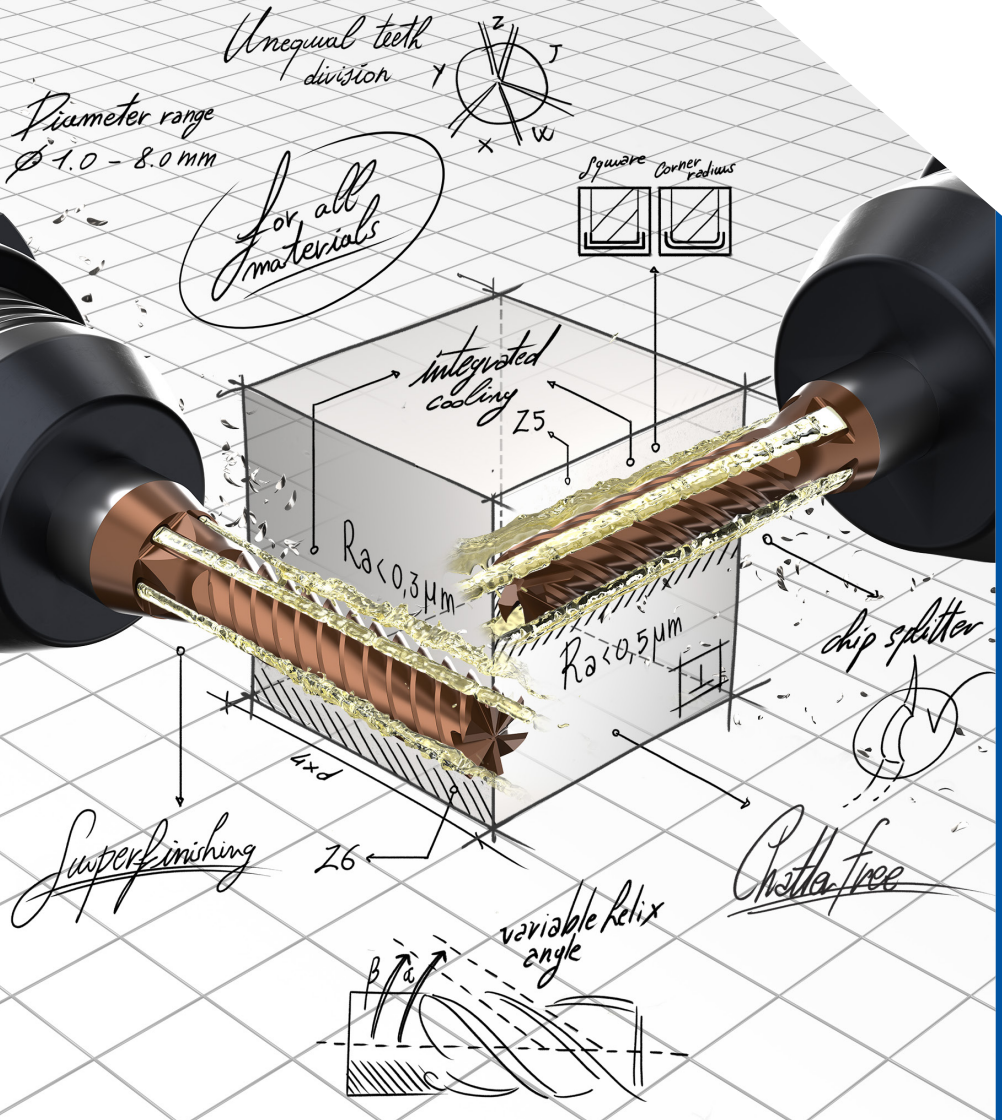
MIKRON TOOL

More than tools

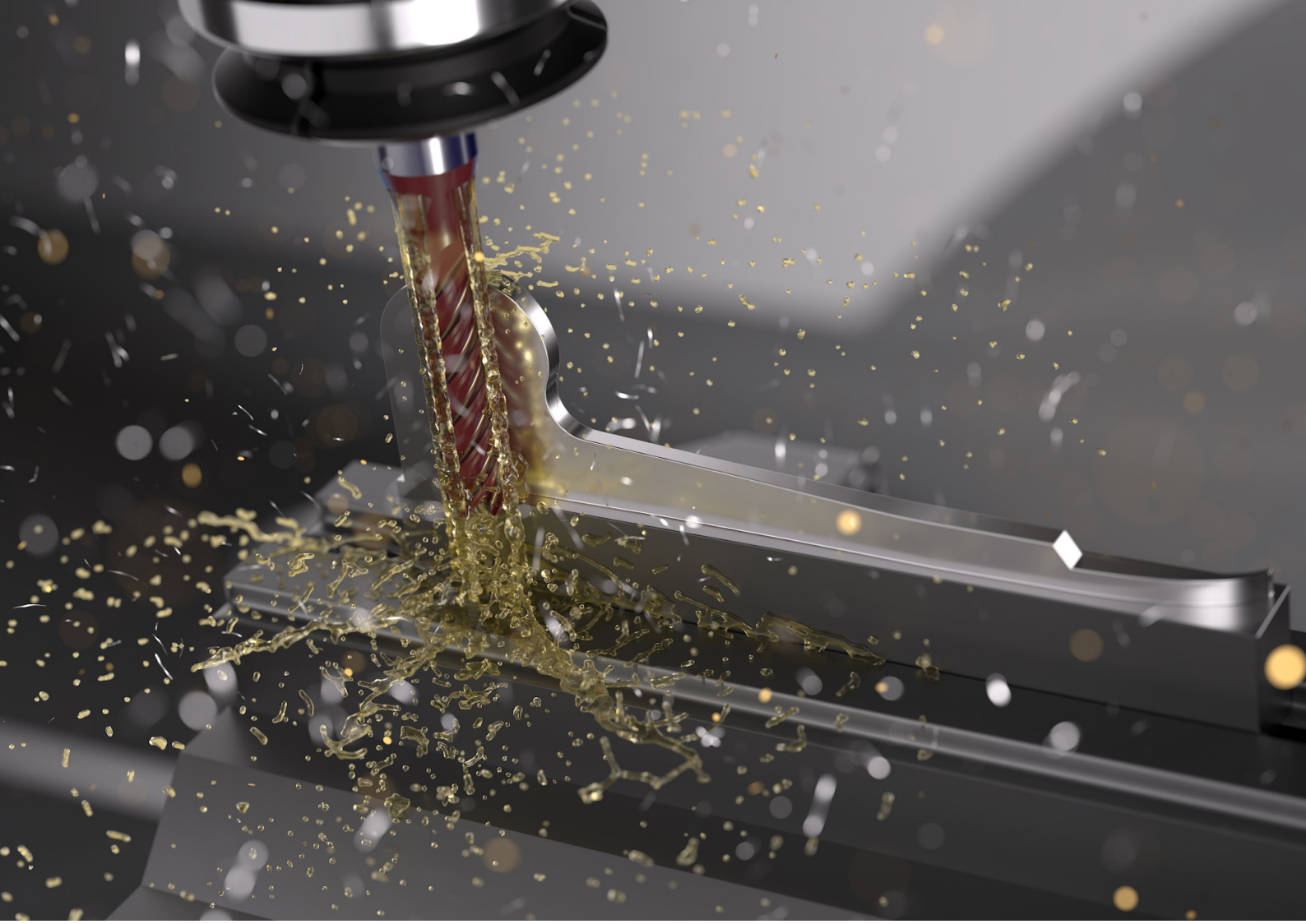
crazy about new endmills

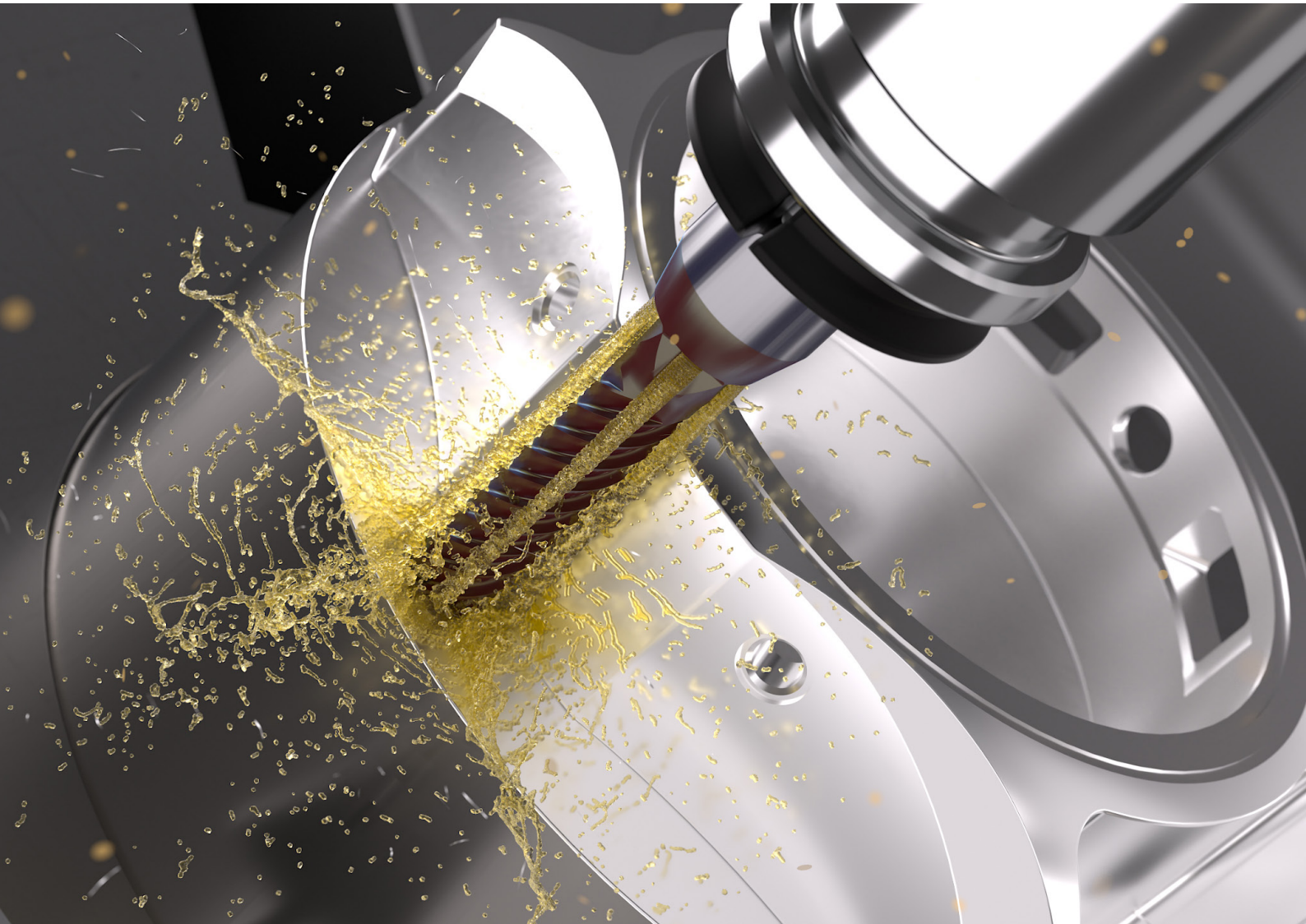
- CHATTER FREE ENDMILL
- SUPER FINISHING ENDMILL



NEW

English - US





A GREAT YEAR FOR THE MIKRON TOOL R&D DEPARTMENT!

Sensational high-performance tools straight from Mikron Tool's R&D department!
Mikron Tool, leading solution provider for the machining of high-performance materials, presents three new high-end solid carbide tools.

- **CrazyMill Cool CF:** A high-performance end mill for high-efficiency milling that delivers excellent surface quality of Ra 0.5 µm or bette. Available in two types:
  - **Square**
  - **Corner radius** NEW
- **CrazyMill Cool SF:** A superfinishing square end mill that achieves grinding / polishing surface quality up to Ra 0.3 µm or better. Both endmills are available in diameters from 1 to 8 mm, with two cutting lengths of 3 × d and 4 × d

Let's discover those products!!!

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2	CRAZYMILL COOL CF Milling depth 3 x d and 4 x d, Ø 1.0 - 8.0 mm | **.039" - .315"**, Z4 and Z5	6
3	CRAZYMILL COOL SF Milling depth 3 x d and 4 x d, Ø 1.0 - 8.0 mm | **.039" - .315"**, Z5 and Z6	34

NEW Overview of new tools

3 NEW PRODUCTS

	CRAZYMILL Cool CF	Square Z4 / Z5	
NEW	CRAZYMILL Cool CF	Corner radius Z4 / Z5	
	CRAZYMILL Cool SF	Square Z5 / Z6	

RECOMMENDATION FOR USE

● Excellent | ◐ Good | ○ Acceptable | ⊠ Not recommended

ø - range [mm]	max. depth	Cooling		P	M	K	N	S_1	S_2		S_3	H_1	H_2	Page
		Int.	Ext.	Unalloyed and alloyed steel	Stainless steel	Cast iron	Non ferrous metals	Super alloys	Alloyed titanium	Pure titanium	CrCo alloys	Hardened steel <55 HRC	Hardened steel ≥55 HRC	
1.0 – 8.0 **.039" – .315"**	3 x d 4 x d	✔	–	●	●	●	●	●	●	●	●	⊠	⊠	**6**
1.0 – 8.0 **.039" – .315"**	3 x d 4 x d	✔	–	●	●	●	●	●	●	●	●	⊠	⊠	**6**
1.0 – 8.0 **.039" – .315"**	3 x d 4 x d	✔	–	●	●	●	●	●	●	●	●	⊠	⊠	**34**

NEW CrazyMill Cool CF

NEW

CRAZYMILL by Mikron Tool Cool CF

REVOLUTION IN CHATTER FREE MACHINING

CrazyMill Cool CF, the latest generation of milling cutters from Mikron Tool, works with minimal side milling cutting pressure and act completely chatter-free.

This is made possible by an ingenious cutting edge geometry that enables highly dynamic milling processes. The milling cutter really comes into its own with thin-walled, delicate workpieces that tend to vibrate or when unstable clamping situations prevail. Pockets and grooves can also be produced highly efficiently, precisely and with extremely smooth running. It is available in the diameter range Ø .039" – .315" (1.0 – 8.0 mm) in two different cutting lengths 3 x d and 4 x d to perform in all materials.

Regrinding: This product is not suitable for regrinding.

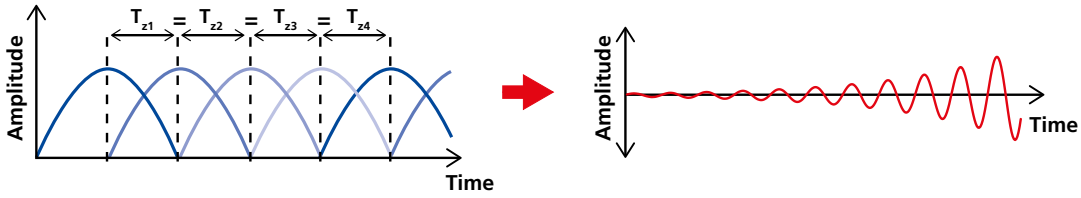
Please note: You couldn't find your suitable version of the CrazyMill Cool CF (diameter, length, cutting direction…)? Ask us about our customized versions!

NEW CrazyMill Cool CF

THE NEW HIGH-PERFORMANCE MILLS FOR SEMI-FINISHING AND FINISHING

1. Challenge

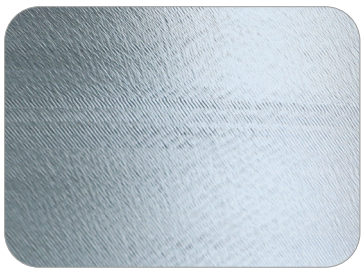
Avoid chattering when milling



Milling is a cutting process with a continuous interrupted cut. Each cutting edge applies a certain amount of pressure to the material. When the cutting edge exits the material, the pressure is released again.

This happens with all the cutting edges of symmetrically designed endmills at a predetermined frequency depending on the "number of cutting edges" x "speed".

If the frequency is kept uniform (see diagram) ($T_{Z1} = T_{Z2} = T_{Z3} = T_{Z4}$), it can lead to an increase in the maximum deflection in the resonance frequency, resulting in vibrations and consequently chatter marks on the workpiece.

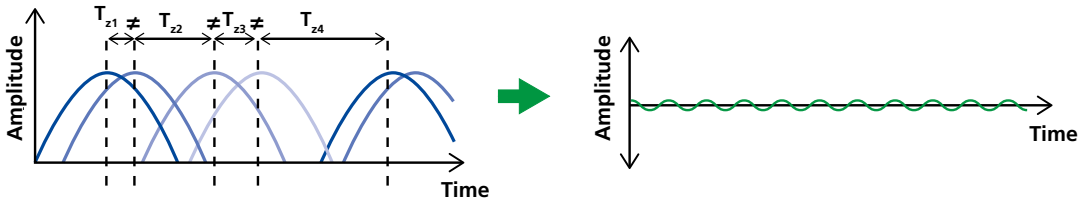


Surface with vibrations
Ra = 27.6 µin (0.7 µm)

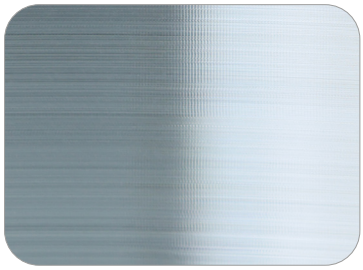
NEW

Solution

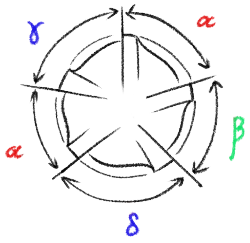
Avoidance of resonance frequencies



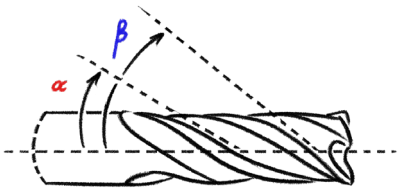
The new CrazyMill Cool CF has been specifically developed, to interrupt this resonance frequency. Using unequal angular teeth division, and a variable helix angle (every cutting edge has a different helix angle) every cutting edge generates a different frequency wave that occur in an irregular timing to the next or the previous cutting edge ($T_{Z1} \neq T_{Z2} \neq T_{Z3} \neq T_{Z4}$).
This results, as shown in the graph, in a resonant frequency amplitude reduction, and guarantees a vibration free surface.



Surface without vibrations
Ra = 13.8 µin (0.35 µm)



Unequal angular teeth division



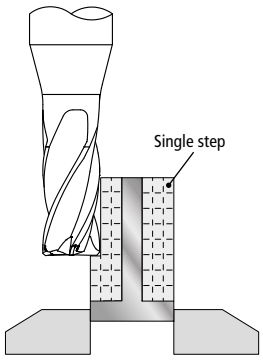
Variable helix angle

NEW CrazyMill Cool CF

THE NEW HIGH-PERFORMANCE MILLS FOR SEMI-FINISHING AND FINISHING

2. Challenge

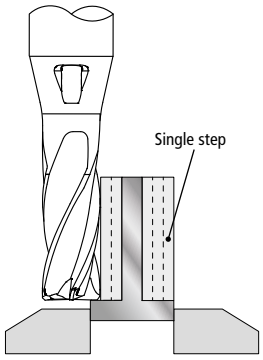
High Removal Rate for thin-walled and unstable workpieces



Thin-walled workpieces such as blades, medical bone plates, and others, are among the most difficult components to machine. The reason for this is that with "unstable workpieces", the cutting forces exerted by an endmill during side milling lead to deformations and vibrations. The result are irregular profiles and chatter marks. To avoid such consequences, low axial and radial engagement are typically set and a low feed rate is also used. The disadvantage is a very low removal rate (Q).

Solution

Low radial pressure



With the new endmill, particular attention has been placed to finding a perfect balance between cutting angle, a relive angle and the cutting edge conditioning.

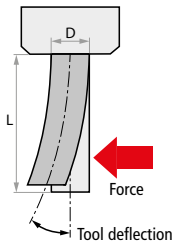
An extremely high cutting ability ensures a very low lateral cutting pressure, so that the endmill can cut reliably even at its maximum axial engagement (4 x d).

A large, or maximum, axial engagement, combined with a highly dynamic milling strategy (HDM), enables a very high removal rate (Q).

NEW

3. Challenge

High shape tolerance - perpendicularity

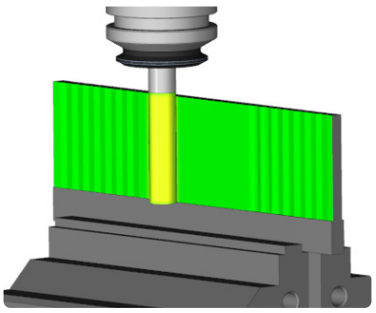


Profile milling with the side milling strategy over the maximum engagement length of the milling cutter (4 x d) must enable a perfectly perpendicular profile within the specified tolerance fields. This must also be possible when using high-speed and highly dynamic milling strategies.

Solution

Low radial cutting forces

Thanks to its specifically designed micro and macro cutting geometries, the CrazyMill Cool CF ensures a very low lateral cutting pressure, which is crucial for keeping the cutting forces perpendicular to the component low. This is a prerequisite for limiting the deflection of the milling cutter to a minimum and thus guaranteeing the shape tolerances and squareness in accordance with the required tolerance values, even at the maximum depth of engagement of the milling cutter.

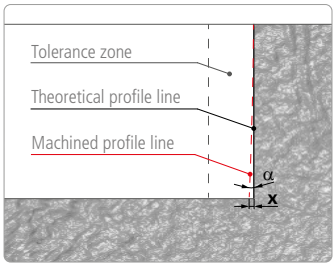


Material: X2CrNiMo17-12-2 / 1.4404 / AISI 316L

Diameter: .236" (6 mm); Milling depth: .945" (24 mm);
Coolant: cutting oil;
Cutting data: v_c = 722 SFM (220 m/min);
f_z = .0012 IPT (0.03 mm);
a_p = .945" (24 mm);
a_e = .0020" (0.05 mm)

Roughness: Ra = 13.8 µin (0.35 µm)

■ Perpendicularity



	Perpendicularity precision
x	.00047" (0.012 mm)
α	- 0.03°

NEW CrazyMill Cool CF

THE NEW HIGH-PERFORMANCE MILLS FOR SEMI-FINISHING AND FINISHING

4. Challenge

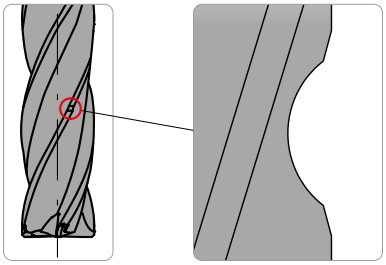
High surface qualitiy – Process reliable chip management

For a reliable machining process, short chips are required. The more axial engagement of the endmill the longer become the chips. Long chips are very hard to manage and evacuate generating a high risk of "chip double-cut", leading to cutting edge chipping and/or to a low surface's quality.

Solution

Optimized chip-splitting for short chips and perfect surface quality

■ **Chip-splitting design**

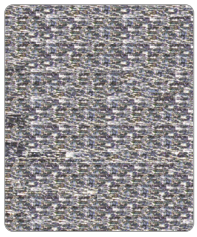


The shape of the chip-splitting has been optimized to ensure short chips and optimum removal. The result is a perfect surface quality.

■ **Surface quality**

Conventional endmill

CrazyMill Cool



Thanks to the chip-splitting, no groove is visible, as would be the case when using a conventional milling cutter. The result is the best surface quality.

NEW

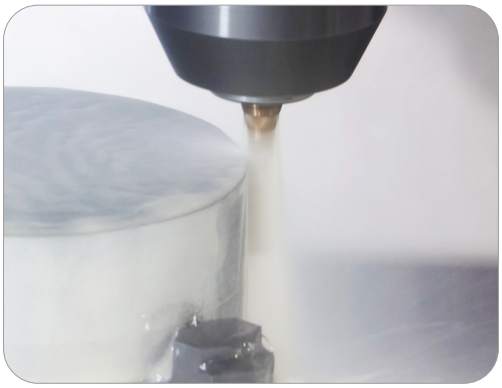
5. Challenge

High temperature & chips in the cutting zone

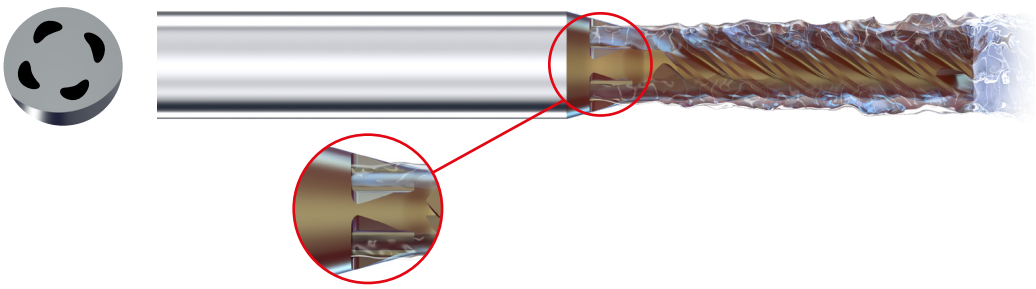
The machining of metals requires a high energy input into the cutting zones. A large proportion of this is converted directly into thermal energy. The higher the heat generated in the cutting zone, the shorter the tool life. It is therefore essential to keep the temperature in the cutting zone as low as possible. A high machining temperature also leads to poorer chip formation, poor chip flow and poor chip evacuation due to the higher plasticity of the chip, which can result in chip jam. These phenomena are exacerbated in materials that are difficult to machine, such as titanium, stainless steel and heat-resistant alloys.

Solution

Integrated cooling in shank



The patented cooling channels of the Mikron Tool milling cutters, which run through the shank, ensure constant and massive cooling of the cutting edges. The excellent cooling performance directly in the cutting area enables a high cutting speed and also reduces wear enormously. The massive coolant jet (from just 218 psi (15 bar)) also guarantees a chip-free machining zone and prevents the chips double cut. High cutting speeds, in combination with an HDM strategy, lead to a reliable milling process with a high removal rate while maintaining excellent surface quality.



Your benefits

The most important features

- Allround endmill geometry: Semi-finishing and finishing
- Innovative flute geometry: Unequal angular teeth division and variable helix angle
- Specific designed cooling concept

Your advantages

- Exploitation of HEM milling
- Mitigated chatter milling
- Very low cutting forces and bending moment
- Controlled low temperature
- Perfect perpendicularity and low roughness
- High performance in difficult-to-machine materials

Your benefits

- Up to 60% higher chip removal rate = reduced machining time
- Excellent surface quality with Ra 19.7 µin (0.5 µm) or better
- Process reliability
- Very long tool life

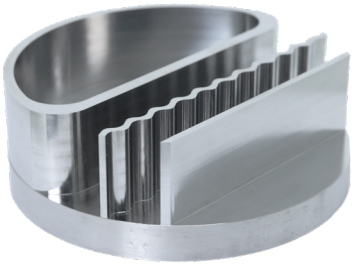
NEW Maximum performance guaranteed

EXAMPLE OF STAINLESS STEEL MACHINING IN COMPARISON

■ **Example**

Higher chip removal rate = faster machining time

Machining: Side milling
Milling depth: .472" (12 mm);
Coolant: Emulsion 8%



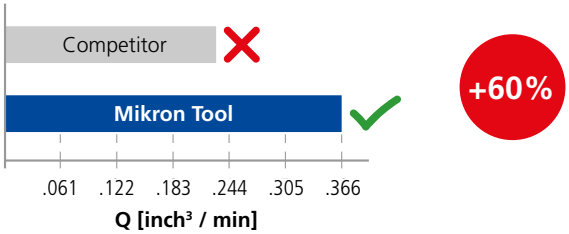
Steinless steel: 1.4435 / X2CrNiMo 18-14-3 / 316L **M**

Tool: CrazyMill Cool CF
Diameter: .118" (3.0 mm)

Cutting data:

Generical endmill		CrazyMill Cool CF	
v_c = **394 SFM** 120 m/min	f_z = **.0008 IPT** 0.020 mm	v_c = **427 SFM** 130 m/min	f_z = **.0009 IPT** 0.024 mm
a_p = **.472"** 12 mmv_c	a_e = **.0118"** 0.3 mm	a_p = **.472"** 12 mm	a_e = **.0118"** 0.3 mm
Z = 4 Flutes		Z = 5 Flutes	

Result:

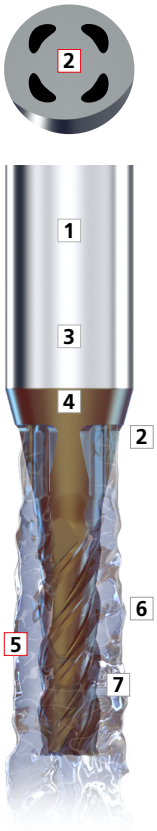


Movie:

3 x d

Type M

- Coated
- Integrated cooling
- l_1 (Effective length): 3xd
  l_2 (Cutting length): 3xd



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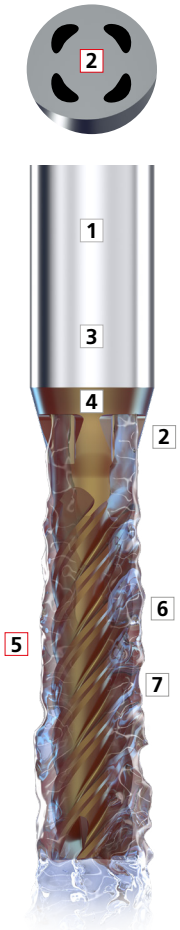
4 x d

Type N

- Coated
- Integrated cooling
- l_1 (Effective length): 4xd
  l_2 (Cutting length): 4xd



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NEW

1 | SHANK
The robust solid carbide shank guarantees stable and vibration-free milling. High precision and extraordinary surface quality are reached.

2 | INTEGRATED COOLING - PATENTED
The integrated cooling channels guarantee constantand maximal cooling of the cutting edges and optimal chip removal. The result is higher cutting speed as well as an excellent surface quality.

3 | CARBIDE
The specially developed micro-grain carbide meets all requirements in terms of mechanical properties.

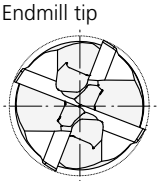
4 | COATING
The high-performance eXedur SNP coating is heat and wear resistant, prevents buildup edges and guarantees optimum chip flushing. The result is a long tool life.

5 | SPECIFIC CHATTER-FREE GEOMETRY
The specific new cutting geometry with unequal angular teeth division and a variable helix angle, leads to an interruption of the resonance frequency allowing a vibration-free machining.

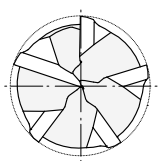
6 | LATERAL CUTTING GEOMETRY
Thanks to the high tool rigidity and the specific designed cutting edges, lower radial machining force are achieved. The result is high perpendicularity precision and high surface quality.

7 | CHIP-SPLITTING
An optimized chip-splitting guarantees short chips and highest surface quality. The chip-splitting is implemented in version M for Ø$d_1 \geq 4$ mm and N for Ø$d_1 \geq 3$ mm.

Endmill tip



4 - Flute
Diameter range
Ø.039" - .098"
(Ø1 - 2.5 mm)



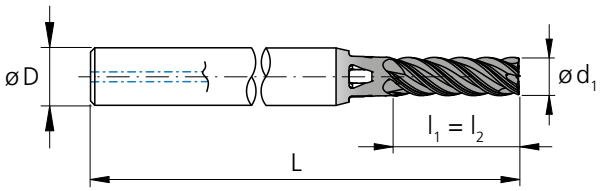
5 - Flute
Diameter range
Ø.118" - .315"
(Ø3 - 8 mm)

NEW Type M - 3 x d - Square / Corner radius - Z4 / Z5

MILLING WITH INTEGRATED COOLING

Square

protection chamfer 45°



l_1 = Effective length
l_2 = Cutting length

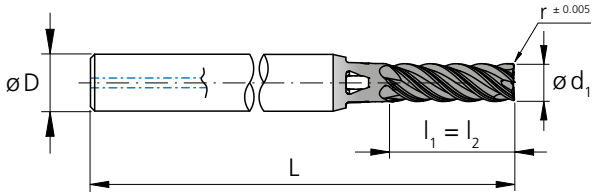
d_1 [inch]	d_1 [inch]	d_1 [mm]	l_1 [inch]	l_1 [mm]	l_2 [mm]	D (h6) [mm]	L [inch]	L [mm]	Z [flutes]	Item number	Availability
	.039	1.0	**.079**	3.0	3.0	4	**1.57**	40	4	2.CMCCF.M1Z4.100.1	■
	.047	1.2	**.094**	3.6	3.6	4	**1.57**	40	4	2.CMCCF.M1Z4.120.1	■
	.059	1.5	**.118**	4.5	4.5	4	**1.57**	40	4	2.CMCCF.M1Z4.150.1	■
1/16	**.0625**	1.587	**.122**	4.8	4.8	4	**1.57**	40	4	2.CMC.SCFM1Z4.F116	■
	.071	1.8	**.142**	5.4	5.4	4	**1.57**	40	4	2.CMCCF.M1Z4.180.1	■
	.079	2.0	**.157**	6.0	6.0	4	**1.57**	40	4	2.CMCCF.M1Z4.200.1	■
3/32	**.0937**	2.381	**.185**	7.1	7.1	4	**1.57**	40	4	2.CMC.SCFM1Z4.F332	■
	.098	2.5	**.197**	7.5	7.5	6	**2.17**	55	4	2.CMCCF.M1Z4.250.1	■
	.118	3.0	**.236**	9.0	9.0	6	**2.17**	55	5	2.CMCCF.M1Z5.300.1	■
1/8	**.1250**	3.175	**.252**	9.5	9.5	6	**2.17**	55	5	2.CMC.SCFM1Z5.F18	■
	.138	3.5	**.276**	10.5	10.5	6	**2.17**	55	5	2.CMCCF.M1Z5.350.1	■
5/32	**.1562**	3.968	**.312**	11.9	11.9	6	**2.17**	55	5	2.CMC.SCFM1Z5.F532	■
	.157	4.0	**.315**	12.0	12.0	6	**2.17**	55	5	2.CMCCF.M1Z5.400.1	■
	.177	4.5	**.354**	13.5	13.5	8	**2.56**	65	5	2.CMCCF.M1Z5.450.1	■
3/16	**.1875**	4.762	**.375**	14.3	14.3	8	**2.56**	65	5	2.CMC.SCFM1Z5.F316	■
	.197	5.0	**.394**	15.0	15.0	8	**2.56**	65	5	2.CMCCF.M1Z5.500.1	■
7/32	**.2189**	5.560	**.438**	16.7	16.7	10	**2.76**	70	5	2.CMC.SCFM1Z5.F732	■
	.236	6.0	**.472**	18.0	18.0	10	**2.76**	70	5	2.CMCCF.M1Z5.600.1	■
1/4	**.2500**	6.350	**.500**	19.1	19.1	10	**2.76**	70	5	2.CMC.SCFM1Z5.F14	■
	.315	8.0	**.630**	24.0	24.0	12	**3.15**	80	5	2.CMCCF.M1Z5.800.1	Δ

■ Stock item
Δ Delivery term upon request, minumum purchase order quantity 3 pcs.

Carbide	3xd1	Z 4-5	Variable		eXedur SNP						ap / ae	

Ø d_1	.004" - .118" (0.1 - 3.0 mm)		.122" - .236" (3.1 - 6.0 mm)		.240" - .394" (6.1 - 10.0 mm)	
Tolerance	- .00055" - .00110"	- 0.014 mm - 0.028 mm	- .00079" - .00150"	- 0.020 mm - 0.038 mm	- .00098" - .00185"	- 0.025 mm - 0.047 mm

Corner radius



l_1 = Effective length
l_2 = Cutting length

d_1 [inch]	d_1 [inch]	d_1 [mm]	l_1 [inch]	l_1 [mm]	l_2 [mm]	D (h6) [mm]	L [inch]	L [mm]	Z [flutes]	r [inch]	r [mm]	Item number	Availability
	.039	1.0	**.118**	3.00	3.00	4	**1.57**	40	4	**.0039**	0.10	2.CMCCF.M2Z4.100.1	■
	.039	1.0	**.118**	3.00	3.00	4	**1.57**	40	4	**.0079**	0.20	2.CMCCF.M3Z4.100.1	■
	.047	1.2	**.142**	3.60	3.60	4	**1.57**	40	4	**.0039**	0.10	2.CMCCF.M2Z4.120.1	■
	.047	1.2	**.142**	3.60	3.60	4	**1.57**	40	4	**.0079**	0.20	2.CMCCF.M3Z4.120.1	■
	.059	1.5	**.177**	4.50	4.50	4	**1.57**	40	4	**.0039**	0.10	2.CMCCF.M2Z4.150.1	■
	.059	1.5	**.177**	4.50	4.50	4	**1.57**	40	4	**.0118**	0.30	2.CMCCF.M3Z4.150.1	■
1/16	**.0625**	1.587	**.187**	4.76	4.76	4	**1.57**	40	4	**.0100**	0.254	2.CMC.RCFM2Z4.F116	■
1/16	**.0625**	1.587	**.187**	4.76	4.76	4	**1.57**	40	4	**.0200**	0.508	2.CMC.RCFM3Z4.F116	■
	.071	1.8	**.213**	5.40	5.40	4	**1.57**	40	4	**.0039**	0.10	2.CMCCF.M2Z4.180.1	■
	.071	1.8	**.213**	5.40	5.40	4	**1.57**	40	4	**.0118**	0.30	2.CMCCF.M3Z4.180.1	■
	.079	2.0	**.236**	6.00	6.00	4	**1.57**	40	4	**.0039**	0.10	2.CMCCF.M2Z4.200.1	■
	.079	2.0	**.236**	6.00	6.00	4	**1.57**	40	4	**.0079**	0.20	2.CMCCF.M3Z4.200.1	■
	.079	2.0	**.236**	6.00	6.00	4	**1.57**	40	4	**.0197**	0.50	2.CMCCF.M4Z4.200.1	■
3/32	**.0937**	2.381	**.281**	7.14	7.14	4	**1.73**	44	4	**.0050**	0.127	2.CMC.RCFM2Z4.F332	■
3/32	**.0937**	2.381	**.281**	7.14	7.14	4	**1.73**	44	4	**.0100**	0.254	2.CMC.RCFM3Z4.F332	■
3/32	**.0937**	2.381	**.281**	7.14	7.14	4	**1.73**	44	4	**.0200**	0.508	2.CMC.RCFM4Z4.F332	■
	.098	2.5	**.295**	7.50	7.50	6	**2.17**	55	4	**.0079**	0.20	2.CMCCF.M2Z4.250.1	■
	.098	2.5	**.295**	7.50	7.50	6	**2.17**	55	4	**.0197**	0.50	2.CMCCF.M3Z4.250.1	■
	.118	3.0	**.354**	9.00	9.00	6	**2.17**	55	5	**.0079**	0.20	2.CMCCF.M2Z5.300.1	■
	.118	3.0	**.354**	9.00	9.00	6	**2.17**	55	5	**.0197**	0.50	2.CMCCF.M3Z5.300.1	■
1/8	**.1250**	3.175	**.375**	9.53	9.53	6	**2.17**	55	5	**.0050**	0.127	2.CMC.RCFM0Z5.F18	■
1/8	**.1250**	3.175	**.375**	9.53	9.53	6	**2.17**	55	5	**.0100**	0.254	2.CMC.RCFM2Z5.F18	■
1/8	**.1250**	3.175	**.375**	9.53	9.53	6	**2.17**	55	5	**.0200**	0.508	2.CMC.RCFM3Z5.F18	■
1/8	**.1250**	3.175	**.375**	9.53	9.53	6	**2.17**	55	5	**.0300**	0.762	2.CMC.RCFM4Z5.F18	■
	.138	3.5	**.413**	10.50	10.50	6	**2.17**	55	5	**.0079**	0.20	2.CMCCF.M2Z5.350.1	■
	.138	3.5	**.413**	10.50	10.50	6	**2.17**	55	5	**.0197**	0.50	2.CMCCF.M3Z5.350.1	■
5/32	**.1562**	3.968	**.469**	11.90	11.90	6	**2.17**	55	5	**.0100**	0.254	2.CMC.RCFM2Z5.F532	■
5/32	**.1562**	3.968	**.469**	11.90	11.90	6	**2.17**	55	5	**.0200**	0.508	2.CMC.RCFM3Z5.F532	■
	.157	4.0	**.472**	12.00	12.00	6	**2.17**	55	5	**.0079**	0.20	2.CMCCF.M2Z5.400.1	■
	.157	4.0	**.472**	12.00	12.00	6	**2.17**	55	5	**.0197**	0.50	2.CMCCF.M3Z5.400.1	■
	.177	4.5	**.531**	13.50	13.50	8	**2.56**	65	5	**.0079**	0.20	2.CMCCF.M2Z5.450.1	■
	.177	4.5	**.531**	13.50	13.50	8	**2.56**	65	5	**.0197**	0.50	2.CMCCF.M3Z5.450.1	■
3/16	**.1875**	4.762	**.563**	14.29	14.29	8	**2.56**	65	5	**.0100**	0.254	2.CMC.RCFM2Z5.F316	■
3/16	**.1875**	4.762	**.563**	14.29	14.29	8	**2.56**	65	5	**.0300**	0.762	2.CMC.RCFM3Z5.F316	■
	.197	5.0	**.591**	15.00	15.00	8	**2.56**	65	5	**.0079**	0.20	2.CMCCF.M2Z5.500.1	■
	.197	5.0	**.591**	15.00	15.00	8	**2.56**	65	5	**.0197**	0.50	2.CMCCF.M3Z5.500.1	■
7/32	**.2189**	5.560	**.657**	16.68	16.68	10	**2.76**	70	5	**.0100**	0.254	2.CMC.RCFM2Z5.F732	■
7/32	**.2189**	5.560	**.657**	16.68	16.68	10	**2.76**	70	5	**.0300**	0.762	2.CMC.RCFM3Z5.F732	■
	.236	6.0	**.709**	18.00	18.00	10	**2.76**	70	5	**.0079**	0.20	2.CMCCF.M2Z5.600.1	■
	.236	6.0	**.709**	18.00	18.00	10	**2.76**	70	5	**.0197**	0.50	2.CMCCF.M3Z5.600.1	■
	.236	6.0	**.709**	18.00	18.00	10	**2.76**	70	5	**.0394**	1.00	2.CMCCF.M4Z5.600.1	■
1/4	**.2500**	6.350	**.750**	19.05	19.05	10	**2.76**	70	5	**.0100**	0.254	2.CMC.RCFM2Z5.F14	■
1/4	**.2500**	6.350	**.750**	19.05	19.05	10	**2.76**	70	5	**.0200**	0.508	2.CMC.RCFM3Z5.F14	■
1/4	**.2500**	6.350	**.750**	19.05	19.05	10	**2.76**	70	5	**.0300**	0.762	2.CMC.RCFM4Z5.F14	■
	.315	8.0	**.945**	24.00	24.00	12	**3.15**	80	5	**.0079**	0.20	2.CMCCF.M2Z5.800.1	Δ
	.315	8.0	**.945**	24.00	24.00	12	**3.15**	80	5	**.0197**	0.50	2.CMCCF.M3Z5.800.1	Δ
	.315	8.0	**.945**	24.00	24.00	12	**3.15**	80	5	**.0394**	1.00	2.CMCCF.M4Z5.800.1	Δ

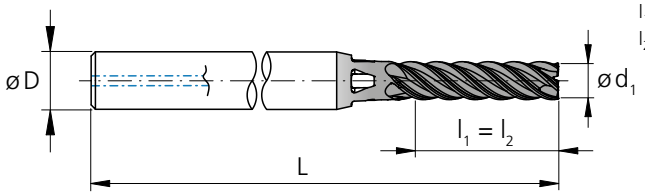
■ Stock item
Δ Delivery term upon request, minumum purchase order quantity 3 pcs.

NEW Type M - 3 x d - Square / Corner radius - Z4 / Z5

MILLING WITH INTEGRATED COOLING

Square

protection chamfer 45°



l_1 = Effective length
l_2 = Cutting length

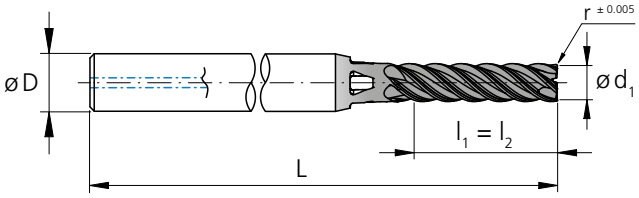
d_1 [inch]	d_1 [inch]	d_1 [mm]	l_1 [inch]	l_1 [mm]	l_2 [mm]	D (h6) [mm]	L [inch]	L [mm]	Z [flutes]	Item number	Availability
	.039	1.0	**.079**	4.0	4.0	4	**1.57**	40	4	2.CMCCF.N1Z4.100.1	■
	.047	1.2	**.094**	4.8	4.8	4	**1.57**	40	4	2.CMCCF.N1Z4.120.1	■
	.059	1.5	**.118**	6.0	6.0	4	**1.57**	40	4	2.CMCCF.N1Z4.150.1	■
1/16	**.0625**	1.587	**.122**	6.3	6.3	4	**1.57**	40	4	2.CMC.SCFN1Z4.F116	■
	.071	1.8	**.142**	7.2	7.2	4	**1.57**	40	4	2.CMCCF.N1Z4.180.1	■
	.079	2.0	**.157**	8.0	8.0	4	**1.73**	44	4	2.CMCCF.N1Z4.200.1	■
3/32	**.0937**	2.381	**.185**	9.5	9.5	4	**1.73**	44	4	2.CMC.SCFN1Z4.F332	■
	.098	2.5	**.197**	10.0	10.0	6	**2.17**	55	4	2.CMCCF.N1Z4.250.1	■
	.118	3.0	**.236**	12.0	12.0	6	**2.17**	55	5	2.CMCCF.N1Z5.300.1	■
1/8	**.1250**	3.175	**.252**	12.7	12.7	6	**2.36**	60	5	2.CMC.SCFN1Z5.F18	■
	.138	3.5	**.276**	14.0	14.0	6	**2.36**	60	5	2.CMCCF.N1Z5.350.1	■
5/32	**.1562**	3.968	**.312**	15.9	15.9	6	**2.36**	60	5	2.CMC.SCFN1Z5.F532	■
	.157	4.0	**.315**	16.0	16.0	6	**2.36**	60	5	2.CMCCF.N1Z5.400.1	■
	.177	4.5	**.354**	18.0	18.0	8	**2.76**	70	5	2.CMCCF.N1Z5.450.1	■
3/16	**.1875**	4.762	**.375**	19.0	19.0	8	**2.76**	70	5	2.CMC.SCFN1Z5.F316	■
	.197	5.0	**.394**	20.0	20.0	8	**2.76**	70	5	2.CMCCF.N1Z5.500.1	■
7/32	**.2189**	5.560	**.438**	22.2	22.2	10	**2.95**	75	5	2.CMC.SCFN1Z5.F732	■
	.236	6.0	**.472**	24.0	24.0	10	**2.95**	75	5	2.CMCCF.N1Z5.600.1	■
1/4	**.2500**	6.350	**.500**	25.4	25.4	10	**3.15**	80	5	2.CMC.SCFN1Z5.F14	■
	.315	8.0	**.630**	32.0	32.0	12	**3.54**	90	5	2.CMCCF.N1Z5.800.1	Δ

■ Stock item
Δ Delivery term upon request, minumum purchase order quantity 3 pcs.

Carbide	4xd1	Z 4-5	Variable		eXedur SNP								

Ø d_1	.004" - .118" (0.1 - 3.0 mm)		.122" - .236" (3.1 - 6.0 mm)		.240" - .394" (6.1 - 10.0 mm)	
Tolerance	- .00055" - .00110"	- 0.014 mm - 0.028 mm	- .00079" - .00150"	- 0.020 mm - 0.038 mm	- .00098" - .00185"	- 0.025 mm - 0.047 mm

Corner radius



l_1 = Effective length
l_2 = Cutting length

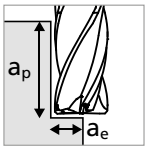
d_1 [inch]	d_1 [inch]	d_1 [mm]	l_1 [inch]	l_1 [mm]	l_2 [mm]	D (h6) [mm]	L [inch]	L [mm]	Z [flutes]	r [inch]	r [mm]	Item number	Availability
	.039	1.0	.157	4.00	4.00	4	1.57	40	4	.0039	0.10	2.CMCCF.N2Z4.100.1	■
	.039	1.0	.157	4.00	4.00	4	1.57	40	4	.0079	0.20	2.CMCCF.N3Z4.100.1	■
	.047	1.2	.189	4.80	4.80	4	1.57	40	4	.0039	0.10	2.CMCCF.N2Z4.120.1	■
	.047	1.2	.189	4.80	4.80	4	1.57	40	4	.0079	0.20	2.CMCCF.N3Z4.120.1	■
	.059	1.5	.236	6.00	6.00	4	1.57	40	4	.0039	0.10	2.CMCCF.N2Z4.150.1	■
	.059	1.5	.236	6.00	6.00	4	1.57	40	4	.0118	0.30	2.CMCCF.N3Z4.150.1	■
1/16	.0625	1.587	.250	6.35	6.35	4	1.57	40	4	.0100	0.254	2.CMC.RCFN2Z4.F116	■
1/16	.0625	1.587	.250	6.35	6.35	4	1.57	40	4	.0200	0.508	2.CMC.RCFN3Z4.F116	■
	.071	1.8	.283	7.20	7.20	4	1.57	40	4	.0039	0.10	2.CMCCF.N2Z4.180.1	■
	.071	1.8	.283	7.20	7.20	4	1.57	40	4	.0118	0.30	2.CMCCF.N3Z4.180.1	■
	.079	2.0	.315	8.00	8.00	4	1.73	44	4	.0039	0.10	2.CMCCF.N2Z4.200.1	■
	.079	2.0	.315	8.00	8.00	4	1.73	44	4	.0079	0.20	2.CMCCF.N3Z4.200.1	■
	.079	2.0	.315	8.00	8.00	4	1.73	44	4	.0197	0.50	2.CMCCF.N4Z4.200.1	■
3/32	.0937	2.381	.375	9.52	9.52	4	1.73	44	4	.0050	0.127	2.CMC.RCFN2Z4.F332	■
3/32	.0937	2.381	.375	9.52	9.52	4	1.73	44	4	.0100	0.254	2.CMC.RCFN3Z4.F332	■
3/32	.0937	2.381	.375	9.52	9.52	4	1.73	44	4	.0200	0.508	2.CMC.RCFN4Z4.F332	■
	.098	2.5	.394	10.00	10.00	6	2.17	55	4	.0079	0.20	2.CMCCF.N2Z4.250.1	■
	.098	2.5	.394	10.00	10.00	6	2.17	55	4	.0197	0.50	2.CMCCF.N3Z4.250.1	■
	.118	3.0	.472	12.00	12.00	6	2.17	55	5	.0079	0.20	2.CMCCF.N2Z5.300.1	■
	.118	3.0	.472	12.00	12.00	6	2.17	55	5	.0197	0.50	2.CMCCF.N3Z5.300.1	■
1/8	.1250	3.175	.500	12.70	12.70	6	2.36	60	5	.0050	0.127	2.CMC.RCFN0Z5.F18	■
1/8	.1250	3.175	.500	12.70	12.70	6	2.36	60	5	.0100	0.254	2.CMC.RCFN2Z5.F18	■
1/8	.1250	3.175	.500	12.70	12.70	6	2.36	60	5	.0200	0.508	2.CMC.RCFN3Z5.F18	■
1/8	.1250	3.175	.500	12.70	12.70	6	2.36	60	5	.0300	0.762	2.CMC.RCFN4Z5.F18	■
	.138	3.5	.551	14.00	14.00	6	2.36	60	5	.0079	0.20	2.CMCCF.N2Z5.350.1	■
	.138	3.5	.551	14.00	14.00	6	2.36	60	5	.0197	0.50	2.CMCCF.N3Z5.350.1	■
5/32	.1562	3.968	.625	15.87	15.87	6	2.36	60	5	.0100	0.254	2.CMC.RCFN2Z5.F532	■
5/32	.1562	3.968	.625	15.87	15.87	6	2.36	60	5	.0200	0.508	2.CMC.RCFN3Z5.F532	■
	.157	4.0	.630	16.00	16.00	6	2.36	60	5	.0079	0.20	2.CMCCF.N2Z5.400.1	■
	.157	4.0	.630	16.00	16.00	6	2.36	60	5	.0197	0.50	2.CMCCF.N3Z5.400.1	■
	.177	4.5	.709	18.00	18.00	8	2.76	70	5	.0079	0.20	2.CMCCF.N2Z5.450.1	■
	.177	4.5	.709	18.00	18.00	8	2.76	70	5	.0197	0.50	2.CMCCF.N3Z5.450.1	■
3/16	.1875	4.762	.750	19.05	19.05	8	2.76	70	5	.0100	0.254	2.CMC.RCFN2Z5.F316	■
3/16	.1875	4.762	.750	19.05	19.05	8	2.76	70	5	.0300	0.762	2.CMC.RCFN3Z5.F316	■
	.197	5.0	.787	20.00	20.00	8	2.76	70	5	.0079	0.20	2.CMCCF.N2Z5.500.1	■
	.197	5.0	.787	20.00	20.00	8	2.76	70	5	.0197	0.50	2.CMCCF.N3Z5.500.1	■
7/32	.2189	5.560	.876	22.24	22.24	10	2.95	75	5	.0100	0.254	2.CMC.RCFN2Z5.F732	■
7/32	.2189	5.560	.876	22.24	22.24	10	2.95	75	5	.0300	0.762	2.CMC.RCFN3Z5.F732	■
	.236	6.0	.945	24.00	24.00	10	2.95	75	5	.0079	0.20	2.CMCCF.N2Z5.600.1	■
	.236	6.0	.945	24.00	24.00	10	2.95	75	5	.0197	0.50	2.CMCCF.N3Z5.600.1	■
	.236	6.0	.945	24.00	24.00	10	2.95	75	5	.0394	1.00	2.CMCCF.N4Z5.600.1	■
1/4	.2500	6.350	1.00	25.40	25.40	10	3.15	80	5	.0100	0.254	2.CMC.RCFN2Z5.F14	■
1/4	.2500	6.350	1.00	25.40	25.40	10	3.15	80	5	.0200	0.508	2.CMC.RCFN3Z5.F14	■
1/4	.2500	6.350	1.00	25.40	25.40	10	3.15	80	5	.0300	0.762	2.CMC.RCFN4Z5.F14	■
	.315	8.0	1.26	32.00	32.00	12	3.54	90	5	.0079	0.20	2.CMCCF.N2Z5.800.1	Δ
	.315	8.0	1.26	32.00	32.00	12	3.54	90	5	.0197	0.50	2.CMCCF.N3Z5.800.1	Δ
	.315	8.0	1.26	32.00	32.00	12	3.54	90	5	.0394	1.00	2.CMCCF.N4Z5.800.1	Δ

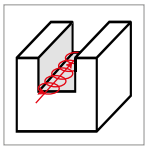
■ Stock item
Δ Delivery term upon request, minumum purchase order quantity 3 pcs.

Type M - Semi-finishing

MILLING WITH INTEGRATED COOLING | CUTTING DATA OVERVIEW

Semi-finishing

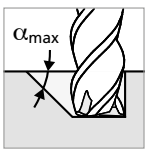




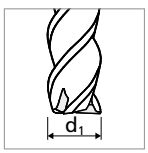
①
- $a_p = 3 \times d_1$
- $a_e = 0.15 \times d_1$

②
- $a_p = 3 \times d_1$
- $a_e = 0.1 \times d_1$

③
- $a_p = 3 \times d_1$
- $a_e = 0.05 \times d_1$



Note:
In case of linear ramp or helical interpolation milling reduce f_z by 20% and use $\alpha = 3°$ for all materials



Materials group	Material	Mat. no.	DIN	AISI/ASTM/UNS	1.0 mm | .039" ① v_c	1.0 mm | .039" ① f_z	1.0 mm | .039" ② v_c	1.0 mm | .039" ② f_z	1.0 mm | .039" ③ v_c	1.0 mm | .039" ③ f_z	1/16" 1.5 mm | .059" ① v_c	1/16" 1.5 mm | .059" ① f_z	1/16" 1.5 mm | .059" ② v_c	1/16" 1.5 mm | .059" ② f_z	1/16" 1.5 mm | .059" ③ v_c	1/16" 1.5 mm | .059" ③ f_z
P	Unalloyed carbon steel Rm < 800 N/mm²	1.0301	C10	AISI 1010	140	0.010	180	0.012	250	0.016	180	0.012	210	0.016	280	0.024
		1.0401	C15	AISI 1015	**459**	**.00039**	**591**	**.00047**	**820**	**.00063**	**591**	**.00047**	**687**	**.00063**	**919**	**.00094**
		1.1191	C45E/CK45	AISI 1045												
		1.0044	S275JR	AISI 1020												
		1.0715	11SMn30	AISI 1215												
	Low alloyed steel Rm > 900 N/mm²	1.5752	15NiCr13	ASTM 3415 / AISI 3310	140	0.010	180	0.012	250	0.016	180	0.012	210	0.016	280	0.024
		1.7131	16MnCr5	AISI 5115	**459**	**.00039**	**591**	**.00047**	**820**	**.00063**	**591**	**.00047**	**687**	**.00063**	**919**	**.00094**
		1.3505	100Cr6	AISI 52100												
		1.7225	42CrMo4	AISI 4140												
		1.2842	90MnCrV8	AISI O2												
	High alloyed tool steel Rm < 1200 N/mm²	1.2379	X153CrMoV12	AISI D2	140	0.008	160	0.010	220	0.015	160	0.011	180	0.015	240	0.022
		1.2436	X210CrW12	AISI D4/D6	**459**	**.00031**	**525**	**.00039**	**722**	**.00059**	**525**	**.00043**	**591**	**.00059**	**787**	**.00087**
		1.3343	HS6-5-2C	AISI M2 / UNS T11302												
		1.3355	HS18-0-1	AISI T1 / UNS T12001												
M	Stainless steel ferritic	1.4016	X6Cr17	AISI 430 / UNS S43000	100	0.010	130	0.012	180	0.016	130	0.012	150	0.016	200	0.024
		1.4105	X6CrMoS17	AISI 430F	**328**	**.00039**	**427**	**.00047**	**591**	**.00063**	**427**	**.00047**	**492**	**.00063**	**656**	**.00094**
	Stainless steel martensitic	1.4034	X46Cr13	AISI 420C	100	0.010	130	0.012	180	0.016	130	0.012	150	0.016	200	0.024
		1.4112	X90CrMoV18	AISI 440B	**328**	**.00039**	**427**	**.00047**	**591**	**.00063**	**427**	**.00047**	**492**	**.00063**	**656**	**.00094**
	Stainless steel martensitic – PH	1.4542	X5CrNiCuNb16-4	AISI 630 / ASTM 17-4 PH	100	0.009	120	0.011	160	0.015	120	0.012	140	0.015	180	0.023
		1.4545	X5CrNiCuNb15-5	ASTM 15-5 PH	**328**	**.00035**	**394**	**.00043**	**525**	**.00059**	**394**	**.00047**	**459**	**.00059**	**591**	**.00091**
	Stainless steel austenitic	1.4301	X5CrNi18-10	AISI 304	100	0.008	120	0.010	160	0.014	120	0.011	140	0.014	180	0.022
		1.4435	X2CrNiMo18-14-3	AISI 316L	**328**	**.00031**	**394**	**.00039**	**525**	**.00050**	**394**	**.00043**	**459**	**.00050**	**591**	**.00087**
		1.4441	X2CrNiMo18-15-3	AISI 316LM												
		1.4539	X1NiCrMoCu25-20-5	AISI 904L												
K	Cast iron	0.6020	GG20	ASTM 30	100	0.010	120	0.012	160	0.017	120	0.012	140	0.015	180	0.024
		0.6030	GG30	ASTM 40B	**328**	**.00039**	**394**	**.00047**	**525**	**.00067**	**394**	**.00047**	**459**	**.00059**	**591**	**.00094**
		0.7040	GGG40	ASTM 60-40-18												
		0.7060	GGG60	ASTM 80-60-03												
N	Aluminium alloy wrought	3.2315	AlMgSi1	ASTM 6351	130	0.015	160	0.018	230	0.025	160	0.019	190	0.024	280	0.034
		3.4365	AlZnMgCu1.5	ASTM 7075	**427**	**.00059**	**525**	**.00071**	**755**	**.00098**	**525**	**.00075**	**623**	**.00094**	**919**	**.00134**
	Aluminium alloy cast	3.2163	GD-AlSi9Cu3	ASTM A380	130	0.015	160	0.018	230	0.025	160	0.019	190	0.024	280	0.034
		3.2381	GD-AlSi10Mg	UNS A03590	**427**	**.00059**	**525**	**.00071**	**755**	**.00098**	**525**	**.00075**	**623**	**.00094**	**919**	**.00134**
	Copper	2.0040	Cu-OF / CW008A	UNS C10100	130	0.015	160	0.018	230	0.025	160	0.019	190	0.024	280	0.034
		2.0065	Cu-ETP / CW004A	UNS C11000	**427**	**.00059**	**525**	**.00071**	**755**	**.00098**	**525**	**.00075**	**623**	**.00094**	**919**	**.00134**
	Brass lead free	2.0321	CuZn37 CW508L	UNS C27400	130	0.015	160	0.018	230	0.025	160	0.019	190	0.024	280	0.034
		2.0360	CuZn40 CW509L	UNS C28000	**427**	**.00059**	**525**	**.00071**	**755**	**.00098**	**525**	**.00075**	**623**	**.00094**	**919**	**.00134**
	Brass, Bronze Rm < 400 N/mm²	2.0401	CuZn39Pb3 / CW614N	UNS C38500	130	0.015	160	0.018	230	0.025	160	0.019	190	0.024	280	0.034
		2.1020	CuSn6	UNS C51900	**427**	**.00059**	**525**	**.00071**	**755**	**.00098**	**525**	**.00075**	**623**	**.00094**	**919**	**.00134**
	Bronze Rm < 600 N/mm²	2.0966	CuAl10Ni5Fe4	UNS C63000	130	0.015	160	0.018	230	0.025	160	0.019	190	0.024	280	0.034
		2.0960	CuAl9Mn2	UNS C63200	**427**	**.00059**	**525**	**.00071**	**755**	**.00098**	**525**	**.00075**	**623**	**.00094**	**919**	**.00134**
S_1	Super alloys	2.4856		Inconel 625	-	-	50	0.008	80	0.011	-	-	75	0.011	100	0.016
		2.4668		Inconel 718			**164**	**.00031**	**262**	**.00043**			**246**	**.00043**	**328**	**.00063**
		2.4617	NiMo28	Hastelloy B-2												
		2.4665	NiCr22Fe18Mo	Hastelloy X												
S_2	Titanium pure	3.7035	Gr.2	ASTM B348 / F67	75	0.009	90	0.012	120	0.018	75	0.012	90	0.015	120	0.022
		3.7065	Gr.4	ASTM B348 / F68	**246**	**.00035**	**295**	**.00047**	**394**	**.00071**	**246**	**.00047**	**295**	**.00059**	**394**	**.00087**
	Titanium alloys	3.7165	TiAl6V4	ASTM B348 / F136	75	0.009	90	0.012	120	0.018	75	0.012	90	0.015	120	0.022
		9.9367	TiAl6Nb7	ASTM F1295	**246**	**.00035**	**295**	**.00047**	**394**	**.00071**	**246**	**.00047**	**295**	**.00059**	**394**	**.00087**
S_3	CrCo alloys	2.4964	CoCr20W15Ni	Haynes 25	-	-	60	0.008	80	0.011	-	-	75	0.011	100	0.016
			CrCoMo28	ASTM F1537			**197**	**.00031**	**262**	**.00043**			**246**	**.00043**	**328**	**.00063**
H_1	Hardened steel < 55 HRC	1.2510	100MnCrMoW4	AISI O1												
H_2	Hardened steel ≥ 55 HRC	1.2379	X153CrMoV12	AISI D2												

v_c [m/min] | **[SFM]**
f_z [mm] | **[IPT]**

RECOMMENDATION FOR USE
● Excellent | ◐ Good | ○ Acceptable | ⊠ Not recommended

P ●	N ●	S3 ●
M ●	S1 ●	H1 ⊠
K ●	S2 ●	H2 ⊠

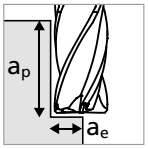
Ød_1

3/32" 2.0 mm | .079"						1/8" 3.0 mm | .118"						5/32" 4.0 mm | .157"						3/16" - 7/32" 5.0 mm | .197"						1/4" 6.0 mm | .236"						8.0 mm | .315"					
①		②		③		①		②		③		①		②		③		①		②		③		①		②		③		①		②		③	
v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z
180 **591**	0.021 **.00083**	210 **687**	0.027 **.00106**	280 **919**	0.040 **.00157**	230 **755**	0.026 **.00102**	250 **820**	0.036 **.00148**	320 **1050**	0.056 **.00220**	230 **755**	0.033 **.00130**	260 **853**	0.044 **.00173**	350 **1148**	0.065 **.00256**	230 **755**	0.038 **.00151**	260 **853**	0.050 **.00197**	350 **1148**	0.074 **.00291**	255 **836**	0.044 **.00173**	285 **935**	0.059 **.00232**	350 **1148**	0.096 **.00378**	255 **836**	0.060 **.00236**	285 **935**	0.080 **.00315**	380 **1247**	0.120 **.00472**
180 **591**	0.021 **.00083**	210 **687**	0.027 **.00106**	280 **919**	0.040 **.00157**	230 **755**	0.026 **.00102**	250 **820**	0.036 **.00148**	320 **1050**	0.056 **.00220**	230 **755**	0.033 **.00130**	260 **853**	0.044 **.00173**	350 **1148**	0.065 **.00256**	230 **755**	0.038 **.00151**	260 **853**	0.050 **.00197**	350 **1148**	0.074 **.00291**	255 **836**	0.044 **.00173**	285 **935**	0.059 **.00232**	350 **1148**	0.096 **.00378**	255 **836**	0.060 **.00236**	285 **935**	0.080 **.00315**	380 **1247**	0.096 **.00472**
180 **591**	0.018 **.00071**	200 **656**	0.024 **.00094**	260 **853**	0.036 **.00148**	180 **591**	0.025 **.00098**	200 **656**	0.034 **.00134**	260 **853**	0.053 **.00209**	200 **656**	0.031 **.00122**	230 **755**	0.041 **.00161**	300 **984**	0.063 **.00248**	200 **656**	0.036 **.00142**	230 **755**	0.047 **.00185**	300 **984**	0.072 **.00283**	200 **656**	0.040 **.00157**	230 **755**	0.052 **.00205**	300 **984**	0.080 **.00315**	200 **656**	0.048 **.00189**	230 **755**	0.063 **.00248**	300 **984**	0.096 **.00378**
140 **459**	0.020 **.00079**	160 **525**	0.026 **.00102**	220 **722**	0.038 **.00151**	160 **525**	0.025 **.00098**	180 **591**	0.033 **.00130**	240 **787**	0.050 **.00197**	180 **591**	0.032 **.00137**	210 **687**	0.041 **.00161**	260 **853**	0.064 **.00252**	180 **591**	0.038 **.00151**	210 **687**	0.049 **.00193**	260 **853**	0.074 **.00291**	190 **623**	0.040 **.00157**	210 **687**	0.054 **.00213**	260 **853**	0.088 **.00228**	190 **623**	0.050 **.00197**	210 **687**	0.068 **.00278**	260 **853**	0.110 **.00433**
140 **459**	0.020 **.00079**	160 **525**	0.026 **.00102**	220 **722**	0.038 **.00151**	160 **525**	0.025 **.00098**	180 **591**	0.033 **.00130**	240 **787**	0.050 **.00197**	180 **591**	0.032 **.00137**	210 **687**	0.041 **.00161**	260 **853**	0.064 **.00252**	180 **591**	0.038 **.00151**	210 **687**	0.049 **.00193**	260 **853**	0.074 **.00291**	190 **623**	0.040 **.00157**	210 **687**	0.054 **.00213**	260 **853**	0.088 **.00228**	190 **623**	0.050 **.00197**	210 **687**	0.068 **.00278**	260 **853**	0.110 **.00433**
120 **394**	0.018 **.00071**	140 **459**	0.023 **.00091**	180 **591**	0.036 **.00148**	140 **459**	0.024 **.00094**	160 **525**	0.031 **.00122**	200 **656**	0.050 **.00197**	160 **525**	0.029 **.00114**	180 **591**	0.038 **.00151**	220 **722**	0.063 **.00248**	160 **525**	0.033 **.00114**	180 **591**	0.044 **.00173**	220 **722**	0.072 **.00283**	160 **525**	0.036 **.00148**	180 **591**	0.049 **.00193**	220 **722**	0.080 **.00315**	160 **525**	0.046 **.00181**	180 **591**	0.061 **.00240**	220 **722**	0.100 **.00394**
120 **394**	0.017 **.00067**	140 **459**	0.022 **.00087**	180 **591**	0.034 **.00134**	140 **459**	0.026 **.00102**	160 **525**	0.034 **.00134**	200 **656**	0.054 **.00213**	160 **525**	0.029 **.00114**	180 **591**	0.039 **.00154**	220 **722**	0.064 **.00252**	160 **525**	0.031 **.00122**	180 **591**	0.042 **.00165**	220 **722**	0.068 **.00278**	160 **525**	0.034 **.00134**	180 **591**	0.046 **.00181**	220 **722**	0.075 **.00295**	160 **525**	0.042 **.00165**	180 **591**	0.056 **.00220**	220 **722**	0.091 **.00358**
140 **459**	0.022 **.00087**	160 **525**	0.029 **.00114**	220 **722**	0.042 **.00165**	160 **525**	0.028 **.00110**	180 **591**	0.038 **.00150**	240 **787**	0.057 **.00244**	200 **656**	0.033 **.00114**	230 **755**	0.043 **.00170**	290 **951**	0.068 **.00278**	210 **687**	0.037 **.00146**	240 **787**	0.048 **.00189**	300 **984**	0.077 **.00303**	230 **755**	0.045 **.00177**	260 **853**	0.060 **.00236**	320 **1050**	0.097 **.00382**	240 **787**	0.060 **.00236**	280 **909**	0.077 **.00303**	340 **1115**	0.127 **.00500**
180 **591**	0.040 **.00157**	210 **687**	0.052 **.00205**	300 **984**	0.073 **.00287**	240 **787**	0.045 **.00177**	260 **853**	0.062 **.00244**	340 **1115**	0.095 **.00374**	260 **853**	0.060 **.00236**	290 **919**	0.083 **.00327**	370 **1214**	0.126 **.00500**	320 **1050**	0.065 **.00256**	350 **1148**	0.089 **.00350**	430 **1411**	0.145 **.00571**	320 **1050**	0.067 **.00264**	350 **1148**	0.092 **.00362**	430 **1411**	0.150 **.00591**	340 **1115**	0.084 **.00331**	360 **1181**	0.119 **.00469**	450 **1476**	0.190 **.00748**
180 **591**	0.040 **.00157**	210 **687**	0.052 **.00205**	300 **984**	0.073 **.00287**	240 **787**	0.045 **.00177**	260 **853**	0.062 **.00244**	340 **1115**	0.095 **.00374**	260 **853**	0.060 **.00236**	290 **919**	0.083 **.00327**	370 **1214**	0.126 **.00500**	320 **1050**	0.065 **.00256**	350 **1148**	0.089 **.00350**	430 **1411**	0.145 **.00571**	320 **1050**	0.067 **.00264**	350 **1148**	0.092 **.00362**	430 **1411**	0.150 **.00591**	340 **1115**	0.084 **.00331**	360 **1181**	0.119 **.00469**	450 **1476**	0.190 **.00748**
180 **591**	0.040 **.00157**	210 **687**	0.052 **.00205**	300 **984**	0.073 **.00287**	240 **787**	0.045 **.00177**	260 **853**	0.062 **.00244**	340 **1115**	0.095 **.00374**	260 **853**	0.060 **.00236**	290 **919**	0.083 **.00327**	370 **1214**	0.126 **.00500**	320 **1050**	0.065 **.00256**	350 **1148**	0.089 **.00350**	430 **1411**	0.145 **.00571**	320 **1050**	0.067 **.00264**	350 **1148**	0.092 **.00362**	430 **1411**	0.150 **.00591**	340 **1115**	0.084 **.00331**	360 **1181**	0.119 **.00469**	450 **1476**	0.190 **.00748**
180 **591**	0.040 **.00157**	210 **687**	0.052 **.00205**	300 **984**	0.073 **.00287**	240 **787**	0.045 **.00177**	260 **853**	0.062 **.00244**	340 **1115**	0.095 **.00374**	260 **853**	0.060 **.00236**	290 **919**	0.083 **.00327**	370 **1214**	0.126 **.00500**	320 **1050**	0.065 **.00256**	350 **1148**	0.089 **.00350**	430 **1411**	0.145 **.00571**	320 **1050**	0.067 **.00264**	350 **1148**	0.092 **.00362**	430 **1411**	0.150 **.00591**	340 **1115**	0.084 **.00331**	360 **1181**	0.119 **.00469**	450 **1476**	0.190 **.00748**
180 **591**	0.040 **.00157**	210 **687**	0.052 **.00205**	300 **984**	0.073 **.00287**	240 **787**	0.045 **.00177**	260 **853**	0.062 **.00244**	340 **1115**	0.095 **.00374**	260 **853**	0.060 **.00236**	290 **919**	0.083 **.00327**	370 **1214**	0.126 **.00500**	320 **1050**	0.065 **.00256**	350 **1148**	0.089 **.00350**	430 **1411**	0.145 **.00571**	320 **1050**	0.067 **.00264**	350 **1148**	0.092 **.00362**	430 **1411**	0.150 **.00591**	340 **1115**	0.084 **.00331**	360 **1181**	0.119 **.00469**	450 **1476**	0.190 **.00748**
180 **591**	0.040 **.00157**	210 **687**	0.052 **.00205**	300 **984**	0.073 **.00287**	240 **787**	0.045 **.00177**	260 **853**	0.062 **.00244**	340 **1115**	0.095 **.00374**	260 **853**	0.060 **.00236**	290 **919**	0.083 **.00327**	370 **1214**	0.126 **.00500**	320 **1050**	0.065 **.00256**	350 **1148**	0.089 **.00350**	430 **1411**	0.145 **.00571**	320 **1050**	0.067 **.00264**	350 **1148**	0.092 **.00362**	430 **1411**	0.150 **.00591**	340 **1115**	0.084 **.00331**	360 **1181**	0.119 **.00469**	450 **1476**	0.190 **.00748**
-	-	70 **230**	0.013 **.00051**	100 **328**	0.018 **.00071**	-	-	80 **262**	0.019 **.00075**	120 **394**	0.026 **.00102**	-	-	90 **295**	0.021 **.00083**	130 **427**	0.029 **.00114**	-	-	90 **295**	0.024 **.00094**	130 **427**	0.033 **.00130**	-	-	90 **295**	0.027 **.00106**	130 **427**	0.038 **.00151**	-	-	90 **295**	0.033 **.00130**	130 **427**	0.046 **.00181**
75 **246**	0.016 **.00063**	90 **295**	0.021 **.00083**	130 **427**	0.029 **.00114**	75 **246**	0.018 **.00071**	90 **295**	0.022 **.00087**	130 **427**	0.030 **.00118**	90 **295**	0.031 **.00122**	110 **361**	0.038 **.00151**	160 **525**	0.053 **.00209**	90 **295**	0.033 **.00130**	110 **361**	0.040 **.00157**	160 **525**	0.055 **.00217**	90 **295**	0.034 **.00134**	110 **361**	0.042 **.00165**	160 **525**	**.00151**	90 **295**	0.037 **.00146**	120 **394**	0.046 **.00181**	170 **558**	0.065 **.00256**
75 **246**	0.016 **.00063**	90 **295**	0.021 **.00083**	130 **427**	0.029 **.00114**	75 **246**	0.025 **.00098**	90 **295**	0.022 **.00087**	130 **427**	0.044 **.00173**	90 **295**	0.031 **.00122**	110 **361**	0.038 **.00151**	160 **525**	0.053 **.00209**	90 **295**	0.033 **.00130**	110 **361**	0.040 **.00157**	160 **525**	0.055 **.00217**	90 **295**	0.034 **.00134**	110 **361**	0.042 **.00165**	160 **525**	0.058 **.00228**	90 **295**	0.037 **.00146**	120 **394**	0.046 **.00181**	170 **558**	0.065 **.00256**
-	-	70 **230**	0.013 **.00051**	100 **328**	0.018 **.00071**	-	-	80 **262**	0.019 **.00075**	120 **394**	0.026 **.00102**	-	-	90 **295**	0.021 **.00083**	130 **427**	0.029 **.00114**	-	-	90 **295**	0.024 **.00094**	130 **427**	0.033 **.00130**	-	-	90 **295**	0.027 **.00106**	130 **427**	0.038 **.00151**	-	-	90 **295**	0.033 **.00130**	130 **427**	0.046 **.00181**

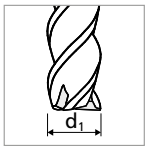
Type M - Finishing

MILLING WITH INTEGRATED COOLING | CUTTING DATA OVERVIEW

Finishing



- $a_p = 3 \times d_1$
- $a_e = 0.02 \times d_1$



Materials group	Material	Mat. no.	DIN	AISI/ASTM/UNS	1.0 mm | .039" v_c	1.0 mm | .039" f_z	1/16" 1.5 mm | .059" v_c	1/16" 1.5 mm | .059" f_z
P	Unalloyed carbon steel Rm < 800 N/mm²	1.0301	C10	AISI 1010	130 **427**	0.009 **.00035**	180 **591**	0.014 **.00055**
		1.0401	C15	AISI 1015				
		1.1191	C45E/CK45	AISI 1045				
		1.0044	S275JR	AISI 1020				
		1.0715	11SMn30	AISI 1215				
	Low alloyed steel Rm > 900 N/mm²	1.5752	15NiCr13	ASTM 3415 / AISI 3310	130 **427**	0.008 **.00032**	180 **591**	0.013 **.00051**
		1.7131	16MnCr5	AISI 5115				
		1.3505	100Cr6	AISI 52100				
		1.7225	42CrMo4	AISI 4140				
		1.2842	90MnCrV8	AISI O2				
	High alloyed tool steel Rm < 1200 N/mm²	1.2379	X153CrMoV12	AISI D2	130 **427**	0.007 **.00028**	180 **591**	0.012 **.00047**
		1.2436	X210CrW12	AISI D4/D6				
		1.3343	HS6-5-2C	AISI M2 / UNS T11302				
		1.3355	HS18-0-1	AISI T1 / UNS T12001				
M	Stainless steel ferritic	1.4016	X6Cr17	AISI 430 / UNS S43000	130 **427**	0.009 **.00035**	180 **591**	0.014 **.00055**
		1.4105	X6CrMoS17	AISI 430F				
	Stainless steel martensitic	1.4034	X46Cr13	AISI 420C	130 **427**	0.009 **.00035**	180 **591**	0.013 **.00051**
		1.4112	X90CrMoV18	AISI 440B				
	Stainless steel martensitic – PH	1.4542	X5CrNiCuNb16-4	AISI 630 / ASTM 17-4 PH	130 **427**	0.009 **.00035**	180 **591**	0.013 **.00051**
		1.4545	X5CrNiCuNb15-5	ASTM 15-5 PH				
	Stainless steel austenitic	1.4301	X5CrNi18-10	AISI 304	130 **427**	0.007 **.00028**	180 **591**	0.009 **.00035**
		1.4435	X2CrNiMo18-14-3	AISI 316L				
		1.4441	X2CrNiMo18-15-3	AISI 316LM				
		1.4539	X1NiCrMoCu25-20-5	AISI 904L				
K	Cast iron	0.6020	GG20	ASTM 30	110 **361**	0.007 **.00028**	130 **427**	0.014 **.00055**
		0.6030	GG30	ASTM 40B				
		0.7040	GGG40	ASTM 60-40-18				
		0.7060	GGG60	ASTM 80-60-03				
N	Aluminium alloy wrought	3.2315	AlMgSi1	ASTM 6351	130 **427**	0.010 **.00039**	180 **591**	0.015 **.00060**
		3.4365	AlZnMgCu1.5	ASTM 7075				
	Aluminium alloy cast	3.2163	GD-AlSi9Cu3	ASTM A380	130 **427**	0.010 **.00039**	180 **591**	0.015 **.00060**
		3.2381	GD-AlSi10Mg	UNS A03590				
	Copper	2.0040	Cu-OF / CW008A	UNS C10100	130 **427**	0.012 **.00047**	180 **591**	0.015 **.00060**
		2.0065	Cu-ETP / CW004A	UNS C11000				
	Brass lead free	2.0321	CuZn37 CW508L	UNS C27400	130 **427**	0.012 **.00047**	180 **591**	0.015 **.00060**
		2.0360	CuZn40 CW509L	UNS C28000				
	Brass, Bronze Rm < 400 N/mm²	2.0401	CuZn39Pb3 / CW614N	UNS C38500	130 **427**	0.012 **.00047**	180 **591**	0.015 **.00060**
		2.1020	CuSn6	UNS C51900				
	Bronze Rm < 600 N/mm²	2.0966	CuAl10Ni5Fe4	UNS C63000	130 **427**	0.010 **.00039**	180 **591**	0.015 **.00060**
		2.0960	CuAl9Mn2	UNS C63200				
S_1	Super alloys	2.4856		Inconel 625	110 **361**	0.005 **.00020**	120 **394**	0.006 **.00024**
		2.4668		Inconel 718				
		2.4617	NiMo28	Hastelloy B-2				
		2.4665	NiCr22Fe18Mo	Hastelloy X				
S_2	Titanium pure	3.7035	Gr.2	ASTM B348 / F67	110 **361**	0.009 **.00035**	120 **394**	0.012 **.00047**
		3.7065	Gr.4	ASTM B348 / F68				
	Titanium alloys	3.7165	TiAl6V4	ASTM B348 / F136	110 **361**	0.009 **.00035**	120 **394**	0.012 **.00047**
		9.9367	TiAl6Nb7	ASTM F1295				
S_3	CrCo alloys	2.4964	CoCr20W15Ni	Haynes 25	110 **361**	0.005 **.00020**	120 **394**	0.006 **.00024**
			CrCoMo28	ASTM F1537				
H_1	Hardened steel < 55 HRC	1.2510	100MnCrMoW4	AISI O1				
H_2	Hardened steel ≥ 55 HRC	1.2379	X153CrMoV12	AISI D2				

v_c [m/min] | **[SFM]**
f_z [mm] | **[IPT]**

RECOMMENDATION FOR USE
● Excellent | ◐ Good | ○ Acceptable | ⊠ Not recommended

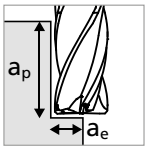
P ●	N ●	S_3 ●
M ●	S_1 ●	H_1 ⊠
K ●	S_2 ●	H_2 ⊠

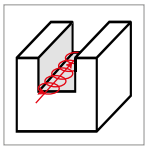
	Ød₁											
	3/32" 2.0 mm | **.079"**		**1/8"** 3.0 mm | **.118"**		**5/32"** 4.0 mm | **.157"**		**3/16" - 7/32"** 5.0 mm | **.197"**		**1/4"** 6.0 mm | **.236"**		8.0 mm | **.315"**	
	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z
	200 **656**	0.020 **.00079**	210 **689**	0.026 **.00103**	220 **722**	0.029 **.00114**	220 **722**	0.032 **.00126**	220 **722**	0.038 **.00150**	220 **722**	0.044 **.00173**
	200 **656**	0.018 **.00071**	210 **689**	0.025 **.00098**	220 **722**	0.028 **.00110**	220 **722**	0.030 **.00118**	220 **722**	0.033 **.00130**	220 **722**	0.040 **.00157**
	200 **656**	0.017 **.00067**	210 **689**	0.023 **.00091**	220 **722**	0.024 **.00094**	220 **722**	0.026 **.00102**	220 **722**	0.029 **.00114**	220 **722**	0.035 **.00138**
	200 **656**	0.020 **.00079**	210 **689**	0.025 **.00098**	220 **722**	0.028 **.00110**	220 **722**	0.030 **.00118**	220 **722**	0.033 **.00130**	260 **853**	0.040 **.00157**
	200 **656**	0.018 **.00071**	210 **689**	0.025 **.00098**	220 **722**	0.027 **.00106**	220 **722**	0.029 **.00114**	220 **722**	0.032 **.00126**	260 **853**	0.038 **.00150**
	200 **656**	0.018 **.00071**	210 **689**	0.025 **.00098**	220 **722**	0.027 **.00106**	220 **722**	0.029 **.00114**	220 **722**	0.032 **.00126**	260 **853**	0.038 **.00150**
	200 **656**	0.017 **.00067**	210 **689**	0.023 **.00091**	220 **722**	0.025 **.00098**	220 **722**	0.028 **.00110**	220 **722**	0.030 **.00118**	260 **853**	0.037 **.00146**
	150 **492**	0.016 **.00063**	160 **525**	0.025 **.00098**	170 **558**	0.029 **.00114**	170 **558**	0.033 **.00130**	170 **558**	0.036 **.00142**	200 **656**	0.042 **.00165**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00161**	270 **886**	0.047 **.00185**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00161**	270 **886**	0.047 **.00185**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00161**	270 **886**	0.047 **.00185**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00161**	270 **886**	0.047 **.00185**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00162**	270 **886**	0.047 **.00186**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00161**	270 **886**	0.047 **.00185**
	130 **427**	0.006 **.00024**	130 **427**	0.009 **.00035**	140 **459**	0.012 **.00047**	140 **459**	0.013 **.00051**	150 **492**	0.014 **.00055**	160 **525**	0.020 **.00079**
	130 **427**	0.016 **.00063**	130 **427**	0.023 **.00091**	140 **459**	0.025 **.00098**	140 **459**	0.028 **.00110**	150 **492**	0.030 **.00118**	160 **525**	0.036 **.00142**
	130 **427**	0.016 **.00063**	130 **427**	0.023 **.00091**	140 **459**	0.025 **.00098**	140 **459**	0.028 **.00110**	150 **492**	0.030 **.00118**	160 **525**	0.036 **.00142**
	130 **427**	0.006 **.00024**	130 **427**	0.009 **.00035**	140 **459**	0.012 **.00047**	140 **459**	0.013 **.00051**	150 **492**	0.014 **.00055**	160 **525**	0.020 **.00079**

Type N - Semi-finishing

MILLING WITH INTEGRATED COOLING | CUTTING DATA OVERVIEW

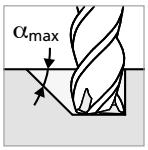
Semi-finishing



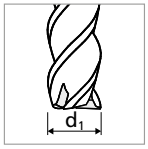


①
- $a_p = 4 \times d_1$
- $a_e = 0.1 \times d_1$

②
- $a_p = 4 \times d_1$
- $a_e = 0.05 \times d_1$



Note:
In case of linear ramp or helical interpolation milling reduce f_Z by 20% and use $\alpha = 3°$ for all materials



Materials group	Material	Mat. no.	DIN	AISI/ASTM/UNS	1.0 mm | .039" ① v_c	1.0 mm | .039" ① f_z	1.0 mm | .039" ② v_c	1.0 mm | .039" ② f_z	1/16" 1.5 mm | .059" ① v_c	1/16" 1.5 mm | .059" ① f_z	1/16" 1.5 mm | .059" ② v_c	1/16" 1.5 mm | .059" ② f_z
P	Unalloyed carbon steel Rm < 800 N/mm²	1.0301	C10	AISI 1010	145 **476**	0.008 **.00032**	200 **656**	0.012 **.00047**	170 **558**	0.011 **.00044**	220 **722**	0.018 **.00071**
		1.0401	C15	AISI 1015								
		1.1191	C45E/CK45	AISI 1045								
		1.0044	S275JR	AISI 1020								
		1.0715	11SMn30	AISI 1215								
	Low alloyed steel Rm > 900 N/mm²	1.5752	15NiCr13	ASTM 3415 / AISI 3310	145 **476**	0.008 **.00032**	200 **656**	0.012 **.00047**	170 **558**	0.011 **.00044**	220 **722**	0.018 **.00071**
		1.7131	16MnCr5	AISI 5115								
		1.3505	100Cr6	AISI 52100								
		1.7225	42CrMo4	AISI 4140								
		1.2842	90MnCrV8	AISI O2								
	High alloyed tool steel Rm < 1200 N/mm²	1.2379	X153CrMoV12	AISI D2	130 **427**	0.007 **.00028**	180 **591**	0.010 **.00039**	140 **459**	0.011 **.00044**	190 **623**	0.015 **.00060**
		1.2436	X210CrW12	AISI D4/D6								
		1.3343	HS6-5-2C	AISI M2 / UNS T11302								
		1.3355	HS18-0-1	AISI T1 / UNS T12001								
M	Stainless steel ferritic	1.4016	X6Cr17	AISI 430 / UNS S43000	100 **328**	0.008 **.00032**	145 **476**	0.011 **.00044**	120 **394**	0.011 **.00044**	160 **525**	0.017 **.00067**
		1.4105	X6CrMoS17	AISI 430F								
	Stainless steel martensitic	1.4034	X46Cr13	AISI 420C	100 **328**	0.008 **.00032**	145 **476**	0.011 **.00044**	120 **394**	0.011 **.00044**	160 **525**	0.017 **.00067**
		1.4112	X90CrMoV18	AISI 440B								
	Stainless steel martensitic – PH	1.4542	X5CrNiCuNb16-4	AISI 630 / ASTM 17-4 PH	100 **328**	0.007 **.00028**	130 **427**	0.010 **.00039**	110 **361**	0.010 **.00039**	140 **459**	0.015 **.00060**
		1.4545	X5CrNiCuNb15-5	ASTM 15-5 PH								
	Stainless steel austenitic	1.4301	X5CrNi18-10	AISI 304	100 **328**	0.007 **.00028**	130 **427**	0.010 **.00039**	110 **361**	0.010 **.00039**	140 **459**	0.015 **.00060**
		1.4435	X2CrNiMo18-14-3	AISI 316L								
		1.4441	X2CrNiMo18-15-3	AISI 316LM								
		1.4539	X1NiCrMoCu25-20-5	AISI 904L								
K	Cast iron	0.6020	GG20	ASTM 30	100 **328**	0.008 **.00032**	130 **427**	0.012 **.00047**	110 **361**	0.011 **.00044**	145 **476**	0.017 **.00067**
		0.6030	GG30	ASTM 40B								
		0.7040	GGG40	ASTM 60-40-18								
		0.7060	GGG60	ASTM 80-60-03								
N	Aluminium alloy wrought	3.2315	AlMgSi1	ASTM 6351	150 **492**	0.013 **.00051**	180 **591**	0.018 **.00071**	150 **492**	0.017 **.00067**	220 **722**	0.024 **.00094**
		3.4365	AlZnMgCu1.5	ASTM 7075								
	Aluminium alloy cast	3.2163	GD-AlSi9Cu3	ASTM A380	150 **492**	0.013 **.00051**	180 **591**	0.018 **.00071**	150 **492**	0.017 **.00067**	220 **722**	0.024 **.00094**
		3.2381	GD-AlSi10Mg	UNS A03590								
	Copper	2.0040	Cu-OF / CW008A	UNS C10100	150 **492**	0.013 **.00051**	180 **591**	0.018 **.00071**	150 **492**	0.017 **.00067**	220 **722**	0.024 **.00094**
		2.0065	Cu-ETP / CW004A	UNS C11000								
	Brass lead free	2.0321	CuZn37 CW508L	UNS C27400	150 **492**	0.013 **.00051**	180 **591**	0.018 **.00071**	150 **492**	0.017 **.00067**	220 **722**	0.024 **.00094**
		2.0360	CuZn40 CW509L	UNS C28000								
	Brass, Bronze Rm < 400 N/mm²	2.0401	CuZn39Pb3 / CW614N	UNS C38500	150 **492**	0.013 **.00051**	180 **591**	0.018 **.00071**	150 **492**	0.017 **.00067**	220 **722**	0.024 **.00094**
		2.1020	CuSn6	UNS C51900								
	Bronze Rm < 600 N/mm²	2.0966	CuAl10Ni5Fe4	UNS C63000	150 **492**	0.013 **.00051**	180 **591**	0.018 **.00071**	150 **492**	0.017 **.00067**	220 **722**	0.024 **.00094**
		2.0960	CuAl9Mn2	UNS C63200								
S_1	Super alloys	2.4856		Inconel 625	50 **164**	0.006 **.00024**	80 **262**	0.008 **.00032**	70 **230**	0.008 **.00032**	100 **328**	0.012 **.00047**
		2.4668		Inconel 718								
		2.4617	NiMo28	Hastelloy B-2								
		2.4665	NiCr22Fe18Mo	Hastelloy X								
S_2	Titanium pure	3.7035	Gr.2	ASTM B348 / F67	90 **295**	0.009 **.00035**	120 **394**	0.014 **.00055**	90 **295**	0.011 **.00044**	120 **394**	0.017 **.00067**
		3.7065	Gr.4	ASTM B348 / F68								
	Titanium alloys	3.7165	TiAl6V4	ASTM B348 / F136	90 **295**	0.009 **.00035**	120 **394**	0.014 **.00055**	90 **295**	0.011 **.00044**	120 **394**	0.017 **.00067**
		9.9367	TiAl6Nb7	ASTM F1295								
S_3	CrCo alloys	2.4964	CoCr20W15Ni	Haynes 25	60 **197**	0.006 **.00024**	80 **262**	0.008 **.00032**	70 **230**	0.008 **.00032**	100 **328**	0.012 **.00047**
			CrCoMo28	ASTM F1537								
H_1	Hardened steel < 55 HRC	1.2510	100MnCrMoW4	AISI O1								
H_2	Hardened steel ≥ 55 HRC	1.2379	X153CrMoV12	AISI D2								

v_c [m/min] | **[SFM]**
f_z [mm] | **[IPT]**

RECOMMENDATION FOR USE
● Excellent | ◐ Good | ○ Acceptable | ⊠ Not recommended

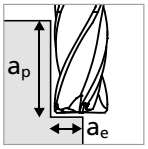
P ●	N ●	S_3 ●
M ●	S_1 ●	H_1 ⊠
K ●	S_2 ●	H_2 ⊠

Ød₁	3/32" 2.0 mm | .079"				1/8" 3.0 mm | .118"				5/32" 4.0 mm | .157"				3/16" - 7/32" 5.0 mm | .197"				1/4" 6.0 mm | .236"				8.0 mm | .315"			
	①		②		①		②		①		②		①		②		①		②		①		②	
	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z
	170 **558**	0.020 **.00079**	220 **722**	0.030 **.00118**	200 **656**	0.027 **.00106**	260 **853**	0.041 **.00161**	210 **689**	0.030 **.00118**	280 **919**	0.046 **.00182**	210 **689**	0.035 **.00138**	280 **919**	0.052 **.00205**	230 **755**	0.042 **.00165**	300 **984**	0.064 **.00252**	230 **755**	0.054 **.00213**	300 **984**	0.083 **.00327**
	170 **558**	0.020 **.00079**	220 **722**	0.030 **.00118**	200 **656**	0.027 **.00106**	260 **853**	0.041 **.00161**	210 **689**	0.030 **.00118**	280 **919**	0.046 **.00182**	210 **689**	0.035 **.00138**	280 **919**	0.052 **.00205**	230 **755**	0.042 **.00165**	300 **984**	0.064 **.00252**	230 **755**	0.054 **.00213**	300 **984**	0.083 **.00327**
	160 **525**	0.017 **.00067**	210 **689**	0.025 **.00098**	160 **525**	0.024 **.00094**	210 **689**	0.036 **.00142**	185 **607**	0.028 **.00110**	240 **787**	0.043 **.00170**	185 **607**	0.033 **.00130**	240 **787**	0.050 **.00197**	185 **607**	0.036 **.00142**	240 **787**	0.056 **.00221**	185 **607**	0.043 **.00170**	240 **787**	0.067 **.00264**
	130 **427**	0.018 **.00071**	180 **591**	0.027 **.00106**	145 **476**	0.025 **.00098**	190 **623**	0.038 **.00150**	170 **558**	0.028 **.00110**	210 **689**	0.044 **.00173**	170 **558**	0.032 **.00126**	210 **689**	0.051 **.00201**	170 **558**	0.038 **.00150**	210 **689**	0.061 **.00241**	170 **558**	0.048 **.00189**	210 **689**	0.077 **.00304**
	130 **427**	0.018 **.00071**	180 **591**	0.027 **.00106**	145 **476**	0.025 **.00098**	190 **623**	0.038 **.00150**	170 **558**	0.028 **.00110**	210 **689**	0.044 **.00173**	170 **558**	0.032 **.00126**	210 **689**	0.051 **.00201**	170 **558**	0.038 **.00150**	210 **689**	0.061 **.00241**	170 **558**	0.048 **.00189**	210 **689**	0.077 **.00304**
	110 **361**	0.016 **.00063**	140 **459**	0.025 **.00098**	130 **427**	0.022 **.00087**	160 **525**	0.035 **.00138**	145 **476**	0.025 **.00098**	180 **591**	0.041 **.00161**	145 **476**	0.031 **.00123**	180 **591**	0.049 **.00193**	145 **476**	0.034 **.00134**	180 **591**	0.056 **.00221**	145 **476**	0.042 **.00165**	180 **591**	0.067 **.00264**
	110 **361**	0.015 **.00060**	140 **459**	0.024 **.00094**	130 **427**	0.024 **.00094**	160 **525**	0.038 **.00150**	145 **476**	0.027 **.00106**	180 **591**	0.044 **.00173**	145 **476**	0.029 **.00114**	180 **591**	0.048 **.00189**	145 **476**	0.032 **.00126**	180 **591**	0.053 **.00209**	145 **476**	0.039 **.00154**	180 **591**	0.064 **.00252**
	120 **394**	0.020 **.00079**	170 **558**	0.029 **.00114**	140 **459**	0.027 **.00106**	190 **623**	0.040 **.00157**	180 **591**	0.030 **.00118**	230 **755**	0.048 **.00189**	190 **623**	0.034 **.00134**	240 **787**	0.053 **.00209**	220 **722**	0.040 **.00157**	270 **886**	0.065 **.00256**	220 **722**	0.054 **.00213**	270 **886**	0.086 **.00339**
	170 **558**	0.036 **.00142**	240 **787**	0.051 **.00201**	210 **689**	0.043 **.00170**	270 **886**	0.067 **.00264**	225 **738**	0.058 **.00229**	300 **984**	0.088 **.00347**	280 **919**	0.062 **.00245**	345 **1115**	0.102 **.00402**	280 **919**	0.064 **.00252**	340 **1115**	0.105 **.00414**	290 **951**	0.082 **.00323**	360 **1181**	0.133 **.00524**
	170 **558**	0.036 **.00142**	240 **787**	0.051 **.00201**	210 **689**	0.043 **.00170**	270 **886**	0.067 **.00264**	225 **738**	0.058 **.00229**	300 **984**	0.088 **.00347**	280 **919**	0.062 **.00245**	345 **1115**	0.102 **.00402**	280 **919**	0.064 **.00252**	340 **1115**	0.105 **.00414**	290 **951**	0.082 **.00323**	360 **1181**	0.133 **.00524**
	170 **558**	0.036 **.00142**	240 **787**	0.051 **.00201**	210 **689**	0.043 **.00170**	270 **886**	0.067 **.00264**	225 **738**	0.058 **.00229**	300 **984**	0.088 **.00347**	280 **919**	0.062 **.00245**	345 **1115**	0.102 **.00402**	280 **919**	0.064 **.00252**	340 **1115**	0.105 **.00414**	290 **951**	0.082 **.00323**	360 **1181**	0.133 **.00524**
	170 **558**	0.036 **.00142**	240 **787**	0.051 **.00201**	210 **689**	0.043 **.00170**	270 **886**	0.067 **.00264**	225 **738**	0.058 **.00229**	300 **984**	0.088 **.00347**	280 **919**	0.062 **.00245**	345 **1115**	0.102 **.00402**	280 **919**	0.064 **.00252**	340 **1115**	0.105 **.00414**	290 **951**	0.082 **.00323**	360 **1181**	0.133 **.00524**
	170 **558**	0.036 **.00142**	240 **787**	0.051 **.00201**	210 **689**	0.043 **.00170**	270 **886**	0.067 **.00264**	225 **738**	0.058 **.00229**	300 **984**	0.088 **.00347**	280 **919**	0.062 **.00245**	345 **1115**	0.102 **.00402**	280 **919**	0.064 **.00252**	340 **1115**	0.105 **.00414**	290 **951**	0.082 **.00323**	360 **1181**	0.133 **.00524**
	170 **558**	0.036 **.00142**	240 **787**	0.051 **.00201**	210 **689**	0.043 **.00170**	270 **886**	0.067 **.00264**	225 **738**	0.058 **.00229**	300 **984**	0.088 **.00347**	280 **919**	0.062 **.00245**	345 **1115**	0.102 **.00402**	280 **919**	0.064 **.00252**	340 **1115**	0.105 **.00414**	290 **951**	0.082 **.00323**	360 **1181**	0.133 **.00524**
	70 **230**	0.010 **.00039**	100 **328**	0.014 **.00055**	80 **262**	0.014 **.00055**	120 **394**	0.020 **.00079**	90 **295**	0.016 **.00063**	130 **427**	0.022 **.00087**	90 **295**	0.018 **.00071**	130 **427**	0.025 **.00098**	90 **295**	0.020 **.00079**	130 **427**	0.029 **.00114**	90 **295**	0.025 **.00098**	130 **427**	0.035 **.00138**
	90 **295**	0.016 **.00063**	130 **427**	0.022 **.00087**	90 **295**	0.017 **.00067**	130 **427**	0.023 **.00091**	100 **328**	0.028 **.00110**	140 **459**	0.040 **.00157**	100 **328**	0.029 **.00114**	140 **459**	0.041 **.00161**	100 **328**	0.031 **.00123**	140 **459**	0.044 **.00173**	110 **361**	0.035 **.00138**	155 **509**	0.049 **.00193**
	90 **295**	0.016 **.00063**	130 **427**	0.022 **.00087**	90 **295**	0.024 **.00094**	130 **427**	0.033 **.00130**	100 **328**	0.028 **.00110**	140 **459**	0.040 **.00157**	100 **328**	0.029 **.00114**	140 **459**	0.041 **.00161**	100 **328**	0.031 **.00123**	140 **459**	0.044 **.00173**	110 **361**	0.035 **.00138**	155 **509**	0.049 **.00193**
	70 **230**	0.010 **.00039**	100 **328**	0.014 **.00055**	80 **262**	0.014 **.00055**	120 **394**	0.020 **.00079**	90 **295**	0.016 **.00063**	130 **427**	0.022 **.00087**	90 **295**	0.018 **.00071**	130 **427**	0.025 **.00098**	90 **295**	0.020 **.00079**	130 **427**	0.029 **.00114**	90 **295**	0.025 **.00098**	130 **427**	0.035 **.00138**

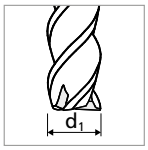
Type N - Finishing

MILLING WITH INTEGRATED COOLING | CUTTING DATA OVERVIEW

Finishing



- $a_p = 4 \times d_1$
- $a_e = 0.02 \times d_1$



Materials group	Material	Mat. no.	DIN	AISI/ASTM/UNS	1.0 mm | .039" v_c	1.0 mm | .039" f_z	1/16" 1.5 mm | .059" v_c	1/16" 1.5 mm | .059" f_z
P	Unalloyed carbon steel Rm < 800 N/mm²	1.0301	C10	AISI 1010	130 **427**	0.009 **.00035**	180 **591**	0.014 **.00055**
		1.0401	C15	AISI 1015				
		1.1191	C45E/CK45	AISI 1045				
		1.0044	S275JR	AISI 1020				
		1.0715	11SMn30	AISI 1215				
	Low alloyed steel Rm > 900 N/mm²	1.5752	15NiCr13	ASTM 3415 / AISI 3310	130 **427**	0.008 **.00032**	180 **591**	0.013 **.00051**
		1.7131	16MnCr5	AISI 5115				
		1.3505	100Cr6	AISI 52100				
		1.7225	42CrMo4	AISI 4140				
		1.2842	90MnCrV8	AISI O2				
	High alloyed tool steel Rm < 1200 N/mm²	1.2379	X153CrMoV12	AISI D2	130 **427**	0.007 **.00028**	180 **591**	0.012 **.00047**
		1.2436	X210CrW12	AISI D4/D6				
		1.3343	HS6-5-2C	AISI M2 / UNS T11302				
		1.3355	HS18-0-1	AISI T1 / UNS T12001				
M	Stainless steel ferritic	1.4016	X6Cr17	AISI 430 / UNS S43000	130 **427**	0.009 **.00035**	180 **591**	0.014 **.00055**
		1.4105	X6CrMoS17	AISI 430F				
	Stainless steel martensitic	1.4034	X46Cr13	AISI 420C	130 **427**	0.009 **.00035**	180 **591**	0.013 **.00051**
		1.4112	X90CrMoV18	AISI 440B				
	Stainless steel martensitic – PH	1.4542	X5CrNiCuNb16-4	AISI 630 / ASTM 17-4 PH	130 **427**	0.009 **.00035**	180 **591**	0.013 **.00051**
		1.4545	X5CrNiCuNb15-5	ASTM 15-5 PH				
	Stainless steel austenitic	1.4301	X5CrNi18-10	AISI 304	130 **427**	0.007 **.00028**	180 **591**	0.009 **.00035**
		1.4435	X2CrNiMo18-14-3	AISI 316L				
		1.4441	X2CrNiMo18-15-3	AISI 316LM				
		1.4539	X1NiCrMoCu25-20-5	AISI 904L				
K	Cast iron	0.6020	GG20	ASTM 30	110 **361**	0.007 **.00028**	130 **427**	0.014 **.00055**
		0.6030	GG30	ASTM 40B				
		0.7040	GGG40	ASTM 60-40-18				
		0.7060	GGG60	ASTM 80-60-03				
N	Aluminium alloy wrought	3.2315	AlMgSi1	ASTM 6351	130 **427**	0.010 **.00039**	180 **591**	0.015 **.00060**
		3.4365	AlZnMgCu1.5	ASTM 7075				
	Aluminium alloy cast	3.2163	GD-AlSi9Cu3	ASTM A380	130 **427**	0.010 **.00039**	180 **591**	0.015 **.00060**
		3.2381	GD-AlSi10Mg	UNS A03590				
	Copper	2.0040	Cu-OF / CW008A	UNS C10100	130 **427**	0.012 **.00047**	180 **591**	0.015 **.00060**
		2.0065	Cu-ETP / CW004A	UNS C11000				
	Brass lead free	2.0321	CuZn37 CW508L	UNS C27400	130 **427**	0.012 **.00047**	180 **591**	0.015 **.00060**
		2.0360	CuZn40 CW509L	UNS C28000				
	Brass, Bronze Rm < 400 N/mm²	2.0401	CuZn39Pb3 / CW614N	UNS C38500	130 **427**	0.012 **.00047**	180 **591**	0.015 **.00060**
		2.1020	CuSn6	UNS C51900				
	Bronze Rm < 600 N/mm²	2.0966	CuAl10Ni5Fe4	UNS C63000	130 **427**	0.010 **.00039**	180 **591**	0.015 **.00060**
		2.0960	CuAl9Mn2	UNS C63200				
S_1	Super alloys	2.4856		Inconel 625	110 **361**	0.005 **.00020**	120 **394**	0.006 **.00024**
		2.4668		Inconel 718				
		2.4617	NiMo28	Hastelloy B-2				
		2.4665	NiCr22Fe18Mo	Hastelloy X				
S_2	Titanium pure	3.7035	Gr.2	ASTM B348 / F67	110 **361**	0.009 **.00035**	120 **394**	0.012 **.00047**
		3.7065	Gr.4	ASTM B348 / F68				
	Titanium alloys	3.7165	TiAl6V4	ASTM B348 / F136	110 **361**	0.009 **.00035**	120 **394**	0.012 **.00047**
		9.9367	TiAl6Nb7	ASTM F1295				
S_3	CrCo alloys	2.4964	CoCr20W15Ni	Haynes 25	110 **361**	0.005 **.00020**	120 **394**	0.006 **.00024**
			CrCoMo28	ASTM F1537				
H_1	Hardened steel < 55 HRC	1.2510	100MnCrMoW4	AISI O1				
H_2	Hardened steel ≥ 55 HRC	1.2379	X153CrMoV12	AISI D2				

v_c [m/min] | **[SFM]**
f_z [mm] | **[IPT]**

RECOMMENDATION FOR USE
● Excellent | ◐ Good | ○ Acceptable | ⊠ Not recommended

P ●	N ●	S_3 ●
M ●	S_1 ●	H_1 ⊠
K ●	S_2 ●	H_2 ⊠

	Ød1 3/32" 2.0 mm | **.079"**		1/8" 3.0 mm | **.118"**		5/32" 4.0 mm | **.157"**		3/16" - 7/32" 5.0 mm | **.197"**		1/4" 6.0 mm | **.236"**		8.0 mm | **.315"**	
	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z
	200 **656**	0.020 **.00079**	210 **689**	0.026 **.00103**	220 **722**	0.029 **.00114**	220 **722**	0.032 **.00126**	220 **722**	0.038 **.00150**	220 **722**	0.044 **.00173**
	200 **656**	0.018 **.00071**	210 **689**	0.025 **.00098**	220 **722**	0.028 **.00110**	220 **722**	0.030 **.00118**	220 **722**	0.033 **.00130**	220 **722**	0.040 **.00157**
	200 **656**	0.017 **.00067**	210 **689**	0.023 **.0091**	220 **722**	0.024 **.00094**	220 **722**	0.026 **.00102**	220 **722**	0.029 **.00114**	220 **722**	0.035 **.00138**
	200 **656**	0.020 **.00079**	210 **689**	0.025 **.00098**	220 **722**	0.028 **.00110**	220 **722**	0.030 **.00118**	220 **722**	0.033 **.00130**	260 **853**	0.040 **.00157**
	200 **656**	0.018 **.00071**	210 **689**	0.025 **.00098**	220 **722**	0.027 **.00106**	220 **722**	0.029 **.00114**	220 **722**	0.032 **.00126**	260 **853**	0.038 **.00150**
	200 **656**	0.018 **.00071**	210 **689**	0.025 **.00098**	220 **722**	0.027 **.00106**	220 **722**	0.029 **.00114**	220 **722**	0.032 **.00126**	260 **853**	0.038 **.00150**
	200 **656**	0.017 **.00067**	210 **689**	0.023 **.0091**	220 **722**	0.025 **.00098**	220 **722**	0.028 **.00110**	220 **722**	0.030 **.00118**	260 **853**	0.037 **.00146**
	150 **492**	0.016 **.00063**	160 **525**	0.025 **.00098**	170 **558**	0.029 **.00114**	170 **558**	0.033 **.00130**	170 **558**	0.036 **.00142**	200 **656**	0.042 **.00165**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00161**	270 **886**	0.047 **.00185**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00161**	270 **886**	0.047 **.00185**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00161**	270 **886**	0.047 **.00185**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00161**	270 **886**	0.047 **.00185**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00162**	270 **886**	0.047 **.00186**
	200 **656**	0.021 **.00083**	210 **689**	0.033 **.00130**	220 **722**	0.035 **.00138**	220 **722**	0.038 **.00150**	220 **722**	0.041 **.00161**	270 **886**	0.047 **.00185**
	130 **427**	0.006 **.00024**	130 **427**	0.009 **.00035**	140 **459**	0.012 **.00047**	140 **459**	0.013 **.00051**	150 **492**	0.014 **.00055**	160 **525**	0.020 **.00079**
	130 **427**	0.016 **.00063**	130 **427**	0.023 **.00091**	140 **459**	0.025 **.00098**	140 **459**	0.028 **.00110**	150 **492**	0.030 **.00118**	160 **525**	0.036 **.00142**
	130 **427**	0.016 **.00063**	130 **427**	0.023 **.00091**	140 **459**	0.025 **.00098**	140 **459**	0.028 **.00110**	150 **492**	0.030 **.00118**	160 **525**	0.036 **.00142**
	130 **427**	0.006 **.00024**	130 **427**	0.009 **.00035**	140 **459**	0.012 **.00047**	140 **459**	0.013 **.00051**	150 **492**	0.014 **.00055**	160 **525**	0.020 **.00079**

NEW Process CrazyMill Cool CF

ACCURATE AND EFFICIENT MILLING

Coolant type, pressure and filtration

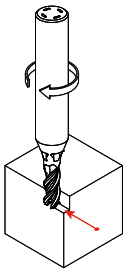
Coolant: for best results, Mikron Tool recommends the use of cutting oil as coolant. Alternatively, water base coolant with EP-Additives (Extreme-Pressure-Additives) can be used as well.

Filter: the large cooling channels permit the use of a standard filter with filter quality of ≤ .002" (0.05 mm).

Coolant pressure: at least 15 bar (218 psi) coolant pressure is required to achieve reliable milling. High pressure is generally better for the cooling and flushing effect.

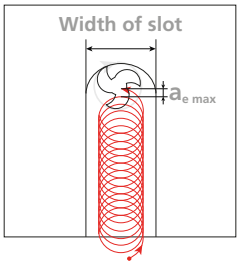
Revolution	[rpm]	≤ 10'000	> 10'000
Minimal pressure	[bar]	15	30
	[psi]	**218**	**435**

Climb milling and conventional milling



Mikron tool recommends climb milling for the machining of side and pocket milling. The chip thickness here is greater at the beginning and decreases continuously; the cutting forces remain low. With conventional milling, however, high cutting forces would push the milling tool away from the part. Thus surface quality decreases.

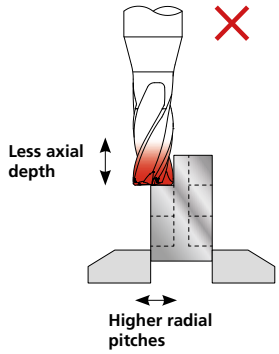
Trochoidal slot milling



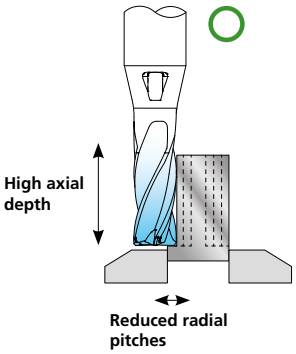
Cutting values: see cutting data chart "Semi-finishing" at page 22 and 26!

MILLING PROCESS

Traditional vs. High efficiency milling (HEM)

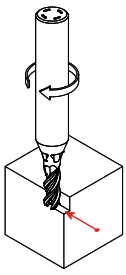


Traditional Milling
Work, heat and wear are concentrated along a smaller portion of the cutting edge.



High Efficiency Milling
Work, heat and wear are spread over entire cutting edge.

Semi-finishing

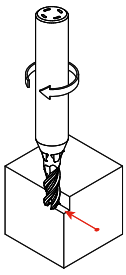


Recommended cutting parameters

v_c and f_z = as specified in the cutting data table

Strategy	Type M	Type N
①	a_p = 3 x d a_e = 0.15 x d	a_p = 4 x d a_e = 0.1 x d
②	a_p = 3 x d a_e = 0.1 x d	a_p = 4 x d a_e = 0.05 x d
③	a_p = 3 x d a_e = 0.05 x d	-

Finishing



Recommended cutting parameters

v_c and f_z = as specified in the cutting data table

Strategy	Type M	Type N
①	a_p = z a_e = 0.02 x d	a_p = 4 x d a_e = 0.02 x d

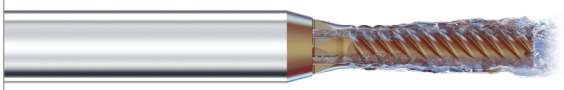
Mastercam **News: Tool libraries of all Mikron Tool catalog products are available on Mastercam's Tech Exchange, ready for download!**

NEW CrazyMill Cool SF

NEW

CRAZYMILL by Mikron Tool Cool SF

IT'S TIME TO SUPER FINISH!



Our "Crazy" R&D department developed a new high-performance endmill for super finishing operation, which once again sets a benchmark in terms of surface quality.

The latest development CrazyMill Cool SF mills surfaces in grinding quality and replaces subsequent grinding operations! This is made possible by the perfect coordination of a completely new milling concept, such as a tailored carbide substrate based on ultra-fine grains, a highly efficient integrated high-performance cooling concept and a cutting edge conditioning system developed specifically for super finishing. In addition, there is a new cutting edge geometry with a variable helix angle and unequal angular teeth division. The new endmill guarantees a completely crazy surface finish in grinding quality - what's more, it mills in the narrowest tolerance ranges.

CrazyMill Cool SF keeps surfaces constantly below Ra 11.8 µin (0.3 µm) for more than seven (!) hours machining time on stainless steel 316L!

Available in different diameters between Ø.039" and .315"(1 mm - 8 mm) in two full cutting lengths of 3 and 4 times diameter.

Regrinding: This product is not suitable for regrinding.

Please note: You couldn't find your suitable version of the CrazyMill Cool SF (diameter, length, cutting direction…)? Ask us about our customized versions!

NEW CrazyMill Cool SF

THE NEW HIGH-PERFORMANCE ENDMILLS FOR SUPER FINISHING

1. Challenge

Avoid and/or reduce subsequent polishing operation

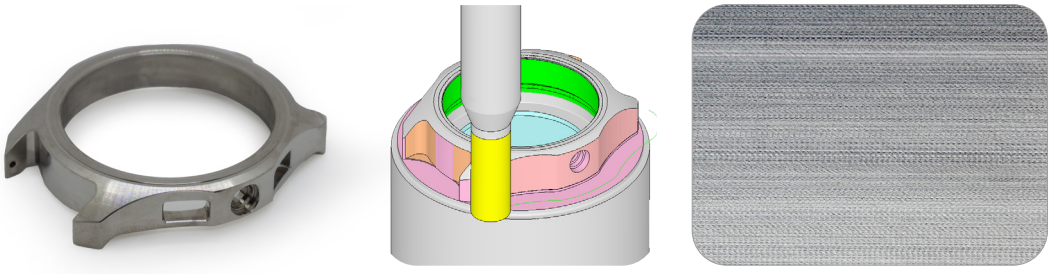
Most of the machined components, need a post surface treatment like grinding, polishing, tumbling and others. Those manufacturing steps can be very costly and very time consuming. Improving the surface quality through the super finishing milling process could avoid or reduce subsequent finishing operations (grinding, tumbling, polishing).

Solution

Surface milling below Ra 11.8 µin (0.3 µm)

The new CrazyMill Cool SF milling cutter is characterized by extremely smooth and sharply ground cutting edges, variable helix angle and unequal angular teeth division and a high number of teeth. These features enable low radial cutting pressure and extremely smooth running, resulting in milling surfaces of grinding quality. After machining, the surfaces have an astonishing roughness value of Ra 11.8 µin (0.3 µm) or better in milling direction (Ra parallel), and endmill axis direction (Ra perpendicular). This allows to shorten the manufacturing process, by avoiding or reducing significantly the post-surface treatment.

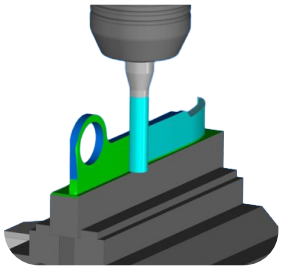
■ **Real case: Watch Ti Gr.5 (3.7165)**



Ra = 8.7 µin (0.22 µm)

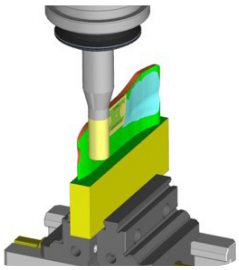
NEW

■ **Real case: Hemostatic clamp 17-4 PH**



Ra = 8.3 µin (0.21 µm)

■ **Real case: Radius compression plate Ti Gr.2 (3.7035)**



Ra = 6.7 µin (0.17 µm)

NEW CrazyMill Cool SF

THE NEW HIGH-PERFORMANCE ENDMILLS FOR SUPER FINISHING

2. Challenge

Tool miniaturization

Z6

The miniaturization of milling tools brings with it the challenge of realizing the highly complex cutting geometries of milling tools even with diameters of less than d = .118" (3 mm). The greatest challenge is to grind these complex geometries on small milling cutter cross-sections with a high number of flutes and at the same time to meet the highest quality requirements for the milling cutters in series with process reliability.

Solution

Highly skilled machine operators and suitable production equipment

State-of-the-art grinding machines with hydrostatic bearings and grinding wheel technologies that are state of the art, are crucial for the production of the latest micro-tools. High-precision digital measuring devices that detect deviations of up to one micrometer are also indispensable. The madmen at Mikron Tool have mastered these production processes and are excellently trained in the use of state-of-the-art tool grinding machines and processes in the micro range. The quality standard of the high-performance milling cutters is correspondingly high, producing the exact workpiece quality guaranteed by Mikron Tool.

NEW

3. Challenge

High performance endmill for all materials

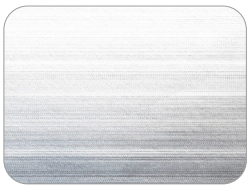
Different materials present different mechanical characteristics. Different toughness, different hardness, different structure, that is different machinability. The best result can be achieved with a macro and micro geometry of the milling cutter cutting edges that is specifically tailored to the respective material. It is far more difficult to develop a cutting edge geometry that is suitable for the most important types of material in the machining sector and at the same time can achieve an outstanding surface quality in grinding quality.

Solution

Mikron Tool's last innovative product

Our "crazy" R&D department developed the new endmill CrazyMill Cool SF for super finishing with one unique cutting geometry. Thanks to this "crazy" development, the CrazyMill Cool SF achieves a surface roughness (perpendicular) of less than Ra 11.8 µin (0.3 µm) and also delivers outstanding shape accuracy on the workpiece. In addition, the CrazyMill Cool SF guarantees a remarkable tool life and extremely fast machining in all the materials shown below.

■ **Stainless Steel**



Ra = 7.1 µin (0.18 µm)

■ **Titanium Gr.5**

Ra = 8.7 µin (0.22 µm)

■ **Titanium Gr.2**

Ra = 7.9 µin (0.20 µm)

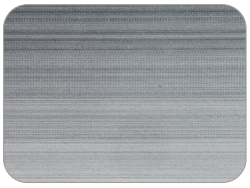
■ **Aluminium**

Ra = 6.3 µin (0.16 µm)

■ **CrCo Alloys**

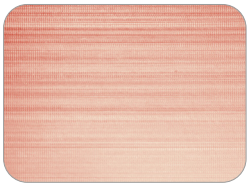
Ra = 9.1 µin (0.23 µm)

■ **Inconel**



Ra = 11.8 µin (0.30 µm)

■ **Copper**



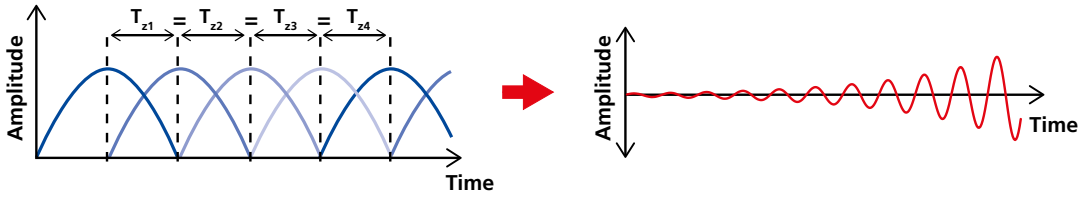
Ra = 5.9 µin (0.15 µm)

NEW CrazyMill Cool SF

THE NEW HIGH-PERFORMANCE ENDMILLS FOR SUPER FINISHING

4. Challenge

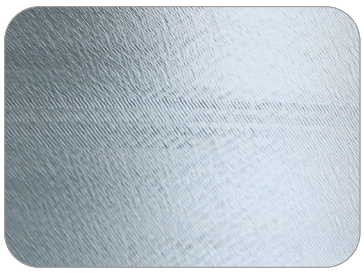
Avoid chattering when milling



Milling is a cutting process with a continuous interrupted cut. Each cutting edge applies a certain amount of pressure to the material. When the cutting edge exits the material, the pressure is released again.

This happens with all the cutting edges of symmetrically designed endmills at a predetermined frequency depending on the "number of cutting edges" x "speed".

If the frequency is kept uniform (see diagram) ($T_{Z1} = T_{Z2} = T_{Z3} = T_{Z4}$), it can lead to an increase in the maximum deflection in the resonance frequency, resulting in vibrations and consequently chatter marks on the workpiece.

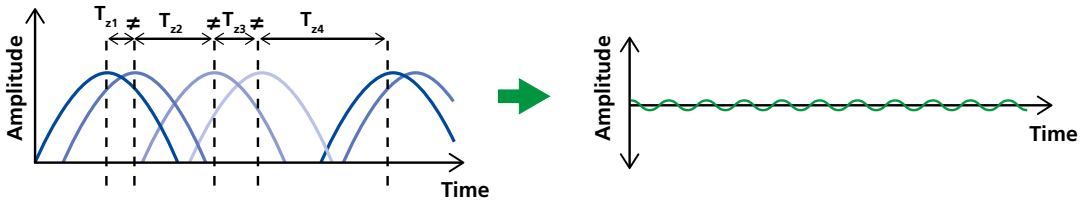


Surface with vibrations

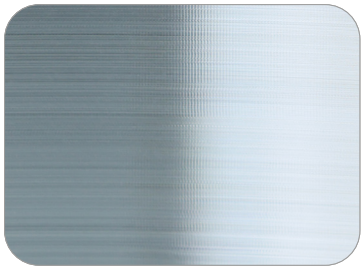
NEW

Solution

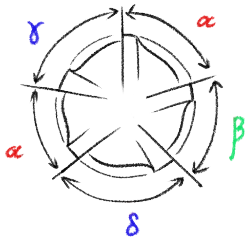
Avoidance of resonance frequencies



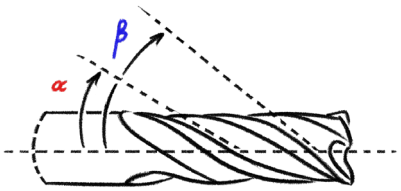
The new CrazyMill Cool SF has been specifically developed, to interrupt this resonance frequency. Using unequal angular teeth division, and a variable helix angle (every cutting edge has a different helix angle) every cutting edge generates a different frequency wave that occur in an irregular timing to the next or the previous cutting edge ($T_{Z1} \neq T_{Z2} \neq T_{Z3} \neq T_{Z4}$).
This results, as shown in the graph, in a resonant frequency amplitude reduction, and guarantees a vibration free surface.



Surface without vibrations



Unequal angular teeth division



Variable helix angle

NEW CrazyMill Cool SF

THE NEW HIGH-PERFORMANCE ENDMILLS FOR SUPER FINISHING

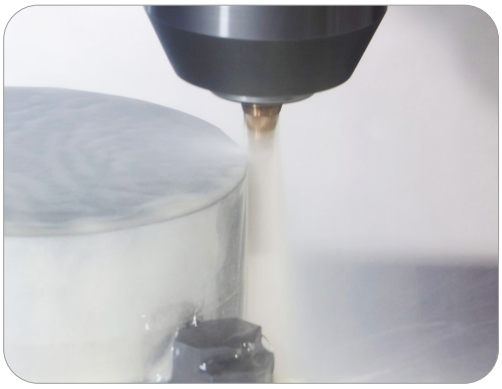
5. Challenge

High temperature & chips in the cutting zone

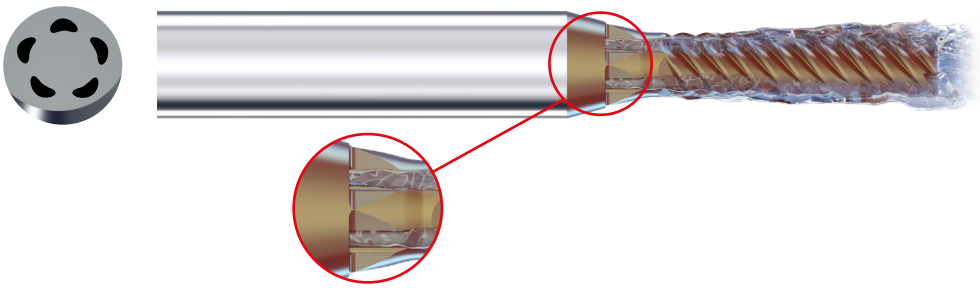
The machining of metals requires a high energy input into the cutting zones. A large proportion of this is converted directly into thermal energy. The higher the heat generated in the cutting zone, the shorter the tool life. It is therefore essential to keep the temperature in the cutting zone as low as possible. A high machining temperature also leads to poorer chip formation, poor chip flow and poor chip evacuation due to the higher plasticity of the chip, which can result in chip jam. These phenomena are exacerbated in materials that are difficult to machine, such as titanium, stainless steel and heat-resistant alloys.

Solution

Integrated cooling in shaft



The patented cooling channels of the Mikron Tool milling cutters, which run through the shank, ensure constant and massive cooling of the cutting edges. The excellent cooling performance directly in the cutting area enables a much high cutting speed and also reduces wear enormously. The massive coolant jet (from just 217 psi, 15 bar) also guarantees a chip-free machining zone and prevents the chips double cut. High cutting speeds, in combination with a higher feed pro flutes, lead to a reliable milling process with a high removal rate while maintaining excellent surface quality.



NEW

6. Challenge

A super finishing milling cutter for all materials?

Milling of high-quality and high-precision workpieces, with the highest demands on surface quality with an Ra (both directions) of less than 11.8 µin (0.3 µm) is a major challenge. In addition, very high feed rates combined with excellent tool life and universal application in various materials seems possible.

Solution

The new CrazyMill Cool SF

The development goal for the CrazyMill Cool SF super finishing milling cutter was to develop an all-rounder that achieves surface finishes in grinding quality below 11.8 µin (0.3 µm) in a wide range of materials. Thanks to the technical features of the milling cutter, the result is simply outstanding. See also the overview!
The CrazyMill Cool SF super finishing milling cutter is the new benchmark in super finishing precision micro milling.
CrazyMill Cool SF: Developed and produced by the madmen from Agno.

Characteristic	Maximum	CrazyMill Cool SF	Competitor 1	Competitor 2	Competitor 3
Ra perpendicular, based on Ra 5.9 - 11.8 µin (0.15 - 0.3 µm)	10	9	8	6	7
Ra parallel, based on Ra 5.9 - 11.8 µin (0.15 - 0.3 µm)	10	10	7	6	4
A (inch²/min)	10	10	6	7	8
Perpedicularity	10	9	5	4	6
Similar performance in stainless steel, titanium, steel, other material	10	8	4	1	3
Tool life, based on Ra 11.8 µin (0.3 µm)	10	10	8	4	5
Overall rating	**10**	**9**	**7**	**5**	**4**

Your benefits

The most important features

- Specific Super Finishing geometry
- Innovative flute geometry: Unequal angular teeth division and variable helix angle
- Specially designed cooling concept

Your advantages

- Mitigated chatter milling
- Very low cutting forces: perfect for side milling of thin-wall parts
- Controlled low temperature
- Reduced post machining process (polishing and tumbling)
- High performance in various materials

Your benefits

- Reduced machining time
- Excellent surface quality with Ra 11.8 µin (0.3 µm) or better
- Process reliability
- Very long tool life

NEW Maximum performance guaranteed

EXAMPLE OF TITANIUM GR.2 MACHINING IN COMPARISON

■ Example

Faster machining time for the best roughness

Machining: Side milling
Milling depth: .945" (24 mm);
Coolant: Emulsion 8%

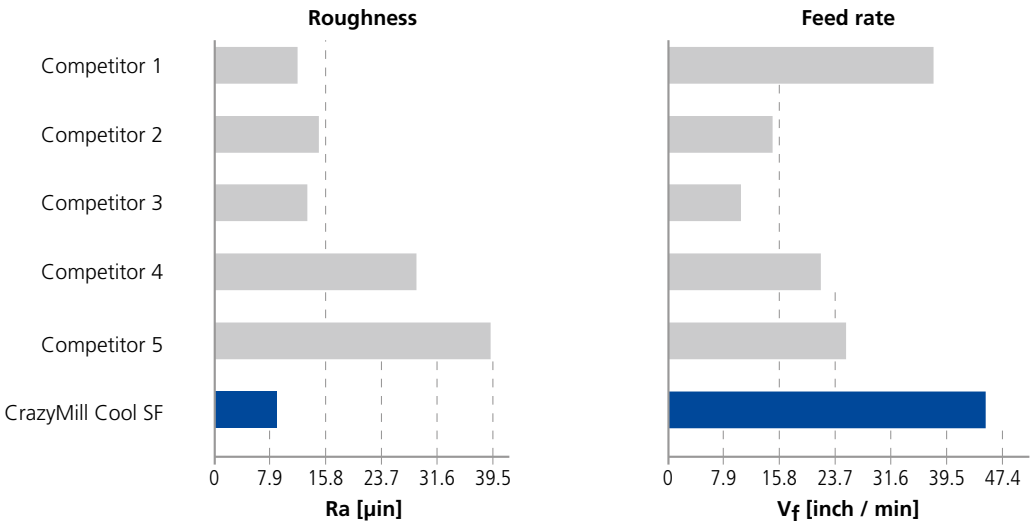
Pure titanium: 3.7035 / Ti Gr.2 / ASTM B348 S2

Tool: CrazyMill Cool SF
Diameter: .236" (6.0 mm)

Cutting data:

	v_c [SFM] | [m/min]	f_z [inch] | [mm]	a_e [inch] | [mm]	a_p [inch] | [mm]	z [flutes]
Competitor 1	**328** | 100	**.00102** | 0.026	**.0071** | 0.18	**.945** | 24	7
Competitor 2	**171** | 52	**.00094** | 0.024	**.0020** | 0.05	**.945** | 24	6
Competitor 3	**151** | 46	**.00055** | 0.014	**.0236** | 0.60	**.945** | 24	7
Competitor 4	**243** | 74	**.00094** | 0.024	**.0020** | 0.05	**.945** | 24	6
Competitor 5	**263** | 80	**.00118** | 0.030	**.0020** | 0.05	**.945** | 24	5
CrazyMill Cool SF	**459** | 140	**.00098** | 0.025	**.0020** | 0.05	**.945** | 24	6

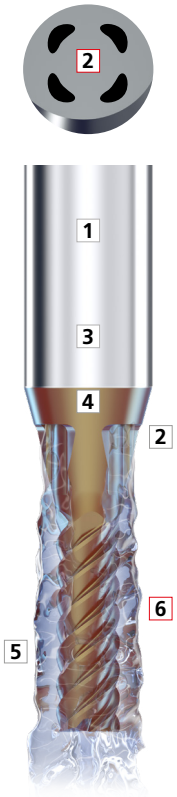
Results:



3 x d

Type M

- Coated
- Integrated cooling
- l_1 (Effective length): 3xd
  l_2 (Cutting length): 3xd



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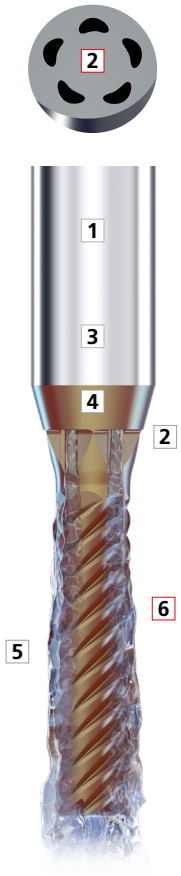
4 x d

Type N

- Coated
- Integrated cooling
- l_1 (Effective length): 4xd
  l_2 (Cutting length): 4xd



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NEW

1 | SHANK
The robust solid carbide shank guarantees stable and vibration-free milling. High precision and extraordinary surface quality are reached.

2 | INTEGRATED COOLING - PATENTED
The integrated cooling channels guarantee constantand maximal cooling of the cutting edges and optimal chip removal. The result is higher cutting speed as well as an excellent surface quality.

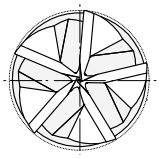
3 | CARBIDE
The specially developed micro-grain carbide meets all requirements in terms of mechanical properties.

4 | COATING
The high-performance eXedur SNP coating is heat and wear resistant, prevents buildup edges and guarantees optimum chip flushing. The result is a long tool life.

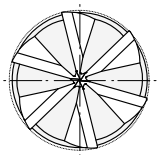
5 | SPECIFIC CHATTER-FREE GEOMETRY
The specific new cutting geometry with unequal angular teeth division and a variable helix angle, leads to an interruption of the resonance frequency allowing a vibration-free machining.

6 | LATERAL CUTTING GEOMETRY
Thanks to the high tool rigidity and the specific designed cutting edges lower radial machining force are achieved. The result is high perpendicularity precision and high surface quality.

Endmill tip



5 - Flute
Diameter range
Ø.039" - .098"
(Ø1 - 2.5 mm)



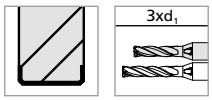
6 - Flute
Diameter range
Ø.118" - .315"
(Ø3 - 8 mm)

Type M - 3 x d - Square - Z5 / Z6

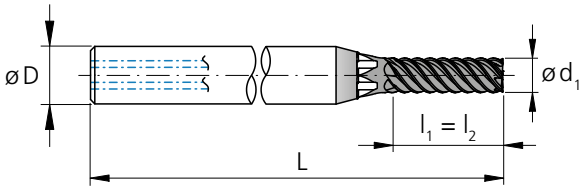
Carbide	Z 5-6	Variable		eXedur SNP			a_p a_e	

Ø d_1	**.004" - .118"** (0.1 - 3.0 mm)		**.122" - .236"** (3.1 - 6.0 mm)		**.240" - .394"** (6.1 - 10.0 mm)	
Tolerance	**- .00055"** **- .00110"**	- 0.014 mm - 0.028 mm	**- .00079"** **- .00150"**	- 0.020 mm - 0.038 mm	**- .00098"** **- .00185"**	- 0.025 mm - 0.047 mm

Square



protection chamfer 45°



l_1 = Effective length
l_2 = Cutting length

d_1 [inch]	d_1 [inch]	d_1 [mm]	l_1 [inch]	l_1 [mm]	l_2 [mm]	D (h6) [mm]	L [inch]	L [mm]	Z [flutes]	Item number	Availability
	.039	1.0	**.079**	3.0	3.0	4	**1.57**	40	5	2.CMCSF.M1Z5.100.1	■
	.047	1.2	**.094**	3.6	3.6	4	**1.57**	40	5	2.CMCSF.M1Z5.120.1	■
	.059	1.5	**.118**	4.5	4.5	4	**1.57**	40	5	2.CMCSF.M1Z5.150.1	■
1/16	**.0625**	1.587	**.122**	4.8	4.8	4	**1.57**	40	5	2.CMC.SSFM1Z5.F116	■
	.071	1.8	**.142**	5.4	5.4	4	**1.57**	40	5	2.CMCSF.M1Z5.180.1	■
	.079	2.0	**.157**	6.0	6.0	4	**1.57**	40	5	2.CMCSF.M1Z5.200.1	■
3/32	**.0937**	2.381	**.185**	7.1	7.1	4	**1.57**	40	5	2.CMC.SSFM1Z5.F332	■
	.098	2.5	**.197**	7.5	7.5	6	**2.17**	55	5	2.CMCSF.M1Z5.250.1	■
	.118	3.0	**.236**	9.0	9.0	6	**2.17**	55	6	2.CMCSF.M1Z6.300.1	■
1/8	**.1250**	3.175	**.252**	9.5	9.5	6	**2.17**	55	6	2.CMC.SSFM1Z6.F18	■
	.138	3.5	**.276**	10.5	10.5	6	**2.17**	55	6	2.CMCSF.M1Z6.350.1	■
5/32	**.1562**	3.968	**.312**	11.9	11.9	6	**2.17**	55	6	2.CMC.SSFM1Z6.F532	■
	.157	4.0	**.315**	12.0	12.0	6	**2.17**	55	6	2.CMCSF.M1Z6.400.1	■
	.177	4.5	**.354**	13.5	13.5	8	**2.56**	65	6	2.CMCSF.M1Z6.450.1	■
3/16	**.1875**	4.762	**.375**	14.3	14.3	8	**2.56**	65	6	2.CMC.SSFM1Z6.F316	■
	.197	5.0	**.394**	15.0	15.0	8	**2.56**	65	6	2.CMCSF.M1Z6.500.1	■
7/32	**.2189**	5.560	**.438**	16.7	16.7	10	**2.76**	70	6	2.CMC.SSFM1Z6.F732	■
	.236	6.0	**.472**	18.0	18.0	10	**2.76**	70	6	2.CMCSF.M1Z6.600.1	■
1/4	**.2500**	6.350	**.500**	19.1	19.1	10	**2.76**	70	6	2.CMC.SSFM1Z6.F14	■
	.315	8.0	**.630**	24.0	24.0	12	**3.15**	80	6	2.CMCSF.M1Z6.800.1	Δ

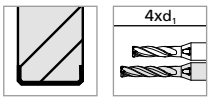
■ Stock item
Δ Delivery term upon request, minumum purchase order quantity 3 pcs.

Type N - 4 x d - Square - Z5 / Z6

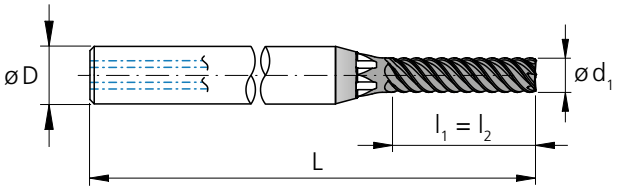
Carbide	Z 5-6	Variable		eXedur SNP				

Ø d_1	**.004" - .118"** (0.1 - 3.0 mm)		**.122" - .236"** (3.1 - 6.0 mm)		**.240" - .394"** (6.1 - 10.0 mm)	
Tolerance	**- .00055"** **- .00110"**	- 0.014 mm - 0.028 mm	**- .00079"** **- .00150"**	- 0.020 mm - 0.038 mm	**- .00098"** **- .00185"**	- 0.025 mm - 0.047 mm

Square



protection chamfer 45°



l_1 = Effective length
l_2 = Cutting length

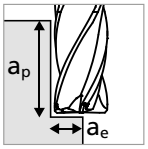
d_1 [inch]	d_1 [inch]	d_1 [mm]	l_1 [inch]	l_1 [mm]	l_2 [mm]	D (h6) [mm]	L [inch]	L [mm]	Z [flutes]	Item number	Availability
	.039	1.0	**.079**	4.0	4.0	4	**1.57**	40	5	2.CMCSF.N1Z5.100.1	■
	.047	1.2	**.094**	4.8	4.8	4	**1.57**	40	5	2.CMCSF.N1Z5.120.1	■
	.059	1.5	**.118**	6.0	6.0	4	**1.57**	40	5	2.CMCSF.N1Z5.150.1	■
1/16	**.0625**	1.587	**.122**	6.3	6.3	4	**1.57**	40	5	2.CMC.SSFN1Z5.F116	■
	.071	1.8	**.142**	7.2	7.2	4	**1.57**	40	5	2.CMCSF.N1Z5.180.1	■
	.079	2.0	**.157**	8.0	8.0	4	**1.73**	44	5	2.CMCSF.N1Z5.200.1	■
3/32	**.0937**	2.381	**.185**	9.5	9.5	4	**1.73**	44	5	2.CMC.SSFN1Z5.F332	■
	.098	2.5	**.197**	10.0	10.0	6	**2.17**	55	5	2.CMCSF.N1Z5.250.1	■
	.118	3.0	**.236**	12.0	12.0	6	**2.17**	55	6	2.CMCSF.N1Z6.300.1	■
1/8	**.1250**	3.175	**.252**	12.7	12.7	6	**2.36**	60	6	2.CMC.SSFN1Z6.F18	■
	.138	3.5	**.276**	14.0	14.0	6	**2.36**	60	6	2.CMCSF.N1Z6.350.1	■
5/32	**.1562**	3.968	**.312**	15.9	15.9	6	**2.36**	60	6	2.CMC.SSFN1Z6.F532	■
	.157	4.0	**.315**	16.0	16.0	6	**2.36**	60	6	2.CMCSF.N1Z6.400.1	■
	.177	4.5	**.354**	18.0	18.0	8	**2.76**	70	6	2.CMCSF.N1Z6.450.1	■
3/16	**.1875**	4.762	**.375**	19.0	19.0	8	**2.76**	70	6	2.CMC.SSFN1Z6.F316	■
	.197	5.0	**.394**	20.0	20.0	8	**2.76**	70	6	2.CMCSF.N1Z6.500.1	■
7/32	**.2189**	5.560	**.438**	22.2	22.2	10	**2.95**	75	6	2.CMC.SSFN1Z6.F732	■
	.236	6.0	**.472**	24.0	24.0	10	**2.95**	75	6	2.CMCSF.N1Z6.600.1	■
1/4	**.2500**	6.350	**.500**	25.4	25.4	10	**3.15**	80	6	2.CMC.SSFN1Z6.F14	■
	.315	8.0	**.630**	32.0	32.0	12	**3.54**	90	6	2.CMCSF.N1Z6.800.1	Δ

■ Stock item
Δ Delivery term upon request, minumum purchase order quantity 3 pcs.

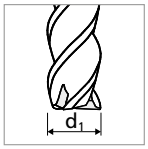
Type M - Finishing

MILLING WITH INTEGRATED COOLING | CUTTING DATA OVERVIEW

Finishing



■ $a_p = 3 \times d_1$



Materials group	Material	Mat. no.	DIN	AISI/ASTM/UNS	a_e	1.0 mm | .039" v_c	f_z
P	Unalloyed carbon steel Rm < 800 N/mm²	1.0301	C10	AISI 1010	0.010 - 0.020 x d1	120 **394**	0.005 - 0.010 **.00020 - .00039**
		1.0401	C15	AISI 1015			
		1.1191	C45E/CK45	AISI 1045			
		1.0044	S275JR	AISI 1020			
		1.0715	11SMn30	AISI 1215			
	Low alloyed steel Rm > 900 N/mm²	1.5752	15NiCr13	ASTM 3415 / AISI 3310		120 **394**	0.005 - 0.010 **.00020 - .00039**
		1.7131	16MnCr5	AISI 5115			
		1.3505	100Cr6	AISI 52100			
		1.7225	42CrMo4	AISI 4140			
		1.2842	90MnCrV8	AISI O2			
	High alloyed tool steel Rm < 1200 N/mm²	1.2379	X153CrMoV12	AISI D2		120 **394**	0.005 - 0.010 **.00020 - .00039**
		1.2436	X210CrW12	AISI D4/D6			
		1.3343	HS6-5-2C	AISI M2 / UNS T11302			
		1.3355	HS18-0-1	AISI T1 / UNS T12001			
M	Stainless steel ferritic	1.4016	X6Cr17	AISI 430 / UNS S43000	0.010 - 0.015 x d1	80 **262**	0.005 - 0.007 **.00020 - .00028**
		1.4105	X6CrMoS17	AISI 430F			
	Stainless steel martensitic	1.4034	X46Cr13	AISI 420C		80 **262**	0.005 - 0.007 **.00020 - .00028**
		1.4112	X90CrMoV18	AISI 440B			
	Stainless steel martensitic – PH	1.4542	X5CrNiCuNb16-4	AISI 630 / ASTM 17-4 PH		80 **262**	0.005 - 0.007 **.00020 - .00028**
		1.4545	X5CrNiCuNb15-5	ASTM 15-5 PH			
	Stainless steel austenitic	1.4301	X5CrNi18-10	AISI 304		80 **262**	0.005 - 0.007 **.00020 - .00028**
		1.4435	X2CrNiMo18-14-3	AISI 316L			
		1.4441	X2CrNiMo18-15-3	AISI 316LM			
		1.4539	X1NiCrMoCu25-20-5	AISI 904L			
K	Cast iron	0.6020	GG20	ASTM 30	0.010 - 0.020 x d1	120 **394**	0.005 - 0.010 **.00020 - .00039**
		0.6030	GG30	ASTM 40B			
		0.7040	GGG40	ASTM 60-40-18			
		0.7060	GGG60	ASTM 80-60-03			
N	Aluminium alloy wrought	3.2315	AlMgSi1	ASTM 6351	0.010 - 0.020 x d1	200 **656**	0.005 - 0.010 **.00020 - .00039**
		3.4365	AlZnMgCu1.5	ASTM 7075			
	Aluminium alloy cast	3.2163	GD-AlSi9Cu3	ASTM A380		200 **656**	0.005 - 0.010 **.00020 - .00039**
		3.2381	GD-AlSi10Mg	UNS A03590			
	Copper	2.0040	Cu-OF / CW008A	UNS C10100		200 **656**	0.005 - 0.010 **.00020 - .00039**
		2.0065	Cu-ETP / CW004A	UNS C11000			
	Brass lead free	2.0321	CuZn37 CW508L	UNS C27400		200 **656**	0.005 - 0.010 **.00020 - .00039**
		2.0360	CuZn40 CW509L	UNS C28000			
	Brass, Bronze Rm < 400 N/mm²	2.0401	CuZn39Pb3 / CW614N	UNS C38500		200 **656**	0.005 - 0.010 **.00020 - .00039**
		2.1020	CuSn6	UNS C51900			
	Bronze Rm < 600 N/mm²	2.0966	CuAl10Ni5Fe4	UNS C63000		200 **656**	0.005 - 0.010 **.00020 - .00039**
		2.0960	CuAl9Mn2	UNS C63200			
S_1	Super alloys	2.4856		Inconel 625	0.005 - 0.010 x d1	40 **131**	0.005 - 0.007 **.00020 - .00028**
		2.4668		Inconel 718			
		2.4617	NiMo28	Hastelloy B-2			
		2.4665	NiCr22Fe18Mo	Hastelloy X			
S_2	Titanium pure	3.7035	Gr.2	ASTM B348 / F67	0.007 - 0.015 x d1	60 **197**	0.005 - 0.010 **.00020 - .00039**
		3.7065	Gr.4	ASTM B348 / F68			
	Titanium alloys	3.7165	TiAl6V4	ASTM B348 / F136		60 **197**	0.005 - 0.010 **.00020 - .00039**
		9.9367	TiAl6Nb7	ASTM F1295			
S_3	CrCo alloys	2.4964	CoCr20W15Ni	Haynes 25	0.005 - 0.010 x d1	80 **262**	0.005 - 0.007 **.00020 - .00028**
			CrCoMo28	ASTM F1537			
H_1	Hardened steel < 55 HRC	1.2510	100MnCrMoW4	AISI O1			
H_2	Hardened steel ≥ 55 HRC	1.2379	X153CrMoV12	AISI D2			

v_c [m/min] | **[SFM]**
f_z [mm] | **[IPT]**

RECOMMENDATION FOR USE
● Excellent | ◐ Good | ○ Acceptable | ⊠ Not recommended

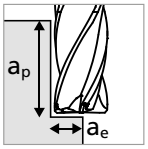
P ●	N ●	S_3 ●
M ●	S_1 ●	H_1 ⊠
K ●	S_2 ●	H_2 ⊠

Ød₁: 1/16" 1.5 mm | **.059"**		3/32" 2.0 mm | **.079"**		1/8" 3.0 mm | **.118"**		5/32" 4.0 mm | **.157"**		3/16" - 7/32" 5.0 mm | **.197"**		1/4" 6.0 mm | **.236"**		8.0 mm | **.315"**	
v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z
140 **459**	0.007-0.015 **.00028-.00059**	140 **459**	0.010-0.020 **.00039-.00079**	160 **525**	0.015-0.030 **.00059-.00118**	180 **591**	0.020-0.040 **.00079-.00157**	180 **591**	0.025-0.050 **.00098-.00197**	200 **656**	0.030-0.060 **.00118-.00236**	200 **656**	0.040-0.080 **.00157-.00315**
140 **459**	0.007-0.015 **.00028-.00059**	140 **459**	0.010-0.020 **.00039-.00079**	160 **525**	0.015-0.030 **.00059-.00118**	180 **591**	0.020-0.040 **.00079-.00157**	180 **591**	0.025-0.050 **.00098-.00197**	200 **656**	0.030-0.060 **.00118-.00236**	200 **656**	0.040-0.080 **.00157-.00315**
140 **459**	0.007-0.015 **.00028-.00059**	140 **459**	0.010-0.020 **.00039-.00079**	160 **525**	0.015-0.030 **.00059-.00118**	180 **591**	0.020-0.040 **.00079-.00157**	180 **591**	0.025-0.050 **.00098-.00197**	200 **656**	0.030-0.060 **.00118-.00236**	200 **656**	0.040-0.080 **.00157-.00315**
100 **328**	0.007-0.012 **.00028-.00047**	100 **328**	0.010-0.015 **.00039-.00059**	120 **394**	0.015-0.025 **.00059-.00098**	140 **459**	0.020-0.030 **.00079-.00118**	140 **459**	0.025-0.035 **.00098-.00138**	160 **525**	0.030-0.045 **.00118-.00177**	160 **525**	0.040-0.060 **.00157-.00236**
100 **328**	0.007-0.012 **.00028-.00047**	100 **328**	0.010-0.015 **.00039-.00059**	120 **394**	0.015-0.025 **.00059-.00098**	140 **459**	0.020-0.030 **.00079-.00118**	140 **459**	0.025-0.035 **.00098-.00138**	160 **525**	0.030-0.045 **.00118-.00177**	160 **525**	0.040-0.060 **.00157-.00236**
100 **328**	0.007-0.012 **.00028-.00047**	100 **328**	0.010-0.015 **.00039-.00059**	120 **394**	0.015-0.025 **.00059-.00098**	140 **459**	0.020-0.030 **.00079-.00118**	140 **459**	0.025-0.035 **.00098-.00138**	160 **525**	0.030-0.045 **.00118-.00177**	160 **525**	0.040-0.060 **.00157-.00236**
100 **328**	0.007-0.012 **.00028-.00047**	100 **328**	0.010-0.015 **.00039-.00059**	120 **394**	0.015-0.025 **.00059-.00098**	140 **459**	0.020-0.030 **.00079-.00118**	140 **459**	0.025-0.035 **.00098-.00138**	160 **525**	0.030-0.045 **.00118-.00177**	160 **525**	0.040-0.060 **.00157-.00236**
140 **459**	0.007-0.015 **.00028-.00059**	140 **459**	0.010-0.020 **.00039-.00079**	160 **525**	0.015-0.030 **.00059-.00118**	180 **591**	0.020-0.040 **.00079-.00157**	180 **591**	0.025-0.050 **.00098-.00197**	200 **656**	0.030-0.060 **.00118-.00236**	200 **656**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
60 **197**	0.007-0.012 **.00028-.00047**	60 **197**	0.010-0.015 **.00039-.00059**	80 **262**	0.015-0.025 **.00059-.00098**	80 **262**	0.020-0.030 **.00079-.00118**	80 **262**	0.025-0.035 **.00098-.00138**	100 **328**	0.030-0.045 **.00118-.00177**	100 **328**	0.040-0.060 **.00157-.00236**
80 **262**	0.006-0.012 **.00024-.00047**	80 **262**	0.008-0.016 **.00031-.00063**	130 **427**	0.011-0.022 **.00043-.00087**	120 **394**	0.012-0.024 **.00047-.00094**	120 **394**	0.014-0.028 **.00055-.00110**	140 **459**	0.015-0.030 **.00059-.00118**	140 **459**	0.020-0.040 **.00079-.00157**
80 **262**	0.006-0.012 **.00024-.00047**	80 **262**	0.008-0.016 **.00031-.00063**	130 **427**	0.011-0.022 **.00043-.00087**	120 **394**	0.012-0.024 **.00047-.00094**	120 **394**	0.014-0.028 **.00055-.00110**	140 **459**	0.015-0.030 **.00059-.00118**	140 **459**	0.020-0.040 **.00079-.00157**
100 **328**	0.007-0.012 **.00028-.00047**	100 **328**	0.010-0.015 **.00039-.00059**	130 **427**	0.015-0.025 **.00059-.00098**	120 **394**	0.020-0.030 **.00079-.00118**	120 **394**	0.025-0.035 **.00098-.00138**	140 **459**	0.030-0.045 **.00118-.00177**	140 **459**	0.040-0.060 **.00157-.00236**

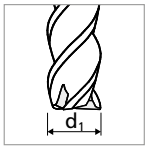
Type N - Finishing

MILLING WITH INTEGRATED COOLING | CUTTING DATA OVERVIEW

Finishing



■ $a_p = 4 \times d_1$



Materials group	Material	Mat. no.	DIN	AISI/ASTM/UNS	a_e	1.0 mm | .039" v_c	1.0 mm | .039" f_z
P	Unalloyed carbon steel Rm < 800 N/mm²	1.0301	C10	AISI 1010	0.010 - 0.020 x d1	120 **394**	0.005 - 0.010 **.00020 - .00039**
		1.0401	C15	AISI 1015			
		1.1191	C45E/CK45	AISI 1045			
		1.0044	S275JR	AISI 1020			
		1.0715	11SMn30	AISI 1215			
	Low alloyed steel Rm > 900 N/mm²	1.5752	15NiCr13	ASTM 3415 / AISI 3310		120 **394**	0.005 - 0.010 **.00020 - .00039**
		1.7131	16MnCr5	AISI 5115			
		1.3505	100Cr6	AISI 52100			
		1.7225	42CrMo4	AISI 4140			
		1.2842	90MnCrV8	AISI O2			
	High alloyed tool steel Rm < 1200 N/mm²	1.2379	X153CrMoV12	AISI D2		120 **394**	0.005 - 0.010 **.00020 - .00039**
		1.2436	X210CrW12	AISI D4/D6			
		1.3343	HS6-5-2C	AISI M2 / UNS T11302			
		1.3355	HS18-0-1	AISI T1 / UNS T12001			
M	Stainless steel ferritic	1.4016	X6Cr17	AISI 430 / UNS S43000	0.010 - 0.015 x d1	80 **262**	0.005 - 0.007 **.00020 - .00028**
		1.4105	X6CrMoS17	AISI 430F			
	Stainless steel martensitic	1.4034	X46Cr13	AISI 420C		80 **262**	0.005 - 0.007 **.00020 - .00028**
		1.4112	X90CrMoV18	AISI 440B			
	Stainless steel martensitic – PH	1.4542	X5CrNiCuNb16-4	AISI 630 / ASTM 17-4 PH		80 **262**	0.005 - 0.007 **.00020 - .00028**
		1.4545	X5CrNiCuNb15-5	ASTM 15-5 PH			
	Stainless steel austenitic	1.4301	X5CrNi18-10	AISI 304		80 **262**	0.005 - 0.007 **.00020 - .00028**
		1.4435	X2CrNiMo18-14-3	AISI 316L			
		1.4441	X2CrNiMo18-15-3	AISI 316LM			
		1.4539	X1NiCrMoCu25-20-5	AISI 904L			
K	Cast iron	0.6020	GG20	ASTM 30	0.010 - 0.020 x d1	120 **394**	0.005 - 0.010 **.00020 - .00039**
		0.6030	GG30	ASTM 40B			
		0.7040	GGG40	ASTM 60-40-18			
		0.7060	GGG60	ASTM 80-60-03			
N	Aluminium alloy wrought	3.2315	AlMgSi1	ASTM 6351	0.010 - 0.020 x d1	200 **656**	0.005 - 0.010 **.00020 - .00039**
		3.4365	AlZnMgCu1.5	ASTM 7075			
	Aluminium alloy cast	3.2163	GD-AlSi9Cu3	ASTM A380		200 **656**	0.005 - 0.010 **.00020 - .00039**
		3.2381	GD-AlSi10Mg	UNS A03590			
	Copper	2.0040	Cu-OF / CW008A	UNS C10100		200 **656**	0.005 - 0.010 **.00020 - .00039**
		2.0065	Cu-ETP / CW004A	UNS C11000			
	Brass lead free	2.0321	CuZn37 CW508L	UNS C27400		200 **656**	0.005 - 0.010 **.00020 - .00039**
		2.0360	CuZn40 CW509L	UNS C28000			
	Brass, Bronze Rm < 400 N/mm²	2.0401	CuZn39Pb3 / CW614N	UNS C38500		200 **656**	0.005 - 0.010 **.00020 - .00039**
		2.1020	CuSn6	UNS C51900			
	Bronze Rm < 600 N/mm²	2.0966	CuAl10Ni5Fe4	UNS C63000		200 **656**	0.005 - 0.010 **.00020 - .00039**
		2.0960	CuAl9Mn2	UNS C63200			
S_1	Super alloys	2.4856		Inconel 625	0.005 - 0.010 x d1	40 **131**	0.005 - 0.007 **.00020 - .00028**
		2.4668		Inconel 718			
		2.4617	NiMo28	Hastelloy B-2			
		2.4665	NiCr22Fe18Mo	Hastelloy X			
S_2	Titanium pure	3.7035	Gr.2	ASTM B348 / F67	0.007 - 0.015 x d1	60 **197**	0.005 - 0.010 **.00020 - .00039**
		3.7065	Gr.4	ASTM B348 / F68			
	Titanium alloys	3.7165	TiAl6V4	ASTM B348 / F136		60 **197**	0.005 - 0.010 **.00020 - .00039**
		9.9367	TiAl6Nb7	ASTM F1295			
S_3	CrCo alloys	2.4964	CoCr20W15Ni	Haynes 25	0.005 - 0.010 x d1	80 **262**	0.005 - 0.007 **.00020 - .00028**
			CrCoMo28	ASTM F1537			
H_1	Hardened steel < 55 HRC	1.2510	100MnCrMoW4	AISI O1			
H_2	Hardened steel ≥ 55 HRC	1.2379	X153CrMoV12	AISI D2			

v_c [m/min] | **[SFM]**
f_z [mm] | **[IPT]**

RECOMMENDATION FOR USE
● Excellent | ◐ Good | ○ Acceptable | ⊠ Not recommended

P ●	N ●	S_3 ●
M ●	S_1 ●	H_1 ⊠
K ●	S_2 ●	H_2 ⊠

Ød₁													
1/16" 1.5 mm | **.059"**		**3/32"** 2.0 mm | **.079"**		**1/8"** 3.0 mm | **.118"**		**5/32"** 4.0 mm | **.157"**		**3/16" - 7/32"** 5.0 mm | **.197"**		**1/4"** 6.0 mm | **.236"**		8.0 mm | **.315"**	
v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z	v_c	f_z
140 **459**	0.007-0.015 **.00028-.00059**	140 **459**	0.010-0.020 **.00039-.00079**	160 **525**	0.015-0.030 **.00059-.00118**	180 **591**	0.020-0.040 **.00079-.00157**	180 **591**	0.025-0.050 **.00098-.00197**	200 **656**	0.030-0.060 **.00118-.00236**	200 **656**	0.040-0.080 **.00157-.00315**
140 **459**	0.007-0.015 **.00028-.00059**	140 **459**	0.010-0.020 **.00039-.00079**	160 **525**	0.015-0.030 **.00059-.00118**	180 **591**	0.020-0.040 **.00079-.00157**	180 **591**	0.025-0.050 **.00098-.00197**	200 **656**	0.030-0.060 **.00118-.00236**	200 **656**	0.040-0.080 **.00157-.00315**
140 **459**	0.007-0.015 **.00028-.00059**	140 **459**	0.010-0.020 **.00039-.00079**	160 **525**	0.015-0.030 **.00059-.00118**	180 **591**	0.020-0.040 **.00079-.00157**	180 **591**	0.025-0.050 **.00098-.00197**	200 **656**	0.030-0.060 **.00118-.00236**	200 **656**	0.040-0.080 **.00157-.00315**
100 **328**	0.007-0.012 **.00028-.00047**	100 **328**	0.010-0.015 **.00039-.00059**	120 **394**	0.015-0.025 **.00059-.00098**	140 **459**	0.020-0.030 **.00079-.00118**	140 **459**	0.025-0.035 **.00098-.00138**	160 **525**	0.030-0.045 **.00118-.00177**	160 **525**	0.040-0.060 **.00157-.00236**
100 **328**	0.007-0.012 **.00028-.00047**	100 **328**	0.010-0.015 **.00039-.00059**	120 **394**	0.015-0.025 **.00059-.00098**	140 **459**	0.020-0.030 **.00079-.00118**	140 **459**	0.025-0.035 **.00098-.00138**	160 **525**	0.030-0.045 **.00118-.00177**	160 **525**	0.040-0.060 **.00157-.00236**
100 **328**	0.007-0.012 **.00028-.00047**	100 **328**	0.010-0.015 **.00039-.00059**	120 **394**	0.015-0.025 **.00059-.00098**	140 **459**	0.020-0.030 **.00079-.00118**	140 **459**	0.025-0.035 **.00098-.00138**	160 **525**	0.030-0.045 **.00118-.00177**	160 **525**	0.040-0.060 **.00157-.00236**
100 **328**	0.007-0.012 **.00028-.00047**	100 **328**	0.010-0.015 **.00039-.00059**	120 **394**	0.015-0.025 **.00059-.00098**	140 **459**	0.020-0.030 **.00079-.00118**	140 **459**	0.025-0.035 **.00098-.00138**	160 **525**	0.030-0.045 **.00118-.00177**	160 **525**	0.040-0.060 **.00157-.00236**
140 **459**	0.007-0.015 **.00028-.00059**	140 **459**	0.010-0.020 **.00039-.00079**	160 **525**	0.015-0.030 **.00059-.00118**	180 **591**	0.020-0.040 **.00079-.00157**	180 **591**	0.025-0.050 **.00098-.00197**	200 **656**	0.030-0.060 **.00118-.00236**	200 **656**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
220 **722**	0.007-0.015 **.00028-.00059**	220 **722**	0.010-0.020 **.00039-.00079**	260 **853**	0.015-0.030 **.00059-.00118**	280 **919**	0.020-0.040 **.00079-.00157**	280 **919**	0.025-0.050 **.00098-.00197**	300 **984**	0.030-0.060 **.00118-.00236**	300 **984**	0.040-0.080 **.00157-.00315**
60 **197**	0.007-0.012 **.00028-.00047**	60 **197**	0.010-0.015 **.00039-.00059**	80 **262**	0.015-0.025 **.00059-.00098**	80 **262**	0.020-0.030 **.00079-.00118**	80 **262**	0.025-0.035 **.00098-.00138**	100 **328**	0.030-0.045 **.00118-.00177**	100 **328**	0.040-0.060 **.00157-.00236**
80 **262**	0.006-0.012 **.00024-.00047**	80 **262**	0.008-0.016 **.00031-.00063**	130 **427**	0.011-0.022 **.00043-.00087**	120 **394**	0.012-0.024 **.00047-.00094**	120 **394**	0.014-0.028 **.00055-.00110**	140 **459**	0.015-0.030 **.00059-.00118**	140 **459**	0.020-0.040 **.00079-.00157**
80 **262**	0.006-0.012 **.00024-.00047**	80 **262**	0.008-0.016 **.00031-.00063**	130 **427**	0.011-0.022 **.00043-.00087**	120 **394**	0.012-0.024 **.00047-.00094**	120 **394**	0.014-0.028 **.00055-.00110**	140 **459**	0.015-0.030 **.00059-.00118**	140 **459**	0.020-0.040 **.00079-.00157**
100 **328**	0.007-0.012 **.00028-.00047**	100 **328**	0.010-0.015 **.00039-.00059**	130 **427**	0.015-0.025 **.00059-.00098**	120 **394**	0.020-0.030 **.00079-.00118**	120 **394**	0.025-0.035 **.00098-.00138**	140 **459**	0.030-0.045 **.00118-.00177**	140 **459**	0.040-0.060 **.00157-.00236**

NEW Process CrazyMill Cool SF

ACCURATE AND EFFICIENT MILLING

Coolant type, pressure and filtration

Coolant: for best results, Mikron Tool recommends the use of cutting oil as coolant. Alternatively, water base coolant with EP-Additives (Extreme-Pressure-Additives) can be used as well.

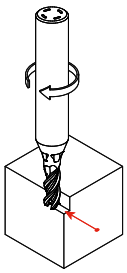
Filter: the large cooling channels permit the use of a standard filter with filter quality of ≤ .002" (0.05 mm).

Coolant pressure: at least 15 bar (218 psi) coolant pressure is required to achieve reliable milling. High pressure is generally better for the cooling and flushing effect.

Revolution	[rpm]	≤ 10'000	> 10'000
Minimal pressure	[bar]	15	30
	[psi]	**218**	**435**

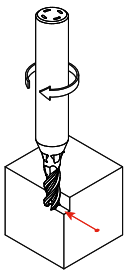
MILLING PROCESS

Climb milling and conventional milling



Mikron tool recommends climb milling for the machining of side milling. The chip thickness here is greater at the beginning and decreases continuously; the cutting forces remain low. With conventional milling, however, high cutting forces would push the milling tool away from the part.Thus surface quality decreases.

Finishing



Recommended cutting parameters

v_c and f_z = as specified in the cutting data table

Strategy	Type M	Type N
①	a_p = 3 x d a_e = 0.005 - 0.020 x d	a_p = 4 x d a_e = 0.005 - 0.020 x d

News: Tool libraries of all Mikron Tool catalog products are available on Mastercam's Tech Exchange, ready for download!

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