

**pdtools**  
SUPERABRASIVES

**PREMIUM**



# **HYBRID BONDED WHEELS**

**HYBRID BONDED WHEELS  
FOR ROTARY TOOLS**



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**HBD01** *hybrid bond is a solution for fluting operations for the workpieces with diameter range from 4 to 22 mm used for 1A1 and 1V1 shapes with infeed up to 6 mm per pass. Grinding parameters and grit sizes are chosen according to the catalog recommendations, when by reducing the feed rate, infeed is increased per pass. Take into consideration: the more angle in 1V1 shaped wheel, the less infeed is, while feed rates remains the same.*

**SPD01** *SPD01 has higher edge retention and longer interval between dressings.*

**HBD02** *hybrid bond has been designed for high-performance clearance angles grinding for 11V9-70 shape for the workpieces OD 4mm and bigger. Has higher angle retention comparing with HBD03 bond. Grinding parameters and grit sizes are selected according to the catalog recommendations.*

**SPD02** *SPD02 has higher performance.*

**HBD03** *bond is a solution for high-quality clearance angles grinding and gashing operations of round tools for 11V9-70 and 12V9-45 shapes. HBD03 has higher surface quality comparing with HBD02 bond. Grinding parameters and grit sizes are selected according to the catalog recommendations.*

**HBD04** *bond is a solution for fluting operations for the workpieces diameter range up to 4 mm and used on 1A1 and 1V1 shapes. Grinding parameters and grit sizes are chosen according to the catalog recommendations, when by reducing the feed rate, infeed is increased per pass. Take into consideration: the more angle in 1V1 shaped wheel, the less infeed is, while feed rates remains the same.*

**HBD05** *bond has been developed for polishing operations on 1A1 and 1V1 shapes. Grinding parameters are selected according to the catalog recommendations.*

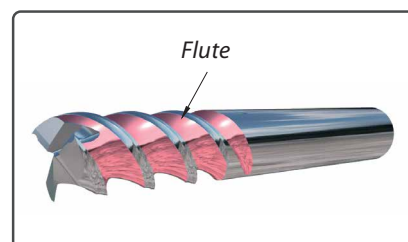
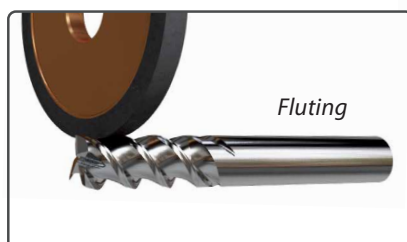
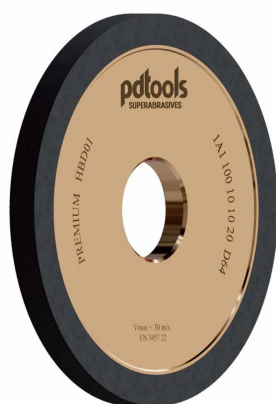
SHAPE	OPERATION	WORKPIECE Ø, MM		
		LARGER THAN 6 MM	4...12 MM	6...22 MM
1A1	Fluting	HBD04 M30	HBD01/SPD01 D46	HBD01/SPD01 D64
	Polishing	HBD05 M10	HBD05 M10	HBD05 M10
1V1 10°, 15°, 20°, 30°	Fluting	HBD04 M30	HBD01/SPD01 D46	HBD01/SPD01 D64
	Polishing	HBD05 M10	HBD05 M10	HBD05 M10
1V1 45°	Fluting	HBD04 M30	HBD01/SPD01 D46	HBD01/SPD01 D64
	Gashing	x	HBD01/SPD01 D46	HBD01/SPD01 D64
11V9-70	Clearance angles grinding	HBD04 M30	HBD02 D46 (higher angle retention)	HBD02 D64 (higher angle retention)
	Clearance angles grinding	HBD04 M30	SPD02 D46 (higher performance)	SPD02 D64 (higher performance)
	Clearance angles grinding	HBD04 M30	HBD03 D46 (higher surface quality)	HBD03 D64 (higher surface quality)
12V9-45	Gashing	HBD04 M30	HBD03 D46	HBD03 D64

*The manufacturer recommends using the wheel according to the catalog recommendations. The customer can use own grinding parameters, but not keeping to These recommenations may lead to premature wear of the wheel or its destruction.*

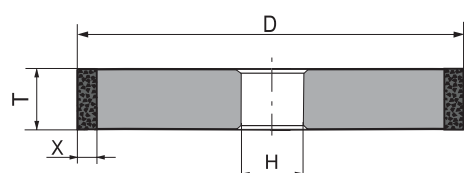
*For production of cutting tools (with large diameters), where flute is cut in several passes, the grinding depth and the feed rate must be selected so that each cycle is carried out with the same productivity. Productivity is the volume of material removed per pass.*

## INTERNATIONAL DIAMOND/CBN GRIT SIZE + SURFACE FINISH

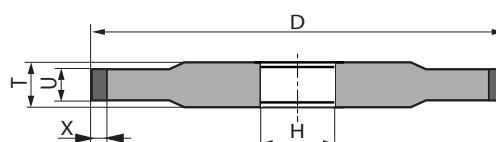
Ukrainian and CIS standards DSTU 3292-95 / GOST 9206-80	FEPA Diamond / CBN	ANSI B74-16 USA	GRIT	GRIT SIZE CLASS
µm	µm	mesh	grit	
160/125	D151/B151	100/120	120	LARGE
80/63	D76/B76	200/230	230	FINE
63/50	D64/B64	230/270	270	
50/40	D46/B46	325/400	400	VERY FINE
40/28	M30/B30	600	600	
14/10	M16/B16	1 500	1 500	MICRON
10/7	M10/B10	2 000	1 700	



**HBD01/SPD01 1A1 and 14A1 grinding wheels are a solution for fluting operations in the diameter range 4...12 mm with D46 and D64 with diameters bigger than 6 mm.**



**shape 1A1  $D \times T \times X \times H$**



**shape 14A1  $D \times T \times U \times X \times H$**





## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD01/SPD01 BOND

Code	Dimensions	Code	Dimensions
FM1-53	1A1 75×5×10×20	FM1-36	1A1 125×10×10×31.75
FM1-54	1A1 75×5×10×31.75	FM1-13	1A1 125×10×10×32
FM1-55	1A1 75×5×10×32	FM1-14	1A1 125×12×10×20
FM1-45	1A1 100×6×10×20	FM1-37	1A1 125×12×10×31.75
FM1-46	1A1 100×6×10×31.75	FM1-15	1A1 125×12×10×32
FM1-47	1A1 100×6×10×32	FM1-16	1A1 125×15×10×20
FM1-00	1A1 100×8×10×20	FM1-38	1A1 125×15×10×31.75
FM1-30	1A1 100×8×10×31.75	FM1-17	1A1 125×15×10×32
FM1-01	1A1 100×8×10×32	FM1-20	1A1 150×8×10×20
FM1-02	1A1 100×10×10×20	FM1-40	1A1 150×8×10×31.75
FM1-31	1A1 100×10×10×31.75	FM1-21	1A1 150×8×10×32
FM1-03	1A1 100×10×10×32	FM1-22	1A1 150×10×10×20
FM1-04	1A1 100×12×10×20	FM1-41	1A1 150×10×10×31.75
FM1-32	1A1 100×12×10×31.75	FM1-23	1A1 150×10×10×32
FM1-05	1A1 100×12×10×32	FM1-24	1A1 150×12×10×20
FM1-06	1A1 100×15×10×20	FM1-42	1A1 150×12×10×31.75
FM1-33	1A1 100×15×10×31.75	FM1-25	1A1 150×12×10×32
FM1-07	1A1 100×15×10×32	FM1-26	1A1 150×15×10×20
FM1-48	1A1 125×6×10×20	FM1-43	1A1 150×15×10×31.75
FM1-10	1A1 125×8×10×20	FM1-27	1A1 150×15×10×32
FM1-35	1A1 125×8×10×31.75	FM1-56	14A1 100×10×5×10×20
FM1-11	1A1 125×8×10×32	FM1-57	14A1 100×10×5×10×31.75
FM1-12	1A1 125×10×10×20	FM1-58	14A1 100×10×5×10×32

## RECOMMENDED FLUTING PARAMETERS FOR HBD01/SPD01 BOND

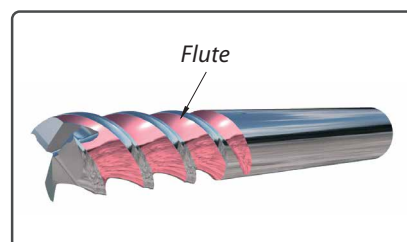
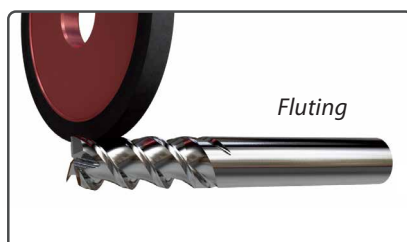
Coolant – oil, wheel speed 16-22 m/s.

		Feedrate S, mm/min																	
		30	40	50	60	80	100	110	120	130	140	150	160	180	200	220	240	250	260
Infeed t, mm	1,5																		
	2																		
	2,5																		
	3																		
	3,5																		
	4																		
	4,5																		
	5																		
	5,5																		
	6																		

-  Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.
-  Optimal conditions for CNC machines with output more than 11 kW.
-  Productive mode that is allowed for CNC machines with power output more than 20 kW.
-  Customer can work at such mode only after consulting the equipment manufacturer.

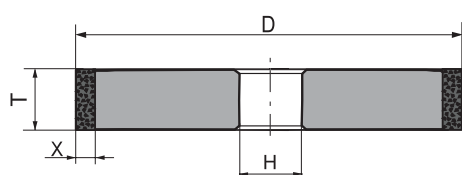
## CASE STUDY FOR HBD01/SPD01 BY CARBIDE END MILL PRODUCTION

MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW	WALTER HELITRONIC POWER 5-AXES CNC, POWER OUTPUT 25 KW
Grinding wheel	1A1 D100 T10 X10 H20 D64 HBD01	1A1 D100 T10 X10 H20 D64 SPD01
Operation	Fluting	
Coolant	Pure oil with superfiltration and chiller	
Workpiece D×L/L flute, mm	16×110/60	20×140/80
Flute q-ty, pcs.	4	4
Infeed per pass, mm	3	3
Feed rate, mm/min	100	150
Wheel speed, m/s	20	18
Machine time, min	3' 3"	3' 3"
Profiling cycle, pcs.	30	100

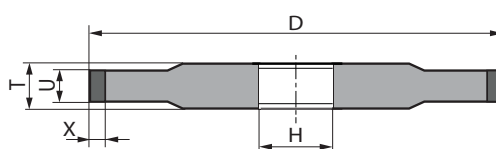


**HBD04 1A1 and 14A1 grinding wheels are a solution for fluting operations in the diameter range up to 6 mm with grit M30.**

**HBD05 1A1 and 14A1 grinding wheels are the balanced supplement for flute surface and cutting edge polishing with grit size M10 in cutting tool production industry.**



**shape 1A1  $D \times T \times X \times H$**



**shape 14A1  $D \times T \times U \times X \times H$**

## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD04 AND HBD05 BONDS

Code	Dimensions	Code	Dimensions
9-9012	1A1 75×5×10×20	0-0064	1A1 100×5×3×20
9-9013	1A1 75×5×10×31.75	0-0065	1A1 100×10×3×20
9-9014	1A1 75×5×10×32	0-0071	1A1 100×10×5×20
9-6941	1A1 75×6×5×10	3-2919	1A1 100×10×7×20
9K6941	1A1 75×6×5×20	0-1004	1A1 100×10×10×20
0-0048	1A1 80×6×3×20	0-0072	1A1 100×12×5×20
0-0054	1A1 80×6×5×20	0M0079	1A1 125×6×3×20
0-0050	1A1 80×10×3×20	0-0079	1A1 125×6×3×32
0-0056	1A1 80×10×5×20	0-0080	1A1 125×10×3×32
0-0253	1A1 80×10×10×20	9-9015	14A1 100×10×5×10×20
0-0063	1A1 100×6×3×20	9-9016	14A1 100×10×5×10×31.75
0-0069	1A1 100×6×5×20	9-9017	14A1 100×10×5×10×32

## RECOMMENDED FLUTING PARAMETERS FOR HBD04 BOND

Coolant – oil, wheel speed 16-22 m/s.


Feedrate  $S$ , mm/min

	80	90	100	130	140	160	170	190	200	210	220	240	250
0.2													
0.5													
0.8													
1													
1,5													

## RECOMMENDED POLISHING PARAMETERS FOR HBD05 BOND

Coolant – oil, wheel speed 16-22 m/s.

		Feedrate $S$ , mm/min												
Infeed $t$ , mm		25	30	40	50	60	70	80	90	100	110	120	130	140
	0.02													
	0.03													
	0.05													

 Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.

 Optimal conditions for CNC machines with output more than 11 kW.

 Productive mode that is allowed for CNC machines with power output more than 20 kW.

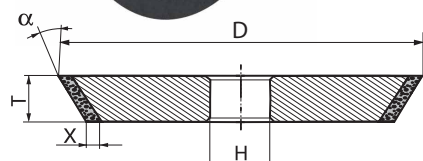
 Customer can work at such mode only after consulting the equipment manufacturer.

## CASE STUDY FOR HBD04 BY CARBIDE END MILL PRODUCTION

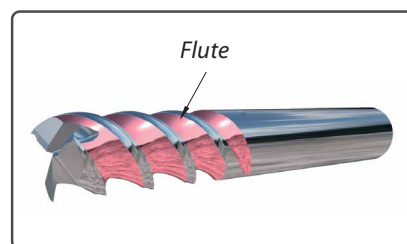
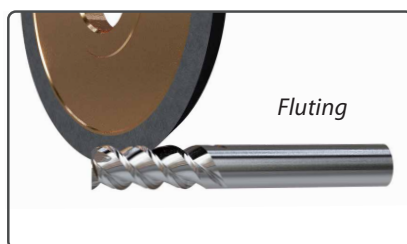
MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW
Grinding wheel	1A1 D75 T5 X10 H20 M30 HBD04
Operation	Fluting
Coolant	Pure oil with superfiltration and chiller
Workpiece D×L, mm	1×4
Flute q-ty, pcs.	2
Infeed per pass, mm	0.25
Feed rate, mm/min	50
Wheel speed, m/s	16
Machine time, min	30"
Profiling cycle, pcs.	75

## CASE STUDY FOR HBD05 BY CARBIDE END MILL POLISHING

MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW
Grinding wheel	1A1 D100 T12 X5 H20 M10 HBD05
Operation	Polishing
Coolant	Pure oil with superfiltration and chiller
Workpiece D×L, mm	8×42
Flute q-ty, pcs.	3
Infeed per pass, mm	0.05
Feed rate, mm/min	80
Wheel speed, m/s	20-22
Machine time, min	1'57"
Profiling cycle, pcs.	50



shape 1V1  $D \times T \times X \times \alpha \times H$



**HBD01/SPD01 1V1 10°; 15°; 20° grinding wheels are a solution for fluting operations in the diameter range 4...12 mm with D46 and D64 with diameters bigger than 6 mm.**

## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD01/SPD01 BOND

Code	Dimensions	Code	Dimensions
FM2-02	1V1 100×10×10×15×20	FM2-75	1V1 125×12×10×10×20
FM2-31	1V1 100×10×10×15×31.75	FM2-76	1V1 125×12×10×31.75
FM2-03	1V1 100×10×10×15×32	FM2-77	1V1 125×12×10×10×32
FM2-04	1V1 100×10×10×20×20	FM2-78	1V1 125×12×10×15×20
FM2-32	1V1 100×10×10×20×31.75	FM2-79	1V1 125×12×10×15×31.75
FM2-05	1V1 100×10×10×20×32	FM2-80	1V1 125×12×10×15×32
FM2-60	1V1 100×12×10×10×20	FM2-81	1V1 125×12×10×20×20
FM2-61	1V1 100×12×10×10×31.75	FM2-82	1V1 125×12×10×20×31.75
FM2-62	1V1 100×12×10×10×32	FM2-83	1V1 125×12×10×20×32
FM2-63	1V1 100×12×10×15×20	FM2120	1V1 125×14×10×10×20
FM2-64	1V1 100×12×10×15×31.75	FM2121	1V1 125×14×10×31.75
FM2-65	1V1 100×12×10×15×32	FM2122	1V1 125×14×10×10×32
FM2-66	1V1 100×12×10×20×20	FM2123	1V1 125×14×10×15×20
FM2-67	1V1 100×12×10×20×31.75	FM2124	1V1 100×14×10×15×31.75
FM2-68	1V1 100×12×10×20×32	FM2125	1V1 125×14×10×15×32
FM2105	1V1 100×14×10×10×20	FM2126	1V1 125×14×10×20×20
FM2106	1V1 100×14×10×10×31.75	FM2127	1V1 125×14×10×20×31.75
FM2107	1V1 100×14×10×10×32	FM2128	1V1 125×14×10×20×32
FM2108	1V1 100×14×10×15×20	FM2180	1V1 150×16×10×10×20
FM2109	1V1 100×14×10×15×31.75	FM2181	1V1 150×16×10×10×31.75
FM2110	1V1 100×14×10×15×32	FM2182	1V1 150×16×10×10×32
FM2111	1V1 100×14×10×20×20	FM2183	1V1 150×16×10×15×20
FM2112	1V1 100×14×10×20×31.75	FM2184	1V1 150×16×10×15×31.75
FM2113	1V1 100×14×10×20×32	FM2185	1V1 150×16×10×15×32
FM2-12	1V1 125×10×10×15×20	FM2186	1V1 150×16×10×20×20
FM2-36	1V1 125×10×10×15×31.75	FM2187	1V1 150×16×10×20×31.75
FM2-13	1V1 125×10×10×15×32	FM2188	1V1 150×16×10×20×32

## RECOMMENDED FLUTING PARAMETERS FOR HBD01/SPD01 BOND

Coolant – oil, wheel speed 16-22 m/s.

		Feedrate S, mm/min																	
		30	40	50	60	80	100	110	120	130	140	150	160	180	200	220	240	250	260
Infeed t, mm	1,5																		
	2																		
	2,5																		
	3																		
	3,5																		
	4																		
	4,5																		
	5																		



Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.



Optimal conditions for CNC machines with output more than 11 kW.



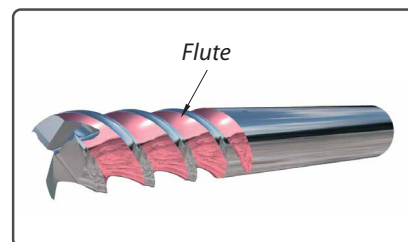
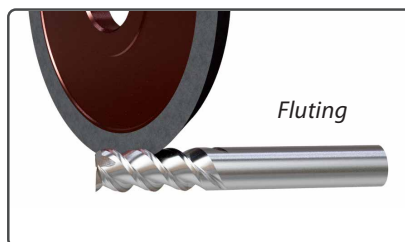
Productive mode that is allowed for CNC machines with power output more than 20 kW.



Customer can work at such mode only after consulting the equipment manufacturer.

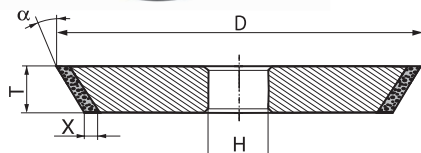
## CASE STUDY FOR HBD01/SPD01 BY CARBIDE END MILL PRODUCTION

MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW	WALTER HELITRONIC POWER 5-AXES CNC, POWER OUTPUT 25 KW
Grinding wheel	1V1 D100 T10 X10 V15 H20 D64 HBD01	1V1 D100 T10 X10 V15 H20 D64 SPD01
Operation	Fluting	
Coolant	Pure oil with superfiltration and chiller	
Workpiece D×L/L flute, mm	16×110/60	20×120/80
Flute q-ty, pcs.	4	4
Infeed per pass, mm	3	4
Feed rate, mm/min	80	120
Wheel speed, m/s	20	18
Machine time, min	4	4' 3"
Profiling cycle, pcs.	25	50



**HBD04 1V1 10°; 15°; 20° grinding wheels are a solution for fluting operations in the diameter range up to 6 mm with grit M30**

**HBD05 1V1 10°; 15°; 20° grinding wheels are developed for flute surface and cutting edge polishing in cutting tool production branch.**



**shape 1V1  $D \times T \times X \times \alpha \times H$**

## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD04 AND HBD05 BONDS

Code	Dimensions	Code	Dimensions
0L7350	1V1 74×8×6×15×20	9D9991	1V1 100×10×10×20×32
0-7350	1V1 75×8×7×20×20	9D3206	1V1 100×12×6×15×20
0-7352	1V1 100×6×7×20×20	9U3206	1V1 100×12×6×20×20
3R2919	1V1 100×10×7×20×31.75	9X3206	1V1 125×12×6×15×20
9C9991	1V1 100×10×10×20×20	9S3211	1V1 125×12×6×20×20

## RECOMMENDED FLUTING PARAMETERS FOR HBD04 BOND

Coolant – oil, wheel speed 16-22 m/s.

**Feedrate S, mm/min**

Infeed t, mm	70	80	90	100	110	130	140	160	170	180	200	220	230
0.2	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Orange
0.5	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Orange	Orange	Grey
0.8	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Orange	Orange	Grey	Grey	Grey
1	Green	Green	Green	Green	Yellow	Yellow	Orange	Orange	Grey	Grey	Grey	Grey	Grey
1,2	Green	Green	Yellow	Yellow	Orange	Orange	Grey	Grey	Grey	Grey	Grey	Grey	Grey



Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.



Optimal conditions for CNC machines with output more than 11 kW.



Productive mode that is allowed for CNC machines with power output more than 20 kW.



Customer can work at such mode only after consulting the equipment manufacturer.

## RECOMMENDED POLISHING PARAMETERS FOR HBD05 BOND

Coolant – oil, wheel speed 16-22 m/s.

		Feedrate S, mm/min												
Infeed t, mm		25	30	40	50	60	70	80	90	100	110	120	130	140
	0.02													
	0.03													
	0.05													



Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.



Optimal conditions for CNC machines with output more than 11 kW.



Productive mode that is allowed for CNC machines with power output more than 20 kW.



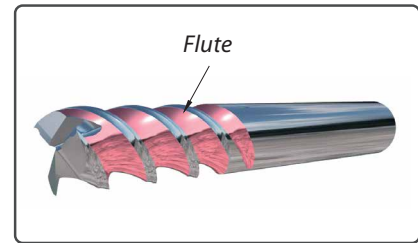
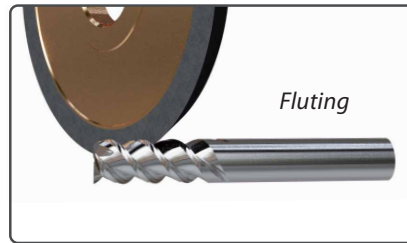
Customer can work at such mode only after consulting the equipment manufacturer.

## CASE STUDY FOR HBD04 BY CARBIDE END MILL PRODUCTION

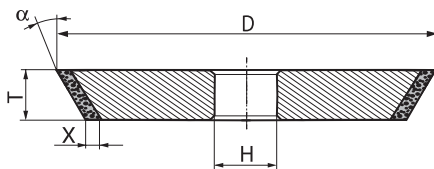
MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW
Grinding wheel	1V1 D75 T8 X7 V20 H20 M30 HBD04
Operation	Fluting
Coolant	Pure oil with superfiltration and chiller
Workpiece D×L, mm	2×5.5
Flute q-ty, pcs.	4
Infeed per pass, mm	0.38
Feed rate, mm/min	50
Wheel speed, m/s	18
Machine time, min	2'27"
Profiling cycle, pcs.	40

## CASE STUDY FOR HBD05 BY CARBIDE END MILL POLISHING

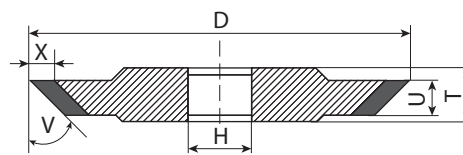
MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW
Grinding wheel	1V1 D100 T12 X6 V15 H20 M10 HBD05
Operation	Polishing
Coolant	Pure oil with superfiltration and chiller
Workpiece D×L, mm	14×20
Flute q-ty, pcs.	4
Infeed per pass, mm	0.05
Feed rate, mm/min	90
Wheel speed, m/s	22
Machine time, min	1'40"
Profiling cycle, pcs.	25



*HBD01/SPD01 1V1 30° and 14V1 30° grinding wheels are a solution for fluting operations in the diameter range 4...12 mm with D46 and D64 with diameters bigger than 6 mm.*



*shape 1V1  $D \times T \times X \times \alpha \times H$*



*shape 14V1  $D \times T \times U \times X \times \alpha \times H$*

## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD01/SPD01 BOND

Code	Dimensions	Code	Dimensions
FM2-48	1V1 75×5×10×30×20	FM2116	1V1 100×14×10×30×32
FM2-49	1V1 75×5×10×30×31.75	FM2129	1V1 125×14×10×30×20
FM2-50	1V1 75×5×10×30×32	FM2130	1V1 125×14×10×30×31.75
FM2-06	1V1 100×10×10×30×20	FM2131	1V1 125×14×10×30×32
FM2-33	1V1 100×10×10×30×31.75	FM2-84	1V1 125×12×10×30×20
FM2-07	1V1 100×10×10×30×32	FM2-85	1V1 125×12×10×30×31.75
FM2-69	1V1 100×12×10×30×20	FM2-86	1V1 125×12×10×30×32
FM2-70	1V1 100×12×10×30×31.75	FM2-54	14V1 100×10×5×10×30×20
FM2-71	1V1 100×12×10×30×32	FM2-55	14V1 100×10×5×10×30×31.75
FM2114	1V1 100×14×10×30×20	FM2-56	14V1 100×10×5×10×30×32
FM2115	1V1 100×14×10×30×31.75		

## RECOMMENDED FLUTING PARAMETERS FOR HBD01/SPD01 BOND

Coolant – oil, wheel speed 16-22 m/s.

		Feedrate S, mm/min																
Infeed t, mm		30	40	50	60	80	100	110	120	130	140	150	160	180	200	220	240	250
	1																	
	1,5																	
	2																	
	2,5																	
	3																	
	3,5																	
	4																	



Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.



Optimal conditions for CNC machines with output more than 11 kW.



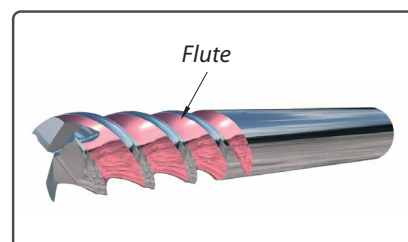
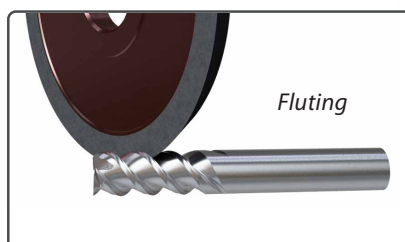
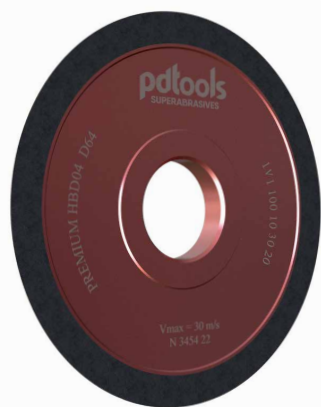
Productive mode that is allowed for CNC machines with power output more than 20 kW.



Customer can work at such mode only after consulting the equipment manufacturer..

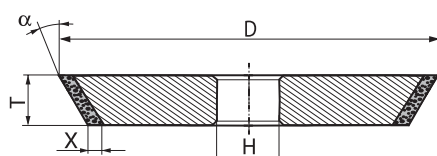
## CASE STUDY FOR HBD01/SPD01 BY CARBIDE END MILL PRODUCTION

MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW	WALTER HELITRONIC POWER 5-AXES CNC, POWER OUTPUT 25 KW
Grinding wheel	1V1 D100 T10 X10 V30 H20 D64 HBD01	1V1 D100 T10 X10 V30 H20 D64 SPD01
Operation	Fluting	
Coolant	Pure oil with superfiltration and chiller	
Workpiece D×L/L flute, mm	12×75/45	12×75/45
Flute q-ty, pcs.	4	4
Infeed per pass, mm	2.5	2.5
Feed rate, mm/min	70	100
Wheel speed, m/s	18	18
Machine time, min	3' 2"	2' 3"
Profiling cycle, pcs.	35	60

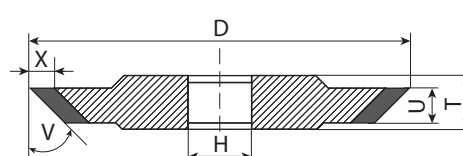


**HBD04 1V1 30° and 14V1 30° grinding wheels are a solution for fluting operations in the diameter range up to 6 mm with grit M30**

**HBD05 1V1 30° and 14V1 30° grinding wheels are developed for flute surface and cutting edge polishing in cutting tool production branch.**



**shape 1V1  $D \times T \times X \times \alpha \times H$**



**shape 14V1  $D \times T \times U \times X \times \alpha \times H$**

### THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD04 AND HBD05 BONDS

Code	Dimensions	Code	Dimensions
9-9000	1V1 75×5×10×30×20	9D3207	1V1 100×12×6×30×20
9-9001	1V1 75×5×10×30×31.75	9S3213	1V1 125×12×6×30×20
9-9002	1V1 75×5×10×30×32	9-9006	14V1 100×10×5×10×30×20
0-7346	1V1 75×8×5×30×20	9-9007	14V1 100×10×5×10×30×31.75
3F2919	1V1 100×10×7×30×20	9-9008	14V1 100×10×5×10×30×32

### RECOMMENDED FLUTING PARAMETERS FOR HBD04 BOND

Coolant – oil, wheel speed 16-22 m/s.

Feedrate S, mm/min

	60	70	80	90	100	110	130	140	150	160	170	180	200
0.2	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Orange
0.3	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Orange	Orange
0.5	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Orange	Orange	Grey
0.8	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Orange	Orange	Grey	Grey	Grey
1	Green	Green	Green	Yellow	Yellow	Orange	Orange	Grey	Grey	Grey	Grey	Grey	Grey

## RECOMMENDED POLISHING PARAMETERS FOR HBD05 BOND

Coolant – oil, wheel speed 16-22 m/s.

		Feedrate $S$ , mm/min												
Infeed $t$ , mm		25	30	40	50	60	70	80	90	100	110	120	130	140
	0.02													
	0.03													
	0.05													



Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.



Optimal conditions for CNC machines with output more than 11 kW.



Productive mode that is allowed for CNC machines with power output more than 20 kW.



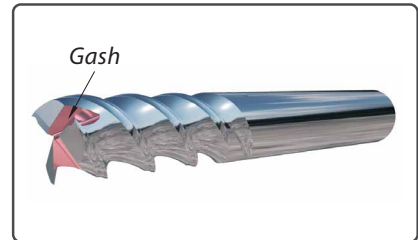
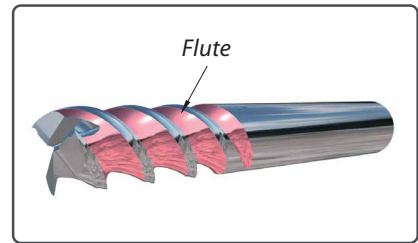
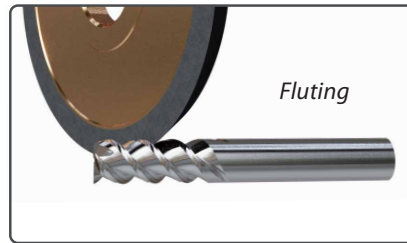
Customer can work at such mode only after consulting the equipment manufacturer.

## CASE STUDY FOR HBD04 BY CARBIDE END MILL PRODUCTION

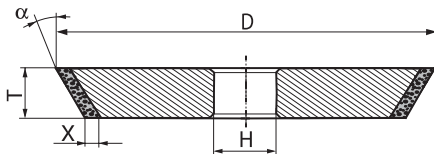
MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW
Grinding wheel	1V1 D75 T5 X10 V30 H20 M30 HBD04
Operation	Fluting
Coolant	Pure oil with superfiltration and chiller
Workpiece D×L, mm	1×4
Flute q-ty, pcs.	4
Infeed per pass, mm	0.2
Feed rate, mm/min	60
Wheel speed, m/s	20
Machine time, min	48"
Profiling cycle, pcs.	60

## CASE STUDY FOR HBD05 BY CARBIDE END MILL POLISHING

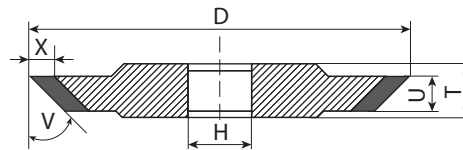
MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW
Grinding wheel	1V1 D100 T12 X6 V30 H20 M10 HBD05
Operation	Polishing
Coolant	Pure oil with superfiltration and chiller
Workpiece D×L, mm	12×35
Flute q-ty, pcs.	4
Infeed per pass, mm	0,02-0,05
Feed rate, mm/min	90
Wheel speed, m/s	22
Machine time, min	3'06"
Profiling cycle, pcs.	30



**HBD01/SPD01 1V1 45° and 14V1 45° grinding wheels are a solution for fluting and gashing operations in the diameter range 4...12 mm with D46 and D64 with diameters bigger than 6 mm.**



**shape 1V1  $D \times T \times X \times \alpha \times H$**



**shape 14V1  $D \times T \times U \times X \times \alpha \times H$**

## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD01/SPD01 BOND

Code	Dimensions	Code	Dimensions
FM2-51	1V1 75×5×10×45×20	FM2-19	1V1 125×10×10×45×32
FM2-52	1V1 75×5×10×45×31.75	FM2-87	1V1 125×12×10×45×20
FM2-53	1V1 75×5×10×45×32	FM2-88	1V1 125×12×10×45×31.75
FM2-72	1V1 100×12×10×45×20	FM2-89	1V1 125×12×10×45×32
FM2-73	1V1 100×12×10×45×31.75	FM2132	1V1 125×14×10×45×20
FM2-74	1V1 100×12×10×45×32	FM2133	1V1 125×14×10×45×31.75
FM2117	1V1 100×14×10×45×20	FM2134	1V1 125×14×10×45×32
FM2118	1V1 100×14×10×45×31.75	FM2-57	14V1 100×10×5×10×45×20
FM2119	1V1 100×14×10×45×32	FM2-58	14V1 100×10×5×10×45×31.75
FM2-18	1V1 125×10×10×45×20	FM2-59	14V1 100×10×5×10×45×32
FM2-39	1V1 125×10×10×45×31.75		

## RECOMMENDED GRINDING PARAMETERS FOR HBD01/SPD01 BOND

Coolant – oil, wheel speed 16-22 m/s.

		Feedrate S, mm/min												
		30	40	50	60	80	100	110	120	130	140	150	160	180
Infeed t, mm	1													
	1,5													
	2													
	2,5													
	3													



Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.



Optimal conditions for CNC machines with output more than 11 kW.



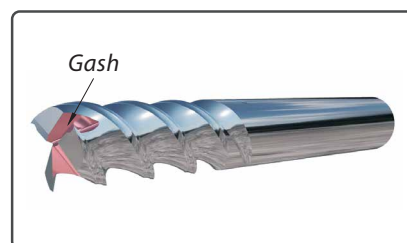
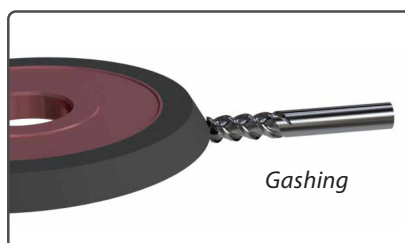
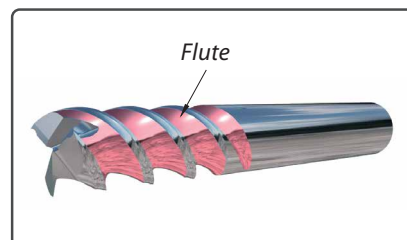
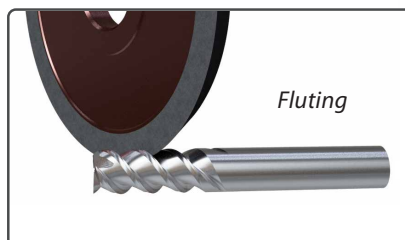
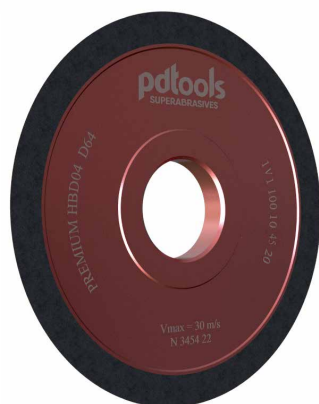
Productive mode that is allowed for CNC machines with power output more than 20 kW.



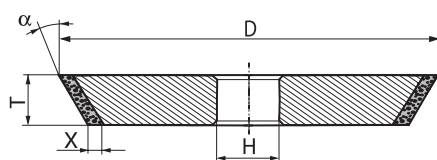
Customer can work at such mode only after consulting the equipment manufacturer.

## CASE STUDY FOR HBD01/SPD01 BY CARBIDE END MILL PRODUCTION

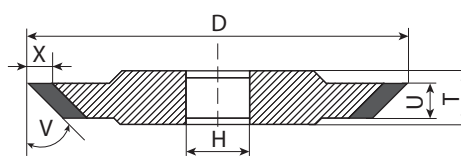
MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW	WALTER HELITRONIC POWER 5-AXES CNC, POWER OUTPUT 25 KW
Grinding wheel	1V1 D100 T10 X10 V45 H20 D64 HBD01	1V1 D100 T10 X10 V45 H20 D64 SPD01
Operation	Fluting	
Coolant	Pure oil with superfiltration and chiller	
Workpiece D×L/L flute, mm	16×110/60	18×100/60
Flute q-ty, pcs.	8	8
Infeed per pass, mm	2.5	2
Feed rate, mm/min	40	110
Wheel speed, m/s	20	18
Machine time, min	14	7
Profiling cycle, pcs.	20	30



**HBD04 1V1 45° and 14V1 45° grinding wheels are a solution for fluting and gashing operations in the diameter range up to 6 mm with grit M30.**



**shape 1V1  $D \times T \times X \times \alpha \times H$**



**shape 14V1  $D \times T \times U \times X \times \alpha \times H$**

## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD04 BOND

Code	Dimensions	Code	Dimensions
9-9003	1V1 75×5×10×45×20	9B3208	1V1 100×12×6×45×20
9-9004	1V1 75×5×10×45×31.75	9K3241	1V1 125×8×6×45×31.75
9-9005	1V1 75×5×10×45×32	3F3241	1V1 125×10×6×45×31.75
9S349	1V1 100×6×5×45×20	9-9009	14V1 100×10×5×45×20
9F3208	1V1 100×10×6×45×32	9-9010	14V1 100×10×5×45×31.75
9-9998	1V1 100×10×10×45×20	9-9011	14V1 100×10×5×45×32

## RECOMMENDED GRINDING PARAMETERS FOR HBD04 BOND

Coolant – oil, wheel speed 16-22 m/s.

		Feedrate S, mm/min												
Infeed t, mm		60	70	80	90	100	110	120	130	140	150	160	170	180
	0.2													
	0.3													
	0.4													
	0.5													
	0.8													



Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.



Optimal conditions for CNC machines with output more than 11 kW.



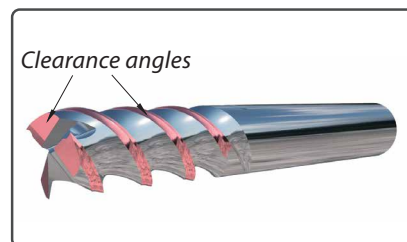
Productive mode that is allowed for CNC machines with power output more than 20 kW.



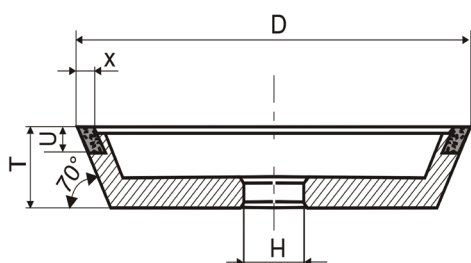
Customer can work at such mode only after consulting the equipment manufacturer.

## CASE STUDY FOR HBD04 BY CARBIDE END MILL PRODUCTION

MACHINE		VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW
Grinding wheel		1V1 D75 T5 X10 V45 H20 M30 HBD04
Operation		Fluting
Coolant		Pure oil with superfiltration and chiller
Workpiece D×L, mm		2×9
Flute q-ty, pcs.		4
Infeed per pass, mm		0.4
Feed rate, mm/min		50
Wheel speed, m/s		22
Machine time, min		1'39"
Profiling cycle, pcs.		30



**HBD02/SPD02 on 11V9-70 grinding wheels are a solution for clearance angles grinding in the diameter range 4...6 mm with D46 and D64 with diameters bigger than 6 mm.**



**shape 11V9-70  $D \times U \times X \times T \times H$**

## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD02/SPD02 BOND

Code	Dimensions
FR1-03	11V9-70 100×10×3×35×20
FR1-04	11V9-70 100×10×3×35×31.75
FR1-05	11V9-70 100×10×3×35×32

## RECOMMENDED GRINDING PARAMETERS FOR HBD02/SPD02 BOND

Coolant – oil, wheel speed 16-22 m/s.

**Feedrate S, mm/min**

	20	30	40	50	60	70	80	100	110	120	130	140	150	160	180	200
Infeed t, mm	0,2	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Orange	Orange	Orange	Orange	Orange
	0,3	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Orange	Orange	Orange	Orange	Orange	Grey
	0,5	Green	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Orange	Orange	Orange	Orange	Orange	Grey	Grey
	1	Green	Green	Yellow	Yellow	Yellow	Yellow	Orange	Orange	Orange	Orange	Grey	Grey	Grey	Grey	Grey



Good roughness and tool tolerances. These grinding parameters provide maximum wheel life and edge retention of the wheel.



Optimal conditions, which ensures good edge retention and sharpening quality.



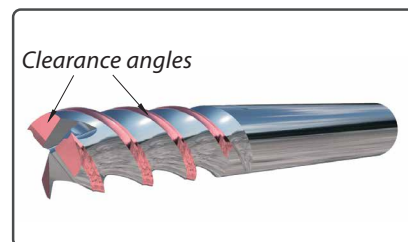
Acceptable level of edge retention and tool roughness. It is possible to apply at a certain length/diameter workpiece ratio.



Customer can work at such mode only after consulting the equipment manufacturer.

## CASE STUDY FOR HBD02/SPD02 BY CARBIDE END MILL PRODUCTION

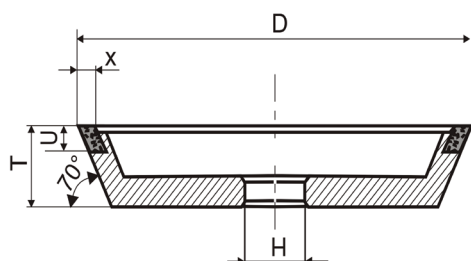
MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW	WALTER HELITRONIC POWER 5-AXES CNC, POWER OUTPUT 25 KW
Grinding wheel	11V9-70 D100 U10 X3 T35 H20 D64 HBD02	11V9-70 D100 U10 X3 T35 H20 D64SPD02
Operation	Clearance angles grinding	
Coolant	Pure oil with superfiltration and chiller	
Workpiece D×L/L flute, mm	20×280	18×72
Flute q-ty, pcs.	2	4
Infeed per pass, mm	0.3	0.5
Feed rate, mm/min	80	120
Wheel speed, m/s	25	25
Machine time, min	3	4
Profiling cycle, pcs.	30	90



**HBD03 on 11V9-70 grinding wheels are a solution for clearance angles and regrinding applications in diameter ranges:**

- from 6 mm with D64;
- 4...12 mm with D46.

**HBD04 11V9-70 grinding wheels are a solution for clearance angles and regrinding in the diameter range up to 6 mm with grit M30.**



**shape 11V9-70  $D \times U \times X \times T \times H$**

## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD03 BOND

Code	Dimensions	Code	Dimensions
FR1-00	11V9-70 75×10×3×30×20	FR1-05	11V9-70 100×10×3×35×32
FR1-01	11V9-70 75×10×3×30×31.75	FR1-06	11V9-70 100×10×3×40×20
FR1-03	11V9-70 100×10×3×35×20	FR1-07	11V9-70 100×10×3×40×31.75
FR1-04	11V9-70 100×10×3×35×31.75	FR1-08	11V9-70 100×10×3×40×32

## RECOMMENDED GRINDING PARAMETERS FOR HBD03 BOND

Coolant – oil, wheel speed 16-22 m/s.

		Feedrate S, mm/min														
Infeed t, mm		20	30	40	50	60	70	80	90	100	110	120	130	140	150	160
	0.2															
	0.3															



Good roughness and tool tolerances. These grinding parameters provide maximum wheel life and edge retention of the wheel.



Optimal conditions for CNC machines with output more than 11 kW.



Productive mode that is allowed for CNC machines with power output more than 20 kW.



Customer can work at such mode only after consulting the equipment manufacturer.

## RECOMMENDED GRINDING PARAMETERS FOR HBD04 M30 BOND

Coolant – oil, wheel speed 16-22 m/s.

Infeed t, mm	Feedrate S, mm/min												
	25	30	40	50	60	70	80	90	100	110	120	130	140
	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4
0.2													
0.3													



Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.



Optimal conditions for CNC machines with output more than 11 kW.



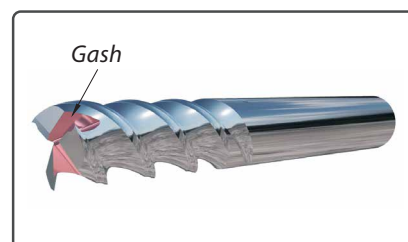
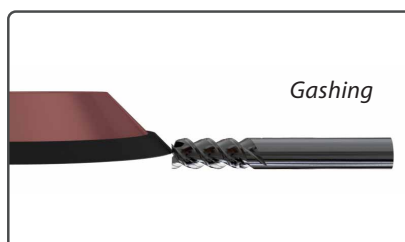
Productive mode that is allowed for CNC machines with power output more than 20 kW.



Customer can work at such mode only after consulting the equipment manufacturer.

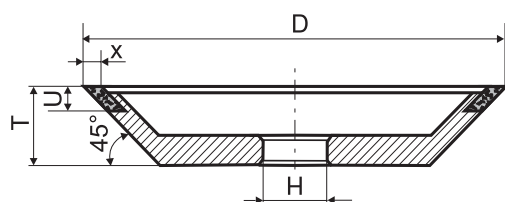
## CASE STUDY FOR HBD03 BY CARBIDE END MILL PRODUCTION

MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW
Grinding wheel	11V9-70 D75 U10 X3 T30 H20 M30 HBD04
Operation	Raduis end mill R1,4 production
Coolant	Pure oil with superfiltration and chiller
Workpiece D×L, mm	2,8×5,5
Flute q-ty, pcs.	2
Infeed per pass, mm	0,05 periphery, 0,3 end surface
Feed rate, mm/min	75
Wheel speed, m/s	18-20
Machine time, min	28"
Profiling cycle, pcs.	60



**HBD03 on 12V9-45 grinding wheels are a solution for gashing and regrinding applications in diameter ranges:**  
- from 6 mm with grit D64;  
- 4... 12 mm with D46.

**HBD04 on 12V9-45 grinding wheels are a solution for gashing and regrinding applications in diameter ranges up to 6 mm with M30 grit.**



**shape 12V9-45  $D \times U \times X \times T \times H$**

## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH HBD03 BOND

Code	Dimensions	Code	Dimensions
FR2-00	12V9-45 75×6×2×16×20	FR2-05	12V9-45 125×10×3×20×32
FR2-01	12V9-45 75×6×2×16×31.75	FR2-06	12V9-45 125×10×3×25×20
FR2-02	12V9-45 75×6×2×16×32	FR2-07	12V9-45 125×10×3×25×31.75
FR2-03	12V9-45 100×10×3×20×20	FR2-08	12V9-45 125×10×3×25×32
FR2-04	12V9-45 100×10×3×20×31.75		

## RECOMMENDED GRINDING PARAMETERS FOR HBD03 BOND

Coolant – oil, wheel speed 20-26 m/s.

		Feedrate $S$ , mm/min																
Infeed $t$ , mm		25	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
	0.5																	
	1																	
	2																	
	3																	



Good roughness and tool tolerances. These grinding parameters provide maximum wheel life and edge retention of the wheel.



Optimal conditions for CNC machines with output more than 11 kW.



Productive mode that is allowed for CNC machines with power output more than 20 kW.



Customer can work at such mode only after consulting the equipment manufacturer.

## RECOMMENDED GRINDING PARAMETERS FOR HBD04 M30

Coolant – oil, wheel speed 20-26 m/s.

		Feedrate S, mm/min												
Infeed t, mm		25	30	40	50	60	70	80	90	100	110	120	130	140
	0.2													
	0.3													
	0.5													
	0.7													



Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.



Optimal conditions for CNC machines with output more than 11 kW.



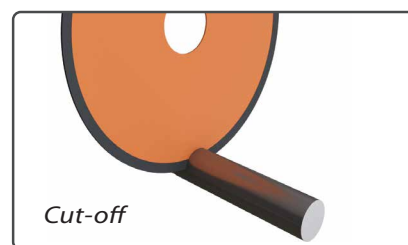
Productive mode that is allowed for CNC machines with power output more than 20 kW.



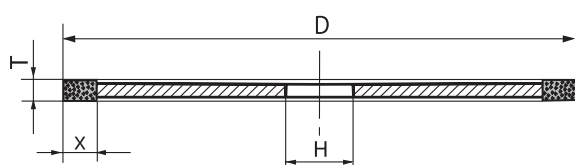
Customer can work at such mode only after consulting the equipment manufacturer.

## CASE STUDY FOR HBD03 BY CARBIDE END MILL PRODUCTION

MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW
Grinding wheel	<b>12V9-45 D75 U6 X2 T16 H20 M30 HBD04</b>
Operation	<i>gashing</i>
Coolant	<i>Pure oil with superfiltration and chiller</i>
Workpiece D×L, mm	3×25
Flute q-ty, pcs.	3
Infeed per pass, mm	0,9
Feed rate, mm/min	20
Wheel speed, m/s	22
Machine time, min	44"
Profiling cycle, pcs.	40



*B1000 1A1R cutting wheels are used to cut workpieces in tool production industry.*



*shape 1A1R  $D \times T \times X \times H$*

## THE MOST FREQUENTLY USED WHEEL DIMENSIONS WITH B1000 BOND

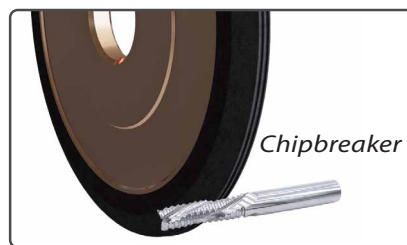
Code	Dimensions	Code	Dimensions
6M0206	1A1R 150×1.2×5×20	6D4002	1A1R 200×1.2×10×20
6K0206	1A1R 150×1.2×5×31.75	6F4002	1A1R 200×1.2×10×31.75
6-0206	1A1R 150×1.2×5×32	6E4002	1A1R 200×1.2×10×32
6Y0234	1A1R 200×1.2×5×20	6J0234	1A1R 200×1.5×5×20
6F0234	1A1R 200×1.2×5×31.75	6M0234	1A1R 200×1.5×5×31.75
6E0234	1A1R 200×1.2×5×32	6-0234	1A1R 200×1.5×5×32
		6K0234	1A1R 200×1.8×5×32

## RECOMMENDED GRINDING PARAMETERS

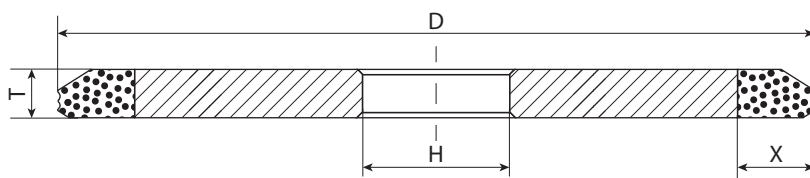
Coolant – oil/emulsion, wheel speed 18-26 m/s.

The feed rate depends on the workpiece diameter and should not be more than 25 mm/min.

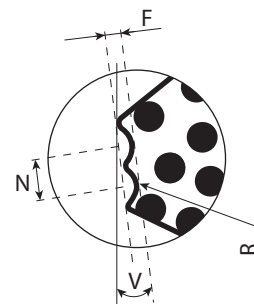
Recommended grit size is D151.



**1S1 is developed for knurled profile grinding in roughing mill production.**



**shape 1S1  $D \times T \times X \times V \times R \times F \times N \times H$**



### THE MOST FREQUENTLY USED WHEEL DIMENSIONS FOR CHIPBREAKER GRINDING

Code	Dimensions	Code	Dimensions
1-1234	1S1 100×6×10×9×0.25×0.4×0.8×20	1-1240	1S1 100×6×10×9×0.3×0.45×1×32
1-1237	1S1 100×6×10×9×0.25×0.4×0.8×31.75	1-1236	1S1 100×6×10×9×0.5×0.7×1.5×20
1-1238	1S1 100×6×10×9×0.25×0.4×0.8×32	1-1241	1S1 100×6×10×9×0.5×0.7×1.5×31.75
1-1235	1S1 100×6×10×9×0.3×0.45×1.0×20	1-1242	1S1 100×6×10×9×0.5×0.7×1.5×32
1-1239	1S1 100×6×10×9×0.3×0.45×1×31.75		

### RECOMMENDED GRINDING PARAMETERS FOR CHIPBREAKER GRINDING

Coolant – oil, wheel speed 16-22 m/s.

		Feedrate $S$ , mm/min														
Infeed $t$ , mm		50	60	70	80	90	100	110	120	130	140	150	160	180	200	220
	0.3															
	0.4															
	0.6															



Better surface roughness. These grinding parameters provide better roughness and tool tolerances. Grinding wheels have maximum dressing interval. Applicable for all types of CNC grinders. Permissible grinding parameters for CNC machines with output up to 11 kW.



Optimal conditions for CNC machines with output more than 11 kW.



Productive mode that is allowed for CNC machines with power output more than 20 kW.



Customer can work at such mode only after consulting the equipment manufacturer.

**CASE STUDY FOR CHIPBREAKER GRINDING BY CARBIDE ROUGHING MILL PRODUCTION**

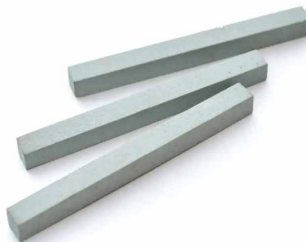
MACHINE	VOLLMER V-GRIND 260 5-AXES CNC, POWER OUTPUT 11 KW
Grinding wheel	1S1 D100 T6 X5 V9 R0.3 F0.45 N1 H20 D64
Operation	Knurled profile grinding
Coolant	Pure oil with superfiltration and chiller
Workpiece D×L, mm	8×30
Flute q-ty, pcs.	3 (94 cuts/mill)
Infeed per pass, mm	0,38
Feed rate, mm/min	150
Wheel speed, m/s	22
Machine time, min	3'19"
Profiling cycle, pcs.	300

## RECOMMENDATIONS FOR THE USE, TRUING AND DRESSING OF DIAMOND AND CBN WHEELS

**Dressing (cleaning)** of diamond and CBN grinding wheels is performed to remove sludge from the working layer and restore grinding ability. The cleaning process should be carried out with aluminium oxide (AlO) (for HBD03, -04, -05 bonds) or silicon carbide (SiC) (for HBD01, -02 bonds) stones. Classically, the stone should be 1 or 2 sizes coarser than a diamond or CBN grinding wheel. The finer the grit on a CBN or diamond wheel is, the softer the stone should be.



Before dressing



After dressing

You can order by POLTAVA DIAMOND TOOLS aluminium oxide dressing stones for your needs.

When using diamond grinding wheels, the following instructions should be observed:

- grinding wheels are to be mounted on holders or flanges and should not be removed until final usage has occurred;
- the tools are to be mounted securely on the machine spindle in accordance with the technical specifications of the equipment used for diamond tool machining;
- the cleaning of resin bonded diamond wheels is to be performed with a pumice stone, of metal bonded wheels with a green silicon carbide bar made with grit sizes 1 or 2 sizes larger than that of the diamond wheel.

**Dressing (truing)** of the diamond layer is necessary to restore its shape, eliminate defects from its working surface, and to restore the required profile. As a rule This is performed without coolant. The most productive way of dressing a diamond layer is to grind it with abrasive wheels. The dressing is performed by wheels of white alumina and green silicon carbide with vitrified bonds with grit

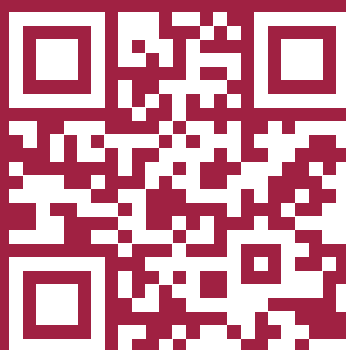
sizes 1 or 2 sizes larger than those of the diamond wheels. Wheels with a hardness of K-H are necessary for dressing resin bond wheels and wheels of a hardness of M-K are necessary for dressing metal bond wheels. The smaller the grit size of the superabrasive material, the softer the dressing tool must be.

### CONDITIONS OF DIAMOND LAYER DRESSING

Diamond grinding wheel position	Dressing conditions			
	Peripheral speed, m/s		Line feed, m/min	Cross feed, mm/double stroke
	Conventional wheel	Diamond/ CBN wheel		
<i>Diamond grinding wheel set on a machine fixture or in the center of circular grinding or sharpening machine</i>	25 – 35	2 – 5	1,0–2,0	0,02–0,04

### PARAMETERS OF VITRIFIED BONDED CONVENTIONAL WHEELS FOR DRESSING OF SUPERABRASIVE LAYERS

Diamond layer parameters		Dressing wheels parameters		
Bond type	Diamond/CBN grade	Abrasive type	Abrasive grade	Hardness
HBD03, HBD04, HBD05	D151 - D126	Aluminum oxide 22A, 23A, 15A, 16A	F70; F80; F100	M-L
	D107 - D91		F100; F120; F150	L-K
	D64 - D46		F150; F180; F230	K-J
	M40 - M16		F280; F360	J
HBD01, SPD01, HBD02, SPD02	D251 - D213	Silicon carbide 62C, 63C, 64C	F40; F46	O-N
	D151 - D126		F60; F70	P-M
	D107 - D91		F80; F100	M-L
	D64 and finer		F120; F150; F180	L-K



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