

solar
DIAMOND



PCD & PCBN Tools



An Introduction to Solar Cutting Tools : PCD & CBN

Natural Diamonds

Diamond is the hardest known to the mankind and only diamond can process the hardest of all materials. Natural Diamond is very hard, is also very sensitive to impact, vibrations and heat caused while machining.

Although natural diamond can perform better than conventional tools on certain material, it proves to be economically unviable. This is due to not only the high cost of natural diamonds but also the additional costs involved in investing in a range of new machines.

Synthetic (Man-made) Diamonds

By man's ingenuity through the manufacture of Polycrystalline Diamond (PCD) Cutting Tools, the Problems posed by Natural Diamond have been eliminated. The main characteristics of PCD cutting tools are the great economics achievable in terms of cost per component, their repeatability and their predictable long life.

PCD has all the positive properties of natural diamond, thus there are no sacrifices made on the hardness of the tool or the surface finish of the component.

A Brief Overview of the Manufacturing Process of PCD

Man-made diamonds are produced from the purest form of graphite. Under conditions of high pressure and temperature, in the presence of certain catalysts, graphite gets converted to micron-sized diamond crystals. The crystals are then finely graded and sintered together with tungsten carbide to produce different grades of PCD blanks.

1 : Typical Physical Properties of Tungsten Carbide Substrate

Transverse rupture strength	390 x 10 ³ psi	2700 MPa
Ultimate compressive strength	600 x 10 ³ psi	4140 MPa
Ultimate tensile strength	210 x 10 ³ psi	1450 MPa
Modulus of elasticity	80 x 10 ³ psi	551 MPa
Proportional limit	140 x 10 ³ psi	965 MPa
Ductile percent elongation	0.3	
Charpy impact strength	17 in-lbs	19.3 Joules

Applications of PCD Cutting Tools

PCD Cutting Tools are used to machine non-ferrous components.

PCD tools are most frequently applied in the automobile Industry - comprising both heavy and light motor vehicles. Some of the materials that have been cost effectively machined with solar PCD Tools include aluminium alloys, copper, bronze, abrasive plastic composites etc.

The most significant application of PCD Cutting Tools, in this new generation of aluminium engine manufacturing, is to machine dissimilar materials such as aluminium engines with grey cast iron cylinder liners - either cast or pressed along with the aluminium - which have to be finish machined along with the aluminium blocks.

2: Comparison of Abrasion Resistance and Hardness of Polycrystalline Diamond vs. Single Crystal Natural Diamond and Carbide

Product Tested	Relative Abrasion Resistance	Indentation Hardness (Kg/mm ²)
Diamond layer of PCD Blank	250	6500-8000
Single-crystal diamond	96-245	8000-12000
Code C-2 cemented tungsten carbide (ISO-K20)	(Not available)	1800-2200

Cubic Boron Nitride (CBN) Tools

Cubic Boron Nitride (CBN) is the hardest and most abrasion resistant material known to man, next only to Diamond.

The manufacturing process and physical properties of CBN are very similar to those of PCD, except that instead of graphite, boron nitride is the building block for CBN. Like graphite, boron nitride is subjected to high temperature and pressure in the presence of catalysts to form cubic crystals of various micron sizes. These crystals are then graded and sintered together with tungsten carbide as the substrate, to form integral CBN blanks.

Like in PCD, the crystals within a CBN blank are also randomly oriented resulting in uniform hardness and abrasion resistance in all directions. The toughness of cemented tungsten carbide combined with the hardness of the CBN layer enables CBN Cutting Tools to withstand the high cutting forces encountered while taking heavy cuts in tough, hard-to-machine material. It also results in high impact resistance needed to withstand the shocks of severe interrupted cuts.

The CBN layer also has very high thermal conductivity - much higher than carbides and especially higher than ceramics. This allows the cutting tools to dissipate the heat generated at very high speeds of machining applications much more efficiently than seen with either carbide or ceramic tools. Unlike conventional cutting tools, CBN does not weaken or soften at very high temperatures. At machining temperatures up to 1000°C, polycrystalline CBN has the advantage of being completely chemically inert as well as retaining its strength and hardness at the cutting edge.

3: Properties of CBN and Hardness Comparison with Tungsten Carbide and Alumina

Transverse Rupture Strength	105 x 10 ³ psi	724 MPa
Modulus of Elasticity	125 x 10 ⁶ psi	862 MPa
Knoop Hardness: CBN	3500 kg/mm ²	
WC k-10	1800 kg/mm ²	
Alumina	2700 kg/mm ²	

The current trend is that of CBN Cutting Tools replacing conventional grinding because of their ability to achieve removal rates up to 10 times greater than grinding.

CBN is available in three different grades, defined by the application for which they are used:

- For rough machining of hard, super alloy or cast iron, **CBN tools with approximately 90%** by volume of CBN, along with titanium nitride and other binder materials are used.
- For finishing of hard metals and alloys, **CBN tools with approximately 65%** by volume of CBN, along with titanium nitride and other binder materials are used.
- For heavy material removal rate and heavy interrupted cuts, **Solid CBN** is used. This type of CBN has no carbide backing; instead, CBN crystals and ceramic phases are sintered together using an advanced high pressure-high temperature process. The Solid CBN has enhanced properties of high fracture toughness, wear resistance and chemical stability making it ideal for this type of heavy machining. The ceramic component provides improved chemical stability, enabling the superior qualities of CBN to be utilised in high-speed finish machining environments.

Another observable trend is the increase in use of round inserts. This shape of inserts has proved to be the strongest and most economical shape. It is the ideal shape when machining large rolls or parts, which demand longer machining time and therefore are likely to generate a large amount of heat. Thus, round inserts are used in the machining of hard facing alloys, hardened steel rolls, powdered metals and hard and soft grey cast iron.

Traditional methods of following up the machining process with grinding have undergone a drastic change with the advent of material such as PCD and CBN. Because of their high abrasion resistance and their ability to machine the hardest material in industry, both PCD and CBN fall into the special category of **Superabrasives**.

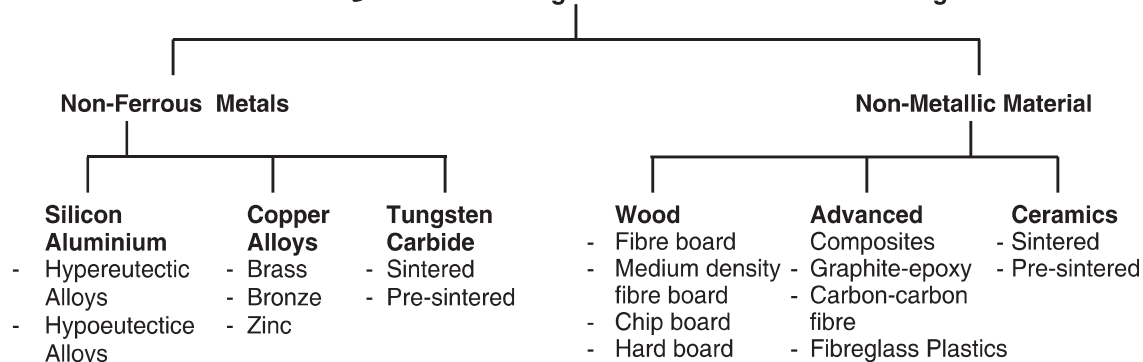
When does one use Superabrasives?

- a For consistent and superior quality on work pieces
- b For difficult to machine material
- c For high-production applications
- d For a jump in productivity
- e For longer tool life

4: Who can use Solar PCD Cutting Tools?

Industries	Applications	Parts
Automotive	- Rough and finish machining of aluminium alloys - Turning, boring, milling and grooving - Dissimilar metal machining - Metal matrix composites	- Transmission cases - Wheels, gear housings - Cylinder heads - Pistons - Aluminium engine blocks with cast iron cylinder lining - Break rotors, pulleys - Cylinder liners - Turbine blades
Aerospace, Defence	- Rough and finish Machining of aluminium alloys, phenolics, composites, polymids, graphite and epoxy	- Aircraft structural parts - Jet engine parts, missile system
Electrical Industries	- Turning and boring	- Commutators, slip rings - Aluminium housing, bushes
Wood Working	- Machining of wood and wood products	- Furniture, log houses, pencils, cabinets

Materials on which Solar PCD Cutting Tools can be used can be categorised into



General Guidelines for Machining with Solar PCD Tools

PCD Tools must be properly prepared and used under conditions that will promote the highest machining performance. To maintain good quality control over the part, it is always wise to establish the life or "cut-off point" of the cutting edge (usually defined by the number of parts machined) and make a practice of changing the cutting tool at that point. If PCD cutting tools are run until they are excessively worn, they will cut inefficiently, increasing machining time and the required cutting force. This, in turn, will result in poor surface finishes and affect the accuracy and geometry of the parts.

The following table provides certain machining guidelines. These guidelines show the conditions within which PCD is being effectively used to machine different materials.

Working Parameters for PCD Cutting Tools					
Material Aluminum alloy	Cutting Speed		Feed Rate		D.O.C.
	ft / min	m / min	in / rev	mm / rev	in mm
(4 - 8 % Si)	4200 ~ 6500	1280 ~ 1980	0.004 ~ 0.025	0.10 ~ 0.63	0.1 ~ 4.0
(9 - 14 % Si)	3300 ~ 5200	1000 ~ 1580	0.004 ~ 0.020	0.10 ~ 0.50	0.1 ~ 4.0
(15 - 18 % Si)	1000 ~ 2300	305 ~ 700	0.004 ~ 0.015	0.10 ~ 0.40	0.1 ~ 4.0
Copper alloys	900 ~ 3000	300 ~ 1000	0.002 ~ 0.006	0.05 ~ 0.15	0.05 ~ 2.0

General Guidelines for Machining with Solar CBN Tools

In general, for machining materials such as pearlitic grey cast iron, powdered metals, high temperature alloys and hardened ferrous metals (>45 HRC) where several interrupted cuts are involved, the higher percentage CBN grade is used.

The higher percentage ceramic-based CBN can be used for rough and finish machining of hardened ferrous metals (>45 HRC), operations where hard turning is replacing grinding and for continuous as well as interrupted cuts in finish machining.

While using CBN tools, the following guidelines are recommended:

- Use rigid machines with sufficient horsepower
- Keep minimum tool overhang
- Use negative rake tools and largest lead angles whenever possible
- Although use of coolant is not mandatory, cutting fluid is generally recommended on long-cut operations
- A proper chamfer should be ground on the cutting edge to minimise edge chipping and increase edge strength. Larger angles and width may be required for severely interrupted cuts. Radius honing is also recommended for severely interrupted cuts

Solar Polycrystalline Cubic Boron Nitride Cutting Tools Application guidelines in Production

Workpiece Material	Hardness in HRC.	Operation	Types of Parts	Speed in (mts/min)	Feed in (mm/rev.)	Depth of cut in mm.	Coolant
Gray C. I.	210 Bhn	Turning	Trans. Hsg.	120-190	0.175	0.62	Yes
Gray C. I.	160 Bhn	Grooving	Ring	100-150	0.04	-	Flood
Gray C. I.	160 Bhn	Boring	Cyl. Liner	900-1000	0.10	0.30	Dry
Gray C. I.	160 Bhn	Boring	Oil pump Case	200-240	0.05	0.20	Flood
Gray C. I.	160 Bhn	Turning	Trans. Oilpump	200	0.25	0.26	Dry
Gray C. I.	200 Bhn	Turning	Brake Drum	550	0.35	0.75	Dry

Workpiece Material	Hardness in HRc.	Operation	Types of Parts	Speed in (mts/min)	Feed in (mm/rev.)	Depth of cut in mm.	Coolant
Rene 77	35 HRc	Turning	Jet Turbine	300	0.23	1.25	Flood
Boron Steel	58-61 HRc	Boring	Roll	105	0.25	0.40	Dry
4620 Steel	60-62 HRc	Milling	Spiral Gear	130	0.015	1.0	Dry
D2 Steel	62 HRc	Milling	Bumper Die	130	-	1.0	Flood
Flame Spray Cobalt	44 HRc	Turning	Valve Seat	130	0.07	0.50	Flood
8620 Steel	59-61 HRc	Turn, Face	Differential Gear	110	0.30	0.25	Flood
Forged Steel	68 HRc	Turning	Big Roll	100	0.62	1.50	Compressed Air
4322 Steel	62 HAc	Milling	Helical Gear	52	0.10	0.12	Dry
8620 Steel	60 HRc	Turning	Pinion Gear	122	0.23	0.20	Flood
4023 Steel	60 HRc	Boring	Ring Gear	115	0.15	0.15	Flood
Ni-Hard C.I.	53-56 HRc	Turn, Face Boring	Pump Case Impellers	100	0.25	0.25	Dry
Hard C.I.	40 HRc	Turning	Shaft	175-200	0.75	0.15	Flood
Nodular C.I.	45-50 HRc	Face, Plunge Turning	Transmission Housing	100	1.00	0.31	Flood/Dry
Ni-Resist Aust Cast Iron	40 HRc	Plunge, Groove	Piston Rings	130	0.08	6.25	Flood
Nodular C.I.	240 Bhn	Finish Bore	Axel Supp.	138	0.64	0.5	Flood
Sintered Iron	120 Bhn	Turn, Groove	Pump Cover	335	0.25	0.41	Flood
Gray C.I.	210 Bhn	Turning	Transmission housing	120-190	0.175	0.62	Flood
Gray C.I.	210Bhn	Cylinder Boring	Engine Block	803	0.10	0.25	Dry
Gray C.I.	220 Bhn	Turning	Trans. Clutch	730	0.20	0.50	No
Gray C.I.	220 Bhn	Turn, Facing	Brake Drum	850	0.60	1.75	No
Gray C.I.	210 Bhn	Boring	Engine Cyl.	1100	0.35	0.20	Yes
Gray C.I.	290 Bhn	Facing	Flywheel	700	0.16	1.25	Yes
Gray C.I.	220 Bhn	Facing	Brake rotor	480-280	0.55	1.5	No
Gray C.I.	210 Bhn	Boring	Engine Cyl.	630	0.35	0.37	Dry
Gray C.I.	200 Bhn	Boring	Valve housing	270	0.15	0.37	Dry
Gray C.I.	200 Bhn	Milling Front	Engine Block	1430	0.25	0.75	Dry
Gray C.I.	230 Bhn	Turning Journel Brg.	Cam Shaft	450	0.42	2.25	Yes
Gray C.I.	210 Bhn	Turning	Clutch Plate	1370	0.35	2.5	Yes

A Special Note on Milling with Solar PCD/CBN Tools and Inserts

It is a well-known fact that in the modern industrial scenario of higher productivity, milling is one of the most popular methods of machining.

With the break through of CNC machines, milling operations are increasingly replacing other conventional machining operations in industries like the mould and die making industries, the automotive industries and the mining and machine tool industries. These modern machines are capable of removing heavy stock at rates faster than any other known method and also with considerably tighter tolerance. Moreover, PCD/CBN Cutting Tools have enabled many difficult-to-machine applications to be performed with greater ease. Thus, operations such as high speed milling of die blanks with form generation and high speed milling of Aluminium alloys, achieving surface finishes of 0.4 to 0.8 μ in Ra value, are much more feasible with the use of these tools on rigid machinery. Machine tool manufacturers, working along with the tool manufacturer, have made it possible for machines to be available with more rigidity and higher spindle speed.

The goal of all the manufacturing industries is to achieve minimum cost per piece or maximum production rate on a given machining operation. This can be achieved first by the correct selection of the application process and having chosen the process, the next step involves the correct selection of tooling and parameters.

PCD/CBN Tools have helped in making this second step of selection much easier, requiring only a simple economic analysis of the machining operation to determine the optimum cutting speed yields minimum cost per piece or maximum production rate.

PCD Tools compete directly against carbide in milling operations. Ceramic or silicon nitride is attempting to bridge the gap between PCD and carbide, but PCD has a clear advantage over all other tooling material. The benefit seen in milling with PCD versus carbide on non-ferrous and non-metallic applications is enormous. An increase in tool life of up to 100 times is common. Additional benefits include better tolerance control on the component, better surface finish and minimal burring. This translates into less scrap, more machine uptime and better tool cost justification.

PCD is gaining and will continue to gain in importance with the introduction of new composite materials that are being used in the aerospace, automotive and other industries. Face milling, end milling, drilling and reaming are the operations popularly performed on this material. PCD is found to have tremendous advantages in performance while machining the complex microstructures of the new composite materials.

Another new application is the milling of dissimilar metals (for example, Aluminium and cast iron) in engine blocks, as mentioned earlier in this catalogue.

The key to success when designing the PCD milling insert is paying close attention to the milling cutter and insert geometries. In many instances, when carbide is used in milling operations, high rake angles ($>20^\circ$) and high clearance angles ($>25^\circ$) are required. These geometries are no longer necessary when using PCD. In fact, in many cases, the reduced rake angle of 5° and clearance angles of 10° have provided a more rigid setup allowing for successful applications in milling of tough material with severe interrupted cuts.

All in all, PCD Milling inserts offer excellent economy through an increase in tool life and by making it possible to achieve high quality at high speeds. Cutting speeds as high as 3000 mts/min, with feed of 2500 mm and depth of cut per pass -2.5 mm are possible. Dry running can easily be applied and the results are excellent with surface finish of 0.8 to 0.4 in Ra and flatness within 30 microns. The economic benefits of using PCD are further contributed to when considering the time saved by eliminating frequent machine-downtime processes such as tool changing and indexing.

PCBN Milling inserts are generally used on cast iron and steel. The geometry of the milling cutter has a significant impact on the performance of the PCBN tool. As regards the rake angle, which is measured from the center of the tool, negative axial-negative radial rake milling cutters are preferred for PCBN applications. An important advantage; of such double negative cutter is that the tools are able to withstand higher cutting forces without fracturing.

The edge preparation of the cutting tools is also important. An edge chamfer of 15°.- 20° for widths of 0.20-0.25 mm along with edge honing of the radius is a must, depending on the application and Job materials.

The combination of negative cutter geometry and chamfer will produce higher cutting forces and require more horsepower, generating very high temperatures. Although these types of machining conditions may not seem ideal, they are, in fact, exactly the right conditions while machining with PCBN. This is because PCBN works better near the eutectic temperature of the material and removes metal more efficiently. The results demonstrate that one has to reevaluate the machine processes in the context of the capabilities of PCBN tools. The use of PCBN tools in milling can be an effective method of increasing material removal rates and productivity while reducing overall machining cost.

Important formulae for milling

v = cutting speed in m/min.

D = milling cutter diameter

N = milling cutter speed (R.P.M.)

Sz= feed per tooth

Z = number of teeth

S = feedrate per revolution

Fz = feedrate in mm/min.

Metric

$$1) V = \frac{D \cdot r \cdot N}{1000}$$

$$2) N = \frac{V \cdot 1000}{D \cdot r}$$

$$3) F_z = S_z \cdot Z \cdot N$$

$$4) S_z = \frac{F_z}{Z \cdot N}$$

$$5) S_z = \frac{F_z}{W}$$

$$6) Z_z = \frac{F_z}{S_z \cdot N_z}$$

Inch

$$V = \frac{r \cdot D \cdot N}{12}$$

$$N = \frac{12V}{D}$$

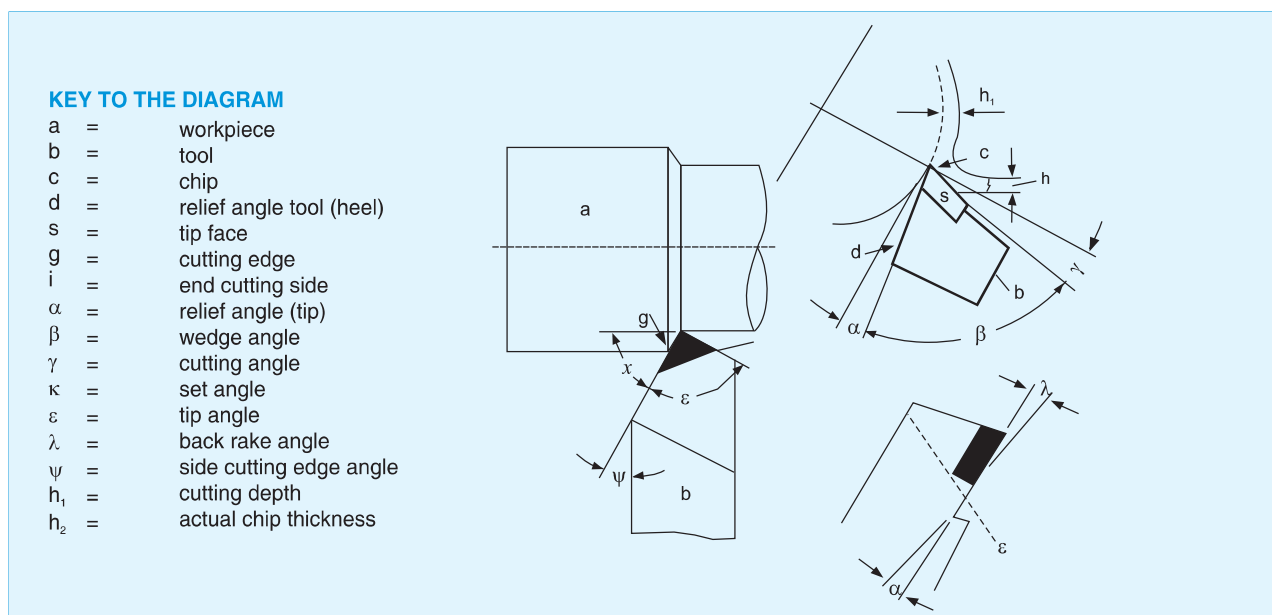
Remaining formulae same as metric

Information for Users

PCD and CBN Cutting Tools developed by Solar provides an economical and time-saving solution to the machining of soft /hard/brittle materials. Our collaborators experience allows us to define the right cutting technology for each application.

Solar are conscious of the continuous development taking place in the application of PCD and CBN and are willing to assist the user in discovering new advantages of technologies that may still seem difficult.

please See Diagram for basic Information.



Technical advantages of Solar PCD turning and milling tools as compared to tungsten carbide:

1. Better surface finish
2. Interrupted-cut without any problems
3. Better ratio of surface finish to cutting forces and metal removal rate.
4. Lower cutting forces
5. Higher cutting speeds, feed rates and cutting depths
- 6.
7. Tool life generally many times more than that of tungsten carbide tools
8. Possibility of closer dimensional tolerances

Technical advantages of Solar CBN turning tools, as compared to tungsten carbide, ceramics or grinding:

1. Turning of extremely tough materials otherwise hard to be ground
2. High cutting speeds and metal removal rate
3. Tool life is substantially increased in comparison to carbide and ceramics
4. Excellent surface finish comparable to ground finish
5. Higher metal removal rate as compared to grinding
6. Possibility of very close tolerance machining due to extremely low tool wear
7. Although not replacing the grinding operation in totality, the use of Solar CBN tools has and will eliminate this operation in many cases.

Use of Coolant

For Solar PCD, Coolant is necessary for obtaining optimum surface finish and tool life. Coolant will avoid material build-up at the cutting edge. The coolant will also help to eliminate heat generation and chips

Cooling is an absolute must when machining thin-walled parts and tough materials. If the cutting operation has to be performed dry, the use of air blasting for cooling and chip removal is recommended. Chips can also be removed with a suction (vacuum) device.

Surface Finishes Achievable

Solar PCD:
Turning: RA_{MAX} 0.1
Milling: RA_{MAX} 2 to 6
Solar CBN:
 RA_{MAX} 0.2

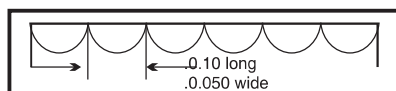
CBN must be used in dry conditions. In certain cases where multiple tools like HSS, Carbide, CBN etc. are used at the same time on the same component and coolant becomes essential, then special coated CBN Inserts are recommended.

Regrinding Prolongs Tool Life

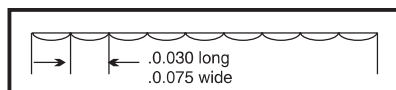
When the cutting edge of a **Solar** Tools becomes dull from normal flank wear, erosion, rounding or microchipping, it can be resharpened by regrinding. Regrinding prolongs tool life, thereby minimizing the cost of the tool. The following chippage code should be followed when deciding whether or not the used Solar tools can be reground:

Examine the cutting edge under 20X magnification for sharpness and quality.

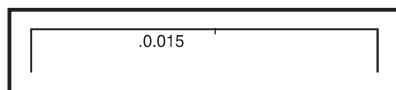
Heavy Chipping - Edges with chips averaging 0.050 mm wide x 0.10 mm long along the entire cutting edge, visible with a 20X eyepiece cannot be reground.



Medium Chipping - Edges with chips averaging 0.030 mm x 0.075 mm along the edge, but not connected, again visible with a 20X eyepiece, also cannot be reground.



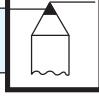
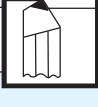
Fine Chipping - Edges with chips that are not visible with a 20X eyepiece, but can be seen at higher magnification, can be reground & Chips averaging 0.015 x 0.040 along the edge.



The Solar Team and our collaborators Fiudi, Italy expertise, is at your disposal to help you to reach optimum results in your machining processes. Please do not hesitate to use the enormous possibilities.

Operation

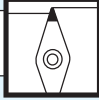
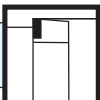
Cutting edge shape

									Type	Page
Turning	Facing	Chamfering	Plunging	Threading	ID turning	Face milling	Corner milling	Profile turning		
●	●				●				SD-AC 	12
●	●		●				●		SD-AD 	12
●	●		●				●		SD-AS 	12
●		●							SD-BS 	12
●	●	●	●				●		SD-DS 	12
●	●	●	●				●		SD-ES 	13
●	●	●							SD-BRD 	13
		●			●				SD-BMT 	13
		●	●		●				SD-BMU 	13
	●	●			●				SD-BBC 	13
●	●	●			●				SD-BAS 	14
●	●	●			●				SD-BAR 	14
	●	●			●				SD-BBE 	14
		●			●				SD-SDT 	14
	●		●		●				SD-SDS 	14
●	●	●		●	●		●		TPUN 	15
●	●	●			●	●	●		TNMA/TNMG 	15
					●				TCMW 	15
●	●	●			●				SNMA/SNMG 	15

* Tolerance specifaion required
 * Specify CBN while ordering

Operation

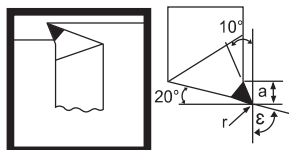
Cutting edge shape

										Type	Page
Turning	Facing	Chamfering	Plunging	Threading	ID turning	Face milling	Corner milling	Profile turning	Grooving		
●		●			●						16
●					●						16
●					●						16
●			●	●	●			●			16/18
						●	●				16/18
●					●			●			17
●					●			●			17
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●					●			●			17
●	●				●						17
●	●				●						17
									●		20-22
●	●	●			●						22
											19

Tolerance specification required
Specify CBN while ordering

BRAZED TOOLS

SD-AC



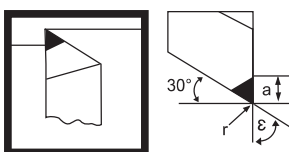
Nose Angle ε 60°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

Order No.	Shank Dimension in mm	Cutting edge ht. h in mm
ARC - 6	6 x 6 x 50	6
ARC - 8	8 x 8 x 65	8
ARC - 10	10 x 10 x 70	10
ARC - 12	12 x 12 x 85	12
ARC - 16	16 x 16 x 100	16
ARC - 20	20 x 20 x 125	20
ARC - 25	25 x 25 x 150	25

SD-AD



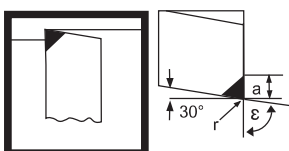
Nose Angle ε 60°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

Order No.	Shank Dimension in mm	Cutting edge ht. h in mm
ARD - 6	6 x 6 x 50	6
ARD - 8	8 x 8 x 65	8
ARD - 10	10 x 10 x 70	10
ARD - 12	12 x 12 x 85	12
ARD - 16	16 x 16 x 100	16
ARD - 20	20 x 20 x 125	20
ARD - 25	25 x 25 x 150	25

SD-AS



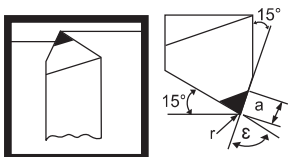
Nose Angle ε 82°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

Order No.	Shank Dimension in mm	Cutting edge ht. h in mm
ARS - 6	6 x 6 x 50	6
ARS - 8	8 x 8 x 65	8
ARS - 10	10 x 10 x 70	10
ARS - 12	12 x 12 x 85	12
ARS - 16	16 x 16 x 100	16
ARS - 20	20 x 20 x 125	20
ARS - 25	25 x 25 x 150	25

SD-BS



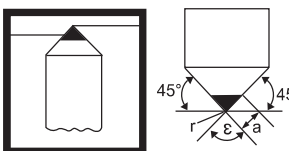
Nose Angle ε 90°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

Order No.	Shank Dimension in mm	Cutting edge ht. h in mm
BRS - 6	6 x 6 x 50	6
BRS - 8	8 x 8 x 65	8
BRS - 10	10 x 10 x 70	10
BRS - 12	12 x 12 x 85	12
BRS - 16	16 x 16 x 100	16
BRS - 20	20 x 20 x 125	20
BRS - 25	25 x 25 x 150	25

SD-DS



Nose Angle ε 90°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

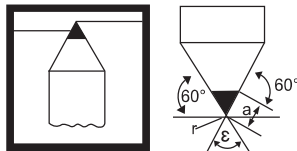
Order No.	Shank Dimension in mm	Cutting edge ht. h in mm
DS - 6	6 x 6 x 50	6
DS - 8	8 x 8 x 65	8
DS - 10	10 x 10 x 70	10
DS - 12	12 x 12 x 85	12
DS - 16	16 x 16 x 100	16
DS - 20	20 x 20 x 125	20
DS - 25	25 x 25 x 150	25

* Other tool nose radius on request
Other dimension on request.

R= Right hand cutting L=Left hand cutting (specify while ordering).
** Other cutting edge width available on request.

While ordering please specify PCD OR CBN

SD-ES



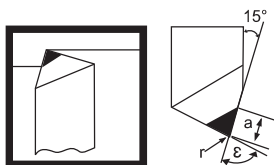
Nose Angle ε 60°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

Order No.	Shank Dimension in mm	Cutting edge ht. h in mm
ES - 6	6 x 6 x 50	6
ES - 8	8 x 8 x 65	8
EC - 10	10 x 10 x 70	10
EC - 12	12 x 12 x 85	12
EC - 16	16 x 16 x 100	16
EC - 20	20 x 20 x 125	20
EC - 25	25 x 25 x 150	25

SD-BRD



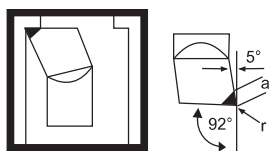
Nose Angle ε 90°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

Order No.	Shank Dimension in mm	Cutting edge ht. h in mm
BRD - 6	6 x 40	3.5
BRD - 8	8 x 50	4.5
BRD - 10	10 x 80	5.5
BRD - 12	12 x 100	6.5
BRD - 16	16 x 120	8.5
BRD - 20	20 x 140	10.5

SD-BMT



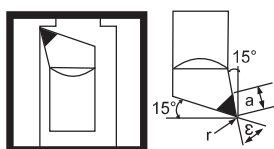
Nose Angle ε 83°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

Order No.	Shank Dimension in mm	Cutting edge ht. h in mm + 0.5mm above centre
BMT - 8	8 x 125	4.5
BMT - 10	10 x 150	5.5
BMT - 12	12 x 175	6.5
BMT - 16	16 x 200	8.5
BMT - 20	20 x 225	10.5
BMT - 25	25 x 250	13

SD-BMU



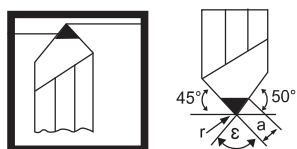
Nose Angle ε 60°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

Order No.	Shank Dimension in mm	Cutting edge ht. h in mm + 0.5mm above centre
BMT - 8	8 x 125	4.5
BMT - 10	10 x 150	5.5
BMT - 12	12 x 175	6.5
BMT - 16	16 x 200	10.5
BMT - 20	20 x 225	10.5
BMT - 25	25 x 250	13

SD-BBC



Nose Angle ε 85°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

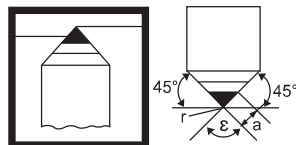
Order No.	Shank Dimension in mm	Cutting edge ht. h in mm + 0.5mm above centre
BBC - 3	3 x 10	2
BBC - 4	4 x 12	2.5
BBC - 5	5 x 15	3
BBC - 6	6 x 20	3.5
BBC - 8	8 x 35	4.5
BBC - 10	10 x 40	5.5
BBC - 12	12 x 50	6.5

* Other tool nose radius on request
Other dimension on request.

R= Right hand cutting L=Left hand cutting (specify while ordering).
** Other cutting edge width available on request.

While ordering please specify PCD OR CBN

SD-BAS



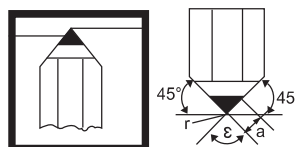
Nose Angle ϵ 60° & 90°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

Order No.	Shank Dimension in mm	Cutting edge ht. h in mm + 0.5mm above centre
BAS - 4	4 x 4 x 12	2.5
BAS - 5	5 x 5 x 15	3.0
BAS - 6	6 x 6 x 20	3.5
BAS - 8	8 x 8 x 25	4.5
BAS - 10	10 x 10 x 40	5.5
BAS - 12	12 x 12 x 50	6.5

SD-BAR



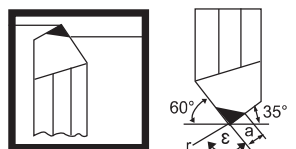
Nose Angle ϵ 60° & 90°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

Order No.	Shank Dimension in mm	Cutting edge ht. h in mm + 0.5mm above centre
BAR - 3	3 x 10	2.0
BAR - 4	4 x 12	2.5
BAR - 5	5 x 15	3.0
BAR - 6	6 x 20	3.5
BAR - 8	8 x 25	4.5
BAR - 10	10 x 20	5.5
BAR - 12	12 x 50	6.5

SD-BBE



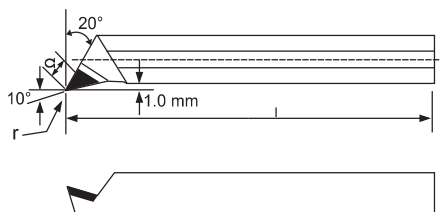
Nose Angle ϵ 85°

*Tool Nose Radius 0.4 & 0.8

**Width of cutting edge-a 4.5, 6.2

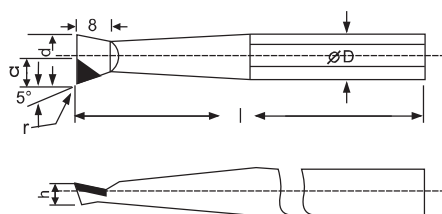
Order No.	Shank Dimension in mm	Cutting edge ht. h in mm + 0.5mm above centre
BBE - 3	3 x 12	2
BBE - 4	4 x 14	2.5
BBE - 5	5 x 16	3
BBE - 6	6 x 20	3.5
BBE - 8	8 x 35	4.5
BBE - 10	10 x 40	5.5
BBE - 12	12 x 50	6.5

SD-SDT



Order No.	Shank Dimension in mm	Cutting edge ht. h in mm + 0.5mm above centre
SDT - 4	4 x 50	2.5
SDT - 5	5 x 60	3.0
SDT - 6	6 x 70	3.5
SDT - 8	8 x 100	4.5
SDT - 10	10 x 120	5.5
SDT - 12	12 x 130	6.5

SD-SDS



Order No.	Shank Dimension d D l	Cutting edge ht. h in mm + 0.5mm above centre
SDS - 5	5 10 60	3.0
SDS - 6	6 10 60	3.5
SDS - 8	8 10 60	4.5
SDS - 10	10 12 70	5.5
SDS - 12	12 12 70	6.5

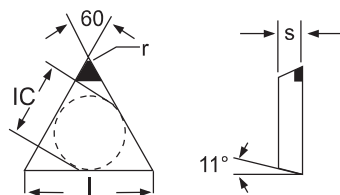
* Other tool nose radius on request
Other dimension on request.

R= Right hand cutting L=Left hand cutting (specify while ordering).
** Other cutting edge width available on request.

While ordering please specify PCD OR CBN

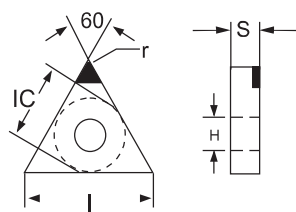
INDEXABLE INSERTS

TPUN



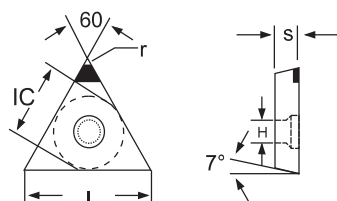
Description	IC	H	S	r
TPUN 110304	6.35	-	3.18	0.4
TPUN 110308	6.35	-	3.18	0.8
TPUN 160304	9.52	-	3.18	0.4
TPUN 160308	9.52	-	3.18	0.8
TPUN 160312	9.52	-	3.18	1.2

TNMA/TNMG



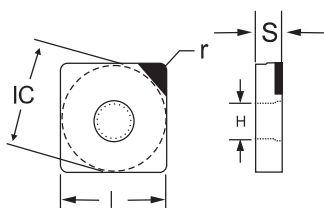
Description	IC	H	S	r
TNMA 160404	9.52	3.80	4.76	0.4
TNMA 160408	9.52	3.80	4.76	0.8
TNMA 160412	9.52	3.80	4.76	1.2
TNMG 160404	9.52	3.80	4.76	0.4
TNMG 160408	9.52	3.80	4.76	0.8
TNMG 160412	9.52	3.80	4.76	1.2

TCMW



Description	IC	H	S	r
TCMW 060102	3.97	2.3	1.60	0.2
TCMW 060104	3.97	2.3	1.60	0.4
TCMW 06T102	3.97	2.3	1.98	0.2
TCMW 06T104	3.97	2.3	1.98	0.4
TCMW 090202	5.56	2.5	2.38	0.2
TCMW 090204	5.56	2.5	2.38	0.4
TCMW 110204	6.35	2.8	2.38	0.4
TCMW 110208	6.35	2.8	2.38	0.8
TCMW 110304	6.35	2.8	3.18	0.4
TCMW 16T304	9.52	4.4	3.97	0.4
TCMW 16T308	9.52	4.4	3.97	0.8

SNMA/SNMG



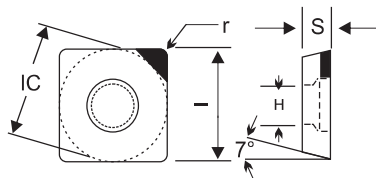
Description	IC	H	S	r
SNMA 120404	12.7	5.16	4.76	0.4
SNMA 120408	12.7	5.16	4.76	0.8
SNMA 120412	12.7	5.16	4.76	1.2
SNMG 120404	12.7	5.16	4.76	0.4
SNMG 120408	12.7	5.16	4.76	0.8
SNMG 120412	12.7	5.16	4.76	1.2

* Other tool nose radius on request
Other dimension on request.

R= Right hand cutting L=Left hand cutting (specify while ordering).
** Other cutting edge width available on request.

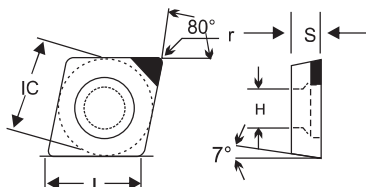
While ordering please specify PCD OR CBN

SCMW



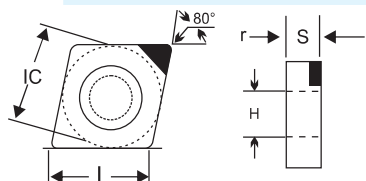
Description	IC	H	S	r
SCMW 09T302	9.52	4.4	3.97	0.2
SCMW 09T304	9.52	4.4	3.97	0.4
SCMW 09T308	9.52	4.4	3.97	0.8
SCMW 120404	12.7	5.5	4.76	0.4
SCMW 120408	12.7	5.5	4.76	0.8

CCMT



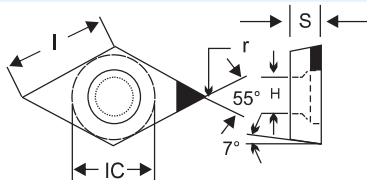
Description	IC	H	S	r
CCMT 060202	6.35	2.8	2.38	0.2
CCMT 060204	6.35	2.8	2.38	0.4
CCMT 090304	9.52	4.4	3.18	0.4
CCMT 090308	9.52	4.4	3.18	0.8
CCMT 09T302	9.52	4.4	3.97	0.2
CCMT 09T304	9.52	4.4	3.97	0.4
CCMT 09T308	9.52	4.4	3.97	0.8
CCMT 120404	12.7	5.5	4.76	0.4
CCMT 120408	12.7	5.5	4.76	0.8

CNMA/CNMG



Description	IC	H	S	r
CNMA 120404	12.7	5.16	4.76	0.4
CNMA 120408	12.7	5.16	4.76	0.8
CNMG 120404	12.7	5.16	4.76	0.4
CNMG 120408	12.7	5.16	4.76	0.8

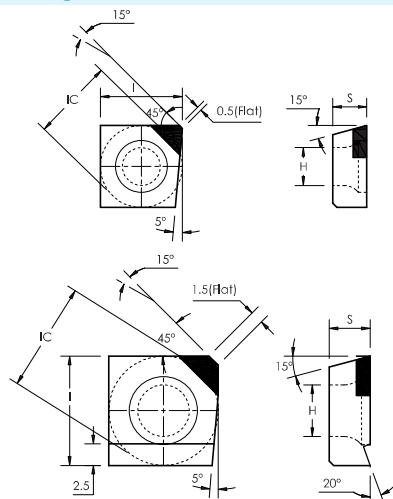
DCMT



Description	IC	H	S	r
DCMT 070202	6.35	2.8	2.38	0.2
DCMT 070204	6.35	2.8	2.38	0.4
DCMT 11T302	9.52	4.4	3.97	0.2
DCMT 11T304	9.52	4.4	3.97	0.4
DCMT 11T308	9.52	4.4	3.97	0.8

SNEW

Milling Inserts



Description	IC	H	S	r
SNEW 09T300 ADFR	9.52	4.4	3.97	-

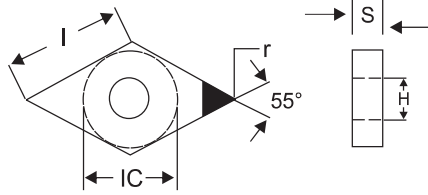
Description	IC	H	S	r
SNEW 120400 ADFR	12.70	6.0	4.76	-

* Other tool nose radius on request
Other dimension on request.

R= Right hand cutting L=Left hand cutting (specify while ordering).
** Other cutting edge width available on request.

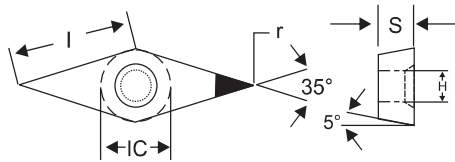
While ordering please specify PCD OR CBN

DNMA/DNMG



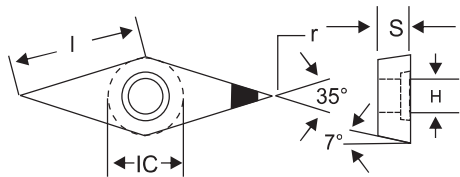
Description	IC	H	S	r
DNMA 150404	12.70	5.16	4.76	0.4
DNMA 150408	12.70	5.16	4.76	0.8
DNMA 150604	12.70	5.16	6.35	0.4
DNMA 150608	12.70	5.16	6.35	0.8
DNMG 150604	12.70	5.16	6.35	0.4
DNMG 150608	12.70	5.16	6.35	0.8

VBMT



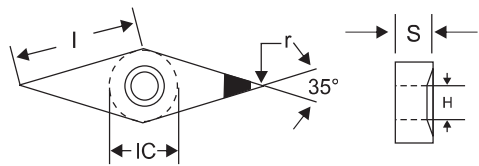
Description	IC	H	S	r
VBMT 080202	4.76	2.30	2.38	0.2
VBMT 080204	4.76	2.30	2.38	0.4
VBMT 080208	4.76	2.30	2.38	0.8
VBMT 110304	6.35	2.80	3.18	0.4
VBMT 110308	6.35	2.80	3.18	0.8
VBMT 160404	9.52	4.40	4.76	0.4
VBMT 160408	9.52	4.40	4.76	0.8
VBMT 160412	9.52	4.40	4.76	1.2

VCMT



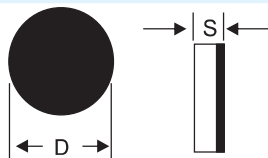
Description	IC	H	S	r
VCMT 080204	4.76	2.30	2.38	0.4
VCMT 110304	6.35	2.80	3.18	0.4
VCMT 110308	6.35	2.80	3.18	0.8
VCMT 16T304	9.52	4.40	3.97	0.4
VCMT 16T308	9.52	4.40	3.97	0.8
VCMT 16T312	9.52	4.40	3.97	1.2
VCMT 160404	9.52	4.40	4.76	0.4
VCMT 160408	9.52	4.40	4.76	0.8

VNMA



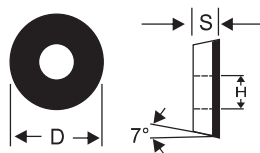
Description	IC	H	S	r
VNMA 160402	9.52	3.80	4.76	0.2
VNMA 160404	9.52	3.80	4.76	0.4
VNMA 160408	9.52	3.80	4.76	0.8
VNMA 160412	9.52	3.80	4.76	1.2

RNGN



Description	D	H	S	r
RNGN 090300T	9.52	-	3.18	-
RNGN 120300T	12.7	-	3.18	-
RNGN 120400T	12.7	-	4.76	-

RCMT



Description	D	H	S	r
RCMT 060200	6.35	2.50	2.38	-
RCMT 080300	8.00	2.90	3.18	-
RCMT 100300	10.00	4.50	3.18	-
RCMT 120400	12.00	5.00	4.76	-

* Other tool nose radius on request
Other dimension on request.

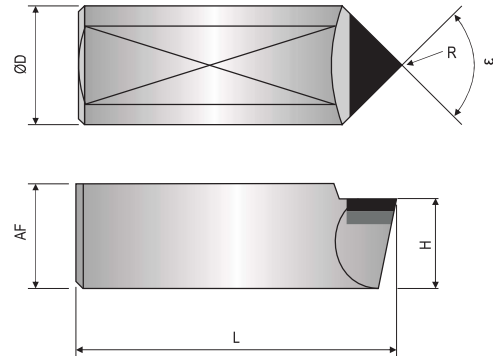
R= Right hand cutting L=Left hand cutting (specify while ordering).
** Other cutting edge width available on request.

While ordering please specify PCD OR CBN

O. D. TURNING TOOL

ØD	H	AF	L	R	ε
4.00	2.50	3.50	10.55	0.20	90°
8.00	4.50	7.00	21.20	0.40	90°
8.00	4.50	7.00	35.20	0.80	90°
8.00	4.50	7.00	21.00	1.00	90°
8.00	4.50	7.00	21.00	1.40	90°

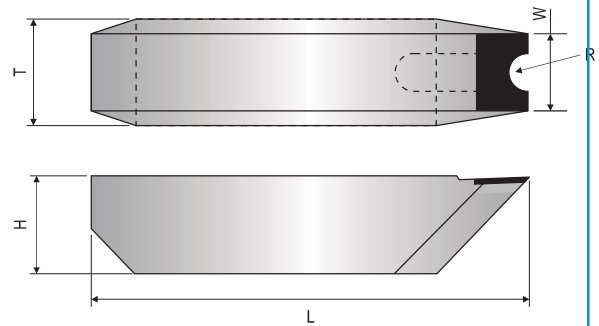
*All Dimensions are in mm.



TRIMMING TOOL

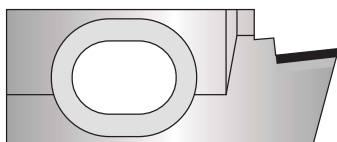
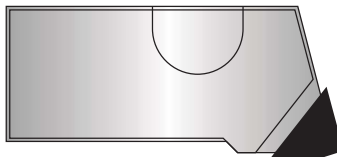
Sr. No.	W	T	H	L	R
01	7.46	10.40	9.40	42.00	1.8
02	7.46	10.40	9.40	42.00	2.34
03	7.46	10.40	9.40	42.00	2.6
04	7.46	10.40	9.40	42.00	3.0
05	7.46	10.40	9.40	42.00	6.2

*All Dimensions are in mm.

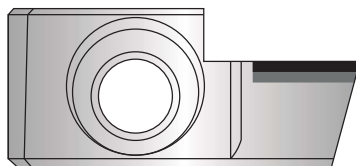
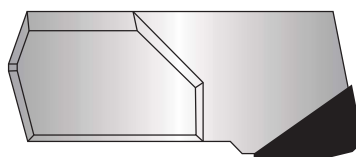


MILLING CARTRIDGE

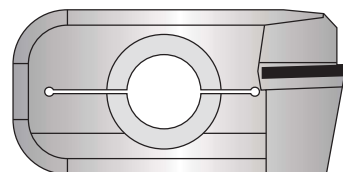
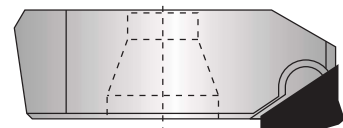
MILLING CARTRIDGE - DMI



MILLING CARTRIDGE - TGT



MILLING CARTRIDGE - RCM



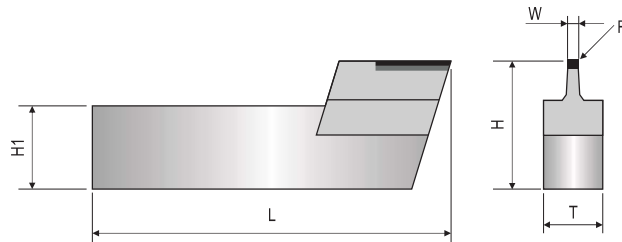
* Other tool nose radius on request
Other dimension on request.

R= Right hand cutting L=Left hand cutting (specify while ordering).
** Other cutting edge width available on request.

While ordering please specify PCD OR CBN

TANGENTIAL TOOL

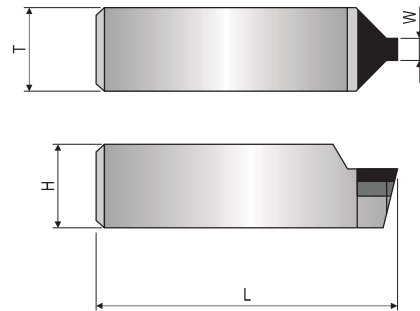
Sr. No.	W	T	H	H1	L	R
01	0.80	12.00	30.00	21.00	90.00	0.40
02	1.24	12.00	30.00	21.00	90.00	0.60
03	0.77	12.00	30.00	21.00	90.00	0.25
04	1.40	12.00	30.00	21.00	90.00	0.30



*All Dimensions are in mm.

CIRCLIP TOOL

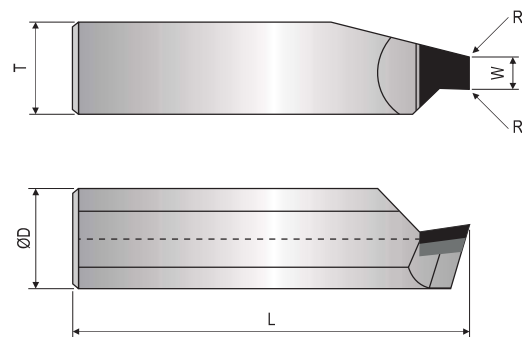
Sr. No.	W	T	H	L
01	1.35	5.00	5.00	18.00
02	1.35	5.00	5.00	24.00
03	1.82	5.00	5.00	25.00



*All Dimensions are in mm.

CIRCLIP TOOL

Sr. No.	W	ØD	T	L	R
01	2.39	6.00	5.50	24.00	0.20



*All Dimensions are in mm.

* Other tool nose radius on request
Other dimension on request.

R= Right hand cutting L=Left hand cutting (specify while ordering).
** Other cutting edge width available on request.

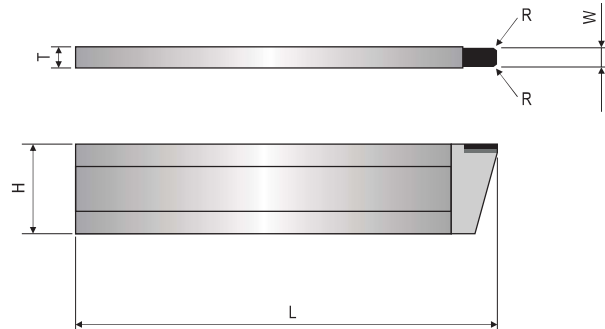
While ordering please specify PCD OR CBN

PCD & CBN GROOVING TOOLS

GROOVING TOOL CARBIDE SHANK

Sr. No.	W	T	H	L	R
1	1.25	1.25	15.00	75.00	0.50
2	2.16	2.16	15.00	75.00	0.25
3	3.64	3.64	15.00	75.00	1.00
4	4.04	4.04	15.00	75.00	0.25
5	5.00	5.00	15.00	7.00	2.00

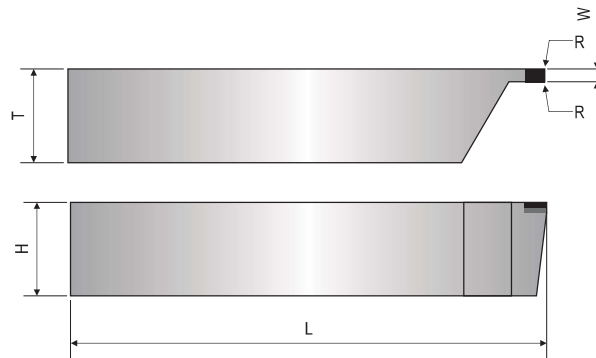
*All Dimensions are in mm.



GROOVING TOOL STEEL SHANK

Sr. No.	W	T	H	L	R
1	2.50	25.00	25.00	150.00	0.50
2	3.00	25.00	25.00	150.00	0.50
3	5.30	25.00	25.00	150.00	0.50

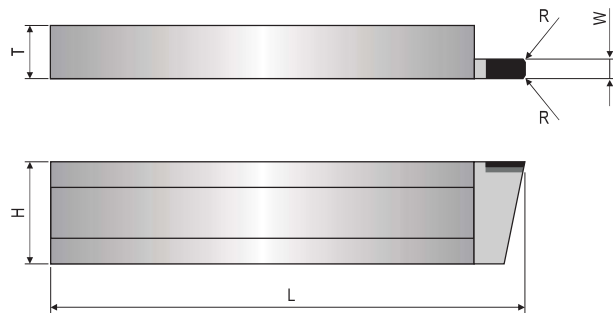
*All Dimensions are in mm.



GROOVING TOOL CARBIDE SHANK (LEFT HAND)

Sr. No.	W	T	H	L	R
1	0.82	2.92	18.50	80.00	0.25
2	1.67	5.06	16.00	75.00	0.25
3	2.02	2.02	15.50	80.00	0.25
4	3.263	7.24	16.00	55.00	0.30
5	4.56	4.56	16.00	75.00	0.30

*All Dimensions are in mm.



* Other tool nose radius on request
Other dimension on request.

R= Right hand cutting L=Left hand cutting (specify while ordering).
** Other cutting edge width available on request.

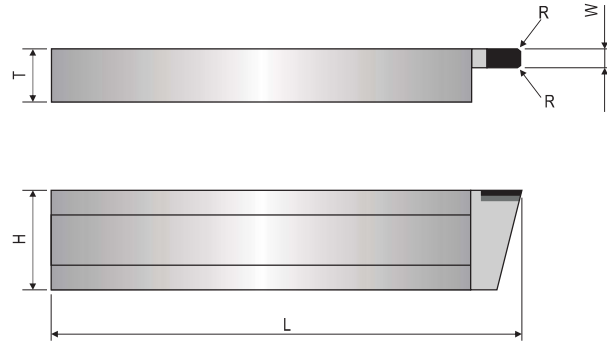
While ordering please specify PCD OR CBN

PCD & CBN GROOVING TOOLS

GROOVING TOOL CARBIDE SHANK (RIGHT HAND)

Sr. No.	W	H	T	L	R
1	0.82	9.50	3.02	75.00	0.20
2	1.02	9.50	3.02	75.00	0.25
3	2.445	15.00	6.44	75.00	0.25
4	4.057	15.00	6.00	75.00	0.95
5	5.10	15.00	8.00	72.00	1.00

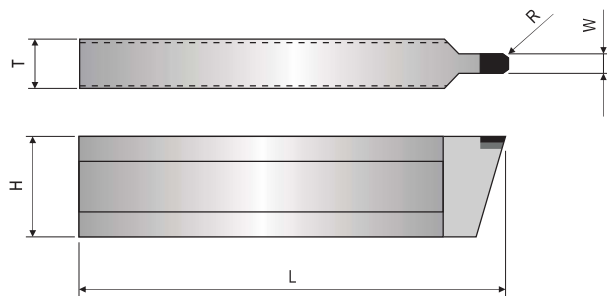
*All Dimensions are in mm.



GROOVING TOOL (SHOULDER TYPE)

Sr. No.	W	T	H	L	R
1	0.837	3.237	8.00	70.00	0.25
2	1.227	4.227	8.00	70.00	0.20
3	1.247	4.247	8.00	70.00	0.20
4	1.547	4.00	8.00	70.00	0.425
5	1.642	4.042	8.00	70.00	0.20

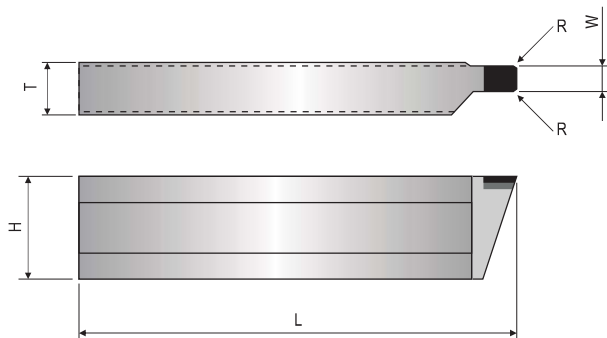
*All Dimensions are in mm.



GROOVING TOOL (ONE SIDE SHOULDER)

Sr. No.	W	T	H	L	R
1	1.527	3.180	8.00	70.00	0.30
2	2.032	2.235	8.00	70.00	0.40

*All Dimensions are in mm.

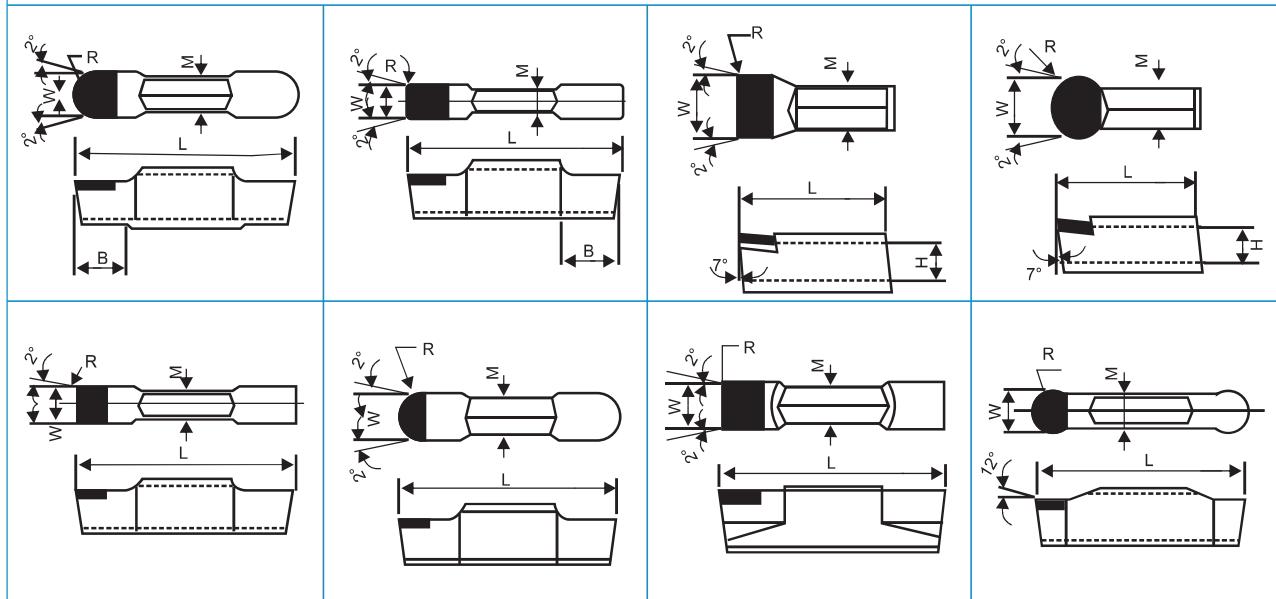
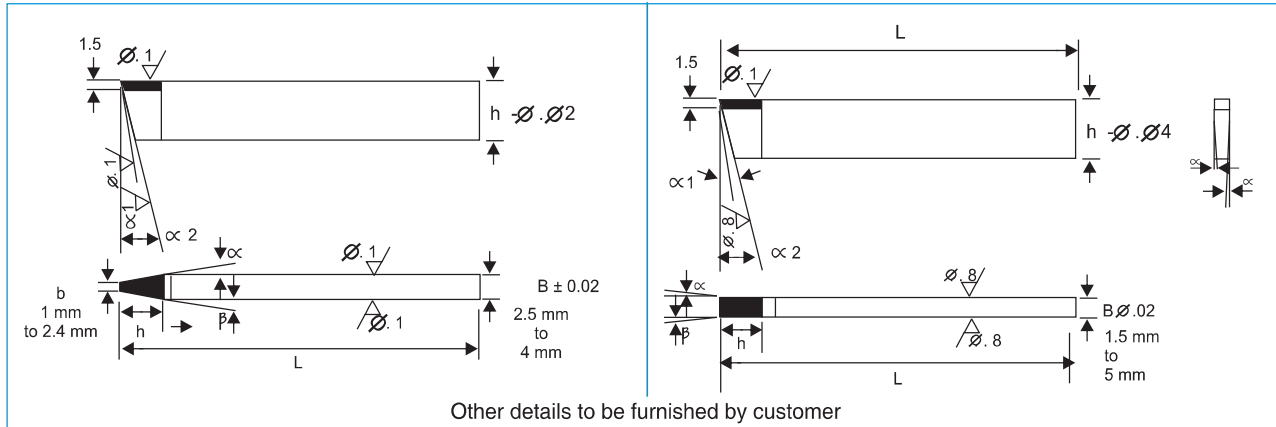


* Other tool nose radius on request
Other dimension on request.

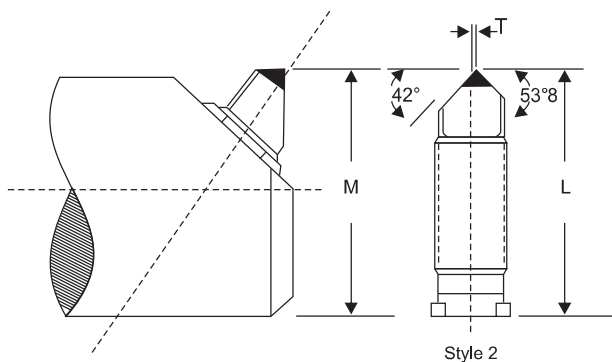
R= Right hand cutting L=Left hand cutting (specify while ordering).
** Other cutting edge width available on request.

While ordering please specify PCD OR CBN

SPECIAL GROOVING TOOLS & INSERTS



MICROBORE TOOLS



T = Tool Point Offset is on the Right of centre of cartridge

Note :

- All dimension in mm.
- 12° top rake can be used for Aluminium
- All specifications subject to change without notice.
- All left hand cartridge will have same Tool Geometry.
- While ordering please specify PCD or CBN

Microbore No.	M. Min Bore	Length	T
SD-M1 A2	16.1	14.2	0.4
SD-M1 B2	13.4	11.4	0.4
SD-M2 A2	21.1	19.9	0.4
SD-M2 B2	18.8	16.8	0.4
SD-M3 A2	26.1	25.5	0.8
SD-M3 B2	23.1	21.5	0.8
SD-M5 A2	41.4	39.8	1.2
SD-M5 B2	35.8	33.4	1.2
SD-M7 A2	58.8	55.7	1.6
SD-M7 B2	53.3	49.3	1.6

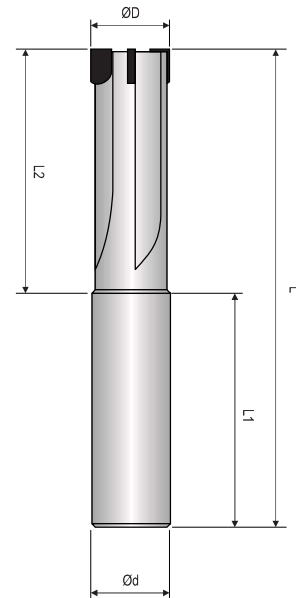
While ordering please specify PCD OR CBN

PCD & CBN REAMERS

4 FLUTE PARALLEL SHANK

D	d	L	L1	L2
Cutting Diameter	Shank Diameter	Overall Length	Shank Length	Working Length
10	10	80	50	30
12	12	80	50	30
14	16	80	50	30
16	16	80	50	30
18	20	80	50	30
20	20	100	60	40
22	25	100	60	40
25	25	100	60	40
28	25	100	60	40
32	25	100	60	40

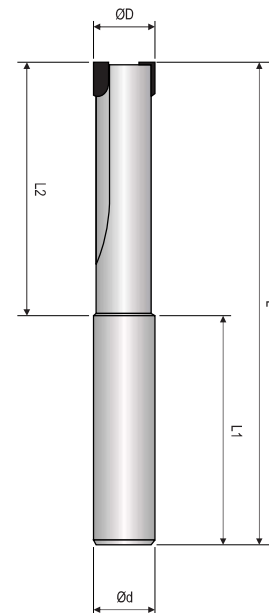
*All Dimensions are in mm.



2 FLUTE PARALLEL SHANK

D	d	L	L1	L2
Cutting Diameter	Shank Diameter	Overall Length	Shank Length	Working Length
06	08	80	50	30
07	10	80	50	30
08	10	80	50	30
10	10	80	50	30
12	12	100	60	40
14	16	100	60	40
16	16	100	60	40
18	20	100	60	40
20	20	100	60	40

*All Dimensions are in mm.



Other sizes can also be made on request

* Other tool nose radius on request
Other dimension on request.

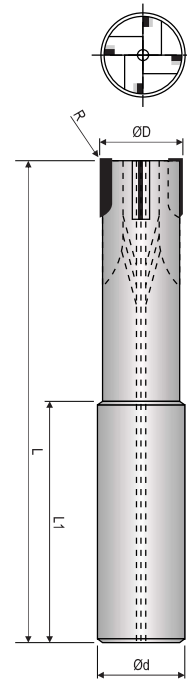
While ordering please specify PCD OR CBN

PCD & CBN ENDMILL

4 FLUTE STEEL SHANK

ØD	Ød	L1	L	R
16.00	16.00	50.00	100	0.80
14.00	14.00	50.00	100	0.80
12.00	12.00	50.00	100	0.80

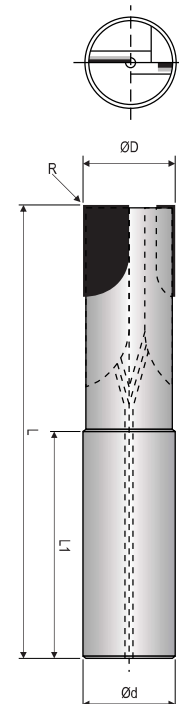
*All Dimensions are in mm.



2 FLUTE STEEL SHANK

ØD	Ød	L1	L	R
20.00	20.00	50.00	100	0.10
18.00	18.00	50.00	100	0.40
16.00	16.00	50.00	100	0.20
21.00	20.00	50.00	120	0.40

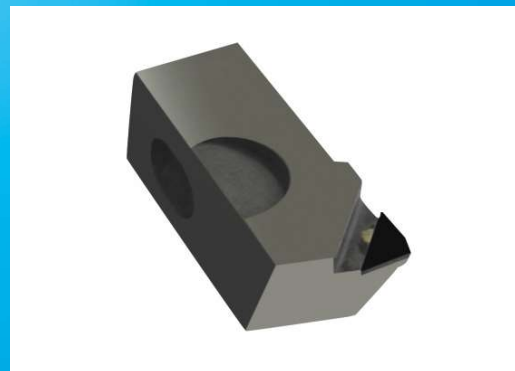
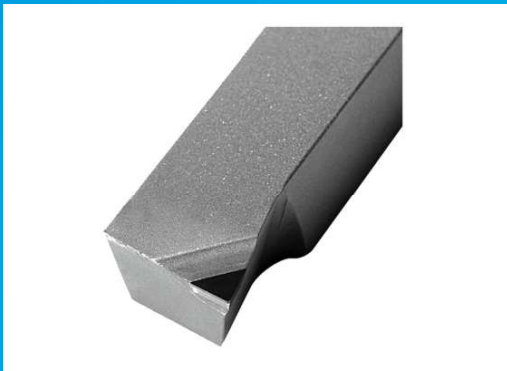
*All Dimensions are in mm.



Other sizes can also be made on request

* Other tool nose radius on request
Other dimension on request.

While ordering please specify PCD OR CBN





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