

Additional  
offset  
shank type!

# Multi functional milling cutters

**BXD** a new range of milling cutters for high performance machining of aluminum alloys and heat resistant materials.

■ Low resistance geometry and inserts with a rigid tool body. High aluminum removal rates of more than 3000 cc/min.

■ **LC15TF**  
New DLC-coated inserts for outstanding aluminum alloy machining performance.

■ **New offset shank type for deeper milling!**



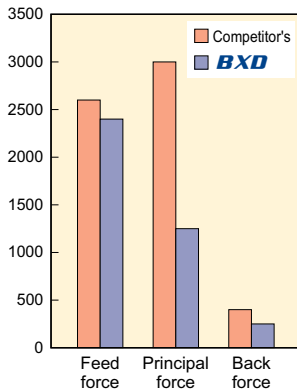
# Milling Cutters for Aluminum and Difficult-to-cut Materials

# BXD

## Features

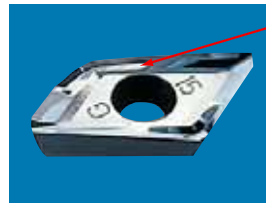
## Low Resistance & High Rigidity Inserts

Specially designed inserts for **BXD** cutters to give excellent performance and high efficiency milling on a wide range of materials.



### Cutting resistance of BXD

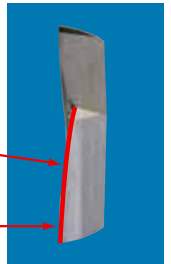
<Cutting conditions>  
 Workpiece : JIS A6061  
 Cutting speed : 1,000m/min  
 Width of cut : 60mm  
 Depth of cut : 2.0mm



Double phased helical rake angles

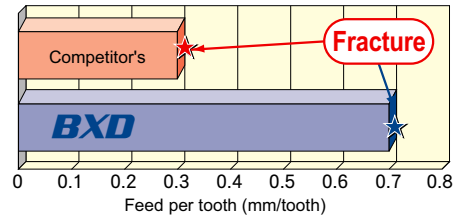
Helical flank

Concave cutting edge line



### Fracture resistance of BXD

<Cutting conditions>  
 Workpiece : JIS S55C  
 Cutting speed : 160m/min  
 Width of cut : 5mm  
 Depth of cut : 5mm



## Multi functional milling

**BXD** for excellent ramping and overall performance.

**② Ramping**  
 BXD4000 with  $\phi 25$ mm ...  
 20° ramping angle  
 BXD7000 with  $\phi 40$ mm ...  
 13° ramping angle.

**① Shoulder milling**

**④ 3D copying**

**⑥ Face milling**

**③ Pocketing**  
 No need for pre-machined holes when pocketing.  
 Up to 5mm sinking depth is possible.

**⑤ Slotting**

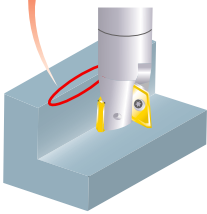
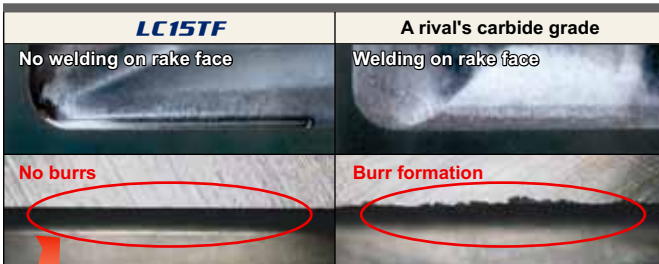
**⑦ Helical cutting**

# Grade Features

## LC15TF

Highly wear and fracture resistant micro-grain cemented carbide **TF15** coupled with Mitsubishi's unique, weld resistant DLC coating provides better surface finishes and enables stable, high-grade machining without burrs. **LC15TF** for both wet and dry machining.

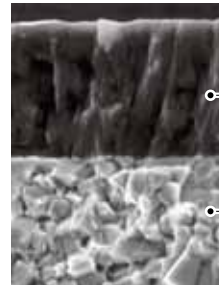
### ● Dry machining example in A5025



<Cutting conditions>

- Holder : BXD4000R322SA32S
- Insert : XDGT1550PDFR-G08
- Workpiece : JIS A5052
- Cutting speed : 200m/min
- Feed per tooth : 0.10mm/tooth
- Depth of cut : ap=5.0mm, ae=8.0mm
- Cutting time : 30 min
- Dry, Down cutting

## MIRACLE® Coated VP15TF



MIRACLE® coating (Al,Ti)N

Cemented carbide substrate **TF15**

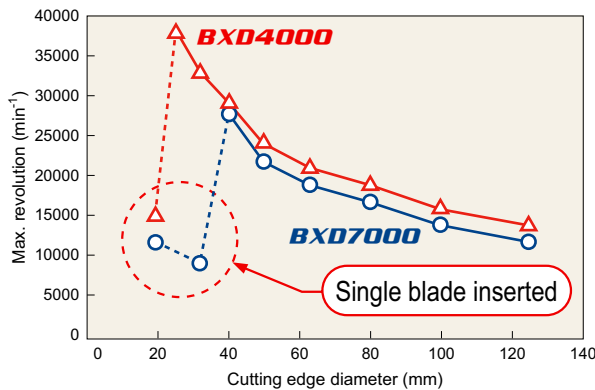
Wear and fracture resistant **TF15** substrate coupled with MIRACLE coating. For high oxidation resistance and adhesion strength to improve tool life on a wide range of difficult to cut materials.

## TF15

Micro-grain cemented carbide with superior resistance to wear and fracturing. **TF15** ensures stable cutting and efficient machining of aluminum alloy. The special mirror treatment on rake the rake face prevents chip welding for reliability and longer tool life.

# Secure High-revolution Milling!

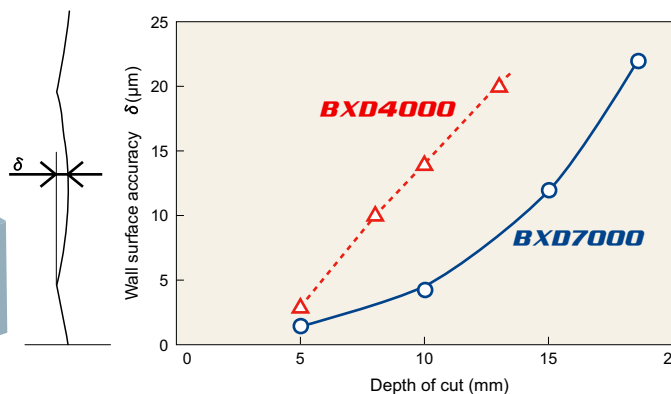
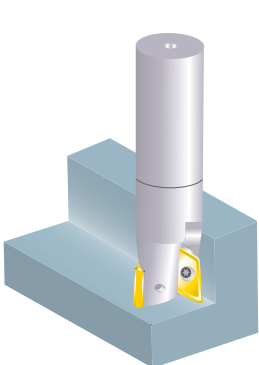
Specially designed screws and Mitsubishi's proprietary "Anti Fly Insert" mechanism (AFI mechanism) guarantees secure and safe high revolution milling.



AFI mechanism

# Excellent Wall Accuracy

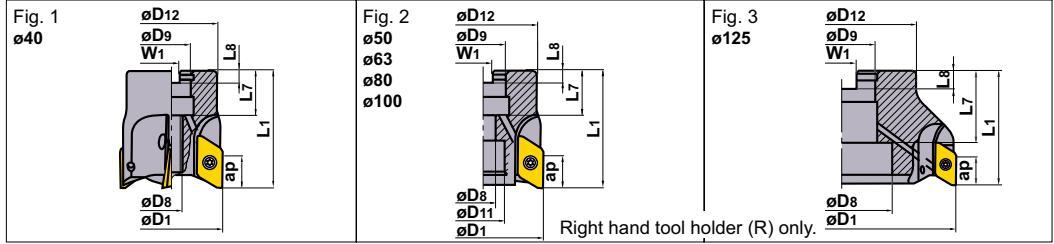
Specially designed G-class inserts with a helical cutting edge for excellent wall accuracy.



Data obtained from performance tests with BXD4000R252SA25 and BXD7000R402SA20S  
 Nose radius : R1.6  
 Revolution : 20,000 (min<sup>-1</sup>)  
 Feed per tooth : 0.2 (mm/tooth)  
 Width of cut : 3 (mm)  
 Workpiece : JIS A7075-T6  
 Wet cutting  
 Wall surface accuracy varies depending on the diameter of the tool.

# BXD

## Arbor type



Right hand tool holder (R) only.

● The following clamp bolts are supplied with each respective cutter

## Set bolt

Diameter		Set Bolt Order Number	Geometry	Geometry		
BXD4000	BXD7000			①	②	③
φ 40	—	LS24H	①			
—	φ 50	HSC08030H		②		
φ 50, φ 63	φ 63	10030H			③	
φ 80	φ 80	12035H				
φ 100	φ 100	16040H				
φ 125	φ 125	MBA20040H				

Light alloy	Cast iron	General steel	Stainless steel	Hardened steel
➔				

Type	Insert Corner Re	Order Number	Stock	Number of Teeth	Dimensions (mm)								Weight (kg)	Max. Depth of Cut ap	Max. Ramping Angle (°)	Max. Allowable Revolution (min <sup>-1</sup> )	Figure	Tools			
					D1	L1	L7	L8	D8	W1	D9	D11						D12	Clamp Screw	Wrench	Insert
BXD4000	A 0.4   3.2	BXD4000-040A03RA	●	3	40	50	18	5.6	M8	8.4	16	—	32	0.3	15	9	29,000	1	TS4SL	①TKY15W	XDGT1550 PDFR-GOO
		-050A04RA	●	4	50	50	20	6.5	11	10.4	22	17	41	0.4	15	6	24,000	2	TS4SL	①TKY15W	
		-063A05RA	●	5	63	50	20	6.5	11	10.4	22	17	50	0.7	15	5	21,000	2	TS4SL	①TKY15W	
		R08005CA	●	5	80	50	26	6	13	9.5	25.4	20	60	1.1	15	3	19,000	2	TS4SL	①TKY15W	
		R10006DA	●	6	100	63	32	8	17	12.7	31.75	26	70	2.0	15	3	16,000	2	TS4SL	①TKY15W	
		R12507EA	●	7	125	63	40	10	56	15.9	38.1	—	80	2.8	15	2	14,000	3	TS4SL	①TKY15W	
BXD4000	B 4.0   5.0	BXD4000-040A03RB	●	3	40	50	18	5.6	M8	8.4	16	—	32	0.3	15	9	29,000	1	TS4SL	①TKY15W	XDGT1550 PDFR-GOO
		-050A04RB	●	4	50	50	20	6.5	11	10.4	22	17	41	0.4	15	6	24,000	2	TS4SL	①TKY15W	
		-063A05RB	●	5	63	50	20	6.5	11	10.4	22	17	50	0.7	15	5	21,000	2	TS4SL	①TKY15W	
		R08005CB	●	5	80	50	26	6	13	9.5	25.4	20	60	1.1	15	3	19,000	2	TS4SL	①TKY15W	
		R10006DB	●	6	100	63	32	8	17	12.7	31.75	26	70	2.0	15	3	16,000	2	TS4SL	①TKY15W	
		R12507EB	●	7	125	63	40	10	56	15.9	38.1	—	80	2.8	15	2	14,000	3	TS4SL	①TKY15W	
BXD7000	A 0.8   3.0	BXD7000-050A02RA	●	2	50	50	18	5.6	9	8.4	16	14	41	0.4	21	9	22,000	2	TS5SL	②TKY25D	XDGT2206 PDFR-GOO
		-063A03RA	●	3	63	50	20	6.5	11	10.4	22	17	45	0.5	21	7	19,000	2	TS5SL	②TKY25D	
		R08004CA	●	4	80	60	26	6	13	9.5	25.4	20	55	1.1	21	5	17,000	2	TS5SL	②TKY25D	
		R10005DA	●	5	100	63	32	8	17	12.7	31.75	26	70	1.8	21	4	14,000	2	TS5SL	②TKY25D	
		R12506EA	●	6	125	63	40	10	56	15.9	38.1	—	90	3.0	21	3	12,000	3	TS5SL	②TKY25D	
		BXD7000	B 4.0   5.0	BXD7000-050A02RB	●	2	50	50	18	5.6	9	8.4	16	14	41	0.4	21	9	22,000	2	
-063A03RB	●			3	63	50	20	6.5	11	10.4	22	17	45	0.5	21	7	19,000	2	TS5SL	②TKY25D	
R08004CB	●			4	80	60	26	6	13	9.5	25.4	20	55	1.1	21	5	17,000	2	TS5SL	②TKY25D	
R10005DB	●			5	100	63	32	8	17	12.7	31.75	26	70	1.8	21	4	14,000	2	TS5SL	②TKY25D	
		R12506EB	●	6	125	63	40	10	56	15.9	38.1	—	90	3.0	21	3	12,000	3	TS5SL	②TKY25D	

Note) Arbor types for attachment to the D9 cutter dimension

Centering Location Diameter (D9)	φ 16	φ 22	φ 25.4	φ 31.75	φ 38.1
Arbor Type	SM1, SMA	FMC, SM1	FMA, FMC	FMA, SMB	FMA, FMB SMB, SMC

Note 1 ) The maximum guaranteed revolution for safety purposes is determined using ISO 15641:2001

Note 2 ) When using high revolution machining, please pay special attention to the balancing of the cutter and the safety measures.



Shank type



Fig. 1: Straight shank

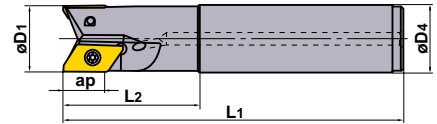
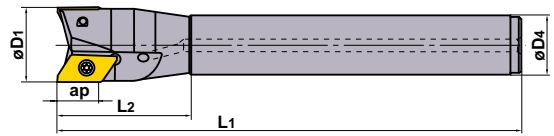


Fig. 2: Offset shank



Right hand tool holder only.

Type	Insert Corner Re	Type	Order Number	Stock	Number of Teeth	Dimensions (mm)					Ramping Angle (°)	Max. Allowable Revolution (min <sup>-1</sup> )	Figure	 Clamp Screw	 Wrench	 Insert
						D1	ap	L1	L2	D4						
BXD4000	A 0.4   3.2	Standard	BXD4000R201SA20SA	●	1	20	15	110	35	20	28	15,000	1	TS4SL	①TKY15W	XDG T1550 PDR-G
			252SA25SA	●	2	25	15	125	50	25	20	38,000	1	TS4SL	①TKY15W	
			282SA25SA	●	2	28	15	125	50	25	17	35,000	2	TS4SL	①TKY15W	
			322SA32SA	●	2	32	15	150	50	32	13	33,000	1	TS4SL	①TKY15W	
			352SA32SA	●	2	35	15	150	50	32	11	31,000	2	TS4SL	①TKY15W	
			403SA32SA	●	3	40	15	170	80	32	9	29,000	2	TS4SL	①TKY15W	
			403SA42SA	●	3	40	15	170	80	42	9	29,000	1	TS4SL	①TKY15W	
	NEW	Long	BXD4000R252SA25LA	●	2	25	15	170	80	25	20	38,000	1	TS4SL	①TKY15W	
			322SA32LA	●	2	32	15	200	80	32	13	33,000	1	TS4SL	①TKY15W	
			BXD4000R282SA25ELA	●	2	28	15	220	50	25	17	35,000	2	TS4SL	①TKY15W	
	NEW	Extra long	352SA32ELA	●	2	35	15	250	50	32	11	31,000	2	TS4SL	①TKY15W	
			403SA32ELA	●	3	40	15	250	65	32	9	29,000	2	TS4SL	①TKY15W	
			BXD4000R201SA20SB	●	1	20	15	110	35	20	28	15,000	1	TS4SL	①TKY15W	
			252SA25SB	●	2	25	15	125	50	25	20	38,000	1	TS4SL	①TKY15W	
B 4.0   5.0	Standard	282SA25SB	●	2	28	15	125	50	25	17	35,000	2	TS4SL	①TKY15W		
		322SA32SB	●	2	32	15	150	50	32	13	33,000	1	TS4SL	①TKY15W		
		352SA32SB	●	2	35	15	150	50	32	11	31,000	2	TS4SL	①TKY15W		
		403SA32SB	●	3	40	15	170	80	32	9	29,000	2	TS4SL	①TKY15W		
	NEW	Long	403SA42SB	●	3	40	15	170	80	42	9	29,000	1	TS4SL	①TKY15W	
			BXD4000R252SA25LB	●	2	25	15	170	80	25	20	38,000	1	TS4SL	①TKY15W	
			322SA32LB	●	2	32	15	200	80	32	13	33,000	1	TS4SL	①TKY15W	
NEW	Extra long	BXD4000R282SA25ELB	●	2	28	15	220	50	25	17	35,000	2	TS4SL	①TKY15W		
		352SA32ELB	●	2	35	15	250	50	32	11	31,000	2	TS4SL	①TKY15W		
		403SA32ELB	●	3	40	15	250	65	32	9	29,000	2	TS4SL	①TKY15W		
		BXD7000R251SA25SA	●	1	25	21	170	80	25	28	12,000	1	TS5S	②TKY25D	XDG T2206 PDR-G	
321SA32SA	●	1	32	21	170	80	32	19	9,500	1	TS5S	②TKY25D				
402SA42SA	●	2	40	21	170	80	42	13	28,000	1	TS5SL	②TKY25D				
B 4.0   5.0	Long	BXD7000R251SA25SB	●	1	25	21	170	80	25	28	12,000	1	TS5S	②TKY25D	XDG T2206 PDR-G	
		321SA32SB	●	1	32	21	170	80	32	19	9,500	1	TS5S	②TKY25D		
		402SA42SB	●	2	40	21	170	80	42	13	28,000	1	TS5SL	②TKY25D		

Note 1 ) The maximum guaranteed revolution for safety purposes is determined using ISO 15641:2001

Note 2 ) When using high revolution machining, please pay special attention to the balancing of the cutter and the safety measures.

Holder and insert corner radius combination

Holder	A Holder					B Holder	
	BXD4000R○○○○○○○A					BXD4000R○○○○○○○B	
Applicable insert Corner R (Re)							
	XDGT.....-G04	XDGT.....-G08	XDGT.....-G16	XDGT.....-G20	XDGT.....-G30	XDGT.....-G40	XDGT.....-G50

Note Please use only holder and insert corner radius combination above.

# Milling Cutters for Aluminum and Difficult-to-cut Materials

## Insert

Work Material	P	Steel	Cutting Conditions (guide) :	● : Stable Cutting   ● : General Cutting   ✖ : Unstable Cutting								
	M	Stainless Steel		Honing :								
Work Material	K	Cast Iron	E : Round   F : Sharp									
	N	Non-ferrous Metal										
	S	Heat-resistant Alloy, Titanium Alloy										
Work Material	H	Hardened Steel										
Cutter Type	Shape	Order Number	Class	Honing	Coated	Carbide	Dimensions (mm)					Geometry
					VP15TF	LC15TF	TF15	L1	L4	S1	F1	
BXD4000		<b>XDGT1550PDFR-G04</b>	G	F	●	●	22	16	5	1.5	0.4	
		<b>1550PDFR-G08</b>	G	F	●	●	22	16	5	1.1	0.8	
		<b>1550PDFR-G12</b>	G	F	●	●	22	16	5	0.7	1.2	
		<b>1550PDFR-G16</b>	G	F	●	●	22	16	5	0.4	1.6	
		<b>1550PDFR-G20</b>	G	F	●	●	21.7	16	5	0.2	2.0	
		<b>1550PDFR-G30</b>	G	F	●	●	20	16	5	0.6	3.0	
		<b>1550PDFR-G32</b>	G	F	●	●	20	16	5	0.4	3.2	
		<b>1550PDFR-G40</b>	G	F	●	●	19	16	5	0.5	4.0	
		<b>XDGT1550PDER-G04</b>	G	E	●		22	16	5	1.5	0.4	
		<b>1550PDER-G08</b>	G	E	●		22	16	5	1.1	0.8	
		<b>1550PDER-G12</b>	G	E	●		22	16	5	0.7	1.2	
		<b>1550PDER-G16</b>	G	E	●		22	16	5	0.4	1.6	
		<b>1550PDER-G20</b>	G	E	●		21.7	16	5	0.2	2.0	
		<b>1550PDER-G30</b>	G	E	●		20	16	5	0.6	3.0	
		<b>1550PDER-G32</b>	G	E	●		20	16	5	0.4	3.2	
		<b>1550PDER-G40</b>	G	E	●		19	16	5	0.5	4.0	
BXD7000		<b>XDGT2206PDFR-G08</b>	G	F	□	●	30	22	6.35	2.0	0.8	
		<b>2206PDFR-G16</b>	G	F	□	●	30	22	6.35	1.2	1.6	
		<b>2206PDFR-G20</b>	G	F	□	●	30	22	6.35	0.8	2.0	
		<b>2206PDFR-G30</b>	G	F	□	●	29	22	6.35	0.6	3.0	
		<b>2206PDFR-G40</b>	G	F	□	●	27.5	22	6.35	0.9	4.0	
		<b>2206PDFR-G50</b>	G	F	□	●	27	22	6.35	0.4	5.0	

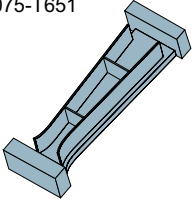
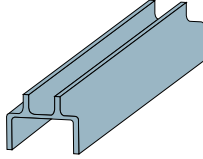
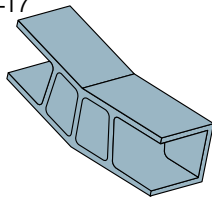
● : Inventory maintained.   □ : Non stock, produced to order only.

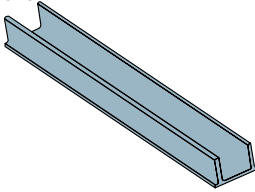
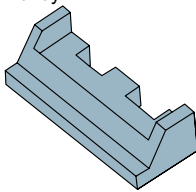
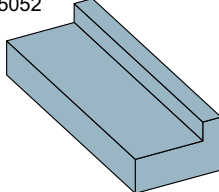
## Recommended Cutting Conditions

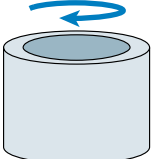
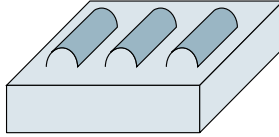
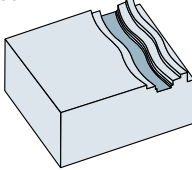
Work Material	Hardness	Insert Grade	Cutting Speed (m/min)	Feed per Tooth (mm/tooth)
<b>N</b> Aluminum Alloy	—	<b>LC15TF</b> <b>TF15</b>	1000 (200—3000)	0.3 (0.1—0.5)
<b>S</b> Titanium Alloy	—	<b>VP15TF</b>	40 (30—60)	0.1 (0.1—0.3)
Heat-resistant Alloy (Inconel etc.)	—	<b>VP15TF</b>	30 (20—40)	0.15 (0.1—0.2)
<b>M</b> Stainless Steel (JIS SUC304 etc.)	≤270HB	<b>VP15TF</b>	140 (120—160)	0.2 (0.1—0.3)
<b>P</b> Mild Steel (JIS SS400, S10C etc.)	≤180HB	<b>VP15TF</b>	180 (150—200)	0.15 (0.1—0.2)
	≤280HB	<b>VP15TF</b>	150 (120—200)	0.15 (0.1—0.2)
		<b>VP15TF</b>	140 (120—160)	0.15 (0.1—0.2)
Carbon Steel, Alloy Steel (JIS S45C, SCM440 etc.)	280—350HB	<b>VP15TF</b>	140 (120—160)	0.15 (0.1—0.2)
Hardened Steel (JIS SKD etc.)	40—60HRC	<b>VP15TF</b>	70 (50—100)	0.1 (0.05—0.15)

- Figures above are a guide lines for optimum general use. They may vary depending on machine rigidity, work clamping and length of tool overhang.
- When using ø20 shank type, set the table feed at under 0.05mm/tooth and maintain observation during cutting.
- Please adjust the table feed when using long- and extra-long- shank types.
- Please adjust the table feed when ramp machining (Recommended feed: 0.05mm/tooth under).

## Application Examples

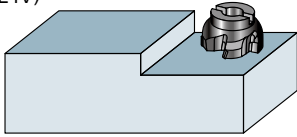


Holder		BXD4000R252SA25SA	BXD4000-050A04RA	BXD4000R0204(ø50.8)
Insert (Grade)		XDGT1550PDFR-G20(TF15)	XDGT1550PDFR-G04(TF15)	XDGT1550PDFR-G08(TF15)
Workpiece		JIS A7075-T651 	JIS A7050 	JIS A7075-T7 
Machine		M/C (BT40 30KW)	M/C (HSK-F63 60KW)	M/C (BT50 30KW)
Cutting Conditions	Revolution (min <sup>-1</sup> )	30,000	20,000	10,000
	Cutting Speed (m/min)	2,360	3,142	1,596
	Depth of Cut (mm)	16	5	5.1
	Width of Cut (mm)	16	35	50.8
	Feed per Tooth (mm/tooth)	0.23	0.15	0.20
	Chip Discharge (cc/min)	3,584	3,141	2,064
Result		<b>BXD</b> obtained excellent wall surface accuracy.	<b>BXD</b> for lower cutting noise, excellent chip discharge and superior surface finish.	<b>BXD</b> achieved more than 12 times longer tool life.

Holder		BXD4000R322SA325SA	BXD4000R252SA25SA	BXD7000R08004CA
Insert (Grade)		XDGT1550PDFR-G30(TF15)	XDGT1550PDFR-G04(TF15)	XDGT2206PDFR-G08(TF15)
Workpiece		JIS A7075 	Aluminum alloy 	JIS A5052 
Machine		M/C (BT50 20KW)	M/C (BT50 22KW)	M/C (BT50 75KW)
Cutting Conditions	Revolution (min <sup>-1</sup> )	7,000	7,500	15,000
	Cutting Speed (m/min)	703	589	3,768
	Depth of Cut (mm)	5	3	6
	Width of Cut (mm)	32	25	70
	Feed per Tooth (mm/tooth)	0.16	0.10	0.33
	Chip Discharge (cc/min)	358	113	8,400
Result		<b>BXD</b> achieved more than 10 times longer tool life.	The <b>BXD</b> displayed low resistance and achieved long tool life.	No vibration and no insert fracturing.

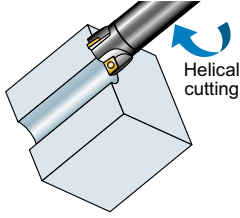
Holder		BXD4000-063A05RA	BXD4000-050A04RA	BXD4000R252SA25SA
Insert (Grade)		XDGT1550PDFR-G04(LC15TF)	XDGT1550PDFR-G08(LC15TF)	XDGT1550PDFR-G08(VP15TF)
Workpiece		JIS A5078 	JIS A5052 	JIS SUS304 
Machine		M/C (BT40 11KW)	M/C (BT40 11KW)	M/C (BT40 18.5KW)
Cutting Conditions	Revolution (min <sup>-1</sup> )	5,600	12,000	1,783
	Cutting Speed (m/min)	1,108	1,884	140
	Depth of Cut (mm)	4	2	7
	Width of Cut (mm)	1.5	25	20
	Feed per Tooth (mm/tooth)	0.34	0.52	0.1
	Chip Discharge (cc/min)	57	1,250	50
Result		LC15TF produced a superior surface finish compared to the competitors non-coated carbide grade that generated a dull surface finish.	Less welding and longer tool life after more than 1 hour duration of machining time with air blow.	The tool could be used on a smaller BT40 type spindle machining center because of the low cutting resistance of inserts.

# BXD

## Application Examples

Holder		BXD4000R12507EA		Competitor's
Insert (Grade)		XDGT1550PDER-G16(VP15TF)		
Workpiece				
Machine		M/C (BT50 15KW)	M/C (BT50 15KW)	
Cutting Conditions	Revolution (min <sup>-1</sup> )	102	38	
	Cutting Speed (m/min)	40	15	
	Depth of Cut (mm)	12	5	
	Width of Cut (mm)	110	110	
	Feed per Tooth (mm/tooth)	1.10	0.06	
	Chip Discharge (cc/min)	94	11	
Result		 <p>Normal chips</p>	 <p>Irregular chips</p>	
		<ul style="list-style-type: none"> <li>• Chip problems solved.</li> <li>• Low resistant.</li> <li>• Excellent all surface accuracy and in surface finish.</li> </ul>		

Holder		BXD4000-050A04RA	
Insert (Grade)		XDGT1550PDER-G04(VP15TF)	
Workpiece			
Machine		M/C (BT50 11KW)	
Cutting Conditions	Revolution (min <sup>-1</sup> )	1,230	
	Cutting Speed (m/min)	193	
	Depth of Cut (mm)	5	
	Width of Cut (mm)	5	
	Pick feed (mm)	5	
	Feed per Tooth (mm/tooth)	0.10	
Result		<ul style="list-style-type: none"> <li>• Accuracy of surface the finished surface flatness is 0.005mm.</li> <li>• Compared to competitor's products, the <b>BXD</b> has lower cutting noise and provides a better surface finish.</li> </ul>	

● Please note that you may not be able to machine materials as shown above, due to rigidity of your tools, of work, or of clamping.

## Operational Guidance

- Use only prescribed inserts and parts.
- The maximum guaranteed revolution for safety purposes is determined using ISO 15641:2001
- Ensure that the cutter operates under the maximum allowable revolution. Even when operating under the maximum allowable revolution, if the spindle revolution is equal to or higher than the values shown in the following table, we recommend that the balance quality grade (with arbor) conforms to G40 or higher based on "JIS B 0905".

Cutting Edge Diameter (mm)	φ 25	φ 32	φ 40	φ 50	φ 63	φ 80	φ 100	φ 125
Revolution (min <sup>-1</sup> )	12,000	9,500	8,500	7,600	6,800	6,000	5,400	4,800

- Please use a special clamping bolt when using the arbor type with through coolant holes.
- Cutting tools have sharp cutting edges and handling them with bare hands may cause injuries. Always wear protectors such as gloves in handling indexable inserts.
- Always apply the recommended clamp torque values as shown below.

BXD4000 : 4 - 5N·m (41 - 51kgf·cm)

BXD7000 : 7 - 8N·m (71 - 82kgf·cm)

**For Your Safety**

- Don't touch inserts and chips without gloves.
- Please machine within the recommended application range, and exchange expired tools with new ones in advance of breakage.
- Please use safety cover and wear safety glasses.
- When using compounded cutting oils, please take fire prevention.
- When attaching inserts or spare parts, please use the attached wrench or spanner.
- When using rotating tools, please make a trial run to check run-out, vibration and abnormal sounds etc.

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(Tools specifications subject to change without notice.)