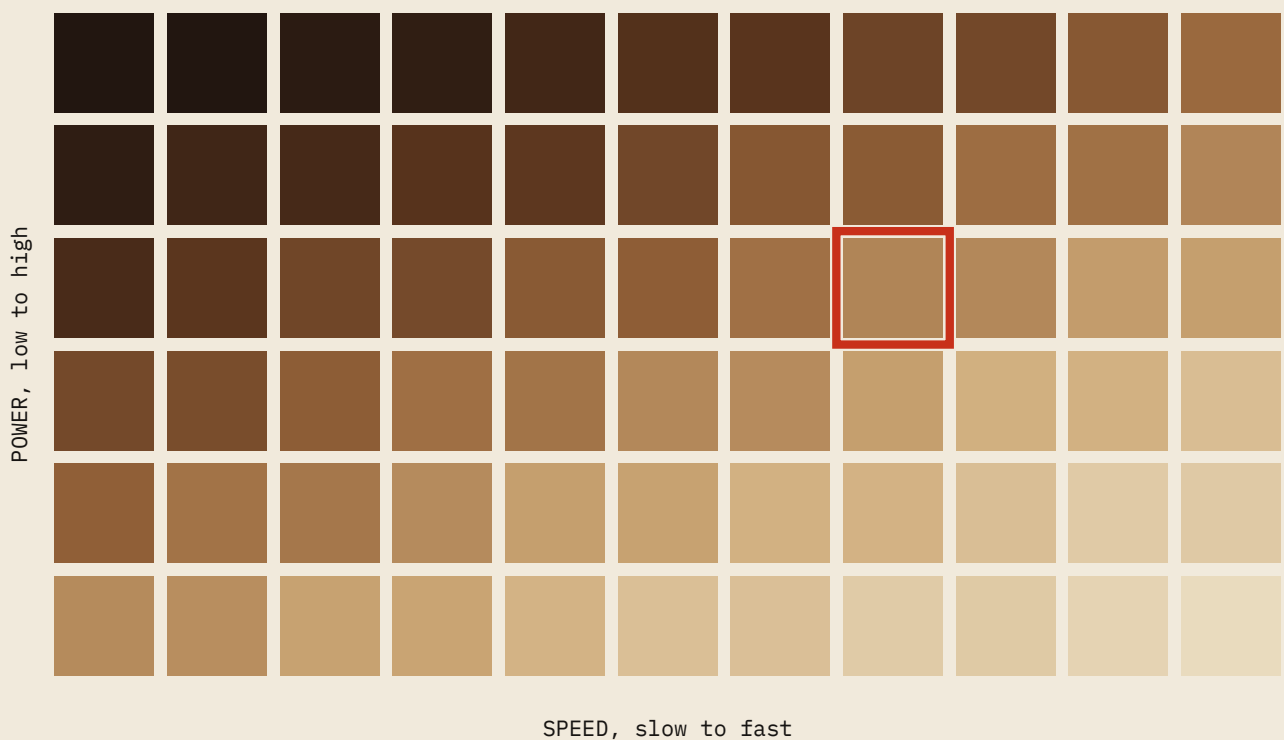


THE LASER SETTINGS HANDBOOK

Starting settings for 18 machines and 9 materials, with the fixes that stop you burning through stock.



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HOW TO USE THIS BOOK

Every number in here is a starting point. Two machines of the same model rarely cut alike, and two sheets of plywood from one shop can differ more than two lasers do.

Where the numbers come from

We compiled the settings from manufacturer documentation, from settings that makers have published, and from the formula working shops use to scale speed with laser power. We have not run these machines ourselves, so treat each row as the first cell of your own test grid.

Ten minutes that replace guessing

- 1** Find your **machine** in part 3 and your **material** in part 2. If the two disagree, start from the machine chapter.
- 2** Focus **first** (chapter 01). A cut that fails on good numbers is often out of focus.
- 3** Burn a **test grid** (chapter 02) on an offcut of the same sheet, around the starting numbers.
- 4** Take the **fastest cell that cuts clean**. Slow and hot leaves more char on the edge.
- 5** Write it down on the log sheet at the back, with the supplier and the thickness you measured.

How to read a settings row

WRITTEN AS	MEANS
 70% / 12 / 1 pass	70 % power, 12 mm/s, one pass. The bar shows the power.
 25% / 250 mm/s	Engraving at 25 % power and 250 mm/s scan speed.
mm/min	LightBurn's default unit on many diode machines. Divide by 60 for mm/s.

The ruler and the bed drawings

Print at 100 % and the ruler at the head of each chapter is true to scale. The bed drawings in part 3 are 1:8, with an A4 sheet and a 300 mm craft sheet drawn in for comparison.



Do not cut PVC, vinyl or a plastic you cannot name. They release chlorine gas, which is toxic and corrodes the machine. Stay with a running laser, keep a fire blanket or a CO2 extinguisher within reach, extract the fumes outdoors, and wear eyewear rated for your wavelength on any machine without a full enclosure.

TIPS AND FIXES

Focus, air and test grids come before any number in a chart. Then what to check when a cut stops working.

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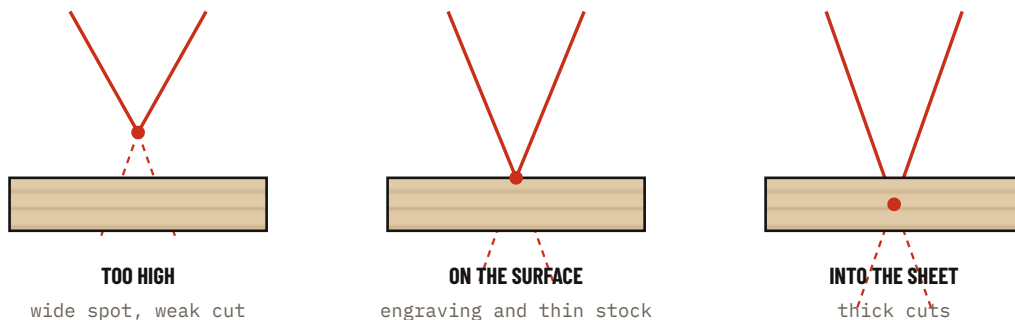
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01

HOW TO FOCUS A LASER PROPERLY (AND THE RAMP TEST THAT PROVES IT)



Soft edges, weak engraving and tapered cuts are focus problems far more often than power problems. This chapter covers how to set focus, how to check it, and the one rule that changes for thick cuts.



The beam narrows to a waist and widens again. Where that waist sits decides the width of the cut.

1. Focus on the material, not the bed

The focus gauge sets the distance between the lens and the *top surface of the workpiece*. The bed doesn't come into it. Swap 3 mm ply for 6 mm and your focus is 3 mm out, enough to soften an engraving where you can see it. Re-focus every time the stock thickness changes. If your machine has autofocus, check that the probe lands on the material and not in a cut-out.

2. The ramp test: find true focus in one burn

Tape a strip of scrap at an angle so one end sits low and the other high, then engrave a single thin line along it. The line is narrowest and darkest where the beam waist crosses the surface. Measure from that point back to your lens and you have your true focal distance, which is often a millimetre or two off the number in the manual. Do this once per lens and write the result on the machine.

3. For thick cuts, drop focus into the material

Most people miss this one. A focused beam is an hourglass, narrow at the waist and wider above and below. Focus on the top surface of 6 mm stock and the beam is already spreading by the time it reaches the bottom. The kerf tapers and the last millimetre never clears. Focus roughly one third of the way into the thickness and the waist sits inside the material, which gives a straighter, cleaner cut. For engraving, keep focus on the surface.

4. Lens focal length changes what you can do

A short lens (1.5") makes a tiny spot that suits fine engraving, but its depth of focus is shallow and it struggles through thick material. A longer lens (2.5"-4") has a larger spot and holds usable focus over more depth, which suits cutting. If you cut thick stock and engrave fine detail on the same machine, buy two lenses. One lens for both jobs is a compromise that does neither well.

5. Things that quietly ruin focus

- **Warped material.** A 2 mm bow moves the surface out of focus across the sheet. Clamp, pin or magnet it flat.
- **A bent focus gauge.** Cheap acrylic gauges get knocked about and shaved by the beam. Check yours against a caliper.
- **Play in the head.** If the carriage rocks, focus shifts as it moves. Check the wheels and eccentric nuts.
- **Bed not parallel.** Focus is right at the front and wrong at the back. Measure head-to-bed at all four corners.



Rule of thumb: Change one thing at a time. Re-focus, run a short test cut and look at it. If you adjust focus, speed and power together, you can't tell which one made the difference.

FAQ

Should I focus on the surface or inside the material?

Focus on the top surface for engraving. For cutting thicker material, focus roughly one third into the thickness so the narrow waist of the beam sits inside the material. You get a straighter kerf and the cut clears the bottom more easily.

What is a ramp test?

Engrave a single line along a piece of scrap propped at an angle. The point where the line is thinnest and darkest is your true focal distance. It is the fastest way to check focus without trusting the supplied gauge.

Why is my laser engraving blurry?

It is almost always focus. Check that you set focus for the actual material thickness, that the material is flat, and that the focus gauge hasn't been bent or burnt. A dirty lens can also soften the spot.

Do I need to refocus for every job?

Refocus whenever the material thickness changes. Same material, same thickness and same lens means no. Machines with a motorised Z or autofocus still need the correct thickness entered.

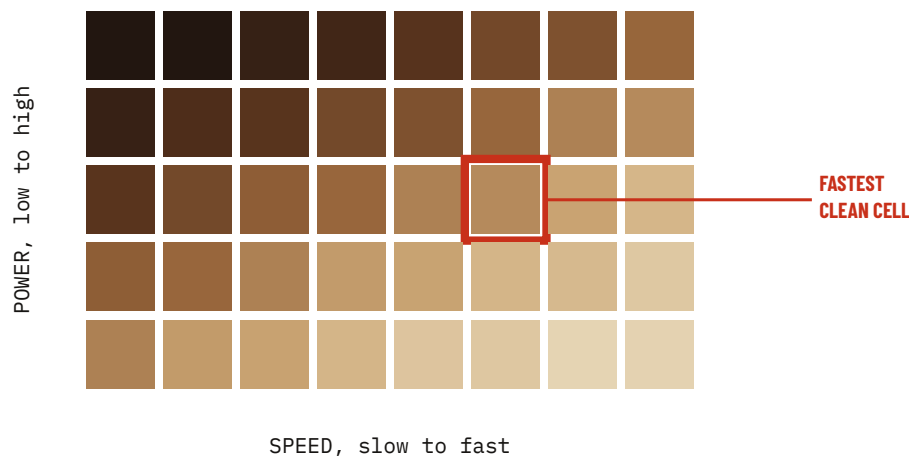
On the site, with the calculator: getlaserquote.com/blog/how-to-focus-a-laser.html

02

HOW TO RUN A LASER MATERIAL TEST GRID (AND READ THE RESULT)



Every settings chart on the internet, including ours, is a starting point. A test grid turns that starting point into *your* numbers, for your machine, your lens and your sheet. It takes about ten minutes, and it is the most valuable habit you can build in laser work.



Read the grid from the fast side. The first cell that cuts clean is your setting.

Why a chart can only get you close

Two identical machines cutting the same nominal material won't want the same settings. These are the things that move the numbers, roughly in order of impact:

- **Focus.** Set it for the exact thickness. An out-of-focus beam is a wide, weak beam.
- **Air assist.** On wood it changes the result more than most setting tweaks.
- **Material batch.** Plywood glue lines, moisture and veneer colour all change how much power reaches the bottom of the kerf. Cast and extruded acrylic behave differently too.
- **Optics.** A lens with a film of resin on it can cost you a third of your power.
- **Age.** CO2 tubes and diodes both fall off over their life. A three-year-old tube doesn't cut like the chart it shipped with.

You can't see any of these in a table. All of them show up in a grid.

The ten-minute version

1. Take an offcut of the same sheet you will cut the job from.

2. Focus for that exact thickness.
3. Generate a 5×5 grid of 15 mm squares, with speed on one axis and power on the other.
4. Bracket a known starting point: about half to double the speed, and a power band around it.
5. Run it with the air assist you will use on the real job.
6. Push the squares out from the back and pick the *fastest, coolest* one that releases cleanly.
7. Write it down. A setting you can't find again is a setting you don't have.

Where to generate the grid

LightBurn

It's built in: **Laser Tools** → **Material Test**. Set the axes to Speed and Power, choose your min and max for each, and set the grid to 5×5. It generates the squares and the labels together, and the labels matter. An unlabelled grid is a puzzle by the time it finishes.

xTool Creative Space

There is no built-in generator. Draw a row of rectangles, then set power and speed per object, since XCS lets you give each object its own parameters. It's tedious the first time. Save the file and you can reuse it for good.

LaserGRBL

Free test-grid templates are easy to find for GRBL machines, or you can use the built-in engraving test pattern. Check the file's units before you run it. Most templates are written in mm/min, and a template meant for a 20 W diode will stall a 5 W one.

What ranges to test, by machine class

These are the brackets we would set for a cut grid on 3 mm plywood. Centre the grid on the middle of the range. If *every* square cuts through, your range was too slow, so retest faster.

MACHINE CLASS	MATERIAL	SPEED RANGE	POWER RANGE	PASSES	NOTE
5-10 W diode	3 mm plywood	120-260 mm/min	80-100%	2-4	Slowest class - expect passes. 6 mm ply is not realistic.
20 W diode	3 mm plywood	200-450 mm/min	80-100%	1-2	One pass is achievable on good ply.
40 W diode	3 mm plywood	400-900 mm/min	80-100%	1-2	Opaque acrylic only - never clear.
40-45 W CO2	3 mm plywood	8-18 mm/s	55-85%	1	K40 / Glowforge class. Cuts clear acrylic.
55-60 W CO2	3 mm plywood	10-24 mm/s	50-80%	1	Sweet spot for most small shops.

MACHINE CLASS	MATERIAL	SPEED RANGE	POWER RANGE	PASSES	NOTE
80-100 W CO2	3 mm plywood	14-30 mm/s	40-70%	1	Too much power scorches thin stock - go faster, not hotter.

i Units trap: diode machines are usually set in **mm/min** and CO2 in **mm/s**. 600 mm/min is 10 mm/s. Mixing the two is the most common reason a "tested" setting does nothing at all.

A cut grid and an engrave grid are different tests

Cut test

Look for release, not darkness. Push each square out from the back with light thumb pressure. The winner is the fastest, lowest-power square that comes out cleanly with no charring on the back face. A square with a beautiful dark edge is usually one you burned too long.

Engrave test

Here you trade contrast against detail and time. Run the grid at the line interval you intend to use, because interval changes both the look and the job time. Judge it from arm's length, not through a loupe, since engraving gets seen at viewing distance. If you raise lines per cm past the point where the lines stop being visible, you buy machine time nobody can see.

Five mistakes that make a test lie to you

Re-using focus from the last job

Focus is set for one exact material thickness. A grid run out of focus tests a wide, weak beam and every square looks bad. Re-focus for the sheet in front of you before the grid, not after.

Testing on a different sheet than the job

Run the grid on an offcut of the same sheet. A different batch of the same nominal material is a different material as far as the laser is concerned.

Steps that are too big

Jumping from 100% to 60% power in one step tells you almost nothing. Five steps across a range you already believe is close beat three steps across a range you are guessing at.

Turning air assist off to 'see better'

On wood, air assist changes the result more than most setting tweaks because it clears smoke out of the kerf. Test with the air assist you will use on the job, at the same pressure.

Judging a cut from the top face

The top always looks fine. Flip the piece over. The back face shows whether the beam made it through cleanly or barely scraped out.

Write the result down

The grid is worthless if the number lives in your head until next month. Keep a material library (LightBurn has one built in) with material, thickness, supplier, focus, air assist and the winning power/speed/passes. Put the supplier in there. It is the field that explains why last month's settings stopped working.

Once you have a reliable speed for a material, the question stops being about settings and becomes one of pricing. Our cutting time calculator turns a path length and that speed into machine time, and the file calculator does it straight from your SVG, DXF or PDF. Typical speeds per material are listed on our material pages.

Starting points to bracket

Don't start a grid from nothing. Start it around a number that is already close:

- Power & speed chart by wattage (chapter 16), 5 W to 100 W, diode and CO2.
- Settings for plywood and MDF (chapter 17)
- Settings for acrylic (chapter 18)
- Settings and speeds for your exact machine: xTool, Glowforge, OMTech, Creality Falcon, Trotec, Aeon and more.

If the grid still won't cut through at any setting, the problem is usually not the settings. See why won't my laser cut all the way through? (chapter 08) If there is no beam at all, see laser powers on but won't fire (chapter 10). For a material nobody has published settings for, see settings for a material with no chart (chapter 03). For scorched edges on an otherwise good cut, see how to stop burn marks on wood (chapter 05).

FAQ

How long does a laser material test grid take?

About 10-15 minutes for a cut grid and 5-10 for an engrave grid, including setup. A 5x5 grid of 15 mm squares is enough for most work. That is far less time than you waste guessing settings on a real job, and you only do it once per material and thickness.

What power and speed range should I test?

Bracket the chart value instead of starting from zero. Take a known starting point for your machine class, then test roughly half to double that speed and a power band around it. On a 40 W diode cutting 3 mm plywood that means about 300-900 mm/min at 80-100% power. On a 60 W CO2 it means about 8-20 mm/s at 55-95%. If every square cuts, your range was too slow, so retest faster.

How do I read a cut test grid?

Push the squares out from the back. The best setting is the fastest, lowest-power square that releases cleanly with a light push and no charring on the back face. Don't pick the square with the darkest edge, because that one is overburnt. If nothing releases, drop the speed or add a pass. Don't raise power to 100% and hold it there.

Why do my settings stop working on a new sheet?

Material batch is the biggest hidden variable. Plywood glue lines, moisture content and even the colour of the top veneer change how much power reaches the bottom of the kerf, and cast acrylic behaves differently from extruded. A lens that needs cleaning or a diode past its first few hundred hours shifts the numbers too. Re-run a small grid when you open a new batch.

Should I test at 100% power?

Include 100% in a cut grid so you can see the ceiling, but don't choose it as your working setting. Running a CO2 tube or a diode flat out continuously shortens its life. If only the 100% square cuts through, slow the speed or add a second pass. That gets you the same result at 80-90% power.

On the site, with the calculator: getlaserquote.com/blog/laser-material-test-grid.html