Solid Carbide End Mills

Inch & Metric

WALTER PROTOTYP

A portion of our metric offering is incorporated into this catalog. To review the complete metric product program please see our global Milling Tools catalog (pictured above) or TEC/CCS.

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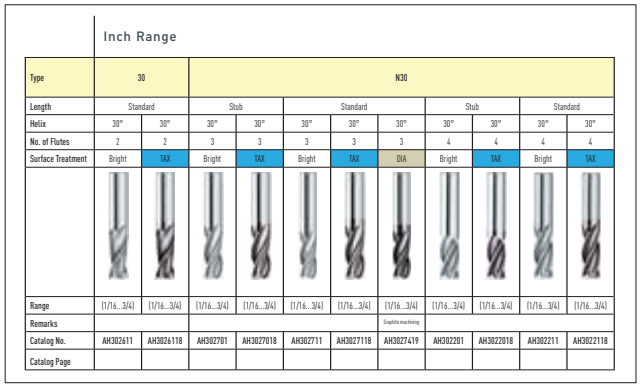
Quick reference

The PROTOTYP catalog has been reorganized.
This page will give you the information needed for selecting and locating products.

Search methods:

There are many ways of getting information. The right one depends on exactly what you're looking for.



Inch Range

Type	30		N30								
Length	Standard		Stub		Standard			Stub		Standard	
Helix	30°	30°	30°	30°	30°	30°	30°	30°	30°	30°	30°
No. of Flutes	2	2	3	3	3	3	3	4	4	4	4
Surface Treatment	Bright	TAX	Bright	TAX	Bright	TAX	DIA	Bright	TAX	Bright	TAX
Range	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4) Graphite machining	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)
Remarks											
Catalog No.	AH302611	AH3026118	AH302701	AH3027018	AH302711	AH3027118	AH3027419	AH302201	AH3022018	AH302211	AH3022118
Catalog Page											

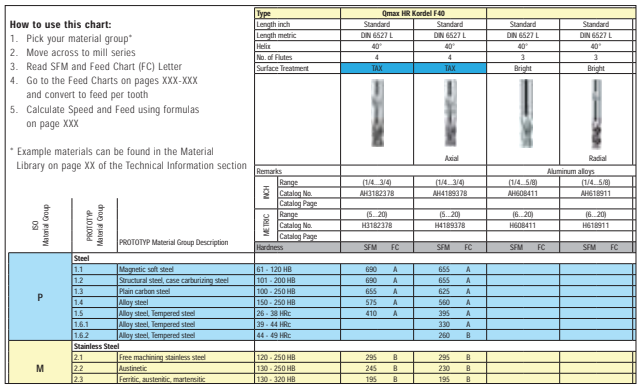
Profile and geometry:

The tool overview located at the beginning of each tabbed section can help you quickly identify a tool and it's basic features.

Code No	page	Code No	page	Code No
A		AH608411	22	H3022118
AH3014118	55	AH618911	23	H3023418
AH3021138	57	AH7073417	100	H3023518
AH302201	50	AH7073717	99	H3024148
AH3022018	50	AH800111	132	H302611
AH302211	51	AH8001118	132	H3026118
AH3022118	51	AH8001119	133	H3027419
AH3023418	56	AH8001918	139	H3053918
AH3023518	56	AH8001919	140	H3058318
AH302611	46	AH8004028	142	H3068118
AH3026118	46	AH8004128	141	H3070118

Catalog Number:

If you already know the catalog number you're looking for, then use the index beginning on page 201.



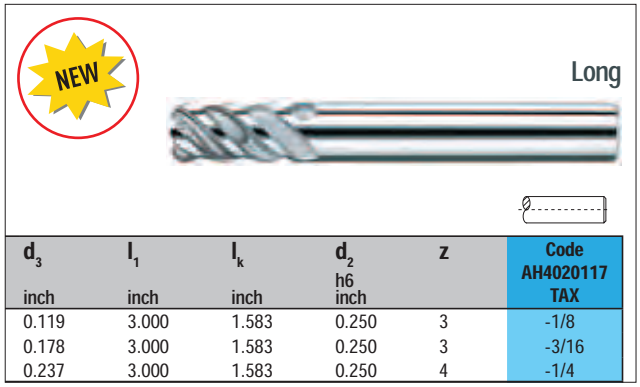
How to use this chart:
1. Pick your material group*
2. Move across to mill series
3. Read SFM and Feed Chart (FC) Letter
4. Go to the Feed Charts on pages XXX-XXX and convert to feed per tooth
5. Calculate Speed and Feed using formulas on page XXX

* Example materials can be found in the Material Library on page XX of the Technical Information section

Type			Qmax HR Kordel F40					
Length inch			Standard	Standard	Standard	Standard		
Length metric			DIN 6527 L	DIN 6527 L	DIN 6527 L	DIN 6527 L		
Helix			40°	40°	40°	40°		
No. of Flutes			4	4	3	3		
Surface Treatment			TAX	TAX	Bright	Bright		
Remarks				Axial		Radial		
					Aluminum alloys			
	INCH	Range	(1/4...3/4)	(1/4...3/4)	(1/4...5/8)	(1/4...5/8)		
		Catalog No.	AH3182378	AH4189378	AH608411	AH618911		
		Catalog Page						
	METRIC	Range	(5...20)	(5...20)	(6...20)	(6...20)		
		Catalog No.	H3182378	H4189378	H608411	H618911		
		Catalog Page						
ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Hardness	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC
P		**Steel**						
	1.1	Magnetic soft steel	61 - 120 HB	690 A	655 A			
	1.2	Structural steel, case carburizing steel	101 - 200 HB	690 A	655 A			
	1.3	Plain carbon steel	100 - 250 HB	655 A	625 A			
	1.4	Alloy steel	150 - 250 HB	575 A	560 A			
	1.5	Alloy steel, Tempered steel	26 - 38 HRc	410 A	395 A			
	1.6.1	Alloy steel, Tempered steel	39 - 44 HRc		330 A			
	1.6.2	Alloy steel, Tempered steel	44 - 49 HRc		260 B			
M		**Stainless Steel**						
	2.1	Free machining stainless steel	120 - 250 HB	295 B	295 B			
	2.2	Austinetic	130 - 250 HB	245 B	230 B			
	2.3	Ferritic, austenitic, martensitic	130 - 320 HB	195 B	195 B			

Application:

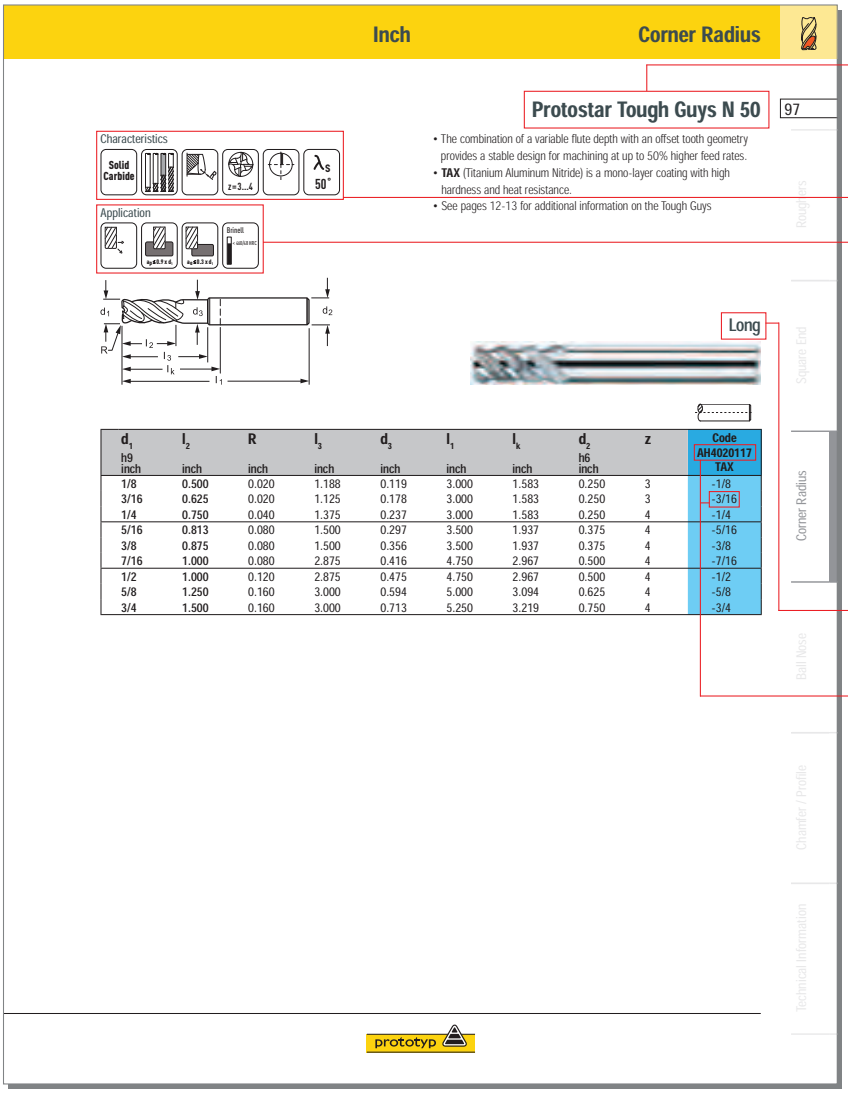
Is there an application that you need a recommendation for? Then use the application guide located at the end of each tabbed section. They are conveniently organized by ISO material groups.



d_3 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH4020117 TAX
0.119	3.000	1.583	0.250	3	-1/8
0.178	3.000	1.583	0.250	3	-3/16
0.237	3.000	1.583	0.250	4	-1/4

New Products:

Are you curious about the latest products in our offering? Look for the "NEW" item icon on the product pages.



d_1 h9 inch	l_2 inch	R inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH4020117 TAX
1/8	0.500	0.020	1.188	0.119	3.000	1.583	0.250	3	-1/8
3/16	0.625	0.020	1.125	0.178	3.000	1.583	0.250	3	-3/16
1/4	0.750	0.040	1.375	0.237	3.000	1.583	0.250	4	-1/4
5/16	0.813	0.080	1.500	0.297	3.500	1.937	0.375	4	-5/16
3/8	0.875	0.080	1.500	0.356	3.500	1.937	0.375	4	-3/8
7/16	1.000	0.080	2.875	0.416	4.750	2.967	0.500	4	-7/16
1/2	1.000	0.120	2.875	0.475	4.750	2.967	0.500	4	-1/2
5/8	1.250	0.160	3.000	0.594	5.000	3.094	0.625	4	-5/8
3/4	1.500	0.160	3.000	0.713	5.250	3.219	0.750	4	-3/4

Product Name

Sketches reference tool geometry (the complete listing of the icons can be found on page 6)

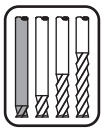
Sketches reference application (the complete listing of the icons can be found on page 6)

Overall length classes

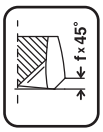
The ordering code:
In every product table you'll find one or more columns labeled "Code", the first part of the order number and the coating. This is valid for all versions of the selected product. You simply add the first part of the order number to the second part in the column above, which corresponds to the size you require.

Example: **AH4020117-3/16**

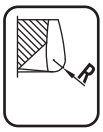
Tool material



Cutting length (e.g. extra short)



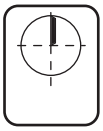
Corner chamfer



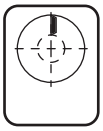
Corner radius

Ball nose

Number of flutes (e.g.number of flutes z = 2...4)

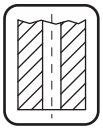


Center cutting



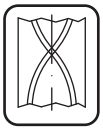
Non-center cutting

Helix angle (e.g. helix angle λ_S=20°)

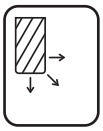


Through coolant, axial exit

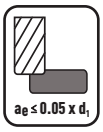
Through coolant, radial exit



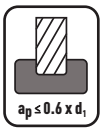
Through coolant, helical flow



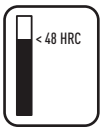
Possible feed direction(s)



Maximum width of cut



Maximum depth of cut for slotting



Workpiece material hardness
(e.g. < 48HRC)

Chipbreaker profiles

Designation – Milling Tools

PROTOSTAR	=	Milling cutter

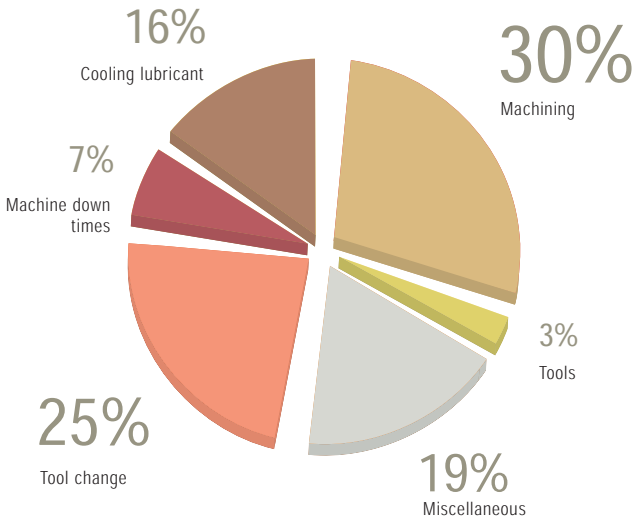
Designation – Milling Tools

30	=	End mill with 30° helix
AL KORDEL G 40	=	Roughing end mill for aluminum alloys
AL 25	=	End mill for aluminum alloys with 25° helix
Compact N 45	=	Economical end mill with 45° helix
FLASH	=	End mill with front radius for high feed roughing
HSC 30	=	End mill for HSC machining with 30° helix
N 30	=	All purpose end mill with 30° helix
N 45	=	All purpose end mill with 45° helix
N 50	=	Finishing end mill with 50° helix
Qmax HR KORDEL F 40	=	Roughing end mill with 40° helix
Ti 40	=	Roughing and finishing end mill for Titanium and Titanium alloys
Ti 45	=	Finishing end mill for Titanium and Titanium alloys
Ti NS 30	=	Roughing end mill for Titanium and Titanium alloys
TOUGH GUYS H 50	=	High feed end mill for materials 48 to 63 HRC
TOUGH GUYS N 50	=	High feed end mill with 50° helix
ULTRA 30	=	End mill for hardened materials with 30° helix
ULTRA H 50	=	Finishing end mill for hardened materials with 50° helix
ULTRA HSC 30	=	End mill for HSC machining of hardened materials

The investment in high-quality tools (at 3% of the overall production costs) has a very positive effect on the remaining 97% of the production costs. The following diagram illustrates the extent to which this capital investment pays off.

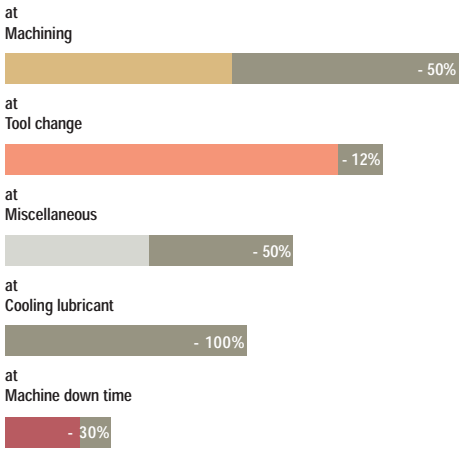
Division of production costs

The price of a tool represents only 3% of the entire production costs.



Saving costs

A tools output can have a great influence on reducing the remaining 97% of costs.



TEC/CCS:

Information is everything and often forms the basis for success. We want to give you more information with our new Computer Cutting-data Service (CCS). The latest version TEC/CCS, allows for swift and precise selection of tools for every machining problem. TEC/CCS can answer the following questions and more.

- Which tool is best suited for my application?
- What are the cutting parameters?
- What is the expected tool life?
- What is the cost per hole?
- Are there alternative solutions?
- What is the price of the selected tooling?
- Which is the best corresponding TITEX tap drill?

PROTOSTAR FLASH

PROTOSTAR FLASH:
Patented extreme feed roughing end mill

The patented PROTOSTAR FLASH can quickly reduce your roughing cycle times when compared to conventional corner radius end mills.

This extreme feed solid carbide end mill offers the following features:

Specialized face geometry
The double radii face geometry allows for a higher feed per tooth (f_z), thus providing higher material removal rates.

TAX (TiALN) coating
A high quality TiALN coating ensures maximum tool life.

Optimized machine use
Machines can be used at their optimal output to reduce cycle time and increase free machine capacity.

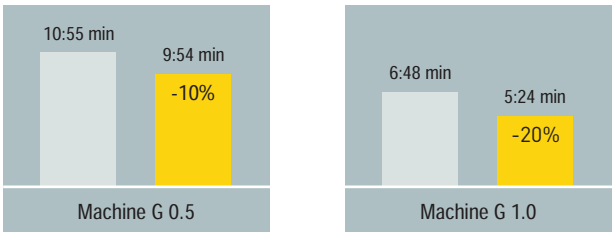
Endurable axial forces
Since the cutting takes place exclusively at the face of the tool, the machine tool spindle is subject almost entirely to axial forces instead of detrimental radial forces.

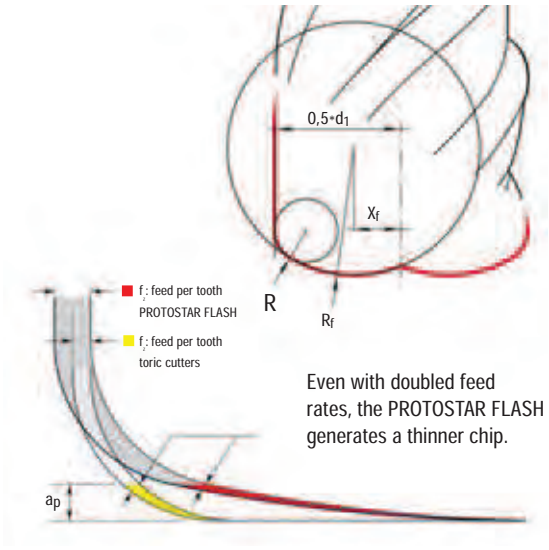
Contour parallel roughing
The advantages of "contour parallel roughing" with corner radius end mills can be further optimized with the PROTOSTAR FLASH.

Calmer milling behavior
The PROTOSTAR FLASH possess calmer machining behavior when compared to indexable carbide tooling.

Reduction in rest material "scaling"
Due to the unique face geometry rest material "scaling" has been minimized. Further reducing the necessary amount of workpiece processing, especially in flat areas.

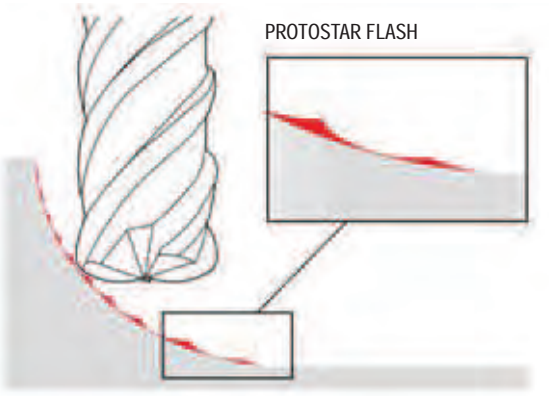
Application example

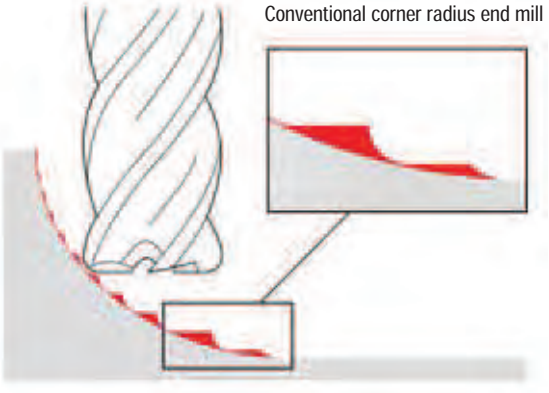




Even with doubled feed rates, the PROTOSTAR FLASH generates a thinner chip.

Minimized rest material with PROTOSTAR FLASH





The right milling strategy is essential

In principle, conventional corner radius end mills roughing strategies can be applied to the PROTOSTAR FLASH.

Cutting depths

We recommend a max. programmed radial cutting width a_e = 0.6 x d_1, and a plunge feed with a ramp angle of 0.5° to max 1.5°.

Critical areas

Within critical areas, e.g. high contact length, narrow contours or islands, attention should be paid to adapting the cutting data. A reduction in axial depth of cut (a_p) or feed per tooth (f_z) may be necessary.

The tool definition is equal to a corner radius end mill (diameter, corner radius R).

Special face geometry

Due to the special face geometry, a minimum deviation occurs at the final contour of the cavity base. This can be easily corrected during the finishing process.

Rest material recognizing

If an area is to be recognized as rest material by means of a CAD / CAM system, the PROTOSTAR FLASH can be modeled accordingly in the tool definition. All necessary measurements can be found on the corresponding catalog page and/or in the TEC/CCS cutting database.

Contour parallel roughing in different materials

The PROTOSTAR FLASH comes in two versions one for materials up to 55 HRC and a version for materials from 55 HRC to 65 HRC.

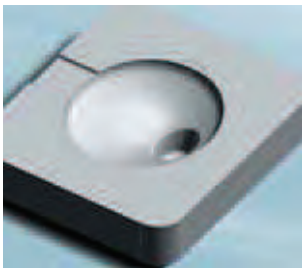
- Alloyed Steel up to 55 HRC
- Hardened Steel to 65 HRC
- Non ferrious material (Al, Cu,...)
- Stainless Steel
  (with reduced cutting depth)

It makes economic roughing of contours in the 2.5D and 3D range with a low cutting depth and high feed possible.

Application example mould cavity
Material: H13 tool steel - 230 HB
Cavity 4.33in X 4.33in, 1.5in deep.
Process: Roughing / pre-finishing, mist coolant
Cycle time: 5:24 min

Tools		
Ø 16 mm (0.630in)		Ø 12 mm (0.472in)
Pocket depths		
18 mm (0.709in)		38 mm (1.497in)
Cutting data		
a_e:	8 mm (0.315in)	6 mm (0.236in)
a_p:	0.9 mm (0.035in)	0.5 mm (0.020in)
v_c:	741 ft/min	670 ft/min
n:	4,500 RPM	5,400 RPM
f_z:	0.024 in/tooth	0.017 in/tooth
v_f:	433 in/min	354 in/min

Application example Mold cavity: 5:24 min




TOUGH GUYS

A milling *"tour de force"*

Areas of application

The "Tough Guy" end mill range N 50 is designed for high-tensile strength steels up to 48 HRC and the H 50 variant is for hardened materials up to 63 HRC. The tools have been developed for applications in general engineering, mold and die and aerospace industries.

The "Tough Guys" can reduce your cycle time and provide a more economical production rate.

Characteristics & benefits

Capable of roughing and finishing
- Greater time savings
- Clean surface finishes
- Less rework

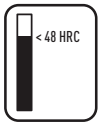
Variable flute depth and spacing provide a stable design capable of high material removal rates
- Greater economy

Smooth running and low spindle pressure
- Troublefree production, high process safety

The latest TiALN coating for dry and wet machining
- Greater tool life

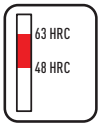
The tools are available in 2 different versions:

TOUGH GUYS N 50

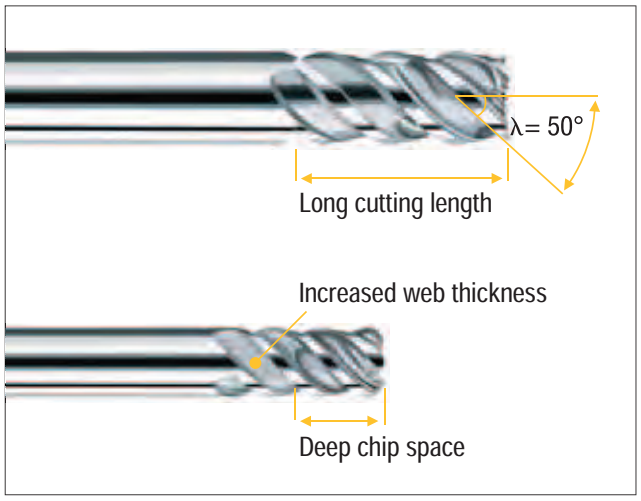


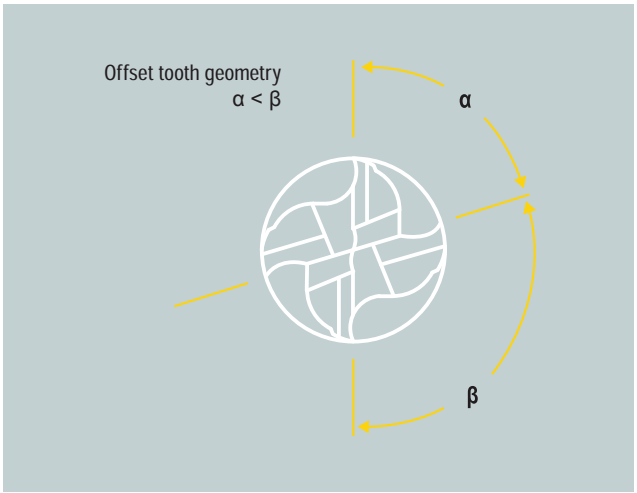
- Double the feed rate as compared to standard tools
- Highly recommended for pocket and slot milling
- The 50° helix and offset tooth geometry combine for low spindle pressure and decreased harmonics

TOUGH GUYS H 50

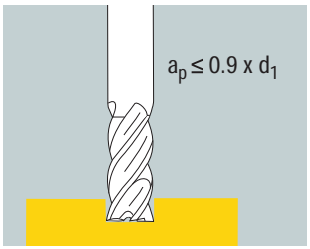


- Slot milling to a depths up to 0.5xd1
- Dry machining with external MQL (minimum quantity lubrication) is possbile

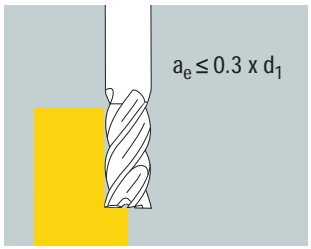




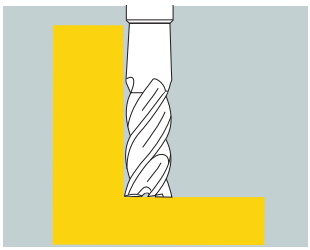
Versatile application range reduces tool and production costs



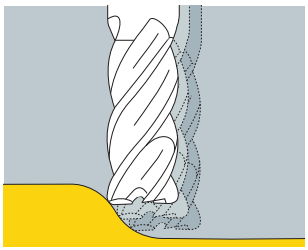
For Roughing
Deep chip space up the front.



For Finishing
50° helix angle provides smooth finishes.



For deep contours (outside and inside)
Available standard with reduced neck diameter to permit longer reach.



For close-contour roughing with greater cutting depth
Available standard with a variety of corner radius.

"Helical plunging"
High level of chip space makes this tool ideal for helical milling.

"Slot milling"
High level of chip space makes this tool ideal for slot milling.

Comparisons of economic efficiency

Application Example

Material: 1045 Carbon steel

Tool: TOUGH GUY N 50
Ordering Code H3121317-16 =
Ø 16 mm (0.630 in)
TAX (TiALN) coated

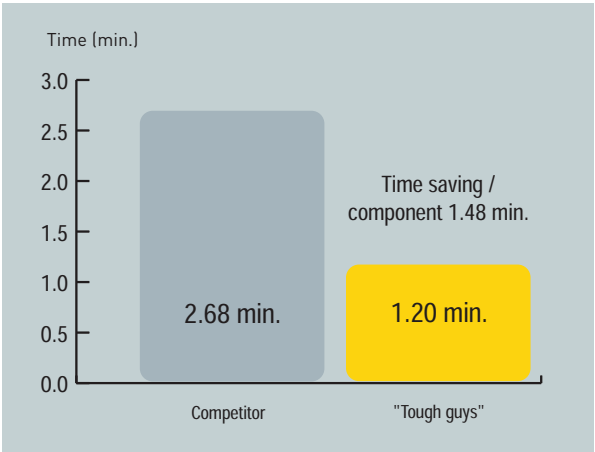
Milling process: 1. Slot milling
a_e = 16 mm (0.630 in); a_p = 12 mm (0.508 in)
Cutting data:
v_c [ft/min] = 413
v_f [in/min] = 28.7

2. Peripheral milling
a_e = 2 mm (0.079 in); a_p = 12.9 mm (0.508 in)

Cutting data:
v_c = [ft/min] = 492
v_f [in/min] = 41.3

Coolant: 5% Soluble oil

Result: 55% reduction in cycle time over previous method. Generating free machine capacity and production savings.



PROTOSTAR Ti

An overview of the PROTOSTAR Ti family

More and more complex components in titanium based materials are being produced. Industry sectors like aerospace, power plant, medical and automotive racing are good examples of this trend. Newer alloys such as Ti 5553 are placing even greater demands on cutting tools.

PROTOTYP has risen to this challenge and has responded with the new PROTOSTAR Ti family of end mills.

PROTOSTAR Ti family of end mills are designed for difficult applications in ISO material group S grade titaniums.

Features like polished flutes, microgeometry and the latest in AlCrN coating technology, all contribute to the successful design.

PROTOSTAR Ti 40:
Solid carbide roughing and finishing end mill

PROTOSTAR Ti 45:
Solid carbide finishing end mill

PROTOSTAR Ti NS 30:
Solid carbide chip breaker roughing end mill

PROTOSTAR Ti 40 – for roughing and finishing

The Tool

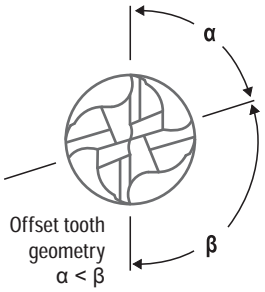
- Solid carbide end mill with corner radius
- Corner radius from 0.2 to 0.4 mm / 0.01 to 0.08 in
- Diameter range from d_1 = 12 to 25 mm / 0.500 to 0.750 in
- Axial coolant through
- λ = 40° helix angle
- 4 flutes with offset tooth geometry
- Metric shanks in accordance with DIN 6535 HA with surface treatment
- Reduced neck
- ACN coating

The Application

- Economic machining of titanium materials
- Roughing and finishing with just one tool
  - HPC machining: Slot milling up to 1.5 x d_1
  - Contour milling with full cutting length
  - Finishing with high cutting speeds to achieve the best possible surface quality

Your advantages

- Highest metal removal rates with maximum depth of cut up to 1.5 x d_1
- Axial internal coolant through provides secure chip evacuation
- Double cutting speed when roughing and finishing as compared to conventional tools
- Offset tooth geometry
  - Quiet milling
  - Vibration-free machining
- Polished flutes
  - For process-secure chip evacuation
  - No built up cutting edges
- Best surface quality due to microgeometry and pre and post-treatment of the cutting edges
- Increased tool life thanks to the ACN coating with post-treatment
- Utmost process security due to special shank treatment for increased torque and force transmission in the tool holder



PROTOSTAR Ti 45 – for finishing at high speeds

The Tool

- Solid carbide finishing end mill with 5 x d_1 cutting length
- Corner radius R = 4 mm / 0.156 in
- Diameter: d_1 = 16, 20 and 25 mm / 0.500 to 0.750 in
- λ = 45° helix angle
- 4 to 5 flutes
- Shank in accordance with DIN 6535 HA
- ACN coating

The Application

- Efficient machining of titanium materials
- Finishing of high root faces and walls
- Finishing with high cutting speeds to achieve the best possible surface quality

Your advantages

- Reduction or elimination of surface rework
- Considerable smoothness machining, due to the helix angle λ = 45°
- Better surface quality, due to of the microgeometry on the cutting edge
- Special pre-treatment of the cutting edge prevents / minimises built up cutting edges
- Increased tool life thanks to the ACN coating with post-treatment

PROTOSTAR Ti NS 30 – for roughing and semi-finishing with chip breaker profile

The Tool

- Solid carbide end mill with modified chip breaker profile
- Stabilized corner edges
- Diameter range from d_1 = 6 up to 25 mm / 0.180 to 0.750 in
- λ = 30° helix angle
- 4 to 5 flutes
- Shank in accordance with DIN 6535 HB and HA
- ACN coating

The Application

- Efficient machining of titanium materials
- Roughing and semi-finishing with just one tool
  - Slot milling up to 1.0 x d_1
  - Contour milling with full cutting length
  - Roughing / finishing profile generates a good surface quality

Your advantages

- Reduced power output thanks to the chip breakers on the cutting edge
- Less reworking of the surface – in some cases, a sufficient surface is created without any further processing
- Short chips due to modified chip breakers – this ensures an easier chip evacuation
- Special pre-treatment of the cutting edge prevents / minimises built up cutting edges
- Increased tool life thanks to the ACN coating with post-treatment

Solid Carbide Roughers

Inch Range

Type	Qmax HR Kordel F 40		AL Kordel G 40		Ti NS 30	Flash	
Length	Standard		Standard		Standard	Standard	
Helix	40°	40°	40°	40°	30°	50°	50°
No. of Flutes	4	4	3	3	4	4	4
Surface Treatment	TAX	TAX	Bright	Bright	ACN	TAX	TAX
							
Coolant supply		Axial		Radial			
Range	(1/4...3/4)	(1/4...3/4)	(1/4...5/8)	(1/4...5/8)	(1/4...5/8)	(1/8...3/4)	(1/8...3/4)
Remarks			Aluminum alloys		Titanium alloys	Hi-Feed	Hard machining
Catalog No.	**AH3182378**	**AH4189378**	**AH608411**	**AH618911**	**AH3083017**	**AH3094718**	**AH3094728**
Catalog Page	20	21	22	23	24	25	26

Metric Range

Type	Qmax HR Kordel F 40		AL Kordel G 40						
Length	DIN 6527 L	DIN 6527 L	DIN 6527 L	DIN 6527 L	DIN 6527 L	P-Norm L	P-Norm L	P-Norm L	P-Norm L
Helix	40°	40°	40°	40°	40°	40°	40°	40°	40°
No. of Flutes	4	4	3	3	3	3	3	3	3
Surface Treatment	TAX	TAX	Bright	Bright	TAX	Bright	HDC	Bright	HDC
									
Coolant supply		Axial		Radial	Radial			Radial	Radial
Range	(5...20)	(5...20)	(6...20)	(6...20)	(6...20)	(6...25)	(6...25)	(6...25)	(6...25)
Remarks			Aluminum alloys						
Catalog No.	**H3182378**	**H4189378**	**H608411**	**H618911**	**H6189118**	**H608771**	**H6087711**	**H608871**	**H6088711**
Catalog Page	27	28	29	30	30	31	31	32	32

Solid Carbide Roughers

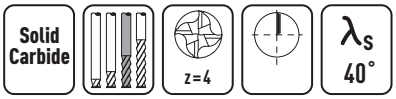
Metric Range

Type	Ti NS 30	Flash		
Length	DIN 6527 L	DIN 6527 L, P-Norm XL		DIN 6527 L
Helix	30°	50°	50°	50°
No. of Flutes	4-5	4	4	4
Surface Treatment	ACN	Bright	TAX	TAX
				
Coolant supply				
Range	(6...25)	(4...20)	(4...20)	(4...20)
Remarks	Titanium alloys	Hi-Feed		Hard Machining
Catalog No.	**H3083017**	**H309471**	**H3094718**	**H3094728**
Catalog Page	33	34	34	35

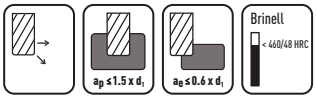
20

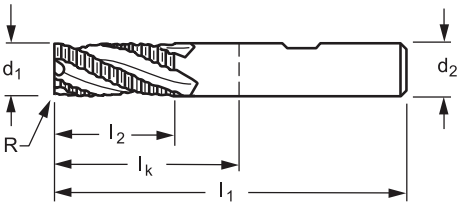
Protostar Qmax HR Kordel F 40

Characteristics



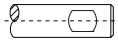
Application





- Roughing end mill with a radiused chip breaker profile that is suitable for a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

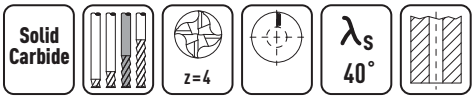
Standard



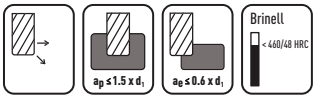
d_1 h12 inch	l_2 inch	R inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3182378 TAX
1/4	0.750	0.013	3.000	1.437	0.375	4	-1/4
5/16	0.813	0.015	3.000	1.437	0.375	4	-5/16
3/8	0.875	0.015	3.000	1.437	0.375	4	-3/8
1/2	1.000	0.015	3.500	1.717	0.500	4	-1/2
5/8	1.250	0.015	3.500	1.594	0.625	4	-5/8
3/4	1.500	0.015	4.000	1.969	0.750	4	-3/4

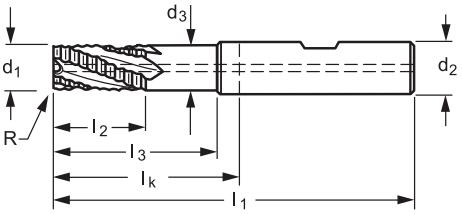
Protostar Qmax HR Kordel F 40

Characteristics



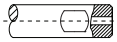
Application





- Roughing end mill with a radiused chip breaker profile that is suitable for a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- Axial coolant through for improved cooling and chip evacuation.
- Long effective length

Standard



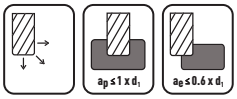
d_1 h12 inch	l_2 inch	R inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH4189378 TAX
1/4	0.750	0.013	0.875	0.230	3.000	1.437	0.375	4	-1/4
5/16	0.813	0.015	1.000	0.293	3.000	1.437	0.375	4	-5/16
3/8	0.875	0.015	1.000	0.355	3.000	1.437	0.375	4	-3/8
1/2	1.000	0.015	1.375	0.475	3.500	1.717	0.500	4	-1/2
5/8	1.250	0.015	1.500	0.594	3.500	1.594	0.625	4	-5/8
3/4	1.500	0.015	2.000	0.713	4.000	1.969	0.750	4	-3/4

22

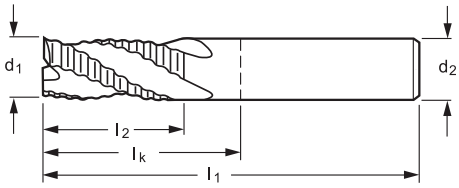
Protostar AL Kordel G 40

Characteristics

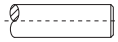
Application



- Roughing end mill with a radiused chip breaker profile for Aluminum and other non-ferrous materials.



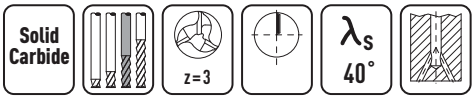
Standard



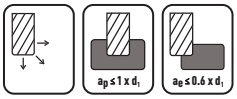
d_1 h12 inch	l_2 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH608411
1/4	0.750	2.500	1.083	0.250	3	-1/4
5/16	0.813	3.000	1.437	0.375	3	-5/16
3/8	0.875	3.000	1.437	0.375	3	-3/8
1/2	1.000	3.500	1.717	0.500	3	-1/2
5/8	1.250	3.500	1.594	0.625	3	-5/8
3/4	1.500	4.000	1.969	0.750	3	-3/4

Protostar AL Kordel G 40

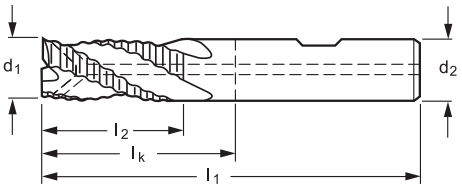
Characteristics



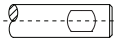
Application



- Roughing end mill with a radiused chip breaker profile for Aluminum and other non-ferrous materials.
- Radial coolant through for improved cooling and chip evacuation.



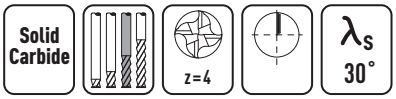
Standard



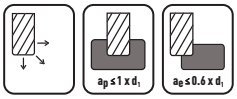
d_1 h12 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH618911
1/4	0.750	3.000	1.437	0.375	3	-1/4
5/16	0.813	3.000	1.437	0.375	3	-5/16
3/8	0.875	3.000	1.437	0.375	3	-3/8
1/2	1.000	3.500	1.717	0.500	3	-1/2
5/8	1.250	3.500	1.594	0.625	3	-5/8
3/4	1.500	4.000	1.969	0.750	3	-3/4

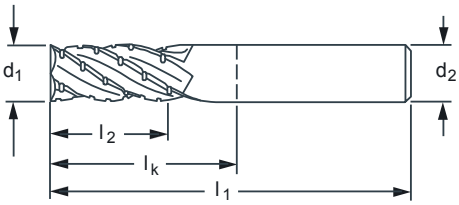
Protostar Ti NS 30

Characteristics



Application

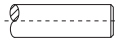




NEW

- Angular chip breaker profile for roughing and semi-finishing of Titanium and Titanium alloys. Suitable for use in other materials.
- **ACN** (Aluminum Chromium Nitride) has a high degree of hardness and heat resistance.
- See pages 14-15 for additional information on the PROTOSTAR Ti

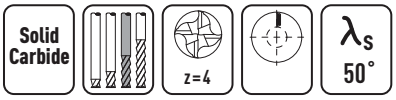
Standard



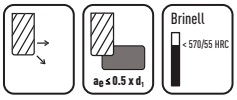
d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3083017 ACN
1/4	0.750	2.500	1.083	0.250	4	-1/4
5/16	0.813	2.500	0.937	0.375	4	-5/16
3/8	0.875	2.500	0.937	0.375	4	-3/8
7/16	1.000	3.500	1.717	0.500	4	-7/16
1/2	1.000	3.500	1.717	0.500	4	-1/2
5/8	1.250	3.500	1.594	0.625	4	-5/8
3/4	1.500	4.000	1.969	0.750	4	-3/4

Protostar Flash

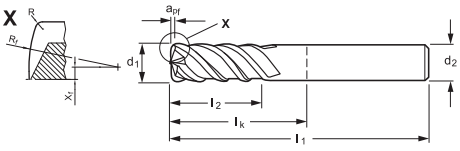
Characteristics



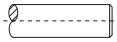
Application



- Special patented tool design for use in high feed applications. Provides maximum material removal rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 10-11 for additional information on the PROTOSTAR FLASH



Standard

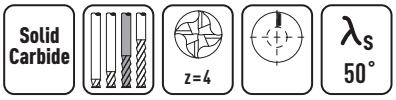


d_1 inch	a_{pf} inch	x_f inch	R_f inch	R_{ers} inch	R inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3094718 TAX
1/8	**0.006**	0.030	0.046	0.023	0.020	0.500	2.500	1.083	0.250	4	-1/8
3/16	**0.010**	0.039	0.098	0.028	0.020	0.625	2.500	1.083	0.250	4	-3/16
1/4	**0.014**	0.051	0.146	0.032	0.020	0.750	2.500	1.083	0.250	4	-1/4
5/16	**0.018**	0.059	0.165	0.054	0.040	0.813	3.000	1.437	0.375	4	-5/16
3/8	**0.024**	0.070	0.181	0.076	0.060	0.875	3.000	1.437	0.375	4	-3/8
7/16	**0.028**	0.079	0.224	0.081	0.060	1.000	3.500	1.717	0.500	4	-7/16
1/2	**0.033**	0.098	0.236	0.086	0.060	1.000	3.500	1.717	0.500	4	-1/2
5/8	**0.039**	0.118	0.315	0.110	0.080	1.250	3.500	1.594	0.625	4	-5/8
3/4	**0.047**	0.157	0.354	0.117	0.080	1.500	4.000	1.969	0.750	4	-3/4

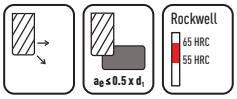
26

Protostar Flash

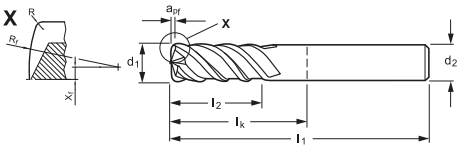
Characteristics



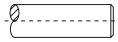
Application



- Special patented tool design for use in high feed applications. Maximum material removal in materials from 55HRC to 65HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 10-11 for additional information on the PROTOSTAR FLASH



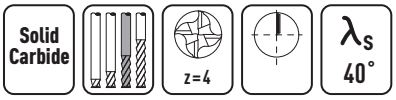
Standard



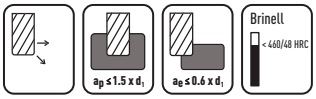
d_1 inch	a_{pf} inch	x_f inch	R_f inch	R_{ers} inch	R inch	l_2 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH3094728 TAX
1/8	0.004	0.020	0.102	0.023	0.020	0.500	2.500	1.083	0.250	4	-1/8
3/16	0.006	0.026	0.236	0.025	0.020	0.625	2.500	1.083	0.250	4	-3/16
1/4	0.008	0.028	0.394	0.028	0.020	0.750	2.500	1.083	0.250	4	-1/4
5/16	0.010	0.031	0.512	0.048	0.040	0.813	3.000	1.437	0.375	4	-5/16
3/8	0.012	0.035	0.630	0.067	0.060	0.875	2.500	0.937	0.375	4	-3/8
7/16	0.014	0.039	0.630	0.069	0.060	1.000	3.500	1.717	0.500	4	-7/16
1/2	0.016	0.047	0.827	0.073	0.060	1.000	3.500	1.717	0.500	4	-1/2
5/8	0.020	0.059	1.181	0.094	0.080	1.250	3.500	1.594	0.625	4	-5/8
3/4	0.024	0.075	1.181	0.102	0.080	1.500	4.000	1.969	0.750	4	-3/4

Protostar Qmax HR Kordel F 40

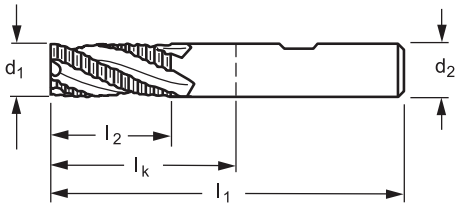
Characteristics



Application



- Roughing end mill with a radiused chip breaker profile that is suitable for a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



DIN 6527 L

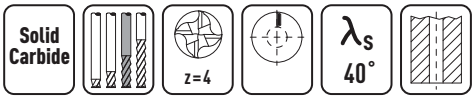
DIN 6535HB

d_1 h12 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3182378 TAX
5	13	57	21	6	4	-5
6	13	57	21	6	4	-6
8	19	63	27	8	4	-8
10	22	72	32	10	4	-10
12	26	83	38	12	4	-12
14	26	83	38	14	4	-14
16	32	92	44	16	4	-16
18	32	92	44	18	4	-18
20	38	104	54	20	4	-20

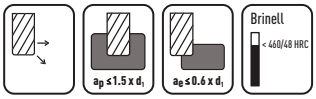
28

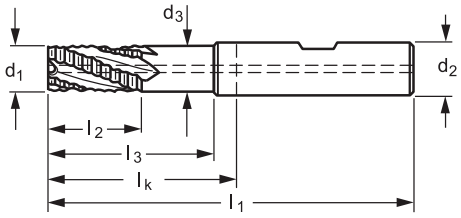
Protostar Qmax HR Kordel F 40

Characteristics



Application





- Roughing end mill with a radiused chip breaker profile that is suitable for a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- Axial coolant through for improved cooling and chip evacuation.
- Long effective length

DIN 6527 L

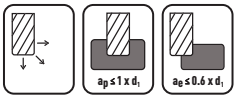
DIN 6535HB

d_1 h12 mm	l_2 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H4189378 TAX
5	13	16	4.75	57	21	6	4	-5
6	13	19	5.5	57	21	6	4	-6
7	16	26	6.5	63	27	8	4	-7
8	19	25	7.5	63	27	8	4	-8
9	19	31	8.5	72	32	10	4	-9
10	22	30	9.5	72	32	10	4	-10
11	26	35	10.45	83	38	12	4	-11
12	26	36	11.4	83	38	12	4	-12
13	26	35	12.35	83	38	14	4	-13
14	26	36	13.3	83	38	14	4	-14
15	32	41	14.25	92	44	16	4	-15
16	32	42	15.2	92	44	16	4	-16
18	32	42	17.1	92	44	18	4	-18
20	38	52	19	104	54	20	4	-20

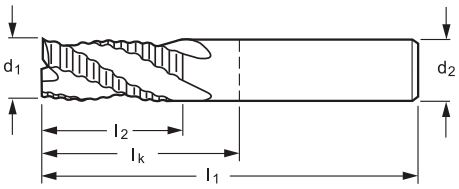
Protostar AL Kordel G 40

Characteristics

Application



- Roughing end mill with a radiused chip breaker profile for Aluminum and other non-ferrous materials.



DIN 6527 L

DIN 6535HA

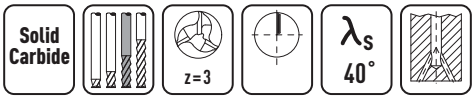
d_1 h12 mm	l_2 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H608411
6	13	57	21	6	3	-6
8	19	63	27	8	3	-8
10	22	72	32	10	3	-10
12	26	83	38	1) 12	3	-12
14	26	83	38	1) 14	3	-14
16	32	92	44	1) 16	3	-16
20	38	104	54	1) 20	3	-20

1) shank tolerance h6

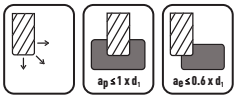
30

Protostar AL Kordel G 40

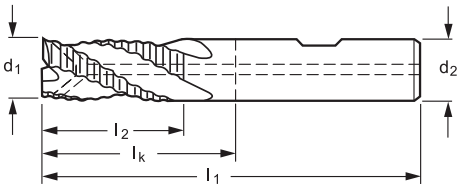
Characteristics



Application



- Roughing end mill with a radiused chip breaker profile for Aluminum and other non-ferrous materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- Radial coolant through for improved cooling and chip evacuation.



DIN 6527 L

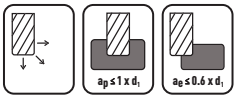
DIN 6535HB DIN 6535HB

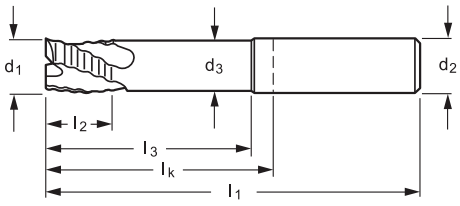
d_1 h12 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H618911	Code H6189118 TAX
6	13	57	21	6	3	-6	-6
8	19	63	27	8	3	-8	-8
10	22	72	32	10	3	-10	-10
12	26	83	38	12	3	-12	-12
14	26	83	38	14	3	-14	-14
16	32	92	44	16	3	-16	-16
20	38	104	54	20	3	-20	-20

Protostar AL Kordel G 40

Characteristics

Application





- Roughing end mill with a radiused chip breaker profile for Aluminum and other non-ferrous materials.
- **HDC** (Hard Carbon) is a mono-layer coating that is resistant to built up edge.
- Long effective length

P-Norm L

DIN 6535HA DIN 6535HA

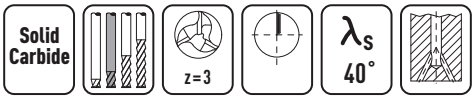
d_1 h12 mm	l_2 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H608771	Code H6087711 HDC
6	10	24	5.5	63	27	8	3	-6	-6
8	12	29	7.5	72	32	10	3	-8	-8
10	14	35	9.5	83	38	1) 12	3	-10	-10
12	16	50	11.4	100	55	1) 12	3	-12	-12
16	20	63	15.2	115	67	1) 16	3	-16	-16
20	20	70	19	125	75	1) 20	3	-20	-20
25	25	75	23.75	135	79	1) 25	3	-25	-25

1) shank tolerance h6

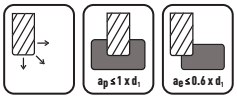
32

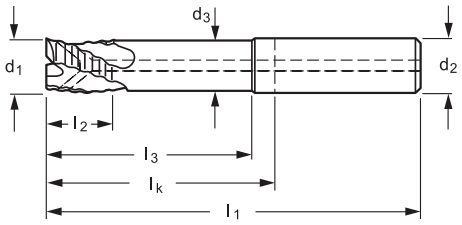
Protostar AL Kordel G 40

Characteristics



Application





- Roughing end mill with a radiused chip breaker profile for Aluminum and other non-ferrous materials.
- **HDC** (Hard Carbon) is a mono-layer coating that is resistant to built up edge.
- Radial coolant through for improved cooling and chip evacuation.
- Long effective length

P-Norm L

DIN 6535HA DIN 6535HA

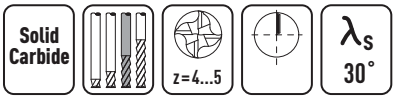
d_1 h12 mm	l_2 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H608871	Code H6088711 HDC
6	10	24	5.5	63	27	8	3	-6	-6
8	12	29	7.5	72	32	10	3	-8	-8
10	14	35	9.5	83	38	[1] 12	3	-10	-10
12	16	50	11.4	100	55	[1] 12	3	-12	-12
16	20	63	15.2	115	67	[1] 16	3	-16	-16
20	20	70	19	125	75	[1] 20	3	-20	-20
25	25	75	23.75	135	79	[1] 25	3	-25	-25

1) shank tolerance h6

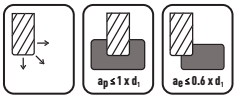
Protostar Ti NS 30

NEW

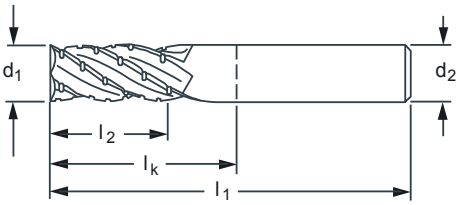
Characteristics



Application



- Angular chip breaker profile for roughing and semi-finishing of Titanium and Titanium alloys. Suitable for use in other materials.
- **ACN** (Aluminum Chromium Nitride) has a high degree of hardness and heat resistance.
- See pages 14-15 for additional information on the PROTOSTAR Ti



DIN 6527 L

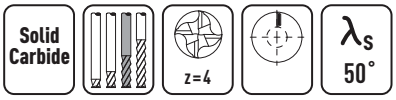
DIN 6535HA

d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3083017 ACN
6	13	57	21	6	4	-6
8	19	63	27	8	4	-8
10	22	72	32	10	4	-10
12	26	83	38	12	4	-12
14	26	83	38	14	4	-14
16	32	92	44	16	4	-16
18	32	92	44	18	4	-18
20	38	104	54	20	4	-20
25	45	121	65	25	5	-25

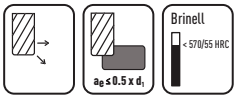
34

Protostar Flash

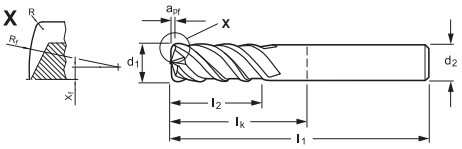
Characteristics



Application



- Special patented tool design for use in high feed applications. Provides maximum material removal rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 10-11 for additional information on the PROTOSTAR FLASH



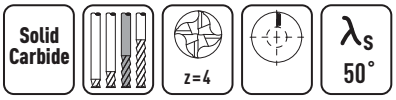
DIN 6527 L; P-Norm XL

DIN 6535HA DIN 6535HA

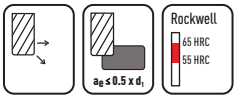
d_1 mm	a_{pf} mm	x_f mm	R_f mm	R_{ers} mm	R mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H309471	Code H3094718 TAX
4	0.2	0.8	2	0.673	0.5	11	57	21	6	4	-4	-4
5	0.25	1.1	2.5	0.714	0.5	13	57	21	6	4	-5	-5
6	0.3	1.4	3	0.755	0.5	15	57	21	6	4	-6	-6
6	0.2	1.4	3	0.755	0.5	15	100	64	6	4	-6-100	-6-100
8	0.5	1.54	4	1.38	1	20	63	27	8	4	-8	-8
8	0.25	1.54	4	1.38	1	20	120	84	8	4	-8-120	-8-120
10	0.7	1.70	5	1.99	1.5	26	72	32	10	4	-10	-10
10	0.3	1.70	5	1.99	1.5	26	150	110	10	4	-10-150	-10-150
12	0.8	2.25	6	2.1	1.5	30	83	38	12	4	-12	-12
16	1	3.1	8	2.747	2	36	92	44	16	4	-16	-16
20	1.3	4.0	10	3.072	2	45	104	54	20	4	-20	-20

Protostar Flash

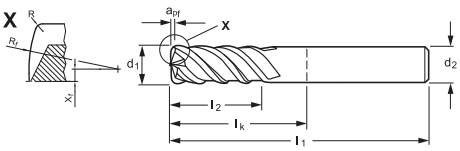
Characteristics



Application



- Special patented tool design for use in high feed applications. Maximum material removal in materials from 55HRC to 65HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 10-11 for additional information on the PROTOSTAR FLASH



DIN 6527 L

DIN 6535HA

d_1 mm	a_{pf} mm	x_f mm	R_f mm	R_{ers} mm	R mm	l_2 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H3094728 TAX
4	0.12	0.6	4	0.618	0.5	11	57	21	6	4	-4
5	0.15	0.7	6	0.656	0.5	13	57	21	6	4	-5
6	0.2	0.7	9	0.693	0.5	15	57	21	6	4	-6
8	0.25	0.78	12	1.226	1	20	63	27	8	4	-8
10	0.3	0.8	15	1.773	1.5	26	72	32	10	4	-10
12	0.4	1.0	18	1.875	1.5	30	83	38	12	4	-12
16	0.5	1.5	24	2.465	2	36	92	44	16	4	-16
20	0.65	2.2	30	2.607	2	45	104	54	20	4	-20

Application guide - Roughers

Speed and Feed Chart: The speeds and feeds in this table are intended for intial setup. These values are a guide, depending on machining conditions, these parameters may need to be adjusted up or down until optimum settings are found.

How to use this chart:

1. Pick your material group*
2. Move across to mill series
3. Read SFM and Feed Chart (FC) Letter
4. Go to the Feed Charts on pages 38-39 and convert to feed per tooth
5. Calculate Speed and Feed using formulas on page 38

* Example materials can be found in the Material Library on page 188-189 of the Technical Information section

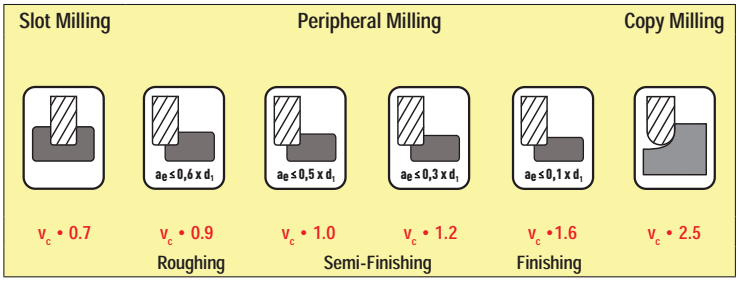
				Type							
				Length inch	Standard		Standard		Standard		Standard	
				Length metric	DIN 6527 L		DIN 6527 L		DIN 6527 L		DIN 6527 L	
				Helix	40°		40°		40°		40°	
				No. of flutes	4		4		3		3	
				Surface treatment	TAX		TAX		Bright		Bright	
							 Axial				 Radial	
				Remarks					Aluminum alloys			
				INCH Range	(1/4...3/4)		(1/4...3/4)		(1/4...5/8)		(1/4...5/8)	
				INCH **Catalog No.**	**AH3182378**		**AH4189378**		**AH608411**		**AH618911**	
				INCH Catalog Page	20		21		22		23	
				METRIC Range	(5...20)		(5...20)		(6...20)		(6...20)	
				METRIC **Catalog No.**	**H3182378**		**H4189378**		**H608411**		**H618911**	
				METRIC Catalog Page	27		28		28		30	
ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Hardness		SFM	FC	SFM	FC	SFM	FC	SFM	FC
P	**Steel**											
	1.1	Magnetic soft steel	61 - 120 HB		690	A	655	A				
	1.2	Structural steel, case carburizing steel	101 - 200 HB		690	A	655	A				
	1.3	Plain carbon steel	100 - 250 HB		655	A	625	A				
	1.4	Alloy steel	150 - 250 HB		575	A	560	A				
	1.5	Alloy steel, Tempered steel	26 - 38 HRc		410	A	395	A				
	1.6.1	Alloy steel, Tempered steel	39 - 44 HRc				330	A				
	1.6.2	Alloy steel, Tempered steel	44 - 49 HRc				260	B				
M	**Stainless Steel**											
	2.1	Free machining stainless steel	120 - 250 HB		295	B	295	B				
	2.2	Austinetic	130 - 250 HB		245	B	230	B				
	2.3	Ferritic, austenitic, martensitic	130 - 320 HB		195	B	195	B				
	2.4	High tensile chrome-nickel alloys	33 - 44 HRc				130	B				
K	**Cast Iron**											
	3.1	Cast Iron	50 - 150 HB		540	A	510	A				
	3.2	Cast Iron	150 - 300 HB		460	A	425	A				
	3.3	Ductile Iron	150 - 200 HB		540	A	510	A				
	3.4	Ductile Iron	14 - 32 HRc		410	A	395	A				
	3.5	Compacted graphite iron	14 - 32 HRc		360	A	330	A				
N	**Non-ferrous Materials**											
	6.1	Copper, unalloyed	80 - 100 HB		1050	C	985	C	740	C	740	C
	6.2	Short chip brass	100 - 200 HB		1050	C	985	C	785	C	740	C
	6.3	Long chip brass	120 - 200 HB		1050	C	985	C	740	C	740	C
	6.4	Cu-Al-Fe alloys	200 - 440 HB		215	C	195	C				
	6.5	Cu-Al-Ni alloys (short chipping)	120 - 250 HB		360	C	360	C	280	C	260	C
	6.6	Cu-Al-Ni alloys (long chipping)	120 - 250 HB		360	C	360	C	280	C	260	C
	7.1	Al, Mg unalloyed	60 - 100 HB						5280	C	4920	C
	7.2	Al, alloyed Si<0.5%	90 - 180 HB						5660	C	4920	C
	7.3.1	Al, alloyed Si>=0.5%<4%	90 - 180 HB						3445	C	3085	C
	7.3.2	Al, alloyed Si>=4%<12%	90 - 180 HB		1445	C	1380	C	1310	C	1245	C
	7.4	Al, alloyed Si>=12%	90 - 180 HB		490	C	490	C	490	C	490	C
	7.5.1	Magnesium Standard alloy	120 - 300 N/mm²		1675	C	1575	C	1310	C	1575	C
	7.5.2	Magnesium -high tensile strength	70 - 120 HB		1460	C	1380	C	1050	C	985	C
	7.5.3	Heat resistant magnesium alloys	120 - 300 N/mm²		1245	C	1180	C	740	C	740	C
S	**High Temp Alloys and Titanium Alloys**											
	4.1	Titanium, unalloyed	120 - 200 HB				395	A	330	A	295	A
	4.2	Titanium, alloyed	14 - 28 HRc				195	A				
	4.3	Titanium, alloyed	28 - 44 HRc				165	A				
	5.1	Nickel, unalloyed	120 - 150 HB						260	A	230	A
	5.2	Nickel, alloyed	150 - 270 HB				165	B				
	5.3	Nickel, alloyed	28 - 49 HRc				100	B				
	9.1	TIC Hard materials	48 - 51 HRc		35	B	35	B				
	9.2	Tungsten alloys	44 - 52 HRc		230	B	195	B				
	9.3	Alloys on Cobalt base	150 - 350 HB		100	B	100	B				
	9.4	Molybdenum alloyed	150 - 350 HB		215	B	195	B				
H	**Hardened Materials**											
	1.7.1	Steel (hardened), short chipping	49 - 55 HRc									
	1.7.2	Steel (hardened), long chipping	49 - 55 HRc									
	1.8.1	Steel (hardened)	55 - 60 HRc									
	1.8.2	Steel (hardened)	60 - 65 HRc									
O	**Synthetic Materials / Others**											
	8.1	Thermoplastics	<50 N/mm²								625	C
	8.2	Thermosetting plastics	<80 N/mm²		590	C	560	C			460	C
	8.3	Reinforced plastic materials	240 - 440 N/mm²		260	C	260	C			165	C
	10.1	Standard graphite	<100 N/mm²		855	C	920	C	855	C	855	C
	10.2	Wear resistant graphite	<100 N/mm²		855	C	920	C	855	C	855	C

	AL Kordel G 40					Ti NS 30	Flash		
						Standard		Standard	Standard
	DIN 6527 L	P-Norm L	P-Norm L	P-Norm L	P-Norm L	DIN 6527 L	DIN 6527 L, P-Norm XL		DIN 6527 L
	40°	40°	40°	40°	40°	30°	50°	50°	50°
	3	3	3	3	3	4-5	4	4	4
	TAX	Bright	HDC	Bright	HDC	ACN	Bright	TAX	TAX
	 Radial			 Radial	 Radial				
	Aluminum alloys					Titanium alloys	Hi-Feed		Hard Machining
						(1/4...5/8)		(1/8...3/4)	(1/8...3/4)
						AH3083017		**AH3094718**	**AH3094728**
						24		25	26
	(6...20)	(6...25)	(6...25)	(6...25)	(6...25)	(6...25)	(4...20)	(4...20)	(4...20)
	H6189118	**H608771**	**H6087711**	**H608871**	**H6088711**	**H3083017**	**H309471**	**H3094718**	**H3094728**
	30	31	31	32	32	33	34	34	35
	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC
								625 D	
								625 D	
								510 D	
								510 D	
								425 D	
						330 A		330 D	
						230 B		295 D	
								330 D	
								260 D	
								195 D	
								165 D	
						525 A	260 D	575 D	
						460 A	230 D	510 D	
						525 A	260 D	575 D	
						425 A	230 D	460 D	
						360 A	165 D	395 D	
	1410 C	770 C		770 C			820 D	1610 D	
	1410 C	770 C		770 C			820 D	1610 D	
	1410 C	770 C		770 C			820 D	1610 D	
						195 C	130 D	230 D	
	490 C	295 C		260 C		360 C	295 D	560 D	
	490 C	260 C		260 C		360 C	295 D	560 D	
	4920 C	5120 C	7940 C	5120 C	9775 C		2495 D	2495 D	
	5280 C	5710 C	7940 C	5120 C	7940 C		2495 D	2495 D	
	5085 C	3430 C	7120 C	3200 C	6400 C		2495 D	2495 D	
	1970 C	1280 C	3280 C	1280 C	3050 C		1380 D	2200 D	
	690 C	525 C	1085 C	510 C	1015 C	490 C	560 D	1280 D	
	2265 C	1280 C	2560 C	1280 C	2560 C		1380 D	2495 D	
	1985 C	1015 C	2725 C	1015 C	2560 C		1115 D	2230 D	
	1705 C	755 C	2560 C	770 C	2560 C		820 D	1905 D	
	560 A	310 A	360 A	310 A					
						330 A			
						245 A			
	425 A	245 A	280 A	245 A					
						165 B			
						100 B			
						35 B		35 D	
						230 B			
						100 B			
						195 B			
								260 D	
								260 D	
									360 D
									195 D
	1410 C		1280 C	655 C	1280 C		560 D	1280 D	
	705 C		655 C	490 C	655 C	590 C	425 D	625 D	
	330 C		165 C	165 C	165 C	260 C	130 D	295 D	
	920 C	855 C	1150 C	855 C	1150 C				
	920 C	855 C	1150 C	855 C	1150 C				

Values

Description	Unit Inch	Unit Metric
Revolutions per minute	min^{-1}	min^{-1}
Cutting Speed	v_c [ft/min]	v_c [m/min]
Feed rate	v_f [inch/min]	v_f [mm/min]
Cutting diameter	d_1 [inch]	d_1 [mm]
Feed per tooth	f_z [inch]	f_z [mm]
Number of teeth	z	z
Axial depth of cut	a_p [inch]	a_p [mm]
Radial width of cut	a_e [inch]	a_e [mm]

Cutting speed factors



Conversions

To m/min from SFM

v_c [m/min] = v_c [ft/min] • 0.3048

To mm from inch

[mm] = [inch] • 25.4

Calculations

RPM with SFM and cutter diameter

$min^{-1} = (v_c$ [ft/min] • 3.82) / d_1 [inch]

RPM with m/min and cutter diameter

$min^{-1} = (v_c$ [m/min] • 1000) / (3.14 • d_1 [mm])

IPM with FPT, number of teeth and RPM

v_f [inch/min] = (f_z [inch] • z • min^{-1})

mm/min with FPT, number of teeth and RPM

v_f [mm/min] = (f_z [mm] • z • min^{-1})

A

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0008	0.0008	0.0012	0.0024	0.0035	0.0047	0.0059	0.0059	0.0079						
0.0020	0.0006	0.0006	0.0010	0.0016	0.0028	0.0039	0.0047	0.0059	0.0079						
0.0040	0.0004	0.0005	0.0008	0.0014	0.0020	0.0031	0.0039	0.0059	0.0079	0.0079	0.0079	0.0079			
0.0080	0.0004	0.0004	0.0006	0.0012	0.0016	0.0024	0.0031	0.0059	0.0071	0.0079	0.0079	0.0079	0.0079	0.0098	
1/64"		0.0004	0.0005	0.0010	0.0012	0.0020	0.0028	0.0047	0.0059	0.0059	0.0059	0.0059	0.0079	0.0098	0.0098
1/32"			0.0004	0.0010	0.0012	0.0016	0.0024	0.0035	0.0047	0.0047	0.0047	0.0047	0.0059	0.0079	0.0098
1/16"				0.0008	0.0012	0.0012	0.0020	0.0031	0.0043	0.0047	0.0047	0.0047	0.0059	0.0079	0.0079
1/8"					0.0008	0.0010	0.0018	0.0030	0.0041	0.0047	0.0047	0.0047	0.0053	0.0069	0.0079
3/16"						0.0008	0.0016	0.0028	0.0039	0.0047	0.0047	0.0047	0.0047	0.0059	0.0079
1/4"							0.0012	0.0024	0.0031	0.0039	0.0039	0.0047	0.0047	0.0059	0.0079
5/16"								0.0020	0.0028	0.0035	0.0039	0.0047	0.0047	0.0059	0.0079
3/8"									0.0024	0.0031	0.0039	0.0047	0.0047	0.0055	0.0063
1/2"										0.0028	0.0035	0.0043	0.0047	0.0055	0.0063
9/16"											0.0031	0.0039	0.0047	0.0051	0.0059
5/8"												0.0035	0.0039	0.0047	0.0059
11/16"													0.0039	0.0043	0.0051
3/4"														0.0039	0.0047
1"															0.0039

B

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0006	0.0006	0.0012	0.0020	0.0031	0.0039	0.0047	0.0047	0.0063						
0.0020	0.0005	0.0005	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047	0.0063						
0.0040	0.0003	0.0004	0.0006	0.0012	0.0016	0.0024	0.0031	0.0047	0.0063	0.0063	0.0063	0.0063			
0.0080	0.0003	0.0003	0.0005	0.0010	0.0014	0.0020	0.0024	0.0047	0.0055	0.0063	0.0063	0.0063	0.0063	0.0079	
1/64"		0.0003	0.0004	0.0008	0.0010	0.0016	0.0024	0.0039	0.0047	0.0047	0.0047	0.0047	0.0063	0.0079	0.0079
1/32"			0.0004	0.0008	0.0010	0.0012	0.0019	0.0031	0.0039	0.0039	0.0039	0.0039	0.0047	0.0063	0.0079
1/16"				0.0006	0.0008	0.0010	0.0020	0.0028	0.0035	0.0039	0.0039	0.0039	0.0047	0.0063	0.0063
1/8"					0.0006	0.0009	0.0018	0.0026	0.0033	0.0039	0.0039	0.0039	0.0043	0.0055	0.0063
3/16"						0.0008	0.0016	0.0024	0.0031	0.0039	0.0039	0.0039	0.0039	0.0047	0.0063
1/4"							0.0012	0.0020	0.0028	0.0031	0.0031	0.0039	0.0039	0.0047	0.0063
5/16"								0.0016	0.0024	0.0031	0.0031	0.0039	0.0039	0.0047	0.0063
3/8"									0.0020	0.0028	0.0031	0.0039	0.0039	0.0047	0.0055
1/2"										0.0024	0.0028	0.0035	0.0039	0.0047	0.0055
9/16"											0.0028	0.0031	0.0039	0.0047	0.0055
5/8"												0.0028	0.0031	0.0039	0.0047
11/16"													0.0031	0.0039	0.0047
3/4"														0.0031	0.0039
1"															0.0039

C

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0014	0.0016	0.0024	0.0039	0.0063	0.0079	0.0098	0.0098	0.0098						
0.0020	0.0012	0.0012	0.0020	0.0031	0.0047	0.0071	0.0079	0.0098	0.0098						
0.0040	0.0008	0.0010	0.0016	0.0024	0.0039	0.0055	0.0071	0.0098	0.0098	0.0098	0.0098	0.0098			
0.0080	0.0008	0.0008	0.0012	0.0020	0.0031	0.0039	0.0055	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	
1/64"		0.0008	0.0008	0.0020	0.0024	0.0035	0.0047	0.0079	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098
1/32"			0.0006	0.0020	0.0024	0.0028	0.0039	0.0063	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098	0.0098
1/16"				0.0016	0.0020	0.0024	0.0031	0.0055	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098	0.0098
1/8"					0.0016	0.0020	0.0030	0.0051	0.0087	0.0087	0.0087	0.0087	0.0093	0.0098	0.0098
3/16"						0.0016	0.0028	0.0047	0.0087	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098
1/4"							0.0020	0.0039	0.0055	0.0071	0.0079	0.0087	0.0087	0.0098	0.0098
5/16"								0.0035	0.0047	0.0063	0.0079	0.0087	0.0087	0.0098	0.0098
3/8"									0.0039	0.0055	0.0071	0.0087	0.0087	0.0098	0.0098
1/2"										0.0047	0.0063	0.0079	0.0087	0.0098	0.0098
9/16"											0.0055	0.0071	0.0087	0.0098	0.0098
5/8"												0.0063	0.0071	0.0087	0.0098
11/16"													0.0071	0.0079	0.0098
3/4"														0.0071	0.0079
1"															0.0079

D

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]									
	Ø 1/8"	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm
1/32"	0.0028	0.0039								
1/16"	0.0028	0.0039	0.0063	0.0098						
1/8"	0.0028	0.0039	0.0063	0.0098						
3/16"		0.0039	0.0063	0.0098	0.0118	0.0138	0.0000	0.0000	0.0000	0.0000
1/4"			0.0063	0.0098	0.0118	0.0138	0.0157	0.0197	0.0000	0.0000
5/16"				0.0098	0.0118	0.0138	0.0157	0.0197	0.0236	0.0276
3/8"					0.0118	0.0138	0.0157	0.0197	0.0236	0.0276
1/2"							0.0157	0.0197	0.0236	0.0276
9/16"							0.0157	0.0197	0.0236	0.0276
5/8"								0.0197	0.0236	0.0276
11/16"									0.0236	0.0276
3/4"										0.0276

Solid Carbide Square End

Inch Range

Type	30		N 30								
Length	Standard		Stub		Standard			Stub		Standard	
Helix	30°	30°	30°	30°	30°	30°	30°	30°	30°	30°	30°
No. of flutes	2	2	3	3	3	3	3	4	4	4	4
Surface treatment	Bright	TAX	Bright	TAX	Bright	TAX	DIA	Bright	TAX	Bright	TAX
											
Range	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)
Remarks							Graphite machining				
Catalog no.	**AH302611**	**AH3026118**	**AH302701**	**AH3027018**	**AH302711**	**AH3027118**	**AH3027419**	**AH302201**	**AH3022018**	**AH302211**	**AH3022118**
Catalog page	46	46	47	47	48	48	49	50	50	51	51

Metric Range

Type	30			N 30			Tough Guys N 50			
Length	DIN 6527 L		P-Norm L	DIN 6527 K	DIN 6527 L	DIN 6527 L	DIN 6527 L			
Helix	30°	30°	30°	30°	30°	30°	50°	50°	50°	50°
No. of flutes	2	2	3	4	4	4	4	4	4	4
Surface treatment	Bright	TAX	DIA	TAX	Bright	TAX	TAX	TAX	TAX	TAX
										
Range	(2...20)	(2...20)	(1...16)	(2...20)	(2...20)	(2...20)	(6...16)	(6...25)	(6...20)	(6...20)
Remarks			Graphite machining							
Catalog no.	**H302611**	**H3026118**	**H3027419**	**H3022018**	**H302211**	**H3022118**	**H4121217**	**H3121317**	**H4021017**	**H4121017**
Catalog page	63	63	64	65	66	66	67	68	69	69

Solid Carbide Square End

Inch Range

Type	Tough Guys N 50			Compact N 45	N 45		N 50	AL 25	AL 45		Tough Guys H 50
Length	Standard		Long	Stub	Long	Extra-Long	Standard	Extra-Long	Standard	Long	Standard
Helix	50°	50°	50°	45°	45°	45°	50°	25°	45°	45°	50°
No. of flutes	3-4	3-4	3-4	4	4-5	4-5	4-8	2	2	2	3-4
Surface treatment	TAX	TAX	TAX	TAX	TAX	TAX	TAX	Bright	Bright	Bright	TAX
											
Range	(1/8...3/4)	(1/8...3/4)	(1/8...3/4)	(1/8...1/2)	(1/4...3/4)	(1/4...3/4)	(1/8...3/4)	(1/8...5/8)	(1/16...5/8)	(1/8...5/8)	(1/8...3/4)
Remarks								Aluminum alloys	Aluminum alloys		Hard machining
Catalog no.	**AH4121217**	**AH3121317**	**AH4021117**	**AH3014118**	**AH3023418**	**AH3023518**	**AH3021138**	**AH602681**	**AH602511**	**AH602551**	**AH3071118**
Catalog page	52	53	54	55	56	56	57	58	59	60	61

Metric Range

Type	Tough Guys N 50		Compact N 45							
Length	P-Norm L		P-Norm S		DIN 6527 K		P-Norm S		DIN 6527 K	
Helix	50°	50°	45°	45°	45°	45°	45°	45°	45°	45°
No. of flutes	3-4	4	3	3	3	3	4	4	4	4
Surface treatment	TAX	TAX	Bright	TAX	Bright	TAX	Bright	TAX	Bright	TAX
										
Range	(2...20)	(4...20)	(2...12)	(2...12)	(2...12)	(2...12)	(2...12)	(2...12)	(2...12)	(2...12)
Remarks										
Catalog no.	**H3021117**	**H4021117**	**H301301**	**H3013018**	**H301311**	**H3013118**	**H301401**	**H3014018**	**H301411**	**H3014118**
Catalog page	70	71	72	72	72	72	73	73	73	73

Solid Carbide Square End

Inch Range

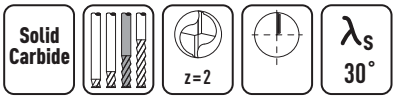
Type	Ultra H 50
Length	Long
Helix	50°
No. of flutes	4-8
Surface treatment	TAX
	
Range	(1/8...3/4)
Remarks	Hard machining
Catalog no.	**AH8083128**
Catalog page	62

Metric Range

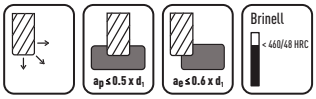
Type	N 45		N 50	N 60	AL 25	AL 45		Tough Guys H 50	Ultra H 50
Length	P-Norm XL		DIN 6527 L	DIN 6527 L	P-Norm L	DIN 6527 L	P-Norm L	P-Norm L	DIN 6527 L, P-Norm L
Helix	45°	45°	50°	60°	25°	45°	45°	50°	50°
No. of flutes	4-5	4-8	4-8	6	2	2	2	3-4	4-8
Surface treatment	TAX	TAX	TAX	TAX	Bright	Bright	Bright	TAX	TAX
									
Range	(6...20)	(4...25)	(3...25)	(6...20)	(2...20)	(1...20)	(6...20)	(2...20)	(3...25)
Remarks					Aluminum alloys	Aluminum alloys		Hard machining	Hard machining
Catalog no.	**H3023418**	**H3023518**	**H3021138**	**H3024148**	**H602681**	**H602511**	**H602551**	**H3071118**	**H8083128**
Catalog page	74	74	75	76	77	78	79	80	81

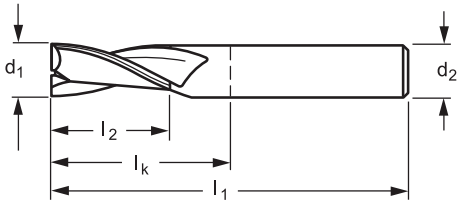
Protostar 30

Characteristics



Application





- All-purpose end mill suitable for use in a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

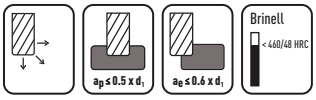
Standard

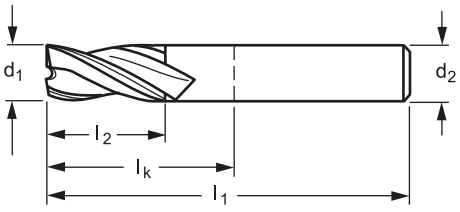
d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH302611	Code AH3026118 TAX
1/16	0.188	2.000	0.583	0.250	2	-1/16	-1/16
3/32	0.375	2.000	0.583	0.250	2	-3/32	-3/32
1/8	0.500	2.500	1.083	0.250	2	-1/8	-1/8
3/16	0.625	2.500	1.083	0.250	2	-3/16	-3/16
1/4	0.750	2.500	1.083	0.250	2	-1/4	-1/4
5/16	0.813	3.000	1.437	0.375	2	-5/16	-5/16
3/8	0.875	3.000	1.437	0.375	2	-3/8	-3/8
7/16	1.000	3.500	1.717	0.500	2	-7/16	-7/16
1/2	1.000	3.500	1.717	0.500	2	-1/2	-1/2
5/8	1.250	3.500	1.594	0.625	2	-5/8	-5/8
3/4	1.500	4.000	1.969	0.750	2	-3/4	-3/4

Protostar N 30

Characteristics

Application





- All-purpose end mill suitable for slot, profile and pocket milling.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

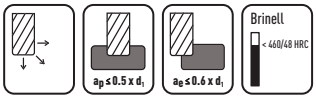
Stub

d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH302701	Code AH3027018 TAX
1/16	0.125	2.000	0.583	0.250	3	-1/16	-1/16
3/32	0.188	2.000	0.583	0.250	3	-3/32	-3/32
1/8	0.250	2.500	1.083	0.250	3	-1/8	-1/8
3/16	0.375	2.500	1.083	0.250	3	-3/16	-3/16
1/4	0.500	2.500	1.083	0.250	3	-1/4	-1/4
5/16	0.500	2.500	0.937	0.375	3	-5/16	-5/16
3/8	0.563	2.500	0.937	0.375	3	-3/8	-3/8
7/16	0.625	3.000	1.717	0.500	3	-7/16	-7/16
1/2	0.625	3.000	1.717	0.500	3	-1/2	-1/2
5/8	0.875	3.000	1.094	0.625	3	-5/8	-5/8
3/4	1.000	3.500	1.469	0.750	3	-3/4	-3/4

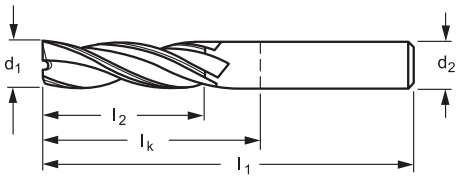
Protostar N 30

Characteristics

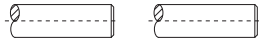
Application



- All-purpose end mill suitable for slot, profile and pocket milling.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



Standard

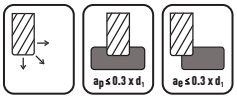


d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH302711	Code AH3027118 TAX
1/16	0.188	2.000	0.583	0.250	3	-1/16	-1/16
3/32	0.375	2.000	0.583	0.250	3	-3/32	-3/32
1/8	0.500	2.500	1.083	0.250	3	-1/8	-1/8
3/16	0.625	2.500	1.083	0.250	3	-3/16	-3/16
1/4	0.750	2.500	1.083	0.250	3	-1/4	-1/4
5/16	0.813	3.000	1.437	0.375	3	-5/16	-5/16
3/8	0.875	3.000	1.437	0.375	3	-3/8	-3/8
7/16	1.000	3.500	1.717	0.500	3	-7/16	-7/16
1/2	1.000	3.500	1.717	0.500	3	-1/2	-1/2
5/8	1.250	3.500	1.594	0.625	3	-5/8	-5/8
3/4	1.500	4.000	1.969	0.750	3	-3/4	-3/4

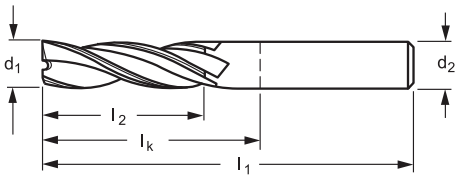
Protostar N 30

Characteristics

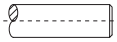
Application



- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.



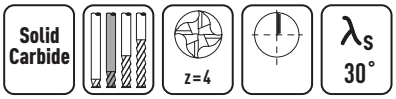
Standard



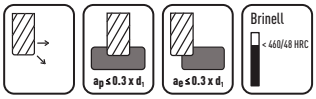
d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3027419 DIA
1/16	0.188	2.000	0.583	0.250	3	-1/16
3/32	0.375	2.000	0.583	0.250	3	-3/32
1/8	0.500	2.500	1.083	0.250	3	-1/8
3/16	0.625	2.500	1.083	0.250	3	-3/16
1/4	0.750	2.500	1.083	0.250	3	-1/4
5/16	0.813	3.000	1.437	0.375	3	-5/16
3/8	0.875	3.000	1.437	0.375	3	-3/8
7/16	1.000	3.500	1.717	0.500	3	-7/16
1/2	1.000	3.500	1.717	0.500	3	-1/2

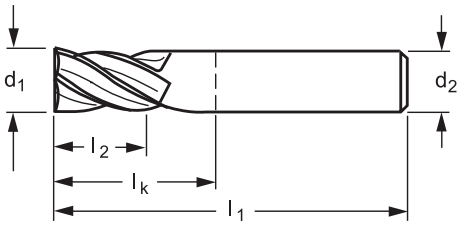
Protostar N 30

Characteristics



Application





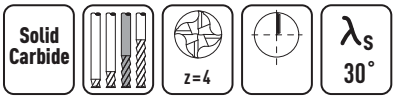
- All-purpose end mill suitable for slot, profile and pocket milling.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Stub

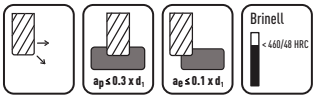
d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH302201	Code AH3022018 TAX
1/16	0.125	2.000	0.583	0.250	4	-1/16	-1/16
3/32	0.188	2.000	0.583	0.250	4	-3/32	-3/32
1/8	0.250	2.500	1.083	0.250	4	-1/8	-1/8
3/16	0.375	2.500	1.083	0.250	4	-3/16	-3/16
1/4	0.500	2.500	1.083	0.250	4	-1/4	-1/4
5/16	0.500	2.500	0.937	0.375	4	-5/16	-5/16
3/8	0.563	2.500	0.937	0.375	4	-3/8	-3/8
7/16	0.625	3.000	1.217	0.500	4	-7/16	-7/16
1/2	0.625	3.000	1.217	0.500	4	-1/2	-1/2
5/8	0.875	3.000	1.094	0.625	4	-5/8	-5/8
3/4	1.000	3.500	0.969	0.750	4	-3/4	-3/4

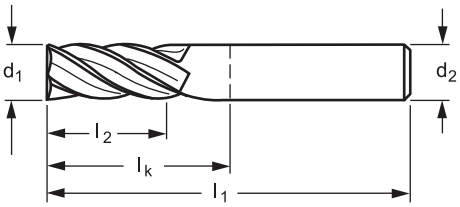
Protostar N 30

Characteristics



Application





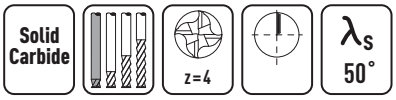
- All-purpose end mill suitable for slot, profile and pocket milling.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Standard

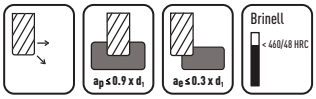
d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH302211	Code AH3022118 TAX
1/16	0.188	2.000	0.583	0.250	4	-1/16	-1/16
3/32	0.375	2.500	1.083	0.250	4	-3/32	-3/32
1/8	0.500	2.500	1.083	0.250	4	-1/8	-1/8
3/16	0.625	2.500	1.083	0.250	4	-3/16	-3/16
1/4	0.750	2.500	1.083	0.250	4	-1/4	-1/4
5/16	0.813	3.000	1.437	0.375	4	-5/16	-5/16
3/8	0.875	3.000	1.437	0.375	4	-3/8	-3/8
7/16	1.000	3.500	1.717	0.500	4	-7/16	-7/16
1/2	1.000	3.500	1.717	0.500	4	-1/2	-1/2
5/8	1.250	3.500	1.594	0.625	4	-5/8	-5/8
3/4	1.500	4.000	1.969	0.750	4	-3/4	-3/4

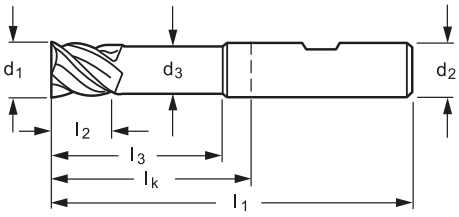
Protostar Tough Guys N 50

Characteristics



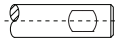
Application





- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys

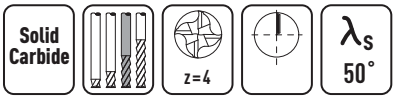
Standard



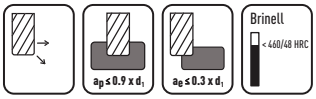
d_1 h10 inch	l_2 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH4121217 TAX
1/4	0.250	0.875	0.237	3.000	1.437	0.375	4	-1/4
5/16	0.313	1.000	0.297	3.000	1.437	0.375	4	-5/16
3/8	0.375	1.000	0.356	3.000	1.437	0.375	4	-3/8
7/16	0.438	1.125	0.416	3.000	1.217	0.500	4	-7/16
1/2	0.500	1.375	0.475	3.500	1.717	0.500	4	-1/2
5/8	0.625	1.500	0.594	3.500	1.594	0.625	4	-5/8
3/4	0.750	2.000	0.713	4.250	2.219	0.750	4	-3/4

Protostar Tough Guys N 50

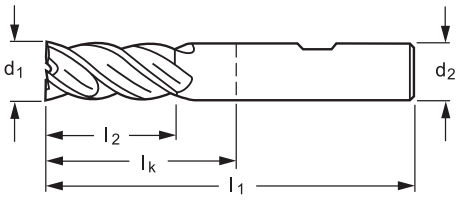
Characteristics



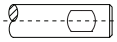
Application



- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



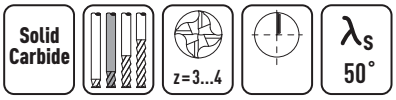
Standard



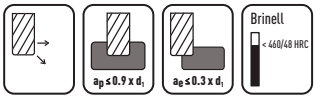
d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3121317 TAX
1/4	0.750	3.000	1.437	0.375	4	-1/4
5/16	0.813	3.000	1.437	0.375	4	-5/16
3/8	0.875	3.000	1.437	0.375	4	-3/8
7/16	1.000	3.500	1.717	0.500	4	-7/16
1/2	1.000	3.500	1.717	0.500	4	-1/2
5/8	1.250	3.500	1.594	0.625	4	-5/8
3/4	1.500	4.000	1.969	0.750	4	-3/4

Protostar Tough Guys N 50

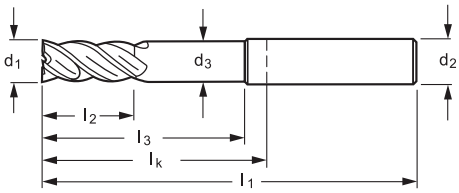
Characteristics



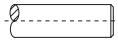
Application



- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



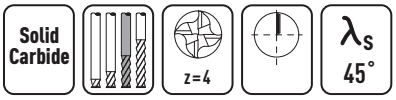
Long



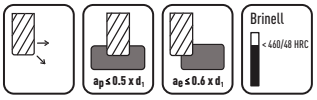
d_1 h10 inch	l_2 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH4021117 TAX
1/8	0.500	1.188	0.119	3.000	1.583	0.250	3	-1/8
3/16	0.625	1.125	0.178	3.000	1.583	0.250	3	-3/16
1/4	0.750	1.375	0.237	3.000	1.583	0.250	4	-1/4
5/16	0.813	1.500	0.297	3.250	1.687	0.375	4	-5/16
3/8	0.875	1.500	0.356	3.250	1.687	0.375	4	-3/8
7/16	1.000	2.875	0.416	4.750	2.967	0.500	4	-7/16
1/2	1.000	2.875	0.475	4.750	2.967	0.500	4	-1/2
5/8	1.250	3.000	0.594	5.000	3.094	0.625	4	-5/8
3/4	1.500	3.000	0.713	5.250	3.219	0.750	4	-3/4

Protostar Compact N 45

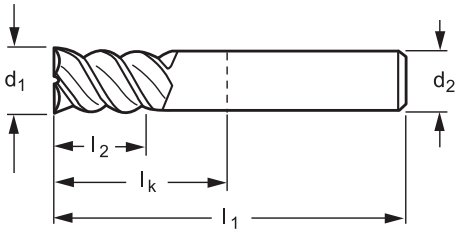
Characteristics



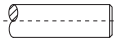
Application



- An economic solution for use in a wide variety of materials
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



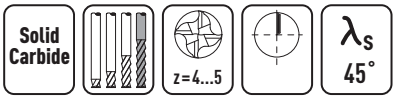
Stub



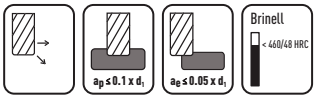
d_1 h11 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3014118 TAX
1/8	0.250	2.500	1.083	0.250	4	-1/8
3/16	0.375	2.500	1.083	0.250	4	-3/16
1/4	0.500	2.500	1.083	0.250	4	-1/4
5/16	0.500	2.500	0.937	0.375	4	-5/16
3/8	0.563	2.500	0.937	0.375	4	-3/8
7/16	0.625	3.000	1.217	0.500	4	-7/16
1/2	0.625	3.000	1.217	0.500	4	-1/2

Protostar N 45

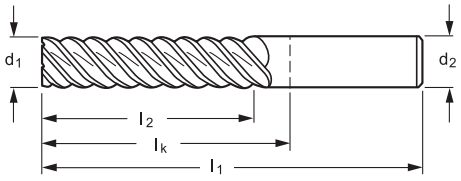
Characteristics



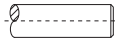
Application



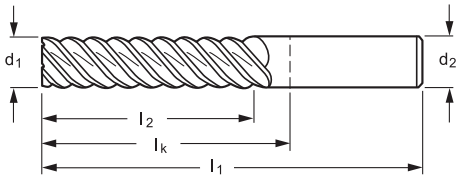
- All-purpose end mill suitable for slot, profile and pocket milling. An excellent choice for finishing operations.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



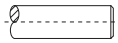
Long



d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3023418 TAX
1/4	1.125	3.000	1.583	0.250	4	-1/4
5/16	1.125	3.000	1.437	0.375	4	-5/16
3/8	1.125	3.000	1.437	0.375	4	-3/8
1/2	2.000	4.500	2.717	0.500	4	-1/2
5/8	2.250	5.000	3.094	0.625	5	-5/8
3/4	2.250	5.000	2.969	0.750	5	-3/4



Extra-Long

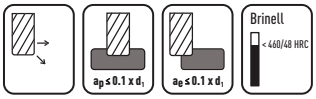


d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3023518 TAX
1/4	1.500	4.000	2.583	0.250	4	-1/4X1.500
5/16	1.625	4.000	2.437	0.375	4	-5/16X1.625
3/8	1.750	4.000	2.437	0.375	4	-3/8X1.750
1/2	3.000	6.000	4.217	0.500	4	-1/2X3.000
5/8	3.000	6.000	4.094	0.625	5	-5/8X3.000
3/4	3.000	6.000	3.969	0.750	5	-3/4X3.000

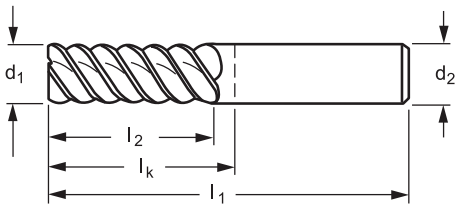
Protostar N 50

Characteristics

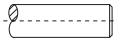
Application



- High helix end mill designed for finishing operations where high quality surface finishes are required.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



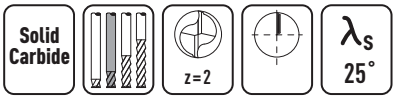
Standard



d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3021138 TAX
1/8	0.500	2.500	1.083	0.250	4	-1/8
3/16	0.625	2.500	1.083	0.250	5	-3/16
1/4	0.750	2.500	1.083	0.250	6	-1/4
5/16	0.813	3.000	1.437	0.375	6	-5/16
3/8	0.875	3.000	1.437	0.375	6	-3/8
7/16	1.000	3.500	1.717	0.500	6	-7/16
1/2	1.000	3.500	1.717	0.500	6	-1/2
5/8	1.250	3.500	1.594	0.625	6	-5/8
3/4	1.500	4.000	1.969	0.750	8	-3/4

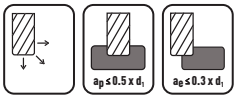
Protostar AL 25

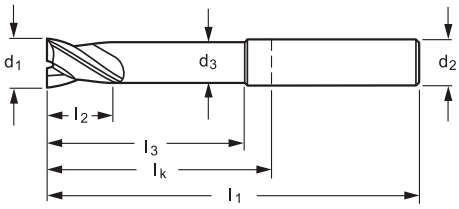
Characteristics



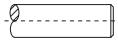
- Primary application is slot and shoulder milling in Aluminum and Aluminum alloys. Also works in unalloyed Ti, Ni and Cu.
- Extra long effective length

Application





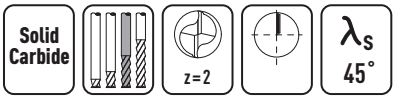
Extra-Long



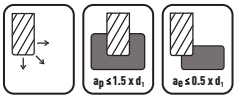
d_1 h10 inch	l_2 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH602681
1/8	0.250	1.062	0.119	3.000	1.583	0.125	2	-1/8
3/16	0.375	1.625	0.178	3.000	1.583	0.188	2	-3/16
1/4	0.500	2.375	0.237	4.000	2.583	0.250	2	-1/4
5/16	0.500	2.375	0.297	4.500	2.937	0.375	2	-5/16
3/8	0.563	2.500	0.356	4.500	2.937	0.375	2	-3/8
1/2	0.625	4.000	0.475	6.000	4.217	0.500	2	-1/2
5/8	0.875	4.000	0.594	6.000	4.094	0.625	2	-5/8
3/4	1.000	4.000	0.713	6.000	3.969	0.750	2	-3/4

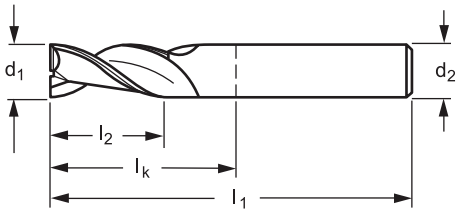
Protostar AL 45

Characteristics



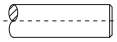
Application





- Primary application is slot and shoulder milling in Aluminum and Aluminum alloys. Also works in unalloyed Ti, Ni and Cu.

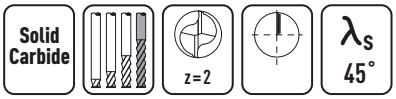
Standard



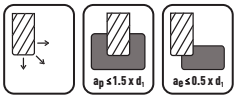
d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH602511
1/16	0.188	2.500	1.083	0.250	2	-1/16
3/32	0.375	2.500	1.083	0.250	2	-3/32
1/8	0.500	2.500	1.083	0.250	2	-1/8
3/16	0.625	2.500	1.083	0.250	2	-3/16
1/4	0.750	2.500	1.083	0.250	2	-1/4
5/16	0.813	3.000	1.437	0.375	2	-5/16
3/8	0.875	3.000	1.437	0.375	2	-3/8
7/16	1.000	3.500	1.717	0.500	2	-7/16
1/2	1.000	3.500	1.717	0.500	2	-1/2
5/8	1.250	3.500	1.594	0.625	2	-5/8
3/4	1.500	4.000	1.969	0.750	2	-3/4

Protostar AL 45

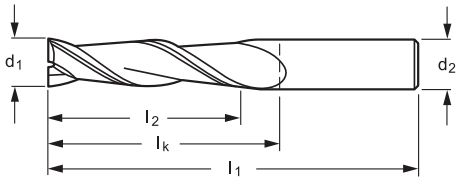
Characteristics



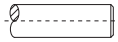
Application



- Suitable for slot, pocket and shoulder milling in Aluminum and Aluminum alloys. An excellent choice for finishing operations.



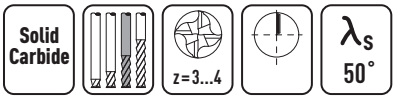
Long



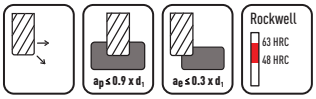
d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH602551
1/8	0.750	2.500	1.083	0.250	2	-1/8
3/16	0.750	2.500	1.083	0.250	2	-3/16
1/4	1.125	3.000	1.583	0.250	2	-1/4
5/16	1.125	3.000	1.437	0.375	2	-5/16
3/8	1.125	3.000	1.437	0.375	2	-3/8
1/2	2.000	4.500	2.717	0.500	2	-1/2
5/8	2.250	5.000	3.094	0.625	2	-5/8
3/4	2.250	5.000	2.969	0.750	2	-3/4

Protostar Tough Guys H 50

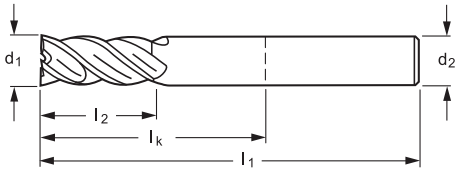
Characteristics



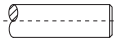
Application



- The combination of a variable flute depth with an offset tooth geometry provides a robust design for machining hardened materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



Standard

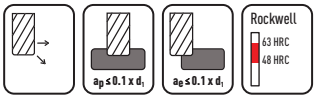


d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3071118 TAX
1/8	0.500	2.500	1.083	0.250	3	-1/8
3/16	0.625	2.500	1.083	0.250	3	-3/16
1/4	0.750	2.500	1.083	0.250	4	-1/4
5/16	0.813	3.000	1.437	0.375	4	-5/16
3/8	0.875	3.000	1.437	0.375	4	-3/8
7/16	1.000	3.500	1.717	0.500	4	-7/16
1/2	1.000	3.500	1.717	0.500	4	-1/2
5/8	1.250	3.500	1.594	0.625	4	-5/8
3/4	1.500	4.000	1.969	0.750	4	-3/4

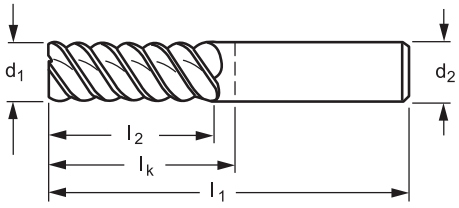
Protostar Ultra H 50

Characteristics

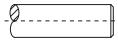
Application



- Finishing operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



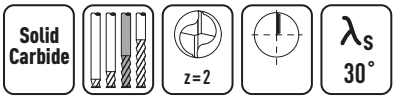
Long



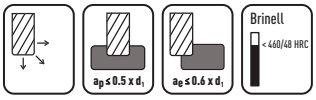
d_1 h10 inch	l_2 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH8083128 TAX
1/8	0.500	2.500	1.083	0.250	4	-1/8X0.500
3/16	0.625	2.500	1.083	0.250	4	-3/16X0.625
1/4	0.750	3.000	1.583	0.250	6	-1/4X0.750
5/16	0.813	3.000	1.437	0.375	6	-5/16X0.813
3/8	0.875	3.000	1.437	0.375	6	-3/8X0.875
7/16	1.000	4.500	2.717	0.500	6	-7/16X1.000
1/2	1.000	4.500	2.717	0.500	6	-1/2X1.000
5/8	1.250	5.000	3.094	0.625	6	-5/8X1.250
3/4	1.500	5.000	2.969	0.750	8	-3/4X1.500

Protostar 30

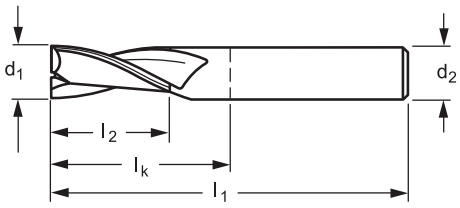
Characteristics



Application



- All-purpose end mill suitable for use in a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



DIN 6527 L

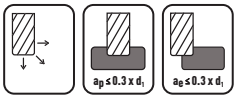
DIN 6535HA DIN 6535HA

d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H302611	Code H3026118 TAX
2	6	57	21	6	2	-2	-2
2.5	7	57	21	6	2	-2.5	-2.5
3	7	57	21	6	2	-3	-3
3.5	7	57	21	6	2	-3.5	-3.5
4	8	57	21	6	2	-4	-4
4.5	8	57	21	6	2	-4.5	-4.5
5	10	57	21	6	2	-5	-5
6	10	57	21	6	2	-6	-6
7	13	63	27	8	2	-7	-7
8	16	63	27	8	2	-8	-8
9	16	72	32	10	2	-9	-9
10	19	72	32	10	2	-10	-10
11	22	83	38	12	2	-11	-11
12	22	83	38	12	2	-12	-12
14	22	83	38	14	2	-14	-14
16	26	92	44	16	2	-16	-16
18	26	92	44	18	2	-18	-18
20	32	104	54	20	2	-20	-20

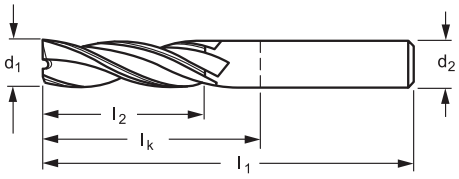
Protostar 30

Characteristics

Application



- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.



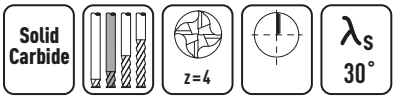
P-Norm L

DIN 6535HA

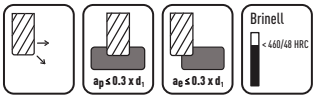
d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3027419 DIA
1	4	38	10	3	3	-1
1.5	6	38	10	3	3	-1.5
2	8	38	12	3	3	-2
3	12	38	10	3	3	-3
4	14	50	22	4	3	-4
5	16	57	21	6	3	-5
6	22	65	29	6	3	-6
8	28	80	44	8	3	-8
10	32	100	60	10	3	-10
12	38	100	55	12	3	-12
16	50	115	67	16	3	-16

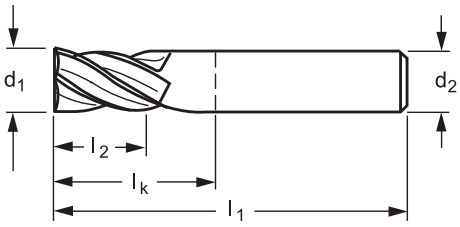
Protostar N 30

Characteristics



Application





- All-purpose end mill suitable for slot, profile and pocket milling.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

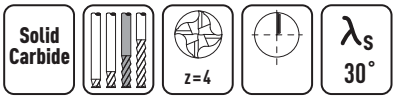
DIN 6527 K

DIN 6535HA

d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3022018 TAX
2	4	50	14	6	4	-2
3	5	50	14	6	4	-3
4	8	54	18	6	4	-4
5	9	54	18	6	4	-5
6	10	54	18	6	4	-6
7	11	58	22	8	4	-7
8	12	58	22	8	4	-8
10	14	66	26	10	4	-10
12	16	73	28	12	4	-12
14	18	75	30	14	4	-14
16	22	82	34	16	4	-16
18	24	84	36	18	4	-18
20	26	92	42	20	4	-20

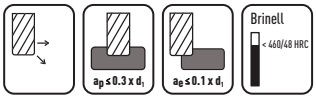
Protostar N 30

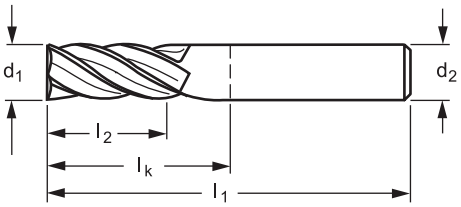
Characteristics



- All-purpose end mill suitable for slot, profile and pocket milling.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application





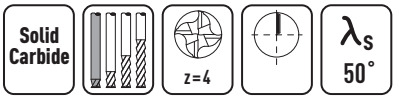
DIN 6527 L

DIN 6535HA DIN 6535HA

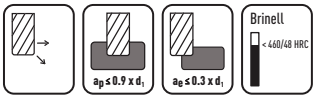
d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H302211	Code H3022118 TAX
2	7	57	21	6	4	-2	-2
2.5	8	57	21	6	4	-2.5	-2.5
3	8	57	21	6	4	-3	-3
3.5	10	57	21	6	4	-3.5	-3.5
4	11	57	21	6	4	-4	-4
4.5	11	57	21	6	4	-4.5	-4.5
5	13	57	21	6	4	-5	-5
5.5	13	57	21	6	4	-5.5	-5.5
6	13	57	21	6	4	-6	-6
6.5	16	63	27	8	4	-6.5	-6.5
7	16	63	27	8	4	-7	-7
8	19	63	27	8	4	-8	-8
9	19	72	32	10	4	-9	-9
10	22	72	32	10	4	-10	-10
12	26	83	38	12	4	-12	-12
14	26	83	38	14	4	-14	-14
16	32	92	44	16	4	-16	-16
18	32	92	44	18	4	-18	-18
20	38	104	54	20	4	-20	-20

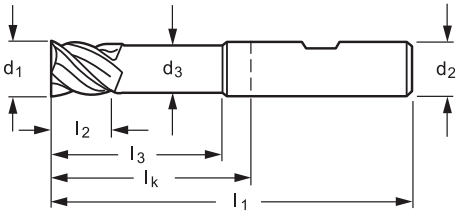
Protostar Tough Guys N 50

Characteristics



Application





- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys

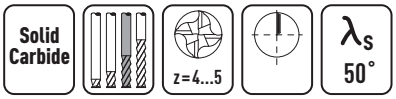
DIN 6527 L

DIN 6535HB

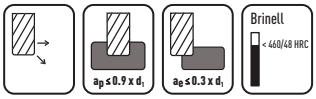
d_1 h10 mm	l_2 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H4121217 TAX
6	6	19	5.7	57	21	6	4	-6
8	8	25	7.6	63	27	8	4	-8
10	10	30	9.5	72	32	10	4	-10
12	12	36	11.4	83	38	12	4	-12
14	14	36	13.3	83	38	14	4	-14
16	16	42	15.2	92	44	16	4	-16

Protostar Tough Guys N 50

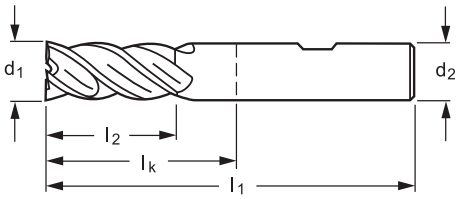
Characteristics



Application



- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



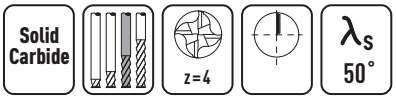
DIN 6527 L

DIN 6535HB

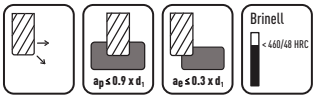
d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3121317 TAX
6	13	57	21	6	4	-6
8	19	63	27	8	4	-8
10	22	72	32	10	4	-10
12	26	83	38	12	4	-12
14	26	83	38	14	4	-14
16	32	92	44	16	4	-16
18	32	92	44	18	4	-18
20	38	104	54	20	4	-20
25	45	121	65	25	5	-25

Protostar Tough Guys N 50

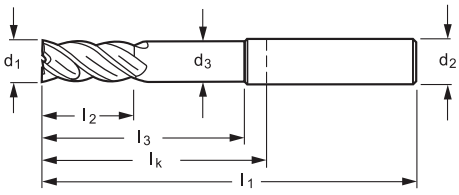
Characteristics



Application



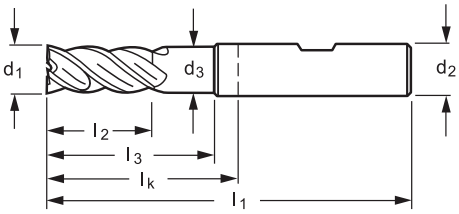
- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



DIN 6527 L

DIN 6535HA

d_1 h10 mm	l_2 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H4021017 TAX
6	13	19	5.7	57	21	6	4	-6
8	19	25	7.6	63	27	8	4	-8
10	22	30	9.5	72	32	10	4	-10
12	26	36	11.4	83	38	12	4	-12
14	26	36	13.3	83	38	14	4	-14
16	32	42	15.2	92	44	16	4	-16
20	38	52	19	104	54	20	4	-20



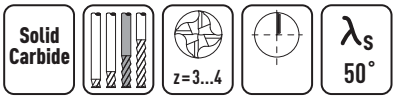
DIN 6527 L

DIN 6535HB

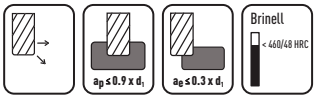
d_1 h10 mm	l_2 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H4121017 TAX
6	13	19	5.7	57	21	6	4	-6
8	19	25	7.6	63	27	8	4	-8
10	22	30	9.5	72	32	10	4	-10
12	26	36	11.4	83	38	12	4	-12
14	26	36	13.3	83	38	14	4	-14
16	32	42	15.2	92	44	16	4	-16
20	38	52	19	104	54	20	4	-20

Protostar Tough Guys N 50

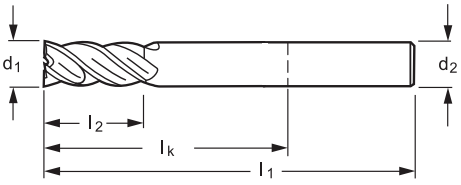
Characteristics



Application



- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



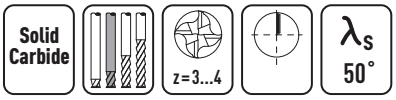
P-Norm L

DIN 6535HA

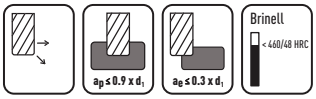
d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3021117 TAX
2	7	57	21	6	3	-2
2.5	8	57	21	6	3	-2.5
3	8	57	21	6	3	-3
3.5	10	57	21	6	3	-3.5
4	11	57	21	6	3	-4
4.5	11	57	21	6	3	-4.5
5	13	57	21	6	3	-5
6	13	65	29	6	4	-6
7	16	80	44	8	4	-7
8	19	80	44	8	4	-8
9	19	100	60	10	4	-9
10	22	100	60	10	4	-10
11	26	100	55	12	4	-11
12	26	100	55	12	4	-12
14	26	104	59	14	4	-14
16	32	115	67	16	4	-16
20	38	125	75	20	4	-20

Protostar Tough Guys N 50

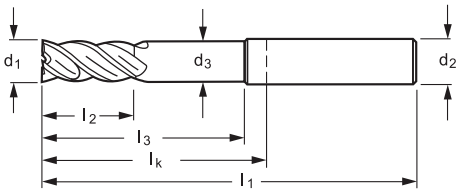
Characteristics



Application



- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys
- Long effective length



P-Norm L

DIN 6535HA

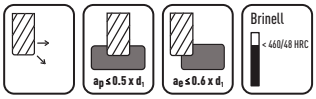
d_1 h10 mm	l_2 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H4021117 TAX
4	11	15	3.8	57	21	6	3	-4
5	13	16	4.75	57	21	6	3	-5
6	13	27	5.7	65	29	6	4	-6
8	19	42	7.6	80	44	8	4	-8
10	22	58	9.5	100	60	10	4	-10
12	26	53	11.4	100	55	12	4	-12
14	26	57	13.3	104	59	14	4	-14
16	32	65	15.2	115	67	16	4	-16
20	38	73	19	125	75	20	4	-20

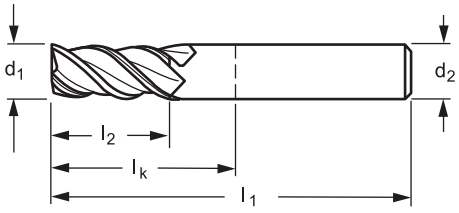
Protostar Compact N 45

Characteristics

- An economic solution for use in a wide variety of materials
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application

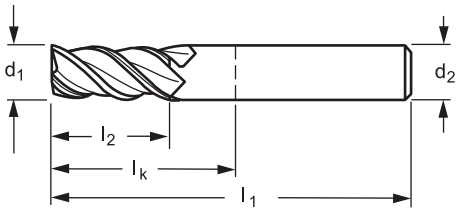




P-Norm S

DIN 6535HA DIN 6535HA

d_1 h11 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H301301	Code H3013018 TAX
2	3	39	12	6	3	-2	-2
3	4	39	12	6	3	-3	-3
4	5	39	12	6	3	-4	-4
5	6	39	12	6	3	-5	-5
6	7	39	12	6	3	-6	-6
8	9	44	17	8	3	-8	-8
10	11	51	20	10	3	-10	-10
12	13	56	22	12	3	-12	-12



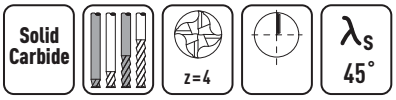
DIN 6527 K

DIN 6535HA DIN 6535HA

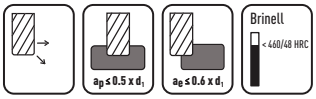
d_1 h11 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H301311	Code H3013118 TAX
2	6	50	14	6	3	-2	-2
3	7	50	14	6	3	-3	-3
4	8	54	18	6	3	-4	-4
5	10	54	18	6	3	-5	-5
6	10	54	18	6	3	-6	-6
8	16	58	22	8	3	-8	-8
10	19	66	26	10	3	-10	-10
12	22	73	28	12	3	-12	-12

Protostar Compact N 45

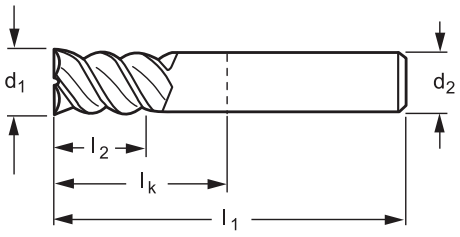
Characteristics



Application



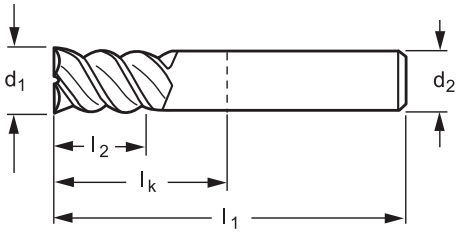
- An economic solution for use in a wide variety of materials
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



P-Norm S

DIN 6535HA DIN 6535HA

d_1 h11 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H301401	Code H3014018 TAX
2	3	39	12	6	4	-2	-2
3	4	39	12	6	4	-3	-3
4	5	39	12	6	4	-4	-4
5	6	39	12	6	4	-5	-5
6	7	39	12	6	4	-6	-6
8	9	44	17	8	4	-8	-8
10	11	51	20	10	4	-10	-10
12	13	56	22	12	4	-12	-12



DIN 6527 K

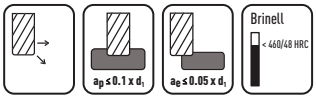
DIN 6535HA DIN 6535HA

d_1 h11 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H301411	Code H3014118 TAX
2	6	50	14	6	4	-2	-2
3	7	50	14	6	4	-3	-3
4	8	54	18	6	4	-4	-4
5	10	54	18	6	4	-5	-5
6	10	54	18	6	4	-6	-6
8	16	58	22	8	4	-8	-8
10	19	66	26	10	4	-10	-10
12	22	73	28	12	4	-12	-12

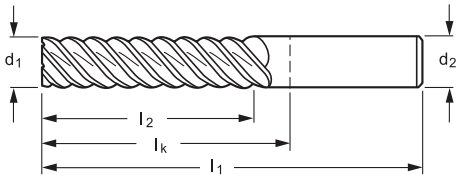
Protostar N 45

Characteristics

Application



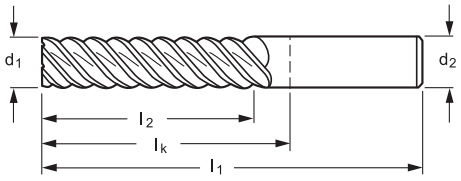
- All-purpose end mill suitable for slot, profile and pocket milling. An excellent choice for finishing operations.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



P-Norm L

DIN 6535HA

d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3023418 TAX
6	22	65	29	6	4	-6
8	28	80	44	8	4	-8
10	32	100	60	10	4	-10
12	40	100	55	12	4	-12
14	50	104	59	14	4	-14
16	50	115	67	16	5	-16
20	55	125	75	20	5	-20



P-Norm XL

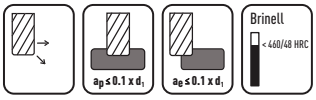
DIN 6535HA

d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3023518 TAX
6	35	80	44	6	4	-6X35
8	45	97	61	8	4	-8X45
10	50	118	78	10	4	-10X50
12	60	120	75	12	4	-12X60
16	65	130	82	16	5	-16X65
16	80	145	97	16	5	-16X80
20	75	145	95	20	6	-20X75
20	100	170	120	20	6	-20X100
25	90	153	97	25	8	-25X90
25	125	188	132	25	8	-25X125

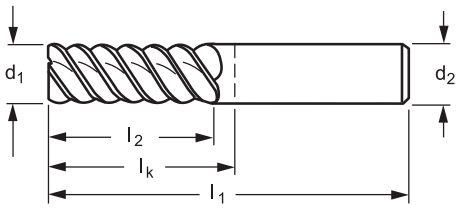
Protostar N 50

Characteristics

Application



- High helix end mill designed for finishing operations where high quality surface finishes are required.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



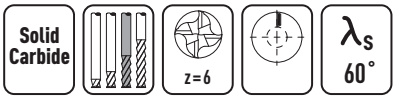
DIN 6527 L

DIN 6535HA

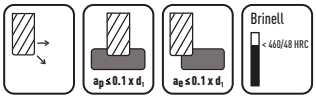
d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3021138 TAX
3	8	57	21	6	4	-3
4	11	57	21	6	4	-4
5	13	57	21	6	5	-5
6	13	57	21	6	6	-6
8	19	63	27	8	6	-8
10	22	72	32	10	6	-10
12	26	83	38	12	6	-12
16	32	92	44	16	6	-16
20	38	104	54	20	8	-20
25	45	121	65	25	8	-25

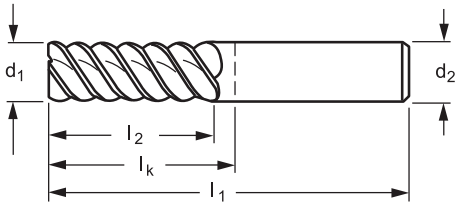
Protostar N 60

Characteristics



Application





- High helix end mill designed for finishing operations where high quality surface finishes are required.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

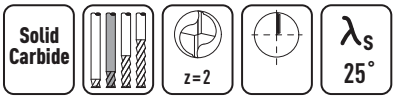
DIN 6527 L

DIN 6535HA

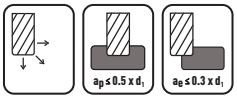
d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3024148 TAX
6	13	57	21	6	6	-6
8	19	63	27	8	6	-8
10	22	72	32	10	6	-10
12	26	83	38	12	6	-12
14	26	83	38	14	6	-14
16	32	92	44	16	6	-16
18	32	92	44	18	6	-18
20	38	104	54	20	6	-20

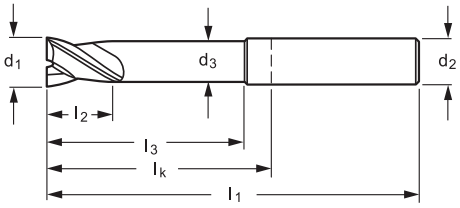
Protostar AL 25

Characteristics



Application





- Primary application is slot and shoulder milling in Aluminum and Aluminum alloys. Also works in unalloyed Ti, Ni and Cu.
- Extra long effective length

P-Norm L

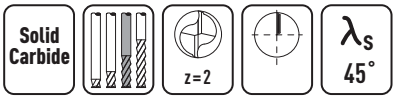
DIN 6535HA

d_1 h10 mm	l_2 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H602681
2	3	9	1.92	38	10	1) 3	2	-2
3	4	12	2.9	38	10	1) 3	2	-3
4	6	14	3.8	50	22	1) 4	2	-4
5	8	16	4.75	57	21	6	2	-5
6	10	28	5.7	65	29	6	2	-6
8	12	35	7.6	80	44	8	2	-8
10	14	45	9.5	90	50	10	2	-10
12	16	50	11.4	100	55	1) 12	2	-12
16	20	63	15.2	115	67	1) 16	2	-16
20	20	70	19	125	75	1) 20	2	-20

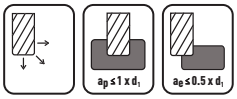
1) shank tolerance h6

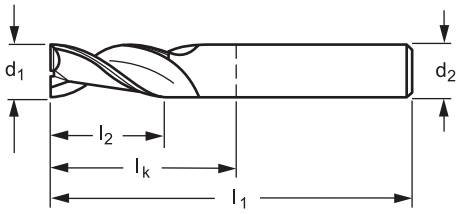
Protostar AL 45

Characteristics



Application





- Suitable for slot, pocket and shoulder milling in Aluminum and Aluminum alloys. An excellent choice for finishing operations.

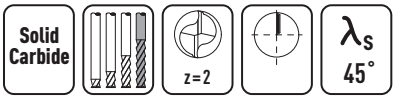
DIN 6527 L

DIN 6535HA

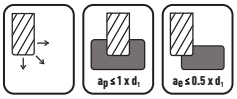
d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H602511
1	3	57	21	6	2	-1
1.5	3	57	21	6	2	-1.5
2	6	57	21	6	2	-2
2.5	7	57	21	6	2	-2.5
3	7	57	21	6	2	-3
3.5	7	57	21	6	2	-3.5
4	8	57	21	6	2	-4
4.5	8	57	21	6	2	-4.5
5	10	57	21	6	2	-5
5.5	10	57	21	6	2	-5.5
6	10	57	21	6	2	-6
8	16	63	27	8	2	-8
10	19	72	32	10	2	-10
12	22	83	38	12	2	-12
14	22	83	38	14	2	-14
16	26	92	44	16	2	-16
18	26	92	44	18	2	-18
20	32	104	54	20	2	-20

Protostar AL 45

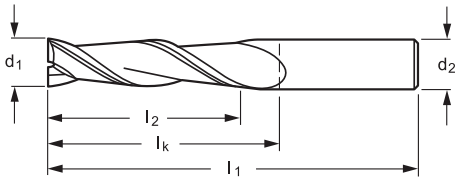
Characteristics



Application



- Suitable for slot, pocket and shoulder milling in Aluminum and Aluminum alloys. An excellent choice for finishing operations.



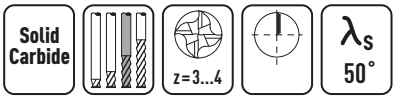
P-Norm L

DIN 6535HA

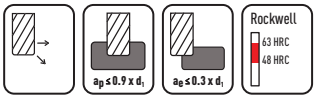
d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H602551
6	35	80	44	6	2	-6
8	45	97	61	8	2	-8
10	50	118	78	10	2	-10
12	60	120	75	12	2	-12
16	65	130	82	16	2	-16
20	75	145	95	20	2	-20

Protostar Tough Guys H 50

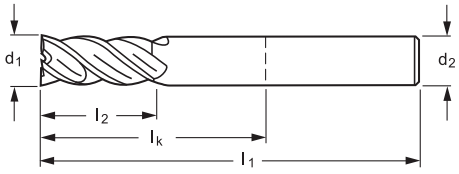
Characteristics



Application



- The combination of a variable flute depth with an offset tooth geometry provides a robust design for machining hardened materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



P-Norm L

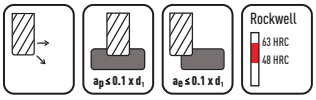
DIN 6535HA

d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3071118 TAX
2	7	57	21	6	3	-2
3	8	57	21	6	3	-3
4	11	57	21	6	3	-4
5	13	57	21	6	3	-5
6	13	65	29	6	4	-6
8	19	80	44	8	4	-8
10	22	100	60	10	4	-10
12	26	100	55	12	4	-12
14	26	104	59	14	4	-14
16	32	115	67	16	4	-16
20	38	125	75	20	4	-20

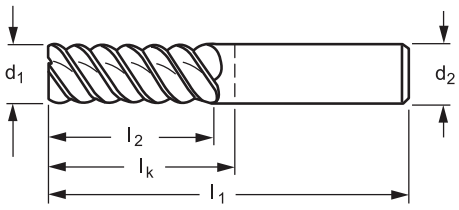
Protostar Ultra H 50

Characteristics

Application



- Finishing operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



DIN 6527 L; P-Norm L

DIN 6535HA

d_1 h10 mm	l_2 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8083128 TAX
3	8	57	21	6	4	-3X8
4	11	57	21	6	4	-4X11
5	13	57	21	6	4	-5X13
6	13	57	21	6	6	-6X13
6	26	70	34	6	6	-6X26
8	19	63	27	8	6	-8X19
8	36	80	44	8	6	-8X36
10	22	72	32	10	6	-10X22
10	46	100	60	10	6	-10X46
12	26	83	38	12	6	-12X26
12	55	110	65	12	6	-12X55
16	32	92	44	16	6	-16X32
16	66	130	82	16	6	-16X66
20	38	104	54	20	8	-20X38
20	80	145	95	20	8	-20X80
25	45	121	65	25	8	-25X45
25	90	153	97	25	8	-25X90

Application guide - Square End

Speed and Feed Chart: The speeds and feeds in this table are intended for intial setup. These values are a guide, depending on machining conditions, these parameters may need to be adjusted up or down until optimum settings are found.

How to use this chart:

1. Pick your material group*
2. Move across to mill series
3. Read SFM and Feed Chart (FC) Letter
4. Go to the Feed Charts on pages 88-89 and convert to feed per tooth
5. Calculate Speed and Feed using formulas on page 88

* Example materials can be found in the Material Library on page 188-189 of the Technical Information section

			Type			**30**					
			Length inch			Standard			Standard		
			Length metric			DIN 6527 L			DIN 6527 L	P-Norm L	
			Helix			30°			30°	30°	
			No. of flutes			2			2	3	
			Surface treatment			Bright			TAX	DIA	
											
			Remarks							Graphite machining	
			INCH	Range		(1/16...3/4)			(1/16...3/4)		
			INCH	**Catalog No.**		**AH302611**			**AH3026118**		
			INCH	Catalog Page		46			46		
			METRIC	Range		(2...20)			(2...20)	(1...16)	
			METRIC	**Catalog No.**		**H302611**			**H3026118**	**H3027419**	
			METRIC	Catalog Page		63			63	64	
ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Hardness	SFM	FC	SFM	FC	SFM	FC		
P	**Steel**										
P	1.1	Magnetic soft steel	61 - 120 HB			690	A				
P	1.2	Structural steel, case carburizing steel	101 - 200 HB			690	A				
P	1.3	Plain carbon steel	100 - 250 HB			655	A				
P	1.4	Alloy steel	150 - 250 HB			560	A				
P	1.5	Alloy steel, Tempered steel	26 - 38 HRc			395	A				
P	1.6.1	Alloy steel, Tempered steel	39 - 44 HRc			330	A				
P	1.6.2	Alloy steel, Tempered steel	44 - 49 HRc			260	B				
M	**Stainless Steel**										
M	2.1	Free machining stainless steel	120 - 250 HB			295	B				
M	2.2	Austinetic	130 - 250 HB			230	B				
M	2.3	Ferritic, austenitic, martensitic	130 - 320 HB			195	B				
M	2.4	High tensile chrome-nickel alloys	33 - 44 HRc			130	B				
K	**Cast Iron**										
K	3.1	Cast Iron	50 - 150 HB	260	A	590	A				
K	3.2	Cast Iron	150 - 300 HB	195	A	490	A				
K	3.3	Ductile Iron	150 - 200 HB	260	A	590	A				
K	3.4	Ductile Iron	14 - 32 HRc	195	A	460	A				
K	3.5	Compacted graphite iron	14 - 32 HRc	165	A	395	A				
N	**Non-ferrous Materials**										
N	6.1	Copper, unalloyed	80 - 100 HB	755	C	1445	C				
N	6.2	Short chip brass	100 - 200 HB	755	C	1445	C				
N	6.3	Long chip brass	120 - 200 HB	755	C	1445	C				
N	6.4	Cu-Al-Fe alloys	200 - 440 HB	115	C	195	C				
N	6.5	Cu-Al-Ni alloys (short chipping)	120 - 250 HB	260	C	490	C				
N	6.6	Cu-Al-Ni alloys (long chipping)	120 - 250 HB	260	C	490	C				
N	7.1	Al, Mg unalloyed	60 - 100 HB	4920	C	4920	C				
N	7.2	Al, alloyed Si<0.5%	90 - 180 HB	4920	C	4920	C				
N	7.3.1	Al, alloyed Si>=0.5%<4%	90 - 180 HB	3150	C	4530	C				
N	7.3.2	Al, alloyed Si>=4%<12%	90 - 180 HB	1245	C	2000	C				
N	7.4	Al, alloyed Si>=12%	90 - 180 HB	490	C	820	C				
N	7.5.1	Magnesium Standard alloy	120 - 300 N/mm²	1245	C	2295	C				
N	7.5.2	Magnesium -high tensile strength	70 - 120 HB	985	C	2035	C				
N	7.5.3	Heat resistant magnesium alloys	120 - 300 N/mm²	755	C	1740	C				
S	**High Temp Alloys and Titanium Alloys**										
S	4.1	Titanium, unalloyed	120 - 200 HB	295	A	590	A				
S	4.2	Titanium, alloyed	14 - 28 HRc	195	A	230	A				
S	4.3	Titanium, alloyed	28 - 44 HRc	130	A	165	A				
S	5.1	Nickel, unalloyed	120 - 150 HB	490	A	855	A				
S	5.2	Nickel, alloyed	150 - 270 HB	65	B	165	B				
S	5.3	Nickel, alloyed	28 - 49 HRc	50	B	100	B				
S	9.1	TIC Hard materials	48 - 51 HRc	25	B	35	B				
S	9.2	Tungsten alloys	44 - 52 HRc	80	B	230	B				
S	9.3	Alloys on Cobalt base	150 - 350 HB	35	B	100	B				
S	9.4	Molybdenum alloyed	150 - 350 HB	80	B	195	B				
H	**Hardened Materials**										
H	1.7.1	Steel (hardened), short chipping	49 - 55 HRc								
H	1.7.2	Steel (hardened), long chipping	49 - 55 HRc								
H	1.8.1	Steel (hardened)	55 - 60 HRc								
H	1.8.2	Steel (hardened)	60 - 65 HRc								
O	**Synthetic Materials / Others**										
O	8.1	Thermoplastics	<50 N/mm²	490	C	1150	C				
O	8.2	Thermosetting plastics	<80 N/mm²	375	C	590	C				
O	8.3	Reinforced plastic materials	240 - 440 N/mm²	130	C	260	C				
O	10.1	Standard graphite	<100 N/mm²	755	C	855	C	1640	C		
O	10.2	Wear resistant graphite	<100 N/mm²	755	C	855	C	1640	C		

	N 30								
	Stub	Stub	Standard	Standard	Standard	Stub	Stub	Standard	Standard
							DIN 6527 K	DIN 6527 L	DIN 6527 L
	30°	30°	30°	30°	30°	30°	30°	30°	30°
	3	3	3	3	3	4	4	4	4
	Bright	TAX	Bright	TAX	DIA	Bright	TAX	Bright	TAX
									
					Graphite machining				
	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)
	AH302701	**AH3027018**	**AH302711**	**AH3027118**	**AH3027419**	**AH302201**	**AH3022018**	**AH302211**	**AH3022118**
	47	47	48	48	49	50	50	51	51
							(2...20)	(2...20)	(2...20)
							H3022018	**H302211**	**H3022118**
							65	66	66
	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC
		690 A		690 A			785 A		690 A
		690 A		690 A			785 A		690 A
		655 A		655 A			755 A		690 A
		560 A		560 A			655 A		590 A
		395 A		395 A			460 A		425 A
		330 A		330 A			360 A		330 A
		260 B		260 B			330 B		295 B
		295 B		295 B			330 B		295 B
		230 B		230 B			260 B		230 B
		195 B		195 B			215 B		195 B
		130 B		130 B			165 B		130 B
	260 A	590 A	245 A	490 A		260 A	590 A	245 A	490 A
	195 A	490 A	195 A	425 A		195 A	490 A	195 A	425 A
	260 A	590 A	245 A	490 A		260 A	590 A	245 A	490 A
	195 A	460 A	195 A	395 A		195 A	460 A	195 A	395 A
	165 A	395 A	165 A	360 A		165 A	395 A	165 A	360 A
	755 C	1445 C	755 C	1445 C					
	755 C	1445 C	755 C	1445 C		820 C	1640 C	740 C	1410 C
	755 C	1445 C	755 C	1445 C					
	115 C	195 C	115 C	195 C		130 C	230 C	115 C	215 C
	260 C	490 C	260 C	490 C		295 C	575 C	260 C	490 C
	260 C	490 C	260 C	490 C					
	4920 C	4920 C	4920 C	4920 C			4920 C	4920 C	4920 C
	4920 C	4920 C	4920 C	4920 C			4920 C	4920 C	4920 C
	3280 C	4595 C	3280 C	4595 C			4595 C	3280 C	4265 C
	1245 C	2000 C	1245 C	2000 C			1970 C	1245 C	1640 C
	490 C	820 C	490 C	820 C		490 C	785 C	490 C	690 C
	1245 C	2295 C	1245 C	2295 C					
	985 C	2035 C	985 C	2035 C					
	755 C	1740 C	755 C	1740 C					
	0	0	0	0					
	295 A	590 A	295 A	590 A					
	195 A	230 A	195 A	230 A		195 A	230 A	180 A	195 A
	130 A	165 A	130 A	165 A		130 A	165 A	130 A	165 A
	490 A	855 A	490 A	855 A					
	65 B	165 B	65 B	165 B		65 B	165 B	65 B	165 B
	50 B	100 B	50 B	100 B		50 B	100 B	50 B	100 B
	25 B	35 B	25 B	35 B		25 B	35 B	35 B	35 B
	80 B	230 B	80 B	230 B		80 B	230 B	80 B	230 B
	35 B	100 B	35 B	100 B		35 B	100 B	35 B	100 B
	80 B	195 B	80 B	195 B		80 B	195 B	80 B	215 B
							260 B		230 B
							260 B		230 B
							705 C	395 C	590 C
							330 C	130 C	260 C
	755 C	855 C	755 C	855 C	1640 C	755 C	985 C	755 C	855 C
	755 C	855 C	755 C	855 C	1640 C	755 C	985 C	755 C	855 C

Application guide - Square End

Speed and Feed Chart: The speeds and feeds in this table are intended for intial setup. These values are a guide, depending on machining conditions, these parameters may need to be adjusted up or down until optimum settings are found.

How to use this chart:

1. Pick your material group*
2. Move across to mill series
3. Read SFM and Feed Chart (FC) Letter
4. Go to the Feed Charts on pages 88-89 and convert to feed per tooth
5. Calculate Speed and Feed using formulas on page 88

* Example materials can be found in the Material Library on page 188-189 of the Technical Information section

			Type	Tough Guys N 50											
			Length inch	Standard		Standard								Long	
			Length metric	DIN 6527 L		DIN 6527 L		DIN 6527 L		DIN 6527 L		P-Norm L		P-Norm L	
			Helix	50°		50°		50°		50°		50°		50°	
			No. of flutes	3-4		3-4		4		4		3-4		3-4	
			Surface treatment	TAX		TAX		TAX		TAX		TAX		TAX	
															
			Remarks												
		INCH	Range	(1/4...3/4)		(1/4...3/4)								(1/8...3/4)	
		INCH	**Catalog No.**	**AH4121217**		**AH3121317**								**AH4021117**	
		INCH	Catalog Page	52		53								54	
		METRIC	Range	(6...16)		(6...25)		(6...20)		(6...20)		(2...20)		(4...20)	
		METRIC	**Catalog No.**	**H4121217**		**H3121317**		**H4021017**		**H4121017**		**H3021117**		**H4021117**	
		METRIC	Catalog Page	67		68		69		69		70		71	
ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Hardness	SFM	FC	SFM	FC	SFM	FC	SFM	FC	SFM	FC	SFM	FC
P	**Steel**														
P	1.1	Magnetic soft steel	61 - 120 HB	785	A	785	A	785	A	785	A	590	A	590	A
P	1.2	Structural steel, case carburizing steel	101 - 200 HB	785	A	785	A	785	A	785	A	590	A	590	A
P	1.3	Plain carbon steel	100 - 250 HB	755	A	755	A	755	A	755	A	590	A	625	A
P	1.4	Alloy steel	150 - 250 HB	655	A	655	A	625	A	655	A	525	A	525	A
P	1.5	Alloy steel, Tempered steel	26 - 38 HRc	460	A	460	A	460	A	460	A	395	A	395	A
P	1.6.1	Alloy steel, Tempered steel	39 - 44 HRc	360	A	360	A	360	A	360	A	330	A	330	A
P	1.6.2	Alloy steel, Tempered steel	44 - 49 HRc	330	B	330	B	330	B	330	B	260	B	260	B
M	**Stainless Steel**														
M	2.1	Free machining stainless steel	120 - 250 HB	330	B	330	B	330	B	330	B	260	B	260	B
M	2.2	Austinetic	130 - 250 HB	260	B	260	B	260	B	260	B	195	B	230	B
M	2.3	Ferritic, austenitic, martensitic	130 - 320 HB	230	B	230	B	230	B	230	B	165	B	195	B
M	2.4	High tensile chrome-nickel alloys	33 - 44 HRc	165	B	165	B	165	B	165	B	130	B	130	B
K	**Cast Iron**														
K	3.1	Cast Iron	50 - 150 HB	590	A	590	A	590	A	590	A	460	A	460	A
K	3.2	Cast Iron	150 - 300 HB	490	A	490	A	490	A	490	A	425	A	425	A
K	3.3	Ductile Iron	150 - 200 HB	590	A	590	A	590	A	590	A	490	A	490	A
K	3.4	Ductile Iron	14 - 32 HRc	460	A	460	A	460	A	460	A	395	A	395	A
K	3.5	Compacted graphite iron	14 - 32 HRc	395	A	395	A	395	A	395	A	330	A	330	A
N	**Non-ferrous Materials**														
N	6.1	Copper, unalloyed	80 - 100 HB												
N	6.2	Short chip brass	100 - 200 HB	1675	C	1675	C	1675	C	1675	C	1310	C	1310	C
N	6.3	Long chip brass	120 - 200 HB	1675	C	1675	C	1675	C	1675	C	1310	C	1310	C
N	6.4	Cu-Al-Fe alloys	200 - 440 HB	230	C	230	C	230	C	230	C	195	C	195	C
N	6.5	Cu-Al-Ni alloys (short chipping)	120 - 250 HB	590	C	590	C	590	C	590	C	490	C	490	C
N	6.6	Cu-Al-Ni alloys (long chipping)	120 - 250 HB	590	C	590	C	590	C	590	C	460	C	490	C
N	7.1	Al, Mg unalloyed	60 - 100 HB	4920	C	4920	C	4920	C	4920	C	4920	C	4920	C
N	7.2	Al, alloyed Si<0.5%	90 - 180 HB	4920	C	4920	C	4920	C	4920	C	4920	C	4920	C
N	7.3.1	Al, alloyed Si>=0.5%<4%	90 - 180 HB	4595	C	4595	C	4595	C	4595	C	4595	C	4595	C
N	7.3.2	Al, alloyed Si>=4%<12%	90 - 180 HB	1970	C	1970	C	1970	C	1970	C	1970	C	1970	C
N	7.4	Al, alloyed Si>=12%	90 - 180 HB	785	C	785	C	785	C	785	C	590	C	590	C
N	7.5.1	Magnesium Standard alloy	120 - 300 N/mm²												
N	7.5.2	Magnesium -high tensile strength	70 - 120 HB												
N	7.5.3	Heat resistant magnesium alloys	120 - 300 N/mm²												
S	**High Temp Alloys and Titanium Alloys**														
S	4.1	Titanium, unalloyed	120 - 200 HB												
S	4.2	Titanium, alloyed	14 - 28 HRc	260	A	260	A	260	A	260	A	195	A	195	A
S	4.3	Titanium, alloyed	28 - 44 HRc	195	A	195	A	195	A	195	A	165	A	165	A
S	5.1	Nickel, unalloyed	120 - 150 HB												
S	5.2	Nickel, alloyed	150 - 270 HB	195	B	195	B	195	B	195	B	165	B	165	B
S	5.3	Nickel, alloyed	28 - 49 HRc	100	B	130	B	130	B	130	B	100	B	100	B
S	9.1	TIC Hard materials	48 - 51 HRc												
S	9.2	Tungsten alloys	44 - 52 HRc	260	B	260	B	260	B	260	B	195	B	195	B
S	9.3	Alloys on Cobalt base	150 - 350 HB	130	B	130	B	130	B	130	B	100	B	100	B
S	9.4	Molybdenum alloyed	150 - 350 HB	230	B	230	B	230	B	230	B	195	B	195	B
H	**Hardened Materials**														
H	1.7.1	Steel (hardened), short chipping	49 - 55 HRc												
H	1.7.2	Steel (hardened), long chipping	49 - 55 HRc												
H	1.8.1	Steel (hardened)	55 - 60 HRc												
H	1.8.2	Steel (hardened)	60 - 65 HRc												
O	**Synthetic Materials / Others**														
O	8.1	Thermoplastics	<50 N/mm²												
O	8.2	Thermosetting plastics	<80 N/mm²	655	C	655	C	655	C	690	C	525	C	525	C
O	8.3	Reinforced plastic materials	240 - 440 N/mm²	295	C	295	C	295	C	295	C	230	C	230	C
O	10.1	Standard graphite	<100 N/mm²	855	C	855	C	855	C	855	C	855	C	855	C
O	10.2	Wear resistant graphite	<100 N/mm²	855	C	855	C	855	C	855	C	855	C	855	C

	Compact N 45											
												Stub
	P-Norm S		P-Norm S		DIN 6527 K		DIN 6527 K		P-Norm S		P-Norm S		DIN 6527 K		DIN 6527 K	
	45°		45°		45°		45°		45°		45°		45°		45°	
	3		3		3		3		4		4		4		4	
	Bright		TAX		Bright		TAX		Bright		TAX		Bright		TAX	
																
															(1/8...1/2)	
															AH3014118	
															55	
	(2...12)		(2...12)		(2...12)		(2...12)		(2...12)		(2...12)		(2...12)		(2...12)	
	H301301		**H3013018**		**H301311**		**H3013118**		**H301401**		**H3014018**		**H301411**		**H3014118**	
	72		72		72		72		73		73		73		73	
	SFM	FC	SFM	FC	SFM	FC	SFM	FC	SFM	FC	SFM	FC	SFM	FC	SFM	FC
			785	A			755	A			855	A			785	A
			785	A			755	A			855	A			785	A
			755	A			755	A			820	A			755	A
			655	A			655	A			690	A			625	A
			460	A			490	A			490	A			460	A
			360	A			395	A			395	A			360	A
			330	B			330	B			330	B			330	B
			360	B			330	B			360	B			330	B
			295	B			260	B			295	B			260	B
			230	B			230	B			230	B			230	B
			165	B			165	B			165	B			165	B
	295	A	655	A	260	A	590	A	295	A	655	A	260	A	590	A
	230	A	560	A	230	A	525	A	230	A	560	A	230	A	525	A
	295	A	655	A	260	A	625	A	295	A	655	A	260	A	625	A
	230	A	490	A	230	A	490	A	230	A	490	A	230	A	490	A
	195	A	425	A	195	A	425	A	195	A	425	A	195	A	425	A
	920	C	1835	C	820	C	1640	C	920	C	1835	C	820	C	1640	C
	920	C	1835	C	820	C	1640	C	920	C	1835	C	820	C	1640	C
	920	C	1835	C	820	C	1640	C	920	C	1835	C	820	C	1640	C
	195	C	260	C	195	C	260	C	195	C	260	C	195	C	260	C
	330	C	655	C	295	C	625	C	330	C	625	C	295	C	625	C
	330	C	655	C	295	C	590	C	330	C	625	C	295	C	590	C
	6035	C	6330	C	5480	C	5740	C	6035	C	6330	C	5480	C	5740	C
	6035	C	6035	C	6100	C	6100	C	6035	C	6035	C	6100	C	6100	C
	3775	C	5710	C	3675	C	5545	C	3775	C	5710	C	3675	C	5545	C
	1510	C	2525	C	1380	C	2295	C	1510	C	2525	C	1380	C	2295	C
	590	C	855	C	560	C	755	C	590	C	855	C	560	C	755	C
	1510	C	2920	C	1380	C	2625	C	1510	C	2920	C	1380	C	2625	C
	1215	C	2560	C	1085	C	2295	C	1215	C	2560	C	1085	C	2295	C
	920	C	2200	C	820	C	1970	C	920	C	2200	C	820	C	1970	C
	360	A	720	A	330	A	655	A	360	A	720	A	330	A	655	A
	230	A	295	A	195	A	260	A	230	A	295	A	195	A	260	A
	165	A	230	A	165	A	195	A	165	A	230	A	165	A	195	A
	590	A	1085	A	560	A	985	A	590	A	1085	A	560	A	985	A
			230	B			195	B			230	B			195	B
			130	B			115	B			130	B			115	B
	100	B	260	B	100	B	260	B								
	35	B	130	B	35	B	130	B								
	100	B	260	B	100	B	260	B								
			260	B			260	B			260	B			260	B
			260	B			260	B			260	B			260	B
	590	C	1445	C	560	C	1310	C								
	460	C	720	C	395	C	655	C								
	165	C	330	C	130	C	295	C								
	755	C	855	C	755	C	855	C								
	755	C	855	C	755	C	855	C								

Application guide - Square End

Speed and Feed Chart: The speeds and feeds in this table are intended for intial setup. These values are a guide, depending on machining conditions, these parameters may need to be adjusted up or down until optimum settings are found.

How to use this chart:

1. Pick your material group*
2. Move across to mill series
3. Read SFM and Feed Chart (FC) Letter
4. Go to the Feed Charts on pages 88-89 and convert to feed per tooth
5. Calculate Speed and Feed using formulas on page 88

* Example materials can be found in the Material Library on page 188-189 of the Technical Information section

Type			N 45		N 50	N 60
Length inch			Long	Extra-Long	Standard	
Length metric			P-Norm L	P-Norm XL	DIN 6527 L	DIN 6527 L
Helix			45°	45°	50°	60°
No. of flutes			4-5	4-8	4-8	6
Surface treatment			TAX	TAX	TAX	TAX
						
Remarks						
INCH	Range		(1/4...3/4)	(1/4...3/4)	(1/8...3/4)	
	Catalog No.		**AH3023418**	**AH3023518**	**AH3021138**	
	Catalog Page		56	56	57	
METRIC	Range		(6...20)	(4...25)	(3...25)	(6...20)
	Catalog No.		**H3023418**	**H3023518**	**H3021138**	**H3024148**
	Catalog Page		74	74	75	76

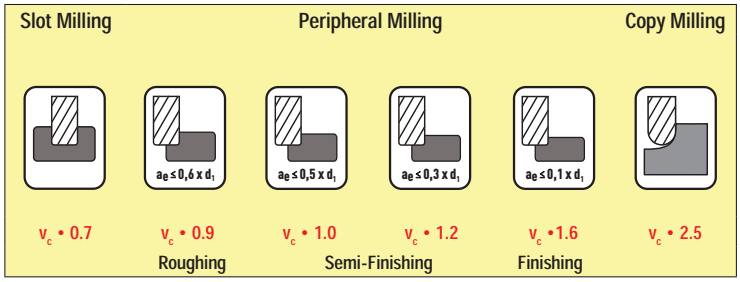
ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Hardness	SFM	FC	SFM	FC	SFM	FC	SFM	FC
	Steel										
P	1.1	Magnetic soft steel	61 - 120 HB	525	A	425	A			655	A
P	1.2	Structural steel, case carburizing steel	101 - 200 HB	525	A	425	A			655	A
P	1.3	Plain carbon steel	100 - 250 HB	490	A	425	A			590	A
P	1.4	Alloy steel	150 - 250 HB	425	A	360	A			525	A
P	1.5	Alloy steel, Tempered steel	26 - 38 HRc	295	A	260	A			360	A
P	1.6.1	Alloy steel, Tempered steel	39 - 44 HRc	260	A	230	A			295	A
P	1.6.2	Alloy steel, Tempered steel	44 - 49 HRc	215	B	195	B			260	B
	Stainless Steel										
M	2.1	Free machining stainless steel	120 - 250 HB	195	B	195	B				
M	2.2	Austinetic	130 - 250 HB	165	B	165	B				
M	2.3	Ferritic, austenitic, martensitic	130 - 320 HB	130	B	130	B				
M	2.4	High tensile chrome-nickel alloys	33 - 44 HRc	100	B	100	B				
	Cast Iron										
K	3.1	Cast Iron	50 - 150 HB	360	A	330	A	490	A	490	A
K	3.2	Cast Iron	150 - 300 HB	330	A	295	A	425	A	395	A
K	3.3	Ductile Iron	150 - 200 HB	395	A	330	A	490	A	490	A
K	3.4	Ductile Iron	14 - 32 HRc	330	A	260	A	395	A	360	A
K	3.5	Compacted graphite iron	14 - 32 HRc	260	A	230	A	360	A	330	A
	Non-ferrous Materials										
N	6.1	Copper, unalloyed	80 - 100 HB	1115	C	950	C				
N	6.2	Short chip brass	100 - 200 HB	1050	C	950	C			1345	C
N	6.3	Long chip brass	120 - 200 HB	1115	C	950	C				
N	6.4	Cu-Al-Fe alloys	200 - 440 HB								
N	6.5	Cu-Al-Ni alloys (short chipping)	120 - 250 HB	395	C	330	C			460	C
N	6.6	Cu-Al-Ni alloys (long chipping)	120 - 250 HB	395	C	330	C				
N	7.1	Al, Mg unalloyed	60 - 100 HB	5050	C	5050	C	5050	C		
N	7.2	Al, alloyed Si<0.5%	90 - 180 HB	5050	C	5050	C	5050	C		
N	7.3.1	Al, alloyed Si>=0.5%<4%	90 - 180 HB	3150	C	3150	C	3150	C		
N	7.3.2	Al, alloyed Si>=4%<12%	90 - 180 HB	1245	C	1245	C	1245	C	1870	C
N	7.4	Al, alloyed Si>=12%	90 - 180 HB	490	C	490	C	490	C		
N	7.5.1	Magnesium Standard alloy	120 - 300 N/mm²	1245	C	1245	C	1245	C		
N	7.5.2	Magnesium -high tensile strength	70 - 120 HB	1015	C	1015	C	1015	C		
N	7.5.3	Heat resistant magnesium alloys	120 - 300 N/mm²	755	C	755	C	755	C		
	High Temp Alloys and Titanium Alloys										
S	4.1	Titanium, unalloyed	120 - 200 HB	460	A	360	A				
S	4.2	Titanium, alloyed	14 - 28 HRc	165	A	130	A			195	A
S	4.3	Titanium, alloyed	28 - 44 HRc	130	A	100	A			165	A
S	5.1	Nickel, unalloyed	120 - 150 HB	655	A	560	A				
S	5.2	Nickel, alloyed	150 - 270 HB	130	B	100	B			165	B
S	5.3	Nickel, alloyed	28 - 49 HRc	65	B	65	B			100	B
S	9.1	TIC Hard materials	48 - 51 HRc								
S	9.2	Tungsten alloys	44 - 52 HRc								
S	9.3	Alloys on Cobalt base	150 - 350 HB					100	B		
S	9.4	Molybdenum alloyed	150 - 350 HB								
	Hardened Materials										
H	1.7.1	Steel (hardened), short chipping	49 - 55 HRc	165	B	130	B			195	B
H	1.7.2	Steel (hardened), long chipping	49 - 55 HRc	165	B	165	B			195	B
H	1.8.1	Steel (hardened)	55 - 60 HRc								
H	1.8.2	Steel (hardened)	60 - 65 HRc								
	Synthetic Materials / Others										
O	8.1	Thermoplastics	<50 N/mm²								
O	8.2	Thermosetting plastics	<80 N/mm²							525	C
O	8.3	Reinforced plastic materials	240 - 440 N/mm²							230	C
O	10.1	Standard graphite	<100 N/mm²							855	C
O	10.2	Wear resistant graphite	<100 N/mm²							855	C

	AL 25		AL 45				Tough Guys H 50		Ultra H 50	
	Extra-Long		Standard		Long		Standard		Long	
	P-Norm L		DIN 6527 L		P-Norm L		P-Norm L		DIN 6527 L, P-Norm L	
	25°		45°		45°		50°		50°	
	2		2		2		3-4		4-8	
	Bright		Bright		Bright		TAX		TAX	
										
	Aluminum alloys		Aluminum alloys							
	(1/8...5/8)		(1/16...5/8)		(1/8...5/8)		(1/8...3/4)		(1/8...3/4)	
	AH602681		**AH602511**		**AH602551**		**AH3071118**		**AH8083128**	
	58		59		60		61		62	
	(2...20)		(1...20)		(6...20)		(2...20)		(3...25)	
	H602681		**H602511**		**H602551**		**H3071118**		**H8083128**	
	77		78		79		80		81	
	SFM	FC	SFM	FC	SFM	FC	SFM	FC	SFM	FC
	655	C	755	C	460	C				
	655	C	755	C	490	C				
	655	C	755	C	490	C				
							195	C	260	C
	4395	C	5050	C	3280	C				
	4920	C	5050	C	3410	C				
	2955	C	3150	C	2135	C				
	1115	C	1245	C	820	C				
	425	C	490	C	295	C				
	1115	C	1245	C	820	C				
	885	C	1015	C	655	C				
	655	C	755	C	490	C				
	260	A	295	A	195	A				
	425	A	490	A	295	A				
							35	B	50	B
							195	B	295	B
							195	B	295	B
							195	B	295	B
							195	B	260	B
							130	B	165	B
	490	C	490	C	295	C				
							525	C	855	C
							230	C	395	C
							855	C	855	C
							855	C	855	C

Values

Description	Unit Inch	Unit Metric
Revolutions per minute	min^{-1}	min^{-1}
Cutting Speed	v_c [ft/min]	v_c [m/min]
Feed rate	v_f [inch/min]	v_f [mm/min]
Cutting diameter	d_1 [inch]	d_1 [mm]
Feed per tooth	f_z [inch]	f_z [mm]
Number of teeth	z	z
Axial depth of cut	a_p [inch]	a_p [mm]
Radial width of cut	a_e [inch]	a_e [mm]

Cutting speed factors



Conversions

To m/min from SFM

v_c [m/min] = v_c [ft/min] • 0.3048

To mm from inch

[mm] = [inch] • 25.4

Calculations

RPM with SFM and cutter diameter

$min^{-1} = (v_c \text{ [ft/min]} \cdot 3.82) / d_1 \text{ [inch]}$

RPM with m/min and cutter diameter

$min^{-1} = (v_c \text{ [m/min]} \cdot 1000) / (3.14 \cdot d_1 \text{ [mm]})$

IPM with FPT, number of teeth and RPM

$v_f \text{ [inch/min]} = (f_z \text{ [inch]} \cdot z \cdot min^{-1})$

mm/min with FPT, number of teeth and RPM

$v_f \text{ [mm/min]} = (f_z \text{ [mm]} \cdot z \cdot min^{-1})$

A

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0008	0.0008	0.0012	0.0024	0.0035	0.0047	0.0059	0.0059	0.0079						
0.0020	0.0006	0.0006	0.0010	0.0016	0.0028	0.0039	0.0047	0.0059	0.0079						
0.0040	0.0004	0.0005	0.0008	0.0014	0.0020	0.0031	0.0039	0.0059	0.0079	0.0079	0.0079	0.0079			
0.0080	0.0004	0.0004	0.0006	0.0012	0.0016	0.0024	0.0031	0.0059	0.0071	0.0079	0.0079	0.0079	0.0079	0.0098	
1/64"		0.0004	0.0005	0.0010	0.0012	0.0020	0.0028	0.0047	0.0059	0.0059	0.0059	0.0059	0.0079	0.0098	0.0098
1/32"			0.0004	0.0010	0.0012	0.0016	0.0024	0.0035	0.0047	0.0047	0.0047	0.0047	0.0059	0.0079	0.0098
1/16"				0.0008	0.0012	0.0012	0.0020	0.0031	0.0043	0.0047	0.0047	0.0047	0.0059	0.0079	0.0079
1/8"					0.0008	0.0010	0.0018	0.0030	0.0041	0.0047	0.0047	0.0047	0.0053	0.0069	0.0079
3/16"						0.0008	0.0016	0.0028	0.0039	0.0047	0.0047	0.0047	0.0047	0.0059	0.0079
1/4"							0.0012	0.0024	0.0031	0.0039	0.0039	0.0047	0.0047	0.0059	0.0079
5/16"								0.0020	0.0028	0.0035	0.0039	0.0047	0.0047	0.0059	0.0079
3/8"									0.0024	0.0031	0.0039	0.0047	0.0047	0.0055	0.0063
1/2"										0.0028	0.0035	0.0043	0.0047	0.0055	0.0063
9/16"											0.0031	0.0039	0.0047	0.0051	0.0059
5/8"												0.0035	0.0039	0.0047	0.0059
11/16"													0.0039	0.0043	0.0051
3/4"														0.0039	0.0047
1"															0.0039

B

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0006	0.0006	0.0012	0.0020	0.0031	0.0039	0.0047	0.0047	0.0063						
0.0020	0.0005	0.0005	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047	0.0063						
0.0040	0.0003	0.0004	0.0006	0.0012	0.0016	0.0024	0.0031	0.0047	0.0063	0.0063	0.0063	0.0063			
0.0080	0.0003	0.0003	0.0005	0.0010	0.0014	0.0020	0.0024	0.0047	0.0055	0.0063	0.0063	0.0063	0.0063	0.0079	
1/64"		0.0003	0.0004	0.0008	0.0010	0.0016	0.0024	0.0039	0.0047	0.0047	0.0047	0.0047	0.0063	0.0079	0.0079
1/32"			0.0004	0.0008	0.0010	0.0012	0.0019	0.0031	0.0039	0.0039	0.0039	0.0039	0.0047	0.0063	0.0079
1/16"				0.0006	0.0008	0.0010	0.0020	0.0028	0.0035	0.0039	0.0039	0.0039	0.0047	0.0063	0.0063
1/8"					0.0006	0.0009	0.0018	0.0026	0.0033	0.0039	0.0039	0.0039	0.0043	0.0055	0.0063
3/16"						0.0008	0.0016	0.0024	0.0031	0.0039	0.0039	0.0039	0.0039	0.0047	0.0063
1/4"							0.0012	0.0020	0.0028	0.0031	0.0031	0.0039	0.0039	0.0047	0.0063
5/16"								0.0016	0.0024	0.0031	0.0031	0.0039	0.0039	0.0047	0.0063
3/8"									0.0020	0.0028	0.0031	0.0039	0.0039	0.0047	0.0055
1/2"										0.0024	0.0028	0.0035	0.0039	0.0047	0.0055
9/16"											0.0028	0.0031	0.0039	0.0047	0.0055
5/8"												0.0028	0.0031	0.0039	0.0047
11/16"													0.0031	0.0039	0.0047
3/4"														0.0031	0.0039
1"															0.0039

C

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0014	0.0016	0.0024	0.0039	0.0063	0.0079	0.0098	0.0098	0.0098						
0.0020	0.0012	0.0012	0.0020	0.0031	0.0047	0.0071	0.0079	0.0098	0.0098						
0.0040	0.0008	0.0010	0.0016	0.0024	0.0039	0.0055	0.0071	0.0098	0.0098	0.0098	0.0098	0.0098			
0.0080	0.0008	0.0008	0.0012	0.0020	0.0031	0.0039	0.0055	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	
1/64"		0.0008	0.0008	0.0020	0.0024	0.0035	0.0047	0.0079	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098
1/32"			0.0006	0.0020	0.0024	0.0028	0.0039	0.0063	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098	0.0098
1/16"				0.0016	0.0020	0.0024	0.0031	0.0055	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098	0.0098
1/8"					0.0016	0.0020	0.0030	0.0051	0.0087	0.0087	0.0087	0.0087	0.0093	0.0098	0.0098
3/16"						0.0016	0.0028	0.0047	0.0087	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098
1/4"							0.0020	0.0039	0.0055	0.0071	0.0079	0.0087	0.0087	0.0098	0.0098
5/16"								0.0035	0.0047	0.0063	0.0079	0.0087	0.0087	0.0098	0.0098
3/8"									0.0039	0.0055	0.0071	0.0087	0.0087	0.0098	0.0098
1/2"										0.0047	0.0063	0.0079	0.0087	0.0098	0.0098
9/16"											0.0055	0.0071	0.0087	0.0098	0.0098
5/8"												0.0063	0.0071	0.0087	0.0098
11/16"													0.0071	0.0079	0.0098
3/4"														0.0071	0.0079
1"															0.0079

Solid Carbide Corner Radius

Inch Range

Type	N 30				Tough Guys N 50		AL 25	Ti 40	Ti 45	HSC 30		
Length	Standard				Standard	Long	Extra-Long	Standard	Extra-Long	P-Norm Mini		Long
Helix	30°	30°	30°	30°	50°	50°	25°	40°	45°	30°	30°	30°
No. of flutes	3	3	4	4	3-4	3-4	2	4	4	2	2	4
Surface treatment	Bright	TAX	Bright	TAX	TAX	TAX	Bright	ACN	ACN	TAX	DIA	TAX
												
Coolant supply								Axial				
Range	(1/8...3/4)	(1/8...3/4)	(1/8...3/4)	(1/8...3/4)	(1/8...3/4)	(1/8...3/4)	(1/4...5/8)	(1/2...5/8)	(1/2...5/8)	(1/64...1/8)	(1/64...1/8)	(1/4...5/8)
Remarks							Aluminum alloys	Titanium alloys	Titanium alloys		Graphite machining	
Catalog no.	**AH802511**	**AH8025118**	**AH809511**	**AH8095118**	**AH3120317**	**AH4020117**	**AH602881**	**AH7073717**	**AH7073417**	**AH4044918**	**AH4044919**	**AH8095918**
Catalog page	94	94	95	95	96	97	98	99	100	101	102	103

Metric Range

Type	Tough Guys N 50				AL 25	Ti 40	Ti 45	HSC 30				
Length	DIN 6527 L		P-Norm L		P-Norm L	DIN 6527 L	P-Norm XL	P-Norm Mini			P-Norm XL	
Helix	50°	50°	50°	50°	25°	40°	45°	30°	30°	30°	30°	30°
No. of flutes	4	3-4	3-4	3-4	2	4	4-5	2	2	2	2	2
Surface treatment	TAX	TAX	TAX	TAX	Bright	ACN	ACN	Bright	TAX	DIA	TAX	DIA
												
Coolant supply						Axial						
Range	(6...20)	(2...20)	(4...20)	(4...20)	(6...20)	(12...25)	(16...25)	(0.4...3)	(0.4...3)	(0.4...3)	(4...12)	(4...12)
Remarks					Aluminum alloys	Titanium alloys	Titanium alloys			Graphite machining		Graphite machining
Catalog no.	**H3120317**	**H4120017**	**H3020117**	**H4020117**	**H602881**	**H7073717**	**H7073417**	**H404491**	**H4044918**	**H4044919**	**H8095918**	**H8095919**
Catalog page	107	108	110	111	112	113	114	115	115	116	117	118

Solid Carbide Corner Radius

Inch Range

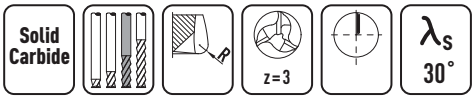
Type	HSC 30	Tough Guys H 50	Ultra H 50
Length	Long	Standard	Long
Helix	30°	50°	50°
No. of flutes	4	3-4	4-8
Surface treatment	DIA	TAX	TAX
			
Coolant supply			
Range	(1/4...1/2)	(1/8...3/4)	(1/8...3/4)
Remarks	Graphite machining	Hard machining	Hard machining
Catalog no.	**AH8095919**	**AH3070118**	**AH8082228**
Catalog page	104	105	106

Metric Range

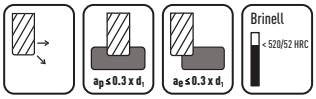
Type	Ultra HSC 30	Tough Guys H 50	Ultra H 50
Length	P-Norm Mini	P-Norm L	DIN 6527 L
Helix	30°	50°	50°
No. of flutes	2	3-4	4-8
Surface treatment	TAX	TAX	TAX
			
Coolant supply			
Range	(0.4...3)	(2...20)	(3...25)
Remarks	Hard machining	Hard machining	Hard machining
Catalog no.	**H4044928**	**H3070118**	**H8082228**
Catalog page	119	120	121

Protostar N 30

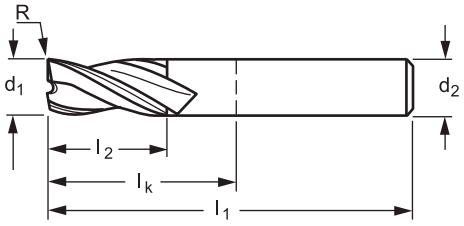
Characteristics



Application



- All-purpose end mill suitable for slot, profile and pocket milling.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

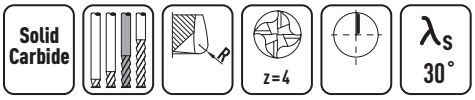


Standard

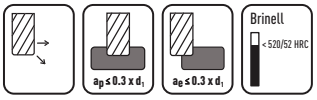
d_1 h9 inch	l_2 inch	R ±0.01 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH802511	Code AH8025118 TAX
1/8	0.500	0.010	2.500	1.083	0.250	3	-1/8-0.010	-1/8-0.010
3/16	0.625	0.015	2.500	1.083	0.250	3	-3/16-0.015	-3/16-0.015
1/4	0.750	0.010	2.500	1.083	0.250	3	-1/4-0.010	-1/4-0.010
1/4	0.750	0.020	2.500	1.083	0.250	3	-1/4-0.020	-1/4-0.020
5/16	0.813	0.010	3.000	1.437	0.375	3	-5/16-0.010	-5/16-0.010
5/16	0.813	0.020	3.000	1.437	0.375	3	-5/16-0.020	-5/16-0.020
3/8	0.875	0.020	3.000	1.437	0.375	3	-3/8-0.020	-3/8-0.020
3/8	0.875	0.030	3.000	1.437	0.375	3	-3/8-0.030	-3/8-0.030
3/8	0.875	0.040	3.000	1.437	0.375	3	-3/8-0.040	-3/8-0.040
7/16	1.000	0.030	3.500	1.717	0.500	3	-7/16-0.030	-7/16-0.030
7/16	1.000	0.040	3.500	1.717	0.500	3	-7/16-0.040	-7/16-0.040
1/2	1.000	0.015	3.500	1.717	0.500	3	-1/2-0.015	-1/2-0.015
1/2	1.000	0.030	3.500	1.717	0.500	3	-1/2-0.030	-1/2-0.030
1/2	1.000	0.060	3.000	1.217	0.500	3	-1/2-0.060	-1/2-0.060
5/8	1.250	0.020	3.500	1.594	0.625	3	-5/8-0.020	-5/8-0.020
5/8	1.250	0.040	3.500	1.594	0.625	3	-5/8-0.040	-5/8-0.040
3/4	1.500	0.030	4.000	1.969	0.750	3	-3/4-0.030	-3/4-0.030
3/4	1.500	0.060	4.000	1.969	0.750	3	-3/4-0.060	-3/4-0.060

Protostar N 30

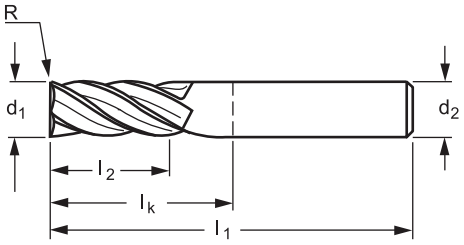
Characteristics



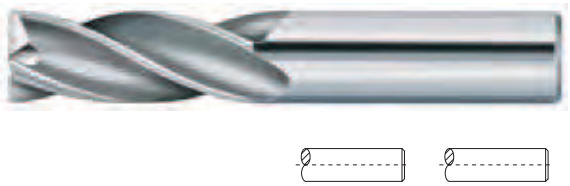
Application



- All-purpose end mill suitable for slot, profile and pocket milling.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



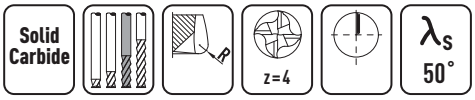
Standard



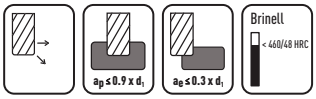
d_1 h9 inch	l_2 inch	R ±0.01 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH809511	Code AH8095118 TAX
1/8	0.500	0.010	2.500	1.083	0.250	4	-1/8-0.010	-1/8-0.010
3/16	0.625	0.015	2.500	1.083	0.250	4	-3/16-0.015	-3/16-0.015
1/4	0.750	0.010	2.500	1.083	0.250	4	-1/4-0.010	-1/4-0.010
1/4	0.750	0.020	2.500	1.083	0.250	4	-1/4-0.020	-1/4-0.020
5/16	0.813	0.010	3.000	1.437	0.375	4	-5/16-0.010	-5/16-0.010
5/16	0.813	0.020	3.000	1.437	0.375	4	-5/16-0.020	-5/16-0.020
3/8	0.875	0.020	3.000	1.437	0.375	4	-3/8-0.020	-3/8-0.020
3/8	0.875	0.030	3.000	1.437	0.375	4	-3/8-0.030	-3/8-0.030
3/8	0.875	0.040	3.000	1.437	0.375	4	-3/8-0.040	-3/8-0.040
7/16	1.000	0.030	3.500	1.717	0.500	4	-7/16-0.030	-7/16-0.030
7/16	1.000	0.040	3.500	1.717	0.500	4	-7/16-0.040	-7/16-0.040
1/2	1.000	0.015	3.500	1.717	0.500	4	-1/2-0.015	-1/2-0.015
1/2	1.000	0.030	3.500	1.717	0.500	4	-1/2-0.030	-1/2-0.030
1/2	1.000	0.060	3.500	1.717	0.500	4	-1/2-0.060	-1/2-0.060
5/8	1.250	0.020	3.500	1.594	0.625	4	-5/8-0.020	-5/8-0.020
5/8	1.250	0.040	3.500	1.594	0.625	4	-5/8-0.040	-5/8-0.040
3/4	1.500	0.030	4.000	1.969	0.750	4	-3/4-0.030	-3/4-0.030
3/4	1.500	0.060	4.000	1.969	0.750	4	-3/4-0.060	-3/4-0.060

Protostar Tough Guys N 50

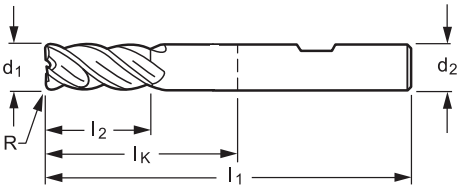
Characteristics



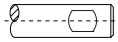
Application



- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



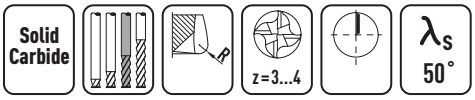
Standard



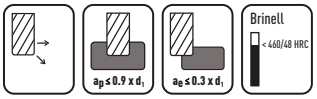
d_1 h9 inch	l_2 inch	R inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3120317 TAX
1/4	0.750	0.040	3.000	1.437	0.375	4	-1/4
5/16	0.813	0.080	3.000	1.437	0.375	4	-5/16
3/8	0.875	0.080	3.000	1.437	0.375	4	-3/8
7/16	1.000	0.080	3.500	1.717	0.500	4	-7/16
1/2	1.000	0.120	3.500	1.717	0.500	4	-1/2
5/8	1.250	0.160	3.500	1.594	0.625	4	-5/8
3/4	1.500	0.160	4.000	1.969	0.750	4	-3/4

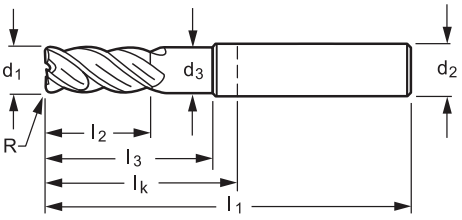
Protostar Tough Guys N 50

Characteristics



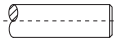
Application





- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys

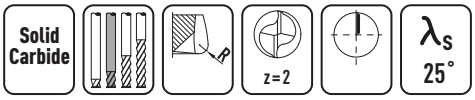
Long



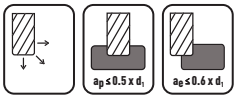
d_1 h9 inch	l_2 inch	R inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH4020117 TAX
1/8	0.500	0.020	1.188	0.119	3.000	1.583	0.250	3	-1/8
3/16	0.625	0.020	1.125	0.178	3.000	1.583	0.250	3	-3/16
1/4	0.750	0.040	1.375	0.237	3.000	1.583	0.250	4	-1/4
5/16	0.813	0.080	1.500	0.297	3.500	1.937	0.375	4	-5/16
3/8	0.875	0.080	1.500	0.356	3.500	1.937	0.375	4	-3/8
7/16	1.000	0.080	2.875	0.416	4.750	2.967	0.500	4	-7/16
1/2	1.000	0.120	2.875	0.475	4.750	2.967	0.500	4	-1/2
5/8	1.250	0.160	3.000	0.594	5.000	3.094	0.625	4	-5/8
3/4	1.500	0.160	3.000	0.713	5.250	3.219	0.750	4	-3/4

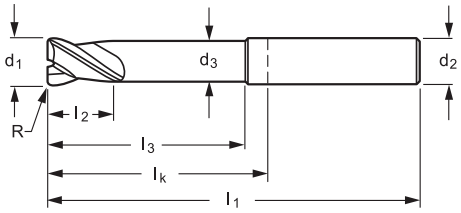
Protostar AL 25

Characteristics



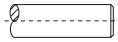
Application





- Primary application is slot and shoulder milling in Aluminum and Aluminum alloys. Also works in unalloyed Ti, Ni and Cu.
- Extra long effective length

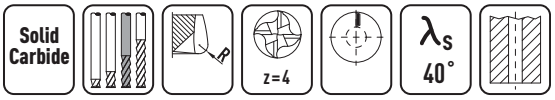
Extra-Long



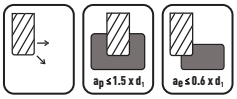
d_1 h9 inch	l_2 inch	R inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH602881
1/4	**0.500**	0.015	2.375	0.237	4.000	2.583	0.250	2	-1/4-0.015
5/16	**0.500**	0.015	2.375	0.297	4.500	2.937	0.375	2	-5/16-0.015
3/8	**0.563**	0.015	2.500	0.356	4.500	2.937	0.375	2	-3/8-0.015
1/2	**0.625**	0.020	4.000	0.475	6.000	4.217	0.500	2	-1/2-0.020
5/8	**0.875**	0.020	4.000	0.594	6.000	4.094	0.625	2	-5/8-0.020
3/4	**1.000**	0.030	4.000	0.713	6.250	4.219	0.750	2	-3/4-0.030

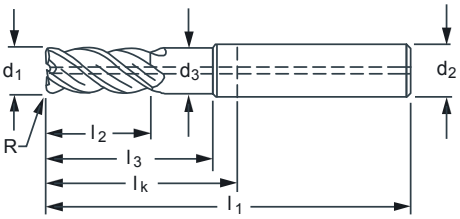
Protostar Ti 40

Characteristics



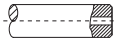
Application





- Special design for roughing and finishing of Titanium and Titanium alloys with the utmost in process security.
- **ACN** (Aluminum Chromium Nitride) has a high degree of hardness and heat resistance.
- Axial coolant through for improved cooling and chip evacuation.
- See pages 14-15 for additional information on the PROTOSTAR Ti

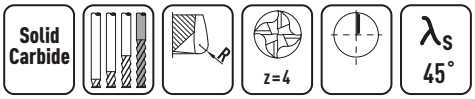
Standard



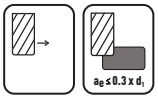
d_1 h9 inch	l_2 inch	R inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH7073717 ACN
1/2	0.625	0.010	1.375	0.475	3.500	1.717	0.500	4	-1/2-0.010
1/2	0.625	0.040	1.375	0.475	3.500	1.717	0.500	4	-1/2-0.040
1/2	0.625	0.080	1.375	0.475	3.500	1.717	0.500	4	-1/2-0.080
5/8	0.875	0.010	1.500	0.594	3.500	1.594	0.625	4	-5/8-0.010
5/8	0.875	0.040	1.500	0.594	3.500	1.594	0.625	4	-5/8-0.040
5/8	0.875	0.080	1.500	0.594	3.500	1.594	0.625	4	-5/8-0.080
3/4	1.000	0.010	2.000	0.713	4.000	1.969	0.750	4	-3/4-0.010
3/4	1.000	0.040	2.000	0.713	4.000	1.969	0.750	4	-3/4-0.040
3/4	1.000	0.080	2.000	0.713	4.000	1.969	0.750	4	-3/4-0.080

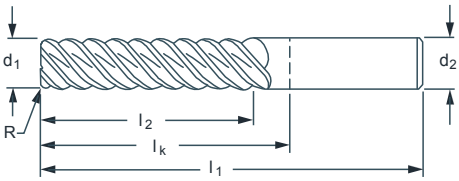
Protostar Ti 45

Characteristics



Application

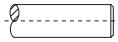




NEW

- High-speed finishing of Titanium and Titanium alloys where surface quality and tool life are paramount.
- **ACN** (Aluminum Chromium Nitride) has a high degree of hardness and heat resistance.
- See pages 14-15 for additional information on the PROTOSTAR Ti

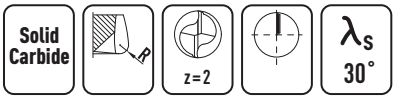
Extra-Long



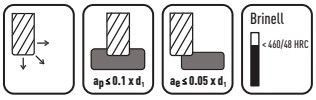
d_1 h9 inch	l_2 inch	R inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH7073417 ACN
1/2	2.000	0.156	4.500	2.717	0.500	4	-1/2-2.000
5/8	2.250	0.156	5.000	3.094	0.625	4	-5/8-2.250
3/4	2.250	0.156	5.000	2.969	0.750	4	-3/4-2.250

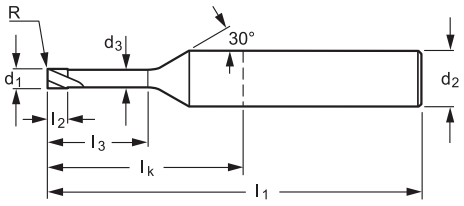
Protostar HSC 30

Characteristics



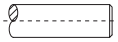
Application





- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

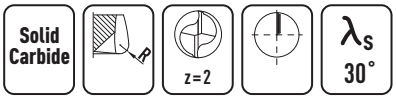
P-Norm Mini



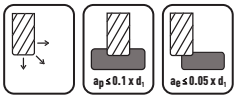
d_1 h7 inch	l_2 inch	R ±0.005 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH4044918 TAX
1/64	0.0156	0.002	0.0469	0.0144	2.500	1.437	0.125	2	-1/64-0.047
1/64	0.0156	0.002	0.0938	0.0144	2.500	1.437	0.125	2	-1/64-0.094
1/32	0.0312	0.002	0.1563	0.0301	2.500	1.437	0.125	2	-1/32-0.156
1/32	0.0312	0.002	0.3125	0.0301	2.500	1.437	0.125	2	-1/32-0.313
3/64	0.0469	0.004	0.3125	0.0457	2.500	1.437	0.125	2	-3/64-0.313
3/64	0.0469	0.004	0.4063	0.0457	2.500	1.437	0.125	2	-3/64-0.406
1/16	0.0625	0.006	0.6250	0.0613	2.500	1.437	0.125	2	-1/16-0.625
1/16	0.0625	0.006	0.3125	0.0613	2.500	1.437	0.125	2	-1/16-0.313
5/64	0.0781	0.006	0.6250	0.0769	2.500	1.437	0.125	2	-5/64-0.625
5/64	0.0781	0.006	0.4063	0.0769	2.500	1.437	0.125	2	-5/64-0.406
3/32	0.0938	0.008	0.4063	0.0926	2.500	1.437	0.125	2	-3/32-0.406
3/32	0.0938	0.008	0.9375	0.0926	2.500	1.437	0.125	2	-3/32-0.938
7/64	0.1094	0.010	0.6250	0.1082	3.000	1.937	0.125	2	-7/64-0.625
7/64	0.1094	0.010	1.2500	0.1082	3.000	1.937	0.125	2	-7/64-1.250
1/8	0.1250	0.012	0.6250	0.1238	3.000	1.937	0.125	2	-1/8-0.625
1/8	0.1250	0.012	1.2500	0.1238	3.000	1.937	0.125	2	-1/8-1.250

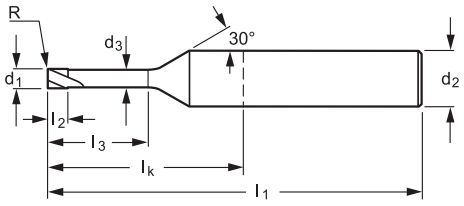
Protostar HSC 30

Characteristics



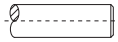
Application





- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.

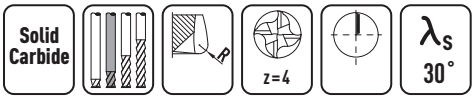
P-Norm Mini



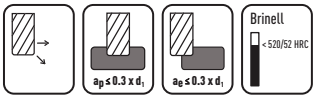
d_1 h8 inch	l_2 inch	R ±0.01 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH4044919 DIA
1/64	**0.0156**	0.002	0.0469	0.0144	2.500	1.437	0.125	2	-1/64-0.047
1/64	**0.0156**	0.002	0.0938	0.0144	2.500	1.437	0.125	2	-1/64-0.094
1/32	**0.0312**	0.002	0.1563	0.0301	2.500	1.437	0.125	2	-1/32-0.156
1/32	**0.0312**	0.002	0.3125	0.0301	2.500	1.437	0.125	2	-1/32-0.313
3/64	**0.0469**	0.004	0.3125	0.0457	2.500	1.437	0.125	2	-3/64-0.313
3/64	**0.0469**	0.004	0.4063	0.0457	2.500	1.437	0.125	2	-3/64-0.406
1/16	**0.0625**	0.006	0.6250	0.0613	2.500	1.437	0.125	2	-1/16-0.625
1/16	**0.0625**	0.006	0.3125	0.0613	2.500	1.437	0.125	2	-1/16-0.313
5/64	**0.0781**	0.006	0.6250	0.0769	2.500	1.437	0.125	2	-5/64-0.625
5/64	**0.0781**	0.006	0.4063	0.0769	2.500	1.437	0.125	2	-5/64-0.406
3/32	**0.0938**	0.008	0.4063	0.0926	2.500	1.437	0.125	2	-3/32-0.406
3/32	**0.0938**	0.008	0.9375	0.0926	2.500	1.437	0.125	2	-3/32-0.938
7/64	**0.1094**	0.010	0.6250	0.1082	2.500	1.437	0.125	2	-7/64-0.625
7/64	**0.1094**	0.010	1.2500	0.1082	2.500	1.437	0.125	2	-7/64-1.250
1/8	**0.1250**	0.012	0.6250	0.1238	2.500	1.437	0.125	2	-1/8-0.625
1/8	**0.1250**	0.012	1.2500	0.1238	2.500	1.437	0.125	2	-1/8-1.250

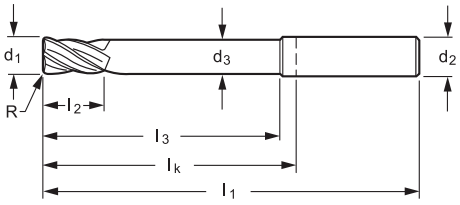
Protostar HSC 30

Characteristics



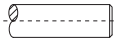
Application





- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

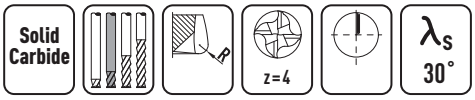
Long



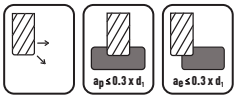
d_1 h9 inch	l_2 inch	R inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH8095918 TAX
1/4	0.250	0.020	1.375	0.246	3.000	1.583	0.250	4	-1/4-1.375
5/16	0.313	0.020	1.500	0.307	3.500	1.937	0.375	4	-5/16-1.500
3/8	0.375	0.040	1.500	0.369	3.500	1.937	0.375	4	-3/8-1.500
1/2	0.500	0.040	2.875	0.492	5.000	3.217	0.500	4	-1/2-2.875
5/8	0.625	0.040	3.000	0.656	5.000	3.094	0.625	4	-5/8-3.000

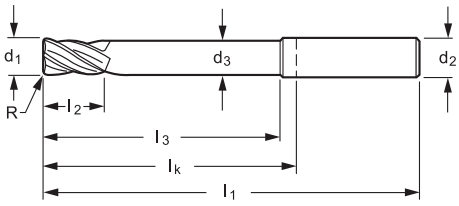
Protostar HSC 30

Characteristics



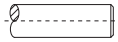
Application





- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.

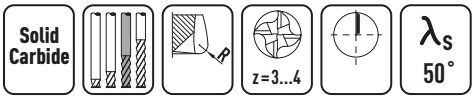
Long



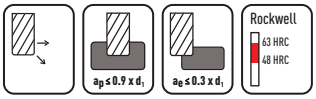
d_1 h9 inch	l_2 inch	R inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH8095919 DIA
1/4	0.250	0.020	1.375	0.246	3.000	1.583	0.250	4	-1/4-1.375
5/16	0.313	0.020	1.500	0.307	3.000	1.437	0.375	4	-5/16-1.500
3/8	0.375	0.040	1.500	0.369	3.000	1.437	0.375	4	-3/8-1.500
1/2	0.500	0.040	2.875	0.492	5.000	3.217	0.500	4	-1/2-2.875

Protostar Tough Guys H 50

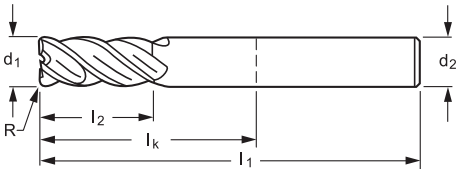
Characteristics



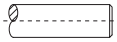
Application



- The combination of a variable flute depth with an offset tooth geometry provides a robust design for machining hardened materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



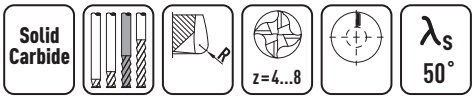
Standard



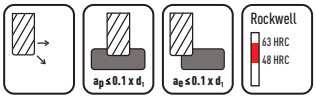
d_1 h9 inch	l_2 inch	R inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3070118 TAX
1/8	0.500	0.020	2.500	1.083	0.250	3	-1/8
3/16	0.625	0.040	2.500	1.083	0.250	3	-3/16
1/4	0.750	0.040	2.500	1.083	0.250	4	-1/4
5/16	0.813	0.080	3.000	1.437	0.375	4	-5/16
3/8	0.875	0.080	3.000	1.437	0.375	4	-3/8
7/16	1.000	0.120	3.500	1.717	0.500	4	-7/16
1/2	1.000	0.120	3.500	1.717	0.500	4	-1/2
5/8	1.250	0.156	3.500	1.594	0.625	4	-5/8
3/4	1.500	0.156	4.000	1.969	0.750	4	-3/4

Protostar Ultra H 50

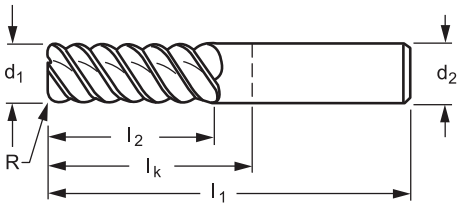
Characteristics



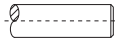
Application



- Finishing operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



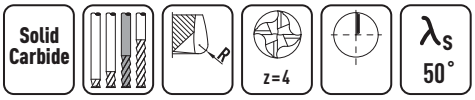
Long



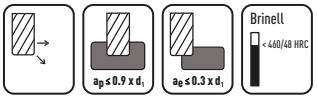
d_1 h9 inch	l_2 inch	R inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH8082228 TAX
1/8	0.500	0.020	2.500	1.083	0.250	4	-1/8-0.020
3/16	0.625	0.020	2.500	1.083	0.250	4	-3/16-0.020
1/4	0.750	0.020	3.000	1.583	0.250	6	-1/4-0.020
1/4	0.750	0.040	3.000	1.583	0.250	6	-1/4-0.040
5/16	0.813	0.020	3.000	1.437	0.375	6	-5/16-0.020
5/16	0.813	0.040	3.000	1.437	0.375	6	-5/16-0.040
3/8	0.875	0.020	3.000	1.437	0.375	6	-3/8-0.020
3/8	0.875	0.040	3.000	1.437	0.375	6	-3/8-0.040
3/8	0.875	0.060	3.000	1.437	0.375	6	-3/8-0.060
7/16	1.000	0.020	4.500	2.717	0.500	6	-7/16-0.020
7/16	1.000	0.040	4.500	2.717	0.500	6	-7/16-0.040
1/2	1.000	0.040	4.500	2.717	0.500	6	-1/2-0.040
1/2	1.000	0.060	4.500	2.717	0.500	6	-1/2-0.060
1/2	1.000	0.090	4.500	2.717	0.500	6	-1/2-0.090
5/8	1.250	0.060	5.000	3.094	0.625	6	-5/8-0.060
5/8	1.250	0.125	5.000	3.094	0.625	6	-5/8-0.125
3/4	1.500	0.060	5.000	2.969	0.750	8	-3/4-0.060
3/4	1.500	0.125	5.000	2.969	0.750	8	-3/4-0.125

Protostar Tough Guys N 50

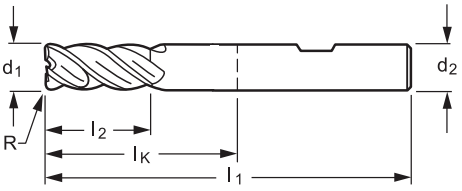
Characteristics



Application



- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



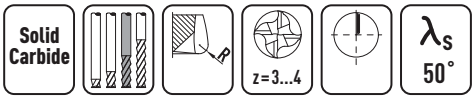
DIN 6527 L

DIN 6535HB

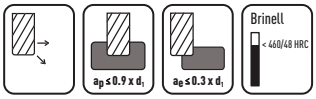
d_1 h9 mm	l_2 mm	R mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3120317 TAX
6	13	1	57	21	6	4	-6
8	19	2	63	27	8	4	-8
10	22	2	72	32	10	4	-10
12	26	3	83	38	12	4	-12
14	26	3	83	38	14	4	-14
16	32	4	92	44	16	4	-16
20	38	4	104	54	20	4	-20

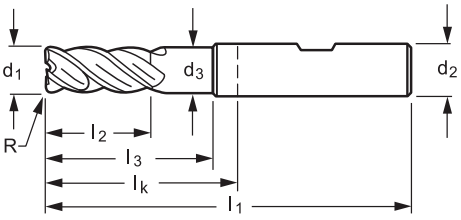
Protostar Tough Guys N 50

Characteristics



Application





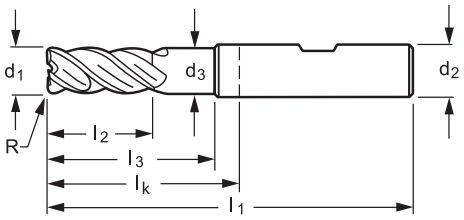
- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys

DIN 6527 L

DIN 6535HB

d_1 h9 mm	l_2 mm	R mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H4120017 TAX
2	7	0.2	9.5	1.92	57	21	6	3	-2-0.2
3	8	0.3	10	2.9	57	21	6	3	-3-0.3
4	11	0.5	15	3.8	57	21	6	3	-4-0.5
5	13	0.5	16	4.75	57	21	6	3	-5-0.5
6	13	0.5	19	5.7	57	21	6	4	-6-0.5
6	13	1	19	5.7	57	21	6	4	-6-1
8	19	0.5	25	7.6	63	27	8	4	-8-0.5
8	19	1	25	7.6	63	27	8	4	-8-1
8	19	1.5	25	7.6	63	27	8	4	-8-1.5
8	19	2	25	7.6	63	27	8	4	-8-2
10	22	0.5	30	9.5	72	32	10	4	-10-0.5
10	22	1	30	9.5	72	32	10	4	-10-1
10	22	1.5	30	9.5	72	32	10	4	-10-1.5
10	22	2	30	9.5	72	32	10	4	-10-2
12	26	0.5	36	11.4	83	38	12	4	-12-0.5
12	26	1	36	11.4	83	38	12	4	-12-1
12	26	1.5	36	11.4	83	38	12	4	-12-1.5
12	26	2	36	11.4	83	38	12	4	-12-2
12	26	2.5	36	11.4	83	38	12	4	-12-2.5
12	26	3	36	11.4	83	38	12	4	-12-3
14	26	1	36	13.3	83	38	14	4	-14-1
14	26	1.5	36	13.3	83	38	14	4	-14-1.5
14	26	2	36	13.3	83	38	14	4	-14-2
14	26	3	36	13.3	83	38	14	4	-14-3

Continuation - Protostar Tough Guys N 50



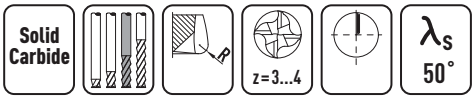
DIN 6527 L

DIN 6535HB

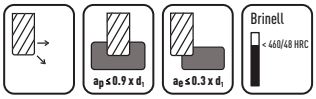
d_1 h9 mm	l_2 mm	R mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H4120017 TAX
16	32	0.5	42	15.2	92	44	16	4	-16-0.5
16	32	1	42	15.2	92	44	16	4	-16-1
16	32	2	42	15.2	92	44	16	4	-16-2
16	32	2.5	42	15.2	92	44	16	4	-16-2.5
16	32	4	42	15.2	92	44	16	4	-16-4
20	38	0.5	52	19	104	54	20	4	-20-0.5
20	38	1	52	19	104	54	20	4	-20-1
20	38	2	52	19	104	54	20	4	-20-2
20	38	2.5	52	19	104	54	20	4	-20-2.5
20	38	4	52	19	104	54	20	4	-20-4

Protostar Tough Guys N 50

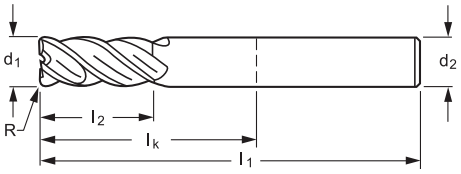
Characteristics



Application



- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



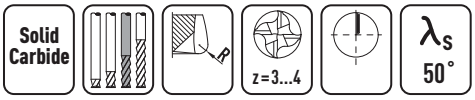
P-Norm L

DIN 6535HA

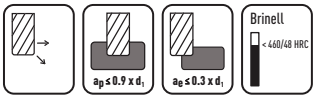
d_1 h9 mm	l_2 mm	R mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3020117 TAX
4	11	1	57	21	6	3	-4
5	13	1	57	21	6	3	-5
6	13	1	65	29	6	4	-6
8	19	2	80	44	8	4	-8
10	22	2	100	60	10	4	-10
12	26	3	100	55	12	4	-12
14	26	3	104	59	14	4	-14
16	32	4	115	67	16	4	-16
20	38	4	125	75	20	4	-20

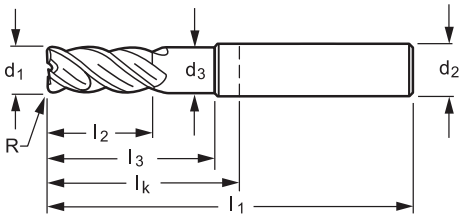
Protostar Tough Guys N 50

Characteristics



Application





- The combination of a variable flute depth with an offset tooth geometry provides a stable design for machining at up to 50% higher feed rates.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys

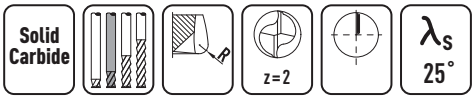
P-Norm L

DIN 6535HA

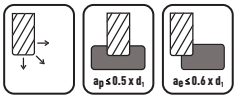
d_1 h9 mm	l_2 mm	R mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H4020117 TAX
4	11	0.5	15	3.8	57	21	6	3	-4-0.5
4	11	1	15	3.8	57	21	6	3	-4
5	13	0.5	16	4.75	57	21	6	3	-5-0.5
5	13	1	16	4.75	57	21	6	3	-5
6	13	0.5	27	5.7	65	29	6	4	-6-0.5
6	13	1	27	5.7	65	29	6	4	-6
8	19	0.5	42	7.6	80	44	8	4	-8-0.5
8	19	1	42	7.6	80	44	8	4	-8-1
8	19	2	42	7.6	80	44	8	4	-8
10	22	0.5	58	9.5	100	60	10	4	-10-0.5
10	22	1	58	9.5	100	60	10	4	-10-1
10	22	2	58	9.5	100	60	10	4	-10
12	26	0.5	53	11.4	100	55	12	4	-12-0.5
12	26	1	53	11.4	100	55	12	4	-12-1
12	26	3	53	11.4	100	55	12	4	-12
14	26	0.5	57	13.3	104	59	14	4	-14-0.5
14	26	1	57	13.3	104	59	14	4	-14-1
14	26	3	57	13.3	104	59	14	4	-14
16	32	0.5	65	15.2	115	67	16	4	-16-0.5
16	32	1	65	15.2	115	67	16	4	-16-1
16	32	2	65	15.2	115	67	16	4	-16-2
16	32	4	65	15.2	115	67	16	4	-16
20	38	1	73	19	125	75	20	4	-20-1
20	38	2	73	19	125	75	20	4	-20-2
20	38	4	73	19	125	75	20	4	-20

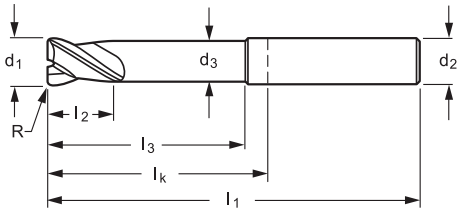
Protostar AL 25

Characteristics



Application





- Primary application is slot and shoulder milling in Aluminum and Aluminum alloys. Also works in unalloyed Ti, Ni and Cu.
- Extra long effective length

P-Norm L

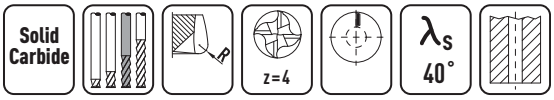
DIN 6535HA

d_1 h9 mm	l_2 mm	R mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H602881
6	10	0.5	28	5.7	65	29	6	2	-6-0.5
6	10	1	28	5.7	65	29	6	2	-6-1
8	12	1	35	7.6	80	44	8	2	-8-1
8	12	2	35	7.6	80	44	8	2	-8-2
10	14	1	45	9.5	90	50	10	2	-10-1
10	14	2	45	9.5	90	50	10	2	-10-2
12	16	1.5	50	11.4	100	55	[1] 12	2	-12-1.5
12	16	3	50	11.4	100	55	[1] 12	2	-12-3
16	20	2	63	15.2	115	67	[1] 16	2	-16-2
16	20	4	63	15.2	115	67	[1] 16	2	-16-4
20	20	2	70	19.0	125	75	[1] 20	2	-20-2
20	20	4	70	19.0	125	75	[1] 20	2	-20-4

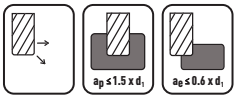
1) shank tolerance h6

Protostar Ti 40

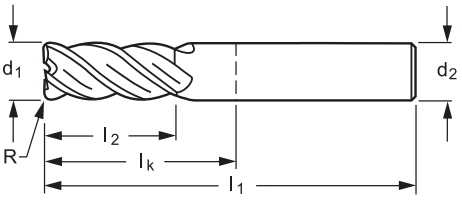
Characteristics



Application



- Special design for roughing and finishing of Titanium and Titanium alloys with the utmost in process security.
- **ACN** (Aluminum Chromium Nitride) has a high degree of hardness and heat resistance.
- Axial coolant through for improved cooling and chip evacuation.
- See pages 14-15 for additional information on the PROTOSTAR Ti



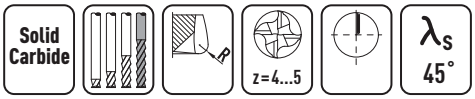
DIN 6527 L

DIN 6535HA

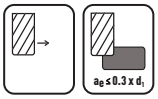
d_1 h9 mm	l_2 mm	R mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H7073717 ACN
12	19	0.2	36	11.4	83	38	12	4	-12-0.2
12	19	2	36	11.4	83	38	12	4	-12-2
12	19	2.5	36	11.4	83	38	12	4	-12-2.5
16	26	0.2	42	15.2	92	44	16	4	-16-0.2
16	26	2	42	15.2	92	44	16	4	-16-2
16	26	2.5	42	15.2	92	44	16	4	-16-2.5
16	26	4	42	15.2	92	44	16	4	-16-4
20	32	0.2	52	19	104	54	20	4	-20-0.2
20	32	2	52	19	104	54	20	4	-20-2
20	32	2.5	52	19	104	54	20	4	-20-2.5
20	32	4	52	19	104	54	20	4	-20-4
25	40	0.2	63	23.75	121	65	25	4	-25-0.2
25	40	2	63	23.75	121	65	25	4	-25-2
25	40	2.5	63	23.75	121	65	25	4	-25-2.5
25	40	4	63	23.75	121	65	25	4	-25-4

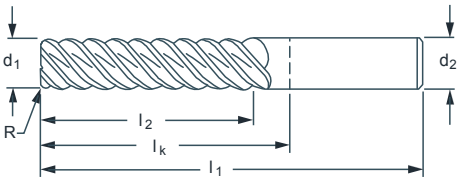
Protostar Ti 45

Characteristics



Application





NEW

- High-speed finishing of Titanium and Titanium alloys where surface quality and tool life are paramount.
- **ACN** (Aluminum Chromium Nitride) has a high degree of hardness and heat resistance.
- See pages 14-15 for additional information on the PROTOSTAR Ti

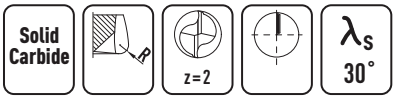
P-Norm XL

DIN 6535HA

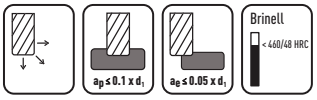
d_1 h9 mm	l_2 mm	R mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H7073417 ACN
16	50	4	115	67	16	4	-16X50
16	90	4	145	97	16	4	-16X90
20	55	4	125	75	20	4	-20X55
20	100	4	170	120	20	4	-20X100
25	90	4	153	74	25	5	-25X90
25	125	4	188	132	25	5	-25X125

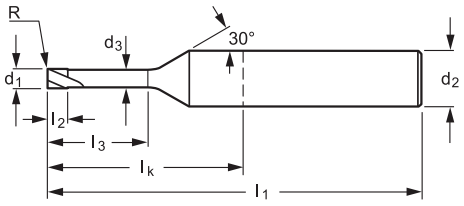
Protostar HSC 30

Characteristics



Application





- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

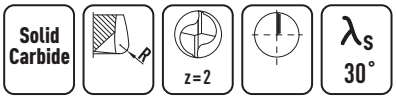
P-Norm Mini

DIN 6535HA DIN 6535HA

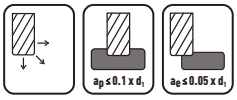
d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H404491	Code H4044918 TAX
0.4	0.4	0.05	1	0.37	38	10	3	2	-0.4-1	-0.4-1
0.4	0.4	0.05	2	0.37	38	10	3	2	-0.4-2	-0.4-2
0.4	0.4	0.05	4	0.37	38	10	3	2	-0.4-4	-0.4-4
0.5	0.5	0.05	1.25	0.47	38	10	3	2	-0.5-1.25	-0.5-1.25
0.5	0.5	0.05	2.5	0.47	38	10	3	2	-0.5-2.5	-0.5-2.5
0.5	0.5	0.05	5	0.47	38	10	3	2	-0.5-5	-0.5-5
0.6	0.6	0.05	1.5	0.57	38	10	3	2	-0.6-1.5	-0.6-1.5
0.6	0.6	0.05	3	0.57	38	10	3	2	-0.6-3	-0.6-3
0.6	0.6	0.05	4.5	0.57	38	10	3	2	-0.6-4.5	-0.6-4.5
0.6	0.6	0.05	6	0.57	38	10	3	2	-0.6-6	-0.6-6
0.6	0.6	0.05	9	0.57	38	10	3	2	-0.6-9	-0.6-9
0.8	0.8	0.05	2	0.77	38	10	3	2	-0.8-2	-0.8-2
0.8	0.8	0.05	4	0.77	38	10	3	2	-0.8-4	-0.8-4
0.8	0.8	0.05	6	0.77	38	10	3	2	-0.8-6	-0.8-6
0.8	0.8	0.05	8	0.77	38	10	3	2	-0.8-8	-0.8-8
0.8	0.8	0.05	12	0.77	60	32	3	2	-0.8-12	-0.8-12
1	1	0.1	2.5	0.97	38	10	3	2	-1-2.5	-1-2.5
1	1	0.1	5	0.97	60	32	3	2	-1-5	-1-5
1	1	0.1	7.5	0.97	60	32	3	2	-1-7.5	-1-7.5
1	1	0.1	10	0.97	60	32	3	2	-1-10	-1-10
1	1	0.1	15	0.97	60	32	3	2	-1-15	-1-15
1	1	0.1	20	0.97	60	32	3	2	-1-20	-1-20
1.5	1.5	0.15	7.5	1.47	60	32	3	2	-1.5-7.5	-1.5-7.5
1.5	1.5	0.15	15	1.47	60	32	3	2	-1.5-15	-1.5-15
2	2	0.2	10	1.97	60	32	3	2	-2-10	-2-10
2	2	0.2	15	1.97	60	32	3	2	-2-15	-2-15
2	2	0.2	20	1.97	60	32	3	2	-2-20	-2-20
2	2	0.2	30	1.97	60	32	3	2	-2-30	-2-30
2.5	2.5	0.25	12.5	2.47	60	32	3	2	-2.5-12.5	-2.5-12.5
2.5	2.5	0.25	25	2.47	60	32	3	2	-2.5-25	-2.5-25
3	3	0.3	15	2.97	60	32	3	2	-3-15	-3-15
3	3	0.3	22.5	2.97	60	32	3	2	-3-22.5	-3-22.5
3	3	0.3	30	2.97	60	32	3	2	-3-30	-3-30

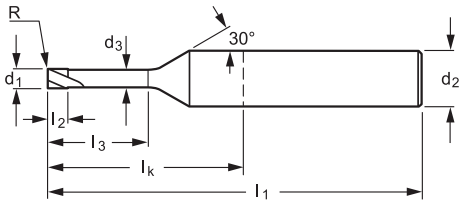
Protostar HSC 30

Characteristics



Application





- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.

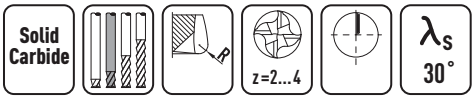
P-Norm Mini

DIN 6535HA

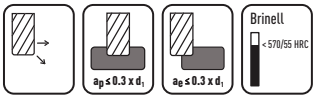
d_1 h8 mm	l_2 mm	R ±0,01 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H4044919 DIA
0.4	0.4	0.05	1	0.37	38	10	3	2	-0.4-1
0.4	0.4	0.05	2	0.37	38	10	3	2	-0.4-2
0.4	0.4	0.05	4	0.37	38	10	3	2	-0.4-4
0.5	0.5	0.05	1.25	0.47	38	10	3	2	-0.5-1.25
0.5	0.5	0.05	2.5	0.47	38	10	3	2	-0.5-2.5
0.5	0.5	0.05	5	0.47	38	10	3	2	-0.5-5
0.6	0.6	0.05	1.5	0.57	38	10	3	2	-0.6-1.5
0.6	0.6	0.05	3	0.57	38	10	3	2	-0.6-3
0.6	0.6	0.05	4.5	0.57	38	10	3	2	-0.6-4.5
0.6	0.6	0.05	6	0.57	38	10	3	2	-0.6-6
0.6	0.6	0.05	9	0.57	38	10	3	2	-0.6-9
0.8	0.8	0.05	2	0.77	38	10	3	2	-0.8-2
0.8	0.8	0.05	4	0.77	38	10	3	2	-0.8-4
0.8	0.8	0.05	6	0.77	38	10	3	2	-0.8-6
0.8	0.8	0.05	8	0.77	38	10	3	2	-0.8-8
0.8	0.8	0.05	12	0.77	60	32	3	2	-0.8-12
1	1	0.1	2.5	0.97	38	10	3	2	-1-2.5
1	1	0.1	5	0.97	60	32	3	2	-1-5
1	1	0.1	7.5	0.97	60	32	3	2	-1-7.5
1	1	0.1	10	0.97	60	32	3	2	-1-10
1	1	0.1	15	0.97	60	32	3	2	-1-15
1	1	0.1	20	0.97	60	32	3	2	-1-20
1.5	1.5	0.15	7.5	1.47	60	32	3	2	-1.5-7.5
1.5	1.5	0.15	15	1.47	60	32	3	2	-1.5-15
2	2	0.2	10	1.97	60	32	3	2	-2-10
2	2	0.2	15	1.97	60	32	3	2	-2-15
2	2	0.2	20	1.97	60	32	3	2	-2-20
2	2	0.2	30	1.97	60	32	3	2	-2-30
2.5	2.5	0.25	12.5	2.47	60	32	3	2	-2.5-12.5
2.5	2.5	0.25	25	2.47	60	32	3	2	-2.5-25
3	3	0.3	15	2.97	60	32	3	2	-3-15
3	3	0.3	22.5	2.97	60	32	3	2	-3-22.5
3	3	0.3	30	2.97	60	32	3	2	-3-30

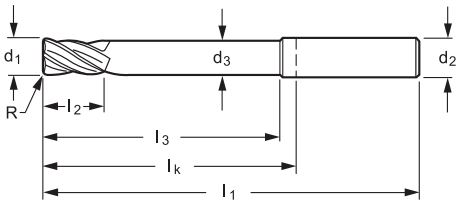
Protostar HSC 30

Characteristics



Application





- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

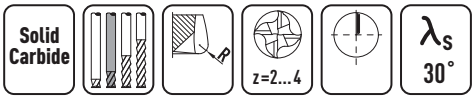
P-Norm XL

DIN 6535HA

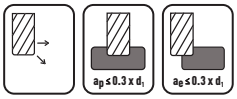
d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8095918 TAX
4	4	0.5	20	3.9	100	64	6	2	-4-20
4	4	0.5	30	3.9	100	64	6	2	-4-30
4	4	0.5	40	3.9	100	64	6	2	-4-40
5	5	0.5	25	4.9	100	64	6	2	-5-25
5	5	0.5	50	4.9	100	64	6	2	-5-50
6	6	0.5	30	5.9	100	64	6	4	-6-30
6	6	0.5	45	5.9	100	64	6	4	-6-45
6	6	0.5	60	5.9	100	64	6	4	-6-60
8	8	0.5	40	7.85	120	84	8	4	-8-40
8	8	0.5	60	7.85	120	84	8	4	-8-60
8	8	0.5	80	7.85	120	84	8	4	-8-80
10	10	1	50	9.85	150	110	10	4	-10-50
10	10	1	75	9.85	150	110	10	4	-10-75
12	12	1	60	11.8	150	105	12	4	-12-60

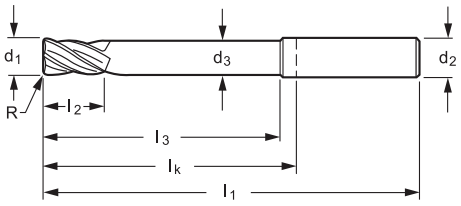
Protostar HSC 30

Characteristics



Application





- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.

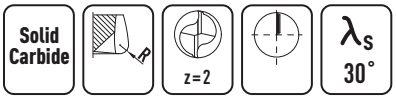
P-Norm XL

DIN 6535HA

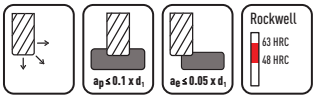
d_1 h8 mm	l_2 mm	R ±0,01 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8095919 DIA
4	4	0.5	20	3.9	100	64	6	2	-4-20
4	4	0.5	30	3.9	100	64	6	2	-4-30
4	4	0.5	40	3.9	100	64	6	2	-4-40
5	5	0.5	25	4.9	100	64	6	2	-5-25
5	5	0.5	50	4.9	100	64	6	2	-5-50
6	6	0.5	30	5.9	100	64	6	4	-6-30
6	6	0.5	45	5.9	100	64	6	4	-6-45
6	6	0.5	60	5.9	100	64	6	4	-6-60
8	8	0.5	40	7.85	120	84	8	4	-8-40
8	8	0.5	60	7.85	120	84	8	4	-8-60
8	8	0.5	80	7.85	120	84	8	4	-8-80
10	10	1	50	9.85	150	110	10	4	-10-50
10	10	1	75	9.85	150	110	10	4	-10-75
12	12	1	60	11.8	150	105	12	4	-12-60
12	12	1	90	11.8	150	105	12	4	-12-90

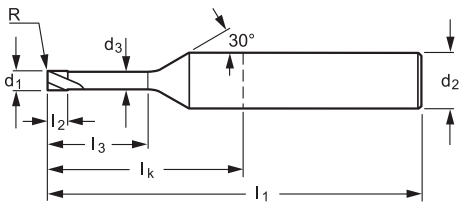
Protostar Ultra HSC 30

Characteristics



Application





- Designed for High-Speed machining operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

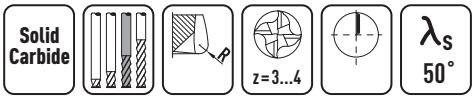
P-Norm Mini

DIN 6535HA

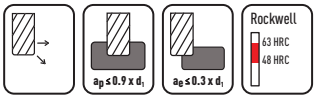
d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H4044928 TAX
0.4	0.4	0.05	1	0.37	38	10	3	2	-0.4-1
0.4	0.4	0.05	2	0.37	38	10	3	2	-0.4-2
0.5	0.5	0.05	1.25	0.47	38	10	3	2	-0.5-1.25
0.5	0.5	0.05	2.5	0.47	38	10	3	2	-0.5-2.5
0.5	0.5	0.05	3.75	0.47	38	10	3	2	-0.5-3.75
0.6	0.6	0.05	1.5	0.57	38	10	3	2	-0.6-1.5
0.6	0.6	0.05	3	0.57	38	10	3	2	-0.6-3
0.6	0.6	0.05	4.5	0.57	38	10	3	2	-0.6-4.5
0.8	0.8	0.05	2	0.77	38	10	3	2	-0.8-2
0.8	0.8	0.05	4	0.77	38	10	3	2	-0.8-4
0.8	0.8	0.05	6	0.77	38	10	3	2	-0.8-6
1	1	0.1	2.5	0.97	38	10	3	2	-1-2.5
1	1	0.1	5	0.97	60	32	3	2	-1-5
1	1	0.1	7.5	0.97	60	32	3	2	-1-7.5
1.5	1.5	0.15	4	1.47	38	10	3	2	-1.5-4
1.5	1.5	0.15	7.5	1.47	60	32	3	2	-1.5-7.5
1.5	1.5	0.15	12	1.47	60	32	3	2	-1.5-12
2	2	0.2	5	1.97	38	10	3	2	-2-5
2	2	0.2	10	1.97	60	32	3	2	-2-10
2	2	0.2	15	1.97	60	32	3	2	-2-15
2.5	2	0.25	6	2.47	38	10	3	2	-2.5-6
2.5	2	0.25	12.5	2.47	60	32	3	2	-2.5-12.5
2.5	2	0.25	20	2.47	60	32	3	2	-2.5-20
3	2	0.3	7.5	2.97	38	10	3	2	-3-7.5
3	2	0.3	15	2.97	60	32	3	2	-3-15
3	2	0.3	22.5	2.97	60	32	3	2	-3-22.5

Protostar Tough Guys H 50

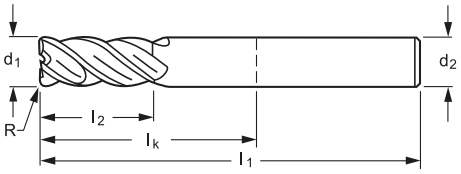
Characteristics



Application



- The combination of a variable flute depth with an offset tooth geometry provides a robust design for machining hardened materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- See pages 12-13 for additional information on the Tough Guys



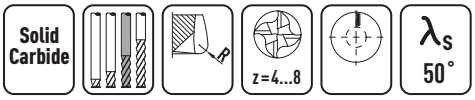
P-Norm L

DIN 6535HA

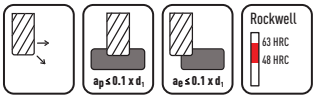
d_1 h9 mm	l_2 mm	R mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3070118 TAX
2	7	0.5	57	21	6	3	-2
3	8	0.5	57	21	6	3	-3
4	11	0.5	57	21	6	3	-4-0.5
4	11	1	57	21	6	3	-4
5	13	0.5	57	21	6	3	-5-0.5
5	13	1	57	21	6	3	-5
6	13	0.5	65	29	6	4	-6-0.5
6	13	1	65	29	6	4	-6
8	19	0.5	80	44	8	4	-8-0.5
8	19	1	80	44	8	4	-8-1
8	19	2	80	44	8	4	-8
10	22	0.5	100	60	10	4	-10-0.5
10	22	1	100	60	10	4	-10-1
10	22	2	100	60	10	4	-10
12	26	0.5	100	55	12	4	-12-0.5
12	26	1	100	55	12	4	-12-1
12	26	2	100	55	12	4	-12-2
12	26	3	100	55	12	4	-12
14	26	0.5	104	59	14	4	-14-0.5
14	26	1	104	59	14	4	-14-1
14	26	2	104	59	14	4	-14-2
14	26	3	104	59	14	4	-14
16	32	0.5	115	67	16	4	-16-0.5
16	32	1	115	67	16	4	-16-1
16	32	2	115	67	16	4	-16-2
16	32	4	115	67	16	4	-16
20	38	0.5	125	75	20	4	-20-0.5
20	38	1	125	75	20	4	-20-1
20	38	2	125	75	20	4	-20-2
20	38	4	125	75	20	4	-20

Protostar Ultra H 50

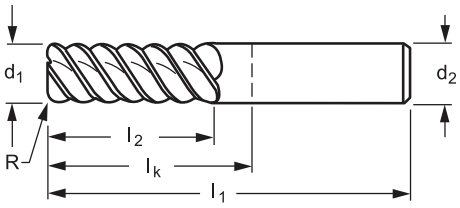
Characteristics



Application



- Finishing operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



DIN 6527 L

DIN 6535HA

d_1 h9 mm	l_2 mm	R mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8082228 TAX
3	8	0.5	57	21	6	4	-3-0.5
4	11	0.5	57	21	6	4	-4-0.5
4	11	1	57	21	6	4	-4-1
5	13	0.5	57	21	6	6	-5-0.5
5	13	1	57	21	6	6	-5-1
6	13	0.5	57	21	6	6	-6-0.5
6	13	1	57	21	6	6	-6-1
8	19	0.5	63	27	8	6	-8-0.5
8	19	1	63	27	8	6	-8-1
8	19	2	63	27	8	6	-8-2
10	22	0.5	72	32	10	6	-10-0.5
10	22	1	72	32	10	6	-10-1
10	22	1.5	72	32	10	6	-10-1.5
10	22	2	72	32	10	6	-10-2
12	26	1	83	38	12	6	-12-1
12	26	1.5	83	38	12	6	-12-1.5
12	26	3	83	38	12	6	-12-3
16	32	1.5	92	44	16	6	-16-1.5
16	32	2	92	44	16	6	-16-2
16	32	4	92	44	16	6	-16-4
20	38	1.5	104	54	20	8	-20-1.5
20	38	2	104	54	20	8	-20-2
20	38	4	104	54	20	8	-20-4

Application guide - Corner Radius

Speed and Feed Chart: The speeds and feeds in this table are intended for intial setup. These values are a guide, depending on machining conditions, these parameters may need to be adjusted up or down until optimum settings are found.

How to use this chart:

1. Pick your material group*
2. Move across to mill series
3. Read SFM and Feed Chart (FC) Letter
4. Go to the Feed Charts on pages 126-127 and convert to feed per tooth
5. Calculate Speed and Feed using formulas on page 126

* Example materials can be found in the Material Library on page 188-189 of the Technical Information section

			Type	**N 30**						
			Length inch	Standard		Standard		Standard		Standard
			Length metric							
			Helix	30°		30°		30°		30°
			No. of flutes	3		3		4		4
			Surface treatment	Bright		TAX		Bright		TAX
										
			Remarks							
		INCH	Range	(1/8...3/4)		(1/8...3/4)		(1/8...3/4)		(1/8...3/4)
		INCH	**Catalog No.**	**AH802511**		**AH8025118**		**AH809511**		**AH8095118**
		INCH	Catalog Page	94		94		95		95
		METRIC	Range							
		METRIC	**Catalog No.**							
		METRIC	Catalog Page							
ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Hardness	SFM	FC	SFM	FC	SFM	FC	SFM FC
P	**Steel**									
	1.1	Magnetic soft steel	61 - 120 HB							
	1.2	Structural steel, case carburizing steel	101 - 200 HB							
	1.3	Plain carbon steel	100 - 250 HB							
	1.4	Alloy steel	150 - 250 HB							
	1.5	Alloy steel, Tempered steel	26 - 38 HRc							
	1.6.1	Alloy steel, Tempered steel	39 - 44 HRc							
	1.6.2	Alloy steel, Tempered steel	44 - 49 HRc							
M	**Stainless Steel**									
	2.1	Free machining stainless steel	120 - 250 HB							
	2.2	Austinetic	130 - 250 HB							
	2.3	Ferritic, austenitic, martensitic	130 - 320 HB							
	2.4	High tensile chrome-nickel alloys	33 - 44 HRc							
K	**Cast Iron**									
	3.1	Cast Iron	50 - 150 HB	260	A	525	A	245	A	490 A
	3.2	Cast Iron	150 - 300 HB	195	A	425	A	195	A	425 A
	3.3	Ductile Iron	150 - 200 HB	260	A	525	A	245	A	490 A
	3.4	Ductile Iron	14 - 32 HRc	230	A	425	A	195	A	395 A
	3.5	Compacted graphite iron	14 - 32 HRc	165	A	360	A	165	A	360 A
N	**Non-ferrous Materials**									
	6.1	Copper, unalloyed	80 - 100 HB	755	C	1445	C			
	6.2	Short chip brass	100 - 200 HB	755	C	1445	C	720	C	1410 C
	6.3	Long chip brass	120 - 200 HB	755	C	1445	C			
	6.4	Cu-Al-Fe alloys	200 - 440 HB	130	C	230	C	130	C	195 C
	6.5	Cu-Al-Ni alloys (short chipping)	120 - 250 HB	260	C	490	C	260	C	490 C
	6.6	Cu-Al-Ni alloys (long chipping)	120 - 250 HB	260	C	490	C	260	C	490 C
	7.1	Al, Mg unalloyed	60 - 100 HB	5415	C	5415	C			
	7.2	Al, alloyed Si<0.5%	90 - 180 HB	5415	C	5415	C			
	7.3.1	Al, alloyed Si>=0.5%<4%	90 - 180 HB	3150	C	4855	C			
	7.3.2	Al, alloyed Si>=4%<12%	90 - 180 HB	1245	C	2000	C			
	7.4	Al, alloyed Si>=12%	90 - 180 HB	490	C	690	C	490	C	690 C
	7.5.1	Magnesium Standard alloy	120 - 300 N/mm²	1245	C	2330	C			
	7.5.2	Magnesium -high tensile strength	70 - 120 HB	1015	C	2035	C			
	7.5.3	Heat resistant magnesium alloys	120 - 300 N/mm²	755	C	1740	C			
S	**High Temp Alloys and Titanium Alloys**									
	4.1	Titanium, unalloyed	120 - 200 HB	295	A	590	A			
	4.2	Titanium, alloyed	14 - 28 HRc	195	A	195	A	195	A	195 A
	4.3	Titanium, alloyed	28 - 44 HRc	130	A	165	A	130	A	165 A
	5.1	Nickel, unalloyed	120 - 150 HB	490	A	855	A			
	5.2	Nickel, alloyed	150 - 270 HB	65	B	165	B	65	B	165 B
	5.3	Nickel, alloyed	28 - 49 HRc	50	B	100	B	50	B	100 B
	9.1	TIC Hard materials	48 - 51 HRc	35	B	35	B	35	B	35 B
	9.2	Tungsten alloys	44 - 52 HRc	100	B	230	B	80	B	230 B
	9.3	Alloys on Cobalt base	150 - 350 HB	35	B	100	B	35	B	100 B
	9.4	Molybdenum alloyed	150 - 350 HB	80	B	230	B	65	B	195 B
H	**Hardened Materials**									
	1.7.1	Steel (hardened), short chipping	49 - 55 HRc							
	1.7.2	Steel (hardened), long chipping	49 - 55 HRc							
	1.8.1	Steel (hardened)	55 - 60 HRc							
	1.8.2	Steel (hardened)	60 - 65 HRc							
O	**Synthetic Materials / Others**									
	8.1	Thermoplastics	<50 N/mm²	525	C	1245	C			
	8.2	Thermosetting plastics	<80 N/mm²	360	C	590	C	395	C	590 C
	8.3	Reinforced plastic materials	240 - 440 N/mm²	130	C	260	C	130	C	260 C
	10.1	Standard graphite	<100 N/mm²	755	C	855	C	720	C	855 C
	10.2	Wear resistant graphite	<100 N/mm²	755	C	855	C	720	C	855 C

	Tough Guys N 50				AL 25	Ti 40	Ti 45
	Standard			Long	Xtra-Long	Standard	Long
	DIN 6527 L	DIN 6527 L	P-Norm L	P-Norm L	P-Norm L	DIN 6527 L	P-Norm XL
	50°	50°	50°	50°	25°	40°	45°
	3-4	3-4	3-4	3-4	2	4	4-5
	TAX	TAX	TAX	TAX	Bright	ACN	ACN
						 Axial	
					Aluminum alloys	Titanium alloys	Titanium alloys
	(1/4...3/4)			(1/8...3/4)	(1/4...5/8)	(1/2...5/8)	(1/2...5/8)
	AH3120317			**AH4020117**	**AH602881**	**AH7073717**	**AH7073417**
	96			97	98	99	100
	(6...20)	(2...20)	(4...20)	(4...20)	(6...20)	(12...25)	(16...25)
	H3120317	**H4120017**	**H3020117**	**H4020117**	**H602881**	**H7073717**	**H7073417**
	107	108	110	111	112	113	114
	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC
	855 A	855 A	655 A	655 A			655 A
	855 A	855 A	655 A	655 A			655 A
	820 A	820 A	690 A	690 A			655 A
	690 A	690 A	590 A	590 A			560 A
	425 A	490 A	425 A	425 A			395 A
	360 A	425 A	330 A	330 A			330 A
		360 B	295 B	295 B			295 B
	360 B	360 B	295 B	295 B			260 B
	295 B	295 B	230 B	230 B			230 B
	230 B	230 B	195 B	195 B			195 B
	165 B	165 B	150 B	150 B			130 B
	655 A	655 A	525 A	525 A			490 A
	560 A	560 A	460 A	460 A			460 A
	655 A	655 A	560 A	560 A			525 A
	525 A	525 A	425 A	425 A			425 A
	460 A	425 A	360 A	360 A			360 A
	1835 C	1835 C	1445 C	1445 C	720 C		
	1835 C	1835 C	1445 C	1445 C	720 C		
	1835 C	1835 C	1445 C	1445 C	720 C		
	260 C	260 C	230 C	230 C	100 C		
	490 C	490 C	425 C	425 C			
	490 C	490 C	425 C	425 C			
	5970 C	5970 C	5350 C	5350 C	4855 C		
	5970 C	5970 C	5085 C	5085 C	4855 C		
	5775 C	5775 C	4790 C	4790 C	3020 C		
	2560 C	2560 C	1970 C	1970 C	1215 C		
	855 C	855 C	655 C	655 C	490 C		
					1215 C		
					985 C		
					720 C		
	755 A	755 A	560 A	560 A	295 A	750 A	655 A
	295 A	295 A	230 A	230 A		335 A	295 A
	230 A	230 A	165 A	165 A		250 A	230 A
	1115 A	1115 A	855 A	855 A	490 A	1085 A	820 A
	230 B	230 B	165 B	165 B		230 B	165 B
	130 B	130 B	100 B	100 B		130 B	100 B
						35 B	35 B
	280 B	280 B	230 B	230 B		260 B	230 B
	130 B	130 B	100 B	100 B		130 B	100 B
						260 B	195 B
	1575 C	1575 C	1215 C	1215 C	490 C		
	720 C	720 C	560 C	560 C	360 C		
	330 C	330 C	260 C	260 C	130 C		
	855 C	855 C	855 C	855 C			
	855 C	855 C	855 C	855 C			

Application guide - Corner Radius

Speed and Feed Chart: The speeds and feeds in this table are intended for intial setup. These values are a guide, depending on machining conditions, these parameters may need to be adjusted up or down until optimum settings are found.

How to use this chart:

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2. Move across to mill series
3. Read SFM and Feed Chart (FC) Letter
4. Go to the Feed Charts on pages 126-127 and convert to feed per tooth
5. Calculate Speed and Feed using formulas on page 126

* Example materials can be found in the Material Library on page 188-189 of the Technical Information section

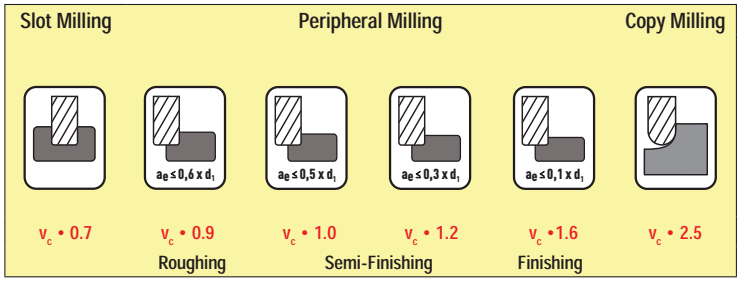
			Type	**HSC 30**						**HSC 30**				
			Length inch			Mini		Mini		Long		Long		
			Length metric	P-Norm Mini		P-Norm Mini		P-Norm Mini		P-Norm XL		P-Norm XL		
			Helix	30°		30°		30°		30°		30°		
			No. of flutes	2		2		2		2		2		
			Surface treatment	Bright		TAX		DIA		TAX		DIA		
														
			Remarks					Graphite machining				Graphite machining		
		INCH	Range			(1/64...1/8)		(1/64...1/8)		(1/4...5/8)		(1/4...1/2)		
		INCH	**Catalog No.**			**AH4044918**		**AH4044919**		**AH8095918**		**AH8095919**		
		INCH	Catalog Page			101		102		103		104		
		METRIC	Range	(0.4...3)		(0.4...3)		(0.4...3)		(4...12)		(4...12)		
		METRIC	**Catalog No.**	**H404491**		**H4044918**		**H4044919**		**H8095918**		**H8095919**		
		METRIC	Catalog Page	115		115		116		117		118		
ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Hardness	SFM	FC	SFM	FC	SFM	FC	SFM	FC	SFM	FC	
P	**Steel**													
P	1.1	Magnetic soft steel	61 - 120 HB			490	A			560	A			
P	1.2	Structural steel, case carburizing steel	101 - 200 HB	260	A	490	A			560	A			
P	1.3	Plain carbon steel	100 - 250 HB	260	A	490	A			560	A			
P	1.4	Alloy steel	150 - 250 HB	230	A	425	A			460	A			
P	1.5	Alloy steel, Tempered steel	26 - 38 HRc	130	A	295	A			330	A			
P	1.6.1	Alloy steel, Tempered steel	39 - 44 HRc	100	A	230	A			295	A			
P	1.6.2	Alloy steel, Tempered steel	44 - 49 HRc	65	B	195	B			245	B			
M	**Stainless Steel**													
M	2.1	Free machining stainless steel	120 - 250 HB	100	B	230	B			230	B			
M	2.2	Austinetic	130 - 250 HB	100	B	165	B			195	B			
M	2.3	Ferritic, austenitic, martensitic	130 - 320 HB	65	B	130	B			165	B			
M	2.4	High tensile chrome-nickel alloys	33 - 44 HRc	35	B	100	B			130	B			
K	**Cast Iron**													
K	3.1	Cast Iron	50 - 150 HB	195	A	395	A			425	A			
K	3.2	Cast Iron	150 - 300 HB	165	A	330	A			360	A			
K	3.3	Ductile Iron	150 - 200 HB	195	A	395	A			425	A			
K	3.4	Ductile Iron	14 - 32 HRc	165	A	295	A			360	A			
K	3.5	Compacted graphite iron	14 - 32 HRc	130	A	260	A			295	A			
N	**Non-ferrous Materials**													
N	6.1	Copper, unalloyed	80 - 100 HB	560	C	1085	C			1085	C			
N	6.2	Short chip brass	100 - 200 HB	560	C	1085	C			1180	C			
N	6.3	Long chip brass	120 - 200 HB	560	C	1085	C			1150	C			
N	6.4	Cu-Al-Fe alloys	200 - 440 HB	100	C	165	C			165	C			
N	6.5	Cu-Al-Ni alloys (short chipping)	120 - 250 HB	195	C	360	C			360	C			
N	6.6	Cu-Al-Ni alloys (long chipping)	120 - 250 HB	195	C	360	C			360	C			
N	7.1	Al, Mg unalloyed	60 - 100 HB	1345	C	1345	C			1410	C			
N	7.2	Al, alloyed Si<0.5%	90 - 180 HB	1345	C	1345	C			1410	C			
N	7.3.1	Al, alloyed Si>=0.5%<4%	90 - 180 HB	1345	C	1345	C	1345	C	1410	C			
N	7.3.2	Al, alloyed Si>=4%<12%	90 - 180 HB	950	C	1345	C	1345	C	1410	C			
N	7.4	Al, alloyed Si>=12%	90 - 180 HB	360	C	525	C			560	C			
N	7.5.1	Magnesium Standard alloy	120 - 300 N/mm²	950	C	1345	C			1410	C			
N	7.5.2	Magnesium -high tensile strength	70 - 120 HB	755	C	1345	C			1410	C			
N	7.5.3	Heat resistant magnesium alloys	120 - 300 N/mm²	560	C	1280	C			1380	C			
S	**High Temp Alloys and Titanium Alloys**													
S	4.1	Titanium, unalloyed	120 - 200 HB	230	A	425	A			460	A			
S	4.2	Titanium, alloyed	14 - 28 HRc	130	A	165	A			165	A			
S	4.3	Titanium, alloyed	28 - 44 HRc	100	A	130	A			130	A			
S	5.1	Nickel, unalloyed	120 - 150 HB	360	A	655	A			690	A			
S	5.2	Nickel, alloyed	150 - 270 HB	65	B	130	B			130	B			
S	5.3	Nickel, alloyed	28 - 49 HRc	35	B	65	B			65	B			
S	9.1	TIC Hard materials	48 - 51 HRc	15	B	35	B							
S	9.2	Tungsten alloys	44 - 52 HRc	65	B	165	B							
S	9.3	Alloys on Cobalt base	150 - 350 HB	35	B	65	B							
S	9.4	Molybdenum alloyed	150 - 350 HB	65	B	165	B							
H	**Hardened Materials**													
H	1.7.1	Steel (hardened), short chipping	49 - 55 HRc											
H	1.7.2	Steel (hardened), long chipping	49 - 55 HRc											
H	1.8.1	Steel (hardened)	55 - 60 HRc											
H	1.8.2	Steel (hardened)	60 - 65 HRc											
O	**Synthetic Materials / Others**													
O	8.1	Thermoplastics	<50 N/mm²	360	C	855	C			950	C			
O	8.2	Thermosetting plastics	<80 N/mm²	295	C	425	C			425	C			
O	8.3	Reinforced plastic materials	240 - 440 N/mm²	100	C	195	C	130	C	195	C			
O	10.1	Standard graphite	<100 N/mm²					1640	C	655	C	1640	C	
O	10.2	Wear resistant graphite	<100 N/mm²					1640	C	655	C	1640	C	

	Ultra HSC 30	Tough Guys H 50	Ultra H 50
		Standard	Long
	P-Norm Mini	P-Norm L	DIN 6527 L
	30°	50°	50°
	2	3-4	4-8
	TAX	TAX	TAX
			
	Hard machining	Hard machining	Hard machining
		(1/8...3/4)	(1/8...3/4)
		AH3070118	**AH8082228**
		105	106
	(0.4...3)	(2...20)	(3...25)
	H4044928	**H3070118**	**H8082228**
	119	120	121
	SFM FC	SFM FC	SFM FC
		590 A	
		425 A	
		330 A	
		295 B	
		525 A	
		460 A	
		560 A	
		425 A	
		360 A	
			330 C
	525 C	525 C	785 C
		655 C	
		2295 C	3970 C
		2000 C	3480 C
		1705 C	2985 C
		35 B	
		230 B	
		100 B	
		230 B	
	330 B	295 B	425 B
	295 B	260 B	395 B
	260 B	230 B	360 B
	150 B	130 B	230 B
		575 C	985 C
		260 C	460 C

Values

Description	Unit Inch	Unit Metric
Revolutions per minute	min^{-1}	min^{-1}
Cutting Speed	v_c [ft/min]	v_c [m/min]
Feed rate	v_f [inch/min]	v_f [mm/min]
Cutting diameter	d_1 [inch]	d_1 [mm]
Feed per tooth	f_z [inch]	f_z [mm]
Number of teeth	z	z
Axial depth of cut	a_p [inch]	a_p [mm]
Radial width of cut	a_e [inch]	a_e [mm]

Cutting speed factors



Conversions

To m/min from SFM

v_c [m/min] = v_c [ft/min] • 0.3048

To mm from inch

[mm] = [inch] • 25.4

Calculations

RPM with SFM and cutter diameter

$min^{-1} = (v_c$ [ft/min] • 3.82) / d_1 [inch]

RPM with m/min and cutter diameter

$min^{-1} = (v_c$ [m/min] • 1000) / (3.14 • d_1 [mm])

IPM with FPT, number of teeth and RPM

v_f [inch/min] = (f_z [inch] • z • min^{-1})

mm/min with FPT, number of teeth and RPM

v_f [mm/min] = (f_z [mm] • z • min^{-1})

A

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0008	0.0008	0.0012	0.0024	0.0035	0.0047	0.0059	0.0059	0.0079						
0.0020	0.0006	0.0006	0.0010	0.0016	0.0028	0.0039	0.0047	0.0059	0.0079						
0.0040	0.0004	0.0005	0.0008	0.0014	0.0020	0.0031	0.0039	0.0059	0.0079	0.0079	0.0079	0.0079			
0.0080	0.0004	0.0004	0.0006	0.0012	0.0016	0.0024	0.0031	0.0059	0.0071	0.0079	0.0079	0.0079	0.0079	0.0098	
1/64"		0.0004	0.0005	0.0010	0.0012	0.0020	0.0028	0.0047	0.0059	0.0059	0.0059	0.0059	0.0079	0.0098	0.0098
1/32"			0.0004	0.0010	0.0012	0.0016	0.0024	0.0035	0.0047	0.0047	0.0047	0.0047	0.0059	0.0079	0.0098
1/16"				0.0008	0.0012	0.0012	0.0020	0.0031	0.0043	0.0047	0.0047	0.0047	0.0059	0.0079	0.0079
1/8"					0.0008	0.0010	0.0018	0.0030	0.0041	0.0047	0.0047	0.0047	0.0053	0.0069	0.0079
3/16"						0.0008	0.0016	0.0028	0.0039	0.0047	0.0047	0.0047	0.0047	0.0059	0.0079
1/4"							0.0012	0.0024	0.0031	0.0039	0.0039	0.0047	0.0047	0.0059	0.0079
5/16"								0.0020	0.0028	0.0035	0.0039	0.0047	0.0047	0.0059	0.0079
3/8"									0.0024	0.0031	0.0039	0.0047	0.0047	0.0055	0.0063
1/2"										0.0028	0.0035	0.0043	0.0047	0.0055	0.0063
9/16"											0.0031	0.0039	0.0047	0.0051	0.0059
5/8"												0.0035	0.0039	0.0047	0.0059
11/16"													0.0039	0.0043	0.0051
3/4"														0.0039	0.0047
1"															0.0039

B

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0006	0.0006	0.0012	0.0020	0.0031	0.0039	0.0047	0.0047	0.0063						
0.0020	0.0005	0.0005	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047	0.0063						
0.0040	0.0003	0.0004	0.0006	0.0012	0.0016	0.0024	0.0031	0.0047	0.0063	0.0063	0.0063	0.0063			
0.0080	0.0003	0.0003	0.0005	0.0010	0.0014	0.0020	0.0024	0.0047	0.0055	0.0063	0.0063	0.0063	0.0063	0.0079	
1/64"		0.0003	0.0004	0.0008	0.0010	0.0016	0.0024	0.0039	0.0047	0.0047	0.0047	0.0047	0.0063	0.0079	0.0079
1/32"			0.0004	0.0008	0.0010	0.0012	0.0019	0.0031	0.0039	0.0039	0.0039	0.0039	0.0047	0.0063	0.0079
1/16"				0.0006	0.0008	0.0010	0.0020	0.0028	0.0035	0.0039	0.0039	0.0039	0.0047	0.0063	0.0063
1/8"					0.0006	0.0009	0.0018	0.0026	0.0033	0.0039	0.0039	0.0039	0.0043	0.0055	0.0063
3/16"						0.0008	0.0016	0.0024	0.0031	0.0039	0.0039	0.0039	0.0039	0.0047	0.0063
1/4"							0.0012	0.0020	0.0028	0.0031	0.0031	0.0039	0.0039	0.0047	0.0063
5/16"								0.0016	0.0024	0.0031	0.0031	0.0039	0.0039	0.0047	0.0063
3/8"									0.0020	0.0028	0.0031	0.0039	0.0039	0.0047	0.0055
1/2"										0.0024	0.0028	0.0035	0.0039	0.0047	0.0055
9/16"											0.0028	0.0031	0.0039	0.0047	0.0055
5/8"												0.0028	0.0031	0.0039	0.0047
11/16"													0.0031	0.0039	0.0047
3/4"														0.0031	0.0039
1"															0.0039

C

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0014	0.0016	0.0024	0.0039	0.0063	0.0079	0.0098	0.0098	0.0098						
0.0020	0.0012	0.0012	0.0020	0.0031	0.0047	0.0071	0.0079	0.0098	0.0098						
0.0040	0.0008	0.0010	0.0016	0.0024	0.0039	0.0055	0.0071	0.0098	0.0098	0.0098	0.0098	0.0098			
0.0080	0.0008	0.0008	0.0012	0.0020	0.0031	0.0039	0.0055	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	
1/64"		0.0008	0.0008	0.0020	0.0024	0.0035	0.0047	0.0079	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098
1/32"			0.0006	0.0020	0.0024	0.0028	0.0039	0.0063	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098	0.0098
1/16"				0.0016	0.0020	0.0024	0.0031	0.0055	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098	0.0098
1/8"					0.0016	0.0020	0.0030	0.0051	0.0087	0.0087	0.0087	0.0087	0.0093	0.0098	0.0098
3/16"						0.0016	0.0028	0.0047	0.0087	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098
1/4"							0.0020	0.0039	0.0055	0.0071	0.0079	0.0087	0.0087	0.0098	0.0098
5/16"								0.0035	0.0047	0.0063	0.0079	0.0087	0.0087	0.0098	0.0098
3/8"									0.0039	0.0055	0.0071	0.0087	0.0087	0.0098	0.0098
1/2"										0.0047	0.0063	0.0079	0.0087	0.0098	0.0098
9/16"											0.0055	0.0071	0.0087	0.0098	0.0098
5/8"												0.0063	0.0071	0.0087	0.0098
11/16"													0.0071	0.0079	0.0098
3/4"														0.0071	0.0079
1"															0.0079

Solid Carbide Ball Nose

Inch Range

Type	30							AL 30	HSC 30			
Length	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard	P-Norm Mini	P-Norm Mini	Long	Long
Helix	30°	30°	30°	30°	30°	30°	30°	30°	30°	30°	30°	30°
No. of flutes	2	2	2	3	3	4	4	2	2	2	4	4
Surface treatment	Bright	TAX	DIA	Bright	TAX	Bright	TAX	Bright	TAX	DIA	TAX	DIA
												
Range	(1/16...3/4)	(1/16...3/4)	(1/16...1/2)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...5/8)	(1/64...1/8)	(1/64...1/8)	(1/4...5/8)	(1/4...1/2)
Remarks			Graphite machining					Aluminum alloys		Graphite machining		Graphite machining
Catalog no.	**AH800111**	**AH8001118**	**AH8001119**	**AH802111**	**AH8021118**	**AH801111**	**AH8011118**	**AH602111**	**AH4046918**	**AH4046919**	**AH8001918**	**AH8001919**
Catalog page	132	132	133	134	134	135	135	136	137	138	139	140

Metric Range

Type	30					AL 30	HSC 30				Ultra HSC 30	Ultra HSC 30
Length	DIN 6527 L	DIN 6527 L	DIN 6527 L	P-Norm L	P-Norm L	P-Norm L	P-Norm Mini	P-Norm Mini	P-Norm Mini	P-Norm XL	P-Norm Mini	DIN 6527 L, P-Norm L
Helix	30°	30°	30°	30°	30°	30°	30°	30°	30°	30°	30°	30°
No. of flutes	2	2	2	4	4	2	2	2	2	2-4	2	2
Surface treatment	Bright	TAX	DIA	Bright	TAX	Bright	Bright	TAX	DIA	TAX	TAX	TAX
												
Range	(1...20)	(1...20)	(1...12)	(3...20)	(3...20)	(2...16)	(0.3...3)	(0.3...3)	(0.3...3)	(4...12)	(0.3...3)	(6...16)
Remarks			Graphite machining			Aluminum alloys			Graphite machining		Hard machining	Hard machining
Catalog no.	**H800111**	**H8001118**	**H8001119**	**H801111**	**H8011118**	**H602111**	**H404691**	**H4046918**	**H4046919**	**H8001918**	**H4046928**	**H8004128**
Catalog page	146	146	147	148	148	149	150	150	152	154	155	156

Inch Range

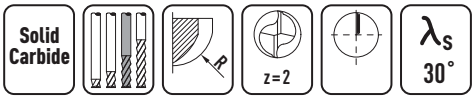
Type	Ultra HSC 30		HSC 30		Ultra HSC 30
Length	Standard	Standard	Long	Long	Long
Helix	30°	30°	30°	30°	30°
No. of flutes	2	2	4	4	4
Surface treatment	TAX	TAX	TAX	DIA	TAX
			 Back cut	 Back cut	 Back cut
Range	(1/8...5/8)	(1/4...5/8)	(1/4...5/8)	(1/4...1/2)	(1/4...5/8)
Remarks	Hard machining			Graphite machining	Hard machining
Catalog no.	**AH8004128**	**AH8004028**	**AH8016418**	**AH8016419**	**AH8016428**
Catalog page	141	142	143	144	145

Metric Range

Type	Ultra HSC 30		HSC 30				Ultra HSC 30	
Length	P-Norm L	DIN 6527 L	P-Norm L	P-Norm L	P-Norm L	P-Norm L	P-Norm L	P-Norm L
Helix	30°	30°	30°	30°	30°	30°	30°	30°
No. of flutes	2	2	2	2	4	4	2	4
Surface treatment	TAX	TAX	TAX	DIA	TAX	DIA	TAX	TAX
			 Back cut	 Back cut	 Back cut	 Back cut	 Back cut	 Back cut
Range	(3...10)	(5...16)	(1...10)	(1...10)	(5...16)	(5...12)	(1...16)	(5...16)
Remarks	Hard machining			Graphite machining		Graphite machining	Hard machining	
Catalog no.	**H8074128**	**H8004028**	**H8006418**	**H8006419**	**H8016418**	**H8016419**	**H8006428**	**H8016428**
Catalog page	157	158	159	160	161	162	163	164

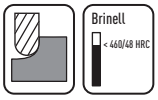
Protostar 30

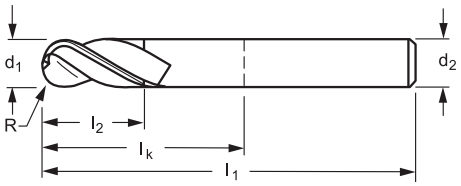
Characteristics



- All-purpose end mill suitable for use in a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application



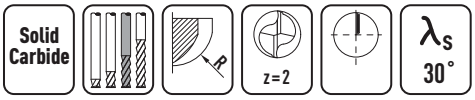


Standard

d_1 h7 inch	l_2 inch	R ±0.005 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH800111	Code AH8001118 TAX
1/16	**0.188**	0.031	2.000	0.583	0.250	2	-1/16	-1/16
3/32	**0.375**	0.047	2.000	0.583	0.250	2	-3/32	-3/32
1/8	**0.500**	0.063	2.500	1.083	0.250	2	-1/8	-1/8
3/16	**0.625**	0.094	2.500	1.083	0.250	2	-3/16	-3/16
1/4	**0.750**	0.125	2.500	1.083	0.250	2	-1/4	-1/4
5/16	**0.813**	0.156	3.000	1.437	0.375	2	-5/16	-5/16
3/8	**0.875**	0.188	3.000	1.437	0.375	2	-3/8	-3/8
7/16	**1.000**	0.219	3.500	1.717	0.500	2	-7/16	-7/16
1/2	**1.000**	0.250	3.500	1.717	0.500	2	-1/2	-1/2
5/8	**1.250**	0.313	3.500	1.594	0.625	2	-5/8	-5/8
3/4	**1.500**	0.375	4.000	1.969	0.750	2	-3/4	-3/4

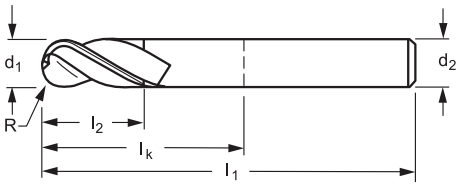
Protostar 30

Characteristics

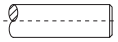


Application

- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.



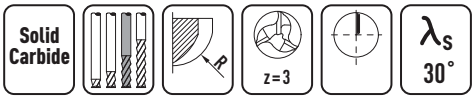
Standard



d_1 h8 inch	l_2 inch	R ±0.005 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH8001119 DIA
1/16	0.188	0.031	2.000	0.583	0.250	2	-1/16
3/32	0.375	0.047	2.000	0.583	0.250	2	-3/32
1/8	0.500	0.063	2.500	1.083	0.250	2	-1/8
3/16	0.625	0.094	2.500	1.083	0.250	2	-3/16
1/4	0.750	0.125	2.500	1.083	0.250	2	-1/4
5/16	0.813	0.156	3.000	1.437	0.375	2	-5/16
3/8	0.875	0.188	3.000	1.437	0.375	2	-3/8
7/16	1.000	0.219	3.500	1.717	0.500	2	-7/16
1/2	1.000	0.250	3.500	1.717	0.500	2	-1/2

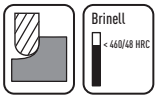
Protostar 30

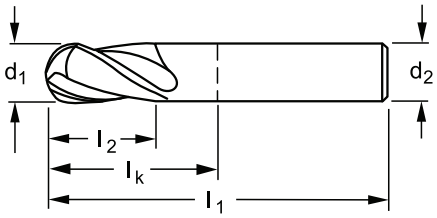
Characteristics



- All-purpose end mill suitable for use in a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application



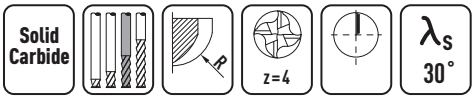


Standard

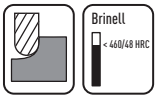
d_1 h9 inch	l_2 inch	R ±0.01 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH802111	Code AH8021118 TAX
1/16	0.188	0.031	2.000	0.583	0.250	3	-1/16	-1/16
3/32	0.375	0.047	2.000	0.583	0.250	3	-3/32	-3/32
1/8	0.500	0.063	2.500	1.083	0.250	3	-1/8	-1/8
3/16	0.625	0.094	2.500	1.083	0.250	3	-3/16	-3/16
1/4	0.750	0.125	2.500	1.083	0.250	3	-1/4	-1/4
5/16	0.813	0.156	3.000	1.437	0.375	3	-5/16	-5/16
3/8	0.875	0.188	3.000	1.437	0.375	3	-3/8	-3/8
7/16	1.000	0.219	3.500	1.717	0.500	3	-7/16	-7/16
1/2	1.000	0.250	3.500	1.717	0.500	3	-1/2	-1/2
5/8	1.250	0.313	3.500	1.594	0.625	3	-5/8	-5/8
3/4	1.500	0.375	4.000	1.969	0.750	3	-3/4	-3/4

Protostar 30

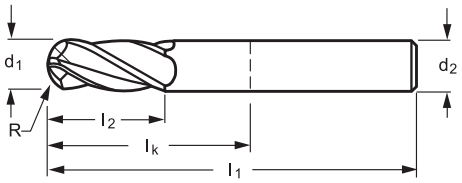
Characteristics



Application



- All-purpose end mill suitable for use in a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

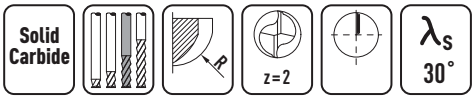


Standard

d_1 h9 inch	l_2 inch	R ±0.01 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH801111	Code AH8011118 TAX
1/16	0.188	0.031	2.000	0.583	0.250	4	-1/16	-1/16
3/32	0.375	0.047	2.000	0.583	0.250	4	-3/32	-3/32
1/8	0.500	0.063	2.500	1.083	0.250	4	-1/8	-1/8
3/16	0.625	0.094	2.500	1.083	0.250	4	-3/16	-3/16
1/4	0.750	0.125	2.500	1.083	0.250	4	-1/4	-1/4
5/16	0.813	0.156	3.000	1.437	0.375	4	-5/16	-5/16
3/8	0.875	0.188	3.000	1.437	0.375	4	-3/8	-3/8
7/16	1.000	0.219	3.500	1.717	0.500	4	-7/16	-7/16
1/2	1.000	0.250	3.500	1.717	0.500	4	-1/2	-1/2
5/8	1.250	0.313	3.500	1.594	0.625	4	-5/8	-5/8
3/4	1.500	0.375	4.000	1.969	0.750	4	-3/4	-3/4

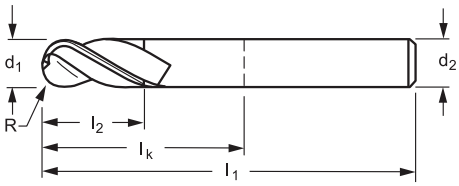
Protostar AL 30

Characteristics

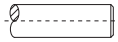


Application

- Ball nose end mill with 2 flutes for Aluminum and Aluminum alloys.



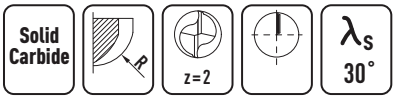
Standard



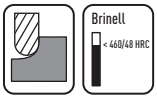
d_1 h9 inch	l_2 inch	R ±0.01 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH602111
1/16	0.188	0.031	2.500	1.083	0.250	2	-1/16
3/32	0.375	0.047	2.500	1.083	0.250	2	-3/32
1/8	0.500	0.063	2.500	1.083	0.250	2	-1/8
3/16	0.625	0.094	2.500	1.083	0.250	2	-3/16
1/4	0.750	0.125	2.500	1.083	0.250	2	-1/4
5/16	0.813	0.156	3.000	1.437	0.375	2	-5/16
3/8	0.875	0.188	3.000	1.437	0.375	2	-3/8
7/16	1.000	0.219	3.500	1.717	0.500	2	-7/16
1/2	1.000	0.250	3.500	1.717	0.500	2	-1/2
5/8	1.250	0.313	3.500	1.594	0.625	2	-5/8
3/4	1.500	0.375	4.000	1.969	0.750	2	-3/4

Protostar HSC 30

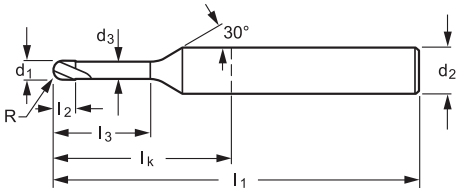
Characteristics



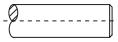
Application



- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



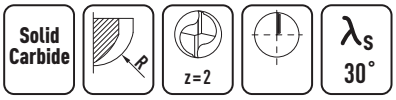
P-Norm Mini



d_1 h7 inch	l_2 inch	R ±0.005 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH4046918 TAX
1/64	0.0156	0.008	0.0469	0.0144	2.500	1.437	0.125	2	-1/64-0.047
1/64	0.0156	0.008	0.0938	0.0144	2.500	1.437	0.125	2	-1/64-0.094
1/32	0.0312	0.016	0.1563	0.0301	2.500	1.437	0.125	2	-1/32-0.156
1/32	0.0312	0.016	0.3125	0.0301	2.500	1.437	0.125	2	-1/32-0.313
3/64	0.0469	0.023	0.3125	0.0457	2.500	1.437	0.125	2	-3/64-0.313
3/64	0.0469	0.023	0.4063	0.0457	2.500	1.437	0.125	2	-3/64-0.406
1/16	0.0625	0.031	0.6250	0.0613	2.500	1.437	0.125	2	-1/16-0.625
1/16	0.0625	0.031	0.3125	0.0613	2.500	1.437	0.125	2	-1/16-0.313
5/64	0.0781	0.039	0.6250	0.0769	2.500	1.437	0.125	2	-5/64-0.625
5/64	0.0781	0.039	0.4063	0.0769	2.500	1.437	0.125	2	-5/64-0.406
3/32	0.0938	0.047	0.4063	0.0926	2.500	1.437	0.125	2	-3/32-0.406
3/32	0.0938	0.047	0.9375	0.0926	2.500	1.437	0.125	2	-3/32-0.938
7/64	0.1094	0.055	0.6250	0.1082	2.500	1.437	0.125	2	-7/64-0.625
7/64	0.1094	0.055	1.2500	0.1082	2.500	1.437	0.125	2	-7/64-1.250
1/8	0.1250	0.063	0.6250	0.1238	2.500	1.437	0.125	2	-1/8-0.625
1/8	0.1250	0.063	1.2500	0.1238	2.500	1.437	0.125	2	-1/8-1.250

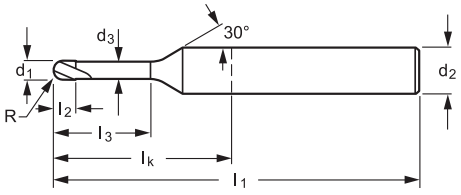
Protostar HSC 30

Characteristics

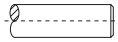


Application

- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.



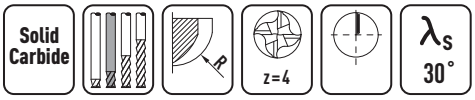
P-Norm Mini



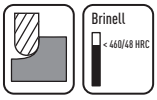
d_1 h8 inch	l_2 inch	R ±0.005 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH4046919 DIA
1/64	0.0156	0.008	0.0469	0.0144	2.500	1.437	0.125	2	-1/64-0.047
1/64	0.0156	0.008	0.0938	0.0144	2.500	1.437	0.125	2	-1/64-0.094
1/32	0.0312	0.016	0.1563	0.0301	2.500	1.437	0.125	2	-1/32-0.156
1/32	0.0312	0.016	0.3125	0.0301	2.500	1.437	0.125	2	-1/32-0.313
3/64	0.0469	0.023	0.3125	0.0457	2.500	1.437	0.125	2	-3/64-0.313
3/64	0.0469	0.023	0.4063	0.0457	2.500	1.437	0.125	2	-3/64-0.406
1/16	0.0625	0.031	0.6250	0.0613	2.500	1.437	0.125	2	-1/16-0.625
1/16	0.0625	0.031	0.3125	0.0613	2.500	1.437	0.125	2	-1/16-0.313
5/64	0.0781	0.039	0.6250	0.0769	2.500	1.437	0.125	2	-5/64-0.625
5/64	0.0781	0.039	0.4063	0.0769	2.500	1.437	0.125	2	-5/64-0.406
3/32	0.0938	0.047	0.4063	0.0926	2.500	1.437	0.125	2	-3/32-0.406
3/32	0.0938	0.047	0.9375	0.0926	2.500	1.437	0.125	2	-3/32-0.938
7/64	0.1094	0.055	0.6250	0.1082	2.500	1.437	0.125	2	-7/64-0.625
7/64	0.1094	0.055	1.2500	0.1082	2.500	1.437	0.125	2	-7/64-1.250
1/8	0.1250	0.063	0.6250	0.1238	2.500	1.437	0.125	2	-1/8-0.625
1/8	0.1250	0.063	1.2500	0.1238	2.500	1.437	0.125	2	-1/8-1.250

Protostar HSC 30

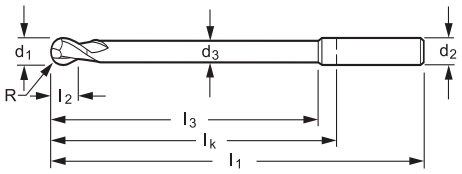
Characteristics



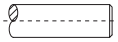
Application



- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



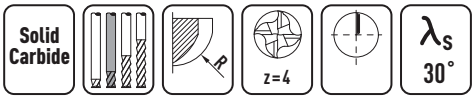
Long



d_1 h7 inch	l_2 inch	R ±0.005 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH8001918 TAX
1/4	0.250	0.125	1.375	0.246	3.000	1.583	0.250	4	-1/4-1.375
5/16	0.313	0.156	1.500	0.307	3.500	1.937	0.375	4	-5/16-1.500
3/8	0.375	0.188	1.500	0.369	3.500	1.937	0.375	4	-3/8-1.500
1/2	0.500	0.250	2.875	0.492	5.000	3.217	0.500	4	-1/2-2.875
5/8	0.625	0.313	3.000	0.656	5.000	3.094	0.625	4	-5/8-3.000

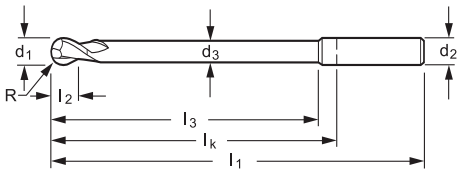
Protostar HSC 30

Characteristics

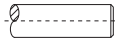


Application

- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.



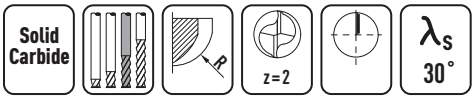
Long



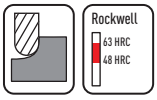
d_1 h8 inch	l_2 inch	R ±0.005 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH8001919 DIA
1/4	**0.250**	0.125	1.375	0.246	3.000	1.583	0.250	4	-1/4-1.375
5/16	**0.313**	0.156	1.500	0.307	3.500	1.937	0.375	4	-5/16-1.500
3/8	**0.375**	0.188	1.500	0.369	3.500	1.937	0.375	4	-3/8-1.500
1/2	**0.500**	0.250	2.875	0.492	5.000	3.217	0.500	4	-1/2-2.875

Protostar Ultra HSC 30

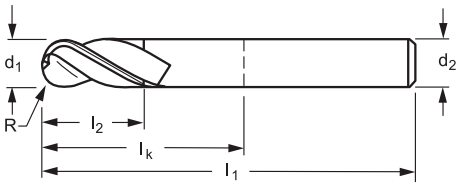
Characteristics



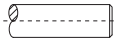
Application



- Designed for High-Speed machining operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



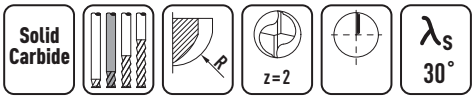
Standard



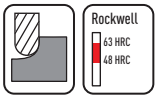
d_1 h7 inch	l_2 inch	R ±0.005 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH8004128 TAX
1/8	0.125	0.063	2.500	1.083	0.250	2	-1/8-2.500
3/16	0.188	0.094	2.500	1.083	0.250	2	-3/16-2.500
1/4	0.250	0.125	2.500	1.083	0.250	2	-1/4-2.500
5/16	0.313	0.156	2.500	0.937	0.375	2	-5/16-2.500
3/8	0.375	0.188	2.500	0.937	0.375	2	-3/8-2.500
7/16	0.438	0.219	2.750	0.967	0.500	2	-7/16-2.750
1/2	0.500	0.250	3.000	1.217	0.500	2	-1/2-3.000
5/8	0.625	0.313	3.500	1.594	0.625	2	-5/8-3.500

Protostar Ultra HSC 30

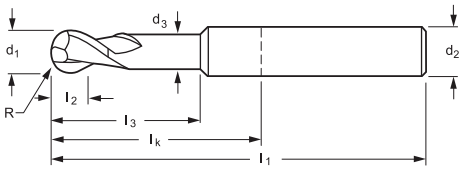
Characteristics



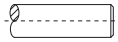
Application



- Designed for High-Speed machining operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



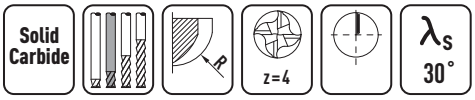
Standard



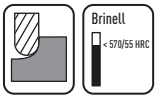
d_1 h7 inch	l_2 inch	R ±0.005 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH8004028 TAX
1/4	**0.250**	0.125	0.875	0.246	2.500	1.083	0.250	2	-1/4
5/16	**0.313**	0.156	1.000	0.307	3.000	1.437	0.375	2	-5/16
3/8	**0.375**	0.188	1.000	0.369	3.000	1.437	0.375	2	-3/8
1/2	**0.500**	0.250	1.375	0.492	3.000	1.217	0.500	2	-1/2
5/8	**0.625**	0.313	1.500	0.617	3.500	1.594	0.625	2	-5/8

Protostar HSC 30

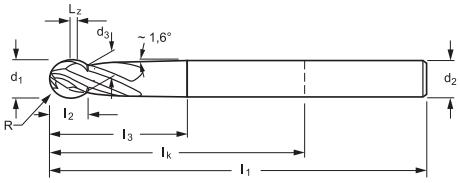
Characteristics



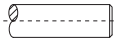
Application



- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- Back cutting ability
- Long effective length



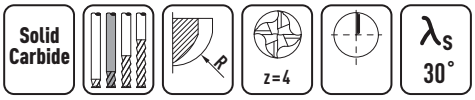
Long



d_1 h7 inch	l_2 inch	R ±0.005 inch	l_3 inch	d_3 inch	l_z inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH8016418 TAX
1/4	0.280	0.125	1.181	0.199	2	4.000	2.583	0.250	4	-1/4
5/16	0.366	0.156	1.417	0.253	3	3.500	1.937	0.375	4	-5/16
3/8	0.415	0.188	1.693	0.304	3	3.500	1.937	0.375	4	-3/8
1/2	0.509	0.250	2.047	0.413	3	6.000	4.217	0.500	4	-1/2
5/8	0.602	0.313	2.402	0.523	3	6.000	4.094	0.625	4	-5/8

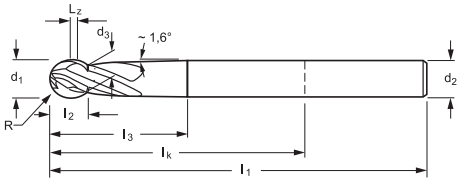
Protostar HSC 30

Characteristics

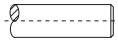


- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.
- Back cutting ability
- Long effective length

Application



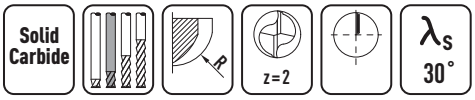
Long



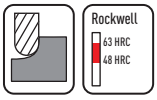
d_1 h8 inch	l_2 inch	R ±0.005 inch	l_3 inch	d_3 inch	l_z inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH8016419 DIA
1/4	0.280	0.125	1.181	0.199	2	4.000	2.583	0.250	4	-1/4-1.181
5/16	0.366	0.156	1.417	0.253	3	4.000	2.437	0.375	4	-5/16-1.417
3/8	0.415	0.188	1.693	0.304	3	4.000	2.437	0.375	4	-3/8-1.693
1/2	0.509	0.250	2.047	0.413	3	6.000	4.217	0.500	4	-1/2-2.047

Protostar Ultra HSC 30

Characteristics



Application



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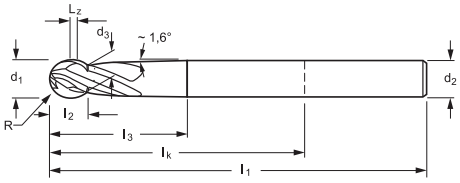
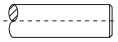
- Back cutting ability
- Long effective length



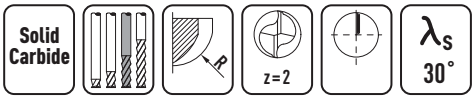
Long



d_1 h7 inch	l_2 inch	R ±0.005 inch	l_3 inch	d_3 inch	l_z inch	l_1 inch	l_k inch	d_2 h5 inch	z	Code AH8016428 TAX
1/4	0.280	0.125	1.181	0.199	2	4.000	2.583	0.250	2	-1/4
5/16	0.366	0.156	1.417	0.253	3	4.000	2.437	0.375	2	-5/16
3/8	0.415	0.188	1.693	0.304	3	4.000	2.437	0.375	2	-3/8
1/2	0.509	0.250	2.047	0.413	3	6.000	4.217	0.500	2	-1/2
5/8	0.602	0.313	2.402	0.523	3	6.000	4.094	0.625	2	-5/8

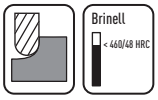
Protostar 30

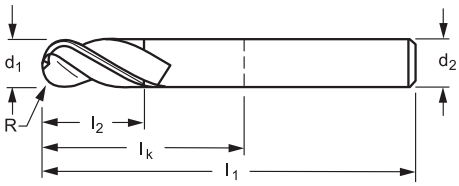
Characteristics



- All-purpose end mill suitable for use in a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application





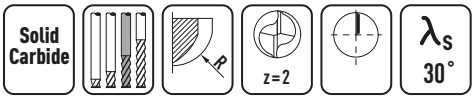
DIN 6527 L

DIN 6535HA DIN 6535HA

d_1 h7 mm	l_2 mm	R ±0,005 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H800111	Code H8001118 TAX
1	3	0.5	38	10	3	2	-1	-1
1.5	3	0.75	38	10	3	2	-1.5	-1.5
2	6	1	38	10	3	2	-2	-2
2.5	7	1.25	38	10	3	2	-2.5	-2.5
3	7	1.5	38	10	3	2	-3	-3
4	8	2	57	21	6	2	-4	-4
5	10	2.5	57	21	6	2	-5	-5
6	10	3	57	21	6	2	-6	-6
7	13	3.5	63	27	8	2	-7	-7
8	16	4	63	27	8	2	-8	-8
9	16	4.5	72	32	10	2	-9	-9
10	19	5	72	32	10	2	-10	-10
12	22	6	83	38	12	2	-12	-12
14	22	7	83	38	14	2	-14	-14
16	26	8	92	44	16	2	-16	-16
18	26	9	92	44	18	2	-18	-18
20	32	10	104	54	20	2	-20	-20

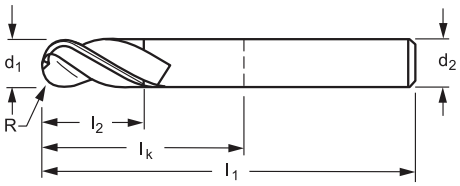
Protostar 30

Characteristics



Application

- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.



DIN 6527 L

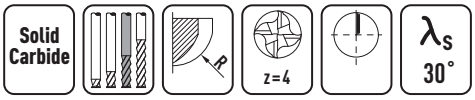
DIN 6535HA

d_1 h8 mm	l_2 mm	R ±0,005 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8001119 DIA
1	3	0.5	38	10	3	2	-1
1.5	3	0.75	38	10	3	2	-1.5
2	6	1	38	10	3	2	-2
2.5	7	1.25	38	10	3	2	-2.5
3	7	1.5	38	10	3	2	-3
4	8	2	57	21	6	2	-4
5	10	2.5	57	21	6	2	-5
6	10	3	57	21	6	2	-6
8	16	4	63	27	8	2	-8
10	19	5	72	32	10	2	-10
12	22	6	83	38	12	2	-12

148

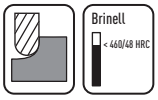
Protostar 30

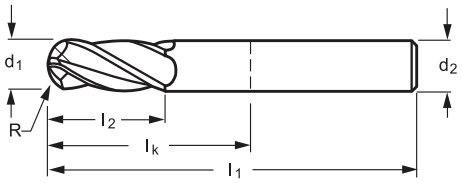
Characteristics



- All-purpose end mill suitable for use in a wide variety of materials.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application





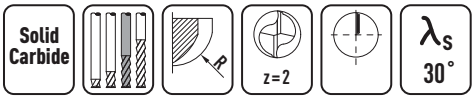
P-Norm L

DIN 6535HA DIN 6535HA

d_1 h9 mm	l_2 mm	R ±0,01 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H801111	Code H8011118 TAX
3	8	1.5	80	44	6	4	-3	-3
4	11	2	80	44	6	4	-4	-4
5	13	2.5	80	44	6	4	-5	-5
6	13	3	80	44	6	4	-6	-6
7	16	3.5	100	64	8	4	-7	-7
8	19	4	100	64	8	4	-8	-8
9	19	4.5	100	60	10	4	-9	-9
10	22	5	100	60	10	4	-10	-10
12	26	6	100	55	12	4	-12	-12
16	32	8	100	52	16	4	-16	-16
20	38	10	125	75	20	4	-20	-20

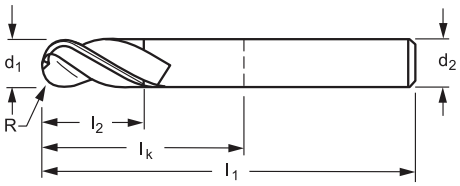
Protostar AL 30

Characteristics



- Ball nose end mill with 2 flutes for Aluminum and Aluminum alloys.

Application



P-Norm L

DIN 6535HA

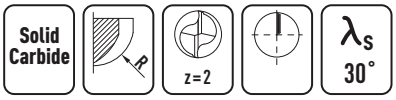
d_1 h9 mm	l_2 mm	R ±0,01 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H602111
2	6	1	60	32	[1] 3	2	-2
3	7	1.5	80	44	6	2	-3
4	8	2	80	44	6	2	-4
5	10	2.5	80	44	6	2	-5
6	10	3	80	44	6	2	-6
8	16	4	100	64	8	2	-8
10	19	5	100	60	10	2	-10
12	22	6	100	55	[1] 12	2	-12
16	26	8	100	52	[1] 16	2	-16

1) shank tolerance h6

150

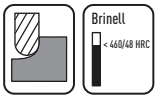
Protostar HSC 30

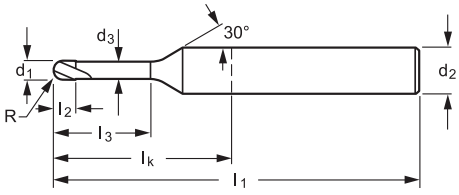
Characteristics



- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application



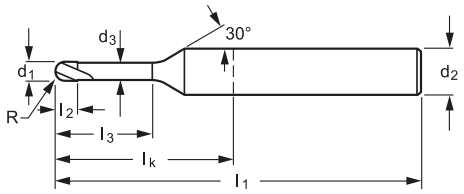


P-Norm Mini

DIN 6535HA DIN 6535HA

d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H404691	Code H4046918 TAX
0.3	0.3	0.15	0.75	0.27	38	10	3	2	-0.3-0.75	-0.3-0.75
0.3	0.3	0.15	1.5	0.27	38	10	3	2	-0.3-1.5	-0.3-1.5
0.3	0.3	0.15	3	0.27	38	10	3	2	-0.3-3	-0.3-3
0.4	0.4	0.2	1	0.37	38	10	3	2	-0.4-1	-0.4-1
0.4	0.4	0.2	2	0.37	38	10	3	2	-0.4-2	-0.4-2
0.4	0.4	0.2	4	0.37	38	10	3	2	-0.4-4	-0.4-4
0.5	0.5	0.25	1.25	0.47	38	10	3	2	-0.5-1.25	-0.5-1.25
0.5	0.5	0.25	2.5	0.47	38	10	3	2	-0.5-2.5	-0.5-2.5
0.5	0.5	0.25	5	0.47	38	10	3	2	-0.5-5	-0.5-5
0.6	0.6	0.3	1.5	0.57	38	10	3	2	-0.6-1.5	-0.6-1.5
0.6	0.6	0.3	3	0.57	38	10	3	2	-0.6-3	-0.6-3
0.6	0.6	0.3	6	0.57	38	10	3	2	-0.6-6	-0.6-6
0.6	0.6	0.3	9	0.57	38	10	3	2	-0.6-9	-0.6-9
0.8	0.8	0.4	2	0.77	38	10	3	2	-0.8-2	-0.8-2
0.8	0.8	0.4	4	0.77	38	10	3	2	-0.8-4	-0.8-4
0.8	0.8	0.4	6	0.77	38	10	3	2	-0.8-6	-0.8-6
0.8	0.8	0.4	8	0.77	38	10	3	2	-0.8-8	-0.8-8
0.8	0.8	0.4	12	0.77	60	32	3	2	-0.8-12	-0.8-12
1	1	0.5	2.5	0.97	38	10	3	2	-1-2.5	-1-2.5
1	1	0.5	5	0.97	60	32	3	2	-1-5	-1-5
1	1	0.5	7.5	0.97	60	32	3	2	-1-7.5	-1-7.5
1	1	0.5	10	0.97	60	32	3	2	-1-10	-1-10
1	1	0.5	15	0.97	60	32	3	2	-1-15	-1-15
1	1	0.5	20	0.97	60	32	3	2	-1-20	-1-20

Continuation - Protostar HSC 30



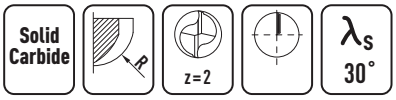
P-Norm Mini

DIN 6535HA DIN 6535HA

d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H404691	Code H4046918 TAX
1.5	1.5	0.75	7.5	1.47	60	32	3	2	-1.5-7.5	-1.5-7.5
1.5	1.5	0.75	15	1.47	60	32	3	2	-1.5-15	-1.5-15
2	2	1	10	1.97	60	32	3	2	-2-10	-2-10
2	2	1	15	1.97	60	32	3	2	-2-15	-2-15
2	2	1	20	1.97	60	32	3	2	-2-20	-2-20
2	2	1	30	1.97	60	32	3	2	-2-30	-2-30
2.5	2.5	1.25	12.5	2.47	60	32	3	2	-2.5-12.5	-2.5-12.5
2.5	2.5	1.25	25	2.47	60	32	3	2	-2.5-25	-2.5-25
3	3	1.5	15	2.97	60	32	3	2	-3-15	-3-15
3	3	1.5	22.5	2.97	60	32	3	2	-3-22.5	-3-22.5
3	3	1.5	30	2.97	60	32	3	2	-3-30	-3-30

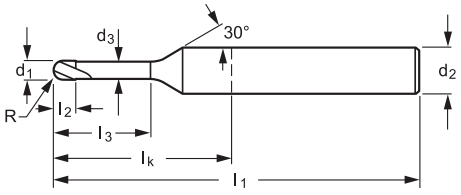
Protostar HSC 30

Characteristics



Application

- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.

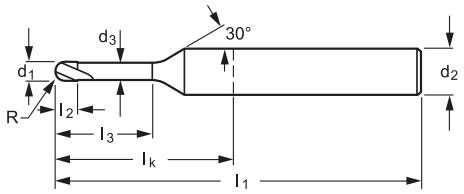


P-Norm Mini

DIN 6535HA

d_1 h8 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H4046919 DIA
0.3	0.3	0.15	0.75	0.27	38	10	3	2	-0.3-0.75
0.3	0.3	0.15	1.5	0.27	38	10	3	2	-0.3-1.5
0.3	0.3	0.15	3	0.27	38	10	3	2	-0.3-3
0.4	0.4	0.2	1	0.37	38	10	3	2	-0.4-1
0.4	0.4	0.2	2	0.37	38	10	3	2	-0.4-2
0.4	0.4	0.2	4	0.37	38	10	3	2	-0.4-4
0.5	0.5	0.25	1.25	0.47	38	10	3	2	-0.5-1.25
0.5	0.5	0.25	2.5	0.47	38	10	3	2	-0.5-2.5
0.5	0.5	0.25	5	0.47	38	10	3	2	-0.5-5
0.6	0.6	0.3	1.5	0.57	38	10	3	2	-0.6-1.5
0.6	0.6	0.3	3	0.57	38	10	3	2	-0.6-3
0.6	0.6	0.3	6	0.57	38	10	3	2	-0.6-6
0.6	0.6	0.3	9	0.57	38	10	3	2	-0.6-9
0.8	0.8	0.4	2	0.77	38	10	3	2	-0.8-2
0.8	0.8	0.4	4	0.77	38	10	3	2	-0.8-4
0.8	0.8	0.4	6	0.77	38	10	3	2	-0.8-6
0.8	0.8	0.4	8	0.77	38	10	3	2	-0.8-8
0.8	0.8	0.4	12	0.77	60	32	3	2	-0.8-12
1	1	0.5	2.5	0.97	38	10	3	2	-1-2.5
1	1	0.5	5	0.97	60	32	3	2	-1-5
1	1	0.5	7.5	0.97	60	32	3	2	-1-7.5
1	1	0.5	10	0.97	60	32	3	2	-1-10
1	1	0.5	15	0.97	60	32	3	2	-1-15
1	1	0.5	20	0.97	60	32	3	2	-1-20

Continuation - Protostar HSC 30



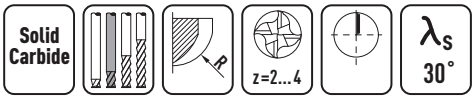
P-Norm Mini

DIN 6535HA

d_1 h8 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H4046919 DIA
1.5	1.5	0.75	7.5	1.47	60	32	3	2	-1.5-7.5
1.5	1.5	0.75	15	1.47	60	32	3	2	-1.5-15
2	2	1	10	1.97	60	32	3	2	-2-10
2	2	1	15	1.97	60	32	3	2	-2-15
2	2	1	20	1.97	60	32	3	2	-2-20
2	2	1	30	1.97	60	32	3	2	-2-30
2.5	2.5	1.25	12.5	2.47	60	32	3	2	-2.5-12.5
2.5	2.5	1.25	25	2.47	60	32	3	2	-2.5-25
3	3	1.5	15	2.97	60	32	3	2	-3-15
3	3	1.5	22.5	2.97	60	32	3	2	-3-22.5
3	3	1.5	30	2.97	60	32	3	2	-3-30

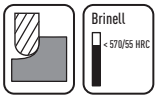
Protostar HSC 30

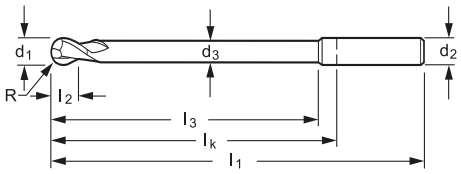
Characteristics



- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application





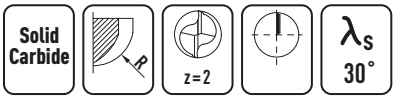
P-Norm XL

DIN 6535HA

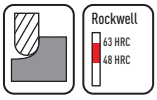
d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8001918 TAX
4	4	2	20	3.9	100	64	6	2	-4-20
4	4	2	30	3.9	100	64	6	2	-4-30
4	4	2	40	3.9	100	64	6	2	-4-40
5	5	2.5	25	4.9	100	64	6	2	-5-25
5	5	2.5	50	4.9	100	64	6	2	-5-50
6	6	3	30	5.9	100	64	6	4	-6-30
6	6	3	45	5.9	100	64	6	4	-6-45
6	6	3	60	5.9	100	64	6	4	-6-60
8	8	4	40	7.85	120	84	8	4	-8-40
8	8	4	60	7.85	120	84	8	4	-8-60
8	8	4	80	7.85	120	84	8	4	-8-80
10	10	5	50	9.85	150	110	10	4	-10-50
10	10	5	75	9.85	150	110	10	4	-10-75
12	12	6	60	11.8	150	105	12	4	-12-60

Protostar Ultra HSC 30

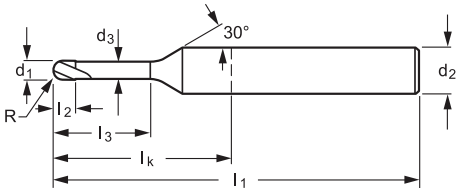
Characteristics



Application



- Machining of hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



P-Norm Mini

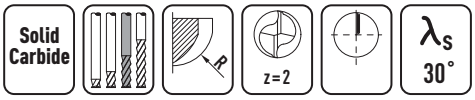
DIN 6535HA

d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H4046928 TAX
0.3	0.3	0.15	0.75	0.27	38	10	3	2	-0.3-0.75
0.4	0.4	0.2	1	0.37	38	10	3	2	-0.4-1
0.4	0.4	0.2	2	0.37	38	10	3	2	-0.4-2
0.5	0.5	0.25	1.25	0.47	38	10	3	2	-0.5-1.25
0.5	0.5	0.25	2.5	0.47	38	10	3	2	-0.5-2.5
0.5	0.5	0.25	3.75	0.47	38	10	3	2	-0.5-3.75
0.6	0.6	0.3	1.5	0.57	38	10	3	2	-0.6-1.5
0.6	0.6	0.3	3	0.57	38	10	3	2	-0.6-3
0.6	0.6	0.3	4.5	0.57	38	10	3	2	-0.6-4.5
0.8	0.8	0.4	2	0.77	38	10	3	2	-0.8-2
0.8	0.8	0.4	4	0.77	38	10	3	2	-0.8-4
0.8	0.8	0.4	6	0.77	38	10	3	2	-0.8-6
1	1	0.5	2.5	0.97	38	10	3	2	-1-2.5
1	1	0.5	5	0.97	60	32	3	2	-1-5
1	1	0.5	7.5	0.97	60	32	3	2	-1-7.5
1.5	1.5	0.75	4	1.47	38	10	3	2	-1.5-4
1.5	1.5	0.75	7.5	1.47	60	32	3	2	-1.5-7.5
1.5	1.5	0.75	12	1.47	60	32	3	2	-1.5-12
2	2	1	5	1.97	38	10	3	2	-2-5
2	2	1	10	1.97	60	32	3	2	-2-10
2	2	1	15	1.97	60	32	3	2	-2-15
2.5	2.5	1.25	6	2.47	38	10	3	2	-2.5-6
2.5	2.5	1.25	12.5	2.47	60	32	3	2	-2.5-12.5
2.5	2.5	1.25	20	2.47	60	32	3	2	-2.5-20
3	3	1.5	7.5	2.97	38	10	3	2	-3-7.5
3	3	1.5	15	2.97	60	32	3	2	-3-15
3	3	1.5	22.5	2.97	60	32	3	2	-3-22.5

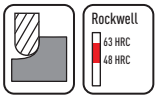
156

Protostar Ultra HSC 30

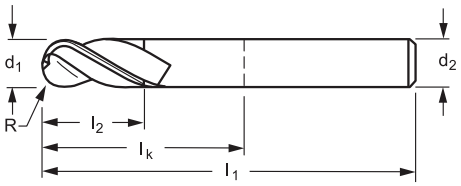
Characteristics



Application



- Designed for High-Speed machining operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



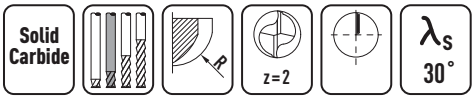
DIN 6527 L; P-Norm L

DIN 6535HA

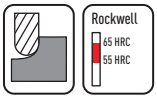
d_1 h7 mm	l_2 mm	R ±0,005 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8004128 TAX
6	6	3	57	21	6	2	-6-57
6	6	3	80	44	6	2	-6-80
8	8	4	63	27	8	2	-8-63
8	8	4	100	64	8	2	-8-100
10	10	5	72	32	10	2	-10-72
10	10	5	100	60	10	2	-10-100
12	12	6	83	38	12	2	-12-83
12	12	6	100	55	12	2	-12-100
16	16	8	125	77	16	2	-16-125

Protostar Ultra HSC 30

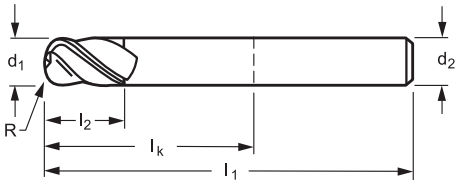
Characteristics



Application



- Designed for High-Speed machining operations in hardened materials from 55HRC to 65HRC
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



P-Norm L

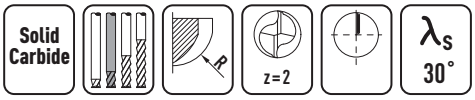
DIN 6535HA

d_1 h7 mm	l_2 mm	R ±0,005 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8074128 TAX
3	3	1.5	57	21	6	2	-3
4	4	2	80	44	6	2	-4
6	6	3	80	44	6	2	-6
8	8	4	100	64	8	2	-8
10	10	5	100	60	10	2	-10

158

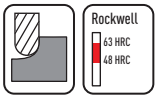
Protostar Ultra HSC 30

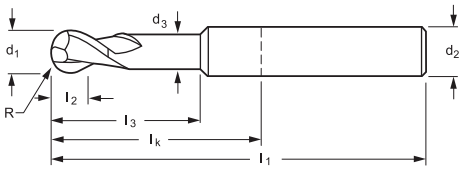
Characteristics



- Designed for High-Speed machining operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application





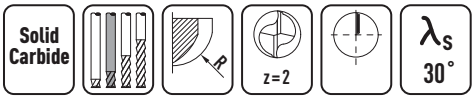
DIN 6527 L

DIN 6535HA

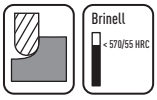
d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8004028 TAX
5	5	2.5	20	4.9	57	21	6	2	-5
6	6	3	24	5.9	63	27	8	2	-6
8	8	4	29	7.85	72	32	10	2	-8
10	10	5	35	9.85	83	38	12	2	-10
12	12	6	36	11.8	83	38	12	2	-12
16	16	8	42	15.8	92	44	16	2	-16

Protostar HSC 30

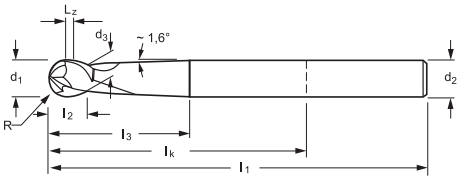
Characteristics



Application



- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- Back cutting ability
- Long effective length



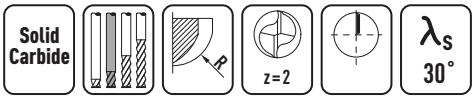
P-Norm L

DIN 6535HA

d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_z mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8006418 TAX
1	2	0.5	20	-	-	75	39	6	2	-1
2	3	1	20	1.7	1.5	75	39	6	2	-2
3	4	1.5	30	2.5	1.5	80	44	6	2	-3
4	5	2	30	3.3	1.5	80	44	6	2	-4
5	7	2.5	43	4.1	2	80	44	6	2	-5
6	7	3	30	4.7	2	100	64	6	2	-6
8	9	4	36	6.5	3	100	64	8	2	-8
10	11	5	43	8.2	3	100	60	10	2	-10

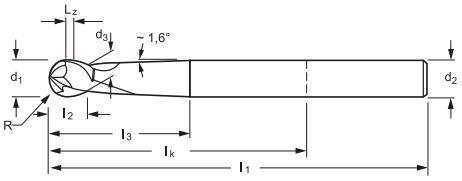
Protostar HSC 30

Characteristics



- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.
- Back cutting ability
- Long effective length

Application



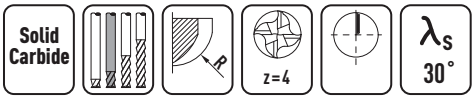
P-Norm L

DIN 6535HA

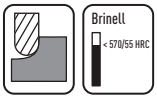
d_1 h8 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_z mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8006419 DIA
1	2	0.5	20	-	-	75	39	6	2	-1
2	3	1	20	1.7	1.5	75	39	6	2	-2
3	4	1.5	30	2.5	1.5	80	44	6	2	-3
4	5	2	30	3.3	1.5	80	44	6	2	-4
5	7	2.5	43	4.1	2	80	44	6	2	-5
6	7	3	30	4.7	2	100	64	6	2	-6
8	9	4	36	6.5	3	100	64	8	2	-8
10	11	5	43	8.2	3	100	60	10	2	-10

Protostar HSC 30

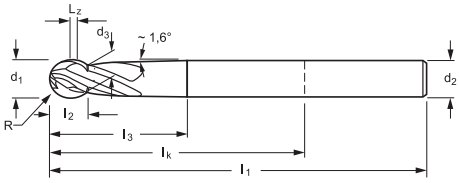
Characteristics



Application



- Designed for High-Speed machining where light depths of cut and high feed rates are utilized.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- Back cutting ability
- Long effective length



P-Norm L

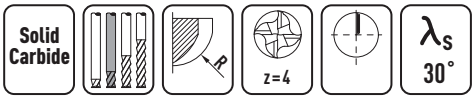
DIN 6535HA

d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_z mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8016418 TAX
5	7	2.5	43	4.1	2	80	44	6	4	-5
6	7	3	30	4.7	2	100	64	6	4	-6
8	9	4	36	6.5	3	100	64	8	4	-8
10	11	5	43	8.2	3	100	60	10	4	-10
12	13	6	52	9.8	3	100	55	12	4	-12
16	15	8	61	13.4	3	150	102	[1] 16	4	-16

1) shank tolerance h6

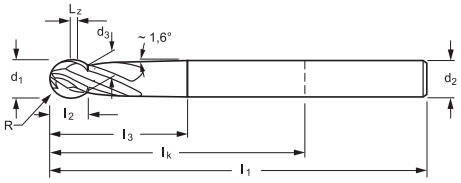
Protostar HSC 30

Characteristics



- **DIA** (Diamond) offers a high degree of wear resistance and is recommended for machining graphite.
- Back cutting ability
- Long effective length

Application

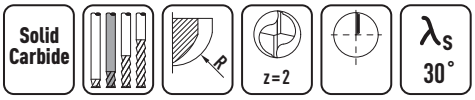


P-Norm L

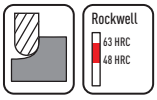
d_1 h8 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_z mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8016419 DIA
5	7	2.5	43	4.1	2	80	44	6	4	-5-43
6	7	3	30	4.7	2	100	64	6	4	-6-30
8	9	4	36	6.5	3	100	64	8	4	-8-36
10	11	5	43	8.2	3	100	60	10	4	-10-43
12	13	6	52	9.8	3	100	55	12	4	-12-52

Protostar Ultra HSC 30

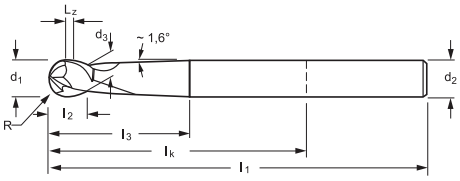
Characteristics



Application



- Designed for High-Speed machining operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- Back cutting ability
- Long effective length



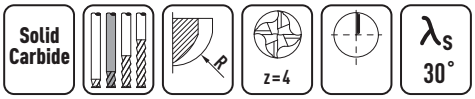
P-Norm L

DIN 6535HA

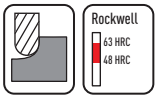
d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_z mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8006428 TAX
1	2	0.5	20	-	-	75	39	6	2	-1
2	3	1	20	1.7	1.5	75	39	6	2	-2
3	4	1.5	30	2.5	1.5	80	44	6	2	-3
4	5	2	30	3.3	1.5	80	44	6	2	-4
5	7	2.5	43	4.1	2	80	44	6	2	-5
6	7	3	30	4.7	2	100	64	6	2	-6
8	9	4	36	6.5	3	100	64	8	2	-8
10	11	5	43	8.2	3	100	60	10	2	-10
12	13	6	52	9.8	3	100	55	12	2	-12
16	15	8	61	13.4	3	150	102	16	2	-16

Protostar Ultra HSC 30

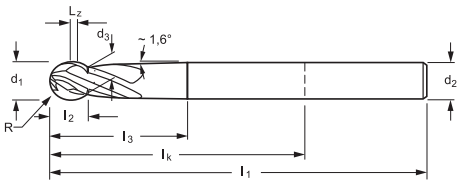
Characteristics



Application



- Designed for High-Speed machining operations in hardened materials from 48HRC to 63HRC.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.
- Back cutting ability
- Long effective length



P-Norm L

DIN 6535HA

d_1 h7 mm	l_2 mm	R ±0,005 mm	l_3 mm	d_3 mm	l_z mm	l_1 mm	l_k mm	d_2 h5 mm	z	Code H8016428 TAX
5	7	2.5	43	4.1	2	80	44	6	4	-5
6	7	3	30	4.7	2	100	64	6	4	-6
8	9	4	36	6.5	3	100	64	8	4	-8
10	11	5	43	8.2	3	100	60	10	4	-10
12	13	6	52	9.8	3	100	55	12	4	-12
16	15	8	61	13.4	3	150	102	16	4	-16

Application guide - Ball Nose

Speed and Feed Chart: The speeds and feeds in this table are intended for intial setup. These values are a guide, depending on machining conditions, these parameters may need to be adjusted up or down until optimum settings are found.

How to use this chart:

1. Pick your material group*
2. Move across to mill series
3. Read SFM and Feed Chart (FC) Letter
4. Go to the Feed Charts on pages 170-171 and convert to feed per tooth
5. Calculate Speed and Feed using formulas on page 170

* Example materials can be found in the Material Library on page 188-189 of the Technical Information section

ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Type	30							
			Length inch	Standard		Standard		Standard		Standard	
			Length metric	DIN 6527 L		DIN 6527 L		DIN 6527 L			
			Helix	30°		30°		30°		30°	
			No. of flutes	2		2		2		3	
			Surface treatment	Bright		TAX		DIA		Bright	
											
			Remarks					Graphite machining			
			INCH Range	(1/16...3/4)		(1/16...3/4)		(1/16...1/2)		(1/16...3/4)	
			INCH **Catalog No.**	**AH800111**		**AH8001118**		**AH8001119**		**AH802111**	
			INCH Catalog Page	132		132		133		134	
			METRIC Range	(1...20)		(1...20)		(1...12)			
			METRIC **Catalog No.**	**H800111**		**H8001118**		**H8001119**			
			METRIC Catalog Page	146		146		147			
			Hardness	SFM	FC	SFM	FC	SFM	FC	SFM	FC
P	**Steel**										
	1.1	Magnetic soft steel	61 - 120 HB			820	A				
	1.2	Structural steel, case carburizing steel	101 - 200 HB			820	A				
	1.3	Plain carbon steel	100 - 250 HB			785	A				
	1.4	Alloy steel	150 - 250 HB			655	A				
	1.5	Alloy steel, Tempered steel	26 - 38 HRc			460	A				
	1.6.1	Alloy steel, Tempered steel	39 - 44 HRc			395	A				
	1.6.2	Alloy steel, Tempered steel	44 - 49 HRc			330	B				
M	**Stainless Steel**										
	2.1	Free machining stainless steel	120 - 250 HB			360	B				
	2.2	Austinetic	130 - 250 HB			260	B				
	2.3	Ferritic, austenitic, martensitic	130 - 320 HB			230	B				
	2.4	High tensile chrome-nickel alloys	33 - 44 HRc			165	B				
K	**Cast Iron**										
	3.1	Cast Iron	50 - 150 HB	295	A	625	A			230	A
	3.2	Cast Iron	150 - 300 HB	230	A	525	A			195	A
	3.3	Ductile Iron	150 - 200 HB	295	A	625	A			260	A
	3.4	Ductile Iron	14 - 32 HRc	230	A	490	A			195	A
	3.5	Compacted graphite iron	14 - 32 HRc	195	A	460	A			165	A
N	**Non-ferrous Materials**										
	6.1	Copper, unalloyed	80 - 100 HB	920	C	1740	C			690	C
	6.2	Short chip brass	100 - 200 HB	920	C	1740	C			720	C
	6.3	Long chip brass	120 - 200 HB	920	C	1740	C			720	C
	6.4	Cu-Al-Fe alloys	200 - 440 HB	130	C	260	C			130	C
	6.5	Cu-Al-Ni alloys (short chipping)	120 - 250 HB	330	C	590	C			260	C
	6.6	Cu-Al-Ni alloys (long chipping)	120 - 250 HB	330	C	590	C			260	C
	7.1	Al, Mg unalloyed	60 - 100 HB	6035	C	6035	C			4920	C
	7.2	Al, alloyed Si<0.5%	90 - 180 HB	6465	C	6465	C			5280	C
	7.3.1	Al, alloyed Si>=0.5%<4%	90 - 180 HB	3775	C	5840	C			3215	C
	7.3.2	Al, alloyed Si>=4%<12%	90 - 180 HB	1510	C	2430	C			1245	C
	7.4	Al, alloyed Si>=12%	90 - 180 HB	590	C	855	C			460	C
	7.5.1	Magnesium Standard alloy	120 - 300 N/mm²	1510	C	2790	C			1575	C
	7.5.2	Magnesium -high tensile strength	70 - 120 HB	1215	C	2430	C			985	C
	7.5.3	Heat resistant magnesium alloys	120 - 300 N/mm²	920	C	2100	C			720	C
S	**High Temp Alloys and Titanium Alloys**										
	4.1	Titanium, unalloyed	120 - 200 HB	360	A	690	A			295	A
	4.2	Titanium, alloyed	14 - 28 HRc	230	A	260	A			195	A
	4.3	Titanium, alloyed	28 - 44 HRc	165	A	195	A			130	A
	5.1	Nickel, unalloyed	120 - 150 HB	590	A	1050	A			460	A
	5.2	Nickel, alloyed	150 - 270 HB	100	B	195	B			65	B
	5.3	Nickel, alloyed	28 - 49 HRc	65	B	130	B			50	B
	9.1	TIC Hard materials	48 - 51 HRc			50	B				
	9.2	Tungsten alloys	44 - 52 HRc			260	B				
	9.3	Alloys on Cobalt base	150 - 350 HB	50	B	130	B			35	B
	9.4	Molybdenum alloyed	150 - 350 HB			230	B				
H	**Hardened Materials**										
	1.7.1	Steel (hardened), short chipping	49 - 55 HRc	65	B	260	B			65	B
	1.7.2	Steel (hardened), long chipping	49 - 55 HRc	65	B	260	B			65	B
	1.8.1	Steel (hardened)	55 - 60 HRc								
	1.8.2	Steel (hardened)	60 - 65 HRc								
O	**Synthetic Materials / Others**										
	8.1	Thermoplastics	<50 N/mm²	590	C	1380	C			490	C
	8.2	Thermosetting plastics	<80 N/mm²	460	C	690	C			330	C
	8.3	Reinforced plastic materials	240 - 440 N/mm²	165	C	295	C			130	C
	10.1	Standard graphite	<100 N/mm²	920	C	1050	C	2430	C	690	C
	10.2	Wear resistant graphite	<100 N/mm²	920	C	1050	C	2430	C	690	C

	30			AL 30	HSC 30				
	Standard	Standard	Standard	Standard		Mini	Mini	Long	Long
		P-Norm L	P-Norm L	P-Norm L	P-Norm Mini	P-Norm Mini	P-Norm Mini	P-Norm XL	
	30°	30°	30°	30°	30°	30°	30°	30°	30°
	3	4	4	2	2	2	2	2-4	4
	TAX	Bright	TAX	Bright	Bright	TAX	DIA	TAX	DIA
									
				Aluminum alloys			Graphite machining		Graphite machining
	(1/16...3/4)	(1/16...3/4)	(1/16...3/4)	(1/16...5/8)		(1/64...1/8)	(1/64...1/8)	(1/4...5/8)	(1/4...1/2)
	AH8021118	**AH801111**	**AH8011118**	**AH602111**		**AH4046918**	**AH4046919**	**AH8001918**	**AH8001919**
	134	135	135	136		137	138	139	140
		(3...20)	(3...20)	(2...16)	(0.3...3)	(0.3...3)	(0.3...3)	(4...12)	
		H801111	**H8011118**	**H602111**	**H404691**	**H4046918**	**H4046919**	**H8001918**	
		148	148	149	150	150	152	154	
	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC	SFM FC
	655 A		655 A			560 A		625 A	
	655 A		655 A			560 A		625 A	
	655 A		655 A			525 A		625 A	
	560 A		560 A			460 A		525 A	
	395 A		395 A			330 A		395 A	
	330 A		330 A			260 A		330 A	
	295 B		295 B			230 B		260 B	
	295 B		295 B			230 B		260 B	
	230 B		230 B			195 B		230 B	
	195 B		195 B			165 B		165 B	
	130 B		130 B			130 B		130 B	
	490 A	230 A	490 A			425 A		490 A	
	460 A	195 A	460 A			360 A		425 A	
	525 A	260 A	525 A			425 A		490 A	
	425 A	195 A	425 A			330 A		395 A	
	360 A	165 A	360 A			295 A		330 A	
	1310 C	690 C	1310 C	690 C	625 C	1180 C		1245 C	
	1410 C	720 C	1410 C	690 C	625 C	1180 C		1345 C	
	1410 C	720 C	1410 C	690 C	625 C	1180 C		1310 C	
	230 C	130 C	230 C		100 C	195 C		195 C	
	525 C	260 C	525 C	260 C	230 C	425 C		490 C	
	525 C	260 C	525 C	260 C	230 C	425 C		490 C	
	4920 C	4920 C	4920 C	4690 C	1345 C			1410 C	
	5280 C	5280 C	5280 C	5050 C	1345 C	1345 C		1410 C	
	4755 C	3215 C	4755 C	3150 C	1345 C	1345 C		1410 C	
	1970 C	1245 C	1970 C	1180 C	1015 C	1345 C		1410 C	
	655 C	460 C	655 C	460 C	395 C	560 C		625 C	
	2265 C	1575 C	2265 C	1180 C	1015 C	1345 C		1410 C	
	1970 C	985 C	1970 C	950 C	820 C	1345 C		1410 C	
	1705 C	720 C	1705 C	690 C	625 C	1345 C		1410 C	
	560 A	295 A	560 A	295 A	230 A			525 A	
	195 A	195 A	195 A			165 A		195 A	
	165 A	130 A	165 A			130 A		165 A	
	785 A	460 A	785 A	460 A	395 A			755 A	
	165 B	65 B	165 B			130 B		165 B	
	100 B	50 B	100 B			80 B		100 B	
	50 B		50 B		35 B	50 B		50 B	
	260 B		260 B		65 B	260 B		260 B	
	130 B	35 B	130 B		35 B	130 B		130 B	
	230 B		230 B		65 B	230 B		230 B	
	230 B	65 B	230 B					230 B	
	230 B	65 B	230 B					230 B	
	1150 C	490 C	1150 C	460 C	395 C	985 C		985 C	
	525 C	330 C	525 C	360 C	295 C	460 C		460 C	
	260 C	130 C	260 C	130 C	100 C	195 C		230 C	
	785 C	690 C	785 C				2035 C	690 C	2295 C
	785 C	690 C	785 C				2035 C	690 C	2295 C

Application guide - Ball Nose

Speed and Feed Chart: The speeds and feeds in this table are intended for intial setup. These values are a guide, depending on machining conditions, these parameters may need to be adjusted up or down until optimum settings are found.

How to use this chart:

1. Pick your material group*
2. Move across to mill series
3. Read SFM and Feed Chart (FC) Letter
4. Go to the Feed Charts on pages 170-171 and convert to feed per tooth
5. Calculate Speed and Feed using formulas on page 170

* Example materials can be found in the Material Library on page 188-189 of the Technical Information section

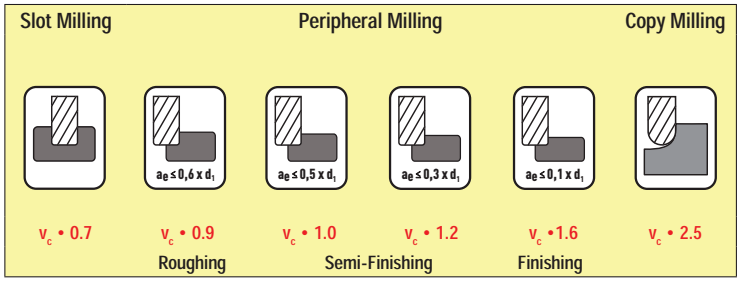
			Type	**Ultra HSC 30**		**Ultra HSC 30**						
			Length inch			Standard				Standard		
			Length metric	P-Norm Mini		DIN 6527 L, P-Norm L		P-Norm L		DIN 6527 L		
			Helix	30°		30°		30°		30°		
			No. of flutes	2		2		2		2		
			Surface treatment	TAX		TAX		TAX		TAX		
												
			Remarks	Hard machining		Hard machining						
		INCH	Range			(1/8...5/8)				(1/4...5/8)		
		INCH	**Catalog No.**			**AH8004128**				**AH8004028**		
		INCH	Catalog Page			141				142		
		METRIC	Range	(0.3...3)		(6...16)		(3...10)		(5...16)		
		METRIC	**Catalog No.**	**H4046928**		**H8004128**		**H8074128**		**H8004028**		
		METRIC	Catalog Page	155		156		157		158		
ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Hardness	SFM	FC	SFM	FC	SFM	FC	SFM	FC	
P	**Steel**											
P	1.1	Magnetic soft steel	61 - 120 HB									
P	1.2	Structural steel, case carburizing steel	101 - 200 HB									
P	1.3	Plain carbon steel	100 - 250 HB									
P	1.4	Alloy steel	150 - 250 HB			785	A	985	A	985	A	
P	1.5	Alloy steel, Tempered steel	26 - 38 HRc			560	A	720	A	720	A	
P	1.6.1	Alloy steel, Tempered steel	39 - 44 HRc			460	A	590	A	590	A	
P	1.6.2	Alloy steel, Tempered steel	44 - 49 HRc			395	B	490	B	490	B	
M	**Stainless Steel**											
M	2.1	Free machining stainless steel	120 - 250 HB									
M	2.2	Austinetic	130 - 250 HB									
M	2.3	Ferritic, austenitic, martensitic	130 - 320 HB									
M	2.4	High tensile chrome-nickel alloys	33 - 44 HRc									
K	**Cast Iron**											
K	3.1	Cast Iron	50 - 150 HB			690	A	690	A	885	A	
K	3.2	Cast Iron	150 - 300 HB			590	A	590	A	720	A	
K	3.3	Ductile Iron	150 - 200 HB			755	A	755	A	950	A	
K	3.4	Ductile Iron	14 - 32 HRc			590	A	590	A	720	A	
K	3.5	Compacted graphite iron	14 - 32 HRc			490	A	490	A	590	A	
N	**Non-ferrous Materials**											
N	6.1	Copper, unalloyed	80 - 100 HB			0	C					
N	6.2	Short chip brass	100 - 200 HB			1970	C			2430	C	
N	6.3	Long chip brass	120 - 200 HB			2100	C			2625	C	
N	6.4	Cu-Al-Fe alloys	200 - 440 HB			295	C			330	C	
N	6.5	Cu-Al-Ni alloys (short chipping)	120 - 250 HB			690	C			855	C	
N	6.6	Cu-Al-Ni alloys (long chipping)	120 - 250 HB			720	C			920	C	
N	7.1	Al, Mg unalloyed	60 - 100 HB									
N	7.2	Al, alloyed Si<0.5%	90 - 180 HB									
N	7.3.1	Al, alloyed Si>=0.5%<4%	90 - 180 HB									
N	7.3.2	Al, alloyed Si>=4%<12%	90 - 180 HB			2920	C			3640	C	
N	7.4	Al, alloyed Si>=12%	90 - 180 HB			920	C			1115	C	
N	7.5.1	Magnesium Standard alloy	120 - 300 N/mm²			3345	C			4165	C	
N	7.5.2	Magnesium -high tensile strength	70 - 120 HB			2920	C			3640	C	
N	7.5.3	Heat resistant magnesium alloys	120 - 300 N/mm²			2525	C			3150	C	
S	**High Temp Alloys and Titanium Alloys**											
S	4.1	Titanium, unalloyed	120 - 200 HB									
S	4.2	Titanium, alloyed	14 - 28 HRc			330	A			395	A	
S	4.3	Titanium, alloyed	28 - 44 HRc			260	A			330	A	
S	5.1	Nickel, unalloyed	120 - 150 HB									
S	5.2	Nickel, alloyed	150 - 270 HB			260	B			295	B	
S	5.3	Nickel, alloyed	28 - 49 HRc			130	B			165	B	
S	9.1	TIC Hard materials	48 - 51 HRc			65	B	65	B	65	B	
S	9.2	Tungsten alloys	44 - 52 HRc			310	B	310	B	310	B	
S	9.3	Alloys on Cobalt base	150 - 350 HB			165	B	165	B	165	B	
S	9.4	Molybdenum alloyed	150 - 350 HB			295	B	295	B	295	B	
H	**Hardened Materials**											
H	1.7.1	Steel (hardened), short chipping	49 - 55 HRc	260	B	330	B	330	B	395	B	
H	1.7.2	Steel (hardened), long chipping	49 - 55 HRc	260	B	360	B	360	B	395	B	
H	1.8.1	Steel (hardened)	55 - 60 HRc	280	B	360	B	360	B	425	B	
H	1.8.2	Steel (hardened)	60 - 65 HRc	165	B	195	B	195	B	230	B	
O	**Synthetic Materials / Others**											
O	8.1	Thermoplastics	<50 N/mm²									
O	8.2	Thermosetting plastics	<80 N/mm²			855	C	855	C	1050	C	
O	8.3	Reinforced plastic materials	240 - 440 N/mm²			360	C	360	C	460	C	
O	10.1	Standard graphite	<100 N/mm²									
O	10.2	Wear resistant graphite	<100 N/mm²									

	HSC 30 back cutting								Ultra HSC 30			
				Long		Long				Long		
	P-Norm L		P-Norm L		Long P-Norm L		P-Norm L		P-Norm L		P-Norm L	
	30°		30°		30°		30°		30°		30°	
	2		2		4		4		2		4	
	TAX		DIA		TAX		DIA		TAX		TAX	
												
			Graphite machining				Graphite machining		Hard machining		Hard machining	
					(1/4...5/8)		(1/4...1/2)				(1/4...5/8)	
					AH8016418		**AH8016419**				**AH8016428**	
					143		144				145	
	(1...10)		(1...10)		(5...16)		(5...12)		(1...16)		(5...16)	
	H8006418		**H8006419**		**H8016418**		**H8016419**		**H8006428**		**H8016428**	
	159		160		161		162		163		164	
	SFM	FC	SFM	FC	SFM	FC	SFM	FC	SFM	FC	SFM	FC
					720	A						
					720	A						
					720	A						
	625	A			625	A			785	A	855	A
	460	A			460	A			560	A	590	A
	360	A			360	A			460	A	490	A
	330	B			330	B			395	B	425	B
					330	B						
					260	B						
					195	B						
					165	B						
	525	A			560	A			690	A	755	A
	425	A			490	A			590	A	655	A
	525	A			590	A			755	A	755	A
	425	A			460	A			590	A	590	A
	360	A			395	A			490	A	525	A
					1475	C						
	1475	C			1575	C			1935	C	2065	C
	1475	C			1575	C			2065	C	2265	C
	230	C			230	C			295	C	330	C
	525	C			560	C			655	C	755	C
	525	C			560	C			720	C	785	C
					4755	C						
					4755	C						
					4755	C						
	2035	C			2200	C					3150	C
	720	C			720	C			885	C	950	C
	2330	C			2525	C			3280	C	3610	C
	2065	C			2200	C			2885	C	3150	C
	1770	C			1870	C			2460	C	2725	C
					625	A						
	195	A			230	A			330	A	330	A
	165	A			165	A			260	A	260	A
					885	A						
	165	B			195	B			230	B	260	B
	100	B			100	B			130	B	165	B
	65	B			65	B			65	B	65	B
	310	B			310	B			310	B	310	B
	165	B			165	B			165	B	165	B
	295	B			295	B			295	B	295	B
	230	B			260	B			330	B	360	B
	230	B			260	B			360	B	360	B
	230	B							360	B	395	B
	130	B							195	B	230	B
					1310	C						
	590	C			590	C			820	C	920	C
	260	C			295	C			360	C	395	C
			2035	C	885	C	2035	C				
			2035	C	885	C	2035	C				

Values

Description	Unit Inch	Unit Metric
Revolutions per minute	min^{-1}	min^{-1}
Cutting Speed	v_c [ft/min]	v_c [m/min]
Feed rate	v_f [inch/min]	v_f [mm/min]
Cutting diameter	d_1 [inch]	d_1 [mm]
Feed per tooth	f_z [inch]	f_z [mm]
Number of teeth	z	z
Axial depth of cut	a_p [inch]	a_p [mm]
Radial width of cut	a_e [inch]	a_e [mm]

Cutting speed factors



Conversions

To m/min from SFM

v_c [m/min] = v_c [ft/min] • 0.3048

To mm from inch

[mm] = [inch] • 25.4

Calculations

RPM with SFM and cutter diameter

$min^{-1} = (v_c$ [ft/min] • 3.82) / d_1 [inch]

RPM with m/min and cutter diameter

$min^{-1} = (v_c$ [m/min] • 1000) / (3.14 • d_1 [mm])

IPM with FPT, number of teeth and RPM

v_f [inch/min] = (f_z [inch] • z • min^{-1})

mm/min with FPT, number of teeth and RPM

v_f [mm/min] = (f_z [mm] • z • min^{-1})

A

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0008	0.0008	0.0012	0.0024	0.0035	0.0047	0.0059	0.0059	0.0079						
0.0020	0.0006	0.0006	0.0010	0.0016	0.0028	0.0039	0.0047	0.0059	0.0079						
0.0040	0.0004	0.0005	0.0008	0.0014	0.0020	0.0031	0.0039	0.0059	0.0079	0.0079	0.0079	0.0079			
0.0080	0.0004	0.0004	0.0006	0.0012	0.0016	0.0024	0.0031	0.0059	0.0071	0.0079	0.0079	0.0079	0.0079	0.0098	
1/64"		0.0004	0.0005	0.0010	0.0012	0.0020	0.0028	0.0047	0.0059	0.0059	0.0059	0.0059	0.0079	0.0098	0.0098
1/32"			0.0004	0.0010	0.0012	0.0016	0.0024	0.0035	0.0047	0.0047	0.0047	0.0047	0.0059	0.0079	0.0098
1/16"				0.0008	0.0012	0.0012	0.0020	0.0031	0.0043	0.0047	0.0047	0.0047	0.0059	0.0079	0.0079
1/8"					0.0008	0.0010	0.0018	0.0030	0.0041	0.0047	0.0047	0.0047	0.0053	0.0069	0.0079
3/16"						0.0008	0.0016	0.0028	0.0039	0.0047	0.0047	0.0047	0.0047	0.0059	0.0079
1/4"							0.0012	0.0024	0.0031	0.0039	0.0039	0.0047	0.0047	0.0059	0.0079
5/16"								0.0020	0.0028	0.0035	0.0039	0.0047	0.0047	0.0059	0.0079
3/8"									0.0024	0.0031	0.0039	0.0047	0.0047	0.0055	0.0063
1/2"										0.0028	0.0035	0.0043	0.0047	0.0055	0.0063
9/16"											0.0031	0.0039	0.0047	0.0051	0.0059
5/8"												0.0035	0.0039	0.0047	0.0059
11/16"													0.0039	0.0043	0.0051
3/4"														0.0039	0.0047
1"															0.0039

B

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0006	0.0006	0.0012	0.0020	0.0031	0.0039	0.0047	0.0047	0.0063						
0.0020	0.0005	0.0005	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047	0.0063						
0.0040	0.0003	0.0004	0.0006	0.0012	0.0016	0.0024	0.0031	0.0047	0.0063	0.0063	0.0063	0.0063			
0.0080	0.0003	0.0003	0.0005	0.0010	0.0014	0.0020	0.0024	0.0047	0.0055	0.0063	0.0063	0.0063	0.0063	0.0079	
1/64"		0.0003	0.0004	0.0008	0.0010	0.0016	0.0024	0.0039	0.0047	0.0047	0.0047	0.0047	0.0063	0.0079	0.0079
1/32"			0.0004	0.0008	0.0010	0.0012	0.0019	0.0031	0.0039	0.0039	0.0039	0.0039	0.0047	0.0063	0.0079
1/16"				0.0006	0.0008	0.0010	0.0020	0.0028	0.0035	0.0039	0.0039	0.0039	0.0047	0.0063	0.0063
1/8"					0.0006	0.0009	0.0018	0.0026	0.0033	0.0039	0.0039	0.0039	0.0043	0.0055	0.0063
3/16"						0.0008	0.0016	0.0024	0.0031	0.0039	0.0039	0.0039	0.0039	0.0047	0.0063
1/4"							0.0012	0.0020	0.0028	0.0031	0.0031	0.0039	0.0039	0.0047	0.0063
5/16"								0.0016	0.0024	0.0031	0.0031	0.0039	0.0039	0.0047	0.0063
3/8"									0.0020	0.0028	0.0031	0.0039	0.0039	0.0047	0.0055
1/2"										0.0024	0.0028	0.0035	0.0039	0.0047	0.0055
9/16"											0.0028	0.0031	0.0039	0.0047	0.0055
5/8"												0.0028	0.0031	0.0039	0.0047
11/16"													0.0031	0.0039	0.0047
3/4"														0.0031	0.0039
1"															0.0039

C

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0014	0.0016	0.0024	0.0039	0.0063	0.0079	0.0098	0.0098	0.0098						
0.0020	0.0012	0.0012	0.0020	0.0031	0.0047	0.0071	0.0079	0.0098	0.0098						
0.0040	0.0008	0.0010	0.0016	0.0024	0.0039	0.0055	0.0071	0.0098	0.0098	0.0098	0.0098	0.0098			
0.0080	0.0008	0.0008	0.0012	0.0020	0.0031	0.0039	0.0055	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	
1/64"		0.0008	0.0008	0.0020	0.0024	0.0035	0.0047	0.0079	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098
1/32"			0.0006	0.0020	0.0024	0.0028	0.0039	0.0063	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098	0.0098
1/16"				0.0016	0.0020	0.0024	0.0031	0.0055	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098	0.0098
1/8"					0.0016	0.0020	0.0030	0.0051	0.0087	0.0087	0.0087	0.0087	0.0093	0.0098	0.0098
3/16"						0.0016	0.0028	0.0047	0.0087	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098
1/4"							0.0020	0.0039	0.0055	0.0071	0.0079	0.0087	0.0087	0.0098	0.0098
5/16"								0.0035	0.0047	0.0063	0.0079	0.0087	0.0087	0.0098	0.0098
3/8"									0.0039	0.0055	0.0071	0.0087	0.0087	0.0098	0.0098
1/2"										0.0047	0.0063	0.0079	0.0087	0.0098	0.0098
9/16"											0.0055	0.0071	0.0087	0.0098	0.0098
5/8"												0.0063	0.0071	0.0087	0.0098
11/16"													0.0071	0.0079	0.0098
3/4"														0.0071	0.0079
1"															0.0079

Solid Carbide Chamfer / Profile

Inch Range

Type	45° Chamfer	45° Debur	Concave Radius
Length	Long	Long	Standard
Helix	0°	0°	0°
No. of flutes	4-6	4-6	3-4
Surface treatment	TAX	TAX	TAX
			
Range	(1/4...3/8)	(1/4...3/8)	(1/32...1/4)
Remarks			Corner Rounding
Catalog no.	**AH3058318**	**AH3053918**	**AH3068118**
Catalog page	176	177	178

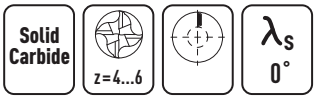
Metric Range

Type	45° Chamfer	45° Debur	Concave Radius
Length	P-Norm L	P-Norm L	DIN 6527 L
Helix	0°	0°	0°
No. of flutes	4-6	4-6	3-4
Surface treatment	TAX	TAX	TAX
			
Range	(6...12)	(6...12)	(0.5...6)
Remarks			Corner Rounding
Catalog no.	**H3058318**	**H3053918**	**H3068118**
Catalog page	179	180	181

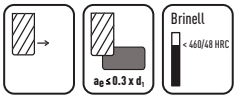
176

Protostar 45° Chamfer Mill

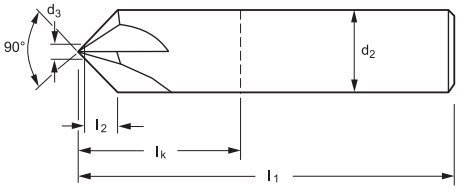
Characteristics



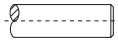
Application



- For applying a chamfer to the workpiece. Able to be used in a diverse material spectrum.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



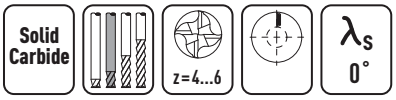
Standard



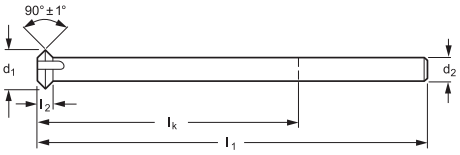
α ± 20`	d_2 h6 inch	l_2 inch	l_1 inch	d_3 inch	l_k inch	z	Code AH3058318 TAX
90°	0.250	0.105	2.500	0.039	1.083	4	-1/4
90°	0.375	0.127	2.500	0.059	0.937	4	-5/16
90°	0.375	0.158	2.500	0.059	0.937	4	-3/8
90°	0.500	0.191	3.000	0.118	1.217	6	-1/2

Protostar 45° Deburring Mill

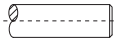
Characteristics



- Removes workpiece burrs by utilizing either the face or back periphery of the mill.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



Long

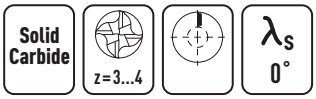


d_1 inch	l_2 inch	l_3 inch	d_3 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3053918 TAX
1/4	0.173	0.750	0.154	4.000	2.583	0.250	4	-1/4
5/16	0.079	-	-	4.000	2.583	0.250	4	-5/16
3/8	0.157	-	-	4.000	2.583	0.250	6	-3/8
1/2	0.236	-	-	4.000	2.583	0.250	6	-1/2

178

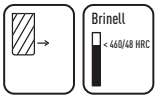
Protostar Concave Radius Mill

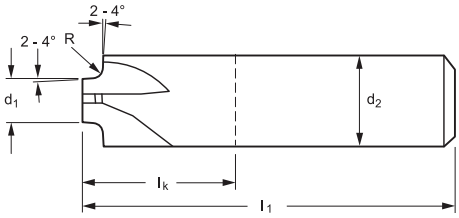
Characteristics



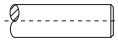
- For applying a corner radius to the workpiece. Able to be used in a diverse material spectrum.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application





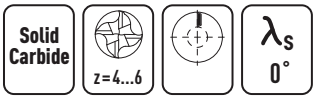
Standard



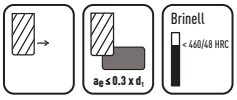
R inch	d1 inch	l_1 inch	l_k inch	d_2 h6 inch	z	Code AH3068118 TAX
1/32	3/19	2.500	1.083	0.250	3	-1/32
1/16	2/17	2.500	1.083	0.250	4	-1/16
1/8	12/61	3.000	1.217	0.500	4	-1/8
3/16	23/73	4.000	1.969	0.750	4	-3/16
1/4	13/30	4.000	1.717	1.000	4	-1/4

Protostar 45° Chamfer Mill

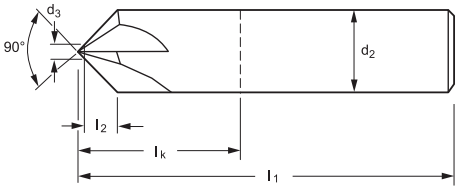
Characteristics



Application



- For applying a chamfer to the workpiece. Able to be used in a diverse material spectrum.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



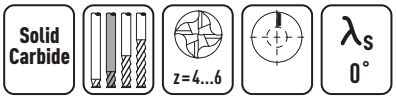
P-Norm L

DIN 6535HA

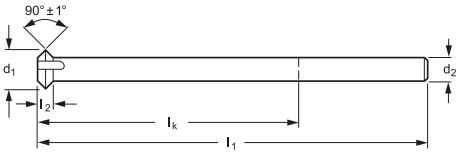
α ± 20'	d_2 h6 mm	l_2 mm	l_1 mm	d_3 mm	l_k mm	z	Code H3058318 TAX
90°	6	2.5	57	1.0	21	4	-6
90°	8	3	80	2.0	44	5	-8
90°	10	4.25	100	1.5	60	4	-10
90°	12	4.5	83	3.0	38	6	-12

Protostar 45° Deburring Mill

Characteristics



- Removes workpiece burrs by utilizing either the face or back periphery of the mill.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.



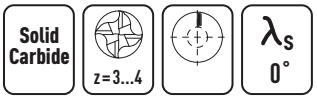
P-Norm L

DIN 6535HA

d_1 -0,3 mm	l_2 mm	l_3 mm	d_3 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3053918 TAX
6	4.25	19	3.9	100	64	6	4	-6
8	2	-	-	100	64	6	4	-8
10	4	-	-	100	64	6	6	-10
12	6	-	-	100	64	6	6	-12

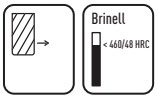
Protostar Concave Radius Mill

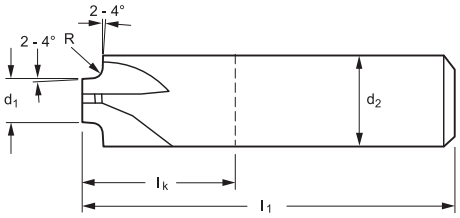
Characteristics



- For applying a corner radius to the workpiece. Able to be used in a diverse material spectrum.
- **TAX** (Titanium Aluminum Nitride) is a mono-layer coating with high hardness and heat resistance.

Application





DIN 6527 L

DIN 6535HA

R ±0,05 mm	d_1 ±0,1 mm	l_1 mm	l_k mm	d_2 h6 mm	z	Code H3068118 TAX
0.5	4	57	21	6	3	-0.5
0.75	4	57	21	6	3	-0.75
0.8	4	57	21	6	3	-0.8
1	4	63	27	8	4	-1
1.25	4	63	27	8	4	-1.25
1.5	4	63	27	8	4	-1.5
2	5	72	32	10	4	-2
2.5	5	72	32	10	4	-2.5
3	5	83	38	12	4	-3
4	6	83	38	14	4	-4
5	6	92	44	16	4	-5
6	8	104	54	20	4	-6

Application guide - Chamfer / Profile

Speed and Feed Chart: The speeds and feeds in this table are intended for intial setup. These values are a guide, depending on machining conditions, these parameters may need to be adjusted up or down until optimum settings are found.

How to use this chart:

1. Pick your material group*
2. Move across to mill series
3. Read SFM and Feed Chart (FC) Letter
4. Go to the Feed Charts on pages 184-185 and convert to feed per tooth
5. Calculate Speed and Feed using formulas on page 184

* Example materials can be found in the Material Library on page 188-189 of the Technical Information section

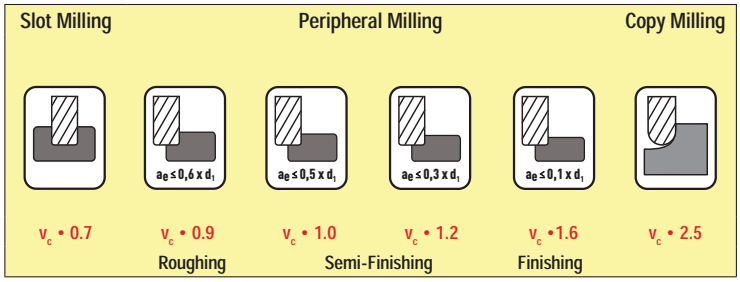
Type		45° Chamfer		45° Debur		Concave Radius	
Length inch		Long		Long		Standard	
Length metric		P-Norm		P-Norm		DIN 6527 L	
Helix		0°		0°		0°	
No. of flutes		4-6		4-6		3-4	
Surface treatment		TAX		TAX		TAX	
							
Remarks						Corner Rounding	
INCH	Range	(1/4...3/8)		(1/4...3/8)		(1/32...1/4)	
INCH	**Catalog No.**	**AH3058318**		**AH3053918**		**AH3068118**	
INCH	Catalog Page	176		177		178	
METRIC	Range	(6...12)		(6...12)		(0.5...6)	
METRIC	**Catalog No.**	**H3058318**		**H3053918**		**H3068118**	
METRIC	Catalog Page	179		180		181	

ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Hardness	SFM	FC	SFM	FC	SFM	FC
P	**Steel**								
	1.1	Magnetic soft steel	61 - 120 HB	655	A	720	A	720	A
	1.2	Structural steel, case carburizing steel	101 - 200 HB	655	A	720	A	720	A
	1.3	Plain carbon steel	100 - 250 HB	625	A	690	A	690	A
	1.4	Alloy steel	150 - 250 HB	525	A	655	A	655	A
	1.5	Alloy steel, Tempered steel	26 - 38 HRc	395	A	425	A	425	A
	1.6.1	Alloy steel, Tempered steel	39 - 44 HRc	330	A	360	A	360	A
	1.6.2	Alloy steel, Tempered steel	44 - 49 HRc	260	B	295	B	295	B
M	**Stainless Steel**								
	2.1	Free machining stainless steel	120 - 250 HB	260	B	295	B	295	B
	2.2	Austinetic	130 - 250 HB	230	B	230	B	230	B
	2.3	Ferritic, austenitic, martensitic	130 - 320 HB	195	B	195	B	195	B
	2.4	High tensile chrome-nickel alloys	33 - 44 HRc	130	B	165	B	165	B
K	**Cast Iron**								
	3.1	Cast Iron	50 - 150 HB	490	A	560	A	560	A
	3.2	Cast Iron	150 - 300 HB	425	A	460	A	460	A
	3.3	Ductile Iron	150 - 200 HB	490	A	560	A	560	A
	3.4	Ductile Iron	14 - 32 HRc	395	A	460	A	460	A
	3.5	Compacted graphite iron	14 - 32 HRc	330	A	395	A	395	A
N	**Non-ferrous Materials**								
	6.1	Copper, unalloyed	80 - 100 HB	1410	C	1410	C	1410	C
	6.2	Short chip brass	100 - 200 HB	1410	C	1540	C	1540	C
	6.3	Long chip brass	120 - 200 HB	1410	C	1410	C	1410	C
	6.4	Cu-Al-Fe alloys	200 - 440 HB	195	C	230	C	230	C
	6.5	Cu-Al-Ni alloys (short chipping)	120 - 250 HB	490	C	525	C	525	C
	6.6	Cu-Al-Ni alloys (long chipping)	120 - 250 HB	490	C	525	C	525	C
	7.1	Al, Mg unalloyed	60 - 100 HB	4855	C	5315	C	5315	C
	7.2	Al, alloyed Si<0.5%	90 - 180 HB	4855	C	5710	C	5710	C
	7.3.1	Al, alloyed Si>=0.5%<4%	90 - 180 HB	4365	C	4985	C	4985	C
	7.3.2	Al, alloyed Si>=4%<12%	90 - 180 HB	1935	C	2135	C	2135	C
	7.4	Al, alloyed Si>=12%	90 - 180 HB	690	C	690	C	690	C
	7.5.1	Magnesium Standard alloy	120 - 300 N/mm²	2230	C	2460	C	2460	C
	7.5.2	Magnesium -high tensile strength	70 - 120 HB	1970	C	2135	C	2135	C
	7.5.3	Heat resistant magnesium alloys	120 - 300 N/mm²	1675	C	1835	C	1835	C
S	**High Temp Alloys and Titanium Alloys**								
	4.1	Titanium, unalloyed	120 - 200 HB	560	A	590	A	590	A
	4.2	Titanium, alloyed	14 - 28 HRc	195	A	230	A	230	A
	4.3	Titanium, alloyed	28 - 44 HRc	165	A	165	A	165	A
	5.1	Nickel, unalloyed	120 - 150 HB	855	A	855	A	855	A
	5.2	Nickel, alloyed	150 - 270 HB	165	B	195	B	195	B
	5.3	Nickel, alloyed	28 - 49 HRc	100	B	100	B	100	B
	9.1	TIC Hard materials	48 - 51 HRc	35	B	35	B	35	B
	9.2	Tungsten alloys	44 - 52 HRc	195	B	230	B	230	B
	9.3	Alloys on Cobalt base	150 - 350 HB	100	B	100	B	100	B
	9.4	Molybdenum alloyed	150 - 350 HB	195	B	230	B	230	B
H	**Hardened Materials**								
	1.7.1	Steel (hardened), short chipping	49 - 55 HRc	195	B	260	B	260	B
	1.7.2	Steel (hardened), long chipping	49 - 55 HRc	195	B	260	B	260	B
	1.8.1	Steel (hardened)	55 - 60 HRc						
	1.8.2	Steel (hardened)	60 - 65 HRc						
O	**Synthetic Materials / Others**								
	8.1	Thermoplastics	<50 N/mm²	1115	C	1150	C	1150	C
	8.2	Thermosetting plastics	<80 N/mm²	655	C	655	C	655	C
	8.3	Reinforced plastic materials	240 - 440 N/mm²	295	C	295	C	295	C
	10.1	Standard graphite	<100 N/mm²	855	C	855	C	855	C
	10.2	Wear resistant graphite	<100 N/mm²	855	C	855	C	855	C

Values

Description	Unit Inch	Unit Metric
Revolutions per minute	min^{-1}	min^{-1}
Cutting Speed	v_c [ft/min]	v_c [m/min]
Feed rate	v_f [inch/min]	v_f [mm/min]
Cutting diameter	d_1 [inch]	d_1 [mm]
Feed per tooth	f_z [inch]	f_z [mm]
Number of teeth	z	z
Axial depth of cut	a_p [inch]	a_p [mm]
Radial width of cut	a_e [inch]	a_e [mm]

Cutting speed factors



Conversions

To m/min from SFM

v_c [m/min] = v_c [ft/min] • 0.3048

To mm from inch

[mm] = [inch] • 25.4

Calculations

RPM with SFM and cutter diameter

$min^{-1} = (v_c$ [ft/min] • 3.82) / d_1 [inch]

RPM with m/min and cutter diameter

$min^{-1} = (v_c$ [m/min] • 1000) / (3.14 • d_1 [mm])

IPM with FPT, number of teeth and RPM

v_f [inch/min] = (f_z [inch] • z • min^{-1})

mm/min with FPT, number of teeth and RPM

v_f [mm/min] = (f_z [mm] • z • min^{-1})

A

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0008	0.0008	0.0012	0.0024	0.0035	0.0047	0.0059	0.0059	0.0079						
0.0020	0.0006	0.0006	0.0010	0.0016	0.0028	0.0039	0.0047	0.0059	0.0079						
0.0040	0.0004	0.0005	0.0008	0.0014	0.0020	0.0031	0.0039	0.0059	0.0079	0.0079	0.0079	0.0079			
0.0080	0.0004	0.0004	0.0006	0.0012	0.0016	0.0024	0.0031	0.0059	0.0071	0.0079	0.0079	0.0079	0.0079	0.0098	
1/64"		0.0004	0.0005	0.0010	0.0012	0.0020	0.0028	0.0047	0.0059	0.0059	0.0059	0.0059	0.0079	0.0098	0.0098
1/32"			0.0004	0.0010	0.0012	0.0016	0.0024	0.0035	0.0047	0.0047	0.0047	0.0047	0.0059	0.0079	0.0098
1/16"				0.0008	0.0012	0.0012	0.0020	0.0031	0.0043	0.0047	0.0047	0.0047	0.0059	0.0079	0.0079
1/8"					0.0008	0.0010	0.0018	0.0030	0.0041	0.0047	0.0047	0.0047	0.0053	0.0069	0.0079
3/16"						0.0008	0.0016	0.0028	0.0039	0.0047	0.0047	0.0047	0.0047	0.0059	0.0079
1/4"							0.0012	0.0024	0.0031	0.0039	0.0039	0.0047	0.0047	0.0059	0.0079
5/16"								0.0020	0.0028	0.0035	0.0039	0.0047	0.0047	0.0059	0.0079
3/8"									0.0024	0.0031	0.0039	0.0047	0.0047	0.0055	0.0063
1/2"										0.0028	0.0035	0.0043	0.0047	0.0055	0.0063
9/16"											0.0031	0.0039	0.0047	0.0051	0.0059
5/8"												0.0035	0.0039	0.0047	0.0059
11/16"													0.0039	0.0043	0.0051
3/4"														0.0039	0.0047
1"															0.0039

B

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0006	0.0006	0.0012	0.0020	0.0031	0.0039	0.0047	0.0047	0.0063						
0.0020	0.0005	0.0005	0.0008	0.0016	0.0024	0.0031	0.0039	0.0047	0.0063						
0.0040	0.0003	0.0004	0.0006	0.0012	0.0016	0.0024	0.0031	0.0047	0.0063	0.0063	0.0063	0.0063			
0.0080	0.0003	0.0003	0.0005	0.0010	0.0014	0.0020	0.0024	0.0047	0.0055	0.0063	0.0063	0.0063	0.0063	0.0079	
1/64"		0.0003	0.0004	0.0008	0.0010	0.0016	0.0024	0.0039	0.0047	0.0047	0.0047	0.0047	0.0063	0.0079	0.0079
1/32"			0.0004	0.0008	0.0010	0.0012	0.0019	0.0031	0.0039	0.0039	0.0039	0.0039	0.0047	0.0063	0.0079
1/16"				0.0006	0.0008	0.0010	0.0020	0.0028	0.0035	0.0039	0.0039	0.0039	0.0047	0.0063	0.0063
1/8"					0.0006	0.0009	0.0018	0.0026	0.0033	0.0039	0.0039	0.0039	0.0043	0.0055	0.0063
3/16"						0.0008	0.0016	0.0024	0.0031	0.0039	0.0039	0.0039	0.0039	0.0047	0.0063
1/4"							0.0012	0.0020	0.0028	0.0031	0.0031	0.0039	0.0039	0.0047	0.0063
5/16"								0.0016	0.0024	0.0031	0.0031	0.0039	0.0039	0.0047	0.0063
3/8"									0.0020	0.0028	0.0031	0.0039	0.0039	0.0047	0.0055
1/2"										0.0024	0.0028	0.0035	0.0039	0.0047	0.0055
9/16"											0.0028	0.0031	0.0039	0.0047	0.0055
5/8"												0.0028	0.0031	0.0039	0.0047
11/16"													0.0031	0.0039	0.0047
3/4"														0.0031	0.0039
1"															0.0039

C

a_e [inch] radial width of cut	Feed per tooth in inches f_z [inch]														
	Ø 0.3mm	Ø 1/64" Ø 0.5mm	Ø 1/32" Ø 1mm	Ø 1/16" Ø 2mm	Ø 1/8" Ø 3mm	Ø 3/16" Ø 4mm	Ø 1/4" Ø 6mm	Ø 5/16" Ø 8mm	Ø 3/8" Ø 10mm	Ø 1/2" Ø 12mm	Ø 9/16" Ø 14mm	Ø 5/8" Ø 16mm	Ø 11/16" Ø 18mm	Ø 3/4" Ø 20mm	Ø 1" Ø 25mm
0.0005	0.0014	0.0016	0.0024	0.0039	0.0063	0.0079	0.0098	0.0098	0.0098						
0.0020	0.0012	0.0012	0.0020	0.0031	0.0047	0.0071	0.0079	0.0098	0.0098						
0.0040	0.0008	0.0010	0.0016	0.0024	0.0039	0.0055	0.0071	0.0098	0.0098	0.0098	0.0098	0.0098			
0.0080	0.0008	0.0008	0.0012	0.0020	0.0031	0.0039	0.0055	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	
1/64"		0.0008	0.0008	0.0020	0.0024	0.0035	0.0047	0.0079	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098	0.0098
1/32"			0.0006	0.0020	0.0024	0.0028	0.0039	0.0063	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098	0.0098
1/16"				0.0016	0.0020	0.0024	0.0031	0.0055	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098	0.0098
1/8"					0.0016	0.0020	0.0030	0.0051	0.0087	0.0087	0.0087	0.0087	0.0093	0.0098	0.0098
3/16"						0.0016	0.0028	0.0047	0.0087	0.0087	0.0087	0.0087	0.0087	0.0098	0.0098
1/4"							0.0020	0.0039	0.0055	0.0071	0.0079	0.0087	0.0087	0.0098	0.0098
5/16"								0.0035	0.0047	0.0063	0.0079	0.0087	0.0087	0.0098	0.0098
3/8"									0.0039	0.0055	0.0071	0.0087	0.0087	0.0098	0.0098
1/2"										0.0047	0.0063	0.0079	0.0087	0.0098	0.0098
9/16"											0.0055	0.0071	0.0087	0.0098	0.0098
5/8"												0.0063	0.0071	0.0087	0.0098
11/16"													0.0071	0.0079	0.0098
3/4"														0.0071	0.0079
1"															0.0079

Material groups

ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Tensile Strength (N/mm²)	Brinell Hardness (HB)	Rockwell Hardness (HRC)	Examples
P		Steel				
	1.1	Magnetic soft steel	200 - 400	60 - 120		1005-1010, 1108-1115, 1210-1215, A36
	1.2	Structural steel, case carburizing steel	350 - 700	100 - 200		1030-1095, 1146-1151, 12L14
	1.3	Plain carbon steel	350 - 850	100 - 250		1020-1035, 1045, 1055, 1060
	1.4	Alloy steel	500 - 850	150 - 250		4140, A2, 4340, M42, M2, T1, P20
	1.5	Alloy steel, Tempered steel	850 - 1200	250 - 350	25 - 38	01, L6, M42, D3, A2, M2, 4140, 8620, P20
	1.6.1	Alloy steel, Tempered steel	1200 - 1400	350 - 410	38 - 44	01, L6, M42, D3, A2, 4140, 8130, P20
	1.6.2	Alloy steel, Tempered steel	1400 - 1600	410 - 470	44 - 49	02, D3
M		Stainless Steel				
	2.1	Free machining stainless steel	400 - 850	120 - 250		303, 416, 430F
	2.2	Austenitic	450 - 850	130 - 250		304, 321, 316, 17-4PH, 15-5PH
	2.3	Ferritic, austenitic, martensitic	450 - 1100	130 - 320		409, 410, 420, 430, 436
	2.4	High tensile chrome-nickel alloys	1100 - 1400	320 - 410	33 - 44	660, A286, AMS
K		Cast Iron				
	3.1	Cast Iron	150 - 500	50 - 150		GG10, GG 40, ASTM A48 class 20
	3.2	Cast Iron	500 - 1000	150 - 300		GG25, GG 40, ASTM A48 class 40
	3.3	Ductile Iron	500 - 700	150 - 200		GGG 40-GGG70, ASTM A220 grade 40010
	3.4	Ductile Iron	700 - 1000	200 - 300	14 - 32	GGG 40-GGG70, ASTM A602 grade 90001
	3.5	Compacted graphite iron	700 - 1000	200 - 300	14 - 32	CGI
N		Non-ferrous Materials				
	6.1	Copper, unalloyed	250 - 350	80 - 100		Commercially pure
	6.2	Short chip brass	350 - 700	100 - 200		ASTM B30
	6.3	Long chip brass	400 - 700	120 - 200		ASTM B36
	6.4	Cu-Al-Fe alloys	700 - 1500	200 - 440	14 - 47	Ampco
	6.5	Cu-Al-Ni alloys (short chipping)	400 - 850	120 - 250		
	6.6	Cu-Al-Ni alloys (long chipping)	400 - 850	120 - 250		
	7.1	Al, Mg unalloyed	200 - 350	60 - 100		Commercially pure, EC, 1060, 1100
	7.2	Al, alloyed Si<0.5%	300 - 600	90 - 180		6061, 7025, 2024
	7.3.1	Al, alloyed Si>=0.5%<4%	300 - 600	90 - 180		4013, 8009, 296.2
	7.3.2	Al, alloyed Si>=4%<12%	300 - 600	90 - 180		356, 380, 319, 355.1, 4043, A356.2
	7.4	Al, alloyed Si>=12%	300 - 600	90 - 180		390, 393
	7.5.1	Magnesium Standard alloy	120 - 300			AZ 81, SAE 50
	7.5.2	Magnesium – high tensile strength	240 - 400	70 - 120		SAE 520, SAE523
	7.5.3	Heat resistant magnesium alloys	120 - 300			

ISO Material Group	PROTOTYP Material Group	PROTOTYP Material Group Description	Tensile Strength (N/mm²)	Brinell Hardness (HB)	Rockwell Hardness (HRC)	Examples
S		High Temp Alloys and Titanium Alloys				
	4.1	Titanium, unalloyed	400 - 700	120 - 200		Commercially pure, ASTM B265 grade 1
	4.2	Titanium, alloyed	700 - 900	200 - 270	14 - 28	TiAl6V4, ASTM 4928
	4.3	Titanium, alloyed	900 - 1400	270 - 410	28 - 44	TiAl6V4, ASTM 4929
	5.1	Nickel, unalloyed	400 - 500	120 - 150		Commercially pure, Nickel 200/300
	5.2	Nickel, alloyed	500 - 900	150 - 270		Monel 400, Hasteloy, Inconel, Waspaloy
	5.3	Nickel, alloyed	900 - 1600	270 - 470	28 - 49	Monel 400, Hasteloy, Inconel, Nimonic
	9.1	TIC Hard materials	1500 - 1700	450 - 500	48 - 51	Ferrotic, Ferrot Titanit
	9.2	Tungsten alloys	1400 - 1800	435 - 550	44 - 52	Densiment, Denal
	9.3	Alloys on Cobalt base	500 - 1200	150 - 350		Celsit
	9.4	Molybdenum alloyed	500 - 1200	150 - 350		
H		Hardened Materials				
	1.7.1	Steel (hardened), short chipping	1600 - 2000	470 - 570	49 - 55	02, D3, 4135, 414, P20
	1.7.2	Steel (hardened), long chipping	1600 - 2000	470 - 570	49 - 55	D2, D3
	1.8.1	Steel (hardened)		570 - 705	55 - 60	D2, D4
	1.8.2	Steel (hardened)			60 - 65	
O		Synthetic Materials / Other				
	8.1	Thermoplastics	<50			Polystyrene, Nylon PVC
	8.2	Thermosetting plastics	<80			Bakelite
	8.3	Reinforced plastic materials	800 - 1500	240 - 440		CFK, GFK, AFK
	10.1	Standard graphite	<100			R8340
	10.2	Wear resistant graphite	<100			R8510

Climb milling vs. Conventional milling

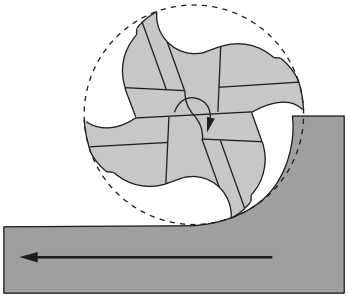
Climb milling

In climb milling, the cutter revolves in the same direction as the table feed. The tooth meets the workpiece at the top of the cut, producing the thickest part of the chip first.

Although climb milling has an increased initial load on the tool, it as able to enter the workpiece quite readily. This initial load can be balanced out by using a high helix end mill.

Overall the tool life of milling cutters is significantly longer with climb milling than with conventional milling. The difference becomes apparent when tougher materials are being machined. Particularly tough materials for example are, high-alloyed steels, titanium alloys and nickel alloys.

For the above reasons climb milling is fundamentally recommended.



Climb Milling

Important: Climb milling creates a negative feed force resulting in a higher degree of radial deflection when compared to conventional milling.

Conventional milling has been found to be more advantageous when machining materials with scale or hardened surfaces. In these cases avoid climb milling.

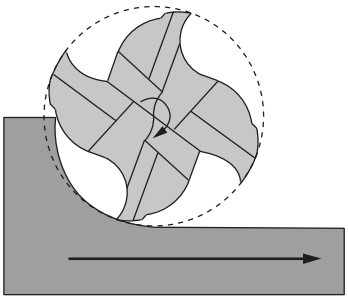
Conventional milling

In conventional milling, the cutter revolves in the opposite direction of the table feed. Therefore, the width of the chip theoretically starts at zero and increases to a maximum width at the end of the cut. This can lead to accelerated tool wear.

Conventional milling requires cutters to have a high level of toughness and can lead to breakage when using carbide.

For the above reasons conventional milling is fundamentally not recommended.

However, the positive feed force created by conventional milling provides a low degree of radial deflection in comparison to climb milling.



Conventional milling

The reduced radial deflection is often preferred for thread milling operations, despite the reduction in tool life.

Typically, slot milling should be treated like a conventional milling operation. An important aspect is the way the cutting edge enters the workpiece.

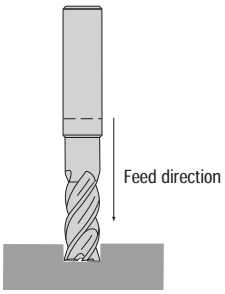
Plunge milling strategies and feeds

Plunge milling is a very routine process for entering into a workpiece. End mills with 2-3 flutes should be used whenever depths are greater than 0.2 x d_1.

Plunge depths in excess of 0.5 x d_1 we recommend the use of 2 flute end mills. Unless, a specially designed 3 flute end mill with an increased chip space in the face region of the tool is available.

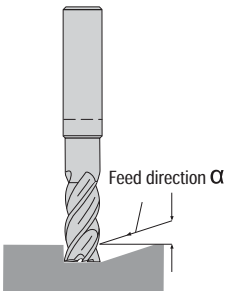
Additional cutting data can also be found in TEC+CCS software (Info button above vfb-feed rate for plunging)

Strategy 1: Axial plunge



Recommended feedrate for axial plunging:
2 flutes = 40% of the calculated feedrate for slot milling.
3 flutes = 30% of the calculated feedrate for slot milling.

Strategy 2: Ramp plunge

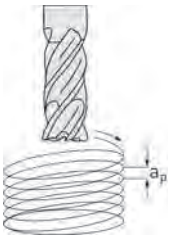


Recommended ramp angle **α**:

Number of flutes	2	3	> = 4
For steel, cast iron, stainless steel, etc.	15°	10°	5°
For aluminum, copper, plastics	30°	20°	10°
For hardened steel	4°	3°	2°

Cutting data: See slot milling (a_e= 1 x d_1 and a_p = maximum axial depth of the ramp)

Strategy 3: Helical plunge



Recommended a_p (depth of cut) per pass:

Material	Aluminium	Steel	Hardened steel
Guideline values for a_p (depth of cut)	0.2 x d_1	0.1 x d_1	0.05 x d_1

Max. possible bore diameter D_{bmax}:

$D_{bmax} = 2 \cdot (d_1\text{-}R)$ With d_1 = End mill Ø and R= corner radius of the end mill

Helical feed notes:
The bore diameter can be up to 2 x d_1.

It is recommended that the bore diameter be as large as possible for ease of chip removal during the machining process, either by coolant or compressed air blast.

When using ball nose end mills, a bevel-like bump inevitably remains in the middle.

Carbide definition

The basis is WC (tungsten carbide); special types in particular the P types have additions of so-called composite carbides such as TiC, TaC, NbC; the binder is Co (Cobalt).

Application groups for carbide

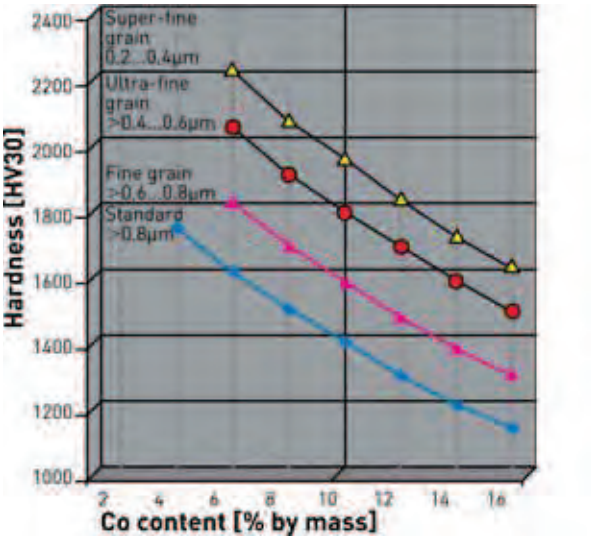
Cutting application area in accordance with ISO	Application
P01 P40	Materials with long chips, e.g. steel, cast steel
M10 M40	Multil-area type, e.g. austenitic steels, ductile iron, machining steels
K03 K40	Materials with short chips, e.g. grey cast iron, hardened steel, non-ferrous metals, plastics, graphite

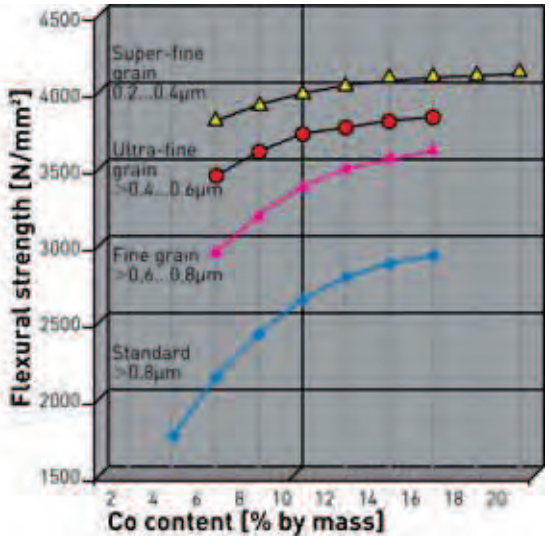
The classification of P, M and K type carbide grades relates to the application and not directly to the carbide composition.

Further developments in the content of carbides and coating technology is leading to an ever increasing use of K-type grades for the machining of long chipping materials such as steel.

P types	Long-chipping materials
M types	Multi-purpose range
K types	Short-chipping materials

Hardness and flexural strength (in accordance with ISO 3327) as a function of grain size and cobalt content in K grades





Coating properties

	Aluminium-Chrom-Nitride	Titanium Aluminum Nitride
Catalog code	ACN	TAX
Coating material	AlCrN	TiAlN
Micro-hardness (HV0.05)	3200	3500
Coating thickness (0.001 mm)	3-4	1-2
Application temperature max. (°C)	1100	800
Color	violet-grey	turquoise
Treatment structure	Monolayer	Monolayer

	Hard Carbon	Diamond
Catalog code	HDC	DIA
Coating material	C	Diamond
Micro-hardness (HV0.05)	6000	>8000
Coating thickness (0.001 mm)	1.5-2	4-6
Application temperature max. (°C)	600	700
Color	glossy-black	black
Treatment structure	Monolayer	Monolayer

Marking of our mills

Solid carbide End Mills e.g.

H4120017-10-1	Code number – Dimension
<=48-63HRC	Application area
10x22	d_1 and cutting length
R1	Radius 1 mm
A1007	Production reference number
49°-28	Helix angle/helix pitch
43/07	Production date week/year

Hardness conversion table

Tensile strength [N/mm²]	Hardness Brinell [HB]	Hardness Rockwell [HRC]	Hardness Vickers [HV 10]	PSI [psi]
150	50		50	22
200	60		60	29
250	80		80	37
300	90		95	43
350	100		110	50
400	120		125	58
450	130		140	66
500	150		155	73
550	165		170	79
600	175		185	85
650	190		200	92
700	200		220	98
750	215		235	105
800	230	22	250	112
850	250	25	265	120
900	270	27	280	128
950	280	29	295	135
1,000	300	31	310	143
1,050	310	33	325	150
1,100	320	34	340	158
1,150	340	36	360	164
1,200	350	38	375	170
1,250	370	40	390	177
1,300	380	41	405	185
1,350	400	43	420	192
1,400	410	44	435	200
1,450	430	45	450	207
1,500	440	46	465	214
1,550		48	480	221
1,600		49	495	228
		51	530	247
		53	560	265
		55	595	283
		57	635	
		59	680	
		61	720	
		63	770	
		64	800	
		65	830	
		66	870	
		67	900	
		68	940	
		69	980	

ISO tolerances

Inch

Nominal value in inches	Measurement conversion in inches of the DIN ISO 286 table listed below																	
	Measurement for external dimensions											Measurement for internal dimensions						
	d11	e8	h5	h6	h7	h8	h9	h10	h11	h12	js14	js16	k10	k11	k12	H6	H7	H11
≤ 0.1181	-0.00079	-0.00055	0	0	0	0	0	0	0	0	+0.00492	+0.01181	+0.00157	+0.00236	+0.00394	+0.00024	+0.00039	+0.00236
	-0.00315	-0.00110	-0.00016	-0.00024	-0.00039	-0.00055	-0.00098	-0.00157	-0.00236	-0.00394	-0.00492	-0.01181	0	0	0	0	0	0
> 0.1181	-0.00118	-0.00079	0	0	0	0	0	0	0	0	+0.00591	+0.01476	+0.00189	+0.00295	+0.00472	+0.00031	+0.00047	+0.00295
≤ 0.2362	-0.00413	-0.00150	-0.00020	-0.00031	-0.00047	-0.00071	-0.00118	-0.00189	-0.00295	-0.00472	-0.00591	-0.01476	0	0	0	0	0	0
> 0.2362	-0.00157	-0.00098	0	0	0	0	0	0	0	0	+0.00709	+0.01772	+0.00228	+0.00354	+0.00591	+0.00035	+0.00059	+0.00354
≤ 0.3937	-0.00512	-0.00185	-0.00024	-0.00035	-0.00059	-0.00087	-0.00142	-0.00228	-0.00354	-0.00591	-0.00709	-0.01772	0	0	0	0	0	0
> 0.3937	-0.00197	-0.00126	0	0	0	0	0	0	0	0	+0.00846	+0.02165	+0.00276	+0.00433	+0.00709	+0.00043	+0.00071	+0.00433
≤ 0.7087	-0.00630	-0.00232	-0.00031	-0.00043	-0.00043	-0.00106	-0.00169	-0.00276	-0.00433	-0.00709	-0.00846	-0.02165	0	0	0	0	0	0
> 0.7087	-0.00256	-0.00157	0	0	0	0	0	0	0	0	+0.01024	+0.02559	+0.00331	+0.00512	+0.00827	+0.00051	+0.00083	+0.00512
≤ 1.1811	-0.00768	-0.00287	-0.00035	-0.00051	-0.00051	-0.0013	-0.00205	-0.00331	-0.00512	-0.00827	-0.01024	-0.02559	0	0	0	0	0	0
> 1.1811	-0.00315	-0.00197	0	0	0	0	0	0	0	0	+0.01220	+0.03150	+0.00394	+0.00630	+0.00984	+0.00063	+0.00098	+0.00630
≤ 1.9685	-0.00945	-0.00350	-0.00043	-0.00063	-0.00063	-0.00154	-0.00244	-0.00394	-0.00630	-0.00984	-0.01220	-0.03150	0	0	0	0	0	0
> 1.9685	-0.00394	-0.00236	0	0	0	0	0	0	0	0	+0.01457	+0.03740	+0.00472	+0.00748	+0.01181	+0.00075	+0.00118	+0.00748
≤ 3.1496	-0.01142	-0.00417	-0.00051	-0.00075	-0.00075	-0.00181	-0.00291	-0.00472	-0.00748	-0.01181	-0.01457	-0.03740	0	0	0	0	0	0
> 3.1496	-0.00472	-0.00283	0	0	0	0	0	0	0	0	+0.01713	+0.04331	+0.00551	+0.00866	+0.01378	+0.00087	+0.00138	+0.00866
≤ 4.7244	-0.01339	-0.00496	-0.00059	-0.00087	-0.00138	-0.00213	-0.00343	-0.00551	-0.00866	-0.01378	-0.01713	-0.04331	0	0	0	0	0	0
> 4.7244	-0.00571	-0.00335	0	0	0	0	0	0	0	0	+0.01969	+0.04921	+0.00630	+0.00984	+0.01575	+0.00098	+0.00157	+0.00984
≤ 7.0866	-0.01555	-0.00583	-0.00071	-0.00098	-0.00157	-0.00248	-0.00394	-0.00630	-0.00984	-0.01575	-0.01969	-0.04921	0	0	0	0	0	0
> 7.0866	-0.00669	-0.00394	0	0	0	0	0	0	0	0	+0.02264	+0.05709	+0.00728	+0.01142	+0.01811	+0.00114	+0.00181	+0.01142
≤ 9.8425	-0.01811	-0.00677	-0.00079	-0.00114	-0.00181	-0.00283	-0.00453	-0.00728	-0.01142	-0.01811	-0.02264	-0.05709	0	0	0	0	0	0

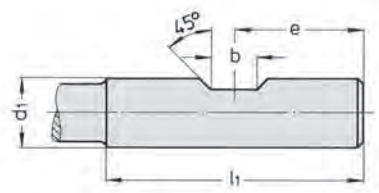
Metric

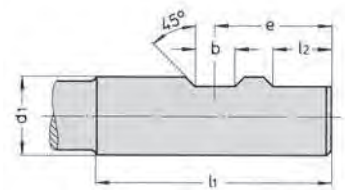
Nominal value in mm	Measurement in µm in acc. DIN ISO 286 (former: DIN 7160 abbr. DIN 7161)																	
	Measurement for external dimensions											Measurement for internal dimensions						
	d11	e8	h5	h6	h7	h8	h9	h10	h11	h12	js14	js16	k10	k11	k12	H6	H7	H11
≤ 3	-20	-14	0	0	0	0	0	0	0	0	+125	+300	+40	+60	+100	+6	+10	+60
	-80	-28	-4	-6	-10	-14	-25	-40	-60	-100	-125	-300	0	0	0	0	0	0
> 3 ≤ 6	-30	-20	0	0	0	0	0	0	0	0	+150	+375	+48	+75	+120	+8	+12	+75
	-105	-38	-5	-8	-12	-18	-30	-48	-75	-120	-150	-375	0	0	0	0	0	0
> 6 ≤ 10	-40	-25	0	0	0	0	0	0	0	0	+180	+450	+58	+90	+150	+9	+15	+90
	-130	-47	-6	-9	-15	-22	-36	-58	-90	-150	-180	-450	0	0	0	0	0	0
> 10 ≤ 18	-50	-32	0	0	0	0	0	0	0	0	+215	+550	+70	+110	+180	+11	+18	+110
	-160	-59	-8	-11	-18	-27	-43	-70	-110	-180	-215	-550	0	0	0	0	0	0
> 18 ≤ 30	-65	-40	0	0	0	0	0	0	0	0	+260	+650	+84	+130	+210	+13	+21	+130
	-195	-73	-9	-13	-21	-33	-52	-84	-130	-210	-260	-650	0	0	0	0	0	0
> 30 ≤ 50	-80	-50	0	0	0	0	0	0	0	0	+310	+800	+100	+160	+250	+16	+25	+160
	-240	-89	-11	-16	-25	-39	-62	-100	-160	-250	-310	-800	0	0	0	0	0	0
50 ≤ 80	-100	-60	0	0	0	0	0	0	0	0	+370	+950	+120	+190	+300	+19	+30	+190
	-290	-106	-13	-19	-30	-46	-74	-120	-190	-300	-370	-950	0	0	0	0	0	0
> 80 ≤ 120	-120	-72	0	0	0	0	0	0	0	0	+435	+1100	+140	+220	+350	+22	+35	+220
	-340	-126	-15	-22	-35	-54	-87	-140	-220	-350	-435	-1100	0	0	0	0	0	0
> 120 ≤ 180	-145	-85	0	0	0	0	0	0	0	0	+500	+1250	+160	+250	+400	+25	+40	+250
	-395	-148	-18	-25	-40	-63	-100	-160	-250	-400	-500	-1250	0	0	0	0	0	0
> 180 ≤ 250	-170	-100	0	0	0	0	0	0	0	0	+575	+1450	+185	+290	+460	+29	+46	+290
	-460	-172	-20	-29	-46	-72	-115	-185	-290	-460	-575	-1450	0	0	0	0	0	0

Shank dimensions

Inch

d_1	l_1	e	b min	b max	h	l_2
3/8	1 9/16	25/32	0.280	0.282	0.325	-
1/2	1 25/32	57/64	0.330	0.332	0.440	-
5/8	1 29/32	61/64	0.400	0.402	0.560	-
3/4	2 1/32	1 1/64	0.455	0.457	0.675	-
7/8	2 1/32	1 1/64	0.455	0.457	0.810	-
1	2 9/32	1 9/64	0.515	0.517	0.925	1/2
1 1/4	2 9/32	1 1/64	0.515	0.517	1.156	1/2
1 1/2	2 11/16	1 3/16	0.515	0.517	1.406	1/2
2	3 1/4	1 27/32	0.700	0.702	1.900	27/32
2 1/2	3 1/2	1 15/16	0.700	0.702	2.400	27/32

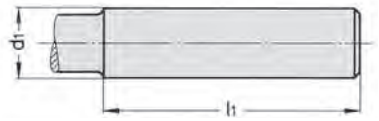




Metric

d_1 h6 mm	l_1 +2 mm	b +0.05 mm	e -1 mm	l_2 +1 mm	h h11 mm
6	36	4.2	18	-	5.1
8	36	5.5	18	-	6.9
10	40	7	20	-	8.5
12	45	8	22.5	-	10.4
14	45	8	22.5	-	12.7
16	48	10	24	-	14.2
18	48	10	24	-	16.2
20	50	11	25	-	18.2
25	56	12	32	17	23.0
32	60	14	36	19	30.0

DIN 6535 HA



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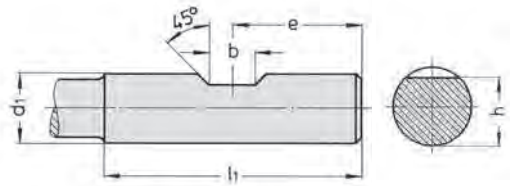
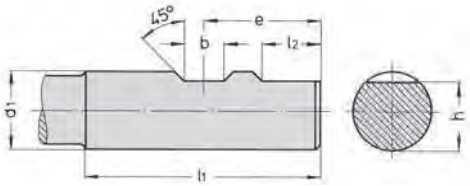




Troubleshooting

Problem	Cause	Solution
Breakage	Feed rate too high	Reduce feed per tooth
	Rigidity	Use shorter length mill
	Chip packing	See chip packing section
	Too much wear	Replace or regrind tool sooner
Chatter / Vibration	Feed rate too low	Increase feed per tooth
	Speed too high	RPM reduction
	Helix angle too low	Increase helix angle
	Number of flutes too low	Increase number of flutes
	Cutter diameter too small	Increase cutter diameter
	Depth of cut too deep	Reduce the depth of cut
	Lack of rigidity	Verify tool holding is rigid
		Check workpiece fixturing is secure
		Check tool runout
		Use shorter length mill, reduce overhang
Chip packing	Excessive removal rate	Reduce feed per tooth / increase RPM
	Insufficient chip evacuation	Increase volume of coolant or air blow
	Insufficient chip space	Reduce the number of flutes
	Depth of cut too deep	Reduce the depth of cut
Chipped cutting edge	Feed rate too high	Reduce feed per tooth
	Lack of rigidity	Verify tool holding is rigid
		Check workpiece fixturing is secure
		Check tool runout
		Use shorter length mill
Cold welding	Insufficient cooling	Increase volume of coolant or air blow
	Improper tool surface	Select appropriate coating for application

Troubleshooting

Problem	Cause	Solution
Deflection	Depth of cut too deep	Reduce the depth of cut
	Feed rate too low	Increase feed per tooth
	Cutter diameter too small	Increase cutter diameter
	Helix angle too low	Increase helix angle
	Lack of rigidity	Use shorter length mill, reduce overhang
	Number of flutes too low	Increase number of flutes
	Milling strategy	Conventional mill instead of climb mill
Excessive wear	Speed too high	RPM reduction
	Milling strategy	Climb mill instead of conventional mill
	Hardened material	Adjust speed / feed, select tool for hardened materials
	Feed rate too slow	Increase feed per tooth
Poor surface finish	Feed rate too high	Reduce feed per tooth
	Speed too slow	Increase RPM
	Helix angle too low	Increase helix angle
	Number of flutes too low	Increase number of flutes
	Insufficient chip evacuation	Increase volume of coolant or air blow

Special construction

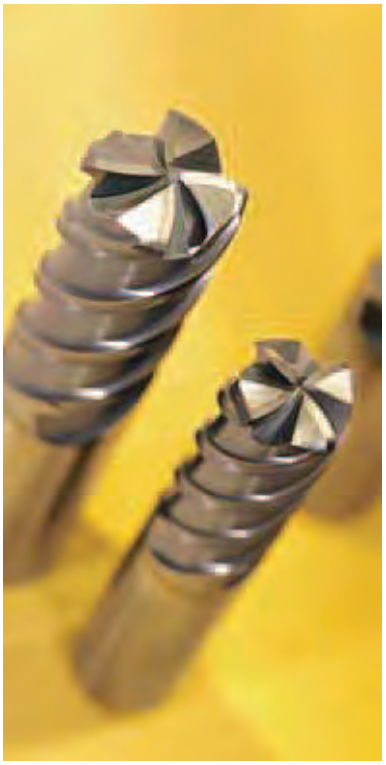
Owing to constant technical development caused by the use of special machines, difficult to machine materials and complex components, there is a growing need for special milling tools of high quality.

For decades, PROTOTYP has been manufacturing special tools to a high standard of performance. These tools have been constantly developed and improved. With PROTOTYP's 90 plus years of experience in the construction of milling tools they have always placed an emphasis on high quality. By employing a highly knowledgable technical staff, PROTOTYP is able to solve difficult milling problems.

In order to be able to offer the best tool and to avoid time-consuming questions, we ask you to give us the following details:

1. Type of mill
2. Dimension, tolerance
3. For special profiles: drawing of profile, if possible
4. Material to be machined (designation and strength)
5. Tool holder: make, type
6. Machine: make, type, driving force
7. Horizontal, vertical machining
8. Lubrication and type or dry machining

In case a detailed agreement about the construction is necessary, we shall send you a drawing for your acceptance.



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