



Vol 7

High Performance Variable Index End Mills for Difficult to Machine Materials

HY-PRO[®] CARB VGX





END MILLS

Chatter free, high performance machining!

The HY-PRO® CARB VGx® End Mill Series from OSG is a field proven milling tool with the capability of chatter free, high performance machining in a wide range of materials and milling applications.

ADVANTAGES

1. Versatile design can be used in all milling operations - slotting, side milling and pocketing - in both roughing and finishing operations.
2. Capable of machining a wide range of materials including carbon steels, alloy steels, cast irons, stainless steels, titanium and nickel alloys.
3. Excels in difficult to machine materials and applications while maintaining high metal removal rates.



VGx® End Mills Feature these Innovative Characteristics:

Variable Index: An unequal index with equal flute spacing allows the VGx® end mills to eliminate chatter by breaking up the harmonics produced during normal milling operations.

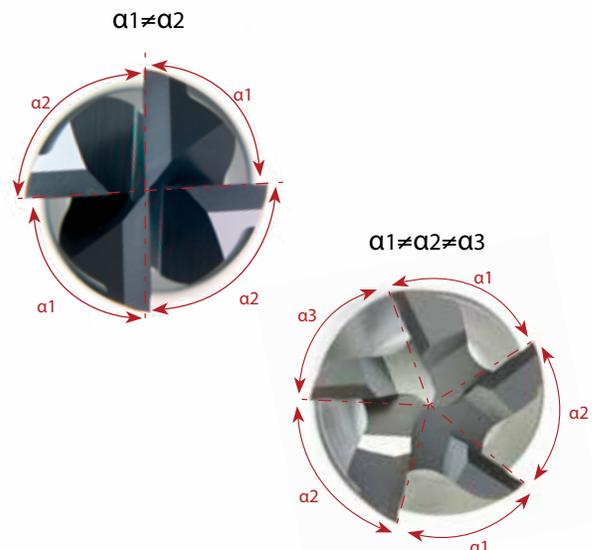
Raised Land: The raised land feature allows for stable consistent milling in mild to severe milling operations.

Eccentric Relief: The unique eccentric relief grind keeps the tool sharp while minimizing friction.

Special Cutting Geometries: The cutting geometries incorporated on the VGx® end mills allow for free cutting in a wide range of materials while inhibiting premature chipping and wear.

TiAlN: OSG's TiAlN coating allows the end mill to cut at accelerated speeds and feeds while minimizing tool wear.

Variable Index



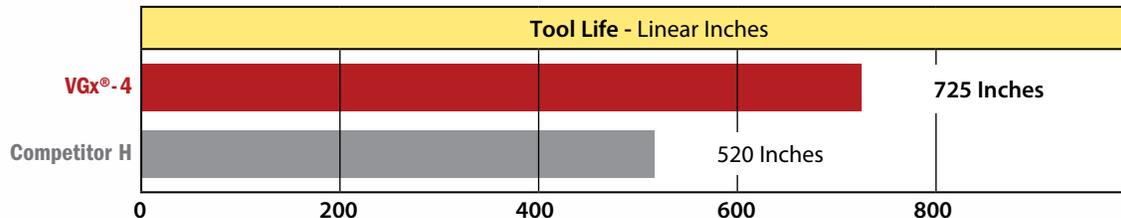
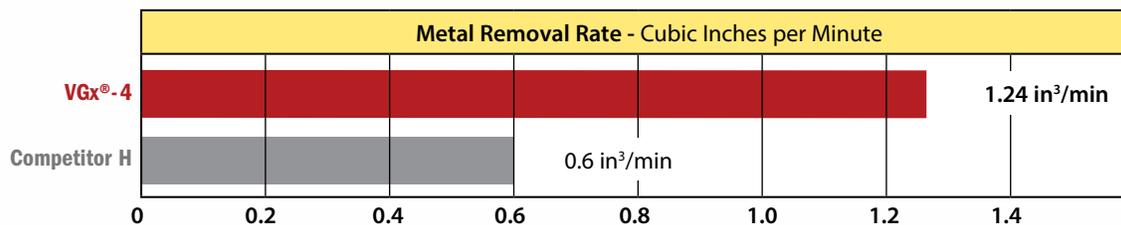
Exceptional Milling Performance in Stainless Steels

VGx®- 4 Flute End Mill Performance

| | |
|--------------------|--------------------------------|
| Tool | 1/2" VGx®-4 with 0.030 CR |
| Material | 304L Stainless Steel |
| Speed | 3,500 RPM |
| Feed | 19 IPM |
| Metal Removal Rate | 1.24 in³/min |
| Milling Method | Side Milling |
| Depth of Cut | Aa=.650" Ar=.100" |
| Coolant | Water Soluble |
| Machine | Vertical Machining Center |

Competitor H End Mill Performance

| | |
|--------------------|---------------------------|
| Tool | 1/2" with 0.030 CR |
| Material | 304L Stainless Steel |
| Speed | 2,300 RPM |
| Feed | 9.2 IPM |
| Metal Removal Rate | 0.60 in ³ /min |
| Milling Method | Side Milling |
| Depth of Cut | Aa=.650" Ar=.100" |
| Coolant | Water Soluble |
| Machine | Vertical Machining Center |

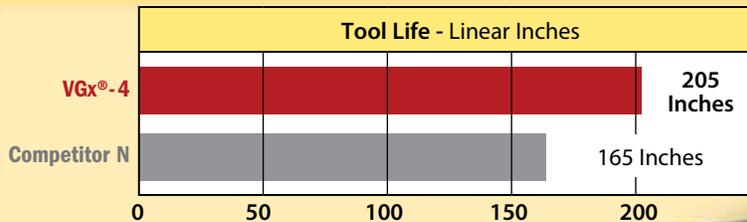


Superior Tool Life in Heat Resistant Alloys

Tool Performance

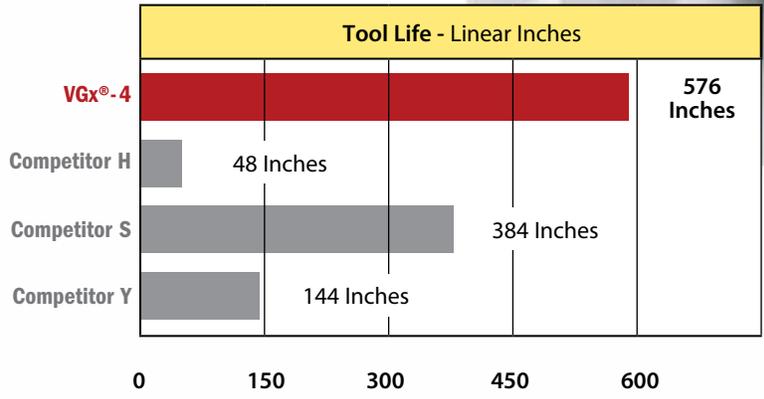
| | |
|----------------|-----------------------------|
| Tool | 1/2" VGx®-4 with 0.100 CR |
| Material | RENE 220 (45 HRC) |
| Speed | 560 RPM |
| Feed | 3.1 IPM |
| Milling Method | Side Milling |
| Depth of Cut | Aa=0.5" Ar=0.1" |
| Coolant | Water Soluble |
| Machine | Horizontal Machining Center |

Tool Life - Linear Inches



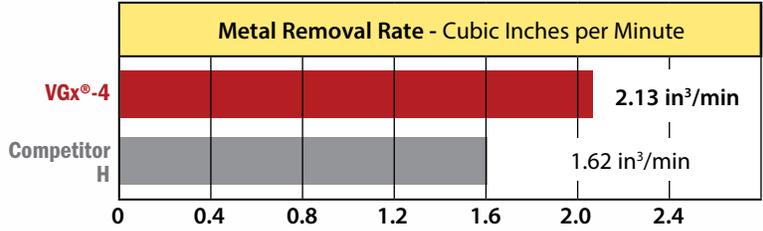
High Efficiency Milling and Superior Tool Life in Heat Resistant Alloys

| Tool Performance | |
|------------------|--|
| Tool | 1/2" VGx [®] -4 with 0.030 CR |
| Material | Inconel 718 (45 HRC) |
| Speed | 993 RPM |
| Feed | 9.9 IPM |
| Milling Method | Side Milling |
| Depth of Cut | Aa=0.75" Ar=0.025" |
| Coolant | Water Soluble |
| Machine | Vertical Machining Center |



Excellent Metal Removal Rates in Titanium

| Tool Performance | |
|------------------|--|
| Tool | 1/2" VGx [®] -4 with 0.030 CR |
| Material | Titanium 6Al4V |
| Speed | 1,337 RPM |
| Feed | 8.5 IPM |
| Milling Method | Slotting |
| Depth of Cut | Aa=0.5" Ar=0.5" |
| Coolant | Water Soluble |
| Machine | Vertical Machining Center |

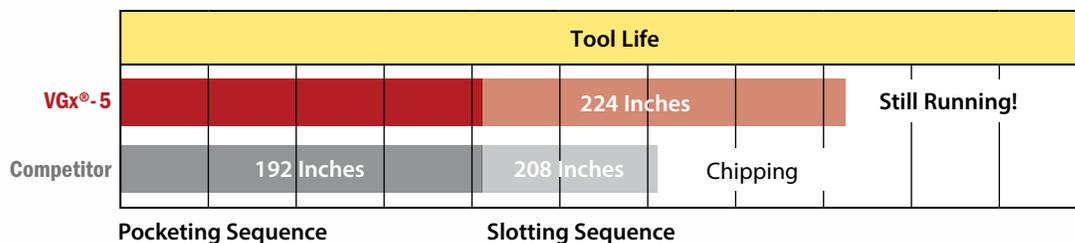
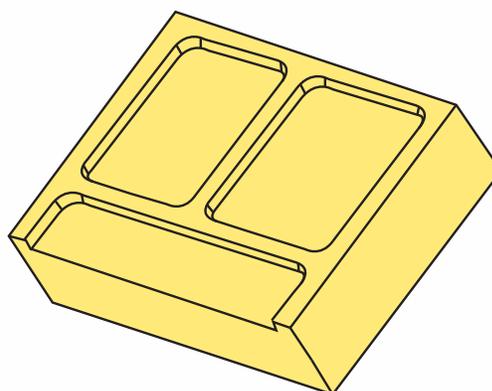




Premium Performance in a Variety of Milling Applications

Pocketing and 1D Slotting in Hardened Stainless

| Tool Performance | |
|------------------|--|
| Tool | 3/8" VGx®-5 with 0.030 CR |
| Material | 17-4 PH H925 (42 HRC) |
| Speed | 2,505 RPM (246 SFM) |
| Feed | 29 IPM (0.0023 IPT) |
| Milling Method | Pocketing & Slotting |
| Depth of Cut | Pocketing: Aa: 0.375" / Ar: 0.1875" Slotting: Aa: 0.375" / 0.375" |
| Coolant | Water Soluble |
| Machine | Vertical Machining Center |



The VGx® end mill shows excellent performance in a variety of machining applications. A study was conducted machining pockets and slotting in hardened stainless steel. The results showed both tools performed the same in pocketing, but the VGx® tool machined twice the distance when slotting.



Competitor: Extreme Chipping



OSG's VGx®-5: Good Wear

VGx® Showed Greater Durability Versus the Competition

Tool Life Comparison in Hardened Stainless

| Tool Performance | |
|------------------|---------------------------|
| Tool | 1/2" VGx®-5 with 0.030 CR |
| Material | 17-4 PH H925 (42 HRC) |
| Speed | 1,566 RPM (205 SFM) |
| Feed | 15.55 IPM (0.002 IPT) |
| Milling Method | Side Milling |
| Depth of Cut | Aa: 0.5" / Ar: 0.25" |
| Coolant | Water Soluble |
| Machine | Vertical Machining Center |

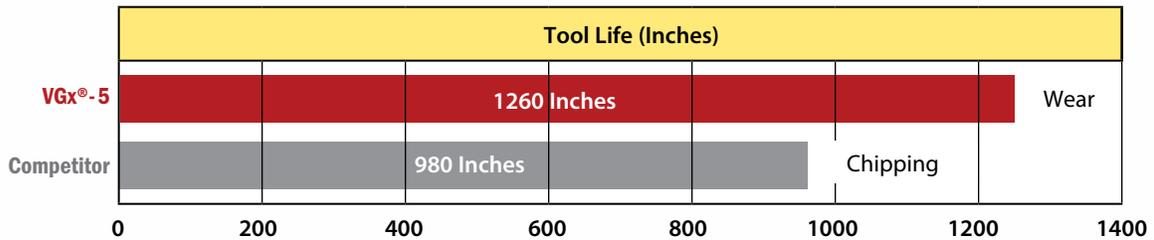
Tool Comparison After 1,200 Inches



OSG's VGx®-5: Mild Chipping;
Good Wear



Competitor: Severe Chipping;
Large Wear

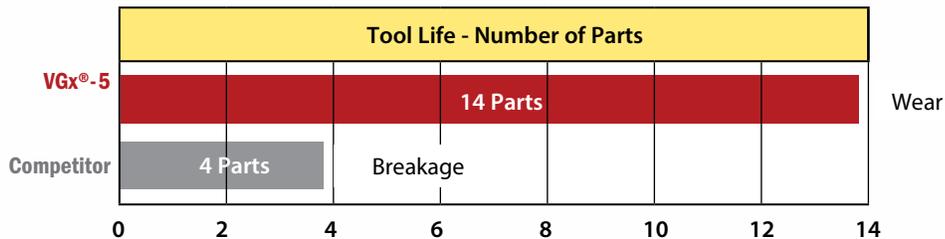


VGx[®] Increases Productivity and Lowers Cost Per Unit

OSG Reduced Cycle Time by 4 Minutes and Extended Tool Life by 10 Parts.



| Tool Performance | | |
|------------------|--|-------------------------------------|
| | OSG | Competitor |
| Tool | 1/2" VGx [®] -5 with 0.030 CR | 1/2" 5 Flute End Mill with 0.030 CR |
| Material | 316 Stainless Steel | |
| Speed | 2,300 RPM (300 SFM) | 2,600 RPM (340 SFM) |
| Feed | 30 IPM (0.0026 IPT) | 24 IPM (0.0018 IPT) |
| Milling Method | Side Milling | |
| Depth of Cut | Aa: 0.075" / Ar: 0.225" | |
| Coolant | Water Soluble | |
| Machine | Vertical Machining Center | |



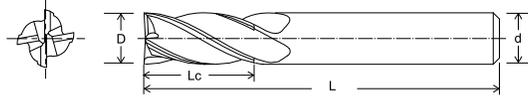


HY-PRO® CARB

High Performance Variable Geometry End Mills

List VG441

Multiple Lengths, 4 Flute, Square End



| EDP Number | EDP Number w/ Weldon Flat | Milling Diameter | Overall Length | Length of Cut | Shank Diameter |
|------------|---------------------------|------------------|----------------|---------------|----------------|
| | | D | L | Lc | d |
| VG441-1250 | - | 1/8 | 1 1/2 | 3/8 | 1/8 |
| VG441-1875 | - | 3/16 | 2 | 7/16 | 3/16 |
| VG441-2500 | - | 1/4 | 2 1/2 | 7/16 | 1/4 |
| VG441-2501 | - | 1/4 | 2 1/2 | 3/4 | 1/4 |
| VG441-2502 | - | 1/4 | 3 1/4 | 1 1/4 | 1/4 |
| VG441-3125 | - | 5/16 | 2 1/2 | 13/16 | 5/16 |
| VG441-3126 | - | 5/16 | 3 1/4 | 1 1/4 | 5/16 |
| VG441-3127 | - | 5/16 | 4 | 1 5/8 | 5/16 |
| VG441-3750 | VG441-3752 | 3/8 | 2 1/2 | 1/2 | 3/8 |
| VG441-3751 | VG441-3753 | 3/8 | 2 1/2 | 7/8 | 3/8 |
| VG441-3754 | VG441-3755 | 3/8 | 4 | 1 1/2 | 3/8 |
| VG441-3756 | VG441-3757 | 3/8 | 4 | 2 1/2 | 3/8 |
| VG441-4375 | VG441-4376 | 7/16 | 2 3/4 | 1 | 7/16 |
| VG441-5007 | VG441-5000 | 1/2 | 2 1/2 | 5/8 | 1/2 |
| VG441-5008 | VG441-5001 | 1/2 | 3 | 1 | 1/2 |
| VG441-5009 | VG441-5002 | 1/2 | 3 1/2 | 1 1/4 | 1/2 |
| VG441-5010 | VG441-5003 | 1/2 | 4 | 1 1/2 | 1/2 |
| VG441-5011 | VG441-5004 | 1/2 | 4 | 2 | 1/2 |
| VG441-5012 | VG441-5005 | 1/2 | 4 | 2 1/2 | 1/2 |
| VG441-5013 | VG441-5006 | 1/2 | 5 | 3 | 1/2 |
| VG441-6255 | VG441-6250 | 5/8 | 3 | 3/4 | 5/8 |
| VG441-6256 | VG441-6251 | 5/8 | 3 1/2 | 1 1/4 | 5/8 |
| VG441-6257 | VG441-6252 | 5/8 | 5 | 1 5/8 | 5/8 |
| VG441-6258 | VG441-6253 | 5/8 | 5 | 2 1/4 | 5/8 |
| VG441-6259 | VG441-6254 | 5/8 | 6 | 3 | 5/8 |
| VG441-7506 | VG441-7500 | 3/4 | 3 1/2 | 7/8 | 3/4 |
| VG441-7507 | VG441-7501 | 3/4 | 4 | 1 1/2 | 3/4 |
| VG441-7508 | VG441-7502 | 3/4 | 4 | 1 5/8 | 3/4 |
| VG441-7509 | VG441-7503 | 3/4 | 5 | 2 1/4 | 3/4 |
| VG441-7510 | VG441-7504 | 3/4 | 6 | 3 | 3/4 |
| VG441-7511 | VG441-7505 | 3/4 | 6 1/4 | 4 | 3/4 |
| VG441-1005 | VG441-1000 | 1 | 4 | 1 1/2 | 1 |
| VG441-1006 | VG441-1001 | 1 | 5 | 2 | 1 |
| VG441-1007 | VG441-1002 | 1 | 5 | 2 1/2 | 1 |
| VG441-1008 | VG441-1003 | 1 | 6 | 3 | 1 |
| VG441-1009 | VG441-1004 | 1 | 7 | 4 | 1 |

Packed: 1 pc. Available TiAlN coating only.



| Work Material | | | | | | | | | | | | | | | |
|---------------|-----------|---------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------------------------|-------------------------------------|-------------------------------------|-----|--------------|
| List No. | Aluminum | | Cast Iron | Carbon Steel | Alloy/Die Steel | Stainless Steels | | | Hardened Steels | | | High Heat Materials | | MMC | Copper Alloy |
| | 6061 7075 | Casting | | | | 300 | 400 | 17-4PH | ~35 HRC | 35-45 HRC | 45-50 HRC | Ti-Alloy | Inconel & Waspaloy | | |
| VG441 | | | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | | |

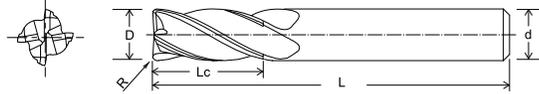
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List VG434

Multiple Lengths, 4 Flute, Corner Radius



| EDP Number | EDP Number w/ Weldon Flat | Milling Diameter | Overall Length | Corner Radius | Length of Cut | Shank Diameter |
|-------------|---------------------------|------------------|----------------|---------------|---------------|----------------|
| | | D | L | R | Lc | d |
| VG434-1250 | - | 1/8 | 1 1/2 | 0.010 | 3/8 | 1/8 |
| VG434-1251 | - | 1/8 | 1 1/2 | 0.015 | 3/8 | 1/8 |
| VG434-1875 | - | 3/16 | 2 | 0.015 | 7/16 | 3/16 |
| VG434-1876 | - | 3/16 | 2 | 0.030 | 7/16 | 3/16 |
| VG434-2500 | - | 1/4 | 2 1/2 | 0.015 | 7/16 | 1/4 |
| VG434-2501 | - | 1/4 | 2 1/2 | 0.030 | 7/16 | 1/4 |
| VG434-2502 | - | 1/4 | 2 1/2 | 0.015 | 3/4 | 1/4 |
| VG434-2503 | - | 1/4 | 2 1/2 | 0.030 | 3/4 | 1/4 |
| *VG434-2504 | - | 1/4 | 2 1/2 | 0.060 | 3/4 | 1/4 |
| VG434-3125 | - | 5/16 | 2 1/2 | 0.015 | 13/16 | 5/16 |
| VG434-3126 | - | 5/16 | 2 1/2 | 0.030 | 13/16 | 5/16 |
| VG434-3750 | VG434-3754 | 3/8 | 2 1/2 | 0.030 | 1/2 | 3/8 |
| VG434-3751 | VG434-3755 | 3/8 | 2 1/2 | 0.030 | 7/8 | 3/8 |
| VG434-3752 | VG434-3756 | 3/8 | 2 1/2 | 0.045 | 7/8 | 3/8 |
| VG434-3753 | VG434-3757 | 3/8 | 2 1/2 | 0.060 | 7/8 | 3/8 |
| VG434-3759 | VG434-3758 | 3/8 | 2 1/2 | 0.015 | 7/8 | 3/8 |
| VG434-4375 | VG434-4377 | 7/16 | 2 3/4 | 0.015 | 1 | 7/16 |
| VG434-4376 | VG434-4378 | 7/16 | 2 3/4 | 0.030 | 1 | 7/16 |
| VG434-5021 | VG434-5020 | 1/2 | 2 1/2 | 0.015 | 5/8 | 1/2 |
| VG434-5009 | VG434-5000 | 1/2 | 2 1/2 | 0.030 | 5/8 | 1/2 |
| VG434-5010 | VG434-5001 | 1/2 | 3 | 0.030 | 1 | 1/2 |
| VG434-5011 | VG434-5002 | 1/2 | 3 | 0.060 | 1 | 1/2 |
| VG434-5012 | VG434-5003 | 1/2 | 3 1/2 | 0.015 | 1 1/4 | 1/2 |
| VG434-5013 | VG434-5004 | 1/2 | 3 1/2 | 0.030 | 1 1/4 | 1/2 |
| VG434-5014 | VG434-5005 | 1/2 | 3 1/2 | 0.045 | 1 1/4 | 1/2 |
| VG434-5015 | VG434-5006 | 1/2 | 3 1/2 | 0.060 | 1 1/4 | 1/2 |
| VG434-5016 | VG434-5007 | 1/2 | 3 1/2 | 0.090 | 1 1/4 | 1/2 |
| VG434-5017 | VG434-5008 | 1/2 | 3 1/2 | 0.125 | 1 1/4 | 1/2 |
| VG434-5019 | VG434-5018 | 1/2 | 4 | 0.020 | 1 1/2 | 1/2 |
| VG434-6254 | VG434-6250 | 5/8 | 3 1/2 | 0.030 | 1 1/4 | 5/8 |
| VG434-6255 | VG434-6251 | 5/8 | 3 1/2 | 0.060 | 1 1/4 | 5/8 |
| VG434-6256 | VG434-6252 | 5/8 | 3 1/2 | 0.090 | 1 1/4 | 5/8 |
| VG434-6257 | VG434-6253 | 5/8 | 3 1/2 | 0.125 | 1 1/4 | 5/8 |
| VG434-7504 | VG434-7500 | 3/4 | 4 | 0.030 | 1 1/2 | 3/4 |
| VG434-7505 | VG434-7501 | 3/4 | 4 | 0.060 | 1 1/2 | 3/4 |
| VG434-7506 | VG434-7502 | 3/4 | 4 | 0.090 | 1 1/2 | 3/4 |
| VG434-7507 | VG434-7503 | 3/4 | 4 | 0.125 | 1 1/2 | 3/4 |
| VG434-7510 | VG434-7508 | 3/4 | 4 | 0.020 | 1 5/8 | 3/4 |
| VG434-7511 | VG434-7509 | 3/4 | 5 | 0.060 | 2 1/4 | 3/4 |
| VG434-1004 | VG434-1000 | 1 | 4 | 0.030 | 1 1/2 | 1 |
| VG434-1005 | VG434-1001 | 1 | 4 | 0.060 | 1 1/2 | 1 |
| VG434-1006 | VG434-1002 | 1 | 4 | 0.090 | 1 1/2 | 1 |
| VG434-1007 | VG434-1003 | 1 | 4 | 0.125 | 1 1/2 | 1 |

Packed: 1 pc. Available TiAlN coating only.



| Work Material | | | | | | | | | | | | | | | |
|---------------|-----------|---------|-----------|--------------|-----------------|------------------|-----|--------|-----------------|-----------|-----------|---------------------|--------------------|-----|--------------|
| List No. | Aluminum | | Cast Iron | Carbon Steel | Alloy/Die Steel | Stainless Steels | | | Hardened Steels | | | High Heat Materials | | MMC | Copper Alloy |
| | 6061 7075 | Casting | | | | 300 | 400 | 17-4PH | ~35 HRC | 35-45 HRC | 45-50 HRC | Ti-Alloy | Inconel & Waspaloy | | |
| VG434 | | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | |

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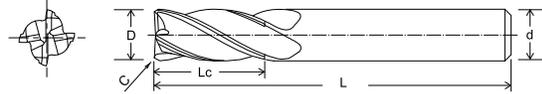


HY-PRO® CARB

High Performance Variable Geometry End Mills

List VG436

Multiple Lengths, 4 Flute, Corner Chamfer



| EDP Number | EDP Number w/ Weldon Flat | Milling Diameter | Overall Length | Corner Chamfer | Length of Cut | Shank Diameter |
|------------|---------------------------|------------------|----------------|----------------|---------------|----------------|
| | | D | L | C | Lc | d |
| VG436-1252 | - | 1/8 | 1 1/2 | 0.010 | 1/8 | 1/8 |
| VG436-1250 | - | 1/8 | 1 1/2 | 0.010 | 1/4 | 1/8 |
| VG436-1251 | - | 1/8 | 1 1/2 | 0.010 | 1/2 | 1/8 |
| VG436-1875 | - | 3/16 | 2 | 0.010 | 5/16 | 3/16 |
| VG436-1876 | - | 3/16 | 2 1/4 | 0.010 | 5/8 | 3/16 |
| VG436-2500 | - | 1/4 | 2 | 0.016 | 3/8 | 1/4 |
| VG436-2501 | - | 1/4 | 2 1/2 | 0.016 | 3/4 | 1/4 |
| VG436-3125 | - | 5/16 | 2 | 0.016 | 1/2 | 5/16 |
| VG436-3126 | - | 5/16 | 2 1/2 | 0.016 | 3/4 | 5/16 |
| - | VG436-3750 | 3/8 | 2 | 0.020 | 1/2 | 3/8 |
| - | VG436-3751 | 3/8 | 2 1/2 | 0.020 | 7/8 | 3/8 |
| - | VG436-4375 | 7/16 | 2 1/2 | 0.020 | 5/8 | 7/16 |
| - | VG436-4376 | 7/16 | 2 3/4 | 0.020 | 7/8 | 7/16 |
| - | VG436-5000 | 1/2 | 2 1/2 | 0.020 | 5/8 | 1/2 |
| - | VG436-5001 | 1/2 | 3 | 0.020 | 1 | 1/2 |
| - | VG436-5002 | 1/2 | 3 1/2 | 0.020 | 1 1/4 | 1/2 |
| - | VG436-5003 | 1/2 | 4 | 0.020 | 1 1/2 | 1/2 |
| - | VG436-6250 | 5/8 | 3 | 0.020 | 3/4 | 5/8 |
| - | VG436-6251 | 5/8 | 3 1/2 | 0.020 | 1 1/4 | 5/8 |
| - | VG436-6252 | 5/8 | 4 1/8 | 0.020 | 1 5/8 | 5/8 |
| - | VG436-7500 | 3/4 | 3 1/2 | 0.020 | 7/8 | 3/4 |
| - | VG436-7501 | 3/4 | 4 | 0.020 | 1 1/2 | 3/4 |
| - | VG436-7502 | 3/4 | 4 | 0.020 | 1 5/8 | 3/4 |
| - | VG436-1000 | 1 | 4 | 0.020 | 1 1/2 | 1 |
| - | VG436-1001 | 1 | 5 | 0.020 | 2 | 1 |

Packed: 1 pc. Available TiAlN coating only.



Work Material

| List No. | Aluminum | | Cast Iron | Carbon Steel | Alloy/Die Steel | Stainless Steels | | | Hardened Steels | | | High Heat Materials | | MMC | Copper Alloy |
|----------|-----------|---------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------------------------|-------------------------------------|-------------------------------------|-----|--------------|
| | 6061 7075 | Casting | | | | 300 | 400 | 17-4PH | ~35 HRC | 35-45 HRC | 45-50 HRC | Ti-Alloy | Inconel & Waspaloy | | |
| VG436 | | | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | | |

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List VG446 **NEW!**



Multiple Lengths, 4 Flute, Reduced Neck, Corner Radius/Corner Chamfer



| EDP Number | EDP Number w/ Weldon Flat | Milling Diameter | Overall Length | Corner Radius | Corner Chamfer | Length of Cut | Neck Diameter | Neck Length | Shank Diameter |
|------------|---------------------------|------------------|----------------|---------------|----------------|---------------|---------------|-------------|----------------|
| | | D | L | R | C | Lc | d1 | L1 | d |
| VG446-2500 | - | 1/4 | 4 | 0.015 | - | 3/8 | 0.235 | 1-1/4 | 1/4 |
| VG446-2501 | - | 1/4 | 4 | 0.030 | - | 3/8 | 0.235 | 1-1/4 | 1/4 |
| VG446-2502 | - | 1/4 | 4 | - | 0.016 | 3/8 | 0.235 | 1-1/4 | 1/4 |
| - | VG446-3750 | 3/8 | 4 | 0.030 | - | 1/2 | 0.353 | 1-7/8 | 3/8 |
| - | VG446-3751 | 3/8 | 4 | 0.060 | - | 1/2 | 0.353 | 1-7/8 | 3/8 |
| - | VG446-3752 | 3/8 | 4 | - | 0.020 | 1/2 | 0.353 | 1-7/8 | 3/8 |
| - | VG446-5000 | 1/2 | 4 | 0.030 | - | 5/8 | 0.470 | 2-1/4 | 1/2 |
| - | VG446-5001 | 1/2 | 4 | 0.060 | - | 5/8 | 0.470 | 2-1/4 | 1/2 |
| - | VG446-5002 | 1/2 | 4 | 0.120 | - | 5/8 | 0.470 | 2-1/4 | 1/2 |
| - | VG446-5003 | 1/2 | 4 | - | 0.020 | 5/8 | 0.470 | 2-1/4 | 1/2 |
| - | VG446-6250 | 5/8 | 4 1/8 | 0.060 | - | 3/4 | 0.588 | 2-1/4 | 5/8 |
| - | VG446-6251 | 5/8 | 4 1/8 | 0.120 | - | 3/4 | 0.588 | 2-1/4 | 5/8 |
| - | VG446-6252 | 5/8 | 4 1/8 | - | 0.020 | 3/4 | 0.588 | 2-1/4 | 5/8 |
| - | VG446-6253 | 5/8 | 5 | - | 0.020 | 3/4 | 0.588 | 3-1/8 | 5/8 |
| - | VG446-7500 | 3/4 | 4 1/4 | - | 0.020 | 1 | 0.705 | 2-1/4 | 3/4 |
| - | VG446-7501 | 3/4 | 5 1/4 | 0.030 | - | 1 | 0.705 | 3-1/4 | 3/4 |
| - | VG446-7502 | 3/4 | 5 1/4 | 0.060 | - | 1 | 0.705 | 3-1/4 | 3/4 |
| - | VG446-7503 | 3/4 | 5 1/4 | 0.120 | - | 1 | 0.705 | 3-1/4 | 3/4 |
| - | VG446-7504 | 3/4 | 5 1/4 | - | 0.020 | 1 | 0.705 | 3-1/4 | 3/4 |
| - | VG446-1000 | 1 | 4 1/2 | - | 0.020 | 1-1/8 | 0.940 | 2-1/4 | 1 |
| - | VG446-1001 | 1 | 5 1/2 | 0.030 | - | 1-1/8 | 0.940 | 3-1/4 | 1 |
| - | VG446-1002 | 1 | 5 1/2 | 0.060 | - | 1-1/8 | 0.940 | 3-1/4 | 1 |
| - | VG446-1003 | 1 | 5 1/2 | 0.120 | - | 1-1/8 | 0.940 | 3-1/4 | 1 |
| - | VG446-1004 | 1 | 5 1/2 | - | 0.020 | 1-1/8 | 0.940 | 3-1/4 | 1 |
| - | VG446-1005 | 1 | 6 1/2 | - | 0.020 | 1-1/8 | 0.940 | 4-1/4 | 1 |

Packed: 1 pc. Available TiAlN coating only.



| Work Material | | | | | | | | | | | | | | | |
|---------------|-----------|---------|-----------|--------------|-----------------|------------------|-----|--------|-----------------|-----------|-----------|---------------------|--------------------|-----|--------------|
| List No. | Aluminum | | Cast Iron | Carbon Steel | Alloy/Die Steel | Stainless Steels | | | Hardened Steels | | | High Heat Materials | | MMC | Copper Alloy |
| | 6061 7075 | Casting | | | | 300 | 400 | 17-4PH | ~35 HRC | 35-45 HRC | 45-50 HRC | Ti-Alloy | Inconel & Waspaloy | | |
| VG446 | | | ☉ | ☉ | ☉ | ☉ | ☉ | ☉ | ☉ | ☉ | ☐ | ☉ | ☉ | | |

☐ good ☉ best





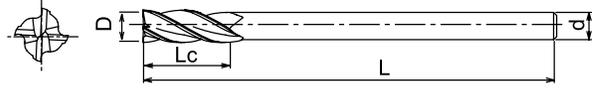
HY-PRO® CARB

High Performance Variable Geometry End Mills

List VG464 **NEW!**



Multiple Lengths, 4 Flute, Extended Length, Square End/Corner Chamfer



| EDP Number | EDP Number w/ Weldon Flat | Milling Diameter | Overall Length | Corner Chamfer | Length of Cut | Shank Diameter |
|------------|---------------------------|------------------|----------------|----------------|---------------|----------------|
| | | D | L | C | Lc | d |
| VG464-2500 | - | 1/4 | 4 | - | 3/8 | 1/4 |
| VG464-2501 | - | 1/4 | 4 | 0.016 | 3/8 | 1/4 |
| - | VG464-3750 | 3/8 | 4 | - | 1/2 | 3/8 |
| - | VG464-3751 | 3/8 | 4 | 0.020 | 1/2 | 3/8 |
| - | VG464-5000 | 1/2 | 5 | - | 5/8 | 1/2 |
| - | VG464-5001 | 1/2 | 5 | 0.020 | 5/8 | 1/2 |
| - | VG464-5002 | 1/2 | 6 | - | 5/8 | 1/2 |
| - | VG464-5003 | 1/2 | 6 | 0.020 | 5/8 | 1/2 |
| - | VG464-6250 | 5/8 | 6 | - | 3/4 | 5/8 |
| - | VG464-6251 | 5/8 | 6 | 0.020 | 3/4 | 5/8 |
| - | VG464-6252 | 5/8 | 7 | - | 3/4 | 5/8 |
| - | VG464-6253 | 5/8 | 7 | 0.020 | 3/4 | 5/8 |
| - | VG464-7500 | 3/4 | 6 | - | 1 | 3/4 |
| - | VG464-7501 | 3/4 | 6 | 0.020 | 1 | 3/4 |
| - | VG464-7502 | 3/4 | 7 | - | 1 | 3/4 |
| - | VG464-7503 | 3/4 | 7 | 0.020 | 1 | 3/4 |
| - | VG464-1000 | 1 | 6 | - | 1-1/8 | 1 |
| - | VG464-1001 | 1 | 6 | 0.020 | 1-1/8 | 1 |
| - | VG464-1002 | 1 | 7 | - | 1-1/8 | 1 |
| - | VG464-1003 | 1 | 7 | 0.020 | 1-1/8 | 1 |

Packed: 1 pc. Available TiAlN coating only.



| Work Material | | | | | | | | | | | | | | | |
|---------------|-----------|---------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------------------------|-------------------------------------|-------------------------------------|-----|--------------|
| List No. | Aluminum | | Cast Iron | Carbon Steel | Alloy/Die Steel | Stainless Steels | | | Hardened Steels | | | High Heat Materials | | MMC | Copper Alloy |
| | 6061 7075 | Casting | | | | 300 | 400 | 17-4PH | ~35 HRC | 35-45 HRC | 45-50 HRC | Ti-Alloy | Inconel & Waspaloy | | |
| VG464 | | | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | | |

good best





List VG441BN **NEW!**



Multiple Lengths, 4 Flute, Ball Nose



| EDP Number | EDP Number w/ Weldon Flat | Milling Diameter | Overall Length | Length of Cut | Shank Diameter |
|---------------|---------------------------|------------------|----------------|---------------|----------------|
| | | D | L | Lc | d |
| VG441-1250-BN | - | 1/8 | 2 | 1/2 | 1/8 |
| VG441-1875-BN | - | 3/16 | 2-1/4 | 5/8 | 3/16 |
| VG441-2500-BN | - | 1/4 | 2-1/2 | 3/4 | 1/4 |
| VG441-3125-BN | - | 5/16 | 2-1/2 | 3/4 | 5/16 |
| - | VG441-3750-BN | 3/8 | 2-1/2 | 7/8 | 3/8 |
| - | VG441-4375-BN | 7/16 | 2-1/2 | 7/8 | 7/16 |
| - | VG441-5000-BN | 1/2 | 3 | 1 | 1/2 |
| - | VG441-5010-BN | 1/2 | 3 | 1-1/4 | 1/2 |
| - | VG441-6250-BN | 5/8 | 3-1/2 | 1-1/4 | 5/8 |
| - | VG441-7500-BN | 3/4 | 4 | 1-1/2 | 3/4 |
| - | VG441-1000-BN | 1 | 4 | 1-1/2 | 1 |
| - | VG441-1010-BN | 1-1/4 | 5 | 2-1/4 | 1-1/4 |

Packed: 1 pc. Available TiAlN coating only.



Work Material

| List No. | Aluminum | | Cast Iron | Carbon Steel | Alloy/Die Steel | Stainless Steels | | | Hardened Steels | | | High Heat Materials | | MMC | Copper Alloy |
|----------|-----------|---------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------------------------|-------------------------------------|-------------------------------------|-----|--------------|
| | 6061 7075 | Casting | | | | 300 | 400 | 17-4PH | ~35 HRC | 35-45 HRC | 45-50 HRC | Ti-Alloy | Inconel & Waspaloy | | |
| VG441BN | | | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | | |

good best





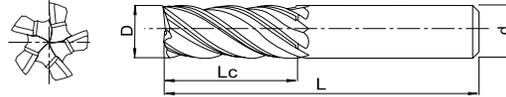
HY-PRO® CARB

High Performance Variable Geometry End Mills

List VG541 **NEW!**



Multiple Lengths, 5 Flute, Square End



| EDP Number | EDP Number w/ Weldon Flat | Milling Diameter | Overall Length | Length of Cut | Shank Diameter |
|------------|---------------------------|------------------|----------------|---------------|----------------|
| | | D | L | Lc | d |
| VG541-1249 | - | 1/8 | 1-1/2 | 9/32 | 1/8 |
| VG541-1250 | - | 1/8 | 1-1/2 | 3/8 | 1/8 |
| VG541-1875 | - | 3/16 | 2 | 7/16 | 3/16 |
| VG541-1874 | - | 3/16 | 2-1/4 | 5/8 | 3/16 |
| VG541-2500 | - | 1/4 | 2 | 3/8 | 1/4 |
| VG541-2501 | - | 1/4 | 2-1/2 | 3/4 | 1/4 |
| VG541-3125 | - | 5/16 | 2 | 15/32 | 5/16 |
| VG541-3124 | - | 5/16 | 2-1/2 | 3/4 | 5/16 |
| VG541-3750 | VG541-3752 | 3/8 | 2 | 1/2 | 3/8 |
| VG541-3751 | VG541-3753 | 3/8 | 2-1/2 | 7/8 | 3/8 |
| VG541-5007 | VG541-5000 | 1/2 | 2-1/2 | 5/8 | 1/2 |
| VG541-5009 | VG541-5002 | 1/2 | 3-1/2 | 1-1/4 | 1/2 |
| VG541-6255 | VG541-6250 | 5/8 | 3 | 3/4 | 5/8 |
| VG541-6256 | VG541-6251 | 5/8 | 3-1/2 | 1-1/4 | 5/8 |
| VG541-7512 | VG541-7513 | 3/4 | 4 | 1-1/8 | 3/4 |
| VG541-7507 | VG541-7501 | 3/4 | 4 | 1-1/2 | 3/4 |
| VG541-1010 | VG541-1011 | 1 | 4 | 1-1/4 | 1 |
| VG541-1005 | VG541-1000 | 1 | 4 | 1-1/2 | 1 |

Packed: 1 pc. Available TiAlN coating only.



Work Material

| List No. | Aluminum | | Cast Iron | Carbon Steel | Alloy/Die Steel | Stainless Steels | | | Hardened Steels | | | High Heat Materials | | MMC | Copper Alloy |
|----------|-----------|---------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------------------------|-------------------------------------|-------------------------------------|-----|--------------|
| | 6061 7075 | Casting | | | | 300 | 400 | 17-4PH | ~35 HRC | 35-45 HRC | 45-50 HRC | Ti-Alloy | Inconel & Waspaloy | | |
| VG541 | | | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | | |

good best

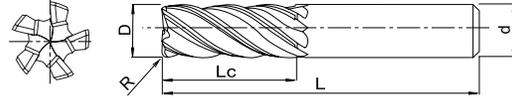




List VG534 NEW!



Multiple Lengths, 5 Flute, Corner Radius



| EDP Number | EDP Number w/ Weldon Flat | Milling Diameter | Overall Length | Corner Radius | Length of Cut | Shank Diameter |
|------------|---------------------------|------------------|----------------|---------------|---------------|----------------|
| | | D | L | R | Lc | d |
| VG534-1875 | - | 3/16 | 2 | 0.015 | 7/16 | 3/16 |
| VG534-1876 | - | 3/16 | 2 | 0.030 | 7/16 | 3/16 |
| VG534-1877 | - | 3/16 | 2 1/4 | 0.015 | 5/8 | 3/16 |
| VG534-1878 | - | 3/16 | 2 1/4 | 0.030 | 5/8 | 3/16 |
| VG534-2505 | - | 1/4 | 2 | 0.015 | 3/8 | 1/4 |
| VG534-2506 | - | 1/4 | 2 | 0.030 | 3/8 | 1/4 |
| VG534-2507 | - | 1/4 | 2 | 0.060 | 3/8 | 1/4 |
| VG534-2502 | - | 1/4 | 2 1/2 | 0.015 | 3/4 | 1/4 |
| VG534-2503 | - | 1/4 | 2 1/2 | 0.030 | 3/4 | 1/4 |
| VG534-2504 | - | 1/4 | 2 1/2 | 0.060 | 3/4 | 1/4 |
| VG534-3122 | - | 5/16 | 2 1/2 | 0.015 | 3/4 | 5/16 |
| VG534-3123 | - | 5/16 | 2 1/2 | 0.030 | 3/4 | 5/16 |
| VG534-3124 | - | 5/16 | 2 1/2 | 0.060 | 3/4 | 5/16 |
| VG534-3764 | VG534-3758 | 3/8 | 2 | 0.015 | 1/2 | 3/8 |
| VG534-3765 | VG534-3759 | 3/8 | 2 | 0.030 | 1/2 | 3/8 |
| VG534-3766 | VG534-3760 | 3/8 | 2 | 0.060 | 1/2 | 3/8 |
| VG534-3751 | VG534-3755 | 3/8 | 2 1/2 | 0.015 | 7/8 | 3/8 |
| VG534-3752 | VG534-3756 | 3/8 | 2 1/2 | 0.030 | 7/8 | 3/8 |
| VG534-3753 | VG534-3757 | 3/8 | 2 1/2 | 0.060 | 7/8 | 3/8 |
| VG534-5024 | VG534-5018 | 1/2 | 2 1/2 | 0.015 | 5/8 | 1/2 |
| VG534-5009 | VG534-5000 | 1/2 | 2 1/2 | 0.030 | 5/8 | 1/2 |
| VG534-5025 | VG534-5019 | 1/2 | 2 1/2 | 0.060 | 5/8 | 1/2 |
| VG534-5026 | VG534-5020 | 1/2 | 2 1/2 | 0.090 | 5/8 | 1/2 |
| VG534-5027 | VG534-5021 | 1/2 | 2 1/2 | 0.120 | 5/8 | 1/2 |
| VG534-5010 | VG534-5001 | 1/2 | 3 | 0.030 | 1 | 1/2 |
| VG534-5011 | VG534-5002 | 1/2 | 3 | 0.060 | 1 | 1/2 |
| VG534-5012 | VG534-5003 | 1/2 | 3 1/2 | 0.015 | 1 1/4 | 1/2 |
| VG534-5013 | VG534-5004 | 1/2 | 3 1/2 | 0.030 | 1 1/4 | 1/2 |
| VG534-5015 | VG534-5006 | 1/2 | 3 1/2 | 0.060 | 1 1/4 | 1/2 |
| VG534-5016 | VG534-5007 | 1/2 | 3 1/2 | 0.090 | 1 1/4 | 1/2 |
| VG534-5017 | VG534-5008 | 1/2 | 3 1/2 | 0.120 | 1 1/4 | 1/2 |
| VG534-6265 | VG534-6258 | 5/8 | 3 | 0.030 | 3/4 | 5/8 |
| VG534-6266 | VG534-6259 | 5/8 | 3 | 0.060 | 3/4 | 5/8 |
| VG534-6267 | VG534-6260 | 5/8 | 3 | 0.090 | 3/4 | 5/8 |
| VG534-6254 | VG534-6250 | 5/8 | 3 1/2 | 0.030 | 1 1/4 | 5/8 |
| VG534-6255 | VG534-6251 | 5/8 | 3 1/2 | 0.060 | 1 1/4 | 5/8 |
| VG534-6256 | VG534-6252 | 5/8 | 3 1/2 | 0.090 | 1 1/4 | 5/8 |
| VG534-7515 | VG534-7508 | 3/4 | 4 | 0.030 | 1 1/8 | 3/4 |
| VG534-7516 | VG534-7509 | 3/4 | 4 | 0.060 | 1 1/8 | 3/4 |
| VG534-7517 | VG534-7510 | 3/4 | 4 | 0.090 | 1 1/8 | 3/4 |
| VG534-7518 | VG534-7511 | 3/4 | 4 | 0.120 | 1 1/8 | 3/4 |
| VG534-7504 | VG534-7500 | 3/4 | 4 | 0.030 | 1 1/2 | 3/4 |
| VG534-7505 | VG534-7501 | 3/4 | 4 | 0.060 | 1 1/2 | 3/4 |
| VG534-7506 | VG534-7502 | 3/4 | 4 | 0.090 | 1 1/2 | 3/4 |
| VG534-7507 | VG534-7503 | 3/4 | 4 | 0.120 | 1 1/2 | 3/4 |
| VG534-1017 | VG534-1010 | 1 | 4 | 0.030 | 1 1/4 | 1 |
| VG534-1018 | VG534-1011 | 1 | 4 | 0.060 | 1 1/4 | 1 |
| VG534-1019 | VG534-1012 | 1 | 4 | 0.090 | 1 1/4 | 1 |
| VG534-1020 | VG534-1013 | 1 | 4 | 0.120 | 1 1/4 | 1 |
| VG534-1004 | VG534-1000 | 1 | 4 | 0.030 | 1 1/2 | 1 |
| VG534-1005 | VG534-1001 | 1 | 4 | 0.060 | 1 1/2 | 1 |
| VG534-1006 | VG534-1002 | 1 | 4 | 0.090 | 1 1/2 | 1 |
| VG534-1007 | VG534-1003 | 1 | 4 | 0.120 | 1 1/2 | 1 |

Packed: 1 pc. Available TiAlN coating only.



| Work Material | | | | | | | | | | | | | | | |
|---------------|-----------|---------|-----------|--------------|-----------------|------------------|-----|--------|-----------------|-----------|-----------|---------------------|--------------------|-----|--------------|
| List No. | Aluminum | | Cast Iron | Carbon Steel | Alloy/Die Steel | Stainless Steels | | | Hardened Steels | | | High Heat Materials | | MMC | Copper Alloy |
| | 6061 7075 | Casting | | | | 300 | 400 | 17-4PH | ~35 HRC | 35-45 HRC | 45-50 HRC | Ti-Alloy | Inconel & Waspaloy | | |
| VG534 | | | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | |

☐ good ☐ best



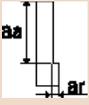
Speeds & Feeds

List VG441 – HY-PRO® CARB VGx® 4 Flute

List VG434 – HY-PRO® CARB VGx® 4 Flute - Corner Radius

List VG436 – HY-PRO® CARB VGx® 4 Flute - Corner Chamfer

Side Milling (Inch)

| Hardness | Up to 25 HRC | | 25 to 30 HRC | | 30 to 35 HRC | | 35 to 45 HRC | | 45 to 50 HRC | | Less than 40 HRC | | Less than 45 HRC | |
|---------------|---|-------------|---|-------------|--|-------------|--|-------------|--------------------|-------------|--------------------|-------------|---|-------------|
| Work Material | Mild Steels Carbon Steels Cast Iron | | 400 Stainless Steels Alloy Steels Tool Steels | | 300 Stainless Steels Hardened Steels Pre-hardened Steels | | PH Stainless Steels Hardened Steels | | Hardened Steels | | Titanium Alloys | | High Temp. Alloys Inconel Hastelloy | |
| Cutting Speed | 400-600 SFM | | 300-500 SFM | | 200-350 SFM | | 150-250 SFM | | 250-400 SFM | | 150-250 SFM | | 100-200 SFM | |
| Depth of Cut | Aa=1.5D Ar=0.5D | |  | | Aa=1.5D Ar=0.5D | | Aa=1.5D Ar=0.5D | | Aa=1.5D Ar=0.5D | | Aa=1.5D Ar=0.5D | | Aa=1.25D Ar=0.3D | |
| Mill Dia. | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min |
| 1/8 | 13,750 | 44.0 | 10,695 | 25.7 | 8,400 | 18.6 | 6,875 | 15.2 | 6,110 | 14.5 | 6,110 | 12.9 | 3,665 | 9.5 |
| 3/16 | 9,170 | 46.8 | 7,130 | 28.8 | 5,600 | 20.6 | 4,585 | 16.9 | 4,075 | 16.3 | 4,075 | 13.7 | 2,445 | 10.9 |
| 1/4 | 6,875 | 46.8 | 5,350 | 31.1 | 4,200 | 20.3 | 3,440 | 16.7 | 3,050 | 16.8 | 3,050 | 13.9 | 1,835 | 11.2 |
| 5/16 | 5,500 | 48.1 | 4,210 | 31.8 | 3,350 | 21.4 | 2,750 | 17.6 | 2,450 | 17.8 | 2,450 | 15.1 | 1,465 | 11.7 |
| 3/8 | 4,585 | 47.1 | 3,565 | 30.5 | 2,800 | 20.6 | 2,290 | 16.9 | 2,040 | 16.3 | 2,040 | 14.6 | 1,220 | 11.1 |
| 7/16 | 3,930 | 45.4 | 3,055 | 30.2 | 2,400 | 20.1 | 1,965 | 16.5 | 1,750 | 16.3 | 1,750 | 14.0 | 1,050 | 11.1 |
| 1/2 | 3,440 | 45.4 | 2,675 | 29.2 | 2,100 | 19.5 | 1,720 | 15.9 | 1,525 | 15.7 | 1,525 | 13.9 | 915 | 10.8 |
| 5/8 | 2,750 | 40.6 | 2,140 | 27.7 | 1,700 | 19.0 | 1,375 | 15.4 | 1,225 | 14.7 | 1,225 | 12.5 | 730 | 9.9 |
| 3/4 | 2,290 | 37.3 | 1,785 | 25.3 | 1,400 | 16.8 | 1,150 | 13.8 | 1,025 | 13.5 | 1,025 | 11.8 | 610 | 9.3 |
| 1 | 1,720 | 33.0 | 1,340 | 22.8 | 1,050 | 14.9 | 860 | 12.2 | 765 | 12.2 | 765 | 10.6 | 460 | 8.4 |

| Long Length of Cut Speed Reduction | | | |
|------------------------------------|---------------------------|-------|-------|
| LOC/D | Reduce Speed | Aa | Ar |
| ≤3 | Use Recommendations above | | |
| 3~4* | 40% x Recommended | 2.5xø | 0.1xø |
| 4~6** | 60% x Recommended | 2.5xø | 0.1xø |

The above cutting conditions are calculated based on short overhang (LOC/D = 2) and should be adjusted accordingly for longer cutting edge lengths. For LOC/D greater than 3 see table on left.
*Feed rate may be increased at this specified depth of cut
**Only recommended for finishing side milling applications

Slotting (Inch)

| Hardness | Up to 25 HRC | | 25 to 30 HRC | | 30 to 35 HRC | | 35 to 45 HRC | | 45 to 50 HRC | | Less than 40 HRC | | Less than 45 HRC | |
|---------------|---|-------------|---|-------------|--|-------------|--|-------------|-----------------|-------------|------------------|-------------|---|-------------|
| Work Material | Mild Steels Carbon Steels Cast Iron | | 400 Stainless Steels Alloy Steels Tool Steels | | 300 Stainless Steels Hardened Steels Pre-hardened Steels | | PH Stainless Steels Hardened Steels | | Hardened Steels | | Titanium Alloys | | High Temp. Alloys Inconel Hastelloy | |
| Cutting Speed | 325-400 SFM | | 250-400 SFM | | 175-275 SFM | | 125-200 SFM | | 200-325 SFM | | 125-200 SFM | | 75-150 SFM | |
| Depth of Cut | Aa=1D | |  | | Aa=0.75D | | Aa=0.75D | | Aa=0.75D | | Aa=0.75D | | Aa=0.25D | |
| Mill Dia. | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min |
| 1/8 | 11,240 | 35.8 | 8,860 | 21.3 | 6,900 | 15.4 | 5,500 | 10.7 | 4,890 | 11.6 | 5,050 | 10.6 | 2,750 | 7.3 |
| 3/16 | 7,495 | 38.5 | 5,910 | 23.9 | 4,600 | 17.5 | 3,670 | 11.5 | 3,260 | 12.8 | 3,350 | 11.5 | 1,835 | 8.1 |
| 1/4 | 5,620 | 37.9 | 4,430 | 25.5 | 3,450 | 17.2 | 2,750 | 12.2 | 2,445 | 14.0 | 2,550 | 11.8 | 1,375 | 8.1 |
| 5/16 | 4,500 | 39.4 | 3,545 | 26.8 | 2,750 | 18.3 | 2,200 | 12.9 | 1,955 | 14.2 | 2,000 | 11.8 | 1,100 | 9.0 |
| 3/8 | 3,750 | 38.2 | 2,955 | 25.5 | 2,300 | 17.5 | 1,835 | 12.2 | 1,630 | 12.8 | 1,700 | 11.6 | 915 | 8.3 |
| 7/16 | 3,210 | 37.1 | 2,530 | 24.7 | 1,950 | 16.7 | 1,575 | 11.8 | 1,395 | 12.8 | 1,450 | 11.8 | 785 | 8.3 |
| 1/2 | 2,810 | 37.2 | 2,215 | 24.2 | 1,700 | 16.1 | 1,375 | 11.5 | 1,225 | 12.8 | 1,300 | 12.1 | 690 | 8.1 |
| 5/8 | 2,250 | 33.1 | 1,775 | 22.5 | 1,400 | 15.9 | 1,100 | 11.0 | 975 | 11.6 | 1,000 | 10.0 | 550 | 7.6 |
| 3/4 | 1,875 | 31.1 | 1,480 | 20.9 | 1,150 | 14.4 | 920 | 10.0 | 815 | 10.5 | 850 | 9.4 | 460 | 6.9 |
| 1 | 1,405 | 26.7 | 1,110 | 18.7 | 875 | 12.6 | 685 | 8.6 | 610 | 9.8 | 650 | 9.0 | 345 | 6.5 |

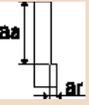
| Long Length of Cut Speed Reduction | | | |
|------------------------------------|------------------------------|-------|-------|
| LOC/D | Reduce Speed | Aa | Ar |
| ≤3 | Use Recommendations above | | |
| 3~4* | 40% x Recommended | 2.5xø | 0.1xø |
| 4~6 | Not Recommended for slotting | | |

The above cutting conditions are calculated based on short overhang (LOC/D = 2) and should be adjusted accordingly for longer cutting edge lengths. For LOC/D greater than 3 see table on left.
*Feed rate may be increased at this specified depth of cut



List VG446 – HY-PRO® CARB VGx® 4 Flute - Reduced Neck List VG464 – HY-PRO® CARB VGx® 4 Flute - Extended Length

Side Milling (Inch)

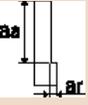
| Hardness | Up to 25 HRC | | 25 to 30 HRC | | 30 to 35 HRC | | 35 to 45 HRC | | 45 to 50 HRC | | Less than 40 HRC | | Less than 45 HRC | |
|---------------|---|-------------|---|-------------|---|-------------|--|-------------|----------------------|-------------|----------------------|-------------|---|-------------|
| Work Material | Mild Steels Carbon Steels Cast Iron | | 400 Stainless Steels Alloy Steels Tool Steels | | 300 Stainless Steels Hardened Steels Pre-hardened Steels | | PH Stainless Steels Hardened Steels | | Hardened Steels | | Titanium Alloys | | High Temp. Alloys Inconel Hastelloy | |
| Cutting Speed | 400-500 SFM | | 300-400 SFM | | 200-350 SFM | | 200-250 SFM | | 175-225 SFM | | 150-250 SFM | | 100-135 SFM | |
| Depth of Cut | Aa=1D Ar=0.4D | | | |  | | Aa=0.75D Ar=0.35D | | Aa=0.75D Ar=0.15D | | Aa=0.75D Ar=0.35D | | Aa=0.75D Ar=0.15D | |
| Mill Dia. | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min |
| 1/4 | 6,875 | 46.8 | 5,350 | 31.1 | 4,200 | 20.3 | 3,440 | 16.7 | 3,050 | 16.8 | 3,050 | 13.9 | 1,835 | 11.2 |
| 3/8 | 4,585 | 47.1 | 3,565 | 30.5 | 2,800 | 20.6 | 2,290 | 16.9 | 2,040 | 16.3 | 2,040 | 14.6 | 1,220 | 11.1 |
| 1/2 | 3,440 | 45.4 | 2,675 | 29.2 | 2,100 | 19.5 | 1,720 | 15.9 | 1,525 | 15.7 | 1,525 | 13.9 | 915 | 10.8 |
| 5/8 | 2,750 | 40.6 | 2,140 | 27.7 | 1,700 | 19.0 | 1,375 | 15.4 | 1,225 | 14.7 | 1,225 | 12.5 | 730 | 9.9 |
| 3/4 | 2,290 | 37.3 | 1,785 | 25.3 | 1,400 | 16.8 | 1,150 | 13.8 | 1,025 | 13.5 | 1,025 | 11.8 | 610 | 9.3 |
| 1 | 1,720 | 33.0 | 1,340 | 22.8 | 1,050 | 14.9 | 860 | 12.2 | 765 | 12.2 | 765 | 10.6 | 460 | 8.4 |

Slotting (Inch)

| Hardness | Up to 25 HRC | | 25 to 30 HRC | | 30 to 35 HRC | | 35 to 45 HRC | | 45 to 50 HRC | | Less than 40 HRC | | Less than 45 HRC | |
|---------------|---|-------------|---|-------------|---|-------------|--|-------------|-----------------|-------------|------------------|-------------|---|-------------|
| Work Material | Mild Steels Carbon Steels Cast Iron | | 400 Stainless Steels Alloy Steels Tool Steels | | 300 Stainless Steels Hardened Steels Pre-hardened Steels | | PH Stainless Steels Hardened Steels | | Hardened Steels | | Titanium Alloys | | High Temp. Alloys Inconel Hastelloy | |
| Cutting Speed | 325-400 SFM | | 250-325 SFM | | 175-275 SFM | | 160-200 SFM | | 140-180 SFM | | 125-200 SFM | | 75-100 SFM | |
| Depth of Cut | Aa=0.6D | | | |  | | Aa=0.4D | | Aa=0.25D | | Aa=0.4D | | Aa=0.15D | |
| Mill Dia. | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min |
| 1/4 | 5,620 | 37.9 | 4,430 | 25.5 | 3,450 | 17.2 | 2,750 | 12.2 | 2,445 | 14.0 | 2,550 | 11.8 | 1,375 | 8.1 |
| 3/8 | 3,750 | 38.2 | 2,955 | 25.5 | 2,300 | 17.5 | 1,835 | 12.2 | 1,630 | 12.8 | 1,700 | 11.6 | 915 | 8.3 |
| 1/2 | 2,810 | 37.2 | 2,215 | 24.2 | 1,700 | 16.1 | 1,375 | 11.5 | 1,225 | 12.8 | 1,300 | 12.1 | 690 | 8.1 |
| 5/8 | 2,250 | 33.1 | 1,775 | 22.5 | 1,400 | 15.9 | 1,100 | 11.0 | 975 | 11.6 | 1,000 | 10.0 | 550 | 7.6 |
| 3/4 | 1,875 | 31.1 | 1,480 | 20.9 | 1,150 | 14.4 | 920 | 10.0 | 815 | 10.5 | 850 | 9.4 | 460 | 6.9 |
| 1 | 1,405 | 26.7 | 1,110 | 18.7 | 875 | 12.6 | 685 | 8.6 | 610 | 9.8 | 650 | 9.0 | 345 | 6.5 |

List VG441BN – HY-PRO® CARB VGx® 4 Flute - Ball Nose

Side Milling (Inch)

| Hardness | Up to 25 HRC | | 25 to 30 HRC | | 30 to 35 HRC | | 35 to 45 HRC | | 45 to 50 HRC | | Less than 40 HRC | | Less than 45 HRC | |
|---------------|---|-------------|---|-------------|---|-------------|--|-------------|---------------------|-------------|---------------------|-------------|---|-------------|
| Work Material | Mild Steels Carbon Steels Cast Iron | | 400 Stainless Steels Alloy Steels Tool Steels | | 300 Stainless Steels Hardened Steels Pre-hardened Steels | | PH Stainless Steels Hardened Steels | | Hardened Steels | | Titanium Alloys | | High Temp. Alloys Inconel Hastelloy | |
| Cutting Speed | 400-500 SFM | | 300-400 SFM | | 200-350 SFM | | 200-250 SFM | | 175-225 SFM | | 150-250 SFM | | 100-135 SFM | |
| Depth of Cut | Aa=1.5D Ar=0.5D | | | |  | | Aa=1.25D Ar=0.4D | | Aa=1.25D Ar=0.2D | | Aa=1.25D Ar=0.4D | | Aa=1D Ar=0.2D | |
| Mill Dia. | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min |
| 1/8 | 13,750 | 44.0 | 10,695 | 25.7 | 8,400 | 18.6 | 6,875 | 15.2 | 6,110 | 14.5 | 6,110 | 12.9 | 3,665 | 9.5 |
| 3/16 | 9,170 | 46.8 | 7,130 | 28.8 | 5,600 | 20.6 | 4,585 | 16.9 | 4,075 | 16.3 | 4,075 | 13.7 | 2,445 | 10.9 |
| 1/4 | 6,875 | 46.8 | 5,350 | 31.1 | 4,200 | 20.3 | 3,440 | 16.7 | 3,050 | 16.8 | 3,050 | 13.9 | 1,835 | 11.2 |
| 5/16 | 5,500 | 48.1 | 4,210 | 31.8 | 3,350 | 21.4 | 2,750 | 17.6 | 2,450 | 17.8 | 2,450 | 15.1 | 1,465 | 11.7 |
| 3/8 | 4,585 | 47.1 | 3,565 | 30.5 | 2,800 | 20.6 | 2,290 | 16.9 | 2,040 | 16.3 | 2,040 | 14.6 | 1,220 | 11.1 |
| 7/16 | 3,930 | 45.4 | 3,055 | 30.2 | 2,400 | 20.1 | 1,965 | 16.5 | 1,750 | 16.3 | 1,750 | 14.0 | 1,050 | 11.1 |
| 1/2 | 3,440 | 45.4 | 2,675 | 29.2 | 2,100 | 19.5 | 1,720 | 15.9 | 1,525 | 15.7 | 1,525 | 13.9 | 915 | 10.8 |
| 5/8 | 2,750 | 40.6 | 2,140 | 27.7 | 1,700 | 19.0 | 1,375 | 15.4 | 1,225 | 14.7 | 1,225 | 12.5 | 730 | 9.9 |
| 3/4 | 2,290 | 37.3 | 1,785 | 25.3 | 1,400 | 16.8 | 1,150 | 13.8 | 1,025 | 13.5 | 1,025 | 11.8 | 610 | 9.3 |
| 1 | 1,720 | 33.0 | 1,340 | 22.8 | 1,050 | 14.9 | 860 | 12.2 | 765 | 12.2 | 765 | 10.6 | 460 | 8.4 |
| 1 1/4 | 1,375 | 26.4 | 1,070 | 18.2 | 850 | 12.1 | 690 | 9.8 | 610 | 9.7 | 610 | 8.3 | 365 | 6.7 |

Slotting (Inch)

| Hardness | Up to 25 HRC | | 25 to 30 HRC | | 30 to 35 HRC | | 35 to 45 HRC | | 45 to 50 HRC | | Less than 40 HRC | | Less than 45 HRC | |
|---------------|---|-------------|---|-------------|---|-------------|--|-------------|-----------------|-------------|------------------|-------------|---|-------------|
| Work Material | Mild Steels Carbon Steels Cast Iron | | 400 Stainless Steels Alloy Steels Tool Steels | | 300 Stainless Steels Hardened Steels Pre-hardened Steels | | PH Stainless Steels Hardened Steels | | Hardened Steels | | Titanium Alloys | | High Temp. Alloys Inconel Hastelloy | |
| Cutting Speed | 325-400 SFM | | 250-325 SFM | | 175-275 SFM | | 160-200 SFM | | 140-180 SFM | | 125-200 SFM | | 75-100 SFM | |
| Depth of Cut | Aa=1D | | | |  | | Aa=0.75D | | Aa=0.5D | | Aa=0.5D | | Aa=0.2D | |
| Mill Dia. | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min |
| 1/8 | 11,240 | 35.8 | 8,860 | 21.3 | 6,900 | 15.4 | 5,500 | 10.7 | 4,890 | 11.6 | 5,050 | 10.6 | 2,750 | 7.3 |
| 3/16 | 7,495 | 38.5 | 5,910 | 23.9 | 4,600 | 17.5 | 3,670 | 11.5 | 3,260 | 12.8 | 3,350 | 11.5 | 1,835 | 8.1 |
| 1/4 | 5,620 | 37.9 | 4,430 | 25.5 | 3,450 | 17.2 | 2,750 | 12.2 | 2,445 | 14.0 | 2,550 | 11.8 | 1,375 | 8.1 |
| 5/16 | 4,500 | 39.4 | 3,545 | 26.8 | 2,750 | 18.3 | 2,200 | 12.9 | 1,955 | 14.2 | 2,000 | 11.8 | 1,100 | 9.0 |
| 3/8 | 3,750 | 38.2 | 2,955 | 25.5 | 2,300 | 17.5 | 1,835 | 12.2 | 1,630 | 12.8 | 1,700 | 11.6 | 915 | 8.3 |
| 7/16 | 3,210 | 37.1 | 2,530 | 24.7 | 1,950 | 16.7 | 1,575 | 11.8 | 1,395 | 12.8 | 1,450 | 11.8 | 785 | 8.3 |
| 1/2 | 2,810 | 37.2 | 2,215 | 24.2 | 1,700 | 16.1 | 1,375 | 11.5 | 1,225 | 12.8 | 1,300 | 12.1 | 690 | 8.1 |
| 5/8 | 2,250 | 33.1 | 1,775 | 22.5 | 1,400 | 15.9 | 1,100 | 11.0 | 975 | 11.6 | 1,000 | 10.0 | 550 | 7.6 |
| 3/4 | 1,875 | 31.1 | 1,480 | 20.9 | 1,150 | 14.4 | 920 | 10.0 | 815 | 10.5 | 850 | 9.4 | 460 | 6.9 |
| 1 | 1,405 | 26.7 | 1,110 | 18.7 | 875 | 12.6 | 685 | 8.6 | 610 | 9.8 | 650 | 9.0 | 345 | 6.5 |
| 1 1/4 | 1,115 | 21.2 | 885 | 14.9 | 700 | 10.1 | 550 | 6.9 | 490 | 7.8 | 500 | 6.9 | 275 | 5.1 |



List VG541 – HY-PRO® CARB VGx® 5 Flute

List VG534 – HY-PRO® CARB VGx® 5 Flute - Corner Radius

Side Milling (Inch)

| Hardness | Up to 25 HRC | | 25 to 30 HRC | | 30 to 35 HRC | | 35 to 45 HRC | | 45 to 50 HRC | | Less than 40 HRC | | Less than 45 HRC | | | |
|---------------|---|-------------|---|-------------|---|-------------|--|-------------|---------------------|-------------|---------------------|-------------|---|-------------|------------------|--|
| Work Material | Mild Steels Carbon Steels Cast Iron | | 400 Stainless Steels Alloy Steels Tool Steels | | 300 Stainless Steels Hardened Steels Pre-hardened Steels | | PH Stainless Steels Hardened Steels | | Hardened Steels | | Titanium Alloys | | High Temp. Alloys Inconel Hastelloy | | | |
| Cutting Speed | 400-600 SFM | | 300-500 SFM | | 200-350 SFM | | 150-250 SFM | | 250-400 SFM | | 150-250 SFM | | 100-200 SFM | | | |
| Depth of Cut | Aa=1.25D Ar=0.5D | | | |  | | | | Aa=1.25D Ar=0.5D | | Aa=1.25D Ar=0.5D | | Aa=1.25D Ar=0.5D | | Aa=1D Ar=0.3D | |
| Mill Dia. | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | | |
| 1/8 | 13,750 | 55.0 | 10,695 | 32.2 | 8,400 | 23.2 | 6,875 | 19.0 | 6,110 | 18.2 | 6,110 | 16.1 | 3,665 | 11.8 | | |
| 3/16 | 9,170 | 58.5 | 7,130 | 36.1 | 5,600 | 25.8 | 4,585 | 21.1 | 4,075 | 20.4 | 4,075 | 17.2 | 2,445 | 13.6 | | |
| 1/4 | 6,875 | 58.4 | 5,350 | 38.9 | 4,200 | 25.4 | 3,440 | 20.8 | 3,050 | 21.1 | 3,050 | 17.4 | 1,835 | 14.1 | | |
| 5/16 | 5,500 | 60.2 | 4,210 | 39.7 | 3,350 | 26.8 | 2,750 | 22.0 | 2,450 | 22.2 | 2,450 | 18.9 | 1,465 | 14.7 | | |
| 3/8 | 4,585 | 58.8 | 3,565 | 38.1 | 2,800 | 25.8 | 2,290 | 21.1 | 2,040 | 20.4 | 2,040 | 18.3 | 1,220 | 13.9 | | |
| 7/16 | 3,930 | 56.8 | 3,055 | 37.8 | 2,400 | 25.1 | 1,965 | 20.6 | 1,750 | 20.4 | 1,750 | 17.5 | 1,050 | 13.8 | | |
| 1/2 | 3,440 | 56.8 | 2,675 | 36.5 | 2,100 | 24.3 | 1,720 | 19.9 | 1,525 | 19.6 | 1,525 | 17.4 | 915 | 13.4 | | |
| 5/8 | 2,750 | 50.7 | 2,140 | 34.6 | 1,700 | 23.8 | 1,375 | 19.3 | 1,225 | 18.4 | 1,225 | 15.6 | 730 | 12.4 | | |
| 3/4 | 2,290 | 46.7 | 1,785 | 31.6 | 1,400 | 21.0 | 1,150 | 17.3 | 1,025 | 16.8 | 1,025 | 14.8 | 610 | 11.6 | | |
| 1 | 1,720 | 41.3 | 1,340 | 28.5 | 1,050 | 18.7 | 860 | 15.3 | 765 | 15.3 | 765 | 13.2 | 460 | 10.5 | | |

| Long Length of Cut Speed Reduction | | | |
|------------------------------------|---------------------------|-------|-------|
| LOC/D | Reduce Speed | Aa | Ar |
| ≤3 | Use Recommendations above | | |
| 3~4* | 40% x Recommended | 2.5xø | 0.1xø |
| 4~6** | 60% x Recommended | 2.5xø | 0.1xø |

The above cutting conditions are calculated based on short overhang (LOC/D = 2) and should be adjusted accordingly for longer cutting edge lengths. For LOC/D greater than 3 see table on left.

*Feed rate may be increased at this specified depth of cut

**Only recommended for finishing side milling applications

| Hardness | Up to 25 HRC | | 25 to 30 HRC | | 30 to 35 HRC | | 35 to 45 HRC | | 45 to 50 HRC | | Less than 40 HRC | | Less than 45 HRC | | | |
|---------------|---|-------------|---|-------------|---|-------------|--|-------------|-----------------|-------------|------------------|-------------|---|-------------|----------|--|
| Work Material | Mild Steels Carbon Steels Cast Iron | | 400 Stainless Steels Alloy Steels Tool Steels | | 300 Stainless Steels Hardened Steels Pre-hardened Steels | | PH Stainless Steels Hardened Steels | | Hardened Steels | | Titanium Alloys | | High Temp. Alloys Inconel Hastelloy | | | |
| Cutting Speed | 325-475 SFM | | 250-400 SFM | | 175-275 SFM | | 125-200 SFM | | 200-325 SFM | | 125-200 SFM | | 75-150 SFM | | | |
| Depth of Cut | Aa=1D | | | |  | | | | Aa=0.75D | | Aa=0.75D | | Aa=0.75D | | Aa=0.25D | |
| Mill Dia. | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | Speed RPM | Feed in/min | | |
| 1/8 | 11,240 | 44.8 | 8,860 | 26.6 | 6,900 | 19.3 | 5,500 | 13.4 | 4,890 | 14.6 | 5,050 | 13.3 | 2,750 | 9.1 | | |
| 3/16 | 7,495 | 48.2 | 5,910 | 29.9 | 4,600 | 21.9 | 3,670 | 14.3 | 3,260 | 16.0 | 3,350 | 14.3 | 1,835 | 10.2 | | |
| 1/4 | 5,620 | 47.5 | 4,430 | 31.9 | 3,450 | 21.6 | 2,750 | 15.3 | 2,445 | 17.5 | 2,550 | 14.8 | 1,375 | 10.2 | | |
| 5/16 | 4,500 | 49.2 | 3,545 | 33.4 | 2,750 | 22.9 | 2,200 | 16.1 | 1,955 | 17.8 | 2,000 | 14.8 | 1,100 | 11.2 | | |
| 3/8 | 3,750 | 47.8 | 2,955 | 31.9 | 2,300 | 21.9 | 1,835 | 15.3 | 1,630 | 16.0 | 1,700 | 14.5 | 915 | 10.4 | | |
| 7/16 | 3,210 | 46.4 | 2,530 | 30.8 | 1,950 | 20.9 | 1,575 | 14.8 | 1,395 | 16.0 | 1,450 | 14.7 | 785 | 10.3 | | |
| 1/2 | 2,810 | 46.5 | 2,215 | 30.2 | 1,700 | 20.1 | 1,375 | 14.3 | 1,225 | 16.0 | 1,300 | 15.1 | 690 | 10.2 | | |
| 5/8 | 2,250 | 41.4 | 1,775 | 28.2 | 1,400 | 19.8 | 1,100 | 13.8 | 975 | 14.5 | 1,000 | 12.5 | 550 | 9.6 | | |
| 3/4 | 1,875 | 38.8 | 1,480 | 26.1 | 1,150 | 18.0 | 920 | 12.5 | 815 | 13.1 | 850 | 11.8 | 460 | 8.7 | | |
| 1 | 1,405 | 33.4 | 1,110 | 23.4 | 875 | 15.8 | 685 | 10.7 | 610 | 12.2 | 650 | 11.3 | 345 | 8.0 | | |

| Long Length of Cut Speed Reduction | | | |
|------------------------------------|------------------------------|-------|-------|
| LOC/D | Reduce Speed | Aa | Ar |
| ≤3 | Use Recommendations above | | |
| 3~4* | 40% x Recommended | 2.5xø | 0.1xø |
| 4~6 | Not Recommended for slotting | | |

The above cutting conditions are calculated based on short overhang (LOC/D = 2) and should be adjusted accordingly for longer cutting edge lengths. For LOC/D greater than 3 see table on left.

*Feed rate may be increased at this specified depth of cut



shaping your dreams

 **Safe use of cutting tools**

- Use safety cover, safety glasses and safety shoes during operation.
- Do not touch cutting edges with bare hands.
- Do not touch cutting chips with bare hands. Chips will be hot after cutting.
- Stop cutting when the tool becomes dull.
- Stop cutting operation immediately if you hear any abnormal cutting sounds.
- Do not modify tools.
- Please use appropriate tools for the operation. Check dimensions to ensure proper selection.

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