NTK

CUTTING TOOLS

CBN Tooling

8000

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Guidelines for Booklet

- This catalog lists products as of April 2020.
- Please note that specifications of the products listed in this catalog may be changed without notice due to continuous research & development and product improvements.
- This catalog contains the major features and relevant information on all of our products. Please contact our sales representatives or dealers if more detailed information is needed.
- Stock Status Symbols
  - ● : Standard stock available for Right-Hand, Left-Hand and neutral products
  - R : Stock available only in Right-Hand
  - L : Stock available only in Left-Hand
  - ○ : Non stock standard
  - ■ : While stock lasts
  - No symbol : Not stocked
- Please note that this catalog was prepared based on products intended mainly for sale in North and South America.

■ Standard

1) Holder Type	Package quantity	Notes
Turning holder	1 pc/case	
Milling cutter	1 pc/case	
2) Spare parts	**Package quantity**	**Notes**
Screw	10 pcs/case	Clamp screw, Clamp bolt, Double screw, Button screw
Seat	10 pcs/case	Shim seat
Clamp	10 pcs/case	Clamp
Wrench and cutter parts (such as cartridges)	5 pcs/case	Wrench, bit, cutter product
Blade	1 pc/case	
Handle, Hose	1 pc/case	Handle with magnet, handle and bit
3) Insert Type	**Package quantity**	**Notes**
BIDEMICS (Brazed)	1 pc/case	JP2
End mill	1 pc/case	SX9 Ceramic end mill
CBN	1 pc/case	B23, B30, B36, B40, B52, B5K, B6K, B99
PCD, Diamond coating	1 pc/case	PD1, PD2, UC1
CTPW insert for cut-off	5 pcs/case	CTPW series
STICK DUO Solid carbide bar	1 pc/case	SHFS, SHFB, SBFS, SBFB, SBB, SBG, SBT, SSP
All others	10 pcs/case	

＊Packaging may vary depending on the product size.
For more information, please contact your nearest distributor or our sales office.

CONTENTS

Guidelines for CBN

Cubic Boron Nitride (CBN) grades are similar to diamond in hardness characteristics but are less chemically reactive to iron (Fe) and can retain its hardness in temperatures exceeding 1800 deg. F. First introduced in the 1980's, CBN tipped inserts began replacing grinding wheels as the preferred process for machining hardened steels. This was determined to be more efficient and accurate for machining mass produced parts for the automotive industry. Because of CBN's physical characteristics that hold up to cutting hard and abrasive materials its applications now include hardened steels, cast irons, and powdered metals (sintered alloys, heat resistant alloys). CBN's low affinity to iron and high hardness properties deliver superior cutting performance during high speed machining of materials. CBN delivers consistent machining results and long tool life because of its resistance to high cutting temperatures and forces.

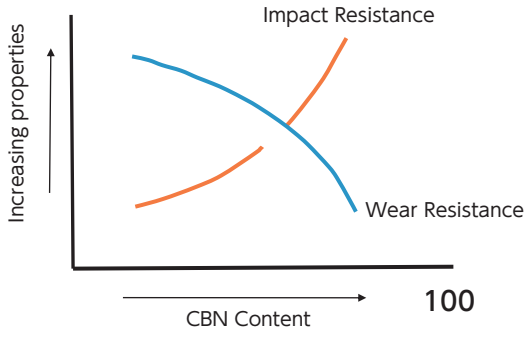
Benefits of using CBN include

- Reduction in equipment cost - Lathes are generally two to three times less expensive than grinding machines
- Increase Production Capacity- Automation of turning machine centers means more parts in less time.
- Save Time- Complicated shapes can be machined in one process by turning the part on a lathe.
- Improved Quality- Turning improves part perpendicularity and concentricity because multiple operations can be performed without re-chucking the part.
- Reduction of Set-Up Time- Simple program changes are needed to machine parts of different sizes.
- Reduction of Industrial Waste- Turning eliminates the expense and environmental problems associated with grinding sludge.

CBN material is difficult to sinter to a substrate so it is necessary to blend it with a binder of metal and ceramic to become PCBN (polycrystalline cubic boron nitride) which allows adhesion to a carbide base to produce CBN tipped inserts; the process consists of pressures over 5GPa and temperatures of 1200 C of higher.

Ceramic binders can contain traces of impurities from the mixing or manufacturing process. The impurities create areas of lower strength and heat resistance than the ceramics and produce points of increased cracking potential. Therefore, it is important when preparing the ceramic binder to create a process that ensures the highest purity. The resulting PCBN insert grades will have significant performance improvements. NTK CBN grades are comprised of high strength cubic boron nitride grains and ceramic binders (TiN or TiCN), which feature outstanding heat resistance.

A grade with higher CBN content results in improved strength and toughness which increases its resistance to breakage.
As CBN content is decreased, its heat resistance is improved and results in a material grade with more wear resistance.



Lower CBN content = Increasing wear resistance

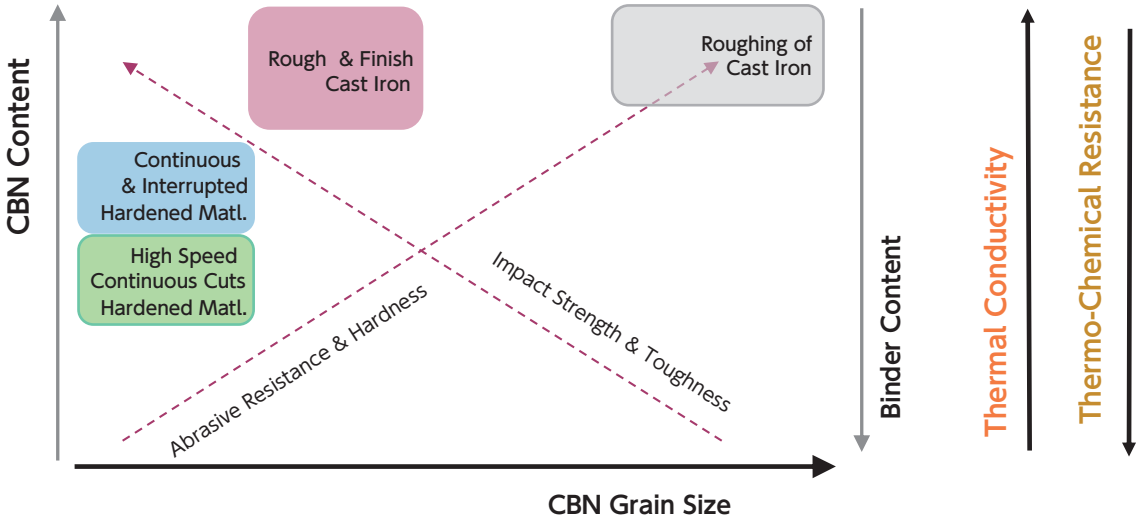
Higher CBN content = Increasing impact resistance

The Right Grade for the Job

The type of machining application will help define the best choice for the CBN grade. The insert selection is one of the first considerations when tooling up for an application. Hard part turning refers to materials at Rockwell hardness 55 Rc and above, and have been heat treated by one of the following: case-hardened, induction hardened, and through-hardened. The different types of steels include: carbon steels, alloy steels, tool steels, and bearing steels. Types of hard irons include: chilled, white, and high chrome irons. The part machining operation will be a semi-finishing or finishing operation. These applications will require an insert with resistance to flank wear. CBN grades excel in roughing and finishing operations because of their excellent resistance to wear and the ability to withstand the destructive effects of high cutting temperatures.

With materials harder than 55 Rc, its carbon content plays a significant role in deciding on the correct grade to apply. Materials with high carbon content will be very abrasive, requiring an insert composed of a high % of CBN and low ceramic binding. This blend will minimize flank wear on the cutting edge but has to be run at slower cutting speeds around 400 SFM to avoid crater wear.

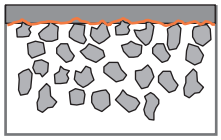
A material with low carbon content will lessen the issue of flank wear. Therefore, the insert composition should have higher ceramic binding content which provides greater resistance to crater wear and enables the insert to be run at higher speeds of around 600 SFM.



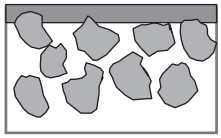
Machining hardened steel and hard materials requires the consideration of certain conditions to ensure the workpiece is cut effectively. The part material characteristics and the CBN grade material characteristics

1. The hardness of the CBN insert ≥ Hardness of the part x 3
   Ex. Hardened steel part at 60 HrC ▶ 700 Hv So the CBN insert is ▶ 3300 Hv

2. The effect of CBN grain size on the surface finish and cutting speed.

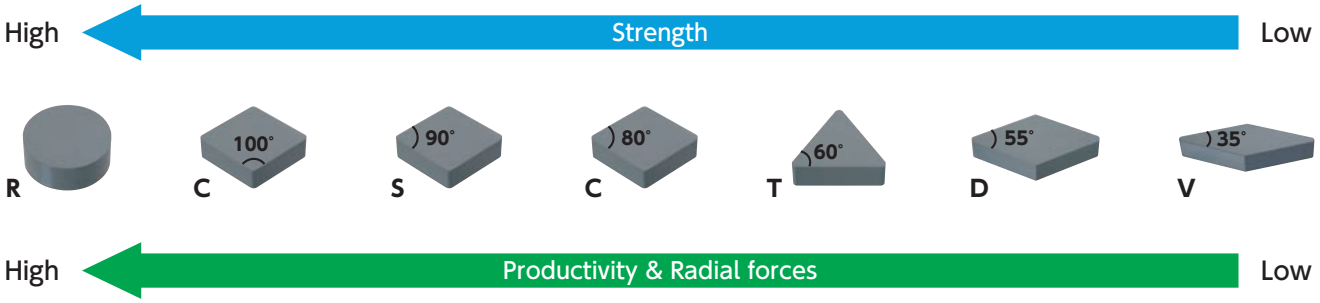


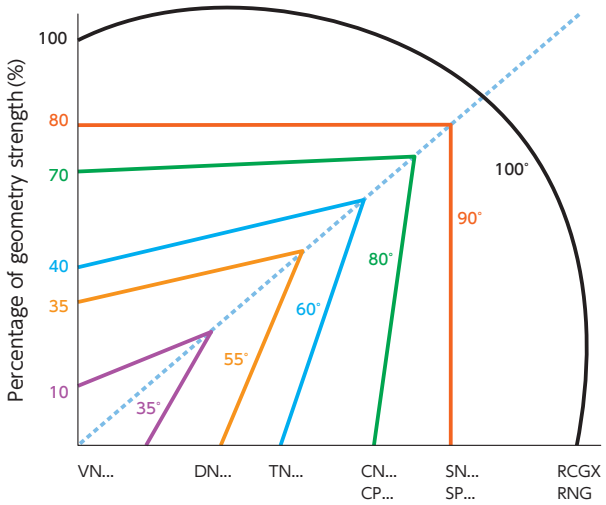
Fine grained CBN — provides a sharp cutting edge and good surface finish



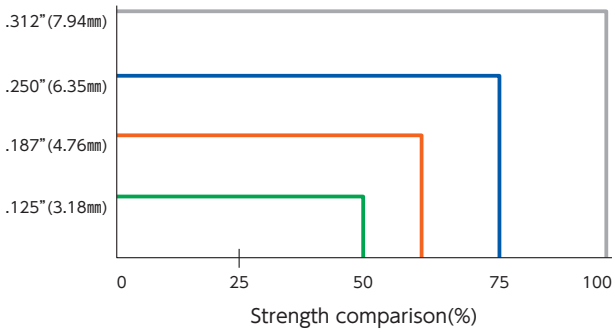
Rough grained CBN — particles hold firmly allowing high speed machining

Guidelines for Insert Selection

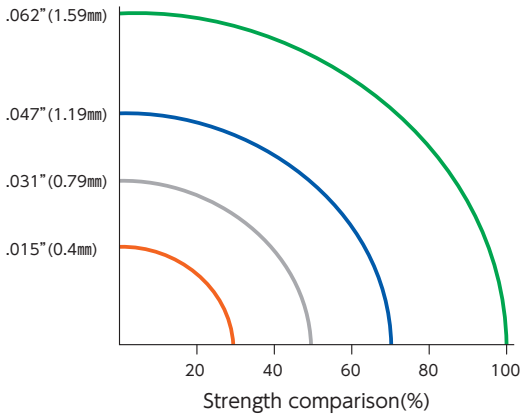




Insert Thickness



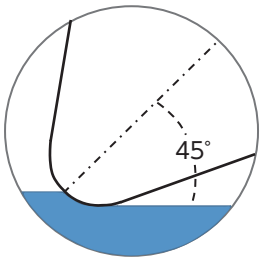
Insert Nose Radius Inches



For the best performance always use the strongest possible insert shape to maximize corner strength and productivity. If the operation allows, it is best to use round inserts or square inserts with a large nose radius and a small entering angle.
Use the largest nose radius possible for the operation, so you increase the strength of the insert which will result in better tool life but remember that this will result in increased tool pressure.
Larger insert thickness gives added strength and integrity during machining offering far better impact resistance, heat dispersion, and longer tool life. This results in higher productivity.

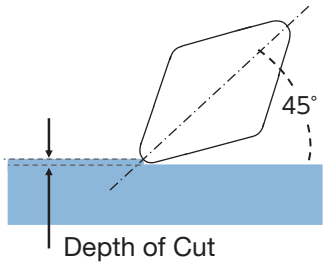
Guidelines for Machining with CBN

Depth of Cut Recommendation based on Insert Corner Radius



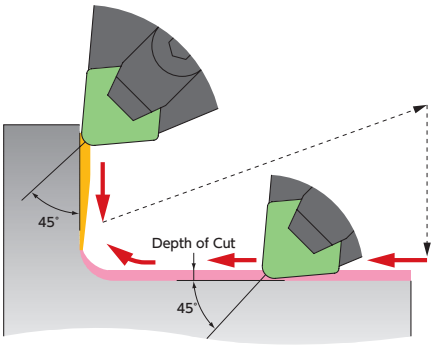
To maximize tool life when using straight-edged inserts (C, D, or S) with corner radii, as opposed to a round insert, the allowable depths of cut are related to the radius and not the insert size. To minimize notching and allow a cut from both directions, the effective machining procedure is to take more material off during the roughing operation, with a round insert. Then the material removal amount for the finishing operation, with a straight edge insert, should be suitable for the nose radius of the insert.

It is important to choose the insert with the appropriate corner radius to complete the finishing operation's depth of cut. If the part has a required radius feature called out, then do not leave more than the amount of material called out for the required insert radius to finish the part and feature. A large corner radius may deflect a part with thin walls because of radial forces generated between the workpiece and insert.



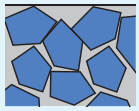
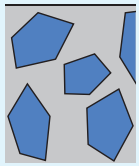
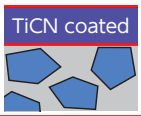
Insert Corner Radius Inch (mm)	Ideal Depth of Cut Inch (mm)	Corner Radius Designation Inch (mm)
.016 (0.38)	.0046 (0.12)	1 (04)
.031 (0.80)	.0092 (0.23)	2 (08)
.047 (1.21)	.0139 (0.35)	3 (12)
.063 (1.59)	.0183 (0.47)	4 (16)
.094 (2.38)	.0275 (0.70)	6 (24)
.125 (3.18)	.0370 (0.93)	8 (32)

Optimum DOC is 5-15% of insert diameter (based on 0 deg. Lead angle)

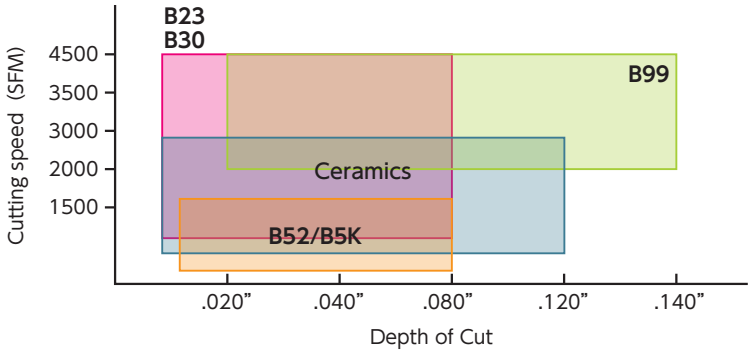


As seen in these photos, by removing the appropriate amount of stock for the nose radius of the insert and staying below the 45° mark of the corner radius notching is minimized allowing a cutting operation to be programmed from both directions on the insert.

CBN Grade Matrix

Grade	Style	CBN Volume	Main Binder	Coating	Applications				
					Cast Iron	Ductile Cast Iron	Hardened Material	Mill Rolls	Powdered Metal
B99(Solid)		**93%**	**AlN**	—	●	○		●	
B23		90%	Ti	—	●				●
B30		95%	Ti	—	●				●
B36		65%	TiCN	—			●		
B40		65%	TiN	—			●		
B52		50%	TiC	—		●	●		
B6K	TiCN coated 	**65%**	**TiCN**	**TiCN**			●		
B5K		**50%**	**TiC**	**TiCN**		●	●		

Gray / Ductile Cast Iron Applications



B99

Features

- *Excellent wear resistance for high-speed cast iron machining*

【 Recommended cutting conditions 】

Grade	Application	Purpose	Cutting speed (SFM)	Feed (IPR)	Depth of cut (inch)	DRY	WET
B99	Turning	Rough Semi finish	2000–4500	.006–.020	.020–.140	●	●

B23

Features

- *Excellent wear resistance due to high CBN content*
- *Ideal for roughing cast iron and machining sintered materials*

【 Recommended cutting conditions 】

Grade	Application	Purpose	Cutting speed (SFM)	Feed (IPR)	Depth of cut (inch)	DRY	WET
B23	Turning	Rough Semi finish	1300–4500	.004–.020	.008–.080	○	●

B52 / B5K

Features

- *Excellent wear resistance due to optimum CBN content with special TiC binders*
- *Ideal for finishing ductile cast iron and continuous cuts for finishing hardened materials*

【 Recommended cutting conditions 】

Grade	Application	Purpose	Cutting speed (SFM)	Feed (IPR)	Depth of cut (inch)	DRY	WET
B52 B5K	Turning	Finish	300–1600	.004–.016	.012–.080	○	●

B30

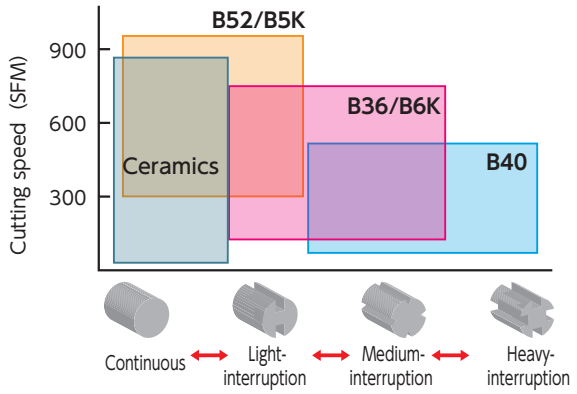
Features

- *Excellent wear resistance due to high CBN content*
- *Designed for finishing cast iron*

【 Recommended cutting conditions 】

Grade	Application	Purpose	Cutting speed (SFM)	Feed (IPR)	Depth of cut (inch)	DRY	WET
B30	Turning	Semi finish Finish	1300–4500	.004–.020	.008–.080	○	●

Hardened Material Applications



B40

Features

- *Exceptional toughness due to special TiN binders*
- *Designed for severely interrupted cutting of hardened materials*

【 Recommended cutting conditions 】

Grade	Application	Purpose	Cutting speed (SFM)	Feed (IPR)	Depth of cut (inch)	DRY	WET
B40	Turning (Heavy interruption)	Rough–Finish	100–500	.002–.008	.004–.040	●	○

B52 / B5K

Features

- *Excellent wear resistance due to optimum CBN content with special TiC binders*
- *Ideal for finishing ductile cast iron and continuous cuts for finishing hardened materials*

【 Recommended cutting conditions 】

Grade	Application	Purpose	Cutting speed (SFM)	Feed (IPR)	Depth of cut (inch)	DRY	WET
B52 B5K	Turning (Continuous / Light interruption)	Rough–Finish	300–1000	.004–.020	.004–.040	○	●

B36 / B6K

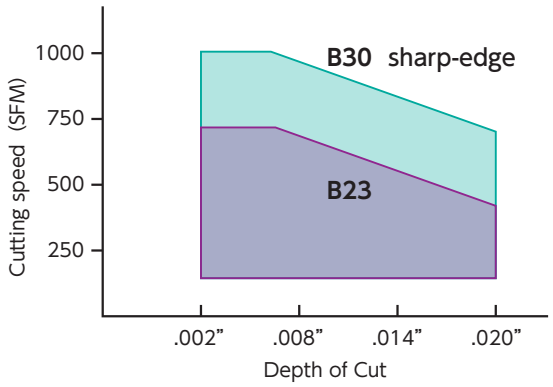
Features

- *Excellent combination of wear resistance and toughness due to special TiCN binders*
- *Best for semi-interrupted cutting of hardened materials*

【 Recommended cutting conditions 】

Grade	Application	Purpose	Cutting speed (SFM)	Feed (IPR)	Depth of cut (inch)	DRY	WET
B36 B6K	Turning (Light interruption / Medium interruption)	Rough–Finish	130–800	.002–.008	.004–.040	●	●

Powdered Metal Applications (sintered alloys / super alloys)



B23

【 Recommended cutting conditions 】

Grade	Application	Purpose	Cutting speed (SFM)	Feed (IPR)	Depth of cut (inch)	DRY	WET
B23	Turning	Rough–Finish	150–750	.001–.008	.002–.020	●	●

B30

【 Recommended cutting conditions 】

Grade	Application	Purpose	Cutting speed (SFM)	Feed (IPR)	Depth of cut (inch)	DRY	WET
B30	Turning	Rough–Finish	150–1000	.001–.008	.002–.020	●	●

Mill Roll Applications

B99

Features

- *Ideal for Mill Roll machining*

【 Recommended cutting conditions 】

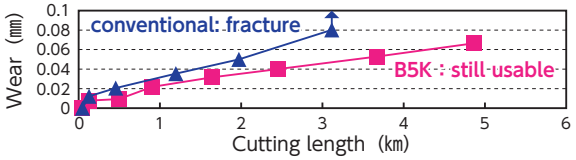
Grade	Application	Purpose	Cutting speed (SFM)	Feed (IPR)	Depth of cut (inch)	DRY	WET
B99	Turning	Rough Semi finish	100–200	.004–.012	.010	●	

CBN Case Studies

Hardened Steel Continuous Cut

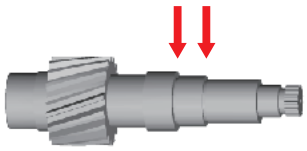
Continuous OD machining of Hardened Steel

Work material : Steel, Carburized & quenched [SCM 415]	Tooling **B5K**
Speed : 656 SFM	
Feed rate : 0.004 IPR	
DOC : .008"	
Coolant : DRY	



Drive-shaft Facing

Material : Steel (HRC58) [SCR420H]	**B52**
Speed : 430 SFM	
Feed : 0.004 IPR	
DOC : .004"	
Coolant : DRY	



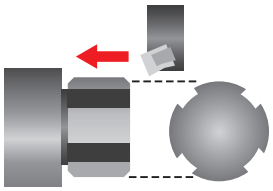
NTK : **B52**	300pcs/corner
Competitor's CBN.	200pcs/corner

B52 has 1.5times longer tool life compare to competitor.

Hardened Steel Interrupted Cut

Automotive part interrupted OD machining

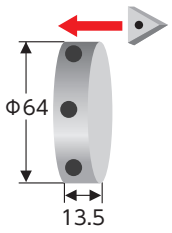
Work material : Steel, Carburized & quenched [SCM 415]	**B6K**
Speed : 250 SFM	
Feed : 0.011 IPR	
DOC : .030"	
Coolant : DRY	



NTK : **B6K**	400pcs
Conventional	150pcs

Machine parts interrupted OD machining

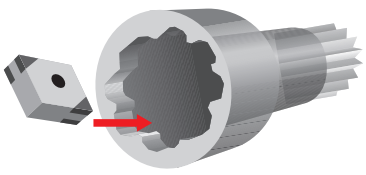
Work material : Carbon Steel(HRC50) quenched Interrupted machining	**B6K**
Speed : 690 ~ 720 SFM	
Feed : 0.003 IPR	
DOC : .008"	
Coolant : WET	



NTK : **B6K**	700pcs
Conventional	400pcs

Automotive parts interrupted boring

Material : Carbon Steel (HRC62)	**B40**
Speed : 360 SFM	
Feed : 0.006 IPR	
DOC : .006"	
Coolant : DRY	

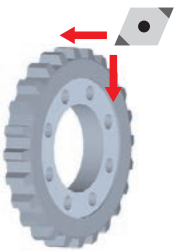


NTK : **B40**	2,300pcs/corner
Competitor's CBN.	1,500pcs/corner

B40 achieved longer tool life without fracture at interrupted machining.

Gear parts coupling external Interrupted OD turning

Material : Carbon Steel (HRC61)	**B40**
Speed : 90 SFM	
Feed : 0.005 IPR	
DOC : .010"	
Coolant : WET	

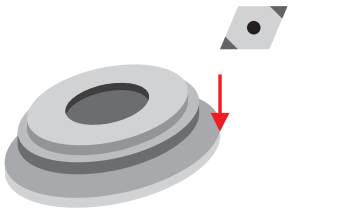


NTK : **B40**	400pcs/corner
Competitor's CBN.	100pcs/corner

Had problems with damage with the interrupted cut, but thanks to B40 which has excellent toughness, tool life became 4 times longer !

Cast Iron

Oil pump Rough OD machining

Material : FC250	**B23**
Speed : 820 SFM	
Feed : .008 IPR	
DOC : .080"	
Coolant : WET	
NTK : **B23**	210pcs/corner
Competitor's CBN.	70pcs/corner

Compared with the competitor's CBN, B23 offered 3 times longer tool life.

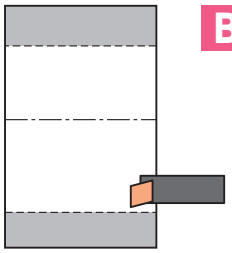
Oil Field - Plunger OD machining

Material : S48C	**B99**
Speed : 450 SFM	
Feed : 0.01 IPR	
DOC : .075"	
Coolant : DRY	
NTK : **B99**	8 pcs

Cut cycle time drastically - no need for grinding process before the turning operation after implementing the RNG43 B99 insert to OD turn part.

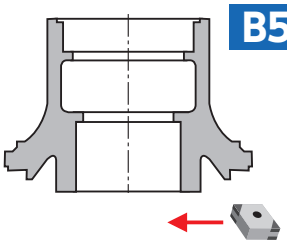
Ductile cast iron (Finish)

ID Boring finish of machine parts

Material : FCD700	**B5K**
Speed : 650 SFM	
Feed : 0.006 IPR	
DOC : .008"	
Coolant : WET	
NTK : **B5K**	12pcs/corner
Competitor's CBN.	6pcs/corner

B5K achieved 2 times longer tool life on this interrupted ID cut.

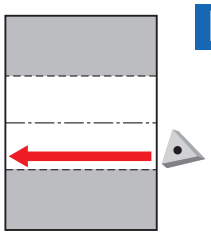
Hub facing

Material : FCD600	**B52**
Speed : 1100 to 1300 SFM	
Feed : 0.003 IPR	
DOC : .008"	
Coolant : WET	
NTK : **B52**	60pcs/corner
Competitor's CBN.	30pcs/corner

B52 achieved 2 times longer tool life compared to competitor's CBN

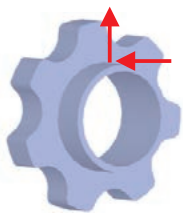
Powdered Metal (Sintered Alloys; Super Alloys)

Machine part internal

Work material : Sintered alloy	**B30**
Speed : 560 SFM	
Feed : 0.004 IPR	
DOC : .006"	
Coolant : DRY	
NTK : **B30**	1500pcs/corner
Competitor's CBN.	1000pcs/corner

B30 has less dimensional change by wear, and 1.5 times longer tool life compared to competition.

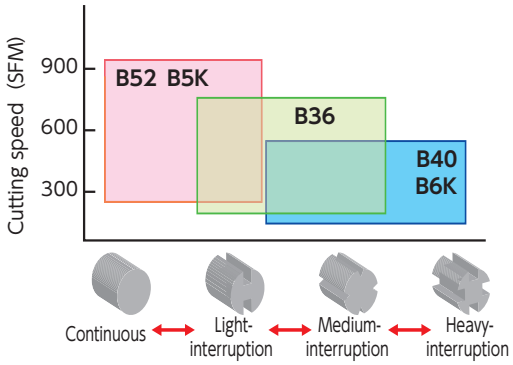
Interrupted OD turning of automotive parts

Work material : Sintered alloy	**B23**
Speed : 650 SFM	
Feed : 0.007 IPR	
DOC : .040"	
Coolant : DRY	
NTK : **B23**	770pcs/corner
Competitor's CBN.	500pcs/corner

B23 has 1.5 times longer tool life compared to competition.

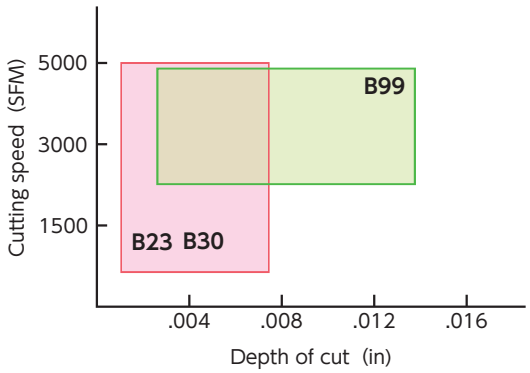
Application Guide

Hardened Steel (Finish)



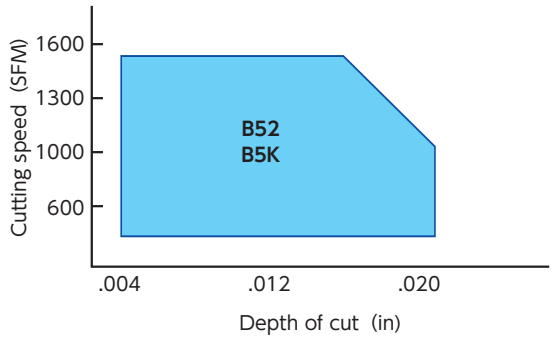
Part Surface Condition	Recommended tool		Speed (SFM)	Feed (IPR)	Depth of cut (in)	Coolant	
	Grade	Edge preparation				DRY	WET
Continuous	**B5K (B52)**	**S0415** SCD	300–1000	~.008	~.020	△	●
Light-interruption Medium-interruption	**B6K (B36)**	**S0525** SXF	240–800	~.006		●	△
Heavy-interruption	**B40**	**S0635** SEH	150–500	~.004		●	△

Gray Cast Iron



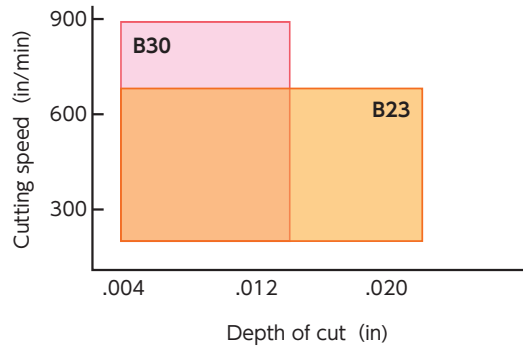
Part Surface Condition	Recommended tool		Cutting (SFM)	Feed (IPR)	Depth of cut (in)	Coolant	
	Grade	Edge preparation				DRY	WET
Continuous	**B30**	**T0420** TCE	1300 to 4000	Up to .020	Up to .080	△	●
Light-interruption Medium-interruption	**B30**	**T0420** TCE				●	△
Heavy-interruption	**B23**	**S0420** SCE				●	△

Ductile Cast Iron (Finish)



Part Surface Condition	Recommended tool		Speed (SFM)	Feed (IPR)	Depth of cut (in)	Coolant	
	Grade	Edge preparation				DRY	WET
Continuous	**B5K (B52)**	**S0415** SCD	300 to 1500	Up To .015	Up To .020	●	△
Light-interruption Medium-interruption	**B5K (B52)**	**S0525** SXF				●	△
Heavy-interruption	**B5K (B52)**	**S0635** SEH				●	△

Powdered Metal (Sintered alloy / Super alloy)



Part Surface Condition	Recommended tool		Cutting (in/min)	Feed (in/rev)	Depth of cut (in)	Coolant	
	Grade	Edge preparation				DRY	WET
Continuous	**B30**	**T0420** TCE	130 to 1000	Up to 0.020	Up to 0.020	△	●
Light-interruption Medium-interruption	**B30**	**T0420** TCE				△	●
Heavy-interruption	**B23**	**S0420** SCE				△	●

● First choice △ Second choice

Grade Recommendations Based on Material

Hard Materials: These include low and medium carbon steels hardened between 45 and 62 Rc. It also includes manganese steel, although it is a softer material.					
Hard Steels	Continuous to light interruption			Heavy Interrupted Machining	
		1st choice	2nd choice		1st choice
Bearing Steels	X	B52	B5K	X	B40
Case Hardened Steels	X	B36	B6K	X	B40
Cold Work Tool Steels	X	B36	B6K	X	B40
High Speed Steels	X	B36	B6K		
High Tensile Steels	X	B52	B36	X	B40
Hot work Tool Steels	X	B52	B5K	X	B40
Manganese Steels (a softer matl.)	X	B36	B30	X	B40
Martensitic Stainless Steel	X	B23	B30	X	B40
Powder Tool Steels	X	B23	B30		

Hard Irons	Continuous to light interruption			Heavy Interrupted Machining	
		1st choice	2nd choice		1st choice
Chilled Irons	X	B99	B30	X	B23
White Irons	X	B99	B30	X	B23
High Chrome Irons	X	B30	B99	X	B23

Soft and Abrasive material: These materials include soft but very abrasive materials. Hardness levels are usually around 200 HB.					
Soft Irons	Continuous to light interruption			Heavy Interrupted Machining	
		1st choice	2nd choice		1st choice
Grey Cast Irons	X	B23	B99	X	B23
Compacted Graphite Irons	X	B23	B30	X	B23
Ductile Irons	X	B52	B30	X	B23

Ferrous Powdered Metal Materials: These include sintered powdered metals that have a hardness level range of 20 to 60Rc and are very abrasive					
Sintered Powdered Metals	Continuous to light interruption			Heavy Interrupted Machining	
		1st choice	2nd choice		1st choice
Powdered Metallurgy alloys	X	B23	B30	X	B23
Valve Seat Materials	X	B52	B30	X	B23

Difficult to Machine Materials: These include other materials that can be machined success-fully.					
Others	Continuous to light interruption			Heavy Interrupted Machining	
		1st choice	2nd choice		1st choice
Hard facing alloys	X	B36	B30	X	B30
Nickel based superalloys	X	B23	B30	(Not Cr-based)	B30
Tungsten Carbides	X	B99	B30	X	B30

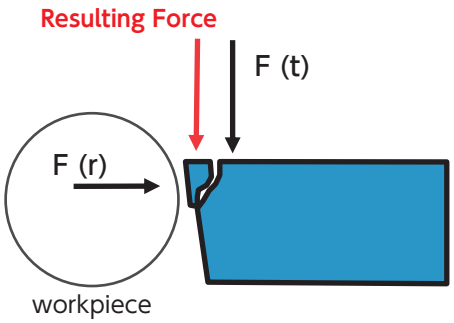
Guidelines for Edge Preparation

Selecting the appropriate Edge Preparations

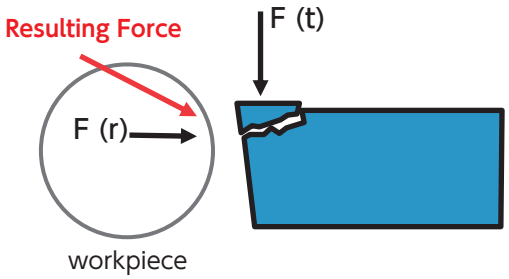
CBN insert performance is dependent upon the machining speed and the insert edge preparation. The appropriate edge condition depends on the application. It is best to use inserts with a honed and chamfered edge preparation, especially for interrupted cuts. A chamfer with a hone provides a strong edge for machining hardened steels and irons. It is ideal to have the cutting forces directed into the body of the insert (between tangential, axial and radial) this is achieved with a negative insert that has a chamfer and hone edge condition (P, S, Z style). If the forces are not balanced the insert will experience chipping and flaking. In cases requiring additional strength select an insert with a large nose radius.

Importance of edge preparation

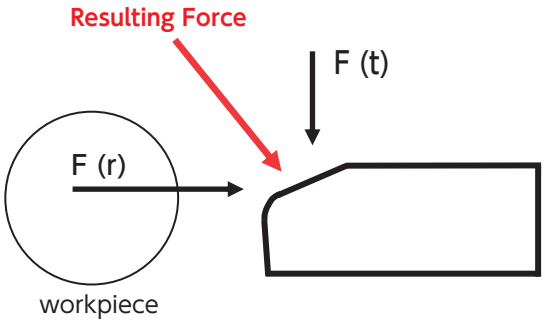
A combination of a high tangential force and a sharp insert edge can result in edge breakage. This is due to unbalanced radial and tangential forces. An example, at tool path entry or during interrupted cutting, all the pressure is directed into the top of the insert. This increases the risk of chipping.



A combination of high radial forces and a sharp insert edge can result in edge flaking. An example, If the feed rate is too high, the force generated will overpower the insert and cause flaking to occur.



This insert is placed in compression with the addition of a chamfer on the edge reducing the chances of breaking or flaking. Radial and tangential forces are balanced to provide the best tool life. The resulting force is directed into the body of the insert ; and is achieved with a negative insert geometry with a chamfer and hone for the edge preparation.



Standard edge preparations are applicable to general applications, but sometimes conditions require special edge preparations to be manufactured. It is important to understand the effect of edge preparations for the work materials.
Example: to finish a part made of pearlitic gray cast iron requires a cutting edge that is fairly forgiving, although extremely abrasive the material hardness is low compared to hardened steels. Inserts are manufactured with optimum cutting edge preparations for the grade and geometries in order to avoid cutting edge fracture caused by heavy loads generated during the machining of hardened steel.

Geometries recommended:

Strong cutting edge geometries are always preferred to reduce the chances for edge chipping.

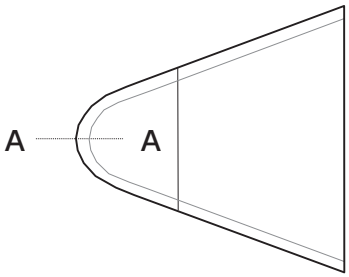
- Negative style inserts
- Chamfered + hone edge preparation
- Big nose radius

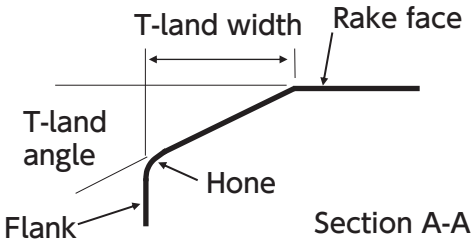
Will produce increased cutting forces, temperatures and the possibility of tool/workpiece deflection.

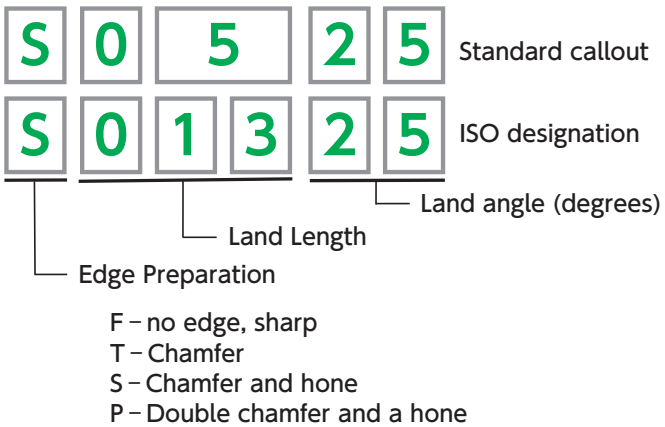
Sharp positive or neutral insert geometries can be utilized when:

- Finishing small boring applications in hardened materials without interruptions
- Finishing unstable components without interruptions
- Finishing gray cast iron parts

This style will produce lower cutting forces, temperatures, and tool/workpiece deflection.
It is important to remember that this edge will be weaker and therefore less resistant to impacts and cutting forces.







Guidelines for Edge Preparation

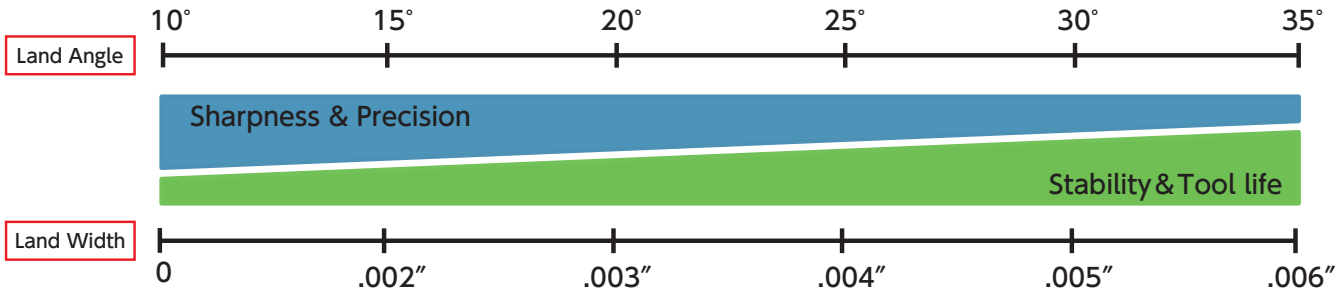
Selecting the Appropriate Edge Preparation:

To achieve success machining with CBN it is important to consider the edge preparation and insert geometry to suite the application. The insert selected must correspond to the CBN grade, the type of material being machined and the operation being performed. PCBN is the second hardest cutting tool material and is relatively brittle compared to tungsten carbide. CBN materials behave similar to ceramics which means geometry and edge preparation are key to machining success. Tool geometry is critical to the success or failure of the application. The range of applications for CBN products place different demands on the insert and creates a relatively small window for optimal performance.

The strength of the cutting edge on CBN inserts increases as the chamfer angle and width increases but with this geometry comes higher cutting forces and temperatures. A large chamfer spreads the forces over a larger area and provides a more durable cutting edge allowing for higher machining feed rates. This larger edge preparation can be applied when process stability and consistent tool life are important to the manufacturer.

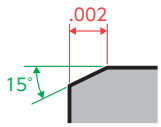
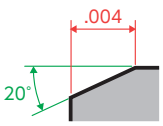
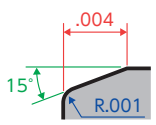
If the surface finish and part dimensioning and tolerances are key requirements then a smaller chamfer will be the best solution. The forces and temperatures will be reduced and vibration will be minimal. In cases where surface finish is critical, then a sharp edge is ideal but will reduce the insert tool life.

It is important to determine the appropriate edge preparation to manufacture quality parts, provide a stable machining process and good tool life.

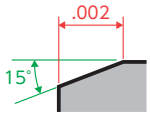
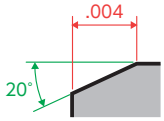
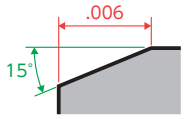
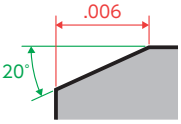


Edge Preparation

Edge Sharpness

Part Specification : FNX Edge : Sharp edge	Edge specification : T0215 Part number : TBD	Edge specification : T0420 Part number : TCE	Edge specification : S0415 Part number : SCD
			

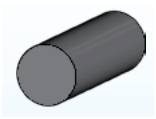
Edge Sharpness

Edge specification : T0215 Part number : TCD	Edge specification : T0420 Part number : TCE	Edge specification : T0615 Part number : TED	Edge specification : T0620 Part number : TEE
			

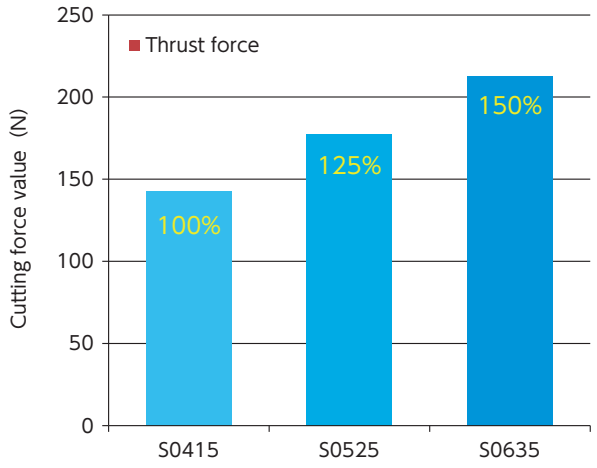
Performance comparison by edge preparatrion

Cutting force

Material : Alloy Steel (HRC63-65)
[SCM415]
Insert : TNGA 332
Parameters : SPEED : 650 SFM
FEED : 0.004 IPR
DOC : .008"
DRY



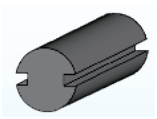
Continuous cutting



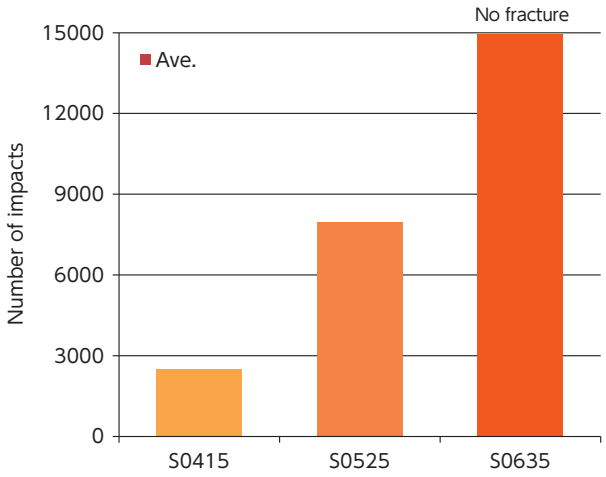
As the edge preparation gets larger the cutting force on the insert edge goes up.

Fracture resistance

Material : Alloy Steel (HRC63-65)
[SCM415]
Insert : TNGA 332
Parameters : SPEED : 250 SFM
FEED : 0.004 IPR
DOC : .012"
DRY

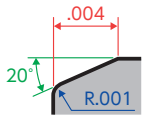
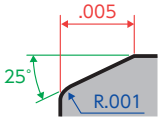
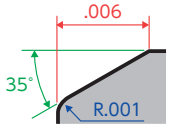


Heavy Interrupted cutting

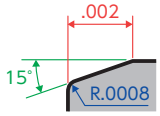
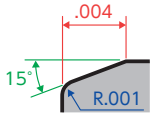
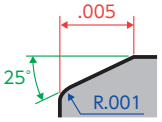
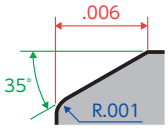


There is a direct correlation between an increase in the edge preparation and improvement of insert fracture resistance.

Edge Strength

Edge specification : S0420 Part number : SCE	Edge specification : S0525 Part number : SXF	Edge specification : S0635 Part number : SEH
		

Edge Strength

Edge specification : Z 0215 Part number : ZCD	Edge specification : S0415 Part number : SCD	Edge specification : S0525 Part number : SXF	Edge specification : S0635 Part number : SEH
			

Guidelines for Turning with CBN

Turning with CBN Inserts

CBN's should not be used for machining easy to cut materials. Applications should include hardened steels, cast irons and tough super alloys

Tool Overhang
Use a rigid machine that is capable of obtaining the optimal conditions for CBN inserts and minimize the tool overhang. Too much overhang causes the holder to deflect resulting in vibration and chatter which can lead to insert breakage. When working with turret style machines, straight edged inserts should be used to eliminate radial tool forces and chatter issues. Stop the cut immediately if chatter is heard. It is an indication that the tool edge is dull or the setup isn't rigid enough.

Toolholder angles and positioning
Angles are built into the holders and include inclination angle, rake angles, and entry angle. Centerline height of the holder is important in hard turning. The position is more critical as the part diameter to machine becomes smaller. The tool should be on-center to slightly below center. For boring applications it is best to set the tool on center or slightly above, because cutting deflection will lower the effective centerline.

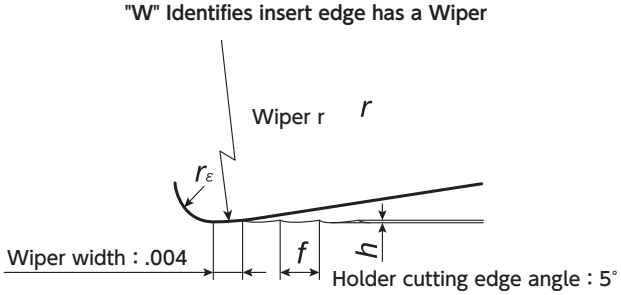
Chamfer the edge of the workpiece to minimize burr formations on the part and to reduce the potential of the insert chipping or breaking upon entry or exit point of work material.

Coolant:
For Continuous cut operations coolant does not have a significant effect on the rate at which the tool wears. The only exceptions are machining tungsten carbide and Inconel with CBN, coolant is recommended. Even though coolant does not influence flank wear, it can be beneficial for controlling temperature and removing chips during the cutting process. Coolant can be a benefit when crater wear is an issue.

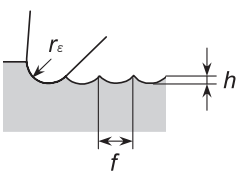
Inserts:
As a general rule there is no need to select a larger insert than necessary. This is especially true when using solid inserts, since they have more edges and are often more cost effective than tipped styles. The insert shape should be selected based on the entry angle required verses requirements of accessibility and versatility. The largest possible insert geometry should be selected for improved strength and economy.

Radius:
The size of the corner radius is an important aspect and impacts the strength of the edge. One step up in size of the radius is equivalent to one step of an increase in grade toughness. This should be considered when determining insert material hardness and wear resistance.

Wiper style inserts:
These inserts are designed with a flat feature that is situated where the straight edge meets the corner radius. Applying an insert with a wiper achieves superior surface finishes when maintaining machining conditions run with a conventional insert. If the feed rates are increased, then a consistent surface finish can be maintained, while lowering machine time. The high feed rate also prevents rubbing, delaying the progression of wear and increasing tool life.



In Normal corner radius

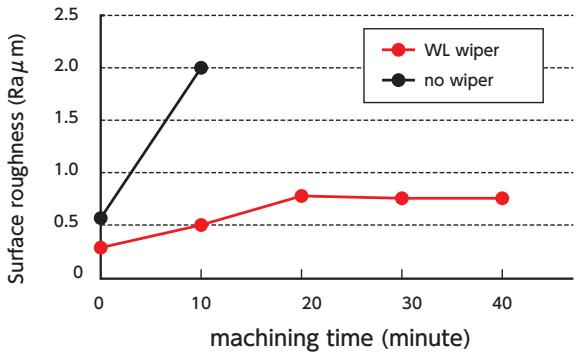


$$h_{(\mu m)} = \frac{f^2}{8\,r_\varepsilon} \times 1000$$

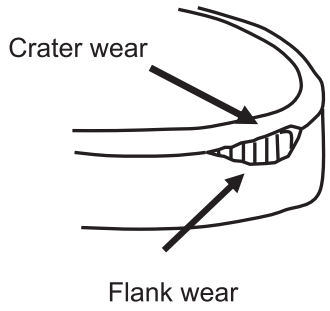
h : Theoretical surface roughness (μm)
f : Feed (mm/rev)
r_ε : Corner radius (mm)

Effect of Wiper Flat on Cutting Edge

CNGA433PQW 320SFM 004IPR 020doc



In most PCBN machining operations where tool life is consistent the cutting edge will wear with a combination of flank wear and crater wear. So it is important to determine the proper machining parameters which will ensure this balanced wear condition. The correct parameters will depend on the part material, the machining operation, and the CBN grade. The cutting edge of an insert is subjected to a combination of high stress, temperatures and even chemical reactions which cause tool wear. The mechanics depends on the tool, workpiece material, cutting geometry, environment, and mechanical and thermal loads. The common results are crater wear, flank wear, notching thermal shock, nose wear, chipping, breakage, and built up edge.



A good balance would be to see a 50 / 50 combination of crater wear and flank wear

Crater wear and flank wear are typical during a finishing operation and are the most common during the metal removal process.

Crater wear is mainly caused by physical, chemical, and/or thermal interactions between the insert face and the chip generated during the machining operation. This wear is due to extremely high temperatures and the forces at the point of contact. A crater is the result of dissolution of the tool material into the chip. The development weakens the cutting edge and leads to inconsistent tool life.

Adhesion is due to micro-welding of the material (chip) to the insert, abrasion of embedded particles on the insert and a reaction between the tool face and the chip.

Flank wear occurs primarily by rubbing of the insert flank face against the workpiece surface and can be minimized by increasing the insert hardness with elevated machining temperatures. It is more common at lower cutting speeds and when machining more abrasive steels.

Material	Hardened Steels H	Powdered Metal Materials P	Gray & Hard Cast Irons K	Superalloys S
Machining Characteristics	Heat and Hardness	Abrasive wear with heat	Abrasive wear with low heat	High heat with low hardness
Issues	Largest group of applications with largest variety of machining operations (from workpiece shape, steels, cutting parameters)	Powdered metal components replacing Cast and forged parts. Difficult to machine valve seat alloys	Hard cast irons are typical applications for CBN Parts: Brake discs and engine blocks	Relatively small amount of applications
CBN Solution	A variety of grades available to cover continuous (H01) cuts to heavy interruptions (H30) 40-70% CBN content Tipped negative geometry inserts	Typically high CBN content tipped insert grades. Low to moderate CBN content grades used on valve seat parts	Most frequently high CBN solid inserts. High CBN grades particularly for positive tools—milling	Low to moderate CBN content grades have been successful

Guidelines for Turning with CBN

Turning with CBN Inserts - Parameters to Consider

About 80% of the heat from cutting should be carried away by the chip, if the parameters are incorrect heat build up on the cutting edge will reduce tool life. It is important to properly apply the speeds and feeds to the application.

Cutting Speed:

CBN is a hard and wear resistant material which needs heat to perform. The largest influence on the rate of flank and crater wear is the speed (SFM). Increasing the cutting speed will increase crater wear while reducing flank wear. Eventually, the edge will reach a point were chipping or flaking will become too great to continue machining.
Tool life is finished when either part dimensioning and tolerances are no longer achieved and the cutting edge is no longer efficient.

Feed Rates:

Often feed selection is based on chip control, power limitations, and surface demands. Impact load at entry (when the insert is cold), at exits, and operations machining up to a shoulder can sometimes result in edge breakage. Utilizing feed adjustments can improve tool life. The idea is to reduce the feed rate when entering and exiting the cut. When the radius is in full contact with the part, maximum feed for the operation can be initiated.
When turning to a shoulder it is beneficial to reduce the feed in order to limit the impact from chip packing and insert overload.

Depth of Cut:

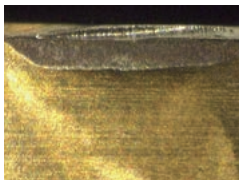
To finish hard materials one or two cuts will be necessary, depending on the heat treatment distortion. If two cuts are needed, the first cut removes the black surface and the second cut achieves the final dimensions and tolerances. It is common to divide the total remaining material in two for two equal DOC passes. The tool wear will be very localized, the chip contact is at the same location on the insert for every part being machined. To extend tool life, it is beneficial to vary the DOC to spread the wear on the insert cutting edge.

The effect of machining parameters on material surface and subsurface stresses		
By Increasing:		The Increase Impacts the Part with an:
Cutting Speed	→	Increase of compressive stresses
Feed rate	→	Increase of compressive stresses
Corner radius	→	Decrease of compressive stresses
Edge hone	→	Increase of compressive stresses
Edge chamfer angle	→	Increase of compressive stresses
Depth of cut	→	No effect
Tool flank wear	→	Increase of formation of a white layer and therefore increased tensile stresses at the surface
	→	Increased of compressive stresses in the subsurface

Troubleshooting

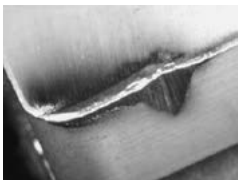
CBN Application		
Problem	Cause	Suggested Action
Poor Surface Quality	Vibration	Check rigidity of tool & set-up
	Too High Feed	Lower feed rate, increase nose radius or change to wiper
	Too Sharp Insert	Increase chamfer angle
	Wrong Grade	Choose finer grain size
Premature Wear	Wrong Speed	Increase speed
	Too sharp of Insert	Increase chamfer angle
	Wrong Grade	Choose finer grain size
Vibration	Poor set-up	Check rigidity of tool & set-up
	Too Light Feed	Increase feed / of DOC
	Too much Pressure	Choose more positive insert geometry / cutting edge angle
	Improper Edge Prep	Reduce chamfer angle
	Too much Pressure	Reduce nose radius

Flank Wear



- Increase cutting speed
- Increase feed rate
- Increase DOC
- Check tool centerline height
- Check material's iron content

Notch Wear

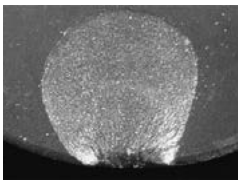


- Increase cutting speed
- Reduce feed rate
- Increase insert approach angle (with a round insert)
- Vary the DOC
- Use insert with chamfered edge

Crater Wear

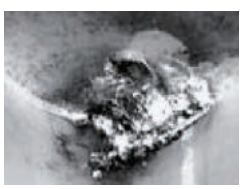
- Reduce cutting speed
- Reduce feed rate
- Reduce insert chamfer angle
- Use sharp edge condition
- Use coated insert
- Use coolant (continuous cuts only)

Rake Face flaking



- Reduce feed and speed
- Consider coolant as factor
- Use insert with larger edge prep: chamfer + hone edge
- Increase cutting edge
- Check tool centerline height
- Reduce insert approach angle

Catastrophic edge breakage



- Reduce DOC (reduce insert load)
- Reduce cutting speed
- Increase nose radius (if possible use round insert)
- Use insert with chamfer + hone
- Check centerline height
- Check condition of holder

Edge Chipping

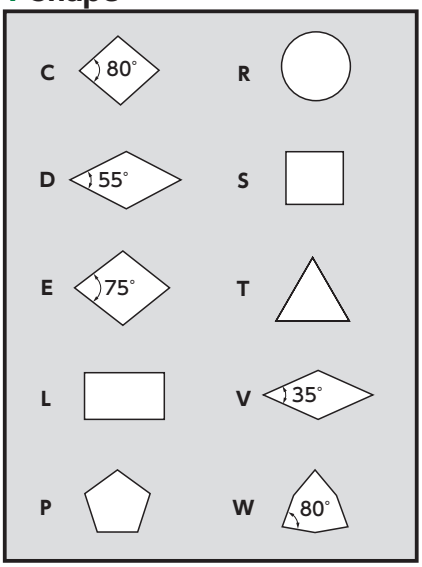
- Use insert with chamfer and hone
- Increase tool rigidity
- Interrupted cuts- chamfer the tool entry and exit path of slots and holes
- Vary cutting speed to eliminate vibration
- Check tool rigidity and centerline height

ANSI / ISO Insert Nomenclature

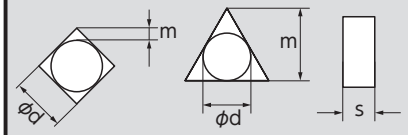
Guide for Insert Description

	1	2	3	4	5
Inch (ANSI)	C	N	G	A	4
Metric (ISO)	C	N	G	A	12

1 Shape



3 Tolerance Class



Symbol	d (inch)	m (inch)	s (inch)
A	±.0010	±.0002	±.0010
F	±.0050	±.0002	±.0010
C	±.0010	±.0005	±.0010
H	±.0050	±.0005	±.0010
E	±.0010	±.0010	±.0010
G	±.0010	±.0010	±.0050
J	±.0020	±.0020	±.0050
K	±.002~±.005	±.0005	±.0010
L	±.002~±.005	±.0010	±.0010
M	±.002~±.005	±.003~±.007	±.0050
N	±.002~±.005	±.003~±.007	±.0010
U	±.003~±.010	±.005~±.015	±.0050

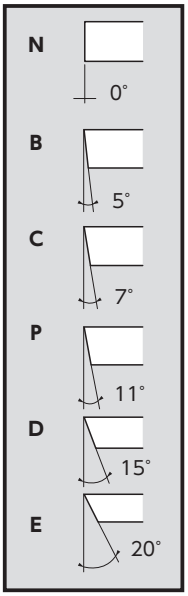
C S T

Inscribed Circle	M tolerance d (inch)	M tolerance m (inch)
1/4"	±.002	±.003
3/8"	±.002	±.003
1/2"	±.003	±.005
5/8"	±.004	±.006
3/4"	±.004	±.006
1"	±.005	±.007

D K

Inscribed Circle	M tolerance d (inch)	M tolerance m (inch)
1/4"	±.002	±.004
3/8"	±.002	±.004
1/2"	±.003	±.006
5/8"	±.004	±.006
3/4"	±.004	±.007

2 Clearances



4 Type

Type	Symbol	Type	Symbol
	N (E)	70°–90°	H
	F		
	R	70°–90°	B
	A		
	G	40°–60°	T
	M	40°–60°	W
Special design	X		

6 Thickness

Thickness S(inch)	Inch	Metric
3/32"	1.5	02
1/8"	2	03
5/32"	2.5	T3
3/16"	3	04
1/4"	4	06
5/16"	5	07
3/8"	6	09
1/2"	8	12

6	7	8	9	10	11	12	13
3	2	P	Q	(W)	T	04	20
04	08	P	Q	(W)	T	010	20
					T	C	E

5 Symbol for Insert Size

Inch		Metric					
Inscribed Circle		C	D	R	S	T	V	W
1/4"	2	06	07	06	11	11	04
3/8"	3	09	11	09	16	16	06
1/2"	4	12	15	12	22	22	08
5/8"	5	16	19	15	27	27	10
3/4"	6	19	23	19	33	33	13
1"	8	25	31	25	44	44	17

7 Corner Radius

Corner Radius	Inch	Metric
.004	04	01
.008	08	02
.016(1/64")	1	04
.031(1/32")	2	08
.047(3/64")	3	12
.063(1/16")	4	16

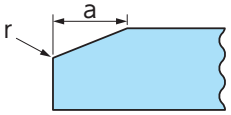
8&9 Cutting Edges

PS	1
PD	2
PT	3
PQ	4
PH	6
PE	8

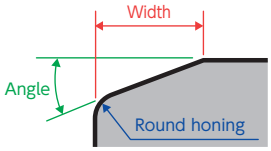
10 Designation

Wiper	W

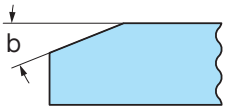
11 Edge Condition 12 Land Width



		Description		a (Land)		r (hone)
		inch	metric	inch		inch
Sharp	FNX	–	–	–	–	–
Chamfered	T	02	005	.002	B	–
		04	010	.004	C	–
		05	013	.005	X	–
		06	015	.006	E	–
Chamfered and Honed	Z	04	010	.004	C	.001
		05	013	.005	X	.001
	S	04	010	.004	C	.002
		05	013	.005	X	.002
		06	015	.006	E	.002
Double Chamfered and Honed	P	48	120	.048		.002



13 Negative Land Angle



Description	b	
15	D	15°
20	E	20°
25	F	25°
30	F	30°

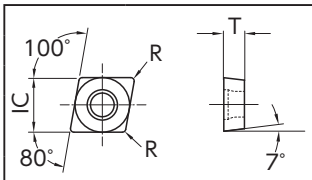
Note: K, J, P & Q show its primary land angle
Note: K, J, P & Q show its primary land width

Insert Stock List

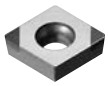
CC. W

(inch)	IC	T
CC.. 21	1/4	3/32
CC.. 32	3/8	5/32

● : 1st Choice ● : 2nd choice



Steel																									
Stainless Steel																									
Cast Iron	●		●		●														●		●				
Non-Ferrous Material																									
Heat Resistant Alloy																			●		●				
Hardened Material	●		●		●		●		●		●														

Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN		CBN (Brazed)																	
								Coated				Coated													
						B99		B5K		B52		B6K		B36		B40		B23		B30					
						EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK				
	CCGW 21.508 PD FNX	1/4	.008	2	.091					5975768	●									5975818	●				
	CCGW 21.508 PD S0415									5734579	●			5981238	●	5975776	●								
	CCGW 21.508 PD S0525									5981782	●			5975792	●										
	CCGW 21.508 PD S0635									5981824	●			5981808	●										
	CCGW 21.51 PD FNX	1/4	.016	2	.091															5975644	●				
	CCGW 21.51 PD S0415									5734587	●			5981832	●	5975651	●								
	CCGW 21.51 PD S0525									5981840	●			5975677	●										
	CCGW 21.51 PD S0635									5981865	●			5981857	●										
	CCGW 21.52 PD FNX	1/4	.031	2	.087					5975685	●														
	CCGW 21.52 PD S0415									5734595	●			5981873	●	5981881	●								
	CCGW 21.52 PD S0525									5981907	●			5975701	●	5981899	●								
	CCGW 21.52 PD T0620													5981154	●										
	CCGW 21.52 PD S0635									5981923	●			5981915	●										
	CCGW 32.508 PD FNX	3/8	.008	2	.091					5975826	●					5975719	●			5975867	●				
	CCGW 32.508 PD S0415									5734611	●			5981949	●										
	CCGW 32.508 PD S0525									5981956	●			5975800	●	5975875	●								
	CCGW 32.508 PD S0635									5981972	●			5981964	●	5975842	●								
	CCGW 32.51 PD FNX	3/8	.016	2	.091					5976295	●					5734603	●			5976287	●				
	CCGW 32.51 PD S0415									5734645	●			5981980	●										
	CCGW 32.51 PD S0525									5982004	●			5976329	●	5976303	●								
	CCGW 32.51 PD S0635									5982038	●			5982012	●	5976337	●			5976352	●				
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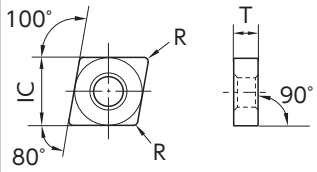
	CCGW 32.52 PD S0415									5734678	●														
	CCGW 32.52 PD S0525									5982053	●			5977582	●	5976360	●								
	CCGW 32.52 PD S0635									5982079	●			5982061	●	5977590	●								
	CCGW 32.53 PD FNX	3/8	.047	2	.063					5977616	●					5734660	●								
	CCGW 32.53 PD S0415									5977624	●														
	CCGW 32.53 PD S0525													5977665	●										

● : Stock ○ : Non stock Standard

CN. A 43

(inch)	IC	T
CN.. 43	1/2	3/16

● : 1st Choice ● : 2nd choice



Steel																							
Stainless Steel																							
Cast Iron	●		●		●										●		●						
Non-Ferrous Material																							
Heat Resistant Alloy															●		●						
Hardened Material	●		●		●		●		●		●												

Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN		CBN (Brazed)															
								Coated				Coated											
						B99		B5K		B52		B6K		B36		B40		B23		B30			
						EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK		
	CNGA 4308 PQ S0415	1/2	.008	4	.091					5762455	●			5982087	●	5977699	●						
	CNGA 4308 PQ T0420																			5977798	●		
	CNGA 4308 PQ S0525									5982160	●			5977764	●	5977772	●						
	CNGA 4308 PQ S0635									5982186	●			5982178	●	5734249	●						
	CNGA 431 PD FNX	1/2	.016	2	.091					5975933	●									5982194	●		
	CNGA 431 PQ FNX			4						5975958	●									5975941	●		
	CNGA 431 PQ S0415							5875745	●	5734348	●	5958236	●	5982202	●	5975966	●						
	CNGA 431 PQ S0420																	5734330	●				
	CNGA 431 PQ T0420																			5734306	●		
	CNGA 431 PQ S0525							5958491	●	5976048	●	5875661	●	5565064	●	5976030	●						
	CNGA 431 PQ S0635							5958483	●	5976063	●	5958228	●	5982210	●	5734256	●						
	CNGA 432 PD FNX	1/2	.031	2	.106															5961602	●		
	CNGA 432 PQ FNX			4						5976154	●									5976147	●		
	CNGA 432 PQ T0215													5981162	●								
	CNGA 432 PQ S0415							5875752	●	5734397	●	5958194	●	5982269	●	5976162	●						
	CNGA 432 PQ S0420																	5734322	●				
	CNGA 432 PQ T0420																			5734298	●		
	CNGA 432 PQ S0525							5958475	●	5976212	●	5875679	●	5565072	●	5976204	●						
	CNGA 432 PQ S0635							5958467	●	5976238	●	5958178	●	5982301	●	5734272	●						
	CNGA 433 PD FNX	1/2	.047	2	.106															5961610	●		
	CNGA 433 PQ FNX			4						5976402	●									5976386	●		
	CNGA 433 PQ T0215													5981170	●								
	CNGA 433 PQ S0415							5875760	●	5734371	●	5958145	●	5982400	●	5982426	●						
	CNGA 433 PQ S0420																	5734314	●				
	CNGA 433 PQ T0420																			5734280	●		
	CNGA 433 PQ S0525							5958442	●	5976444	●	5958137	●	5982434	●	5976436	●						
	CNGA 433 PQ S0635							5958434	●	5976477	●	5958129	●	5982442	●	5734264	●						
	CNGA 434 PQ S0415	1/2	.063	4	.102					5976527	●			5982491	●	5982509	●						
	CNGA 434 PQ S0420																	5982665	●				
	CNGA 434 PQ T0420																			5976543	●		
	CNGA 434 PQ S0525									5982681	●	5958111	●	5976535	●	5982673	●						
	CNGA 434 PQ S0635									5982723	●			5982699	●	5982707	●						
	CNGA 435 PQ S0415	1/2	.079	4	.102					5982756	●			5982731	●	5982749	●						
	CNGA 435 PQ S0420																	5982764	●				
	CNGA 435 PQ T0420																			5982822	●		
	CNGA 435 PQ S0525									5982780	●	5958103	●	5976550	●	5982772	●						
	CNGA 435 PQ S0635									5982814	●			5982798	●	5982806	●						
with wiper	CNGA 431 PQW S0415	1/2	.016	4	.102					5734355	●			5982236	●	5976097	●						
	CNGA 431 PQW S0635									5976139	●			5982244	●	5762380	●						
	CNGA 432 PQW S0415	1/2	.031	4	.102					5734389	●			5982343	●	5982350	●						
	CNGA 432 PQW S0635									5982376	●			5982368	●	5762398	●						
	CNGA 433 PQW S0415	1/2	.047	4	.102					5734363	●			5982459	●	5982467	●						
	CNGA 433 PQW S0635									5982475	●			5976501	●	5762406	●						
round Dimple	CNGZ 434 T0820	1/2	.063	—	—	6001141	●																

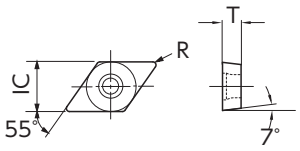
● : Stock ○ : Non stock Standard

Insert Stock List

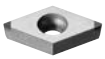
DC. W

(inch)	IC	T
DC.. 21	1/4	3/32
DC.. 32	3/8	5/32

● : 1st Choice ● : 2nd choice



Steel	
Stainless Steel	
Cast Iron	● ● ● ● ●
Non-Ferrous Material	
Heat Resistant Alloy	● ●
Hardened Material	● ● ● ● ● ●

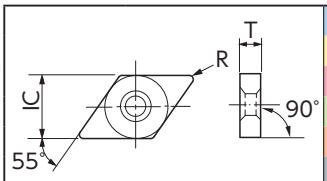
Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN		CBN (Brazed)													
						B99		Coated B5K		B52		Coated B6K		B36		B40		B23		B30	
						EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK
	DCGW 21.508 PD FNX	1/4	.008	2	.094					5976576	●										
	DCGW 21.508 PD S0415									5735147	●										
	DCGW 21.508 PD S0635															5976592	●				
	DCGW 21.51 PD FNX	1/4	.016	2	.087					5976618	●									5976600	●
	DCGW 21.51 PD S0415									5735154	●										
	DCGW 21.51 PD S0635															5762414	●				
	DCGW 21.52 PD FNX	1/4	.031	2	.075					5976642	●										
	DCGW 21.52 PD S0415									5735162	●					5976659	●				
	DCGW 21.52 PD S0525															5976683	●				
	DCGW 21.52 PD S0635															5976691	●				
	DCGW 32.504 PD S0415	3/8	.004	2	.091					5976741	●										
	DCGW 32.508 PD FNX	3/8	.008	2	.094					5976766	●									5976758	●
	DCGW 32.508 PD S0415							5875794	●	5735188	●			5982830	●	5976774	●				
	DCGW 32.508 PD S0525									5982848	●			5976790	●	5976808	●				
	DCGW 32.508 PD S0635									5982863	●			5982855	●	5735170	●				
	DCGW 32.51 PD FNX	3/8	.016	2	.087					5976832	●									5976824	●
	DCGW 32.51 PD S0415							5875802	●	5735204	●			5982871	●	5976840	●				
	DCGW 32.51 PD T0415													5981196	●						
	DCGW 32.51 PD S0525									5982897	●			5976865	●	5976873	●				
	DCGW 32.51 PD S0635									5982921	●			5982905	●	5735196	●				
	DCGW 32.52 PD FNX	3/8	.031	2	.075					5976899	●										
	DCGW 32.52 PD S0415									5735220	●					5976907	●				
	DCGW 32.52 PD S0525									5982939	●					5976923	●				
	DCGW 32.52 PD S0635									5983168	●					5735212	●				
	DCGW 32.53 PD S0415	3/8	.047	2	.102					5976949	●										

● : Stock ○ : Non stock Standard

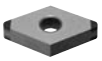
DN. A 4

(inch)	IC	T
DN.. 43	1/2	3/16

● : 1st Choice ● : 2nd choice



	Steel	Stainless Steel	Cast Iron	Non-Ferrous Material	Heat Resistant Alloy	Hardened Material
Solid CBN			●			●
CBN (Brazed) Coated			●			●
CBN (Brazed) Coated			●			●
CBN (Brazed) Coated			●			●
CBN (Brazed)						●
CBN (Brazed)						●
CBN (Brazed)			●		●	
CBN (Brazed)			●		●	

Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN B99 EDP	Solid CBN B99 STOCK	CBN (Brazed) Coated B5K EDP	B5K STOCK	CBN (Brazed) B52 EDP	B52 STOCK	CBN (Brazed) Coated B6K EDP	B6K STOCK	CBN (Brazed) B36 EDP	B36 STOCK	CBN (Brazed) B40 EDP	B40 STOCK	CBN (Brazed) B23 EDP	B23 STOCK	CBN (Brazed) B30 EDP	B30 STOCK
	DNGA 4308 PQ S0415	1/2	.008	4	.094					5762471	●					5983176	●				
	DNGA 4308 PQ T0420																			5976998	●
	DNGA 4308 PQ S0525									5983184	●					5976964	●				
	DNGA 4308 PQ S0635									5983192	●					5734694	●				
	DNGA 431 PD FNX	1/2	.016	2	.087															5983200	●
	DNGA 431 PQ FNX			4						5977020	●									5977012	●
	DNGA 431 PQ S0415							5875778	●	5734736	●	5958079	●	5983218	●	5977038	●				
	DNGA 431 PQ S0420																	5983226	●		
	DNGA 431 PQ T0420																			5977293	●
	DNGA 431 PQ S0525							5958640	●	5983234	●	5875687	●	5565098	●	5977228	●				
	DNGA 431 PQ S0635							5958632	●	5977277	●	5958061	●	5977236	●	5734728	●				
	DNGA 432 PD FNX	1/2	.031	2	.075															5983242	●
	DNGA 432 PQ FNX			4						5977319	●									5977301	●
	DNGA 432 PQ S0415							5875786	●	5734777	●	5958053	●	5983259	●	5977327	●				
	DNGA 432 PQ S0420																	5734744	●		
	DNGA 432 PQ T0420																			5734751	●
	DNGA 432 PQ S0525							5958624	●	5983267	●	5875695	●	5565106	●	5977368	●				
	DNGA 432 PQ S0635							5958616	●	5977384	●	5958046	●	5983275	●	5734769	●				
	DNGA 433 PD FNX	1/2	.047	2	.102															5983283	●
	DNGA 433 PQ FNX			4						5977400	●										
	DNGA 433 PQ S0415							5958608	●	5734819	●	5958038	●	5983291	●	5977426	●				
	DNGA 433 PQ S0420																	5734785	●		
	DNGA 433 PQ T0420																			5734793	●
	DNGA 433 PQ S0525							5958590	●	5983309	●	5958020	●	5977459	●	5977467	●				
	DNGA 433 PQ S0635							5958582	●	5977517	●	5958012	●	5977491	●	5734801	●				
	DNGA 434 PQ S0525	1/2	.063	4	.087					5983374	●					5983366	●				
	DNGA 434 PQ S0415							5958566	●	5977533	●	5958004	●	5983317	●	5983325	●				
	DNGA 434 PQ S0420																	5983333	●		
	DNGA 434 PQ T0420																			5977558	●
	DNGA 434 PQ S0525							5958558	●			5957972	●	5977541	●						
	DNGA 434 PQ S0635							5958541	●	5983408	●	5957964	●	5983382	●	5983390	●				
	DNGA 435 PQ S0415	1/2	.079	4	.094							5957956	●								
	DNGA 435 PQ S0525											5957949	●	5977574	●						
	DNGA 435 PQ S0635											5958087	●								
	DNGA 4408 PQ S0415	1/2	.008	4	.091					5977806	●										
	DNGA 441 PQ S0415	1/2	.016	4	.094					5977814	●										
	DNGA 441 PQ T0420																			5977848	●
	DNGA 441 PQ S0525													5977830	●						
	DNGA 442 PQ S0415	1/2	.031	4	.075					5977855	●										
	DNGA 442 PQ T0420																			5977871	●
	DNGA 442 PQ S0525													5977863	●						
	DNGA 443 PQ S0415	1/2	.047	4	.102					5977889	●										
	DNGA 443 PQ T0420																			5977905	●
	DNGA 443 PQ S0525													5977897	●						
	DNGA 444 PQ S0415	1/2	.063	4	.087					5977921	●										
	DNGA 444 PQ T0420																			5977947	●
	DNGA 444 PQ S0525													5977939	●						

● : Stock ○ : Non stock Standard

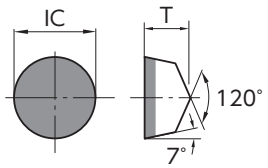
Insert Stock List

RCGX

(inch)	IC	T
RCGX 102	1/4	.309
RCGX 103	3/8	.309
RCGX 104	1/2	.312

(inch)	IC	T
RCGX 105	5/8	.388
RCGX 106	3/4	.388

● : 1st Choice ● : 2nd choice



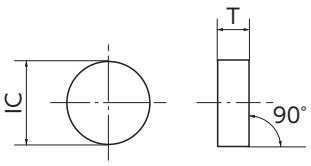
	Steel	Stainless Steel	Cast Iron	Non-Ferrous Material	Heat Resistant Alloy	Hardened Material
Solid CBN	B99					●
CBN (Brazed) Coated	B5K		●			●
	B52		●			●
CBN (Brazed) Coated	B6K					●
	B36					●
	B40					●
	B23		●		●	
	B30		●		●	

Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN B99 EDP	STOCK	B5K EDP	STOCK	B52 EDP	STOCK	B6K EDP	STOCK	B36 EDP	STOCK	B40 EDP	STOCK	B23 EDP	STOCK	B30 EDP	STOCK
	RCGX 102 P4815	1/4	—	—	—	6001164	●													5015003	●
	RCGX 103 P4815	3/8	—	—	—	6001165	●													5015011	●
	RCGX 104 P4815	1/2	—	—	—	6001166	●													5015029	●
	RCGX 105 P4815	5/8	—	—	—	6001167	●													5048764	●
	RCGX 106 P4815	3/4	—	—	—	6001168	●													5048772	●

RNG

(inch)	IC	T
RN.. 32	3/8	1/8
RN.. 43	1/2	3/16

● : 1st Choice ● : 2nd choice



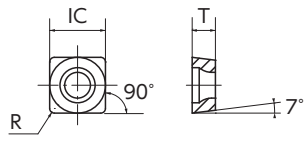
	Steel	Stainless Steel	Cast Iron	Non-Ferrous Material	Heat Resistant Alloy	Hardened Material
Solid CBN	B99					●
CBN (Brazed) Coated	B5K		●			●
	B52		●			●
CBN (Brazed) Coated	B6K					●
	B36					●
	B40					●
	B23		●		●	
	B30		●		●	

Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN B99 EDP	STOCK	B5K EDP	STOCK	B52 EDP	STOCK	B6K EDP	STOCK	B36 EDP	STOCK	B40 EDP	STOCK	B23 EDP	STOCK	B30 EDP	STOCK
	RNG 32 Z0525	3/8	—	—	—	6000929	●														
	RNG 43 Z0525	1/2	—	—	—	6000928	●														

SCGW 32

(inch)	IC	T
SCGW.. 32	3/8	5/32

● : 1st Choice ● : 2nd choice



	Steel	Stainless Steel	Cast Iron	Non-Ferrous Material	Heat Resistant Alloy	Hardened Material
Solid CBN	B99					●
CBN (Brazed) Coated	B5K		●			●
	B52		●			●
CBN (Brazed) Coated	B6K					●
	B36					●
	B40					●
	B23		●		●	
	B30		●		●	

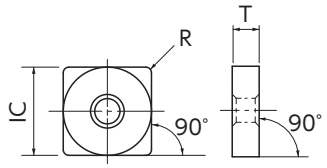
Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN B99 EDP	STOCK	B5K EDP	STOCK	B52 EDP	STOCK	B6K EDP	STOCK	B36 EDP	STOCK	B40 EDP	STOCK	B23 EDP	STOCK	B30 EDP	STOCK
	SCGW 32.51 PQ Z0415	3/8	.016	4	.059															5981220	●
	SCGW 32.52 PQ Z0415		.031	4	.051															5981204	●

● : Stock ○ : Non stock Standard

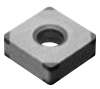
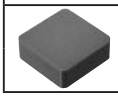
SN.

(inch)	IC	T
SN.. 32	3/8	1/18
SN.. 43	1/2	3/16

● : 1st Choice ● : 2nd choice



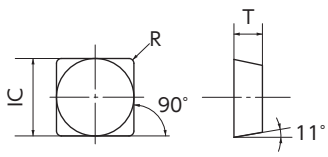
Steel	
Stainless Steel	
Cast Iron	●
Non-Ferrous Material	
Heat Resistant Alloy	
Hardened Material	●

Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN		CBN (Brazed) Coated				CBN (Brazed)		CBN (Brazed) Coated									
						B99		B5K		B52		B6K		B36		B40		B23		B30			
						EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK		
	SNGA 4308 PE S0525	1/2	.008	8	.059					5984174	●			5977962	●	5983424	●						
	SNGA 431 PE S0415		.016		.059					5977970	●					5984182	●						
	SNGA 431 PE S0420																	5984190	●				
	SNGA 431 PE T0420																			5735253	●		
	SNGA 431 PE S0525													5977996	●								
	SNGA 431 PE S0635									5984208	●					5735261	●						
	SNGA 432 PE S0415		.031		.051					5735352	●					5984216	●						
	SNGA 432 PE S0420																	5984224	●				
	SNGA 432 PE T0420																			5735337	●		
	SNGA 432 PE S0525													5565049	●								
	SNGA 432 PE S0635									5984232	●					5735345	●						
	SNGA 433 PE S0415		.047		.059					5735394	●					5984257	●			5984240	●		
	SNGA 433 PE S0420																	5735360	●				
	SNGA 433 PE T0420																			5735378	●		
	SNGA 433 PE S0525													5984265	●								
	SNGA 433 PE S0635									5984273	●					5735386	●						
	SNGA 434 PE S0415		.063		.051					5978200	●												
	SNGA 434 PE T0420																			5978226	●		
	SNGA 434 PE S0525													5978218	●								
	SNG 324 S0825	3/8	.063	8	—	6000988	●																
	SNMN 434 S0825	1/2	.063	8	—	6001131	●																

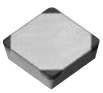
SPG 32

(inch)	IC	T
SP.. 32	3/8	1/8

● : 1st Choice ● : 2nd choice



Steel	
Stainless Steel	
Cast Iron	●
Non-Ferrous Material	
Heat Resistant Alloy	
Hardened Material	●

Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN		CBN (Brazed) Coated				CBN (Brazed)		CBN (Brazed) Coated									
						B99		B5K		B52		B6K		B36		B40		B23		B30			
						EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK		
	SPG 321 PQ S0415	3/8	.016	4	.059					5978242	●					5984281	●						
	SPG 321 PQ S0420																	5736269	●				
	SPG 321 PQ T0420																			5978283	●		
	SPG 321 PQ S0635									5984299	●					5978275	●						
	SPG 322 PQ S0415	3/8	.031	4	.051					5978291	●					5984307	●						
	SPG 322 PQ S0420																	5736293	●				
	SPG 322 PQ T0420																			5736301	●		
	SPG 322 PQ S0635									5984315	●					5978325	●						
	SPG 323 PQ S0415	3/8	.047	4	.059					5978341	●					5984323	●						
	SPG 323 PQ S0420																	5984331	●				
	SPG 323 PQ T0420																			5984364	●		
	SPG 323 PQ S0635									5984356	●					5984349	●						

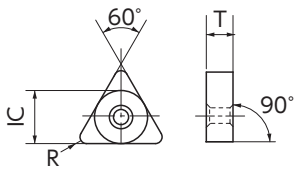
● : Stock ○ : Non stock Standard

Insert Stock List

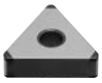
TN. A 33

● : 1st Choice ● : 2nd choice

(inch)	IC	T
TN.. 33	3/8	3/16



Steel																							
Stainless Steel																							
Cast Iron	●		●		●												●		●				
Non-Ferrous Material																							
Heat Resistant Alloy																	●		●				
Hardened Material	●		●		●		●		●		●												

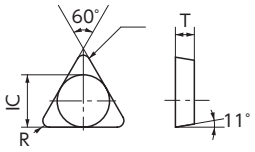
Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN		CBN (Brazed)															
								Coated				Coated											
						B99		B5K		B52		B6K		B36		B40		B23		B30			
						EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK		
	TNGA 3304 PH FNX	3/8	.004	6	.083					5979216	●												
	TNGA 3304 PH S0415							5958384	●	5736335	●	5957816	●			5979224	●						
	TNGA 3304 PH S0525							5958244	●	5979257	●	5957923	●			5979240	●						
	TNGA 3304 PH S0635									5979273	●					5979265	●						
	TNGA 3308 PT FNX	3/8	.008	3	.087															5984398	●		
	TNGA 3308 PH FNX			6						5979299	●									5979281	●		
	TNGA 3308 PH S0415							5875810	●	5736343	●	5957915	●	5984372	●	5979307	●						
	TNGA 3308 PH S0525							5958251	●	5979349	●	5957907	●	5979323	●	5979331	●						
	TNGA 3308 PH S0635							5958269	●	5979364	●			5984380	●	5736251	●						
	TNGA 331 PT FNX	3/8	.016	3	.079															5880224	●		
	TNGA 331 PH FNX			6						5979372	●												
	TNGA 331 PH S0415							5875828	●	5736467	●	5957899	●	5984406	●	5979380	●						
	TNGA 331 PH S0420																	5984414	●				
	TNGA 331 PH T0420																			5736434	●		
	TNGA 331 PH S0525							5958277	●	5978499	●	5875729	●	5565155	●	5979414	●						
	TNGA 331 PH S0635							5958285	●	5978531	●	5960935	●	5978507	●	5736442	●			5984638	●		
	TNGA 332 PT FNX	3/8	.031	3	.067															5880232	●		
	TNGA 332 PH FNX			6						5978572	●												
	TNGA 332 PH S0415							5875844	●	5736509	●	5957881	●	5984646	●	5978580	●						
	TNGA 332 PH S0420																	5736475	●				
	TNGA 332 PH T0420																			5736483	●		
	TNGA 332 PH S0525							5958293	●	5978655	●	5875737	●	5565171	●	5978648	●						
	TNGA 332 PH S0635							5958319	●	5978689	●	5960927	●	5978663	●	5736491	●			5984653	●		
	TNGA 333 PT FNX	3/8	.047	3	.091															5984760	●		
	TNGA 333 PH FNX			6						5978721	●									5978713	●		
	TNGA 333 PH S0415							5958327	●	5736582	●	5957873	●	5984711	●	5984729	●						
	TNGA 333 PH S0420																	5736533	●				
	TNGA 333 PH T0420																			5736558	●		
	TNGA 333 PH S0525							5958335	●	5978762	●	5957865	●	5978754	●	5984737	●						
	TNGA 333 PH S0635							5958343	●	5978804	●	5957857	●	5978788	●	5736566	●			5984745	●		
	TNGA 334 PH S0415	3/8	.063	6	.083			5958350	●	5978820	●	5957840	●										
	TNGA 334 PH T0420																			5978861	●		
	TNGA 334 PH S0525							5958368	●			5957832	●	5978838	●								
	TNGA 334 PH S0635							5958376	●			5957824	●	5978853	●								
	TNGA 433 PH S0415	1/2	.047	6	.091											5978887	●						
	TNGA 433 PH S0635															5978895	●						

● : Stock ○ : Non stock Standard

TPG

(inch)	IC	T
TP.. 22	1/4	1/8
TP.. 32	3/8	1/8

● : 1st Choice ● : 2nd choice



Steel	
Stainless Steel	
Cast Iron	● ● ● ● ●
Non-Ferrous Material	
Heat Resistant Alloy	● ●
Hardened Material	● ● ● ● ● ●

Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN		CBN (Brazed)													
								Coated				Coated									
						B99		B5K		B52		B6K		B36		B40		B23		B30	
						EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK
	TPG 2208 PT S0415	1/4	.008	3	.087					5978911	●										
	TPG 2208 PT S0420															5984778	●				
	TPG 2208 PT S0525									5984794	●					5984786	●				
	TPG 2208 PT S0635									5984802	●					5978929	●				
	TPG 221 PT S0415	1/4	.016	3	.079					5978937	●					5984828	●				
	TPG 221 PT S0420															5978945	●				
	TPG 221 PT T0420																			5978994	●
	TPG 221 PT S0525									5984836	●					5978952	●				
	TPG 221 PT S0635									5984844	●					5736756	●				
	TPG 222 PT S0415	1/4	.031	3	.067					5979000	●					5984851	●				
	TPG 222 PT S0420															5979018	●				
	TPG 222 PT T0420																			5979042	●
	TPG 222 PT S0525									5984869	●					5979026	●				
	TPG 222 PT S0635									5984877	●					5736772	●				
	TPG 223 PT S0415	1/4	.047	3	.091					5979059	●					5984927	●				
	TPG 223 PT S0420															5984935	●				
	TPG 223 PT T0420																			5979075	●
	TPG 223 PT S0525									5984968	●					5984943	●				
	TPG 223 PT S0635									5984976	●					5979067	●				
	TPG 3208 PT S0415	3/8	.008	3	.087					5979422	●					5984984	●				
	TPG 3208 PT S0525									5985056	●					5985007	●				
	TPG 3208 PT S0635									5985064	●					5979430	●				
	TPG 321 PT S0415	3/8	.016	3	.079					5979448	●					5985072	●				
	TPG 321 PT S0420															5979455	●				
	TPG 321 PT T0420																			5979513	●
	TPG 321 PT S0525									5985080	●					5979463	●				
	TPG 321 PT S0635									5985106	●					5736822	●				
	TPG 322 PT S0415	3/8	.031	3	.067					5979521	●					5985114	●				
	TPG 322 PT S0420															5979539	●				
	TPG 322 PT T0420																			5736830	●
	TPG 322 PT S0525									5985122	●					5979547	●				
	TPG 322 PT S0635									5985130	●					5736848	●				
	TPG 323 PT S0415	3/8	.047	3	.091					5979588	●					5985148	●				
	TPG 323 PT S0420															5985155	●				
	TPG 323 PT T0420																			5979604	●
	TPG 323 PT S0525									5985171	●					5985163	●				
	TPG 323 PT S0635									5979596	●					5985189	●				

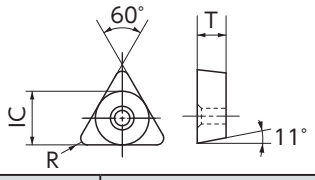
● : Stock ○ : Non stock Standard

Insert Stock List

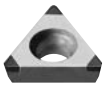
TPG

(inch)	IC	T
TP.. 22	1/4	1/8
TP.. 73	7/32	3/32
TP.. 74	7/32	1/8

● : 1st Choice ● : 2nd choice



Steel																					
Stainless Steel																					
Cast Iron	●		●		●												●		●		
Non-Ferrous Material																					
Heat Resistant Alloy																	●		●		
Hardened Material	●		●		●		●		●		●										

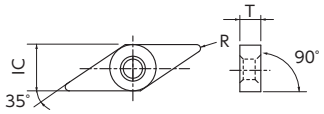
Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN		CBN (Brazed)													
								Coated				Coated									
						B99		B5K		B52		B6K		B36		B40		B23		B30	
						EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK
	TPGD 7308 PT S0415	7/32	.008	3	.087					5979612	●			5985205	●						
	TPGD 7308 PT S0525									5985213	●			5979620	●						
	TPGD 7308 PT S0635									5985262	●			5985247	●						
	TPGD 731 PT S0415	7/32	.016	3	.079					5979638	●			5985288	●						
	TPGD 731 PT S0525									5985296	●			5979646	●						
	TPGD 731 PT S0635									5985312	●			5985304	●						
	TPGD 732 PT S0415	7/32	.031	3	.067					5979653	●			5985320	●						
	TPGD 732 PT S0525									5985338	●			5979661	●						
	TPGD 732 PT S0635									5985379	●			5985353	●						
	TPGD 743 PT S0415	7/32	.047	3	.091					5979679	●			5985387	●						
	TPGD 743 PT S0525									5985395	●			5979687	●						
	TPGD 743 PT S0635									5985411	●			5985403	●						
	TPGW 2208 PT S0415	1/4	.008	3	.087					5736632	●			5985486	●	5985494	●				
	TPGW 2208 PT T0420																			5980016	●
	TPGW 2208 PT S0525									5985502	●			5979711	●						
	TPGW 2208 PT S0635									5985528	●			5985510	●	5980024	●				
	TPGW 221 PT S0415	1/4	.016	3	.079					5736681	●			5985536	●	5979992	●				
	TPGW 221 PT T0420																			5736640	●
	TPGW 221 PT S0525									5985544	●			5979976	●	5980065	●				
	TPGW 221 PT T0615																	5985585	●	5985593	●
	TPGW 221 PT S0635									5985577	●			5985569	●	5736673	●				
	TPGW 222 PT S0415	1/4	.031	3	.067					5736723	●			5985601	●	5980099	●				
	TPGW 222 PT T0420																			5980156	●
	TPGW 222 PT S0525									5985619	●			5980123	●	5980131	●				
	TPGW 222 PT T0615																	5985650	●		
	TPGW 222 PT S0635									5985643	●			5985635	●	5736715	●				
	TPGW 223 PT S0415	1/4	.047	3	.091					5980164	●					5985668	●				
	TPGW 223 PT T0420																			5980180	●
	TPGW 223 PT S0525									5985684	●					5985676	●				
	TPGW 223 PT T0615																	5985700	●		
	TPGW 223 PT S0635									5985692	●					5980172	●				

● : Stock ○ : Non stock Standard

VB / VC

(inch)	IC	T
VB.. 22	1/4	1/8
VB.. 33	3/8	3/16
VC.. 22	1/4	1/8
VC.. 33	3/8	3/16

● : 1st Choice ● : 2nd choice



Steel																					
Stainless Steel																					
Cast Iron	●		●		●												●		●		
Non-Ferrous Material																					
Heat Resistant Alloy																	●		●		
Hardened Material	●		●		●		●		●		●										

Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN		CBN (Brazed)													
								Coated				Coated									
						B99		B5K		B52		B6K		B36		B40		B23		B30	
						EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK
	VBGW 2208 PD FNX	1/4	.008	2	.102															5980206	●
	VBGW 2208 PD S0415									5737184	●			5985825	●						
	VBGW 2208 PD S0525									5985833	●			5980222	●						
	VBGW 2208 PD S0635									5980230	●			5985866	●						
	VBGW 221 PD FNX	1/4	.016	2	.098															5980248	●
	VBGW 221 PD S0415									5737200	●			5985874	●						
	VBGW 221 PD T0420																			5737192	●
	VBGW 221 PD S0525									5985890	●			5980289	●						
	VBGW 221 PD S0635									5980297	●			5985908	●						
	VBGW 222 PD S0415	1/4	.031	2	.063					5981337	●										
	VBGW 222 PD T0420																			5737218	●
	VBGW 222 PD S0525									5985916	●										
	VBGW 222 PD S0635									5981360	●										
	VBGW 223 PD S0415	1/4	.047	2	.106					5981386	●										
	VBGW 223 PD T0420																			5981394	●
	VBGW 223 PD S0525									5985924	●										
	VBGW 223 PD S0635									5985932	●										
	VBGW 3308 PD S0415	3/8	.008	2	.102					5737234	●										
	VBGW 3308 PD S0525									5985940	●										
	VBGW 3308 PD S0635									5985957	●										
	VBGW 331 PD S0415	3/8	.016	2	.098					5737242	●										
	VBGW 331 PD S0525									5985965	●										
	VBGW 331 PD S0635									5985973	●										
	VBGW 332 PD S0415	3/8	.031	2	.063					5737259	●			5985981	●						
	VBGW 332 PD S0525									5985999	●			5981436	●						
	VBGW 332 PD S0635									5986013	●			5986005	●						
	VBGW 333 PD S0415	3/8	.047	2	.106					5981444	●										
	VBGW 333 PD S0525									5986021	●										
	VBGW 333 PD S0635									5986039	●										
	VCGW 1.51.508 PD S0415	3/16	.008	2	.102					5981485	●										
	VCGW 1.51.508 PD S0525													5981493	●						
	VCGW 1.51.51 PD S0415	3/16	.016	2	.098					5981501	●										
	VCGW 1.51.51 PD S0525													5981519	●						
	VCGW 1.51.52 PD S0415	3/16	.031	2	.063					5981535	●										
	VCGW 1.51.52 PD S0525													5981543	●						
	VCGW 2208 PD S0415	1/4	.008	2	.102					5981550	●					5986047	●				
	VCGW 2208 PD S0635									5986054	●					5981568	●				
	VCGW 221 PD S0415	1/4	.016	2	.098					5737275	●					5986062	●				
	VCGW 221 PD S0635									5986070	●					5762430	●				
	VCGW 222 PD S0415	1/4	.031	2	.098					5762497	●					5986088	●				
	VCGW 222 PD S0635									5986096	●					5762448	●				
	VCGW 223 PD S0415	1/4	.047	2	.106					5981618	●					5986146	●				
	VCGW 223 PD S0635									5986187	●					5986153	●				
	VCGW 3308 PD S0415	3/8	.008	2	.102											5986195	●				
	VCGW 3308 PD S0635															5986203	●				
	VCGW 331 PD S0415	3/8	.016	2	.098					5737309	●					5986211	●				
	VCGW 331 PD T0420																			5980354	●
	VCGW 331 PD S0635									5986229	●					5737291	●				
	VCGW 332 PD S0415	3/8	.031	2	.063					5737333	●					5986237	●				
	VCGW 332 PD T0420																			5980388	●
	VCGW 332 PD S0635									5986245	●					5737325	●				
	VCGW 333 PD S0415	3/8	.047	2	.106					5980396	●					5986252	●				
	VCGW 333 PD T0420																			5980404	●
	VCGW 333 PD S0635									5986278	●					5986260	●				

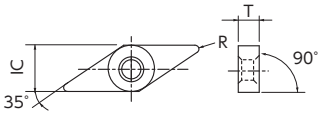
● : Stock ○ : Non stock Standard

Insert Stock List

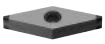
VNGA 33

● : 1st Choice ● : 2nd choice

(inch)	IC	T
VN.. 33	3/8	3/16



Steel																					
Stainless Steel																					
Cast Iron	●		●		●												●		●		
Non-Ferrous Material																					
Heat Resistant Alloy																	●		●		
Hardened Material	●		●		●		●		●		●										

Shape	Item Number	IC	R	No. of edge	Length of edge	Solid CBN		CBN (Brazed)													
								Coated				Coated									
						B99		B5K		B52		B6K		B36		B40		B23		B30	
						EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK	EDP	STOCK
	VNGA 3304 PQ S0415	3/8	.004	4	.106					5980594	●										
	VNGA 3304 PQ S0635															5980412	●				
	VNGA 3308 PD FNX	3/8	.008	2	.102															5986286	●
	VNGA 3308 PQ FNX			4																5980420	●
	VNGA 3308 PQ S0415							5959028	●	5980446	●			5986294	●	5980438	●				
	VNGA 3308 PQ T0420																			5980495	●
	VNGA 3308 PQ S0525							5958913	●	5980479	●			5980453	●	5980461	●				
	VNGA 3308 PQ S0635							5958921	●	5986310	●			5986302	●	5762422	●				
	VNGA 331 PD FNX	3/8	.016	2	.098															5986328	●
	VNGA 331 PQ FNX			4						5980529	●									5980503	●
	VNGA 331 PQ S0415							5875851	●	5736905	●	5958657	●	5986336	●	5980537	●				
	VNGA 331 PQ T0420																			5736889	●
	VNGA 331 PQ S0525							5958947	●	5986344	●	5875703	●	5565122	●	5980560	●				
	VNGA 331 PQ S0635							5958954	●	5980958	●	5958723	●	5980578	●	5736897	●				
	VNGA 332 PD FNX	3/8	.031	2	.063															5986351	●
	VNGA 332 PQ FNX			4						5980982	●									5980974	●
	VNGA 332 PQ S0415							5875869	●	5736939	●	5958715	●	5986369	●	5980990	●				
	VNGA 332 PQ T0420																			5736913	●
	VNGA 332 PQ S0525							5958962	●	5986377	●	5875711	●	5565130	●	5981030	●				
	VNGA 332 PQ S0635							5958988	●	5986385	●	5958707	●	5981048	●	5736921	●				
	VNGA 333 PD FNX	3/8	.047	2	.106															5986393	●
	VNGA 333 PQ S0415			4				5958996	●	5981089	●	5958681	●	5986401	●	5981071	●				
	VNGA 333 PQ T0420																			5981139	●
	VNGA 333 PQ S0525							5959002	●	5986419	●	5958673	●	5981097	●	5981105	●				
	VNGA 333 PQ S0635							5959010	●	5981121	●	5958665	●	5986435	●	5736947	●				

● : Stock ○ : Non stock Standard

Grade Comparison Chart

			SUMITOMO	MITSUBISHI	KYOCERA	TUNGALOY	KENNAMETAL
B99	DUCTILE / CAST IRON K1 K10 K15 K20 K25 K30	MILL ROLL	BN7000 BNS800 BN700 BN7500	MBS140	KBN900	BX90S BXC90	KB1340 KB1345
B23	DUCTILE / CAST IRON K1 K10 K15 K20 K25 K30	POWDERED METALS/ SUPER ALLOYS 01 10 20 30	BN7000 BN7000 BN7500 BN7500 BNS800 BN700 BN700	MBS140 MB710	KBN900 KBN570	BX850 BX470 BX480 BX950	KB1340 KB5630 KB1345
B30	DUCTILE / CAST IRON K1 K10 K15 K20 K25 K30	POWDERED METALS/ SUPER ALLOYS 01 10 20 30	BN7000 BN7000 BN700 BN700 BN7500 BN7500	MB730 MB835 MB710 MB4020	KBN60M KBN70M	BX850 BX470 BX870 BX480 BX950	KB1630 KB5630
B52	DUCTILE / CAST IRON K1 K10 K15 K20 K25 K30	HARDENED MATERIAL H1 CONTINUOUS	BN500 BN500 BN1000 BNC2020 BNX10 BNX20 BNC200(C) BNC160	MB710 MBC010 MB730 MB810 MB5015	KBN510 KBN05M(C) KBN60M KBN475	BX910 BX310 BX930 BX530 BXM10(C)	KD120 KB9610 KB1630 KB5610 KB1610
B5K (Coated)	DUCTILE / CAST IRON K1 K10 K15 K20 K25 K30	HARDENED MATERIAL H20 LIGHT CONTINUOUS	BN500 BN500 BNC2010 BNX10 BNC100 BNC160 BNC200(C)	MBC010(C)	KBN525 KBN10M(C)	BXM10(C)	KD120 KB9610 KB5610 KB1610
B36		HARDENED MATERIAL H20 MEDIUM	BN250 BNX20 BNX25 BN2000 BNC200(C)	MB8025 MB825	KBN525 KBN25M	BX330 BX530 BXM20(C)	KB5625 KB1625 BN9610
B6K (Coated)		HARDENED MATERIAL H30 HEAVY	BNC200 BN250 BNC300(C) BN2000	MB825 BC8020(C)	KBN525 KBN25M(C)	BXM20(C) BXC50(C) BXM20(C)	KB5625 KB1625
B40		HARDENED MATERIAL H30	BNX25 BN2000 BN350 BNC300(C)	MB825 MB835 BC8020(C)	KBN900 KBN35M(C)	BX360 BX380	KB1630 KB9640 KB5625 KB5630

(C) Coated grade

			SANDVIK	SECO	ISCAR	SPK	FUNIK
B99	DUCTILE / CAST IRON K1 K10 K15 K20 K25 K30	MILL ROLL		CBN500 CBN600	IB90A IB25KD	WBN100 WBN120	FBN7200 FBN6500
B23	DUCTILE / CAST IRON K1 K10 K15 K20 K25 K30	POWDERED METALS/ SUPER ALLOYS 01 10 20 30	CB7925	CBN600 CBN010 CBN500 CBN170 CBN300 CBN200 CBN400C	IB05S IB10S IB90A IB90 IB25KD	WBN105 WBN700 WBN115	FBK7510 FBN6500 FBK7520 FBK7530
B30	DUCTILE / CAST IRON K1 K10 K15 K20 K25 K30	POWDERED METALS/ SUPER ALLOYS 01 10 20 30	CB7925 CB7050 CB50	CBN200 CBN010 CBN300 CBN170 CBN400C	IB05S IB10S IB90A IB90 IB25KD	WBN105 WBN700 WBN750	FBK7510 FBN6200 FBK7520 FBK7530
B52	DUCTILE / CAST IRON K1 K10 K15 K20 K25 K30	HARDENED MATERIAL H1 CONTINUOUS	CB7525 CB7015 CB7050 CB20 CB50	CBN300 CBN060K CBN600 CBN300P CBN400C	IB05S IB05H IB10S IB10HC IB90A IB90 IB25KD	WBN750 WBN550 WBN600 WBN650	FBK9540 FBK9550 FBN7200 FBN7200 FBN8300
B5K (Coated)	DUCTILE / CAST IRON K1 K10 K15 K20 K25 K30	HARDENED MATERIAL H20 LIGHT CONTINUOUS	CB7050 CB7015 CB20	CBN060K	IB10K IB05H IB10HC	WBN750 WBN600 WBN650	FBK9540 FBK9550 FBN7200 FBN6200 FBN7200 FBN8300
B36		HARDENED MATERIAL H20 MEDIUM	CB7025 CB20 CB50 CB7035	CBN200 CBN300P	IB50 IB55 IB10H IB10HC IB20H IB20HC IB25HA IB25HC	WBN600	FBK9530
B6K (Coated)		HARDENED MATERIAL H30 HEAVY	CB7025	CBN160C(C) CBN200 CBN300P	IB50 IB55 IB10H IB10HC IB20H IB20HC IB25HA IB25HC	WBN600 WBN650	FBK9530 FBN6200 FBN8300
B40		HARDENED MATERIAL H30	CB7525	CBN500	IB25HC IB90 IB25HA	WBN500	FBK9560 FBN8000

MEMO

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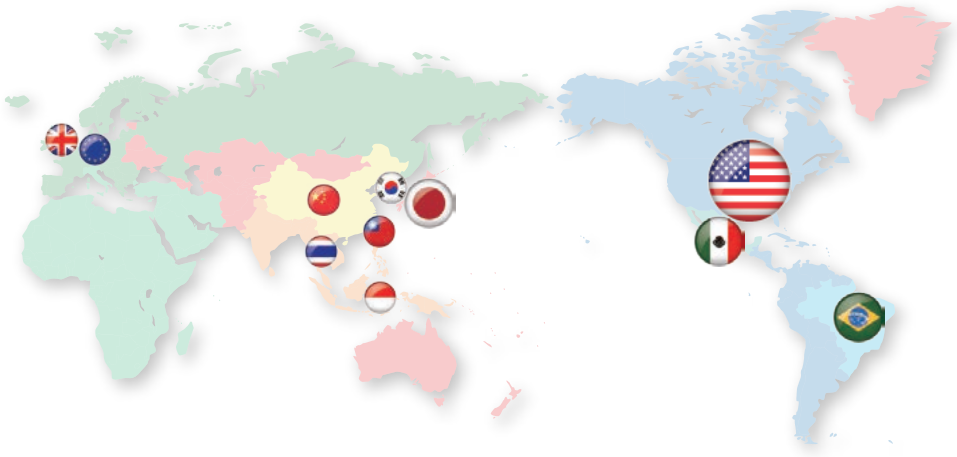

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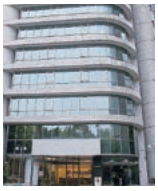

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【March.,2020】