

## Parameters for Diamond Cutters (PCD)

### General:

The carbide shank of this center cutting tool is equipped with one or two cutting plates of polycrystalline diamond (PCD). This material consists of many unit crystals which will be sintered at a very high temperature and pressure. It has a very fine granulation, is extremely hard and nearly free from abrasion. So you can process non-ferrous metals like aluminium without cooling. In spite of that you will achieve a fantastic endurance and best surface qualities. Tests in ceramics have shown for instance a more than hundredfold endurance compared with a carbide tool.

### Fields of Application:

- A **Single Tooth Cutter** is – due to its large flute – especially suitable for working on plastics or softer wood.
- A **Double Tooth Cutter** will be used for all harder materials like aluminium, harder wood, reinforced plastics, ceramics, graphite, compound materials and other highly abrasive materials.

### Hints for Machining:

- In general, liquid cooling is not necessary for diamond tools. However, we recommend to cool with compressed air in order to blow out the milled channel and to prevent chips from clogging there. The straight flute of a diamond tool cannot transport the chips so effectively to the top like the spiral flute of a carbide tool.
- An effective dust extraction can enhance the effect of the air cooling.
- Be careful when you have milled very deep channels. In this case, it is often no longer possible to extract the chips effectively and even the spray nozzle does not always reach the ground of the channel.
- The less porous your material is, the more you should take care that the chips will be optimally blown out with compressed air. Porous materials (ceramics, wood, certain foam materials) produce very small chips with just a little risk of clogging. A long-chipping material like aluminium on the other hand produces rather great chips with an increased risk of clogging. Thus you should set – especially when milling deeper channels – only a small value for the dipping depth into the workpiece.
- When you choose a tool, you should always choose one with a chip channel that is a little bit greater than the total material thickness. The length of the cutting edge should be a little bit longer than the set dipping depth. Tools which have a chip channel which is considerably oversized are less stable, so they can break more easily and they do not have an optimal true running accuracy. If the chip channel is smaller than the material thickness, the chips cannot be removed any more. This leads to worse milling results and possibly also to a broken tool. Tools with an especially long cutting edge should be used only for a finishing step, because here the chip removing capacity is slightly limited, too.
- The following guiding values apply for the dipping depth of the tool into the workpiece:
 

aluminium	0.2 to 0.4 fold cutting edge diameter
GRP/CRP	0.3 to 0.6 fold cutting edge diameter
plastics (acrylic, PVC etc.)	0.5 to 1 fold cutting edge diameter
ceramics/graphite	0.5 to 1 fold cutting edge diameter
wood	1 to 2 fold cutting edge diameter
- Tip: You can use a diamond single tooth cutter when you want to process the materials listed under "Fields of Application" with a smaller cutting edge diameter. For technical reasons, it is not possible to equip tools with smaller cutting edge diameters with more than one cutting edge. Please take care that you readjust the rotational speed and the feed rate accordingly while processing these materials.

### Other Important Hints:

- Diamond tools are not suitable for working on steel.
- Some laser tool measuring devices do not recognize the diamond automatically, so they return wrong tool lengths. Please adjust the tool manually in such a case.
- As the diamond is not conductive, this tool cannot be used with measuring units which need to establish an electrical contact for the measuring process (for instance the automatic z adjustment unit from vhf).
- The diamond is regrindable for several times. We offer this service on request. Please allow approximately 14 days for this service.



Single tooth cutter (left) and double tooth cutter (right) with cutting edges of polycrystalline diamonds

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## Please note...

In order to achieve best results with your new precision tool for a long time, you should set your tool parameters according to the following data. However, whether it is actually possible to work with these theoretically determined values for feed rate and rotational speed depends on the interaction of a number of factors. Thus we cannot assume liability for the calculated values. Among others, the following factors determine the machining process:

- additional cooling with compressed air or lubrication?
- power/maximum rotational speed of the spindle
- minimum/maximum feed rate of the CAM system
- controller features (look-ahead path calculation, etc.)
- stiffness of the machine.

## Formulas

$$\text{Rotational Speed: } n \text{ [rev/min]} = \frac{v_c \text{ [m/min]} \times 1000}{\pi \times d \text{ [mm]}}$$

$$\text{Feed Rate: } v_f \text{ [mm/min]} = f_z \text{ [mm]} \times z \times n \text{ [rev/min]}$$

### Variables:

n	rotational speed	$v_f$	feed rate
$v_c$	cutting speed	$f_z$	feed per tooth
d	cutting edge diameter	z	number of cutter teeth

## Cutting Speed

Material	Cutting Speed $v_c$ [m/min]
Copper alloy (brass-bronze)	400–900
Copper alloy (aluminium-bronze)	300–700
Cast aluminium alloy, Si < 8%	400–1800
Cast aluminium alloy, Si > 8%	300–800
Graphite	200–1000
Ceramics	200–700
GRP/CRP materials	300–1800
Plastics (PVC, acrylics, ...)	400–1800
Wood	400–1200

## Feed per Tooth

Cutting Edge Diameter (d)	Feed per Tooth ( $f_z$ )
3.00 mm	0.012–0.05
4.00 mm	0.016–0.08
6.00 mm	0.020–0.12
8.00 mm	0.025–0.15

### Hints for the calculation

#### Cutting speed/rotational speed:

A diamond tool can achieve very high cutting speeds (rotational speed of up to 100,000 RPM) because there is no risk that the cutting edge may overheat. As such a speed can be reached by only few spindle types, you could work theoretically in most cases with the maximum rotational speed of your spindle. However, we do recommend to stay approximately 20% below the maximum rotational speed in order to reduce the spindle load. Moreover, the spindle runs smoother then. The minimum rotational speed, however, should amount to at least 18,000 RPM.

#### Which values should be used for the calculation?

In general, you should approximately choose the average value of the given range for the cutting speed and the lower value for the feed per tooth. So you will work with rather high rotational speeds and low feed rates. Then you can approximate slowly to the optimum values for your given conditions. Please insert the rotational speed with which you actually work into the formula for calculating the feed rate in case it should deviate from the rotational speed which you have calculated before.

#### Sample calculation:

You want to mill aluminium (Si < 8%) with a PCD double tooth cutter. Your spindle has a rotational speed range of up to 60,000 RPM, however, you want to avoid a higher spindle load and so you work with a maximum of 50,000 RPM:

$$\text{Rotational Speed: } \frac{1100 \text{ m/min} \times 1000}{3.14 \times 6 \text{ mm}} = 58,386 \text{ RPM}$$

$$\text{Feed rate: } 0.018 \text{ mm} \times 2 \times 50,000 \text{ RPM} = 1,800 \text{ mm/min} = 30.0 \text{ mm/s}$$