8	(6,4)	—	182	—	585
170	—	86,8	(5,4)	—	178	26	570
167	—	86,0	(4,4)	—	175	—	560
163	—	85,0	(3,3)	—	171	25	545
156	—	82,9	(0,9)	—	163	—	525
149	—	80,8	—	—	156	23	505
143	—	78,7	—	—	150	22	490
137	—	76,4	—	—	143	21	460
131	—	74,0	—	—	137	—	450
126	—	72,0	—	—	132	20	435
121	—	69,8	—	—	127	19	415
116	—	67,6	—	—	122	18	400
111	—	65,7	—	—	117	15	385

1) Figures within the ( ) are not commonly used
2) Rockwell A, C and D scales utilises a diamond brale
3) 1 N/mm^2 = 1 MPa

■ Finished Surface Roughness

● Types of Surface Roughness Measurements

Types	Symbol	Method of Determination	Descriptive Figure
Maximum Height	※1) Ry	This is the value (expressed in μm) measured from the deepest valley to the highest peak of the reference line, ℓ, extracted from the profile. (Disregard unusually high peaks and deep valleys as they are considered as flaws.)	
Ten-point Mean Roughness	※2) Rz	From the profile, extract a portion to be the reference line, ℓ. Select the 5 highest peak and 5 deepest valleys. Measure the distance between the two lines and express it in μm. (1 μm = 0,001mm)	
Calculated Roughness	Ra	This method is to obtain a center line between the peaks and valleys within the reference line, ℓ. Fold along the center line to superimpose the valleys against the peaks. (Shaded portions with dashed outline on the right figure). Take the total shaded area and divided it by ℓ in μm.	

Designated values of the above types of surface roughness, standard reference length values and the triangular symbol classifications are shown on the table on the right.

※1) Ry : According to new **JIS B 0601**:2001 (Old symbol: Rz)
※2) Rz : According to new **JIS B 0601**:2001 (Old symbol: Rz_{JIS})

Designated values for ※1) Ry	Designated values for ※2) Rz	Designated values for Ra	Standard reference length values, ℓ (mm)	Triangular Symbols
(0,05S) 0,1S 0,2S 0,4S	(0,05Z) 0,1Z 0,2Z 0,4Z	(0,013a) 0,025a 0,05a 0,10a	—	▽▽▽▽
0,8S	0,8Z	0,20a	0,25	
1,6S 3,2S 6,3S	1,6Z 3,2Z 6,3Z	0,4a 0,8a 1,6a	0,8	▽▽▽
12,5S (18S) 25S	12,5Z (18Z) 25Z	3,2a 6,3a	2,5	▽▽
(35S) 50S (70S) 100S	(35Z) 50Z (70Z) 100Z	12,5a 25a	—	▽
(140S) 200S (280S) 400S (560S)	(140Z) 200Z (280Z) 400Z (560Z)	(50a) (100a)	—	—

Remarks: The designated values in the brackets do not apply unless otherwise stated.

Spare Parts

P

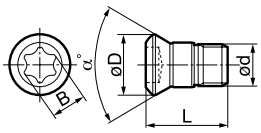
P1–P8

Screw P2-P4
Lever Pin, Shim, Nut P4-P6
Shim Pin, Eccentric Pin P7
Wrench P8

Screw

■ Screw

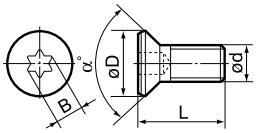
High Precision Screw



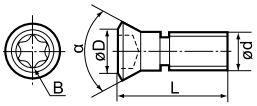
Cat. No.	Stock	Dimensions (mm)						
		d	Pitch	L	D	B	α°	
BFTG0408F	●	M4	0,5	7,5	5,7	T15	61	3,4
BTTG0409F	●	M4	0,5	8,4	6,15	T15	61	3,4
BFTG0513F	●	M5	0,5	13	6,8	T20	61	5,0
BFTG0617F	●	M6	0,75	16,5	8	T25	61	7,5
BFTG0621F	❍	M6	0,75	21	9,5	T25	61	7,5
BFTG0825F	●	M8	0,75	24,5	12	T25	61	7,5

Torx Flat Head Screw

Cat. No.	Stock	Dimensions (mm)						
		d	Pitch	L	D	B	α°	
BFTX016033	❍	M1,6	0,35	3,3	2,6	T6	60	0,2
BFTX02508	●	M2,5	0,45	7,5	3,45	T8	60	-
BFTX0309		M3	0,5	8,8	4,2	T10	60	-
BFTX03508	●	M3,5	0,6	8	5,1	T10	52	2,0
BFTX03584	●	M3,5	0,6	7,4	5,2	T15	60	3,0
BFTX03588	●	M3,5	0,6	8,8	5,2	T15	60	3,4
BFTX0408	●	M4	0,7	8	5,5	T15	60	-
BFTX0414	●	M4	0,7	14,5	5,5	T15	60	3,0
BFTX0515		M5	0,8	15	7	T20	60	-
BFTX0613		M6	1,0	13	9	T25	60	-
BFTX0615		M6	1,0	15	9	T25	60	-
BFTX0617		M6	1,0	17	9	T25	60	-

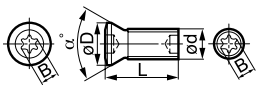


Cat. No.	Stock	Dimensions (mm)						
		d	Pitch	L	D	B	α°	
BFTX0203A	●	M2	0,4	3	2,7	T6	90	0,5
BFTX0204A	●	M2	0,4	4,3	2,7	T6	90	0,5
BFTX0305A	●	M3	0,5	5,3	4,3	T10	90	-
BFTX0306A	●	M3	0,5	5,8	4,3	T10	90	2,0
BFTX0307A	●	M3	0,5	6,8	4,3	T10	90	2,0
BFTX0407A	●	M4	0,7	7,3	5,6	T15	90	3,4
BFTX0410A	●	M4	0,7	10,3	5,6	T15	90	3,4
BFTX0509A	●	M5	0,8	9,3	6,9	T20	90	5,0



Cat. No.	Stock	Dimensions (mm)						
		d	Pitch	L	D	B	α°	
BFTX01604N	●	M1,6	0,35	4,2	2,4	T6	60	0,2
BFTX0203N	●	M2	0,4	3	2,7	T6	60	0,5
BFTX0204N	●	M2	0,4	4,3	2,7	T6	60	0,5
BFTX02205N	●	M2,5	0,45	4,5	3	T6	60	0,5
BFTX2206NT	❍	M2,2	0,45	6	3,2	T1,8	60	0,7
BFTX02505N	●	M2,5	0,45	4,5	3,45	T8	60	1,1
BFTX02506N	●	M2,5	0,45	5,5	3,45	T8	60	1,5
BFTX02508NV	●	M2,5	0,45	7,5	3,5	T8	60	1,5
BFTX0306N	❍	M3	0,5	5,8	4,2	T10	60	2,0
BFTX0307N	●	M3	0,5	6,5	4,2	T10	60	2,0
BFTX03085N	❍	M3	0,5	8,5	5,4	T10	60	-
BFTX0309N	●	M3	0,5	9	4,2	T10	60	3,0
BFTX0312N	❍	M3	0,5	12	5,4	T10	60	-
BFTX03509N	●	M3,5	0,6	8,5	4,9	T10	60	-
BFTX0406N	●	M4	0,7	6	5,6	T15	60	-
BFTX0407N	●	M4	0,7	7	5,6	T15	60	3,0
BFTX0409N	●	M4	0,7	9	5,6	T15	60	3,4
BFTX0412N	●	M4	0,7	12	5,5	T15	60	3,0
BFTX0509N	●	M5	0,8	9	7	T20	60	5,0
BFTX0511N	●	M5	0,8	11,5	7	T20	60	5,0
BFTX0513N	●	M5	0,8	13	7	T20	60	5,0
BFTX0515N	●	M5	0,8	15	7	T20	60	-
BFTX0615N	●	M6	1,0	15	9	T25	60	5,0
BFTX0619N	●	M6	1,0	19	9	T25	60	5,0

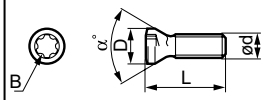
Torx Flat Head Screw



Cat. No.	Stock	Dimensions (mm)						
		d	Pitch	L	D	B	α°	
BFTX0410T8L	●	M4	0,7	9,6	5,6	T8	60	1,1
BFTX0410T8R	●							

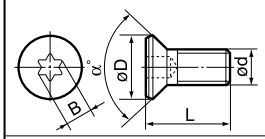
■ Screw

Torx Plus Flat Head Screw



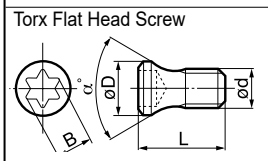
Cat. No.	Stock	Dimensions (mm)						
		d	Pitch	L	D	B	α°	
BFTX01804IP	❍	M1,8	0,35	3,7	2,45	6IP	60	0,5
BFTX02505IP	●	M2,5	0,45	4,5	3,45	8IP	60	-
BFTX02506IP	●	M2,5	0,45	5,5	3,45	8IP	60	-
BFTX0305IP	●	M3	0,5	5,3	3,8	8IP	60	2,0
BFTX0306IP	●	M3	0,5	6	3,8	8IP	60	2,0
BFTX0307IP	●	M3	0,5	7	4,3	10IP	55	2,0
BFTX0308IP	●	M3	0,5	8	3,8	8IP	60	-
BFTX03510IP	●	M3,5						
BFTX03512IP	●	M3,5	0,6	11,5	5,3	15IP	60	3,0
BFTX03584IP	●	M3,5	0,6	7,4	5,1	15IP	60	-
BFTX03510IP08	●	M3,5	0,6	10	5,3	8IP	60	-
BFTX03510IP15	●	M3,5	0,6	10	5,3	15IP	60	-
BFTX0407IP	●	M4	0,7	8,0	5,6	15IP	60	3,0
BFTX0409IP	●	M4	0,7	9,0	5,6	15IP	60	3,0
BFTX0412IP	●	M4	0,7	12	5,5	15IP	60	3,0
BFTX0418IP	●	M4	0,7	18	5,5	15IP	60	-
BFTX04513IP20	●	M4,5	0,75	13,1	6,8	20IP	60	-
BFTX0511IP	●	M5	0,8	11,5	7	20IP	60	-
BFTX0513IP	●	M5	0,8	13	7	20IP	60	-
BFTX0615IP	●	M6	1,0	15	9	25IP	60	-

Torx Flat Head Screw



Cat. No.	Stock	Dimensions (mm)						
		d	Pitch	L	D	B	α°	
BFTX03510SD		M3,5	0,6	10	5,3	T10	60	2,0
BFTX03517SD		M3,5	0,6	17	5,3	T10	60	2,0
BFTX0517SD		M5	0,8	17	7,2	T20	60	5,0
BFTX0618SD		M6	1,0	18		T25	60	7,5

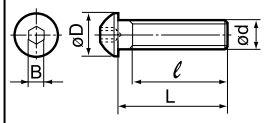
Torx Flat Head Screw



Cat. No.	Stock	Dimensions (mm)						
		d	Pitch	L	D	B	α°	
BFTY02205	●	M2,2	0,45	5,0	3,05	T7	60	-
BFTY02206	●	M2,2	0,45	5,6	3,05	T7	60	1,0

Button Head Cap Screw

Hexagonal Hole Type



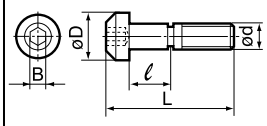
T Type with Torx Hole

(BH410T)

Cat. No.	Stock	Dimensions (mm)						
		d	Pitch	L	ℓ	D	B	
BH0304		M3	0,5	4	Full	5,5	2	-
BH0306	●	M3	0,5	6	Full	5,5	2	-
BH0308 (FBUP3-A0-9)	●	M3	0,5	8	Full	5,5	2	1,0
BH0310	●	M3	0,5	10	Full	5,5	2	-
BH0315	❍	M3	0,5	10	Full	5,5	2	-
BH03504	●	M3,5	0,6	4	Full	7	2	-
BH0408	❍	M4	0,7	8	Full	6	2,5	-
BH0415		M4	0,7	15	Full	7,5	2,5	-
BH0510		M5	0,8	10	Full	9,5	3	-
BH0516	●	M5	0,8	16	14,4	9,5	3	-
BH0616	●	M6	1,0	16	14	10,5	4	-
BH0620	●	M6	1,0	20	Full	10,5	4	-
BH0824R		M8	1,25	24	20	12	4	-
BH0824L		M8	1,25	24	20	12	4	-
BH0825		M8	1,25	25	22,5	14	5	-
BH0830R	❍	M8	1,25	30	26	12	4	-
BH0830L	●	M8	1,25	30	26	12	4	-
BH0832		M8	1,25	32	29,5	14	5	-
BH1030R		M10	1,5	30	26	14	5	-
BH1030L	●	M10	1,5	30	26	14	5	-
BH1036R		M10	1,5	36	32	14	5	-
BH1036L		M10	1,5	36	32	14	5	-

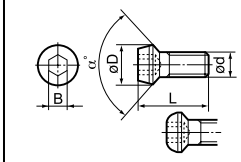
■ Screw

Phillip Head Cap Screw



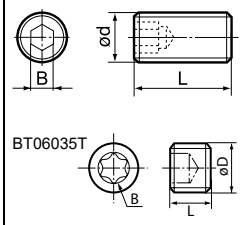
Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	D	B	N·m
BHA0525	●	M5	0,8	25,5	9,5	8,5	3	4,0
BHA0625	●	M6	1,0	30	11,3	10,5	4	4,5
BHA0834		M8	1,25	34,2	12,7	12,0	5	-
BHE0407		M4	0,7	9,5	2	5,7	2,5	1,8
BHE0510		M5	0,8	13	3	7,7	3	2,7

Button Head Screw



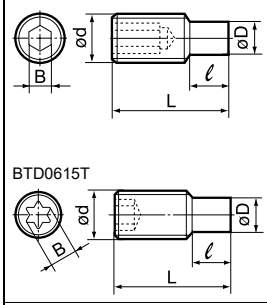
Cat. No.	Stock	Dimensions (mm) d	Pitch	L	D	B	α°	N·m
BHF0203L		M2	0,4	4	3	1,5	90	
BHF0203B		M2	0,4	5,5	3,5	1,5	90	
BHF0306R	●	M3	0,5	6,3	4,2	2	90	1,0
BHF0308R	●	M3	0,5	8	4,2	2	90	1,0
BHF0410	●	M4	0,7	11,5	6	3	90	–
BHF0623	❍	M6	1,0	23	12	4	90	7,0

Set Screw



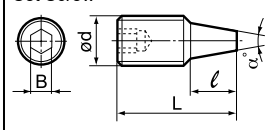
Cat. No.	Stock	Dimensions (mm) d	Pitch	L	D	B	α°	N·m
BT0306		M3	0,5	6	-	1,5	-	-
BT0310		M3	0,5	10	-	1,5	-	-
BT0404	●	M4	0,7	4	-	2	-	-
BT0408	❍	M4	0,7	8	-	2	-	-
BT0412	❍	M4	0,7	12	-	2	-	-
BT0506	●	M5	0,8	6	-	2,5	-	-
BT0510		M5	0,8	10	-	2,5	-	-
BT0610	❍	M6	1,0	10	-	3	-	-
BT0612		M6	1,0	12	-	3	-	-
BT0620		M6	1,0	20	-	3	-	-
BT06035T		M6	1,0	3,5	-	T15	-	-

Set Screw



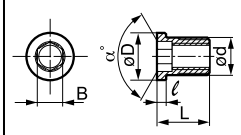
Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	D	B	N·m
BTD0408		M4	0,7	8	2	2,8	2	-
BTD0410		M4	0,7	10	2	2,8	2	-
BTD0412		M4	0,7	12	2	2,8	2	-
BTD0508		M5	0,8	8	3	3,5	2,5	-
BTD05F09		M5	0,5	9	2	4	T15	-
BTD0510	❍	M5	0,8	10	3	3,5	2,5	3,0
BTD0518		M5	0,8	18	4	3,5	2,5	-
BTD0609	❍	M6	1,0	9	2	4	3	-
BTD0615		M6	1,0	15	5	4	3	-
BTD0618		M6	1,0	18	5	4	3	-
BTD0620		M6	1,0	20	5	4	3	-
BTD0812	❍	M8	1,25	12	2	5	4	-
BTD0818		M8	1,25	18	6	5	4	-
BTD0820		M8	1,25	20	6	5	4	-
BTD0825		M8	1,25	25	8,5	5	4	-
BTD0615T		M6	1,0	15	5	4,3	T20	-

Set Screw



Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	B	α°	N·m
BTT0407	●	M4	0,5	7	2,6	2	60	-
BTT0411	●	M4	0,5	11	2,6	2	60	-
BTT0511		M5	0,8	11	5	2	20	-
BTT0615		M6	1,0	15	6	2,5	20	

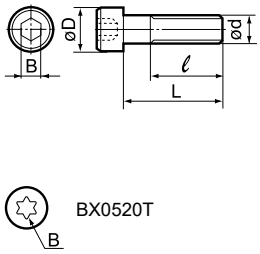
Special Hollow Screw



Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	D	B	N·m
BW0507F	●	M5	0,5	7	1,2	6,3	3,5	-
BW0609F	●	M6	0,75	9	1,5	7,7	4	-
BW0508F-SD		M5	0,5	8	1,2	6,3	3,5	
BW0810F-SD		M8	0,75	10	1,8	10	5	
BW0912F-SD		M9	0,75	12				

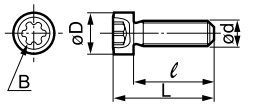
■ Screw

Cap Screw



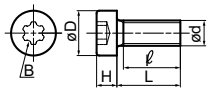
Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	D	B	N·m
BX0304	❍	M3	0,5	4	Full	5,5	2,5	-
BX0308	●	M3	0,5	8	Full	5,5	2,5	-
BX0315	❍	M3	0,5	15	Full	5,5	2,5	-
BX0410		M4	0,7	10	Full	7	3	-
BX0414	●	M4	0,7	14	Full	7	3	-
BX0425	❍	M4	0,7	25	20	7	3	-
BX0508		M5	0,8	8	Full	8,5	4	-
BX0510		M5	0,8	10	Full	8,5	4	-
BX0512	●	M5	0,8	12	Full	8,5	4	-
BX0515	●	M5	0,8	15	Full	8,5	4	-
BX0520	●	M5	0,8	20	Full	8,5	4	5,0
BX0520T	●	M5	0,8	20	16	8,5	T20	-
BX0615	❍	M6	1,0	15	Full	10	5	-
BX0620	❍	M6	1,0	20	Full	10	5	-
BX0622	●	M6	1,0	22	18	10	5	-
BX1045	❍	M10						
BX1060	❍	M10	1,5	60		16	8	
BX1070	❍	M10						
BX1240	❍	M12						

Cap Screw (Torx Plus)



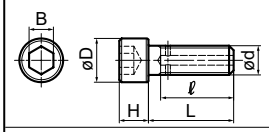
Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	D	B	N·m
BXD02208IP	●	M2,2	0,45	7,5	5,7	3,5	8IP	-
BXD02509IP	●	M2,5	0,45	9	7	4,1	10IP	-
BXD03011IP	●	M3	0,5	10,5	8	4,9	15IP	-
BXD03512IP	●	M3,5	0,6	11,5	8,8	5,5	15IP	-
BXD04014IP	●	M4	0,7	12,5	9,5	6	20IP	-
BXD04515IP	●	M4,5	0,75	14,3	10,8	6,8	25IP	-

Cap Screw (Torx Plus)



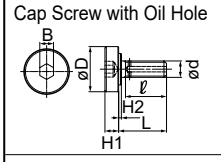
Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	D	H	B	N·m
BXA0310IP	❍	M3	0,5	7,5	Full	5,3	2,4	10IP	2,0
									-
									-

Cap Screw with Oil Hole



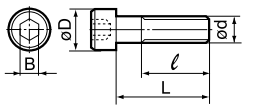
Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	D	H	B	N·m
BXH0825-D13		M8	1,25	25	Full	13	8	6	-
BXH1030-D16		M10	1,5	30	Full	16	10	8	-
BXH1235-D18		M12	1,75	35	Full	18	12	10	-

Cap Screw with Oil Hole



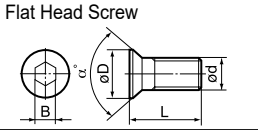
Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	D	H1	H2	B	N·m
BXH1235-D33		M12	1,75	35	Full	33	10	2	10	-
BXH1635-D40		M16	2,0	35	30	40	10	-	14	-
BXH2036-D50		M20	2,5	36	29	50	14	4	17	-

Cap Screw



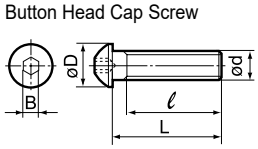
Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	D	B	N·m
EHBX0512	●	M5	0,8	12	10,5	8	4	-

Flat Head Screw



Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	B	α°	N·m
FBUP2-A0-8	❍	M3	0,5	10	5,5	2	82	1,0
FBUP3-A0-9	●							
FBUP4-A0-8		M5	0,8	15	9,3	3	82	2,7

Button Head Cap Screw

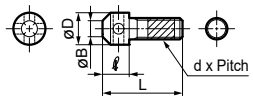


Cat. No.	Stock	Dimensions (mm) d	Pitch	L	ℓ	D	B	N·m
FBUP3-A0-9	●	M3	0,5	8	Full	5,5	2	1,0

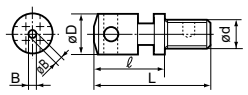
Screw, Lever Pin

■ Screw

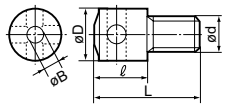
Axial adjustment Screw



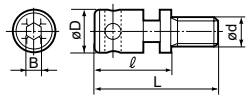
Cat. No.	Stock	d	Pitch	L	ℓ	D	B	N·m
FMJ	●	M4	0,5	15	5	6	3	-



Cat. No.	Stock	d	Pitch	L	ℓ	D	B	N·m
FMUJ	❍	M4	0,7	17	10,5	6	1	-

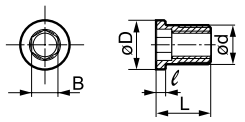


Cat. No.	Stock	d	Pitch	L	ℓ	D	B	N·m
RFJ	❍	M4	0,7	12	6	6	2	-



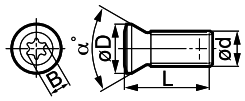
Cat. No.	Stock	d	Pitch	L	ℓ	D	B	N·m
SRFJ		M4	0,7	17	10,5	6	2	-

Special Hollow Screw



Cat. No.	Stock	d	Pitch	L	ℓ	D	B	N·m
KGBS1111	●	M5	0,5	8	1,2	6	3,5	
KGBS1221	●	M6	0,75	9	1,5	7,5	4,5	

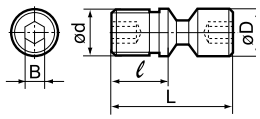
Torx Flat Head Screw



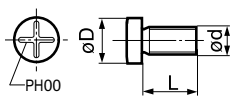
Cat. No.	Stock	d	Pitch	L	D	B	α°	N·m
KSS1111	●	3,5	0,6	11	5,2	T15	55	3,5
KSS1221	●	4,5	0,75	12	6,6	T15,3	55	4,5

Screw for Lever Lock

(LCS2B)



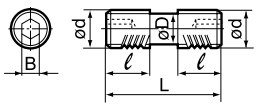
Cat. No.	Stock	d	Pitch	L	ℓ	D	B	N·m
LCS2B		M3	0,5	10	3,05	3,6	2	-
LCS3	●	M6	1,0	17	10	6	2,5	-
LCS3B-SD		M5	0,8	9,5	4,2	5	2	-
LCS3DB-SD		M5	0,8	12	6	5	2	-
LCS3S		M6	1,0	15	10	6	2,5	-
LCS3TB-SD		M6	1,0	16,7	9,6	6	2,5	-
LCS3TE	●	M6	1,0	15,5	8,5	6	2,5	-
LCS4	●	M8	1,0	21	10	8	3	-
LCS4B-SD		M6	1,0	13,4	9	6	2,5	-
LCS41BS-SD		M8	1,0	17	9,3	8	3	-
LCS42BS-SD	●	M8	1,0	20,7	9,8	8	3	-
LCS4CA	●	M8	1,0	17,5	10	8	3	-
LCS5	●	M8	1,0	25	12	8	3	-
LCS5B-SD		M8	1,0	20,5	12,3	8	3	-
LCS5DB-SD		M8	1,0	21,1	11,4	8	3	-
LCS6	❍	M10	1,0	27,2	14,4	9,8	4	-
LCS6B-SD	●	M10	1,0	27,2	14,4	10	4	-
LCS10	●	M5	0,8	14,5	8,5	5	2	-
LCS12	●	M6	1,0	17	9,6	6	2,5	-
LCS16	●	M6	1,0	21	13,6	6	2,5	-
LCS20	●	M8	1,0	23,5	13,2	8	3	-
LCS25		M10	1,0	30	17,4	10	4	-
LCS32		M12	1,0	36	19,3	12	5	-



Cat. No.	Stock	d	Pitch	L	-	D	-	N·m
MIB1.6-2	●	M1,6	0,35	2,0	-	2,4	-	0,2
MIB1.6-2.5	●	M1,6	0,35	2,5	-	2,4	-	0,2
MIB1.6-3	●	M1,6	0,35	3,0	-	2,4	-	0,2

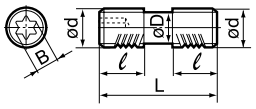
■ Double Screw

Double Screw



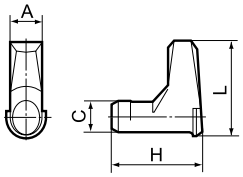
Cat. No.	Stock	d	Pitch	L	ℓ	D	B	N·m
WB4-8		M4	0,7	7,5	3	3,0	2	-
WB5-10	●	M5	0,8	10	4	3,8	2,5	-
WB5-12	❍	M5	0,8	12	5	3,8	2,5	-
WB5-18	❍	M5						
WB6-13	❍	M6	1,0	13	5	4,5	3	-
WB6-16	●	M6	1,0	16	6	4,5	3	-
WB6-20	❍	M6	1,0	20	8,5	4,5	3	-
WB6-30	❍	M6	1,0	30	12	4,5	3	-
WB8-20	●	M8	1,25	20	8,5	6,2	4	-
WB8-24	●	M8	1,25	24	8,5	6,2	4	-
WB8-30	●	M8	1,25	30	11,5	6,2	4	-
WB8F-30		M8	1,0	30	11,5	6,2	4	-

Torx Double Screw

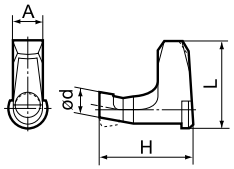


Cat. No.	Stock	d	Pitch	L	ℓ	D	B	N·m
WB6-16T	●	M6	1,0	16	6	4,5	T20	-
WB6-20T	❍	M6	1,0	20	8,5	4,5	T20	-
WB6-20TL	❍	M6	1,0	20	8,5	4,5	T20	-
WB7-15T	●	M7	1,0	15	5,5	5	T25	-
WB7F-15T		M7	0,75	15	8,5	5,5	T25	-
WB7F-20TL		M7	0,75	20	8,5	5,5	T25	-
WB8-22T	●	M8	1,25	22	8,5	6,2	T27	-
WB8-22TL	❍	M8	1,25	22	8,5	6,2	T27	-
WB8-30T	●	M8	1,25	30	11,5	6,2	T27	-
WB8-30TL		M8	1,25	30	11,5	6,2	T27	-
WB8R-16T	❍	M8	1,25	14	5,5	6,2	T27	-

■ Lever Pin

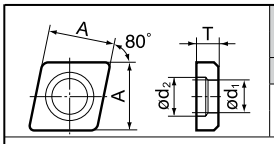


Cat. No.	Stock	A	H	L	C
LCL3		3,7	12	10	3,6
LCL3-SD	●	3,7	12	10	3,55
LCL3C-SD		3,1	7,8	9,9	3,1
LCL3D-SD	●	3,7	11,5	12	3,55
LCL3DB-SD		3,1	9,4	11,5	3,1
LCL3S	●	3,7	10,6	10	3,6
LCL3T-SD		2,6	6,3	7,2	2,15
LCL4		4,7	14	14,55	4,7
LCL4-SD	●	4,65	13,2	13,35	4,7
LCL4C-SD		4,65	10	13,35	4,7
LCL4D-SD	●	4,65	14,8	16	4,7
LCL4T-SD		4,65	13,2	13,35	4,7
LCL5		6	17	17,1	6
LCL5-SD		6	17,3	16,65	6
LCL5C-SD		7,5	18,1	20,5	7,5
LCL6-SD		7,5	21	20,5	7,5
LCL8		8,6	25,4	25,4	8,6

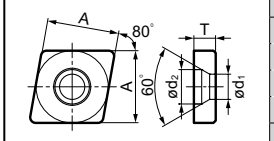


Cat. No.	Stock	A	H	L	C
LCL06	●	2,5	6,28	7,0	2
LCL09	●	3,5	9,3	10,75	3
LCL10	●	3,4	11,8	10,8	3
LCL12	●	3,7	13,4	12,9	3,5
LCL16	●	4,6	17,6	18,4	4,4
LCL20	❍	6	18,9	20,4	5,6
LCL32		8,5	26,8	29,8	8

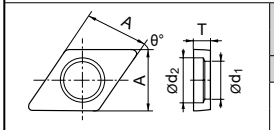
■ Shim



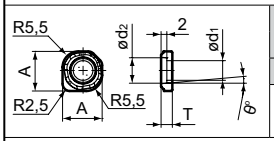
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
CCS09T3	●	8,525	2,38	5,4	6,4		



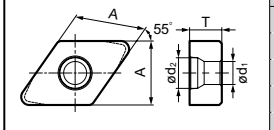
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
CNS1204	●	12,57	4,76	4,4	6,0		
CNS1606	●	15,75	4,76	5,5	7,5		
CNS1906	●	18,70	6,35	5,5	7,5		
CNS2509	○	25,27	6,35	6,6	9,5		
CNS1203B	●	12,57	3,18	3,4	4,5		
CNS1204B	●	12,57	4,76	4,4	6,0		



Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
DCS11T3	●	8,5	2,38	5,3	6,4		

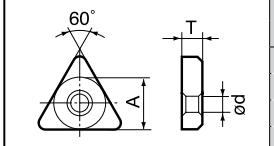


Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		θ°
DGCS13R	●	13,7	3,9	6,8	8,8		5

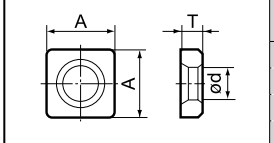


Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
DNS1504	●	12,57	6,35	4,4	6,0		
DNS1506	●	12,57	4,76	4,4	6,0		
DNS1104B	○	9,45	4,73	3,4	4,5		
DNS1504B	○	12,57	6,35	4,4	6,0		
DNS1506B	○	12,57	4,76	4,4	6,0		

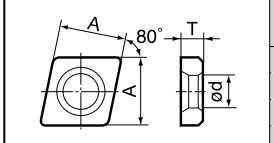
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
HE060011E	●						



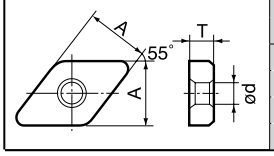
Cat. No.	Stock	Dimensions (mm)					
		A	T	d			
LST317SD	●	9,5	2,7	5,2			
LST42SD		12,65	3,18	6,9			



Cat. No.	Stock	Dimensions (mm)					
		A	T	d			
LSS32SD		9,48	3,18	5			
LSS42SD	●	12,65	3,18	6,9			
LSS53SD		15,85	4,76	7,9			
LSS63SD		19	4,76	10			

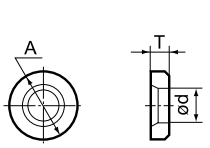


Cat. No.	Stock	Dimensions (mm)					
		A	T	d			
LSC32SD			3,18	5			
LSC42SD	●	12,65	3,18	6,9			
LSC53SD		15,85	4,76	7,9			
LSC63SD	●	19	4,76	10			

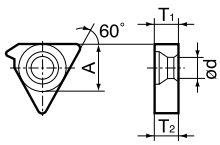


Cat. No.	Stock	Dimensions (mm)					
		A	T	d			
LSD32SD	●	8,5	3,18	5			
LSD42SD		12,65	3,18	6,9			

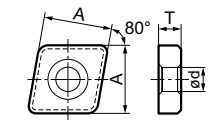
■ Shim



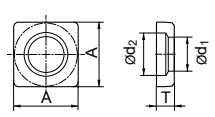
Cat. No.	Stock	Dimensions (mm)					
		A	T	d			
LSR817	○	8,4	2,7	5,2			
LSR10	●	8,4	3,18	4,7			
LSR12	●	10	3,18	4,7			
LSR16	●	13,5	4,76	6,3			
LSR20	●	17,2	4,76	7,9			
LSR25		22	6,35	9,5			



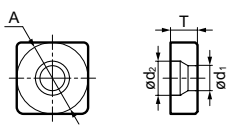
Cat. No.	Stock	Dimensions (mm)					
		A	T_1	T_2	d_2		
LSTE31-0	●	9,5	2,7	2,7	5,2		
LSTE31-1	●	9,5	2,67	2,91	5,2		
LSTE31-2	●	9,5	2,64	3,11	5,2		



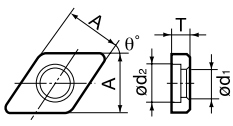
Cat. No.	Stock	Dimensions (mm)					
		A	T	d			θ°
SCND433	○	12,65	4,76	3,4			80
SCN0903		9,5	3,18	3,4			



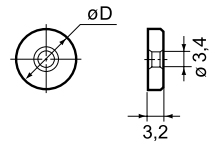
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
SCS1204		11,5	3,18	6,4	7,9		



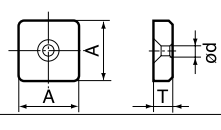
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
SNS1204	●	12,57	4,76	4,4	6,0		
SNS1506		15,75	4,76	5,5	7,5		
SNS1906	●	18,92	6,35	5,5	7,5		
SNS2507	○	25,27	7,93	6,6	9,5		
SNS2509	●	25,27	6,35	6,6	9,5		



Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		θ°
SVW322	○	9,5	3,18	4,7	6,5		35
SFW433		12,65	4,76	6,2	8,0		50
SDW323	●	9,5	3,18	4,7	6,5		55
SDW423	●	12,65	3,18	6,2	8,0		55
SDW433							
SCW423	●	12,65	3,18	6,2	8,0		80
SCW433							
SCW635	○	19	4,76	9	11,5		80



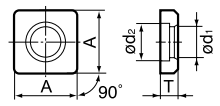
Cat. No.	Stock	Dimensions (mm)					
		D					
SRND32	●	9,5					
SRND42	○	12,7					



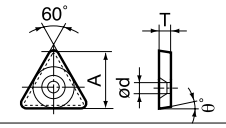
Cat. No.	Stock	Dimensions (mm)					
		A	T	d			
SSND423		12,5	3,18	3,4			
SSND423Z	○						
SSND433	○	12,5	4,76	3,4			

Shim, Nut

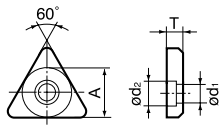
■ Shim



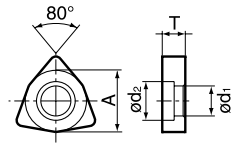
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
SSW423		12,65	3,18	6,2	8		
SSW433	●	12,65	4,76	6,2	8		
SSW635		19	4,76	9	11,5		



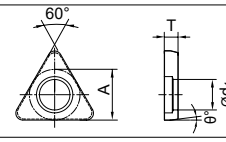
Cat. No.	Stock	Dimensions (mm)					
		A	T	d			θ°
STPD322	●	8,4	3,18	3,4			6
STPD422	❍	11,0	3,18	3,4			6



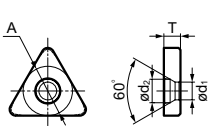
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
STW323	●	9,5	3,18	4,7	6,5		
STW434	●	12,65	4,76	6,2	8		
STW333	❍						



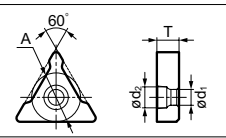
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
SWW433	●	12,65	5,15	6,2	8		
LSW317	●						



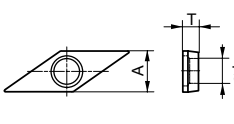
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		θ°
TCS16T3		8,8	2,38	5,3	6,3		7



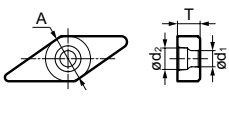
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
TNS1604	●	9,45	4,76	3,4	4,5		
TNS1603B	❍	9,45	3,18	3,4	4,5		
TNS1604B	❍	9,45	4,76	3,4	4,5		



Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
TRW5505	●	10,5	4,76	3,4	4,5		



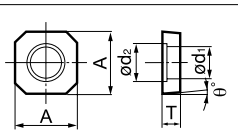
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
VCS1604	●	8,25	3,18	5,3	6,4		



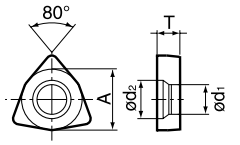
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
VNS1604	●	9,45	4,76	3,4	4,5		

■ Shim

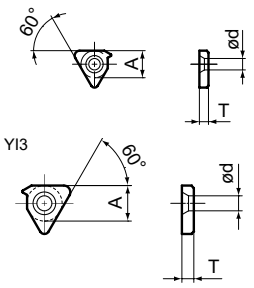
Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
WFXS4R	●	10,17	3,0	5,5	7,5		



Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		θ°
WGCS13R	●	10,7	3,0	5,5	7,5		5

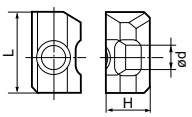


Cat. No.	Stock	Dimensions (mm)					
		A	T	d_1	d_2		
WNS0604	●	9,52	3,18	3,5	4,5		
WNS0804	●	12,57	4,76	4,4	6,3		
WNS0603B		9,27	3,18	3,4	4,5		
WNS0803B	❍	12,57	3,18	3,4	4,5		
WNS0804B	❍	12,57	4,76	4,4	6,0		



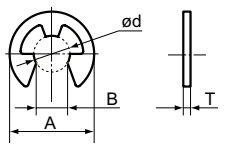
Cat. No.	Stock	Dimensions (mm)					
		A	T	d			
YE3	●	9,5	3,2	4			
YI3	●	9,5	3,2	4			

■ Seat



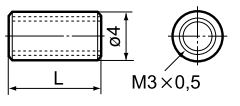
Cat. No.	Stock	Dimensions (mm)					
		d	L	H			
PWSS4R	▲	4,6	15	8			

■ Ring

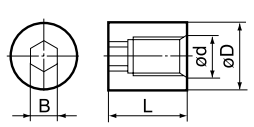


Cat. No.	Stock	Dimensions (mm)					
		A	B	T	d		
ER03		7	2,6	0,6	3		
ER04	●	9	3,5	0,6	4		
ER05	●	11	4,3	0,6	5		

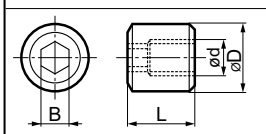
■ Nut



Cat. No.	Stock	Dimensions (mm)					
		L					
BNBW-2	●	3					
BNBW-4	❍	4					
BNBW-7	❍	7					



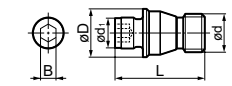
Cat. No.	Stock	Dimensions (mm)					
		d	L	D	B		
CPM32N	●	M4	7,5	7	3		
CPM43N	●	M5	8,5	7	3		
CPM43S	❍	M5	6	7	3		



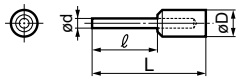
Cat. No.	Stock	Dimensions (mm)					
		d	Pitch	L	D	B	
CPV33N	●	M4	0,5	6,0	6,0	2,5	

Shim Pin, Eccentric Pin

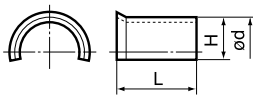
■ Shim Pin



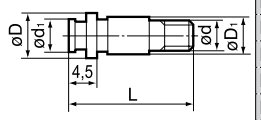
Cat. No.	Stock	Dimensions (mm)					
		d	Pitch	L	D	d_1	B
HE060011P	●	M6	0,75	14,5	7,8	5,0	2,5



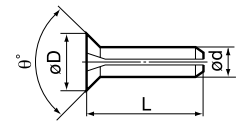
Cat. No.	Stock	Dimensions (mm)					
		d	D	L			
LP04	●	0,4	1,1	4,7			
LP06	●	0,4	1,1	6,0			
LP07	●	0,4	1,1	7,7			



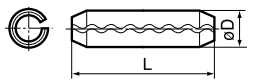
Cat. No.	Stock	Dimensions (mm)					
		d	H	L			
LSP3		5	3,5	5,5			
LSP3SD	●	5	3,5	5,5			
LSP4		6,7	4	7			
LSP4SD		6,7	4	7			
LSP5SD		7,7	4,5	8,5			
LSP6SD		9,85	5,9	11,1			
LSP8		13,05	10	12			
LSP10	●	5	3,3	6,5			
LSP16	●	6,6	4,5	9			
LSP20	●	8,2	5,5	9			
LSP25	❍	9,8	6,5	11			
LSP32		13	10	12			



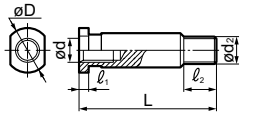
Cat. No.	Stock	Dimensions (mm)					
		d	Pitch	L	D	D_1	d_1
MP317	●	M4	0,7	15,5	6	4	3,7
MP320	●	M4	0,7	19,5	6	4	3,7
MP416	●	M5	0,8	14	7,5	6	5
MP420	●	M5	0,8	20	7,5	6	5
MP432		M5	0,8	32	7,5	6	5
MP531							
MP534							



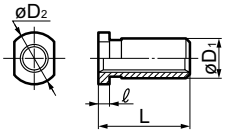
Cat. No.	Stock	Dimensions (mm)					
		d		L	D		θ°
SPP308		3,2		8	4,8		120



Cat. No.	Stock	Dimensions (mm)					
				L	D		
SPP3	●			14	3,2		

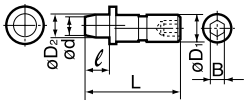


Cat. No.	Stock	Dimensions (mm)					
		d_1	d_2	L	D	ℓ_1	ℓ_2
VP20	●	M3,5	M4	12,0	5,0	≥4,5	≥4,5
VP25	●	M3,5	M4	17,0	5,0	≥4,5	≥4,5
VP32	●	M3,5	M4	24,0	5,0	≥4,5	≥4,5

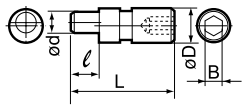


Cat. No.	Stock	Dimensions (mm)					
		d	Pitch	L	ℓ	D_1	D_2
VP32B	●	M3,5	0,6	8,0	1,4	5,0	6,5
VP40B	●	M3,5	0,6	11,5	1,4	5,0	6,5

■ Eccentric Pin



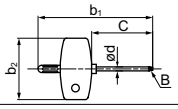
Cat. No.	Stock	Dimensions (mm)					
		d	D_1	D_2	L	ℓ	B
CPB34	●	3,4	4,1	5,5	14	5	2,5
CPB35	❍	3,4	4,1	5,5	17	5	2,5
CPB42	●	4,5	5,5	7	14	5	3
CPB43	●	4,5	5,5	7	19	5	3
CPB43S	●	4,5	5,5	7	16	5	3
CPB44T	❍	4,5	5,5	7	22	5	3
CPB45T	❍	4,5	5,5	7	27	5	3
CPB64	❍	6,8	8,2	10,5	24	6,6	4



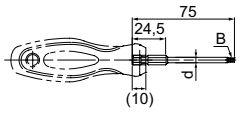
Cat. No.	Stock	Dimensions (mm)					
		d	D_1	D_2	L	ℓ	B
CPU304C	❍	3,3	5,5	-	10	3,5	3

■ Wrench

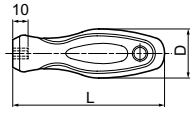
Hex Wrench (Torx Plus)



Cat. No.	Stock	Dimensions (mm)					
		B	d	C	b_1	b_2	
TRXW10IP		10IP	2,6	40	75	40	



Cat. No.	Stock	Dimensions (mm)						
		B	d					
TRB10IP	●	10IP	4					
TRB15IP	●	15IP	4					
TRB20IP	●	20IP	4,55					
TRB25IP	●	25IP	5					

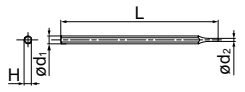


Cat. No.	Stock	Dimensions (mm)		
		D	L	Remarks
HPS1015	●	32	99,4	For 10IP, 15IP
HPL2025		35,5	110,3	For 20IP, 25IP

Wrench

■ Wrench

Socket Wrench



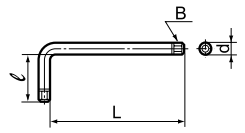
Cat. No.	Stock	Dimensions (mm)					
		d_1	d_2	L	H		
ANT		5	2	100	4,5		

Hex Wrench (Hexagonal)

Cat. No.	Stock	Dimensions (mm)					
		B	L	ℓ			
LH020	●	2	50	16			
LH025	●	2,5	56	18			
LH030	●	3	63	20			
LH035	●	3,5	68	22			
LH040	●	4	70	25			
LH050	❍	5	80	28			
LH060		6	90	32			

Cat. No.	Stock	Dimensions (mm)					
LH035K	●						
LH045K							

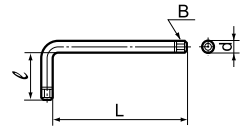
Torx Wrench



Cat. No.	Stock	Dimensions (mm)					
		B	d	L	ℓ		
LT15	❍	T15					
LT20	❍	T20	3,9	57,2	19,1		
LT25	❍	T25	4,4	60,3	20,2		
LT27	●	T27	4,96	63,5	21,5		
LT1510	❍	T15	3,26	62	10		

Cat. No.	Stock	Dimensions (mm)					
LT15K	●						

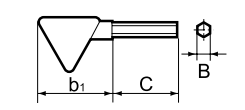
Torx Plus Wrench



Cat. No.	Stock	Dimensions (mm)					
		B	d	L	ℓ		
LT15IP	❍						
LT20IP		T20	4,0	57	18,5		
LT25IP		T25	4,5	60	19,5		

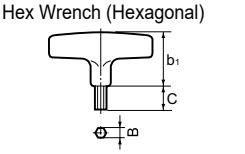
Cat. No.	Stock	Dimensions (mm)					
SDBSM	●						

Hex Wrench (Hexagonal)



Cat. No.	Stock	Dimensions (mm)					
		B	b_1	C			
TH015		1,5	35	30			
TH020	●	2	35	39			
TH025	●	2,5	35	39			

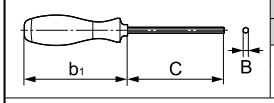
Hex Wrench (Hexagonal)



Cat. No.	Stock	Dimensions (mm)					
		B	b_1	C			
TH030	●	3	48	28			
TH040	●	4	48	37			
TH050	❍	5	48	45			

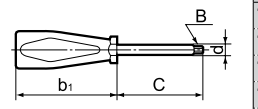
■ Wrench

Hex Wrench (Hexagonal)



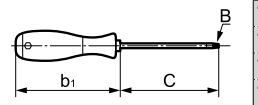
Cat. No.	Stock	Dimensions (mm)					
		B	C	b_1			
HD040	❍	4	75	111			

Torx Wrench



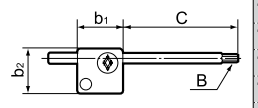
Cat. No.	Stock	Dimensions (mm)					
		B	d	C	B_1		
TRD07	●	T7	2,0	45	70		
TRD08	●	T8	2,3	55	70		
TRD15	❍	T15	3,3	70	100		
TRD20	●	T20	3,9	100	90		
TRD25	●	T25	5,3	80	110		

Torx Plus Wrench



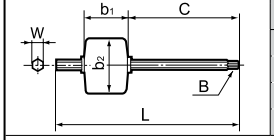
Cat. No.	Stock	Dimensions (mm)					
		B	C	b_1			
TRDR06IP05	●						
TRDR08IP	●	8IP	60	104			
TRDR10IP	●	10IP	80	111			
TRDR15IP	●	15IP	80	111			
TRDR20IP	●	20IP	100	118			
TRDR25IP	●	25IP	100	118			

Torx Wrench



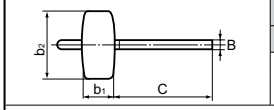
Cat. No.	Stock	Dimensions (mm)					
		B	C	b_1	b_2		
TRX06	●	T6	35,5	15	15		
TRX08	●	T8	38,5	19	19		
TRX10	●	T10	42,1	22	22		
TRX15	●	T15	46	22	27		
TRX20	●	T20	49	22	30		

Torx Plus Wrench



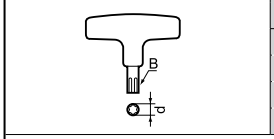
Cat. No.	Stock	Dimensions (mm)					
		B	C	b_1	b_2		
TRX06IP	●	6IP	34	15	15		

Hex Wrench (Hexagonal)



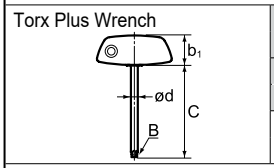
Cat. No.	Stock	Dimensions (mm)					
		B	C	b_1	b_2		
TSW040	●	4	60	20	40		

Torx Wrench



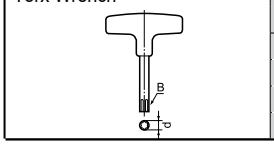
Cat. No.	Stock	Dimensions (mm)					
		B	d				
TT25	●	T25	4,4				
TT27	●	T27	5,0				

Torx Plus Wrench



Cat. No.	Stock	Dimensions (mm)					
		B	d	C	b_1		
TTR15IP	●	15IP	4,0	80	25,5		

Torx Wrench



Cat. No.	Stock	Dimensions (mm)					
		B	d				
TTX15W	●	T15	4,0				
TTX20	●	T20	3,9				

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P

P9–P22

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A - B

A		
16ER******CB	F64	Threading inserts
16IR******CB	F65	Threading inserts
1,8x45	G83, G85, M56, M71, M73	Spare parts
AECT******PEFRA	G72, G73, H61, H63	Indexable insert
AFBSM**	M50, M51	Spare parts
ANB****R	G79, G81, H85, H87, M63, M65, M67, M69	SUMIDIA blades
ANB****R-G	G79, G81, H85, H87, M63, M65, M67, M69	SUMIDIA blades
ANB****R-GB	G79, G81, H85, H87, M63, M65, M67, M69	SUMIDIA blades
ANB****R-H	G79, G81, H85, H87, M63, M65, M67, M69	SUMIDIA blades
ANB****R-L	G79, G81, H85, H87, M63, M65, M67, M69	SUMIDIA blades
ANB****R-W	G79, G81, H85, H87, M63, M65, M67, M69	SUMIDIA blades
ANB****R-WS	G79, G81, H85, H87, M63, M65, M67, M69	SUMIDIA blades
ANB****R-GX	G79, G81, H85, H87, M63, M65, M67, M69	SUMIDIA blades
ANT	P3	Spare parts
ANXA*****R**	G74, G78, H82, M58, M62	Cutter
ANXA*****RS**	G74, G78, H82, M58, M62	Cutter
ANXS*****E**	G74, H82, H84, M58, M66	Cutter
ANXS*****M**	G74, H82, H86, M58, M68	Modular cutter
ANXS*****R**	G74, G80, H82, M58, M64	Cutter
ANXS*****RS**	G74, G80, H82, M58, M64	Cutter
AOET******PEER-F	G41, G51, G57, H27, H37, H39, H41, H45, H49, H53	Indexable insert
AOET******PEER-P**	G41, H27, H37, H39, H41, H49,	Indexable insert
AOET******PEFR-S	G41, G51, G57, H27, H37 H39, H41, H45, H49, H53	Indexable insert
AOET**T3**PEER-F	G41, G49, G55, H27, H31, H33, H35, H43, H47, H51	Indexable insert
AOET**T3**PEER-P**	G41, H27, H31, H33, H35, H43, H47,	Indexable insert
AOET**T3**PEFR-S	G41, G49, G55, H27, H31, H33, H35, H43, H47, H51	Indexable insert
AOMT******PEER-G	G41, G51, G57, H27, H37, H39, H41, H45, H49, H53	Indexable insert
AOMT******PEER-H	G41, G51, G57, H27, H37, H39, H41, H45, H49, H53	Indexable insert
AOMT******PEER-L	G41, G51, G57, H27, H37, H39, H41, H45, H49, H53	Indexable insert
AOMT**T3**PEER-G	G41, G49, G55, H27, H31, H33, H35, H43, H47, H51	Indexable insert
AOMT**T3**PEER-H	G41, G49, G55, H27, H31, H33, H35, H43, H47, H51	Indexable insert
ASM****	J36	Solid endmill
ASM****DL	J30	Solid endmill
ASM****DL-R**	J30	Solid endmill
AXET******PEFR-S	G58, G59, H57, H58, H65, H66	Indexable insert
AXMT******PDER-G	G58, H56	Indexable insert
AXMT******PDER-H	G58, H56	Indexable insert
AXMT******PDER-L	G58, H56	Indexable insert
AXMT******PDFR-S	G58, H56	Indexable insert
AXMT******PEER-E	G58, G59, H57, H58, H65, H66	Indexable insert
AXMT******PEER-EH	G58, G59, H57, H58, H65, H66	Indexable insert
AXMT******PEER-G	G58, G59, H57, H58, H65, H66	Indexable insert
AXMT******PEER-H	G58, G59, H57, H58, H65, H66	Indexable insert
AXMT******PEER-L	G58, G59, H58, H66	Indexable insert

B		
B***-SCLC R/L ****-**	E14	Boring bar
B***-SDQC R/L ****-**	E17	Boring bar
B***-SDUC R/L ****-**	E16	Boring bar
B***-STUP R/L ****-**	E20	Boring bar
BBT**M*-**	H5	Integreted Arbor
BBT**M**-**	H5	Integreted Arbor
BCS**	F56, F58	Spare parts
BFTG****F	P2	Spare parts
BFTX****	P2	Spare parts
BFTX*****	P2	Spare parts
BFTX****A	P2	Spare parts
BFTX****IP	P2	Spare parts
BFTX****IPS	F43	Spare parts
BFTX*****IP**	P2	Spare parts
BFTX*****IPS	F43	Spare parts
BFTX****N	P2	Spare parts
BFTX*****N	P2	Spare parts
BFTX*****NV	P2	Spare parts
BFTX****SD	P2	Spare parts
BFTX*****SD	P2	Spare parts
BFTX****T8 R/L	F20, P2	Spare parts
BFTY*****	P2	Spare parts
BH****	P2	Spare parts
BH*****	P2	Spare parts
BH**** R/L	P2	Spare parts
BHA****	P3	Spare parts
BHF****	P3	Spare parts
BNB*** R/L	M53	Boring bar
BNBB**R	M52	Boring bar
BNBC	M53	Spare parts
BNBP 2R***-*** *	J41, M75	SUMIBORON endmill
BNBW-*	P6	Spare parts
BNES****	J40, M74	SUMIBORON endmill
BNGC R/L	M56	Spare parts
BNGG R/L ****-TT	M56	Tool holder
BNGS R/L TT	M56	Spare parts
BNTT**** R/L	M56	SUMIBORON insert
BNZ***R	M53	Boring bar
BSME R/L *****D*S6	M50	Boring bar
BT****	P3	Spare parts
BT****E	F26, F30	Spare parts
BT*****T	P3	Spare parts
BTD****	P3	Spare parts
BTR****	D30	Indexable insert
BTT****	P3	Spare parts
BW****F	P3	Spare parts
BW****F-SD	P3	Spare parts
BWS**	F56, F58	Spare parts
BX****	P3	Spare parts
BX****T	P3	Spare parts
BXA****IP	P3	Spare parts
BXH****D**	P3	Spare parts
BXBR*****R	E24	Boring bar
BXBR*****R-NB	E24	Boring bar
BXD*****IP	P3	Spare parts

C		
C***-SCLP R/L **	E15	Boring bar
C***-SSKP R/L **	E18	Boring bar
C***-STUB R/L **	E20	Boring bar
C***-STUP R/L **	E20	Boring bar
C***-SWUB R/L **	E23	Boring bar
CBC*	D25	Spare parts
CBC****	D25	Spare parts
CBD4 R/L	D25	Spare parts
CBS**	D25	Spare parts
CCET******LFY/RFY	C63	Indexable insert
CCET**T***LFY/RFY	C63	Indexable insert
CCET**X***LFY/RFY	C63	Indexable insert
CCET**X****LFY/RFY	C63	Indexable insert
CCEW**X***LF-NU	M5	SUMIBORON insert
CCEW**X***LT-NU	M5	SUMIBORON insert
CCGT******LAY/RAY	C65	Indexable insert
CCGT**X***LFY/RFY	C65	Indexable insert
CCGT******LFX/RFX	C64	Indexable insert
CCGT*******LFX/RFX	C64	Indexable insert
CCGT**T***LFX/RFX	C64	Indexable insert
CCGT**T****LFX/RFX	C64	Indexable insert
CCGT**X***LFYS/RFYS	C64	Indexable insert
CCGT**X****LFYS/RFYS	C64	Indexable insert
CCGT******M NFC	C64	Indexable insert
CCGT******M NSC	C65	Indexable insert
CCGT******M NSI	C65	Indexable insert
CCGT******NAG	C65	Indexable insert
CCGT******NFV NC2	M4	SUMIBORON insert
CCGT******NFV NU2	M6	SUMIBORON insert
CCGT******NLV NC2	M4	SUMIBORON insert
CCGT******NLV NU2	M6	SUMIBORON insert
CCGT******NSC	C65	Indexable insert
CCGW**T***	M5	SUMIBORON insert
CCGW******HS-NC2	M4	SUMIBORON insert
CCGW******HS-NU	M5	SUMIBORON insert
CCGW******HS-NU2	M6	SUMIBORON insert
CCGW******LE-NC2	M4	SUMIBORON insert
CCGW******LS-NC2	M4	SUMIBORON insert
CCGW******LT-NU	M5	SUMIBORON insert
CCGW******LT-NC2	M4	SUMIBORON insert
CCGW******NC-2	M4	SUMIBORON insert
CCGW******NC-W2	M4	SUMIBORON insert
CCGW******NC-WG2	M4	SUMIBORON insert
CCGW******NC-WH2	M4	SUMIBORON insert
CCGW******NS	M5	SUMIBORON insert
CCGW******NU	M5	SUMIBORON insert
CCGW******NU-2	M6	SUMIBORON insert
CCGW******NU-WG2	M6	SUMIBORON insert
CCGW******NU-WH2	M6	SUMIBORON insert
CCH***	G67, H11, H12	Spare parts
CCLN R/L ****-***	D25	Tool holder
CCM 6B L/R	F50	Spare parts
CCM 8 LONG	D25, D26	Spare parts
CCM 8 UL	D25, F50	Spare parts
CCM 8 UR	F50	Spare parts
CCMT******	M8	SUMIDIA insert
CCMT******L/R-DM NU	M8	SUMIDIA insert
CCMT******NF	M8	SUMIDIA insert
CCMT******NFB	C66	Indexable insert
CCMT******NFP	C66	Indexable insert
CCMT******NGD NF	M8	SUMIDIA insert
CCMT******NGU	C67	Indexable insert
CCMT******NLD NF	M8	SUMIDIA insert
CCMT******NLB	C66	Indexable insert
CCMT******NLU	C66	Indexable insert
CCMT******NLU-W	C66	Indexable insert
CCMT******NMU	C67	Indexable insert
CCMT******NSC	C67	Indexable insert
CCMT******NSK	C67	Indexable insert
CCMT******NSU	C66	Indexable insert
CCMT**T***NUS	C67	Indexable insert
CCMW******	C67	Indexable insert
CCMW******NF	M8	SUMIDIA insert
CCMW******RH	M8, M45	SUMIDIA insert
CCMW**T***	C67	Indexable insert
CCS**T*	P5	Spare parts
CGA R/L **** ***	M55	SUMIBORON insert
CNGA******	C26	Indexable insert
CNGA******ES-NC4	M9	SUMIBORON insert
CNGA******HS-NC2	M10	SUMIBORON insert
CNGA******HS-NC4	M10	SUMIBORON insert
CNGA******HS-NU2	M12	SUMIBORON insert
CNGA******HT-NU2	M11	SUMIBORON insert
CNGA******LE-NU2	M11	SUMIBORON insert
CNGA******LE-NC2	M9	SUMIBORON insert
CNGA******LF-NU2	M11	SUMIBORON insert
CNGA******LS-NU2	M11	SUMIBORON insert
CNGA******LS-NC2	M9	SUMIBORON insert
CNGA******LS-NC4	M9	SUMIBORON insert
CNGA******LT-NU2	M11	SUMIBORON insert
CNGA******LT-NC2	M9	SUMIBORON insert
CNGA******NC-2	M9	SUMIBORON insert
CNGA******NC-4	M9	SUMIBORON insert
CNGA******NC-W4	M9	SUMIBORON insert
CNGA******NC-WG4	M9	SUMIBORON insert
CNGA******NC-WH4	M9	SUMIBORON insert
CNGA******NU	M12	SUMIBORON insert
CNGA******NU-2	M11	SUMIBORON insert
CNGA******NS-2	M11	SUMIBORON insert
CNGA******NU-W2	M11	SUMIBORON insert
CNGA******NU-WG2	M11	SUMIBORON insert
CNGA******NU-WH2	M11	SUMIBORON insert
CNGA******US-NU2	M12	SUMIBORON insert
CNGG******LAX/RAX	C28	Indexable insert
CNGG******NEF	C28	Indexable insert
CNGG******NFV NC4	M10	SUMIBORON insert
CNGG******NLV NC4	M10	SUMIBORON insert
CNGG******NSV NC4	M10	SUMIBORON insert
CNGG******NGH	C28	Indexable insert
CNGG******NSU	C28	Indexable insert
CNGM******NLV NU2	M12	SUMIBORON insert
CNGN******	M13	SUMIBORON insert
CNGX******	M13	SUMIBORON insert
CNMA******	C28	Indexable insert
CNMA******	M13	SUMIBORON insert
CNMA******NS	M13	SUMIBORON insert
CNMA******NU	M13	SUMIBORON insert
CNMA******NU-W	M13	SUMIBORON insert
CNMG******NEF	C20	Indexable insert
CNMG******NEG	C22	Indexable insert
CNMG******NEM	C23	Indexable insert
CNMG******NEX	C22	Indexable insert
CNMG******NFA	C20	Indexable insert

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C - D

CNMG******NFB	C20	Indexable insert
CNMG******NFE	C20	Indexable insert
CNMG******NFL	C20	Indexable insert
CNMG******NGE	C22	Indexable insert
CNMG******NGU	C21	Indexable insert
CNMG******NGU-W	C21	Indexable insert
CNMG******NGZ	C25	Indexable insert
CNMG******NLU	C20	Indexable insert
CNMG******NLU-W	C20	Indexable insert
CNMG******NME	C23	Indexable insert
CNMG******NMU	C23	Indexable insert
CNMG******NMX	C24	Indexable insert
CNMG******NSE	C21	Indexable insert
CNMG******NSE-W	C21	Indexable insert
CNMG******NSU	C21	Indexable insert
CNMG******NSX	C21	Indexable insert
CNMG******NUG	C22	Indexable insert
CNMG******NUP	C23	Indexable insert
CNMG******NUX	C24	Indexable insert
CNMG******NUZ	C25	Indexable insert
CNMM******NHF	C26	Indexable insert
CNMM******NHG	C26	Indexable insert
CNMM******NHP	C26	Indexable insert
CNMM******NHU	C27	Indexable insert
CNMM******NHW	C27	Indexable insert
CNMM******NMH	C26	Indexable insert
CNMM******NMP	C26	Indexable insert
CNMX******NF	M13	SUMIDIA insert
CNMX******L/R	C26	Indexable insert
CNS****	P5	Spare parts
CNS****B	P5	Spare parts
CPB**	P7	Spare parts
CPB**S	P7	Spare parts
CPB**T	P7	Spare parts
CPGT******NSD	C66	Indexable insert
CPGW******NC2	M7	SUMIBORON insert
CP-M*-**-*	F20	Spare parts
CPM**N	P6	Spare parts
CPM**S	P6	Spare parts
CPMH******NUS	C69	Indexable insert
CPMT******NFB	C68	Indexable insert
CPMT******NGU	C69	Indexable insert
CPMT******NLB	C68	Indexable insert
CPMT******NLU	C68	Indexable insert
CPMT******NLU-W	C68	Indexable insert
CPMT******NMU	C69	Indexable insert
CPMT******NSU	C69	Indexable insert
CPMT******NUS	C69	Indexable insert
CPMW******NF	M7	SUMIDIA insert
CPU***C	P7	Spare parts
CPV**N	P6	Spare parts
CRDN N****-***	D26	Tool holder
CRSN R/L ****-***	D26	Tool holder
CSBN R/L ****-***	D25	Tool holder
CSKN R/L ****-***	D25	Tool holder
CTL******N/L/R	F54	Indexable insert
CTR******N/L/R NB	F54	Indexable insert
CTR******N/L/R	F54	Indexable insert

D

D***-DCLC R/L ****-**	E8	Boring bar
D***-DDUN R/L ****-**	E9	Boring bar
D***-DTFN R/L ****-**	E12	Boring bar
D***-DWLN R/L ****-**	E13	Boring bar
D***-SCLC R/L ****-**	E14	Boring bar
D***-SDQC R/L ****-**	E17	Boring bar
D***-SDUC R/L ****-**	E16	Boring bar
D***-STUP R/L ****-**	E20	Boring bar
D***-SVUB R/L ****-**	E21	Boring bar
D***-SVZB R/L ****-**	E21	Boring bar
DABB***C-R	M57	SUMIDIA-Bohrstange
DABB***N-R	M57	SUMIDIA-Bohrstange
DAL****H	M78	SUMIDIA-Bohrer
DC R/L-*	D25	Spare parts
DCGT******LAY/RAY	C72	Indexable insert
DCGT******LFX/RFX	C70	Indexable insert
DCGT*******LFX/RFX	C70	Indexable insert
DCGT******LFY/RFY	C71	Indexable insert
DCGT*******LFY/RFY	C71	Indexable insert
DCGT******LFYS/RFYS	C70	Indexable insert
DCGT*******LFYS/RFYS	C70	Indexable insert
DCGT******LSD/RSD	C71	Indexable insert
DCGT******M NFC	C70	Indexable insert
DCGT******M NSC	C72	Indexable insert
DCGT******M NSI	C72	Indexable insert
DCGT******NAG	C71	Indexable insert
DCGT******N-FV NC2	M14	SUMIBORON insert
DCGT******N-FV NU2	M15	SUMIBORON insert
DCGT******N-LV NC2	M14	SUMIBORON insert
DCGT******N-LV NU2	M15	SUMIBORON insert
DCGT******NSC	C72	Indexable insert
DCGW******	C72	Indexable insert
DCGW******HS-NC2	M14	SUMIBORON insert
DCGW******HS-NU	M16	SUMIBORON insert
DCGW******HS-NU2	M15	SUMIBORON insert
DCGW******LE-NC2	M14	SUMIBORON insert
DCGW******LE-NU2	M15	SUMIBORON insert
DCGW******LF-NU	M16	SUMIBORON insert
DCGW******LF-NU2	M15	SUMIBORON insert
DCGW******LS-NC2	M14	SUMIBORON insert
DCGW******LT-NU	M16	SUMIBORON insert
DCGW******LT-NC2	M14	SUMIBORON insert
DCGW******LU-NC2	M15	SUMIBORON insert
DCGW******NC-2	M14	SUMIBORON insert
DCGW******NC-WG2	M14	SUMIBORON insert
DCGW******NC-WH2	M14	SUMIBORON insert
DCGW******NS	M16	SUMIBORON insert
DCGW******NU	M16	SUMIBORON insert
DCGW******NU-2	M15	SUMIBORON insert
DCGW******NU-WG2	M15	SUMIBORON insert
DCGW******NU-WH2	M15	SUMIBORON insert
DCLN R/L ****-***	D12	Tool holder
DCMT******	M17	SUMIDIA insert
DCMT******L/R-DM NU	M17	SUMIDIA insert
DCMT******NF	M17	SUMIDIA insert
DCMT******NFB	C73	Indexable insert
DCMT******NFP	C73	Indexable insert
DCMT******NGD NF	M17	SUMIDIA insert
DCMT******NGU	C73	Indexable insert
DCMT******NLD NF	M17	SUMIDIA insert
DCMT******NLB	C73	Indexable insert

DCMT******NLU	C73	Indexable insert
DCMT******NMU	C73	Indexable insert
DCMT******NSK	C73	Indexable insert
DCMT******NSU	C73	Indexable insert
DCMW******	C73	Indexable insert
DCMW******NF	M17	SUMIDIA insert
DCMW******RH	M17, M45	SUMIDIA insert
DCMX**T***NLUW	C73	Indexable insert
DCS**T*	P5	Spare parts
DDHN R/L ****-***	D13	Tool holder
DDJN R/L ****-***	D13	Tool holder
DDL***V	M78	SUMIDIA drill
DDNN N ****-***	D13	Tool holder
DFC*****E	H16, H17	Indexable endmill
DFC*****E**	H17	Indexable endmill
DFCM*****E	H16, H17	Indexable endmill
DFCM*****E**	H17	Indexable endmill
DFC*****RS	G24, H16	Cutter
DFCF*****RS	G24, H16	Cutter
DFCM*****RS	G24, H16	Cutter
DGC*****EW	H6	Indexable endmill
DGC*****RS	G8	Cutter
DGCF*****RS	G8	Cutter
DGCM*****RS	G8	Cutter
DGCS**R	P5	Spare parts
DML***V	M79	SUMIDIA drill
DMSW*****E	H8	Indexable endmill
DMSW*****EL	H8	Indexable endmill
DMSW*****M	H9	Indexable endmill
DMSW*****R	G63, G66	Cutter
DMSW*****RS	G63, G66	Cutter
DNGA******	C34	Indexable insert
DNGA******ES-NC2	M19	SUMIBORON insert
DNGA******ES-NC4	M19	SUMIBORON insert
DNGA******HS-NC2	M19	SUMIBORON insert
DNGA******HS-NC4	M19	SUMIBORON insert
DNGA******HS-NU2	M20	SUMIBORON insert
DNGA******LE-NC2	M18	SUMIBORON insert
DNGA******LF-NU2	M20	SUMIBORON insert
DNGA******LS-NC2	M19	SUMIBORON insert
DNGA******LS-NC4	M19	SUMIBORON insert
DNGA******LT-NC2	M18	SUMIBORON insert
DNGA******LT-NU2	M20	SUMIBORON insert
DNGA******NC-2	M18	SUMIBORON insert
DNGA******NC-4	M18	SUMIBORON insert
DNGA******NC-WG4	M18	SUMIBORON insert
DNGA******NC-WH4	M18	SUMIBORON insert
DNGA******NU	M20	SUMIBORON insert
DNGA******NU-2	M20	SUMIBORON insert
DNGA******NU-WG2	M20	SUMIBORON insert
DNGA******NU-WH2	M20	SUMIBORON insert
DNGG******LAX/RAX	C36	Indexable insert
DNGG******LUM/RUM	C36	Indexable insert
DNGG******NEF	C36	Indexable insert
DNGG******NFV NC4	M19	SUMIBORON insert
DNGG******NLV NC4	M19	SUMIBORON insert
DNGG******NGH	C36	Indexable insert
DNGG******NSU	C36	Indexable insert
DNGG******N-SV NC4	M19	SUMIBORON insert
DNGM******N-LV NU2	M20	SUMIBORON insert
DNGA******	M21	SUMIBORON insert
DNGN******	M21	SUMIBORON insert
DNMA******	C35	Indexable insert
DNMA******	M21	SUMIBORON insert
DNMA******NF	M21	SUMIDIA insert
DNMA******NS	M21	SUMIBORON insert
DNMA******NU	M21	SUMIBORON insert
DNMA******RH	M21, M45	SUMIDIA insert
DNMG******LHM/RHM	C33	Indexable insert
DNMG******LUM/RUM	C32	Indexable insert
DNMG******NEF	C30	Indexable insert
DNMG******NEG	C31	Indexable insert
DNMG******NEM	C32	Indexable insert
DNMG******NEX	C31	Indexable insert
DNMG******NFA	C29	Indexable insert
DNMG******NFB	C29	Indexable insert
DNMG******NFE	C29	Indexable insert
DNMG******NFL	C29	Indexable insert
DNMG******NGE	C31	Indexable insert
DNMG******NGU	C30	Indexable insert
DNMG******NGZ	C33	Indexable insert
DNMG******NLU	C29	Indexable insert
DNMG******NME	C32	Indexable insert
DNMG******NMU	C32	Indexable insert
DNMG******NMX	C33	Indexable insert
DNMG******NSE	C30	Indexable insert
DNMG******NSU	C30	Indexable insert
DNMG******NSX	C30	Indexable insert
DNMG******NUG	C31	Indexable insert
DNMG******NUP	C32	Indexable insert
DNMG******NUX	C33	Indexable insert
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DNMM******NHP	C34	Indexable insert
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DNXF***** RS	G14	Cutter
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FMUE	G85, M73	Spare parts
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GNDM R/L ****JX****	F18	Tool holder
GNDM R/L ****JX*****	F18	Tool holder
GNDM R/L ****JX***J	F20	Tool holder
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GSXVL****-***D	J20	Solid endmill
GSXVL****S-R**-***D	J21	Solid endmill
GSXVL****-R**-***D	J21	Solid endmill
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LCS**BS-SD	P4	Spare parts
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M**	H5	Spare parts
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MDF****L2D	K27	Multi-drill
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MDF****H5D	K29, K30	Multi-drill
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MDSS****	K40	Multi-drill
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MSX*****ES	H11	Indexable endmill
MSX*****EW	H11	Indexable endmill
MSX*****M**Z*	H12	Indexable endmill
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MTIX******E**	H69	Indexable endmill
MTIX******E*****	H69	Indexable endmill
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MTJN R/L V-**	D23	Tool holder
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PCLN R/L ****-***	D18	Tool holder
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PSC**DDJN R/L*****-15	D41	Polygon tool holder
PSC**DDHN R/L*****-15	D41	Polygon tool holder
PSC**DSBN R/L*****-12	D41	Polygon tool holder
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PSC**SCLC R/L*****-09	D43	Polygon tool holder
PSC**SDJC R/L*****-11	D43	Polygon tool holder
PSC**SDHC R/L*****-11	D43	Polygon tool holder
PSC**SSBC R/L*****-12	D43	Polygon tool holder
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PSC**SVHC R/L*****-16	D45	Polygon tool holder
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RDET****M0EN-G	G21, H76, H77	Indexable insert
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SEMT****AGSR-G	G11, H7	Indexable insert
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SNEU****ANER-G	G9, H6	Indexable insert
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SNEW****ADTR-U-NF	G67, M71	SUMIDIA insert
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SOMT******PDER-G	G26, G29, G71, H15, H19, H79, H80	Indexable insert
SOMT******PDER-H	G26, G29, G71, H15, H19, H79, H80	Indexable insert
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SOMT******PZER-G	G26, G28, G70, H15, H18, H79, H80	Indexable insert
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SSEHVL****W-R**	J25	Solid endmill
SSEHVL****WS-R**	J25	Solid endmill
SSHC R/L********	F43	Indexable insert
SSHG R/L*******	F43, F44	Indexable insert
SSHR R/L*****	F43, F44	Indexable insert
SSM****	J38, J39	Solid endmill
SSND***	P5	Spare parts
SSTE R*******	F63	Tool holder
SSTI R*******	F63	Tool holder
SSUP****ZX	J33	Solid endmill
SSUP****ZX-R**	J33	Solid endmill
SSW***	P6	Spare parts
STAC R/L ****-***	D37	Tool holder
STFH**-*	F56	Tool holder
STFS R/L ****-*	F56	Tool holder
STGC R/L ****-***	D37	Tool holder
STPD***	P6	Spare parts
STW***	P6	Spare parts
SUF*S R/L	G12	Spare parts
SVJB R/L ****-***	D38	Tool holder
SVLC R/L ****-***	D39	Tool holder
SVP**	D38, E21, E22	Spare parts
SVPB R/L ****-***	D38	Tool holder
SVPC R/L ****-***	D39	Tool holder
SVVB N ****-***	D38	Tool holder
SVW***	P5	Spare parts
SWW	P6	Spare parts

T

TBGN******	C88	Indexable insert
TBGN******B	M25	SUMIBORON insert
TBGN******NF	M25	SUMIDIA insert
TBGR******LW	C88	Indexable insert
TBGT******LAY/RAY	C80	Indexable insert
TBGT******LFW/RFW	C80	Indexable insert
TBGT******LFX/RFX	C80	Indexable insert
TBGT******LFY/RFY	C80	Indexable insert
TBGT******LW/RW	C80	Indexable insert
TBGW******	C80	Indexable insert
TBGW******NF	M25	SUMIDIA insert
TCGT******LFX/RFX	C81	Indexable insert
TCGT******LFY/RFY	C81	Indexable insert
TCGT******M NSC	C81	Indexable insert
TCGT******M NSI	C81	Indexable insert
TCGT******NAG	C81	Indexable insert
TCGW******NC	M26	SUMIBORON insert
TCGW******NC-3	M26	SUMIBORON insert
TCGW******NU	M26	SUMIBORON insert
TCMT******NF	M26	SUMIDIA insert
TCMT******NFB	C82	Indexable insert
TCMT******NFP	C82	Indexable insert
TCMT******NLB	C82	Indexable insert
TCMT******NLU	C82	Indexable insert
TCMT******NSK	C82	Indexable insert
TCMT******NSU	C82	Indexable insert
TCMW******	C82	Indexable insert
TCS**T*	P6	Spare parts
TEGN******	C89	Indexable insert
TGA R/L ****BF	F51	Indexable insert
TGA R/L ****(E)	F52	Indexable insert
TGA R/L ****R	F53	Indexable insert
TGA R/L *T**	F53	Indexable insert
TF**	M42	Spare parts
TH***	P8	Spare parts
TNGA******	C54	Indexable insert
TNGA******ES-NC6	M27	SUMIBORON insert
TNGA******HS-NC3	M27	SUMIBORON insert
TNGA******HS-NC6	M27	SUMIBORON insert
TNGA******HS-NU3	M29	SUMIBORON insert
TNGA******HT-NU3	M29	SUMIBORON insert
TNGA******LE-NC3	M27	SUMIBORON insert
TNGA******LE-NU3	M29	SUMIBORON insert
TNGA******LS-NC3	M27	SUMIBORON insert
TNGA******LS-NU3	M29	SUMIBORON insert
TNGA******LT-NC3	M27	SUMIBORON insert
TNGA******LF-NU3	M29	SUMIBORON insert
TNGA******NC3	M27	SUMIBORON insert
TNGA******NC6	M27	SUMIBORON insert
TNGA******NU3	M29	SUMIBORON insert
TNGA******T NU3	M29	SUMIBORON insert
TNGA******US-NU3	M29	SUMIBORON insert
TNGG******LAX/RAX	C54	Indexable insert
TNGG******LFT/RFT	C53	Indexable insert
TNGG******LFY/RFY	C53	Indexable insert
TNGG******LFX/RFX	C53	Indexable insert
TNGG******LST/RST	C53	Indexable insert
TNGG******LUM/RUM	C54	Indexable insert
TNGG******N-FV NC6	M28	SUMIBORON insert
TNGG******N-LV NC6	M28	SUMIBORON insert
TNGG******NGH	C54	Indexable insert
TNGG******NSU	C53	Indexable insert
TNGG******N-SV NC6	M28	SUMIBORON insert
TNGM******N-LV NU3	M29	SUMIBORON insert
TNGN******	M29	SUMIBORON insert
TNMA******	C52	Indexable insert
TNMA******	M30	SUMIBORON insert
TNMA******NU	M30	SUMIBORON insert
TNMA******NS	M30	SUMIBORON insert
TNMG******LHM/RHM	C50	Indexable insert
TNMG******LUM/RUM	C48	Indexable insert
TNMG******NEF	C46	Indexable insert
TNMG******NEG	C48	Indexable insert
TNMG******NEM	C49	Indexable insert
TNMG******NEX	C48	Indexable insert
TNMG******NFA	C46	Indexable insert
TNMG******NFB	C46	Indexable insert
TNMG******NFE	C46	Indexable insert

TNMG******NFL	C46	Indexable insert
TNMG******NGE	C47	Indexable insert
TNMG******NGU	C47	Indexable insert
TNMG******NGZ	C50	Indexable insert
TNMG******NLU	C46	Indexable insert
TNMG******NME	C49	Indexable insert
TNMG******NMU	C49	Indexable insert
TNMG******NMX	C49	Indexable insert
TNMG******NSE	C47	Indexable insert
TNMG******NSU	C46	Indexable insert
TNMG******NSX	C47	Indexable insert
TNMG******NUG	C48	Indexable insert
TNMG******NUP	C48	Indexable insert
TNMG******NUX	C49	Indexable insert
TNMG******NUZ	C50	Indexable insert
TNMM******NHG	C51	Indexable insert
TNMM******NHP	C51	Indexable insert
TNMM******NMP	C51	Indexable insert
TNMM******	C51	Indexable insert
TNMX******NF	M30	SUMIDIA insert
TNS****	P6	Spare parts
TNS****B	P6	Spare parts
TPGN******	C88	Indexable insert
TPGN******	M31	SUMIBORON insert
TPGN******HS	M31	SUMIBORON insert
TPGN******LT	M31	SUMIBORON insert
TPGN******NF	M31	SUMIDIA insert
TPGN******T NF	M31	SUMIBORON insert
TPGN******NU	M31	SUMIBORON insert
TPGR******LW/RW	C88	Indexable insert
TPGT******LAY/RAY	C84	Indexable insert
TPGT******LFW/RFW	C83	Indexable insert
TPGT******LFX/RFX	C83	Indexable insert
TPGT******LFY/RFY	C84	Indexable insert
TPGT******LSD/RSD	C85	Indexable insert
TPGT******LW/RW	C85	Indexable insert
TPGT******M NFC	C83	Indexable insert
TPGT******N-FV NC3	M32	SUMIBORON insert
TPGT******N-FV NU3	M33	SUMIBORON insert
TPGW******	C84	Indexable insert
TPGW******	M32	SUMIBORON insert
TPGW******HS-NC3	M32	SUMIBORON insert
TPGW******HS-NU	M34	SUMIBORON insert
TPGW******LE-NC3	M32	SUMIBORON insert
TPGW******LE-NU3	M34	SUMIBORON insert
TPGW******LF-NU	M33	SUMIBORON insert
TPGW******LF-NU3	M34	SUMIBORON insert
TPGW******LS-NC3	M32	SUMIBORON insert
TPGW******LT-NC3	M32	SUMIBORON insert
TPGW******LT-NU	M33	SUMIBORON insert
TPGW******NC	M32	SUMIBORON insert
TPGW******NC3	M32	SUMIBORON insert
TPGW******NF	M34	SUMIDIA insert
TPGW******NU	M33	SUMIBORON insert
TPGW******NU3	M34	SUMIBORON insert
TPGX******L/R-SDW	C85	Indexable insert
TPMH******NSF	C87	Indexable insert
TPMN******	C89	Indexable insert
TPMR******NFK	C89	Indexable insert
TPMR******NSF	C89	Indexable insert
TPMR******NUJ	C89	Indexable insert
TPMT******L-DM NU	M35	SUMIDIA insert
TPMT******NFB	C86	Indexable insert
TPMT******NFK	C86	Indexable insert
TPMT******N-GD NF	M35	SUMIDIA insert
TPMT******NGU	C87	Indexable insert
TPMT******N-LD NF	M35	SUMIDIA insert
TPMT******NLB	C86	Indexable insert
TPMT******NLU	C86	Indexable insert
TPMT******NMU	C87	Indexable insert
TPMT******NSF	C87	Indexable insert
TPMT******NSU	C87	Indexable insert
TPMW******RF	M35	SUMIDIA insert
TPMW******RH	M35, M45	SUMIDIA insert
TRB**IP	P7	Spare parts
TRCP*	D11, E11	Spare parts
TRD**	P8	Spare parts
TRDR**IP	P8	Spare parts
TRM******-FL	C52, D11, E11	Indexable insert
TRM******-GU	C52, D11, E11	Indexable insert
TRM******-LU	C52, D11, E11	Indexable insert
TRM******-SU	C52, D11, E11	Indexable insert
TRW****	P6	Spare parts
TRX**	P8	Spare parts
TRX**IP	P8	Spare parts
TRX**IP**	D35	Spare parts
TRXW**IP	P7	Spare parts
TSX*****E	G30, H20, H22, H23	Indexable endmill
TSXF*****E	G30, H20, H22, H23	Indexable endmill
TSXM*****E	G30, H20, H23,	Indexable endmill
TSX*****RS	G30, G34, G35, H20	Cutter
TSXF*****RS	G30, G34, G37, H20	Cutter
TSXM*****RS	G30, G36, H20	Cutter
TSXR*****E	G30, H20, H24, H25	Indexable endmill
TSXR*****RS	G30, G38, G39, H20	Cutter
TSW***	P8	Spare parts
TT**	P8	Spare parts
TTR**IP	P8	Spare parts
TTX**	P8	Spare parts

U

UF*K R/L	G12	Spare parts
UF*S R/L	G12	Spare parts
UFKW R/L	G12	Spare parts
UFO**** R/L-S	G12	Cutter
UFOF**** R/L-S	G13	Cutter
UFTW R/L	G12	Spare parts
UW*****R	G13	Indexable insert

V- W

V

VBGT******LAY/RAY	C91	Indexable insert
VBGT******LFX/RFX	C91	Indexable insert
VBGT******LFY/RFY	C91	Indexable insert
VBGT******LFYS/RFYS	C91	Indexable insert
VBGT******M NSI	C91	Indexable insert
VBGW******HS-NC2	M37	SUMIBORON insert
VBGW******HS-NU	M36	SUMIBORON insert
VBGW******LE-NC2	M37	SUMIBORON insert
VBGW******LE-NU2	M37	SUMIBORON insert
VBGW******LS-NC2	M37	SUMIBORON insert
VBGW******LT-NC2	M37	SUMIBORON insert
VBGW******LT-NU	M36	SUMIBORON insert
VBGW******NC	M36	SUMIBORON insert
VBGW******NC2	M37	SUMIBORON insert
VBGW******NU	M36	SUMIBORON insert
VBGW******NU2	M37	SUMIBORON insert
VBMT******NFB	C90	Indexable insert
VBMT******NFP	C90	Indexable insert
VBMT******NGU	C90	Indexable insert
VBMT******NLB	C90	Indexable insert
VBMT******NLU	C90	Indexable insert
VBMT******NMU	C90	Indexable insert
VBMT******NSK	C90	Indexable insert
VBMT******NSU	C90	Indexable insert
VBMW******	C90	Indexable insert
VCGT******LFX/RFX	C92	Indexable insert
VCGT******LFY/RFY	C92	Indexable insert
VCGT******M NFC	C92	Indexable insert
VCGT******M NSI	C92	Indexable insert
VCGT******NAG	C92	Indexable insert
VCGW******HS NC2	M38	SUMIBORON insert
VCGW******LS NC2	M38	SUMIBORON insert
VCGW******LT NU	M38	SUMIBORON insert
VCGW******NC2	M38	SUMIBORON insert
VCGW******NU	M38	SUMIBORON insert
VCMT******	M39	SUMIDIA insert
VCMT******NF	M39	SUMIDIA insert
VCMT******NFB	C93	Indexable insert
VCMT******NGU	C93	Indexable insert
VCMT******NLD NF	M39	SUMIDIA insert
VCMT******NGD NF	M39	SUMIDIA insert
VCMT******NLB	C93	Indexable insert
VCMT******NLU	C93	Indexable insert
VCMT******NSK	C93	Indexable insert
VCMT******NSU	C93	Indexable insert
VCMW******	M39	SUMIBORON insert
VCMW******NF	M39	SUMIDIA insert
VCMW******RH	M39, M45	SUMIDIA insert
VCS****	P6	Spare parts
VNGA******ES-NC4	M41	SUMIBORON insert
VNGA******HS-NC4	M41	SUMIBORON insert
VNGA******HS-NU2	M40	SUMIBORON insert
VNGA******LS-NC2	M41	SUMIBORON insert
VNGA******LS-NC4	M41	SUMIBORON insert
VNGA******LT-NC2	M41	SUMIBORON insert
VNGA******LT-NU2	M40	SUMIBORON insert
VNGA******NC2	M41	SUMIBORON insert
VNGA******NC4	M41	SUMIBORON insert
VNGA******NU	M40	SUMIBORON insert
VNGA******NU2	M40	SUMIBORON insert
VNGG******LAX/RAX	C57	Indexable insert
VNGG******NEF	C57	Indexable insert
VNGG******NFV NC4	M41	SUMIBORON insert
VNGG******NLV NC4	M41	SUMIBORON insert
VNGG******NSU	C57	Indexable insert
VNGM******NLV NU2	M42	SUMIBORON insert
VNMA******	C55	Indexable insert
VNMA******	M42	SUMIBORON insert
VNMA******NU	M42	SUMIBORON insert
VNMA******NS	M42	SUMIBORON insert
VNMA******NF	M42	SUMIDIA insert
VNMA******RH	M42, M45	SUMIDIA insert
VNMG******NEF	C55	Indexable insert
VNMG******NEG	C56	Indexable insert
VNMG******NEX	C56	Indexable insert
VNMG******NFA	C55	Indexable insert
VNMG******NFB	C55	Indexable insert
VNMG******NFE	C55	Indexable insert
VNMG******NFL	C55	Indexable insert
VNMG******NGE	C56	Indexable insert
VNMG******NGU	C56	Indexable insert
VNMG******NGZ	C57	Indexable insert
VNMG******NLU	C55	Indexable insert
VNMG******NSE	C56	Indexable insert
VNMG******NSU	C56	Indexable insert
VNMG******NSX	C56	Indexable insert
VNMG******NUG	C56	Indexable insert
VNMG******NUP	C57	Indexable insert
VNMG******NUX	C57	Indexable insert
VNMG******NUZ	C57	Indexable insert
VNMX******	M42	SUMIDIA insert
VNMX******NF	M42	SUMIDIA insert
VNS****	P6	Spare parts
VP**	P7	Spare parts
VP**B	P7	Spare parts

W

WAS******.	K66	Eccentric sleeve
WAX****E**	H62, H63	Indexable endmill
WAX****EL**	H62, H63	Indexable endmill
WAX****RS	G72, G73	Cutter
WB*-**	P4	Spare parts
WB*-**T	P4	Spare parts
WB*F-**T	P4	Spare parts
WB*-**TL	P4	Spare parts
WB*F-**TL	P4	Spare parts
WB*R-**T	P4	Spare parts
WBGT******LFW/RFW	C94	Indexable insert
WBGT******LFX/RFX	C94	Indexable insert
WBGT******LFY/RFY	C94	Indexable insert
WBGT******LW/RW	C94	Indexable insert
WBMF****L	H73	Indexable endmill
WBMF****M	H73	Indexable endmill
WBMF****MM**N	H73	Indexable endmill
WBMF****S	H73	Indexable endmill
WBMR****LL	H71	Indexable endmill
WBMR****LLW	H71	Indexable endmill
WBMR****M	H71	Indexable endmill
WBMR****MW	H71	Indexable endmill
WBMR****S	H71	Indexable endmill
WCFH**-*	F58, F59	Tool holder

WCFN/R/L*	F57, F60	Indexable insert
WCFN/R/L*A	F57, F60	Indexable insert
WCFN/R/L*B	F57, F60	Indexable insert
WCFN/R/L*T	F57, F60	Indexable insert
WCFN*GF	F57, F60	Indexable insert
WCFN*GG	F57, F60	Indexable insert
WCF R/L*CF	F57,	Indexable insert
WCFS R/L **-*	F59	Tool holder
WDMT****ZDTR	G67, H11, H12	Indexable insert
WDMT****ZDTR-H	G67, H11, H12	Indexable insert
WDX***D2S**	K56	Multi-drill
WDX***D3S**	K58	Multi-drill
WDX***D4S**	K60	Multi-drill
WDX***D5S**	K62	Multi-drill
WDXT******-G	K57, K59, K61, K63, K67	Indexable insert
WDXT******-H	K57, K59, K61, K63, K67	Indexable insert
WDXT******-L	K57, K59, K61, K63, K67	Indexable insert
WDXT******-M	K57, K59, K61, K63	Indexable insert
WEX****E	H56, H57, H58	Indexable endmill
WEX****E**	H58	Indexable endmill
WEX****EL	H56, H57, H58	Indexable endmill
WEX****EL**	H56, H57	Indexable endmill
WEX****EL**Z*	H57	Indexable endmill
WEX****EW	H57, H58	Indexable endmill
WEX****F	G58	Cutter
WEX****M**Z*	H57, H58,	Indexable endmill
WEZ*****E**	G40, H26, H30, H36,	Indexable endmill
WEZ*****E****	G40, H26, H30, H36,	Indexable endmill
WEZ*****EL**	G40, H26, H34, H40,	Indexable endmill
WEZ*****ES****	G40, H26, H32, H38,	Indexable endmill
WEZ*****M****Z*	G40, H26, H46, H48	Indexable endmill
WEZ*****R**	G40, G44, G46, H26	Cutter
WEZ*****RS**	G40, G44, G46, H26	Cutter
WEZR*****E****Z**	G40, H26, H42, H44	Indexable endmill
WEZR*****M****Z*	G40, H26, H50, H52	Indexable endmill
WEZR*****RS****Z**	G40, G54, G56, H26	Cutter
WFX*****E	G26, H18, H19	Indexable endmill
WFX*****R	G26	Cutter
WFX*****E **	H18	Indexable endmill
WFXF*****E	G26, H19	Indexable endmill
WFXM*****E	G26, H18	Indexable endmill
WFX*****M	G26	Indexable endmill
WFX*****M**Z*	H18, H58	Indexable endmill
WFX*****RS	G26, G28, G29	Cutter
WFXC*****E	G26, H78, H79	Indexable endmill
WFXC*****M	G26, H80	Indexable endmill
WFXF*****R	G26	Cutter
WFXF*****RS	G26, G28, G29	Cutter
WFXH*****M	G26, H14	Indexable endmill
WFXH*****M**Z*	H15	Indexable endmill
WFXH*****RS	G26, G70, G71	Cutter
WFXH*****RSZ6	G70	Cutter
WFXM*****R	G26	Cutter
WFXM*****RS	G26, G28	Cutter
WFXS*R	P6	Spare parts
WGCS**R	P6	Spare parts
WGX*****EW	H7	Indexable endmill
WGX*****RS	G10	Cutter
WGXF*****RS	G10	Cutter
WGXM*****RS	G10	Cutter
WNGA******HS-NC6	M43	SUMIBORON insert
WNGA******LS-NC3	M43	SUMIBORON insert
WNGA******LS-NC6	M43	SUMIBORON insert
WNGA******LT-NC3	M43	SUMIBORON insert
WNGA******NC6	M43	SUMIBORON insert
WNGA******NC-WG6	M43	SUMIBORON insert
WNGA******NC-WH6	M43	SUMIBORON insert
WNGG******NSU	C60	Indexable insert
WNMA******	C62	Indexable insert
WNMA******NU	M43	SUMIBORON insert
WNMG******NEF	C59	Indexable insert
WNMG******NEG	C60	Indexable insert
WNMG******NEM	C60	Indexable insert
WNMG******NEX	C60	Indexable insert
WNMG******NFA	C58	Indexable insert
WNMG******NFB	C58	Indexable insert
WNMG******NFE	C58	Indexable insert
WNMG******NFL	C58	Indexable insert
WNMG******NGE	C60	Indexable insert
WNMG******NGU	C59	Indexable insert
WNMG******NGU-W	C59	Indexable insert
WNMG******NGZ	C61	Indexable insert
WNMG******NLU	C58	Indexable insert
WNMG******NLU-W	C58	Indexable insert
WNMG******NME	C61	Indexable insert
WNMG******NMU	C61	Indexable insert
WNMG******NMX	C61	Indexable insert
WNMG******NSE	C59	Indexable insert
WNMG******NSE-W	C59	Indexable insert
WNMG******NSU	C59	Indexable insert
WNMG******NSX	C59	Indexable insert
WNMG******NUG	C60	Indexable insert
WNMG******NUP	C60	Indexable insert
WNMG******NUX	C61	Indexable insert
WNMG******NUZ	C61	Indexable insert
WNMM******NHG	C62	Indexable insert
WNMM******NMP	C62	Indexable insert
WNMU****ZNER-G	G66, H8, H9	Indexable insert
WNMU****ZNER-H	G66, H8, H9	Indexable insert
WNS****	P6	Spare parts
WNS****B	P6	Spare parts
WPMT******NLB	C95	Indexable insert
WRCX*****EL	H74	Indexable endmill
WRCX*****EM	H74	Indexable endmill
WRCX*****ES	H74	Indexable endmill
WRCX*****M**Z*	H75	Indexable endmill
WRCX*****RS	G17	Cutter
WRCXF*****RS	G17	Cutter
WRCXX*****RS	G17	Cutter
WRX****RH **E**	H65, H66	Indexable endmill
WRX****RH **F**	G59	Cutter
WRX****RH **W**	H65, H66	Indexable endmill

Index

X - Z

X		
XCLN R/L ****-***	D27	Tool holder
XEEW****AGER-W	G13	Indexable insert
XEEW****AGER-WR	G11, H7	Indexable insert
XEEW****AGFR-W-NF	G13	Indexable insert
XNEU****ANEN-W	G9, H6	Indexable insert
XNMU****PNER-G	G25, G27, H14, H15	Indexable insert
XNMU****PNER-GS	G25, H17	
XNMU****PNER-H	G25, G27, H14, H15	Indexable insert
XNMU****PNER-L	G25, G27, H14, H15	Indexable insert
XOEW******PDTR-W	G31, H17	Indexable insert
XOEW******PZTR-W	G30, H14	Indexable insert
XOMT*****PEER-E	G61, H69	Indexable insert
XP**	F20	Spare parts
XP**-E	F26, F30	Spare parts
XSBN R/L ****-***	D27	Tool holder

Y		
YE*	P6	Spare parts
YI*	P6	Spare parts

Z		
ZNEX******LE-NC	M44	SUMIBORON insert
ZNEX******LT-NC	M44	SUMIBORON insert
ZNEX******NC	M44	SUMIBORON insert
ZNEX******NU	M44	SUMIBORON insert
ZNMT*******	H71	Indexable insert
ZNMT*******-C	H71	Indexable insert
ZNMT*******-N	H71	Indexable insert
ZNMT*******-S	H71	Indexable insert
ZPGU*******	H73	Indexable insert

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Notes

Target Products	Hazards	Measures
General precautions for cutting tools	The tools have sharp cutting edges. There is a risk of injury if held directly with bare hands.	Always wear protective equipment, such as protective tools when removing the tool from the case or mounting it onto a machine.
	Improper use or incorrect use conditions may cause the tool to breake or scatter, and could cause injury.	Always use protective equipment such as safety covers and protective eyewear. Always use within the scope of the recommended conditions. Refer to the intruction manual, catalogue and other relevant documents.
	The tool could break and fly off if the cutting force increases suddenly because of impact loads or excessive wear and could cause injury.	Always use protective equipment such as safety covers and protective eyewear. Replace the tool at an early stage.
	Very hot chips could scatter or elongated chips could be discharged, and cause injury or burns.	Always use protective equipment such as safety covers and protective eyewear. When removing the chips, always stop the machine, wear protective gloves, and use tools such as nippers or clippers.
	The tool and work materials will become very hot during turning. There is a risk of burn if these are touched directly with bare hands immediately after machining.	Always wear protective equipment such as protective gloves.
	There is a risk of igniting or fires from the sparks generated during turning, or the heat generated from broken pieces and chips.	Do not use in an area where there is a risk of fires or explosions. Always provide fire prevention measures when using water-insoluble turning oil solution.
	When using at a high rotation speed, if the balance including the machine tool holder is poor, the deflection or vibration could cause tool damage and injury.	Always use protective equipment such as safety covers and protective eyewear. Always carry out trial operation, and confirm that there is no deflection, vibration or abnormal noise.
	There is a risk of injury if you touch the burrs formed on the workpiece with bare hands.	Do not touch with bare hands.
General precautions for cutting edge indexable tools	If insert or parts are not properly clamped, they could come off or fly off during turning and cause injury.	Clean the mounting surface and fixing parts free of foreign matter, before mounting the insert. When mounting, use the enclosed spanner and confirm that the insert and parts are securely clamped. Never use parts other than the designated inserts or parts.
	If the parts are tightened excessively with an auxiliary tool such as a pipe, the insert or part could break and come off or fly off.	Do not use auxiliary tools such as pipes. Use the enclosed spanner.
	Using the tool with high-speed rotation is extremely dangerous as the parts or inserts could fly off with the centrifugal force. Pay special attention to safety when handling.	Always use within the scope of the recommended conditions. Refer to the instruction manual, catalog and other relevant documents.
Various cutters and other tools used with rotation	The cutters have very sharp cutting edges. Touching these with bare hands could result in injury.	Always wear protective equipment such as protective gloves.
	Tools could sway or vibrate if the eccentric rotation or balance is poor. There is a risk of injury if they break or fly off.	Keep the rotation speed within the scope of the recommended conditions. Periodically adjust the accuracy and balance of the rotating sections so that eccentric rotation or deflection do not occur because of bearing wear, etc.
Drills	When machining a through hole while rotating the workpiece, a disc-shaped uncut section may fly off at the point of penetration. This disc is sharp and very dangerous.	Always use protective equipment such as safety covers and protective eyewear. Also take measures such as attaching a cover to the chuck section.
	The very small drill has a pointed end, and is very sharp. It could stab or break when directly touched with a finger, and be difficult to remove. The end could fly off if it breaks.	Take special care to safety when handling. Always wear protective gloves and protective eyewear, etc.
Brazing tool	There is a risk of injury if the insert comes off or breaks, etc.	Confirm that the insert is properly brazed before using. Do not use in conditions that could become very hot.
Others	Repeated brazing is dangerous as the insert could break during use.	Do not use an insert that has been repeated brazed as the strength will have dropped.
	Using this product for a purpose other than the designated application can break the machine or tool and is very dangerous.	Observe the designated usage.

Finally,
this brochure describes the basic safety information. For further information, refer to the instruction manual, catalog and other relevant documents for each tool, or contact Sumitomo Electric Hardmetal. Sumitomo Electric Hardmetal will not be held liable for any damage and injuries resulting from changes to the specifications, including alterations and modifications, made without consent from Sumitomo Electric Hardmetal.

Tool Engineering Services

In order to provide a higher level of support and satisfaction for our customers,
Sumitomo Electric Industries has created the Tool Engineering Service system.
We have created several Tool Engineering Centers around the world as bases for this support.
The Tool Engineering Centers provide a wide range of support to assist user manufacturing activities,
with services including training (at the Center), test cuts, technical consulting,
line diagnostics (at the user's site) and tooling proposals.

Tool Engineering Center Locations

Japan

- ▶Itami Tool Engineering Center (**I-TEC**)
- ▶Yokohama Tool Engineering Center (**Y-TEC**)
- ▶Hokkaido Igetalloy Tool Engineering Center (**H-TEC**)
- ▶Tokai Tool Engineering Center (**T-TEC**)
- ▶Kyushu Tool Engineering Center (**K-TEC**)

Overseas

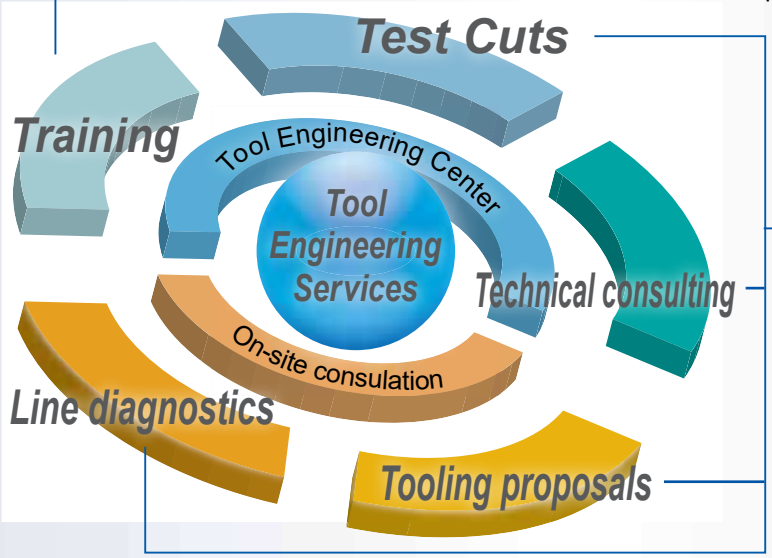
- ▶**Germany / European Design & Engineering Center** (**E-DEC**)
- ▶Thailand / Thailand Tool Engineering Center (**Ti-TEC**)
- ▶Shanghai / Shanghai Tool Engineering Center (**S-TEC**)
- ▶U.S.A. / Americas Tool Engineering Center (**A-TEC**)
- ▶Indonesia / Indonesia Tool Engineering Center (**In-TEC**)
- ▶India Tool Engineering Center

1 Training

To make it easy for anyone to take part, the Centers offer training courses designed for a variety of different training objectives and participants.
*Contact your nearest SEI sales office for detailed training curricula.

2 Performance evaluation technology

To attain improvements in machining on sites, manufacturers must rely on more than just the subjective guidance provided by experience and instinct. Today's advanced measuring instruments can make machining phenomena observable, and clarify problems.



3 Test cuts and technical consulting

The Tool Engineering Centers can make test cuts on user workpieces, and work with users to create more detailed technical proposals. The Centers can also provide solutions to various machining problems, general line diagnostics for machining lines, and tooling support for new lines.
*Contact your nearest SEI sales office for more information.

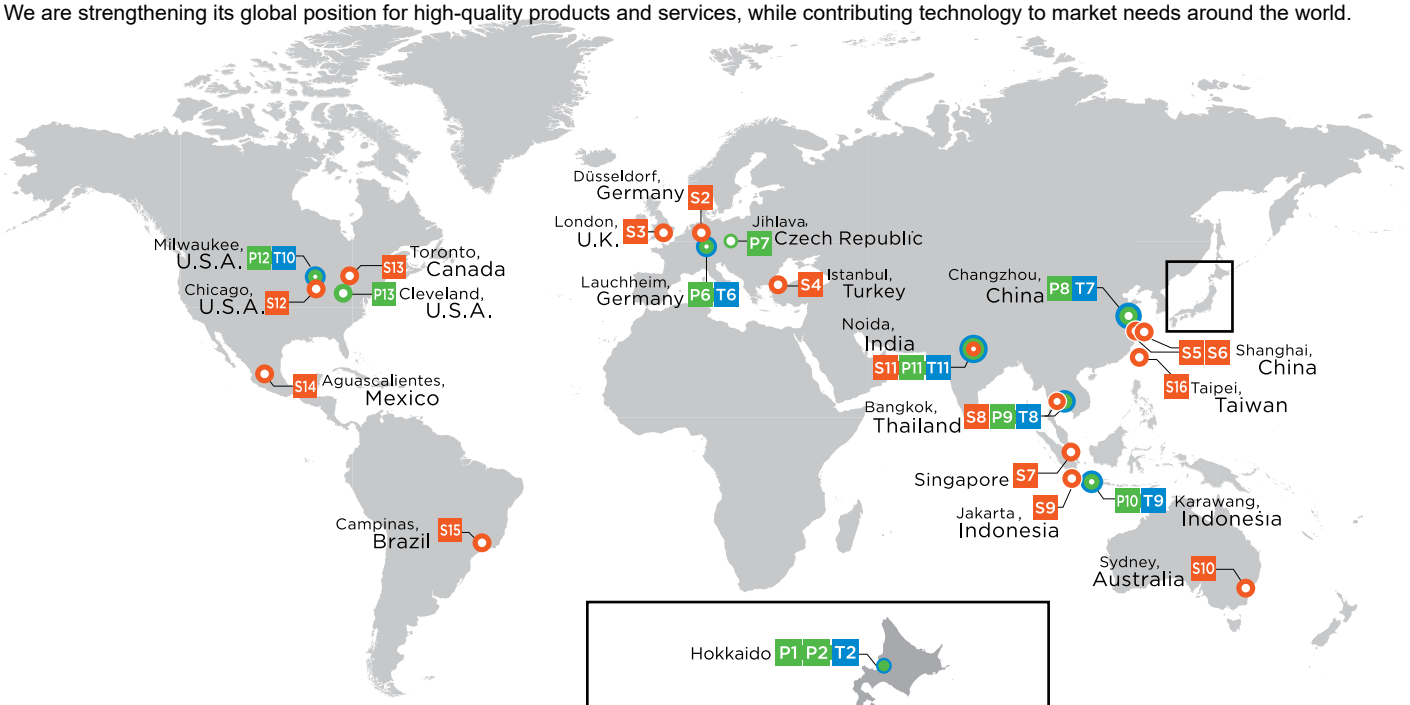
SUMITOMO
CARBIDE - CBN - DIAMOND

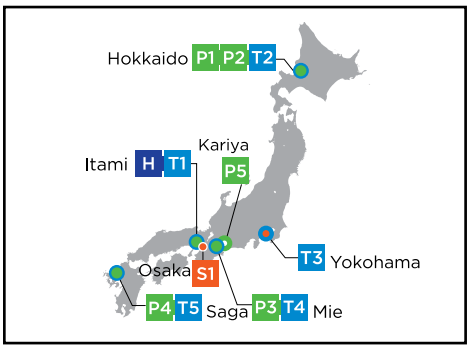
SUMITOMO ELECTRIC

CUTTING TOOLS

WORLDWIDE LOCATIONS

We are strengthening its global position for high-quality products and services, while contributing technology to market needs around the world.





- Sales Network (●)
- Production Network
- Tool Engineering Center

H Sumitomo Electric Industries Ltd. Hardmetal Div.
Sumitomo Electric Hardmetal Corp.

Production Network

P1 Hokkaido Sumiden Precision Co., Ltd.

P2 Hokkaido Precision Tool Co., Ltd.

P3 Tokai Sumiden Precision Tool Co., Ltd.

P4 Kyushu Sumiden Seimitsu Ltd.

P5 Asdex Corporation

P6 Sumitomo Electric Hartmetallfabrik GmbH

P7 Sumitomo Electric Hartmetallfabrik GmbH, organizační složka.

P8 Sumitomo Electric Hardmetal Manufacturing (Changzhou) Co., Ltd

P9 Sumitomo Electric Hardmetal Manufacturing (Thailand), Ltd

P10 PT. Sumiden Hardmetal Manufacturing Indonesia

P11 Motherson Techno Tools Ltd.

P12 Sumitomo Electric Carbide Manufacturing, Inc. (WI)

P13 Sumitomo Electric Carbide Manufacturing, Inc. (OH)