

# 3M™ Hybrid Diamond Grinding Wheel 6PHU

## High Performance Fluting X-Series

Available in two formulations for your tungsten carbide fluting needs, 3M™ Hybrid Diamond 6PHU X-Series Fluting Wheels are developed with an innovative hybrid bond. The 3M™ Hybrid Diamond X96B X-Series Fluting Wheel's free-cutting formulation is designed for fast-fluting of standard end mills and other tools benefitting from low-power fluting.



### X96A

Excellent form holding.

### X96B

High removal rates,  
extreme free-cutting.

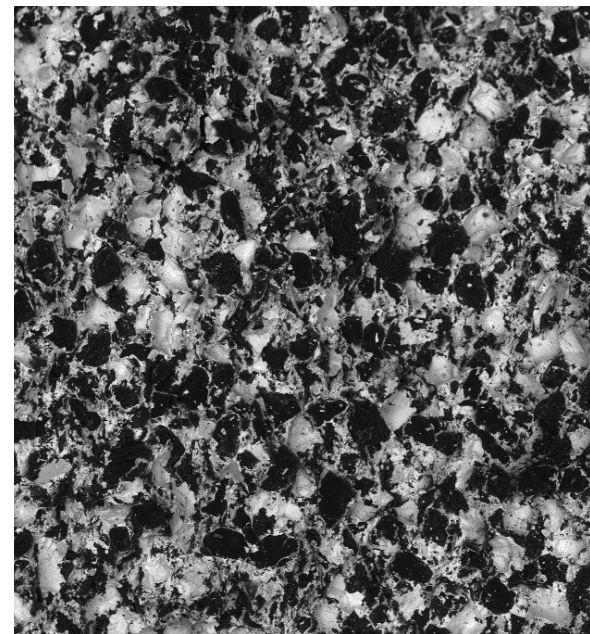
- **Reduced spindle power — (X96B)**  
Reduced cycle time; increased parts per dress
- **Improved form retention — (X96A)**  
Increased parts per truing
- **Full copper body**
- **EDM dressable**

#### 3M™ Hybrid Bond Diamond Grinding Wheel 6PHU Grinding Wheel Cost-Benefit Analysis

Conditions	Data
Current Wheel	3M™ Hybrid Bond Diamond Grinding Wheel 6PHN
Workpiece Material	Tungsten Carbide End-Mill
Workpiece Diameter [mm]	12
No. of Flutes	4
Flute Depth [mm]	2.4
Flute Length [mm]	30
Helix Angle	30
Wheel Wear [mm] After 100 Pcs	0.1
Current Wheel Price	\$400
Current Process Cost Per Part	\$1.35
New Grinding Wheel X-Series	3M™ Hybrid Bond Diamond Grinding Wheel 6PH
New Process Time/Cost	\$0.91

**Overall cost savings: 33%**

Example: at 10,000 workpieces/year = \$4,400 total savings for single operation



**Innovative X-Series bond**

# Technical Operating Parameters

The table below provides operating parameter guidelines for fluting with our new X-Series wheels. Parameters for X96A (form-holding) and X96B (free-cutting) are based on specific removal rate ( $Q'_w$ ) ranges developed under laboratory test conditions and verified in production settings.

Recommended parameters are guidelines only: Optimized parameters are dependent upon tool geometry and machine setup. Current process parameters should be used for initial setup guidance.

**Recommended wheel speed: 3,150 SFPM (16m/s). Wheel speed can be adjusted to optimize performance. Faster wheel speeds can make the wheel act harder to provide improved form, while slower wheel speeds tend to “soften” the wheel, enhancing the cut performance.**

**Formula:**

$$Q'_w = \frac{a_e \cdot v_f}{60} \quad v_f = \frac{Q'_w \cdot 60}{a_e}$$

## Process Parameters for Grinding Flutes on Tungsten Carbide Drill Bits and Milling Cutters

Starting parameters are guidelines only: Optimized parameters are dependent upon tool geometry and machine setup. Current process parameters should be used for initial setup guidance.

		Feed $V_f$ [mm/min]											
		40	50	60	70	80	90	100	120	140	160	180	200
Profile depth $a_e$ [mm]	1.0	0.7	0.8	1.0	1.2	1.3	1.5	1.7	2.0	2.3	2.7	3.0	3.3
	1.5	1.0	1.3	1.5	1.8	2.0	2.3	2.5	3.0	3.5	4.0	4.5	5.0
	2.0	1.3	1.7	2.0	2.3	2.7	3.0	3.3	4.0	4.7	5.3	6.0	6.7
	2.5	1.7	2.1	2.5	2.9	3.3	3.8	4.2	5.0	5.8	6.7	7.5	8.3
	3.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0
	3.5	2.3	2.9	3.5	4.1	4.7	5.3	5.8	7.0	8.2	9.3	10.5	11.7
	4.0	2.7	3.3	4.0	4.7	5.3	6.0	6.7	8.0	9.3	10.7	12.0	13.3
	4.5	3.0	3.8	4.5	5.3	6.0	6.8	7.5	9.0	10.5	12.0	13.5	15.0
	5.0	3.3	4.2	5.0	5.8	6.7	7.5	8.3	10.0	11.7	13.3	15.0	16.7
	5.5	3.7	4.6	5.5	6.4	7.3	8.3	9.2	11.0	12.8	14.7	16.5	18.3
6.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	12.0	14.0	16.0	18.0	20.0	

Start parameters D280 X96A (form holding)
  Start parameters D280 X96B (free cutting)

## Application examples:

Application Example X96A		Grinding Parameters	
Workpiece	TC Step Drill 3.6–6.9 mm OD	Feed rate	$v_f = 38$ mm/min
Grinding wheel	3M™ 6PHU 1A1-5-0.5-0.375 D280 X96A-1.25	Fluting depth	3.6–6.9 mm / 1 pass
Grinding machine	Walter Helitronic Power	Spec. material removal rate	$Q'_w = 2.3\text{--}4.4$ mm <sup>3</sup> /mm · s
Lubricant	Oil		

Application Example X96B		Grinding Parameters	
Workpiece	TC milling cutter 25 mm with 2 flutes, 30 helix angle	Feed rate	$v_f = 107$ mm/min
Grinding wheel	3M™ 6PHU 1A1-7-0.625-0.375-D280 X96B-2	Fluting depth	4.0 mm / 1 pass
Grinding machine	Rollomatic 6000XL	Spec. material removal rate	$Q'_w = 7.2$ mm <sup>3</sup> /mm · s
Lubricant	Oil		

Source: 3M internal data

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