

GENERAL CATALOG - VOL. 5

USER'S GUIDE

we improve, we evolve, we **ADD**

2025/2026



Tungaloy's Insights – Smart Manufacturing

Tungaloy, as one of the leaders in the metal removal industry, offers the latest innovations in grades and geometries for superb performance and tool life.

*Tungaloy's latest innovations in cutting tools
contribute to carbon neutrality*



VOL. 5

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The specifications are subject to change without prior notice for product improvements. Also, the products may be discontinued in the future due to the development of new products. The dimensions of all products are shown in inch (in) and millimeters (mm) where applicable.

About the dimension symbols conforming to ISO13399

■ What is ISO13399?

ISO13399 is an international standard for the purpose of standardizing the electronic data of tools in the world.

■ Switching to the dimension symbols conforming to ISO13399

In this catalog, we use the dimension symbols (properties) conforming to ISO13399 international standard.

Below are the examples of the change.

■ Examples of the change:

	Before	After
Insert		
Turning		
Milling		
Drilling		

ISO13399 standardizes not only the format of 2D and 3D CAD data but also the tool dimension symbols (properties) and reference position information. This allows the tool information to be read and combined into NC programs and CAM software, regardless of any tool maker's data. In addition to General Catalog (paper catalog), we are also updating the symbols in e-catalog (electronic catalog on our website) to the properties conforming to ISO13399. The e-catalog also provides 2D and 3D CAD data in accordance with ISO13399 standard.

■ Insert

New symbol	Old symbol	Description
AN	-	Main cutting edge relief angle
APMX	Max. ap	Maximum depth of cut
AS	A	Side cutting edge relief angle
BW	B	Body width
BS	bs	Side cutting edge (wiper) length
CDX	T max	Maximum groove depth
CW	W	Grooving edge width
D1	ød1	Mounting hole diameter
DCONMS	øDs	Mounting part diameter on the machine
DMIN	øDm	Minimum machining diameter
EPSR	-	Nose angle
GAN	-	Rake angle (insert)
IC	ød	Inscribed circle diameter
INSD	A	Insert diameter (round type)
INSL	B	Insert length
KAPR	κ	Approach angle
LBB	-	Chipbreaker width
LE	A	Effective cutting edge length
LF	L1	Standard length
M	m	Distance from inscribed circle to cutting edge (m dimension)
PDX	t	Thread position (X direction)
PDY	ℓ3	Thread position (Y direction)
PNA	θ	Cutting edge angle
PSIRL	θ	Left-hand front cutting edge angle
PSIRR	θ	Right-hand front cutting edge angle
RE	r	Corner radius
S	T	Thickness
W1	-	Insert width

■ Turning, Grooving

New symbol	Old symbol	Description
B	b	Shank width
BD	øD1, øD2, øD3	Body external diameter
CDX	ar	Maximum groove depth
CND	-	Oil hole diameter
CNT	-	Oil hole plug size
CUTDIA	øDmax	Maximum parting diameter
CW	W	Grooving edge width
CWN	-	Minimum grooving edge width
CWX	-	Maximum grooving edge width
DAXN	øDm	Minimum diameter in face grooving
DAXX	øDmax	Maximum diameter in face grooving
DCONMS	øDs	Mounting part diameter on the machine
DCONWS	øD, ød2	Mounting part diameter on the workpiece
DMIN	øDm	Minimum machining diameter
GAMF	α	Radial rake angle
GAMP	θ	Axial rake angle
H	h	Shank length
HBH	h2	Height of offset on the bottom of head
HBKL	f2	Length of uneven level on the back of head
HBKW	L2	Width of uneven level on the back of head
HBL	L2	Length of offset on the bottom of head
HF	h1	Standard height
KAPR	κ	Approach angle
LB	L	Body length
LF	L1	Standard length
LH	L2	Head length
OAH	h4	Overall height
OAL	L1	Overall length
OAW	L3	Overall width
PSIR	β	Lead angle
WB	-	Body width
WF	f	Standard width
WFS	f2	Standard width (the second corner)

About the dimension symbols conforming to ISO13399

■ Tooling system

New symbol	Old symbol	Description
APMX	Max. ap	Maximum depth of cut
BD	$\varnothing D1, \varnothing D2, \varnothing D3$	Body external diameter
BHTA	α	Neck taper angle (half of nose angle)
BTED	$\varnothing d1$	Taper tip diameter
CRKS	S	Mounting screw size
DBC	$\varnothing d3$	Bolt hole pitch diameter
DCONMS	$\varnothing Ds$	Mounting part diameter on the machine
DCONWS	$\varnothing D, \varnothing d2$	Mounting part diameter on the workpiece
DMIN	$\varnothing Dm$	Minimum machining diameter
GAMF	$\alpha, R.R.$	Radial rake angle
GAMP	$\theta, A.R.$	Axial rake angle
KAPR	κ	Cutting edge angle
LB	L2, L3	Body length
LF	L	Standard length
LPR	L1	Parting length
LS	ℓs	Shank length
LSC	Lmin	Clamp length
LSCX	Lmax	Maximum clamp length
OAH	H4	Overall height
OAL	L	Overall length
OAW	W	Overall width
THID	-	Mounting screw size
WB	W	Body width
WF	f	Standard width

■ Drilling

New symbol	Old symbol	Description
BD	$\varnothing D1, \varnothing D2, \varnothing D3$	Body external diameter
CND	-	Oil hole diameter
CNT	-	Oil hole plug size
CRKS	S	Mounting screw size
DC	$\varnothing Dc$	Machining diameter
DCONMS	$\varnothing Ds$	Mounting part diameter on the machine
DCONWS	$\varnothing D, \varnothing d2$	Mounting part diameter on the workpiece
DSCFMS	$\varnothing D$	Connecting part diameter
KAPR	κ	Cutting edge angle
LCF	ℓ	Flute length
LF	Lf	Standard length (from the drill shoulder)
LPR	-	Parting length (from flange to tip)
LS	ℓs	Shank length
LU	ℓ	Machinable depth
NOF	z	Number of flutes
OAL	L	Overall length (from tip)
PL	PL	Distance from drill tip to shoulder
ZEFP	Z eff	Number of effective cutting edges on periphery

■ Milling


New symbol	Old symbol	Description
APMX	Max. ap	Maximum depth of cut
BD	$\varnothing D1, \varnothing D2, \varnothing D3$	Body external diameter
BHTA	α	Neck taper angle (half of nose angle)
CBDP	ℓ	Mounting hole depth
CDX	Max. ae	Maximum slot width
CHW	k	Chamfer width on the corner
CICT	z	Number of inserts
CRKS	S	Mounting screw size
CW	W	Slotting edge width
CWN	-	Minimum slotting edge width
CWX	-	Maximum slotting edge width
DBC	$\varnothing d3$	Bolt hole pitch diameter
DC	$\varnothing Dc$	Machining diameter
DCONMS	$\varnothing d$	Mounting part diameter on the machine
DCONWS	$\varnothing D, \varnothing d2$	Mounting part diameter on the workpiece
DSCFMS	$\varnothing Db$	Mounting surface diameter on the machine
DCX	$\varnothing Dc1$	Maximum machining diameter
GAMF	R.R.	Radial rake angle
GAMP	A.R.	Axial rake angle
H	T	Width across flat
KAPR	κ	Cutting edge angle
KWW	a	Drive key width
LF	Lf	Standard length
LH	Lf	Neck length
LS	ℓs	Shank length
NOF	z	Number of flutes
OAL	L, L6	Overall length
PDX	t	Thread position (X direction)
PNA	θ	Cutting edge angle
PSIR	β	Lead angle
RMPX	θ	Maximum ramping angle
THUB	T	Hub height (slot mill)
WT	Kg	Weight
ZEFP	Z eff	Number of effective cutting edges on the periphery

Note:

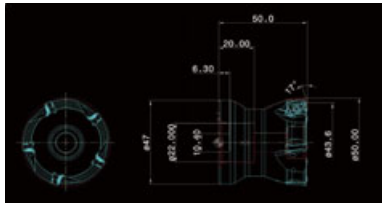
- Symbols unspecified in ISO13399 standard and Tungaloy's original symbols are not included.
- The symbols still under discussion are included. Please note any change or addition may occur.

■ CAD data provided in e-catalog

● 2D data (DXF format file)




Turning:
Shows the insert with standard corner radius.




Milling:
Includes actual cutting edge curve (CUT layer) and body cross section (NOCUT layer).

● 3D data Light type (STP format file): Can be used to check tool path and interference.

Turning: Equipped with an insert with a standard corner radius.

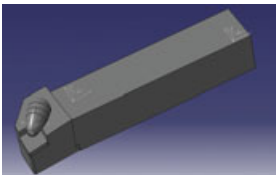


Milling: A rotating body model of an actual cutting edge curve and a body cross section.




● 3D data Detail type (STP format file): Can be used to create a new tool layout chart. (Can be combined with any insert model on a CAD software.)

Turning



Milling



Grade



Grade

Coated Grade / CVD

A002

Coated Grade / PVD

A003

Ceramic

A005

Cermet

A005

CBN

A006

PCD

A007

Cemented Carbide

A007

Grade comparison chart

A008

Chipbreaker comparison chart

A020

CVD - Coated Grade

Grade	Coating		Application	Feature	Turning	Grooving	Milling	Drilling
	Main composition	Thickness / μm						
T9205 P01 - P10 K10 - K20	Ti compound +Al ₂ O ₃	18	P K	- High wear resistance - Excellent performance in high-speed cutting	█			
T9215 P10 - P20 M10 - M20 K10 - K20	Ti compound +Al ₂ O ₃	18	P M K	- Well-balanced between wear and chipping resistance - First choice for steel - High versatility for a wide range of applications	█			
T9225 P15 - P25 M15 - M25	Ti compound +Al ₂ O ₃	18	P M	- First choice for roughing to medium cutting - High fracture resistance	█	█		
T9235 P30 - P40	Ti compound +Al ₂ O ₃	18	P	- High fracture resistance in heavy interrupted cutting	█			
New T6215 P10 - P30 M10 - M30	TiCN-Al ₂ O ₃	8	P M	- High wear resistance at medium to high speed machining - First choice CVD grade for stainless steel cutting	█			
New T505 K10 - K20	TiCN-Al ₂ O ₃	23	K	- High wear resistance in high-speed continuous cutting	█			
T5105 K05 - K15	TiCN-Al ₂ O ₃	16	K	- High resistance to wear and plastic deformation in high-speed continuous cutting	█			
T515 K10 - K20	TiCN-Al ₂ O ₃	16	K	- First choice CVD grade for cast iron machining	█	█		
T5115 K10 - K20	TiCN-Al ₂ O ₃	16	K	- Stable machining in a wide range of applications from continuous to interrupted cutting	█			
T5125 K15 - K30	TiCN-Al ₂ O ₃	16	K	- Toughness to prevent sudden fracture - Ideal for heavy interrupted cutting	█			
T313V -	TiCN-Al ₂ O ₃	3	Threading	- High resistance to plastic deformation	█			
T3225 P20 - P35 M20 - M35	TiCN-Al ₂ O ₃	10	P M	- High chipping and fracture resistance - Suitable for milling steel and stainless steel			█	
T3130 P20 - P40 M20 - M40	TiCN-Al ₂ O ₃	6	P M	- Good balance between wear and chipping resistance - Suitable for milling steel and stainless steel			█	
T1215 K10 - K25	TiCN-Al ₂ O ₃	10	K	- Good balance between wear and chipping resistance - Suitable for milling cast iron			█	
T1115 K10 - K25	TiCN-Al ₂ O ₃	11	K	- High wear resistance - Suitable for milling cast iron			█	

PVD - Coated Grade

Grade

A

Grade	Coating		Applica- tion	Feature	Turning	Grooving	Milling	Drilling	Insert
	Main composition	Thick- ness / μm							
AH110 P05 - P15 M05 - M15 K10 - K25 S05 - S15	(Ti, Al)N	3	P M K S	- High wear resistance - Suitable for finishing steel, cast iron, and difficult-to-cut material	█		█		Ext. Toolholder
AH120 P15 - P25 M15 - M25 K15 - K30 S10 - S25	(Ti, Al)N	3	P M K S	- Good balance between wear and fracture resistance - Suitable for machining steel, stainless steel, and cast iron under general cutting conditions	█		█		Int. Toolholder
AH130 P25 - P40 M25 - M40	(Ti, Al)N	3	P M	- High chipping and fracture resistance - Designed for machining austenitic stainless steel under general cutting conditions			█		Int. Toolholder
AH140 M30 - M45	(Ti, Al)N	3	M	- High fracture resistance - Suitable for milling stainless steel			█		Threading
AH170 P20 - P35 M20 - M35 K15 - K30	(Ti, Al)N	3	P M K	- High wear resistance - Designed for drilling carbon steel and cast iron				█	Threading
AH180 P20 - P35 M20 - M35 K15 - K30	(Ti, Al)N	3	P M K	- High wear resistance - Designed for drilling carbon steel, cast iron, and stainless steel				█	Grooving
AH3225 P20 - P35 M20 - M35	(Ti, Al)SiCrN	5	P M	- Good balance between wear and fracture resistance - Suitable for steel and stainless steel			█		Miniature tool
AH330 P15 - P30	(Ti, Al)N	3	P	- Excellent wear resistance	█		█		Miniature tool
AH3135 P30 - P40 M30 - M40	(Ti, Al)N	4	P M	- High fracture resistance - Suitable for machining steel and stainless steel under general cutting conditions			█	█	Milling cutter
AH3035 P20 - P45 H20 - H30	(Ti, Al)N	5	P H	- Good balance between wear and chipping resistance - Suitable for machining high-hardened steel at high feed			█		Milling cutter
AH4035 M30 - M45	(Ti, Al)N	5	M	- Good balance between wear and fracture resistance - Suitable for difficult-to-cut stainless steel			█		Milling cutter
New AH6225 P20 - P30 M15 - M30	(Ti, Al)N	6	P M	- First choice PVD grade for stainless steel machining - A versatile PVD grade for excellent performance in a wide range of stainless steel applications	█		█		Endmill
AH6030 M25 - M35 S15 - S30	(Ti, Al)N	5	M S	- High fracture resistance - Suitable for drilling stainless steel and heat-resistant alloy under general cutting conditions			█	█	Drilling tool
New AH6235 P30 - P40 M30 - M40	(Ti, Al)N	6	P M	- Provides high reliability in interrupted cutting with large depths of cut	█		█		Drilling tool
AH710 P05 - P15 K05 - K15 H05 - H15	(Ti, Al)N	3	P K H	- High wear resistance - Suitable for finishing cast iron and high-hardened steel	█	█	█		Tooling System
AH7025 P20 - P30 M20 - M30 S15 - S25	(Ti, Al)N	3.5	P M S	- Excellent wear resistance and high rigidity - First choice for grooving of various materials		█	█		Tooling System
AH725 P15 - P30 M15 - M30 K25 - K30 S15 - S25	(Ti, Al)N	2	P M K S	- Good balance between wear and chipping resistance - Suitable for machining steel and stainless steel under general cutting conditions	█	█	█	█	User's Guide

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PVD - Coated Grade

Grade	Coating		Application	Feature	Turning	Grooving	Milling	Drilling
	Main composition	Thickness / μm						
AH730 P15 - P30	(Ti, Al)N	3	P	- Good balance between wear and fracture resistance				
AH750 H15 - H30	(Ti, Al)N	3	H	- High wear resistance - Designed for milling high-hardened material				
AH8005 M01 - M10 S01 - S10 H10 - H20	(Al,Ti)N	3.5	M S H	- Good resistance to wear and adhesion - Excellent performance in machining heat-resistant alloy at high speed				
AH905 S01 - S10	(Al, Ti)N	1.5	S	- High resistance to wear and built-up edge				
AH8015 P10 - P20 M10 - M20 K10 - K25 S10 - S20 H10 - H20	(Al,Ti)N	3.5	P M K S H	- Good balance between wear and fracture resistance - First choice for machining heat-resistant alloy under general cutting conditions - First choice for threading				
AH9130 P15 - P35 M25 - M35 K10 - K25 S15 - S30	(Ti, Al)SiCrN	4.5	P M K S	- High wear resistance - Designed for drilling various materials				
AH9030 P15 - P35 K10 - K25	(Ti, Al)N	5	P K	- High wear resistance - Suitable for drilling steel and cast iron at high speed				
APH730 P20 - P30 M20 - M30 S15 - S25	(Ti, Al)N	4.5	P M S	- Well balanced in wear and fracture resistance				
DS1100 N05 - N20	DLC coating	Thin layer	N	- High wear resistance - Suitable for finishing aluminum				
DS1200 N10 - N25	DLC coating	Thin layer	N	- Good balance between wear and chipping resistance - Suitable for semi-finishing to finishing of aluminum				
GH110 P10 - P20 M10 - M20 K10 - K25 N05 - N15 S10 - S20	Ti(C, N, O)	3	P M K N S	- High wear resistance				
GH130 P25 - P40 M25 - M40 K25 - K40	Ti(C, N, O)	3	P M K	- High chipping and fracture resistance - Suitable for steel, stainless steel, and cast iron				
GH330 P15 - P30 M15 - M30 K05 - K30	Ti(C, N, O)	3	P M K	- High resistance to wear and fracture - Suitable for continuous to medium interrupted cutting				
GH730 P20 - P35 M20 - M35 K20 - K30	Ti(C, N, O)	3	P M K	- High wear resistance - Suitable for turning and grooving at low speed				
J740 -	TiN	1	For swiss lathes	- Ultra-fine-grain cemented carbide coated with TiN-based compound				
SH725 P20 - P30 M20 - M30	(Ti, Al)N	2	P M	- High wear resistance - Designed for machining steel and stainless steel - First recommendation for swiss part machining				
SH730 P20 - P35 M20 - M35 S05 - S15	(Ti, Al)N	1	P M S	- High wear resistance - Designed for machining steel, stainless steel, and difficult-to-cut material				
YH170 P20 - P35 M20 - M35	Ti(C, N)	1.5	P M	- High resistance to wear and fracture - Designed for drilling carbon steel and stainless steel				
YH180 P20 - P35 M20 - M35	Ti(C, N)	1.5	P M	- High wear resistance - Designed for drilling carbon steel and stainless steel				

Ceramic

Grade

A

Grade	Hardness (HRA)	Application	Feature	Insert				Insert
				Turning	Grooving	Milling	Drilling	
LX10	94.0	H	- Alumina base - Suitable for continuous cutting of high-hardened material	█				B
LX11	94.0	H	- Alumina base (TiN coating) - Suitable for continuous cutting of high-hardened material	█				C
LX21	94.0	K	- Alumina base - Excellent chipping resistance in continuous cutting of cast iron	█				D
FX105	93.0	K	- Silicon nitride base - Suitable for high-speed machining of cast iron	█		█		E
FX510	94.0	S K N	- SiAlON base - Suitable for heat-resistant alloy, such as nickel-based alloy			█		F
CX710	92.9	K	- Silicon nitride base - Suitable for high-speed machining of cast iron	█				G
TZ120	93.0	K	- Ceramic grade with ZrO ₂ and Al ₂ O ₃ - Suitable for machining of centrifugal cast iron	█				H
TW43	94.0	S	- Whisker-reinforced Al ₂ O ₃ ceramic for super alloy machining			█		I
TS200	93.1	S	- SiAlON ceramic grade - Suitable for high-speed finishing operation of heat-resistant alloys			█		J
TS300	94.3	S	- SiAlON ceramic grade - Suitable for high-speed roughing operation of heat-resistant alloys			█		K

Cermet

Grade	Coating		Application	Feature	Milling cutter				Milling cutter
	Main composition	Thickness / μm			Turning	Grooving	Milling	Drilling	
NS520	Uncoated	-	P K	- High wear resistance	█				L
NS9530	Uncoated	-	P K	- High fracture resistance - Suitable for finishing to medium cutting of steel	█	█			M
AT9530	(Ti,Al)N laminated coating	3	P	- High wear resistance - First choice for machining alloy steel	█				
GT9530	Ti(C, N, O)	3	P K	- High wear resistance - Excellent surface quality in finishing	█				
J9530	TiN	1	For Swiss lathes	- Suitable for small-part machining	█	█			
NS740	Uncoated	-	P	- High resistance to fracture and thermal crack - High-rigidity grade for milling			█		
X407	Uncoated	-	P	- High wear resistance in finishing with dry cutting	█		█		
N308	Uncoated	-	P	- High wear resistance			█		

CBN

Grade	Hardness (Hv)	T.R.S. (GPa)	Application	Feature	Turning	Grooving	Milling	Drilling
BXA10	3200 ~ 3400	1.00 ~ 1.10	H	- Coated CBN with excellent performance in continuous cutting with middle speed range for hardened steel	■	■		
BXM10	2700 ~ 2900	0.80 ~ 0.90	H	- Coated CBN for excellent performance in high-speed continuous cutting of hardened steel	■			
BX310	2700 ~ 2900	0.80 ~ 0.90	H	- High wear resistance - Designed for high-speed continuous cutting of hardened steel	■			
BXA20	3300 ~ 3500	1.30 ~ 1.50	H	- Coated CBN for excellent performance in machining hardened steel	■			
BXM20	3500 ~ 3700	1.35 ~ 1.50	H	- Coated CBN for machining hardened steel in a wide range of application area	■			
BX360	3200 ~ 3400	1.00 ~ 1.10	H	- Suitable for general machining of hardened steel	■	■		
BX380	3500 ~ 3700	1.15 ~ 1.30	H	- High fracture resistance - Designed for heavy interrupted cutting of hardened steel	■			
New BR35F	3100 ~ 3300	1.40 ~ 1.60	H	- Coated CBN with outstanding fracture resistance in heavy-interrupted machining of hardened steel	■			
BXC50	3500 ~ 3700	1.15 ~ 1.30	H	- Coated CBN with high fracture resistance in continuous to interrupted cutting	■			
BX330	2800 ~ 3000	0.85 ~ 0.95	H	- Excellent sharpness - Designed for finishing hardened steel	■			
BX850	3300 ~ 3500	0.75 ~ 0.85	H	- High fracture resistance - Good performance in high-speed face milling			■	
BXC90	3900 ~ 4100	1.80 ~ 1.90	K	- Coated solid CBN for high-speed machining of cast iron	■		■	
BX910	2600 ~ 2800	0.80 ~ 0.90	K	- Excellent wear resistance in high-speed machining - Designed for centrifugally cast iron	■			
BX930	3000 ~ 3200	0.95 ~ 1.20	K	- Designed for ductile cast iron	■			
BX470	4100 ~ 4300	1.90 ~ 2.10	Sintered metal	- Excellent sharpness - Suitable for ferrous sintered metal	■			
BX480	4100 ~ 4300	1.90 ~ 2.10	Sintered metal K	- Hardest CBN - Ideal for ferrous sintered metal - Suitable for high-speed face milling of cast iron	■		■	
BX815	3000 ~ 3200	1.00 ~ 1.10	S	- High wear resistance and thermo stability - Suitable for high-speed machining of Inconel	■			

PCD

Grade	Grain size (µm)	Hardness (Hv)	T.R.S. (GPa)	Application	Feature	Turning	Grooving	Milling	Drilling
DX110	< 1	8500	1.8	N	- Excellent sharpness for high surface quality - Suitable for finishing non-ferrous metal and nonmetal	█	█	█	█
DX120	4.5	9000	1.8	N	- Suitable for finishing non-ferrous metal and nonmetal	█	█	█	█
DX140	12.5	10000	1.7	N	- High wear resistance - Designed for machining non-ferrous metal and nonmetal	█	█	█	█
DX160	28	11000	1.6	N	- Designed for machining ceramic, cemented carbide, and nonmetal	█	█	█	█
DX180	45	12000	1.5	N	- Designed for machining ceramic, cemented carbide, and nonmetal	█	█	█	█

Cemented Carbide

Grade	Hardness (HRA)	T.R.S. (GPa)	Application	Turning	Grooving	Milling	Drilling
TH03 P05 M05 K05 N05	93.8	1.9	P M K N	█	█	█	█
KS05F K05 S05 N05	93.0	2.9	K S N	█	█	█	█
TH10 P10 M10 K10 N10	92.0	2.4	P M K N	█	█	█	█
KS15F N15	91.5	3.0	N	█	█	█	█
KS20 K20 N20 S20	90.8	2.8	K S N	█	█	█	█
UX30 P30 M30	91.1	2.3	P M	█	█	█	█
EM10 P10 - P25 K10 - K25	91.5	3.4	P K	█	█	█	█

Grade	Hardness (HRA)	T.R.S. (GPa)	Application	Turning	Grooving	Milling	Drilling
UM K10 - K25 N10 - N25	90.9	3.5	K N	█	█	█	█
G1F P10 - P25 K10 - K25	92	2.6	P K	█	█	█	█
MD20 P20 - P35 M20 - M35	91.5	3.9	P M	█	█	█	█

Grade

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Ext. Toolholder

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Grade Comparison Chart

●CVD Coated Grades for Turning

ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	NTK	Kennametal	Seco Tools	Walter	Iscar	TaeguTec	Ceratizit
Classification	Symbol													
P	P01	T9205	UE6105		GC4305	CA510	HG8010		KCP05B KCP05 KCPK05	TP0501	WPP05S	IC8150 IC9150	TT8105 TT8105B	CTCK110
	P10	T9205 T9215	UE6105 UE6110 MC6015 MC6115	AC8015P AC8020P	GC4305 GC4315 GC4415	CA515	HG8010 GM8020	CP7	KCP10B KCP10	TP0501 TP1501	WPP10S WPP10G WPPV10	IC8150 IC9150	TT8115 TT8115B	CTC3110 CTCK120 CTCP115-P
	P20	T9215 T9225	MC6015 MC6025 MC6115 MC6125	AC8015P AC8020P AC8025P	GC4315 GC4325 GC4415 GC4425	CA515 CA525 CA025P	HG8025 GM8020 GM25	CP7	KCP25B KCP25	TP1501 TP2501	WPP20S WPP20G WPPV20	IC8150 IC9150 IC8250 IC9250	TT8125 TT8125B TT5100	CTCP115 CTCP115-P CTCP125 CTCP125-P
	P30	T9225 T9235	MC6025 MC6035 MC6125	AC8025P AC8035P AC8030M	GC4325 GC4335 GC4425	CA530 CA025P	HG8025 GM8035 GM25		KCP30B KCP30	TP2501 TP3501	WPP30S WPP30G	IC8350 IC9350	TT8125 TT8125B TT5100 TT8135 TT8135B	CTCP125 CTCP125-P CTCP135-P
	P40	T9235 T6215	MC6035	AC8035P AC8030M	GC4335	CA530	GM8035 GX30		KCP40B KCP40	TP3501		IC8350 IC9350	TT8135 TT8135B TT7100	
M	M10	T6215	MC7015	AC6020M	GC2015	CA6515			KCM15B KCM15	TM1501		IC9250	TT9215	CTCM120
	M20	T6215	MC7015 MC7025	AC6020M	GC2015 GC2025 GC2220	CA6525	HG8025 GM25		KCM25B KCM25	TM1501 TM2501		IC9350	TT9215 TT9225	CTCM120 CTCM130
	M30	T6215	MC7025 US735	AC6030M	GC2025 GC2035	CA6525	GM8035 GM25 GX30		KCM35B KCM35	TM2501 TM3501		IC9350	TT9225 TT9235	CTCM130
	M40		US735		GC2035		GX30			TM4000			TT9235	
K	K01	T505 T5105	MC5005 MC5105 UC5105	AC405K	GC3005 GC3205	CA4505 CA310	HX3505	CP1	KCK05B KCK05	TK0501		IC5005	TT7005	
	K10	T505 T515 T5105 T5115	MC5015 MC5115 MH515 UC5115	AC4010K AC415K	GC3210 GC3215	CA4515 CA315	HX3515 HG8010	CP1	KCK15B KCK15	TK0501	WKK10S WKV10 WAK10	IC9150 IC5005 IC5010	TT7005 TT7015	CTC3110 CTCK110
	K20	T515 T5115 T5125	MC5015 MC5125 UC5115	AC4015K AC420K	GC3225	CA320	HX3515 GM8020	CP1	KCK20B KCK20	TK1501	WKK20S WKV20 WAK20	IC9150 IC5010	TT7015 TT7025 TT7310	CTCK120 CTCP115
	K30	T5125		AC8025P			HG8025				WAK30	IC4050 IC8150	TT7025	CTCP125

Note: The above table is selected from a publication. We have not obtained approval from each company.

●PVD Coated Grade for Turning

ISO Classification	Symbol	Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	NTK	Kennametal	Seco Tools	Walter	Iscar	TaeguTec	Ceratizit	
P	P01					PR1705									
	P10	AH8005	VP10RT MS6015	AC1030U AC530U ACZ150	GC1105	PR1705 PR930 PR1725	IP2000	VM1 DT4 DM4	KC5010 KCU10	TS2000 CP200		IC807 IC907 IC808 IC908 IC1007	TT4410 TT7010	CTPX710 CTPX715	
		AH120 AH725 SH725 AH730 J740 AH8015 AH6225	VP15TF VP20MF VP10RT VP20RT UP20M MS6015	AC1030U AC530U	GC1125	PR1725 PR930 PR1225 PR1025	IP2000	VM1 DT4 DM4 TM4 QM3	KC5025 KCU25 KCS10 KCU10 KC5010	TS2500 CP200		IC807 IC907 IC808 IC908 IC830 IC1010	TT9030 TT4410	CTPX710 CTPX715 CTPM125	
	P30	AH120 AH725 AH7025 SH725 SH730 J740 AH8015 AH6225	VP15TF VP20MF VP20RT UP20M MS7025	AC1030U	GC1125	PR1725 PR1225 PR1535 PR1025	IP3000	QM3 TM4	KC5025 KCU25 KCU25	CP500 CP600		IC928 IC528 IC228 IC830 IC1010 IC1030	TT9030 TT8020 TT8010 TT9080 TT7220	CTPM125	
		AH120 AH725 AH6225	MS7025			PR1535	IP3000	QM3		CP500 CP600		IC228 IC528 IC1030	TT8020 TT8010 TT4430 TT9020	CTPM125	
M01											WSM01	IC806 IC1007			
M	M10	AH8005 AH6225	VP10RT	AC5005S ACZ150	GC1105 GC1115	PR930 PR1725	IP100S IP050S	VM1 DT4 DM4 ZM3	KC5010 KCU10 KCS10B KCS10	TS2000 TS2500 CP200	WSM10 WSM10S WSM01	IC807 IC907 IC808 IC908 IC1010	*TT4410 TT5080*	CTPM125 CTPX710 CTPX715	
	M20	AH8015 AH120 AH7025 AH725 SH725 SH730 AH6225	VP10RT VP15TF VP20MF VP20RT UP20M MS7025 MS9025	AC5015S	GC1115 GC1125	PR930 PR1225 PR1725 PR1025	IP100S IP050S	VM1 DT4 DM4 ST4 TM4 ZM3 QM3	KC5025 KCU25 KCS10 KCU10 KC5010	TS2500 CP200 CP500 CP600	WSM20S	IC808 IC908 IC830 IC1030	TT9030 TT8010 TT4410 TT5080 TT9080	CTPM125 CWN15	
		AH120 AH725 SH725 SH730 J740 AH6235	VP15TF VP20MF VP20RT UP20M MP7035 MS7025 MS9025	AC6040M AC1030U AC5025S AC530U	"GC1125 GC2035"	PR1225 PR1535 PR1725 PR1025	IP100S	DT4 DM4 QM3 ST4 TM4 ZM3	KC5025 KCU25	CP500 CP600	WSM30S	IC528 IC228 IC830 IC1030	TT8020 TT4430 TT8010 TT8080 TT7220	CTPM125	
	M40	AH6235	MP7035	AC6040M	GC2035	PR1535		ST4 QM3 TM4		CP600		IC228 IC528	TT8010 TT8020		
	K01	AH110													
K	K10	AH110 GH110 AH110	VP10RT	ACZ150					KC5010 KCU10 KCS10B KCS10	TS2000 CP200		IC807 IC907	TT9030 TT7010 TT6080	CTPX715	
	K20	AH120 AH7025 AH8015 AH6225	VP10RT VP20RT VP15TF	AC1030U						KC5025 KCU25	TS2500 CP200 TS2000		IC807 IC907 IC808 IC908 IC1007 IC1010	*TT9030 TT7010 TT6080 TT9080	CTPX715
		AH120 GH130	VP15TF VP20RT								CP500		IC807 IC907 IC808 IC908	TT9030	CTPX715
S	S01	AH8005	VP05RT MP9005	AC5005S AC5015S ACZ150		PR005S	JP9105		KCS10B		WSM10S	IC804 IC806	TT3010		
	S10	AH8005 AH8015 AH6225	VP10RT MP9015	AC5005S AC5015S	GC1105	PR015S PR005S	JP9105 JP9115	QM3 ZM3	KC5025 KCU25 KCS10B KCS10 KC5010 KCU10	TS2000 TS2500 CP200 CP500	WSM10S WSM01 WNN10	IC806 IC1007 IC1010	TT3010 TT3020 TT5080	CTPX710 CTPX715	
		AH8015 AH7025 AH6225	MP9015 VP20RT MP9025 MS9025	AC5015S AC5025S	GC1115 GC1125	PR015S PR1535	JP9115		KC5025 KCU25 KCS10B	TS2000 TS2500 CP200 CP500 CP600	WSM20S	IC807 IC907 IC808 IC908 IC806 IC1010	TT3020 TT4430 TT9030 TT9080	CTPX710 CTPX715	
	S30	AH7025 AH6235	VP20RT MP9025 MS9025	AC5025S	GC1125	PR1535				CP600	WSM30S	IC830 IC928	TT4430 TT8020 TT9030		

Note: The above table is selected from a publication. We have not obtained approval from each company.

Grade Comparison Chart

●Cermet for Turning

ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	NTK	Kennametal	Seco Tools	Walter	Iscar	TaeguTec	Ceratizit
Classification	Symbol													
P	P01	NS520	AP25N VP25N	T1000A		TN610 PV710						IC20N IC520N	PV3010	CTEP10 TCM407
	P10	AT9530 GT9530 J9530	AP25N VP25N NX2525	T1500Z T1500A	CT5015 GC1525	TN610 TN620 PV710 PV720 CCX			KT315 KTP10	TP1020	WCE10	IC20N IC30N IC520N IC530N	PV3010 CT3000	CTEP10 TCM10 TCM407
	P20	AT9530 GT9530 NS9530 J9530	AP25N VP25N VP45N NX2525 NX3035 MP3025	T1500A T1500Z T2500A T2500Z	GC1525	TN620 PV720	CZ25			TP1020 TP1030	WCE10	IC20N IC30N IC520N IC530N	PV3010 CT3000	TCM10
	P30	NS9530	VP45N NX3035 MP3025	T2500Z T3000Z		PV730	CZ25					IC530N		
M	M10	NS520	AP25N VP25N NX2525	T1000A	GC1525	TN620 TN610 PV720 PV710			KT315 KTP10	TP1030		IC20N IC30N IC520N IC530N	PV3010 CT3000	CTEP10 TCM10 TCM407
	M20	AT9530 GT9530 NS9530 J9530	AP25N VP25N NX2525	T1500A		TN620 PV720 PV730	CZ25					IC30N IC530N	PV3010 CT3000	
	M30	NS9530		T3000Z			CZ25							
K	K01	NS520	AP25N VP25N	T1000A		PV7005							PV3010	CTEP10 TCM10 TCM407
	K10	AT9530 GT9530 NS9530 J9530	AP25N VP25N NX2525		CT5015	TN60 CCX	CZ25		KT315 KTP10				PV3010 CT3000	TCM10
	K20	NS9530	AP25N VP25N NX2525				CZ25						PV3010 CT3000	

Note: The above table is selected from a publication. We have not obtained approval from each company.

●Cemented Carbide for Turning

Classification	ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	NTK	Kennametal	Seco Tools	Walter	Iscar	TaeguTec	Ceratzit
	Symbol														
P	P01														
	P10	TH10		ST10P											S26T
	P20	KS20		ST20E									IC50M	P20	S26T S40T
	P30	KS15F UX30	UTi20T	A30									IC28 IC50M	P30	S40T
	P40		UTi20T										IC28		
M	M10	TH10		EH510						K313 KU10 K68	890		IC20		
	M20	KS20	UTi20T	EH520						K313 KU10 K68	HX 883		IC20		CTW7120 H210T U17T
	M30	UX30	UTi20T	A30									IC28		
	M40												IC28		S40T
K	K01	TH03	HTi05												CTWK601
	K10	TH10	HTi10	G10E	H13A	KW10	WH10			K313 KU10 K68	890		IC20	K10	H210T H10T U17T
	K20	KS15F KS20	UTi20T	G10E	H13A	KW10					890 HX 883		IC20	K20	CTW7120 H210T H10T U17T
	K30		UTi20T		H13A						883				TSM30
	K40														
	K01	TH03	HTi05												
N	N01	KS05F				H10	GW05						IC04		
	N10	TH10	HTi10	H1	H10	GW05 KW10	WH10	KM1		K313 KU10 K68	890 HX KX	WK1	IC20 IC28	K10	H210T H10T U17T
	N20	KS15F		H1	H13A			KM1			890 HX KX 883	WK1	IC20 IC28	K20	CTW7120 H210T H10T U17T
	N30										883				
S	S01		MT9005 RT9005		H10A	SW05							IC20		
	S10	KS05F TH10	MT9015 RT9010	EH510	H10F	SW10 KW10	WH10	KM1		K313 KU10 K68	890 883	WK1 WS10	IC20	K10	H210T H10T
	S20	KS15F KS20	MT9015 RT9010	EH520	H13A H10F	SW25		KM1			890 883	WK1 WS10	IC20 IC28	K20	CTW7120 H210T H10T
	S30										883				
H	H01												IC20		
	H10	TH10			H13A		WH10						IC20	K10	
	H20										890 HX 883				

Note: The above table is selected from a publication. We have not obtained approval from each company.

Grade Comparison Chart

●CBN and PCD for Turning

ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	Dijet	NTK	Seco Tools	Kennametal	Iscar	Ingersoll	TaeguTec	Widia	Walter	Ceratizit
Classification	Symbol																
K	K01	BX930 BX910 BX870	MB710 MB730 MB5015 MB5015	NCB100 BN500 BNC500	CB50	KBN475 KBN60M			B52		KB1630 KB1345	IB10K		TB7015	WBH10C	WCB80	CTB S10U
	K10	BX470 BX480	MB730 MB5015 MB4020	BN7000 BN500	CB7525 CB50	KBN65M KBN65B		JBN795	B23 B30 B52	CBN200 CBN300 CBN400C	KB1640 KB1345	IB05S IB10S	TB730	TB730	WBK40U	WCB80 WCB50	CTB S10U
	K20	BXC90 BX90S	MB4020 MB4120 MBS140	BNC8115 BNS8125	CB7925	KBN900 KBN70M			B23 B30 B52	CBN300 CBN500	KB5630	IB90A IB90 IB25KD		TB7020	WBK45U	WCB80	CTB S20C
	K30	BXC90 BX90S	MBS140 BC5030	BNS8125		KBN900			B16	CBN500	KB9640	IB90A IB25KD	KB90A	KB90A			
S	S01	BX815	MB730	NCB100 BN7000				JBN795	JP2	CBN170		IB05S IB10S		KB90			CTB S10U
	S10	BX480	MB4020 MB4120	BN7500 BN7115	CB7050	KBN65B KBN65M			B23 B30	CBN200	KB1630	IB05S IB10S		KB90A	WBK45U	WCB80	CTB S20C
H	H01	BXM10 BX310	BC8105 BC8110 MBC010 MB810 MB8110	BNC2010 BNC2115 BN1000 BN2000 BNX10 BN1000	CB7105	KBN510 KBN05M KBN10M			B52 B5K	CBN010 CBN100 CBN160C CBN050C	KB1610 KB5610*	IB05H IB10HC	TB610	TB610	WBH10C	WCB30	CTB H15C CTB H15U
	H10	BXA10 BXM10 BX330 BX530	BC8210 MB020 MB8025 MB8110 MB825	BNC2020 BNC2115 BN2000	CB7015 CB7115 CB7025	KBN525 KBN05M KBN10M		JBN245	B36 B52 B6K	CBN150 CBN200 CBN300 CBN060K CBN160C CBN400C	KB9610 KB1610 KB5610	IB50 IB55 IB10H IB10HC IB20H IB25HA		TB2015	WBH10C WBH10P WBH10U	WCB30 WCB50	CTB H15C CTB H15U
	H20	BXM20 BXA20 BX360	BC8220 MBC020 MB8025 MB8120	BNC200 BNC2020 BNC2125 BNX20	CB7015 CB7125 CB50	KBN525 KBN05M KBN10M KBN25M KBN020		JBN300	B22 B36 B40 B6K	CBN200 CBN300 CBN160C CBN400C CH2540	KB5625 KB1625	IB20H IB20HC IB25HA IB25HC	TB650 TB2030	TB650	WBH25P	WCB50 WCB80	CTB H20C CTB H21U
	H30	BR35F BXC50 BX380	BC8130 MB8130 MB835	BNC300 BN350 BNX25		KBN30M KBN35M KBN900		JBN300	B22 B40	CH3515	KB1630 KB9640	IB25HC IB90	TB670	TB670	WBH40C		CTB H40C CTB H40U
N	N01	DX160 DX180	MD205	DA90	CD05	KPD230		JDA30 JDA735	PD1		KD1405	ID5					CTD PU20
	N10	DX140	MD205 MD220	DA150	CD10	KPD010 KPD230		JDA715	PD1	PCD05 PCD10	KD100 KD1400 KD1425	ID5	IN90D	TD810	WDN25U	WCD10	CTD PU20
	N20	DX120	MD220 MD230	DA2200 DA1000	CD10	KPD010		JDA715	PD2	PCD05 PCD20	KD1425		IN90D	KP300	WDN25U	WCD10	CTD PD20
	N30	DX110	MD2030 MD230	DA2200 DA1000		PKD001		JDA10		OVD20 PCD30 PCD30M				TD830		WCD10	

Note: The above table is selected from a publication. We have not obtained approval from each company.

●Ceramic for Turning

ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	Dijet	NTK	Seco Tools	Kennametal	Iscar	Ingersoll	TaeguTec	Widia	Walter	Ceratizit
Classification	Symbol																
K	K01	TZ120 LX21		NB90S	CC620	KA30 A65 KT66 PT600M			HC1 HW2		KY1310 KY1615	IN110		AW120 AB30	CW2015		CTN3105 CTS3105
	K10	CX710 FX105			CC6190 CC650	A65 KT66 A66N PT600M			HC2 HC5 HC6		KY1310 KY1615	IN23 IS6	IN70N	AB30 AS10	CW2015 CW5025	WSN10	CTN3105 CTM3110 CTI3105 CTN3110 CTS3105
	K20	FX105 CX710			CC6190	KS6000 KS6050			SP9 SX9		KY1320 KY3400 KY3500 KY4300	IS8	IN70N	SC10	CW5025	WSN10	CTM3110 CTN3110
S	S01	TS200							JX1	CS100	KY1525 KY2100	IS25		TC3020			
	S10	TW43 TS300		WX120	CC670 CC6060 CC6065	KS6030 KS6040			WA1 WA5 SX9	CW100 CS300	KY1540 KYS30 KY2100 KY4300	IW7 IS35		TC430 TC3030	CW3020	WWS20	
H	H01	LX10 LX11		NB100C	CC6050 CC650	PT600M			HC2 HC5 HC6		KY4300	IN420 IN22		AB2010	CW2015		CTS3105
	H10				CC6050 CC670 CC6190	A66N PT600M			HC7 WA1		KY4400	IN23		AB2010 AB20 AB30	CW2015		CTS3105

Note: The above table is selected from a publication. We have not obtained approval from each company.

Grade Comparison Chart

●CVD Coated Grade for Milling

ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	Dijet	NTK	Seco Tools	Kennametal	Iscar	Ingersoll	TaeguTec	Widia	Walter	Ceratizit
Classification	Symbol																
P	P01									MP1501		IC9015 IC5400 IC8080 IC9080			TN2510		
	P10		FH7020 MC7020	ACP100 XCU2500 ACP2000	GC4220 GC4330					MP1501	KCPM20	IC9015 IC5400 IC8080 IC9080 IC4100 IC5100			TN2510 TN7525	WKP25	GM226+
	P20	T3225	FH7020 F7030 MC7020	ACP100 XCU2500 ACP2000	GC4330 GC4340		GX2140 GX2160			MP1501 MP2501	KCPM20 KCPK30 KCPM30	IC8080 IC9080 IC4100 IC5100 IC9250 IC520M	IN6530	TT7800	TN7525 TN7535	WKP25 WKP35 WKP35S	GM226+
	P30	T3130 T3225	F7030	ACP100 XCU2500 ACP2000	GC4230 GC4340		GX2140 GX2160			MP2501	KCPK30 KCPM30	IC9250 IC520M IC4050 IC635	IN6530	TT7800	TN7525 TN7535	WKP25 WKP35 WKP35S	GM226+ GM246 GM43+
	P40				GC4240 GC4340		GX2160				KCPK30 KCPM30	IC4050 IC635	IN6530	TT7800	TN7535	WKP35 WKP35S	GM246 GM43+
M	M10			ACM200 XCU2500							KCPM20	IC9250 IC520M IC9350			TN7525		
	M20	T3225	F7030 MC7020	ACM200 XCU2500		CA6535	AX2040			T350M	KCPM20 KCPM30	IC9250 IC520M IC9350 IC4050 IC635	IN6530	TT7800	TN7525 TN7535		CTC5235 GM226+
	M30	T3225 T3130	F7030	ACM200 XCU2500	GC2040	CA6535	GX2160 AX2040			T350M	KCPM30	IC9350 IC4050 IC635	IN6530	TT7800	TN7525 TN7535		CTC5235 CTC5240 GM226+ GM246 GM43+
	M40				GC2040	CA6535	GX2160			T350M		IC635	IN6530		TN7535		CTC5235 CTC5240 GM246 GM43+
K	K01		MC5020			CA420M		JC605W				IC8080 IC4100 IC5100 IC9150			TN2510 TN5505	WKP15	CTC3215
	K10	T1215 T1115	MC5020 MC520	ACK200 XCK200 ACK200	GC3220	CA420M	GX2120	JC605W		MK1500	KCK15	IC8080 IC4100 IC5100 IC9150 IC9080 IC520M		TT6800	TN2510 TN5505 TN5515 TN5520	WKP15 WKP25	CTC3215 SR216 SR226+
	K20	T1215	MC5020	ACK200 XCK2000 XCU2500 ACK2000	GC3220 GC3330 GC3040	CA420M	GX2120 GX2140	JC605W		MK1500	KC915M	IC5100 IC9150 IC9080 IC520M IC4050	IN6515 IN6530	TT6800	TN5515 TN5520	WKP15 WKP25 WKP35 WKP35S	SR216 SR226+
	K30		MC5020		GC3330 GC3040		GX2140			MK1500	KC930M	IC520M IC4050	IN6515 IN6530			WKP25 WKP35 WKP35S	

Note: The above table is selected from a publication. We have not obtained approval from each company.

●PVD Coated Grade for Milling

ISO Classification	ISO Symbol	Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	Dijet	NTK	Seco Tools	Kennametal	Iscar	Ingersoll	TaeguTec	Widia	Walter	Ceratizit	
P	P01	AH710 AH110			GC1010		ATH80D JP4105	JC8003			KC505M KC510M KC515M	IC903		TT2510 TT5505	TN2505 TN6505			
	P10	AH120 AH725	MP6120 VP15TF	ACP200 ACU2500	GC1010 GC1025	PR830 PR1225 PR1230 PR1525	ATH80D PN08M ATH10E PN15M JP4105 JP4115 JP4120	JC8003 JC8015 JC5015 JC5118	DM4	F40M	KC505M KC510M KC515M KC610M KC715M	IC903 IC907 IC950 IC908 IC910 IC380 IC900	IN2505	TT2510 TT5505 TT5515 TT7080	TN2505 TN2525 TN6425 TN6505	WHH15 WXM15		
	P20	AH120 AH725 AH3135 AH9030 AH3225	MP6120 VP15TF MP6130 UP20M VP20RT	ACP200 ACP300 ACP3000 ACU2500	GC1025 GC1030 GC2030	PR830 PR1225 PR1230 PR1525	JP4120 JS4045 CY250	JC8015 JC5015 JC5118 JC5040			F40M	KC522M KC525M KC527M KC530M KC537M KC610M KC620M KC635M KC715M KC720M KC730M	IC907 IC950 IC908 IC910 IC380 IC900 IC830 IC928 IC1008	IN2040 IN2505 IN4005 IN4030	TT2510 TT5505 TT5525 TT7080 TT9080	TN2525 TN6425 TN6430 TN6525	WHH15 WXM15	CTP1235 CTP1625
	P30	AH120 AH725 AH3135 AH130 AH6030 AH3225	MP6120 VP15TF MP6130 UP20M VP20RT VP30RT	ACP200 ACP300 ACP3000 ACU2500	GC1025 GC1030 GC2030	PR830 PR1225 PR1230 PR1525	JS4045 CY250 JM4160	JC5118 JC5040 JC8050 JC7560			F40M	KC525M KC527M KC530M KC537M KC610M KC620M KC720M KC725M KC730M KC735M	IC907 IC950 IC908 IC910 IC380 IC900 IC830 IC928 IC1008	IN2040 IN2505 IN2530 IN4005 IN4030	TT5525 TT7080 TT8020 TT8080 TT9030 TT9080	TN6430 TN6525 TN6540	WSP45 WSP46	CTP1235 CTP1625 CTP2235
	P40	AH140	VP30RT	ACP300 ACP3000 ACU2500	GC1030 GC2030		JM4160	JC5118 JC5040 JC8050 JC7560			F40M	KC537M KC720M KC725M KC735M	IC830 IC928 IC1008	IN2040 IN2530 IN4005 IN4030	TT8020	TN6540	WSP45 WSP46	CTP1235 CTP2235
	M01				GC1010		PCS08M		DM4				IC907 IC903					
M	M10	AH725	VP15TF	ACM100 ACK300 ACP300 ACU2500	GC1010 GC1025 GC1030 GC2030	PR830 PR1225 PR1525 PR1535	PCS08M CY150		DM4		KC515M KC610M KC635M KC720M	IC907 IC903	IN2505	TT5525 TT9030 TT9080	TN6425 TN6525	WXM15		
	M20	AH725 AH3135 AH130 AH6030 AH3225	VP15TF MP7130 MP7030 UP20M VP20RT	ACM300 ACP300 ACU2500	GC1025 GC1030 GC1040 GC2030	PR830 PR1225 PR1525 PR1535	CY150 CY250	JC8015 JC5015 JC5118	DM4	F40M	KC522M KC525M KC530M KC537M KC610M KC635M KC720M KC730M	IC380 IC900 IC908 IC928 IC1008	IN2005 IN2505 IN2530 IN4005	TT8020 TT8080	TN6425 TN6525	WXM15 WSM35 WSM36	CTP1235 CTP1625	
	M30	AH3135 AH130	VP15TF MP7130 MP7030 UP20M VP20RT MP7140 VP30RT	ACM300	GC1040 GC2030	PR830 PR1225 PR1525 PR1535	CY250 JM4160	JC8015 JC5015 JC5118 JC8050 JC7560		F40M	KC522M KC525M KC530M KC537M KC725M KC730M KC735M	IC380 IC900 IC908 IC928 IC1008 IC328 IC330	IN2005 IN2505 IN2530 IN4005 IN4030	TT8020 TT8080	TN6540	WSM35 WSM36 WSP45 WSP46	CTP1235 CTP2235	
	M40	AH140	MP7140 VP30RT	ACM300	GC1040	PR1225 PR1525 PR1535	JM4160	JC5015 JC5118 JC8050 JC7560		F40M	KC725M	IC1008 IC328 IC330	IN2005 IN2530 IN4005 IN4030	TT8020	TN6540	WSM35 WSM36 WSP45 WSP46	CTP2235	
	K01	AH110	MP8010		GC1010	PR1510	ATH80D JP4105	JC8003				IC380 IC900		TT6080	TN2505 TN6405 TN6505		AMZ	
	K	K10	AH110 AH120	MP8010 VP15TF	ACK3000 ACU2500	GC1010 GC1020	PR1210 PR1510	ATH80D JP4105 JP4120 CY150	JC8015		MK2050	KC514M KC515M KC520M KC620M	IC380 IC900 IC810 IC910	IN2015 IN2505 IN4015	TT6080	TN2505 TN6405 TN6505 TN6510	WHH15 WXM15 WKK25	AMZ CTP3220 CTP6215
K20		AH120 AH9030	MP8010 VP15TF VP20RT	ACK300 ACK3000 ACU2500	GC1020	PR1210 PR1510	JP4120 CY150	JC8015 JC5015		MK2050	KC514M KC520M KC522M KC524M KC527M KC610M KC620M KC635M	IC810 IC910 IC950 IC350 IC830 IC928	IN2015 IN2505 IN4015 IN4030		TN2525 TN6510 TN6520 TN6525	WHH15 WXM15 WKK25	CTP3220 CTP1625	
K30		AH120	VP15TF VP20RT	ACK300 ACK3000 ACU2500		PR1510	CY250	JC8015 JC5015		MK2050	KC522M KC524M KC527M KC537M KC610M KC620M KC635M	IC830 IC928 IC1008 IC808 IC908	IN2015 IN2505 IN4015 IN4030		TN6430 TN6525 TN6540	WKK25		

Note: The above table is selected from a publication. We have not obtained approval from each company.

Grade Comparison Chart

●PVD Coated Grade for Milling

ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	Dijet	NTK	Seco Tools	Kennametal	Iscar	Ingersoll	TaeguTec	Widia	Walter	Ceratizit
Classification	Symbol																
N	N01										KC410M KC510M KC5410			TT6080	TN6501		AMZ
	N10	DS1100		DL1000 DL2000	GC1025 GC1030		SD5010 HD7010				KC410M KC510M KC5410 KC620M			TT6080 TT8020	TN6501 TN6502	WXN15	AMZ
	N20	DS1200	LC15TF	DL1000 DL2000	GC1025 GC1030		SD5010 HD7010			F15M	KC422M KC620M			TT8020		WXN15	
S	S01	AH110 AH710			GC1010	PR905 PR1210 PR1535		JC8003 JC8015			KC510M	IC808 IC907 IC908			TN6405		AMZ
	S10	AH120 AH725	MP9120 VP15TF MP9130	ACM100 ACK300 ACP300 ACU2500	S30T GC1010 GC1030 GC2030	PR905 PR1210 PR1535	PTH13S JS1025	JC8003 JC8015 JC5015 JC5118		MS2050	KC510M KC610M	IC808 IC907 IC908 IC903	IN2505 IN2530	TT9030 TT9080 TT8080	TN6405 TN6425		AMZ CTP1625
	S20	AH725 AH130 AH6030	MP9120 VP15TF MP9130 MP9140	ACM300 ACP300 ACU2500	S30T GC1030 GC1040 GC2030 GC2040	PR905 PR1210 PR1535	PTH13S JS1025	JC8015 JC5015 JC5118 JC8050 JC7560		MS2050 F40M	KC522M KC610M	IC300 IC900 IC830 IC928	IN2505 IN2530	TT8080 TT8020	TN6425	WSM35 WSM36	CTP1235 CTP1625
	S30	AH130	MP9130 MP9140	ACM300	S30T GC1040 GC2040	PR1535		JC5118 JC8050 JC7560		MS2050 F40M	KC522M KC525M KC725M	IC830 IC928	IN2530	TT8020	TN6540	WSM35 WSM36 WSP45 WSP46	CTP1235 CTP2235
H	H01	AH110 AH710 AH8005	MP8010		GC1010			DH102 JC6102 JC8003 JC8008			KC510M	IC903		TT2510 TT5505	TN2505		
	H10	AH110 AH120 AH710 AH8015	MP8010 VP15TF		GC1010 GC1025 GC1030		PTH08M JP4105	JC6102 JC8003 JC8008 JC8015 JC5118		MH1000 F15M	KC505M KC510M KC635M	IC903 IC808 IC907 IC908		TT5515 TT6080	TN2505 TN2525	WHH15	CTP6215
	H20	AH120 AH725 AH9030	VP15TF		GC1025 GC1030		JP4105	JC8015 JC5118		F15M	KC635M	IC808 IC907 IC908 IC380 IC900		TT5515 TT6080	TN2525	WHH15	CTP6215
	H30									MP3000 F30M		IC380 IC900 IC1008					

Note: The above table is selected from a publication. We have not obtained approval from each company.

●Cermet for Milling

ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	Dijet	NTK	Seco Tools	Kennametal	Iscar	Ingersoll	TaeguTec	Widia	Walter	Ceratzit
Classification	Symbol																
P	P01			T250A	CT530	TN60 TN100M	MZ1000						IN0560	CT3000			TCC410
	P10	NS740	NX2525	T250A T2500A	CT530	TN60 TN100M TC60M	MZ1000 MZ2000 CH550	NIT CX75 CX90		MP1020	KTPK20	IC30N	IN0560 IN60C	CT3000 CT7000	TTI25		TCC410 TCM10
	P20	NS740	NX2525 MX3020	T250A T2500A T4500A		TN60 TN100M TC60M	MZ2000 MZ3000 CH500 CH7030	NIT CX75 CX90 SC30		MP1020	KTPK20	IC30N	IN60C	CT3000 CT7000	TTI25		TCM10
	P30		NX4545 MX3030	T250A T2500A T4500A			MZ3000 CH7035		C7X			IC30N	IN0545	CT7000			
M	M10	NS740	NX2525	T250A T2500A	CT530	TN60 TN100M TC60M	MZ1000 CH550	NIT CX75			KTPK20	IC30N	IN0560	CT3000 CT7000	TTI25		TCC410
	M20	NS740	NX2525 MX3020	T250A T2500A T4500A		TN60 TN100M TC60M	MZ2000 MZ3000 CH500 CH7030	NIT CX75 SC30	C7X	MP1020	KTPK20	IC30N		CT7000	TTI25		TCC410 TCM10
	M30		NX4545 MX3030	T4500A			MZ3000 CH7035	SC30									
K	K01						MZ1000 CH550	NIT									TCC410
	K10	NS740	NX2525				MZ2000 MZ3000 CH500 CH7030	NIT CX75			KTPK20			CT7000			TCC410 TCM10
	K20		NX2525 MX3020 MX3030				MZ2000 MZ3000 CH500 CH7030 CH7035	CX75			KTPK20						

Note: The above table is selected from a publication. We have not obtained approval from each company.

Grade Comparison Chart

●Cemented Carbide for Milling

ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	Dijet	NTK	Seco Tools	Kennametal	Iscar	Ingersoll	TaeguTec	Widia	Walter	Ceratizit
Classification	Symbol																
P	P01																
	P10																S26T
	P20		UTi20T	A30N			EX35				K125M	IC50M		P30	TTM		S26T
	P30	UX30	UTi20T	A30N	SM30		EX40				K125M	IC50M IC28		P30	TTM TTR		S26T
	P40				SM30							IC28			TTR		
M	M01																
	M10											IC20 IC07 IC08					S26T
	M20		UTi20T		SM30							IC07 IC08			TTM		S26T
	M30		UTi20T	A30N	SM30							IC28			TTM TTR		S26T
	M40			A30N								IC28			TTR		
K	K01		HTi05T			KW10					K115M K313			K10	THM-F		
	K10	TH10	HTi10	G10E	H13A	KW10 GW25	WH10				K115M K313 K110M	IC20		K10	THM-F THM		CTW4615 H216T
	K20		HTi10 UTi20T	G10E	H13A	KW10 GW25				HX	KMF	IC20	IN10K		THM THR		CTW4615 H216T
	K30		UTi20T								KMF		IN10K		THR		
	K40												IN10K				
N	N01	KS05F	HTi10		H10	KW10					K115M				THM-U	WK10	
	N10	TH10	HTi10 MT2010		H10 H13A H10F	KW10 GW25	WH10			H15	K115M K313 K110M	IC20 IC08		K10 UF10	THM-U THM-F THR-S	WK10	CTW4615 H216T
	N20	KS15F	HTi10 TF15 MT2010	H1 H20	H13A H10F	KW10 GW25				HX H15 H25	KMF K313 K110M	IC20 IC08 IC28		K10 UF10	THM-F THR-S THM	WMG40	CTW4615 H216T
	N30		TF15	H1 H20						H25	KMF	IC28				WMG40	
S	S01					KW10					K313	IC20					
	S10			EH520	H13A	KW10 GW25		FZ15			K313 K110M	IC20 IC07 IC08			THM-F		
	S20	KS20		EH520	H10F H13A	KW10 GW25		FZ15		HX H25	KMF	IC20 IC07 IC08 IC28			THM		
	S30				H10F							IC07 IC08					
H	H01				H1P			FZ05									
	H10				H1P			FZ05 FZ15				IC20			THM-F		
	H20							FZ15									

Note: The above table is selected from a publication. We have not obtained approval from each company.

●CBN and PCD for Milling

ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Dijet	NTK	Seco Tools	Kennametal	Iscar	Ingersoll	TaeguTec	Widia	Walter	Ceratzit
Classification	Symbol															
K	K10	BX480	MB710 MB730	BN7000	CB50	KBN475	JBN795 JBN500	B30 B52	CBN200		IB85	IN80B	KB90	WBK40U	WCB80	TA201
	K20	BXC90	MB4120	BNC8115 BNS8125					CBN300 CBN400C	KB1340						
H	H20	BX850		BN7000			JBN245		CBN100							
	H30				CB50					KB1340		IN80B			WCB80	TA201
N	N10	DX140 DX160	MD220	DA1000	CD10	KPD230	JDA30 JDA735	PD1	PCD20 PCD30M	KD1415	ID5	IN90D		WDN25U	WCD10	CTD4205
	N20		MD2030	DA1000		KPD010	JDA10			KD1425	ID8					
	N30	DX110	MD2030	DA1000		KPD001			PCD05	KD1420						

Note: The above table is selected from a publication. We have not obtained approval from each company.

●Ceramic for Milling

ISO		Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Sandvik	Kyocera	Moldino	Dijet	NTK	Seco Tools	Kennametal	Iscar	Ingersoll	TaeguTec	Widia	Walter	Ceratzit
Classification	Symbol																
K	K01	LX21		NB90S	CC6190 CC650	KA30 A65 KT66 PT600M			HC1 HW2 HC2		KY1310 KY1615			AW20 AB30 AS10	CW2015		CTN3105 CTS3105
	K10	CX710 FX105			CC6190 CC650	A65 KT66 A66N PT600M			HC1 HW2 WA1 WA5		KY1310 KY1320 KY1615 KY3400		IN70N	AB30 AS10	CW2015 CW5025	WSN10	CTN3105 CTM3110 CTI3105 CTN3110 CTS3105
	K20	FX105 CX710			CC6190	KS6000			SP9 SX9		KY1320 KY3400 KY3500 KY4300		IN70N	AS10	CW5025	WSN10	CTM3110 CTN3110
S	S01								JX1		KY1525 KY2100						
	S10	TW43		WX120	CC670 CC6060 CC6065	CF1			WA1 WA5 SX3 SX7 SX9		KY1525 KY1540 KY2100 KY4300			AS20 TC430	CW3020		
H	H01	TW43		NB100C	CC6050 CC650	A65 KT66 A66N PT600M			ZC4 ZC7		KY4300			AW20	CW2015		CTS3105
	H10			NB100C	CC6050 CC670 CC6190	A65 KT66 A66N PT600M			HC4 HC7 WA1		KY1615 KY4400			AB2010 AB20 AB30	CW2015		CTS3105

Note: The above table is selected from a publication. We have not obtained approval from each company.

Chipbreaker Comparison Chart

● Negative insert type

ISO Classification	Cutting Mode	Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Kyocera	Sandvik	Moldino	Kennametal	Seco Tools	Iscar	TaeguTec	Walter	Ceratizit	
P	Precision finishing	01 TF	PK FH	FA	GP	PF	FE	FS, LF	FF1	SF, PP, TF	FA			
	Finishing and light cutting	TS, TSF PS, ZF NS AS TQ	FP FY LP SH SA SY	SU FL SE, SX	XP, PP XQ, HQ, CJ, XS	PF LC MF R/L-K XF	BE, BH AB, CT CE	FF, FN	MF2	F3P NF, SF	FG VF, EA FC MC ML, MP	NF3 NS6	CF, TF	
	Finishing and light cutting (With Wiper)	AFW, FW ASW, SW	SW MW	LUW SEW GUW	WP WQ WF	WL, WF WMX WM, WR			FW MW RW	W-FF2 W-MF1 W-M3 W-M6	WF WG	WS WT	NF NM	TFQ TMQ
	Medium cutting	TM, AM PM, DM ZM, NM All-round, TA	MA MH, MP	GU GE, UX	HS, PT, GT CS, PS	PM, QM XM, XRM	AH AE, AY, B	MN	MF5 M3	M3P, M3M PP, TF, GN	PC, MT MC, MG	NMT, NM4	TMF, TMM M50	
	Medium to heavy cutting	TH THS	RP, GH	MU, ME HG	PH All-round	HM, PR MR	RE	RN, RP MR	M5 MR7	NR MR	RT	MM5, NM6 NM9	TM TRM	
Heavy cutting	TU TRS TUS	HM, HX HL, HR HZ, HV	HG, HP HU, HW HF	PX	PR, MR HR, QR	TE, UE HX, HE H	RM RH	R RR	R3P NM	HT, HD RX, RH HY, HZ	NR6 NRF NRR	TRR, TR R28, R58 R88		
M	Finishing and light cutting	SF SS	GM, LM	EX, EG SU, EF	GU MQ	MF, XF	MP BH, AB	FP, FF	FF1 MF1 MF3	TF, VL	EA, SF, SU FG	NF4 NMS	CF, F30, M34 F32, TF	
	Medium cutting	SM, SA S, TA SDM	MM, MA MS	GU HM	MU	MM, QM XM	PV, SE DE	MP, P	MF4 M3	M3M, PP	EM, ET	NM4	TMF, M42 M30, M52	
	Heavy cutting	SH, TH TU	GH, RM HL	EM, MU	MS TK	MR HM, PR	AH, AE	UP, RP	M5 MR3	MR, MH		NR4 NRT, NRS	TM, M60 TRM, TMR, TRR R80	
K	Finishing	CF	LK, MA	UZ	C	KF, XF	Y, AH	FN, MT		GN	FG		CF	
	Medium cutting	CM All-round	MK GK	GZ	ZS All-round	KM, QM XM, XMR	RE VA	RP, UN	M4 M5		MT MG	NM5	M50	
	Heavy cutting	CH Flat-top	RK Flat-top	Flat-top	GC Flat-top	KR Flat-top	RE, V	MA Flat-top	MR9 Flat-top		RT	Flat-top	TMR, TR R28 R58, R88	
N	Cutting of non-ferrous metals	P 28		AX	AH, A3	MF		MS GR		PP			F32	
S	Finishing	HRF	FJ, LS MJ	EF EX	SQ, SX	SF	VI	FS MS	MF1			NFT NF4		
	Medium cutting	HRM HMM SA, 28 SDM	MS RS, GJ	EG MU EM	SQ, SX	SMR	VI	UP RP	MF4 M1	PP	SM	NMS NM4, NRS, NR4	M34, M52	

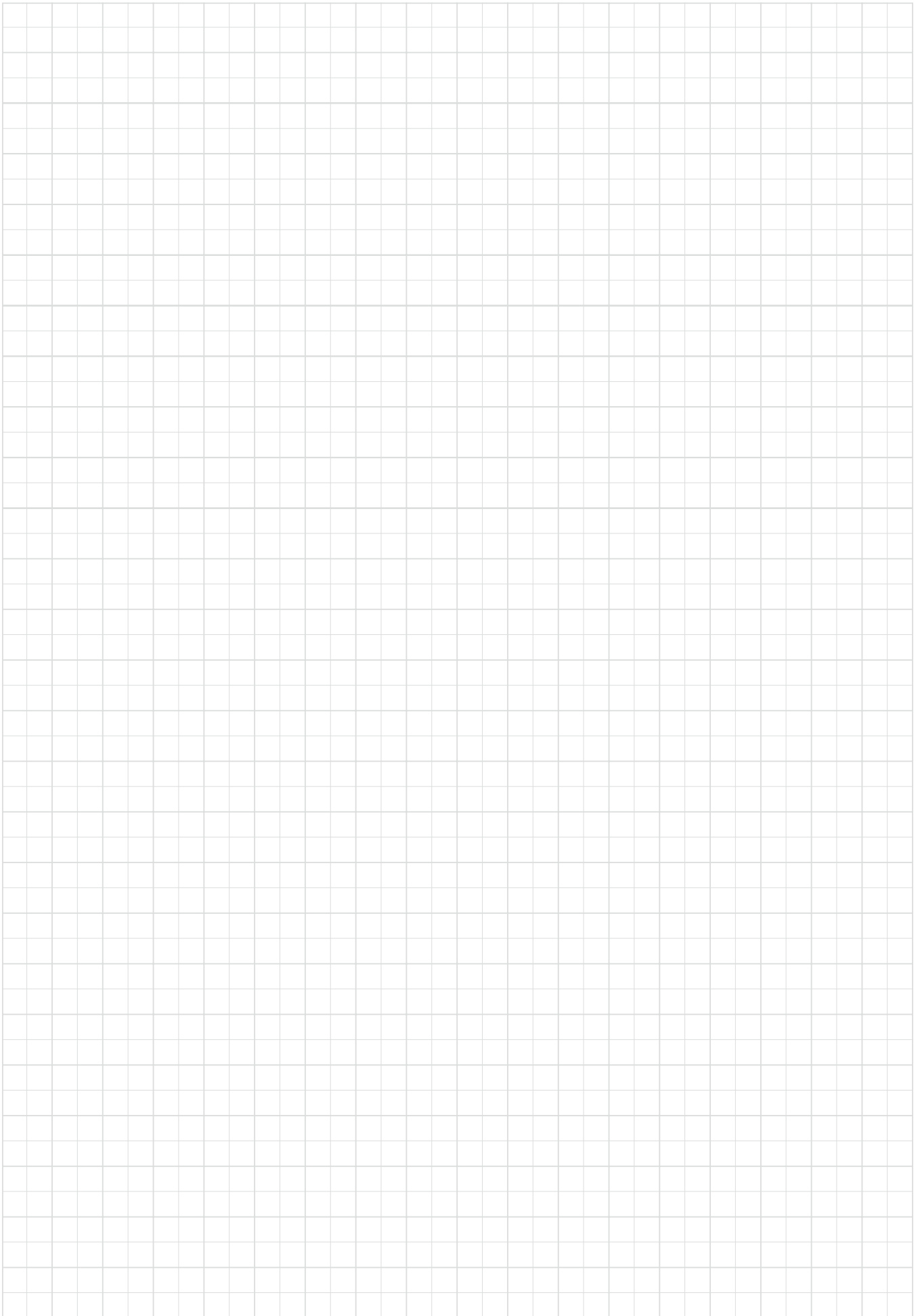
Note: Above charts are based on published data and not authorized by each manufacturer.

● Positive insert type

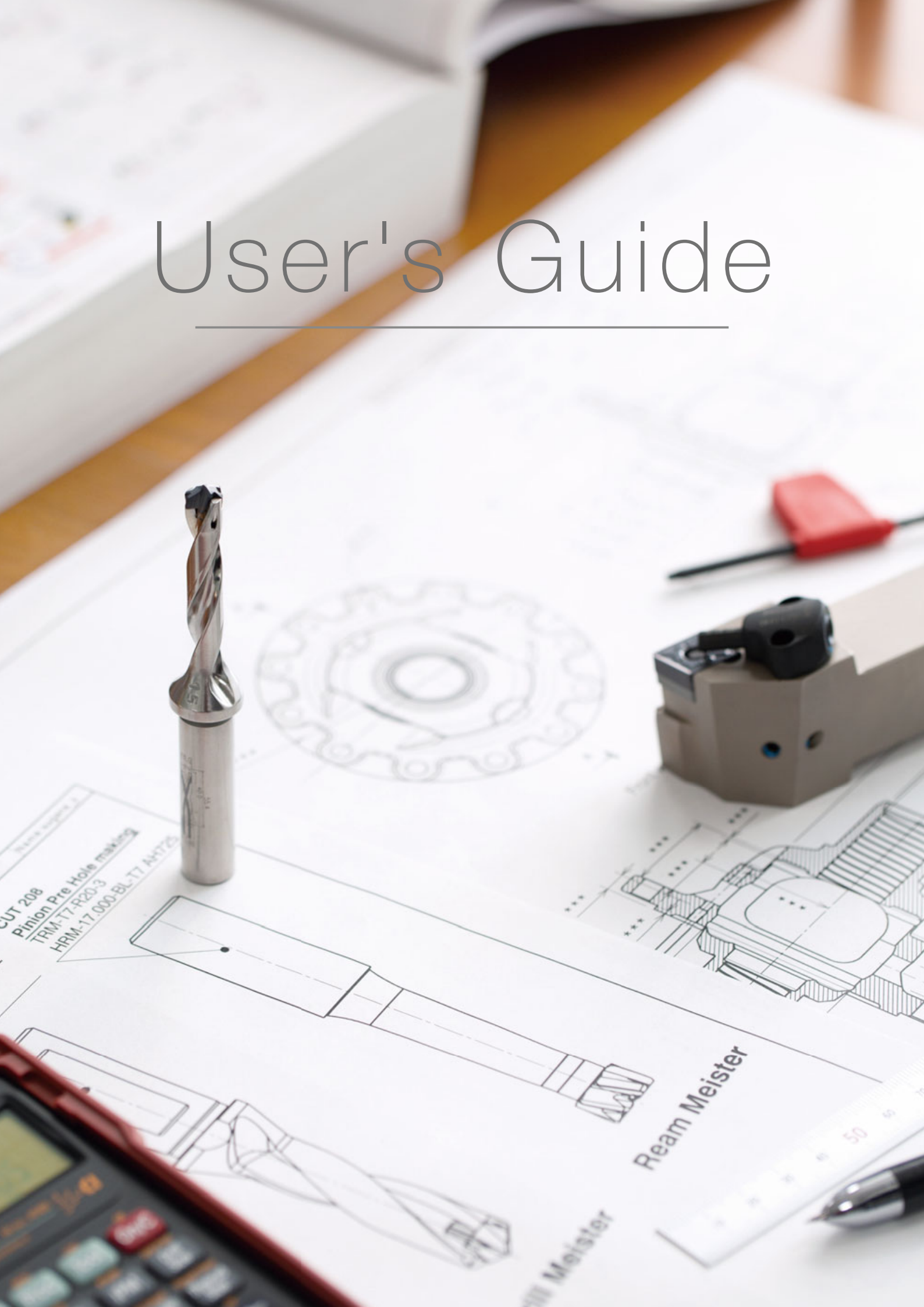
ISO Classification	Cutting Mode	Tungaloy	Mitsubishi Carbide	Sumitomo Electric	Kyocera	Sandvik	Moldino	NTK	Kennametal	Seco Tools	Iscar	TaeguTec	Walter	Ceratzit	
P	Precision finishing	01	FV	FC	CF, CK		JQ		GM	FF1 F1	SF		PF2	F32	
	Finishing and light cutting	PSF, PF, SS PS, PSS TS, TSF	FP, FV, SV LP SVX	FP, LU FK, SC SU	GQ GP XP PP, VF WP	R/L-K PF UF WF, WK, WM	JQ JE		11, LF VF, FP FW, MW	MF2	PF SM, 14, 17 19, XL R/L RF, LF	FA FG GF	PF5 PF4 PS5 PF, PM	SF SMF SMW, 25Q	
		TSW, SW W08-20	SW, MW	LUW, SDW											
	Medium cutting	PM TM All-round RS	MP MV No sign	SU, MU SC	All-round HQ, XQ GK	PM UM, PR UR	JE		MP MF	M3 M5	DT, HQ	MT MT	PM5	SM	
High-feed, small depth of cut cutting	61									No sign 14	No sign				
M	Finishing	PSF, SS	FM, SV	FC		R/L-K UF, MF			11, VF	FF1 MF2		FG			
	Finishing to Medium cutting	PSS PS	LM SV	SI, GU LB, SU	MQ	MM UM			LF, FP	M3			PF4	SF, SMF	
	Medium cutting	PM	MM	MU	HQ	MR UR			MF, MP	M5			PM5	F23, F43 SM	
K	Cutting of cast irons	CM Flat-top	MK Flat-top	FC, MU Flat-top	KF KM UM, KR	Flat-top			11, VF, FP MP, MF Flat-top	M5 Flat-top	19	MT Flat-top	PS5, PM5 Flat-top	SF 25P 27, 29	
N	Cutting of non-ferrous metals	AL P Ground	AZ R/L-F R/L	AG AY AW LD, GD	AH	AL			HP, LF	AL	AS	FL	PF2 PM2	23P 25P 27, 29	
S	Finishing	PSF	FJ	FC	MQ	MF, UF, R/L-K			HP	F1				SF	
	Finishing to Medium cutting	PSS PS	LS, MS	SU, GU		MM SM			LF, FP	MF2				F23	
	Medium cutting	All-round		SI		UM, MR, UR						FG	PF2, PF4	SM, 25P, 29	
P M N S	Turning on small lathes	JP, 01 W08, W15, W20 J08	R/L-SR R/L-SN R/L-SS FS-P, F	W, SD FX, FY	CF, SKS R/L-F, R/L-FSF ER/L-U FR/L-U R/L-U FR/L-U, R/L-USF MF, R/F-FSF SK, GF CK, GQ	F, M UM	No sign	AMX AZ7 YL, AM3 U CL	LF		SM F2M	GF, GW SL SA SM SH	PM5		
		JS, JSS	LS-P	LU, FP, FK, SU FC, SI, SC											
		JRP, JSR, JPP J10, TS, JTS TSW SS	SW, MW SRF SMG												

Note: Above charts are based on published data and not authorized by each manufacturer.

MEMO



User's Guide



CUT 208
Pinion Pre Hole marking
TRM-T7-R20-3
HRM-17.000-BL-T7-AHTZ

Ream Meister

Mill Meister

USER'S GUIDE

Technical Reference

L003 -

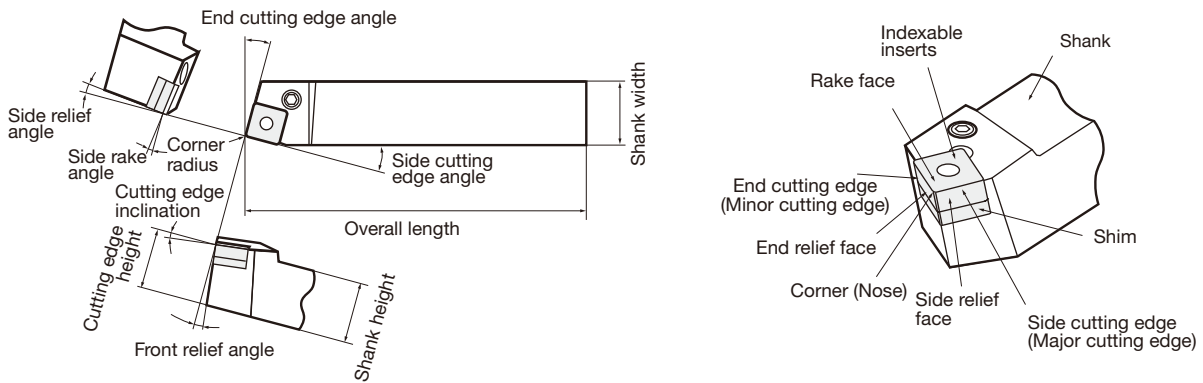
Parts for Tools

L118 -

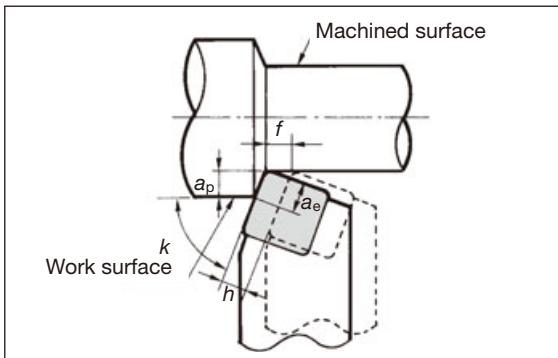
Turning Tools



Name of tools parts

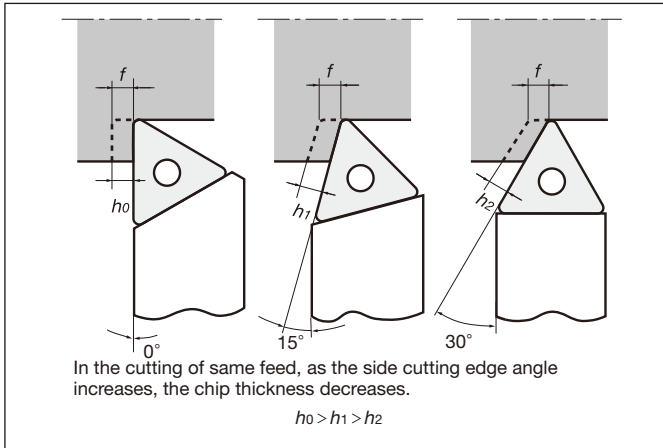


Relating angles between tool and workpiece



- a_p ... Depth of cut (Distance between work surface and machined surface)
- a_e ... Length of cutting edge engaging in cutting.
- k ... Cutting edge angle (Angle to be made by cutting edge and work surface)
- f ... Feed per revolution
- h ... Thickness to be cut per revolution
- Machined surface ... Workpiece surface after having machined.
- Work surface ... Workpiece surface to be cut.

Effect of side cutting edge angle



Honing

TAC indexable inserts of steel cutting grades are honed. Honing specifications are shown in the following table.

Edge condition	Shape
Sharp edge	
Round honing	
Chamfered honing	

Effects of tool geometry on cutting phenomena

Phenomena	Flank wear	Crater wear	Edge strength	Cutting force	Surface finish	Chattering	Cutting edge temperature	Chip shape and flow
Increasing								
Cutting edge inclination	-	Decrease	Lower	Radial force decrease	-	Less tendency	Lower	Effect on flow direction
Side rake angle	-	Decrease	Lower	Decrease	-	-	Lower	Effect on shape
Relief angle	Decrease	-	Lower	Decrease	-	Likely to occur	Lower	-
End cutting edge angle	Decrease	-	Lower	Radial force decrease	Roughen	Less tendency	Lower	-
Side cutting edge angle	Decrease	Decrease	Increase	Radial force decrease	-	Likely to occur	Increase	Decrease thickness
Nose radius	Decrease to some level		Increase	Increase	Improve	Likely to occur	Increase	Effect on flow direction
Honing width	Increase	-	Increase	Increase	-	Likely to occur	Increase	-

Turning Tools

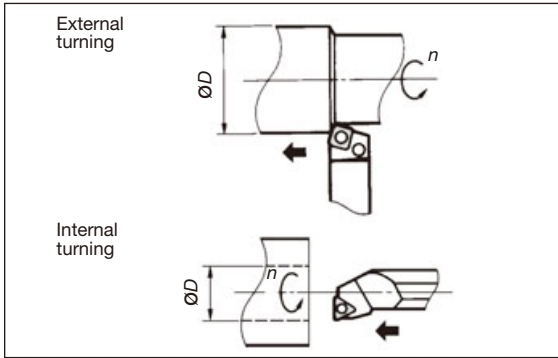
Relations between cutting force and cutting conditions or cutting phenomena

Condition	Grey cast iron (HB130)	Stainless steel (HB145)	Carbon steel (HB230)
Cutting speed and cutting force $f = 0.008$ ipr $a_p = 0.079$ " Side cutting edge angle 0° Corner radius $RE = 0.016$ "			
Depth of cut and cutting force $V_c = 330$ SFM $f = 0.008$ ipr Side cutting edge angle 0° Corner radius $RE = 0.016$ "			
Feed and cutting force $V_c = 330$ SFM $a_p = 0.079$ " Side cutting edge angle 0° Corner radius $RE = 0.016$ "			
Corner radius and cutting force $V_c = 330$ SFM $f = 0.008$ ipr $a_p = 0.047$ " Side cutting edge angle 0°			
Side cutting edge angle and cutting force $V_c = 330$ SFM $f = 0.008$ ipr $a_p = 0.079$ " Corner radius $RE = 0.016$ "			
Side rake angle and cutting force $V_c = 330$ SFM $f = 0.008$ ipr $a_p = 0.079$ " Side cutting edge angle 0° Corner radius $RE = 0.008$ "			

* 9.8N = 1kgf

Calculation formulas for turning

● Cutting speed



When calculating cutting speed from number of revolutions:

$$V_c = \frac{\pi \times \varnothing D \times n}{3.82}$$

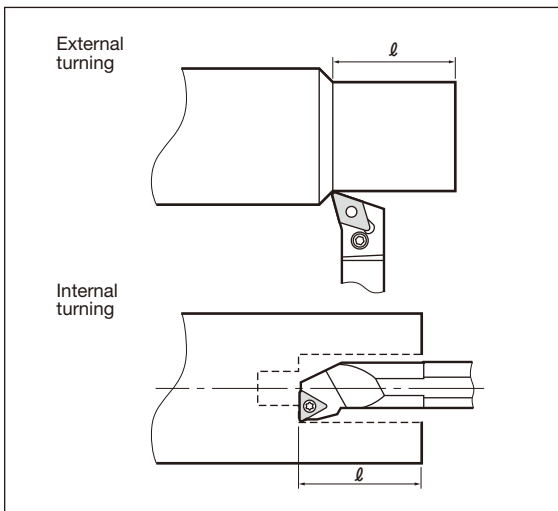
V_c : Cutting speed (sfm)
 n : Number of revolution (rpm)
 $\varnothing D$: Diameter of workpiece (in)
 $\pi \approx 3.14$

When calculating required number of revolutions from cutting speed:

$$n = \frac{V_c \times 3.82}{\pi \times \varnothing D}$$

Example : Calculating the cutting speed when turning a $\varnothing 6$ mm-diameter workpiece at 250 rpm
 $V_c = \frac{3.14 \times 6 \times 250}{3.82} = 392 \text{ sfm}$

● Cutting time on external and internal turning

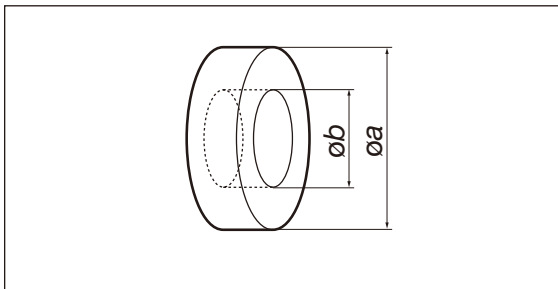


$$T = \frac{\ell}{f \times n}$$

(min)

T : Cutting time (min)
 ℓ : Cutting length (in)
 f : Feed (ipr)
 n : Number of revolution (rpm)

● Cutting time on face turning

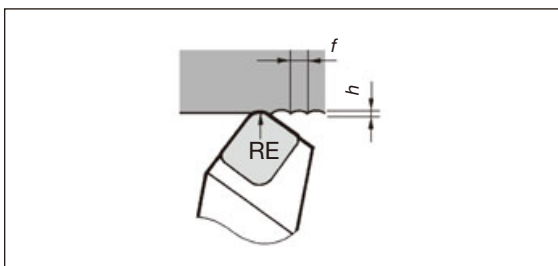


$$T = \frac{\pi \times (\varnothing a^2 - \varnothing b^2)}{4000 \times v_c \times f}$$

(min)

V_c : Cutting speed (sfm)
 f : Feed (ipr)
 T : Cutting Time (min)

● Theoretical surface roughness



$$h = \frac{f^2}{8 \times r} \times 1000$$

(μm)

h : Surface roughness (μm)
 f : Feed (ipr)
 r : Nose radius (in) (RE)

() The notation in the brackets is the one used in the catalog (ISO compliant)

● Power consumption

$$P_c = \frac{F \times V_c}{33000}$$

(HP)

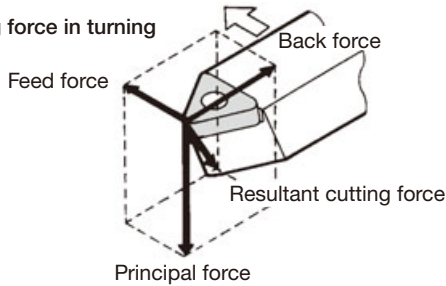
P_c : Power requirement (HP)
 F : Cutting force (N)
 V_c : Cutting speed (sfm)

Turning Tools

Cutting forces

- (1) Finding from the diagram based on experimental data.
- (2) In case determining by simplified equation:

Cutting force in turning



$$F = k_c \times a_p \times f \times 1000$$

(lb-force)

F : Cutting force (lb-force)
 k_c : Specific cutting force
 KPI (Kilo pound force)
 a_p : Depth of cut (in)
 f : Feed (ipr)

Example :
 Calculating the cutting force when cutting a high carbon steel (1055) at $f = 0.007$ ipr and $a_p = 0.118$ ".
 $F = 499 \times 0.118 \times 0.0078 \times 1000 = 460$ lb-force

Calculating power requirement

$$P_c = \frac{k_c \times a_p \times v_c \times f}{33}$$

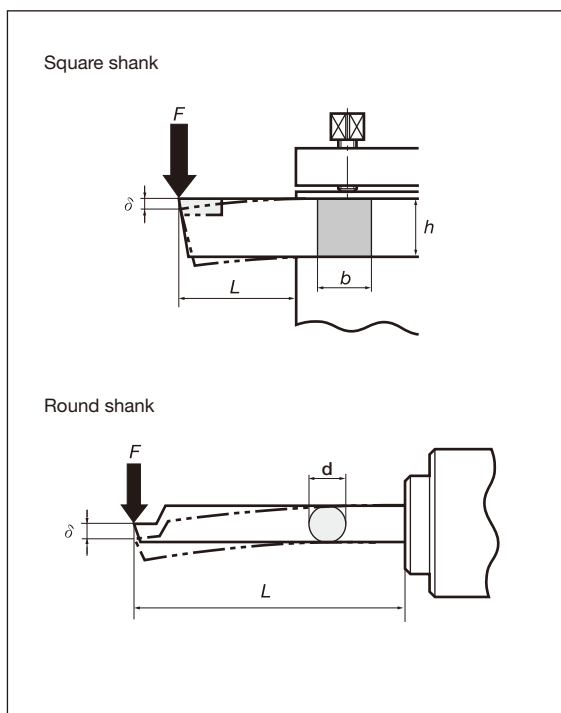
(kW)

c : Net power requirement (H)
 k_c : Specific cutting force (KPI)
 [Refer to the Table below]
 v_c : Cutting speed (sfm)
 a_p : Depth of cutting (in)
 f : Feed (ipr)

Value of specific cutting force (k_c)

Workpiece material (JIS)	Tensile strength (PSI)	Hardness (HB)	Value of specific cutting force on feed k_c (KPI)				
			0.0016 (ipr)	0.004 (ipr)	0.008 (ipr)	0.016 (ipr)	0.039 (ipr)
SS400, S15C	56,565	100	497	412	355	302	247
S35C, S40C	85,572	170	612	506	426	363	302
S50C, SCr430	113,855	230	711	583	497	426	348
SCM440, SNCM439	142,137	300	782	640	548	470	384
SDK	225,992 (56HRC)	56HRC	1,217	996	853	725	598
FC200	(160HB)	160	370	284	236	194	149
FCD600	(200HB)	200	483	370	306	254	194
Aluminum alloy	(89HB)	89	196	164	138	117	97
Aluminum			152	126	107	93	75
Magnesium alloy			57	57	57	57	57
Brass			157	157	157	157	157

Bending stress and tool deflection



Bending stress

(1) Square shank

$$S = \frac{6 \times F \times L \times 145}{b \times h^2}$$

(PSI)

(2) Round shank

$$S = \frac{32 \times F \times L \times 145}{\pi \times d^3}$$

(PSI)

S : Bending stress in shank (PSI)
 F : Cutting force (lb)
 L : Overhang length of tool (in)
 b : Shank width (in) : (B)
 h : Shank height (in) : (H)
 d : Shank diameter (in) : (DCONMS)
 E : Modulus of elasticity of shank material (lb/in²)

Tool deflection (in)

(1) Square shank

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

(in)

(2) Round shank

$$\delta = \frac{64 \times F \times L^3}{3 \times \pi \times E \times d^4}$$

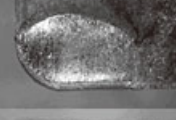





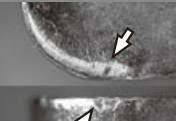










(in)

() The notation in the brackets is the one used in the catalog (ISO compliant)

(Ref.) Values of E

Material	MPa (SPI)	{kgf/mm ² }
Steel	30,457,980	30,457,980
Cemented Carbide	81,221,280 ~ 89,923,560	81,221,280 ~ 89,923,560

Troubleshooting in turning

Typical tool failure		Countermeasure		
		Tool grade	Cutting conditions	
Flank wear		<ul style="list-style-type: none"> Change to more wear resistant grades P, M, K30 → 20 → 10 	<ul style="list-style-type: none"> Reduce cutting speed Change to appropriate feed Change to wet cutting 	<ul style="list-style-type: none"> Decrease honing width Increase relief angle Increase end cutting edge angle Increase corner radius Select free-cutting chipbreaker Increase rake angle
				
Crater wear		<ul style="list-style-type: none"> Change to more wear resistant grades P, M, K30 → 20 → 10 	<ul style="list-style-type: none"> Reduce cutting speed Reduce feed Reduce depth of cut Change to wet cutting 	<ul style="list-style-type: none"> Increase rake angle Select an appropriate chipbreaker Increase side cutting edge angle Increase corner radius
				
Notch wear		<ul style="list-style-type: none"> Change to more wear resistant grades P, M, K30 → 20 → 10 	<ul style="list-style-type: none"> Reduce cutting speed Reduce feed 	<ul style="list-style-type: none"> Increase rake angle Increase side cutting edge angle
				
Fracture		<ul style="list-style-type: none"> Change to tougher grades Change to thermal-shock resistant grades P, M, K10 → 20 → 30 	<ul style="list-style-type: none"> Reduce feed Reduce depth of cut Improve holding rigidity of work and tool Reduce overhang length of toolholder Improve looseness in machine 	<ul style="list-style-type: none"> Reduce rake angle Select a chipbreaker with high edge strength Increase honing width Increase side cutting edge angle Select larger shank size Increase corner radius
				
Chipping		<ul style="list-style-type: none"> Change to tougher grades P, M, K10 → 20 → 30 	<ul style="list-style-type: none"> Reduce cutting speed Reduce feed Reduce depth of cut Improve holding rigidity of work and tool Reduce overhang length of toolholder Improve looseness in machine 	<ul style="list-style-type: none"> Reduce rake angle Select a chipbreaker with high edge strength Increase honing width Increase side cutting edge angle Select larger shank size
				
Flaking		<ul style="list-style-type: none"> Change to tougher grades P, M, K10 → 20 → 30 	<ul style="list-style-type: none"> Reduce cutting speed Reduce feed 	<ul style="list-style-type: none"> Reduce rake angle Increase corner radius Increase honing width
				
Plastic deformation		<ul style="list-style-type: none"> Change to more wear resistant grade P, M, K30 → 20 → 10 	<ul style="list-style-type: none"> Reduce cutting speed Change to appropriate feed Reduce depth of cut Supply cutting fluid in adequate volume 	<ul style="list-style-type: none"> Increase relief angle Increase rake angle Reduce corner radius Reduce side cutting edge angle Select a free-cutting chipbreaker
				
Chip welding		<ul style="list-style-type: none"> Use a grade which has a low tendency to adhere to workpiece material Cemented carbide → Coated carbide or cermet 	<ul style="list-style-type: none"> Increase cutting speed Increase feed Change to water-insoluble cutting fluid Change to wet cutting 	<ul style="list-style-type: none"> Increase rake angle Select a free-cutting chipbreaker Decrease honing width
				
Built-up edge		<ul style="list-style-type: none"> Change to tougher grades Change to thermal-shock resistant grades P, M, K10 → 20 → 30 	<ul style="list-style-type: none"> Reduce cutting speed Reduce feed Change to dry cutting Supply cutting fluid in adequate volume Reduce depth of cut Change to water-insoluble cutting fluid 	<ul style="list-style-type: none"> Increase rake angle Select a free-cutting chipbreaker Decrease honing width
Thermal cracking		<ul style="list-style-type: none"> Change to tougher grades Change to thermal-shock resistant grades P, M, K10 → 20 → 30 	<ul style="list-style-type: none"> Reduce cutting speed Reduce feed Change to dry cutting Supply cutting fluid in adequate volume Reduce depth of cut Change to water-insoluble cutting fluid 	<ul style="list-style-type: none"> Increase rake angle Select a free-cutting chipbreaker Decrease honing width

Turning Tools

Troubleshooting in turning

Problem	Cause	Countermeasure	
		Tool	Cutting conditions and others
Deteriorated surface roughness	<ul style="list-style-type: none"> Increased tool wear 	<ul style="list-style-type: none"> Select a more wear resistant grade Use an insert with a larger rake angle Select a freer-cutting chipbreaker type Use an insert with a larger nose radius Use a more lightly honed insert Use an insert of closer tolerance (from M class to G class) 	<ul style="list-style-type: none"> Select a proper feed Decrease the cutting speed Use a cutting fluid
	<ul style="list-style-type: none"> Edge chipping 	<ul style="list-style-type: none"> Use a tougher grade Select a chipbreaker with strong cutting edges Use a largely honed insert Increase the side cutting edge angle Use a larger shank size 	<ul style="list-style-type: none"> Decrease the depth of cut Decrease the feed Use a more rigid machine Improve the holding rigidity of the tool and workpiece Shorten the overhang of the toolholder Improve the machine looseness
	<ul style="list-style-type: none"> Chip welding Built-up-edge 	<ul style="list-style-type: none"> Select a grade with less affinity with the Workpiece material Use an insert with a larger rake angle Select a freer-cutting chipbreaker type Use a more lightly honed insert Use an insert of closer tolerance (from M class to G class) 	<ul style="list-style-type: none"> Increase the cutting speed Increase the feed Use a water-insoluble cutting fluid Use a cutting fluid
	<ul style="list-style-type: none"> Vibration and chatter 	<ul style="list-style-type: none"> Use a tougher grade Use an insert with a larger rake angle Select a freer-cutting chipbreaker type Use an insert with a smaller nose radius Decrease the side cutting edge angle Use a more lightly honed insert Use a larger shank size 	<ul style="list-style-type: none"> Use a proper cutting speed Decrease the feed Decrease the depth of cut Improve the holding rigidity of the tool and workpiece Shorten the overhang of the toolholder Improve the machine looseness
Deteriorated dimensional accuracy	<ul style="list-style-type: none"> Improper insert accuracy 	<ul style="list-style-type: none"> Use an insert of closer tolerance (from M class to G class) 	
	<ul style="list-style-type: none"> Incomplete engagement of tool and workpiece 	<ul style="list-style-type: none"> Use an insert with a larger rake angle Select a freer-cutting chipbreaker type Use an insert with a smaller nose radius Use a more lightly honed insert 	<ul style="list-style-type: none"> Improve the holding rigidity of the tool and workpiece Shorten the overhang of the toolholder Improve the machine looseness
Burr occurrence	<ul style="list-style-type: none"> Unsuitable cutting speed 		<ul style="list-style-type: none"> Decrease the cutting speed Increase the feed Use a cutting fluid
	<ul style="list-style-type: none"> Worn tool or improper cutting edge geometry 	<ul style="list-style-type: none"> Use a harder grade Use an insert with a larger rake angle Select a freer-cutting chipbreaker type Increase the relief angle Use an insert with a smaller nose radius Decrease the side cutting edge angle Use a more lightly honed insert 	
Edge breakout	<ul style="list-style-type: none"> Improper cutting speed 		<ul style="list-style-type: none"> Decrease the feed Decrease the depth of cut
	<ul style="list-style-type: none"> Worn tool or improper cutting edge geometry 	<ul style="list-style-type: none"> Use a harder grade Use an insert with a larger rake angle Select a freer-cutting chipbreaker type Increase the side cutting edge angle Use an insert with a larger nose radius Use a more lightly honed insert Use a larger shank size 	<ul style="list-style-type: none"> Improve the holding rigidity of the tool and workpiece Shorten the overhang of the toolholder Improve the machine looseness
Fuzzy surface finish	<ul style="list-style-type: none"> Improper cutting conditions 		<ul style="list-style-type: none"> Increase the cutting speed Select a proper feed Use a water-insoluble cutting fluid Use a cutting fluid
	<ul style="list-style-type: none"> Worn tool or improper cutting edge geometry 	<ul style="list-style-type: none"> Use a harder grade. Select a grade with less affinity with the Workpiece material Use an insert with a larger rake angle Select a freer-cutting chipbreaker type Use a more lightly honed insert 	

Chipbreakers

Chip controllability

Necessity of chip control

- ① Why is chip control needed?
- ② Effect of improper chip control

① Why is chip control needed?

What is chip?

For making a product from a workpiece, removed objects produced by a tool which is set to cut to a specified depth with the relative motion of the tool and the workpiece.

Problems when chips are not properly controlled

Necessity of chip control (Problems and effects)

Problems	Effects
<ol style="list-style-type: none"> 1. Scattering of chips and coolant. 2. Wrapping around the workpiece and the tool. 3. Accumulation on the tool, jig, and machining facilities. 	<ol style="list-style-type: none"> 1. Disturbs unmanned and automated machining. 2. Disturbs high-speed and high-efficiency machining. 3. Degrades finished surface. 4. Threatens operator's safety. 5. Reduced operation rate.

Additional problems when chips are not properly controlled

② Effect of improper chip control

Effects on quality

- Defective work.
- Defective surface finish
- Chip entangling

Effects on operation




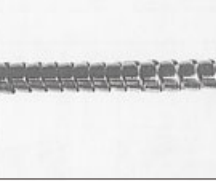


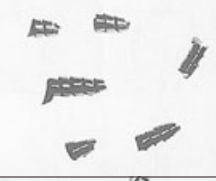
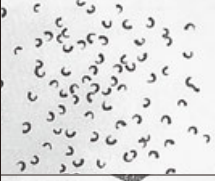
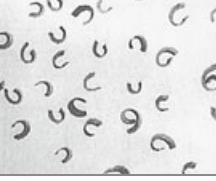
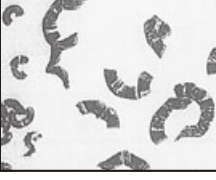

- Increased number of man-hours for handling.
- Increased tool costs.
- Troublesome chip handling.
- Machine stoppage and reduced operation rate.

Effect on safety and health.

- Stain and damage on machine caused from improper carrying-out of chips.
- Dangerous effects on the human body. (Injury and burns on hand, etc.)

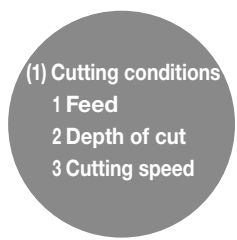
Effective measures

"Chipbreaker"

Classification	Chip shape		Description of chip shape	Acceptability	Effect
	Depth of cut: small	Depth of cut: large			
Shape A			Chips irregularly entangled	Not acceptable	<ul style="list-style-type: none"> • Wrapping around the tool or workpiece or accumulation around the cutting point, hindering cutting • Possible damage to the machined surface
Shape B			Long continuous spiral chips $l > 2"$	 Acceptable	<ul style="list-style-type: none"> • Bulky during transport in the automatic line • May be preferred when one operator handles one machine
Shape C			Short spiral chips $l < 2"$		<ul style="list-style-type: none"> • Smooth chip flow • Difficult to scatter • Favorable shape
Shape D			"C" or "9" shaped chips (Around one coiling)		<ul style="list-style-type: none"> • Favorable shape if not scattering • Not bulky and easy to transport
Shape E			Excessively broken chips. Thin pieces or connected in a form of wave as shown in the figure left	Not acceptable	<ul style="list-style-type: none"> • Readily scattering. If scattering is the only trouble, it may be acceptable because the chip cover, etc. may be used. • Tend to cause chatter, causing harm on the finished surface roughness or tool life.

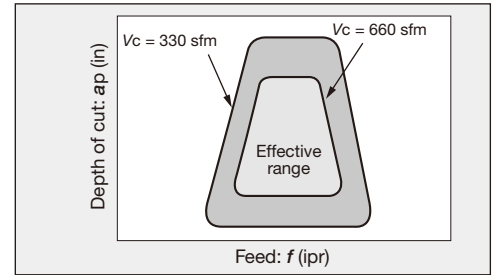
Chipbreakers

Factors affecting chip control



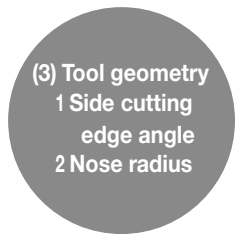
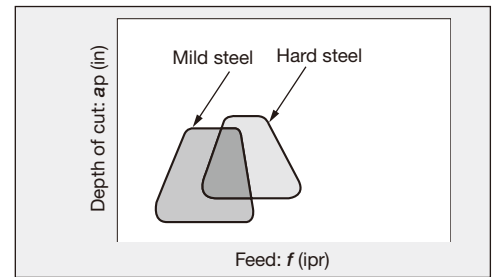
- Of these, feed has the greatest effect followed by depth of cut and cutting speed in order listed.
- Feed is proportionate to the thickness of chips.
- Depth of cut is proportionate to the width of chips.
- There are optimum values (effective range) in feed and depth of cut.
- Cutting speed is in inverse proportion to chip thickness. Effective range becomes narrow at high speed.

● Effect of cutting speed on chipbreaker effective range



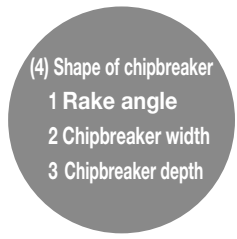
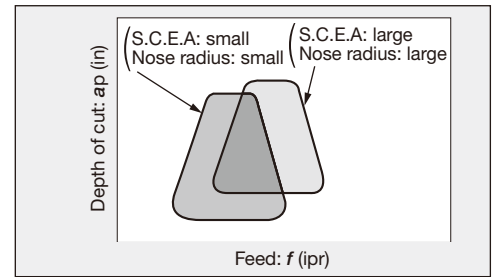
- These are related to thickness of chips and ease of curling.
- Mild steel chips are thicker than those of hard steel.
- Hard steel chips are liable to curl more than those of mild steel.
- Chips that do not curl are thin. As an exception, in case of mild steel even if thick, may not curl.

● Effect of material type on chipbreaker effective range



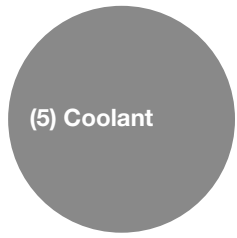
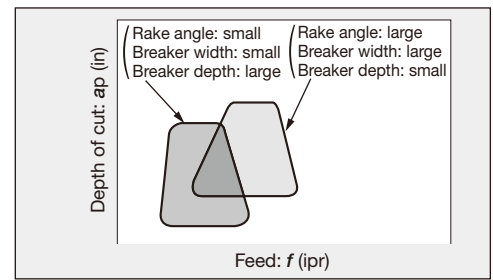
- Side cutting edge angle is relative to chip thickness and width
- Side cutting edge angle is preferably small.
- Nose radius is relative to thickness and width and the direction of flowing out.
- In finishing, small nose radius, whilst for rough cutting, large nose radius is better.

● Effect of tool geometry on chipbreaker effective range



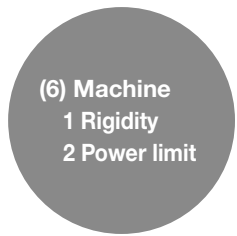
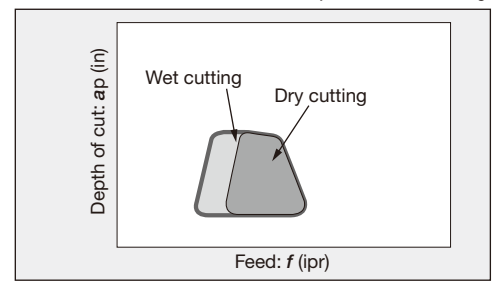
- Rake angle is in inverse proportion to chip thickness.
- Depending on the Workpiece material, there is an optimum value.
- Chipbreaker width is selected proportionately to feed.
- Narrow at low feed and wide at high feed.
- Chipbreaker depth is to be selected so as to be inversely proportionate to feed.
- Deep at low feed and shallow at high feed.

● Effect of chipbreaker shape on chipbreaker effective range



- Effective range is wider with wet cutting.
- Especially at low feed range is liable to curl.

● Effect of with/without of coolant on chipbreaker effective range



- The machine has enough power and mechanical strength.
- Select the machine consistent with the size of Workpiece material to be used.

Wiper Insert

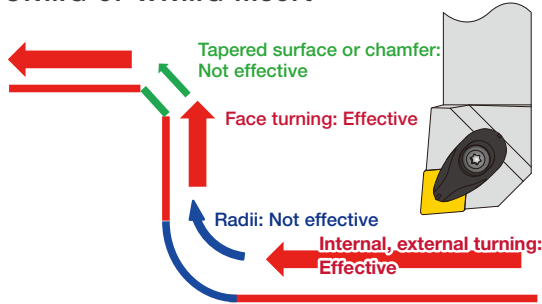


Machining program compensation for wiper -SW / -FW insert

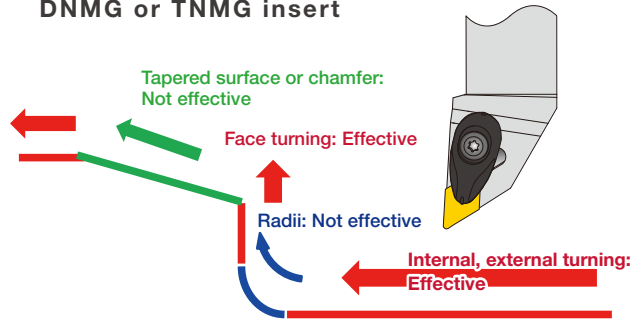
The nose radius on a wiper insert has a different configuration from that on standard ISO insert's. Machining program adjustments are, therefore, required to generate a correct offset for the wiper insert to machine the correct workpiece dimension. No compensation is needed, however, for the positive, CCMT-SW wiper insert.

Wiper effectiveness (surface finish quality improvement) by applications

CNMG or WNMG insert



DNMG or TNMG insert



Program compensations by insert shapes and applications

Match your insert shape and application to find the proper compensation method.

Application	Insert shape	CNMG/WNMG -SW/FW	DNMG/TNMG -SW/FW	CCMT-SW
		Type L	Type J, G, F	Type L
Internal, External and Face turning		Proceed to Compensation ① (See Page L012)	Proceed to Compensation ④ (See Page L013)	No compensation needed
Including tapered surface		Proceed to Compensation ①, ② (See Page L012)	Proceed to Compensation ④, ⑤ (See Page L013 - L014)	↑
Including corner radius		Proceed to Compensation ①, ③ (See Page L012)	Proceed to Compensation ④ (See Page L013) Proceed to Compensation ⑥ (See Page L014)	↑
Including tapered surface and corner radius		Proceed to Compensation ①, ②, ③ (See Page L012)	Proceed to Compensation ④, ⑤, ⑥ (See Page L013 - L014)	↑

Wiper Insert

Compensations for CNMG / WNMG -SW / -FW

Compensations ① Tool offsets (Compensations for X- and Z-axis)

Match the insert approach angle and the insert style to find the value and compensate the machining program for the insert radius.
 *This compensation procedure will not be necessary if the insert is compensated with the built-in tool presetter after insert replacement.

CNMG/WNMG-SW/-FW (Type L)

Nose Radius	X-axis direction	Z-axis direction
R0.016	0.001	0.001
R0.031	0.002	0.002
R0.047	0.002	0.002

(Unit: in)

Compensations ② Program compensations for tapered surface (proceed after ①) (in)

To machine tapered surfaces, compensate the nose radius position in the x-axis position to obtain the correct workpiece dimension.

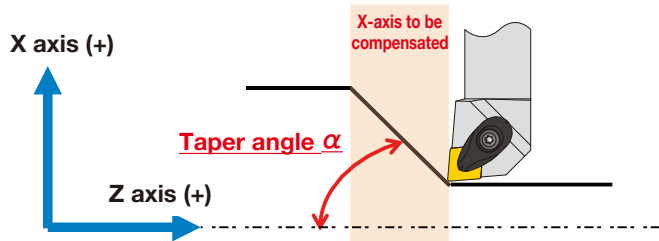
Compensations for x-axis when using CNMG or WNMG-SW/-FW (Tool approach angle: L) insert

Match the insert nose radius and the angle of the surface taper to find the value in Table 1 below to compensate the **x-axis position**.

For CNMG/WNMG-SW/-FW (Type L)

Compensation values for x-axis (in)

Nose radius (in)	Taper angle α (θ)																			
	0	0.197	0.394	0.591	0.787	0.984	1.181	1.378	1.575	1.772	1.969	2.165	2.362	2.559	2.756	2.953	3.150	3.346	3.543	
R0.016	0	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0
R0.031	0	0.001	0.002	0.002	0.003	0.003	0.004	0.004	0.004	0.004	0.005	0.006	0.006	0.007	0.007	0.007	0.007	0.005	0.005	0
R0.047	0	0.001	0.002	0.002	0.003	0.003	0.004	0.004	0.004	0.004	0.005	0.006	0.006	0.007	0.007	0.007	0.007	0.006	0.006	0



Compensations ③ Program compensation for corner radii (proceed after ①) (in)

To achieve the correct corner radius dimension on the workpiece, compensate the tool position, using the values listed below for respective insert styles.

CNMG/WNMG-SW/-FW (Type L)

Nose Radius	Deviation on the corner radius	Compensate radius by
R0.016	0.002	+0.005
R0.031	0.003	+0.007
R0.047	0.003	+0.007

(Unit: in)

Compensations for DNMG / TNMG -SW / -FW

● Compensations ④ Tool offsets (Compensations for X- and Z-axis)

Match the insert approach angle and the insert style to find the value and compensate the machining program for the insert radius.
*This compensation procedure will not be necessary if the insert is compensated with the built-in tool presetter after insert replacement.

DNMG-SW/-FW (Type J)

Nose Radius	X-axis direction	Z-axis direction
R0.016	0.009	0.001
R0.031	0.009	0.002
R0.047	0.005	0.001

(Unit: in)

TNMG-SW/-FW (Type J)

Nose Radius	X-axis direction	Z-axis direction
R0.016	0.009	0.002
R0.031	0.008	0.002
R0.047	0.006	0.002

(Unit: in)

TNMG-SW/-FW (Type G)

Nose Radius	X-axis direction	Z-axis direction
R0.016	0.009	0.001
R0.031	0.008	0.001
R0.047	0.006	0.001

(Unit: in)

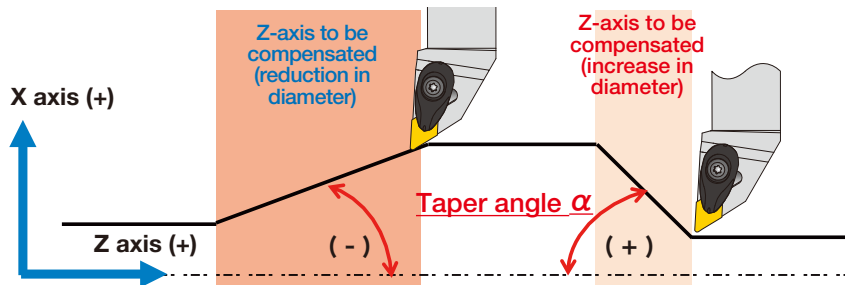
TNMG-SW/-FW (Type F)

Nose Radius	X-axis direction	Z-axis direction
R0.016	0.001	0.009
R0.031	0.001	0.008
R0.047	0.001	0.006

(Unit: in)

● Compensations ⑤ Program compensations for tapered surface (proceed after ④) (in)

To machine tapered surfaces with DNMG or TNMG-SW/-FW insert, compensate both the x-axis and z-axis positions. Since these inserts are commonly used for profiling, to machine a tapered surface with a gradual reduction in diameter, the z-axis position has to be compensated in the negative direction.



Compensations for x- and z-axes when using DNMG or TNMG-SW/-FW

Match the insert nose radius and the angle of the surface taper to find the value in below to compensate the x-axis and/or z-axis positions.

For DNMG-SW/-FW (Type J)

X-axis compensation values for plus-tapered surface (increase in diameter)(in)

(Unit: in)

Nose radius (in)	Taper angle α (θ)																			
	0	0.197	0.394	0.591	0.787	0.984	1.181	1.378	1.575	1.772	1.969	2.165	2.362	2.559	2.756	2.953	3.150	3.346	3.543	
R0.016	0	-0.0004	-0.0004	-0.0004	-0.0004	-0.0008	-0.0012	-0.0016	-0.0024	-0.0031	-0.0039	-0.0055	-0.0075	-0.0079	-0.0079	-0.0075	-0.0075	-0.0075	-0.0075	0
R0.031	0	0.0004	0.0008	0.0008	0.0012	0.0012	0.0008	0.0004	0.0000	-0.0008	-0.0020	-0.0035	-0.0059	-0.0067	-0.0059	-0.0051	-0.0047	-0.0043	-0.0043	0
R0.047	0	0.0008	0.0016	0.0020	0.0024	0.0028	0.0028	0.0024	0.0016	0.0008	-0.0008	-0.0035	-0.0067	-0.0075	-0.0063	-0.0055	-0.0051	-0.0051	-0.0059	0

Z-axis compensation values for minus-tapered surface (reduction in diameter)(in)

Nose radius (in)	Taper angle α (θ)				
	-0.984	-0.787	-0.591	-0.394	-0.197
R0.016	0.013	0.013	0.013	0.013	0.013
R0.031	0.012	0.013	0.013	0.013	0.013
R0.047	0.013	0.014	0.015	0.016	0.016

(Unit: in)

* Match the taper angle and insert nose radius to find the value in Table 2 and compensate the NC program by either adding or deducting the value.

Example:

Tapering a surface of +45° (increase in diameter) with a R0.031" insert.

Current NC program: X3.937"

Compensation value: -0.001"

Parameter after compensation: X3.936"

Wiper Insert

Compensations for DNMG / TNMG -SW / -FW

● Compensations ⑤ Program compensations for tapered surface (proceed after ④) (in)

For TNMG-SW/-FW (Type J)



X-axis compensation values for plus-tapered surface (increase in diameter) (in)

Nose radius (in)	Taper angle α (θ)																		
	0	0.197	0.394	0.591	0.787	0.984	1.181	1.378	1.575	1.772	1.969	2.165	2.362	2.559	2.756	2.953	3.150	3.346	3.543
R0.016	0	0	0	-0.0004	-0.0004	-0.0008	-0.0012	-0.0016	-0.0020	-0.0028	-0.0039	-0.0055	-0.0071	-0.0098	-0.0110	-0.0110	-0.0106	-0.0106	0
R0.031	0	0.0004	0.0008	0.0012	0.0016	0.0016	0.0016	0.0012	0.0008	0	-0.0008	-0.0024	-0.0043	-0.0075	-0.0087	-0.0079	-0.0075	-0.0083	0
R0.047	0	0.0008	0.0020	0.0028	0.0031	0.0035	0.0039	0.0035	0.0031	0.0024	0.0012	-0.0008	-0.0039	-0.0087	-0.0102	-0.0098	-0.0098	-0.0122	0

(Unit: in)

Z-axis compensation value for minus-tapered surface (reduction in diameter) (in)

Nose radius (in)	Taper angle α (θ)				
	-0.984	-0.787	-0.591	-0.394	-0.197
R0.016	0.0165	0.0165	0.0165	0.0161	0.0157
R0.031	0.0138	0.0126	0.0130	0.0134	0.0130
R0.047	0.0165	0.0142	0.0150	0.0154	0.0146

(Unit: in)

For TNMG-SW/-FW (Type G)

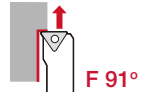


X-axis compensation values for plus-tapered surface (increase in diameter) (in)

Nose radius (in)	Taper angle α (θ)																		
	0	0.197	0.394	0.591	0.787	0.984	1.181	1.378	1.575	1.772	1.969	2.165	2.362	2.559	2.756	2.953	3.150	3.346	3.543
R0.016	0	0	-0.0004	-0.0004	-0.0008	-0.0012	-0.0016	-0.0020	-0.0028	-0.0035	-0.0047	-0.0063	-0.0087	-0.0110	-0.0114	-0.0114	-0.0114	-0.0126	0
R0.031	0	0.0004	0.0008	0.0008	0.0012	0.0008	0.0008	0.0004	-0.0004	-0.0012	-0.0024	-0.0039	-0.0067	-0.0098	-0.0098	-0.0098	-0.0110	-0.0157	0
R0.047	0	0.0012	0.0024	0.0031	0.0035	0.0039	0.0043	0.0039	0.0035	0.0028	0.0016	-0.0004	-0.0035	-0.0071	-0.0071	-0.0071	-0.0079	-0.0134	0

(Unit: in)

For TNMG-SW/-FW (Type F)



X-axis compensation values for plus-tapered surface (increase in diameter) (in)

Nose radius (in)	Taper angle α (θ)																		
	0	0.197	0.394	0.591	0.787	0.984	1.181	1.378	1.575	1.772	1.969	2.165	2.362	2.559	2.756	2.953	3.150	3.346	3.543
R0.016	0	-0.0012	-0.0020	-0.0031	-0.0039	-0.0051	-0.0051	-0.0043	-0.0039	-0.0035	-0.0031	-0.0028	-0.0024	-0.0020	-0.0020	-0.0016	-0.0012	-0.0008	0
R0.031	0	-0.0016	-0.0020	-0.0028	-0.0035	-0.0047	-0.0039	-0.0028	-0.0020	-0.0012	-0.0004	0.0004	0.0012	0.0020	0.0028	0.0035	0.0043	0.0051	0
R0.047	0	-0.0012	-0.0016	-0.0020	-0.0028	-0.0035	-0.0020	-0.0004	0.0012	0.0028	0.0043	0.0059	0.0071	0.0087	0.0098	0.0110	0.0126	0.0138	0

(Unit: in)

● Compensations ⑥ Program compensation for corner radii (proceed after ④) (in)

To achieve the correct corner radius dimension on the workpiece, compensate the tool position, using the values listed below for respective insert styles.

DNMG-SW/-FW (Type J)

Nose Radius	Deviation on the corner radius	Compensate radius by
R0.016	0	0
R0.031	0.0008	+0.0079
R0.047	0.0039	+0.0134

(Unit: in)

TNMG-SW/-FW (Type J)

Nose Radius	Deviation on the corner radius	Compensate radius by
R0.016	0	0
R0.031	0.0012	+0.0051
R0.047	0.0043	+0.0142

(Unit: in)

TNMG-SW/-FW (Type G, Type F)

Nose Radius	Deviation on the corner radius	Compensate radius by
R0.016	0	0
R0.031	0.0008	+0.0059
R0.047	0.0035	+0.0150

(Unit: in)

Additional information on offsetting -SW / -FW wiper inserts

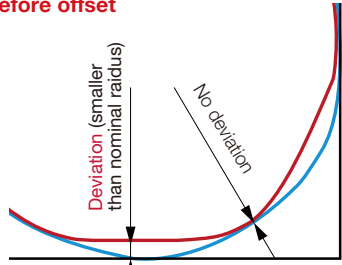
● Compensations ①, ④ Tool offsets (Compensations for X- and Z-axis)

Why need to offset ?

Ex. When using DNMG433

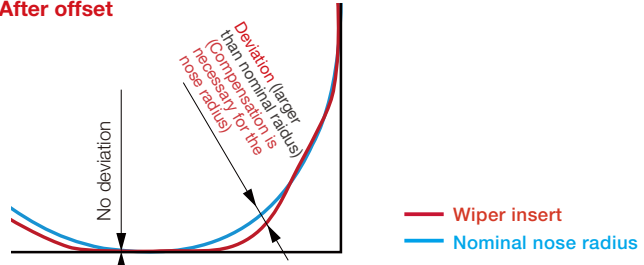
The wiper insert does not provide the exact corner radius. A deviation from the standard nose radius shape as shown below will always occur when going into a corner. An additional program adjustment is, therefore, required to achieve the correct corner radius or tapered surface dimension on the workpiece.

Before offset



Wiper nose radius' contour is slightly smaller than the nominal radius.
→ The nose radius profile deviates from the required corner radius, thus the actual corner profile will be **incorrect**.

After offset



Wiper nose radius' contour is partially larger than the nominal radius.
→ No compensations necessary for ID, OD, or face turning.
Meanwhile, **due to these deviations, compensations to the NC program are necessary when turning corners and tapered surfaces** for the correct workpiece dimensions.

● Compensations ③, ⑥ Program compensation for corner radii (proceed after ①, ④) (in)

Compensation for corner radius

Ex. When using DNMG433

Example: to machine a corner radius = R0.079", using insert nose radius = R0.047".

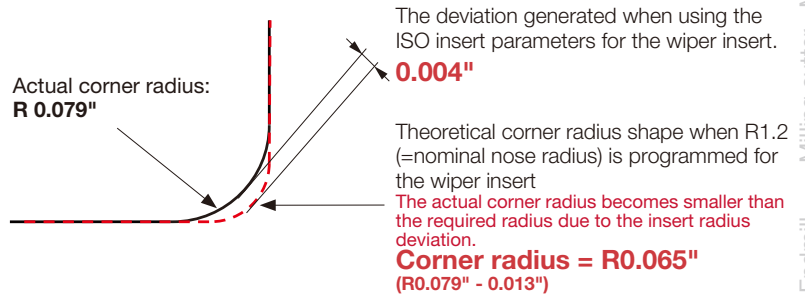
For standard ISO insert: DNMG433-**

Input R0.8 for G2 or G3 (circular interpolation) to compensate the nose radius deviation.

Wiper insert

For wiper insert: DNMG433-SW/-FW

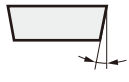
Input **R0.055"** (= R0.031" + 0.013" from the list) for the nose radius, instead of R0.8, to compensate the nose radius deviation.



Designation system for Insert

Symbol	Shape	Nose angle (degree)	Figure
H	Hexagonal	120°	
O	Octagonal	135°	
P	Pentagonal	108°	
S	Square	90°	
T	Triangular	60°	
C	Rhombic	80°	
D		55°	
E		75°	
F		50°	
G	G-shape (Tungaloy's symbol)	70°	
M	Rhombic	86°	
V		35°	
Y	Y-shape (Tungaloy's symbol)	25°	
W	Trigon	80°	
L	Rectangular	90°	
A	Parallelogram	85°	
B		82°	
K		55°	
R	Round	-	

Symbol	Relief angle
A	3°
B	5°
C	7°
D	15°
E	20°
F	25°
G	30°
N	0°
P	11°
O	Others
X	Special




Symbol (class)	Tolerance (inch)		
	Cutting point	Thickness (S)	I.C. dia. (IC)
A	±0.0002	±0.0001	±0.0001
F	±0.0002	±0.0001	±0.0005
C	±0.0005	±0.0001	±0.0001
H	±0.0005	±0.0001	±0.0005
E	±0.001	±0.001	±0.001
G	±0.001	±0.005	±0.001
J	±0.0002	±0.001	±0.002 ~ ±0.005
K	±0.0005	±0.001	±0.002 ~ ±0.005
L	±0.001	±0.001	±0.002 ~ ±0.005
M	±0.003 ~ ±0.007	±0.005	±0.002 ~ ±0.005
N	±0.003 ~ ±0.007	±0.001	±0.002 ~ ±0.005
U	±0.005 ~ ±0.015	±0.005	±0.003 ~ ±0.01


1 Shape

Note: For rhombic and parallelogram inserts, use the smaller nose angle.

1




[Example]




1

2




[Example]




2

3




[Example]




3

4




[Example]




4

5



[Example]



5

4 Groove and hole					
Symbol	Hole	Shape of hole	Chip-breaker	Shape	
N	Without	-	Without		
R			Single-sided		
F			Double-sided		
A	With	Cylindrical hole	Without		
M			Single-sided		
G			Double-sided		
W			Partly cylindrical hole, single-side 40° - 60° Counter sink	Without	
T				Single-sided	
Q			Partly cylindrical hole, double-side 40° - 60° Counter sink	Without	
U	Double-sided				
B	Partly cylindrical hole, single-side 70° - 90° Counter sink	Without			
H		Single-sided			
C	Partly cylindrical hole, double-side 70° - 90° Counter sink	Without			
J					
X					

5 Size (I.C)			
Symbol		Dimensions (in)	
Normal series	Small series	I.C.	Fraction
(1.2)	5	0.156	5/32
(1.5)	6	0.187	3/16
(1.8)	7	0.219	7/32
2	(8)	0.250	1/4
(2.5)	0	0.313	5/16
3		0.375	3/8
4		0.500	1/2
5		0.625	5/8
6		0.750	3/4
7		0.875	7/8
8		1.000	1
(10)		1.250	1-1/4

ANSI Designation

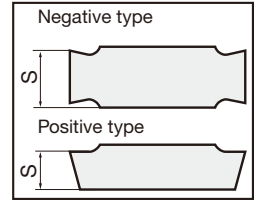
● Detailed accuracy

Corner angles larger than 55°

Inscribed circle	Tolerance on inscribed circle dia. (IC)		Tolerance on corner height (M)		Shape
	J,K,M,N (class)	U (class)	J,K,M,N (class)	U (class)	
0.250	±0.002	±0.003	±0.003	±0.005	H W
0.375					O R
0.500	±0.003	±0.005	±0.005	±0.008	P
0.625					S
0.750					T
1.000	±0.005	±0.010	±0.007	±0.015	C,E,M

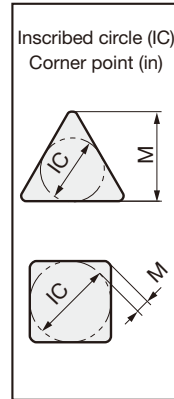
● Note on insert thickness

Thickness of insert with chipbreaker grooves is defined as shown to the right.



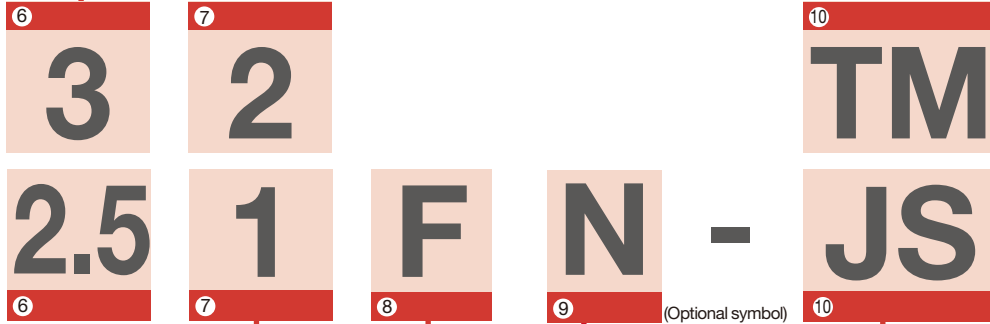
For angles at 55° (M-Class)

Inscribed circle	Tolerance on inscribed circle dia. (IC)	Tolerance on corner height (M)	Applicable insert shape
0.250	±0.002	±0.004	D
0.375			
0.500	±0.003	±0.006	
0.625	±0.004	±0.007	
0.750			



Symbol		Thickness (in)	
Normal series	Small series		
-	2	0.062	1/16
1.5	3	0.094	3/32
2	4	0.125	1/8
2.5	5	0.156	5/32
3	6	0.187	3/16
3.5	-	0.219	7/32
4	-	0.250	1/4
5	-	0.313	5/16
6	-	0.375	3/8

[Example]



7 Corner radius

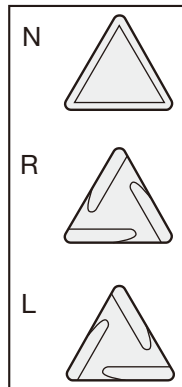
Symbol	Corner radius RE (in)	
V	0.001	-
0	0.004	1/256
0.5	0.008	1/128
1	0.016	1/64
2	0.031	1/32
3	0.047	3/64
4	0.062	1/16
5	0.078	5/64
6	0.094	3/32
7	0.109	7/64
8	0.125	1/8

8 Major cutting edge

Symbol	Cutting edge	Shape
F	Sharp	

9 Hand of insert

Symbol	Hand
R	Right
L	Left
N	Neutral



10 Our company's own symbols showing cutting edge conditions. For details, refer to page B007.

Insert hole size chart

Insert hole size		
	I.C.	Diameter
Negatives	1/4	0.089
	3/8	0.150
	1/2	0.203
	5/8	0.250
	3/4	0.312
	1	0.359
Positives	1 1/4	0.346
	5/32	0.087
	3/16	0.087
	13/64	0.110
	7/32	0.094
	1/4	0.110
	5/16	0.134
	3/8	0.173
1/2	0.217	
5/8	0.217	



Designation System for ISO Inserts

● How to decide the insert designation (conforms to JIS B4120-1998, ISO 1832 / AM1:1998)

Symbol	Shape	Nose angle (degree)	Figure
H	Hexagonal	120°	
O	Octagonal	135°	
P	Pentagonal	108°	
S	Square	90°	
T	Triangular	60°	
C	Rhombic	80°	
D		55°	
E		75°	
F		50°	
G	G-shape (Tungaloy's symbol)	70°	
M	Rhombic	86°	
V		35°	
Y	Y-shape (Tungaloy's symbol)	25°	
W	Trigon	80°	
L	Rectangular	90°	
A	Parallelogram	85°	
B		82°	
K		55°	
R	Round	-	

1 Shape

Symbol	Relief angle
A	3°
B	5°
C	7°
D	15°
E	20°
F	25°
G	30°
N	0°
P	11°
O	Others
X	Special

2 Relief angle

Symbol (class)	Tolerance (mm)		
	Corner height (M)	Thickness (S)	I.C. dia. (IC)
A	±0.005	±0.025	±0.025
F	±0.005	±0.025	±0.013
C	±0.013	±0.025	±0.025
H	±0.013	±0.025	±0.013
E	±0.025	±0.025	±0.025
G	±0.025	±0.13	±0.025
J	±0.005	±0.025	±0.005 ~ ±0.13
K	±0.013	±0.025	±0.05 ~ ±0.13
L	±0.025	±0.025	±0.05 ~ ±0.13
M	±0.08 ~ ±0.18	±0.13	±0.05 ~ ±0.13
N	±0.08 ~ ±0.18	±0.025	±0.05 ~ ±0.13
U	±0.13 ~ ±0.38	±0.13	±0.08 ~ ±0.25

3 Accuracy

Note: For rhombic and parallelogram inserts, use the smaller nose angle.

[Example]
[Example]

1 T 2 N 3 M 4 G 5 16

1 C 2 C 3 G 4 T 5 09

4 Groove and hole					
Symbol	Hole	Shape of hole	Chip-breaker	Shape	
N	Without	-	Without		
R			Single-sided		
F			Double-sided		
A	With	Cylindrical hole	Without		
M			Single-sided		
G			Double-sided		
W			Partly cylindrical hole, single-side 40° - 60° Counter sink	Without	
T			Single-sided		
Q			Without		
U	Partly cylindrical hole, double-side 40° - 60° Counter sink	Double-sided			
B	With	Partly cylindrical hole, single-side 70° - 90° Counter sink	Without		
H			Single-sided		
C			Without		
J			Double-sided		
X	Special				

5 Cutting edge length and I.C. symbol																
* (R)		(S)		(C)		(W)		(T)		(D)		(V)		(K)		I.C. dia.
Symbol	Length	Symbol	Length	Symbol	Length	Symbol	Length	Symbol	Length	Symbol	Length	Symbol	Length	Symbol	Length	
		03	3.97	03	4.0			06	6.9	04	4.8					3.97
		04	4.76	04	4.8			08	8.2	05	5.8	08	8.3			4.76
05	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
		05	5.56	05	5.6	03	3.8	09	9.6	06	6.8					5.56
06	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
		06	6.35	06	6.5	04	4.3	11	11	07	7.8	11	11.2			6.35
		07	7.94	08	8.1	05	5.4	13	13.8	09	9.7					7.94
08	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8
09	9.525	09	9.525	09	9.7	06	6.5	16	16.5	11	11.6	16	16.6	16	19.7	9.525
10	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
12	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
12	12.7	12	12.7	12	12.9	08	8.7	22	22	15	15.5	22	22.1			12.7
15	15.875	15	15.875	16	16.1	10	10.9	27	27.5	19	19.4					15.875
16	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
19	19.05	19	19.05	19	19.3	13	13	33	33	23	23.3					19.05
20	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20
		22	22.225	22	22.6			38	38.5	27	27.1					22.225
25	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25
25	25.4	25	25.4	25	25.8			44	44	31	31					25.4
31	31.75	31	31.75	32	32.2			55	55	38	38.8					31.75
32	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32

*When M0 is included in Designation, the inscribed-circle diameter is metric size. (mm)

● Detailed accuracy for J,K,L,M,N and U classes

For inserts with nose corner angles larger than 55°

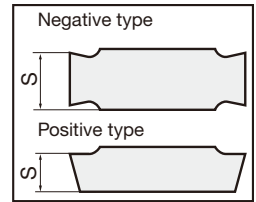
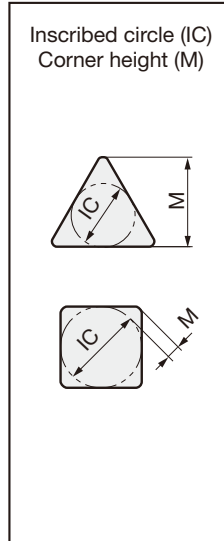
Inscribed circle	Tolerance on inscribed circle dia. (IC)		Tolerance on corner height (M)		Applicable insert shape
	J,K,L,M,N (class)	U (class)	J,K,L,M,N (class)	U (class)	
6.35	±0.05	±0.08	±0.08	±0.13	H W
9.525					
12.7	±0.08	±0.13	±0.13	±0.2	O R
15.875					
19.05	±0.1	±0.18	±0.15	±0.27	P
25.4					
31.75	±0.13	±0.25	±0.18	±0.38	S
32					
	±0.15	±0.25	±0.2	±0.38	T
					C,E,M

For M-type inserts with nose corner angles of 55° (Shape: D), 35° (Shape: V), 25° (Shape: Y)

Inscribed circle	Tolerance on inscribed circle dia. (IC)		Tolerance on corner height (M)	Applicable insert shape
	J,K,L,M,N (class)	U (class)		
6.35	±0.05	±0.08	±0.11	D
9.525				
12.7				
15.875	±0.1	±0.18	±0.15	±0.18
19.05				
6.35	±0.05	±0.08	±0.16	V
9.525				Y

● Insert thickness

For many of the inserts with chipbreaker, the insert height of the cutting edge is lower. In that case, the insert thickness outlined in the drawing of external dimensions is equivalent of "S" in the figure on the right.

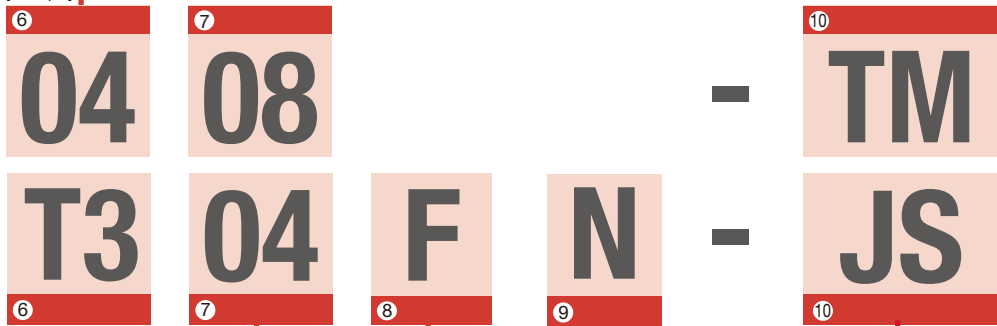


Symbol	Thickness (mm)
X1	1.39
O1	1.59
T1	1.98(1.79)
O2	2.38
T2	2.78
O3	3.18
T3	3.97
O4	4.76
O5	5.56
O6	6.35
O7	7.94
O9	9.52

Thickness

6 Thickness

[Example]



7 Corner radius

Symbol	Corner radius RE (mm)
00	0.03
02	0.2
04	0.4
08	0.8
12	1.2
16	1.6
20	2
24	2.4
28	2.8
32	3.2

8 Major cutting edge

Symbol	Cutting edge	Shape
F	Sharp	
E	Rounded	
W.T	Chamfered	
S	Combination	

9 Hand of insert

Symbol	Hand
R	Right
L	Left
N	Neutral

10 Chipbreaker

Symbol	Applications	Symbol	Applications
01(TF)	Precision finishing (Basic selection)	AFW	Small depth of cut and high feed (Wiper type Inserts)
TS	Finishing (Basic selection)	ASW	Small depth of cut and high feed (Wiper type Inserts)
TSF	Finishing (Basic selection)	CB	Medium cutting
TM	Medium cutting (Basic selection)	CM	Medium cutting of cast irons
THS	Medium to heavy cutting (Basic selection)	All-round	Medium cutting
TRS	Medium to heavy cutting	A	Finishing (Right and left hand)
TUS	Heavy cutting	B	Finishing (Right and left hand)
DM	Medium cutting	C	Finishing (Right and left hand)
HRF	Finishing	D	Finishing (Right and left hand)
HRM	Finishing to medium cutting	P	Finishing of Aluminum alloys
HMM	Finishing to medium cutting	W	Finishing (Angular type)
SF	Finishing of stainless steels	PSF	Finishing (Positive type)
SS	Finishing of stainless and mild steels	PSS	Finishing to light cutting (Positive insert)
SM	Medium cutting of stainless steels	PS	Finishing to medium cutting (Positive type Basic selection)
S	Medium cutting of stainless steels	PM	Medium cutting (Positive type)
SH	Medium to heavy cutting of stainless steels	AL	Finishing to medium cutting of aluminum alloys
SA	For heat-resisting alloys and stainless steels	RS	Medium cutting (For round inserts)
ZF	Finishing and profiling	W□□	Finishing (Angular type)
ZM	Finishing to medium cutting and profiling	H□□	Finishing to medium cutting (Parallel)
NS	Finishing and profiling	11	Finishing
NM	Finishing to medium cutting and profiling	61	Small depth of cut and high feed (For round inserts)
AS	Small depth of cut and high feed	S1	Finishing (For KNMX type)
TA	Medium cutting	J08,J10	For small lathes
TQ	Medium cutting	JS	For small lathes
AM	Small depth of cut and high feed	JRP	For small lathes
FW	Finishing (Wiper type)	JPP	For small lathes
SW	Finishing to medium cutting (Wiper type)	JSP	For small lathes

Designation system for Toolholders

A,C	Clamp-on
D	Double clamp ("One Double")
E	Eccentric pin lock
M	Multi-clamp
P	Pin-lock
S	Screw-on
T	Taper-lock
W	Wedge-on
1 Clamping system	

Symbol	Shape	Offset						
A		Without	G		With	R		Without
B		Without	J		With	V		Without
C		Without	K		With	X*		With
D		Without	L		With	Y		With
E		Without	N		Without	*mark: Tungaloy's symbol		
F		Without	P		Without			
			Q		With			
3 Cutting edge style								

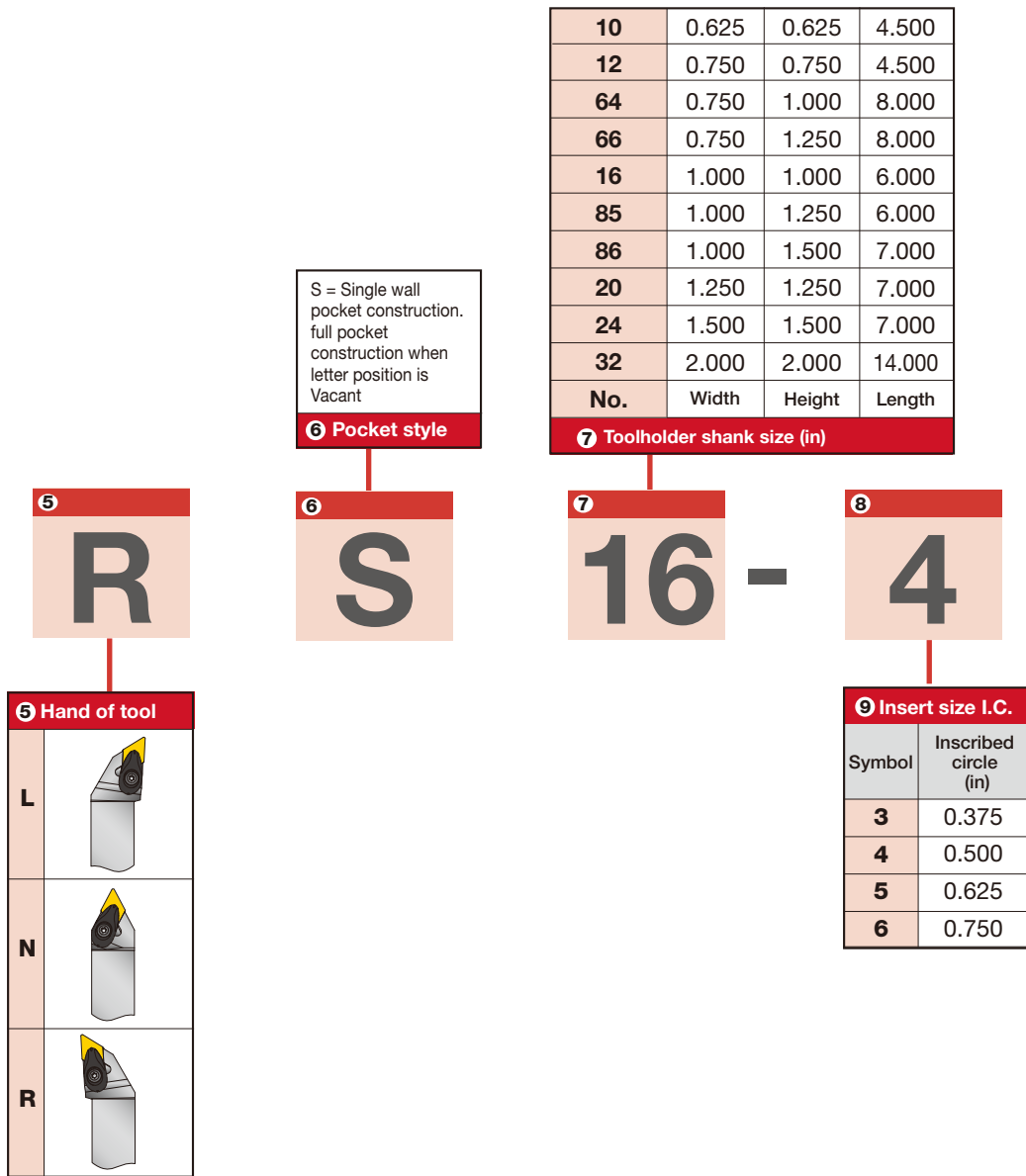
(Example)



2 Insert shape	
C	80° Rhombic
D	55° Rhombic
K	55° Parallelogram
R	Round
S	Square
T	Triangular
V	35° Rhombic
W	Trigon

4 Relief angle of insert	
C	0°
B	5°
C	7°
D	15°
E	20°
P	11°

ANSI Designation



Designation System for External Toolholders

A Double Clamping		JP Side lever clamping	
C Clamp-on		JS Screw-on	
D One-Double		JT Side clamping	
P Lever-lock		M Multi clamping	
		X Double Clamping	
		S Screw-on	
		T Taper-lock	

1 Clamping system

Symbol	Shape	Offset	H		With	P *		Without
A		Without	I		Without	Q *		With
			J		With	S		With
			J2 *		Without	V		Without
B		Without	K		With	U		With
C		Without	L		With	X		With
D		Without	L2 *		Without	Y		With
E		With	N		Without	Z		Without
G		With	N3 *		With	No mark: ISO symbol *mark: Tungaloy's symbol		
			P *		Without			

3 Cutting edge style

(Example)

1
A

W

3
L

N

R

(Example)

P

2
T

G

4
N

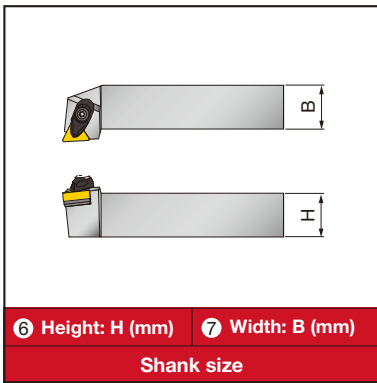
5
R

2 Insert shape	
C	80° Rhombic
D	55° Rhombic
K	55° Parallelogram
R	Round
S	Square
T	Triangular
V	35° Rhombic
W	Trigon

4 Relief angle of insert	
C	
B	
N	
P	

5 Hand of tool	
L	
N	
R	

ISO Designation



6
25
20

7
25
20

F	80	*MiniForceTurn
F	85*	
H	100	
X	120	
K	125	
M	150	
P	170	
Q	180	
R	200	
S	250	
T	300	
U	350	

8 Holder length

8
M
K

9
08
3

RD	Ceramic insert with dimple
C	For ceramic insert
A	Turning A

11 Added symbol

11
A
3

9 Insert size	
Symbol	Inscribed circle (mm)
3	9.525
4	12.7
5	15.875
6	19.05
8	25.4

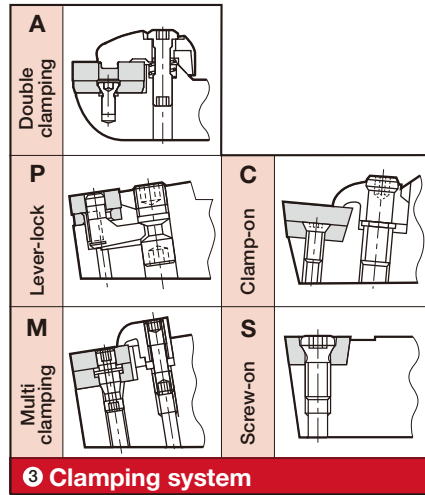
In the ISO metric system, edge length of inserts is expressed by L in 2 digits.

10 Insert thickness	
Symbol	Thickness (mm)
2	3.18
3	4.76

Grade
Insert
Ext. Toolholder
Int. Toolholder
Threading
Grooving
Miniature tool
Milling cutter
Endmill
Drilling tool
Tooling System
User's Guide
Index

A
B
C
D
E
F
G
H
I
J
K
L
M

Designation system for Toolholders



C		80° Rhombic
D		55° Rhombic
K		55° Parallelogram
R		Round
S		Square
T		Triangular
V		35° Rhombic
Y		25° Rhombic (Non ISO)
W		Trigon

4 Insert shape



1 Bar composition

A	Steel shank with oil hole
E	Carbide shank with steel head & oil hole
C	Carbide shank with steel head
S	Steel shank

2 Bar diameter (in)

06	0.375
08	0.500
10	0.625
12	0.750
16	1.000
20	1.250

Metric: The diameter of the bar is shown in mm.

ANSI Designation

Symbol	Style	Offset						
A		Without	G		With	S		With
			J		Without	V		Without
B		Without	K		With	U		With
			L		Without	X*		With
C		Without	L		With	Y		With
D		Without	N		Without	Z		Without
E		Without	P*		Without	Note *mark: Tungaloy standard No mark: ISO standard		
F		With	Q*		With			

6 Relief angle of insert	
N	0°
B	5°
C	7°
D	15°
E	20°
P	11°

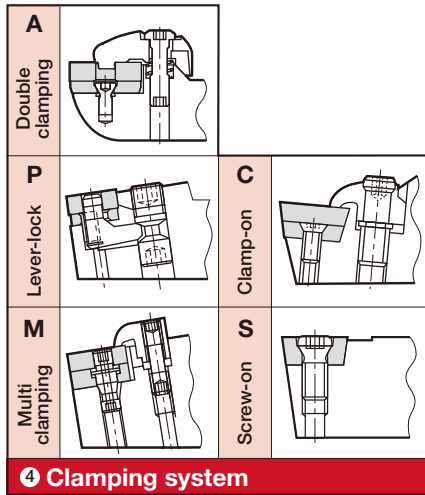
5 L **6** C **7** R **8** 3 - **9** D14

7 Hand of tool	
R	
L	
N	Neutral

8 Insert size I.C.	
Symbol	Inscribed circle (in)
3	0.375
4	0.500
5	0.625
6	0.750

9 Min. bore diameter (in)	
Stream Jet Bar	
D14	14/16 (ø0.875)

Designation System for Internal Toolholders



C		80° Rhombic
D		55° Rhombic
K		55° Parallelogram
R		Round
S		Square
T		Triangular
V		35° Rhombic
Y		25° Rhombic (Non ISO)
W		Trigon

5 Insert shape



1 Bar composition	
A	Steel shank with oil hole
E	Carbide shank with steel head & oil hole
C	Carbide shank with steel head
S	Steel shank
T	Steel shank reinforced with carbide plates ("Tsuppari-Ichiban")
JS	J series Steel shank

2 Bar diameter
Bar diameter is shown in mm.

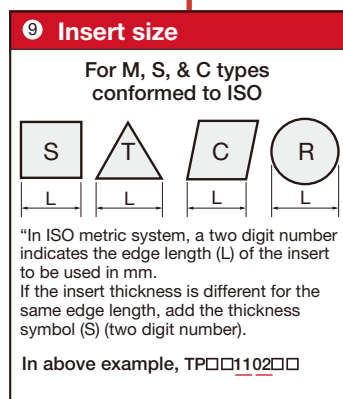
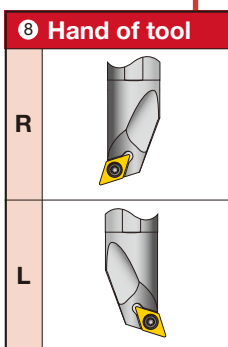
3 Toolholder length (mm)	
F	80
G	90
H	100
J	110
K	125
L	130
M	150
P	170
Q	180
R	200
S	250
T	300
U	350

ISO Designation

Symbol	Style	Offset					
A		Without	G		With	S	
			J			V	
B		Without	K		With	X*	
C		Without	L		With	Y	
D		Without	N		Without	Z	
E		Without	P*		Without	Note *mark: Tungaloy standard No mark: ISO standard	
F		With	Q*		With		

C	
B	
N	
P	
X	Special

6 U **7** P **8** R **9** 1102 **10** C - **11** D140



10 Oil hole

Only "Tsuppari-Ichiban" holder

11 Min. bore diameter (mm)

Stream Jet Bar		Tsuppari-Ichiban	
D140	ø14	D14	ø14

Designation System for CBN / PCD Inserts

CBN Insert

Regular type

T 2 QP - CNGA120404 -L

1 2 3 4 5

2 Number of corners

3 Type

QP	Flat-brazed type inserts
QS	WavyJoint

4 ISO symbol

5 Special feature & chipbreaker

Without, SR	Standard cutting edge	SP	Standard cutting edge (MiniForce-Turn)
F	Sharp edge	-HP	With chipbreaker
-L	Excellent wear resistance	-HS	With chipbreaker
-LF	Lower cutting force, superior sharpness	-HF	With chipbreaker
-LC	Excellent crater wear resistance	-HM	With chipbreaker
-H, HC	Excellent fracture resistance	W	With wiper
-E	Lower cutting force	W□	With wiper
LT	For smooth machining with lower cutting force		

1 "T" means 10 pieces per package.

Regrindable type

TNGA 330.5 - QBN

1 2

1 ANSI symbol

2 CBN inserts

For **TUNGCUT**

S G N 200 - 020 -S

1 2 3 4 5

1 Number of edge

S	Single corner
---	---------------

2 Application

G	Grooving
T	Turning·Grooving

3 For use

N	Non breaker
H	High feed

4 Groove width (mm)

200	2
-----	---

5 Corner radius: RE (mm)

020	0.2
-----	-----

5

Without	Lower cutting force
-S, -SR	Standard cutting edge
-H	Excellent fracture resistance

For XG R/L

XG R 63 15 S - QBN

1 2 3 4 5

1 For grooving tool GX-type

2 Hand of Insert

L	Left
R	Right

3 Groove width (mm)

10	1
15	1.5

4 Corner radius: RE (mm)

S	0.2
---	-----

5 CBN inserts

For **TUNGTHREAD**

1 QP - 16 E R 60 - 014 -SP

1 2 3 4 5 6 7 8

1 Number of corners

2 Type

QP	Flat-brazed type inserts
----	--------------------------

3 Type

16	9.525
----	-------

4 Internal/External

E	External
---	----------

5 Hand of Insert

R	Right
---	-------

6 Thread profile

60	60°
----	-----

7 Corner radius: RE (mm)

014	0.14
-----	------

8 Special feature & chipbreaker

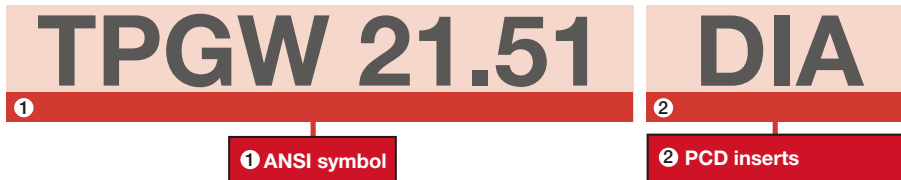
-SP	Standard cutting edge (TungThread)
-----	------------------------------------

PCD Insert

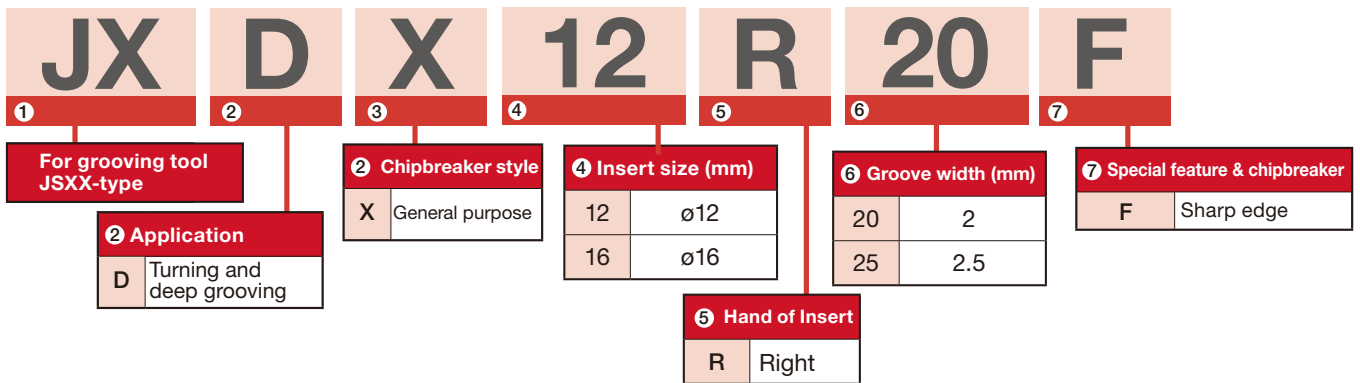
Regular type



Regrindable type



For **DUO J CUT**



CBN Inserts

Edge preparation specifications

CBN inserts with special edge preparation specifications are made to order. Refer to the following description.

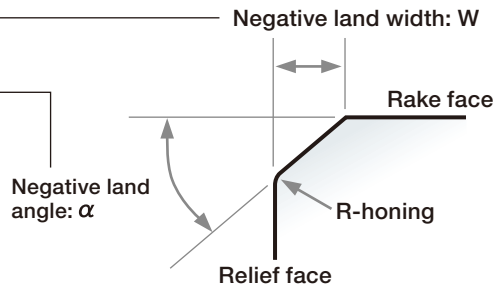
Designation system for edge specifications

Example:
Negative land width: 0.13 mm
Negative land angle: -25°
With R-honing



Shape Negative land width: W Negative land angle: α

- T ... Chamfered
- S ... Chamfered + R-honing
- E ... R-honing alone
- F ... Sharp edge

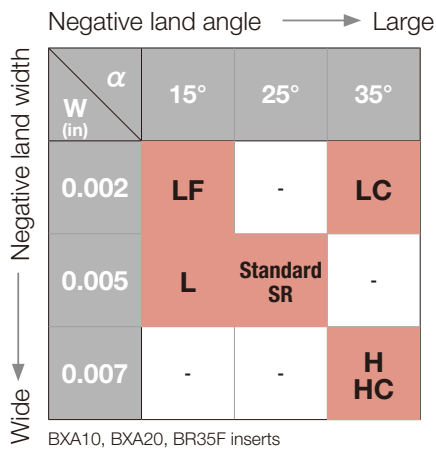


Standard edge specifications

Grade	BXA10	BXA20	BR35F	BXM10	BXM20	BXC50	BX310	BX330	BX360	BX380	BX470	BX480	BX910	BX930
Negative insert	S01325	S01325	S01325	S01325	S01325	S01325	S01325	S01325	S01325	S01325	T01315	S01325	S01315	S01315
Positive insert	S01325	S01325	S01325	S01325	S01325	-	S00515	S00515	S00515	-	T01315	S00515	S01315	S00515

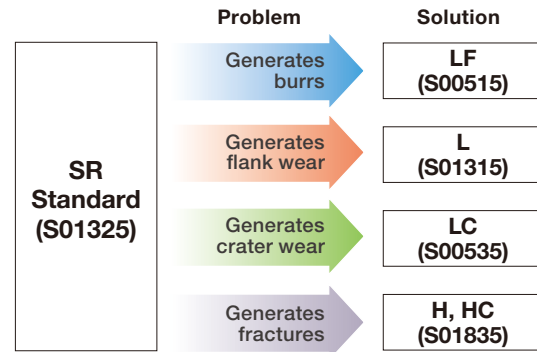
5 edge preparation options covering various hard turning

Edge preparations turning applications



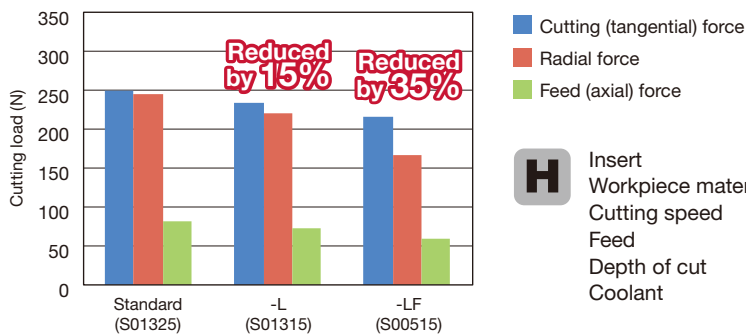
Selections of edge preparations

Allows you to select the most suited types of edge prep for your applications



Cutting loads

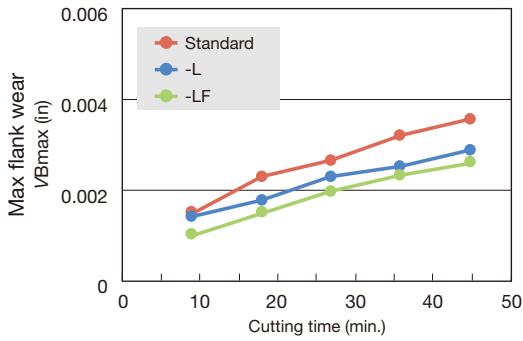
The -L and -LF provide reduced cutting loads over the standard edge prep type



H Insert : ZQP-CNGA432
 Workpiece material : 4140
 Cutting speed : $V_c = 328$ sfm
 Feed : $f = 0.012$ ipr
 Depth of cut : $a_p = 0.008$ "
 Coolant : Dry

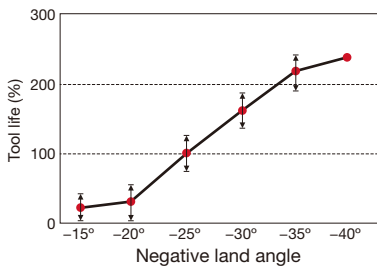
● Flank wear

The -L and -LF provide reduced flank wear over the standard edge prep type



H Insert : ZQP-CNGA432
 Workpiece material : 4140
 Cutting speed : $V_c = 328$ sfm
 Feed : $f = 0.012$ ipr
 Depth of cut : $a_p = 0.008$ "
 Coolant : Wet

■ Relationship between negative land angle and tool life in interrupted turning



Insert : TNGN 331 QBN BX270
 Edge preparation : □□°+ R-honing
 Workpiece material : 4140 (Alloy steel, 60HRC)
 Cutting speed : $V_c = 328$ sfm
 Feed : $a_p = 0.01$ "
 Depth of cut : Dry
 Coolant : Dry

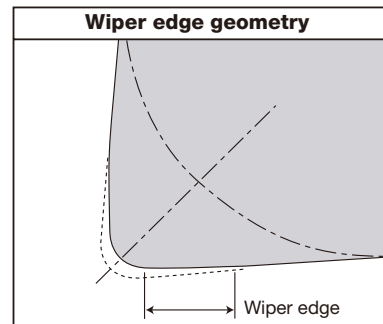
● For interrupted cutting, large negative land angle is favorable to minimize fracture.

■ Wiper insert

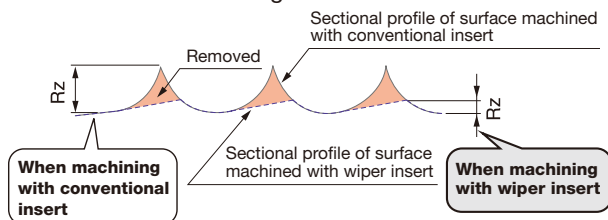
● A finishing edge (wiper edge) is formed at the point of intersection between corner radius and straight cutting edge.

● Effect of wiper edge

- Doubles the productivity → Reduced machining time
 The wiper edge can double the feed rate and moreover does not deteriorate the surface roughness. (Note: Feed rate: $*f < 0.3$ mm/rev)
- Superior surface roughness → By integrating roughing and finishing into one process, productivity can be increased.
 Compared with conventional inserts only with corner radius, surface roughness can be improved with the wiper edge.



■ Profiles of surface roughness



■ Recommended toolholders for wiper inserts

	2QP-CNGA 43* FW	3QP-WNGA 43* FW	2QP-DNGA 43*-WJ	3QP-TNGA 33*-WG
End cutting angle	95°		93°	91°
External toolholder	ACLNR/L**4-A	AWLNR/L**4-A	ADJNR/L**4-A	ATGNR/L**3-A
	DCLNR/L**12	DWLNR/L**08	DDJNR/L**15	DTGNR/L**16
Internal toolholder	A**-ACLNR/L4-D...	A**-AWLNR/L**4-D...	A**-ADUNR/L4-D...	A**-ATFNR/L3-D...

CBN Grades

H CBN series for hardened steel and hard material

Application area

Necessity of CBN grades

The condition necessary to cut the work: **Material is: Hardness of tool \geq Hardness of tool X 3**

- Hardened steel (60HRC) \rightarrow 700 Hv
- CBN (BX360) \rightarrow 3300 Hv
- Cemented carbide \rightarrow 1600 Hv

Relation of CBN grain size, surface roughness, and cutting speed

[Fine-grained CBN]

Fine grained CBN provided with sharp cutting edge.
Good surface roughness

[Rough-grained CBN]

Rough grained CBN. CBN particles are hold firmly.
Allows high speed machining

Features of CBN grades for machining hardened steel and other hard materials

Fewer CBN content \Rightarrow Increasing wear resistance
Much CBN content \Rightarrow Increasing impact resistance

Basic selection of CBN grades in machining of hardened steel and hard material

● Coated CBN grades

- BXA10** For continuous and light interrupted cutting
- BXA20** For general purpose, less than $V_c = 590$ sfm
- BR35F** For Interrupted cutting
- BXM10** For high speeds cutting
- BXM20** For general purpose, more than $V_c = 590$ sfm

● Uncoated CBN grades

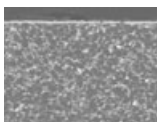
- BX310** For high speeds / Priority on wear resistance in continuous cutting
- BX330** For medium speeds / Priority on surface quality
- BX360** For low to medium speeds / General purpose grade with excellent fracture resistance
- BX380** For low to medium speeds / Priority on fracture resistance in heavy interrupted cutting

Application area of coated CBN grades

● Continuous cutting

● Interrupted cutting

Effects of Coated CBN grades



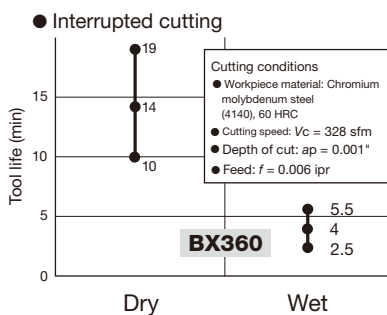
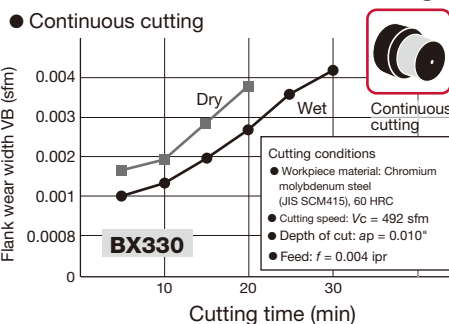
Coated on hard CBN
Hardness:
CBN > Coating layer

- **Protect CBN from oxidation wear**
Since the coating layer intercepts air, oxidation wear of CBN can be prevented.
- **Peeling of coating layer can be prevented**
Hard and deformation resistant CBN is excellent substrate material.



Improved resistance to flank wear

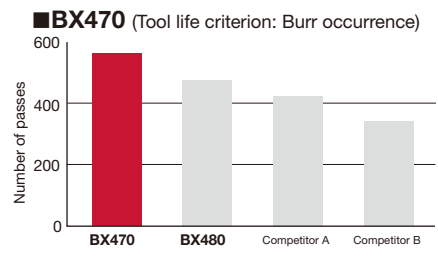
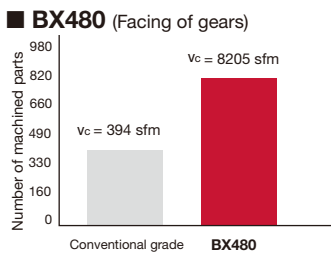
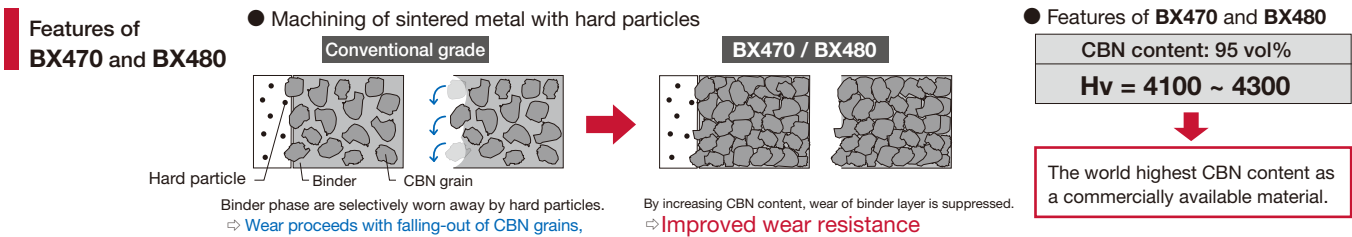
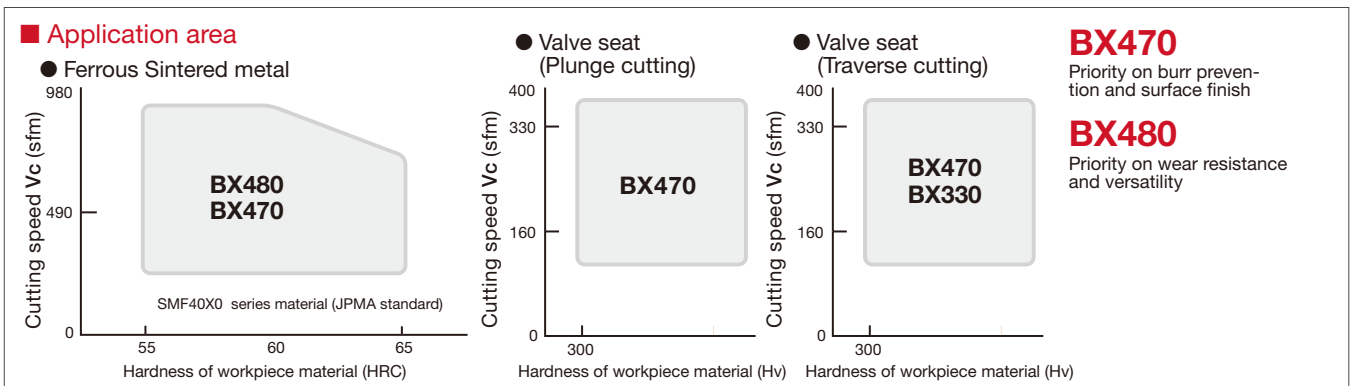
Effects of coolant in machining of hardened steel



- In continuous cutting, wet cutting is superior to dry cutting in tool life for wear.
- In interrupted cutting, dry cutting is superior to wet cutting in tool life for fracture.

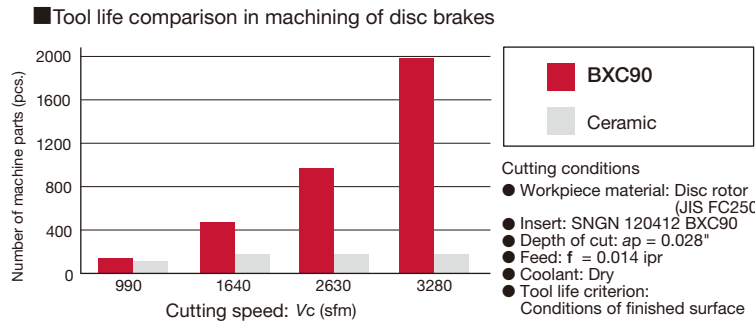
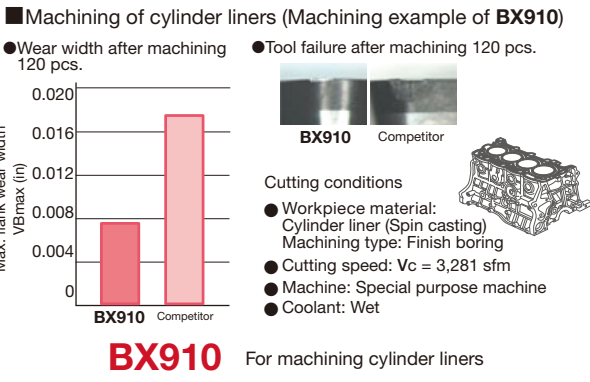
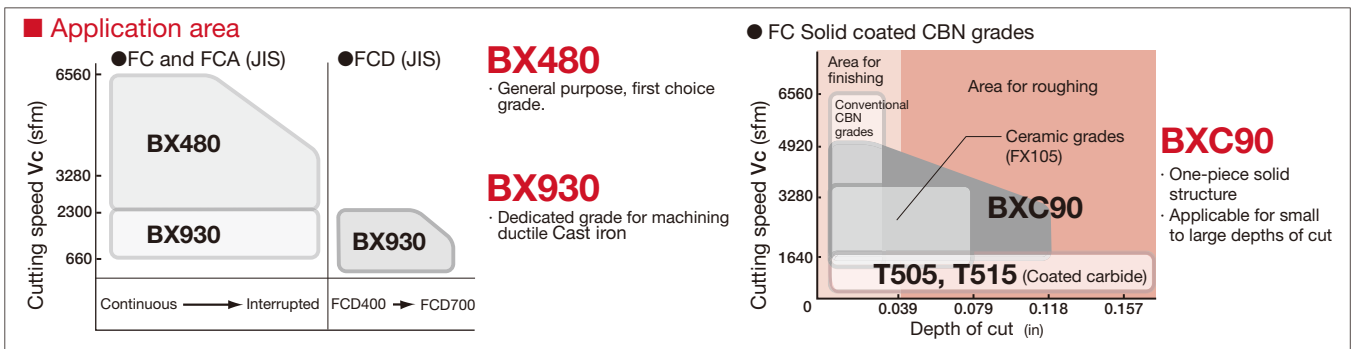


CBN series for sintered metal



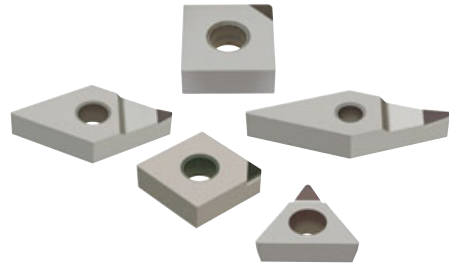
- Cutting conditions**
- Workpiece material: Sintered metal (> HRA60)
 - Insert: DCMW11T308
 - Depth of cut: $ap = 0.008'' \sim 0.020''$
 - Feed: $f = 0.003$ ipr
 - Coolant: Water soluble type
 - Interrupted cutting
- Cutting conditions**
- Workpiece material: Sintered metal (> HRA60), Nitriding, Hard particles included
 - Cutting speed: $Vc = 361$ sfm
 - Depth of cut: $ap = 0.006''$
 - Feed: $f = 0.004$ ipr
 - Coolant: Water soluble type
 - Interrupted cutting
- Cutting conditions**
- Workpiece material: Ferrous Sintered metal
 - Cutting speed: $Vc = 328$ sfm
 - Depth of cut: $ap = 0.006'' \sim 0.012''$
 - Feed: $f = 0.003 \sim 0.010$ ipr
 - Dry and interrupted cutting

CBN series for grey cast iron and ductile cast iron



PCD grade, DIA series

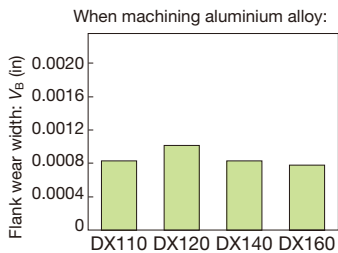
Expanded product line allows DIA tools to be applied to wider workpiece materials and cutting conditions.



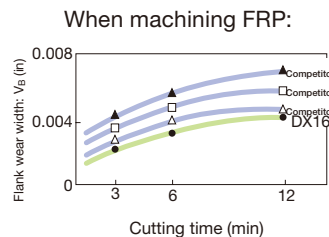
Features and applications (Physical and mechanical properties)

	DX110	DX120	DX140	DX160
Grade				
Property	Super fine grained grade. Excels in surface finish.	Fine grained grade. Excels in surface finish.	General purpose grade	High purity grade for hard materials
Approx. grain size of diamond (µm)	< 1	5	13	28
Hardness (Hv)	8500	→		10000 (Harder)
Wear resistance	→			Higher
Grindability (Cutting edge sharpness)	Better	←		

Cutting performance (Wear resistance)

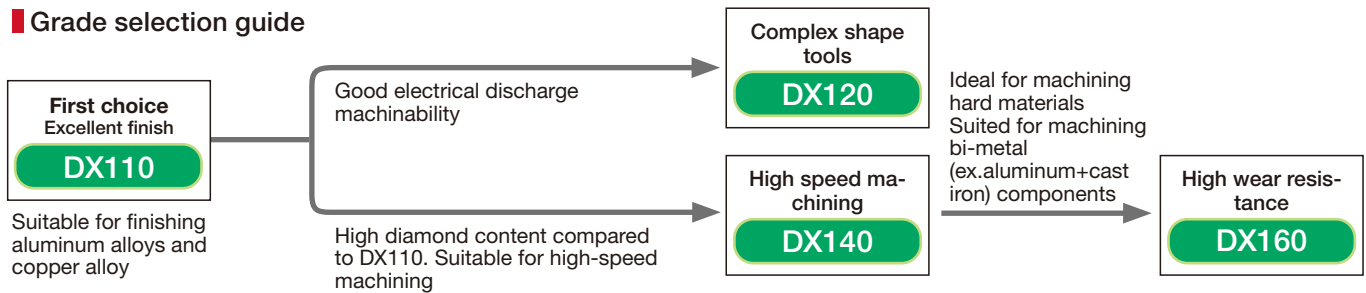


- Continuous external turning**
- Workpiece material: 10 % Si, aluminum alloy
 - Insert: SPGN120308-DIA
 - Toolholder: CSBPR2525M4
 - Cutting speed: $v_c = 1,640$ sfm
 - Feed: $f = 0.004$ ipr
 - Depth of cut: $a_p = 0.020$ "
 - Coolant: Dry cutting
 - Cutting time: 30 min



- Face milling**
- Workpiece material: Fiber reinforced plastics (FRP)
 - Insert: SFCN42ZFN-DIA
 - Milling cutter: THF4408RIA
 - Cutting speed: $v_c = 3,091$ sfm
 - Feed: $f = 0.004$ ipr
 - Depth of cut: $a_p = 0.059$ "
 - Coolant: Dry cutting

Grade selection guide



STANDARD CUTTING CONDITIONS

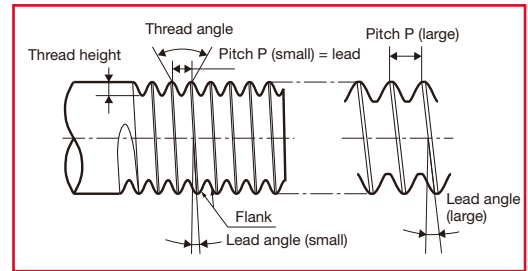
ISO	Workpiece material	Grade				Cutting speed v_c (sfm)	Depth of cut a_p (in)	Feed f (ipr)
		DX110	DX120	DX140	DX160			
N	Aluminum alloys (Si < 12 %)	◎	○	○		4921 (3281 - 8202)	0.020 (0.002 - 0.079)	0.004 (0.002 - 0.008)
	Aluminum alloys (Si ≥ 12 %)	◎	○	○	○	1969 (1312 - 2625)	0.020 (0.002 - 0.079)	0.004 (0.002 - 0.008)
	Copper, brass	◎	○	○		2625 (1640 - 4921)	0.020 (0.002 - 0.079)	0.004 (0.002 - 0.008)
	Phosphor bronze	◎	○	○		1312 (984 - 1640)	0.020 (0.002 - 0.079)	0.004 (0.002 - 0.008)
	Carbon, graphite		○	○	◎	1312 (984 - 1640)	0.020 (0.002 - 0.079)	0.004 (0.002 - 0.008)
	FRP		○	○	◎	2297 (1640 - 3281)	0.008 (0.002 - 0.020)	0.002 (0.001 - 0.004)
	Plastics	◎	○	○		2297 (1640 - 3281)	0.008 (0.002 - 0.020)	0.001 (0.0004 - 0.002)
	Cemented carbides			○	◎	49 (33 - 66)	0.004 (0.002 - 0.008)	0.001 (0.0004 - 0.002)
	Green ceramics			○	◎	427 (328 - 492)	0.020 (0.002 - 0.079)	0.002 (0.001 - 0.004)

(Note) ◎ : First choice ○ : Second choice

Fundamentals of screw threads

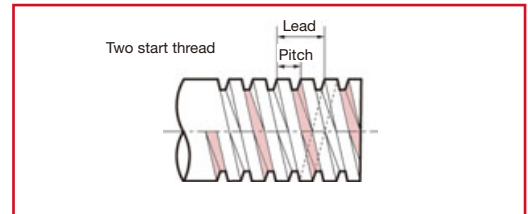
● Relationship between lead, lead angle and pitch

1. Lead is the axial distance a screw advances in one rotation. In single start screw, the lead is equal to the pitch.
2. The inclination angle of a threaded groove is called lead angle. In screws of the same diameter, the lead angle increases as the pitch increases.
3. The side face of a completed thread groove is called flank. The distance between the crest and the root is called thread height.



● Single and multi start thread

1. The single start thread has a single groove. Two start thread or three start thread has two grooves or three grooves respectively.
2. The pitch of multi start thread is the distance of adjoining groove.
3. When viewing the section of the multi start thread, the pitch is same as that of the single start thread. The lead of the two or three start thread is twice or three times the pitch. The multi start thread is mainly used for trapezoidal threads.



● Tolerance class of threads

Tolerance classes of screw threads are expressed as follows:
Metric coarse external thread: 6h, 6g Metric coarse internal thread: 5H, 6H

These classes are ranked with tolerances of thread diameter, pitch, thread angle, etc. For fastening applications, 6H- and

6g-class (former JIS second class) threads, manufactured by cutting or rolling, are generally used. 5H- and 4h-class threads (former JIS first class) are generally finished by grinding.

For example, M8-6g means metric coarse external thread of 6g tolerance class.

TAC threading insert

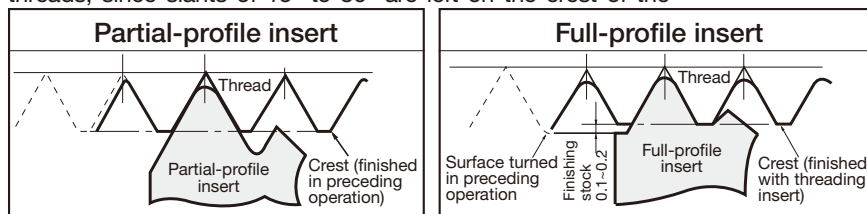
● Difference between full-profile and partial-profile insert

● Full-profile insert

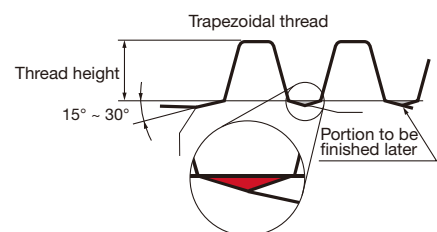
In the full-profile insert, the major diameter of the thread is finished by the profiled finishing edge as shown in Figure below. Therefore, about 0.1 mm of finishing stock must be left on the outer surface of the workpiece before threading. In trapezoidal threads, since slants of 15° to 30° are left on the crest of the

thread as shown in Figure below, these portions must be finished by another tool later.

Full-profile insert could produce no burr and good thread by the profiled finishing edge.



● When machining trapezoidal threads:



● Partial-profile insert

Partial-profile inserts can not be used for finishing of the crest, but can be applied to a wide range of pitches.

For example

Designation	Pitch (mm)	TPI	Insert radius RE (mm)
16ERA60	0.5 ~ 1.5	48 ~ 16	0.06
16ERG60	1.75 ~ 3	14 ~ 8	0.22

Corner radii of inserts are fitted to the thread of the smallest pitch.

● Difference between external and internal use inserts

In full-profile inserts for metric and unified threads, the corner radius and thread height differ from those for the external and internal use insert respectively. Therefore, the right hand insert for external use and the left hand insert for internal use are not the same tool.

Since the rake angles of toolholders are -10° for external toolholders and -15° for internal toolholders, the external / internal toolholders can not be used for machining internal / external thread.

In Whitworth thread, though the external thread and internal thread have the same thread form, the external and internal toolholders are incompatible because of the different rake angle.

For example

Designation	Applicable inserts	Insert radius R RE (in)	Thread height (in)	Rake angle of holders
16ER20ISO	External	0.010	0.060	-10°
16IL20ISO	Internal	0.006	0.051	-15°



Shim replacement method of ST-type tools

Compensated lead angle of tool and tool relief angle

When the pitch is large or the screw diameter is small, the lead angle becomes large and the effective relief angle on the advance flank side β_2 becomes small. In particular, this will cause shorter life of the insert in the case of trapezoidal screw with small flank angle. It is ideal without any interference for the thread cutting insert to have an equal relief angle on both right and left. Replace the shim so that the rake face of insert faces the thread groove direction (that is, $\beta = \beta_3$).

Calculating the thread lead angle

The thread lead angle is calculated as follows:

$$\beta = \tan^{-1}(\ell / \pi d) = \tan^{-1}(nP / \pi d)$$

β : Thread lead angle
 ℓ : Lead
 n : No. of threads
 P : Pitch
 d : Pitch diameter

Calculating the relief angle of tool

The relief angle β_1 is calculated as follows:

$$\beta_1 = \tan^{-1}(\tan \theta \cdot \tan \alpha)$$

The α of a standard toolholder is 10° for external threading and 15° for internal threading.

Included angle 2θ	θ	β_1	
		External threading tool	Internal threading tool
60°	30°	5.8°	8.8°
55°	27.5°	5.2°	7.9°
30°	15°	2.7°	4.1°
29°	14.5°	2.6°	4°

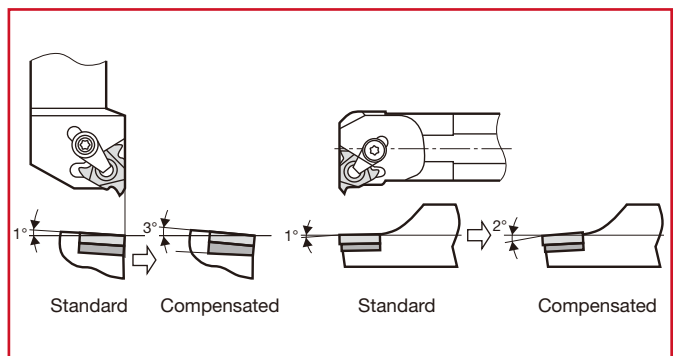
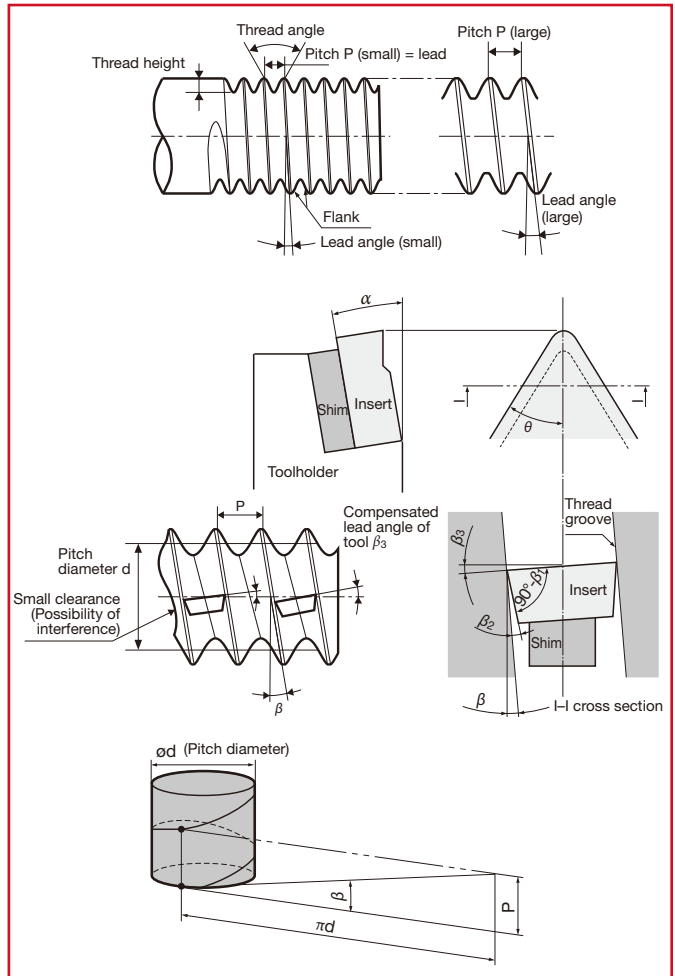
Accordingly, the effective relief angle is calculated as follows:

$$\beta_2 = \beta_1 + \beta_3 - \beta$$

β : Thread lead angle
 β_2 : Effective relief angle of tool
 β_3 : Compensated lead angle of tool

In other words, $\beta_1 = \beta_2$ when the thread lead angle is equal to the compensated lead angle of tool. Namely, the relief angle of the tool itself is equal to the effective relief angle. If the wrong compensated lead angle is used, $\beta_1 > \beta_2$. The effective relief angle becomes smaller and cause the interference between the flank side of insert and the thread groove. Therefore, carry out compensation of the lead angle so that the following range is obtained:

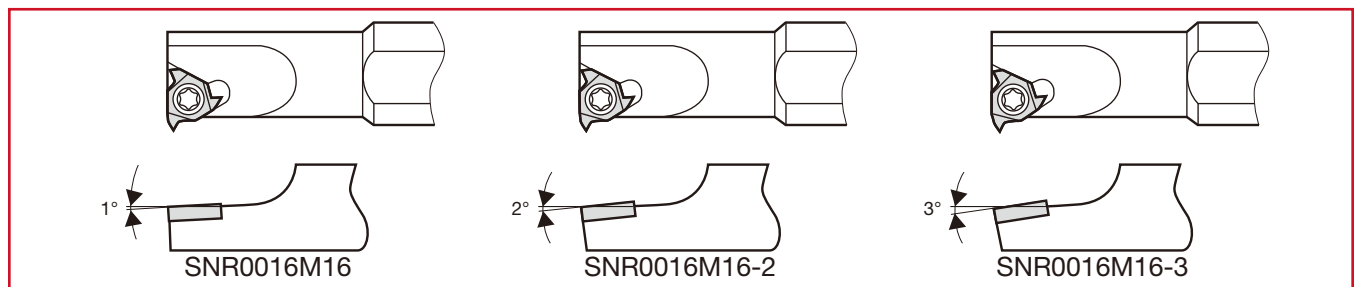
$\pm 1^\circ$ when the thread angle is 60° and 55°
 $\pm 0.5^\circ$ when the thread angle is 30° and 29°



Compensation of lead angle for shim less internal toolholders

When using internal threading toolholders without shim, the above-mentioned method can not be applied for lead angle compensation. Therefore, special toolholders for large lead angles are available as

shown below. The final figure of the designation (-2 or -3) indicates 2° or 3° lead angle to be used respectively. For the toolholders without these figures, please check GAMP of toolholders by catalog.



Type of shim and compensated lead angle of tool

The designation of the shim and compensated lead angles of tool are shown in the table.

Compensated lead angles of tool β_3	-2°	-1°	0°	1°	2°	3°	4°
Shim	□□□-98	□□□-99	□□□-0	□□□-1	□□□-2	□□□-3	□□□-4

Note: The last numeral of the shim designation is the compensated lead angle.v

Toolholders and applicable shims

Shim replacement method of ST-type tools
Screw-on / clamp-on dual toolholders

Toolholder designation	Shim	
	R	L
CER/L □□□□□ 16DT	AE16-□DT	AN16-□DT
CER/L □□□□□ 22DT	GXE22-□DT	GXN22-□DT
TCNR/L □□□□□ 16DT	AN16-□DT	AE16-□DT
TCNR/L □□□□□ 22DT	GXN22-□DT	GXE22-□DT

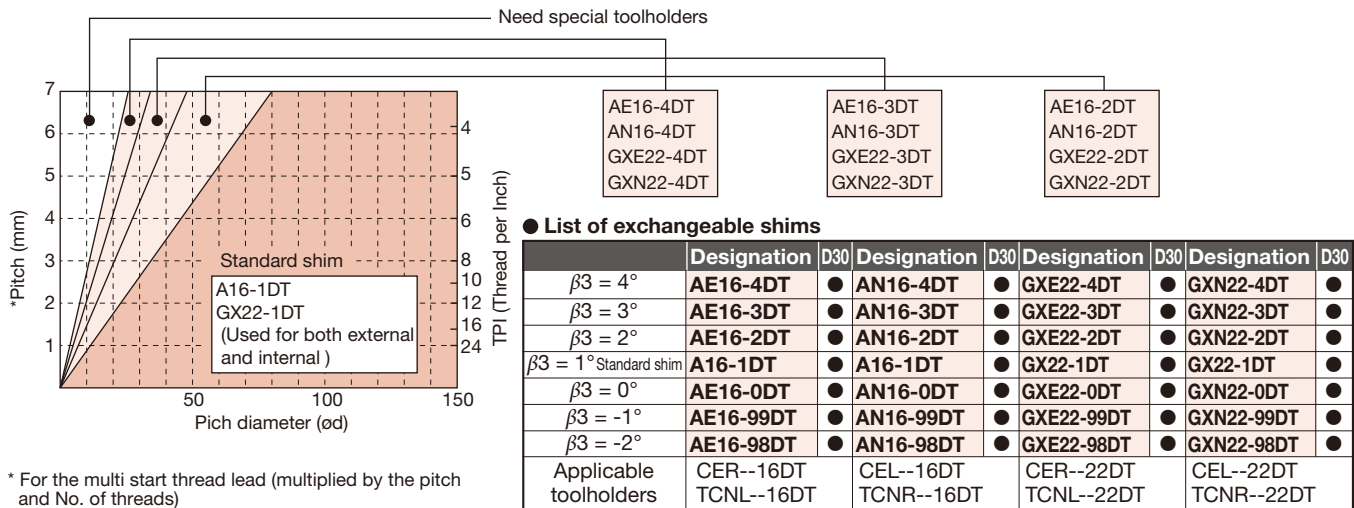
Note: Standard shim is AE16-1DT or GX22-1DT. Other types are optional.

Clamp-on type toolholders

Toolholder designation	Shim	
	R	L
CER/L □□□□□ 16-T	AE16-□	AN16-□
CER/L □□□□□ 22-T	NXE22-□	NXN22-□
CER/L □□□□□ 27-T	NXE27-□	NXN27-□
CNR/L □□□□□ 16	AN16-□	AE16-□
CNR/L □□□□□ 22	NXN22-□	NXE22-□
CNR/L □□□□□ 27	NXN27-□	NXE27-□
B-CER/L □□□□□ 16	AE16-□	AN16-□

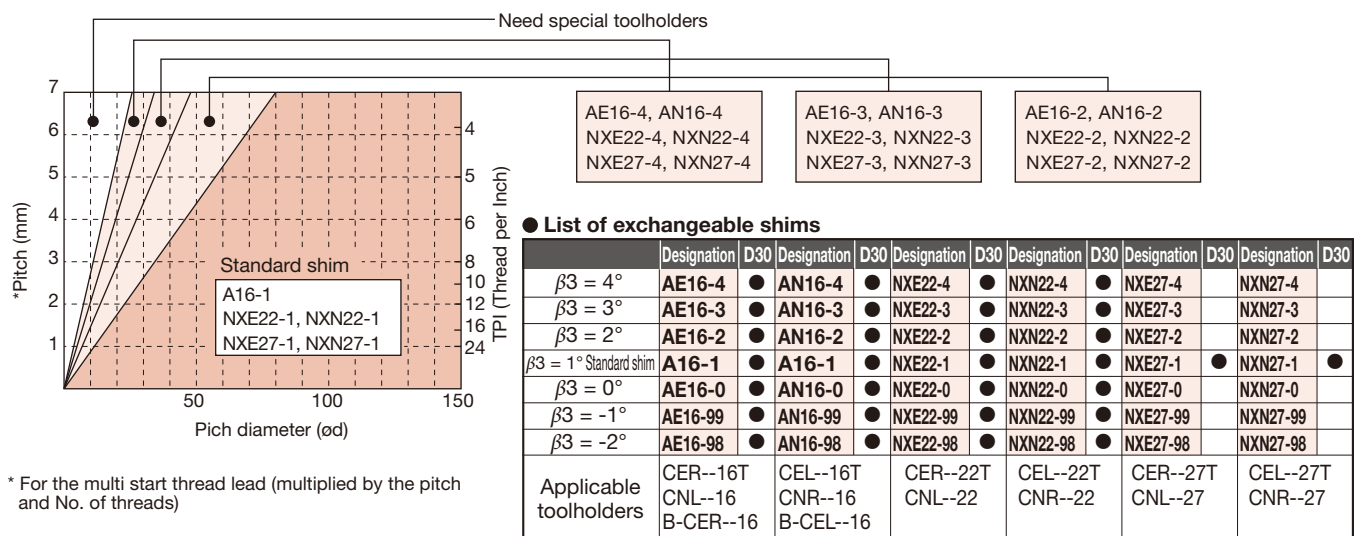
Note: Standard shim is □□□□□-1. Other types are optional.

Shim selection guide for screw-on / clamp-on dual ST-type tools



* For the multi start thread lead (multiplied by the pitch and No. of threads)

Shim selection guide for clamp-on type ST-tools



* For the multi start thread lead (multiplied by the pitch and No. of threads)

● : Line up

Threading Methods and Combinations

External threading			
Right hand thread		Left hand thread	
Work rotation	Regular	Work rotation	Reverse
Feed direction	Push	Feed direction	Push
Hand of toolholder	Right	Hand of toolholder	Left
Hand of insert	Right	Hand of insert	Left
Standard shim	①	Standard shim	②
Work rotation	Regular	Work rotation	Reverse
Feed direction	Pull	Feed direction	Pull
Hand of toolholder	Left	Hand of toolholder	Right
Hand of insert	Left	Hand of insert	Right
Standard shim	④	Standard shim	③
Work rotation	Reverse	Work rotation	Regular
Feed direction	Push	Feed direction	Push
Hand of toolholder	Right	Hand of toolholder	Left
Hand of insert	Right	Hand of insert	Left
Standard shim	①	Standard shim	②
Work rotation	Reverse	Work rotation	Regular
Feed direction	Pull	Feed direction	Pull
Hand of toolholder	Left	Hand of toolholder	Right
Hand of insert	Left	Hand of insert	Right
Standard shim	④	Standard shim	③

Internal threading			
Right hand thread		Left hand thread	
Work rotation	Regular	Work rotation	Reverse
Feed direction	Push	Feed direction	Push
Hand of toolholder	Right	Hand of toolholder	Left
Hand of insert	Right	Hand of insert	Left
Standard shim	②	Standard shim	①
Work rotation	Reverse	Work rotation	Regular
Feed direction	Pull	Feed direction	Pull
Hand of toolholder	Left	Hand of toolholder	Right
Hand of insert	Left	Hand of insert	Right
Standard shim	③	Standard shim	④

Standard shim			
No.	New	No.	New
①	A16-1DT	②	A16-1DT
	A16-1		A16-1
	GX22-1DT		GX22-1DT
	NXE22-1		NXN22-1
③	AE16-99DT	④	AN16-99DT
	AE16-99		AN16-99
	GXE22-99DT		GXN22-99DT
	NXE22-99		NXN22-99
	NXE27-99		NXN27-99

Infeed per Pass and Number of Passes

■ 30° Trapezoidal (TR) inserts

		For external					For internal				
Pitch		2	3	4	5	6	2	3	4	5	6
Height of thread		1.25	1.75	2.25	2.75	3.5	1.25	1.75	2.25	2.75	3.5
Total depth of cut		1.35	1.85	2.35	2.85	3.6	1.35	1.85	2.35	2.85	3.6
Number of passes	1	0.25	0.25	0.3	0.3	0.3	0.2	0.22	0.25	0.25	0.25
	2	0.2	0.22	0.25	0.25	0.25	0.18	0.2	0.22	0.22	0.22
	3	0.2	0.2	0.22	0.2	0.23	0.18	0.18	0.2	0.2	0.21
	4	0.18	0.18	0.2	0.2	0.2	0.16	0.16	0.2	0.18	0.2
	5	0.15	0.17	0.18	0.18	0.18	0.15	0.16	0.17	0.18	0.18
	6	0.12	0.16	0.16	0.16	0.18	0.13	0.16	0.16	0.16	0.18
	7	0.1	0.14	0.15	0.16	0.16	0.1	0.14	0.16	0.16	0.16
	8	0.1	0.14	0.14	0.15	0.16	0.1	0.14	0.14	0.15	0.16
	9	0.05	0.12	0.14	0.14	0.16	0.1	0.12	0.14	0.14	0.16
	10		0.12	0.12	0.14	0.16	0.05	0.12	0.12	0.14	0.16
	11		0.1	0.12	0.14	0.16		0.1	0.12	0.14	0.16
	12		0.05	0.12	0.12	0.15		0.1	0.12	0.12	0.15
	13			0.1	0.12	0.15		0.05	0.1	0.12	0.15
	14			0.1	0.12	0.15			0.1	0.12	0.15
	15			0.05	0.12	0.14			0.1	0.12	0.14
	16				0.1	0.14			0.05	0.1	0.14
	17				0.1	0.12				0.1	0.12
	18				0.1	0.12				0.1	0.12
	19				0.05	0.12				0.1	0.12
	20					0.12				0.05	0.12
	21					0.1					0.1
	22					0.1					0.1
	23					0.05					0.1
	24										0.05
	25										
	26										

(Unit: mm)

■ 29° Trapezoidal (TR) inserts

		For external			For internal		
TPI		8	6	5	8	6	5
Height of thread		1.88	2.41	2.92	1.88	2.41	2.92
Total depth of cut		1.98	2.51	3.02	1.98	2.51	3.02
Number of passes	1	0.25	0.25	0.25	0.22	0.22	0.22
	2	0.22	0.22	0.22	0.2	0.2	0.2
	3	0.2	0.2	0.2	0.18	0.18	0.18
	4	0.18	0.18	0.18	0.16	0.18	0.18
	5	0.16	0.17	0.18	0.16	0.16	0.16
	6	0.16	0.16	0.16	0.16	0.15	0.16
	7	0.16	0.16	0.16	0.15	0.15	0.15
	8	0.14	0.14	0.14	0.14	0.14	0.14
	9	0.14	0.14	0.14	0.14	0.14	0.14
	10	0.12	0.14	0.14	0.12	0.14	0.14
	11	0.1	0.14	0.14	0.1	0.14	0.14
	12	0.1	0.12	0.14	0.1	0.12	0.14
	13	0.05	0.12	0.12	0.1	0.12	0.12
	14		0.12	0.12	0.05	0.12	0.12
	15		0.1	0.12		0.1	0.12
	16		0.1	0.12		0.1	0.12
	17		0.05	0.12		0.1	0.12
	18			0.12		0.05	0.12
	19			0.1			0.1
	20			0.1			0.1
	21			0.05			0.1
	22						0.05
	23						
	24						
	25						
	26						

(Unit: mm)

■ PT full-profile inserts

		For external				For internal		
TPI		28	19	14	11	19	14	11
Height of thread		0.6	0.86	1.16	1.48	0.86	1.16	1.48
Total depth of cut		0.7	0.96	1.26	1.58	0.96	1.26	1.58
Number of passes	1	0.25	0.28	0.3	0.3	0.22	0.25	0.25
	2	0.2	0.2	0.25	0.25	0.2	0.22	0.22
	3	0.1	0.18	0.2	0.22	0.18	0.18	0.18
	4	0.1	0.15	0.15	0.18	0.16	0.14	0.18
	5	0.05	0.1	0.11	0.15	0.1	0.12	0.15
	6		0.05	0.1	0.12	0.05	0.1	0.13
	7			0.1	0.11	0.05	0.1	0.12
	8			0.05	0.1		0.1	0.1
	9				0.1		0.05	0.1
	10				0.05			0.1
	11							0.05
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							
	26							

(Unit: mm)

■ NPT full-profile inserts

		For external				For internal		
TPI		18	14	11.5	8	14	11.5	8
Height of thread		1.14	1.47	1.79	2.58	1.47	1.79	2.58
Total depth of cut		1.24	1.57	1.89	2.68	1.57	1.89	2.68
Number of passes	1	0.2	0.25	0.25	0.3	0.22	0.22	0.25
	2	0.18	0.22	0.22	0.25	0.2	0.2	0.2
	3	0.17	0.2	0.2	0.2	0.18	0.18	0.2
	4	0.16	0.18	0.18	0.2	0.18	0.18	0.2
	5	0.14	0.17	0.18	0.2	0.16	0.16	0.2
	6	0.12	0.16	0.17	0.2	0.14	0.16	0.2
	7	0.12	0.12	0.16	0.18	0.12	0.16	0.18
	8	0.1	0.12	0.14	0.18	0.12	0.14	0.18
	9	0.05	0.1	0.12	0.16	0.1	0.12	0.16
	10		0.05	0.12	0.16	0.1	0.12	0.16
	11			0.1	0.14	0.05	0.1	0.14
	12			0.05	0.14		0.1	0.14
	13				0.12		0.05	0.12
	14				0.1			0.1
	15				0.1			0.1
	16				0.05			0.1
	17							0.05
	18							
	19							
	20							
	21							
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	24							
	25							
	26							

(Unit: mm)

Threading guidelines

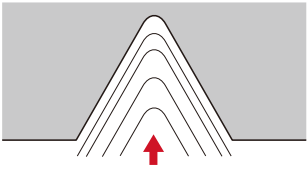
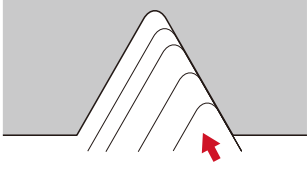
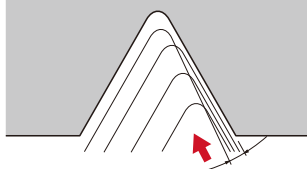
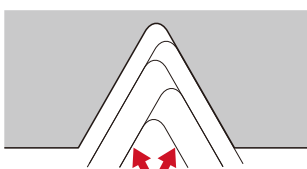
Determine the infeed per pass and number of threads whilst referring to the table and description below.

Pitch (mm)	0.5	0.75	1	1.25	1.5	1.75	2	2.5	3	3.5	4	4.5	5 ~
TPI	48	32	24	20	16	14	12	10	8	7	6	5.5	5 ~
No. of passes	4 ~ 6	4 ~ 7	4 ~ 8	5 ~ 9	6 ~ 10	7 ~ 12	7 ~ 12	8 ~ 14	10 ~ 16	11 ~ 18	11 ~ 18	11 ~ 19	12 ~ 24

Note:

- When using the full-profile insert, set the total infeed amount by taking the finish stock of 0.1mm into account.
- Set the first infeed to 150 ~ 200% of nose R and do not allow it to exceed 0.5 mm.
- The infeed amount during the final pass must be a minimum of 0.05 mm. No zero cuts should be made. (Extra small infeed or zero cutting of work hardened surfaces will reduce tool life.)
- The partial-profile insert or inside diameter insert has small nose R. Reduce the infeed per pass and increase the no. of passes.
- Regarding standard infeed per passes and no. of passes, please refer to page **L039**.

Infeed methods for threading tools

Infeed method	Features
 <p>Straight infeed (radial infeed)</p>	<ul style="list-style-type: none"> • Most simple and usual method • Suitable for relatively small pitch threads of easily machinable material. • Chip contact length on right and left is longer, causing chattering, with increased load on the nose end. • When the half included angle is not symmetrical to the right and left, infeeding in the direction of 1/2 of the included angle will ensure equal machining with right and left cutting edges.
 <p>Single edge infeed (flank infeed)</p>	<ul style="list-style-type: none"> • Suitable for large pitch threads or easy to tear materials. Effectively prevents chattering. • Chips are discharged in one direction only. Satisfactory chip control. • Edge on the right (with zero infeed) tends to be worn heavily.
 <p>Modified single-edge infeed (flank infeed)</p>	<ul style="list-style-type: none"> • Suitable for large pitch threads or easy to tear materials. Effectively prevents chattering. • Chips are discharged in one direction only. Satisfactory chip control. • Edge on the right performs some cutting, therefore wear of this edge can thus be suppressed.
 <p>Alternating flank infeed</p>	<ul style="list-style-type: none"> • Suitable for large pitch threads or easy to tear material. Effectively prevents chattering. • Chips are discharged alternately in right and left directions, resulting possibly in entanglement. • Right and left edges are used alternately, ensuring uniform wear and extending tool life.

Selection of ST-type Toolholders

Selection of internal threading toolholders

Relation between internal toolholders and machinable threads

In the tables starting from next page, the relationships between toolholders, inserts, threads to be machined, and shims to be replaced are shown. In these tables, the criteria are set as follows.

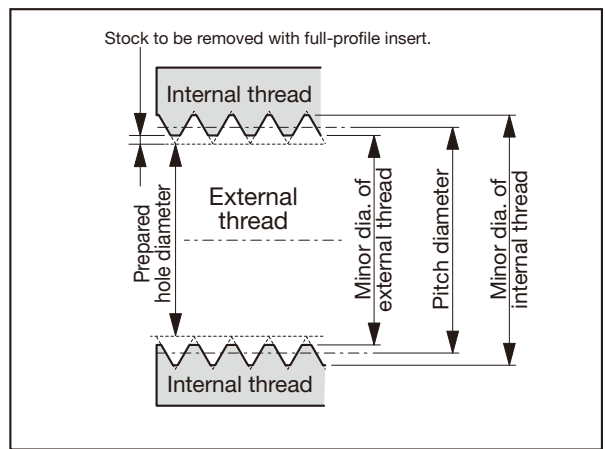
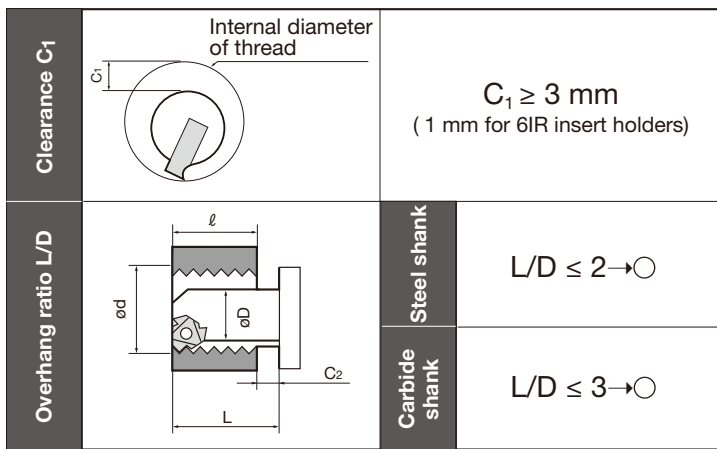
- The minimum machining diameter.
- The L/D ratio of the toolholder.
- The lead angle of the thread.
- Cutting conditions

Especially when machining near the minimum machining diameter, the compensation for the lead angle should be done carefully.

Moreover, in threading, because chips generally can not be broken into small pieces, the shank size should be selected in consideration of adequate clearance (C_1).

Symbols

<input type="checkbox"/>	Recommended
<input type="checkbox"/>	Usable
<input type="checkbox"/>	Needs replacing of the shim. "2" indicates "Change to the shim for 2° lead angle".
<input type="checkbox"/>	Unusable



How to use the tables

- ① Firstly, find the nominal thread diameter. Example: M35 X 1.5
- ② The table indicates that the lead angle is $0^\circ 48'$.
- ③ The Cat. No. of the insert to be used corresponds with IR15ISO.
- ④ By following the row to the right, and marks are found. The mark indicates the optimum toolholder type. The toolholders of mark are usable, but less rigid because the shank diameter against the threading diameter is smaller than those of marked toolholder. In this example, CNR0025R16 and TCNR0020R16DT are the optimum toolholders. The insert Cat.No. is 16IR15ISO.
- ⑤ In the case of M33 X 3 thread, the lead angle is $1^\circ 46'$. By following the row to the right, mark is found. This indicates that the shim should be replaced to 2° type. For calculation of the lead angle, refer to page [L036](#).

Metric fine screw thread (ISO) (For full size of this table, see page [L044](#).)

Nominal size	Pitch	Effective diameter	Lead angle	Shank material		Steel shank								Carbide shank			"Tsuppari-Ichiban"						
				Insert size	Holder Cat. No.	6IR	11IR	16IR	22IR	6IR	11IR	16IR	16IR	22IR									
M33x1.5	1.5	32.03	$0^\circ 51'$	IR15ISO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
M33x2	2	31.7	$1^\circ 09'$	IR20ISO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
M33x3	3	31.05	$1^\circ 46'$	IR30ISO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
M35x1.5	1.5	34.03	$0^\circ 48'$	IR15ISO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
M36x1.5	1.5	35.03	$0^\circ 47'$	IR15ISO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
M36x2	2	34.7	$1^\circ 03'$	IR20ISO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
M36x3	3	34.05	$1^\circ 20'$	IR30ISO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
M38x1.5	1.5	37.03	$0^\circ 51'$	IR15ISO	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Selection of ST-type Toolholders

Unified fine screw thread (UNF)

Nominal size	TPI	Pitch diameter	Lead angle	Shank material	Steel shank									Carbide shank									"Tsuppari-Ichiban"				
				Insert size	6IR			11IR			16IR			6IR			11IR			16IR			16IR				
				Holder Cat. No.	SNR0006H06-2	SNR0006H06-3	SNR0008H06-2	SNR0008H06-3	SNR0010K11-2	SNR0013L11-2	SNR0016M16	SNR0016M16-2	CNR0020P16	CNR0025R16	SNR0006K06SC-2	SNR0006K06SC-3	SNR0008K06SC-2	SNR0008K06SC-3	SNR0010M11SC	SNR0010M11SC-2	SNR0012P11SC	SNR0012P11SC-2	SNR0016R16SC	SNR0016R16SC-2	TSNR0016Q16	TCNR0020R16DT	TCNR0025S16DT
3/8-24UNF	24	8.84	2°11'	(IR24UN)																							
				IRA60																							
7/16-20UNF	20	10.29	2°15'	(IR20UN)																							
				IRA60	○										○												
1/2-20UNF	20	11.87	1°57'	(IR20UN)																							
				IRA60	•		○								•		○										
9/16-18UNF	18	13.37	1°55'	(IR18UN)																							
				IRA60	•		○								•		○										
5/8-18UNF	18	14.96	1°43'	(IR18UN)																							
				IRA60	•		○								•		○										
3/4-16UNF	16	18.02	1°36'	IR16UN						○									○								
7/8-14UNF	14	21.05	1°34'	IR14UN					•	○									•		○						
1-12UNF	12	24.03	1°36'	IR12UN								○										○					
1 1/8-12UNF	12	27.2	1°25'	IR12UN							○											○		○			
1 1/4-12UNF	12	30.38	1°16'	IR12UN							•		○									○		•	○		
1 3/8-12UNF	12	33.55	1°09'	IR12UN							•		•	○								○		•	•	○	
1 1/2-12UNF	12	36.73	1°03'	IR12UN							•		•	○								○		•	•	○	

Unified extra fine screw thread (UNEF)

Nominal size	TPI	Pitch diameter	Lead angle	Shank material	Steel shank									Carbide shank									"Tsuppari-Ichiban"			
				Insert size	6IR			11IR			16IR			6IR			11IR			16IR			16IR			
				Holder Cat. No.	SNR0006H06-2	SNR0008H06-2	SNR0010K11	SNR0010K11-2	SNR0013L11	SNR0013L11-2	SNR0016M16	SNR0016M16-2	CNR0020P16	CNR0025R16	CNR0032S16	SNR0006H06SC-2	SNR0008H06SC-2	SNR0010K11	SNR0010K11-2	SNR0012L11	SNR0012L11-2	SNR0016M16	SNR0016M16-2	TSNR0016Q16	TCNR0020R16DT	TCNR0025S16DT
3/8	32	9.01	1°61'	IR32UN																						
7/16	28	10.52	1°57'	IR28UN	○									○												
1/2	28	12.11	1°37'	IR28UN																						
9/16	24	13.6	1°42'	IR24UN																						
5/8	24	15.19	1°27'	IR24UN																						
11/16	24	16.77	1°15'	IR24UN				○										○								
3/4	20	18.22	1°27'	IR20UN				○										○								
13/16	20	19.81	1°17'	IR20UN				•		○								•		○						
7/8	20	21.4	1°08'	IR20UN				•		○								•		○						
15/16	20	22.99	1°01'	IR20UN				•		•		○						•		○					○	
1	20	24.57	0°94'	IR20UN				•		•		○						•		•		○		○		
1 1/16	18	26.07	0°99'	IR18UN				•		•		○						•		•		○		○		
1 1/8	18	27.66	0°93'	IR18UN				•		•		○						•		•		○		○		
1 3/16	18	29.25	0°88'	IR18UN				•		•		•		○				•		•		○		•	○	
1 1/4	18	30.83	0°84'	IR18UN				•		•		•		○				•		•		○		•	○	
1 5/16	18	32.42	0°79'	IR18UN				•		•		•		○				•		•		○		•	○	
1 3/8	18	34.01	0°76'	IR18UN				•		•		•		•	○			•		•		○		•	•	○
1 7/16	18	35.6	0°72'	IR18UN				•		•		•		•	○			•		•		○		•	•	○
1 1/2	18	37.18	0°69'	IR18UN				•		•		•		•	○			•		•		○		•	•	○
1 9/16	18	38.77	0°66'	IR18UN				•		•		•		•	○			•		•		○		•	•	○
1 5/8	18	40.36	0°64'	IR18UN				•		•		•		•	•	○		•		•		○		•	•	○
1 11/16	18	41.95	0°61'	IR18UN				•		•		•		•	•	○		•		•		○		•	•	○

Note : The above tables show correspondence of internal toolholders at the time of setting clearance between thread and toolholder to 3 mm (1 mm in case of SN type) and the finishing stock to 0.1 mm.

Whitworth British Standard (BSW) (for pipe)

Nominal size	TPI	Pitch diameter	Lead angle	Shank material Insert size Holder Cat. No. Insert Cat. No.	Steel shank										Carbide shank		"Tsuppari-Ichiban"					
					16IR					22IR					16IR		16IR		22IR			
					SNR0016M16	SNR0016M16-2	SNR0016M16-3	CNR0020P16	CNR0025R16	CNR0032S16	SNR0020Q22	SNR0020Q22-2	SNR0020Q22-3	CNR0025R22	CNR0032S22	SNR0016M16	SNR0016M16-2	TSNR0016Q16	TCNR0020R16DT	TCNR0025S16DT	TSNR0020R22	TCNR0025S22DT
7/16	14	9.95	3°32'	IR14W																		
1/2	12	11.34	3°40'	IR12W																		
9/16	12	12.93	2°98'	IR12W																		
5/8	11	14.4	2°92'	IR11W																		
11/16	11	15.98	2°63'	IR11W																		
3/4	10	17.42	2°66'	IR10W																		
7/8	9	20.42	2°52'	IR9W																		
1	8	23.37	2°48'	IR8W																		
1 1/8	7	26.25	2°52'	IR7W																		
1 1/4	7	29.43	2°25'	IR7W								○										
1 1/2	6	35.39	2°18'	IR6W								○										
1 3/4	5	41.2	2°25'	IR5W								•							②			

② : Change the shim to NXN22-2 ←

② : Change the shim to GXN22-2DT ←

Whitworth British Standard Fine (BSF) (for pipe)

Nominal size	TPI	Pitch diameter	Lead angle	Shank material Insert size Holder Cat. No. Insert Cat. No.	Steel shank										Carbide shank		"Tsuppari-Ichiban"										
					6IR		11IR		16IR			22IR			6IR		16IR		16IR		22IR						
					SNR0006H06-2	SNR0008H06-2	SNR0010K11	SNR0010K11-2	SNR0016M16	SNR0016M16-2	SNR0016M16-3	CNR0020P16	CNR0025R16	SNR0020Q22	SNR0020Q22-2	SNR0020Q22-3	CNR0025R22	CNR0032S22	SNR0006H06SC-2	SNR0008H06SC-2	SNR0016M16	SNR0016M16-2	TSNR0016Q16	TCNR0020R16DT	TCNR0025S16DT	TSNR0020R22	TCNR0025S22DT
7/16	18	10.21	2°52'	IR18W																							
1/2	16	11.68	2°48'	IR16W	○											○											
9/16	16	13.27	2°18'	IR16W	•	○										•	○										
5/8	14	14.71	2°25'	IR14W																							
11/16	14	16.3	2°03'	IR14W				○																			
3/4	12	17.69	2°18'	IR12W																							
7/8	11	20.75	2°03'	IR11W																							
1	10	23.77	1°95'	IR10W						○																	
1 1/8	9	26.77	1°92'	IR9W						○									○								
1 1/4	9	29.94	1°72'	IR9W						•		②							○			②					
1 3/8	8	32.89	1°76'	IR8W						•		②							○			②					
1 1/2	8	36.07	1°61'	IR8W						•		•	②						○			•	②				
1 5/8	8	39.24	1°48'	IR8W					•			•	○					○		•		•	○				
1 3/4	7	42.13	1°57'	IR7W									○		②									②			
2	7	48.48	1°37'	IR7W								•				•	○					•	○				
2 1/4	6	54.44	1°42'	IR6W								•				•	○					•	○				
2 1/2	6	60.79	1°27'	IR6W								•				•	○					•	○				
2 3/4	6	67.14	1°15'	IR6W								•				•	○					•	○				
3	5	72.95	1°27'	IR5W								•				•	○					•	○				
3 1/4	5	79.3	1°17'	IR5W								•				•	○					•	○				

② : Change the shim to AN16-2 ←

② : Change the shim to NXN22-2 ←

② : Change the shim to AN16-2DT ←

② : Change the shim to GXN22-2DT ←

Note : The above tables show correspondence of internal toolholders at the time of setting clearance between thread and toolholder to 3 mm (1 mm in case of SN type) and the finishing stock to 0.1 mm.

Selection of ST-type Toolholders

30° trapezoidal thread (TR) (for machine parts)

1/2

Nominal size	Pitch	Pitch diameter	Lead angle	Shank material Insert size Holder Cat. No. Insert Cat. No.	Steel shank												Carbide shank			"Tsuppari-Ichiban"							
					16IR						22IR			27IR			16IR			16IR		22IR					
					SNR0016M16	SNR0016M16-2	SNR0016M16-3	CNR0020P16	CNR0025R16	CNR0032S16	CNR0040T16	CNR0050U16	SNR0020Q22	SNR0020Q22-2	SNR0020Q22-3	CNR0025R22	CNR0032S22	CNR0040T27	(CNR0050U27)	SNR0016R16SC	SNR0016R16SC-2	(SNR0016R16SC-3)	TSNR0016C16	TCNR0020R16DT	TCNR0025S16DT	(TCNR0032T16DT)	TSNR0020R22
TR22×3	3	20.5	2°40'	IR30TR																							
TR24×5	5	21.5	4°14'	IR50TR																							
TR24×3	3	22.5	2°26'	IR30TR																							
TR26×5	5	23.5	3°52'	IR50TR																							
TR26×3	3	24.5	2°14'	IR30TR		○																					
TR28×5	5	25.5	3°34'	IR50TR																							
TR28×3	3	26.5	2°04'	IR30TR		•											○										
TR30×6	6	27	4°03'	IR60TR																							
TR30×3	3	28.5	1°55'	IR30TR		•											○										
TR32×6	6	29	3°46'	IR60TR																							
TR32×3	3	30.5	1°48'	IR30TR		•		②									•					②					
TR34×6	6	31	3°32'	IR60TR																							
TR34×3	3	32.5	1°41'	IR30TR		•		②									•					②					
TR36×6	6	33	3°19'	IR60TR																							
TR36×3	3	34.5	1°35'	IR30TR		•		2	②								•					②	②				
TR38×3	3	36.5	1°30'	IR30TR		•		2	②								•					②	②				
TR40×3	3	38.5	1°25'	IR30TR	•			•	○								○					•	○				
TR42×3	3	40.5	1°21'	IR30TR	•			•	○								○					•	○				
TR44×3	3	42.5	1°17'	IR30TR	•			•	•	○							○					•	•	○			
TR46×3	3	44.5	1°14'	IR30TR	•			•	•	○							○					•	•	○			
TR48×3	3	46.5	1°11'	IR30TR	•			•	•	○							○					•	•	○			
TR50×3	3	48.5	1°08'	IR30TR	•			•	•	○							○					•	•	○			
TR52×3	3	50.5	1°05'	IR30TR	•			•	•	•	○						○					•	•	○			
TR55×3	3	53.5	1°01'	IR30TR	•			•	•	•	○						○					•	•	○			
TR60×3	3	58.5	0°56'	IR30TR	•			•	•	•	○						○					•	•	○			

② : Change the shim to AN16-2 ←

② : Change the shim to AN16-2DT ←

30° trapezoidal thread (TR) (for machine parts)

2/2

Nominal size	Pitch	Pitch diameter	Lead angle	Shank material Insert size Holder Cat. No. Insert Cat. No.	Steel shank												Carbide shank			"Tsuppari-Ichiban"								
					16IR						22IR			27IR			16IR			16IR		22IR						
					SNR0016M16	SNR0016M16-2	SNR0016M16-3	CNR0020P16	CNR0025R16	CNR0032S16	SNR0020Q22	SNR0020Q22-2	SNR0020Q22-3	CNR0025R22	CNR0032S22	(CNR0040T22)	(CNR0050U22)	(CNR0063V22)	CNR0040T27	(CNR0050U27)	(CNR0063V27)	SNR0016R16SC	SNR0016R16SC-2	(SNR0016R16SC-3)	TSNR0016C16	TCNR0020R16DT	TCNR0025S16DT	(TCNR0032T16DT)
TR65×4	4	63	1°09'	IR40TR																								
TR70×4	4	68	1°04'	IR40TR																								
TR75×4	4	73	1°00'	IR40TR																								
TR80×4	4	78	0°56'	IR40TR																								
TR85×4	4	83	0°53'	IR40TR																								
TR90×4	4	88	0°50'	IR40TR																								
TR95×4	4	93	0°47'	IR40TR																								
TR100×4	4	98	0°45'	IR40TR																								
TR105×4	4	103	0°42'	IR40TR																								
TR110×4	4	108	0°41'	IR40TR																								
TR115×6	6	112	0°59'	IR60TR																								
TR120×6	6	117	0°56'	IR60TR																								
TR125×6	6	122	0°54'	IR60TR																								
TR130×6	6	127	0°52'	IR60TR																								
TR135×6	6	132	0°50'	IR60TR																								
TR140×6	6	137	0°48'	IR60TR																								
TR145×6	6	142	0°46'	IR60TR																								
TR150×6	6	147	0°45'	IR60TR																								
TR155×6	6	152	0°43'	IR60TR																								
TR160×6	6	157	0°42'	IR60TR																								
TR165×6	6	162	0°41'	IR60TR																								
TR170×6	6	167	0°39'	IR60TR																								

Note : The above tables show correspondence of internal toolholders at the time of setting clearance between thread and toolholder to 3 mm (1 mm in case of SN type) and the finishing stock to 0.1 mm.

Selection of ST-type Toolholders

■ National taper pipe thread (NPT) (for pipe)

Nominal size	TPI	Pitch	Lead angle	Shank material		Steel shank										Carbide shank						"Tsuppari-Ichiban"															
				Insert size	6IR					16IR					6IR			16IR			16IR																
					Holder Cat. No.	SNR0006H06-2	SNR0006H06-3	SNR0008H06-2	SNR0008H06-3	SNR0016M16	SNR0016M16-2	SNR0016M16-3	CNR0020P16	CNR0025R16	CNR0032S16	(CNR0040T16)	(CNR0050U16)	SNR0006K06SC-2	SNR0006K06SC-3	SNR0008K06SC-2	SNR0008K06SC-3	SNR0016R16SC	SNR0016R16SC-2	(SNR0016R16SC-3)	TSNR0016Q16	TCNR0020R16DT	TCNR0025S16DT	(TCNR0032T16DT)									
3/8NPT	18	1.41	1°37'	IR18NPT	•			○									•		○																		
1/2NPT	14	1.81	1°40'	IR14NPT																																	
3/4NPT	14	1.81	1°19'	IR14NPT							○														○												
1NPT	11.5	2.21	1°17'	IR115NPT								○													○												
1 1/4NPT	11.5	2.21	1°00'	IR115NPT								○			•	•		○							○							•	•	•	○		
1 1/2NPT	11.5	2.21	0°52'	IR115NPT								○			•	•		○							○							•	•	•	○		
2NPT	11.5	2.21	0°41'	IR115NPT								○			•	•	•	•	○						○								•	•	•	○	
2 1/2NPT	8	3.175	0°50'	IR8NPT								○			•	•	•	•	○						○								•	•	•	○	
3NPT	8	3.175	0°40'	IR8NPT								○			•	•	•	•	○						○								•	•	•	○	
3 1/2NPT	8	3.175	0°35'	IR8NPT								○			•	•	•	•	○						○									•	•	•	○
4NPT	8	3.175	0°31'	IR8NPT								○			•	•	•	•	○						○									•	•	•	○
5NPT	8	3.175	0°25'	IR8NPT											○	○	○	○	○													○	○	○	○		
6NPT	8	3.175	0°21'	IR8NPT													○	○	○													○	○	○	○		
8NPT	8	3.175	0°16'	IR8NPT														○	○													○	○	○	○		
10NPT	8	3.175	0°13'	IR8NPT															○	○												○	○	○	○		
12NPT	8	3.175	0°11'	IR8NPT																○	○											○	○	○	○		
14NPT	8	3.175	0°10'	IR8NPT																	○	○										○	○	○	○		
16NPT	8	3.175	0°09'	IR8NPT																		○	○									○	○	○	○		
18NPT	8	3.175	0°08'	IR8NPT																			○	○								○	○	○	○		
20NPT	8	3.175	0°07'	IR8NPT																					○	○						○	○	○	○		
24NPT	8	3.175	0°06'	IR8NPT																						○	○					○	○	○	○		

○ : Change the shim to AN16-0 ←

○ : Change the shim to AN16-ODT ←

■ 29° trapezoidal thread (ACME) (for machine parts, pipe)

Nominal size	TPI	Pitch	Pitch diameter	Lead angle	Shank material		Steel shank										Carbide shank			"Tsuppari-Ichiban"																	
					Insert size	16IR					22IR					27IR		16IR			16IR			22IR													
						Holder Cat. No.	SNR0016M16	SNR0016M16-2	SNR0016M16-3	CNR0020P16	CNR0025R16	CNR0032S16	SNR0020Q22	SNR0020Q22-2	SNR0020Q22-3	CNR0025R22	CNR0032S22	CNR0040T27	(CNR0050U27)	SNR0016R16SC	SNR0016R16SC-2	SNR0016R16SC-3	TSNR0016Q16	TCNR0020R16DT	TCNR0025S22DT	(TCNR0032T22DT)											
3/8	12	2.12	8.465	4°33'	IR12ACME																																
7/16	12	2.12	10.053	3°50'	IR12ACME																																
1/2	10	2.54	11.43	4°03'	IR10ACME																																
5/8	8	3.18	14.274	4°03'	IR8ACME																																
3/4	6	4.23	16.934	4°33'	IR6ACME																																
7/8	6	4.23	20.109	3°50'	IR6ACME																																
1	5	5.08	22.86	4°03'	IR5ACME																																
1-1/8	5	5.08	26.035	3°33'	IR5ACME																																
1-1/4	5	5.08	29.21	3°10'	IR5ACME																																
1-3/8	4	6.35	31.75	3°39'	IR4ACME																																
1-1/2	4	6.35	34.925	3°19'	IR4ACME																																
1-3/4	4	6.35	41.275	2°48'	IR4ACME																																
2	4	6.35	47.625	2°26'	IR4ACME																																

Because this thread standard is characterized with large pitch and small diameter, (that is a large lead angle) the standard inserts and toolholders can not be used for machining this thread type. The application is limited to outside of the standard.

Note : The above tables show correspondence of internal toolholders at the time of setting clearance between thread and toolholder to 3 mm (1 mm in case of SN type) and the finishing stock to 0.1 mm.

Threading Inserts



Edge Orientation and Description of Threading Inserts

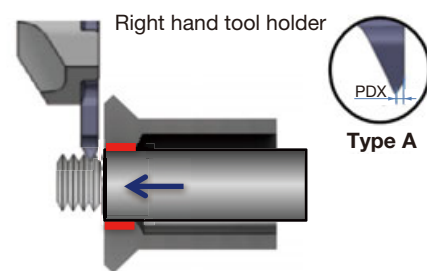
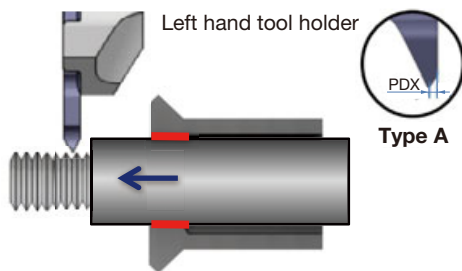
	Edge Orientation		
	Type A	Type B	Type N
Right hand			
Left hand			

JXTG 12 F R - 60 A - 005

Insert shape: JXTG 12
 Insert size: F
 Hand: R
 Thread angle: 60
 Edge orientation: A
 Corner radius: 005

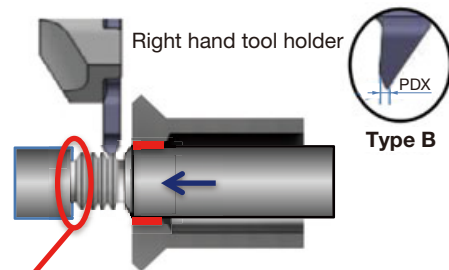
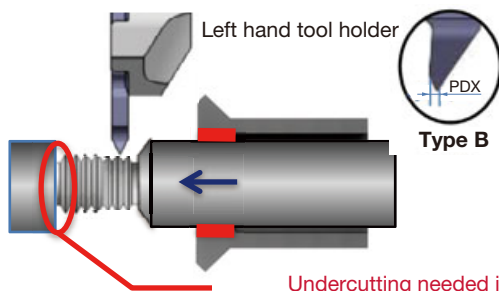
F: sharp edge

When to Use Type A Threading Insert or Type B



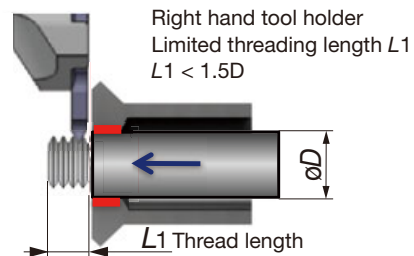
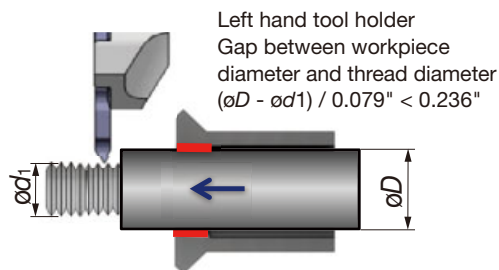
Threading close to the wall

Threading operation following back-turning

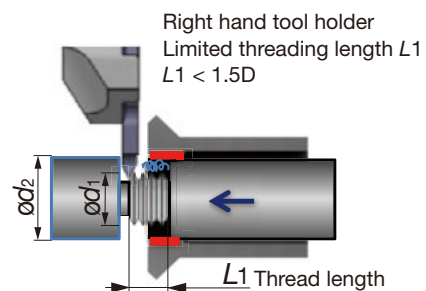
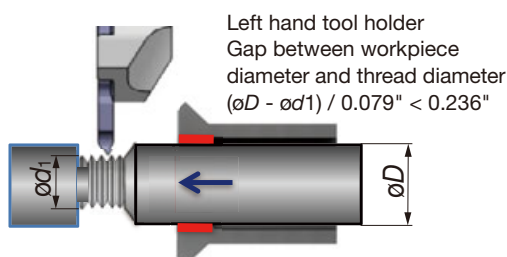


Undercutting needed in previous process

Threading Workpiece in Main Spindle



Threading operation following back-turning



Designation system for Threading Inserts

Designation system for TT-type insert

Insert

TT	R	42	M	-005
①	①	②	③	④
	① Hand	② Insert size (mm)	③ Thread type	④ Corner radius (mm)
	R Right L Left	Inscribed circle 12.7 Thickness 3.2	M 60° thread angle W 55° thread angle	Blank 0 -005 0.05

Toolholder

TT-	20	20	R	E
①	①	②	③	④
	① Shank height (mm)	② Shank width (mm)	③ Hand	④ External or Internal
			R Right L Left	E External I Internal

Designation system for ST-type insert

16	I	R	175	ISO	- B																																																																															
①	②	③	④	⑤	⑥																																																																															
① Insert size	② External or Internal	③ Hand of cut	④ Thread type	⑤ Thread type	⑥ Chipbreaker																																																																															
<table border="1"> <thead> <tr> <th>Symbol</th> <th>I. C. dia (mm)</th> </tr> </thead> <tbody> <tr><td>6</td><td>-</td></tr> <tr><td>11</td><td>6.35</td></tr> <tr><td>16</td><td>9.525</td></tr> <tr><td>22</td><td>12.7</td></tr> <tr><td>27</td><td>15.875</td></tr> </tbody> </table>	Symbol	I. C. dia (mm)	6	-	11	6.35	16	9.525	22	12.7	27	15.875	<table border="1"> <tbody> <tr><td>E</td><td>External</td></tr> <tr><td>I</td><td>Internal</td></tr> </tbody> </table>	E	External	I	Internal	<table border="1"> <tbody> <tr><td>R</td><td>Right hand</td></tr> <tr><td>L</td><td>Left hand</td></tr> </tbody> </table>	R	Right hand	L	Left hand	<table border="1"> <thead> <tr> <th colspan="2">Partial-profile inserts</th> </tr> </thead> <tbody> <tr><td>A</td><td>Pitch: 0.5 ~ 1.5 mm TPI: 48 ~ 16</td></tr> <tr><td>AG</td><td>Pitch: 0.5 ~ 3 mm TPI: 48 ~ 8</td></tr> <tr><td>G</td><td>Pitch: 1.75 ~ 3 mm TPI: 14 ~ 8</td></tr> <tr><td>N</td><td>Pitch: 3.5 ~ 5 mm TPI: 7 ~ 5</td></tr> <tr><td>Z</td><td>Pitch: 4 ~ 6 mm TPI: 6 ~ 4</td></tr> <tr> <th colspan="2">Full-profile inserts</th> </tr> <tr><td colspan="2">pitch (mm)×10 or 100 TPI (Thread Per Inch) (Examples) 05: 0.5 mm pitch×10 175: 1.75 mm pitch×100 14: 14 TPI</td></tr> </tbody> </table>	Partial-profile inserts		A	Pitch: 0.5 ~ 1.5 mm TPI: 48 ~ 16	AG	Pitch: 0.5 ~ 3 mm TPI: 48 ~ 8	G	Pitch: 1.75 ~ 3 mm TPI: 14 ~ 8	N	Pitch: 3.5 ~ 5 mm TPI: 7 ~ 5	Z	Pitch: 4 ~ 6 mm TPI: 6 ~ 4	Full-profile inserts		pitch (mm)×10 or 100 TPI (Thread Per Inch) (Examples) 05: 0.5 mm pitch×10 175: 1.75 mm pitch×100 14: 14 TPI		<table border="1"> <thead> <tr> <th colspan="2">Partial-profile inserts</th> </tr> </thead> <tbody> <tr><td>60°</td><td>60° thread angle</td></tr> <tr><td>55°</td><td>55° thread angle</td></tr> <tr><td>TR</td><td>30° trapezoidal</td></tr> <tr><td>ACME</td><td>29° trapezoidal</td></tr> <tr> <th colspan="2">Full-profile inserts</th> </tr> <tr><td>ISO</td><td>Metric</td></tr> <tr><td>UN</td><td>Unified</td></tr> <tr><td>W</td><td>Whitworth</td></tr> <tr><td>PT</td><td>Taper pipe</td></tr> <tr><td>NPT</td><td>National taper pipe</td></tr> <tr><td>NPTF</td><td>National taper pipe</td></tr> <tr><td>RAPI</td><td rowspan="2">API round</td></tr> <tr><td>RD</td></tr> <tr><td>BAPI</td><td>API buttress</td></tr> <tr><td>RD</td><td>Round (DIN405)</td></tr> <tr><td>UNJ</td><td>UNJ</td></tr> <tr><td>MJ</td><td></td></tr> </tbody> </table>	Partial-profile inserts		60°	60° thread angle	55°	55° thread angle	TR	30° trapezoidal	ACME	29° trapezoidal	Full-profile inserts		ISO	Metric	UN	Unified	W	Whitworth	PT	Taper pipe	NPT	National taper pipe	NPTF	National taper pipe	RAPI	API round	RD	BAPI	API buttress	RD	Round (DIN405)	UNJ	UNJ	MJ		<table border="1"> <tbody> <tr><td>B</td><td>With (Basic selection)</td></tr> <tr><td>M</td><td>With</td></tr> <tr><td>CB</td><td>With</td></tr> <tr><td>-</td><td>Without</td></tr> </tbody> </table>	B	With (Basic selection)	M	With	CB	With	-	Without
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Thread Milling CNC Program for Internal Thread

THREADMILLING

Right-hand thread (climb milling) from bottom up. Program is based on tool center.

This method of programming needs no tool radius compensation value, other than an offset for wear.

$$A = \frac{D_o - D}{2}$$

A = Radius of tool path
 D_o = Major thread diameter
 D = Cutting diameter

General Program

```

G90 G00 G54 G43 H1X0 Y0 Z10 S (n : Number of revolutions)
G00 Z-(to thread depth)
G01 G91 G41 D1 X (A/2) Y-(A/2) Z0 F (Center of tool)
G03 X(A/2) Y(A/2) R (A/2) Z(1/8 pitch) F (Cutting edge)
G03 X0 Y0 I -(A) J0 Z (pitch)
G03 X-(A/2) Y(A/2) R (A/2) Z(1/8 pitch)
G01 G40 X -(A/2) Y-(A/2) Z0
G90 X0 Y0 Z0
    
```

Internal Thread

Example: M20x2.0 IN-RH (Thread depth 20 mm)

Tool : MTEC1010C27 2.0ISO

(Cutting dia. 10 mm)

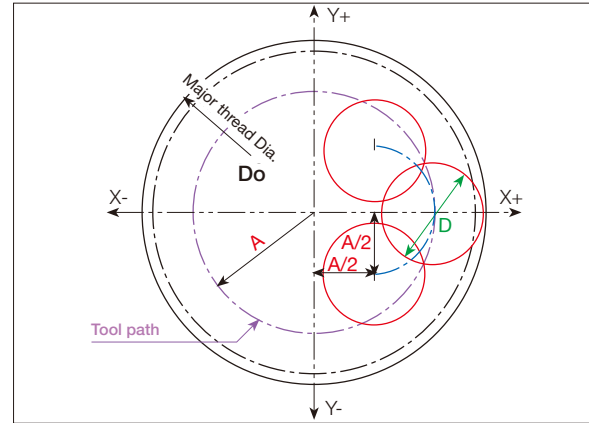
$A = (D_o - D) / 2 = (20 - 10) / 2 = 5$

$A/2 = 2.5$

(Tool compensation of radius=0)

```

G90 G0 G54 G43 G17 H1X0 Y0 Z10 S4000
G0 Z-20
G01 G91 G41 D1X 2.5 Y-2.5 Z0 F840
G03 X2.5 Y2.5 R2.5 Z0.25 F420
G03 X0 Y0 I-5.0 J0 Z2.0
G03 X-2.5 Y2.5 R2.5 Z0.25
G01 G40 X-2.5 Y-2.5 Z0
G90 G0 X0 Y0 Z0
M30
%
    
```

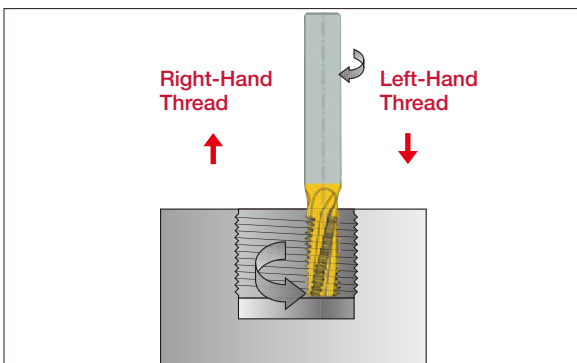


$$F \text{ (Center of tool)} = n \times f \times z$$

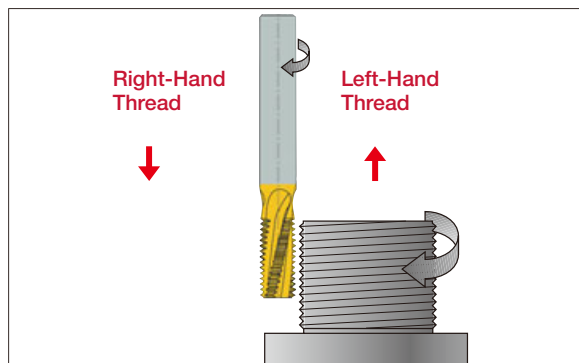
$$F \text{ (Cutting edge)} = \frac{D_o - D}{D_o} \times n \times f \times z$$

n : Number of revolutions
 f : rev / tooth
 z : Number of edge

Internal Thread



External Thread

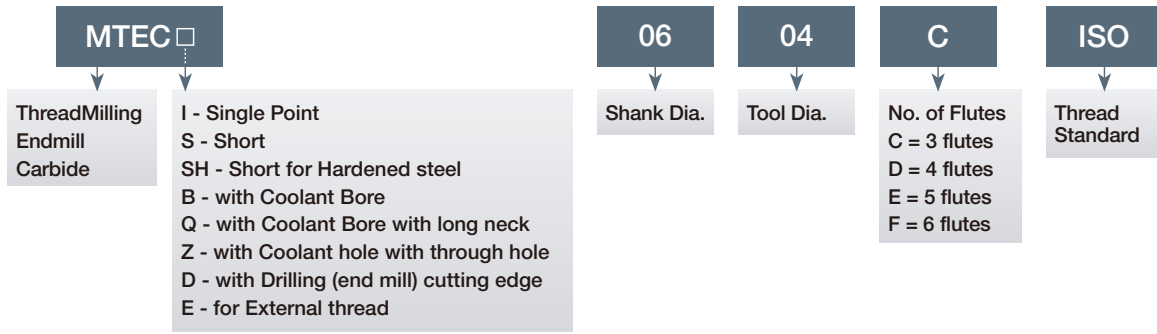


A thread milling operation is applicable for thread cutting in non-symmetrical parts utilizing the advantage of helical interpolation programs on modern machining centers.



For more details, please check ThreadMilling advisor.

SOLIDTHREAD Designation system

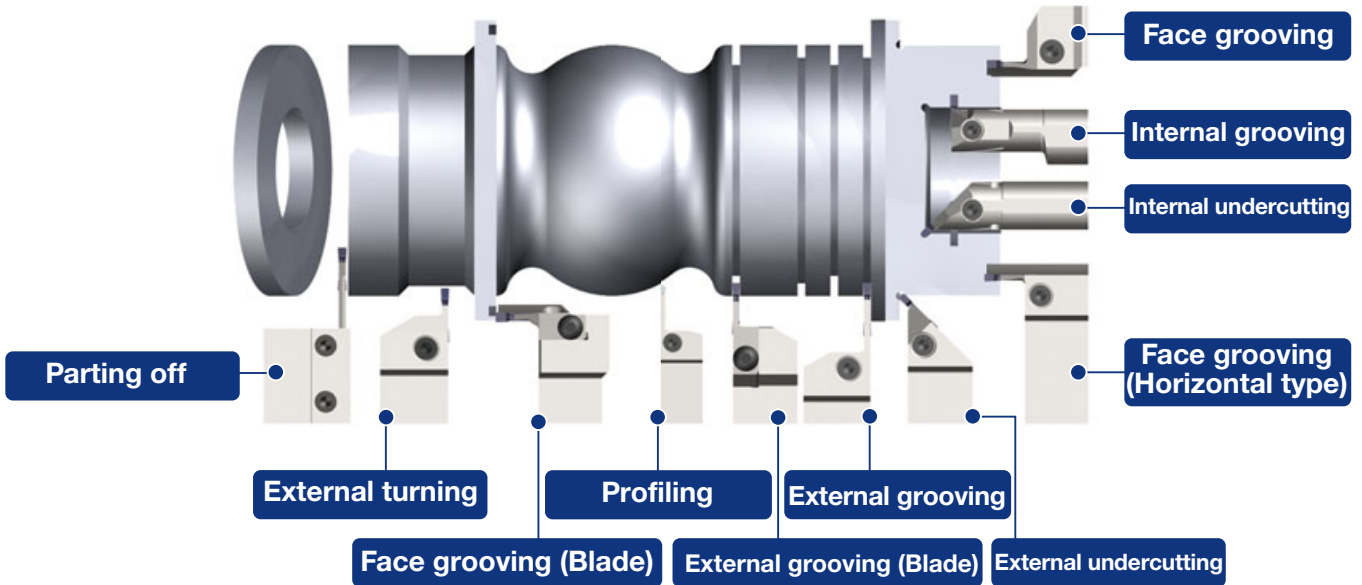


Grooving and Parting Tools

TUNGCUT

Features of TungCut

● Multi-functional grooving system



Mono block toolholders

High rigidity !



Adaptor

Available for various machining !



Blades with tool blocks

Suitable for large diameter machining !



● Insert Application

Insert	Application						
	Grooving			Parting	Turning		
	External	Internal	Face		External	Internal	Face
DGM / SGM	●		●	●			
DGS / SGS	●		●	●			
DGG	●		●	●			
DGL	●		●	●			
DGE	●		●	●			
DTM	●		●	●	●		●
DTE	●		●	●	●		●
DTX	●	●	●	●	●	●	●
DTR / STR	●		●		●		●
DTIU	●	●					
DTI	Undercutting	Undercutting				●	
DGIM / DGIS		●					
DTF			●				●
DTA					●	●	
SGN	●				Al wheel machining	Al wheel machining	
STH					●	●	●

Grade
Insert
Ext. Toolholder
Int. Toolholder
Threading
Grooving
Miniature tool
Milling cutter
Endmill
Drilling tool
Tooling System
User's Guide
Index



Grooving and Parting Tools

TUNGCUT

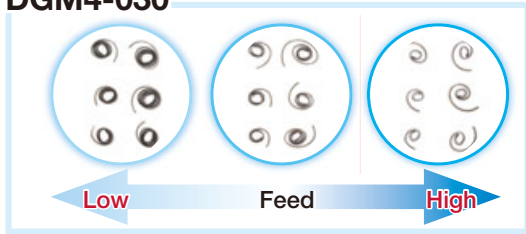
■ Ideal chip forms of TungCut inserts

Carbon steel
(1045)

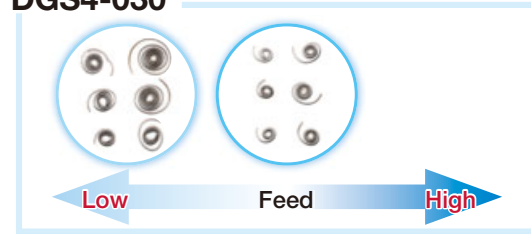


GROOVING AND PARTING

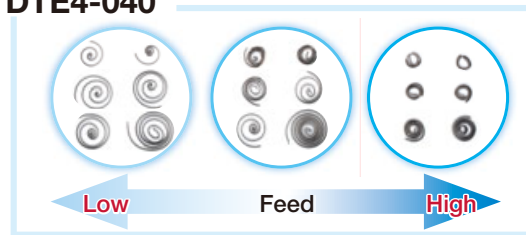
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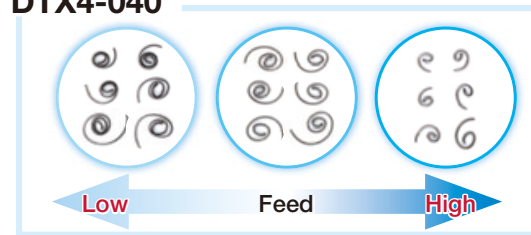
DGS4-030



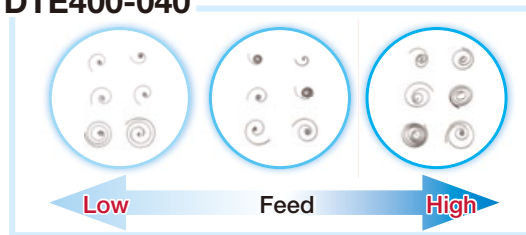
DTE4-040



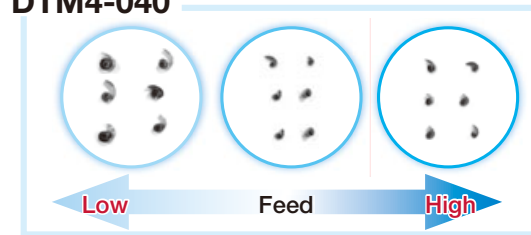
DTX4-040



DTE400-040



DTM4-040

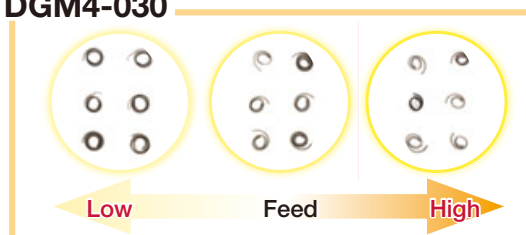


GROOVING AND PARTING

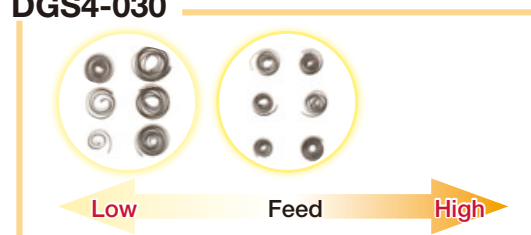
Stainless steel
(304)



DGM4-030



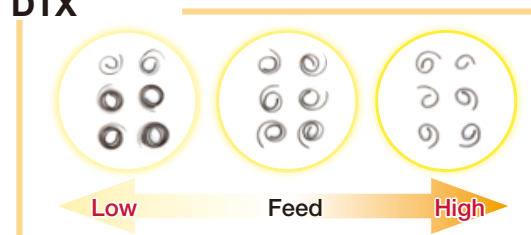
DGS4-030



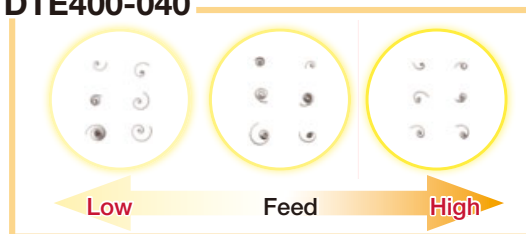
DTE4-040



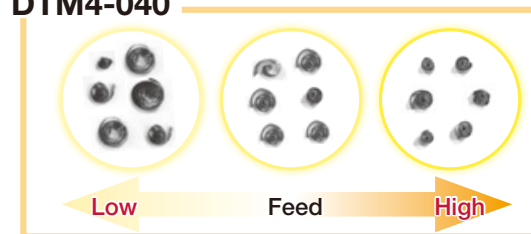
DTX



DTE400-040



DTM4-040





GROOVING, PARTING, AND TURNING

DTE

Its wide cutting edge is designed to provide good chip control at high feed rates



DTM

First choice chipbreaker for various applications. Optimized geometry for smooth chip breaking and flow



DTX

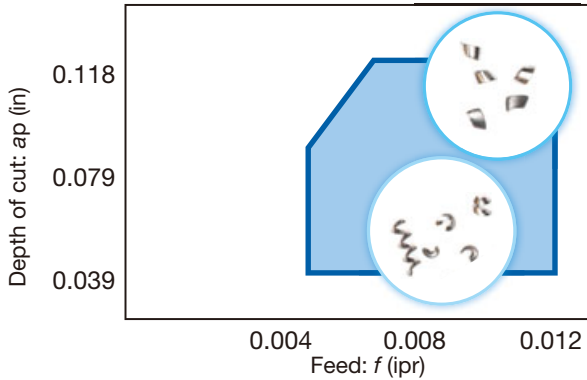
Provides good cutting performance in grooving. Its narrow cutting edge width provides excellent chip formation at low feed rates



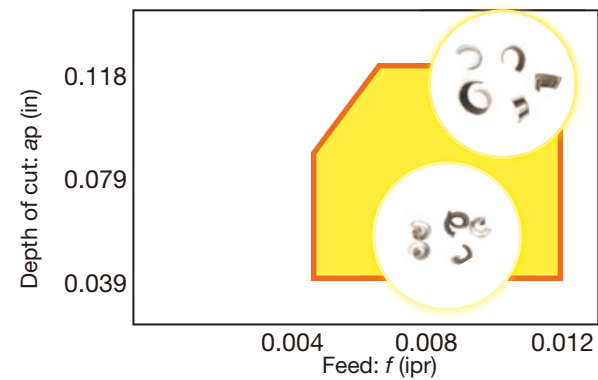
P Carbon steel (1045)

M Stainless steel (304)

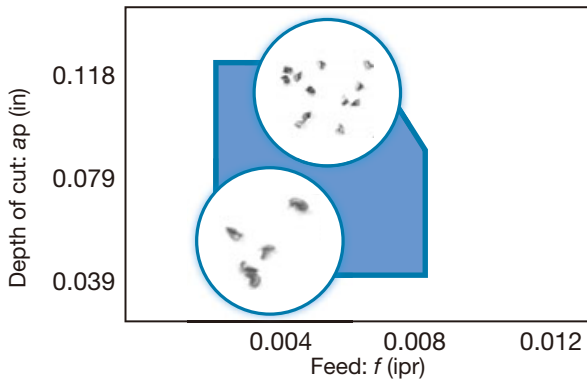
DTE4-040



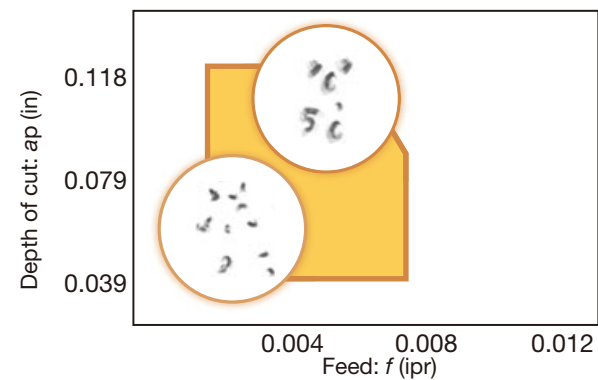
DTE4-040



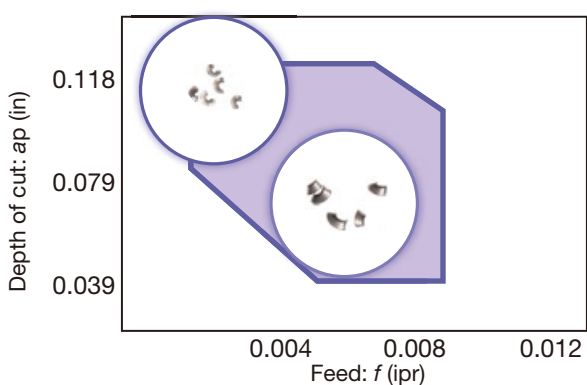
DTM4-040



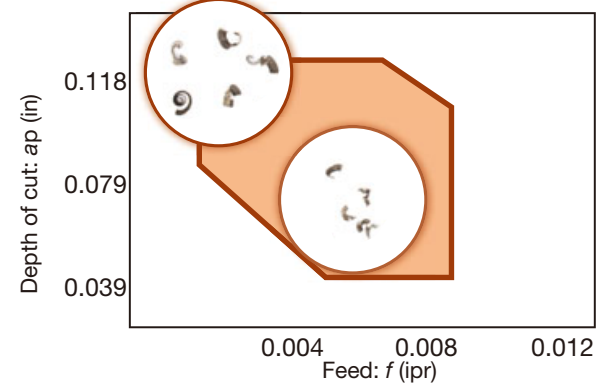
DTM4-040



DTX4-040



DTX4-040



Grooving and Parting Tools

TUNG CUT

■ Ideal chip forms of TungCut inserts

● Excellent chip control at low feed rates

P Bearing steel
(52100)

DGL
First choice chipbreaker for bearing steel. Excellent chip control at low feed rates.



Material : SUJ2
Holder : CTER16-3T09
Insert : DGL3-025
Cutting speed : Vc = 164, 328 sfm
Groove width : 0.118"

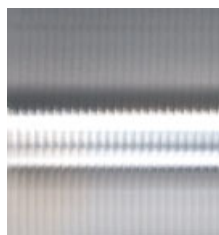
	$f = 0.001$ ipr	$f = 0.002$ ipr	$f = 0.003$ ipr	$f = 0.004$ ipr
Vc = 164				
Vc = 328				

■ Notes when using STH insert

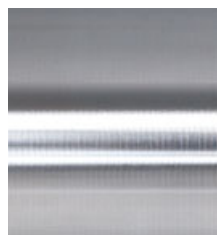
Since the wiper geometry consists of a long arc, TungCut CBN insert provides wavy surface finishing, despite the results with excellent Ra values.

TUNG CUT
Feed: $f = 0.039$ ipr

ISO turning insert
(with 0.031" nose radius)
Feed: $f = 0.004$ ipr



Surface quality
Ra = 0.3 μm (11.8Uin)

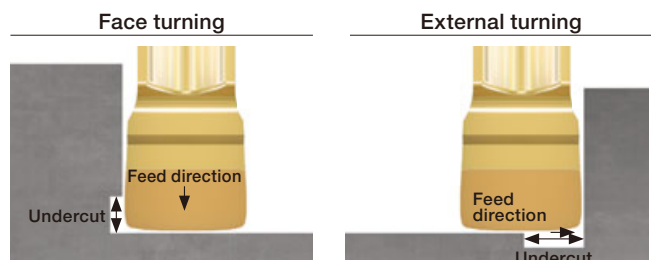


Surface quality
Ra = 0.4 μm (15.75Uin)

H Insert : STH500-SR BXA10
: 2QP-CNGA120408 BXA10
Holder : CTEL16-5T12
: ACLNL164-A
Workpiece material : 4140 (60HRC)
Cutting speed : Vc = 492 sfm
Feed : $f = 0.004, 0.039$ ipr
Depth of cut : $a_p = 0.004$ "
Application : External turning, continuous cut
Coolant : Wet

Due to the wiper geometry, ensure machine is programmed so that the wiper section of the cutting edge completely passes over the workpiece edge when external turning or face turning, otherwise, material will be left uncut on the workpiece. When cutting towards the wall or bottom, provide proper undercutting, as listed below, at the wall or bottom to eliminate uncut material.

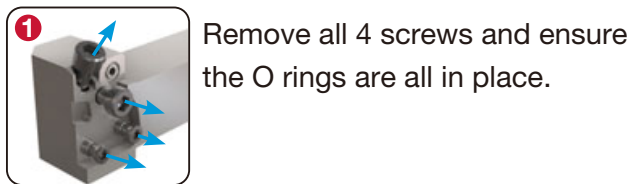
Designation	CW ± 0.0 (in)	Application	Minimum undercutting required (in)
STH300-SR	0.118	External	0.059
		Face	0.016
STH500-SR	0.197	External	0.098
		Face	0.028



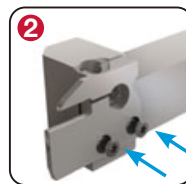
TUNG M^{OBULAR} SYSTEM

How to install and remove the blade and insert

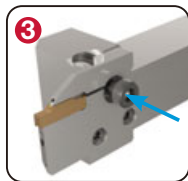
● Assembly



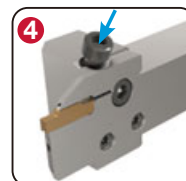
1 Remove all 4 screws and ensure the O rings are all in place.



2 Place the blade and tighten 2 bottom clamping screws.



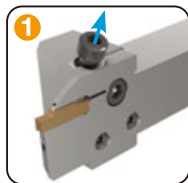
3 Place the insert in the pocket and tighten the fixing screw in the center.



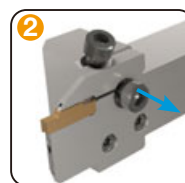
4 Place the long screw in the angular direction and tighten to clamp the insert.

Please follow the installation order as shown above. When the screws are tightened in the 4 → 3 order, the insert clamping may be insufficient and unstable.

● Disassembly

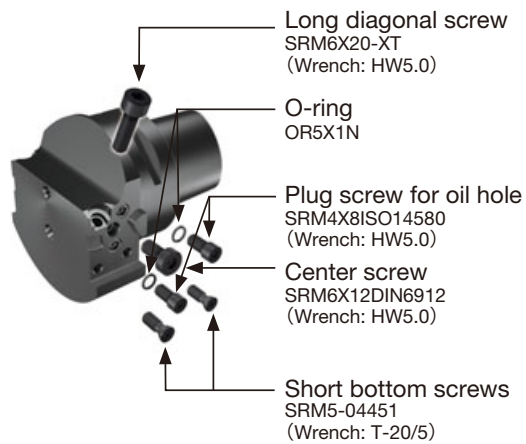
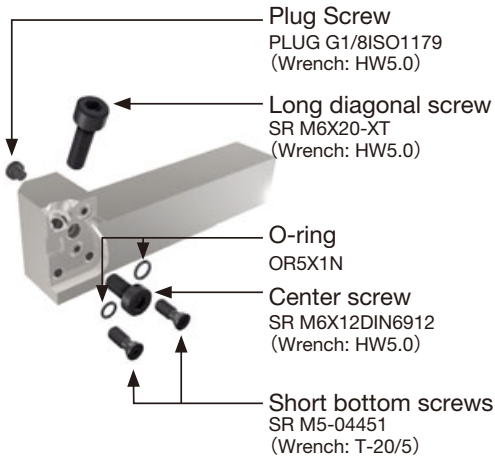


1 First loosen the long screw in the angular direction.



2 Loosen the Fixing screw in the center and remove the insert.

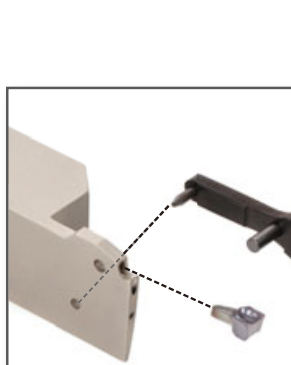
Loosening the long screw alone may not release the insert.



All parts listed here are included in the tool holder.

EASY M^{ULTI} CUT

Procedure to clamp and unclamp insert



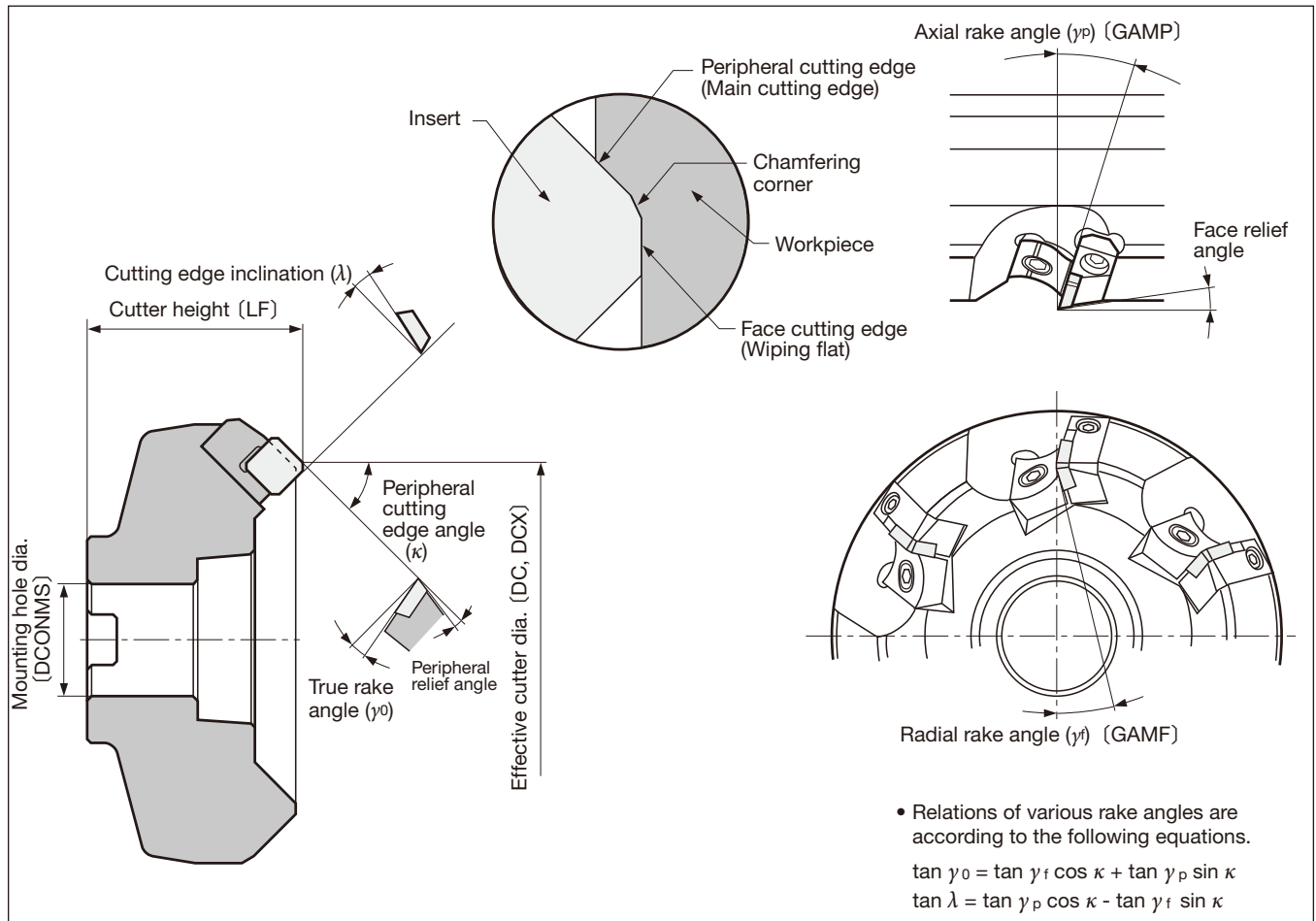
Grooving and Parting Tools

Points to consider for grooving and parting operations

Application	Points
<p>Groove-turning</p>	<ul style="list-style-type: none"> To achieve best wiper effect, aP must be greater than the corner radius of the insert. Do not use no more than 80% of the cutting edge length. Use a chipbreaker geometry best suited for turning. Use the toolholder with the shortest possible CDX (cutting depth maximum) to ensure maximum tool rigidity and process security. The insert may be deflected by axial cutting force during turning, causing the workpiece diameter to be smaller than the required dimension(See Fig. 1). A minor tool length compensation may, therefore, be required. Exact amount of change can be measured by running a test workpiece. Refer to the charts in Fig. 2 below for diameter compensation values. <div style="display: flex; justify-content: space-around; align-items: center;"> <div data-bbox="343 616 582 873"> <p>Fig. 1</p> </div> <div data-bbox="694 616 1045 929"> <p>Insert : DTE300-040 Toolholder: CTER16-3T09</p> <p>Fig. 2 Value of compensation</p> </div> <div data-bbox="1061 616 1460 929"> <p>Insert : DTE400-040 Toolholder: CTER16-4T10</p> </div> </div>
<p>Parting off</p>	<ul style="list-style-type: none"> Adjustment of the cutting edge height is crucial to obtain the best possible part quality in parting operations. Adjust so that the center height is not off by more than ± 0.004". Setting the parting tool upside down aids in better chip evacuation and preventing parts from flying when parted off. If the center height is set too low, a pip may remain on the parted surface. Optimize tool life by reducing feed to 30% about 0.197" before the workpiece center. Use a left- or right-handed insert with an angled front and smallest possible corner radii to prevent or minimize pips. Use a parting tool with the thickest shank height (H) as possible for maximum tool rigidity and stability. Use an overhang as short as possible for minimum tool deflection and process security. When the parting distance is greater than the insert length, use a single-ended insert. Use a insert as thin as possible. This minimizes the cutting force and saves material. To avoid part surface from being damaged after the cut, move the tool in the axial direction to keep the cutting edge off the part before retreating the tool in the radial direction.
<p>Face grooving</p>	<ul style="list-style-type: none"> Chip control during face grooving operations is, generally, more challenging than general grooving operations. Optimize the insert geometry considering whether the application involves grooving or groove-and-turning. DAXMIN (axial groove inside diameter minimum) and DAXX (axial groove outside diameter maximum) in the lists indicate the diameter range of face groove width machinable from the first cut. Choose the diameter range of the first cut (DAXMIN and DAXX). Use the tool for the largest diameter that fits your groove and turn from the outside towards the center to expand, and never cut the other way around. Use the same feed and aP as for O.D. grooving. For effective chip evacuation, use peck grooving method or set the tool upside down to eliminate chip nesting and chip re-cutting.
<p>Internal grooving</p>	<ul style="list-style-type: none"> DMIN indicates minimum bore diameter that can be machined with no interference. Optimize the insert geometry considering whether the application involves grooving or groove-and-turning. Chip evacuation is challenging in internal grooving operations. Use coolant-through toolholder whenever possible. Use a toolholder as thick as possible or use a vibration-resistant carbide shank to increase tool rigidity for chatter-free machining. Always turn from the bore end towards the entrance to reduce chip nesting inside the bore and promote better chip evacuation.

Milling tools

Nomenclature for face milling cutter

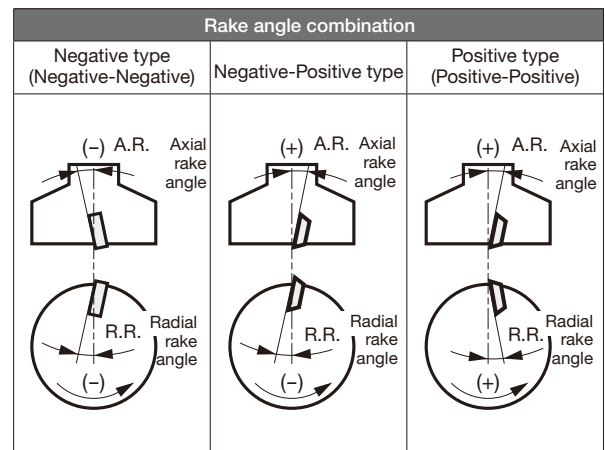


() The notation in the brackets is the one used in the catalog (ISO compliant)

Cutter geometry and applications

Condition		Rake angle combination and applicability		
		Negative-Negative	Negative-Positive	Positive-Positive
Shapes of cutting edge	γ_p (GAMP)	-	+	+
	γ_r (GAMF)	-	-	+
	γ_0	-	+	+
Workpiece material	Carbon steels, alloy steels (< 300HB)	△	⊙	⊙
	Stainless steels (< 300HB)	×	⊙	○
	Die steels (< 300HB)	△	⊙	○
	Cast irons Ductile cast irons	⊙	○	○
	Aluminum alloys	×	○	⊙
	Copper and its alloys	×	○	⊙
	Titanium and its alloys	×	○	○
	Hardened steels (40 ~ 55HRC)	○	○	×
Features		<ul style="list-style-type: none"> Higher cutting edge strength Many usable corners of inserts 	<ul style="list-style-type: none"> Excellent chip removal Higher cutting edge strength and Freer cutting action 	<ul style="list-style-type: none"> Most excellent cutting action
Typical examples of mills		DoPent	TungMill DoTriple-Mill	TFE12 DPD09

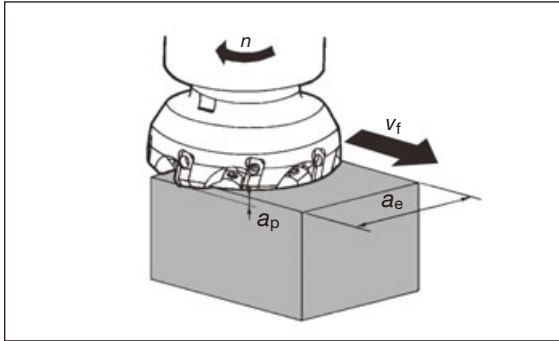
() The notation in the brackets is the one used in the catalog (ISO compliant)



Milling tools

Calculation formulas for milling

● Cutting speed



● Cutting speed (Calculated from number of revolutions)

$$SFM = \frac{RPM \times D}{3.82}$$

v_c : Cutting speed (m/min)
 D : Effective diameter (mm) (DC, DCX)
 n : Number of revolutions (min^{-1})
 $\pi \approx 3.14$

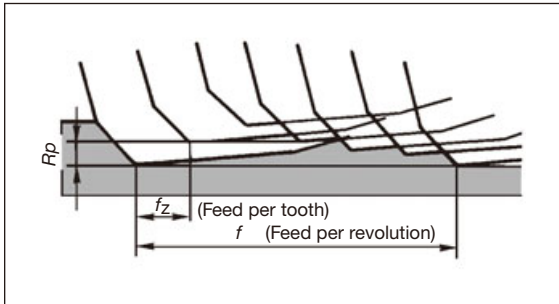
● Number of revolution (Calculated from cutting speed)

$$RPM = \frac{SFM \times 3.82}{D}$$

● Feed speed and feed per tooth

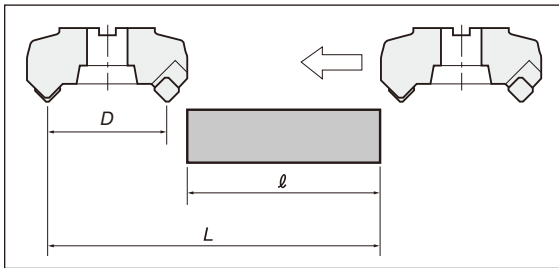
$$V_f = f_z \times z \times n$$

v_f : Feed speed (mm/min)
 f_z : Feed per tooth (mm/t)
 z : No. of teeth of the cutter
 n : Number of revolutions (min^{-1})



Feed speed is relative speed of cutter and Workpiece material and in the normal milling machine, it is the table speed. In milling, the feed per tooth is very important. The recommended cutting condition is expressed by v_c and f_z and using the above equation calculate n and v_f and input in the machine.

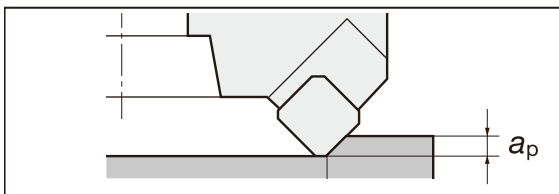
● Cutting time on face milling



$$T = \frac{L}{V_f}$$

T : Cutting time (min)
 L : Total table feed length.
 (l : Workpieces length (mm) + ϕD_c : Effective cutter diameter (mm) (DC, DCX))
 v_f : Feed speed (mm/min)
 () The notation in the brackets is the one used in the catalog (ISO compliant)

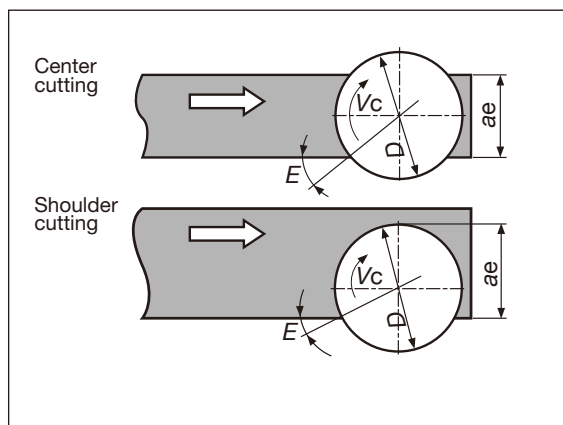
Depth of cut and width of cut



● Depth of cut

Determine by required allowance for machining and capacity of the machine. In case of mill, there are cutting limits according to shape and size of the insert. Please see spec in the catalogue.

a_p : Depth of cut (mm)



● Width of cut and engagement angle

There is an appropriate engagement angle depending on the cutter diameter, cutting position, Workpiece material, etc., and ordinarily the values in the table below are used as a guide.

D : Cutter diameter (mm) (DC, DCX)
 E : Engagement angle
 a_e : Width of cut (mm)
 () The notation in the brackets is the one used in the catalog (ISO compliant)

Center cutting

Workpiece material	Appropriate E	Cutter dia. and a_e
Steel	~ 42°	$a_e \approx \frac{2}{3} D$
Cast iron	~ 53°	$a_e \approx \frac{4}{5} D$

Shoulder cutting

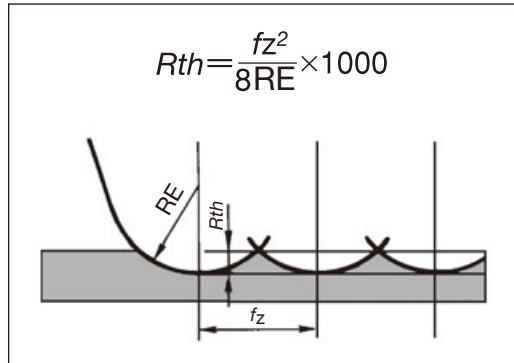
Workpiece material	Appropriate E	Cutter dia. and a_e
Steel	~ 30°	$a_e \approx \frac{3}{5} D$
Cast iron	~ 40°	$a_e \approx \frac{3}{4} D$

Roughness of finished surface

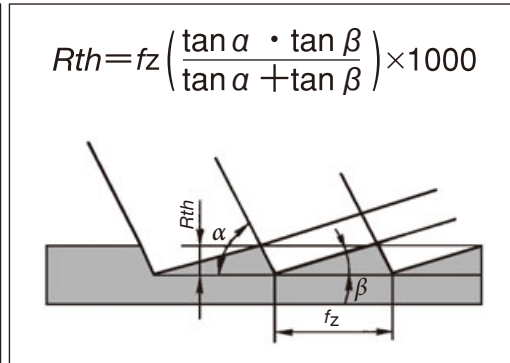
(1) Theoretical surface roughness

Theoretical roughness as shown below, is the same as for single point turning

● With corner radius RE



● Without corner radius RE



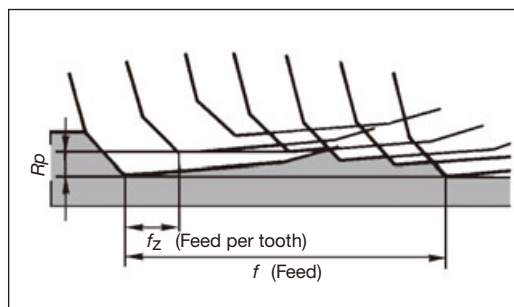
R_{th} : Theoretical roughness (μm)

f_z : Feed per tooth (ipt)

RE : Corner radius (in)

α : Corner angle

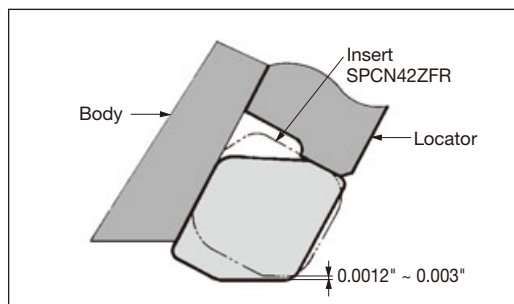
β : Face cutting edge angle



(2) Actual surface roughness

A facemill cutter in practice is composed of multiple point cutting edges and is prone to create uneven peaks, or an axial runout error (R_p) on cutting edges. One or two cutting edges being non-coplanar to the rest invariably create the dominant mark on a face-milled surface, producing periodic patterns corresponding to the feed per revolution f (ipr) superimposing on the feed per tooth f_z (ipt).

Improving surface roughness



Face run out must be minimized and a low feed and high speed should be used. Also, in order to attain good finished surface at high efficiency, there are the following methods:

- (1) In case of ordinary mill
Use wiper insert as shown in the figure at left.
- (2) Use of super finish mill for finishing.
 - Use of combination mills with finishing insert such as TFD4400-A and TFP4000IA ($a_p < 0.039$ ").
 - Use of super finish mill for finishing such as NMS cutters and SFP4000 etc.

Milling tools

Calculating power requirement

$$P_c = \frac{k_c \times a_p \times a_e \times v_f}{330}$$

(HP)

Because practical power requirements depend on the type of mill (proportional to the true rake angle) and the motor efficiency of the machine used, the result calculated from the above formula should be considered as a rough guide.

P_c : Net power requirement (HP)

k_c : Specific cutting force (KPI)
[Refer to the Table below]

a_p : Depth of cut (in)

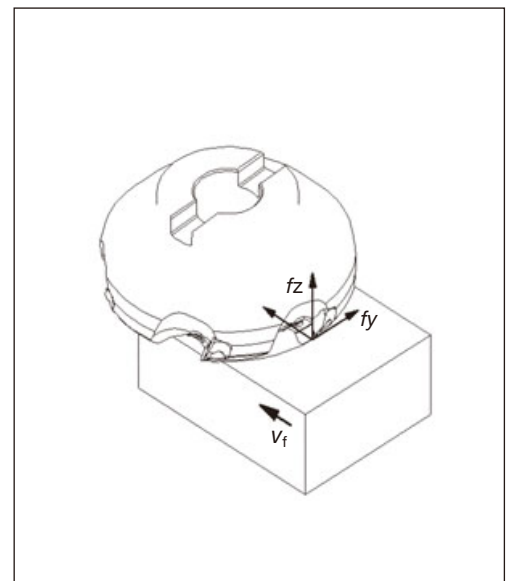
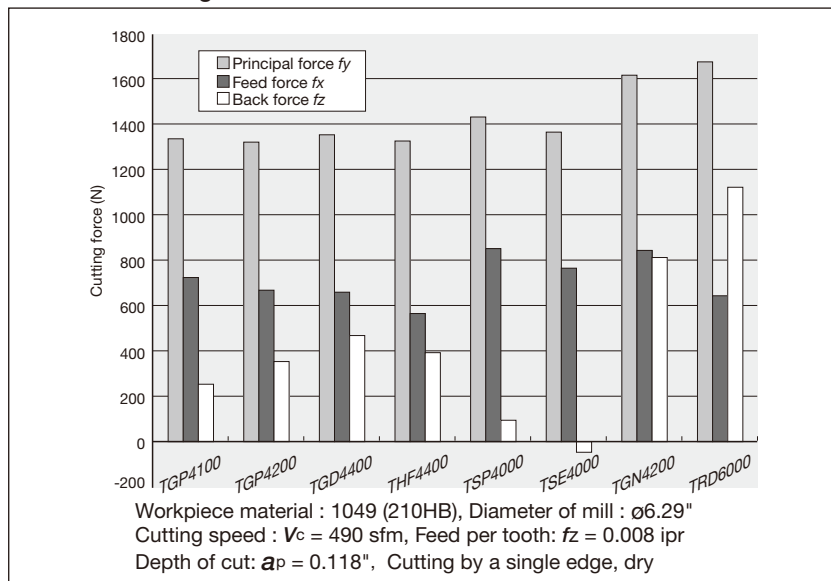
a_e : Width of cut (in)

v_f : Feed speed (in/min)

Values of specific cutting force (k_c)

Workpiece material (JIS)	Tensile strength	Value of specific cutting force on feed per tooth k_c (N/mm ²)				
	MPa	0.004 (ipt)	0.006 (ipt)	0.008 (ipt)	0.012 (ipt)	0.016 (ipt)
SS400	75,420	312	290	276	254	239
S55C	111,679	286	270	261	255	235
SCM435	105,878	355	341	319	287	248
SKT4	(HB352)	294	292	263	244	231
SC450	75,420	393	367	350	325	307
FC250	(HB200)	241	210	191	167	149
Al (Si)	29,008	96	84	76	67	59
Brass	72,519	158	139	127	110	99

Values of cutting force



Conversion from cutting speed to number of revolutions

(unit : min⁻¹)

Cutter diameter DC, DCX (in)	Cutting speed : V_c (sfm)												
	33	98	164	328	410	492	656	984	1,640	2,625	3,281	6,562	13,123
0.394	318	955	1,592	3,184	3,980	4,777	6,369	9,554	15,923	25,477	31,847	63,694	127,388
0.472	265	796	1,326	2,653	3,317	3,980	5,307	7,961	13,269	21,231	26,539	53,078	106,157
0.630	199	597	995	1,990	2,488	2,985	3,980	5,971	9,952	15,923	19,904	39,808	79,617
0.787	159	477	796	1,592	1,990	2,388	3,184	4,777	7,961	12,738	15,923	31,847	63,694
0.984	127	382	636	1,273	1,592	1,910	2,547	3,821	6,369	10,191	12,738	25,477	50,955
1.181	106	318	530	1,061	1,326	1,592	2,123	3,184	5,307	8,492	10,615	21,231	42,462
1.260	99	298	497	995	1,244	1,492	1,990	2,985	4,976	7,961	9,952	19,904	39,808
1.378	90	272	454	909	1,137	1,364	1,819	2,729	4,549	7,279	9,099	18,198	36,396
1.575	79	238	398	796	995	1,194	1,592	2,388	3,980	6,369	7,961	15,923	31,847
1.969	63	191	318	636	796	955	1,273	1,910	3,184	5,095	6,369	12,738	25,477
2.480	50	151	252	505	631	758	1,011	1,516	2,527	4,044	5,055	10,110	20,220
3.150	39	119	199	398	497	597	796	1,194	1,990	3,184	3,980	7,961	15,923
3.937	31	95	159	318	398	477	636	955	1,592	2,547	3,184	6,369	12,738
4.921	25	76	127	254	318	382	509	764	1,273	2,038	2,547	5,095	10,191
6.299	19	59	99	199	248	298	398	597	995	1,592	1,990	3,980	7,961
7.874	15	47	79	159	199	238	318	477	796	1,273	1,592	3,184	6,369
9.843	12	38	63	127	159	191	254	382	636	1,019	1,273	2,547	5,095
12.402	10	30	50	101	126	151	202	303	505	808	1,011	2,022	4,044

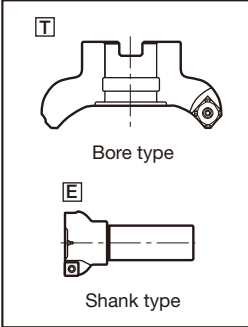
Note: In this table, the effects of centrifugal force on the rotating balance of the tool and the toolholder, flying risk of cutter parts, and limited value of toolholder destruction are not considered. Therefore, when using the tool at high speeds, be sure to observe the specified condition range.



Trouble shooting in face milling

Trouble	Possible causes	Countermeasures
Rapid wear of cutting edge	• Improper insert grade selection (Insufficient wear resistance)	• Use a grade with high wear resistance P30 → P20
	• Excessive cutting speed	• Select cutting speed suited for Workpiece material and insert grade
	• Inadequate feed	• Use standard cutting condition in catalog as guide
Rapid chipping of cutting edge	• Improper Insert grade selection (Insufficient toughness)	• Use a grade with high fracture resistance P10 → P20
	• Cutting hard material and unfavorable surface condition	• Decrease cutting speed • Use cutter with strong cutting edge
	• Excessive feed	• Proper selection of feed conditions, using recommended cutting conditions in catalog as guide
	• Excessive pressure applied on cutting edge	• Proper selection of engaging angle
	• Machining superalloys	• Use a negative-positive type cutter with large corner angle
Fracturing	• Cracking due to thermal shock	• Select insert grade of stronger thermal shock resistance • Decrease cutting speed
	• Continuous use of excessively worn insert	• Shorten replacement standard time of insert
	• Cutting hard material	• Use cutter with stronger cutting edge • Use cutter of larger corner angle
	• Obstruction to chip flow • Recutting of chips after chip welding	• Use cutter with better chip expulsion • Select insert grades difficult for chips to adhere Cemented carbides → cermets, coated grades • Use air blow
	• Excessively slow cutting, too fine feed	• Select cutting speed and feed optimized for insert grade and Workpiece material
Excessive chip welding or build-up on cutting edge	• Cutting soft material such as aluminum, copper, mild steel	• Use cutter with large rake angle
	• Cutting stainless steel	• Coated grades (AH130, AH3135)
	• Use of cutter with negative rake or too small rake angle	• Use cutter with large rake angle
Rough finish	• Effect of built-up edge	• Increase cutting speed • Appropriate cutting depth (finish allowance) • Change insert grade For steels : P → coated → cermet For cast irons : K → coated
	• Effect of face cutting edge run out	• Proper installing of inserts • Use insert of high dimensional accuracy • Cleaning of insert pocket
	• Continuous use of excessively worn insert	• Shorten replacement standard time of insert
	• Remarkable feed marks	• Feed per revolution to be set within flatland width • Use wiper insert type cutter such as T/EAW13 • Use cutter exclusively for finishing
Chattering	• Unstable clamping of workpiece	• Check clamping method of workpiece
	• Cutting of welded construction of thin steel plate	• Use cutter of large rake angle and small corner angle
	• Excessive cutting condition	• Re-examine allowable chip removal rate according to motor HP
	• Face milling of narrow width workpiece	• Use cutter of small cutter diameter and with many teeth
	• Too many simultaneous cutting teeth engagement	• Reduce No. of teeth

New Designation System for Milling Cutters

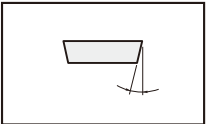


T Bore type
E Shank type

Symbol	Type
T	Bore type
E	Shank type

1 Type

H Hybrid TAC Mill Series



Symbol	Relief angle
C	7°
P	11°
D	15°
E	20°
F	25°
N	0°
Others	Special

3 Relief angle

Symbol	Hand
R	Right
L	Left

5 Direction of cut

Symbol	Unit
M	mm
U	in

7 Unit

Symbol	Type
T--: General type	
-	JIS
E	ISO
A	ANSI
E--: Shank type	
-	Cylindrical
W	Weldon
C	Combination

9 Attachment specification

10 Number of inserts

1 2 3 4 5 6 7 8 9 10

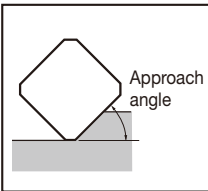
T P A 10 R 200 U 0075 A 04

1 2 3 4 5 6 7 8 9 10 11

E P A 15 R 150 U 0125 W 02 L

2 Angle, Category

Symbol	Cutting edge angle
P	90° ~ 80°
E	80° ~ 70°
D	60° ~ 50°
A	50° ~ 40°
L	With long cutting edge
Others	Special

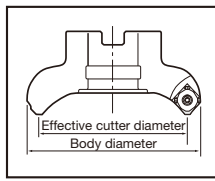


4 Cutting edge length

Symbol	Size (ℓ)
S	
T	
R	
H	
A	

6 Effective cutter diameter

Symbol	Size
M: Unit in mm	
080	80 mm
200	200 mm
I: Unit in inch	
200	2 in



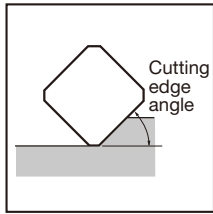
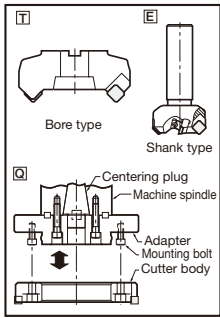
8 Attachment size

Symbol	Size
M: Unit in mm Hole diameter	
20.0	20 mm
25.4	25.4 mm
31.7	31.75 mm
47.6	47.625 mm
I: Unit in inch Hole diameter	
0075	0.75 in
0125	1.25 in
0200	2 in
E--: Shank type Shank diameter	
10.0	10 mm
12.0	12 mm
16.0	16 mm
25.0	25 mm
32.0	32 mm

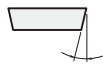
11 Additional feature

Symbol	Type
W	Wedge clamp
L	Long shank
LE	Long edge
CS	Carbide shank
N	No coolant hole

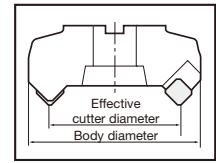
Previous products



Symbol	Relief angle
C	7°
D	15°
E	20°
F	25°
N	0°
P	11°
X	Others



R		S		C		A		Inscribed circle dia. (in)		
Symbol	Size	Symbol	Size	Symbol	Size	Symbol	Size			
		06	0.250	06	0.255	11	0.433	0.250		
		07	0.313	08	0.319	13	0.543	0.313		
		09	0.375	09	0.375	09	0.382	16	0.650	0.375
		10	0.394	-	-	-	-	-	-	0.394
		12	0.472	-	-	-	-	-	-	0.472
		12	0.500	12	0.500	12	0.508	22	0.866	0.500
		15	0.625	15	0.625	16	0.634	27	1.080	0.625
		16	0.630	-	-	-	-	-	-	0.630
		19	0.750	19	0.750	19	0.760	33	1.300	0.750
		20	0.787	-	-	-	-	-	-	0.787
		25	0.984	-	-	-	-	-	-	0.984
		25	1.000	25	0.630	25	1.016	44	1.730	1.000
		31	1.250	31	1.250	32	1.268	55	2.160	1.250



Symbol	Effective diameter (in)
050	1.97
063	2.480
080	3.150
100	3.937
125	4.921
160	6.299
200	7.874
250	9.843
315	12.402
355	13.976
400	15.748

Symbol	Type
V	Vertical insert
Q	Quick change
E	Shank
T	Bore
S	Special
D	All PCD tipped
Q	All PCBN tipped

Symbol	Cutting edge angle
X	Others
Z	Others
V	Others
P	90° ~ 80°
E	80° ~ 70°
D	60° ~ 50°
A	50° ~ 40°

③ Relief angle

④ Cutting edge length

⑤ Effective cutter diameter

Example

Metric system

1 T **2** A **3** D **4** 12 **5** 063 **6** R

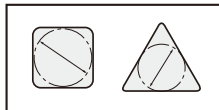
Example

Inch system

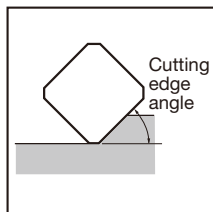
1 T **8** M **3** D **9** 4 **10** 4 **11** 06 **6** R **7** I

⑧ Application, etc.	
Symbol	Application, geometry etc.
M	For machining centers
F	For finishing
G	General purpose
S	For square shoulder milling
H	High rake geometry
P	Negative axial, positive radial rake geometry
R	Use round inserts
U	For difficult to cut materials
C	For chamfering
L	Long edge type
T	For threading

⑨ Size of applicable insert	
Symbol	I. C. (in)
3	0.375
4	0.500
5	0.625
6	0.750
7	0.875
8	1.000
9	1.250

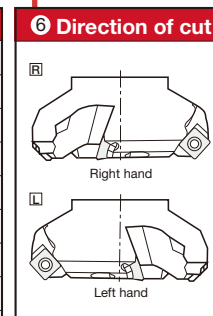
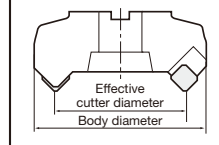


⑩ Angle	
Symbol	Cutting edge angle
0	90° ~ 80°
1	80° ~ 70°
2	70° ~ 60°
3	60° ~ 50°
4	50° ~ 40°
5	40° ~ 30°
6	30° ~ 20°
7	20° ~ 10°



⑪ Effective cutter diameter	
Symbol	Effective diameter (in)
50	1.970
63	2.480
03	3.150
04	3.937
05	4.921
06	6.299
08	7.874
10	9.843
12	12.402
14	13.976
16	15.748

Note: For diameter of less than 80mm, nominal dimensions (mm) of effective diameter are shown.



⑦ Additional feature	
B	Close pitch
I	Irregular pitch
A(-A)	Modified type
S	For distinguishing shank size
L	Long shank

Note: The above nomenclature is not applicable for VSN6000I, MS cutter, TCB, PES1500 and TBN etc.

Designation System for Milling Inserts

Symbol	Hole	Shape of hole	Chipbreaker	Shape
N	Without	-	Without	
R			Single-sided	
F			Double-sided	
W	With	Partly cylindrical hole, single-side 40° - 60° Counter sink	Without	
T			Single-sided	
Q			Double-sided	
U	With	Partly cylindrical hole, double-side 40° - 60° Counter sink	Without	
B			Single-sided	
H			Double-sided	
C	With	Partly cylindrical hole, single-side 70° - 90° Counter sink	Without	
J			Single-sided	
X			Double-sided	

4 Groove and hole

Shape	Cutting edge length (ℓ)
S	
T	
R	
H	
A	

5 Cutting edge length

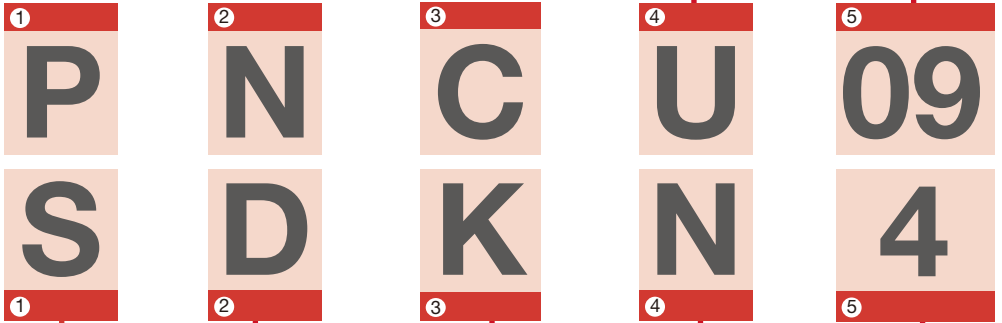
Symbol	Thickness (mm)
02	2.38
03	3.18
T3	3.97
04	4.76
05	5.56
06	6.35
07	7.94
09	9.52

Thickness

6 Thickness

(Example)

Metric



(Example)

Inch



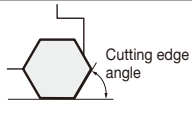
1 Shape			
Symbol	Shape	Nose angle (degree)	Figure
H	Hexagonal	120°	
S	Square	90°	
T	Triangular	60°	
C	Rhombic	80°	
E		75°	
G		70°	
L	Rectangular	90°	
A	Parallelogram	85°	
R	Round		
W	Wiper	80°	
W	Special	-	
O	Octagonal	135°	
P	Pentagonal	108°	
X	Special	Others	
Y	Special		
Z	Special		

2 Relief angle	
Symbol	Relief angle
C	7°
D	15°
E	20°
F	25°
G	30°
M	Others
N	0°
P	11°
Q	Other applications
O	Other applications
X	Other applications
S	Other applications
W	2-step relief

3 Accuracy (mm)			
Symbol (class)	Corner height (m)	Thickness (s)	I. C. dia. (ød)
A	± 0.005	± 0.025	± 0.025
C	± 0.013	± 0.025	± 0.025
E	± 0.025	± 0.025	± 0.025
G	± 0.025	± 0.13	± 0.025
H	± 0.013	± 0.025	± 0.013
K	± 0.013	± 0.025	± 0.05 ~ ± 0.13
M	± 0.08 ~ ± 0.18	± 0.13	± 0.05 ~ ± 0.13
N	± 0.08 ~ ± 0.18	± 0.025	± 0.05 ~ ± 0.13


Standard I. C. dia.	I. C. dia. (ød) tolerance		Corner height (mm) tolerance	
	J, K, L, M, N	U	M, N	U
6.35	± 0.05	± 0.08	± 0.08	± 0.13
9.525				
12.7	± 0.08	± 0.13	± 0.13	± 0.2
15.875				
19.05	± 0.1	± 0.18	± 0.15	± 0.27
25.4				
	± 0.13	± 0.25	± 0.18	± 0.38

Symbol	Cutting edge angle
A	45°
D	60°
E	75°
F	85°
G	70°
H	87°
P	90°
U	Special, small entering angle
Z	Special, universal



7 Cutting edge angle

Symbol	Relief angle
A	3°
B	5°
C	7°
D	15°
E	20°
F	25°
G	30°
N	0°
P	11°
Z	Special



8 Wiper relief angle

Symbol	Cutting edge	Shape
F	Sharp	
E	Round	
T	Chamfer	
S	Combination	
P	Combination	

9 Major cutting edge

Symbol	Hand of insert
R	Right
L	Left
N	Without

10 Hand of insert

Symbol	Description
HM	General-purpose high feed milling chipbreaker
MM	General-purpose milling chipbreaker
MW	Milling insert with wiper edge
B	Milling insert for burr removal
D	Insert with diamond sintered body
W	Wiper insert (multiple corners)
WS	Wiper insert (single corner)
WD	Wiper insert (with diamond sintered body)
BD	Wiper for burr removal (diamond sintered body)
MJ	General-purpose milling chipbreaker
MH	Milling chipbreaker with reinforced cutting edge
ML	Milling chipbreaker for low cutting force
MS	Milling chipbreaker for stainless steel
HJ	High feed milling chipbreaker
AJ	Milling chipbreaker for non-ferrous metal
NMJ	General-purpose milling chipbreaker with serration
NAJ	Milling chipbreaker with serration for non-ferrous metal

11 Supplementary symbol

6 05
6 2

7 G
7 Z

8 N

9 E
9 T

10 R
10 N

11 MJ
11 16

4 Groove and hole		
Symbol	Shape of hole	Hole
A	Without	With
F	Double side	Without
G	Double side	With
M	Single side	With
N	Without	With
U	Without	Without
W	Without	With

5 Inscribed circle (I. C.)		
Symbol	I. C. dia. (mm)	
Inch	3	9.525
	4	12.7
	5	15.875
	6	19.05

6 Thickness		
Symbol	Thickness (mm)	
Inch	2	3.18
	3	4.76
	4	6.35
	6	9.52

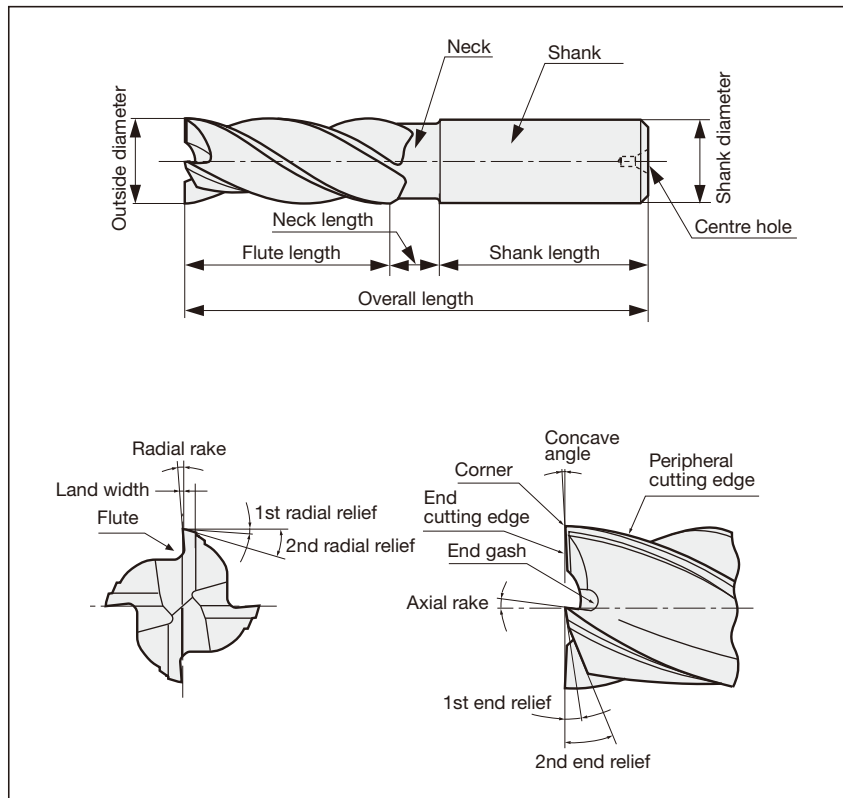
7 Corner radius	
Symbol	Corner radius (mm)
1	0.4 (0.397)
2	0.8 (0.794)
3	1.2 (1.191)
4	1.6 (1.588)
5	2.0 (1.984)
6	2.4 (2.381)

Symbol	Description
F	Special design (e.g. for MS cutter)
H	 Chamfer for corner angle 60°
S	 Chamfer for corner angle 15°
Z	 Flat chamfer

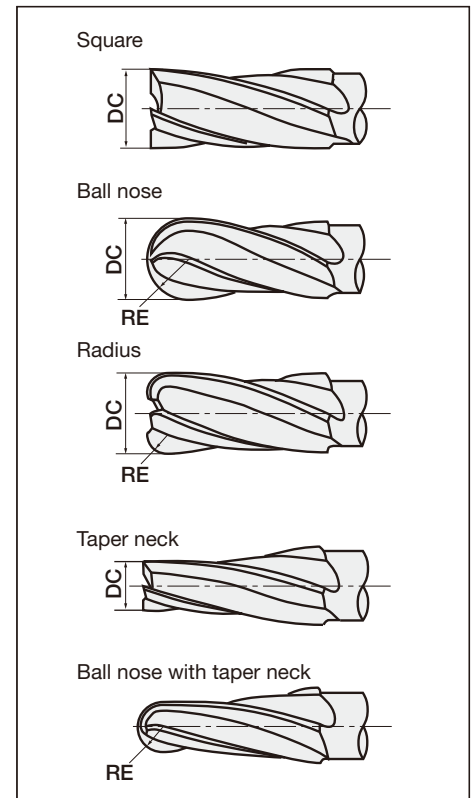
*For wiper inserts, the designation uses "W" as the shape symbol of inch items. For metric items, the shape symbol is the same as that of regular inserts, and a supplementary symbol, such as W, WS, and WD, is at the end of each designation.

Solid Carbide Endmills

Part details

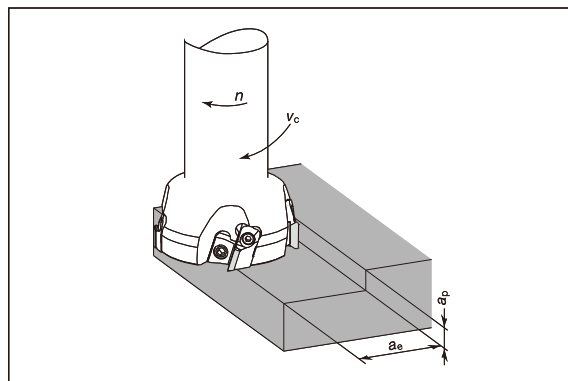


Types



Cutting condition of Endmills

● Cutting speed



- Cutting speed (Calculated from number of revolutions)

$$SFM = \frac{RPM \times D}{3.82}$$

SFM: Cutting speed

D : Effective diameter (in) (DC)

RPM: Number of revolutions (min⁻¹)

- Number of revolution (Calculated from cutting speed)

$$RPM = \frac{SFM \times 3.82}{D}$$

- Feed speed and feed per tooth

$$V_f = f_z \times z \times n$$

V_f : Feed speed (in/min)

f_z : Feed per tooth (ipt)

z : No. of teeth of the endmills

n : Number of revolutions (min⁻¹)

() The notation in the brackets is the one used in the catalog (ISO compliant)

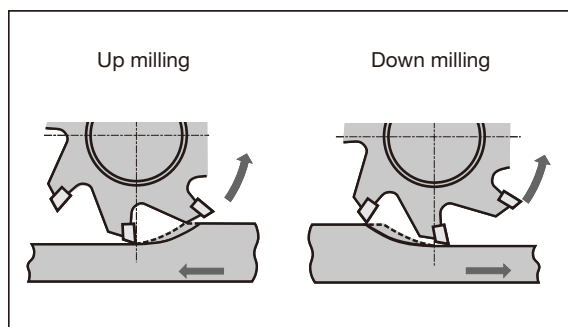
- Depth of cut

The necessary capacity of the machine is limited by the length of cut edge of the endmill.

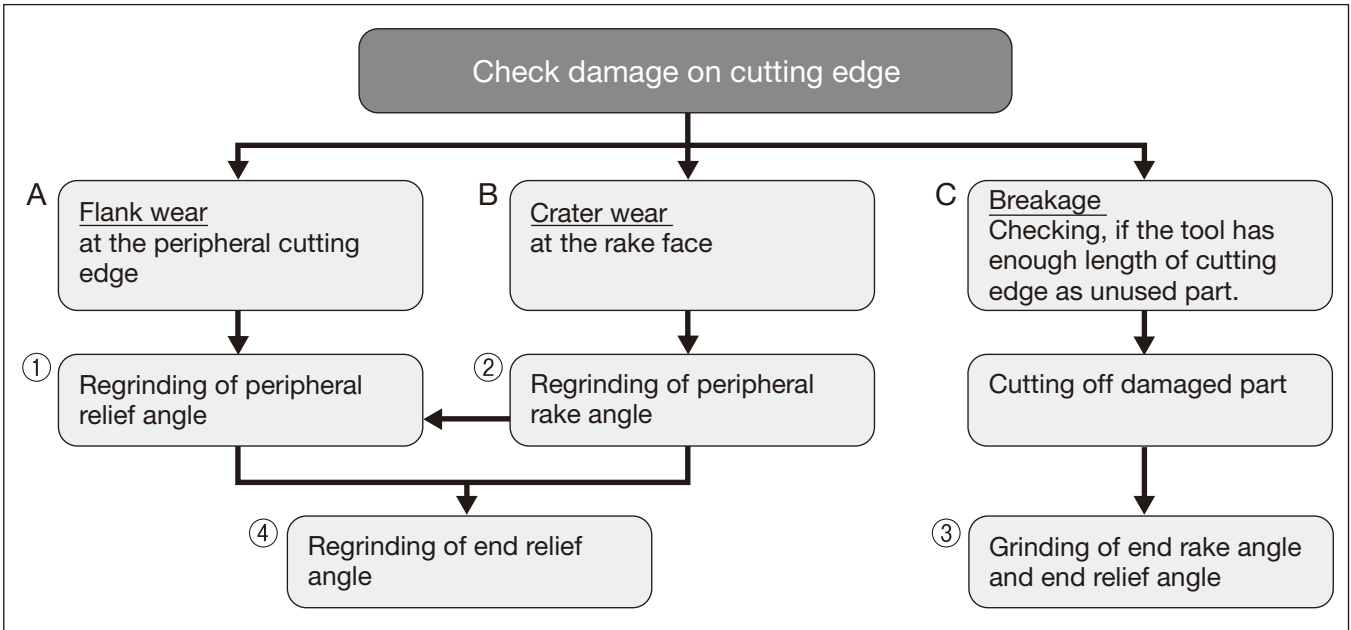
- Up milling and down milling

Down milling generally produces better tool life and surface roughness.

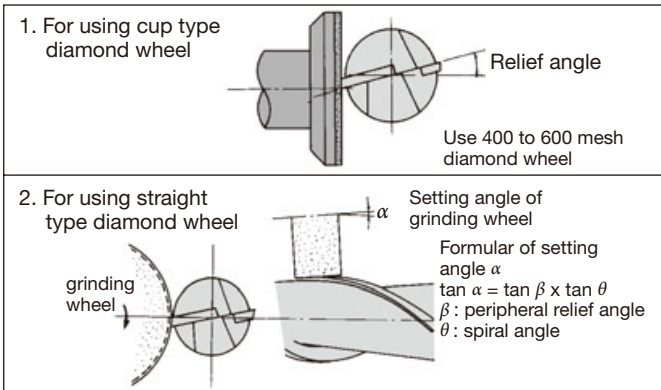
In case of cast iron sand inclusion or welding surface, up milling is recommended.



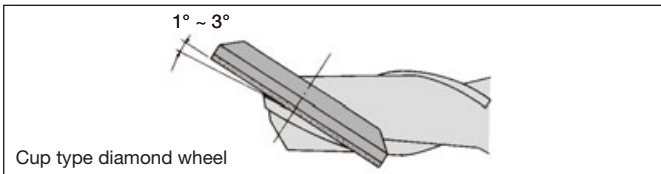
Regrinding procedures of solid carbide endmill



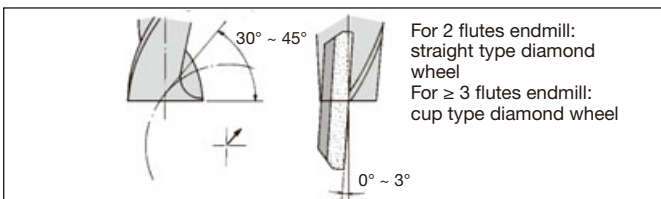
1 Regrinding of end relief angle



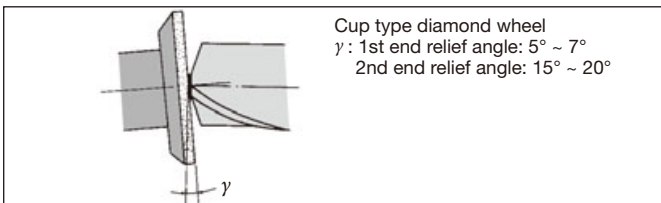
2 Regrinding of peripheral rake angle



3 Regrinding of end rake angle (End gash)



4 Regrinding of end relief angle



Notice of regrinding

- (1) If, after checking the damage of the cutting edge, the damage is as case "A" or "B" of the flow chart, the tool must be reground.
Too much damage of the cutting edge requires too much stock removal and thus reduces tool life.
- (2) Please use diamond grinding wheel.
- (3) Peripheral relief angle must be ground between 18° and 10°.
Relief angle of small diameter cutters for aluminum machining must be a large degree.
- (4) First check if "C" in flow chart can be adapted for the case of coated endmill or not.
If procedure "C" can be adapted for regrinding, tool life after the grinding would be more improved than new one. The reason is remaining coated layer of cutting edge and shorter tool length will keep much higher rigidity of the tool than before regrinding.
- (5) Please check run out of peripheral cutting edge, face cutting edge, with Vee block after regrinding.
The value of the run out must be controlled within 0.0004".

Notice for regrinding of ball nose endmill

- Regrinding of relief angle only is available. The dimension of nose radius will be smaller after grinding.
- Honing of cutting edge is necessary after regrinding.

Solid Carbide Endmills

■ Trouble shooting in Endmilling

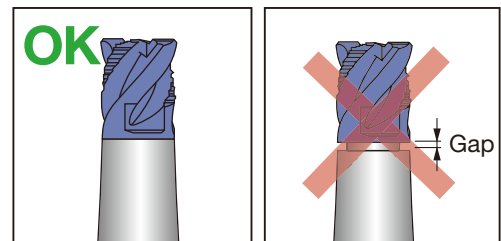
Trouble	Possible causes	Countermeasures
Breakage	<ul style="list-style-type: none"> ● At the start of machining ● At the end of machining 	<ul style="list-style-type: none"> ● Reduce feed. ● Reduce tool overhang length. ● Exchange to short cutting edge tool.
	When usual machining	<ul style="list-style-type: none"> ● Reduce feed. ● Managing tool life → Exchange in shorter time. ● Replace chuck or collet to new one. ● Reduce tool overhang length. ● Make optimum honing on the edge. ● Reduce flutes. E.g. 4 flutes → 3flutes, or 2flutes. ● Use enough coolant. Change direction of supplying coolant.
	When change the direction of feed	<ul style="list-style-type: none"> ● Use the circular interpolation in NC machine. Stop feed shortly before changing. ● Lower feed around changing part. ● Replace chuck or collet to new one.
Fracture on cutting edge	Chipping on corner edge	<ul style="list-style-type: none"> ● Chamfer the corner with hand-stick grinder. ● Down cutting ⇒ Upward milling.
	Chipping on boundary part	<ul style="list-style-type: none"> ● Change cutting direction, Down cutting → Upward milling. ● Reduce cutting speed.
	Chipping on central part or all edges.	<ul style="list-style-type: none"> ● Make slight honing on the edge. Or make honing bigger. ● Change spindle revolution number. ● Increase cutting speed. ● If chattering, increase feed. ● Use coolant or air blast. ● Replace chuck or collet to new one. ● Decrease cutting speed.
	Fracture on cutting edge	<ul style="list-style-type: none"> ● Decrease feed. ● Reduce flutes. E.g. 4 flutes → 3flutes, or 2flutes. ● Make slight honing on the edge. Or make honing bigger. ● Replace chuck or collet to new one. <p>[For Solid carbide endmill]</p> <ul style="list-style-type: none"> ● Decrease cutting speed. ● Use enough coolant. Change direction of supplying coolant.
Large wear in short time		<ul style="list-style-type: none"> ● Decrease cutting speed. ● Change cutting direction, Upward milling → down cutting. ● Increase feed. ● Use coolant or air blast. ● In reground tool, grind flank face with FINER wheel.

(Continued on next page)

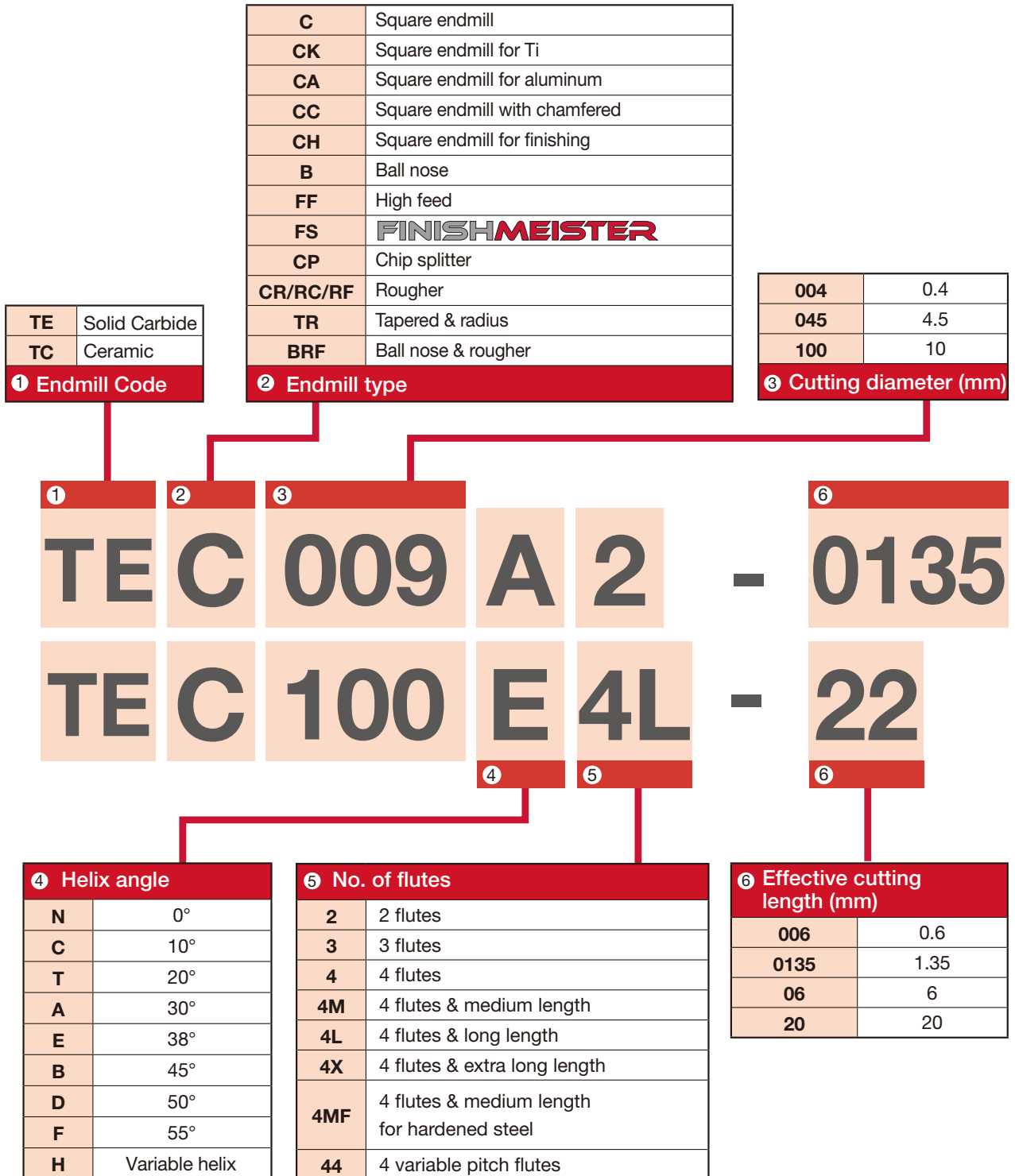
Trouble	Possible causes	Countermeasures
Poor surface finish	Bright, but Wavy surface	<ul style="list-style-type: none"> ● Reduce feed per tooth. ● Increase flutes; E.g. 2 flutes → 3flutes, or 4flutes.
	Small chips are welded on surface.	<ul style="list-style-type: none"> ● Increase cutting speed. ● Use coolant or air blast, or increase coolant. ● Make slight honing on the edge. ● Upward milling → Down cutting. ● Increase feed per tooth. Increase Depth of Cut.
	Scratches on the surface	<ul style="list-style-type: none"> ● Make slight honing on the edge. ● Use non-water soluble coolant. ● Down cutting → Upward milling.
	Poor surface by over cutting	<ul style="list-style-type: none"> ● Reduce depth of cut. ● Increase cutting speed. ● Reduce feed per tooth.
Poor accuracy	Finish size becomes a minus tendency.	<ul style="list-style-type: none"> ● Upward milling → Down cutting. ● Reduce depth of cut. ● Replace chuck or collet to new one. ● Reduce overhang length. ● Increase cutting speed.
	Poor straightness	<ul style="list-style-type: none"> ● Reduce depth of cut. ● Replace chuck or collet to new one. ● Reduce overhang length. ● Increase cutting speed. ● Increase flutes; E.g. 2 flutes → 4flutes. ● Reduce feed per tooth. ● Check the edge. Change tool, when needed.
Chattering		<ul style="list-style-type: none"> ● Increase feed per tooth. Reduce feed per tooth, when current feed is more than 0.003 ipr. ● Change cutting speed. ● Replace chuck or collet to new one. ● Reduce overhang length. ● Use 2 flutes tool in roughing. Use 4 flutes tool in finishing. ● Down cutting → Upward milling.

CAUTIONARY POINTS IN USE

- The cutting heads specified by Tungaloy must be used. Avoid using alternate heads that are not Tungaloy products as this will damage the shank and can cause severe accident or injury.
- Before setting the head, clean the connection screw with an air blast or a wiping cloth to remove chips and other foreign matter that may remain.
- Do not apply the lubricant to the connection screw.
- Please use the correct wrench with the correct cutting head. Tighten the head slowly until the face of the head contacts the shank. (Please refer to the picture shown on the right.) Do not re-tightening or over-tightening. Excessive tightening may cause the cutting head to break.
- Do not apply excessive force or a hammer when tightening or exchanging the cutting heads.



SOLIDMEISTER Designation System



Tolerance

Diameter range	Cutting diameter DC ^{e8}	Shank DCONMS ^{h6}
< 3	-0.014 - 0.028	0 - 0.007
3 - 6	-0.02 - 0.038	0 - 0.008
6 - 10	-0.025 - 0.047	0 - 0.009
10 - 18	-0.032 - 0.059	0 - 0.011
18 - 30	-0.04 - 0.073	0 - 0.013

/04	4
/10 /1.5	10 / 1.5°
/14	14

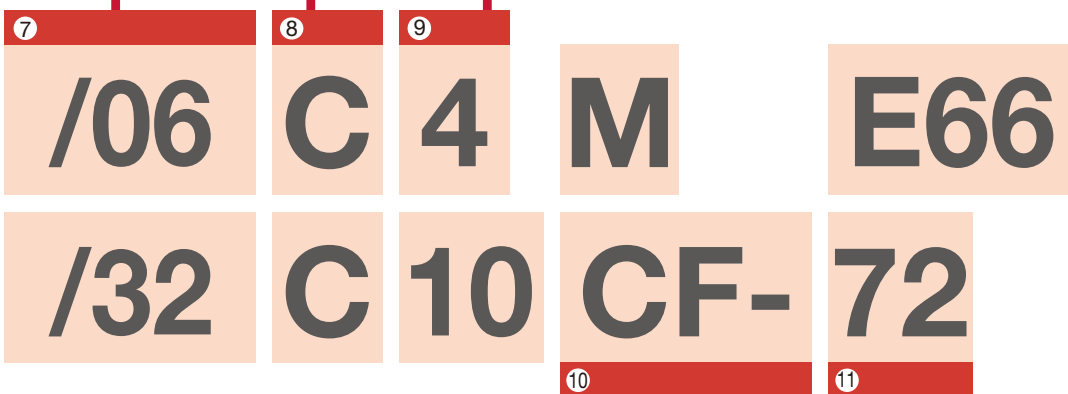
C	Cylindrical
W	Weldon

055	5.5
08	8
4	4

7 Length of neck / Angle neck (mm)

8 Shank type

9 Shank diameter (mm)



10 Workpiece material / Additional feature	
-	General
S	Stainless steel
M	Steel medium hardness ≤ 55 HRC
H	Steel high hardness ≥ 55 HRC
R02A	Aluminum
CF	VARIABLEMEISTER
R16	Corner radius: 1.6

11 Overall length / Corner radius	
66	66 mm
180	180 mm
E**	Eco type
M	Medium
R08	Corner radius: 0.8

TUNGMEISTER Designation System

Shank

V **SS** **037** **L300** **S** **06** **U** **S**

1 Series		3 Shank diameter (in)		4 Length (in)		7 Additional feature	
V	TungMeister	031	ø0.315	L300	3.000	U	Inch
2 Shank type		037	ø0.375	5 Shape of shank		8 Shank material	
SS	Straight neck	050	ø0.500	S	Cylindrical	S	Steel
TS	Taper neck	062	ø0.625	W	Weldon	C	Carbide
SC	Slotting	075	ø0.750	6 Connection screw size		W	Tungsten
ST	for T-Slotting	100	ø1.000	05	S05		
AD	TungFlex adapter			06	S06		
				08	S08		
				10	S10		
				12	S12		
				15	S15		

Head

• Square endmill

V **E** **E** **031** **L20** **R000** - **U** **03** **S05**

• Ball nose endmill

V **B** **D** **075** **L62** - **B** **G** - **U** **04** **S12**

1 Series		3 Helix angle / Rake face		6 Corner shape / Angle		8 Additional feature	
V	TungMeister	B	0°	Chamfer type		U	Inch
2 Cutting edge		C	15°	C006	0.006 x 45°	9 The number of flutes	
E	Square	D	30°	C012	0.012 x 45°	General	
B	Ball	E	38° ~ 50°	C024	0.024 x 45°	02	2
R	Radius	F	60°	Chamfering head		06	6
FX	for high feed	T	Land	A30	30°	10 Connection screw size	
CA	for chamfering	H	Variable helix	A60	60°	S05	S05
CP	Spot drilling	4 Diameter (in)		Ball nose		S06	S06
CW	for chamfering (front and back)	050	ø0.500	SG	Sphere / high precision	S08	S08
CR	for R chamfering	100	ø1.000	BM	Ball / general purpose	S10	S10
GC	for counter boring	5 Cutting edge length (in)		BG	Ball / high precision	S12	S12
DP	for center drilling	Length		7 Additional feature		S15	S15
S	for slotting	L37	0.375	I	Irregular pitch		
T	for T-slot milling	L87	0.875	A	for aluminum		
				R	for roughing		
				C	Combined edge		

Shank

V **SS** **D10** **L070** **S** **06** - **W** - **A**

1 2 3 4 5 6 7 8

1 Series	
V	TungMeister

2 Shank type	
SS	Straight neck
TS	Taper neck
SC	Slotting
ST	T-slotting
AD	TungFlex adapter
ER	ER collet holder

3 Shank diameter (mm)	
D06	ø6
D08	ø8
D10	ø10
D12	ø12
D16	ø16
D20	ø20
D25	ø25
D32	ø32
VSC, VAD type	
100	ø10
120	ø12
130	ø13
180	ø18
210	ø21
VER type	
11A	Collet size
16A	Collet size

4 Length (mm)	
L070	70

5 Shape of shank	
S	Cylindrical
W	Weldon

6 Connection screw size	
04	S04
05	S05
06	S06
08	S08
10	S10
12	S12
15	S15
21	S21

7 Shank material	
S	Steel
C	Carbide
W	Tungsten

8 Additional feature	
A	with coolant hole
M	Thread size (TungFlex adapters)

Head

- Square endmill

V **E** **E** **080** **L05.0** **R00** - **03** **S05**

1 2 3 4 5 6 7 8 9

- Ball nose endmill

V **B** **D** **200** **L15.0** - **BG** - **04** **S12**

1 2 3 4 5 6 7 8 9

1 Series	
V	TungMeister

2 Cutting edge	
E	Square
B	Ball
R	Radius
FX	High feed
CA	Chamfering
CP	Spot drilling
DS	Spot drill with helical flutes
CW	Chamfering (front and back)
CR	R chamfering
GC	Counterboring
DP	Center drilling
S	Slotting
TB	T-slotting
FM	Face milling
BO	Taper barrel
BN	Bull nose
BL	Lens
MT	Threading (full profile)
TR	Threading (partial profile)

3 Helix angle / Rake face	
B	0°
C	15°
D	30°, 37°, 47°
E	38°, 45°, 50°
F	60°
H	43°
T	Land

4 Diameter (mm)	
060	ø6
200	ø20

5 Cutting edge length (mm)	
Length	
L07.0	7
L15.0	15
Groove width	
W1.50	1.5
W1.57	1.57
W10.0	10

6 Corner shape / Angle	
Nose radius	
R00	Sharp edge
R005	R0.05
R01	R0.1
R05	R0.5
R10	R1.0
Chamfer type	
C15	0.15 x 45°
C30	0.3 x 45°
C60	0.6 x 45°
Chamfering head	
A30	30°
A60	60°
R chamfering head	
R10	R1.0
R16	R1.6
Ball nose	
SG	Sphere / high precision
BM	Ball / general purpose
BG	Ball / high precision
Threading	
IS**	ISO metric, pitch**
UN**	Unified, **TPI
W**	Whitworth, pitch**

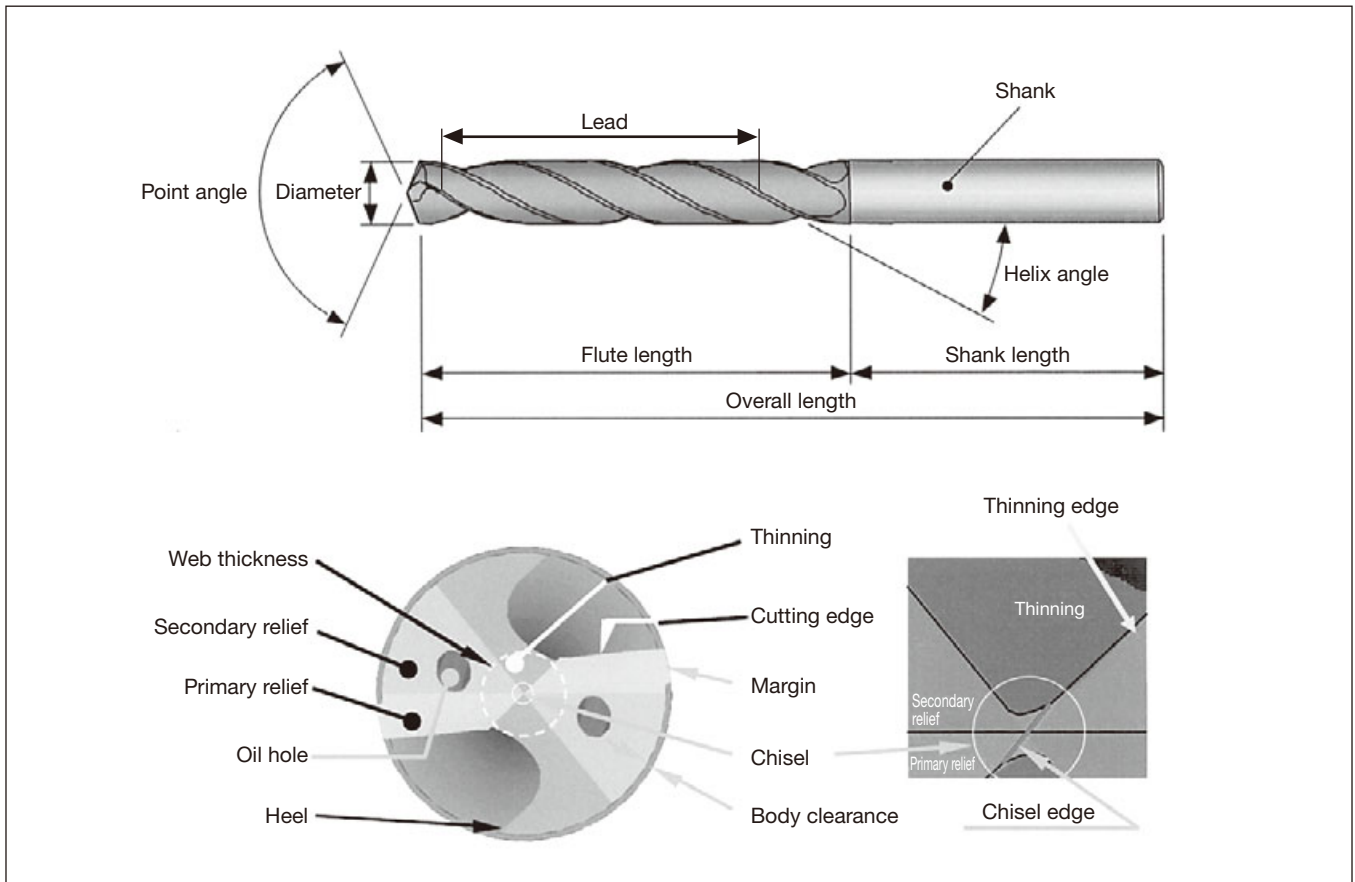
7 Additional feature	
I	Irregular pitch (or Intermittent edge)
A	for aluminum
R	Serrated edge
C	Combined edge

8 The number of flutes	
General	
02	2
06	6
Slotting head VST type	
3	3
4	4

9 Connection screw size	
S04	S04
S05	S05
S06	S06
S08	S08
S10	S10
S12	S12
S15	S15
S21	S21

Drill

Nomenclature for solid carbide drills



Cutting forces and power requirement

● Twist drill

Power requirement
$P_C = KD^2n (0.647 + 17.29f) \times 10^{-6}$ (kW)
Thrust force
$T_C = 570KDf^{0.85}$ (N)
Torque
$M_C = \frac{KD^2 (0.630 + 16.84f)}{100}$ (N·m)

- P_C : Power requirement (kW)
- T_C : Thrust force (N)
- M_C : Torque (N·m)
- D : Drill diameter (mm) [DC]
- f : Feed (mm/rev)
- n : No. of revolutions (min⁻¹)
- K : Material constant... Refer to the Table at right

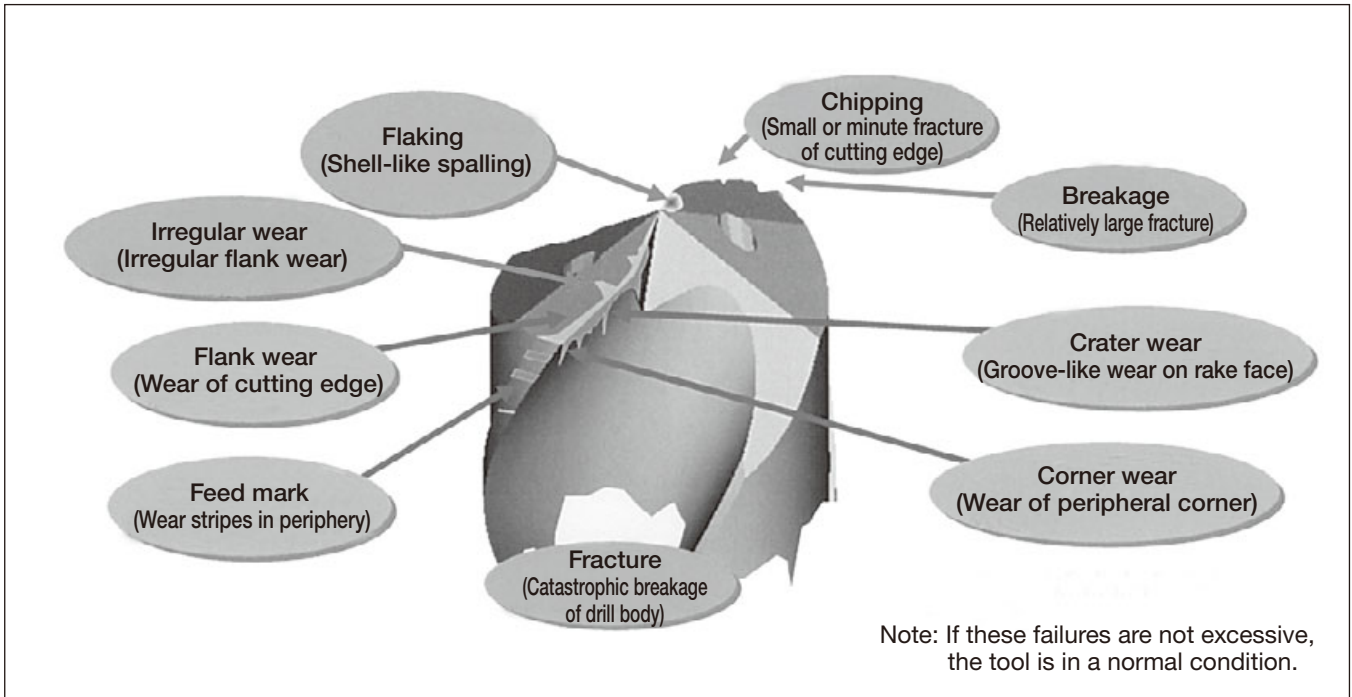
() The notation in the brackets is the one used in the catalog (ISO compliant)

● Material constant compensating for power requirement and thrust force

Workpiece material	Tensile strength		Brinell hardness (HB)	Material constant (K)
	MPa(N/mm ²)	{Kg/mm ² }		
Cast iron	210	21	177	1.00
Cast iron	280	28	198	1.39
Cast iron	350	35	224	1.88
Aluminum	250	25	100	1.01
Low carbon steel (JIS S20C)	550	55	160	2.22
Free cutting steel (JIS SUM32)	620	62	183	1.42
Manganese steel (JIS SMn438)	630	63	197	1.45
Nickel chromium steel (JIS SNC236)	690	69	174	2.02
4115 steel Cr0.5, Mo0.11, Mn0.8	630	63	167	1.62
Chromium molybdenum steel (JIS SCM430)	770	77	229	2.10
Chromium molybdenum steel (JIS SCM440)	940	94	269	2.41
Nickel chromium molybdenum steel (JIS SNCM420)	750	75	212	2.12
Nickel chromium molybdenum steel (JIS SNCM625)	1,400	140	390	3.44
Chromium vanadium steel				
Cr0.6, Mn0.6, V0.12	580	58	174	2.08
Cr0.8, Mn0.8, V0.1	800	80	255	2.22

A
B
C
D
E
F
G
H
I
J
K
L
M

Cutting edge failure of solid carbide drills

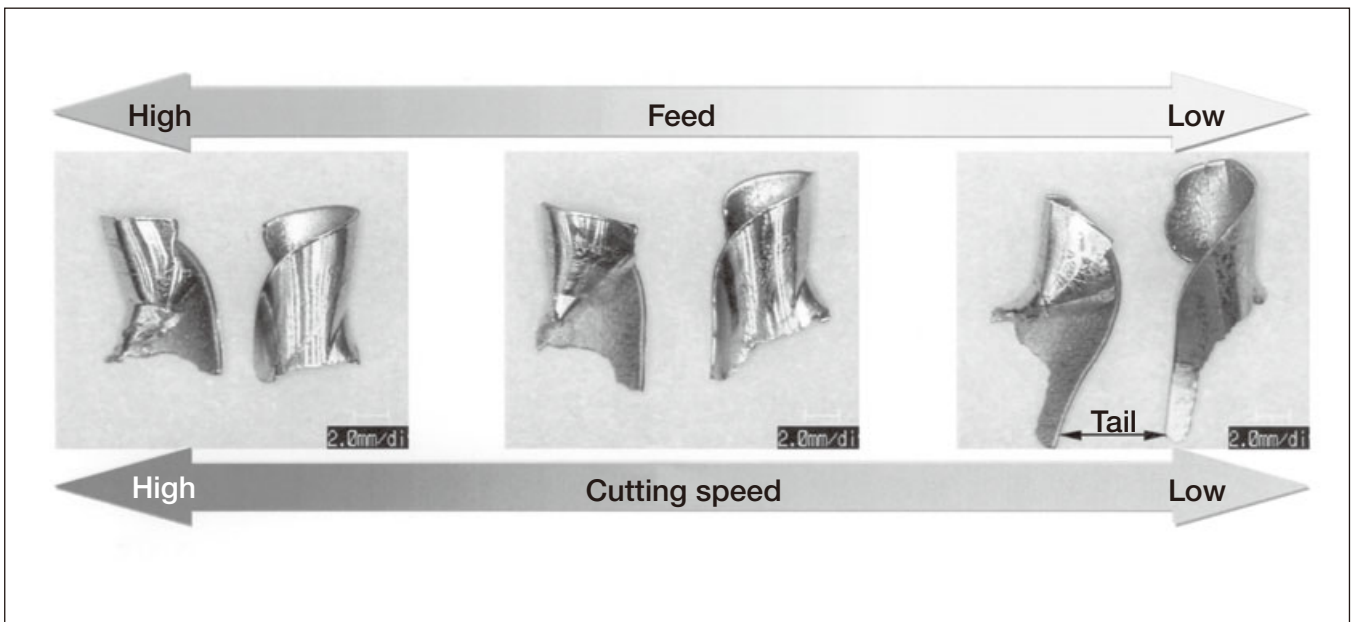


Change of chip shapes in drilling

Change of chip shapes relating to cutting conditions

Photographs below show the change of chip shapes relating to change of the feed and the cutting speed. These chip shapes are all well controlled in a proper condition range.

When the speed and feed are low, the chip shows whitish color and the tail of the chip tends to lengthen gradually. In contrast, as the speed or the feed increases, the chip tends to increase in brightness and becomes a compact shape with a short tail. These changes in the shape depend on the cutting temperature. As the temperature increases, chips tend to be broken.

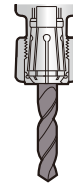


Guidelines for correct usage of carbide drills

● Holders for solid carbide drills:

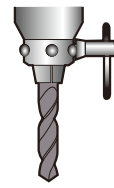
A collet chuck holder is recommended for use with carbide drills. When using a milling chuck holder, a collet chuck with a straight shank or straight collet should be used.

OK



Collet chuck

X

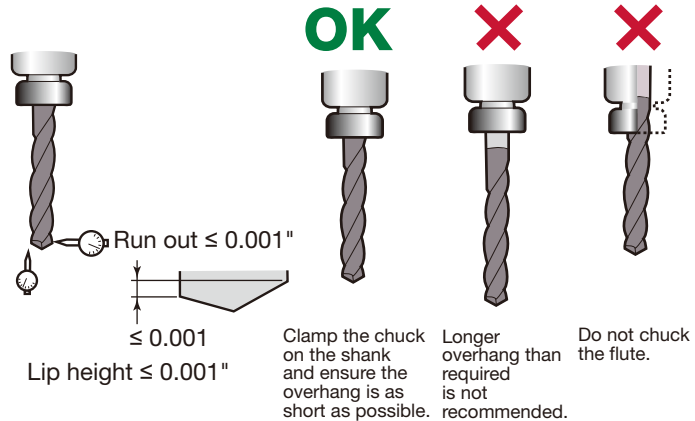


Drill chuck

● Chucking drills:

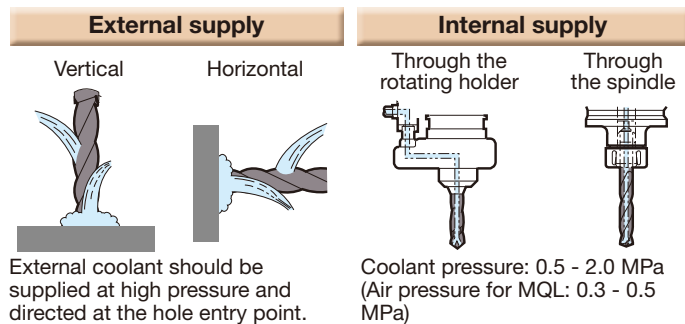
■ Radial run out and lip height should be less than 0.001". If run out or lip height is larger (close to 0.002"), machining is possible. However, less accurate holes or short tool life may be a result.

■ Overhang length should be as short as possible.



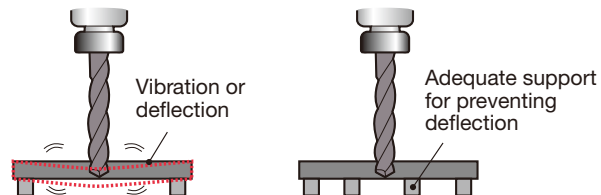
● Coolant Supply:

When using a drill without a coolant hole, such as the DSW-DE type, coolant should always be directed to the entrance of the hole. Maintaining this supplying is very important for stable drilling performance.



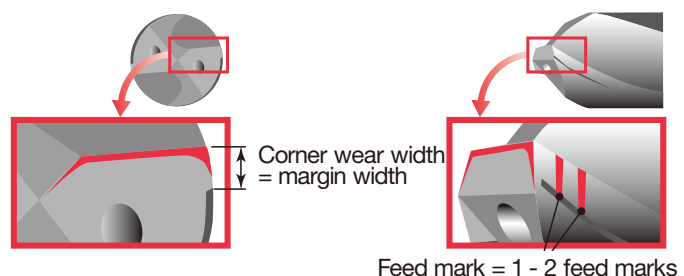
● Clamping workpieces:

As solid carbide drills have a higher thrust force, machining with low rigidity or inadequate support can cause fractures or breakages through vibration. It is important the workpiece is rigidly clamped and has adequate support.

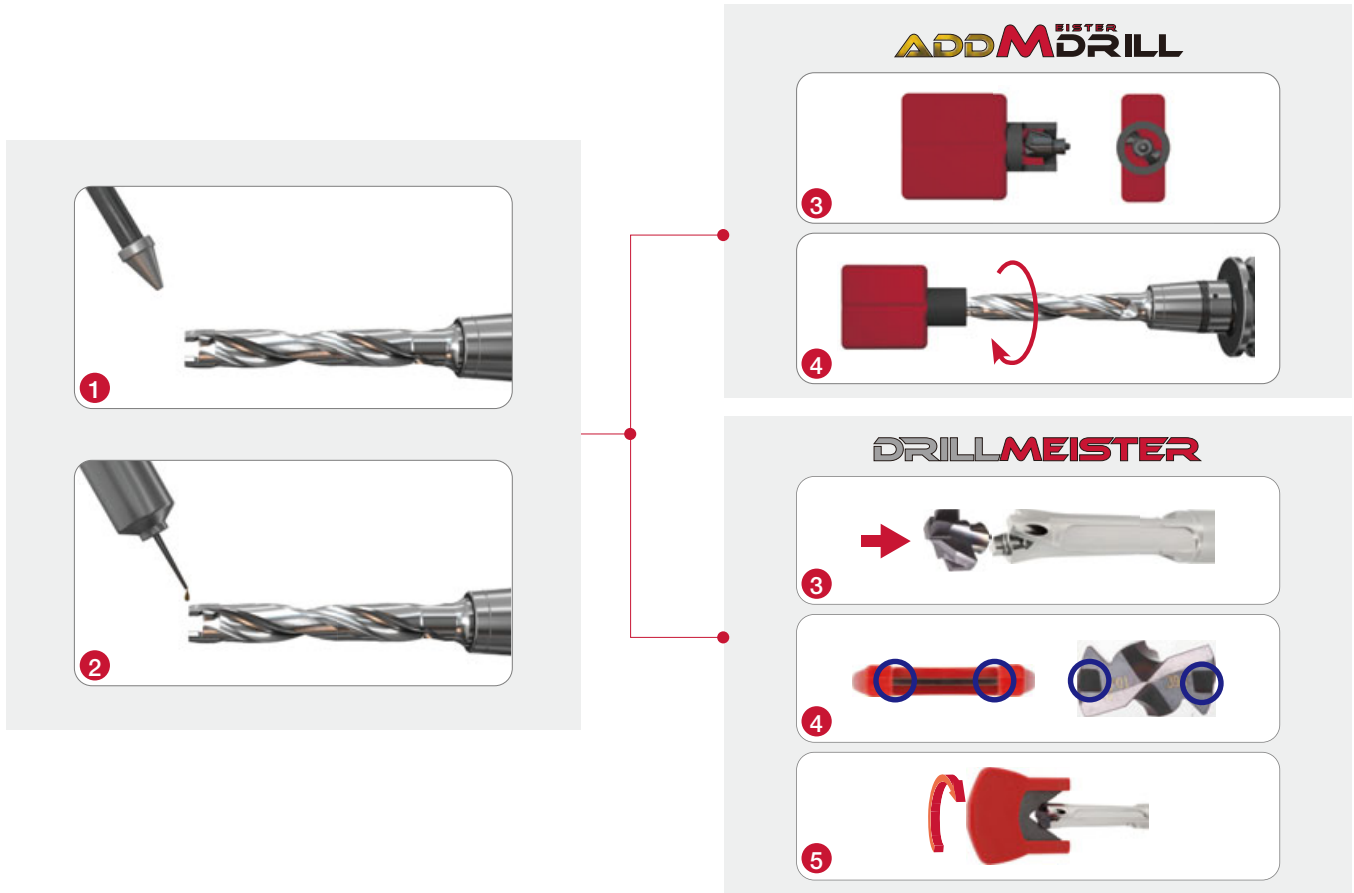


● The criteria of tool life:

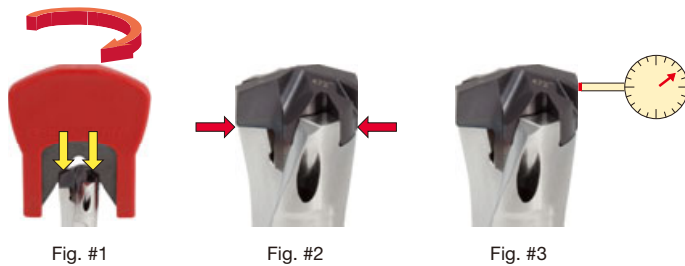
- Corner wear width: equal to margin width
- Feed mark: 1 - 2 feed marks on the margin
- Spindle load increase: 30% higher than starting level
- Irregular situation: worse chip control, hole diameter change, worse surface finish, larger burrs, bigger sound.



● Drilling head mounting procedure



● Instruction for proper head mounting

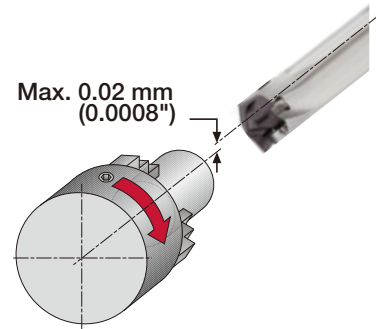


Procedures

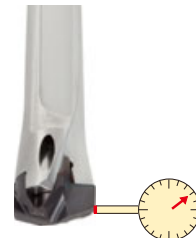
- ① Thoroughly clean the contacting areas on the drill body and the head with compressed air, lubricate them, and put the drill head in the pocket.
- ② Place the clamping key in the grooves on the drill head. Push the head in the pocket with equal torque on the right and the left sides. Rotate the clamping key to lock the head in the pocket completely. (Fig. #1).
- ③ Be sure that there is no gap in the contact surfaces between the head and the drill body. Use a 0.0004" shim to check for the gap. (Fig. #2)
- ④ If there is a gap thicker than 0.0004", unclamp the head and return to procedure No. ①.
- ⑤ Measure the run-out at the margin of the drill head. Run-out must be 0.002" or smaller. (Fig. #3) (Recommended value: 0.0008" or smaller)
If the run-out exceeds 0.002", unclamp the head and return to procedure No. ①.

Note: #1: If the clamping torque is not equally applied on the right and the left sides of the drill head, there may be a gap between the head and the body, which increases the run-out of the head.
Note: #2: Low accuracy in holding the drill body may affect the run-out. If the run-out is large, check the accuracy in holding the drill body.

● Alignment recommendation

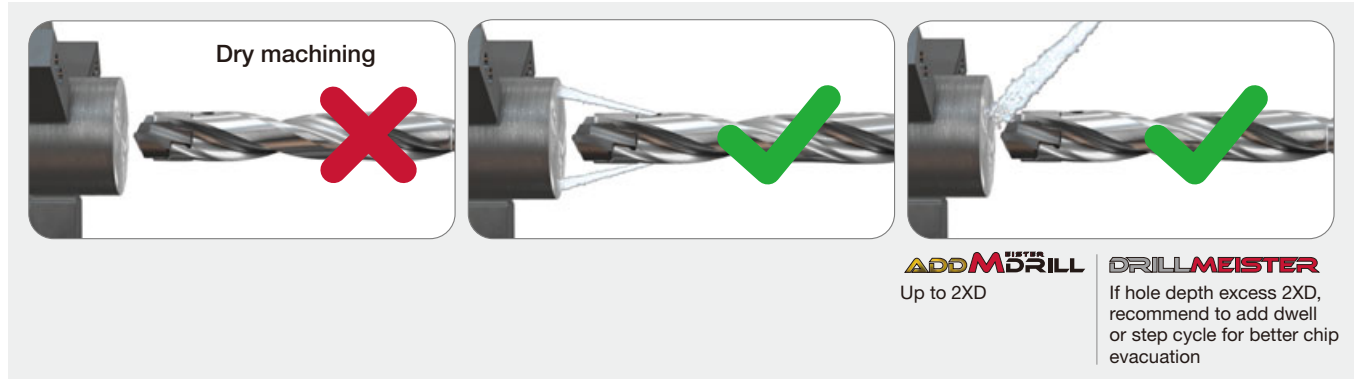


● Runout recommendation

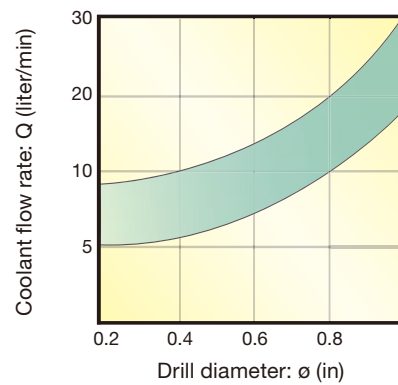
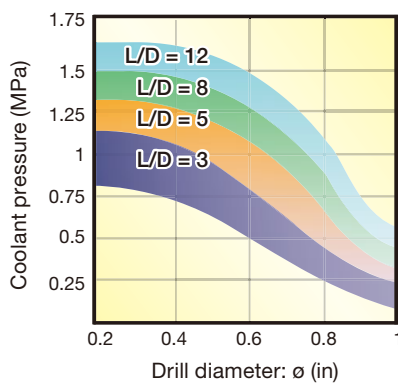


	ADD M ^{FISTER} DRILL	DRILLMEISTER
Max. 0.0008"		
Ideal		≤ 0.0008"
Acceptable		≤ 0.002"
Not acceptable		> 0.002"

● Coolant recommendation



● Recommended coolant flow rate and pressures

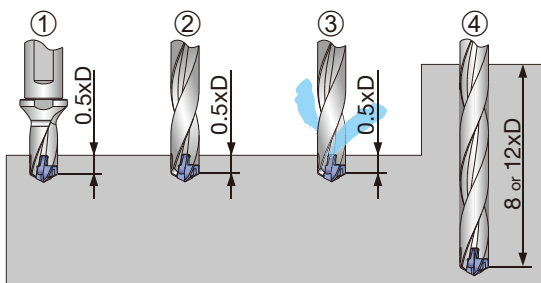


● Application range and recommended tool lengths for application irregularities

Please use the shortest tool length possible

Application	Stacked plate	Complex exit	Rough / cast surface	Inclined surface	Legend
					✓ OK ✗ Impossible
ADDM DRILL	✗	✗	✗	✗	
DRILLMEISTER	✓	Up to 8xD ✓	Up to 5xD ✓	Up to 3xD ✓	
Application	Curved surface	Hole expansion	Plunging	Counter boring	
ADDM DRILL	✗	✗	✗	✗	
DRILLMEISTER	Up to 3xD ✓	Up to 3xD ✓	Up to 3xD ✓	✗	

● Tips when using 8xD and 12xD drills



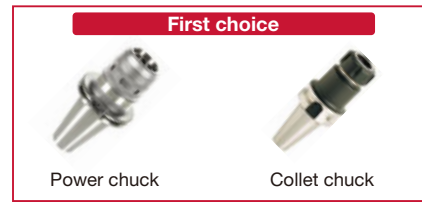
- ① Drill a pilot hole in the depth of 0.5xD.
The same head diameter should be used for the pre-hole and the main drilling process.
 - ② Rotate the drill at a low speed (eg. 100 rpm). While maintaining the drill speed, slowly feed into the pilot hole for several millimeters from the entry.
 - ③ Activate the internal coolant and increase the drill rotation to the required speed.
 - ④ Drill to the required depth using the recommended cutting parameters.
- Note: Use DMC-style drill head for deep holes from 8xD up to 12xD depths without a pilot hole.

● Head combinations of pre-hole to main hole

		Pre-hole		
		DMP	DMC	DMF
Hole	DMP	Good 	Not good 	Not good
	DMC	Good 	Good 	Good
	DMF	Not good 	Not good 	Good

● Holders recommended for M/C

TID-F...



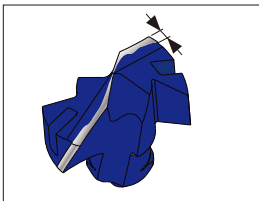
TID-R...



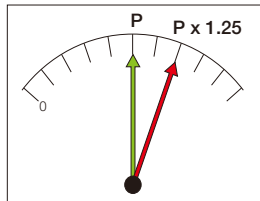
Note: If you need to use a 12xD body with a side-lock holder, the shank will need to have a flat area which may be placed additionally.

● When to change drill heads (Criteria for the end of tool life)

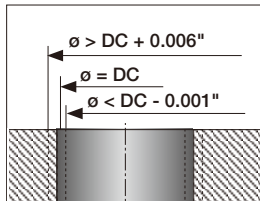
Replace the drill head when the following phenomena occur during the machining:



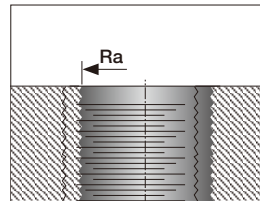
Width of corner wear reaches



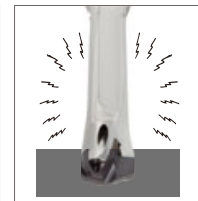
Spindle load exceeds 125% of the normal value



Hole diameter is 0.006" larger or 0.001" smaller than the drill diameter



Surface roughness deterioration



Vibration or unusual noise

ADD M DRILL : 0.008" - 0.012"
DRILL MASTER : 0.004" - 0.008"

KEY FOR MEASURING HEAD RELEASE TORQUE

The release torque in unclamping a head is measured with a torque driver to determine the body's tool life. Please refer to the below for the standard release torque value which indicates the end of tool life (The value less than the standard should be judged as the end of tool life).

Dedicated key designation :
KHS-TID10-19.99



*Can be connected with a commercially available torque driver.



Head designation	Release torque value to indicate tool replacement (lbf · ft)
DMP100-109	0.15
DMP110-119	0.15
DMP120-129	0.18
DMP130-139	0.18
DMP140-149	0.22
DMP150-159	0.22
DMP160-169	0.26
DMP170-179	0.26
DMP180-189	0.3
DMP190-199	0.3

● How to change drill head

- Caution when installing the drill head

Install the drill head so that the arrow etched on the drill head should be facing to the arrow on the drill body.



- Tightening and loosening of insert clamping screw

To unclamp rotate the screw 3-5 times counter-clockwise.

No need to remove the screw from the body.



.Please change the screw to new one when the screw does not rotate smoothly

● Application range and recommended tool lengths for application irregularities

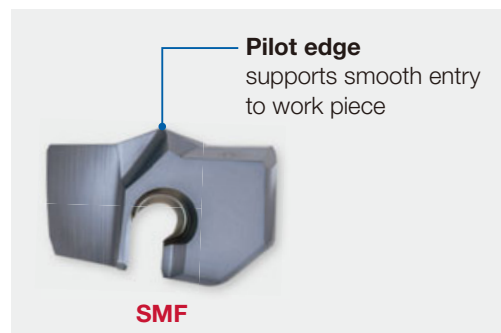
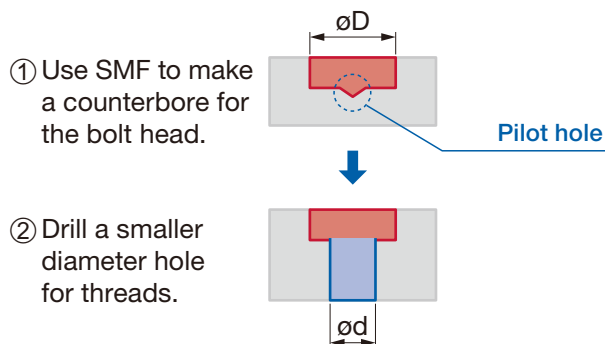
Please use the shortest tool length possible.

	Stacked plate	Irregular exit	Rough / cast surface	Inclined surface	✓ OK
Application					
DRILLFMEISTER	✓	Up to 8xD ✓	Up to 5xD ✓	Up to 3xD ✓	
Application					
DRILLFMEISTER	Up to 3xD ✓	Up to 3xD ✓	Up to 3xD ✓	Up to 3xD ✓	

● Drilling of step holes

- Follow the procedures outlined below for efficient drilling of step holes.
- SMF drill head creates a small divot in the center of the hole bottom. The divot will then pilot a drill used in the following process to create a concentric hole.

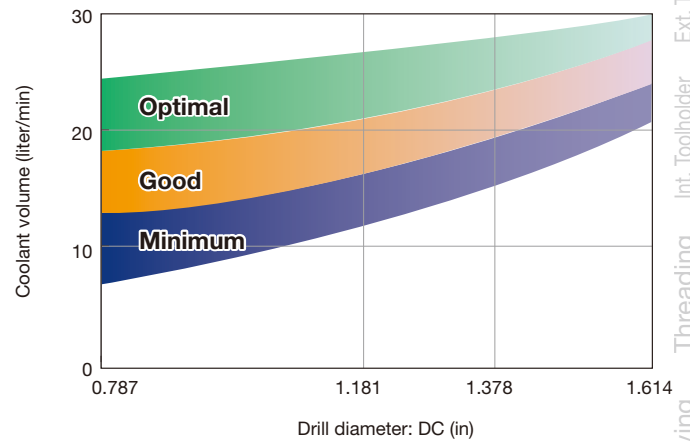
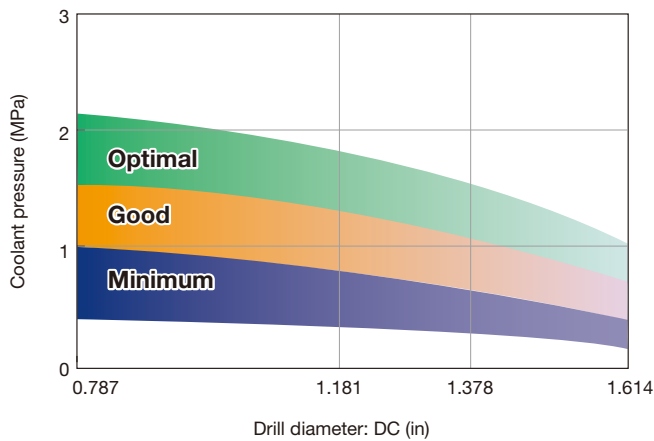
Recommended procedures



● When using for boring operations

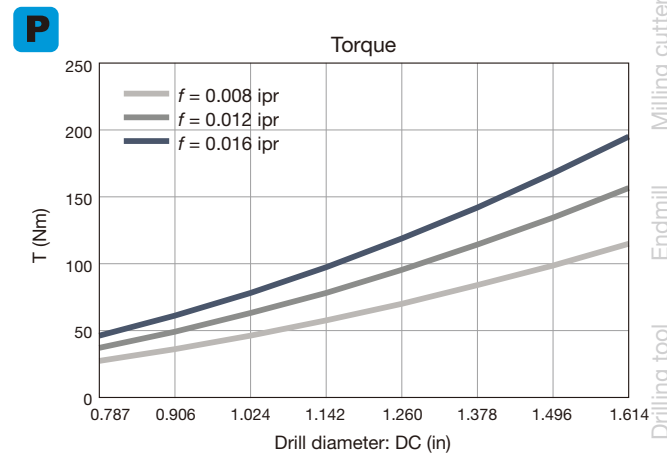
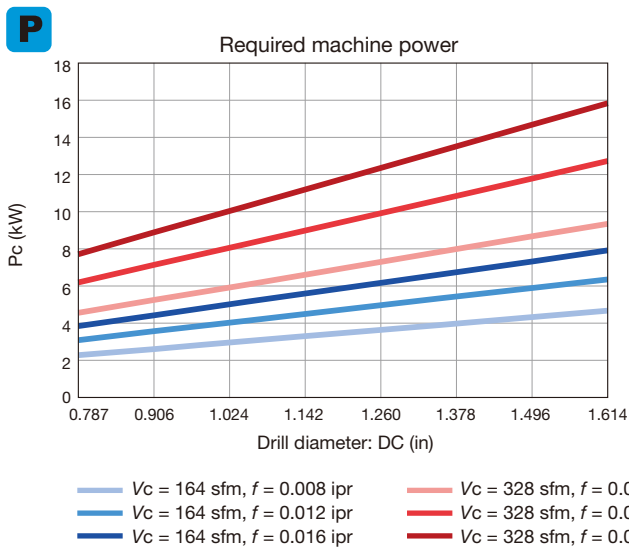
- The above procedures can also be used for boring operations.
- For boring operations, use SMF drill head with flat edges.
- SMF drill head will create long chips in the continuous cuts. For successful chip evacuation, use a dwelling or pecking method.

● Recommended coolant pressure and volume



Note: External coolant will also do. For holes exceeding 2xD depth, use dwelling or peck drilling method to promote smooth chip evacuation.

● Required machine power and torque



- Please access "Tungaloy machining power" to calculate more detailed cutting forces.

<https://www.imc-i.com/mpwr/Unit/mm/Company/Tungaloy>



Troubleshooting for solid carbide drills

Problem		Cause	Countermeasure
Abnormal wear	Relief surface	Inappropriate cutting speed	<ul style="list-style-type: none"> •Increase the cutting speed by 10 % within standard conditions if abnormal wear is around center. •Lower the cutting speed by 10 % within standard conditions if abnormal wear is on the periphery.
		Inappropriate cutting fluid	<ul style="list-style-type: none"> •Check the filter. •Use the cutting fluid superior in lubricity. (Increase the dilution rate)
	Margin	Inappropriate cutting speed	<ul style="list-style-type: none"> •Lower the cutting speed by 10 %.
		Regrinding timing, insufficient reground amount	<ul style="list-style-type: none"> •Shorten the regrinding timing.
		Insufficient rigidity of the machine and workpiece	<ul style="list-style-type: none"> •Change the clamp method to the one with rigidity.
		Insufficient drill rigidity	<ul style="list-style-type: none"> •Use smallest possible overhang.
		Inappropriate cutting fluid	<ul style="list-style-type: none"> •Check the filter. •Use the cutting fluid superior in lubricity. (increase the dilution rate)
Intermittent cutting when entering	<ul style="list-style-type: none"> •Avoid interruption at entry and exit. •Lower the feed by about 50 % during entering into and leaving from the workpiece. 		
Chipping and fracture	Chisel section (center of drill cutting edge)	Insufficient rigidity of the drill	<ul style="list-style-type: none"> •Reduce the drill overhang as much as possible. •Increase the feed at entry when the low speed feed is selected in standard cutting condition range. •Use a bushing or a center drill.
		Insufficient rigidity of the machine and workpiece	<ul style="list-style-type: none"> •Change the clamp method to the one with rigidity.
		Inappropriate entry into the workpiece	<ul style="list-style-type: none"> •Avoid interruption at entry into the workpiece. •Lower the feed by 10 % at entry.
		High workpiece hardness	<ul style="list-style-type: none"> •Lower the feed by 10 %.
		Inappropriate honing	<ul style="list-style-type: none"> •Check if honing has been made to the center of cutting edge.
	Peripheral cutting edge	Insufficient drill rigidity	<ul style="list-style-type: none"> •Lower the cutting speed by 10 %. •Increase the feed at entry when the low speed feed is selected in standard cutting condition range.
		Inappropriate drill mounting accuracy	<ul style="list-style-type: none"> •Check the run out accuracy after drill installation. (0.0012" or less)
		Insufficient machinery and workpiece rigidity	<ul style="list-style-type: none"> •Change the clamp method to the one with rigidity. •Lower the feed during entering into and leaving from the workpiece.
		Inappropriate honing	<ul style="list-style-type: none"> •Check if honing has been made to the cutting edge periphery.
	Margin	Insufficient machine and workpiece rigidity	<ul style="list-style-type: none"> •Change the clamp method to the one with rigidity.
		Insufficient drill rigidity	<ul style="list-style-type: none"> •Use smallest possible overhang. •Use a bushing or center drill.
		Regrinding timing and insufficient amount of reground stock	<ul style="list-style-type: none"> •Shorten the regrinding timing.
		Intermittent cutting when entering or exiting the cut	<ul style="list-style-type: none"> •Avoid interruption at entry and exit. •Lower the feed by about 50 % during entering into and leaving from the workpiece.
Breakage	Tendency to cause chipping or develop abnormal wear	<ul style="list-style-type: none"> •Check the failure mode condition before breakage and find out the wear and chip countermeasures. 	
	Chip packing in the drill flutes	<ul style="list-style-type: none"> •Review the cutting conditions. •For internal coolant supply, raise the supply pressure of cutting fluid. •Use peck feed for deep holes. 	
	Insufficient machine output	<ul style="list-style-type: none"> •Review the cutting conditions. •Use the machine with high power. 	
Insufficient hole accuracy	Insufficient rigidity of the machinery and workpiece	<ul style="list-style-type: none"> •Change to the clamp method with rigidity 	
	Inappropriate drill installation accuracy	<ul style="list-style-type: none"> •Check the run out accuracy of drill mounting. (0.0012" or less) 	
	Chip packing in the flutes.	<ul style="list-style-type: none"> •Review the cutting conditions. •Raise the cutting oil supply pressure. •Use peck-feed for deep holes. 	
	Inappropriate edge sharpening accuracy	<ul style="list-style-type: none"> •Check the edge shape accuracy. 	
Prolonged chips	Inappropriate cutting conditions	<ul style="list-style-type: none"> •Increase the feed by 10 % within standard conditions. 	
	Inappropriate honing	<ul style="list-style-type: none"> •Provide the appropriate honing. 	
	Cutting edge with chipping or breakage	<ul style="list-style-type: none"> •Lower the cutting speed by 10 %. 	



Regrinding method

Please refer to the following instructions prior to regrinding DSW type drills.

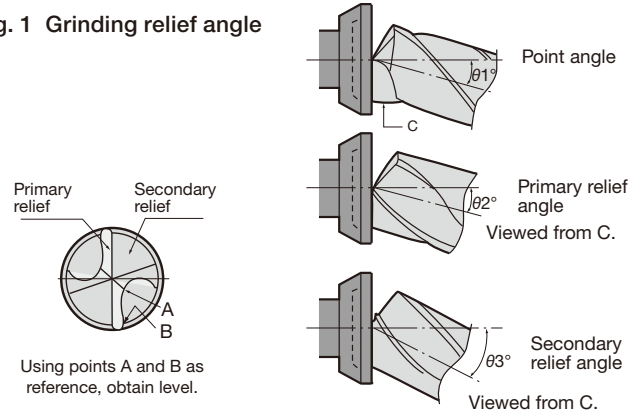
Before regrinding

Check the cutting edge for damage and wear. If any large fracture is found, remove with a silicon carbide wheel.

(1) Grinding the flank

- Use a 280 to 400 grit diamond cup type wheel of 3.937" ~ 7.874" in diameter.
- 1) Grind the relief surface so that primary relief angle (θ) of 2° can be formed as shown in Fig.1. After grinding the other side likewise, do sparkout grinding so that the difference of the lip height will be kept within 0.0008".
- 2) In the cases of DSW types: After grinding the primary relief angle (θ) 2° , without rotating the drill, grind the secondary relief surface so that the relief angle (θ) of 3° can be formed. In the same way as 2), take care to bring the ridge line formed between the primary and secondary relief surfaces to the drill center. (Values (θ) of $1^\circ \sim 3^\circ$ are shown in Table 1)

Fig. 1 Grinding relief angle



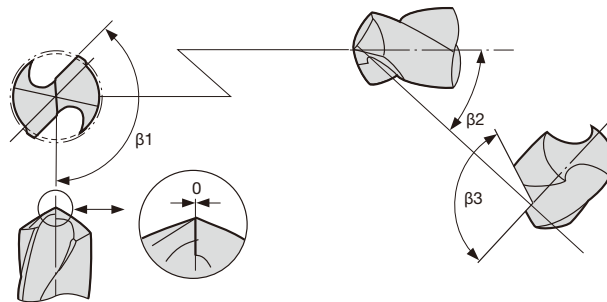
(2) Thinning

- Use a 280 ~ 400 grit diamond straight-type wheel of 3.937" ~ 7.874" in diameter.
- Conduct thinning in the same manner as cross thinning (X-type).
- Values of β_1 to β_3 written in the figures are given in the Table 2.

Table 1	θ_1 (Point angle)	θ_2 (Primary relief angle)	θ_3 (Secondary relief angle)
DSW	-20°	$-6^\circ \sim -12^\circ$	$-23^\circ \sim -27^\circ$

Table 2	β_1	β_2	β_3
DSW	$147^\circ \sim 153^\circ$	$30^\circ \sim 42^\circ$	$95^\circ \sim 110^\circ$

Fig. 2



(3) Honing

- The honing angle θ and width H should be varied depending on the drill type, diameter, and work material. Recommended honing specifications are given in the Table below.
- Honing procedures (refer to Fig.3)
 - (1) Round the R portion shown in Fig.3 in large.
 - (2) Then, roughly hone the cutting edge lines by using an electro-deposited diamond file of around 170 grit.
 - (3) Carry out finish honing by using a diamond hand stick of 400 to 600 grit.
- The honing width should be changed depending on the drill diameter. For smaller side of diameters, the width should be in smaller side of values given in the Table.

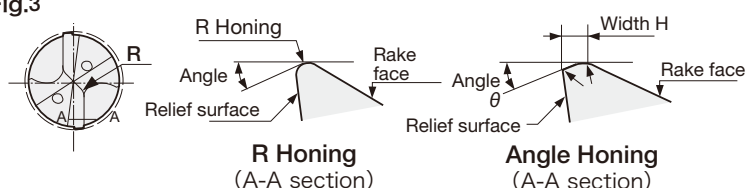
● Angle honing

	$\sim \phi 0.236"$	$\phi 0.236" \sim \phi 0.394"$	$\phi 0.394" \sim \phi 0.630"$
θ	-20°	-20°	-20°
H	0.001" ~ 0.002"	0.002" ~ 0.003"	0.003" ~ 0.004"

● R Honing

Dimensions (in)	R Honing R (in)
$DC \leq \phi 0.236"$	0.0008" ~ 0.0016"
$\phi 0.236" < DC \leq \phi 0.630"$	0.0012" ~ 0.0020"

Fig.3



After regrinding, check the following before use.

- The difference of the lip height is kept within 0.0008".
- Any damaged portion on the cutting edges is not left.
- Cutting edges are properly honed.
- Any grinding burr is not left.

Notes:

- For more details on regrinding, consult the nearest Tungaloy sales office.

SOLIDDRILL Designation System

DSW **088** - **035** - **10** - **D** **E** **3**

1 2 3 4 5 6 7

1 Series	
DSW	Series name of solid drill

2 Drill diameter DC (mm)	
088	ø8.8

3 Effective flute length LU (mm)	
035	35

4 Shank diameter DCONMS (mm)	
10	ø10

5 DIN 6535 - Form HA	
----------------------	--

6 Coolant Supply	
E	External (without coolant hole)
I	Internal (with coolant hole)

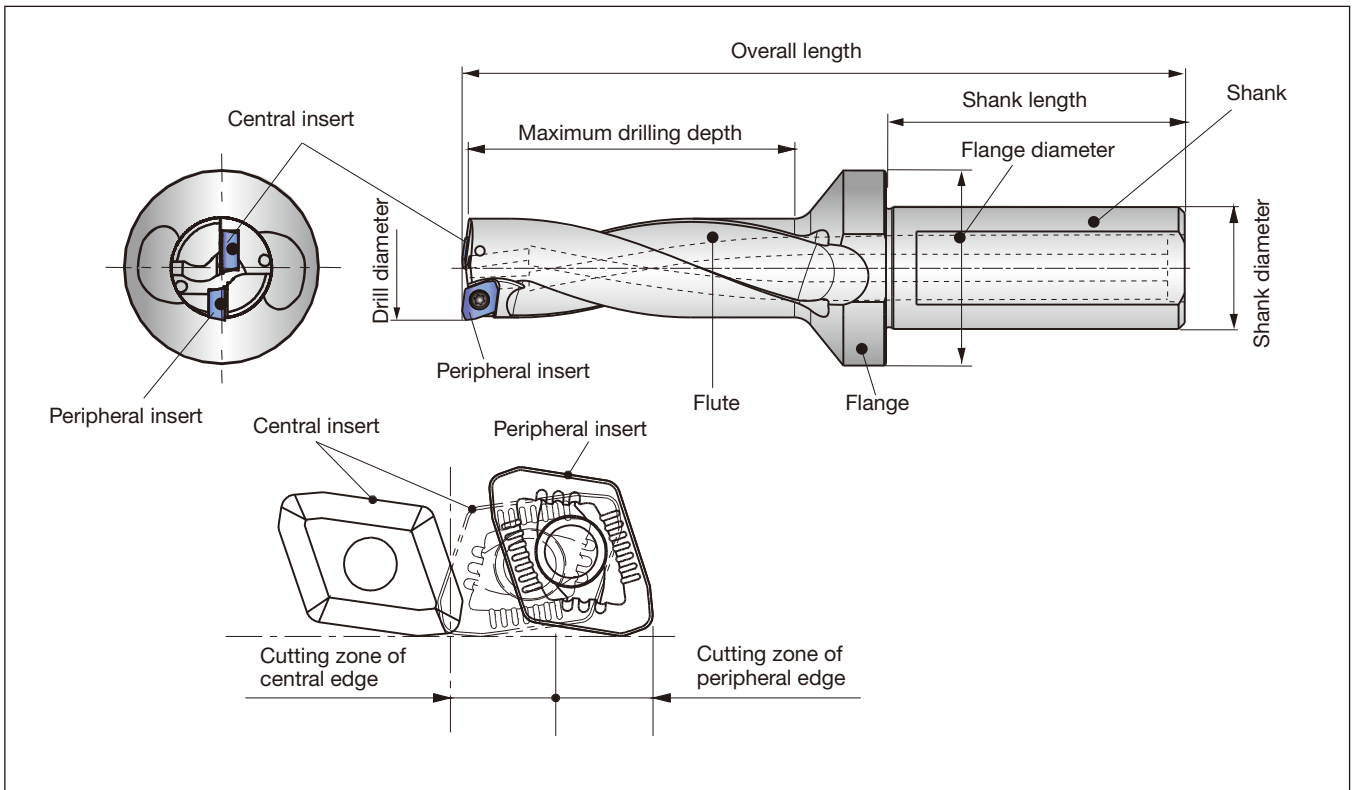
7 Drilling depth	
Approximate value of L/D ratio.	
Caution: Code may be different from the actual length. This is dependent upon the tool diameter.	

Caution: "Effective flute length" shows the maximum flute length for effective chip evacuation. The actual drilling depth may be shorter than described depending on the work material or cutting conditions.

Indexable Drill

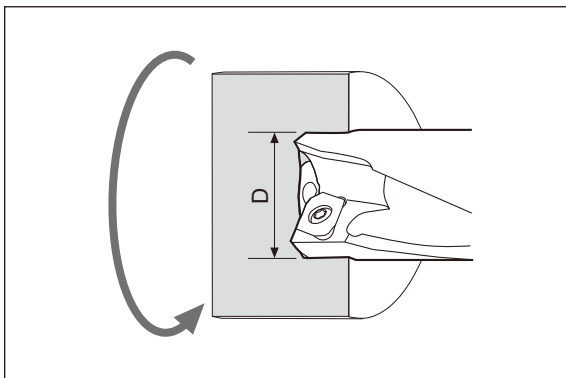
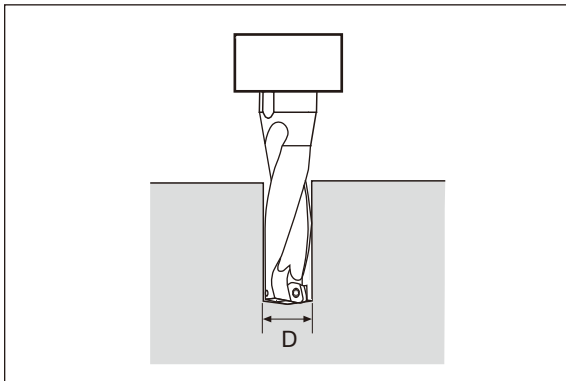


Nomenclature for Indexable drill



Calculation formulas for Indexable drill

Cutting speed



When calculating cutting speed from number of revolutions: (Drilling formulas)

$$SFM = \frac{RPM \times D}{3.82}$$

SFM: Cutting speed
D : Drill diameter (in) (DC)
RPM: Number of revolution (min⁻¹)

When calculating required number of revolutions from cutting speed: (Drilling formulas)

$$RPM = \frac{SFM \times 3.82}{D}$$

When calculating cutting speed from number of revolutions: (Where the workpiece rotates.)

$$V_c = \frac{\pi \times D \times n}{1000}$$

V_c : Cutting speed (sfm)
D : Drilling diameter (in) (DC)
 n : Number of revolutions (min⁻¹)
 $\pi \approx 3.14$

When calculating required number of revolutions from cutting speed: (Where the workpiece rotates.)

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

Calculation of feed speed

$$v_f = f \times n \text{ (mm/min)}$$

v_f : Feed speed (in/min)
f : Feed (ipr)
 n : Number of revolutions (min⁻¹)

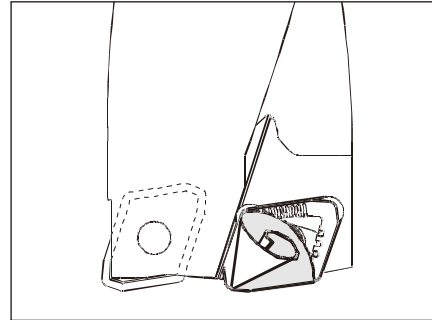
() The notation in the brackets is the one used in the catalog (ISO compliant)

Indexable Drill

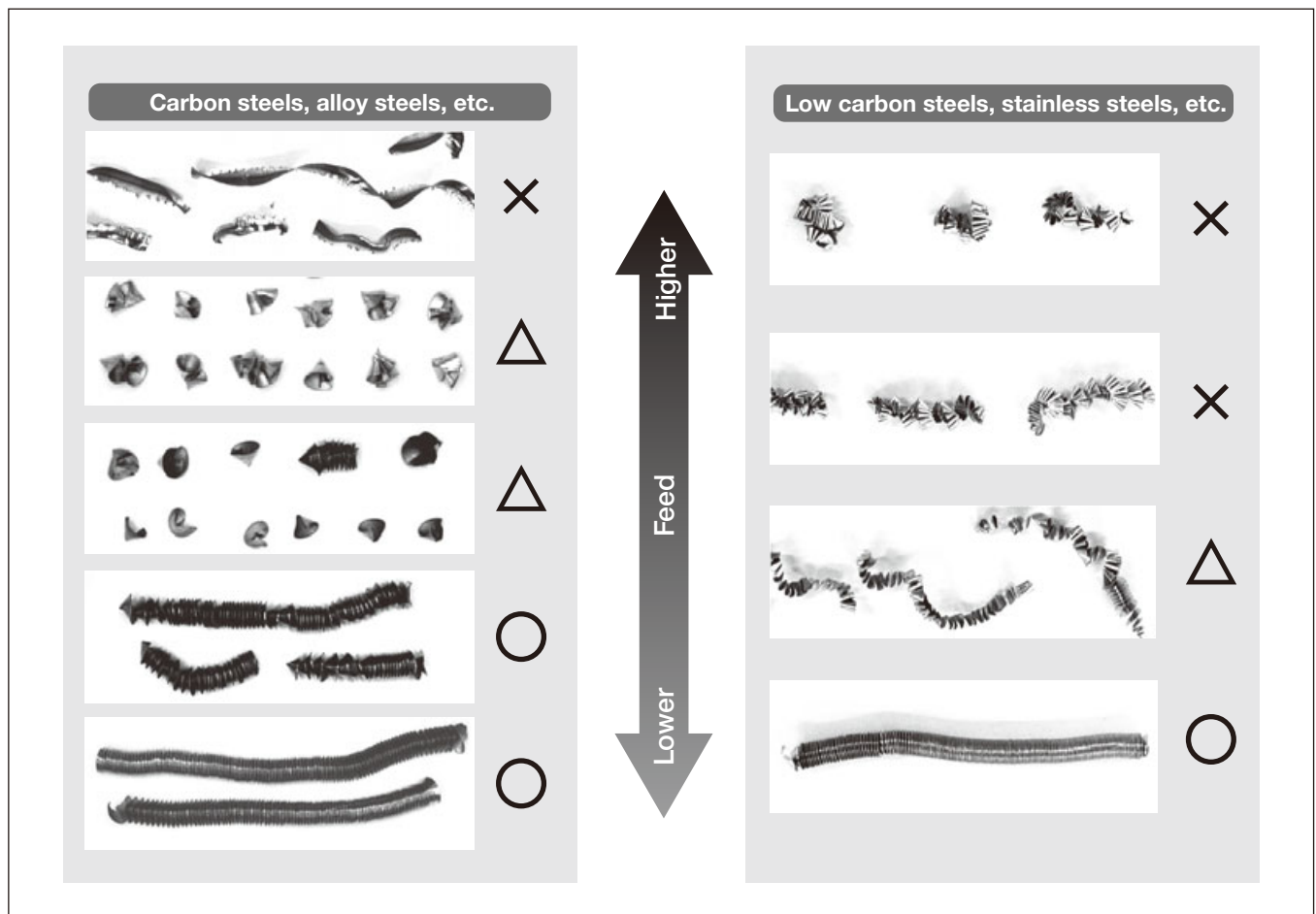
Chip shapes

Chip shape produced with central insert

- A conical coil shape whose apex point coincides with the rotating center of the drill is the basic shape. The chips are broken into small sections with increases in feed. However, excessively high feed causes the chip to increase in thickness and develops vibration which disturbs stable machining.
- In TDX drills, \bigcirc marked chips shown below are the most preferable shapes. This type of chip is broken into adequate lengths by centrifugal forces when used in tool-rotating condition. On the other hand, when used in work-rotating condition such as on a lathe, a continuously long chip is often produced without entangling.

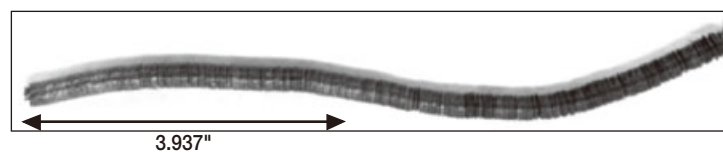


Relation between chip shapes and feeds (In the case of central insert)



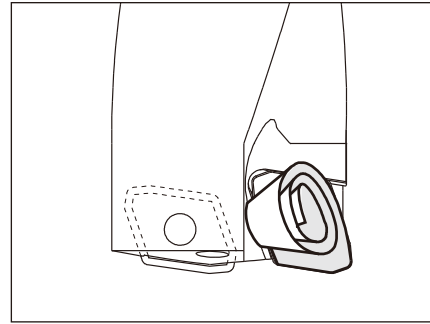
Example of chip shape in work-rotating applications (In the case of central insert)

($\phi 1.024''$, 1.045, $V_c = 330$ sfm, $f = 0.004$ ipr)



● Chip shape produced with peripheral insert

- Chip problems such as entangling are mainly caused by chips produced with the peripheral insert. These problems are dependent on the types of Workpiece material and the cutting conditions.
- As shown below, when the feed is extremely low, the chips jump over the chipbreaker groove and the continuously long chips may wrap around the drill body.
- When the feed is too high, the chips increase in thickness and can not be curled.
- Therefore, it is important to select proper cutting conditions to suit the machining so that well controlled chips will be formed.



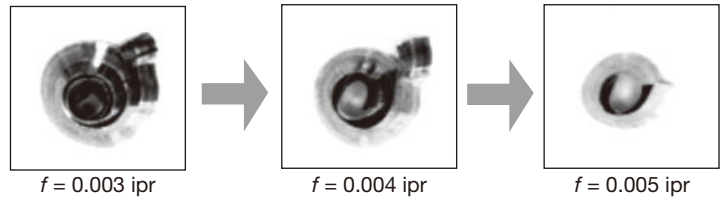
Medium to high carbon steels, alloy steels, etc.

As shown below, several turns of coil are an ideal shape.
As the feed increases, the curl radius and the number of turns tend to decrease.

● Typical chip shapes of general steels



● Variation of chip shapes relating to feeds



Stainless steels, low-carbon steels, low-alloy steels, etc.

- When machining long-chip materials such as stainless steels and mild steels, the wrong selection of cutting conditions results in chip entangling and tool breakage at worst. Therefore, cutting conditions should be carefully selected.
- “C” shaped, continuous coils of several to ten turns having adequately divided lengths are the ideal shape.

● Ideal chip shapes

	Stainless steel (JIS SUS 304) ($\phi 0.866"$, $V_c = 330$ sfm, $f = 0.004$ ipr)	Mild steel (JIS SS400) ($\phi 0.866"$, $V_c = 530$ sfm, $f = 0.003$ ipr)
DS chipbreaker		
DJ chipbreaker		

For machining stainless steels or low carbon steels, DS chipbreaker is recommended.
When using a TDX drill in tool-rotating condition, DS chipbreaker produces compact chips and allows more stable machining than DJ chipbreaker. When using it in work-rotating condition, DS chipbreaker provides outstanding affect on chip control.

Indexable Drill

● Chip shapes which tend to entangle and remedies against them

① Apple-peel-like chips

These chips are often produced in machining mild steels or low-carbon steels at low-speeds and low-feeds.

Remedies

Increase the cutting speed in stages by 20% within the range of standard cutting conditions. If there is no effect, increase the feed by about 10 % as the cutting speed is raised by 20%.



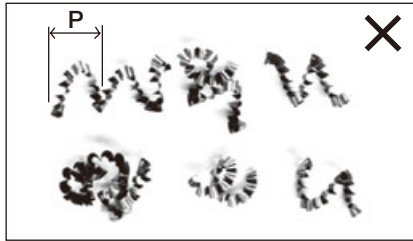
Apple-peel-like chips (Without curling)

② Short-lead chips

These chips are often produced in machining stainless steels at low-feeds and tend to entangle on the tool in spite of short length.

Remedies

Increase the feed by about 10 %. If there is no effect, increase the cutting speed in stages by 10% within the range of standard cutting conditions.



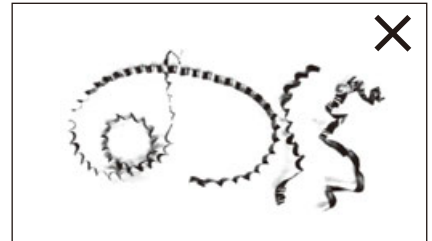
Continuously curled "C" shape chips with short lead (P).

③ Very long chips

Often produced in machining mild steels or low-carbon steels under improper cutting conditions.

Remedies

Increase the cutting speed in stages by 20% within the range of standard cutting conditions. If there is no effect, decrease the feed by about 10 % as the cutting speed is raised by 20%.

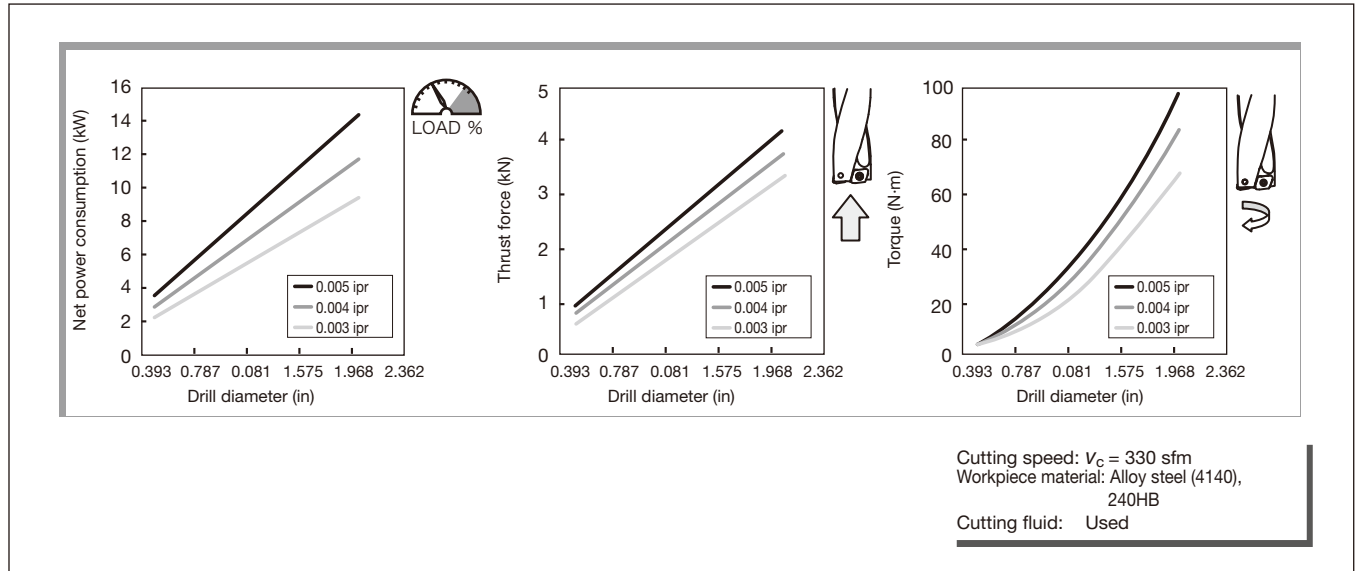


Continuously coiled long chips

■ Cutting forces

The charts below show a guideline for cutting forces. Use TDX drills on a machine with ample power and sufficient rigidity.

● Guidelines for cutting forces



TUNGSIX-DRILL / TUNGDRILLTWISTED

Troubleshooting for indexable drills

Use EZ sleeves for the following purposes

Hole diameter adjustment on the milling machine

Adjusting the finishing diameter when milling
Adjusting the finishing diameter in tool-rotating applications such as on machining centres and milling machines:

By using **EZ sleeve**, the finishing diameter can be adjusted in the range from **+0.024" to -0.008"**.

Scale for adjusting finishing diameter in milling (Periphery of sleeve)

Adjusting cutting edge height on lathe

Lathe
Adjusting of the cutting edge height in work rotating applications such as on lathes:

By using **EZ sleeve**, the cutting edge height can be adjusted in the range from **+0.012" to -0.008"**. It results in eliminating troubles caused by improper cutting-edge height.

Scale for adjusting cutting edge height in turning (Front face of sleeve)

Setting of EZ sleeve

Hole diameter adjustment on the milling machine

As shown in the Figure right, set the EZ sleeve between the drill shank and the toolholder.

Align the graduated scale on the periphery of the EZ sleeve with the center of the flat of the drill flange. In the Figure shown right, the sleeve is set so that the finishing diameter will be increased by 0.4 mm.

When rotating the EZ sleeve, insert the wrench into the hole at the flange periphery and rotate the EZ sleeve. Screws A + B have to be loosened. Secure the drill by screw A. Secure the EZ sleeve by lightly tightening screw B. Tighten screw B only lightly otherwise EZ sleeve can be damaged!

Adjusting cutting edge height on lathe

As shown in the Figure right, set the EZ sleeve between the drill shank and the toolblock.

Align the graduated scale on the front face of the Esleeve with the center of the flat of the drill flange. In the Figure shown right, the sleeve is set so that the center of the drill will shift by 0.1 mm to the plus (+) direction.

Cautious points

- The scale is only a rough guide, so be sure to measure the actual drilling diameter to confirm the result. Especially in turning, test machining is recommended as the drilling diameter will vary according to the adjustment.
- Can not be used for collect chuck holders.
- Over L/D 4 or bigger adjustment, please reduce feed.
- For smaller adjustment, the drill itself will interfere with the hole diameter. It is recommended that hole diameter should be adjusted to a larger diameter than the drill diameter.

Indexable Drill

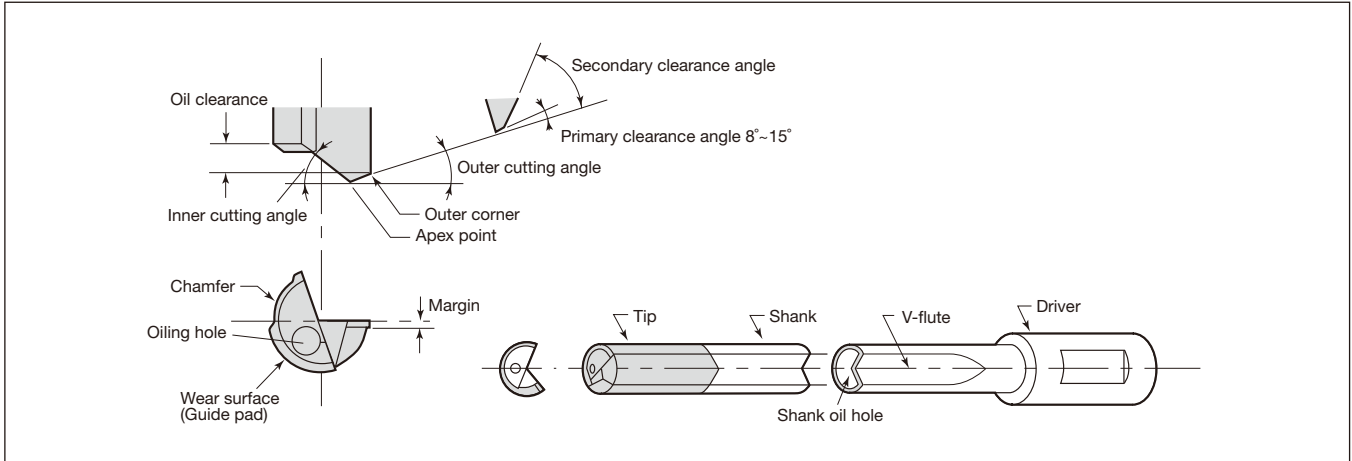
Troubleshooting for indexable drills

		Problem	Cause	Countermeasure
Abnormal wear	Central cutting edge	Relief surface	Inappropriate cutting conditions	<ul style="list-style-type: none"> ● Increase the cutting speed by 10 % within standard conditions. ● Lower the feed by 10 %.
	Peripheral cutting edge	Relief surface	Inappropriate cutting conditions	<ul style="list-style-type: none"> ● Increase the cutting speed by 10 % within standard conditions. ● When the feed is extremely low or high, set up it within standard conditions.
	Common	Relief surface	Varieties and supply of cutting fluid	<ul style="list-style-type: none"> ● Confirm that the cutting fluid flow is higher than 7 liter/min. ● The concentration of cutting fluid must be higher than 5 %. ● Use the cutting fluid superior in lubricity. ● Change to internal cutting fluid supply from external one.
			Vibration in drilling	<ul style="list-style-type: none"> ● Change to the machine with higher torque. ● Change to the clamp method with rigidity. ● Change the drill setting method.
			Unsuitable for selection of grade	<ul style="list-style-type: none"> ● Change the grade to high wear resistant.
		Crater	Looseness of screws	<ul style="list-style-type: none"> ● Tighten the screw.
			Cutting heat is too high	<ul style="list-style-type: none"> ● Change to internal cutting fluid supply from external one. ● Increase the supply rate of the cutting fluid. (Higher than 10 liter/min.) ● Lower the feed by 20 % within standard conditions. ● Lower the cutting speed by 20 % within standard conditions.
		Excessive chip welding	<ul style="list-style-type: none"> ● Lower the feed by 20 % within standard conditions. ● Lower the cutting speed by 20 % within standard conditions. 	
	Chipbreaker	Chip packing	<ul style="list-style-type: none"> ● Increase the cutting speed by 20% and lower the feed by 20% within standard conditions. ● Raise the fluid pressure (for higher than 1.5 MPa). 	
	Chipping and fracture	Central cutting edge	The rotation center of drill	Misalignment for workpiece rotation
Large offset				<ul style="list-style-type: none"> ● Check the manual and use the tool in the allowable offset range.
No flatness of machined surface				<ul style="list-style-type: none"> ● Flatten the entry surface in pre-machining. ● Set the feed for lower than 0.002 ipr in rough surface area.
High feed				<ul style="list-style-type: none"> ● Lower the feed by 20 ~ 50 % within standard conditions.
Peripheral cutting edge		Peripheral corner area	Using a chipping corner	<ul style="list-style-type: none"> ● Confirm the corner when exchanging inserts.
			Using inserts in excess of tool-life	<ul style="list-style-type: none"> ● Exchange the corner or the insert before the nose wear reaches 0.012".
			No flatness of machined surface	<ul style="list-style-type: none"> ● Flatten the entry surface in pre-machining. ● Set the feed for lower than 0.002 ipr at rough surface area.
			The existence of interrupted area	<ul style="list-style-type: none"> ● Set the feed for lower than 0.002 ipr in interrupted area.
Common		The unused corner area and cutting edge	Using a chipped corner	<ul style="list-style-type: none"> ● Confirm the corner when exchanging inserts.
			High hardness of workpiece	<ul style="list-style-type: none"> ● Increase the cutting speed by 20 % and lower the feed by 20 % within standard conditions. ● Raise the fluid pressure (for higher than 1.5 MPa).
			Chip packing	<ul style="list-style-type: none"> ● Lower the feed by 20 % within standard conditions.
		Contact boundary	Machinery impact	<ul style="list-style-type: none"> ● Change to continuous feed in case of pick feeding.
			Using inserts in excess of tool-life	<ul style="list-style-type: none"> ● Exchange the corner or the insert before the nose wear reaches 0.012".
		Flaking	Vibration in drilling	<ul style="list-style-type: none"> ● Change to the machine with higher rigidity. ● Change to the clamp method with rigidity. ● Change the drill setting method.
			High hardness of workpiece	<ul style="list-style-type: none"> ● Set the feed for lower than 0.002 ipr.
		Common	Common	Thermal impact
Unsuitable for selection of grade	<ul style="list-style-type: none"> ● Change the grade to toughness. 			
		Looseness of screws	<ul style="list-style-type: none"> ● Tighten the screw. 	

Troubleshooting for indexable drills

	Problem	Cause	Countermeasure	
Scratch marks on the tool	The tool periphery	Misalignment of workpiece rotation	● Set the misalignment to 0 ~ 0.008".	
		Offset machining in excess of allowable range	● Use the tool in the allowable offset range.	
		Offset direction reduced diameter of workpiece	● Set offset direction extended diameter of workpiece	
		No flatness of the entry surface	● Flatten the entry surface in pre-machining. ● Set the feed for lower than 0.002 ipr in rough surface area.	
		Chipping of peripheral cutting edge	● Exchange the insert.	
		Bend of workpiece	● Change to the clamp method with rigidity.	
		Chip packing	● Increase the cutting speed by 20 % and lower the feed by 20 % within standard conditions. ● Raise the fluid pressure (for higher than 1.5 MPa).	
Inappropriate hole accuracy	Hole diameter	Misalignment for workpiece rotation	● Set the misalignment to 0 ~ 0.008".	
		Inappropriate offset contents	● Adjust offset contents.	
		No flatness of the entry surface	● Flatten the entry surface in pre-machining. ● Set the feed for lower than 0.002 ipr at rough surface area.	
		Bend of workpiece	● Change to the clamp method with rigidity.	
	Roughness	Varieties and supply of cutting fluid	● The concentration of cutting fluid must be higher than 5 %. ● Use the cutting fluid superior in lubricity. ● Change to internal cutting fluid supply from external one.	
		Inappropriate cutting conditions	● Increase the cutting speed by 20 % within standard conditions. ● Lower the feed by 20 % within standard conditions.	
	Common	Failures of inserts	● Exchange the insert.	
		Chip packing	● Increase the cutting speed by 20 % and lower the feed by 20 % within standard conditions. ● Raise the fluid pressure (for higher than 1.5 MPa).	
		Looseness of screws	● Tighten the screw.	
Chip control	Prolonged and twisted of chips	Inappropriate cutting conditions	● Work within standard conditions. ● Increase the cutting speed by 10 % within standard conditions. ● Increase the feed by 10 % within standard conditions.	
		Failures of inserts	● Exchange inserts.	
		Machining by external fluid supply	● Change to internal cutting fluid supply from external one. ● Work by step feed. ● Use dwell function for 0.1 sec approximately.	
		Chips around the central cutting edge	● There is a tendency to shorten the chips when shifting to higher speed and feed.	
	Chip packing	Fluid supply	● Change to internal cutting fluid supply from external one. ● Raise the fluid pressure (for higher than 1.5 MPa).	
		Inappropriate cutting conditions	● Increase the cutting speed by 20 % and lower the feed by 20 % within standard conditions. ● Raise the fluid pressure (for higher than 1.5 MPa).	
	Common	Large failure of drill holders	● Exchange the drill holder.	
		Looseness of screws	● Tighten the screw.	
	Others	Chatter	Inappropriate cutting conditions	● Lower the cutting speed by 20 % within standard conditions. ● Increase the feed by 10 % within standard conditions.
			Large wear of inserts	● Exchange the insert.
Vibration in drilling			● Change to the machine with higher torque rigidity. ● Change to the clamp method with rigidity. ● Change the drill setting method.	
Looseness of screws			● Tighten the screw.	
Machine stop		Insufficient machine power and torque	● Use the range of number of revolutions suited machine spec. Lower the feed by 20 ~ 50%.	
		Burned inserts	● Exchange inserts before the failure becomes larger. ● Check the oil-hole plug screw is tightly screwed in place. ● Check that the fluid flows powerfully from the drill. ● Lower the cutting speed and the feed by 20 % within standard conditions.	
Large burr		Failures of inserts	● Exchange the insert.	
		Inappropriate cutting conditions	● Lower the feed by 20 ~ 50% just before leaving from the workpiece.	

Nomenclature for gun drill





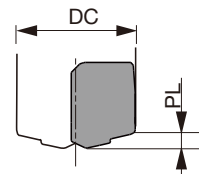
APPLICATION RANGE

Feed f (ipr)	0.001 - 0.002	0.001 - 0.02	0.004 - 0.012
Application	<p>OK Cross hole drilling</p>	<p>OK Inclined exit</p> <p>0.630" or less (for standard drill)</p>	<p>OK Boring</p>

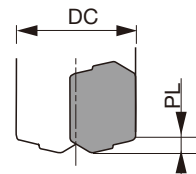
BLIND HOLE SHAPES OF THE HOLE BOTTOM

DC	Insert	Maximum difference
		PL
0.394 - 0.465	ZSGT06...	0.067
0.465 - 0.551	LOGT06...	0.071
0.551 - 0.630	TOHT07...	0.079
0.630 - 0.709	TOHT08...	0.087
0.709 - 0.787	TOHT09...	0.118
0.788 - 0.866	TOHT10...	0.126
0.866 - 0.984	TOHT11...	0.134
0.985 - 1.102	TOHT12...	0.142

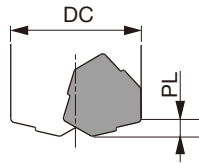
ZSGT06...



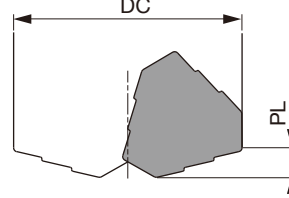
LOGT06...



TOHT07..., 08...

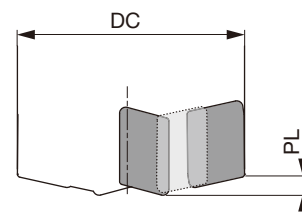


TOHT09... - TOHT12...



DC	Central	Insert Intermediate	Peripheral	Maximum difference
				PL
1.103 - 1.135	FBM07**-C	FBM06**-I	FBH06**-P	0.098
1.136 - 1.142	FBM07**-C	FBM06**-I	FBH06**-P	0.102
1.142 - 1.174	FBM07**-C	FBM06**-I	FBH06**-P	0.098
1.175 - 1.181	FBM07**-C	FBM06**-I	FBH06**-P	0.110
1.181 - 1.206	FBM07**-C	FBM07**-I	FBH08**-P	0.110
1.206 - 1.241	FBM07**-C	FBM07**-I	FBH08**-P	0.114
1.242 - 1.276	FBM07**-C	FBM07**-I	FBH08**-P	0.118
1.276 - 1.299	FBM07**-C	FBM07**-I	FBH08**-P	0.122
1.300 - 1.320	FBM07**-C	FBM07**-I	FBH08**-P	0.114
1.320 - 1.356	FBM07**-C	FBM07**-I	FBH08**-P	0.118
1.356 - 1.378	FBM07**-C	FBM07**-I	FBH08**-P	0.122
1.378 - 1.394	FBM08**-C	FBM07**-I	FBH08**-P	0.118
1.395 - 1.417	FBM08**-C	FBM07**-I	FBH08**-P	0.122
1.418 - 1.438	FBM08**-C	FBM07**-I	FBH08**-P	0.114
1.438 - 1.473	FBM08**-C	FBM07**-I	FBH08**-P	0.118
1.474 - 1.496	FBM08**-C	FBM07**-I	FBH08**-P	0.122
1.496 - 1.501	FBM08**-C	FBM07**-I	FBH09**-P	0.130
1.501 - 1.535	FBM08**-C	FBM07**-I	FBH09**-P	0.134
1.536 - 1.544	FBM08**-C	FBM07**-I	FBH09**-P	0.126
1.544 - 1.575	FBM08**-C	FBM07**-I	FBH09**-P	0.130

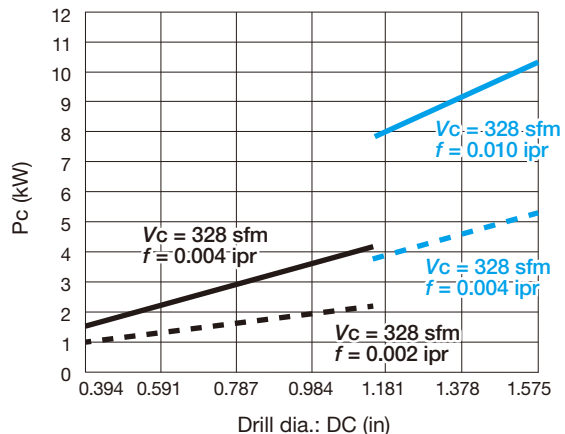
FBM...



REQUIRED SPINDLE POWER AND COOLANT PRESSURE

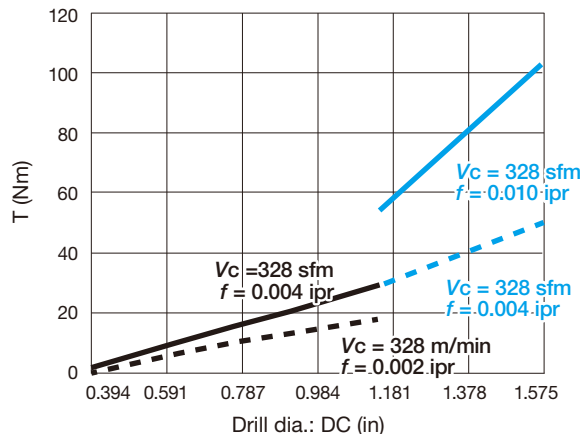
Net power

P 1055

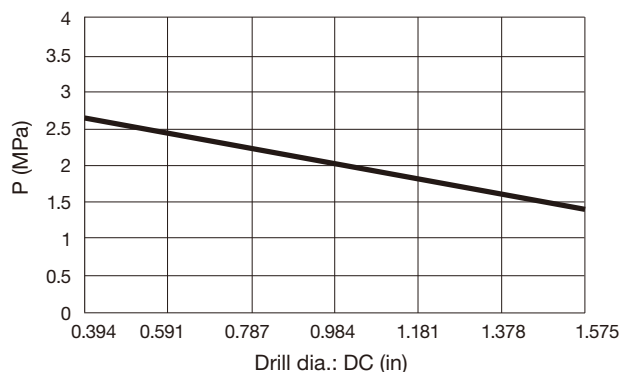


Torque

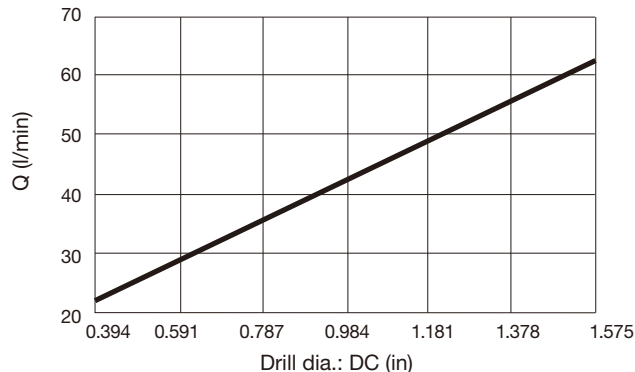
P 1055



Coolant pressure



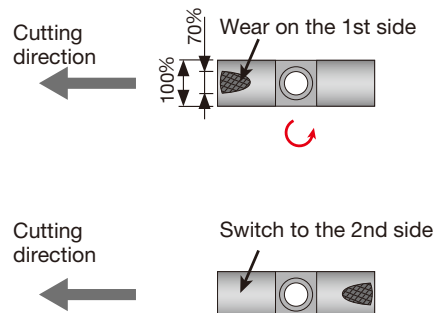
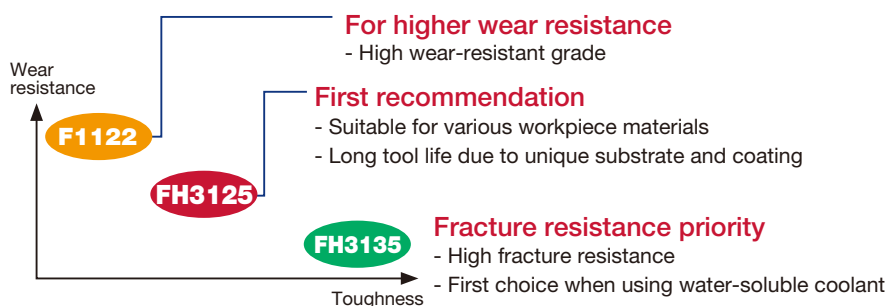
Coolant flow rate



Guide pad grade and the timing for replacement

Guide pads are subject to wear, like inserts

- The guide pad has two sides.
- Each guide pad can be used on two sides. When the first corner wears out to 70% of the width, reverse the guide pad to use the second side.
- Replace with a new guide pad when the second side wears out.



Drilling procedure on machining centers and lathes

Proceed as instructed below in order to maximize the tool performance.

	<p>① Drill a pilot hole Hole diameter tolerance: $+0.0004'' - +0.002''$ Hole depth: $H = 1.0''$ Note: Drill $H = 1.8''$ when using an MCTRCH drill (for cross-hole). Please use DrillMeister or DrillForce-Meister for a pilot hole. Use a drill with 3xD or smaller. Note: Recommend to use a drill with 5xD when using an MCTRCH drill.</p>
	<p>② Start coolant ③ Slowly insert DeepTri-Drill into the pilot hole No. of revolution: $n = 50 - 100 \text{ rpm}$ Feed rate: $V_f = 4 - 12 \text{ ipm}$ Note: Do not rotate the drill at full machining speed before engaging the pilot hole.</p>
	<p>④ Stop the drill at $H = 0.8''$ depth Note: Stop at $H = 1.6''$ when using an MCTRCH drill. ⑤ Start rotating at full machining speed</p>
	<p>⑥ Start feeding At the entry ($H = 0.8'' - 1.2''$) → Feed: $f = 80\%$ of programmed feed Note: Drill $H = 1.6'' - 2.0''$ when using an MCTRCH drill. Hole depth: $H \geq 1.2''$ → Feed: $f = 100\%$ Note: Drill $H = 2.0''$ or more when using an MCTRCH drill.</p>
	<p>⑦ For a through hole Continue drilling until the drill head passes through the workpiece by $1.0''$. Note: When machining gummy materials such as low carbon steel, reduce the feed rate to 70% of the normal level right before exiting the material to prevent chips from scattering. ⑧ Stop the rotation and coolant ⑨ Return the drill, and operation finished</p>

How to use a trlg type deeptri-drill on a horizontal machining center or boring machine

When using the TRLG drill on a conventional machining center or horizontal boring machine where there are no drilling-bush supports available, a pilot hole needs to be further deepened with a MCTR drill to better support the long gundrill. A long gundrill such as the TRLG type drill tends to “whip” when the pilot hole is too short to support the gundrill.

	<p>① Drill a pilot hole</p>
	<p>② Expand the pilot hole deeper using a MCTR drill</p>
	<p>③ Drill with a TRLG drill at a reduced rotation and feed. Use the following parameters: No. of revolution: $n = 50 - 100 \text{ rpm}$ Feed speed: $V_f = 4 - 12 \text{ ipm}$</p>
	<p>④ When DeepTri-Drill reaches all the way to the end of the pilot hole, increase drill rotation to full machining speed.</p>
	<p>⑤ Start feeding to complete the drilling</p>

(Caution)
Always use Step ② to prevent the gundrill from whipping, which may lead to drill breakage and a possible superfluous injury.

Troubleshooting in gun drilling

Problem		Cause	Trigger	Countermeasure
Breaking of drill	At entry into workpiece	Machine	Clamping the workpiece is unstable.	Clamp the workpiece firmly.
			The guide bush is apart from the workpiece surface at the entry.	Contact the guide bush closely with the workpiece.
			The machine's rapid feed is used.	Use cutting feed.
			Whipping effect occurs.	Place a whip guide at the appropriate position.
			The shape of the guide bush is not suitable.	Use the guide bush in the shape suitable for the workpiece.
		Drill	The drill is not set properly.	Set the drill with an appropriate torque, hydraulic pressure, etc.
	Regrinding is in poor quality.		Make sure no damage is left on the drill and that the cutting edge geometry is not changed.	
	Cutting condition	The feed (f) is too high.	Use low feed.	
	Workpiece	The workpiece surface is slanted.	Use low feed.	
	During drilling	Machine	Clamping the workpiece is unstable.	Clamp the workpiece firmly.
			The shape of the guide bush is not suitable.	Modify the shape of the guide bush. See "Chip packing" for the details.
			The feed speed (V_f) varies.	Use mechanical feed.
		Drill	The number of revolutions varies (decreases).	Increase the machine power or adjust the cutting conditions.
			Abnormal damage occurs.	See "Short tool life" for the details.
		Cutting condition	The feed (f) is not suitable.	Use an appropriate feed.
		Workpiece	Interrupted or cross drilling is required.	Change the tool to a standard gundrill.
	Others	Chip packing occurs.	See "Chip packing" for the details.	
	At exit from workpiece	Drill	The tip is too long.	Make the tip length short.
			The selection of the guide pads is not suitable.	Use 2 guide pads instead of 3.
			The clearance of the coolant hole is too large.	Reduce the clearance of the coolant hole.
		Cutting condition	The feed (f) is too high.	Use low feed.
Workpiece	The workpiece surface is slanted.	Use low feed.		
During retracting	Machine	Clamping the workpiece is unstable.	Clamp the workpiece firmly.	
	Cutting condition	Burnishing torque (cutting power) is increased due to reduced hole diameter.	Reduce cutting speed (V_c).	

Troubleshooting in gun drilling

Problem	Cause	Trigger	Countermeasure	
Hole accuracy	Rough surface finish	Machine	Clamping the workpiece is unstable.	Clamp the workpiece firmly.
		Machine	The type of coolant is not appropriate.	Use water-insoluble coolant.
		Machine	Foreign material is in the coolant.	Thoroughly filtrate the coolant (Use a filter with the filtration accuracy in 10µm or less).
		Machine	The run-out of the spindle is too large.	Minimize the run-out of the spindle.
		Machine	The clearance between the guide bush and the drill is not appropriate.	Replace the guide bush (The clearance should be between +0.00012" and +0.00031").
		Machine	The feed speed (Vf) varies.	Use mechanical feed.
		Machine	The number of revolutions varies (decreases).	Increase the machine power or adjust the cutting conditions.
		Drill	Abnormal damage occurs.	See "Short tool life" for the details.
		Drill	Regrinding is in poor quality.	Make sure no damage is left on the drill and that the cutting edge geometry is not changed.
		Cutting condition	The feed (f) is too high.	Reduce the feed.
	Others	Chip packing occurs.	See "Chip packing" for the details.	
	Unacceptable circularity, cylindricity, and oversize	Machine	The clearance between the guide bush and the drill is not appropriate.	Replace the guide bush (The clearance should be between +0.00012" and +0.00031").
		Machine	The guide bush is apart from the workpiece surface at the entry.	Contact the guide bush closely with the workpiece.
		Machine	The type of coolant is not appropriate.	Use water-insoluble coolant.
		Machine	The concentricity of the guide bush and the spindle is too large.	Decrease the concentricity of the guide bush and the spindle.
		Drill	Abnormal damage occurs.	See "Short tool life" for the details.
		Drill	Regrinding is in poor quality.	Make sure no damage is left on the drill and that the cutting edge geometry is not changed.
		Cutting condition	The feed (f) is not suitable.	Use an appropriate feed.
		Workpiece	Interrupted or cross drilling is required.	Change the tool to a standard gundrill.
		Others	Chip packing occurs.	See "Chip packing" for the details.
		Bending of hole	Machine	Clamping the workpiece is unstable.
	Machine		The guide bush is apart from the workpiece surface at the entry.	Contact the guide bush closely with the workpiece.
	Machine		The concentricity of the guide bush and the spindle is too large.	Decrease the concentricity of the guide bush and the spindle.
	Machine		The clearance between the guide bush and the drill is not appropriate.	Replace the guide bush (The clearance should be between +0.00012" and +0.00031").
	Drill		The selection of the guide pads is not suitable.	Use 2 guide pads instead of 3.
	Drill		Regrinding is in poor quality.	Make sure no damage is left on the drill and that the cutting edge geometry is not changed.
	Cutting condition		The feed (f) is too high.	Reduce the feed.
Workpiece	Workpiece		The workpiece has blow holes or unevenness.	Use the workpiece without defect.
	Workpiece		The workpiece surface is slanted at the entry.	Use low feed.
	Workpiece		Interrupted or cross drilling is required.	Change the tool to a standard gundrill.

Troubleshooting in gun drilling

Problem		Cause	Trigger	Countermeasure
Short tool life	Abnormal wear	Machine	The type of coolant is not appropriate.	Use water-insoluble coolant.
			Foreign material is in the coolant.	Thoroughly filtrate the coolant (Use a filter with the filtration accuracy in 10µm or less).
			The clearance between the guide bush and the drill is not appropriate.	Replace the guide bush (The clearance should be between +0.003" and +0.008").
			Whipping effect occurs.	Place a whip guide at the appropriate position.
			The concentricity of the guide bush and the spindle is too large.	Decrease the concentricity of the guide bush and the spindle.
			The coolant temperature is too high.	Increase the capacity of the tank.
		Drill	The selection of the guide pads is not suitable.	Use 2 guide pads instead of 3.
			Regrinding is in poor quality.	Make sure no damage is left on the drill and that the cutting edge geometry is not changed.
			The drill's overall length is excessive.	Reduce the drill's overall length.
			Excessive wear occurs and the chip shape changes.	Regrind the gundrill (ease the tool life criteria).
		Cutting condition	The cutting speed (Vc) is too high.	Reduce the cutting speed.
			The feed (f) is too high.	Reduce the feed.
			The coolant pressure is not high enough.	Increase the coolant pressure.
		Workpiece	The material quality varies.	Reduce the cutting speed (Vc).
Chip control	Chip packing	Machine	The shape of the guide bush is not suitable.	Modify the tip of the guide bush to match the shape of the workpiece surface at the entry.
			The number of revolutions varies (decreases).	Increase the machine power or adjust the cutting conditions.
			The chip box is too small for smooth chip evacuation.	Enlarge the chip box.
		Cutting condition	The feed (f) is not suitable.	Use an appropriate feed.
			The coolant pressure is not high enough.	Increase the coolant pressure.
		Workpiece	Interrupted or cross drilling is required.	Change the tool to a standard gundrill.
	The operation is for stacked plates.		Change the cutting edge shape so that the cores become small.	
	The material quality varies.		Increase the feed.	
	Chip entanglement	Drill	The cutting edge is fractured or chipped.	See "Breakage" for the details.
			Wear on the outer corner is excessive.	Regrind the gundrill (ease the tool life criteria).
		Cutting condition	The feed (f) is too low.	Increase the feed.
Workpiece		Drilling a center hole is required.	Make the center hole as small as the drill diameter and increase the coolant pressure.	

DEEPT^{RI} DRILL Designation system

Designation for tailor-made tools

Special tool code may be created per below according to your specific drilling needs.

1 **MCTR** **2** **18.50** **XM** **3** **25** - **4** **22**

1 Series		2 Drill dia. DC (mm)		3 Driver dia. DCONMS (mm)		4 LU/DC ratio	
MCTR	DeepTri-Drill (For machining centers and lathes)	18.50	18.50	25	25		
MCTRCH	DeepTri-Drill (For cross hole drilling on machining centers and CNC lathes)						

For tailor-made drills, use the guide below to make the designation (Cat. No).

1 **TRLG** **2** **18.50** **X** **3** **900** - **4** **23**

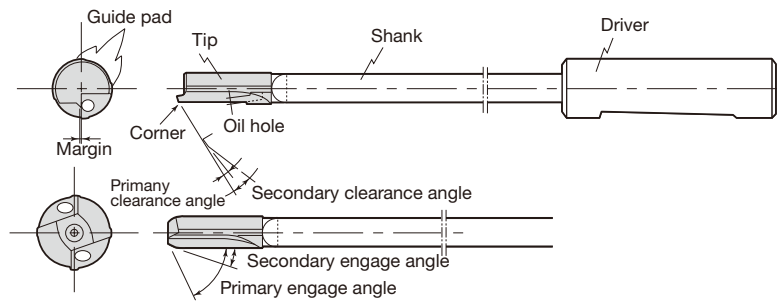
1 Series		2 Drill dia. DC (mm)		3 Overall length: L (mm)		4 Driver code	
TRLG	DeepTri-Drill (For gundrill machines)	18.50	18.50	900	900	23	23
TRLGCH	DeepTri-Drill (For cross hole drilling on gundrilling machines)						

Grade
Insert
Ext. Toolholder
Int. Toolholder
Threading
Grooving
Miniature tool
Milling cutter
Endmill
Drilling tool
Tooling System
User's Guide
Index



Reamer

Nomenclature for gun reamer



Troubleshooting in gun reaming

Trouble		Possible cause	Countermeasure		
Breaking of reamer	Increased burnishing torque due to excessively small stock allowance	● Chamfer angle small	● Enlarge chamfer angle and increase stock allowance		
		● Excessive wear in peripheral cutting edge.	● Reduce cutting speed to prevent peripheral wear of edge ● Increase lubricity of cutting fluid		
	Sticking	● Faulty filtering of cutting fluid ● Incorrect selection of cutting fluid ● Insufficient cutting fluid pressure	● Improve filtering accuracy ● Change to fluid with higher lubricity ● Increase fluid pressure		
Mechanical trouble			● Repair electrical system ● Improve clamping method of workpiece		
Faulty machining accuracy	Unacceptable surface roughness	Excessive feed rate per tooth	● Reduce fluid pressure ● Increase number of teeth		
		Improper tool specifications	● Excessive chamfer angle ● Excessive back taper ● Peripheral run out excessive	● Reduce chamfer angle ● Reduce back taper ● Improve run out accuracy	
	Too large and inconsistent over size	Faulty regrinding	● Cutting edge run out is large ● Residual damage of preceding process	● Improve run out accuracy ● Remove residual damage completely	
		Improper cutting fluid	● Excessive fluid pressure ● Improper selection of cutting fluid	● Reduce fluid pressure ● Increase activity and lubricity of the fluid	
	Faulty machine accuracy			● Correct spindle run out and bushing clearance and alignment	
	Faulty clamping of workpiece		● Clamping position wrong ● Clamping force inadequate	● Improper clamping position ● Increase clamping force	
	Defective out-of-roundness	Faulty machine accuracy		● Excessive bushing clearance ● Faulty spindle run out and alignment	● Correct bushing clearance ● Correct spindle run out and alignment
		Improper tool specifications		● Outer run out of reamer large ● Insufficient reamer rigidity	● Correct peripheral run out ● Increase reamer rigidity
		Faulty clamping position of workpiece			● Change clamping position
		Unevenness in wall thickness of workpiece			● Reduce reamer guide width (margin width)
	Insufficient oversize allowance	Chamfer angle small		● Increase chamfer angle	
		Excessive wear in peripheral cutting edge	● Too high cutting speed ● Faulty lubricity of cutting fluid	● Decrease cutting speed ● Increase lubricating capacity	
Faulty regrinding (residual damage)			● Increase regrinding stock amount		

International Tolerance

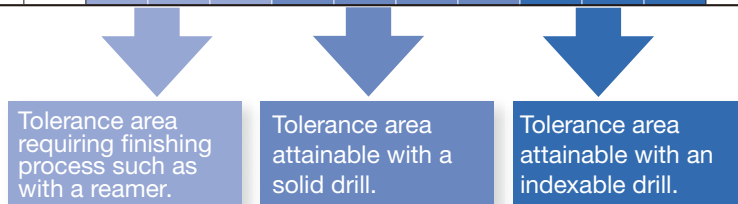
IT (International Tolerance) Grades

IT grades shows a tolerance allowable for difference of the diameters of a hole and a shaft. As the number added after IT increases, the tolerance becomes rough. Depending on the basic size, the tolerance value in each grade varies.

In the catalog, IT grades are shown as a guide of dimensional dispersion in the diameters of holes machined with the drill. For information, H8 tolerance for a $\varnothing 8.0$ hole is 0 to + 0.022 mm, the width of the value is the same as that of IT 8.

In the Table shown below, tolerance areas attainable with typical drilling tools are distinguished by using different colors. Solid drills are generally used for machining holes of IT 9 to 12. For machining a hole of better than IT 8, finishing process such as reaming is required. For a hole better than IT 5, high-precision finishing is required. Above description is based on machining of general steel. In practice, the IT grade attained with the tool varies widely depending on the hardness and the composition of the work material.

Basic size (mm)		International tolerance grade																	
		IT1	IT2	IT3	IT4	IT5	IT6	IT7	IT8	IT9	IT10	IT11	IT12	IT13	IT14	IT15	IT16	IT17	IT18
>	≤							(μm)						(mm)					
-	3	0.8	1.2	2	3	4	6	10	14	25	40	60	0.1	0.14	0.25	0.4	0.6	1	1.4
3	6	1	1.5	2.5	4	5	8	12	18	30	48	75	0.12	0.18	0.3	0.48	0.75	1.2	1.8
6	10	1	1.5	2.5	4	6	9	15	22	36	58	90	0.15	0.22	0.36	0.58	0.9	1.5	2.2
10	18	1.2	2	3	5	8	11	18	27	43	70	110	0.18	0.27	0.43	0.7	1.1	1.8	2.7
18	30	1.5	2.5	4	6	9	13	21	33	52	84	130	0.21	0.33	0.52	0.84	1.3	2.1	3.3
30	50	1.5	2.5	4	7	11	16	25	39	62	100	160	0.25	0.39	0.62	1	1.6	2.5	3.9
50	80	2	3	5	8	13	19	30	46	74	120	190	0.3	0.46	0.74	1.2	1.9	3	4.6
80	120	2.5	4	6	10	15	22	35	54	87	140	220	0.35	0.54	0.87	1.4	2.2	3.5	5.4
120	180	3.5	5	8	12	18	25	40	63	100	160	250	0.4	0.63	1	1.6	2.5	4	6.3
180	250	4.5	7	10	14	20	29	46	72	115	185	290	0.46	0.72	1.15	1.85	2.9	4.6	7.2
250	315	6	8	12	16	23	32	52	81	130	210	320	0.52	0.81	1.3	2.1	3.2	5.2	8.1
315	400	7	9	13	18	25	36	57	89	140	230	360	0.57	0.89	1.4	2.3	3.6	5.7	8.9
400	500	8	10	15	20	27	40	63	97	155	250	400	0.63	0.97	1.55	2.5	4	6.3	9.7
500	630	9	11	16	22	32	44	70	110	175	280	440	0.7	1.1	1.75	2.8	4.4	7	11
630	800	10	13	18	25	36	50	80	125	200	320	500	0.8	1.25	2	3.2	5	8	12.5
800	1000	11	15	21	28	40	56	90	140	230	360	560	0.9	1.4	2.3	3.6	5.6	9	14
1000	1250	13	18	24	33	47	66	105	165	260	420	660	1.05	1.65	2.6	4.2	6.6	10.5	16.5
1250	1600	15	21	29	39	55	73	125	195	310	500	780	1.25	1.95	3.1	5	7.8	12.5	19.5
1600	2000	18	25	35	46	65	92	150	230	370	600	920	1.5	2.3	3.7	6	9.2	15	23
2000	2500	22	30	41	55	78	110	175	280	440	700	1100	1.75	2.8	4.4	7	11	17.5	28
2500	3150	26	36	50	68	96	135	210	330	540	860	1350	2.1	3.3	5.4	8.6	13.5	21	33



Deviations in Commonly Used Fits

Deviations of Shafts to be Used in Commonly Used Fits (JIS B0401 extract)

Basic size step (mm)		Tolerance zone class of shaft (μm)															
>	≤	e9	f6	f7	f8	g5	g6	h5	h6	h7	h8	h9	js5	js6	js7	k5	k6
-	3	-14 -39	-6 -12	-6 -16	-6 -20	-2 -6	-2 -8	0 -4	0 -6	0 -10	0 -14	0 -25	±2	±3	±5	+4 0	+6 0
3	6	-20 -50	-10 -18	-10 -22	-10 -28	-4 -9	-4 -12	0 -5	0 -8	0 -12	0 -18	0 -30	±2.5	±4	±6	+6 +1	+9 +1
6	10	-25 -61	-13 -22	-13 -28	-13 -35	-5 -11	-5 -14	0 -6	0 -9	0 -15	0 -22	0 -36	±3	±4.5	±7	+7 +1	+10 +1
10	14	-32 -75	-16 -27	-16 -34	-16 -43	-6 -14	-6 -17	0 -8	0 -11	0 -18	0 -27	0 -43	±4	±5.5	±9	+9 +1	+12 +1
14	18																
18	24	-40 -92	-20 -33	-20 -41	-20 -53	-7 -16	-7 -20	0 -9	0 -13	0 -21	0 -33	0 -52	±4.5	±6.5	±10	+11 +2	+15 +2
24	30																
30	40	-50 -112	-25 -41	-25 -50	-25 -64	-9 -20	-9 -25	0 -11	0 -16	0 -25	0 -39	0 -62	±5.5	±8	±12	+13 +2	+18 +2
40	50																
50	65	-60 -134	-30 -49	-30 -60	-30 -76	-10 -23	-10 -29	0 -13	0 -19	0 -30	0 -46	0 -74	±6.5	±9.5	±15	+15 +2	+21 +2
65	80																
80	100	-72 -159	-36 -58	-36 -71	-36 -90	-12 -27	-12 -34	0 -15	0 -22	0 -35	0 -54	0 -87	±7.5	±11	±17	+18 +3	+25 +3
100	120																

In every step given in the table, the value on the upper side shows the upper deviation and the value on the lower side, the lower deviation.

Deviations of Holes to be Used in Commonly Used Fits. (JIS B0401 extract)

Basic size step (mm)		Tolerance zone class of hole (μm)																
>	≤	E7	E8	E9	F6	F7	F8	G6	G7	H6	H7	H8	H9	H10	JS6	JS7	K6	K7
-	3	+24 +14	+28 +14	+39 +14	+12 +6	+16 +6	+20 +6	+8 +2	+12 +2	+6 0	+10 0	+14 0	+25 0	+40 0	±3	±5	0 -6	0 -10
3	6	+32 +20	+38 +20	+50 +20	+18 +10	+22 +10	+28 +10	+12 +4	+16 +4	+8 0	+12 0	+18 0	+30 0	+48 0	±4	±6	+2 -6	+3 -9
6	10	+40 +25	+47 +25	+61 +25	+22 +13	+28 +13	+35 +13	+14 +5	+20 +5	+9 0	+15 0	+22 0	+36 0	+58 0	±4.5	±7	+2 -7	+5 -10
10	14	+50 +32	+59 +32	+75 +32	+27 +16	+34 +16	+43 +16	+17 +6	+24 +6	+11 0	+18 0	+27 0	+43 0	+70 0	±5.5	±9	+2 -9	+6 -12
14	18																	
18	24	+61 +40	+73 +40	+92 +40	+33 +20	+41 +20	+53 +20	+20 +7	+28 +7	+13 0	+21 0	+33 0	+52 0	+84 0	±6.5	±10	+2 -11	+6 -15
24	30																	
30	40	+75 +50	+89 +50	+112 +50	+41 +25	+50 +25	+64 +25	+25 +9	+34 +9	+16 0	+25 0	+39 0	+62 0	+100 0	±8	±12	+3 -13	+7 -18
40	50																	
50	65	+90 +60	+106 +60	+134 +60	+49 +30	+60 +30	+76 +30	+29 +10	+40 +10	+19 0	+30 0	+46 0	+74 0	+120 0	±9.5	±15	+4 -15	+9 -21
65	80																	
80	100	+107 +72	+126 +72	+159 +72	+58 +36	+71 +36	+90 +36	+34 +12	+47 +12	+22 0	+35 0	+54 0	+87 0	+140 0	±11	±17	+4 -18	+10 -25
100	120																	

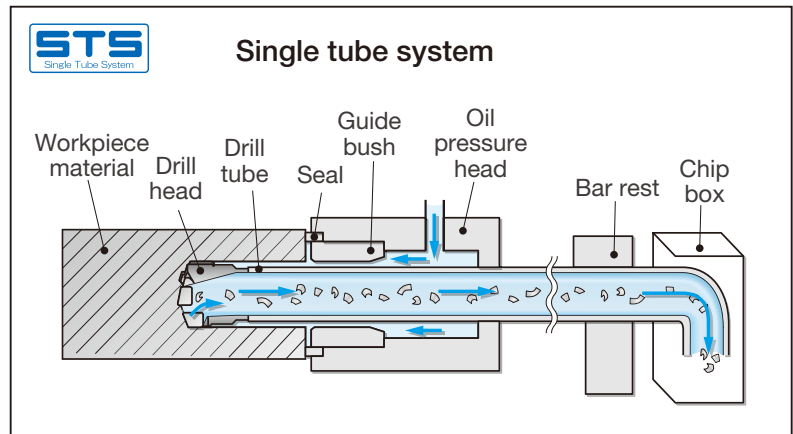
In every step given in the table, the value on the upper side shows the upper deviation and the value on the lower side, the lower deviation.

Deep hole drilling head series

Single Tube System (STS) and Double Tube System (DTS)

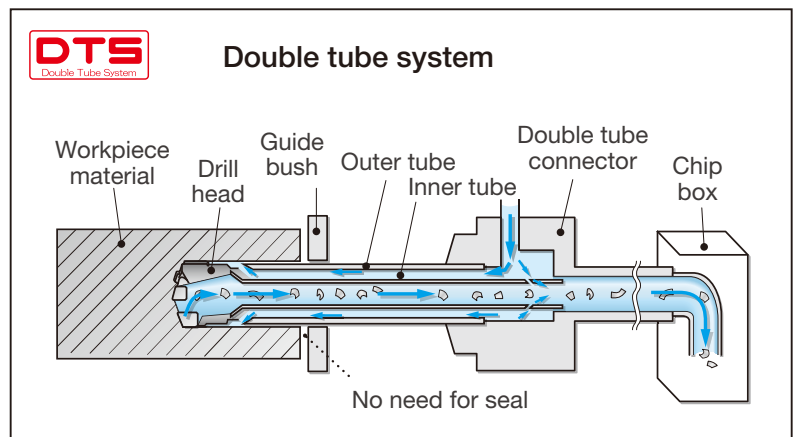
Single Tube System (STS)

The STS may also be referred to as the BTA system in the deep hole drilling process. A large volume of coolant is pumped under high pressure to the cutting area in the workpiece. Chips are then forced out through the drill tube at the back and they do not touch workpiece allowing super surface finish. STS is a very good method to obtain holes of high productivity and high accuracy by using a dedicated drilling machine and a sealing with the workpiece.



Double Tube System (DTS)

The DTS is characterized by its two tube construction and is therefore known as the double tube system. A sealing system and pressure head, which is required in the Single Tube System (STS) is not necessary for the DTS and it is therefore suitable for conventional general purpose machines such as lathes or machining centers. In general, because of less efficient chip evacuation than the STS the recommended max drilling depth is 1000mm. However, the unique DTC-R tube connector that is capable of supplying high pressure coolant can successfully achieve drilling depths of up to 2000 mm.



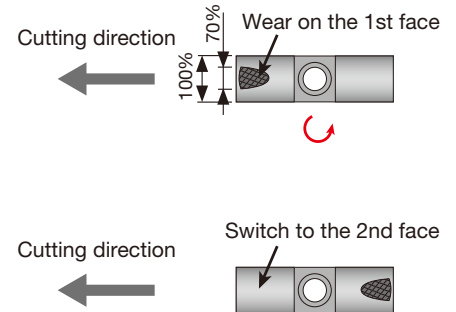
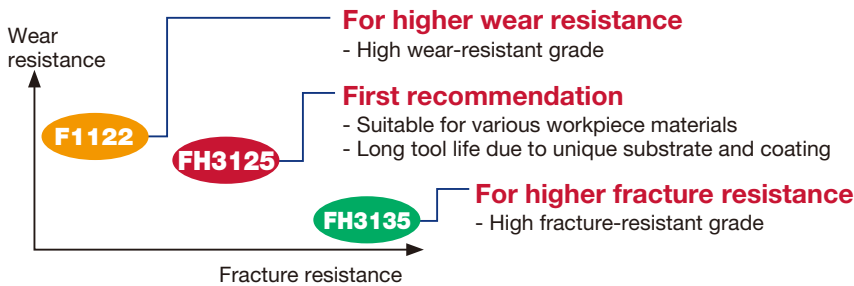
Grade
Insert
B
C
D
E
F
G
H
I
J
K
L
M
User's Guide
Tooling System
Drilling tool
Endmill
Milling cutter
Miniature tool
Grooving
Threading
Int. Toolholder
Ext. Toolholder

Deep hole drilling head series

Replacing guide pads

Guide pads are subject to wear, like inserts

- The guide pad can be used on two end faces.
- When the first face wears up to 70% of its width, reverse the guide pad to use the second face.
- Replace with a new guide pad when the second face wears out.

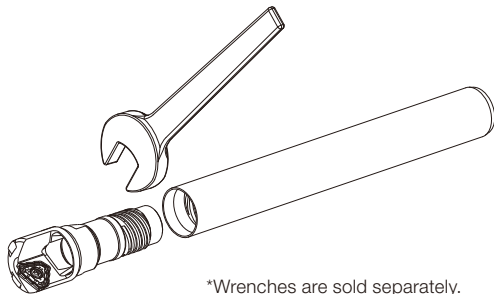


GP	06-085	F1122
Series	Size	Grade

GP	06-20-085	-DC	FH3135
Series	Size	Double chamfer	Grade

Replacing guide pads

Please be sure to use a wrench for a drill head to be clamped firmly.



WHEN TO REPLACE THE FILLER WITH A GUIDE PAD AND PROTECTOR

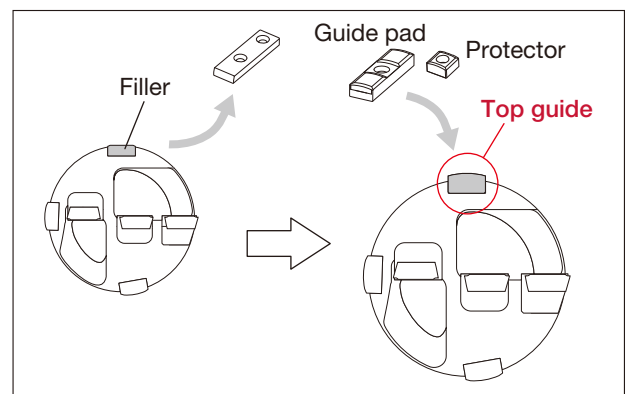
Replace the filler with a guide pad and protector when following is required:



- Higher hole precision
- Deep holes with an L/D ratio of over 50:1
- Drilling parts with a center hole
- A large stock removal that exceeds the marginal DOC* of the peripheral edge as specified in the list below.

*Maximum DOC of peripheral insert

Cartridge	DOC (mm)	Guide pad
OZ402-04	6.4	GP08.../GP10...
OZ402-32	7.2	GP10.../GP14...
OZ402-43	10.4	GP14.../GP18...
OZ402-63	12.0	GP18...



There is no pocket for the top guide pad furnished on the drill heads in diameters smaller than 92 mm.

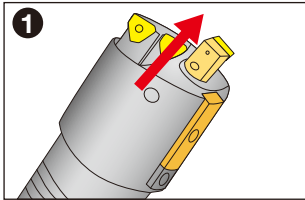
Please contact your dealer for further information.



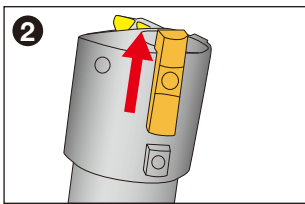
Drill diameter calibration

Please note that inserts must be ordered separately as they are not included in the UNIDEX tool. To achieve successful drilling with UNIDEX deep hole drill, it is critical to set and maintain adequate clearance between the tool diameter and guide pad diameter. After installing inserts, make sure to properly calibrate the tool diameter by following the steps outlined below. Always proceed with the same calibration procedures when the inserts are indexed or exchanged. This is especially important when using inserts from a new batch as they may greatly deviate the tool diameter.

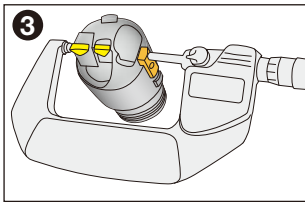
⚠ Poor hole precision, abnormal wear of inserts or guide pads, or serious tool damage may occur if the insert and guide pad diameters are not properly calibrated.



1 Remove the intermediate cartridge to avoid interference with the guide screw.

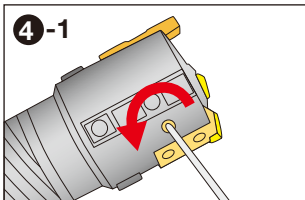


2 Move the dimensional guide pad to the measuring position parallel to the peripheral insert.
2-1 Unscrew the lock screw of the dimensional guide pad and slide the dimensional guide pad to the measuring position.
2-2 Tighten the lock screw to fix the guide pad.

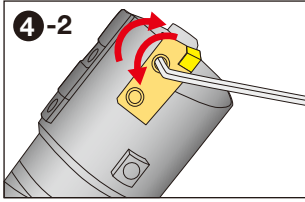


3 Measure the diameter with a micrometer. Use an h8 tolerance for the tool diameter unless otherwise required.

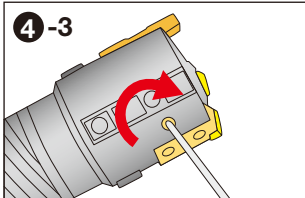
If the diameter at this point is out of tolerance, go to Step **4**.
 If the diameter at this point is in tolerance, go to Step **5**.



4 Adjust the peripheral cartridge
4-1 First loosen the lock screw of the peripheral cartridge and then slightly re-tighten the lock screw.



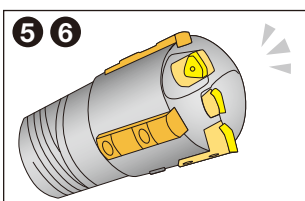
4-2 Adjust the cartridge by loosening or tightening the two adjusting screws on the cartridge and measure the diameter using a micrometer. Repeat steps until the required diameter is attained.



4-3 After attaining the required diameter, securely tighten the lock screw to fix the cartridge.

4-4 Measure the diameter with a micrometer to assure that the required diameter is attained. If not attained, start from Step **4-1**.

⚠ Make sure that the two adjusting screws on the peripheral cartridge are tightened. If the tool is used with either of the screws left loosened, the cartridge will move during machining due to cutting forces and may cause damage.



5 Return the dimensional guide pad to the original position and tighten the lock screw.

6 Replace the intermediate cartridge to the original position and tighten the lock screw.

⚠ Whenever inserts are indexed or exchanged, always make sure that all the screws on the drill are securely tightened. If chatter occurred during machining, it may cause the screws to be loosened.

Approximate Conversion Table of Hardness

● **Approximate conversion value for Brinell hardness. *1**

(The source: JIS HB Ferrous Materials and Metallurgy I -2005)

HB		HV	Rockwell *3				HS	Approx. tensile strength (MPa) *2	HB		HV	Rockwell *3				HS	Approx. tensile strength (MPa) *2
Brinell, 10mm ball, Load 3000kg		Vickers	HRA	HRB	HRC	HRD	Shore		Brinell, 10mm ball, Load 3000kg		Vickers	HRA	HRB	HRC	HRD	Shore	
Standard ball	Tungsten carbide ball		A Scale, Load 60kg, Brale Diamond	B Scale, Load 100kg, Diameter 1/16 in. Steel ball	C Scale, Load 150kg, brale diamond	D Scale, Load 100kg, Brale Diamond			Standard ball	Tungsten carbide ball		A Scale, Load 60kg, Brale Diamond	B Scale, Load 100kg, Diameter 1/16 in. Steel ball	C Scale, Load 150kg, brale diamond	D Scale, Load 100kg, Brale Diamond		
-	-	940	85.6	-	68.0	76.9	97	-	429	429	455	73.4	-	45.7	59.7	61	1510
-	-	920	85.3	-	67.5	76.5	96	-	415	415	440	72.8	-	44.5	58.8	59	1460
-	-	900	85.0	-	67.0	76.1	95	-	401	401	425	72.0	-	43.1	57.8	58	1390
-	(767)	880	84.7	-	66.4	75.7	93	-	388	388	410	71.4	-	41.8	56.8	56	1330
-	(757)	860	84.4	-	65.9	75.3	92	-	375	375	396	70.6	-	40.4	55.7	54	1270
-	(745)	840	84.1	-	65.3	74.8	91	-	363	363	383	70.0	-	39.1	54.6	52	1220
-	(733)	820	83.8	-	64.7	74.3	90	-	352	352	372	69.3	(110.0)	37.9	53.8	51	1180
-	(722)	800	83.4	-	64.0	73.8	88	-	341	341	360	68.7	(109.0)	36.6	52.8	50	1130
-	(712)	-	-	-	-	-	-	-	331	331	350	68.1	(108.5)	35.5	51.9	48	1095
-	(710)	780	83.0	-	63.3	73.3	87	-	321	321	339	67.5	(108.0)	34.3	51.0	47	1060
-	(698)	760	82.6	-	62.5	72.6	86	-	-	-	-	-	-	-	-	-	-
-	(684)	740	82.2	-	61.8	72.1	-	-	311	311	328	66.9	(107.5)	33.1	50.0	46	1025
-	(682)	737	82.2	-	61.7	72.0	84	-	302	302	319	66.3	(107.0)	32.1	49.3	45	1005
-	(670)	720	81.8	-	61.0	71.5	83	-	293	293	309	65.7	(106.0)	30.9	48.3	43	970
-	(656)	700	81.3	-	60.1	70.8	-	-	285	285	301	65.3	(105.5)	29.9	47.6	-	950
-	(653)	697	81.2	-	60.0	70.7	81	-	277	277	292	64.6	(104.5)	28.8	46.7	41	925
-	(647)	690	81.1	-	59.7	70.5	-	-	269	269	284	64.1	(104.0)	27.6	45.9	40	895
-	(638)	680	80.8	-	59.2	70.1	80	-	262	262	276	63.6	(103.0)	26.6	45.0	39	875
-	630	670	80.6	-	58.8	69.8	-	-	255	255	269	63.0	(102.0)	25.4	44.2	38	850
-	627	667	80.5	-	58.7	69.7	79	-	248	248	261	62.5	(101.0)	24.2	43.2	37	825
-	-	677	80.7	-	59.1	70.0	-	-	241	241	253	61.8	100.0	22.8	42.0	36	800
-	601	640	79.8	-	57.3	68.7	77	-	235	235	247	61.4	99.0	21.7	41.4	35	785
-	-	640	79.8	-	57.3	68.7	-	-	229	229	241	60.8	98.2	20.5	40.5	34	765
-	-	640	79.8	-	57.3	68.7	-	-	223	223	234	-	97.3	(18.8)	-	-	-
-	578	615	79.1	-	56.0	67.7	75	-	217	217	228	-	96.4	(17.5)	-	33	725
-	-	607	78.8	-	55.6	67.4	-	-	212	212	222	-	95.5	(16.0)	-	-	705
-	555	591	78.4	-	54.7	66.7	73	2055	207	207	218	-	94.6	(15.2)	-	32	690
-	-	579	78.0	-	54.0	66.1	-	2015	201	201	212	-	93.8	(13.8)	-	31	675
-	534	569	77.8	-	53.5	65.8	71	1985	197	197	207	-	92.8	(12.7)	-	30	655
-	-	553	77.1	-	52.5	65.0	-	1915	192	192	202	-	91.9	(11.5)	-	29	640
-	514	547	76.9	-	52.1	64.7	70	1890	187	187	196	-	90.7	(10.0)	-	-	620
-	-	539	76.7	-	51.6	64.3	-	1855	183	183	192	-	90.0	(9.0)	-	28	615
-	-	530	76.4	-	51.1	63.9	-	1825	179	179	188	-	89.0	(8.0)	-	27	600
-	495	528	76.3	-	51.0	63.8	68	1820	174	174	182	-	87.8	(6.4)	-	-	585
(495)	-	539	76.7	-	51.6	64.3	-	1855	170	170	178	-	86.8	(5.4)	-	26	570
-	-	530	76.4	-	51.1	63.9	-	1825	167	167	175	-	86.0	(4.4)	-	-	560
-	-	516	75.9	-	50.3	63.2	-	1780	163	163	171	-	85.0	(3.3)	-	25	545
(477)	-	508	75.6	-	49.6	62.7	-	1740	156	156	163	-	82.9	(0.9)	-	-	525
-	477	508	75.6	-	49.6	62.7	66	1740	149	149	156	-	80.8	-	-	23	505
(461)	-	495	75.1	-	48.8	61.9	-	1680	143	143	150	-	78.7	-	-	22	490
-	-	491	74.9	-	48.5	61.7	-	1670	137	137	143	-	76.4	-	-	21	460
-	461	491	74.9	-	48.5	61.7	65	1670	131	131	137	-	74.0	-	-	-	450
444	-	474	74.3	-	47.2	61.0	-	1595	126	126	132	-	72.0	-	-	20	435
-	-	472	74.2	-	47.1	60.8	-	1585	121	121	127	-	69.8	-	-	19	415
-	444	472	74.2	-	47.1	60.8	63	1585	116	116	122	-	67.6	-	-	18	400
-	-	472	74.2	-	47.1	60.8	-	1585	111	111	117	-	65.7	-	-	15	385

Note :

*1: This table is based on AMS Metals Handbook, the 8th Edition, Volume 1, and includes some information added to "Approx. tensile strength (MPa)," such as the values calculated in metric; and Brinell hardness that exceeds recommended values.

*2: 1 MPa = 1 N/mm²

*3: Figures in () are not commonly used. It's just reference.

Surface Roughness

(According to JIS B 0601, 2001 and its explanation.)

Type	Symbol	How to determine	Example (Fig.)
Arithmetic mean roughness	Ra	<p>Ra means the value obtained by the following formula and expressed in micrometer (μm) when sampling only the reference length from the roughness curve in the direction of mean line, taking X-axis in the direction of mean line and Y-axis in the direction of longitudinal magnification of this sampled part and the roughness curve is expressed by $y=f(x)$:</p> $Ra = \frac{1}{\ell} \int_0^{\ell} f(x) dx$ <p>where, ℓ : reference length</p>	
Maximum height	Rz	<p>Rz shall be that only the reference length is sampled from the roughness curve in the direction of mean line, the distance between the top of profile peak line and the bottom of profile valley line on this sampled portion is measured in the longitudinal magnification direction of roughness curve and the obtained value is expressed in micrometer (μm).</p> $Rz = Rp + Rv$	
Ten point mean roughness	Rz_{JIS}	<p>Rz_{JIS} shall be that only the reference length is sampled from the roughness curve in the direction of its mean line, the sum of the average value of absolute values of the heights of five highest profile peaks (Zp) and the depths of five deepest profile valleys (Zv) measured in the vertical magnification direction from the mean line of this sampled portion and this sum is expressed in micrometer (μm)</p> $Rz_{JIS} = \frac{ Zp1 + Zp2 + Zp3 + Zp4 + Zp5 + Zv1 + Zv2 + Zv3 + Zv4 + Zv5 }{5}$	<p>where, $Zp1, Zp2, Zp3, Zp4, Zp5$: altitudes of the heights of five highest profile peaks of the sampled portion corresponding to the reference length ℓ</p> <p>where, $Zv1, Zv2, Zv3, Zv4, Zv5$: altitudes of the depths of five deepest profile valleys of the sampled portion corresponding to the reference length ℓ</p>



Symbols of Metals

● Carbon steel and alloy steel for structural use

Type	Japan	International	Other countries				
	JIS		ISO	U.S.A. AISI SAE	Great Britain BS BS/EN	Germany DIN DIN/EN	France NF NF/EN
Carbon steel	S10C	C10	1010	C10 C10E C10R	C10E C10R	C10E C10R	-
	S15C	C15E4 C15M2	1015	C15 C15E C15R	C15E C15R	C15E C15R	-
	S20C	-	1020	C22, C22E C22R	C22 C22E C22R	C22 C22E C22R	-
	S25C	C25 C25E4 C25M2	1025	C25 C25E C25R	C25 C25E C25R	C25 C25E C25R	-
	S30C	C30 C30E4 C30M2	1030	C30 C30E C30R	C30 C30E C30R	C30 C30E C30R	30Г
	S35C	C35 C35E4 C35M2	1035	C35 C35E C35R	C35 C35E C35R	C35 C35E C35R	35Г
	S40C	C40 C40E4 C40M2	1039 1040	C40 C40E C40R	C40 C40E C40R	C40 C40E C40R	40Г
	S43C	-	1042 1043	080A42	-	-	40Г
	S45C	C45 C45E4 C45M2	1045 1046	C45 C45E C45R	C45 C45E C45R	C45 C45E C45R	45Г
	S48C	-	-	-	-	-	45Г
	S50C	C50 C50E4 C50M2	1049	C50 C50E C50R	C50 C50E C50R	C50 C50E C50R	50Г
	S53C	-	1050 1053	-	-	-	50Г
	S55C	C55 C55E4 C55M2	1055	C55 C55E C55R	C55 C55E C55R	C55 C55E C55R	-
	S58C	C60 C60E4 C60M2	1059 1060	C60 C60E C60R	C60 C60E C60R	C60 C60E C60R	60Г

Type	Japan	International	Other countries					
	JIS		ISO	U.S.A. AISI SAE	Great Britain BS BS/EN	Germany DIN DIN/EN	France NF NF/EN	Russia ГОСТ
Nickel chromium steel	SNC236	-	-	-	-	-	40XH	
	SNC415(H)	-	-	-	-	-	-	
	SNC631(H)	-	-	-	-	-	30XH3A	
	SNC815(H)	15NiCr13	-	15NiCr13	15NiCr13	15NiCr13	-	
	SNC836	-	-	-	-	-	-	
Alloy steel	Nickel chromium molybdenum steel	SNCM220	20NiCrMo2 20NiCrMoS2	8615 8617(H) 8620(H) 8622(H)	20NiCrMo2-2 20NiCrMoS2-2	20NiCrMo2-2 20NiCrMoS2-2	20NiCrMo2-2 20NiCrMoS2-2	-
		SNCM240	41CrNiMo2 41CrNiMoS2	8637 8640	-	-	-	-
	SNCM415	-	-	-	-	-	-	
	SNCM420(H)	-	4320(H)	-	-	-	20XH2M(20XHM)	
	SNCM431	-	-	-	-	-	-	
	SNCM439	-	4340	-	-	-	-	
	SNCM447	-	-	-	-	-	-	
	SNCM616	-	-	-	-	-	-	
	SNCM625	-	-	-	-	-	-	
	SNCM630	-	-	-	-	-	-	
	SNCM815	-	-	-	-	-	-	

Note: The above chart is based on published data and not authorized by each manufacturer.

● Alloy steel

Type	Japan	International	Other countries							
			JIS	ISO	U.S.A.		Great Britain	Germany	France	Russia
					AISI SAE	BS BS/EN	DIN DIN/EN	NF NF/EN	ГОСТ	
Alloy steel	Chromium steel	SCr415(H)	-	-	17Cr3 17CrS3	17Cr3 17CrS3	17Cr3 17CrS3	17Cr3 17CrS3	15X 15XA	
		SCr420(H)	20Cr4(H) 20CrS4	5120(H)	-	-	-	-	20X	
		SCr430(H)	34Cr4 34CrS4	5130(H) 5132(H)	34Cr4 34CrS4	34Cr4 34CrS4	34Cr4 34CrS4	34Cr4 34CrS4	30X	
		SCr435(H)	34Cr4 34CrS4 37Cr4 37CrS4	5132	37Cr4 37CrS4	37Cr4 37CrS4	37Cr4 37CrS4	37Cr4 37CrS4	35X	
		SCr440(H)	37Cr4 37CrS4 41Cr4 41CrS4	5140(H)	530M40 41Cr4 41CrS4	41Cr4 41CrS4	41Cr4 41CrS4	41Cr4 41CrS4	40X	
		SCr445(H)	-	-	-	-	-	-	45X	
	Chromium molybdenum steel	SCM415(H)	-	-	-	-	-	-	-	
		SCM418(H)	18CrMo4 18CrMoS4	-	18CrMo4 18CrMoS4	18CrMo4 18CrMoS4	18CrMo4 18CrMoS4	18CrMo4 18CrMoS4	20XM	
		SCM420(H)	-	-	708M20(708H20)	-	-	-	20XM	
		SCM430	-	4130	-	-	-	-	30XM 30XMA	
		SCM432	-	-	-	-	-	-	-	
		SCM435(H)	34CrMo4 34CrMoS4	4137(H)	34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	34CrMo4 34CrMoS4	35XM	
		SCM440(H)	42CrMo4 42CrMoS4	4140(H) 4142(H)	42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	42CrMo4 42CrMoS4	-	
	SCM445(H)	-	4145(H) 4147(H)	-	-	-	-	-		
	Manganese steel and manganese chromium steel	SMn420(H)	22Mn6(H)	1522(H)	-	-	-	-	-	
SMn433(H)		-	1534	-	-	-	-	30Г2 35Г2		
SMn438(H)		36Mn6(H)	1541(H)	-	-	-	-	35Г2 40Г2		
SMn443(H)		42Mn6(H)	1541(H)	-	-	-	-	40Г2 45Г2		
SMnC420(H)		-	-	-	-	-	-	-		
SMnC443(H)	-	-	-	-	-	-	-			
Aluminium chromium molybdenum steel	SACM645	41CrAlMo74	-	-	-	-	-	-		

● Stainless steel

Type	Japan	International	Other countries							
			JIS	ISO	U.S.A.		Great Britain	Germany	France	Russia
					UNS	AISI SAE	BS BS/EN	DIN DIN/EN	NF NF/EN	ГОСТ
Stainless steel	Austenitic	SUS201	X12CrMnNiN17-7-5	S20100	201				Z12CMN17-07Az	
		SUS202	X12CrMnNiN18-9-5	S20200	202	284S16				12X17T9AH4
		SUS301	X10CrNi18-8	S30100	301	301S21		X12CrNi17-7	Z11CN17-08	07X16H6
		SUS301L	X2CrNiN18-7					X2CrNiN18-7		
		SUS301J1						X12CrNi17-7		
		SUS302		S30200	302	302S25			Z12CN18-09	12X18H9
		SUS302B	X12CrNiSi18-9-3	S30215	302B					
		SUS303	X10CrNiS18-9	S30300	303	303S21		X10CrNiS18-9	Z8CNF18-09	
		SUS303Se		S30323	303Se	303S41				12X18H10E
		SUS303Cu								
		SUS304	X5CrNi18-9	S30400	304	304S31		X5CrNi18-10	Z7CN18-09	08X18H10
		SUS304L	X2CrNi18-9	S30403	304L	304S11		X2CrNi19-11	Z3CN19-11	03X18H11
		SUS304N1	X5CrNiN18-8	S30451	304N				Z6CN19-09Az	
		SUS304N2		S30452						
		SUS304LN	X2CrNiN18-9	S30453	304LN			X2CrNiN18-10	Z3CN18-10Az	
		SUS304J1								
SUS304J2										
SUS304J3			S30431	S30431						
SUS305	X6CrNi18-12	S30500	305	305S19		X5CrNi18-12	Z8CN18-12	06X18H11		

Note: The above chart is based on published data and not authorized by each manufacturer.

Symbols of Metals

● Stainless steel

Type	Japan	International	Other countries									
			U.S.A.		Great Britain	Germany	France	Russia				
			JIS	ISO	UNS	AISI SAE	BS BS/EN	DIN DIN/EN	NF NF/EN	ГОСТ		
Stainless steel	Austenitic	SUS305J1										
		SUS309S			S30908	309S					Z10CN24-13	
		SUS310S	X6CrNi25-21		S31008	310S	310S31				Z8CN25-20	10X23H18
		SUS315J1										
		SUS315J2										
		SUS316	X5CrNiMo17-12-2 X3CrNiMo17-12-3		S31600	316	316S31	X5CrNiMo17-12-2 X5CrNiMo17-13-3	Z7CND17-12-02 Z6CND18-12-03			
		SUS316F										
		SUS316L	X2CrNiMo17-12-2 X2CrNiMo17-12-3 X2CrNiMo18-14-3		S31603	316L	316S11	X2CrNiMo17-13-2 X2CrNiMo17-14-3	Z3CND17-12-02 Z3CND17-12-03		03X17H14M3	
		SUS316N			S31651	316N						
		SUS316LN	X2CrNiMoN17-11-2 X2CrNiMoN17-12-3		S31653	316LN		X2CrNiMoN17-12-2 X2CrNiMoN17-13-3	Z3CND17-11Az Z3CND17-12Az			
		SUS316Ti	X6CrNiMoTi17-12-2		S31635			X6CrNiMoTi17-12-2	Z6CNDT17-12		08X17H13M2T	
		SUS316J1										
		SUS316J1L										
		SUS317			S31700	317	317S16					
		SUS317L	X2CrNiMo19-14-4		S31703	317L	317S12	X2CrNiMo18-16-4	Z3CND19-15-04			
	SUS317LN	X2CrNiMoN18-12-4		S31753				Z3CND19-14Az				
	SUS317J1											
	SUS317J2											
	SUS317J3L											
	SUS836L			N08367								
	SUS890L	X1CrNiMoCu25-20-5		N08904	N08904	904S14		Z2NCU25-20				
	SUS321	X6CrNiTi18-10		S32100	321	321S31	X6CrNiTi18-10	Z6CNT18-10		08X18H10T		
	SUS347	X6CrNiNb18-10		S34700	347	347S31	X6CrNiNb18-10	Z6CNNb18-10		08X18H12B		
	SUS384	X3NiCr18-16		S38400	384			Z6CN18-16				
	SUSXM7	X3CrNiCu18-9-4		S30430	304Cu	394S17		Z2CNU18-10				
	SUSXM15J1			S38100				Z15CNS20-12				
	Austenitic Ferritic	SUS329J1		S32900	329							
		SUS329J3L	X2CrNiMoN22-5-3	S31803	31803			Z3CNDU22-05Az		08X21H6M2T		
		SUS329J4L	X2CrNiMoCuN25-6-3	S32250	32250			Z3CNDU25-07Az				
	Ferritic	SUS405	X6CrAl13	S40500	405	405S17	X6CrAl13	Z8CA12				
SUS410L							Z3C14					
SUS429			S42900	429								
SUS430		X6Cr17	S43000	430	430S17	X6Cr17	Z8C17		12X17			
SUS430F		X7CrS17	S43020	430F		X7CrS18	Z8CF17					
SUS430LX		X3CrTi17 X3CrNb17	S43035			X6CrTi17	Z4CT17					
SUS430J1L		X2CrTi17				X6CrNb17	Z4CNb17					
SUS434		X6CrMo17-1	S43400	434	434S17	X6CrMo17-1	Z8CD17-01					
SUS436L		X1CrMoTi16-1	S43600	436								
SUS436J1L												
SUS444		X2CrMoTi18-2	S44400	444				Z3CDT18-02				
SUS445J1												
SUS445J2												
SUS447J1				S44700								
SUSXM27				S44627				Z1CD26-01				
Martensitic	SUS403		S40300	403								
	SUS410	X12Cr13	S41000	410	410S21	X10Cr13	Z13C13					
	SUS410S	X6Cr13	S41008	410S	403S17	X6Cr13	Z8C12		08X13			
	SUS410F2											
	SUS410J1		S41025									
	SUS416	X12CrS13	S41600	416	416S21			Z11CF13				
	SUS420J1	X20Cr13	S42000	420	420S29	X20Cr13	Z20C13		20X13			
	SUS420J2	X30Cr13	S42000	420	420S37	X30Cr13	Z33C13		30X13			
	SUS420F	X29CrS13	S42020	420F				Z30CF13				
	SUS420F2											
	SUS429J1											
	SUS431	X19CrNi16-2	S43100	431	431S29	X20CrNi17-2	Z15CN16-02		20X17H2			
	SUS440A	X70CrMo15	S44002	440A				Z70C15				
	SUS440B		S44003	440B								
	SUS440C	X105CrMo17	S44004	440C				Z100CD17	95X18			
SUS440F		S44020	S44020									
Precipitation hardening type	SUS630	X5CrNiCuNb16-4	S17400	S17400			Z6CNU17-04					
	SUS631	X7CrNiAl17-7	S17700	S17700		X7CrNiAl17-7	Z9CNA17-07		09X17H7I0			
	SUS631J1											

Note: The above chart is based on published data and not authorized by each manufacturer.

● Heat resistant steel

Type	Japan	International	Other countries						
	JIS		ISO	U.S.A.		Great Britain	Germany	France	Russia
		UNS		AISI SAE	BS BS/EN	DIN DIN/EN	NF NF/EN	ГОСТ	
Heat resistant steel Austenitic	SUH31				331S42			Z35CNWS14-14	45X14H14B2M
	SUH35		S63008		349S52			Z52CMN21-09Az	
	SUH36				349S54		X53CrMnNi21-9	Z55CMN21-09Az	55X20T9 AH4
	SUH37		S63017		381S34				
	SUH38								
	SUH309		S30900	309	309S24			Z15CN24-13	
	SUH310		S31000	310	310S24		CrNi2520	Z15CN25-20	20X25H20C2
	SUH330		N08330	N08330				Z12NCS35-16	
	SUH660		S66286					Z6NCTV25-20	
	SUH661		R30155						
Heat resistant steel Ferritic	SUH21						CrAl1205		
	SUH409	X6CrTi12	S40900	409	409S19		X6CrTi12	Z6CT12	
	SUH409L	X2CrTi12						Z3CT12	
Heat resistant steel Martensitic	SUH446		S44600	446				Z12C25	15X28
	SUH1		S65007		401S45		X45CrSi9-3	Z45CS9	
	SUH3							Z40CSD10	40X10C2M
	SUH4				443S65			Z80CSN20-02	
	SUH11								40X9C2
	SUH600								20X12BHMБФP
	SUH616		S42200						

● Tool steel

Type	Japan	International	U.S.A.	Type	Japan	International	U.S.A.
	JIS				ISO		
Carbon tool steel	SK140	-	-	Alloy tool steel	SKS5	-	-
	SK120	C120U	W1-11 1/2		SKS51	-	L6
	SK105	C105U	W1-10		SKS7	-	-
	SK95	-	W1-9		SKS81	-	-
	SK90	C90U	-		SKS8	-	-
	SK85	-	W1-8		SKS4	-	-
	SK80	C80U	-		SKS41	-	-
	SK75	-	-		SKS43	105V	W2-9 1/2
	SK70	C70U	-		SKS44	-	W2-8 1/2
	SK65	-	-		SKS3	-	-
	SK60	-	-		SKS31	-	-
High speed steel	SKH2	HS18-0-1	T1	SKS93	-	-	
	SKH3	-	T4	SKS94	-	-	
	SKH4	-	T5	SKS95	-	-	
	SKH10	-	T15	SKD1	X210Cr12	D3	
	SKH40	HS6-5-3-8	-	SKD2	X210CrW12	-	
	SKH50	HS1-8-1	-	SKD10	X153CrMoV12	-	
	SKH51	HS6-5-2	M2	SKD11	-	D2	
	SKH52	HS6-6-2	M3-1	SKD12	X100CrMoV5	A2	
	SKH53	HS6-5-3	M3-2	SKD4	-	-	
	SKH54	HS6-5-4	M4	SKD5	X30WCrV9-3	H21	
	SKH55	HS6-5-2-5	-	SKD6	-	H11	
	SKH56	-	M36	SKD61	X40CrMoV5-1	H13	
	SKH57	HS10-4-3-10	-	SKD62	X35CrWMoV5	H12	
	SKH58	HS2-9-2	M7	SKD7	32CrMoV12-28	H10	
SKH59	HS2-9-1-8	M42	SKD8	38CrCoW18-17-17	H19		
Alloy tool steel	SKS11	-	F2	SKT3	-	-	
	SKS2	-	-	SKT4	55NiCrMoV7	-	
	SKS21	-	-	SKT6	45NiCrMo16	-	

● Special use steel

Type	Japan	International	U.S.A.	Type	Japan	International	U.S.A.
	JIS				ISO		
Free cutting carbon steels	SUM11	-	1110	Free cutting carbon steels	SUM32	-	-
	SUM12	-	1109		SUM41	1109	1137
	SUM21	9S20	1212		SUM42	-	1141
	SUM22	11SMn28	1213		SUM43	44SMn28	1144
	SUM22L	11SMnPb28	-				
	SUM23	-	1215				
	SUM23L	-	-				
	SUM24L	11SMnPb28	12L14				
	SUM25	12SMn35	-				
	SUM31	-	1117				
	SUM31L	-	-				
High carbon chromium				SUJ1	-	-	
				SUJ2	B1	52100	
				SUJ3	B2	ASTM A 485 Grade 1	
				SUJ4	-	-	
				SUJ5	-	-	

Note: The above chart is based on published data and not authorized by each manufacturer.

Symbols of Metals

● Casting or forging steel

Type	Japan	International	Other countries					
	JIS		ISO	U.S.A. AISI ASTM	Great Britain BS BS/EN	Germany DIN DIN/EN	France NF NF/EN	Russia ГОСТ
Casting steel	Carbon steel casting	SC	200-400, 230-450, 270-480	U-	A1, A2	GS-	GE230, GE280, GE320	-
	Steel casting for welded structure	SCW	200-400W, 230-450W, 270-480W, 340-550W	WCA, WCB, WCC	A4	-	GE230, GE280	-
	Heat resisting steel casting	SCH	GX40CrSi24, GX40CrNiSi22-10, GX40NiCrSi38-19	Grade HC, HD, HF	309C30, 310C45, 330C12	-	GX40NiCrNb45-35, GX50NiCrCoW35-25-15-5	-
	Steel casting for high temperature and high pressure service	SCPH	-	Grade WC1, WC6, WC9	A1, A2, B1, B2, B3, B4, B5, B7	G20Mo5, G17CrMo5-5, G17CrMo5-10	G17CrMo9-10, GX15CrMo5, GP240GH, GP280GH	-
Steel casting for low temperature and high pressure service	SCPL	-	Grade LCB, LC1, LC2, LC3	AL1, BL2	-	FB-M, FC1-M, FC2-M, FC3-M	-	
Casting iron	Grey iron casting	FC	100,150,200,250, 300,350	No.20,25,30,35, 40,45,50	EN-GJL-	EN-GJL-	EN-GJL-	-
	Spheroidal graphite iron casting	FCD	700-2, 600-3, 500-7, 450-10, 400-15, 400-18, 350-22	60-40-18, 65-45-12, 8-55-06, 100-70-03, 120-90-02	EN-GJS-	EN-GJS-	EN-GJS-	B4
	Austempered spheroidal graphite iron casting	FCAD	-	-	EN-GJS-	EN-GJS-	EN-GJS-	-
	Austenitic iron casting	FCA-FCDA-	L-, S-	Type 1, 2, Type D-2, D-3A Class 1, 2	F1, F2, S2W, S5S	GGL-, GGG-	L-, S-	-
Forging steel	Carbon steel forging for general use	SF	-	Class A, B, C, D, E, F	C22, C25, C30, C35, C40, C45, C50, C55, C60	P285, P355	P245, P280, P305	-
	Chromium molybdenum steel forgings for general use	SFCM	-	Class E, F, G, I Grade 3A, 4 Class G, J, K, L, M	-	-	-	-
	Nickel Chromium molybdenum steel forgings for general use	SFNCM	-	Class G, H, I, J Class 3A, 4, 5, 6 Class K, L, M	-	-	-	-

● Non-ferrous alloy

Type	Japan	International	Other countries		
	JIS		ISO	U.S.A. ASTM SAE	Great Britain BS BS/EN
Copper alloy casting	CAC101	-	-	-	-
	CAC102	-	-	-	-
	CAC103	-	-	-	-
Brass casting	CAC201	-	-	-	-
	CAC202	-	C85400	-	-
	CAC203	-	C85700	-	-
High strength brass casting	CAC301	-	C86500	-	-
	CAC302	-	C86400	-	-
	CAC303	-	C86200	-	-
	CAC304	-	C86300	-	-
Bronze casting	CAC401	-	C84400	-	-
	CAC402	-	C90300	-	-
	CAC403	-	C90500	-	-
	CAC406	-	C83600	-	-
	CAC407	-	C92200	-	-
Phosphor bronze casting	CAC502A	-	-	-	-
	CAC502B	-	C90700	-	-
	CAC503A	-	C90800	-	-
	CAC503B	-	-	-	-
Aluminium bronze casting	CAC701	-	C95200	-	-
	CAC702	-	C95400	-	-
	CAC703	-	C95410	-	-
	CAC704	-	C95800	-	-
Silicon bronze castings	CAC801	-	-	-	-
	CAC802	-	C87500	-	-
	CAC803	-	C87400	-	-
					CuZn16Si4-C(CC761S)

Note: The above chart is based on published data and not authorized by each manufacturer.

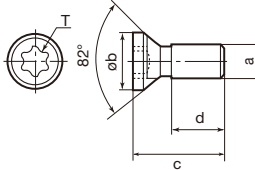
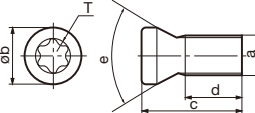
● Non-ferrous alloy

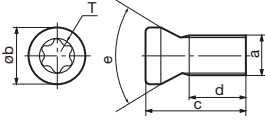
Type	Japan		Other countries				
	JIS	International ISO	U.S.A.	Great Britain	Germany	France	
			ASTM SAE	BS BS/EN	DIN DIN/EN	NF NF/EN	
Aluminium alloy	Aluminium alloy ingots for casting	AC1B	Al-Cu4MgTi	204.0		EN AC-2100	
		AC2A	-	-		-	
		AC2B	-	319.0			-
		AC3A	-	-			EN AC-44100
		AC4A	-	-			-
		AC4B	Al-Si8Cu3	333.0			EN AC-46200
		AC4C	Al-Si7Mg(Fe)	356.0			EN AC-42000
		AC4CH	Al-Si7Mg0.3	A356.0			EN AC-42100
		AC4D	-	355.0			EN AC-45300
		AC5A	Al-Cu4Ni2Mg2	242.0			-
		AC7A	-	514.0			-
		AC8A	Al-Si12CuNiMg	-	-		EN AC-48000
		AC8B	-	-	-		-
		AC8C	-	332.0			-
	AC9A	-	-	-		-	
	AC9B	-	-	-		-	
	Aluminium alloy die casting	ADC1	-	A413.0			-
		ADC3	-	A360.0			-
		ADC5	-	518.0			-
		ADC6	-	-			-
		ADC10	-	-			-
		ADC10Z	-	A380.0			-
		ADC12	-	-			-
		ADC12Z	-	383.0			-
	ADC14	-	B390.0			-	
	Magnesium alloy	Magnesium alloy casting	MC5	-	AM100A		-
			MC6	-	ZK51A		-
			MC7	-	ZK61A		-
MC8			MgRE3Zn2Zr	EZ33A		EN MC65120	
MC9			MgAg3RE2Zr	QE22A		EN MC65210	
MC10			MgZn4RE1Zr	ZE41A		EN MC35110	
Magnesium alloy die casting		MD1A	-	AZ91A		G-A9Z1Y4	
		MDC1B	-	AZ91B		-	
		MDC1D	MgAl9Zn1(A)	AZ91D		EN MC21120	
		MDC2B	MgAl6Mn	AM60B		EN MC21320	
Type	Japan		Other countries				
	JIS	International ISO	U.S.A.	Great Britain	Germany	France	
			ASTM AA	BS BS/EN	DIN DIN/EN	NF NF/EN	
Aluminium alloy	Aluminium alloy extruded shapes	A5052S	-	5052		EN AW-5052	
		A5454S	-	5454		EN AW-5454	
		A5083S	AlMg4.5Mn0.7	5083		EN AW-5083	
		A5086S	-	5086		EN AW-5086	
		A6061S	AlMg1SiCu	6061		EN AW-6061	
		A6063S	AlMg0.7Si	6063		EN AW-6063	
		A7003S	-	-		EN AW-7003	
		A7N01S	-	-		-	
		A7075S	AlZn5.5MgCu	7075		EN AW-7075	

Note: The above chart is based on published data and not authorized by each manufacturer.

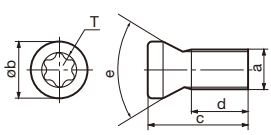
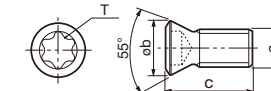
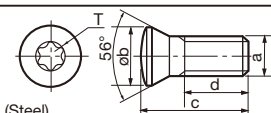
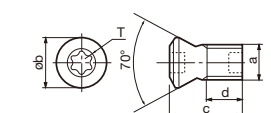
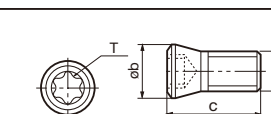
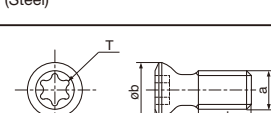
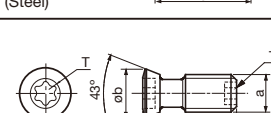



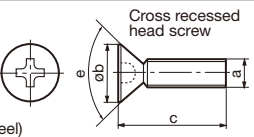
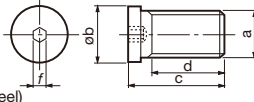
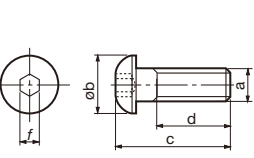
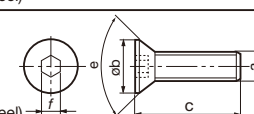
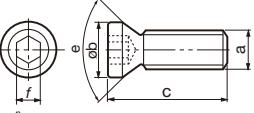
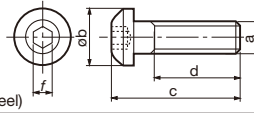
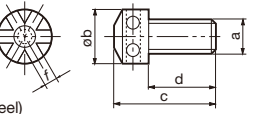
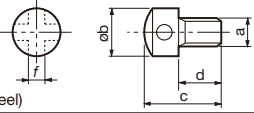
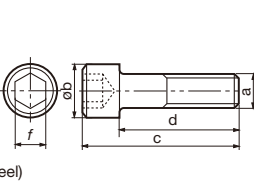
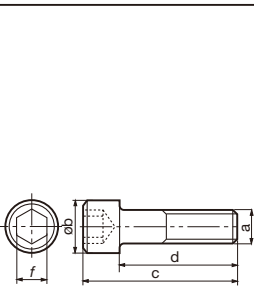
Screws

Shape	Designation	Dimension (in)					T / f	Torque (lbs-ft)		
		a	øb	c	d	e				
 (Steel)	CSTA-NO2	#2-56UNC	0.157	0.236	0.157	82°	T8	0.96		
	CSTA-NO2S			0.197	0.118					
	CSTA-NO2L			0.315	0.236					
	CSTA-NO3	#3-48UNC	0.169	0.276	0.157	80°	T9	1.70		
	CSTA-NO5	#5-40UNC	0.197	0.315	0.197					
	CSTA-1.6	M1.6x0.35	0.098	0.122	0.035					
	CSTA-4	M4x0.7	0.276	0.394	0.303	82°	T15	2.58		
	CSTA-5	M5x0.8	0.283	0.591	0.433					
	CSTA-5S			0.472	0.315					
	CSTA-5SS			0.374	0.217					
	CSTA-5ST25			0.472	0.315					
	CSPA-5IP15			0.280	0.280				0.591	0.433
	CSPA-5SIP15								0.472	0.315
	CSPA-5IP20								0.591	0.433
	CSPA-5SIP20								0.472	0.315
 (Steel)	CSP-2L033			M2x0.4	0.102				0.130	0.075
	CSTB-2					0.106	0.130	0.055		
	CSTB-2L	0.205	0.130							
	CSTB-2L040	0.157	0.083							
	CSTB-2.2	M2.2x0.45	0.138	0.138	0.240	0.138	60°	T7	0.74	
	CSTB-2.2L038				0.150	0.087				
	CSTB-2.2S				0.181	0.079				
	CSTB-2.2L053DR				0.118	0.209				0.126
	CSTB-2.2L053DL				0.118	0.209				0.126
	CSTB-2.2R	0.122	0.240	0.146						
	CSTB-2.5	M2.5x0.45	0.138	0.138	0.236	0.134	T8	0.96		
	CSTB-2.5L046				0.128	0.181	0.102	T7	0.66	
	CSTB-2.5L080				0.138	0.315	0.213	0.96	T8	0.96
	CSTB-2.5B					0.217	0.102			
	CSTB-2.5L054DR					0.213	0.114		T7	
	CSTB-2.5L054DL					0.189	0.087		T8	
	CSTB-2.5S	0.161	0.161	0.315	0.177	1.70	T9	1.70		
	CSTB-3			0.165	0.028					
	CSTB-3L042			0.197	0.079					
	CSTB-3L050	M3x0.5	0.165	0.165	0.319	0.185	T8	0.96		
	CSTB-3L081				0.161	0.236	0.098	T9	1.70	
	CSTB-3S				0.209	0.492	0.157	2.58	T15	2.58
	CSTB-3.5ST	0.205	0.256	0.122						
	CSTB-3.5H	0.217	0.331	0.169						
	CSTB-3.5	M3.5x0.6	0.256	0.256	0.394	0.217	60°	T20	3.69	
	CSTB-3.5T				0.335	0.157				
	CSTB-3.5TS				0.185	0.331				0.193
	CSTB-3.5D				0.217	0.433				0.295
	CSTB-3.5L110				0.189	0.453				0.276
	CSTB-3.5L115	0.189	0.189	0.189	0.453	0.256	2.58	T10	1.84	
CSTB-3.5L115-S	0.492				0.256					
CSTB-3.5L	0.209				0.492	0.331				
CSTC-4L	M4x0.7	0.217	0.217	0.449	0.291	60°	T15	2.58		
CSTB-4				0.236	0.079					
CSTB-4L060				0.334	0.137					
CSTB-4L085				0.224	0.354				0.217	
CSTB-4L090				0.217	0.453				0.256	
CSTB-4L115-S				0.217	0.315				0.157	
CSTB-4S	0.252	0.579								
CSTB-4ST	M4x0.5	0.252	0.579	0.157	0.96	T8	0.96			
CSTB-4SD	M4x0.7	0.217	0.315							
CSTB-4M	M4x0.7	0.217	0.374	0.217	2.58	T15	2.58			
CSTB-4F	M4x0.5	0.276	0.579	0.343						
CSTB-4TS	M4x0.7	0.256	0.354	0.177	3.69	T20	3.69			
CSTB-5	M5x0.8	0.276	0.276	0.472		0.295				
CSTB-5S				0.374		0.197				
CSTB-5L105				0.413	0.240					

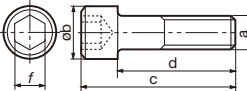
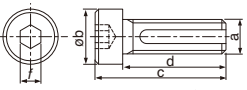
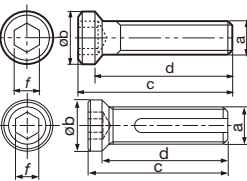
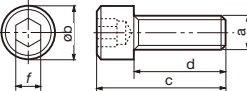
Shape	Designation	Dimension (in)						Torque (lbs-ft)	
		a	øb	c	d	e	T / f		
	CSTB-5L120			0.472	0.256				
	CSTB-5L159		0.283	0.626	0.441				
	CSTB-5L163-S		0.272	0.642	0.445			4.43	
	CSTC-4L055DR	M4x0.5	0.213	0.217	0.079	44°	T8/T10	0.96/1.84	
	CSTC-4L055DL	M4x0.5	0.213	0.217	0.079		T8/T10	0.96/1.84	
	CSTC-4L100DR	M4x0.7	0.213	0.394	0.234		T8/T10	0.96/1.84	
	CSTC-4L100DL	M4x0.7	0.213	0.394	0.234		T8/T10	0.96/1.84	
	CSPB-1.8L3.3	M1.8x0.35	0.094	0.130	0.039	60°	6IP	0.37	
	CSPB-1.8L3.6			0.142	0.051				
	CSPB-1.8FL4.3			0.169	0.091				
	CSPB-2L043	M2x0.4	0.106	0.169	0.098	6IP	0.52		
	CSPB-2H			0.102	0.134			0.063	
	CSPB-2.2	M2.2x0.45	0.118	0.236	0.154	7IP	0.74		
	CSPB-2.2SH			0.157	0.079			0.81	
	CSPB-2.5	M2.5x0.45	0.138	0.236	0.138	8IP	0.96		
	CSPB-2.5S			0.165	0.067				
	CSPB-2.5SH			0.130	0.205			0.130	7IP
	CSPB-3.5	M3.5x0.6	0.205	0.354	0.220	15IP	2.58		
	(Steel)	CSPB-3.5S	M3.5x0.6	0.205	0.256	0.122	60°	15IP	2.58
	CSPB-4	M4x0.7	0.217	0.457	0.291				
	CSPB-4S			0.323	0.157				
	CSPB-5	M5x0.8	0.276	0.472	0.295	20IP	3.69		
	VX040024A	M4	0.215	0.354	0.236	T15	3.32		
	VX040028A	M4	0.205	0.382	0.185	44°	T15	3.32	
	SR-M2.5X0.45-L6IP7	M2.5x0.45	0.134	0.236	0.136	60°	7IP	0.89	
	SR10503833L040	M2.5x0.45	0.128	0.157	0.079		T7	0.96	
	SR14-500/L5.1	M4	0.217	0.201	0.091		T15	2.58	
	SR14-500-L7.0	M4	0.217	0.276	0.165	T15	2.58		
	SR14-506	M4x0.7	0.224	0.315	0.185	T15	3.54		
	SR14-554/S	M4x0.7	0.224	0.366	0.197	T15	3.32		
	SR14-560	M2.2x0.45	0.138	0.252	0.150	50°	T8	0.89	
	SR14-560/S	M2.5x0.45	0.138	0.211	0.108		T8	0.89	
	SR14-562	M3.5	0.189	0.344	0.219	60°	T10	2.36	
	SR14-562/S	M3.5	0.189	0.256	0.130		T10	2.36	
	SR14-571/S	M3.5x0.6	0.201	0.295	0.157		T10	2.36	
	SR14-591	M5x0.8	0.260	0.531	0.299	T20	3.69		
	SR34-508	M2.2x0.45	0.124	0.181	0.105	T7	0.66		
	SR34-514	M2.5x0.45	0.130	0.205	0.126	T7	0.66		
	SR76-943	M6	0.378	0.787	0.394	90°	T20	3.69	
	SR76-961	M5	0.260	0.531	0.289	61°	T15	2.58	
	SR76-963	M5	0.339	0.787	0.378	91°	T15	2.58	
	SR 10503833-S	M2.5X0.45	0.128	0.150	0.069	60°	T7	0.66	
	SR 114-018-L3.40	M2.5	0.142	0.132	0.079	56°	T6	0.52	
	SM35-114-H0	M3.5x0.6	0.220	0.449	0.201	60°	T15	2.58	
	SM40-143-H0	M4X0.7	0.220	0.563	0.331	61°	T15	2.58	
	TS25F080A	M2.25X0.35	0.146	0.272	0.083	60°	T8	0.96	
	TS25064I	M2.5X0.45	0.138	0.252	0.150	50°	T8	0.96	
	TS30F100A	M3X0.35	0.181	0.327	0.087	60°	T10	1.84	
	TS30085I/HG	M3X0.5	0.169	0.335	0.220		T9	1.70	
	TS30100I/HG-P	M3x0.5	0.169	0.276	0.161		9IP	1.48	
	TS30C72I	M3X0.5	0.165	0.283	0.177		T9	1.70	
	TS40085I/HG	M4	0.224	0.335	0.177		T15	2.58	
	TS35085I/HG	M3X0.6	0.209	0.335	0.169		T15	2.58	
	TS40093I/HG	M4	0.224	0.366	0.169		T15	2.58	
	TS40B100I	M4	0.236	0.394	0.236		R3.0	T15	2.58
	TS40F120A	M4X0.5	0.236	0.417	0.118		60°	T15	2.58
	TS45120I	M4.5	0.272	0.472	0.295		R3.5	T20	3.69
	TS50115I	M5	0.276	0.447	0.252	60°	T20	3.69	
	TS50230D3	M5X0.8	0.276	0.906	0.531		T20	-	
	TS50250D35	M5X0.8	0.295	0.984	0.571		T25	-	
	TS50F160A	M5X0.5	0.276	0.547	0.138		T20	3.69	
(Steel)									

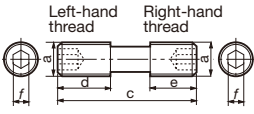
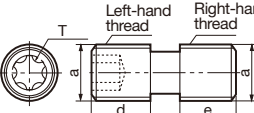
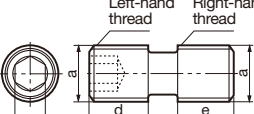

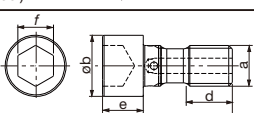
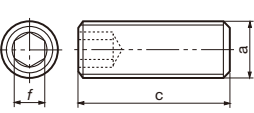
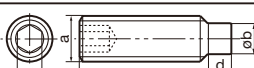
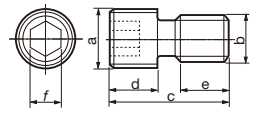
Screws

Shape	Designation	Dimension (in)					T / f	Torque (lbs-ft)
		a	øb	c	d	e		
 (Steel)	TS60265D4	M6X1.0	0.315	1.043	0.610	60°	T25	-
	TS60285D42	M6X1.0	0.335	1.122	0.657		T25	-
	TS60320D5	M6X1.0	0.374	1.220	0.709		T25	-
	TS60F200A	M6X0.75	0.323	0.657	0.177		T20	5.16
	TS70F250A	M7X0.75	0.394	0.827	0.220		T25	5.16
	TS80340D6	M8X1.25	0.394	1.339	0.787		T25	-
	TS80F300A	M8X1.0	0.472	0.984	0.287		T30	7.38
 (Steel)	CSPD-1.8S	M1.8x0.35	0.094	0.130	0.055		6IP	0.52
	CSTD-3T	M3x0.5	0.169	0.276	0.177		T10	1.84
	CSPD-3				0.165		10IP	1.84
 (Steel)	CSTB-4.5L110P	M4.5X0.75	0.260	0.461	0.276		T15	2.58
 (Steel)	SRM5X0.8IP20X+ACROLYTE	M5X0.8	0.362	0.591	0.386		20IP	5.53
 (Steel)	CSTC-2	M2x0.4	0.122	0.201	-		T6	0.52
 (Steel)	CSTR-4L100	M4x0.7	0.224	0.394	0.217		T15	2.58
 (Steel)	SR16-212-01397	M5x0.8	0.252	0.492	0.268		T20/T10	1.84
	SR16-212-01397L							
 (Steel)	CST-3.5	M3.5X0.6	0.236	0.189	-		T9	1.70
	CST-3.5S			0.138	-			
	CST-5	M5x0.8	0.394	0.709	0.512		T25	3.69
	CST-5S			0.472	0.276			
	CSTF-2L055-S	M2x0.4	0.106	0.217	0.150		T6	0.52

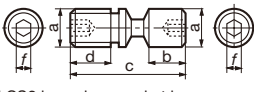
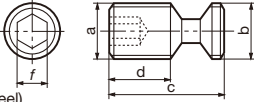
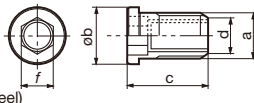
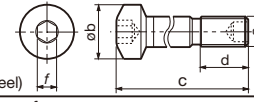
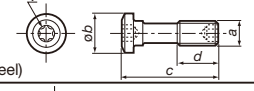
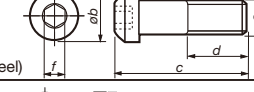
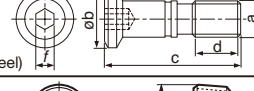


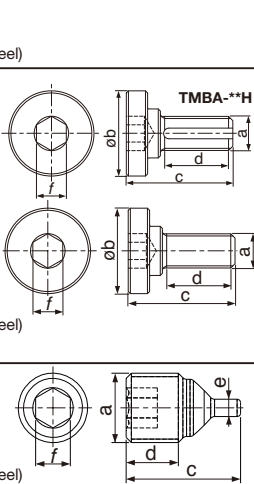
Shape	Designation	Dimension (in)						Torque (lbs-ft)
		a	ob	c	d	T / f	e	
 (Steel)	SM2.5x0.45x8	M2.5x0.45	0.197	0.315	-	-	90°	-
	SM2.5x0.5x8	M2.5x0.5	0.197	0.315	-	-	90°	-
	SM3x0.5x6	M3x0.5	0.236	0.236	-	-	90°	-
	SM3x0.5x8			0.315	-	-	90°	-
	SM3x0.5x10			0.394	-	-	90°	-
 (Steel)	MSP-5	M5x0.8	0.240	0.311	0.193	2	1.11	
	MSP-6.3	M6.3x1	0.303	0.500	0.390	2.5	2.21	
 (Steel)	BHM3-8	M3x0.5	0.217	0.394	0.315	2	1.11	
	BHM4-8	M4x0.7	0.276	0.417		2.5	1.62	
	BHM4-10			0.496	0.394			
	BHM5-14	M5x0.8	0.354	0.693	0.551	3	2.21	
	BHM6-20-A	M6x1.0	0.413	0.945	0.787	4	3.69	
	BHM8-25U	M8	0.551	1.154	0.984	5	6.27	
	BHM8-30U			1.350	1.181			
 (Steel)	CSHM-3-8	M3	0.236	0.315	-	2	90°	1.11
 (Steel)	CSHB-4-A	M4	0.217	0.433	-	T15	60°	1.48
	CSHB-6	M6	0.335	0.748	-	4	60°	3.69
	CSHB-6-A	M6	0.335	0.748	3.69			
 (Steel)	RT-1	M6	0.394	0.886	0.551	4	3.69	
	RT-2	M8	0.512	1.220	0.787	5	6.27	
 (Steel)	ASM6	M6	0.394	0.709	0.472	3	-	
	AJM5F	M5x0.5	0.354	0.512	0.315	2	-	
	AJM5	M5x0.8	0.354	0.512	0.315	2	-	
 (Steel)	ASM34S	M3	0.189	0.315	0.197	2	-	
	ASM34L			0.433	0.315		-	
	ASM54	M5x0.8	0.354	0.551	0.354	3	-	
 (Steel)	CHHM3.5-10	M3.5x0.6	0.236	0.531	0.394	3	2.21	
	CHHM4-10	M4x0.7	0.276	0.551				
	CHHM5-14	M5x0.8	0.335	0.748	0.551	4	3.69	
	CHHM5-18			0.906	0.709			
	CHHM6-15	M6	0.394	0.827	0.591	5	6.27	
	CHHM6-20			1.024	0.787			
	CHHM6-25			1.220	0.984			
 (Steel)	CM3X0.5X6	M3x0.5	0.217	0.354	0.236	2.5	1.62	
	CM3X0.5X10			0.512	0.394			
	CM4X0.7X10			0.551	0.394			
	CM4X0.7X12	M4x0.7	0.276	0.630	0.472	3	2.21	
	CM4X0.7X14			0.709	0.551			
	CM4X0.7X15			0.748	0.591			
	CM4X0.7X20			0.945	0.787			
	CM5X0.8X8	M5x0.8	0.335	0.512	0.315	4	3.69	
	CM5X0.8X10-A			0.591	0.394			
	CM5X0.8X12			0.669	0.472			
	CM5X0.8X12-A			0.669	0.472			
	CM5X0.8X14			0.709	0.551			
	CM5X0.8X16			0.827	0.630			
	CM5X0.8X16-A			0.827	0.630			
	CM5X0.8X18			0.906	0.709			
	CM5X0.8X20-A			0.984	0.787			
	CM5X0.8X25-A			1.181	0.984			

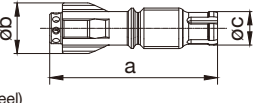
Screws

Shape	Designation	Dimension (in)							Torque (lbs-ft)				
		a	øb	c	d	e	f	g					
 <p>Hex. socket head screw (JISB1176)</p>  <p>CM***H</p>	CM6X1X16-A	M6x1.0	0.394	0.866	0.630	0.197		6.27					
	CM6X1X20-A			1.024	0.787								
	CM6X1X25-A			1.220	0.984								
	CM6X1.0X40-A			1.811	1.575								
	CM6X10			0.630	0.394								
	CM6X16			0.866	0.630								
	CM6X20	1.024	0.787	M6	0.394	0.197		6.27					
	CM6X25	1.220	0.984										
	CM6X30-S	1.417	1.181										
	CM8X1.25X20-A	1.102	0.787						M8x1.25	0.512	0.236		18.44
	CM8X1.25X25-A	1.299	0.984										
	CM8X30H	1.417	1.181										
	CM10X30H	M10x1.5	0.630	1.496	1.181	0.236		29.50					
	CM12X30H	M12x1.75	0.709	1.575		0.315		51.63					
	CM16X40H	M16x2	0.945	2.126	1.575	0.394		73.75					
	CM16x75	M16	0.945	3.583	2.953	0.551		73.75					
	CM16x120	M16	0.945	5.354	4.724	0.551		73.75					
	CM16x140	M16	0.945	6.142	5.512	0.551		73.75					
	CM20x80	M20	1.181	3.937	3.150	0.669		110.63					
	CM20x120	M20	1.181	5.512	4.724	0.669		110.63					
	CM20x150	M20	1.181	6.693	5.906	0.669		110.63					
	CAP-CM12x1.75x50	M12	0.709	2.441	1.969	0.394		51.63					
	CAP-CM16X2.0X55	M16	0.945	2.795	2.165	0.551		29.50					
	CAP-CM20X2.5X50	M20	1.181	2.756	1.969	0.669		73.75					
	C0.375X1.125H	3/8-24UNF	0.562	1.500	1.125	0.219		25.81					
	C0.500X1.375H	1/2-20UNF	0.750	1.875	1.375	0.313		51.63					
	SD06-A3	M10x1.5	0.630	2.756	2.362	0.315		29.50					
	SRM6X16DIN912-12.9	M6x1	0.394	0.866	0.630	0.197							
	VC00TEDI12040F	M12	1.024	2.008	1.575	0.315		44.25					
	VC00TEDI20040F	M20	1.929	1.969	1.358	0.472		110.63					
VC00TANG16040F	M16	1.811	1.831	1.299	0.394		44.25						
SD08-98	M12x1.75	0.709	3.031	2.559	0.394		51.63						
LHM12x1.75x30-C	M12	0.709	1.453	1.181	0.315		51.63						
VC004762110035F	M10	0.630	1.772	1.378	0.315		44.25						
FCS3	M3x0.5	0.217	0.630	0.472	0.098								
(Steel)	FCS6	M6x1	0.394	1.024	0.787	0.197							
 <p>FSHM*-H</p>	FSHM8-30	M8x1.25	0.433	1.181	1.063	0.197		18.44					
	FSHM8-30H							18.44					
	FSHM10-40	M10	0.551	1.575	1.437	0.236		29.50					
	FSHM10-40H							29.50					
 <p>SHCM4</p>	SHCM4-10	M4x0.7	0.236	0.551	0.394	0.118		2.21					
	SHCM4-12			0.630	0.472								
	SHCM4-16			0.787	0.630								
(Steel)	CTS-M6	M6x1	0.394	0.984	0.748	0.157		3.69					
(Steel)	RSFTS-050M	M10	0.984	2.047	1.673	0.236							

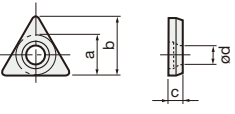
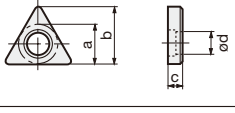
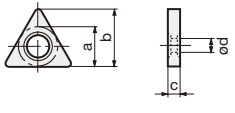
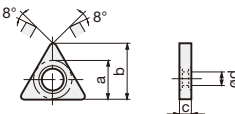
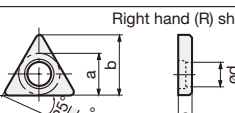
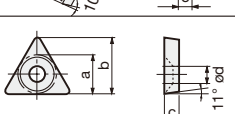
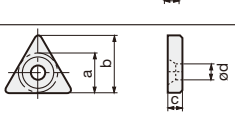
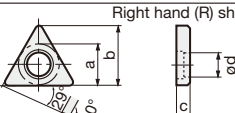
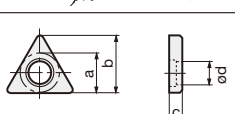
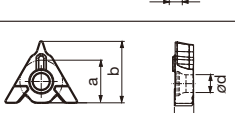
Shape	Designation	Dimension (in)						Torque (lbs-ft)	
		a	øb	c	d	e	T / f		
 (Steel)	MCS520-2.5	M5x0.8		0.787	0.276	0.236	0.098	2.21	
	MCS620-3	M6x1			0.276	0.118	4.43		
	MCS625-3			0.984	0.394			0.315	
	MCS825-4	M8x1			1.122	0.472	0.413	0.157	5.90
	MCS828-4			1.181	0.453	0.453			
	NDS-8A			0.787	0.315	0.315			
	NDS-8S	M8x1.25			0.787	0.315	0.315		
	RSRGR5M40	M4x0.5			0.354	0.144	0.164	T8	0.96
	SR PS 118-0273	M10			1.575	0.650	0.591	0.197	29.50
 (Steel)	DS-5T	M5x0.8		0.472	0.197	0.197	T10	2.58	
	DS-6T	M6		0.591	0.236	0.236	T15	2.58	
	DS-6P	M6x1		0.827	0.276	0.276	15IP	4.43	
	FDS-8ST	M8x1		0.787	0.315	0.315	T27	7.38	
	FDS-8ST-18			0.709		0.236			
 (Steel)	DS-6	M6x1		0.591	0.236	0.236	0.118	4.43	
	DS-8	M8x1.25		0.630	0.276	0.276	0.157	5.90	
	DS-8S			0.512	0.217	0.217			
	DS-10	M10x1.5		1.024	0.394	0.472	0.197	5.90	
	FDS-6Z	M6x0.75		0.807		0.217	0.118	4.43	
	FDS-8	M8x1		1.024	0.315	0.394	0.157	5.90	
	FDS-8S			0.787		0.315			
	FDS-8SS			0.728		0.256			
	 (Steel)	SS100	1/4-20UNC			0.750			
S-412		10-32UNF			0.750				
 (Steel)	SHM8x1.25x35-C	M8	13	1.693	0.906	0.315	0.236	18.44	
	SHM10x1.5x30-C	M10	16	1.575	0.669	0.394	0.315	29.50	
	SHM16x2x35-C	M16	24	2.008	0.709	0.630	0.551	73.75	
	SHM20x2.5x40-C	M20	30	2.283	0.787	0.709	0.669	110.63	
	 Hex. socket screw (Flat end)(JISB1177)	SSHM2.5-3	M2.5		0.118			0.059	0.74
SSHM3-3		M3		0.118					
SSHM3-4				0.157					
SSHM3-6		M4		0.236			0.079	1.11	
SSHM4-4				0.157					
SSHM4-5				0.197					
SSHM4-6				0.236					
SSHM4-8				0.315					
SSHM4-10				0.394					
SSHM4-14				0.551					
SSHM5-6		M5		0.236			0.098	1.48	
SSHM5-10				0.394					
SSHM5-16				0.630					
SSHM6-12		M6		0.472			0.118	2.21	
SSHM6-16				0.630					
SSHM6-18				0.709					
SSHM6-20				0.787					
SSHM8-8		M8		0.315			0.157	3.69	
SSHM8-10				0.394					
SSHM8-12				0.472					
SSHM8-14			0.551						
SSHM8-16			0.630						
SSHM8-18			0.709						
 Hex. socket screw (Cylindrical end) (JISB1177)	M5x7	M5	3.5	0.276	0.049	-	0.098	1.48	
	M5x8			0.315		-			
	M5x10			0.394		-			
	M6x30	M6	4	1.181	0.059	-	0.118	2.21	
 (Steel)	JDS-3525	M3.5x0.35	M2.5 x0.45	0.295	0.118	0.098	0.079	0.74	
	JDS-5040	M5x0.5	M4 x0.7	0.394	0.157	0.157	0.098	0.74	

Screws

Shape	Designation	Dimension (in)					T / f	Torque (lbs-ft)
		a	b	c	d	e		
 <p>LCS2 has a hex. socket in threaded end only.</p> <p>(Steel)</p>	LCS2	M5	0.197	0.551	0.256		0.079	1.11
	LCS3	M6	0.236	0.669				
	LCS3B			0.591			0.098	1.48
	LCS4	M8	0.315	0.827	0.378	0.118	2.21	
	LCS4K			0.689				
	LCS4CA			0.256				
	LCS5			0.984				
	LCS5CA			0.807	0.335			
	LCS6	M10	0.386	1.071	0.390		0.157	3.69
	LCS8	M12	0.465	1.417	0.504		0.197	5.90
LCS8C	M10	0.386	1.189	0.524		0.157	3.69	
 <p>(Steel)</p>	LCS22	M5	M5	0.394	0.185		0.079	1.11
	LCS22A	M6	M6	0.421				
	LCS23A	M5	M5	0.516	0.201		0.098	1.48
	LCS33	M5	M5	0.472	0.244		0.079	1.11
	LCS43	M6	M6	0.531	0.287		0.098	1.48
	 <p>(Steel)</p>	DTS5-3.5	M5	0.248	0.341	M3.5		0.138
DTS5-3.5SS		0.268						
DTS5-3.5S		0.276						
DTS6-4		M6	0.303	0.402	M4	0.157	3.69	
DTS6-4.5			0.295	0.394	M4.5	0.177	3.69	
 <p>(Steel)</p>	DLCS33	M5	0.354	1.240	0.394		0.118	2.21
	DLCS43	M6	0.472	1.339	0.374		0.157	3.69
	DLCS54	M8x1	0.551	1.614	0.433			5.16
	DLCS64	M10x1	0.630	1.969	0.591		0.197	5.90
 <p>(Steel)</p>	ACS-5W	M5	0.315	0.787	0.335		T15	2.95
	ACS-6W	M6	0.394	1.024	0.476		T20	4.72
 <p>(Steel)</p>	ACS3	M5x0.8	0.295	1.008	0.472 - 0.591		0.118	2.95
	ACS4	M6x1	0.354	1.091	0.551 - 0.669		0.157	5.16
 <p>(Steel)</p>	WCS3	M6	0.374	0.886	0.315		0.118	2.21
 <p>(Steel)</p>	PT1/4GN		0.519	0.394	-		0.236	7.01
	1/8-28		0.383	0.276	-		0.197	5.90
 <p>(Steel)</p>	LS-8	M8	0.236	1.299	0.787		0.157	3.69
 <p>(Steel)</p>	CCS4-A							
	BH5-10-A							
	BH4-10-A							
	BH-40050-A							
	TMBA-M10	M10x1.5	1.063	1.181	0.827		0.315	29.50
	TMBA-M12	M12x1.75	1.299	1.417	1.024		0.394	51.63
	TMBA-M12H	M12x1.75		1.358				
	TMBA-M16	M16x2	1.575	1.969	1.575		0.551	73.75
	TMBA-M16H	M16x2						
	TMBA-M20	M20x2.5	1.969	2.205	1.654		0.669	110.63
TMBA-M20H	M20x2.5							
TMBA-M24	M24x3	2.559	2.717	2.165		0.748	110.63	
TMBA-M24H	M24x3							
TMBA-0.500H	1/2-20UNF	1.299	1.335	1.000		0.313	51.63	
TMBA-0.6255.375H	5/8-11UNF	1.484	2.256	1.75		0.313		
TMBA-0.750H	3/4-16UNF	1.969	2.294	1.861		0.500	110.63	
SR-10400611	M4X0.5		0.260	0.118		1	0.079	

Shape	Designation	Dimension (in)			Torque (lbs-ft)
		a	øb	øc	
 <p>(Steel)</p>	SCR-TRM-T5	1.031	0.228	0.169	5.16 - 5.90
	SCR-TRM-T6	1.043	0.248	0.189	5.90 - 7.38
	SCR-TRM-T7	1.102	0.291	0.228	9.59 - 11.06
	SCR-TRM-T8	1.248	0.386	0.248	12.54 - 14.75
	SCR-TRM-T9	1.358	0.461	0.264	15.49 - 16.96

Shims

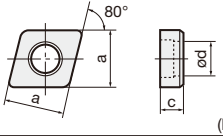
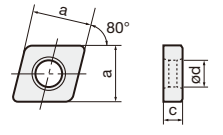
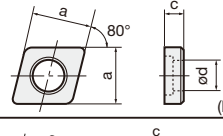
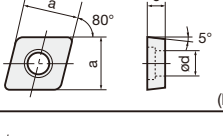
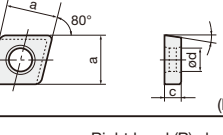
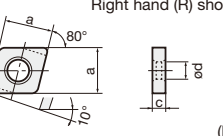
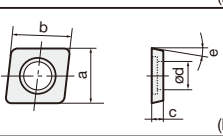
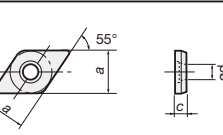
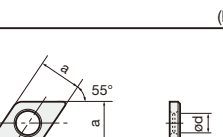
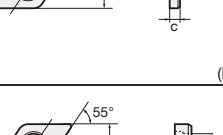
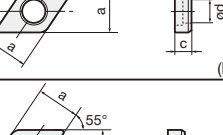
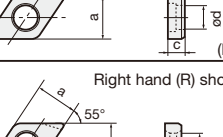
Shape	Designation	Dimension (in)				
		a	b	c	ød	
	AST322	0.366	0.520	0.126	0.173	
	AST422	0.492	0.709			
	MST-322	0.358	0.508	0.128	0.228	
	MST-432	0.492	0.705	0.189	0.287	
	MST-533	0.614	0.874		0.382	
	MST-644	0.740	1.047	0.252	0.445	
	LST317	0.366	0.520	0.106	0.197	
	LST42	0.492	0.709	0.126	0.264	
	LST53	0.618	0.878	0.189	0.303	
	LST42K	0.429	0.614	0.126	0.264	
	LST317CA	0.366	0.520	0.106	0.197	
	LST42CA	0.492	0.709	0.126	0.264	
	ELST42	0.453	0.650	0.126	0.256	
	ELST317	0.335	0.472	0.106	0.193	
	ELST317BR					
	ELST317BL					
	PAT-32	0.323	0.461	0.126	0.138	
	*PAT-53	0.528	0.780	0.189	0.197	
	NAT-32	0.374	0.528	0.126	0.138	
	NAT-42E	0.488	0.701		0.122	
	LST317BR	0.366	0.520	0.106	0.197	
	LST317BL					
	SST32	0.335	0.469	0.126	0.213	
	LST33	0.433	0.624	0.187	0.173	

Note: * marked shims are made of steel.

Shims

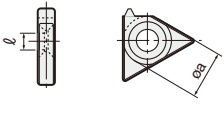
Shape	Designation	Dimension (in)				
		a	b	c	ød	e
 (D30)	ASS422	0.492		0.126	0.173	
	CS44-A			0.185		
 (D30)	ASS533	0.618		0.189	0.217	
	ASS634	0.744				
 (D30)	ELSS32	0.335		0.126	0.193	
	LSS33	0.366		0.169	0.197	
	ELSS42	0.461		0.126	0.256	
	LSS42	0.492			0.264	
	ELSS53	0.579		0.189	0.315	
	LSS53	0.618			0.303	
	ELSS63	0.705			0.382	
	LSS63	0.744				
	ELSS84	0.953		0.252	0.508	
	LSS84	0.992			0.516	
 (D30)	NAS-42	0.500		0.126	0.138	
	NAS-04	1.240		0.252	0.358	
 (D30)	MSS-432	0.492		0.189	0.287	
	MSS-442			0.252		
 (D30)	SSS32	0.335		0.126	0.213	
 (D30)	LSS42BR	0.492		0.126	0.264	
	LSS42BL					
 (D30)	PAS-32	0.323		0.126	0.118	
	PAS-42	0.449			0.138	
	*PAS-63	0.669		0.189	0.197	
 (D30)	LSS42CA	0.492		0.126	0.264	8°
	LSS53CA	0.618		0.189	0.303	10°
 (D30)	FSSA1102	0.457		0.079	0.217	13°
 (D30)	FSSP1102	0.433		0.079	0.217	17°
 (D30)	ASC322	0.366		0.126	0.173	
	ASC422	0.492				
	ASC533	0.618		0.189	0.217	
	ASC634	0.744				
	CC44-A	0.492				

Note: * marked shims are made of steel.

Shape	Designation	Dimension (in)				
		a	b	c	ød	e
 (D30)	MSC-432	0.492		0.189	0.287	
	MSC-442			0.252		
	MSC-533	0.614		0.189	0.382	
	MSC-543			0.252		
	MSC-634	0.740			0.445	
 (D30)	ELSC32	0.335		0.126	0.244	
	LSC42	0.492			0.256	
	ELSC42	0.461		0.189	0.303	
	LSC53	0.618			0.319	
	ELSC53	0.579		0.382		
	ELSC63	0.705				
	LSC63	0.744				
	LSC317	0.366		0.106	0.197	
 (D30)	SSC32	0.335		0.126	0.213	
	SSC4T3	0.449		0.157	0.260	
 (D30)	SSC4T3-P	0.449		0.157	0.260	5°
	SSC54-P	0.528				5°
 (D30)	LSC42CA	0.492		0.126	0.264	8°
	LSC53CA	0.618		0.189	0.303	10°
 (D30)	LSC42BR	0.492		0.126	0.264	
	LSC42BL					
 (D30)	ZSA1102	0.413	11	0.079	0.216	11°
	ZSA1502	0.614	12.4		0.236	11°
 (D30)	ASD322	0.366		0.126	0.173	
	ASD423	0.492		0.126	0.173	
	ASD432	0.492		0.189	0.173	
	CD44-A	0.492		0.185		
 (D30)	ELSD32	0.335		0.126	0.193	
	ELSD42	0.461			0.256	
	LSD42	0.492		0.189	0.264	
	LSD42A					
	LSD43					
LSD43A						
 (D30)	MSD-322	0.366		0.126	0.228	
	MSD-432	0.492		0.189	0.287	
	MSD-442			0.252		
 (D30)	SSD32	0.335		0.126	0.213	
	 (D30)	ELSD317BR	0.335		0.106	0.193
ELSD317BL						
LSD42BR		0.492		0.126	0.264	
LSD42BL						


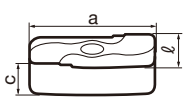
Shims

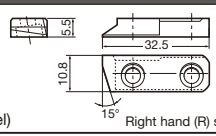
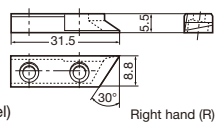
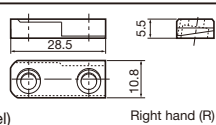
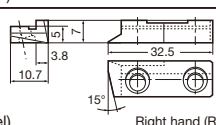
Shape	Designation	Dimension (in)					
		ϕa	b	c	ϕd		
<p>Left hand (L) shown</p>	LSZ42BR	0.492		0.126	0.264		
	LSZ42BL						
	ASV322	0.366		0.126	0.173		
	CV34-A	0.366		0.185			
	MSV-322	0.365		0.126	0.228		
	SSV32	0.331			0.213		
	SSV42	0.433			0.248		
<p>Left hand (L) shown</p>	CSK54R	0.370	0.583	0.189	0.138		
	CSK54L						
	ASW322	0.367	0.453	0.126	0.173		
	ASW422	0.492	0.598				
<p>LSW312BR type shown</p>	LSW312	0.367	0.453	0.106	0.197		
	LSW42	0.492	0.610	0.126	0.264		
<p>LSW312BR type shown</p>	LSW312BR	0.367	0.453	0.106	0.197		
	LSW312BL						
	MSW-432	0.504	0.622	0.189	0.287		
	MSW-533	0.630	0.776		0.382		
	MSW-633	0.756	0.933		0.445		
<p>Right hand (R) shown</p>	MSW-432BR	0.504	0.622	0.189	0.287		
	MSW-432BL						
	CH44-A		0.492	0.185			
	ASR420	0.492		0.126	0.173		
	LSR32	0.350		0.126	0.197		
	LSR32C	0.331				0.264	
	LSR42	0.476				0.197	
	LSR42C	0.390		0.189	0.264		
	LSR53C	0.551			0.323		
	LSR63C	0.677			0.382		
LSR84C	0.862		0.252	0.382			
	MSR-43	0.492		0.189	0.287		
	MSR-44			0.252			
	SSR32	0.343		0.125	0.205		
<p>Right hand (R) shown</p>	G16EL/IR	0.374	-	0.126	0.157		
	G16ER/IL			0.126			
	G16EL/IR-DT			0.156	0.213		
	G16ER/IL-DT			0.156			

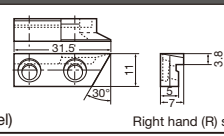
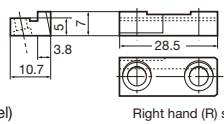
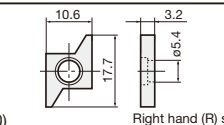
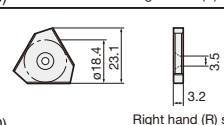
Shape	Designation	Dimension (in)			
		ϕa	ℓ	Lead angle	
	AE16-4DT	0.374	0.213	4°	
	AE16-3DT		0.213	3°	
	AE16-2DT		0.213	2°	
	A16-1DT		0.213	1°	
	AE16-0DT		0.213	0°	
	AE16-99DT		0.213	-1°	
	AE16-98DT		0.213	-2°	
	AE16-4		0.157	4°	
	AE16-3		0.157	3°	
	AE16-2		0.157	2°	
	A16-1		0.169	1°	
	AE16-0		0.157	0°	
	AE16-99		0.157	-1°	
	AE16-98		0.157	-2°	
	AN16-4DT	0.374	0.213	4°	
	AN16-3DT		0.213	3°	
	AN16-2DT		0.213	2°	
	AN16-0DT		0.213	0°	
	AN16-99DT		0.213	-1°	
	AN16-98DT		0.213	-2°	
	AN16-4		0.157	4°	
	AN16-3		0.157	3°	
	AN16-2		0.157	2°	
	AN16-0		0.157	0°	
	AN16-99		0.157	-1°	
	AN16-98		0.157	-2°	
	GXE16-98		0.374	0.157	-2°
	GXE16-98DT			0.213	-2°
	GXE16-99	0.157		-1°	
	GXE16-99DT	0.213		-1°	
	GXE16-0	0.157		0°	
	GXE16-0DT	0.213		0°	
	GXE16-1	0.169		1°	
	GX16-1DT	0.213		1°	
	GXE16-2	0.157		2°	
	GXE16-2DT	0.213		2°	
	GXE16-3	0.157		3°	
	GXE16-3DT	0.213		3°	
	GXE16-4	0.157		4°	
	GXE16-4DT	0.213		4°	
	GXE22-98DT	0.500	0.260	-2°	
	GXE22-99DT			-1°	
GXE22-0DT	0°				
GX22-1DT	1°				
GXE22-2DT	2°				
GXE22-3DT	3°				
GXE22-4DT	4°				
GXN16-98	0.374	0.157	-2°		
GXN16-98DT		0.213	-2°		
GXN16-99		0.157	-1°		
GXN16-99DT		0.213	-1°		
GXN16-0		0.157	0°		
GXN16-0DT		0.213	0°		
GXN16-1		0.169	1°		
GXN16-2		0.157	2°		
GXN16-2DT		0.213	2°		
GXN16-3		0.157	3°		
GXN16-3DT		0.213	3°		
GXN16-4		0.157	4°		
GXN16-4DT		0.213	4°		
GXN22-98DT		0.500	0.260	-2°	
GXN22-99DT	-1°				
GXN22-0DT	0°				
GXN22-2DT	2°				
GXN22-3DT	3°				
GXN22-4DT	4°				

(D30)

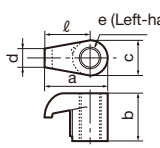
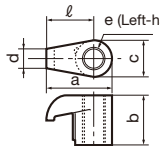
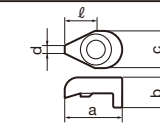
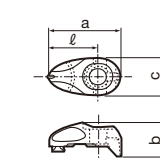
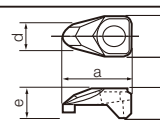
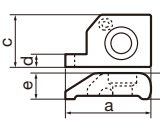
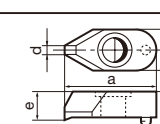
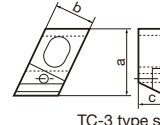
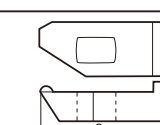
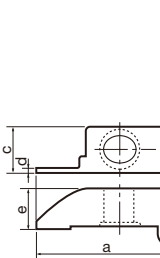
Shims

Shape	Designation	Dimension (in)					
		a	øa	ℓ	c	Lead angle	
	NXE22-98	0.500	0.626	0.157	0.177	-2°	
	NXE22-99					-1°	
	NXE22-0					0°	
	NXE22-1					1°	
	NXE22-2					2°	
	NXE22-3					3°	
	NXE22-4					4°	
	NXE27-98					0.626	0.626
	NXE27-99	-1°					
	NXE27-0	0°					
	NXE27-1	1°					
	NXE27-2	2°					
	NXE27-3	3°					
	NXE27-4	4°					
	NXN22-98	0.500	0.500	0.157	0.177		
	NXN22-99					-1°	
	NXN22-0					0°	
	NXN22-1					1°	
	NXN22-2					2°	
	NXN22-3					3°	
	NXN22-4					4°	
	NXN27-98					0.626	0.626
	NXN27-99	-1°					
	NXN27-0	0°					
NXN27-1	1°						
NXN27-2	2°						
NXN27-3	3°						
NXN27-4	4°						
(D30)							
	TSL12R	0.472		0.185	0.177	4.5°	
	TSL12L	0.472		0.185	0.177	4.5°	
	TSL16R	0.626		0.252	0.197	5°	
	TSL16L	0.626		0.252	0.197	5°	
	TSL24R	0.937		0.370	0.280	7°	
	TSL24L	0.937		0.370	0.280	7°	
	TSL12RI	0.421		0.185	0.177	4.5°	
	TSL12LI	0.421		0.185	0.177	4.5°	
	TSL16RI	0.740		0.252	0.197	5°	
	TSL16LI	0.740		0.252	0.197	5°	
	(D30)						

Shape	Designation
 (Steel) Right hand (R) shown	SL-1R
	SL-1L
 (Steel) Right hand (R) shown	SL-2R
	SL-2L
 (Steel) Right hand (R) shown	SL-3R
	SL-3L
 (Steel) Right hand (R) shown	SL-6R
	SL-6L

Shape	Designation
 (Steel) Right hand (R) shown	SL-7R
	SL-7L
 (Steel) Right hand (R) shown	SL-8R
	SL-8L
 (D30) Right hand (R) shown	SGSR151
	SGSL151
 (D30) Right hand (R) shown	STN62R
	STN62L

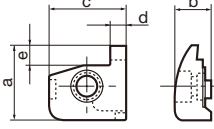
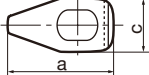
Clamps

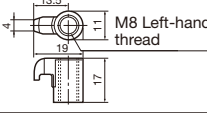
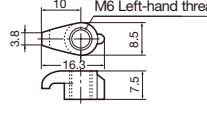
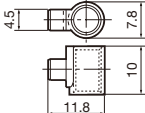
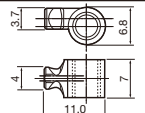
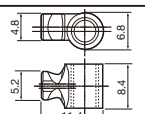
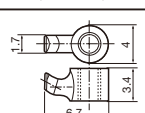
Shape	Designation	Dimension (in)					
		a	b	c	d	e	ℓ
 e (Left-hand thread)	MCL-5M	0.579	0.433	0.307	0.157	M5	0.425
	MCL-6	0.732	0.453	0.374		M6	0.543
	MCL-8S	0.752	0.531	0.429	0.197	M8	0.535
	MCL-8M	0.886					0.669
	MCL-8L	1.004	0.571	0.787			
 e (Left-hand thread)	MCPM-6	0.579	0.441	0.311	0.157	M5	0.425
	MCPM-9	0.752	0.661	0.429	0.197	M8×1	0.535
	MCPM-12	0.886					0.669
	MCPM-20	0.732	0.374	0.374	0.157	M6	0.543
	MCPM-21		0.480				
	MCPM-22	0.846	0.520				0.657
	MCPM-30	1.004	0.661	0.429	0.197	M8×1	0.787
		DCPM-33	0.630	0.366	0.413	0.094	
DCPM-43		0.835	0.453	0.531	0.118		0.520
DCPM-54		1.016	0.600	0.551	0.138		
DCPM-64		1.118	0.610	0.630	0.157		
	ACP3S	0.898	0.374	0.394			0.591
	ACP3S-E	0.854	0.374	0.394			0.547
	ACP3L	1.232	0.472	0.512			0.917
	ACP3L-E	1.039	0.472	0.512			0.724
	ACP4S	1.012	0.472	0.512			0.697
	ACP5S	1.185	0.508	0.591	-	-	0.815
	ACP6S	1.315	0.504	0.650	-	-	0.945
		ACP3	0.705	0.394	0.394	0.256	0.248
ACP4		1.020	0.547	0.472	0.276	0.425	
 Right hand (R) shown	CTC-3R	1.142	0.346	0.630	0.087	0.315	
	CTC-3L						
	CTC-4R			0.669	0.126		
	CTC-4L						
	CTC-5R			0.709	0.165		
	CTC-5L						
	CP81A	1.102	0.413	0.472	0.138	0.315	
	CP81B						
 TC-3 type shown, TC-4 : Left-hand thread	TC-3	0.748	0.492	0.327	-	-	-
	TC-4	0.850		0.315			
	TF-72	0.866	0.445				
	TF-73	0.866	0.445				
	TF-184	0.866	0.445				
	TF-185	0.866	0.445				
	CCR2	1.366	0.587	0.421	0.047	0.413	
	CCL2						
	CCR3				0.087		
	CCL3						
	CCR4				0.110		
	CCL4						
	CCR5				0.126		
	CCL5						
	CCR6				0.154		
	CCL6						
CCR8	0.193						
CCL8							

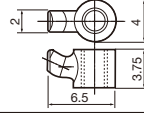
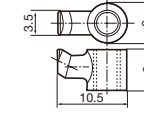
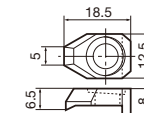
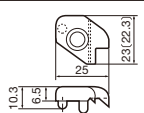
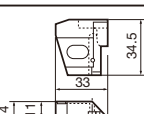
Grade
Insert
Ext. Toolholder
Int. Toolholder
Threading
Grooving
Miniature tool
Milling cutter
Endmill
Drilling tool
Tooling System
User's Guide
Index



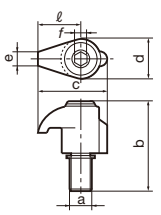
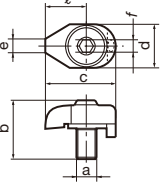
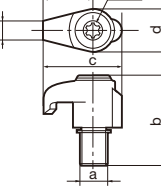
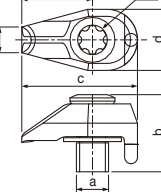
Clamps

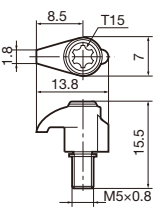
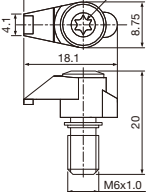
Shape	Designation	Dimension (in)					
		a	b	c	d	e	
 <p>Right hand (R) shown</p>	CFG-3SR	0.866	0.433	0.909	0.079	0.236	
	CFG-3SL						
	CFG-4SR						
	CFG-4SL	1.260			0.118	0.630	
	CFG-4DR						
	CFG-4DL						
	CFG-5SR	0.866		0.157	0.236		
	CFG-5SL						
	CFG-5DR	1.260				0.630	
	CFG-5DL						
	CFG-6SR	0.906		0.197	0.276		
	CFG-6SL						
	CFG-6DR	1.299				0.669	
	CFG-6DL						
	CFG-8SR	1.102		1.067	0.276		0.315
	CFG-8SL						
CFG-8DR	1.496	0.709					
CFG-8DL							
(Steel)							
	CCP4-A	1.146		0.551			
	(Steel)						

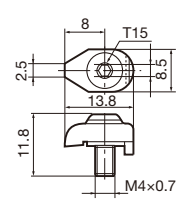
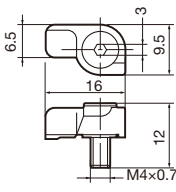
Shape	Designation
 <p>M8 Left-hand thread</p>	NF-84A
(Steel)	
 <p>M6 Left-hand thread</p>	CP536
(Steel)	
	CP91
(Steel)	
	CP900
(Steel)	
	CP910
(Steel)	
	JCP-1
(Steel)	

Shape	Designation
	JCP-2
(Steel)	
	JCP-3 JCP-3N
(Steel)	
	CQ-1
(Steel)	
 <p>Right hand (R) shown</p>	CPK5R CPK5L
(Steel)	
 <p>Right hand (R) shown</p>	C11R-5 C11L-5
(Steel)	

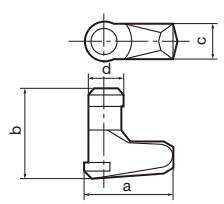
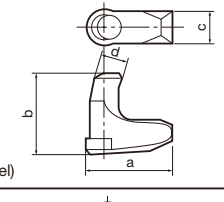
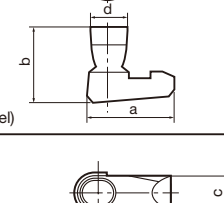
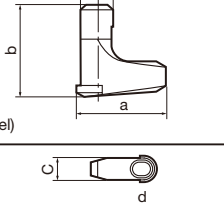
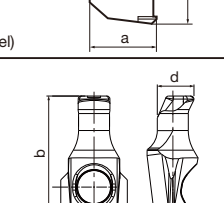
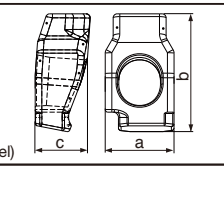

Clamp Sets

Shape	Designation	Dimension (in)						
		a	b	c	d	e	ℓ	T / f
 (Steel)	CSG-5S	M5×0.8	0.531	0.543	0.276	0.071	0.335	0.098
	CSG-5		0.610					
	CSG-6S	M6×1	0.709	0.642	0.335	0.098	0.394	0.118
	CSG-6L		0.846					
	CSG-8S	M8×1	0.827	0.807	0.433	0.138	0.492	0.157
	CSG-8		0.925					
	 (Steel)	CSW-00	M4×0.7	0.453	0.472	0.315	0.079	0.295
CSW-1		M5×0.8	0.650	0.650	0.374	0.157	0.394	0.118
CSW-0		M4×0.7	0.453	0.543	0.335	0.098	0.315	0.098
CSW-2		M6×1	0.787	0.807	0.433	0.236	0.512	0.157
CSW-40		M4×0.7	0.472	0.520	0.315	0.079	0.295	0.098
CSW-50		M5×0.8	0.591	0.665	0.394		0.374	0.118
 (Steel)		CSP16	M5×0.8	0.610	0.567	0.272	0.126	0.358
	CSP22	M6×1	0.787	0.713	0.350	0.165	0.453	T20
	CSP27	M8×1.25	0.925	0.961	0.469	0.154	0.614	0.157
 (Steel)	CSY-15	M4×0.7	0.457	0.453	0.276	0.118	0.236	15IP
	CSY-20	M5×0.8	0.472	0.709	0.374	0.157	0.433	20IP

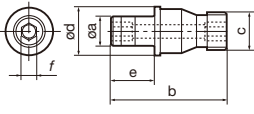
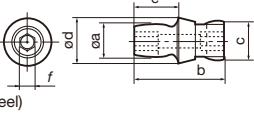
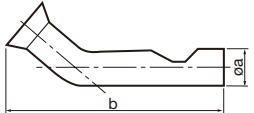
Shape	Designation
 (Steel)	CSG-5T
 (Steel)	CSX20

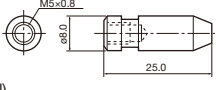
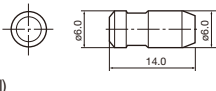
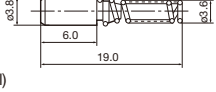
Shape	Designation
 (Steel)	CSW-0T
 (Steel)	CSL-4

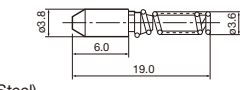
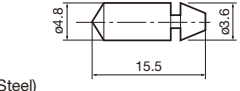
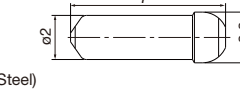
Levers

Shape	Designation	Dimension (in)				
		a	b	c	d	
 (Steel)	LCL3	0.394	0.472	0.146	0.142	
	LCL4	0.575	0.551	0.185	0.185	
	LCL5	0.673	0.669	0.236	0.236	
	LCL6	0.807	0.827	0.295	0.295	
	LCL8	1.000	1.000	0.339	0.339	
 (Steel)	LCL3C	0.425	0.465	0.134	0.118	
	LCL4C	0.512	0.528	0.146	0.134	
	LCL5C	0.732	0.697	0.185	0.177	
	LCL6C	0.807	0.748	0.236	0.224	
	LCL8C	0.953	0.925	0.295	0.244	
 (Steel)	LCL22N	0.295	0.256	0.102	0.081	
	LCL32N	0.394	0.307	0.126	0.126	
	LCL33NL	0.453	0.374	0.122	0.142	
	LCL33N	0.394	0.370	0.126	0.126	
	LCL43N	0.528	0.394	0.185	0.185	
 (Steel)	LCL23	0.307	0.335	0.102	0.083	
	LCL33	0.398	0.476	0.142	0.146	
	LCL33L	0.472	0.453	0.122	0.142	
	LCL43S	0.531	0.520	0.185	0.185	
	LCL43M					
	LCL44	0.634	0.575	0.185	0.185	
	LCL54	0.650	0.677	0.240	0.236	
 (Steel)	DLCL43	0.612	0.551	0.197	0.185	
	DLCL54	0.752	0.752	0.240	0.236	
	DLCL64	0.846	0.827	0.295	0.295	
 (Steel)	SLLV-1		0.305	0.134	0.096	
	SLLV-2		0.305	0.134	0.108	
 (Steel)	FCL4	0.197	0.306	0.150		
	FCL8	0.394	0.563	0.212		

Pins

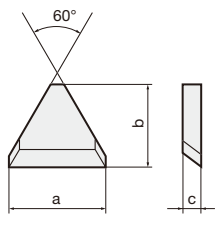
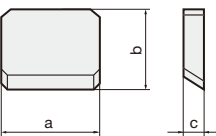
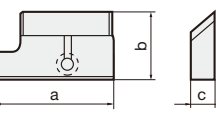
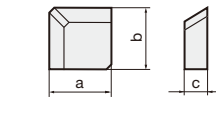
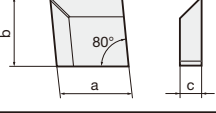
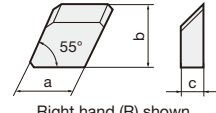
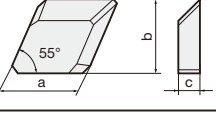

Shape	Designation	Dimension (in)					
		øa	b	øc	ød	e	f
 (Steel)	MLP32L	0.154	0.346	M5×0.8	0.220	0.138	0.079
	MLP33	0.146					
	MLP34L	0.146					
	MLP46	0.197	0.677	M6.3×1	0.307	0.217	0.098
	MLP46L		0.732				
	MLP58	0.244	0.862	M8×1	0.406	0.272	0.118
	MLP68	0.307		M10×1			
	MLP68L		0.949				
 (Steel)	MLP44	0.197	0.520	M6.3×1	0.280	0.217	0.098
	MLP33L	0.146	0.409	M5×0.8	0.220	0.201	0.079
 (Steel)	SW99	0.315	1.870				

Shape	Designation
 (Steel)	SP-8
 (Steel)	SP-6
 (Steel)	BP-3

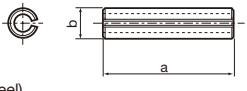
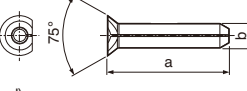
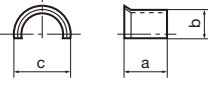
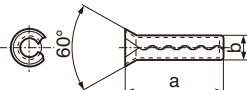
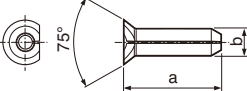
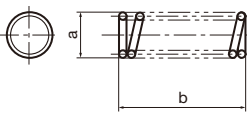
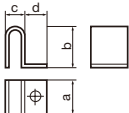
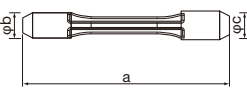
Shape	Designation
 (Steel)	BP-360
 (Steel)	BP-490
 (Steel)	SL-PI-2



Chipbreaker Pieces

Shape	Designation	Dimension (in)				
		a	b	c		
 (TX30)	CBT-2S	0.346	0.299	0.079		
	CBT-2M	0.291	0.260			
	CBT-3S	0.524	0.476	0.098		
	CBT-3M	0.484	0.437			
	CBT-3L	0.445	0.398			
	CBT-4S	0.740	0.665			
	CBT-4M	0.701	0.626			
	CBT-4L	0.661	0.567			
	NCT-2S	0.559	0.465			
	NCT-2M	0.512	0.425			
	NCT-2L	0.469	0.386			
 (TX30)	CBS-3S	0.374	0.327		0.079	
	CBS-3M		0.287			
	CBS-4S	0.500	0.457	0.098		
	CBS-4SN					
	CBS-4M		0.417			
	CBS-4L		0.358			
	NCS-3S		0.441			
	NCS-3M		0.402			
	NCS-3L		0.343			
 Right hand (R) shown (TX30)	B11 R-5	0.945	0.512		0.197	
	B11 L-5					
 (TX30)	CBS-4SN	0.453	0.453	0.098		
	CBS-4MN	0.413	0.413			
	CBS-4LN	0.354	0.354			
	NCS-3SN	0.441	0.441			
	NCS-3MN	0.402	0.402			
	NCS-3LN	0.343	0.343			
 (TX30)	CBC-4SN	0.453	0.453	0.098		
	CBC-4MN	0.413	0.413			
	CBC-4LN	0.374	0.374			
 Right hand (R) shown (TX30)	CBD-4SR	0.500	0.453	0.098		
	CBD-4MR		0.413			
	CBD-4ML					
	CBD-4LR		0.374			
 (TX30)	CBD-4SN	0.453	0.453	0.098		
	CBD-4MN	0.413	0.413			
 (TX30)	CBR-4SN	0.500	0.469	0.098		
	CBR-4MN		0.429			

Springs (Springs for Shims)

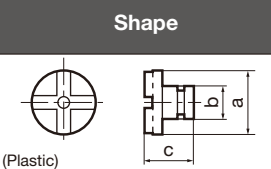
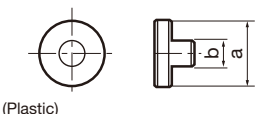
Shape	Designation	Dimension (in)					
		a	b	c	d		
 (Steel)	SP-2.5	0.472	0.106				
 (Steel)	SP-16-L14	0.535	0.112				
 (Steel)	LSP3	0.217	0.118	0.232			
	LSP3L	0.276					
	LSP4		0.157	0.299			
	LSP4S						
	LSP5	0.335	0.177	0.346			
	LSP6	0.433	0.232	0.429			
	LSP6C	0.335	0.189	0.366			
	LSP8	0.472	0.394	0.606			
 (Steel)	PSP-2.5	0.394	0.106				
	PSP-4.0	0.630	0.165				
	PSP301	0.299	0.118				
 (Steel)	PSP-16	0.384	0.112				
 (Steel)	BP-0	0.142	0.512				
	BP-5-A						
	BP-7	0.276	0.433				
	BP-8.8	0.346	0.394				
	BP-9	0.327					
	BP-10	0.386					
	SP913	0.354	0.512				
 (Steel)	BSP-1	0.307	0.295	0.189	0.236		
 (Steel)	PN3-4	2.520	0.354	0.394			

Grade
 Insert
 Ext. Toolholder
 Int. Toolholder
 Threading
 Grooving
 Grooving tool
 Miniature tool
 Milling cutter
 Endmill
 Drilling tool
 Tooling System
 User's Guide
 Index

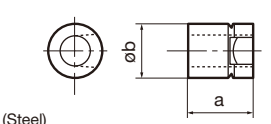


Parts for Tools

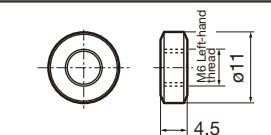
Coolant Supply Attachment

Shape	Designation	Dimension (in)				
		a	b	c	Thread	
 (Plastic)	EA-20	0.787	0.394	0.591		
	EA-25	0.984				
	EA-32	1.260	0.630			
 (Plastic)	CA-16	0.630	0.315	M6		
	CA-20	0.787	0.335	M6		
	CA-25	0.984	0.453	R1/8		
	CA-32	1.260	0.453	R1/8		
	CA-40	1.575	0.453	R1/8		

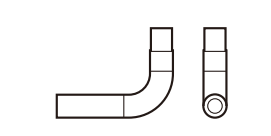
Pistons

Shape	Designation	Dimension (in)			
		a	øb		
 (Steel)	DPIS33	0.496	0.354		
	DPIS43	0.465	0.394		
	DPIS44	0.528	0.394		
	DPIS54	0.630	0.512		
	DPIS64		0.591		

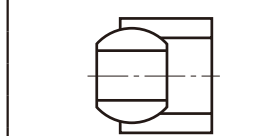
Nuts

Shape	Designation
	SRW11

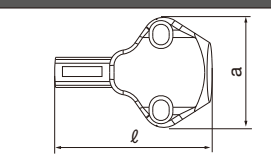
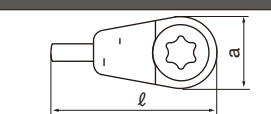
Coolant Pipe & Nozzle

Shape	Designation
	PNZ5

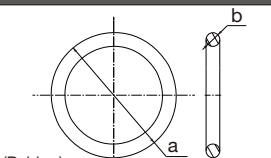
Coolant Nozzle

Shape	Designation
	CNZ125
	SATZ-M8X1-M3
	SATZ-M10X1-M5
	EZ104
	EZ83

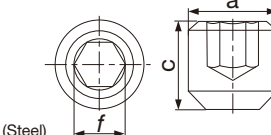
Coolant unit

Shape	Designation	Dimension (in)	
		a	ℓ
	CU-CW-CHP	0.819	1.169
	CU-D-CHP	0.819	1.165
	CU-V-CHP	0.819	1.181
	S-CU-CHP	0.276	0.638

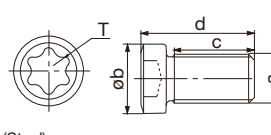
O-ring for TungTurn-Jet

Shape	Designation	Dimension (in)			
		a	øb		
 (Rubber)	OR6.4X0.9N	0.323	0.035		
	OR14X2.5NN	0.748	0.098		

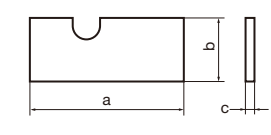
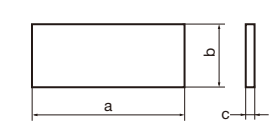
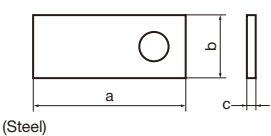
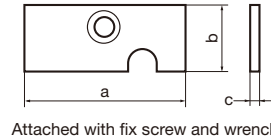
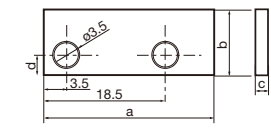
Coolant screw for TungTurn-Jet

Shape	Designation	Dimension (in)				
		a	c			T / f
 (Steel)	SRM4X4 TL360	M4	0.157			0.079

Mounting screw for TungTurn-Jet

Shape	Designation	Dimension (in)				
		a	øb	c	d	T / f
 (Steel)	SRM3	M3X0.5	0.165	0.276	0.193	T8

Sizing Plates

Shape	Designation	Dimension (in)				
		a	b	c	d	
 (Steel)	S0816A	2.165	0.610	0.031		
	S1016A			0.039		
	S0816B	1.969		0.031		
	S1016B			0.039		
	S0816C	1.772		0.031		
	S1016C			0.039		
	S0820A	2.402	0.768	0.031		
	S1020A			0.039		
	S0820B	2.146		0.031		
	S1020B			0.039		
	SM-00	0.709		0.315	0.039	
 (Steel)	SW04	1.004		0.228	0.010	
	SW05	1.457	0.327		0.010	
	SW06	1.417	0.425	0.020		
	SW08	1.398		0.484	0.079	
 (Steel)	S0810	1.575	0.433	0.031		
	S1010			0.039		
 Attached with fix screw and wrench. (Steel)	PSTR08	0.945	0.433	0.059		
	PSTL08					
	PSTR10	1.654	0.650	0.079		
	PSTL10					
	PSTR12	1.850	0.748	0.079		
	PSTL12					
 (Steel)	AP0801	1.024	0.374	0.020	0.118	
	AP0802			0.039		
	AP0803			0.059		
	AP0804			0.079		
	AP0805			0.098		
	AP1101	1.181	0.453	0.020	0.197	
	AP1102			0.039		
	AP1103			0.059		
	AP1104			0.079		
	AP1105			0.098		
	AP1106			0.118		

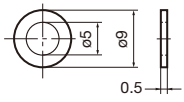
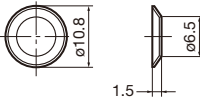
SW04 is composed of three plates and SW05 to SW08 are composed of four plates.

Note on fixing screws: PSTR/L08 is attached with CSSM2-4 and other types are attached with CSHM3-8.

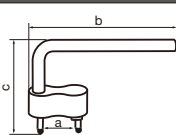
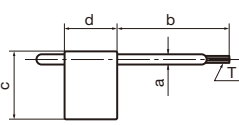
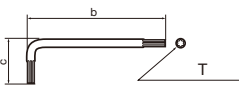
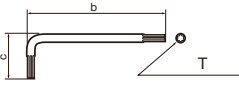
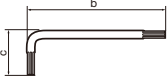
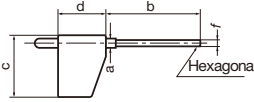
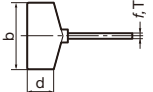
Parts for Tools

Washers

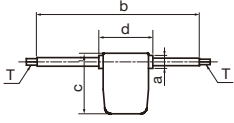
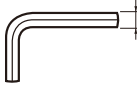
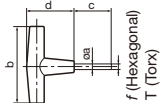
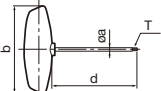
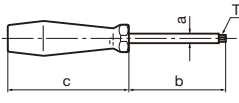
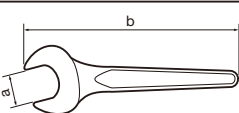

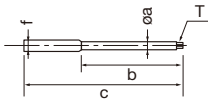
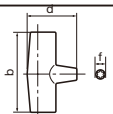
Shape	Designation	Dimension (in)					
		ϕa	ϕb				
	VA4	0.299	0.161				
	VA5	0.362	0.201				
	VA6	0.413	0.240				

Shape	Designation
	CPW5
	CDW6

Wrenches and Drivers

Shape	Designation	Dimension (in)						
		a	b	c	d	f	T	
	CRW23	0.382	3.091	2.165				
	CRW33	0.366						
	T-6F	0.079	1.378	0.571	0.591		T6	
	T-7F			0.748	0.748		T7	
	T-8F	0.098	1.575	0.925	0.787		T8	
	T-9F	0.118					T9	
	T-15F	0.138	1.772	1.102	0.827		T15	
	T-20F	0.157					T20	
	IP-6F	0.079	1.378	0.583	0.587		6IP	
	SET T-15/5	0.138	1.772	1.102	0.827		T15	
	T-20TORX	0.154	1.929	1.181	0.866		T20	
	T-6L		1.890	0.630			T6	
	T-8L							T8
	T-9L							T9
	T-15L		2.323	0.866			T15	
	T-25TORX		2.598	0.917			T25	
	KEYV-T20		2.362	0.866			T20	
	KEYV-T25		2.559	0.906			T25	
	KEYV-T30L		7.480	1.457			T30	
	KEYV-T40L		8.189	1.693			T40	
	KEYV-T50L		9.134	1.890			T50	
	QL-39		3.346	1.181				
	P-2F	0.157	1.732	0.787	0.492	0.079		
	P-2.5F	0.197	1.772	0.984	0.787	0.098		
	HW2.0/5RED	0.118	1.496	0.591	0.591	0.079		
	P-2.5T		1.654		0.591	0.098		
	T-15DF		1.575		0.787		T15	

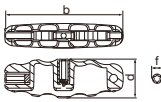
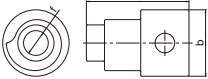
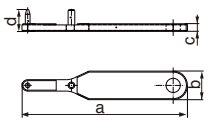
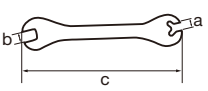
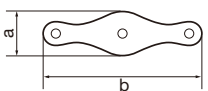
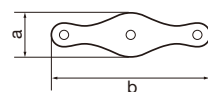
Wrenches, Drivers and Lubricant

Shape	Designation	Dimension (in)						
		a	b	c	d	f	T	
	T-1008/5	0.256	3.346	1.102	0.984	-	T10/T8	
	T-2010/5					-	T10/T20	
	1/4HEX					0.250		
	5/32HEX					0.156		
	1/8HEX					0.125		
	3/32HEX					0.094		
	P-2					0.079		
	P-2.5					0.098		
	P-3					0.118		
	P-3.5					0.138		
	P-4					0.157		
	P-4.5					0.177		
	TP-3A		2.756	1.181	1.791	0.118		
	TP-4			1.260		0.157		
	TP-5		3.346	1.594	2.087	0.197		
	T-27T		3.268	1.063	2.008		T27	
							T15	
	T-15T	0.157	3.150		3.937		T15	
	T-20T					T20		
	IP-20T					20IP		
 <p>Handle shape somewhat varies depending on the type number from the above figure.</p>	T-6D	0.098	1.772	2.756			T6	
	T-7DB			2.953			T7	
	T-7D	0.079		2.756				
	T-8D	0.102	2.402	2.657				T8
	T-9D	0.118	2.559	3.150				T9
	T-10D	0.130	2.756	3.543				T10
	T-15D	0.144	2.795	3.937				T15
	T-20D	0.181	3.543					T20
	T-25D	0.173	3.425	3.386				T25
	IP-6DB	0.000	1.772	2.756				6IP
	IP-7D	0.098	1.772	2.953				7IP
	IP-8D	0.118	0.118	3.150				8IP
	IP-9D	0.130	2.362	3.937				9IP
	IP-10D	0.130	2.795	3.504				10IP
	IP-15D	0.157	3.150	3.937				15IP
	IP-20D	0.157	3.543	3.937				20IP
		KS-21	0.827	7.677				
KS-24		0.945	8.465					
KS-27		1.063	9.252					
KS-32		1.260	10.827					
KS-36		1.417	12.008					
	M-1000							
	BT15S	0.154	1.969	3.543		0.236	T15	
	BT15M	0.154	1.969	4.646		0.236	T15	
	BT20S	0.181	1.969	3.543		0.236	T20	
	BT20M	0.181	1.969	4.646		0.236	T20	
	BLD IP15/S7	0.154	1.969	3.543		0.236	15IP	
	BLD IP15/M7	0.154	1.969	4.646		0.236	15IP	
	BLD IP20/S7	0.181	1.969	3.543		0.236	20IP	
	BLD IP20/M7	0.181	1.969	4.646		0.236	20IP	
	BLD T10/S7	0.154	2.244	2.953		0.236	T10	
	BLD T10/S7-A	0.154	2.244	2.953		0.236	T10	
	H-TB		3.937		1.457	0.236		
	H-TBS		2.953		1.457	0.236		

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Wrenches and Drivers

Shape	Designation	Dimension (in)					
		a	b	c	d	f	T
	H-TB2W		3.740		1.236	0.236	
	AJC08		0.433		0.669	0.161	
	ECW-456EF	3.425	0.591	0.157	0.453		
	ECW-456I	3.169	0.866	0.157	0.413		
	KEYV-S05	0.157	0.217	3.937			
	KEYV-S06	0.213	0.315	4.921			
	KEYV-S08	0.260	0.394	5.906			
	KEYV-S10	0.303	0.512	6.890			
	KEYV-S12	0.370	0.630	9.843			
	KEYV-W20						
	KEYV-177	1.142	4.331				
	KEYV-217	1.142	4.331				
	KGDT-100	1.260	4.272				
	KGDT-110	1.260	4.272				
	KGDT-120	1.260	4.272				
	KGDT-130	1.260	4.272				
	KGDT-140	1.260	4.272				
	KGDT-150	1.260	4.272				
	K-TRM-T5	0.866	3.209				
	K-TRM-T6	1.063	3.622				
	K-TRM-T7	1.236	4.213				
	K-TRM-T8	1.417	4.331				
	K-TRM-T9	1.496	4.331				

Parts for Tools

Locators

Designation	Applicable Tool
LD150R	TXD15125R ~ TXD15315R
LD440R/L	TMD44 TGD4400R/L-A TFD44
LD442R/L	EGD4400R
LD540R/L	TMD54
LE302R	ESE3050R (RS**) ~ 3063R (RS**)
LE303R/L	TSE3003R/LIA ~ 3006R/LIA
LE402AR	ESE4050RA ESE4063RA
LE403R/L	TSE4003R/LIA TSE4004R/LIA ESE4003RIA-S32
LE405R/L	TSE4005R/LIA ~ 4012R/LIA
LE413R/L	THE40
LE444R/L	TME4403R/LI ~ 4405R/LI TME4403R/LB ~ 4405R/LB EME4405R ~ 4404RI
LE446R/L	TME4406R/LI ~ 4412R/LI TME4406R/LB ~ 4412R/LB
LE540R/L	TME54
LF440R/L	THF44
LF540R/L	THF54
LF602R	ERF6050R ~ ERF6063R
LF602R/L	TRF6003R/LI ~ TRF6006R/LI TRF6008R/LI ~ TRF6012R/LI
LMS56R/L	MS08R/L ~ MS12R/L
LN423R/L	TGN42
LN645R/L	TPN64
LP403R/L	TSP4003R/LIA ~ TSP4004R/LIA TFP4004R/LIA
LP405R/L	TSP4005R/LIA ~ TSP4012R/LIA TFP4005R/LIA ~ TFP4012R/LIA
LP413R/L	TGP41 TGP42
LP514R/L	TGP51
LPP16R	TPP16
LR602R/L	ERD6050RA ~ ERD6063RA
LR603R/L	TRD6003R/L TRD6004R/L ~ TRD6008R/L
LV525R/L	VSN 1
LV530R/L	VSN 2
LV556R/L	VSN60
LW400R	EFP4063R
LW400R/L	TFD44 TFP4000 SFP4000
LW402R	EFP4050R

Insert locking wedges

Designation	Applicable Tool
FDS-8SST	EDPD09063R EDPD09063RB
FDS-8ST-18	EDP09080R EDPD09080RB DPD09100R~DPD09160R DPD09100RB~DPD09160RB
FW-242R/L	ø63
FW-243R/L	ø80~100
FW-245R/L	ø125 ~
FW304R/L-D	DAD15 DPD15 EDPD15 QPP15
WF150R	TXD15125R ~ TXD15315R
WF310R/L	TGP4100BA TGP4103R/LIA
WF330N	TSE4003R/LIA TSE4004R/LIA ESE4003RIA-S32 TSP4003R/LIA ~ TSP4004R/LIA TFP4004R/LIA
WF330R/L	TSE3003R/LIA ~ 3006R/LIA
WF444R/L	TME4403R/LI ~ 4405R/LI TME4403R/LB ~ 4405R/LB EME4405R ~ 4404RI TME4406R/LI ~ 4412R/LI TME4406R/LB ~ 4412R/LB
WF500R	TSE4005R/LIA ~ 4012R/LIA TSP4005R/LIA ~ TSP4012R/LIA TFP4005R/LIA ~ TFP4012R/LIA
WF500R/L	TMD54 TGP51 THF54
WF50R/L	TME54
WF602R	ERF6050R ~ ERF6063R
WF603R/L	TRF6003R/LI ~ TRF600R/LI
WF608R/L	TRF6008R/LI ~ TRF6012R/LI
WF875N	TPYD06 EPYD06
WN645R/L	TPN64
WP193TR/L	EGD4400R
WP440R/L	TMD44 TGD4400R/L-A TFD44 TGP4100IA ~ TGP4112R/LIA TGP42 THF44 THE40
WR602R/LW	ERD6050RA ~ ERD6063RA
WR603R/L	TRD6003R/L TRD6004R/L ~ TRD6008R/L
WT402R	ESE4050RA ESE4063RA
WT402R/L	EME4450RB ~ 4404RB

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Parts for Tools

Locator adjusting wedges

Designation	Applicable Tool
FW-305	TFD44 TFP40 SFP4000 EFP4063
FW325R/L-D	DAD15 QPP15 DPD15 EDPD15
RSFTC1008	TPYP12...
RSFTC1009	EPYP12M032C25.0R05
RSFTC1011	EPYP12M025C25.0R03

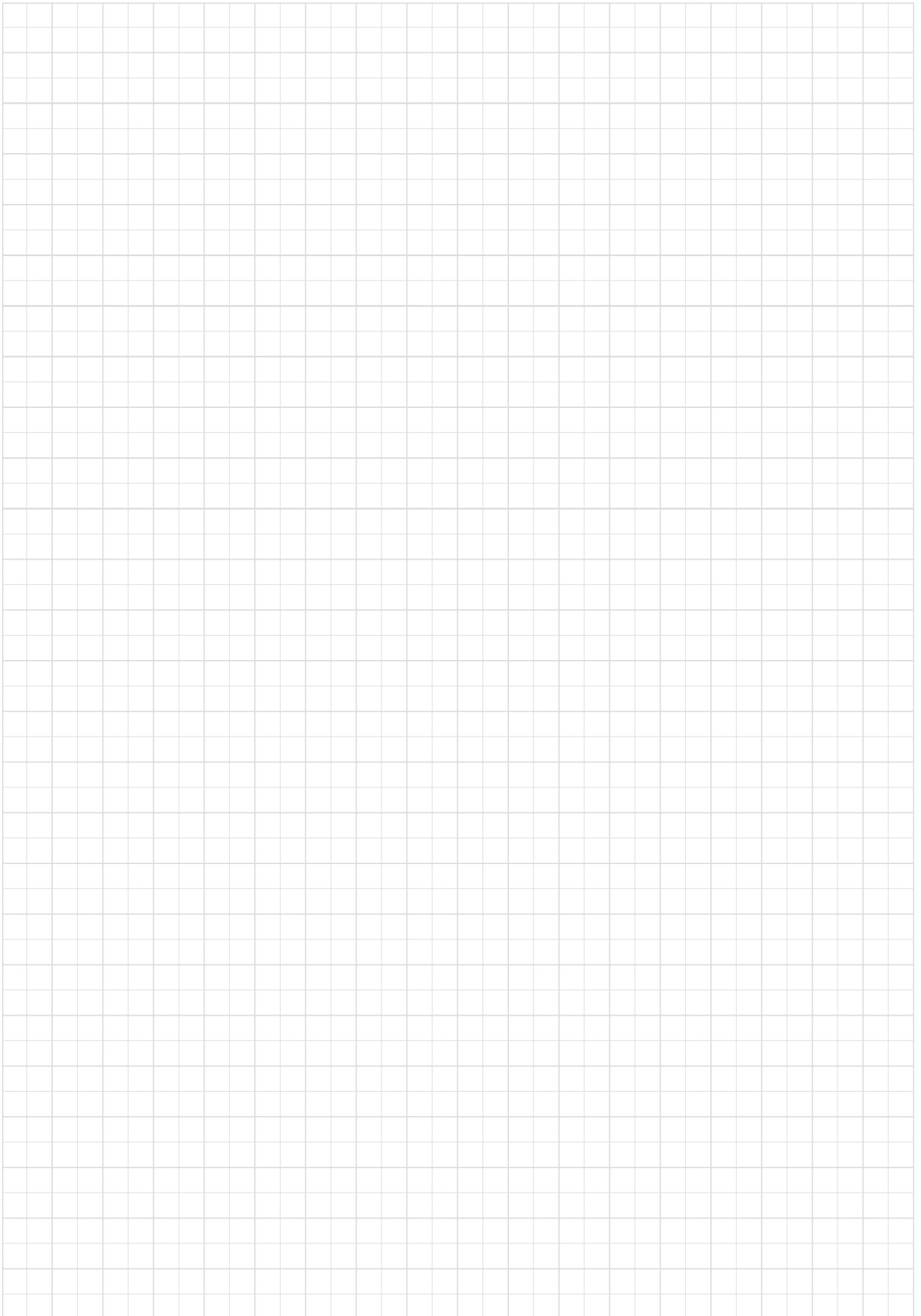
Fine adjusting screws

Designation	Applicable Tool
AJM5	DPD09 EDPD09
ASM34L	DPD24

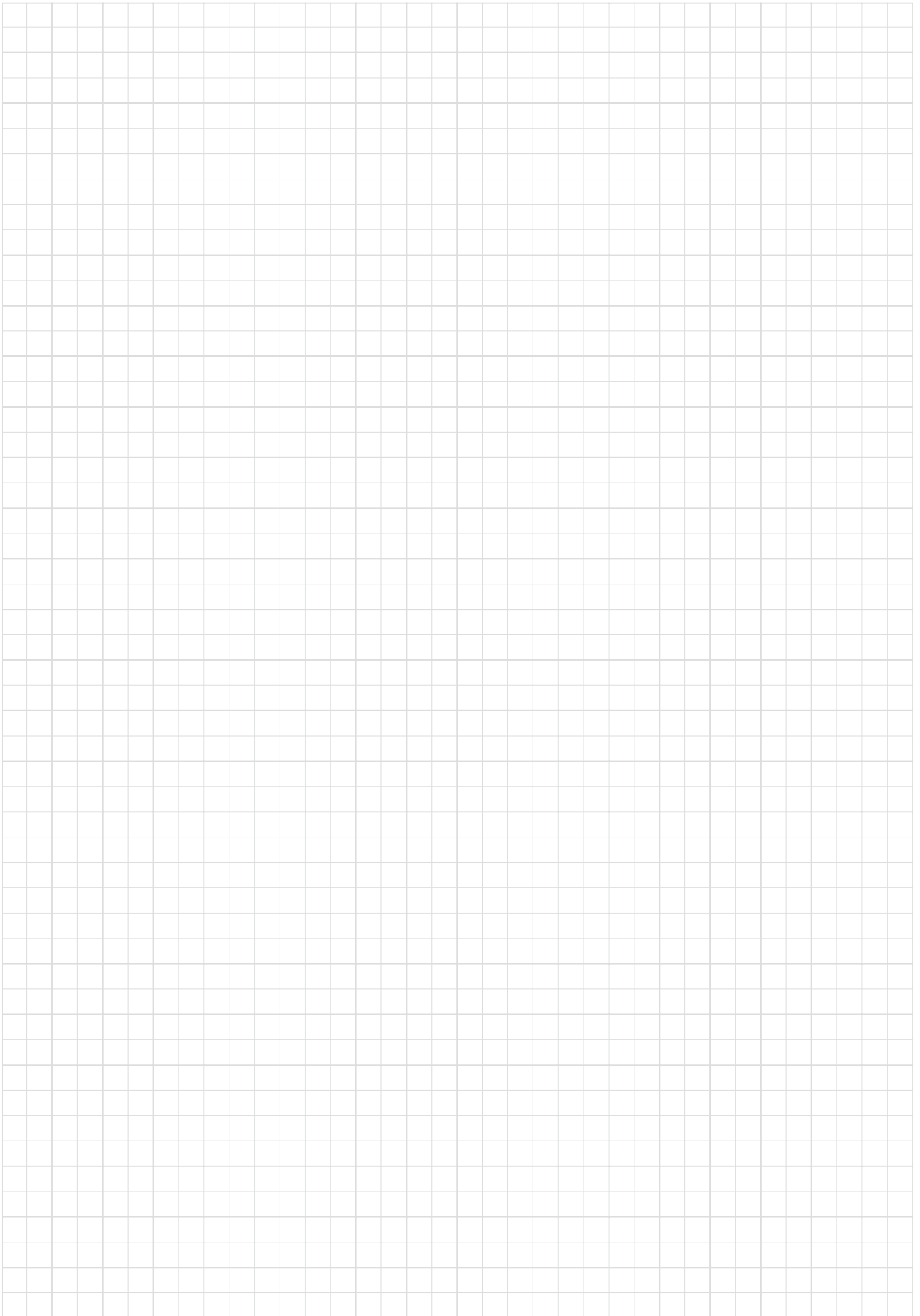
Cover

Designation	Applicable Tool
RSFTS6063M	TPYP12M063B22.0R10
RSFTS6080	TPYP12*080B**R12
RSFTS6100	TPYP12*100B**R16
RSFTS6125	TPYP12*125B**R20

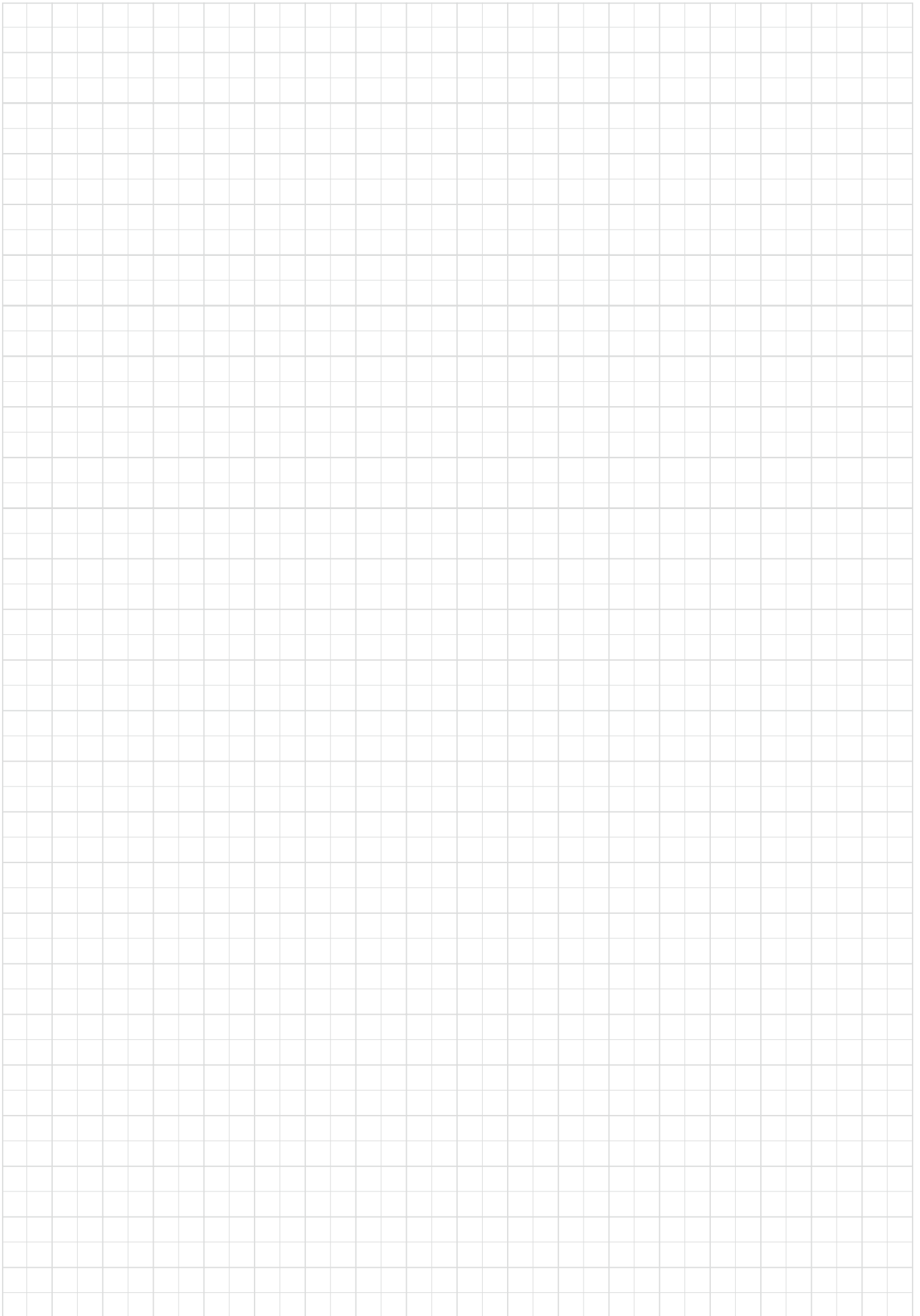
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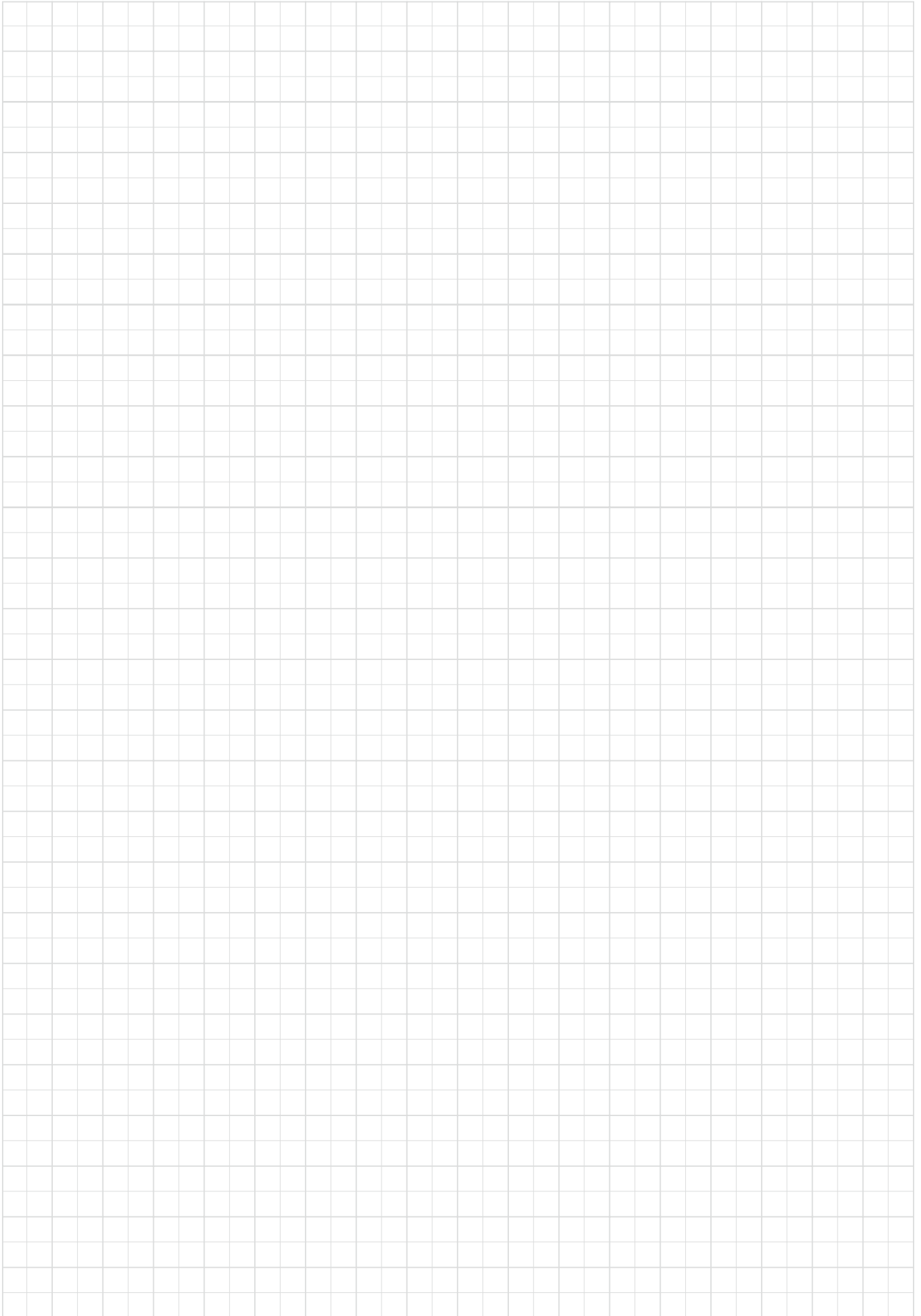
MEMO



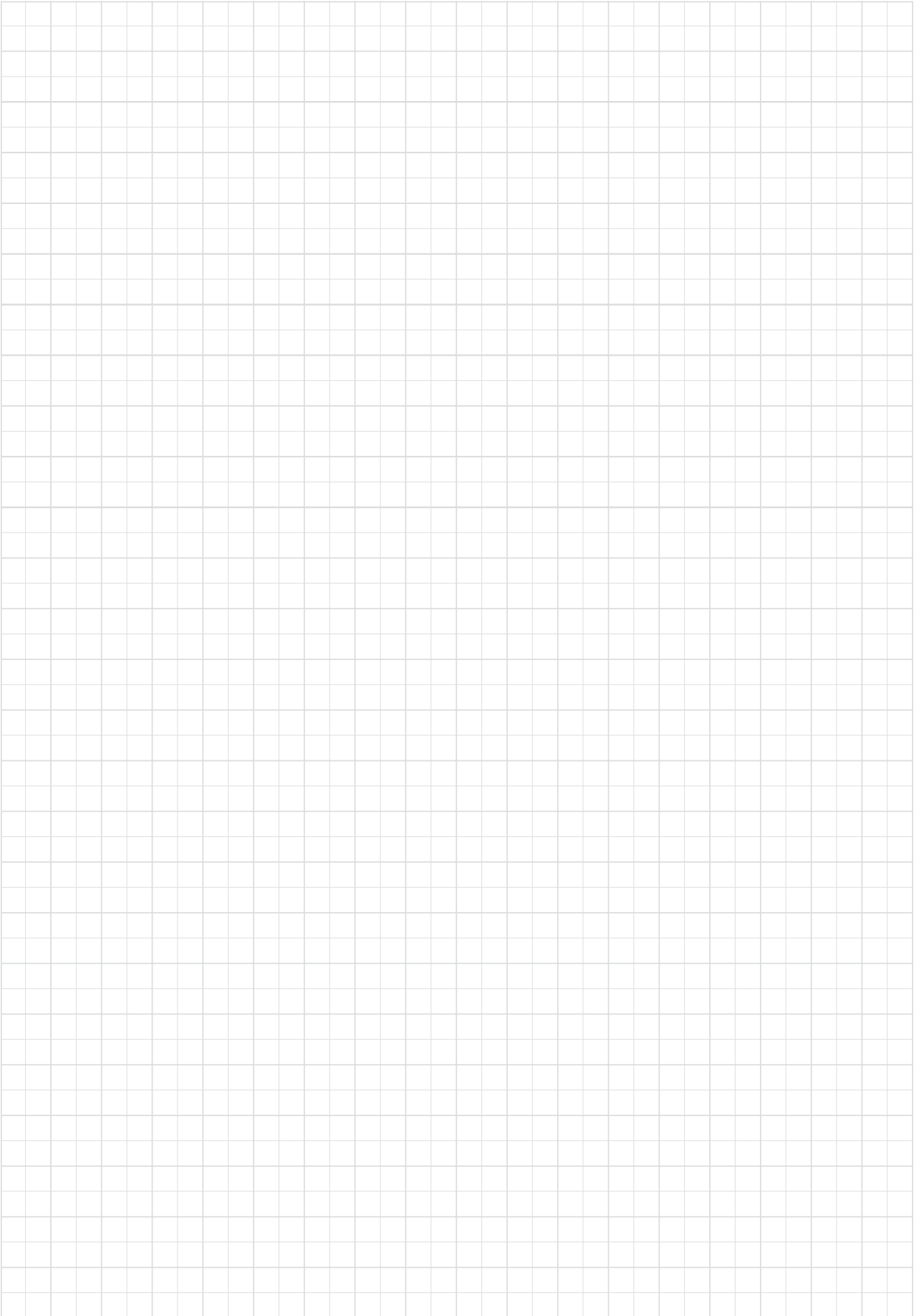
MEMO



MEMO



MEMO



Worldwide Network



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Iwaki Plant

Products: Cutting Tools

Nagoya Plant

Products: Cutting Tools

Kyushu Plant

Products: CBN
PCD Tools
Deep Hole Drills

Nirasaki Plant

Products: Cutting Tools
Friction Materials (TungFric)
Wear Resistant Tools
Civil Engineering Tools



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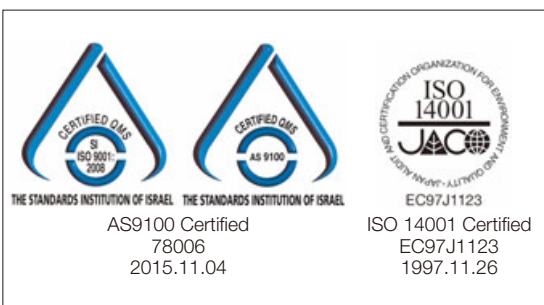
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