M

Endmills

CERAMATIC / Solid Ceramic EndMill

Features

- *Extremely high speed machining for HRSA materials with our durable SiAlON grade "SX9"*
- *More than 15 times higher productivity than a Carbide end mill*
- *4, 6 and 8 flutes are available*
- *Unique patent pending design provides toughness to the edge*

RCE for HRSA materials

➡M4

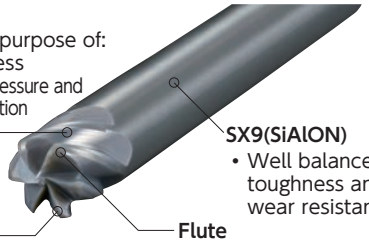
Ceramic specialist's design

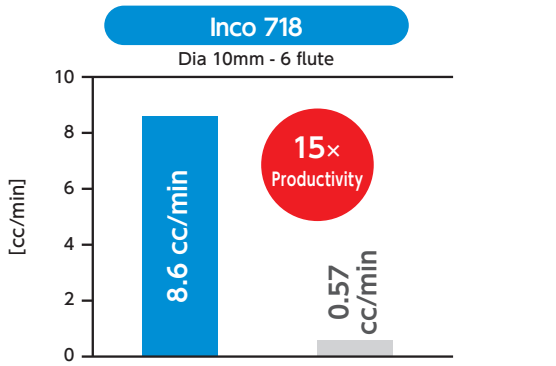
Helix angle
- Designed for the purpose of:
  - 4-flute: toughness
  - 6-flute: less tool pressure and better chip evacuation

SX9(SiAlON)
- Well balanced for toughness and wear resistance

Bottom edge
- Unique shape provides toughness

Flute
- Optimized for HRSA materials
- Excellent toughness

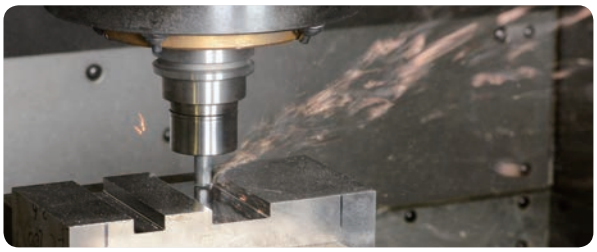




	SX9	Carbide
Cutting Speed (m/min)	600	40
Feed (mm/t)	0.03	⬅
DOC (mm)	3.0	⬅

RCS for Cast iron / HRSA materials

➡M5

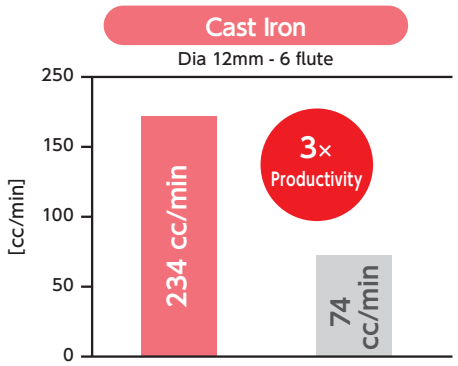


Helix angle
- Designed for the purpose of:
  - 4-flute: toughness
  - 6/8-flute: less tool pressure and better chip evacuation

Flute
- Three flute options up to 8 flute

End Gash
- Bigger end gash brings toughness

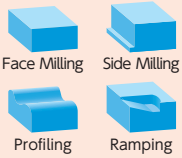
Edge
- Added chamfer provides toughness for cast iron machining



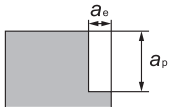
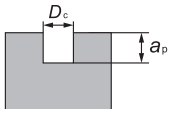
	SX9	Carbide
Cutting Speed (m/min)	700	110
Feed (mm/t)	0.05	⬅
DOC (mm)	3.5	7.0

4-flute

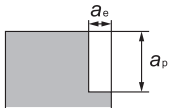
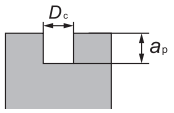
6-flute **8-flute**



Recommend Cutting Conditions for HRSA material

Application	Grade	ϕD_c	Flute	Cutting Speed (m/min) 150 600 1000	Feed (mm/t)	Depth of cut a_p (mm)	Width of cut a_e (mm)	Coolant
Face Milling 	SX9	3/8"	4/6/8		0.03	1.4	—	DRY
		1/2"				1.9		
		5/8"				2.4		
		3/4"				2.9		
		8mm				1.2		
		10mm				1.5		
		12mm				1.8		
		16mm				2.4		
		20mm				3.0		
Side Milling 	SX9	3/8"	4/6/8		0.03	4.8	0.9	DRY
		1/2"				6.4	1.3	
		5/8"				8.0	1.6	
		3/4"				9.5	1.9	
		8mm				4.0	0.8	
		10mm				5.0	1.0	
		12mm				6.0	1.2	
		16mm				8.0	1.6	
		20mm				10.0	2.0	
Slotting 	SX9	3/8"	4		0.03	2.4	—	DRY
		1/2"				3.2		
		5/8"				4.0		
		8mm				2.0		
		10mm				2.5		
		12mm				3.0		
		16mm				4.0		
		3/8"	6			1.4		DRY
		1/2"				1.9		
		5/8"				2.4		
		8mm				1.2		
		10mm				1.5		
		12mm				1.8		
		16mm				2.4		
		3/4"	8		0.03	2.9	—	
		16mm				3.0		

Recommended cutting conditions for Cast Iron

Application	Grade	ϕD_c	Flute	Cutting Speed (m/min) 150 600 1000	Feed (mm/t)	Depth of cut a_p (mm)	Width of cut a_e (mm)	Coolant
Face Milling 	SX9	1/2"	4/6/8		0.1	2.4	—	DRY
		5/8"				5.0		
		3/4"				4.8		
		12mm				3.0		
		16mm				4.0		
		20mm				5.0		
Side Milling 	SX9	1/2"	4/6/8		0.1	9.5	2.1	DRY
		5/8"				11.9	2.6	
		3/4"				14.3	3.2	
		12mm				9.0	2.0	
		16mm				12.0	2.5	
		20mm				15.0	3.3	
Slotting 	SX9	1/2"	4/6/8		0.1	2.4	—	DRY
		5/8"				4.0		
		3/4"				4.8		
		12mm				3.0		
		16mm				4.0		
		20mm				5.0		

For Maximum Productivity

- *A continuous cut is recommended. An interrupted cut may cause chipping or breakage.*
- *When using a Hydraulic or Shrink chuck, blow air to the arbor body, DON'T blow air to the endmill itself.*
- *A Minimum speed of 300m/min is required. (Don't run at lower speed.)*
- *A 1.5 degree ramping angle is recommended. Run at 50% lower feed rate when ramping cut.*

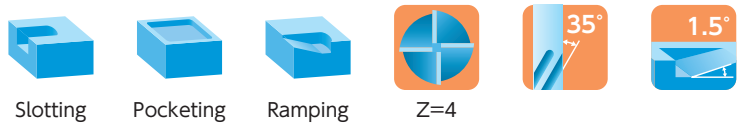
When cutting HRSA materials

- Continue to machine even if you see BUE, removing BUE may cause chipping or breakage to the edge.
- High speed machining work hardens the material. For this reason, leave at least 0.3mm of material for a finishing process.

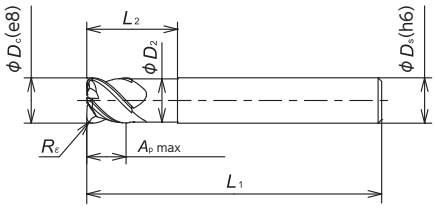
RCE for HRSA Materials

RCE-H4 (4-flute with Neck)

○No center cutting edge



Slotting　Pocketing　Ramping　Z=4



Tolerances

φDc / φDs	e8	h6
8mm, 10mm, 3/8"	-0.024/-0.047	+0/-0.009
12mm, 1/2"	-0.032/-0.059	+0/-0.011

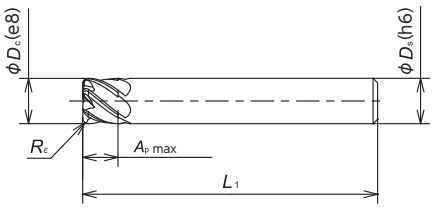
Heat Resistant Alloy　S　●　● : 1st Choice　● : 2nd choice

Item Number	Grade SX9	Flute	φDc (mm)	φDc (Inch)	φDs (mm)	φDs (Inch)	φD2 (mm)	φD2 (Inch)	Rε (mm)	Rε (Inch)	Ap max (mm)	Ap max (Inch)	L1 (mm)	L1 (Inch)	L2 (mm)	L2 (Inch)
RCEM 080H4R100S	●	4	**8.0**	—	8.0	—	7.6	—	1.0	—	6.0	—	60	—	16	—
100H4R125S	●		**10.0**	—	10.0	—	9.6	—	1.25	—	7.5	—	65	—	20	—
120H4R150S	●		**12.0**	—	12.0	—	11.6	—	1.5	—	9.0	—	70	—	24	—
RCEI 375H4R047S	●		**9.525**	3/8	9.525	3/8	9.125	.359	1.19	.047	7.14	9/32	63.5	2.5	19.05	3/4
500H4R068S	●		**12.7**	1/2	12.7	1/2	12.3	.484	1.73	.068	9.525	3/8	69.9	2.75	25.4	1

RCE-J6 (6-flute)

○No center cutting edge

Face Milling　Side Milling　Profiling　Ramping　Z=6



Tolerances

φDc / φDs	e8	h6
8mm, 10mm, 3/8"	-0.024/-0.047	+0/-0.009
12mm, 1/2"	-0.032/-0.059	+0/-0.011

Heat Resistant Alloy　S　●　● : 1st Choice　● : 2nd choice

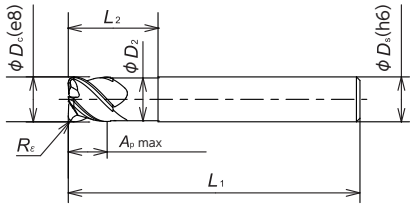
Item Number	Grade SX9	Flute	φDc (mm)	φDc (Inch)	φDs (mm)	φDs (Inch)	φD2 (mm)	φD2 (Inch)	Rε (mm)	Rε (Inch)	Ap max (mm)	Ap max (Inch)	L1 (mm)	L1 (Inch)	L2 (mm)	L2 (Inch)
RCEM 080J6R100S	●	6	**8.0**	—	8.0	—	—	—	1.0	—	6	—	60	—	—	—
100J6R125S	●		**10.0**	—	10.0	—	—	—	1.25	—	7.5	—	65	—	—	—
120J6R150S	●		**12.0**	—	12.0	—	—	—	1.5	—	9	—	70	—	—	—
RCEI 375J6R047S	●		**9.525**	3/8	9.525	3/8	—	—	1.19	.047	7.14	9/32	63.5	2.5	—	—
500J6R068S	●		**12.7**	1/2	12.7	1/2	—	—	1.73	.068	9.525	3/8	69.9	2.75	—	—

RCS for Cast Iron / HRSA Materials

RCS-H4

○No center cutting edge

Slotting　Pocketing　Ramping　Z=4



Tolerances

ϕDc / ϕDs	e8	h6
12mm, 16mm, 1/2", 5/8"	-0.032/-0.059	+0/-0.011

Cast Iron	K	●
Heat Resistant Alloy	S	●

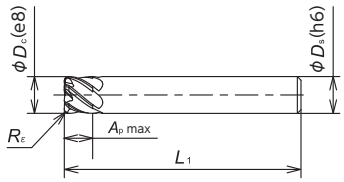
● : 1st Choice　● : 2nd choice

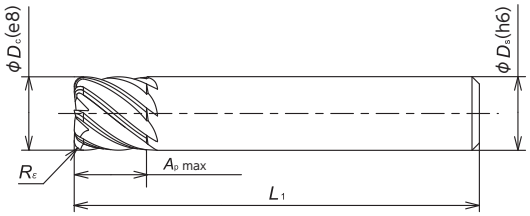
Item Number	Grade SX9	Flute	ϕDc (mm)	ϕDc (Inch)	ϕDs (mm)	ϕDs (Inch)	ϕD2 (mm)	ϕD2 (Inch)	Re (mm)	Re (Inch)	Ap max (mm)	Ap max (Inch)	L1 (mm)	L1 (Inch)	L2 (mm)	L2 (Inch)
RCSM 120H4R150S	●	4	**12.0**	—	12.0	—	11.6	—	1.5	—	9.0	—	70	—	24	—
160H4R200S	●		**16.0**	—	16.0	—	15.5	—	2.0	—	12.0	—	75	—	32	—
RCSI 500H4R068S	●		**12.7**	1/2	12.7	1/2	12.3	.484	1.73	.068	9.525	3/8	69.85	2.75	25.4	1
625H4R078S	●		**15.875**	5/8	15.875	5/8	15.375	.609	1.98	.078	11.91	.469	76.2	3	31.75	1.25

RCS-J6 / RCS-J8

○No center cutting edge

Face Milling　Side Milling　Profiling　Ramping　Z=6　Z=8





Tolerances

ϕDc / ϕDs	e8	h6
12mm, 16mm, 1/2", 5/8"	-0.032/-0.059	+0/-0.011
20mm, 3/4"	-0.040/-0.073	+0/-0.013

Cast Iron	K	●
Heat Resistant Alloy	S	●

● : 1st Choice　● : 2nd choice

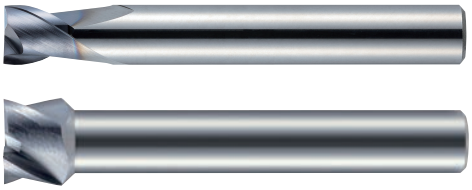
Item Number	Grade SX9	Flute	ϕDc (mm)	ϕDc (Inch)	ϕDs (mm)	ϕDs (Inch)	ϕD2 (mm)	ϕD2 (Inch)	Re (mm)	Re (Inch)	Ap max (mm)	Ap max (Inch)	L1 (mm)	L1 (Inch)	L2 (mm)	L2 (Inch)
RCSM 120J6R150S	●	6	**12.0**	—	12.0	—	—	—	1.5	—	9.0	—	70	—	—	—
160J6R200S	●		**16.0**	—	16.0	—	—	—	2.0	—	12.0	—	75	—	—	—
RCSI 500J6R068S	●		**12.7**	1/2	12.7	1/2	—	—	1.73	.068	9.525	3/8	69.85	2.75	—	—
625J6R078S	●		**15.875**	5/8	15.875	5/8	—	—	1.98	.078	11.91	.469	76.2	3	—	—
RCSM 200J8R250S	●	8	**20.0**	—	20.0	—	—	—	2.5	—	15.0	—	110	—	—	—
RCSI 750J8R094S	●		**19.05**	3/4	19.05	3/4	—	—	2.38	.094	14.29	.562	107.95	4.25	—	—

S-MILL / Solid Carbide Endmill

Features

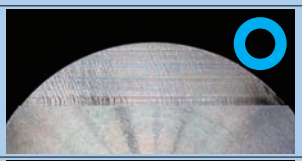
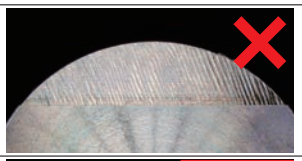
- The tools sharpness creates a remarkable finish on machined surface.
- 2, 3, and 4 flute designs with a selection of diameters to cover a variety of applications. (2 flute available in 2mmϕ)
- 40, 45, and 50mm lengths ideal for automatic lathes.

Two style



Three flute options

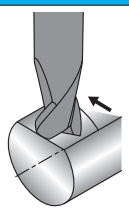
Surface finish

	NTK (S-MILL)	Competitor A	Competitor B
Magnified work material (side face)			
Magnified work material			
	Excellent surface finish	Bad surface finish	

Material: SUS304 (ϕ16mm) ϕ6mm −2 flute 3,000 rpm, F=300mm/min, a_p=3.0mm, a_e=1.2mm

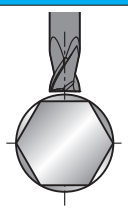
Field Result

SUS416F (D-cut)
ϕ6mm-2 flute

3,200 rpm	
Feed : 140 mm/min	
DOC : 0.6 mm	
WET	
NTK : **S-MILL**	12,000 pcs/corner+α
Competitor's solid endmill	10,000 pcs/corner

The competitor's end mill showed an obvious decrease in surface finish quality as it reached the end of its tool life. NTK's S-MILL maintained a quality surface finish throughout the extent of its longer tool life.

S45C (AF 8mm HEX)
ϕ6mm-2 flute

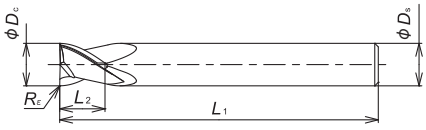
2,600 rpm	
Feed : 480 mm/min	
DOC : 1.0 mm	
WET	
NTK : **S-MILL**	70 pcs/corner+α
Competitor's solid endmill	50 pcs/corner

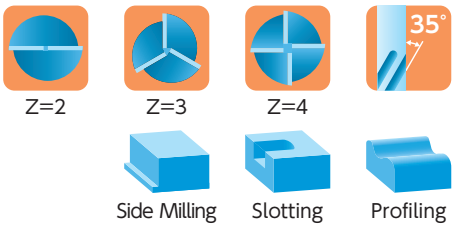
The S-MILL sharpness reduces the occurance of burrs and tool life is increased; clear improvements over the competitor's tool. The sharp cutting edge also produces noticeably less sound than the current tooling.

RWEM

○No center cutting edge

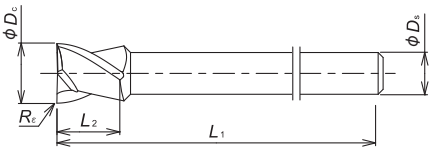
Figure-1





○No center cutting edge

Figure-2



Steel	P	●
Stainless steel	M	●

● : 1st Choice ● : 2nd choice

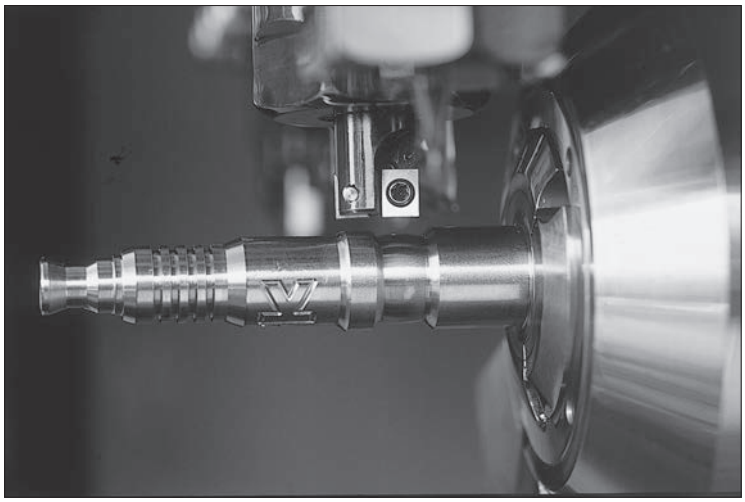
Item Number	Figure	Grade AC3	Flute	φDc (mm)	φDc (Inch)	φDs (mm)	φDs (Inch)	L1 (mm)	L1 (Inch)	L2 (mm)	L2 (Inch)	Rε (mm)	Rε (Inch)
RWEM020H2R00S04	1	●	2	2.0	.080	4.0	.158	40.0	1.575	2.0	.080	0.0	0.0
RWEM030H2R00S04	1	●		3.0	.118	4.0	.158	40.0	1.575	3.0	.118	0.0	0.0
RWEM040H2R00S04	1	●		4.0	.158	4.0	.158	40.0	1.575	4.0	.158	0.0	0.0
RWEM050H2R00S06	1	●		5.0	.197	6.0	.236	45.0	1.772	5.0	.197	0.0	0.0
RWEM060H2R00S06	1	●		6.0	.236	6.0	.236	45.0	1.772	6.0	.236	0.0	0.0
RWEM070H2R00S08	1	●		7.0	.276	8.0	.315	50.0	1.969	6.0	.236	0.0	0.0
RWEM080H2R00S07	2	●		8.0	.315	7.0	.276	50.0	1.969	6.0	.236	0.0	0.0
RWEM080H2R00S08	1	●		8.0	.315	8.0	.315	50.0	1.969	6.0	.236	0.0	0.0
RWEM100H2R00S07	2	●		10.0	.394	7.0	.276	50.0	1.969	6.0	.236	0.0	0.0
RWEM100H2R00S10	1	●		10.0	.394	10.0	.394	50.0	1.969	6.0	.236	0.0	0.0
RWEM030H3R00S04	1	●	3	3.0	.118	4.0	.158	40.0	1.575	3.0	.118	0.0	0.0
RWEM040H3R00S04	1	●		4.0	.158	4.0	.158	40.0	1.575	4.0	.158	0.0	0.0
RWEM050H3R00S06	1	●		5.0	.197	6.0	.236	45.0	1.772	5.0	.197	0.0	0.0
RWEM060H3R00S06	1	●		6.0	.236	6.0	.236	45.0	1.772	6.0	.236	0.0	0.0
RWEM070H3R00S08	1	●		7.0	.276	8.0	.315	50.0	1.969	6.0	.236	0.0	0.0
RWEM080H3R00S07	2	●		8.0	.315	7.0	.276	50.0	1.969	6.0	.236	0.0	0.0
RWEM080H3R00S08	1	●		8.0	.315	8.0	.315	50.0	1.969	6.0	.236	0.0	0.0
RWEM100H3R00S07	2	●		10.0	.394	7.0	.276	50.0	1.969	6.0	.236	0.0	0.0
RWEM100H3R00S10	1	●		10.0	.394	10.0	.394	50.0	1.969	6.0	.236	0.0	0.0
RWEM030H4R00S04	1	●	4	3.0	.118	4.0	.158	40.0	1.575	3.0	.118	0.0	0.0
RWEM040H4R00S04	1	●		4.0	.158	4.0	.158	40.0	1.575	4.0	.158	0.0	0.0
RWEM050H4R00S06	1	●		5.0	.197	6.0	.236	45.0	1.772	5.0	.197	0.0	0.0
RWEM060H4R00S06	1	●		6.0	.236	6.0	.236	45.0	1.772	6.0	.236	0.0	0.0
RWEM070H4R00S08	1	●		7.0	.276	8.0	.315	50.0	1.969	6.0	.236	0.0	0.0
RWEM080H4R00S07	2	●		8.0	.315	7.0	.276	50.0	1.969	6.0	.236	0.0	0.0
RWEM080H4R00S08	1	●		8.0	.315	8.0	.315	50.0	1.969	6.0	.236	0.0	0.0
RWEM100H4R00S07	2	●		10.0	.394	7.0	.276	50.0	1.969	6.0	.236	0.0	0.0
RWEM100H4R00S10	1	●		10.0	.394	10.0	.394	50.0	1.969	6.0	.236	0.0	0.0

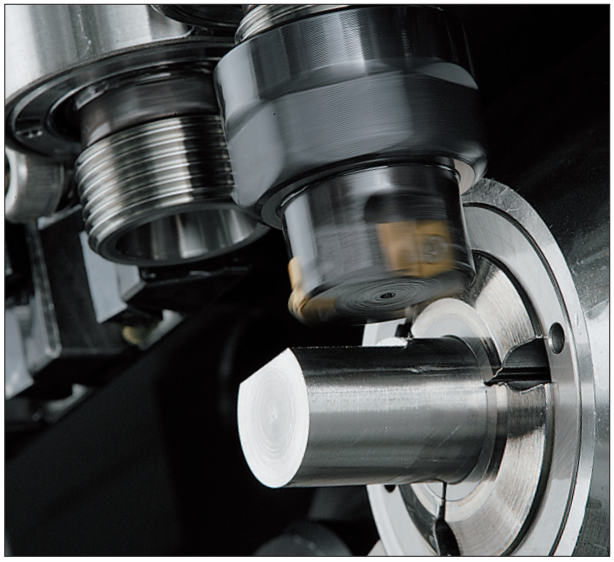
【Recommend Cutting Conditions】

Flute	Cutting diameter φDc (mm)	Carbon steel S45C		Alloy steel SCM435		Stainless steel SUS304		ae=φDc×0.2		ae=φDc×0.5		ae=φDc×0.75		ae=φDc×0.9		ae=φDc
		RPM (min-1)	Feed (mm/min)	RPM (min-1)	Feed (mm/min)	RPM (min-1)	Feed (mm/min)	ap (mm)	ae (mm)	ap (mm)	ae (mm)	ap (mm)	ae (mm)	ap (mm)	ae (mm)	ap (mm)
2 flutes	2.0	6,000	100	6,000	100	6,000	90	≦2.0	0.4	≦0.8	1.0	≦0.6	1.5	≦0.5	1.8	≦0.4
	3.0	6,000	210	6,000	240	6,000	180	≦3.0	0.6	≦1.2	1.5	≦0.9	2.3	≦0.7	2.7	≦0.6
	4.0	6,000	320	5,600	300	5,200	240	≦4.0	0.8	≦1.6	2.0	≦1.2	3.0	≦1.0	3.6	≦0.8
	5.0	5,000	370	4,500	330	4,100	260	≦5.0	1.0	≦2.0	2.5	≦1.5	3.8	≦1.2	4.5	≦1.0
	6.0	4,200	380	3,700	340	3,400	270	≦6.0	1.2	≦2.4	3.0	≦1.8	4.5	≦1.5	5.4	≦1.2
	7.0	3,600	370	3,200	330	3,000	270	≦6.0	1.4	≦2.8	3.5	≦2.1	5.3	≦1.7	6.3	≦1.4
	8.0	3,200	360	2,800	320	2,600	250	≦6.0	1.6	≦3.2	4.0	≦2.4	6.0	≦2.0	7.2	≦1.6
	10.0	2,500	320	2,200	280	2,100	230	≦6.0	2.0	≦4.0	5.0	≦3.0	7.5	≦2.5	9.0	≦2.0
3 flutes	3.0	6,000	250	6,000	250	6,000	220	≦3.0	0.6	≦1.2	1.5	≦0.9	2.3	≦0.7	2.7	≦0.6
	4.0	6,000	390	5,600	360	5,200	290	≦4.0	0.8	≦1.6	2.0	≦1.2	3.0	≦1.0	3.6	≦0.8
	5.0	5,000	440	4,500	400	4,100	310	≦5.0	1.0	≦2.0	2.5	≦1.5	3.8	≦1.2	4.5	≦1.0
	6.0	4,200	460	3,700	410	3,400	330	≦6.0	1.2	≦2.4	3.0	≦1.8	4.5	≦1.5	5.4	≦1.2
	7.0	3,600	450	3,200	400	3,000	320	≦6.0	1.4	≦2.8	3.5	≦2.1	5.3	≦1.7	6.3	≦1.4
	8.0	3,200	430	2,800	380	2,600	310	≦6.0	1.6	≦3.2	4.0	≦2.4	6.0	≦2.0	7.2	≦1.6
	10.0	2,500	380	2,200	330	2,100	280	≦6.0	2.0	≦4.0	5.0	≦3.0	7.5	≦2.5	9.0	≦2.0
4 flutes	3.0	6,000	290	6,000	290	6,000	250	≦3.0	0.6	≦1.2	1.5	≦0.9	2.3	≦0.7	2.7	≦0.6
	4.0	6,000	450	5,500	410	5,200	340	≦4.0	0.8	≦1.6	2.0	≦1.2	3.0	≦1.0	3.6	≦0.8
	5.0	5,000	520	4,500	460	4,100	370	≦5.0	1.0	≦2.0	2.5	≦1.5	3.8	≦1.2	4.5	≦1.0
	6.0	4,200	540	3,700	480	3,400	380	≦6.0	1.2	≦2.4	3.0	≦1.8	4.5	≦1.5	5.4	≦1.2
	7.0	3,600	520	3,200	460	3,000	380	≦6.0	1.4	≦2.8	3.5	≦2.1	5.3	≦1.7	6.3	≦1.4
	8.0	3,200	500	2,800	440	2,600	360	≦6.0	1.6	≦3.2	4.0	≦2.4	6.0	≦2.0	7.2	≦1.6
	10.0	2,500	440	2,200	390	2,100	320	≦6.0	2.0	≦4.0	5.0	≦3.0	7.5	≦2.5	9.0	≦2.0

・Cutting conditions (machine, work material...) affects surface finish and burr generation.
If cutting performance is not good with above cutting conditions, please adjust speed and feed by same ratio.

Small Diameter Indexable Endmills





Features

- **Attach 20mm end mills in ER16 collet**
- Just change inserts to index. No need to make any adjustments
- High quality surface finish, as low as 1um (Rz) when wiper inserts are used
- Corner radius as small as 0.05mm
- In addition to D cut, ramp machining can be performed*

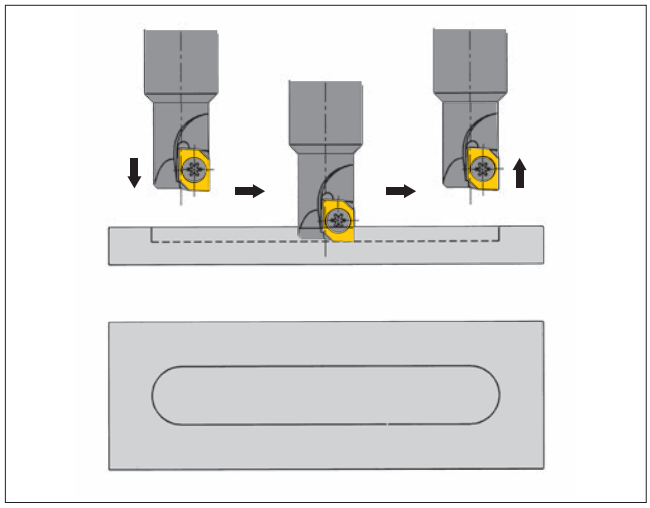
*A combination of single-blade type endmills and inserts with center blade is required

【Recommended Cutting Conditions】

Work Material	Speed (m/min)	Axial feed (mm/t)	Traverse feed (mm/t)	Depth of cut (mm)	Width of cut
Steel	80 - 120	~0.03	~0.05	~3.0	~50% of cutter diameter
Stainless Steel	40 - 60	~0.02	~0.04	~2.0	~50% of cutter diameter

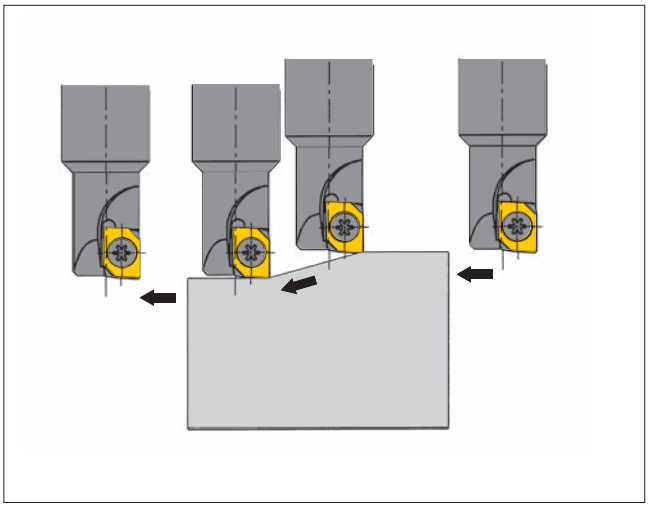
Application Example

■Application Example-1



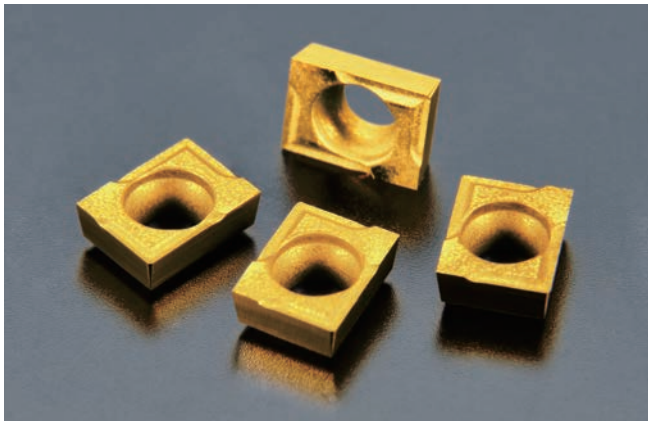
- A single tooth endmill equipped with a center cutting edge insert can be used for both plunge and side cut operations.

■Application Example-2



- A single tooth endmill equipped with a center cutting edge insert can be used for slope milling operations.

Insert



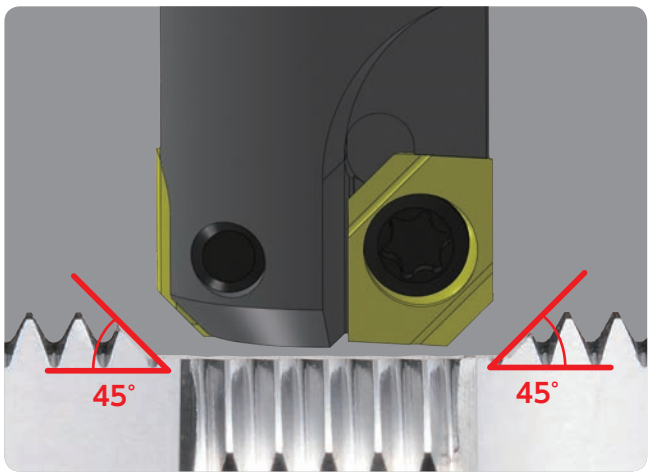
Wiper

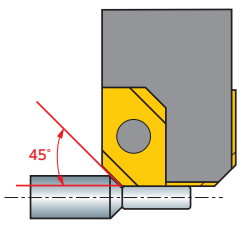
- Excellent surface finish obtained with new wiper insert

Chipbreaker

- Less tool pressure with chipbreaker

45°



Chamfered surface finish insert	
S45C	
Speed : 95 m/min	
Feed : 0.14 mm/rev	
DOC : 1.0 mm	
WET	
NTK : **QM3 C45 type**	700 pcs
Competitor's solid endmill	500 pcs

REZ Series

REZ

〈D cutting = lead angle 90 type end milling tool〉

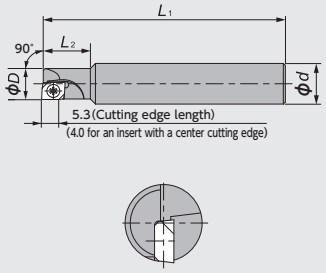


Figure-1

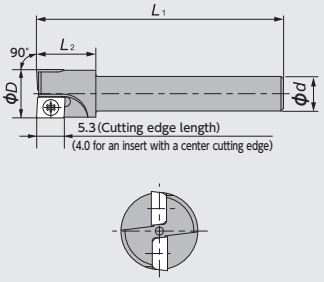


Figure-2

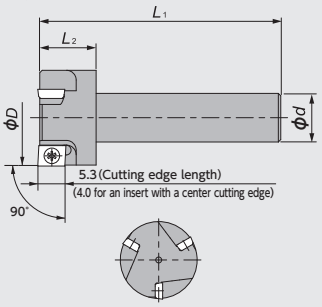


Figure-3 ●Right-Hand style shown

〈D cutting = lead angle 45 type end milling tool〉

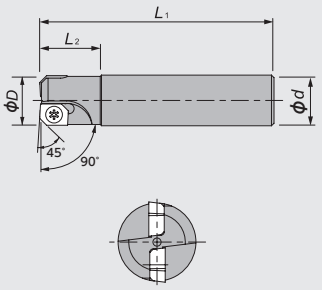
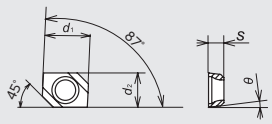


Figure-4

REZ Series - Toolholders

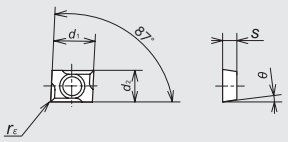
Figure	Code No.	Item Number	Stock R	Stock L	No. of teeth	Dimensions (mm) ϕD	ϕd	L1	L2	Gage insert	Spare Parts: Clamp screw	Spare Parts: Wrench
1	5276498	**REZ080C1R212**	●		1	8	10	60	12	CZH04□□CFR□□□	FS102-2.2×4.0	T-07
	5285812	**100C1R218**	●					75		CZH05□□CFR□□□		
2	5520317	**REZ100B2R329**	●		2	10	5	40	10	CZH04□□CFR□□□	FS102-2.2×4.3	
	5120936	**100C2R133**	●				6	50	12			
	5120951	**100C2R132**	●				7					
	5137971	**100C2R141**	●				10					
	5355458	**120C2R141**	●			12						
	5355466	**140C2R141**	●			14						
3	5520325	**REZ150B3R330**	●		3	15	5	40	10			
	5496088	**200M3R319**	●			20	7	50	12			
	5496096	**200M3R320**	●				10					
4	5880281	**REZ100C2R461**	●		2	10	10	50	12	CZH0400CFR-C45 CZH04□□CFR□□□		
	5880299	**100C2R466**	●				7					

REZ Series - Inserts



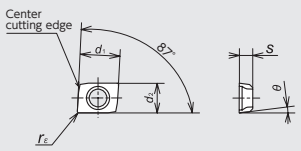
Chipbreaker without wiper

Figure-1



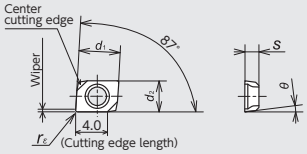
chipbreaker

Figure-2



Center cutting edge without wiper

Figure-3



Center cutting edge with wiper

Figure-4

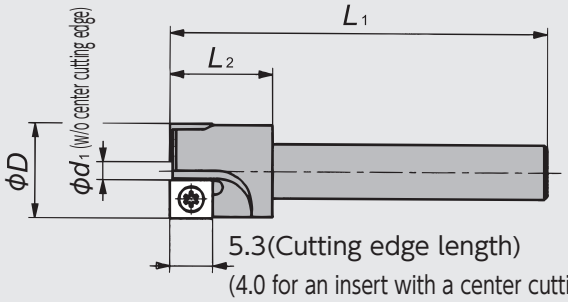
Figure	Item Number	Dimensions (mm) d1	d2	s	θ	c or rε	PVD Coated Carbide ZM3	Stock	TM4	Stock	DT4	Stock	QM3	Stock	DM4	Stock
1	**CZH0400CFR-C45** ※	5.56	4.20	1.88	7°	C1.35					5880315	●	5880307	●		
2	**CZH04005CFR-BL**	5.56	4.20	1.88	7°	0.05			5819008	●					5900907	●
	0402CFR-BL					0.2			5818984	●					5900915	●
3	**CZH04005CFR-070**	5.56	4.20	1.88	7°	0.05	5230479	●	–	–	5849815	●				
	0402CFR-070					0.2	5120944	●	–	–	5849823	●				
4	**CZH04005CFR-140**	5.56	4.20	1.88	7°	0.05	5310883	●	–	–	5849831	●				
	0402CFR-140					0.2	5310958	●	–	–	5849849	●				
	CZH05005CFR-141	5.28	5.56	2.18	10°	0.05	5310925	●	–	–						
	0502CFR-141					0.2	5310909	●	–	–						

※ Must be used with REZ100C2R461/466Cuters.

REL Series

REL

Standard type end milling tool
Cutter diameter : ϕ10

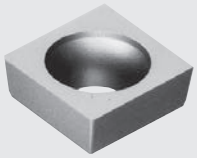


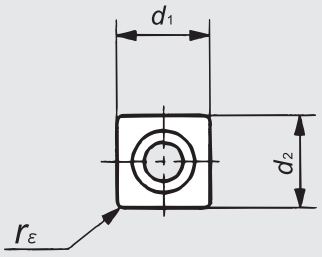
● Right-hand style shown

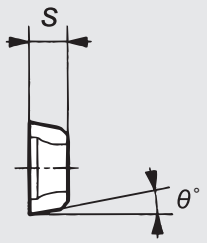
REL Series - Toolholders

Code No.	Item Number	Stock R	Stock L	No. of teeth	Dimensions (mm) ϕD	ϕd	ϕd_1	L_1	L_2	Gage insert	Spare Parts: Clamp screw	Spare Parts: Wrench
5092358	**REL100C2R107**	●		2	10	7	(1.2)	50	12	CLH04 □□ CFN-045	FS102-2.2*4.3	T-07
5092374	**100C2R106**	●				10						

REL Series - Inserts





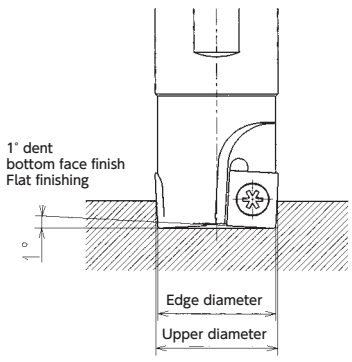


Item Number	Dimensions (mm) d_1	d_2	s	θ	r_ε	PVD coated carbide ZM3	Stock
CLH04005CFN-045	5.56	4.20	1.88	7°	0.05	5101894	●
0402CFN-045					0.2	5066535	●

Precaution for using REL type

When using the REL type end milling tool, tapering will occur on the side machined area of the work piece by the following amount:

Depth of cut (mm)	Top face machining dia – Bottom face machining dia (mm)
2	0.05
3	0.08
4	0.12
5	0.15



RCL type rectangular tooth chamfering type

Features

- Cycle time can be reduced by using micro-grain carbide grade inserts. (Compared with the high-speed steel (HSS) end milling tools).
- Improved surface finish

① Cutter diameter and machining conditions

Cutter diameter	Recommended module	Recommended feed rate
ϕ 14	2.25 or less	0.3㎜ /rev or less
ϕ 12	2.15 or less	0.3㎜ /rev or less

If the recommended module or the recommended feed rate is exceeded, the clamping screw should be re-tightened at least once or twice a day to prevent loss of secure clamping.

Precautions

① When mounting the end milling tool, ensure a minimum amount of overhang from the chuck to the tool nose in order to prevent run out during machining (Target value: approx. 20 mm)

② As is probably known, gear tooth chamfering applies shock loading due to interrupted cutting. For this reason, the holder and clamping screw may deteriorate quicker than normal. Therefore, we request that you replace the holder and clamping screw periodically with new ones for safer and more stable operation.

③ In addition, please re-tighten the clamping screw regularly to avoid loss of clamping force during machining.

【Actual examples】

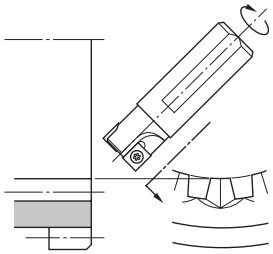
Gear tooth chamfering on sleeve

Work material : SCM415

Cutting speed (m/㎜) = 154

No. of revolutions (㎜$^{-1}$) = 3,500

Cutting oil : WET



NTK : **ZM3** 2-insert	2,000 pcs
Competitor's PVD-coated carbide Single insert	200 pcs

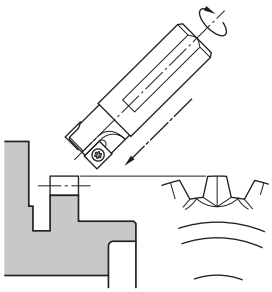
Gear chamfering on speed gear

Work material : SCr420 (HB140 ～ 230)

Cutting speed (m/㎜) = 42

No. of revolutions (㎜$^{-1}$) = 955

Cutting oil : WET



NTK : **ZM3** 2-insert	1,500 pcs
SKH55 Solid	100 pcs

RCL Series

RCL Gear tooth chamfering type

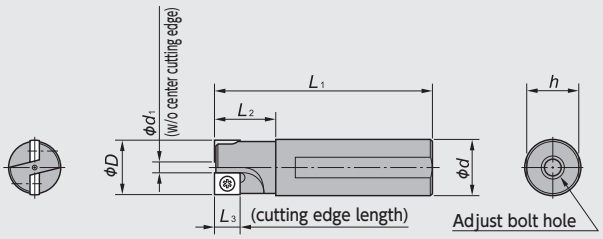


Figure-1

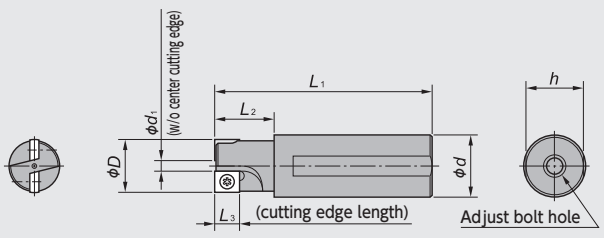


Figure-2

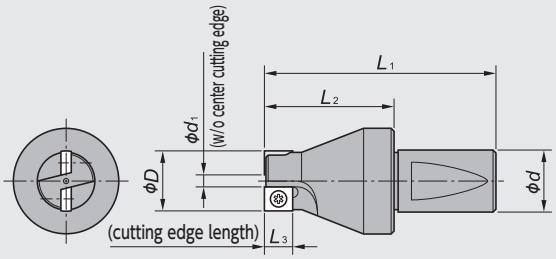


Figure-3

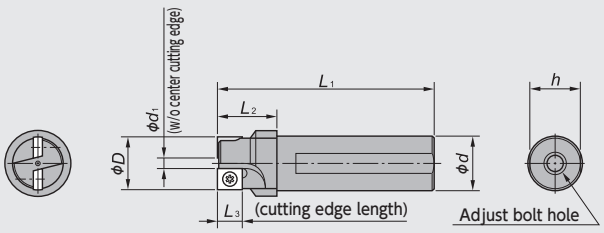


Figure-4

●Right-hand style shown

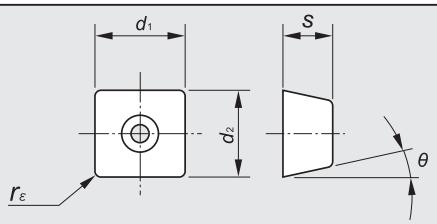
RCL Series - Toolholders

Figure	Code No.	Item Number	Stock R	Stock L	Dimensions (mm) ϕD	ϕd	ϕd1	h	L1	L2	L3	Adjust bolt hole	Gage insert	Spare Parts: Clamp screw	Spare Parts: Wrench
1	5025952	RCL120D2R050	●		12	12	(ϕ3)	11	60	15	(5)	M4＊20L	CLH0402C□□□-004	FS101-2.5＊5	CLR-15S (A)
	5025945	L050		●											
	5005046	RCL140D2R021	●		14	14	(ϕ4)	13	55		(6)	M6＊20L	CLH050□CFN		
	5005053	L021		●											
2	5034913	RCL120D2R059	●		12	14	(ϕ3)	13	55	15	(5)	M6＊20L	CLH0402C□□□-004	FS101-2.5＊5	CLR-15S (A)
	5034921	L059		●											
3	5005236	RCL140Z2R020	●		14	14	(ϕ4)	–	54	30	(6)	–	CLH050□CFN	FS101-2.5＊5	CLR-15S (A)
	5005228	L020		●											
4	5051792	RCL100D2R066	●		10	10	(ϕ3)	9.5	60	18	(5)	M4＊20L	CLH0402C□□□-035	FS104-2.0＊4.3	T-06 (B)
	5051784	L066		●											

【Cutting edge process】

FN	Sharp edge
TNB	T00525

RCL Series - Inserts



Item Number	Dimensions (mm) d1	d2	s	θ	rε	PVD Coated Carbide ZM3	Stock	DM4	Stock
CLH0402CFN-035	5.56	4.20	1.88	7°	0.2	5051750	●	5846951	●
CTNB035						5084819	●	5847744	●
CFN-004	5.56	4.76	1.88	7°	0.2	5027123	●	5847736	●
CTNB004						5019351	●	5827381	●
CLH0502CFN	6.35	5.56	2.18	11°	0.2	5992201	●	5847710	●
CLH0504CFN					0.4	5996186	●	5847702	●

MEMO

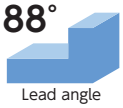
N

Rotating Tools
(Milling Cutters)

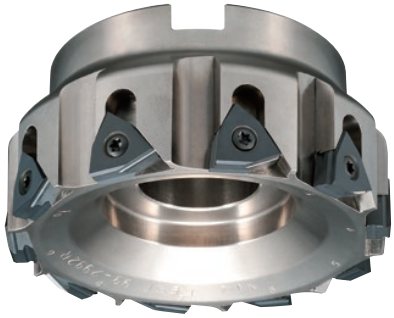
FU-HA (JWNXM)

Stable gray cast iron milling with lower cutting force

- Maximizes ceramic insert potential and can mill faster than 1,000m/min



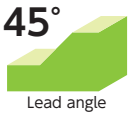
A.R. 5°
R.R. 4° , 7° , 10°

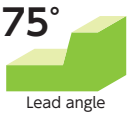


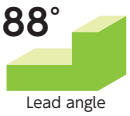
N4

FDX

- Extremely economical as SNGN1204 style inserts with 8 cutting edges can be used
- Capable of producing excellent surface finish, by utilising inserts with chipbreakers and wiper facets







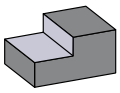
A.R.-6°
R.R.-10°

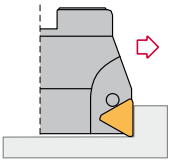
N6

NEW

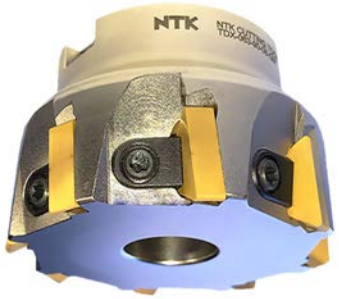
TDX

- Economical & Multi-Functional
- TNGN 1604 style inserts with 6 cutting edges
- Low Cutting Force





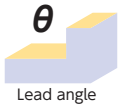
NEW



N7

HMC

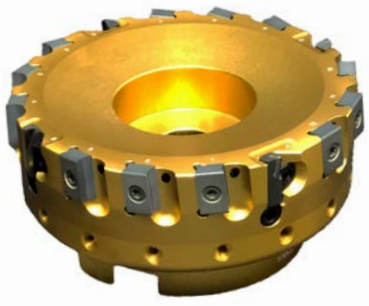
- Hybrid Milling Cutter with adjustable inserts
- Finishing Cast Iron by using SX6 & B30
- Roughing Aluminum by using SX6 & PD1



A.R.-4°
R.R.0°

θ : 88°

NEW



N8

XTM

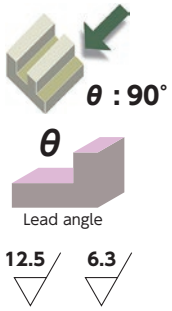
- Offers high efficiency machining due to the multi-blade design and possibility for greater depth of cut
- Offers a reduction in cutting force via our special chipbreaker design

A.R.–4°
R.R.0°

N9

QTE / QTS

- Ceramic milling cutter capable of shoulder milling now released
- Accommodates from φ20 up to φ250 cutters



N10

N10

RNIW / RPIW

- Round insert Milling cutter for cast iron and for high-temperature resistant materials HRSA (Inconell, Rene, MAR,Waspelloy....)

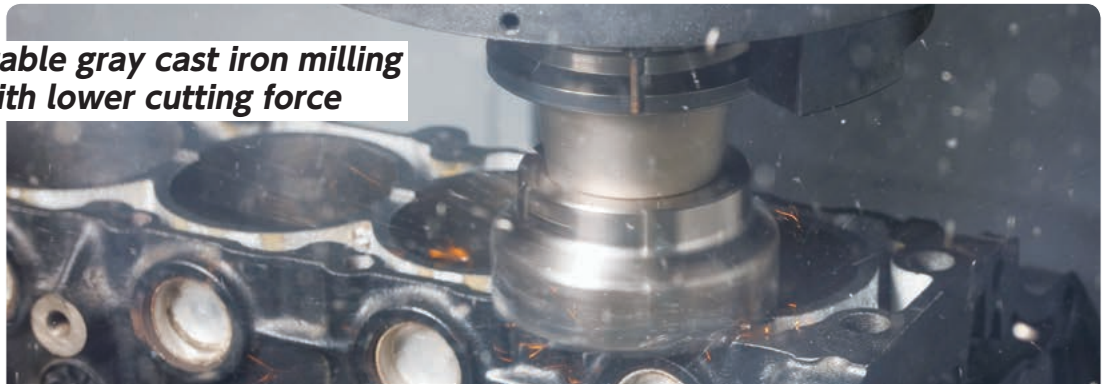
N11

N12

NEW

N13

FU-HA Cutter (JWNXM)



- *Stable gray cast iron milling with lower cutting force*

WATCH ON YouTube

- *Maximizes ceramic insert potential and can mill faster than 1000m/min*

Thanks to lower cutting forces, work piece chipping is reduced Apply up to Ap 6mm

Available cutter dia. ϕ63 - ϕ160

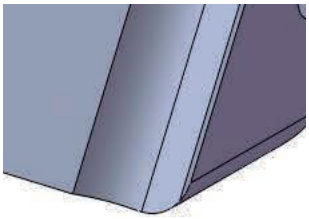
Silicon Nitride grade is the best choice for roughing cast iron with scale. Tool pressure is reduced because of the sharper cutting edge and the ground-in chipbreaker

Very cost efficient with a unique 6 cutting edge design

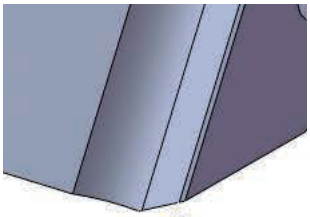
Thanks to low-cutting resistance, machine over load is avoided

Cutting condition

v_c=800m/min f_z=0.10mm/t a_p=3.0mm a_e=80.0mm



【Radius type】



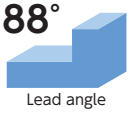
【Chamfered type】

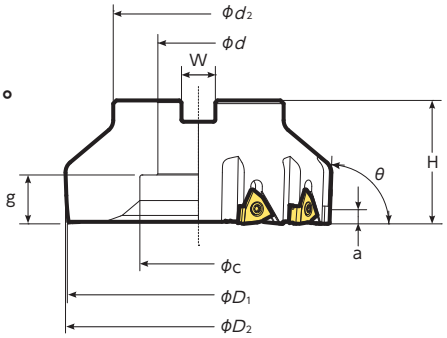
Two edge preparation are available.
Radius type good for high feed milling.
Chamfered type with excellent edge sharpness.

Cycle time reduction with single pass and achieve longer tool life.
Lesser machine horsepower required.

A. R. +5°
R. R. +4°, +7°, +10°

88°





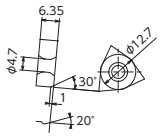
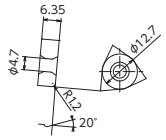
JWNXM type milling body

θ	Code No.	Part number	Stock	No. of inserts	Dimensions (mm)										Weight (kg)	Rake angle (°)		Centering location type
					ϕD1	ϕD2	H	a※1	a※2	ϕd1	W	ϕd2	ϕc	g		A.R.	R.R.	
88°	QUE002327	JWNXM063-88-06R-GM	●	6	63	63	50	5.5	4.5	22	10.4	60	18	15.5	0.9	+5	+4	FMC
	QUE002823	JWNXM080-88-08R-GM	●	8	80	80				27	12,4		36	15	1.1		+7	FMA
	QUE002749	JWNXM100-88-10R-GM	●	10	100	100				32	14,4	80	50	18	1.8		+10	
		JWNXM125-88-12R-GM	●	12	125	125	58			40	16,4		55	23	3			
		JWNXM160-88-16R-GM	●	16	160	160	60			40	16,4	100	72	22	4.9			

※1 Dimension when set the insert 「WNX44-C10T01020」
※2 Dimension when set the insert 「WNX44-R12T01020」

Parts	
Clamping Screw FSI 26-4.0×12-LH 5861935 Sales quantity 10pcs/case	Wrench LLR-T15 5701909 Sales quantity 5pcs/case

Insert

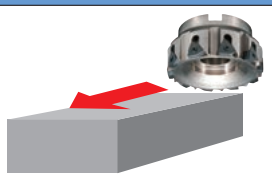
Shape	Dimensions (mm)	Part number	C or r_ε	Grade	
		WNX44-C10T01020	C1.0	SX6	●
				SP9	●
		WNX44-R12T01020	R1.2	SX6	●
				SP9	●

● : New standard stock items

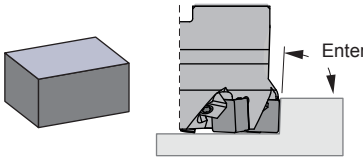
Recommended cutting conditions

Grade	Work material	Cutting speed (m/min)	Feed (mm/t)	Depth of cut (mm)
	K	400 500 600 700 800 900 1000 1100 1200 1300 1400	0.05 0.1 0.15 0.2 0.25 0.3	
SX6	Gray cast iron			~6 (mm)
SP9	Ductile cast iron			

Case study

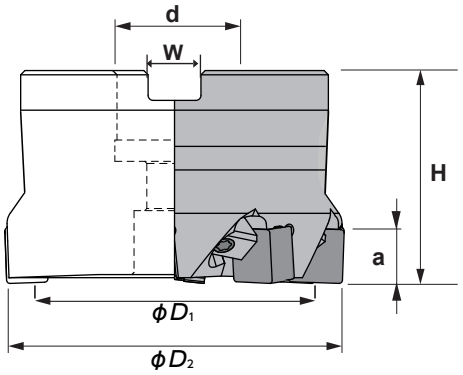
Transmission case ●Work material : FC23			
	current tool	NTK	
Holder	Competitor	JWNXM125A3810R12	
Insert	Ceramic insert	SX6 WNX44-R12T01020	
Cutting speed (m/min)	500	←	
Feed pertooth (mm/t)	0.13	←	As for competitor's milling cutter, we needed to change inserts to new ones due to the wearprogress and lower clamping force of work material after machining 60 pcs. This was caused by increasing Cutting force. NTK NEW Milling cutter "FU-HA MILL" achieved 2 times longer competitor's. Low cutting force avoided the problem occurred by competitor's milling cutter.
Depth of cut (mm)	1	←	
Coolant	DRY	←	
Tool life (pcs/coner)	60	120	

FDX Cutter



45°, 75°, 88°, 90°

Adjustable Cutter available!



Characteristics:

Negative milling cutter with 45°, 75°, 88°, 90° entering angle. Its strong inserts accept high cutting depths and high feed per teeth. First option for cast iron milling.

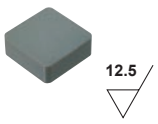
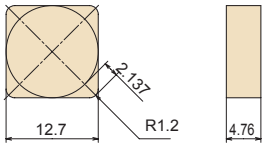
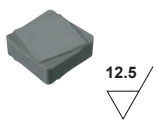
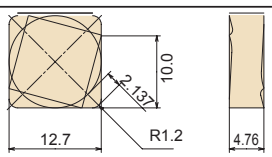
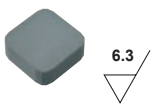
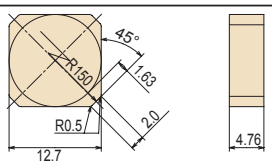
Spare parts

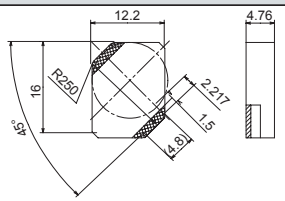
Clamp - W6226-GM

Clamping screw- AOB-6S-T30-GM
***Will be replaced from 2020:**
WS0616-T15-GM, (QEU003866)

θ	Item number	Reference	Standard		Dimensions (mm)							Weight
					ϕD1	ϕD2	H	a	ϕd	W	ϕd2	(kg)
45°	QEU003191	**FDX050-45-05R-GM**	●	5	50	58	50	8	22	10,4	45	0.78
		FDX063-45-06R-GM	●	6	63	72	50	8	22	10,4	58	0.93
	QEU003676	**FDX080-45-08R-GM**	●	8	80	95	50	8	27	12,4	62	1.21
		FDX100-45-10R-GM	●	10	100	120	50	8	32	14,7	62	1.66
	QEU002622	**FDX125-45-13R-GM**	●	13	125	146	58	8	40	16,4	83	2.80
75°	QEU000508	**FDX050-75-05R-GM**	●	5	50	57	50	12	22	10.4	45	0.65
	QEU000509	**FDX063-75-06R-GM**	●	6	63	70	50	12	22	10.4	58	0.79
	QEU000487	**FDX080-75-08R-GM**	●	8	80	87	50	12	27	12,4	62	1.06
	QEU000510	**FDX100-75-10R-GM**	●	10	100	107	50	12	32	14,7	62	1.39
	QEU000493	**FDX125-75-13R-GM**	●	13	125	132	58	12	40	16,4	83	2.56
		FDX160-75-16R-GM	●	16	160	166	60	12	40	16,4	100	4.1
88°	QEU000477	**FDX050-88-05R-GM**	●	5	50	51	50	12	22	10.4	45	0.65
	QEU000478	**FDX063-88-06R-GM**	●	6	63	64	50	12	22	10.4	58	0.79
	QEU000479	**FDX080-88-08R-GM**	●	8	80	81	50	12	27	12,4	62	1.06
	QEU000480	**FDX100-88-10R-GM**	●	10	100	101	50	12	32	14,7	62	1.39
	QEU000492	**FDX125-88-13R-GM**	●	13	125	126	58	12	40	16,4	83	2.56
	QEU000484	**FDX160-88-16R-GM**	●	16	160	156	60	12	40	16,4	100	4.1
90°	QEU002366	**FDX050-90-05R-GM**	●	5	50	50	50	12,7	22	10.4	45	0.65
	QEU000515	**FDX063-90-06R-GM**	●	6	63	63	50	12,7	22	10.4	58	0.79

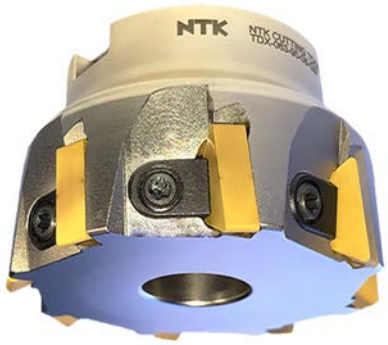
Applicable inserts

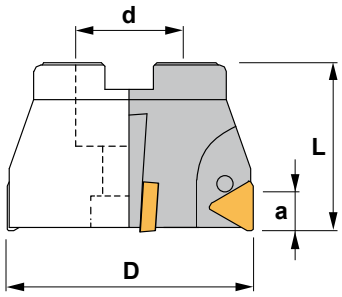
Shape	Dimensions (mm)	Reference	R	Silicon Nitride		Whisker
				SX6	SP9	WA1
		**SNGN 120408 T00520**	0.8			●
		SNGN 120408 T02020	0.8	●	●	
		SNGN 120412 T00520	1.2			●
		SNGN 120412 T02020	1.2	●	●	
		SNGN 120416 T00520	1.6			●
		SNGN 120416 T02020	1.6	●	●	
 with chipbreaker		**SNGF 120412 TRC-C**	1.2	●	●	
 with wiper		**SNGN 1204AN TW**	—	●	●	

Dimensions (mm)	Reference	R	CBN	
			B30	B52
 θ=45°	**FDX 1204-45-50R**	—	●	●

NEW

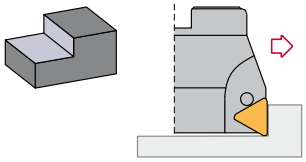
TDX Cutter





Characteristics:

Economical & Multi-Functional
TNGN 1604 style inserts with 6 cutting edges

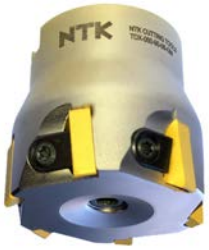


Item number	Reference		D	L	a	d	Insert	Kg
QEU003878	*TDX040-90-04-GM	04	40	50	16	22	TNGN 1604..	0,70
QEU003700	TDX050-90-06-GM	06	50	50	16	22	TNGN 1604..	0,78
QEU003678	TDX063-90-08-GM	08	63	50	16	22	TNGN 1604..	0,93
QEU003679	TDX080-90-10-GM	10	80	50	16	27	TNGN 1604..	1,21
	TDX100-90-14-GM	14	100	50	16	32	TNGN 1604..	1,66
	TDX125-90-16-GM	16	125	63	16	40	TNGN 1604..	2,80

Spare parts

Clamp - W6226-GM
*Clamp for TDX040: W6336-GM

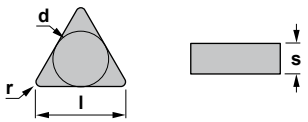
Clamping screw- WS0616-T15-GM



Applicable insert

TNGN Triangular negative insert.

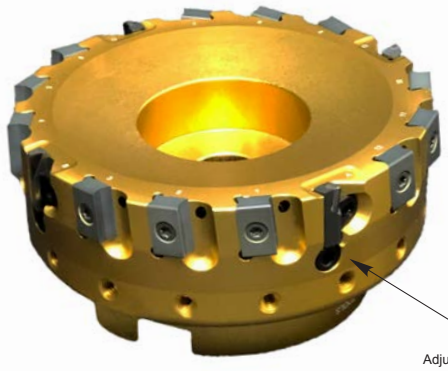
Reference	l	s	d
TNGN 1604..	16,50	4,76	9,52



TNGN

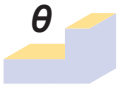
NEW

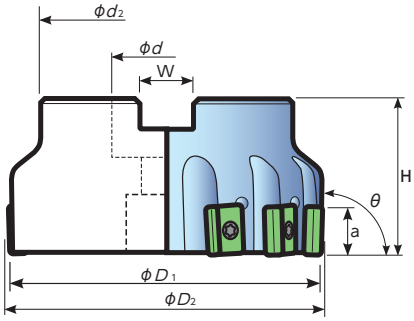
HMC Cutter



A.R.-4°
R.R.0°

θ : 88°





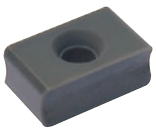
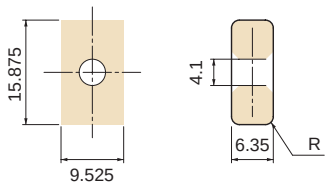
θ	Item No.	Reference	Standard		Dimensions(mm)									Weight (kg)
					ϕD1	ϕD2	H	a	ϕd	W	ϕd2	ϕc	g	
88°	QEU003684	HMC063-88-06/2-GM	●	6/2	63	66	50	14	22	10,4	58			0,76
	QEU003685	HMC080-88-08/2-GM	●	8/2	80	83	50	14	27	12,4	58			0,96
	QEU003686	HMC100-88-10/3-GM	●	10/3	100	103	50	14	32	14,7	77			1,47
	QEU003513	HMC125-88-12/4-GM	●	12/4	125	128	58	14	40	16,4	77			1,92

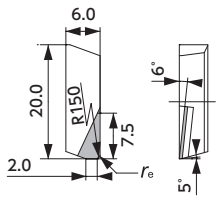
Spare parts

Parts LNX-Inserts	
Clamping screw	Wrench
	
LRIS-4＊12 **QEU000791** 10pcs/case	LLR-25S **5364930** 1pcs/case

Parts HFT-Inserts				
Wedge	Axial set screw		Wedge set screw	
	Screw	Screwdriver	Screw	Screwdriver
HLW179	CS0510A	LW-4	WS0512	LW-2.5
				

Applicable inserts

Shape	Dimensions	Part No.	R	Grade
		**LNX 324-08 FNX08** **(For Aluminum)** **LNX 324-08 T00520** **(For Cast Iron)**	0.8	**SX6** ●

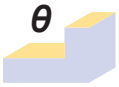
Wiper	Shape	Item Number	Corner angle	Max DOC (mm)		A.R.	r_ε (mm)	PCD / CBN	
				AL	GG			PD1	B30
Yes (Rounded)	For Standard use 	**HFT 802006 C05**	90°	7.5	0,5	6°	C0.5	●	●
Yes (Rounded)		**HFT 802006 R04**	90°	7.5	0,5	6°	R0.4	●	●

● : Standard
● : Coming Soon

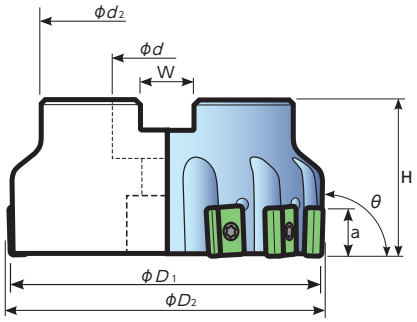
XTM Cutter

A.R.−4°
R.R.0°

θ : 88°



12.5

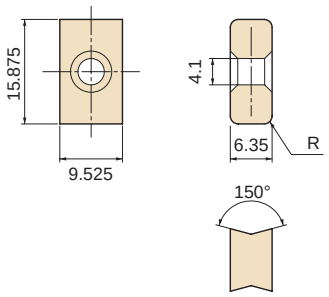


θ	Item No.	Reference	Standard		Dimensions(mm)									Weight (kg)
					ϕD1	ϕD2	H	a	ϕd	W	ϕd2	ϕc	g	
88°	QEU000471	**XTM080-88-10R-GM**	●	10	80	83	50	14	27	12,4	58			1.1
	QEU000473	**XTM100-88-13R-GM**	●	13	100	103	50	14	32	14,7	77			1.8
	QEU000475	**XTM125-88-16R-GM**	●	16	125	128	58	14	40	16,4	77			3.1

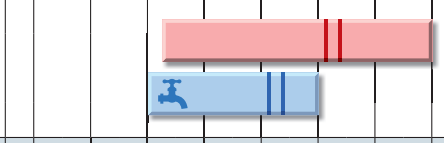
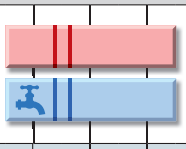
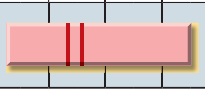
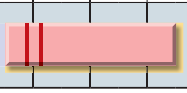
Parts	
Clamping screw	Wrench
	
LRIS-4＊12 **QEU000791** 10pcs/case	LLR-25S **5364930** 1pcs/case

Screwdrivers (Optional)		
		
HLR-25S **5485214** 1pc/case	XX2815-04 **5485172** 1pc/case	XX2815-04-25S **5485255** 1pc/case

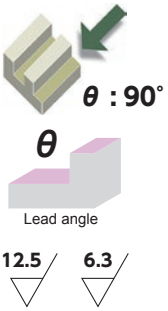
Applicable inserts

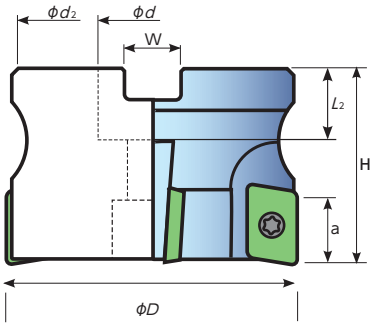
Shape	Dimensions	Part No.	R	Grade
		**LNX 324-08T01020**	0.8	**SX6** ● **SX9** ●
		LNX 324-12T01020	1.2	**SX6** ● **SX9** ●
		LNX 324-16T01020	1.6	**SX6** ● **SX9** ●

● : Standard

Recommended cutting conditions				
Grade	Work material	Cutting speed (m/min)	Feed rate (mm/tooth)	Depth of cut (mm)
	K	400 500 600 700 800 900 1000 1100	0.05 0.1 0.15 0.2 0.25 0.3	
SX6	Normal cast iron			～8 (mm)
SX9	Ductile cast iron			

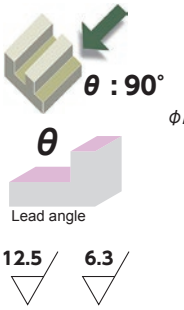
QTS Cutter

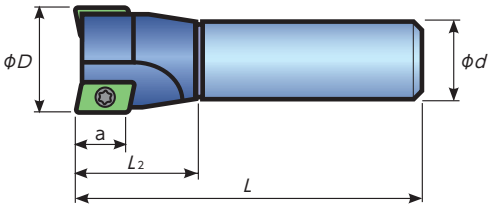




Reference	Standard		Dimensions (mm)							Item No.	Weight (kg)	A.R.	R.R.	Insert Screw	Wrench	Insert
			ϕD	H	L_2	a	ϕd	W	$ϕd_2$							
QTS040-90-4R-GM	●	4	40	40	18	14	16	8.4	35	QEU000464	0.2	+6°	−13°	521673 M4x9-GM	T-15A	APCW 1604
QTS050-90-5R-GM	●	5	50	40	22	14	22	10.4	45	QEU000465	0.3	+6°	−10°			
QTS063-90-6R-GM	●	6	63	50	22	14	22	10.4	58	QEU000466	1.4	+6°	−12°			
QTS080-90-8R-GM	●	8	80	50	25	14	27	12,4	58	QEU000467	1.9	+6°	−12°			

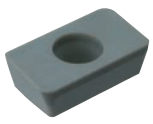
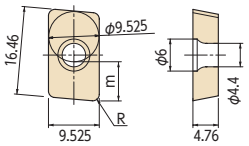
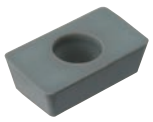
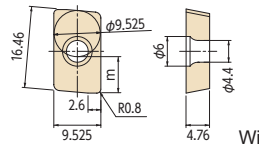
QTE Cutter





Reference	Standard		Dimensions (mm)					Item No.	Weight (kg)	A.R.	R.R.	Insert Screw	Wrench	Insert
			ϕD	L	L_2	a	ϕd							
QTE025-90-2R-GM	●	2	25	100	30	14	25	QEU000461	0.3	+6°	−13°	521673 M4x9-GM	T-15A	APCW 1604
QTE032-90-3R-GM	●	3	32	110	35	14	32	QEU000462	0.5	+6°	−13°			
QTE040-90-4R-GM	●	4	40	110	37	14	32	QEU000463	0.6	+6°	−13°			

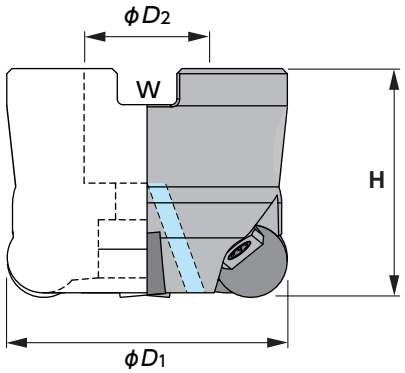
Inserts

Shape	Reference	R	m	Silicon Nitride	
				SX6	SP9
 	APCW 160408 T01020	0.8	7.314	●	●
	APCW 160412 T01020	1.2	7.278	●	●
	APCW 160420 T01020	2.0	7.205	●	●
  With Wiper	APCW 1604 PDTR	—	7.163	●	●

Recommended Cutting Conditions

Work Material	Grade	Dry	Wet	Cutting Speed (m/min) 200 350 500 650 800 950 1100 1250	Feed (mm/t) 0.05 0.1 0.15 0.2 0.25 0.3	Depth of Cut (mm)
K						
Gray Cast Iron	SX6	●	○			~ 8.0
Gray Cast Iron	SP9	●	●			~ 8.0
Ductile Iron	SP9	●	○			~ 8.0

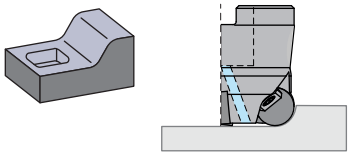
RNIW Cutter



Characteristics:

Round negative insert cutter for slot milling, peripheral milling, ramp milling and drilling, pocket milling and copy milling.

It can be used in only one pass (roughing and finishing).



Item No.	Reference	Standard		ϕD_1	Dimensions (mm)			Clamp	Clamping screw	Applicable Insert	Weight
					H	ϕD_2	W				(kg)
QEU000481	**RNIW050-05R-GM**	●	5	50	50	22	10.4	AMS-6T-GM SP2002-8	AOB-6S-T30-GM	RNGN 1207	0.42
QEU000482	**RNIW063-06R-GM**	●	6	63							0.55
QEU000459	**RNIW080-07R-GM**	●	7	80		27	12.4				0.85

● : Standard

***The table shows only a small selection of the RNIW series. For 1204 inserts are also cutters available. Please contact us**

Spare parts

Clamp - AMS-6T-GM

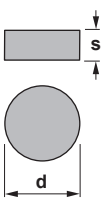
Clamping screw - AOB-6S-T30-GM
***Will be replaced from 2020:**
WS0616-T15-GM, (QEU003866)

Applicable insert

RNGN

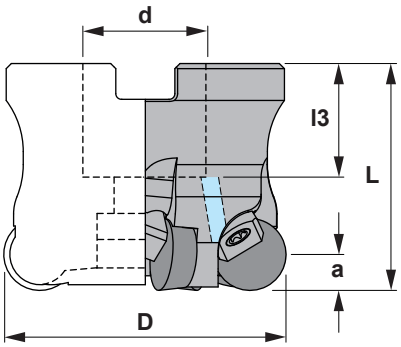
Round negative insert

Reference	s	d
RNGN 1207..	7,94	12,70

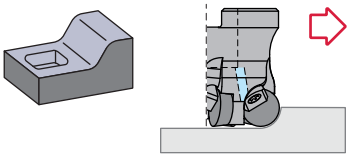


RNGN

RPIW Cutter



Characteristics:
Round insert cutter for slot milling, peripheral milling, ramp milling and drilling, pocket milling and copy milling.
It can be used in only one pass (roughing and finishing).



RPIW

Reference		D	L	l3	a	d	Insert	Kg
RPIW040-04R-C	4	40	40	18	6,35	16	RPGN 1204..	0,200
RPIW050-05R-C	5	50	40	20	6,35	22	RPGN 1204..	0,330

Spare parts

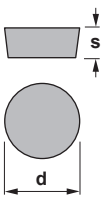
Reference					Nm
RPIW040-04R-C	1058-C	6226-C	1166-C	5515-C	3.0
RPIW050-05R-C	912,10-C	6226-C	1166-C	5515-C	3.0

Applicable insert

RPGN

Round negative insert.

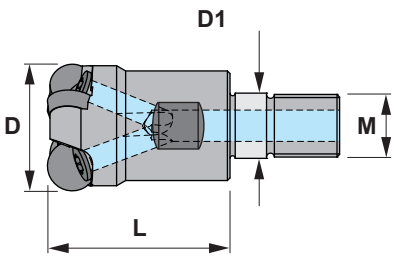
Reference	s	d
RPGN 1204..	4,76	12,70



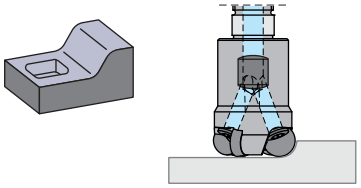
RPGN

NEW

RPIW Cutter



Characteristics:
Round insert end mill for slot milling, peripheral milling, ramp milling and drilling, pocket milling and copy milling.
It can be used in only one pass (roughing and finishing)



RPIW

Item No.	Reference		L	M	D	D1	Insert	Kg
QEU002779	RPIW016-02R-C	2	23	M8	16	8,5	RPGN 0602..	0,030
QEU002528	RPIW020-03R-C	3	30	M10	20	10,5	RPGN 0602..	0,060
QEU002527	RPIW025-03R-C	3	35	M12	25	12,5	RPGN 0903..	0,100
QEU002777	RPIW032-04R-C	4	43	M16	32	16,5	RPGN 0903..	0,210
QEU002778	RPIW032-03R-C	3	43	M16	32	16,5	RPGN 1204..	0,220

Spare parts

Reference			Nm
RPIW016-02R-C	1240-C	5515-C	3.0
RPIW020-03R-C	1240-C	5515-C	3.0
RPIW025-03R-C	1250-C	5520-C	4.0
RPIW032-04R-C	1250-C	5520-C	4.0
RPIW032-03R-C	1260-C	5525-C	5.0

Arbor

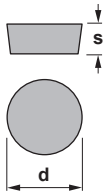
23.315.	A20.315.	13.315.	A11.315.	40.315.	40.315E.
					

Applicable insert

RPGN

Round negative insert.

Reference	s	d
RPGN 0602..	2,38	6,35
RPGN 0903..	3,18	9,52
RPGN 1204..	4,76	12,70

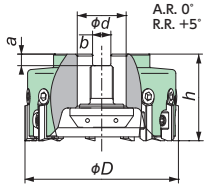


RPGN

JHF Cutter

- *More teeth = More productivity*
- *Light weight aluminum body*
- *Adjustable edge height*
- *Produces outstanding surface finishes*
- *Internal coolant supply*
- *Inserts can be regrinded up to 4 times*
- *Set up & Balancing service is available*

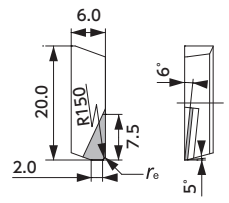
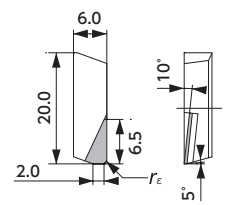
Cutter



Item Number	Stock		Weight (kg)	Dimensions (mm) φD	h	φ d	b	a	Max RPM	Arbor style mm	Arbor bolt	Recommended tightening torque N • m
JHF050C2200R07-GM	●	7	0.23	50	45	22	10.4	6.3	20,000	22	CS1040A	20
JHF063C2200R10-GM	●	10	0.38	63	45	22	10.4	6.3	20,000	22	CS1040A	20
JHF080A2700R12-GM	●	12	0.48	80	45	27	12,4	6	18,000	27	MBC-M12	40
JHF100A3200R16-GM	●	16	0.74	100	45	32	14,4	6	18,000	32	MBC-M12	60
JHF125A4000R22-GM	●	22	1.10	125	45	40	16,4	6	15,000	40	MBC-M12	80

∗ Includes inserts and parts

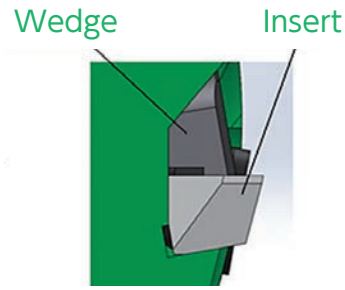
Insert

Wiper	Shape	Item Number	Corner angle	Max DOC (mm)	A.R.	r_ε (mm)	PCD PD1
Yes (Rounded)	For Standard use 	HFT 802006 C05	90°	7.5	6°	C0.5	●
Yes (Rounded)		HFT 802006 R04	90°	7.5	6°	R0.4	●
Yes (Straight)	For less tool pressure 	HFT 702010 W05	90°	6.5	10°	Double chamfer	●

Spare Parts

Item number	Arbor bolt	Wedge	Axial set screw		Wedge set screw	
			Screw	Screwdriver	Screw	Screwdriver
JHF050C2200R07-GM	CS1040A	HLW179 	CS0510A 	LW-4	WS0512 	LW-2.5
JHF063C2200R10-GM						
JHF080A2700R12-GM	MBC-M12					
JHF100A3200R16-GM						
JHF125A4000R22-GM						

Safety clamp mechanism



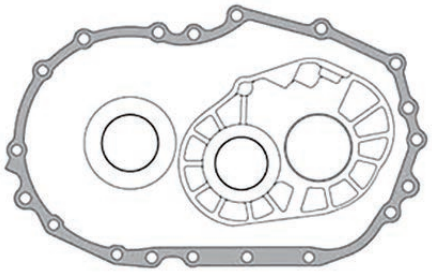
● Unique pocket prevents inserts from becoming dislodged

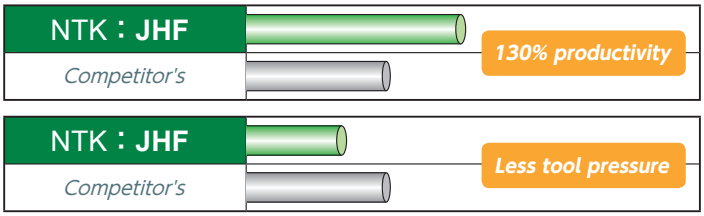
Field Result

Part : Transmission Case
Material : ADC12

Cutter : JHF063C220R10
Insert : HFT802005C05 PD1

	NTK	Competitor's
Number of edges	**10**	6
Insert grade	PD1	PCD
RPM	10,000	12,000
SFM	6490	7790
IPM	**400**	312
IPT	0.004	0.004
DOC	.02"	.02"
Spindle load	**23%**	34%
Flatness	**6μm**	20μm

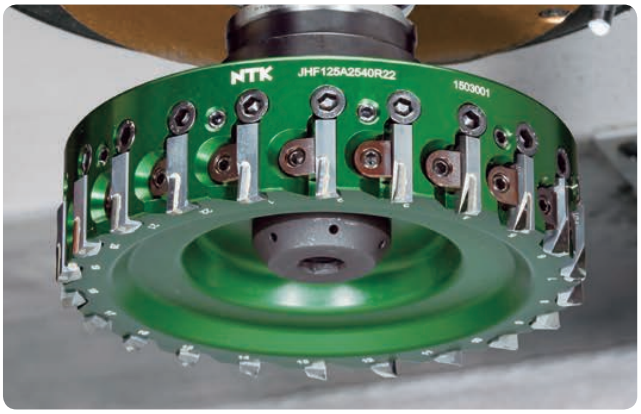




Recommend Cutting Conditions

Work Material	Grade	Dry	Wet	Cutting Speed (m/min) 300 900 1500 2100 2700 3300 3900 4500 5100 5700	Feed (mm/t) 0.05 0.1 0.15 0.2 0.25 0.3	Depth of Cut (mm)
N Aluminum Alloy (Si≦13)	PD1	○	●			~6.35
Aluminum Alloy (Si≧13)	PD1	○	●			~6.35

More teeth=More productivity

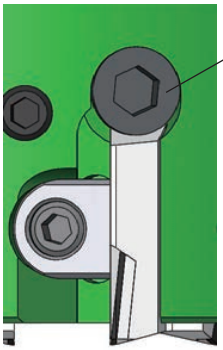


- Easy to cut cycle time

Light weight aluminum body

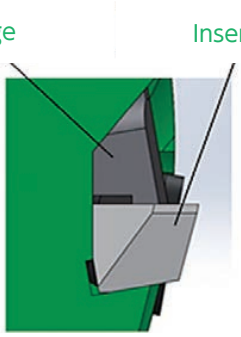
- A 25 HP machine can mount a ϕ125 mm cutter

Adjustable edge height



- Easy adjustment system for axial direction

Safety clamp mechanism



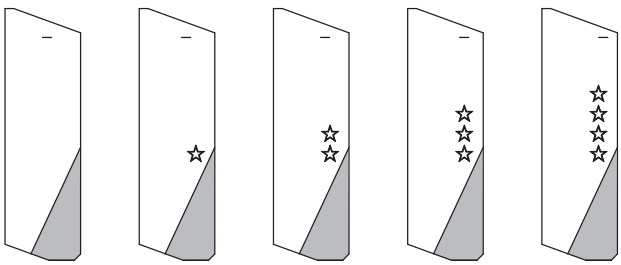
- Unique pocket prevents inserts from becoming dislodged

NTK Regrinding Program

- Inserts can be reground up to (4*) times.
- The diameter and height of the insert will change by .004" after each regrinding.
- The set of inserts placed back in to the cutter must have the same amount of stars indicating number of regrinding.

*The number of regrinding per insert may vary depending on cutting Conditions.

Each insert will be marked with a star to indicate how many times it has been reground.



New	After 1st regrinding	After 2nd regrinding	After 3rd regrinding	After 4th regrinding

1. Send the inserts back to NTK Cutting Tools.
   Minimum order is 30 pcs.
   Note: Send always inserts with the same amount of regrinding stars.
   (For orders greater than 50 pcs, NTK will manage the inserts in lots for regrinding process.)
2. Delivery will be 6-8 weeks upon receiving your inserts.
3. The insert number will be changed to the following HFT802006C05 RPD1.
4. When installing NTK inserts into a cutter, please make sure that all the inserts have the same number of regrinding stars.

Internal coolant supply

- Coolant through mounting bolt for better chip evacuation

High speed capability

- Up to 20,000 rpm capability

Produces outstanding surface finishes

- Unique cutting edge wiper produces excellent surface finishes

Less burrs

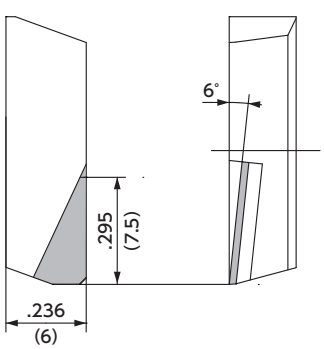
- A 45 degree chamfer on the insert reduces edge burrs

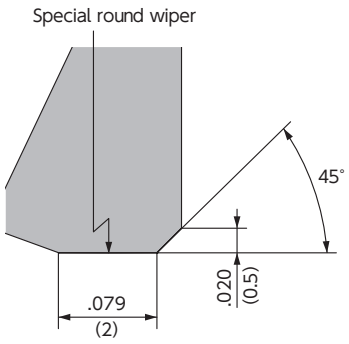
Reduced cutting forces

- Sharp multi-faceted cutting edges reduce tool pressure

Inserts can be reground up to 4 times

- Refer to back cover page for details





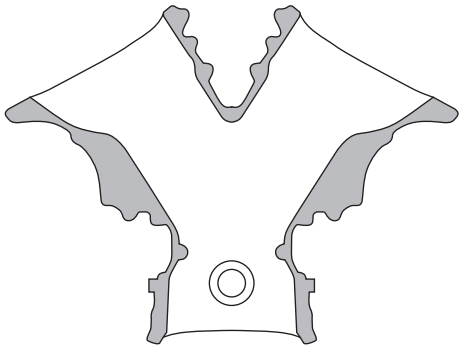
HFT802006C05 shown.

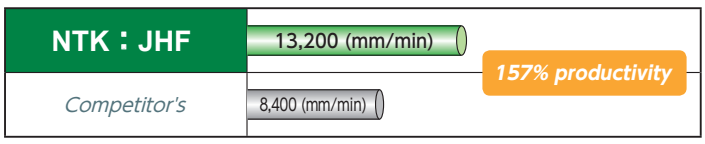
Field Result

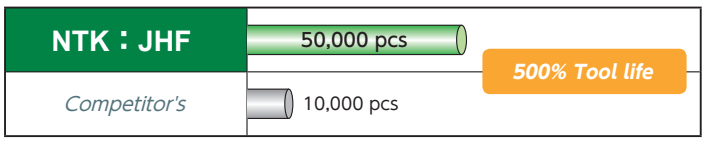
Part : Chain Cover
Material : ADC12

Cutter : JHF125A2540R22
Insert : HFT802006C05 PD1

	NTK	Competitor's
Number of edges	**22**	14
n (min-1)	10,000	⬅
Vc (m/min)	3,925	⬅
Vf (mm/min)	**13,200**	8,400
f (mm/t)	0.06	⬅
DOC (mm)	2.8 (1 Pass)	2.0 + 0.8 (2 Passes)
Tool life	**50,000pcs**	10,000pcs







MEMO

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NTK
CUTTING TOOLS

Information

Grade Comparison Chart

BIDEMICS/Ceramics

	NTK	GREENLEAF	HERTEL	INDEXABLE	ISCAR	KENNAMETAL	KYOCERA	NEWCOMER	ROMAY	SANDVIK	SPK	SSANGYONG	SUMIOTOMO	TAEGUTECH	TUNGALOY	VALENITE
Cast iron K	HC1 HW2	GEM19	AC5	I50	IN11	K060	KA30	NP5200	CC10			SZ200 SZ300		AB120 AW20		
	HC2 HC6	GEM7	HT610CA MC2	I100	IN22 IN23	K090 KY1615	A65 A66N PT600M	NP5000	CC20 CC30	CC620 CC650 CC6050	SN60 SN80 SH2	SD200 ST100 ST300 ST500 SD200 TA300 TC300	NB90S	AB30	LX11 LX21 CX710	Q32
	SX6 SP9	CSN100 CSN200 GSN100 HSN100 HSN200		MW30 MW43	IS6 IS8 IS80	KY3000 KY3400 KY3500 KYK25 KYK35 KY4400 KYK10 KY1320	CS7050 KS500 KS6000 KS6050		CC510 CC513 CC514 CC514SC CC515 CC516 CC516SC	CC1690 CC6090 CC6190	SL506 SL508 SL550C SL554C SL654 SL808 SL854C	SN26 SN300 SN400 SN500 SN600 SN700 SN800	NS260 NS260C SN2000K SN2100K	AS10 AS500 SC10 AW20 AB30 AB20	CX710 FX105	VPQ130 VPQ135
Heat resistant alloy S	JX1 JX3															
	WA1 WA5	WG300 WG600 WG700			IW7	KY1525 KY4300			CC60	CC670		SW400 SW500 SW700 SW800	WX1500 WX120	TC430		
	SX3 SX7 SX9	XSYTIN-1		MW37	IS9	KY1540 KY2100 KYS25 KYS30 KYSP30 KYSM10	CF1 KS6030 KS6040		CC5477	CC6060 CC650 CC6065		SN800 SN900	WX2500 WX2000	AS20	M101S	
Hardened material H	HC7 ZC7	GEN7	HT610CA	I100	IN22 IN23 IN420	KY1615 KY4400	A65 A66N KT66 PT600M		CC30SC	CC6050 CC650		ST500 TM300 TC100 TC300	NB90S NB150H	AW120 AB30	LX11	Q35 VPZ205 VPZ215
	WA1 WA5	WG300 WG600 WG700			IW7	KY4300 KYS25				CC670		SW400 SW500 SW700 SW800				

BIDEMICS/CBN

	NTK	DIJET	HITACHI	INDEXABLE	ISCAR	KENNAMETAL	KYOCERA	MITSUBISHI	SANDVIK	SECO	SPK	SSANGYONG	SUMIOTOMO	TAEGUTECH	TUNGALOY	WALTER
Cast iron K	B23 B30 B16	JBN330 JBN795	BH200 BH250	CBN90 CBN95 CBN100	IB50 IB55 IB85	KB1345 KB1630 KB5630 KB9610 KB9640 KB1340	KBN60M KBN65B KBN900	BC5030 MB710 MB730 MB5015 MBS140	CB7525 CB7925	CBN20 CBN050C CBN200 CBN300 CBN300P CBN350 CBN600	WBN100 WBN105 WBN115 WBN120 WBN750	SBN1000 SBN1600	BN500 BN600 BN700 BNS800	KB90 KB90A TB650 TB670 TB730	BX470 BX480 BX850 BX870 BX90S BX910 BX930 BX950 BXC90	
Heat resistant alloy S	JP2															
				CBN80		KB1340 KB1630 KB5630		MB730		CBN170			BN700	KB90 TB730	BX950	
Hardened material H	B52 B36 B40 B5K B6K B22	JBN245 JBN300	BH200 BH250	CBN45 CBN50 CBN60 CBN70	IB10HC IB20H IB25HA IB25HC IB50 IB55	KB1340 KB1610 KB1625 KB5610 KB5625 KB5630 KB9610 KB9640	KBN05M KBN10C KBN10M KBN25C KBN25M KBN30M KBN35N KBN510 KBN525 KBN900	BC8020 MB810 MB825 MB835 MB8025 MBC010	CB20 CB50 CB7015 CB7025 CB7525	CBN10 CBN050C CBN100 CBN150 CBN160P CBN170 CBN200 CBN300P CBN350	WBN500 WBN550 WBN600 WBN650	SBN1000 SBN2000 SBN4000	BN250 BN300 BN350 BN1000 BN2000 BNC80 BNC100 BNC150 BNC160 BNC200 BNC300 BNC2010 BNC2020 BNX10 BNX20 BNX25 BNX300	KB50 TB610 TB650 TB670	BX310 BX330 BX360 BX380 BX530 BXC50 BXM10 BXM20	VPC225 WLB30 WLB50

PCD

	NTK	DIJET	INDEXABLE	ISCAR	KENNAMETAL	KYOCERA	MITSUBISHI	SANDVIK	SECO	SSANGYONG	SUMIOTOMO	TAEGUTECH	TUNGALOY	WALTER
Non-ferrous material N	PD1 PD2	JDA10 JDA30 JDA40 JDA715 JDA735 JDA745	PCD3 PCD-F PCD-UF	ID5 ID8	KD1400 KD1405 KD1425 KD1410 KD1415 KD1425	KPD001 KPD010 KPD230	MD205 MD220 MD230	CD10	PD10 PD20 PD30	SPD1000 SPD2000 SPD3000	DA10 DA90 DA150 DA200 DA1000 DA2200	KP100 KP300 KP500	DX110 DX120 DX140 DX160 DX180	WCD10

(Note) This chart is based on published data and not authorized by each manufacturer

Non coated carbide

	NTK	DIJET	GREENLEAF	HITACHI	INDEXABLE	ISCAR	KENNAMETAL	KYOCERA	MITSUBISHI	ROMAY	SANDVIK	SECO	SUMIOTOMO	TAEGUTECH	TUNGALOY	WALTER
Steel P	**KM1** **KM3**	DX30 DX35 SR30 SRT	G20M G60 G50 G70	EX35 EX40 EX45 WS10	CI5 CI6 CI7 CI9	IC50M IC54 IC70 IC28	KU10 K420 K125M	PW30	UTi20T			S10M S25M S60M	A30 ST10P ST20E ST30E ST40E	CT3000	TX40 UX25 UX30	
Non-ferrous material N	**KM1** **KM3**	CR1 KG03 KG1 KG10 KG20 KG30 KT9 LF12	G02 G23	WH02 WH05 WH10 WH20D	CI1 CI2 CI3 CI4 CI65	IC04 IC10 IC20 IC28	K313 K68 K110M K115M K600 K1	GW15 GW25 KW10	HTi05T HTi10 UTi20T	R600	H10 H10F H13A	883 890 HX	EH520 G10E H1	UF1	G1F G2 G2F G3 KS05F KS15F KS20 TH03 TH10 TU10	WK1 WSN10

PVD coated carbide

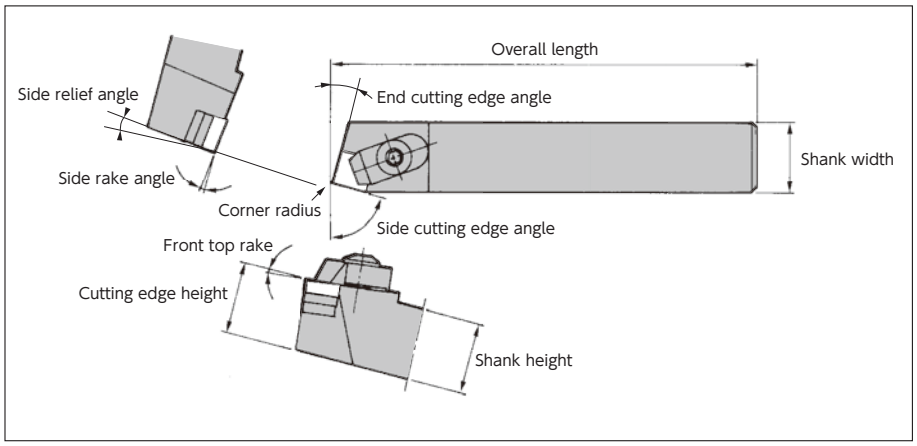
	NTK	DIJET	GREENLEAF	HITACHI	INDEXABLE	ISCAR	KENNAMETAL	KYOCERA	MITSUBISHI	SANDVIK	SECO	SUMIOTOMO	TAEGUTECH	TUNGALOY	WALTER
Steel P	**VM1** **ZM3** **QM3** **TM4** **DT4** **DM4**	JC5003 JC5015 JC5030 JC5040	G915 G920 G925 G935	CY15 CY150 CY250 CY9020 HC844 IP2000 IP3000	CI25A CI29	IC328 IC507 IC807 IC907 IC908 IC928 IC3028 IC830 IC570	KC5010 KC5025 KC5510 KC5525 KCU10 KCU25 KC710 KC720 KC722 KC730 KC735M KC792M	PR915 PR930 PR1005 PR1025 PR1115 PR1215 PR1225	VP10MF VP10RT VP15TF VP20MF VP20RT	GC1125 GC1525 GC15 GC1025 GC1145 GC2035 GC2145 GC4125	CP200 CP250 CP500	AC350 AC520U AC530U ACZ150 ACZ310 ACZ330 ACZ350	TT1040 TT7220 TT8010 TT8020 TT9030 TT9080	AH120 AH130 AH140 AH710 AH725 AH730 AH740 GH130 GH330 SH730 AH330 GH730	WSM30 WXM33 WXP20 WXP43
Stainless steel M	**ST4** **VM1** **ZM3** **QM3** **TM4** **DT4** **DM4**	JC5003 JC5015 JC5030 JC5040	G915 G920 G925	CY250 CY9020 IP050S IP100S	CI23 CI24 CI29	IC308 IC507 IC520 IC807/907 IC908 IC928 IC1008 IC1028 IC3028 IC830 IC570	KC5010 KC5025 KC5510 KC5525 KCU10 KCU25 KC710 KC720 KC722 KC730 KC735M KC792M	PR915 PR930 PR1025 PR1125 PR1215 PR1225	VP10MF VP10RT VP15TF VP20MF VP20RT	GC15 GC1005 GC1025 GC1105 GC1115 GC1125 GC1145 GC1525 GC2030 GC2035 GC4125	CP200 CP250 CP500 TS2000 TS2500	AC350 AC510U AC520U AC530U AC6040M ACZ150 ACZ310 ACZ330 ACZ350 EH510Z EH520Z AC6030M AC610M AC830P AC630M	TT1040 TT5080 TT7010 TT7080 TT7220 TT8010 TT8020 TT9030 TT9080 TT9020	AH120 AH130 AH140 AH710 AH725 AH730 GH130 GH330 GH730 SH730 AH330	WXM20 WXM33 WXN10 WXP20 WXP43
Cast iron K	**QM3** **DM4**	JC5003 JC5015		CY10H CY100H CY9020		IC507 IC508 IC908 IC910 IC808 IC1008	KC5010 KC5025 KC5510 KC5525 KCU10 KCU25 KC720 KC730	PR905 PR1215	VP10RT VP15TF VP20RT	GC1020 GC1125 GC15	CP200 CP250 CP500 DTS2500 TK1000 TK2000 TS2000	AC510U AC520U AC530U ACZ310 EH10Z EH20Z EH510Z AC405K	TT1040 TT6080 TT7010 TT7080	AH110 AH120 GH110 GH130	
Heat resistant alloy S			G920 G925			IC807/907 IC908 IC830	KC5010 KC5510 KC5525 KC7310 KCU10 KCU25			GC15 GC1005 GC1025 GC1105 GC1115 GC1125 GC2145 GC4125		AC510U AC520U AC530U	TT8125 TT8135 TT8020 TT9030 TT9080 TT9020	AH905	
Hardened material H							KC5010 KC5510 KCU10 KCU25			GC1010 GC1025 GC1030		AC503U			

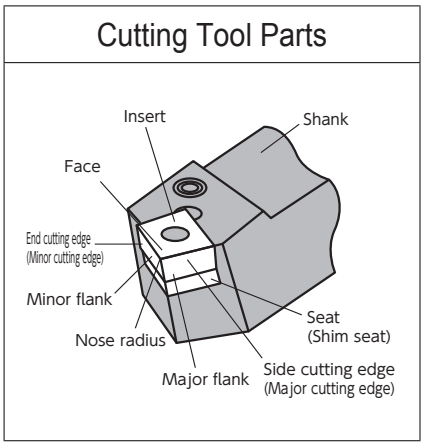
CVD coated carbide

	NTK	DIJET	GREENLEAF	HITACHI	INDEXABLE	ISCAR	KENNAMETAL	KYOCERA	MITSUBISHI	ROMAY	SANDVIK	SECO	SUMIOTOMO	TAEGUTECH	TUNGALOY	WALTER
Cast iron K	**CP1** **CP7**	JC050W JC105V JC110V JC215V JC605W JC605X JC610	GA5022 GA5023	GM25 GM8015 GM8020 GM8025 HG3305 HG3315 HG8010 HX3505 HX3515	CIN2 CINX CIT3 CIT6 CIX	IC418 IC428 IC9007 IC9015 IC9150	KCK05 KCK15 KCK20 KCP05 KCP10 KCP25 KCP30 KC9325	CA4010 CA4115 CA4120 CA4505 CA4515 CA5505	MC5005 MC5015 MY5015 UC5105 UC5115 UE6110	R100 R200 R500	GC3005 GC3205 GC3210 GC3215 GC4215 GC4315	MK1500 TH1000 TK1000 TK2000 TP200 TP2500 TX150	AC300G AC410K AC420K AC700G AC810P AC820P AC8025P ACK200	TT6300 TT6800 TT7005 TT7015	T1015 T1115 T5105 T5115 T5125	WPP01 WPP10 WPP20

Turning Tool Terminology

Toolholder part names

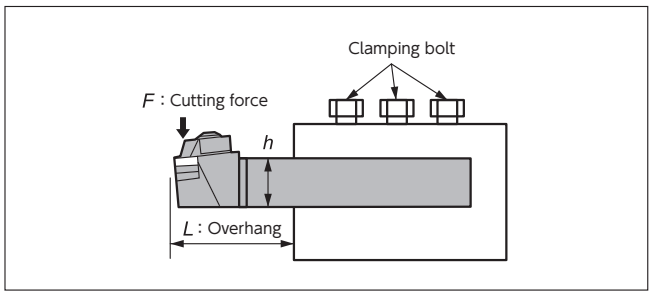




Holder rigidity

Toolholder deflection

$$\delta = \frac{4 \times F \times L^3}{E \times b \times h^3} = \frac{4 \times k_c \times f \times L^3}{E \times b \times h^3}$$

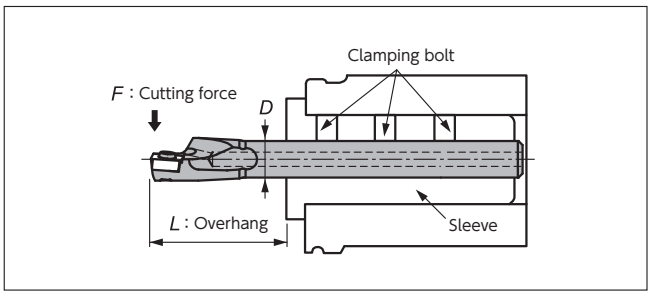


Symbol	Term	Unit
δ	Deflection amount	mm
b	Shank width	mm
h	Shank height	mm
E	Young's modulus	N/mm²
a_p	Depth of cut	mm
f	Feed amount	mm/rev
k_c	Specific cutting force	N/mm²
L	Overhang	mm
F	Cutting force	N

($F = k_c \times a_p \times f$)

Boring bar deflection

$$\delta = \frac{64 \times F \times L^3}{3 \times E \times \pi \times D^4} = \frac{64 \times k_c \times a_p \times f \times L^3}{3 \times E \times \pi \times D^4}$$



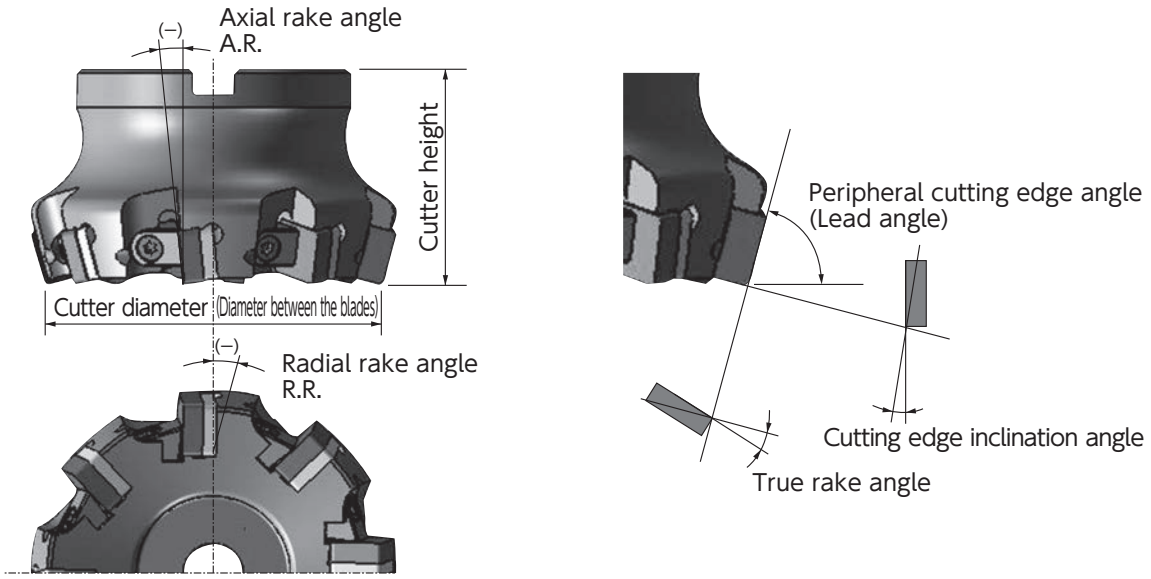
Symbol	Term	Unit
δ	Deflection amount	mm
D	Shank width	mm
E	Young's modulus	N/mm²
a_p	Depth of cut	mm
f	Feed amount	mm/rev
k_c	Specific cutting force	N/mm²
L	Overhang	mm
F	Cutting force	N

($F = k_c \times a_p \times f$)

An important factor in improving the rigidity of a toolholder is to ensure the overhang of the tool shank is as short as possible.

Milling Cutter Terminology

Milling cutter terminology



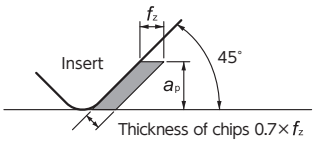
Functions of each cutting edge angle

Name	Function	Effects
Radial rake angle: R.R.	Controls the direction of chip evacuation and cutting force	Negative (−): Excels in chip control performance
Axial rake angle: A.R.	Controls the direction of chip evacuation and cutting force	Positive (+): Excels in cutting performance and BUE resistance
Lead angle	Controls the thickness and evacuation direction of chips	Larger lead angles decrease the thickness of chips and relieves cutting load
True rake angle	Actual rake angle	Larger angles excel in cutting performance and BUE resistance, but lower the cutting edge strength Smaller angles increase the cutting edge strength but lower the BUE resistance
Cutting edge tilt angle	Controls the direction of chip evacuation	Larger angles excel in chip control performance and relieve cutting load, but lower the strength of the insert corner

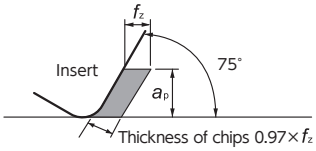
Functions of each angle

《Lead angle》: Relationship of this angle and chip thickness

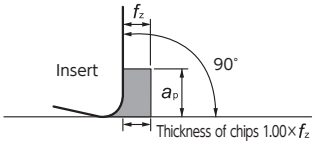
Lead angle : 45 degrees



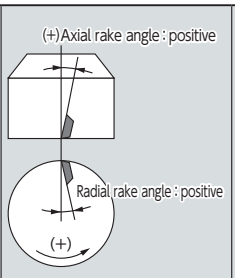
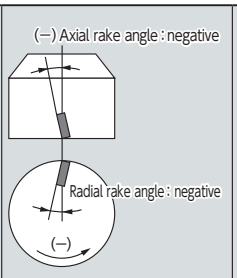
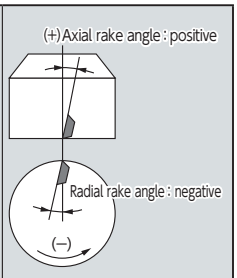
Lead angle : 75 degrees



Lead angle : 90 degrees

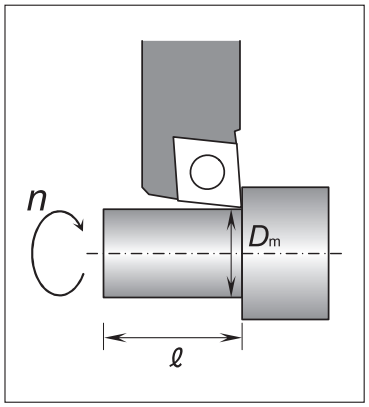


《Rake angle》: Combinations and characteristics

Combinations of the angles for basic cutting edge shapes		 Double-positive cutting edge shape(DP edge shape)	 Double-negative cutting edge shape(DN edge shape)	 Negative-positive cutting edge shape(NP edge shape)
Radial rake angle(R.R.)		Positive (+)	Negative (−)	Negative (−)
Axial rake angle(A.R.)		Positive (+)	Negative (−)	Positive (+)
Insert specification		Positive (single side used)	Negative(both sides used)	Positive(single side used)
Work material	Steel	●	—	●
	Cast iron	—	●	●
	Aluminum alloy	●	—	—

Calculation Formula for Turning

Calculating the cutting speed



Calculating the cutting speed from the rotation speed

$$v_c = \frac{\pi \times D_m \times n}{1000} \quad (m/min)$$

Calculating the revolution speed from the cutting speed

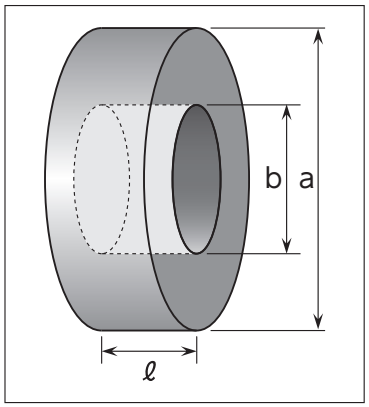
$$n = \frac{1000 \times v_c}{\pi \times D_m} \quad (min^{-1})$$

v_c : Cutting speed (m/min)
D_m : Machining diameter (mm)
n : Spindle speed (min^{-1})
π : Pi (3.14)

Example : Obtaining a cutting speed for machining a work piece of 200 mm diameter at the spindle speed of 1,000 min^{-1}:

$$v_c = \frac{\pi \times 200 \times 1000}{1000} = 628\ (m/min)$$

Calculating the cutting time



Calculating the cutting time for OD (ID) machining

$$T = \frac{\ell}{f \times n} \quad (min)$$

T : Cutting time (min)
ℓ : Cutting length (mm)
f : Feed rate (mm/rev)
n : Spindle speed (min^{-1})

Calculating the cutting time for facing

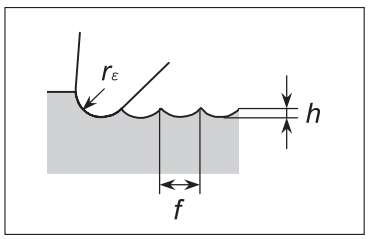
$$T = \frac{\pi \times (a^2 - b^2)}{4000 \times v_c \times f} \quad (min)$$

T : Cutting time (min)
v_c : Cutting speed (m/min)
f : Feed amount (mm/rev)
π : Pi (3.14)

Example : Obtaining a cutting time for machining of work to be cut 100 mm long at the spindle speed of 1,000 min^{-1} and at a feed rate of 0.1 mm/rev:

$$T = \frac{100}{0.1 \times 1000} = 1\ (min)$$

Calculating the theoretical surface roughness



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

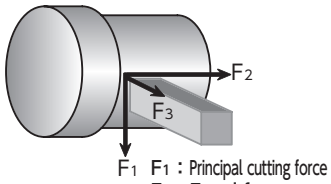
h : Theoretical surface roughness (μm)
f : Feed amount (mm/rev)
r_ε : Corner radius (mm)

Example : Obtaining the theoretical surface roughness when machining with an insert having 0.8 corner radius at a feed rate of 0.1 mm/rev:

$$h = \frac{0.1^2}{8 \times 0.8} \times 1000 = 1.56\ (\mu m)$$

【Guidelines for actually finished surface roughness】
Steel type work: Theoretical surface roughness × 1.5 to 3
Cast iron type work: Theoretical surface roughness × 3 to 5

Calculating the cutting force



F1 : Principal cutting force
F2 : Feed force
F3 : Thrust force

$$F_{(N)} = k_c \times a_p \times f$$

F : Cutting force (N)
k_c : Specific cutting force (N/mm²) *See the table below.
a_p : Depth of cut (mm)
f : Feed amount (mm/rev)

Example : Calculating the cutting force for grey cast iron cut at the feed rate of 0.2 mm/rev and with a depth of cut of 3 mm:

$$F = 1800 \times 3 \times 0.2 = \underline{1080\,(N)}$$

Calculating the power required

$$P_{c\,(kW)} = \frac{v_c \times f \times a_p \times k_c}{60 \times 10^3 \times \eta}$$

P_c : Required power (kW)
v_c : Cutting speed (m/min)
f : Feed amount (mm/rev)
a_p : Depth of cut (mm)
k_c : Specific cutting force (N/mm²) *See the table below.
η : Mechanical efficiency (0.7~0.8)

Example : Calculating the cutting power for the machining of grey cast iron at a cutting speed of 700 m/min, feed rate of 0.4 mm/rev, and with a depth of cut of 2 mm (with 0.8 set as the mechanical efficiency):

$$P_c = \frac{700 \times 0.4 \times 2 \times 1400}{60 \times 10^3 \times 0.8} = \underline{16.33\,(kW)}$$

Specific cutting force

Work material		Tensile strength or hardness	Specific cutting force (N/mm²) "k_c" to cutting feed rate (mm/rev)				
			0.1mm/rev	0.2mm/rev	0.3mm/rev	0.4mm/rev	0.6mm/rev
Soft steel		520	3,610	3,100	2,720	2,500	2,280
Medium steel		620	3,080	2,700	2,570	2,450	2,300
Hard steel		720	4,500	3,600	6,250	2,950	2,640
Tool steel	SKD	670	3,040	2,800	2,630	2,500	2,400
		770	3,150	2,850	2,620	2,450	2,340
Cr-Mo steel	SCM	600	3,610	3,200	2,880	2,700	2,500
		730	4,500	3,900	3,400	3,150	2,850
Alloy steel	SNCM	900	3,070	2,650	2,350	2,200	1,980
		HB350	3,310	2,900	2,580	2,400	2,200
Gray cast iron	FC	HB200	2,110	1,800	1,600	1,400	1,330

Calculating the volume of chips produced

$$Q_{(cm^3/min)} = v_c \times f \times a_p$$

Q : Volume of evacuated chips (cm³/min)
v_c : Cutting speed (m/min)
a_p : Depth of cut (mm)
f : Feed amount (mm/rev)

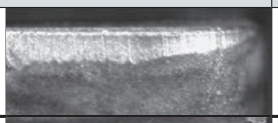
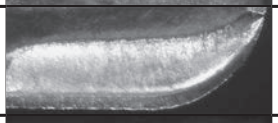
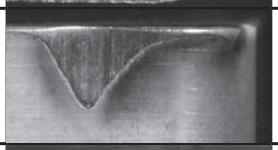
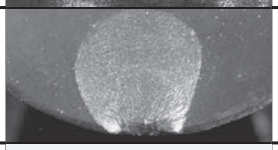
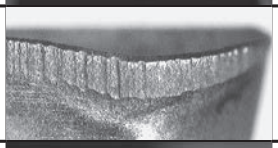
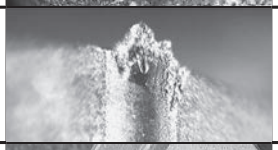
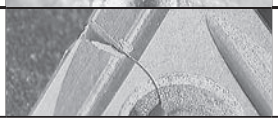
Example : Obtaining the volume of chips evacuated per minute for machining at a cutting speed of 700 m/min, feed of 0.4 mm/rev, and a depth of cut of 2mm

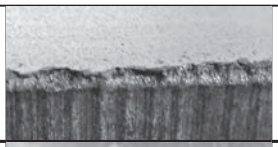
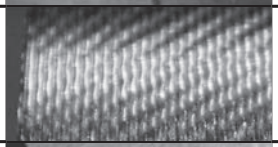
$$Q = 700 \times 0.4 \times 2 = \underline{560\,(cm^3/min)}$$

Troubleshooting for Turning

Type of problem	Possible cause	Corrective measures: Material/grade selection: Change to a harder material/grade	Change to a tougher material/grade	Change to a material/grade more resistant to thermal shock	Change to a material/grade more resistant to deposition	Cutting conditions: Cutting speed (Decrease ↘ / Increase ↗)	Feed rate (Decrease ↘ / Increase ↗)	Depth of cut (Decrease ↘ / Increase ↗)	Coolant: Use non-water-soluble type	Coolant: Review dry or wet operation	Tool shape: Review the type of chipbreaker	Rake angle (Decrease ↘ / Increase ↗)	Nose radius of the insert (Decrease ↘ / Increase ↗)	Side cutting edge angle (Decrease ↘ / Increase ↗)	Cutting edge strength, honing (Decrease ↘ / Increase ↗)	Improve the accuracy of insert	Improve the rigidity of the holder	Machine/installation: Improve the installation accuracy of the cutting tool	Review the overhang of the cutting tool	Prevent vibration of the machine, improve the machine rigidity
Short tool life	Excessive insert wear	Unsuitable tool material/grade	●																	
		Unsuitable cutting edge shape									●	↗	↗	↗	↘					
		Improper cutting conditions				↘	↗			Wet										
	Fracture/chipping of the cutting edge	Unsuitable tool material/grade		●																
		Improper cutting conditions					↘	↘												
		Insufficient cutting edge strength									●		↗		↗					
		Thermal shock			●	↘	↘	↘	●	Dry										
		Built-up edge				↗	↗		●	Wet										
		Insufficient toughness															●	●	●	●
Poor dimensional accuracy	Variation in dimensions during cutting	Improper accuracy of insert														●				
		Clearance/relief of the work/tool									●	↗	↘	↘	↘		●	●	●	●
	Need for offsetting during cutting	Increased flank wear	●										↗							
		Built-up edge				↗														
		Improper cutting conditions				↘	↗													
Poor surface finish	Poor surface roughness	Deposition				↗			●	Wet										
		Unsuitable cutting edge shape									●		↗							
		Chatter				↘	↘	↘									●	●	●	●
Heat	Deterioration in tool life/accuracy due to excessive heat generation	Improper cutting conditions				↘	↘	↘												
		Unsuitable cutting edge shape									●	↗			↘					
Burring, chipping, scuffing	Burring	Boundary wear	●																	
		Improper cutting conditions				↘	↕			Wet										
		Unsuitable cutting edge shape									●	↗	↘	↘	↘					
	Chipping	Improper cutting conditions					↘	↘												
		Unsuitable cutting edge shape									●	↗	↗	↗	↘					
		Vibration															●	●	●	●
	Scuffing	Unsuitable tool material/grade																		
		Improper cutting conditions				↗			●	Wet										
		Unsuitable cutting edge shape									●	↗			↘					
		Vibration															●	●	●	●
Chip control	Elongated chips	Improper cutting conditions				↘	↗	↗		Wet										
		Chipbreaker's effective chip control range									●									
		Unsuitable cutting edge shape											↘	↘						

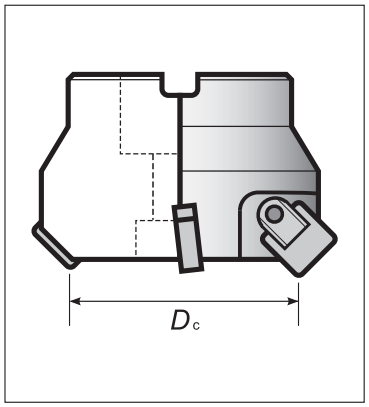
Troubleshooting Case Studies: Turning

	Case/Symptom		Possible causes	Corrective measures
Insert	VB wear		●The material / grade is too soft ●Cutting speed is too high ●Relief angle is too small	●Use a coated grade ●Choose a material/grade highly resistant to wear ●Decrease the cutting speed
	Wear on face		●High temperature causes chemical reactions between the insert material and chips	●Use a coated grade ●Decrease both of the cutting speed and feed rate ●Widen the rake angle
	Notching wear		●The work surface is too hard ●Boundary area has been oxidized ●Burrs, caused by chips in the sheared form, have been cut	●Widen the side cutting edge angle ●Make the nose radius larger so that cutting is performed within the radius ●Use a round insert
	Chipping/ fracture		●Feed rate is too high ●Chips have become trapped ●Chatter resulting in vibration	●Enlarge the honed edge ●Make the nose radius larger ●Narrow the rake angle to secure the cutting edge strength
	Flaking		●This is due to compressive forces being applied to the cutting edge from elastic deformation in the area being cut ●This occurs when deposited/adhered material is peeled off	●Change the cutting conditions by checking the cutting edge ●Choose a material/grade highly resistant to fracture ●Increase the coolant rate and pressure ●Improve the run-out of the main spindle of the machine
	Plastic deformation		●High cutting force and excessive heat is applied to the cutting edge	●Choose a material/grade highly resistant to wear ●Decrease both of the cutting speed and feed rate ●Make the nose radius larger ●Use coolant
	Built-up edge		●This occurs because the cutting temperature is lower than the recrystallization temperature of the work material	●Increase the cutting speed ●Use coolant with excellent lubrication performance ●Change to a grade with less affinity to the work material
	Deposition		●The deposition is caused to the face by a chemical reactions of the work material due to heat generation	●Increase the cutting speed ●Widen the relief angle ●Hone the face with a mirror-like-surface finish ●Change to a grade with less affinity to the work material
	Clamping crack		●The insert was clamped under improper seating conditions	●Clean the clamping areas and install the insert in the recommended way ●Tighten to the specified torque

Work piece	Chipping		●The feed rate is too high ●An unsuitable insert was selected	●Decrease the feed rate ●Use a smaller edge preparation ●Change to a grade highly resistant to boundary wear ●Change the cutting edge angle of the holder
	Burring		●The feed rate is incorrect ●The shape of insert is not suitable	●Decrease the feed rate ●Use a smaller edge preparation
	Chatter mark		●The cutting force is too great ●The rigidity of the work piece and cutting tool is insufficient	●Decrease the feed rate ●Use a smaller edge preparation ●Ensure tool overhang is minimised ●Change the cutting edge angle of the holder
	Gouging		●Vibration of the cutting edge due to deposition/built-up edge	●Increase the cutting speed ●Use cutting oil excellent in lubrication performance ●Change to a grade with less affinity to the work material

Calculation Formula for Milling Processes

Calculating the cutting speed



Calculating the cutting speed from the rotation speed

$$v_c = \frac{\pi \times D_c \times n}{1000} \quad (m/min)$$

Calculating the revolution speed from the cutting speed

$$n = \frac{1000 \times v_c}{\pi \times D_c} \quad (min^{-1})$$

v_c : Cutting speed (m/min)
D_c : Cutter diameter (mm)
n : Spindle speed (min^{-1})
π : Pi (3.14)

Example : Obtaining the cutting speed for machining with an 200 mm diameter cutter at the Spindle speed of 1,000 min^{-1}:

$$v_c = \frac{\pi \times 200 \times 1000}{1000} = 628\,(m/min)$$

Calculating the feeding speed and feed rate

Calculating the feed rate per blade

$$f_z = \frac{v_f}{z \times n} \quad (mm/t)$$

Calculating the feeding speed per minute

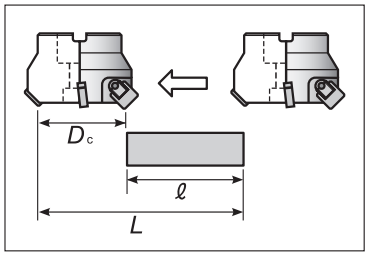
$$v_f = f_z \times z \times n \quad (mm/min)$$

f_z : Inch amount per tooth (mm/t)
v_f : Table feed (mm/min)
z : Number of tooth
n : Spindle speed (min^{-1})

Example : Obtaining the feed rate for milling with a 10-teeth cutter at the 0.2mm/t and the revolution speed of 1,000 min^{-1}

$$v_f = 0.2 \times 10 \times 1000 = 2000\,(mm/min)$$

Calculating the machining time



$$T = \frac{L}{v_f} \quad (min)$$

T : Cutting time (min)
L : Total length of table feed (mm) ($\ell + D_c$)
v_f : Table feed (mm/min)

Example : Obtaining the machining time for milling 200 mm on a work piece fed at the rate of 1000 (mm/min)

$$T = \frac{200}{1000} = 0.2\,(min)$$

Calculating the cutting power

$$P_c = \frac{a_e \times a_p \times v_f \times k_c}{60 \times 10^6 \times \eta} \quad (kW)$$

P_c : Required power (kW)
a_e : Cutting length (mm)
a_p : Depth of cut (mm)
v_f : Feed rate (mm/min)
k_c : Specific cutting force (N/mm²) *See the table below.
η : Mechanical efficiency (0.7~0.8)

Example : Calculating the power required to machine gray cast iron for a length of 150 mm, at a feed rate of 1,100 mm/min, and with a depth of cut of 3 mm (with 0.8 set as the mechanical efficiency and 0.2 mm as the feed par tooth/blade)

$$P_c = \frac{150 \times 3 \times 1100 \times 1400}{60 \times 10^6 \times 0.8} = 14.44\,(kW)$$

Specific cutting force

Work material		Tensile strength or hardness	Specific cutting force (N/mm²) "k_c" to cutting feed amount (mm/rev)				
			0.1mm/t	0.2mm/t	0.3mm/t	0.4mm/t	0.6mm/t
Soft steel		520	2,200	1,950	1,820	1,700	1,580
Medium steel		620	1,980	1,800	1,730	1,600	1,570
Hard steel		720	2,520	2,200	2,040	1,850	1,740
Tool steel	SKD	670	1,980	1,800	1,730	1,700	1,600
		770	2,030	2,030	1,800	1,750	1,700
Cr-Mo steel	SCM	600	2,180	2,000	1,860	1,800	1,670
		730	2,540	2,250	2,140	2,000	1,800
Alloy steel	SNCM	900	2,000	1,800	1,680	1,600	1,500
		HB350	2,100	1,900	1,760	1,700	1,530
Gray cast iron	FC	HB200	1,750	1,400	1,240	1,050	970
Aluminum alloy	AC,ADC	160	580	480	400	350	320

※For power required for NTK HCC, please refer to page P31.

Calculating the volume of evacuated chips

$$Q = a_e \times a_p \times v_f \quad (cm^3/min)$$

Q : Volume of evacuated chips (cm³/min)
a_e : Cutting length (mm)
a_p : Depth of cut (mm)
v_f : Feed rate (mm/min)

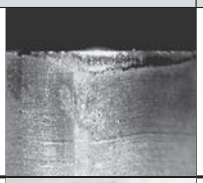
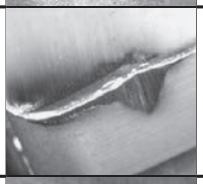
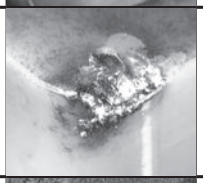
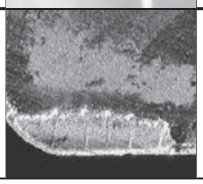
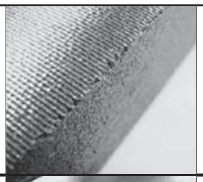
Example : Obtaining the volume of chips evacuated per minute for machining at a cutting speed of 700 m/min, feed rate of 0.4 mm/rev, and with a 2 mm depth of cut:

$$Q = 150 \times 3 \times 1100 = 495\,(cm^3/min)$$

Troubleshooting for Milling

Type of problem	Possible cause	Corrective measures: Material/grade selection: Change to a harder material/grade	Change to a tougher material/grade	Change to a material/grade more resistant to thermal shock	Change to a material/grade more resistant to deposition	Cutting conditions: Cutting speed ↘ Decrease	Cutting speed ↗ Increase	Feed rate ↘ Decrease	Feed rate ↗ Increase	Depth of cut ↘ Decrease	Depth of cut ↗ Increase	Review cutter diameter and cutting width	Review tool path	Coolant: Wet	Coolant: Dry	Tool shape: Relief angle of insert ↘ Decrease	Relief angle of insert ↗ Increase	Nose radius of cutting edge ↘ Decrease	Nose radius of cutting edge ↗ Increase	Cutting edge strength, honing ↘ Decrease	Cutting edge strength, honing ↗ Increase	Number of teeth/blades	Enlarge the chip pocket	Check the wiper shape	Improve accuracy of cutting edge run-out	Improve rigidity of tool
Damaged or broken cutting edge of the insert	Increased flank wear	Improper cutting conditions					↘							●							↗					
		Unsuitable cutting edge shape	●													↗			↘			●				
	Increased wear on face	Improper cutting conditions					↘		↘		↘			●												
		Unsuitable cutting edge shape	●													↗		↗		↘						
	Fracture/ chipping on cutting edge	Improper cutting conditions						↘		↘			●													
		Unsuitable cutting edge shape		●												↘		↗		↗				●	●	●
	Thermal shock	Improper cutting conditions					↘		↘		↘				●											
		Unsuitable cutting edge shape			●											↗				↘						
	Built-up edge	Improper cutting conditions					↗		↗					●												
		Unsuitable cutting edge shape				●										↗				↘						
Machining accuracy	Poor surface finish	Improper cutting conditions					↗		↘		↘			●												
		Unsuitable cutting edge shape	●			●														↘		↘		●	●	
	Burring	Improper cutting conditions						↓↑		↘	●	●														
		Unsuitable cutting edge shape														↗		↘		↘				●		
	Chipping	Improper cutting conditions						↘		↘		●														
		Unsuitable cutting edge shape														↗		↗		↘		↗		●		
	Poor flatness and parallelism	Improper cutting conditions						↘		↘				●		↗		↘		↘		↘		●	●	●
Others	Increased chatter/ vibration	Improper cutting conditions					↘		↘		↘	●	●			↗		↘		↘		↘				
	Poor chip evacuation	Improper cutting conditions					↗		↘			●		●	●											
		Unsuitable tool/blade edge shape														↗						↘	●			

Troubleshooting Case Studies: Milling

	Case/Symptom		Possible causes	Corrective measures
Insert	VB wear		●Cutting speed is too high. ●Feed rate is too low. ●The shape of the insert is not suitable. ●The material / grade of the insert is not suitable.	●Decrease the cutting speed. ●Increase the feed rate. ●Make the nose radius larger. ●Change to a grade highly resistant to boundary wear.
	Notching wear		●The material / grade of the inserts is not suitable. ●The shape of the cutter is not suitable ●The shape of insert is not suitable.	●Change to a grade highly resistant to boundary wear. ●Widen the rake angle. ●Change the Insert shape to a different one.
	Chipping / fracture		●The cutting speed is incorrect. ●The shape of the cutter is not suitable ●The shape of insert is not suitable.	●Decrease the feed rate and depth of cut in order to reduce the cutting force. ●Use a smaller edge preparation. ●Prepare the cutting edge to give it a round honing. ●Change to a grade highly resistant to fracture.
	Thermal crack		●The cutting conditions are incorrect ●The material / grade of insert is not suitable	●Decrease the cutting speed. ●Change to dry cutting from wet cutting. ●Use a material / grade highly resistant to thermal shock
Work piece	Chipping		●The feed rate is too high. ●An unsuitable insert is selected. ●The shape of the cutter is not suitable.	●Decrease the feed rate. ●Use a smaller edge preparation ●Change to a grade highly resistant to boundary wear. ●Set the lead angle at 45 degrees.
	Burring		●The feed rate is incorrect. ●The shape of insert is not suitable. ●The shape of the cutter is not suitable.	●Adjust the feed rate. ●Use a smaller edge preparation. ●Make the lead angle narrower.

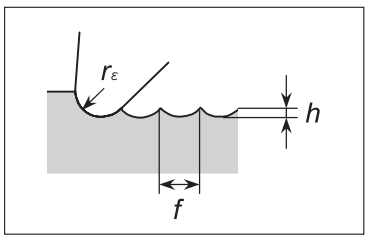
Surface Roughness Standards

			JIS B0601 (2001) ISO 4287 (1997) / ISO 1302 (2002)	JIS B0601 (1994) JIS B0031 (1982)
Cross-section curve			No filter, digital signal	No filter, digital signal
	Evaluation length		Shape length	—
	Maximum height		Pt	—
	10-point average roughness		—	—
Roughness curve			Phase correction, band λs-λc	Phase correction, short wavelength λc
	Evaluation length		Determine individually for each standard length λc.	Average for ℓn, calculated for each standard length λc
	Maximum height		Maximum height **Rz**	Maximum height Ry
	Set standard length based on height parameters Rz, Rmax, and Ry.	0.25mm	0.1~0.5μm	0.1~0.5μm
		0.8mm	0.5~10μm	0.5~10μm
		2.5mm	10~50μm	10~50μm
	Dimension indicated in drawing		U 0.008 − 2.5/Rz 1.5 L − 2.5/Rz 0.7	Ry = 1.6~0.8 λc 0.25
	10-point average roughness		**Rz_{JIS}**	Rz
	Center line average roughness		Ra_{75}	Ra75
	Arithmetic average roughness		Arithmetic average roughness **Ra**	Arithmetic average roughness Ra
	Set standard length based on height parameters Rz, Rmax, and Ry.	0.25mm	0.1~0.5μm	0.1~0.5μm
		0.8mm	0.5~10μm	0.5~10μm
		2.5mm	10~50μm	10~50μm
	Dimension indicated in drawing		U "2RC" − 0.8/Ra75 3.1 L "2RC" − 0.8/Ra75 1.5	1.6~3.2

Theoretical surface roughness

The theoretical surface roughness for lathe machining is the minimum value which can be obtained under the set machining conditions, and can be expressed by the following formula.

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



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

Actual surface roughness

- When machining steel: Theoretical surface roughness x 1.5-3
- When machining cast iron: Theoretical surface roughness x 3-5

Surface finish improvement measures

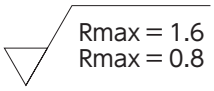
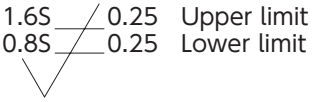
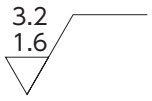
- Increase the nose radius.
- Use a wiper insert.
- Adjust the cutting speed and/or feed amount.
- Change the material and/or shape of the insert

Relationship with triangle symbols

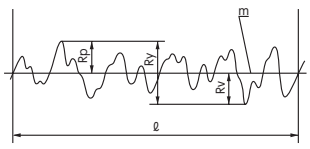
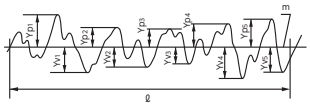
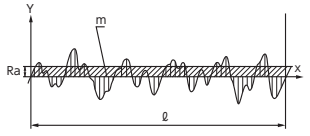
Arithmetic average roughness Ra (μm)	Maximum height Rz (μm)	10-point average roughness Rz_{JIS} (μm)	※ (Triangle symbol)
0.025	0.1	0.1	▽▽▽▽
0.05	0.2	0.2	
0.1	0.4	0.4	
0.2	0.8	0.8	
0.4	1.6	1.6	▽▽▽
0.8	3.2	3.2	
1.6	6.3	6.3	
3.2	12.5	12.5	▽▽
6.3	25	25	
12.5	50	50	▽
25	100	100	

• Examples of reading
(i) When Ra = 1.6μm ➡ 1.6μm Ra
(ii) When Rz = 6.3μm ➡ 6.3μm Rz
(iii) When Rz_{JIS} = 6.3μm ➡ 6.3μm Rz_{JIS}

※The finishing symbols (triangle symbol ▽ and symbol ~) are no longer used in JIS pursuant to the 1994 revision.

JIS B0601 (1982) JIS B0031 (1982)	JIS B0601 (1970) JIS B0031 (1970)	JIS B0601 (1970)
No filter, analog signal	No filter, analog signal	No filter, analog signal
One standard length	One standard length	One standard length
Rmax	Rmax (S indication)	Hmax (S)
Rz	Rz (Z indication)	—
2RC, short wavelength cut-off λc	2RC, short wavelength cut-off λc	—
One measured length ≧ 3λc	One measured length ≧ 3λc	—
—	—	—
0.8μm or less	0.8μm or less	Select from 0.3, 1, 3, 5 and 10mm
0.8~6.3μm	0.8~6.3μm	Select from 0.3, 1, 3, 5 and 10mm
6.3~25μm	6.3~25μm	Select from 0.3, 1, 3, 5 and 10mm
	Surface symbol or triangle symbol 	Triangle symbol 0.8S or less ▽▽▽▽ 1.5S~6S ▽▽▽ 12S~25S ▽▽ 35S or higher ▽
—	—	—
Ra	Ra ("a" indication)	—
—	—	—
—	—	—
Ra shall be 12.5μm or less.	λc shall be 0.8 mm.	—
12.5~100μm	—	—
	Surface symbol or triangle symbol 0.2a or less ▽▽▽▽ 0.4a~1.6a ▽▽▽ 3.2a~6.3a ▽▽ 12.5a to 25a or more ▽	—

Obtaining the surface roughness

Type	New symbol JIS B0601:'01	Old symbol JIS B0601:'94	Calculation	Obtaining method (example)
Max. height (Peak)	Rz	Ry	The addition of the max. value for the depth Rv and the max. height Rp on the roughness curve for the reference length: $Rz = Rp + Rv$	
Average roughness of 10 points	Rz_{JIS}	Rz	The addition of the average of the maximum to fifth highest vales and the average of the deepest to the fifth deepest values on the roughness curve for the reference length: $Rz_{JIS} = \frac{(Yp1+Yp2+Yp3+Yp4+Yp5)+(Yv1+Yv2+Yv3+Yv4+Yv5)}{5}$	
Arithmetic average of roughness	Ra	Ra	The average of absolute values on the roughness curve f (x) for the reference length: $Ra = \frac{1}{\ell}\int_0^{\ell}\{f(x)\}$	

Conditions for measuring R parameters

Non-cyclic wave form (random wave form)		Settings for measuring	
Range of Ra (μm)	Range of Rz (μm)	Reference length ℓr (mm) = cut-off λc (mm)	Evaluated length ℓn (mm) = ℓr × 5
0.006<Ra≦0.2	0.025<Rz≦0.1	0.08	0.4
0.02<Ra≦0.1	0.1<Rz≦0.5	0.25	1.25
0.1<Ra≦2	0.5<Rz≦10	0.8	4
2<Ra≦10	10<Rz≦50	2.5	12.5
10<Ra≦80	50<Rz≦200	8	40

Spare Parts - Wrenches

Standard Items

Item Number	Appearance
CLR-13S (Formerly RLR-13S)	
CLR-15S (Formerly RLR-15S)	
RLR-20S	
LLR-25S	
LLR-25S-20＊65	
LLR-28S	

Optional Items

〈LLR Type〉

Item Number	Appearance
LLR-13S	
LLR-15S	
LLR-20S	

〈Driver type wrench for increased adaptability〉

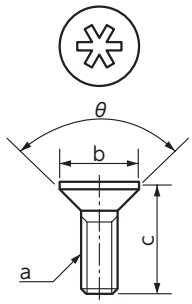
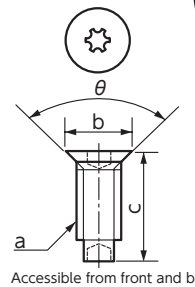
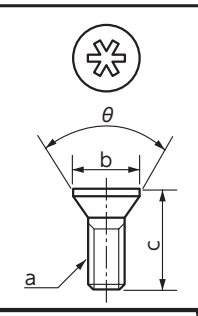
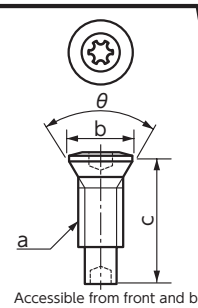
Item Number	Magnetic Driver Handle
XX2815-04	

Item Number	Replaceable Bits
HLR-13S	
HLR-15S	
HLR-20S	
HLR-25S	

〈Driver type wrench kits〉

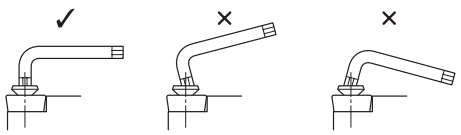
Item Number	Contents
XX2815-04-13S	XX2815-04 with HLR-13S
XX2815-04-15S	XX2815-04 with HLR-15S
XX2815-04-20S	XX2815-04 with HLR-20S
XX2815-04-25S	XX2815-04 with HLR-25S

Clamp Screws and Wrenches

Clamp Screw			Dimension (mm)				Standard Wrench		Adaptable standard wrench	
Appearance	Order Code	Item Number	a	b	c	θ (°)	Order Code	Item Number	LR	Hexalobular (6 – LOBE)
	5704739	**LR-S-2×3.5**	M2×P0.4	3.1	3.5	82	5681994	**CLR-13S**	LR-1	T-6
	5907704	**LR-S-2×3.7**	M2×P0.4	3.1	3.7	82				
	5907712	**LR-S-2×4.4**	M2×P0.4	3.1	4.4	82				
	5907720	**LR-S-2×5.5**	M2×P0.4	3.0	5.5	90				
	5907738	**LR-S-2.5×4.8**	M2.5×P0.45	3.6	4.8	82	5681978	**CLR-15S**	LR-2	T-7
	5704747	**LR-S-2.5×5.5**	M2.5×P0.45	3.6	5.5	82				
	5907746	**LR-S-2.5×6**	M2.5×P0.45	3.5	6.0	90				
	5907753	**LR-S-2.5×6.8**	M2.5×P0.45	3.5	6.8	90				
 Accessible from front and back	5773619	**LR-S-3×5.8**	M3×P0.5	4.1	5.8	90	5485164	**RLR-20S**	LR-3	T-10
	5907761	**LR-S-3×6.2**	M3×P0.5	5.2	6.2	82				
	5907779	**LR-S-3×7.8**	M3×P0.5	4.0	7.8	90				
	5907787	**LR-S-4×5.8**	M4×P0.7	5.8	6.0	82				
	5907795	**LR-S-4×9**	M4×P0.7	5.8	9.0	82				
	5116991	**LR-S-4×10PW**	M4×P0.7	5.8	10.0	90	5681978	**CLR-15S**	LR-2	T-7
	5534029	**LRIS-2×6**	M2×P0.4	2.6	6.0	60	5681994	**CLR-13S**	LR-1	T-6
	5907803	**LRIS-2.2×6**	M2.2×P0.45	3.15	6.0	60				
	5989181	**LRIS-2.5×5**	M2.5×P0.45	3.6	5.0	60	5681978	**CLR-15S**	LR-2	T-7
	5907811	**LRIS-2.5×7**	M2.5×P0.45	3.6	7.0	60				
	5907829	**LRIS-3×6**	M3×P0.5	4.0	6.0	60	5485164	**RLR-20S**	LR-3	T-10
	5428156	**LRIS-3×8**	M3×P0.5	4.2	8.0	60				
	5477328	**LRIS-4×5**	M4×P0.7	5.85	5.0	60	5364930 5794698	**LLR-25S** **LLR-25S-20＊65**	LR-4	T-15
	5907837	**LRIS-4×6**	M4×P0.7	5.85	6.0	60				
	5977566	**LRIS-4×8**	M4×P0.7	5.85	8.0	60				
	5907845	**LRIS-4×10**	M4×P0.7	5.85	10.0	60				
	5684105	**LRIS-4×12**	M4×P0.7	5.85	12.0	60				
 Accessible from front and back	5907852	**LRIS-5×10**	M5×P0.8	7.0	9.5	60	5364948	**LLR-28S**	-	T-20
	5116983	**LRIS-4×10PW**	M4×P0.7	5.7	10.0	60	5681978	**CLR-15S**	LR-2	T-7
	5090576	**LRIS-4×12PW**	M4×P0.7	5.7	12.0	60				

Attention: When tightening screws

- Make sure the wrench tip and wrench hole are neither deformed nor stripped
- Engage the wrench straight to screw hole



- Do not apply more torque than the recommended amount (as shown to the right)

Note: Wrenches and bits come in a pack of five
Clamp screws come in a pack of ten

Recommended Tightening Torque

Item Number	Recommended Tightening Torque (N•m)
CLR LLR HLR **13S**	0.7
CLR LLR HLR **15S**	1.4
RLR LLR HLR **20S**	3.0
LLR HLR **25S**	5.0
LLR HLR **28S**	7.0
LW-4	12
LW-5	15

Material Cross Reference Chart

ISO	Country / Standard	U.S.A. AISI / SAE	Japan JIS	Germany DIN
Stainless steel M		**Stainless Steel (Ferrite/Martensitic)**		
		403	SUS403	X6Cr13
				X7Cr14
		416	SUS416	X12CrS13
		430	SUS430	X6Cr17
		410	SUS410	X10Cr13
			SUS420J2	X46Cr13
		405		X6CrAL13
		420		X20Cr13
		431	SUS431	X19CrNi17-2
		430F	SUS430F	X14CrMoS17
		434	SUS434	X6CrMoS17-2
		CA6-	SCS5	X3CrNiMo13-4
		405	SUS405	X10CrAL13
		HNV6	SUH4	X85CrMoV18-2
		446	SUH446	X10CrAL2-4
		EV8	SUH35,SUH36	X53CrMnNiN21-9
		S44400		X1CrMoTi18-2
				X20CrMoV12-1
		630		X5CrNiCuNb16-4
		Stainless Steel (Austenitic)		
		304L		X2CrNi19-11
		304	SUS304	X5CrNi18-10
		303	SUS303	X8CrNiS18-9
			SUS304L	
		304L	SCS19	X2CrNi19-11
		301	SUS301	X9CrNi18-8
		304LN	SUS304LN	X2CrNi18-10
		316	SUS316	X5CrNiMo17-2-2
		316LN	SUS316LN	X2CrNiMoN17-13-3
		316L		X2CrNiMoN17-12-2
		316L	SCS16	X2CrNiMo18-14-3
			SUS316L	
		317L	SUS317L	X2CrNiMo18-15-4
		UNS		X1NiCrMoCu25-20-5
		V 0890A		
		321	SUS321	X6CrNiTi18-10
		347	SUS347	X10CrNiNb18-10
		316Ti		X6CrNiMoTi17-12-2
		318		X10CrNiMoNb 18-12
		309	SUH309	X15CrNiSi20-12
		310S	SUH310	X8CrNi25-21
		308	SCS17	X2CrNiMoN17-11-2
		17-7PH		X7CrNiAL 17-7
		N08028		X1NiCrMoCu31-27-4
		Stainless Steel (Austenitic/Ferrite)		
		S31500		X2CrNiN23-4
		S32900		X8CrNiMo27-5
		S32304		X2CrNiN23-4
		S31803		X2CrNiMoN22-53
Hardened material H		5130H	SCr430H	34Cr4
		5135H	SCr435H	37Cr4
		4135H	SCM435H	34CrMo4
		4140H	SCM440H	42CrMo4

ISO	Country / Standard	U.S.A. AISI / SAE	Japan JIS	Germany DIN
Cast iron K		**Malleable cast iron**		
		–	FCMB310	–
		32510	FCMW330	EN-GJMB350-10
		40010	FCMW370	EN-GJMB450-6
		50005	FCMW490	EN-GJMB550-4
		70003	FCMP540	
		A220-70003	FCMP590	EN-GJMB650-2
		A220-80002	FCMP690	EN-GJMB700-2
		Gray cast iron		
		No 20 B	FC100	EN-GJL-100
		No 25 B	FC150	EN-GJL-150
		No 30 B	FC200	EN-GJL-200
		No 35 B	FD250	EN-GJL-250
		No 40 B	–	–
		No 45 B	FC300	EN-GJL-300
		No 50 B	FC350	EN-GJL-350
		No 55 B	–	EN-JLZ
		A436 Type 2	–	GGL-NiCr20-2
		Ductile cast iron		
		60-40-18	FCD400	EN-GJL-400-15
		–	–	EN-GJL-400-18-LT
		80-55-06	FCD500	EN-GJL-500-7
		A43D2	–	EN-GJSA-500
		–	FCD600	EN-GJS-600-3
		100-70-03	FCD700	EN-GJS-700-2
Nonferrous material N		SC64D	C4BS	G-AlSi9MGWA
		GD-AlSI12	AC4A	G-ALMG5
		356.1	A5052	
		A413.0	A6061	GD-AlSi12
		A380.1	A7075	GD-AlSi8Cu3
		A413.1	ADC12	G-AlSi12(Cu)
		A413.2		G-AlSi12
		A360.2		G-AlSi10Mg(Cu)
Heat-resistant alloy S		**Heat-resistant alloy**		
		330	SUH330	X12NiCrSi36 16
			SCH15	G-X40NiCrSi36-18
		5390A		
		5666		NiCr22Mo9Nb
				NiCr20Ti
		5660		NiFe35Cr14MoTi
		5391		S-NiCr13A16MoNb
		5383		NiCr19Fe19NbMo
		4676		NiCu30AL3Ti
				NiCr20TiAk
		AMS 5399		NiCr19Co11MoTi
		AMS 5544		NiCr19Fe19NbMo
		AMS 5397		NiCo15Cr10MoAl
		5537C		CoCr20W15Ni
		AMS 5772		CoCr22W14Ni
		Titanium alloy		
		AMS R54520		TiAl5Sn2.5
		AMS R56400		TiAl6V4
		AMS R56401		TiAl6V4ELl
				TiAl4Mo4Sn4Si0.5

ISO	Country / Standard	U.S.A. AISI/SAE	Japan JIS	Germany DIN
Steel P		**Carbon steel**		
		A570.36	STKM12A;C	S235JRG2
		1115		GC16E
		A573-8165		S235J2G3
		1015		C15
		1020		C22
		1213	SUM22	11SMn30
		12L13	SUM22L	11SMnPb30
				10SPb20
		1215		11SMn37
		12L14		11SMnPb37
		1015	S15C	Ck15E
		1025	S25C	Ck25E
		A572-60		S380N
		A572-60		17MnV7
		1035		C35
		1045		C45
		1040		35S20
		1039		40Mn4
		1335	SMn438(H)	36Mn5
		1330	SCMn1	28Mn6
		1035	S35C	C35G
		1045	S45C	C45E
		1050	S50C	C53G
		1055		C55
		1060		C60E
		1055	S55C	C55E
		1060	S58C	C60E
		1095		C101E
		W1	SK3	C101u
		W210	SUP4	C105W1
		Alloy steel		
		ASTMA353		X8Ni9
		2515		12Ni19
				14NiCrMo13
		D3	SKD1	X210Cr12
		H13	SKD61	X40CrMo134
		A2	SKD12	X100CrMoV51
			SKD2	X210CrW12
		S1		45WCrV7
		H21	SKD5	X30WCrV93
				X30WCrV9
				X165CrMoV12
		HW3	SUH1	X45GrSi93
		D3	SUH3	S6-5-2
		M2	SKH51	S6-5-2
		M35	SKH55	S6-5-2-5
		M7		S6-9-2
		HNV3		X210Cr12G

ISO	Country / Standard	U.S.A. AISI/SAE	Japan JIS	Germany DIN
Steel P		A573-81	SM400A;B;C	S275J2G3
			SM490A;B;C;YA;YB	S355J2G3+C2
		5120		DS355J2G3
		9255		55Si7
		9262		S340MGC
		52100	SUJ2	100Cr6
		ASTM		16Mo3
		4520		16Mo5
		ASTM		14Ni6
		8620	SNCM220(H)	21NiCrMo2
		8740	SNCM240	40NiCrMo22
				17CrNiMo6
		5015	SCr415(H)	15Cr3
		5140	SCr440	42Cr4
		5155	SUP9(A)	55Cr3
			SCM415(H)	15CrMo5
		8740	SNCM240	40NiCrMo8-4
		5015	SCr415(H)	15Cr3
		ASTMA182		13CrMo5
		ASTMA182		13CrMo4-5
				14MoV63
				31CrMo12
				39CrMoV13
		L1		41CrS4
		8620		22Mo4
				50CoMo4
				16MnCr5
				31NiCrMo14
		L6		50NiCr13
		3135	SNC236	36NiCr6
		3415	SNC415(H)	14NiCr10
		3415;3310	SNC815(H)	14NiCr14
		9255		
		9840		36CrNiMo4
		4340		34CrNiMo6
		5132	SCr430(H)	34Cr4
		5140	SCr440(H)	41Cr4
		5115		16MnCr5
		4130	SCM420;SCM430	25CrMo4
		4137;4135	SCM432;SCCRM3	34CrMo4
		4140;4142	SCM440	41CrMo4
		4140	SCM440(H)	42CrMo4
				32CrMo12
		6150	SUP10	51CrV4
				41CrMo7
		L3		100Cr6
			SKS31	105WCr6
			SKS2,SKS3	
		L6	SKT4	55NiCrMoV6
		Cast steel		
			SEMnH1	
			SCMnH/1	G-X120Mn12

Ni-based Heat Resistant Alloys

● Material Specifications Cross-Reference List-Aerospace Material Designation

Commercial designation	Hardness Brinell HB		Nominal composition Approximate content in %										
	Ann.	Aged	Ni	Cr	Co	Fe	Mo	C	Mn	Si	Al	Ti	Others
Astroloy*	—	—	56.9	15.0	15.0	—	5.25	0.06	—	—	4.0	3.5	0.05
AerMet 100			11.1	3.1	13.4	70.0	1.20	0.23				0.05	
GMR 235*	—	—	63.3	15.5	—	10.0	5.2	0.15	0.25	0.6	3.0	2.0	0.06
GMR 235D	—	—	63.0	15.5	—	4.5	5.0	0.15	0.1	0.3	3.5	2.5	0.05
Hastalloy B*	140	—	64.3	0.6	1.25	5.5	28.0	0.1	0.8	0.7	—	—	—
Hastalloy B-3			65.0	1.5	3.00	1.5	28.5	0.01	3.0	0.1	0.5		1.0
Hastalloy C*	200	—	54.1	16.0	1.25	5.75	17.0	0.07	0.8	0.7	—	—	4.0
Hastalloy C-22			56.0	22.0	2.50	3.00			0.5	0.1			3.8
Hastalloy C*22HS			74.0	22.0	1.00	2.00							0.0
Hastalloy C-276			57.0	16.0	2.50	5.00	16.0	0.01	1.0	0.1			1.0
Hastalloy N*	—	—	72.2	7.0	0.25	3.0	16.5	0.06	0.4	0.25	0.5	—	0.21
Hastalloy W*	—	—	62.7	5.0	1.25	5.5	24.5	0.06	0.5	0.5	—	—	—
Hastalloy X*	160	—	47.1	22.0	1.5	18.5	9.0	0.1	0.6	0.6	—	—	0.6
Hastelloy R235*	—	—	61.0	15.0	2.5	10.0	5.5	0.15	0.25	0.6	3.0	2.0	—
Haynes 25			10.0	20.0	51.0	3.0	1.0	0.10	1.50	0.4			15.0
Haynes 75	—	—	73.7	20.0	—	5.0	—	0.12	—	—	0.25	0.4	0.5
Haynes 80A	—	—	70.9	20.0	2.0	3.0	—	0.1	—	—	1.5	2.5	—
Haynes 188			22.0	22.0	39.0	3.0		0.1	1.25	0.35			1.0
Haynes 263	—	25	51.4	20.0	20.0	—	6.0	0.06	—	—	1.0	1.5	—
Haynes 600	—	—	75.9	16.0	—	8.0	—	0.08	—	—	—	—	—
Haynes 625	—	—	61.4	21.0	—	5.0	9.0	0.1	—	—	—	—	3.5
Haynes 718	—	43	53.5	18.0	—	19.0	3.0	0.08	—	—	0.5	0.9	5.0
Haynes X-750	—	37	74.9	16.0	—	7.0	—	0.08	—	—	0.8	0.25	1.0
IN-100*	—	—	61.6	10.0	15.0	—	3.0	0.18	1.2	0.5	5.5	4.75	—
Incoloy A-286			25.5	15.0		56.5						2.10	
Incoloy 800			35.0	23.0		39.5		0.10			0.6	0.60	1.8
Incoloy 804*	—	—	41.0	29.5	—	26.0	—	0.1	1.0	0.75	0.25	0.6	0.5
Incoloy 825*	180	—	42.0	21.0	—	30.0	3.0	0.04	—	—	—	1.0	2.0
Incoloy 901*	180	300	44.3	12.5	—	34.0	6.0	0.05	0.24	0.12	0.15	2.7	0.15
Incoloy 903*	—	380	39.0	—	15.0	41.0	—	0.02	—	—	0.7	1.4	3.0
Incoloy 909			38.0		13.0	42.0	1.25			0.4	0.0	1.5	4.7
Incoloy MA956				20.0		74.0					4.5	0.5	0.5
Inconel 600*	170	—	75.0	15.5	—	8.0	—	0.05	—	—	—	—	—
Inconel 601*	150	—	60.0	23.0	—	14.0	—	0.05	—	—	1.4	—	—
Inconel 604*	180	—	74.4	15.8	—	7.2	—	0.04	0.2	0.2	—	—	0.1
Inconel 617			52.0	22.0	12.5	1.5	9.5				1.2		
Inconel 625*	180	—	61.0	21.5	—	2.5	9.0	0.04	0.5	0.5	0.4	0.4	3.6
Inconel 625CLF			61.0	21.5		2.5	9.0						3.6
Inconel 700*	—	350	46.0	15.0	23.5	0.7	3.75	0.12	0.1	0.3	3.0	2.2	—
Inconel 702*	—	—	79.6	15.6	—	0.35	—	0.04	0.05	0.2	3.0	0.7	—
Inconel 706*	—	—	42.0	16.0	—	40.0	—	0.03	0.2	0.3	0.4	1.75	—
Inconel 713*	—	—	75.0	12.5	—	—	4.2	0.12	—	—	6.1	0.8	—
Inconel 718*	180	380	52.5	19.0	—	19.0	3.0	0.04	0.35	0.35	0.9	0.9	0.1
Inconel 718SPF			54.0	18.0		18.5	3.0					1.0	5.0
Inconel 722*	—	380	74.8	15.0	—	6.5	—	0.04	0.55	0.2	0.6	2.4	—
Inconel 751*	—	—	70.0	15.5	—	7.0	—	0.1	1.0	0.5	1.5	2.6	0.5
Inconel 781	—	—	70.0	16.0	—	8.0	—	0.07	2.25	0.15	0.1	3.0	0.2
Inconel 783			30.0	3.5	26.5	27.0		0.03	0.05		6.0	0.4	
Inconel HX			47.0	22.0	1.5	18.0	9.0						0.6
Inconel MA754			77.5	20.0		1.0					0.3	0.5	0.6
Inconel X-750*	—	390	73.0	15.5	—	7.0	—	0.04	0.35	0.35	0.7	2.5	—
Invar 36			36.0	0.25	0.5	62.0		0.15	0.60	0.40			1.00
Invar 42			41.0			56.0		0.50	0.40				1.00
Jessop G39*	130	—	67.5	19.5	—	5.0	3.0	0.5	—	—	—	—	4.5
Jessop G64*	220	—	60.7	11.0	—	2.0	3.0	0.15	—	—	6.0	—	4.0
Jessop G81*	—	300	79.3	20.0	13.0	—	—	0.05	—	—	1.3	2.3	—
Jethete M-152			2.5	16.8			1.8	0.12	0.7	0.18			0.6
Jethete M-252*	—	320	55.3	20.0	10.0	—	10.0	0.15	0.5	0.5	1.0	2.6	—
MAR-M 200*	—	—	69.4	9.0	10.0	—	—	0.15	—	—	5.0	2.0	13.5
MAR-M 246*	—	270	59.5	9.0	10.0	0.2	2.5	0.15	—	—	5.5	1.5	11.5
MAR-M 421*	—	—	62.3	15.5	10.0	—	1.7	0.15	—	—	4.3	1.75	5.3
MAR-M 432*	—	—	52.3	15.5	20.0	—	—	0.15	—	—	2.8	4.3	5.0
Monel 400*	110	—	65.0	—	—	1.5	—	0.12	1.0	—	—	—	32.0
Monel 405			63.0			2.5		0.30	2.0	0.5			34.0
Monel K-500*	120	290	64.0	—	—	1.0	—	0.13	0.8	—	2.8	0.6	30.0

* These alloys can be hardened by an aging process

USA		UK	France	Germany		Others
SAE	AMS	BS	AFNOR	Werkst.-Nr	DIN1706	
—	—	—	—	—	—	—
—	—	—	—	—	—	AISI:686
—	—	—	—	—	NiCr16MoAl	—
5396A	5396	—	ND37FeV	2.48	S-NiMo30	N10001
5388C	5388	—	—	2.4602	NiCr17Mo17FeW	N10002
5771	5607	—	—	—	—	N10003
—	5786	—	—	—	—	N10004
5390A	5390	—	NC22FeD	2.4603	—	N06002
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	5872	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	5596/5597	—	—	—	—	—
—	5542/5593	—	NC15TNbA	—	—	—
—	5397	—	—	LW2.4674	NiCo15Cr10MoAlTi	N13100
—	—	—	—	—	—	—
—	—	3072-76	NC21FeDU	2.4858	NiCr21Mo	N08825
—	5660	—	ZSNCDT42	LW2.4662	NiFe35Cr14MoTi	N09901
—	—	—	—	—	—	—
5540	5580	3072-76	NC15Fe	2.4816	NiCr15Fe	N06600
—	5715	—	—	2.4851	NiCr23Fe	N06601
—	—	—	—	—	—	—
	5887-89					
—	5666	—	NC22FeDNB	2.4856	NiCr22Mo9Nb	N06625
	5879					
—	—	—	NK27CADT	—	NiCo29Cr15MoAlTi	—
—	5550	—	—	—	—	N07702
—	5702	—	—	—	—	N09707
—	5391	3146-3	NC12AD	LW2.4670	S-NiCr13Al6MoNb	—
5383	5589	HR8	NC19FeNB	LW24668	NiCr19Fe19NbMo	N07713
	5596G					
—	5541	—	NC16FeTi	—	NiCr16FeTi	N07722
—	—	—	—	—	—	N07751
—	—	—	—	—	—	—
	5536					
5542G	5582	—	NC16FeTNb	2.4669	NiCr16FeTi	N07750
—	—	—	—	—	NiCr20MoW	—
—	—	—	—	—	NiCr11AlWNb	—
—	—	—	—	—	NiCr20Co18Ti	—
—	5551	—	—	2.4916	S-NiCr19Co	N07252
—	—	—	—	—	NiW13Co10Cr9AlTi	—
—	—	—	—	2.4675	NiCo10W10Cr9AlTi	—
—	—	—	—	—	NiCR16Co10WAlTi	—
—	—	—	—	—	NiCo20Cr16WAlTi	—
4544	4574	3072-76	NU30	2.436	NiCu30Fe	N04400
4676	—	3072-76	—	2.4375	NiCu30Al	N05500

Ni-based Heat Resistant Alloys

● Material Specifications Cross-Reference List-Aerospace Material Designation

Commercial designation	Hardness Brinell HB		Nominal composition Approximate content in %										
	Ann.	Aged	Ni	Cr	Co	Fe	Mo	C	Mn	Si	Al	Ti	Others
Monel R-405*	110	—	66.0	—	—	1.2	—	0.15	1.0	—	—	—	31.06
Multimet N155			21.0	22.5	21		3.5	0.16	2.0	1.0			4.50
Nickel 200			99.0			0.4		0.15	0.35	0.35			0.26
Nickel 201			99.0			0.4		0.02	0.35	0.35			0.26
Nimocast 80*	—	—	69.9	20.0	2.0	5.0	—	0.1	—	—	1.0	2.0	—
Nimocast 90*	—	—	52.9	20.0	18.0	5.0	—	0.1	—	—	1.5	2.5	—
Nimocast 713	—	—	72.6	13.4	—	—	4.5	0.12	—	—	6.2	1.0	2.3
Nimocast 842	—	—	57.7	22.0	10.0	—	10.0	0.3	—	—	—	—	—
Nimocast PD16	—	—	43.8	16.5	—	34.0	3.3	0.06	—	—	1.2	1.2	—
Nimocast PE10	—	—	56.4	20.0	—	—	6.0	—	—	—	—	—	9.0
Nimocast PK24	—	—	61.1	9.5	15.0	—	3.0	0.17	—	—	5.5	4.7	1.0
Nimonic 75*	170	—	75.0	19.5	—	4.0	—	0.12	—	—	—	0.4	—
Nimonic 80A*	—	350	75.0	19.5	—	—	—	0.08	—	—	1.4	2.4	—
Nimonic 86			65.0	25.0			10.0						
Nimonic 90*	—	346	59.0	19.5	16.5	—	—	0.08	—	—	1.5	2.5	—
Nimonic 95	—	—	49.9	19.5	—	5.0	—	0.11	—	1.0	2.0	3.5	—
Nimonic 101			48.0	24.2	19.7		1.5				1.4	3.0	
Nimonic 105*	—	320	53.0	15.0	20.0	—	5.0	0.12	—	—	4.7	1.2	—
Nimonic 115*	—	350	59.0	14.2	13.2	—	4.0	0.16	—	—	5.0	4.0	—
Nimonic 242	—	—	58.0	21.5	10.0	—	10.5	—	—	—	—	—	—
Nimonic 263/C263*	—	275	51.5	20.2	20.0	—	6.0	0.06	—	—	0.5	2.0	—
Nimonic 901*	—	350	44.0	12.5	—	35.0	5.7	0.04	—	—	0.3	2.9	—
Nimonic PE11			39.0	18.0		34.0	5.2				0.8	2.3	
Nimonic PE13	—	—	49.0	21.8	1.5	18.5	9.0	0.1	0.5	0.5	—	—	0.6
Nimonic PE16*	—	250	43.5	16.5	—	34.0	3.3	0.06	—	—	1.2	1.2	—
Nimonic PK25	—	—	49.9	19.0	19.5	—	4.0	0.08	0.8	0.8	2.9	2.9	—
Nimonic PK31	—	—	53.8	20.0	14.0	—	4.5	—	—	—	0.4	2.3	5.0
Nimonic PK33*	—	350	55.9	18.0	14.0	0.5	7.0	0.05	0.25	0.25	2.1	2.2	—
R-235*	—	—	63.3	15.0	1.2	10.0	5.5	0.12	0.1	0.3	2.0	2.5	—
Refractaloy 26	—	—	38.0	19.0	20.0	16.0	3.2	0.03	0.8	1.0	0.2	2.75	—
Rene 41	—	—	53.1	19.0	11.0	1.8	10.0	0.09	0.3	0.3	1.5	3.1	—
Rene 63	—	—	54.4	14.0	15.0	0.5	6.0	0.05	0.1	0.2	3.8	2.5	3.5
Rene 77	—	—	57.6	15.0	15.0	0.4	4.2	0.17	0.1	0.1	4.3	3.3	—
Rene 80	—	—	61.0	14.0	9.5	—	4.0	0.15	—	—	—	4.0	8.0
Rene 95	—	—	64.5	14.0	8.0	—	3.5	0.15	—	—	—	2.5	3.5
Rene 100	—	—	60.6	10.0	15.0	—	3.0	0.18	—	—	5.5	4.7	—
Rene 125	—	—	60.0	8.9	10.0	—	2.0	0.1	—	—	4.7	2.5	7.0
TRW 1800	—	—	70.0	13.0	—	—	—	0.1	—	—	6.0	0.06	10.5
TRW V1 A	—	—	70.5	6.0	7.5	—	2.0	0.13	—	—	5.4	1.0	6.3
Udimar 250			18.0		8.0	68.0	5.0				0.1	0.4	
Udimar 300			18.5		9.0	66.0	5.0				0.1	0.7	
Udimet 500*	—	—	51.7	19.0	19.0	—	4.0	0.1	0.1	0.1	3.0	3.0	—
Udimet 520			56.0	19.0	12.0		6.0				2.0	3.0	1.0
Udimet 630	—	—	51.0	17.0	—	17.5	3.0	0.04	—	—	0.6	1.1	4.1
Udimet 700	—	—	54.6	15.0	17.5	—	—	0.1	—	—	4.4	3.4	—
Udimet 710	—	—	55.0	18.0	15.0	0.5	1.5	0.07	—	—	2.5	5.0	1.5
Udimet 718*	180	380	52.5	18.0	—	18.0	3.0	0.05	—	—	0.6	0.1	5.2
Udimet 720			56.0	16.0	14.7		3.0				2.5	5.0	1.3
Udimet alloy D-979			45.0	15.0		27.0	4.0				1.0	3.0	4.0
Udimet L-605			10.0	20.5	50.0	3.0			1.5				15.0
Udimet alloy R41			55.0	19.0	11.0		10.0				1.5	3.1	
Waspaloy*	—	HRC35-42	56.9	19.8	13.5	0.8	4.45	0.07	0.1	0.1	1.4	3.0	—

* These alloys can be hardened by an aging process

USA		UK	France	Germany		Others
SAE	AMS	BS	AFNOR	Werkst.-Nr	DIN1706	
4674	7234	—	—	—	—	N04405
—	—	3146	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
5391A	—	HC203	NC13AD	2.467	S-NiCr13Al6MoNb	—
—	5397	HC204	NK15CAT	LW2.4674	—	—
—	—	—	—	—	NiFe33Cr17Mo	—
—	—	3146	—	—	—	—
—	—	HR5,203-4	NC20T	2.463	NiCr20Ti	—
—	—	Hr401,601	NC20TA	2.4631	NiCr20TiAk	N07080
—	—	Hr2,202	Nc20ATV	2.4632	NiCr20Co18Ti	N07090
—	—	—	—	—	—	—
—	—	HR3	NCKD20ATV	2.4634	NiCo20C15MoAlTi	—
—	—	HR4	NCK15ATD	2.4636	NiCo15Cr15MoAlTi	—
—	—	—	—	—	—	—
—	—	HR10	NCK20D	2.465	NiCr15Co19MoTi	—
5660C	5661A	—	ZSNCDT42	2.4662	NiCr15MoTi	—
5536E	5754E	HR6,204	NC22FeD	2.4665	NiCr22Fe18Mo	—
—	—	HR207	NW11AC	—	NiFe33Cr17Mo	—
5751A	5753	—	NKOD20ATU	2.4666	NiCr18CoMo	—
—	—	—	—	—	—	—
—	—	—	NC19KDUV	—	NiCr20Co16MoTi	—
—	—	—	—	—	—	—
—	—	—	Z6NKCDT38	—	—	—
—	5399	—	NC19KDT	2.4973	NiCr19Co11MoTi	N07041
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	NC14K8	—	—	—
—	—	—	—	—	NiCo15Cr10MoAlTi	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	NiTa9Co8W6CrAl	—
	6512					
—	5751	—	NCK19DAT	2.4983	NiCr18Co18MoTi	N07500
—	—	—	—	2.4668	NiCr19NbMo	—
—	—	—	NCKD20AT	2.4636	NiCo15CrMoAlTi	—
—	—	—	NC18TDA	—	—	—
5383	5589	HR8	NC19FeN	LW2.4668	NiCr19Fe19NbMo	N07718
	5759					
—	5544	—	NC20K14	LW2.4668	NiCr19Fe19NbMo	N07001

Co-based Heat Resistant Alloys

● Material Specifications Cross-Reference List-Aerospace Material Designation

Commercial designation	Hardness Brinell HB		Nominal composition Approximate content in %										
	Ann.	Aged	Ni	Cr	Co	Fe	Mo	W	Mn	Si	Al	Ti	Others
Air Resist 13	—	—	1.0	—	79.6	2.5	—	11.0	—	—	3.5	—	4.12
Air Resist 213	—	—	—	19.0	65.8	—	—	4.7	—	—	3.5	—	6.68
Altemp S 816	—	—	20.0	20.0	47.6	—	4.0	4.0	—	—	—	—	0.4
FSX 414	—	—	10.0	29.0	52.8	1.0	—	7.0	—	—	—	—	0.25
Haynes 25*	—	—	10.0	20.0	49.0	3.0	—	15.0	1.5	0.5	—	—	0.1
Haynes 36	—	—	10.0	18.5	52.8	2.0	—	14.5	1.2	0.6	—	—	0.4
Haynes 151	—	—	—	20.0	65.6	—	—	12.8	0.5	0.5	—	0.15	0.47
Haynes 188*	—	—	22.0	22.0	38.0	2.5	—	14.0	1.0	0.4	—	—	0.1
HS 6*	—	—	2.5	28.0	60.5	3.0	—	5.0	—	—	—	—	1.0
HS 21*	—	—	3.0	27.0	62.6	2.0	5.0	—	0.6	0.6	—	—	0.25
HS 25	—	—	10.0	20.0	48.4	3.0	—	15.0	1.5	2.0	—	—	0.1
HS 30	—	—	16.0	24.0	51.4	1.0	6.0	—	0.6	0.6	—	—	0.4
HS 31	—	—	10.0	25.0	53.8	1.5	—	8.0	0.6	0.8	—	—	0.4
HS 36	—	—	10.0	18.0	53.1	2.0	—	15.0	1.5	—	—	—	0.4
Inconel 783			28.5	3.0	34.0	26.0					5.4	0.1	3.0
J 1570*	—	—	28.0	19.0	39.0	2.0	—	7.0	—	—	—	—	—
J 1650	—	—	27.0	19.0	38.0	—	—	12.0	—	—	—	—	0.2
Jessop 832	—	—	12.0	19.0	44.0	17.0	2.0	—	0.8	0.3	—	—	3.5
Jessop 834	—	—	12.0	19.0	42.0	20.0	2.0	—	—	—	—	—	6.5
Jessop 865	—	—	10.5	25.5	53.0	2.0	—	7.5	0.6	0.6	—	—	0.45
Jessop 875	—	—	—	21.0	66.0	—	—	11.0	—	—	—	—	2.45
Jessop 887	—	—	10.0	20.0	50.0	3.0	—	15.0	0.5	1.5	—	—	0.1
Jessop X-40			10.5	25.5	53.0	1.5	—	7.5	0.75	0.75	—	—	0.5
Jessop X-45			10.5	25.5	54.7	2.0	—	7.0	—	—	—	—	0.25
Jessop X-50			20.5	25.5	40.3	4.0	—	12.0	—	—	—	—	0.75
Jessop X-63			10.0	25.0	57.6	1.0	6.0	—	—	—	—	—	0.45
Jetalloy 209	—	—	10.0	20.0	52.0	1.0	—	15.0	—	—	—	2.0	0.02
L-251	—	—	10.0	19.0	56.0	1.0	—	14.0	—	—	—	—	0.4
L-605	—	—	10.0	20.0	51.0	1.6	—	15.0	1.5	0.6	—	—	0.1
M 203	—	—	25.0	20.0	38.0	1.6	—	12.0	0.8	1.0	0.7	2.0	1.67
M 204	—	—	25.0	18.0	42.0	1.6	—	12.0	—	—	—	—	1.27
M 205	—	—	25.0	18.0	40.0	1.6	—	12.0	—	—	2.7	—	1.67
ME16				15.0	23.0	2.0	5				5.0		22.25
MP35N			37.0	21.0	29.2	1.0	10.5		0.15	0.15		1.0	0.04
MAR-M 302	—	—	—	21.5	57.0	0.75	—	10.0	0.1	0.2	—	—	10.0
MAR-M 322	—	—	—	21.5	60.0	0.75	—	9.0	0.1	0.1	—	0.75	7.7
MAR-M 509	—	—	10.0	23.0	55.0	—	—	7.0	0.05	0.05	—	0.2	4.6
MAR-M 905	—	—	20.0	20.0	55.0	—	—	—	—	—	—	0.5	7.65
MAR-M 918	—	—	20.0	20.0	52.0	0.4	—	—	0.1	0.1	—	0.5	7.65
NF3				14.3	22.4		3.9				4.8	4.6	17.90
Refractaloy 70	—	—	20.0	21.0	46.0	0.5	8.0	4.0	—	—	—	—	0.08
STELLITE 6				26.0	72.0			5.0					
UDIMET 188			22.0	22.0	38.0	3.0		14.0	1.25				
V-36	—	—	20.0	25.0	43.2	2.4	4.0	2.0	0.6	0.5	—	—	2.29
Wl-52			0.5	21.0	62.6	2.0	—	11.0	0.25	0.25	—	—	2.45

* These alloys can be hardened by an aging process

USA		UK	France	Germany		Others
SAE	AMS	BS	AFNOR	Werkst.-Nr	DIN1706	
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	(5534)	—	—	LW2.4989	CoCr20Ni20W	—
—	—	—	—	—	—	—
5537C	5759	—	KC20WN	LW2.4964	CoCr20W15Ni	—
—	—	—	—	—	CoCr19W14NiB	—
—	—	—	—	—	CoCr20W13	—
—	5772	—	KC22WN	—	CoCr22W14Ni	—
—	5373	—	—	—	—	R30006
—	5385	3531	—	—	CoCr29Mo	R30021
	5759	—	KC20WN	LW2.4964	CoCr20W15Ni	—
5380	—	—	—	—	CoCr25NiW	R30030
5382	—	3146	—	LW2.4670	CoCr25NiW	R30031
—	—	—	—	—	CoCr19W14NiB	—
	5940					
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	CoCr19Fe16NiMoVNb	—
—	—	—	—	—	CoCr19Fe20NiMoVNb	—
—	—	—	—	—	CoCr25Niw	—
—	—	—	—	—	CoCr21W11Nb	—
—	—	—	—	—	CoCr20W15Ni	—
—	5382	3156-2	—	LW2.4670	CoCr25NiW	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	5759	—	—	2.4964	CoCr20W15Ni	R30605
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
	5844					
—	—	—	—	—	CoCrW10TaZrB	—
—	—	—	—	—	CoCr22W9TaZrNb	—
—	—	3146-3	—	—	CoCr24Ni10WTaZrB	—
—	—	—	—	—	—	—
—	—	—	—	—	CoCr20Ni20Ta	—
—	—	—	—	—	—	—
—	—	—	—	—	CoCr25NiMoWNb	—
—	—	—	—	—	CoCr12MoW	—

Swiss Machine List

Citizen/Cincom

Machine Model	Gang Station			Turret Station				Sleeve Station	Hand	Max cutting dia
	Metric		Number of tools	Metric		Number of tools		Metric		
	h×b	L		h×b	L	Turret	Station	mm		mm
A12	□10	100	5	—	—	—	—	ϕ19.05/ϕ20	R	ϕ12
A16	□10	100	5	—	—	—	—	ϕ19.05/ϕ20	R	ϕ16
A20	□12(□13)	120	5-7	—	—	—	—	ϕ25.4	R	ϕ20
A25	□12(□13)	120	5/6	—	—	—	—	ϕ25.4	R	ϕ25
A32	□16	150	6	—	—	—	—	ϕ25.4	R	ϕ32
B12, B12E	□10	100	5	—	—	—	—	ϕ19.05/ϕ20	R	ϕ12
B16E	□10	120	5	—	—	—	—	ϕ19.05/ϕ20	R	ϕ16
B20	□12(□13)	120	6	—	—	—	—	ϕ19.05/ϕ20	R	ϕ20
BL12	□10	60-120	5	—	—	—	—	ϕ19.05/ϕ20	R	ϕ12
BL20	□12(□13)	120	7	—	—	—	—	ϕ19.05/ϕ20	R	ϕ20
BL25	□12(□13)	120	7	—	—	—	—	ϕ19.05/ϕ20	R	ϕ25
C12	□10	120	6	—	—	—	—	ϕ19.05	R	ϕ12
C16	□10	120	6	—	—	—	—	ϕ19.05	R	ϕ16
C32	□16	130	5	—	—	—	—	ϕ25.4	R	ϕ32
D25 VIII	□16	—	10					ϕ25.4	R	ϕ25
E32	—	—	—	□16(19×13)	90	2	10/Turret	ϕ25.4	R	ϕ32
F10	—	—	—	□10	60	1	10	ϕ19.05	R	ϕ10
F12	—	—	—	□10	60	1	10	ϕ19.05	R	ϕ12
F16	—	—	—	□10	60	1	10	ϕ19.05	R	ϕ16
F20	—	—	—	□16(19×13)	90	1	10	ϕ25.4	R	ϕ20
F25	—	—	—	□16(19×13)	90	1	10	ϕ25.4	R	ϕ25
FL25	—	—	—	□16	90	1	12	ϕ16	R	ϕ25
FL42	—	—	—	□16	90	1	12	ϕ16	R	ϕ42
G10	—	—	—	□10	60	1	8	—	R	ϕ10
G16	—	—	—	□10	60	1	8	—	R	ϕ16
G32	—	—	—	□16(19×13)	90	1	10	—	R	ϕ32
K12, K12E	□10	100	7	—	—	—	—	ϕ20	R	ϕ12
K16, K16E	□12	100	6	—	—	—	—	ϕ20	R	ϕ16
L10	□8	100-130	5	—	—	—	—	ϕ15.875	R	ϕ10
L12	□10	100	6	—	—	—	—	ϕ19.05	R	ϕ12
L16, L16E	□12(□10)	130	7	—	—	—	—	ϕ19.05	R	ϕ16
L20, L20E, L20X	□12	130	7	—	—	—	—	ϕ19.05	R	ϕ20
L25	□16	130	5	—	—	—	—	ϕ25.4	R	ϕ25
L32	□16	130	5	—	—	—	—	ϕ25.4	R	ϕ32
M$_2$12, M$_3$12	□10	120	5	□10	60	1	10	ϕ19.05	R	ϕ12
M$_2$16, M$_3$16, M$_4$16	□10	120	5	□10	60	1	10	ϕ19.05	R	ϕ16
M$_2$20, M$_3$20	□12	130	5	□16	90	1	10	ϕ25.4	R	ϕ20
M$_2$32, M$_3$32, M$_4$32	□16	130	5	□16	90	1	10	ϕ25.4	R	ϕ32
M20	□13(□12)	150	5	□10	60	1	10	ϕ19.05	R	ϕ20
MSL12	□10	120	—	—	—	—	—	—	R	ϕ12
R04	□8	120	7	—	—	—	—	ϕ15.875	R	ϕ4
R07	□8	120	5	—	—	—	—	ϕ15.875	R	ϕ7
RL02	□16	60-150	Max 6	—	—	—	—	ϕ16/ϕ20	L	ϕ25
RL21	□10(□12)	90	—	—	—	—	—	ϕ19.05	R	ϕ35

● STAR

Machine Model	Gang Station			Turret Station				Sleeve Station	Hand	DS-Sleeve item number	Max cutting dia
	Metric		Num ber of tools	Metric		Number of tools		Metric			
	h×b	L		h×b	L	Turret	Station	mm			mm
ECAS-12	□10	95-150	6					ϕ22	R	SS-DSU-L23 SS-DSU-SK	ϕ13
ECAS-20	□12(16)	80-144	6					ϕ22	R	SS-DSU-L23 SS-DSU-SK	ϕ20
ECAS-20T				□12(16)	80	3	8/Turret	ϕ22	R	SS-DSU-B8D34	ϕ20
ECAS-32T	□16	80-120	4	□16	60-78	2	10/Turret	ϕ22/32	R	SS-DSU-SK	ϕ32
JNC-10				□8	65	1	6	-	L	—	ϕ10
JNC-16				□10	80	1	6	-	L	—	ϕ16
JNC-25/32				□16	78-120	1	10	ϕ22	R	—	ϕ25/ϕ32
KJR-16B/25B				□16	78	1	12/16	ϕ22	R	—	ϕ16/ϕ25
KNC-16/20				□16	68	1	16	ϕ22	R	—	ϕ16/ϕ20
KNC-25II/32II				□16	78	1	20	ϕ22/32	R	—	ϕ25/ϕ32
RNC-10/16	□10	80-120	5					ϕ22	R	—	ϕ10/ϕ16
RNC-16II/16BII	□10	80-120	5					ϕ22	R	—	ϕ16
SA-16R	□10	95-120	6					ϕ22	R	—	ϕ16
SB-12II/12R/16II	□12(10)	95-130	6(7)					ϕ22	R	SS-DSU-L23 SS-DSU-SK	ϕ12/ϕ13/ϕ16
SB-16/16R	□12(10)	95-130	6(7)					ϕ22	R	SS-DSU-L23 SS-DSU-SK	ϕ16
SB-20/20R	□12(10)	95-130	6(7)					ϕ22	R	SS-DSU-L23 SS-DSU-SK	ϕ20
SC-20	□12	95-130	6					ϕ22	R	—	ϕ20
SE-12/12B, 16/16B	□10	95-120	5					ϕ22	R	—	ϕ13/ϕ16
SF-25				□16	73-98	1	10	ϕ22/32	R	—	ϕ25
SG-42				□16(20)	84-88	1	10	ϕ22/32	R	—	ϕ42
SH-12/16	□10	95-120	5					ϕ22	R	—	ϕ13/ϕ16
SH-7	□8	95-120	5					ϕ22	R	—	ϕ7
SI-12/12C	□10	80-130	6					ϕ22	R	—	ϕ13
SR-10J	□8	67-110	6					ϕ22	R	SS-DSU-L23 SS-DSU-SK	ϕ10
SR-16/20	□12	95-120	5					ϕ22	R	—	ϕ16/ϕ20
SR-20J	□12	100-135	6					ϕ22	R	SS-DSU-L23 SS-DSU-SK	ϕ20
SR-20R/20RII/20RIII	□12	100-135	6					ϕ22	R	SS-DSU-L23 SS-DSU-SK	ϕ20
SR-20RIV	□12	100-130	7					ϕ22	R	SS-DSU-B8L23	ϕ20
SR-25J/32J	□16	95-155	6					ϕ22/32	R	SS-DSU-L23 SS-DSU-SK	ϕ25/ϕ32
SR-32, SR-32J, SR-38	□16	100-135	6					ϕ22	R	—	ϕ32
SR32JII	□16		6					ϕ22	R	SS-DSU-B8L23 SS-DSU-B8D34	ϕ32
SST-16	□12	95-115	5					ϕ22	R	—	ϕ16
ST-20				□12(16)	70-78	3	8/Turret	ϕ22	R	—	ϕ20
ST-38				□16(20)	85	3	10/Turret	ϕ22/32	R	—	ϕ38
SV-12/20	□12	95-135	4	□12	70-78	1	8	ϕ22	R	—	ϕ13/ϕ20
	□12/□16	95-135	5	□16	65-70	1	8		R	—	
SV-32	□16	95-135	4	□16	80-88	1	10	ϕ22/32	R	—	ϕ32
SV-32J/32JII	□16	95-135	4	□16	65-70	1	8	ϕ22/32	R	—	ϕ32
SV-38R	□16+□20 (Cut off)	95-135	5	□16(20)	84-88	1	10	ϕ22/32	R	SS-DSU-B8D34	ϕ38
SW-12RII	□10	80-115	6					ϕ16	R	SS-DSU-B8L23	ϕ13
SW-20	□12(16)	80-144	6					ϕ22	R	SS-DSU-B8L23	ϕ20
SW-7	□8	80-120	4					—	R	—	ϕ7

TSUGAMI

Machine Model	Gang Station			Turret Station				Sleeve Station	Hand	Max cutting dia
	Metric		Number of tools	Metric		Number of tools		Metric		
	h×b	L		h x b	L	Turret	Station	mm		mm
P013H/P014H	□8	100-120	6	—	—	—	—	ϕ16	R	ϕ1
P033H/P034H	□8	100-120	6	—	—	—	—	ϕ16	R	ϕ3
B007-III	□7(□8/□10)	85	8	—	—	—	—	ϕ25	R	ϕ7
B073-II	□8	85	9					ϕ20	R	ϕ7
B074/B07-V	□8	85	9	—	—	—	—	ϕ20	R	ϕ7
B074-II	□8	85	6	—	—	—	—	ϕ20	R	ϕ7
B0123/B0124/B0125/B0126	□12	85	9	—	—	—	—	ϕ20	R	ϕ12
B012F/B012-V/BE12-V	□12	85	9	—	—	—	—	ϕ20	R	ϕ12
B0123-II/B0124-II/B0125-II/ B0126-II	□12	85	9	—	—	—	—	ϕ20	R	ϕ12
B016MF	□12	85	9	—	—	—	—	ϕ20	R	ϕ16
B018-III	□12	85	9	—	—	—	—	ϕ20	R	ϕ18
B0203/B0204/B0205/B025-II/ B0205-III/B0206-II	□12	85	9	—	—	—	—	ϕ20	R	ϕ20
B0203-II/B0204-II/B0206-II	□12	85	9	—	—	—	—	ϕ20	R	ϕ20
B020F/B020-V/BE20-V	□12	85	9	—	—	—	—	ϕ20	R	ϕ20
B026-V	□12(□16)	85	6	—	—	—	—	ϕ25	R	ϕ26
B0265-II/B0266-II	□16	100	12					ϕ25	R	ϕ26
B0325-II/B0326-II	□16	100	12					ϕ25	R	ϕ32
B0385/B0385L	□16	125	8	—	—	—	—	ϕ32	R	ϕ38
B038T	□16	125	3	□20	125	1	8	ϕ25/ϕ32	R	ϕ38
BA20-III	□12	85	6	—	—	—	—	ϕ25	R	ϕ20
BA26-III	□12(□16)	85	6	—	—	—	—	ϕ25	R	ϕ26
BC18	□12	85	10	—	—	—	—	ϕ25	R	ϕ18
BC25	□12	85	10	—	—	—	—	ϕ10/ϕ25	R	ϕ25
BE18	□12	85	9	—	—	—	—	ϕ20	R	ϕ18
BH20/BH20Z	□12	85	4	□12	85	1	12	ϕ25/ϕ32	R	ϕ20
BH38	□16	125	7	□20	125	1	12	ϕ25/ϕ32	R	ϕ38
BM07	□8	85	9	—	—	—	—	ϕ20	R	ϕ7
BM163/BM164/BM165	□12	85	9	—	—	—	—	ϕ20	R	ϕ16
BM20-V	□12	85	9	—	—	—	—	ϕ20	R	ϕ20
BN12-III	□12	85	7	—	—	—	—	ϕ20	R	ϕ12
BN20-III	□12(□16)	85	7	—	—	—	—	ϕ20	R	ϕ20
BS12-V	□12	85	8(12)	—	—	—	—	ϕ20/ϕ25	R	ϕ12
BS18-III	□12	85	7(10)	—	—	—	—	ϕ14/ϕ25	R	ϕ18
BS20-V	□12	85	8(12)	—	—	—	—	ϕ20/ϕ25	R	ϕ20
BS26(ABC)-V	□16	100	7(10)	—	—	—	—	ϕ16/ϕ25	R	ϕ26
BS32C-V	□16	100	6	—	—	—	—	ϕ16/ϕ25	R	ϕ32
BU12	□12	85	4	□12	80	1	8	ϕ20	R	ϕ51
BU20	□12	85	4	□12	80	1	8	ϕ20	R	ϕ20
BU26	□16	100	7	□20	80	1	8	ϕ20/ϕ32	R	ϕ26
BU38	□16	100	7	□20	80	1	8	ϕ20/ϕ32	R	ϕ38
BW07-III	□12	85	7	—	—	—	—	ϕ20	R	ϕ7
BW12-III/BW129Z	□12	85	7	—	—	—	—	ϕ20	R	ϕ12
BW20-III/BW209Z	□12(□16)	85	7	—	—	—	—	ϕ20	R	ϕ20
C004-III	□13	60-100	6-8	—	—	—	—	-ϕ10	R/L	ϕ120
C150	□10	60-100	4-6	—	—	—	—	-ϕ8	R/L	ϕ80
C180	□12	60-100	4-6	—	—	—	—	-ϕ10	R/L	ϕ120
C220	□13	60-100	6-8	—	—	—	—	-ϕ10	R/L	ϕ120
C300-III	□16	100-130	6-10	—	—	—	—	-ϕ14	R/L	ϕ170
CH154	□12	60-100	-16	—	—	—	—	-ϕ10	R/L	ϕ15
M34J	—	—	—	□20	125	1	12	ϕ20/ϕ32	R	ϕ34

Machine Model	Gang Station			Turret Station				Sleeve Station	Hand	Max cutting dia
	Metric		Number of tools	Metric		Number of tools		Metric		
	h×b	L		h x b	L	Turret	Station	mm		mm
M42J/M42D/M42SD	—	—	—	□20	125	1	12	ϕ25/ϕ32	R	ϕ42
M50SY-III	—	—	—	□20	100	1	12	ϕ32	R	ϕ51
M50J	—	—	—	□20	100	1	12	ϕ20/ϕ32	R	ϕ51
MB25	—	—	—	□20	80	2	8/Turret	ϕ20/ϕ32	R	ϕ25
MB35-III	—	—	—	□20	80	2	8/Turret	ϕ20/ϕ32	R	ϕ35
MB38-III	—	—	—	□20	80	2	8/Turret	ϕ20/ϕ32	R*	ϕ38
MB50-III	—	—	—	□20	80	2	8/Turret	ϕ20/ϕ32	R	ϕ50
MU26	—	—	—	□20	80	2	8/Turret	ϕ20/ϕ32	R	ϕ26
MU38	—	—	—	□20	80	2	8/Turret	ϕ20/ϕ32	R	ϕ38
NU50-III	—	—	—	□20	100	1	12	ϕ20/ϕ32	R	ϕ51
B020M-II/SS20M/SS20M-5AX	□10*	46	—	BT15 spindle			24	ϕ20	R	ϕ20
S205/S206	□12(□16)	100	8	—	—	—	—	ϕ20/ϕ22	R	ϕ20
SS20	□16	100	8	—	—	—	—	ϕ20/ϕ22	R	ϕ20
SS207/SS207-5AX	□12(□16)	100	8	—	—	—	—	ϕ20/ϕ22	R	ϕ20
SS26	□16	100	7	—	—	—	—	ϕ20/ϕ22	R	ϕ26
SS267/SS267-5AX	□16	100	8					ϕ25	R	ϕ26
SS32/SS32L	□16	100	7	—	—	—	—	ϕ20/ϕ22	R	ϕ32
SS327/SS327-5AX	□16	100	8					ϕ25	R	ϕ32
TMB2	—	—	—	□20	125	1	16	ϕ32	R	ϕ51
TMU1	—	—	—	□20	125	1	16	ϕ32	R	ϕ38
TMA8-IV/TMA8J	□20*	100		KM40 spindle			30		R	ϕ220
M06J				□25	150	1	8	ϕ32/ϕ40	R	ϕ260
M06SY				□25	150	1	12	ϕ32/ϕ40	R	ϕ260
M06JC				□20	125	1	8	ϕ32/ϕ40	R	ϕ260
M08J				□25	150	1	8	ϕ32/ϕ40	R	ϕ280
M08SY/M08D/M08SD				□25	150	1	12	ϕ32/ϕ40	R	ϕ280

● DMG MORI

Machine Model	Gang Station			Sleeve Station	Hand	Max cutting dia
	Metric		Number of tools	Metric		
	h×b	L		mm		mm
Sprint 20/5	□12		6	ϕ20	R	ϕ20
Sprint 20/8	□12		6	ϕ20	R	ϕ20
Sprint 32/5	□16		6	ϕ20	R	ϕ32
Sprint 32/8	□16		6	ϕ20	R	ϕ32

NOMURA

Machine Model	Gang Station			Sleeve Station	Hand	Max cutting dia
	Metric		Number of tools	Metric		
	h×b	L		mm		mm
NS-P1053A	□9.5	130	5	—	R	ϕ10
NN-10C	□10	130	6	ϕ17	R	ϕ10
NN-10E	□10	130	6	ϕ16	R	ϕ10
NN-10C2	□10	130	6	ϕ17	R	ϕ10
NN-10CS	□10	130	6	ϕ17	R	ϕ10
NN-10CS (No live tools)	□10	130	5	ϕ17	R	ϕ10
NN-10SII	□10	130	5	ϕ17 (ϕ23)	R	ϕ10
NN-10T	□10	130	7	ϕ17 (ϕ23)	R	ϕ10
NN-10SB5	□10	130	5	ϕ17 (ϕ23)	R	ϕ16
NN-16SB5	□10	130	5	ϕ17 (ϕ23)	R	ϕ16
NN-16SB6 Type1	□12.7	130	5	ϕ17 (ϕ22)	R	ϕ16
NN-16SB6 Type2	□12.7	130	5	ϕ17 (ϕ22)	R	ϕ16
NN-16SB6 Type2.5	□12.7	130	5	ϕ17 (ϕ22)	R	ϕ16
NN-16SB6 Type3	□12.7	130	5	ϕ17 (ϕ22)	R	ϕ16
NN-16SB7	□12.7		5(7)	ϕ16	R	ϕ16
NN-16HIII	□12	130	6	ϕ23	R	ϕ16
NN-20HIII	□12	130	6	ϕ23	R	ϕ20
NN-16UIII	□12	130	5	ϕ23	R	ϕ16
NN-20UIII	□12	130	5	ϕ23	R	ϕ20
NN-20CS	□12.7	130	5(6)	ϕ22	R	ϕ20 (ϕ25)
NN-20U5	□12.7	130	5(6)	ϕ22	R	ϕ20 (ϕ25)
NN-16UB5	□12	130	5	ϕ23	R	ϕ16
NN-20UB5	□12	130	5	ϕ23	R	ϕ20
NN-20UB7	□12	130	6	ϕ23	R	ϕ20
NN-20UB8	□12.7	130	5(6)	ϕ22	R	ϕ20 (ϕ25)
NN-20YB	□12	130	8	ϕ23	R	ϕ20
NN-25UB8	□12		5	ϕ22	R	ϕ25
NN-32UB8	□16		5	ϕ22	R	ϕ32
NN-38UB8	□20		5	ϕ22/ϕ32	R	ϕ38
NN-25YB/32YB	□16	130	8	ϕ23/ϕ32	R	ϕ25/ϕ32
NN-32YB2	□16	130	5	ϕ22/ϕ32	R	ϕ32
NN-32YB3	□16		5	ϕ22/ϕ32	R	ϕ32
NN-32YB3XB	□16		6	ϕ22/ϕ32	R	ϕ32
NN-16J	□12.7	130	6	ϕ23	R	ϕ16
NN-20J	□12.7	130	6	ϕ23	R	ϕ20
NN-20J2	□12.7	130	6	ϕ22	R	ϕ20
NN-20J3	□12.7		6	ϕ23	R	ϕ20
NN-20J3XB	□12.7		5	ϕ23	R	ϕ20

TORNOS

Machine Model	Gang Station			Turret Station			Sleeve Station	Hand	Max cutting dia
	Metric		Number of tools	Metric		Number of tools	Metric		
	h×b	L		h x b	L		mm		mm
EvoDECO 10/10	□8		8				φ20/φ25	R	φ10
EvoDECO 10/8	□8		8				φ20/φ25	R	φ10
EvoDECO 16/10	□12		10				φ20/φ25	R	φ16
EvoDECO 16/8	□12		10				φ20/φ25	R	φ16
EvoDECO 20	□16		10				φ20/φ25	R	φ25.4
EvoDECO 32	□16		10				φ20/φ25	R	φ32
Swiss ST 26	□12		17				φ20/φ22/φ25	R	φ25.4
Sigma 20/6	□16		14				φ20	R	φ25.4
Sigma 32/6	□16		14				φ32	R	φ32
SwissNano	□8		7				φ12/φ16	R	φ4
Delta 12/4	□12	85	5				φ20	R	φ12
Delta 12/5	□12	85	5				φ20	R	φ12
Delta 20/4	□12	85	5				φ20	R	φ20
Delta 20/5	□12	85	5				φ20	R	φ20
Delta 38/5B	□20	125	8				φ25/φ32	R	φ38
Delta 38/5BL	□20	125	8				φ25/φ32	R	φ38
Gamma 20/5	□16	100	8				φ20/φ22	R	φ20
Gamma 20/6	□16	100	8				φ20/φ22	R	φ20
CT20	□12	100	5					R	φ20
MultiSwiss 6X16				□16		6	φ25		
MultiSwiss 8X26				□16		8	φ25		
MultiSwiss 6X32				□16		8	φ25		
Swiss GT13	□12		8				φ20/φ22		13
Swiss GT26	□16		9				φ20/φ22		26
Swiss GT26B	□16		8				φ20/φ22		26
Swiss GT32	□16		9				φ20/φ22		32
Swiss GT32B	□16		8				φ20/φ22		32
SwissDeco 26-G	□16		8				φ20/φ25		26
SwissDeco 26-T	□16			□16		8	φ20/φ25		26
SwissDeco 26-TB	□16			□16		8	φ20/φ25		26
SwissDeco 32-G	□16		8				φ20/φ25		32
SwissDeco 26-T	□16			□16		8	φ20/φ25		32
SwissDeco 26-TB	□16			□16		8	φ20/φ25		32

Hanwha Machinery

Machine Model	Gang Station			Turret Station			Sleeve Station	Hand	Max cutting dia
	Metric		Number of tools	Metric		Number of tools	Metric		
	h×b	L		h x b	L		mm		mm
XD 03	□8		6				φ15.87	R	φ3
XD 07	□8		6				φ15.87	R	φ7
XD 12	□12		5				φ20	R	φ12
XD 16	□12		5				φ20	R	φ16
XD 20 / 20V	□12		6				φ25	R	φ20
XDI20	□12		6				φ25	R	φ20
XD 26	□16		5				φ25	R	φ26
XD32	□16		5				φ32	R	φ32
XD 38	□16		5				φ32	R	φ38
XD 42	□20		5				φ32	R	φ42
XE 12	□12		6				φ20	R	φ12
XE 16	□12		6				φ20	R	φ16
XE 20	□12		6				φ25	R	φ20
XE 26	□16		5				φ25	R	φ26
XE 35	□16		5				φ32	R	φ35
XP 12 /12S	□12		6				φ20	R	φ12
XP 16 /16S	□12		6				φ20	R	φ16
XP 20	□12		6				φ25	R	φ20
XP 26 / 26S	□16		5				φ25	R	φ26
STL38H	□16		5	□16			φ32	R	φ38

Hardness Comparison Chart

Vickers Hardness	Rockwell hardness			Brinell hardness, 10 mm balls, 3000 kgf load	Shore hardness	Tensile strength Kgf/mm² [N/m²] Approximate value MPa (1)
	Scale A Load: 60 kgf brale indenter	Scale C Load: 150 kgf brale indenter	Scale B Load: 100 kgf Diameter 1/16" indenter	Tungsten carbide ball		
(HV)	(HRA)	(HRC)	(HRB)		(HS)	
2200	(95.1)	–	–	–	–	
2100	(94.6)	–	–	–	–	
2000	94.2	–	–	–	–	
1900	93.7	(80.5)	–	–	–	
1800	93.2	(79.2)	–	–	–	
1700	92.7	(77.9)	–	–	–	
1600	91.8	(76.6)	–	–	–	
1500	91.0	(75.3)	–	–	–	
1450	90.4	(74.6)	–	–	–	
1400	90.0	74.0	–	–	–	
1350	89.6	73.4	–	–	–	
1300	89.1	72.7	–	–	–	
1250	88.6	72.1	–	–	–	
1200	88.1	71.5	–	–	–	
1150	87.6	70.9	–	–	–	
1100	87.1	70.3	–	–	–	
1050	86.6	69.6	–	–	–	
1000	86.2	68.9	–	–	–	
940	85.6	68.0	–	–	97	
920	85.3	67.5	–	–	96	
900	85.0	67.0	–	–	95	
880	84.7	66.4	–	(767)	93	
860	84.4	65.9	–	(757)	92	
840	84.1	65.3	–	(745)	91	
820	83.8	64.7	–	(733)	90	
800	83.4	64.0	–	(722)	88	
780	83.0	63.3	–	(710)	87	
760	82.6	62.5	–	(698)	86	
740	82.2	61.8	–	(684)	84	
720	81.8	61.0	–	(670)	83	
700	81.3	60.1	–	(656)	81	
690	81.1	59.7	–	(647)	–	
680	80.8	59.2	–	(638)	80	
670	80.6	58.8	–	630	–	
660	80.3	58.3	–	620	79	
650	80.0	57.8	–	611	–	
640	79.8	57.3	–	601	77	
630	79.5	56.8	–	591	–	
620	79.2	56.3	–	582	75	
610	78.9	55.7	–	573	–	
600	78.6	55.2	–	564	74	
590	78.4	54.7	–	554	–	
580	78.0	54.1	–	545	72	
570	77.8	53.6	–	535	–	
560	77.4	53.0	–	525	71	
550	77.0	52.3	–	517	–	
540	76.7	51.7	–	507	69	
530	76.4	51.1	–	497	–	
520	76.1	50.5	–	488	67	
510	75.7	49.8	–	479	–	
500	75.3	49.1	–	471	66	

Vickers Hardness	Rockwell hardness			Brinell hardness, 10 mm balls, 3000 kgf load	Shore hardness	Tensile strength Kgf/mm² [N/m²] Approximate value MPa (1)
	Scale A Load: 60 kgf brale indenter	Scale C Load: 150 kgf brale indenter	Scale B Load: 100 kgf Diameter 1/16" indenter	Tungsten carbide ball		
(HV)	(HRA)	(HRC)	(HRB)		(HS)	
490	74.9	48.4	–	460	–	
480	74.5	47.7	–	452	64	
470	74.1	46.9	–	442	–	
460	73.6	46.1	–	433	62	
450	73.3	45.3	–	425	–	
440	72.8	44.5	–	415	59	
430	72.3	43.6	–	405	–	
420	71.8	42.7	–	397	57	
410	71.4	41.8	–	388	–	
400	70.8	40.8	–	379	55	
390	70.3	39.8	–	369	–	
380	69.8	38.8	(110.0)	360	52	
370	69.2	37.7	–	350	–	
360	68.7	36.6	(109.0)	341	50	
350	68.1	35.5	–	331	–	
340	67.6	34.4	(108.0)	322	47	
330	67.0	33.3	–	313	–	
320	66.4	32.2	(107.0)	303	45	
310	65.8	31.0	–	294	–	
300	65.2	29.8	(105.5)	284	42	
295	64.8	29.2	–	280	–	
290	64.5	28.5	104.5	275	41	
285	64.2	27.8	–	270	–	
280	63.8	27.0	103.5	265	40	
275	63.5	26.4	–	261	–	
270	63.1	25.6	102.0	256	38	
265	62.7	24.8	–	252	–	
260	62.4	24.0	101.0	247	37	825
255	62.0	23.1	–	243	–	805
250	61.6	22.2	99.5	238	36	795
245	61.2	21.3	–	233	–	780
240	60.7	20.3	98.1	228	34	765
230	–	18.0	96.7	219	33	730
220	–	15.7	95.0	209	32	695
210	–	13.4	93.4	200	30	670
200	–	(11.0)	91.5	190	29	635
190	–	(8.5)	89.5	181	28	605
180		(6.0)	87.1	171	26	580
170		(3.0)	85.0	162	25	545
160		(0.0)	81.7	152	24	515
150			78.7	143	22	490
140			75.0	133	21	455
130			71.2	124	20	425
120			66.7	114		390
110			52.3	105		–
100			56.2	95		–
95			52.0	90		–
90			48.0	86		–
85			41.0	81		–

(1) 1 MPa = 1 N/mm²
(2)This table is an excerpt from the JIS Iron and Steel Handbook
(3)Values in parentheses in the above table are not usually used

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Item number (alphabetical order)

(○ represents a number and □ represents a letter)

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Reference		Page
CNMX○○○○○○PF (PCD)	Insert	E21
COUP-R1/8	Parts	K15
CPGH○○○○○○ (Carbide)	Insert	E41
CPR/L5	Parts	H26,etc.
CPR/L6	Parts	H26
CRDCN○○○○□○○	Holder	F32
CRDNN○○○○□○○	Holder	F30
CRGNR/L○○○○□○○	Holder	F30
CRN○	Parts	F33,etc.
CRXCR/L	Holder	F33
CS○○○○	Parts	F33,etc.
CS○○○○A	Parts	N15
CSDNN○○○○□○○	Holder	F17
CSHNR/L○○○○□○○	Holder	F19
CSSNR/L○○○○□○○	Holder	F17
CSVB○○	Insert	G50,G96
CSVC○○	Insert	G72,G97
CSVF○○	Insert	G21,G96
CSVG○○	Insert	G97,H15
CSVR/L○○	Holder	G95,etc.
CSVT○○	Insert	G97, I 10
CTDP○○□	Insert	G88
CTDPR/L○○	Holder	G88
CTP○○	Insert	G76,G77,G79
CTPA○○	Insert	G82 ～ G84
CTPAR/L○○	Holder	G55,G81
CTPR/L○○	Holder	G75
CTPS○○□□	Insert	G73,G99
CTPSR/L○○	Holder	G98,etc.
CTPW○○□R/L	Insert	G86
CTPWR/L○○	Holder	G86
CTPX○○FR/L	Insert	G78
CTV○○□	Insert	G91
CTV○○□○○□	Insert	G87,G91
CTVN○○□○	Holder	G87
CTVR/L○○□	Holder	G87,G90
CTWPR/L○○○○□-○□○○	Holder	G89
CVR/L○□□	Parts	H30
CZH○○○○	Insert	M10
D		
DC5TN	Parts	F23,etc.
DC6CN	Parts	F9,etc.
DC6DN	Parts	F13,etc.
DC6VN	Parts	F27,etc.
DCET○○○○○○ (Carbide)	Insert	E42
DCET○○□○○○ (Carbide)	Insert	E42
DCGT○○○○○○ (Carbide)	Insert	E42,E43
DCGT○○□○○○ (Carbide)	Insert	E42,E43

Reference		Page
DCGW○○○○○○ (Carbide)	Insert	E43
DCGW○○○○○○PD (CBN)	Insert	E29
DCGW○○□○○○ (PCD)	Insert	E29
DCGW○○□○○○ (Carbide)	Insert	E29
DCMT○○○○○○ (Carbide)	Insert	E42,E43
DCMT○○○○○○P (PCD)	Insert	E29
DCMT○○□○○○ (Carbide)	Insert	E29,E42,E43
DCMT○○□○○○P (PCD)	Insert	E29
DNGA○○○○○○□○○○○○	Insert	E8
DNGA○○○○○○BQ	Insert	E22
DNGA○○○○○○PQ (CBN)	Insert	E22
DNGG○○○○○○ (Carbide)	Insert	E36
DNGG○○○○○○□○○○○○AG	Insert	E8
DNGN○○○○○○□○○○○○	Insert	E8
DNGX○○○○○○□○○○○○	Insert	E8
DNMG○○○○○○ (Carbide)	Insert	E36
DNMX○○○○○○PF (PCD)	Insert	E23
DS-FGVR/L○○	Holder	H38
DS-GTTR/L○○	Holder	G61,H19
DS-LBMBL○○	Holder	K6
DS-PTXR/L○○(□)-○○	Holder	G39
DS-SCLR/L○○	Holder	G23
DS-SDUR/L○○(□)-○○	Holder	G27
DS-SDXR/L○○(□)-○○	Holder	G27
DS-STTR/L○○□	Holder	I 15
DS-SVVPN○○-○○	Holder	G33
DS-SVXPR/L○○-○○	Holder	G33
DS-SVXR/L○○(□)-○○	Holder	G31
DS-TBPR/L○○	Holder	G53
DS-TTPR/L○○	Holder	I 12
E		
ENGN○○○○○○□○○○○○	Insert	E8
ERGH□○○○○○	Insert	E45,K27
F		
FBV○○□○○□○□□□	Insert	H39
FDX○○○○-○○-○○□	Cutter	N6
FGV○○○R/L□○○□○	Insert	H39
FGVR/L○○○○	Holder	H38
FSI01-○○○＊○	Parts	M13
FSI02-○○○＊○○○	Parts	M10,etc.
FSI04-○○○＊○○○	Parts	M13
FSI17-○○○＊○○○	Parts	I 21
FSI22-○○○＊○○	Parts	N10
FSI23-○○○＊○	Parts	N10
FSI24-○○○＊○○○	Parts	I 21

Item number (alphabetical order)

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Item number (alphabetical order)

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Reference		Page
LWU-○	Parts	F31,etc.
M		
M○＊○○	Parts	F9,etc.
MBC-M○○	Parts	N23
MBL○○○□□	Insert	K24,K25
N		
NBH○○○○○□	Holder	K8,K9
NGTAR/L○○○○○○-○○□	Holder	H21,H26
NGTBR/L○○○○○○-○○□	Holder	H21,H26
NGTNR/L○○○○○○-○○	Holder	H21,H26
NTTBR/L○○○○○○	Holder	Ⅰ15
P		
PCLNR/L○○○○□○○	Holder	F9
PDJNR/L○○○○□○○	Holder	F13
PLUG-RC1/8	Parts	K15
PSBNR/L○○○○□○○	Holder	F19
PSDNN○○○○□○○	Holder	F17
PTANR/L○○○○□○○□	Holder	G39
PTLNR/L○○○○□○○	Holder	F23
PTM○○□○○○	Insert	L32
PTXNR/L○○○○□○○□	Holder	G39
Q		
QTE○○○-○○-○□	Cutter	N10
QTS○○○-○○-○□	Cutter	N10
R		
RBGX○○□□□	Insert	E17,L31
RCE□○○○□○□○○○□	Endmill	M4
RCGX○○○○○○□○○○○○	Insert	E17,L18,L27
RCGX○○○○□□	Insert	E17,L18,L27
RCGY○○○○○○□□□	Insert	E17,L22
RCL○○○□○R/L○○○	Holder	M13
RCS□○○○□○□○○○□	Endmill	M5
REL○○○□○□○○○	Holder	M11
REZ○○○□○□○○○	Holder	M10
RLR-○○S	Parts	O16,etc.
RNIW○○○□○○○□○○	Cutter	N11
RNGN○○○○○○□○○○○○	Insert	E9,L23,L30,N11
RNGN○○○○○○□○○○	Insert	E9,L23,L30
RNGN○○○○○○S	Insert	E23
RPIW○○○□○○○□○○	Cutter	N12
RPGN○○○○○○□○○○○○	Insert	E15,N12
RPGN○○○○○○□	Insert	E15,
RPGX○○○○○○□○○○○○	Insert	E17,L18
RPGX○○○○□□□	Insert	E17,L18

Reference		Page
RWEM○○○□○□○○□○○	Endmill	M7
S		
S○○-H	Adapter	K33
S○○□-BGR○○□○○	Holder	H35
S○○□-HCLNR/L○○	Holder	K34
S○○□-HDUNR/L○○	Holder	K35
S○○□-HSKNR/L○○	Holder	K36
S○○□-MBR□○○-OH	Holder	K24
S○○□-SCL□R/L○○□○○-OH	Holder	K28
S○○□-SEXRR/L□○□○○-OH	Holder	K27
S○○□-STU□R/L○○□○○-OH	Holder	K30
S○○□-TCLNR/L○○	Holder	K34
S○○□-TSKNR/L○○	Holder	K36
S○○□-WCLNR/L○○	Holder	K34
S○○□-WDUNR/L○○	Holder	K35
S○○□-WSKNR/L○○	Holder	K36
S○○□-WWLNR/L○○	Holder	K37
SBB○○○□□○○○	Insert	K11
SBFB○○○□○○○□	Insert	K11
SBFS○○○□○○○□	Insert	K11
SBG○○○○○○□□	Insert	H34
SBT○○○□○	Insert	Ⅰ16
SCACR/L○○○○□(□)○○□	Holder	G23
SCGW○○□○○○PQ(CBN)	Insert	E30
SCJ-M○	Parts	K15
SCJ-R1/8	Parts	K15
SCLCR/L○○-□○○	Holder	G23
SCLCR/L○○○○□○○	Holder	G23
SDCW○○○○○○□	Insert	N8
SDEW○○○○○○	Insert	E45
SDJCR/L○○-□○○	Holder	G25
SDJCR/L○○○○□(□)○○□	Holder	G25
SDNCN○○-□○○	Holder	G25
SDQCR/L○○-□○○	Holder	G25
SDW○○○○-○○-○○□	Insert	N8
SDXCR/L○○○○□○○□	Holder	G25
SFG○○○□○○○□	Insert	H37
SHF□○○○□○○○□	Insert	K21
SNEN○○○○□□□○○○○○	Insert	N6
SNGA○○○○○○□○○○○○	Insert	E10
SNGA○○○○○○PE(CBN)	Insert	E24
SNGF○○○○○○□□□-□	Insert	N6
SNGN○○○○○○□○○○○○	Insert	E10,E11,N13,N15,N17
SNGN○○○○□□□	Insert	N6
SNGX○○○○○○□○○○○○	Insert	E11
SNMG○○○○○○(Carbide)	Insert	E37
SNMN○○○○○○S(CBN)	Insert	E24

Item number (alphabetical order)

(○ represents a number and □ represents a letter)

Item number (alphabetical order)

(○ represents a number and □ represents a letter)

Reference		Page
VNGG○○○○○○ (Carbide)	Insert	E38
VNMG○○○○○○ (Carbide)	Insert	E38
VPET○○○○○○	Insert	E50
VPGT○○○○○○	Insert	E50
W		
W○○○	Parts	F31,etc.
WCBNR/L○○○○□○○	Holder	F11
WCLNR/L○○○○□○○	Holder	F9
WDHNR/L○○○○□○○	Holder	F15
WDJNR/L○○○○□○○	Holder	F13
WDNNR/L○○○○□○○	Holder	F15
WNGA○○○○○○□○○○○○	Insert	E14
WNGG○○○○○○ (Carbide)	Insert	E38
WNMG○○○○○○ (Carbide)	Insert	E38
WNX○○-□○○□○○○○○	Insert	N5
WS○○○	Parts	F31
WS0512	Parts	N6
W6226-GM	Parts	N6,N7
WSDNN○○○○□○○	Holder	F17
WSSNR/L○○○○□○○	Holder	F17
WTFNR/L○○○○□○○	Holder	F25
WTGNR/L○○○○□○○	Holder	F23
WVJNR/L○○○○□○○	Holder	F27
WVPNR/L○○○○□○○	Holder	F27
WVVNN○○○○□○○	Holder	F27
WWLNR/L○○○○□○○	Holder	F29
X		
XTM○○○-○○-○○□	Cutter	N9
XX2815-04	Parts	O16,etc.
Y		
Y-GTPAR/L○○	Holder	H17
Y-GTTR/L○○□	Holder	G61,H19
Y-SDJCR/L	Holder	G27
Y-SDNCN○○-○○□	Holder	G27
Y-SVJCR/L○○○○□○○□-OH	Holder	G29
Y-TBPR/L○○□	Holder	G53

keyword (alphabetical order)

keyword (alphabetical order)

MEMO