EMUGE FRANKEN

FRANKEN

CIRCLE SEGMENT & TURBINE END MILLS FOR **MACHINING BLADES AND OTHER COMPLEX PARTS**

Circle Segment and Turbine End Mills for Aerospace and Turbine Machining Strategies

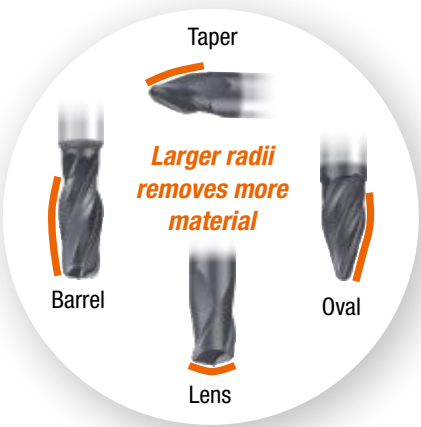
Unique Geometry Designed for High Performance Machining

Circle Segment End Mills – an Emuge Innovation

Circle Segment end mills feature unique design forms with large radii, allowing a much larger axial depth of cut during pre-finish and finishing. This generates higher cutting forces than conventional ball-nose cutters due to the large radii on the face and radial cutting edges. These tools enable substantially more material removal with fewer passes in 5-Axis machining, generating **cycle time reductions of over 80% and up to 50% smoother surface finishes.**

Circle Segment solid-carbide end mills are ideal for mold making, machining turbine blades, impellers and blisks, and are offered in four geometries. Oval and taper form mills are ideal for curved shapes, freely engaging more of the cutting edge. Barrel design mills provide highly effective flank milling to the sides of spiral grooves and similar applications, while lens shape mills excel in narrow channels or in lands on molds. Each type is available in various diameters and lengths. Specific CAM system software such as hyperMill® or Mastercam® is required to support and compute the geometries of Circle Segment end mills to achieve optimum performance.

Over 80% Cycle time Reductions!

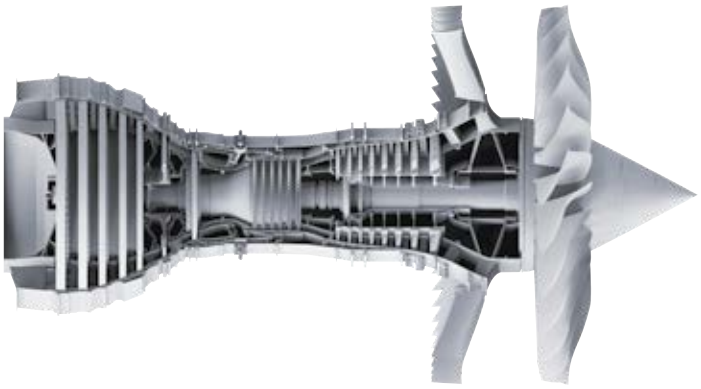


Turbine End Mills

Emuge Turbine Solid Carbide End Mills were developed to meet the requirements of materials and complex component geometry design found in aerospace and turbine industries. In addition to turbine parts, these tools are also widely used in the die and mold industry.

Complex shapes including wide sweeping radii and deep pocketed cavities present a broad range of challenges for machinists and programmers. The Emuge turbine milling program was developed to provide standard solutions to special problems.

Realize unprecedented cycle time reductions and tool life in challenging forms and materials, including Ti, Ni and more.



The Emuge Turbine end mill range is comprised of solid carbide tools for the roughing and finishing of components on turbines or other complex 5-Axis parts.

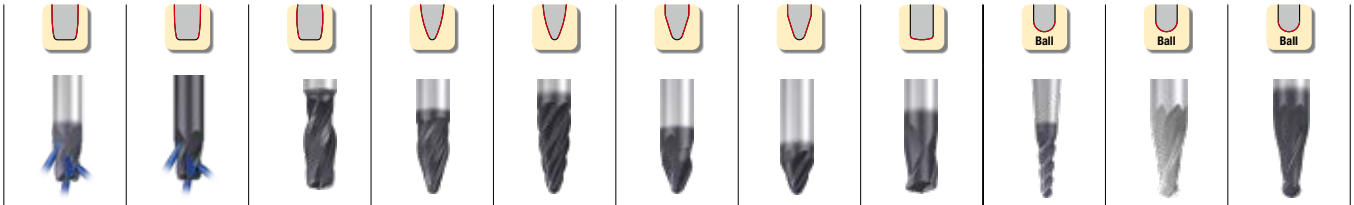
Product finder

Please note:
The suitability is indicated as follows:

■ = very suitable
□ = suitable

Please find the cutting conditions on pages 9 up to 49.

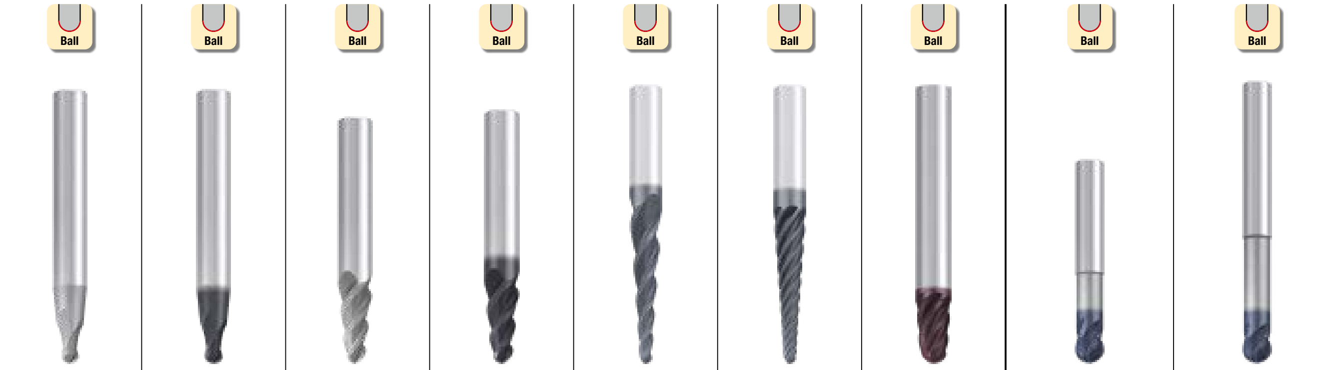
		Applications – Materials	Hardness Range HRC	Hardness Range BHN	Hardness Range N/mm²	Material – Examples
P		**Steel materials**				
P	1.1	Cold-extrusion steels, Construction steels, Free-cutting steels, etc.		≤ 180	≤ 600	1010 / 1018 / 1020 / 12L14 / 12L15 / A36 / T1
P	2.1	Construction steels, Cementation steels, Steel castings, etc.	≤ 22	≤ 235	≤ 800	A36 / T1 / 1030-1095 / 4140 / 4340 / 8620
P	3.1	Cementation steels, Heat-treatable steels, Cold work steels, etc.	≤ 31	≤ 295	≤ 1000	4140 / 4340 / 8620 / P20 / H13 / D2 / A2 / S7 / H1150
P	4.1	Heat-treatable steels, Cold work steels, Nitriding steels, etc.	≤ 38	≤ 355	≤ 1200	4140 / 4340 / 8620 / P20 / H13 / D2 / 300M / 52100 / M1-M42
P	5.1	High-alloyed steels, Cold work steels, Hot work steels, etc.	≤ 44	≤ 415	≤ 1400	4140 / 4340 / 8620 / P20 / H13 / D2 / 300M / 52100
M		**Stainless steel materials**				
M	1.1	Ferritic, martensitic	≤ 29	≤ 280	≤ 950	410 / 440 / 440C / 17-4 PH
M	2.1	Austenitic	≤ 29	≤ 280	≤ 950	303 / 304 / 316 / 316L / 321
M	3.1	Austenitic-ferritic (Duplex)	≤ 35	≤ 325	≤ 1100	
M	4.1	Austenitic-ferritic heat-resistant (Super Duplex)	≤ 39	≤ 370	≤ 1250	
K		**Cast materials**				
K	1.1	Cast iron with lamellar graphite (GJL)		30 - 75	100 - 250	Grey cast irons G10-GG40
K	1.2			75 - 135	250 - 450	
K	2.1	Cast iron with nodular graphite (GJS)		105 - 150	350 - 500	Nodular GGG40-GGG70
K	2.2			150 - 265	500 - 900	
K	3.1	Cast iron with vermicular graphite (GJV)		90 - 120	300 - 400	
K	3.2			120 - 150	400 - 500	Compact graphite iron (CGI)
K	4.1	Malleable cast iron (GTMW, GTMB)		70 - 145	250 - 500	
K	4.2			150 - 235	500 - 800	White iron
N		**Non-ferrous materials**				
N		Aluminium alloys				
N	1.1	Wrought aluminium alloys		≤ 60	≤ 200	7075
N	1.2			≤ 105	≤ 350	6061-T6 / 2024-T4
N	1.3			≤ 165	≤ 550	
N	1.4	Aluminium cast alloys Si ≤ 7%				
N	1.5	Aluminium cast alloys 7% < Si ≤ 12%				
N	1.6	Aluminium cast alloys 12% < Si ≤ 17%				
N		Copper alloys				
N	2.1	Pure copper, low-alloyed copper		≤ 120	≤ 400	
N	2.2	Copper-zinc alloys (brass, long-chipping)		≤ 165	≤ 550	
N	2.3	Copper-zinc alloys (brass, short-chipping)		≤ 165	≤ 550	
N	2.4	Copper-aluminium alloys (alu bronze, long-chipping)		≤ 235	≤ 800	
N	2.5	Copper-tin alloys (tin bronze, long-chipping)		≤ 205	≤ 700	
N	2.6	Copper-tin alloys (tin bronze, short-chipping)		≤ 120	≤ 400	
N	2.7	Special copper alloys		≤ 180	≤ 600	
N	2.8		≤ 44	≤ 415	≤ 1400	
N		Magnesium alloys				
N	3.1	Magnesium wrought alloys		≤ 150	≤ 500	
N	3.2	Magnesium cast alloys		≤ 150	≤ 500	
N		Synthetics				
N	4.1	Duroplastics (short-chipping)				
N	4.2	Thermoplastics (long-chipping)				
N	4.3	Fibre-reinforced synthetics (fibre content ≤ 30%)				
N	4.4	Fibre-reinforced synthetics (fibre content > 30%)				
N		Special materials				
N	5.1	Graphite				
N	5.2	Tungsten-copper alloys				
N	5.3	Composite materials				
S		**Special materials**				
S		Titanium alloys				
S	1.1	Pure titanium		≤ 135	≤ 450	CP1 / CP2
S	1.2	Titanium alloys	≤ 27	≤ 265	≤ 900	6AL4V
S	1.3		≤ 39	≤ 370	≤ 1250	
S		Nickel alloys, cobalt alloys and iron alloys				
S	2.1	Pure nickel		≤ 180	≤ 600	
S	2.2	Nickel-based alloys	≤ 31	≤ 295	≤ 1000	Monel 500 / Hastelloy / 625 Inconel
S	2.3		≤ 49	≤ 475	≤ 1600	718 Inconel
S	2.4	Cobalt-based alloys	≤ 31	≤ 295	≤ 1000	
S	2.5		≤ 49	≤ 475	≤ 1600	Haynes 25
S	2.6	Iron-based alloys	≤ 46	≤ 445	≤ 1500	Incoloy 925
H		**Hard materials**				
H	1.1	High strength steels, hardened steels, hard castings	44 - 50			
H	1.2		50 - 55			
H	1.3		55 - 60			
H	1.4		60 - 63			
H	1.5		63 - 66			



Circle Segment								Turbine			
NR fine		N						NR fine	NF fine		
ø8 - 16 mm	ø8 - 16 mm	r_2 = 50 mm	r_2 = 50 - 95 mm	ø10 - 16 mm	$\alpha/_2$=12.5 - 70° r_2=50 - 1500 mm	$\alpha/_2$=12.5 - 70° r_2=200 - 1500 mm	r_2 = 6 - 25 mm	$\alpha/_2$=4° r=2 - 4 mm	$\alpha/_2$=3 - 8° r=0.5 - 2 mm	$\alpha/_2$=3 - 8° r=0.5 - 2 mm	
4	4	4	3 - 4	6	2 - 3	4 - 6	3	3	2	2	# Flutes
3552LZ	**3554LZ**	**3542L**	**3538L**	**3539L**	**3540L**	**3541L**	**3544L**	**3546L**	**3446 / 3447**	**3446L**	
–	–	–	–	–	–	–	–	–	–	–	
8	10	12	14	16	18	20	22	24	26	26	Page
9	11	13	15	17	19	21	23	25	27	27	v_c / f_z
■	■	■	■	■	■	■	■	■		■	1.1
■	■	■	■	■	■	■	■	■		■	2.1
■	■	■	■	■	■	■	■	■		■	3.1
■	■	■	■	■	■	■	■	■		□	4.1
■	■	■	■	■	■	■	■	■		□	5.1
■	■	■	■	■	■	■	■	■		■	1.1
■	■	■	■	■	■	■	■	■		■	2.1
■	■	□	□	□	□	□	□	■			3.1
■	■	□	□	□	□	□	□	■			4.1
		■	■	■	■	■	■			■	1.1
		■	■	■	■	■	■			■	1.2
		■	■	■	■	■	■			■	2.1
		□	□	□	□	□	□			■	2.2
		■	■	■	■	■	■			□	3.1
		■	■	■	■	■	■			□	3.2
		■	■	■	■	■	■			□	4.1
		□	□	□	□	□	□			□	4.2
■	■	■	■	■	■	■	■	■	■	■	1.1
■	■	■	■	■	■	■	■	■	■	■	1.2
■	■	■	■	■	■	■	■	■	■	■	1.3
		■	■	■	■	■	■			■	1.4
										□	1.5
											1.6
		■	■	■	■	■	■			■	2.1
		■	■	■	■	■	■			■	2.2
		■	■	■	■	■	■			■	2.3
		■	■	■	■	■	■			■	2.4
		■	■	■	■	■	■			■	2.5
		■	■	■	■	■	■			■	2.6
		■	■	■	■	■	■			□	2.7
		■	■	■	■	■	■			□	2.8
		■	■	■	■	■	■			■	3.1
		■	■	■	■	■	■			■	3.2
		□	□	□	□	□			■	■	4.1
		□	□	□	□	□			■	■	4.2
										■	4.3
										■	4.4
											5.1
		□	□	□	□	□	□			■	5.2
										■	5.3
■	■	■	■	■	■	■	■	■		■	1.1
■	■	■	■	■	■	■	■	■		■	1.2
■	■	■	■	■	■	■	■	■		□	1.3
		■	■	■	■	■	■			■	2.1
■	■	■	■	■	■	■		■		■	2.2
■	■	□	□	□	□	□		■		□	2.3
■	■	■	■	■	■	■		■		□	2.4
■	■	□	□	□	□	□		■		□	2.5
■	■	□	□	□	□	□		■		□	2.6
		□	□	■	□	■					1.1
		□	□	■	□	■					1.2
				■		■					1.3
											1.4
											1.5

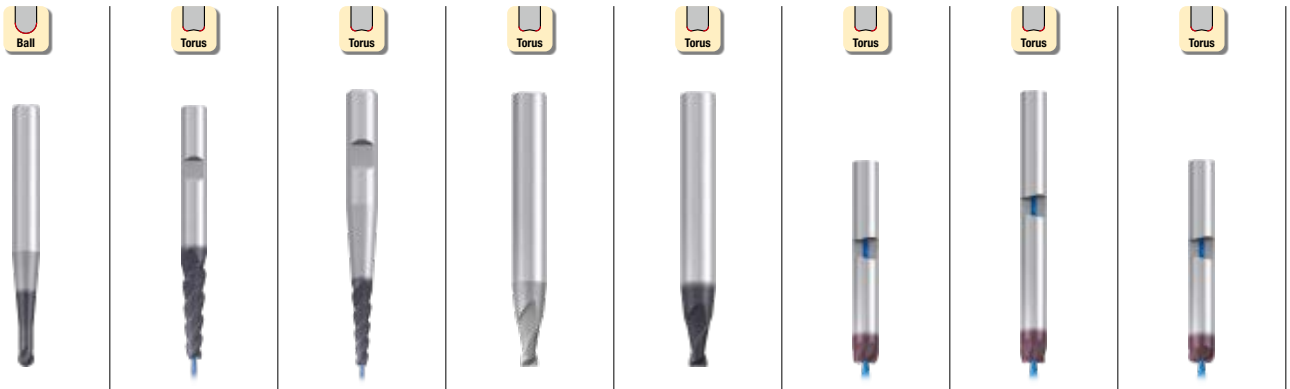
P M K N S H

■ = very suitable □ = suitable



		Turbine							Hard-Cut	
		N							H	
		$\alpha/2$=3 - 8° r=1.5-3mm	$\alpha/2$=3 - 8° r=1.5-3mm	$\alpha/2$=3 - 17.5° r=0.5-3mm	$\alpha/2$=3 - 17.5° r=0.5-3mm	$\alpha/2$= 4° r=2-4mm	$\alpha/2$= 4° r=2-4mm	$\alpha/2$= 4° r=3-8mm	ø3-12mm	ø6-12mm
# Flutes		2	2	2	2	3	3/6	3/6	4	4
		3442 / 3443	3442L	3440 / 3441	3440L	3550L	3548L	2679A	2834A	2842A
		–	–	–	–	–	–	–	–	–
Page		28	28	30	30	32	33	34	36	38
v_c / f_z		29	29	31	31	32	33	35	37	39
P	1.1		■		■	■	■	■	□	□
	2.1		■		■	■	■	■	□	□
	3.1		■		■	■	■	■	■	■
	4.1		□		□	■	■	■	■	■
	5.1		□		□	■	■	■	■	■
M	1.1		■		■	■	■	■		
	2.1		■		■	■	■	■		
	3.1					■	■	■		
	4.1					■	■	■		
K	1.1		■		■			■	■	■
	1.2		■		■			■	■	■
	2.1		■		■			■	■	■
	2.2		■		■			■	■	■
	3.1		□		□			■	■	■
	3.2		□		□			■	■	■
	4.1		□		□			■	■	■
	4.2		□		□			■	■	■
N	1.1	■	■	■	■					
	1.2	■	■	■	■					
	1.3	■	■	■	■	■	■			
	1.4		■		■	■	■			
	1.5		□		□	■	■			
	1.6									
	2.1		■		■			■		
	2.2		■		■			■	□	□
	2.3		■		■			■	■	■
	2.4		■		■			■	□	□
	2.5		■		■			■	□	□
	2.6		■		■			■	■	■
	2.7		□		□			■	■	■
	2.8		□		□			■	■	■
	3.1		■		■					
	3.2		■		■					
	4.1	■	■	■	■					
	4.2	■	■	■	■					
	4.3		■		■					
	4.4		■		■					
	5.1									
	5.2		■		■					
	5.3		■		■					
S	1.1		■		■	■	■	■		■
	1.2		■		■	■	■	■		■
	1.3		□		□	■	■	■		■
	2.1		■		■			■		■
	2.2		■		■	■	■	■		■
	2.3		□		□	■	■	■		■
	2.4		□		□	■	■	■		■
	2.5		□		□	■	■	■		■
	2.6		□		□	■	■	■		■
H	1.1								■	■
	1.2								■	■
	1.3								■	■
	1.4								■	■
	1.5								■	■

■ = very suitable □ = suitable



	Turbine								
	N	**NR** fine		**N**					
	ø4 - 10 mm	$\alpha/_2 = 3°$ ø6.5 - 8.5 mm	$\alpha/_2 = 3°$ ø5 - 8.5 mm	$\alpha/_2 = 3\text{-}8°$ $ød_1 = 3\text{-}5$ mm	$\alpha/_2 = 3\text{-}8°$ $ød_1 = 3\text{-}5$ mm	$\alpha/_2 = 8°$ $ød_1 = 8\text{-}11$ mm	$\alpha/_2 = 8°$ $ød_1 = 9\text{-}19$ mm	$ød_1 = 8\text{-}16$ mm	
	4	4	3	2	2	7 - 9	5 - 13	5 - 9	# Flutes
	2564L	**–**	**–**	**3444 / 3445**	**3444L**	**2677AZ**	**2678AZ**	**2676AZ**	
	–	**3534LZ**	**3532LZ**	**–**	**–**	**–**	**–**	**–**	
	40	42	42	44	44	46	46	48	Page
	41	43	43	45	45	47	47	49	v_c / f_z
	■	■	■		■	■	■	■	1.1
	■	■	■		■	■	■	■	2.1
	■	■	■		■	■	■	■	3.1
	■	■	■		□	■	■	■	4.1
	■	■	■		□	■	■	■	5.1
	■	■	■		■	■	■	■	1.1
	■	■	■		■	■	■	■	2.1
	■	■	■			■	■	■	3.1
	■	■	■			■	■	■	4.1
	□				■	■	■	■	1.1
	□				■	■	■	■	1.2
	□				■	■	■	■	2.1
	□				■	■	■	■	2.2
	□				□	■	■	■	3.1
	□				□	■	■	■	3.2
	□				□	■	■	■	4.1
	□				□	■	■	■	4.2
		■	■	■	■				1.1
		■	■	■	■				1.2
		■	■	■	■				1.3
					■				1.4
					□				1.5
									1.6
	■				■	■	■	■	2.1
	■				■	■	■	■	2.2
	■				■	■	■	■	2.3
	■				■	■	■	■	2.4
	■				■	■	■	■	2.5
	■				■	■	■	■	2.6
	■				□	■	■	■	2.7
	■				□	■	■	■	2.8
					■				3.1
					■				3.2
				■	■				4.1
				■	■				4.2
					■				4.3
					■				4.4
									5.1
					■				5.2
					■				5.3
	■	■	■		■	■	■	■	1.1
	■	■	■		■	■	■	■	1.2
	■	■	■		□	■	■	■	1.3
	■				■	■	■	■	2.1
	■	■	■		■	■	■	■	2.2
	■	■	■		□	■	■	■	2.3
	■	■	■		□	■	■	■	2.4
	■	■	■		□	■	■	■	2.5
	■	■	■		□	■	■	■	2.6
	□								1.1
	□								1.2
	□								1.3
									1.4
									1.5

P M K N S H

■ = very suitable □ = suitable

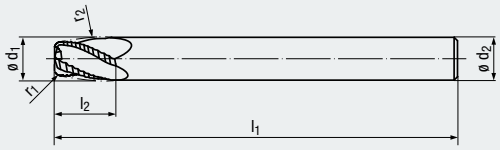
- High performance tool
- With 4 flutes
- Variable spacing
- Low-vibration machining
- Highly efficient roughing

NR | fine

Solid Carbide | ICR

DIN 6535 HA HB

30°



Icon Descriptions (see page 51)

Oval Form – ER

Universal

COATING ALCR

Applications – materials (see page 5)

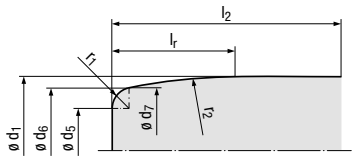
- Especially suitable for high-strength materials
- Also suitable in Nickel-based alloys
- For the machining of titanium alloys
- Suitable in all turbine materials
- Optimized for pre-finishing Impellers and Integrated Bladed Rotors (IBR) made from aluminum, titanium and Inconel

P 1.1-5.1
M 1.1-4.1
N 1.1-1.3
S 1.1-1.3
S 2.2-2.6

Tool Dimensions / mm

d_1	r_1	r_2	l_2	l_1	ø d_2 h6	# Flutes	Tool No.
8	1	40	12	80	8	**4**	**3552LZ.08040A**
10	1.5	45	12	95	10	**4**	**3552LZ.10045A**
12	2	50	14	100	12	**4**	**3552LZ.12050A**
16	2	60	18	128	16	**4**	**3552LZ.16060A**

Dimensions for tool database



l_r = r_2 is tangential to d_1

d_6 = Tangent point of r_1 and r_2

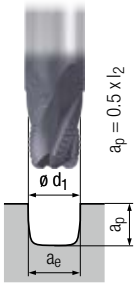
d_7 = $d_5 + 2 \times r_1$

d_1	r_1	r_2	l_2	l_r	ø d_5	ø d_6	ø d_7
8	1	40	12	10	3.895	5.841	5.895
10	1.5	45	12	10	5.323	8.265	8.323
12	2	50	14	12	5.894	9.806	9.894
16	2	60	18	16	8.570	12.452	12.570

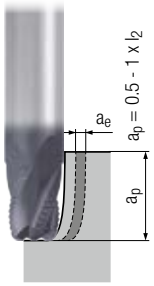
Oval Form – ER

Valid for Tool No.:

3552LZ



$a_e = d_1$



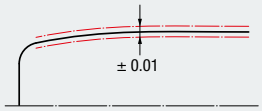
a_e = 0.5 - 1 mm

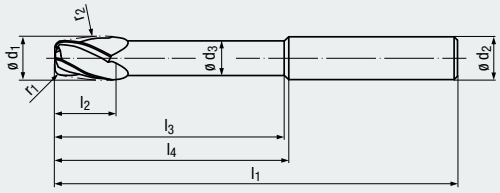
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	100	0.004 x d_1	140	0.005 x d_1		■	□	■
	2.1	90	0.004 x d_1	130	0.004 x d_1		■	□	■
	3.1	90	0.003 x d_1	120	0.004 x d_1		■	□	■
	4.1	80	0.002 x d_1	110	0.003 x d_1		■	□	■
	5.1	70	0.002 x d_1	100	0.003 x d_1		■	□	■
M	1.1	80	0.004 x d_1	100	0.005 x d_1				■
	2.1	70	0.003 x d_1	80	0.004 x d_1				■
	3.1	60	0.002 x d_1	70	0.003 x d_1				■
	4.1	60	0.002 x d_1	70	0.003 x d_1				■
K	1.1								
	1.2								
	2.1								
	2.2								
	3.1								
	3.2								
	4.1								
	4.2								
N	1.1	280	0.006 x d_1	400	0.006 x d_1				■
	1.2	200	0.005 x d_1	280	0.005 x d_1				■
	1.3	140	0.004 x d_1	200	0.004 x d_1				■
	1.4								
	1.5								
	1.6								
	2.1								
	2.2								
	2.3								
	2.4								
	2.5								
	2.6								
	2.7								
	2.8								
	3.1								
	3.2								
	4.1								
	4.2								
	4.3								
	4.4								
	5.1								
	5.2								
	5.3								
S	1.1	90	0.002 x d_1	120	0.004 x d_1				■
	1.2	75	0.002 x d_1	100	0.003 x d_1				■
	1.3	45	0.002 x d_1	60	0.002 x d_1				■
	2.1								
	2.2	25	0.002 x d_1	30	0.002 x d_1				■
	2.3	25	0.002 x d_1	30	0.002 x d_1				■
	2.4	25	0.002 x d_1	30	0.002 x d_1				■
	2.5	15	0.002 x d_1	20	0.002 x d_1				■
	2.6	25	0.002 x d_1	30	0.002 x d_1				■
H	1.1								
	1.2								
	1.3								
	1.4								
	1.5								

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 4 flutes
- Variable spacing
- Low-vibration machining
- Highly efficient finishing
- Form tolerance ±0.01 mm





N

Solid Carbide | ICR

DIN 6535 HA HB | Form ± 0.01

30°

Icon Descriptions (see page 51)

Oval Form – ER

Universal

Coating ALCR

Applications – materials (see page 5)

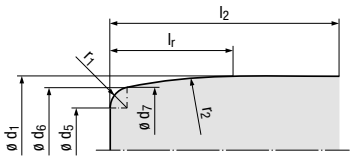
- Especially suitable for high-strength materials
- Also suitable in Nickel-based alloys
- For the machining of titanium alloys
- Suitable in all turbine materials
- Optimized for finishing Impellers and Integrated Bladed Rotors (IBR) made from aluminum, titanium and Inconel

P 1.1-5.1
M 1.1-4.1
N 1.1-1.3
S 1.1-1.3
S 2.2-2.6

Tool Dimensions / mm

d_1	r_1	r_2	l_2	l_1	l_3	l_4	ø d_3	ø d_2 h6	# Flutes	Tool No.
8	1	40	12	80	42	44	7	8	**4**	**3554LZ.08040A**
10	1.5	45	12	95	52	55	8.5	10	**4**	**3554LZ.10045A**
12	2	50	14	100	61	65	10	12	**4**	**3554LZ.12050A**
16	2	60	18	128	76	80	14	16	**4**	**3554LZ.16060A**

Dimensions for tool database



d_1	r_1	r_2	l_2	l_r	ø d_5	ø d_6	ø d_7
8	1	40	12	10	3.895	5.841	5.895
10	1.5	45	12	10	5.323	8.265	8.323
12	2	50	14	12	5.894	9.806	9.894
16	2	60	18	16	8.570	12.452	12.570

l_r = r_2 is tangential to d_1

d_6 = Tangent point of r_1 and r_2

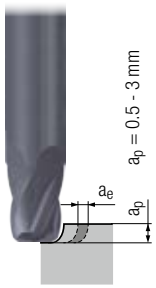
d_7 = $d_5 + 2 \times r_1$

Oval Form – ER

Valid for Tool No.:

3554LZ

N



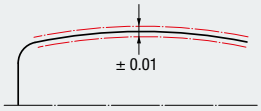
a_e = 0.1 - 0.3 mm

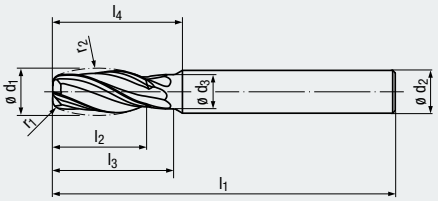
		v_c [m/min]	f_z [mm]			MQL	
P	1.1	200	0.005 x d_1		■	□	■
	2.1	180	0.004 x d_1		■	□	■
	3.1	160	0.004 x d_1		■	□	■
	4.1	140	0.003 x d_1		■	□	■
	5.1	120	0.003 x d_1		■	□	■
M	1.1	120	0.005 x d_1				■
	2.1	100	0.004 x d_1				■
	3.1	80	0.003 x d_1				■
	4.1	80	0.003 x d_1				■
K	1.1						
	1.2						
	2.1						
	2.2						
	3.1						
	3.2						
	4.1						
	4.2						
N	1.1	400	0.006 x d_1				■
	1.2	280	0.005 x d_1				■
	1.3	200	0.004 x d_1				■
	1.4						
	1.5						
	1.6						
	2.1						
	2.2						
	2.3						
	2.4						
	2.5						
	2.6						
	2.7						
	2.8						
	3.1						
	3.2						
	4.1						
	4.2						
	4.3						
	4.4						
	5.1						
	5.2						
	5.3						
S	1.1	120	0.005 x d_1				■
	1.2	100	0.004 x d_1				■
	1.3	60	0.003 x d_1				■
	2.1						
	2.2	30	0.003 x d_1				■
	2.3	30	0.002 x d_1				■
	2.4	30	0.003 x d_1				■
	2.5	20	0.002 x d_1				■
	2.6	30	0.002 x d_1				■
H	1.1						
	1.2						
	1.3						
	1.4						
	1.5						

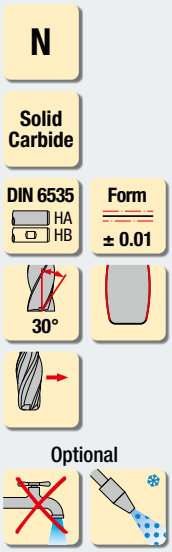
v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 4 flutes
- Low-vibration machining
- Highly efficient finishing
- Form tolerance ±0.01 mm







Icon Descriptions (see page 51)

Barrel Form – ER

Universal

Coating ALCR

Applications – materials (see page 5)

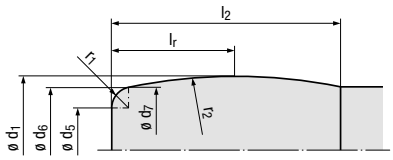
- Especially suitable for high-strength materials
- For almost all materials
- Suitable for HSC finishing

P	1.1-5.1	
M	1.1-2.1	3.1-4.1
K	1.1-2.1	2.2
K	3.1-4.1	4.2
N	1.1-1.4	
N	2.1-3.2	4.1-4.2, 5.2
S	1.1-2.2	2.3
S	2.4	2.5-2.6
H		1.1-1.2

Tool Dimensions / mm

d_1	r_1	r_2	l_2	l_3	l_1	ø d_3	l_4	ø d_2 h6	# Flutes	Tool No.
10	2	50	21	28	80	8	30	10	**4**	**3542L.10050A**

Dimensions for tool database



d_1	r_1	r_2	l_2	l_r	ø d_5	ø d_6	ø d_7
10	2	50	21	11.747	4	7.917	8

l_r = r_2 is (theoretically) tangential to d_1

d_6 = Tangent point of r_1 and r_2

$d_7 = d_5 + 2 \times r_1$

Barrel Form – ER

N

Allowance
0.05 - 0.1 mm

Allowance
0.1 - 0.2 mm

Valid for Tool No.:

3542L

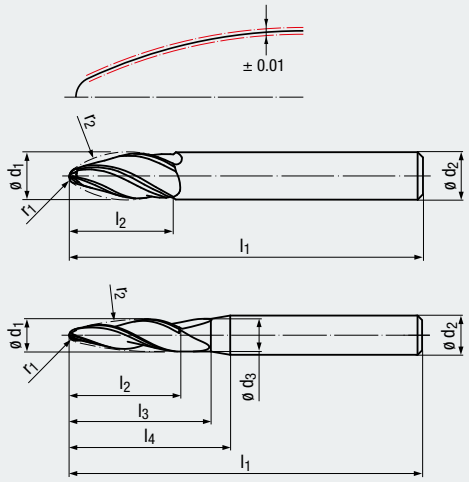
In order to calculate the rotational speed n, the diameter d_1 has to be used.

		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	420	0.004 x d_1	420	0.003 x d_1	□	■	□	■
	2.1	375	0.004 x d_1	375	0.003 x d_1	□	■	□	■
	3.1	315	0.003 x d_1	315	0.003 x d_1	□	■	□	■
	4.1	300	0.003 x d_1	300	0.002 x d_1	□	■		
	5.1	270	0.003 x d_1	270	0.002 x d_1	□	■		
M	1.1	150	0.005 x d_1	150	0.003 x d_1			□	■
	2.1	120	0.005 x d_1	120	0.003 x d_1			□	■
	3.1	90	0.004 x d_1	90	0.002 x d_1			□	■
	4.1	60	0.004 x d_1	60	0.002 x d_1			□	■
K	1.1	280	0.005 x d_1	280	0.004 x d_1	□	■		
	1.2	280	0.005 x d_1	280	0.004 x d_1	□	■		
	2.1	250	0.004 x d_1	250	0.003 x d_1	□	■		
	2.2	250	0.004 x d_1	250	0.003 x d_1	□	■		
	3.1	210	0.004 x d_1	210	0.003 x d_1	□	■		
	3.2	210	0.004 x d_1	210	0.003 x d_1	□	■		
	4.1	180	0.003 x d_1	180	0.002 x d_1	□	■		
	4.2	140	0.003 x d_1	140	0.002 x d_1	□	■		
N	1.1	600	0.004 x d_1	600	0.003 x d_1			□	■
	1.2	600	0.004 x d_1	600	0.003 x d_1			□	■
	1.3	600	0.003 x d_1	600	0.002 x d_1			□	■
	1.4	410	0.004 x d_1	410	0.003 x d_1			□	■
	1.5								
	1.6								
	2.1	270	0.005 x d_1	270	0.004 x d_1			□	■
	2.2	270	0.005 x d_1	270	0.004 x d_1			□	■
	2.3	270	0.005 x d_1	270	0.004 x d_1		□	□	■
	2.4	255	0.004 x d_1	255	0.003 x d_1			□	■
	2.5	255	0.004 x d_1	255	0.003 x d_1			□	■
	2.6	255	0.004 x d_1	255	0.003 x d_1		□	□	■
	2.7	150	0.003 x d_1	150	0.002 x d_1			□	■
	2.8	150	0.003 x d_1	150	0.002 x d_1			□	■
	3.1	410	0.005 x d_1	410	0.004 x d_1			□	■
	3.2	410	0.005 x d_1	410	0.004 x d_1			□	■
	4.1	410	0.005 x d_1	410	0.004 x d_1		□	□	■
	4.2	600	0.005 x d_1	600	0.004 x d_1			□	■
	4.3								
	4.4								
	5.1								
	5.2	150	0.005 x d_1	150	0.003 x d_1				■
	5.3								
S	1.1	100	0.006 x d_1	100	0.004 x d_1				■
	1.2	80	0.005 x d_1	80	0.003 x d_1				■
	1.3	60	0.005 x d_1	60	0.003 x d_1				■
	2.1	80	0.004 x d_1	80	0.002 x d_1				■
	2.2	30	0.004 x d_1	30	0.002 x d_1				■
	2.3	30	0.004 x d_1	30	0.002 x d_1				■
	2.4	30	0.004 x d_1	30	0.002 x d_1				■
	2.5	30	0.004 x d_1	30	0.002 x d_1				■
	2.6	30	0.004 x d_1	30	0.002 x d_1				■
H	1.1	130	0.005 x d_1	130	0.003 x d_1	□	■		
	1.2	100	0.005 x d_1	100	0.003 x d_1	□	■		
	1.3								
	1.4								
	1.5								

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 3 or 4 flutes
- Low-vibration machining
- Highly efficient finishing
- Form tolerance ±0.01 mm



N

Solid Carbide

DIN 6535 HA HB

Form ± 0.01

30°

Optional

Icon Descriptions (see page 51)

Oval Form – VR

Universal

Coating ALCR

Applications – materials (see page 5)

- Especially suitable for high-strength materials
- For almost all materials
- Suitable for HSC finishing

P	1.1-5.1	
M	1.1-2.1	3.1-4.1
K	1.1-2.1	2.2
K	3.1-4.1	4.2
N	1.1-1.4	
N	2.1-3.2	4.1-4.2, 5.2
S	1.1-2.2	2.3
S	2.4	2.5-2.6
H		1.1-1.2

Tool Dimensions / mm

d_1	r_1	r_2	l_2	l_3	l_1	ø d_3	l_4	ø d_2 h6	# Flutes	Tool No.
3	0.75	50	11	14	62	3	25	6	**3**	**3538L.03050A** NEW MICRO
4	0.75	60	14	18	62	4	25	6	**3**	**3538L.04060A** NEW MICRO
5	1	75	17	22	62	5	25	6	**3**	**3538L.05075A** NEW MICRO
6	1	95	22	–	62	–	–	6	**3**	**3538L.06095A**
8	1	90	25	–	68	–	–	8	**3**	**3538L.08090A**
10	2	85	26	–	72	–	–	10	**4**	**3538L.10085A**
12	2	80	28	–	83	–	–	12	**4**	**3538L.12080A**
16	3	75	31	–	92	–	–	16	**4**	**3538L.16075A**

Machining example

Component: Flange of a fuel pipe from the aerospace industry

Application: Finishing of the round inner contour and parts of the outer contour

Oval Form – VR

N

Allowance
0.05 - 0.1 mm

Allowance
0.1 - 0.2 mm

Allowance
0.2 - 0.3 mm

Valid for Tool No.:

3538L

In order to calculate the rotational speed n, the diameter d_1 has to be used.

		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	420	0.004 x d_1	420	0.003 x d_1	420	0.003 x d_1	□	■	□	■
	2.1	375	0.004 x d_1	375	0.003 x d_1	375	0.003 x d_1	□	■	□	■
	3.1	315	0.003 x d_1	315	0.003 x d_1	315	0.002 x d_1	□	■	□	■
	4.1	300	0.003 x d_1	300	0.002 x d_1	300	0.002 x d_1	□	■		
	5.1	270	0.003 x d_1	270	0.002 x d_1	270	0.002 x d_1	□	■		
M	1.1	150	0.005 x d_1	150	0.004 x d_1	150	0.003 x d_1			□	■
	2.1	120	0.005 x d_1	120	0.004 x d_1	120	0.003 x d_1			□	■
	3.1	90	0.004 x d_1	90	0.003 x d_1	90	0.002 x d_1			□	■
	4.1	60	0.004 x d_1	60	0.003 x d_1	60	0.002 x d_1			□	■
K	1.1	280	0.005 x d_1	280	0.004 x d_1	280	0.003 x d_1	□	■		
	1.2	280	0.005 x d_1	280	0.004 x d_1	280	0.003 x d_1	□	■		
	2.1	250	0.004 x d_1	250	0.003 x d_1	250	0.003 x d_1	□	■		
	2.2	250	0.004 x d_1	250	0.003 x d_1	250	0.003 x d_1	□	■		
	3.1	210	0.004 x d_1	210	0.003 x d_1	210	0.003 x d_1	□	■		
	3.2	210	0.004 x d_1	210	0.003 x d_1	210	0.003 x d_1	□	■		
	4.1	180	0.003 x d_1	180	0.002 x d_1	180	0.002 x d_1	□	■		
	4.2	140	0.003 x d_1	140	0.002 x d_1	140	0.002 x d_1	□	■		
N	1.1	600	0.004 x d_1	600	0.003 x d_1	600	0.003 x d_1			□	■
	1.2	600	0.004 x d_1	600	0.003 x d_1	600	0.003 x d_1			□	■
	1.3	600	0.003 x d_1	600	0.002 x d_1	600	0.002 x d_1			□	■
	1.4	410	0.004 x d_1	410	0.003 x d_1	410	0.003 x d_1			□	■
	1.5										
	1.6										
	2.1	270	0.005 x d_1	270	0.004 x d_1	270	0.003 x d_1			□	■
	2.2	270	0.005 x d_1	270	0.004 x d_1	270	0.003 x d_1			□	■
	2.3	270	0.005 x d_1	270	0.004 x d_1	270	0.003 x d_1		□	□	■
	2.4	255	0.004 x d_1	255	0.003 x d_1	255	0.003 x d_1			□	■
	2.5	255	0.004 x d_1	255	0.003 x d_1	255	0.003 x d_1			□	■
	2.6	255	0.004 x d_1	255	0.003 x d_1	255	0.003 x d_1		□	□	■
	2.7	150	0.003 x d_1	150	0.002 x d_1	150	0.002 x d_1			□	■
	2.8	150	0.003 x d_1	150	0.002 x d_1	150	0.002 x d_1			□	■
	3.1	410	0.005 x d_1	410	0.004 x d_1	410	0.003 x d_1			□	■
	3.2	410	0.005 x d_1	410	0.004 x d_1	410	0.003 x d_1			□	■
	4.1	410	0.005 x d_1	410	0.004 x d_1	410	0.003 x d_1		□	□	■
	4.2	600	0.005 x d_1	600	0.004 x d_1	600	0.003 x d_1			□	■
	4.3										
	4.4										
	5.1										
	5.2	150	0.005 x d_1	150	0.004 x d_1	150	0.003 x d_1				■
	5.3										
S	1.1	100	0.006 x d_1	100	0.005 x d_1	100	0.004 x d_1				■
	1.2	80	0.005 x d_1	80	0.004 x d_1	80	0.003 x d_1				■
	1.3	60	0.005 x d_1	60	0.004 x d_1	60	0.003 x d_1				■
	2.1	80	0.004 x d_1	80	0.003 x d_1	80	0.002 x d_1				■
	2.2	30	0.004 x d_1	30	0.003 x d_1	30	0.002 x d_1				■
	2.3	30	0.004 x d_1	30	0.003 x d_1	30	0.002 x d_1				■
	2.4	30	0.004 x d_1	30	0.003 x d_1	30	0.002 x d_1				■
	2.5	30	0.004 x d_1	30	0.003 x d_1	30	0.002 x d_1				■
	2.6	30	0.004 x d_1	30	0.003 x d_1	30	0.002 x d_1				■
H	1.1	130	0.005 x d_1	130	0.004 x d_1	130	0.003 x d_1	□	■		
	1.2	100	0.005 x d_1	100	0.004 x d_1	100	0.003 x d_1	□	■		
	1.3										
	1.4										
	1.5										

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 6 flutes
- Low-vibration machining
- Highly efficient finishing
- Form tolerance ±0.01 mm

N

Solid Carbide

DIN 6535 HA HB

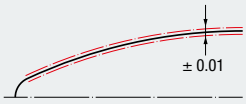
Form ± 0.01

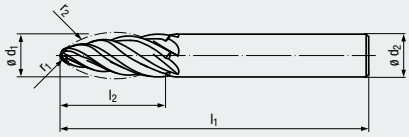
30°

Optional

≤ 60 HRC

Icon Descriptions (see page 51)





Oval Form – VR

Universal

Coating ALCR

Applications – materials (see page 5)

- Especially suitable for high-strength materials
- For almost all materials
- Hard machining of up to 60 HRC
- Suitable for HSC finishing

P	1.1-5.1	
M	1.1-2.1	3.1-4.1
K	1.1-2.1	2.2
K	3.1-4.1	4.2
N	1.1-1.4	
N	2.1-3.2	4.1-4.2, 5.2
S	1.1-2.2	2.3
S	2.4	2.5-2.6
H	1.1-1.3	

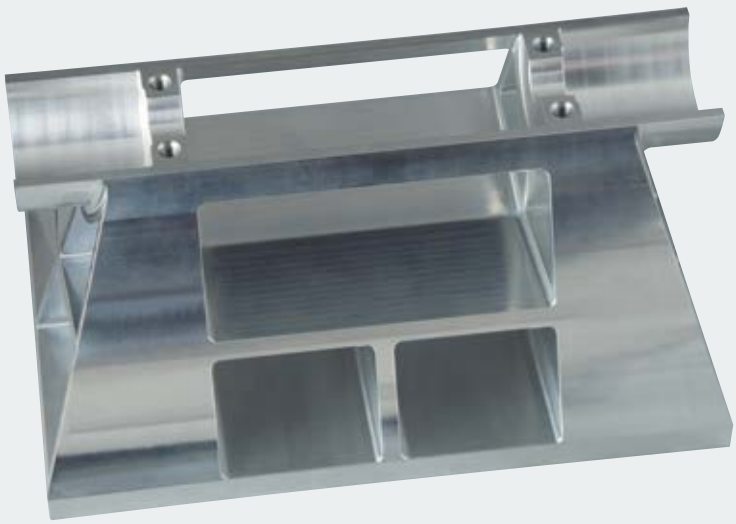
Tool Dimensions / mm

d_1	r_1	r_2	l_2	l_1	ø d_2 h6	# Flutes	Tool No.
10	2	85	26	72	10	**6**	**3539L.10085A**
12	2	80	28	83	12	**6**	**3539L.12080A**
16	3	75	31	92	16	**6**	**3539L.16075A**

Machining example

Component: Bearing block from mechanical engineering

Application: Complete finishing of the the outer contour, inner contour and the pockets



Oval Form – VR

N

Allowance
0.05 - 0.1 mm

Allowance
0.1 - 0.2 mm

Valid for Tool No.:

3539L

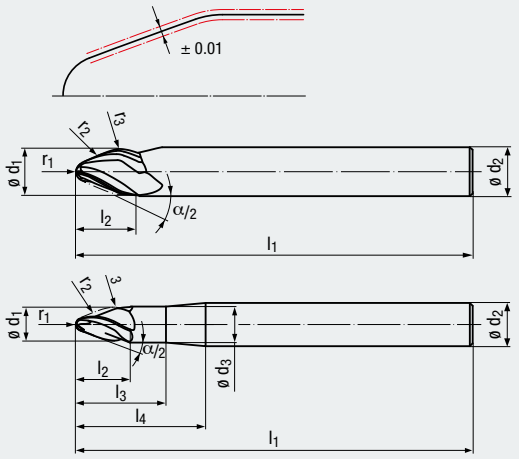
In order to calculate the rotational speed n, the diameter d_1 has to be used.

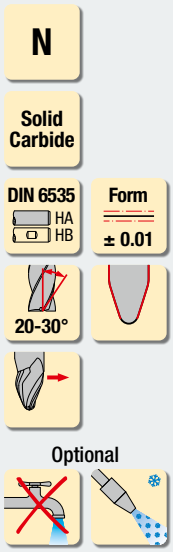
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	420	0.003 x d_1	420	0.002 x d_1	□	■	□	■
	2.1	375	0.003 x d_1	375	0.002 x d_1	□	■	□	■
	3.1	315	0.002 x d_1	315	0.002 x d_1	□	■	□	■
	4.1	300	0.002 x d_1	300	0.001 x d_1	□	■		
	5.1	270	0.002 x d_1	270	0.001 x d_1	□	■		
M	1.1	150	0.003 x d_1	150	0.002 x d_1			□	■
	2.1	120	0.003 x d_1	120	0.002 x d_1			□	■
	3.1	90	0.002 x d_1	90	0.001 x d_1			□	■
	4.1	60	0.002 x d_1	60	0.001 x d_1			□	■
K	1.1	280	0.004 x d_1	280	0.003 x d_1	□	■		
	1.2	280	0.004 x d_1	280	0.003 x d_1	□	■		
	2.1	250	0.003 x d_1	250	0.002 x d_1	□	■		
	2.2	250	0.003 x d_1	250	0.002 x d_1	□	■		
	3.1	210	0.003 x d_1	210	0.002 x d_1	□	■		
	3.2	210	0.003 x d_1	210	0.002 x d_1	□	■		
	4.1	180	0.002 x d_1	180	0.001 x d_1	□	■		
	4.2	140	0.002 x d_1	140	0.001 x d_1	□	■		
N	1.1	600	0.003 x d_1	600	0.002 x d_1			□	■
	1.2	600	0.003 x d_1	600	0.002 x d_1			□	■
	1.3	600	0.002 x d_1	600	0.001 x d_1			□	■
	1.4	410	0.003 x d_1	410	0.002 x d_1			□	■
	1.5								
	1.6								
	2.1	270	0.004 x d_1	270	0.003 x d_1			□	■
	2.2	270	0.004 x d_1	270	0.003 x d_1			□	■
	2.3	270	0.004 x d_1	270	0.003 x d_1		□	□	■
	2.4	255	0.003 x d_1	255	0.002 x d_1			□	■
	2.5	255	0.003 x d_1	255	0.002 x d_1			□	■
	2.6	255	0.003 x d_1	255	0.002 x d_1		□	□	■
	2.7	150	0.002 x d_1	150	0.001 x d_1			□	■
	2.8	150	0.002 x d_1	150	0.001 x d_1			□	■
	3.1	410	0.004 x d_1	410	0.003 x d_1			□	■
	3.2	410	0.004 x d_1	410	0.003 x d_1			□	■
	4.1	410	0.004 x d_1	410	0.003 x d_1		□	□	■
	4.2	600	0.004 x d_1	600	0.003 x d_1			□	■
	4.3								
	4.4								
	5.1								
	5.2	150	0.003 x d_1	150	0.002 x d_1				■
	5.3								
S	1.1	100	0.005 x d_1	100	0.004 x d_1				■
	1.2	80	0.004 x d_1	80	0.003 x d_1				■
	1.3	60	0.004 x d_1	60	0.003 x d_1				■
	2.1	80	0.003 x d_1	80	0.002 x d_1				■
	2.2	30	0.003 x d_1	30	0.002 x d_1				■
	2.3	30	0.003 x d_1	30	0.002 x d_1				■
	2.4	30	0.003 x d_1	30	0.002 x d_1				■
	2.5	30	0.003 x d_1	30	0.002 x d_1				■
	2.6	30	0.003 x d_1	30	0.002 x d_1				■
H	1.1	130	0.004 x d_1	130	0.003 x d_1	□	■		
	1.2	100	0.004 x d_1	100	0.003 x d_1	□	■		
	1.3	80	0.003 x d_1	80	0.002 x d_1	□	■		
	1.4								
	1.5								

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 2 or 3 flutes
- Low-vibration machining
- Highly efficient finishing
- Form tolerance ±0.01 mm





Icon Descriptions (see page 51)

Taper Form – VR

< 45°

Universal

≥ 45°

Universal

Coating

ALCR

Applications – materials (see page 5)

- Especially suitable for high-strength materials
- For almost all materials
- Suitable for HSC finishing

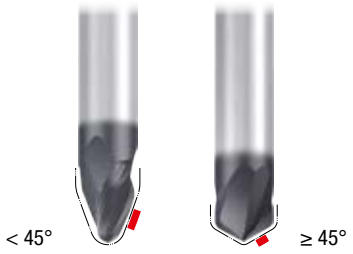
P	1.1-5.1	
M	1.1-2.1	3.1-4.1
K	1.1-2.1	2.2
K	3.1-4.1	4.2
N	1.1-1.4	
N	2.1-3.2	4.1-4.2, 5.2
S	1.1-2.2	2.3
S	2.4	2.5-2.6
H		1.1-1.2

Tool Dimensions / mm

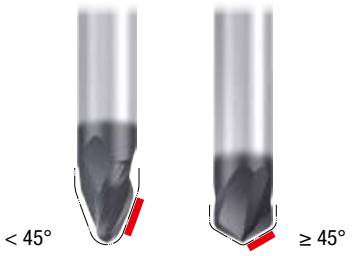
α/2	ø d1	r1	r2	r3	l2	l3	l1	ø d3	l4	ø d2 h6	# Flutes	Tool No.	Tool No.
12.5°	16	2	1000	5	31	–	108	–	–	16	3	3540L.1610AA	–
	16	4	1000	5	24	–	108	–	–	16	3	3540L.1610AB	–
17.5°	3	0.75	50	1.5	4	7	62	3	14	6	3	3540L.03050A NEW MICRO	–
	4	0.75	125	2	5.5	9.5	62	4	18	6	3	3540L.04125A NEW MICRO	–
	5	1	150	2.5	7.5	12.5	62	5	18	6	3	3540L.05150A NEW MICRO	–
	6	1	250	3	9.5	–	62	–	–	6	3	3540L.06250A	–
20°	8	1.5	250	4	10.5	–	68	–	–	8	3	3540L.08250A	–
	10	2	250	5	12.5	–	80	–	–	10	3	3540L.10250A	–
	12	3	250	6	13.5	–	93	–	–	12	3	3540L.12250A	–
	16	4	500	8	18.5	–	108	–	–	16	3	3540L.16500A	–
	16	4	1500	8	18.5	–	108	–	–	16	3	3540L.1615AA	–
42.5°	12	1	200	1	8	–	93	–	–	12	3	3540L.12200A	–
60°	10	1	200	1.5	6	–	80	–	–	10	2	–	3540L.10200A
70°	10	1	200	2	6	–	80	–	–	10	2	–	3540L.10200B

Taper Form – VR

N



Allowance
0.05 - 0.1 mm



Allowance
0.1 - 0.2 mm

Valid for Tool No.:

3540L

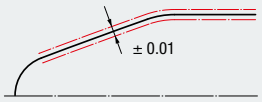
In order to calculate the rotational speed n, the diameter d_1 has to be used.

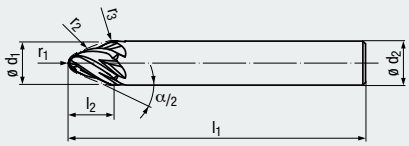
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	420	0.004 x d_1	420	0.003 x d_1	□	■	□	■
	2.1	375	0.004 x d_1	375	0.003 x d_1	□	■	□	■
	3.1	315	0.003 x d_1	315	0.003 x d_1	□	■	□	■
	4.1	300	0.003 x d_1	300	0.002 x d_1	□	■		
	5.1	270	0.003 x d_1	270	0.002 x d_1	□	■		
M	1.1	150	0.004 x d_1	150	0.003 x d_1			□	■
	2.1	120	0.004 x d_1	120	0.003 x d_1			□	■
	3.1	90	0.003 x d_1	90	0.002 x d_1			□	■
	4.1	60	0.003 x d_1	60	0.002 x d_1			□	■
K	1.1	280	0.007 x d_1	280	0.004 x d_1	□	■		
	1.2	280	0.007 x d_1	280	0.004 x d_1	□	■		
	2.1	250	0.006 x d_1	250	0.003 x d_1	□	■		
	2.2	250	0.006 x d_1	250	0.003 x d_1	□	■		
	3.1	210	0.006 x d_1	210	0.003 x d_1	□	■		
	3.2	210	0.006 x d_1	210	0.003 x d_1	□	■		
	4.1	180	0.004 x d_1	180	0.002 x d_1	□	■		
	4.2	140	0.003 x d_1	140	0.002 x d_1	□	■		
N	1.1	600	0.004 x d_1	600	0.003 x d_1			□	■
	1.2	600	0.004 x d_1	600	0.003 x d_1			□	■
	1.3	600	0.003 x d_1	600	0.002 x d_1			□	■
	1.4	410	0.004 x d_1	410	0.003 x d_1			□	■
	1.5								
	1.6								
	2.1	270	0.005 x d_1	270	0.004 x d_1			□	■
	2.2	270	0.005 x d_1	270	0.004 x d_1			□	■
	2.3	270	0.005 x d_1	270	0.004 x d_1		□	□	■
	2.4	255	0.004 x d_1	255	0.003 x d_1			□	■
	2.5	255	0.004 x d_1	255	0.003 x d_1			□	■
	2.6	255	0.004 x d_1	255	0.003 x d_1		□	□	■
	2.7	150	0.003 x d_1	150	0.002 x d_1			□	■
	2.8	150	0.003 x d_1	150	0.002 x d_1			□	■
	3.1	410	0.005 x d_1	410	0.004 x d_1			□	■
	3.2	410	0.005 x d_1	410	0.004 x d_1			□	■
	4.1	410	0.005 x d_1	410	0.004 x d_1		□	□	■
	4.2	600	0.005 x d_1	600	0.004 x d_1			□	■
	4.3								
	4.4								
	5.1								
	5.2	150	0.004 x d_1	150	0.003 x d_1				■
	5.3								
S	1.1	100	0.005 x d_1	100	0.004 x d_1				■
	1.2	80	0.004 x d_1	80	0.003 x d_1				■
	1.3	60	0.004 x d_1	60	0.003 x d_1				■
	2.1	80	0.003 x d_1	80	0.002 x d_1				■
	2.2	30	0.003 x d_1	30	0.002 x d_1				■
	2.3	30	0.003 x d_1	30	0.002 x d_1				■
	2.4	30	0.003 x d_1	30	0.002 x d_1				■
	2.5	30	0.003 x d_1	30	0.002 x d_1				■
	2.6	30	0.003 x d_1	30	0.002 x d_1				■
H	1.1	130	0.005 x d_1	130	0.003 x d_1	□	■		
	1.2	100	0.005 x d_1	100	0.003 x d_1	□	■		
	1.3								
	1.4								
	1.5								

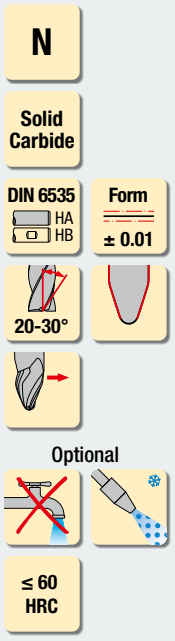
v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 4 or 6 flutes
- Low-vibration machining
- Highly efficient finishing
- Form tolerance ±0.01 mm







Icon Descriptions (see page 51)

Taper Form – VR

< 45°	≥ 45°
	
Universal	**Universal**

Coating ALCR

Applications – materials (see page 5)

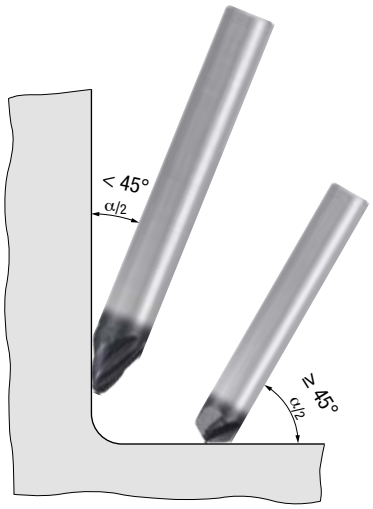
- Especially suitable for high-strength materials
- For almost all materials
- Hard machining of up to 60 HRC
- Suitable for HSC finishing

P	1.1-5.1	
M	1.1-2.1	3.1-4.1
K	1.1-2.1	2.2
K	3.1-4.1	4.2
N	1.1-1.4	
N	2.1-3.2	4.1-4.2, 5.2
S	1.1-2.2	2.3
S	2.4	2.5-2.6
H	1.1-1.3	

Tool Dimensions / mm

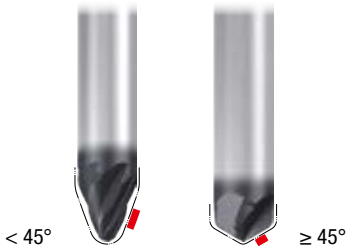
α/2	ø d1	r1	r2	r3	l2	l1	ø d2 h6	# Flutes	Tool No.	Tool No.
12.5°	16	2	1000	5	31	108	16	6	3541L.1610AA	–
	16	4	1000	5	24	108	16	6	3541L.1610AB	–
20°	10	2	250	5	12.5	80	10	6	3541L.10250A	–
	12	3	250	6	13.5	93	12	6	3541L.12250A	–
	16	4	500	8	18.5	108	16	6	3541L.16500A	–
	16	4	1500	8	18.5	108	16	6	3541L.1615AA	–
42.5°	12	1	200	1	8	93	12	6	3541L.12200A	–
60°	10	1	200	1.5	6	80	10	4	–	3541L.10200A
70°	10	1	200	2	6	80	10	4	–	3541L.10200B

Only use with tilt angle α/2!

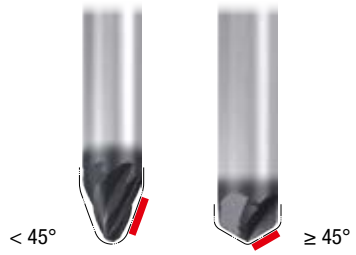


Taper Form – VR

N



Allowance
0.05 - 0.1 mm



Allowance
0.1 - 0.2 mm

Valid for Tool No.:

3541L

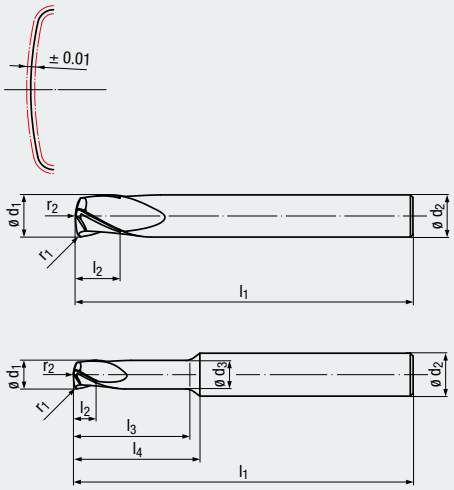
In order to calculate the rotational speed n, the diameter d_1 has to be used.

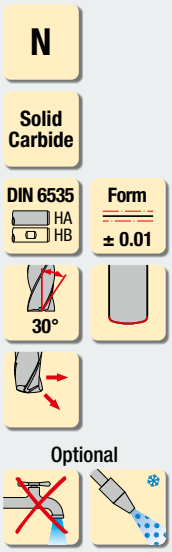
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	420	0.003 x d_1	420	0.002 x d_1	□	■	□	■
	2.1	375	0.003 x d_1	375	0.002 x d_1	□	■	□	■
	3.1	315	0.002 x d_1	315	0.002 x d_1	□	■	□	■
	4.1	300	0.002 x d_1	300	0.001 x d_1	□	■		
	5.1	270	0.002 x d_1	270	0.001 x d_1	□	■		
M	1.1	150	0.003 x d_1	150	0.002 x d_1			□	■
	2.1	120	0.003 x d_1	120	0.002 x d_1			□	■
	3.1	90	0.002 x d_1	90	0.001 x d_1			□	■
	4.1	60	0.002 x d_1	60	0.001 x d_1			□	■
K	1.1	280	0.004 x d_1	280	0.003 x d_1	□	■		
	1.2	280	0.004 x d_1	280	0.003 x d_1	□	■		
	2.1	250	0.003 x d_1	250	0.002 x d_1	□	■		
	2.2	250	0.003 x d_1	250	0.002 x d_1	□	■		
	3.1	210	0.003 x d_1	210	0.002 x d_1	□	■		
	3.2	210	0.003 x d_1	210	0.002 x d_1	□	■		
	4.1	180	0.002 x d_1	180	0.001 x d_1	□	■		
	4.2	140	0.002 x d_1	140	0.001 x d_1	□	■		
N	1.1	600	0.003 x d_1	600	0.002 x d_1			□	■
	1.2	600	0.003 x d_1	600	0.002 x d_1			□	■
	1.3	600	0.002 x d_1	600	0.001 x d_1			□	■
	1.4	410	0.003 x d_1	410	0.002 x d_1			□	■
	1.5								
	1.6								
	2.1	270	0.004 x d_1	270	0.003 x d_1			□	■
	2.2	270	0.004 x d_1	270	0.003 x d_1			□	■
	2.3	270	0.004 x d_1	270	0.003 x d_1		□	□	■
	2.4	255	0.003 x d_1	255	0.002 x d_1			□	■
	2.5	255	0.003 x d_1	255	0.002 x d_1			□	■
	2.6	255	0.003 x d_1	255	0.002 x d_1		□	□	■
	2.7	150	0.002 x d_1	150	0.001 x d_1			□	■
	2.8	150	0.002 x d_1	150	0.001 x d_1			□	■
	3.1	410	0.004 x d_1	410	0.003 x d_1			□	■
	3.2	410	0.004 x d_1	410	0.003 x d_1			□	■
	4.1	410	0.004 x d_1	410	0.003 x d_1		□	□	■
	4.2	600	0.004 x d_1	600	0.003 x d_1			□	■
	4.3								
	4.4								
	5.1								
	5.2	150	0.003 x d_1	150	0.002 x d_1				■
	5.3								
S	1.1	100	0.005 x d_1	100	0.004 x d_1				■
	1.2	80	0.004 x d_1	80	0.003 x d_1				■
	1.3	60	0.004 x d_1	60	0.003 x d_1				■
	2.1	80	0.003 x d_1	80	0.002 x d_1				■
	2.2	30	0.003 x d_1	30	0.002 x d_1				■
	2.3	30	0.003 x d_1	30	0.002 x d_1				■
	2.4	30	0.003 x d_1	30	0.002 x d_1				■
	2.5	30	0.003 x d_1	30	0.002 x d_1				■
	2.6	30	0.003 x d_1	30	0.002 x d_1				■
H	1.1	130	0.004 x d_1	130	0.003 x d_1	□	■		
	1.2	100	0.004 x d_1	100	0.003 x d_1	□	■		
	1.3	80	0.003 x d_1	80	0.002 x d_1	□	■		
	1.4								
	1.5								

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 3 flutes
- Low-vibration machining
- Highly efficient finishing
- Form tolerance ±0.01 mm





Icon Descriptions (see page 51)

Lens Form – ER

Universal

Coating ALCR

Applications – materials (see page 5)

- Especially suitable for high-strength materials
- For almost all materials
- Suitable for HSC finishing

P	1.1-5.1	
M	1.1-2.1	3.1-4.1
K	1.1-2.1	2.2
K	3.1-4.1	4.2
N	1.1-1.4	
N	2.1-3.2	5.2
S	1.1-2.1	

Tool Dimensions / mm

ø d_1	r_1	r_2	l_2	l_3	l_1	ø d_3	l_4	ø d_2 h6	# Flutes	Tool No.
4	0.25	6	4	18	62	4	20	6	**3**	**3544L.04006A**
6	0.5	10	6	–	62	–	–	6	**3**	**3544L.06010A**
8	0.75	15	8	–	68	–	–	8	**3**	**3544L.08015A**
10	1	20	10	–	80	–	–	10	**3**	**3544L.10020A**
12	1.25	25	12	–	93	–	–	12	**3**	**3544L.12025A**

Machining example

Component: Integral component from the aerospace industry

Application: Finishing of the deep pockets and the bottom surfaces

Lens Form – ER

N

Valid for Tool No.:

3544L

Allowance
0.05 - 0.1 mm

Allowance
0.1 - 0.2 mm

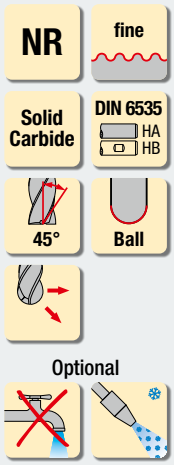
In order to calculate the rotational speed n, the diameter d_1 has to be used.

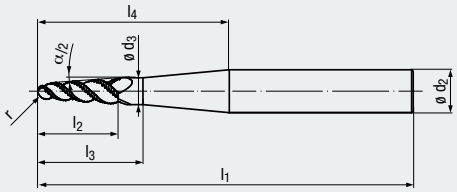
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	420	0.004 x d_1	420	0.003 x d_1	□	■	□	■
	2.1	375	0.004 x d_1	375	0.003 x d_1	□	■	□	■
	3.1	315	0.003 x d_1	315	0.003 x d_1	□	■	□	■
	4.1	300	0.003 x d_1	300	0.002 x d_1	□	■		
	5.1	270	0.003 x d_1	270	0.002 x d_1	□	■		
M	1.1	150	0.005 x d_1	150	0.003 x d_1			□	■
	2.1	120	0.005 x d_1	120	0.003 x d_1			□	■
	3.1	90	0.004 x d_1	90	0.002 x d_1			□	■
	4.1	60	0.004 x d_1	60	0.002 x d_1			□	■
K	1.1	300	0.005 x d_1	300	0.004 x d_1	□	■		
	1.2	300	0.005 x d_1	300	0.004 x d_1	□	■		
	2.1	270	0.004 x d_1	270	0.003 x d_1	□	■		
	2.2	270	0.004 x d_1	270	0.003 x d_1	□	■		
	3.1	220	0.004 x d_1	220	0.003 x d_1	□	■		
	3.2	220	0.004 x d_1	220	0.003 x d_1	□	■		
	4.1	200	0.003 x d_1	200	0.002 x d_1	□	■		
	4.2	150	0.003 x d_1	150	0.002 x d_1	□	■		
N	1.1	900	0.004 x d_1	900	0.003 x d_1			□	■
	1.2	900	0.004 x d_1	900	0.003 x d_1			□	■
	1.3	900	0.003 x d_1	900	0.002 x d_1			□	■
	1.4	600	0.004 x d_1	600	0.003 x d_1			□	■
	1.5								
	1.6								
	2.1	270	0.004 x d_1	270	0.003 x d_1			□	■
	2.2	270	0.004 x d_1	270	0.003 x d_1			□	■
	2.3	270	0.004 x d_1	270	0.003 x d_1		□	□	■
	2.4	255	0.003 x d_1	255	0.002 x d_1			□	■
	2.5	255	0.003 x d_1	255	0.002 x d_1			□	■
	2.6	255	0.003 x d_1	255	0.002 x d_1		□	□	■
	2.7	150	0.003 x d_1	150	0.002 x d_1			□	■
	2.8	150	0.003 x d_1	150	0.002 x d_1			□	■
	3.1	600	0.004 x d_1	600	0.003 x d_1			□	■
	3.2	600	0.004 x d_1	600	0.003 x d_1			□	■
	4.1								
	4.2								
	4.3								
	4.4								
	5.1								
	5.2	150	0.005 x d_1	150	0.003 x d_1				■
	5.3								
S	1.1	150	0.006 x d_1	150	0.004 x d_1				■
	1.2	120	0.005 x d_1	120	0.003 x d_1				■
	1.3	90	0.005 x d_1	90	0.003 x d_1				■
	2.1	120	0.004 x d_1	120	0.002 x d_1				■
	2.2								
	2.3								
	2.4								
	2.5								
	2.6								
H	1.1								
	1.2								
	1.3								
	1.4								
	1.5								

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 3 flutes
- Roughing profile
- Variable spacing
- Low-vibration machining
- Taper angle 4°





Icon Descriptions (see page 51)

Tapered Ball Nose End Mill

Universal

Coating — ALCR

Applications – materials (see page 5)

- Especially suitable for difficult to cut materials
- For all tough materials
- Optimized for machining Impellers and Integrated Bladed Rotors (IBR) made from aluminum, titanium and Inconel

P 1.1-5.1
M 1.1-4.1
N 1.1-1.3
S 1.1-1.3
S 2.2-2.6

Tool Dimensions / mm

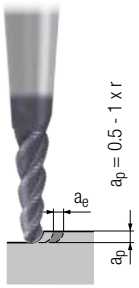
$\alpha/2$	r	l_2	l_3	l_1	l_4	ø d_3	ø d_2 h6	# Flutes	Tool No.
4°	**2**	20	27	80	37.7	6.5	8	**3**	**3546L.04020C**
	2	25	32	95	52	7.2	10	**3**	**3546L.04020B**
	2	30	37	120	66	7.9	12	**3**	**3546L.04020A**
	3	35	42	140	81	10.6	16	**3**	**3546L.04030A**
	4	40	46	155	96	13	20	**3**	**3546L.04040A**

Tapered Ball Nose End Mill

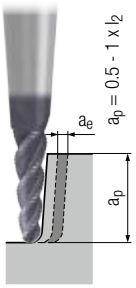
NR

Valid for Tool No.:

3546L

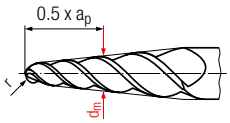


a_e < 100%



a_e = 0.5 - 1 mm

For the calculation of rpm (n), use the average diameter d_m (measuring point at 0.5 x a_p).



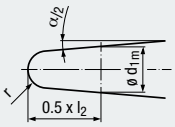
$$n = \frac{v_c \times 1000}{d_m \times \pi} \text{ [rpm]}$$

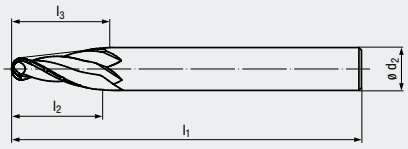
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	100	0.014 x r	120	0.018 x r		■	□	■
	2.1	90	0.012 x r	110	0.016 x r		■	□	■
	3.1	90	0.010 x r	100	0.014 x r		■	□	■
	4.1	80	0.010 x r	100	0.012 x r		■	□	■
	5.1	70	0.010 x r	90	0.012 x r		■	□	■
M	1.1	100	0.014 x r	120	0.018 x r				■
	2.1	100	0.013 x r	100	0.016 x r				■
	3.1	70	0.012 x r	70	0.014 x r				■
	4.1	70	0.010 x r	70	0.012 x r				■
K	1.1								
	1.2								
	2.1								
	2.2								
	3.1								
	3.2								
	4.1								
	4.2								
N	1.1	280	0.020 x r	400	0.030 x r				■
	1.2	200	0.025 x r	280	0.030 x r				■
	1.3	140	0.030 x r	200	0.030 x r				■
	1.4								
	1.5								
	1.6								
	2.1								
	2.2								
	2.3								
	2.4								
	2.5								
	2.6								
	2.7								
	2.8								
	3.1								
	3.2								
	4.1								
	4.2								
	4.3								
	4.4								
	5.1								
	5.2								
	5.3								
S	1.1	90	0.015 x r	100	0.020 x r				■
	1.2	75	0.012 x r	80	0.017 x r				■
	1.3	45	0.010 x r	60	0.015 x r				■
	2.1								
	2.2	25	0.010 x r	30	0.018 x r				■
	2.3	25	0.010 x r	30	0.016 x r				■
	2.4	25	0.010 x r	30	0.014 x r				■
	2.5	15	0.010 x r	20	0.012 x r				■
	2.6	25	0.010 x r	30	0.012 x r				■
H	1.1								
	1.2								
	1.3								
	1.4								
	1.5								

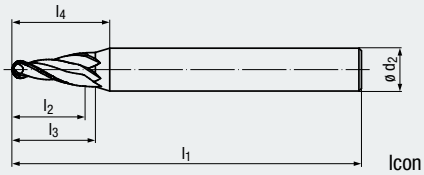
v_c = Cutting speed
f_z = Feed per tooth

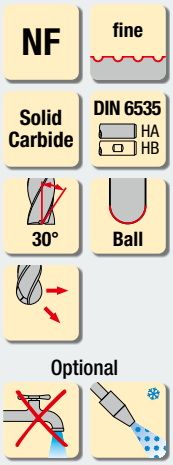
■ = very suitable
□ = suitable

- Multi-functional tool
- Fine semi-finishing profile
- With 2 flutes
- Various taper angles
- Also available with polished chip space









Icon Descriptions (see page 51)

Tapered Ball Nose End Mills

Universal | **Universal**

Coating

Applications – materials (see page 5)

- For almost all materials
- Suitable for roughing and finishing

N 1.1-1.3
N 4.1-4.2

ALCR
P 1.1-3.1 4.1-5.1
M 1.1-2.1
K 1.1-2.2 3.1-4.2
N 1.1-1.4 1.5
N 2.1-2.6 2.7-2.8
N 3.1-4.4, 5.2-5.3
S 1.1-1.2 1.3
S 2.1-2.2 2.3-2.6

Tool Dimensions / mm

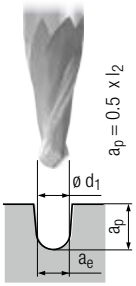
α/2	r ±0.01	l2	l3	l1	l4	d1m	ø d2 h6	# Flutes	Tool No.	Tool No.	Tool No.
3°	1.5	20	20	62	24	3.90	6	2	3446.03015A	3447.03015A	3446L.03015A
	2	31	31	80	35	5.42	8	2	3446.03020B	3447.03020B	3446L.03020B
4°	0.5	20	20	62	24	2.33	6	2	3446.04005A	3447.04005A	3446L.04005A
	1	20	20	62	24	3.26	6	2	3446.04010A	3447.04010A	3446L.04010A
	1.5	20	20	63	25	4.20	8	2	3446.04015A	3447.04015A	3446L.04015A
	2	30	30	72	–	5.83	8	2	3446.04020B	3447.04020B	3446L.04020B
6°	0.5	20	24	62	–	3.00	6	2	3446.06005A	3447.06005A	3446L.06005A
	1	19	19	62	–	3.80	6	2	3446.06010A	3447.06010A	3446L.06010A
	1.5	15	15	62	–	4.28	6	2	3446.06015A	3447.06015A	3446L.06015A
	1.5	25	25	68	–	5.33	8	2	3446.06015B	3447.06015B	3446L.06015B
	2	20	20	68	–	5.70	8	2	3446.06020A	3447.06020A	3446L.06020A
	2	30	30	80	–	6.76	10	2	3446.06020B	3447.06020B	3446L.06020B
8°	0.5	18	18	62	–	3.40	6	2	3446.08005A	3447.08005A	3446L.08005A
	1	15	15	62	–	3.85	6	2	3446.08010A	3447.08010A	3446L.08010A
	1.5	19	19	63	–	5.28	8	2	3446.08015A	3447.08015A	3446L.08015A
	2	23	23	72	–	6.71	10	2	3446.08020A	3447.08020A	3446L.08020A

Tapered Ball Nose End Mills

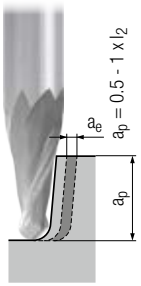
NF

Valid for Tool Nos.:

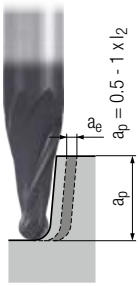
3446
3446L
3447



$a_e = d_1$

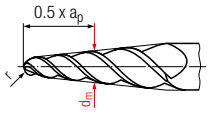


a_e = 0.1 - 1.0 mm



a_e = 0.1 - 1.0 mm

For the calculation of rpm (n), use the average diameter d_m (measuring point at 0.5 x a_p).



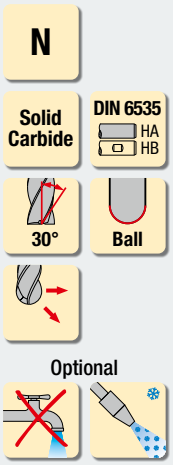
$$n = \frac{v_c \times 1000}{d_m \times \pi} \text{ [rpm]}$$

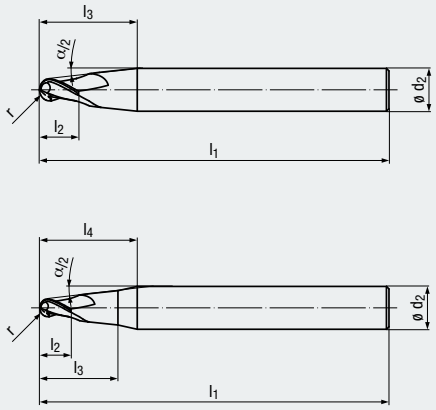
		Uncoated				ALCR					
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1					160	0.010 x r	□	■	□	■
	2.1					140	0.010 x r	□	■	□	■
	3.1					120	0.008 x r	□	■	□	
	4.1					100	0.008 x r	□	■	□	
	5.1					80	0.006 x r	□	■	□	
M	1.1					80	0.006 x r			□	■
	2.1					70	0.006 x r			□	■
	3.1										
	4.1										
K	1.1					160	0.010 x r	■	■		
	1.2					160	0.010 x r	■	■		
	2.1					140	0.008 x r	■	■		
	2.2					140	0.008 x r	■	■		
	3.1					120	0.008 x r	■	■		
	3.2					120	0.008 x r	■	■		
	4.1					100	0.006 x r	■	■		
	4.2					80	0.006 x r	■	■		
N	1.1	350	0.040 x r	300	0.020 x r	350	0.016 x r			□	■
	1.2	350	0.040 x r	300	0.020 x r	350	0.014 x r			□	■
	1.3	320	0.035 x r	270	0.017 x r	350	0.012 x r			□	■
	1.4					280	0.014 x r			□	■
	1.5					240	0.012 x r			□	■
	1.6										
	2.1					140	0.010 x r			□	■
	2.2					140	0.010 x r			□	■
	2.3					140	0.010 x r	□	□	□	■
	2.4					120	0.008 x r			□	■
	2.5					120	0.008 x r			□	■
	2.6					120	0.008 x r	□	□	□	■
	2.7					70	0.006 x r			□	■
	2.8					70	0.006 x r			□	■
	3.1					320	0.018 x r			□	■
	3.2					320	0.014 x r			□	■
	4.1			180	0.016 x r	240	0.016 x r		□	□	■
	4.2			160	0.016 x r	350	0.016 x r		□	□	■
	4.3					180	0.012 x r		□	□	■
	4.4					90	0.012 x r		□	□	■
	5.1										
	5.2					80	0.006 x r			□	■
	5.3					160	0.012 x r	□	■		■
S	1.1					80	0.008 x r			□	■
	1.2					60	0.006 x r			□	■
	1.3					40	0.006 x r			□	■
	2.1					50	0.006 x r			□	■
	2.2					20	0.004 x r			□	■
	2.3					20	0.004 x r			□	■
	2.4					20	0.004 x r			□	■
	2.5					15	0.004 x r			□	■
	2.6					20	0.004 x r			□	■
H	1.1										
	1.2										
	1.3										
	1.4										
	1.5										

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- Multi-functional tool
- With 2 flutes
- Various taper angles
- Also available with polished chip space





Icon Descriptions (see page 51)

Tapered Ball Nose End Mills

Universal | **Universal**

Coating | ALCR

Applications – materials (see page 6)

- For almost all materials
- Suitable for roughing and finishing

N 1.1-1.3
N 4.1-4.2

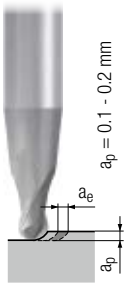
P 1.1-3.1 4.1-5.1
M 1.1-2.1
K 1.1-2.2 3.1-4.2
N 1.1-1.4 1.5
N 2.1-2.6 2.7-2.8
N 3.1-4.4, 5.2-5.3
S 1.1-1.2 1.3
S 2.1-2.2 2.3-2.6

Tool Dimensions / mm

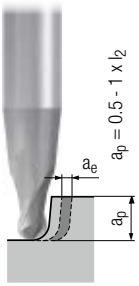
α/2	r ±0.01	l2	l3	l1	l4	ø d2 h6	# Flutes	Tool No.	Tool No.	Tool No.
3°	1.5	4	24	63	26	8	2	3442.03015A	3443.03015A	3442L.03015A
	3	7	38	80	39	10	2	3442.03030A	3443.03030A	3442L.03030A
4°	1.5	4	24	63	26	8	2	3442.04015A	3443.04015A	3442L.04015A
	3	7	33	80	–	10	2	3442.04030A	3443.04030A	3442L.04030A
6°	1.5	4	26	63	–	8	2	3442.06015A	3443.06015A	3442L.06015A
	3	7	23	80	–	10	2	3442.06030A	3443.06030A	3442L.06030A
8°	1.5	4	27	80	–	10	2	3442.08015A	3443.08015A	3442L.08015A
	3	7	25	83	–	12	2	3442.08030A	3443.08030A	3442L.08030A

Tapered Ball Nose End Mills

N

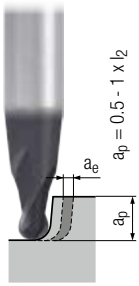


a_e = 0.1 - 0.2 mm



a_e = 0.1 - 0.2 mm

a_e = 0.1 - 0.2 mm

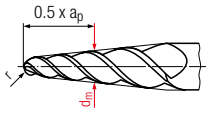


a_e = 0.1 - 0.2 mm

Valid for Tool Nos.:

3442
3442L
3443

For the calculation of rpm (n), use the average diameter d_m (measuring point at 0.5 x a_p).



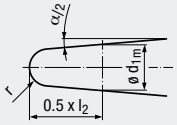
$$n = \frac{v_c \times 1000}{d_m \times \pi} \text{ [rpm]}$$

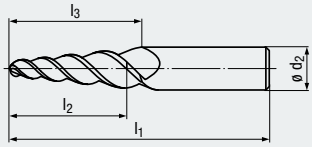
		Uncoated				ALCR							
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1					300	0.010 x r	160	0.010 x r	□	■	□	■
	2.1					260	0.010 x r	140	0.010 x r	□	■	□	■
	3.1					220	0.008 x r	120	0.008 x r	□	■	□	
	4.1					180	0.008 x r	100	0.008 x r	□	■	□	
	5.1					150	0.006 x r	80	0.006 x r	□	■	□	
M	1.1					150	0.006 x r	80	0.006 x r			□	■
	2.1					120	0.006 x r	70	0.006 x r			□	■
	3.1												
	4.1												
K	1.1					300	0.010 x r	160	0.010 x r	■	■		
	1.2					300	0.010 x r	160	0.010 x r	■	■		
	2.1					260	0.008 x r	140	0.008 x r	■	■		
	2.2					260	0.008 x r	140	0.008 x r	■	■		
	3.1					220	0.008 x r	120	0.008 x r	■	■		
	3.2					220	0.008 x r	120	0.008 x r	■	■		
	4.1					180	0.006 x r	100	0.006 x r	■	■		
	4.2					150	0.006 x r	80	0.006 x r	■	■		
N	1.1	490	0.016 x r	250	0.016 x r	700	0.016 x r	350	0.016 x r			□	■
	1.2	490	0.014 x r	250	0.014 x r	700	0.014 x r	350	0.014 x r			□	■
	1.3	490	0.012 x r	250	0.012 x r	700	0.012 x r	350	0.012 x r			□	■
	1.4					500	0.014 x r	280	0.014 x r			□	■
	1.5					450	0.012 x r	240	0.012 x r			□	■
	1.6												
	2.1					260	0.010 x r	140	0.010 x r			□	■
	2.2					260	0.010 x r	140	0.010 x r			□	■
	2.3					260	0.010 x r	140	0.010 x r	□	□	□	■
	2.4					220	0.008 x r	120	0.008 x r			□	■
	2.5					220	0.008 x r	120	0.008 x r			□	■
	2.6					220	0.008 x r	120	0.008 x r	□	□	□	■
	2.7					140	0.006 x r	70	0.006 x r			□	■
	2.8					140	0.006 x r	70	0.006 x r			□	■
	3.1					600	0.018 x r	320	0.018 x r			□	■
	3.2					600	0.014 x r	320	0.014 x r			□	■
	4.1	320	0.016 x r	170	0.016 x r	460	0.016 x r	240	0.016 x r		□	□	■
	4.2	460	0.016 x r	250	0.016 x r	650	0.016 x r	350	0.016 x r		□	□	■
	4.3					250	0.012 x r	180	0.012 x r		□	□	■
	4.4					180	0.012 x r	90	0.012 x r		□	□	■
	5.1												
	5.2					180	0.006 x r	80	0.006 x r			□	■
	5.3					300	0.012 x r	160	0.012 x r	□	■		■
S	1.1					150	0.008 x r	80	0.008 x r			□	■
	1.2					120	0.006 x r	60	0.006 x r			□	■
	1.3					70	0.006 x r	40	0.006 x r			□	■
	2.1					110	0.006 x r	50	0.006 x r			□	■
	2.2					30	0.004 x r	20	0.004 x r			□	■
	2.3					30	0.004 x r	20	0.004 x r			□	■
	2.4					30	0.004 x r	20	0.004 x r			□	■
	2.5					20	0.004 x r	15	0.004 x r			□	■
	2.6					30	0.004 x r	20	0.004 x r			□	■
H	1.1												
	1.2												
	1.3												
	1.4												
	1.5												

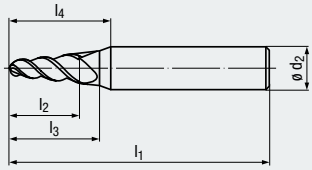
v_c = Cutting speed
f_z = Feed per tooth

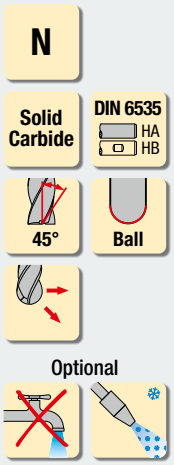
■ = very suitable
□ = suitable

- Multi-functional tool
- With 3 flutes
- Various taper angles
- Also available with polished chip space









Icon Descriptions (see page 51)

Tapered Ball Nose End Mills

Universal

With polished chip space

Universal

Coating

Applications – materials (see page 6)

- For almost all materials
- Suitable for finishing

N 1.1-1.3
N 4.1-4.2

ALCR

P 1.1-3.1 4.1-5.1
M 1.1-2.1
K 1.1-2.2 3.1-4.2
N 1.1-1.4 1.5
N 2.1-2.6 2.7-2.8
N 3.1-4.4, 5.2-5.3
S 1.1-1.2 1.3
S 2.1-2.2 2.3-2.6

Tool Dimensions / mm

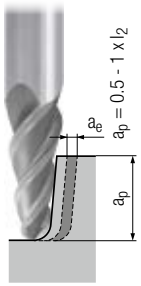
α/2	r ±0.005	l2	l3	l1	l4	d1m	ø d2 h6	# Flutes	Tool No.	Tool No.	Tool No.
3°	1.5	20	20	62	24	3.90	6	3	3440.03015A	3441.03015A	3440L.03015A
	2	21	21	66	–	4.90	6	3	3440.03020A	3441.03020A	3440L.03020A
	2	31	31	80	35	5.42	8	3	3440.03020B	3441.03020B	3440L.03020B
	3	22	22	72	–	6.85	8	3	3440.03030A	3441.03030A	3440L.03030A
	3	31	31	80	35	7.32	10	3	3440.03030B	3441.03030B	3440L.03030B
4°	0.5	20	20	62	24	2.33	6	3	3440.04005A	3441.04005A	3440L.04005A
	1	20	20	62	24	3.26	6	3	3440.04010A	3441.04010A	3440L.04010A
	1.5	20	20	63	25	4.20	8	3	3440.04015A	3441.04015A	3440L.04015A
	2	20	30	68	–	5.13	8	3	3440.04020A	3441.04020A	3440L.04020A
	2	30	30	72	–	5.83	8	3	3440.04020B	3441.04020B	3440L.04020B
	3	25	31	72	–	7.34	10	3	3440.04030A	3441.04030A	3440L.04030A
	3	31	31	80	–	7.76	10	3	3440.04030B	3441.04030B	3440L.04030B
6°	0.5	20	24	62	–	3.00	6	3	3440.06005A	3441.06005A	3440L.06005A
	1	19	19	62	–	3.80	6	3	3440.06010A	3441.06010A	3440L.06010A
	1	29	29	72	–	4.85	8	3	3440.06010B	3441.06010B	3440L.06010B
	1.5	15	15	62	–	4.28	6	3	3440.06015A	3441.06015A	3440L.06015A
	1.5	25	25	68	–	5.33	8	3	3440.06015B	3441.06015B	3440L.06015B
	2	20	20	68	–	5.70	8	3	3440.06020A	3441.06020A	3440L.06020A
	2	30	30	80	–	6.76	10	3	3440.06020B	3441.06020B	3440L.06020B
	3	21	21	72	–	7.61	10	3	3440.06030A	3441.06030A	3440L.06030A
	3	31	31	83	–	8.66	12	3	3440.06030B	3441.06030B	3440L.06030B
8°	0.5	18	18	62	–	3.40	6	3	3440.08005A	3441.08005A	3440L.08005A
	1	15	15	62	–	3.85	6	3	3440.08010A	3441.08010A	3440L.08010A
	1	22	22	63	–	4.83	8	3	3440.08010B	3441.08010B	3440L.08010B
	1.5	19	19	63	–	5.28	8	3	3440.08015A	3441.08015A	3440L.08015A
	1.5	26	26	72	–	6.26	10	3	3440.08015B	3441.08015B	3440L.08015B
	2	23	23	72	–	6.71	10	3	3440.08020A	3441.08020A	3440L.08020A
17.5°	0.5	8	8	57	–	3.26	6	3	3440.17505A	3441.17505A	3440L.17505A

Tapered Ball Nose End Mills

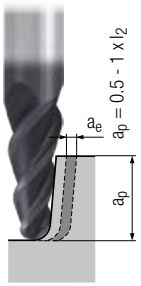
N

Valid for Tool Nos.:

3440
3440L
3441

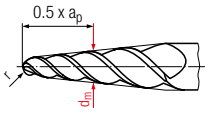


a_e = 0.1 - 0.2 mm



a_e = 0.1 - 0.2 mm

For the calculation of rpm (n), use the average diameter d_m (measuring point at 0.5 x a_p).



$$n = \frac{v_c \times 1000}{d_m \times \pi} \text{ [rpm]}$$

		Uncoated		ALCR					
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1			120	0.010 x r	□	■	□	■
	2.1			100	0.010 x r	□	■	□	■
	3.1			90	0.008 x r	□	■	□	
	4.1			70	0.008 x r	□	■	□	
	5.1			60	0.006 x r	□	■	□	
M	1.1			60	0.006 x r			□	■
	2.1			50	0.006 x r			□	■
	3.1								
	4.1								
K	1.1			120	0.010 x r	■	■		
	1.2			120	0.010 x r	■	■		
	2.1			100	0.008 x r	■	■		
	2.2			100	0.008 x r	■	■		
	3.1			90	0.008 x r	■	■		
	3.2			90	0.008 x r	■	■		
	4.1			70	0.006 x r	■	■		
	4.2			60	0.006 x r	■	■		
N	1.1	180	0.016 x r	260	0.016 x r			□	■
	1.2	180	0.014 x r	260	0.014 x r			□	■
	1.3	180	0.012 x r	260	0.012 x r			□	■
	1.4			200	0.014 x r			□	■
	1.5			180	0.012 x r			□	■
	1.6								
	2.1			100	0.010 x r			□	■
	2.2			100	0.010 x r			□	■
	2.3			100	0.010 x r	□	□	□	■
	2.4			80	0.008 x r			□	■
	2.5			80	0.008 x r			□	■
	2.6			80	0.008 x r	□	□	□	■
	2.7			50	0.006 x r			□	■
	2.8			50	0.006 x r			□	■
	3.1			240	0.018 x r			□	■
	3.2			240	0.014 x r			□	■
	4.1	130	0.016 x r	180	0.016 x r		□	□	■
	4.2	110	0.016 x r	160	0.016 x r		□	□	■
	4.3			100	0.012 x r		□	□	■
	4.4			70	0.012 x r		□	□	■
	5.1								
	5.2			60	0.006 x r			□	■
	5.3			120	0.012 x r	□	■		■
S	1.1			60	0.008 x r			□	■
	1.2			50	0.006 x r			□	■
	1.3			30	0.006 x r			□	■
	2.1			40	0.006 x r			□	■
	2.2			15	0.004 x r			□	■
	2.3			15	0.004 x r			□	■
	2.4			15	0.004 x r			□	■
	2.5			10	0.004 x r			□	■
	2.6			15	0.004 x r			□	■
H	1.1								
	1.2								
	1.3								
	1.4								
	1.5								

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 3 flutes
- Finishing geometry

N

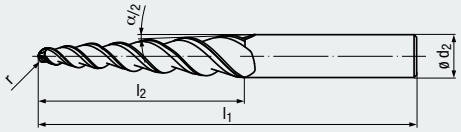
Solid Carbide

DIN 6535 HA HB

34/35/36°

Ball

Optional



Icon Descriptions (see page 51)

Tapered Ball Nose End Mill

Universal

Coating ALCR

Applications – materials (see page 6)

- Especially suitable for difficult to cut materials
- For all tough materials

P 1.1-5.1
M 1.1-4.1
N 1.3-1.5
S 1.1-1.3
S 2.2-2.6

Tool Dimensions / mm

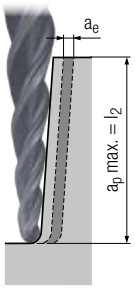
α/2	r ±0.01	l2	l1	ø d2 h6	# Flutes	Tool No.
4°	2	59	120	12	3	3550L.04020A
	2	87	150	16	3	3550L.04020B
	3	74	140	16	3	3550L.04030A
	3	103	165	20	3	3550L.04030B
	4	89	155	20	3	3550L.04040A

Cutting Data

Tapered Ball Nose End Mill

N

a_e = 0.5 - 1 mm

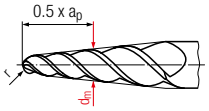


a_e = 0.1 - 0.2 mm

Valid for Tool No.:

3550L

For the calculation of rpm (n), use the average diameter d_m (measuring point at 0.5 x a_p).



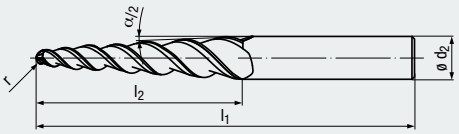
$$n = \frac{v_c \times 1000}{d_m \times \pi} \text{ [rpm]}$$

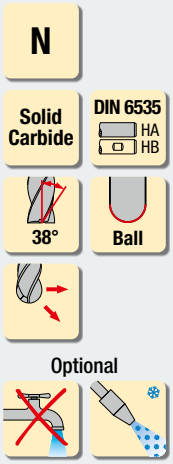
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	120	0.07	80	0.05		■	□	■
	2.1	110	0.06	70	0.05		■	□	■
	3.1	100	0.05	60	0.04		■	□	■
	4.1	90	0.04	60	0.04		■		
	5.1	80	0.04	50	0.03		■		
M	1.1	90	0.07	60	0.03				■
	2.1	90	0.07	60	0.03				■
	3.1	70	0.07	50	0.03				■
	4.1	70	0.07	50	0.03				■
N	1.3	280	0.12	200	0.06				■
	1.4	200	0.12	140	0.06				■
	1.5	140	0.12	100	0.06				■
S	1.1	90	0.07	60	0.03				■
	1.2	75	0.07	50	0.03				■
	1.3	45	0.07	30	0.03				■
	2.2	25	0.07	15	0.03				■
	2.3	25	0.07	15	0.03				■
	2.4	25	0.07	15	0.03				■
	2.5	15	0.07	10	0.03				■
	2.6	25	0.07	15	0.03				■

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- 3 flutes in the ball nose section
- 6 radial flutes





Icon Descriptions (see page 51)

Tapered Ball Nose End Mill

Universal

Coating ALCR

Applications – materials (see page 6)

- Especially suitable for difficult to cut materials
- For all tough materials

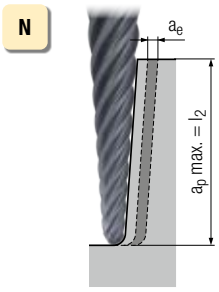
P	1.1-5.1
M	1.1-4.1
N	1.3-1.5
S	1.1-1.3
S	2.2-2.6

Tool Dimensions / mm

α/2	r ±0.01	l2	l1	ø d2 h6	# Flutes	Tool No.
4°	2	59	120	12	3/6	3548L.04020A
	2	87	150	16	3/6	3548L.04020B
	3	74	140	16	3/6	3548L.04030A
	3	103	165	20	3/6	3548L.04030B
	4	89	155	20	3/6	3548L.04040A

Cutting Data

Tapered Ball Nose End Mill

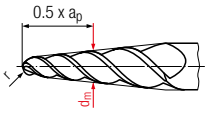


a_e = 0.1 - 0.2 mm

Valid for Tool No.:

3548L

For the calculation of rpm (n), use the average diameter d_m (measuring point at 0.5 x a_p).



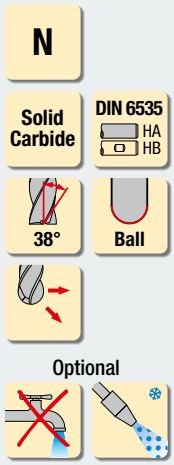
$$n = \frac{v_c \times 1000}{d_m \times \pi} \text{ [rpm]}$$

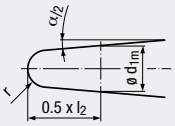
		v_c [m/min]	f_z [mm]			MQL	
P	1.1	80	0.05		■	□	■
	2.1	70	0.04		■	□	■
	3.1	60	0.04		■	□	■
	4.1	60	0.03		■		
	5.1	50	0.03		■		
M	1.1	60	0.03				■
	2.1	60	0.03				■
	3.1	50	0.03				■
	4.1	50	0.03				■
N	1.3	200	0.06				■
	1.4	140	0.06				■
	1.5	100	0.06				■
S	1.1	60	0.03				■
	1.2	50	0.03				■
	1.3	30	0.03				■
	2.2	15	0.03				■
	2.3	15	0.03				■
	2.4	15	0.03				■
	2.5	10	0.03				■
	2.6	15	0.03				■

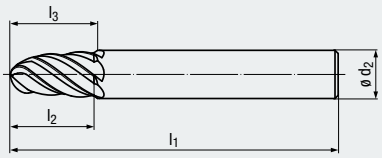
v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- 3 flutes in the ball nose section
- 6 radial flutes







Icon Descriptions (see page 51)

Tapered ball nose end mill

Universal

Coating — TIALN

Applications – materials (see page 6)

- Especially suitable for high-strength materials
- Also suitable in Nickel-based alloys
- For the machining of titanium alloys
- Suitable in all turbine materials

P 1.1-5.1
M 1.1-4.1
K 1.1-4.2
N 2.1-2.8
S 1.1-2.6

Tool Dimensions / mm

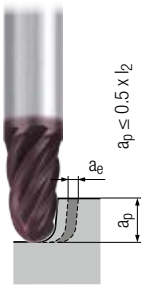
α/2	r ±0.01	l2	l3	l1	d1m	ø d2 h6	# Flutes	Tool No.
4°	**3**	30	47	108	7.89	12	**3/6**	**2679A.04030A**
	3.5	39	39	108	9.26	12	**3/6**	**2679A.04035A**
	4	32	32	108	9.70	12	**3/6**	**2679A.04040A**
	5	35	49	108	11.77	16	**3/6**	**2679A.04050A**
	6	34	34	108	13.57	16	**3/6**	**2679A.04060A**
	8	36	36	108	17.44	20	**3/6**	**2679A.04080A**

Tapered ball nose end mill

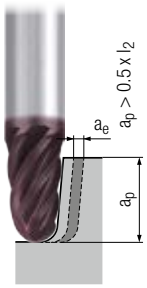
N

Valid for Tool No.: 2679A

Pre-finishing

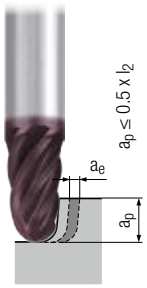


a_e = 0.5 mm

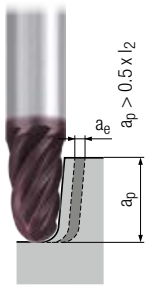


a_e = 0.5 mm

Finishing

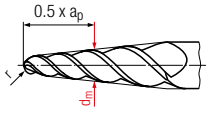


a_e = 0.2 mm



a_e = 0.2 mm

For the calculation of rpm (n), use the average diameter d_m (measuring point at 0.5 x a_p).



$$n = \frac{v_c \times 1000}{d_m \times \pi} \text{ [rpm]}$$

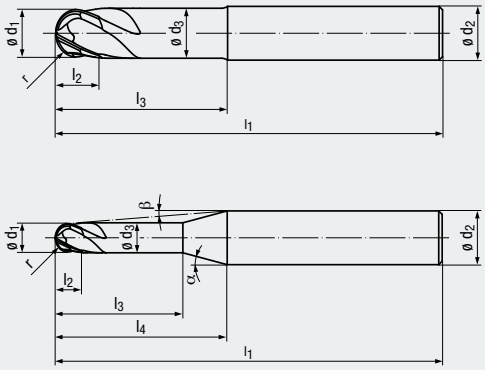
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	130	0.008 x r	100	0.007 x r	160	0.011 x r	120	0.009 x r	□	■	□	■
	2.1	120	0.007 x r	90	0.006 x r	150	0.010 x r	110	0.008 x r	□	■	□	■
	3.1	110	0.006 x r	90	0.006 x r	140	0.009 x r	100	0.007 x r	□	■	□	
	4.1	110	0.006 x r	80	0.005 x r	130	0.008 x r	100	0.006 x r	□	■	□	
	5.1	100	0.005 x r	80	0.004 x r	120	0.007 x r	90	0.005 x r	□	■	□	
M	1.1	70	0.006 x r	60	0.005 x r	90	0.008 x r	70	0.006 x r			□	■
	2.1	60	0.005 x r	50	0.004 x r	80	0.007 x r	60	0.005 x r			□	■
	3.1	50	0.004 x r	40	0.004 x r	60	0.006 x r	40	0.005 x r			□	■
	4.1	30	0.004 x r	30	0.003 x r	40	0.005 x r	30	0.004 x r			□	■
K	1.1	150	0.010 x r	120	0.008 x r	190	0.013 x r	140	0.011 x r	□	■		□
	1.2	150	0.010 x r	120	0.008 x r	190	0.013 x r	140	0.011 x r	□	■		□
	2.1	140	0.009 x r	110	0.008 x r	170	0.012 x r	130	0.010 x r	□	■		□
	2.2	140	0.009 x r	110	0.008 x r	170	0.012 x r	130	0.010 x r	□	■		□
	3.1	130	0.008 x r	100	0.007 x r	160	0.011 x r	120	0.009 x r	□	■		□
	3.2	130	0.008 x r	100	0.007 x r	160	0.011 x r	120	0.009 x r	□	■		□
	4.1	110	0.007 x r	90	0.006 x r	140	0.010 x r	100	0.008 x r	□	■		□
	4.2	100	0.006 x r	80	0.006 x r	120	0.009 x r	90	0.007 x r	□	■		
N	1.1												
	1.2												
	1.3												
	1.4												
	1.5												
	1.6												
	2.1	160	0.008 x r	130	0.007 x r	200	0.011 x r	150	0.009 x r			□	■
	2.2	160	0.008 x r	130	0.007 x r	200	0.011 x r	150	0.009 x r			□	■
	2.3	160	0.008 x r	130	0.007 x r	200	0.011 x r	150	0.009 x r			□	■
	2.4	140	0.006 x r	110	0.006 x r	170	0.009 x r	130	0.007 x r			□	■
	2.5	140	0.006 x r	110	0.006 x r	170	0.009 x r	130	0.007 x r			□	■
	2.6	140	0.006 x r	110	0.006 x r	170	0.009 x r	130	0.007 x r			□	■
	2.7	90	0.006 x r	70	0.005 x r	110	0.008 x r	80	0.006 x r			□	■
	2.8	90	0.006 x r	70	0.005 x r	110	0.008 x r	80	0.006 x r			□	■
	3.1												
	3.2												
	4.1												
	4.2												
	4.3												
	4.4												
	5.1												
	5.2												
	5.3												
S	1.1	100	0.008 x r	80	0.007 x r	120	0.011 x r	90	0.009 x r			□	■
	1.2	70	0.007 x r	60	0.006 x r	90	0.010 x r	70	0.008 x r			□	■
	1.3	50	0.006 x r	40	0.006 x r	60	0.009 x r	40	0.007 x r			□	■
	2.1	70	0.007 x r	50	0.006 x r	90	0.010 x r	60	0.008 x r			□	■
	2.2	30	0.006 x r	20	0.005 x r	40	0.008 x r	30	0.006 x r			□	■
	2.3	20	0.005 x r	20	0.004 x r	30	0.007 x r	20	0.005 x r			□	■
	2.4	30	0.006 x r	20	0.005 x r	40	0.008 x r	30	0.006 x r			□	■
	2.5	20	0.005 x r	10	0.004 x r	20	0.007 x r	20	0.005 x r			□	■
	2.6	20	0.004 x r	20	0.004 x r	30	0.006 x r	20	0.005 x r			□	■
H	1.1												
	1.2												
	1.3												
	1.4												
	1.5												

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

Hard-Cut

- High performance tool
- Patented chisel edge
- With 4 flutes
- 2 center cutting edges
- Short, stable flute length
- 2 lengths available



H

Solid Carbide

DIN 6535 HA HB

30°

Ball

3-5°

Optional

≤ 66 HRC

Icon Descriptions (see page 51)

Ball nose end mill

High Strength Materials

Coating — TIALN

Applications – materials (see page 6)

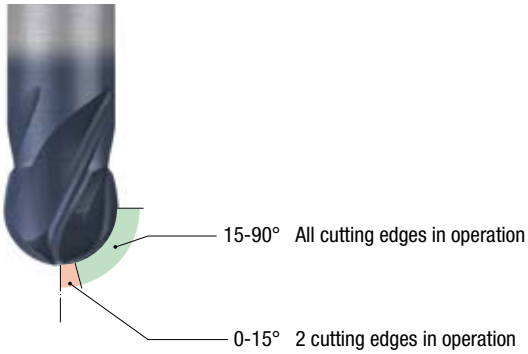
- For machining hard materials up to 66 HRC
- For finishing with very high surface quality
- Suitable for HSC finishing

P	3.1-5.1	1.1-2.1
K	1.1-4.2	
N	2.3, 2.6-2.8	
N		2.2, 2.4-2.5
H	1.1-1.5	

Tool Dimensions / mm

Short Design

ø d_1 ±0.01	r ±0.005	l_2	l_3	l_1	ø d_3	l_4	ø d_2 h5	α	β	# Flutes	Tool No.
3	1.5	3.5	10	57	2.8	20	6	11.5°	5°	**4**	**2834A.003**
4	2	4	12	57	3.8	20	6	11°	3.5°	**4**	**2834A.004**
5	2.5	5	14	57	4.7	20	6	10°	2°	**4**	**2834A.005**
6	3	6	20	57	5.6	–	6	–	–	**4**	**2834A.006**
8	4	7	25	63	7.6	–	8	–	–	**4**	**2834A.008**
10	5	8	30	72	9.6	–	10	–	–	**4**	**2834A.010**
12	6	10	35	83	11.5	–	12	–	–	**4**	**2834A.012**



Hard-Cut

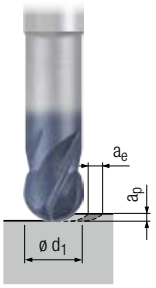
Ball nose end mill
short design (4 flutes)

H

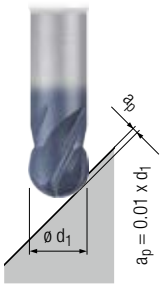
Valid for Tool No.:

2834A

Roughing (4 flutes)



Finishing (4 flutes)



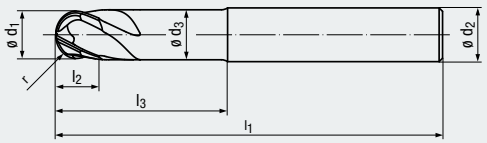
		v_c [m/min]	f_z [mm]	a_e [mm]	a_p [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	280	0.011 x d_1	0.1 x d_1	0.05 x d_1	360	0.008 x d_1	□	■	□	■
	2.1	240	0.011 x d_1	0.1 x d_1	0.05 x d_1	320	0.008 x d_1	□	■	□	■
	3.1	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.007 x d_1	□	■	□	
	4.1	170	0.008 x d_1	0.1 x d_1	0.05 x d_1	220	0.006 x d_1	□	■	□	
	5.1	140	0.006 x d_1	0.1 x d_1	0.05 x d_1	180	0.0054 x d_1	□	■	□	
M	1.1										
	2.1										
	3.1										
	4.1										
K	1.1	280	0.011 x d_1	0.1 x d_1	0.05 x d_1	360	0.008 x d_1	□	■		□
	1.2	280	0.011 x d_1	0.1 x d_1	0.05 x d_1	360	0.008 x d_1	□	■		□
	2.1	250	0.009 x d_1	0.1 x d_1	0.05 x d_1	320	0.006 x d_1	□	■		□
	2.2	250	0.009 x d_1	0.1 x d_1	0.05 x d_1	320	0.006 x d_1	□	■		□
	3.1	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.006 x d_1	□	■		
	3.2	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.006 x d_1	□	■		
	4.1	170	0.006 x d_1	0.1 x d_1	0.05 x d_1	220	0.005 x d_1	□	■		
	4.2	150	0.006 x d_1	0.1 x d_1	0.05 x d_1	180	0.005 x d_1	□	■		
N	1.1										
	1.2										
	1.3										
	1.4										
	1.5										
	1.6										
	2.1										
	2.2	250	0.011 x d_1	0.1 x d_1	0.05 x d_1	320	0.008 x d_1			□	■
	2.3	250	0.011 x d_1	0.1 x d_1	0.05 x d_1	320	0.008 x d_1	□	□	□	■
	2.4	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.007 x d_1			□	■
	2.5	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.007 x d_1			□	■
	2.6	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.007 x d_1	□	□	□	■
	2.7	130	0.006 x d_1	0.1 x d_1	0.05 x d_1	170	0.006 x d_1			□	■
	2.8	130	0.006 x d_1	0.1 x d_1	0.05 x d_1	170	0.005 x d_1			□	■
	3.1										
	3.2										
	4.1										
	4.2										
	4.3										
	4.4										
	5.1										
	5.2										
	5.3										
S	1.1										
	1.2										
	1.3										
	2.1										
	2.2										
	2.3										
	2.4										
	2.5										
	2.6										
H	1.1	130	0.008 x d_1	0.05 x d_1	0.02 x d_1	180	0.006 x d_1	□	■		
	1.2	120	0.007 x d_1	0.05 x d_1	0.02 x d_1	160	0.005 x d_1	□	■		
	1.3					140	0.005 x d_1	□	■		
	1.4					110	0.004 x d_1	□	■		
	1.5					90	0.003 x d_1	□	■		

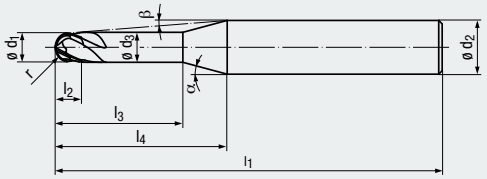
v_c = Cutting speed
f_z = Feed per tooth

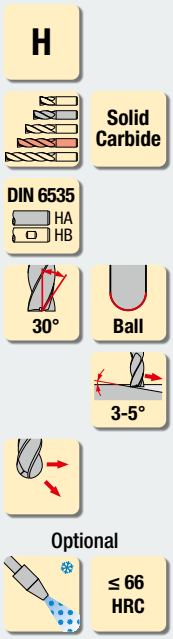
■ = very suitable
□ = suitable

Hard-Cut

- High performance tool
- Patented chisel edge
- With 4 flutes
- 4 center cutting edges
- Short, stable flute length
- 2 lengths available







Icon Descriptions (see page 51)

Ball nose end mill

High Strength Materials

Coating — TIALN

Applications – materials (see page 6)

- For machining hard materials up to 66 HRC
- For finishing with very high surface quality
- Suitable for HSC finishing

P	3.1-5.1	1.1-2.1
K	1.1-4.2	
N	2.3, 2.6-2.8	
N		2.2, 2.4-2.5
S	1.1-2.6	
H	1.1-1.5	

Tool Dimensions / mm

Long Design

ø d_1 ±0.01	r ±0.005	l_2	l_3	l_1	ø d_3	l_4	ø d_2 h5	α	β	# Flutes	Tool No.
6	3	6	30	80	5.6	–	6	–	–	**4**	**2842A.006**
8	4	7	35	80	7.6	–	8	–	–	**4**	**2842A.008**
10	5	8	45	100	9.6	–	10	–	–	**4**	**2842A.010**
12	6	10	50	100	11.5	–	12	–	–	**4**	**2842A.012**

Hard-Cut

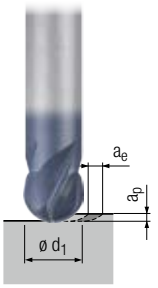
Ball nose end mill
long design (4 flutes)

H

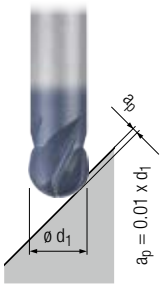
Valid for Tool No.:

2842A

Roughing (4 flutes)



Finishing (4 flutes)

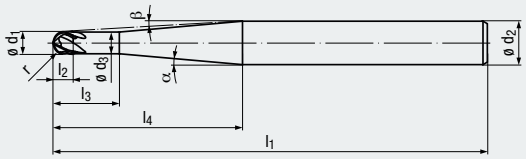


		v_c [m/min]	f_z [mm]	a_e [mm]	a_p [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	280	0.011 x d_1	0.1 x d_1	0.05 x d_1	360	0.008 x d_1	□	■	□	■
	2.1	240	0.011 x d_1	0.1 x d_1	0.05 x d_1	320	0.008 x d_1	□	■	□	■
	3.1	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.007 x d_1	□	■	□	
	4.1	170	0.008 x d_1	0.1 x d_1	0.05 x d_1	220	0.006 x d_1	□	■	□	
	5.1	140	0.006 x d_1	0.1 x d_1	0.05 x d_1	180	0.0054 x d_1	□	■	□	
M	1.1										
	2.1										
	3.1										
	4.1										
K	1.1	280	0.011 x d_1	0.1 x d_1	0.05 x d_1	360	0.008 x d_1	□	■		□
	1.2	280	0.011 x d_1	0.1 x d_1	0.05 x d_1	360	0.008 x d_1	□	■		□
	2.1	250	0.009 x d_1	0.1 x d_1	0.05 x d_1	320	0.006 x d_1	□	■		□
	2.2	250	0.009 x d_1	0.1 x d_1	0.05 x d_1	320	0.006 x d_1	□	■		□
	3.1	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.006 x d_1	□	■		
	3.2	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.006 x d_1	□	■		
	4.1	170	0.006 x d_1	0.1 x d_1	0.05 x d_1	220	0.005 x d_1	□	■		
	4.2	150	0.006 x d_1	0.1 x d_1	0.05 x d_1	180	0.005 x d_1	□	■		
N	1.1										
	1.2										
	1.3										
	1.4										
	1.5										
	1.6										
	2.1										
	2.2	250	0.011 x d_1	0.1 x d_1	0.05 x d_1	320	0.008 x d_1			□	■
	2.3	250	0.011 x d_1	0.1 x d_1	0.05 x d_1	320	0.008 x d_1	□	□	□	■
	2.4	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.007 x d_1			□	■
	2.5	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.007 x d_1			□	■
	2.6	210	0.009 x d_1	0.1 x d_1	0.05 x d_1	270	0.007 x d_1	□	□	□	■
	2.7	130	0.006 x d_1	0.1 x d_1	0.05 x d_1	170	0.006 x d_1			□	■
	2.8	130	0.006 x d_1	0.1 x d_1	0.05 x d_1	170	0.005 x d_1			□	■
	3.1										
	3.2										
	4.1										
	4.2										
	4.3										
	4.4										
	5.1										
	5.2										
	5.3										
S	1.1					150	0.006 x d_1				■
	1.2					120	0.005 x d_1				■
	1.3					70	0.005 x d_1				■
	2.1					110	0.006 x d_1				■
	2.2					50	0.004 x d_1				■
	2.3					40	0.004 x d_1				■
	2.4					40	0.004 x d_1				■
	2.5					30	0.003 x d_1				■
	2.6					40	0.003 x d_1				■
H	1.1	130	0.008 x d_1	0.05 x d_1	0.02 x d_1	180	0.006 x d_1	□	■		
	1.2	120	0.007 x d_1	0.05 x d_1	0.02 x d_1	160	0.005 x d_1	□	■		
	1.3					140	0.005 x d_1	□	■		
	1.4					110	0.004 x d_1	□	■		
	1.5					90	0.003 x d_1	□	■		

v_c = Cutting speed
f_z = Feed per tooth

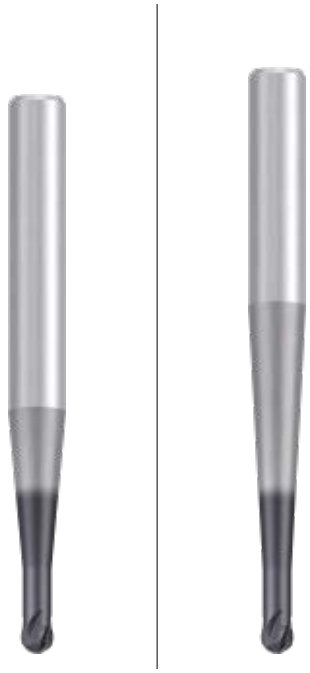
■ = very suitable
□ = suitable

- Multi-functional, high performance tool
- With 220-240° ball nose
- 4 center cutting edges
- 2 lengths available



Icon Descriptions (see page 51)

Ball nose end mills “Lollipop”



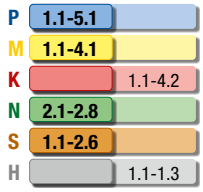
Universal

Coating

ALCR

Applications – materials (see page 7)

- For many materials up to 55 HRC
- Machining of undercuts
- Suitable for High-Speed finishing of turbine blades
- Especially suitable for difficult to cut materials



Tool Dimensions / mm

Long Design

ø d_1 -0.04	r -0.002	l_2	l_3	l_1	ø d_3	l_4	ø d_2 h5	α	β	# Flutes	Tool No.
4	2	3.3	10	90	3	38.6	8	5°	3.5°	**4**	**2564L.04010B**
6	3	4.6	15	100	5	43.6	10	5°	3°	**4**	**2564L.06015B**
8	4	6.6	20	108	6	54.3	12	5°	2.5°	**4**	**2564L.08020B**
10	5	8.3	25	125	7.5	73.6	16	5°	2°	**4**	**2564L.10025B**

Extra Long Design

ø d_1 -0.04	r -0.002	l_2	l_3	l_1	ø d_3	l_4	ø d_2 h5	α	β	# Flutes	Tool No.
4	2	3.3	10	95	3	57.7	8	3°	2.5°	**4**	**2564L.04010A**
6	3	4.6	15	105	5	62.7	10	3°	2°	**4**	**2564L.06015A**
8	4	6.6	20	125	6	77.2	12	3°	2°	**4**	**2564L.08020A**
10	5	8.3	25	160	7.5	106.1	16	3°	2°	**4**	**2564L.10025A**

Ball nose with fully functional cutting edge up to 240°

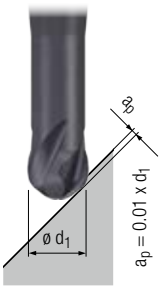
Ball nose end mills “Lollipop” long design (4 flutes)

Valid for Tool No.:

2564L

N

Finishing (4 flutes)

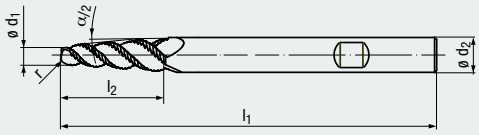


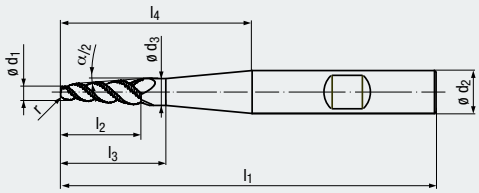
		v_c [m/min]	f_z [mm]			MQL	
P	1.1	280	0.008 x d_1	□	■	□	■
	2.1	260	0.008 x d_1	□	■	□	■
	3.1	240	0.007 x d_1	□	■	□	
	4.1	220	0.006 x d_1	□	■	□	
	5.1	180	0.0054 x d_1	□	■	□	
M	1.1	130	0.006 x d_1			□	■
	2.1	110	0.006 x d_1			□	■
	3.1	80	0.005 x d_1			□	■
	4.1	80	0.005 x d_1			□	■
K	1.1	280	0.008 x d_1	□	■		□
	1.2	260	0.008 x d_1	□	■		□
	2.1	240	0.006 x d_1	□	■		□
	2.2	220	0.006 x d_1	□	■		□
	3.1	200	0.006 x d_1	□	■		
	3.2	200	0.006 x d_1	□	■		
	4.1	180	0.005 x d_1	□	■		
	4.2	150	0.005 x d_1	□	■		
N	1.1						
	1.2						
	1.3						
	1.4						
	1.5						
	1.6						
	2.1	260	0.008 x d_1			□	■
	2.2	260	0.008 x d_1			□	■
	2.3	260	0.008 x d_1	□	□	□	■
	2.4	220	0.007 x d_1			□	■
	2.5	220	0.007 x d_1			□	■
	2.6	220	0.007 x d_1	□	□	□	■
	2.7	130	0.006 x d_1			□	■
	2.8	130	0.005 x d_1			□	■
	3.1						
	3.2						
	4.1						
	4.2						
	4.3						
	4.4						
	5.1						
	5.2						
	5.3						
S	1.1	150	0.006 x d_1				■
	1.2	120	0.005 x d_1				■
	1.3	70	0.005 x d_1				■
	2.1	110	0.006 x d_1				■
	2.2	50	0.004 x d_1				■
	2.3	40	0.004 x d_1				■
	2.4	40	0.004 x d_1				■
	2.5	30	0.003 x d_1				■
	2.6	40	0.003 x d_1				■
H	1.1	160	0.006 x d_1	□	■		
	1.2	140	0.005 x d_1	□	■		
	1.3	120	0.005 x d_1	□	■		
	1.4						
	1.5						

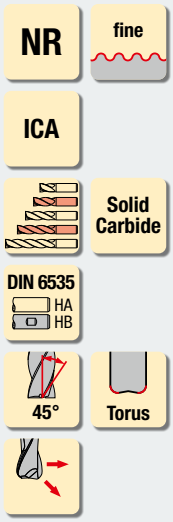
v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 3 and 4 flutes
- Roughing profile
- Variable spacing
- Low-vibration machining
- Taper angle 3°

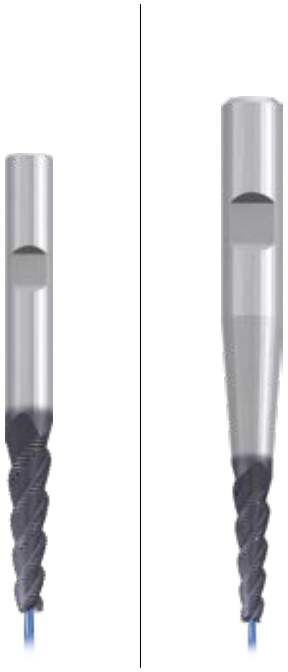






Icon Descriptions (see page 51)

Tapered torus end mills



Universal

Coating ALCR

Applications – materials (see page 7)

- Especially suitable for high-strength materials
- Also suitable in Nickel-based alloys
- For the machining of titanium alloys
- Suitable in all turbine materials
- Optimized for machining Impellers and Integrated Bladed Rotors (IBR) made from aluminum, titanium and Inconel

P	1.1-5.1
M	1.1-4.1
N	1.1-1.3
S	1.1-1.3
S	2.2-2.6

Tool Dimensions / mm

Short Design

α/2	ø d1 -0.05	r	l2	l3	l1	l4	ø d3	ø d2 h6	# Flutes	Tool No.
3°	**6.5**	1	14	–	68	–	–	8	**4**	**3534LZ.03065A**
	7.5	1	23.5	–	80	–	–	10	**4**	**3534LZ.03075A**
	8.5	1	33	–	93	–	–	12	**4**	**3534LZ.03085A**

Long Design

α/2	ø d1 -0.05	r	l2	l3	l1	l4	ø d3	ø d2 h6	# Flutes	Tool No.
3°	**5**	1	20	29.5	80	38	7.1	8	**3**	**3532LZ.03050A**
	5.5	1	25	34.5	95	52.5	8.1	10	**3**	**3532LZ.03055A**
	6	1	30	39.5	120	67	9.1	12	**3**	**3532LZ.03060A**

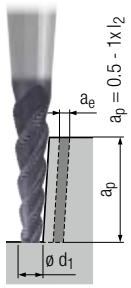
Tapered torus end mills

NR

Valid for Tool Nos.:

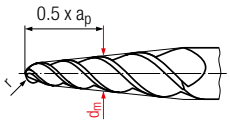
3532LZ
3534LZ

a_e < 100%



a_e = 0.5 - 1 mm

For the calculation of rpm (n), use the average diameter d_m (measuring point at 0.5 x a_p).



$$n = \frac{v_c \times 1000}{d_m \times \pi} \text{ [rpm]}$$

		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	100	0.005 x d_1	140	0.005 x d_1		■	□	■
	2.1	90	0.004 x d_1	130	0.004 x d_1		■	□	■
	3.1	90	0.004 x d_1	120	0.004 x d_1		■	□	■
	4.1	80	0.003 x d_1	110	0.003 x d_1		■	□	■
	5.1	70	0.003 x d_1	100	0.003 x d_1		■	□	■
M	1.1	100	0.004 x d_1	110	0.004 x d_1				■
	2.1	80	0.003 x d_1	90	0.003 x d_1				■
	3.1	60	0.002 x d_1	80	0.002 x d_1				■
	4.1	50	0.002 x d_1	60	0.002 x d_1				■
K	1.1								
	1.2								
	2.1								
	2.2								
	3.1								
	3.2								
	4.1								
	4.2								
N	1.1	280	0.006 x d_1	400	0.006 x d_1				■
	1.2	200	0.005 x d_1	280	0.005 x d_1				■
	1.3	140	0.004 x d_1	200	0.004 x d_1				■
	1.4								
	1.5								
	1.6								
	2.1								
	2.2								
	2.3								
	2.4								
	2.5								
	2.6								
	2.7								
	2.8								
	3.1								
	3.2								
	4.1								
	4.2								
	4.3								
	4.4								
	5.1								
	5.2								
	5.3								
S	1.1	90	0.002 x d_1	120	0.002 x d_1				■
	1.2	75	0.002 x d_1	100	0.002 x d_1				■
	1.3	45	0.002 x d_1	60	0.002 x d_1				■
	2.1								
	2.2	25	0.002 x d_1	30	0.002 x d_1				■
	2.3	25	0.002 x d_1	30	0.002 x d_1				■
	2.4	25	0.002 x d_1	30	0.002 x d_1				■
	2.5	15	0.002 x d_1	20	0.002 x d_1				■
	2.6	25	0.002 x d_1	30	0.002 x d_1				■
H	1.1								
	1.2								
	1.3								
	1.4								
	1.5								

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- Multi-functional tool
- With 2 flutes
- Various taper angles
- Also available with polished chip space

N

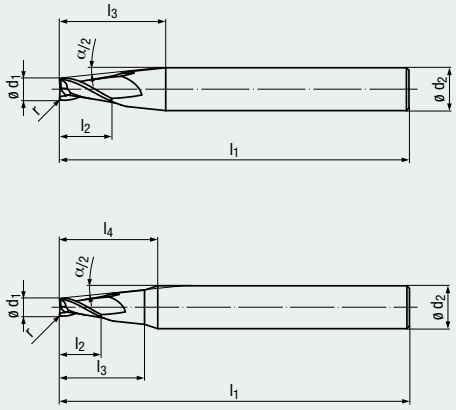
Solid Carbide

DIN 6535 HA HB

30°

Torus

Optional



Icon Descriptions (see page 51)

Tapered torus end mills

With polished chip space

Universal

Universal

Coating

ALCR

Applications – materials (see page 7)

- For almost all materials
- Suitable for roughing

N 1.1-1.3
N 4.1-4.2

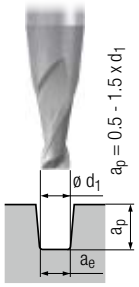
P 1.1-3.1 4.1-5.1
M 1.1-2.1
K 1.1-2.2 3.1-4.2
N 1.1-1.4 1.5
N 2.1-2.6 2.7-2.8
N 3.1-4.4, 5.2-5.3
S 1.1-1.2 1.3
S 2.1-2.2 2.3-2.6

Tool Dimensions / mm

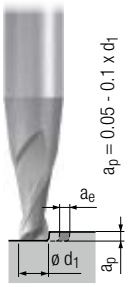
α/2	ø d_1	r ±0.01	l_2	l_3	l_1	l_4	ø d_2 h6	# Flutes	Tool No.	Tool No.	Tool No.
3°	3	0.3	6	24	63	26	8	2	3444.03003A	3445.03003A	3444L.03003A
	4	0.4	8	24	63	26	8	2	3444.03004A	3445.03004A	3444L.03004A
	5	0.5	10	25	63	26	8	2	3444.03005A	3445.03005A	3444L.03005A
4°	3	0.3	6	24	63	26	8	2	3444.04003A	3445.04003A	3444L.04003A
	4	0.4	8	25	63	26	8	2	3444.04004A	3445.04004A	3444L.04004A
	5	0.5	10	23	63	–	8	2	3444.04005A	3445.04005A	3444L.04005A
6°	3	0.3	6	25	63	–	8	2	3444.06003A	3445.06003A	3444L.06003A
	4	0.4	8	20	63	–	8	2	3444.06004A	3445.06004A	3444L.06004A
	5	0.5	10	25	80	–	10	2	3444.06005A	3445.06005A	3444L.06005A
8°	3	0.3	6	25	80	–	10	2	3444.08003A	3445.08003A	3444L.08003A
	4	0.4	8	22	80	–	10	2	3444.08004A	3445.08004A	3444L.08004A
	5	0.5	10	25	83	–	12	2	3444.08005A	3445.08005A	3444L.08005A

Tapered torus end mills

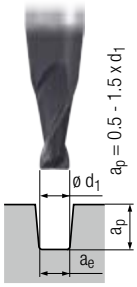
N



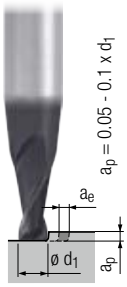
$a_e = d_1$



$a_e = 0.3 - 1 \times d_1$



$a_e = d_1$

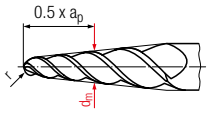


$a_e = 0.3 - 1 \times d_1$

Valid for Tool Nos.:

3444
3444L
3445

For the calculation of rpm (n), use the average diameter d_m (measuring point at 0.5 x a_p).



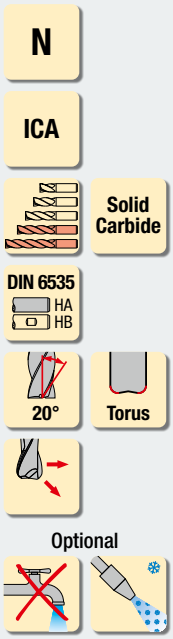
$$n = \frac{v_c \times 1000}{d_m \times \pi} \text{ [rpm]}$$

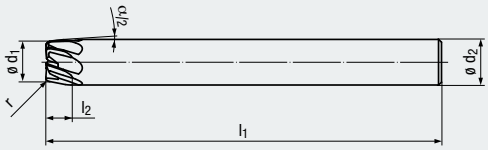
		Uncoated				ALCR							
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1							220	0.010 x d_1	□	■	□	■
	2.1							200	0.009 x d_1	□	■	□	■
	3.1							160	0.008 x d_1	□	■	□	
	4.1							130	0.007 x d_1	□	■	□	
	5.1							110	0.006 x d_1	□	■	□	
M	1.1							110	0.006 x d_1			□	■
	2.1							90	0.006 x d_1			□	■
	3.1												
	4.1												
K	1.1							220	0.010 x d_1	■	■		
	1.2							220	0.010 x d_1	■	■		
	2.1							190	0.008 x d_1	■	■		
	2.2							190	0.008 x d_1	■	■		
	3.1							160	0.008 x d_1	■	■		
	3.2							160	0.008 x d_1	■	■		
	4.1							130	0.006 x d_1	■	■		
	4.2							110	0.006 x d_1	■	■		
N	1.1	280	0.010 x d_1	350	0.016 x d_1	400	0.010 x d_1	500	0.016 x d_1			□	■
	1.2	280	0.008 x d_1	350	0.014 x d_1	400	0.008 x d_1	500	0.014 x d_1			□	■
	1.3	250	0.006 x d_1	350	0.012 x d_1	350	0.006 x d_1	500	0.012 x d_1			□	■
	1.4							380	0.014 x d_1			□	■
	1.5							340	0.012 x d_1			□	■
	1.6												
	2.1							200	0.010 x d_1			□	■
	2.2							200	0.010 x d_1			□	■
	2.3							200	0.010 x d_1	□	□	□	■
	2.4							160	0.008 x d_1			□	■
	2.5							160	0.008 x d_1			□	■
	2.6							160	0.008 x d_1	□	□	□	■
	2.7							100	0.006 x d_1			□	■
	2.8							100	0.006 x d_1			□	■
	3.1							450	0.018 x d_1			□	■
	3.2							450	0.014 x d_1			□	■
	4.1			220	0.015 x d_1			320	0.015 x d_1		□	□	■
	4.2			350	0.015 x d_1			500	0.015 x d_1		□	□	■
	4.3							200	0.012 x d_1		□	□	■
	4.4							140	0.012 x d_1		□	□	■
	5.1												
	5.2							120	0.006 x d_1			□	■
	5.3							220	0.012 x d_1	□	■		■
S	1.1					50	0.004 x d_1	110	0.007 x d_1			□	■
	1.2					40	0.003 x d_1	90	0.006 x d_1			□	■
	1.3					30	0.003 x d_1	50	0.005 x d_1			□	■
	2.1							80	0.006 x d_1			□	■
	2.2							30	0.004 x d_1			□	■
	2.3							30	0.004 x d_1			□	■
	2.4							30	0.004 x d_1			□	■
	2.5							20	0.004 x d_1			□	■
	2.6							30	0.004 x d_1			□	■
H	1.1												
	1.2												
	1.3												
	1.4												
	1.5												

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

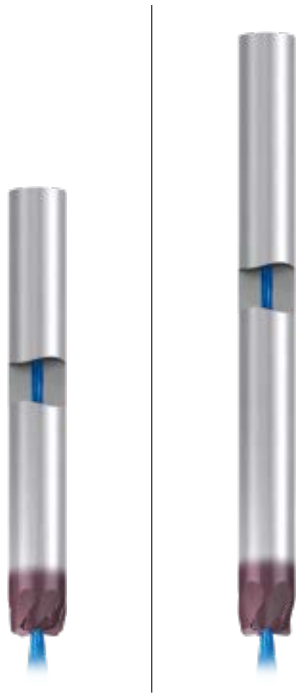
- High performance tool
- With 5-13 flutes
- Variable spacing
- Low-vibration machining
- Internal coolant supply, axial exit (ICA)





Icon Descriptions (see page 51)

Tapered torus end mills



Universal

Coating TIALN

Applications – materials (see page 7)

- Especially suitable for high-strength materials
- Also suitable in Nickel-based alloys
- For the machining of titanium alloys
- Suitable in all turbine materials

P 1.1-5.1
M 1.1-4.1
K 1.1-4.2
N 2.1-2.8
S 1.1-2.6

Tool Dimensions / mm

Long Design

α/2	ø d1	r ±0.01	l2	l1	ø d2 h6	# Flutes	Tool No.
8°	8	0.8	7.5	80	10	7	2677AZ.008008
	9	1	3.5	80	10	7	2677AZ.009010
	10	1	7.5	80	12	9	2677AZ.010010
	11	1	3.5	80	12	9	2677AZ.011010

Extra Long Design

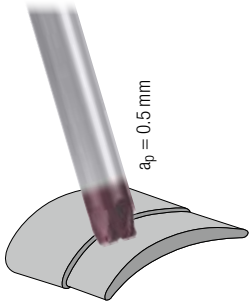
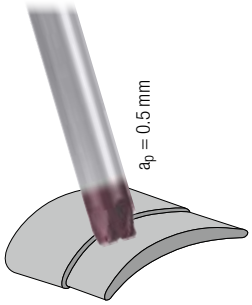
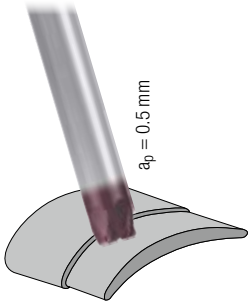
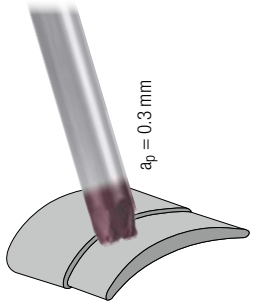
α/2	ø d1	r ±0.01	l2	l1	ø d2 h6	# Flutes	Tool No.
8°	9	1	3.5	108	10	5	2678AZ.009010
	10	1	7.5	108	12	7	2678AZ.010010
	11	1	3.5	108	12	7	2678AZ.011010
	15	1	3.5	108	16	9	2678AZ.015010
	15	1	3.5	108	16	13	2678AZ.115010
	19	1	3.5	108	20	9	2678AZ.019010
	19	1	3.5	108	20	13	2678AZ.119010

Tapered torus end mills long and extra long design

Valid for Tool Nos.:

2677AZ
2678AZ

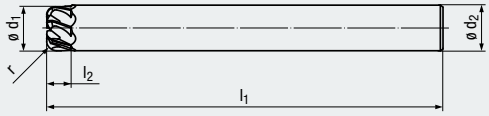
N

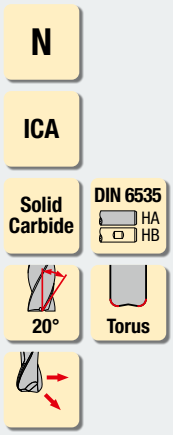
		Roughing		Roughing		Semi Finishing		Finishing					
		 a_e = 1 mm		 a_e = 1.5 mm		 a_e = 0.5 mm		 a_e = 0.5 mm					
		v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]	v_c [m/min]	f_z [mm]			MQL	
P	1.1	160	0.005 x d_1	140	0.004 x d_1	180	0.008 x d_1	200	0.006 x d_1	□	■	□	■
	2.1	150	0.005 x d_1	130	0.004 x d_1	170	0.007 x d_1	190	0.005 x d_1	□	■	□	■
	3.1	140	0.004 x d_1	120	0.003 x d_1	160	0.006 x d_1	180	0.005 x d_1	□	■	□	
	4.1	130	0.004 x d_1	110	0.003 x d_1	150	0.006 x d_1	170	0.004 x d_1	□	■	□	
	5.1	120	0.003 x d_1	110	0.002 x d_1	140	0.005 x d_1	160	0.004 x d_1	□	■	□	
M	1.1	90	0.004 x d_1	80	0.003 x d_1	100	0.006 x d_1	120	0.004 x d_1			□	■
	2.1	80	0.003 x d_1	70	0.002 x d_1	90	0.005 x d_1	100	0.004 x d_1			□	■
	3.1	60	0.003 x d_1	50	0.002 x d_1	70	0.004 x d_1	80	0.003 x d_1			□	■
	4.1	40	0.002 x d_1	40	0.002 x d_1	50	0.004 x d_1	60	0.003 x d_1			□	■
K	1.1	190	0.006 x d_1	160	0.005 x d_1	210	0.01 x d_1	240	0.007 x d_1	□	■		□
	1.2	190	0.006 x d_1	160	0.005 x d_1	210	0.01 x d_1	240	0.007 x d_1	□	■		□
	2.1	170	0.006 x d_1	150	0.004 x d_1	190	0.009 x d_1	220	0.007 x d_1	□	■		□
	2.2	170	0.006 x d_1	150	0.004 x d_1	190	0.009 x d_1	220	0.007 x d_1	□	■		□
	3.1	160	0.005 x d_1	140	0.004 x d_1	180	0.008 x d_1	200	0.006 x d_1	□	■		□
	3.2	160	0.005 x d_1	140	0.004 x d_1	180	0.008 x d_1	200	0.006 x d_1	□	■		□
	4.1	140	0.005 x d_1	120	0.004 x d_1	160	0.007 x d_1	180	0.005 x d_1	□	■		□
	4.2	120	0.004 x d_1	110	0.003 x d_1	140	0.006 x d_1	160	0.005 x d_1	□	■		
N	1.1												
	1.2												
	1.3												
	1.4												
	1.5												
	1.6												
	2.1	200	0.005 x d_1	180	0.004 x d_1	230	0.008 x d_1	260	0.006 x d_1			□	■
	2.2	200	0.005 x d_1	180	0.004 x d_1	230	0.008 x d_1	260	0.006 x d_1			□	■
	2.3	200	0.005 x d_1	180	0.004 x d_1	230	0.008 x d_1	260	0.006 x d_1			□	■
	2.4	170	0.004 x d_1	150	0.003 x d_1	190	0.006 x d_1	220	0.005 x d_1			□	■
	2.5	170	0.004 x d_1	150	0.003 x d_1	190	0.006 x d_1	220	0.005 x d_1			□	■
	2.6	170	0.004 x d_1	150	0.003 x d_1	190	0.006 x d_1	220	0.005 x d_1			□	■
	2.7	110	0.004 x d_1	90	0.003 x d_1	120	0.006 x d_1	140	0.004 x d_1			□	■
	2.8	110	0.004 x d_1	90	0.003 x d_1	120	0.006 x d_1	140	0.004 x d_1			□	■
	3.1												
	3.2												
	4.1												
	4.2												
	4.3												
	4.4												
	5.1												
	5.2												
	5.3												
S	1.1	120	0.005 x d_1	110	0.004 x d_1	140	0.008 x d_1	160	0.006 x d_1			□	■
	1.2	90	0.005 x d_1	80	0.004 x d_1	100	0.007 x d_1	120	0.005 x d_1			□	■
	1.3	60	0.004 x d_1	50	0.003 x d_1	70	0.006 x d_1	80	0.005 x d_1			□	■
	2.1	90	0.005 x d_1	80	0.004 x d_1	100	0.007 x d_1	110	0.005 x d_1			□	■
	2.2	40	0.004 x d_1	30	0.003 x d_1	50	0.006 x d_1	50	0.004 x d_1			□	■
	2.3	30	0.003 x d_1	30	0.002 x d_1	30	0.005 x d_1	40	0.004 x d_1			□	■
	2.4	40	0.004 x d_1	30	0.003 x d_1	50	0.006 x d_1	50	0.004 x d_1			□	■
	2.5	20	0.003 x d_1	20	0.002 x d_1	30	0.005 x d_1	30	0.004 x d_1			□	■
	2.6	30	0.003 x d_1	30	0.002 x d_1	30	0.004 x d_1	40	0.003 x d_1			□	■
H	1.1												
	1.2												
	1.3												
	1.4												
	1.5												

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

- High performance tool
- With 5-9 flutes
- Variable spacing
- Low-vibration machining
- Internal coolant supply, axial exit (ICA)





Icon Descriptions (see page 51)

Torus End Mill

Universal

Coating — TIALN

Applications – materials (see page 7)

- Especially suitable for high-strength materials
- Also suitable in Nickel-based alloys
- For the machining of titanium alloys
- Suitable in all turbine materials

P	1.1-5.1
M	1.1-4.1
K	1.1-4.2
N	2.1-2.8
S	1.1-2.6

Tool Dimensions / mm

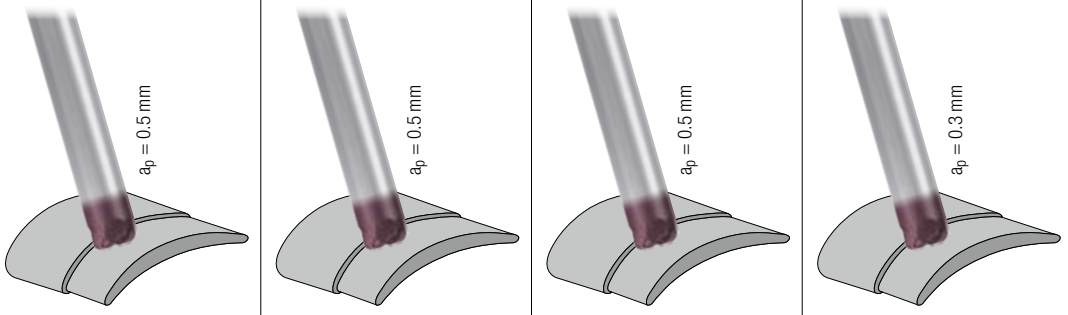
ø d_1 f8	r ±0.01	l_2	l_1	ø d_2 h6	# Flutes	Tool No.
8	1	3	80	8	**5**	**2676AZ.008010**
8	2	4	80	8	**5**	**2676AZ.008020**
10	1	3	80	10	**7**	**2676AZ.010010**
10	2	4	80	10	**7**	**2676AZ.010020**
12	1	3	108	12	**7**	**2676AZ.012010**
12	2	4	108	12	**7**	**2676AZ.012020**
16	1	3	108	16	**9**	**2676AZ.016010**
16	2	4	108	16	**9**	**2676AZ.016020**

Torus End Mill

N

Valid for Tool No.:

2676AZ



		Roughing v_c [m/min]	Roughing f_z [mm]	Roughing v_c [m/min]	Roughing f_z [mm]	Semi Finishing v_c [m/min]	Semi Finishing f_z [mm]	Finishing v_c [m/min]	Finishing f_z [mm]			MQL	
P	1.1	160	0.008 x d_1	140	0.007 x d_1	180	0.009 x d_1	200	0.006 x d_1	□	■	□	■
	2.1	150	0.007 x d_1	130	0.006 x d_1	170	0.008 x d_1	190	0.005 x d_1	□	■	□	■
	3.1	140	0.006 x d_1	120	0.006 x d_1	160	0.007 x d_1	180	0.005 x d_1	□	■	□	
	4.1	130	0.006 x d_1	110	0.005 x d_1	150	0.006 x d_1	170	0.004 x d_1	□	■	□	
	5.1	120	0.005 x d_1	110	0.004 x d_1	140	0.005 x d_1	160	0.004 x d_1	□	■	□	
M	1.1	90	0.006 x d_1	80	0.005 x d_1	100	0.006 x d_1	120	0.004 x d_1			□	■
	2.1	80	0.005 x d_1	70	0.004 x d_1	90	0.005 x d_1	100	0.004 x d_1			□	■
	3.1	60	0.004 x d_1	50	0.004 x d_1	70	0.005 x d_1	80	0.003 x d_1			□	■
	4.1	40	0.004 x d_1	40	0.003 x d_1	50	0.004 x d_1	60	0.003 x d_1			□	■
K	1.1	190	0.01 x d_1	160	0.008 x d_1	210	0.011 x d_1	240	0.007 x d_1	□	■		□
	1.2	190	0.01 x d_1	160	0.008 x d_1	210	0.011 x d_1	240	0.007 x d_1	□	■		□
	2.1	170	0.009 x d_1	150	0.008 x d_1	190	0.01 x d_1	220	0.007 x d_1	□	■		□
	2.2	170	0.009 x d_1	150	0.008 x d_1	190	0.01 x d_1	220	0.007 x d_1	□	■		□
	3.1	160	0.008 x d_1	140	0.007 x d_1	180	0.009 x d_1	200	0.006 x d_1	□	■		□
	3.2	160	0.008 x d_1	140	0.007 x d_1	180	0.009 x d_1	200	0.006 x d_1	□	■		□
	4.1	140	0.007 x d_1	120	0.006 x d_1	160	0.008 x d_1	180	0.005 x d_1	□	■		□
	4.2	120	0.006 x d_1	110	0.006 x d_1	140	0.007 x d_1	160	0.005 x d_1	□	■		
N	1.1												
	1.2												
	1.3												
	1.4												
	1.5												
	1.6												
	2.1	200	0.008 x d_1	180	0.007 x d_1	230	0.009 x d_1	260	0.006 x d_1			□	■
	2.2	200	0.008 x d_1	180	0.007 x d_1	230	0.009 x d_1	260	0.006 x d_1			□	■
	2.3	200	0.008 x d_1	180	0.007 x d_1	230	0.009 x d_1	260	0.006 x d_1			□	■
	2.4	170	0.006 x d_1	150	0.006 x d_1	190	0.007 x d_1	220	0.005 x d_1			□	■
	2.5	170	0.006 x d_1	150	0.006 x d_1	190	0.007 x d_1	220	0.005 x d_1			□	■
	2.6	170	0.006 x d_1	150	0.006 x d_1	190	0.007 x d_1	220	0.005 x d_1			□	■
	2.7	110	0.006 x d_1	90	0.005 x d_1	120	0.006 x d_1	140	0.004 x d_1			□	■
	2.8	110	0.006 x d_1	90	0.005 x d_1	120	0.006 x d_1	140	0.004 x d_1			□	■
	3.1												
	3.2												
	4.1												
	4.2												
	4.3												
	4.4												
	5.1												
	5.2												
	5.3												
S	1.1	120	0.008 x d_1	110	0.007 x d_1	140	0.009 x d_1	160	0.006 x d_1			□	■
	1.2	90	0.007 x d_1	80	0.006 x d_1	100	0.008 x d_1	120	0.005 x d_1			□	■
	1.3	60	0.006 x d_1	50	0.006 x d_1	70	0.007 x d_1	80	0.005 x d_1			□	■
	2.1	90	0.007 x d_1	80	0.006 x d_1	100	0.008 x d_1	110	0.005 x d_1			□	■
	2.2	40	0.006 x d_1	30	0.005 x d_1	50	0.006 x d_1	50	0.004 x d_1			□	■
	2.3	30	0.005 x d_1	30	0.004 x d_1	30	0.005 x d_1	40	0.004 x d_1			□	■
	2.4	40	0.006 x d_1	30	0.005 x d_1	50	0.006 x d_1	50	0.004 x d_1			□	■
	2.5	20	0.005 x d_1	20	0.004 x d_1	30	0.005 x d_1	30	0.004 x d_1			□	■
	2.6	30	0.004 x d_1	30	0.004 x d_1	30	0.005 x d_1	40	0.003 x d_1			□	■
H	1.1												
	1.2												
	1.3												
	1.4												
	1.5												

v_c = Cutting speed
f_z = Feed per tooth

■ = very suitable
□ = suitable

Test Cuts Program

Exploring new technology and tooling designs is the best way for progressive manufacturers to stay ahead of the competition. New tooling solutions can sometimes be the best way to reduce cycle times and improve product quality. But breaking into production or tying up critical machines for testing new tool styles is not always an option.

CNC Programming Assistance

On-staff Emuge CNC programmers develop machining cycles in conjunction with the most popular CAD/CAM providers such as Mastercam, Open Mind and others. Manufacturers from a broad range of industries look to Emuge CNC programming assistance to enable cost-effective and efficient manufacturing solutions. Not just from a CAM programming perspective, but also incorporating tool designs that allow for optimum performance.

Emuge's Technology Center offers a test cut service that allows manufacturers to run test cuts on actual piece parts or sample materials and also 3-Axis and 5-Axis programming assistance along with programming simulations when required.

The Process

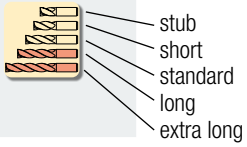
- Customers provide Emuge with sample piece parts and drawings that are then evaluated by trained Emuge tooling engineers.
- Tool process and application improvements are recommended and submitted to the customer.
- Once approved, a series of test cuts are performed and documented.
- Once an optimum solution is identified and approved, Emuge develops the solution.

The Outcome

- Full documentation of the operating parameters and CNC machining programs.
- Tool type recommendations for milling, drilling and threading.
- Full documentation of results.
- Video documentation of tooling solutions.
- Emuge field engineers will then work with the manufacturer to implement the solutions when requested.

Icon Descriptions

Constructional length



The applicable tool length is shaded in orange.

Internal coolant supply

ICA

ICR

ICA = Internal coolant supply, axial exit
ICR = Internal coolant supply, radial exit

Shank design for metric tools

DIN 6535
HA
HB

Tool for High Strength Materials

H

Helix angle

30°

The helix angle of tools is shown.
If there are variable helix angles, they are also shown.

Form Tolerance

Form
± 0.01

Tool Type

N — Finishing end mill design without chip breaker

NF — Semi-finishing end mill design with flat chip breaker

NR — Roughing end mill design with smooth chip breaker

Chip breaker

fine

fine

Depending on form (e.g. round or flat) and size (coarse, medium, fine) of the chip breakers, end mills generate appropriate milling marks shown.

Cutting edge design and face geometry

Torus — Torus

220-240° — Lollipop

Ball — Ball Nose

Circle Segment cutting edge design and face geometry

Taper

Oval

Lens

Barrel

Ramping angle

3-5°

The specified angle is the recommended angle for ramping applications.

Feed direction

The red arrows mark the recommended feed directions of the respective cutters.

Coolant and lubrication

Dry machining

Cold-air nozzle

MQL — Minimum-quantity lubrication (MQL)

Solutable coolant

Hard Milling

44-66 HRC

These tools are suitable for hard milling.
The hardness range or the maximum hardness of the material to be machined is indicated in Rockwell (HRC).

EMUGE FRANKEN

Ask about how to increase your machining speed and tool life with Emuge FPC Chucks.

Emuge high precision / performance FPC Mill / Drill Chucks provide unprecedented rigidity, vibration dampening, concentricity, machining speed, and tool life vs. conventional chuck technologies for milling and drilling applications. Available in a wide range of styles, internal and peripheral coolant options, and MQL-adaptable.

Slim Line Design
Ideal for 5-Axis

1. World's only chuck with 1:16 worm gear, a patented design delivering 3 tons of traction force.

2. Optimal Pull-Out Protection via optional Pin-Lock Collet System.

3. High rigidity. Patented design and body provides 100% holding power.

4. Mechanical drive actuated with a hex wrench. Simple design, highly accurate.

5. Maximum dampening. Collet-cone assembly absorbs virtually all vibration.

To learn more, visit:

emuge.com/products/tool-holders/milling-drilling-holders

EMUGE Corp.
1800 Century Drive, West Boylston, MA 01583
800-323-3013 • www.emuge.com

Emuge Corp. has been the product technology and performance leader in their field for 100 years. Emuge manufactures an extensive line of taps, drills, thread mills, end mills, toolholders, clamping devices and other rotary cutting tools, over 40,000 items sold through distributors worldwide.