TECHNICAL

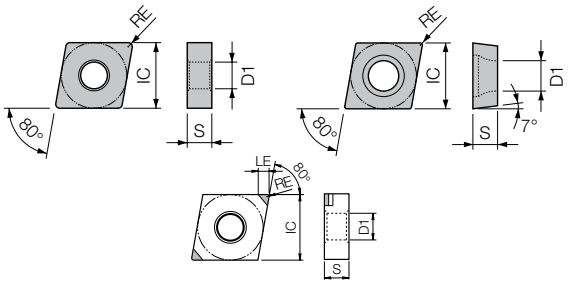
R

R1 - R72

Turning Dimensions

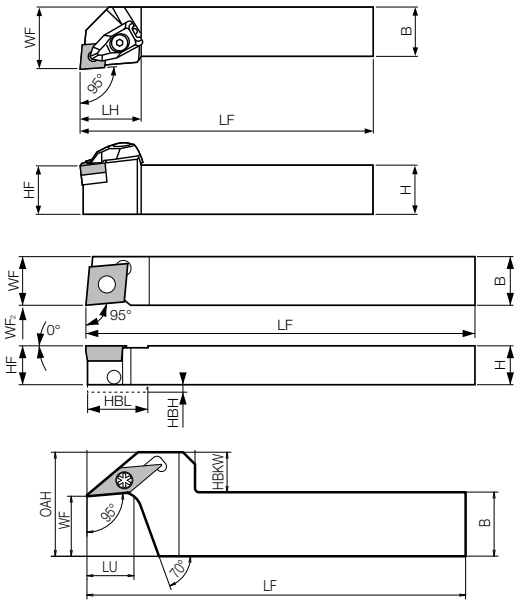
Turning Inserts

New Symbol	Description	Previous Symbol
AN	Relief Angle	α
D1	Hole Diameter	Ød
IC	Inscribed Circle Diameter	A
RE	Corner Radius	rε
S	Insert Thickness	T
LE	Edge Length (PCD / CBN Tip)	S



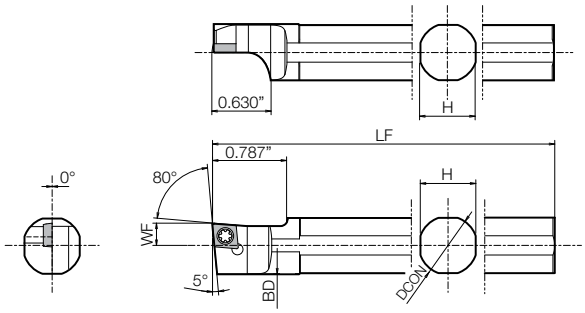
External Turning Holders (Square Shank)

New Symbol	Description	Previous Symbol
B	Shank Width	B
H	Shank Height	H1
HF	Cutting Edge Height	h
HBL	Head Bottom Offset Length	L2
HBH	Head Bottom Offset Height	H2
HBKW	Head Back Offset Width	F2
LF	Functional Length	L1
LH	Head Length	L2
LU	Usable Length	T
LN	Neck Length	L3, L4
WF	Cutting Edge Distance	F1
WF_2, WFS	Cutting Edge Distance (Secondary)	F2
OAH	Overall Height	F1
MHD	Mounting Hole Distance	M1
MHD2	Mounting Hole Distance (Secondary)	M2



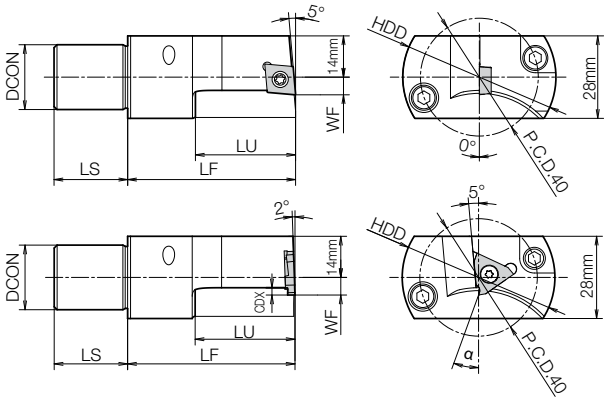
External Turning Holders (Round Shank)

New Symbol	Description	Previous Symbol
DCON	Connection Diameter	ØD, ØD1
LF	Functional Length	L1
WF	Cutting Edge Distance	F1
WF_2	Cutting Edge Distance (Secondary)	F2
BD	Body Diameter	Ød, Ød1
H	Shank Flat Width	H1



Sub-Spindle Turning Holders

New Symbol	Description	Previous Symbol
DCON	Connection Diameter	ØD
HDD	Head Diameter	ØD1, ØD2
LF	Functional Length	L2
LS	Shank Length	-
LU	Usable Length	L3
WF	Cutting Edge Distance	F1
WF_2	Cutting Edge Distance (Secondary)	F2
CDX	Maximum Cutting Depth	B



Boring Dimensions

Boring Bars

New Symbol	Description	Previous Symbol
DMIN	Minimum Bore Diameter	ØA
DCON	Connection Diameter	ØD, ØD1
GAMO	Rake Angle	θ
H	Shank Flat Width	H
LF	Functional Length	L1
LH	Head Length	L2
LPR	Full Length	L1
LU	Usable Length	L2
RE	Corner Radius	rε
WF	Cutting Edge Distance	F
WF_2	Cutting Edge Distance (Secondary)	F2

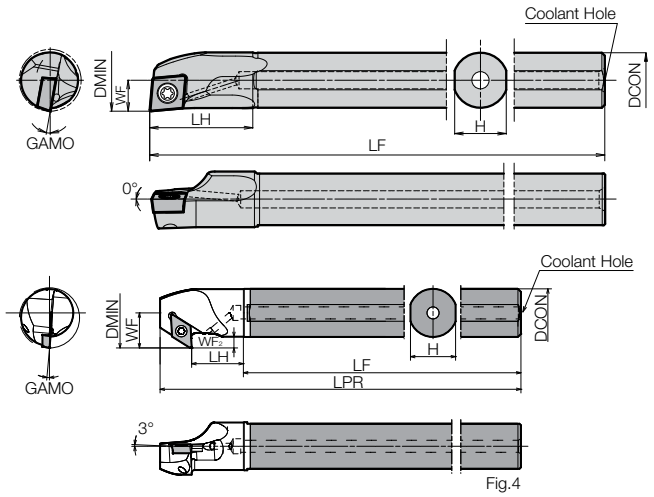
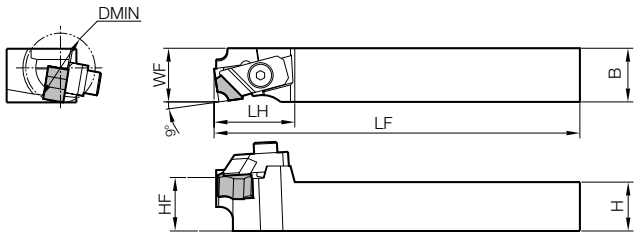


Fig.4

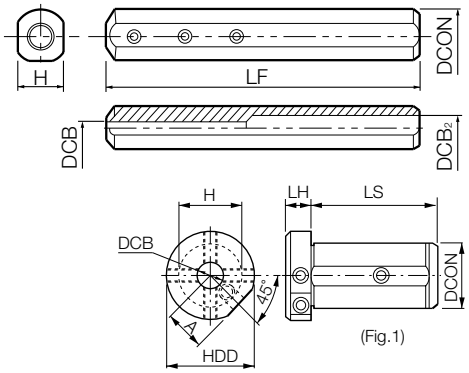
Boring Bars (Square Shank)

New Symbol	Description	Previous Symbol
DMIN	Minimum Bore Diameter	ØA
B	Shank Width	B
H	Shank Height	H1
HF	Cutting Edge Height	h
LF	Functional Length	L1
LH	Head Length	L2
WF	Cutting Edge Distance	F1



Boring Bar Sleeves

New Symbol	Description	Previous Symbol
DCON	Connection Diameter	ØD, ØD1
DCB	Connection Bore Diameter	Ød1
HDD	Head Diameter	ØD2
DCB_2	Connection Bore Diameter (Secondary)	Ød1, Ød2
H	Shank Flat Width	-
LF	Functional Length	L1
LS	Shank Length	L1
LH	Head Length	L2
A	Head Flat Distance	-

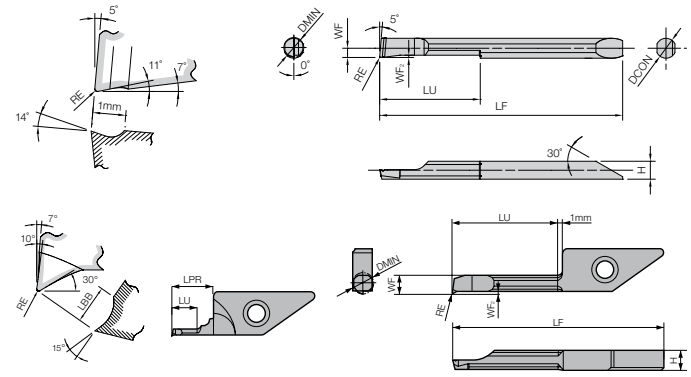


(Fig.1)

Boring Dimensions (Continued)

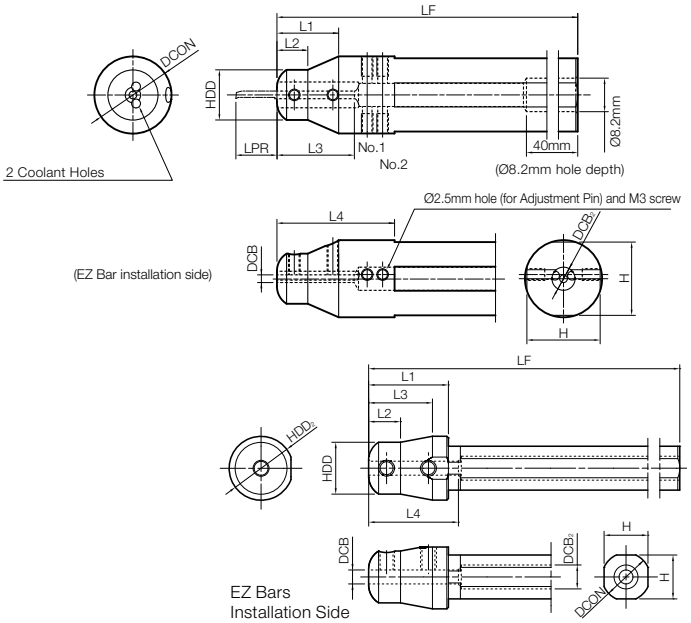
Micro Boring Bars

New Symbol	Description	Previous Symbol
DMIN	Minimum Bore Diameter	ØA
H	Bar Flat Height	-
LF	Functional Length	L1
LU	Usable Length	L2
LPR	Bar Overhang Length	L3
WF	Cutting Edge Distance	F
WF_2	Cutting Edge Distance (Secondary)	S
RE	Corner Radius	rε
LBB	Cutting Edge Width	W



Micro Boring Bar Sleeves

New Symbol	Description	Previous Symbol
DCB	Connection Bore Diameter	Ød1
DCON	Connection Diameter	ØD1
HDD	Neck Diameter	ØD2
HDD_2	Head Diameter	ØD3
DCB_2	Connection Bore Diameter (Secondary)	Ød2
H	Shank Flat Height	-
LF	Functional Length	L1
L1	Head Length	L2
L2	Neck Length	L3
L3	Connection Bore Depth	L4
LPR	Bar Overhang Length	T
No.1	Overhang Length of Bar at Position 1	-
No.2	Overhang Length of Bar at Position 2	-
No.3	Overhang Length of Bar at Position 3	-
No.4	Overhang Length of Bar at Position 4	-



Micro Boring Bar Holders (Round Shank)

New Symbol	Description	Previous Symbol
DCON	Connection Diameter	ØD1
HDD	Head Diameter	ØD2
H	Shank Flat Height	-
LF	Functional Length	L1
LH	Head Length	L2
WF	Cutting Edge Height	F1
L2	Neck Length	-

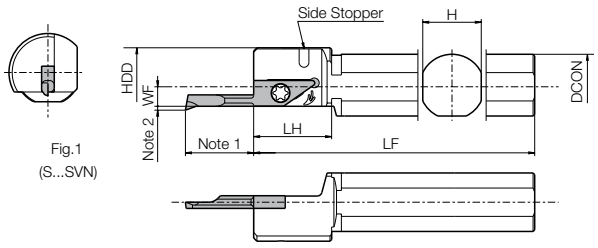
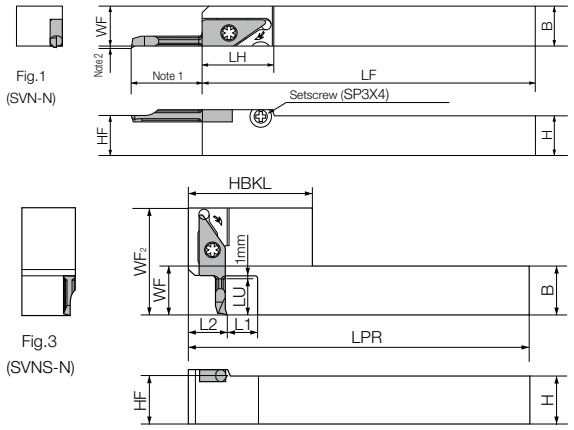


Fig.1
(S...SVN)

Boring Dimensions (Continued)

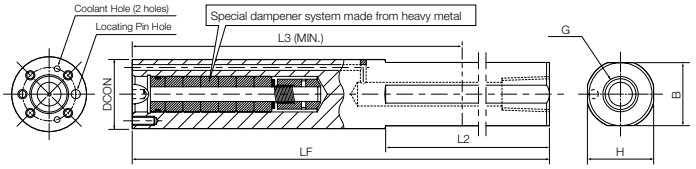
Micro Boring Bar Holders (Square Shank)

New Symbol	Description	Previous Symbol
HF	Cutting Edge Height	h
H	Shank Height	H1
B	Shank Width	-
LF	Functional Length	L1
LPR	Protruding Length	L1
LH	Head Length	L2
HBKL	Head Back Offset Length	F2
HBKW	Head Back Offset Width	F2
WF	Cutting Edge Distance	F1
WF_2	Cutting Edge Distance (Secondary)	F1
LU	Usable Length	F3
L1	Holder Clearance Distance 1	L3
L2	Holder Clearance Distance 2	L4



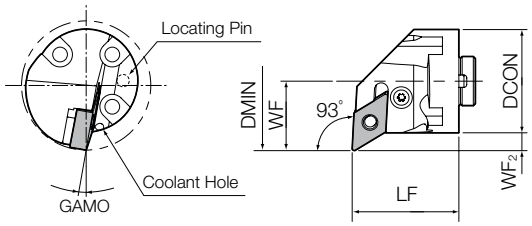
Boring Bar Adapters

New Symbol	Description	Previous Symbol
DCON	Connection Diameter	ØD1
H	Shank Flat Height	-
B	Shank Flat Width	-
LF	Functional Length	L1
L2	Shank Length	-
L3 (Min)	Minimum Modification Length	-
G	Coolant Hole Thread Size	-



Replaceable Boring Bar Heads

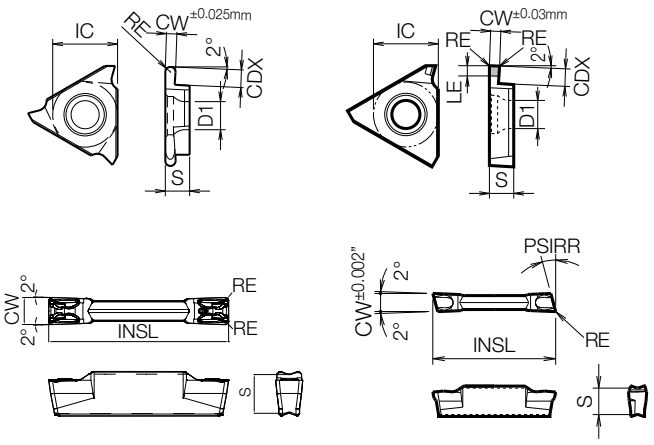
New Symbol	Description	Previous Symbol
DMIN	Minimum Bore Diameter	ØA
DCON	Connection Diameter	ØD
LF	Functional Length	L1
WF	Cutting Edge Distance	F
WF_2	Cutting Edge Distance (Secondary)	S
GAMO	Rake Angle	θ
RE	Corner Radius	rε



Grooving & Cut-Off Dimensions

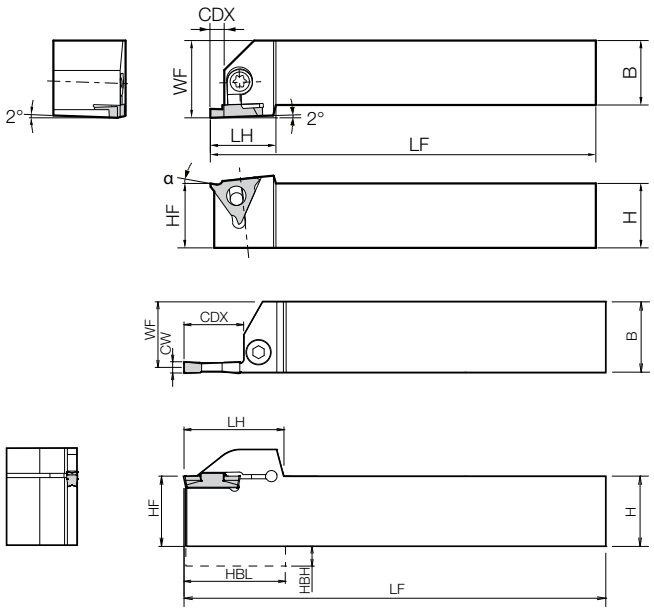
Grooving & Cut-Off Inserts

New Symbol	Description	Previous Symbol
IC	Inscribed Circle Diameter	A
BCH	Corner Chamfer Length	C
CDX	Maximum Cutting Depth	B
CW	Cutting Edge Width	W
CUTDIA	Maximum Cut-Off Diameter	ØDmax
LE	Edge Length (PCD / CBN Tip)	S
D1	Hole Diameter	Ød
DAXN	Face Groove Diameter (Min.)	ØD
DAXX	Face Groove Diameter (Max.)	ØD
INSL	Insert Length	L
PSIRR	Lead Angle	θ
RE	Corner Radius	rε
S	Insert Thickness	H, T, M
W1	Insert Width	A



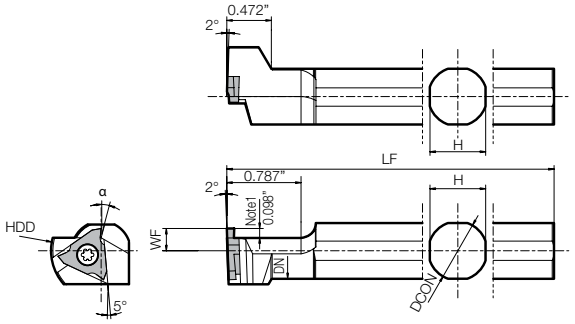
External Grooving Holders (Square Shank)

New Symbol	Description	Previous Symbol
B	Shank Width	-
CDX	Maximum Cutting Depth	T
H	Shank Height	H1
HF	Cutting Edge Height	h
HBL	Head Bottom Offset Length	L3
HBH	Head Bottom Offset Height	H2
HBKW	Head Back Offset Width	F2
LF	Functional Length	L1
LH	Head Length	L2
LN	Neck Length	-
WF	Cutting Edge Distance	F1
GAMP	Axial Rake Angle	θ
MHD	Mounting Hole Distance	M1
MHD2	Mounting Hole Distance (Secondary)	M2



External Grooving Holders (Round Shank)

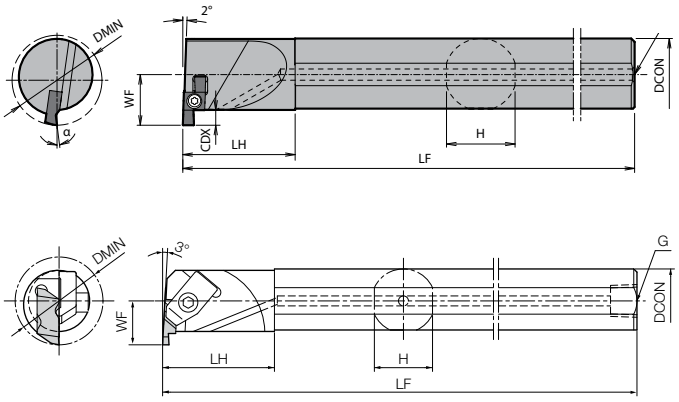
New Symbol	Description	Previous Symbol
DCON	Connection Diameter	ØD
LF	Functional Length	L1
WF	Cutting Edge Distance	F1
DN	Neck Diameter	Ød1
HDD	Head Diameter	Ød2
H	Shank Flat Height	H1



Grooving & Cut-Off Dimensions (Continued)

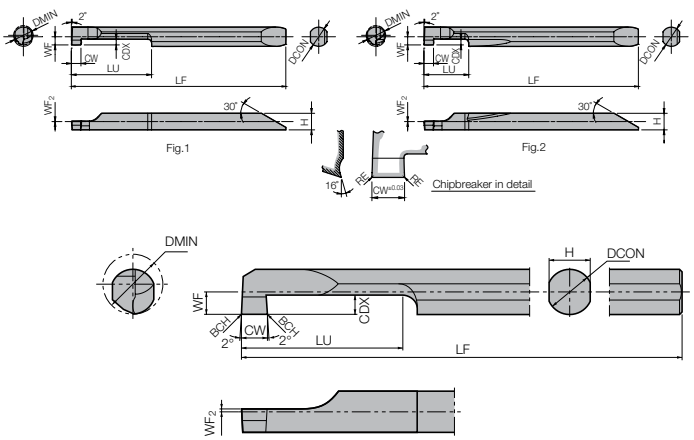
Internal Grooving Holders

New Symbol	Description	Previous Symbol
DMIN	Minimum Bore Diameter	ØA
DCON	Connection Diameter	ØD
H	Shank Flat Height	H1
LF	Functional Length	L1
LH	Head Length	L2
LU	Usable Length	L2
WF	Cutting Edge Distance	F1
CDX	Maximum Cutting Depth	T
G	Coolant Hole Thread Size	-



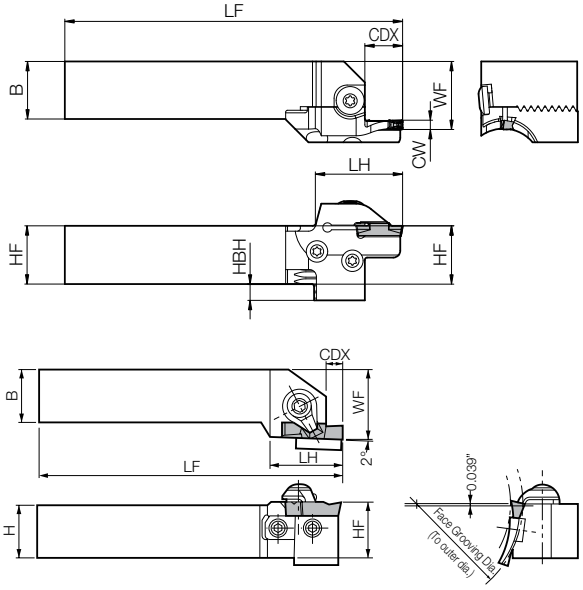
Micro Grooving Bars

New Symbol	Description	Previous Symbol
DMIN	Minimum Bore Diameter	ØA
DCON	Connection Diameter	ØD
DAXN	Face Groove Diameter (Min.)	ØD
DAXX	Face Groove Diameter (Max.)	ØD
CW	Cutting Edge Width	W
BCH	Corner Chamfer Length	C
H	Bar Flat Height	H1
LF	Functional Length	L1
LU	Usable Length	L2
WF	Cutting Edge Distance	F
WF_2	Cutting Edge Distance (Secondary)	L4
LH	Head Length	L2
CDX	Maximum Cutting Depth	T
RE	Corner Radius	rε



Face Grooving Toolholders

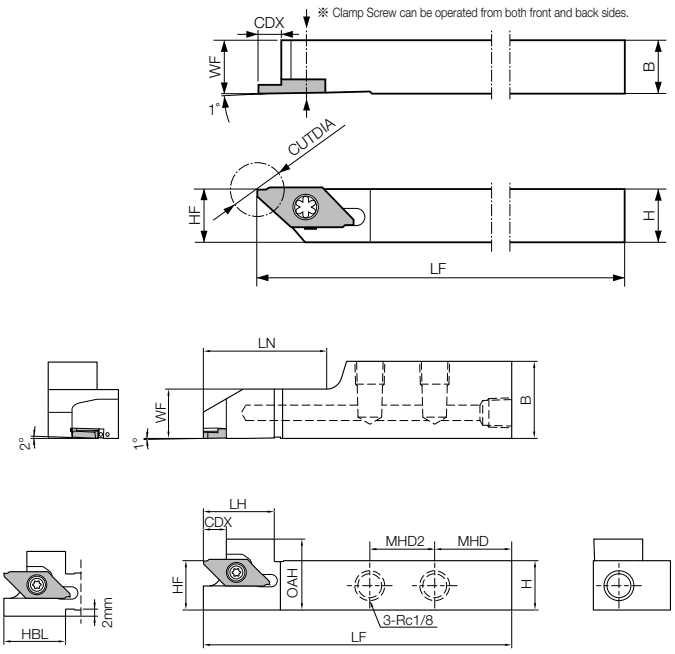
New Symbol	Description	Previous Symbol
DAXN	Face Groove Diameter (Min.)	ØD
DAXX	Face Groove Diameter (Max.)	ØD
H	Shank Height	H1
HF	Cutting Edge Height	h
HBH	Head Bottom Offset Height	H2
B	Shank Width	-
LF	Functional Length	L1
LH	Head Length	L2
WF	Cutting Edge Distance	F, F1
WF_2	Cutting Edge Distance (Secondary)	S
CDX	Maximum Cutting Depth	T
CW	Cutting Edge Width	W



Grooving & Cut-Off Dimensions (Continued)

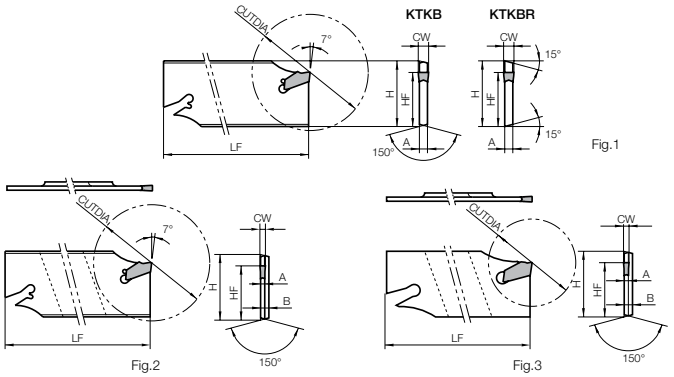
Cut-Off Toolholders

New Symbol	Description	Previous Symbol
CUTDIA	Maximum Cut-Off Diameter	ØDmax
H	Shank Height	H1
HF	Cutting Edge Height	h
OAL	Overall Length	L1
B	Shank Width	-
LF	Functional Length	L1
LH	Head Length	L2
LN	Neck Length	L3
LN2	Neck Length (Secondary)	-
HBL	Head Bottom Offset Length	L3
HBH	Head Bottom Offset Height	H2
WF	Cutting Edge Distance	F1
CDX	Maximum Cutting Depth	T
GAMP	Axial Rake Angle	θ
MHD	Mounting Hole Distance	M1
MHD2	Mounting Hole Distance (Secondary)	M2



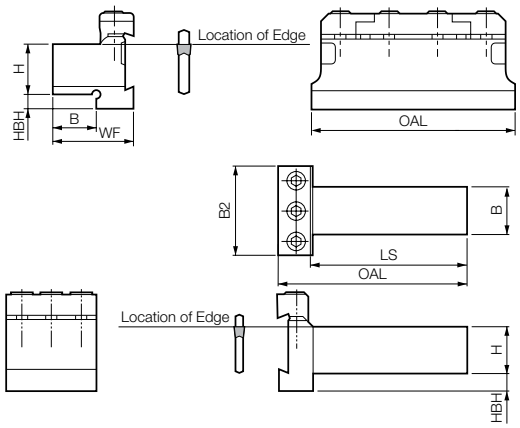
Cut-Off Blades

New Symbol	Description	Previous Symbol
CUTDIA	Maximum Cut-Off Diameter	ØDmax
H	Blade Height	H1
HF	Cutting Edge Height	h
B	Blade Width	-
LF	Functional Length	L1
A	Insert Mount Width	-
CW	Cutting Edge Width	W



Cut-Off Tool Blocks

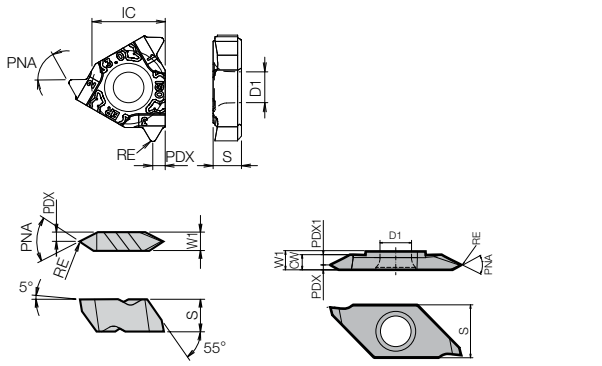
New Symbol	Description	Previous Symbol
H	Shank Height	H1
HBH	Head Bottom Offset Height	H2
B	Shank Width	B1
B2	Blade Mount Width	-
OAL	Overall Length	L1
LS	Shank Length	L2



Threading Dimensions

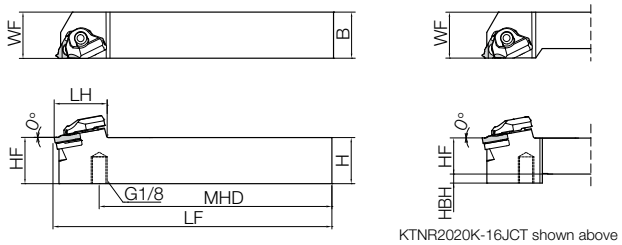
Threading Inserts

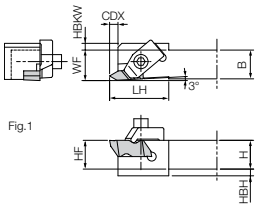
New Symbol	Description	Previous Symbol
IC	Inscribed Circle Diameter	A
S	Insert Thickness	T
D1	Hole Diameter	Ød
PDX	Profile Distance	S, S1
PDX1	Profile Distance (Secondary)	S2
PNA	Included Angle	θ
RE	Corner Radius	rε
W1	Insert Width	T
CW	Cutting Edge Width	W

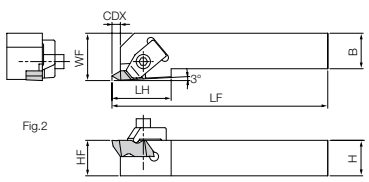


External Threading Toolholders (Square Shank)

New Symbol	Description	Previous Symbol
H	Shank Height	H1
HF	Cutting Edge Height	h
HBH	Head Bottom Offset Height	H2
B	Shank Width	-
LF	Functional Length	L1
LH	Head Length	L2
WF	Cutting Edge Distance	F1
MHD	Mounting Hole Distance	M1
HBKW	Head Back Offset Width	F2
CDX	Maximum Cutting Depth	T
LPR	Protruding Length	T

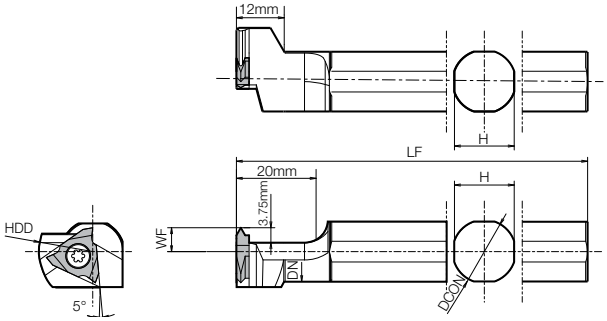






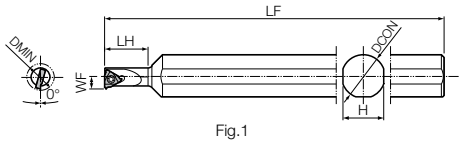
External Threading Toolholders (Round Shank)

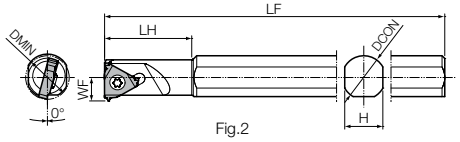
New Symbol	Description	Previous Symbol
DCON	Connection Diameter	ØD
LF	Functional Length	L1
WF	Cutting Edge Distance	F1
DN	Neck Diameter	Ød1
HDD	Head Diameter	Ød2
H	Shank Flat Height	H1



Internal Threading Toolholders

New Symbol	Description	Previous Symbol
DMIN	Minimum Bore Diameter	ØA
DCON	Connection Diameter	ØD
H	Shank Flat Width	-
LF	Functional Length	L1
LH	Head Length	L2
WF	Cutting Edge Distance	F1

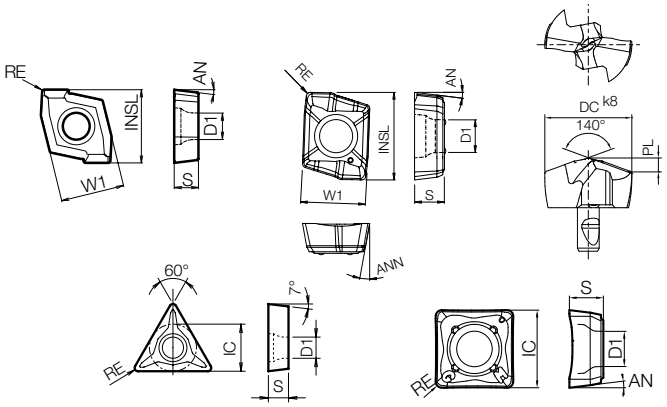




Drilling Dimensions

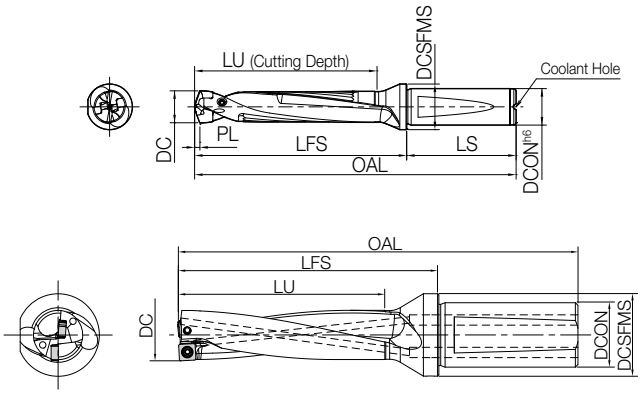
Drilling Inserts

New Symbol	Description	Previous Symbol
IC	Inscribed Circle Diameter	A
S	Insert Thickness	T
W1	Insert Width	W
INSL	Insert Length	L
D1	Hole Diameter	Ød
DC	Cutting Diameter	ØDc
DC_2	Cutting Diameter	ØD2
PL	Point Length	Lp
RE	Corner Radius	rε
AN	Relief Angle (Minor)	α
ANN	Relief Angle (Major)	β



Drilling Toolholders

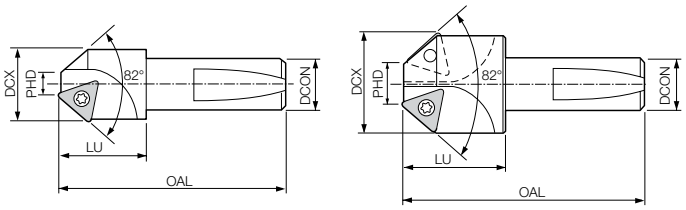
New Symbol	Description	Previous Symbol
DC	Cutting Diameter	ØDc
DCON	Connection Diameter	ØD
OAL	Overall Length	L
LFS	Functional Length	L1
LU	Cutting Depth	L3
LS	Shank Length	-
DCSFMS	Contact Surface Diameter Machine Side	Ød1
LCF	Flute Length	L2
Rc	Coolant Hole Thread Size	-



Drilling Dimensions (Continued)

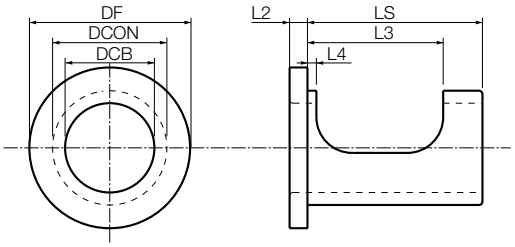
Countersinks

New Symbol	Description	Previous Symbol
DCX	Maximum Cutting Diameter	ØD
PHD	Premachined Hole Diameter	ØDs
DCON	Connection Diameter	Ød
OAL	Overall Length	L
LU	Usable Length	L1



Drilling Sleeves

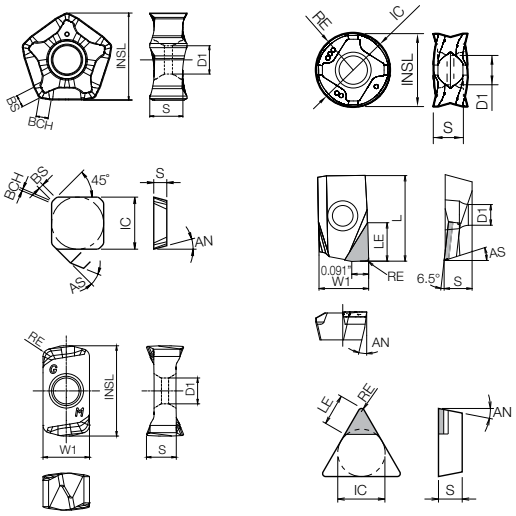
New Symbol	Description	Previous Symbol
DCB	Connection Bore Diameter	Ød
DCON	Connection Diameter	ØD1
DF	Flange Diameter	ØD2
LS	Shank Length	L1



Milling Dimensions

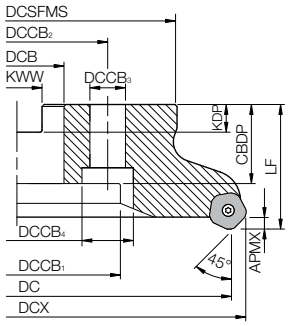
Milling Inserts

New Symbol	Description	Previous Symbol
IC	Inscribed Circle Diameter	A
S	Insert Thickness	T
BCH	Corner Chamfer Length	X
RE	Corner Radius	rε
BS	Wiper Edge Length	Z
INSL	Insert Length	L
D1	Hole Diameter	Ød
L	Cutting Edge Length	W
W1	Insert Width	A
AN	Relief Angle (Major)	α
AS	Relief Angle (Wiper Edge)	β
LE	Edge Length (PCD / CBN Tip)	S
GAN	Insert Rake Angle	θ



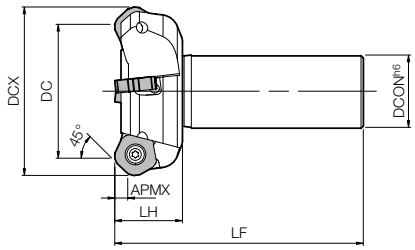
Face Mills

New Symbol	Description	Previous Symbol
DC	Cutting Diameter	ØD
DCX	Maximum Cutting Diameter	ØD1
DCSFMS	Contact Surface Diameter Machine Side	ØD2
DCB	Connection Bore Diameter	Ød
$DCCB_1$	Connection Counterbore Diameter	Ød1
$DCCB_2$	Mounting Bolt Hole Diameter	Ød2
LF	Functional Length	H
CBDP	Connection Bore Depth	E
KDP	Keyway Depth	a
KWW	Keyway Width	b
PCD	Secondary Bolt Distance	ØC
APMX	Maximum Cutting Depth	S
KAPR	Lead Angle	-



End Mills

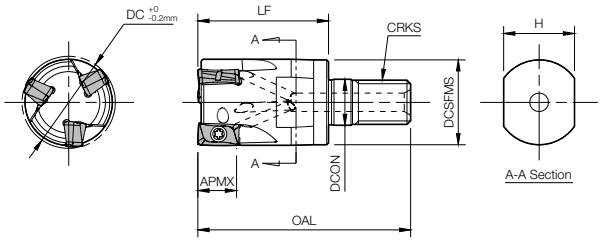
New Symbol	Description	Previous Symbol
DC	Cutting Diameter	ØD
DCX	Maximum Cutting Diameter	ØD1
DCON	Connection Diameter	Ød, Ød1
DN	Neck Diameter	Ød2
CW	Cutting Width	W
LF	Functional Length	L
LH	Head Length	ℓ, ℓ1, L2
LU	Usable Length	ℓ2
LS	Shank Length	L3
LN	Neck Length	L1
APMX	Maximum Cutting Depth	S
RMPX	Maximum Ramping Angle	α
A.R.	Axial Rake Angle	-
R.R.	Radial Rake Angle	-
KAPR	Lead Angle	-
TA	Taper Angle	θ



Milling Dimensions (Continued)

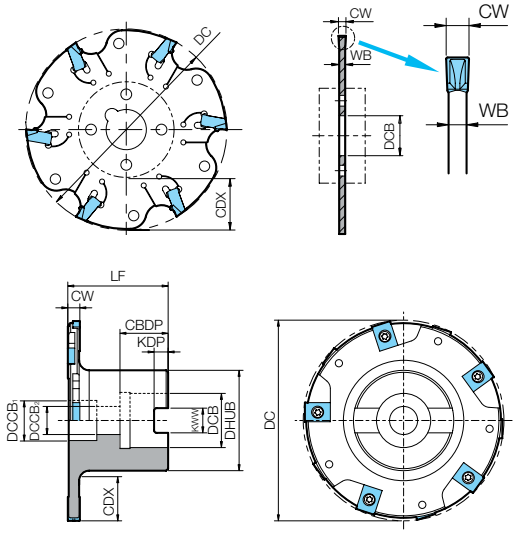
Modular End Mills

New Symbol	Description	Previous Symbol
DC	Cutting Diameter	ØD
DCSFMS	Contact Surface Diameter Machine Side	ØD1
DCON	Connection Diameter	Ød
OAL	Overall Length	L
LF	Functional Length	L1
CRKS	Connection Retaining Knob Thread Size	M1
H	Weldon Flat Width	-
APMX	Maximum Cutting Depth	S
RMPX	Maximum Ramping Angle	α
A.R.	Axial Rake Angle	-
R.R.	Radial Rake Angle	-
KAPR	Lead Angle	-



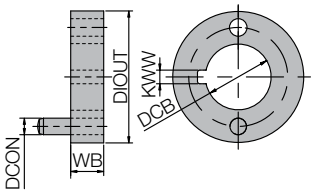
Slot Mills

New Symbol	Description	Previous Symbol
CW	Cutting Edge Width	W
CDX	Maximum Cutting Depth	T
DC	Cutting Diameter	ØD
DCB	Connection Bore Diameter	Ød
WB	Body Width	A
DCSFMS	Contact Surface Diameter Machine Side	Ød1
DHUB	Hub Diameter	ØA
THUB	Hub Thickness	A
LF	Functional Length	L1
LN	Neck Leck	H
CBDP	Connection Bore Depth	E
KDP	Keyway Depth	a
KWW	Keyway Width	b
$DCCB_1$	Connection Counterbore Diameter	Ød1
$DCCB_2$	Mounting Bolt Hole Diameter	Ød2
APMX	Maximum Cutting Depth	W.O.C.1, S



Slot Mill Drive Rings

New Symbol	Description	Previous Symbol
DCB	Connection Bore Diameter	Ød
DIOUT	Outside Diameter	ØD
WB	Body Width	A1
KWW	Keyway Width	a
DCON	Connection Diameter	Ød1



MATERIAL GROUPS			
Name	Group	Representative Materials	Description
Steel	1	1008, 1010, 1015, 1018, 1022, 1025, 1030, 1040, 1045, 1050, 1055, 1110, 1140, 1151, 1525, 1526, 1541, 1552, 10L18, 11L14, 12L13, 12L14	Low to medium carbon steels Leaded and freer cutting
	2	1340, 4140, 4145, 5140, 8640, 4150, 4060, 5150, 6150, 8650, 8660, 8620, 8630, 50100, 51100, 52100	Medium to high carbon steels and alloy steels
	3	A2, D2, M2, D4, M7, M35, M50, S7	Tool steel, high alloy steel casting
	4	Case hardened steel, induction hardened steel, heat treated steel	Hardened steels (>40Rc)
Stainless Steel	5	303, 304, 310, 316, 317, 321	Austenitic, moderate to difficult machinability
	6	403, 410, 416, 422, 430	Martensitic, free cutting stainless
	7	13-8Mo, 15-5PH, 17-4PH, 17-7PH	Wrought stainless steel Precipitation hardened
Cast Iron	8	A48-64, G3000, G4000, J431a	Gray cast iron with low to medium hardness
	9	A439-62, A476-67, A536-67, J434, 60-40-18, 80-55-06, A48-50B, A48-60B, D4512	Medium hard alloy cast iron Moderate to difficult to machine Malleable castings, nodular cast iron
	10	Cast iron with hardness greater than 36Rc	Chilled cast iron
Powdered Metals	11	P/M iron, P/M steel, P/M copper iron, P/M copper steel, P/M nickel steel, P/M infiltrated steel	Consolidated compacts of metal powders Generally considered to have poor machinability
Heat-Resistant Alloy	12	Inconel, Hastelloy, Waspalloy, Rene, Monel	Nickel and iron based superalloys
	13	Stellite, Haynes 188, Haynes 25 (L605)	Cobalt based superalloys
	14	Titanium, tungsten, tantalum, zirconium	Titanium based alloys and refractory metals
Non-Ferrous Alloys	15	Aluminum less than 8% silicon, brass, silver, platinum, gold	Non-ferrous alloys Free machining
	16	Aluminum greater than 8% silicon, aluminum castings, aluminum bronze, copper alloys	Non-ferrous alloys Non-free machining
Non-Metallics	17	Plastics, graphite, epoxy, nylon, "Green" ceramics, PVC, teflon, fiberglass, glass, sintered ceramics, fiber reinforced plastic	Easy to difficult to machine non-metallics

Steel Turning

Negative Inserts

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.006 ipr	0.018 ipr
	Cermet	0.001 ipr	0.005 ipr	0.010 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
1	CA025P	500	650	800
	CA510	550	700	850
	CA515	550	700	850
	CA525	450	600	750
	CA530	400	550	700
	PR1425	300	450	600
	PR1225	300	450	600
	PR930	300	450	600
	TN610	750	975	1200
	TN620	700	925	1150
	PV710	800	1050	1300
	PV720	750	975	1200

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.007 ipr	0.0014 ipr
	Cermet	0.001 ipr	0.004 ipr	0.008 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
2	CA025P	450	600	750
	CA510	550	675	800
	CA515	550	675	800
	CA525	400	550	700
	CA530	400	550	700
	PR1425	250	375	500
	PR1225	250	375	500
	PR930	250	375	500
	TN610	600	800	1000
	TN620	500	700	900
	PV710	650	850	1050
	PV720	650	800	950

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.007 ipr	0.014 ipr
	Cermet	0.001 ipr	0.004 ipr	0.008 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
3	CA025P	450	600	750
	CA510	550	675	800
	CA515	550	675	800
	CA525	400	550	700
	CA530	400	550	700
	PR1425	250	375	500
	PR1225	250	375	500
	PR930	250	375	500
	TN610	600	800	1000
	TN620	500	700	900
	PV710	650	850	1050
	PV720	650	800	950

Positive Inserts

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.001 ipr	0.004 ipr	0.008 ipr
	Cermet	0.001 ipr	0.005 ipr	0.010 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
1	CA025P	450	600	750
	CA510	500	650	800
	CA515	500	650	800
	CA525	400	550	700
	CA530	350	500	650
	PR1425	300	450	600
	PR1225	300	450	600
	PR930	300	450	600
	TN610	750	975	1200
	TN620	700	925	1150
	PV710	800	1050	1300
	PV720	750	975	1200

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.001 ipr	0.004 ipr	0.008 ipr
	Cermet	0.001 ipr	0.004 ipr	0.008 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
2	CA025P	350	475	600
	CA510	400	550	700
	CA515	400	550	700
	CA525	300	425	550
	CA530	300	425	550
	PR1425	200	350	500
	PR1225	200	350	500
	PR930	200	350	500
	TN610	600	800	1000
	TN620	500	700	900
	PV710	650	850	1050
	PV720	650	800	950

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.001 ipr	0.004 ipr	0.008 ipr
	Cermet	0.001 ipr	0.004 ipr	0.008 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
3	CA025P	350	450	550
	CA510	400	550	700
	CA515	400	550	700
	CA525	250	375	500
	CA530	250	375	500
	PR1425	200	350	500
	PR1225	200	350	500
	PR930	200	350	500
	TN610	600	800	1000
	TN620	500	700	900
	PV710	650	850	1050
	PV720	650	800	950

Note)
Recommended cutting conditions seen above are general machining parameters.
For more accurate cutting conditions, see specific products in previous sections.

For Material Groups See Page R14

Steel Turning

Material		Grade Type	Machining Parameters								
			Feed Rate								
			Finishing			Finishing-Medium			Medium-Roughing		
		Ceramic	See Below			See Below			See Below		
		CBN	See Below			See Below			-		
Material Group	Hardness	Grade	Cutting Speed (sfm)								
			FROM	MEDIAN	TO	FROM	MEDIAN	TO	FROM	MEDIAN	TO
4	44Rc 0.009 ipr MAX	A65	240	800	1050	240	800	1050			
		A66N	240	800	1050	240	800	1050			
		PT600M	240	800	1050	240	800	1050			
		KBN510	240	900	1200						
		KBN525	240	900	1200						
		KBN900				300	400	500	300	400	500
		KBN05M	290	1089	1450	290	1089	1450			
		KBN10M	264	990	1320	264	990	1320			
		KBN25M	264	990	1320	264	990	1320			
		KBN30M	240	890	1190	240	890	1190			
		KBN35M	240	890	1190	240	890	1190			
	48Rc 0.009 ipr MAX	A65	230	750	980	230	750	980			
		A66N	230	750	980	230	750	980			
		PT600M	230	750	980	230	750	980			
		KBN510	230	850	1150						
		KBN525	230	850	1150						
		KBN900				300	400	500	300	400	500
		KBN05M	280	1030	1400	280	1030	1400			
		KBN10M	230	850	1140	230	850	1140			
		KBN25M	253	935	1265	253	935	1265			
		KBN30M	230	850	1140	230	850	1140			
		KBN35M	230	850	1140	230	850	1140			
	52Rc 0.008 ipr MAX	A65	200	660	800	200	660	800			
		A66N	200	660	800	200	660	800			
		PT600M	200	660	800	200	660	800			
		KBN510	200	700	1000						
		KBN525	200	700	1000						
		KBN900				250	350	450	250	350	450
		KBN05M	240	850	1210	240	850	1210			
		KBN10M	220	770	1100	220	770	1100			
		KBN25M	220	770	1100	220	770	1100			
		KBN30M	200	700	1000	200	700	1000			
		KBN35M	200	700	1000	200	700	1000			
	56Rc 0.006 ipr MAX	A65	175	550	650	175	550	650			
		A66N	175	550	650	175	550	650			
		PT600M	175	550	650	175	550	650			
		KBN510	175	600	800						
		KBN525	175	600	800						
		KBN900				200	300	400	200	300	400
		KBN05M	240	850	1210	240	850	1210			
		KBN10M	220	770	1100	220	770	1100			
		KBN25M	220	770	1100	220	770	1100			
		KBN30M	200	700	1000	200	700	1000			
		KBN35M	200	700	1000	200	700	1000			
	60Rc 0.004 ipr MAX	A65	150	450	650	150	450	650			
		A66N	150	450	650	150	450	650			
		PT600M	150	450	650	150	450	650			
		KBN510	150	500	675						
		KBN525	150	500	675						
		KBN900				150	250	350	150	250	350
		KBN05M	180	600	825	180	600	825			
		KBN10M	165	550	750	165	550	750			
		KBN25M	165	550	750	165	550	750			
		KBN30M	150	500	675	150	500	675			
		KBN35M	150	500	675	150	500	675			
	64Rc 0.004 ipr MAX	A65	100	400	450	100	400	450			
		A66N	100	400	450	100	400	450			
		PT600M	100	400	450	100	400	450			
		KBN510	100	450	550						
		KBN525	100	450	550						
		KBN900				100	200	300	100	200	300
		KBN05M	120	550	660	120	550	660			
		KBN10M	110	500	600	110	500	600			
		KBN25M	110	500	600	110	500	600			
		KBN30M	100	450	540	100	450	540			
		KBN35M	100	450	540	100	450	540			

Note)
Recommended cutting conditions seen above are general machining parameters.
For more accurate cutting conditions, see specific products in previous sections.

For Material Groups See Page R14

Stainless Steel Turning

Negative Inserts

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.008 ipr	0.014 ipr
	Cermet	0.002 ipr	0.004 ipr-	0.008 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
5	**PR1225**	300	450	600
	PR930	250	400	550
	PR1535	225	388	550
	CA6515	400	575	750
	CA6525	300	500	700
	TN620	300	400	500
	PV720	350	450	550

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.008 ipr	0.014 ipr
	Cermet	0.002 ipr	0.003 ipr	0.004 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
6	**PR1225**	250	400	550
	PR930	200	350	500
	PR1535	200	350	500
	CA6515	300	400	500
	CA6525	250	325	400
	TN620	250	375	500
	PV720	300	425	550

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.008 ipr	0.014 ipr
	Cermet	0.002 ipr	0.003 ipr	0.004 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
7	**PR1225**	250	400	550
	PR930	200	350	500
	PR1535	200	350	500
	CA6515	300	400	500
	CA6525	250	325	400
	TN620	250	375	500
	PV720	300	425	550

Positive Inserts

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.001 ipr	0.004 ipr	0.006 ipr
	Cermet	0.002 ipr	0.004 ipr-	0.008 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
5	**PR1225**	250	325	400
	PR930	200	263	325
	PR1535	200	263	325
	CA6515	350	425	500
	CA6525	300	375	450
	TN620	300	375	450
	PV720	350	425	500

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.004 ipr	0.006 ipr
	Cermet	0.002 ipr	0.003 ipr	0.004 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
6	**PR1225**	125	213	300
	PR930	100	175	250
	PR1535	100	175	250
	CA6515	150	275	400
	CA6525	225	288	350
	TN620	200	300	400
	PV720	250	350	450

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.004 ipr	0.006 ipr
	Cermet	0.002 ipr	0.003 ipr	0.004 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
7	**PR1225**	125	213	300
	PR930	100	175	250
	PR1535	100	175	250
	CA6515	150	275	400
	CA6525	225	288	350
	TN620	200	300	400
	PV720	250	350	450

Note)
Recommended cutting conditions seen above are general machining parameters.
For more accurate cutting conditions, see specific products in previous sections.

For Material Groups See Page R14

Cast Iron Turning

Negative Inserts

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 ipr	0.008 ipr	0.012 ipr
	Cermet	0.004 ipr	0.008 ipr	0.012 ipr
	Ceramic	0.004 ipr	0.008 ipr	0.012 ipr
	CBN	0.002 ipr	0.007 ipr	0.012 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
8	**CA310**	650	825	1000
	CA315	500	650	800
	CA320	500	650	800
	PR905	500	650	800
	PV7005	1000	1150	1300
	KS6000	650	1075	1500
	KS6050	800	1200	1600
	CS7050	1000	1400	1800
	PT600M	1000	1500	2000
	KBN900	1600	2800	4000
	KBN60M	1100	1650	2200

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 ipr	0.008 ipr	0.012 ipr
	Cermet	0.004 ipr	0.008 ipr	0.012 ipr
	Ceramic	0.004 ipr	0.006 ipr	0.008 ipr
	CBN	0.004 ipr	0.006 ipr	0.008 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
9	**CA310**	500	650	800
	CA315	400	600	800
	CA320	400	550	700
	PR905	400	550	700
	PV7005	500	750	1000
	KS6000	600	850	1100
	KS6050	600	850	1100
	CS7050	650	900	1150
	PT600M	650	925	1200
	KBN900	800	1150	1500
	KBN60M	650	975	1300

Positive Inserts

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.004 ipr	0.008 ipr
	Cermet	0.002 ipr	0.004 ipr	0.008 ipr
	Ceramic	0.002 ipr	0.004 ipr	0.008 ipr
	CBN	0.002 ipr	0.004 ipr	0.008 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
8	**CA310**	350	425	500
	CA315	300	375	450
	CA320	300	350	400
	PR905	300	350	400
	PV7005	500	750	1000
	KS6000	550	875	1200
	KS6050	600	1000	1400
	CS7050	800	1200	1600
	PT600M	800	1300	1800
	KBN900	1400	2200	3000
	KBN60M	900	1350	1800

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.004 ipr	0.008 ipr
	Cermet	0.002 ipr	0.004 ipr	0.008 ipr
	Ceramic	0.002 ipr	0.004 ipr	0.008 ipr
	CBN	0.002 ipr	0.004 ipr	0.008 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
9	**CA310**	350	425	500
	CA315	300	375	450
	CA320	300	350	400
	PR905	300	350	400
	PV7005	400	650	900
	KS6000	500	750	1000
	KS6050	500	750	1000
	CS7050	550	800	1050
	PT600M	550	850	1150
	KBN900	700	1050	1400
	KBN60M	550	875	1200

Note)
Recommended cutting conditions seen above are general machining parameters.
For more accurate cutting conditions, see specific products in previous sections.

For Material Groups See Page R14

Heat-Resistant Alloy Turning

Negative Inserts

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.006 ipr	0.012 ipr
	Ceramic	0.004 ipr	0.008 ipr	0.012 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
12	PR005S	100	200	300
	PR015S	80	155	230
	PR1535	130	165	200
	PR1305	150	205	260
	PR1310	130	165	200
	PR1325	110	135	160
	PR1225	80	115	150
	PR930	80	115	150
	CA6515	80	120	160
	CA6525	80	115	150
	KS6030	500	850	1200
	KS6040	500	750	1000

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 IPT	0.005 IPT	0.006 IPT
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
12	PR005S	100	200	300
	PR015S	80	155	230
	CA6515	80	120	160
	CA6525	80	115	150
	PR1535	130	165	200
	SW05	130	230	330
	PR1305	150	205	260
	PR1310	130	165	200
	PR1325	110	135	160
	PR1225	110	135	160

Positive Inserts

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipr	0.006 ipr	0.012 ipr
	Ceramic	0.004 ipr	0.008 ipr	0.012 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
12	PR005S	100	200	300
	PR015S	80	155	230
	PR1535	80	140	200
	PR1305	150	205	260
	PR1310	130	165	200
	PR1325	110	135	160
	PR1225	80	115	150
	PR930	80	115	150
	CA6515	80	115	150
	CA6525	80	115	150
	KS6030	500	850	1200
	KS6040	500	750	1000

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 IPT	0.005 IPT	0.006 IPT
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
12	PR005S	100	200	300
	PR015S	80	155	230
	CA6515	80	120	160
	CA6525	80	115	150
	PR1535	130	165	200
	SW05	130	230	330
	PR1305	150	205	260
	PR1310	125	163	200
	PR1325	110	135	160
	PR1225	110	135	160

Note)
Recommended cutting conditions seen above are general machining parameters.
For more accurate cutting conditions, see specific products in previous sections.

For Material Groups See Page R14

Non-Ferrous Turning

Negative Inserts

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 ipr	0.010 ipr	0.016 ipr
	PCD	0.002 ipr	0.004 ipr	0.006 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
15	**KW10**	650	1150	2300
	PDL010	700	1300	2600
	PDL025	700	1300	2600
	KPD001	1000	3250	6500
	KPD010	1000	3250	6500

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 ipr	0.010 ipr	0.016 ipr
	PCD	0.002 ipr	0.004 ipr	0.006 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
16	**KW10**	600	1100	2200
	PDL010	650	1250	2500
	PDL025	650	1250	2500
	KPD001	950	3200	6400
	KPD010	950	3200	6400

Positive Inserts

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 ipr	0.010 ipr	0.016 ipr
	PCD	0.002 ipr	0.004 ipr	0.006 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
15	**KW10**	300	625	950
	PDL010	350	675	1000
	PDL025	350	675	1000
	KPD001	500	850	1200
	KPD010	500	850	1200

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 ipr	0.010 ipr	0.016 ipr
	PCD	0.002 ipr	0.004 ipr	0.006 ipr
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
16	**KW10**	250	575	850
	PDL010	300	625	900
	PDL025	300	625	900
	KPD001	450	800	1100
	KPD010	450	800	1100

Note)
Recommended cutting conditions seen above are general machining parameters.
For more accurate cutting conditions, see specific products in previous sections.

For Material Groups See Page R14

Steel Milling

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	00.004 ipt	0.006 ipt	0.010 ipt
	Cermet	00.002 ipt	0.004 ipt	0.006 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
1	**PR830**	350	550	650
	PR1225	390	590	820
	PR1230	400	600	725
	PR1525	390	590	820
	PR1535	390	590	820
	TN100M	500	900	1100
	TN620M	650	820	1000

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipt	0.004 ipt	0.006 ipt
	Cermet	0.002 ipt	0.004 ipt	0.006 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
2	**PR830**	350	500	600
	PR1225	330	520	720
	PR1230	400	600	725
	PR1525	390	590	820
	PR1535	390	590	820
	TN100M	300	650	800
	TN620M	590	720	820

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipt	0.004 ipt	0.008 ipt
	Cermet	0.002 ipt	0.004 ipt	0.005 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
3	**PR830**	200	425	550
	PR1225	260	460	590
	PR1230	325	525	675
	PR1525	390	590	820
	PR1535	390	590	820
	TN100M	250	450	600
	TN620M	500	590	720

Note)
Recommended cutting conditions seen above are general machining parameters.
For more accurate cutting conditions, see specific products in previous sections.

For Material Groups See Page R14

Stainless Steel Milling

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipt	0.004 ipt	0.006 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
5	**PR1225**	330	520	660
	PR1525	330	520	660
	PR1535	330	520	660
	CA6535	590	790	960

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipt	0.005 ipt	0.008 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
6	**PR1225**	-	-	-
	PR1525	-	-	-
	PR1535	490	660	820
	CA6535	590	790	980

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.003 ipt	0.005 ipt	0.008 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
7	**PR1225**	-	-	-
	PR1525	-	-	-
	PR1535	300	390	490
	CA6535	-	-	-

Cast Iron Milling

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 ipt	0.010 ipt	0.016 ipt
	Ceramic	0.002 ipt	0.004 ipt	0.008 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
8	**PR1210**	390	590	820
	PR1510	390	590	820
	CA420M	550	750	980
	KS6000	650	2500	3300
	KS6050	1900	2950	3900
	CS7050	1900	2950	3900

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 ipt	0.008 ipt	0.012 ipt
	Ceramic	0.002 ipt	0.004 ipt	0.008 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
9	**PR1210**	330	490	660
	PR1510	330	490	660
	CA420M	490	660	820
	KS6000	500	1200	1800
	KS6050	1300	1950	2950
	CS7050	1300	1950	2950

Note)
Recommended cutting conditions seen above are general machining parameters.
For more accurate cutting conditions, see specific products in previous sections.

For Material Groups See Page R14

Heat-Resistant Alloy Milling

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.003 ipt	0.005 ipt	0.006 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
12	**PR1535**	70	100	160
	CA6535	70	100	160

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.003 ipt	0.006 ipt	0.008 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
14	**PR1535**	130	200	260

Non-Ferrous Milling

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.004 ipt	0.008 ipt	0.012 ipt
	PCD	0.002 ipt	0.004 ipt	0.008 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
15	**KW10**	660	1970	2950
	GW25	660	1970	2950
	PDL025	660	1640	2620
	KPD001	1640	3280	4920
	KPD230	1640	3280	4920

Material	Grade Type	Machining Parameters		
		Feed Rate		
	Carbide	0.002 ipt	0.005 ipt	0.008 ipt
	PCD	0.002 ipt	0.004 ipt	0.006 ipt
Material Group	Grade	Cutting Speed (sfm)		
		FROM	MEDIAN	TO
16	**KW10**	660	820	980
	GW25	660	820	980
	PDL025	660	820	980
	KPD001	980	2460	3280
	KPD230	980	2460	3280

Note)
Recommended cutting conditions seen above are general machining parameters.
For more accurate cutting conditions, see specific products in previous sections.

For Material Groups See Page R14

Inch / Metric Conversion Chart

• Cutting Speed (Vc)

Cutting Speed (Vc)	
SFM	m/min
300	91
600	183
900	274

SFM = (0.262 x rpm) x dia.(inch)
3.28feet/min (SFM) = 1m/min

SFM (Surface Feet per Minute)

• D.O.C. (ap)

D.O.C. (ap)	
inch	mm
0.02	0.5
0.04	1.0
0.08	2.0

1inch = 25.4mm
0.04inch = 1mm

• IPR Feed Rate (f)

Feed Rate (f)	
ipr	m/min
0.002	0.05
0.004	0.1
0.008	0.2

1ipr = 25.4mm/rev
0.004ipr = 0.1mm/rev

ipr (Inch per Revolution)
mm/rev (mm per Revolution)

• IPT Feed Rate (fz)

Feed Rate (fz)	
ipt	mm/t
0.002	0.05
0.004	0.1
0.008	0.2

1ipt = 25.4mm/t
0.004ipt = 0.1mm/t

ipt (Inch per Tooth)
mm/t (mm per Tooth)

• Torque

lbft	Nm
0.738	1

lbft (Pound x Feet)
Nm (Newton x Meter)

SI Derived Units Conversion Chart

(Extracted from JIS Handbook "Iron & Steel")

• Force

N	kgf	dyn
1	$1.019\ 72X10^{-1}$	$1X10^{5}$
9.806 65	1	$9.806\ 65X10^{5}$
$1X10^{-5}$	$1.019\ 72X10^{-6}$	1

• Stress

Pa or N/m^2	MPa or N/mm^2	kgf/mm^2	kgf/cm^2	kgf/m^2
1	$1X10^{-6}$	$1.019\ 72X10^{-7}$	$1.019\ 72X10^{-5}$	$1.019\ 72X10^{-1}$
$1X10^{6}$	1	$1.019\ 72X10^{-1}$	$1.019\ 72X10$	$1.019\ 72X10^{5}$
$9.806\ 65X10^{6}$	9.806 65	1	$1X10^{-2}$	$1X10^{-6}$
$9.806\ 65X10^{4}$	$9.806\ 65X10^{-2}$	$1X10^{-2}$	1	$1X10^{-4}$
9.806 65	$9.806\ 65X10^{-6}$	$1X10^{-6}$	$1X10^{-4}$	1

• Pressure

Pa	kPa	MPa	bar	kgf/cm2
1	$1X10^{-3}$	$1X10^{-6}$	$1X10^{-5}$	$1.019\ 72X10^{-5}$
$1X10^{3}$	1	$1X10^{-3}$	$1X10^{-2}$	$1.019\ 72X10^{-2}$
$1X10^{6}$	$1X10^{3}$	1	1X10	1.019 72X10
$1X10^{5}$	$1X10^{2}$	$1X10^{-1}$	1	1.019 72
$9.806\ 65X10^{4}$	9.806 65X10	$9.806\ 65X10^{-2}$	$9.806\ 65X10^{-1}$	1

• Power

W	kW	kgf · m/s	PS	kcal/h
1	$1X10^{-3}$	$1.019\ 72X10^{-1}$	$1.359\ 62X10^{-3}$	$8.600\ 00X10^{-1}$
$1X10^{3}$	1	$1.019\ 72X10^{-2}$	1.359 62	$8.600\ 00X10^{2}$
9.806 65	$9.806\ 65X10^{-3}$	1	$1.333\ 33X10^{-2}$	8.433 71
$7.355X10^{2}$	$7.355X10^{-1}$	7.5X10	1	$6.325\ 29X10^{2}$
1.162 79	$1.162\ 79X10^{-3}$	$1.185\ 72X10^{-1}$	$1.580\ 95X10^{-3}$	1

• Revolution

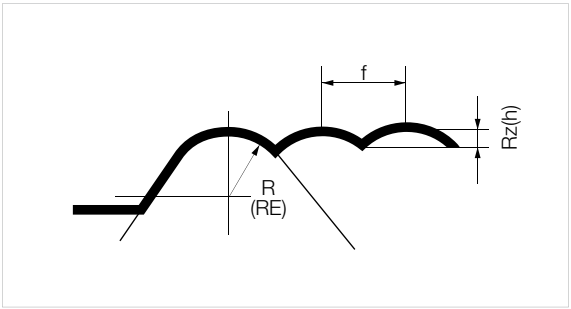
min^{-1}	s^{-1}	r.p.m.
1	0.0167	1
60	1	60

Theoretical (Geometrical) Surface Roughness

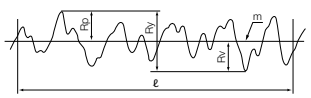
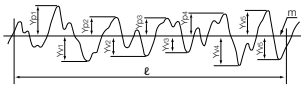
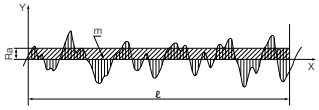
Theoretical Surface Roughness for Turning indicates the minimum roughness value from the cutting conditions and it is shown by the formula as follows:

$$Rz(h)=\frac{f^2}{8R(RE)}x10^3$$

Rz(h) : Theoretical Surface Roughness [μm]
f : Feed Rate [mm/rev]
R(RE) : Corner Radius of Insert [mm]



How to Obtain Surface Roughness Values

Type	Symbol	How to Obtain	Explanation
Max. Height Roughness	Rz	Ry is a mean value in micron meter obtained from the distance of the highest peaks and the lowest valleys within the range of sampled reference length (l) in the direction of the center line of the roughness curve. Note) When calculating Rz, extraordinarily high or low threads are considered as damages and excluded from the calculation, and only standard lengths are used. Rz=Rp+Rv	
Ten Points Mean Roughness	RzJIS	Rz is a mean value in micron meter obtained from the distance of 5 highest peaks (Yp) and the 5 lowest valleys (Yv) measured from the center line of the roughness curve within the range of sampled reference length "l ". $RzJIS=\frac{(Yp1+Yp2+Yp3+Yp4+Yp5)+(Yv1+Yv2+Yv3+Yv4+Yv5)}{5}$	Yp1,Yp2,Yp3,Yp4,Yp5 : Distance from the mean line to highest 5 peaks in the range of sampled reference length "l " Yv1,Yv2,Yv3,Yv4,Yv5 : Distance from the mean line to the lowest 5 valleys in the range of sampled reference length "l " 
Arithmetical Mean Roughness	Ra	Ra is obtained from the following formula in micron meter, the roughness curve is expressed by y=f(x), the X-axis is in the direction of the center line and the Y-axis is the vertical magnification of the roughness curve in the range of sampled reference length "l ". $Ra=\frac{1}{\ell}\int_0^{\ell}\{f(x)\}dx$	

Relationship with Triangle Symbol

Arithmetical Mean Roughness Ra(μm)	Max. Height Roughness Rz(μm)	Ten Points Mean Roughness RzJIS(μm)	※(Relationship with Triangle)
0.025	0.1	0.1	▽▽▽▽
0.050	0.2	0.2	
0.100	0.4	0.4	
0.200	0.8	0.8	
0.400	1.6	1.6	▽▽▽
0.800	3.2	3.2	
1.600	6.3	6.3	
3.200	12.5	12.5	▽▽
6.300	25.0	25.0	
12.500	50.0	50.0	▽
25.000	100.0	100.0	

※ Finishing symbol (Triangle ▽ and wave ~) was removed from JIS standard in the 1994 Revision.

- How to Indicate
  ① When Ra is 1.6μm→1.6μmRa
  ② When Rz is 6.3μm→6.3μmRz
  ③ When RzJIS is 6.3μm→6.3μmRzJIS

Indication in JIS Standard

Example of Ra Indication		Example of Ry, (Rz) Indication	
① When indicating the upper limit only (when upper limit is 6.3 mRa)	6.3	① When indicating upper limit only Indicate surface roughness following the parameter symbol.	Rz6.3
② When indicating both lower and upper limit (when upper limit is 6.3 mRa, lower limit is 1.6 mRa)	6.3 1.6	② When indicating both lower and upper limit Indicate surface roughness as (upper limit ~ lower limit) following the parameter symbol.	Rz6.3~1.6

Note: The indications of Ra and Rz are different.

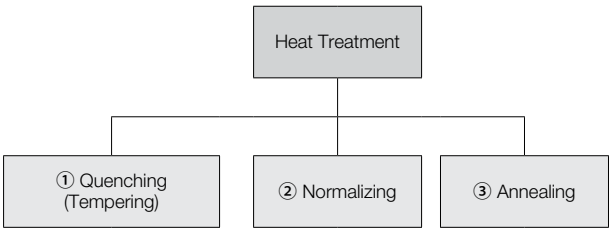
Caution-Symbols for Surface Roughness

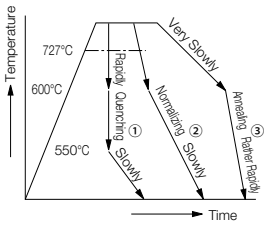
The above information is based on JIS B 0601-2001. However, some symbols were revised as shown in the right table in accordance with ISO Standard from JIS B 0601-2001 version. Ten Points Mean Roughness (Rz) was eliminated from 2001 version but it still remains as RzJIS reference, since it was popular in Japan.

Type	Symbol of JIS B 0601-1994		Symbol of JIS B 0601-2001
Max. Height Roughness	Ry	→	Rz
Ten Points Mean Roughness	Rz	→	(RzJIS)
Arithmetical Mean Roughness	Ra	→	Ra

Heat Treatment

One of the ways to determine the hardness of steel is the heat treatment and it is classified to 3 types.





Heat Treatment Method

① Quenching (Tempering)	After heating to over 727°C, cool rapidly down to 550°C in water or oil.	Quenching makes steel hard because it cools down red-hot steel very rapidly in water or oil, but it may promote internal stress. In order to remove such internal stress, tempering is used. (After cooled down once, reheat it to 200°C~600°C)
② Normalizing	After heating to over 727°C, cool down rapidly to 600°C and then to normal temperature.	It miniaturizes the crystals. (Steel is also composed of small cells.) It is used to improve the mechanical character or machinability.
③ Annealing	After heating to over 727°C, cool down very slowly to 600°C, then to normal temperature.	It miniaturizes the crystals like the process of normalizing, but the crystal size is bigger than that of normalizing. It targets machinability improvement and distortion correction.

Hardness Value

Hardness	Reference Standard	Example	Explanation of Example
Brinell Hardness	JIS Z 2243:1992	250HB	Hardness Value : 250, Hardness Symbol : HB
		200~250HB	When the hardness has the range
Vickers Hardness	JIS Z 2244:1998	640HV	Hardness Value : 640, Hardness Symbol : HV
Rockwell Hardness	JIS Z 2245:1992	60HRC	Hardness Value : 60, Hardness Symbol : HRC
Shore Hardness	JIS Z 2246:1992	50HS	Hardness Value : 50, Hardness Symbol : HS

Vickers Hardness Conversion Chart

Vickers Hardness (HV)	Brinell Hardness 10mm Dia. Ball Load: 3000kgf (HB)		Rockwell Hardness[2]			Shore Hardness (HS)	Tensile Strength MPa[1]
	Standard Ball	Tungsten Carbide Ball	A Scale Load: 60kgf Diamond Point (HRA)	B Scale Load: 100kgf 1.60mm (1/16in) Ball (HRB)	C Scale Load: 150kgf Diamond Point (HRC)		
940	-	-	85.6	-	68.0	97	
920	-	-	85.3	-	67.5	96	
900	-	-	85.0	-	67.0	95	
880	-	(767)	84.7	-	66.4	93	
860	-	(757)	84.4	-	65.9	92	
840	-	(745)	84.1	-	65.3	91	
820	-	(733)	83.8	-	64.7	90	
800	-	(722)	83.4	-	64.0	88	
780	-	(710)	83.0	-	63.3	87	
760	-	(698)	82.6	-	62.5	86	
740	-	(684)	82.2	-	61.8	84	
720	-	(670)	81.8	-	61.0	83	
700	-	(656)	81.3	-	60.1	81	
690	-	(647)	81.1	-	59.7	-	
680	-	(638)	80.8	-	59.2	80	
670	-	630	80.6	-	58.8	-	
660	-	620	80.3	-	58.3	79	
650	-	611	80.0	-	57.8	-	
640	-	601	79.8	-	57.3	77	
630	-	591	79.5	-	56.8	-	
620	-	582	79.2	-	56.3	75	
610	-	573	78.9	-	55.7	-	
600	-	564	78.6	-	55.2	74	
590	-	554	78.4	-	54.7	-	2055
580	-	545	78.0	-	54.1	72	2020
570	-	535	77.8	-	53.6	-	1985
560	-	525	77.4	-	53.0	71	1950
550	505	517	77.0	-	52.3	-	1905
540	496	507	76.7	-	51.7	69	1860
530	488	497	76.4	-	51.1	-	1825
520	480	488	76.1	-	50.5	67	1795
510	473	479	75.7	-	49.8	-	1750
500	465	471	75.3	-	49.1	66	1705
490	456	460	74.9	-	48.4	-	1660
480	448	452	74.5	-	47.7	64	1620
470	441	442	74.1	-	46.9	-	1570
460	433	433	73.6	-	46.1	62	1530
450	425	425	73.3	-	45.3	-	1495
440	415	415	72.8	-	44.5	59	1460
430	405	405	72.3	-	43.6	-	1410
420	397	397	71.8	-	42.7	57	1370
410	388	388	71.4	-	41.8	-	1330
400	379	379	70.8	-	40.8	55	1290
390	369	369	70.3	-	39.8	-	1240
380	360	360	69.8	(110.0)	38.8	52	1205
370	350	350	69.2	-	37.7	-	1170
360	341	341	68.7	(109.0)	36.6	50	1130
350	331	331	68.1	-	35.5	-	1095
340	322	322	67.6	(108.0)	34.4	47	1070
330	313	313	67.0	-	33.3	-	1035
320	303	303	66.4	(107.0)	32.2	45	1005
310	294	294	65.8	-	31.0	-	980
300	284	284	65.2	(105.5)	29.8	42	950
295	280	280	64.8	-	29.2	-	935
290	275	275	64.5	(104.5)	28.5	41	915
285	270	270	64.2	-	27.8	-	905
280	265	265	63.8	(103.5)	27.1	40	890
275	261	261	63.5	-	26.4	-	875
270	256	256	63.1	(102.0)	25.6	38	855
265	252	252	62.7	-	24.8	-	840
260	247	247	62.4	(101.0)	24.0	37	825
255	243	243	62.0	-	23.1	-	805
250	238	238	61.6	99.5	22.2	36	795
245	233	233	61.2	-	21.3	-	780
240	228	228	60.7	98.1	20.3	34	765
230	219	219	-	96.7	(18.0)	33	730
220	209	209	-	95.0	(15.7)	32	695
210	200	200	-	93.4	(13.4)	30	670
200	190	190	-	91.5	(11.0)	29	635
190	181	181	-	89.5	(8.5)	28	605
180	171	171	-	87.1	(6.0)	26	580
170	162	162	-	85.0	(3.0)	25	545
160	152	152	-	81.7	(0.0)	24	515
150	143	143	-	78.7	-	22	490
140	133	133	-	75.0	-	21	455
130	124	124	-	71.2	-	20	425
120	114	114	-	66.7	-	-	390
110	105	105	-	62.3	-	-	-
100	95	95	-	56.2	-	-	-
95	90	90	-	52.0	-	-	-
90	86	86	-	48.0	-	-	-
85	81	81	-	41.0	-	-	-

- Extracted from JIS Handbook "Iron & Steel" (SAE J 417)

Note 1) 1MPa = 1N/mm²

2) Value in ( ) is not in practical use, but reference only

Metal

Class	Name of JIS Standard	Symbol
Structural Steel	Rolled Steel for Welded Structure	SM
	Re-Rolled Steel	SRB
	Rolled Steel for General Structure	SS
	Light Gauge Steel for General Structure	SSC
	Hot-Rolled Steel Plate, Sheet and Strip for Automobile Structural Use	SAPH
Steel Sheet	Cold-Rolled Steel Plate, Sheet and Strip	SPC
	Hot-Rolled Soft Steel Plate, Sheet and Strip	SPH
Steel Pipe	Carbon Steel Pipe for Ordinary Piping	SGP
	Carbon Steel Pipe for Boiler / Heat Exchanger	STB
	Seamless Steel Pipe for High Pressure Gas Cylinder	STH
	Carbon Steel Pipe for General Structural Use	STK
	Carbon Steel Pipe for Machine Structural Use	STKM
	Alloy Steel Pipe for Structural Use	STKS
	Stainless Steel Pipe for Machine Structural Use	SUS-TK
	Steel Square Pipe for General Structural Use	STKR
	Alloy Steel Pipe for Ordinary Piping	STPA
	Carbon Steel Pipe for Pressure Service	STPG
	Carbon Steel Pipe for High-Temperature Service	STPT
	Carbon Steel Pipe for High-Pressure Service	STS
	Stainless Steel Pipe for Ordinary Piping	SUS-TP
Steel for Machine Structural Use	Carbon Steel for Machine Structural Use	SxxC, SxxCK
	Aluminium Chromium Molybdenum Steel	SACM
	Chromium Molybdenum Steel	SCM
	Chromium Steel	SCr
	Nickel Chromium Steel	SNC
	Nickel Chromium Molybdenum Steel	SNCM
	Manganese Steel and Manganese Chromium Steel for Machine Structural Use	SMn, SMnC
Special Steel – Tool Steel	Carbon Tool Steel	SK
	Hollow Drill Steel	SKC
	Alloy Tool Steel	SKS, SKD, SKT
	High Speed Tool Steel	SKH
Special Steel – Special Steel	Free Cutting Carbon Steel	SUM
	High Carbon Chromium Bearing Steel	SUJ
	Spring Steel	SUP
Special Steel – Stainless Steel	Stainless Steel Bar	SUS-B
	Hot-Rolled Stainless Steel Plate, Sheet and Strip	SUS-HP, SUS-HS
	Cold-Rolled Stainless Steel Plate, Sheet and Strip	SUS-CP, SUS-CS
Special Steel – Heat Resistant Steel	Heat-Resisting Steel Bar	SUH-B, SUH-CB
	Heat-Resisting Steel Plate and Sheet	SUH-HP, SUH-CP
Special Steel – Super Alloy	Corrosion-Resisting and Heat-Resisting Superalloy Bar	NCF-B
	Corrosion-Resisting and Heat-Resisting Superalloy Plate and Sheet	NCF-P
Forged Steel	Carbon Steel Forging	SF
	Chromium Molybdenum Steel Forging	SFCM
	Nickel Chromium Molybdenum Steel Forging	SFNCM
Cast Iron	Gray Cast Iron	FC
	Spheroidal Graphite Cast Iron	FCD
	Blackheart Malleable Cast Iron	FCMB
	Whiteheart Malleable Cast Iron	FCMW
	Pearlitic Malleable Cast Iron	FCMP
Cast Steel	Carbon Cast Steel	SC
	High Tensile Strength Carbon Cast Steel & Low Alloy Cast Steel	SCC
	Stainless Cast Steel	SCS
	Heat-Resisting Cast Steel	SCH
	High Manganese Cast Steel	SCMnH
	Cast Steel for High Temperature and High Pressure Service	SCPH

Non-Ferrous Metal

Class	Name of JIS Standard	Symbol
Copper	Copper and Copper Alloy Sheet / Strip	CxxxxP CxxxxPP CxxxxR
	Copper and Copper Alloy Rod and Bar	CxxxxBD CxxxxBDS CxxxxBE
Aluminum Alloy and Aluminum Alloy Expanded Material	Aluminum and Al. Alloy Sheet / Strip	AxxxxP AxxxxPC
	Aluminum and Al. Alloy Rod, Bar, and Wire	AxxxxBE AxxxxBES AxxxxBD AxxxxBDS AxxxxW AxxxxWS
	Aluminum and Al. Alloy Extruded Shape	AxxxxS
	Aluminum and Al. Alloy Forging	AxxxxFD AxxxxFH
Magnesium Alloy Expanded Material	Magnesium Alloy Sheet and Plate	MP
	Magnesium Alloy Rod and Bar	MB
Nickel Alloy	Nickel Copper Alloy Sheet and Plate	NCuP
	Nickel Copper Alloy Rod and Bar	NCuB
Titanium Expanded Material	Titanium Rod and Bar	TB
Casting	Brass Casting	CAC20x
	High Strength Brass Casting	CAC30x
	Bronze Casting	CAC40x
	Phosphoric Bronze Casting	CAC50x
	Aluminum Bronze Casting	CAC70x
	Aluminum Alloy Casting	AC
	Magnesium Alloy Casting	MC
	Zinc Alloy Die Casting	ZDCx
	Aluminum Alloy Die Casting	ADC
	Magnesium Alloy Die Casting	MD
	White Metal	WJ

Steel

CLASS	USA AISI / SAE	JAPAN JIS	CHINA GB	UK BS	GERMANY DIN	FRANCE NF	RUSSIA ГОСТ
CARBON STEEL FOR MACHINE STRUCTURAL USE	1010	S10C	08 10	040A10 045A10 045M10	C10E C10R	XC10	
	1012	S12C		040A12		XC12	
	1015	S15C	15	055M15	C15E C15R		
	1017	S17C				XC18	
	1020	S20C	20	070M20 C22 C22E C22R	C22 C22E C22R	C22 C22E C22R	
	1023	S22C					
	1025	S25C	25	C25 C25E C22R	C25 C25E C25R	C25 C25E C25R	
	1029	S28C					25Г
	1030	S30C	30	080A30 080M30 C30 C30E C30R	C30 C30E C30R	C30 C30E C30R	30Г
		S33C					30Г
	1035	S35C	35	C35 C35E C35R	C35 C35E C35R	C35 C35E C35R	35Г
	1038	S38C					35Г
	1039 1040	S40C	40	080M40 C40 C40E C40R	C40 C40E C40R	C40 C40E C40R	40Г
	1042 1043	S43C		080A42			40Г
	1045 1046	S45C	45	C45 C45E C45R	C45 C45E C45R	C45 C45E C45R	45Г
		S48C		080A47			45Г
	1049	S50C	50	080M50 C50 C50E C50R	C50 C50E C50R	C50 C50E C50R	50Г
	1050 1053	S53C					50Г
	1055	S55C	55	070M55 C55 C55E C55R	C55 C55E C55R	C55 C55E C55R	
	1059 1060	S58C	60	C60 C60E C60R	C60 C60E C60R	C60 C60E C60R	60Г
		S09CK		045A10 045M10	C10E	XC10	
		S15CK	15F		C15E	XC12	
		S20CK				XC18	

Steel

CLASS	USA AISI / SAE	JAPAN JIS	CHINA GB	UK BS	GERMANY DIN	FRANCE NF	RUSSIA ГОСТ
NICKEL CHROMIUM STEEL		SNC236			36NiCr6		40XH
		SNC415	12CrNi2		14NiCr10		
		SNC631	30CrNi3		36NiCr10		30XH3A
		SNC815	12Cr2Ni4	655M13	15NiCr13		
		SNC836	37CrNi3		31NiCr14		
NICKEL CHROMIUM MOLYBDENUM STEEL	8615 8617 8620 8622	SNCM220	20CrNiMo	805A20 805M20 805A22 805M22	20NiCrMo2 20NiCrMoS2	20NCD 2	
	8637 8640	SNCM240			40NiCrMo2-2		
		SNCM415					
	4320	SNCM420	18CrNiMnMoA		17NiCrMo6-4		20XH2M (20XHM)
		SNCM431			30CrNiMo8		
	4340	SNCM439	40CrNiMoA		40NiCrMo6		
		SNCM447			34CrNiMo6		
		SNCM616					
		SNCM625					
		SNCM630					
		SNCM815					
CHROMIUM STEEL		SCr415	15Cr 15CrA		17Cr3 17CrS3		15X 15XA
	5120	SCr420	20Cr				20X
	5130 5132	SCr430	30Cr	34Cr4 34CrS4	34Cr4 34CrS4	34Cr4 34CrS4	30X
	5132	SCr435	35Cr	37Cr4 37CrS4	37Cr4 37CrS4	37Cr4 37CrS4	35X
	5140	SCr440	40Cr	530M40 41Cr4 41CrS4	41Cr4 41CrS4	41Cr4 41CrS4	40X
		SCr445	45Cr 50Cr				45X
CHROMIUM MOLYBDENUM STEEL		SCM415	15CrMo		15CrMo4		
		SCM418	20CrMo		18CrMo4 18CrMoS4		20XM
		SCM420		708M20	20CrMo5		20XM
		SCM421					
	4131	SCM430	30CrMo 30CrMoA				30XM 30XMA
		SCM432					
	4137	SCM435	35CrMo	34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	35XM
	4140 4142	SCM440	42CrMo	708M40 709M40 42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	
	4145 4147	SCM445					
		SCM822					

Steel

CLASS	USA AISI / SAE	JAPAN JIS	CHINA GB	UK BS	GERMANY DIN	FRANCE NF	RUSSIA ГОСТ
MANGANESE CHROMIUM STEEL MANGANESE STEEL	1522	SMn420	20Mn2	150M19	20Mn5		
	1534	SMn433	30Mn2 35Mn2	150M36	34Mn5		30Г2 35Г2
	1541	SMn438	40Mn2	150M36	36Mn5		35Г2 40Г2
	1541	SMn443	45Mn2				40Г2 45Г2
	5115	SMnC420	15CrMn		16MnCr5		
	5140	SMnC443	40CrMn				
STRUCTURAL STEEL WITH SPECIFIED HARDENABILITY BAND (H-SHAPE STEEL)	1522H	SMn420H					
		SMn433H					
	1541H	SMn438H					
	1541H	SMn443H					
		SMnC420H					
		SMnC443H					
		SCr415H	15CrH		17Cr3 17CrS3		15X
	5120H	SCr420H	20Cr1H		17Cr3		20X
	5130H 5132H	SCr430H		34Cr4 34CrS4	34Cr4 34CrS3	34Cr4 34CrS4	30X
	5135H	SCr435H		37Cr4 37CrS4	37Cr4 34CrS4	37Cr4 37CrS4	35X
	5140H	SCr440H	40CrH	41Cr4 41CrS4	41Cr4 41CrS4	41Cr4 41CrS4	40X
	4118H	SCN415H	15CrMoH		15CrMo5		
		SCM418H			18CrMo4 18CrMoS4		
	4118H	SCM420H	20CrMoH	708H20	18CrMo4		
	4135H 4137H	SCM435H		34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	
	4140H 4142H	SCM440H		42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	
	4145H 4147H	SCM445H					
		SCM822H					
		SNC415H					
		SNC631H					
		SNC815H	12Cr2Ni4H	655H13	15NiCr13		
	8617H 8620H 8622H	SNCM220H	20CrNiMoH	805H17 805H20 805H22	21NiCrMo2	20N CD 2	
	4320H	SNCM420H	20CrNi2MoH		20NiCrMoS6-4		

Steel

CLASS	USA		JAPAN	CHINA	UK	GERMANY	FRANCE	RUSSIA
	UNS	AISI	JIS	GB	BS	DIN	NF	ГОСТ
STAINLESS STEEL	S20100	201	SUS 201	1Cr17Mn6Ni5N			Z12CMN17-07Az	
	S20200	202	SUS 202	1Cr18Mn8Ni5N	284S16			12Х17Г9АН4
	S30100	301	SUS 301	1Cr18Mn10Ni5Mo3N 1Cr17Ni7	301S21	X12CrNi17 7	Z11CN17-08	07Х16Н6
			SUS 301L			X2CrNiN18-7		
			SUS 301J1			X12CrNi17 7		
	S30200	302	SUS 302	1Cr18Ni9	302S25		Z12CN18-09	12Х18Н9
	S30215	302B	SUS 302B					
	S30300	303	SUS 303	Y1Cr18Ni9	303S21	X10CrNiS18 9	Z8CNF18-09	
	S30323	303Se	SUS 303Se	Y1Cr18Ni9Se	303S41			12Х18Н10Е
	S30400	304	SUS 304	0Cr18Ni9	304S31	X5CrNi18 10	Z7CN18-09	08Х18Н10
	S30403	304L	SUS 304L	00Cr18Ni10	304S11	X2CrNi19 11	Z3CN19-11	03Х18Н11
	S30451	304N	SUS 304N1	0Cr18Ni9N			Z6CN19-09Az	
	S30452		SUS 304N2	0Cr19Ni10NbN				
	S30453	304LN	SUS 304LN	00Cr18Ni10N		X2CrNiN18 10	Z3CN18-10Az	
			SUS 304J1					
			SUS 304J2					
	S30431	S30431	SUS 304J3					
	S30500	305	SUS 305	1Cr18Ni12	305S19	X5CrNi18 12	Z8CN18-12	06Х18Н11
			SUS 305J1					
	S30908	309S	SUS 309S	0Cr23Ni13			Z10CN24-13	
	S31008	310S	SUS 310S	0Cr25Ni20	310S31		Z8CN25-20	10Х23Н18
	S31600	316	SUS 316	0Cr17Ni12Mo2	316S31	X5CrNiMo17 12 2	Z7CND17-12-02	
						X5CrNiMo17 13 3	Z6CND18-12-03	
	S31603	316L	SUS 316L	00Cr17Ni14Mo2	316S11	X2CrNiMo17 13 2	Z3CND17-12-02	
						X2CrNiMo17 14 3	Z3CND17-13-03	03Х17Н14М3
	S31651	316N	SUS 316N	0Cr17Ni12Mo2N				
	S31653	316LN	SUS 316LN	00Cr17Ni13Mo2N		X2CrNiMoN17 12 2	Z3CND17-11Az	
						X2CrNiMoN17 13 3	Z3CND17-12Az	
	S31635		SUS 316Ti			X6CrNiMoTi17 12 2	Z6CNDT17-12	08Х17Н13М2Т
			SUS 316J1	0Cr18Ni12Mo2Cu2				
			SUS 316J1L	00Cr18Ni14Mo2Cu2				
	S31700	317	SUS 317	0Cr19Ni13Mo3	317S16			
	S31703	317L	SUS 317L	00Cr19Ni13Mo3	317S12	X2CrNiMo18 16 4	Z3CND19-15-04	
	S31753		SUS 317LN				Z3CND19-14Az	
			SUS 317J1	0Cr18Ni16Mo5				
			SUS 317J2					
			SUS 317J3L					
	N08367		SUS 836L					
	N08904	N08904	SUS 890L		904S14		Z2NCDU25-20	
	S32100	321	SUS 321	1Cr18Ni9Ti 0Cr18Ni10Ti	321S31	X6CrNiTi18 10	Z6CNT18-10	08Х18Н10Т
	S34700	347	SUS 347	0Cr18Ni11Nb	347S31	X6CrNiNb18 10	Z6CNNb18-10	08Х18Н12Б
	S38400	384	SUS 384				Z6CN18-16	
	S30430	304Cu	SUS XM7	0Cr18Ni9Cu3	394S17		Z2CNU18-10	
	S38100		SUS XM15J1	0Cr18Ni13Si4			Z15CNS20-12	
	S32900	329	SUS 329J1	0Cr26Ni5Mo2				
	S39240	S31803	SUS 329J3L				Z3CNDU22-05Az	08Х21Н6М2Т
	S39275	S31260	SUS 329J4L				Z3CNDU25-07Az	

Steel

CLASS	USA		JAPAN	CHINA	UK	GERMANY	FRANCE	RUSSIA
	UNS	AISI	JIS	GB	BS	DIN	NF	ГОСТ
STAINLESS STEEL	S40500	405	SUS 405	0Cr13Al 0Cr13	405S17	X6CrAl13	Z8CA12	
			SUS 410L	00Cr12			Z3C14	
	S42900	429	SUS 429					
	S43000	430	SUS 430	1Cr17	430S17	X6Cr17	Z8C17	12X17
	S43020	430F	SUS 430F	Y1Cr17		X7CrMoS18	Z8CF17	
	S43035		SUS 430LX			X6CrTi17	Z4CT17	
			SUS 430J1L			X6CrNb17	Z4CNb17	
	S43400	434	SUS 434	1Cr17Mo	434S17	X6CrMo17 1	Z8CD17-01	
	S43600	436	SUS 436L					
			SUS 436J1L					
	S44400	444	SUS 444				Z3CDT18-02	
	S44700		SUS 447J1	00Cr30Mo2				
	S44627		SUS XM27	00Cr27Mo			Z1CD26-01	
	S40300	403	SUS 403	1Cr12				
	S41000	410	SUS 410	1Cr13	410S21	X10Cr13	Z13C13	
	S41008	410S	SUS 410S		403S17	X6Cr13	Z8C12	08X13
			SUS 410F2					
	S41025		SUS 410J1	1Cr13Mo 1Cr12Mo		X12CrS13		
	S41600	416	SUS 416	Y1Cr13	416S21		Z11CF13	
	S42000	420	SUS 420J1	2Cr13	420S29	X20Cr13	Z20C13	20X13
	S42000	420	SUS 420J2	3Cr13	420S37	X30Cr13	Z33C13	30X13
	S42020	420F	SUS 420F	Y3Cr13			Z30CF13	
			SUS 420F2					
			SUS 429J1					
	S43100	431	SUS 431	1Cr17Ni2	431S29	X20CrNi17 2	Z15CN16-02	20X17H2
	S44002	440A	SUS 440A	7Cr17			Z70C15	
	S44003	440B	SUS 440B	8Cr17				
	S44004	440C	SUS 440C	9Cr18 11Cr17 9Cr18Mo			Z100CD17	95X18
	S44020	S44020	SUS 440F	Y11Cr17				
	S17400	S17400	SUS 630	0Cr17Ni4CuNb		X5CrNiCuNb16-4	Z6CNU17-04	
	S17700	S17700	SUS 631	0Cr17Ni7Al		X7CrNiAl17 7	Z9CNA17-07	09X17H7 Ю
			SUS 632J1					

Representative Classification of Stainless Steel

Stainless Steel (Austenitic Related)

JIS	
SUS201	SUS309S
SUS202	SUS310S
SUS301	SUS316
SUS302	SUS316L
SUS302B	SUS316N
SUS303	SUS317
SUS303Se	SUS317L
SUS304	SUS321
SUS304L	SUS347
SUS304N1	SUS384
SUS304N2	SUSXM7
SUS305	SUSXM15J1
SUS308	

Stainless Steel (Ferritic Related)

JIS
SUS405
SUS429
SUS430
SUS430F
SUS434
SUSXM27

Stainless Steel (Martensitic Related)

JIS
SUS403
SUS410
SUS410S
SUS416
SUS420J1
SUS420F
SUS431
SUS440A
SUS440B
SUS440C
SUS440F

Stainless Steel (Precipitation Hardened Related)

JIS
SUS630
SUS631

Steel

CLASS	USA		JAPAN	CHINA	UK	GERMANY	FRANCE	RUSSIA
	UNS	AISI	JIS	GB	BS	DIN	NF	ГОСТ
HEAT RESISTING STEEL			SUH 31		331S42		Z35CNWS14-14	45Х14Н14В2М
			SUH 35		349S52		Z52CMN21-09Az	
	S63008		SUH 36	5Cr21Mn9Ni4N	349S54	X53CrMnNi21-9	Z55CMN21-09Az	55Х20 Г 9АН4
	S63017		SUH 37	2Cr21Ni12N	381S34			
			SUH 38					
	S30900	309	SUH 309	2Cr23Ni13	309S24		Z15CN24-13	
	S31000	310	SUH 310	2Cr25Ni20	310S24	CrNi2520	Z15CN25-20	20Х25Н20С2
	N08330	N08330	SUH 330	1Cr16Ni35			Z12NCS35-16	
	S66286		SUH 660	0Cr15Ni25Ti2MoAlVB			Z6NCTV25-20	
	R30155		SUH 661					
			SUH 21			CrAl1205		
	S40900	409	SUH 409		409S19	X6CrTi12	Z6CT12	
			SUH 409L				Z3CT12	
	S44600	446	SUH 446	2Cr25N			Z12C25	15Х28
	S65007		SUH 1	4Cr9Si2	401S45	X45CrSi9-3	Z45CS9	
			SUH 3	4Cr10Si2Mo			Z40CSD10	40Х10С2М
			SUH 4	8Cr20Si2Ni	443S65		Z80CSN20-02	
			SUH 11					40Х 9С2
			SUH 600	2Cr12MoVNbN				20Х12ВНМБФР
	S42200		SUH 616	2Cr12NiMoWV				

Representative Classification of Heat Resisting Steel

Heat Resisting Steel (Austenitic Related)

JIS
SUH31
SUH35
SUH36
SUH37
SUH38
SUH309
SUH310
SUH330
SUH660
SUH661

Heat Resisting Steel (Ferritic Related)

JIS
SUH21
SUH409
SUH446

Heat Resisting Steel (Martensitic Related)

JIS
SUH1
SUH3
SUH4
SUH11
SUH600
SUH616

Steel

CLASS	USA AISI / SAE	JAPAN JIS	CHINA GB	UK BS	GERMANY DIN	FRANCE NF	RUSSIA ГОСТ
CARBON TOOL STEEL		SK140 (SK1)	T13			C140E3U	Y13
	W1-11$^{1}/_{2}$	SK120 (SK2)	T12			C120E3U	Y12
	W1-10	SK105 (SK3)	T11		C105W1	C105E2U	Y11
	W1-9	SK95 (SK4)	T10			C90E2U	Y10
	W1-8	SK85 (SK5)	T8Mn T9		C80W1	C90E2U C80E2U	Y8Г Y9
		SK75 (SK6)	T8		C80W1	C80E2U C70E2U	Y8
		SK65 (SK7)	T7		C70W2	C70E2U	Y7
HIGH SPEED TOOL STEEL	T1	SKH2	W18Cr4V	BT1		HS18-0-1	P18
	T4	SKH3	W18Cr4VCo5	BT4	S18-1-2-5	HS18-1-1-5	P18K5Ф2
	T5	SKH4	W18Cr4V2Co8	BT5		HS18-0-2-9	P18K5Ф
	T15	SKH10	W12Cr4V5Co5	BT15	S12-1-4-5	HS12-1-5-5	
	M2	SKH51	W6Mo5Cr4V2	BM2	S6-5-2	HS6-5-2	P6M5
	M3-1	SKH52	CW6Mo5Cr4V2 W6Mo5Cr4V3				P6M5Ф3
	M3-2	SKH53	CW6Mo5Cr4V3		S6-5-3	HS6-5-3	P6M5Ф3
	M4	SKH54		BM4		HS6-5-4	
	M35 M41	SKH55	W6Mo5Cr4V2Co5 W7Mo5Cr4V2Co5	BM35	S6-5-2-5	HS6-5-2-5HC	P6M5K5
	M36	SKH56					
		SKH57		BT42	S10-4-3-10	HS10-4-3-10	
	M7	SKH58	W2Mo9Cr4V2			HS2-9-2	
	M42	SKH59	W2Mo9Cr4VCo8	BM42	S2-10-1-8	HS2-9-1-8	
ALLOY TOOL STEEL	F2	SKS11					XB4
		SKS2			105WCr6	105WCr5	XBГ
		SKS21	W				
		SKS5					
	L6	SKS51					
		SKS7					
		SKS8	Cr06			C140E3UCr4	13X
	S1	SKS4	5CrW2Si 6CrW2Si				6XB2C 5XB2CФ
	S1	SKS41	4CrW2Si				4XB2C
	W2-9$^{1}/_{2}$	SKS43		BW2		100V2	
	W2-8	SKS44					
		SKS3	9CrWMn				9XBГ
		SKS31	CrWMn		105WCr6	105WCr5	XBГ
		SKS93					
		SKS94					
		SKS95	8MnSi				
	D3	SKD1	Cr12	BD3	X210Cr12	X200Cr12	X12
	D2	SKD10	Cr12Mo1V1		X153CrMoV12		X12MФ
	D2	SKD11	Cr12MoV	BD2	X153CrMoV12	X160CrMoV12	
	A2	SKD12	Cr5Mo1V	BA2		X100CrMoV5	
		SKD4				X32WCrV3	
	H21	SKD5	3Cr2W8V	BH21	X30WCrV9-3	X30WCrV9	
	H11	SKD6	4Cr5MoSiV	BH11	X38CrMoV51	X38CrMoV5	4X5MФC
	H13	SKD61	4Cr5MoSiV1	BH13	X40CrMoV51	X40CrMoV5	4X5MФ1C
	H12	SKD62		BH12		X35CrWMoV5	3X3M3Ф
	H10	SKD7	4Cr3Mo3SiV	BH10	X32CrMoV33	32CrMoV12-18	
	H19	SKD8		BH19			
		SKT3				55CrNiMoV4	
		SKT4	5CrNiMo	BH224 / 5	55NiCrMoV6	55NiCrMoV7	5XHM

Steel

CLASS	USA **AISI / SAE**	JAPAN **JIS**	CHINA **GB**	UK **BS**	GERMANY **DIN**	FRANCE **NF**	RUSSIA **ГОСТ**
SPRING STEEL	1075 1078	SUP3					75 80 85
		SUP6	55Si2Mn		56SiCr7	60Si7	60С2
	9260	SUP7	60Si2Mn 60Si2MnA		61SiCr7	60Si7	60С2Г
	5155	SUP9	55CrMnA		55Cr3	55Cr3	
	5160	SUP9A	60CrMnA		55Cr3	60Cr3	
	6150	SUP10	50CrVA	735A51, 735H51	50CrV4	51CrV4	ХФА50ХГФА
	51B60	SUP11A	60CrMnBA		51CrV4		50ХГР
	9254	SUP12		685A57, 685H57	54SiCr6	54SiCr6	
	4161	SUP13	60CrMnMoA	705A60, 705H60	60CrMn3-2	60CrMo4	
FREE CUTTING CARBON STEEL	1110	SUM11					
	1108	SUM12	Y12				
	1212	SUM21					
	1213	SUM22	Y15	(230M07)	9SMn28	S250	
	12L13	SUM22L	Y12Pb		9SMnPb28	S250Pb	
	1215	SUM23					
		SUM23L					
	12L14	SUM24L	Y15Pb		9SMnPb28	S250Pb	
		SUM25			9SMn36	S300	
	1117	SUM31			15S10		
		SUM31L					
		SUM32	Y20	210M15, 210A15		(13MF4)	
	1137	SUM41	Y30 Y35			(35MF6)	
	1141	SUM42	Y40Mn			(45MF6.1)	
	1144	SUM43		(226M44)		(45MF6.3)	
CARBON CHROMIUM BEARING STEEL	51100	SUJ1	GCr4				
	52100	SUJ2	GCr5		100Cr6	100Cr6	ШХ15
	ASTM A 485 Grade 1	SUJ3	GCr15SiMn				
		SUJ4	GCr15SiMo				
		SUJ5	GCr18Mo				

Cast Iron

CLASS	USA AISI / SAE	JAPAN JIS	CHINA GB	UK BS	GERMANY DIN	FRANCE NF	RUSSIA ГОСТ
GRAY CAST IRON	NO.20	FC100	HT100	100			СУ10
	NO.30	FC150	HT150	150	GG15	FGL150	СУ15
	NO.35	FC200	HT200	200	GG20	FGL200	СУ20
	NO.45	FC250	HT250	250	GG25	FGL250	СУ25
	NO.50	FC300	HT300	300	GG30	FGL300	СУ30
	NO.60	FC350	HT350	350	GG35	FGL350	СУ35
					GG40	FGL400	СУ40
NODULAR CAST IRON	60-40-18	FCD400	QT400-18	400/17	GGG40	FGS370-17	ВУ40
	65-45-12	FCD450	QT450-10	420/12		FGS400-12	ВУ45
	70-50-05	FCD500	QT500-7	500/7	GGG50	FGS500-7	ВУ50
	80-60-03	FCD600	QT600-3	600/7	GGG60	FGS600-2	ВУ60
	100-70-03	FCD700	QT700-2	700/2	GGG70	FGS700-2	ВУ70
	120-90-02	FCD800	QT800-2	800/2	GGG80	FGS800-2	ВУ80
			QT900-2	900/2			ВУ100

Non-Ferrous Metal

CLASS	USA AISI / SAE	JAPAN JIS	CHINA GB	UK BS	GERMANY DIN	FRANCE NF	RUSSIA ГОСТ
ALUMINUM ALLOY	1199		1A99		A199.99R		A99
			1A97		A199.98R		A97
			1A95				A95
		A1080	1A80	1080(1A)	A199.90	1080A	A8
	1050	A1050	1A50	1050(1B)	A199.50	1050A	A5
	5052	A5052	5A02	NS4	AlMg2.5	5052	Amg
			5A03	NS5			AMg3
	5056	A5056	5A05	NB6	AlMg5		AMg5V
	5456	A5556	5A30	NG61		5957	
	2036	A2117	2A01		AlCu2.5Mg0.5	2117	D18
		A2017	2A11	HF15	AlCuMg1	2017S	D1
	2124	A2024	2A12		AlCuMg2	2024	D16AVTV
	2319		2B16				
		A2N01	2A80				AK4
	2218	A2018	2A90				AK2
	2014	A2014	2A14		AlCuSiMn	2014	AK8
	6061	A6061		6061		6061	
	7175	A7075	7A09		AlZnMgCu1.5	7075	V95P
ALUMINUM ALLOY CASTING	356.2	AC4C	ZAlSi7Mn	LM25	G-AlSi7Mg		
	413.2	AC3A	ZAlSi12	LM6	G-Al12	A-S12-Y4	AL2
	355.2		ZAlSi5Cu1Mg				AL5
	413.0	AC8A	ZAlSi2Cu2Mg1		G-Al12(Cu)		
			ZAlCu5Mn				AL19
	201.0		ZAlCu5MnCdVA				
	520.2		ZAlMg10	LM10	G-AlMg10	AG11	AL8
			ZAlMg5Si		G-AlMg5Si		AL13

CVD Coated Carbide (Turning)

• This table is Kyocera´s own estimation based on publications and is not authorized by companies mentioned in it.

Classification		Kyocera	Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Class	Symbol											
P (Steel)	P01	CA510 CA5505	JC110V	HG8010 HC5000 HG3305	UE6105 UE6005 UE6015	-	GC4305 GC4005 GC4205	TP0501 TP0500 TP1000	AC700G AC810P	T9005 T9105	KCP05B KCP05 KC9105	IC8150 IC9150
	P10	CA510 CA515 CA5505 CA5515	JC110V JC215V	GM10 GM20 GM8015 HG8010	MC6015 UE6105 UE6110 UE6005 UE6010 UE6020	CP2 CP5 CP7	GC4205 GC4015 GC3115 GC4215 GC4315	TP1501 TP1000 TP1500 TP100	AC700G AC2000 AC810P AC820P AC8015P AC8025P	T9005 T9105 T9015 T9115 T9215	KCK05 KCP10B KCP10 KC9010 KC9110	IC8150 IC9150 IC9250
	P20	CA025P CA525 CA5515 CA5525 CR9025	JC110V JC215V	GM20 GM8020 HG8025	MC6025 UC6010 UE6110 UE6020	CP2 CP5 CP7	GC4025 GC4215 GC4220 GC4225 GC4325	TP2501 TP2000 TP2500 TP200	AC2000 AC3000 AC820P AC830P AC8025P	T9015 T9115 T9025 T9125 T9225	KCP25B KCP25 KC9125 KC9225 KC9325	IC8250 IC9125 IC9250 IC9350
	P30	CA025P CA525 CA5525 CA530 CA5535 CR9025	JC215V JC325V	GM25 GM8035 HG8025	MC6025 UE6020 MC6035 UE6035 UH6400	-	GC4225 GC4230 GC4235 GC2135 GC4335	TP2501 TP3501 TP2500 TP2000 TP3500 TP200	AC3000 AC630M AC830P ACP100 AC8035P	T9125 T9035 T9135 T3130	KCP30B KCP30 KC9040 KC9140	IC635 IC8350 IC9350
	P40	CA530 CA5535	JC325V JC450V JC540V	GX30	MC6035 UE6035 UH6400	-	GC4035 GC4235 GC4240 GC4335	TP40	AC630M AC830P ACP100	T9035 T3130	KCP40B KCP40 KC9140 KC9240	IC635
M (Stainless Steel)	M10	CA6515	JC605X JC110V	GM10 HS9105	MC7015 US7020	CP2 CP5	GC2015 GC2220	TP1500 TP100	AC610M AC6020M	T9015 T9115	KCM15B KCM15 KC9010 KC9110 KC9210	IC8250 IC9250 IC9350 IC6015
	M20	CA6525	JC110V JC215V	GM8020 HG8025 HS9115	US7020 MC7025	CP2 CP5	GC1515 GC2015 GC2025 GC2220	TM2000 TP200	AC6020M AC6030M AC610M AC630M AC830P	T6020 T6120 T9115 T9125	KCM25B KCM25 KC9025 KC9125 KC9225	IC8350 IC9250 IC9350 IC6025
	M30	-	JC215V JC325V JC525X	GM25 GM8035	MC7025 US735	-	GC2040 GC235	TM4000 TP3501 TP300	AC6030M AC630M AC830P	T6030 T6130 T9125	KCM35B KCM35 KC9240	IC8350 IC9350 IC4050
	M40	-	JC525X	GX30	US735	-	-	TP40	-	-	KC9045 KC9245	IC635
K (Cast Iron)	K01	CA310 CA4505 CA5505	JC105V JC605W JC050W	HG3305 HG3315 HX3505 HX3515	MC5005 UC5105 UC5015	CP1	GC3205 GC3210	TK0501 TH1000 TK1001	AC405K AC410K AC300G AC4010K	T5105 T5010	KCPK05 KC9315 KCK05B KCK05	IC5005 IC428 IC9007 IC9150
	K10	CA310 CA315 CA4505 CA4515 CA5505	JC050W JC110V JC605W JC108W	GM8015 HX3515 HG8010 HG3315	UC5015 UC5105 UC5115 UE6010 MC5015	CP1 CP2 CP5	GC3205 GC3210 GC3215 GC3115	TK1000 TK2000 TK2001 MK1500	AC4010K AC410K AC415K AC700G AC4015K	T515 T5105 T5115 T5010	KC9110 KC9120 KC9315 KCK15B KCK15	IC5010 IC418 IC428 IC9015 IC9007
	K20	CA315 CA320 CA4515	JC110V JC215V JC108W JC605W	GM8020 HG8025	MC5015 MY5015 UE6010 UC5115 UE6110	CP2 CP5	GC4225 GC3215 GC3220 GC3225	TK2000 TX150 TP200	AC4015K AC420K AC700G AC820P	T515 T5115 T5125 T5020	KC9125 KC9320 KC9325 KCK20B KCK20	IC418 IC9015
	K30	CA320	JC215V	GM25	UE6110	-	GC3040 GC4335	TP2500 TP200	-	T5125 T9125	KCP25B KC9320	-

PVD Coated Carbide (for Turning)

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Classification		Kyocera	Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Class	Symbol											
P (Steel)	P01	PR1705	JC5003						ACZ150		KC5510	
	P10	PR1705 PR930 PR1025 PR1115 PR1215 PR1225 PR1725	JC5003 JC5030	CY15 CY150 IP2000	MS6015 VP10MF	VM1 TM1 TA1 TAS DT4 DM4	GC1025	CP200	ACZ150 ACZ310 AC520U	AH710	KC5010 KC5510 KU10T	IC507 IC807 IC907
	P20	PR930 PR1025 PR1115 PR1215 PR1225 PR1625 PR1725	JC5015 JC5030 JC5040	CY150 IP2000	MS6015 VP10RT VP15TF VP20MF UP20M VP20RT	QM1 VM1 TA1 TAS	GC1020 GC1025 GC4125 GC1125	CP250	ACZ310 ACZ330 AC520U	AH7025 AH710 AH725 AH730 SH725 SH730	KC5025 KC5525 KC7215 KC7315 KU25T	IC507 IC907 IC908
	P30	PR1025 PR1225 PR1535	JC5015 JC5040	CY250 CY9020 HC844 IP3000	VP10RT VP15TF VP20MF UP20M	ZM3 QM3 TAS	GC1125 GC1145 GC1115 GC1105	CP500	ACZ330 ACZ350 AC530U AC1030U	GH330 AH120 AH740 AH9030	KC7015 KC7020 KC7235 KU25T	IC328 IC928 IC3028
	P40	PR1535	JC5040	CY250 HC844		ZM3 QM3 TAS	GC1145 GC2145	CP600	ACZ350	AH140 AH740 J740	KC7030 KC7040 KC7140	IC328 IC3028
M (Stainless Steel)	M10	PR1025 PR1215 PR1225	JC5003	IP050S JP9105	VP10MF VP10RT	VM1 TM1 TA1	GC1005 GC1025 GC1105 GC15	TS2000 CP200 CP250	EH510Z ACZ150 AC510U	AH710	KC5010 KC5510 KC6005 KCU10	IC507 IC520 IC807 IC907
	M20	PR930 PR1025 PR1125 PR1215 PR1725 PR1225 PR1515	JC5015 JC5030 JC5040 JC8015 JC5118	IP100S GX30 JP9115	VP10RT VP15TF VP20MF UP20M VP20RT	ST4 QM1 VM1 TA1 TAS DT4 DM4	H5D6 GC1025 GC1115 GC4125 GC1125 GC30	TTP2050 TS2500 CP200 CP250 CP500	EH520Z ACZ150 ACZ310 AC520U AC1030U	AH630 AH725 AH730 GH330 GH730 SH725 SH730	KC5025 KC5525 KC7020 KC7025 KCU25	IC308 IC507 IC907 IC908 IC3028
	M30	PR1125 PR1535	JC5015 JC5030 JC5040 JC5118	CY250 CY9020	VP15TF VP20MF UP20M MP7035	ST4 ZM3 QM3 TAS	GC1020 GC2035 GC2030	CP500	ACZ330 ACZ350 AC530U AC6040M	AH6030 AH120 AH725	KC7030 KC7225	IC908 IC1008 IC1028 IC3028
	M40	PR1535	JC5118		MP7035	ZM3 QM3 TAS	GC2145 GC1145	CP600	AC6040M ACZ350	J740 AH140 AH645		IC228 IC928 IC328
K (Cast Iron)	K01		JC5003						EH10Z	AH110	KC5515	IC910
	K10	PR905 PR1215	JC5003 JC5015	CY100H CY10H	VP05RT	TA1 TM1	GC1010	TS2000 CP200	EH10Z EH510Z AC510U	GH110 AH110	KC5010 KC7210	IC807 IC910 IC507 IC908
	K20	PR905 PR1215	JC5015	IP2000 CY9020	VP10RT VP15TF VP20RT	QM1 TA1	GC1020 GC1120	TS2500 CP200 CP250	EH20Z ACZ310 AC520U AC530U AC1030U	AH120 AH725	KC5025 KC5525 KC7015 KC7215 KC7315	IC508 IC908
	K30				VP15TF VP20RT	QM3 TA3	GC1030	CP500	ACZ310		KC7225	IC508 IC908
S (Difficult-to-cut Materials)	S01	PR005S	JC5003		MP9005 VP05RT					AH8005 AH905		IC804 IC806
	S10	PR005S PR015S	JC5015 JC8015	JP9105	MP9005 MP9015 VP10RT		GC1105 GC1005 GC1025	CP200 TS2000	AC510U AC5015S	AH8015 AH905 SH730 AH110	KC5010 KC5510 KCU10 KCS10	IC807 IC808 IC907 IC908
	S20	PR015S PR1535	JC5015 JC8015	JP9115	MP9015 MT9015 VP20RT MP9025		GC1025 GC1125	CP250 TS2500	AC510U AC520U AC5025S	AH8015 AH120 AH725	KC5025 KC5525 KCU25	IC806 IC808 IC908
	S30	PR1535			MP9025		GC1125		AC520U	AH725		IC3028

Cermet (Turning)

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Classification		Kyocera	Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Class	Symbol											
P (Steel)	P01	TN610 PV710	LN10 CX50	CH350	AP25N VP25N NX1010	T3N T15 Q15	-	-	T110A T1000A	NS520 GT530 GT720 J530	KT1120 KT125 HTX	IC20N IC520N
	P10	TN610 TN620 TN6020 TN60 PV710 PV720 CCX	LN10 CX50 CX75 NIT PX75	CH350 CZ25	NX2525 AP25N VP25N	T15 C7Z Z15	CT5015 CT525	TP1020 CM CMP	T1500Z T2000Z T1200A T1500A	NS9530 NS520 GT9530 GT530 GT730 AT9530	KT315 KT175 HT2 KTP10	IC20N IC520N IC530N IC75T
	P20	CCX TN620 TN90 TN6020 PV720	CX50 CX75 CX90 NAT PX90	CH550 CH7030 CZ1025 CZ25	MP3025 NX2525 NX3035 AP25N VP45N	T15 C7X C7Z	CT525 CT530 GC1525	TP1020 C15M TP1030	T1200A T1500A T2000Z T2500Z T3000Z	NS9530 NS530/730 GT9530 GT530/730 AT9530	PS5 KT5020	IC20N IC520N IC530N IC75T IC30N
	P30	PV730	CX90 CX99 SUZ	-	NX4545 VP45N	N40 C7X	CT530 GC1525	TP1030	T3000Z T250A	NS740	-	IC75T IC30N
M (Stainless Steel)	M10	TN620 TN60 TN6020 PV720	LN10	CH350	NX2525 AP25N VP25N	T15 C7X C7Z Z15	CT5015 CT525	CM CMP	T110A T1000A T2000Z	NS520 J530	KT1120 KT315 KT125	IC20N IC520N
	M20	TN620 TN90 TN6020 PV720	CX50 CX75 PX75 NIT NAT	CH550 CH7030 CZ1025	NX2525 NX3025 AP25N VP25N	C7X C7Z Q15	CT530 GC1525	TP1020 C15M	T1500A T2000Z	NS530 NS730 GT530 GT730	KT175 HT2 PS5 KT5020	IC30N IC530N
	M30	PV730	CX75 CX90 PX90 CX99 SUZ	CZ25	NX4545	C7X	-	TP1030	T3000Z T250A	NS740	-	-
K (Cast Iron)	K01	PV7005 CCX	LN10	-	AP25N VP25N	T3N T15 Q15	-	-	T110A T1000A	NS520	KT1120	-
	K10	TN610 CCX PV710 PV7005	LN10	CH350	NX2525 AP25N VP25N	T15 C7X C7Z Z15	CT5015	-	T1200A T1500A T2000Z	NS530 NS730 GT530 GT730	KT315 HTX KTP10	-
	K20	-	NIT	CZ25	NX2525 AP25N VP25N	-	-	-	T3000Z	-	KT5020	-

Carbide

• Boldface grade shows PVD Coated Cermet.

Classification		Kyocera	Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Class	Symbol											
P (Steel)	P10	-	SRT	WS10	STi10T	-	S1P	-	ST10P	TX10S	K2885	IC70
	P20	-	SRT DX30	EX35	STi20 UTi20T	-	SMA	S10M	ST20E	TX20 TX25	K125M	IC70 IC50M
	P30	-	SR30 DX30 DX35	EX35 EX40	UTi20T	-	SM30	S25M	A30N A30 ST30E	TX30 UX30	KMF	IC50M IC54
	P40	-	SR30 DX35	EX45	-	-	S6	S60M	ST40E	TX40	PVA	IC54
K (Cast Iron)	K01	-	KG03	WH02 WH05	HTi05T	-	H1P	-	H1 H2	TH03 KS05F	K68 K10	IC04
	K10	KW10 GW15	KG10 KT9	WH10	HTi10	KM1	H1P H10 HM	890	EH10 EH510	G1F TH10 H10T	KMI K8735 K313	IC20
	K20	GW25	CR1 KG20	WH20	HTi20T UTi20T	KM3	H13A	883 890 HX	G10E EH20 EH520	G2F KS15F KS20	KMF	IC20 IC10
	K30	-	KG30	-	-	-	-	883	G3 G10E	G3 UX30	THR	IC10 IC28
V (Wear and Shock Resistant Tool)	V40	-	G5 GD195	WH50	GTi30	-	-	-	G5	D40	-	-
	V50	VW50	MH3 MH4 GD174 GD201	WH60	GTi35 GTi40 GTi30S	-	-	-	G6	D50	-	-
	V60	-	MH5 MH7 MH8 GD206	WB60	GTi40S GTi50S	-	-	-	G7 G8	D60	-	-

Coated Carbide (Milling / Drilling)

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Classification		Kyocera	Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Class	Symbol											
P (Steel)	P10	PR1225	JC5003 JC5030 JC8003 DH103	JP4105 JX1020 JP4005	F7010	-	GC1025 GC1010	-	ACP100	-	KC715M	-
	P20	PR1525 PR1225 PR1230 CA520D	DH108 DH110 DH115 JC8015 JC8118	JP4120 JS4045 JP4020 TB6020 JX1015 GX2140	MC7020 MP6120 F7030 UP20M MV1020	TM1 DT4 DM4	GC1130 GC1030 GC4220 GC4020 GC4030 GC4334	MP1500 T250M T25M T20M	ACP200 ACP2000 ACU2500	T313W AH725	KC522M KC525M KCPM20	IC330 IC250 IC520M IC950 IC5400 IC1008
	P30	PR1230 PR1535	JC6235 JC5015 JC5040 JC5240 JC8050 JC7550	CY250 CY9020 TB6045 JX1045 JM4060 GX2160	MP6130 F7030 VP15TF VP30RT	ZM3	GC1130 GC4040 GC4230 GC4330	MP2500 T250M T25M F25M F30M	AC230 ACP300 ACP3000	T3130 GH330 AH120 AH330 AH730 AH3135	KC994M KC725M KC792M KC530M KCPK30 KCPM40	IC330 IC328 IC635 IC830 IC908 IC928
	P40	-	JC7550 JC5040 JC7560	CY250 HC844 TB6060 JX1060	VP30RT	-	GC4040 GC4240 GC4340	MP3000 T350M T60M T25M	AC230 ACZ330 ACZ350	AH140	KC735M	IC635 IC928 IC4050
M (Stainless Steel)	M10	PR1225	DH108	CY9020 JX1020 JP4020	F7010	-	GC1025 GC1030	-	ACM100 ACM200 EH10Z	-	KC522M	-
	M20	PR1525 PR1225	JC730U JC835S JC8118 JC5015 JC5030 JC5040	PN215 CY150 TB6020 JX1015 CY250	MC7020 MH515 F7030 VP15TF VP20RT MP7030 MP7130	DT4 DM4	GC2030 S30T GC2334 GC2044	MS2050 MP2500 T250M T25M F20M F25M F30M	ACM200 ACP200 EH20Z ACU2500	GH330 AH330 AH120 AH130 AH725 AH3135	KC730M KC525M	IC380 IC908 IC928
	M30	CA6535 PR1535	JC835S JC8015 JC5015 JC5118 JC8050	JM4160 JM4060 TB6045 JX1045 GX2160	F7030 VP30RT MP7140	ZM3	GC1040 GC2040 S40T	T350M T250M F40M	ACM300 ACP300 ACZ350	T3130 AH130	KC994M KC725M KCPK30	IC380 IC328 IC330
	M40	-	JC7560	-	VP30RT	-	-	MM4500	ACZ350	AH140	-	IC830
K (Cast Iron)	K01	-	DH202 DH102	TB6005	-	-	-	MH1000	ACK100	AH110	-	IC5100 IC4100
	K10	PR1510 PR905 PR1210	DH103 JC8015 JC610 JC605W JC8118	JP4005 CY10H CY100H CY9020	MP8010 MC5020 VP10RT MV1020	-	GC1010 GC3220 K15W	MK1500 T150M F15M	ACK2000 ACK200 AC211 ACU2500	T1015 T1115 AH110 T1215	KCK15 KC915M	IC5100 IC4010 IC910 DT7150 IC810
	K20	CA420M PR905 PR1210 CA415D	JC605X JC610 JC5015 JC8015 JC8118	TH315 CY150 TB6020 JX1015	VP15TF VP20RT	-	GC1020 GC3020 K20W/K20D GC3330 GC3334	MP1500 T150M T250M MK2000 MK2050	EH20Z ACZ310 ACK300 ACK3000	AH120 AH725 T1215	KC520M KC920M KC925M KC992M	IC810 IC910 IC928
	K30	-	JC5080 JC6235	-	-	-	GC3040 GC4040	MK3000 T250M	-	GH130	KC930M	IC928
S (Heat-resistant Alloy)	S10	CA6535 PR1535 PR1210	DH202 DH102 DH103 JC7518	PCS08M PTH13S JS1025	MP9120 VP15TF	-	GC1030 GC1025 GC1010	MS2050	ACM100 ACM200 ACK300	-	KC510M	IC903 IC807 IC808 IC908
	S20	CA6535 PR1535 PR1210	JC8118 IC5015 JC8050 JC7560 JC7550	CY100H CY10H	MP9120 VP15TF MP9130 MP9030	-	GC1030 GC2030 S30T GC1130 GC4344	MP2050	ACU2500 ACM200	-	KC525M	IC903 IC807 IC808 IC908 IC830 IC928
	S30	PR1535	JC8050 JC7560	-	MP9140	-	GC2040 S40T	F40M	ACM300	-	KC725M KCSM40	IC328 IC330

Cermet (Milling)

• This table is Kyocera´s own estimation based on publications and is not authorized by companies mentioned in it.

Classification		Kyocera	Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Class	Symbol											
P (Steel)	P10	TN60 TN620M PV60M	NIT CX75	CH550 MZ1000	NX2525	-	-	C15M	-	NS530 NS730	KT530M KT195M	-
	P20	TN620M TN100M TN60 PV60M	NAT CX75 CX90	CH570 CH7030	NX2525 MX3020	C7X C7Z	CT530	C15M MP1020	T2500A T250A T1500A	NS530 NS730 NS740	HT7 KT530M KT605M	IC30N
	P30	-	CX90 CX99 SC30	CH7035	NX4545 MX3030	-	-	-	T4500A	NS540	-	IC30N
M (Stainless Steel)	M10	TN60 TN620M PV60M	-	MZ1000	NX2525	-	-	C15M	-	-	-	-
	M20	TN620M TN100M TN60 PV60M	NIT CX75 NAT	CH550 CH570 CH7030	NX2525	-	CT530	C15M	T2500A T250A	NS530	KT7 KT530M KT605M	IC30N
	M30	-	CX75 CX90 CX99 SC30	-	NX4545	-	-	-	T4500A	NS740 N308	-	-
K (Cast Iron)	K01	-	LN10	-	-	-	-	-	-	-	-	-
	K10	PV60M	LN10 CX75	MZ1000 CH550	NX2525	-	-	-	-	-	-	IC30N
	K20	-	NIT	CH7030 CH7035	NX2525	-	-	-	-	-	-	-

Ceramic

Classification		Kyocera	Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Class	Symbol											
K (Cast Iron)	K01	KA30 A65 KT66 PT600M CS7050 KS6015	-	NPC-H2 NPC-A2	-	SE1 HC1 HC2 HC5 HC6 HW2	CC620 CC650	-	NB90S NB90M WX120	TZ120	KW80 KY1615 AC5	IN11 IS6
	K10	KS6015 A65 KT66 A66N PT600M CS7050 KS6050	-	NX NXA Whiskal WIN	-	WA1 HC2 HC6 HC7	CC6090 CC6190 GC1690	-	WX120 NS260C	LX11 LX21	KYK10 KYK25 KB90 KY1320 KY3000 KY3400	IN420 IN22 IN23 IS80
	K20	KS6050	-	-	-	SX6 SX9 SP9	CC6090 CC6190 GC1690	-	WX120	WG300 FX105 CX710	KYK35 KY3400 KY3500	IS8
S (Difficult-to-cut Material)	S01	-	-	-	-		CC650	-	-	-	KY2100	-
	S10	CF1 KS6030 KS6040	CA200	Whiskal WIN	-	JX1 JP2 WA1 WA5 SX3 SX7 SX9	CC670 CC6060 CC6065 CC6160	-	WX120	WG300	KYS25 KY4300 KY1525 KY1540	IS25 IS9
	S20	-	-	-	-	JX3	CC6220 CC6230	-	WX120	-	KYS30	IS35 IW7
H (Hardened Material)	H01	A65 KT66 A66N PT600M	-	NPC-A2	-	HC4 HC7 ZC7	CC650 CC670 CC6050	-	NB100C	LX11 LX21	KY4400	-
	H10	A65 KT66 A66N PT600M	-	NPC-A2 Whiskal WIN	-	ZC7 WA1 WA5	CC670	-	-	WG300	KY4300	-

• Boldface grade shows PVD Coated Ceramic.

CBN

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Classification		Kyocera	Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Class	Symbol											
K (Cast Iron)	K01	KBN475	JBN795	-	BC5110	B20 B22 B30	CB7525 CB50 CB7050	CBN050C CBN300P	BN500 BNC500	BX910 BX930 BX950	-	IB50 IB85
	K10	KBN60M KBN900	JBN330	BH200	MB710 MB5015 MB4020	B22 B23	CB50 CB7050	CBN20 CBN200 CBN300	BN600 BN700 BN7000	BX950 BXC90 BX470	KB1630 KB1345 KB9610	IB55 IB90
	K20	KBN900	-	BH250	MB4120 MBS140 BC5030	B16 B40	-	CBN350 CBN500 CBN600	BN7000 BNS800	BX950 BXC90 BX90S	KB9640	-
H (Hardened Material)	H01	KBN510 KBN05M KBN10M	DH102	-	BC8105 BC8110 MBC010 MB810	B24 B52 B5K	CB20	CBN050C CBN010 CBN10 CBN100	BN1000 BNX10 BNC100 BNC160 BNC2010	BXA30 BX310 BXC30 BXM10	KB1610	IB20H IB25HC IB50
	H10	KBN510 KBN525 KBN05M KBN10M KBN25M	JC6102 JC8003 JBN500 JBN300 JBN330	BH200	BC8120 MBC020 BC8020 MB8025 MB825	B24 B36 B54 B52 B5K	CB7015 CB7050 CB50 CB7105	CBN150 CBN060K CBN200 CBN160C	BNC160 BNX20 BN2000 BNC200 BNC2020	BXM10 BXA40 BX330 BX360 BXC50 BXA20	KBH10 KBH10B KB1615 KB1625 KB5610 KB9610	IB10HC IB50
	H20	KBN25M KBN35M KBN900	JC8003 JC5015 JBN245	BH250	BC8120 MBC020 BC8020 MB8025	B22 B36 B6K	CB7025 CB7525 CB7115	CBN350 CBN300P CBN400C CBN500 CH2540	BNX25 BN350 BNC300	BX380 BXC50 BXM20 BXA20	KBH20 KBH20B KB1340 KB5625 KB9640	IB55 IB25HA
	H30	KBN35M KBN900	JBN245	BH250	MB835 BC8130	B40 B6K	CB7125 CB7525 CB7135	CH3515	BNC300 BN350	BX380 BXC50 BXM20 BXA20	KB5630 KB9640	IB55 IB25HA
Stainless Steel	-	KBN65B KBN570 KBN65M KBN70M	JBN795 JBN500	-	MB4120 MB4020	-	-	CBN200	BN350 BN7000 BN7500	BX450 BX470 BX480	KB5630	IB05S IB10H IB10S

• Boldface grade shows PVD Coated CBN.

PCD (Diamond)

Classification		Kyocera	Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Class	Symbol											
N (Non-ferrous Metals)	N01	KPD001	JDA30 JDA735	-	MD205	PD1	CD05 CD10	PCD05 PCD10	DA90 DA1000 DA2200	DX180 DX160	PD100 KD1400 KD1405	-
	N10	KPD001 KPD010 KPD230 KPD250	JDA40 JDA745	-	MD220	PD2	CD10	PCD10 PCD20	DA150 DA1000 DA2200	DX140	KD100 KD1400 KD1415	ID5
	N20	KPD001 KPD010 KPD230 KPD250	JDA10 JDA715	-	MD230	-	-	PCD30 PCD30M	DA1000 DA2200	DX110 DX120	KD1425	-

Molded Chipbreaker Cross Reference Table

Negative Inserts

• This table is Kyocera's own estimation based on publications and is not authorized by companies mentioned in it.

Cutting Range		Kyocera		Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
		General Chipbreaker	Chipbreaker for Gummy Material / Soft Steel										
Carbon Steel / Alloy Steel	Finishing (With Wiper Edge)	WF WP	-	-	-	SW	-	WL WF	W-FF2 W-MF2	SEW LUW	AFW FW	FW	WF
	Finishing - Medium (With Wiper Edge)	WE WQ	-	-	-	MW	-	WM WMX	W-M3 W-M5	GUW	ASW SW	MW	WG
	Finishing	DP GP PP	XF XP	F1 FA FT PF	BE BH FE	F FH FS FY PK FP	UL WM ZF1	XF QF	FF1	FP FB FE SP FA FL LU	TF 01 AS TSF	FF UF FS LF	F3P SF PF
	Finishing - Medium	HQ PQ CQ CJ VC VF	XQ	UA UT	AB B CE CT	SH C SA LP SY	WV WR	LC PF	FF2 MF2	SU EX SJ SX UJ SE	TS NS CB 11 17 27 ZF	K RP FN FM	NF SM
	Medium - Roughing	PG GS PS	XS	UR UB	AE DE AH	MV MP MA MH	Z5 ZW1	XM QM SM SMC PM PMC	M3 MF3	UA UG GE GU	AM DM NM TM ZM	MN	M3P TF PP
	Medium - Roughing High Feed Rate	PT GT	-	GC PQ	AR AY	GH RP	GS	MR XMR	M5 MR5 MR6	MU UX ME	TH 32Y 32 37	RP RN	R3P NR
	Roughing	Standard PH	-	GG LG GQ	RE	MT Standard	G	Standard 23 HM	MR7	MC MU MX UZ	31 33 F-K THS	PR MG	GN
	Roughing Single Sided High Feed Rate	PX	-	GS RM UC UP UD	H HX HE TE UE	HV HR HX HZ HL HM	-	QR PR HR	R4 R5 R6 R7 RR6 R57 RP	HG HP MP HF	TU TRS 57 65 TUS	RP RH RM RW	TNM NM
Stainless Steel	Finishing	MQ SQ	-	SF	BH MP	FS SH FJ LM LS	ZF1	MF	M1	SU EF	SF SS	FP	F3M VL F3S
	Medium - Roughing	MS MU TK SG SX	-	GP SZ	DE SE PV VI	MS MA GM MJ MM ES MH GH GJ RM RS	ZP WS	MM MMC MR XMR SM SMR SF SGF SMC MRR	MF1 MF3 A3 A5 M5 56 R8 RR9 MF4	EG EX MU UP EM	HMM SM SA S SH HRM HPF	P MP MS UP	TF PP M3M R3M
Cast Iron	Medium	KQ KG C Standard	-	-	AH VA VY	LK MF Standard	-	KF KM	-	UZ UX UJ	Standard 33 CF	FN	GN
	Roughing	KH GC ZS	-	-	-	GH RK	-	KR KRR	MR9	GZ	CM CH	RP UN	NR
Non-ferrous Metals	Medium - Roughing	AH	-	-	-	-	-	AL	95	AG	P	GP MS	PP

Positive Inserts

Cutting Range		Kyocera		Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
		General Chipbreaker	Chipbreaker for Gummy Material / Soft Steel										
Carbon Steel / Alloy Steel	Minute D.O.C.	CF	-	-	-	-	-	-	-	-	01	-	-
	Finishing (with Wiper Edge)	WP	-	-	-	SW	-	WF WK	W-F1 W-F2	LUW SDW	SW	FW	WF
	Finishing	PF DP GP PP VF	XP	ASF	-	FV SQ FP SMG	AZ3 AMX AZ7	PF UF XF	FF1	FB GU FC FK FP LU	PF PSF 23	11 GF UF FP	PF SM
	Finishing - Medium ①	HQ	XQ	ACB FT	JE	MQ MV LP	AF1	PM UM SMC	F1 M3	LB SF SU SS	PS PSS 24	LF	14
	Finishing - Medium ②	GK	-	BM	JQ	Without Indication	QD CL	PF PMC XM	MF2 M5	US GU	-	-	F3P
	Medium	Standard	-	-	J	MP Standard	AM3	PR UR KM XR	F2	MU SC	PM	GM MP MR	Standard
Stainless Steel	Finishing	MQ	-	-	MP	FM FV SV LM LS MS	-	MF MMC SM MR	-	LU	PSS JS PF PSF PS PM	FW FP MW	PF WF F2M
Non-ferrous Metals	Finishing - Medium	AP AH	-	ALU	-	AZ	-	AL	AL	AG AW	AL	HP	AF AS

Positive Inserts (For Small Parts Machining)

Cutting Range		Kyocera	Dijet	Hitachi	Mitsubishi	NTK	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Carbon Steel / Alloy Steel	Minute D.O.C.	CF	-	-	-	-	-	-	-	01	-	-
	Finishing	PF CK GF SKS	ASF	JQ	FP FV SMG LS-P	AZ7 AMX ZR	PF XF	FF1	SI FC	PF	11 UF FP	PF SM
	Finishing - Medium	GQ SK	ACB FT	JE	LP AM MV	AM3 YL	PM XM	F1 MF2	SU	PS	LF	14
	Medium	GK	-	J	MP Standard	QD CL	PR	F2	SC	PM	MF MP	Standard
Stainless Steel	Finishing	MQ	-	MP	FM FV SV LM	-	MF	-	LU	JS PF PSF	FW FP MW	WF
Non-ferrous Metals	Finishing - Medium	AP AH	ALU	-	AZ	-	AL	AL	AG AW	AL	HP	AF AS

Cera-Notch Conversion Chart

Insert Style	Kyocera	Horizon	Tool-Flo	Kennametal	RTW	Valenite	Sandvik	Mitsubishi
Notch Style Grooving Insert								
Face Grooving	KCFP	HF	FLF	NF	-	-	TLF*	EF
ID/OD Grooving	KCG/KCGP	HG	FLG	NG	PG	VLG	TLG*	EG
ID/OD with Chipbreaker	KCGP MY	HG RK-LK	FLG CB	NG RK-LK	PG RK-LK	-	-	EG RK-LK
ID/OD with Positive Rake	KCGP	HGP	FLGP	NGP	-	VLGP	TLGP*	EGP
ID/OD Deep Grooving	KCGDP	HGD	FLGD	NGD	PGD	-	-	EGD
Full Nose Radius	KCRP	HR	FLR	NR	PR	VLR	TLR*	EGR
Full Nose Radius with Postive Rake	KCRP	HRP	FLRP	NRP	PRP	VLRP	TLRP*	-
Notch Style Threading Insert								
60° V Partial Profile	KCT	HT	FLT	NT	PT	VLT	TLT*	ET
60° V Fine Pitch Positive	KCTK	HTK	FLTK	NTK	PTK	VLTK	TLTK*	-
60° V Postive	KCTP	HTP	FLTP	NTP	PTP	VLTP	TLTP*	-

* Sandvik inserts require a Kyocera or industrial standard clamp due to different clamping system.

Milling Insert Part Number Cross Reference

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Kyocera ANSI	Kyocera ISO	Class	Applications	Hitachi	Mitsubishi	Sandvik	Sumitomo	Tungaloy	Iscar
SDMR42AUER-H SDKR42AUEN-S	**SDMR1203AUER-H SDKR1203AUEN-S**	M K	Steel	SDKR42TN	(SDNR1203AEEN-JS)		SDMR1203AEEN SDMR1203AETN	SDMR1203AETN-MJ SDKR1203AESR-MJ SDKR1203AETN-MJ SDKR1203AEPN-MS SDKR42ZSR-MJ SDKR42ZPN-MS	SDKR1203AUTR-HS SDKR1203AUN-76
SDKN42AUTN	**SDKN1203AUTN**	K		SDK42TN-C9	SDKN1203AEN SDKN1203AETN (SDNN1203AETN1)		SDKN42MT (SDNN1203AETN)	SDKN1203AETN-12 SDKN42ZTN	SDKN1203AETN
SDKN42AUFN	**SDKN1203AUFN**	K	Cast Iron	SDK42FN-C9			SDKN42M (SDNN1203AEEN)	SDKN1203AEFN-12 SDKN42ZFN	
			Non-Ferrous				SDKN42M	(SDCN1203AEFN-D) (SDCN42ZFN-DIA)	
SDKN53AUTN	**SDKN1504AUTN**	K	Steel	SDK53TN-C9	SDKN1504AEN SDKN1504AETN		SDKN53MT	SDKN1504AETN SDKN53ZTN	SDKN1504AETN
SEMR42AFER-H SEKR42AFEN-S	**SEMR1203AFER-H SEKR1203AFEN-S**	M K	Steel	SEKR42TN	(SEER1203AFEN-JS)	SEKR1203AZ-WM (SEER1203AZ-WL)	SEMR1203AFEN (SEER1203AFEN)	SEMR1203AFTN-MJ SEKR1203AFSR-MJ SEKR1203AFTN-MJ SEKR1203AFPN-MS	SEKR1203AFTR-HS SEKR1203AFR-HS SEKR1203AFN-76 SEKR1203AF-N-42
SEEN42AFTN	**SEEN1203AFTN**	E		SEE42TN-C9	SEEN1203AFTN1		SEEN42MT	SEEN1203AFTNCR-14	
SEKN42AFTN	**SEKN1203AFTN**	K		SEK42TN-C9	SEKN1203AFTN1 (SENN1203AFTN1)	SEKN1203AZ (SEMN1203AZ)	SEKN42MT (SENN1203AFTN)	SEKN1203AFTN SEKN1203AFTN-16 SEKN42AFTN SEKN42AFTN16	
SEKN42AFFN	**SEKN1203AFFN**	K	Cast Iron	SEK42FN-C9	(SEEN1203AFFN1)	SEKN1203AZ (SEMN1203AZ)	SEKN42M (SENN1203AFEN)	SEKN1203AFFN SEKN42AFFN	
SEEN42AFFN	**SEEN1203AFFN**	E	Non-Ferrous	SEE42FN-C9	(SECN1203AFFR1)				
SEKN42EFTR	**SEKN1203EFTR**	K	Steel	SEK42TR-G3	SEKN1203EFTR1	(SECN1203EER)		SEKN1203EFTR (SECN1203EFTR) (SEEN1203EFTR) (SECN42EFTRCR) (SEEN42EFTRCR)	
SEKN53AFTN	**SEKN1504AFTN**	K	Steel	SEK53TN-C9		SEKN1504AZ	SEKN53MT		SEKN1504AFTN
SPEN42EESR	**SPEN1203EESR**	E	Cast Iron	(SPK42FR-A3E)	SPEN42EFSR1 SPEN1203EESR1 SPEN1203EEER1 (SPNN1203EEER1)				
SPMR42EDER-H SPKR42EDER-S	**SPMR1203EDER-H SPKR1203EDER-S**	M K	Steel		(SPER1203EDER-JS)	SPKN1203EDR-WH		SPKR1203EDSR-MJ SPKR42SSR-MJ	SPKR1203EDR-76 SPKR1203EDTR-HS
SPCN42EDTR	**SPCN1203EDTR**	C			(SPEN1203EDR)	(SPAN1203EDR)	SPCH42TR-R	SPCN1203EDTR SPCN42STR	
SPKN42EDTR	**SPKN1203EDTR**	K		SPK42TR-A3	SPKN1203EDR	SPKN1203EDR	(SPCH42TR) (SPCH42TR-R)	SPKN1203EDTR SPKN42STR (SPEN1203EDTR) (SPEN42STR)	SPKN1203EDTR SPKN1203EDTR-42
SPKN42EDFR	**SPKN1203EDFR**	K	Cast Iron	SPK42FR-A3		SPKN1203EDR	(SPCH42R)	SPKN1203EDFR SPKN42SFR	SPKN1203EDFR
SPKN53EDTR	SPKN1504EDTR	K	Steel	SPK53TR-A3	SPKN1504EDR	SPKN1504EDR	(SPCH53TR-R)	SPKN1504EDTR SPKN53STR (SPCN1504EDTR) (SPCN53STR)	SPKN1504EDTR
SPKN53EDFR	SPKN1504EDFR	K	Cast Iron	SPK53FR-A3			(SPCH53R-R) (SPCH53TR-R)	SPKN1504EDFR SPKN53SFR	SPKN1504EDFR

- Tolerance is different for part numbers in ( ).
- Since edge shape of milling inserts is slightly different by each manufacturer, please adjust edges (Z axis direction) during operation.

Milling Insert Part Number Cross Reference

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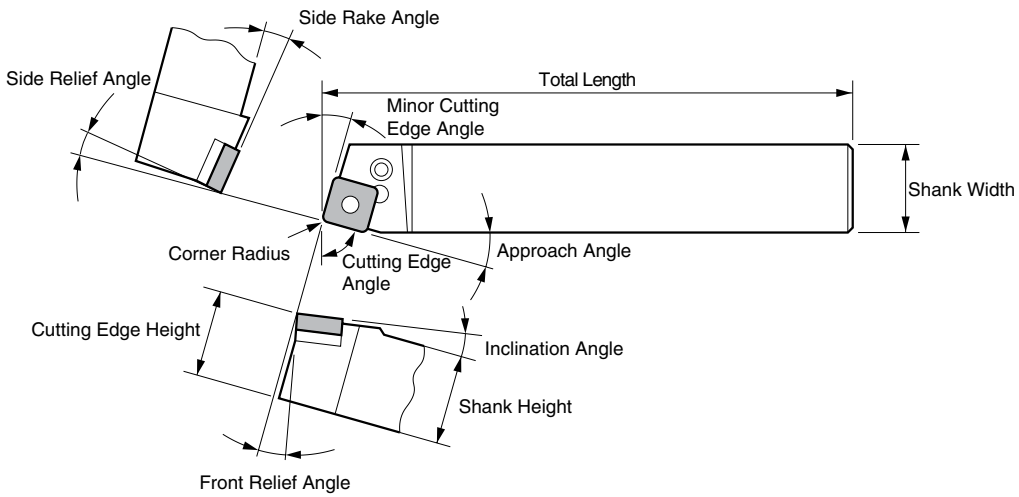
Kyocera ANSI	Kyocera ISO	Class	Applications	Hitachi	Mitsubishi	Sandvik	Sumitomo	Tungaloy	Iscar
SPCN42XPTR	**SPCN1203XPTR**	C	Steel	SPC42TR-A5				SPCN1203ZPTR SPCN42ZTR	
SPKN42XPTR	**SPKN1203XPTR**	K		SPK42TR-A5				SPKN1203ZPTR SPKN42ZTR (SPEN1203ZPTR) (SPEN42ZTR)	
SPKN42XPFR	**SPKN1203XPFR**	K	Cast Iron	SPK42FR-A5				SPKN1203ZPFR SPKN42ZFR	
SPKN53XETR	**SPKN1504XETR**	K	Steel		SPK53C2SR				
TPMR32PDER-H	**TPMR1603PDER-H**	M	Steel		(TPER1603PPER-JS)	(TPKN1603PPR-WH)			(TPKR1603PPTR-HS)
TPKN32PDTR	**TPKN1603PDTR**	K		TPK32TR-E0 TPK32TR-G0	TPKN1603PPR (TPEN1603PPR)	TPKN1603PPR	TPKN32TR		TPKN1603PPTR
TPKN32PDFR	**TPKN1603PDFR**	K	Cast Iron	TPK32FR-E0		TPKN1603PPR	TPKN32R		TPKN1603PPFR
TPMR43PDER-H **TPKR43PDER-S**	**TPMR2204PDER-H** **TPKR2204PDER-S**	M K	Steel		(TPER2204PDER-JS)	TPKN2204PDR-WH		TPMR2204PDSR-MJ TPKR2204PDSR-MJ TPKR43ZSR-MJ	TPKR2204PDTR-HS TPKR2204PD-R-76
TPKN43PDTR	**TPKN2204PDTR**	K		TPK43TR-E0 TPK43TR-G0	TPKN2204PDR (TPEN2204PDR)	TPKN2204PDR	(TPCH43TR)	TPKN2204PPTR TPKN43ZTR (TPCN2204PPTR) (TPCN43ZTR)	TPKN2204PDTR TPKN2204PDTR-42
TPKN43PDFR	**TPKN2204PDFR**	K	Cast Iron	TPK43FR-E0			(TPCH43R)	TPKN2204PPFR TPKN43ZFR (TPCN2204PPFR) (TPCN43ZFR) (TPEN2204PPTR-16) (TPEN43ZTR)	TPKN2204PDFR
TEMR32PTER-H	**TEMR1603PTER-H**	M	Steel		(TEER1603PEER-JS)			(TEKR1603PEPR-MS)	
TEKN32PTTR	**TEKN1603PTTR**	K		TEK32TR-G0 (TEE32TR-G0)	(TEEN1603PETR1)		TEKN32TR	(TECN1603PETR) (TEEN1603PETR) (TECN32ZTR) (TEEN32ZTR)	
TEKN32PTFR	**TEKN1603PTFR**	K	Cast Iron	TEK32FR-G0 (TEE32FR-G0)	(TEEN1603PEFR1)		TEKN32R	(TEEN1603PEFR) (TEEN32ZFR)	
TEEN32PTFR	**TEEN1603PTFR**	E	Non-Ferrous		(TECN1603PEFR1)		TEEN32R	(TECN1603PEFR-D) (TECN32ZFR-DIA)	
TEMR43PTER-H **TEKR43PTER-S**	**TEMR2204PTER-H** **TEKR2204PTER-S**	M K	Steel		(TEER2204PEER-JS)			TEKR2204PEPR-MS	
TEEN43PTTR	**TEEN2204PTTR**	E		TEE43TR-G0E (TEK43TR-G0E)	TEEN2204PETR1		TEEN43TR	TEEN2204PETR (TECN2204PETR) TEEN43ZTR (TECN43ZTR)	
TEKN43PTTR	**TEKN2204PTTR**	K		TEK43TR-G0E	TEKN2204PETR1		TEKN43TR	(TEEN2204PETR) (TECN2204PETR) (TEEN43ZTR) (TECN43ZTR)	
TEKN43PTFR	**TEKN2204PTFR**	K	Cast Iron	TEK43FR-G0E	(TEEN2204PEFR1)		TEKN43R	(TEEN2204PEFR) (TEEN43ZFR)	
			Non-Ferrous		(TECN2204PEFR1)		(TEEN43R)	(TECN2204PEFR-D) (TECN43ZFR-DIA)	
SNCN43XNTN	**SNCN1204XNTN**	C	Steel	SNC43TN-D5	SNC43B2S		(CSN43MT)	SNCN1204ZNTN SNCN43ZTN	
SNKN43XNTN	**SNKN1204XNTN**	K		SNK43TN-D5	SNK43B2S		(CSN43MT)	SNKN1204ZNTN SNKN43ZTN	
SNMF43XNTN	**SNMF1204XNTN**	M	Steel	(SNKF43TN-D5)	(SNKF43B2S)		(CSNB43MT)	(SNKF1204ZNTN) (SNKF43ZFN)	

- Tolerance is different for part numbers in ( ).
- Since edge shape of milling inserts is slightly different by each manufacturer, please adjust edges (Z axis direction) during operation.

Terms and Angles of Turning Toolholder



Function of Tool Angles

Tool Angle	Name	Function	Effect
Rake Angle	Side Rake Angle	• Affects cutting force, cutting heat, chip evacuation and tool life.	• If it is positive (+) angle, sharper cutting performance is obtained. (less cutting resistance, less edge strength) • Positive (+) angle is recommended for easy to machine workpieces or thin workpieces. • Smaller rake angle or negative (-) angle is recommended when a stronger edge is required like scale cutting or interrupted cutting.
	Inclination Angle		
Relief Angle	Front Relief Angle Side Relief Angle	• Prevents the tool's contact to the workpiece surface, except the cutting edge.	• When it is small, the cutting edge becomes strong, but the wear at relief faces may shorten the tool life.
Cutting Edge Angle	Cutting Edge Angle	• Affects chip control and the direction of cutting force.	• When it is large, chip thickness becomes thick and chip control improves.
	Approach Angle	• Affects chip control and the direction of cutting force.	• When it is large, chip thickness becomes thin and chip control worsens, but cutting force is dispersed and edge strength improves. • When it is small, chip control ability improves.
	Minor Cutting Edge Angle	• Prevents friction between cutting edge and work surface.	• When it is large, edge strength deteriorates.

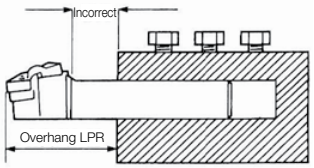
Toolholder Rigidity

1. Flexure of Toolholder

$$\delta = \frac{4 \times F \times L^3}{E \times b \times H^3} = \frac{4 \times k \times ap \times f \times L^3}{E \times b \times H^3}$$

Symbol	Name	Unit
δ (Delta)	Deflection	mm
b	Shank Width	mm
H	Shank Height	mm
E	Young ratio	N/mm^2
ap	Depth of Cut	mm
f	Feed Rate	mm/rev
k	Specific Cutting Force	N/mm^2
LPR	Overhang	mm
F	Cutting force	N

(F = k × ap × f)



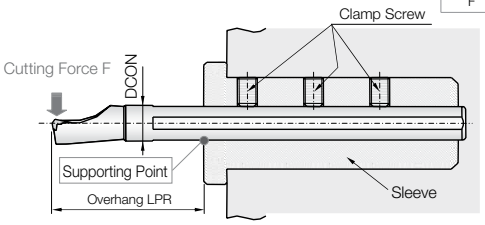
The flexural strength of toolholder will decrease by increasing of shank height by third root and will decrease of reducing over hang by third root.
Minimizing toolholder shank over hang as much as possible is important as well as shank's sectional square measure.

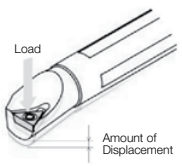
2. Flexure of Boring Bar

$$\delta = \frac{64 \times F \times (LPR)^3}{3 \times E \times \pi \times (DCON)^4} = \frac{64 \times k \times ap \times f \times (LPR)^3}{3 \times E \times \pi \times (DCON)^4}$$

Symbol	Name	Unit
δ (Delta)	Deflection	mm
DCON	Shank Dia.	mm
E	Young ratio	N/mm^2
ap	Depth of Cut	mm
f	Feed Rate	mm/rev
k	Specific Cutting Force	N/mm^2
LPR	Overhang	mm
F	Cutting force	N

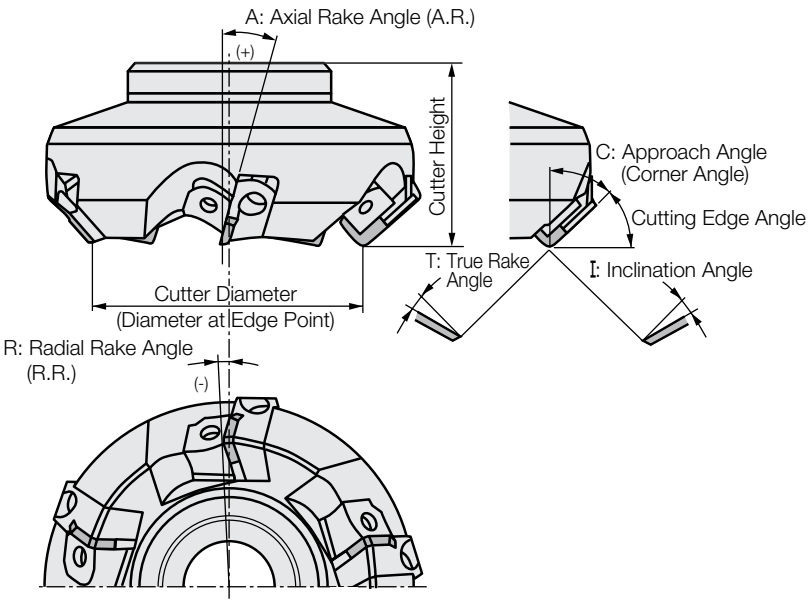
(F = k × ap × f)

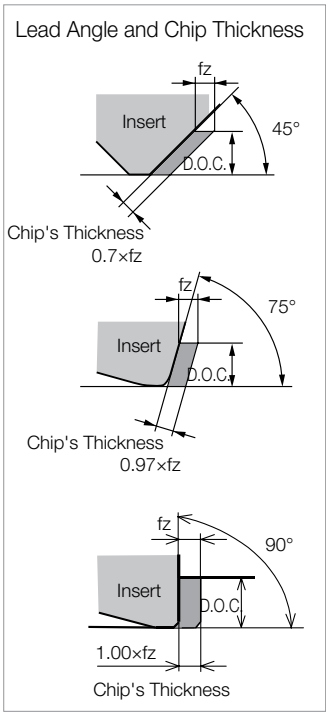




R TECHNICAL

Terms and Angles of Milling Cutters





Function of Tool Angles

Symbol	Name	Function	Effect
A	Axial Rake Angle (A.R.)	Controls chip flow direction and cutting force	When it is positive ··· Good cutting performance and less chip welding
R	Radial Rake Angle (R.R.)	Controls chip flow direction and cutting force	When it is negative ··· Good chip evacuation
C	Approach Angle	Controls chip thickness and chip flow direction	When it is large ··· Thinner chip thickness Lower cutting load
T	True Rake Angle	Actual rake angle	When it is positive ··· Good cutting performance and less chip welding, but lower edge strength When it is negative ··· Higher edge strength but easier to weld
I	Inclination Angle	Controls chip flow direction	When it is positive ··· Good chip evacuation Less cutting force Lower edge stability of the corner part

True Rake Calculation Formula : $\tan T = \tan R \times \cos C + \tan A \times \sin C$

Cutting Edge Inclination Angle Formula : $\tan I = \tan A \times \cos C - \tan R \times \sin C$

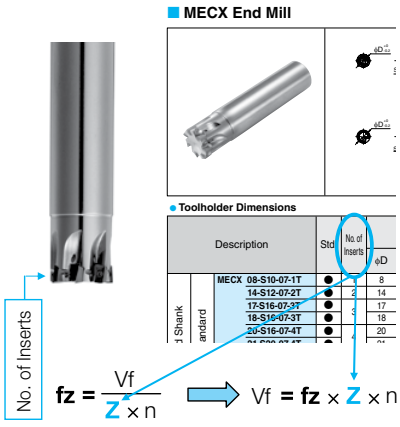
Number of Inserts (Z)

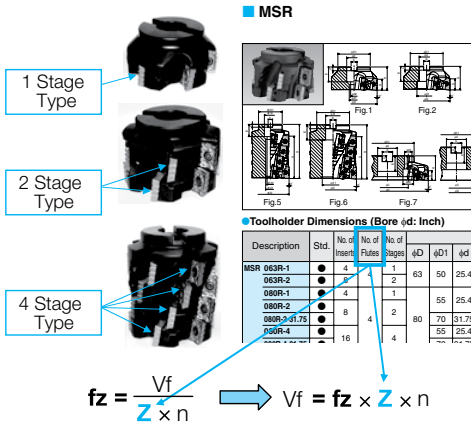
1) If there is one stage

If the number of stage is one, it is not indicated on the catalog. Please use "No. of inserts" of the catalogue for "Z" of the formula to calculate cutting conditions.

2) If the number of stages is more than two

If the number of stages is more than two, it is indicated on the catalog. Please use "No. of Flutes" of the catalogue for "Z" of the formula to calculate cutting conditions.





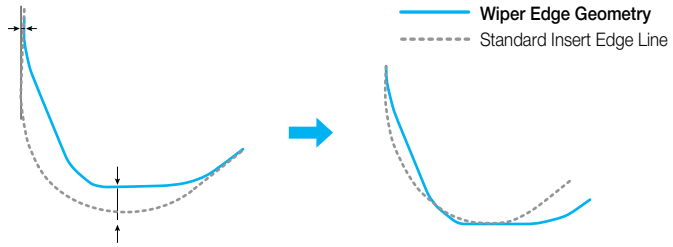
WF / WE Chipbreaker Edge Position Offset Adjustment

For D type and T type, cutting edge offsets are required.

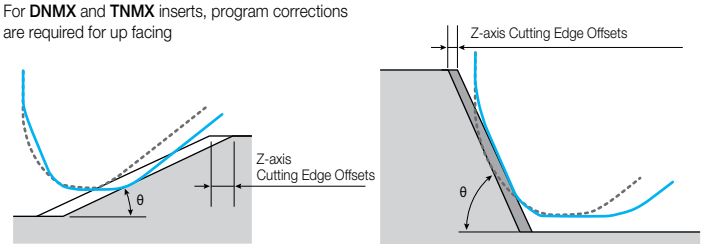
Cutting Edge Offsets (in)					
DNMX431WF DNMX441WF		**DNMX432WF DNMX442WF**		**DNMX433WF DNMX443WF**	
X-axis	Z-axis	X-axis	Z-axis	X-axis	Z-axis
0.0094	0.0008	0.0055	0.0004	0.0043	0.0004

Cutting Edge Offsets (in)					
TNMX331WF		**TNMX332WF**		**TNMX333WF**	
X-axis	Z-axis	X-axis	Z-axis	X-axis	Z-axis
0.0094	0.0004	0.0063	0.0000	0.0043	0.0000

For **DNMX** and **TNMX** inserts, cutting edge offsets are required



For **DNMX** and **TNMX** inserts, program corrections are required for up facing



DNMX43 Insert
DNMX44 Insert

Z-axis Cutting Edge Offsets (in)

Corner-R (RE) (in)	Ramping Angle θ					
	0°	5°	10°	15°	20°	25°
1/64	0.0000	-0.0134	-0.0138	-0.0142	-0.0142	-0.0142
1/32	0.0000	-0.0102	-0.0102	-0.0098	-0.0094	-0.0087
3/64	0.0000	-0.0059	-0.0067	-0.0063	-0.0059	-0.0059

Z-axis Cutting Edge Offsets (in)

Corner-R (RE) (in)	Up Facing Angle θ																		
	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
1/64	0.0000	-0.0008	-0.0012	-0.0012	-0.0016	-0.0020	-0.0024	-0.0028	-0.0031	-0.0035	-0.0039	-0.0043	-0.0047	-0.0039	-0.0031	-0.0024	-0.0016	-0.0008	0.0000
1/32	0.0000	0.0051	0.0047	0.0043	0.0035	0.0028	0.0020	0.0016	0.0008	0.0000	-0.0008	-0.0020	-0.0028	-0.0024	-0.0016	-0.0008	-0.0004	-0.0004	0.0000
3/64	0.0000	0.0142	0.0134	0.0122	0.0106	0.0094	0.0079	0.0063	0.0051	0.0035	0.0020	0.0000	-0.0016	-0.0016	-0.0012	-0.0008	-0.0004	-0.0004	0.0000

TNMX33 Insert

Z-axis Cutting Edge Offsets (in)

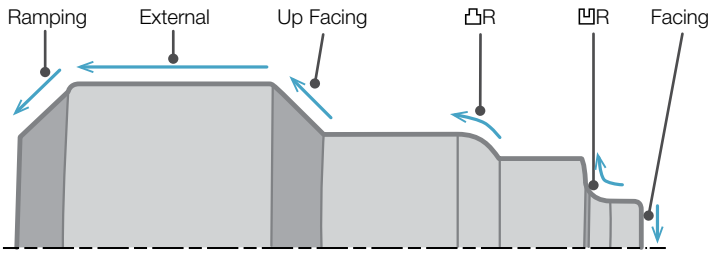
Corner-R (RE) (in)	Ramping Angle θ					
	0°	5°	10°	15°	20°	25°
1/64	0.0000					
1/32	0.0000					
3/64	0.0000					

Do not use TNMX33 insert for ramping

Z-axis Cutting Edge Offsets (in)

Corner-R (RE) (in)	Up Facing Angle θ																		
	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
1/64	0.0000	-0.0024	-0.0020	-0.0020	-0.0024	-0.0028	-0.0031	-0.0031	-0.0035	-0.0039	-0.0043	-0.0047	-0.0051	-0.0047	-0.0039	-0.0028	-0.0020	-0.0008	0.0000
1/32	0.0000	0.0043	0.0043	0.0039	0.0031	0.0024	0.0016	0.0008	0.0000	-0.0008	-0.0016	-0.0024	-0.0031	-0.0031	-0.0024	-0.0016	-0.0008	-0.0004	0.0000
3/64	0.0000	0.0134	0.0126	0.0114	0.0098	0.0087	0.0075	0.0059	0.0055	0.0031	0.0016	0.0000	-0.0020	-0.0020	-0.0012	-0.0004	0.0000	0.0000	0.0000

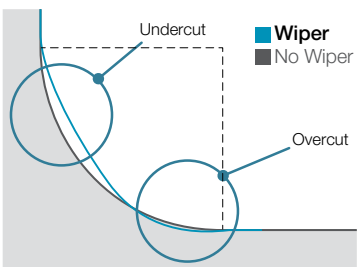
Caution (Finished Edge Line)



Application	Caution
External / Facing	Please check the applicable toolholder to confirm the lead angle matches the angle of the wiper.
Up Facing Ramping	For D type and T type inserts, Z-axis program corrections are required.
R • R	Do not use wiper inserts if a precise radial shape is needed.

Radius Cutting (Differences from Non-wiper Insert)

When machining a profile or radius on a workpiece, please note that DNMX and TNMX wiper inserts have some limitations.
Please refer to the list on the right for finished dimensions.



D Type Inserts

Unit: in

Nominal Corner R	Finished Dimension
0.016 (1/64)	R0.016 $^{+0.016}_{-0}$
0.032 (1/32)	R0.032 ±0.008
0.047 (3/64)	R0.047 $^{+0.012}_{-0.016}$

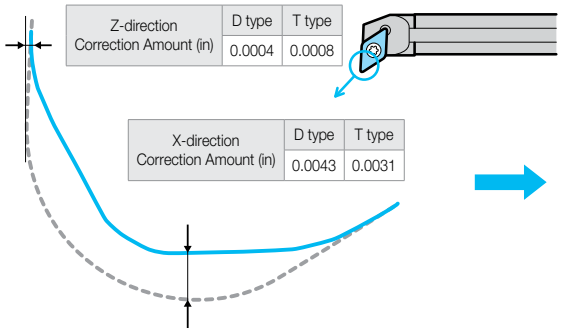
T Type Inserts

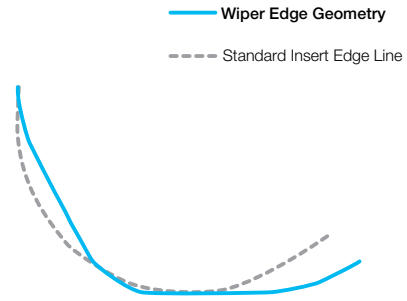
Unit: in

Nominal Corner R	Finished Dimension
0.016 (1/64)	R0.016 $^{+0.016}_{-0}$
0.032 (1/32)	R0.032 ±0.008
0.047 (3/64)	R0.047 $^{+0}_{-0.016}$

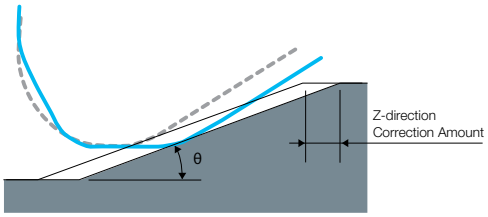
WP Chipbreaker Edge Position Offset Adjustment

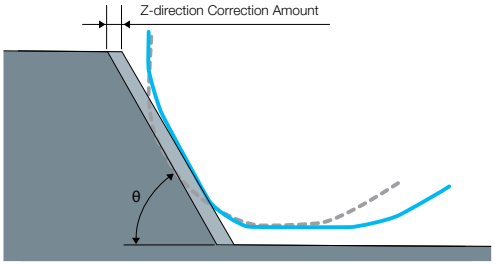
For D type and T type, cutting edge offsets are required.





For D type and T type, program corrections are required for ramping and profiling.





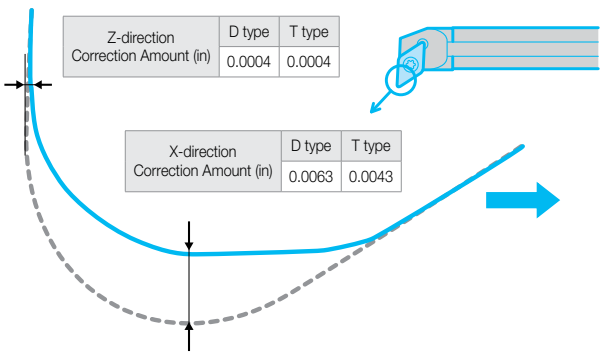
Ramping Angle θ	0°	5°	10°	15°	20°	25°
Z-direction Correction Amount (in) D type	0	-0.0055	-0.0059	-0.0063	-0.0063	-0.0067
Z-direction Correction Amount (in) T type	0	-0.0063	-0.0067	-0.0067	-0.0067	-

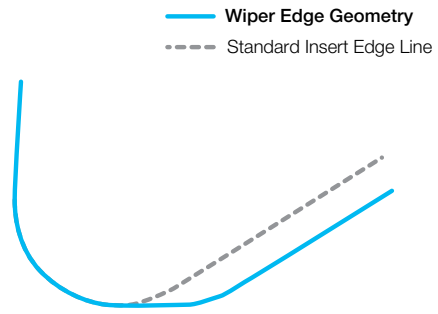
Profiling Angle θ	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°
Z-direction Correction Amount (in) D type	0.0000	0.0028	0.0024	0.0016	0.0012	0.0008	0.0004	0.0000	-	-	-
Z-direction Correction Amount (in) T type	0.0000	0.0028	0.0024	0.0020	0.0020	0.0016	0.0012	0.0008	0.0004	0.0004	0.0000

Profiling Angle θ	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
Z-direction Correction Amount (in) D type	-0.0004	-0.0008	-0.0012	-0.0016	-0.0020	-0.0020	-0.0016	-0.0012	-0.0008	-0.0004	0.0000
Z-direction Correction Amount (in) T type	-	-	-	-0.0004	-0.0008	-0.0012	-0.0016	-0.0012	-0.0008	-0.0004	0.0000

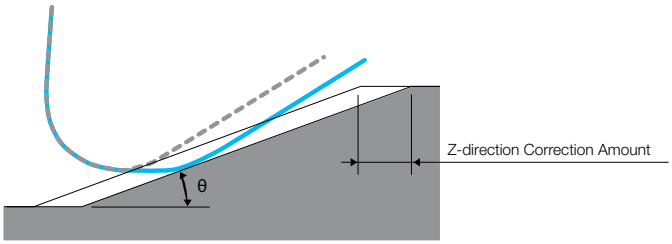
Handed Insert

For D type and T type, cutting edge offsets are required.



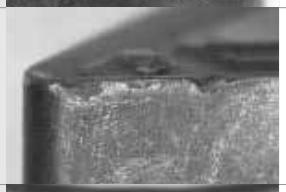
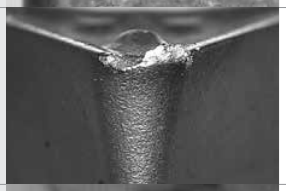


For D type and T type, program corrections are required for ramping.



Ramping Angle θ	0°	5°	10°	15°	20°	25°
Z-direction Correction Amount (in) D type	0	-0.0087	-0.0094	-0.0094	-0.0098	-0.0098
Z-direction Correction Amount (in) T type		-0.0094	-0.0094	-0.0098	-0.0094	-

Cutting Edges Figuration and Countermeasures

Typical Cutting Edge Figuration		Observation	Causes	Countermeasures
Nose Wear		• Deterioration of surface roughness and dimensional accuracy	• Too high Vc • End of tool life	• Reduce Vc • Change to higher wear resistant grade
Notching		• Burr formation • Cutting force increase	• Too high f and Vc	• Sharper cutting performance • Reduce Vc • Change to higher heat resistant grade
Crater Wear		• Chip control deterioration • Surface finish deterioration (peeled surface)	• Too high Vc	• Reduce Vc • Change to high speed type like Cermet or Al2O3 coated insert
Plastic Deformation		• Workpiece dimension's change • Crack at nose	• Too high cutting load • Inappropriate tool grade	• Change to harder grade • Reduce f and ap
Crack from Wear		• Surface finish's sudden deterioration • Workpiece dimension changes	• Too high Vc	• Reduce the pre-set tool life • Change to higher wear resistant grade
Chipping		• Cutting force increase • Surface roughness deterioration	• Too high f • Chattering • Lack of insert toughness	• Reduce f and ap • Change to more rigid toolholder • Change to tougher grade
Crack from Welding or Built-up Edge		• Surface finish deterioration • Cutting force increase	• Too low Vc	• Increase Vc • Improve sharp cutting performance (rake angle, chamfer)
Mechanical Fracture		• Sudden cracking • Unstable tool life	• Too high f and ap • Chattering	• Change to tougher grade • Enlarge chamfer • Enlarge Corner-R(r) • Change to more rigid toolholder
Fracture from Thermal Crack		• Cracking by heat cycle • Possible in interrupted cutting and milling	• Too high Vc and f	• Reduce f • Reduce Vc • Change to dry cutting
Flaking		• Possible in high-hardness material cutting • Possible in machining with chattering	• Lack of insert toughness • Lack of toolholder's rigidity	• Change to harder grade (TiC-base ceramic to CBN.) • Change to more rigid toolholder • Change edge preparation

Turning

Trouble	Trouble Item	Countermeasures: Change to Harder Grade	Change to Tougher Grade	Change to More Thermal Shock Resistant Grade	Change to More Welding Resistant Grade	Vc (Higher (Larger) ↑ Lower (Smaller) ↓)	f (Higher (Larger) ↑ Lower (Smaller) ↓)	D.O.C. (Higher (Larger) ↑ Lower (Smaller) ↓)	Tool Path Review	Coolant: Wet	Coolant: Dry	Chipbreaker Review	Rake Angle (Larger ↑ Smaller ↓)	Corner-R (rε) (Larger ↑ Smaller ↓)	Approach Angle (Larger ↑ Smaller ↓)	Edge Strength / Honing (Larger ↑ Smaller ↓)	Change to Higher Tolerance (M→G)	Toolholder Rigidity	Workpiece / Tool Installation	Overhang Length	Machine: Power, Rigidity
Unstable Dimension	Unstable Workpiece Dimension	Unsuitable Insert Tolerance															●				
		Tool and Workpiece Evacuation										●	●↑	●↓	●↓			●	●	●	●
	Frequent Offset During Cutting	Flank Wear Increase	●											●↑							
		Unsuitable Cutting Conditions					●↓	●↑													
		Built-up Edge				●	●↑														
Surface Roughness	Poor Surface Roughness	Poor Cutting by Tool Wear	●			●	●↓				●		●	●↑	●↑		●↓	●				
		Chipping		●				●↓	●↓				●		●↑		●↑			●	●	●
		Welding, Built-up Edge				●	●↑				●		●	●↑			●↓	●				
		Unsuitable Cutting Conditions					●↑	●↓	●↓		●											
		Unsuitable Tool Geometry											●		●↑		●↓	●				
		Vibration, Chattering		●			●↓	●*1↓	●↓				●	●↑	●↓	●↓	●↓		●	●	●	●
Heat	Deterioration of Accuracy or Tool Life by Cutting Heat	Unsuitable Cutting Conditions					●↓	●↓	●↓		●											
		Unsuitable Tool Geometry	●										●	●↑			●↓					
Bur, Chipping	Burr	Unsuitable Cutting Conditions					●↓	●↑		●	●											
		Unsuitable Tool Geometry	●										●	●↑	●↓	●↓	●↓					
	Workpiece Chip Off	Unsuitable Cutting Conditions						●↓	●↓	●												
		Unsuitable Tool Geometry	●										●	●↑	●↑	●↑	●↓		●	●	●	●
	Scuffing	Unsuitable Cutting Conditions					●↑	●*2↓			●											
		Unsuitable Tool Geometry	●			●							●	●↑			●↓					
Edge Damage	Wear Increase at Relief Face, Rake Face	Flank Wear	●				●↓				●		●	●↑	●↑		●↓					
		Rake Face Wear	●				●↓	●↓	●↓		●		●	●↑		●↑						
	Notching	Notching				●	●↓				●											
	Chipping	Vibration, Chattering		●				●↓	●↓				●			●↑	●↑		●	●	●	●
	Crack	Unsuitable Tool Geometry		●	●			●↓	●↓				●		●↑	●↑	●↑		●	●	●	●
	Thermal Crack	Work Hardness, Unsuitable Cutting Conditions			●		●↓	●↓	●↓			●	●	●↑			●↓					
	Edge Nose Deformation	Edge Nose Deformation at Interrupted Cutting	●				●↓	●↓	●↓				●	●↓	●↑	●↑	●↑					
	Built-up Edge	Work Hardness, Unsuitable Cutting Conditions				●	●↑	●↑			●		●	●↑			●↓	●				
Chip Control	Long, Tangling Chips	Unsuitable Cutting Conditions					*3●↓	●↑	●↑	●		●										
		Unsuitable Tool Geometry											●		●↓	●↓						
	Chips scattering	Unsuitable Cutting Conditions						●↓	●↓			●										
		Unsuitable Tool Geometry											●		●↑	●↑						

*1) To prevent chattering, the higher f may be suitable.
*2) To prevent scuffing, the higher f may be suitable.
*3) When using X-chipbreaker insert for soft steel and low carbon steel, the higher Vc cuts chips short.

Milling

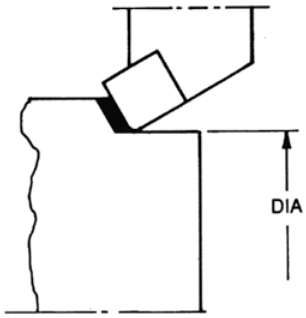
Problem	Problem Item	Countermeasures: Change to Harder Grade	Change to Tougher Grade	Change to More Thermal Shock Resistant Grade	Change to More Welding Resistant Grade	Vc (Higher (Larger) ↑ Lower (Smaller) ↓)	fz (Higher (Larger) ↑ Lower (Smaller) ↓)	D.O.C. (Higher (Larger) ↑ Lower (Smaller) ↓)	Tool Path Review	Coolant: Usage of Mist	Coolant: Dry	Insert with Chipbreaker	Relief Angle (Larger ↑ Smaller ↓)	Corner Angle (Larger ↑ Smaller ↓)	Approach Angle (Larger ↑ Smaller ↓)	Edge Strength / Honing (Larger ↑ Smaller ↓)	Number of Inserts (Larger ↑ Smaller ↓)	Chip Pocket (Larger ↑ Smaller ↓)	Wiper Edge (Relief Angle) Review	Insert Runout Check	Cutter Rigidity	Setting: Workpiece / Tool Installation	Setting: Overhang Length	Machine: Power, Rigidity
Edge Damage	Flank Wear Increase	Unsuitable Cutting Conditions									●													
		Unsuitable Tool Geometry	●											●		●			●					
	Rake Face Wear Increase	Unsuitable Cutting Conditions									●													
		Unsuitable Tool Geometry	●											●	●	●								
	Chipping, Cracking	Unsuitable Cutting Conditions								●	●													
		Unsuitable Tool Geometry		●										●	●	●			●	●	●	●	●	●
	Edge Breakage by Thermal Shock	Unsuitable Cutting Conditions										●												
		Unsuitable Tool Geometry			●									●		●								
	Built-up Edge	Unsuitable Cutting Conditions									●													
		Unsuitable Tool Geometry				●								●		●								
Cutting Accuracy	Poor Surface Finish	Unsuitable Cutting Conditions									●													
		Unsuitable Tool Geometry	●			●										●	●		●	●		●	●	●
	Burr Formation	Unsuitable Cutting Conditions								●	●													
		Unsuitable Tool Geometry												●	●	●			●					
	Workpiece Chip Off	Unsuitable Cutting Conditions									●													
		Unsuitable Tool Geometry												●	●	●	●		●					
	Poor Planeness / Parallelness	Tool and Workpiece Evacuation										*5 ●		●	●	●	●	●		●	●	●	●	●
Others	Heavy Chattering, Vibration	Unsuitable Cutting Conditions, Installation					●	*1 ●	*2 ●	*4 ●	●			●	●	●	●	●				●	●	●
	Damaging Chips	Unsuitable Cutting Conditions					●	*3 ●		●		*6 ●	●											
		Unsuitable Tool Geometry												●	●			●	●					

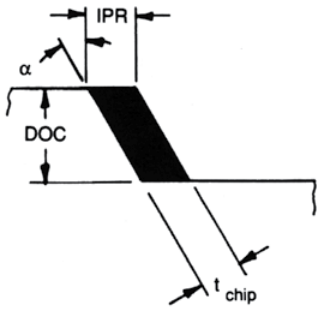
*1) To prevent chattering, the higher fz may be suitable.
*2) To prevent chattering, the larger ap may be suitable.
*3) Higher fz may be suitable.
*4) Down-cut method is recommended for helical end milling.
*5) If the surface is warped by cutting heat.
*6) Compressed air is recommended.

Drilling

Problem / Countermeasures / Check Item			Insert Grade		Cutting Conditions			Tool Geometry			Setting				Machine
			Change to Harder Grade	Change to Tougher Grade	Vc	f	Coolant Discharge Condition	Chipbreaker Review	Inner Edge's Center Height Check (Core Dia. Check)	Tool Rigidity Improvement (Short Type)	Workpiece / Tool Installation	Insert Installation	Offset Check (Lathe Operation Only)	Adjustable Sleeve Usage	Power, Rigidity
					Higher (Larger) ↑ Lower (Smaller) ↓				Larger ↑ Smaller ↓						
Edge Damage	Unusual Wear	Unsuitable Cutting Speed (too high)	●		●↓										
		Unsuitable Cutting Speed (too low)		●	●↑										
		Unsuitable Coolant Discharge					●								
		Poor Rigidity of Machine / Workpiece									●				●
		Small Hole Dia.											●	●	
		Unsuitable Tool Grade	●												
	Inner Edge Cracking	No core, Too Small Core							●↑						
		Poor Rigidity of Machine / Workpiece								●	●				●
		Unstable Drilling Start				●↓									
		High Hardness Workpiece	●		●↓	●↓									
		Clogged Chips			●↑				●↓						
		Unstable Insert Installation										●			
	Outer Edge Cracking	Poor Rigidity of Machine / Workpiece									●				●
		Unstable Drilling Start				●↓									
		High Hardness Workpiece	●		●↓	●↓									
		Poor Chip Control		●	●↑										
		Unstable Insert Installation										●			
Toolholder, Others	Scratches on Tool Body	Poor Rigidity of Machine / Workpiece									●				●
		Inaccurate Tool Installment											●	●	
		Clogged Chips			●↑	●↓									
		Unstable Drilling Start				●↓									
	Poor Hole Dia. Accuracy / Surface Finish	Poor Rigidity of Machine / Workpiece									●				●
		Poor Rigidity of Toolholder								●		●			
		Inaccurate Tool Installment											*●	●	
		Clogged Chips			●↑	●↓			●↓						
		Large Core Dia.							●↓						
		Unstable Drilling Start				●↓									
		Unsuitable Coolant Discharge					●								
	Large Chattering / Vibration	Unsuitable Cutting Conditions, Installation			●↑	●↓				●	●				●
	Long Chips	Unsuitable Cutting Conditions			●↑										
		Unsuitable Chipbreaker						●							
	Machine Failure	Lack of Machine Power			●↓	●↓		●							●

Turning





Surface Speed per Minute

SFM= 0.262 × DIA × RPM

Revolutions per Minute

$$RPM = \frac{3.820 \times SFM}{DIA}$$

Feedrate (inches/minute)

IPM= IPR × RPM

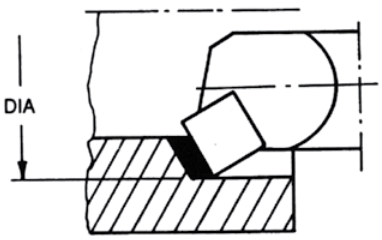
Chip Thinning for Non-Round Inserts (inches/revolution)

$$\text{Programmed IPR} = \frac{t_{chip\ Max}}{\cos 1}$$

Chip Thinning for Round Inserts (inches/revolution)

$$\text{Programmed IPR} = \frac{t_{chip\ Max}}{\sqrt{\frac{4ap}{ic} \cdot \left(\frac{2ap}{ic}\right)^2}}$$

Boring



Metal Removal Rate

Q= 12 × DOC × IPR × SFM (in^3/minute)

Horsepower Required at the Spindle

HPS= Q × UHP

Horsepower Required at the Motor

$$HPM = \frac{HPS}{EFF}$$

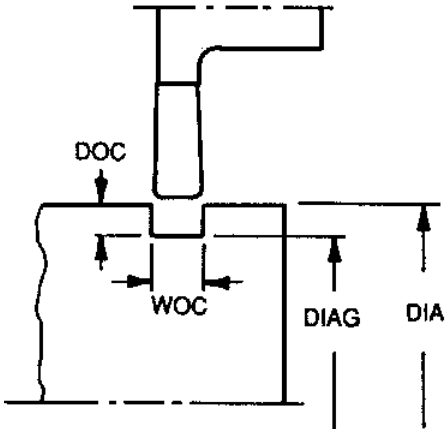
Time in Cut (seconds)

$$T = \frac{15.7 \times DIA \times LOC}{SFM \times IPR}$$

or

$$T = \frac{60 \times LOC}{IPM}$$

External Grooving



Surface Speed per Minute

SFM= 0.262 × DIA × RPM

Revolutions per Minute

$$RPM = \frac{3.820 \times SFM}{DIA}$$

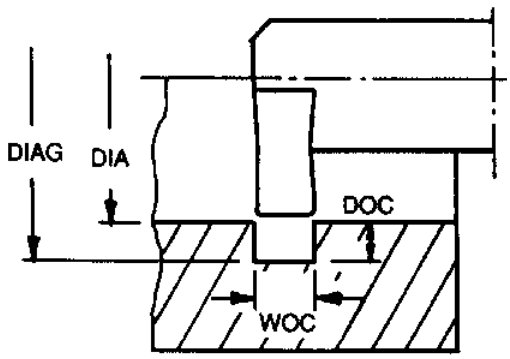
Feedrate (inches/minute)

IPM= IPR × RPM

Feedrate (inches/revolution)

$IPR = t_{chip}$

Internal Grooving



Metal Removal Rate

Q= 12 × WOC × IPR × SFM (cu.in/minute)

Horsepower Required at the Spindle

HPS= Q × UHP

Horsepower Required at the Motor

$$HPM = \frac{HPS}{EFF}$$

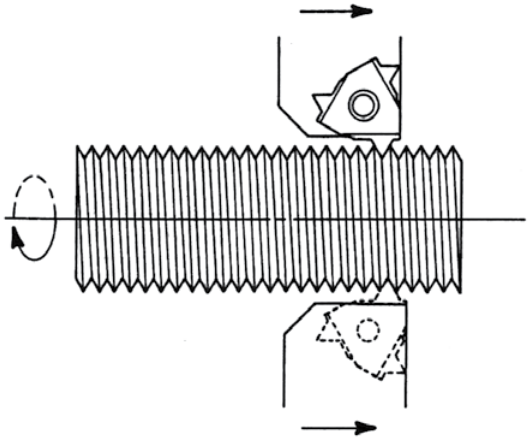
Time in Cut (seconds)

$$T = \frac{7.85 \times DOC \times (DIA + DIAG)}{SFM \times IPR}$$

or

$$T = \frac{60 \times LOC}{IPM}$$

External Threading



Surface Speed per Minute

$$SFM = 0.262 \times DIA \times RPM$$

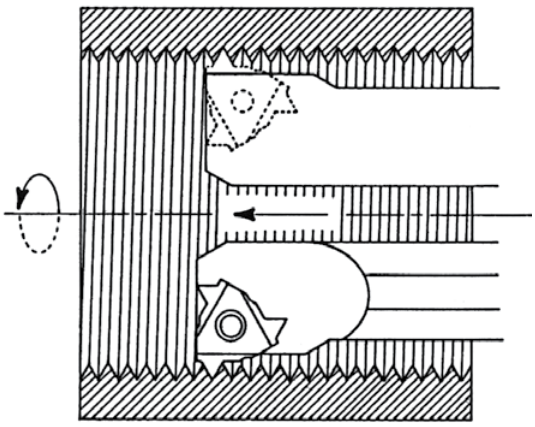
Revolutions per Minute

$$RPM = \frac{3.820 \times SFM}{DIA}$$

Feedrate (inches/minute)

$$IPM = IPR \times RPM$$

Internal Threading



Time in Cut (seconds)

$$T = \frac{60 \times LOC \times NO.\ OF\ PASSES}{IPR \times RPM}$$

Feedrate

Standard Threads

$$IPR = \frac{1}{TPI}$$

Metric Threads

$$IPR = \frac{P_{mm}}{25.4}$$

Definition of Terms

DIA = Diameter of the Workpiece (Inches)

DOC = Depth of Cut (Inches)

EFF = Machine Efficiency

f = Feedrate (See IPM and IPR)

HPM = Horsepower Required at the Motor

HPS = Horsepower Required at the Spindle

IPM = Feedrate (Inches per Minute)

IPR = Feedrate (Inches per Revolution)

IC = Insert inscribed circle (inches)

LOC = Length of Cut (Inches)

Q = Metal Removal Rate (Cubic Inches per Minute)

RPM = Revolutions per Minute

SFM = Surface Speed (Feet per Minute)

T = Time (in Seconds)

$t_{chip\ Max}$ = Maximum Recommended Chip Thickness (Inches)

UHP = Unit Horsepower Factor

1 = Lead Angle

Turning

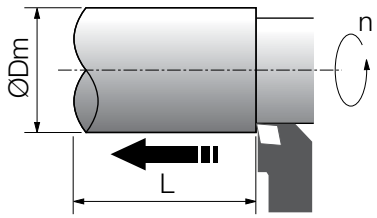
Cutting Speed

$$Vc = \frac{\pi \times Dm \times n}{1000}$$

Vc : Cutting Speed [m/min]

Dm : Workpiece Diameter [mm]

n : Spindle Revolution [min^{-1}]



Power Requirement

$$Pc = \frac{Ks \times Vc \times ap \times f}{6120 \times \eta}$$

$$P_{HP} = \frac{Ks \times Vc \times ap \times f}{4500 \times \eta}$$

Pc : Power Requirement [kW]

P_{HP} : Power Requirement (Horse Power) [HP]

Vc : Cutting Speed [m/min]

ap : Depth Of Cut [mm]

f : Feed Rate [mm/rev]

Ks : Specific Cutting Resistance [kgf/mm^{-2}]

η : Mechanical Efficiency (0.7 ~ 0.8)

Ks Figure	
Low Carbon Steel	190
Medium Carbon Steel	210
High Carbon Steel	240
Low Alloy Steel	190
High Alloy Steel	245
Cast Iron	93
Malleable Cast Iron	120
Bronze, Brass	70

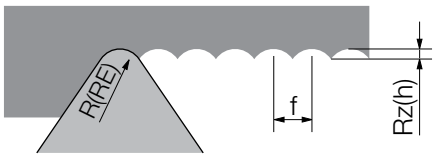
Surface Roughness

$$Rz=h = \frac{f2}{8 \times R(RE)} \times 1000$$

Rz=h : Theoretical Surface Roughness [µm]

f : Feed Rate [mm/rev]

R(RE) : Corner Radius of Insert [mm]



Chip Removal Volume

$$Q = Vc \times ap \times f$$

Q : Chip Removal Volume [cm^3/min]

Vc : Cutting Speed [m/min]

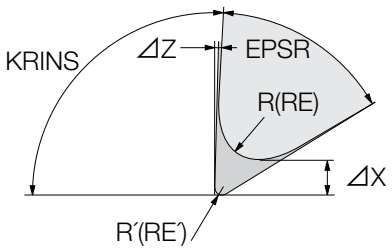
ap : Depth Of Cut [mm]

f : Feed Rate [mm/rev]

Edge Position Compensation

$$\Delta X = (R\text{-}R') \times \left\{ \frac{\cos(\frac{\alpha}{2} + (\beta - 90°))}{\sin\frac{\alpha}{2}} - 1 \right\}$$

$$\Delta Z = (R\text{-}R') \times \left\{ \frac{\sin(\frac{\alpha}{2} + (\beta - 90°))}{\sin\frac{\alpha}{2}} - 1 \right\}$$



ΔX : X-axis Direction Edge Position Compensation [mm]

ΔZ : Z-axis Direction Edge Position Compensation [mm]

R : Corner-R before Change [mm]

R´ : Corner-R before Change [mm]

EPSR : Insert Corner Angle [°]

KRINS : Toolholder's Cutting Edge Angle [°]

Toolholder Type	Insert Corner Angle (EPSR)	Cutting Edge Angle (KRINS)	ΔX	ΔZ
PCLN	80°	95°	0.100 x (R-R´)	0.100 x (R-R´)
PTGN	60°	91°	0.714 x (R-R´)	0.030 x (R-R´)
PDJN	55°	93°	0.866 x (R-R´)	0.099 x (R-R´)
PDHN	55°	107.5°	0.531 x (R-R´)	0.531 x (R-R´)
PVLN	35°	95°	2.072 x (R-R´)	0.273 x (R-R´)
PVPN	35°	117.5°	1.351 x (R-R´)	1.351 x (R-R´)
PSBN	90°	75°	0.225 x (R-R´)	-0.293 x (R-R´)

Example: Compensation when changing corner-R from 0.80 to 0.40, using PCLN type holder,

ΔX= 0.100 x (0.80 - 0.40) = 0.04 (mm)

ΔZ= 0.100 x (0.80 - 0.40) = 0.04 (mm)

Turning (Cutting Time)

Cutting Time (External Turning Case 1: 1 Pass machining)

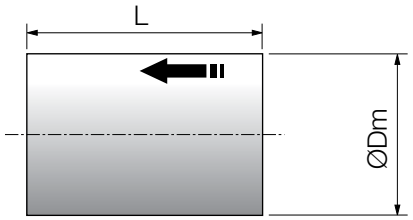
- At Constant Revolution

$$T = \frac{60 \times L}{f \times n}$$

- At Constant Cutting Speed

$$T = \frac{60 \times \pi \times L \times Dm}{1000 \times f \times Vc}$$

T : Cutting Time [second]
L : Cutting Length [mm]
f : Feed Rate [mm/rev]
n : Spindle Revolution [min^{-1}]
Dm : Workpiece Diameter [mm]
Vc : Cutting Speed [m/min]



Cutting Time (External Turning Case 2: Multi-Pass machining)

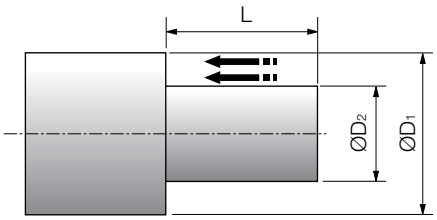
- At Constant Revolution

$$T = \frac{60 \times L}{f \times n} \times N$$

- At Constant Cutting Speed

$$T = \frac{60 \times \pi \times L \times (D_1 + D_2)}{2 \times 1000 \times f \times Vc} \times N$$

T : Cutting Time [second]
L : Cutting Length [mm]
ap : Depth Of Cut per Pass [mm]
f : Feed Rate [mm/rev]
n : Spindle Revolution [min^{-1}]
D_1 : Max. Diameter of Workpiece [mm]
D_2 : Min. Diameter of Workpiece [mm]
Vc : Cutting Speed [m/min]
N : Number of Passes = $(D_1 - D_2)/ap/2$ (if it is indivisible, obtain integer by rounding up one place of decimals.)



Cutting Time (Facing)

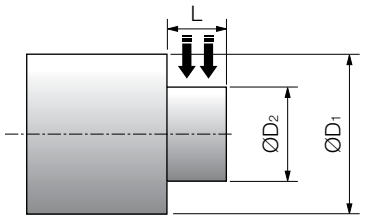
- At Constant Revolution

$$T = \frac{60 \times (D_1 - D_2)}{2 \times f \times n} \times N$$

- At Constant Cutting Speed

$$T_1 = \frac{60 \times \pi \times (D_1 + D_2 \times D_1 - D_2)}{4000 \times f \times Vc} \times N$$

T : Cutting Time [second]
T_1 : Machining Time before reaching Max. Spindle Revolution [second]
L : Cutting Length [mm]
ap : Depth Of Cut per Pass [mm]
f : Feed Rate [mm/rev]
n : Spindle Revolution [min^{-1}]
D_1 : Max. Diameter of Workpiece [mm]
D_2 : Min. Diameter of Workpiece [mm]
Vc : Cutting Speed [m/min]
N : Number of Passes = $(D_1 - D_2)/ap/2$ (if it is indivisible, obtain integer by rounding up one place of decimals.)



Cutting Time (Grooving)

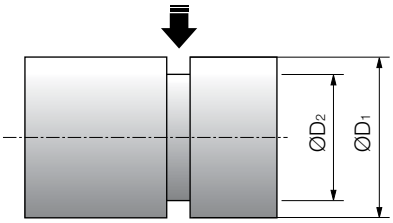
- At Constant Revolution

$$T = \frac{60 \times (D_1 - D_2)}{2 \times f \times n} \times N$$

- At Constant Cutting Speed

$$T_1 = \frac{60 \times \pi \times (D_1 + D_2) \times (D_1 - D_2)}{4000 \times f \times Vc}$$

T : Cutting Time [second]
T_1 : Machining Time before reaching Max. Spindle Revolution [second]
L : Cutting Length [mm]
f : Feed Rate [mm/rev]
n : Spindle Revolution [min^{-1}]
D_1 : Max. Diameter of Workpiece [mm]
D_2 : Min. Diameter of Workpiece [mm]
Vc : Cutting Speed [m/min]



Cutting Time (Cut-Off)

- At Constant Revolution

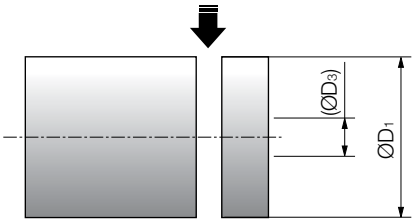
$$T = \frac{60 \times D_1}{2 \times f \times n}$$

- At Constant Cutting Speed

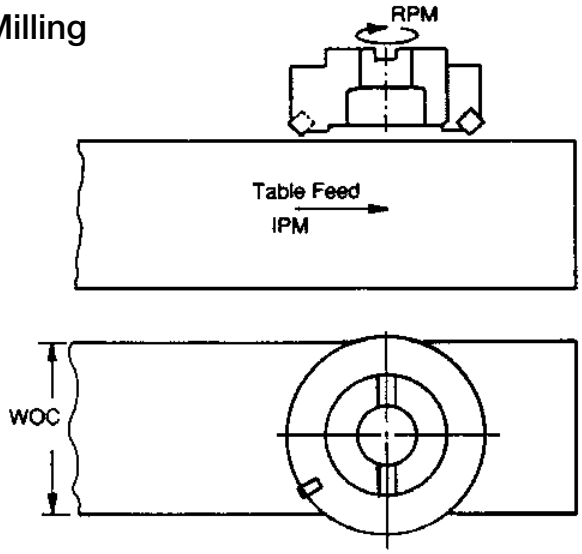
$$T_1 = \frac{60 \times \pi \times (D_1 + D_3) \times (D_1 - D_3)}{4000 \times f \times Vc}$$

$$T_3 = T_1 + \frac{60 \times D_3}{2 \times f \times N_{max}}$$

T : Cutting Time [second]
T_1 : Machining Time before reaching Max. Spindle Revolution [second]
T_3 : Machining Time when reaching Max. Spindle Revolution [second]
f : Feed Rate [mm/rev]
n : Spindle Revolution [min^{-1}]
n_{max} : Max. Spindle Revolution [min^{-1}]
D_1 : Max. Diameter of Workpiece [mm]
D_3 : Diameter when reaching Max. Spindle Revolution [mm]
Vc : Cutting Speed [m/min]



Milling



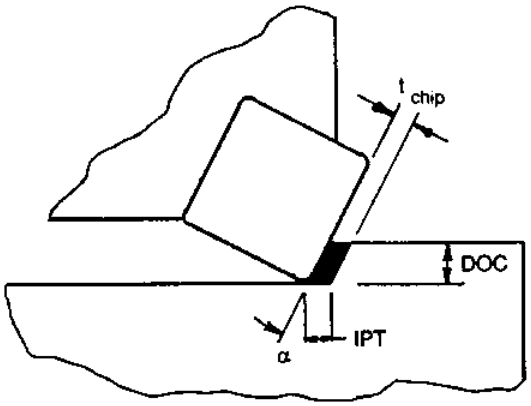


Table Feed with f_1 Compensation (inches/minute)
= IPT × N × RPM × f_1

Surface Speed per Minute

SFM = 0.262 × DIA × RPM

Revolutions per Minute

$$RPM = \frac{3.820 \times SFM}{DIA}$$

Feedrate (inches/minute)

IPM = IPT × N × RPM

Feedrate (inches/tooth)

$$\text{Programmed IPT} = \frac{t_{chip\ Max}}{\cos \alpha}$$

Radial Chip Thinning for 90° Cutters

$$f_1 = \frac{1/2 \left(\frac{Dia}{Ae}\right)}{\sqrt{\left(\frac{Dia}{Ae}\right)^{-1}}}$$

Metal Removal Rate

Q = WOC DOC × IPM (in/min)

Horsepower Required at the Spindle

HPS = Q × UHP

Horsepower Required at the Motor

HPM = HPS/EFF

Time in Cut (Seconds)

$$T = \frac{15.7 \times DIA \times LOC}{SFM \times IPR \times N}$$

or

$$T = \frac{60 \times LOC}{IPM}$$

Definition of Terms

DIA = Diameter of the Workpiece (Inches)
D.O.C. = Axial Depth of Cut (Inches)
EFF = Machine Efficiency
f = Feedrate (See IPM, IPR, and IPT)
HPM = Horsepower Required at the Motor (HP)
HPS = Horsepower Required at the Spindle (HP)
IPM = Feedrate (Inches per Minute)
IPR = Feedrate (Inches per Revolution)
IPT = Feedrate (Inches per Tooth)
f_1 = Cutter Compensation Factor
WOC = Width of Cut (Inches)
LOC = Length of Cut (Inches)
N = Number of Effective Teeth in Cutter
Q = Metal Removal Rate (Cubic Inches per Minute)
RPM = Revolutions per Minute
SFM = Surface Speed (Feet per Minute)
T = Time (in Seconds)
$t_{chip\ Max}$ = Maximum Recommended Chip Thickness (Inches)
UHP = Unit Horsepower Factor
α = Lead Angle

Milling

Cutting Speed

$$Vc = \frac{\pi \times DC \times n}{1{,}000}$$

Vc : Cutting Speed [m/min]
DC : Cutter Diameter [mm]
n : Spindle Revolution [min^{-1}]

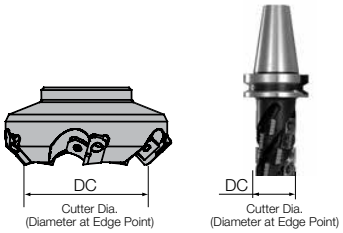
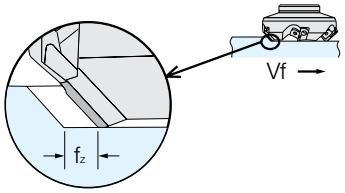


Table Feed & Feed per Tooth

$$Vc = \frac{Vf}{Z \times n}$$

fz : Feed per Tooth [mm/t]
Vf : Table Feed [mm/min]
Z : Number of Inserts
n : Spindle Revolution [min^{-1}]



Power Requirement

$$Pc = \frac{Ks \times Q}{6{,}120 \times \eta} = \frac{Ks \times ae \times Vf \times ap}{6{,}120{,}000 \times \eta}$$

$$= \frac{Ks \times ae \times fz \times Z \times N \times ap}{6{,}120{,}000 \times \eta}$$

Pc : Power Requirement [kW]
Vf : Power Requirement (Horse Power) [HP]
ae : Width of Cut [mm]
Vf : Table Feed [mm/min]
fz : Feed per Tooth [mm/t]
Z : Number of Inserts
n : Spindle Revolution [min^{-1}]
ap : Depth of Cut [mm]
Ks : Specific Cutting Force [kgf/mm^2]
η : Mechanical Efficiency (0.7~0.8)
Q : Chip Removal Volume [cm^3/min = cc/min]

Ks Figure	
Low Carbon Steel	190
Medium Carbon Steel	210
High Carbon Steel	240
Low Alloy Steel	190
High Alloy Steel	245
Cast Iron	93
Malleable Cast Iron	120
Bronze, Brass	70

Chip Removal Volume

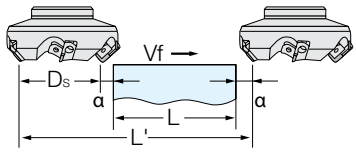
$$Q = \frac{ae \times Vf \times ap}{1{,}000} = \frac{ae \times fz \times Z \times n \times ap}{1{,}000}$$

Q : Chip Removal Volume [cm^3/min = cc/min]
ae : Width of Cut [mm]
Vf : Table Feed [mm/min]
fz : Feed per Tooth [mm/t]
Z : Number of Inserts
n : Spindle Revolution [min^{-1}]
ap : Depth of Cut [mm]

Cutting Time

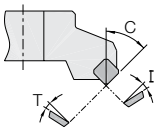
$$T = \frac{60 \times L'}{Vf} = \frac{60 \times L'}{fz \times Z \times n}$$

T : Cutting Time [seconds]
L' : Total Table Transfer Length [mm]
(= L + Ds + 2α)
L : Workpiece Length [mm]
Ds : Cutter Diameter [mm]
α : Idling Distance [mm]
Vf : Table Feed [mm/min]
fz : Feed per Tooth [mm/t]
Z : Number of Inserts
n : Spindle Revolution [min^{-1}]



True Rake Angle

$$\tan T = \tan R \times \cos C + \tan A \times \sin C$$



True Rake Angle

$$\tan I = \tan A \times \cos C - \tan R \times \sin C$$

A (GAMP) : Axial Rake Angle (A.R.) [°] (-90° < A < 90°)
R (GAMF) : Radial Rake Angle (R.R.) [°] (-90° < R < 90°)
C (KAPR) : Approach Angle [°] (0° < C < 90°)
T (GAMN) : True Rake Angle [°] (-90° < T < 90°)
I (GAMO) : Inclination Angle [°] (-90° < I < 90°)

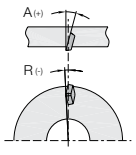
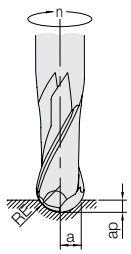


Table Feed & Feed per Tooth

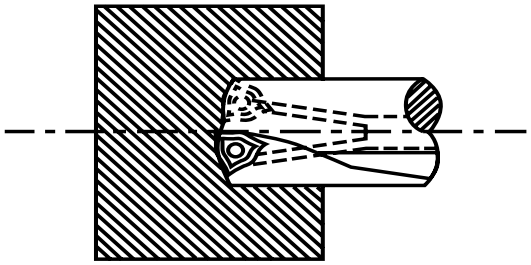
$$n = \frac{1{,}000 \times Va}{2 \times \pi \times \sqrt{a(2RE\text{-}ap)}}$$

n : Revolution [min^{-1}]
RE : Radius of Ball-Nose End Mill (Ball Part's Radius [mm])
ap : Depth of Cut [mm]
Va : Cutting Speed at Position a [m/min])

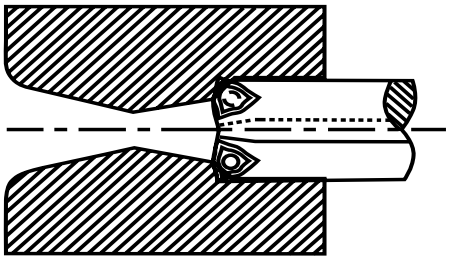


Drilling

DRILLING



CORE DRILLING



SURFACE SPEED PER MINUTE
SFM = 0.262 x DIA x RPM

REVOLUTIONS PER MINUTE
$$RPM = \frac{3.82 \times SFM}{DIA}$$

FEEDRATE (inches per minute)
IPM = IPR x RPM

FEEDRATE (inches per revolution)
IPR=IPT x N

METAL REMOVAL RATE (in^3 per minute)
DRILL: Q=3 x DIA x IPR x SFM
COREDRILL: Q=12 x DOC x IPR x SFM

HORSEPOWER REQUIRED AT THE SPINDLE
HPS = Q x UHP

HORSEPOWER REQUIRED AT THE MOTOR
$$HPM = \frac{HPS}{EFF}$$

TIME IN CUT
$$T = \frac{15.7 \times DIA \times LOC}{SFM \times IPR}$$

or

$$T = \frac{60 \times LOC}{IPM}$$

Definition of Terms

DIA = DIAMETER OF THE DRILL (INCHES)
DOC = DEPTH OF CUT (INCHES)
EFF = MACHINE EFFICIENCY
HPM = HORSEPOWER AT MOTOR
HPS = HORSEPOWER AT SPINDLE
IPM = FEEDRATE (INCHES PER MINUTE)
IPR = FEEDRATE (INCHES PER REVOLUTION)
IPT = CHIPLOAD (INCHES PER TOOTH)
LOC = LENGTH OF CUT (INCHES)
N = NUMBER OF EFFECTIVE FLUTES
N = 1 FOR DRILLS
N = 2 FOR COREDRILLS
Q = METAL REMOVAL RATE (CUBIC INCHES PER MINUTE)
RPM = REVOLUTIONS PER MINUTE
SFM = SURFACE SPEED (FEET PER MINUTE)
T = TIME (SECONDS)
UHP = UNIT HORSEPOWER (SEE TABLE BELOW)

UNIT HORSEPOWER FACTORS

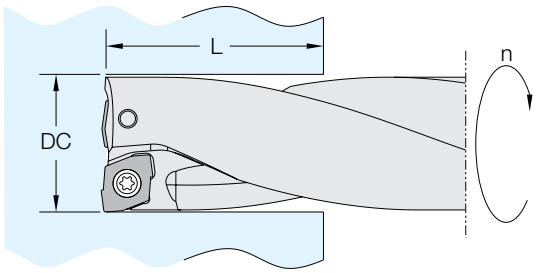
Material	Hardness (BHN)	UHP Factor (HP/in3/min)	Material	Hardness (BHN)	UHP Factor (HP/in3/min)
Aluminum	---	0.25	1050	225	0.80
Brass	---	0.25	4140	275	0.70
Copper	---	0.30	52100	225	0.67
Gray Cast Iron	200	0.33	6150	375	1.30
Nodular Iron	225	0.54	Cast Steel	225	0.62
Inconel 700	330	1.10	Stainless Steel	225	0.73
1020	165	0.58			

Drilling

Cutting Speed

$$Vc = \frac{\pi \times DC \times n}{1{,}000}$$

Vc : Cutting Speed [m/min]
DC : Drill Diameter [mm]
n : Spindle Revolution [min^{-1}]



Feed Rate

$$Vf = fz \times Z \times n$$

Vf : Table Feed [mm/min]
fz : Feed per Tooth [mm/t]
Z : Number of Inserts
n : Spindle Revolution [min^{-1}]

Cutting Time

$$T = \frac{60 \times L}{f \times n} = \frac{60 \times \pi \times DC \times L}{1{,}000 \times Vc \times f}$$

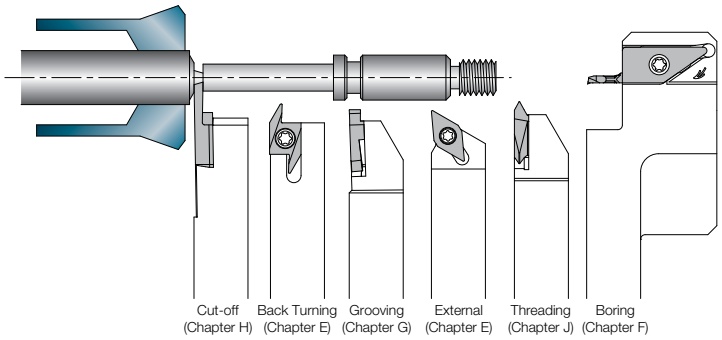
T : Cutting Time [second]
L : Drilling Depth [mm]
f : Feed Rate [mm/rev]
n : Spindle Revolution [min^{-1}]
DC : Drill Diameter [mm]
Vc : Cutting Speed [m/min]

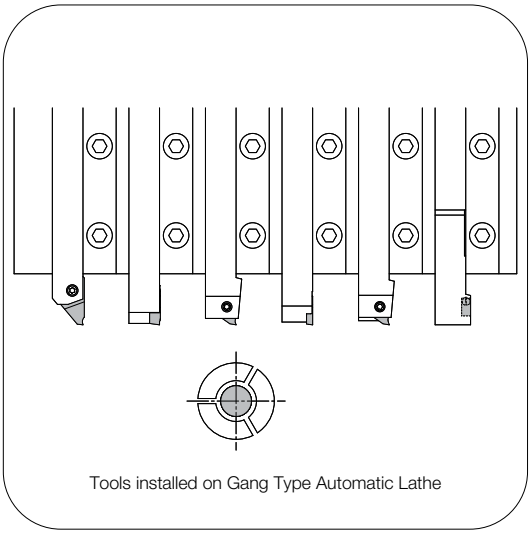
Power Requirement

$$Pc = \frac{DC}{20} \times \frac{Vc}{100} \times \left(1 + \left(\frac{2.5 \times f}{0.1}\right)\right)$$

Pc : Power Requirement [kW]
DC : Drill Diameter [mm]
Vc : Cutting Speed [m/min]
f : Feed Rate [mm/rev]

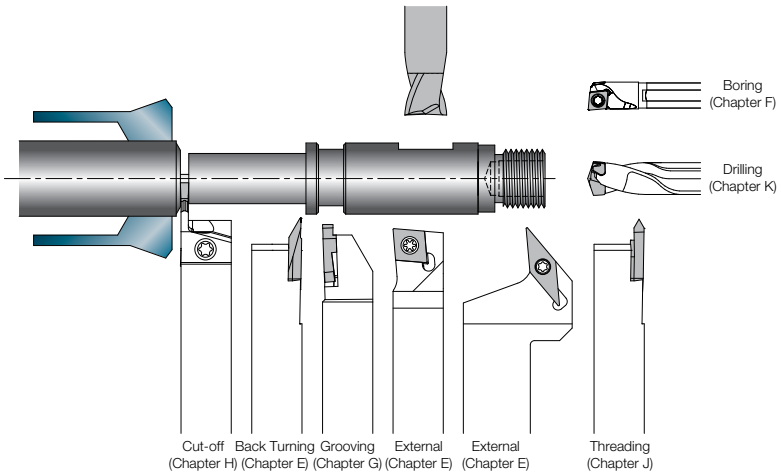
Tooling Example ① CNC Automatic Lathe (Gang Type)

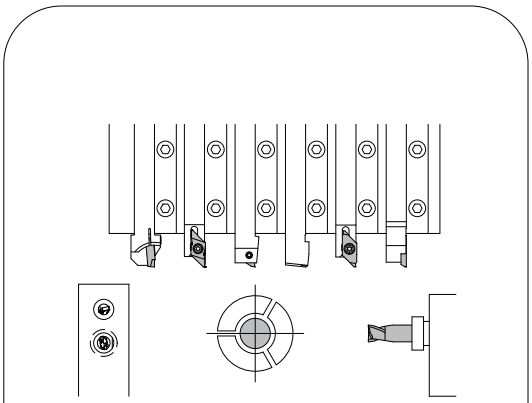




Tools installed on Gang Type Automatic Lathe

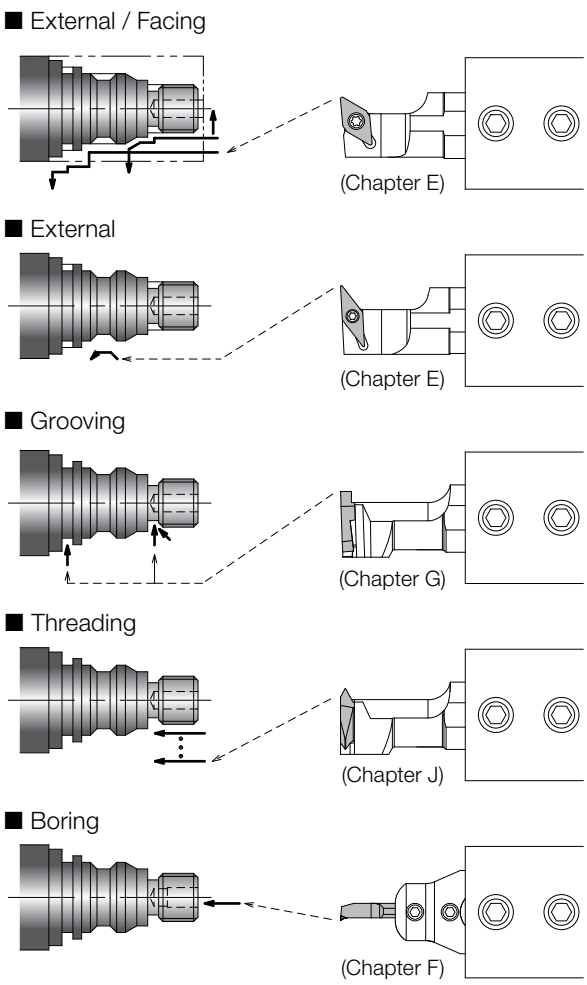
Tooling Example ② CNC Automatic Lathe (Gang Type)

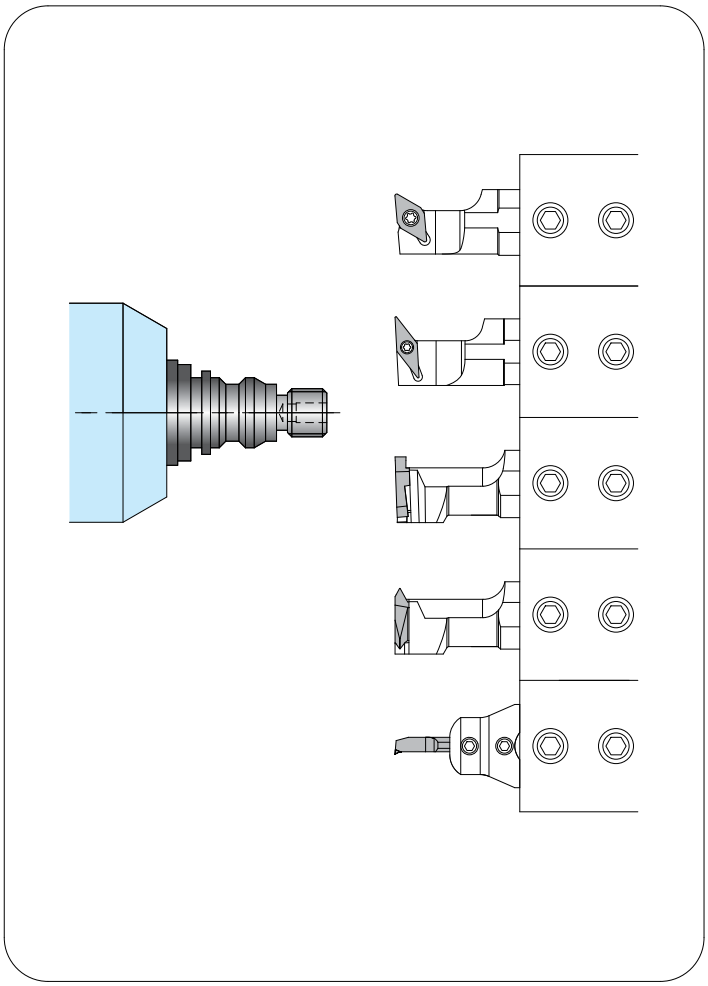




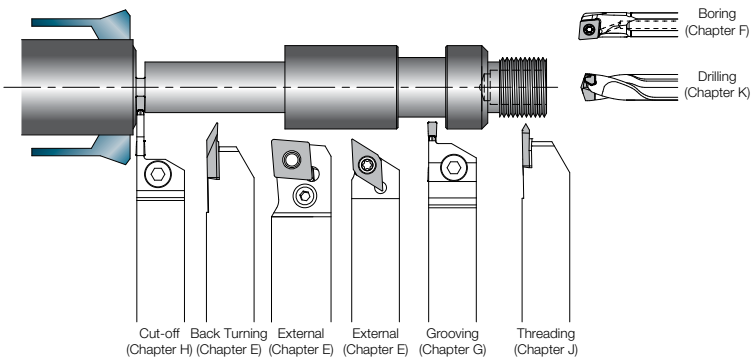
Tools installed on Gang Tool Post + Milling Toolholders

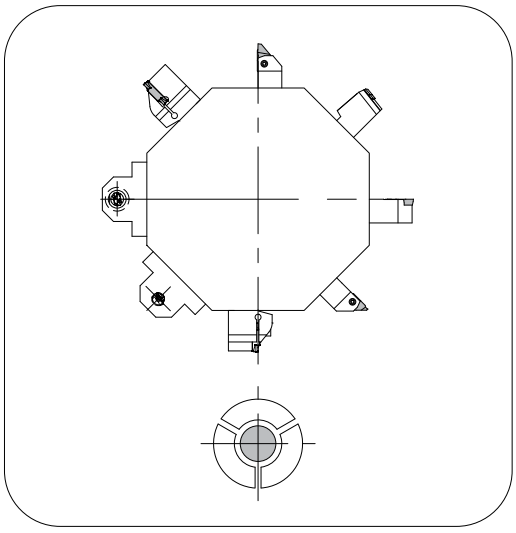
Tooling Example ③ CNC Automatic Lathe (Opposed Gang Type)





Tooling Example ④ CNC Automatic Lathe (Turret Type)





Automatic Lathe List by Manufacturer and Tooling Examples see page ➔ R66~R71

CITIZEN MACHINERY (Cincom Products)

Model	Toolholder Dimensions (Gang-Type)	Number of tools	Toolholder Dimensions (Turret-Type)	Number of tools	Sleeve Diameter (Horizontal / Opposed)	Number of tools	Max. Cutting Dia.	Notes
A12/16	10 x 10 x 100	5			Ø19.05/Ø20	Ø12/Ø16	Ø12 / Ø16	-
A20	12(13) x 12(13) x 120 Cut-Off Toolholder : □16mm	6			Ø25.4	Ø20	Ø20	-
A20 VII	12(13) x 12(13) x 120 Cut-Off Toolholder : □16mm	6			Ø25.4	Ø20	Ø20	-
A32	16 x 16 x 150	6			Ø25.4	Ø32	Ø32	-
B12	10 x 10 x 100	5			Ø19.05/Ø20	Ø12	Ø12	-
B12E/B16E	10 x 10 x 120(60)	5			Ø19.05(Ø20OP)	Ø12/Ø16	Ø12 / Ø16	-
B20	12(13) x 12(13) x 120	6			Ø19.05/Ø20	Ø20	Ø20	-
BL12	10 x 10 x 60 ~ 120	5			Ø20(Ø19.05)	Ø12	Ø12	-
BL20/25	12(13) x 12(13) x 120	4 ~ 7			Ø20(Ø19.05)	Ø20/Ø25	Ø20 / Ø25	-
C12/16	10 x 10 x 120	6			Ø19.05	Ø12/Ø16	Ø12 / Ø16	-
C32	16 x 16 x 130	5			Ø25.4	Ø32	Ø32	-
D25	16 x 16 x 150 Cut-Off Toolholder : □19mm				Ø25.4	Ø25	Ø16	-
F10			10 x 10 x 60	10	Ø19.05	Ø10	Ø20	-
F12			10 x 10 x 60	10	Ø19.05	Ø12	Ø25	-
F16			10 x 10 x 60	10	Ø19.05	Ø16	Ø32	-
F20			16(19) x 16(13) x 90	10	Ø25.4	Ø20	Ø10	-
F25			16(19) x 16(13) x 90	10	Ø25.4	Ø25	Ø12	-
FL25			16 x 16 x 90	12		Ø25	Ø16	-
FL42			16 x 16 x 90	12		Ø42	Ø20	-
G32			16(19) x 16(19) x 90	10	-	Ø32	Ø25	-
K12/16	12(10) x 12(10) x 100	6(7)			Ø19.05/Ø20	Ø12/Ø16	Ø25	-
K12E/K16E	12 x 12 x 120	6			Ø19.05/Ø20	Ø12/Ø16	Ø42	-
L10	8 x 8 x 100 ~ 130	5			Ø15.875	Ø10	Ø32	-
L12	10 x 10 x 100	6			Ø19.05	Ø12	Ø12 / Ø16	-
L16	12(10) x 12(10) x 130	5			Ø19.05	Ø16	Ø12 / Ø16	-
L20,L20E	12 x 12 x 130 Cut-Off Toolholder : □16mm	5			Ø19.05	Ø20	Ø10	-
L20X,L220	12(13,16) x 12(13,16) x 120 Cut-Off Toolholder : □16mm	5 ~ 7			Ø19.05/Ø25	Ø20	Ø12	-
L25	16 x 16 x 130	5			Ø25.4	Ø25	Ø16	-
L32	16 x 16 x 130	5			Ø25.4	Ø32		-
M12	10 x 10 x 120	5	10 x 10 x 60	10+α	Ø19.05	Ø12		-
M16	10 x 10 x 120	5	10 x 10 x 60	10+α	Ø19.05	Ø16	Ø25	-
M20	16 x 16 x 130	5	16 x 16 x 90	10+α	Ø25.4	Ø20	Ø32	-
M32	16 x 16 x 130	5	16 x 16 x 90	10+α	Ø25.4	Ø32	Ø12	-
MC20	13 x 13 x 120	2 + 2 + 2			Ø19.05/Ø20.0	Ø20.0	Ø16	-
MSL12	10 x 10 x 120				-	Ø12	Ø20	-
R04	8 x 8 x 120	5			Ø15.875	Ø4	Ø32	-
R07	8 x 8 x 120	5			Ø15.875	Ø7	Ø16	-
RL01	10(8) x 10(8) x 90				Ø16(Ø20)	Ø10	Ø20	-
RL02	16 x 16 x 90				Ø20	Ø20	Ø20.0	-
RL21	10(12) x 10(12) x 90				Ø19.05	Ø35	Ø12	-

- This table is approved by machine manufacturers.
- Manufacturers are in no particular order.

CITIZEN MACHINERY (Miyano Products)

Model	Toolholder Dimensions (Gang-Type)	Number of tools	Toolholder Dimensions (Turret-Type)	Number of tools	Sleeve Diameter (Horizontal / Opposed)	Number of tools	Max. Cutting Dia.	Notes
ABX-51SY2			20 x 20 x 125(100)	24	Ø25	48	Ø51	
ABX-51SYY2			20 x 20 x 125(100)	24	Ø25	48	Ø51	
ABX-51TH5			20 x 20 x 125(100)	36	Ø25	72	Ø51	
ABX-51THY2			20 x 20 x 125(100)	36	Ø25	72	Ø51	
ABX-64SY2			20 x 20 x 125(100)	24	Ø25	48	Ø64	
ABX-64SYY2			20 x 20 x 125(100)	24	Ø25	48	Ø64	
ABX-64TH5			20 x 20 x 125(100)	36	Ø25	72	Ø64	
ABX-64THY2			20 x 20 x 125(100)	36	Ø25	72	Ø64	
BNA-34C			20 x 20 x 125(100)	8(16)	Ø25	24	Ø34	
BNA-34DHY			20 x 20 x 125(100)	14(22)	Ø25	27	Ø34	
BNA-34S			20 x 20 x 125(100)	8(16)	Ø25	24	Ø34	
BNA-42C/C2			20 x 20 x 125(100)	8(16)	Ø25	24	Ø42	
BNA-42DHY			20 x 20 x 125(100)	14(22)	Ø25	27	Ø42	
BNA-42DHY2			20 x 20 x 125(100)	14(22)	Ø25	27	Ø42	
BNA-42DHY3			20 x 20 x 125(100)	14(22)	Ø25	27	Ø42	
BNA-42GTY	20 x 20 x 125(100)	3	20 x 20 x 125(100)	8(16)	Ø25	24(7)	Ø42	
BNA-42MSY2			20 x 20 x 125(100)	8(16)	Ø25	24	Ø42	
BNA-42S/S2			20 x 20 x 125(100)	8(16)	Ø25	24	Ø42	
BNA-42C5/SY5			20 x 20 x 125(100)	12(24)	Ø25	24	Ø42	
BNC-42C7			20 x 20 x 125(100)	8(16)	Ø25	24	Ø42	
BND-51C2			20 x 20 x 125(100)	12	Ø25	24	Ø51	
BND-51S2			20 x 20 x 125(100)	12	Ø25	24	Ø51	
BND-51SY2			20 x 20 x 125(100)	12	Ø25	24	Ø51	
BNE-42S6			20 x 20 x 125(100)	24	Ø25	48	Ø42	
BNE-42SY6			20 x 20 x 125(100)	24	Ø25	48	Ø42	
BNE-51S6			20 x 20 x 125(100)	24	Ø25	48	Ø51	
BNE-51SY6			20 x 20 x 125(100)	24	Ø25	48	Ø51	
BNE-51MSY			20 x 20 x 125(100)	24	Ø25	48	Ø51	
BNJ-34S3/S5			20 x 20 x 125(100)	18	Ø25	30	Ø34	
BNJ-34SY3/SY5			20 x 20 x 125(100)	18	Ø25	30	Ø34	
BNJ-42S3/S5			20 x 20 x 125(100)	18	Ø25	30	Ø42	
BNJ-42S6			20 x 20 x 125(100)	20	Ø25	40	Ø42	
BNJ-42SY3/SY5			20 x 20 x 125(100)	18	Ø25	30	Ø42	
BNJ-42SY5			20 x 20 x 125(100)	18	Ø25	30	Ø42	
BNJ-42SY6			20 x 20 x 125(100)	20	Ø25	40	Ø42	
BNJ-51S3/S5			20 x 20 x 125(100)	18	Ø25	30	Ø51	
BNJ-51SY3/SY5			20 x 20 x 125(100)	18	Ø25	30	Ø51	
BNJ-51SY6			20 x 20 x 125(100)	20	Ø25	40	Ø51	
GN-3200	12(16) x 12(16) x 70 ~ 120	4 ~ 5			Ø20	4 ~ 5	Ø40	
GN-3200W	12(16) x 12(16) x 70 ~ 120	4 ~ 5			Ø20	4 ~ 5	Ø40	
GN-4200	12(16) x 12(16) x 70 ~ 120	7 ~ 8			Ø20	7 ~ 8	Ø40	
LX-06E2			20 x 20 x 125(100)	8	Ø32	8		6 inch power chuck
LX-06E3			20 x 20 x 125(100)	8	Ø32	8		6 inch power chuck
LX-08C			25 x 25 x 150	10	Ø40	10		8 inch power chuck
LX-08E2			25 x 25 x 150	8	Ø40	8		8 inch power chuck
LX-08E3			25 x 25 x 150	8	Ø40	8		8 inch power chuck
LX-08R			20 x 20 x 125(100)	10	Ø25	20		8 inch power chuck
LZ-01R2			20 x 20 x 125(100)	12	Ø25	24		8 inch power chuck
LZ-01RY2			20 x 20 x 125(100)	12	Ø25	24		8 inch power chuck
LZ-02R2			20 x 20 x 125(100)	10	Ø25	20		8 inch power chuck
LZ-02RY2			20 x 20 x 125(100)	10	Ø25	20		8 inch power chuck
RL01 III	10 x 10 x 70 ~ 120	2 ~ 3			Ø16	2 ~ 3	Ø10	
RL01 V	10 x 10 x 70 ~ 120	2 ~ 3			Ø16	2 ~ 3	Ø10	
RL03	12(16) x 12(16) x 70 ~ 120	4 ~ 5			Ø20	4 ~ 5	Ø40	
VC03	12(16) x 12(16) x 70 ~ 120	4 ~ 5			Ø20	4 ~ 5	Ø40	

* Number of tools shown in parentheses ( ) is the maximum number of toolholders mountable including Ø25 sleeves.

- This table is approved by machine manufacturers.
- Manufacturers are in no particular order.

STAR MICRONICS

Model	Toolholder Dimensions (Gang-Type)	Number of tools	Toolholder Dimensions (Turret-Type)	Number of tools	Sleeve Diameter (Horizontal / Opposed)	Number of tools	Max. Cutting Dia.	Notes
ECAS-12	10×10×95~150	6			Ø22		Ø13	
ECAS-20	12×12×80~150	6			Ø22		Ø20	
	16×16×80~144							
ECAS-20T			16×16×60~78		Ø22 / Ø32		Ø20	
			16×16×80~88					
ECAS-32T			16×16×60~78	10	Ø22 / Ø32		Ø32	
			16×16×80~88	10				
JNC-10			8×8×65	6			Ø10	
JNC-16			10×10×80	6			Ø16	
JNC-25/32			10×10×78~120	10	Ø22		Ø25 / 32	
KJR-16B/25B			16×16×78	12/16	Ø22 / Ø32			
KNC-16/20			16×16×68	16	Ø22			
KNC-25II/32II			16×16×78	20	Ø22 / Ø32			
RNC-10	10×10×80~120	5			Ø22			
RNC-16	10×10×80~120	5			Ø22			
SA-16R	10×10×95~120	6			Ø22			
SB-16 (A/C/D/E)	12×12×95~130	5			Ø22 (Front & Rear) / (Ø22)	4/4		Only D/E for Back Clamp Sleeves
	12×12×95~130	6				4/4		
	10×10×95~130	6				4/4		
SB-12II (C/E)	12×12×95~130	6				4/4		Only E for Back Clamp Sleeves
SB-16II (C/E)	12×12×95~130	6				4/4		
	10×10×95~130	6				4/4		
SB-20 A/C/E	12×12×95~130	6				4/4		
SB-12R typeG	12×12×95~130	6				4/4	Ø13	
	10×10×95~130	7				4/4		
SB-16R/20R typeN	12×12×95~130	6				4/4	Ø16 / Ø23	
	10×10×95~130	7				4/4		
SB-16R/20R typeG	12×12×95~130	6				4/4	Ø16 / Ø23	
	10×10×95~130	7				4/4		
SC20	12×12×95~130	5			Ø22 / -	4		
	10×10×95~130	6				4/4		
SE-12B/16B	10×10×95~120	5			Ø22		Ø13 / 16	
SG-42			16×16×84~88		Ø22 / Ø32		Ø42	
			16×16×71~82					
			20×20×84~88					
SH-7	8×8×95~120	5			Ø22		Ø7	
SH-12/16	10×10×95~120	5			Ø22		Ø13 / 16	
SI-12/12C	10×10×80~130	6			Ø22		Ø13	
SR-10J	8×8×67~110 (Spacer is needed)	6			Ø16	4		
SR-20RII	12×12×100~135	6		4	Ø22	6/8	Ø23	Toolpost for 2 Toolholders (Deep Boring) on the Front Side
SR-20III	12×12×95~135	6			Ø22	6/8	Ø23	
SR-20IVtypeA	12×12×100~130	7			Ø22 (Front & Rear) / Ø22	6/8	Ø23	
SR-20IVtypeB	12×12×100~130	7			Ø22 (Front & Rear) / Ø22	6/8	Ø23	
SR-25J/32J	16×16×95~155	6		4	Ø22+Ø32 (Front & Rear) / Ø22		Ø32	
SW-12RII	10×10×95~115	7			Ø16(Front & Rear) / Ø22	4/8	Ø13	
ST-20			12×12×73~79		Ø22 / Ø32		Ø20	
			12×12×65~73(Cut-Off)					
			16×16×64~73					
			16×16×65~73(Cut-Off)					
ST-38			16×16×83~88		Ø22 / Ø32		Ø32 / Ø38	
			16×16×71~82					
			16×16×84~88(Cut-Off)					
			20×20×84~88					
			20×20×84~88(Cut-Off)					
SV-38R	16×16×105~135	4	16×16×84~88		Ø22 / Ø32	- / 8	Ø32 / Ø38	
	20×20×115~135(Cut-Off)	1	16×16×71~82					
			20×20×84~88					
SV-12/20	12×12×95~135	5	12×12×70~78		Ø22 / Ø32			
	16×16×95~135	4	16×16×65~70					
SV-32	16×16×95~135	4	16×16×60~78		Ø22 / Ø32			
			16×16×80~88					
SW-7	8×8×80~120	6					Ø7	

- This table is approved by machine manufacturers.
- Manufacturers are in no particular order.

TSUGAMI

Model	Toolholder Dimensions (Gang-Type)	Number of tools	Toolholder Dimensions (Turret-Type)	Number of tools	Sleeve Diameter (Horizontal / Opposed)	Number of tools	Max. Cutting Dia.	Notes
B0123-III	12×12×85	9	-	-	Ø20 / -	4 / -	Ø12	
B0124/125/126-III	12×12×85	9	-	-	Ø20 / Ø20	4 / 4	Ø12	
B0203-III	12×12×85	9	-	-	Ø20 / Ø20	4 / 4	Ø20	
B0204/205/206-III	12×12×85	9	-	-	Ø20 / Ø20	4 / 4	Ø20	
B020M-II	-	-	-	-	- / Ø20	- / 1	Ø20	
B0265/265B/266-II	16×16×100	12	-	-	Ø25 / Ø25	5 / 4	Ø26	
B0325/325B/326-II	16×16×100	12	-	-	Ø25 / Ø25	5 / 4	Ø32	
B0385/385L	20×20×125	8	-	-	Ø32 / Ø32	3 / 5	Ø38	
B038T	-	-	20×20×125	St.8	Ø32 / Ø25		Ø38	
B073/074-II	8×8×85	9			Ø20	4	Ø7	
BH20/BH20Z	12×12×85	4	12×12×85	St.12	Ø25 / Ø32		Ø20	
BH38	16×16×125	5	20×20×125	St.12	Ø25 / Ø32		Ø38.1	
BM163-III	12×12×85	9	-	-	Ø20 / -	4 / -	Ø16	
BM164/165-III	12×12×85	9	-	-	Ø20 / Ø20	4 / 4	Ø16	
C150/CH154	12×12×60~100	4~6	-	-	-		Ø80	
C180	12×12×60~100	4~6	-	-	-		Ø120	
C220/220T	12×12×60~100	6~8	-	-	-		Ø120	
C300-IV	16×16×100~130	6~10	-	-	-		Ø165	
C300H	16×16×100~130	6~10	-	-	-		Ø165	
P013	8×8×100~120	6	-	-	Ø16 / -	3 / -	Ø1	
P013-II	8×8×100~120	6	-	-	Ø16 / -	3 / -	Ø1	
P014	8×8×100~120	6	-	-	Ø16 / Ø16	3 / 3	Ø1	
P014-II	8×8×100~120	6	-	-	Ø16 / Ø16	3 / 3	Ø1	
P033	8×8×100~120	6	-	-	Ø16 / -	3 / -	Ø3	
P033-II	8×8×100~120	6	-	-	Ø16 / -	3 / -	Ø3	
P034	8×8×100~120	6	-	-	Ø16 / Ø16	3 / 3	Ø3	
P034-II	8×8×100~120	6	-	-	Ø16 / Ø16	3 / 3	Ø3	
S205/206/SS207	12×12×100	8	-	-	Ø22 / Ø20	5 / 4	Ø20	
SS26	16×16×100	7	-	-	Ø22 / Ø20	5 / 4	Ø26	
SS32/32L	16×16×100	7	-	-	Ø22 / Ø20	5 / 4	Ø32	
SS20M	-	-	-	-	- / Ø20	- / 1	Ø20	
SS267	16×16×100	7	-	-	Ø22 / Ø20	5 / 4	Ø26	
SS327	16×16×100	7	-	-	Ø22 / Ø20	5 / 4	Ø32	
MB25	-	-	20×20×90	2×St.8	Ø20 / Ø32	5 / 4	Ø25	
M42J/M42SD	-	-	20×20×125	St.12	Ø25 / Ø32		Ø42	
M50J/M50SY-III	-	-	20×20×100	St.12	Ø20 / Ø32		Ø51	
M06JC		-	20×20×125	St.8	Ø25		Ø220 / Ø42	
M06J		-	25×25×150	St.8	Ø32 / Ø40		Ø260 / Ø51	
M08J		-	25×25×150	St.8	Ø32 / Ø40		Ø280 / Ø65	
M06D		-	25×25×150	St.12	Ø40		Ø260 / Ø51	
M08D		-	25×25×150	St.12	Ø40		Ø280 / Ø65	
M06SD		-	25×25×150	St.12	Ø40		Ø260 / Ø51	
M08SD		-	25×25×150	St.12	Ø40		Ø280 / Ø65	
M06SY		-	25×25×150	St.12	Ø40		Ø260 / Ø51	
M08SY		-	25×25×150	St.12	Ø40		Ø280 / Ø65	
TMU1	20×20×100~125	1	20×20×125	St.16	Ø32 / Ø32		Ø38	
TMB2	20×20×100~125	1	20×20×125	St.16	Ø32 / Ø32		Ø51	
TMA8-IV	20×20×100~125	1			Ø32 / Ø32		Ø65	
TMA8J	20×20×100~125	1			Ø32 / Ø32		Ø65	
TMA8H	20×20×100~125	1			Ø32 / Ø32		Ø65	

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- Manufacturers are in no particular order.

AMADA

Model	Toolholder Dimensions (Gang-Type)	Number of tools	Toolholder Dimensions (Turret-Type)	Number of tools	Sleeve Diameter (Horizontal / Opposed)	Number of tools	Max. Cutting Dia.	Notes
G05	16×16				Ø20		Ø50×40	
G06	16×16				Ø20		Ø60×60	
G07	16×16				Ø20		Ø100×100	
G07M	20×20				Ø20		Ø100×100	
G07F	16×16				Ø20		Ø120×120	
GG5	16×16				Ø20		Ø50×40	
GS04	16×16				Ø20		Ø30×20	
J1			20×20	8	Ø25		Ø120×120	
J3			25×25	8	Ø32		Ø170	
J5			25×25	8	Ø32		Ø240	
JJ1			20×20	8	Ø32		Ø50×50	
JJ3			25×25	8	Ø32		Ø100×100	
JJ3M			25×25	12	Ø32		Ø100×100	
Ai8			20×20	8	Ø25		Ø50×50	
A12			16×16	12	Ø25		Ø80×50	
A18S			20×20	18	Ø25		Ø80×50	
AD12			16×16	9	Ø25		Ø80×50	
AD18S			20×20	15	Ø25		Ø80×50	
AA1			20×20	8	Ø25		Ø50×50	
Mi8			16×16	5	Ø20		Ø70×70	
S10			20×20	12	Ø25		Ø250×150	
V8G			20×20	15	Ø32		Ø220×450	
V10T			20×20	30(15×2)	Ø32		Ø250×450	

Nomura DS

Model	Toolholder Dimensions (Gang-Type)	Number of tools	Toolholder Dimensions (Turret-Type)	Number of tools	Sleeve Diameter (Horizontal / Opposed)	Number of tools	Max. Cutting Dia.	Notes
NN-10C	10×10×130	6			Ø17		Ø10	
NN-10CS	10×10×130	5			Ø17	4	Ø10	
NN-10SII	10×10×130	5			Ø23		Ø10	
NN-10SB5	10×10×130	5			Ø23		Ø13	
NN-10T	10×10×130	7			Ø23		Ø10	
NN-16HIII	12×12×130	6			Ø23		Ø16	
NN-16J	12.7×12.7×130	6			Ø23		Ø16	
NN-16SB5	10×10×130	5			Ø23		Ø16	
NN-16SB6 Type1	12.7×12.7×130	7			Ø17(Ø22)	4	Ø16	
NN-16SB6 Type2	12.7×12.7×130	5			Ø17(Ø22)	4	Ø16	
NN-16SB6 Type2.5	12.7×12.7×130	6			Ø17(Ø22)	5	Ø16	
NN-16SB6 Type3	12.7×12.7×130	5			Ø17(Ø22)	4	Ø16	
NN-16SB7	12.7×12.7×130	5			Ø16	4	Ø16	
NN-16UIII	12×12×130	5			Ø23		Ø16	
NN-16UB5	12×12×130	5			Ø23		Ø16	
NN-20CS	12.7×12.7×130	5(6)			Ø22	4	Ø20(Ø25)	
NN-20HIII	12×12×130	6			Ø23		Ø20	
NN-20J	12.7×12.7×130	6			Ø23		Ø20	
NN-20J2	12.7×12.7×130	6			Ø22	4	Ø20	
NN-20UIII	12×12×130	5			Ø23		Ø20	
NN-20U5	12.7×12.7×150	5(6)			Ø22	4	Ø20(Ø25)	
NN-20UB5	12×12×130	5			Ø23		Ø20	
NN-20UB7	12×12×130	6			Ø23		Ø20	
NN-20UB8	12.7×12.7×150	5(6)			Ø22	4	Ø20(Ø25)	
NN-20YB	12×12×130	8			Ø23		Ø20	
NN-25YB/32YB	16×16×130	8			Ø23 / Ø32		Ø25 / Ø32	
NN-32YB2	16×16×130	5			Ø22 / Ø32	4	Ø32	

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EGURO

Model	Toolholder Dimensions (Gang-Type)	Number of tools	Toolholder Dimensions (Turret-Type)	Number of tools	Sleeve Diameter (Horizontal / Opposed)	Number of tools	Max. Cutting Dia.	Notes
SANAX-6	12×12	5 (Max.)	-	5	Ø16	-	Ø15.0	-
SANAX-8	16×16	5 (Max.)	-	5	Ø25 / Ø30	-	Ø20.0	-
	12×12	7 (Max.)	-	5	Ø25 / Ø30	-	Ø20.0	-
SANAX-10	16×16	5 (Max.)	-	5	Ø25 / Ø30	-	Ø25.5	-
EBN-10EX	12×12	6 (Max.)	-	-	Ø20	-	Ø25.5	-
NUCBOY-8EX	12×12	6 (Max.)	-	-	Ø20	-	Ø20.0	-
NUCLET-10EX	16×16	10 (Max.)	-	-	Ø20	-	Ø25.5	-
NUCPAL-10EX	16×16	10 (Max.)	-	-	Ø20	-	Ø25.5	-

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List of Instruments and Applicable Small Tools and Toolholders

Models of Major Machine Tool Manufacturers				Applicable Toolholders
Manufacturer	Model (Automatic Lathe)	Toolholder Size	Total Length of Attached Toolholder (MAX)	
Citizen Machinery	A12,A16,B12,L12,M416,RL01,RL21	10×10	100	...1010F···
	K12,K16	12×12		...1212F···
	RL02	16×16		...1616H···
	B12E,B16E,BL12,C12,C16,$M_2$12,$M_2$16 $M_3$12,$M_3$16,MSL12	10×10	120	...1010JX···
	A20,A20VII,B20,BL20,BL25,K12E,K16E L20X,L220	12×12		...1212JX···
	L16,L20,L20E	12×12	130	...1212JX···
	C32,L25,L32,M20,$M_2$20,$M_2$32 $M_2$0,$M_3$32,$M_4$32	16×16		...1616JX···
Star Micronics	RNC-10,RNC-16,SA-16R,SE-12B/16B SH-12/16	10×10	120	...1010JX···
	SI-12,SI-12C	10×10	130	...1010JX···
	SB-16A,SB-16C,SB-16D,SC20	12×12	130	...1212JX···
	SR20RII,SR20III,SV12,SV20	12×12	135	...1212JX···
	SV32,SV32J,SV32JII	16×16		...1616JX···
	ECAS-12	10×10	150	...1010JX···
	ECAS-20	12×12		...1212JX···
	SR25J,SR32J	16×16		...1616JX···
Tsugami	B007	10×10	85	...1010F···
	B0,BA,BC,BH20,BM,BU12,BU20 BS12,BS18,BS20	12×12		...1212F···
	C004,C150,C180,C220	12×12	100	...1212F···
	BH38,BS26,BS32,BU26,BU38	16×16		...1616H···
Nomura DS	NN-10C,NN-10CS,NN-10SII NN-10SB5,NN-10SII,NN-10T,NN-16SB5	10×10	130	...1010JX···
	NN-16HIII,NN-16UB5,NN-16UIII,NN-16J NN-20HIII,NN-20UIII,NN-20UB5,NN-20YB	12×12		...1212JX···
	NN-25YB	16×16		...1616JX···

• Manufacturers are in no particular order.

Parts Compatibility of Lever Lock Toolholders

1) For better usability of lever lock toolholders, some levers, lock screws and shims are modified.

2) It is highly recommended to use only new parts. However, they are compatible with conventional parts and can be used together with them.

3) It is possible to use new parts only with a toolholder which has been in use.

4) When purchasing replacements, order them stating the new numbers.

5) Some of the shims remain unmodified.

Category	Ref. Page	Toolholder Description			Spare Parts					
					Lever		Lock Screw		Shim	
					New No.	Conventional	New No.	Conventional	New No.	Conventional
External Toolholders	D9	PCLNR/L		····-09	LL-1N	LL-1	LS-1N	LS-1	LC-32N	LC-32
				····-12	LL-2N	LL-2	LS-2N	LS-2	LC-42N	LC-42
				····-16	LL-5N	LL-5	LS-4N	LS-4	LC-53N	LC-53
	D13	PDJNR/L		····-11	LL-1DN	LL-1D	LS-1N	LS-1	LD-32N	LD-32
				····-15	LL-3N	LL-3	LS-2N	LS-2	LD-42	
	D15	PSBNR/L		····-09	LL-1N	LL-1	LS-1N	LS-1	LS-32	
				····-12	LL-2N	LL-2	LS-2N	LS-2	LS-42	
		PSKNR/L		····-09	LL-1N	LL-1	LS-1N	LS-1	LS-32	
				····-12	LL-2N	LL-2	LS-2N	LS-2	LS-42	
		PSSNR/L		····-09	LL-1N	LL-1	LS-1N	LS-1	LS-32	
				····-12	LL-2N	LL-2	LS-2N	LS-2	LS-42	
		PSDNN		····-09	LL-1N	LL-1	LS-1N	LS-1	LS-32	
				····-12	LL-2N	LL-2	LS-2N	LS-2	LS-42	
	D17	PTGNR/L		1212F-11	LL-03N	LL-03	LS-03N	LS-03	-	
				····-11	LL-03TN	LL-03T	LS-03SN	LS-03S	-	
				····-16	LL-1N	LL-1	LS-1N	LS-1	LT-32N	LT-32
				····-22	LL-2N	LL-2	LS-2N	LS-2	LT-42N	LT-42
		PTFNR/L		1212F-11	LL-03N	LL-03	LS-03N	LS-03	-	
				····-11	LL-03TN	LL-03T	LS-03SN	LS-03S	-	
				····-16	LL-1N	LL-1	LS-1N	LS-1	LT-32N	LT-32
				····-22	LL-2N	LL-2	LS-2N	LS-2	LT-42N	LT-42
	D25	PRGCR/L		····-12	LL-1CN	LL-1C	LS-1N	LS-1	LR-12C	
		PRXCR/L		····-12						
		PRGNR/L		····-09	LL-1N	LL-1	LS-1N	LS-1	LR-80	
				····-12	LL-2N	LL-2	LS-2N	LS-2	LR-81	
	D27	PWLNR/L		····-06	LL-1N	LL-1	LS-1N	LS-1	LW-32N	LW-32
				····-08	LL-2N	LL-2	LS-2N	LS-2	LW-42N	LW-42
Boring Bars	F92	□16M-	PCLNR/L	09-20	LL-03SN	LL-03S	LS-03SN	LS-03S	-	
		□20Q-		09-27	LL-1N	LL-1	LS-1SN	LS-1S	LC-32N	LC-32
		□25R-		09-32						
		····-	PCLNR/L	12···	LL-2N	LL-2	LS-2N	LS-2	LC-42NR/L	LC-42R/L
	F93	····-	PDUNR/L	11···	LL-1DN	LL-1D	LS-1SN	LS-1S	LD-32N	LD-32
	F99	····-	PTUNR/L	11···	LL-03TN	LL-03T	LS-03SN	LS-03S	-	
		S25R-	PTUNR/L	16-30	LL-03SN	LL-03S	LS-03SN	LS-03S	-	
		S32S-		16-40	LL-1N	LL-1	LS-1N	LS-1	LT-32N	LT-32
		S40T-		16-50						
	F100	□16M-	PWLNR/L	06-20	LL-03SN	LL-03S	LS-03SN	LS-03S	-	
		□20Q-		06-27	LL-1N	LL-1	LS-1SN	LS-1S	LW-32N	LW-32
		□25R-		06-32						
	F102	····-	PWLNR/L	08···	LL-2N	LL-2	LS-2N	LS-2	LW-42NR/L	LW-42R/L
Turning Mill	N15	T63H-	PCLNR/L	-DX12	LL-2N	LL-2	LS-2N	LS-2	LC-42N	LC-42
		T63H-	PCMNN	-□12						
		T63H-	PDJNR/L	-DX15	LL-3N	LL-3	LS-2N	LS-2	LD-42	
	N16	T63H-	PDNNN	-□15						
		T63H-	PTGNR/L	-DX16	LL-1N	LL-1	LS-1N	LS-1	LT-32N	LT-32
	N17	T63H-	PWLNR/L	-DX08	LL-2N	LL-2	LS-2N	LS-2	LW-42N	LW-42