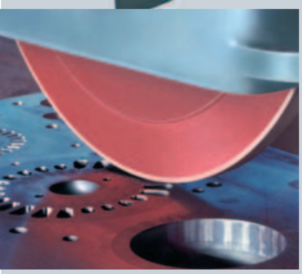
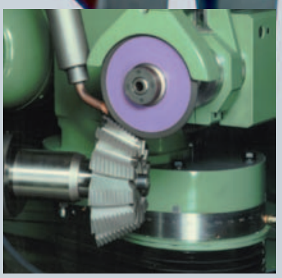
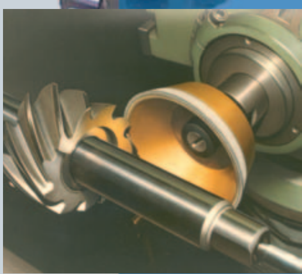
WINTER

Diamond grinding wheels CBN grinding wheels

Main catalogue




SAINT-GOBAIN
ABRASIVES

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Diamond grinding wheels
CBN grinding wheels

Grinding is defined in the German Industrial Standard DIN 8589 as abrasive cutting with geometrically unspecified cutting edges. All grinding wheels with an abrasive layer of diamond or cubic boron nitride (CBN) are grinding tools in the sense of DIN 8589. Their "cutting edges" are formed by the abrasive grits diamond or CBN.

WINTER diamond and CBN grinding wheels are known and used throughout the world. Their reputation as top quality products has been built up by intensive research and extensive experience in production, and a wealth of expertise in application engineering.

Diamond abrasives feature unsurpassed hardness and resistance to wear; hence their use in the abrasive machining of hard, brittle and short-chipping materials such as glass, ceramics, quartz, ferrites, semiconductor materials, graphite, wear-resistant spray-on or weld-on alloys, glass fibre reinforced plastics and similar hard-to-machine materials. In special cases diamond tools may also be economical for machining cast steel and cast iron.
The properties of grinding wheels can be modified to enable them to perform both rough grinding and finish and fine grinding. Diamond wheels feature low wear even at high material removal rates; thus they can achieve the required shape, dimensional and surface tolerances even with difficult-to-grind materials.

Cost comparisons between conventional abrasives (aluminium oxide and silicon carbide) and diamond show that diamond used on appropriate grinding machines is more economical for the grinding of cemented carbides and similar hard-to-grind materials.

Cutting fluid should be used wherever possible in order to achieve high material removal rates coupled with low wear of the diamond wheel.

Cubic Boron Nitride (CBN), like synthetic diamond, is produced by high-pressure, high-temperature synthesis. The process used for incorporating it in grinding wheels is almost identical with that used for diamond. CBN is the second hardest abrasive, surpassed only by diamond. Compared with diamond it offers economic advantages in the grinding of ferrous materials, such as steel. Compared with conventional abrasives it offers advantages especially in the grinding of hard-to-machine steels with large proportions of alloy and hardness ratings of 55 HRC and above, e.g. high-speed steels and chrome steels. CBN wheels feature considerably lower wear, making it easier to achieve the necessary shape and dimension accuracies. A particular advantage in the grinding of hard-to-machine materials is that CBN wheels cause less damage to the surface integrity of the workpiece; thus HSS tools ground with CBN wheel often have longer life than those ground with conventional abrasives.

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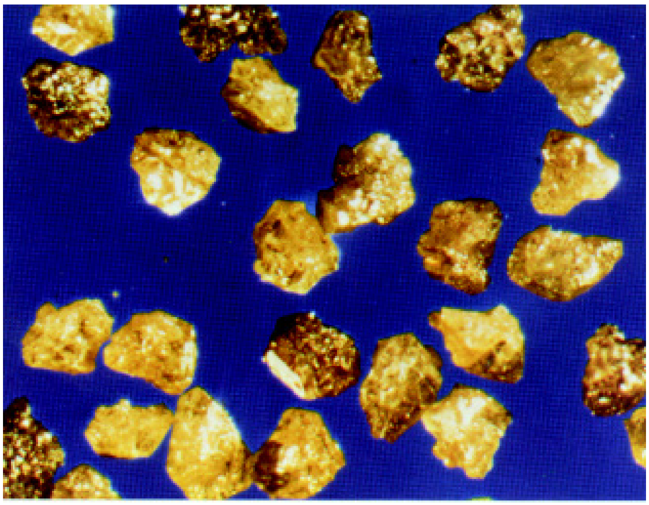


Fig. 1: Synthetic diamond

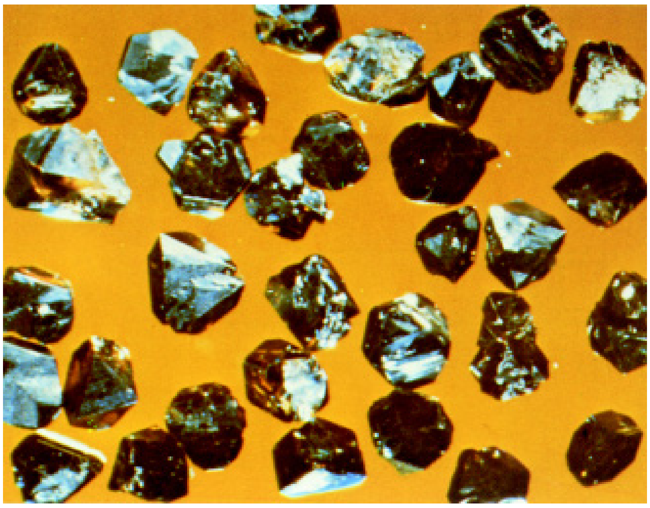
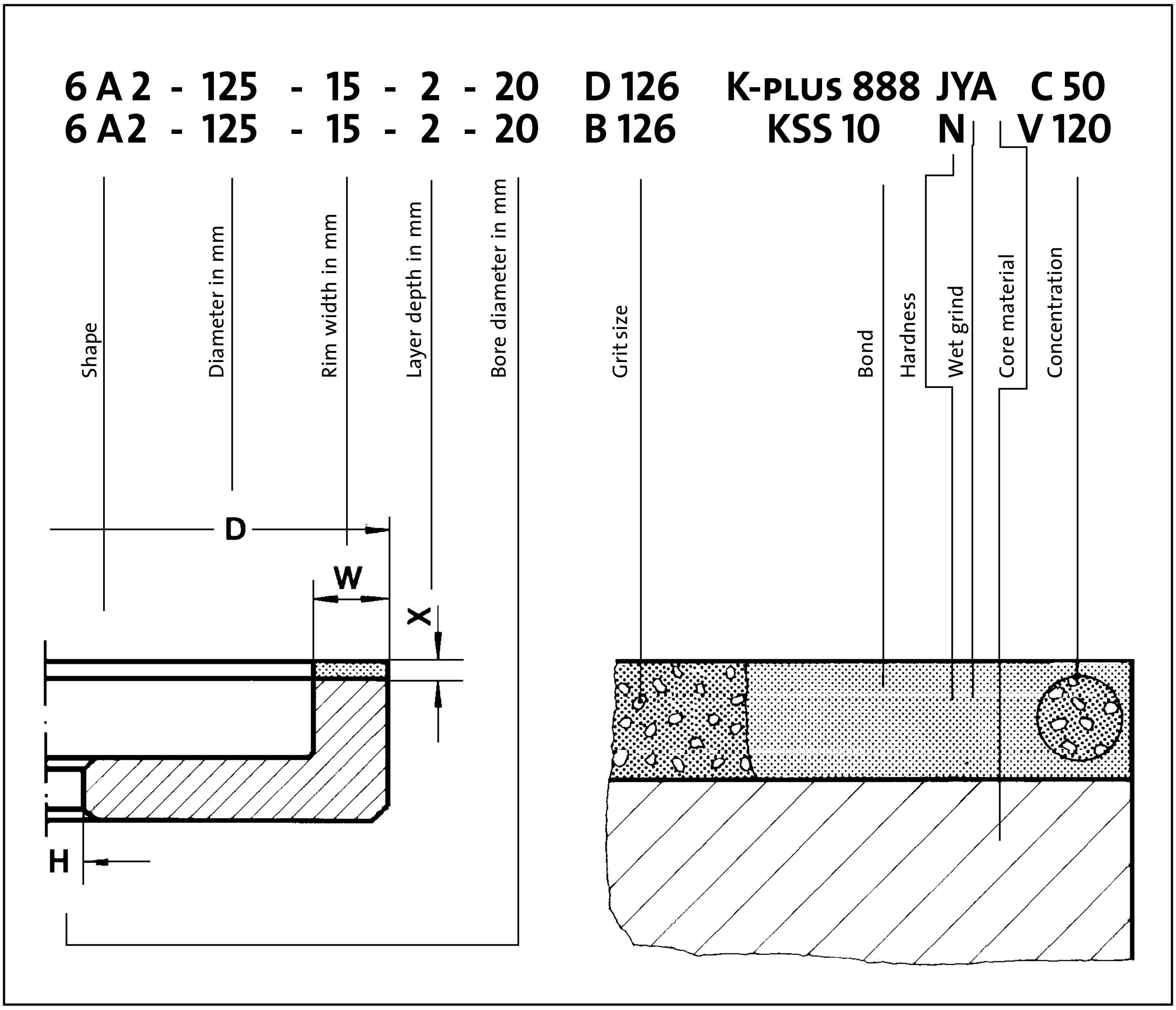


Fig. 2: Cubic boron nitride

Wheel parameters - Order data - selection criteria

Order data

The following example shows for shape 6A2 which details are necessary for complete description of a grinding wheel. Corresponding data are applicable for all other shapes.



Core materials and core shapes

The core is in most cases the decisive factor for static and dynamic strength of the wheel. Depending on the type of abrasive and the desired grinding characteristics, it may be made of aluminium, aluminium/ resin composite (standard for resin bond wheels), all synthetic resin, steel or ceramic material. Suitable choice of core material permits the manufacture of wheels with higher cutting speeds - their disintegration speed is above the range of the present testing methods for increased peripheral speeds. Cutting speeds of 200 m/s have been demonstrated in experiments with CBN wheels.

The most important shapes are codified in the FEPA* Standard for Diamond and Cubic Boron Nitride Grinding Wheels, which has been adopted by ISO as ISO 6104 - 1979 and by DIN as DIN 69800ff. The specific parameters of each application must naturally be taken into account. The core material has a major influence on the vibration and heat characteristics of the wheel; this is indicated qualitatively in the following table for resin bond wheels:

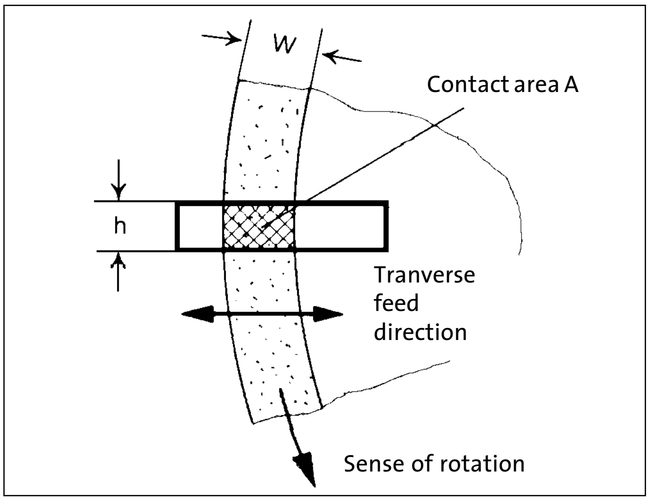
Core material	Identification	Vibration dampening	Heat dissipation	Mechanical strength
Aluminium	A	poor	very good	very good
Aluminium/ synthetic resin composite (standard)	none	medium	satisfactory	good
All synthetic resin	B	good	poor	satisfactory (not sufficient for thin-walled cores)
Steel	E	poor	very good	very good
Cores made of aluminium/synthetic-resin composite represent a good compromise between the divergent characteristics, and are therefore the standard version. This is the version that will be delivered unless otherwise specified in the order. For aluminium cores add the identification 'W' to the bond designation; for all synthetic-resin cores add the identification "B"; for steel add "E" (example: K-plus 888 JA).				

Table 1:
Qualitative characteristics of various core materials.

*) FEPA = Fédération Européenne des Fabricants de Produits Abrasifs.

Rim width (W)

Fig. 3: Contact area



The rim width not only affects economic performance, but also grinding characteristics.
Stock removal during grinding takes place within the contact area **A**, derived from the rim width **W** and the workpiece thickness presented to the grinding wheel **h**.

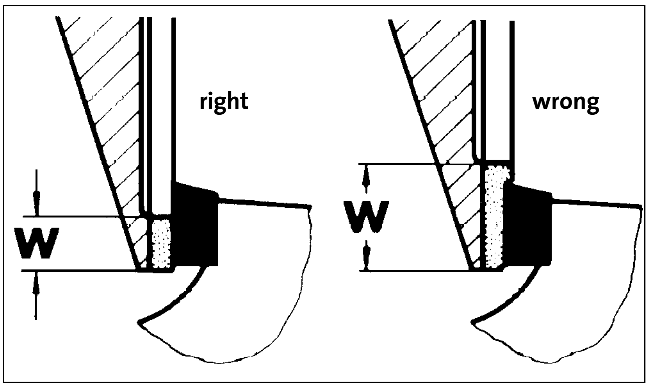
In general the contact areas should be kept as small as possible, i.e. rim width should be kept to a minimum.
Advantages of smaller rim width:
- Improved free-cutting properties
- Cooler grinding
- Better chip flow
- Easier achievement of straight edges and plane surfaces.

Disadvantages of small rim width:
- Aggressive grinding with narrow abrasive sections can cause the operator to lose his feeling for what the wheel can take without sustaining damage; wider abrasive sections give indication of overstraining by noise or smell, or in the case of steel grinding by discolouration of the grinding surface.

- Narrow-rim wheels produce a rougher workpiece surface for the same number of passes and the same crossfeed; this may have to be compensated for by additional sparking-out passes at greatly reduced crossfeed rate.

Fig. 4: Rim width and grinding width of workpiece

The rim width must always be less than the grinding width of the workpiece. Otherwise a shoulder is made in the abrasive section, damaging the cutting edges.
Large rim widths give the operator better control for offhand grinding.



Superabrasive layer depth (X)

Greater layer depths are more economical, since they have comparatively little effect on manufacturing costs. In practical terms this means:
Wheels with "twice the layer depth" cost less than "twice the price".
Layer depth generally has no effect on the grinding process.

Special dimensions

Non-standard wheel dimensions are available on special order, which results in longer delivery time and possible additional charges.

Bore

WINTER diamond and CBN wheels are manufactured in H6 quality; this gives optimum grinding characteristics immediately after mounting, assuming appropriate flange accuracies with minimum deviations in concentricity and surface alignment.

Grit sizes

The grit sizes for diamond and CBN are shown in Table 2. It can be seen that the FEPA Standard uses the same basis for diamond and CBN grit sizes. The grit designations differ in the letters D (for diamond) and B (for CBN), placed before the index number.

The FEPA Standard for "sieve" grit sizes ends with D 461 B 46 as the finest grit size. The grit series is continued downwards by the “micron powder sizes”, which are classified chiefly by an elutriation

process. There is a FEPA Standard in existence for the micron grit sizes; the WINTER Standard uses a different classification with the designations D 25 ... D 0.25 for diamond and B 30 ... B 1 for CBN.

There is a major difference between micron grits and sieve grits. Even when the data for size distribution are similar the tolerances for micron grits are much smaller. This results in lower stock removal rates and finer surface finishes.

The grit designations laid down by FEPA have been adopted by ISO as ISO 6106-1980 and by DIN as DIN 848 T 1, 3.80.

International standardization of grit sizes for diamond and cubic boron nitride

Sieve grit designation							**Micron grit sizes *)**		
Diamond FEPA-Standard **WINTER designation** narrow	wide	**CBN** FEPA-Standard **WINTER designation** narrow	wide	**Diamond + CBN** US Standard ASTM-E-11-70 narrow	wide	Nominal mesh size to ISO 6106 DIN 848 Part 1, 1980 µm	**Diamond WINTER designation**	**CBN WINTER designation**	For comparison grit size µm
D 1181	D 1181	B 1181	B 1181	16/ 18	16/20	1180/ 1000	D 25		32- 52
D 1001		B 1001		18/ 20		1000/ 850	D 20 B	B 30	30-40
D 851	D 852	B 851	B 852	20/ 25	20/30	850/ 710	D 20 A		25-30
D 711		B 711		25/ 30		710/ 600	D 15		10- 25
D 601	D 602	B 601	B 602	30/ 35	30/40	600/ 500	D 15 C		20- 25
D 501		B 501		35/ 40		500/ 425	D 15 B	B 15	15-20
D 426	D 427	B 426	B 427	40/ 45	40/50	425/ 355	D 15 A	B 9	10- 15
D 356		B 356		45/ 50		355/ 300	D 7	B 6	5- 10
D 301		B 301		50/ 60		300/ 250	D 3	B 3	2- 5
D 251	D 252	B 251	◤ B 252	60/ 70		250/ 212	D 1	B 1	1- 2
D 213		B 213		70/ 80		212/ 180	D 0,7		0.5- 1
◤ D 181		◤ B 181		80/ 100		180/ 150	D 0,25		<0.5
◤ D 151		◤ B 151		100/ 120		150/ 125			
◤ D 126		◤ B 126		120/ 140		125/ 106			
◤ D 107		◤ B 107		140/ 170		106/ 90			
◤ D 91		◤ B 91		170/ 200		90/ 75			
D 76		B 76		200/ 230		75/ 63			
◤ D 64		◤ B 64		230/ 270		63/ 53			
D 54		B 54		270/ 325		53/ 45			
◤ D 46		◤ B 46		325/400		45/ 38			

◤ = Grits recommended by WINTER

*) Similar FEPA Standard exists with designations M 63...M 1.0

FEPA = Fédération Européenne des Fabricants de Produits Abrasifs.

Table 2: FEPA standard for diamond and CBN grits and WINTER designations for micron grit sizes.

When a wheel is in proper grinding condition, the grit points should project about 115 to 113 of the “grain diameter” above the bond surface; material removal is not possible without this projection. It is clear from this fact that grit particle size is the restricting factor for infeed rate in reciprocating grinding and for crossfeed in creep feed grinding.

In practice this means:
Avoid large infeed rates with fine-grit wheels,
Use coarse-grit wheels for rough grinding.

Excessive infeed rates cause accelerated bond wear, rapidly increasing grit projection. This results in weakening of bond retention forces causing grit to fail out of the bond, resulting in poor wheel life.

Other things being equal the coarser wheel will generally have the longer life - without additional too) costs, since the grit size has no effect on the price of a wheel.
General selection principle:

Not “as fine as possible”
But “as coarse as permissible”.

CBN grit sizes have only minor effect on workpiece surface quality compared with diamond grit sizes. Thus for CBN there is generally no selection of different grit sizes for rough grinding and finish grinding; normally a medium grit size is chosen, e.g ... B 91 ... B 151.

Bonds

The retention forces of the bond affect the grinding characteristics of the wheel. It is essential for the diamond or CBN particles to be embedded in the bond such that they are retained under the forces and temperatures occurring in the grinding operation. On the other hand the bond must also provide space for chip removal. See also Figs. 5 and 6. A large number of different bonds are required for the handling of various different grinding applications:

Synthetic resin bonds
The WINTER identification are:
- “K-plus” 1 “GRESSO” for diamond
- “KSS” for CBN.

Synthetic resin bonds are used in dry and wet grinding as both manual and automatic feed grinding machines since they are particularly adaptable to the required application parameters. The required properties are exhibited by both phenolic and polyimide resins; the intensive research and development work that has been put into these resins has resulted in bonds which are used in well over 50% of all grinding wheels produced, both in diamond and CBN wheels.

Metal bonds
The WINTER identifications are:
- “BZ, ST, T and H” / “M-plus 789” / “VFF, VF and VP” for diamond
- “MSS” / “B-MC” for CBN.

Metal bonds are in most cases bronze bonds (BZ and ST), but in special cases carbide bonds (T + H) are also used. D-MC and B-MC bonds are likewise bronze bonds, but unlike other metal bonds they can be profiled by crushing.
VFF is the bond most commonly used for the grinding of polycrystalline diamond.

Metal bonds tend to give particularly long tool life, but are generally inferior to synthetic resin bonds with regard to material removal rate. The exception to this are the D- and B-MC bonds.

Electroplated bonds
The WINTER identifications are:
- "S" for diamond
- "GSS" for CBN.

A single layer of abrasive is bonded to the wheel body by an electrodeposition process. Depending on the thickness of the electroplated metal bond, the grit particles protrude from the bond by between 30% and 50% of their diameter (see Fig. 6).

Vitrified bonds
The WINTER designation is:
-"VSS" for CBN.

This less usual type of bond is suitable for long-chipping materials in view of its porosity; that is why it is only used for CBN wheels, where it is intended for the wet grinding of certain steel types.

Bond hardness ratings for synthetic resin and vitrified bonds
Different bond hardness ratings are available within the individual bond types in order to provide closer adaptation to the specific grinding application. The hardness figure characterizes grinding behaviour or effective hardness of the grinding wheel; it is thus a measure of the cutting forces and temperatures occurring during grinding and not a measure of penetration resistance of the grinding wheel surface (see Table 3).

General features of different bond hardness ratings

General bond characteristics

	Softer bond	Harder bond
Cutting action	Free cutting	Less aggressive
Material removal rate	Higher	Lower
Grinding pressure	Lower	Higher
Grinding ratio	Lower	Higher
Wheel life	Shorter	Longer
Grinding temperature	Lower	Higher

Bond selection criteria

	Softer bond better	Harder bond better
Grinding width	Wide	Narrow
Grit size	Fine	Coarse
Workpiece hardness	Harder	Softer
Dry/Wet	Dry	Wet
Other criteria	Heat sensitive workpieces	High dimensional tolerance requirement

Bond overview tables

Diamond wheels	Hardness grade J	N	R	T	Wear hard-ness	Recommendations for application
Sp 2003	–	–	–	–	more wear-resistant →	Wet grinding, creep-feed grinding with straight wheels (GRESSO)
Sp 2002	–	–	–	–		Wet grinding, centreless and cup wheels (GRESSO)
W-plus 3060	–	–	–	–		High-performance wet grinding, creep-feed grinding, preferably oil cooling
W-plus 3061	–	–	–	–		High-performance wet grinding, creep-feed grinding, preferably oil cooling
W-plus 3083	–	–	–	–		High-performance wet grinding, creep-feed grinding, preferably oil cooling
W-plus 3090	–	–	–	–		High-performance wet grinding, creep-feed grinding, preferably oil cooling
K-plus 920	–	–	–	–		Normally dry grinding; for creep-feed grinding with cooling
K-plus 1313Y	–	N	R	(T)		Wet grinding, for carbide and steel, for tough-hard carbides, ferro-titanite
K-plus 4821	–	–	–	–		High-performance wet grinding, creep-feed grinding
K-plus 888Y	J	N	R	(T)		Wet (and dry) grinding, universal bond for high-performance grinding
K-plus 888	J	N	R	–		Dry grinding, universal bond for high-performance grinding
K-plus 1414	J	N	–	–		Dry grinding, for tool grinding with cup wheels
K-plus 777	J	N	R	–		Dry grinding
K-plus 730	–	–	–	–		Soft grinding, dry grinding bond
K-plus 888F	–	–	–	–		Only for polish-grinding with grit sizes £ D 25
NF, NG	–	–	–	–		Only for cup and peripheral wheels for grinding polycrystalline diamond

Table 3 a: Synthetic resin bonds - diamond

CBN wheels	Hardness grade J	N	R	T	Wear-hard-ness	Recommendations for application
KSS 920	–	–	–	–	more wear-resistant →	Dry and wet grinding for narrow-rim straight wheels, wear-resistant bond for cup wheels in wet grinding
KSS	–	N	R	(T)		Dry grinding, edge-stable bond
KSS Y	–	N	R	(T)		Wet grinding, universal bond for straight wheels
KSS 10	J	N	–	–		Dry grinding, universal bond for tool grinding with cup wheels
KSS 12	–	N	–	–		
KSS 007	J	N	–	–		Extremely high speed grinding up to 40 m/s cutting speed and high infeed rates, soft-grinding but wear-resistant, dry grinding only
					Notes on the significance of hardness grades with synthetic resin bonds	
	J				for cup and dish wheels with grinding edge widths ffi 7 mm	
	–	**N**			for all wheels with grinding edge widths = 4...7 mm	
	–	–	**R**		for all narrow and stable-edge wheels £ 5 mm	
	–	–	–	**(T)**	very hard; for exceptional cases only.	

Table 3 b: Synthetic resin bonds - CBN

Diamond wheels	Wear hard-ness	Recommendation for application, normally wet grinding
BZ 444	more wear-resistant →	Pointed profile wheels with highest form stability
BZ 387		Universal bonds for straight wheels and profile wheels, for cup wheels with grinding edge width £ 6 mm, very edge-stable
BZ 335		Cup wheels and straight wheels, good for short-chipping non-metallic materials, e.g. precious stones
BZ 324		Cup wheels, shape 6A9
BZ 560		Universal bond for cup wheels, grinding edge width ﬃ 6 mm, also suitable for dry grinding
BZ 537		Cup wheels for grinding carbides and steel, mainly reciprocating grinding
BZ 587		Cup and straight wheels, e.g. for creep feed grinding
BZ 366		Cup and straight wheels for grinding of monocrystalline diamond
M-plus 789		Extremely soft and cool grinding creep feed grinding bond, also for dry grinding, suitable for carbide/steel combination, only available in certain dimensions
VFF, VF, VP		Cup wheels for grinding of polycrystalline diamond

CBN wheels	Wear hard-ness	Recommendation for application, normally wet grinding
MSS 363	moere wear-resistant →	Narrow-edge straight wheels
MSS 387		Universal bond for straight wheels
MSS 387.1		Special bond for profile wheels for HSS bandsaw grinding
MSS 560		Universal bond for cup wheels, in some cases also for dry grinding
MSS 587		Creep feed grinding bond for long-chipping steel types and grey cast irons
MSS 789		Extremely soft and cool grinding bond for 11V9 wheels

Diamond wheel	**CBN** wheel	
D-MC	B-MC	Crushable = profilable metal bond for straight wheels for profile creep feed grinding, wet grinding only

Table 4: Sintered metal bonds

Diamond wheels	**CBN** wheels	Recommendations for application
S	GSS	Standard bond for single-layer application
G	–	Standard bond for multi-layer abrasive Shape 1A1 and profile wheels

Table 5: Electroplated metal bonds

Diamond wheels	**CBN** wheels	Recommendations for application
– –	VSS 2001 to VSS 3404	Bond specification depends on grinding task (e.g. VSS 2001 NK 1AC or VSS 2804 EK 1AC)

Table 6: Vitrified bonds

Bond wear and self-sharpening effect

With the exception of the electroplated bond, the abrasive particles do not protrude from the bond after manufacture. The bond has to be broken back by an additional process in order to create a protrusion between the grit points and the bond surface. This is generally achieved by means of dressing with a silicon carbide wheel.

Grinding layer in new condition (delivery condition)

After dressing, the abrasive particles protrude above the bond surface by approx. 20 to 30% of their diameter. This protrusion enables them to penetrate into the workpiece, permitting grinding (see Fig. 5).

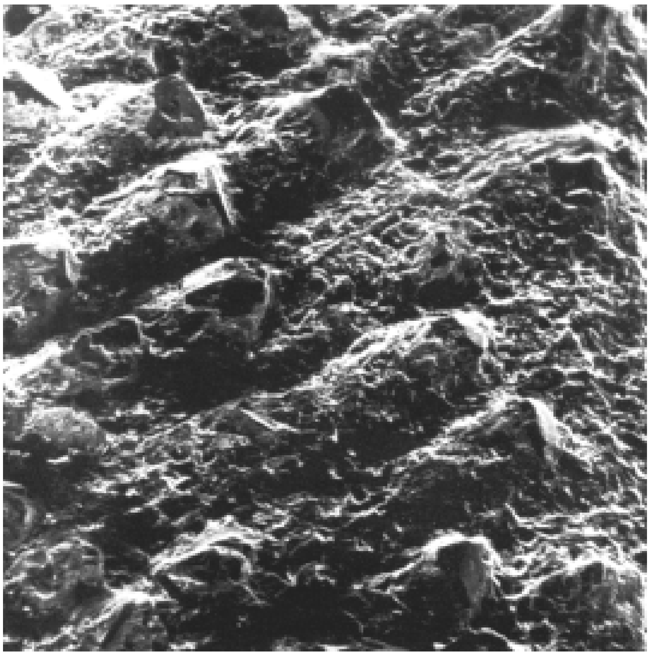


Fig. 5: Grinding layer of a synthetic resin bond wheel in new condition.

Electroplated tools are manufactured in such a way that the bond deposited on the wheel core still leaves 30 to 50% of the grit particles free; thus the wheel is immediately ready for grinding (see Fig. 6).

Fig. 6: Grinding layer of an electroplated single-layer diamond wheel in new condition.

Bond wear in operation, self-sharpening effect

If the specification is correctly chosen (grit size - bond - concentration) and the operating conditions are well adapted, abrasive particles and bond wear uniformly, so that the wheel remains in constant grinding readiness. This process is known as the self-sharpening effect. This describes the condition in which the wheel constantly regenerates itself and releases particles which have become dull. Selfsharpening results from the workpiece chips breaking away the bond, which exposes new sharp abrasive particles, so that the wheel remains free-cutting (see Fig. 7).

Fig. 7: Grinding layer of a resin-bond CBN wheel in its self-sharpening zone (free-cutting layer).

Grinding layer with defective self-sharpening effect

In contrast to the wheel with the free-cutting action in its Self-sharpening zone, insufficient bond wear or excessive grit breakout results in a dull abrasive coating; the particles protrude insufficiently from the bond or do not protrude from it at all. This causes drag, chatter and thermal and mechanical overload, with consequent damage to the wheel and workpiece (see Fig. 8).

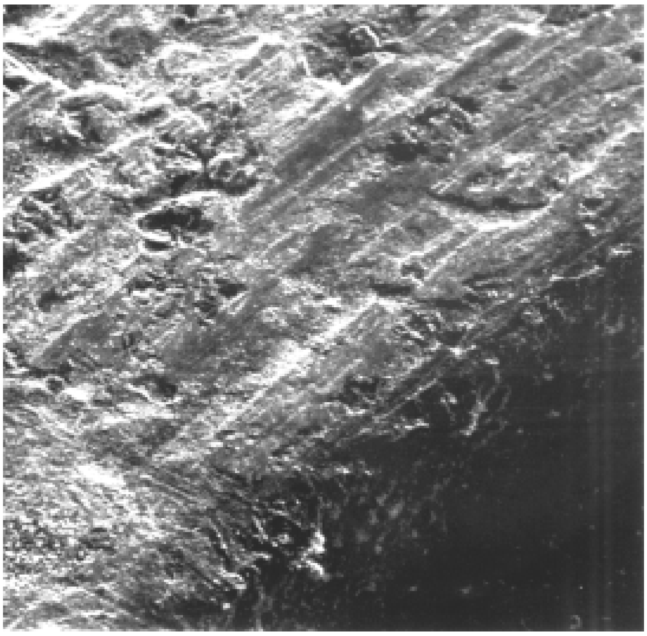


Fig. 8: Grinding layer of a resin-bond CBN wheel with insufficient bond wear (dull layer).

The opposite of the dull wheel is excessively aggressive wheel, resulting in too much bond wear. The wheel thus wears too quickly and is uneconomical.

Exception: single-layer electroplated wheels

On single-layer electroplated wheels the particles protrude from the bond to different extents, within their particle size distribution range and depending on their random position on the core (see Fig. 6). This means that new wheels have very aggressive grinding characteristics, but this is reduced in the

course of time due to natural wear. Since no new particles are exposed by bond wear it is not possible to speak of a self-sharpening effect with this type of tool.
For multi-layer tools the character is similar to that of a wheel with sintered metal bond; a self-sharpening effect is possible.

Summary
The optimum bond is not the bond with the least wear, but the bond with the correct wear characteristic. It can even be said that a wheel with no bond wear cannot retain its grinding ability.

Concentration

The concentration figure specifies the proportion of diamond or CBN in the abrasive layer. As a general rule for the selection of the appropriate concentration, a high concentration can be recommended for small contact areas and coarse grits and a low concentration is advisable for large contact areas and fine grits.
The common concentration designations are as follows:

Diamond	Diamond weight in carats per cm³ abrasive volumen		CBN	CBN weight in carats per cm³ abrasive volumen
C 50	2.2 ct / cm³		V 120	2.09 ct / cm³
C 75	3.3 ct / cm³		V 180	3.13 ct / cm³
C 100	4.4 ct / cm³		V 240	4.18 ct / cm³
C 125	5.5 ct / cm³		V 300	5.22 ct / cm³

Table 7: Mean concentration

The basic value C 100 for diamond signifies that for every cm³ abrasive layer volume 4.4 carats (1 carat = 0.2 g) of grit were used (corresponding to 25% by volume). The basic value V240 for CBN indicates that 24% by volume CBN were used in the abrasive coating. These data do not apply to electroplated wheels.
Concentration is one of the most important parameters of a diamond or CBN wheel. It affects stock removal rate and wheel life and also the shape and dimension accuracy of the workpiece to be ground. However, this does not mean that the higher concentration is necessarily the more effective one for a given grinding task; the concentration must be suited to the other wheel parameters, the grinding technique and the operational conditions.
The concentration defines the diamond or CBN content of the abrasive layer and thus contributes accordingly to the price of the wheel.
The following criteria are generally applied for selection of concentration:

Higher concentrations C100 ... C125 1 V 240 ... V 300:
- High requirements for profile and edge stability
- Small abrasive layer thicknesses
- Hard bond
- Coarser grit
- Creep feed grinding

Standard concentration C 50 ... C 75 1 V120 ... V 180:
- Straight wheels for surface and cylindrical grinding
- Cup wheels, e.g. for tool grinding
- Larger abrasive layer thicknesses
- Soft bond
- Finer grit

Low concentration C 25 ... C38 1 V90 ... V120:
- Cup wheels with extremely wide rim widths
- Wheels with extremely fine grit size.

Assessment criteria for diamond and CBN wheels

Required wheel characteristics

The grinding wheel must fulfill a whole series of requirements in order to provide a successful solution for a grinding job both in technical and economic respect.
The grinding wheel must be capable of providing the surface finish required on the workpiece, i.e. the desired surface quality (roughness and surface integrity), shape, dimensions, flatness, straightness and similar requirements; it must remove the required amount of material in the shortest possible time; and it must have the longest possible life.
Every grinding expert knows from his daily experience that these conflicting requirements cannot all be fulfilled simultaneously.

Some examples:
Good surface finish on the workpiece requires
Small grit size or
High concentration or
Additional grinding time for finish-grinding or
Additional grinding time for sparking out.
Long wheel life requires
Hard bond or
Larger grit size or
Higher concentration

Theoretical relationships

The economics of a diamond or CBN wheel depend on its grinding behaviour and the material removal rate that is set or achieved in the grinding operation.
The grinding behaviour is stated in terms of the grinding ratio or G-ratio:

$$G = \frac{V_w}{\Delta V_s} \text{ [mm}^3\text{/mm}^3\text{]}$$

The **material removal rate** indicates the amount of workpiece volume removed per unit of time. Calculation of this value is different depending on the grinding process.
The **material removal rate** Q_w is calculated from the parameters set and excludes any time losses due to:
Wheel overrun
Dressing
Mounting and dismounting
Sparking out
Measurement
Machine deflection or
Wheel wear.
The nominal material removal rate Q_w is used principally in order to determine the load on the grinding wheel and the grinding machine caused by the setting parameters.

$$Q_w = a_e \cdot h_w \cdot v_f \text{ [mm}^3\text{/min]}$$

The **real material removal rate** Q_{wr} is calculated from the workpiece volume removed V, divided by the process time per workpiece t_p and thus includes all downtimes. Q_{wr} is a measure for the productivity, economics of the grinding process and is an assessment criterion for the comparison of different grinding wheels and processes.

$$Q'_w = \frac{a_e \cdot v_f}{60} \text{ [mm}^3\text{/mm} \cdot \text{s]}$$

The **specific material removal rate** Q'_w is comparable with the material removal rate Q_w, but is related to 1 mm contact width.

This makes it possible to compare grinding results from wheels of different dimensions. This specific material removal rate Q'_w is mainly used in profile creep-feed grinding and in centreless grinding. For profile grinding it is usual to consider the part that has the largest allowance to be removed.

The following equations apply for O'_w:

For surface creep-feed grinding:

$$Q_{wr} = \frac{V_w}{t_p} \text{ [mm}^3\text{/min]}$$

For centreless grinding:

$$Q'_w = \frac{(d_w - a_e) \cdot \pi \cdot a_e \cdot v_f}{b_s} \text{ [mm}^3\text{/min} \cdot \text{mm]}$$

where

a_e	=	Depth of cut	[mm]
b_s	=	Width of grinding layer	[mm]
d_w	=	Workpiece diameter	[mm]
G	=	Grinding ratio	[mm³/mm³]
h_w	=	Workpiece height	[mm]
Q_w	=	Material removal rate	[mm³/min]
Q'_w	=	Specific material removal rate	[mm³/mm · s]
Q_{wr}	=	Real material removal rate	[mm³/min]
t_p	=	Process time (cycle time)	[min]
v_f	=	Feed rate	[mm/min]
DV_c	=	Grinding wheel layer volume	[mm³]
V_w	=	Removal volume	[mm³]
p	=	Pi	[–]

Required machine characteristics

Even today, diamond and CBN wheels are mostly used on conventional grinding machines that were originally designed for the use of conventional wheels (aluminium oxide, silicon carbide). The technological limit in the high-performance grinding of hard-to-machine materials is then in many cases not set by the diamond or CBN wheel, but by the machine. Newly developed machines, which take account of the performance capability of modern diamond and CBN wheels, have shifted the performance limit for grinding towards higher material removal rates.

The features of new designs of this kind are:

- Higher cutting speeds
- Creep feed grinding capability (large depth of cut, small feed rate)
- High spindle drive power
- Increased machine rigidity
- Improved coolant equipment (high pressure, high flow volume)
- Suitable dressing process.

Recommended cutting speeds

The cutting speeds indicated in Table 8 are empirical values taken from practical experience; there should be no deviation from these values in conventional grinding processes, unless there is a good reason for doing so.
This table does not include the latest results in high-speed grinding with CBN wheels.

Influence of wheel peripheral speed on G-ratio wet grinding with diamond, G = f (V_c)

The wear on the diamond and CBN grit is mainly due to the generation of heat.
When grinding is done without coolant, short-term temperatures up to 1000°C may occur at the individual cutting points. In additions, the ability of bonds to hold grits is impaired by high temperature effects. For high material removal volume with low wheel wear it is therefore advisable to grind wet, i.e. to use a cutting fluid in the grinding process. Practical experience shows that the optimum life of diamond wheels is mostly at wheel peripheral speeds between 25 and 40 m/s. One reason for this optimum, that does not only occur with diamond, is the lower thermal load on the abrasive.

The latest research work shows that the wheel peripheral speed of 90 m/s can be increased if a special coolant device is used for dissipation of the greater heat.

Wet grinding with CBN

Unlike with diamond wheels, the G-ratio with CBN wheels increases with higher wheel peripheral speeds up to a maximum of 200 m/s, on conditions that optimal cooling/ lubrication is provided.

Dry grinding with diamond and CBN

For both diamond and CBN wheels, in dry grinding a G-ratio optimum with respect to wheel peripheral speed is found within the range of values that is usual today, due to the grinding temperature generated.

General manufacturing tolerances for metal and resin bond WINTER grinding wheels

Diamond and CBN wheels only achieve their remarkable grinding characteristics if the grinding layer is properly dressed, in other words ready for grinding, and the radial and axial runout and shape and dimensional tolerances and also balance error are minimized.
The data indicated in Table 9 are applicable only for metal bond and resin bond diamond and CBN wheels, but not for electroplated or vitrified bonds. Closer tolerance ranges are available on request.

Measurement of runout

The manufacturing tolerances can only be retained on the machine if the wheel is likewise mounted within the required tolerances and rotates with low vibration. It is advisable to leave the grinding wheel on the flange that is first selected throughout the wheel life. If a closer tolerance range is desired, the flange has to be sent in so that the grinding wheel can be ground over in mounted condition. But even after this procedure, it may be necessary to dress the wheel on the machine after the wheel has been mounted. This requirement for subsequent dressing does not apply to electroplated wheels, which must not be dressed under any circumstances.

Measurement of runout with cup wheels

Axial runout is an essential point in reciprocating grinding with cup wheels.
In creep feed grinding, with infeed generally < 0.1 mm, it is also necessary to keep a check on radial runout (see Fig. 9).

Fig. 9: Checking runout.

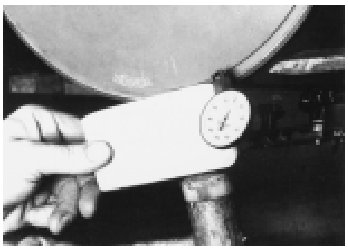


Fig. 10: Adjusting radial runout of a peripherical wheel.

Recommended wheel peripheral speeds in m/s for diamond and CBN wheels					
Tool type	Bond		Wet grinding Cup wheels	Peripheral wheels	Dry grinding Cup and peripheral wheels
Diamond grinding wheels and grinding pins	Resin	K-plus	25...40	25...40...(90)	14...18
	Resin	GRESSO	25...40	25...40	-
	Metal	BZ	15...30	15...30	8...12
	Metal	M-plus	20...26	-	10...14 Creep feed
			10...18	-	10...14 Reciprocating
	Metal	D-MC	-	25...40*)	- Creep feed
	Plated	S	10...20	10...20	5...15
CBN grinding wheels and grinding pins	Resin	KSS	30...50...	30...120...	15...30
	Resin	KSS 007	-	-	30...40
	Metal	MSS	15...60	-	10...15
	Metal	B-MC	-	30...60*)	- Creep feed
	Plated	GSS	30...120...	30...120...	15...20
	Vitrified	VSS	30...60	30...80	-

Table 8: Recommended wheel peripheral speeds *) Creep feed

Tolerance type	Element	Characteristic	Tolerance: Symbol	Tolerance: Related to	Tolerance value (Restricted tolerance range on request)	
Dimensional tolerance	Layer angle			General	DIN 7168 m	
	Layer profile			General	DIN 7168 m	
	Bore			General	H6	
	Core			General	DIN 7168 m	
Shape and position tolerance	Layer	Axial and radial runout	↗	MC bond	Ø ≤ 180 mm	Ø > 180 mm
				≤ D / B 91 ≥ D / B 91	0.010 mm 0.015 mm	0.020 mm 0.025 mm
				General		
				≤ D / B 251 ≥ D / B 251	0.020 mm 0.030 mm	0.030 mm 0.030 mm
		Angularity of face surface of cup wheels	⊥	W < 20 mm W ≥ 20 mm	0.01 mm 0.02 mm	
		Cylindricity of layer width for 1A1 wheels	⌭	T / U > 10 mm T / U > 50 mm	0.01 mm 0.02 mm	
	Core			MC bond	Ø ≤ 250 mm	Ø > 250 mm
		Flatness of contact surface Axial runout Parallelism	▱ ↗ //		0.015 mm 0.010 mm 0.015 mm	0.025 mm 0.020 mm 0.025 mm
				General	Ø ≤ 750 mm	Ø > 750 mm
		Flatness of contact surface Axial runout Parallelism	▱ ↗ //		0.015 mm 0.015 mm 0.015 mm	0.025 mm 0.025 mm 0.025 mm
		Radial runout (incl. band) (Ø ffi 245 mm)	↗		0.01 mm	
Minimum crest radius		Convex crest Convex crest	– –	Grit size and included angle	R = 0.05...0.4 mm R = 0.02...0.3 mm	
Minimum included angle		Convex crest	–		≥ 15°	

Table 9: Standard tolerances for WINTER diamond and CBN wheels in resinoid metal bond.

Measuring runout of peripheral wheels

When using peripheral grinding wheels, it is important only to use flanges with a g6 fit of the mounting cylinder. Before they are clamped tight, the wheels are to be placed on a wooden base and mounted on the flange by means of light taps of a hammer, to achieve the minimum possible radial runout (see Fig. 10).

If the radial runout can be set to less than 0.01 mm in this way, further dressing is not necessary.

All WINTER grinding wheels with a diameter equal to or greater than 245 mm have an indicating band, which runs exactly concentric to the bore and the abrasive layer. The indicating band can thus be used to check wheel runout on the machine (see Fig. 10).

Balancing

WINTER grinding wheels leave the factory in balanced condition. It is nevertheless recommended that the balance error is checked on the machine in completely mounted condition at operating speed. The maximum permitted value of effective vibration feed caused by the balance error vertical to the spindle axis is $v_{eff} < 0.05$ mm/s. An effective method for this balance error and vibration measurement is the electronic tester using stroboscope lamp for adjustment, and a vibration pickup. Balancing is absolutely necessary for operation of diamond and CBN wheels at high peripheral speeds.

Shape overview with details in tables

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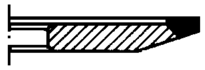
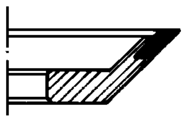
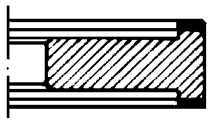
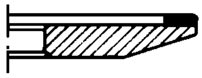
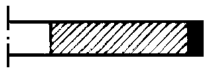
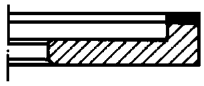
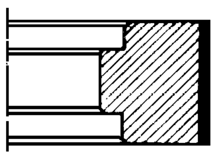
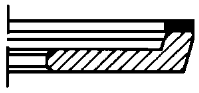
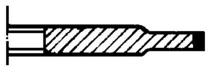
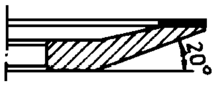
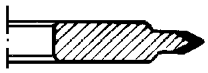
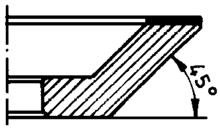
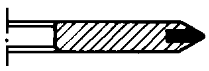
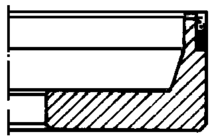
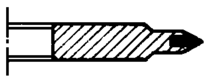
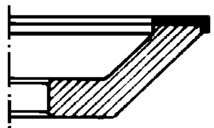
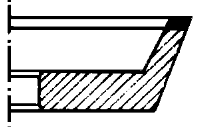
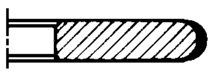
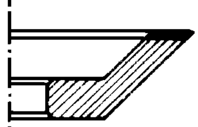
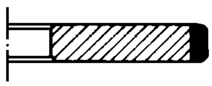
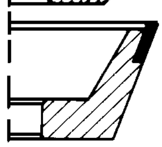
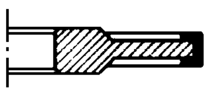
	4ET9	14		12V9	25
	4BT9	14		9A3	26
	4A2	15		1A1	27-29
	6A2	16-17		9A1	29
	11A2	18		14A1	30
	12A2 20°	19		14EE1	31-32
	12A2 45°	20		1E6Q	33-34
	6A9	21		14E6Q	35-36
	12C9	22		14F1	37
	11V2	23		1FF1	38
	12V2	23		1L1	39
	11V9	24		14U1	39

Shape overview of available wheels (no table details)

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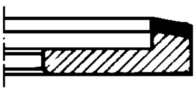
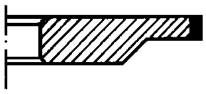
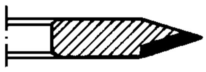
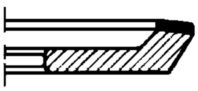
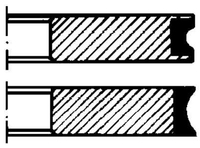
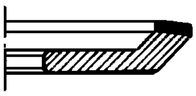
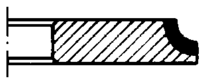
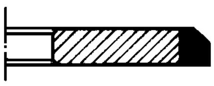
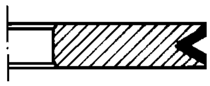
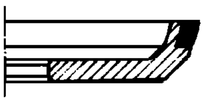
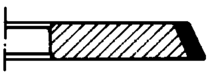
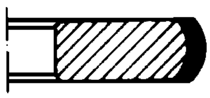
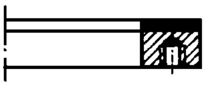
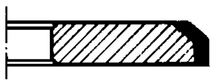
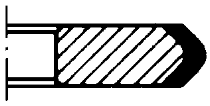
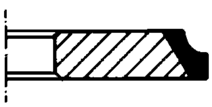
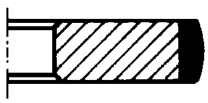
 6V5	 3A1	 *) 707
 11V5	 1B1	 *) 708
 12V5	 1E1	 *) 709
 4V4	 1M1	 *) 711
 15V9	 1V1	 *) 712
 2A2T	 1Y1	 *) 713
 222	 *) 700	 *) 714
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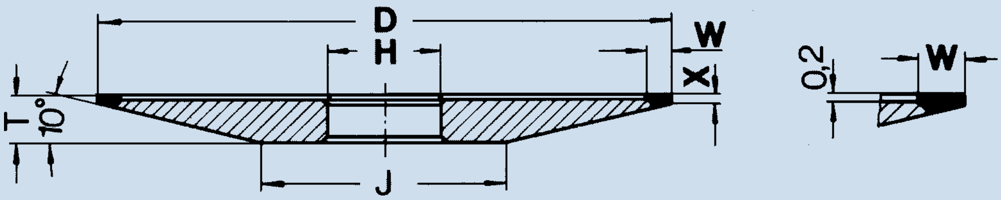
4ET9



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4ET9	100	4	1	1		6	43
4ET9	125	5	2	2		8	57
4ET9	150	5	2	2		10	59

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
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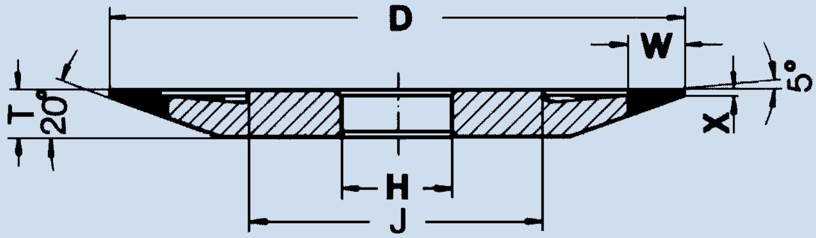
Metal bond	4ET9	100	4	1	20	D107	Bz 387	C100

4BT9



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4BT9	70	6	1	1		8	32
4BT9	80	6	1	1		8	42
4BT9	100	10	1	1		10	50
4BT9	125	10	1	1		12	65

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
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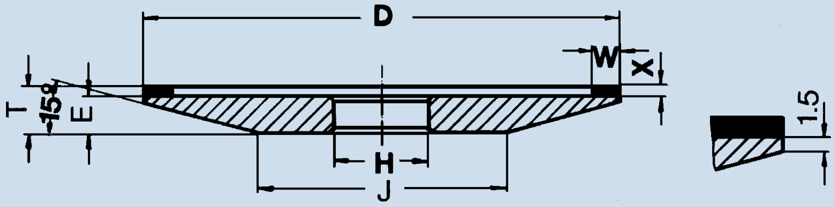
Metal bond	4BT9	80	6	1	20	D91	Bz 387	C75

4A2



FEPA-Form	D	W	X		H	T-X	E	J
			resinbond	metalbond				
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4A2	100	6	2 • 3 • 4	1 • 2 • 3 • 4		6	6	66
4A2	125	5	2 • 3 • 4	1 • 2 • 3 • 4		7	7	84
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4A2	125	7	2 • 3 • 4	1 • 2 • 3 • 4		7	7	84
4A2	125	8	2 • 3 • 4	1 • 2 • 3 • 4		7	7	84
4A2	150	4	2 • 3 • 4	1 • 2 • 3 • 4		9	9	94
4A2	150	6	2 • 3 • 4	1 • 2 • 3 • 4		9	9	94

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
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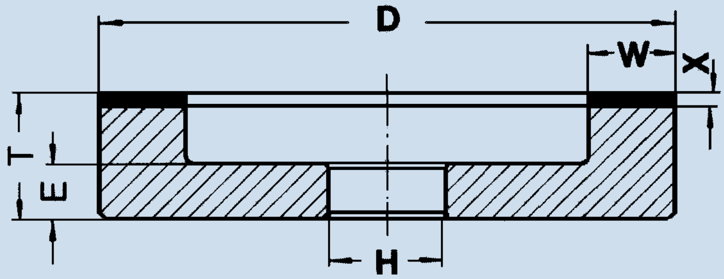
Metal bond	4A2	100	6	2	20	D 91	Bz 560	C 50

6A2



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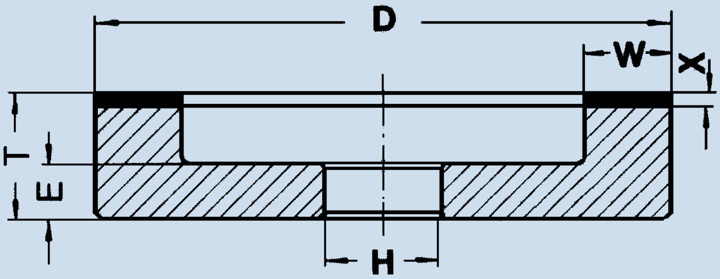
6A2	50	6	2•3•4	1•2•3•4		20	10
6A2	75	3	2•3•4	1•2•3•4		20	10
6A2	75	5	2•3•4	1•2•3•4		20	10
6A2	75	6	2•3•4	1•2•3•4		20	10
6A2	75	10	2•3•4	1•2•3•4		20	10
6A2	100	3	2•3•4	1•2•3•4		23	10
6A2	100	4	2•3•4	1•2•3•4		23	10
6A2	100	6	2•3•4	1•2•3•4		23	10
6A2	100	7	2•3•4	1•2•3•4		23	10
6A2	100	8	2•3•4	1•2•3•4		23	10
6A2	100	10	2•3•4	1•2•3•4		23	10
6A2	100	15	2•3•4	1•2•3•4		23	10
6A2	125	3	2•3•4	1•2•3•4		23	10
6A2	125	5	2•3•4	1•2•3•4		23	10
6A2	125	6	2•3•4	1•2•3•4		23	10
6A2	125	7	2•3•4	1•2•3•4		23	10
6A2	125	8	2•3•4	1•2•3•4		23	10
6A2	125	10	2•3•4	1•2•3•4		23	10
6A2	125	12,5	2•3•4	1•2•3•4		23	10
6A2	125	15	2•3•4	1•2•3•4		23	10
6A2	125	20	2•3•4	1•2•3•4		23	10
6A2	125	25	2•3•4	1•2•3•4		23	10
6A2	125	30	2•3•4	1•2•3•4		23	10
6A2	150	5	2•3•4	1•2•3•4		23	10
6A2	150	6	2•3•4	1•2•3•4		23	10
6A2	150	10	2•3•4	1•2•3•4		23	10
6A2	150	12,5	2•3•4	1•2•3•4		23	10
6A2	150	15	2•3•4	1•2•3•4		23	10
6A2	150	20	2•3•4	1•2•3•4		23	10
6A2	150	25	2•3•4	1•2•3•4		23	10
6A2	150	30	2•3•4	1•2•3•4		23	10
6A2	150	40	2•3•4	1•2•3•4		23	10
6A2	175	6	2•3•4	1•2•3•4		25	10
6A2	175	10	2•3•4	1•2•3•4		25	13
6A2	175	15	2•3•4	1•2•3•4		25	13
6A2	175	20	2•3•4	1•2•3•4		25	13
6A2	175	25	2•3•4	1•2•3•4		25	13
6A2	175	35	2•3•4	1•2•3•4		25	13
6A2	175	40	2•3•4	1•2•3•4		25	13
6A2	200	10	2•3•4	1•2•3•4		25	13
6A2	200	15	2•3•4	1•2•3•4		25	13
6A2	200	20	2•3•4	1•2•3•4		25	13
6A2	200	25	2•3•4	1•2•3•4		25	13

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
Resin bond	6A2	125	12.5	2	20	D 91	K-plus 888 J	C 50
Metal bond	6A2	150	15	1	20	D 126	Bz 560	C 75

WINTER

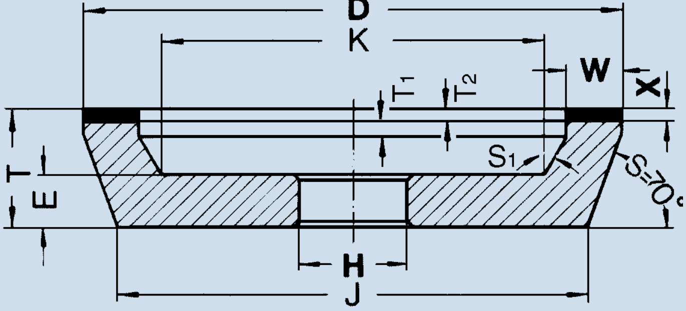
6A2



FEPA-Form	D	W	X resinbond	X metalbond	H	T-X	E
6A2	200	40	2 • 3 • 4	1 • 2 • 3 • 4	State bore dimension	25	13
6A2	200	50	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	200	60	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	200	70	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	220	5	2 • 3 • 4	1 • 2 • 3 • 4		25*	13*
6A2	220	8	2 • 3 • 4	1 • 2 • 3 • 4		25*	13*
6A2	220	12	2 • 3 • 4	1 • 2 • 3 • 4		25*	13*
6A2	220	18	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	220	25	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	220	40	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	250	5	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	250	6	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	250	8	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	250	10	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	250	15	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	250	20	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	250	25	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	250	60	2 • 3 • 4	1 • 2 • 3 • 4		25	13
6A2	300	10	2 • 3 • 4	1 • 2 • 3 • 4		30	15
6A2	300	12,5	2 • 3 • 4	1 • 2 • 3 • 4		30	15
6A2	300	25	2 • 3 • 4	1 • 2 • 3 • 4		30	15
6A2	350	6	2 • 3 • 4	1 • 2 • 3 • 4		35	18
6A2	350	10	2 • 3 • 4	1 • 2 • 3 • 4		35	18
6A2	350	25	2 • 3 • 4	1 • 2 • 3 • 4		35	18

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
Resin bond	6A2	200	10	4	50	D 91	K-plus 888 J	C 50
Metal bond	6A2	200	10	4	50	D 151	Bz 537	C 25

11A2



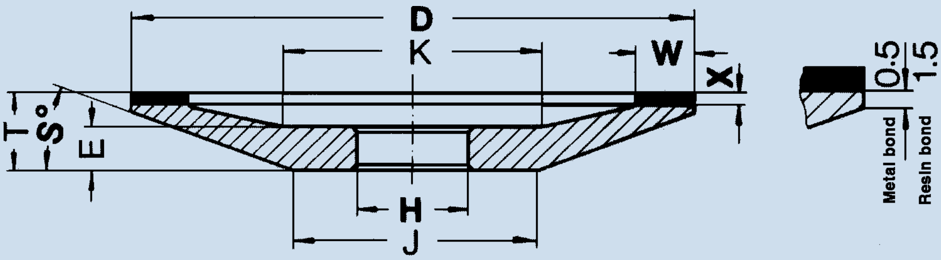
FEPA-Form	D	W	X resinbond	X metalbond	H	T-X	E	K* (*Min. dimension)	J
11A2	50	3	2 • 3 • 4	1 • 2 • 3 • 4	State bore dimension (< 60 % of J)	20	10	34	38
11A2	50	5	2 • 3 • 4	1 • 2 • 3 • 4		20	10	31	38
11A2	50	6	2 • 3 • 4	1 • 2 • 3 • 4		20	10	29	38
11A2	75	3	2 • 3 • 4	1 • 2 • 3 • 4		20	10	57	63
11A2	75	5	2 • 3 • 4	1 • 2 • 3 • 4		20	10	53	63
11A2	75	6	2 • 3 • 4	1 • 2 • 3 • 4		20	10	51	63
11A2	75	10	2 • 3 • 4	1 • 2 • 3 • 4		20	10	46	63
11A2	90	10	2 • 3 • 4	1 • 2 • 3 • 4		23	10	49	68
11A2	100	3	2 • 3 • 4	1 • 2 • 3 • 4		23	10	78	86
11A2	100	5	2 • 3 • 4	1 • 2 • 3 • 4		23	10	74	86
11A2	100	6	2 • 3 • 4	1 • 2 • 3 • 4		23	10	72	86
11A2	100	7	2 • 3 • 4	1 • 2 • 3 • 4		23	10	70	86
11A2	100	8	2 • 3 • 4	1 • 2 • 3 • 4		23	10	68	86
11A2	100	10	2 • 3 • 4	1 • 2 • 3 • 4		23	10	68	86
11A2	125	3	2 • 3 • 4	1 • 2 • 3 • 4		23	10	103	111
11A2	125	5	2 • 3 • 4	1 • 2 • 3 • 4		23	10	99	111
11A2	125	6	2 • 3 • 4	1 • 2 • 3 • 4		23	10	97	111
11A2	125	7	2 • 3 • 4	1 • 2 • 3 • 4		23	10	95	111
11A2	125	8	2 • 3 • 4	1 • 2 • 3 • 4		23	10	93	111
11A2	125	10	2 • 3 • 4	1 • 2 • 3 • 4		23	10	93	111
11A2	125	12,5	2 • 3 • 4	1 • 2 • 3 • 4		23	10	88	111
11A2	150	5	2 • 3 • 4	1 • 2 • 3 • 4		23	10	124	136
11A2	150	6	2 • 3 • 4	1 • 2 • 3 • 4		23	10	122	136
11A2	150	10	2 • 3 • 4	1 • 2 • 3 • 4		23	10	118	136
11A2	150	12,5	2 • 3 • 4	1 • 2 • 3 • 4		23	10	113	136
11A2	150	15	2 • 3 • 4	1 • 2 • 3 • 4		23	10	108	136

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
Resin bond	11A2	75	6	2	20	D 64	K-plus 888 RY	C 50
Metal bond	11A2	100	6	1	20	D 91	Bz 560	C 75

WINTER

12A2

S = 20°



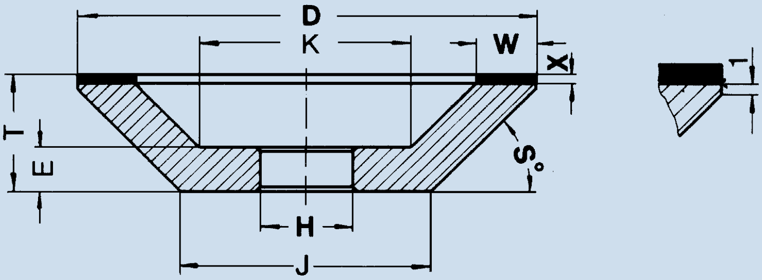
FEPA-Form	D	W	X		S°	H	T-X	E	K*	J
			resinbond	metalbond					*Min. dimension	
12A2	50	3	2•3•4	1•2•3•4	20	State bore dimension (< 60 % of J)	8	6	29	15
12A2	50	5	2•3•4	1•2•3•4	20		8	6	25	15
12A2	50	6	2•3•4	1•2•3•4	20		8	6	23	15
12A2	75	3	2•3•4	1•2•3•4	20		8	6	54	34
12A2	75	5	2•3•4	1•2•3•4	20		8	6	50	34
12A2	75	6	2•3•4	1•2•3•4	20		8	6	50	34
12A2	75	10	2•3•4	1•2•3•4	20		8	6	40	34
12A2	100	3	2•3•4	1•2•3•4	20		10	8	79	48
12A2	100	5	2•3•4	1•2•3•4	20		10	8	75	48
12A2	100	6	2•3•4	1•2•3•4	20		10	8	73	48
12A2	100	7	2•3•4	1•2•3•4	20		10	8	71	48
12A2	100	8	2•3•4	1•2•3•4	20		10	8	69	48
12A2	100	10	2•3•4	1•2•3•4	20		10	8	65	48
11A2	125	3	2•3•4	1•2•3•4	20		14	8	74	51
12A2	125	5	2•3•4	1•2•3•4	20		14	8	70	51
12A2	125	6	2•3•4	1•2•3•4	20		14	8	68	51
12A2	125	7	2•3•4	1•2•3•4	20		14	8	66	51
12A2	125	8	2•3•4	1•2•3•4	20		14	8	64	51
11A2	125	10	2•3•4	1•2•3•4	20		14	8	60	51
12A2	125	12,5	2•3•4	1•2•3•4	20		14	8	55	51
12A2	150	5	2•3•4	1•2•3•4	20		16	9	88	65
12A2	150	6	2•3•4	1•2•3•4	20		16	9	86	65
12A2	150	10	2•3•4	1•2•3•4	20		16	9	78	65
11A2	150	12,5	2•3•4	1•2•3•4	20		16	9	73	65
12A2	150	15	2•3•4	1•2•3•4	20		16	9	68	65
12A2	175	5	2•3•4	1•2•3•4	20		18	10	105	79
12A2	175	6	2•3•4	1•2•3•4	20		18	10	103	79
12A2	175	10	2•3•4	1•2•3•4	20		18	10	95	79
11A2	175	15	2•3•4	1•2•3•4	20		18	10	85	79
12A2	200	6	2•3•4	1•2•3•4	20		20	12	130	93
12A2	200	10	2•3•4	1•2•3•4	20		20	12	120	93
12A2	200	15	2•3•4	1•2•3•4	20		20	12	110	93
12A2	250	3	2•3•4	1•2•3•4	20		23	13	169	126
11A2	250	5	2•3•4	1•2•3•4	20		23	13	165	126
12A2	250	10	2•3•4	1•2•3•4	20		23	13	155	126

Order example	FEPA Code	D	W	X	S°	H	Grit Size	Bond	Concentration
Resin bond	12A2	100	5	2	20	20	D46	K-plus 888 N	C50
Metal bond	12A2	100	5	2	20	20	B126	KSS 10 J	V120

12A2

S = 45°

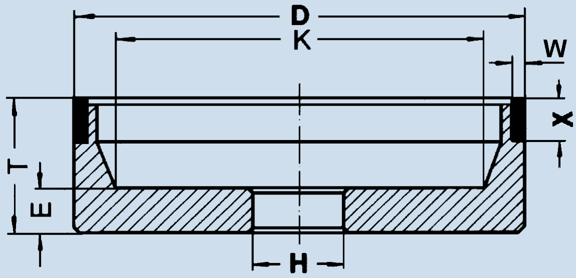
Further dimensions
see pages 19



FEPA-Form	D	W	X resinbond	X metalbond	S°	H	T-X	E	K* (*Min. dimension)	J
12A2	75	3	2 • 3 • 4	1 • 2 • 3 • 4	45	State bore dimension (< 60 % of J)	20	10	41	37
12A2	75	5	2 • 3 • 4	1 • 2 • 3 • 4	45		20	10	37	37
12A2	75	6	2 • 3 • 4	1 • 2 • 3 • 4	45		20	10	35	37
12A2	75	10	2 • 3 • 4	1 • 2 • 3 • 4	45		20	10	39	37
12A2	100	3	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	61	56
12A2	100	5	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	57	56
12A2	100	6	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	61	56
12A2	100	7	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	59	56
12A2	100	8	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	57	56
12A2	100	10	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	57	56
12A2	100	15	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	47	56
11A2	125	3	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	86	81
12A2	125	5	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	82	81
12A2	125	6	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	86	81
12A2	125	7	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	84	81
12A2	125	8	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	82	81
11A2	125	10	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	82	81
12A2	125	12,5	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	77	81
12A2	125	15	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	72	81
12A2	150	5	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	107	106
12A2	150	6	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	105	106
12A2	150	10	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	111	106
11A2	150	12,5	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	106	106
12A2	150	15	2 • 3 • 4	1 • 2 • 3 • 4	45		23	10	101	106

Order example	FEPA Code	D	W	X	S°	H	Grit Size	Bond	Concentration
Resin bond	12A2	100	5	2	45	20	B 126	KSS 10 J	V 120
Metal bond	12A2	125	10	1	45	20	D 91	Bz 560	C 75

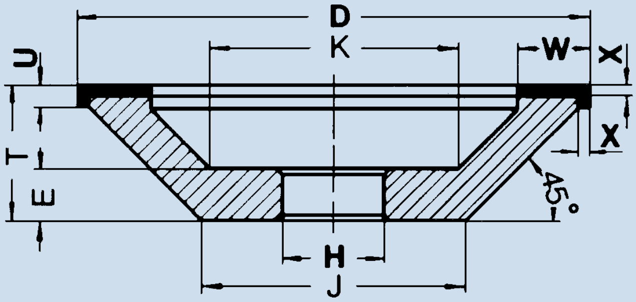
6A9



FEPA-Form	D	W resinbond	W metalbond	X	H	T	E	K
6A9	75	–	1,5	6	State bore dimension (< 60 % of J)	25	10	60
6A9	75	–	1,5	10		25	10	60
6A9	75	2	1,5	6		25	10	60
6A9	75	2	2	10		25	10	60
6A9	75	3	3	6		25	10	60
6A9	75	3	3	10		25	10	60
6A9	100	–	1,5	6		30	10	80
6A9	100	–	1,5	10		30	10	80
6A9	100	2	2	6		30	10	80
6A9	100	2	2	10		30	10	80
6A9	100	3	3	6		30	10	80
6A9	100	3	3	10		30	10	80
6A9	125	–	1,5	6		30	10	107
6A9	125	–	1,5	10		30	10	107
6A9	125	2	2	6		30	10	107
6A9	125	2	2	10		30	10	107
6A9	125	3	3	6		30	10	107
6A9	125	3	3	10		30	10	107
6A9	150	2	2	6		35	10	132
6A9	150	2	2	10		35	10	132
6A9	150	3	3	6		35	10	132
6A9	150	3	3	10		35	10	132

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
Resin bond	6A9	125	2	6	20	D 126	K-plus 888 RY	C 75
Metal bond	6A9	75	1,5	6	20	D 126	Bz 324	C 125

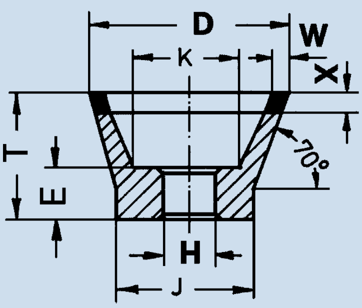
12C9

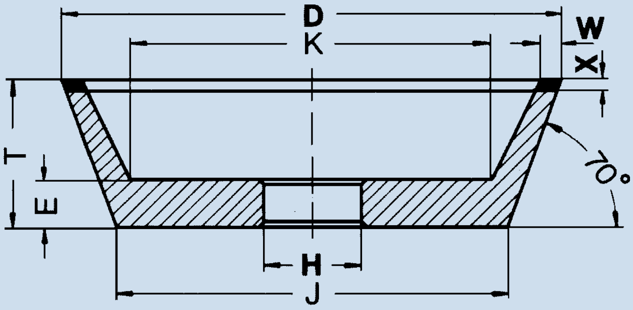


FEPA-Form	D	W	X resinbond	X metalbond	U	H	T	E	K*	J*
									*Min. dimension	
12C9	100	10	2	1	4	State bore dimension (< 60 % of J)	26	10	53	52
12C9	125	6	2	1	4		26	10	86	77
12C9	125	10	2	1	4		26	10	78	77
12C9	150	10	2	1	4		26	12	107	102
12C9	150	15	2	1	5		26	12	97	104

Order example	FEPA Code	D	W	X	U	H	Grit Size	Bond	Concentration
Resin bond	12C9	100	10	2	4	20	D 91	K-plus 888N	C 50
Metal bond	12C9	100	10	1	4	20	D 126	Bz 387	C 100

11V2

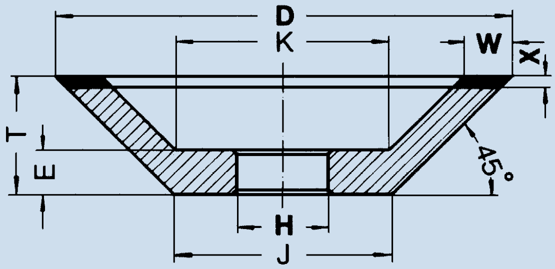




FEPA-Form	D	W	X resinbond	X metalbond	H	T-X	E	K*	J*
								*Min. dimension	
11V2	30	2	2 • 3 • 4 • 5	1 • 2	State bore dimension (< 60 % of J)	15	8	14	15
11V2	40	2	2 • 3 • 4 • 5	1 • 2		17	9	22	24
11V2	75	4	2 • 3 • 4 • 5	1 • 2		30	10	47	53
11V2	100	4	2 • 3 • 4 • 5	1 • 2		30	10	72	78

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
Resin bond	11V2	100	4	2	20	D 91	K-plus 888 R	C 75
Metal bond	11V2	100	4	1	20	D 91	Bz 560	C 75

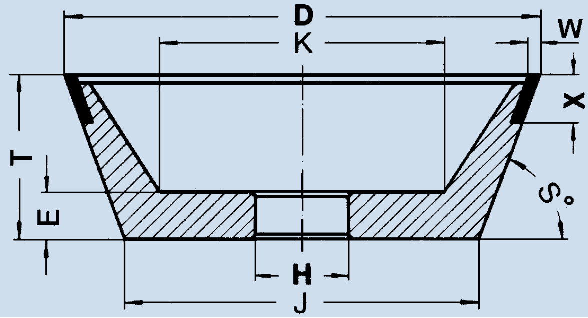
12V2



FEPA-Form	D	W	X resinbond	X metalbond	H	T-X	E	K*	J (*Min. dimension)
12V2	75	5	2 • 3 • 4	1 • 2	State bore dimension (< 60 % of J)	23	10	30	45
12V2	100	5	2 • 3 • 4	1 • 2		23	10	30	46
12V2	100	7	2 • 3 • 4	1 • 2		23	10	30	46
12V2	100	10	2 • 3 • 4	1 • 2		23	10	30	46
12V2	125	5	2 • 3 • 4	1 • 2		23	10	60	71
12V2	125	8	2 • 3 • 4	1 • 2		23	10	60	71
12V2	125	10	2 • 3 • 4	1 • 2		23	10	60	71
12V2	150	6	2 • 3 • 4	1 • 2		23	12	90	96
12V2	150	10	2 • 3 • 4	1 • 2		23	12	90	96

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
Resin bond	12V2	100	5	2	20	D91	K-plus 888 R	C75
Metal bond	12V2	100	5	2	20	D126	Bz 560	C100

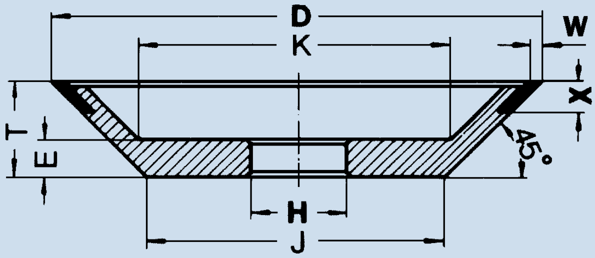
11V9



FEPA-Form	D	W resinbond	W metalbond	X	H	T	E	S°	K	J
11V9	50	2	2	6	State bore dimension (< 60 % of J)	30	10	70	28	39
11V9	50	2	2	10		30	10	70	28	39
11V9	75	1,5	1,5	6		30	10	70	40	53
11V9	75	1,5	1,5	10		30	10	70	40	53
11V9	75	2	2	6		30	10	70	40	53
11V9	75	2	2	10		30	10	70	40	53
11V9	75	3	3	6		30	10	70	40	53
11V9	75	3	3	10		30	10	70	40	53
11V9	90	1,5	1,5	10		35	10	70	55	65
11V9	90	1,5	1,5	10		35	10	70	55	65
11V9	95,3	3,2	3,2	6		35	10	70	60	70
11V9	95,3	3,2	3,2	9,3		35	10	70	60	70
11V9	100	1,5	1,5	6		35	10	70	55	75
11V9	100	1,5	1,5	10		35	10	70	55	75
11V9	100	2	2	6		35	10	70	55	75
11V9	100	2	2	10		35	10	70	55	75
11V9	100	2,5	2,5	10		30	10	85	80	95
11V9	100	3	3	6		35	10	70	55	75
11V9	100	3	3	10		35	10	70	55	75
11V9	120	2,5	2,5	10		30	10	85	100	115
11V9	125	1,5	1,5	6		40	10	70	75	96
11V9	125	1,5	1,5	10		40	10	70	75	96
11V9	125	2	2	6		40	10	70	75	96
11V9	125	2	2	10		40	10	70	75	96
11V9	125	3	3	6		40	10	70	75	96
11V9	125	3	3	10		40	10	70	75	96
11V9	150	1,5	1,5	6		50	10	70	90	114
11V9	150	1,5	1,5	10		50	10	70	90	114
11V9	150	3	3	6		50	10	70	90	114
11V9	150	3	3	10		50	10	70	90	114

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
Resin bond	11V9	100	3	10	20	D126	K-plus 1414 N	C75
Resin bond	11V9	100	2	10	20	B126	KSS 10 N	V180

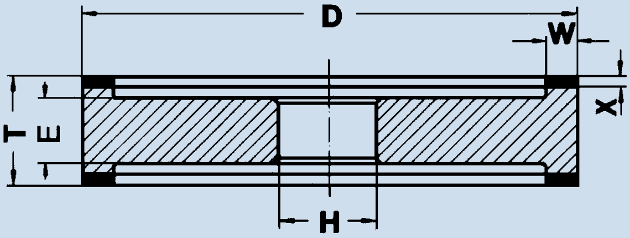
12V9



FEPA-Form	D	W resinbond	W metalbond	X	H	T	E	K	J
12V9	**50**	**2**	**2**	**6**	State bore dimension (< 60 % of J)	20	10	20	30
12V9	**75**	**2**	**2**	**6**		20	10	45	35
12V9	**75**	**3**	**3**	**6**		20	10	45	35
12V9	**100**	**2**	**2**	**6**		20	10	65	60
12V9	**100**	**3**	**3**	**6**		20	10	65	60
12V9	**125**	**2**	**2**	**6**		25	10	80	75
12V9	**125**	**2**	**2**	**6**		25	10	80	75
12V9	**125**	**3**	**3**	**6**		25	10	80	75
12V9	**125**	**3**	**3**	**6**		25	10	80	75

Order example	FEPA Code	D	W	X	H	Grit Size	Bond	Concentration
Resin bond	12V9	100	2	6	20	D 91	K-plus 888 R	C 75
Resin bond	12V9	100	2	6	20	B 126	KSS 10 N	V 180

9A3

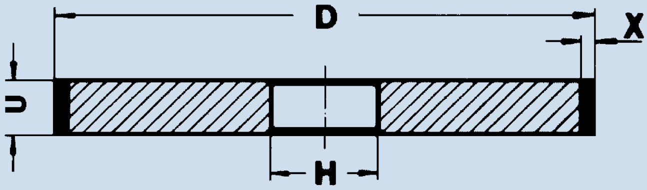


FEPA-Form	D	W	X		T	H	E
			resinbond	metalbond			
9A3	100	6	2 • 3	1 • 2 • 3	22	State bore dimension	10
9A3	100	8	2 • 3	1 • 2 • 3	22		10
9A3	100	10	2 • 3	1 • 2 • 3	22		10
9A3	125	6	2 • 3	1 • 2 • 3	22		10
9A3	125	8	2 • 3	1 • 2 • 3	22		10
9A3	125	10	2 • 3	1 • 2 • 3	22		10
9A3	150	6	2 • 3	1 • 2 • 3	25		14
9A3	150	6	2 • 3	1 • 2 • 3	35		14
9A3	150	8	2 • 3	1 • 2 • 3	25		14
9A3	150	8	2 • 3	1 • 2 • 3	35		14
9A3	150	10	2 • 3	1 • 2 • 3	25		14
9A3	150	10	2 • 3	1 • 2 • 3	35		14
9A3	150	15	2 • 3	1 • 2 • 3	25		14
9A3	150	15	2 • 3	1 • 2 • 3	35		14
9A3	175	6	2 • 3	1 • 2 • 3	25		14
9A3	175	6	2 • 3	1 • 2 • 3	35		14
9A3	175	8	2 • 3	1 • 2 • 3	25		14
9A3	175	8	2 • 3	1 • 2 • 3	35		14
9A3	175	10	2 • 3	1 • 2 • 3	25		14
9A3	175	10	2 • 3	1 • 2 • 3	35		14
9A3	175	15	2 • 3	1 • 2 • 3	25		14
9A3	175	15	2 • 3	1 • 2 • 3	35		14
9A3	200	8	2 • 3	1 • 2 • 3	30		18
9A3	200	10	2 • 3	1 • 2 • 3	30		18
9A3	200	15	2 • 3	1 • 2 • 3	30		18

Order example	FEPA Code	D	W	X	T	H	Grit Size	Bond	Concentration
Resin bond	9A3	175	8	2	35	20	D46	K-plus 888 NYA	C31
Metal bond	9A3	175	8	1	35	20	D91	Bz560	C50

1A1

see also 14A1
Can be manufactured
in both shapes.



FEPA-Form	D	U*	X resinbond	X metalbond	H
1A1	20	4	2•3•4	1•2•3•4	State bore dimension
1A1	20	5	2•3•4	1•2•3•4	
1A1	20	6	2•3•4	1•2•3•4	
1A1	20	8	2•3•4	1•2•3•4	
1A1	20	10	2•3•4	1•2•3•4	
1A1	25	3	2•3•4	1•2•3•4	
1A1	25	4	2•3•4	1•2•3•4	
1A1	25	6	2•3•4	1•2•3•4	
1A1	25	8	2•3•4	1•2•3•4	
1A1	25	10	2•3•4	1•2•3•4	
1A1	30	3	2•3•4	1•2•3•4	
1A1	30	6	2•3•4	1•2•3•4	
1A1	30	8	2•3•4	1•2•3•4	
1A1	40	4	2•3•4	1•2•3•4	
1A1	40	8	2•3•4	1•2•3•4	
1A1	40	10	2•3•4	1•2•3•4	
1A1	50	4	2•3•4	1•2•3•4	
1A1	50	6	2•3•4	1•2•3•4	
1A1	50	8	2•3•4	1•2•3•4	
1A1	50	10	2•3•4	1•2•3•4	
1A1	50	20	2•3•4	1•2•3•4	
1A1	75	3	2•3•4	1•2•3•4	
1A1	75	4	2•3•4	1•2•3•4	
1A1	75	5	2•3•4	1•2•3•4	
1A1	75	6	2•3•4	1•2•3•4	
1A1	75	10	2•3•4	1•2•3•4	
1A1	75	12	2•3•4	1•2•3•4	
1A1	75	20	2•3•4	1•2•3•4	
1A1	100	3	2•3•4	1•2•3•4	
1A1	100	4	2•3•4	1•2•3•4	
1A1	100	5	2•3•4	1•2•3•4	
1A1	100	6	2•3•4	1•2•3•4	
1A1	100	10	2•3•4	1•2•3•4	
1A1	100	12	2•3•4	1•2•3•4	
1A1	100	20	2•3•4	1•2•3•4	
1A1	125	3	2•3•4	1•2•3•4	
1A1	125	4	2•3•4	1•2•3•4	
1A1	125	5	2•3•4	1•2•3•4	
1A1	125	6	2•3•4	1•2•3•4	
1A1	125	10	2•3•4	1•2•3•4	
1A1	125	12	2•3•4	1•2•3•4	
1A1	125	15	2•3•4	1•2•3•4	
1A1	125	20	2•3•4	1•2•3•4	
1A1	125	30	3•4	1•2•3•4	
1A1	150	3	5	1•2•3•4	

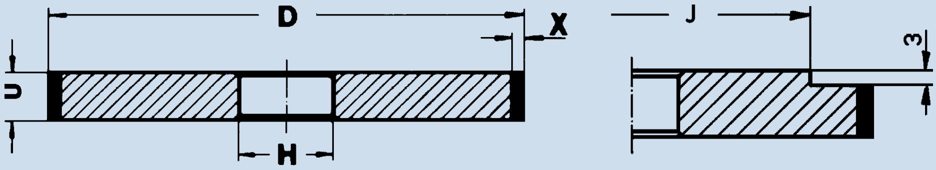
* Larger overall thickness dimensions U are available by putting individual wheels together.

Other dimensions for internal grinding see Catalogue No. 10.

Order example	FEPA Code	D	U	X	H	Grit Size	Bond	Concentration
Resin bond	1A1	40	10	2	20	D91	K-plus 888 RYE	C100
Resin bond	1A1	50	10	2	20	B126	KSS RYA	V180

1A1

see also 14A1



FEPA-Form	D	U*	X resinbond	X metalbond	H
1A1	150	4	2•3•4	1•2•3•4	State bore dimension
1A1	150	5	2•3•4	1•2•3•4	
1A1	150	6	2•3•4	1•2•3•4	
1A1	150	8	2•3•4	1•2•3•4	
1A1	150	10	2•3•4	1•2•3•4	
1A1	150	12	2•3•4	1•2•3•4	
1A1	150	15	2•3•4	1•2•3•4	
1A1	150	20	2•3•4	1•2•3•4	
1A1	150	30	3•4	1•2•3•4	
1A1	175	6	5	1•2•3•4	
1A1	175	10	2•3•4	1•2•3•4	
1A1	175	12	2•3•4	1•2•3•4	
1A1	175	15	2•3•4	1•2•3•4	
1A1	175	20	2•3•4	1•2•3•4	
1A1	175	30	3•4	1•2•3•4	
1A1	200	6	5	1•2•3•4	
1A1	200	8	5	1•2•3•4	
1A1	200	10	2•3•4	1•2•3•4	
1A1	200	12	2•3•4	1•2•3•4	
1A1	200	15	2•3•4	1•2•3•4	
1A1	200	20	2•3•4	1•2•3•4	
1A1	200	30	3•4	1•2•3•4	
1A1	245	10	2•3•4	1•2•3•4	
1A1	245	12	2•3•4	1•2•3•4	
1A1	245	15	2•3•4	1•2•3•4	
1A1	245	20	2•3•4	1•2•3•4	
1A1	245	30	3•4	1•2•3•4	
1A1	250	6	5	1•2•3•4	
1A1	250	10	2•3•4	1•2•3•4	
1A1	250	12	2•3•4	1•2•3•4	
1A1	250	15	2•3•4	1•2•3•4	
1A1	250	20	2•3•4	1•2•3•4	
1A1	250	25	3•4	1•2•3•4	
1A1	250	30	3•4	1•2•3•4	
1A1	300	10	2•3•4	1•2•3•4	
1A1	300	12	2•3•4	1•2•3•4	
1A1	300	15	2•3•4	1•2•3•4	
1A1	300	20	2•3•4	1•2•3•4	
1A1	300	30	3•4	1•2•3•4	
1A1	350	10	2•3•4	1•2•3•4	
1A1	350	12	2•3•4	1•2•3•4	
1A1	350	15	2•3•4	1•2•3•4	
1A1	350	20	2•3•4	1•2•3•4	
1A1	350	25	3•4	1•2•3•4	
1A1	350	30	3•4	1•2•3•4	

* Larger overall thickness dimensions U are available by putting individual wheels together.

from D = 245 mm 3 mm indicating band turned together with bore and following the abrasive layer. Tolerance to DIN 7168 m.

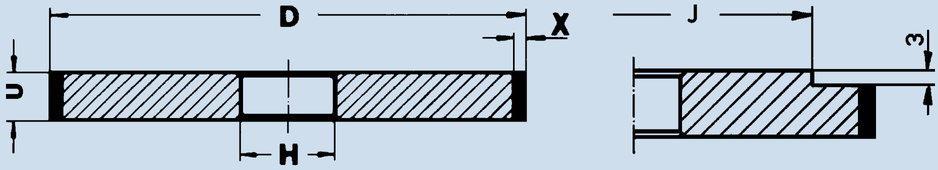
D (mm)	J (mm)
245	195
250	200
300	240
350	280
400	330
450	380
500	420
600	520

Order example	FEPA Code	D	U	X	H	Grit Size	Bond	Concentration
Resin bond	1A1	200	15	2	76	B126	KSS RYB	V120
Metal bond	1A1	200	15	2	76	D126	Bz387	C100

WINTER

1A1

See also 14A1



FEPA-Form	D	U*	X resinbond	X metalbond	H
1A1	400	10	2 • 3 • 4	1 • 2 • 3 • 4	State bore dimension
1A1	400	20	2 • 3 • 4	1 • 2 • 3 • 4	
1A1	400	30	3 • 4	1 • 2 • 3 • 4	
1A1	500	20	2 • 3 • 4	1 • 2 • 3 • 4	
1A1	500	30	3 • 4	1 • 2 • 3 • 4	
1A1	600	20	2 • 3 • 4	1 • 2 • 3 • 4	
1A1	600	30	3 • 4	1 • 2 • 3 • 4	

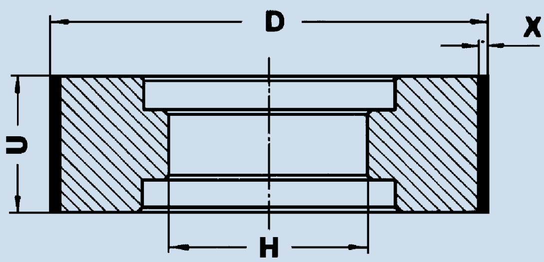
* Larger overall thickness dimensions U are available by putting individual wheels together.

from D = 245 mm 3 mm indicating band turned together with bore and following the abrasive layer. Tolerance to DIN 7168 m.

D (mm)	J (mm)
245	195
250	200
300	240
350	280
400	330
450	380
500	420
600	520

Order example	FEPA Code	D	U	X	H	Grit Size	Bond	Concentration
Resin bond	1A1	300	15	2	dep. on flange	D126	K-plus 1313TYB	C75
Resin bond	1A1	300	30	4	127	B151	KSS RYB	V120

9A1



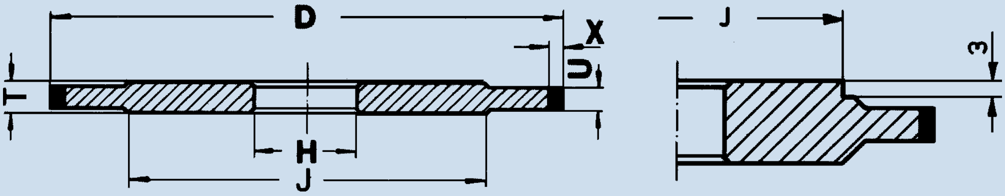
FEPA-Form	D	U	X electropl. bond only	H*
9A1	110	120	0,65 • 1,15	State bore dimension
9A1	120	120	0,65 • 1,15	
9A1	125	50	0,65 • 1,15	
9A1	150	50	0,65 • 1,15	
9A1	250	60	0,65 • 1,15	
9A1	250	100	0,65 • 1,15	
9A1	300	60	0,65 • 1,15	
9A1	300	100	0,65 • 1,15	
9A1	300	150	0,65 • 1,15	
9A1	350	100	0,65 • 1,15	
9A1	350	150	0,65 • 1,15	
9A1	400	200	0,65 • 1,15	

* As a rule mounting flange must be sent in.

Order example	FEPA Code	D	U	X	H	Grit Size	Bond	Concentration
Electropl. bond	9A1	350	150	0,65	dep. on flange	D126	G825	C170

14A1

See also 1A1



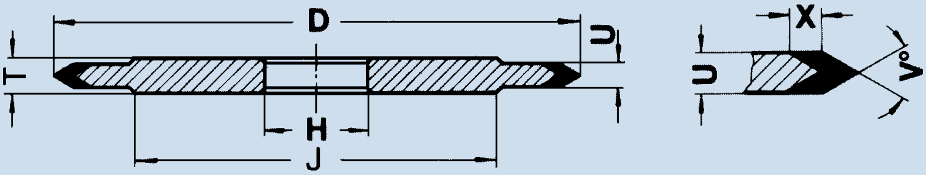
FEPA-Form	D	U	X resinbond	X metalbond	H	T resin/metal	J
14A1	75	3	3 • 5	3 • 5	State bore dimension (< 60 % of J)	5	50
14A1	75	4	2 • 3 • 4 • 5	2 • 3 • 4 • 5		5	50
14A1	100	1	5	5		6	70
14A1	100	2	5	5		6	70
14A1	100	3	3 • 5	3 • 5		6	70
14A1	100	4	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		6	70
14A1	100	5	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		6	70
14A1	125	1	5	5		6	100
14A1	125	2	5	5		6	100
14A1	125	3	3 • 5	3 • 5		6	100
14A1	125	4	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		6	100
14A1	125	5	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		6	100
14A1	150	1	5	5		8	120
14A1	150	2	5	5		8	120
14A1	150	3	3 • 5	3 • 5		8	120
14A1	150	4	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		8	120
14A1	150	5	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		8	120
14A1	150	6	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		8	120
14A1	175	1	5	5		8	140
14A1	175	3	3 • 5	3 • 5		8	140
14A1	175	4	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		8	140
14A1	175	5	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		8	140
14A1	175	6	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		8	140
14A1	200	2	3 • 5	3 • 5		10	160
14A1	200	3	3 • 5	3 • 5		10	160
14A1	200	4	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		10 10	160
14A1	200	5	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		10 10	160
14A1	200	6	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		10 10	160
14A1	200	8	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		10 10	160
14A1	250	6	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		16 12	200
14A1	250	10	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		16 12	200
14A1	300	10	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		20 16	240
14A1	350	10	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		20 16	280
14A1	400	10	2 • 3 • 4 • 5	1 • 2 • 3 • 4 • 5		25 16	330

from D = 250 mm 3 mm indicating band.

Order example	FEPA Code	D	U	X	H	Grit Size	Bond	Concentration
Resin bond	14A1	100	4	2	20	D 91	K-plus 888 R	C 75
Metal bond	14A1	100	4	1	20	D 91	Bz 560	C 75

WINTER

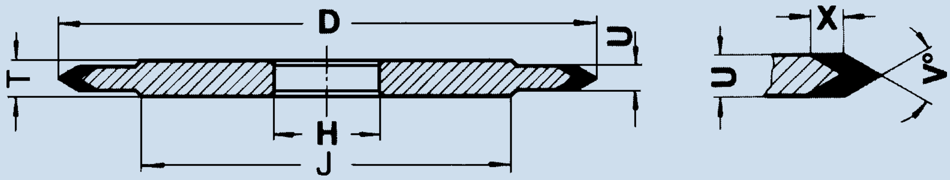
14EE1



FEPA-Form	D	U	X resinbond	X metalbond	V°	H	T	J
14EE1	100	3	6	3	35°	State bore dimension (< 60 % of J)	6	70
14EE1	100	3	5	2,5	45°		6	70
14EE1	100	3	4	2	60°		6	70
14EE1	100	3	3	1,5	90°		6	70
14EE1	100	4	6	3	35°		6	70
14EE1	100	4	5	2,5	45°		6	70
14EE1	100	4	4	2	60°		6	70
14EE1	100	4	3	1,5	90°		6	70
14EE1	125	3	6	3	35°		6	100
14EE1	125	3	5	2,5	45°		6	100
14EE1	125	3	4	2	60°		6	100
14EE1	125	3	3	1,5	90°		6	100
14EE1	125	4	6	3	35°		6	100
14EE1	125	4	5	2,5	45°		6	100
14EE1	125	4	4	2	60°		6	100
14EE1	125	4	3	1,5	90°		6	100
14EE1	150	3	6	3	35°		6	120
14EE1	150	3	5	2,5	45°		6	120
14EE1	150	3	4	2	60°		6	120
14EE1	150	3	3	1,5	90°		6	120
14EE1	150	4	6	3	35°		6	120
14EE1	150	4	5	2,5	45°		6	120
14EE1	150	4	4	2	60°		6	120
14EE1	150	4	3	1,5	90°		6	120
14EE1	175	4	6	3	35°		8	140
14EE1	175	4	5	2,5	45°		8	140
14EE1	175	4	4	2	60°		8	140
14EE1	175	4	3	1,5	90°		8	140
14EE1	175	5	6	3	35°		8	140
14EE1	175	5	5	2,5	45°		8	140
14EE1	175	5	4	2	60°		8	140
14EE1	175	5	3	1,5	90°		8	140
14EE1	200	4	6	3	35°		10	160
14EE1	200	4	5	2,5	45°		10	160
14EE1	200	4	4	2	60°		10	160

Order example	FEPA Code	D	U	X	V°	H	Grit Size	Bond	Concentration
Resin bond	14EE1	150	4	4	60	20	D126	K-plus 920 A	C100
Resin bond	14EE1	150	4	4	60	20	B107	KSS 10 N	V180

14EE1

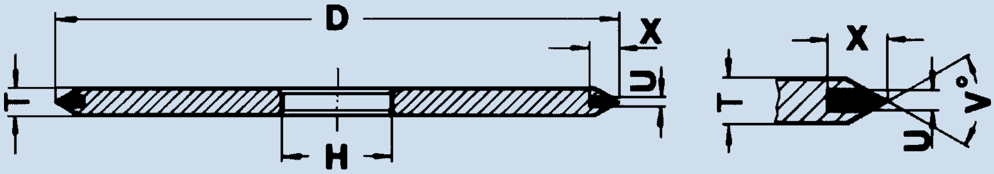


FEPA-Form	D	U	X resinbond	X metalbond	V°	H	T	J
14EE1	200	4	3	1,5	90°	State bore dimension (< 60 % of J)	10	160
14EE1	200	5	6	3	35°		10	160
14EE1	200	5	5	2,5	45°		10	160
14EE1	200	5	4	2	60°		10	160
14EE1	200	5	3	1,5	90°		10	160
14EE1	250	4	6	3	35°		15	200
14EE1	250	4	5	2,5	45°		15	200
14EE1	250	4	4	2	60°		15	200
14EE1	250	4	3	1,5	90°		15	200
14EE1	250	5	6	3	35°		15	200
14EE1	250	5	5	2,5	45°		15	200
14EE1	250	5	4	2	60°		15	200
14EE1	250	5	3	1,5	90°		15	200

Order example	FEPA Code	D	U	X	V°	H	Grit Size	Bond	Concentration
Resin bond	14EE1	200	5	6	60	51	B 107	KSS 10 N	V 180
Metal bond	14EE1	200	5	2	60	51	D 91	Bz 387	C 75

1E6Q

See also 14E6Q

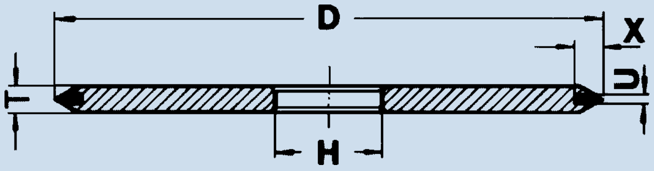


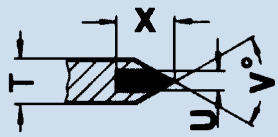
FEPA-Form	D	U	X resinbond	X metalbond	V°	H	T	
1E6Q	40	1	5	5	*30°	State bore dimension	4	* Minimum angle 30°
1E6Q	40	1	5	5	35°		4	
1E6Q	40	1	5	5	45°		4	
1E6Q	40	1	5	5	60°		4	
1E6Q	40	1	5	5	90°		4	
1E6Q	40	2	5	5	*30°		4	
1E6Q	40	2	5	5	35°		4	
1E6Q	40	2	5	5	45°		4	
1E6Q	40	2	5	5	60°		4	
1E6Q	40	2	5	5	90°		4	
1E6Q	50	1	5	5	*30°		4	
1E6Q	50	1	5	5	35°		4	
1E6Q	50	1	5	5	45°		4	
1E6Q	50	1	5	5	60°		4	
1E6Q	50	1	5	5	90°		4	
1E6Q	50	2	5	5	*30°		4	
1E6Q	50	2	5	5	35°		4	
1E6Q	50	2	5	5	45°		4	
1E6Q	50	2	5	5	60°		4	
1E6Q	40	2	5	5	90°		4	
1E6Q	75	1	5	5	*30°		4	
1E6Q	75	1	5	5	35°		4	
1E6Q	75	1	5	5	45°		4	
1E6Q	75	1	5	5	60°		4	
1E6Q	75	1	5	5	90°		4	
1E6Q	75	2	5	5	*30°		4	
1E6Q	75	2	5	5	35°		4	
1E6Q	75	2	5	5	45°		4	
1E6Q	75	2	5	5	60°		4	
1E6Q	75	2	5	5	90°		4	
1E6Q	100	1	5	5	*30°		4	
1E6Q	100	1	5	5	35°		4	
1E6Q	100	1	5	5	45°		4	
1E6Q	100	1	5	5	60°		4	
1E6Q	100	1	5	5	90°		4	

Order example	FEPA Code	D	U	X	V°	H	Grit Size	Bond	Concentration
Resin bond	1E6Q	100	1	5	60	20	B126	KSS 10 N	V180
Metal bond	1E6Q	75	2	5	60	20	D107	Bz 387	C100

1E6Q

See also 14E6Q



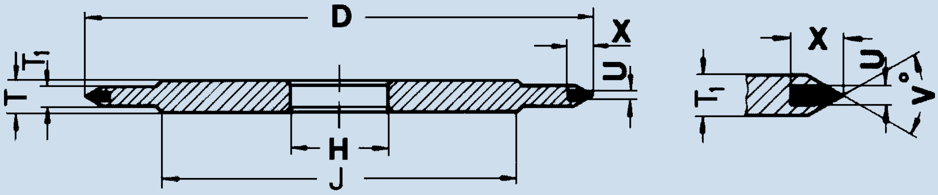


FEPA-Form	D	U	X resinbond	X metalbond	V°	H	T	
1E6Q	100	2	5	5	*30°	State bore dimension	4	* Minimum angle 30°
1E6Q	100	2	5	5	35°		4	
1E6Q	100	2	5	5	45°		4	
1E6Q	100	2	5	5	60°		4	
1E6Q	100	2	5	5	90°		4	
1E6Q	125	1	5	5	*30°		5	
1E6Q	125	1	5	5	35°		5	
1E6Q	125	1	5	5	45°		5	
1E6Q	125	1	5	5	60°		5	
1E6Q	125	1	5	5	90°		5	
1E6Q	125	2	5	5	*30°		5	
1E6Q	125	2	5	5	35°		5	
1E6Q	125	2	5	5	45°		5	
1E6Q	125	2	5	5	60°		5	
1E6Q	125	2	5	5	90°		5	
1E6Q	150	1	5	5	*30°		5	
1E6Q	150	1	5	5	35°		5	
1E6Q	150	1	5	5	45°		5	
1E6Q	150	1	5	5	60°		5	
1E6Q	150	1	5	5	90°		5	
1E6Q	150	2	5	5	*30°		5	
1E6Q	150	2	5	5	35°		5	
1E6Q	150	2	5	5	45°		5	
1E6Q	150	2	5	5	60°		5	
1E6Q	150	2	5	5	90°		5	

Order example	FEPA Code	D	U	X	V°	H	Grit Size	Bond	Concentration
Resin bond	1E6Q	125	1	5	60	20	B126	KSS 10 N	V240
Metal bond	1E6Q	150	1	5	60	20	D91	Bz 444	C100

14E6Q

See also 1E6Q



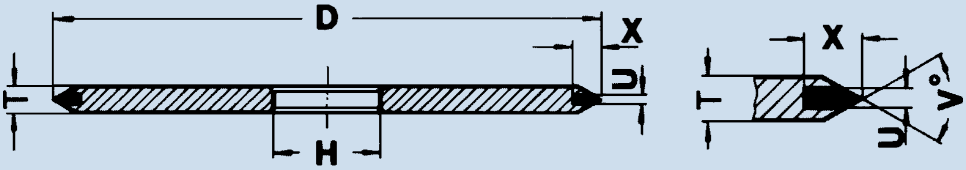
FEPA-Form	D	U	X		V°	H	T	T_1	J
			resinbond	metalbond					
14E6Q	40	1	5	5	*30°	State bore dimension (< 60% of J)	6	4	22
14E6Q	40	1	5	5	35°		6	4	22
14E6Q	40	1	5	5	45°		6	4	22
14E6Q	40	1	5	5	60°		6	4	22
14E6Q	40	1	5	5	90°		6	4	22
14E6Q	40	2	5	5	*30°		6	4	22
14E6Q	40	2	5	5	35°		6	4	22
14E6Q	40	2	5	5	45°		6	4	22
14E6Q	40	2	5	5	60°		6	4	22
14E6Q	40	2	5	5	90°		6	4	22
14E6Q	50	1	5	5	*30°		6	4	32
14E6Q	50	1	5	5	35°		6	4	32
14E6Q	50	1	5	5	45°		6	4	32
14E6Q	50	1	5	5	60°		6	4	32
14E6Q	50	1	5	5	90°		6	4	32
14E6Q	50	2	5	5	*30°		6	4	32
14E6Q	50	2	5	5	35°		6	4	32
14E6Q	50	2	5	5	45°		6	4	32
14E6Q	50	2	5	5	60°		6	4	32
14E6Q	40	2	5	5	90°		6	4	32
14E6Q	75	1	5	5	*30°		6	4	50
14E6Q	75	1	5	5	35°		6	4	50
14E6Q	75	1	5	5	45°		6	4	50
14E6Q	75	1	5	5	60°		6	4	50
14E6Q	75	1	5	5	90°		6	4	50
14E6Q	75	2	5	5	*30°		6	4	50
14E6Q	75	2	5	5	35°		6	4	50
14E6Q	75	2	5	5	45°		6	4	50
14E6Q	75	2	5	5	60°		6	4	50
14E6Q	75	2	5	5	90°		6	4	50
14E6Q	100	1	5	5	*30°		6	4	80
14E6Q	100	1	5	5	35°		6	4	80
14E6Q	100	1	5	5	45°		6	4	80
14E6Q	100	1	5	5	60°		6	4	80
14E6Q	100	1	5	5	90°		6	4	80
14E6Q	100	2	5	5	*30°		6	4	80
14E6Q	100	2	5	5	35°		6	4	80
14E6Q	100	2	5	5	45°		6	4	80
14E6Q	100	2	5	5	60°		6	4	80
14E6Q	100	2	5	5	90°		6	4	80
14E6Q	125	1	5	5	*30°		7	5	100
14E6Q	125	1	5	5	35°		7	5	100
14E6Q	125	1	5	5	45°		7	5	100
14E6Q	125	1	5	5	60°		7	5	100
14E6Q	125	1	5	5	90°		7	5	100

* Minimum angle 30°

Order example	FEPA Code	D	U	X	V°	H	Grit Size	Bond	Concentration
Resin bond	14E6Q	100	1	5	30	20	D126	K-plus 920 A	C100
Resin bond	14E6Q	100	1	5	35	20	B107	KSS 10 N	V240

14E6Q

See also 1E6Q



FEPA-Form	D	U	X resinbond	X metalbond	V°	H	T	T1	J
14E6Q	125	2	5	5	*30°	State bore dimension (< 60 % of J)	7	5	100
14E6Q	125	2	5	5	35°		7	5	100
14E6Q	125	2	5	5	45°		7	5	100
14E6Q	125	2	5	5	60°		7	5	100
14E6Q	125	2	5	5	90°		7	5	100
14E6Q	150	1	5	5	*30°		7	5	120
14E6Q	150	1	5	5	35°		7	5	120
14E6Q	150	1	5	5	45°		7	5	120
14E6Q	150	1	5	5	60°		7	5	120
14E6Q	150	1	5	5	90°		7	5	120
14E6Q	150	2	5	5	*30°		7	5	120
14E6Q	150	2	5	5	35°		7	5	120
14E6Q	150	2	5	5	45°		7	5	120
14E6Q	150	2	5	5	60°		7	5	120
14E6Q	150	2	5	5	90°		7	5	120
14E6Q	220	1	5	5	*30°		12	5	180
14E6Q	220	1	5	5	35°		12	5	180
14E6Q	220	1	5	5	45°		12	5	180
14E6Q	220	1	5	5	60°		12	5	180
14E6Q	220	1	5	5	90°		12	5	180
14E6Q	220	2	5	5	*30°		12	5	180
14E6Q	220	2	5	5	35°		12	5	180
14E6Q	220	2	5	5	45°		12	5	180
14E6Q	220	2	5	5	60°		12	5	180
14E6Q	220	2	5	5	90°		12	5	180

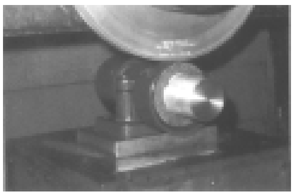
* Minimum angle 30°

Order example	FEPA Code	D	U	X	V°	H	Grit Size	Bond	Concentration
Resin bond	14E6Q	125	2	5	35	20	D126	K-plus 920 A	C100
Resin bond	14E6Q	125	2	5	45	20	B107	KSS 10 N	V240

Dressing tools and WINTER sharpening stones for diamond and CBN wheels

WINTER dressing units

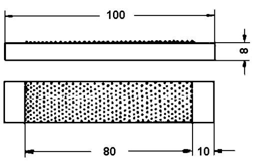
with rotary SiC grinding wheel (brake-controlled) for dressing of diamond and CBN wheels complete with 1 pc. 37 C602 N5V and 1 pc.. 37 C802 I5V.
Spare grinding wheels:
37 C46-N5V
37 C602-N5V
37 C802-I5V available ex stock



Use dry only. Subsequent sharpening with WINTER Stone only if necessary.

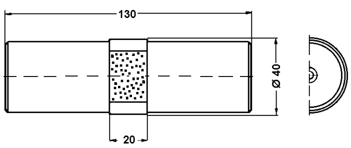
1S 09 H-80-20-8
WINTER diamond dressing stick

for dressing of CBN wheels (KSS) on surface grinders.
Use with coolant.
Subsequent sharpening with WINTER Stone necessary



1S 44B-40-20
WINTER dressing cylinder

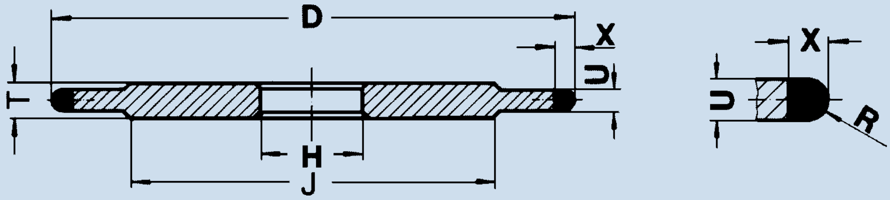
for dressing CBN wheels (KSS) on cylindrical grinders.
Use with coolant.
Subsequent sharpening with WINTER Stone necessary



WINTER

14F1

See also 14A1



FEPA-Form	D	U	X resinbond	X metalbond	R	H	T	J
14F1	40	2	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1	State bore dimension (< 60 % of J)	6	25
14F1	40	3	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1,5		6	25
14F1	40	4	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	2		6	25
14F1	50	2	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1		6	30
14F1	50	3	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1,5		6	30
14F1	50	4	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	2		6	30
14F1	75	2	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1		6	50
14F1	75	3	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1,5		6	50
14F1	75	4	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	2		6	50
14F1	100	2	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1		6	70
14F1	100	3	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1,5		6	70
14F1	100	4	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	2		6	70
14F1	125	2	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1		6	100
14F1	125	3	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1,5		6	100
14F1	125	4	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	2		6	100
14F1	150	2	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1		8	120
14F1	150	3	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	1,5		8	120
14F1	150	4	2,5 • 3 • 4 • 5	2,5 • 3 • 4 • 5	2		8	120

Order example	FEPA Code	D	U	X	R	H	Grit Size	Bond	Concentration
Resin bond	14F1	150	4	4	2	20	B107	KSS RA	V180
Metal bond	14F1	150	2	5	1	51	D91	Bz387	C100

WINTER Stone No. 1a (65x65x16)

for cleaning layer surface only.

WINTER Stone No. 2 (100x24x13)

for sharpening metal and resin bond diamond and CBN wheels, generally up to grit size D/B 151.
Sharpen with wet stone only.
Use off-hand or clamped.

WINTER Stone No. 3 (100x40x15)

for sharpening vitrified bond CBN wheels and pins.

WINTER Stone No. 3a (80x15x10)

for sharpening vitrified bond CBN wheels and pins.

WINTER Stone No. 4 (90x70x20)

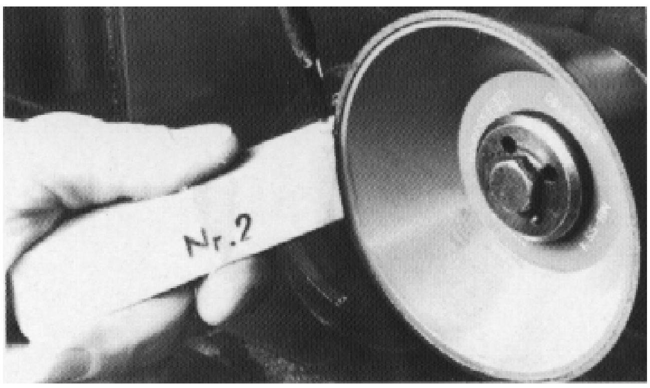
for sharpening metal bond diamond and CBN wheels (BZ/MSS). With little coolant.

WINTER Stone No. 5 (100x50x25)

Explanations: see WINTER Stone No. 2

WINTER Stone No. 8 (100x6x6)

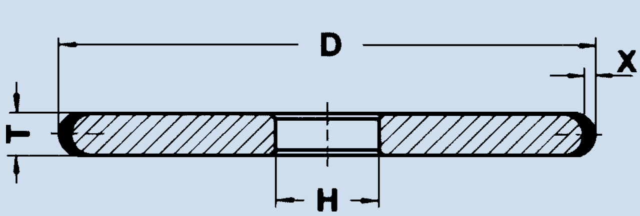
for sharpening ID saw blades.

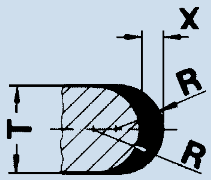


Further measurements and types of hardness on enquiry.

1FF1

See also 14F1



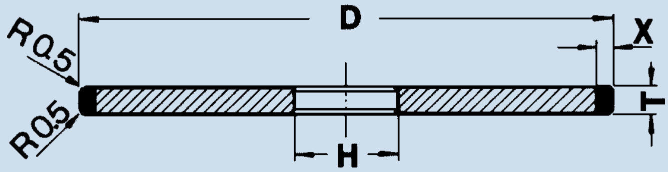


FEPA-Form	D	T*	X		R	H
			resinbond	metalbond		
1FF1	40	6	2	1	3	State bore dimension
1FF1	50	6	2	1	3	
1FF1	50	8	2	1	4	
1FF1	50	10	2	1	5	
1FF1	75	6	2	1	3	
1FF1	75	8	2	1	4	
1FF1	75	10	2	1	5	
1FF1	100	6	2	1	3	
1FF1	100	8	2	1	4	
1FF1	100	10	2	1	5	
1FF1	100	12	2	1	6	
1FF1	125	6	2	1	3	
1FF1	125	8	2	1	4	
1FF1	125	10	2	1	5	
1FF1	125	12	2	1	6	
1FF1	125	16	2	1	8	
1FF1	150	6	2	1	3	
1FF1	150	8	2	1	4	
1FF1	150	10	2	1	5	
1FF1	150	12	2	1	6	
1FF1	150	16	2	1	8	
1FF1	150	20	2	1	10	

* Other thickness/radii available

Order example	FEPA Code	D	T	X	R	H	Grit Size	Bond	Concentration
Resin bond	1FF1	150	6	2	3	32	D126	K-plus 920 A	C100
Resin bond	1FF1	150	6	1	3	20	B126	KSS 10 N	V240

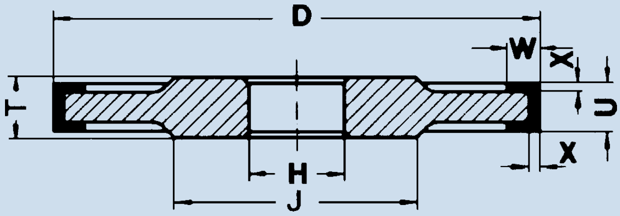
1L1



FEPA-Form	D	T	X resinbond	X metalbond	R	H
1L1	75	3	2 • 3	1 • 1,5 • 2 • 3	0,5	State bore dimension
1L1	75	4	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	75	5	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	90	5	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	90	6	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	100	3	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	100	4	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	100	5	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	125	3	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	125	4	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	125	5	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	125	6	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	150	3	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	150	4	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	150	5	2 • 3	1 • 1,5 • 2 • 3	0,5	
1L1	150	6	2 • 3	1 • 1,5 • 2 • 3	0,5	

Order example	FEPA Code	D	T	X	R	H	Grit Size	Bond	Concentration
Metal bond	1L1	100	1	1	0,5	20	D 126	Bz 387	C100

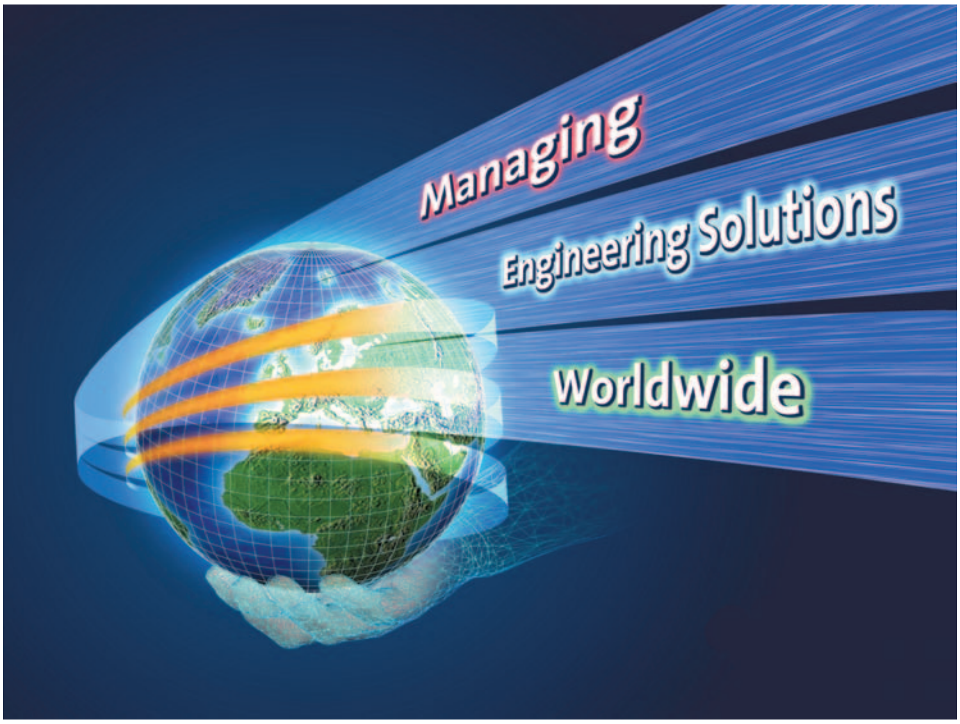
14U1



FEPA-Form	D	W	X resinbond	X metalbond	U	H	T	J
14U1	100	6	2	1	3 *	State bore dimension (< 60 % of J)	8	50
14U1	100	6	2	1	4 *		8	50
14U1	100	6	2	1	5		8	50
14U1	100	6	2	1	6		8	50
14U1	100	10	2	1	10		12	50
14U1	125	3 *	2	1	6		8	65
14U1	125	6	2	1	3 *		8	65
14U1	125	6	2	1	5		8	65
14U1	125	10	2	1	10		12	65
14U1	150	3 *	2	1	6		8	80
14U1	150	6	2	1	8		10	80
14U1	150	10	2	1	10		12	80

* Abrasive throughout

Order example	FEPA Code	D	W	X	U	H	Grit Size	Bond	Concentration
Resin bond	14U1	100	6	2	6	32	D 91	K-plus 888 N	C75
Metal bond	14U1	100	6	1	6	20	D 91	Bz 387	C100



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