ENDMILLS

Korloy Endmills, with New technology and our technical know-how,
are the best for increasing productivity and machinability

A

GRADES & CHIP BREAKERS

KORLOY's new grades are designed with optimal substrates for each application and are PVD coated for high temperature, high hardness and oxidation resistance, or CVD coated for high tempeure and wear resistance. Additionally, the improved post-coating treatment provides superior surface finishes to ensure the highest levels of quality and productivity.

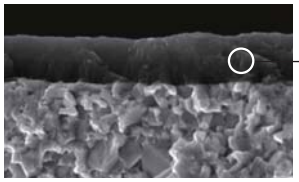
Solid endmills grade selection

Grades for H Endmill

PC303S/PC310U

- Ultrafine substrate & high hardness coatings for excellent wear resistance
- Special surface treatment provides higher chipping resistance

Features



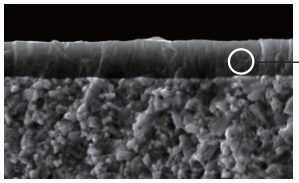
Exceptional wear resistance resulting from extremely hard coating layers

Grades for Z Endmill

PC315E

- Fine substrate & lubricative coatings for stable machinability

Features



Lubricative coatings for excellent machinability

Selection system

Workpiece		Grade	ISO	Application range
P	Steel	PC303S	P01	
		PC310U	P10	PC303S, PC203F
		PC315F	P20	PC310U
		PC320	P30	PC315E, PC320, PC215F
			P40	
M	Stainless steel	PC303S	M01	
		PC310U	M10	PC303S, PC203F, PC310U
		PC320S	M20	PC320S
		PC315E	M30	PC315E, PC320, PC215F
K	Cast iron	PC303S	K01	
		PC310U	K10	PC303S, PC203F, PC310U
		PC315E	K20	
		PC320	K30	PC315E, PC320, PC215F
			K40	
S	HRSA	PC320S	S20	PC320S, PC315E, PC320, PC215F
		PC315E	S30	
N	Nonferrous	ND3000 new	N01	ND3000 new
		ND2100 new	N05	ND2100 new, PD1005 new, PD1010 new, H01, H05S, PC210C
		PD3000	N10	
		H01	N20	
H	High hardness steel	PC303S	H01	
		PC203F	H10	PC303S, PC203F, PC310U
		PC310U	H20	

Solid endmills grade selection

Grade information for each product

Item	Grade	
	Coated	Uncoated
H Endmill	PC303S, PC310U	-
V Endmill	PC215F	-
Z Endmill	PC315E	-
F Endmill	PC203F	-
T Endmill	PC2510, ND3000	H01
I+ Endmill	PC320	-
Z+ Endmill	PC320U	-
S+ Endmill	PC320S	-

Item	Carbide		HSS	
	Coated	Uncoated	Coated	Uncoated
R+ Endmill	PC10T, PC20T PC30T, PC40T	FN30T	HC10T, HC20T, HC30T	HN20T, HN30T
Aluminum Solid Endmill	PD1005, PD1010	H01	-	-
A+ Endmill	-	H05S	-	-
C-Max	PC210C	-	-	-
Super Endmill	SL	-	-	-
D Endmill	ND3000	-	-	-
Composite Router Endmill	ND2100	-	-	-
Brazed Endmill	PC221F	FCC	-	-

The features of Coated grades

Workpiece	ISO	Features
PC303S	P05 ~ P15 K05 ~ K15 H05 ~ H15	• Excellent wear/chipping resistance in high speed machining due to the combination of ultra fine substrate and PVD coating • For high speed machining of high hardness steel • New film applied with excellent oxidation resistance and hardness at high temperature
PC310U	P10 ~ P20 K10 ~ K20 H10 ~ H20	• Excellent wear/chipping resistance in high speed machining due to the combination of ultra fine substrate and PVD coating • For high speed machining of high hardness steel • New film applied with excellent oxidation resistance and hardness at high temperature
PC315E PC320	P20 ~ P35 K20 ~ K35	• Excellent wear/welding resistance in high speed machining due to the combination of ultra fine substrate and PVD coating • For low/medium speed machining of general steel • New film applied with excellent chipping/wear resistance
PC320S	M20 ~ M30 S20 ~ S30	• Low to medium speed cutting of stainless steel and heat resistant alloys • Advanced coating layers with increased resistance to built-up edge and oxidation • Excellent resistance to wear and built-up edge at high speeds due to the ultrafine substrate and dedicated coating layers
PC210C	N10 ~ N20	• Medium to high speed cutting of copper and copper electrode • Medium to high speed cutting of acrylic materials • K-Silver coating with excellent lubrication and wear and chipping resistant substrate
ND3000* new	N01 ~ N05	• For electrode machining of graphite at medium to high speeds • Dia. coating layer with high wear resistance and lubrication
ND2100* new	N03 ~ N08	• For composite materials • Diamond-coated layers with excellent adhesion
PD1005	N05 ~ N10	• For Non-ferrous metals(Aluminum alloy) machining • DLC(Diamond Like Carbon) coating layer with high wear resistance and lubrication

∗ : CVD

Features of KORLOY endmills

Index	Features
H Endmill (Endmill for high hardness steel)	• Negative cutting edges proper to machine high hardness heat-treated workpiece under HRC70 • Longer tool life with the use of ultra fine substrate and high hardness film
Z Endmill / I+ Endmill (Endmill for general cutting)	• Excellent in machining various workpieces such as carbon steel, alloy steel, cast iron, pre hardened steel, etc. under HRC45 • Longer tool life with the use of ultra fine substrate and new coating technology
T Endmill (For dental purpose)	• Endmill for dental prostheses made of zirconia, titanium, Co-Cr, wax, PMMA, and glass ceramic • Custom-made tools for each type of milling machines for dental purpose
Z+ Endmill	• Universal endmill applicable to a variety of workpiece materials under HRC47 • Roughing and finishing availability • Improved tool life thanks to the new substrate and the most advanced coating • Inhibited chipping and longer cutting time due to the optimized blade design
SSEA / A+ Endmill (Endmill for aluminum)	• Suitable for high speed machining in aluminum and other Non-ferrous materials • Can accomplish excellent surface finishing, superior chip removal in high feed rate
S+ Endmill (Endmill for hard-to-cut materials)	• Sharp cutting edge and high rake angle with streamline chip pocket shows good cutting performance in stainless steel machining where work hardening is a problem
R+ Endmill	• High efficient roughing endmill for medium to rough cutting • Excellent machining efficiency thanks to the high efficient roughing edge design • Reduced cutting force thanks to specifically designed corners, and irregular flute spacing and lead angle
D Endmill	• Diamond-coated endmill for graphite and ceramic • Excellent wear resistance thanks to the diamond coating of high hardness and high purity • Optimized for high speed and heavy duty cutting thanks to the strong grip of coating • Excellent cutting performance and finish thanks to the optimized blade design of high rake
Composite Router Endmill	• Router endmill for machining composite materials (CFRP & GFRP) • Minimized machining defects thanks to its design to prevent flaking, peeling off and burrs • Excellent resistance to wear and flaking thanks to the nano-crystalline diamond coating of high hardness and high purity
C-Max	• Ideally suited for machining copper, brass, bronze, and Non-ferrous materials thanks to the optimized combination between K-Silver coating with excellent lubrication and resistance to wear and chipping, and the dedicated substrate
Super Endmill	• High lubricated coating and special surface treatment • Improved welding and chipping resistance and machining stability due to surface treatment technology

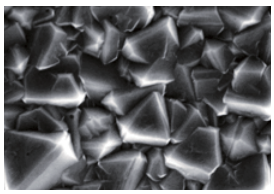
Diamond coated grades

Grade for graphite and ceramic

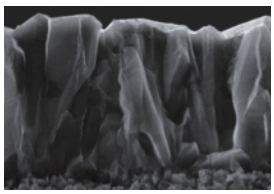
ND3000 new

- SP3-crystalline diamond coatings of high purity and high hardness
- Improved adhesion between coated layers and the substrate that is specialized for diamond coatings
- Excellent tool life when machining graphite and ceramic

Surface of ND3000



Cross section of ND3000's coated layers

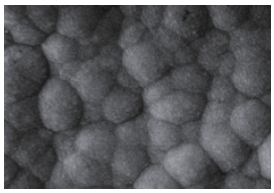


Grade for composite materials

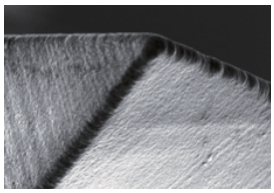
ND2100 new

- Improved surface finish and wear resistance due to the control technology of nano-crystalline diamond particles
- Improved flaking resistance due to the substrate that is specialized for diamond coatings
- High quality and high precision machining availability thanks to sharp edges
- Excellent tool life when machining composite materials

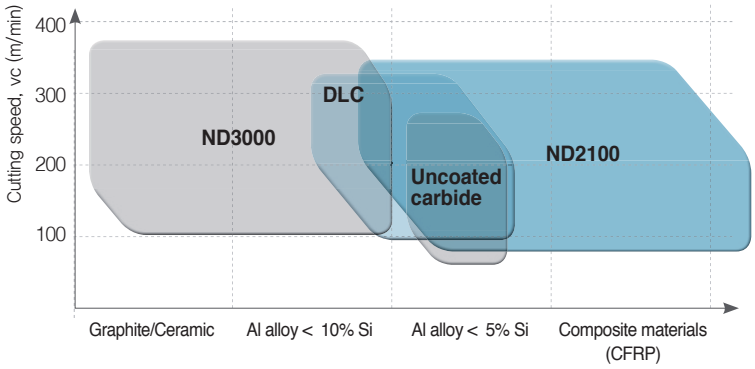
Surface of ND2100



Sharp edges of ND2100



Application range



Selection system

Workpiece			Grade	ISO	Application range
N	Nonferrous	Graphite/ Ceramic	ND3000 new	N01	ND3000 new
		Al alloy	ND3000 new ND2100 new	N05	ND2100 new
		Composite materials	ND2100 new	N10	

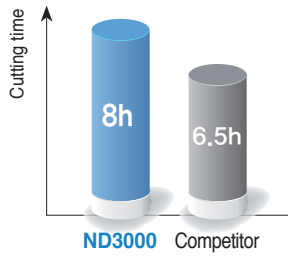
The features of diamond coated grades

Grade	ISO	Features
ND3000 new	N01 ~N05	• For continuous roughing of graphite, ceramic, and Al alloy at high speeds • Exceptional cutting performance due to high resistance to wear and flaking • High hardness diamond coatings of high purity SP3-crystalline structure
ND2100 new	N03~N08	• For continuous finishing of composite materials and Al alloy at high speeds • Stable machinability due to durable sharp edges • Nano-crystalline diamond coatings under particle control

Application examples (ND3000/ND2100)

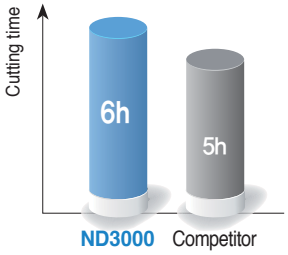
N Graphite mold

- **Cutting condition** vc (m/min) = 100, fz (mm/t) = 0.11, ap (mm) = 0.26, dry
- **Designation** **Endmill** : DBE4060-110-N250S06 (ND3000)
- **Test result**



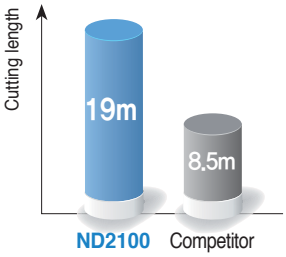
N Graphite mold

- **Cutting condition** vc (m/min) = 300, fz (mm/t) = 0.1 ap (mm) = 0.15, dry
- **Designation** **Endmill** : DBE2060-080-N250S06 (ND3000)
- **Test result**



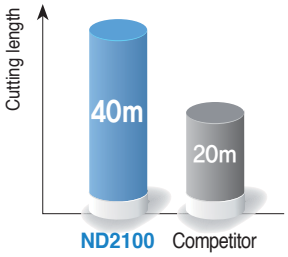
N CFRP

- **Cutting condition** vc (m/min) = 200, fn (mm/rev) = 0.21, ap (mm) = 10, ae (mm) = 2.8
- **Designation** **Endmill** : CCR2080-075 (ND2100)
- **Test result**



N CFRP

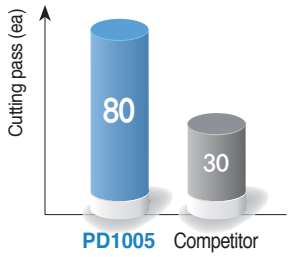
- **Cutting condition** vc (m/min) = 200, fz (mm/t) = 0.17 ap (mm) = 10, ae (mm) = 1.2
- **Designation** **Endmill** : CCLR4080-075 (ND2100)
- **Test result**



Application examples (PD1005/PD1010)

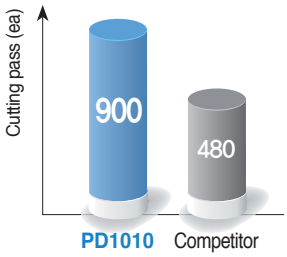
N Al-Si alloy

- **Workpiece** Aluminum die casting materials, ALDC7 (Si 8%)
- **Cutting condition** vc (m/min) = 400, fn (mm/rev) = 0.25-0.3, ap (mm) = 1.0-1.5, wet
- **Designation** **Insert** : CNMG120408-HA (PD1005) **Holder**: PCLNR2525-M12
- **Test result**



N Al-Si alloy

- **Workpiece** Aluminum forging materials, AC4C (Si 7%)
- **Cutting condition** vc (m/min) = 740, fn (mm/rev) = 0.15, ap (mm) = 1.0-1.5, wet
- **Designation** **Insert** : XEKT19M504FR-MA (PD1010) **Holder**: PAXS5032HR-A
- **Test result**



F

ENDMILLS

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are the best for increasing productivity and machinability

Technical Information for Endmills

Solid Endmills

Solid Endmills

Brazed Endmills

Special Endmill order Form

Z B E 2 040 - 050 -

1	2	3	4	5	6
Series	Type	Endmill	No. of flutes	Cutting dia.	Overall length

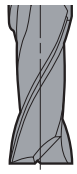
1 Series

Z B E 2 040 - 050 - R T - V N S

Z, IP, ZP: Endmill for general usage
P: High speed/ hardness Endmill
C: Copper, Copper alloy Endmill
D: Graphite, Non-Ferrous Endmill
V: Variable Endmill
FM: High feed Endmill
SSEA, AP: Aluminum Endmill
SP: Stainless Endmill
CC: Composite Router Endmill
T: Dental Endmill

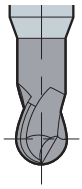
2 Type

Z B E 2 040 - 050 - R T - V N S



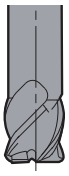
Flat type

F



Ball type

B



Radius type

R

3 Endmill

Z B E 2 040 - 050 - R T - V N S

4 No. of flutes

Z B E 2 040 - 050 - R T - V N S

2 Flutes

2

3 Flutes

3

4 Flutes

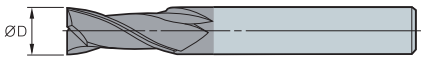
4

6 Flutes

6

5 Cutting dia

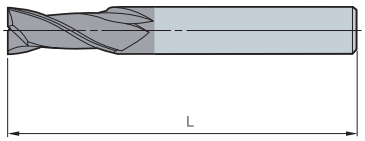
Z B E 2 040 - 050 - R T - V N S



Notation	ØD (mm)
040	Ø4.0
060	Ø6.0
080	Ø8.0
100	Ø10.0

6 Overall length

Z B E 2 040 - 050 - R T - V N S



Overall length	
Notation	L (mm)
050	50
080	80
100	100

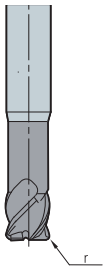
※ The above code system is not applied for SSEA (Aluminum Endmill) and ZSE (Brazing Endmill)

R02 T00 - V05 N12 S06

7 Corner radius | 8 Taper angle | 9 Flute length | 10 Neck length | 11 Shank diameter

7 Corner radius

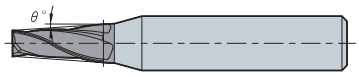
Z B E 2 040 - 050 - **R** T - V N S



Corner radius	
Notation	R (mm)
R02	r 0.2
R05	r 0.5
R10	r 1.0
R15	r 1.5

8 Taper angle

Z B E 2 040 - 050 - R **T** - V N S

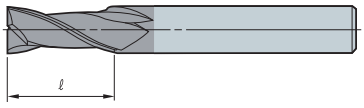


T (θ°): Taper Angle

Taper angle	
Notation	T (θ°)
T10	1°
T15	1.5°
T20	2°

9 Flute length

Z B E 2 040 - 050 - R T - **V** N S

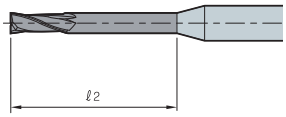


Taper length	
Notation	(mm)
V05	5
V10	10
V15	15

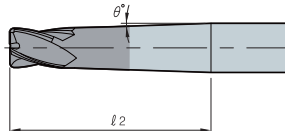
※ This code system is also for special endmills

10 Neck length

Z B E 2 040 - 050 - R T - V **N** S



Long Neck



Taper Long Neck

ℓ_2 (mm): Neck Length

T (θ°): Taper Angle

Long neck	
Notation	ℓ_2 (mm)
N05	5
N08	8
N10	10
N12	12

Taper long neck	
Notation	ℓ_2+T(θ°)
N0510	5+1°
N0815	8+1.5°
N1020	10+2°
N1225	12+2.5°

11 Shank diameter

Z B E 2 040 - 050 - R T - V N **S**

Shank diameter	
Notation	Ød (mm)
S06	Ø6
S08	Ø8
S10	Ø10
S12	Ø12
S16	Ø16

Type	Shape	Designation	Grade	Figure	Coated	Used	No. of flute	Size		Workpiece						page
								Min	Max	P Steel	M Stainless steel	K Cast iron	N Non-ferrous metal	S Heat resistant alloy, Titanium alloy	H Hardened steel	
new H Endmill	Ball	PBE2000	PC303S		○	High speed High hardness	2	0.5	12	◎		◎		○	◎	F12
	Radius	PRE4000	PC310U		○	High speed High hardness	4	3	12	◎		◎		○	◎	F13
V Endmill	Flat	VFE4000	PC215F		○	General	4	2.5	16	◎	○	○		○	○	F16
new Z Endmill	Flat	ZFE2000	PC315E		○	General	2	1	16	◎	○	◎		○		F20
		ZFE4000	PC315E		○	General	4	1	16	◎	○	◎		○		F21
	Short flat	ZSFE2000	PC315E		○	General	2	1	12	◎	○	◎		○		F22
		ZSFE4000	PC315E		○	General	4	1	12	◎	○	◎		○		F22
	Ball	ZBE2000	PC315E		○	General	2	1	12	◎	○	◎		○		F23
F Endmill	High feed	FME4000	PC203F		○	High speed High hardness	4	6	12	○		○		◎	◎	F26
	High feed long	FMLE4000	PC203F		○	High speed High hardness	4	6	12	○		○		◎	◎	F26
new T Endmill	Ball	TZBE	ND3000		○	Dental, Zirconia	2	0.6	3				◎			F27
		TTBE	PC2510		○	Dental, Metal	2	0.6	3					◎		F27
		TWBE	H01		–	Dental, Wax	2	0.6	3				◎			F27
new D Endmill	Flat	DFE2000	ND3000		○	Graphite, Ceramics	2	1	12				◎			F32
		DFE4000	ND3000		○	Graphite, Ceramics	4	2	12				◎			F33
	Ball	DBE2000	ND3000		○	Graphite, Ceramics	2	0.6	12				◎			F34 F35
		DBE4000	ND3000		○	Graphite, Ceramics	4	2	12				◎			F36

◎: Excellent ○: Good

Type	Shape	Designation	Grade	Figure	Coated	Used	No. of flute	Size		Workpiece						page
								Min	Max	P Steel	M Stainless steel	K Cast iron	N Non-ferrous metal	S Heat resistant alloy, Titanium alloy	H Hardened steel	
Solid Endmills for aluminum	Flat	SSEA2000	H01 PD3000		– (○)	Aluminum	2	1	20	○			◎			F38
	Flat	SSEA3000	H01 PD3000		– (○)	Aluminum	3	2	16	○			◎			F38
	Ball	SSBEA2000	H01 PD3000		– (○)	Aluminum	2	1	20	○			◎			F39
C-Max	Flat	CFE2000	PC210C		○	Copper, Copper alloy	2	1	12	○			◎			F41
	Long neck flat	CFNE2000	PC210C		○	Copper, Copper alloy	2	0.5	4	○			◎			F41
	Ball	CBE2000	PC210C		○	Copper, Copper alloy	2	1	12	○			◎			F42
	Long neck ball	CBNE2000	PC210C		○	Copper, Copper alloy	2	0.5	4	○			◎			F42
	Radius	CRE2000	PC210C		○	Copper, Copper alloy	2	2	12	○			◎			F43
	Long neck radius	CRNE2000	PC210C		○	Copper, Copper alloy	2	1	4	○			◎			F43
new Super Endmill	Radius	SRES4000	SL		○	HRSA	4	3	20					◎		F46~ F50
new Composite Router Endmill	Flat	CCDR4000	ND2100		○	Composite CFRP, GFRP	4	6	8				◎			F52
		CCDR6000	ND2100		○	Composite CFRP, GFRP	6	10	12				◎			F52
		CCHR4000	ND2100		○	Composite CFRP, GFRP	4	6	8				◎			F53
		CCHR6000	ND2100		○	Composite CFRP, GFRP	6	10	12				◎			F53
		CCR2000	ND2100		○	Composite CFRP, GFRP	2	4	12				◎			F54
		CCLR4000	ND2100		○	Composite CFRP, GFRP	4	4	12				◎			F55
		CCRR6000	ND2100		○	Composite CFRP, GFRP	6	6	8				◎			F56
		CCRR8000	ND2100		○	Composite CFRP, GFRP	8	10	12				◎			F56

◎: Excellent ○: Good

Type	Shape	Designation	Grade	Figure	Coated	Used	No. of flute	Size		Workpiece						page
								Min	Max	P Steel	M Stainless steel	K Cast iron	N Non-ferrous metal	S Heat resistant alloy, Titanium alloy	H Hardened steel	
I+ Endmill	Flat	IPFE2000	PC320		○	General	2	1	20	◎	○	◎		○		F60
		IPFE4000	PC320		○	General	4	1	20	◎	○	◎		○		F62
	Long flat	IPLFE2000	PC320		○	General	2	1	20	◎	○	◎		○		F61
		IPLFE4000	PC320		○	General	4	1	20	◎	○	◎		○		F63
	Ball	IPBE2000	PC320		○	General	2	1	20	◎	○	◎		○		F64
	Ball	IPBE4000	PC320		○	General	4	1	20	◎	○	◎		○		F66
	Long ball	IPLBE2000	PC320		○	General	2	1	16	◎	○	◎		○		F65
	Radius	IPRE2000	PC320		○	General	2	1	12	◎	○	◎		○		F67 F68
		IPRE4000	PC320		○	General	4	2	12	◎	○	◎		○		F70
	Long radius	IPLRE2000	PC320		○	General	2	3	12	◎	○	◎		○		F69
		IPLRE4000	PC320		○	General	4	3	12	◎	○	◎		○		F71
Z+ Endmill new	Flat	ZPFE2000	PC320U		○	General	2	1	20	◎	○	◎		○		F75
	Short flat	ZPSFE2000	PC320U		○	General	2	1	16	◎	○	◎		○		F76
	Long flat	ZPLFE2000	PC320U		○	General	2	2	20	◎	○	◎		○		F76
	Long flute	ZPLFE2000	PC320U		○	General	2	2	20	◎	○	◎		○		F77
	Flat	ZPFE4000	PC320U		○	General	4	1	20	◎	○	◎		○		F78
	Short flat	ZPSFE4000	PC320U		○	General	4	1	16	◎	○	◎		○		F79
	Long flat	ZPLFE4000	PC320U		○	General	4	2	20	◎	○	◎		○		F80

◎: Excellent ○: Good

Type	Shape	Designation	Grade	Figure	Coated	Used	No. of flute	Size		Workpiece						page
								Min	Max	P Steel	M Stainless steel	K Cast iron	N Non-ferrous metal	S Heat resistant alloy, Titanium alloy	H Hardened steel	
Z+ Endmill new	Long flute	ZPLFE4000	PC320U		○	General	4	1	20	◎	○	◎		○		F81
	Flat	ZPFE3000	PC320U		○	General	3	2	25	◎	○	◎		○		F82
		ZPFE6000	PC320U		○	General	6	6	20	◎	○	◎		○		F82
	Ball	ZPBE2000	PC320U		○	General	2	0.8	20	◎	○	◎		○		F83
	Long ball	ZPLBE2000	PC320U		○	General	2	2	12	◎	○	◎		○		F84
	Ball	ZPBE4000	PC320U		○	General	4	2	20	◎	○	◎		○		F84
	Radius	ZPRE2000	PC320U		○	General	2	1	16	◎	○	◎		○		F85
	Long radius	ZPLRE2000	PC320U		○	General	2	6	16	◎	○	◎		○		F86
	Radius	ZPRE4000	PC320U		○	General	4	1.5	16	◎	○	◎		○		F87
	Long radius	ZPLRE4000	PC320U		○	General	4	6	16	◎	○	◎		○		F88
S+ Endmill new	Flat	SPFE4000	PC320S		–	STS	4	1	12	○	◎	○		◎		F91
	Long flat	SPLFE4000	PC320S		–	STS	4	1	12	○	◎	○		◎		F91
R+ Endmill	Roughing	RPAE	FN30T		–	Aluminum	3	6	25				◎			F97
		RPE-FP-H	PC30T		○	General	4	5	20	◎	○	◎		○		F97
		RPLE-FP-H	PC30T		○	General	4	5	20	◎	○	◎		○		F98
		RPE-XG	PC30T		○	General	4	6	20	◎	○	◎		○		F98
		RPE-FP-L	PC30T		○	General	4	5	20	◎	○	◎		○		F99
		RPE-RG	PC40T		○	General	4	5	20	◎	○	◎		○		F99

◎: Excellent ○: Good

Type	Shape	Designation	Grade	Figure	Coated	Used	No. of flute	Size		Workpiece						page
								Min	Max	P Steel	M Stainless steel	K Cast iron	N Non-ferrous metal	S Heat resistant alloy, Titanium alloy	H Hardened steel	
R+ Endmill	Roughing	RPE-RG	HN30T HC30T		○	General	4	6	20	◎	○	◎		○		F100
		RPE-FF	HC30T		○	General	4	6	20	◎	○	◎		○		F100
		RPE-FP	HC30T		○	General	4	6	20	◎	○	◎		○		F101
		RPE-RG	HN20T HC10T HC20T		○	General	4	6	50	◎	○	◎		○		F102
A+ Endmill	Flat	APFE2000	H05S		–	Aluminum	2	1	20				◎			F105
		APFE3000	H05S		–	Aluminum	3	1	20				◎			F105
	Middle flat	APMFE2000	H05S		–	Aluminum	2	3	20				◎			F106
		APMFE3000	H05S		–	Aluminum	3	3	20				◎			F106
PCD Endmill	Flat	PDE1000	DP200		–	Nonferrous, High speed	1	4.6	6				◎			F115
		PDE2000	DP200		–	Nonferrous, High speed	2	6	12				◎			F115
Brazed Endmill	Flat	ZSE200	FCC PC221F		– (○)	Cast iron, Steel	2	14	50	○	○	◎		○		F118
		ZSE300	FCC PC221F		– (○)	Cast iron, Steel	3	14	50	○	○	◎		○		F118 F119
		ZSE400	FCC PC221F		– (○)	Cast iron, Steel	4	14	50	○	○	◎		○		F119
		ZSE600	FCC PC221F		– (○)	Cast iron, Steel	6	34	50	○	○	◎		○		F119
		ZSEA200	FCC		–	Aluminum, Copper	2	15	50				◎			F120
	Long flat	ZSEL200	FCC PC221F		–	Cast iron, Steel	2	14	50	○	○	◎		○		F121
		ZSEL400	FCC PC221F		–	Cast iron, Steel	4	16	40	○	○	◎		○		F121
		ZSEXL200	FCC PC221F		–	Cast iron, Steel	2	20	25	○	○	◎		○		F121
	Ball	ZSBE200	FCC PC221F		–	Cast iron, Steel	2	13	50	○	○	◎		○		F122

◎: Excellent ○: Good

Endmill for high speed machining for high hardened steel

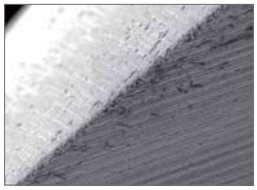
H Endmill new

- For cutting high hardened and heat-treated steel under HRC70
- New coating technology improves wear resistance
- A new shape improves machinability
- High speed and highly accurate machining available

Features

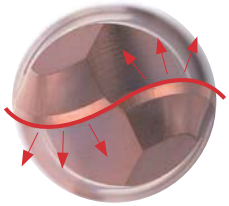
- New grade (PC303S, PC310U) - Ultra fine substrate and AlTiSiN coating guarantee excellent wear resistance
- Special edge treatment - Special cutting edge design was applied for less chipping and longer tool life
- High accuracy with tolerance h5 - High quality production system enables tolerance-h5 throughout the whole series

After special edge treatment



before

PBE (Ball)



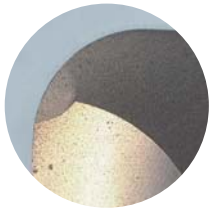
Cutting load is dispersed

S shape of ball

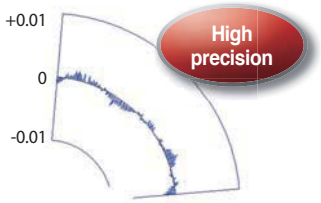
- The S shape of ball disperses cutting loads
- The tolerance of ball R is under ±0.005 mm

PRE (Radius)

H Endmill radius



New shape of corner R



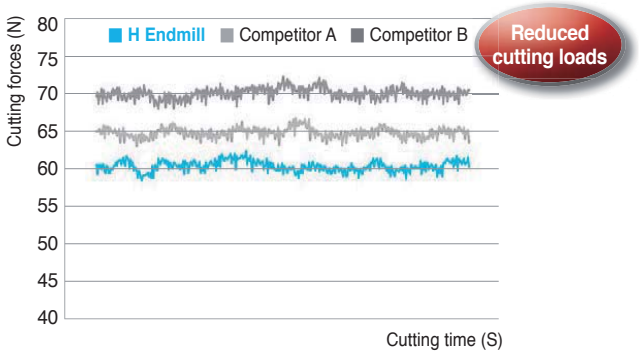
Measurement result of tolerance of corner R

- The new shape of corner R reduces cutting loads
- The tolerance of corner R is under ±0.005 mm

Performance evaluation

- **Workpiece** STD11 (HRC60)
- **Cutting conditions** Diameter = Ø8.0, n (min^{-1}) = 4,000, vc (m/min) = 100
  vf (mm/min) = 800, fz (mm/t) = 0.05
  ap (mm) = 8.0, ae (mm) = 0.25, dry
- **Tools** PRE4080-100-R05

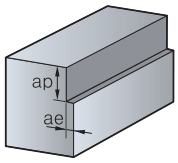
※ Special cutting edge design reduces cutting loads and prolongs tool life



Recommended cutting conditions (PRE4000 Radius)

Workpiece / Conditions / Diameter (Ø)	Above HRC40 (HPM1, KP4M, etc.)		Below HRC55 (NAK55, NAK80, STAVAX, etc.)		HRC55~HRC70 (STD11, STD61, etc.)	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
3	17,300	1,250	11,500	840	7,500	256
4	13,200	1,300	8,800	880	5,600	268
5	12,500	1,500	8,300	1,000	5,100	296
6	10,350	1,400	6,900	950	4,200	280
8	7,800	1,350	5,200	900	3,200	264
10	6,150	1,260	4,100	840	2,550	248
12	5,250	1,260	3,500	840	2,100	240

Application tip



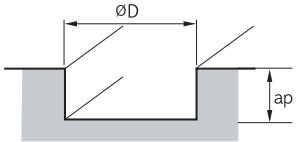
■ Shouldering depth (ap) and radial depth (ae)
- ap = 0.1D
- ae = 0.03D

※ Workpiece should be clamped rigidly. In case of vibration, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (PRE4000 Radius)

Workpiece / Conditions / Diameter (Ø)	Above HRC40 (HPM1, KP4M, etc.)		Below HRC55 (NAK55, NAK80, STAVAX, etc.)		HRC55~HRC70 (STD11, STD61, etc.)	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
3	17,300	544	11,500	336	7,500	128
4	13,200	560	8,800	352	5,600	136
5	12,500	644	8,300	400	5,100	144
6	10,350	616	6,900	384	4,200	144
8	7,800	576	5,200	356	3,200	132
10	6,150	544	4,100	332	2,550	124
12	5,250	544	3,500	332	2,100	124

Application tip



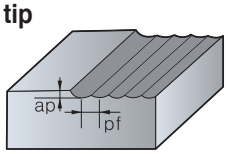
■ Slotting depth (ap)
- ap = 0.05D
- ae = 1.0D

※ Workpiece should be clamped rigidly. In case of vibration, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (PBE2000 Ball)

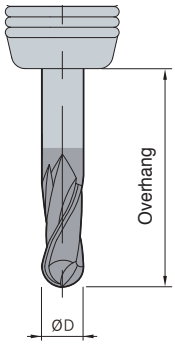
Workpiece / Conditions / Diameter(Ø)	Above HRC40 (HPM1, KP4M, etc.)		Under HRC55 (NAK55, NAK80, STAVAX, etc.)		HRC55~HRC70 (STD11, STD61, etc.)	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
0.5	35,000	1,470	31,500	1,330	28,000	1,050
1	35,000	2,940	31,500	2,660	28,000	2,000
1.2	33,600	3,010	30,100	2,695	26,600	2,100
1.5	33,600	3,150	30,100	2,800	25,900	2,150
2	33,460	3,360	28,000	2,800	24,500	2,200
2.5	25,900	3,710	22,400	2,800	17,500	2,200
3	22,260	3,710	18,550	2,800	16,500	2,200
4	16,730	3,710	14,000	2,800	13,000	2,200
5	17,800	4,900	15,000	3,750	12,500	2,100
6	13,400	4,100	11,000	3,100	10,000	2,500
8	10,700	3,500	9,000	2,700	8,000	2,150
10	8,900	3,100	7,500	2,400	6,600	1,900
12	6,680	2,500	5,600	1,900	5,000	1,550

Application tip



- ap = 0.02D
- pf = 0.05D

※ Workpiece should be clamped rigidly. In case of vibration, reduce R.P.M and feed rate by the same ratio



Cutting condition by overhang

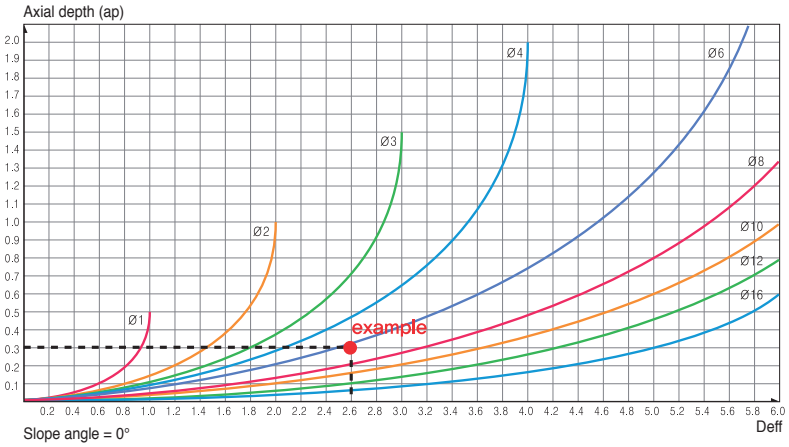
- For shank taper type, Cutting conditions are based on the case of being clamped at neck part
  - When the overhang is increased by 1D in comparion to the overhang, decrease R.P.M and feed by 10%
- In case of the straight type adjust conditions according to the overhang
  - Ex: When the overhang is 3D and is increased by 1D, decrease R.P.M and feed by 10%

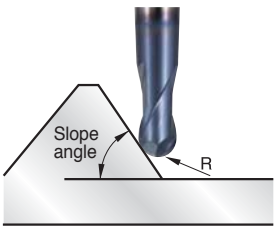
Cutting speed formulas (Ball endmills)

- Efficient cutting speed Veff = (π × Deff × n)/1000 (n = min^{-1})
- Efficient diameter Deff calculation formula Deff = ($2\sqrt{ap(D-ap)} \times \alpha$)
  D = Ø (Tool diameter), Deff = Efficient diameter
- Efficient cutting speed formulas: When slope Ø is 0° Veff = (π × Deff × n)/1000
  Deff = Efficient, diameter Calculate Deff as ap with various ball endmills

α:		
	α = 1	Slope angle θ = 0°
	α = 1.2	Slope angle θ = 7°
	α = 1.5	Slope angle θ = 15°
	α = 1.7	Slope angle θ = 30°
	α = 2.17	Slope angle θ = 45°
	α = 2.3	Slope angle θ = 60°

Cutting speed formulas (Ball endmills, slope angle = 0°)



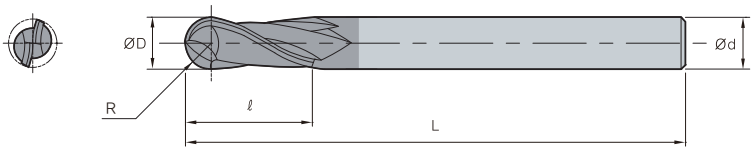


Ex) **Diameter**: 6 mm, ap = 0.3 mm,
Deff = 2.6 mm, N = 14,000 (min^{-1})
Slope angle 0°: Veff = 113.7 (m/min)
Slope angle 15°: Veff = 113.7 x 1.5 = 170.6 (m/min)

Notice

- Cutting conditions are up to the machine's condition and the shape of cutting
- Use cutting fluid that is proper to the workpiece and produces few temperature reactions

PBE2000 (Ball)

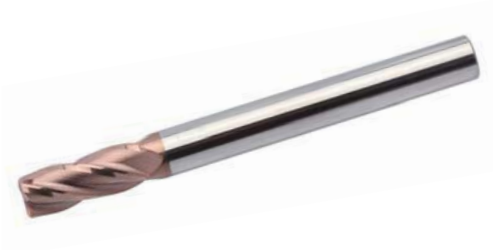


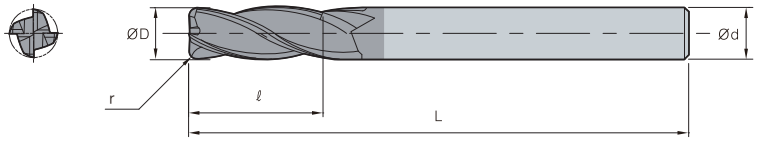
ØD	Tolerance
~Ø5.9	0.00~ -0.015
Ø6.0~	0.00~ -0.025

(mm)

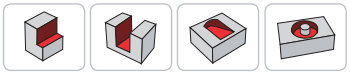
Designation		R	ØD	Ød	ℓ	L
PBE	2005-040	0.25	0.5	6	1	40
	2010-050	0.5	1	6	2.5	50
	2012-050	0.6	1.2	6	3	50
	2015-050	0.75	1.5	6	4	50
	2020-050	1	2	6	5	50
	2025-060	1.25	2.5	6	7	60
	2030-060	1.5	3	6	8	60
	2040-070	2	4	6	8	70
	2050-080	2.5	5	6	10	80
	2060-090	3	6	6	12	90
	2080-100	4	8	8	14	100
	2100-100	5	10	10	18	100
	2120-110	6	12	12	22	110

PRE4000 (Radius)





ØD	Tolerance
~Ø5.9	0.00~ -0.015
Ø6.0~	0.00~ -0.025



(mm)

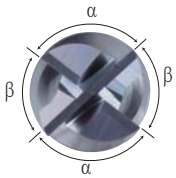
Designation		ØD	Ød	ℓ	L	r
PRE 4	4030-060-R01	3	6	8	60	0.1
	4030-060-R02	3	6	8	60	0.2
	4030-060-R03	3	6	8	60	0.3
	4030-060-R05	3	6	8	60	0.5
	4040-070-R01	4	6	10	70	0.1
	4040-070-R02	4	6	10	70	0.2
	4040-070-R03	4	6	10	70	0.3
	4040-070-R05	4	6	10	70	0.5
	4040-070-R10	4	6	10	70	1
	4060-090-R02	6	6	15	90	0.2
	4060-090-R03	6	6	15	90	0.3
	4060-090-R05	6	6	15	90	0.5
	4060-090-R10	6	6	15	90	1
	4080-100-R02	8	8	20	100	0.2
	4080-100-R03	8	8	20	100	0.3
	4080-100-R05	8	8	20	100	0.5
	4080-100-R10	8	8	20	100	1
	4100-100-R03	10	10	25	100	0.3
	4100-100-R05	10	10	25	100	0.5
	4100-100-R10	10	10	25	100	1
	4120-110-R03	12	12	30	110	0.3
	4120-110-R05	12	12	30	110	0.5
	4120-110-R10	12	12	30	110	1

Improved productivity with effective machining due to less vibration

V Endmill

Variable Endmill

- Irregular helix angle
- Irregular indexing angle



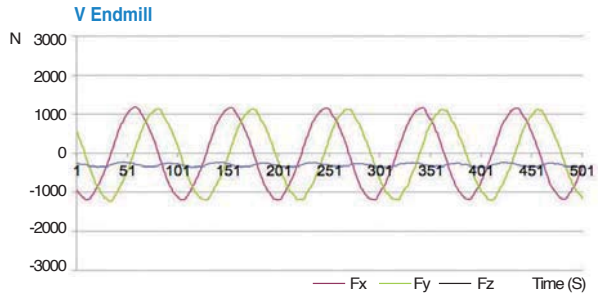
※ Irregular flute spacing = Decreased vibration by setting up cutting edges position variably

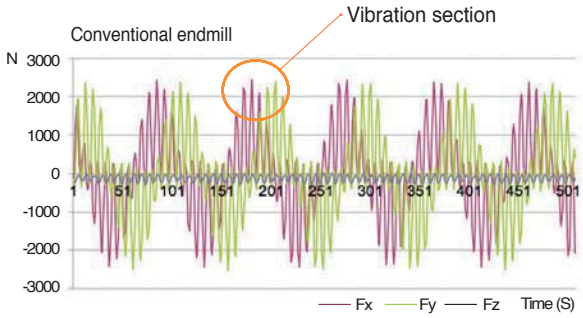
Features

- 30% increased cutting speed (vc) and feed rate (vf) to boost productivity
- High quality machining is ensured thanks to minimized tool vibrations and excellent surface finish

Performance (Vibration test)

- **Workpiece** SCM440
- **Cutting condition** D = Ø8.0, n (m/min) = 3183, vc (m/min) = 80, vf (mm/min) = 713, fz (mm/t) = 0.055, ap (mm) = 8.0, ae (mm) = 8, dry
- **Tools** V Endmill VFE4080-060, Conventional endmill

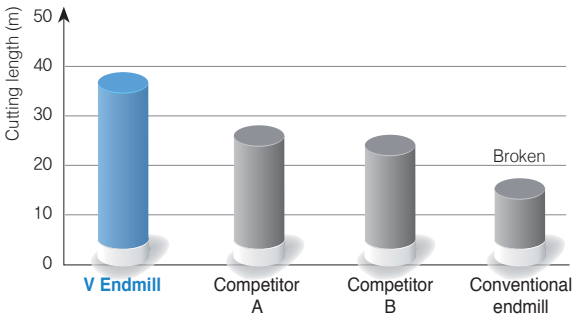




Performance (Surface finish)

- **Workpiece** STS304
- **Cutting condition** D = Ø8.0, n (min^{-1}) = 3979, vc (m/min) = 100, vf (mm/min) = 796, fz (mm/t) = 0.05, ap (mm) = 12, ae (mm) = 0.8, dry
- **Tools** VFE4080-060

Edge			
Surface finish			
Division	V Endmill	Competitor A Irregular flute spacing endmill	Competitor B Irregular flute spacing endmill

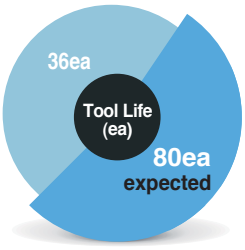


Application examples

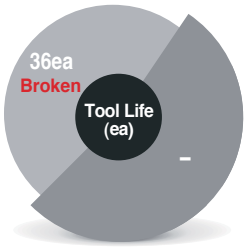
- **Workpiece** SNCM439 (HRC 43~45)
- **Cutting condition** D = Ø8.0, n (m/min) = 6000, vc (m/min) = 150, vf (mm/min) = 600, fz (mm/t) = 0.025, ap (mm) = 7, ae (mm) = 0.8, wet (Water-soluble)
- **Tools** VFE4080-060

V Endmill

Conventional endmill



V Endmill(VFE4080)



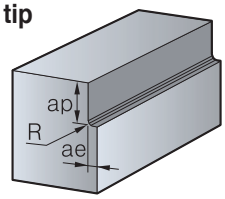
Conventional endmill

Recommended cutting conditions

■ Shouldering

Diameter (ØD)	Alloy & Carbon steel, HRC25 or less (SM, SCM)				Mold steel, HRC35~45 (STS, KP4M)			
	R.P.M (min^{-1})	Feed (mm/min)	ap (mm)	ae (mm)	R.P.M (min^{-1})	Feed (mm/min)	ap (mm)	ae (mm)
2.5	15,915	1,241	3.8	0.7	12.732	891	0.3	0.3
3.0	13,263	1,241	4.5	0.8	10,610	891	0.3	0.3
3.5	11,368	1,241	5.3	0.9	9,095	891	0.4	0.4
4.0	9,947	1,241	6.0	1.1	7,958	891	0.4	0.4
5.0	7,958	1,241	7.5	1.4	6,366	891	0.5	0.5
6.0	6,631	1,241	9.0	1.6	5,305	891	0.6	0.6
7.0	5,684	1,241	10.5	1.9	4,547	891	0.7	0.7
8.0	4,974	1,194	12.0	2.2	3,979	891	0.8	0.8
9.0	4,421	1,194	13.5	2.4	3,537	891	0.9	0.9
10.0	3,979	1,194	15.0	2.7	3,183	891	1.0	1.0
12.0	3,316	1,194	18.0	3.2	2,653	891	1.2	1.2
14.0	2,842	1,194	21.0	3.8	2,274	891	1.4	1.4
16.0	2,487	1,194	24.0	4.3	1,989	891	1.6	1.6

Application tip



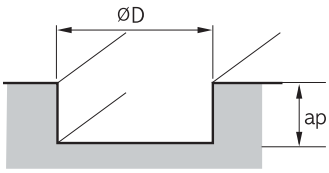
※ Cutting condition by overhang

1. Standard overhang: Follow cutting condition above
2. Long overhang: When the overhang is increased by 10 mm, decrease feed 5% & ae 5%

■ Slotting

Diameter (ØD)	Alloy & Carbon steel, HRC25 or less (SM, SCM)			Mold steel, HRC35~45 (STS, KP4M)		
	R.P.M (min^{-1})	Feed (mm/min)	ap (mm)	R.P.M (min^{-1})	Feed (mm/min)	ap (mm)
2.5	15.915	1,035	2.8	12,732	700	2.5
3.0	13,263	1,035	3.3	10,610	700	3.0
3.5	11,268	1,035	3.9	9,095	700	3.5
4.0	9,947	1,035	4.4	7,958	700	4.0
5.0	7,958	1,035	5.5	6,366	700	5.0
6.0	6,631	1,035	6.6	5,305	700	6.0
7.0	5,687	1,035	7.7	4,549	700	7.0
8.0	4,974	1,035	8.8	3,979	700	8.0
9.0	4,421	1,035	9.9	3,537	700	9.0
10.0	3,979	1,035	11.0	3,183	700	10.0
12.0	3,316	1,035	13.2	2,653	700	12.0
14.0	2,842	1,035	15.4	2,274	700	14.0
16.0	2,487	1,035	17.6	1,989	700	16.0

Application tip



※ Cutting condition by overhang

1. Standard overhang: Follow cutting condition above
2. Long overhang: When the overhang is increased by 10 mm, decrease feed 5% & ae 5%

VFE4000 (Flat)

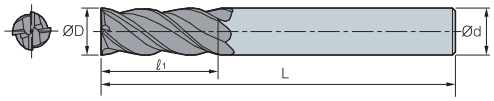


Fig. 1

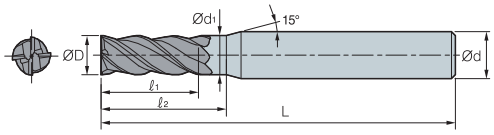


Fig. 2

4 | H·A 40°/43° | h6 shank | Substrate PC215F

ØD	Tolerance
Ø2.5~Ø9	0.00~ -0.02
Ø10~Ø16	0.00~ -0.03

(mm)

Designation		ØD	Ød	d1	ℓ1	ℓ2	L	Fig.
VFE 4	4025-045	2.5	6.0	2.48	6.0	8.0	45	2
	4030-050	3.0	6.0	2.98	7.0	9.5	50	2
	4035-050	3.5	6.0	3.48	8.0	11.0	50	2
	4040-050	4.0	6.0	3.98	9.0	12.0	50	2
	4050-050	5.0	6.0	4.98	12.0	16.0	50	2
	4060-050	6.0	6.0	-	14.0	-	50	1
	4070-060	7.0	8.0	6.97	16.0	21.0	60	2
	4080-060	8.0	8.0	-	19.0	-	60	1
	4090-070	9.0	10.0	8.97	20.0	27.0	70	2
	4100-075	10.0	10.0	-	23.0	-	75	1
	4120-080	12.0	12.0	-	27.0	-	80	1
	4140-085	14.0	14.0	-	31.0	-	85	1
	4160-090	16.0	16.0	-	36.0	-	90	1

Fine performance and high quality Endmill for general cutting

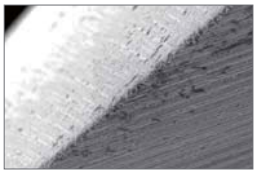
Z Endmill new

- Endmill for general cutting of various workpieces under HRC45 (carbon steel, alloy steel, cast iron, pre-hardened steel, etc.)
- New shape and coating improves performance and tool life
- Optimized edge design for less chipping and stable machining

Features

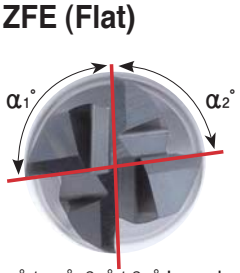
- New grade (PC315E) - Fine substrate and lubricative coating guarantee excellent performance at high speed and high temperature
- Special edge treatment - Special cutting-edge design was applied for less chipping and longer tool life
- High accuracy with tolerance-h5 - High quality production system enables tolerance-h5 throughout the whole series

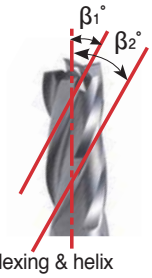
After special edge treatment



before

ZFE (Flat)

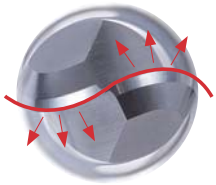




$\alpha_1^\circ \neq \alpha_2^\circ$, $\beta_1^\circ \neq \beta_2^\circ$ Irregular indexing & helix

- Irregular indexing & helix prevent chattering and improve surface

ZBE (Ball)



Cutting load is dispersed

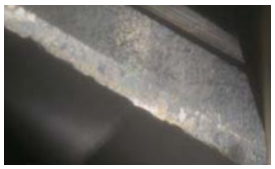
S shape of ball

- The S shape of ball disperses cutting loads
- The tolerance of ball R is under ±0.005 mm

Application examples

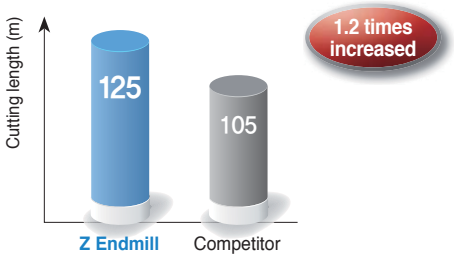
- **Workpiece** Carbon steel (SM45C, ~ HRC20)
- **Cutting condition** D = Ø8.0, n (min^{-1}) = 7,165, vc (m/min) = 180, vf (mm/min) = 1.433, fz (mm/t) = 0.05, ap (mm) = 8, ae (mm) = 0.8, dry
- **Tools** ZFE4080-070

Z Endmill



Competitor

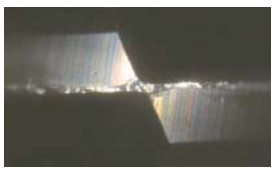
■ Test result



- Cutting edge treatment for less chipping

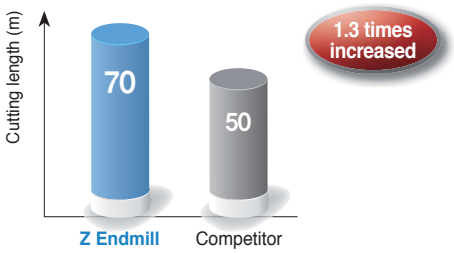
- **Workpiece** Carbon steel (SM45C, ~ HRC20)
- **Cutting condition** D = Ø8.0, n (min^{-1}) = 5,175, vc (m/min) = 130, vf (mm/min) = 1.035, fz (mm/t) = 0.1, ap (mm) = 0.5, ae (mm) = 1.6, dry
- **Tools** ZFE2080-100

Z Endmill



Competitor

■ Test result

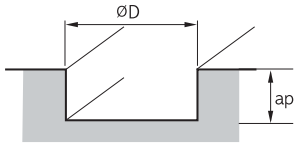


- New grade improves wear resistance

Recommended cutting conditions (ZFE2000/ZSFE2000 Flat)

Workpiece / Condition / Diameter (Ø)	Alloy steel & carbon steel (under HRC30)		Pre-hardened steel (HRC30~45)		Stainless steel	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
1	19,745	175	13,057	100	10,500	70
2	11,560	190	7,560	120	6,300	90
3	8,920	210	5,560	140	4,620	120
4	7,560	300	4,620	180	3,880	150
5	6,300	320	3,780	190	3,160	160
6	5,560	350	3,360	220	2,840	180
8	4,200	380	2,520	200	2,100	180
10	3,260	330	2,000	160	1,680	160
12	2,740	280	1,680	130	1,360	130
16	2,200	220	1,360	110	1,060	110

Application tip



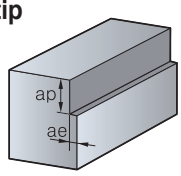
■ Slotting depth (ap)
- D ≤ Ø3 (ap = 0.2D)
- D > Ø3 (ap = 0.5D)

※ Workpiece should be clamped rigidly. In case of vibration, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (ZFE4000/ZSFE4000 Flat)

Workpiece / Condition / Diameter (Ø)	Alloy steel & carbon steel (under HRC30)		Pre-hardened steel (HRC30~45)		Stainless steel	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
2	11,560	280	7,560	170	6,300	140
3	8,920	320	5,560	200	4,620	170
4	7,560	570	4,620	350	3,880	280
5	6,300	600	3,780	360	3,160	300
6	5,560	660	3,360	410	2,840	330
8	4,200	710	2,520	380	2,100	350
10	3,260	610	2,000	300	1,680	300
12	2,740	520	1,680	250	1,360	240
16	2,200	410	1,360	200	1,100	200

Application tip



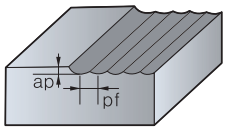
■ Shouldering depth (ap) and radial depth (ae)
- ap = 1.0D
- ae = 0.05D

※ Workpiece should be clamped rigidly. In case of vibration, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (ZBE2000 Ball)

Workpiece / Condition / Diameter (Ø)	Alloy steel & carbon steel (under HRC30)		Pre-hardened steel (HRC30~45)	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
1	30,000	2,880	30,000	2,520
1.2	30,000	3,060	28,800	2,580
1.5	30,000	3,240	28,800	2,700
2	29,820	3,420	28,680	2,880
3	19,860	3,600	19,080	3,180
4	14,940	3,600	14,340	3,180
5	11,160	3,480	10,680	2,940
6	8,340	2,910	8,040	2,460
8	6,660	2,520	6,420	2,100
10	5,580	2,220	5,340	1,860
12	4,170	1,770	4,008	1,500

Application tip

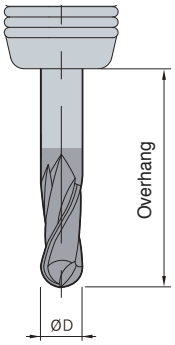


- ap = 0.03D
- pf = 0.05D

※ Workpiece should be clamped rigidly. In case of vibration, reduce R.P.M and feed rate by the same ratio

Cutting condition by overhang

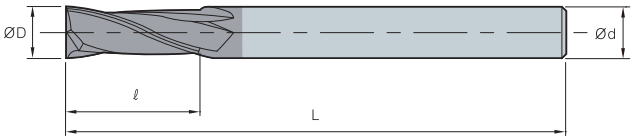
- For shank taper type, Cutting conditions are based on the case of being clamped at neck part
  - When the overhang is increased by 1D in comparion to the overhang, decrease R.P.M and feed by 10%
- In case of the straight type adjust conditions according to the overhang
  - Ex: When the overhang is 3D and is increased by 1D, decrease R.P.M and feed by 10%



Notice

- Cutting conditions are up to the machine's condition and the shape of cutting
- Use cutting fluid that is proper to the workpiece and produces few temperature reactions

ZFE2000 (Flat)

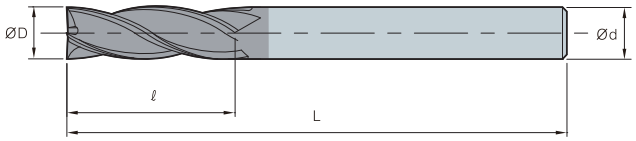


ØD	Tolerance
~Ø5.9	0.00~ -0.015
Ø6.0~	0.00~ -0.025

(mm)

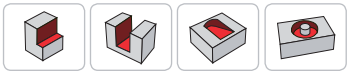
Designation		ØD	Ød	ℓ	L
ZFE 2	2010-050-S4	1	4	2.5	50
	2010-050-S6	1	6	2.5	50
	2012-050-S4	1.2	4	3	50
	2012-050-S6	1.2	6	3	50
	2015-050-S4	1.5	4	4	50
	2015-050-S6	1.5	6	4	50
	2020-050-S4	2	4	6	50
	2020-050-S6	2	6	6	50
	2025-050-S4	2.5	4	7.5	50
	2025-050-S6	2.5	6	7.5	50
	2030-050-S4	3	4	9	50
	2030-050-S6	3	6	9	50
	2035-050	3.5	6	10	50
	2040-050-S4	4	4	11	50
	2040-050-S6	4	6	11	50
	2045-050	4.5	6	14	50
	2050-060	5	6	15	60
	2055-060	5.5	6	15	60
	2060-060	6	6	15	60
	2065-060	6.5	8	18	60
	2070-060	7	8	20	60
	2075-060	7.5	8	20	60
	2080-070	8	8	20	70
	2085-070	8.5	10	22	70
	2090-070	9	10	22	70
	2095-070	9.5	10	24	70
	2100-075	10	10	25	75
	2120-080	12	12	30	80
	2140-100	14	14	35	100
	2160-100	16	16	40	100

ZFE4000 (Flat)



4 | Multiple H·A | h5 shank | Substrate PC315E

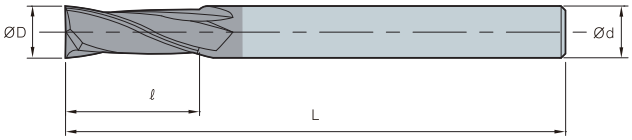
ØD	Tolerance
~Ø5.9	0.00~ -0.015
Ø6.0~	0.00~ -0.025



(mm)

Designation		ØD	Ød	ℓ	L
ZFE 4	4010-050-S4	1	4	2.5	50
	4010-050-S6	1	6	2.5	50
	4012-050-S4	1.2	4	3	50
	4012-050-S6	1.2	6	3	50
	4015-050-S4	1.5	4	4	50
	4015-050-S6	1.5	6	4	50
	4020-050-S4	2	4	6	50
	4020-050-S6	2	6	6	50
	4025-050-S4	2.5	4	7.5	50
	4025-050-S6	2.5	6	7.5	50
	4030-050-S4	3	4	9	50
	4030-050-S6	3	6	9	50
	4035-050	3.5	6	10	50
	4040-050-S4	4	4	11	50
	4040-050-S6	4	6	11	50
	4045-050	4.5	6	14	50
	4050-060	5	6	15	60
	4055-060	5.5	6	15	60
	4060-060	6	6	15	60
	4065-060	6.5	8	18	60
	4070-060	7	8	20	60
	4075-060	7.5	8	20	60
	4080-070	8	8	20	70
	4085-070	8.5	10	22	70
	4090-070	9	10	22	70
	4095-070	9.5	10	24	70
	4100-075	10	10	25	75
	4120-080	12	12	30	80
	4140-100	14	14	35	100
	4160-100	16	16	40	100

ZSFE2000/4000 (Short flat)

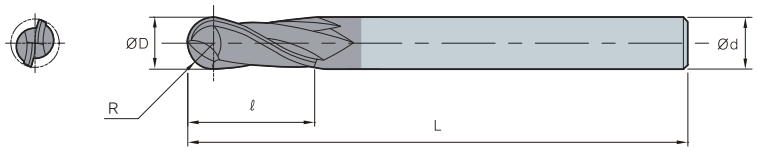


ØD	Tolerance
~Ø5.9	0.00~ -0.015
Ø6.0~	0.00~ -0.025

(mm)

Designation		ØD	Ød	ℓ	L
ZSFE 2	2010-040-S4	1	4	1.5	40
	2010-040-S6	1	6	1.5	40
	2012-040-S4	1.2	4	1.5	40
	2012-040-S6	1.2	6	1.5	40
	2015-040-S4	1.5	4	2.2	40
	2015-040-S6	1.5	6	2.2	40
	2020-040-S4	2	4	3	40
	2020-040-S6	2	6	3	40
	2025-040-S4	2.5	4	4	40
	2025-040-S6	2.5	6	4	40
	2030-045-S4	3	4	4.5	45
	2030-045-S6	3	6	4.5	45
	2040-045-S4	4	4	6	45
	2040-045-S6	4	6	6	45
	2060-050	6	6	9	50
	2080-060	8	8	12	60
	2100-065	10	10	15	65
	2120-070	12	12	18	70
ZSFE 4	4010-040-S4	1	4	1.5	40
	4010-040-S6	1	6	1.5	40
	4012-040-S4	1.2	4	1.5	40
	4012-040-S6	1.2	6	1.5	40
	4015-040-S4	1.5	4	2.2	40
	4015-040-S6	1.5	6	2.2	40
	4020-040-S4	2	4	3	40
	4020-040-S6	2	6	3	40
	4025-040-S4	2.5	4	4	40
	4025-040-S6	2.5	6	4	40
	4030-045-S4	3	4	4.5	45
	4030-045-S6	3	6	4.5	45
	4040-045-S4	4	4	6	45
	4040-045-S6	4	6	6	45
	4060-050	6	6	9	50
	4080-060	8	8	12	60
	4100-065	10	10	15	65
	4120-070	12	12	18	70

ZBE2000 (Ball)



2 | H·A 30° | h5 shank | Substrate PC315E

ØD	Tolerance
~Ø5.9	0.00~ -0.015
Ø6.0~	0.00~ -0.025

(mm)

Designation		R	ØD	Ød	ℓ	L
ZBE 2	2010-050-S4	0.5	1	4	2.5	50
	2010-050-S6	0.5	1	6	2.5	50
	2012-050-S4	0.6	1.2	4	3	50
	2012-050-S6	0.6	1.2	6	3	50
	2015-050-S4	0.75	1.5	4	4	50
	2015-050-S6	0.75	1.5	6	4	50
	2020-050-S4	1	2	4	5	50
	2020-050-S6	1	2	6	5	50
	2025-060-S4	1.25	2.5	4	6	60
	2025-060-S6	1.25	2.5	6	6	60
	2030-060-S4	1.5	3	4	8	60
	2030-060-S6	1.5	3	6	8	60
	2035-070	1.75	3.5	6	8	70
	2040-070-S4	2	4	4	8	70
	2040-070-S6	2	4	6	8	70
	2045-080	2.25	4.5	6	9	80
	2050-080	2.5	5	6	10	80
	2055-090	2.75	5.5	6	11	90
	2060-090	3	6	6	12	90
	2065-090	3.25	6.5	8	13	90
	2070-090	3.5	7	8	14	90
	2080-100	4	8	8	14	100
	2085-100	4.25	8.5	10	16	100
	2090-100	4.5	9	10	18	100
	2100-100	5	10	10	18	100
	2120-110	6	12	12	22	110

High efficiency and high feed machining

F Endmill

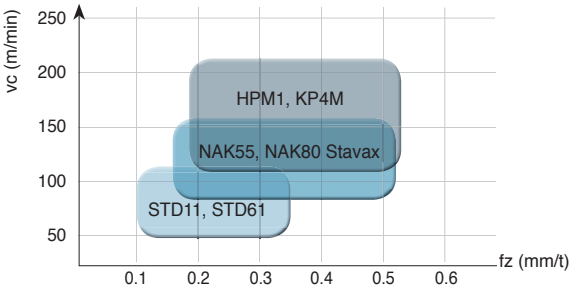
Feed-up Endmill

- Improved productivity and shortened working time thanks to high feed capability
- Manufacturing cost reduction could be expected as it enables to apply highly efficient machining

Feature

- Highly efficient operation by setting up wider chip pocket area
- High feed machining is possible by dispersing cutting forces

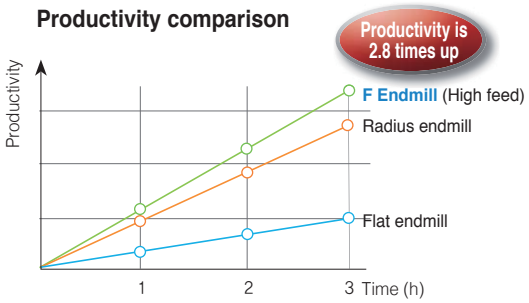
Application by workpiece



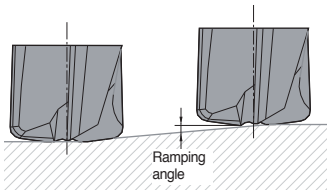
Productivity example

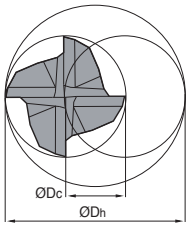
Type	Speed (vc)	Feed (fz)	D.O.C		Machining volume (mm^3/min)
			ap	ae	
F Endmill (High feed)	180	0.30	0.5	5.0	135,000
Radius endmill	200	0.09	1.0	5.0	90,000
Flat endmill	120	0.05	8.0	0.2	48,000

Higher productivity by feed increase. 2.8 times

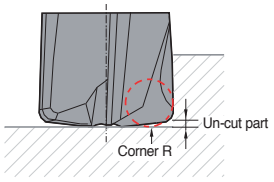


Programing information

Ramping	Ramping angle	Feed
	1°	100%
	2°	80%
	3°	60%
	4°	50%

Helical	Diameter (ØD)	Min. diameter	Max. diameter
	6	7.8	12
	8	10.2	16
	10	12.4	20
	12	14.9	24

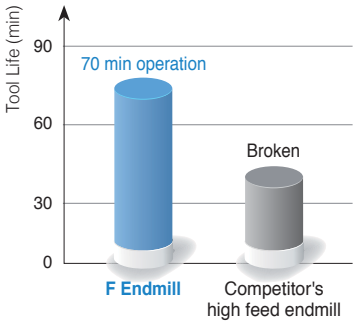
∗ ØDc: Feed(Tool center) ∗ ØDh: Machining area

CAM Ramping	Diameter (ØD)	Endmill-R	CAM-Radius	Un-cut part
	6	0.5	0.7	0.21
	8	0.5	0.8	0.32
	10	1.0	1.3	0.36
	12	1.2	1.6	1.45

Application examples

- **Workpiece** STD61+SKT (HRC45~50)
- **Cutting condition** D = Ø12, n (min^{-1}) = 4000, vc (m/min) = 150.8, vf (mm/min) = 4000, fz (mm/t) = 0.25, ap (mm) = 3.6, ae (mm) = 0.6, dry
- **Tools** FME4120-075-R12

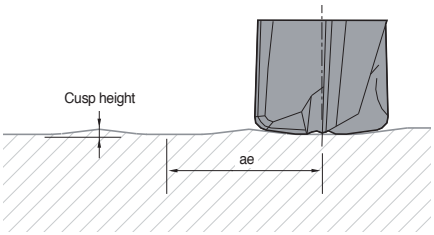
■ **Test result**



Recommended cutting conditions

Cusp height by radial depth of cut

Diameter (ØD)	Radial depth ae (mm)					
	0.1xD	0.2xD	0.3xD	0.4xD	0.5xD	0.6xD
6	0	0	0	0.02	0.06	0.11
8	0	0	0	0.04	0.10	0.15
10	0	0	0.01	0.07	0.14	0.21
12	0	0	0.01	0.08	0.17	0.25



Medium cut

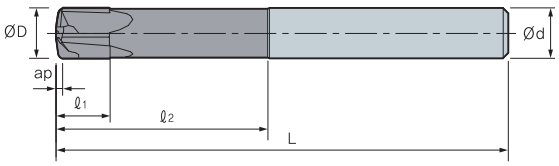
Diameter (ØD)	Mold steel HRC35~45 (HPM1, KP4M)				Mold steel HRC45~55 (NAK55, NAK80, STAVAX)				Heat treated steel HRC55~ (SKD11, STD61)			
	RPM n (min^{-1})	Feed vf (mm/min)	ap (mm)	ae (mm)	RPM n (min^{-1})	Feed vf (mm/min)	ap (mm)	ae (mm)	RPM n (min^{-1})	Feed vf (mm/min)	ap (mm)	ae (mm)
6	11,600	11,200	0.24	1.6	9,000	7,570	0.21	1.6	5,800	3,500	0.18	1.6
8	8,700		0.32	2.2	6,700		0.28	2.2	4,300		0.24	2.2
10	7,000		0.40	2.7	5,400		0.35	2.7	3,500		0.30	2.7
12	5,800		0.48	3.3	4,500		0.42	3.3	2,900		0.36	3.3

Roughing cut

Diameter (ØD)	Mold steel HRC35~45 (HPM1, KP4M)				Mold steel HRC45~55 (NAK55, NAK80, STAVAX)				Heat treated steel HRC55~ (SKD11, STD61)			
	RPM n (min^{-1})	Feed vf (mm/min)	ap (mm)	ae (mm)	RPM n (min^{-1})	Feed vf (mm/min)	ap (mm)	ae (mm)	RPM n (min^{-1})	Feed vf (mm/min)	ap (mm)	ae (mm)
6	8,488	9,167	0.27	3.0	6,366	6,112	0.24	3.0	4,244	2,546	0.21	3.0
8	6,366		0.36	4.0	4,775		0.32	4.0	3,183		0.28	4.0
10	5,093		0.45	5.0	3,820		0.40	5.0	2,546		0.35	5.0
12	4,244		0.54	6.0	3,183		0.48	6.0	2,122		0.42	6.0

* Cutting condition by overhang
1. Standard overhang: Follow cutting conditions above
2. Long type: Apply 80% feed & 80% ae
3. Long overhang: When the overhang is increased by 10 mm from the standrad items, decrease feed 5% & ae 5%

FME4000 (High feed)

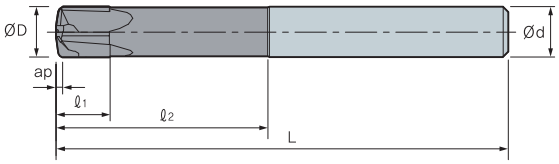


ØD	Tolerance
Ø6~Ø12	-0.01~ -0.03

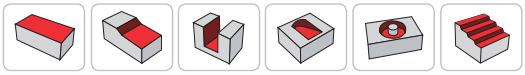
(mm)

Designation		R	ØD	Ød	ℓ1	ℓ2	L	Max. ap (mm)	CAM-Radius
FME	4060-050-R05	0.5	6	6	4.5	18	50	0.35	0.7
4	4080-060-R05	0.5	8	8	6	24	60	0.45	0.8
	4100-070-R10	1.0	10	10	7.5	30	70	0.65	1.3
	4120-075-R12	1.2	12	12	9	36	75	0.78	1.6

FMLE4000 (High feed long)



ØD	Tolerance
Ø6~Ø12	-0.01~ -0.03



(mm)

Designation		R	ØD	Ød	ℓ1	ℓ2	L	Max. ap (mm)	CAM-Radius
FMLE	4060-090-R05	0.5	6	6	4.5	30	90	0.35	0.7
4	4080-090-R05	0.5	8	8	6	40	90	0.45	0.8
	4100-100-R10	1.0	10	10	7.5	50	100	0.65	1.3
	4120-110-R12	1.2	12	12	9	60	110	0.78	1.6

Endmill for machining dental prostheses

T Endmill new

- For machining dental prostheses made of zirconia, titanium, Co-Cr, wax, PMMA, etc
- Optimized cutting performance by matching a proper grade with each type of materials
- Inhibited unevenness and excellent finish in machined surfaces due to the optimized cutting-edge design
- Specialized tool shape for each machine type

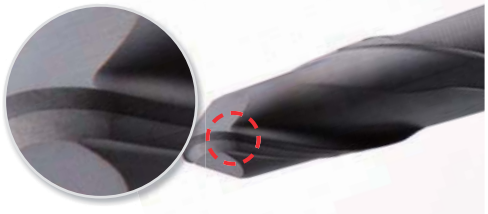
Code system

T Z BE 2 030 - 050 - N100 S04 (Z-MATCH)

- **T Endmill**
- **Workpiece**: Z: Zirconia; T: Ti/Co-Cr; W: Wax/PMMA
- **Type**: BE: Ball Endmill; FE: Flat Endmill; RE: Radius Endmill
- **No. of flutes**: 2: 2 Flute
- **Drill dia.**: 030: 3 mm
- **Overall length**: 050: 5 mm
- **Neck length**: N100: 10 mm
- **Shank dia.**: S04: 4 mm
- **Machine Maker**

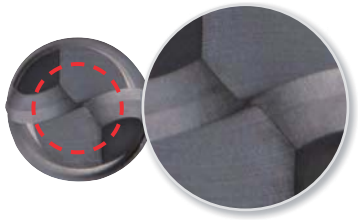
Features

- A dedicated tool for each machine - Meets marketplace demands
- A specialized grade for each workpiece - Provides optimized performance for various materials of implants
- Optimized cutting-edge design - Enables excellent machinability



Tangential cutting-edge shape

- One-Pass Grinding applied
- Inhibited unevenness and excellent finish in machined surfaces



Center-Matched ball shape

- Optimized center shape ensures relief angle at the ball point
- Cutting edges of the ball point shape provide excellent wear resistance and cutting performance

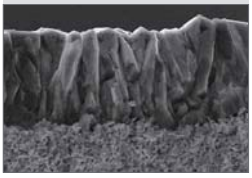
Grade solution for zirconia

- **Development of ND3000 (Diamond-coated grade)**
  - High hardness diamond coating that is excellent in machining graphite and ceramic
  - Optimized for high speed and medium duty cutting thanks to its excellent grip to coated layers

Surface of ND3000

High hardness diamond coating (Hv 10,000) provides excellent wear resistance

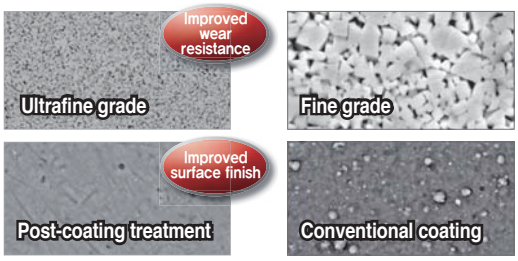
Cross section of coated layers



Specialized grade for Zirconia provides excellent adhesion

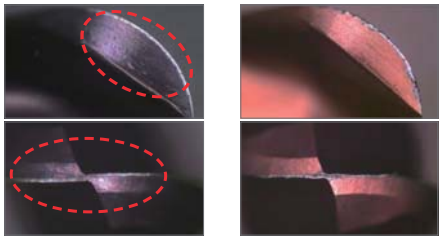
Grade solution for titanium

- **Development of PC2510 (Coated grade for high hardened steel)**
  - Post-coating treatment was applied to improve surface finish
  - A grade optimized for interrupted machining of high hardness steels and wet treatment accompanying high thermal shock. Its ultrafine substrate features high toughness which allows stable performance



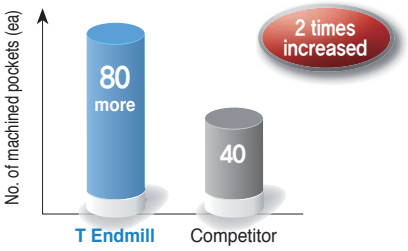
Performance evaluation

- **Workpiece** Co-Cr
- **Cutting conditions** vc (m/min) = 150, fz (mm/t) = 0.08, ap (mm) = 0.13, ae (mm) = 0.7, wet
- **Tools** TTBE2030-050



T Endmill | Competitor

■ Test result

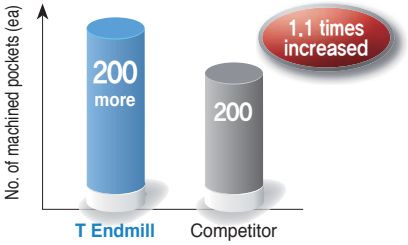


Excellent resistance to toughness and wear thanks to the new grade PC2510

Application examples

- **Use** Implant crowns
- **Workpiece** Zirconia
- **Cutting conditions** vc (m/min) = 140, fz (mm/t) = 0.05, ae (mm) = 0.6, dry
- **Tools** TZBE2020-044-N200S03 (DOF)

■ Test result



Recommended cutting conditions (Titanium & Co-Cr)

Diameter (Ø)	Application	ap (mm)	ae (mm)	n (min^{-1})	vf (mm/min)
3.0	Roughing	0.12	0.7	10,500	1,150
2.5	Medium	0.08	0.53	11,500	850
2.0	Medium	0.08	0.42	14,500	850
1.5	Finishing	0.04	0.32	19,000	850
1.0	Finishing	0.02	0.07	28,500	850
0.6	Finishing	0.02	0.07	28,500	850

Recommended cutting conditions for zirconia

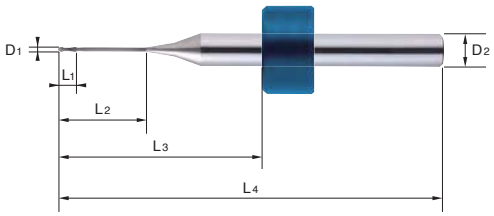
Diameter (Ø)	Application	ap (mm)	ae (mm)	n (min^{-1})	vf (mm/min)
3.0	Roughing	0.5	1.5	23,500	1,600
2.5	Medium	0.3	1.25	28,000	1,200
2.0	Finishing	0.3	1.0	35,000	1,200
1.0	Finishing	0.1	0.2	38,500	1,050
0.6	Finishing	0.1	0.2	63,500	630

Special T Endmill order form

• Stop rings and other tool resources can be made to order

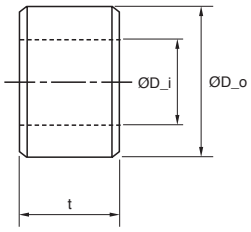
[Data sheet]

Type of machine	
Workpiece	
Dental material	
Cutting diameter (D_1)	
Shank diameter (D_2)	
Cutting length (L_1)	
Neck length (L_2)	
Stop ring position (L_3)	
Overall length (L_4)	
Stop ring shape	

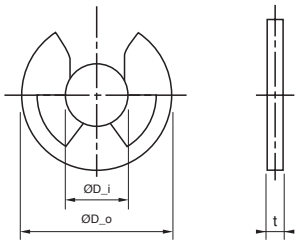


※ Should you make a special order, please complete this form and send it to an adjacent KORLOY sales office

[Stop ring specification]



< Plastic ring >



< E type ring >

(mm)

Type	Stop ring			Shank diameter		
	ØD_o	ØD_i	t	Ø3	Ø4	Ø6
Plastic ring	Ø7.55	Ø3	4.45	●		
	Ø7.7	Ø4	5.0		●	
	Ø10.5	Ø6	6.5			●
E type ring	Ø6.0	Ø2.5	0.4	●		

※ Stop ring can be made to order when specified sizes are send to an adjacent KORLOY sales office

Diamond coated endmill

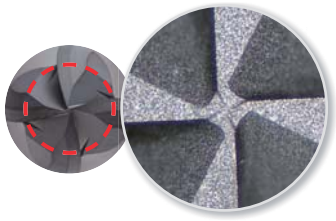
D Endmill new

- Tangential cutting-edge geometries for excellent surface finish
- Excellent wear resistance due to high hardness and high purity diamond coating
- Advanced surface finish and cutting performance thanks to sharp edges and tangential tool geometries

Features

Tangential cutting-edge geometries

- One-Pass grinding system
- Prevents stepped cone on the machined surface
- 2-flutes and 4-flutes tooling with a ball nose

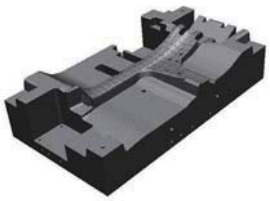


Center-matched ball shape (4-flutes)

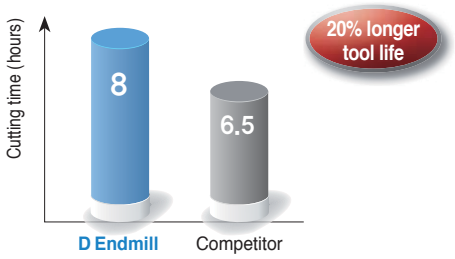
- Ball point shape for high feed machining
- Improved rigidity and excellent surface finish

Application examples

- **Workpiece** Graphite mold
- **Cutting conditions** vc (m/min) = 100, fz (mm/t) = 0.11, ap (mm) = 0.26, dry
- **Tools** DBE4060-110-N250S06

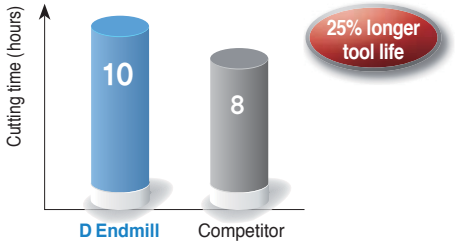


■ **Test result**



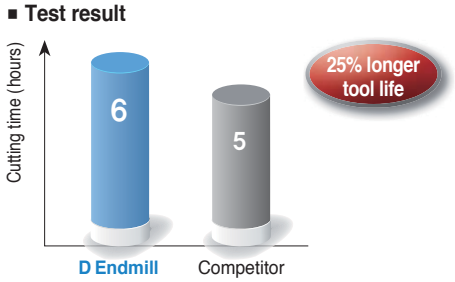
- **Workpiece** Graphite mold
- **Cutting conditions** vc (m/min) = 180, fz (mm/t) = 0.1, ap (mm) = 0.2, dry
- **Tools** DBE2060-110-N250S06

■ **Test result**



- **Workpiece** Graphite mold
- **Cutting conditions** vc (m/min) = 300, fz (mm/t) = 0.1, ap (mm) = 0.15, dry
- **Tools** DBE2060-080-N250S06

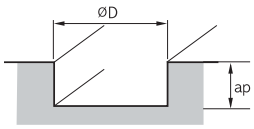
■ **Test result**



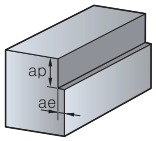
Recommended cutting conditions (Flat)

Tool	DFE2000 (Slotting)		DFE2000 (Shouldering)		DFE4000 (Shouldering)	
Workpiece	Graphite					
Conditions / Diameter (Ø)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
1	40,000	500	40,000	700	-	-
2	25,000	570	25,000	800	25,000	1,600
3	20,000	570	20,000	800	20,000	1,600
4	18,000	680	18,000	950	18,000	1,900
5	14,000	960	14,000	1,200	14,000	2,400
6	11,000	1,000	11,000	1,400	11,000	2,800
8	8,000	930	8,000	1,300	8,000	2,600
10	6,500	860	6,500	1,200	6,500	2,400
12	5,500	860	5,500	1,200	5,500	2,400

Application tip



■ **Slotting depth (ap)**
- D ≤ Ø2.5, ap = 0.3D
- D > Ø2.5, ap = 0.5D



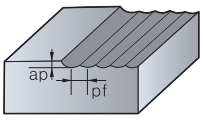
■ **Shouldering depth (ap)**
- D ≤ Ø2.5, ap = 1.5D, ae = 0.05D
- D > Ø2.5, ap = 1.5D, ae = 0.1D

※ Workpiece should be clamped rigidly In case of vibrations, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (Ball)

Tool	DBE2000		DBE4000	
Workpiece	Graphite			
Conditions / Diameter (Ø)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
1	16,000	400	-	-
2	16,000	800	16,000	1,200
3	16,000	1,450	16,000	2,000
4	16,000	2,100	16,000	3,100
5	15,500	2,550	15,000	3,800
6	15,000	2,950	15,000	4,400
8	13,000	3,000	13,000	4,500
10	11,500	3,000	12,000	4,600
12	10,700	3,200	10,000	4,700

Application tip



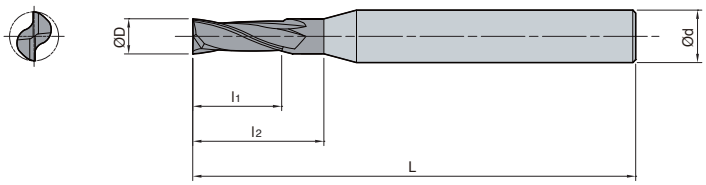
■ **Depth of cut (ap)**
- ap = 0.2D
- pf = 0.2D

※ Workpiece should be clamped rigidly In case of vibrations, reduce R.P.M and feed rate by the same ratio

Notice

- Cutting conditions are up to the machine's condition and the shape of cutting
- Workpiece should be clamped rigidly. In case of vibrations, reduce RPM and feed rate by the same ratio
- When the overhang is longer than 3D, reduce RPM and feed rate

DFE2000 (Flat)



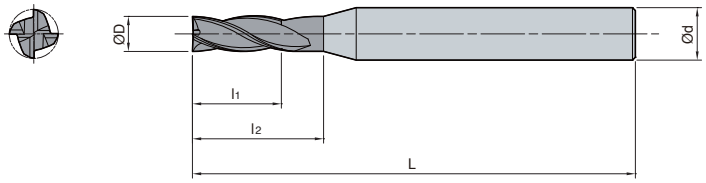
2 | H·A 30° | Substrate ND3000 | h6 shank

ØD	Tolerance
~Ø5.9	0.00~ -0.02
Ø6.0~	0.00~ -0.03

(mm)

Designation		ØD	Ød	l_1	l_2	L
DFE 2	2010-045-N050S04	1	4	3	5	45
	2010-060-N050S04	1	4	3	5	60
	2010-060-N100S04	1	4	3	10	60
	2010-060-N150S04	1	4	3	15	60
	2010-060-N200S04	1	4	3	20	60
	2010-060-N250S04	1	4	3	25	60
	2015-060-N050S04	1.5	4	4	5	60
	2015-060-N100S04	1.5	4	4	10	60
	2015-060-N150S04	1.5	4	4	15	60
	2015-060-N200S04	1.5	4	4	20	60
	2015-060-N250S04	1.5	4	4	25	60
	2020-045-N080S04	2	4	6	8	45
	2020-080-N080S04	2	4	6	8	80
	2020-080-N100S04	2	4	6	10	80
	2020-080-N150S04	2	4	6	15	80
	2020-080-N200S04	2	4	6	20	80
	2020-080-N250S04	2	4	6	25	80
	2020-080-N300S04	2	4	6	30	80
	2020-080-N400S04	2	4	6	40	80
	2030-050-N100S06	3	6	9	10	50
	2030-080-N100S04	3	4	9	10	80
	2030-080-N200S04	3	4	9	20	80
	2030-080-N250S04	3	4	9	25	80
	2030-080-N300S04	3	4	9	30	80
	2030-080-N400S04	3	4	9	40	80
	2040-050-N160S06	4	6	12	16	50
	2040-080-N160S04	4	4	12	16	80
	2050-060-N200S06	5	6	15	20	60
	2050-110-N200S06	5	6	15	20	110
	2060-060-N180S06	6	6	18	-	60
	2060-110-N250S06	6	6	18	25	110
	2060-150-N250S06	6	6	18	25	150
	2080-070-N250S08	8	8	25	-	70
	2080-150-N400S08	8	8	25	40	150
	2100-080-N300S10	10	10	30	-	80
	2100-150-N500S10	10	10	30	50	150
	2120-080-N350S12	12	12	35	-	80
	2120-150-N600S12	12	12	35	60	150

DFE4000 (Flat)



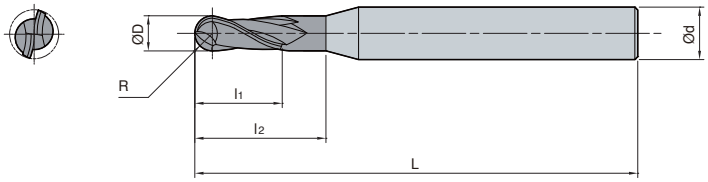
4 | H·A 30° | Substrate ND3000 | h6 shank

ØD	Tolerance
~Ø5.9	0.00~ -0.02
Ø6.0~	0.00~ -0.03

(mm)

Designation		ØD	Ød	l_1	l_2	L
DFE 4	4020-045-N060S04	2	4	6	8	45
	4020-060-N100S04	2	4	10	12	60
	4030-050-N100S06	3	6	10	12	50
	4030-060-N150S04	3	4	15	18	60
	4040-050-N150S06	4	6	15	18	50
	4040-080-N200S04	4	4	20	-	80
	4060-060-N180S06	6	6	18	-	60
	4060-110-N300S06	6	6	30	-	110
	4060-150-N300S06	6	6	30	-	150
	4080-070-N250S08	8	8	25	-	70
	4080-110-N400S08	8	8	40	-	110
	4080-150-N400S08	8	8	40	-	150
	4100-080-N250S10	10	10	25	-	80
	4100-110-N400S10	10	10	40	-	110
	4100-150-N500S10	10	10	50	-	150
	4120-080-N300S12	12	12	30	-	80
	4120-110-N400S12	12	12	40	-	110
	4120-150-N500S12	12	12	50	-	150

DBE2000 (Ball)



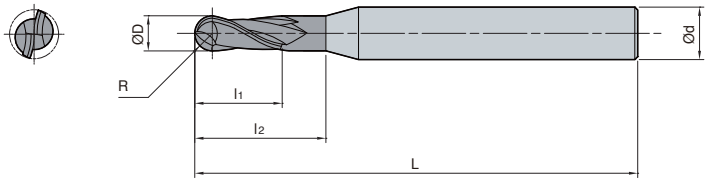
2 | H·A 30° | Substrate ND3000 | h6 shank

ØD	Tolerance
~Ø5.9	0.00~ -0.02
Ø6.0~	0.00~ -0.03

(mm)

Designation		R	ØD	Ød	l_1	l_2	L
DBE 2	2006-045-N020S04	0.3	0.6	4	2	2	45
	2006-045-N050S04	0.3	0.6	4	2	5	45
	2006-045-N080S04	0.3	0.6	4	2	8	45
	2006-045-N100S04	0.3	0.6	4	2	10	45
	2008-045-N030S04	0.4	0.8	4	2.5	3	45
	2008-045-N050S04	0.4	0.8	4	2.5	5	45
	2008-045-N100S04	0.4	0.8	4	2.5	10	45
	2010-060-N030S04	0.5	1	4	3	3	60
	2010-060-N050S04	0.5	1	4	3	5	60
	2010-060-N080S04	0.5	1	4	3	8	60
	2010-060-N100S04	0.5	1	4	3	10	60
	2010-060-N120S04	0.5	1	4	3	12	60
	2010-060-N150S04	0.5	1	4	3	15	60
	2010-060-N200S04	0.5	1	4	3	20	60
	2010-080-N250S04	0.5	1	4	3	25	80
	2010-080-N300S04	0.5	1	4	3	30	80
	2010-080-N350S04	0.5	1	4	3	35	80
	2010-080-N400S04	0.5	1	4	3	40	80
	2015-060-N050S04	0.75	1.5	4	4	5	60
	2015-080-N100S04	0.75	1.5	4	4	10	80
	2015-080-N150S04	0.75	1.5	4	4	15	80
	2015-080-N200S04	0.75	1.5	4	4	20	80
	2015-080-N250S04	0.75	1.5	4	4	25	80
	2015-080-N300S04	0.75	1.5	4	4	30	80
	2015-080-N350S04	0.75	1.5	4	4	35	80
	2015-080-N400S04	0.75	1.5	4	4	40	80
	2020-060-N080S04	1	2	4	6	8	60
	2020-080-N100S04	1	2	4	6	10	80
	2020-080-N150S04	1	2	4	6	15	80
	2020-080-N200S04	1	2	4	6	20	80
	2020-080-N250S04	1	2	4	6	25	80
	2020-080-N300S04	1	2	4	6	30	80
	2020-080-N350S04	1	2	4	6	35	80
	2020-100-N400S04	1	2	4	6	40	100
	2020-100-N450S04	1	2	4	6	45	100
	2020-100-N500S04	1	2	4	6	50	100

DBE2000 (Ball)

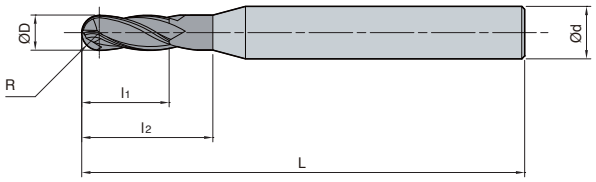


ØD	Tolerance
~Ø5.9	0.00~ -0.02
Ø6.0~	0.00~ -0.03

(mm)

Designation		R	ØD	Ød	l_1	l_2	L
DBE	2030-060-N100S04	1.5	3	4	9	10	60
2	2030-100-N150S04	1.5	3	4	9	15	100
	2030-100-N200S04	1.5	3	4	9	20	100
	2030-100-N250S04	1.5	3	4	9	25	100
	2030-100-N300S04	1.5	3	4	9	30	100
	2030-100-N350S04	1.5	3	4	9	35	100
	2030-100-N400S04	1.5	3	4	9	40	100
	2030-100-N500S04	1.5	3	4	9	50	100
	2040-060-N160S04	2	4	4	12	16	60
	2040-080-N160S04	2	4	4	12	16	80
	2040-080-N300S04	2	4	4	12	30	80
	2040-100-N160S04	2	4	4	12	16	100
	2040-100-N400S04	2	4	4	12	40	100
	2040-130-N160S04	2	4	4	12	16	130
	2040-130-N400S04	2	4	4	12	40	130
	2050-110-N200S06	2.5	5	6	15	20	110
	2060-080-N250S06	3	6	6	20	25	80
	2060-110-N250S06	3	6	6	20	25	110
	2060-150-N300S06	3	6	6	20	30	150
	2080-080-N300S08	4	8	8	25	30	80
	2080-110-N300S08	4	8	8	25	30	110
	2080-150-N500S08	4	8	8	25	50	150
	2080-200-N400S08	4	8	8	25	40	200
	2100-080-N400S10	5	10	10	30	40	80
	2100-110-N400S10	5	10	10	30	40	110
	2100-150-N600S10	5	10	10	30	60	150
	2100-200-N500S10	5	10	10	30	50	200
	2120-110-N500S12	6	12	12	35	50	110
	2120-150-N500S12	6	12	12	35	50	150
	2120-200-N600S12	6	12	12	35	60	200

DBE4000 (Ball)



4 | H·A 30° | Substrate ND3000 | h6 shank

ØD	Tolerance
~Ø5.9	0.00~ -0.02
Ø6.0~	0.00~ -0.03

(mm)

Designation		R	ØD	Ød	l_1	l_2	L
DBE	4020-060-N080S04	1	2	4	6	8	60
4	4020-080-N100S04	1	2	4	6	10	80
	4020-080-N200S04	1	2	4	6	20	80
	4020-080-N300S04	1	2	4	6	30	80
	4020-080-N400S04	1	2	4	6	40	80
	4030-060-N100S04	1.5	3	4	9	10	60
	4030-100-N150S04	1.5	3	4	9	15	100
	4030-100-N200S04	1.5	3	4	9	20	100
	4030-100-N300S04	1.5	3	4	9	30	100
	4030-100-N400S04	1.5	3	4	9	40	100
	4030-100-N500S04	1.5	3	4	9	50	100
	4040-060-N160S04	2	4	4	12	16	60
	4040-080-N160S04	2	4	4	12	16	80
	4040-100-N160S04	2	4	4	12	16	100
	4040-130-N160S04	2	4	4	12	16	130
	4060-080-N250S06	3	6	6	20	25	80
	4060-110-N250S06	3	6	6	20	25	110
	4060-150-N300S06	3	6	6	20	30	150
	4080-080-N300S08	4	8	8	25	30	80
	4080-110-N300S08	4	8	8	25	30	110
	4080-150-N350S08	4	8	8	25	35	150
	4080-200-N400S08	4	8	8	25	40	200
	4100-080-N350S10	5	10	10	30	35	80
	4100-110-N350S10	5	10	10	30	35	110
	4100-150-N400S10	5	10	10	30	40	150
	4100-200-N500S10	5	10	10	30	50	200
	4120-110-N500S12	6	12	12	35	50	110
	4120-150-N500S12	6	12	12	35	50	150
	4120-200-N600S12	6	12	12	35	60	200

Good chip evacuation and fine resistance for built up edge

Solid Endmills for Aluminum

- Good surface finish with miinimized cutting load and built-up edge occurrence
- DLC coating
  - Higher hardness (Hv3000-7000), About 3 to 6 times longer tool life comparing uncoated endmill
  - Fine surface roughness on workpiece with excellent lubricative effect by low friction co-efficient (u < 0.1)
- Superior in Aluminum, Aluminum alloys, Copper and Copper alloys

Features of copper & aluminum machining

- Built-up edge is easily generated though the workpiece has low cutting resistance and chip-removal is fine
- As it has high coefficient of thermal expansion, deflection degree due to machining heat is huge, and it also influences to workpiece quality and residual stress
- While machining, chips can easily damage on the workpiece's surface as the workpice has low hardness, and tool life is over due to flank wear in general

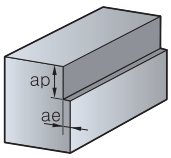
Trouble shooting for copper & aluminum machining

- Use a higher rake angled tool with sharper edges, and minimizes cutting load and built-up edge generating by using oil (MQL) mist
- Increase Vc and reduce the depth of cut for a better surface finish and productivity

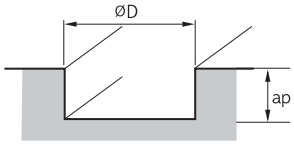
Recommended cutting conditions (SSEA2000)

Workpiece / Condition / Diameter (Ø)	Shouldering				Slotting			
	Aluminum alloy (A7075)		Aluminum alloy (cast) (AC4B)		Aluminum alloy (A7075)		Aluminum alloy (cast) (AC4B)	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
1	40,000	480	40,000	368	40,000	368	40,000	280
2	40,000	880	38,000	680	38,000	680	32,000	440
3	32,000	1,120	25,000	760	25,000	760	21,000	480
4	24,000	1,200	19,000	800	19,000	800	13,000	520
5	19,000	1,280	15,000	880	15,000	800	13,000	560
6	16,000	1,520	13,000	960	13,000	880	11,000	600
8	12,000	1,520	9,500	960	9,500	960	8,000	640
10	9,500	1,520	7,600	960	7,600	960	6,400	640
12	8,000	1,520	6,400	960	6,400	960	5,300	640
16	6,000	1,520	4,800	960	4,800	800	4,000	576
20	4,800	1,200	3,800	800	3,800	776	3,200	528

Application tip



■ **Shouldering depth (ap) and radial deoth (ae)**
- ap: ≤ 2.0D
- ae: ≤ 0.2D (D < Ø3)
  : ≤ 0.5D (D ≥ Ø3)



■ **Slotting depth (ap)**
- ap: ≤ D (max: 12 mm)

※ Workpiece should be clamped rigidly In case of vibrations, reduce R.P.M and feed rate by the same ratio

SSEA2000/3000 (Flat)

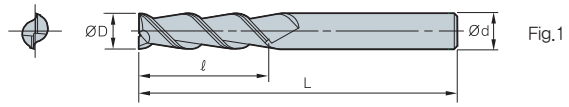


Fig.1

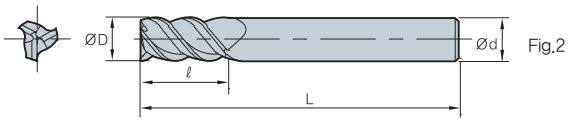


Fig.2



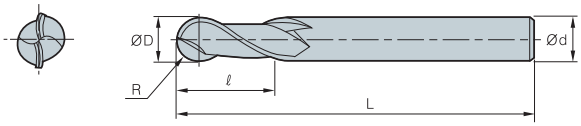
ØD	Tolerance
Ø1~Ø6	-0.010~ -0.030
Ø7~Ø10	-0.015~ -0.040
Ø11~Ø20	-0.020~ -0.050

(mm)

Designation		ØD	Ød	ℓ	L	Fig.
SSEA	2010	1	6	3	40	1
	2015	1.5	6	4	40	1
	2020	2	6	6	40	1
	2025	2.5	6	7	40	1
	2030	3	6	10	45	1
	2035	3.5	6	10	45	1
	2040	4	6	12	45	1
	2050	5	6	15	50	1
	2060	6	6	15	50	1
	2070	7	8	20	60	1
	2080	8	8	20	60	1
	2090	9	10	20	70	1
	2100	10	10	25	70	1
	2110	11	12	25	75	1
	2120	12	12	30	75	1
	2130	13	16	30	90	1
	2140	14	16	35	90	1
	2150	15	16	40	90	1
	2160	16	16	40	90	1
	2180	18	18	45	100	1
	2200	20	20	45	100	1
SSEA	3020	2	6	6	40	2
	3030	3	6	10	45	2
	3035	3.5	6	10	45	2
	3040	4	6	12	45	2
	3050	5	6	15	50	2
	3060	6	6	15	50	2
	3070	7	8	20	60	2
	3080	8	8	20	60	2
	3090	9	10	20	70	2
	3100	10	10	25	70	2
	3110	11	12	25	75	2
	3120	12	12	30	75	2
	3130	13	16	30	90	2
	3140	14	16	35	90	2
	3150	15	16	40	90	2
	3160	16	16	40	90	2

Special endmills order: SSEA◎◎◎◎I-L
Ex.1) 3 flutes, diameter: 6.3.I: 17, L: 60 SSEA3063 17-60L
Ex.2) 3 flutes, diameter: 6.3.standard type SSEA3063

SSBEA2000 (Ball)



ØD	Tolerance
All	0~ -0.03

(mm)

Designation		R	ØD	Ød	ℓ	L
SSBEA	2010	0.5	1	6	3	70
2	2015	0.75	1.5	6	4	70
	2020	1	2	6	6	70
	2025	1.25	2.5	6	8	70
	2030	1.5	3	6	10	70
	2035	1.75	3.5	6	10	70
	2040	2	4	6	12	70
	2045	2.25	4.5	6	15	80
	2050	2.5	5	6	15	80
	2055	2.75	5.5	6	15	80
	2060	3	6	6	15	80
	2065	3.25	6.5	8	20	90
	2070	3.5	7	8	20	90
	2075	3.75	7.5	8	20	90
	2080	4	8	8	20	90
	2085	4.25	8.5	10	25	100
	2090	4.5	9	10	25	100
	2100	5	10	10	25	100
	2110	5.5	11	12	30	110
	2120	6	12	12	30	110
	2130	6.5	13	16	35	120
	2140	7	14	16	35	120
	2150	7.5	15	16	40	120
	2160	8	16	16	40	120
	2170	8.5	17	20	40	130
	2180	9	18	20	45	130
	2190	9.5	19	20	45	130
	2200	10	20	20	45	130

Special endmills order: SSBEA2◎◎◎l-L
Ex.1) 2 flutes, diameter: 6.3.l: 17, L: 60 SSBEA3063 17-60L
Ex.2) 2 flutes, diameter: 6.3.standard type SSBEA3063

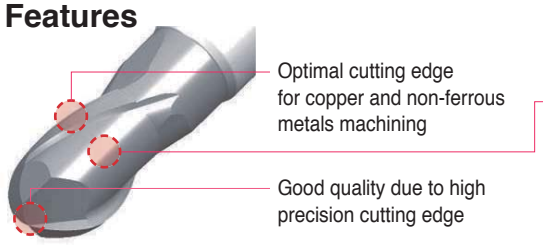
Long tool life and good surface roughness for copper based electrode machining

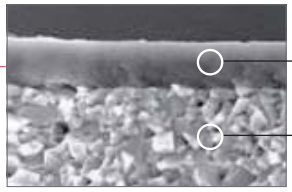
C-Max

Copper

- Superior lubricity, wear resistance & chipping resistance due to the K-Silver coating layer and optimal substrate
- Optimal for copper and non-ferrous metal machining
- Wide line up (ball, flat, radius & long neck type)

Features





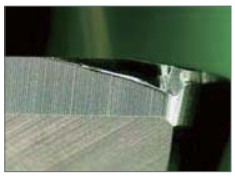
PC210C

Coating layer (K-Silver)
: Enhancing wear resistance and lubrication

Substrate
: Optimal for wear and chipping resistance

Application example

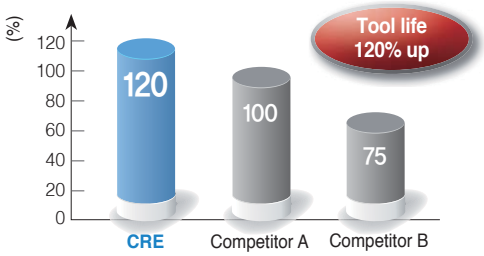
- **Workpiece** Cu, Electrode machining
- **Cutting conditions** vc (m/min) = 70, fz (mm/t) = 0.083, ap (mm) = 0.6, ae (mm) = 3.0
- **Tools** CRE4100-070-R10


CRE


Competitor A


Competitor B

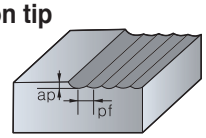
■ **Test result**



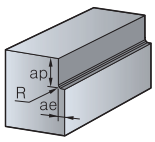
Recommended cutting conditions

Workpiece	CBE/CBNE		CFE/CFNE		CRE/CRNE	
	Copper alloys					
Condition / Diameter (Ø)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
0.5	40,000	2,600	40,000	1,800	-	-
1	40,000	2,800	40,000	2,000	40,000	2,000
1.5	40,000	3,200	40,000	2,400	30,000	2,400
2	40,000	3,600	30,000	1,800	30,000	1,800
3	40,000	4,000	23,000	1,380	20,000	1,380
4	32,000	3,200	15,000	900	15,000	900
5	25,000	2,500	12,000	750	12,000	750
6	21,000	2,100	10,000	600	10,000	600
8	16,000	1,600	8,000	480	8,000	480
10	13,000	1,300	6,400	384	6,400	384
12	9,000	900	5,400	324	5,400	324

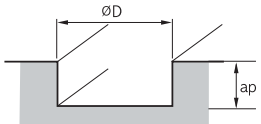
Application tip



• ap = 0.1D
• pf = 0.2D



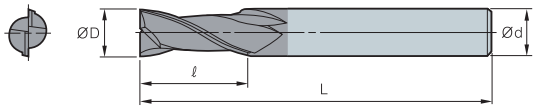
• ap = 1.5D
• ae = 0.1D



• ap ≤ 1.5D

※ Workpiece should be clamped rigidly In case of vibrations, reduce R.P.M and feed rate by the same ratio

CFE2000 (Flat)



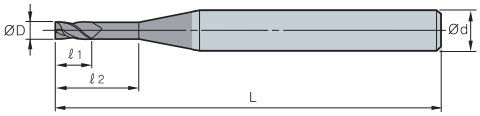
2 | H·A 30° | CrN | Substrate PC210C

ØD	Tolerance
Ø0.5~Ø6	0.00~0.01
Ø8~Ø12	0.00~0.02

(mm)

Designation		ØD	Ød	ℓ	L
CFE 2	2010-040	1	4	2.5	40
	2015-040	1.5	4	4	40
	2020-045	2	4	5	45
	2030-045	3	6	8	45
	2040-050	4	6	11	50
	2050-060	5	6	13	60
	2060-060	6	6	13	60
	2080-060	8	8	19	60
	2100-070	10	10	22	70
	2120-075	12	12	26	75

CFNE2000 (Long neck flat)



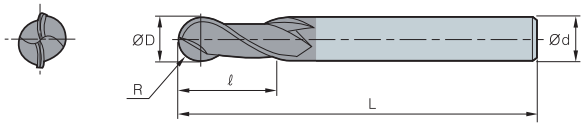
2 | H·A 30° | CrN | Substrate PC210C

ØD	Tolerance
Ø0.5~Ø6	0.00~0.01
Ø8~Ø12	0.00~0.02

(mm)

Designation		ØD	Ød	ℓ1	ℓ2	L
CFNE 2	2005-045-N2	0.5	4	0.8	2	45
	2005-045-N4	0.5	4	0.8	4	45
	2005-045-N6	0.5	4	0.8	6	45
	2005-050-N8	0.5	4	0.8	8	50
	2010-045-N4	1	4	1.5	4	45
	2010-045-N6	1	4	1.5	6	45
	2010-050-N8	1	4	1.5	8	50
	2010-050-N10	1	4	1.5	10	50
	2015-045-N6	1.5	4	2.3	6	45
	2015-050-N8	1.5	4	2.3	8	50
	2015-050-N10	1.5	4	2.3	10	50
	2015-050-N12	1.5	4	2.3	12	50
	2020-045-N6	2	4	3	6	45
	2020-050-N8	2	4	3	8	50
	2020-050-N10	2	4	3	10	50
	2020-055-N12	2	4	3	12	50
	2030-050-N10	3	4	4.5	10	50
	2030-050-N12	3	4	4.5	12	50
	2030-060-N14	3	4	4.5	14	60
	2030-060-N16	3	4	4.5	16	60
	2040-050-N12	4	6	6	12	50
	2040-050-N16	4	6	6	16	50
	2040-060-N20	4	6	6	20	60

CBE2000 (Ball)



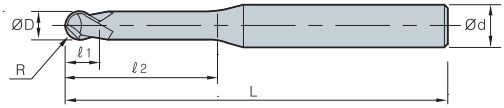
2 | H·A 30° | CrN | Substrate PC210C

ØD	Tolerance	R Tolerance
Ø0.5~Ø6	0.00~0.01	±0.005
Ø8~Ø12	0.00~0.02	±0.005

(mm)

Designation		R	ØD	Ød	ℓ	L
CBE 2	2010-050	0.5	1	4	2.5	50
	2015-050	0.75	1.5	4	4	50
	2020-050	1	2	4	5	50
	2030-060	1.2	3	6	8	60
	2040-070	2	4	6	8	70
	2050-080	2.5	5	6	10	80
	2060-080	3	6	6	12	80
	2080-090	4	8	8	14	90
	2100-100	5	10	10	18	100
	2120-110	6	12	12	22	110

CBNE2000 (Long neck ball)



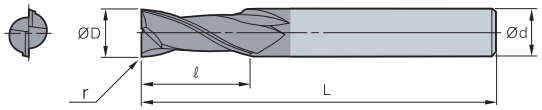
2 | H·A 30° | CrN | Substrate PC210C

ØD	Tolerance
Ø0.5~Ø6	0.00~0.01
Ø8~Ø12	0.00~0.02

(mm)

Designation		R	ØD	Ød	ℓ1	ℓ2	L
CBNE 2	2005-045-N2	0.25	0.5	4	0.5	2	45
	2005-045-N4	0.25	0.5	4	0.5	4	45
	2005-045-N6	0.25	0.5	4	0.5	6	45
	2005-050-N8	0.25	0.5	4	0.5	8	50
	2010-045-N4	0.5	1	4	1	4	45
	2010-045-N6	0.5	1	4	1	6	45
	2010-050-N8	0.5	1	4	1	8	50
	2010-050-N10	0.5	1	4	1	10	50
	2015-050-N8	0.75	1.5	4	1.5	8	50
	2015-050-N10	0.75	1.5	4	1.5	10	50
	2015-050-N12	0.75	1.5	4	1.5	12	50
	2015-055-N14	0.75	1.5	4	1.5	14	55
	2020-050-N8	1	2	4	2	8	50
	2020-050-N10	1	2	4	2	10	50
	2020-050-N12	1	2	4	2	12	50
	2020-055-N14	1	2	4	2	14	55
	2030-050-N10	1.5	3	4	3	10	50
	2030-050-N12	1.5	3	4	3	12	50
	2030-055-N14	1.5	3	4	3	14	55
	2030-055-N16	1.5	3	4	3	16	60
	2040-060-N16	2	4	6	4	16	60
	2040-060-N20	2	4	6	4	20	60
	2040-070-N25	2	4	6	4	25	70
	2040-070-N30	2	4	6	4	30	70

CRE2000 (Radius)



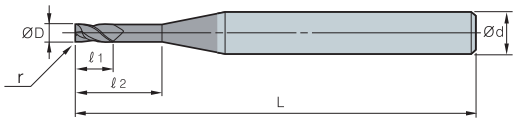
2 | H·A 30° | CrN | Substrate PC210C

ØD	Tolerance	R Tolerance
Ø0.5~Ø6	0.00~0.01	±0.005
Ø8~Ø12	0.00~0.02	±0.005

(mm)

Designation		r	ØD	Ød	ℓ	L
CRE 2	2020-045-R05	0.5	2	4	5	45
	2030-045-R05	0.5	3	6	8	45
	2040-050-R05	0.5	4	6	11	50
	2050-060-R05	0.5	5	6	13	60
	2060-060-R05	0.5	6	6	13	60
	2080-060-R10	1	8	8	19	60
	2100-070-R10	1	10	10	22	70
	2120-075-R10	1	12	12	26	75

CRNE2000 (Long neck radius)



2 | H·A 30° | CrN | Substrate PC210C

ØD	Tolerance	R Tolerance
Ø0.5~Ø6	0.00~0.01	±0.005
Ø8~Ø12	0.00~0.02	±0.005

(mm)

Designation		r	ØD	Ød	ℓ1	ℓ2	L
CRNE 2	2010-045-R02N4	0.2	1	4	1.5	4	45
	2010-045-R02N6	0.2	1	4	1.5	6	45
	2010-050-R02N8	0.2	1	4	1.5	8	50
	2010-050-R02N10	0.2	1	4	1.5	10	50
	2015-045-R02N6	0.2	1.5	4	2.3	6	45
	2015-050-R02N8	0.2	1.5	4	2.3	8	50
	2015-050-R02N10	0.2	1.5	4	2.3	10	50
	2015-050-R02N12	0.2	1.5	4	2.3	12	50
	2020-045-R05N6	0.5	2	4	3	6	45
	2020-050-R05N8	0.5	2	4	3	8	50
	2020-050-R05N10	0.5	2	4	3	10	50
	2020-055-R05N12	0.5	2	4	3	12	50
	2030-050-R05N10	0.5	3	4	4.5	10	50
	2030-050-R05N12	0.5	3	4	4.5	12	50
	2030-060-R05N14	0.5	3	4	4.5	14	60
	2030-060-R05N16	0.5	3	4	4.5	16	60
	2040-050-R05N12	0.5	4	6	6	12	50
	2040-050-R05N16	0.5	4	6	6	16	50
	2040-060-R05N20	0.5	4	6	6	20	60

Endmill for Ni series HRSA machining (Inconel, Hastelloy, Waspaloy and etc.)

Super Endmill for HRSA new

- Exclusive endmill for plane engines, generator and turbine parts.
- Optimal endmill for Ni Based super alloy HRSA machining (Inconel, Hastelloy, Waspaloy and etc.)

* HRSA: Heat Resistance Super Alloy. Heating resisting alloy

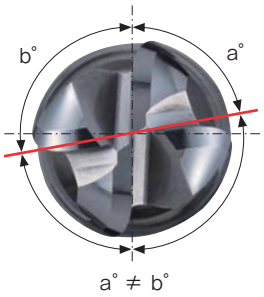
Code system

S RE S 4 120 - 080 - R30

Super Endmill	Type	Workpiece	No. of flutes	Tool diameter	Overall length	Corner R
	R: Radius Endmill	S: Super alloy T: Titanium/STS	4: 4 Flute	120: Ø12.0 mm	080: 80 mm	30: 30 mm

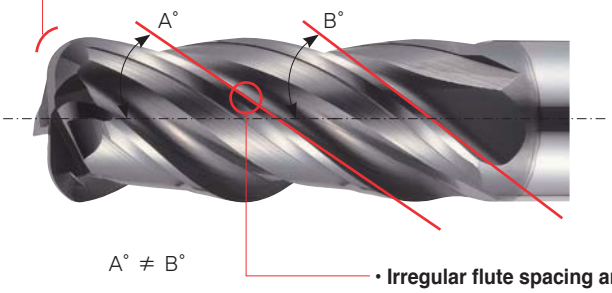
Features

- Aerospace and generator industries: Exclusive endmill for HRSA and machining parts of engine and turbine
- Irregular flute spacing and helix angle design: Reducing chattering and improving stability in machining
- High rigidity core web design: Improving chip evacuation and stability in machining
- Sharp cutting edge: Reducing cutting load and work hardening
- Excellent tool life: New grade with excellent wear resistance coating and high toughness substrate



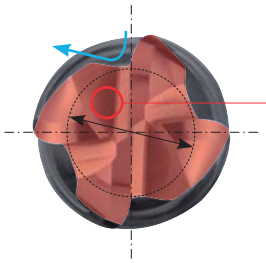
a° ≠ b°

• Sharp cutting edge
- Applied corner radius gash and positive rake angle
- Reduced cutting load and work hardening



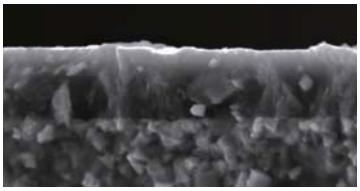
A° ≠ B°

• Irregular flute spacing and helix angle
- Reducing chattering
- Increasing machining stability



• High rigidity core web design
- Improved chip evacuation
- Increased machining stability

Features of grade



Super Lubricating Coating

• High lubricative coating and special surface treatment technology
- Surface treatment technology improves welding resistance and machining stability

Performance evaluation

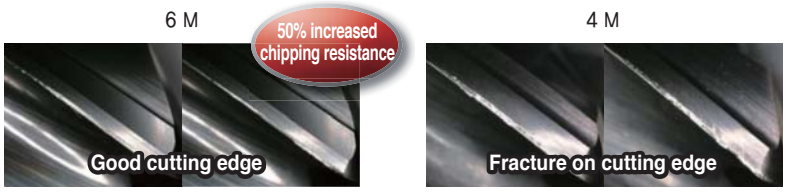
- **Workpiece** Inconel718 (HRC43~46)
- **Cutting conditions** Diameter = Ø12, vc (m/min) = 40, fz (mm/t) = 0.05, ap (mm) = 18, ae (mm) = 0.6, wet (Emulsion)
- **Tools** SRES4120-080-R10(SL Coating)

High quality due to high toughness substrate and improved machining stability

Super Endmill | Competitor

- **Workpiece** Inconel718 (HRC43~46)
- **Cutting conditions** Diameter = Ø12, vc (m/min) = 40, fz (mm/t) = 0.05, ap (mm) = 18, ae (mm) = 0.6, wet (Soluble)
- **Tools** SRES4120-080-R10(SL Coating)

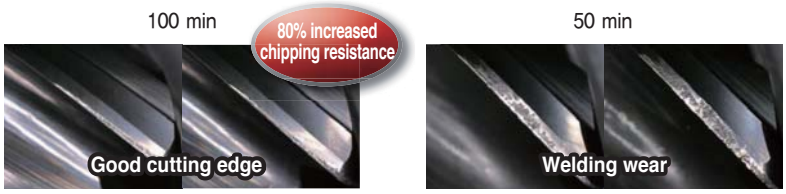
High quality due to high toughness substrate and improved machining stability



Super Endmill | Competitor

- **Workpiece** Waspaloy (HRC36~38)
- **Cutting conditions** Diameter = Ø12, vc (m/min) = 30, fz (mm/t) = 0.04, ap (mm) = 6, ae (mm) = 18, Trochoidal machining wet (Soluble)
- **Tools** SRES4120-080-R10(SL Coating)

High quality due to high toughness substrate and improved machining stability

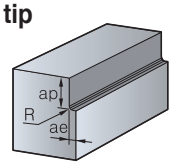


Super Endmill | Competitor

Recommended cutting conditions

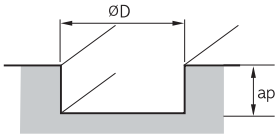
Workpiece / Condition / Diameter (Ø)	Ni based heat resistant super alloy (Inconel718, 625)			
	RPM n (min^{-1})	Feed vf (mm/min)	RPM n (min^{-1})	Feed vf (mm/min)
3	3,800	220	2,500	125
4	3,000	240	1,900	135
5	2,450	245	1,500	145
6	2,100	250	1,250	145
8	1,600	225	945	155
10	1,250	215	760	145
12	1,050	210	630	145
16	765	210	475	110
20	635	200	380	110

Application tip



■ **Shouldering depth (ap)**

- ap : ≤ 1.5D
- ae : ≤ 0.05D



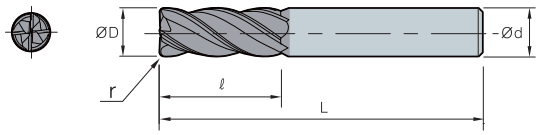
■ **Slotting depth (ap)**

- ap : ≤ 0.2D

Notice

- Please adjust the recommended cutting conditions properly, according to the condition of your machines, the target shapes, and your purpose for machining
- Please set the machine with high rigidity and check the workpiece clamping
- Please select proper coolant for workpiece materials and check the pressure and amount of coolant enough for machining
- In case of chattering, reduce RPM and feed rate by the same ratio

SRES4000 (Radius)



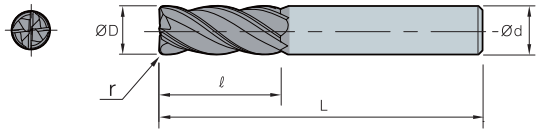
4 | HA 35°/38° | SL coating | h6 shank

ØD	Tolerance	R Tolerance
Ø1~Ø6	0.00 ~ -0.015	±0.01
Ø6.1~Ø20	0.00 ~ -0.020	±0.01

(mm)

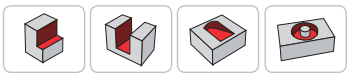
	Designation	ØD	Ød	ℓ	L	r
SRES 4	4030-055-R02	3	6	8	55	0.2
	4030-055-R03	3	6	8	55	0.3
	4030-055-R05	3	6	8	55	0.5
	4040-055-R02	4	6	10	55	0.2
	4040-055-R03	4	6	10	55	0.3
	4040-055-R05	4	6	10	55	0.5
	4040-070-R02	4	6	10	70	0.2
	4040-070-R03	4	6	10	70	0.3
	4040-070-R05	4	6	10	70	0.5
	4050-055-R02	5	6	15	55	0.2
	4050-055-R03	5	6	15	55	0.3
	4050-055-R05	5	6	15	55	0.5
	4050-090-R02	5	6	15	90	0.2
	4050-090-R03	5	6	15	90	0.3
	4050-090-R05	5	6	15	90	0.5
	4060-060-R03	6	6	15	60	0.3
	4060-060-R05	6	6	15	60	0.5
	4060-060-R08	6	6	15	60	0.8
	4060-060-R10	6	6	15	60	1
	4060-060-R15	6	6	15	60	1.5
	4060-060-R20	6	6	15	60	2
	4060-090-R03	6	6	15	90	0.3
	4060-090-R05	6	6	15	90	0.5
	4060-090-R08	6	6	15	90	0.8
	4060-090-R10	6	6	15	90	1
	4060-090-R15	6	6	15	90	1.5
	4060-090-R20	6	6	15	90	2

SRES4000 (Radius)



4 | H A 35°/38° | SL coating | h6 shank

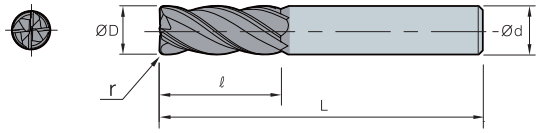
ØD	Tolerance	R Tolerance
Ø1~Ø6	0.00 ~ -0.015	±0.01
Ø6.1~Ø20	0.00 ~ -0.020	±0.01



(mm)

	Designation	ØD	Ød	ℓ	L	r
SRES 4	4080-070-R03	8	8	20	70	0.3
	4080-070-R05	8	8	20	70	0.5
	4080-070-R08	8	8	20	70	0.8
	4080-070-R10	8	8	20	70	1
	4080-070-R15	8	8	20	70	1.5
	4080-070-R20	8	8	20	70	2
	4080-070-R25	8	8	20	70	2.5
	4080-070-R30	8	8	20	70	3
	4080-100-R03	8	8	20	100	0.3
	4080-100-R05	8	8	20	100	0.5
	4080-100-R08	8	8	20	100	0.8
	4080-100-R10	8	8	20	100	1
	4080-100-R15	8	8	20	100	1.5
	4080-100-R20	8	8	20	100	2
	4080-100-R25	8	8	20	100	2.5
	4080-100-R30	8	8	20	100	3
	4100-075-R03	10	10	25	75	0.3
	4100-075-R05	10	10	25	75	0.5
	4100-075-R08	10	10	25	75	0.8
	4100-075-R10	10	10	25	75	1
	4100-075-R15	10	10	25	75	1.5
	4100-075-R20	10	10	25	75	2
	4100-075-R25	10	10	25	75	2.5
	4100-075-R30	10	10	25	75	3
	4100-100-R03	10	10	25	100	0.3
	4100-100-R05	10	10	25	100	0.5
	4100-100-R08	10	10	25	100	0.8
	4100-100-R10	10	10	25	100	1
	4100-100-R15	10	10	25	100	1.5
	4100-100-R20	10	10	25	100	2
	4100-100-R25	10	10	25	100	2.5
	4100-100-R30	10	10	25	100	3

SRES4000 (Radius)



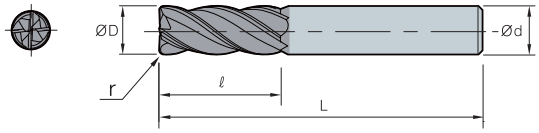
4 | HA 35°/38° | SL coating | h6 shank

ØD	Tolerance	R Tolerance
Ø1~Ø6	0.00 ~ -0.015	±0.01
Ø6.1~Ø20	0.00 ~ -0.020	±0.01

(mm)

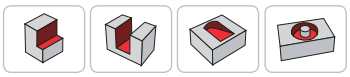
	Designation	ØD	Ød	ℓ	L	r
SRES 4	4120-080-R05	12	12	30	80	0.5
	4120-080-R08	12	12	30	80	0.8
	4120-080-R10	12	12	30	80	1
	4120-080-R15	12	12	30	80	1.5
	4120-080-R20	12	12	30	80	2
	4120-080-R25	12	12	30	80	2.5
	4120-080-R30	12	12	30	80	3
	4120-080-R35	12	12	30	80	3.5
	4120-080-R40	12	12	30	80	4
	4120-110-R05	12	12	30	110	0.5
	4120-110-R08	12	12	30	110	0.8
	4120-110-R10	12	12	30	110	1
	4120-110-R15	12	12	30	110	1.5
	4120-110-R20	12	12	30	110	2
	4120-110-R25	12	12	30	110	2.5
	4120-110-R30	12	12	30	110	3
	4120-110-R35	12	12	30	110	3.5
	4120-110-R40	12	12	30	110	4
	4140-090-R05	14	14	35	90	0.5
	4140-090-R08	14	14	35	90	0.8
	4140-090-R10	14	14	35	90	1
	4140-090-R15	14	14	35	90	1.5
	4140-090-R20	14	14	35	90	2
	4140-090-R30	14	14	35	90	3
	4140-150-R05	14	14	35	150	0.5
	4140-150-R08	14	14	35	150	0.8
	4140-150-R10	14	14	35	150	1
	4140-150-R15	14	14	35	150	1.5
	4140-150-R20	14	14	35	150	2
	4140-150-R30	14	14	35	150	3

SRES4000 (Radius)



4 | H A 35°/38° | SL coating | h6 shank

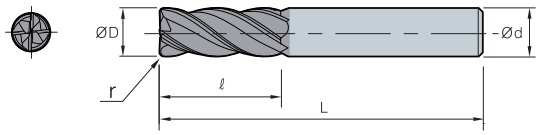
ØD	Tolerance	R Tolerance
Ø1~Ø6	0.00 ~ -0.015	±0.01
Ø6.1~Ø20	0.00 ~ -0.020	±0.01



(mm)

	Designation	ØD	Ød	ℓ	L	r
SRES 4	4160-100-R05	16	16	42	100	0.5
	4160-100-R08	16	16	42	100	0.8
	4160-100-R10	16	16	42	100	1
	4160-100-R15	16	16	42	100	1.5
	4160-100-R20	16	16	42	100	2
	4160-100-R25	16	16	42	100	2.5
	4160-100-R30	16	16	42	100	3
	4160-100-R35	16	16	42	100	3.5
	4160-100-R40	16	16	42	100	4
	4160-100-R50	16	16	42	100	5
	4160-100-R60	16	16	42	100	6
	4160-150-R05	16	16	42	150	0.5
	4160-150-R08	16	16	42	150	0.8
	4160-150-R10	16	16	42	150	1
	4160-150-R15	16	16	42	150	1.5
	4160-150-R20	16	16	42	150	2
	4160-150-R25	16	16	42	150	2.5
	4160-150-R30	16	16	42	150	3
	4160-150-R35	16	16	42	150	3.5
	4160-150-R40	16	16	42	150	4
	4160-150-R50	16	16	42	150	5
	4160-150-R60	16	16	42	150	6
	4180-100-R05	18	20	45	100	0.5
	4180-100-R08	18	20	45	100	0.8
	4180-100-R10	18	20	45	100	1
	4180-100-R15	18	20	45	100	1.5
	4180-100-R20	18	20	45	100	2
	4180-100-R30	18	20	45	100	3
	4180-150-R05	18	20	45	150	0.5
	4180-150-R08	18	20	45	150	0.8
	4180-150-R10	18	20	45	150	1
	4180-150-R15	18	20	45	150	1.5
	4180-150-R20	18	20	45	150	2
	4180-150-R30	18	20	45	150	3

SRES4000 (Radius)



4 | HA 35°/38° | SL coating | h6 shank

ØD	Tolerance	R Tolerance
Ø1~Ø6	0.00 ~ -0.015	±0.01
Ø6.1~Ø20	0.00 ~ -0.020	±0.01

(mm)

	Designation	ØD	Ød	ℓ	L	r
SRES 4	4200-100-R05	20	20	48	100	0.5
	4200-100-R10	20	20	48	100	1
	4200-100-R15	20	20	48	100	1.5
	4200-100-R20	20	20	48	100	2
	4200-100-R25	20	20	48	100	2.5
	4200-100-R30	20	20	48	100	3
	4200-100-R35	20	20	48	100	3.5
	4200-100-R40	20	20	48	100	4
	4200-100-R50	20	20	48	100	5
	4200-100-R60	20	20	48	100	6
	4200-150-R05	20	20	48	150	0.5
	4200-150-R10	20	20	48	150	1
	4200-150-R15	20	20	48	150	1.5
	4200-150-R20	20	20	48	150	2
	4200-150-R25	20	20	48	150	2.5
	4200-150-R30	20	20	48	150	3
	4200-150-R35	20	20	48	150	3.5
	4200-150-R40	20	20	48	150	4
	4200-150-R50	20	20	48	150	5
	4200-150-R60	20	20	48	150	6

Router endmill for machining composite materials

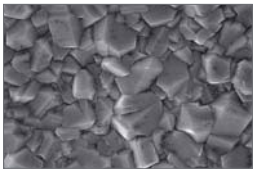
Composite Router Endmill new

- Router endmills optimized for machining composite materials (CFRP/GFRP)
- Excellent tool life thanks to nano-crystal diamond coating
- Blade design for reducing flaking and burrs
- Improved productivity through high efficiency machining

Features

- Diamond-coated grade ND2100 for machining composite materials
- High hardness diamond coating (over Hv 8,000)
- Nano-diamond coating with excellent resistance to friction and welding
- Improved resistance to flaking thanks by applying the specialized grade for diamond coating

Nano-diamond coating

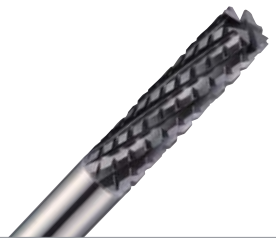

Existing diamond coating

CCDR (Dual Helix Router Endmill)

- Dual helix design to inhibit flaking on upper and lower faces of workpieces
- Endmill for finishing, profiling, and grooving

CCHR(High-performance Router Endmill)

- Multi flute nick shaped for high efficient machining
- Endmill for shape contouring, grooving, roughing



CCR (Router Endmill)

- Down cut design for low vibrations and cutting force
- Endmill for roughing, profiling, and grooving

CCLR (Low Helix Router Endmill)

- Fewer burrs thanks to the low axial cutting force
- Endmill for finishing, profiling, and blind groove making

CCRR (Reverse Helix Router Endmill)

- Reverse helix design to inhibit a drift in the workpiece's course
- Endmill for finishing, profiling, and through groove making

CCDR4000/6000 (Flat)

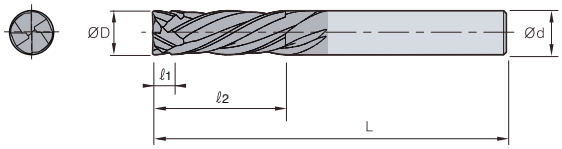


Fig.1

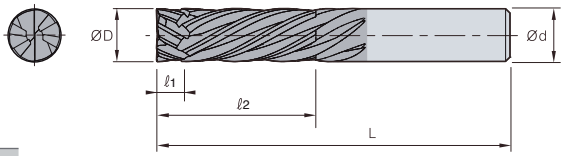


Fig.2

4 6 H·A 30°/90° Substrate ND2100 h5 shank

ØD	Tolerance
Ø6~12	0.00~ -0.03 mm

(mm)

Designation		ØD	Ød	ℓ1	ℓ2	L	Fig.
CCDR 4	4060-065	6	6	3	18	65	1
	4080-075	8	8	4	24	75	1
CCDR 6	6100-085	10	10	5	30	85	2
	6120-100	12	12	6	36	100	2

4 6 H·A 30°/90° Substrate ND2100 h5 shank

ØD	Tolerance
Ø0.250~0.500	0.0000~ -0.0012 inch

(inch)

Designation		ØD	Ød	ℓ1	ℓ2	L	Fig.
CCDR 4	402500	1/4 0.250	0.250	0.125	0.750	2.500	1
	402500L	1/4 0.250	0.250	0.125	1.500	4.000	1
CCDR 6	603750	3/8 0.375	0.375	0.125	1.000	3.250	2
	603750L	3/8 0.375	0.375	0.125	1.500	4.000	2
	605000	1/2 0.500	0.500	0.125	1.000	3.250	2
	605000L	1/2 0.500	0.500	0.125	1.500	4.000	2

CCHR4000/6000 (Flat)

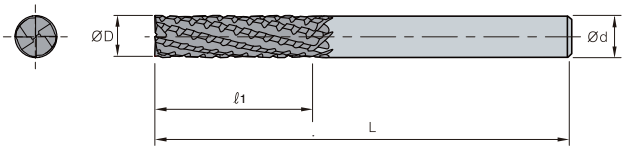


Fig.1

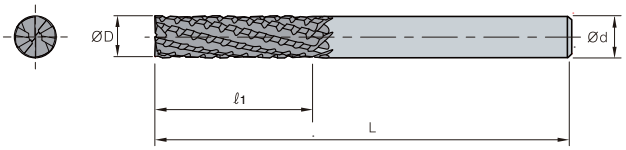


Fig.2

4 6 H·A 15° Substrate ND2100 h5 shank

ØD	Tolerance
Ø6~12	0.00 ~ -0.05 mm

(mm)

Designation		ØD	Ød	ℓ1	L	Fig.
CCHR 4	4060-065	6	6	18	65	1
	4080-075	8	8	24	75	1
CCHR 6	6100-085	10	10	30	85	2
	6120-100	12	12	36	100	2

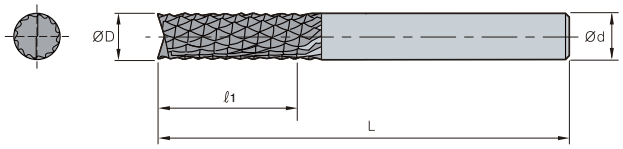
4 6 H·A 15° Substrate ND2100 h5 shank

ØD	Tolerance
Ø0.250~0.500	0.0000 ~ -0.002 inch

(inch)

Designation		ØD	Ød	ℓ1	L	Fig.
CCHR 4	402500	1/4 0.250	0.250	0.750	2.500	1
	402500L	1/4 0.250	0.250	1.500	4.000	1
CCHR 6	603750	3/8 0.375	0.375	1.000	3.250	2
	603750L	3/8 0.375	0.375	1.500	4.000	2
	605000	1/2 0.500	0.500	1.000	3.250	2
	605000L	1/2 0.500	0.500	1.500	4.000	2

CCR2000 (Flat)



2 | H·A -27° | Substrate ND2100 | h5 shank

ØD	Tolerance
Ø4~12	-0.02 ~ -0.08 mm

(mm)

Designation		ØD	Ød	ℓ1	L
CCR 2	2040-050	4	4	12	50
	2050-050	5	5	15	50
	2060-065	6	6	18	65
	2080-075	8	8	24	75
	2100-085	10	10	30	85
	2120-100	12	12	36	100

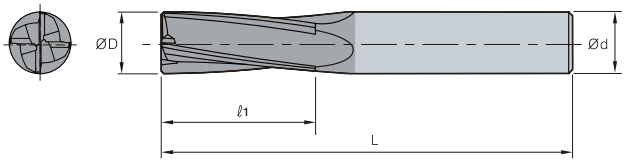
2 | H·A -27° | Substrate ND2100 | h5 shank

ØD	Tolerance
Ø0.250~0.500	-0.0008 ~ -0.0032 inch

(inch)

Designation		ØD	Ød	ℓ1	L
CCR 2	202500	1/4 0.250	0.250	0.750	2.500
	202500L	1/4 0.250	0.250	1.500	4.000
	203750	3/8 0.375	0.375	1.000	3.250
	203750L	3/8 0.375	0.375	1.500	4.000
	205000	1/2 0.500	0.500	1.000	3.250
	205000L	1/2 0.500	0.500	1.500	4.000

CCLR4000 (Flat)



4 | H·A 15° | Substrate ND2100 | h5 shank

ØD	Tolerance
Ø4~12	0.00 ~ -0.03 mm

(mm)

Designation		ØD	Ød	ℓ1	L
CCLR 4	4040-050	4	4	12	50
	4050-050	5	5	15	50
	4060-065	6	6	18	65
	4080-075	8	8	24	75
	4100-085	10	10	30	85
	4120-100	12	12	36	100

4 | H·A 15° | Substrate ND2100 | h5 shank

ØD	Tolerance
Ø0.250~0.500	0.0000 ~ -0.0012 inch

(inch)

Designation		ØD	Ød	ℓ1	L
CCLR 4	402500	1/4 0.250	0.250	0.750	2.500
	402500L	1/4 0.250	0.250	1.500	4.000
	403750	3/8 0.375	0.375	1.000	3.250
	403750L	3/8 0.375	0.375	1.500	4.000
	405000	1/2 0.500	0.500	1.000	3.250
	405000L	1/2 0.500	0.500	1.500	4.000

CCRR6000/8000 (Flat)

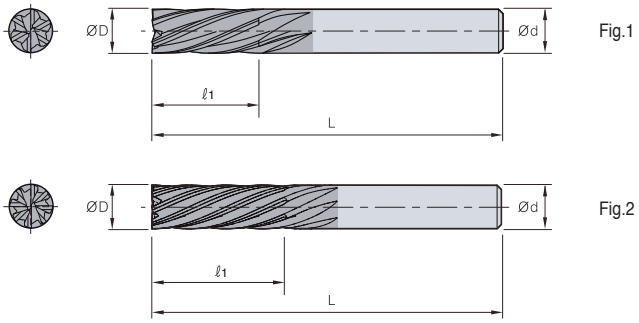


Fig.1

Fig.2

6 8 H·A -25° Substrate ND2100 h5 shank

ØD	Tolerance
Ø6~12	0.00 ~ -0.03 mm

(mm)

Designation		ØD	Ød	ℓ1	L	Fig.
CCRR 6	6060-065	6	6	18	65	1
	6080-075	8	8	24	75	1
CCRR 8	8100-085	10	10	30	85	2
	8120-100	12	12	36	100	2

6 8 H·A -25° Substrate ND2100 h5 shank

ØD	Tolerance
Ø0.250~0.500	0.0000 ~ -0.0012 inch

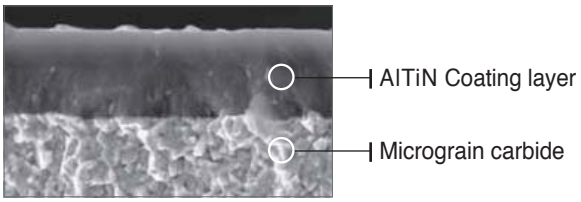
(inch)

Designation		ØD	Ød	ℓ1	L	Fig.
CCRR 6	602500	1/4 0.250	0.250	0.750	2.500	1
	602500L	1/4 0.250	0.250	1.500	4.000	1
CCRR 8	803750	3/8 0.375	0.375	1.000	3.250	2
	803750L	3/8 0.375	0.375	1.500	4.000	2
	805000	1/2 0.500	0.500	1.000	3.250	2
	805000L	1/2 0.500	0.500	1.500	4.000	2

Stable performance guaranteed for workpiece workpieces under HRC45

I+ Endmill

- Tough substrate & wear-resisting coating technology applied
- Wide application range in general use
  - Stable performance guaranteed for workpiece which is under 45HRC
- Saving cost by higher productivity

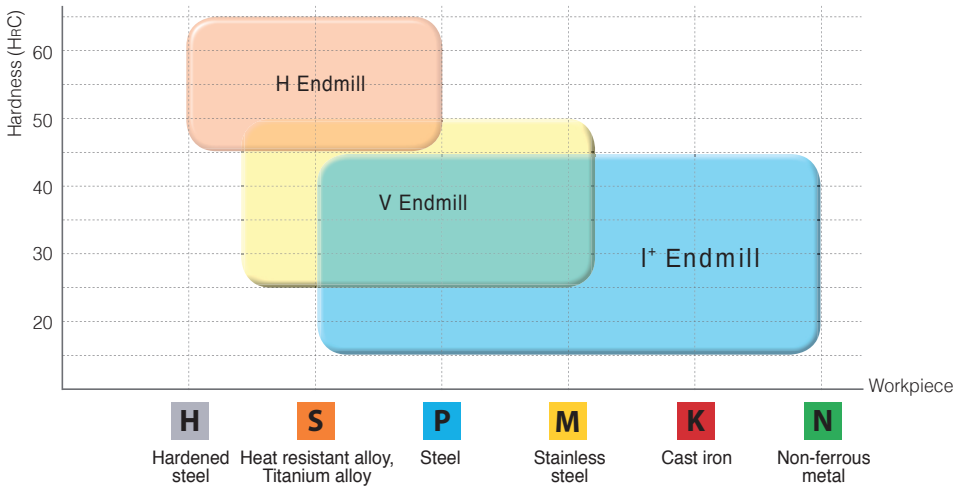


PC320

Product line-up

- IPBE: I Plus Ball Endmill (Ø1~Ø20)
- IPFE: I Plus Flat Endmill (Ø1~Ø20)
- IPRE: I Plus Radius Endmill (Ø1~Ø12)

Application area

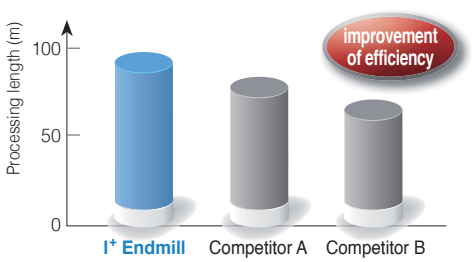


Performance evaluation

- **Workpiece** SM45C
- **Cutting conditions** Diameter = Ø8.0, n (min-1) = 5173, vc (m/min) = 130.0, vf (mm/min) = 1034, fz (mm/t) = 0.1, ap (mm) = 0.5, ae (mm) = 1.6, dry
- **Tools** IPBE2080-060

I+ Endmill | Competitor A | Competitor B

■ **Test result**

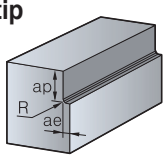


Recommended cutting conditions (Flat)

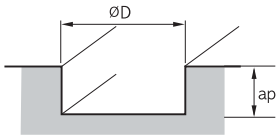
■ IPFE2000

Diameter (ØD)	Carbon steel, Alloy steel~HRC30 (SM50C, SCM, GC250, Cast iron)			Alloy steel, High speed steel HRC30~45 (Pre-hardened steels, STD61, NAK)			Stainless steel (STS304, STS316)		
	R.P.M n (min^{-1})	Feed vf (mm/min)		R.P.M n (min^{-1})	Feed vf (mm/min)		R.P.M n (min^{-1})	Feed vf (mm/min)	
		Shouldering	Slotting		Shouldering	Slotting		Shouldering	Slotting
1.0	30,000	600	480	20,000	400	320	12,600	300	180
1.5	20,000	600	480	14,000	400	320	8,400	300	180
2.0	15,000	600	480	10,000	400	400	6,300	300	180
2.5	12,000	600	480	8,200	400	320	5,100	300	180
3.0	10,000	600	480	7,000	400	320	4,200	300	180
4.0	7,500	600	480	5,200	400	320	3,100	300	180
5.0	6,000	600	480	4,200	400	320	2,500	300	180
6.0	5,000	600	480	3,500	400	320	2,100	300	180
8.0	4,000	520	410	2,800	350	280	1,600	260	150
10.0	3,200	450	360	2,200	300	240	1,300	230	130
12.0	2,700	410	320	1,900	270	210	1,100	210	120
16.0	2,000	240	190	1,400	210	160	840	160	100
20.0	1,600	200	160	1,100	170	130	680	140	80

Application tip



■ **Shouldering depth (ap) and radial depth (ae)**
- ap: ≤ 1.5 (All dia.)
- ae: ≤ 0.1D (D ≤ Ø3)
  ≤ 0.2D (D > Ø3)

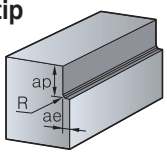


■ **Slotting depth (ap)**
- ap: ≤ 0.1D (D ≤ Ø2)
  ≤ 0.2D (D > Ø2)

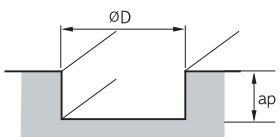
■ IPFE4000

Diameter (ØD)	Carbon steel, Alloy steel ~HRC30 (SM50C, SCM, GC250, Cast iron)			Alloy steel, High speed steel HRC30~45 (Pre-hardened steels, STD61, NAK)			Stainless steel (STS304, STS316)		
	R.P.M n (min^{-1})	Feed vf (mm/min)		R.P.M n (min^{-1})	Feed vf (mm/min)		R.P.M n (min^{-1})	Feed vf (mm/min)	
		Shouldering	Slotting		Shouldering	Slotting		Shouldering	Slotting
1.0	30,000	900	720	20,000	600	480	12,600	450	270
1.5	20,000	900	720	14,000	600	480	8,400	450	270
2.0	15,000	900	720	10,000	600	480	6,300	450	270
2.5	12,000	900	720	8,200	600	480	5,100	450	270
3.0	10,000	900	720	7,000	600	480	4,200	450	270
4.0	7,500	900	720	5,200	600	480	3,100	450	270
5.0	6,000	900	720	4,200	600	480	2,500	450	270
6.0	5,000	900	720	3,500	600	480	2,100	450	270
8.0	4,000	780	620	2,800	520	410	1,600	390	230
10.0	3,200	680	540	2,200	450	360	1,300	340	200
12.0	2,700	620	490	1,900	410	320	1,100	310	180
16.0	2,000	360	280	1,400	310	240	840	240	140
20.0	1,600	300	240	1,100	250	200	680	210	120

Application tip



■ **Shouldering depth (ap) and radial depth (ae)**
- ap: ≤ 1.5 (All dia.)
- ae: ≤ 0.1D (D ≤ Ø3)
  ≤ 0.2D (D > Ø3)



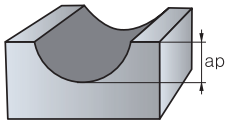
■ **Slotting depth (ap)**
- ap: ≤ 0.1D (D ≤ Ø2)
  ≤ 0.2D (D > Ø2)

Recommended cutting conditions (Ball)

■ IPBE2000

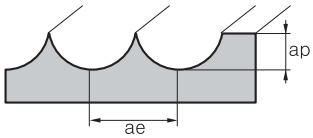
Diameter (ØD)	Carbon steel (SM50C)		Alloy steel (SCM, STD, STS, KP4M, NAK)		Mold steel ~HRC45 (STD61)		Non-ferrous metal (Aluminum)	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
1.0	40,000	1,200	38,000	1,200	29,000	900	40,000	1,000
1.5	30,000	1,270	25,500	1,100	19,000	700	40,000	1,360
2.0	24,000	1,160	19,000	800	14,300	600	40,000	2,000
2.5	19,000	1,000	15,300	670	11,500	510	38,000	2,400
3.0	16,000	930	13,000	600	9,600	460	32,000	2,400
3.5	13,700	930	11,400	580	8,200	450	27,300	2,400
4.0	12,000	930	10,000	570	7,200	450	24,000	2,400
5.0	9,600	930	8,000	560	5,700	450	19,000	2,400
6.0	8,000	930	6,400	540	4,800	450	16,000	2,400
8.0	6,000	900	4,800	540	3,600	450	12,000	2,400
10.0	4,800	900	3,800	540	2,900	450	9,600	2,300
12.0	4,000	900	3,200	540	2,400	450	8,000	2,100
14.0	3,400	900	2,750	540	2,050	450	6,800	2,000
16.0	3,000	900	2,400	540	1,800	450	6,000	2,000
20.0	2,400	900	1,900	520	1,450	450	4,800	2,000

Application tip



■ Slotting depth (ap)

• ap: 0.1×R (~45HRC)
0.08 ×R (~50HRC)



(R0.1~0.5 = 0.2×R)
0.3×R

■ Shouldering depth (ap) and radial depth (ae)

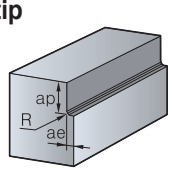
~0.16×R R ≦ 0.3 (~45HRC)
~0.25×R R ≦ 3 (~45HRC)
~0.17×R R ≦ 4 (~45HRC)
~0.05×R (~50HRC)

Recommended cutting conditions (Radius)

■ IPRE2000

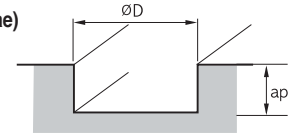
Diameter (ØD)	Carbon steel, Alloy steel ~HRC30 (SM50C, SCM, GC250, Cast iron)			Alloy steel, High speed steel HRC30~45 (Pre-hardened steels, STD61, NAK)			Stainless steel (STS304, STS316)		
	R.P.M n (min^{-1})	Feed vf (mm/min)		R.P.M n (min^{-1})	Feed vf (mm/min)		R.P.M n (min^{-1})	Feed vf (mm/min)	
		Shouldering	Slotting		Shouldering	Slotting		Shouldering	Slotting
2.0	11,000	180	180	7,200	110	110	6,000	90	90
3.0	8,500	200	160	5,300	130	100	4,400	110	66
4.0	7,200	360	290	4,400	220	180	3,000	180	110
5.0	6,000	380	300	3,600	230	180	2,400	190	110
6.0	5,300	420	340	3,200	240	190	2,200	210	130
8.0	4,000	450	360	2,400	240	190	1,600	220	130
10.0	3,200	390	310	1,900	190	150	1,300	190	110
12.0	2,700	330	260	1,600	160	130	1,000	150	90

Application tip



■ Shouldering depth (ap) and radial depth (ae)

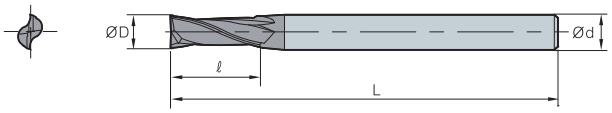
• ap: ≤ 1.5D
• ap: ≤ 0.1D



■ Slotting depth (ap)

• ap: ≤ 0.3D

IPFE2000 (Flat)





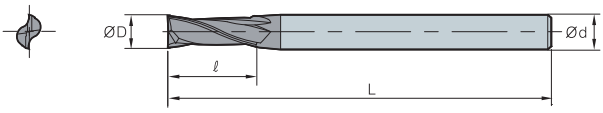

ØD	Tolerance
Ø1~Ø12	0.00~ -0.02
Ø12.1~Ø20	0.00~ -0.03




(mm)

Designation		ØD	Ød	ℓ	L
IPFE	2010-050-S3	1	3	3	50
	2010-050-S4	1	4	3	50
	2010-050	1	6	3	50
	2015-050-S3	1.5	3	4	50
	2015-050-S4	1.5	4	4	50
	2015-050	1.5	6	4	50
	2020-050-S3	2	3	6	50
	2020-050-S4	2	4	6	50
	2020-050	2	6	6	50
	2025-050-S3	2.5	3	8	50
	2025-050-S4	2.5	4	8	50
	2025-050	2.5	6	8	50
	2030-050-S3	3	3	8	50
	2030-050-S4	3	4	8	50
	2030-050	3	6	8	50
	2035-050-S4	3.5	4	10	50
	2035-050	3.5	6	10	50
	2040-050-S4	4	4	11	50
	2040-050	4	6	11	50
	2045-050	4.5	6	13	50
	2050-050	5	6	13	50
	2055-050	5.5	6	13	50
	2060-050	6	6	16	50
	2065-060	6.5	8	16	60
	2070-060	7	8	16	60
	2075-060	7.5	8	19	60
	2080-060	8	8	20	60
	2085-075	8.5	10	20	75
	2090-075	9	10	20	75
	2095-075	9.5	10	25	75
	2100-075	10	10	25	75
	2105-075	10.5	12	25	75
	2110-075	11	12	30	75
	2115-075	11.5	12	30	75
	2120-075	12	12	32	75
	2140-100	14	16	40	100
	2160-100	16	16	40	100
	2180-100	18	20	45	100
	2200-100	20	20	45	100

IPLFE2000 (Long flat)



ØD	Tolerance
Ø1~Ø12	0.00~ -0.02
Ø12.1~Ø20	0.00~ -0.03

Long shank type

(mm)

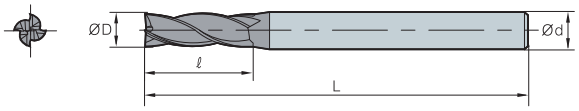
Designation		ØD	Ød	ℓ	L
IPLFE 2	2060-075	6	6	16	75
	2060-100	6	6	16	100
	2080-075	8	8	20	75
	2080-100	8	8	20	100
	2100-100	10	10	25	100
	2100-150	10	10	25	150
	2120-100	12	12	32	100
	2120-150	12	12	32	150

Long flute type

(mm)

Designation		ØD	Ød	ℓ	L
IPLFE 2	2010-050-V7S4	1	4	7	50
	2015-050-V9S4	1.5	4	9	50
	2020-050-V12S4	2	4	12	50
	2025-050-V12S4	2.5	4	12	50
	2030-060-V15S6	3	6	15	60
	2035-060-V15S6	3.5	6	15	60
	2040-075-V20S6	4	6	20	75
	2045-075-V20S6	4.5	6	20	75
	2050-075-V25S6	5	6	25	75
	2055-075-V25S6	5.5	6	25	75
	2060-075-V30S6	6	6	30	75
	2070-100-V30S8	7	8	30	100
	2080-100-V40S8	8	8	40	100
	2090-100-V40S10	9	10	40	100
	2100-100-V40S10	10	10	40	100
	2110-100-V40S12	11	12	40	100
	2120-100-V50S12	12	12	50	100
	2140-150-V50S16	14	16	50	150
	2160-150-V60S16	16	16	60	150
	2200-200-V90S20	20	20	90	200

IPFE4000 (Flat)



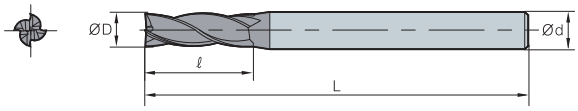
4 | H A 35° | Substrate PC320 | h6 shank

ØD	Tolerance
Ø1~Ø12	0.00~ -0.02
Ø12.1~Ø20	0.00~ -0.03

(mm)

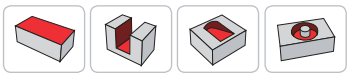
Designation		ØD	Ød	ℓ	L
IPFE 4	4010-050-S3	1	3	3	50
	4010-050-S4	1	4	3	50
	4010-050	1	6	3	50
	4015-050-S3	1.5	3	4	50
	4015-050-S4	1.5	4	4	50
	4015-050	1.5	6	4	50
	4020-050-S3	2	3	6	50
	4020-050-S4	2	4	6	50
	4020-050	2	6	6	50
	4025-050-S3	2.5	3	8	50
	4025-050-S4	2.5	4	8	50
	4025-050	2.5	6	8	50
	4030-050-S3	3	3	8	50
	4030-050-S4	3	4	8	50
	4030-050	3	6	8	50
	4035-050-S4	3.5	4	10	50
	4035-050	3.5	6	10	50
	4040-050-S4	4	4	11	50
	4040-050	4	6	11	50
	4045-050	4.5	6	13	50
	4050-050	5	6	13	50
	4055-050	5.5	6	13	50
	4060-050	6	6	16	50
	4065-060	6.5	8	16	60
	4070-060	7	8	16	60
	4075-060	7.5	8	19	60
	4080-060	8	8	20	60
	4085-075	8.5	10	20	75
	4090-075	9	10	20	75
	4095-075	9.5	10	25	75
	4100-075	10	10	30	75
	4105-075	10.5	12	30	75
	4110-075	11	12	30	75
	4115-075	11.5	12	30	75
	4120-075	12	12	32	75
	4140-100	14	16	40	100
	4160-100	16	16	40	100
	4180-100	18	20	45	100
	4200-100	20	20	45	100

IPLFE4000 (Long flat)



4 | H A 35° | Substrate PC320 | h6 shank

ØD	Tolerance
Ø1~Ø12	0.00~ -0.02
Ø12.1~Ø20	0.00~ -0.03



Long shank type

(mm)

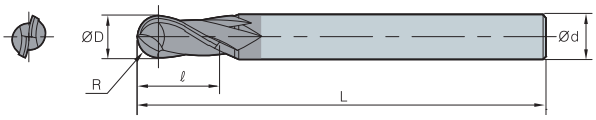
Designation		ØD	Ød	ℓ	L
IPLFE 4	4060-075	6	6	16	75
	4060-100	6	6	16	100
	4080-075	8	8	20	75
	4080-100	8	8	20	100
	4100-100	10	10	30	100
	4100-150	10	10	30	150
	4120-100	12	12	32	100
	4120-150	12	12	32	150

Long flute type

(mm)

Designation		ØD	Ød	ℓ	L
IPLFE 4	4010-050-V6S4	1	4	6	50
	4015-050-V9S4	1.5	4	9	50
	4020-050-V12S4	2	4	12	50
	4025-050-V12S4	2.5	4	12	50
	4030-060-V15S6	3	6	15	60
	4035-060-V15S6	3.5	6	15	60
	4040-075-V20S6	4	6	20	75
	4045-075-V20S6	4.5	6	20	75
	4050-075-V25S6	5	6	25	75
	4055-075-V25S6	5.5	6	25	75
	4060-075-V30S6	6	6	30	75
	4070-100-V30S8	7	8	30	100
	4080-100-V40S8	8	8	40	100
	4090-100-V40S10	9	10	40	100
	4100-100-V40S10	10	10	40	100
	4110-100-V40S12	11	12	40	100
	4120-100-V50S12	12	12	50	100
	4140-150-V50S16	14	16	50	150
	4160-150-V60S16	16	16	60	150
	4200-200-V90S20	20	20	90	200

IPBE2000 (Ball)

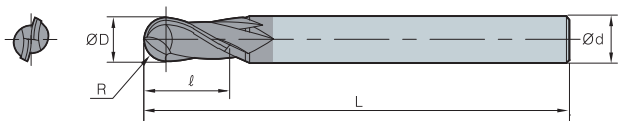


ØD	Tolerance
Ø1~Ø12	0.00~ -0.02
Ø12.1~Ø20	0.00~ -0.03

(mm)

Designation		R	ØD	Ød	ℓ	L
IPBE 2	2010-050-S3	0.5	1	3	2	50
	2010-050-S4	0.5	1	4	2	50
	2010-050	0.5	1	6	2	50
	2015-050-S3	0.75	1.5	3	3	50
	2015-050-S4	0.75	1.5	4	3	50
	2015-050	0.75	1.5	6	3	50
	2020-050-S3	1	2	3	4	50
	2020-050-S4	1	2	4	4	50
	2020-050	1	2	6	4	50
	2025-050-S3	1.25	2.5	3	5	50
	2025-050-S4	1.25	2.5	4	5	50
	2025-050	1.25	2.5	6	5	50
	2030-050-S3	1.5	3	3	6	50
	2030-050-S4	1.5	3	4	6	50
	2030-050	1.5	3	6	6	50
	2035-050-S4	1.75	3.5	4	7	50
	2035-050	1.75	3.5	6	7	50
	2040-050-S4	2	4	4	8	50
	2040-050	2	4	6	8	50
	2045-050	2.25	4.5	6	9	50
	2050-050	2.5	5	6	10	50
	2060-050	3	6	6	12	50
	2070-060	3.5	7	8	14	60
	2080-060	4	8	8	16	60
	2090-075	4.5	9	10	18	75
	2100-075	5	10	10	20	75
	2120-075	6	12	12	24	75
	2140-100	7	14	16	28	100
	2160-100	8	16	16	32	100
	2180-100	9	18	20	36	100
	2200-100	10	20	20	40	100

IPLBE2000 (Long ball)

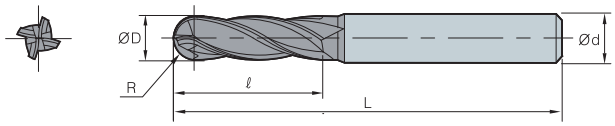


ØD	Tolerance
Ø1~Ø12	0.00~ -0.02
Ø12.1~Ø16	0.00~ -0.03

(mm)

Designation		R	ØD	Ød	ℓ	L
IPLBE	2010-075	0.5	1	6	2	75
2	2010-100	0.5	1	6	2	100
	2015-075	0.75	1.5	6	3	75
	2015-100	0.75	1.5	6	3	100
	2020-075	1	2	6	4	75
	2020-100	1	2	6	4	100
	2025-075	1.25	2.5	6	5	75
	2025-100	1.25	2.5	6	5	100
	2030-075	1.5	3	6	6	75
	2030-100	1.5	3	6	6	100
	2035-100	1.75	3.5	6	7	100
	2040-075	2	4	6	8	75
	2040-100	2	4	6	8	100
	2050-075	2.5	5	6	10	75
	2050-100	2.5	5	6	10	100
	2060-075	3	6	6	12	75
	2060-100	3	6	6	12	100
	2060-150	3	6	6	12	150
	2080-075	4	8	8	16	75
	2080-100	4	8	8	16	100
	2080-150	4	8	8	16	150
	2100-100	5	10	10	20	100
	2100-150	5	10	10	20	150
	2100-200	5	10	10	20	200
	2120-100	6	12	12	24	100
	2120-150	6	12	12	24	150
	2120-200	6	12	12	24	200
	2160-150	8	16	16	32	150
	2160-200	8	16	16	32	200

IPBE4000 (Ball)



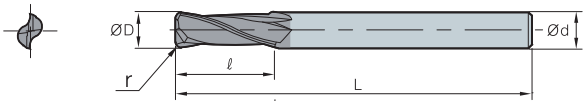
4 | H A 35° | Substrate PC320 | h6 shank

ØD	Tolerance
Ø1~Ø12	0.00~ -0.02
Ø12.1~Ø20	0.00~ -0.03

(mm)

Designation		R	ØD	Ød	ℓ	L
IPBE 4	4010-050-S4	0.5	1	4	2	50
	4010-050	0.5	1	6	2	50
	4015-050-S4	0.75	1.5	4	3	50
	4015-050	0.75	1.5	6	3	50
	4020-050-S4	1	2	4	4	50
	4020-050	1	2	6	4	50
	4025-050-S4	1.25	2.5	4	5	50
	4025-050	1.25	2.5	6	5	50
	4030-050-S3	1.5	3	3	6	50
	4030-050-S4	1.5	3	4	6	50
	4030-050	1.5	3	6	6	50
	4035-050-S4	1.75	3.5	4	7	50
	4035-050	1.75	3.5	6	7	50
	4040-050-S4	2	4	4	8	50
	4040-050	2	4	6	8	50
	4045-050	2.25	4.5	6	9	50
	4050-050	2.5	5	6	10	50
	4060-050	3	6	6	12	50
	4070-060	3.5	7	8	14	60
	4080-060	4	8	8	16	60
	4090-075	4.5	9	10	18	75
	4100-075	5	10	10	20	75
	4120-075	6	12	12	24	75
	4140-100	7	14	16	28	100
	4160-100	8	16	16	32	100
	4180-100	9	18	20	36	100
	4200-100	10	20	20	40	100

IPRE2000 (Radius)

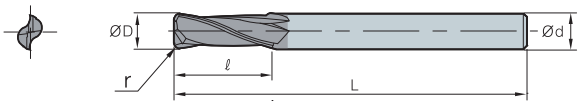


ØD	Tolerance
Ø1~Ø12	0.00~ -0.02

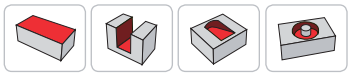
(mm)

Designation		ØD	Ød	ℓ	L	r
IPRE 2	2010-050-R01	1	4	3	50	0.1
	2010-050-R02	1	4	3	50	0.2
	2010-050-R03	1	4	3	50	0.3
	2015-050-R02	1.5	4	4	50	0.2
	2015-050-R03	1.5	4	4	50	0.3
	2020-050-R02	2	4	6	50	0.2
	2020-050-R03	2	4	6	50	0.3
	2020-050-R05	2	4	6	50	0.5
	2025-050-R02	2.5	4	8	50	0.2
	2030-050-R02-S3	3	3	8	50	0.2
	2030-050-R03-S3	3	3	8	50	0.3
	2030-050-R05-S3	3	3	8	50	0.5
	2030-050-R10-S3	3	3	8	50	1
	2030-050-R02	3	4	8	50	0.2
	2030-050-R03	3	4	8	50	0.3
	2030-050-R05	3	4	8	50	0.5
	2030-050-R10	3	4	8	50	1
	2040-050-R02	4	4	10	50	0.2
	2040-050-R03	4	4	10	50	0.3
	2040-050-R05	4	4	10	50	0.5
	2040-050-R10	4	4	10	50	1
	2040-050-R15	4	4	10	50	1.5
	2050-050-R02	5	6	13	50	0.2
	2050-050-R03	5	6	13	50	0.3
	2050-050-R05	5	6	13	50	0.5
	2050-050-R10	5	6	13	50	1
	2060-050-R02	6	6	15	50	0.2
	2060-050-R03	6	6	15	50	0.3
	2060-050-R05	6	6	15	50	0.5
	2060-050-R10	6	6	15	50	1
	2060-050-R15	6	6	15	50	1.5
	2060-050-R20	6	6	15	50	2

IPRE2000 (Radius)



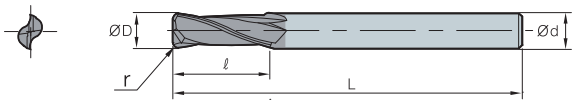
ØD	Tolerance
Ø1~Ø12	0.00~ -0.02



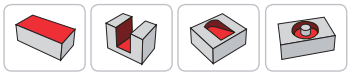
(mm)

Designation		ØD	Ød	ℓ	L	r
IPRE 2	2080-060-R03	8	8	20	60	0.3
	2080-060-R05	8	8	20	60	0.5
	2080-060-R10	8	8	20	60	1
	2080-060-R15	8	8	20	60	1.5
	2080-060-R20	8	8	20	60	2
	2080-060-R25	8	8	20	60	2.5
	2080-060-R30	8	8	20	60	3
	2100-075-R03	10	10	25	75	0.3
	2100-075-R05	10	10	25	75	0.5
	2100-075-R10	10	10	25	75	1
	2100-075-R15	10	10	25	75	1.5
	2100-075-R20	10	10	25	75	2
	2100-075-R25	10	10	25	75	2.5
	2100-075-R30	10	10	25	75	3
	2120-075-R03	12	12	30	75	0.3
	2120-075-R05	12	12	30	75	0.5
	2120-075-R10	12	12	30	75	1
	2120-075-R15	12	12	30	75	1.5
	2120-075-R20	12	12	30	75	2
	2120-075-R25	12	12	30	75	2.5
	2120-075-R30	12	12	30	75	3

IPLRE2000 (Long radius)



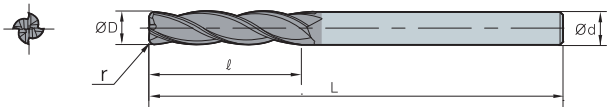
ØD	Tolerance
Ø3~Ø12	0.00~ -0.02



(mm)

Designation		ØD	Ød	ℓ	L	r
IPLRE	2030-075-R03	3	3	8	75	0.3
	2030-075-R05	3	3	8	75	0.5
	2030-075-R10	3	3	8	75	1
	2040-075-R03	4	4	10	75	0.3
	2040-075-R05	4	4	10	75	0.5
	2040-075-R10	4	4	10	75	1
	2040-075-R15	4	4	10	75	1.5
	2060-100-R03	6	6	15	100	0.3
	2060-100-R05	6	6	15	100	0.5
	2060-100-R10	6	6	15	100	1
	2060-100-R15	6	6	15	100	1.5
	2060-100-R20	6	6	15	100	2
	2080-100-R03	8	8	20	100	0.3
	2080-100-R05	8	8	20	100	0.5
	2080-100-R10	8	8	20	100	1
	2080-100-R15	8	8	20	100	1.5
	2080-100-R20	8	8	20	100	2
	2080-100-R25	8	8	20	100	2.5
	2080-100-R30	8	8	20	100	3
	2100-100-R03	10	10	25	100	0.3
	2100-100-R05	10	10	25	100	0.5
	2100-100-R10	10	10	25	100	1
	2100-100-R15	10	10	25	100	1.5
	2100-100-R20	10	10	25	100	2
	2100-100-R25	10	10	25	100	2.5
	2100-100-R30	10	10	25	100	3
	2120-100-R03	12	12	30	100	0.3
	2120-100-R05	12	12	30	100	0.5
	2120-100-R10	12	12	30	100	1
	2120-100-R15	12	12	30	100	1.5
	2120-100-R20	12	12	30	100	2
	2120-100-R25	12	12	30	100	2.5
	2120-100-R30	12	12	30	100	3

IPRE4000 (Radius)



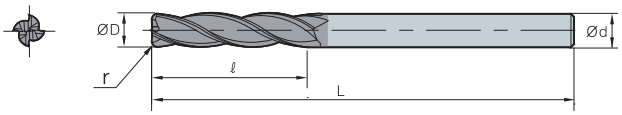
4 | H A 35° | Substrate PC320 | h6 shank

ØD	Tolerance
Ø2~Ø12	0.00~ -0.02

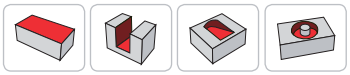
(mm)

Designation		ØD	Ød	ℓ	L	r
IPRE 4	4020-050-R02	2	4	6	50	0.2
	4020-050-R03	2	4	6	50	0.3
	4020-050-R05	2	4	6	50	0.5
	4025-050-R02	2.5	4	8	50	0.2
	4030-050-R02-S3	3	3	8	50	0.2
	4030-050-R03-S3	3	3	8	50	0.3
	4030-050-R05-S3	3	3	8	50	0.5
	4030-050-R10-S3	3	3	8	50	1
	4030-050-R02	3	4	8	50	0.2
	4030-050-R03	3	4	8	50	0.3
	4030-050-R05	3	4	8	50	0.5
	4030-050-R10	3	4	8	50	1
	4040-050-R02	4	4	10	50	0.2
	4040-050-R03	4	4	10	50	0.3
	4040-050-R05	4	4	10	50	0.5
	4040-050-R10	4	4	10	50	1
	4040-050-R15	4	4	10	50	1.5
	4050-050-R02	5	6	13	50	0.2
	4050-050-R03	5	6	13	50	0.3
	4050-050-R05	5	6	13	50	0.5
	4050-050-R10	5	6	13	50	1
	4060-050-R02	6	6	15	50	0.2
	4060-050-R03	6	6	15	50	0.3
	4060-050-R05	6	6	15	50	0.5
	4060-050-R10	6	6	15	50	1
	4060-050-R15	6	6	15	50	1.5
	4060-050-R20	6	6	15	50	2
	4080-060-R03	8	8	20	60	0.3
	4080-060-R05	8	8	20	60	0.5
	4080-060-R10	8	8	20	60	1
	4080-060-R15	8	8	20	60	1.5
	4080-060-R20	8	8	20	60	2
	4080-060-R25	8	8	20	60	2.5
	4080-060-R30	8	8	20	60	3
	4100-075-R03	10	10	25	75	0.3
	4100-075-R05	10	10	25	75	0.5
	4100-075-R10	10	10	25	75	1
	4100-075-R15	10	10	25	75	1.5
	4100-075-R20	10	10	25	75	2
	4100-075-R25	10	10	25	75	2.5
	4100-075-R30	10	10	25	75	3
	4120-075-R03	12	12	30	75	0.3
	4120-075-R05	12	12	30	75	0.5
	4120-075-R10	12	12	30	75	1
	4120-075-R15	12	12	30	75	1.5
	4120-075-R20	12	12	30	75	2
	4120-075-R25	12	12	30	75	2.5
	4120-075-R30	12	12	30	75	3

IPLRE4000 (Long radius)



ØD	Tolerance
Ø3~Ø12	0.00~ -0.02



(mm)

Designation		ØD	Ød	ℓ	L	r
IPLRE 4	4030-075-R03	3	3	8	75	0.3
	4030-075-R05	3	3	8	75	0.5
	4030-075-R10	3	3	8	75	1
	4040-075-R03	4	4	10	75	0.3
	4040-075-R05	4	4	10	75	0.5
	4040-075-R10	4	4	10	75	1
	4040-075-R15	4	4	10	75	1.5
	4060-100-R03	6	6	15	100	0.3
	4060-100-R05	6	6	15	100	0.5
	4060-100-R10	6	6	15	100	1
	4060-100-R15	6	6	15	100	1.5
	4060-100-R20	6	6	15	100	2
	4080-100-R03	8	8	20	100	0.3
	4080-100-R05	8	8	20	100	0.5
	4080-100-R10	8	8	20	100	1
	4080-100-R15	8	8	20	100	1.5
	4080-100-R20	8	8	20	100	2
	4080-100-R25	8	8	20	100	2.5
	4080-100-R30	8	8	20	100	3
	4100-100-R03	10	10	25	100	0.3
	4100-100-R05	10	10	25	100	0.5
	4100-100-R10	10	10	25	100	1
	4100-100-R15	10	10	25	100	1.5
	4100-100-R20	10	10	25	100	2
	4100-100-R25	10	10	25	100	2.5
	4100-100-R30	10	10	25	100	3
	4120-100-R03	12	12	30	100	0.3
	4120-100-R05	12	12	30	100	0.5
	4120-100-R10	12	12	30	100	1
	4120-100-R15	12	12	30	100	1.5
	4120-100-R20	12	12	30	100	2
	4120-100-R25	12	12	30	100	2.5
	4120-100-R30	12	12	30	100	3

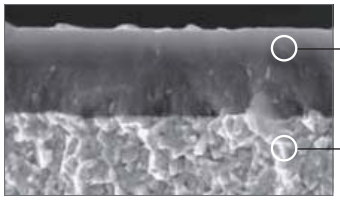
Highly efficient and economical endmill for general cutting

Z+ Endmill

- Wide application range from roughing to finishing on various types of workpiece materials up to HRC47
- Increased tool life thanks to a new substrate and advanced coating layers
- Prevention of chipping and extended cutting tume thnks to its optimized edge design

Features

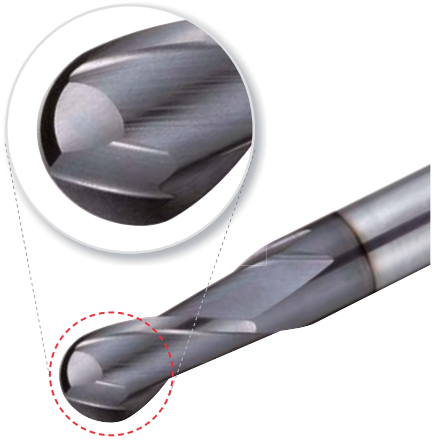
- Wide range of workpiece materials - Carbon steel, alloy steel, cast iron, etc
- Extended tool life - Newly invented substrate and high-tech coating layers applied
- Higher productivity - Wide application range from roughing to finishing

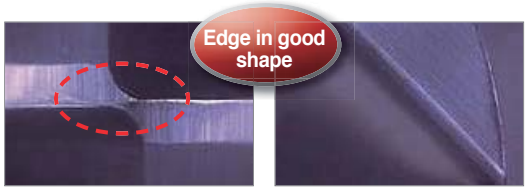


AlCrSiN coating layer
: Coating lubrication making possible high temperature/high speed machining

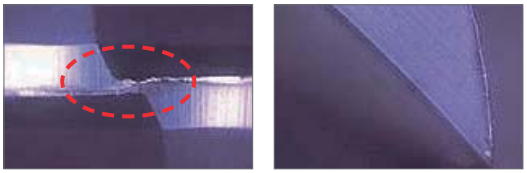
Ultra-fine substrate
: Substrate with excellent wear resistance applied

PC320U





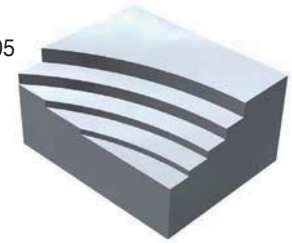
Z+ Endmill
Exceptional cutting edge rigidity



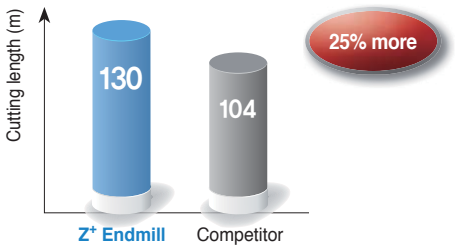
Competitor

Application examples

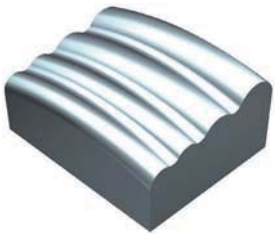
■ **Workpiece** Carbon steel (C45, ~HRC20)
■ **Cutting conditions** vc (m/min) = 180, fz (mm/t) = 0.05
ap (mm) = 8, dry
■ **Tools** ZPFE4080-060



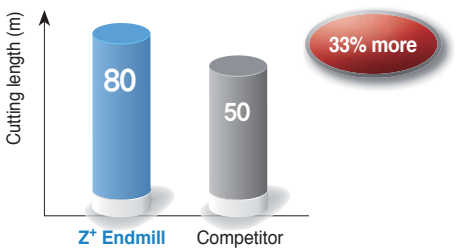
■ **Test result**



■ **Workpiece** Carbon steel (C45, ~HRC20)
■ **Cutting conditions** vc (m/min) = 130, fz (mm/t) = 0.1
ap (mm) = 0.5, dry
■ **Tools** ZPBE2080-100



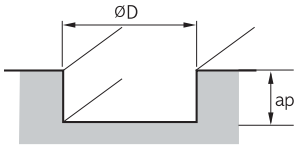
■ **Test result**



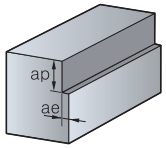
Recommended cutting conditions (ZPFE2000/ZPSFE2000 Flat)

Workpiece / Cutting conditions / Diameter (Ø)	Alloy steel and Carbon steel (under HRC30)		Pre-hardened steel, Mold steel (HRC30~47)		Stainless steel	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
1	19,745	175	13,057	100	10,500	70
2	11,560	190	7,560	120	6,300	90
3	8,920	210	5,560	140	4,620	120
4	7,560	300	4,620	180	3,880	150
5	6,300	320	3,780	190	3,160	160
6	5,560	350	3,360	220	2,840	180
8	4,200	380	2,520	200	2,100	180
10	3,260	330	2,000	160	1,680	160
12	2,740	280	1,680	130	1,360	130
16	2,200	220	1,360	110	1,060	110

Application tip



■ **Slotting depth (ap)**
- D ≤ Ø2.5 (ap = 0.3D)
- D > Ø2.5 (ap = 0.5D)



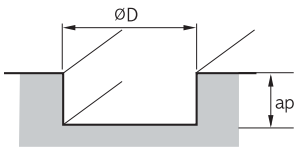
■ **Shouldering depth (ap)**
- D ≤ Ø2.5 (ap = 1.5D, ae = 0.05D)
- D > Ø2.5 (ap = 1.5D, ae = 0.1D)

※ Workpiece should be clamped rigidly. In case of vibrations, reduce RPM and feed rate by the same ratio

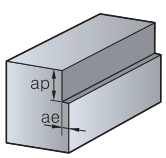
Recommended cutting conditions (ZPFE4000/ZPSFE4000 Flat)

Workpiece / Cutting conditions / Diameter (Ø)	Alloy steel and Carbon steel (under HRC30)		Pre-hardened steel, Mold steel (HRC30~47)		Stainless steel	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
2	11,560	280	7,560	170	6,300	140
3	8,920	320	5,560	200	4,620	170
4	7,560	570	4,620	350	3,880	280
5	6,300	600	3,780	360	3,160	300
6	5,560	660	3,360	410	2,840	330
8	4,200	710	2,520	380	2,100	350
10	3,260	610	2,000	300	1,680	300
12	2,740	520	1,680	250	1,360	240
16	2,200	410	1,360	200	1,100	200

Application tip



■ **Slotting depth (ap)**
- D ≤ Ø2.5 (ap = 0.3D)
- D > Ø2.5 (ap = 0.5D)



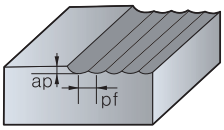
■ **Shouldering depth (ap)**
- D ≤ Ø2.5 (ap = 1.5D, ae = 0.05D)
- D > Ø2.5 (ap = 1.5D, ae = 0.1D)

※ Workpiece should be clamped rigidly. In case of vibrations, reduce RPM and feed rate by the same ratio

Recommended cutting conditions (ZPBE2000 Ball)

Workpiece / Cutting conditions / Diameter (Ø)	Alloy steel and Carbon steel (under HRC30)		Pre-hardened steel, Mold steel (HRC30~47)	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
1	30,000	2,880	30,000	2,520
1.2	30,000	3,060	28,800	2,580
1.5	30,000	3,240	28,800	2,700
2	29,820	3,420	28,680	2,880
3	19,860	3,600	19,080	3,180
4	14,940	3,600	14,340	3,180
5	11,160	3,480	10,680	2,940
6	8,340	2,910	8,040	2,460
8	6,660	2,520	6,420	2,100
10	5,580	2,220	5,340	1,860
12	4,170	1,770	4,008	1,500

Application tip



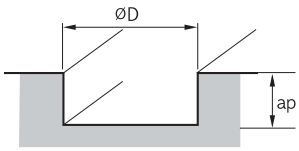
- ap = 0.03D
- pf = 0.05D

※ Workpiece should be clamped rigidly. In case of vibrations, reduce RPM and feed rate by the same ratio

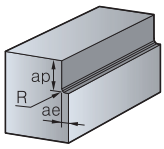
Recommended cutting conditions (ZPRE2000 Radius)

Workpiece / Cutting conditions / Diameter (Ø)	Alloy steel and Carbon steel (under HRC30)		Pre-hardened steel, Mold steel (HRC30~47)		Stainless steel	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
6	5,300	420	3,200	240	2,400	180
8	4,000	450	2,700	210	2,040	150
10	3,200	390	2,400	180	1,600	120
12	2,700	330	2,040	150	1,300	100
14	2,400	270	1,600	120	1,000	70
16	2,040	200	1,300	100	1,300	60

Application tip



■ **Slotting depth (ap)**
- ap: ≤ 0.3D



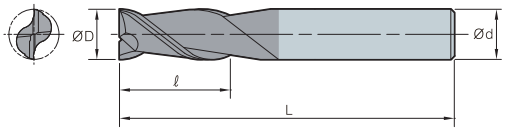
■ **Shouldering depth (ap)**
- ap: ≤ 1.5D
- ae: ≤ 0.1D

※ Workpiece should be clamped rigidly. In case of vibrations, reduce RPM and feed rate by the same ratio

Notice

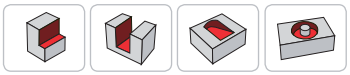
- Please adjust the recommended cutting conditions properly, according to the condition of your machines, the target shapes, and your purpose for machining
- Workpiece should be clamped rigidly. In case of vibrations, reduce RPM and feed rate by the same ratio
- In case of overhang over 3D, reduce RPM and feed rate

ZPFE2000 (Flat)



2 | H·A 35° | Substrate PC320U | h6 shank

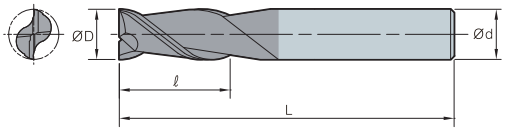
ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03



(mm)

Designation		ØD	Ød	ℓ	L
ZPFE 2	2010-050-S4	1.0	4	3	50
	2015-050-S4	1.5	4	4	50
	2020-050-S4	2.0	4	6	50
	2025-050-V6S4	2.5	4	6	50
	2025-050-V8S4	2.5	4	8	50
	2030-050-S4	3.0	4	9	50
	2030-050	3.0	6	9	50
	2035-050-S4	3.5	4	9	50
	2035-050	3.5	6	9	50
	2040-050-S4	4.0	4	11	50
	2040-050	4.0	6	11	50
	2045-050	4.5	6	11	50
	2050-050	5.0	6	13	50
	2060-050	6.0	6	16	50
	2065-060	6.5	8	16	60
	2070-060	7.0	8	20	60
	2075-060	7.5	8	20	60
	2080-060	8.0	8	20	60
	2085-075	8.5	10	23	75
	2090-075	9.0	10	23	75
	2095-075	9.5	10	25	75
	2100-075	10.0	10	25	75
	2105-075	10.5	12	26	75
	2110-075	11.0	12	28	75
	2120-075	12.0	12	30	75
	2140-100	14.0	14	34	100
	2150-090	15.0	16	36	90
	2160-100	16.0	16	36	100
	2170-100	17.0	20	40	100
	2180-100	18.0	18	40	100
	2190-100	19.0	20	40	100
	2200-100	20.0	20	40	100

ZPSFE2000 (Short flat)



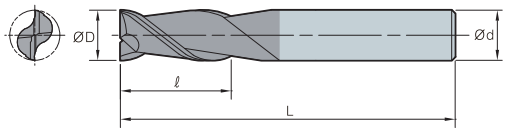
2 | H·A 35° | Substrate PC320U | h6 shank

ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03

(mm)

Designation		ØD	Ød	ℓ	L
ZPSFE 2	2010-050-S4	1.0	4	2	50
	2015-050-S4	1.5	4	2	50
	2020-050-S4	2.0	4	3	50
	2025-050-S4	2.5	4	4	50
	2030-050-S4	3.0	4	5	50
	2040-050-S4	4.0	4	6	50
	2050-050	5.0	6	8	50
	2060-050	6.0	6	9	50
	2070-050	7.0	8	10	50
	2080-050	8.0	8	12	50
	2100-075	10.0	10	15	75
	2120-075	12.0	12	18	75
	2160-100	16.0	16	24	100

ZPLFE2000 (Long flat)



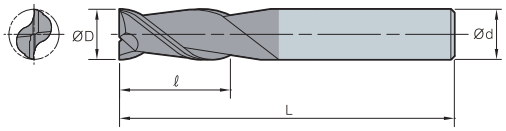
2 | H·A 35° | Substrate PC320U | h6 shank

ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03

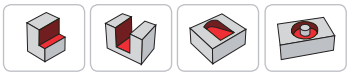
(mm)

Designation		ØD	Ød	ℓ	L
ZPLFE 2	2020-075-S4	2.0	4	6	75
	2030-075-S4	3.0	4	9	75
	2030-075	3.0	6	12	75
	2040-075-S4	4.0	4	11	75
	2050-075	5.0	6	20	75
	2060-100	6.0	6	16	100
	2060-100-V20S6	6.0	6	20	100
	2080-075	8.0	8	20	75
	2080-100	8.0	8	25	100
	2100-100	10.0	10	30	100
	2120-100	12.0	12	35	100
	2160-150	16.0	16	36	150
	2200-150	20.0	20	45	150

ZPLFE2000 (Long flute)



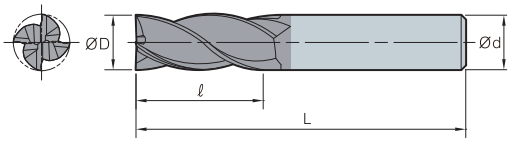
ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03



(mm)

Designation		ØD	Ød	ℓ	L
ZPLFE 2	2020-075-V15S4	2.0	4	15	75
	2030-075-V25S4	3.0	4	25	75
	2040-075-V30S4	4.0	4	30	75
	2050-075-V30S6	5.0	6	30	75
	2060-075-V35S6	6.0	6	35	75
	2080-100-V40S8	8.0	8	40	100
	2100-100-V45S10	10.0	10	45	100
	2120-100-V50S12	12.0	12	50	100
	2140-100-V55S14	14.0	14	55	100
	2160-150-V50S16	16.0	16	50	150
	2160-150-V60S16	16.0	16	60	150
	2180-150-V65S18	18.0	18	65	150
	2200-150-V70S20	20.0	20	70	150

ZPFE4000 (Flat)



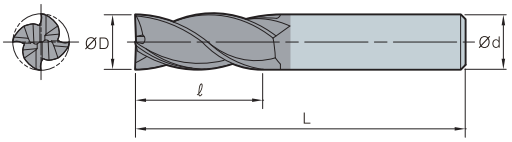
4 | H·A 35° | Substrate PC320U | h6 shank

ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03

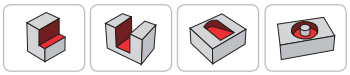
(mm)

Designation		ØD	Ød	ℓ	L
ZPFE 4	4010-050-S4	1.0	4	3	50
	4015-050-S4	1.5	4	5	50
	4015-050	1.5	6	5	50
	4020-050-S4	2.0	4	6	50
	4020-050	2.0	6	6	50
	4025-050-S4	2.5	4	8	50
	4025-050	2.5	6	8	50
	4030-050	3.0	6	6	50
	4030-050-S4	3.0	4	9	50
	4030-050-V9S6	3.0	6	9	50
	4035-050-S4	3.5	4	11	50
	4035-050	3.5	6	9	50
	4040-050-S4	4.0	4	11	50
	4040-050	4.0	6	11	50
	4045-050	4.5	6	11	50
	4050-050	5.0	6	8	50
	4050-050-V13S6	5.0	6	13	50
	4055-050	5.5	6	16	50
	4060-050	6.0	6	16	50
	4065-060	6.5	8	16	60
	4070-060	7.0	8	20	60
	4075-060	7.5	8	20	60
	4080-060	8.0	8	20	60
	4085-075	8.5	10	23	75
	4090-075	9.0	10	23	75
	4095-075	9.5	10	23	75
	4100-075	10.0	10	25	75
	4110-075	11.0	12	28	75
	4120-075	12.0	12	30	75
	4130-100	13.0	14	32	100
	4140-075	14.0	14	32	75
	4140-100	14.0	14	34	100
	4150-100	15.0	16	36	100
	4160-100	16.0	16	36	100
	4160-100-V40S16	16.0	16	40	100
	4160-100-V45S16	16.0	16	45	100
	4170-100-S18	17.0	18	38	100
	4180-100-S18	18.0	18	45	100
	4200-100-S20	20.0	20	45	100

ZPSFE4000 (Short flat)



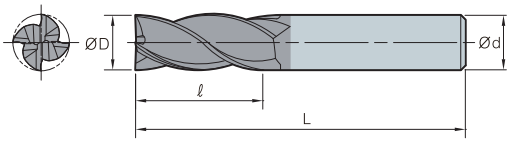
ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03



(mm)

Designation		ØD	Ød	ℓ	L
ZPSFE 4	4010-050-S4	1.0	4	2	50
	4015-050-S4	1.5	4	2	50
	4020-050-S4	2.0	4	3	50
	4025-050-S4	2.5	4	4	50
	4030-050-S4	3.0	4	5	50
	4040-050-S4	4.0	4	6	50
	4050-050	5.0	6	8	50
	4060-050	6.0	6	9	50
	4070-050	7.0	8	10	50
	4080-050	8.0	8	12	50
	4100-075	10.0	10	15	75
	4120-075	12.0	12	18	75
	4160-100	16.0	16	24	100

ZPLFE4000 (Long flat)



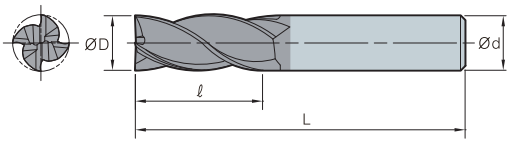
4 | H·A 35° | Substrate PC320U | h6 shank

ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03

(mm)

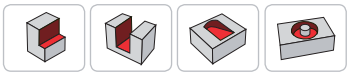
Designation		ØD	Ød	ℓ	L
ZPLFE 4	4020-075-S4	2.0	4	10	75
	4030-075-S4	3.0	4	12	75
	4040-075-S4	4.0	4	11	75
	4040-050-V15S4	4.0	4	15	75
	4050-075	5.0	6	20	75
	4060-075	6.0	6	16	75
	4060-075-V20S6	6.0	6	20	75
	4080-075	8.0	8	20	75
	4080-100-S8	8.0	8	25	100
	4100-100	10.0	10	30	100
	4100-100-V35S10	10.0	10	35	100
	4120-100	12.0	12	35	100
	4160-150	16.0	16	36	150
	4200-150	20.0	20	45	150

ZPLFE4000 (Long flute)



4 | H·A 35° | Substrate PC320U | h6 shank

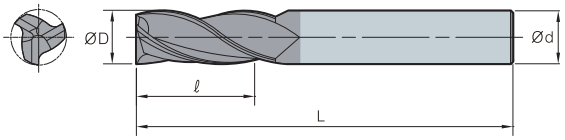
ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03



(mm)

Designation		ØD	Ød	ℓ	L
ZPLFE 4	4010-050-V04S4	1.0	4	4	50
	4020-050-V10S4	2.0	4	10	50
	4030-060-V15S4	3.0	4	15	60
	4030-060-V16S6	3.0	6	16	60
	4040-060-V20S4	4.0	4	20	60
	4040-075-V20S6	4.0	6	20	75
	4040-075-V30S4	4.0	4	30	75
	4050-075-V25S6	5.0	6	25	75
	4050-075-V30S6	5.0	6	30	75
	4060-075-V30S6	6.0	6	30	75
	4060-075-V35S6	6.0	6	35	75
	4080-100-V35S8	8.0	8	35	100
	4080-100-V40S8	8.0	8	40	100
	4100-100-V45S10	10.0	10	45	100
	4100-100-V50S10	10.0	10	50	100
	4120-100-V45S12	12.0	12	45	100
	4120-100-V50S12	12.0	12	50	100
	4140-100-V45S14	14.0	14	45	100
	4160-150-V50S16	16.0	16	50	150
	4160-150-V60S16	16.0	16	60	150
	4160-150-V70S16	16.0	16	70	150
	4180-150-V70S18	18.0	18	70	150
	4200-150-V70S20	20.0	20	70	150

ZPFE3000 (Flat)



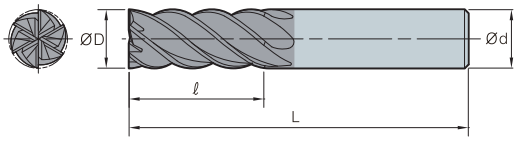
3 | H·A 35° | Substrate PC320U | h6 shank

ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03

(mm)

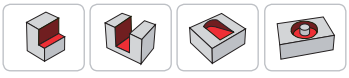
Designation		ØD	Ød	ℓ	L
ZPFE 3	3020-050-S4	2.0	4	6	50
	3030-050-S4	3.0	4	9	50
	3040-050-S4	4.0	4	11	50
	3050-050	5.0	6	13	50
	3060-050	6.0	6	16	50
	3065-060	6.5	8	16	60
	3080-060	8.0	8	20	60
	3095-075	9.5	10	24	75
	3100-075	10.0	10	25	75
	3120-075	12.0	12	30	75
	3106-100	16.0	16	36	100
	3180-100	18.0	18	40	100
	3200-100	20.0	20	45	100
	3250-100	25.0	25	50	100

ZPFE6000 (Flat)



6 | H·A 35° | Substrate PC320U | h6 shank

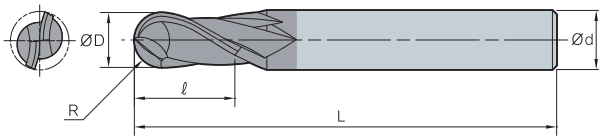
ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03



(mm)

Designation		ØD	Ød	ℓ	L
ZPFE 6	6060-050	6.0	6	15	50
	6080-060	8.0	8	20	60
	6100-075	10.0	10	25	75
	6120-075	12.0	12	30	75
	6160-100	16.0	16	36	100
	6200-100	20.0	20	45	100

ZPBE2000 (Ball)

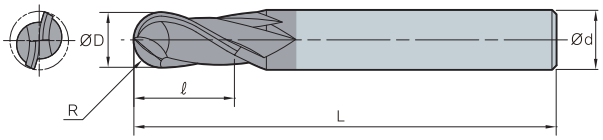


ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03

(mm)

Designation		R	ØD	Ød	ℓ	L
ZPBE 2	2008-050-S4	0.4	0.8	4	1.6	50
	2009-050-S4	0.5	0.9	4	1.8	50
	2010-050-S4	0.5	1.0	4	2	50
	2015-050-S4	0.8	1.5	4	3	50
	2020-050-S4	1.0	2.0	4	4	50
	2020-050	1.0	2.0	6	4	50
	2025-050-S4	1.3	2.5	4	5	50
	2030-050-S4	1.5	3.0	4	6	50
	2030-050	1.5	3.0	6	6	50
	2040-050-S4	2.0	4.0	4	8	50
	2040-050	2.0	4.0	6	8	50
	2050-050	2.5	5.0	6	10	50
	2060-050	3.0	6.0	6	12	50
	2070-060	3.5	7.0	8	14	60
	2080-060	4.0	8.0	8	14	60
	2090-075	4.5	9.0	10	16	75
	2100-075	5.0	10.0	10	18	75
	2110-075	5.5	11.0	12	20	75
	2120-075	6.0	12.0	12	22	75
	2130-090	6.5	13.0	14	26	90
	2140-090	7.0	14.0	14	26	90
	2150-090	7.5	15.0	16	30	90
	2160-100	8.0	16.0	16	30	100
	2200-100	10.0	20.0	20	38	100

ZPLBE2000 (Long ball)



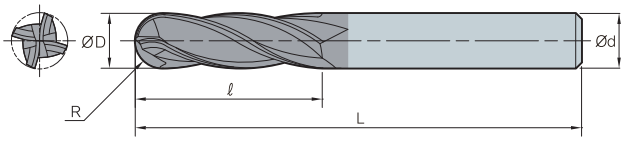
2 | H·A 35° | Substrate PC320U | h6 shank

ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03

(mm)

Designation		R	ØD	Ød	ℓ	L
ZPLBE 2	2020-075-S4	1.0	2.0	4	4	75
	2030-075-S4	1.5	3.0	4	6	75
	2030-075	1.5	3.0	6	6	75
	2040-075-S4	2.0	4.0	4	8	75
	2040-075	2.0	4.0	6	8	75
	2050-075	2.5	5.0	6	10	75
	2060-075	3.0	6.0	6	12	75
	2080-100	4.0	8.0	8	14	100
	2100-100	5.0	10.0	10	18	100
	2120-100	6.0	12.0	12	20	100

ZPBE4000 (Ball)



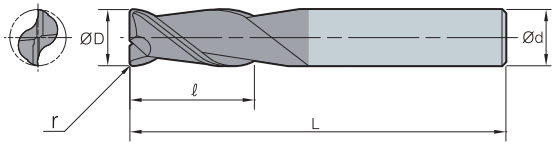
4 | H·A 35° | Substrate PC320U | h6 shank

ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03

(mm)

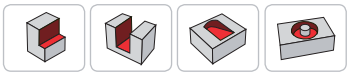
Designation		R	ØD	Ød	ℓ	L
ZPBE 4	4020-050-S4	1.0	2.0	4	4	50
	4025-050-S4	1.3	2.5	4	5	50
	4030-050-S4	1.5	3.0	4	6	50
	4030-050	1.5	3.0	6	6	50
	4040-050-S4	2.0	4.0	4	8	50
	4040-050	2.0	4.0	6	8	50
	4050-050	2.5	5.0	6	10	50
	4060-050	3.0	6.0	6	12	50
	4070-060	3.5	7.0	8	14	60
	4080-060	4.0	8.0	8	14	60
	4090-075	4.5	9.0	10	16	75
	4100-075	5.0	10.0	10	18	75
	4110-075	5.5	11.0	12	20	75
	4120-075	6.0	12.0	12	22	75
	4140-075	7.0	14.0	14	24	75
	4160-100	8.0	16.0	16	30	100
	4200-100	10.0	20.0	20	38	100

ZPRE2000 (Radius)



2 | H·A 35° | Substrate PC320U | h6 shank

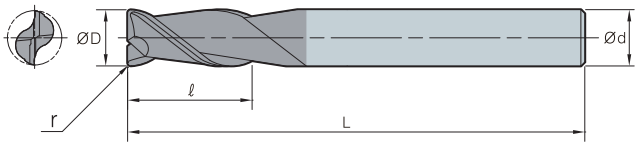
ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03



(mm)

Designation		ØD	Ød	ℓ	L	r
ZPRE 2	2010-050-S4-R02	1.0	4	3	50	0.2
	2020-050-S4-R02	2.0	4	6	50	0.2
	2030-050-S4-R02	3.0	4	9	50	0.2
	2030-050-R02	3.0	6	9	50	0.2
	2030-050-S4-R03	3.0	4	9	50	0.3
	2030-050-R03	3.0	6	9	50	0.3
	2030-050-S4-R05	3.0	4	9	50	0.5
	2030-050-R05	3.0	6	9	50	0.5
	2040-050-S4-R02	4.0	4	11	50	0.2
	2040-050-R02	4.0	6	11	50	0.2
	2040-050-S4-R03	4.0	4	11	50	0.3
	2040-050-R03	4.0	6	11	50	0.3
	2040-050-S4-R05	4.0	4	11	50	0.5
	2040-050-R05	4.0	6	11	50	0.5
	2040-050-S4-R10	4.0	4	11	50	1.0
	2050-050-R02	5.0	6	13	50	0.2
	2050-050-R03	5.0	6	13	50	0.3
	2050-050-R05	5.0	6	13	50	0.5
	2050-050-R010	5.0	6	13	50	1.0
	2060-050-R05	6.0	6	16	50	0.5
	2060-050-R10	6.0	6	16	50	1.0
	2060-050-R15	6.0	6	16	50	1.5
	2060-050-R20	6.0	6	16	50	2.0
	2080-060-R03	8.0	8	20	60	0.3
	2080-060-R05	8.0	8	20	60	0.5
	2080-060-R10	8.0	8	20	60	1.0
	2080-060-R15	8.0	8	20	60	1.5
	2080-060-R20	8.0	8	20	60	2.0
	2100-075-R03	10.0	10	25	75	0.3
	2100-075-R06	10.0	10	25	75	0.6
	2100-075-R10	10.0	10	25	75	1.0
	2100-075-R15	10.0	10	25	75	1.5
	2100-075-R20	10.0	10	25	75	2.0
	2100-075-R30	10.0	10	25	75	3.0
	2120-075-R05	12.0	12	30	75	0.5
	2120-075-R10	12.0	12	30	75	1.0
	2120-075-R15	12.0	12	30	75	1.5
	2120-075-R20	12.0	12	30	75	2.0
	2120-075-R30	12.0	12	30	75	3.0
	2160-100-R10	16.0	16	36	100	1.0
	2160-100-R20	16.0	16	36	100	2.0
	2160-100-R30	16.0	16	36	100	3.0

ZPLRE2000 (Long radius)

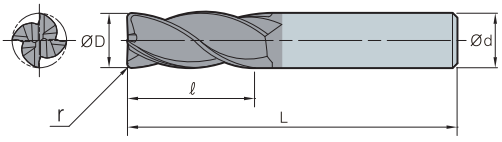


ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03

(mm)

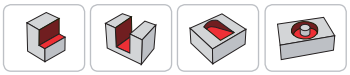
Designation		ØD	Ød	ℓ	L	r
ZPLRE 2	2060-075-R05	6.0	6	16	75	0.5
	2060-075-R10	6.0	6	16	75	1.0
	2060-075-R15	6.0	6	16	75	1.5
	2080-100-R05	8.0	8	20	100	0.5
	2080-100-R10	8.0	8	20	100	1.0
	2080-100-R15	8.0	8	20	100	1.5
	2100-100-R05	10.0	10	25	100	0.5
	2100-100-R10	10.0	10	25	100	1.0
	2100-100-R15	10.0	10	25	100	1.5
	2100-100-R20	10.0	10	25	100	2.0
	2120-100-R05	12.0	12	30	100	0.5
	2120-100-R10	12.0	12	30	100	1.0
	2120-100-R15	12.0	12	30	100	1.5
	2120-100-R20	12.0	12	30	100	2.0
	2160-150-R05	16.0	16	36	150	0.5
	2160-150-R10	16.0	16	36	150	1.0
	2160-150-R15	16.0	16	36	150	1.5
	2160-150-R20	16.0	16	36	150	2.0

ZPRE4000 (Radius)



4 | H·A 35° | Substrate PC320U | h6 shank

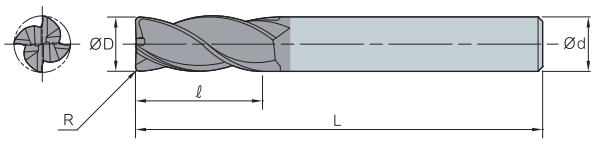
ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03



(mm)

Designation		ØD	Ød	ℓ	L	r
ZPRE 4	4015-050-S4-R02	1.5	4	5	50	0.2
	4020-050-S4-R02	2.0	4	6	50	0.2
	4030-050-S4-R02	3.0	4	9	50	0.2
	4030-050-S4-R03	3.0	4	9	50	0.3
	4030-050-S4-R05	3.0	4	9	50	0.5
	4040-050-S4-R02	4.0	4	11	50	0.2
	4040-050-S4-R03	4.0	4	11	50	0.3
	4040-050-S4-R05	4.0	4	11	50	0.5
	4040-050-S4-R10	4.0	4	11	50	1.0
	4045-050-R10	4.5	6	12	50	1.0
	4050-050-R02	5.0	6	13	50	0.2
	4050-050-R05	5.0	6	13	50	0.5
	4050-050-R10	5.0	6	13	50	1.0
	4050-050-R15	5.0	6	13	50	1.5
	4060-050-R05	6.0	6	16	50	0.5
	4060-050-R10	6.0	6	16	50	1.0
	4060-050-R15	6.0	6	16	50	1.5
	4080-060-R03	8.0	8	20	60	0.3
	4080-060-R05	8.0	8	20	60	0.5
	4080-060-R10	8.0	8	20	60	1.0
	4080-060-R15	8.0	8	20	60	1.5
	4080-060-R20	8.0	8	20	60	2.0
	4100-075-R03	10.0	10	25	75	0.3
	4100-075-R05	10.0	10	25	75	0.5
	4100-075-R10	10.0	10	25	75	1.0
	4100-075-R15	10.0	10	25	75	1.5
	4100-075-R20	10.0	10	25	75	2.0
	4100-075-R25	10.0	10	25	75	2.5
	4100-075-R30	10.0	10	25	75	3.0
	4120-075-R05	12.0	12	30	75	0.5
	4120-075-R10	12.0	12	30	75	1.0
	4120-075-R15	12.0	12	30	75	1.5
	4120-075-R20	12.0	12	30	75	2.0
	4120-075-R25	12.0	12	30	75	2.5
	4120-075-R30	12.0	12	30	75	3.0
	4160-100-R05	16.0	16	36	100	0.5
	4160-100-R10	16.0	16	36	100	1.0
	4160-100-R20	16.0	16	36	100	2.0
	4160-100-R30	16.0	16	36	100	3.0

ZPLRE4000 (Long radius)



4 | H·A 35° | Substrate PC320U | h6 shank

ØD	Tolerance
~Ø11.9	0.00~ -0.02
Ø12~	0.00~ -0.03

(mm)

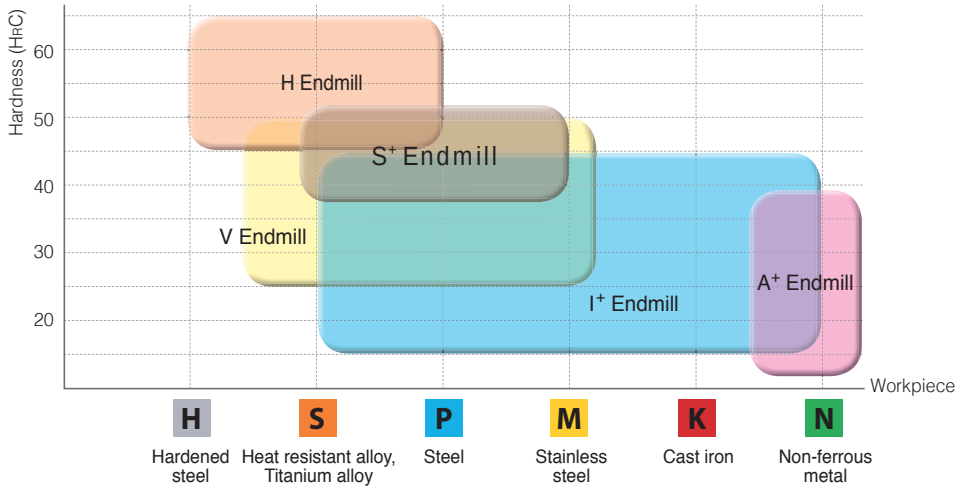
Designation		ØD	Ød	ℓ	L	r
ZPLRE 4	4060-075-R05	6.0	6	16	75	0.5
	4060-075-R10	6.0	6	16	75	1.0
	4060-075-R15	6.0	6	16	75	1.5
	4080-100-R05	8.0	8	20	100	0.5
	4080-100-R10	8.0	8	20	100	1.0
	4080-100-R15	8.0	8	20	100	1.5
	4080-100-R20	8.0	8	20	100	2.0
	4100-100-R05	10.0	10	25	100	0.5
	4100-100-R10	10.0	10	25	100	1.0
	4100-100-R15	10.0	10	25	100	1.5
	4100-100-R20	10.0	10	25	100	2.0
	4120-100-R05	12.0	12	30	100	0.5
	4120-100-R10	12.0	12	30	100	1.0
	4120-100-R15	12.0	12	30	100	1.5
	4120-100-R20	12.0	12	30	100	2.0
	4120-100-R30	12.0	12	30	100	3.0
	4160-150-R05	16.0	16	36	150	0.5
	4160-150-R10	16.0	16	36	150	1.0
	4160-150-R15	16.0	16	36	150	1.5
	4160-150-R20	16.0	16	36	150	2.0
	4160-150-R30	16.0	16	36	150	3.0

Endmill for Stainless steel machining

S+ Endmill

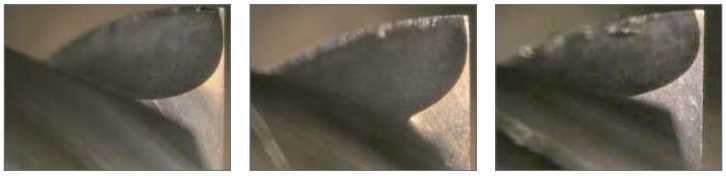
- Strong cutting edge ensures long tool life
- Special coating with high oxidation resistance
- High rake angle and curvilinear chip pocket allow chip evacuation
- Special cutting edge prevents hardening of tools
- Optimal machinability in stainless steel machining
- Available for steel, alloy steel and hardening steel machining
- Available for multiple operations (Shouldering, slotting and ramping etc.)

Application area



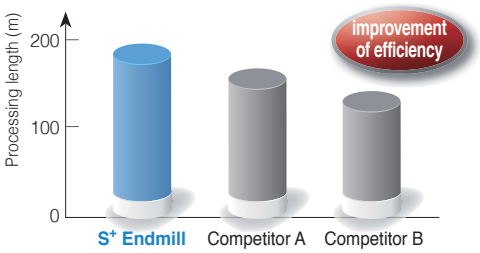
Performance evaluation

- **Workpiece** STS304
- **Cutting conditions** Diameter = Ø8.0, n (min^{-1}) = 4.000, vc (m/min) = 100, vf (mm/min) = 480, fz (mm/t) = 0.04, ap (mm) = 8, ae (mm) = 0.8, dry
- **Tools** SPFE4080-060



S+ Endmill | Competitor A | Competitor B

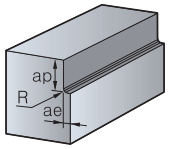
Test result



Recommend cutting conditions

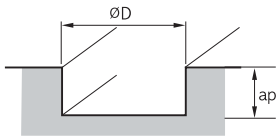
Workpiece / Condition / Diameter (Ø)	Stainless steel STS		Titanium alloy /Inconel		Normal steel (SS, SM) (Under HRC 25)		Alloy steel (SCM) (HRC 25~35)		Hardened steel (STD) (HRC 40~50)	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
2	5,500	240	2,600	90	9,000	540	6,000	3,200	4,000	240
4	4,000	260	2,000	90	6,600	600	4,500	340	3,000	280
6	3,000	360	1,200	90	4,800	720	3,000	360	2,500	280
8	2,000	390	1,000	100	3,600	750	2,200	460	2,000	300
10	1,700	410	800	120	2,800	750	1,800	460	1,500	300
12	1,500	380	700	100	2,400	710	1,500	410	1,200	280
14	1,200	320	600	95	2,200	660	1,300	370	1,000	270
16	1,000	270	500	90	1,800	490	1,100	320	800	230
20	750	250	400	85	900	270	900	270	600	200

Application tip



■ **Shouldering depth (ap) and radial depth (ae)**

- Normal steel, Alloy steel, Stainless steel: ap = 1.5D, ae = 0.1D
- Titanium alloy, Inconel, Hardened steel: ap = 1.5D, ae = 0.05D



■ **Slotting depth (ap)**

- Normal steel, Alloy steel: ap = 1.0D
- Stainless steel: ap = 0.3D
- Titanium alloy, Inconel, Hardened steel: ap = 0.2D

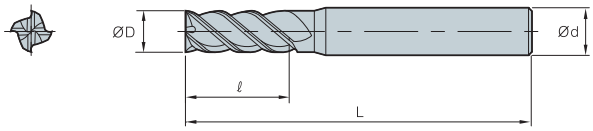
Stainless steel machining

- Low thermal conductivity of stainless steel alloy causes conducting heat to the tool and fracture and chipping
- Stainless steel alloy has high cutting resistance, and it easily causes wear on tools
- High temperature in stainless steel alloy machining lowers cutting conditions and decrease the quality of surface roughness

Trouble shooting for stainless steel

- Getting low cutting conditions
- Getting deeper ap than the work hardened layer and use tools with sharp cutting edge
- Use coolant

SPFE4000 (Flat)



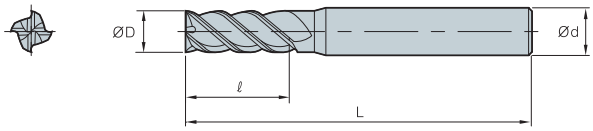
4 | H·A 45° | Substrate PC320S | h6 shank

ØD	Tolerance
Ø1~Ø12	0.00~ -0.02

(mm)

Designation		ØD	Ød	ℓ	L
SPFE 4	4010-050	1.0	4	3	50
	4015-050	1.5	4	4	50
	4020-050	2.0	4	6	50
	4025-050	2.5	4	8	50
	4030-050	3.0	4	9	50
	4030-050-S6	3.0	6	9	50
	4040-050	4.0	4	11	50
	4040-050-S6	4.0	6	11	50
	4050-050	5.0	6	13	50
	4060-050	6.0	6	16	50
	4080-060	8.0	8	20	60
	4100-075	10.0	10	30	75
	4120-075	12.0	12	32	75

SPLFE4000 (Long flat)



4 | H·A 45° | Substrate PC320S | h6 shank

ØD	Tolerance
Ø1~Ø12	0.00~ -0.02

(mm)

Designation		ØD	Ød	ℓ	L
SPLFE 4	4010-050	1.0	4	4	50
	4015-050	1.5	4	6	50
	4020-050	2.0	4	8	50
	4025-050	2.5	4	10	50
	4030-050-S6	3.0	6	12	50
	4040-050-S6	4.0	6	16	50
	4050-060	5.0	6	20	60
	4060-060	6.0	6	24	60
	4080-075	8.0	8	35	75
	4100-100	10.0	10	45	100
	4120-100	12.0	12	45	100

High efficient roughing endmill

R+ Endmill new

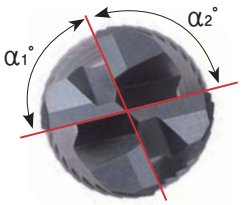
- Cost-effective cutting-edge design for rough machining
- Decreased cutting load by implementing specifically designed edges, irregular flute spacing,and unequal lead angle

Feature

- Excellent machining efficiency - Special design for medium to rough cutting
- Longer cutting life - Extended tool cost thanks to newly applied grades
- Higher cutting performance - Blade design ideal for roughing

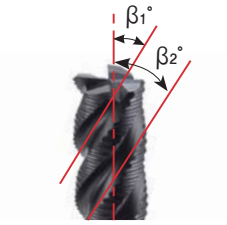
Lower cutting load
- Ideal for medium to rough cutting
- Special edge design

Smooth cutting
- Serrated cutting edges
- 3 Combo R



- Irregular flute spacing to prevent chattering

$(\alpha_1^\circ \neq \alpha_2^\circ)$



- Irregular lead angles to disperse cutting force

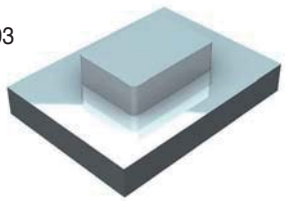
$(\beta_1^\circ \neq \beta_2^\circ)$

Grade system

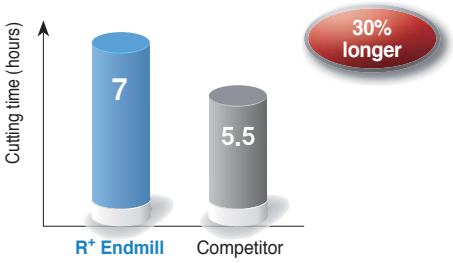
Carbide roughing		HSS roughing	
FN30T	Carbide, uncoated	HN30T	HSS PM, uncoated
PC10T	Carbide, TiCN coated	HN20T	HSS, uncoated
PC20T	Carbide, TiN coated	HC10T	HSS, TiCN coated
PC30T	Carbide, TiAlN coated	HC20T	HSS, TiN coated
PC40T	Carbide, TiAlCrN coated	HC30T	HSS PM, TiAlN coated

Application examples

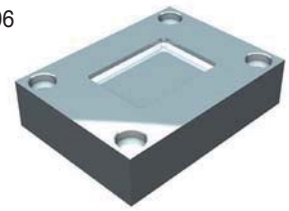
- **Workpiece** Mold
- **Cutting conditions** vc (m/min) = 57, fz (mm/t) = 0.03
  ap (mm) = 8, dry
- **Tools** RPE4080-075-FF



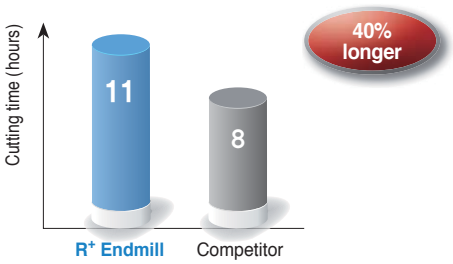
■ **Test result**



- **Workpiece** Mold
- **Cutting conditions** vc (m/min) = 68, fz (mm/t) = 0.06
  ap (mm) = 8, dry
- **Tools** RPE4080-063-FP-H



■ **Test result**

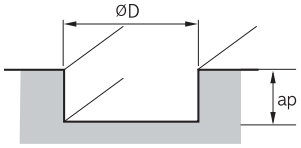


Recommended cutting conditions (RPAE)

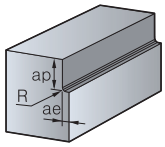
*For Carbide

Workpiece / Conditions / Diameter (Ø)	Aluminum, Non-ferrous metal		Aluminum, Non-ferrous metal	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
6	13,000	1,125	13,000	1,400
8	10,400	1,300	10,400	1,600
10	10,400	1,585	10,400	2,000
12	10,400	1,950	10,400	1,650
14	7,800	1,675	7,800	2,050
16	7,800	1,755	7,800	2,250
18	5,200	1,300	5,200	1,700
20	5,200	1,495	5,200	1,800
25	5,000	1,495	5,000	1,800

Application tip



■ **Slotting depth (ap)**
- ap : ≤ 0.2D



■ **Shouldering depth (ap)**
- ap : ≤ 1.5D
- ae : ≤ 0.15D

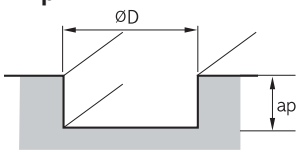
※ Workpiece should be clamped rigidly. In case of vibrations, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (RP(L)E-FP-H)

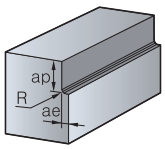
*For Carbide

Workpiece / Conditions / Diameter (Ø)	Alloy steel, Carbon steel (≤ HRC25)		Alloy steel, Carbon steel, Pre-hardened steel (HRC25~HRC40)		Alloy steel, Carbon steel (≤ HRC25)		Alloy steel, Carbon steel, Pre-hardened steel (HRC25~HRC40)	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
6	12,000	1,550	10,600	1,100	15,800	2,570	14,300	1,850
8	9,000	1,650	8,100	1,180	11,900	2,700	10,700	1,950
10	7,200	1,650	6,400	1,180	9,500	2,700	8,500	1,950
12	6,000	1,540	5,400	1,140	8,000	2,570	7,100	1,850
14	5,200	1,540	4,750	1,095	7,000	2,510	6,250	1,800
16	4,500	1,540	4,100	1,050	6,000	2,450	5,400	1,750
18	4,400	1,435	3,650	975	5,400	2,295	4,850	1,625
20	3,600	1,330	3,200	900	4,800	2,140	4,300	1,500
25	3,200	1,200	2,800	850	4,400	2,000	3,800	1,400

Application tip



■ **Slotting depth (ap)**
- ap : ≤ 1.0D (≤ HRC25)
  ≤0.8D (HRC25~40)



■ **Shouldering depth (ap)**
- ap : ≤ 1.0D
- ae : ≤ 0.5D (≤ HRC25)
  ≤ 0.35D (HRC25~40)

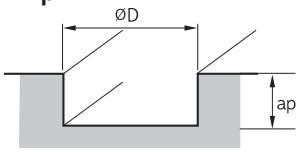
※ Workpiece should be clamped rigidly. In case of vibrations, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (RPE-XG)

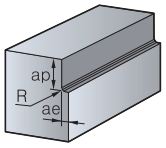
*For Carbide

Workpiece / Conditions / Diameter (Ø)	Alloy steel, Carbon steel (≤ HRC25)		Alloy steel, Carbon steel, Pre-hardened steel (HRC25~HRC40)		Alloy steel, Carbon steel (≤ HRC25)		Alloy steel, Carbon steel, Pre-hardened steel (HRC25~HRC40)	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
6	12,000	1,090	10,600	770	15,800	1,800	14,300	1,300
8	9,000	1,160	8,100	830	11,900	1,890	10,700	1,370
10	7,200	1,160	6,400	830	9,500	1,890	8,500	1,370
12	6,000	1,080	5,400	800	8,000	1,800	7,100	1,300
14	5,200	1,080	4,750	770	7,000	1,760	6,250	1,260
16	4,500	1,080	4,100	740	6,000	1,720	5,400	1,230
18	4,400	1,000	3,650	680	5,400	1,610	4,850	1,140
20	3,600	930	3,200	630	4,800	1,500	4,300	1,050
25	3,200	840	2,800	600	4,400	1,400	3,800	980

Application tip



■ **Slotting depth (ap)**
- ap: ≤ 1.0D (≤ HRC25)
  ≤ 0.8D (HRC25~40)



■ **Shouldering depth (ap)**
- ap: ≤ 1.0D
- ae: ≤ 0.5D (≤ HRC25)
  ≤ 0.35D (HRC25~40)

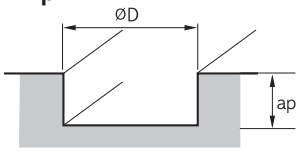
※ Workpiece should be clamped rigidly. In case of vibrations, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (RPE-FP-L)

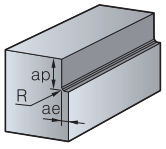
*For Carbide

Workpiece / Conditions / Diameter (Ø)	Alloy steel, Carbon steel (≤ HRC35)		Pre-hardened steel (HRC35~HRC45)		High hardened steel (HRC45~HRC55)	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
6	12,400	840	8,400	570	3,400	260
8	9,200	840	6,300	570	2,400	240
10	7,600	840	5,100	570	2,000	290
12	6,000	840	4,200	570	1,680	260
14	5,200	840	3,600	570	1,400	200
16	4,800	760	3,300	510	1,200	160
18	4,400	720	2,700	420	1,100	150
20	3,600	560	2,400	360	1,000	150
25	3,200	620	2,160	410	900	160

Application tip



■ **Slotting depth (ap)**
- ap: ≤ 0.3D (≤ HRC45)
  ≤ 0.05D (HRC45~55)



■ **Shouldering depth (ap)**
- ap: ≤ 1.0D
- ae: ≤ 0.3D (≤ HRC45)
  ≤ 0.05D (HRC45~55)

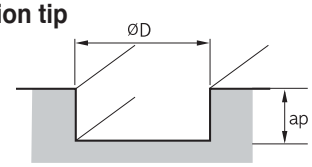
※ Workpiece should be clamped rigidly. In case of vibrations, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (RPE-RG)

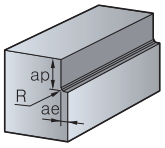
*For Carbide

Workpiece / Conditions / Diameter (Ø)	Alloy steel, Carbon steel (≤ HRC25)		Alloy steel, Carbon steel, Pre-hardened steel (HRC25~HRC40)		Alloy steel, Carbon steel (≤ HRC25)		Alloy steel, Carbon steel, Pre-hardened steel (HRC25~HRC40)	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
6	12,000	1,240	10,600	880	15,800	2,060	14,300	1,480
8	9,000	1,320	8,100	940	11,900	2,160	10,700	1,560
10	7,200	1,320	6,400	940	9,500	2,160	8,500	1,560
12	6,000	1,230	5,400	910	8,000	2,060	7,100	1,480
14	5,200	1,230	4,750	880	7,000	2,010	6,250	1,440
16	4,500	1,230	4,100	840	6,000	1,960	5,400	1,400
18	4,400	1,150	3,650	780	5,400	1,840	4,850	1,300
20	3,600	1,060	3,200	720	4,800	1,710	4,300	1,200
25	3,200	960	2,800	680	4,400	1,600	3,800	1,120

Application tip



■ **Slotting depth (ap)**
- ap: ≤ 1.0D (≤ HRC25)
  ≤ 0.8D (HRC25~40)



■ **Shouldering depth (ap)**
- ap: ≤ 1.0D
- ae: ≤ 0.5D (≤ HRC25)
  ≤ 0.35D (HRC25~40)

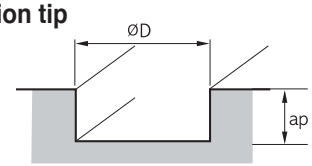
※ Workpiece should be clamped rigidly. In case of vibrations, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (RPE-FF, FP, RG)

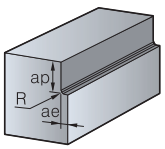
*For HSS PM

Workpiece / Conditions / Diameter (Ø)	Alloy steel, Carbon steel, High speed steel		Alloy steel, Carbon steel, High speed steel (≤ HRC20)		Alloy steel, Carbon steel, High speed steel (HRC20~HRC30)		Alloy steel, Carbon steel, High speed steel (HRC30~HRC40)	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
6	2,700	200	2,100	155	1,500	100	1,250	90
8	2,300	250	1,800	200	1,300	140	1,000	110
10	1,800	360	1,400	275	1,000	170	850	140
12	1,500	360	1,150	290	850	200	700	155
14	1,300	360	1,000	290	720	200	600	155
16	1,150	360	900	290	625	200	520	155
18	1,000	360	850	290	580	200	470	155
20	920	370	720	290	500	200	420	155
22	850	370	620	290	450	200	380	155
25	750	360	570	275	400	190	340	155

Application tip



■ **Slotting depth (ap)**
- ap: ≤ 0.15D



■ **Shouldering depth (ap)**
- ap: ≤ 1.5D (All dia.)
- ae: ≤ 0.5D (All dia.)

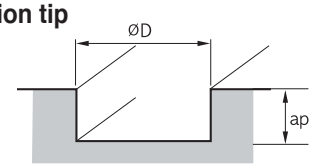
※ Workpiece should be clamped rigidly. In case of vibrations, reduce R.P.M and feed rate by the same ratio

Recommended cutting conditions (RPE-RG)

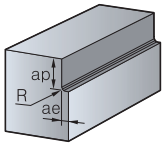
*For HSS Co

Workpiece / Conditions / Diameter (Ø)	Alloy steel, Carbon steel, High speed steel		Alloy steel, Carbon steel, High speed steel (≤ HRC20)		Alloy steel, Carbon steel, High speed steel (HRC20~HRC30)		Alloy steel, Carbon steel, High speed steel (HRC30~HRC40)	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
6	1,800	80	1,600	60	1,200	55	800	30
8	1,400	105	1,100	75	900	65	560	45
10	1,100	150	900	120	800	110	450	60
12	900	180	800	140	630	110	400	70
14	800	180	700	140	560	110	350	70
16	700	180	560	140	450	110	280	70
18	630	180	500	140	400	110	250	70
20	560	180	450	140	400	110	220	70
22	500	220	450	170	350	140	220	70
25	450	220	400	170	310	140	180	85
28	400	210	350	160	280	130	160	85
30	350	210	310	160	250	130	160	85
32	350	210	280	160	220	130	140	85
36	310	210	250	160	200	130	120	85
40	280	200	220	150	180	120	110	80
50	220	200	180	170	160	140	90	80

Application tip



■ **Slotting depth (ap)**
- ap: ≤ 0.15D

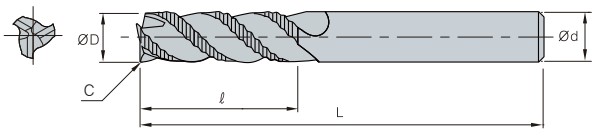


■ **Shouldering depth (ap)**
- ap: ≤ 1.5D
- ae: ≤ 0.1D

※ Workpiece should be clamped rigidly. In case of vibrations, reduce R.P.M and feed rate by the same ratio

RPAE (Wave roughing endmill for Al)

Carbide



3 | H·A 45° | Substrate FN30T | h6 shank

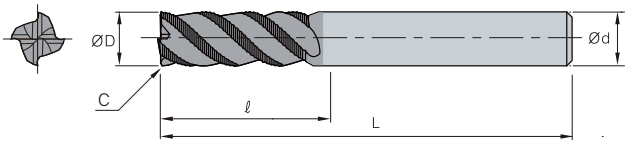
ØD	Tolerance
Ø6 ~ Ø25	0.00 ~ -0.05

(mm)

Designation		ØD	Ød	ℓ	L	C
RPAE	3060-063	6.0	6	18	63	0.3
3	3070-063	7.0	8	23	63	0.3
	3080-063	8.0	8	23	63	0.3
	3090-080	9.0	10	30	80	0.3
	3100-080	10.0	10	30	80	0.3
	3110-080	11.0	12	32	80	0.5
	3120-080	12.0	12	32	80	0.5
	3140-080	14.0	14	32	80	0.5
	3160-105	16.0	16	48	105	0.5
	3180-105	18.0	18	48	105	0.5
	3200-105	20.0	20	50	105	0.5
	3250-105	25.0	25	50	105	0.5

RPE-FP-H (Fine pitch standard type roughing endmill)

Carbide, High helix angle, irregular flute spacing and lead



4 | H·A 40/42° | Substrate PC30T | h6 shank

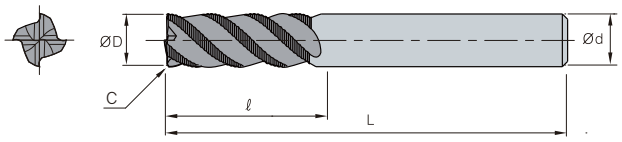
ØD	Tolerance
Ø5 ~ Ø20	0.00 ~ -0.05

(mm)

Designation		ØD	Ød	ℓ	L	C
RPE	4050-057-FP-H	5.0	6	13	57	0.3
4	4060-057-FP-H	6.0	6	13	57	0.5
	4080-063-FP-H	8.0	8	19	63	0.5
	4100-072-FP-H	10.0	10	22	72	0.5
	4120-082-FP-H	12.0	12	26	82	0.5
	4140-082-FP-H	14.0	16	26	82	0.6
	4160-092-FP-H	16.0	16	32	92	0.6
	4180-092-FP-H	18.0	20	32	92	0.6
	4200-0104-FP-H	20.0	20	38	104	0.6

RPLE-FP-H (Fine pitch long type roughing endmill)

Carbide, High helix angle, irregular flute spacing and lead



4 | H·A 40/42° | Substrate PC30T | h6 shank

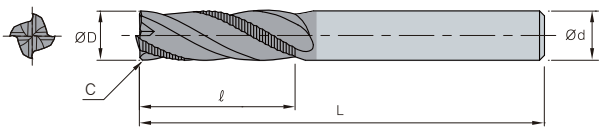
ØD	Tolerance
Ø5 ~ Ø20	0.00 ~ -0.05

(mm)

Designation		ØD	Ød	ℓ	L	C
RPLE 4	4050-063-FP-H	5.0	6	19	63	0.3
	4060-063-FP-H	6.0	8	19	63	0.5
	4080-072-FP-H	8.0	8	28	72	0.5
	4100-082-FP-H	10.0	10	34	82	0.5
	4120-097-FP-H	12.0	12	40	97	0.5
	4140-097-FP-H	14.0	16	40	97	0.6
	4160-108-FP-H	16.0	16	48	108	0.6
	4180-108-FP-H	18.0	20	48	108	0.6
	4200-122-FP-H	20.0	20	56	122	0.6

RPE-XG (Endmill for finishing and roughing)

Carbide



4 | H·A 30° | Substrate PC30T | h6 shank

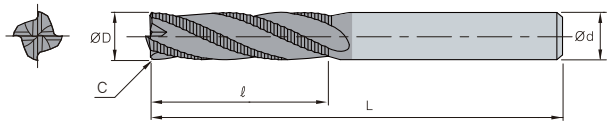
ØD	Tolerance
Ø6 ~ Ø20	0.00 ~ -0.05

(mm)

Designation		ØD	Ød	ℓ	L	C
RPE 4	4060-052-XG	6.0	6	14	52	0.25
	4070-063-XG	7.0	8	18	63	0.3
	4080-063-XG	8.0	8	18	63	0.3
	4090-080-XG	9.0	10	22	80	0.3
	4100-080-XG	10.0	10	22	80	0.3
	4110-080-XG	11.0	12	26	80	0.4
	4120-080-XG	12.0	12	26	80	0.4
	4140-080-XG	14.0	14	30	80	0.4
	4160-105-XG	16.0	16	34	105	0.6
	4180-105-XG	18.0	18	38	105	0.6
	4200-105-XG	20.0	20	42	105	0.6

RPE-FP-L (Roughing endmill for fine pitches)

Carbide,
irregular flute spacing and lead



4 | H·A 18/23° | Substrate PC30T | h6 shank

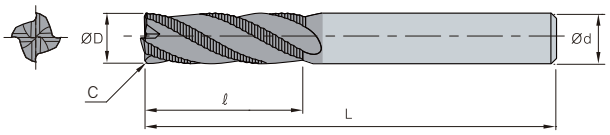
ØD	Tolerance
Ø5 ~ Ø20	0.00 ~ -0.05

(mm)

Designation		ØD	Ød	ℓ	L	C
RPE 4	4050-060-FP-L	5.0	6	13	60	0.3
	4060-080-FP-L	6.0	8	13	80	0.5
	4080-080-FP-L	8.0	8	19	80	0.5
	4100-080-FP-L	10.0	10	22	80	0.5
	4120-080-FP-L	12.0	12	26	80	0.5
	4140-085-FP-L	14.0	16	26	85	0.6
	4160-100-FP-L	16.0	16	32	100	0.6
	4180-100-FP-L	18.0	20	32	100	0.6
	4200-105-FP-L	20.0	20	38	105	0.6

RPE-RG (Standard roughing endmill)

Carbide



4 | H·A 30° | Substrate PC40T | h6 shank

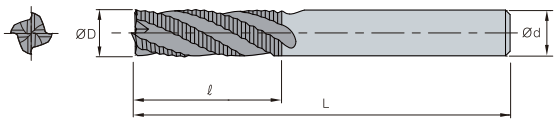
ØD	Tolerance
Ø5 ~ Ø20	0.00 ~ -0.05

(mm)

Designation		ØD	Ød	ℓ	L	C
RPE 4	4050-050-RG	5.0	6	13	50	0.3
	4060-050-RG	6.0	6	16	50	0.3
	4080-060-RG	8.0	8	20	60	0.3
	4100-075-RG	10.0	10	25	75	0.3
	4120-080-RG	12.0	12	30	80	0.4
	4140-100-RG	14.0	16	35	100	0.6
	4160-100-RG	16.0	16	40	100	0.6
	4180-110-RG	18.0	20	40	110	0.6
	4200-110-RG	20.0	20	45	110	0.6

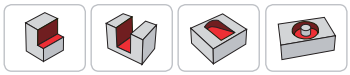
RPE-RG (4F roughing endmill)

HSS PM



4 | H·A 30° | HSSE PM | Substrate HN30T HC30T | h6 shank

ØD	Tolerance
Ø6 ~ Ø20	±0.1

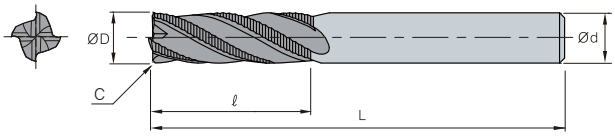


(mm)

Designation		ØD	Ød	ℓ	L
RPE 4	4060-060-RG	6.0	6	20	60
	4070-070-RG	7.0	10	20	70
	4080-075-RG	8.0	10	25	75
	4090-075-RG	9.0	10	30	75
	4100-085-RG	10.0	10	35	85
	4120-100-RG	12.0	12	40	100
	4140-100-RG	14.0	16	40	100
	4160-110-RG	16.0	16	50	110
	4180-110-RG	18.0	20	50	110
	4200-125-RG	20.0	20	60	125

RPE-FF (Roughing endmill for fine pitches)

HSS PM, Irregular flute spacing



4 | H·A 25/30 | HSSE PM | Substrate HC30T | h6 shank

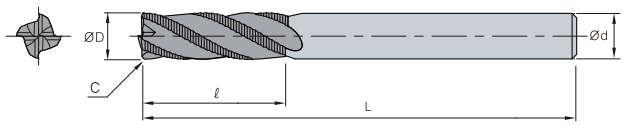
ØD	Tolerance
Ø6 ~ Ø20	±0.1

(mm)

Designation		ØD	Ød	ℓ	L	C
RPE 4	4060-060-FF	6.0	6	20	60	0.5
	4070-070-FF	7.0	10	20	70	0.5
	4080-075-FF	8.0	10	25	75	0.5
	4090-075-FF	9.0	10	30	75	0.5
	4100-085-FF	10.0	10	35	85	0.5
	4120-100-FF	12.0	12	40	100	0.6
	4140-100-FF	14.0	12	40	100	0.6
	4160-110-FF	16.0	16	50	110	0.6
	4180-110-FF	18.0	16	50	110	0.6
	4200-125-FF	20.0	20	60	125	0.6

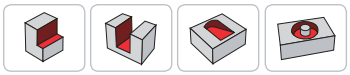
RPE-FP (Roughing endmill for fine pitches)

HSS PM,
irregular flute spacing and lead



4 | H·A 25°/30° | HSSE PM | Substrate HC30T | h6 shank

ØD	Tolerance
Ø6 ~ Ø12.0	0.00 ~ -0.05
Ø12.1 ~ Ø20.0	0.00 ~ -0.1

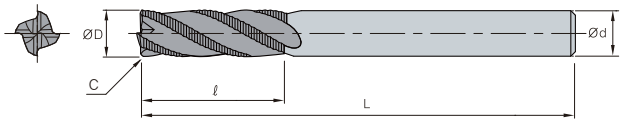


(mm)

Designation		ØD	Ød	ℓ	L	C
RPE 4	4060-080-FP	6.0	6	13	80	0.5
	4070-080-FP	7.0	10	16	80	0.5
	4080-085-FP	8.0	10	19	85	0.5
	4090-095-FP	9.0	10	19	95	0.5
	4100-100-FP	10.0	10	22	100	0.5
	4120-110-FP	12.0	12	26	110	0.6
	4140-110-FP	14.0	12	26	110	0.6
	4160-125-FP	16.0	16	32	125	0.6
	4180-125-FP	18.0	16	32	125	0.6
	4200-140-FP	20.0	20	38	140	0.6

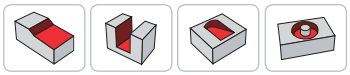
RPE-RG (Roughing endmill)

HSS



4 | H·A 30° | HSSE Co 8% | Substrate HN20T HC20T HC10T | h6 shank

ØD	Tolerance
Ø6 ~ Ø50	±0.1



(mm)

Designation		ØD	Ød	ℓ	L
RPE 4	4060-060-RG	6.0	6	15	60
	4070-065-RG	7.0	8	20	65
	4080-065-RG	8.0	8	20	65
	4090-075-RG	9.0	10	25	75
	4100-075-RG	10.0	10	25	75
	4110-080-RG	11.0	12	30	80
	4120-080-RG	12.0	12	30	80
	4130-090-RG	13.0	12	35	90
	4140-090-RG	14.0	12	35	90
	4150-095-RG	15.0	12	40	95
	4160-095-RG	16.0	16	40	95
	4170-095-RG	17.0	16	40	95
	4180-105-RG	18.0	16	40	105
	4190-110-RG	19.0	16	45	110
	4200-110-RG	20.0	20	45	110
	4210-110-RG	21.0	20	45	110
	4220-110-RG	22.0	20	45	110
	4230-110-RG	23.0	20	45	110
	4240-120-RG	24.0	25	50	120
	4250-120-RG	25.0	25	50	120
	4260-120-RG	26.0	25	50	120
	4270-125-RG	27.0	25	55	125
	4280-125-RG	28.0	25	55	125
	4300-125-RG	30.0	25	55	125
	4320-145-RG	32.0	32	60	145
	4340-145-RG	34.0	32	60	145
	4350-145-RG	35.0	32	60	145
	4360-145-RG	36.0	32	60	145
	4380-150-RG	38.0	32	65	150
	4400-150-RG	40.0	32	65	150
	4420-155-RG	42.0	42	65	155
	4440-155-RG	44.0	42	65	155
	4450-160-RG	45.0	42	70	160
	4460-160-RG	46.0	42	70	160
	4500-160-RG	50.0	42	70	160

Endmill series for aluminum machining

A+ Endmill

- Endmills for rough, medium to finish cutting of aluminum
- Optimized solutions for each application type - A wide selection of tools provided for various machining processes
- Higher machining efficiency - advanced flute design and cutting edge technology applied

Features

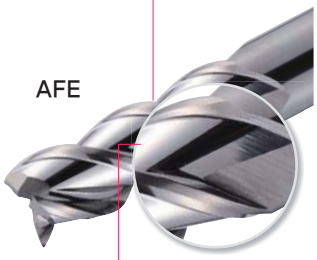
Sharp cutting edges and double relief angles
- Reduced cutting force
- Inhibited tool breakage due to reinforced cutting edges

APFE

U-shaped flutes with mirror-like finishing
- Efficient chip evacuation through wide chip pockets
- Inhibited build-up edges due to mirror-like finishing

Sharp cutting edges
- Long tool life and improved cost efficiency
- Reduced cutting force

AFE



Mirror-like flute surface
- Inhibited chip welding
- Reduced cutting force due to less build-up edges

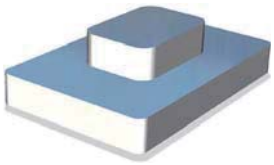
Blade design of wave form
- Lower cutting force
- Efficient chip evacuation through chip breaking

RPAE

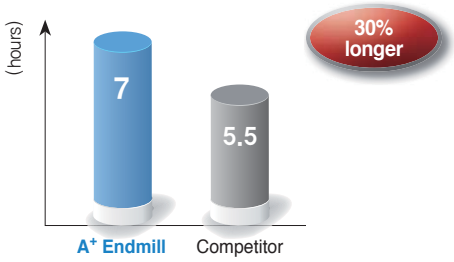
Sharp cutting edges
- Lower cutting force
- Reduced loads over equipment

Application examples

■ **Workpiece** Jig (A7075)
■ **Cutting conditions** vc (m/min) = 200, fz (mm/t) = 0.05, ap (mm) = 8, ae (mm) = 2, wet
■ **Tools** APFE3080-060

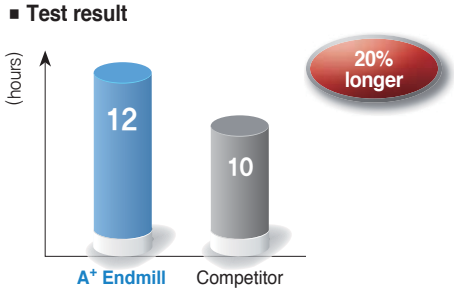


■ **Test result**



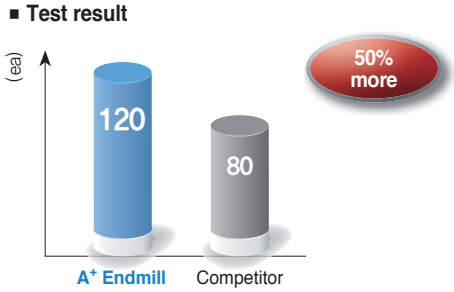
■ **Workpiece** Inside milling of smart phones (Al60 series)
■ **Cutting conditions** vc (m/min) = 65, fz (mm/t) = 0.02, ap (mm) = 1, ae (mm) = 1, wet
■ **Tools** AFE3010-050-V3S6

■ **Test result**



■ **Workpiece** Roughing aluminum rectangular tubes (Al70 series)
■ **Cutting conditions** vc (m/min) = 330, fz (mm/t) = 0.05, ap (mm) = 15, ae (mm) = 1.5, dry
■ **Tools** RPAE3100-080

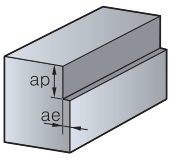
■ **Test result**



Recommended Cutting Conditions (APFE/AFE)

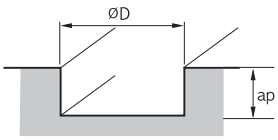
Workpiece / Conditions / Diameter (Ø)	Shouldering				Slotting			
	Aluminum alloy (A7075)		Aluminum alloy mold (AC4B)		Aluminum alloy (A7075)		Aluminum alloy mold (AC4B)	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
1	40,000	480	40,000	368	40,000	368	40,000	280
2	40,000	880	38,000	680	38,000	680	32,000	440
3	32,000	1,120	25,000	760	25,000	760	21,000	480
4	24,000	1,200	19,000	800	19,000	800	13,000	520
5	19,000	1,280	15,000	880	15,000	800	13,000	560
6	16,000	1,520	13,000	960	13,000	880	11,000	600
8	12,000	1,520	9,500	960	9,500	960	8,000	640
10	9,500	1,520	7,600	960	7,600	960	6,400	640
12	8,000	1,520	6,400	960	6,400	960	5,300	640
16	6,000	1,520	4,800	960	4,800	800	4,000	576
20	4,800	1,200	3,800	800	3,800	776	3,200	528

Application tip



■ Shouldering depth (ap)

- ap : ≤ 2.0D
- ae : ≤ 0.2D (D < Ø3)
  : ≤ 0.5D (D ≥ Ø3)



■ Slotting depth (ap)

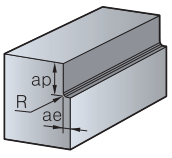
- ap : ≤ D (Maximum 12 mm)

※ Workpiece should be clamped rigidly. In case of vibrations, reduce R.P.M and feed rate by the same ratio

Recommended Cutting Conditions (RPAE/APRE)

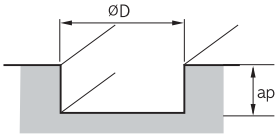
Workpiece / Conditions / Diameter (Ø)	Shouldering				Slotting			
	Aluminum alloy (A7075)		Aluminum alloy mold (AC4B)		Aluminum alloy (A7075)		Aluminum alloy mold (AC4B)	
	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)	RPM n (min-1)	Feed vf (mm/min)
4	20,000	8,000	16,000	6,400	15,000	5,000	12,000	4,000
5	16,000	6,500	12,800	5,200	12,000	4,000	9,600	3,200
6	13,500	6,000	10,800	4,800	10,500	3,800	8,400	3,100
8	10,500	4,700	8,400	3,800	8,000	3,000	6,400	2,400
10	8,500	3,800	6,800	3,100	6,500	2,500	5,200	2,000
12	6,800	3,050	5,500	2,500	5,250	2,000	4,200	1,600
14	5,800	2,600	4,700	2,100	4,500	1,700	3,600	1,400
16	5,200	2,350	4,200	1,900	4,000	1,500	3,200	1,200
18	4,700	2,100	3,800	1,700	3,550	1,300	2,900	1,100
20	4,200	1,900	3,400	1,600	3,200	1,200	2,600	1,000
25	3,400	1,500	2,800	1,200	2,550	1,000	2,100	800

Application tip



■ Shouldering depth (ap)

- ap : ≤ 1.5D
- ae : ≤ 0.5D



■ Slotting depth (ap)

- ap : ≤ 1.5D

※ Workpiece should be clamped rigidly. In case of vibrations, reduce R.P.M and feed rate by the same ratio

APFE2000/3000 (Flat)

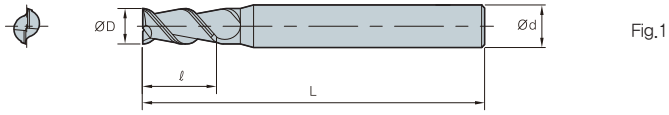


Fig.1

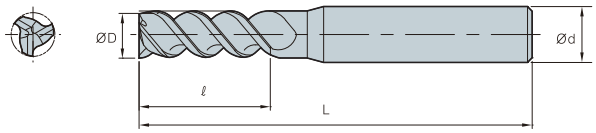
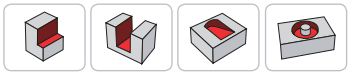


Fig.2

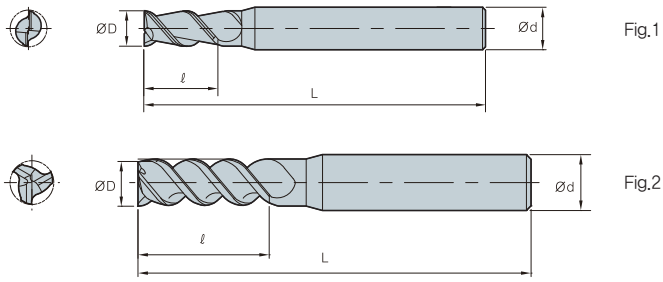
ØD	Tolerance
Ø1 ~ Ø6	-0.00 ~ -0.02
Ø6.1 ~ Ø8	-0.00 ~ -0.025
Ø8.1 ~ Ø20	-0.00 ~ -0.03



(mm)

Designation		ØD	Ød	ℓ	L	Fig.
APFE 2	2010-050-S6	1	6	3	50	1
	2015-050-S6	1.5	6	4	50	1
	2020-050-S4	2	4	6	50	1
	2025-050	2.5	6	8	50	1
	2030-050	3.0	6	9	50	1
	2040-050	4.0	6	12	50	1
	2050-050	5.0	6	15	50	1
	2060-050	6.0	6	18	50	1
	2080-060	8.0	8	20	60	1
	2100-075	10.0	10	30	75	1
	2120-075	12.0	12	32	75	1
	2160-100	16.0	16	45	100	1
	2200-100	20.0	20	45	100	1
APFE 3	3010-050-S4	1	4	3	50	2
	3015-050-S4	1.5	4	4	50	2
	3020-050-S4	2	4	6	50	2
	3025-050	2.5	6	8	50	2
	3030-050	3.0	6	9	50	2
	3040-050	4.0	6	12	50	2
	3050-050	5.0	6	15	50	2
	3060-050	6.0	6	18	50	2
	3080-060	8.0	8	20	60	2
	3100-075	10.0	10	30	75	2
	3120-075	12.0	12	32	75	2
	3160-100	16.0	16	45	100	2
	3200-100	20.0	20	45	100	2

APMFE2000/3000 (Middle flat)



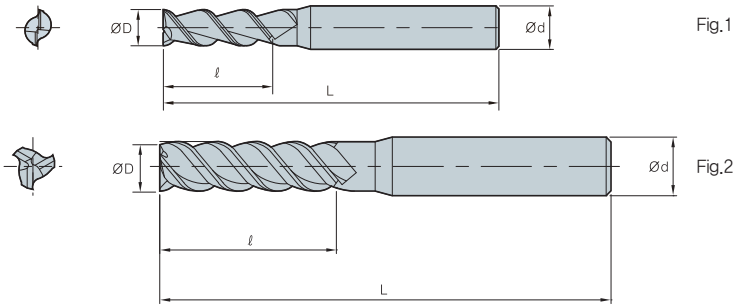
2 | 3 | H·A 50° | Substrate H05S | h6 shank

ØD	Tolerance
Ø1 ~ Ø6	0.00 ~ 0.02
Ø6.1 ~ Ø8	0.00 ~ 0.025
Ø8.1 ~ Ø20	0.00 ~ 0.03

(mm)

Designation		ØD	Ød	ℓ	L	Fig.
APMFE 2	2030-060	3.0	6	11	60	1
	2040-060	4.0	6	14	60	1
	2050-060	5.0	6	17	60	1
	2060-065	6.0	6	22	65	1
	2080-065	8.0	8	25	65	1
	2100-080	10.0	10	37	80	1
	2120-080	12.0	12	40	80	1
	2160-110	16.0	16	55	110	1
	2200-125	20.0	20	60	125	1
APMFE 3	3030-060	3.0	6	11	60	2
	3040-060	4.0	6	14	60	2
	3050-060	5.0	6	17	60	2
	3060-065	6.0	6	22	65	2
	3080-065	8.0	8	25	65	2
	3100-080	10.0	10	37	80	2
	3120-080	12.0	12	40	80	2
	3160-110	16.0	16	55	110	2
	3200-125	20.0	20	60	125	2

APLFE2000/3000 (Long flat)

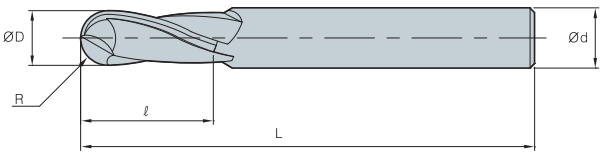


ØD	Tolerance
Ø1 ~ Ø6	0.00 ~ 0.02
Ø6.1 ~ Ø8	0.00 ~ 0.025
Ø8.1 ~ Ø20	0.00 ~ 0.03

(mm)

Designation		ØD	Ød	ℓ	L	Fig.
APLFE 2	2030-060	3.0	6	12	60	1
	2040-060	4.0	6	16	60	1
	2050-060	5.0	6	20	60	1
	2060-075	6.0	6	25	75	1
	2080-075	8.0	8	32	75	1
	2100-100	10.0	10	45	100	1
	2120-100	12.0	12	45	100	1
	2160-150	16.0	16	65	150	1
	2200-150	20.0	20	75	150	1
APLFE 3	3030-060	3.0	6	12	60	2
	3040-060	4.0	6	16	60	2
	3050-060	5.0	6	20	60	2
	3060-075	6.0	6	25	75	2
	3080-075	8.0	8	32	75	2
	3100-100	10.0	10	45	100	2
	3120-100	12.0	12	45	100	2
	3160-150	16.0	16	65	150	2
	3200-150	20.0	20	75	150	2

APBE2000 (Ball)



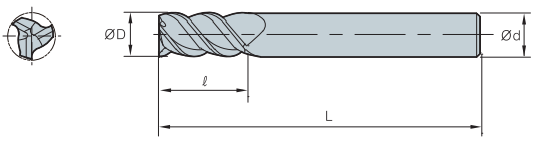
2 | H·A 25° | Substrate H05S | h6 shank

ØD	Tolerance
Ø1 ~ Ø6	0.00 ~ 0.02
Ø6.1 ~ Ø8	0.00 ~ 0.025
Ø8.1 ~ Ø20	0.00 ~ 0.03

(mm)

Designation		ØD	Ød	ℓ	L
APBE 2	2010-050	1.0	4	2	50
	2015-050	1.5	4	3	50
	2020-050	2.0	4	4	50
	2025-050	2.5	4	5	50
	2030-050	3.0	4	6	50
	2035-050	3.5	4	7	50
	2040-050	4.0	4	8	50
	2045-050	4.5	6	9	50
	2050-050	5.0	6	10	50
	2055-050	5.5	6	11	50
	2060-050	6.0	6	12	50
	2080-060	8.0	8	16	60
	2100-075	10.0	10	20	75
	2120-075	12.0	12	24	75

AFE3000 (Short flat)

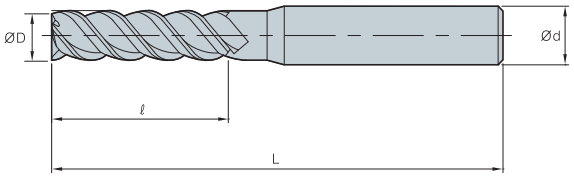


ØD	Tolerance
Ø1 ~ Ø12	0.00 ~ -0.02
Ø12.1 ~ Ø20	0.00 ~ -0.03

(mm)

Designation		ØD	Ød	ℓ	L
AFE	3010-040-V2S6	1	6	2	40
3	3010-040-V2.5S6	1	6	2.5	40
	3015-040-V3S6	1.5	6	3	40
	3020-040-V3S6	2	6	3	40
	3030-045-V4S6	3	6	4	45
	3030-045-V8S6	3	6	8	45
	3040-045-V5S6	4	6	5	45
	3040-045-V8S6	4	6	8	45
	3040-045-V11S6	4	6	11	45
	3050-045-V6S6	5	6	6	45
	3060-050-V7S6	6	6	7	50
	3060-050-V13S6	6	6	13	50
	3080-060-V9S8	8	8	9	60
	3080-060-V19S8	8	8	19	60
	3100-065-V11S10	10	10	11	65
	3100-065-V22S10	10	10	22	65
	3120-070-V13S12	12	12	13	70
	3120-070-V26S12	12	12	26	70
	3160-090-V18S16	16	16	18	90
	3160-090-V32S16	16	16	32	90
	3200-090-V22S20	20	20	22	90
	3200-090-V38S20	20	20	38	90

AFE3000 (Flat)



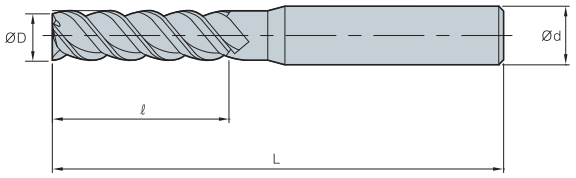
3 | H·A 30° | Substrate H05S | h6 shank

ØD	Tolerance
Ø1 ~ Ø12	0.00 ~ -0.02
Ø12.1 ~ Ø20	0.00 ~ -0.03

(mm)

Designation		ØD	Ød	ℓ	L
AFE	3010-050-V3S6	1	6	3	50
3	3015-050-V5S6	1.5	6	5	50
	3020-050-V6S6	2	6	6	50
	3030-055-V11S6	3	6	11	55
	3040-055-V13S6	4	6	13	55
	3050-055-V17S6	5	6	17	55
	3060-060-V17S6	6	6	17	60
	3080-070-V22S8	8	8	22	70
	3100-075-V27S10	10	10	27	75
	3120-080-V32S12	12	12	32	80
	3160-100-V42S16	16	16	42	100
	3200-100-V48S20	20	20	48	100

AFE3000 (Long flat)

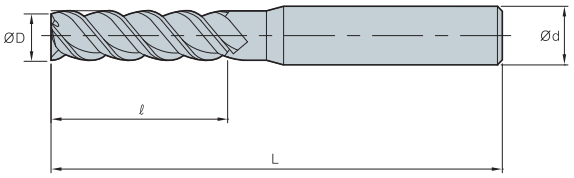


ØD	Tolerance
Ø1 ~ Ø12	0.00 ~ -0.02
Ø12.1 ~ Ø20	0.00 ~ -0.03

(mm)

Designation		ØD	Ød	ℓ	L
AFE	3010-060-V4S6	1	6	4	60
	3010-060-V6S6	1	6	6	60
	3015-060-V6S6	1.5	6	6	60
	3015-060-V8S6	1.5	6	8	60
	3015-060-V10S6	1.5	6	10	60
	3020-060-V8S6	2	6	8	60
	3020-060-V10S6	2	6	10	60
	3020-060-V12S6	2	6	12	60
	3030-065-V15S6	3	6	15	65
	3030-070-V20S6	3	6	20	70
	3030-075-V25S6	3	6	25	75
	3030-080-V30S6	3	6	30	80
	3040-065-V16S6	4	6	16	65
	3040-070-V20S6	4	6	20	70
	3040-075-V26S6	4	6	26	75
	3040-080-V30S6	4	6	30	80
	3060-060-V22S6	6	6	22	60
	3060-070-V25S6	6	6	25	70
	3060-075-V30S6	6	6	30	75
	3060-080-V35S6	6	6	35	80
	3060-090-V42S6	6	6	42	90
	3060-100-V50S6	6	6	50	100
	3080-080-V28S8	8	8	28	80
	3080-080-V30S8	8	8	30	80
	3080-085-V35S8	8	8	35	85
	3080-090-V40S8	8	8	40	90
	3080-095-V45S8	8	8	45	95
	3080-100-V50S8	8	8	50	100
	3080-105-V55S8	8	8	55	105
	3080-110-V65S8	8	8	65	110

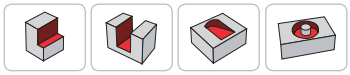
AFE3000 (Long flat)



Substrate H05S

h6 shank

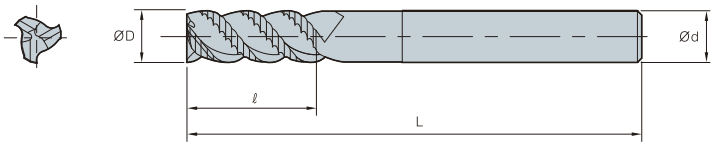
ØD	Tolerance
Ø1 ~ Ø12	0.00 ~ -0.02
Ø12.1 ~ Ø20	0.00 ~ -0.03



(mm)

Designation		ØD	Ød	ℓ	L
AFE	3100-090-V32S10	10	10	32	90
3	3100-090-V35S10	10	10	35	90
	3100-090-V40S10	10	10	40	90
	3100-100-V45S10	10	10	45	100
	3100-100-V50S10	10	10	50	100
	3100-110-V55S10	10	10	55	110
	3100-110-V60S10	10	10	60	110
	3100-120-V65S10	10	10	65	120
	3120-095-V40S12	12	12	40	95
	3120-100-V45S12	12	12	45	100
	3120-100-V50S12	12	12	50	100
	3120-110-V55S12	12	12	55	110
	3120-110-V60S12	12	12	60	110
	3120-120-V65S12	12	12	65	120
	3120-120-V70S12	12	12	70	120
	3120-135-V75S12	12	12	75	135
	3160-105-V52S16	16	16	52	105
	3160-110-V55S16	16	16	55	110
	3160-130-V65S16	16	16	65	130
	3160-150-V75S16	16	16	75	150
	3160-160-V85S16	16	16	85	160
	3160-180-V95S16	16	16	95	180
	3160-190-V105S16	16	16	105	190
	3160-200-V115S16	16	16	115	200
	3200-110-V55S20	20	20	55	110
	3200-130-V65S20	20	20	65	130
	3200-150-V75S20	20	20	75	150
	3200-160-V85S20	20	20	85	160
	3200-180-V95S20	20	20	95	180
	3200-190-V105S20	20	20	105	190
	3200-200-V115S20	20	20	115	200
	3200-220-V125S20	20	20	125	220

APRE3000 (Roughing)



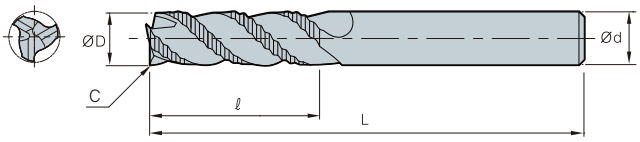
3 | H·A 45° | Substrate H05S | h6 shank

ØD	Tolerance
Ø4 ~ Ø8	0.00 ~ -0.07
Ø8.1 ~ Ø25	0.00 ~ -0.10

(mm)

Designation		ØD	Ød	ℓ	L
APRE	3040-050	4.0	6	8	50
3	3050-050	5.0	6	13	50
	3060-050	6.0	6	15	50
	3065-060	6.5	8	16	60
	3070-060	7.0	8	16	60
	3075-060	7.5	8	20	60
	3080-060	8.0	8	20	60
	3085-075	8.5	10	20	75
	3090-075	9.0	10	20	75
	3095-075	9.5	10	22	75
	3100-075	10.0	10	25	75
	3110-075	11.0	12	30	75
	3120-075	12.0	12	30	75
	3130-075	13.0	14	30	75
	3140-075	14.0	16	32	75
	3150-075	15.0	16	32	75
	3160-100	16.0	16	35	100
	3170-100	17.0	20	35	100
	3180-100	18.0	20	35	100
	3200-100	20.0	20	45	100
	3250-105	25.0	25	50	105

RPAE3000 (Wave roughing)



3 | H·A 45° | Substrate FN30T | h6 shank

ØD	Tolerance
Ø6 ~ Ø10	0.000 ~ -0.058
Ø10 ~ Ø18	0.000 ~ -0.070
Ø18 ~ Ø25	0.000 ~ -0.084

(mm)

Designation		ØD	Ød	ℓ	L	L
RPAE	3060-063	6.0	6	18	63	0.3
3	3070-063	7.0	8	23	63	0.3
	3080-063	8.0	8	23	63	0.3
	3090-080	9.0	10	30	80	0.3
	3100-080	10.0	10	30	80	0.3
	3110-080	11.0	12	32	80	0.5
	3120-080	12.0	12	32	80	0.5
	3140-080	14.0	14	32	80	0.5
	3160-105	16.0	16	48	105	0.5
	3180-105	18.0	18	48	105	0.5
	3200-105	20.0	20	50	105	0.5
	3250-105	25.0	25	50	105	0.5

Longer tool life and good surface finishes

PCD Endmill

- Longer tool life and good surface roughness
- Reducing burrs at non-ferrous metals machining
- 1000 type: Ultra finishing for non-ferrous metals
- 2000 type: Optimal for aluminum alloy, carbon steel, graphite and reinforced Plastic machining

PCD endmill code system

PDE	2	080
Endmill	**No. of Flute**	**Diameter**
PDE: PCD Endmill	2 Flutes	Ø8.0

Recommended cutting conditions

Workpiece	vc (m/min)	n (min^{-1})	fz (mm/t)
Aluminum alloy, Copper	30~300	2,000~12,000	0.02~0.07
Reinforced plastic	35~300	2,800~16,000	0.04~0.12
Carbon steel, Graphite	10~100	5,300~16,000	0.04~0.2

Special endmill order form

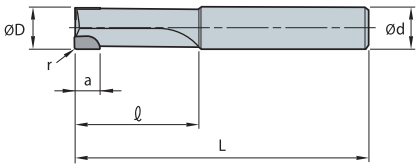


Fig.1

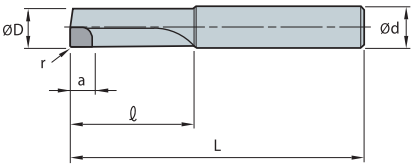
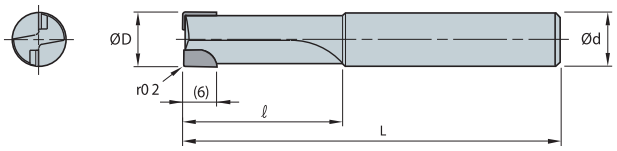


Fig.2

Designation	Fig.	No. of Flute	Dimension (mm)					
			ØD	Ød	r	a	ℓ	L
PDES								

※ Depending on customer requests, we can make special Endmill

PDE1000/2000 (Flat)



(mm)

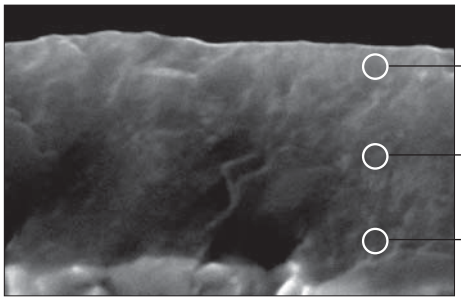
Designation		ØD	Ød	ℓ	L
PDE 1	1040	4	6	15	45
	1050	5	6	15	50
	1060	6	6	20	60
PDE 2	2060	6	8	20	60
	2070	7	8	20	60
	2080	8	8	20	60
	2090	9	10	25	70
	2100	10	10	25	70
	2120	12	12	25	75

High precision machining with our high stiffness design

Brazed Endmills

- Applicable for high speed machining as it reduced frictional resistance while improving its wear resistance by implementing exlcusive substrate and PVD coating
- Long tool life due to absorbing impact through brazed body in heavy interruption
- General steel, alloy steel, mild steel, dice steel, stainless steel, cast iron, ductile cast iron
- ZSEA: Aluminum, Aluminum alloy, Copper, Copper alloy, Non-ferrous materials
- Coating brazed endmills (special) – Guaranteed long tool life due to high new-concept hardness and oxidation resistant coating

Features



Top layer
Improvement of hardness and oxidation resistance

Main layer
Improvement of adhesion and chipping resistance

Ultra fine substrate

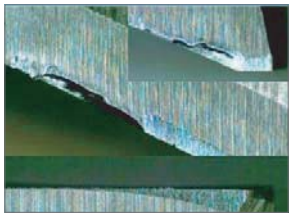
PC221F Coating

Brazed Endmills code system

Z	S	E	2	14	-	S
Brazed	Spiral	Endmill	No. of flutes	Diameter		Additional item classification
		E: Flat (Steel) EA: Flat (Al, Cu) EL: Flat long (Steel) EXL: Flat long (Steel) BE: Ball (Steel)	2: 2 Flutes 3: 3 Flutes	Ø14		S: Ø42.0 Q: Coated SQ: Ø42.0 Coated Standard shank Diameter: none

Wear resistance test

Coated ZSE(PC221F)

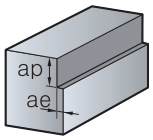


Carbide ZSE

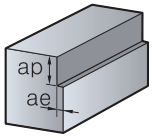
Recommended cutting conditions (ZSE200 Flat)

Workpiece / Condition / Diameter (Ø)	SM50C,SCM,GC (~HRC30)		STD61,STD11 (HRC30~45)		STD61 (HRC45~55)	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
20	1,600	152	950	88	560	44
25	1,300	136	750	72	450	36
30	1,100	120	650	64	370	32
40	800	96	500	56	280	24
50	650	88	400	48	220	20

Application tip



■ **Side milling (under HRC45)**
- ap: ≤ 1.5D
- ae: ≤ 0.1D



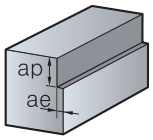
■ **Side milling (over HRC45)**
- ap: ≤ 1D (Max: 1 mm)

※ Above table based on side milling, when it enters to ae direction, you should apply reduced cutting condition
※ When it enters to ae direction, for finishing you should increase revolution speed and feed in the table

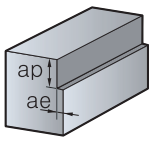
Recommended cutting conditions (ZSE400 Flat)

Workpiece / Condition / Diameter (Ø)	SM50C,SCM,GC (~HRC30)		STD61,STD11 (HRC30~45)		STD61 (HRC45~55)	
	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)	R.P.M n (min^{-1})	Feed vf (mm/min)
20	1,600	230	950	133	560	66
25	1,300	205	750	109	450	54
30	1,100	180	650	96	370	48
40	800	145	500	85	280	36
50	650	135	400	72	220	30

Application tip



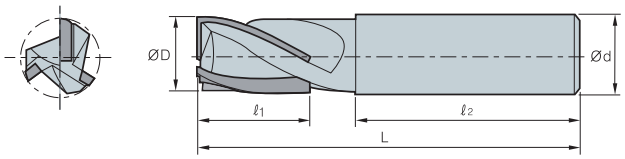
■ **Side milling (under HRC45)**
- ap: ≤ 1.5D
- ae: ≤ 0.1D



■ **Side milling (over HRC45)**
- ap: ≤ 1D (Max: 1 mm)

※ Above table based on side milling, when it enters to ae direction, you should apply reduced cutting condition
※ When it enters to ae direction, for finishing you should increase revolution speed and feed in the table

ZSE200/300 (Flat)



2 | 3 | H·A 24°~26° | Carbide | Substrate FCC PC221F

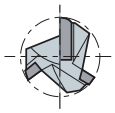
ØD	Tolerance
All	0.00~ -0.05

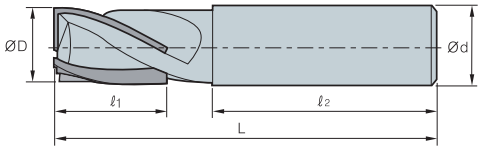
(mm)

	Designation	ØD	Ød	ℓ1	ℓ2	L
ZSE 2	214	14	16	28	57	95
	215	15	16	28	57	95
	216(Q)	16	16	28	55	95
	217	17	20	30	70	115
	218	18	20	30	70	115
	219	19	20	30	70	115
	220(Q)	20	20	30	70	115
	221	21	20	35	65	115
	222	22	20	35	65	115
	223	23	25	35	75	125
	224	24	25	35	75	125
	225	25	25	35	75	125
	226(Q)	26	25	35	75	125
	227	27	25	35	75	125
	228	28	25	35	75	125
	229	29	32	40	95	150
	230(Q)	30	32	40	95	150
	231	31	32	40	95	150
	232	32	32	45	90	150
	233	33	32	45	90	150
	234	34	32	50	85	150
	235	35	32	50	85	150
	236	36	32	50	85	150
	237	37	32	55	80	150
	238	38	32	55	80	150
	238S	38	42	55	80	150
	240(Q)	40	32	60	75	150
	240S	40	42	60	75	150
	242	42	32	60	75	150
	244	44	32	65	80	160
	245	45	32	65	80	160
	245S	45	42	65	80	160
	247	47	32	65	80	160
	248	48	32	65	80	160
	248S	48	42	65	80	160
	250	50	32	65	80	160
	250S	50	42	65	80	160
ZSE 3	314	14	16	28	57	95
	315	15	16	28	57	95
	316	16	16	28	55	95
	317	17	20	30	70	115
	318	18	20	30	70	115
	319	19	20	30	70	115
	320	20	20	30	70	115
	322	22	20	35	65	115
	325	25	25	35	75	125
	326	26	25	35	75	125
	328	28	25	35	75	125
	330	30	32	40	95	150
	331	31	32	40	95	150

Special Endmills order: ZSE○○○○I-L
Ex.1) 2 flutes, diameter: 6.3, l: 10, L: 60 ZSBE2063 10-60L
Ex.2) 2 flutes, diameter: 6.3, standard type ZSE2063

ZSE300/400/600 (Flat)





3 4 6 H·A 24°~26° Carbide Substrate FCC PC221F

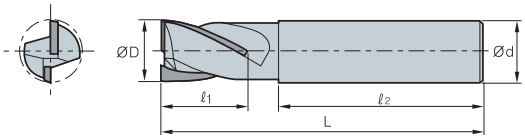
ØD	Tolerance
All	0.00~ -0.05

(mm)

Designation		ØD	Ød	ℓ1	ℓ2	L
ZSE 3	332	32	32	45	90	150
	333	33	32	45	90	150
	334	34	32	50	85	150
	335	35	32	50	85	150
	338	38	32	55	80	150
	338S	38	42	55	80	150
	340	40	32	60	75	150
	340S	40	42	60	75	150
	342	42	32	60	75	150
	345	45	32	65	80	160
	345S	45	42	65	80	160
	350	50	32	65	80	160
	350S	50	42	65	80	160
ZSE 4	414	14	16	28	57	95
	415	15	16	28	57	95
	416(Q)	16	16	28	55	95
	417	17	20	30	70	115
	418	18	20	30	70	115
	419	19	20	30	70	115
	420(Q)	20	20	30	70	115
	421	21	20	35	65	115
	422	22	20	35	65	115
	423	23	25	35	75	125
	424	24	25	35	75	125
	425(Q)	25	25	35	75	125
	426	26	25	35	75	125
	427	27	25	35	75	125
	428	28	25	35	75	125
	429	29	32	40	95	150
	430	30	32	40	95	150
	432(Q)	32	32	45	90	150
	435	35	32	50	80	150
	438	38	32	55	85	150
	438S	38	42	55	85	150
	440(Q)	40	32	60	75	150
	440S	40	42	60	75	150
	445	45	32	65	80	160
	445S	45	42	65	80	160
	450	50	32	65	80	160
	450S	50	42	65	80	160
ZSE 6	634	34	32	50	85	150
	635	35	32	50	85	150
	638	38	32	55	80	150
	638S	38	42	55	80	150
	640	40	32	60	75	150
	640S	40	42	60	75	150
	645	45	32	65	80	160
	645S	45	42	65	80	160
	650	50	32	65	80	160
	650S	50	42	65	80	160

Special Endmills order: ZSE○○○○l-L
Ex.1) 2 flutes, diameter: 6.3, l: 10, L: 60 ZSBE2063 10-60L
Ex.2) 2 flutes, diameter: 6.3, standard type ZSE2063

ZSEA200 (Flat)

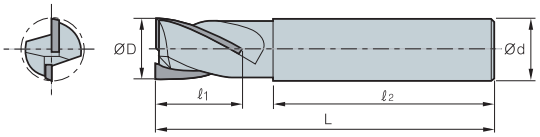



ØD	Tolerance
All	0.00~ -0.05

(mm)

Designation		ØD	Ød	ℓ1	ℓ2	L
ZSEA	215	15	16	28	57	95
	216	16	16	28	55	95
	218	18	20	30	70	115
	219	19	20	30	70	115
	220	20	20	30	70	115
	221	21	20	35	65	115
	222	22	20	35	65	115
	223	23	25	35	75	125
	224	24	25	35	75	125
	225	25	25	35	75	125
	228	28	25	35	75	125
	230	30	32	40	95	150
	232	32	32	45	90	150
	238	38	32	55	80	150
	240	40	32	60	75	150
	250	50	32	65	80	160

ZSEL200/400, ZSEXL200 (Long flat)

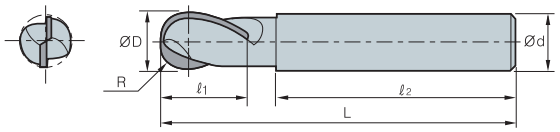


ØD	Tolerance
All	0.00~ -0.05

(mm)

Designation		ØD	Ød	ℓ1	ℓ2	L
ZSEL	214	14	16	50	55	120
2	216	16	16	50	55	120
	218	18	20	60	65	140
	220	20	20	60	65	140
	222	22	20	60	65	140
	225	25	25	70	65	150
	230	30	32	80	85	180
	232	32	32	90	85	190
	235	35	32	100	85	200
	240	40	42	100	105	220
	245	45	42	120	95	230
	250	50	42	120	95	230
ZSEL	416	16	16	50	55	120
4	420	20	20	60	65	140
	425	25	25	70	65	150
	430	30	32	80	85	180
	435	35	32	100	85	200
	440	40	42	100	105	220
ZSEXL	220	20	20	120	65	200
2	222	22	20	120	65	200
	225	25	25	140	65	220

ZSBE200 (Ball)



2 | H·A 24°~26° | Carbide | Substrate FCC PC221F

ØD	Tolerance
All	0.00~ -0.05

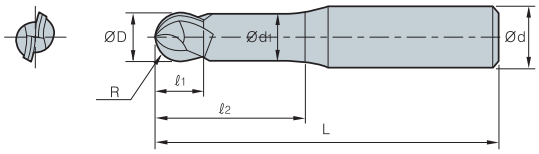
(mm)

Designation		R	ØD	Ød	ℓ1	ℓ2	L
ZSBE	213	6.5	13	16	30	60	100
2	214	7	14	16	30	65	100
	215	7.5	15	16	35	55	100
	216Q	8	16	16	35	55	100
	217	8.5	17	20	35	65	110
	218	9	18	20	35	65	110
	219	9.5	19	20	35	65	110
	220Q	10	20	20	35	65	110
	221	10.5	21	20	35	65	110
	222	11	22	20	35	65	110
	223	11.5	23	25	40	65	120
	224	12	24	25	40	70	120
	225	12.5	25	25	40	70	120
	230	15	30	32	40	70	130
	231	15.5	31	32	40	80	130
	232	16	32	32	50	75	140
	233	16.5	33	32	50	75	140
	234	17	34	32	50	85	150
	235	17.5	35	32	50	85	150
	235S	17.5	35	42	50	85	150
	236	18	36	32	50	85	150
	236S	18	36	42	50	85	150
	237	18.5	37	32	50	95	160
	237S	18.5	37	42	50	95	160
	238	19	38	32	50	95	160
	238S	19	38	42	50	95	160
	239	19.5	39	32	50	95	160
	239S	19.5	39	42	50	95	160
	240	20	40	32	50	95	160
	240S	20	40	42	50	95	160
	245	22.5	45	32	50	105	170
	245S	22.5	45	42	50	105	170
	250	25	50	32	50	105	170
	250S	25	50	42	50	105	170

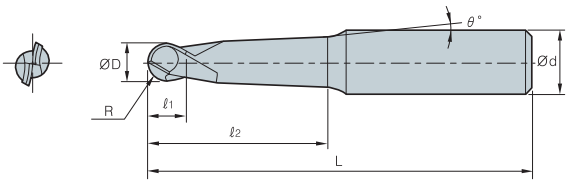
- **ZSBE200**
  Special Endmills order: ZSBE2◎◎l-L
  Ex 1) 2 flutes diameter: 6 3 l: 10 L: 60 ZSBE 206310-60L
  Ex.2) 2 flutes, diameter: 6.3, standard type ZSBE2063

- **ZSEA200**
  Special Endmills order : ZSEA2◎◎l-L
  Ex.1) 2 flutes, diameter: 16.3, l: 28, L: 95 ZSEA2163 28-95L
  Ex.2) 2 flutes, diameter: 17.0, standard type ZSEA2170

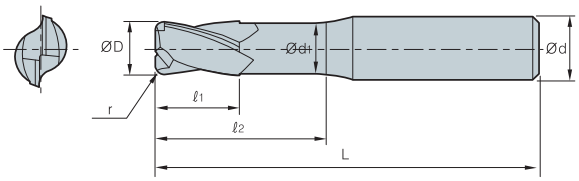
- **ZSEL200/400, ZSEXL200**
  Special Endmills orde r: ZSEL◎◎◎l-L



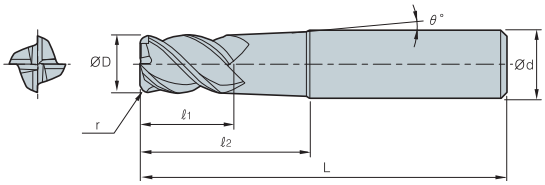
Designation	Flute	R	ØD	Ød	Ød$_1$	ℓ$_1$	ℓ$_2$	L



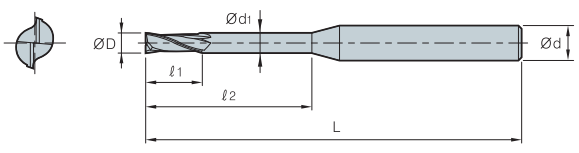
Designation	Flute	R	ØD	Ød	ℓ$_1$	ℓ$_2$	L	θ°



Designation	Flute	ØD	Ød	Ød$_1$	r	ℓ$_1$	ℓ$_2$	L



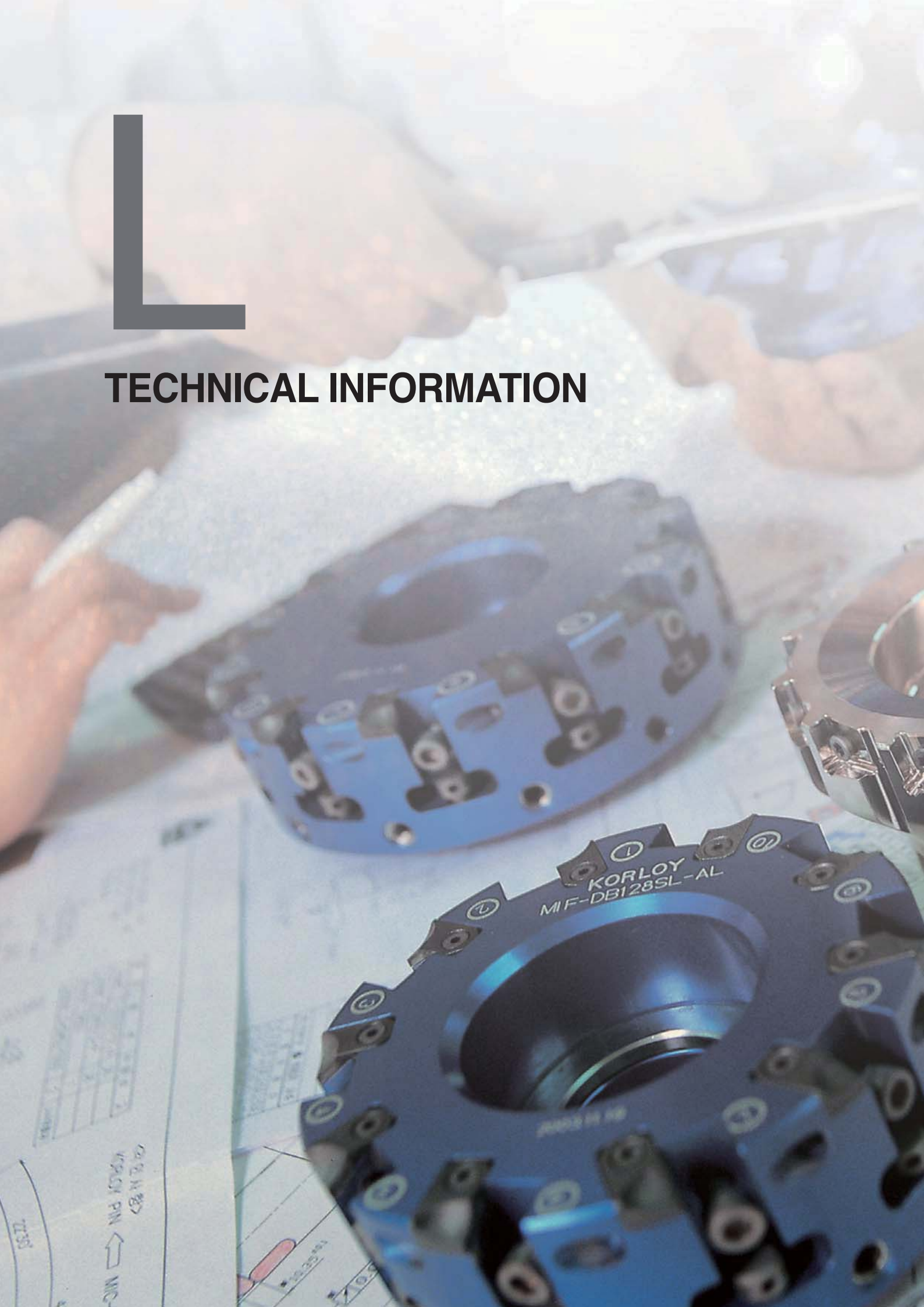
Designation	Flute	ØD	r	Ød	ℓ$_1$	ℓ$_2$	L	θ°



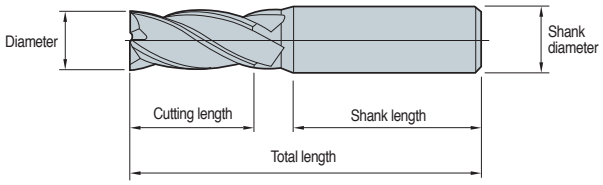
Designation	Flute	ØD	Ød	Ød$_1$	ℓ$_1$	ℓ$_2$	L

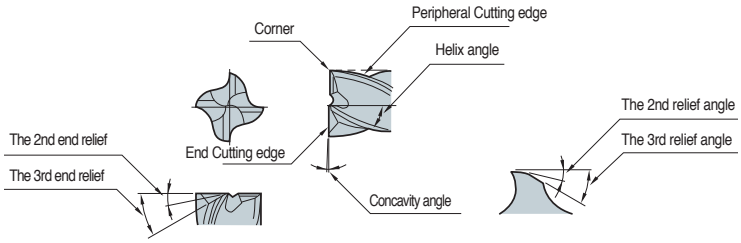
L

TECHNICAL INFORMATION



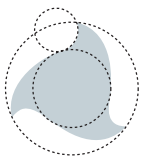
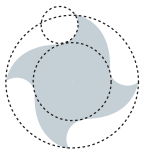
Endmill's shape and names





The comparison according to number of flute

● Features of number of flute

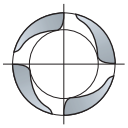
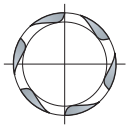
Ø10mm	2 flutes	3 flutes	4 flutes
Shape			
Cross section	44mm²	46mm²	48mm²
Ratio	56%	58%	61%
Advantages	Good chip flow	Good chip flow	High rigidity
Disadvantages	Weak rigidity	Difficult to measure external diameter	Bad chip flow
Usages	Side facing, Grooving	Side facing, Grooving	Side cutting
	Multi-functional	Medium, finishing	Finishing

● Affection of number of flute

Specification	Major features	2 flutes	4 flutes
Tool rigidity	Torsional rigidity	○	◎
	Bending rigidity	○	◎
Surface finish	Surface roughness	○	◎
	Machining precision	○	◎
Chip control	Chip clogging	◎	○
	Chip evacuation	◎	○
Grooving	Chip evacuation	◎	○
	Grooving	◎	○
Side facing	Surface finish	○	◎
	Vibration	◎	○

◎: Excellent ○: Good

The differences between general endmills and high speed endmills

General endmills		High speed endmills	
Cross section shape	Features	Cross section shape	Features
	- Applied for Low speed, High depth of cut, Low feed - Low hardness workpiece(general steel, cast iron)		- Applied for high speed, low depth of cut, high feed - Useful for hardened workpiece such as die steel

Calculations of cutting condition

● Calculations of Cutting speed

$$vc = \frac{\pi \times D \times n}{1000} \qquad n = \frac{1000 \times vc}{\pi \times D}$$

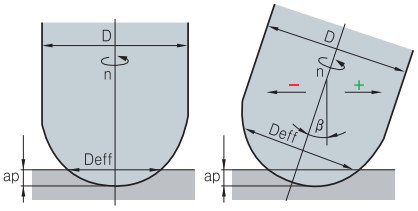
● Calculations of feed speed

$vf = n \times fn$ or $n \times fz \times z$

$$fn = \frac{vf}{n} \qquad fz = \frac{fn}{z} \text{ or } \frac{vf}{n \times z}$$

vc: Cutting speed (m/min)
π: Circular constant (3.141592)
D: Endmill diameter (mm)
n: Revolution per minute (min^{-1})
vf: Feed speed (m/min)
fn: Feed per revolution (mm/rev)
fz: Feed per flute (mm/t)
z: Number of flute

Ball endmills cutting speed calculation formulas

Revolution per minute	$n = \frac{vc \times 1000}{D \times \pi}$
Cutting speed	$vc = \frac{D \times \pi \times n}{1000}$
Feed per tooth	$fz = \frac{vf}{z \times n}$
Feed per revolution	$fn = fz \times z$
Feed speed	$vf = fz \times z \times n$
Chip removal rate	$Q = ae \times ap \times vf$
Effective diameter of Ball Endmill	$D_{eff} = 2 \times \sqrt{D \times ap - ap^2}$ Calculation Table
	$D_{eff} = D \times \sin\left[\beta \pm \arccos\left(\frac{D-2ap}{D}\right)\right]$

The affection of flute length

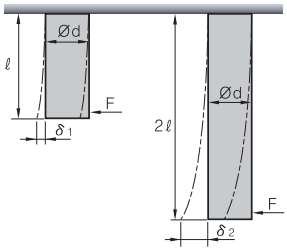
Expression of aspect ratio

- Aspect ratio
- ℓ/d
- Ex) 3D, 15D, 22D

Deformation rate according to length

- Deformation rate is reaction force against external force
- Proportional to the cube of length
- Set flute length and overall length as short as possible
- The more flute the better rigidity
- When flute width rate is narrower drill's rigidity is higher

$$\delta = \frac{P\ell^3}{3EI}$$



δ = Deformation volume **ℓ** = Length of cut

P = Cutting force **E** = Elasticity coefficient

I = Inertia moment ($I = \frac{\pi d^4}{64}$)

- ℓ: 2ℓ
- δ1: δ1 = 8δ1 = δ2

Spindle revolution conversion table (RPM) - external diameter

vc / External	Cutting speed (vc, m/min)															
	20	30	40	50	60	70	80	90	100	120	140	150	180	200	250	300
0.2	31,831	47,746	63,662	79,577	95,493	111,408	127,324	143,239	159,155	190,986	222,817	238,720	286,479	318,310	397,887	477,465
0.3	21,221	31,831	42,441	53,052	63,662	74,272	84,883	95,493	106,103	127,324	148,545	159,155	190,986	212,207	265,258	318,310
0.4	15,915	23,873	31,831	39,789	47,746	55,704	63,662	71,620	79,577	95,493	111,408	119,366	143,239	159,155	198,944	238,732
0.5	12,732	19,099	25,465	31,831	38,197	44,563	50,930	57,296	63,662	76,394	89,127	95,493	114,592	127,324	159,155	190,986
0.6	10,610	15,915	21,221	26,526	31,831	37,136	42,441	47,746	53,052	63,662	74,272	79,577	95,493	106,103	132,629	159,155
0.7	9,095	13,642	18,189	22,736	27,284	31,831	36,378	40,926	45,473	54,567	63,662	68,209	81,851	90,946	113,682	136,419
0.8	7,958	11,937	15,915	19,894	23,873	27,852	31,831	35,810	39,789	47,746	55,704	59,683	71,620	79,577	99,472	119,366
0.9	7,074	10,610	14,147	17,684	21,221	24,757	28,294	31,831	35,368	42,441	49,515	53,052	63,662	70,736	88,419	106,103
1	6,366	9,549	12,732	15,915	19,009	22,282	25,465	28,648	31,831	38,197	44,563	47,746	57,296	63,662	79,577	95,793
1.5	4,244	6,366	8,488	10,610	12,732	14,854	16,977	19,099	21,221	25,465	29,709	31,831	38,197	42,441	53,052	63,662
2	3,183	4,775	6,366	7,958	9,549	11,141	12,732	14,324	15,915	19,099	22,282	23,873	28,648	31,831	39,789	47,746
2.5	2,546	3,820	5,093	6,366	7,639	8,913	10,186	11,459	12,732	15,279	17,825	19,099	22,918	25,465	31,831	38,197
3	2,122	3,183	4,244	5,305	6,366	7,427	8,488	9,549	10,610	12,732	14,854	15,915	19,099	21,221	26,526	31,831
3.5	1,819	2,728	3,638	4,547	5,457	6,366	7,276	8,185	9,095	10,913	12,732	13,642	16,370	18,189	22,736	27,284
4	1,592	2,387	3,183	3,979	4,775	5,570	6,366	7,162	7,958	9,549	11,141	11,937	14,324	15,915	19,894	23,873
4.5	1,415	2,122	2,829	3,537	4,244	4,951	5,659	6,366	7,074	8,488	9,903	10,610	12,732	14,147	17,684	21,221
5	1,273	1,910	2,546	3,183	3,820	4,456	5,093	5,730	6,366	7,639	8,913	9,549	11,459	12,732	15,915	19,099
5.5	1,157	1,736	2,315	2,894	3,472	4,051	4,630	5,209	5,787	6,945	8,102	8,681	10,417	11,575	14,469	17,362
6	1,061	1,592	2,122	2,653	3,183	3,714	4,244	4,775	5,305	6,366	7,427	7,958	9,549	10,610	13,263	15,915
6.5	979	1,469	1,959	2,449	2,938	3,428	3,918	4,407	4,897	5,876	6,856	7,346	8,815	9,794	12,243	14,691
7	909	1,364	1,819	2,274	2,728	3,183	3,638	4,093	4,547	5,457	6,366	6,821	8,185	9,095	11,368	13,642
7.5	849	1,273	1,698	2,122	2,546	2,971	3,395	3,820	4,244	5,093	5,942	6,366	7,639	8,488	10,610	12,732
8	796	1,194	1,592	1,989	2,387	2,785	3,183	3,581	3,979	4,775	5,570	5,968	7,162	7,958	9,947	11,937
8.5	749	1,123	1,498	1,872	2,247	2,621	2,996	3,370	3,745	4,494	5,243	5,617	6,741	7,490	9,362	11,234
9	707	1,061	1,415	1,768	2,122	2,476	2,829	3,183	3,537	4,244	4,951	5,305	6,366	7,074	8,842	10,610
9.5	670	1,005	1,340	1,675	2,010	2,345	2,681	3,016	3,351	4,021	4,691	5,026	6,031	6,701	9,377	10,052
10	637	955	1,273	1,592	1,910	2,228	2,546	2,865	3,183	3,820	4,456	4,775	5,730	6,366	7,958	9,549
11	579	868	1,157	1,447	1,736	2,026	2,315	2,604	2,894	3,472	4,051	4,341	5,209	5,787	7,234	8,681
12	531	796	1,061	1,326	1,592	1,857	2,122	2,387	2,653	3,183	3,714	3,979	4,775	5,305	6,631	7,958
13	490	735	979	1,224	1,469	1,714	1,959	2,204	2,449	2,938	3,428	3,673	4,407	4,897	6,121	7,346
14	455	682	909	1,137	1,364	1,592	1,819	2,046	2,274	2,728	3,183	3,410	4,093	4,547	5,684	6,821
15	424	637	849	1,061	1,273	1,485	1,698	1,910	2,122	2,546	2,971	3,183	3,820	4,244	5,305	6,366
16	398	597	796	995	1,194	1,393	1,592	1,790	1,989	2,387	2,785	2,984	3,581	3,979	4,974	5,968
17	374	562	749	969	1,123	1,311	1,498	1,685	1,872	2,247	2,621	2,809	3,370	3,745	4,681	5,617
18	354	531	707	884	1,061	1,238	1,415	1,592	1,768	2,122	2,476	2,653	3,183	3,537	4,421	5,305
19	335	503	670	838	1,005	1,173	1,340	1,508	1,675	2,010	2,345	2,513	3,016	3,351	4,188	5,026
20	318	477	637	796	955	1,114	1,273	1,432	1,592	1,910	2,228	2,387	2,865	3,183	3,979	4,775
21	303	455	606	758	909	1,061	1,213	1,364	1,516	1,819	2,122	2,274	2,728	3,032	9,789	4,547
22	289	434	579	723	868	1,013	1,157	1,302	1,447	1,736	2,026	2,170	2,604	2,894	3,617	4,341
23	277	415	554	692	830	969	1,107	1,246	1,384	1,661	1,938	2,076	2,491	2,768	3,460	4,152
24	265	398	531	663	796	928	1,061	1,194	1,326	1,592	1,857	1,989	2,387	2,653	3,316	3,979
25	255	382	509	637	764	891	1,019	1,146	1,273	1,528	1,783	1,910	2,292	2,546	3,183	3,820

Tool failure and trouble shooting

Trouble		Causes	Solutions																	
			Cutting condition					Tool shape						Grade		etc				
			Cutting speed	Feed	Depth of cut	Coolant	Up cut-down cut	Relief angle	Lead angle	Length of flute	Number of flute	Honing	Chip pocket	Toughness	Hardness	Machine rigidity	Machine vibration	Workpiece fixing	Overhang
Damage at cutting edge	Excessive periphery cutting edge	Improper cutting condition	⬇	⬆		◉											⬆		
	Chipping	Improper cutting condition Generating built up edge Weak tool rigidity Improper grade		⬇			⬇	⬇				◉		⬆			⬇	⬆	⬇
	Fracture during operation	Improper cutting conditions Excessive cutting load Excessive overhang		⬇	⬇					⬇			⬆			⬆		⬆	⬇
Poor surface finish		Generating built-up edge	⬆	⬆		◉			⬆			◉							
		Chattering	⬇				⬇			⬇						⬆	⬇	⬆	⬇
		Poor straightness		⬇	⬇		⬆		⬆	⬇									⬇
Poor machining precision (Machined size, perpendicularity)		Improper cutting conditions Improper tool shape	⬆	⬇			⬇			⬇	⬆					⬆	⬇		⬇
Bad chip evacuation		Excessive cutting volume Improper chip pocket Improper cutting conditions		⬇	⬇						⬇		⬆						

⬆ : Increase ⬇: Decrease ●: use ◉: Correct use