FANAR®

Solid Carbide End Mills

Catalogue - Edition **20**

Tool Factory Fanar Joint Stock Company is a leading manufacturer of cutting tools for metalworking.

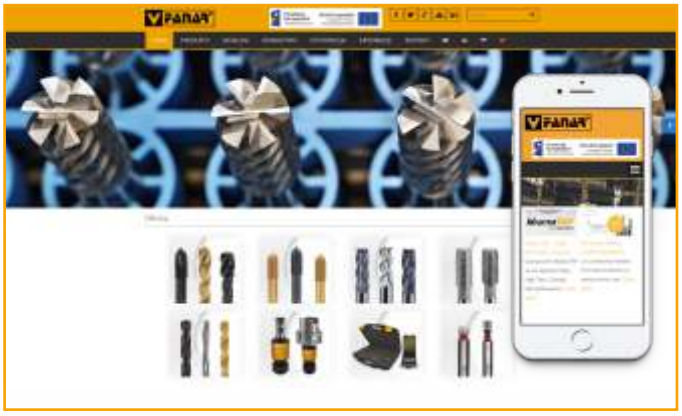
For many years, we focus on innovation, quality and continous development. Our knowledge and experience, which is supported by **newest technology and modern stock of machine tools** allow us to offer innovative products meeting highest quality requirements. We are trusted supplier in the country and abroad. We are cooperating with the world's biggest producers of such industries as: automotive, aerospace, medical, home appliances and many others.

A wide range of products supported by service, technical advice, and IT new solutions in customer service ensure a high level of customer satisfaction.

We are producer with global reach

Our tools are distributed to more than **40 countries**.More and more recognizable brand of producer of the highest quality allows for further international expansion. Looking for **tools of the highest quality thread** take advantage of our global distribution network.The current list of official distributors available on the

Detailed information on the website **www.fanar.eu**



Cutting geometry

- Z=4 — Number of flutes
- Possible feed directions
- Square corner
- Corner radius
- Ball nose
- For High Feed Machining
- l 40° — Helix angle
- l 35°-39° — Variable helix angle
- Equal pitch
- Unequal pitch
- Typ HR — Chip breaker

PVD coatings

- TS — TiAlN + TiAlSiN
- AT — AlTiN
- TB — TiB_2
- AD — AlCrN
- PVD — Uncoated

Shank type

- Straight shank acc. to DIN-6535-HA
- Weldon shank acc. to DIN-6535-HB

● - Primary application
○ - Secondary application

The speed values are orientational.
The speed should be adjust experimentally

		Example	Material number		Material group
220		11SMnPb30, 10SPb20, 35S20, 11SMn37	1.0718, 1.0722, 1.0726, 1.0736	P1	P
190	-	S235JR,S275JR, C22, C45	1.0038, 1.0044, 1.0402, 1.0503	P2	
190	-	C55, C60, C60E	1.0535, 1.0601, 1.1221	P3	
210	-	C25E, C53G, G18Mo5, 16Mo5	1.1158, 1.1213, 1.5422, 1.5423	P4	
300	32	C55, C55E, C60E	1.0535, 1.1203, 1.1221	P5	
175	-	36Mn5, 107CrV3, 100Cr6, 20NiCrMo2-2, 41Cr4	1.1167, 1.2210, 1.3505, 1.6523, 1.7035	P6	
300	32	34Cr4, 25CrMo4, Weldox 700, Weldox 900	1.7033, 1.7218	P7	
380	41	36NiCr6, 34CrNiMo6, 55Cr3, 51CrV4	1.5710, 1.6582, 1.7176, 1.8159	P8	
420	45	55Si7, 60SiCr7, 55NiCrMoV6, 40CrMoV13-9	1.0904, 1.0961, 1.2713, 1.8523	P9	
210	-	X210Cr12, X100CrMoV5-1, HS6-5-2-5, HS6-5-2	1.2080, 1.2363, 1.3243, 1.3343	P10	
300	32	HS6-5-2-5, HS18-1-2-5, HS 10-2-5-8, HS 6-5-3-8	1.3243, 1.3255, 1.3253, 1.3294	P11	
420	45	X30WCrV9-3	1.2581	P12	
210	-	X6Cr13, X12Cr13, X14CrMoS17, X6CrMo17-1	1.4000, 1.4006, 1.4104, 1.4113	P13	
330	34	X12Cr13, GX20Cr14, X19CrNi17-2 , X45CrSi9-3-1	1.4006, 1.4027, 1.4057, 1.4718	P14	
210	-	X5CrNi18-10, X5CrNiMo17-12-2, X2CrNiMo18-14-3, X12NiCrSi36-16	1.4301, 1.4401, 1.4435 ,1.4864	M1	M
300	32	X9CrNi18-8, X53CrMnNiN21-9	1.4310, 1.4871	M2	
240	23	X2CrNiN23-4, X2CrNiMoN17-13-3, X2CrNiMoN22-5-3, X2CrNiMoCuN25-6-3	1.4362, 1.4429, 1.4462, 1.4507	M3	
120	-	EN-GJL-100 , EN-GJL-200, EN-GJL-300, EN-GJL-400	0.6010, 0.6020, 0.6030, 0.6040	K1	K
160	-	EN-GJV-300, EN-GJV-400, EN-GJV-500, EN-GJV-550	-	K2	
150	-	EN-GJMW-300-26, EN-GJMB-350-10, EN-GJMB-450-6	0.8035, 0.8135, 0.8145	K3	
240	-	EN-GJMB-550-4, EN-GJMB-700-2, EN-GJMB-800-1	0.8155, 0.8170, 0.8180	K4	
210	-	EN-GJS-400-15, EN-GJS-500-7, EN-GJS-700-2	0.7040, 0.7050, 0.7070	K5	
420	45	EN-GJS-800-8, EN-GJS-1200-2, EN-GJS-1400-1	-	K6	
-	-	ENAW-Al99.5, ENAW-AlSi1MgMn (PA4), ENAW-AlMg0.7Si (PA38), ENAW-AlMg3 (PA11)	3.0255, 3.2315, 3.3206, 3.3535	N1	N
152	-	ENAW-AlCu6BiPb, ENAW-AlCu4MgSi(A) (PA6), ENAW-AlZn5.5MgCu (PA9) ENAW-AlMg4.5Mn0.7 (PA13)	3.1655, 3.1325, 3.4365, 3.3547	N2	
75	-	ENAC-AlSi12, ENAC-AlSi12(Fe), ENAC-AlSi12(Cu), ENAC-AlMg5	3.2581, 3.2582, 3.2583, 3.3561	N3	
90	-	ENAC-AlCu4MgTi, ENAC-AlSi7Mg0.3, ENAC-AlSi9Mg, ENAC-AlSi10Mg(a)	3.1371, 3.2371, 3.2373, 3.2381	N4	
130	-	ENAC-AlSi17Cu4Mg	-	N5	
70	-	EN-MAMgMn1, EN-MCMgRE3Zn2Zr, EN-MCMgRE2Ag2Zr, EN-MCMgAl4Si	3.5101, 3.5103, 3.3506, 3.5470	N6	
100	-	Cu-OF, Cu-DHP, CuZn35Mn2Al1Fe1-C, CuAl10Ni5Fe4	2.0040, 2.0090, 2.0592, 2.0966	N7	
180	-	CuZn37 (M63), CuAl10Ni5Fe4, CuSn8P	2.0321, 2.0966, 2.1030	N8	
120	-	CuZn40Pb2 (M58)(MO58), CuSn7Zn4Pb7-C, CuSn5Zn5Pb5-C, CuSn10Pb10-C	2.0402, 2.1090, 2.1096, 2.1176	N9	
300	32	AMPCO 8, AMPCO 21, AMPCO M4	-	N10	
200	-	Incoloy 909, Multimet 155, X10NiCrAlTi3220 (Incoly 800), X40CoCrNi2020	1.4876, 1.4977	S1	S
280	29	Incoloy A-286, Unitemp 212	-	S2	
250	25	Incoloy 864, Nimocast 713	-	S3	
350	38	Inconel 718, Nimonic 80A	-	S4	
320	34	GMR 235*, Jessop G81*	-	S5	
200	-	Ti 99.8, TiCu2	3.7025, 3.7124	S6	
375	40	Ti-6Al-4V, Ti-6Al-2Mo-2Cr, Ti-6Al-6Mo-4Zr-2Sn	3.7165	S7	
410	44	Ti-10V-2Fe-3Al, Ti-13V-11Cr-3Al	-	S8	
	50	Weldox 1100, Weldox 1300, Hardox 500	-	H1	H
	55	Hardox 550, Hardox 600, Armox 600 T	-	H2	
	60	Hardox Extreme	-	H3	
	55	GX260NiCr42, GX330NiCr42, GX300CrMoNi15-2-1	0.9620, 0.9625, 0.9640	H4	

Technical information

Groups of Tools by Applications

MASTERMILL High performance end mills dedicated to work on machining centers, for machining steel, stainless steel up to 45 HRC, cast iron and difficult to machine materials based on titanium and nickel.

X-MILL General purpose end mills for machining materials with hardness up to 35 HRC.

HRC End mills produced of comented carbide grade with nano-grain size (< 0,2µm), dedicated for machining materials in hardened condition. Optimized geometry and TS coating allow machining materials with higher hardness than 65 HRC.

AL Group of tools with cutting geometry optimized to machining non-ferrous materials. Polished flutes and TB coating allow high performance machining of aluminium and copper alloys.

Annealed	A	
Tempered	QT	
Hardened and tempered	HT	
Precipitation hardened	PH	

Material group					Rm	HB	HRC
		Steel					
P	P1	Non-alloyed steel	Free cutting steel	A	750	220	
	P2		C ≤ 0,55 %	A	650	190	-
	P3		C > 0,55 %	A	650	190	-
	P4		C ≤ 0,55 %	QT	700	210	-
	P5		C > 0,55 %	QT	1000	300	32
	P6	Low-alloyed steel		A	600	175	-
	P7			QT	1000	300	32
	P8			QT	1200	380	41
	P9			QT	1400	420	45
	P10	High-alloyed steel and high-alloyed tool steel		A	700	210	-
	P11			A	1000	300	32
	P12			HT	1400	420	45
	P13	Stainless steel	Ferritic/martensitic	A	700	210	-
	P14		Martensitic	QT	1100	330	34
		Stainless steel					
M	M1	Stainless steel	Austenitic		700	210	-
	M2		Austenitic (PH)	PH	1000	300	32
	M3		Duplex		800	240	23
		Cast iron					
K	K1	Grey cast iron(GJL)			400	120	-
	K2	Cast iron with vermicular graphite (GJV) CGI			550	160	-
	K3	Malleable cast iron (GJMW / GJMB)			500	150	-
	K4	Malleable cast iron (GJMB)			800	240	-
	K5	Cast iron with spheroidal graphite (GJS)			700	210	-
	K6	Cast iron with spheroidal graphite (GJS) ADI			1400	420	45
		Non-ferrous metals					
N	N1	Aluminium wrought alloys			200	-	-
	N2			PH	500	152	-
	N3	Cast aluminium alloys	Si ≤ 12%		250	75	-
	N4		Si ≤ 12%	PH	300	90	-
	N5		Si> 12 %		450	130	-
	N6	Magnesium alloys			250	70	-
	N7	Copper and copper alloys	Pure, Non-alloyed		350	100	-
	N8		Cu-alloys, long-chipping		600	180	-
	N9		Cu-alloys, short-chipping		400	120	-
	N10		High-strength,		1000	300	32
		Superalloys and titanium					
S	S1	Heat-resistant alloys	Fe-based	A	675	200	-
	S2			PH	950	280	29
	S3		Ni / Co base	A	850	250	25
	S4			PH	1200	350	38
	S5			C	1100	320	34
	S6	Titanium alloys	Pure titanium		675	200	-
	S7		α and β alloys		1250	375	40
	S8		β alloys		1400	410	44
		Hard materials					
H	H1	Hardened steel		HT			50
	H2			HT			55
	H3			HT			60
	H4	Hardened cast iron		HT			55

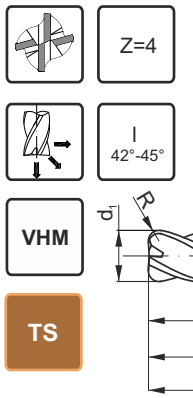
FANAR®

MASTERMILL

For machining steel and cast iron with hardness up to 45 HRC, stainless steel and difficult to machine materials

MASTERMILL

	440N	R440N
		
Workpiece material	P M K N S H	P M K N S H
Shank		
Tool material	VHM	VHM
Coating	TS	TS
Corner type		



d_1	d_2h6	d_3	l_1	l_2	l_3	Z	R	INDEX	
6	6	5,5	57	13	21	4	0,25	M9-44GMA0-0060	M9-44GMAC-0060
6	6	5,5	57	13	21	4	0,5	-	M9-44GMA1-0060
8	8	7,5	63	19	27	4	0,5	M9-44GMA0-0080	M9-44GMA1-0080
10	10	9,5	72	22	32	4	0,5	M9-44GMA0-0100	M9-44GMA1-0100
12	12	11,5	83	26	38	4	0,5	M9-44GMA0-0120	M9-44GMA1-0120
14	14	13	83	26	38	4	0,5	M9-44GMA0-0140	M9-44GMA1-0140
16	16	15	92	32	44	4	0,5	M9-44GMA0-0160	M9-44GMA1-0160
16	16	15	92	32	44	4	1	-	M9-44GMA3-0160
18	18	17	92	32	44	4	0,5	M9-44GMA0-0180	M9-44GMA1-0180
20	20	19	104	38	55	4	0,5	M9-44GMA0-0200	M9-44GMA1-0200
20	20	19	104	38	55	4	1	-	M9-44GMA3-0200

ISO		Vc [m/min]	d_1 [mm]							
			6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P4	150-200	0,020	0,030	0,045	0,055	0,060	0,065	0,070	0,080
	P5-P12	120-160	0,015	0,030	0,040	0,045	0,050	0,055	0,060	0,065
	P13	70-130	0,010	0,020	0,020	0,035	0,040	0,045	0,050	0,055
	P14	70-110	0,010	0,020	0,020	0,035	0,040	0,045	0,050	0,055
M	M1	80-120	0,010	0,020	0,020	0,035	0,040	0,045	0,050	0,055
	M2-M3	60-100	0,015	0,025	0,040	0,045	0,050	0,055	0,060	0,065
K	K1-K6	140-200	0,020	0,025	0,040	0,045	0,050	0,055	0,060	0,065
N	N1-N5	240-280	0,050	0,055	0,065	0,075	0,080	0,085	0,090	0,095
	N7-N10	260-300	0,050	0,055	0,060	0,070	0,075	0,080	0,085	0,090
S	S1-S5	30-50	0,020	0,030	0,050	0,055	0,060	0,065	0,070	0,075
	S6-S8	40-70	0,020	0,035	0,050	0,055	0,060	0,065	0,070	0,075

Example of order

M9-44GMAC-0060
MASTERMILL R440N 6x5,5x6x13x21x57 R0,25 VHM TS

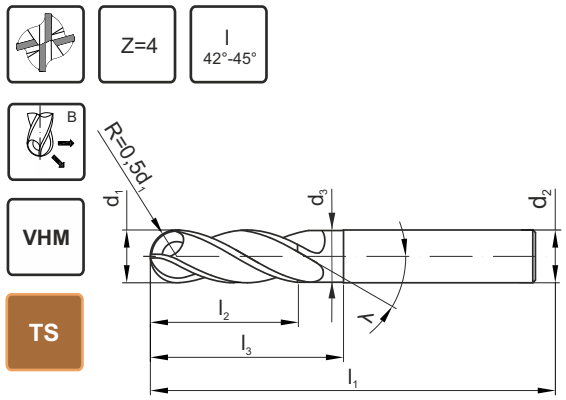
R - for tools with corner radius

Another tool dimensions available on request

For machining steel and cast iron with hardness up to 45 HRC, stainless steel and difficult to machine materials

MASTERMILL

B440N



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	TS
Corner type	

d_1	d_2h6	d_3	l_1	l_2	l_3	Z	R	INDEX
3	6	-	57	8	-	4	1,5	M9-44GMAX-0030
4	6	-	57	11	-	4	2,0	M9-44GMAX-0040
5	6	-	57	13	-	4	2,5	M9-44GMAX-0050
6	6	5,5	57	13	21	4	3,0	M9-44GMAX-0060
8	8	7,5	63	19	27	4	4,0	M9-44GMAX-0080
10	10	9,5	72	22	32	4	5,0	M9-44GMAX-0100
12	12	11,5	83	26	38	4	6,0	M9-44GMAX-0120
14	14	13	83	26	38	4	7,0	M9-44GMAX-0140
16	16	15	92	32	44	4	8,0	M9-44GMAX-0160
18	18	17	92	32	44	4	9,0	M9-44GMAX-0180
20	20	19	104	38	55	4	10,0	M9-44GMAX-0200

ISO		Vc [m/min]	d_1 [mm]										
			3	4	5	6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P4	150-200	0,025	0,025	0,030	0,040	0,050	0,060	0,070	0,075	0,080	0,085	0,090
	P5-P12	120-160	0,025	0,025	0,030	0,035	0,050	0,055	0,060	0,065	0,070	0,075	0,080
	P13	70-130	0,025	0,025	0,030	0,030	0,045	0,045	0,050	0,055	0,060	0,065	0,070
	P14	70-110	0,015	0,015	0,025	0,030	0,045	0,045	0,050	0,055	0,060	0,065	0,070
M	M1	80-120	0,020	0,020	0,025	0,030	0,045	0,045	0,050	0,055	0,060	0,065	0,070
	M2-M3	60-100	0,020	0,020	0,025	0,040	0,045	0,050	0,055	0,060	0,065	0,070	0,075
K	K1-K5	140-200	0,025	0,025	0,030	0,040	0,060	0,060	0,070	0,075	0,080	0,085	0,090
N	N1-N5	240-280	0,035	0,040	0,050	0,050	0,055	0,065	0,075	0,080	0,085	0,090	0,095
	N7-N10	260-300	0,030	0,035	0,045	0,050	0,055	0,060	0,070	0,075	0,080	0,085	0,090
S	S3-S5	30-50	0,010	0,010	0,010	0,015	0,025	0,025	0,040	0,045	0,050	0,055	0,060
	S6-S8	40-70	0,010	0,010	0,015	0,020	0,030	0,030	0,040	0,045	0,050	0,060	0,065

Example of order

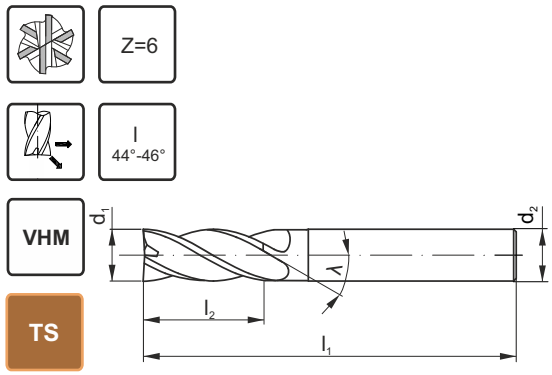
M9-44GMAX-0060
MASTERMILL B440N 6x5,5x6x13x21x57 VHM TS

Another tool dimensions available on request

For machining steel and cast iron with hardness up to 45 HRC, stainless steel and difficult to machine materials

MASTERMILL

645



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	TS
Corner type	

d_1	d_2h6	l_1	l_2	Z	INDEX
6	6	57	16	6	M9-64GM00-0060
8	8	63	20	6	M9-64GM00-0080
10	10	72	25	6	M9-64GM00-0100
12	12	83	30	6	M9-64GM00-0120
14	14	83	35	6	M9-64GM00-0140
16	16	92	40	6	M9-64GM00-0160
20	20	104	45	6	M9-64GM00-0200

ISO		Vc [m/min]	d_1 [mm]						
			6	8	10	12	14	16	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P4	170-220	0,015	0,020	0,025	0,030	0,035	0,040	0,050
	P5-P12	160-190	0,010	0,020	0,020	0,030	0,030	0,040	0,050
	P13	120-150	0,010	0,010	0,020	0,025	0,030	0,030	0,040
	P14	80-130	0,010	0,010	0,020	0,025	0,030	0,030	0,040
M	M1	100-130	0,010	0,010	0,020	0,025	0,030	0,030	0,040
	M2-M3	70-110	0,015	0,020	0,035	0,040	0,045	0,045	0,055
K	K1-K6	105-135	0,015	0,020	0,025	0,030	0,030	0,035	0,045
N	N1-N5	200-250	0,015	0,020	0,025	0,030	0,035	0,040	0,045
	N7-N10	150-200	0,010	0,010	0,020	0,025	0,030	0,030	0,040
S	S3-S5	40-70	0,015	0,025	0,025	0,040	0,045	0,050	0,060
	S6-S8	60-90	0,020	0,030	0,030	0,040	0,045	0,050	0,065

Example of order

M9-64GM00-0060
MASTERMILL 645 6x6x16x57 VHM TS

Corner radius and another tool dimensions available on request

	MASTERMILL				X-MILL								Name
	440N	R440N	B440N	645	230	230L	B230	B230L	345	R345	440S	R440S	
													
	Z=4	Z=4	Z=4	Z=6	Z=2	Z=2	Z=2	Z=2	Z=3	Z=3	Z=4	Z=4	Number of flutes
	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	Tool material
	TS	TS	TS	TS	AT	AT	AT	AT	AT	AT	AT	AT	Coating
													Corner type
	8	8	9	10	14	15	16	17	18	18	19	19	Page
	●	●	●	●	●	●	●	●	●	●	●	●	P1
	●	●	●	●	●	●	●	●	●	●	●	●	P2
	●	●	●	●	●	●	●	●	●	●	●	●	P3
	●	●	●	●	●	●	●	●	●	●	●	●	P4
	●	●	●	●	●	●	●	●	●	●	●	●	P5
	●	●	●	●	●	●	●	●	●	●	●	●	P6
	●	●	●	●	●	●	●	●	●	●	●	●	P7
	●	●	●	●	●	●	●	●	●	●	●	●	P8
	●	●	●	●	●	●	●	●	●	●	●	●	P9
	●	●	●	●	●	●	●	●	●	●	●	●	P10
	●	●	●	●	●	●	●	●	●	●	●	●	P11
	●	●	●	●	●	●	●	●	●	●	●	●	P12
	●	●	●	●	●	●	●	●	●	●	●	●	P13
	●	●	●	●	●	●	●	●	●	●	●	●	P14
	●	●	●	●					○	○	○	○	M1
	●	●	●	●					○	○	○	○	M2
	●	●	●	●					○	○	○	○	M3
	●	●	●	●	●	●	●	●	●	●	●	●	K1
	●	●	●	●	●	●	●	●	●	●	●	●	K2
	●	●	●	●	●	●	●	●	●	●	●	●	K3
	●	●	●	●	●	●	●	●	●	●	●	●	K4
	●	●	●	●	●	●	●	●	●	●	●	●	K5
	●	●	●	●	●	●	●	●	●	●	●	●	K6
	○	○	○	○					○	○	○	○	N1
	○	○	○	○					○	○	○	○	N2
	○	○	○	○					○	○	○	○	N3
	○	○	○	○					○	○	○	○	N4
	○	○	○	○					○	○	○	○	N5
													N6
	○	○	○	○	○	○	○	○	○	○	○	○	N7
	○	○	○	○	○	○	○	○	○	○	○	○	N8
	○	○	○	○	○	○	○	○	○	○	○	○	N9
	○	○	○	○					○	○	○	○	N10
	●	●	●	●					○	○	○	○	S1
	●	●	●	●					○	○	○	○	S2
	●	●	●	●					○	○	○	○	S3
	●	●	●	●					○	○	○	○	S4
	●	●	●	●					○	○	○	○	S5
	●	●	●	●					○	○	○	○	S6
	●	●	●	●					○	○	○	○	S7
	●	●	●	●					○	○	○	○	S8
	○	○	○	○									H1
													H2
													H3
													H4

Name	X-MILL									ZGR
	440N	R440N	440NL	R440NL	430L	R430L	B440	540	R540	420
										
Number of flutes	Z=4	Z=4	Z=4	Z=4	Z=4	Z=4	Z=4	Z=5	Z=5	Z=3-4
Tool material	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM
Coating	AT	AT	AT	AT	AT	AT	AT	AT	AT	AT
Corner type										
Page	21	21	22	22	23	23	24	25	25	26
P1	●	●	●	●	●	●	●	●	●	●
P2	●	●	●	●	●	●	●	●	●	●
P3	●	●	●	●	●	●	●	●	●	●
P4	●	●	●	●	●	●	●	●	●	●
P5	●	●	●	●	●	●	●	●	●	●
P6	●	●	●	●	●	●	●	●	●	●
P7	●	●	●	●	●	●	●	●	●	●
P8	●	●	●	●	●	●	●	●	●	●
P9	●	●	●	●	●	●	●	●	●	●
P10	●	●	●	●	●	●	●	●	●	●
P11	●	●	●	●	●	●	●	●	●	●
P12	●	●	●	●	●	●	●	●	●	●
P13	●	●	●	●	●	●	●	●	●	●
P14	●	●	●	●	●	●	●	●	●	●
M1	○	○	○	○			○	○	○	○
M2	○	○	○	○			○	○	○	○
M3	○	○	○	○			○	○	○	○
K1	●	●	●	●	●	●	●	●	●	○
K2	●	●	●	●	●	●	●	●	●	○
K3	●	●	●	●	●	●	●	●	●	○
K4	●	●	●	●	●	●	●	●	●	○
K5	●	●	●	●	●	●	●	●	●	○
K6	●	●	●	●	●	●	●	●	●	○
N1	○	○	○	○			○	○	○	
N2	○	○	○	○			○	○	○	
N3	○	○	○	○			○	○	○	
N4	○	○	○	○			○	○	○	
N5	○	○	○	○			○	○	○	
N6										
N7	○	○	○	○	○	○	○	○	○	
N8	○	○	○	○	○	○	○	○	○	
N9	○	○	○	○	○	○	○	○	○	
N10	○	○	○	○			○	○	○	
S1	○	○	○	○			○	○	○	
S2	○	○	○	○			○	○	○	
S3	○	○	○	○			○	○	○	
S4	○	○	○	○			○	○	○	
S5	○	○	○	○			○	○	○	
S6	○	○	○	○			○	○	○	
S7	○	○	○	○			○	○	○	
S8	○	○	○	○			○	○	○	
H1										●
H2										○
H3										
H4										○

	HRC			AL									Name
	HFM 200	B415N	R645	130	245	R245	B245	345	R345	345NL	B345NL	445	
													
	Z=2	Z=4	Z=6	Z=1	Z=2	Z=2	Z=2	Z=3	Z=3	Z=3	Z=3	Z=4	Number of flutes
	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	VHM	Tool material
	TS	TS	TS	PVD	PVD / TB	PVD / TB	TB	PVD / TB	PVD / TB	TB	TB	PVD	Coating
													Corner type
	30	31	32	36	37-38	37-38	39	40-43	40-43	44	45	46	Page
	○												P1
	○												P2
	○												P3
	○												P4
	●												P5
	○												P6
	●												P7
	●												P8
	●												P9
	○												P10
	●												P11
	●												P12
	○												P13
	●												P14
													M1
													M2
													M3
	●												K1
	●												K2
	●												K3
	●												K4
	●												K5
	●												K6
				●	●	●	●	●	●	●	●	●	N1
				●	●	●	●	●	●	●	●	●	N2
				●	●	●	●	●	●	●	●	●	N3
				●	●	●	●	●	●	●	●	●	N4
				●	●	●	●	●	●	●	●	●	N5
													N6
				●	●	●	●	●	●	●	●	●	N7
				●	●	●	●	●	●	●	●	●	N8
				●	●	●	●	●	●	●	●	●	N9
				●	●	●	●	●	●	●	●	●	N10
													S1
													S2
													S3
													S4
													S5
													S6
													S7
													S8
	●	●	●										H1
	○	●	●										H2
		●	●										H3
	○	●	●										H4

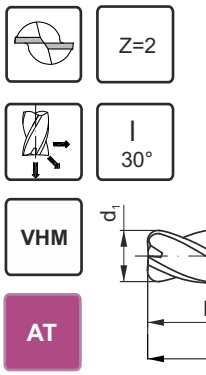
FANAR®

X-MILL

For machining steel and cast iron with hardness up to 35 HRC

X-MILL

230



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	AT
Corner type	

d_1	d_2h6	l_1	l_2	Z	INDEX
1	4	50	3	2	M9-234X00-0010
1,5	4	50	4	2	M9-234X00-0015
2	4	50	6	2	M9-234X00-0020
2,5	4	50	8	2	M9-234X00-0025
3	4	50	8	2	M9-234X00-0030
4	4	50	14	2	M9-234X00-0040
5	6	50	16	2	M9-234X00-0050
6	6	50	19	2	M9-234X00-0060
7	8	58	19	2	M9-234X00-0070
8	8	58	20	2	M9-234X00-0080
9	10	72	22	2	M9-234X00-0090
10	10	72	25	2	M9-234X00-0100
11	12	73	25	2	M9-234X00-0110
12	12	73	30	2	M9-234X00-0120
14	14	83	35	2	M9-234X00-0140
16	16	92	40	2	M9-234X00-0160
18	18	100	45	2	M9-234X00-0180
20	20	100	45	2	M9-234X00-0200

ISO		Vc [m/min]	d_1 [mm]														
			1	1,5	2	2,5	3	4	5	6-7	8-9	10-11	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P5	70-110	0,002	0,005	0,005	0,010	0,015	0,025	0,035	0,040	0,050	0,070	0,090	0,090	0,110	0,120	0,130
	P6-P12	50-80	0,002	0,004	0,005	0,050	0,010	0,015	0,025	0,030	0,035	0,050	0,060	0,065	0,080	0,085	0,090
	P13-P14	60-90	0,005	0,005	0,007	0,010	0,010	0,010	0,010	0,015	0,020	0,025	0,030	0,030	0,035	0,035	0,040
K	K1-K4	90-110	0,003	0,005	0,010	0,015	0,020	0,030	0,035	0,035	0,040	0,050	0,060	0,065	0,080	0,085	0,090
	K5-K6	80-90	0,003	0,005	0,010	0,015	0,020	0,030	0,035	0,035	0,040	0,050	0,060	0,065	0,080	0,085	0,090
N	N7-N9	150-170	0,005	0,005	0,010	0,010	0,010	0,015	0,015	0,025	0,030	0,035	0,045	0,050	0,055	0,090	0,100

Example of order

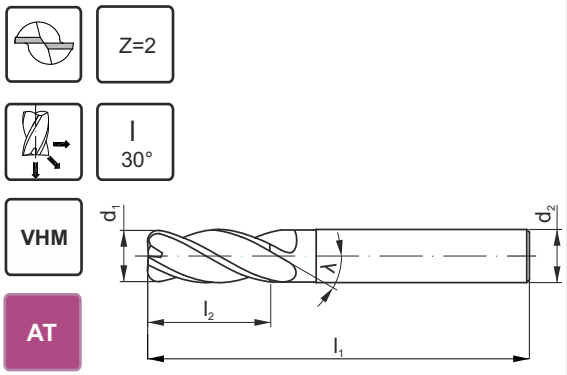
M9-234X00-0010
X-MILL 230 1x4x3x50 VHM AT

Another tool dimensions available on request

For machining steel and cast iron with hardness up to 35 HRC

X-MILL

230L



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	AT
Corner type	

d_1	d_2h6	l_1	l_2	Z	INDEX
6	6	75	15	2	M9-234X20-0060
6	6	100	15	2	M9-234X20-0060A
8	8	100	20	2	M9-234X20-0080
10	10	100	25	2	M9-234X20-0100
10	10	150	25	2	M9-234X20-0100A
12	12	100	30	2	M9-234X20-0120
12	12	150	30	2	M9-234X20-0120A

ISO		Vc [m/min]	d_1 [mm]			
			6	8	10	12
			fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P5	60-90	0,030	0,040	0,055	0,065
	P6-P14	50-80	0,010	0,015	0,020	0,025
K	K1-K4	80-100	0,030	0,030	0,040	0,045
	K5-K6	80-90	0,030	0,030	0,040	0,045
N	N7-N9	150-170	0,020	0,025	0,030	0,040

Example of order

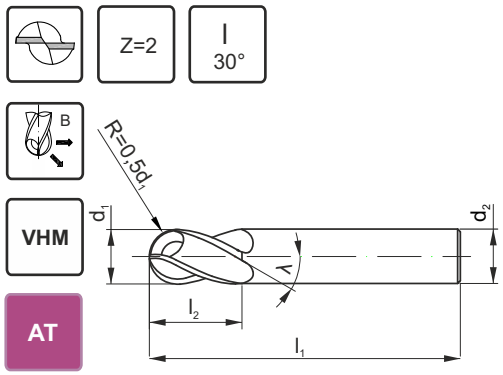
M9-234X20-0060
X-MILL 230L 6x6x15x75 VHM AT

Another tool dimensions available on request

For machining steel and cast iron with hardness up to 35 HRC

X-MILL

B230



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	AT
Corner type	

d_1	d_2h6	l_1	l_2	Z	INDEX
1	4	50	2	2	M9-234X0X-0010
1,5	4	50	3	2	M9-234X0X-0015
2	4	50	4	2	M9-234X0X-0020
2,5	4	50	5	2	M9-234X0X-0025
3	4	50	6	2	M9-234X0X-0030
4	4	50	8	2	M9-234X0X-0040
5	6	50	10	2	M9-234X0X-0050
6	6	50	12	2	M9-234X0X-0060
8	8	58	16	2	M9-234X0X-0080
10	1	72	20	2	M9-234X0X-0100
12	12	73	24	2	M9-234X0X-0120
16	16	92	32	2	M9-234X0X-0160
18	18	100	40	2	M9-234X0X-0180
20	20	100	40	2	M9-234X0X-0200

ISO		Vc [m/min]	d_1 [mm]													
			1	1,5	2	2,5	3	4	5	6	8	10	12	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P5	70-110	0,002	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,050	0,070	0,085	0,110	0,120	0,130
	P6-P12	50-80	0,002	0,005	0,005	0,005	0,010	0,015	0,025	0,030	0,035	0,050	0,060	0,080	0,085	0,090
K	K1-K4	90-110	0,003	0,005	0,010	0,015	0,020	0,030	0,035	0,035	0,035	0,050	0,060	0,070	0,075	0,080
	K5-K6	80-90	0,003	0,005	0,010	0,015	0,020	0,030	0,035	0,035	0,035	0,045	0,045	0,055	0,055	0,070
N	N7-N9	150-170	0,005	0,010	0,015	0,025	0,030	0,035	0,040	0,045	0,045	0,050	0,060	0,070	0,080	0,090

Example of order

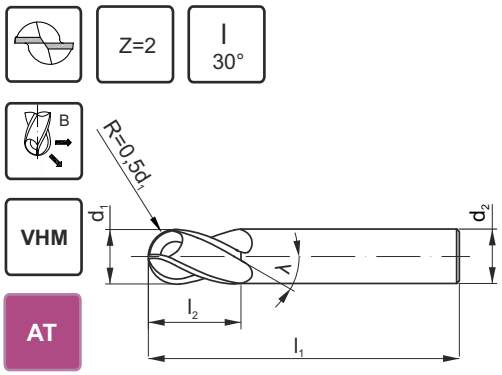
M9-234X0X-0010
X-MILL B230 1x4x2x50 VHM AT

Another tool dimensions available on request

For machining steel and cast iron with hardness up to 35 HRC

X-MILL

B230L



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	AT
Corner type	

d_1	d_2h6	l_1	l_2	Z	INDEX
6	6	75	12	2	M9-234X2X-0060
6	6	100	12	2	M9-234X2X-0060A
8	8	100	16	2	M9-234X2X-0080
10	10	100	20	2	M9-234X2X-0100
10	10	150	20	2	M9-234X2X-0100A
12	12	100	24	2	M9-234X2X-0120
12	12	150	24	2	M9-234X2X-0120A
16	16	150	32	2	M9-234X2X-160

ISO		Vc [m/min]	d_1 [mm] 6 fz [mm]	8 fz [mm]	10 fz [mm]	12 fz [mm]	14 fz [mm]	16 fz [mm]
P	P1-P5	70-110	0,040	0,050	0,070	0,085	0,090	0,110
	P6-P12	50-80	0,030	0,035	0,050	0,060	0,065	0,080
K	K1-K4	90-110	0,035	0,035	0,050	0,060	0,065	0,070
	K5-K6	80-90	0,035	0,035	0,045	0,045	0,050	0,055
N	N7-N9	150-170	0,045	0,045	0,050	0,060	0,065	0,070

Example of order

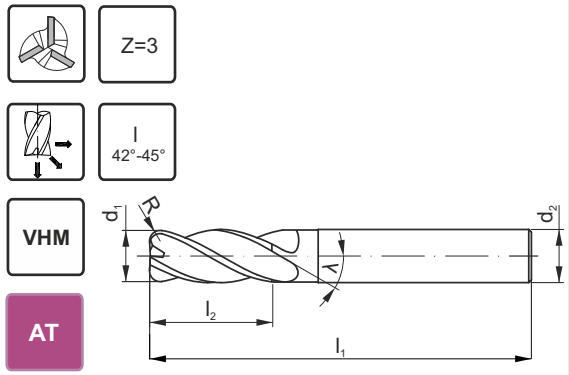
M9-234X20-0060
X-MILL B230L 6x6x12x75 VHM AT

Another tool dimensions available on request

For machining steel, stainless steel and cast iron with hardness up to 35 HRC

X-MILL

345	345	R345	R345



Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	AT	AT	AT	AT
Corner type				

d_1	d_2h6	l_1	l_2	Z	R	INDEX			
3	6	57	8	3	0,3	M9-344X00-0030	M9-344X00-0030-B	M9-344X0D-0030	M9-344X0D-0030-B
4	6	57	11	3	0,3	M9-344X00-0040	M9-344X00-0040-B	M9-344X0D-0040	M9-344X0D-0040-B
5	6	57	13	3	0,3	M9-344X00-0050	M9-344X00-0050-B	M9-344X0D-0050	M9-344X0D-0050-B
6	6	57	13	3	0,5	M9-344X00-0060	M9-344X00-0060-B	M9-344X01-0060	M9-344X01-0060-B
8	8	63	19	3	0,5	M9-344X00-0080	M9-344X00-0080-B	M9-344X01-0080	M9-344X01-0080-B
8	8	63	19	3	1,0	-	-	M9-344X03-0080	M9-344X03-0080-B
8	8	63	19	3	1,5	-	-	M9-344X04-0080	M9-344X04-0080-B
10	10	72	22	3	0,5	M9-344X00-0100	M9-344X00-0100-B	M9-344X01-0100	M9-344X01-0100-B
10	10	72	22	3	2,0	-	-	M9-344X05-0100	M9-344X05-0100-B
12	12	83	26	3	0,7	M9-344X00-0120	M9-344X00-0120-B	M9-344X02-0120	M9-344X02-0120-B
12	12	83	26	3	2,0	-	-	M9-344X05-0120	M9-344X05-0120-B
14	14	83	26	3	0,7	M9-344X00-0140	M9-344X00-0140-B	M9-344X02-0140	M9-344X02-0140-B
16	16	92	32	3	1,0	M9-344X00-0160	M9-344X00-0160-B	M9-344X03-0160	M9-344X03-0160-B

ISO		Vc [m/min]	d_1 [mm]								
			3	4	5	6	8	10	12	14	16
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P5	130-160	0,010	0,015	0,025	0,030	0,050	0,060	0,075	0,080	0,085
	P6-P9	80-110	0,010	0,015	0,020	0,025	0,040	0,045	0,055	0,060	0,065
	P10-P12	60-80	0,010	0,015	0,020	0,025	0,040	0,045	0,055	0,060	0,065
	P13	90-140	0,010	0,015	0,020	0,025	0,040	0,045	0,055	0,060	0,065
	P14	90-140	0,005	0,010	0,015	0,020	0,030	0,040	0,045	0,050	0,055
M	M1	90-140	0,010	0,015	0,020	0,025	0,040	0,050	0,060	0,065	0,070
	M2-M3	60-90	0,005	0,010	0,015	0,020	0,030	0,040	0,045	0,050	0,055
K	K1-K6	90-130	0,005	0,010	0,020	0,025	0,040	0,045	0,050	0,055	0,060
N	N1-N5	240-280	0,035	0,040	0,050	0,050	0,055	0,065	0,075	0,080	0,085
	N7-N10	260-300	0,030	0,035	0,045	0,050	0,055	0,060	0,070	0,075	0,080
S	S1,S3	15-25	0,005	0,010	0,015	0,020	0,025	0,035	0,040	0,045	0,050
	S2,S4-S5	10-20	0,005	0,010	0,010	0,015	0,020	0,025	0,030	0,035	0,040
	S6	40-60	0,010	0,015	0,015	0,020	0,025	0,030	0,040	0,045	0,050
	S7-S8	15-20	0,010	0,015	0,015	0,020	0,025	0,030	0,040	0,045	0,050

Example of order

M9-344X00-0030
X-MILL 345 3x6x8x57 VHM AT

R - for tools with corner radius

Another tool dimensions available on request

For machining steel, stainless steel and cast iron with hardness up to 35 HRC

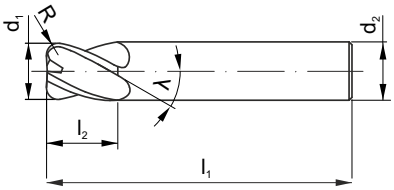

Z=4


l
35°-39°

VHM

AT

Version without corner radius is protected by corner chamfer:
for Ø < 6mm f_1 = 0,1x45°
for Ø ≥ 6mm f_1 = 0,2x45°



X-MILL

	440S	440S	R440S	R440S
				
Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	AT	AT	AT	AT
Corner type				

d_1	d_2h6	l_1	l_2	Z	R	INDEX			
3	6	54	7	4	0,3	M9-444X10-0030	M9-444X10-0030-B	M9-444X1D-0030	M9-444X1D-0030-B
4	6	54	8	4	0,3	M9-444X10-0040	M9-444X10-0040-B	M9-444X1D-0040	M9-444X1D-0040-B
5	6	54	10	4	0,3	M9-444X10-0050	M9-444X10-0050-B	M9-444X1D-0050	M9-444X1D-0050-B
6	6	54	10	4	0,5	M9-444X10-0060	M9-444X10-0060-B	M9-444X11-0060	M9-444X11-0060-B
8	8	58	12	4	0,5	M9-444X10-0080	M9-444X10-0080-B	M9-444X11-0080	M9-444X11-0080-B
8	8	58	12	4	1,0	-	-	M9-444X13-0080	M9-444X13-0080-B
10	10	66	14	4	0,5	M9-444X10-0100	M9-444X10-0100-B	M9-444X11-0100	M9-444X11-0100-B
10	10	66	14	4	1,0	-	-	M9-444X13-0100	M9-444X13-0100-B
10	10	66	14	4	1,5	-	-	M9-444X14-0100	M9-444X14-0100-B
12	12	73	16	4	0,5	M9-444X10-0120	M9-444X10-0120-B	M9-444X11-0120	M9-444X11-0120-B
12	12	73	16	4	0,7	-	-	M9-444X12-0120	M9-444X12-0120-B
12	12	73	16	4	1,0	-	-	M9-444X13-0120	M9-444X13-0120-B
14	14	75	18	4	0,5	M9-444X10-0140	M9-444X10-0140-B	M9-444X11-0140	M9-444X11-0140-B
16	16	82	22	4	0,5	M9-444X10-0160	M9-444X10-0160-B	M9-444X11-0160	M9-444X11-0160-B
16	16	82	22	4	1,0	-	-	M9-444X13-0160	M9-444X13-0160-B
16	16	82	22	4	2,0	-	-	M9-444X15-0160	M9-444X15-0160-B
20	20	92	26	4	1,0	M9-444X10-0200	M9-444X10-0200-B	M9-444X13-0200	M9-444X13-0200-B

ISO		Vc [m/min]	d_1 [mm]									
			3	4	5	6	8	10	12	14	16	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P7	130-160	0,005	0,010	0,015	0,020	0,030	0,045	0,055	0,060	0,065	0,080
	P8-P13	60-110	0,005	0,010	0,010	0,015	0,025	0,040	0,045	0,050	0,055	0,065
	P14	90-140	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,055
M	M1	90-140	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,055
	M2	60-90	0,005	0,010	0,010	0,015	0,025	0,040	0,045	0,050	0,055	0,065
	M3	60-80	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,055
K	K1-K6	90-130	0,005	0,010	0,020	0,025	0,030	0,040	0,045	0,050	0,055	0,065
N	N1-N5	240-280	0,035	0,040	0,045	0,050	0,055	0,065	0,075	0,080	0,085	0,095
	N7-N10	260-300	0,030	0,035	0,045	0,050	0,055	0,060	0,070	0,075	0,080	0,090
S	S1-S5	15-25	0,005	0,005	0,010	0,020	0,030	0,050	0,055	0,060	0,065	0,080
	S6-S8	40-60	0,005	0,010	0,015	0,020	0,035	0,050	0,055	0,060	0,065	0,080

Example of order
M9-444X10-0030
X-MILL 440S 3x6x7x54 VHM AT

R - for tools with corner radius

Another tool dimensions available on request

For machining steel, stainless steel and cast iron with hardness up to 35 HRC

X-MILL

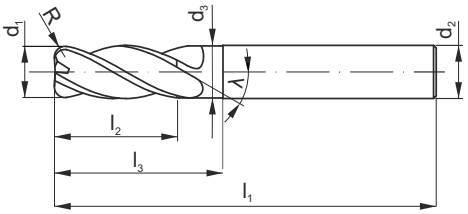
Z=4

l 35°-39°

VHM

AT

Version without corner radius is protected by corner chamfer:
for Ø < 6mm f_1 = 0,1x45°
for Ø ≥ 6mm f_1 = 0,2x45°



	440N	440N	R440N	R440N
				
Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	AT	AT	AT	AT
Corner type				

d_1	d_2h6	d_3	l_1	l_2	l_3	Z	R	INDEX			
1	4	-	50	3	-	4	-	M9-444XA0-0010	-	-	-
1,5	4	-	50	4	-	4	-	M9-444XA0-0015	-	-	-
2,0	4	-	50	6	-	4	-	M9-444XA0-0020	-	-	-
2,5	4	-	50	8	-	4	-	M9-444XA0-0025	-	-	-
3	6	-	57	8	-	4	0,3	M9-444XA0-0030	M9-444XA0-0030-B	M9-444XAD-0030	M9-444XAD-0030-B
4	6	-	57	11	-	4	0,3	M9-444XA0-0040	M9-444XA0-0040-B	M9-444XAD-0040	M9-444XAD-0040-B
5	6	-	57	13	-	4	0,3	M9-444XA0-0050	M9-444XA0-0050-B	M9-444XAD-0050	M9-444XAD-0050-B
6	6	5,5	57	13	21	4	0,5	M9-444XA0-0060	M9-444XA0-0060-B	M9-444XA1-0060	M9-444XA1-0060-B
6	6	5,5	57	13	21	4	1,0	-	-	M9-444XA3-0060	M9-444XA3-0060-B
8	8	7,5	63	19	27	4	0,5	M9-444XA0-0080	M9-444XA0-0080-B	M9-444XA1-0080	M9-444XA1-0080-B
8	8	7,5	63	19	27	4	1,0	-	-	M9-444XA3-0080	M9-444XA3-0080-B
8	8	7,5	63	19	27	4	2,0	-	-	M9-444XA5-0080	M9-444XA5-0080-B
10	10	9,2	72	22	32	4	0,5	M9-444XA0-0100	M9-444XA0-0100-B	M9-444XA1-0100	M9-444XA1-0100-B
10	10	9,2	72	22	32	4	1,0	-	-	M9-444XA3-0100	M9-444XA3-0100-B
10	10	9,2	72	22	32	4	2,0	-	-	M9-444XA5-0100	M9-444XA5-0100-B

ISO		Vc [m/min]	d_1 < 3 mm			
			1	1,5	2	2,5
			fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P5	75	0,004	0,008	0,015	0,015
	P6-P12	60	0,003	0,006	0,010	0,010
K	K1-K4	100	0,003	0,006	0,010	0,015
	K5-K6	85	0,003	0,006	0,020	0,025
N	N7-N9	170	0,005	0,010	0,015	0,020

ISO		Vc [m/min]	3	4	5	6	8	10	12	14	16	18	20	25
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P7	130-160	0,005	0,010	0,015	0,020	0,030	0,045	0,055	0,060	0,065	0,070	0,080	0,095
	P8-P13	60-110	0,005	0,010	0,010	0,015	0,025	0,040	0,045	0,050	0,055	0,060	0,065	0,080
	P14	90-140	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,050	0,055	0,065
M	M1	90-140	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,050	0,055	0,065
	M2	60-90	0,005	0,010	0,010	0,015	0,025	0,040	0,045	0,050	0,055	0,060	0,065	0,080
	M3	60-80	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,050	0,055	0,065
K	K1-K6	90-130	0,005	0,010	0,020	0,025	0,030	0,040	0,045	0,050	0,055	0,060	0,065	0,080
N	N1-N5	240-280	0,035	0,040	0,050	0,050	0,055	0,065	0,075	0,080	0,085	0,090	0,095	0,105
	N7-N10	260-300	0,030	0,035	0,045	0,050	0,055	0,060	0,070	0,075	0,080	0,085	0,090	0,105
S	S1-S5	15-25	0,005	0,005	0,010	0,020	0,030	0,050	0,055	0,060	0,065	0,070	0,080	0,095
	S6-S8	40-60	0,005	0,005	0,015	0,020	0,035	0,050	0,055	0,060	0,065	0,070	0,080	0,095

Example of order

M9-444XA1-0060
X-MILL R440N 6x5,5x6x13x21x57 R0,5 VHM AT

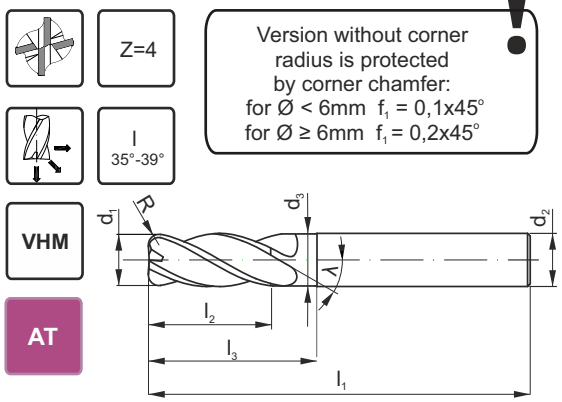
R - for tools with corner radius

Another tool dimensions available on request

For machining steel, stainless steel and cast iron with hardness up to 35 HRC

X-MILL

440N	440N	R440N	R440N



Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	AT	AT	AT	AT
Corner type				

d_1	d_2h6	d_3	l_1	l_2	l_3	Z	R	INDEX			
12	12	11	83	26	38	4	0,5	M9-444XA0-0120	M9-444XA0-0120-B	M9-444XA1-0120	M9-444XA1-0120-B
12	12	11	83	26	38	4	0,7	-	-	M9-444XA2-0120	M9-444XA2-0120-B
12	12	11	83	26	38	4	1,0	-	-	M9-444XA3-0120	M9-444XA3-0120-B
12	12	11	83	26	38	4	1,5	-	-	M9-444XA4-0120	M9-444XA4-0120-B
12	12	11	83	26	38	4	2,0	-	-	M9-444XA5-0120	M9-444XA5-0120-B
12	12	11	83	26	38	4	3,0	-	-	M9-444XA7-0120	M9-444XA7-0120-B
14	14	13	83	26	38	4	0,5	M9-444XA0-0140	M9-444XA0-0140-B	M9-444XA1-0140	M9-444XA1-0140-B
14	14	13	83	26	38	4	0,7	-	-	M9-444XA2-0140	M9-444XA2-0140-B
14	14	13	83	26	38	4	1,0	-	-	M9-444XA3-0140	M9-444XA3-0140-B
14	14	13	83	26	38	4	2,0	-	-	M9-444XA5-0140	M9-444XA5-0140-B
16	16	15	92	32	44	4	0,5	M9-444XA0-0160	M9-444XA0-0160-B	M9-444XA1-0160	M9-444XA1-0160-B
16	16	15	92	32	44	4	1,0	-	-	M9-444XA3-0160	M9-444XA3-0160-B
16	16	15	92	32	44	4	2,0	-	-	M9-444XA5-0160	M9-444XA5-0160-B
16	16	15	92	32	44	4	3,0	-	-	M9-444XA7-0160	M9-444XA7-0160-B
18	18	17	92	32	44	4	1,0	M9-444XA0-0180	M9-444XA0-0180-B	M9-444XA3-0180	M9-444XA3-0180-B
20	20	19	104	38	55	4	1,0	M9-444XA0-0200	M9-444XA0-0200-B	M9-444XA3-0200	M9-444XA3-0200-B
20	20	19	104	45	55	4	1,0	M9-444XA0-0200A	M9-444XA0-0200A-B	M9-444XA3-0200A	M9-444XA3-0200A-B
20	20	19	104	45	55	4	2,0	-	-	M9-444XA5-0200A	M9-444XA5-0200A-B
25	25	24	122	55	66	4	1,0	M9-444XA0-0250	M9-444XA0-0250-B	M9-444XA3-0250	M9-444XA3-0250-B

ISO		Vc [m/min]	d_1 [mm]											
			3	4	5	6	8	10	12	14	16	18	20	25
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P7	130-160	0,005	0,010	0,015	0,020	0,030	0,045	0,055	0,060	0,065	0,070	0,080	0,095
	P8-P13	60-110	0,005	0,010	0,010	0,015	0,025	0,040	0,045	0,050	0,055	0,060	0,065	0,080
	P14	90-140	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,050	0,055	0,065
M	M1	90-140	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,050	0,055	0,065
	M2	60-90	0,005	0,010	0,010	0,015	0,025	0,040	0,045	0,050	0,055	0,060	0,065	0,080
	M3	60-80	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,050	0,055	0,065
K	K1-K6	90-130	0,005	0,010	0,020	0,025	0,030	0,040	0,045	0,050	0,055	0,060	0,065	0,080
N	N1-N5	240-280	0,035	0,040	0,050	0,050	0,055	0,065	0,075	0,080	0,085	0,090	0,095	0,105
	N7-N10	260-300	0,030	0,035	0,045	0,050	0,055	0,060	0,070	0,075	0,080	0,085	0,090	0,105
S	S1-S5	15-25	0,005	0,005	0,010	0,020	0,030	0,050	0,055	0,060	0,065	0,070	0,080	0,095
	S6-S8	40-60	0,005	0,005	0,015	0,020	0,035	0,050	0,055	0,060	0,065	0,070	0,080	0,095

Example of order

M9-444XA0-0120
X-MILL R440N 12x11x12x26x38x83 R0,5 VHM AT

R - for tools with corner radius

Another tool dimensions available on request

For machining steel, stainless steel and cast iron with hardness up to 35 HRC

X-MILL

440NL	440NL	R440NL	R440NL

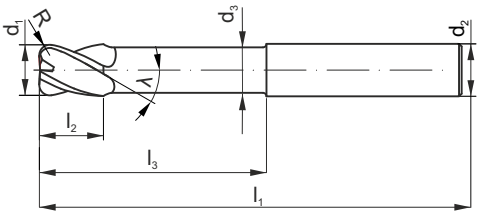
Z=4

l
35°-39°

Version without corner radius is protected by corner chamfer:
for Ø < 6mm f_1 = 0,1x45°
for Ø ≥ 6mm f_1 = 0,2x45°

VHM

AT






Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	AT	AT	AT	AT
Corner type				

d_1	d_2h6	d_3	l_1	l_2	l_3	Z	R	INDEX			
3	6	2,7	57	7	17	4	0,3	M9-444XG0-0030	M9-444XG0-0030-B	M9-444XGD-0030	M9-444XGD-0030-B
4	6	3,7	63	8	22	4	0,3	M9-444XG0-0040	M9-444XG0-0040-B	M9-444XGD-0040	M9-444XGD-0040-B
5	6	4,7	67	10	27	4	0,3	M9-444XG0-0050	M9-444XG0-0050-B	M9-444XGD-0050	M9-444XGD-0050-B
6	6	5,5	74	10	32	4	0,5	M9-444XG0-0060	M9-444XG0-0060-B	M9-444XG1-0060	M9-444XG1-0060-B
6	6	5,5	74	10	32	4	1,0	-	-	M9-444XG3-0060	M9-444XG3-0060-B
8	8	7,5	90	12	46	4	0,5	M9-444XG0-0080	M9-444XG0-0080-B	M9-444XG1-0080	M9-444XG1-0080-B
8	8	7,5	90	12	46	4	1,0	-	-	M9-444XG3-0080	M9-444XG3-0080-B
10	10	9,2	102	14	55	4	0,5	M9-444XG0-0100	M9-444XG0-0100-B	M9-444XG1-0100	M9-444XG1-0100-B
10	10	9,2	102	14	55	4	1,0	-	-	M9-444XG3-0100	M9-444XG3-0100-B
10	10	9,2	102	14	55	4	2,5	-	-	M9-444XG6-0100	M9-444XG6-0100-B
12	12	11	117	16	64	4	0,5	M9-444XG0-0120	M9-444XG0-0120-B	M9-444XG1-0120	M9-444XG1-0120-B
12	12	11	117	16	64	4	1,0	-	-	M9-444XG3-0120	M9-444XG3-0120-B
16	16	15	141	22	87	4	0,5	M9-444XG0-0160	M9-444XG0-0160-B	M9-444XG1-0160	M9-444XG1-0160-B
16	16	15	141	22	87	4	1,0	-	-	M9-444XG3-0160	M9-444XG3-0160-B
16	16	15	141	22	87	4	2,0	-	-	M9-444XG5-0160	M9-444XG5-0160-B
20	20	19	164	26	110	4	1,0	M9-444XG0-0200	M9-444XG0-0200-B	M9-444XG3-0200	M9-444XG3-0200-B

ISO		Vc [m/min]	d_1 [mm]									
			3	4	5	6	8	10	12	14	16	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P7	130-160	0,005	0,010	0,015	0,020	0,030	0,045	0,055	0,060	0,065	0,080
	P8-P13	60-110	0,005	0,010	0,010	0,015	0,025	0,040	0,045	0,050	0,055	0,065
	P14	90-140	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,055
M	M1	90-140	0,005	0,005	0,010	0,015	0,020	0,035	0,040	0,045	0,045	0,055
	M2	60-90	0,005	0,010	0,010	0,015	0,025	0,040	0,045	0,050	0,055	0,065
	M3	60-80	0,005	0,005	0,010	0,015	0,025	0,035	0,040	0,045	0,045	0,055
K	K1-K6	90-130	0,005	0,010	0,020	0,025	0,030	0,040	0,045	0,050	0,055	0,065
N	N1-N5	240-280	0,035	0,040	0,050	0,050	0,055	0,065	0,075	0,080	0,085	0,095
	N7-N10	260-300	0,030	0,035	0,045	0,050	0,055	0,060	0,070	0,075	0,080	0,090
S	S1-S5	15-25	0,005	0,010	0,015	0,020	0,030	0,050	0,055	0,060	0,065	0,080
	S6-S8	40-60	0,005	0,010	0,015	0,020	0,035	0,050	0,055	0,060	0,650	0,075

Example of order

M9-444XGD-0030
X-MILL 440NL 3x2,7x6x7x17x57 R0,3 VHM AT

R - for tools with corner radius

Another tool dimensions available on request

For machining steel and cast iron with hardness up to 35 HRC

X-MILL

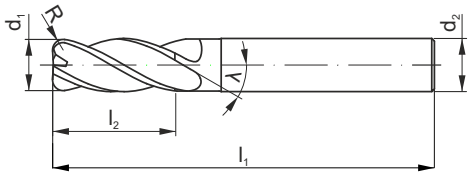
	430L	430L	R430L
			
Workpiece material	P M K N S H	P M K N S H	P M K N S H
Shank			
Tool material	VHM	VHM	VHM
Coating	AT	AT	AT
Corner type			

Z=4

I
30°

VHM

AT



d_1	d_2h6	l_1	l_2	Z	R	INDEX		
2	4	50	15	4	-	M9-434X20-0020	-	-
3	4	50	20	4	0,3	M9-434X20-0030	-	M9-434X2D-0050
4	4	75	25	4	0,3	M9-434X20-0040	-	M9-434X2D-0060
5	6	75	30	4	0,3	M9-434X20-0050	M9-434X20-0050-B	M9-434X2D-0050
6	6	75	30	4	0,5	M9-434X20-0060	M9-434X20-0060-B	M9-434X21-0060
8	8	100	40	4	0,5	M9-434X20-0080	M9-434X20-0080-B	M9-434X21-0080
10	10	100	40	4	0,5	M9-434X20-0100	M9-434X20-0100-B	M9-434X21-0100
12	12	100	45	4	0,7	M9-434X20-0120	M9-434X20-0120-B	M9-434X22-0120
16	16	150	60	4	1,0	M9-434X20-0160	M9-434X20-0160-B	M9-434X23-0160
20	20	150	60	4	1,0	M9-434X20-0200	M9-434X20-0200-B	M9-434X23-0200

ISO		Vc [m/min]	d_1 [mm]									
			2	3	4	5	6	8	10	12	16	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P5	50-65	0,010	0,015	0,020	0,030	0,040	0,060	0,075	0,085	0,100	0,110
	P6-P12	40-50	0,005	0,010	0,010	0,100	0,010	0,015	0,020	0,020	0,025	0,030
K	K1-K4	60-80	0,005	0,010	0,010	0,015	0,030	0,030	0,040	0,050	0,055	0,060
	K5-K6	50-70	0,005	0,010	0,010	0,015	0,030	0,030	0,040	0,050	0,055	0,060
N	N7-N9	90-140	0,015	0,025	0,030	0,030	0,035	0,040	0,050	0,060	0,075	0,090

Example of order

M9-434X20-0020
X-MILL 440L 3x4x15x50 VHM AT

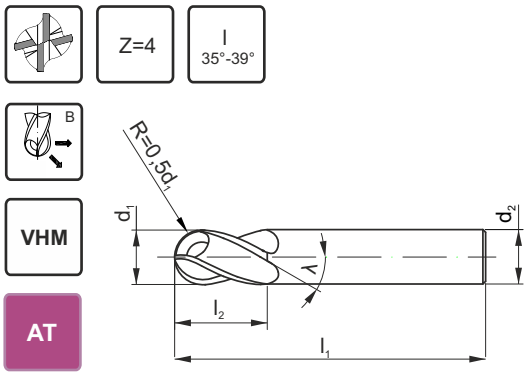
R - for tools with corner radius

Another tool dimensions available on request

For machining steel, stainless steel and cast iron with hardness up to 35 HRC

X-MILL

B440



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	AT
Corner type	

d_1	d_2h6	l_1	l_2	Z	R	INDEX
3	6	54	7	4	1,5	M9-444X1X-0030
4	6	54	8	4	2,0	M9-444X1X-0040
5	6	54	10	4	2,5	M9-444X1X-0050
6	6	54	10	4	3,0	M9-444X1X-0060
8	8	58	12	4	4,0	M9-444X1X-0080
10	10	66	14	4	5,0	M9-444X1X-0100
12	12	73	16	4	6,0	M9-444X1X-0120
14	14	75	18	4	7,0	M9-444X1X-0140
16	16	82	22	4	8,0	M9-444X1X-0160
18	18	84	24	4	9,0	M9-444X1X-0180
20	20	92	26	4	10,0	M9-444X1X-0200

ISO		Vc [m/min]	d_1 [mm]										
			3	4	5	6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P13	80-130	0,025	0,025	0,030	0,040	0,060	0,060	0,070	0,075	0,080	0,085	0,090
	P14	60-70	0,015	0,015	0,025	0,030	0,040	0,045	0,050	0,055	0,060	0,065	0,070
M	M1-M2	80-110	0,020	0,020	0,025	0,040	0,045	0,050	0,055	0,060	0,065	0,070	0,075
K	K1-K6	80-130	0,025	0,025	0,030	0,040	0,060	0,060	0,070	0,075	0,080	0,085	0,090
N	N1-N5	240-280	0,035	0,040	0,050	0,050	0,055	0,065	0,075	0,080	0,085	0,090	0,095
	N7-N10	260-300	0,030	0,035	0,045	0,050	0,055	0,060	0,070	0,075	0,080	0,085	0,090
S	S1-S5	20-30	0,010	0,010	0,010	0,015	0,025	0,025	0,040	0,045	0,050	0,055	0,060
	S6-S8	40-55	0,010	0,010	0,015	0,020	0,030	0,030	0,040	0,045	0,050	0,060	0,065

Example of order

M9-444X1X-0030
X-MILL B440 3x6x7x54 VHM AT

Another tool dimensions available on request

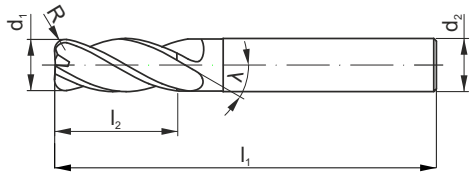
For machining steel, stainless steel and cast iron with hardness up to 35 HRC

X-MILL

540	540	R540	R540

VHM

AT



Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	AT	AT	AT	AT
Corner type				

d_1	d_2h6	l_1	l_2	Z	R	INDEX			
6	6	57	13	5	0,5	M9-544X00-0060	M9-544X00-0060-B	M9-544X01-0060	M9-544X01-0060-B
8	8	63	19	5	0,5	M9-544X00-0080	M9-544X00-0080-B	M9-544X01-0080	M9-544X01-0080-B
8	8	63	19	5	1,0	-	-	M9-544X03-0080	M9-544X03-0080-B
8	8	63	19	5	1,5	-	-	M9-544X04-0080	M9-544X04-0080-B
8	8	63	19	5	2,0	-	-	M9-544X05-0080	M9-544X05-0080-B
10	10	72	22	5	0,5	M9-544X00-0100	M9-544X00-0100-B	M9-544X01-0100	M9-544X01-0100-B
10	10	72	22	5	2,5	-	-	M9-544X06-0100	M9-544X06-0100-B
12	12	83	26	5	0,5	M9-544X00-0120	M9-544X00-0120-B	M9-544X01-0120	M9-544X01-0120-B
12	12	83	26	5	0,7	-	-	M9-544X02-0120	M9-544X02-0120-B
12	12	83	26	5	1,0	-	-	M9-544X03-0120	M9-544X03-0120-B
14	14	83	26	5	0,5	M9-544X00-0140	M9-544X00-0140-B	M9-544X01-0140	M9-544X01-0140-B
16	16	92	32	5	0,5	M9-544X00-0160	M9-544X00-0160-B	M9-544X01-0160	M9-544X01-0160-B
16	16	92	32	5	1,0	-	-	M9-544X03-0160	M9-544X03-0160-B
16	16	92	32	5	2,0	-	-	M9-544X05-0160	M9-544X05-0160-B
18	18	92	32	5	1,0	M9-544X00-0180	M9-544X00-0180-B	M9-544X03-0180	M9-544X03-0180-B
20	20	104	38	5	1,0	M9-544X00-0200	M9-544X00-0200-B	M9-544X03-0200	M9-544X03-0200-B

ISO		Vc [m/min]	d_1 [mm]							
			6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P13	130-150	0,035	0,040	0,050	0,065	0,070	0,075	0,080	0,090
	P14	90-100	0,030	0,035	0,040	0,045	0,065	0,070	0,070	0,075
M	M1-M2	90-120	0,030	0,035	0,040	0,045	0,065	0,070	0,070	0,075
K	K1-K6	110-140	0,035	0,040	0,050	0,065	0,070	0,075	0,075	0,090
N	N1-N5	240-280	0,050	0,055	0,065	0,075	0,080	0,085	0,085	0,095
	N7-N10	260-300	0,050	0,055	0,060	0,070	0,075	0,080	0,085	0,090
S	S1-S5	20-30	0,015	0,020	0,025	0,035	0,045	0,050	0,050	0,060
	S6-S8	40-65	0,030	0,035	0,040	0,050	0,055	0,065	0,065	0,075

Example of order

M9-544X00-0060
X-MILL 540 6x6x13x57 VHM AT

R - for tools with corner radius

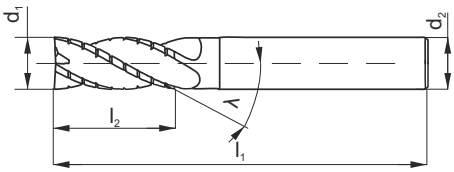
Another tool dimensions available on request

For roughing steel, cast iron, difficult to machine materials and non-ferrous materials

ZGR

	420	420
		
Workpiece material	P M K N S H	P M K N S H
Shank		
Tool material	VHM	VHM
Coating	AT	AT
Corner type		

Typ HR | Z=3-4 | l 20° | VHM | AT



d_1	d_2h6	l_1	l_2	Z	INDEX	
6	6	57	16	3	M9-424A00-0060	M9-424A00-0060-B
7	8	63	16	3	M9-424A00-0070	M9-424A00-0070-B
8	8	63	16	3	M9-424A00-0080	M9-424A00-0080-B
9	10	72	19	4	M9-424A00-0090	M9-424A00-0090-B
10	10	72	22	4	M9-424A00-0100	M9-424A00-0100-B
12	12	83	26	4	M9-424A00-0120	M9-424A00-0120-B
14	14	83	26	4	M9-424A00-0140	M9-424A00-0140-B
16	16	92	32	4	M9-424A00-0160	M9-424A00-0160-B
18	18	92	32	4	M9-424A00-0180	M9-424A00-0180-B
20	20	104	38	4	M9-424A00-0200	M9-424A00-0200-B

ISO		Vc [m/min]	d_1 [mm]							
			6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P2	100-140	0,030	0,035	0,035	0,045	0,050	0,055	0,060	0,070
	P9-P11	100-120	0,025	0,030	0,030	0,035	0,040	0,045	0,045	0,050
	P13-P14	50-65	0,015	0,020	0,020	0,025	0,030	0,035	0,035	0,040
M	M1-M2	40-60	0,015	0,020	0,020	0,025	0,030	0,035	0,035	0,040
K	K1-K2	110-160	0,030	0,035	0,045	0,050	0,055	0,056	0,060	0,070
	K3-K6	80-110	0,020	0,020	0,035	0,035	0,040	0,040	0,045	0,050
H	H1,H2,H4	50-90	0,020	0,020	0,035	0,030	0,035	0,035	0,040	0,040

Example of order

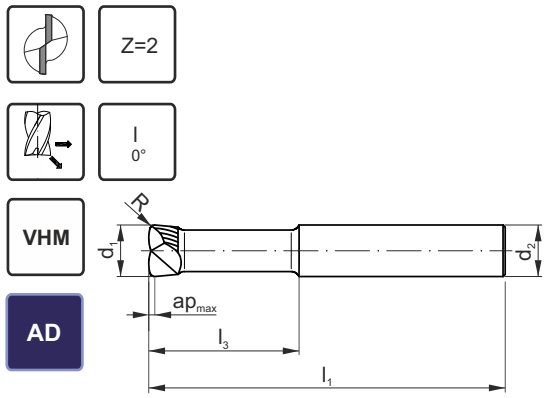
M9-424A00-0060
ZGR 420 6x6x16x57 VHM AT

HRC

For high feed machining materials with hardness up to 55 HRC

HRC

HFM 200



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	AD
Corner type	

d_1	d_2h6	l_1	ap_{max}	l_3	Z	R	INDEX
6	6	57	0,30	20	2	0,6	M9-20E9A0-0060
8	8	63	0,35	20	2	0,8	M9-20E9A0-0080
10	10	72	0,40	30	2	1,0	M9-20E9A0-0100
12	12	83	0,70	35	2	1,2	M9-20E9A0-0120
16	16	92	0,80	50	2	1,6	M9-20E9A0-0160

ISO		Vc [m/min]	a_e[mm]	d_1 [mm]				
				6	8	10	12	16
				fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
P	P1-P5	300-350	0,4 - 0,6xD	0,4	0,5	0,6	0,8	1,2
	P6-P14	200-250	0,4 - 0,6xD	0,3	0,4	0,5	0,6	1,0
K	K1-K3	400-450	0,4 - 0,6xD	0,4	0,5	0,6	0,8	1,2
	K4-K6	300-350	0,4 - 0,6xD	0,3	0,4	0,5	0,6	1,0
H	H1,H2,H4	70-120	0,2 - 0,4xD	0,3	0,4	0,5	0,6	1,0

H - group materials may only be machined dry. For more information see chapter 3.4. in Technical Information.

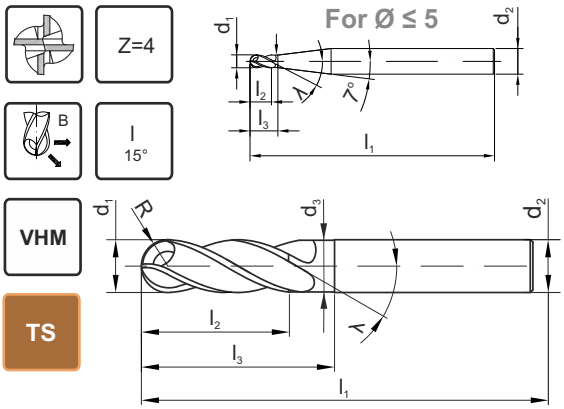
Example of order

M9-20E9A0-0060
HRC HFM 200 6x6x20x57 R0,6 VHM AD

For hardened materials

HRC

B415N



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	TS
Corner type	

d_1	d_2h6	d_3	l_1	l_2	l_3	Z	R	INDEX
3	6	2,9	57	7	21	4	1,5	M9-41G9AX-0030
4	6	3,9	57	8	21	4	2,0	M9-41G9AX-0040
5	6	4,9	57	10	21	4	2,5	M9-41G9AX-0050
6	6	5,9	57	10	21	4	3,0	M9-41G9AX-0060
8	8	7,8	63	12	23	4	4,0	M9-41G9AX-0080
10	10	9,8	72	14	27	4	5,0	M9-41G9AX-0100
12	12	11,8	75	16	30	4	6,0	M9-41G9AX-0120
16	16	15,8	92	22	44	4	8,0	M9-41G9AX-0160

ISO		Vc [m/min]	d_1 [mm]							
			3	4	5	6	8	10	12	16
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
H	H1	180-220	0,040	0,055	0,070	0,085	0,100	0,120	0,160	0,220
	H2, H4	140-180	0,030	0,035	0,055	0,065	0,080	0,100	0,150	0,175
	H3	115-160	0,025	0,035	0,045	0,055	0,065	0,085	0,100	0,150

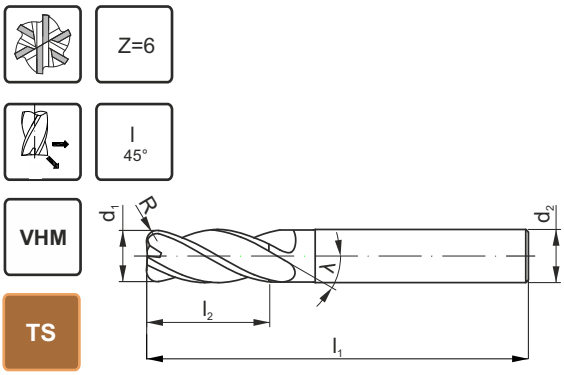
H - group materials may only be machined dry. For more information see chapter 3.4. in Technical Information.

Example of order

M9-41G9AX-0030
HRC B415N 3x2,9x6x7x21x57 VHM TS

Another tool dimensions available on request

For hardened materials	HRC R645



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	TS
Corner type	

d_1	d_2h6	l_1	l_2	Z	R	INDEX
6	6	57	13	6	0,5	M9-64G901-0060
8	8	63	19	6	0,5	M9-64G901-0080
10	10	72	22	6	1,0	M9-64G903-0100
12	12	75	26	6	1,0	M9-64G903-0120
16	16	92	32	6	1,5	M9-64G904-0160

ISO		Vc [m/min]	d_1 [mm]				
			6	8	10	12	16
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
H	H1	80-140	0,035	0,050	0,060	0,070	0,085
	H2-H4	50-80	0,025	0,035	0,045	0,050	0,065

H - group materials may only be machined dry. For more information see chapter 3.4. in Technical Information.

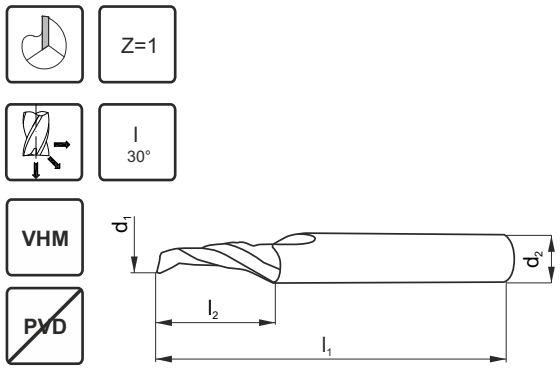
Example of order

M9-464G901-0060
HRC R645 6x6x13x57 R0,5 VHM TS

Another tool dimensions available on request

AL

For machining aluminium alloys and other non-ferrous materials	AL 130



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	-
Corner type	

d_1	d_2h_6	l_1	l_2	Z	INDEX
3	6	57	12	1	M9-131700-0030
4	6	57	12	1	M9-131700-0040
5	6	57	14	1	M9-131700-0050
6	6	57	16	1	M9-131700-0060
8	8	63	20	1	M9-131700-0080
10	10	72	22	1	M9-131700-0100

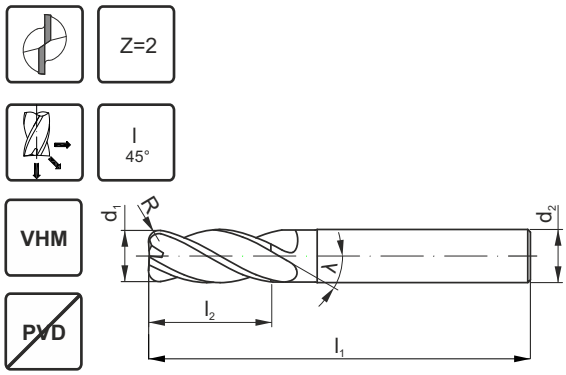
ISO		Vc [m/min]	d_1 [mm]					
			3	4	5	6	8	10
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N2	250-400	0,010	0,015	0,020	0,025	0,030	0,035
	N3-N5	290-440	0,010	0,015	0,020	0,025	0,030	0,035
	N7-N9	210-360	0,005	0,010	0,015	0,020	0,025	0,030

Example of order

M9-131700-0030
AL 130 3x6x12x57 VHM

Another tool dimensions available on request

For machining aluminium alloys and other non-ferrous materials	AL			
	245	245	R245	R245
				
Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	-	-	-	-
Corner type				



d_1	d_2	l_1	l_2	Z	R	INDEX			
3	3	39	12	2	0,3	M9-241700-0030	-	M9-24170D-0030	-
4	4	51	12	2	0,3	M9-241700-0040	-	M9-24170D-0040	-
5	5	51	14	2	0,3	M9-241700-0050	-	M9-24170D-0050	-
6	6	57	16	2	0,5	M9-241700-0060	M9-241700-0060-B	M9-241701-0060	M9-241701-0060-B
6	6	57	16	2	1	-	-	M9-241703-0060	M9-241703-0060-B
8	8	63	20	2	0,5	M9-241700-0080	M9-241700-0080-B	M9-241701-0080	M9-241701-0080-B
8	8	63	20	2	1	-	-	M9-241703-0080	M9-241703-0080-B
10	10	72	22	2	0,5	M9-241700-0100	M9-241700-0100-B	M9-241701-0100	M9-241701-0100-B
12	12	83	32	2	0,5	M9-241700-0120	M9-241700-0120-B	M9-241701-0120	M9-241701-0120-B
14	14	83	32	2	0,5	M9-241700-0140	M9-241700-0140-B	M9-241701-0140	M9-241701-0140-B
16	16	92	36	2	0,5	M9-241700-0160	M9-241700-0160-B	M9-241701-0160	M9-241701-0160-B
18	18	92	45	2	1	M9-241700-0180	M9-241700-0180-B	M9-241703-0180	M9-241703-0180-B
20	20	104	50	2	1	M9-241700-0200	M9-241700-0200-B	M9-241703-0200	M9-241703-0200-B

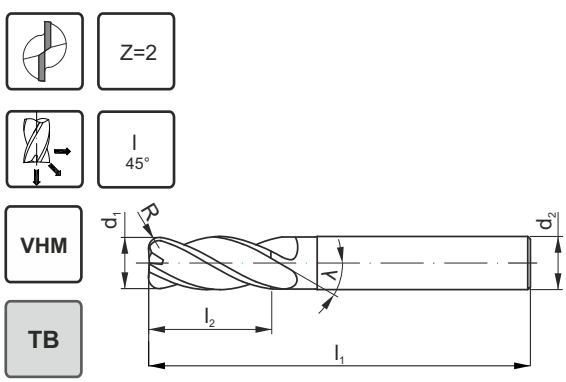
ISO		Vc [m/min]	d_1 [mm]										
			3	4	5	6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N2	180-270	0,035	0,045	0,050	0,060	0,090	0,110	0,135	0,145	0,155	0,180	0,200
	N3-N4	380-480	0,045	0,055	0,065	0,080	0,150	0,160	0,170	0,200	0,230	0,250	0,270
	N7-N9	180-270	0,010	0,015	0,020	0,025	0,030	0,035	0,050	0,050	0,055	0,090	0,100

Example of order

M9-241700-0030
AL 245 3x3x12x39 R0,3 VHM

R - for tools with corner radius

Another tool dimensions available on request

For machining aluminium alloys and other non-ferrous materials	AL			
	245	245	R245	R245
				
Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	TB	TB	TB	TB
Corner type				

d_1	d_2	l_1	l_2	Z	R	INDEX			
3	3	39	12	2	0,3	M9-24B700-0030	-	M9-24B70D-0030	-
4	4	51	12	2	0,3	M9-24B700-0040	-	M9-24B70D-0040	-
5	5	51	14	2	0,3	M9-24B700-0050	-	M9-24B70D-0050	-
6	6	57	16	2	0,5	M9-24B700-0060	M9-24B700-0060-B	M9-24B701-0060	M9-24B701-0060-B
6	6	57	16	2	1	-	-	M9-24B703-0060	M9-24B703-0060-B
8	8	63	20	2	0,5	M9-24B700-0080	M9-24B700-0080-B	M9-24B701-0080	M9-24B701-0080-B
8	8	63	20	2	1	-	-	M9-24B703-0080	M9-24B703-0080-B
10	10	72	22	2	0,5	M9-24B700-0100	M9-24B700-0100-B	M9-24B701-0100	M9-24B701-0100-B
12	12	83	32	2	0,5	M9-24B700-0120	M9-24B700-0120-B	M9-24B701-0120	M9-24B701-0120-B
14	14	83	32	2	0,5	M9-24B700-0140	M9-24B700-0140-B	M9-24B701-0140	M9-24B701-0140-B
16	16	92	36	2	0,5	M9-24B700-0160	M9-24B700-0160-B	M9-24B701-0160	M9-24B701-0160-B
18	18	92	45	2	1	M9-24B700-0180	M9-24B700-0180-B	M9-24B703-0180	M9-24B703-0180-B
20	20	104	50	2	1	M9-24B700-0200	M9-24B700-0200-B	M9-24B703-0200	M9-24B703-0200-B

ISO		Vc [m/min]	d_1 [mm]										
			3	4	5	6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N2	180-270	0,035	0,045	0,050	0,060	0,090	0,110	0,135	0,145	0,155	0,180	0,200
	N3-N4	380-480	0,045	0,055	0,065	0,080	0,150	0,160	0,170	0,200	0,230	0,250	0,270
	N7-N9	180-270	0,010	0,015	0,020	0,025	0,030	0,035	0,050	0,050	0,055	0,090	0,100

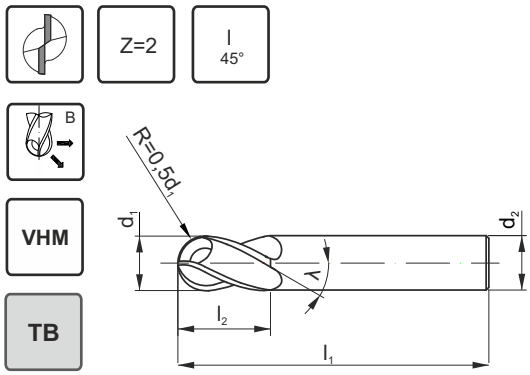
Example of order

M9-24B700-0030
AL 245 3x3x12x39 R0,3 VHM TB

R - for tools with corner radius

Another tool dimensions available on request

For machining aluminium alloys and other non-ferrous materials	AL B245



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	TB
Corner type	

d_1	d_2	l_1	l_2	Z	R	INDEX
3	3	39	12	2	1,5	M9-24B70X-0030
4	4	51	12	2	2	M9-24B70X-0040
5	5	51	14	2	2,5	M9-24B70X-0050
6	6	57	16	2	3	M9-24B70X-0060
8	8	63	20	2	4	M9-24B70X-0080
10	10	72	22	2	5	M9-24B70X-0100
12	12	83	32	2	6	M9-24B70X-0120
16	16	92	36	2	8	M9-24B70X-0160

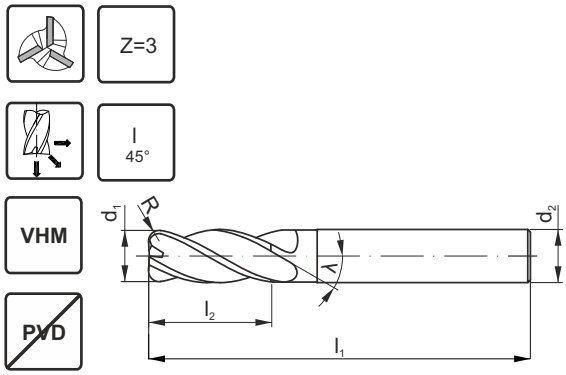
ISO		Vc [m/min]	d_1 [mm]							
			3	4	5	6	8	10	12	16
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N4	230-350	0,030	0,035	0,040	0,050	0,070	0,085	0,110	0,175
	N7-N9	130-170	0,007	0,008	0,010	0,015	0,025	0,030	0,040	0,055

Example of order

M9-24B70X-0030
AL B245 3x3x12x39 VHM TB

Another tool dimensions available on request

For machining aluminium alloys and other non-ferrous materials	AL			
	345	345	R345	R345
				
Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	-	-	-	-
Corner type				



d_1	d_2	l_1	l_2	Z	R	INDEX			
3	3	39	12	3	0,3	M9-341700-0030	-	M9-34170D-0030	-
4	4	51	12	3	0,3	M9-341700-0040	-	M9-34170D-0040	-
5	5	51	14	3	0,3	M9-341700-0050	-	M9-34170D-0050	-
6	6	57	16	3	0,5	M9-341700-0060	M9-341700-0060-B	M9-341701-0060	M9-341701-0060-B
6	6	57	16	3	1	-	-	M9-341703-0060	M9-341703-0060-B
8	8	63	20	3	0,5	M9-341700-0080	M9-341700-0080-B	M9-341701-0080	M9-341701-0080-B
8	8	63	20	3	1	-	-	M9-341703-0080	M9-341703-0080-B
8	8	63	20	3	2	-	-	M9-341705-0080	M9-341705-0080-B
10	10	72	22	3	0,5	M9-341700-0100	M9-341700-0100-B	M9-341701-0100	M9-341701-0100-B
10	10	72	22	3	1	-	-	M9-341703-0100	M9-341703-0100-B
10	10	72	22	3	1,5	-	-	M9-341704-0100	M9-341704-0100-B
10	10	72	22	3	2	-	-	M9-341705-0100	M9-341705-0100-B
10	10	72	22	3	2,5	-	-	M9-341706-0100	M9-341706-0100-B
12	12	83	32	3	0,5	M9-341700-0120	M9-341700-0120-B	M9-341701-0120	M9-341701-0120-B
12	12	83	32	3	1	-	-	M9-341703-0120	M9-341703-0120-B
12	12	83	32	3	1,5	-	-	M9-341704-0120	M9-341704-0120-B
12	12	83	32	3	2	-	-	M9-341705-0120	M9-341705-0120-B
12	12	83	32	3	2,5	-	-	M9-341706-0120	M9-341706-0120-B
12	12	83	32	3	3	-	-	M9-341707-0120	M9-341707-0120-B

ISO		Vc [m/min]	d_1 [mm]										
			3	4	5	6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N4	350-450	0,020	0,030	0,055	0,070	0,085	0,100	0,115	0,135	0,150	0,200	0,220
	N7-N9	160-280	0,020	0,030	0,040	0,550	0,070	0,090	0,095	0,105	0,120	0,140	0,150

Example of order

M9-34170D-0030
AL R345 3x3x12x39 R0,3 VHM

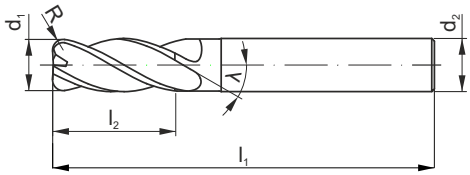
R - for tools with corner radius

Another tool dimensions available on request

For machining aluminium alloys and other non-ferrous materials

AL

345	345	R345	R345



Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	-	-	-	-
Corner type				

d_1	d_2	l_1	l_2	Z	R	INDEX			
14	14	83	32	3	0,5	M9-341700-0140	M9-341700-0140-B	M9-341701-0140	M9-341701-0140-B
14	14	83	32	3	1	-	-	M9-341703-0140	M9-341703-0140-B
16	16	92	36	3	0,5	M9-341700-0160	M9-341700-0160-B	M9-341701-0160	M9-341701-0160-B
16	16	92	36	3	1	-	-	M9-341703-0160	M9-341703-0160-B
16	16	92	36	3	2	-	-	M9-341705-0160	M9-341705-0160-B
16	16	92	36	3	2,5	-	-	M9-341706-0160	M9-341706-0160-B
16	16	92	36	3	3	-	-	M9-341707-0160	M9-341707-0160-B
18	18	92	45	3	1	M9-341700-0180	M9-341700-0180-B	M9-341703-0180	M9-341703-0180-B
20	20	104	50	3	1	M9-341700-0200	M9-341700-0200-B	M9-341703-0200	M9-341703-0200-B
20	20	104	50	3	2	-	-	M9-341705-0200	M9-341705-0200-B
20	20	104	50	3	3	-	-	M9-341707-0200	M9-341707-0200-B
20	20	104	50	3	4	-	-	M9-341708-0200	M9-341708-0200-B

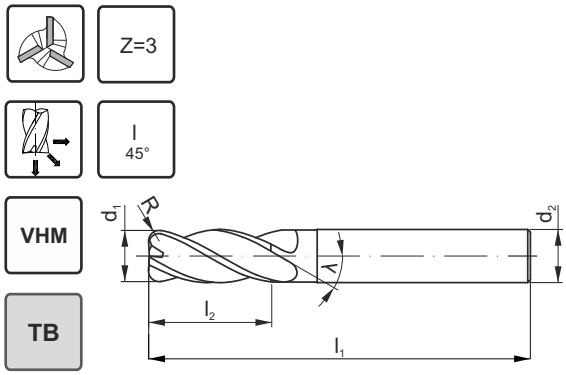
ISO		Vc [m/min]	d_1 [mm]										
			3	4	5	6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N4	350-450	0,020	0,030	0,054	0,069	0,085	0,100	0,115	0,135	0,150	0,200	0,220
	N7-N9	160-280	0,020	0,030	0,040	0,055	0,070	0,090	0,095	0,105	0,120	0,140	0,150

Example of order
M9-341701-0140
AL R345 14x14x32x83 R0,5 VHM

R - for tools with corner radius

Another tool dimensions available on request

For machining aluminium alloys and other non-ferrous materials	AL			
	345	345	R345	R345
				
Workpiece material	P M K N S H	P M K N S H	P M K N S H	P M K N S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	TB	TB	TB	TB
Corner type				



d_1	d_2	l_1	l_2	Z	R	INDEX			
3	3	39	12	3	0,3	M9-34B700-0030	-	M9-34B70D-0030	-
4	4	51	12	3	0,3	M9-34B700-0040	-	M9-34B70D-0040	-
5	5	51	14	3	0,3	M9-34B700-0050	-	M9-34B70D-0050	-
6	6	57	16	3	0,5	M9-34B700-0060	M9-34B700-0060-B	M9-34B701-0060	M9-34B701-0060-B
6	6	57	16	3	1	-	-	M9-34B703-0060	M9-34B703-0060-B
8	8	63	20	3	0,5	M9-34B700-0080	M9-34B700-0080-B	M9-34B701-0080	M9-34B701-0080-B
8	8	63	20	3	1	-	-	M9-34B703-0080	M9-34B703-0080-B
8	8	63	20	3	2	-	-	M9-34B705-0080	M9-34B705-0080-B
10	10	72	22	3	0,5	M9-34B700-0100	M9-34B700-0100-B	M9-34B701-0100	M9-34B701-0100-B
10	10	72	22	3	1	-	-	M9-34B703-0100	M9-34B703-0100-B
10	10	72	22	3	1,5	-	-	M9-34B704-0100	M9-34B704-0100-B
10	10	72	22	3	2	-	-	M9-34B705-0100	M9-34B705-0100-B
10	10	72	22	3	2,5	-	-	M9-34B706-0100	M9-34B706-0100-B
12	12	83	32	3	0,5	M9-34B700-0120	M9-34B700-0120-B	M9-34B701-0120	M9-34B701-0120-B
12	12	83	32	3	1	-	-	M9-34B703-0120	M9-34B703-0120-B
12	12	83	32	3	1,5	-	-	M9-34B704-0120	M9-34B704-0120-B
12	12	83	32	3	2	-	-	M9-34B705-0120	M9-34B705-0120-B
12	12	83	32	3	2,5	-	-	M9-34B706-0120	M9-34B706-0120-B
12	12	83	32	3	3	-	-	M9-34B707-0120	M9-34B707-0120-B

ISO		Vc [m/min]	d_1 [mm]										
			3	4	5	6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N4	350-450	0,020	0,030	0,054	0,069	0,085	0,100	0,115	0,135	0,150	0,200	0,220
	N7-N9	160-280	0,020	0,030	0,040	0,055	0,070	0,090	0,095	0,105	0,120	0,140	0,150

Example of order

M9-34B70D-0030
AL R345 3x3x12x39 R0,3 VHM TB

R - for tools with corner radius

Another tool dimensions available on request

For machining aluminium alloys and other non-ferrous materials

AL

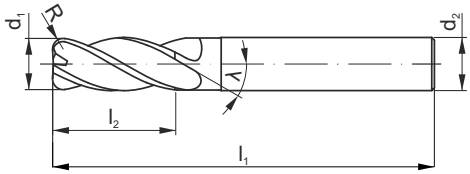
345	345	R345	R345

Z=3

l 45°

VHM

TB



Workpiece material	P M K **N** S H	P M K **N** S H	P M K **N** S H	P M K **N** S H
Shank				
Tool material	VHM	VHM	VHM	VHM
Coating	TB	TB	TB	TB
Corner type				

d_1	d_2	l_1	l_2	Z	R	INDEX			
14	14	83	32	3	0,5	M9-34B700-0140	M9-34B700-0140-B	M9-34B701-0140	M9-34B701-0140-B
14	14	83	32	3	1	-	-	M9-34B703-0140	M9-34B703-0140-B
16	16	92	36	3	0,5	M9-34B700-0160	M9-34B700-0160-B	M9-34B701-0160	M9-34B701-0160-B
16	16	92	36	3	1	-	-	M9-34B703-0160	M9-34B703-0160-B
16	16	92	36	3	2	-	-	M9-34B705-0160	M9-34B705-0160-B
16	16	92	36	3	2,5	-	-	M9-34B706-0160	M9-34B706-0160-B
16	16	92	36	3	3	-	-	M9-34B707-0160	M9-34B707-0160-B
18	18	92	45	3	1	M9-34B700-0180	M9-34B700-0180-B	M9-34B703-0180	M9-34B703-0180-B
20	20	104	50	3	1	M9-34B700-0200	M9-34B700-0200-B	M9-34B703-0200	M9-34B703-0200-B
20	20	104	50	3	2	-	-	M9-34B705-0200	M9-34B705-0200-B
20	20	104	50	3	3	-	-	M9-34B707-0200	M9-34B707-0200-B
20	20	104	50	3	4	-	-	M9-34B708-0200	M9-34B708-0200-B

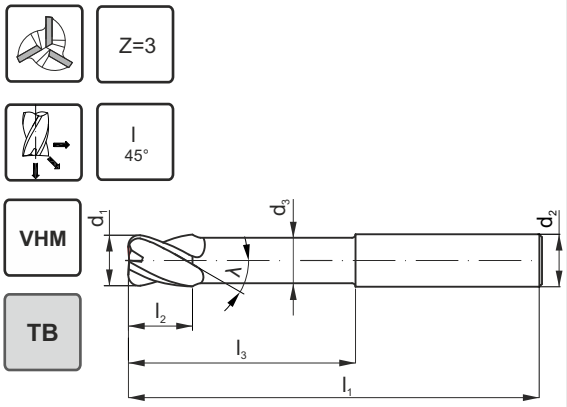
ISO		Vc [m/min]	d_1 [mm]										
			3	4	5	6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N4	350-450	0,020	0,030	0,054	0,069	0,085	0,100	0,115	0,135	0,150	0,200	0,220
	N7-N9	160-280	0,020	0,030	0,040	0,055	0,070	0,090	0,095	0,105	0,120	0,140	0,150

Example of order
M9-34B701-0140
AL R345 14x14x32x83 R0,5 VHM TB

R - for tools with corner radius

Another tool dimensions available on request

For machining aluminium alloys and other non-ferrous materials	AL 345NL



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	TB
Corner type	

d_1	d_2h6	Ćd_3	l_1	l_2	l_3	Z	INDEX
3	6	2,7	57	7	17	3	M9-34B7A0-0030
4	6	3,7	63	8	22	3	M9-34B7A0-0040
5	6	4,7	67	10	27	3	M9-34B7A0-0050
6	6	5,5	74	10	32	3	M9-34B7A0-0060
8	8	7,5	90	12	46	3	M9-34B7A0-0080
10	10	9,2	102	14	55	3	M9-34B7A0-0100
12	12	11	117	16	64	3	M9-34B7A0-0120
16	16	15	141	22	87	3	M9-34B7A0-0160

ISO		Vc [m/min]	d_1 [mm]										
			3	4	5	6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N4	150-250	0,020	0,030	0,055	0,070	0,085	0,100	0,115	0,135	0,150	0,200	0,220
	N7-N9	100-200	0,020	0,030	0,040	0,550	0,070	0,090	0,100	0,105	0,120	0,140	0,150

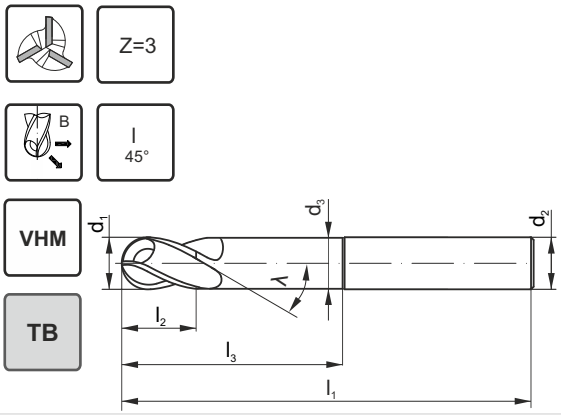
Example of order

M9-34B7A0-0030
AL 345NL 3x2,7x6x7x17x57 VHM TB

Corner radius and another tool dimensions available on request

SOLID CARBIDE END MILLS WITH BALL NOSE AL B345NL

For machining aluminium alloys and other non-ferrous materials	AL B345NL



Workpiece material	P M K N S H
Shank	
Tool material	VHM
Coating	TB
Corner type	

d_1	d_2h6	Ćd_3	l_1	l_2	l_3	Z	R	INDEX
3	6	2,7	57	7	17	3	1,5	M9-34B7AX-0030
4	6	3,7	63	8	22	3	2	M9-34B7AX-0040
5	6	4,7	67	10	27	3	2,5	M9-34B7AX-0050
6	6	5,5	74	10	32	3	3	M9-34B7AX-0060
8	8	7,5	90	12	46	3	4	M9-34B7AX-0080
10	10	9,2	102	14	55	3	5	M9-34B7AX-0100
12	12	11	117	16	64	3	6	M9-34B7AX-0120
16	16	15	141	22	87	3	8	M9-34B7AX-0160

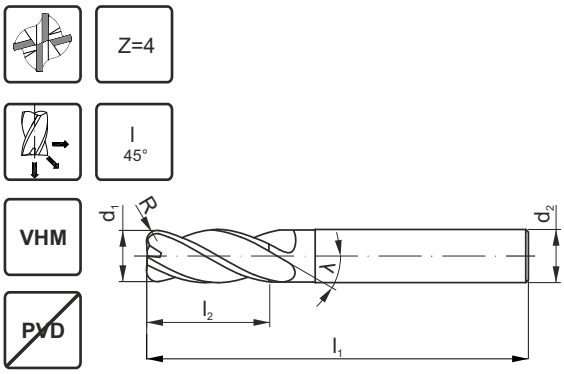
ISO		Vc [m/min]	d_1 [mm]								
			3	4	5	6	8	10	12	14	16
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N4	150-250	0,020	0,030	0,055	0,070	0,085	0,100	0,115	0,135	0,150
	N7-N9	100-200	0,020	0,030	0,040	0,550	0,070	0,090	0,100	0,105	0,120

Example of order

M9-34B7AX-0030
AL B345NL 3x2,7x6x7x17x57 VHM TB

Another tool dimensions available on request

For machining aluminium alloys and other non-ferrous materials	AL	
	445	445
		
Workpiece material	P M K N S H	P M K N S H
Shank		
Tool material	VHM	VHM
Coating	-	-
Corner type		



d_1	d_2	l_1	l_2	Z	INDEX	
3	3	39	12	4	M9-441700-0030	-
4	4	51	12	4	M9-441700-0040	-
5	5	51	15	4	M9-441700-0050	-
6	6	57	18	4	M9-441700-0060	M9-441700-0060-B
8	8	63	24	4	M9-441700-0080	M9-441700-0080-B
10	10	72	30	4	M9-441700-0100	M9-441700-0100-B
12	12	83	36	4	M9-441700-0120	M9-441700-0120-B
14	14	83	42	4	M9-441700-0140	M9-441700-0140-B
16	16	92	48	4	M9-441700-0160	M9-441700-0160-B
18	18	92	54	4	M9-441700-0180	M9-441700-0180-B
20	20	104	60	4	M9-441700-0200	M9-441700-0200-B

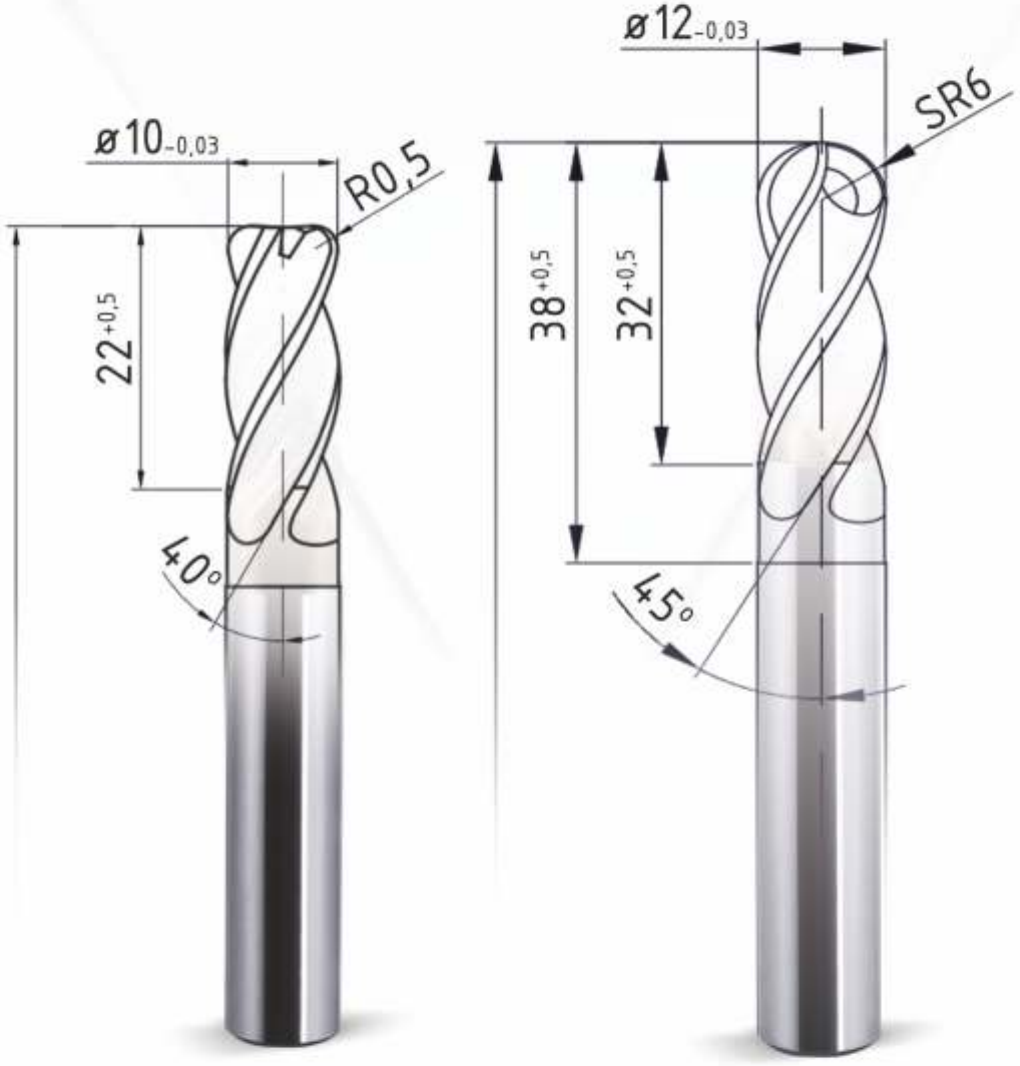
ISO		Vc [m/min]	d_1 [mm]										
			3	4	5	6	8	10	12	14	16	18	20
			fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]	fz [mm]
N	N1-N4	270-400	0,025	0,035	0,045	0,055	0,060	0,065	0,070	0,075	0,080	0,090	0,110
	N7-N9	130-250	0,020	0,030	0,035	0,040	0,045	0,050	0,055	0,060	0,075	0,085	0,090

Example of order

M9-441700-0030
AL 445 3x3x12X39 VHM

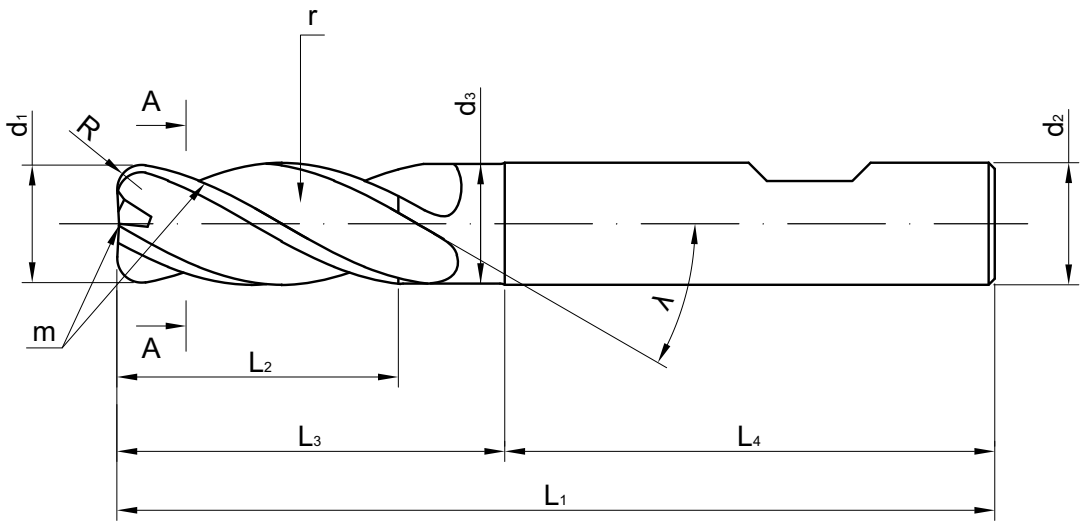
Another tool dimensions available on request

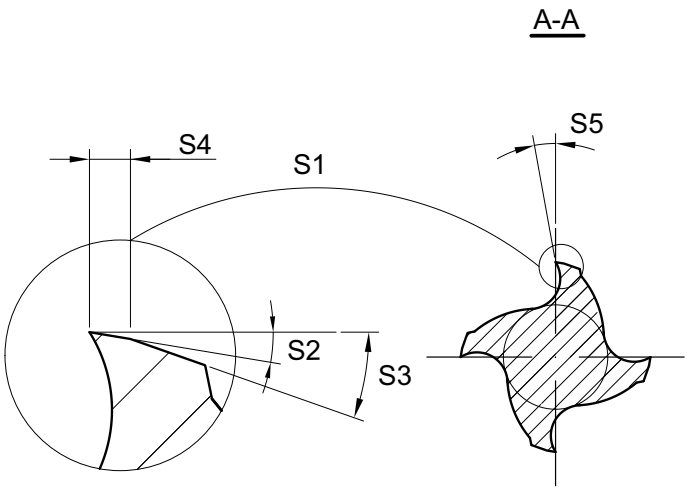
Technical Information



1. End mills

1.1. End mill construction elements





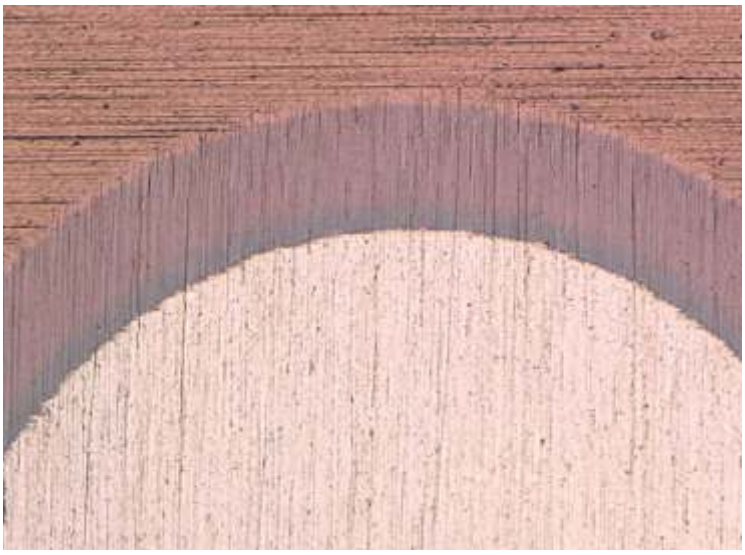
L1 - overall length
L2 - length of cut
L3 - reach length
L4 - shank length
d1 - working part diameter
d2 - shank diameter
d3 - neck diameter
r - chip flute

λ - helix angle
R - corner radius
S1 - relief
S2 - I relief angle
S3 - II relief angle
S4 - width of I relief
S5 - rake angle
m - cutting edges

1.2. PVD coatings

TS COATING

Coating	TiAlN + TiAlSiN
Structure	Nanocomposite
Hardness	3800 $HV_{0,05}$
Max. working temp	1100°C
Coefficient of friction	0,15
Color of coating	coppery 



Due to silicon content in TiAlN coating, TS has multilayer nanocomposie structure. TS is being produced in the newest HiPIMS technology which ensures mechanical properties unreachable for other methods. Coatings produced in HiPIMS technology are characterized by the highest cracking resistant. Composition and coating technology causes that new TS coating works very well both in traditional materials from P, K ISO groups and in difficult to machine M, S groups.

TB COATING

Coating	TiB_2
Structure	Monolayer
Hardness	4000 $HV_{0,05}$
Max. working temp	900°C
Color of coating	Silver 

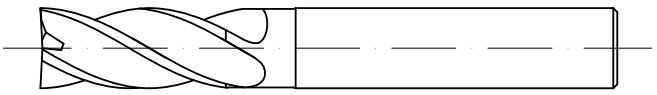
The material of coating, the TiB_2 (titanium diboride), is a ceramic material with outstanding properties with regard to its hardness and resistance to abrasion. With its carefully prepared composition (no affinity with aluminum), the material provides high chemical stability and prevents the processed material buildup on cutting edges. The dropless method of manufacturing the coating allows to obtain a very smooth finish, which in turn translates into a very good quality the workpieces' surfaces. The coating is designed for processing materials form the Group N, mainly aluminum alloys (Si<12%) and unalloyed titanium.

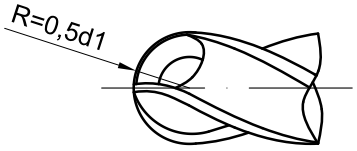
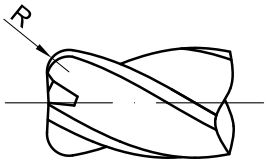
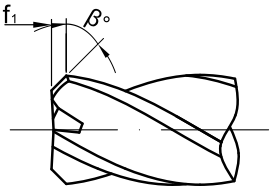
AT COATING

Coating	AlTiN
Structure	Gradient
Hardness	3700 $HV_{0,05}$
Max. working temp	900°C
Coefficient of friction	0,3
Color of coating	Purplish-Grey 

The AT Coating, with the increased Aluminum (Al) content, features high hardness and temperature resistance. The released from the coating, during processing, aluminum oxides serve as additional lubrication of a tool, and at the same they create a thermal barrier, preventing the coating from being worn out, even in the most extreme conditions. Chemical composition and the nanogradient structure ensure high hardness of the coating. As a result, the high resistance to abrasion is achieved, which directly translates into the tool's longer life. The coating may be used for tools exposed to high temperatures, and is suitable for work both, with coolant and without it. The coating is designed for process ing materials from the Groups P, M, K, N, S.

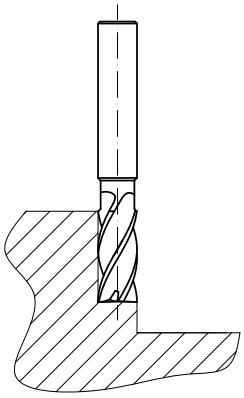
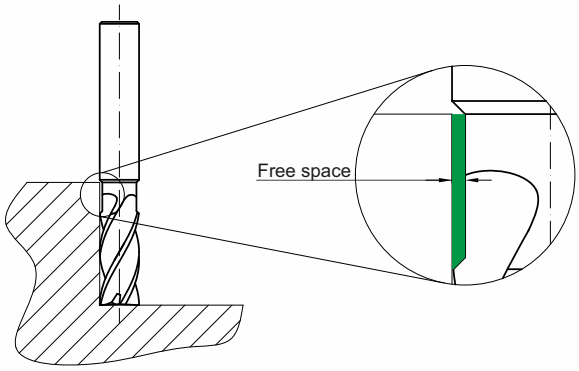
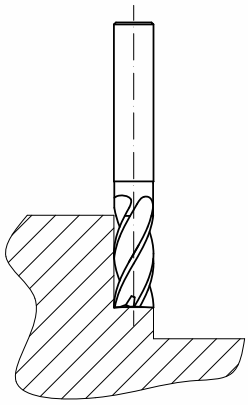
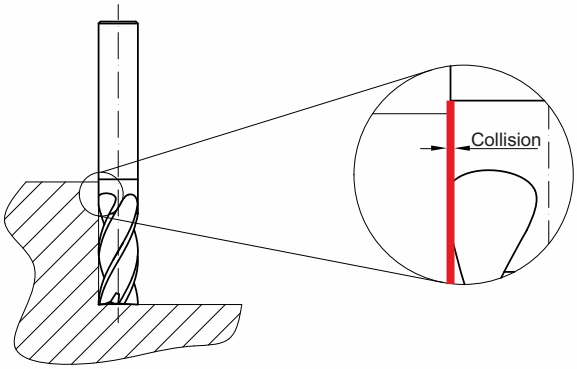
1.3. Corner variants

Sharp corner


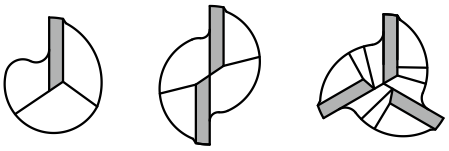
Ball nose	Corner radius	Corner chamfer
		

1.4. Neck

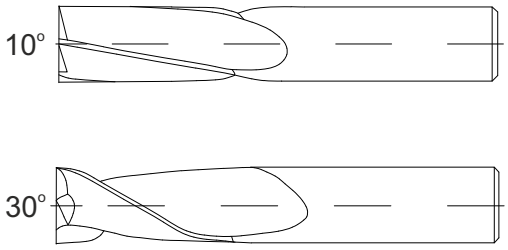
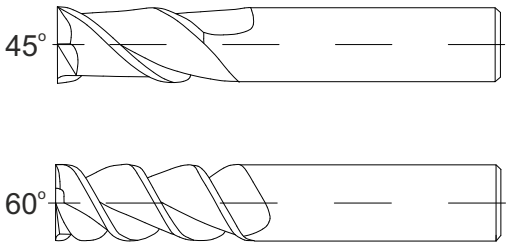
Neck of milling cutter is designed for extension working part of a tool. The table below shows a difference between end mills with and without neck.

	1st pass	2nd pass
With neck		
Without neck		

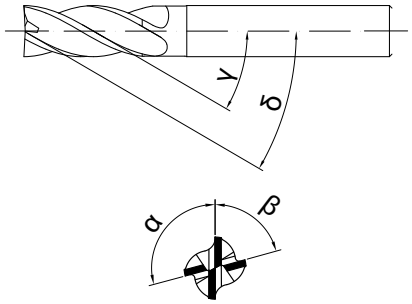
1.5. Flutes number

Low number of flutes		• Bigger capacity of flutes • Possibility of working with a larger width ae • Easier chip evacuation
More flutes		• Larger core • Greater rigidity of the tool • Better surface quality • Higher feed values

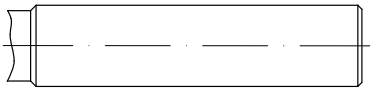
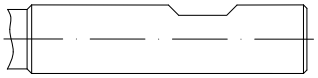
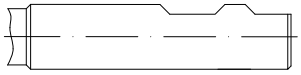
1.6. Helix angle

Smaller helix angle		• Lower risk of pulling out of the holder • Higher risk of vibrations
Bigger helix angle		• More teeth in workpiece in the same time • Longer cutting edges • Less vibration • Better surface quality

1.7. Variable helix angle and pitch

Unequal helix angle and pitch		• Cause that intervals between peaks of cutting forces are irregular • Reduce vibrations • Increase tool life • Allow to work with high cutting speeds.

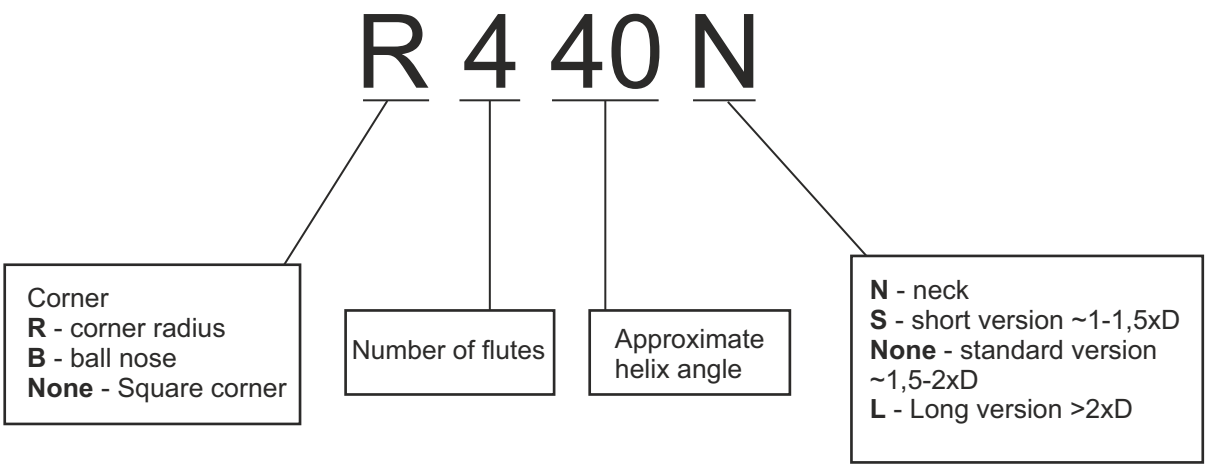
1.8. Shank types

Diameter	Cylindrical- Form HA	Weldon shank - Form HB
Ø6 - Ø20		
Ø25 - Ø32		

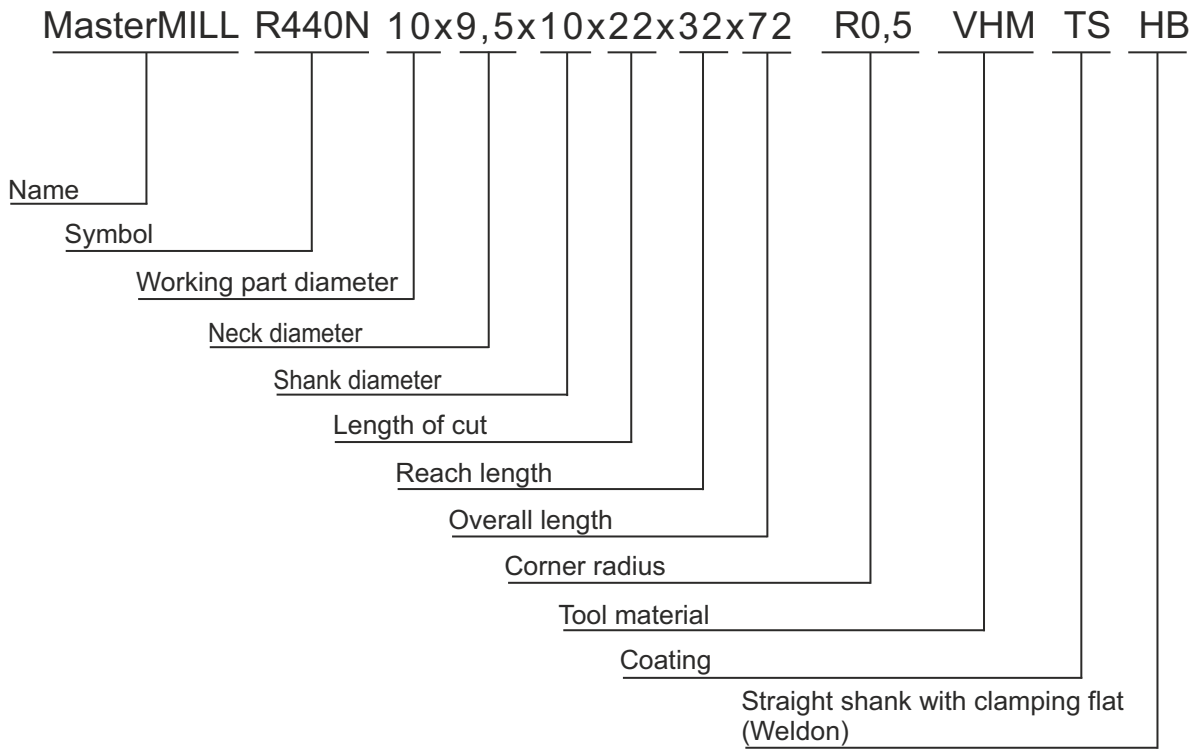
2. Designation and application

2.1. Tool groups according to application

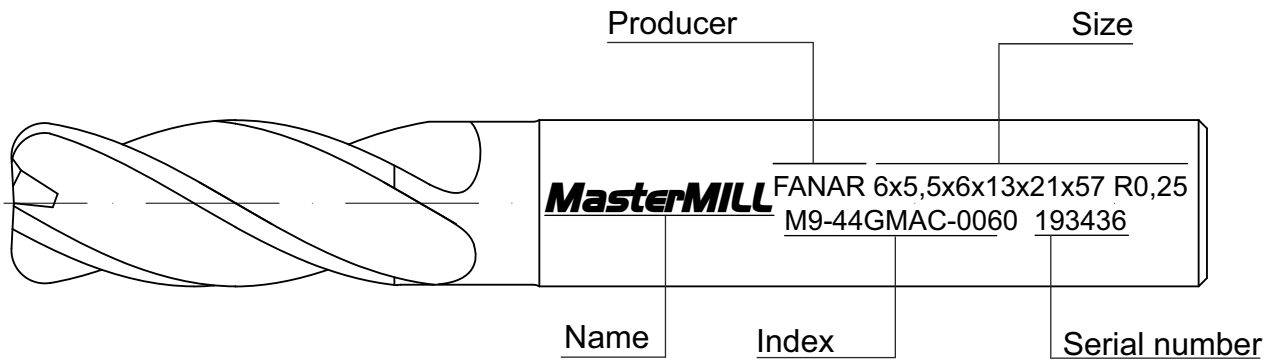
MASTERMILL P M K N S	High performance end mills dedicated to work on machining centers, for machining steel, stainless steel up to 45 HRC, cast iron and difficult to machine materials based on titanium and nickel.
X-MILL P M K	General purpose end mills for machining materials with hardness up to 35 HRC.
AL N	Group of tools with cutting geometry optimized to machining non-ferrous materials. Polished flutes and TB coating allow high performance machining of aluminium and copper alloys.
HRC H	End mills produced of comented carbide grade with nano-grain size (0,2 µm), dedicated for machining materials in hardened condition. Optimized geometry and TS coating allow machining materials with higher hardness than 65 HRC.



2.2. Designation



2.3. Marking



3. Technological recommendations for milling

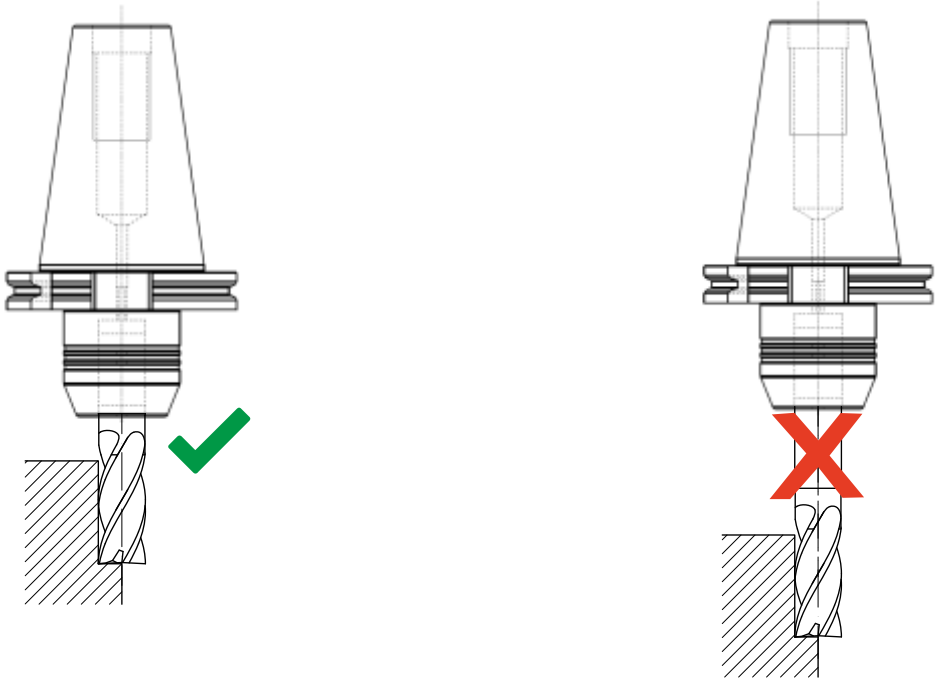
3.1. Effective milling is the result of:

- technical condition of the machine
- the proper selection of the end mills
- the selection of a precise and rigid holder
- rigid and securely fixation of work piece
- choice of coolant
- machine processing strategy

3.2. Correct tool selection

Milling cutter should be selected from selection table according to machined workpiece material. Adjust the cutter suitable for the material and dimensions; as short as possible, with a short cutting length and a larger diameter.For grooving choose end mills with a smaller number of flutes (2-3) for good chip evacuation. For profiling use 4-6 flutes cutters, in order to obtain a better surface quality and durability of the cutter.

3.3. Holder



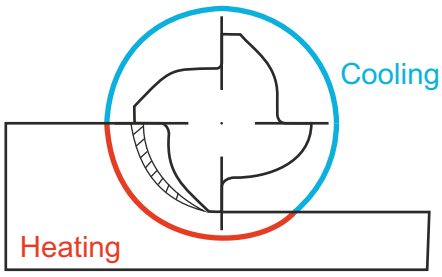
For high speed milling use the hydraulic holder or with shrink fit short reach, ensuring rigidity and precision mounting. Always secure the minimum influence of the tool holder.

3.4. Dry and wet milling

Dry milling increases the life of the cutting edge.

The milling operation in contrast to drilling is an inherently intermittent process. This causes the temperatures generated at the cutting edge to constantly fluctuate between various levels of hot and cold.

The cutting edge of a mill is subjected to thermal shocks and cyclic stresses that can result in cracking and, decreasing of tool life.



The best solution to facilitate chip removal and prevent recutting of chips is to use compressed air systems.

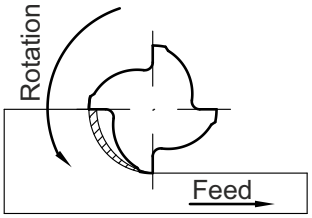
Justified cases of using coolant during working with carbide cutters are:

- finishing of stainless steel and aluminium
- milling of heat resistant alloys
- milling of thin walled components.

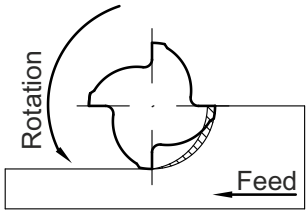
3.5. Processing technology and strategy

To increase the tool life,the climb-milling is recommended. Milling of the pockets usually begins with a pre-drill the hole. It is also used a spiral interpolation or linear ramping.

Climb milling



Conventional milling

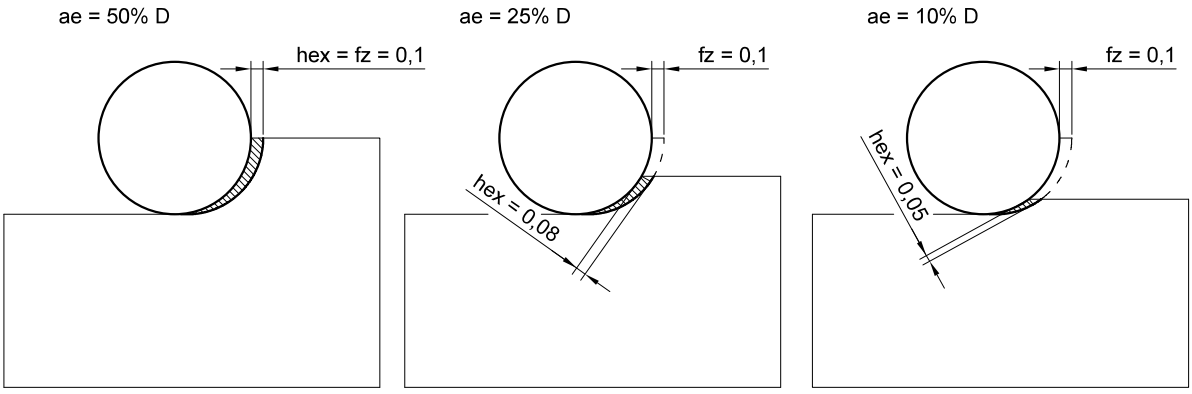


In these cases, the feed rate should be reduced to 25-50% of the values shown in the tables and cutting speed used as for grooving. In any case operating conditions can vary considerably. Therefore at the beginning of machining is recommended to reduce cutting to 50% from the tables selection, and then increasing to them. Deviations from the described conditions, exceeding the axial depth Ap and width Ae, can lead to a reduction in the cutting parameters V and f_z from those given in the tables.

3.6. High speed milling

HSM (High Speed Machining) – machining strategies based on chip thickness control and tool load reduction. By properly modifying the machining parameters, and in some cases using tools with a special design, it is possible to achieve lower mechanical and thermal load of cutting edges while increasing productivity.

Influence of the cutting width on the thickness of the chip.



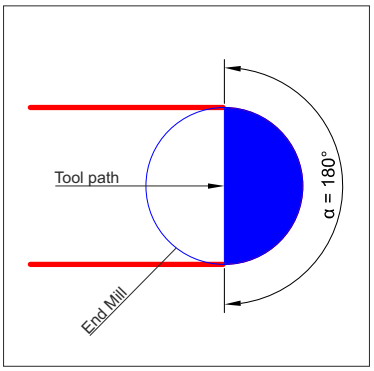
The most common milling strategies based on chip thickness control are:

- Trochoidal milling
- High Feed Milling (HFM)

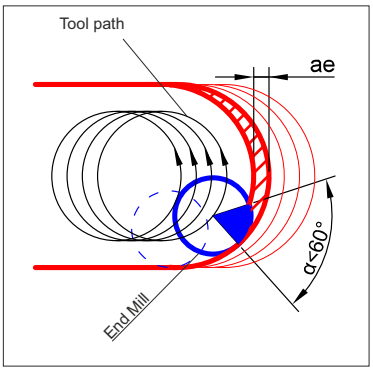
3.6.1. Trochoidal milling

High Feed Milling - Milling strategy developed to reduce chip thickness by using a tool with a special face geometry. This kind of a tool allows machining with several times higher feed rates than conventional machining.

- **Very small milling width ae and small wrap angle of the tool** - reduction of chip thickness hex and radial forces
- **Highest possible cutting speed Vc and number of flutes** - high feed speeds and productivity
- **Full length of cutting edges in use** – even wear of cutting edges



Milling a groove in a full material

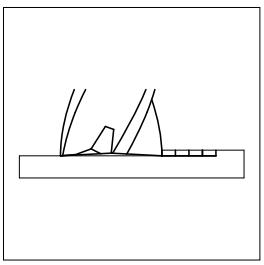


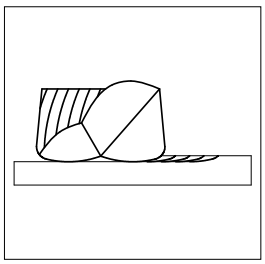
Trochoidal milling

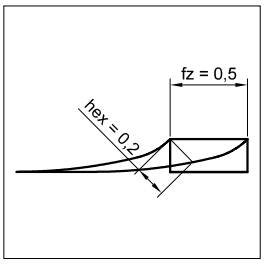
3.6.2. HFM - High Feed Milling

High Feed Milling - Milling strategy developed to reduce chip thickness by using a tool with a special face geometry. This kind of a tool allows machining with several times higher feed rates than conventional machining.

- **Very low cutting depth a_p** - reduced chip thickness hex and radial forces
- **Large cutting width a_e and feed per tooth fz** - even wear of the specially shaped cutting edge
- **Highest possible feed per tooth and number of teeth** - high feed speeds and productivity


Face of standard end mill


Face of milling cutter for High Feed Milling



Comparison of the chip shape with the same feed per tooth

3.6.3. Machine requirements:

- High speed spindle
- High dynamics of the machine - frequent changes of direction and feed values
- Balancing tools with a tool holder
- Necessity to be able to program the toolpath - CAM software
- Proper tool design

4. Formula and tables

4.1. Basic formulas

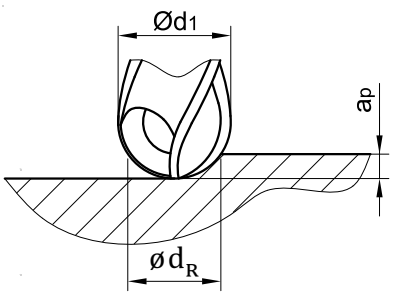
Symbol	Unit	Name	Formula
V_c	m/min	Cutting speed	$v_c = \frac{d_1 \times \pi \times n}{1000}$
n	1/min	Rotational speed	$n = \frac{1000 \times v_c}{d_1 \times \pi}$
V_f	mm/min	Rate of feed	$v_f = f_z \times n \times z$
f_z	mm	Feed per tooth	$f_z = \frac{v_f}{n \times z}$

d_1 [mm] - diameter of milling cutters

z - number of teeth

4.2. Ball nose end mills real cutting diameter

	Depth of cut ap [mm]																
Ø d1	0,01	0,02	0,03	0,04	0,05	0,08	0,1	0,15	0,2	0,3	0,5	0,8	1,0	2,0	3,0	4,0	5,0
1	0,199	0,280	0,341	0,392	0,436	0,543	0,600	0,714	0,800	0,917	1,000	-	-	-	-	-	-
2	0,282	0,398	0,486	0,560	0,624	0,784	0,872	1,054	1,200	1,428	1,732	1,960	2,000	-	-	-	-
3	0,346	0,488	0,597	0,688	0,768	0,967	1,077	1,308	1,497	1,800	2,236	2,653	2,828	2,828	-	-	-
4	0,399	0,564	0,690	0,796	0,889	1,120	1,249	1,520	1,744	2,107	2,646	3,200	3,464	4,000	-	-	-
5	0,447	0,631	0,772	0,891	0,995	1,255	1,400	1,706	1,960	2,375	3,000	3,666	4,000	4,899	4,899	-	-
6	0,489	0,692	0,846	0,977	1,091	1,376	1,536	1,873	2,154	2,615	3,317	4,079	4,472	5,657	6,000	-	-
8	0,565	0,799	0,978	1,129	1,261	1,592	1,778	2,170	2,498	3,040	3,873	4,800	5,292	6,928	7,746	8,000	-
10	0,632	0,894	1,094	1,262	1,411	1,782	1,990	2,431	2,800	3,412	4,359	5,426	6,000	8,000	9,165	9,798	10,000
12	0,693	0,979	1,198	1,383	1,546	1,953	2,182	2,666	3,072	3,747	4,796	5,987	6,633	8,944	10,392	11,314	11,832
14	0,748	1,058	1,295	1,495	1,670	2,111	2,358	2,883	3,323	4,055	5,196	6,499	7,211	9,798	11,489	12,649	13,416
16	0,800	1,131	1,384	1,598	1,786	2,257	2,522	3,084	3,555	4,341	5,568	6,974	7,746	10,583	12,490	13,856	14,832
18	0,848	1,199	1,468	1,695	1,895	2,395	2,676	3,273	3,774	4,609	5,916	7,419	8,246	11,314	13,416	14,967	16,125
20	0,894	1,264	1,548	1,787	1,997	2,525	2,821	3,451	3,980	4,862	6,245	7,838	8,718	12,000	14,283	16,000	17,321



$$\text{ø}d_R = 2 \cdot \sqrt{a_p(\text{ø}d_1 - a_p)}$$

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