GUIDE 4 OF 6

Set Up Your Tools

Carvio works out every toolpath from the bit you will use: how wide it is, what shape its tip has, how fast it may cut. This guide puts your bits into the **Tool Database** with safe starting values.

IN THIS GUIDE

- The three bits a beginner needs
- What Carvio needs to know about a bit
- Adding your own bits to the Tool Database
- Feeds and speeds in plain words, with safe starting values
- V-bits, materials and tool numbers
- What a bad cut is telling you

YOU WILL NEED

- Your bits, and their packaging or the shop's listing
- Calipers (a cheap digital pair is fine)
- The collets that came with your spindle or router

The three bits a beginner needs

You do not need a drawer full of bits. Three cover almost everything in these guides, and the starter library in Carvio already has all three.

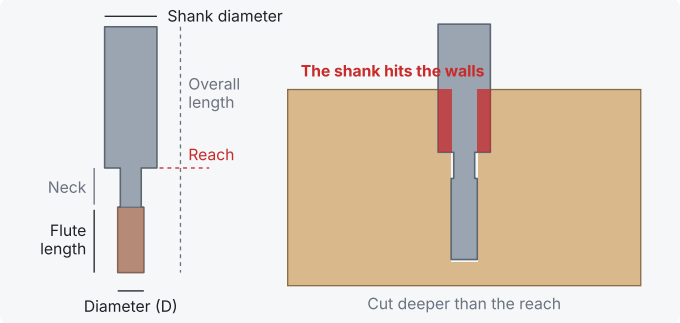
Bit	What it is for	Buy
6 mm (or 1/4 inch) end mill	Cutting parts out, pockets, roughing. Your workhorse.	Two flutes, carbide, "upcut" or "downcut". Downcut leaves a cleaner top edge on plywood.
3 mm (or 1/8 inch) end mill	Small pockets, tight inside corners, fine parts.	Two flutes, carbide. Breaks more easily, so cut gently.
60 or 90 degree V-bit	Lettering and decorative carving (V-carving), chamfered edges.	A 60 degree bit suits most signs; 90 degrees gives wider, shallower letters.
Later: ball nose	Smooth 3D shapes.	Not needed for your first cuts.

Shank size and collets

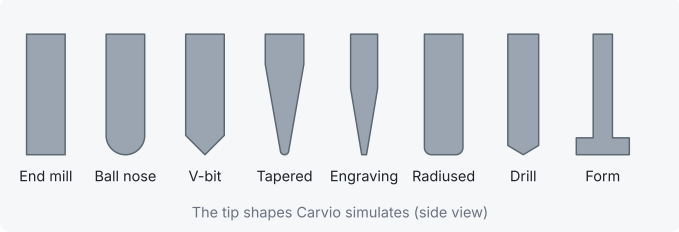
The **shank** is the plain part of the bit that goes into the spindle. It must match a **collet** you own exactly: a 1/4 inch shank (6.35 mm) does not fit a 6 mm collet, and a 1/8 inch shank (3.175 mm) needs a 1/8 inch collet. Check what collets came with your spindle before you buy bits. Never use bits with a guide bearing on a CNC machine.

What Carvio needs to know about a bit

Every bit in the Tool Database has a few sizes and a few cutting values. The sizes come from the bit; the cutting values are how hard you will drive it.



The sizes of a bit. The cut can go no deeper than the flute length without the shank rubbing on the walls.

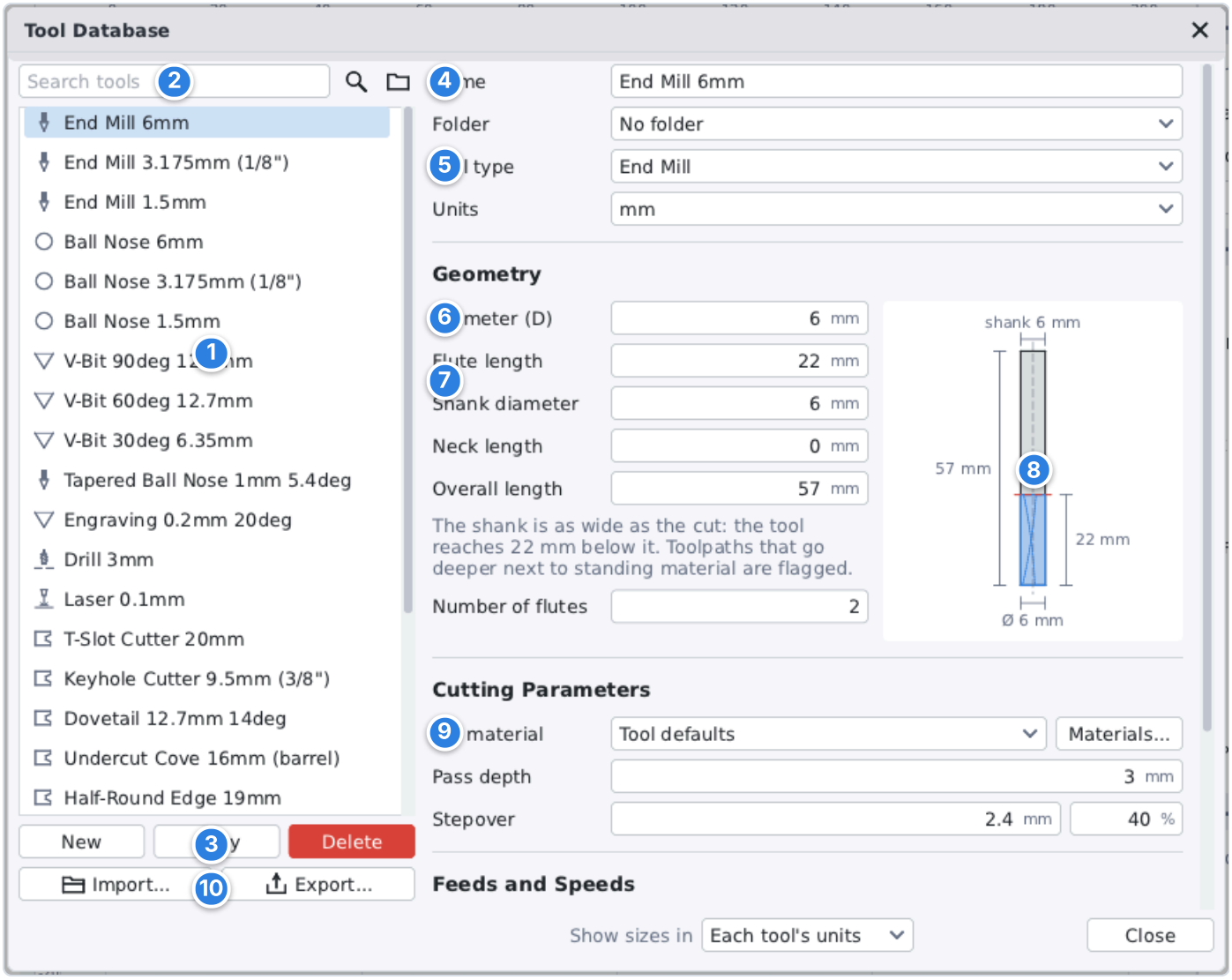


The tip shapes Carvio knows. For now you need **End mill** and **V-bit**.

Field	What it means	Where to find it
Diameter (D)	How wide the bit cuts. **The most important number**: every part and hole comes out wrong by the same amount if it is off.	On the packaging. Worn or cheap bits run a little small; a test slot measured with calipers tells the truth.
Flute length	The length of the cutting part. Carvio warns when a toolpath would cut deeper than this next to standing material.	Measure the fluted part with calipers.
Shank diameter	The plain part that goes in the collet.	On the packaging, or measure it.
Overall length	Tip to top of the shank. Only used to draw the bit.	Measure it.
Number of flutes	How many cutting edges. Most beginner bits have two.	Count them at the tip.
Pass depth, Stepover, Spindle speed, Feed rate, Plunge rate	How deep, how wide, how fast. Explained on the next pages.	Start from the table in this guide; adjust after a test cut.

Open the Tool Database

Choose **Toolpaths > Tool Database...** from the menu, or click **Tool Database** at the bottom of the Toolpath Operations on the Toolpaths tab. The list on the left holds the starter bits; click one and its details appear on the right.



The Tool Database with the starter 6 mm end mill selected.

1. **The tool list**. The starter bits come in metric sizes; the "3.175mm (1/8 inch)" ones are the imperial sizes.
2. **Search** finds a bit by name, size or number. The folder button groups bits into folders (handy once you own a lot of them).
3. **New** adds a blank bit. **Copy** duplicates the selected one, the easiest way to add your own. **Delete** removes it.
6. **Diameter (D)**: the cutting diameter.
7. **Flute length**, **Shank diameter**, **Neck length** (0 for most bits) and **Overall length**.
8. The **picture** redraws as you type, so a typo shows up at once.
9. **Cutting Parameters** and, below them, **Feeds and Speeds**: the values a toolpath starts with when it uses this bit. **For material** lets a bit keep different values for different materials (see *Materials* below).

4. **Name**: say what it is, with its size: "6mm downcut end mill". The name is what you will pick in every toolpath form.
5. **Tool type** is the tip shape; **Units** says whether this bit's sizes are typed in mm or inches. An imperial bit can be entered in inches even in a metric job.

10. **Import...** and **Export...** share tool lists as files, for example one a bit maker gives you.

Changes are saved as you make them. **Close** just closes the dialog. The tools live in a file in Carvio's settings folder, so they survive updates.

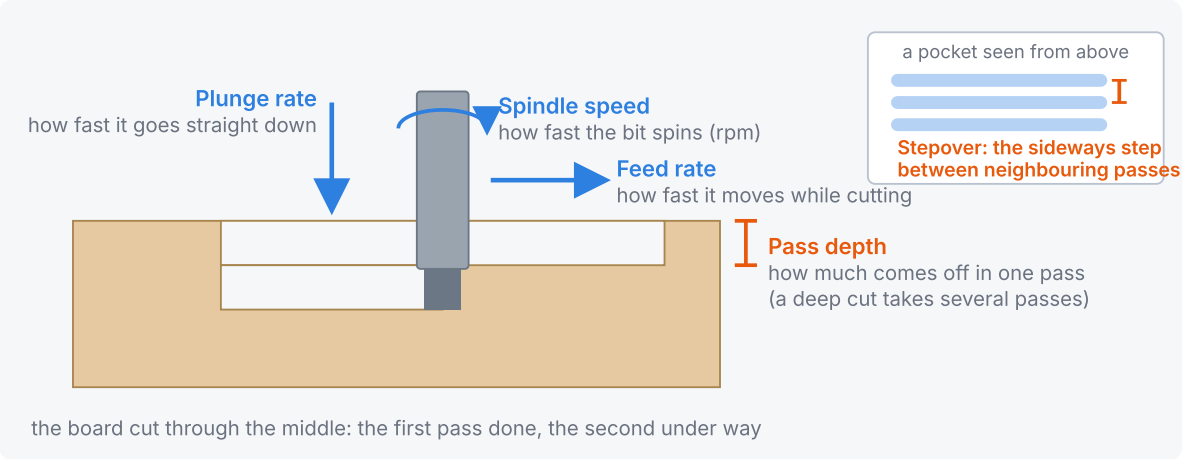
Add your own bit in five steps

1. In the list, click the starter bit nearest to yours (for a 1/4 inch end mill, **End Mill 3.175mm (1/8")** is the same family; for a 6 mm one, **End Mill 6mm**).
2. Click **Copy**. The copy appears below it, selected.
3. Change the **Name**. If the bit is imperial, set **Units** to inches first, then type the sizes as they are written on the packaging (0.25 for a 1/4 inch bit).
4. Type the **Diameter**, **Flute length**, **Shank diameter** and **Overall length**. Check the picture looks like the bit in your hand.
5. Scroll down and set the cutting values from the table on the next page. Give it a **Tool number** nobody else has (1, 2, 3...). Done: it is ready to pick in any toolpath form.

> **Do this for every bit you own**
> Ten minutes now saves you from picking "End Mill 6mm" for a 1/4 inch bit later and wondering why every part is 0.35 mm too small.

Feeds and speeds in plain words

A router bit cuts by taking small chips. Five numbers decide how big those chips are and how hard the machine works. They are not magic: there is a safe range for each, and a beginner should start at the gentle end of it.

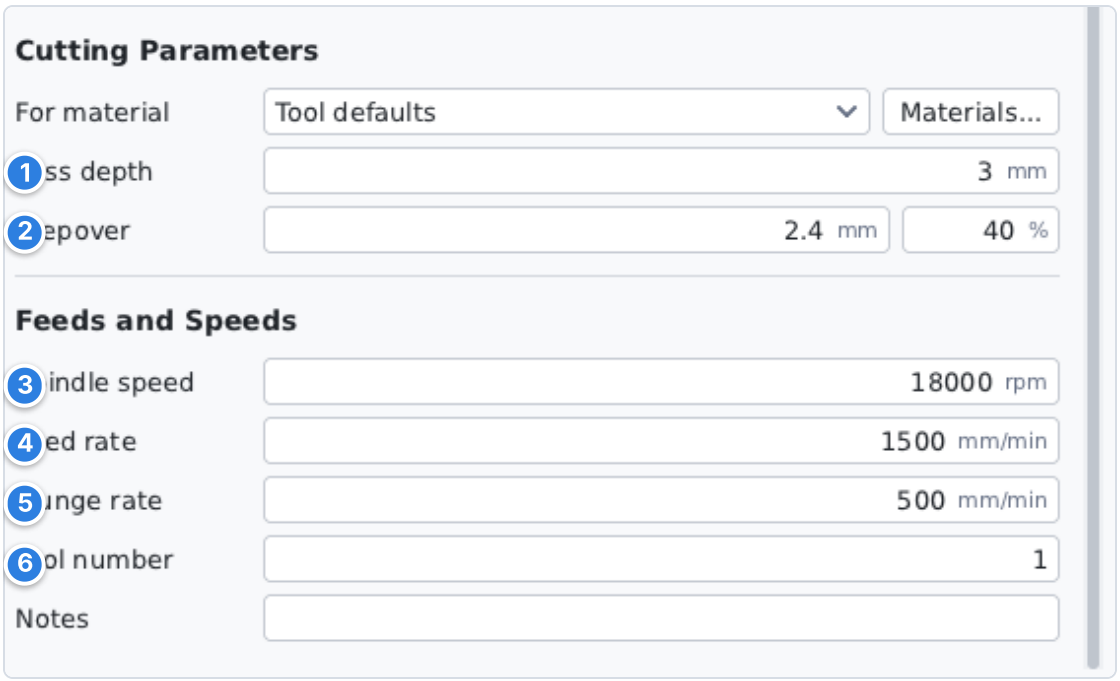


Pass depth, stepover and feed rate: how deep, how far across, how fast.

Value	What it means	Rule of thumb
Spindle speed (rpm)	How fast the bit spins.	Most hobby spindles and trim routers do well at 16000 to 20000 rpm with small bits. Leave it there to begin with.
Feed rate (mm/min)	How fast the bit moves sideways while cutting.	Too slow burns the wood and dulls the bit; too fast chatters and stalls the motors. Start around 1000 to 1500 mm/min for a 6 mm bit in soft wood.
Plunge rate (mm/min)	How fast the bit moves straight down into the material.	A third of the feed rate. End mills are poor at drilling straight down.
Pass depth (mm)	How deep one pass goes. A cut deeper than this is taken in several passes.	Half the diameter of the bit in soft wood, a third in hardwood, less on a small or flexible machine.
Stepover (mm or %)	How far across the bit moves between two neighbouring passes when clearing an area (a pocket).	40% of the diameter is a good general value. Carvio shows both the mm and the percentage.

Where the values go

Scroll the right-hand side of the Tool Database down to **Cutting Parameters** and **Feeds and Speeds**.



The lower part of a tool's settings.

1. **Pass depth**: how deep each pass goes.
2. **Stepover**: type either the distance or the percentage; the other follows.
3. **Spindle speed** in rpm.
4. **Feed rate**: the sideways cutting speed.
5. **Plunge rate**: the speed straight down.
6. **Tool number**: the number Carvio calls out at a tool change ("load T2"). Give each bit its own. **Notes** is for yourself: where you bought it, which collet, how a test cut went.

Safe starting values

These are deliberately gentle values for a hobby router with two-flute carbide bits. Cut your first parts with them, then speed up in steps once the cuts are clean and the machine sounds happy. A small desktop machine with a weak spindle should halve the feed rate and pass depth.

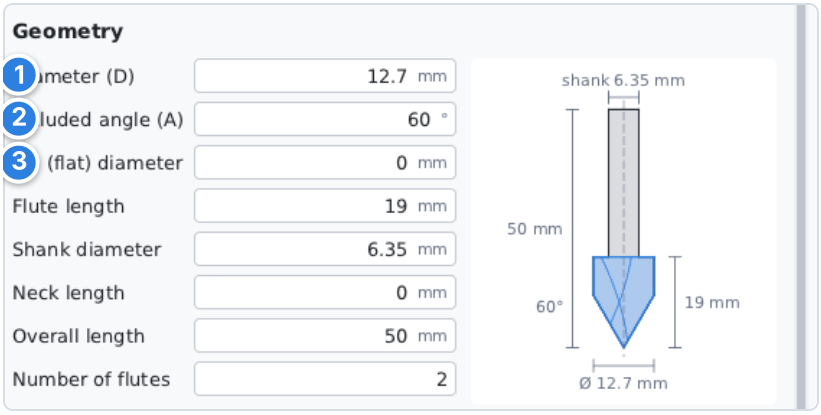
Bit	Material	Spindle	Feed	Plunge	Pass depth	Stepover
6 mm / 1/4" end mill	Softwood, plywood, MDF	18000 rpm	1500 mm/min	500 mm/min	3 mm	40%
	Hardwood	18000 rpm	1200 mm/min	400 mm/min	2 mm	40%
	Acrylic, HDPE	16000 rpm	1000 mm/min	300 mm/min	1.5 mm	40%
3 mm / 1/8" end mill	Softwood, plywood, MDF	18000 rpm	1000 mm/min	300 mm/min	1.5 mm	40%
	Hardwood	18000 rpm	800 mm/min	300 mm/min	1 mm	40%
60 or 90 degree V-bit	Any wood	18000 rpm	1000 mm/min	300 mm/min	3 mm	10%

In inches: 1500 mm/min is about 60 in/min, 1000 mm/min about 40 in/min, 3 mm about 1/8 inch. Carvio shows the units your app is set to (Edit > Preferences > Units).

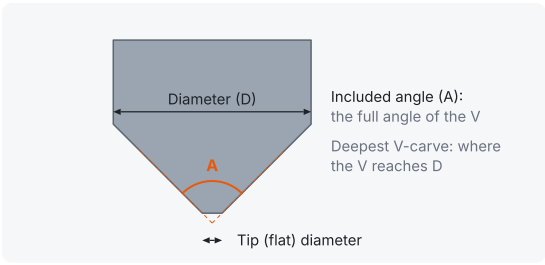
> **A toolpath can override these**
>
> Every toolpath form has a **Tool Settings** section showing the same five values. Change them there to affect that one toolpath only; change them here to change the starting point for every new toolpath.

V-bits

A V-bit carves letters whose width changes with depth: the deeper it goes, the wider the cut. Carvio works the depths out from the bit's **angle**, so the angle must be right.



The starter 60 degree V-bit.



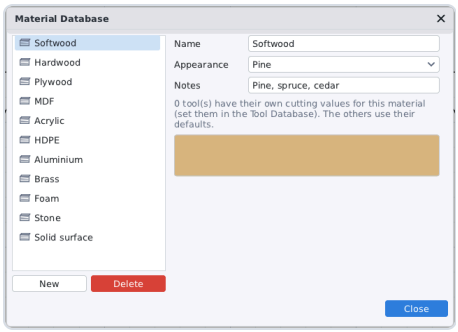
1. **Diameter (D)**: the widest part of the V, usually the same as the shank. V-carving can go no deeper than where the bit reaches this width.
2. **Included angle (A)**: the full angle of the V: 60 for a 60 degree bit, 90 for a 90. Some makers quote half of it ("30 degrees per side"); double that.
3. **Tip (flat) diameter**: 0 for a sharp point. Engraving bits often have a small flat, 0.1 to 0.5 mm, printed on the packaging.

Materials

Toolpaths > Material Database... lists the materials you cut. Each job picks one in Job Setup (Guide 6). A material does two things: it paints the 3D view and the simulation with its **Appearance**, and it lets a bit keep **its own cutting values for that material**.

That second part is optional. The values on the bit itself (**Tool defaults**) are used whenever the bit has nothing special for the job's material. To add material-specific values, open the bit in the Tool Database, pick the material under **For material**, click **Set values for...** and type the slower hardwood numbers (say). Softwood can keep the defaults.

The list comes with the usual suspects. **New** adds your own, for example "Baltic birch 18 mm".



The Material Database.

⚠ What a bad cut is telling you

What you see or hear	What it usually means	Fix
Burn marks, smoke, a smell of scorched wood	The bit rubs instead of cutting: feed too slow for the spindle speed, or a dull bit.	Raise the feed rate by a quarter, or lower the spindle speed. Replace a dull bit.
Loud chatter, a rattling or screaming noise	Too much bite: pass depth or feed too high, or the bit sticks too far out of the collet.	Halve the pass depth. Push the shank further into the collet (leave only what the cut needs).
The motors stall or the part comes out shifted ("lost steps")	The machine was asked to push harder than it can.	Lower feed rate and pass depth. Check the belts, wheels and couplings are tight.
Fuzzy, torn top edges on plywood	An upcut bit lifts the top veneer.	Use a downcut or compression bit for the final pass, and a sharp one.
Parts come out slightly too small or holes too big	The Diameter in the Tool Database is bigger than the real bit (often 6 mm entered for a 1/4 inch bit, or the other way round).	Cut a test slot, measure it with calipers, and type that number as the Diameter.
The bit pulled down out of the collet during a cut	The collet was not tight, the wrong size, or the pass was far too deep.	Clean the collet and nut, use the right size, tighten properly. Reduce the pass depth.
A warning that the shank will hit the walls	The toolpath cuts deeper than the bit's flute length.	Use a longer bit, or cut in two setups. Check the flute length you typed.
Plastic melts and welds back together	Spindle too fast, feed too slow, chips not clearing.	Lower the spindle speed, raise the feed, use a single-flute bit for plastics.
Carved letters are too wide or the V does not reach the corners	The V-bit's angle is wrong in the Tool Database (half-angle entered), or the Diameter is too small.	Enter the full included angle; measure the widest part of the V.

Next: Guide 5, Connect, Jog, Home and Set Zero: the first time you move the machine from Carvio.

The Carvio Beginner Guides: 1 Start Here · 2 Know Your Machine · 3 Set Up Your Machine in Carvio · 4 Set Up Your Tools · 5 Connect, Jog, Home and Set Zero · 6 Your First Job and Test Cuts