

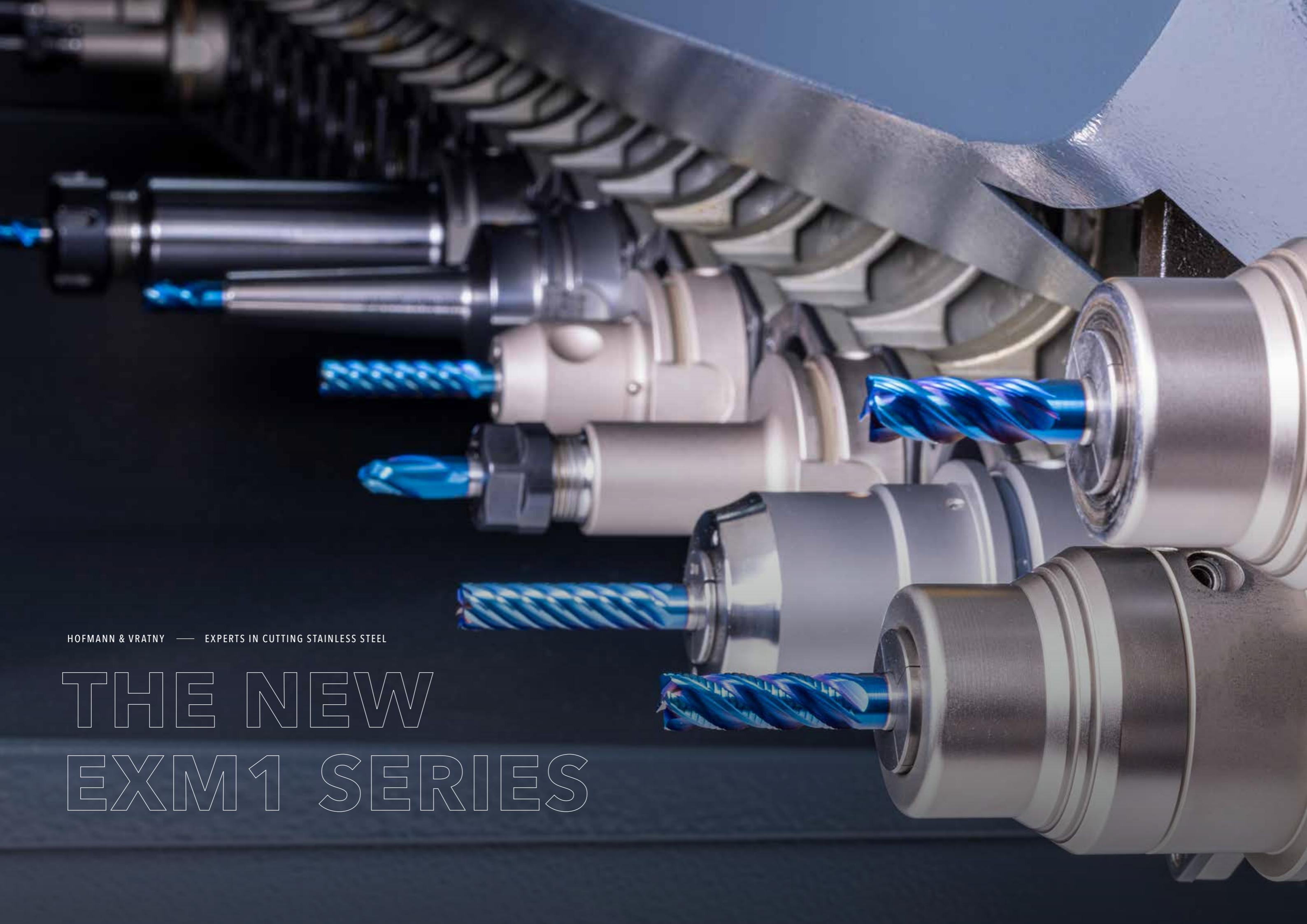


Expert

2022

EXM1-SERIES





HOFMANN & VRATNY — EXPERTS IN CUTTING STAINLESS STEEL

THE NEW EXM1 SERIES

THE RIGHT MILLING CUTTER. AT ALL TIMES.

Welcome to Hofmann & Vratny. As the leading manufacturer of solid carbide milling cutters. we enable companies throughout the world to manufacture their products.

Every day. our strong team works on our collective goal of producing the best milling cutters in the world. Companies from the medical industry. semiconductor industry. machine and plant construction. aviation. aerospace engineering and. not least. the automotive industry have been using our milling cutters for many years now. Quality - Made in Bavaria.

The success of our company is built on innovation. a culture of cooperation. open dealings on an equal footing and many years of successful and trustful collaboration with our business partners. You can count on us. our milling cutters and our irrepressible drive to shape the future of the industry together. To us. that means shaping tomorrow.

Andreas Vratny

Zdenek Vratny

Marius Heinemann-Grüder



46
YEARS OF
EXPERIENCE

2 Mio.
MILLING
CUTTERS
PRODUCED
EVERY YEAR

MADE IN BAVARIA

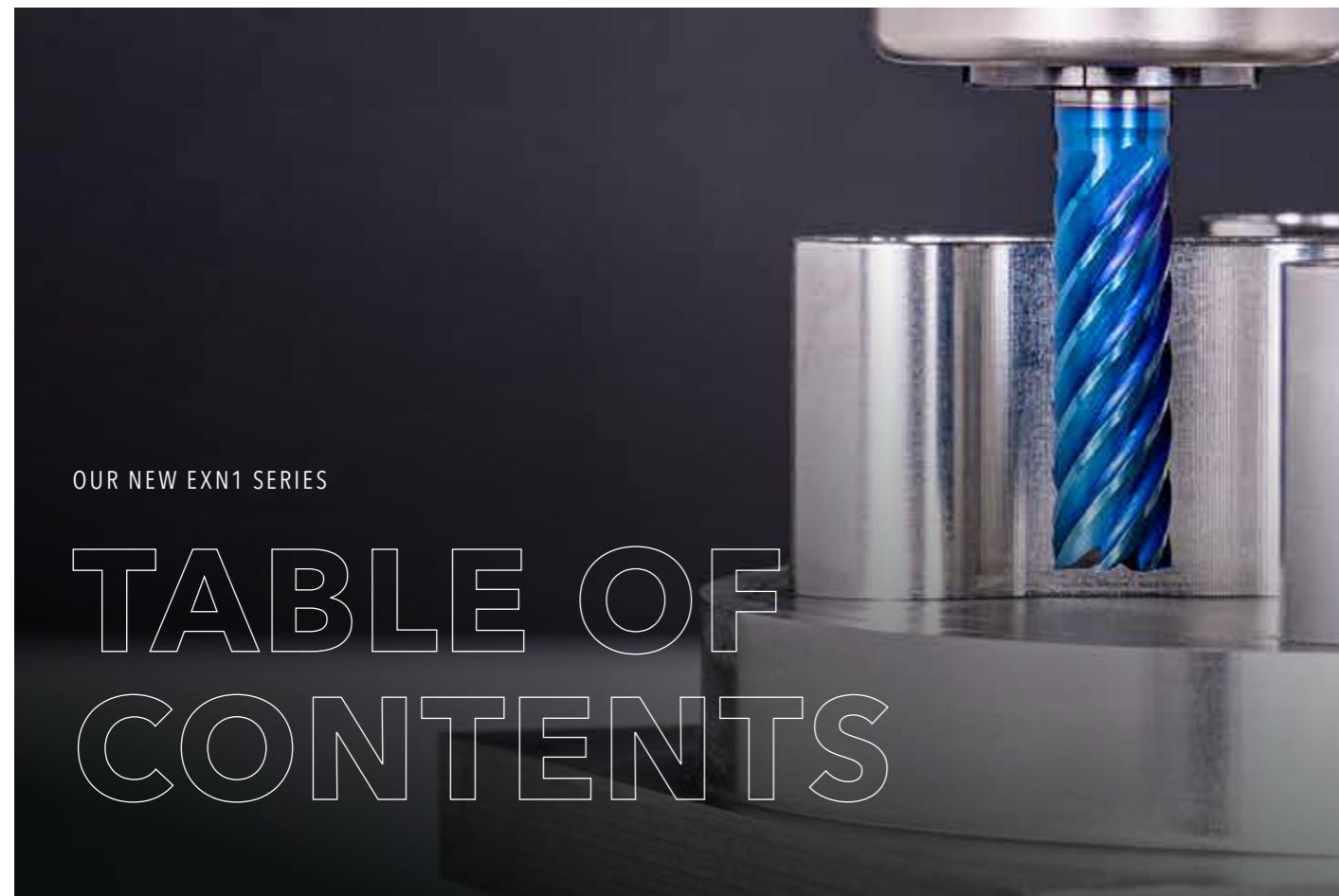


MADE
IN
BAVARIA

PROVEN QUALITY

Our milling cutters are used by companies all over the world. Still they all have the same origin: Our production sites in Bavaria. Germany.

As a traditional company. we are proud of our strong connection to the region. Ever since we were founded. we have been firmly tied to our homeland. and our team works on producing the best milling cutters in the world in a familial environment. Genuine quality work. the highest-quality craftsmanship and a strong promotion and retention of our talent: This is what Made in Bavaria means to us.



OUR NEW EXM1 SERIES

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EXM1-M03 CHIPMAKER

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EXM1-M04 MIRRORMAKER

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EXM1-M04-0043 | EXM1 Mirrormaker Z7 4xD ANNX 56



EXM1-M08 ROWMAKER

EXM1-M08-0003 | EXM1 Rowmaker Z2 1.5xD short ANNX 58



EXM1-M08-0013 | EXM1 Rowmaker Z2 1.5xD long ANNX 60



EXM1-M08-0203 | EXM1 Rowmaker Z4 1.5xD short ANNX 62



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THE NEW EXM1 SERIES

Experts in cutting stainless steel



OUR NEW EXM1 SERIES PERFORMS WELL EVEN WITH THE MOST DEMANDING STAINLESS STEELS. OTHERWISE KNOWN AS SUPER DUPLEX STEELS

Stainless steels are very popular in industry not only because of their corrosion resistance. they are also hygienic. temperature-resistant and extremely durable.

Stainless steels are mostly used in the food industry. medical technology. the pharmaceutical industry. the chemical industry and in the off-shore sector. Depending on the requirements. different alloys are used. which are classified into the following categories:

- Ferritic
- Martensitic
- Austenitic
- Austenitic-ferritic (duplex)

The H&V EXM1 Series was developed to reliably machine these different structures and also to withstand components such as nickel. manganese. tungsten or titanium.

- Designed for high productivity and lasting durability
- Ultra-fine grain substrate specially developed for demanding material structures. Maximum bending strength and fracture toughness combined with moderate hardness
- Innovative tool geometries ensure a wide range of uses and enable use in a wide variety of milling techniques



A SPECIAL EDGE PREPARATION PROCESS ENSURES:

- Entirely homogeneous cutting edges
- Even distribution of cutting forces
- Improved surface quality of the component
- Controlled and even wear



ERLEBEN SIE DIE EXM1-SERIE IN ACTION

BEFORE EDGE PREPARATION



AFTER EDGE PREPARATION





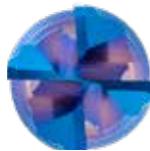
EXPERT M1 PERFORMMAKER (M01) Z4



▶ IN ACTION

Adapted face with two cutting edges up to the centre for reliable helical immersion

Reinforced cutting edge with protection radius for maximum stability



- Optimised geometry for high radial cutting depths. full slot milling up to 1xD and trochoidal machining
- Innovative grinding of the flute back for continuous optimum cooling of the cutting edges and prevention of thermal shocks
- Special unequal tooth pitch paired with variable helical pitch for perfectly smooth running even at the highest cutting and feed speeds
- Particularly stable tool core with a slightly conical shape
- Available in 1.5xD and 2xD
- Available as HA and HB
- Including ANNX coating



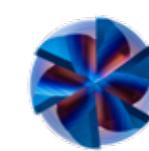
EXPERT M1 CHIPMAKER (M03) Z6



▶ IN ACTION

Adapted face cutting edge for reliable helical immersion

Reinforced cutting edge with protection radius for maximum stability



- Six cutting edges for optimised performance and an excellent chip removal rate
- Reinforced chip cups for high radial cutting depths
- Optimised chip spaces for perfect removal of chips that tend to stick
- Special unequal tooth pitch coupled with variable helical pitch for perfectly smooth running
- Available in 2xD, 3xD and 4xD
- Available as HA and HB
- Includes ANNX coating



EXPERT M1 SLOTHAKER (M02) Z4



▶ IN ACTION

Adapted face with two cutting edges up to the centre for reliable helical immersion

Reinforced cutting edge with protection radius for maximum stability



- Optimised knurled toothing for the smallest chips in volume machining
- Particularly stable tool core with a slightly conical shape
- Special unequal tooth pitch paired with variable helical pitch for perfectly smooth running even at the highest cutting and feed speeds
- Extra-large chip chambers for safe chip evacuation with high radial depth of cutting
- Available in 2xD and 3xD
- Available as HA and HB
- Including ANNX coating



EXPERT M1 MIRRORMAKER (M04) Z7



▶ IN ACTION

Face-finish bevel for smooth workpiece surfaces



- Seven cutting edges with a special finish and optimised geometry for the highest surface quality
- Adapted chip spaces for the safe removal of particularly fine and long chips when finishing
- Slightly conical tool core and special helical pitch for the smoothest running possible and dimensional accuracy
- Available in 3xD and 4xD
- Includes ANNX coating



EXPERT M1 ROWMAKER (M08) Z2

Adapted face geometry
for optimum performance
and perfect dimensional
accuracy

Radius tolerance
determined by radius
 $\leq 2 \text{ mm} = \pm 0.003 \text{ mm}$
 $> 2 \text{ mm} = \pm 0.005 \text{ mm}$



- Adapted core for smooth running
- Special chip spaces designed for optimal chip disposal when roughing and finishing
- Defined microbevel for support enables use in the high-speed range
- Optimised cross-cutting edge for maximum stability in the tool centre
- Available in standard and long versions
- Includes ANNX coating



EXPERT M1 ROWMAKER (M08) Z4

Four cutting edges.
right up to the centre
Reinforced face geometry
combined with a special
finishing bevel for maximum
performance and optimum
surface quality

Radius tolerance
determined by radius
 $\leq 2 \text{ mm} = \pm 0.003 \text{ mm}$
 $> 2 \text{ mm} = \pm 0.005 \text{ mm}$



- Adapted wedge angle and helical pitch for smooth running and cutting
- Optimised chip spaces designed for maximum chip disposal, even in the high-speed range
- Maximum cutting performance with four cutting edges
- Available in standard and long versions
- Includes ANNX coating



► IN ACTION

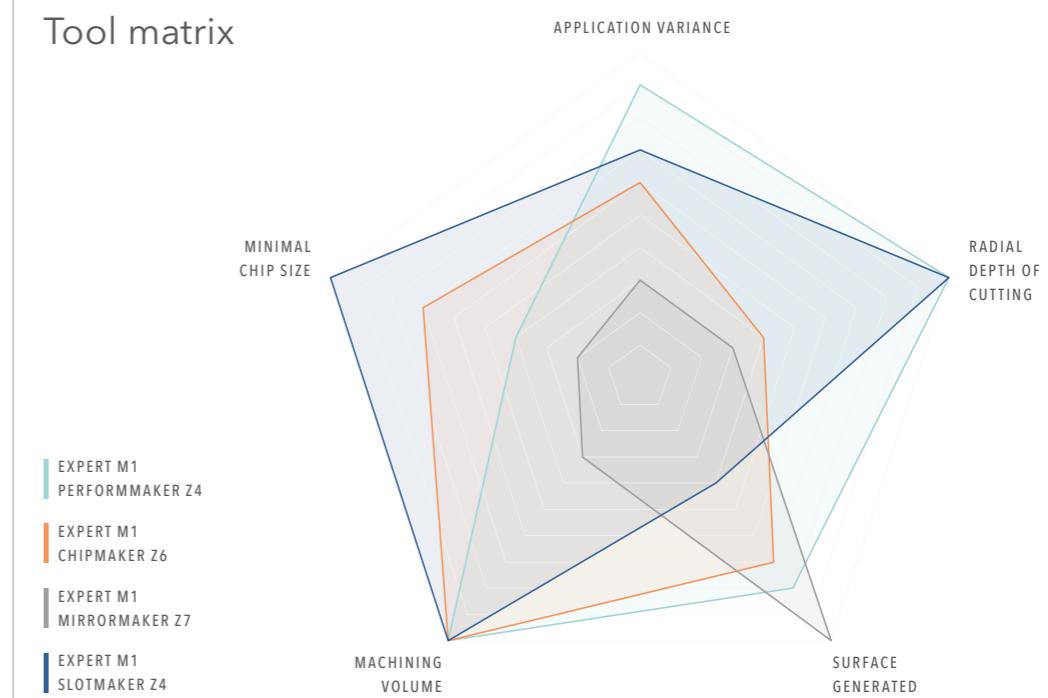
PERFORMANCE COMPARISON

COMPARING THE PERFORMANCE WITHIN THE EXM1 SERIES

The tool matrix for our EXM1 Series compares the performance of individual milling cutters within the series. The values clearly show the performance in relation to the respective property in order to help you choose the right tool for every requirement.



Tool matrix



OUR NEW PERFORMMAKER Z4 2xD ANNX (EXM1-M01-0124)

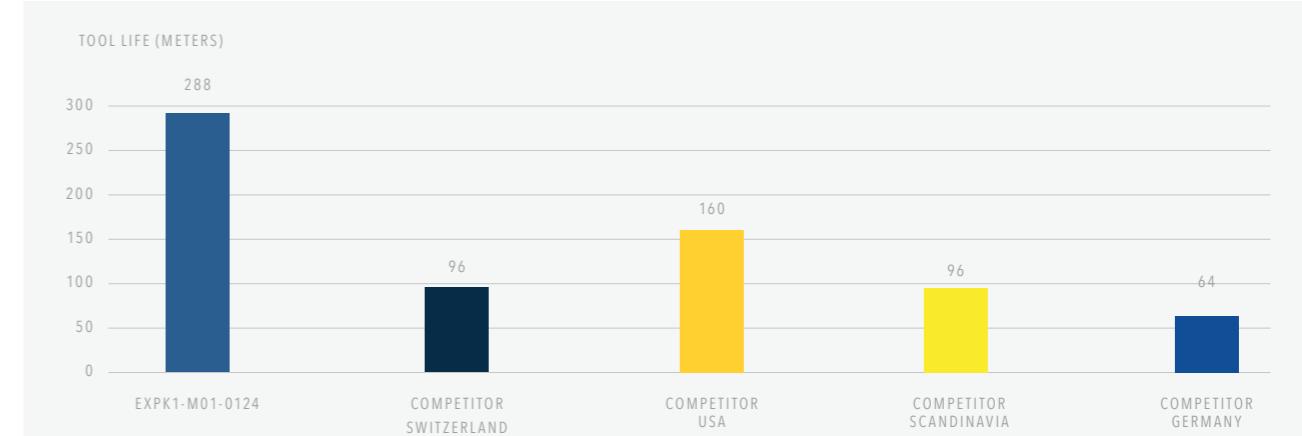
COMPARISON WITH THE COMPETITION

Comparison of tool life when trimming in V2A - 1.4301 (X5CrNi18-10)

During in-house tests carried out at our own research center, our new Performmaker came out on top in the comparison with its competitors.

Technical parameters for trimming

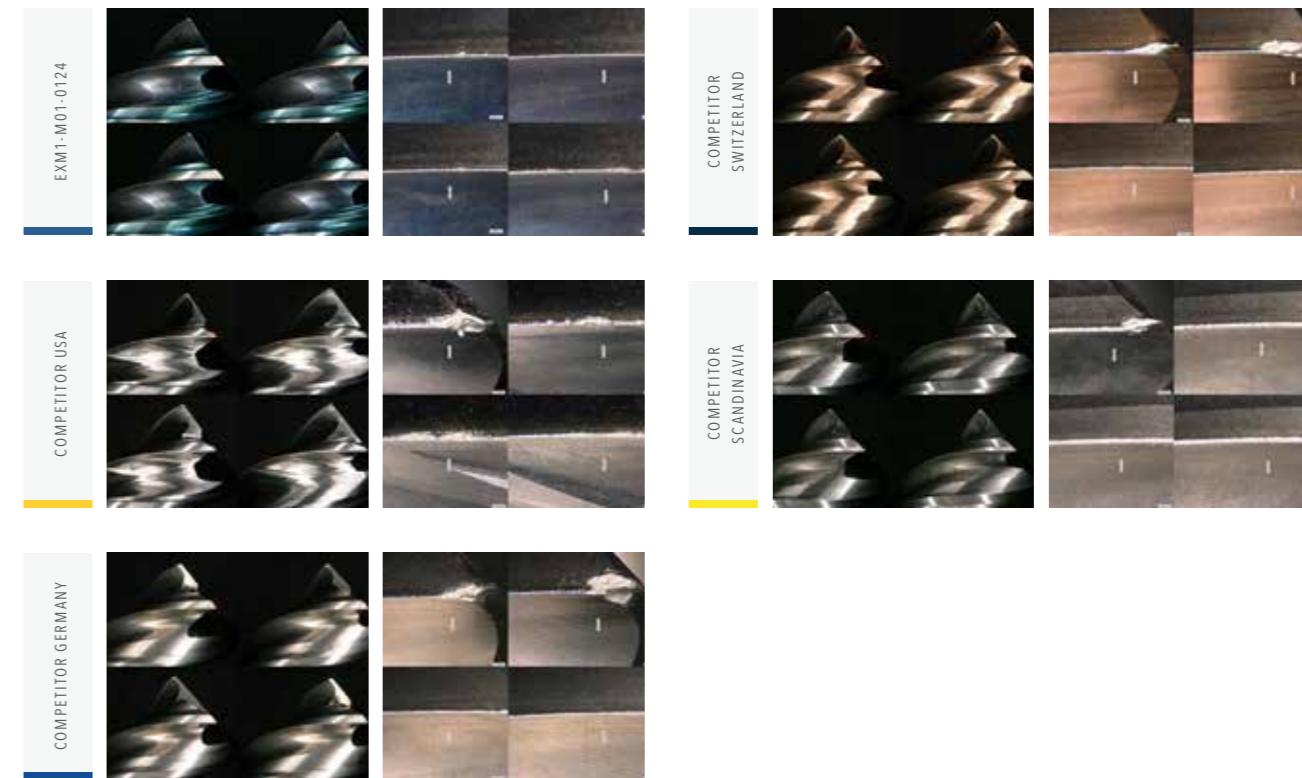
Vc	100 m/min
fz	0.062 mm/Z
ap	12 mm
ae	2.4 mm
Cooling	cooling lubricant



In addition to our EXM1 Performmaker Z4, these high-resolution photos also show our competitors' tools at the end of their respective service lives. Our Performmaker clearly stands out from our competitors' tools in terms of tool life and wear to its cutting edge.

TOOL LIFE CRITERION = WEAR OF CUTTING EDGE AND BREAKOUTS

End mill Z4 Ø12 2xD	Tool life in meters	Wear on cutting edge in mm (average)	Tool life in minutes
EXM1-M01-0124	288	0.06	438
Competitor Switzerland	128	0.11	146
Competitor USA	160	0.15	243
Competitor Scandinavia	96	0.10	146
Competitor Germany	64	0.16	97



OUR NEW PERFORMMAKER Z4 2xD ANNX (EXM1-M01-0124)

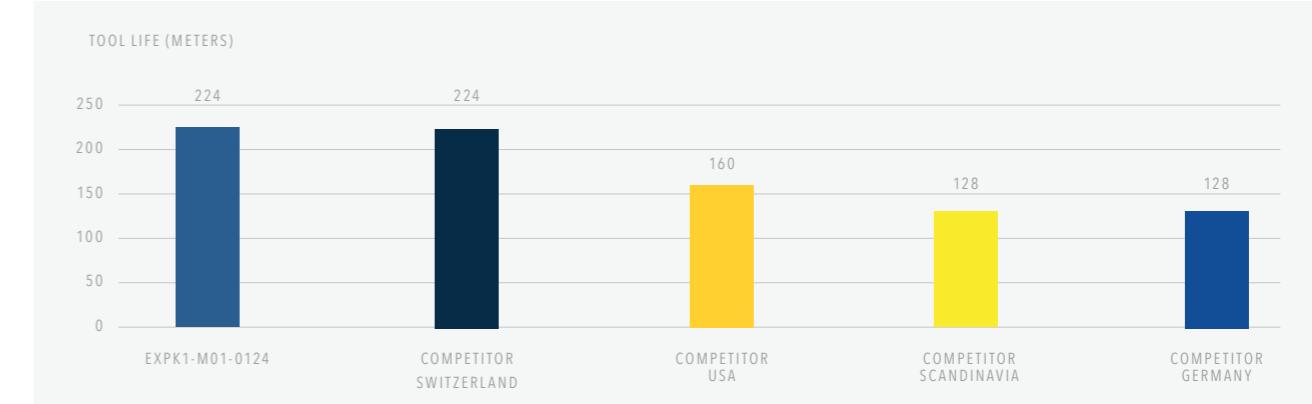
COMPARISON WITH THE COMPETITION

Comparison of tool life when trimming in V4A - 1.4571 (X6CrNiMoTi17-12-2)

During in-house tests carried out at our own research center, our new Performmaker came out on top in the comparison with its competitors.

Technical parameters for trimming

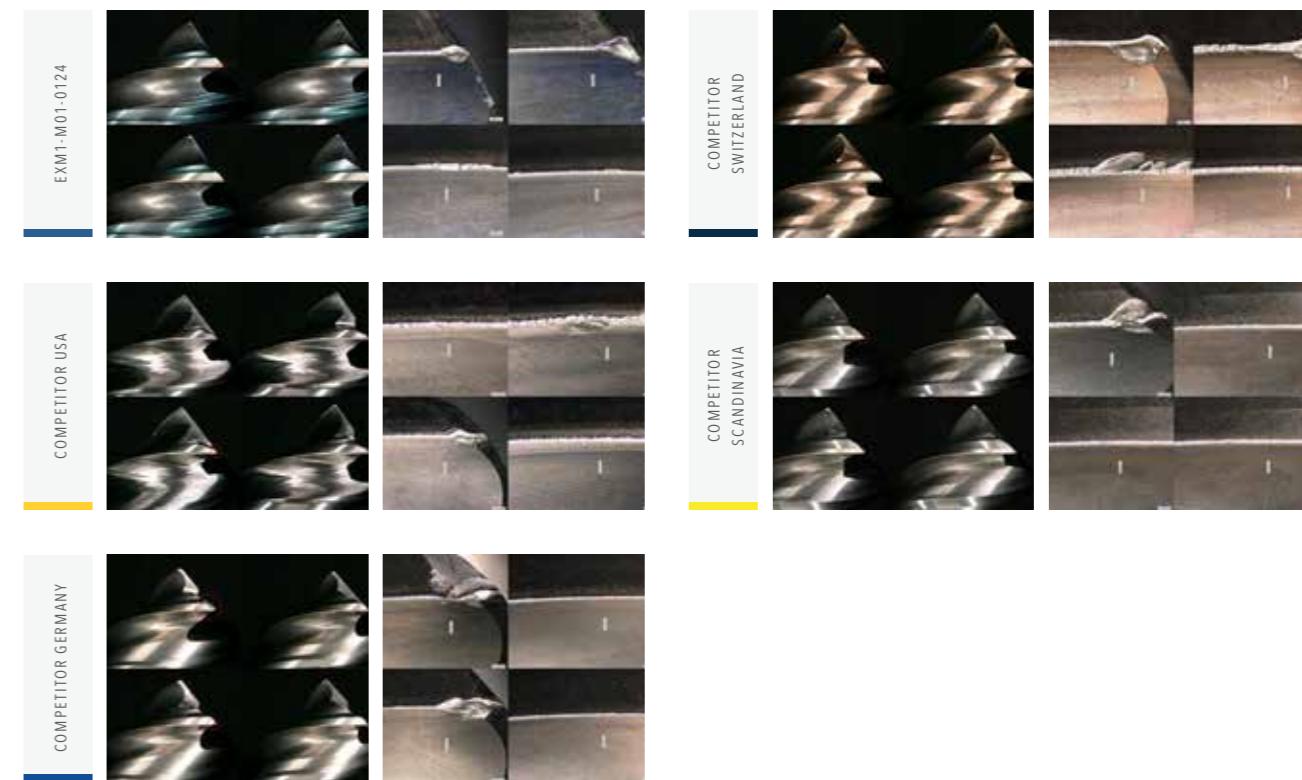
Vc	85 m/min
fz	0.062 mm/Z
ap	12 mm
ae	2.4 mm
Cooling	cooling lubricant



In addition to our EXM1 Performmaker Z4, these high-resolution photos also show our competitors' tools at the end of their respective service lives. Our Performmaker clearly stands out from our competitors' tools in terms of tool life and wear to its cutting edge.

TOOL LIFE CRITERION = WEAR OF CUTTING EDGE AND BREAKOUTS

End mill Z4 Ø12 2xD	Tool life in meters	Wear on cutting edge in mm (average)	Tool life in minutes
EXM1-M01-0124	224	0.16	401
Competitor Switzerland	224	0.24	401
Competitor USA	160	0.14	286
Competitor Scandinavia	128	0.15	229
Competitor Germany	128	0.12	229



OUR NEW PERFORMMAKER Z4 2xD ANNX (EXM1-M01-0124)

COMPARISON WITH THE COMPETITION

Comparison of tool life when trimming in Duplex - 1.4462 (X2CrNiMoN 22-5-3)

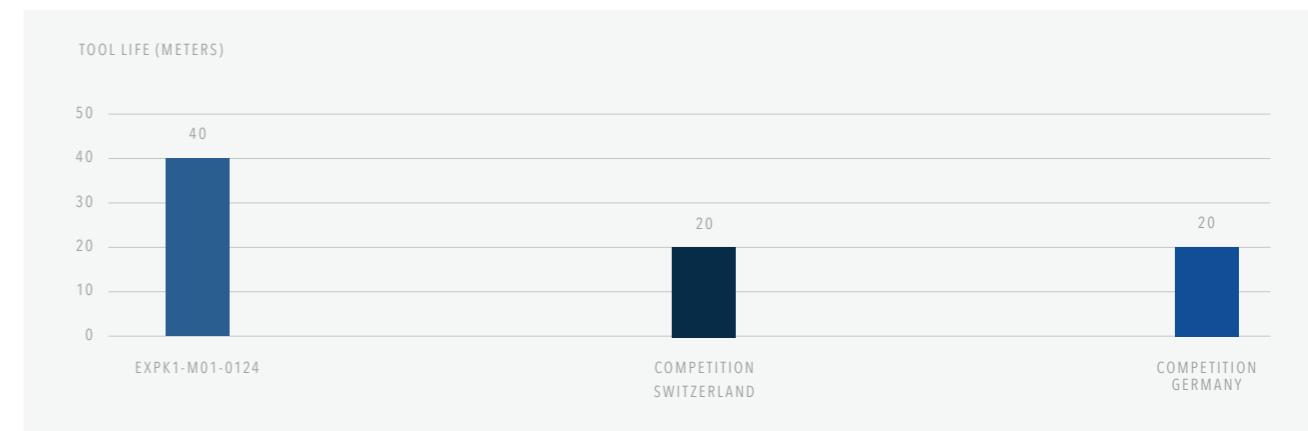
During in-house tests carried out at our own research center, our new Performmaker came out on top in the comparison with its competitors.

Technical parameters for trimming

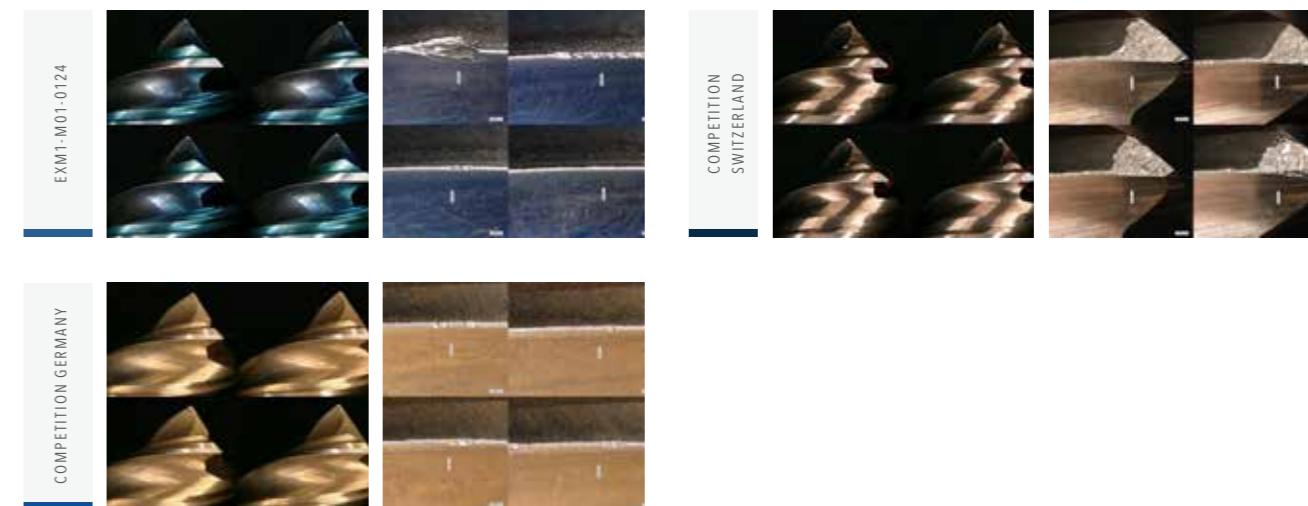
Vc	75 m/min
fz	0.062 mm/Z
ap	12 mm
ae	2.4 mm
Cooling	cooling lubricant

TOOL LIFE CRITERION = WEAR OF CUTTING EDGE AND BREAKOUTS

End mill Z4 Ø12 2xD	Standweg in Meter	Schneidkantenverschleiß in mm (Mittelwert)	Standzeit in Minuten
EXM1-M01-0124	40	0,12	80
Competitor Switzerland	20	1,00	40
Competitor Germany	20	0,09	40



In addition to our EXM1 Performmaker Z4, these high-resolution photos also show our competitors' tools at the end of their respective service lives. Our Performmaker clearly stands out from our competitors' tools in terms of tool life and wear to its cutting edge.



ALPHA NOX NAVY X

ANNX | state-of-the-art. nano-structured multi-layer coating specially designed for machining stainless steel

We have created a new nano-structured multi-layer coating based on AlTiSiCrN in order to process different types of structure and material additives in stainless steel that can be difficult to machine.

Particularly when using super duplex steels, there is immense pressure on the cutting edges. Thanks to the multi-layer, nano-structuring of our new AlphaNox Navy X coating, a high level of elasticity is achieved and the internal stress of the coating is reduced. There is very controlled wear and the coating wears off very evenly. Layer spalling and premature breakouts are effectively prevented.

The key properties of our ANNX coating at a glance:

- Can be widely used with all stainless steels and types of structure
- Breakout prevention through low internal stress and high elasticity of the coating
- Long-lasting protection of the hard metal against material fatigue thanks to special components and structure of the coating

Finishing X as viewed through a scanning electron microscope

**ANNX**

Outstanding layer smoothing – our new Finishing X technique

Finishing X is the name we have given to a special type of layer smoothing used in combination with AlphaNox Navy that is characterised by unparalleled evenness, more homogeneous wear, and improved wear resistance. It has been developed specially to prevent micro-breakouts caused by droplets coming loose and guarantee a chip disposal process that will remain at its optimum level for a long time. The effects of the symbiosis between our AlphaNox Navy and the Finishing X technique at a glance:

- Improved surface quality during finishing
- Optimised chip disposal due to smooth chip spaces
- Maximum stability for coating and cutting edges
- Reduction of built-up edges and chips sticking on the tool
- Absolute smoothness for a reduced friction coefficient (0.4)

ALPHANOX NAVY X ANNX - AT A GLANCE

Structure	Nanostructured multilayer
Components	Aluminium chromium titanium nitride
Layer thickness	3-4 µm
Layer hardness	approx. 3000 - 3200HV
Adhesion factor	Friction coefficient: approx. 0.4 (dry on steel)
Max. operating temperature	approx. 1100°C
Cooling	wet machining (limited suitability for dry machining)
Main application	Stainless Steel
Secondary application	Stainless steel (limited suitability)

DIGITAL SERVICES

DISTRIBUTION PARTNERS

We enable companies around the world to manufacture their products. Therefore we work with reliable partners at an international level to ensure that our milling cutters are always available exactly where they are needed and can be delivered straight into your hands.

FIND OUT MORE
ABOUT OUR GLOBAL
SALES PARTNERS



Browse all EXM1 Series products in our shop

Discover the products in the EXM1 Series online or search for the ideal tool for your application based on various product features. We guarantee that you will find the perfect milling cutter for your machining needs using our online platform.



WHAT ARE YOU
WAITING FOR?



STILL CAN'T FIND A SUITABLE MILLING CUTTER?

No problem – simply customize an existing tool. Using our configurator for special milling cutters, you can customize existing tools to your needs in an instant or create your own tools based on predefined types.

WE WILL RESPOND TO ALL
REQUESTS SUBMITTED VIA THE
CONFIGURATOR WITHIN ONE
WORKING DAY AT THE LATEST



NUMBERING SYSTEM

DISTINGUISHING FEATURES

PRODUCT LINE

BC Basic
EX Expert

TOOL TYPE

D Drilling
M Milling

MILLING CUTTER TYPE

- 01 End mill cutter | PERFORMMAKER
- 02 Roughing cutter | SLOTHAKER
- 03 Trochoidal cutter | CHIPMAKER
- 04 Finishing cutter | MIRRORMAKER
- 05 Single flute cutter | BALANCEMAKER
- 06 Torus cutter | FORMMAKER
- 07 Face torus cutter | BLADEMAKER
- 08 Full radius cutter | ROWMAKER
- 09 Deburring cutter | CHAMFMAKER
- 10 Forward and backward deburring cutter | FB CHAMFMAKER
- 11 Corner rounding cutter | ROUNDMAKER
- 12 Forward and backward corner rounding cutter | FB ROUNDMAKER
- 13 Engraving cutter | TEXTMAKER
- 14 Conical cutter | SLOPEMAKER
- 15 Micro end mill cutter | PERFORMMAKER MICRO
- 16 Micro torus cutter | FORMMAKER MICRO
- 17 Micro full radius cutter | ROWMAKER MICRO

EX M 1 - M 01 - 0293

MAIN APPLICATION VERSION

PK	Steel & Cast Iron	0	Origin Version
H	Hardened Steel	1	Version 1.0
M	Stainless Steel	2	Version 2.0
O	Graphite. CRP/GRP	3	Version 3.0
T	Titanium		
S	Superalloy		
N	NF Material		
U	Universal		

OTHER DISTINGUISHING FEATURES

EX M 1 - M 01 - 0293 - 12/0.5

PRODUCT IDENT

e.g. 0023

DIMENSION

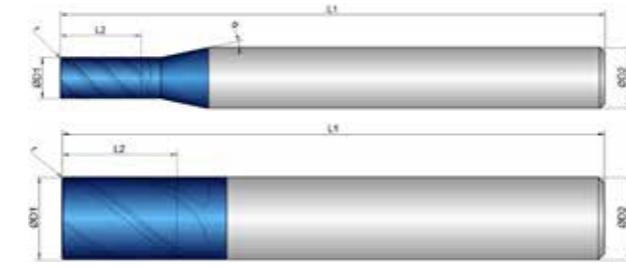
- 3x10 Cutting diameter x length of undercut
- 12/0.5 Cutting diameter / corner radius
- 10 Diameter

Cooling		Strategy	ETC	HPC				
Tolerance	e8	Application						
Coating	AlphaNox Navy X	Features						

- Extra stable tool core with a slightly conical course
- Special unequal tooth pitch combined with variable helical pitch for smooth running

- Designed for maximum removal rate when milling with high radial depth of cut and in the full slot up to 1xD
- For process reliable ramping, helical immersion and diving (drilling) up to 1xD

- Innovative grinding of the flute back for constant, ideal cooling of the cutting edges and prevention of thermal shocks



Roughing

inappropriate optimal inappropriate optimal

EXM1-M01-0113	D1 mm ø	L2 mm	L1 mm	D2 mm ø	z #	r mm	α °	
3	3.0	6.0	54.0	6.0	4	0.10	40	12
4	4.0	8.0	54.0	6.0	4	0.10	40	12
5	5.0	9.0	54.0	6.0	4	0.20	40	12
6	6.0	10.0	54.0	6.0	4	0.20	40	0
8	8.0	12.0	58.0	8.0	4	0.20	40	0
10	10.0	14.0	66.0	10.0	4	0.20	40	0
12	12.0	16.0	73.0	12.0	4	0.20	40	0
16	16.0	22.0	82.0	16.0	4	0.30	40	0
20	20.0	26.0	92.0	20.0	4	0.30	40	0



Download Catalog Pages (PDF)

Dimension	Ø 3	Ø 4	Ø 5	Ø 6	Ø 8	Ø 10
Infeed in mm	ae= 1xD ap= 1xD	ae= 0.2xD ap= 1xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 1xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 1xD
Application						
Material	Strength (N/mm²)	Feed (mm/Z)	fz	fz	fz	fz

M	STAINLESS STEEL	Vc (m/min)
1.1	ferritic/martensitic	<850 110 0.02 0.03 0.025 0.032 0.03 0.04 0.035 0.045 0.05 0.06 0.055 0.07
2.1	austenitic	<650 100 0.018 0.025 0.02 0.028 0.025 0.035 0.03 0.04 0.045 0.055 0.05 0.065
2.2	austenitic	<750 90 0.015 0.02 0.018 0.022 0.022 0.03 0.025 0.035 0.04 0.05 0.045 0.06
3.1	DUPLEX STEEL super austenitic	<1100 75 0.012 0.018 0.015 0.02 0.018 0.025 0.022 0.03 0.035 0.045 0.04 0.055
P	STEEL	Vc (m/min)
1.1-1.5	unalloyed	<1100 180 0.02 0.025 0.02 0.025 0.03 0.035 0.04 0.045 0.05 0.06 0.055 0.07
2.1-2.4	low alloyed	<1300 145 0.015 0.02 0.015 0.02 0.025 0.03 0.035 0.04 0.045 0.055 0.05 0.065
3.1-3.3	high alloyed	<1400 135 0.012 0.018 0.012 0.018 0.022 0.028 0.032 0.038 0.042 0.052 0.045 0.06
K	CASTINGS	Vc (m/min)
1.1	grey cast iron	<1000 200 0.02 0.025 0.02 0.025 0.03 0.035 0.04 0.045 0.05 0.06 0.055 0.07
T	TITANIUM	Vc (m/min)
2.1-2.3	pure/alloyed	<1000 50 0.02 0.02 0.02 0.03 0.04 0.04 0.05 0.06 0.06

Dimension	Ø 12	Ø 16	Ø 20
Infeed in mm	ae= 1xD ap= 1xD	ae= 0.2xD ap= 1xD	ae= 1xD ap= 1xD
Application			
Material	Strength (N/mm²)	Feed (mm/Z)	fz

M	STAINLESS STEEL	Vc (m/min)
1.1	ferritic/martensitic	<850 110 0.065 0.08 0.07 0.09 0.09 0.11
2.1	austenitic	<650 100 0.06 0.075 0.065 0.085 0.08 0.1
2.2	austenitic	<750 90 0.055 0.07 0.06 0.08 0.07 0.09
3.1	DUPLEX STEEL super austenitic	<1100 75 0.05 0.065 0.055 0.075 0.06 0.08

P	STEEL unalloyed	Vc (m/min)
1.1-1.5	STEEL unalloyed	<1100 180 0.06 0.08 0.07 0.09 0.09 0.11
2.1-2.4	STEEL low alloyed	<1300 145 0.055 0.075 0.06 0.08 0.08 0.1

K	CASTINGS	Vc (m/min)
1.1	grey cast iron	<1000 200 0.06 0.08 0.08 0.09 0.09 0.11

T	TITANIUM	Vc (m/min)
2.1-2.3	pure/alloyed	<1000 50 0.07 0.08 0.08 0.09

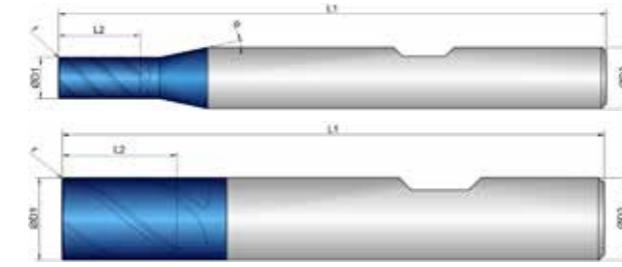
NOTE | The values marked in turquoise are side applications!

Cooling		Strategy	ETC	HPC			
Tolerance	e8	Application					
Coating	AlphaNox Navy X	Features	HB	≠			

- Extra stable tool core with a slightly conical course
- Special unequal tooth pitch combined with variable helical pitch for smooth running

- Designed for maximum removal rate when milling with high radial depth of cut and in the full slot up to 1xD
- For process reliable ramping, helical immersion and diving (drilling) up to 1xD

- Innovative grinding of the flute back for constant, ideal cooling of the cutting edges and prevention of thermal shocks



Roughing

inappropriate optimal inappropriate optimal

	D1 mm ø	L2 mm	L1 mm	D2 mm ø	z #	r mm		α °
EXM1-M01-0114	3.0	6.0	54.0	6.0	4	0.10	40	12
3	4.0	8.0	54.0	6.0	4	0.10	40	12
4	5.0	9.0	54.0	6.0	4	0.20	40	12
5	6.0	10.0	54.0	6.0	4	0.20	40	0
6	8.0	12.0	58.0	8.0	4	0.20	40	0
8	10.0	14.0	66.0	10.0	4	0.20	40	0
10	12.0	16.0	73.0	12.0	4	0.20	40	0
12	16.0	22.0	82.0	16.0	4	0.30	40	0
16	20.0	26.0	92.0	20.0	4	0.30	40	0
20								



Dimension	Ø 3		Ø 4		Ø 5		Ø 6		Ø 8		Ø 10	
	Infeed in mm	ae= 1xD ap= 1xD	ae= 0.2xD ap= 1xD	ae= 1xD ap= 1xD								
	Application											

Material	Strength (N/mm²)	Vc (m/min)													
		Feed (mm/Z)	fz	fz	fz	fz	fz	fz	fz	fz	fz				
	1.1	STAINLESS STEEL	<850												
1.1	ferritic/martensitic	<850	110	0.02	0.03	0.025	0.032	0.03	0.04	0.035	0.045	0.05	0.06	0.055	0.07
2.1	austenitic	<650	100	0.018	0.025	0.02	0.028	0.025	0.035	0.03	0.04	0.045	0.055	0.05	0.065
2.2	austenitic	<750	90	0.015	0.02	0.018	0.022	0.022	0.03	0.025	0.035	0.04	0.05	0.045	0.06
3.1	DUPLEX STEEL super austenitic	<1100	75	0.012	0.018	0.015	0.02	0.018	0.025	0.022	0.03	0.035	0.045	0.04	0.055
P	STEEL	Vc (m/min)													
1.1-1.5	unalloyed	<1100	180	0.02	0.025	0.02	0.025	0.03	0.035	0.04	0.045	0.05	0.06	0.055	0.07
2.1-2.4	low alloyed	<1300	145	0.015	0.02	0.015	0.02	0.025	0.03	0.035	0.04	0.045	0.055	0.05	0.065
3.1-3.3	high alloyed	<1400	135	0.012	0.018	0.012	0.018	0.022	0.028	0.032	0.038	0.042	0.052	0.045	0.06
K	CASTINGS	Vc (m/min)													
1.1	grey cast iron	<1000	200	0.02	0.025	0.02	0.025	0.03	0.035	0.04	0.045	0.05	0.06	0.055	0.07
T	TITANIUM	Vc (m/min)													
2.1-2.3	pure/alloyed	<1000	50	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06		

Dimension	Ø 12		Ø 16		Ø 20	
	Infeed in mm	ae= 1xD ap= 1xD	ae= 0.2xD ap= 1xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 1xD	ae= 1xD ap= 1xD
	Application					

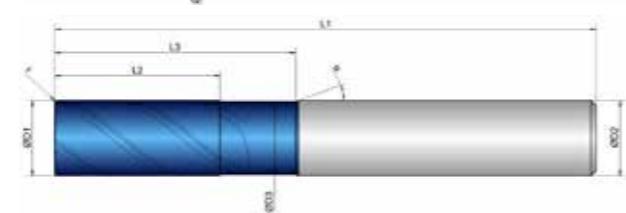
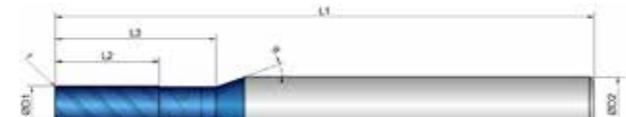
Material	Strength (N/mm²)	Vc (m/min)									
		Feed (mm/Z)	fz	fz	fz	fz	fz	fz	fz	fz	fz
	1.1	STAINLESS STEEL	<850								
1.1	ferritic/martensitic	<850	110	0.065	0.08	0.07	0.09	0.09	0.11		
2.1	austenitic	<650	100	0.06	0.075	0.065	0.085	0.08	0.1		
2.2	austenitic	<750	90	0.055	0.07	0.06	0.08	0.07	0.09		
3											

Cooling		Strategy	ETC	HPC			
Tolerance	e8	Application					
Coating	AlphaNox Navy X	Features	HA	≠			

- Extra stable tool core with a slightly conical course
- Special unequal tooth pitch combined with variable helical pitch for smooth running

- Designed for maximum removal rate when milling with high radial depth of cut and in the full slot up to 1.5xD
- For process reliable ramping, helical immersion and diving (drilling) up to 1xD

- Innovative grinding of the flute back for constant, ideal cooling of the cutting edges and prevention of thermal shocks



Roughing

	Finishing				
	inappropriate	optimal	inappropriate	optimal	

	D1 mm Ø	D3 mm Ø	L2 mm	L3 mm	L1 mm	D2 mm Ø	z #	r mm	R mm	α °
EXM1-M01-0123										
2	2.0	1.8	5.0	10.0	57.0	6.0	4	0.10	40	20
3	3.0	2.8	8.0	13.0	57.0	6.0	4	0.10	40	20
4	4.0	3.8	11.0	17.0	57.0	6.0	4	0.10	40	20
5	5.0	4.8	13.0	20.0	57.0	6.0	4	0.20	40	20
6	6.0	5.8	13.0	20.0	57.0	6.0	4	0.20	40	20
8	8.0	7.7	19.0	25.0	63.0	8.0	4	0.20	40	20
10	10.0	9.7	22.0	32.0	72.0	10.0	4	0.20	40	20
12	12.0	11.6	26.0	38.0	83.0	12.0	4	0.20	40	20
16	16.0	15.5	32.0	44.0	92.0	16.0	4	0.30	40	20
20	20.0	19.5	41.0	54.0	104.0	20.0	4	0.30	40	20



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Dimension	Ø2	Ø3	Ø4	Ø5	Ø6	Ø8
Infeed in mm	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD

Application							
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Material	Strength (N/mm²)	Feed (mm/Z)	fz									
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M STAINLESS STEEL	Vc (m/min)											
--------------------------	-------------------	--	--	--	--	--	--	--	--	--	--	--

1.1 ferritic/martensitic	<850	110	0.015	0.022	0.02	0.03	0.025	0.032	0.03	0.04	0.035	0.045
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2.1 austenitic	<650	100	0.012	0.02	0.018	0.025	0.02	0.028	0.025	0.035	0.03	0.04
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2.2 austenitic	<750	90	0.01	0.018	0.015	0.02	0.018	0.022	0.022	0.03	0.025	0.035
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3.1 DUPLEX STEEL super austenitic	<1100	75	0.008	0.015	0.012	0.018	0.015	0.02	0.018	0.025	0.022	0.03
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P STEEL	Vc (m/min)											
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1.1-1.5 unalloyed	<1100	180	0.015	0.022	0.02	0.025	0.02	0.025	0.03	0.035	0.04	0.045
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2.1-2.4 low alloyed	<1300	145	0.012	0.018	0.015	0.02	0.015	0.02	0.025	0.03	0.035	0.04
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3.1-3.3 high alloyed	<1400	135	0.01	0.015	0.012	0.018	0.012	0.018	0.022	0.028	0.032	0.038
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K CASTINGS	Vc (m/min)											
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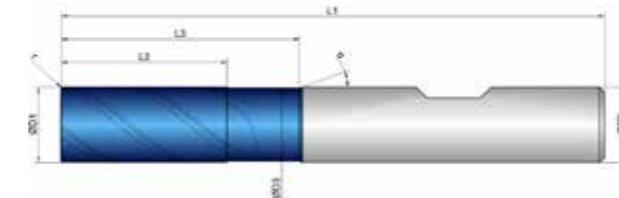
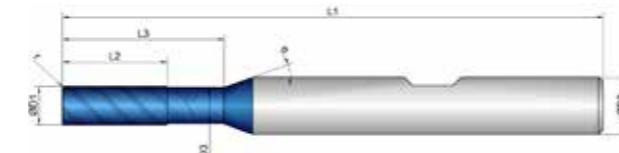
1.1 grey cast iron	<1000	200	0.015	0.022	0.02	0.025	0.02	0.025	0.03	0.
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Cooling		Strategy	ETC	HPC			
Tolerance	e8	Application					
Coating	AlphaNox Navy X	Features	HB	≠			

- Extra stable tool core with a slightly conical course
- Special unequal tooth pitch combined with variable helical pitch for smooth running

- Designed for maximum removal rate when milling with high radial depth of cut and in the full slot up to 1.5xD
- For process reliable ramping, helical immersion and diving (drilling) up to 1xD

- Innovative grinding of the flute back for constant, ideal cooling of the cutting edges and prevention of thermal shocks



Roughing

	Roughing				Finishing			
	inappropriate				optimal			

	D1 mm	D3 mm	L2 mm	L3 mm	L1 mm	D2 mm	z #	r mm	R °	α °
EXM1-M01-0124	mm	mm	mm	mm	mm	mm	#	mm	°	°
2	2.0	1.8	5.0	10.0	57.0	6.0	4	0.10	40	20
3	3.0	2.8	8.0	13.0	57.0	6.0	4	0.10	40	20
4	4.0	3.8	11.0	17.0	57.0	6.0	4	0.10	40	20
5	5.0	4.8	13.0	20.0	57.0	6.0	4	0.20	40	20
6	6.0	5.8	13.0	20.0	57.0	6.0	4	0.20	40	20
8	8.0	7.7	19.0	25.0	63.0	8.0	4	0.20	40	20
10	10.0	9.7	22.0	32.0	72.0	10.0	4	0.20	40	20
12	12.0	11.6	26.0	38.0	83.0	12.0	4	0.20	40	20
16	16.0	15.5	32.0	44.0	92.0	16.0	4	0.30	40	20
20	20.0	19.5	41.0	54.0	104.0	20.0	4	0.30	40	20



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Dimension	Ø2	Ø3	Ø4	Ø5	Ø6	Ø8
Infeed in mm	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD

Strength (N/mm²)	Feed (mm/Z)	fz									
------------------	-------------	----	----	----	----	----	----	----	----	----	----

M STAINLESS STEEL	Vc (m/min)										
1.1 ferritic/martensitic	<850	110	0.015	0.022	0.02	0.03	0.025	0.032	0.03	0.04	0.035
2.1 austenitic	<650	100	0.012	0.02	0.018	0.025	0.02	0.028	0.025	0.035	0.03
2.2 austenitic	<750	90	0.01	0.018	0.015	0.02	0.018	0.022	0.02	0.025	0.035
3.1 DUPLEX STEEL super austenitic	<1100	75	0.008	0.015	0.012	0.018	0.015	0.02	0.018	0.025	0.022

P STEEL	Vc (m/min)										
1.1-1.5 unalloyed	<1100	180	0.015	0.022	0.02	0.025	0.02	0.025	0.03	0.035	0.04
2.1-2.4 low alloyed	<1300	145	0.012	0.018	0.015	0.02	0.015	0.02	0.025	0.03	0.035
3.1-3.3 high alloyed	<1400	135	0.01	0.015	0.012	0.018	0.012	0.018	0.022	0.028	0.032

K CASTINGS	Vc (m/min)										
1.1 grey cast iron	<1000	200	0.015	0.022	0.02	0.025	0.02	0.025	0.03	0.035	0.04

T TITANIUM	Vc (m/min)										
2.1-2.3 pure/alloyed	<1000	50	0.015	0.02	0.02	0.03	0.02	0.03	0.04	0.05	0.05

Dimension	Ø10	Ø12	Ø16	Ø20
Infeed in mm	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD

M STAINLESS STEEL	Vc (m/min)										
1.1 ferritic/martensitic	<850	110	0.055	0.07	0.065	0.08	0.07	0.09	0.09	0.11	
2.1 austenitic	<650	100	0.05	0.065	0.06	0.075	0.065	0.085	0.08	0.1	
2.2 austenitic	<750	90	0.045	0.06	0.055	0.07	0.06	0.08	0.07	0.09	
3.1 DUPLEX STEEL super austenitic	<1100	75	0.04	0.055	0.05	0.065	0.055	0.075	0.06	0.08	

Cooling		Strategy	ETC	HPC		Expert	
Tolerance	e8	Application					
Coating	AlphaNox Navy X	Features	HA	≠		2xD	



- Extra stable tool core with a slightly conical shape
- Optimized roughing teeth for soft cut and small chips
- Special unequal tooth pitch paired with variable helical pitch

- For roughing, up to 2xD full slot
- For process reliable, helical immersion
- For high radial cutting depths

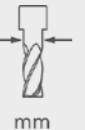
- Also ideally designed for trochoidal mi

Roughing

Finish

inappropriate

optimal

EXM1-M02-0123	D1	D3	L2	L3	L1	D2	z	r		α
										
4	4.0	0.0	8.0	0.0	57.0	6.0	4	0.10	40	12
5	5.0	0.0	9.0	0.0	57.0	6.0	4	0.20	40	12
6	6.0	5.6	13.0	19.0	57.0	6.0	4	0.20	40	20
8	8.0	7.6	19.0	25.0	63.0	8.0	4	0.20	40	20
10	10.0	9.6	22.0	30.0	72.0	10.0	4	0.32	40	20
12	12.0	11.4	26.0	36.0	83.0	12.0	4	0.32	40	20
16	16.0	15.4	32.0	42.0	92.0	16.0	4	0.32	40	20
20	20.0	19.4	41.0	52.0	104.0	20.0	4	0.50	40	20



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	Dimension	Ø4		Ø5		Ø6		Ø8		Ø10		Ø12	
	Infeed in mm	ae= 1xD	ae= 0.2xD	ae= 1xD	ae= 0.2xD								
	Application	ap= 1xD	ap= 2xD	ap= 1xD	ap= 2xD								
Strength													

Material	Strength (N/mm ²)	Feed (mm/Z)	fz										
STAINLESS STEEL		Vc (m/min)											
ferritic/martensitic	<850	100	0.02	0.028	0.025	0.035	0.03	0.04	0.045	0.055	0.05	0.065	0.055
austenitic	<650	90	0.018	0.025	0.02	0.03	0.025	0.035	0.04	0.05	0.045	0.06	0.05
austenitic	<750	80	0.015	0.02	0.018	0.025	0.02	0.03	0.035	0.045	0.04	0.055	0.045
DUPLEX STEEL super austenitic	<1100	70	0.012	0.015	0.015	0.02	0.015	0.025	0.03	0.04	0.035	0.05	0.04
STEEL		Vc (m/min)											
unalloyed	<1100	180	0.018	0.022	0.025	0.03	0.035	0.04	0.045	0.055	0.05	0.065	0.055
low alloyed	<1300	145	0.012	0.018	0.02	0.025	0.03	0.035	0.04	0.05	0.045	0.06	0.05
high alloyed	<1400	135	0.01	0.015	0.015	0.02	0.028	0.032	0.038	0.048	0.04	0.055	0.045
CASTINGS		Vc (m/min)											
grey cast iron	<1000	200	0.018	0.022	0.025	0.03	0.035	0.04	0.045	0.055	0.05	0.065	0.055
TITANIUM		Vc (m/min)											
pure/alloyed	<1000	60	0.008	0.012	0.012	0.02	0.022	0.028	0.033	0.043	0.035	0.05	0.04

Dimension	Ø16		Ø20	
Infeed in mm	ae=	ae=	ae=	ae=
	1xD	0.2xD	1xD	0.2xD
	ap=	ap=	ap=	ap=
	1xD	2xD	1xD	2xD
Application				
Strength				

Material	Strength (N/mm ²)	Feed (mm/Z)		fz	fz	fz	fz
		Vc (m/min)					
STAINLESS STEEL							
ferritic/martensitic	<850	100	0.06	0.08	0.08	0.1	
austenitic	<650	90	0.055	0.075	0.07	0.09	
austenitic	<750	80	0.05	0.07	0.06	0.08	
DUPLEX STEEL super austenitic		<1100	70	0.045	0.065	0.05	0.07

Vc (m/min)						
STEEL unalloyed	<1100	180	0.07	0.085	0.08	0.1
STEEL low alloyed	<1300	145	0.065	0.075	0.07	0.09
STEEL high alloyed	<1400	135	0.06	0.07	0.065	0.08

CASTINGS	Vc (m/min)					
grey cast iron	<1000	200	0.07	0.085	0.08	0.1

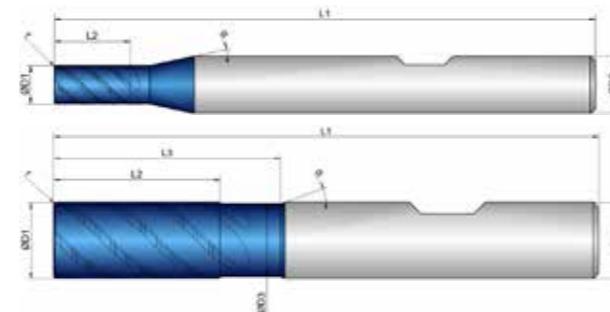
TITANIUM	Vc (m/min)					
pure/alloyed	<1000	60	0.05	0.07	0.06	0.08

| The values marked in turquoise are side applications!

Cooling		Strategy	ETC	HPC			
Tolerance	e8	Application					
Coating	AlphaNox Navy X	Features	HB	≠			

- Extra stable tool core with a slightly conical shape
- Optimized roughing teeth for soft cut and small chips
- Special unequal tooth pitch paired with variable helical pitch

- For roughing, up to 2xD full slot
- For process reliable, helical immersion
- For high radial cutting depths
- Also ideally designed for trochoidal milling



Roughing Finishing

	inappropriate					optimal						inappropriate					optimal				
EXM1-M02-0124	D1 mm	D3 mm	L2 mm	L3 mm	L1 mm	D2 mm	z #	r mm	R mm	α °		D1 mm	D3 mm	L2 mm	L3 mm	L1 mm	D2 mm	z #	r mm	R mm	α °
4	4.0	0.0	8.0	0.0	57.0	6.0	4	0.10	40	12		4.0	0.0	8.0	0.0	57.0	6.0	4	0.10	40	12
5	5.0	0.0	9.0	0.0	57.0	6.0	4	0.20	40	12		5.0	0.0	9.0	0.0	57.0	6.0	4	0.20	40	12
6	6.0	5.6	13.0	19.0	57.0	6.0	4	0.20	40	20		6.0	5.6	13.0	19.0	57.0	6.0	4	0.20	40	20
8	8.0	7.6	19.0	25.0	63.0	8.0	4	0.20	40	20		8.0	7.6	19.0	25.0	63.0	8.0	4	0.20	40	20
10	10.0	9.6	22.0	30.0	72.0	10.0	4	0.32	40	20		10.0	9.6	22.0	30.0	72.0	10.0	4	0.32	40	20
12	12.0	11.4	26.0	36.0	83.0	12.0	4	0.32	40	20		12.0	11.4	26.0	36.0	83.0	12.0	4	0.32	40	20
16	16.0	15.4	32.0	42.0	92.0	16.0	4	0.32	40	20		16.0	15.4	32.0	42.0	92.0	16.0	4	0.32	40	20
20	20.0	19.4	41.0	52.0	104.0	20.0	4	0.50	40	20		20.0	19.4	41.0	52.0	104.0	20.0	4	0.50	40	20



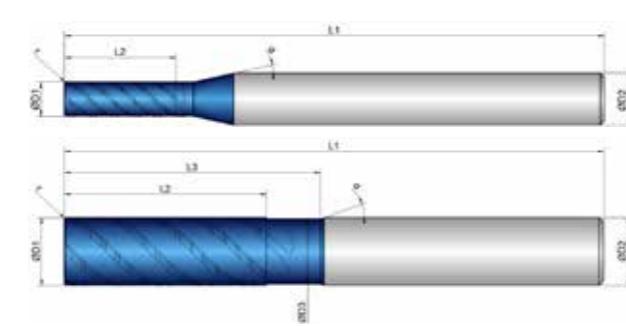
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Dimension	Ø4		Ø5		Ø6		Ø8		Ø10		Ø12	
	Infeed in mm	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD	ae= 1xD ap= 1xD								
	Application											

Material	Strength (N/mm²)	Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)					
		Feed (mm/Z)	fz	Feed (mm/Z)	fz	Feed (mm/Z)	fz	Feed (mm/Z)	fz	Feed (mm/Z)	fz	Feed (mm/Z)	fz	Feed (mm/Z)	fz		
	1.1	STAINLESS STEEL	ferritic/martensitic	<850	100	0.02	0.028	0.025	0.035	0.03	0.04	0.045	0.055	0.05	0.065	0.055	0.07
2.1	austenitic	<650	90	0.018	0.025	0.02	0.03	0.025	0.035	0.04	0.05	0.045	0.06	0.05	0.065	0.05	0.065
2.2	austenitic	<750	80	0.015	0.02	0.018	0.025	0.02	0.03	0.035	0.045	0.04	0.055	0.045	0.06	0.055	0.06
3.1	DUPLEX STEEL super austenitic	<1100	70	0.012	0.015	0.015	0.02	0.015	0.025	0.03	0.04	0.035	0.05	0.04	0.055	0.045	0.055
P	STEEL	Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)			
1.1-1.5	unalloyed	<1100	180	0.018	0.022	0.025	0.03	0.035	0.04	0.045	0.055	0.05	0.065	0.055	0.075	0.065	0.075
2.1-2.4	low alloyed	<1300	145	0.012	0.018	0.02	0.025	0.03	0.035	0.04	0.05	0.045	0.06	0.05	0.07	0.06	0.07
3.1-3.3	high alloyed	<1400	135	0.01	0.015	0.015	0.02	0.028	0.032	0.038	0.048	0.04	0.055	0.045	0.065	0.055	0.065
K	CASTINGS	Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)			
1.1	grey cast iron	<1000	200	0.018	0.022	0.025	0.03	0.035	0.04	0.045	0.055	0.05	0.065	0.055	0.075	0.065	0.075
T	TITANIUM	Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)		Vc (m/min)			
2.1-2.3	pure/alloyed	<1000	60	0.008	0.012	0.012	0.02	0.028	0.033	0.043	0.035	0.05	0.04	0.06	0.04		

Cooling		Strategy	ETC	HPC						
Tolerance	e8	Application								
Coating	AlphaNox Navy X	Features	HA	≠						

- Extra stable tool core with a slightly conical shape
- Optimized roughing teeth for soft cut and small chips
- Special unequal tooth pitch paired with variable helical pitch



Roughing

Finishing

	inappropriate					optimal				
	D1	D3	L2	L3	L1	D2	z	r		α
EXM1-M02-0153										
4	4.0	0.0	13.0	0.0	67.0	6.0	4	0.10	40	12
5	5.0	0.0	16.0	0.0	67.0	6.0	4	0.20	40	12
6	6.0	5.6	18.0	24.0	67.0	6.0	4	0.20	40	20
8	8.0	7.6	24.0	30.0	70.0	8.0	4	0.20	40	20
10	10.0	9.6	30.0	38.0	80.0	10.0	4	0.32	40	20
12	12.0	11.4	36.0	46.0	93.0	12.0	4	0.32	40	20
16	16.0	15.4	48.0	58.0	110.0	16.0	4	0.32	40	20
20	20.0	19.4	60.0	74.0	125.0	20.0	4	0.50	40	20



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Dimension	Ø4	Ø5	Ø6	Ø8	Ø10	Ø12
Infeed in mm	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD
Application						

Material	Strength (N/mm²)	Feed (mm/Z)	fz								
M STAINLESS STEEL											

1.1	ferritic/martensitic	<850	100	0.018	0.025	0.022	0.03	0.022	0.035	0.035	0.05
2.1	austenitic	<650	90	0.015	0.022	0.018	0.025	0.018	0.03	0.03	0.045
2.2	austenitic	<750	80	0.012	0.02	0.015	0.02	0.015	0.025	0.025	0.04
3.1	DUPLEX STEEL super austenitic	<1100	70	0.01	0.015	0.012	0.018	0.012	0.02	0.02	0.035

P STEEL											
1.1-1.5	unalloyed	<1100	180	0.015	0.02	0.022	0.03	0.03	0.035	0.04	0.05
2.1-2.4	low alloyed	<1300	145	0.01	0.015	0.018	0.025	0.025	0.03	0.035	0.045
3.1-3.3	high alloyed	<1400	135	0.008	0.012	0.015	0.022	0.022	0.028	0.032	0.042

K CASTINGS											
1.1	grey cast iron	<1000	200	0.015	0.02	0.022	0.03	0.03	0.035	0.04	0.05
T TITANIUM											

2.1-2.3	pure/alloyed	<1000	60	0.006	0.01	0.01	0.018	0.018	0.025	0.03	0.04
Note The values marked in turquoise are side applications!											

Dimension	Ø16	Ø20		
Infeed in mm	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD	ae= 1xD ap= 1xD	ae= 0.2xD ap= 2xD
Application				

Material	Strength (N/mm²)	Feed (mm/Z)	fz	fz
M STAINLESS STEEL				
1.1	ferritic/martensitic	<850	100	0.055
2.1	austenitic	<650	90	0.05
2.2	austenitic	<750	80	0.045
3.1	DUPLEX STEEL super austenitic	<1100	70	0.04

P STEEL				
1.1-1.5	STEEL unalloyed	<1100	180	0.065
2.1-2.4	STEEL low alloyed	<1300	145	0.06
3.1-3.3	STEEL high alloyed	<1400	135	0.055

K CASTINGS			</

Cooling		Strategy	ETC	HPC		Expert	
Tolerance	e8	Application					
Coating	AlphaNox Navy X	Features	HB	≠		3xD	



- Extra stable tool core with a slightly conical shape
- Optimized roughing teeth for soft cut and small chips
- Special unequal tooth pitch paired with variable helical pitch

■ For roughing, up to 2xD full slot

■ For process reliable, helical immersion

- For high radial cutting depth

Also ideally designed for trochoidal milling

Roughing

Finishi

inappropriate

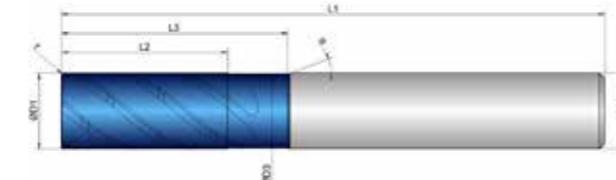
optimal

	D1	D3	L2	L3	L1	D2	z	r	α
EXM1-M02-									
0154	mm \varnothing	mm \varnothing	mm	mm	mm	mm \varnothing	#	mm	°

4	4.0	0.0	13.0	0.0	67.0	6.0	4	0.10	40	12
5	5.0	0.0	16.0	0.0	67.0	6.0	4	0.20	40	12
6	6.0	5.6	18.0	24.0	67.0	6.0	4	0.20	40	20
8	8.0	7.6	24.0	30.0	70.0	8.0	4	0.20	40	20
10	10.0	9.6	30.0	38.0	80.0	10.0	4	0.32	40	20
12	12.0	11.4	36.0	46.0	93.0	12.0	4	0.32	40	20
16	16.0	15.4	48.0	58.0	110.0	16.0	4	0.32	40	20
20	20.0	19.4	60.0	74.0	125.0	20.0	4	0.50	40	20

Cooling		Strategy				
Tolerance	e8					
Coating	AlphaNox Navy X					

- 6 cutting edges for best performance and an excellent material removal rate
- Optimized cutting edges and chip chambers to effectively prevent built-up edges and chip stuck



For roughing and finishing under ETC conditions

For process reliable, helical immersion

Ideal chip evacuation, even with high feed rates and big radial depth of cutting

Roughing



inappropriate

Finishing



inappropriate

optimal

EXM1-M03-0103	D1 mm Ø	D3 mm Ø	L2 mm	L3 mm	L1 mm	D2 mm Ø	z #	r mm		α °
6	6.0	5.8	15.0	19.0	57.0	6.0	6	0.15	40	20
8	8.0	7.8	21.0	25.0	63.0	8.0	6	0.20	40	20
10	10.0	9.8	24.0	30.0	72.0	10.0	6	0.20	40	20
12	12.0	11.8	29.0	36.0	83.0	12.0	6	0.20	40	20
16	16.0	15.8	35.0	42.0	92.0	16.0	6	0.30	40	20
20	20.0	19.8	44.0	52.0	104.0	20.0	6	0.30	40	20



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Dimension	Ø6 Infeed in mm ae= 0.1xD ap= Lmax	Ø8 ae= 0.1xD ap= Lmax	Ø10 ae= 0.1xD ap= Lmax	Ø12 ae= 0.1xD ap= Lmax	Ø16 ae= 0.1xD ap= Lmax	Ø20 ae= 0.1xD ap= Lmax
Application						

Material	Strength (N/mm²)	Feed (mm/Z)	fz	fz	fz	fz	fz
M STAINLESS STEEL	Vc (m/min)						
1.1 ferritic/martensitic	<850	190	0.075	0.09	0.11	0.13	0.15
2.1 austenitic	<650	170	0.065	0.08	0.09	0.11	0.13
2.2 austenitic	<750	140	0.06	0.07	0.08	0.1	0.12
3.1 DUPLEX STEEL super austenitic	<1100	120	0.045	0.05	0.06	0.08	0.1

P	STEEL	Vc (m/min)						
1.1-1.5 unalloyed	<1100	240	0.06	0.08	0.09	0.11	0.14	0.16
2.1-2.4 low alloyed	<1300	180	0.55	0.07	0.085	0.1	0.13	0.14
3.1-3.3 high alloyed	<1400	165	0.05	0.065	0.08	0.09	0.12	0.13

K	CASTINGS	Vc (m/min)						
1.1 grey cast iron	<1000	220	0.06	0.08	0.09	0.11	0.14	0.16

T	TITANIUM	Vc (m/min)						
2.1-2.3 pure/alloyed	<1000	100	0.05	0.065	0.08	0.09	0.12	0.13

NOTE | The values marked in turquoise are side applications!
We recommend the use of HB shank and side lock arbor. (EXM1-M03-0104)
Values for ETC-milling; please reduce Vc and fz by 20% using side milling.

STILL CAN'T FIND A SUITABLE MILLING CUTTER?

No problem – simply customize an existing tool. Using our configurator for special milling cutters, you can customize existing tools to your needs in an instant or create your own tools based on predefined types.

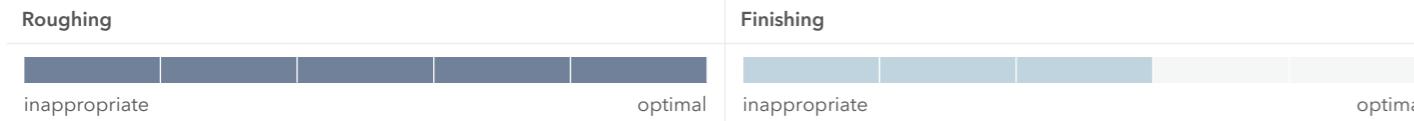
WE WILL RESPOND TO ALL REQUESTS SUBMITTED VIA THE CONFIGURATOR WITHIN ONE WORKING DAY AT THE LATEST



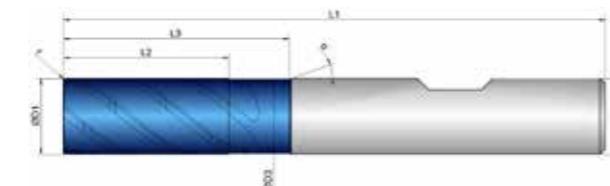
Cooling		Strategy				
Tolerance	e8	Application				
Coating	AlphaNox Navy X	Features				

- 6 cutting edges for best performance and an excellent material removal rate
- Optimized cutting edges and chip chambers to effectively prevent built-up edges and chip stuck

- For roughing and finishing under ETC conditions
- For process reliable, helical immersion
- Ideal chip evacuation, even with high feed rates and big radial depth of cutting



EXM1-M03-0104	D1 mm \varnothing	D3 mm \varnothing	L2 mm	L3 mm	L1 mm	D2 mm \varnothing	z #	r mm	R mm	α $^{\circ}$
6	6.0	5.8	15.0	19.0	57.0	6.0	6	0.15	40	20
8	8.0	7.8	21.0	25.0	63.0	8.0	6	0.20	40	20
10	10.0	9.8	24.0	30.0	72.0	10.0	6	0.20	40	20
12	12.0	11.8	29.0	36.0	83.0	12.0	6	0.20	40	20
16	16.0	15.8	35.0	42.0	92.0	16.0	6	0.30	40	20
20	20.0	19.8	44.0	52.0	104.0	20.0	6	0.30	40	20

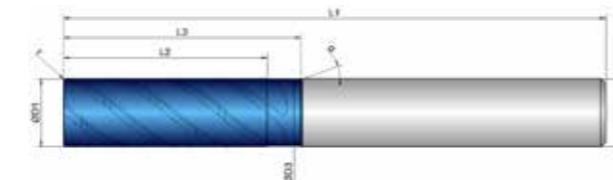


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Dimension	$\varnothing 6$	$\varnothing 8$	$\varnothing 10$	$\varnothing 12$	$\varnothing 16$	$\varnothing 20$
	Infeed in mm ae= 0.1xD ap= Lmax	ae= 0.1xD ap= Lmax				
Application						
Material	Strength (N/mm²)	Feed (mm/Z) fz	fz	fz	fz	fz
M STAINLESS STEEL	Vc (m/min)					
1.1 ferritic/martensitic	<850	190	0.075	0.09	0.11	0.13
2.1 austenitic	<650	170	0.065	0.08	0.09	0.11
2.2 austenitic	<750	140	0.06	0.07	0.08	0.1
3.1 DUPLEX STEEL super austenitic	<1100	120	0.045	0.05	0.06	0.08
P STEEL	Vc (m/min)					
1.1-1.5 unalloyed	<1100	240	0.06	0.08	0.09	0.11
2.1-2.4 low alloyed	<1300	180	0.55	0.07	0.085	0.1
3.1-3.3 high alloyed	<1400	165	0.05	0.065	0.08	0.09
K CASTINGS	Vc (m/min)					
1.1 grey cast iron	<1000	220	0.06	0.08	0.09	0.11
T TITANIUM	Vc (m/min)					
2.1-2.3 pure/alloyed	<1000	100	0.05	0.065	0.08	0.09

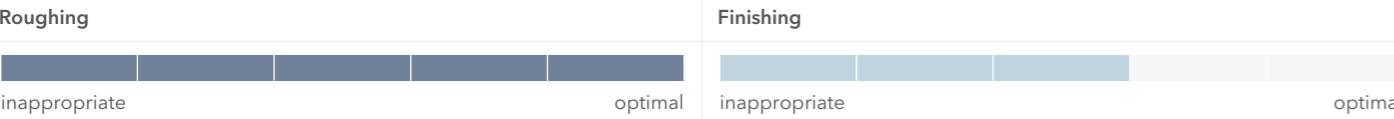
NOTE | The values marked in turquoise are side applications!
Values for ETC-milling; please reduce Vc and fz by 20% using side milling.

Cooling		Strategy				
Tolerance	e8					
Coating	AlphaNox Navy X					



- 6 cutting edges for best performance and an excellent material removal rate
- Optimized cutting edges and chip chambers to effectively prevent built-up edges and chip stuck

- For roughing and finishing under ETC conditions
- For process reliable, helical immersion
- Ideal chip evacuation, even with high feed rates and big radial depth of cutting



EXM1-M03-0113	D1 mm \varnothing	D3 mm \varnothing	L2 mm	L3 mm	L1 mm	D2 mm \varnothing	z #	r mm		
6	6.0	5.8	20.0	25.0	63.0	6.0	6	0.15	40	20
8	8.0	7.8	26.0	30.0	70.0	8.0	6	0.20	40	20
10	10.0	9.8	32.0	36.0	80.0	10.0	6	0.20	40	20
12	12.0	11.8	39.0	45.0	93.0	12.0	6	0.20	40	20
16	16.0	15.8	51.0	55.0	110.0	16.0	6	0.30	40	20
20	20.0	19.8	63.0	70.0	125.0	20.0	6	0.30	40	20



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Dimension	$\varnothing 6$ Infeed in mm ae= 0.07xD ap= Lmax	$\varnothing 8$ ae= 0.07xD ap= Lmax	$\varnothing 10$ ae= 0.07xD ap= Lmax	$\varnothing 12$ ae= 0.07xD ap= Lmax	$\varnothing 16$ ae= 0.07xD ap= Lmax	$\varnothing 20$ ae= 0.07xD ap= Lmax
Application						

Material	Strength (N/mm²)	Feed (mm/Z)	fz	fz	fz	fz	fz
M STAINLESS STEEL	Vc (m/min)						
1.1 ferritic/martensitic	<850	190	0.075	0.09	0.11	0.13	0.15
2.1 austenitic	<650	170	0.065	0.08	0.09	0.11	0.13
2.2 austenitic	<750	140	0.06	0.07	0.08	0.1	0.12
3.1 DUPLEX STEEL super austenitic	<1100	120	0.045	0.05	0.06	0.08	0.1

P	STEEL	Vc (m/min)						
1.1-1.5 unalloyed	<1100	240	0.06	0.08	0.09	0.11	0.14	0.16
2.1-2.4 low alloyed	<1300	180	0.55	0.07	0.085	0.1	0.13	0.14
3.1-3.3 high alloyed	<1400	165	0.05	0.065	0.08	0.09	0.12	0.13

K	CASTINGS	Vc (m/min)						
1.1 grey cast iron	<1000	220	0.06	0.08	0.09	0.11	0.14	0.16

T	TITANIUM	Vc (m/min)						
2.1-2.3 pure/alloyed	<1000	100	0.05	0.065	0.08	0.09	0.12	0.13

NOTE | The values marked in turquoise are side applications!
We recommend the use of HB shank and side lock arbor. (EXM1-M03-0114)
Values for ETC-milling; please reduce Vc and fz by 20% using side milling.

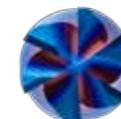
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No problem – simply customize an existing tool. Using our configurator for special milling cutters, you can customize existing tools to your needs in an instant or create your own tools based on predefined types.

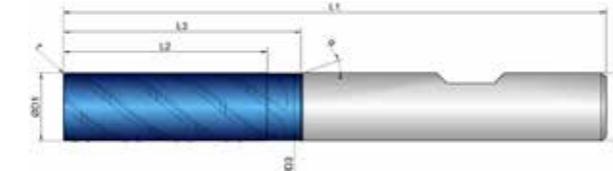
WE WILL RESPOND TO ALL REQUESTS SUBMITTED VIA THE CONFIGURATOR WITHIN ONE WORKING DAY AT THE LATEST



Cooling		Strategy	ETC	
Tolerance	e8	Application		Exper
Coating	AlphaNox Navy X	Features		



- 6 cutting edges for best performance and an excellent material removal rate
- Optimized cutting edges and chip chambers to effectively prevent built-up edges and chip stuck



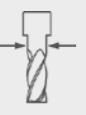
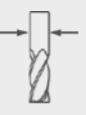
- For roughing and finishing under ETC conditions
- For process reliable, helical immersion

- Ideal chip evacuation, even with high feed rates and big radial depth of cutting

Roughing

Finish

inappropriate

EXM1-M03-0114	D1	D3	L2	L3	L1	D2	z	r		α
										
6	6.0	5.8	20.0	25.0	63.0	6.0	6	0.15	40	20
8	8.0	7.8	26.0	30.0	70.0	8.0	6	0.20	40	20
10	10.0	9.8	32.0	36.0	80.0	10.0	6	0.20	40	20
12	12.0	11.8	39.0	45.0	93.0	12.0	6	0.20	40	20
16	16.0	15.8	51.0	55.0	110.0	16.0	6	0.30	40	20
20	20.0	19.8	63.0	70.0	125.0	20.0	6	0.30	40	20

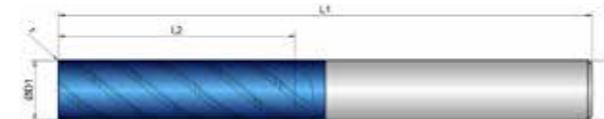


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NOTE | The values marked in turquoise are side applications!
Values for ETC-milling; please reduce V_c and f_z by 20% using side milling

Cooling		Strategy				
Tolerance	e8	Application				
Coating	AlphaNox Navy X	Features				

- 6 cutting edges for best performance and an excellent material removal rate
- Optimized cutting edges and chip chambers to effectively prevent built-up edges and chip stuck



Roughing



Finishing



EXM1-M03-0123	D1 mm ø	L2 mm	L1 mm	D2 mm ø	z #	r mm	
6	6.0	26.0	67.0	6.0	6	0.15	40
8	8.0	34.0	75.0	8.0	6	0.20	40
10	10.0	42.0	90.0	10.0	6	0.20	40
12	12.0	51.0	100.0	12.0	6	0.20	40
16	16.0	67.0	125.0	16.0	6	0.30	40
20	20.0	83.0	150.0	20.0	6	0.30	40



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Dimension	Ø6	Ø8	Ø10	Ø12	Ø16	Ø20		
	Infeed in mm ae= 0.05xD ap= Lmax	ae= 0.05xD ap= Lmax						
Application								
M STAINLESS STEEL	Vc (m/min)							
1.1 ferritic/martensitic	<850	190	0.065	0.08	0.1	0.12	0.14	0.16
2.1 austenitic	<650	170	0.055	0.07	0.08	0.1	0.12	0.14
2.2 austenitic	<750	140	0.045	0.06	0.07	0.09	0.11	0.13
3.1 DUPLEX STEEL super austenitic	<1100	120	0.04	0.045	0.05	0.07	0.09	0.11
P STEEL						Vc (m/min)		
1.1-1.5 unalloyed	<1100	240	0.05	0.07	0.08	0.1	0.13	0.15
2.1-2.4 low alloyed	<1300	180	0.045	0.06	0.075	0.09	0.12	0.13
3.1-3.3 high alloyed	<1400	165	0.04	0.055	0.07	0.08	0.11	0.12
K CASTINGS						Vc (m/min)		
1.1 grey cast iron	<1000	220	0.05	0.07	0.08	0.1	0.13	0.15
T TITANIUM						Vc (m/min)		
2.1-2.3 pure/alloyed	<1000	100	0.04	0.055	0.07	0.08	0.11	0.12

NOTE | The values marked in turquoise are side applications!
We recommend the use of HB shank and side lock arbor. (EXM1-M03-0124)
Values for ETC-milling; please reduce Vc and fz by 20% using side milling.



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WE WILL RESPOND TO ALL REQUESTS SUBMITTED VIA THE CONFIGURATOR WITHIN ONE WORKING DAY AT THE LATEST



Cooling		Strategy				
Tolerance	e8	Application				
Coating	AlphaNox Navy X	Features				

- 6 cutting edges for best performance and an excellent material removal rate
- Optimized cutting edges and chip chambers to effectively prevent built-up edges and chip stuck



For roughing and finishing under ETC conditions

For process reliable, helical immersion

Ideal chip evacuation, even with high feed rates and big radial depth of cutting

Roughing



Finishing



EXM1-M03-0124	D1 mm \varnothing	L2 mm	L1 mm	D2 mm \varnothing	z #	r mm	
6	6.0	26.0	67.0	6.0	6	0.15	40
8	8.0	34.0	75.0	8.0	6	0.20	40
10	10.0	42.0	90.0	10.0	6	0.20	40
12	12.0	51.0	100.0	12.0	6	0.20	40
16	16.0	67.0	125.0	16.0	6	0.30	40
20	20.0	83.0	150.0	20.0	6	0.30	40



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Dimension	$\varnothing 6$ Infeed in mm ae= 0.05xD ap= Lmax	$\varnothing 8$ ae= 0.05xD ap= Lmax	$\varnothing 10$ ae= 0.05xD ap= Lmax	$\varnothing 12$ ae= 0.05xD ap= Lmax	$\varnothing 16$ ae= 0.05xD ap= Lmax	$\varnothing 20$ ae= 0.05xD ap= Lmax
Application						

Material	Strength (N/mm²)	Feed (mm/Z)	fz	fz	fz	fz	fz
M STAINLESS STEEL	Vc (m/min)						
1.1 ferritic/martensitic	<850	190	0.065	0.08	0.1	0.12	0.14
2.1 austenitic	<650	170	0.055	0.07	0.08	0.1	0.12
2.2 austenitic	<750	140	0.045	0.06	0.07	0.09	0.11
3.1 DUPLEX STEEL super austenitic	<1100	120	0.04	0.045	0.05	0.07	0.09
P STEEL	Vc (m/min)						
1.1-1.5 unalloyed	<1100	240	0.05	0.07	0.08	0.1	0.13
2.1-2.4 low alloyed	<1300	180	0.045	0.06	0.075	0.09	0.12
3.1-3.3 high alloyed	<1400	165	0.04	0.055	0.07	0.08	0.11
K CASTINGS	Vc (m/min)						
1.1 grey cast iron	<1000	220	0.05	0.07	0.08	0.1	0.13
T TITANIUM	Vc (m/min)						
2.1-2.3 pure/alloyed	<1000	100	0.04	0.055	0.07	0.08	0.11

NOTE | The values marked in turquoise are side applications!
Values for ETC-milling; please reduce Vc and fz by 20% using side milling.

Cooling		Strategy	HPC		
Tolerance	e8	Application			
Coating	AlphaNox Navy X	Features	HA		

- Slightly conical tool core and special helical pitch
- 7 specially finished cutting edges with optimized geometry
- Face-Finish-bevel for smooth workpiece surfaces

- 7 cutting edges for highest feed rates

- For excellent surfaces and maximum dimensional accuracy



Roughing

	Finishing				
	inappropriate	optimal	inappropriate	optimal	

EXM1-M04-0033	D1 mm ø	D3 mm ø	L2 mm	L3 mm	L1 mm	D2 mm ø	z #		α °
6	6.0	5.8	20.0	25.0	63.0	6.0	7	39	20
8	8.0	7.8	26.0	30.0	70.0	8.0	7	39	20
10	10.0	9.5	32.0	36.0	80.0	10.0	7	39	20
12	12.0	11.5	39.0	46.0	93.0	12.0	7	39	20
16	16.0	15.5	52.0	57.0	110.0	16.0	7	39	20
20	20.0	19.5	64.0	72.0	125.0	20.0	7	39	20



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Dimension	Ø6 Infeed in mm ae= 0.05xD ap= Lmax	Ø8 ae= 0.05xD ap= Lmax	Ø10 ae= 0.05xD ap= Lmax	Ø12 ae= 0.05xD ap= Lmax	Ø16 ae= 0.05xD ap= Lmax	Ø20 ae= 0.05xD ap= Lmax
Application						

Material	Strength (N/mm²)	Feed (mm/Z)	fz	fz	fz	fz	fz
M STAINLESS STEEL	Vc (m/min)						

1.1 ferritic/martensitic	<850	90	0.028	0.03	0.032	0.034	0.036	0.038
2.1 austenitic	<650	80	0.026	0.028	0.03	0.032	0.034	0.036
2.2 austenitic	<750	75	0.024	0.026	0.028	0.03	0.032	0.034
3.1 DUPLEX STEEL super austenitic	<1100	65	0.02	0.022	0.024	0.026	0.028	0.03

P STEEL	Vc (m/min)							
1.1-1.5 unalloyed	<1100	230	0.03	0.032	0.034	0.036	0.038	0.04
2.1-2.4 low alloyed	<1300	200	0.028	0.03	0.032	0.034	0.036	0.038
3.1-3.3 high alloyed	<1400	180	0.025	0.027	0.029	0.031	0.033	0.035

K CASTINGS	Vc (m/min)							
1.1 grey cast iron	<1000	215	0.028	0.03	0.032	0.034	0.036	0.038

T TITANIUM	Vc (m/min)							
2.1-2.3 pure/alloyed	<1000	70	0.022	0.024	0.026	0.028	0.03	0.032

NOTE | The values marked in turquoise are side applications!
to achieve high surface quality, use ae=0.2mm for Ø6-10; ae=0.3mm for Ø12-20
We recommend an empty pass for high surface quality and size accuracy.



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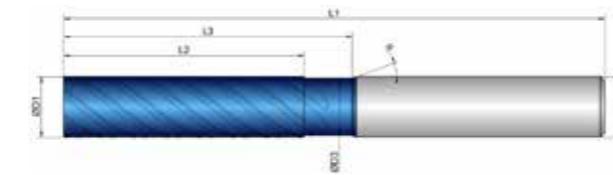


Cooling		Strategy		
Tolerance	e8	Application		
Coating	AlphaNox Navy X	Features		

- Slightly conical tool core and special helical pitch
- 7 specially finished cutting edges with optimized geometry
- Face-Finish-bevel for smooth workpiece surfaces

- 7 cutting edges for highest feed rates

- For excellent surfaces and maximum dimensional accuracy



Roughing

Finishing

	inappropriate	optimal	inappropriate	optimal
--	---------------	---------	---------------	---------

EXM1-M04-0043	D1 mm	D3 mm	L2 mm	L3 mm	L1 mm	D2 mm	z #		α
6	6.0	5.8	26.0	32.0	63.0	6.0	7	39	20
8	8.0	7.8	34.0	40.0	80.0	8.0	7	39	20
10	10.0	9.5	42.0	48.0	90.0	10.0	7	39	20
12	12.0	11.5	51.0	56.0	100.0	12.0	7	39	20
16	16.0	15.5	67.0	72.0	125.0	16.0	7	39	20
20	20.0	19.5	84.0	90.0	150.0	20.0	7	39	20



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Dimension	Ø6 Infeed in mm ae= 0.03xD ap= Lmax	Ø8 ae= 0.03xD ap= Lmax	Ø10 ae= 0.03xD ap= Lmax	Ø12 ae= 0.03xD ap= Lmax	Ø16 ae= 0.03xD ap= Lmax	Ø20 ae= 0.03xD ap= Lmax
-----------	--	------------------------------	-------------------------------	-------------------------------	-------------------------------	-------------------------------



Strength (N/mm²)	Feed (mm/Z) fz	fz	fz	fz	fz	fz
------------------	----------------	----	----	----	----	----

M	STAINLESS STEEL	Vc (m/min)							
1.1	ferritic/martensitic	<850	90	0.028	0.03	0.032	0.034	0.036	0.038
2.1	austenitic	<650	80	0.026	0.028	0.03	0.032	0.034	0.036
2.2	austenitic	<750	75	0.024	0.026	0.028	0.03	0.032	0.034
3.1	DUPLEX STEEL super austenitic	<1100	65	0.02	0.022	0.024	0.026	0.028	0.03

P	STEEL	Vc (m/min)							
1.1-1.5	unalloyed	<1100	210	0.03	0.032	0.034	0.036	0.038	0.04
2.1-2.4	low alloyed	<1300	170	0.028	0.03	0.032	0.034	0.036	0.038
3.1-3.3	high alloyed	<1400	150	0.025	0.027	0.029	0.031	0.033	0.035

K	CASTINGS	Vc (m/min)							
1.1	grey cast iron	<1000	190	0.028	0.03	0.032	0.034	0.036	0.038

T	TITANIUM	Vc (m/min)							
2.1-2.3	pure/alloyed	<1000	65	0.022	0.024	0.026	0.028	0.03	0.032

NOTE | The values marked in turquoise are side applications!
to achieve high surface quality, use ae=0.2mm for Ø6-10; ae=0.3mm for Ø12-20
We recommend an empty pass for high surface quality and size accuracy.

Cooling		Strategy	HSC		
Tolerance	f8	Application			
Coating	AlphaNox Navy X	Features	HA		

- Adjusted core for smooth running
- Defined microbevel for support and stabilization
- Optimized cross cutting edge for maximum stability in the tool center

- For use in HSC milling
- For roughing and finishing

- Radius tolerance $r \leq 2$ mm: ± 0.003 mm
- Radius tolerance $r > 2$ mm: ± 0.005 mm

Roughing

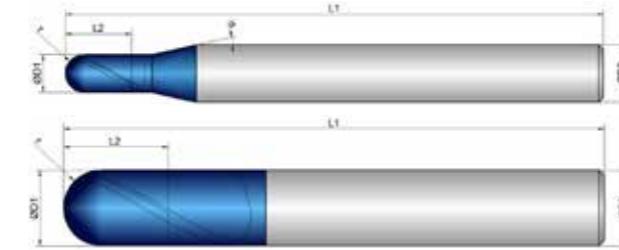
inappropriate

optimal

Finishing

inappropriate

optimal



	D1 mm \varnothing	L2 mm	L1 mm	D2 mm \varnothing	z #	r mm		
EXM1-M08-0003	0.5	1.5	57.0	6.0	2	0.25	30	12
0,5	0.5	1.5	57.0	6.0	2	0.25	30	12
1	1.0	2.0	57.0	6.0	2	0.50	30	12
1,5	1.5	3.0	57.0	6.0	2	0.75	30	12
2	2.0	4.0	57.0	6.0	2	1.00	30	12
2,5	2.5	5.0	57.0	6.0	2	1.25	30	12
3	3.0	6.0	57.0	6.0	2	1.50	30	12
4	4.0	7.0	57.0	6.0	2	2.00	30	12
5	5.0	8.0	57.0	6.0	2	2.50	30	12
6	6.0	10.0	57.0	6.0	2	3.00	30	0
8	8.0	12.0	63.0	8.0	2	4.00	30	0
10	10.0	14.0	72.0	10.0	2	5.00	30	0
12	12.0	16.0	83.0	12.0	2	6.00	30	0



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Dimension	Ø 0.5	Ø 1	Ø 1.5	Ø 2	Ø 2.5	Ø 3	Ø 4	Ø 5	Ø 6	Ø 8	Ø 10	Ø 12			
	Infeed in mm ae = 0.05xD ap = 0.05xD	ae = 0.05xD ap = 0.05xD													
Application															
Material															
Strength (N/mm²)															
M STAINLESS STEEL															
Vc (m/min)															
1.1	ferritic/martensitic	<850	140	0.015	0.025	0.03	0.045	0.05	0.055	0.065	0.075	0.09	0.11	0.12	0.13
2.1	austenitic	<650	120	0.01	0.02	0.025	0.04	0.045	0.05	0.06	0.07	0.08	0.1	0.11	0.12
2.2	austenitic	<750	100	0.008	0.015	0.02	0.035	0.04	0.045	0.055	0.065	0.075	0.095	0.1	0.11
3.1	DUPLEX STEEL super austenitic	<1100	80	0.006	0.012	0.015	0.03	0.035	0.04	0.05	0.06	0.07	0.085	0.09	0.1
P STEEL															
Vc (m/min)															
1.1-1.5	unalloyed	<1100	240	0.012	0.022	0.025	0.04	0.045	0.05	0.06	0.07	0.08	0.1	0.11	0.12
2.1-2.4	low alloyed	<1300	190	0.01	0.018	0.02	0.035	0.04	0.045	0.055	0.065	0.07	0.09	0.1	0.11
3.1-3.3	high alloyed	<1400	185	0.008	0.012	0.018	0.03	0.035	0.04	0.05	0.06	0.065	0.085	0.09	0.1
K CASTINGS															
Vc (m/min)															
1.1	grey cast iron	<1000	280	0.01	0.018	0.02	0.035	0.04	0.045	0.055	0.065	0.07	0.09	0.1	0.11
T TITANIUM															
Vc (m/min)															
2.1-2.3	pure/alloyed	<1000	70	0.006	0.01	0.015	0.02	0.022	0.025	0.03	0.035	0.04	0.05	0.07	0.09

NOTE | The values marked in turquoise are side applications!



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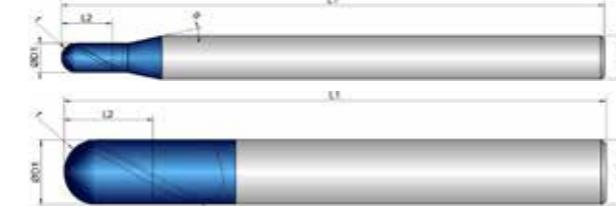


Cooling		Strategy	
Tolerance	f8	Application	
Coating	AlphaNox Navy X	Features	



- Adjusted core for smooth running
- Defined microbevel for support and stabilization
- Optimized cross cutting edge for maximum stability in the toe

- For use in HSC milling
- For roughing and finishing
- Long version for deeper cavities



- Radius tolerance $r \leq 2$ mm: ± 0.003 mm
- Radius tolerance $r > 2$ mm: ± 0.005 mm

Roughing



inappropriate

Finishi

optimal inappropriate optimal

EXM1-M08-0013	D1	L2	L1	D2	z	r		α
0,5	0.5	1.5	75.0	6.0	2	0.25	30	12
1	1.0	2.0	75.0	6.0	2	0.50	30	12
1,5	1.5	3.0	75.0	6.0	2	0.75	30	12
2	2.0	4.0	75.0	6.0	2	1.00	30	12
2,5	2.5	5.0	75.0	6.0	2	1.25	30	12
3	3.0	6.0	75.0	6.0	2	1.50	30	12
4	4.0	7.0	75.0	6.0	2	2.00	30	12
5	5.0	8.0	75.0	6.0	2	2.50	30	12
6	6.0	10.0	75.0	6.0	2	3.00	30	0
8	8.0	12.0	75.0	8.0	2	4.00	30	0
10	10.0	14.0	85.0	10.0	2	5.00	30	0
12	12.0	16.0	100.0	12.0	2	6.00	30	0



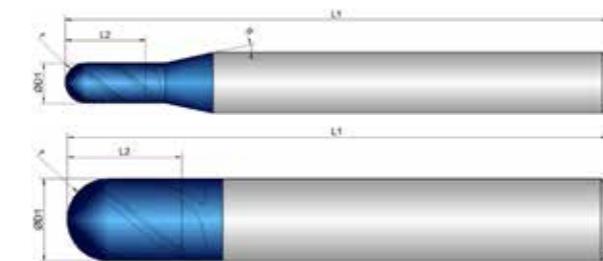
Download Ca
Pages (PDF)

	Download Catalog Pages (PDF)	Dimension	Ø0.5	Ø1	Ø1.5	Ø2	Ø2.5	Ø3	Ø4	Ø5	Ø6	Ø8	Ø10	Ø12
			infeed in mm	ae= 0.05xD ap= 0.05xD										
		Application												
Material	Strength (N/mm²)	Feed (mm/Z)	fz	fz	fz	fz	fz	fz	fz	fz	fz	fz	fz	fz
STAINLESS STEEL		Vc (m/min)												
ferritic/martensitic	<850	130	0.015	0.025	0.03	0.045	0.05	0.055	0.065	0.075	0.09	0.11	0.12	0.13
austenitic	<650	110	0.01	0.02	0.025	0.04	0.045	0.05	0.06	0.07	0.08	0.1	0.11	0.12
austenitic	<750	90	0.008	0.015	0.02	0.035	0.04	0.045	0.055	0.065	0.075	0.095	0.1	0.11
DUPLEX STEEL super austenitic	<1100	70	0.006	0.012	0.015	0.03	0.035	0.04	0.05	0.06	0.07	0.085	0.09	0.1
STEEL		Vc (m/min)												
unalloyed	<1100	220	0.012	0.022	0.025	0.04	0.045	0.05	0.06	0.07	0.08	0.1	0.11	0.12
low alloyed	<1300	170	0.01	0.018	0.02	0.035	0.04	0.045	0.055	0.065	0.07	0.09	0.1	0.11
high alloyed	<1400	165	0.008	0.012	0.018	0.03	0.035	0.04	0.05	0.06	0.065	0.085	0.09	0.1
CASTINGS		Vc (m/min)												
grey cast iron	<1000	250	0.01	0.018	0.02	0.035	0.04	0.045	0.055	0.065	0.07	0.09	0.1	0.11
TITANIUM		Vc (m/min)												
pure/alloyed	<1000	60	0.006	0.01	0.015	0.02	0.022	0.025	0.03	0.035	0.04	0.05	0.07	0.09

NOTE | The values marked in turquoise are side applications!

Cooling		Strategy	HSC		
Tolerance	f8	Application			
Coating	AlphaNox Navy X	Features	HA		

- Adjusted wedge angle and helical pitch for smooth running and a soft cut
- Reinforced face geometry with a special finishing bevel for maximum performance and surface quality



Roughing	Finishing
inappropriate	optimal

inappropriate optimal inappropriate optimal

EXM1-M08-0203	D1 mm ø	L2 mm	L1 mm	D2 mm ø	z #	r mm	R °	β °
3	3.0	5.0	54.0	6.0	4	1.50	40	12
4	4.0	8.0	54.0	6.0	4	2.00	40	12
5	5.0	9.0	54.0	6.0	4	2.50	40	12
6	6.0	10.0	54.0	6.0	4	3.00	40	0
8	8.0	12.0	59.0	8.0	4	4.00	40	0
10	10.0	14.0	66.0	10.0	4	5.00	40	0
12	12.0	16.0	73.0	12.0	4	6.00	40	0
16	16.0	22.0	82.0	16.0	4	8.00	40	0



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Dimension	Ø3	Ø4	Ø5	Ø6	Ø8	Ø10	Ø12	Ø16
Infeed in mm	ae= 0.05xD ap= 0.05xD							
Application								

Material	Strength (N/mm²)	Feed (mm/Z)	fz	fz	fz	fz	fz	fz
M STAINLESS STEEL			Vc (m/min)					
1.1 ferritic/martensitic	<850	140	0.045	0.055	0.06	0.07	0.09	0.1
2.1 austenitic	<650	120	0.04	0.05	0.055	0.065	0.08	0.09
2.2 austenitic	<750	100	0.035	0.045	0.05	0.06	0.075	0.08
3.1 DUPLEX STEEL super austenitic	<1100	80	0.03	0.04	0.045	0.055	0.07	0.08

P	STEEL	Vc (m/min)
1.1-1.5	unalloyed	<1100
2.1-2.4	low alloyed	<1300
3.1-3.3	high alloyed	<1400

K	CASTINGS	Vc (m/min)
1.1	grey cast iron	<1000

T	TITANIUM	Vc (m/min)
2.1-2.3	pure/alloyed	<1000

NOTE | The values marked in turquoise are side applications!

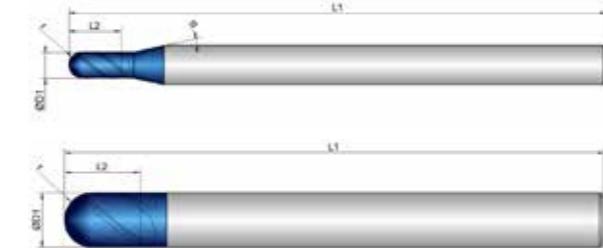
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WE WILL RESPOND TO ALL REQUESTS SUBMITTED VIA THE CONFIGURATOR WITHIN ONE WORKING DAY AT THE LATEST



Cooling		Strategy	HSC		
Tolerance	f8	Application			
Coating	AlphaNox Navy X	Features	HA		

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- Adjusted wedge angle and helical pitch for smooth running and a soft cut
- Reinforced face geometry with a special finishing bevel for maximum performance and surface quality

- For use in HSC milling
- For roughing and finishing
- Long version for deeper cavities

- Highest machining performance due to four cutting edges
- Radius tolerance $r \leq 2 \text{ mm}$: $\pm 0.003 \text{ mm}$
- Radius tolerance $r > 2 \text{ mm}$: $\pm 0.005 \text{ mm}$

Roughing

inappropriate

Finishing

inappropriate optimal

EXM1-M08-0223	D1 mm \varnothing	L2 mm	L1 mm	D2 mm \varnothing	z #	r mm		β °
3	3.0	5.0	83.0	6.0	4	1.50	40	12
4	4.0	8.0	83.0	6.0	4	2.00	40	12
5	5.0	9.0	83.0	6.0	4	2.50	40	12
6	6.0	10.0	83.0	6.0	4	3.00	40	0
8	8.0	12.0	100.0	8.0	4	4.00	40	0
10	10.0	14.0	100.0	10.0	4	5.00	40	0
12	12.0	16.0	100.0	12.0	4	6.00	40	0
16	16.0	22.0	125.0	16.0	4	8.00	40	0

Dimension	Ø3 Infeed in mm ae= 0.05xD ap= 0.05xD	Ø4 ae= 0.05xD ap= 0.05xD	Ø5 ae= 0.05xD ap= 0.05xD	Ø6 ae= 0.05xD ap= 0.05xD	Ø8 ae= 0.05xD ap= 0.05xD	Ø10 ae= 0.05xD ap= 0.05xD	Ø12 ae= 0.05xD ap= 0.05xD	Ø16 ae= 0.05xD ap= 0.05xD
Application								

Material	Strength (N/mm ²)	Feed (mm/Z)	fz						
----------	----------------------------------	-------------	----	----	----	----	----	----	----

M	STAINLESS STEEL	Vc (m/min)									
1.1	ferritic/martensitic	<850	130	0.045	0.055	0.06	0.07	0.09	0.1	0.11	0.13
2.1	austenitic	<650	110	0.04	0.05	0.055	0.065	0.08	0.09	0.1	0.12
2.2	austenitic	<750	90	0.035	0.045	0.05	0.06	0.075	0.08	0.09	0.11
3.1	DUPLEX STEEL super austenitic	<1100	70	0.03	0.04	0.045	0.055	0.07	0.07	0.08	0.1

P	STEEL	Vc (m/min)									
1.1-1.5	unalloyed	<1100	220	0.04	0.05	0.06	0.07	0.09	0.1	0.11	0.13
2.1-2.4	low alloyed	<1300	170	0.035	0.045	0.055	0.065	0.085	0.095	0.1	0.12
3.1-3.3	high alloyed	<1400	165	0.03	0.04	0.05	0.06	0.08	0.09	0.09	0.11

K	CASTINGS	Vc (m/min)									
1.1	grey cast iron	<1000	250	0.035	0.045	0.055	0.065	0.085	0.095	0.1	0.12

T	TITANIUM	Vc (m/min)									
2.1-2.3	pure/alloyed	<1000	60	0.02	0.025	0.03	0.035	0.045	0.06	0.08	0.1

NOTE | The values marked in turquoise are side applications!

EXPLANATION

APPLICATIONS

	Multipass milling		Trimming		Deburring		Engraving
	Corner rounding		Full slot milling		Forward and backward deburring		

COOLINGS

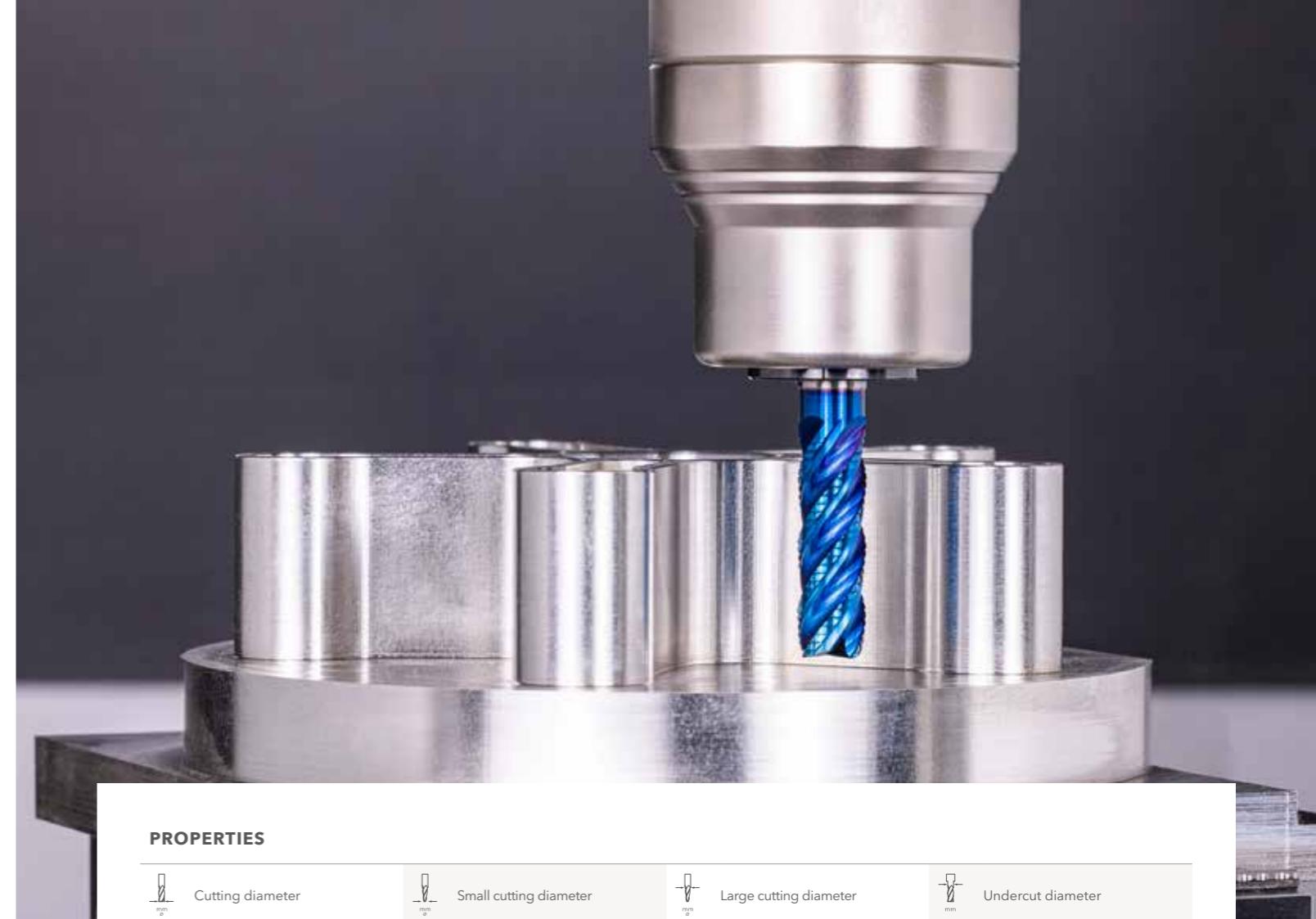
	Air-cooling		Dry machining		Oil cooling		Cooling Lubricant
	Minimum quantity lubrication						

FEATURES

	2xD		3xD		4xD		5xD
	Center cutting		Non-center cutting		Without Weldon		With Weldon
	Internal cooling		Dynamic helical pitch		Chip breaker		Unequal tooth pitch
	Roughing teeth		Helical immersion		Feed directions x.y		Feed directions x.y.z
	Feed directions x.y.z						

STRATEGY

	Extended Trochoidal Cutting		High Performance Cutting		High Speed Cutting		Multi Task Cutting
	Universal Machining						



PROPERTIES

	Cutting diameter		Small cutting diameter		Large cutting diameter		Undercut diameter
	Length of cut		Total bevel length		Undercut length		Total length
	Shank diameter		Number of teeth		Corner radius		Corner bevel
	Programming radius		Maximum depth of cut		Helical angle		Alpha angle

APPLICATION TABLE

The values given in the application table are only guidelines. These values are largely dependent on the machining situation and application.

FIGURES

All technical drawings and photographs are given as an example. The product may deviate from the original in terms of colour and dimensions.

M 1.1 STAINLESS STEEL | ferritic/martensitic <850 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.4000	X6Cr13	X 6 Cr 13	Z 6 C 13	403 S 17	X 6 Cr 13	2301	X 6 Cr 13	SUS 403	403
1.4002	X6CrAl13	X 6 CrAl 13	Z 6 CA 13	405 S 17	X 6 CrAl 13	2302	X 6 CrAl 13	SUS 405	405
1.4003	X2CrNi12	X2CrNi12	CLC 4003		F 12N				
1.4005	X12CrS13	X 12 Cr 13	Z 12 CF 13	416 S 21	X 12 CrS 13	2380	X 12 CrS 13	SUS 416	416
1.4006	X10Cr13	X 12 Cr 13 KD	Z 12 C 13	410 S 21	X 12 Cr 13	2302	X 12 Cr 13	SUS 410	410
1.4008	GX8CrNi13	GX 7 CrNiMo 12 1	Z 12 CN 13 M	410 C 21	GX 12 Cr 13		SCS 1	414	
1.4016	X6Cr17	X 8 Cr 17	Z 8 C 17	430 S 15	X 8 Cr 17 KD	2320	X 8 Cr 17	SUS 430	430
1.4017	X6CrNi171	X 6 CrNi 17 1	F 17 N		X 6 CrNi 17 1				
1.4021	X20Cr13	X 20 Cr 13	Z 20 C 13	420 S 37	X 20 Cr 13	2303	X 20 Cr 13	SUS 420 J1	420
1.4024	X15Cr13	X 15 Cr 13	Z 12 C 13 M	420 S 29	X 12 Cr 13		SUS 410 J1		
1.4027	GX20Cr14		Z 20 C 13 M	420 C 29			SCS 2		
1.4028	X30Cr13	X 30 Cr 13	Z 30 Cr 13	420 S 45	X 30 Cr 13	2304	X 30 Cr 13	SUS 420 J2	420
1.4031	X40Cr13	X 40 Cr 13	Z 40 C 14		X 40 Cr 14	2304	X 40 Cr 13	SUS 420	420
1.4034	X45Cr13	X 45 Cr 13	Z 40 C 14	420 S 45	X 40 Cr 14		X 46 Cr 13		420
1.4057	X19CrNi172	X 19 CrNi 17 2	Z 15 CN 16.02	431 S 29	X 16 CrNi 16	2321	X 15 CrNi 16	SUS 431	431
1.4059	GX22CrNi17		Z 20 CN 17.2 M	ANC 2					
1.4085	GX70Cr29								
1.4086	GX120Cr29			425 C 11					
1.4104	X12CrMoS17	X 14 CrMoS 17	Z 10 CF 17	441 S 29	X 10 CrS 17	2383	X 10 CrS 17	SUS 430 F	430 F
1.4105	X4CrMoS18	X 6 CrMoS 17	Z 6 CDF 18-02				SUS 430 F	430	
1.4106	X10CrMo13								
1.4107	GX8CrNi12	GX 8 CrNi 12		GX 8 CrNi 12					
1.4108	X100CrMo13								
1.4109	X65CrMo14	X 70 CrMo 15	Z 70 CD 14			SUS 440 A	440 A		
1.4110	X55CrMo14		Z 50 CD 13						
1.4111	X110CrMoV15		Z 4 CN b 17		X 6 CrNb 17		SUS 430 LX		
1.4112	X90CrMoV18	X 90 CrMoV 18	Z 3 CT 1 2	409 S 19	X 6 Cr Ti 1 2		SUS 440 B	440 B	
1.4113	X6CrMo171	X 8 CrMo 17	Z 8 CD 17.02	434 S 17	X 8 CrMo 17	2325	SUS 434	434	
1.4115	X20CrMo171								
1.4116	X45CrMoV15	X 50 CrMoV 15	Z 50 CD 15	X50 CrMoV 15	X 46 CrMo 16				
1.4117	X38CrMoV15								
1.4119	X15CrMo13								
1.4120	X20CrMo13		Z 20 CD 14						
1.4122	X35CrMo17	X 35 CrMo 17 1	X39CrMo17-1		X 35 CrMo 17				
1.4123	X15TN								
1.4125	X105CrMo17	X 105 CrMo 17	Z 100 CD 17		X 105 CrMo 17		SUS 440 C	440 C	
1.4136	GX70CrMo292		Z 60 CD 29.2 M						
1.4138	GX120CrMo292								
1.4313	X5CrNi134	X 3 CrNiMo 13 4	Z 4 CDN 13.4	425 C 11	X 3 CrNiMo 13 4	2385	SCS 5	CA 6-NM	
1.4317	GX4CrNi134	GX 4 CrNi 13 4	GX 4 CrNi 13 4		GX 4 CrNi 13 4				
1.4351	X3CrNi134	X 3 CrNi 14 04 KE							
1.4405	GX5CrNiMo165	GX 4 CrNiMo 16 5 1	GX 4 CrNiMo 16 5 1		GX 4 CrNiMo 16 5 1				
1.4502	X8CrTi18	X 6 Cr 18 KE							
1.4510	X6CrTi17	X 8 CrTi 17	Z 8 CT 17		X 6 CrTi 17		X 8 CrTi 17	SUS 430 LX	430 Ti
1.4511	X6CrNb17	X 3 CrNb 17	Z 8 CNb 17		X 6 CrNb 17		SUS 430 LX	430 Nb	
1.4512	X6CrTi12	X 5 CrTi 12	Z 6 CT 12	409 S 19	X 6 CrTi12		SUH 409	409	
1.4523	X8CrMoTi17	X 2 CrMoTiS 18 2	X 2 CrMoTiS 18 2						
1.4528	X105CrCoMo182								
1.4535	X90CrCoMoV17								
1.4543	X3CrNiCuT129		X 6 CrNiB 18 11			HNV 2			
1.4704	X45SiCr16-11	45SiCr16-11							
1.4710	GX30CrSi6	GX 30 CrSi 6							
1.4712	X10CrSi6	K 51255							
1.4713	X10CrAlSi7	X 10 CrAlSi 7							
1.4718	X45CrSi93	X 45 CrSi 8	Z 45 CS 9	401 S 45	X 45 CrSi 8	F.3220	SUH 1	HNV 3	
1.4722	X10CrSi13				X 10 CrSi 13				
1.4724	X10CrAl13	X 10 CrAl 13	Z 10 C 13	BH 12	X 10 CrAl 12		X 10 CrAl 13	SUS 405	H-12
1.4725	X8CrAl144	CrAl 14 4	K 91670						
1.4729	GX40CrSi13				GX 35 Cr 13		SCH 1		
1.4740	GX40CrSi17				GX 35 Cr 17				
1.4742	X10CrAl18		Z 10 CAS 18	403 S 15	X 8 Cr 17	X 10 CrAl 18	SUH 21	430	
1.4745	GX40CrSi23								
1.4747	X80CrNiSi20	X 80 CrNiSi 20	Z 80 CSN 20.02	433 S 65	X 80 CrSiNi 20	X 80 CrSiNi 20-02	SUH 4	HNV 6	
1.4762	X10CrAl24	X 10 CrAl 24	Z 10 CAS 24		X 16 Cr 26	2322	X 10 CrAl 24	SUH 442	446
1.4767	X8CrAl205	CrAl 20 5							
1.4773	X8Cr30								
1.4776	GX40CrSi29			452 C 11	GX 35 Cr 28		SCH 2		

M 2.1 STAINLESS STEEL | austenitic <650 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.4300	X12CrNi188					302			
1.4301	X5CrNi1810	X 6 CrNi 18 10 KD	Z 6 CN 18.09	304 S 15	X 5 CrNi 18 10	2332	X 5 CrNi 18 11	SUS 304	304 H
1.4302	X5CrNi199	X 6 CrNi 20 10 KE	Z 6 CN 18.09	308 S 96					
1.4303	X5CrNi1812	X 8 CrNi 18 12 KD	Z 8 CN 17.07	305 S 19	X 8 CrNi 19 10		X 8 CrNi 18 12	SUS 305	308
1.4305	X10CrNiS189	X 8 CrNiS 19 9	Z 8 CNF 18.09	303 S 31	X 8 CrNiS 18 9	2346	F.310.C	SUS 303	303
1.4307	X2CrNi189	X 2 CrNi 18 9	CLC 18.9.L	304 S 11	X 2 CrNi 18 9		SUS 304 L	304 L	
1.4308	GX6CrNi189	X 2 CrNi 18 7	Z 6 CN 18.10 M	304 C 15	GX 5 CrNi 19 10	2333	SCS 13	CF-8	
1.4310	X12CrNi177	X 12 CrNi 17 7	Z 12 CN 17.07	301 S 21	X 12 CrNi 17 07		X 12 CrNi 17 07	SUS 301	301
1.4311	X2CrNiN1810	X 2 CrNiN 18 10	Z 8 CN 18.12	304 S 62	X 8 CrNi 19 10	2371	X 8 CrNi 18 12	SUS 304 LN	304 LN
1.4312	GX10CrNi188		Z 10 CN 18.9 M	302 C 25				SCS 12	

M 2.2 STAINLESS STEEL | austenitic <750 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.4866	X33CrNiMnN238	X 33 CrNiMnN 23 8	X 33 CrNiMnN 23 8						
1.4871	X53CrMnNiN219		Z 52 CMN 21.09	349 S 54	X 53 CrMnNiN 21 9		X 53 CrMnNiN 21-09	SUH 35	EV 8
1.4873	X45CrNiW189	X 45 CrNiW 18 9	Z 35 CNWS 14.14	331 S 40	X 45 CrNiW 18 9		X 45 CrNiSiW 18-09	SUH 31	
1.4878	X12CrNiTi189	X 10 CrNiTi 18 10	Z 6 CNT 18.12	321 S 20	X 6 CrNiTi 18.11	2337	X 6 CrNiTi 18 11	SUS 321	321
1.4881	X70CrMnNiN216				X 70 CrMnNiN 21 6				EV 11
1.4882	X50CrMnNiNb219	X 50 CrMnNiNb 21 9	Z 50 CMNNb 21.09						
1.4919	X6CrNiMo1713	X 6 CrNiMo 17 12 2	Z 6 CND 17.13 B	316 S 51					316 H
1.4948	X6CrNi1811	X 6 CrNi 18 10	Z 6 CN 18.09	304 S 51	X 5 CrNi 18 10 KW	2333			
1.4949	X3CrNi1811				X 2 CrNiN 18 11				
1.4961	X8CrNiNb1613			347 S 51		X 7 CrNiNb 16 13			
1.4981	X8CrNiMoNb1616					X 7 CrNiMo 16 16			

M 3.1 DUPLEX STEEL | super austenitic <1100 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.4162	X2CrMnNiN2252	X 2 CrMnNiN 22 5 2			X2CrMnNiN21-5-1		S32101	LDX 2101	S321 01
1.4362	X2CrNiN234	X 2 CrNiN 23 4	Z 3 CN 23 04 AZ			2327			S323 04
1.4410	X2CrNiMoN2574	X 2 CrNiMoN 25 7 4	Z 5 CND 20.10 M		X 2 CrNiMoN 25 7 4		SCS 14 A	S327 50	
1.4460	X4CrNiMo2752	X 3 CrNiMo 27 5 2	X 2 CrNiMo 25 7 3		X 3 CrNiMo 27 5 2	2324	X 8 CrNiMo 27 05	SUS 329 J1	S325 50
1.4462	X2CrNiMoN2253	X 2 CrNiMoN 22 5 3	Z 3 CND 22.05 AZ	318 S 13	X 2 CrNiMoN 22 5 3	2377		SUS 329 J3L	S318 03
1.4465	X1CrNiMoN25252	X 1 CrNiMoN 25 2 2	Z 1 CND 25.22 AZ						S310 50
1.4501	X2CrNiMoCuWN2574	X 2 CrNiMoCuWN 25 7 4	Z 3 CND 25.06 AZ				SM 25 Cr	S327 60	
1.4507	X2CrNiMoCuN2563	X 2 CrNiMoCuN 25 6 3	Z 3 CNDU 25.06 AZ				QSA 2505	S325 20	
1.4534	X3CrNiMoAl1382		Z 4 CNDAT 13.09					S138 00	
1.4548	X5CrNiCuNb1744	X 5 CrNiCuNb 16 4	X 5 CrNiCuNb 16 4				SUS 630	S174 00	
1.4568	X7CrNiAl177	X 7 CrNiAl 17 7	Z 9 CNA 17 07	301 S 81	X 7 CrNiAl 17 7	2388	X 7 CrNiAl 17 7	SUS 631	S177 00

P 1.1 STEEL | unalloyed <500 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.0498	ST42.8						STPT 42		
1.0044	ST442	E28-2	4360-43 B	Fe 430 BFN	1412	AE 275-B	SM 41 B	570 Gr. 40	
1.0420	GS38	GE 200	230-400M			1306			
1.0446	GS45	GE 230	E23-45M	A1		1305	F.221	SC 450	
1.0136	St42-3								
1.0254	St37.0	P235T1				STPG 38			
1.1120	GS20Mn5					SMnC 420			
1.1121	Ck10	2 C 10	XC 10	040 A 10	C 10	1265	C 10 k	S 10 C	1010
1.1131	GS15Mn5								
1.1151	Ck22	2 C 22	XC 25	050 A 20	C 20		C 25 k	S 22 C	1023
1.5523	19MnB4		170 H 20			20 Mn B 4 DF		SWRCHB	
1.8961	WTSt373		Fe 360 D FF			SMA 50 A			
1.0035	ST33		A 33	FE 320			SS 330		
1.0037	ST37-2					STKR 400			
1.0710	15S10								
1.0715	9SMn28	11 Smn 28	S 250	230 M 07	CF 9 Smn 28	1912	11 Smn 28	SUM 22	1213
1.0718	9SMnPb28	11 SmnPb 28	S 250 Pb	CF 9 SmnPb 28	1914	11 SmnPb 28	SUM 22 L	12 L 13	
1.0721	10S20	10 S 20	10 F 1	210 M 15	CF 10 S 20	10 S 20		1108	
1.0722	10SPb20	10 SPb 20	10 Pb F 2	CF 10 SPb 20		10 SPb 20		11 L 08	
1.0736	9SMn36	S300	240 M 07	CF 9 Smn 36		12 Smn 35	SUM 25	1215	
1.0737	9SMnPb36	S 300 Pb	CF 9 SmnPb 36	1926		12 SmnPb 35		12 L 14	

P 1.2 STEEL | unalloyed <700 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.0553	S244J0	S355J0	E 36-3	En 50 C	Fe 510 C FN				SM 520 M
1.0581	ST52.4								SG 49
1.1140	C15R	C15R	C15R	C15R					C 16 k-1
1.1141	Ck15	2 C 15	XC 15	080 M 15	C 15	1370	C 16 k	S 15 C	1015
1.1190	S355G15								SM 50 A
1.0116	ST373		E 24-3	4360-40 C	Fe 37-3	1312	A 360 C		A 570 Gr. 36
1.0144	ST443		E 28-3	4360-43 C	Fe 430 D FF	1414	AE 275-D	SM 41 B	A 573 Gr. 70
1.0401	C15		CC12	080 M 15	C 15	1350	F.111	S 15 C	1015
1.0402	C22	1 C 22	CC 22	070 M 20	C 22		C 22 k	SFVC 1	
1.0406	C25	1 C 25	CC 25	070 M 26	C 25		C 25 k	S 22 C	1025
1.0461	STE255								
1.0482	19Mn5		A 52 CP	224-460					SG 37
1.0486	STE285				FE E 285 KG		AE 285 KG	SM 41 A	
1.0501	C35	1 C 35	CC 35	060 A 35	C 35	1550	F.113	S 35 C	1035
1.0503	C45	1 C 45	CC 45	080 M 46	C 45	1650	C 45 k	S 45 C	1045
1.0505	STE315								SM 50 A
1.0511	C40	1 C 40		080 M 40				F.114.A	S 40 C
1.0528	C30	1 C 30	CC 32	080 M 30	C 30			SUP 7	1030
1.0540	C50	1 C 50		080 M 50			1674	S 50 C	10

P 1.3 STEEL | unalloyed <850 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.1165	GS30Mn5		35 M 5	120 M 36		1330	30 Mn 5	SMn 433 H	1330
1.1525	C80W1	C 80 U	Y1 90		C 80 KU	1880	F.513	W 108	
1.1545	C105W1	C 105 U	Y1 105	BW 1A	C 100 KU	1880	F.515	W 110	
1.1620	C70W2	C 70 U							
1.1625	C80W2		Y1 80	BW 1B	C 80 KU	C 80	SKC 3	W 1	
1.1645	C105W2					C 102	SK 3		
1.1663	C125W	C 120 U	Y2 120		C 120 KU	C 120	SK 2	W 112	
1.1673	C135W		Y2 140		C 140 KU		SK 1		
1.1740	C60W		Y3 55				SK 7		
1.1820	C55W								
1.1830	C85W	C 90 U	Y3 90			SK 5	1084		
1.1744	C67W		Y1 70			F.512		A-6	
1.1750	C75W			BW 1A				W 1	
1.5404	21MoV53								
1.5406	17MoV84								
1.5633	24Ni8	G 9 Ni 10	22 N 8	G 9 Ni 10		SCPL 21			
1.6311	20MnMoNi45	20 MnMoNi 4 5				SCV 2 B			
1.7242	16CrMo4	18 CrMo 4	15 CD 3.5	18 CrMo 4	18 CrMo 4	SCM 418 H			
1.7258	24CrMo4					SCM 822 H			
1.7259	26CrMo7								
1.7273	24CrMo10								
1.7337	14CrMo44			A18 CrMo 4 5 KW		A 387 Gr. 12 Cl. 2			
1.7350	22CrMo44								
1.7362	12CrMo195	X 12 CrMo 5	Z 10 CD 5.05	3606-625	16 CrMo 20 5		SCMV 6		
1.7709	21CrMoV57	21 CrMoV 5 7	20 CDV 5.07						
1.7766	17CrMoV10								
1.7779	20CrMoV135								

P 1.4 STEEL | unalloyed <950 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.0062	ST601								
1.0532	ST522	S 390 G 1 S							
1.0535	C55	1 C 55	C 55	070 M 55	C 55	1655	C 55	1055	
1.0570	ST523	S 355 J2 F3	E 36-3	4360-50 B	Fe 510 B	2132	A 510 C	SM 50 YB	
1.0728	60S20	60 S 20	60 MF 4					1151	
1.1203	Ck55	2 C 55	XC 55 H1	070 M 55	C 55	1655	C 55 k	S 55 C	1055
1.7276	10CrMo11		12 CD 10						
1.7281	16CrMo93		20 CD 8						

P 1.5 STEEL | unalloyed <1100 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.0070	ST702			A 70-2			Fe 70-2		
1.0601	C60	1 C 60	AF 70 C 55	080 A 62	C 60			S 60 C-CSP	1060
1.1221	Ck60	2 C 60	XC 60	060 A 62	C 60	1678		S 58 C	1060
1.1223	Cm60	3 C 60	C 60 R	080 A 67	C 60 R				
1.0603	C67W								

P 2.1 STEEL | low alloyed <750 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.0961	60SiCr7	60 SiCr 8	60 SC 7	250 A 61	60 SiCr 8		60 SiCr 8	SUP 7	9262
1.2101	62SiMnCr4								
1.2162	21MnCr5	21 MnCr 5	20 NC 5					SCR 420 H	
1.2208	31CrV3								
1.2210	115CrV3	107 CrV 3 KU	100 C 3		107 CrV 3 KU		F.520.L	L2	
1.2235	80CrV2						F.520.J		
1.2241	51CrV4	51 CRMnV 4			51 CrMnV 4 KU				S6
1.2307	29CrMoV9								
1.2323	48CrMoV67		45 CDV 6						
1.2382	GX155CrVMo121								
1.2414	120W4							F.532	
1.2542	45WCrV7	45 WCrV 8		BS 1	45 WCrV 8 KU	2710	45 WCrSi 8	S1	
1.2552	80WCrV8						60 WCrSi 8		
1.2726	26NiCrMoV5								
1.2737	28NiCrV5								
1.2738	40CrMnNiMo864	40CrMnNiMo8-6-4							
1.2826	60MnSi4		60 MSC 4						
1.2838	145V33								
1.2842	90MnCrV8	90 MnV 8	90 MV 8	BO 2	90 MnVCr 8 KU			0 2	
1.5752	14NiCr14	13 NiCr 12	16 NC 12	655 M 13	16 NiCr 11			SNC 815 H	E3310
1.5919	15CrNi6	14 CrNi 6	16 NC 6	S 107	16 CrNi 4			SNCM 420	
1.7003	38Cr2	38 Cr 2 KD	38 C 2	120 M 36	38 Cr 3		38 Cr 3	SMn 438	50 B40
1.7012	13Cr2								
1.7045	42Cr4	40 NiCrMo 3	42 C 4 TS	530 A 40	41 Cr 4	2245	42 Cr 4	SCr 440	5140
1.7103	67SiCr5	67 SiCr 5			67 SiCr 5				
1.7131	16MnCr5	16 MnCr 5 KD	16 MC 5	527 M 17	16 MnCr 5	2173	16 MnCr 5	SCR 415	5115
1.7271	23CrMoB33								
1.7715	14MoV63	14 MoV 6-3		1503-660-440				13 MoCrV 6	
1.8907	STE500							SM 58	
1.8911	ESTE380								

P 2.2 STEEL | low alloyed <950 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.0902	46Si7		45 S7				46 Si 7		
1.0906	65Si7			250 A 61					
1.0985	QSTE500N								
1.1157	40Mn4		35 M 5	150 M 36				1039	
1.1167	36Mn5		40 M 5	150 M 36		2120	36 Mn 5		1335
1.1170	28Mn6	28 Mn 6	35 M 5	150 M 17	C 28 Mn		36 Mn 6	SCMn 1	1330
1.1199	49MnVS3			280 M 01					
1.2002	125Cr1		Y2 120 C						
1.2003	75Cr1		35 M 5	150 M 36					
1.2004	85Cr1		Y1 100 C 2						
1.2008	140Cr3		Y2 140 C				SKS 8		
1.2056	90Cr3								
1.2057	105Cr4				F.120.J		SKC 11		
1.2108	90CrSi5	P 280 GH		C 100 KU	2092		SFVC 2A		
1.2109	125CrSi5								
1.2127	105MnCr4			100 CrMn 4 KU			SUJ 3		
1.2206	140CrV1		130 C 3					0 6	
1.2242	59CrV4								
1.2243	61CrSiV5								
1.2249	45SiCrV6								
1.2303	100CrMo5				F.520.F		L 7		
1.2312	40CrMnMoS86		40 CMD 8						
1.2519	110WCrV5				102 WCrV 5				
1.2562	142WV13								
1.2740	28NiCrMoV10								
1.2743	60NiCrMoV124								
1.2747	28NiMo17								
1.2766	35NiCrMo16								
1.2851	34CrAl6								
1.3501	100Cr2		100 C 2			E 50100			
1.3503	105Cr4					E51100			
1.3505	100Cr6	100 Cr 6	100 C 6	535 A 99	100 Cr 6	2258	100 Cr 6	SUJ 2	E52100
1.3520	100CrMn6	100 Cr Mn 6	100 CM 6				100 CrMn 6		

P 2.3 STEEL | low alloyed <1100 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.2419	105WCr6		105 WCr 5		105 WC 13				
1.2511	80WCrV3					107 WcR 5 KU	2140	105 WCr 5	SKS 31
1.2515	100WV4								SKS 21
1.3561	44Cr2		46 Cr 1 KD		44 Cr 2				5046
1.3563	43CrMo4				43 CrMo 4				4142
1.3565	48CrMo4								
1.5023	38Si7								
1.5025	51Si7		50 Si 7			48 Si 7	2090		9259 H
1.5029	71Si7								
1.5085	51Mn7								
1.5094	38MnS6		38 MnS 6						
1.5131	50MnSi4								
1.5141	53MnSi4								
1.5142	60MnSi5								
1.5213	15MnV5								
1.5217	20MnV6								
1.5223	42MnV7								
1.5225	51MnV7								
1.5231	38MnSiVS5								
1.5232	27MnSiVS6								
1.5233	44MnSiVS6								
1.5403	17MnMoV64					1501-261			SBV 3
1.5526	30MnB4								
1.5710	36NiCr6			30 NC 6	640 A 35				SNC 236 3135
1.5736	36NiCr10			30 NC 11		35 NiCr 9			SNC 631 H 3435
1.5755	31NiCr14			18 NC 13	653 M 31				SNC 836
1.6225	11NiMn54								
1.6310	20MnMoni55			18 MND 5					
1.6368	15NiCuNb5				3604-591				SBV 2
1.6511	36CrNiMo4	36 CrNiMo 4	40 NCD 3	816 M 40	38 NiCrMo 4 KB		35 NiCrMo 4		9840
1.6582	34CrNiMo6	34 CrNiMo 6	35 NCD 6	817 M 40	35 NiCrMo 4 KB	2541	40 NiCrMo 7	SNCM 447	4340
1.6946	30CrMoNiV511								
1.6948	26NiCrMoV115								
1.6971	79Ni1								
1.6972	83Ni1								
1.7038	37CrS4		37 CrS 4						SUP 11 50 B50 H
1.7214	25CrMo4					25 CrMo 4 F			
1.7389	GX12CrMo101								
1.7561	42CrV6								
1.7701	51CrMoV4			51 CDV 4		51 CrMoV 4			
1.7707	30CrMoV9								
1.7711	40CrMoV47		40 CrMo V 4 6	42 CDV 4	1506-670-860				SNB 21-1-5
1.7725	GS30CrMoV64								
1.7733	24CrMoV55			20 CDV 6		24 CrMoV 5 5			
1.7735	14CrMoV69								
1.7741	42CrMoV73								
1.7755	GS45CrMoV104								
1.7756	GS36CrMoV104		G 36 CrMoV 10 4						
1.8070	21CrMoV511					21 CrMoV 5 11			
1.8159	50CrV4		51 CrV 4	50 CV 4	735 A 50	50 CrV 4	2230	51 CrV 4	SUP 10 6150
1.8212	21CrMoW12								
1.8521	15CrMoV59								
1.8509	41CrAlMo7	41 CrAlMo 7	40 CAD 6.12	905 M 39	41 CrAlMo 7	2940	41 CrAlMo 7	SACM 645	E 71400
1.8515	31CrMo12	31 CrMo 12	30 CD 12	722 M 24	31 CrMo 12	2240	31 CrMo 12		
1.8523	39CrMoV139	39 CrMoV 13 9		897 M 39	36 CrMoV 10				
1.8550	34CrAlNi7	34 CrAlMo 5							
1.8827	S460M		E 460	S 460 M	S 460 M				

P 2.4 STEEL | low alloyed <1300 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.1273	90Mn4			060 A 96			SUP 4	1090	
1.2311	40CrMnMo7			BP 20	35 CrMo 8 KU			P 20	
1.2710	45NiCr6								
1.2762	75CrMoNiW67								
1.5864	35NiCr18								
1.6587	17CrNiMo6	17 CrNiMo 7	18 NCD 6	820 A 16	18 NiCrMo 7	2523	14 NiCrMo 13	SNCM 815	
1.7222	42CrMoPb4								
1.7225	42CrMo4.M4S	42 CrMo 4	42 CD 4	708 A 42	42 CrMo 4	2244		SCM 440 H	4140
1.7227	42CrMoS4	42 CrMoS 4	42 CD	708 H 42	42 CrMoS 4	2244	40 CrMo 4		
1.7238	49CrMo4								

P 3.1 STEEL | high alloyed <800 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.2362	X63CrMoV51								
1.2363	X100CrMoV51	X 100 CrMo V 1	Z 100 CDV 5	BA 2	X 100 CrMo V 5 KU	2260	X 100 CrMoV 5	SKD 12	A 2
1.2367	X38CrMoV53								
1.2376	X96CrMoV12								
1.2379	X155CrMo121	X 153 CrMoV 12	Z 160 CDV 12	BD 2	X 155 CrVMo 12 KU	2310		SKD 11	D 2
1.2453	X130W5								
1.2564	X30WCrV41	30 WCrV 15 1				F.527			
1.2567	X30WCrV53	X 30 WCrV 5 3	Z 32 WCV 5		X 30 WCrV 5 3 KU			SKD 4	
1.2606	X37CrMoW51		Z 35 CWDV 5	BH 12	X 35 CrMoW 05 KU		F.537	SKD 62	H 12
1.2631	X50CrMoW911								
1.2786	X13NiCrSi3615	X 13 CrNiSi 36 15	Z 35 NCS 37-18						
1.2889	X45CoCrMoV553								

P 3.2 STEEL | high alloyed <1100 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.2083	X42Cr13	X 42 Cr 13	Z 40 C 14		X 41 Cr 13 KU	2314		SUS 420 J2	420
1.2316	X36CrMo17	X 36 CrMo 17	X38CrMo 16 1		X 38 CrMo 16 1 KU		X 38 CrMo 16		D-4
1.2343	X38CrMoV11	X 38 CrMoV 5 1	Z 38 CDV 5	BH 11	X 37 CrMoV 5 1 KU		X 37 CrMoV 5	SKD 6	H 11
1.2344	X40CrMoV51	X 40 CrMoV 5 1	Z 40 CDV 5	BH 13	X 40 CrMoV 5 1 1 KU	2242	X 40 CrMoV 5	SKD 61	H 13
1.2436	X210CrW12	X 210 CrW 12	Z 210 CW 12		X 215 CrW 12 1 KU	2312	X 210 CrW 12	SKD 2	
1.2581	X30WCrV93	X 30 WCrV 9 3	Z 30 WCV 9	BH 21	X 30 WCrV 9 3 KU		X 30 WCrV 9	SKD 5	H 21
1.2601	X165CrMoV12	X 165 CrMoV 12			X 165 CrMoW 12 KU	2310	X 160 CrMoV 12		
1.2622	X60WCrMoV94								
1.2678	X45CrCoWV555					H 19			
1.2731	X50NiCrWV1313								
1.2764	X19NiCrMo4								
1.2767	X45NiCrMo4	40 NiCrMo 4	Y 35 NCD 16		42 NiCrMo 15 7 KU			A 9	
1.2779	X6NiCrTi2615				S 66286			660	
1.2787	X23CrNi17	HS 6-5-2	Z 85 WDCV 06 05	04 02	BM 2	HS 6 5 2 2	2722		SKH 9
1.3302	S1214	HS 12 1 4			X 150 WV 1305 KU			A 7	
1.3318	S1212	HS 02.01.12							
1.3401	X120Mn12	X 120 Mn 12	Z 120 M 12	BW 10	X G 120 Mn 12	2183	AM-X 120 Mn 12	SCMnH 1	A 128
1.3543	X102CrMo17	X 102 CrMo 17	X100CrMo17		X 105 CrMo 17		X 100 CrMo 17		
1.3549	X89CrMoV81								
1.3551	80MoCrV4216		80 DCV 40	T 11350	X 80 MoCrV 4 4		80 MoCrV 40-16		M 50

P 3.3 STEEL | high alloyed <1400 N/mm²

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
1.2709	X3NiCoMoTi1895								
1.2790	72SiNiCrMoV54								
1.2888	X20CoCrWMo109								
1.3202	S12145		HS12-1-5-5						T 15
1.3207	S104310	HS10-4-3-10	Z130WKCDV10-10-04-04		BT 42		HS 12-1-5-5		
1.3243	S6525	HS6-5-2-5	KCV 06-05-04-02				HS 6-5-2-5	2723	
1.3246	S7425	HS1-8-1	Z110 WKCDV 07-05-04		T 11341		HS 7-4-2-5		
1.3247	S21018	HS2-9-1-8	Z110 DKCWV 09-08-04		BM 42		HS 2-9-1-8		
1.3249	S2928				BM 34		2-9-2-8		
1.3255	S18125	HS18-1-1-4	Z80 WKCV 18-05-04-01		BT 4		HS 18-1-1-5		
1.3257	S181215								
1.3265	S181210	HS18-0-1-10					HS 18-0-1-10		
1.3342	SC652	HS6-5-2	Z90 WDCV 06-05-04-02				HSC 6-5-3		
1.3343	S652	HS6-5-3	Z85 WDCV 06-05-04-02		BM 2		HS 6-5-2	2722	
1.3344	S653		Z120 WDCV 06-05-04-03				6-5-3		
1.3346	S291	HS1-8-1	Z85 DCWV 08-04-02-01		BM 1		HS 1-8-1		
1.3348	S292	HS2-9-2	Z100 DCWV 09-04-02-02				HS 2-9-2	2782	
1.3355	S1801	HS18-0-1	Z80 WCV 18-04-01		BT 1		HS 18-0-1		

K 1.1 GREY CAST IRON <600 N/mm² (180 HB)

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
0.6010	GG10	GJL-100	FGL 100	Grade 100	G 10	0110-00	FG 10	FC 100	A48-20 B
0.6012	GG150 HB	GJL-HB 170							
0.6015	GG15	GJL-150	FGL 150	Grade 150	G 15	0115-00	FG 15	FC 150	A48-25 B
0.601									

K 2.2 MODULAR CAST IRON <850 N/mm² (250 HB)

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
0.7060	GGG60	GJS 600-3	FGS 600-3	SNG 600/3	GS 600/3	0732-03		FCD 600	80-55-06
0.7070	GGG70	GJS 700-2	FGS 700-2	SNG 700/2	GS 700-2	0737-01		FCD 700	100-70-03
0.7080	GGG80	GJS 800-2	FGS 800-2	SNG 800/2	GS 800-2			FCD 800	

K 3.1 MALLEABLE CAST IRON <440 N/mm² (130 HB)

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
0.8038	GTWS3818	GJMW-360-12	MB 300-12	W 38-12	W38-12	5922			
0.8040	GTW4005	GJMW-400-5	MB 400-5	W 40-05	GMB 40			FCMW 370	
0.8045	GTW4507	GJMW-450-7	MB 450-7	W 40-07	GMB 45			FCMW 440	
0.8055	GTW55				GMB 55				
0.8065	GTW65				GMB 65				
0.8135	GTS3510	GJMB-350-10	MN 350-10	B 340/12		0815		FCMP 330	32510
0.8145	GTS4506	GJMB-450-6	MP 45-06	P 440/7		0852		FCMP 440 c3	40010

K 3.2 MALLEABLE CAST IRON <800 N/mm² (230 HB)

Materialnumber	Germany DIN	Europe EN	France AFNOR	Great Britain BS	Italy UNI	Sweden SIS	Spain UNE	Japan JIS	USA AISI
0.8035	GTW3504	GJMW-350-4						FCMW 330 c1	
0.8155	GTS5504	GJMB-550-4	MP 50-5	P 510/4		0854		FCMP 490	50005
0.8165	GTS6502	GJMB-650-2	MP 60-3	P 570/3		0858		FCMP 540	70003
0.8170	GTS7002	GJMB-700-2	Mn 700-2	P 690/2	GMN 70	0862		FCMP 690	90001

Technical formulas

Calculate cutting speed (m/min)

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

Explanation of terms

Calculate rotational speed (rpm)

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

Vc Cutting speed in m/min

Calculate feed rate (mm/min)

$$V_f = n * z * f_z$$

n Rotational speed in rpm

Calculate feed per tooth (mm/number of teeth)

$$f_z = \frac{V_f}{n * z}$$

Vf Feed rate in mm/min

Calculate chip removal rate (cm³/min)

$$Q = \frac{ap * ae * V_f}{1000}$$

fz Feed per tooth in mm/number of teeth

Calculate average chip thickness (mm)

$$h_m = f_z * \frac{\sqrt{ae}}{D}$$

ap Depth of cut in mm

ae Width of cut in mm

hm Average chip thickness in mm

Q Chip removal rate in cm³/min

D Diameter of tool in mm



GENERAL TERMS OF SALE

§ 1 SCOPE

1. These General Terms of Sale apply to all business relationships between Hofmann & Vratny OHG (hereinafter referred to as "Hofmann & Vratny") and its customers (hereinafter referred to individually as the "Ordering Party" and collectively as the "Ordering Parties").

2. These General Terms of Sale only apply to Ordering Parties that are entrepreneurs pursuant to §§ 14 and 310 para. 1 of the BGB (Civil Code of Germany), legal entities under public law, and/or special funds under public law.

3. The scope of application of these General Terms of Sale includes, but is not limited to, contracts regarding the sale and/or delivery of chattels (hereinafter referred to as "Goods") regardless of whether they are produced by Hofmann & Vratny or procured from suppliers (§§ 433 and 651 of the BGB). Unless agreed upon otherwise, the version of these General Terms of Sale applicable at the time the Ordering Party places an order and in any case the most recent version of these General Terms of Sale provided to the Ordering Party in writing in the form of a master agreement also shall apply to similar contracts made at a later date without Hofmann & Vratny being required to make reference to them in every individual case.

4. These General Terms of Sale shall apply exclusively. These General Terms of Sale also shall apply if and when Hofmann & Vratny executes a delivery without reservation despite having knowledge of the Ordering Party's terms of sale which contradict or deviate from these General Terms of Sale. Any of the Ordering Party's terms of sale which contradict or deviate from these General Terms of Sale shall become part of a contract only with Hofmann & Vratny's express prior consent. Such requirement to consent shall apply in any case even, for example, if the Ordering Party refers to its terms of sale as part of an order placement and Hofmann & Vratny does not object explicitly to such terms.

5. If Hofmann & Vratny and the Ordering Party have entered into any individual agreements, such individual agreements shall prevail over these General Terms of Sale. The content of such individual agreements only can be substantiated by a written contract or by written confirmation from Hofmann & Vratny. Individual agreements (e.g., outline delivery contracts, quality assurance agreements) and information provided in Hofmann & Vratny's order confirmation shall prevail over these General Terms of Sale. In case of doubt, commercial clauses shall be interpreted based on the Incoterms® issued by the International Chamber of Commerce in Paris (ICC) and applicable at the time the contract is entered into.

6. All of the Ordering Party's legal declarations and notifications made with regard to the contract (e.g., in connection with deadlines or notices of defects, rescission, or reduction) shall be made in writing to be effective. In the context of these General Terms of Sale, in writing shall include written and text forms (e.g., letters, e-mails, faxes). Legal requirements regarding form and other verifications including, but not limited to, cases of doubt regarding the legitimation of the notifying party shall remain unaffected.

7. All references to applicable laws shall be for the purpose of clarification only. Unless amended in or excluded expressly from these General Terms of Sale, laws shall apply even without express reference.

§ 2 OFFERS AND ACCEPTANCE

1. All offers made by Hofmann & Vratny shall be subject to change and shall be non-binding including if and when images, drawings, technical documentation, calculations, analyses, other documents or product descriptions of whatever nature (hereinafter referred to as "Documents") are provided to the Ordering Party if the proprietary rights and copyrights to those Documents are retained by Hofmann & Vratny.

2. All orders for Goods placed by the Ordering Party shall constitute binding offers. Unless stated otherwise in the respective order, Hofmann & Vratny shall be entitled to accept an offer within two weeks after receipt of said offer.

3. Hofmann & Vratny shall accept offers in writing (e.g., in the form of an order confirmation) or by delivering the respective Goods to the Ordering Party.

4. All proprietary rights and copyrights to Documents shall remain with Hofmann & Vratny. Documents marked as confidential shall be forwarded to third parties only with the express written consent of Hofmann & Vratny.

§ 3 DELIVERY DEADLINES AND DEFAULT OF DELIVERY

1. Delivery deadlines shall be agreed upon by Hofmann & Vratny and the individual Ordering Party or shall be specified by Hofmann & Vratny upon acceptance of the order or in the order confirmation.

2. Hofmann & Vratny's compliance with delivery obligations shall be conditional upon the Ordering Party's on-time and proper compliance with the Ordering Party's obligations including, but not limited to, the provision of the papers, permits and approvals required to be provided by the Ordering Party and the receipt by Hofmann & Vratny of the agreed-upon down payment, if any. In the event of delays, the delivery time shall be extended reasonably.

3. If Hofmann & Vratny is unable to meet any binding delivery deadlines for reasons beyond the control of Hofmann & Vratny (non-availability of services), the Ordering Party shall be notified without undue delay and shall be provided with an estimated new delivery deadline. If the agreed upon Goods do not become available before the new deadline expires, Hofmann & Vratny shall be entitled to rescind the contract in whole or in part and shall reimburse the Ordering Party without undue delay for any and all consideration paid up to that time. For the fulfillment of this clause, non-availability of services shall include, but shall not be limited to, delayed delivery from any of Hofmann & Vratny's suppliers for reasons beyond the control of Hofmann & Vratny or its suppliers, or if Hofmann & Vratny is not responsible for procuring the Goods.

4. If failure to comply with a delivery deadline is due to an act of God, industrial dispute or other event beyond the control of Hofmann & Vratny, the delivery time shall be extended reasonably. The same shall apply if and when any such act of God, industrial dispute or other event has arisen at any of Hofmann & Vratny's sub-suppliers which event can be demonstrated to have had an impact on compliance with the delivery deadline. Hofmann & Vratny shall notify the Ordering Party of such circumstances without undue delay. Events also shall be deemed to be beyond Hofmann & Vratny's control if and when they occur during a delay. In this case, the delay shall be deemed to be suspended for the duration of the respective event.

5. The beginning of a period of delivery default shall be in accordance with the law, but shall in any case require a reminder issued by the Ordering Party.

6. If a contract regarding stand-by delivery has been signed, Hofmann & Vratny shall deliver and invoice the Goods no later than 12 months after the date of such contract (hereinafter referred to as the "Recall Period"), even if the Ordering Party has failed to recall the Goods by that time. After the Recall Period has expired, Hofmann & Vratny can notify the Ordering Party of Hofmann & Vratny's readiness to deliver and can request that the Ordering Party recall the Goods within a reasonable period of time. If the Ordering Party fails to recall the Goods within such period, Hofmann & Vratny shall be entitled to demand an additional lumpsum compensation for warehousing costs (hereinafter referred to as the "Warehousing Allowance"). The Warehousing Allowance shall be 0.5% of the net value of the purchased Goods for every full week, but shall not exceed 5% of the net value of the purchased Goods in total. The Ordering Party shall be free to prove that Hofmann & Vratny did not incur any damages or that any damages incurred were lower than the Warehousing Allowance. If the Ordering Party fails to recall the Goods within the Recall Period determined by Hofmann & Vratny, Hofmann & Vratny shall be entitled to dispose of the Goods as Hofmann & Vratny sees fit. The statutory provisions regarding rescission shall remain unaffected.

7. All references to applicable laws shall be for the purpose of clarification only. Unless amended in or excluded expressly from these General Terms of Sale, laws shall apply even without express reference.

§ 4 DELIVERY AND DEFAULT OF ACCEPTANCE

1. Unless agreed upon otherwise, all deliveries shall be ex works, that is, the

place of performance for deliveries and for all subsequent actions. Unless agreed upon otherwise, upon request and at the expense of the Ordering Party the Goods shall be delivered to another destination (hereinafter referred to as "Sales Involving the Carriage of Goods"). Unless agreed upon otherwise, Hofmann & Vratny shall be entitled to determine the shipment method (including, but not limited to, the forwarder, the type of shipment and the packaging).

2. Partial deliveries shall be admissible, provided the Ordering Party reasonably can be expected to accept them.

3. Delivered Goods shall be accepted by the Ordering Party even if the delivered Goods have minor defects provided the Ordering Party reasonably can be expected to accept such Goods.

4. The risk of accidental destruction and/or deterioration of the Goods shall transfer to the Ordering Party no later than upon surrender of the Goods. In the case of Sales Involving the Carriage of Goods, the risk of accidental destruction and/or deterioration of the Goods and the risk of delay shall transfer to the Ordering Party no later than at the time of delivery of the Goods to the forwarder, carrier, or any other person designated to execute shipment of the Goods. Delivery shall be deemed to have been effected even if the Ordering Party is in default of acceptance.

5. If the Ordering Party is in default of acceptance or fails to cooperate or if delivery is delayed for other reasons for which the Ordering Party is responsible, Hofmann & Vratny shall be entitled to demand reimbursement for the damages incurred in connection therewith including additional expenses (e.g., warehousing costs).

§ 5 TERMS OF PAYMENT

1. Unless agreed upon otherwise in individual cases, Hofmann & Vratny's prices plus statutory sales tax valid at the time the contract is signed shall apply. The prices indicated in Hofmann & Vratny's catalogs are non-binding and subject to change and/or correction.

2. Unless agreed upon otherwise, in the case of Sales Involving the Carriage of Goods the Ordering Party shall bear the costs of packaging and transportation ex works and the costs, if any, for transportation insurance if such insurance is requested by the Ordering Party. All customs and other fees, taxes and other public charges also shall be borne by the Ordering Party unless agreed upon otherwise. Ownership of the packaging for transportation and otherwise pursuant to the Verpackungsordnung (Packaging Ordinance of Germany) shall transfer to the Ordering Party and such packaging shall not be returned to Hofmann & Vratny. Pallets shall be exempt from this rule.

3. Unless agreed upon otherwise in the order confirmation, the purchase price plus statutory sales tax shall be due and payable without any deductions within 14 days after the date of invoicing and delivery or acceptance of the Goods. However, Hofmann & Vratny reserves the right to make full or partial deliveries against cash in advance at any time including during an ongoing business relationship. The assertion of such right shall be communicated no later than at the time the order confirmation is issued. The Ordering Party shall be deemed to be in default of payment upon the expiration of the aforementioned payment deadline. The applicable rate of interest on the purchase price of the Goods shall become payable during the default period. The right to assert claims for more substantial compensation shall be reserved. Hofmann & Vratny's right to claim commercial-rate default interest (§ 353 of the HGB) shall remain unaffected.

4. The Ordering Party's rights of set-off and retention shall be limited to the extent the Ordering Party's claim is determined in a court of law or is undisputed. The Ordering Party's rights based on defects in the purchased Goods (see § 7 hereof) shall remain unaffected.

5. After the contract has been signed, if there is evidence that Hofmann & Vratny's claim to the purchase price will be compromised due to lack of performance on the part of the Ordering Party, Hofmann & Vratny shall be entitled to refuse performance pursuant to the applicable laws and, after setting a deadline, if applicable, shall be entitled to rescind the contract. In the case of contracts regarding the production of customized items, Hofmann & Vratny shall be entitled to rescind the contract immediately and the laws regarding the expendability of setting deadlines shall remain unaffected.

§ 6 RETENTION OF TITLE

1. Until all pending and future receivables in connection with the business relationship between Hofmann & Vratny and the Ordering Party are paid in full, Hofmann & Vratny shall retain ownership of the Goods. If the Ordering Party violates the contract including, but not limited to, default of payment, Hofmann & Vratny shall be entitled to rescind the contract pursuant to the applicable laws and to demand the surrender of the Goods.

2. Goods subject to retention of title shall not be pledged or assigned as collateral before the Ordering Party has paid in full. The Ordering Party shall notify Hofmann & Vratny in writing without undue delay in the event of a filing for commencement of insolvency proceedings or if third parties gain access (e.g., seizures) to Goods belonging to Hofmann & Vratny.

3. If the Ordering Party violates the contract including, but not limited to, by failing to pay the purchase price when due, Hofmann & Vratny shall be entitled to rescind the contract pursuant to the applicable laws and to demand the surrender of the Goods due to the retention of title and the rescission.

4. Until further notice, the Ordering Party shall be entitled to resell and/or process in the ordinary course of business any Goods subject to retention of title. In this case, the provisions below also shall apply.

a) The retention of title shall include title to the full value of work products resulting from processing, mixing or combining the Goods, in which case Hofmann & Vratny shall be deemed to be the manufacturer. If and when third-party goods are processed, mixed or combined and such third parties retain ownership, Hofmann & Vratny shall acquire coownership pro rata of the invoiced value of work products so processed, mixed or combined. In all other cases, the creation of work products shall be subject to the same provisions as the delivered Goods subject to retention of title.

b) The Ordering Party hereby agrees to assign to Hofmann & Vratny as collateral any and all receivables against third parties resulting from the resale of the Goods or work results in full or in the amount of Hofmann & Vratny's estimated share of co-ownership pursuant to a) above, and Hofmann & Vratny hereby accepts such assignment. The Ordering Party's obligations under § 6.2 hereof also shall apply with respect to the receivables assigned.

c) In addition to Hofmann & Vratny, the Ordering Party shall remain authorized to collect receivables. Hofmann & Vratny undertakes to refrain from collecting receivables as long as the Ordering Party meets its payment obligations vis-à-vis Hofmann & Vratny and does not fail to perform and Hofmann & Vratny does not assert its retention of title by asserting a right under § 6.3 hereof. Otherwise, Hofmann & Vratny shall be entitled to demand that the Ordering Party inform Hofmann & Vratny of such receivables assigned and of the names of the debtors, provide Hofmann & Vratny with all the information required for collecting such receivables and the pertinent documents, and inform the debtors (third parties) of the assignment. In addition, in this case Hofmann & Vratny shall be entitled to revoke the Ordering Party's authorization to resell and/or process Goods which are subject to retention of title.

5. Upon request of the Ordering Party, Hofmann & Vratny shall release the collateral to which Hofmann & Vratny is entitled insofar as the realizable value of such collateral exceeds the receivables to be collateralized by more than 10 percent. Hofmann & Vratny shall be free in its decision regarding which collateral to release.

§ 7 LIABILITY FOR DEFECTS AND CLAIMS FOR DEFECTS

1. Unless otherwise agreed upon herein, the Ordering Party's rights based on defects in quality and/or in title (including delivery of the wrong Goods or insufficient amounts, improper assembly/installation, or incomplete instructions) shall be subject to the applicable laws. The special legal stipulations regarding reimbursement of expenses at the time of delivery of newly produced Goods (supplier's recourse as specified in §§ 478, 445a, 445b and §§ 445c, 327 para. 5, 327u of the BGB) shall remain unaffected in any case, unless equal-value compensation has been agreed upon, for example, as part of a quality assurance agreement.

2. Hofmann & Vratny's liability for defects shall be based first and foremost on the respective agreement entered into regarding the quality and the postulated use of the Goods (including fittings and instructions). In this context,

an agreement regarding the quality of Goods shall be any and all product descriptions and manufacturer-provided information outlined in the individual agreement or made publicly known by Hofmann & Vratny (including, but not limited to, in catalogs or on Hofmann & Vratny's internet homepage) at the time the contract was signed. However, if and when no agreement regarding quality has been entered into, the presence or absence of a defect shall be determined based on the legal regulations (§ 434 para. 3 of the BGB). Statements made publicly by the manufacturer or on the manufacturer's behalf including, but not limited to, in advertising materials or on labels on the Goods shall prevail over other third parties' statements. In the case of Goods comprising digital elements or other digital content, Hofmann & Vratny shall be responsible for providing and, if required, updating the digital content only if defined expressly in an agreement regarding the quality of Goods, as stipulated above. Hofmann & Vratny shall not assume any liability for public statements made by the manufacturer or other third parties.

3. Hofmann & Vratny shall not assume liability for any defects of which the Ordering Party is aware, or for any defects of which the Ordering Party is grossly negligent if it is not aware (§ 442 of the BGB) at the time the contract is signed. The assertion of claims by the Ordering Party regarding defects shall be conditional upon the Ordering Party's meeting of its statutory duty to inspect and to give notice of defects (§§ 377 and 381 of the HGB (Commercial Code of Germany)). If a defect in the Goods becomes apparent during or after inspection, the Ordering Party shall give written notice to Hofmann & Vratny without undue delay. Regardless of the Ordering Party's duty to inspect and to give notice of defects, the Ordering Party shall give written notice of obvious defects within two weeks after delivery, which notice shall be deemed to have been given in a timely manner if it is transmitted before the end of such period. If the Ordering Party fails to inspect the Goods properly and/or to give proper notice of any defects, Hofmann & Vratny shall not assume liability for any defects for which no notice was given.

4. If any of the Goods are defective, Hofmann & Vratny shall be free to offer supplementary action to remedy the defect or defects (supplementary remedy) or to deliver defect-free Goods (replacement) to the Ordering Party. In individual cases, the Ordering Party may refuse a supplementary action selected by Hofmann & Vratny that the Ordering Party considers to be unreasonable. It is Hofmann & Vratny's right to refuse to offer supplementary action under the applicable laws shall remain unaffected. The requirement for Hofmann & Vratny to provide any supplementary action owed shall be conditional upon the Ordering Party's paying of the purchase price when due. However, the Ordering Party shall be entitled to retain a reasonable portion of the purchase price pro rata in consideration of the defect. The Ordering Party shall give Hofmann & Vratny the time and the opportunity to provide the supplementary action owed including, but not limited to, providing Hofmann & Vratny the opportunity to inspect the Goods which are subject to complaint. If Hofmann & Vratny opts to replace the Goods, at Hofmann & Vratny's request the Ordering Party shall return the defective Goods to Hofmann & Vratny in accordance with the applicable laws; however, the Ordering Party shall not have the right to request to return the defective Goods. Supplementary action shall not include the disassembly, removal, or de-installation of defective Goods nor the assembly, mounting, or installation of defect-free Goods, provided Hofmann & Vratny was not originally obligated to provide such services; any rights the Ordering Party may have to be reimbursed for such costs (hereinafter referred to as "Disassembly and Assembly Costs") shall remain unaffected.

5. If in fact a defect is present, any and all expenses incurred in connection with inspections and supplementary action including, but not limited to, transportation, road, labor and material costs, and Disassembly and Assembly Costs shall be borne by Hofmann & Vratny in accordance with the laws and these General Terms of Sale. However, if the Ordering Party's demand for remedy of a defect is proven to be invalid because the Ordering Party was aware or was grossly negligent if it was not aware that no defect actually was present, Hofmann & Vratny can demand reimbursement from the Ordering Party for any costs incurred therewith. If the costs of supplementary remedy would be disproportionately high, the Ordering Party shall not be entitled to claim remedy of defects.

6. If and when a reasonable deadline for supplementary action set by the buyer has expired unsuccessfully or can be disregarded under the law, the Ordering Party can rescind the purchasing contract in accordance with the law or reduce the purchase price. However, no right to rescind shall apply in the case of insignificant defects.

7. The Ordering Party's claims for damages or reimbursement for wasted expenses shall be limited by the provisions of § 8 below and shall be excluded in all other cases.

8. The statute of limitations for claims for defects in quality and in title shall be one year after delivery of the Goods. The statute of limitations shall commence upon delivery of the Goods provided acceptance has been agreed upon. Other special legal stipulations regarding statutes of limitations (including, but not limited to, § 438 para. 1 no. 1, no. 2, para. 3, §§ 444, 445b of the BGB) shall remain unaffected. The aforementioned statutes of limitations specified in the purchasing laws also shall apply to any contractual and extra-contractual claims for reimbursement made by the Ordering Party based on a defect in the Goods, unless applying the regular statute of limitations stipulated by law (§§ 195, 199 of the BGB) would result in a reduced statute of limitations in individual cases. Any claims for reimbursement the Ordering Party may have pursuant to § 8 para. 2 p. 1 and p. 2 (a) and pursuant to the Produkthaftungsgesetz (Product Liability Act of Germany) shall be subject exclusively to the statutes of limitations stipulated by law.

§ 8 OTHER LIABILITIES

1. Unless agreed upon otherwise in these General Terms of Sale and in the provisions below, Hofmann & Vratny's liability for breach of contractual and non-contractual obligations shall be in accordance with the applicable laws.

2. Hofmann & Vratny's liability for damages, regardless of the legal reasons and of whether or not they are known, as part of Verschuldenshaftung (liability arising from damage caused by negligent act) shall include intent and gross negligence. Subject to the limitations of liability stipulated by law (e.g., diligence with its own affairs, insignificant breach of duty), in the event of minor negligence Hofmann & Vratny's liability shall be limited to (a) damages resulting from harm to life, body or health and/or (b) damages resulting from the not-insignificant breach of a material contractual obligation, that is, an obligation which must be met to make the proper fulfillment of the contract possible and the meeting of which the Ordering Party relies upon and can rely upon on a regular basis. In this case, however, Hofmann & Vratny's liability shall be limited to reimbursement of the foreseeable damages typical in such cases.

3. The limitation of liability specified above also shall apply vis-à-vis third parties and in the event of a breach of duty by any person (including to his/her own benefit) for which Hofmann & Vratny is responsible by law; however, it shall not apply if and when Hofmann & Vratny is found to have failed to disclose a defect maliciously or has assumed a guarantee for the quality of the Goods and for the Ordering Party's claims under the Produkthaftungsgesetz.

4. The Ordering Party can rescind or cancel a contract due to a breach of obligation other than a breach based on a defect only if and when Hofmann & Vratny is responsible for such breach of obligation. The Ordering Party shall not have an unrestricted right to terminate a contract. All other cases shall be subject to the applicable laws and legal consequences.

§ 9 APPLICABLE LAW AND JURISDICTION

1. These General Terms of Sale and all legal relationships between Hofmann & Vratny and the Ordering Party shall be subject to the laws of the Federal Republic of Germany under exclusion of the provisions of uniform international law. The CISG shall not apply.

2. Any and all disputes arising directly or indirectly from the contractual relationship shall be subject exclusively, including at an international level, to the jurisdiction of Aßling if the Ordering Party is a businessperson as defined in the Handelsgesetzbuch (Commercial Code of Germany), a legal entity under public law, or a special fund under public law. The same shall apply if the Ordering Party is an entrepreneur pursuant to §§ 14 of the BGB. However, in any case Hofmann & Vratny shall be entitled to sue the Ordering Party at the place of performance of the obligation to deliver under these General Terms of Sale and/or under a prevailing individual agreement or at the Ordering Party's general jurisdiction. Prevailing legal regulations including, but not limited to, regarding exclusive jurisdictions, shall remain unaffected.

Hofmann & Vratny OHG
June 2022

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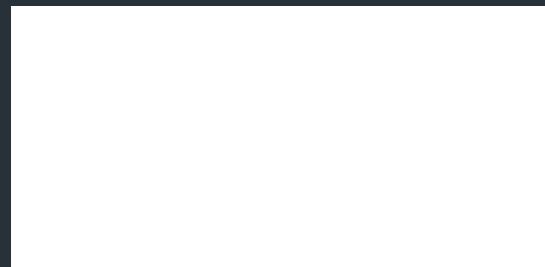
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