R

All dimension markings in the catalog are complied with ISO13399. Symbol, detail and previous symbol are shown below.

1. Insert

Symbol	Detail	Previous symbol
AN	Relief angle	α
D1	Hole diameter	ød
IC	I.C. Size	A
RE	Corner-R	rε
S	Insert thickness	T

2. Toolholder for external

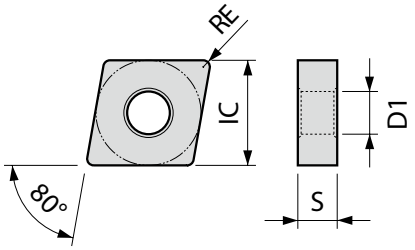
Symbol	Detail	Previous symbol
B	Shank width	B
H	Shank height	H1
HF	Edge height	h
LF	Overall length	L1
LH	Head length	L2
WF	Functional width	F1

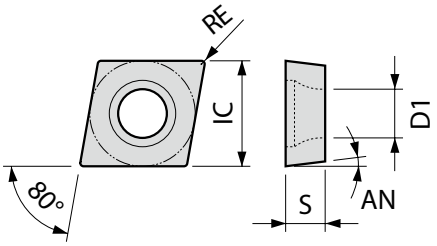
3. Small parts machining

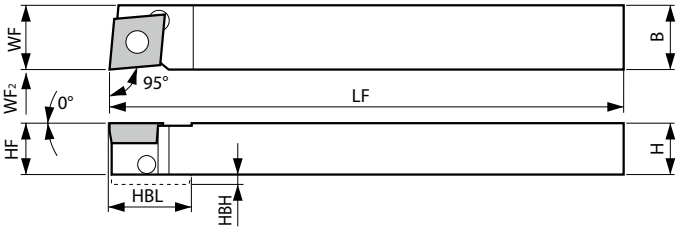
Symbol	Detail	Previous symbol
B	Shank width	B
H	Shank height	H1
HF	Edge height	h
LF	Overall length	L1
LH	Head length	L2
LU	Usable length	L2
WF	Functional width	F1

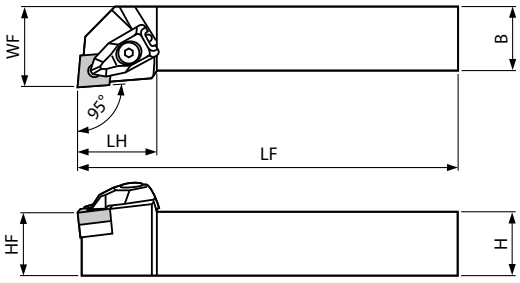
4. Boring bars

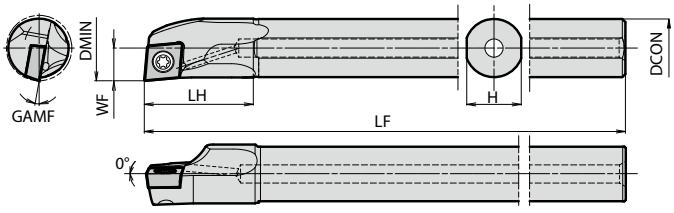
Symbol	Detail	Previous symbol
DMIN	Min. bore dia.	øA
DCON	Shank dia.	øD, øD1
GAMF	Radial rake angle	θ
H	Shank width	H
LF	Overall length	L1
LH	Head length	L2
LPR	Overall length	L1
LU	Usable length	L2
RE	Corner-R	rε
WF	Functional width	F









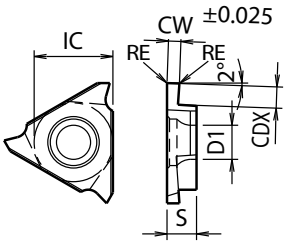


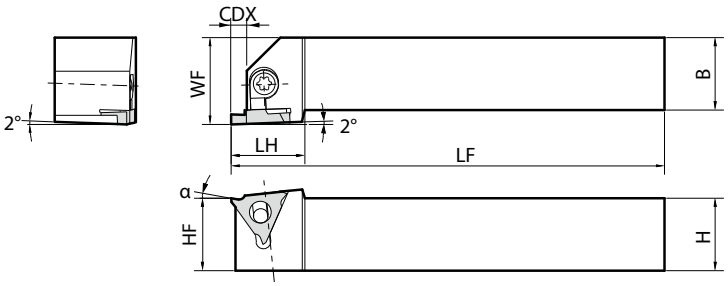
5. Grooving / Cut-off inserts

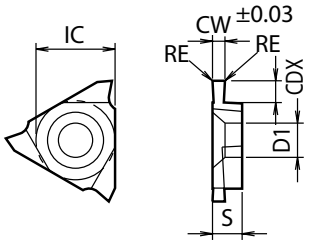
Symbol	Detail	Previous symbol
IC	I.C. Size	A
BCH	Chamfer width	C
CDX	Max. cutting depth	B
CW	Edge width	W
D1	Hole diameter	ød
DAXN	External dia. of the groove (max.)	øD
DAXX	External dia. of the groove (min.)	øD
INSL	Insert length	L
PSIR$^{R}_{L}$	Lead angle	θ
RE	Corner-R	rε
S	Insert thickness	H, T
W1	Insert width	A

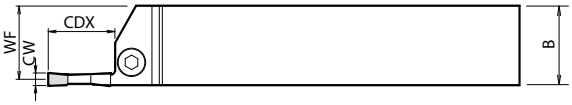
6. Grooving / Cut-off toolholders

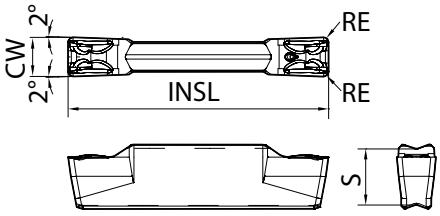
Symbol	Detail	Previous symbol
B	Shank width	B
CDX	Max. cutting depth	T
CUTDIA	Max. cut-off dia.	øDmax
DAXN	External dia. of the groove (max.)	øD
DAXX	External dia. of the groove (min.)	øD
DCB	Connection bore dia. (Sleeve)	ød1
DMIN	Min. Bore dia.	øA
DCON	Shank dia.	øD, øD1
H	Shank height	H1
HF	Edge height	h
LF	Overall length	L1
LH	Head length	L2
WF	Functional width	F1

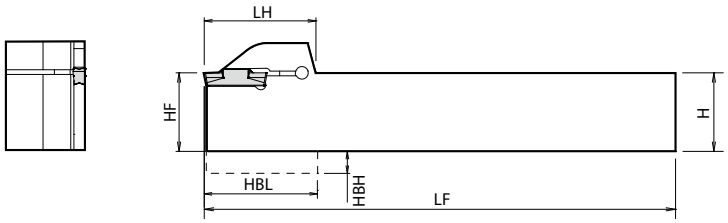


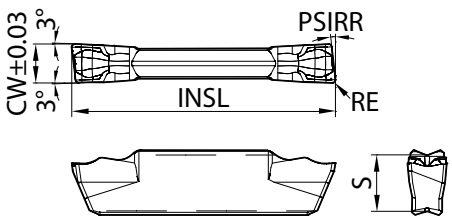












7. Threading inserts

Symbol	Detail	Previous symbol
IC	I.C. S ize	A
D1	Hole diameter	ød
PNA	Thread angle	θ
PDX	Profile distance	S
S	Insert thickness	T
RE	Corner-R	rε

8. Threading toolholders

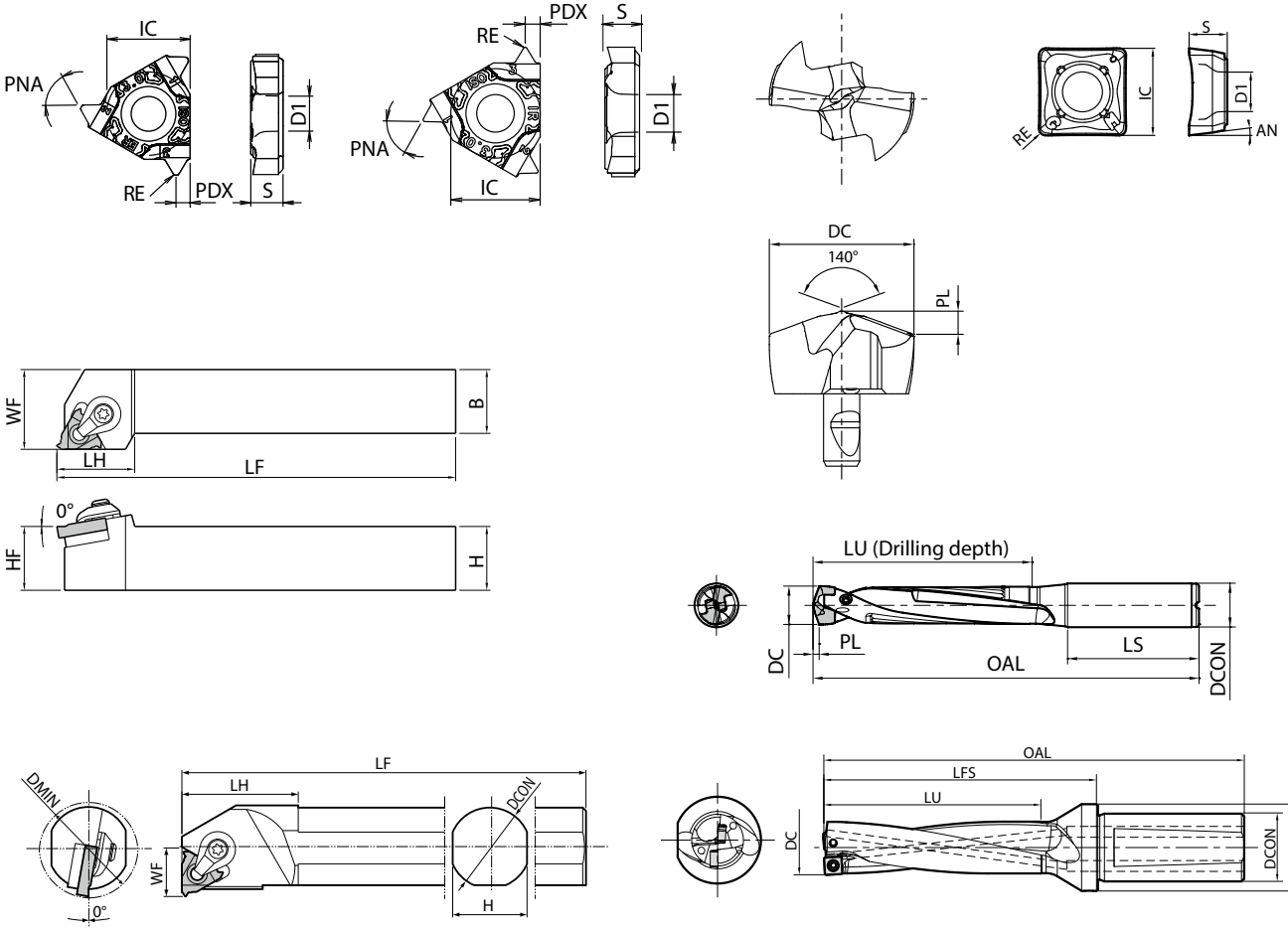
Symbol	Detail	Previous symbol
B	Shank width	B
DMIN	Min. Bore dia.	øA
DCON	Shank dia.	øD
H	Shank height	H1
HF	Edge height	h
LF	Overall length	L1
LH	Head length	L2
LU	Usable length	L2
WF	Functional width	F, F1

9. Inserts for drill

Symbol	Detail	Previous symbol
IC	I.C. Size	A
D1	Hole diameter	ød
DC	Drill dia.	øDc
PL	Drill head point length	Lp
RE	Corner-R	rε
S	Insert thickness	T
INSL	Insert length	A
W1	Insert width	W

10. Drill holder

Symbol	Detail	Previous symbol
DC	Drill dia.	øDc
DCON	Shank dia.	øDs
OAL	Overall length	L
LU	Usable length (Drilling depth)	L3
PL	Drill head point length	Lp
LS	Shank length	Ls
DCSFMS	Flange dia.	ød1
LFS	Functional length	L1
LCF	Flute length	L2



11. Solid end mill

Symbol	Detail	Previous symbol
APMX	Max. depth of cut	ℓ
CHW	Chamfer width	C
DC	Cutting dia.	øDc
DCON	Shank dia.	øDs
DN	Neck dia.	øD1
LF	Overall length	L
LU	Under neck length	ℓ2
RE	Corner-R	rε, r
ZEFP	No. of inserts	Z

12. Solid drill

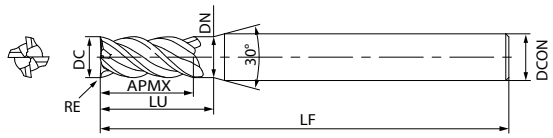
Symbol	Detail	Previous symbol
OAL	Overall length	L
DC	Cutting dia.	øDc
DCON	Shank dia.	øDs
LCF	Flute length	ℓ
LN	Under neck length	ℓ2
LS	Shank length	Ls
LU	Usable length	ℓe

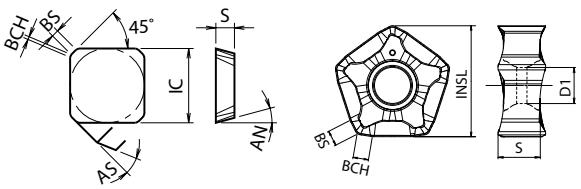
13. Milling inserts

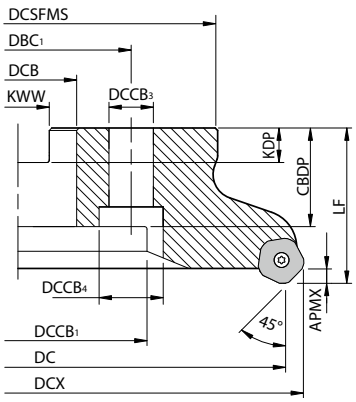
Symbol	Detail	Previous symbol
BCH	Corner chamfer length	X
BS	Wiper edge width	Z
D1	Hole diameter	ød
IC	I.C. Size	A
INSL	Insert length	W
L	Cutting edge length	W
RE	Corner-R	rε
S	Insert thickness	T

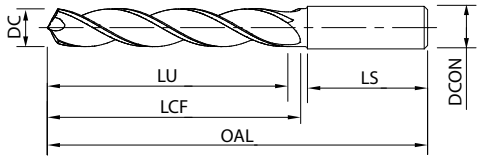
14. Toolholder for milling

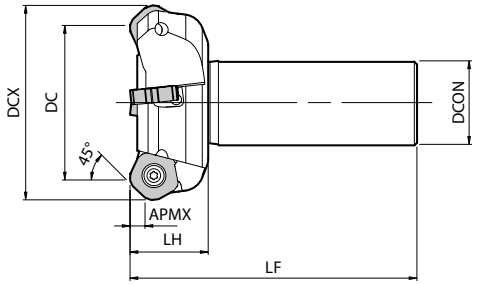
Symbol	Detail	Previous symbol
APMX	Max. depth of cut	S
CBDP	Connection bore depth	E
DC	Cutting dia.	øD
DCB	Bore dia.	ød
DCON	Shank dia.	øDs
DCSFMS	Contact surface dia.	øD2
DCX	Maximum cutting dia.	øD1
KDP	Keyway depth	a
KWW	Keyway width	b
LF	Toolholder height	H
LH	Head length	ℓ

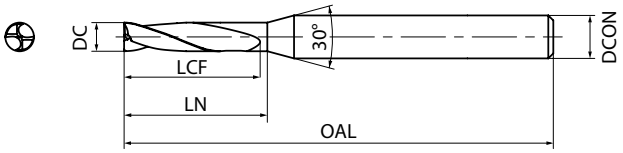












SI derived units conversion chart

Bold units are the ones by SI derived unit.

Extracted from JIS handbook "Iron & steel"

Force

N	kgf	dyn
1	$1.019\,72 \times 10^{-1}$	1×10^{5}
9.806 65	1	$9.806\,65 \times 10^{5}$
1×10^{-5}	$1.019\,72 \times 10^{-6}$	1

Stress

1Pa=1N/m^2,1MPa=1N/mm^2

Pa or N/m^2	**MPa or N/mm^2**	kgf/mm^2	kgf/cm^2	kgf/m^2
1	**1×10^{-6}**	$1.019\,72 \times 10^{-7}$	$1.019\,72 \times 10^{-5}$	$1.019\,72 \times 10^{-1}$
1×10^{6}	**1**	$1.019\,72 \times 10^{-1}$	$1.019\,72 \times 10$	$1.019\,72 \times 10^{5}$
$9.806\,65 \times 10^{6}$	**9.806 65**	1	1×10^{2}	1×10^{6}
$9.806\,65 \times 10^{4}$	**$9.806\,65 \times 10^{-2}$**	1×10^{-2}	1	1×10^{4}
9.806 65	**$9.806\,65 \times 10^{-6}$**	1×10^{-6}	1×10^{-4}	1

Pressure

1Pa=1N/m^2

Pa	**kPa**	**MPa**	bar	kgf/cm^2
1	**1×10^{-3}**	**1×10^{-6}**	1×10^{-5}	$1.019\,72 \times 10^{-5}$
1×10^{3}	**1**	**1×10^{-3}**	1×10^{-2}	$1.019\,72 \times 10^{-2}$
1×10^{6}	**1×10^{3}**	**1**	1×10	$1.019\,72 \times 10$
1×10^{5}	**1×10^{2}**	**1×10^{-1}**	1	1.019 72
$9.806\,65 \times 10^{4}$	**$9.806\,65 \times 10$**	**$9.806\,65 \times 10^{-2}$**	$9.806\,65 \times 10^{-1}$	1

Cutting symbol

Cutting conditions below are indicated by the new symbols listed in 2nd column.

1. Turning

Cutting conditions	Symbol	Previous symbol	Unit
Cutting speed	Vc	V	m/min
Feed rate	f	f	mm/rev
Depth of cut	ap	d	mm
Edge width	CW	W	mm
Workpiece dia.	Dm	D	mm
Required power	Pc	Pkw	kW
Specific cutting force	kc	Ks	MPa
Theoretical surface roughness	h	Rz	µm
Corner radius	RE	R	mm
Revolution	n	N	min^{-1}

2. Milling

Cutting conditions	Symbol	Previous symbol	Unit
Cutting speed	Vc	V	m/min
Feed speed	Vf	F	mm/min
Feed per tooth	fz	f	mm/t
Feed rate	f	f	mm/rev
No. of inserts	Z	Z	teeth
Depth of cut	ap	d	mm
Width of cut	ae	w	mm
Pick feed	Pf	Pf	mm
Required power	Pc	Pkw	kW
Specific cutting force	kc	Ks	MPa
Chip removal volume	Q	Q	cm^3/min
Revolution	n	N	min^{-1}

3. Drilling

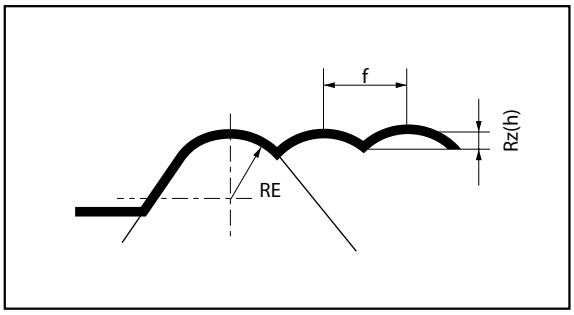
Cutting conditions	Symbol	Previous symbol	Unit
Cutting speed	Vc	V	m/min
Feed speed	Vf	F	mm/min
Feed rate	f	f	mm/rev
Drill dia.	DC	D (Ds)	mm
Required power	Pc	Pkw	kW
Specific cutting force	kc	Ks	MPa
Drilling depth	H	d	mm
Revolution	n	N	min^{-1}

Theoretical (Geometrical) surface roughness

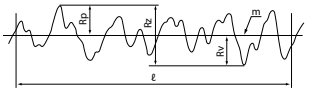
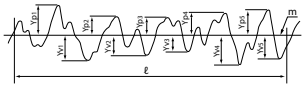
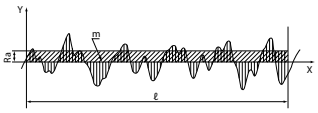
Theoretical surface roughness for turning indicates the minimum roughness value from the cutting conditions and it is shown by the formula as follows.

$$Rz(h) = \frac{f^2}{8RE} \times 10^3$$

Rz(h): Theoretical surface roughness [µm]
f: Feed rate [mm/rev]
RE: Corner radius of insert [mm]



How to obtain surface roughness values

Type	Symbol	How to obtain	Explanation
Max. height roughness	Rz	Rz 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	RzJIS 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 the 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 ". $Ra = \frac{1}{\ell}\int_0^{\ell}\{f(x)\}\,dx$	

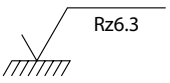
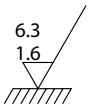
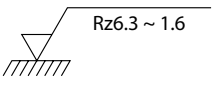
Relationship with triangle symbol

Arithmetical mean roughness Ra(µm)	Max. height roughness Rz(µm)	Ten points mean roughness RzJIS(µm)	*(Triangle symbol)
0.025 0.05 0.1 0.2	0.1 0.2 0.4 0.8	0.1 0.2 0.4 0.8	▽▽▽▽
0.4 0.8 1.6	1.6 3.2 6.3	1.6 3.2 6.3	▽▽▽
3.2 6.3	12.5 25	12.5 25	▽▽
12.5 25	50 100	50 100	▽

* Triangle symbol 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 Rz indication	
1. When indicating the upper limit only (when upper limit is 6.3µmRa)		1. When indicating the upper limit only indicate surface roughness following the parameter symbol.	
2. When indicating both lower and upper limit (when upper limit is 6.3µmRa, lower limit is 1.6µmRa)		2. When indicating both lower and upper limit indicate surface roughness as (upper limit ~ lower limit) following the parameter symbol.	

Note: The indications of Ra and Rz are different.

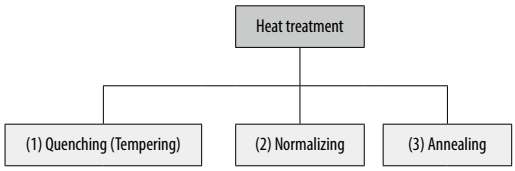
Caution-symbols for surface roughness

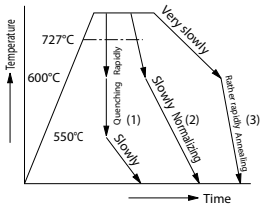
The above information is based on JIS B 0601-2001.
However, some symbols were revised as shown in the right table in accordance with ISO Standard from JIS B 0601-2001 version.
Ten Points Mean Roughness (Rz) was eliminated from 2001 version but it still remains as RzJIS reference, since it was popular 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		Detail	Effect
	· Quenching (Tempering)	After heating to 727˚C or over, 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)
	· Normalizing	After heating to 727˚C or over, 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.
	· Annealing	After heating to 727˚C or over, 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 expression

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: 3,000kgf (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 1.6mm (1/16in) dia. 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

Vickers hardness (HV)	Brinell hardness 10mm dia. ball Load: 3,000kgf (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 1.6mm (1/16in) dia. ball (HRB)	C scale Load: 150kgf Diamond point (HRC)		
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. 1 MPa = 1 N/mm^2
2. Value in ( ) is not in practical use, but reference only.

Ferrous materials

Classification		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
Machine structural steel		Carbon steel for machine structural use	SxxC, SxxCK
		Aluminum 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	Free cutting carbon steel	SUM
		High carbon chromium bearing steel	SUJ
		Spring steel	SUP
	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
	Heat-resisting steel	Heat-resisting steel bar	SUH-B, SUH-CB
		Heat-resisting steel plate and sheet	SUH-HP, SUH-CP
	Superalloy	Corrosion-resisting and heat-resisting superalloy bar	NCF-B
		Corrosion-resisting and heat-resisting superalloy plate and sheet	NCF-P

Classification	Name of JIS standard	Symbol
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 metals

Classification	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 alloys and aluminum alloys 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

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

Steel

Classification	Japan	China	USA	UK	Germany	France	Russia
	JIS	GB	AISI/SAE	BS	DIN	NF	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	SNCM220	20CrNiMo	8615 8617 8620 8622	805A20 805M20 805A22 805M22	20NiCrMo2 20NiCrMoS2	20NCD 2	
	SNCM240		8637 8640		40NiCrMo2-2		
	SNCM415						
	SNCM420	18CrNiMnMoA	4320		17NiCrMo6-4		20XH2M (20XHM)
	SNCM431				30CrNiMo8		
	SNCM439	40CrNiMoA	4340		40NiCrMo6		
	SNCM447				34CrNiMo6		
	SNCM616						
	SNCM625						
	SNCM630						
	SNCM815						
Chromium steel	SCr415	15Cr 15CrA			17Cr3 17CrS3		15X 15XA
	SCr420	20Cr	5120				20X
	SCr430	30Cr	5130 5132	34Cr4 34CrS4	34Cr4 34CrS4	34Cr4 34CrS4	30X
	SCr435	35Cr	5132	37Cr4 37CrS4	37Cr4 37CrS4	37Cr4 37CrS4	35X
	SCr440	40Cr	5140	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						
	SCM430	30CrMo 30CrMoA	4130				30XM 30XMA
	SCM432						
	SCM435	35CrMo	4137	34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	35XM
	SCM440	42CrMo	4140 4142	708M40 709M40 42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	
	SCM445		4145 4147				
	SCM822						

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Technical information

Steel

Classification	Japan	China	USA	UK	Germany	France	Russia
	JIS	GB	AISI/SAE	BS	DIN	NF	ГОСТ
Manganese steel Manganese chromium steel	SMn420	20Mn2	1522	150M19	20Mn5		
	SMn433	30Mn2 35Mn2	1536	150M36	34Mn5		30Г2 35Г2
	SMn438	40Mn2	1541	150M36	36Mn5		35Г2 40Г2
	SMn443	45Mn2	1541				40Г2 45Г2
	SMnC420	15CrMn	5115		16MnCr5		
	SMnC443	40CrMn	5140				
Structural steel with specified hardenability band	SMn420H		1522H				
	SMn433H						
	SMn438H		1541H				
	SMn443H		1541H				
	SMnC420H						
	SMnC443H						
	SCr415H	15CrH			17Cr3 17CrS3		15Х
	SCr420H	20Cr1H	5120H		17Cr3		20Х
	SCr430H		5130H 5132H	34Cr4 34CrS4	34Cr4 34CrS3	34Cr4 34CrS4	30Х
	SCr435H		5135H	37Cr4 37CrS4	37Cr4 34CrS4	37Cr4 37CrS4	35Х
	SCr440H	40CrH	5140H	41Cr4 41CrS4	41Cr4 41CrS4	41Cr4 41CrS4	40Х
	SCM415H	15CrMoH	4118H		15CrMo5		
	SCM418H				18CrMo4 18CrMoS4		
	SCM420H	20CrMoH	4118H	708H20	18CrMo4		
	SCM435H		4135H 4137H	34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	
	SCM440H	42CrMoH	4140H 4142H	42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	
	SCM445H		4145H 4147H				
	SCM822H						
	SNC415H						
	SNC631H						
	SNC815H	12Cr2Ni4H		655H13	15NiCr13		
	SNCM220H	20CrNiMoH	8617H 8620H 8622H	805H17 805H20 805H22	21NiCrMo2	20N CD 2	
	SNCM420H	20CrNi2MoH	4320H		20NiCrMoS6-4		

Steel

Classification	Japan	China	USA		UK	Germany	France	Russia
	JIS	GB	UNS	AISI	BS	DIN	NF	ГОСТ
Stainless steel	SUS 201	1Cr17Mn6Ni5N	S20100	201			Z12CMN17-07Az	
	SUS 202	1Cr18Mn8Ni5N	S20200	202	284S16			12X17Г9AH4
	SUS 301	1Cr18Mn10Ni5Mo3N 1Cr17Ni7	S30100	301	301S21	X12CrNi17 7	Z11CN17-08	07X16H6
	SUS 301L		S30153			X2CrNiN18-7		
	SUS 301J1					X12CrNi17 7		
	SUS 302	1Cr18Ni9	S30200	302	302S25		Z12CN18-09	12X18H9
	SUS 302B		S30215	302B				
	SUS 303	Y1Cr18Ni9	S30300	303	303S21	X10CrNiS18 9	Z8CNF18-09	
	SUS 303Se	Y1Cr18Ni9Se	S30323	303Se	303S41			12X18H10E
	SUS 304	0Cr18Ni9	S30400	304	304S31	X5CrNi18 10	Z7CN18-09	08X18H10
	SUS 304L	00Cr18Ni10	S30403	304L	304S11	X2CrNi19 11	Z3CN19-11	03X18H11
	SUS 304N1	0Cr18Ni9N	S30451	304N			Z6CN19-09Az	
	SUS 304N2	0Cr19Ni10NbN	S30452					
	SUS 304LN	00Cr18Ni10N	S30453	304LN		X2CrNiN18 10	Z3CN18-10Az	
	SUS 304J1							
	SUS 304J2							
	SUS 304J3		S30431	S30431				
	SUS 305	1Cr18Ni12	S30500	305	305S19	X5CrNi18 12	Z8CN18-12	06X18H11
	SUS 305J1							
	SUS 309S	0Cr23Ni13	S30908	309S			Z10CN24-13	
	SUS 310S	0Cr25Ni20	S31008	310S	310S31		Z8CN25-20	10X23H18
	SUS 316	0Cr17Ni12Mo2	S31600	316	316S31	X5CrNiMo17 12 2	Z7CND17-12-02	
	SUS 316F					X5CrNiMo17 13 3	Z6CND18-12-03	
	SUS 316L	00Cr17Ni14Mo2	S31603	316L	316S11	X2CrNiMo17 13 2	Z3CND17-12-02	
						X2CrNiMo17 14 3	Z3CND17-13-03	03X17H14M3
	SUS 316N	0Cr17Ni12Mo2N	S31651	316N				
	SUS 316LN	00Cr17Ni13Mo2N	S31653	316LN		X2CrNiMoN17 12 2	Z3CND17-11Az	
						X2CrNiMoN17 13 3	Z3CND17-12Az	
	SUS 316Ti		S31635			X6CrNiMoTi17 12 2	Z6CNDT17-12	08X17H13M2T
	SUS 316J1	0Cr18Ni12Mo2Cu2						
	SUS 316J1L	00Cr18Ni14Mo2Cu2						
	SUS 317	0Cr19Ni13Mo3	S31700	317	317S16			
	SUS 317L	00Cr19Ni13Mo3	S31703	317L	317S12	X2CrNiMo18 16 4	Z3CND19-15-04	
	SUS 317LN		S31753				Z3CND19-14Az	
	SUS 317J1	0Cr18Ni16Mo5						
	SUS 317J2							
	SUS 317J3L							
	SUS 836L		N08367					
	SUS 890L		N08904	N08904	904S14		Z2NCDU25-20	
	SUS 321	1Cr18Ni9Ti 0Cr18Ni10Ti	S32100	321	321S31	X6CrNiTi18 10	Z6CNT18-10	08X18H10T
	SUS 347	0Cr18Ni11Nb	S34700	347	347S31	X6CrNiNb18 10	Z6CNNb18-10	08X18H12Б
	SUS 384		S38400	384			Z6CN18-16	
	SUS XM7	0Cr18Ni9Cu3	S30430	304Cu	394S17		Z2CNU18-10	
	SUS XM15J1	0Cr18Ni13Si4	S38100				Z15CNS20-12	
	SUS 329J1	0Cr26Ni5Mo2	S32900	329				
	SUS 329J3L		S39240	S31803			Z3CNDU22-05Az	08X21H6M2T
	SUS 329J4L		S39275	S31260			Z3CNDU25-07Az	

Steel

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

JIS
SUS630
SUS631

Steel

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

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

Classification	Japan	China	USA	UK	Germany	France	Russia
	JIS	GB	AISI/ASTM	BS	DIN	NF	ГОСТ
Carbon tool steel	SK140 (SK1)	T13				C140E3U	У13
	SK120 (SK2)	T12	W1-11$^{1}/_{2}$			C120E3U	У12
	SK105 (SK3)	T11	W1-10		C105W1	C105E2U	У11
	SK95 (SK4)	T10	W1-9			C90E2U	У10
	SK85 (SK5)	T8Mn T9	W1-8		C80W1	C90E2U C80E2U	У8Г У9
	SK75 (SK6)	T8			C80W1	C80E2U C70E2U	У8
	SK65 (SK7)	T7			C70W2	C70E2U	У7
High speed tool steel	SKH2	W18Cr4V	T1	BT1		HS18-0-1	Р18
	SKH3	W18Cr4VCo5	T4	BT4	S18-1-2-5	HS18-1-1-5	Р18К5Ф2
	SKH4	W18Cr4V2Co8	T5	BT5		HS18-0-2-9	Р18К5Ф
	SKH10	W12Cr4V5Co5	T15	BT15	S12-1-4-5	HS12-1-5-5	
	SKH51	W6Mo5Cr4V2	M2	BM2	S6-5-2	HS6-5-2	Р6М5
	SKH52	CW6Mo5Cr4V2 W6Mo5Cr4V3	M3-1				Р6М5Ф3
	SKH53	CW6Mo5Cr4V3	M3-2		S6-5-3	HS6-5-3	Р6М5Ф3
	SKH54		M4	BM4		HS6-5-4	
	SKH55	W6Mo5Cr4V2Co5 W7Mo5Cr4V2Co5	M35 M41	BM35	S6-5-2-5	HS6-5-2-5HC	Р6М5К5
	SKH56		M36				
	SKH57			BT42	S10-4-3-10	HS10-4-3-10	
	SKH58	W2Mo9Cr4V2	M7			HS2-9-2	
	SKH59	W2Mo9Cr4VCo8	M42	BM42	S2-10-1-8	HS2-9-1-8	
Alloy tool steel	SKS11		F2				ХВ4
	SKS2				105WCr6	105WCr5	ХВГ
	SKS21	W					
	SKS5						
	SKS51		L6				
	SKS7						
	SKS8	Cr06				C140E3UCr4	13Х
	SKS4	5CrW2Si 6CrW2Si	S1				6ХВ2С 5ХВ2СФ
	SKS41	4CrW2Si	S1				4ХВ2С
	SKS43		W2-9$^{1}/_{2}$	BW2		100V2	
	SKS44		W2-8				
	SKS3	9CrWMn					9ХВГ
	SKS31	CrWMn			105WCr6	105WCr5	ХВГ
	SKS93						
	SKS94						
	SKS95	8MnSi					
	SKD1	Cr12	D3	BD3	X210Cr12	X200Cr12	Х12
	SKD10	Cr12Mo1V1	D2		X153CrMoV12		Х12МФ
	SKD11	Cr12MoV	D2	BD2	X153CrMoV12	X160CrMoV12	
	SKD12	Cr5Mo1V	A2	BA2		X100CrMoV5	
	SKD4					X32WCrV3	
	SKD5	3Cr2W8V	H21	BH21	X30WCrV9-3	X30WCrV9	
	SKD6	4Cr5MoSiV	H11	BH11	X38CrMoV51	X38CrMoV5	4Х5МФС
	SKD61	4Cr5MoSiV1	H13	BH13	X40CrMoV51	X40CrMoV5	4Х5МФ1С
	SKD62		H12	BH12		X35CrWMoV5	3Х3М3Ф
	SKD7	4Cr3Mo3SiV	H10	BH10	X32CrMoV33	32CrMoV12-18	
	SKD8		H19	BH19			
	SKT3					55CrNiMoV4	
	SKT4	5CrNiMo		BH224/5	55NiCrMoV6	55NiCrMoV7	5ХНМ

Steel

Classification	Japan	China	USA	UK	Germany	France	Russia
	JIS	GB	AISI/ASTM	BS	DIN	NF	ГОСТ
Spring steel	SUP3		1075 1078				75 80 85
	SUP6	55Si2Mn			56SiCr7	60Si7	60C2
	SUP7	60Si2Mn 60Si2MnA	9260		61SiCr7	60Si7	60C2Г
	SUP9	55CrMnA	5155		55Cr3	55Cr3	
	SUP9A	60CrMnA	5160		55Cr3	60Cr3	
	SUP10	50CrVA	6150	735A51, 735H51	50CrV4	51CrV4	ХФА50ХГФА
	SUP11A	60CrMnBA	51B60		51CrV4		50ХГР
	SUP12		9254	685A57, 685H57	54SiCr6	54SiCr6	
	SUP13	60CrMnMoA	4161	705A60, 705H60	60CrMn3-2	60CrMo4	
Free cutting carbon steel	SUM11		1110				
	SUM12	Y12	1108				
	SUM21		1212				
	SUM22	Y15	1213	(230M07)	9SMn28	S250	
	SUM22L	Y12Pb	12L13		9SMnPb28	S250Pb	
	SUM23		1215				
	SUM23L						
	SUM24L	Y15Pb	12L14		9SMnPb28	S250Pb	
	SUM25				9SMn36	S300	
	SUM31		1117		15S10		
	SUM31L						
	SUM32	Y20		210M15, 210A15		(13MF4)	
	SUM41	Y30 Y35	1137			(35MF6)	
	SUM42	Y40Mn	1141			(45MF6.1)	
	SUM43		1144	(226M44)		(45MF6.3)	
High carbon chromium bearing steel	SUJ1	GCr4	51100				
	SUJ2	GCr15	52100		100Cr6	100Cr6	ЩХ15
	SUJ3	GCr15SiMn	ASTM A 485 Grade 1				
	SUJ4	GCr15SiMo					
	SUJ5	GCr18Mo					

Cast iron

Classification	Japan	China	USA	UK	Germany	France	Russia
	JIS	GB	AISI/SAE	BS	DIN	NF	ГОСТ
Gray cast iron	FC100	HT100	NO.20	100	GG10		СУ10
	FC150	HT150	NO.30	150	GG15	FGL150	СУ15
	FC200	HT200	NO.35	200	GG20	FGL200	СУ20
	FC250	HT250	NO.45	250	GG25	FGL250	СУ25
	FC300	HT300	NO.50	300	GG30	FGL300	СУ30
	FC350	HT350	NO.60	350	GG35	FGL350	СУ35
					GG40	FGL400	СУ40
Nodular cast iron	FCD400	QT400-18	60-40-18	400/17	GGG40	FGS370-17	ВУ40
	FCD450	QT450-10	65-45-12	420/12		FGS400-12	ВУ45
	FCD500	QT500-7	70-50-05	500/7	GGG50	FGS500-7	ВУ50
	FCD600	QT600-3	80-60-03	600/7	GGG60	FGS600-2	ВУ60
	FCD700	QT700-2	100-70-03	700/2	GGG70	FGS700-2	ВУ70
	FCD800	QT800-2	120-90-02	800/2	GGG80	FGS800-2	ВУ80
		QT900-2		900/2			ВУ100

Non-ferrous metals

Classification	Japan	China	USA	UK	Germany	France	Russia
	JIS	GB	ASTM	BS	DIN	NF	ГОСТ
Aluminum alloys		1A99	1199		A199.99R		A99
		1A97			A199.98R		A97
		1A95					A95
	A1080	1A80		1080(1A)	A199.90	1080A	A8
	A1050	1A50	1050	1050(1B)	A199.50	1050A	A5
	A5052	5A02	5052	NS4	AlMg2.5	5052	Amg
		5A03		NS5			AMg3
	A5056	5A05	5056	NB6	AlMg5		AMg5V
	A5556	5A30	5456	NG61		5957	
	A2117	2A01	2036		AlCu2.5Mg0.5	2117	D18
	A2017	2A11		HF15	AlCuMg1	2017S	D1
	A2024	2A12	2124		AlCuMg2	2024	D16AVTV
		2B16	2319				
	A2N01	2A80					AK4
	A2018	2A90	2218				AK2
	A2014	2A14	2014		AlCuSiMn	2014	AK8
	A7075	7A09	7175		AlZnMgCu1.5	7075	V95P
Aluminum alloy casting	AC4C	ZAlSi7Mn	356.2	LM25	G-AlSi7Mg		
	AC3A	ZAlSi12	413.2	LM6	G-Al12	A-S12-Y4	AL2
		ZAlSi5Cu1Mg	355.2				AL5
	AC8A	ZAlSi2Cu2Mg1	413.0		G-Al12(Cu)		
		ZAlCu5Mn					AL19
		ZAlCu5MnCdVA	201.0				
		ZAlMg10	520.2	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	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
	Symbol											
P (Steel)	P01	CA510	JC110V	HG8010 HG3305	MC6115 MC6015		GC4405 GC4305 GC4315	TP0501	AC8015P AC810P	T9205 T9105	KCP05B KCP05 KCPK05	IC8150 IC5005
	P10	CA115P CA510 CA515	JC110V JC215V	GM8015 HG8010	MC6115 MC6015 MY5015 MC6125	CP7	GC4405 GC4415 GC4305 GC4315 GC4325	TP0501 TP1501	AC8015P AC8020P AC810P	T9205 T9105 T9215 T9115	KCP05B KCP05 KCPK05 KCP10B KCP10	IC8150 IC8250 IC5005
	P20	CA125P CA025P CA525 CR9025	JC110V JC215V	GM8020 HG8025	MC6115 MC6015 MY5015 MC6125 MC6025 UE6020	CP7	GC4415 GC4315 GC4425 GC4325 GC4335	TP1501 TP2501 TP3501 TP25 TP40	AC8020P AC8025P AC820P	T9215 T9115 T9225 T9125	KCP10B KCP10 KCP25B KCP25	IC8150 IC8250 IC8350
	P30	CA125P CA025P CA525 CA530 CR9025	JC215V JC325V JC450V	GM25 GM8035 HG8025	MC6125 MC6025 UE6020 MC6035 UH6400	CP7	GC4425 GC4325 GC4335	TP2501 TP3501 TP25 TP40	AC8035P AC830P AC6030M AC630M	T9225 T9125 T9235 T9135	KCP25B KCP25 KCP30B KCP30	IC8250 IC8350
	P40	CA530	JC325V JC450V	GX30	MC6035 UH6400		GC4335 GC4325	TP3501 TP40	AC8035P AC830P AC6030M AC630M	T9235 T9135 T6215	KCP30B KCP30 KCP40B KCP40	IC8350
M (Stainless steel)	M10	CA6515	JC605X JC110V	HG8025	MC7015 US7020		GC2015 GC1515	TM1501	AC6020M	T6215 T6120	KCM15B KCM15	IC6015 IC8150
	M20	CA6515 CA6525	JC605X JC110V	HG8025 GM8020	MC7015 US7020 MC7025		GC1515 GC2015 GC2025 GC2220	TM1501 TM2501	AC6020M AC6030M AC630M	T6215 T6120 T6130	KCM15B KCM15 KCM25B KCM25	IC6015 IC6025 IC8150 IC8250
	M30	CA6525	JC110V JC525X	HG8025 GM25 GM8035	MC7025 US7020 US735		GC2025 GC2220 GC235	TM1501 TM2501 TM3501	AC6030M AC630M AC8035P AC830P	T6215 T6130	KCM25B KCM25 KCM35B KCM35	IC6025 IC8350
	M40		JC525X	GX30 GM8035	MC7025 US735		GC235	TP40 TM2501 TM3501	AC6030M AC630M		KCM35B KCM35	
K (Cast iron)	K01	CA310 CA4505	JC050W JC105V JC605W	HX3505 HX3515	MC5105 MC5005		GC3210 GC3005 GC4305	TK0501	AC4010K	T5105 T505	KCK05B KCK05	IC5005 IC428
	K10	CA310 CA315 CA4505 CA4515	JC050W JC105V JC110V JC108W	HX3305 HX3515 HG8010 HG8025 GM8020	MC5105 MC5115 MC5005 MC5015 MY5015 MH515	CP1	GC3210 GC3005 GC4305 GC4315	TK0501 TK1501	AC4010K AC4015K	T5105 T5115 T505 T515	KCK05B KCK05 KCK15B KCK15	IC5005 IC5010 IC418 IC428 IC8150
	K20	CA315 CA320 CA4515	JC110V JC108W JC215V	HX3515 HG8010 GM8020 HG8025	MC5115 MC5125 MC5015 MY5015 MH515	CP1	GC3210 GC3225 GC4315 GC4325	TK0501 TK1501	AC4015K AC420K AC425K AC8025P	T5115 T5125 T515	KCK15B KCK15 KCK20B KCK20	IC5005 IC5010 IC418 IC428 IC8150
	K30	CA320	JC108W JC215V	GM8020 HG8025	MC5125		GC3225 GC4325	TK1501		T5125	KCP25B KCK20	

PVD Coated Carbide (Turning)

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Classification		Kyocera	Dijet	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
	Symbol											
P (Steel)	P01	PR1705										
	P10	PR1705 PR1215 PR1725 PR2015		IP2000	MS6015 VP10MF VP10RT	VM1 DT4 DM4		TS2000 CP200	AC1030U ACZ150 AC5005S AC5015S AC5025S AC520U	AH8005	KCS10 KCU10 KC5010	IC807 IC907 IC1007
	P20	PR1215 PR1225 PR1625 PR1725 PR2015 PR2025		IP2000	MS6015 VP10MF VP10RT VP15TF	VM1 QM3 DT4 TM4 DM4	GC1125 GC15	TS2000 TS2500 CP200	AC1030U AC5025S AC520U AC530U	AH8015 AH6225 AH120 AH725 SH725	KCS10 KCU10 KC5010 KCU25 KC5025	IC807 IC808 IC907 IC908 IC1007
	P30	PR1225 PR1535 PR2025		IP2000 IP3000	MS6015 MS7025 VP15TF VP20MF VP20RT	QM3 TM4	GC1125	TS2500 CP500 CP600	AC1030U AC530U	AH8015 AH6225 AH7025 SH730 J740	KCU25 KC5025	IC808 IC908 IC830 IC1008 IC228 IC528
	P40	PR1535 PR2025		IP3000	VP15TF VP20MF VP20RT	QM3 TM4		CP500 CP600	AC1030U	AH6225		IC830 IC228 IC528 IC3028
M (Stainless steel)	M10	PR1215 PR1225 PR2025 PR120S	JC5003 JC8015	IP050S IP100S	VP10MF VP10RT	VM1 DT4 DM4	GC1115 GC1125 GC15	TS2000 TS2050 TS2500 CP200	AC5005S AC5015S AC510U AC520U ACZ150	AH8005 AH6225	KCS10 KCU10 KC5010	IC806 IC807 IC907 IC1007
	M20	PR1215 PR1725 PR1225 PR1515 PR2025 PR120S	JC5003 JC8015 JC5015 JC5118	IP100S	MS7025 MS9025 VP10MF VP10RT VP15TF	VM1 QM3 DT4 TM4 DM4 ZM3 ST4	GC1115 GC1125 GC15	TS2000 TS2500 CP200 CP500	AC5015S AC5025S AC1030U AC520U	AH8015 AH6225 AH7025 AH120 AH725	KCS10 KCU10 KC5010 KCU25 KC5025	IC808 IC908 IC1008
	M30	PR1125 PR1535 PR2025	JC5015 JC5118	IP100S	MS7025 MS9025 VP15TF VP20MF VP20RT	QM3 DT4 TM4 DM4 ZM3 ST4	GC2035 GC1125	TS2500 CP500 CP600	AC5025S AC6040M AC1030U AC520U AC530U	AH6235 SH725 SH730 J740	KCU25 KC5025	IC908 IC830 IC1008
	M40	PR1535	JC5118		MP7035 VP15TF VP20MF VP20RT	QM3 TM4 ST4	GC2035	CP500 CP600	AC6040M AC1030U AC530U	AH6235		IC830 IC3028
K (Cast iron)	K01	PR2015								AH110	KCS10 KCU10 KC5010	
	K10	PR1215 PR2015			VP10RT		GC15	TS2000 CP200	AC1030U AC510U ACZ150 AC5015S	AH110 GH110	KCS10 KCU10 KC5010	
	K20	PR1215 PR2015			VP10RT VP15TF VP20RT			TS2000 TS2500 CP200	AC1030U AC510U ACZ150 AC5015S AC5025S	AH8015 AH6225 AH7025 AH120	KCS10 KCU10 KC5010 KCU25 KC5025	IC807 IC907 IC908 IC1007 IC1008
	K30	PR2015			VP15TF VP20RT			TS2000 TS2500 CP200 CP500	AC1030U AC530U	AH120 GH130	KCU25 KC5025	IC807 IC907 IC908 IC1007 IC1008
S (Difficult-to-cut material)	S01	PR005S PR115S	JC5003		MV9005 MP9005 VP05RT			TH1000		AH8005		IC804
	S10	PR005S PR015S PR115S PR120S	JC8015 JC5015 JC5118	HS9105 JP9105	MP9005 MP9015 VP10RT		GC1105	TH1000 TS2000 TS2050 CP200	AC5005S AC5015S AC510U ACZ150	AH8005 AH8015 AH6225	KCS10 KCU10 KC5010	IC806 IC807 IC907 IC1007
	S20	PR015S PR115S PR120S PR1535	JC5015 JC5118	HS9115 JP9115	MP9015 MP9025 MS9025 VP15TF		GC1105 GC1115 GC1125 GC15	TS2000 TS2050 TS2500 CP200	AC5015S AC5025S AC1030U AC520U	AH8015 AH7025 AH6225	KCS10 KCU10 KCU25	IC907 IC908 IC1007 IC1008
	S30	PR1535			MP9025 MS9025 VP20RT		GC1125			AH7025 AH6235	KCU25 KC5025	IC908 IC1008

Cermet (Turning)

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Classification		Kyocera	Dijet	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
	Symbol											
P (Steel)	P01	TN610 **PV710**	LN10		**AP25N** **VP25N**	T15 **Q15**	CT5015 CT525		T1000A **T1500Z**	NS520	**KT315** **KTP10**	IC20N **IC520N**
	P10	TN610 TN620 TN60 **PV710** **PV720** **PV7040** **CCX**	LN10 NIT		NX2525 **AP25N** **VP25N**	T15 **Q15** **Z15**	CT5015 CT525 **GC1525**	TP1020 TP1030	T1000A T1500A **T1500Z**	**AT9530** **GT9530** **J9530**	**KT315** **KTP10**	IC20N IC30N **IC520N** **IC530N**
	P20	TN620 TN90 **PV720** **PV730**	NIT CX75 **PX90**	**CZ25**	NX2525 NX3035 **MP3025** **AP25N** **VP45N**	C7X N40 **C7Z**	CT5015 **GC1525**	TP1020 TP1030	T1500A T2500A **T1500Z** **T2500Z**	NS9530 **AT9530** **GT9530** **J9530**		IC20N IC30N **IC520N** **IC530N**
	P30	**PV730**	CX75 **PX90**	**CZ25**	NX3035 **MP3025** **VP45N**	C7x N40 **C7Z**	**GC1525**		T2500A **T2500Z**	NS9530		IC30N **IC530N**
M (Stainless steel)	M10	TN610 TN620 **PV710** **PV720**	LN10 NIT CX75		**AP25N** **VP25N**	T15 **Z15** **Q15**	CT525 **GC1525**		T1000A	NS520	**KT315** **KTP10**	IC20N **IC520N**
	M20	TN620 TN90 **PV720** **PV730**	LN10 NIT CX75 **PX90**		NX2525 **AP25N** **VP25N**	**Q15**	**GC1525**	TP1030	T1000A T1500A	NS9530 **AT9530** **GT9530** **J9530**		IC20N IC30N **IC520N** **IC530N**
	M30	**PV730**	**PX90**	**CZ25**					T1500A	NS9530		IC30N **IC530N**
K (Cast iron)	K01	**PV7005** **CCX**	LN10 NIT		**AP25N** **VP25N**	T15 **Q15**	CT5015			NS520	**KT315** **KTP10**	
	K10	TN60 **CCX** **PV7005** **PV7040**	LN10 NIT	**CZ25**	NX2525 **AP25N** **VP25N**	T15 **Q15** **Z15**	CT5015		T1000A	NS9530 **AT9530** **GT9530** **J9530**	**KT315** **KTP10**	
	K20		NIT	**CZ25**	NX2525 **AP25N** **VP25N**					NS9530		

Boldface grade shows PVD Coated Cermet. (CCX is CVD Coated Cermet grade)

Carbide

Classification		Kyocera	Dijet	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
	Symbol											
K (Cast iron)	K01	KW10	KG03	WH01 WH05	HTi05T				H2 H1	TH03	K313 K68 GH1 K115M	
	K10	KW10 GW15	KG10 KT9 CR1	WH10	HTi05T HTi10		H13A	HX 890	H1 EH510	TH10	K313 K68 K110M	IC20
	K20	GW15 GW25	KT9 CR1 KG20	WH20	HTi10 UTi20T		H13A	HX 890 883	G10E H10E EH520	KS15F KS20	K313 K68 GH2	IC20
	K30		KG30		UTi20T		H13A	HX 883	G10E H10E			
N (Non-ferrous metals)	N01	GW05			HTi10 MT2010		H10	H15		KS05F	GH1 K115M	
	N10	KW10 GW15 GW25	KT9 CR1	WH10	HTi10 MT2010	KM1	H10 H13A	KX HX 890 H15 H25		TH10	K313 K68 K110M	IC4 IC20 IC28
	N20	GW15 GW25	KT9 CR1		HTi10 MT2010 TF15		H10 H13A	KX HX 890 883 H15 H25		KS15F	K313 K68 GH2	IC20 IC28
	N30				TF15			KX HX 883 H25				IC28
S (Difficult-to-Cut Material)	S01	SW05			MT9005 RT9005		H10A					
	S10	KW10 SW10 GW15 GW25	KG10	WH10	MT9005 RT9005 MT9015 RT9010		H10A H10F H13A	HX 890 883	EH510 EH520	KS05F TH10	K313 K68 K110M	IC20
	S20	SW10 SW25 GW25	KG20		MT9015 RT9010 TF15 RT9020	KM1	H10A H10F H13A	HX 890 883 H25	EH510 EH520	KS15F TH10	K313 K68 GH2	IC20 IC28
	S30	SW25			TF15 RT9020		H10F H13A	HX 883				

Coated carbide (Milling / Drill)

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Classification		Kyocera	Dijet	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
	Symbol											
P (Steel)	P10	PR1825 PR1525	DH108 DH110 DH111 DH115	PCA12M PN15M PN208 JP4105	**MV1020**		GC1010	F40M MK2050 **MP1501** **MP2501**	ACP200 **ACP2000** **ACP100**	AH120 AH725	KC505M KC510M KC515M	IC608 IC902 **IC5400**
	P20	PR1825 PR1835 PR1525 **CA520D**	DH111 DH115 JC8015 JC8118	CY150 CY9020 JP4120	MP6120 VP15TF **MC7020** **FH7020** **F7030**	TM1 DT4 DM4	GC1130 **GC4220** **GC4330** **GC3040**	F40M MP3000 **MP1501** **MP2501** **MP3501**	ACP3000 ACU2500 ACP200 **XCU2500** **ACP2000**	AH3135 AH9030 AH3225 **T3225**	KC522M KC525M	IC808 IC810 IC900 IC908 IC910 **IC5500**
	P30	PR1825 PR1835 PR1525 PR1535	JC8118 JC8050 JC7550 JC7560	HC844 CY25 CY250 JS4045 **GF30**	MP6130 VP15TF VP20RT UP20M **F7030**	ZM3	GC1130 GC2030 **GC4330** **GC3040**	F40M F25M MP3000 **MP2501** **MP3501**	ACP3000 ACU2500 ACP300 **XCU2500**	AH3225 AH6030 AH130 **T3130** **T3225**	KC530M KC725M KC735M KCPM40 **KCPK30**	IC300 IC830 IC845 IC908 IC910
	P40	PR1835 PR1535	JC5240 JC8050 JC7550 JC7560	PTH30E PTH40H JS4060 GX2140 **GX2160**	VP30RT		**GC2040** **GC4340**	F40M MP2050 **MP2501** **MP3501**	ACP3000 ACU2500 ACP300	AH140	KC725M KC735M KCPM40 **KCPK30**	IC328 IC330 IC830 IC928 IC4050
M (Stainless steel)	M10	PR1835 PR1535 **CA6535**	DH108 DH111 DS108 JC8015	PN15M PN215	**MC7020**		GC1010 GC1130	F40M F25M	ACM100 ACK300 **XCS2000** **ACM200**	AH725	KC515M	IC608 IC902 **IC5400**
	M20	PR1835 PR1525 PR1535 **CA6535**	DH108 DH111 DS108 JC8015 JC8118	JP4120	VP15TF **MC7020** **F7030**	DT4 DM4	GC2030 S30T GC1130	F40M MS2050	ACS2500 ACU2500 ACP300 **XCU2500** **ACM200**	AH3135 AH3225 AH6030 AH725 **T3225**	KC522M KC525M	IC300 IC808 IC900 IC908 **IC5820**
	M30	PR1835 PR1525 PR1535 **CA6535**	JC8118 JC8050 JC7550 JC7560	HC844 CY250 JS4045 PTH30E	MP7130 MP7030 VP20RT UP20M	ZM3	GC1040 S30T **GC2040** **GC4230** **GC4240**	F40M MS2050 **T25M** **MM4500**	ACM300 ACS2500 ACS3000 **XCU2500** **ACM200**	AH3135 AH130 **T3225** **T3130**	KC530M KC725M KC735M KCPM40 KCSM30	IC330 IC830 IC882 IC928 **IC5820**
	M40	PR1835 PR1525 PR1535 **CA6535**	JC8050 JC7550 JC7560	PTH40H JM4160 AX2040 **GX2160**	MP7140 VP30RT		GC1040 **S40T** **GC2040** **GC4240**	F40M MP2050 **MM4500**	ACM300 ACS3000	AH140	KC725M KCPM40 KCSM40	IC328 IC882
K (Cast iron)	K01	PR1810 PR1510 **CA415D**	DH102 DH103	ATH80D ATH08M TH308	MP8010 **MV1020** **MC5020**		GC1010	MK2050 MH1000 **MK1500**	ACK3000	AH110		IC902
	K10	PR1810 PR1510 **CA415D** **CA420M**	DH108 DH110 DH111 JC8015	ATH10E TH315 CY100H	MP8010 **MV1020** **MC5020**		GC1020 **GC3220** **K15W**	MK2050 MH1000 **MK1500**	ACK3000 **XCK2000** **ACK2000** **ACK200**	AH110 AH120 **T1215** **T1115**	KC514M KCK15 KCK20	IC608 IC903 **IC5100**
	K20	PR1810 PR1510 **CA415D** **CA420M**	DH115 JC8015 JC8118	CY9020 CY150 PTH13S JP4120 **GX2120**	VP15TF **MV1020** **MC5020** **MC520**		**GC3330** **GC3040** **K15W** **K20W** **K20D**	MK2050 **MK1500** **MP3501**	ACK3000 ACU2500 **XCK2000** **XCU2500** **ACK2000**	AH120 AH9030 **T1215**	KC520M KC524M KCK20	IC808 IC810 IC908 IC910 **DT7150**
	K30	PR1810 PR1510	JC8118 JC5240	CY250 JS4045 GX2040 **GX2160**	VP20RT **MC5020**		GC3330 GC3040 K20W	MK2050 F40M **MK1500** **MP3501**	ACK3000 ACU2500 ACK300	AH120	KC522M KC524M **KCPK30**	IC808 IC810 IC908 IC910
S (Difficult-to-Cut Material)	S10	PR1535 **CA6535**	DS108 DS118 JC8015 JC8118	JP4120 JS1025	MP9120 VP15TF		GC1010 GC1130	F40M MS2050 **MS2500**	ACM100 ACU2500 ACK300 ACP300	AH120 AH725	KC510M	IC380 IC902 IC908 IC928
	S20	PR1535 **CA6535**	DS150 JC8050 JC8118	PTH30H	MP9120 MP9130 VP15TF		S30T GC2030 GC1130	F40M MS2050 **MS2500**	ACS2500 ACU2500 ACP300	AH725 AH130 AH6030	KC522M KC525M KCSM30	IC840 IC882 IC900 **IC5280**
	S30	PR1535	JC7550 JC7560	JM4160	MP9140		GC1040 **S40T** **GC2040**	MS2050	ACM300 ACS2500 ACS3000	AH130	KC522M KC725M KCSM40	IC328 IC330 IC830 IC928

Cermet (Milling)

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Classification		Kyocera	Dijet	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
	Symbol											
P (Steel)	P10	TN620M TN100M **PV60M**	CX75	CH550 **MZ1000**	NX2525 **VP25N**		CT530			NS740	KTPK20	IC30N
	P20	TN620M TN100M **PV60M**	CX75 CX90	CH7000	NX2525 MX3020 **VP25N**		CT530			NS740	KTPK20	IC30N
	P30	TN620M TN100M	CX90		MX3030 NX4545				T2500A T250A T4500A			IC30N
M (Stainless steel)	M10	TN100M	CX75		NX2525 **VP25N**		CT530			NS740		IC30N
	M20	TN100M	CX75	CH550	NX2525 MX3020 **VP25N**		CT530			NS740	KTPK20	IC30N
	M30				MX3030 NX4545							
K (Cast Iron)	K01		CX75									
	K10		CX75		NX2525 **VP25N**					NS740	KTPK20	
	K20		CX75		NX2525 MX3020 MX3030 **VP25N**						KTPK20	

Boldface grade shows PVD Coated Cermet.

Ceramic

Classification		Kyocera	Dijet	Nippon Tungsten	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
	Symbol											
K (Cast Iron)	K01	KA30 A65 KS6015 **A66N** **PT600M** **CS7050**		NPC-H2 NPC-A2		HC1 HC2 HC6 HW2 WA1 WA5	CC6190 CC620 CC650		NB90S	TZ120 LX21	KYK10	IN110 IN22 IN23 IS6 IS8 **IS80**
	K10	A65 KS6015 KS6050 **A66N** **PT600M** **CS7050**		NX **NXA** Whiskal WIN		HC1 HC2 HC6 HW2 WA1 WA5 SX6 **SP9**	CC6190			FX105 CX710	KYK10 KY3500 **KYK25**	IN110 IN22 IN23 IS6 IS8 **IS420** **IS80**
	K20	KS6050				SX6 SX9				FX105 CX710	KY3500	IS8 **IS80**
S (Difficult-to-cut material)	S01	KS6030				JX1 JX3 **JP2 120**	CC6060 CC6160 CC6065 CC670	CS100	WX120	WG300 FX510 TS300		IN110 IS25
	S10	KS6030 KS6040	CA200	Whiskal WIN		JX1 JX3 WA1 WA5 SX3 SX7 **JP2 120**	CC6060 CC6160 CC6065 CC670	CS100 CS300 CW100	WX120		KYS30 KYSP30 **KYS25**	IS25 IS35 IS9 IW7
	S20	KS6040				JX1 JX3 SX9 **JP2 120**			WX120		KYSP30	IS9 IW7
H (Hard materials)	H01	A65 **A66N** **PT600M**		NPC-A2		HC2 HC7 **450 ZC7**	CC6050 CC650		**NB100C**	LX10 **LX11**		
	H10	A65 **A66N** **PT600M**		NPC-A2 Whiskal WIN		**450**	CC670		**NB100C**	WG300	KY1615	IN22 IN23 IW7 **IN420**

Boldface grade shows PVD Coated Ceramic.

CBN

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Classification		Kyocera	Dijet	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
	Symbol											
K (Cast iron)	K01	KBN475 **KBN60M** **KBN900**	JBN795 JBN330 JBN500		MB710 **BC5110**	B23 B30 B52	CB7925 CB50 **CB7525**	CBN300	BN7125 BN500 NCB100 **BNC500**	BX910 BX930 BX870	KB1630 **KB5630**	IB50
	K10	**KBN60M** **KBN900**	JBN795 JBN300 JBN330 JBN500 JBN245	BH200	MB730 MB4120	B23 B30 B52	CB7925 CB50 **CB7525**	CBN200 CBN300 CBN600 **CK2065** **CH3515** **CBN160C** **CBN300P** **CBN400C**	BN7125 BN500 **BNC500**	BX470 BX480	KB1630 KB1340 **KB5630**	IB50 IB55 IB90
	K20	**KBN900**	JBN245	BH250	MB730 MB4120 MBS140	B16	CB50	CBN200 CBN300 CBN500 CBN600 **CK2065** **CH3515** **CBN160C** **CBN300P** **CBN400C**	BN7125 BNS8125 **BNC8115**	BX90S **BXC90**	KB1630 KB1340 KB1345 **KB5630** **KBK45**	
H (Hard materials)	H01	KBN510 **KBN010** **KBN05M** **KBN10M**	JBN245 JBN795 JBN500		**BC8105**	B52 **B5K**	CB20 CB50 **CB7105**	CBN010 **CH0550**	BN1000 BN2000 BNX10 **BNC2105** **BNC2010** **BNC2115**	BX310 **BXM10**	KBH10	IB50 IB10H **IB10HC**
	H10	KBN510 KBN525 **KBN010** **KBN020** **KBN05M** **KBN10M** **KBN25M** **KBN900**	JBN795 JBN500	BH200	MB8110 MB8120 **BC8110** **BC8120** **BC8210** **BC8220**	B36 **B6K**	CB50 **CB7105** **CB7015**	CBN010 CBN150 **CH0550** **CH1050** **CBN060K**	BN2000 **BNC2010** **BNC2020** **BNC2115** **BNC2125** **BNC160** **BNC200**	BX330 BX530 **BXA10** **BXM10**	KBH10 **KB5610**	IB50 IB55 IB10H **IB10HC**
	H20	**KBN020** **KBN25M** **KBN35M** **KBN900**		BH250	MB8120 **BC8120** **BC8220**	B36 B40	CB7025 **CB7125** **CB7525**	CBN150 **CH1050** **CBN060K** **CH2540** **CH2581** **CH3515**	BN2000 BNX20 **BNC2020** **BNC2125** **BNC200**	BX360 BX850 **BXA20** **BXM20**	KBH10 KBH20 **KB5625**	IB55 IB20H **IB25HA** **IB25HC**
	H30	**KBN020** **KBN35M** **KBN900**		BH250	MB8130 **BC8220** **BC8130**	B40 B22	CB7135 **CB7525**	**CH2540** **CH2581** **CH3515**	BN350 **BNC300**	BX380 **BXC50** **BR35F**	KBH20 KB1630 **KB5625** **KB5630**	IB55 IB20H **IB25HA** **IB25HC**
Sintered steel	-	KBN570 **KBN70M**	JBN795 JBN330		MB4120	B23 B30	CB7135 **CB7125**	CBN200	BN7115 BN7125	BX470 BX480	**KB5630**	IB05S IB10S IB90

Boldface grade shows PVD Coated CBN.

PCD

Classification		Kyocera	Dijet	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
	Symbol											
N (Non-ferrous metals)	N01	KPD001 KPD230 KPD250	JDA30 JDA735			UC1 PD1 PD2	CD05 CD10	PCD05	DA90 DA150 DA1000	DX160 DX180	KD1400 KD1405	ID5
	N10	KPD001 KPD010 KPD230 KPD250	JDA735 JDA10		MD220	PD1 PD2	CD05 CD10	PCD05 PCD20 PCD30	DA150 DA1000	DX140 DX160	KD1400 KD1405 KD1410 KD1415 KD1425	ID5
	N20	KPD001 KPD010 KPD230 KPD250	JDA10 JDA715		MD220 MD2030	PD1 PD2		PCD05 PCD20 PCD30 PCD30M	DA1000 DA2200	DX110 DX120	KD1400 KD1425	

Molded chipbreaker cross reference table

Negative inserts

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Cutting range		Kyocera		Dijet	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
		General chip-breaker	Chipbreaker for sticky 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	PMG 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 Standard	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, Difficult-to-cut material	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 V	LK MK 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	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
		General chipbreaker	Chipbreaker for sticky material / Soft steel										
Carbon steel / Alloy steel	Minute ap	CF	-	-	-	-	-	-	-	-	01	-	-
	Finishing (with wiper edge)	WP	-	-	-	SW	-	WF WK WM	W-F1 W-F2	LUW SDW	SW	FW	WF
	Finishing	PF DP GP PP VF	XP	ASF	-	FV SQ FP SMG	AZ3 AMX AZ7 FG	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	No Indication	QD CL	PF PMC XM	MF2 M5	US GU	-	-	F3P
	Medium	Standard	-	-	J	MP Standard	AM5 AM3 AZ8	PR UR KM XR	F2	MU SC	PM	GM MP MR	Standard
Stainless steel, Difficult-to-cut material	Finishing - Medium	MQ	-	-	MP	FM FV SV LM LS MS	-	MF MMC SM MR MM	-	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 automatic lathe)

Cutting range		Kyocera	Dijet	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	NTK Cutting Tools	Sandvik	Seco	Sumitomo	Tungaloy	Kennametal	Iscar
Carbon steel / Alloy steel	Minute ap	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 AWI	-	AZ	-	AL	AL	AG AW	AL	HP	AF AS

Milling insert description cross reference table

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Kyocera	Class	Applications	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	Sandvik	Sumitomo	Tungaloy	Iscar
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
SDKN1203AUTN	K		SDK42TN-C9	SDKN1203AEN SDKN1203AETN (SDNN1203AETN1)		SDKN42MT (SDNN1203AETN)	SDKN1203AETN-12 SDKN42ZTN	SDKN1203AETN
SDKN1203AUFN	K	Cast Iron	SDK42FN-C9			SDKN42M (SDNN1203AEEN)	SDKN1203AEFN-12 SDKN42ZFN	
		Non-ferrous metals				SDKN42M	(SDCN1203AEFN-D) (SDCN42ZFN-DIA)	
SDKN1504AUTN	K	Steel	SDK53TN-C9	SDKN1504AEN SDKN1504AETN		SDKN53MT	SDKN1504AETN SDKN53ZTN	SDKN1504AETN
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
SEEN1203AFTN	E		SEE42TN-C9	SEEN1203AFTN1		SEEN42MT	SEEN1203AFTNCR-14	
SEKN1203AFTN	K		SEK42TN-C9	SEKN1203AFTN1 (SENN1203AFTN1)	SEKN1203AZ (SEMN1203AZ)	SEKN42MT (SENN1203AFTN)	SEKN1203AFTN SEKN1203AFTN-16 SEKN42AFTN SEKN42AFTN16	
SEKN1203AFFN	K	Cast Iron	SEK42FN-C9	(SEEN1203AFFN1)	SEKN1203AZ (SEMN1203AZ)	SEKN42M (SENN1203AFEN)	SEKN1203AFFN SEKN42AFFN	
SEEN1203AFFN	E	Non-ferrous metals	SEE42FN-C9	(SECN1203AFFR1)				
SEKN1203EFTR	K	Steel	SEK42TR-G3	SEKN1203EFTR1	(SECN1203EER)		SEKN1203EFTR (SECN1203EFTR) (SEEN1203EFTR) (SECN42EFTRCR) (SEEN42EFTRCR)	
SEKN1504AFTN	K	Steel	SEK53TN-C9		SEKN1504AZ	SEKN53MT		SEKN1504AFTN
SPEN1203EESR	E	Cast iron	(SPK42FR-A3E)	SPEN42EFSR1 SPEN1203EESR1 SPEN1203EEER1 (SPNN1203EEER1)				
SPMR1203EDER-H SPKR1203EDER-S	M K	Steel		(SPER1203EDER-JS)	SPKN1203EDR-WH		SPKR1203EDSR-MJ SPKR42SSR-MJ	SPKR1203EDR-76 SPKR1203EDTR-HS
SPCN1203EDTR	C			(SPEN1203EDR)	(SPAN1203EDR)	SPCH42TR-R	SPCN1203EDTR SPCN42STR	
SPKN1203EDTR	K		SPK42TR-A3	SPKN1203EDR	SPKN1203EDR	(SPCH42TR) (SPCH42TR-R)	SPKN1203EDTR SPKN42STR (SPEN1203EDTR) (SPEN42STR)	SPKN1203EDTR SPKN1203EDTR-42
SPKN1203EDFR	K	Cast iron	SPK42FR-A3		SPKN1203EDR	(SPCH42R)	SPKN1203EDFR SPKN42SFR	SPKN1203EDFR
SPKN1504EDTR	K	Steel	SPK53TR-A3	SPKN1504EDR	SPKN1504EDR	(SPCH53TR-R)	SPKN1504EDTR SPKN53STR (SPCN1504EDTR) (SPCN53STR)	SPKN1504EDTR
SPKN1504EDFR	K	Cast iron	SPK53FR-A3			(SPCH53R-R) (SPCH53TR-R)	SPKN1504EDFR SPKN53SFR	SPKN1504EDFR

Note 1. Tolerance class is different for description in ( ).

2. Since edge shape of milling insert is slightly different by each maker, please adjust edges (Z-axis direction) during operation.

Milling insert description cross reference table

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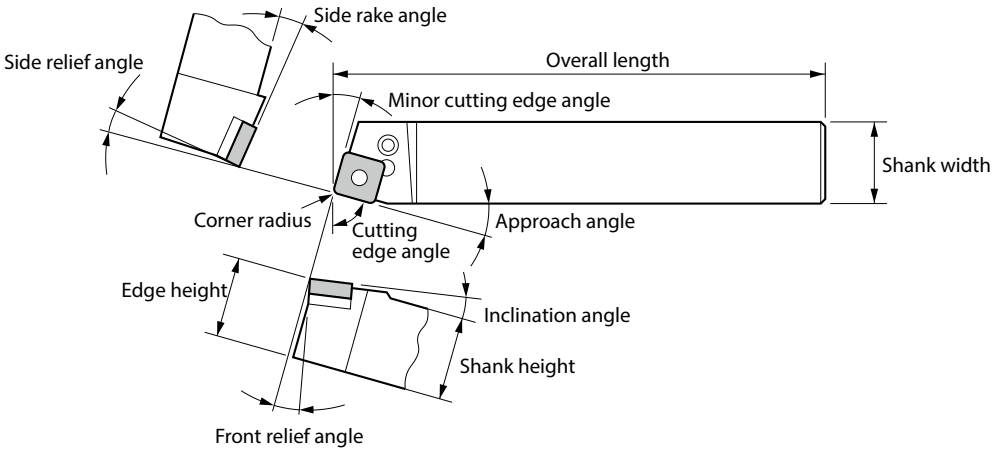
Kyocera	Class	Applications	MOLDINO (Mitsubishi Hitachi Tool)	Mitsubishi	Sandvik	Sumitomo	Tungaloy	Iscar
SPCN1203XPTR	C	Steel	SPC42TR-A5				SPCN1203ZPTR SPCN42ZTR	
SPKN1203XPTR	K		SPK42TR-A5				SPKN1203ZPTR SPKN42ZTR (SPEN1203ZPTR) (SPEN42ZTR)	
SPKN1203XPFR	K	Cast iron	SPK42FR-A5				SPKN1203ZPFR SPKN42ZFR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

Note 1. Tolerance class is different for description in ( ).

2. Since edge shape of milling insert is slightly different by each maker, please adjust edges (Z-axis direction) during operation.

Terms and angles of turning toolholder



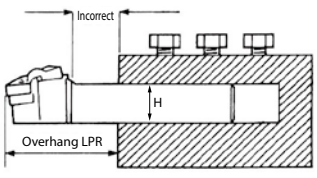
Function of tool angle

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 force, 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 machining or interrupted machining.
	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 workpiece surface.	· When it is large, edge strength deteriorates.

Toolholder rigidity

1. Flexure of toolholder

$$\delta = \frac{4 \times F \times (LPR)^3}{E \times B \times H^3} = \frac{4 \times k \times ap \times f \times (LPR)^3}{E \times B \times H^3}$$



Symbol	Name	Unit
δ (Delta)	Deflection	mm
B	Shank width	mm
H	Shank height	mm
E	Young ratio	N/mm²
ap	Depth of cut	mm
f	Feed rate	mm/rev
k	Specific cutting force	N/mm²
LPR	Overhang	mm
F	Cutting force	N

(F = k x ap x f)

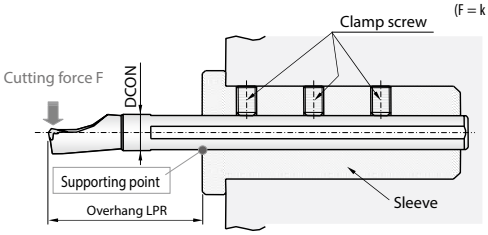
The flexural strength of toolholder will decrease by increasing of shank height by third root and will decrease of reducing overhang by third root. Minimizing toolholder shank overhang as much as possible is important as well as shank's sectional square measure.

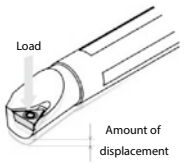
2. Flexure of boring bar

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

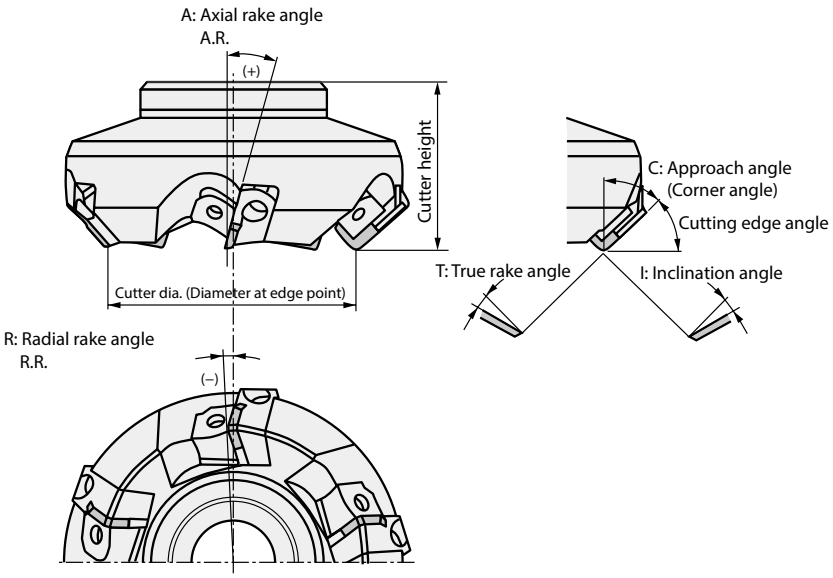
Symbol	Name	Unit
δ (Delta)	Deflection	mm
DCON	Shank dia.	mm
E	Young ratio	N/mm²
ap	Depth of cut	mm
f	Feed rate	mm/rev
k	Specific cutting force	N/mm²
LPR	Overhang	mm
F	Cutting force	N

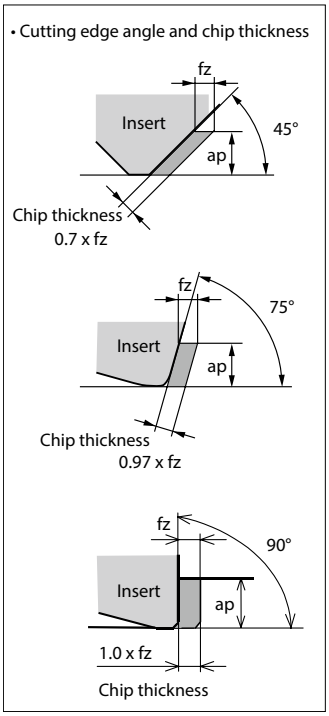
(F = k x ap x f)





Terms and angles of milling cutter





Function of tool angle

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

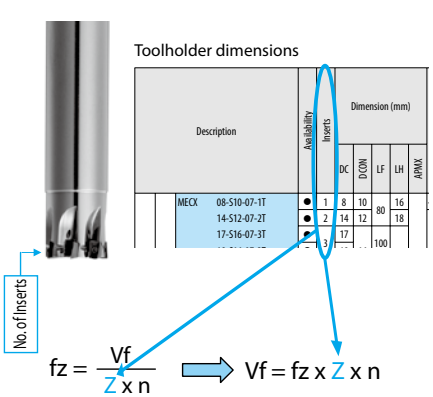
The formula for true rake angle: $\tan T = \tan R \times \cos C + \tan A \times \sin C$

The formula for inclination angle: $\tan I = \tan A \times \cos C - \tan R \times \sin C$

No. of Inserts (Z)

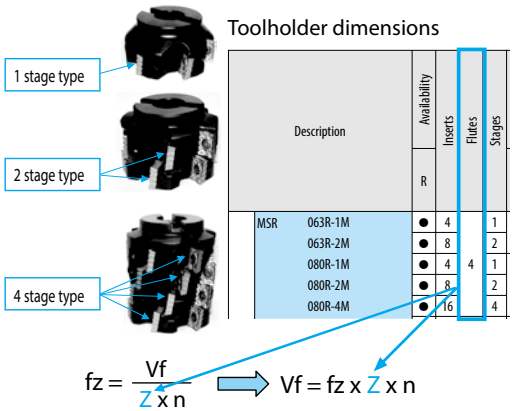
1) If the number of stages is one

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



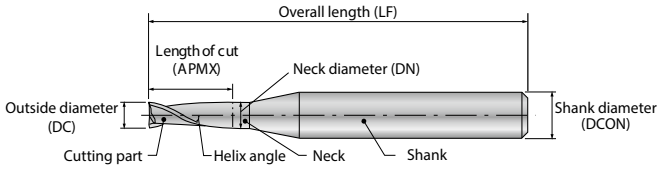
2) If the number of stages is more than two

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

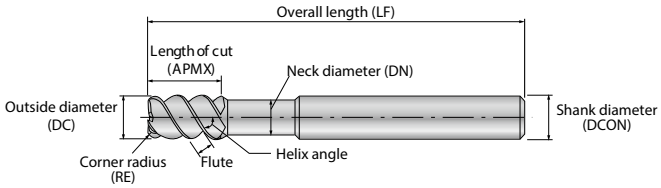


Terms of solid end mill

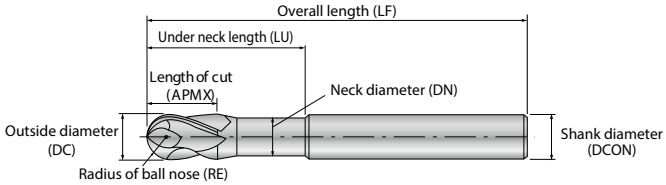
Square



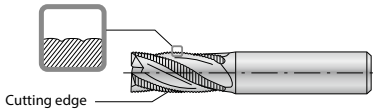
Radius



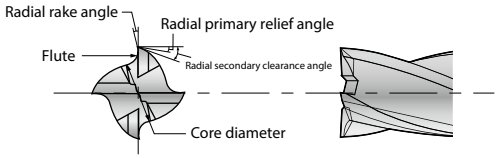
Ball-nose



Cutting edge shape



Cutting edge profile

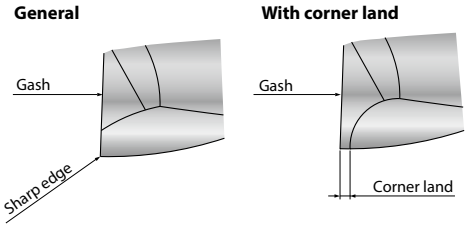


* The illustration shows squared 4 flutes tool

Core diameter rate (%) = Core diameter ÷ Outside dia. x 100

Cutting edge with corner land

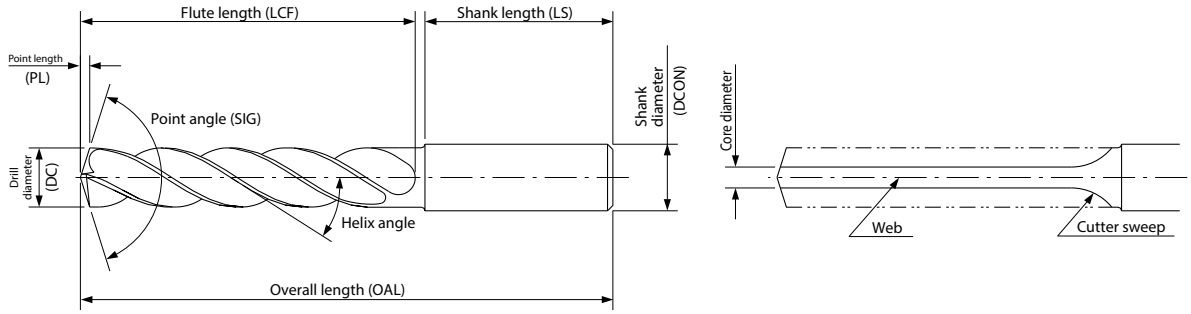
Advanced fracture resistance with corner land

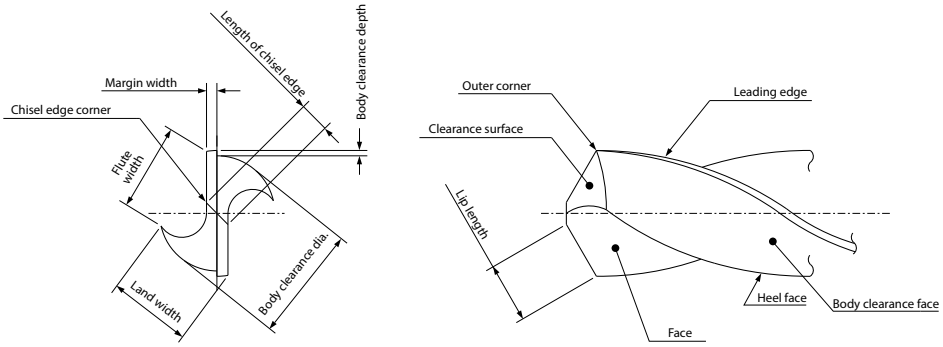


Trouble shooting of solid end mill

Trouble	Trouble item	Countermeasures	Cutting conditions: Vc	fz	ap	Cutting direction	Low pick feed	Compressed air	Coolant: Increase volume	Oil based coolant	Wet working	Tool geometry: Helix angle	No. of blades	Diameter	Tool rigidity enhancement	Large chip pocket	Setting: Workpiece / tool installation	Shorten tool overhang	Machine: Power, rigidity
		Check item	Higher (larger) ↑ Lower (smaller) ↓									Larger ↑ more smaller ↓ less							
Edge damage	Cutting edge wear	Unsuitable cutting conditions	● ↓							●									
		Less number of blades											● ↑						
		Up cut				Down-cut													
	Chipping of cutting edge	Unsuitable cutting conditions		● ↓	● ↓														
		Lack of cutting edge strength													●				
		Insufficient clamping force															●	●	●
	Fracture occurs	Unsuitable cutting conditions			● ↓														
		Lack of tool rigidity												● ↑	●				
		Chip packing							●							●			
Cutting accuracy	Poor finished surface on walls	Unsuitable cutting conditions	● ↓		● ↓														
		Chip jamming						●	●		●								
		Cutting edge wear	● ↓																
	Poor finished surface on faces	Large pick feed					●												
	Out of vertical	Unsuitable cutting conditions		● ↓	● ↓														
		Lack of tool rigidity										● ↑	● ↑	● ↑	●				
		Cutting edge wear	● ↓																
	Poor dimensional accuracy	Unsuitable cutting conditions	● ↓	● ↓	● ↓														
		Insufficient clamping force															●	●	●
Others	Heavy chattering, vibration	Unsuitable cutting conditions	● ↓	● ↓															
		Lack of tool rigidity										● ↑	● ↑	● ↑	●				
		Insufficient clamping force															●	●	●
	Chip jamming	Unsuitable cutting conditions		● ↓	● ↓														
		Improper tool geometry											● ↓			●			

Terms of solid drill



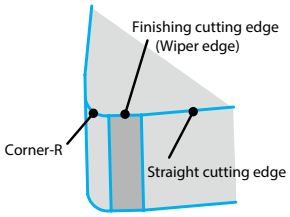


Trouble shooting of solid drill

Trouble	Trouble item	Countermeasures	Vc	fz	Lower feed at initial cutting	Lower feed when breaking through	Step feed	Coolant: Increase volume	Coolant: Increase pressure	Chisel width	Honing width	Core diameter	Shorten flute length	Use internal coolant type tool	Improve tool installation accuracy	Flat workpiece face	Shorten tool overhang	Power, rigidity
		Check item	Cutting conditions							Tool geometry					Setting			Machine
			Higher (larger)↑ Lower (smaller)↓							Larger ↑ more Smaller ↓ less								
Edge damage	Fracture occurs	Unsuitable cutting conditions		●↓														
		Poor rigidity of drill										●↑	●					
		Sloping machine face														●		
	Large peripheral cutting edge and margin land wear	Unsuitable cutting conditions	●↓															
		High cutting heat at the cutting edge point						●						●				
		Poor run-out accuracy													●			
	Chipping on peripheral cutting edge	Unsuitable cutting conditions		●↓			●											
		Large deflection of tool holder													●			●
		Chattering occurs (vibration)									●↓						●	●
	Chipping on chisel	Too wide chisel width								●↓								
		Poor entry			●													
		Chattering occurs (vibration)									●↓						●	●
Cutting accuracy	Enlarge hole diameter	Unsuitable cutting conditions	●↑															
		Poor rigidity of drill										●↑	●					
	Reduce hole diameter	Unsuitable cutting conditions	●↓															
		High cutting heat at cutting edge point						●						●				
	Poor straightness	Poor rigidity of drill										●↑	●					
		Large deflection of tool holder													●			●
	Poor hole position accuracy, roundness, straightness, surface roughness	Unsuitable cutting conditions			●													
		Poor rigidity of drill										●↑	●					
		Large deflection of tool holder													●			●
		Insufficient clamping force																
Burr	Large burrs at hole exit	Unsuitable cutting conditions				●												
		Improper tool geometry									●↓							
Chip control	Long chips	Unsuitable cutting conditions		●↑														
		Poor chip disposal						●	●			●↓		●				
	Chip packing	Unsuitable cutting conditions	●↓	●↓														
		Poor chip disposal						●	●					●				

About wiper inserts

A wiper insert is designed with a wiper edge that is located between corner radius and straight cutting edge shown as right figure.

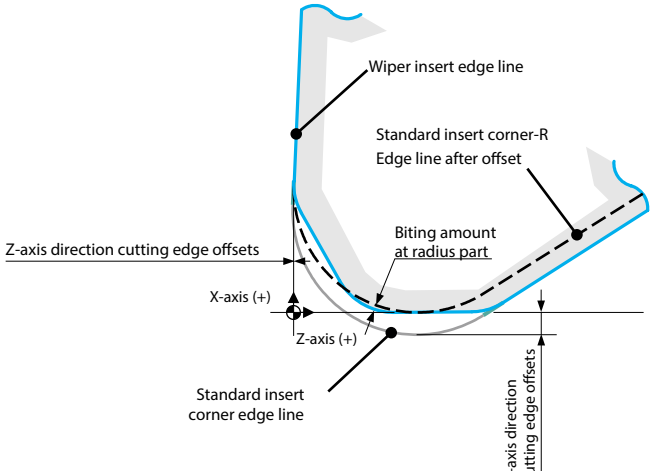


Advantages

- A wiper edge geometry provides improved surface finish quality even at increased feed rate
- Improved machining efficiency : Reduced cutting time with higher feed rate as well as consolidation of roughing and finishing provide high machining efficiency
- Longer tool life : Reduced cutting time with higher feed rate leads to increase part production
- Excellent chip control : Higher feed rate makes chips thicker, which provides easier-to-break chips

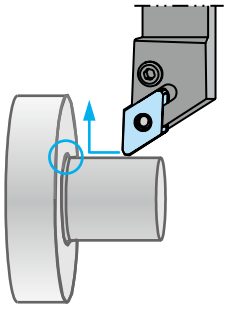
Precautions when using WF / WE chipbreaker (negative insert)

Tip of corner-R (DNMX, TNMX)



Cautions when machining inside corner-R

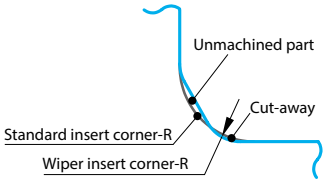
Do not use this wiper insert if a precise inside corner-R is required when such a machining in the figure below.



* From external turning to up facing without arc complement
(A wiper edge does not work during up facing)

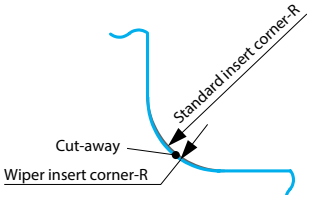
DNMX / TNMX
WF chipbreaker

- More incomplete cutting and excessive cutting during machining with this chipbreaker than the machining with a standard insert
- The inside corner-R dimension become smaller than the requirement.



CNMG / WNMG
WF / WE chipbreaker

- The inside corner-R dimension would be smaller than the requirement (Cutting excessively).



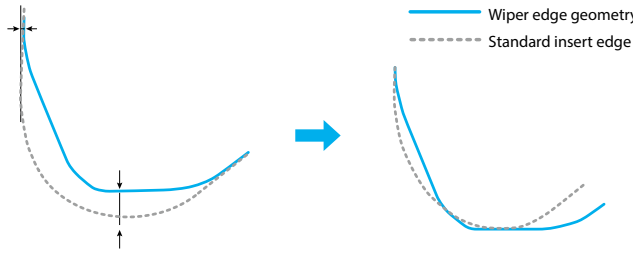
WF / WE chipbreaker edge position offset adjustment

WF / WE chipbreaker (Negative Insert) edge position offset adjustment

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

Cutting edge offsets (mm)					
DNMX150404WF DNMX150604WF		DNMX150408WF DNMX150608WF		DNMX150412WF DNMX150612WF	
X-axis direction	Z-axis direction	X-axis direction	Z-axis direction	X-axis direction	Z-axis direction
0.24	0.02	0.14	0.01	0.11	0.01

Cutting edge offsets (mm)					
TNMX160404WF		TNMX160408WF		TNMX160412WF	
X-axis direction	Z-axis direction	X-axis direction	Z-axis direction	X-axis direction	Z-axis direction
0.24	0.01	0.16	0.00	0.11	0.00

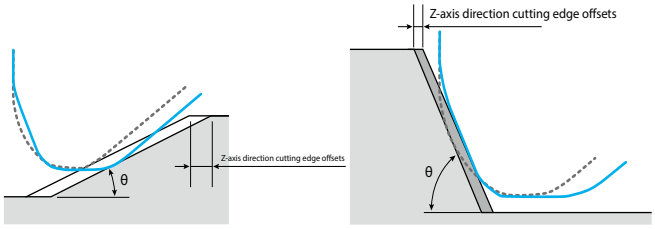


For D type and T type inserts, program corrections are required for ramping and up facing.

Program corrections for tapered part of workpiece (Z-axis direction cutting edge offsets)

DNMX1504 / DNMX1506 type

Corner-R(RE) (mm)	Ramping angle θ					
	0°	5°	10°	15°	20°	25°
0.4	0.00	-0.34	-0.35	-0.36	-0.36	-0.36
0.8	0.00	-0.26	-0.26	-0.25	-0.24	-0.22
1.2	0.00	-0.15	-0.17	-0.16	-0.15	-0.15



Corner-R(RE) (mm)	Up facing angle θ																		
	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
0.4	0.00	-0.02	-0.03	-0.03	-0.04	-0.05	-0.06	-0.07	-0.08	-0.09	-0.10	-0.11	-0.12	-0.10	-0.08	-0.06	-0.04	-0.02	0.00
0.8	0.00	0.13	0.12	0.11	0.09	0.07	0.05	0.04	0.02	0.00	-0.02	-0.05	-0.07	-0.06	-0.04	-0.02	-0.01	-0.01	0.00
1.2	0.00	0.36	0.34	0.31	0.27	0.24	0.20	0.16	0.13	0.09	0.05	0.00	-0.04	-0.04	-0.03	-0.02	-0.01	-0.01	0.00

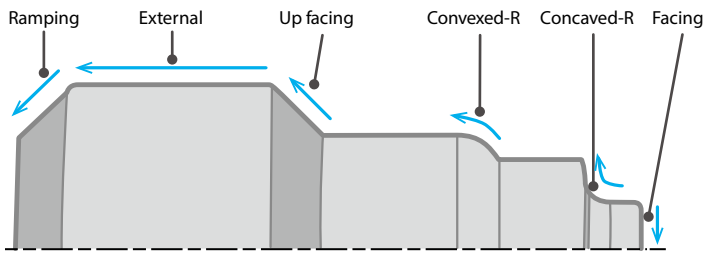
TNMX1604 type

Corner-R(RE) (mm)	Ramping angle θ					
	0°	5°	10°	15°	20°	25°
0.4	0.00					
0.8	0.00					
1.2	0.00					

Do not use TNMX1604 type insert for ramping.

Corner-R(RE) (mm)	Up facing angle θ																		
	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
0.4	0.00	-0.06	-0.05	-0.05	-0.06	-0.07	-0.08	-0.08	-0.09	-0.10	-0.11	-0.12	-0.13	-0.12	-0.10	-0.07	-0.05	-0.02	0.00
0.8	0.00	0.11	0.11	0.10	0.08	0.06	0.04	0.02	0.00	-0.02	-0.04	-0.06	-0.08	-0.08	-0.06	-0.04	-0.02	-0.01	0.00
1.2	0.00	0.34	0.32	0.29	0.25	0.22	0.19	0.15	0.14	0.08	0.04	0.00	-0.05	-0.05	-0.03	-0.01	0.00	0.00	0.00

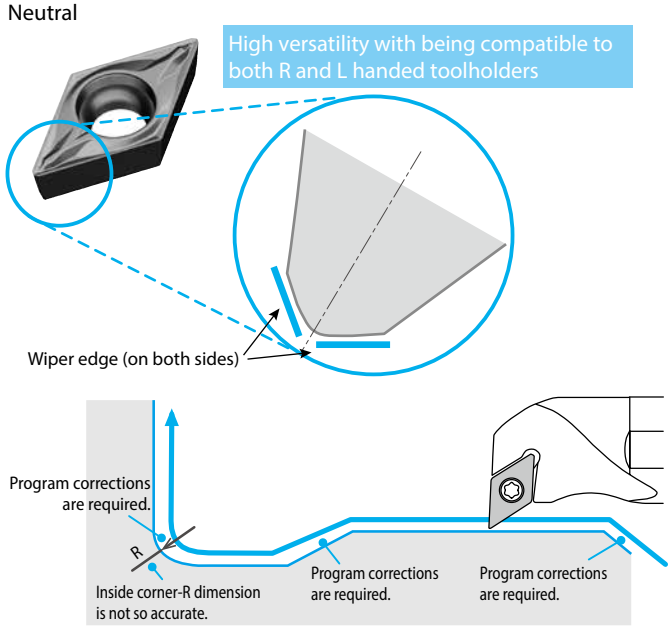
Caution (Finished edge line)



Applications	Notes
External / Facing	Toolholders for D type and T type would not be able to provide sufficient performance depending on a toolholder. Please use an applicable toolholder.
Up facing Ramping	For D type and T type inserts, program corrections on Z-axis direction are required.
Convexed-R / Concaved-R	Do not use wiper insert if a precise R shape is needed.

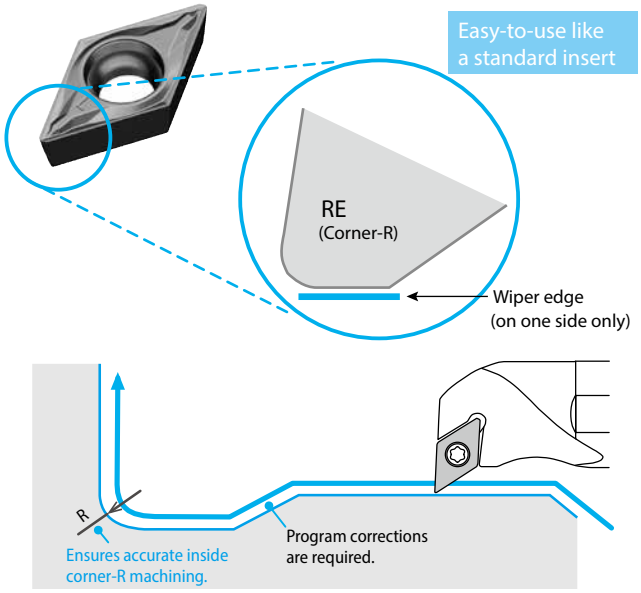
Precautions when using WP chipbreaker (Positive insert)
Proper use for a neutral insert and a handed insert

Neutral



When use a neutral type insert,
· you need to correct programs for three areas.
· it should be used for machining which does not require inside corner-R accuracy.

Handed (Left-hand shown)

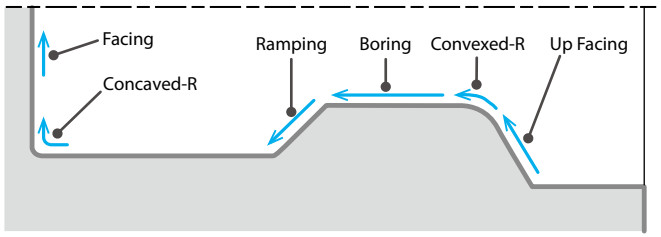


When use a handed insert,
· you need to correct program for ramping.
· it provides accurate inside corner-R machining.

Less program correction is required as well as easy-to-use like a standard insert

* Position of cutting edge differs from a standard insert. Cutting edge adjustment is required.

Caution (Finished edge line)



Neutral

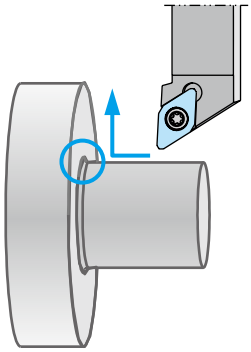
Applications	Caution
Boring / Facing	Toolholders for D type and T type would not be able to provide sufficient performance depending on a toolholder. Please use an applicable toolholder.
Up Facing / Ramping	For D type and T type inserts, program corrections on Z-axis direction are required.
Convexed-R / Concaved-R	Do not use wiper inserts if a precise R shape is needed.

Handed

Applications	Caution
Boring	Toolholders for D type and TP type would not be able to provide sufficient performance depending on a toolholder. Please use an applicable toolholder.
Ramping	For D type and TP type inserts, program corrections on Z-axis direction are required.
Convexed-R / Concaved-R	Surface finish quality is as standard insert is.
Up Facing	Surface finish quality is as standard insert is.
Facing	Surface finish quality is as standard insert is.

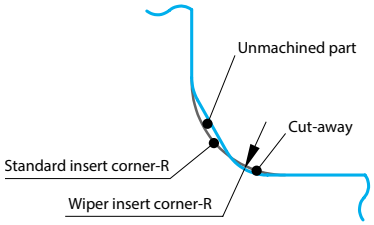
Cautions when machining inside corner-R

Do not use this wiper insert if a precise inside corner-R is required when such a machining in the figure below.



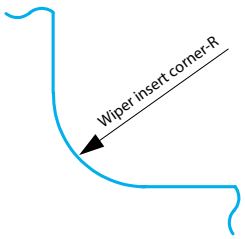
DCMX / TC(P)MX * Neutral
WP chipbreaker

· More incomplete cutting and excessive cutting during machining with this chipbreaker than the machining with a standard insert
· The inside corner-R dimension become smaller



CCMT * Neutral
DCMX / TPMX * Handed
WP chipbreaker

· No problem in the finished line on workpiece (Adjustments are required)



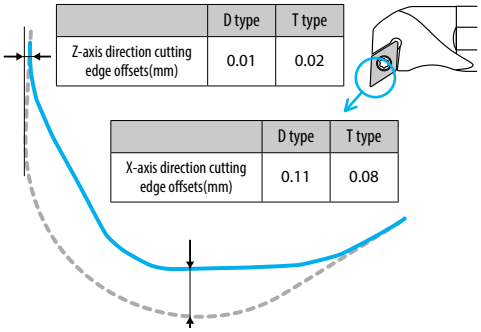
WP chipbreaker (Positive insert) Edge position offset adjustment

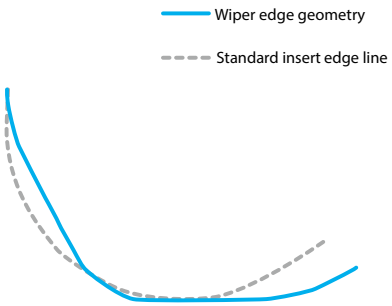
Neutral

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

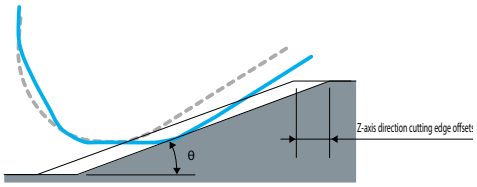
	D type	T type
Z-axis direction cutting edge offsets(mm)	0.01	0.02

	D type	T type
X-axis direction cutting edge offsets(mm)	0.11	0.08

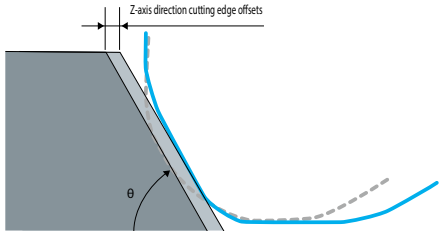




For D type and T type inserts, program corrections are required for ramping and up facing.



Ramping angle θ	0°	5°	10°	15°	20°	25°
Z-axis direction cutting edge offsets (mm) D type	0	-0.14	-0.15	-0.16	-0.16	-0.17
Z-axis direction cutting edge offsets (mm) T type	0	-0.16	-0.17	-0.17	-0.17	-



Profiling angle θ	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°
Z-axis direction cutting edge offsets (mm) D type	0.00	0.07	0.06	0.04	0.03	0.02	0.01	0.00	-	-	-
Z-axis direction cutting edge offsets (mm) T type	0.00	0.07	0.06	0.05	0.05	0.04	0.03	0.02	0.01	0.01	0.00

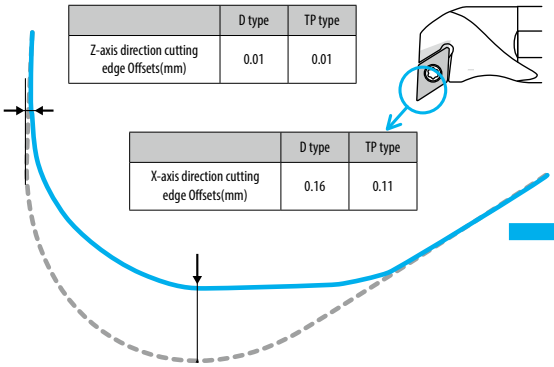
Profiling angle θ	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
Z-axis direction cutting edge offsets (mm) D type	-0.01	-0.02	-0.03	-0.04	-0.05	-0.05	-0.04	-0.03	-0.02	-0.01	0.00
Z-axis direction cutting edge offsets (mm) T type	-	-	-	-0.01	-0.02	-0.03	-0.04	-0.03	-0.02	-0.01	0.00

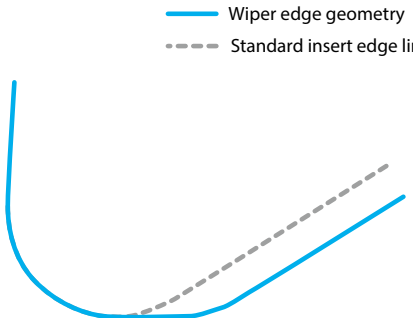
Handed

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

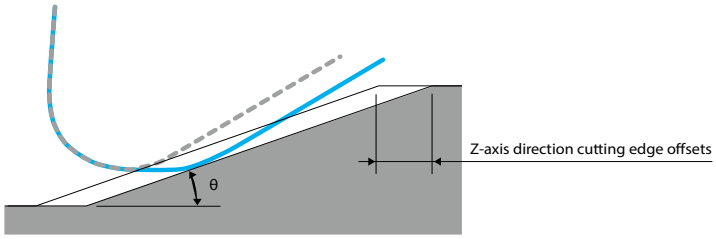
	D type	TP type
Z-axis direction cutting edge Offsets(mm)	0.01	0.01

	D type	TP type
X-axis direction cutting edge Offsets(mm)	0.16	0.11



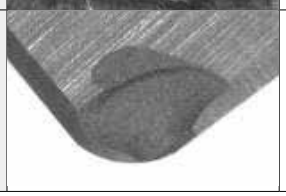


For D type and TP type inserts, program corrections are required for ramping.



Ramping angle θ	0°	5°	10°	15°	20°	25°
Z-axis direction cutting edge offsets (mm) D type	0	-0.22	-0.24	-0.24	-0.25	-0.25
Z-axis direction cutting edge offsets (mm) TP type	0	-0.24	-0.24	-0.25	-0.24	-

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 Al_2O_3 coated insert grade
Plastic deformation		• Workpiece dimension changes • Crack at nose	• Too high cutting load • Inappropriate insert grade	• Change to harder grade • Reduce f and ap
Crack from wear		• Surface finish's sudden deterioration • Workpiece dimension changes	• Too high Vc	• Change the tool earlier • 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(RE) • Change to more rigid toolholder
Fracture from thermal crack		• Cracking by heat cycle • Possible in interrupted machining and milling	• Too high Vc and f	• Reduce f • Reduce Vc • Change to dry cutting
Flaking		• Possible in hard materials machining • Possible in machining with chattering	• Lack of insert toughness • Poor rigidity of toolholder	• Change to tougher 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	f	ap	Tool path review	Coolant: Wet	Coolant: Dry	Chipbreaker review	Rake angle	Corner-R(RE)	Approach angle	Edge strength / Honing	Change to higher tolerance (M→G)	Toolholder rigidity	Workpiece / Tool Installation	Overhang length	Power, rigidity
		Check item	Insert grades				Cutting conditions						Tool geometry							Setting		Machine
							Higher (Larger) ↑ Lower (Smaller) ↓						Larger ↑ Smaller ↓									
Unstable dimension	Unstable workpiece dimension	Unsuitable insert tolerance																●				
		Tool and workpiece evacuation											●	●↑	●↓	●↓			●	●	●	●
	Frequent offset during machining	Flank wear increase	●												●↑							
		Unsuitable cutting conditions					●↓	●↑														
		Built-up edge				●	●↑															
Surface roughness deterioration	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 insert grades and tool geometry	●										●	●↑			●↓					
Burr, workpiece chip off and scuffing	Burr	Unsuitable cutting conditions					●↓	●↑		●	●											
		Unsuitable insert grades and tool geometry	●										●	●↑	●↓	●↓	●↓					
	Workpiece chip off	Unsuitable cutting conditions						●↓	●↓	●												
		Unsuitable insert grades and tool geometry	●										●	●↑	●↑	●↑	●↓		●	●	●	●
	Scuffing	Unsuitable cutting conditions					●↑	*2 ●↓			●											
		Unsuitable insert grades and tool geometry	●			●							●	●↑			●↓					
Edge damage	Wear increase at relief face, rake face	Flank wear	●				●↓				●		●	●↑	●↑		●↓					
		Rake face wear	●				●↓	●↓	●↓		●		●	●↑		●↑						
	Notching	Notching				●	●↓				●											
	Chipping	Vibration, chattering		●				●↓	●↓				●			●↑	●↑		●	●	●	●
	Crack	Unsuitable insert grades and cutting conditions		●	●			●↓	●↓				●		●↑	●↑	●↑		●	●	●	●
	Thermal crack	Work hardness, unsuitable insert grades and cutting conditions			●		●↓	●↓	●↓			●	●	●↑			●↓					
	Edge nose deformation	Edge nose deformation during interrupted machining	●				●↓	●↓	●↓				●	●↓	●↑	●↑	●↑					
	Built-up edge	Work hardness, unsuitable insert grades and 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

Trouble	Trouble item	Countermeasures	Insert grades: Change to harder grade	Insert grades: Change to tougher grade	Insert grades: Change to more thermal shock resistant grade	Insert grades: Change to more welding resistant grade	Cutting conditions: Vc (Higher (Larger)↑ Lower (Smaller)↓)	Cutting conditions: fz (Higher (Larger)↑ Lower (Smaller)↓)	Cutting conditions: ap (Higher (Larger)↑ Lower (Smaller)↓)	Cutting conditions: Cutter dia. cutting width review	Cutting conditions: Tool path review	Cutting conditions: Coolant: Usage of mist	Cutting conditions: Coolant: Dry	Tool geometry: Insert with chipbreaker	Tool geometry: Relief angle (Larger ↑ Smaller ↓)	Tool geometry: Corner angle (Larger ↑ Smaller ↓)	Tool geometry: Edge strength / Honing (Larger ↑ Smaller ↓)	Tool geometry: No. of inserts (More↑ Less↓)	Tool geometry: Chip pocket (Larger↑ Smaller↓)	Tool geometry: Wiper edge (Relief angle) review	Tool geometry: Insert runout check	Tool geometry: 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 / parallelism	Tool and workpiece evacuation						●↓	●↓			*5 ●		●	●↑	●↓	●↓	●↓		●	●	●	●	●	●
Others	Heavy chattering, vibration	Unsuitable cutting conditions, installation					●↓	*1 ●↓	*2 ●↓	●	*4 ●			●	●↑	●↓	●↓	●↓				●	●	●	●
	Chip jamming	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 (MagicDrill series)

Trouble	Trouble item	Countermeasures	Insert grades: Change to harder grade	Insert grades: Change to tougher grade	Cutting conditions: Vc (Higher (Larger)↑ Lower (Smaller)↓)	Cutting conditions: fz (Higher (Larger)↑ Lower (Smaller)↓)	Cutting conditions: Coolant discharge condition	Tool geometry: Chipbreaker review	Tool geometry: Inner edge's center height check (Core dia. check) (Larger ↑ Smaller ↓)	Tool geometry: Toolholder rigidity improvement (Short type)	Setting: Workpiece / Tool installation	Setting: Insert installation	Setting: Offset check	Setting: Adjustable sleeve usage	Machine: Power, rigidity
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.											*1 ●	●	
		Unsuitable insert 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											*1 ●	●	
		Clogged chips			●↑	●↓									
		Unstable drilling start				●↓									
	Poor hole dia. accuracy / Surface finish	Poor rigidity of machine / workpiece									●				●
		Poor rigidity of toolholder								●		●			
		Inaccurate tool installment											*1 ●	●	
		Clogged chips			●↑	●↓			●↓						
		Large core dia.							●↓						
		Unstable drilling start				●↓									
		Unsuitable coolant discharge					●								
	Large vibration / chattering	Unsuitable cutting conditions, installation			●↑	●↓				●	●				●
	Long chips	Unsuitable cutting conditions			●↑										
		Unsuitable chipbreaker						●							
	Machine failure	Lack of machine power			●↓	●↓		●							●

*1. For lathe operation

Turning

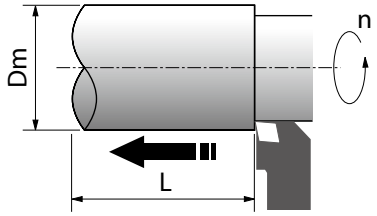
Cutting speed

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

Vc : Cutting speed [m/min]

Dm : Workpiece dia. [mm]

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



Power requirement

$$Pc = \frac{Ks \times Vc \times ap \times f}{6{,}120 \times \eta}$$

$$P_{HP} = \frac{Ks \times Vc \times ap \times f}{4{,}500 \times \eta}$$

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 force [kgf/mm^2]

η : Mechanical efficiency (0.7 ~ 0.8)

Ks [kgf/mm^2]	
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

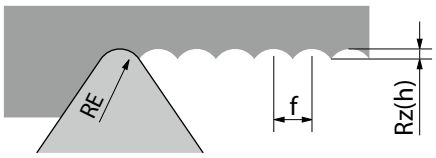
Theoretical surface roughness

$$Rz(h) = \frac{f^2}{8 \times RE} \times 1{,}000$$

Rz(h): Theoretical surface roughness [μm]

f : Feed rate [mm/rev]

RE : Corner radius of insert [mm]



Chip removal volume

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

Q : Chip removal volume [$cm^3/min=cc/min$]

Vc : Cutting speed [m/min]

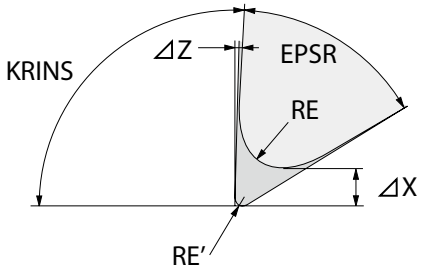
ap : Depth of cut [mm]

f : Feed rate [mm/rev]

Edge position compensation when changing corner-R(RE)

$$\Delta X = (RE - RE') \times \left\{ \frac{\cos\left(\frac{EPSR}{2} + (KRINS - 90°)\right)}{\sin\frac{EPSR}{2}} - 1 \right\}$$

$$\Delta Z = (RE - RE') \times \left\{ \frac{\sin\left(\frac{EPSR}{2} + (KRINS - 90°)\right)}{\sin\frac{EPSR}{2}} - 1 \right\}$$



ΔX : X-axis direction cutting edge offsets [mm]

ΔZ : Z-axis direction cutting edge offsets [mm]

RE : Corner-R before change [mm]

RE': Corner-R after change [mm]

EPSR : Insert corner angle [°]

KRINS : Toolholder's cutting edge angle [°]

Toolholder type	Insert corner angle EPSR	Cutting edge angle KRINS	ΔX	ΔZ
DCLN / PCLN	80°	95°	0.100 x (RE-RE')	0.100 x (RE-RE')
DTGN / PTGN	60°	91°	0.714 x (RE-RE')	0.030 x (RE-RE')
DDJN / PDJN	55°	93°	0.866 x (RE-RE')	0.099 x (RE-RE')
DDHN / PDHN	55°	107.5°	0.531 x (RE-RE')	0.531 x (RE-RE')
DVLN / PVLN	35°	95°	2.072 x (RE-RE')	0.273 x (RE-RE')
DVPN / PVPN	35°	117.5°	1.351 x (RE-RE')	1.351 x (RE-RE')
DSBN / PSBN	90°	75°	0.225 x (RE-RE')	-0.293 x (RE-RE')

Example: Compensation when changing corner-R from 0.8 to 0.4, using PCLN toolholder,

ΔX=0.100 x (0.8-0.4)=0.04(mm)

ΔZ=0.100 x (0.8-0.4)=0.04(mm)

Turning (Cutting time)

Cutting time (External turning case 1: 1 pass machining)

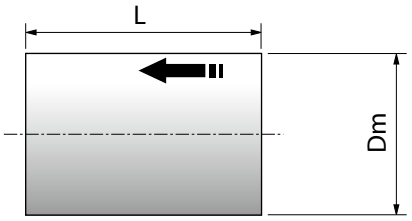
At constant revolution

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

At constant cutting speed

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

T : Cutting time [sec]
L : Cutting length [mm]
f : Feed rate [mm/rev]
n : Spindle revolution [min^{-1}]
Dm : Workpiece dia. [mm]
Vc : Cutting speed [m/min]



Cutting time (External turning case 2: multi-pass machining)

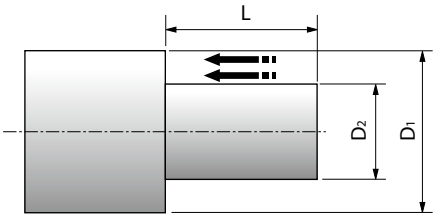
At constant revolution

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

At constant cutting speed

$$T = \frac{60 \times \pi \times L \times (D_1 + D_2)}{2 \times 1{,}000 \times f \times Vc} \times N$$

T : Cutting time [sec]
L : Cutting length per pass [mm]
ap : Depth of cut per pass [mm]
f : Feed rate [mm/rev]
n : Spindle revolution [min^{-1}]
D_1 : Max. dia. of workpiece [mm]
D_2 : Min. dia. of workpiece [mm]
Vc : Cutting speed [m/min]
N : Number of passes = (D1 - D2) / ap / 2 (if it is indivisible, obtain integer by rounding up one place of decimals.)



Cutting time (Facing)

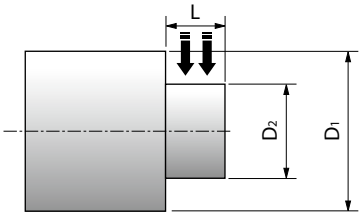
At constant revolution

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

At constant cutting speed

$$T_1 = \frac{60 \times \pi \times (D_1 + D_2) \times (D_1 - D_2)}{4{,}000 \times f \times Vc} \times N$$

T : Cutting time [sec]
T_1 : Cutting time before reaching Max. spindle revolution [sec]
L : Cutting length [mm]
ap : Depth of cut per pass [mm]
f : Feed rate [mm/rev]
n : Spindle revolution [min^{-1}]
D_1 : Max. dia. of workpiece [mm]
D_2 : Min. dia. of workpiece [mm]
Vc : Cutting speed [m/min]
N : Number of passes = L / ap (if it is indivisible, obtain integer by rounding up one place of decimals.)



Cutting time (Grooving)

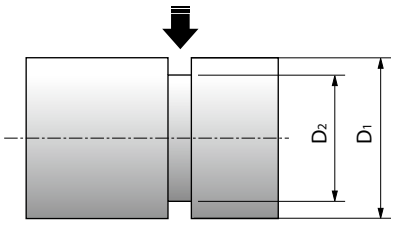
At constant revolution

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

At constant cutting speed

$$T_1 = \frac{60 \times \pi \times (D_1 + D_2) \times (D_1 - D_2)}{4{,}000 \times f \times Vc}$$

T : Cutting time [sec]
T_1 : Cutting time before reaching Max. spindle revolution [sec]
L : Cutting length [mm]
f : Feed rate [mm/rev]
n : Spindle revolution [min^{-1}]
D_1 : Max. dia. of workpiece [mm]
D_2 : Min. dia. of workpiece [mm]
Vc : Cutting speed [m/min]



Cutting time (Cut-off)

At constant revolution

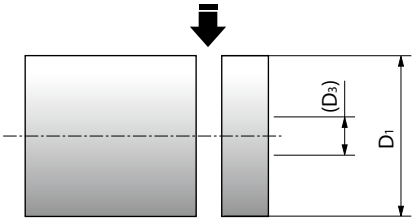
$$T = \frac{60 \times D_1}{2 \times f \times n}$$

At constant cutting speed

$$T_1 = \frac{60 \times \pi \times (D_1 + D_3) \times (D_1 - D_3)}{4{,}000 \times f \times Vc}$$

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

T : Cutting time [sec]
T_1 : Cutting time before reaching Max. spindle revolution [sec]
T_3 : Cutting time when reaching Max. spindle revolution [sec]
f : Feed rate [mm/rev]
n : Spindle revolution [min^{-1}]
n_{max} : Max. spindle revolution [min^{-1}]
D_1 : Max. dia. of workpiece [mm]
D_3 : Diameter when reaching max. spindle revolution [mm]
Vc : Cutting speed [m/min]



Milling

Cutting speed

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

Vc : Cutting speed [m/min]

DC : Cutter dia. [mm]

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

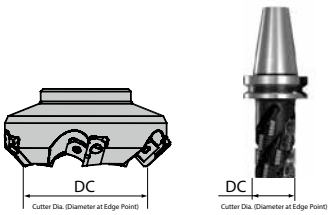


Table feed & feed per tooth

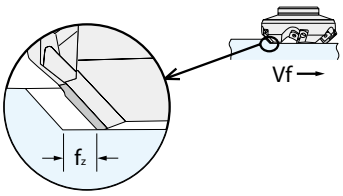
$$f_z = \frac{Vf}{Z \times n}$$

f_z : Feed per tooth [mm/t]

Vf : Table feed [mm/min]

Z : No. of inserts

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



Power requirement

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

$$= \frac{K_s \times ae \times f_z \times Z \times n \times ap}{6{,}120{,}000 \times \eta}$$

$$P_{HP} = \frac{6{,}120}{4{,}500} \times Pc$$

Pc : Power requirement [kW]

P_{HP} : Power requirement (Horse power) [HP]

ae : Width of cut [mm]

Vf : Table feed [mm/min]

f_z : Feed per tooth [mm/t]

Z : No. of inserts

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

ap : Depth of cut [mm]

K_s : Specific cutting force [kgf/mm^2]

η : Mechanical efficiency (0.7 ~ 0.8)

Q : Chip removal volume [cm^3/min=cc/min]

Ks [kgf/mm^2]	
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

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

Q : Chip removal volume [cm^3/min=cc/min]

ae : Width of cut [mm]

Vf : Table feed [mm/min]

f_z : Feed per tooth [mm/t]

Z : No. of inserts

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

ap : Depth of cut [mm]

Cutting time

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

T : Cutting time [sec]

L' : Total table transfer length [mm]
(= L+DC+2α)

L : Workpiece length [mm]

DC : Cutter dia. [mm]

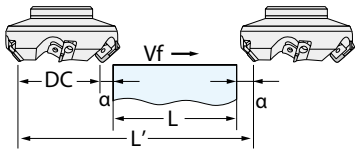
α : Idling distance [mm]

Vf : Table feed [mm/min]

f_z : Feed per tooth [mm/t]

Z : No. of inserts

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



True rake angle

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

Inclination angle

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

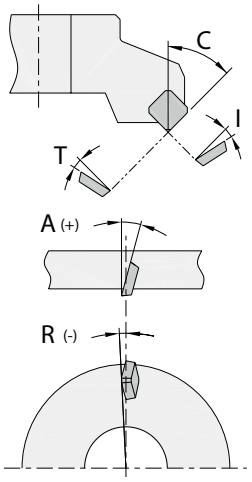
A (GAMP) : Axial rake angle (A.R.) [°] (-90° < A < 90°)

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°)



Ball-nose end mill cutting speed & revolution

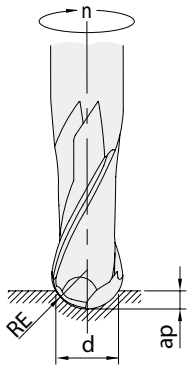
$$n = \frac{1{,}000 \times V_a}{2 \times \pi \times \sqrt{ap(2RE-ap)}}$$

n : Revolution [min^{-1}]

RE : Radius of ball-nose end mill (Ball part's radius) [mm]

ap : Depth of cut [mm]

V_a : Cutting speed at actual dia. d [m/min]



Drilling (MagicDrill series)

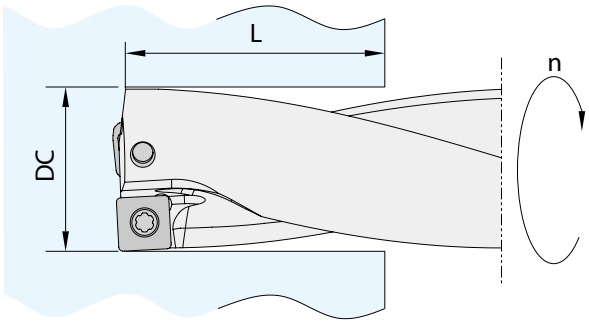
Cutting speed

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

Vc : Cutting speed [m/min]

DC : Drill dia. [mm]

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



Feed rate (Milling)

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

Vf : Table feed [mm/min]

fz : Feed per tooth [mm/t]

Z : No. of inserts (No. of insert = 1)

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 [sec]

L : Drilling depth [mm]

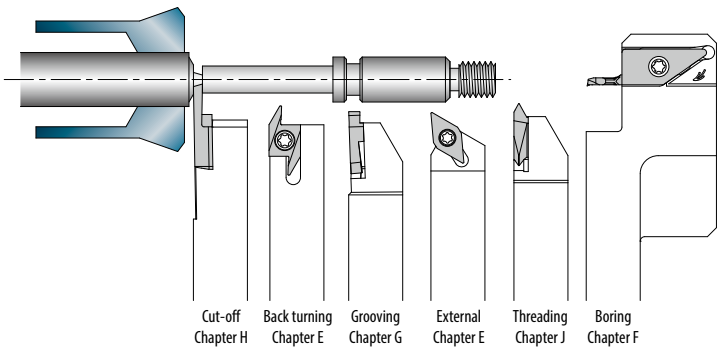
f : Feed rate [mm/rev]

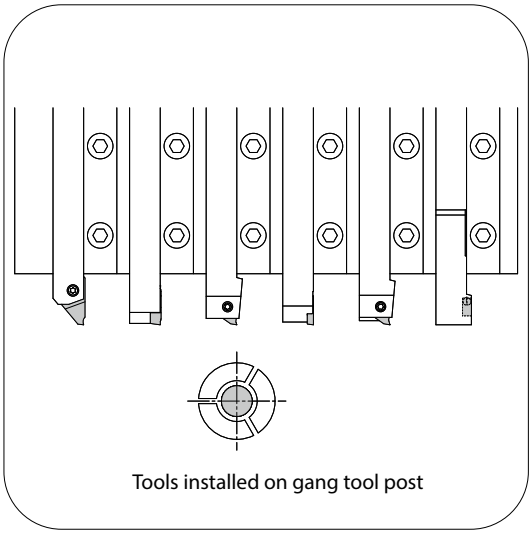
n : Spindle revolution [min^{-1}]

DC : Drill dia. [mm]

Vc : Cutting speed [m/min]

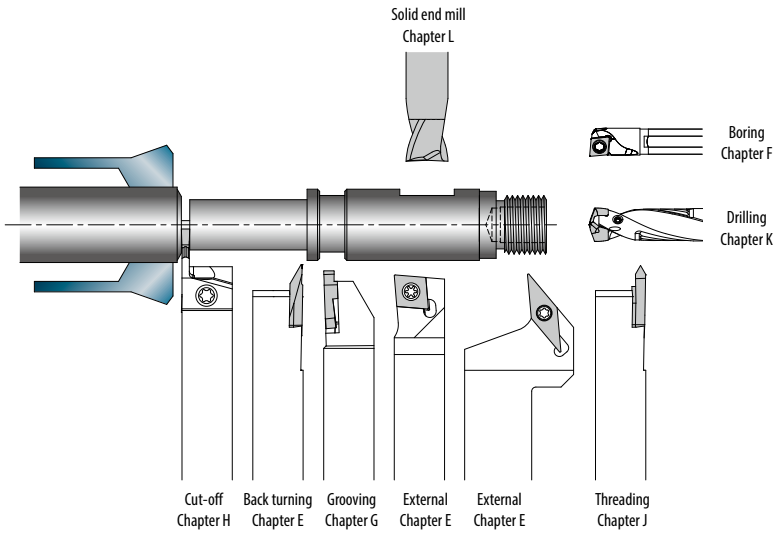
Tooling example1: CNC automatic lathe (Gang type)

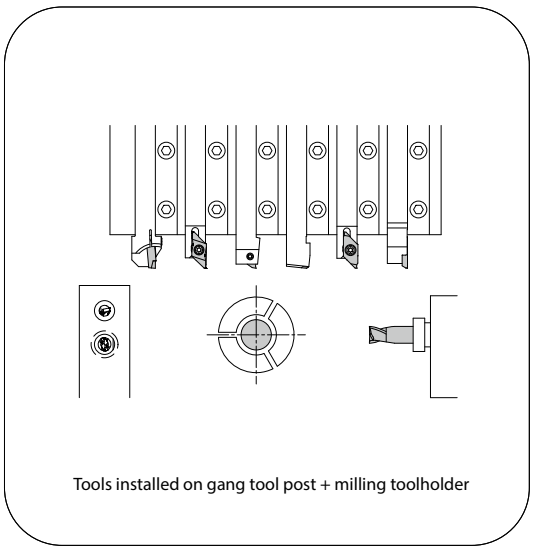




Tools installed on gang tool post

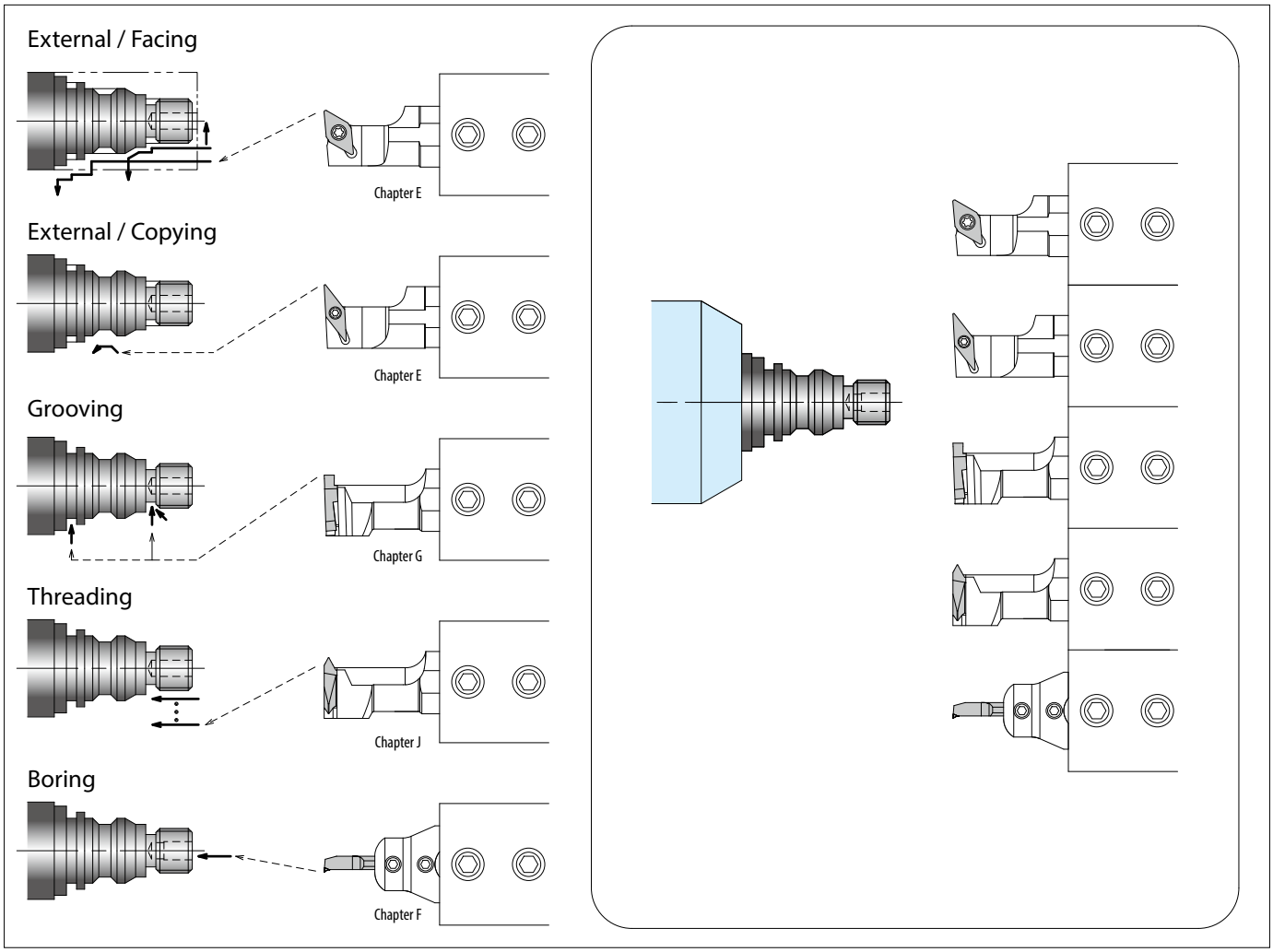
Tooling example 2: CNC automatic lathe (Gang type)



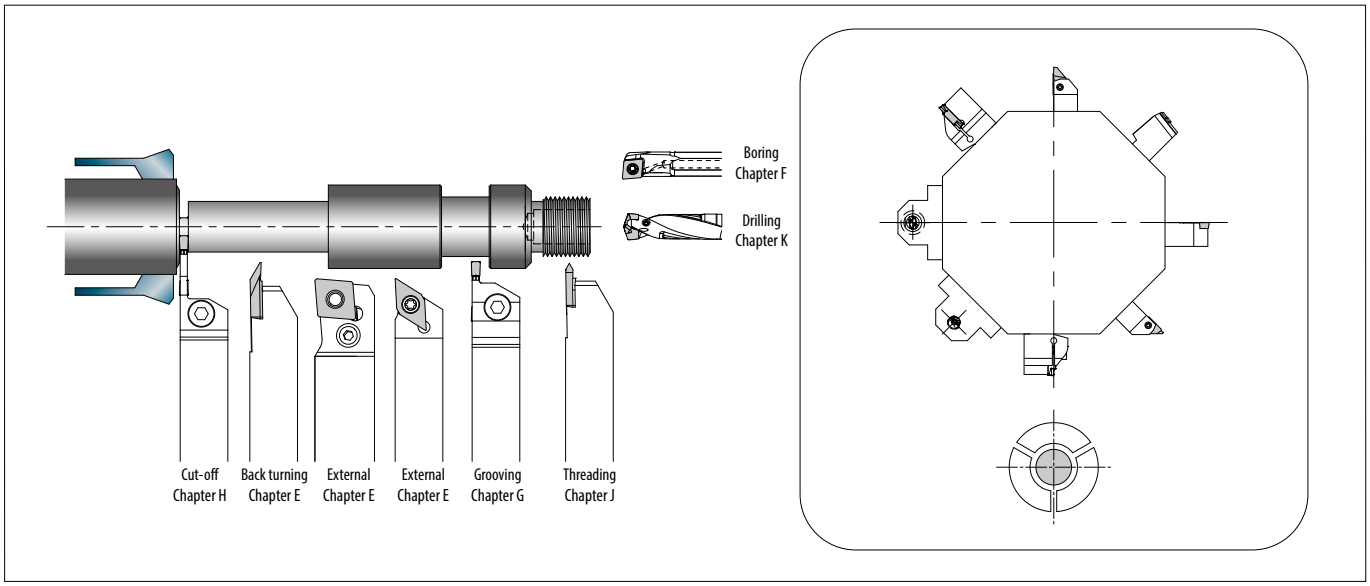


Tools installed on gang tool post + milling toolholder

Tooling example 3: CNC automatic lathe (Opposed gang type)



Tooling example 4: CNC automatic lathe (Turret type)



For Tooling Layout and Automatic Lathe List by Manufacturer, See Page **R46~R54**

Citizen machinery (Cincom Products)

Model	Toolholder dimensions (Gang tool post)	Number of tools	Toolholder dimensions (Turret tool post)	Number of tools	Sleeve dia. (Horizontal/Opposed)	Max. cutting dia.	Remarks
A12/16	10 x 10 x 100	5			ø19.05/ø20	ø12/ø16	
A20	12(13) x 12(13) x 120 * Cut-off toolholder : □16mm	6			ø25.4	ø20	
A20 Ⅶ	12(13) x 12(13) x 120 * Cut-off toolholder : □16mm	6			ø25.4	ø20	
A32	16 x 16 x 150	6			ø25.4	ø32	
B12	10 x 10 x 100	5			ø19.05/ø20	ø12	
B12E/B16E	10 x 10 x 120(60)	5			ø19.05(ø20^{OP})	ø12/ø16	
B20	12(13) x 12(13) x 120	6			ø19.05/ø20	ø20	
BL12	10 x 10 x 60 ~ 120	5			ø20(ø19.05)	ø12	
BL20/25	12(13) x 12(13) x 120	4 ~ 7			ø20(ø19.05)	ø20/ø25	
C12/16	10 x 10 x 120	6			ø19.05	ø12/ø16	
C32	16 x 16 x 130	5			ø25.4	ø32	
D25	16 x 16 x 150 * Cut-off toolholder : □19mm				ø25.4	ø25	
F10			10 x 10 x 60	10	ø19.05	ø10	
F12			10 x 10 x 60	10	ø19.05	ø12	
F16			10 x 10 x 60	10	ø19.05	ø16	
F20			16(19) x 16(13) x 90	10	ø25.4	ø20	
F25			16(19) x 16(13) x 90	10	ø25.4	ø25	
FL25			16 x 16 x 90	12		ø25	
FL42			16 x 16 x 90	12		ø42	
G32			16(19) x 16(19) x 90	10	-	ø32	
K12/16	12(10) x 12(10) x 100	6(7)			ø19.05/ø20	ø12/ø16	
K12E/K16E	12 x 12 x 120	6			ø19.05/ø20	ø12/ø16	
L10	8 x 8 x 100 ~ 130	5			ø15.875	ø10	
L12	10 x 10 x 100	6			ø19.05	ø12	
L16	12(10) x 12(10) x 130	5			ø19.05	ø16	
L20,L20E	12 x 12 x 130 * Cut-off toolholder : □16mm	5			ø19.05	ø20	
L20X,L220	12(13,16) x 12(13,16) x 120 * Cut-off toolholder : □16mm	5 ~ 7			ø19.05	ø20	
L25	16 x 16 x 130	5			ø25.4	ø25	
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	
M20	16 x 16 x 130	5	16 x 16 x 90	10 + α	ø25.4	ø20	
M32	16 x 16 x 130	5	16 x 16 x 90	10 + α	ø25.4	ø32	
MC20	13 x 13 x 120	2 + 2 + 2			ø19.05/ø20.0	ø20.0	
MSL12	10 x 10 x 120				-	ø12	
R04	8 x 8 x 120	5			ø15.875	ø4	
R07	8 x 8 x 120	5			ø15.875	ø7	
RL01	10(8) x 10(8) x 90				ø16(ø20)	ø10	
RL02	16 x 16 x 90				ø20	ø20	
RL21	10(12) x 10(12) x 90				ø19.05	ø35	

Manufacturers are in no particular order.

Citizen machinery (Miyano Products)

Model	Toolholder dimensions (Gang tool post)	Number of tools	Toolholder dimensions (Turret tool post)	Number of tools	Sleeve dia. (Horizontal/Opposed)	Number of tools	Max. cutting dia.	Remarks
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	
ANX-42SYY			20 x 20 x 125(100)	24(48)	ø25	48	ø42	
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/S			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-42S2			20 x 20 x 125(100)	8(16)	ø25	24	ø42	
BNA-42CY5/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	
BNE-51MYY			20 x 20 x 125(100)	24	ø25	48	ø51	
BNE-65MYY			20 x 20 x 125(100)	24	ø25	48	ø65	
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		ø40	
GN-3200W	12(16) x 12(16) x 70 ~ 120	4 ~ 5			ø20		ø40	"Number of tools" is per turret.
GN-4200	12(16) x 12(16) x 70 ~ 120	6 ~ 7			ø20		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		6 inch power chuck
LZ-01RY2			20 x 20 x 125(100)	12	ø25	24		6 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
RL01Ⅲ	10 x 10 x 70 ~ 120	2 ~ 3			ø16		ø10	
RL01Ⅴ	10 x 10 x 70 ~ 120	2 ~ 3			ø16		ø10	
RL03	12(16) x 12(16) x 70 ~ 120	4 ~ 5			ø20		ø40	
VC03	12(16) x 12(16) x 70 ~ 120	4 ~ 5			ø20		ø40	

* Number of tools shown in parentheses is the maximum number of toolholder mountable including ø25 sleeves.

Manufacturers are in no particular order.

Star Micronics

Model	Toolholder dimensions (Gang tool post)	Number of tools	Toolholder dimensions (Turret tool post)	Number of tools	Sleeve dia. (Front/Rear)	Number of tools	Max. cutting dia.	Remarks
SB-16 (A/C/D/E)	12 x 12 x 95 ~ 130	5			ø22/ø22	4/4	ø16	Only D/E for rear-end sleeves
	12(10) x 12(10) x 95 ~ 130	6			ø22/ø22	4/4	ø16	
SB-12Ⅱ (C/E)	12 x 12 x 95 ~ 130	6			ø22/ø22	4/4	ø13	Only E for rear-end sleeves
SB-16Ⅱ (C/E)	12(10) x 12(10) x 95 ~ 130	6			ø22/ø22	4/4	ø16	
SB-20 A/C/E	12 x 12 x 95 ~ 130	6			ø22/ø22	4/4	ø20	
SB-12R typeG	12 x 12 x 95 ~ 130	6			ø22/ø22	4/4	ø13	
	10 x 10 x 95 ~ 130	7			ø22/ø22	4/4		
SB-16Ⅲ	12 x 12 x 95 ~ 130	5			ø22/ø22	4/4	ø16	
	10 x 10 x 95 ~ 130	6			ø22/ø22	4/4		
SB-16R/20R typeN	12 x 12 x 95 ~ 130	6			ø22/ø22	4/4	ø16/ø23	
	10 x 10 x 95 ~ 130	7			ø22/ø22	4/4		
SB-16R/20R typeG	12 x 12 x 95 ~ 130	6			ø22/ø22	4/4	ø16/ø23	
	10 x 10 x 95 ~ 130	7			ø22/ø22	4/4		
SB-16R/20R typeGB	12 x 12 x 95 ~ 130	6			ø22/ø22	4/4	ø16/ø23	
	10 x 10 x 95 ~ 130	7			ø22/ø22	4/4		
SP-20	12 x 12 x 100 ~ 130	8			ø22 or ø22+ø32/ø22	5 or 4/4	ø25.4	
	12×12×100 ~ 130 + 16×16×100 ~ 130	7						
SC20	12 x 12 x 95 ~ 130	5			ø22/-	4/-	ø20	
	10 x 10 x 95 ~ 130	6			ø22/-	4/-		
SG-42			16 x 16 x 84 ~ 88(71 ~ 82)		ø22+ø32/-		ø42	
			20 x 20 x 84 ~ 88					
SL-7/10	10 x 10 x 95 ~ 115	6			ø16+ø22/ø16+ø22	4~6/6	ø10	
	8 x 8 x 68 ~ 115	6						
SR-10J	8 x 8 x 67 ~ 110 (Spacer is needed)	6			ø16/ø16+ø22	4/4	ø10	
SR-20RⅡ	12 x 12 x 100 ~ 135	6			ø22/ø22	4/4	ø23	
SR-20RⅢ	12 x 12 x 95 ~ 135	6			ø22/ø22	6/4	ø23	Toolpost for 2 toolholders (deep boring) on the front side
SR-20J typeC	12 x 12 x 95 ~ 135	6			ø22/ø22	6/4	ø23	
SR-20J typeN	12 x 12 x 95 ~ 135	6			ø22/ø22	6/4	ø23	
SR-20JⅡ typeA	12 x 12 x 100 ~ 135	6			ø22/ø22	7/4	ø23	
SR-20JⅡ typeB	12 x 12 x 100 ~ 135	6			ø22/ø22	7/8	ø23	
SR-20Ⅳ typeA	12 x 12 x 100 ~ 130	7			ø22/ø22	6/8	ø23	
SR-20Ⅳ typeB	12 x 12 x 100 ~ 130	7			ø22/ø22	6/8	ø23	
SR-25J/32J	16 x 16 x 95 ~ 155	6			ø22+ø32/ø22	4/4	ø32	
SR-32JⅡ typeA	16 x 16 x 95 ~ 165	6			ø22+ø32/ø22	5/6	ø34	
SR-32JⅡ typeB	16 x 16 x 95 ~ 165	6			ø22+ø32/ø22	5/8	ø34	
SB-32JⅢ typeA	16 x 16 x 95 ~ 165	6			ø22+ø32/ø22	5/6	ø34	
SB-32JⅢ typeB	16 x 16 x 95 ~ 165	6			ø22+ø32/ø22	5/8	ø34	
SD-26 typeS	16 x 16 x 95 ~ 135	7			ø22+ø32/ø22	5/8	ø26	Toolpost for 2 toolholders (deep boring) on the front side
SD-26 typeG	16 x 16 x 95 ~ 135	7			ø22+ø32/ø22	5/8	ø26	
SD-26 typeE	16 x 16 x 95 ~ 135	7			ø22+ø32/ø22	5/8	ø26	
SD-26 typeC	16 x 16 x 95 ~ 135	7			ø22+ø32/ø22	5/8	ø26	
SR-38 typeA	16 x 16 x 95 ~ 135	4			ø22+ø32/ø22	5/8	ø38	
	16 x 16 x 100	2						
	20 x 20 x 105 ~ 135 (Cut-off)	1						
SR-38 typeB	16 x 16 x 95 ~ 135	4			ø22+ø32/ø22	5/8	ø38	
	16 x 16 x 100	2						
	20 x 20 x 105 ~ 135 (Cut-off)	1						
SR-38J	16 x 16 x 95 ~ 135	4			ø22+ø32/ø22	5/4	ø38	
	16 x 16 x 95 ~ 135 (Optional)	3						
	20 x 20 x 105 ~ 135 (Cut-off)	1						
ST-20			12 x 12 x 73 ~ 79		ø22+ø32/ø22+ø32		ø20	
			12 x 12 x 65 ~ 73 (Cut-off)					
			16 x 16 x 64 ~ 73					
			16 x 16 x 65 ~ 73 (Cut-off)					
ST-38			16 x 16 x 83 ~ 88		ø22+ø32/ø22+ø32		ø38	
			16 x 16 x 71 ~ 82					
			16 x 16 x 84 ~ 88 (Cut-off)					
			20 x 20 x 84 ~ 88					
			20 x 20 x 84 ~ 88 (Cut-off)					
SV-12/20	12 x 12 x 95 ~ 135	5	12 x 12 x 70 ~ 78		ø22+ø32/-		ø12/ø20	
	16 x 16 x 95 ~ 135	4	16 x 16 x 65 ~ 70					
SV-20R	12 x 12 x 95 ~ 135	7	12 x 12 x 70 ~ 78		ø22+ø32/ø22	- / 8	ø23	
	16 x 16 x 95 ~ 135	6	16 x 16 x 65 ~ 70					
SV-32	16 x 16 x 95 ~ 135	4	16 x 16 x 60 ~ 78(80 ~ 88)		ø22+ø32/-		ø32	
SV-38R	16 x 16 x 105 ~ 135	4	16 x 16 x 84 ~ 88		ø22+ø32/ø34	- / 8	ø38	
	20 x 20 x 115 ~ 135 (Cut-off)	1	16 x 16 x 71 ~ 82					
			20 x 20 x 84 ~ 88					
SW-12RⅡ	10x 10 x 95 ~ 115	7			ø16/ø22	4/8	ø13	
SW-20	12 x 12 x 80 ~ 150	6			ø22/ø22	4/8	ø23	
	16 x 16 x 80 ~ 144							
SX-38 typeA	16 x 16 x 95 ~ 135	4	16 x 16 x 84 ~ 88		ø22+ø32/ø34	- / 8	ø38	
	20 x 20 x 105 ~ 135 (Cut-off)	1	16 x 16 x 71 ~ 82					
			20 x 20 x 84 ~ 88					
SX-38 typeB	16 x 16 x 95 ~ 135	4	16 x 16 x 84 ~ 88		ø22+ø32/ø34	- / 8	ø38	
	20 x 20 x 105 ~ 135 (Cut-off)	1	16 x 16 x 71 ~ 82					
			20 x 20 x 84 ~ 88					

Manufacturers are in no particular order.

Eguro

Model	Toolholder dimensions (Gang tool post)	Number of tools	Toolholder dimensions (Turret tool post)	Number of tools	Sleeve dia. (Horizontal/Opposed)	Number of tools	Max. cutting dia.	Remarks
NUCBOY-8EX	12 x 12	6			ø20 or ø25 or ø30	5	ø20	
NUCLET-10EX/EL	16 x 16	6			ø20 or ø25 or ø30	5	ø25.5	
NUCPAL-10EX/EL	16 x 16	10			ø20 or ø25 or ø30	8	ø25.5	
NUCLET-10vv	16 x 16	6			ø20 or ø25 or ø30	5	ø25.5	
NUCBOY-8LL	12 x 12	2			ø20 or ø25 or ø30	2	ø20	
NUCLET-10LL	16 x 16	2			ø20 or ø25 or ø30	2	ø25.5	
NUCROBO-8EX	12 x 12	6			ø20 or ø25 or ø30	5	ø20	
NUCROBO-101	16 x 16	6			ø20 or ø25 or ø30	5	ø25.5	
NUCROBO-202	16 x 16	10			ø20 or ø25 or ø30	8	ø25.5	
SANAX-6	12 x 12	10			ø12 or ø16/ø30	3~6/2	ø15	
SANAX-10	16 x 16	10			ø20 or ø30/ø30	5~8/3	ø25.5	
SANATURN-6	12 x 12	5			ø16/ø30	3~5/2	ø15	
SANATURN-10	16 x 16	6			ø20/ø30	7/3	ø25.5	
EBN-10EX	12 x 12	5			ø20 or ø25 or ø30	4	ø25.5	
GL-120	12 x 12	4			-		ø20	
EB-6	8 x 8	2			-		ø15	
EB-8	10 x 10	2			-		ø20	
EB-10	10 x 10	2			-		ø25.5	

Manufacturers are in no particular order.

Tsugami

Model	Toolholder dimensions (Gang tool post)	Number of tools	Toolholder dimensions (Turret tool post)	Number of tools	Sleeve dia. (Horizontal/Opposed)	Number of tools	Max. cutting dia.	Remarks
B073C	8 x 8 x 85	9	-	-	ø20/-	4/-	ø7	
B073-VR	8 x 8 x 85	9	-	-	ø20/-	4/-	ø7	
B075C	8 x 8 x 85	9	-	-	ø20/ø20	4/4(8)	ø7	
B075-VR	8 x 8 x 85	9	-	-	ø20/ø20	4/4(8)	ø7	
B0123C	12 x 12 x 85	9	-	-	ø20/-	4/-	ø12	
B0123-VR	12 x 12 x 85	9	-	-	ø20/-	4/-	ø12	
B0125C	12 x 12 x 85	9	-	-	ø20/ø20	4/4(8)	ø12	
B0126C	12 x 12 x 85	9	-	-	ø20/ø20	4/4(8)	ø12	
B0125-VR	12 x 12 x 85	9	-	-	ø20/ø20	4/4(8)	ø12	
B0126-VR	12 x 12 x 85	9	-	-	ø20/ø20	4/4(8)	ø12	
B0128W	12 x 12 x 85	9	-	-	ø20/ø20	4/4(8)	ø12	
B0203-VR	12 x 12 x 85	9	-	-	ø20/-	4/-	ø20	
B0205-VR	12 x 12 x 85	9	-	-	ø20/ø20	4/4(8)	ø20	
B0206-VR	12 x 12 x 85	9	-	-	ø20/ø20	4/4(8)	ø20	
B0208W	12 x 12 x 85	9	-	-	ø20/ø20	4/4(8)	ø20	
BM163-VR	12 x 12 x 85	9	-	-	ø20/-	4/-	ø16	
BM165-VR	12 x 12 x 85	9	-	-	ø20/ø20	4/4(8)	ø16	
BW127J-II	12 x 12 x 85	7	-	-	ø20/ø20	3/4(9)	ø12	
BW128J-II	12 x 12 x 85	7	-	-	ø20/ø20	3/4(9)	ø12	
BW128ZJ-I / II	12 x 12 x 85	7	-	-	ø20/ø20	3/4(9)	ø12	
BW129ZJ-I / II	12 x 12 x 85	7	-	-	ø20/ø20	3/4(9)	ø12	
BW207J-II	12 x 12 x 85/16 x 16 x 85	5/2	-	-	ø20/ø20	3/4(9)	ø20	
BW208J-II	12 x 12 x 85/16 x 16 x 85	5/2	-	-	ø20/ø20	3/4(9)	ø20	
BW208ZJ-I / II	12 x 12 x 85/16 x 16 x 85	5/2	-	-	ø20/ø20	3/4(9)	ø20	
BW209ZJ-I / II	12 x 12 x 85/16 x 16 x 85	5/2	-	-	ø20/ø20	3/4(9)	ø20	
B0265-III	16 x 16 x 100	12	-	-	ø25/ø25	7/4(9)	ø26	
B0266-III	16 x 16 x 100	12	-	-	ø25/ø25	7/8(13)	ø26	
B0265V-III	16 x 16 x 100	6	-	-	ø25/ø25	7/4(9)	ø26	
B0266V-III	16 x 16 x 100	6	-	-	ø25/ø25	7/8(13)	ø26	
B0325-III	16 x 16 x 100	12	-	-	ø25/ø25	7/4(9)	ø32	
B0326-III	16 x 16 x 100	12	-	-	ø25/ø25	7/8(13)	ø32	
B0325V-III	16 x 16 x 100	6	-	-	ø25/ø25	7/4(9)	ø32	
B0326V-III	16 x 16 x 100	6	-	-	ø25/ø25	7/8(13)	ø32	
B0385(L)-III	16 x 16 x 100/20 x 20 x 125	11/1	-	-	ø32,ø25/ø32	3,2/5(10)	ø38	
B0386(L)-III	16 x 16 x 100/20 x 20 x 125	11/1	-	-	ø32,ø25/ø32	3,2/5(13)	ø38	
B0385(L)V-III	16 x 16 x 100/20 x 20 x 125	5/1	-	-	ø32,ø25/ø32	3,2/5(10)	ø38	
B0386(L)V-III	16 x 16 x 100/20 x 20 x 125	5/1	-	-	ø32,ø25/ø32	3,2/5(13)	ø38	
B038T	16 x 16 x 125/20 x 20 x 125	2 ~ 5/1	20 x 20 x 125	St.8	ø32/ø25		ø38	
C150	12 x 12 x 60 ~ 100	4 ~ 6	-	-	-		ø80	
C180	12 x 12 x 60 ~ 100	4 ~ 6	-	-	-		ø120	
C220/220T	12 x 12 x 60 ~ 100	6 ~ 8	-	-	-		ø120	
C200	12 x 12 x 60 ~ 100	4 ~ 6	-	-	-		ø120	
P013	8 x 8 x 100 ~ 120	6	-	-	ø16/-	3/-	ø1	
P014	8 x 8 x 100 ~ 120	6	-	-	ø16/ø16	3/(3)	ø1	
P033	8 x 8 x 100 ~ 120	6	-	-	ø16/-	3/-	ø3	
P034	8 x 8 x 100 ~ 120	6	-	-	ø16/ø16	3/(3)	ø3	
P036W	8 x 8 x 100 ~ 120	6	-	-	ø16/ø16	4/(4)	ø3	
P053	8 x 8 x 100 ~ 120	6	-	-	ø16/-	3/-	ø5	
P054	8 x 8 x 100 ~ 120	6	-	-	ø16/ø16	3/(3)	ø5	
S205-II	12 x 12 x 100	9	-	-	ø25/ø25	7/4(9)	ø20	
S206-II	12 x 12 x 100	9	-	-	ø25/ø25	7/8(13)	ø20	
S205A-II	12 x 12 x 100	9	-	-	ø25/ø25	5/4(9)	ø20	
S206A-II	12 x 12 x 100	9	-	-	ø25/ø25	5/8(13)	ø20	
SS207-II (-5AX)	12 x 12 x 100	8	-	-	ø22/ø20	6/8(12)	ø20	
SS267-III (-5AX)	16 x 16 x 100	8	-	-	ø25/ø25	6/8(12)	ø26	
SS327-III (-5AX)	16 x 16 x 100	8	-	-	ø25/ø25	6/8(12)	ø32	
BW269ZJ	16 x 16 x 100	7	-	-	ø25/ø25	7/8(13)	ø26	
BW329ZJ	16 x 16 x 100	7	-	-	ø25/ø25	7/8(13)	ø32	
MB25	-	-	20 x 20 x 90	2 x St.8	ø20/ø32	5/4	ø25	
M06JC-II		-	20 x 20 x 125	St.8	ø25		ø220/ø42	
M06J-II		-	25 x 25 x 150	St.8	ø32/ø40		ø260/ø51	
M08J-II		-	25 x 25 x 150	St.8	ø32/ø40		ø280/ø65	
M08JL5-II		-	25 x 25 x 150	St.8	ø32/ø40		ø280/ø65	
M08JL8-II		-	25 x 25 x 150	St.8	ø32/ø40		ø280/ø65	
M06D-II		-	25 x 25 x 150	St.12	ø40		ø260/ø51	
M08D-II		-	25 x 25 x 150	St.12	ø40		ø280/ø65	
M06DY-II		-	25 x 25 x 150	St.12	ø40		ø260/ø51	
M08DY-II		-	25 x 25 x 150	St.12	ø40		ø280/ø65	
M06SJ-II		-	25 x 25 x 150	St.12	ø40		ø260/ø51	
M08SJ-II		-	25 x 25 x 150	St.12	ø40		ø280/ø65	
M06SD-II		-	25 x 25 x 150	St.12	ø40		ø260/ø51	
M08SD-II		-	25 x 25 x 150	St.12	ø40		ø280/ø65	
M06SY-II		-	25 x 25 x 150	St.12	ø40		ø260/ø51	
M08SY-II		-	25 x 25 x 150	St.12	ø40		ø280/ø65	
M10J		-	25 x 25 x 150	St.12	ø40		ø400/ø80	
M10JL10		-	25 x 25 x 150	St.12	ø40		ø400/ø80	
M10D		-	25 x 25 x 150	St.12	ø40		ø400/ø80	
B020M-III	12 x 12 x 100	1	-	-	ø25/ø25	1/6	ø20	
SS20MH-III-5AX	12 x 12 x 100	1	-	-	ø25/ø25	1/6	ø20	
B026M-III	20 x 20 x 100 ~ 125	1	-	-	ø32/ø25	1/10	ø26	
SS26MH-III-5AX	20 x 20 x 100 ~ 125	1	-	-	ø32/ø25	1/10	ø26	
B038M	20 x 20 x 100 ~ 125	1	-	-	ø32/ø25	1/10	ø38	
SS38MH-5AX	20 x 20 x 100 ~ 125	1	-	-	ø32/ø25	1/10	ø38	
TMA8F	20 x 20 x 100 ~ 125	1			ø32/ø32		ø220/ø65	
TMA8J	20 x 20 x 100 ~ 125	1			ø32/ø32		ø220/ø65	
TMA8H	20 x 20 x 100 ~ 125	1			ø32/ø32		ø220/ø65	

Manufacturers are in no particular order.

Nomura DS

Model	Toolholder dimensions (Gang tool post)	Number of tools	Toolholder dimensions (Turret tool post)	Number of tools	Sleeve dia. (Horizontal/Opposed)	Number of tools	Max. cutting dia.	Remarks
NN-10C	10 x 10 x 130	6			ø17		ø10	
NN-10CS	10 x 10 x 130	5			ø17	4	ø10	
NN-10SII	10 x 10 x 130	5			ø23		ø10	
NN-10T	10 x 10 x 130	7			ø23		ø10	
NN-10SB5	10 x 10 x 130	5			ø23		ø13	
NN-10EX2	10 x 10 x 120	6			ø16	4	ø10	
NN-10EX2	10 x 10 x 80	7			ø16	4	ø10	
NN-10EX3	10 x 10 x 80	7			ø16	4	ø10	
NN-16SB5	10 x 10 x 130	5			ø23		ø16	
NN-16SB6 Type1	12 x 12 x 130*	7			ø17(ø22)	4	ø16	
NN-16SB6 Type2	12 x 12 x 130*	5			ø17(ø22)	4	ø16	
NN-16SB6 Type2.5	12 x 12 x 130*	6			ø17(ø22)	5	ø16	
NN-16SB6 Type3	12 x 12 x 130*	5			ø17(ø22)	4	ø16	
NN-16SB7	12 x 12 x 130*	5			ø16	4	ø16	
NN-16SB7-M8	12 x 12 x 130*	5			ø16	4	ø16	
NN-20SB	12 x 12 x 130*	5			ø16	3	ø20	
					ø22	2	ø20	
NN-16HIII	12 x 12 x 130	6			ø23		ø16	
NN-20HIII	12 x 12 x 130	6			ø23		ø20	
NN-16UIII	12 x 12 x 130	5			ø23		ø16	
NN-20UIII	12 x 12 x 130	5			ø23		ø20	
NN-20CS	12 x 12 x 130*	5(6)			ø22	4	ø20(ø25)	
NN-20U5	12 x 12 x 150*	5(6)			ø22	4	ø20(ø25)	
NN-32U5	12 x 12 x 150*	3(4)			ø32	1	ø32	
	16 x 16 x 130	2			ø22	3		
NN-16UB5	12 x 12 x 130	5			ø23		ø16	
NN-20UB5	12 x 12 x 130	5			ø23		ø20	
NN-20UB7	12 x 12 x 130	6			ø23		ø20	
NN-20UB8	12 x 12 x 150*	5(6)			ø22	4	ø20(ø25)	
NN-20UB10	12 x 12 x 150*	5(6)			ø22	4	ø20(ø25)	
NN-32UB8	12 x 12 x 150*	3(4)			ø32	1	ø32	
	16 x 16 x 130	2			ø22	3		
NN-32UB10W	12 x 12 x 150*	3(4)			ø32	1	ø32	
	16 x 16 x 130	2			ø22	3		
NN-20YB	12 x 12 x 130	6			ø23		ø20	
NN-25YB/32YB	16 x 16 x 130	5			ø23/ø32		ø25/ø32	
NN-32YB5	16 x 16 x 130	5			ø22/ø32	4	ø32	
NN-32YB5 XB	16 x 16 x 130	6			ø22/ø32	5/1	ø32	
NN-16J	12 x 12 x 130*	6			ø23		ø16	
NN-20J	12 x 12 x 130*	6			ø23		ø20	
NN-20J2	12 x 12 x 130*	6			ø22	4	ø20	
NN-20J5	12 x 12 x 130*	6			ø22	4	ø20	
NN-20J5 XB	12 x 12 x 130*	5			ø22	4	ø20	
NN-32J	16 x 16 x 130	6			ø25	2	ø32	
					ø32	3		
NN-32DB	16 x 16 x 130	8			ø22	4	ø32	
					ø32	1		
NN-38DB	20 x 20 x 130	7			ø22	4	ø38	
					ø32	1		
NN-38KM	16 x 16 x 130	5			ø25	3	ø38	
					ø32	2		

* 12.7 x 12.7 toolholder mountable

Manufacturers are in no particular order.

List of instruments and applicable small parts machining 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, RL01, RL21	10 x 10	100	…1010F-..
	K12, K16	12 x 12		…1212F-..
	RL02	16 x 16		…1616H-..
	B12E, B16E, BL12, C12, C16, M12, M16 MSL12	10 x 10	120	…1010JX-..
	A20, A20Ⅵ, B20, BL20, BL25, K12E, K16E L20X, L220, MC20	12 x 12		…1212JX-..
	L16, L20, L20E	12 x 12	130	…1212JX-..
	C32, L25, L32, M20, M32	16 x 16		…1616JX-..
	A32, D25		150	
Star Micronics	SW-12RⅡ	10 x 10	120	…1010JX-..
	SB-16A, SB-16C, SB-16D, SB-12Ⅱ, SB-16Ⅱ SB-12R/16R/20R, SR-20Ⅳ, SB-20A/C/E, SC20	12 x 12	130	…1212JX-..
	SR-20RⅡ, SR-20Ⅲ, SV-12, SV-20, SR-20J	12 x 12	135	…1212JX-..
	SV-20R, SV-32, SV-38R, SR-38J, SX-38	16 x 16		…1616JX-..
	SR-25J, SR-32J, SW-20	16 x 16	150	…1616JX-..
Tsugami	B0, BH20, BM, BW2	12 x 12	85	…1212F-..
	C150, C180, C220, S205, S206, SS207	12 x 12	100	…1212F-..
	BH38, B0265, B0266, B0325, B0326 SS26, SS32/32L, SS267, SS327	16 x 16		…1616H-..
Nomura DS	NN-10C, NN-10CS, NN-10EX2, NN-10SⅡ NN-10SB5, NN-10T, NN-16SB5	10 x 10	130	…1010JX-..
	NN-16HⅢ, NN-16J, NN-16SB6/7, NN-16UB5, NN-16UⅢ, NN-20CS, NN-20HⅢ, NN-20J/J2/J5, NN-20SB, NN-20UⅢ, NN-20U5, NN-20UB5/7, NN-20YB	12 x 12		…1212JX-..
	NN-25YB, NN-32DB, NN-32YB/YB5, NN-32J, NN-38KM	16 x 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.

Classification	Toolholder description			Spare parts					
				Lever		Lock screw		Shim	
				New No.	Conventional	New No.	Conventional	New No.	Conventional
External turning toolholders	PCLN$^{R}_{L}$		.....-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
	PDJN$^{R}_{L}$		.....-11	LL-1DN	LL-1D	LS-1N	LS-1	LD-32N	LD-32
			.....-15	LL-3N	LL-3	LS-2N	LS-2	LD-42	
	PSBN$^{R}_{L}$		.....-09	LL-1N	LL-1	LS-1N	LS-1	LS-32	
			.....-12	LL-2N	LL-2	LS-2N	LS-2	LS-42	
	PSKN$^{R}_{L}$		.....-09	LL-1N	LL-1	LS-1N	LS-1	LS-32	
			.....-12	LL-2N	LL-2	LS-2N	LS-2	LS-42	
	PSSN$^{R}_{L}$		.....-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	
	PTGN$^{R}_{L}$		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
	PTFN$^{R}_{L}$		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
	PRGC$^{R}_{L}$		.....-12	LL-1CN	LL-1C	LS-1N	LS-1	LR-12C	
	PRXC$^{R}_{L}$		.....-12						
	PRGN$^{R}_{L}$		.....-09	LL-1N	LL-1	LS-1N	LS-1	LR-80	
			.....-12	LL-2N	LL-2	LS-2N	LS-2	LR-81	
	PWLN$^{R}_{L}$		.....-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	□16M-	PCLN$^{R}_{L}$	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						
	....-	PCLN$^{R}_{L}$	12-..	LL-2N	LL-2	LS-2N	LS-2	LC-42N$^{R}_{L}$	LC-42$^{R}_{L}$
	....-	PDUN$^{R}_{L}$	11-..	LL-1DN	LL-1D	LS-1SN	LS-1S	LD-32N	LD-32
	....-	PTUN$^{R}_{L}$	11-..	LL-03TN	LL-03T	LS-03SN	LS-03S	-	
	S25R-	PTUN$^{R}_{L}$	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						
	□16M-	PWLN$^{R}_{L}$	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						
	....-	PWLN$^{R}_{L}$	08-..	LL-2N	LL-2	LS-2N	LS-2	LW-42N$^{R}_{L}$	LW-42$^{R}_{L}$
Turning mill	T63H-	PCLN$^{R}_{L}$	-DX12	LL-2N	LL-2	LS-2N	LS-2	LC-42N	LC-42
	T63H-	PCMNN	-□12						
	T63H-	PDJN$^{R}_{L}$	-DX15	LL-3N	LL-3	LS-2N	LS-2	LD-42	
	T63H-	PDNNN	-□15						
	T63H-	PTGN$^{R}_{L}$	-DX16	LL-1N	LL-1	LS-1N	LS-1	LT-32N	LT-32
	T63H-	PWLN$^{R}_{L}$	-DX08	LL-2N	LL-2	LS-2N	LS-2	LW-42N	LW-42