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**My Perpetual Safety Disclaimer:** You'll burn your eye out, kid! I am not a pro by any stretch of my imagination, so please exercise sufficient caution to avoid equipment damage, wasting materials, or injury to yourself or others.

And then there's this Blue Light Hazard article.

**For My Metric Friends:** God forbid, but somewhere in this article I think I might have referenced that most-abhorred, illogical unit of measurement known as "inches." If so, I beg your forgiveness and pray you will be appeased by the conversion widget which I have included just for you at the very bottom of this page. :-)

## Endurance Lasers Lens Pack Comparisons

by John Walker

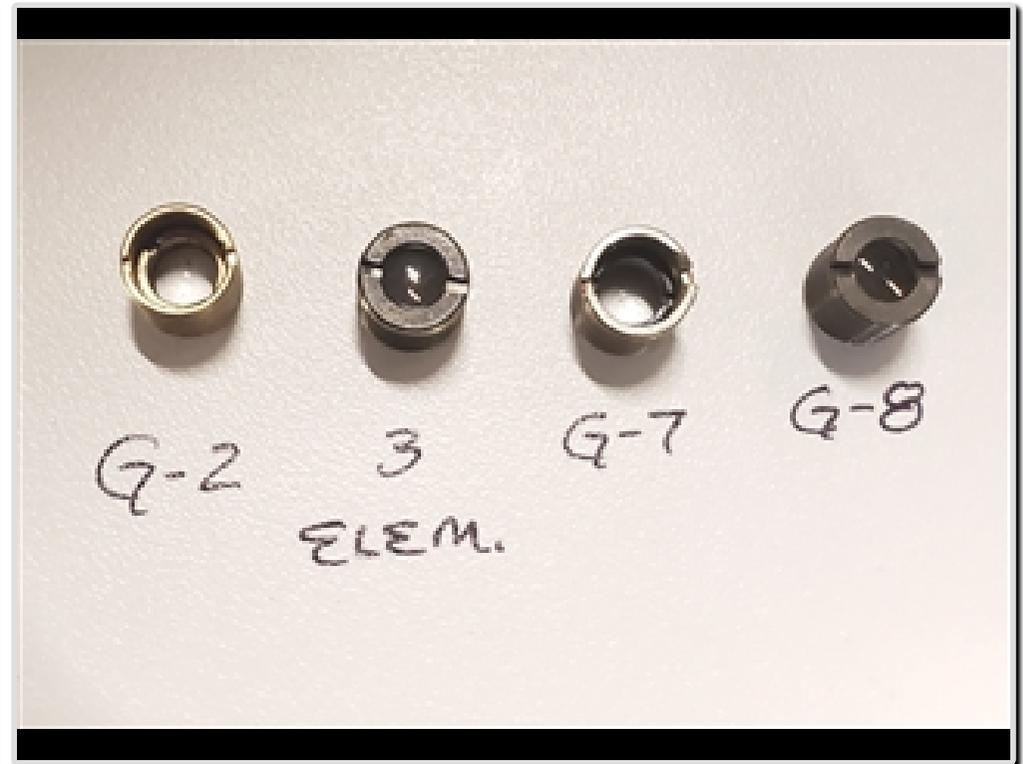
As you may know, Endurance Lasers offers several different lens configurations which are now available in a ["pack."](#) I now have the standard 3-Element, which came with my laser, and the G-2, G-7, and G-8 lenses which I received a couple of weeks ago. Now that I had them all, why not do a little experimenting?

My goal, then, was to determine which performed best at the tasks of cutting and engraving, using the same four woods that I had used in my previous tests: 1/4" Solid Poplar and Luan Ply, and 1/8" Baltic Birch Ply, Bass, Balsa woods. While the through-cutting goal was pretty straight forward, i.e., focus the lens and then get through the material with the best-looking cut using the fewest passes, the goal for photo engraving was necessarily different. It was NOT to produce the best looking raster image possible, as will become blatantly obvious a bit later. Rather, I merely sought to fairly compare the outcomes of the lenses using identical settings for the same image. (If I live to be 65 (next year), I don't know that I could determine which of the infinite settings could objectively lead to a "best picture" conclusion.)

If you've been following along to this point, you know that I have previously written two articles about using the Endurance 10 Watt Laser to [Through-Cut](#) and [Photo Engrave](#) using the standard 3-Element lens. While I didn't repeat the through-cutting test with the 3-Element, I have included photos here from the previous experiment for

comparison with these new lenses. And I did again bring out the 3-Element lens for the photo engraving portion so you could fairly compare all four lenses using the same image.

I hope this article will help you to decide which will best suit your needs.



## Decisions, Decisions

I'm assuming that those of us who want to cut through things like wood and plastics, but cannot yet afford a CO2 laser, will try to get the highest rated diode available. (Such a search is how I first found Endurance.) But a laser's power rating is nothing without a proper lens to deliver it. As you can see in the table, [here](#), under "Transparency," different lenses allow (or block) a certain percentage of light. For example, the 3-Element lens allows only 70% of the beam to pass through, which significantly reduces your laser's effectiveness. For those of us in the production business, this means a loss of nearly 20 minutes per hour! No thanks.

This is why I wanted a more complimentary lens. But which one - or two? As I discovered while conducting these tests, the choice wasn't as simple as I had imagined. For example, again referring to the table in the link above, the G-2 lens is the most powerful, delivering a whopping 96% of the laser's capability. If power is your primary need, you'll want this lens! But it isn't ideal for *all* that I do, and may not be for you, either.

## A Word On Focusing

I took great care to ensure the lenses were as in-focus as could possibly be achieved with my eyeballs, which still work, mostly. What may look like a charred or out-of-focus cut is the shadow within the kerf, because my lazy (busy) backside has yet to fashion a suitable light table. In hindsight, I coulda shoulda woulda shown the cutouts beside their holes.

I adjusted the focus for each wood and for each lens. If my math is right, that's 4 lenses times 5 different wood types, or a minimum of 20 separate focusings for this project. Further, if I thought something didn't look right, I refocused and cut again. And again. AND I adjusted, and readjusted, the distance from the lens (not the heatsink/housing) to the material. These cuts truly are the best that I could get.

### Lens Focal Lengths Used for Cutting and Engraving

G-2	1.25"
3-Element	2.5"
G-7	3.25"
G-8	3"

## Through-Cutting

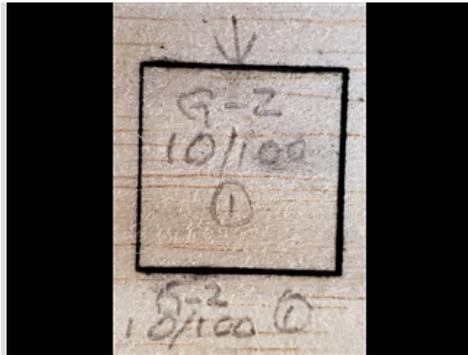
If you haven't read my previous articles, my pencil notations on the stock and cut-outs might lose you. So, before we get to it, here is a general explanation:

Excepting the photos for the 3-Element lens, I've noted the type of lens I used. Mostly, this will show near the top with a G prefix, followed by the lens number. The line that follows, with two numbers separated by a slash, indicates the speed in Inches Per Minute (IPM) followed by the power setting. In every case, I have used 100% power. Then, when you see something like 2 x .0625, it is the number of passes (2 in this case) and the depth of cut per pass expressed in fractions of an inch. On the 3-Element photos, you may see a third reference prefixed with a single or double "A". On those earlier tests, this was the distance from the material that [my Air Assist nozzle](#) was located. For the current tests, Air Assist was roughly position .5" above the material in all cases.

## Cutting 1/8" Balsa Wood

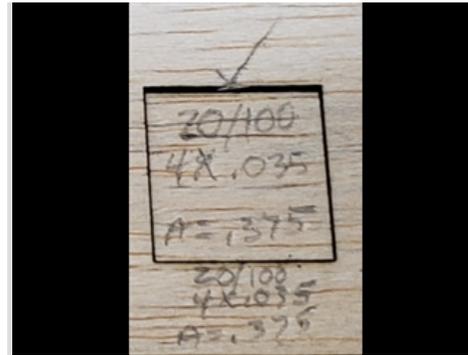
I know some of us like to cut balsa to make airplanes and whatnot, and each of the lenses did a pretty good job. I've only shown one photograph per wood type, again opting for the best look with the fewest cuts. If speed isn't an issue, you may be able to get a slightly better looking cut by adding another pass and adjusting your other settings accordingly.





### G-2 Lens 24 Seconds

This lens's short focal length and correspondingly wide divergence over short distances make it difficult to maintain a narrow through-cut the deeper you go. This isn't really an aesthetics issue, here, as the cuts on both the stock and the part look great once separated. The only time I could see the cut's width becoming a factor is if dimensions are critical.



### 3-Element Lens 48 Seconds

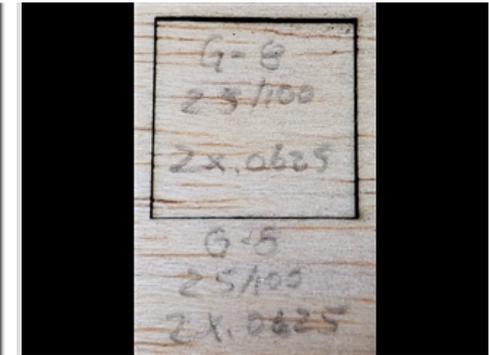
As I mentioned, all of the 3-Element photos are from my earlier tests.

I think this lens's longer focal length makes for a clean cut, albeit with a few more passes than I'd like for production work. As I recall (remember, I tested the 3-Element a while ago), I tried to get away with fewer, but ran into a charring problem. Fewer passes means slower travel, so more heat and charring for something as soft as Balsa.



### G-7 Lens 32 Seconds

This lens checks off my need for a longer focal length on some of my projects, while still transmitting a respectable amount of light/power. Needing to make only two passes at a decent speed (15 IPM) makes this a lens to consider.

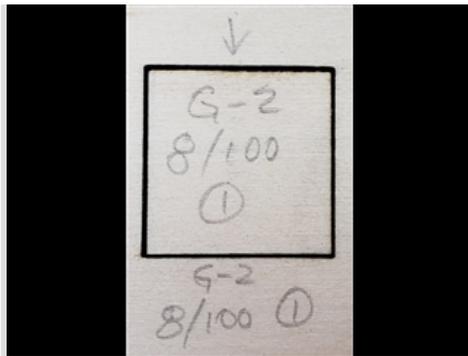


### G-8 Lens 19 Seconds

Ain't this a beaut? Look at the fine kerf. Look at that speed! At 25 IPM, it only takes 19 seconds to cut what the G-7 did in 32. And, for the record, it WILL cut the Balsa in one pass at 8 IPM, but I liked the look of the two pass a little better. Plus 25 IPM is nearly 40% faster. All of this is achievable due to its 90% light pass-through.

## Cutting 1/8" Bass Wood

I originally bought the bass wood to make tiny lapel pins and for photo engraving as the wood is quite white and the grain fine. Like Balsa, it's a pretty soft wood and requires a bit of care to prevent charring when trying to cut with slower speeds to get through in the fewest possible passes.



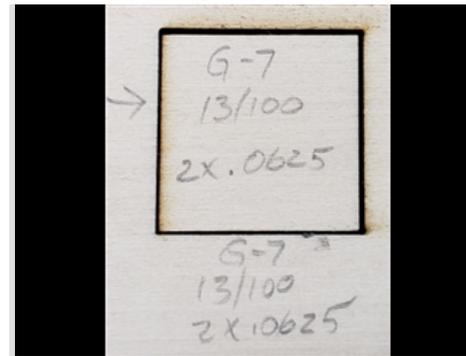
### G-2 Lens 30 Seconds

Bass, while still soft, isn't as much so as Balsa, so I had to slow it down a bit to get through in one pass. The whiter wood also makes the cut look cleaner.



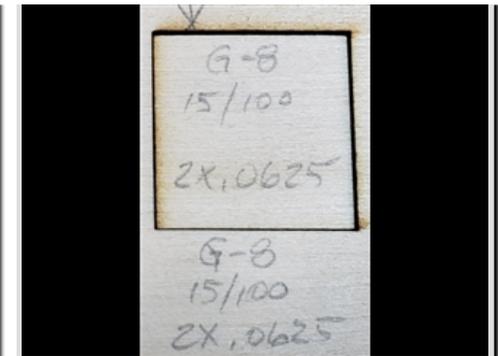
### 3-Element Lens 48 Seconds

With this being the "slowest" of the lenses, it figures that it would take the most passes to produce a good looking cut. Perfectly acceptable, though. 48 seconds here, versus 30 for the G-2, 37 for the G-7, and 32 for the G-8.



### G-7 Lens 37 Seconds

I'm not sure why, but both this lens and the G-8 produced a bit of flare on the top surface. (The bottom looked clean.) All of the wood I used was raw, i.e., no finish of any kind. I believe I read somewhere that this flaring can be eliminated by sealing the wood before cutting, and then basically wiping off any discoloration. Haven't yet tried this myself, though.

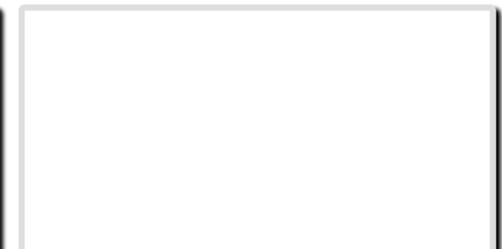
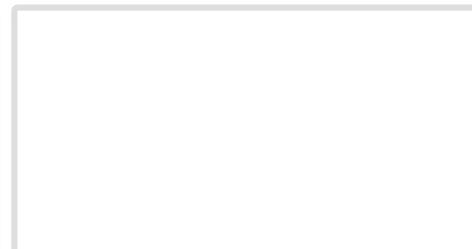
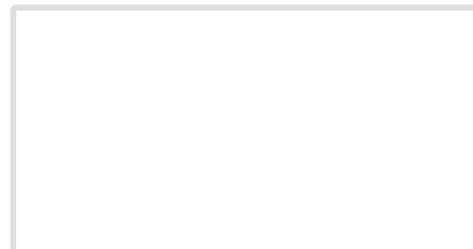
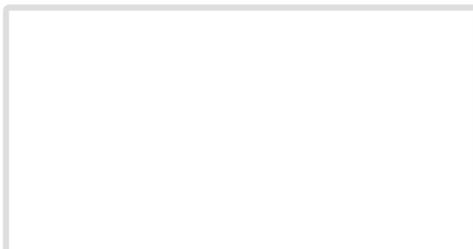


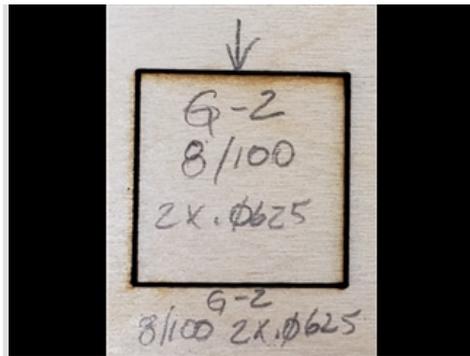
### G-8 Lens 32 Seconds

As with the G-7, there's a bit of flaring, but nothing drastic. All lenses cut pretty cleanly in the Bass.

## Cutting 1/8" Baltic Birch Ply

This is the wood that I will be cutting most, so was really interested in the outcome, here. In terms of both quality and speed, it looks like the G-8 comes out on top.





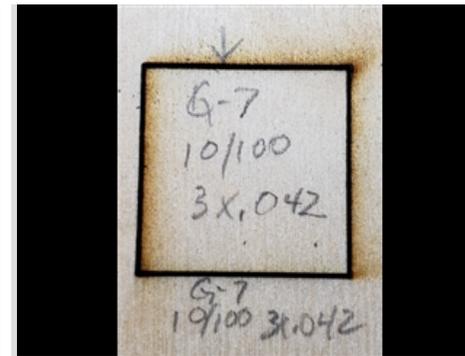
### G-2 Lens 1 Minute

Although the speed is equal to that of the G-8, I prefer the latter's finer cut. Some of what I'll be doing are finger-jointed boxes, so I don't want too much slop in the joints. I'm afraid the wider kerf of the G-2 might make it necessary to patch some gaps. On the other hand, it might give me a desirable clearance. This is a test for another day.



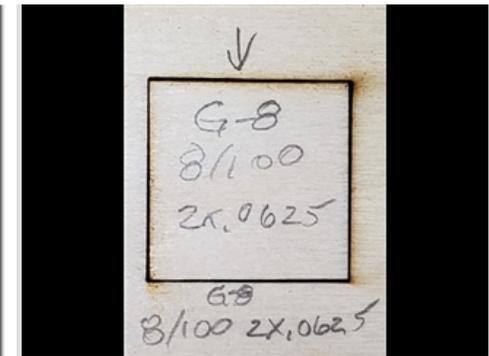
### 3-Element Lens 2.4 Minutes

Again, an acceptable cut, but this lens's relatively glacial pace is likely going to relegate it to the spare parts bin - carefully, of course.



### G-7 Lens 1.2 Minutes

Twice as fast as the 3-Element, but not as pretty as the G-8. This flaring could be caused by several factors, but I doubt that it's the lens. Still, all of these were cut from the same piece of wood, same temp and humidity, and same Air Assist, so I'm baffled.

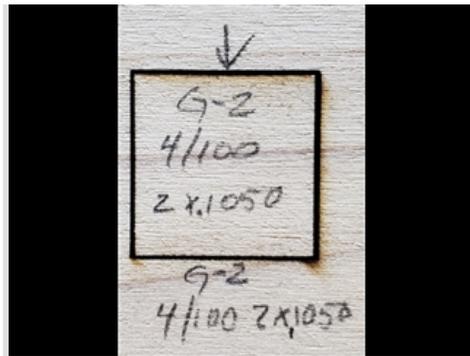


### G-8 Lens 1 Minute

Oddly, this cut looked better at 2 passes than another I did at 3 - with different speeds of course. Usually for me, the more and shallower the passes, the prettier the cut. Anyway, I'm pretty satisfied with this.

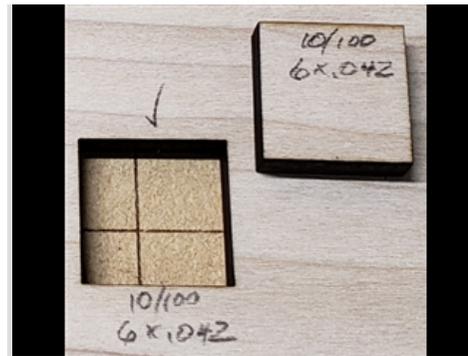
## Cutting 1/4" Poplar

Poplar is readily available to me, is relatively inexpensive, sufficiently sturdy at this thickness, and good-looking enough for many projects. While I wasn't too surprised to see the G-2 and G-8 run neck and neck, I expected that the G-7 would outperform the 3-Element. I imagine it was something I did, but, even after I ran the test a couple of times, I got the same result.



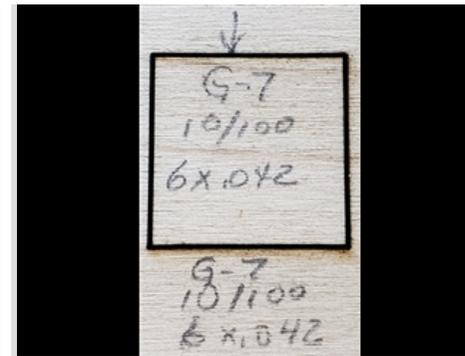
### G-2 Lens 2 Minutes

Great! Only two passes to get a handsome cut. (One pass was close, but no cigar.) In terms of equipment wear and tear - on a Shapeoko XXL in my case - the G-2's two, slow passes outshine the G-8's 5.



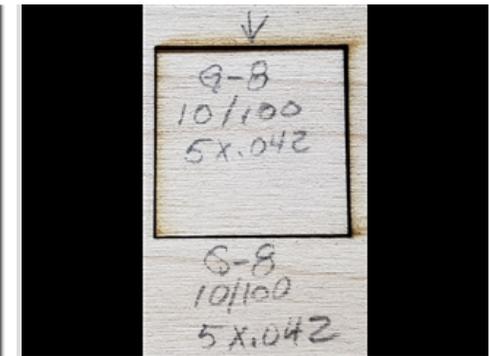
### 3-Element Lens 2.4 Minutes

When I ran the 3-Element test a few weeks ago, I was thrilled just to see it get through this stuff! But, at nearly a half a minute slower than either the G-2 or the 8, she's gotta go!



### G-7 Lens 2.4 Minutes

As I mentioned in this subsection's intro, I'm surprised that it didn't do better than the 3-Element, but the G-8 wasn't really a rock star here, either. Plus, I had the same relative results in the next (Luan) section where everything was readjusted. Although I'd've wanted it to be faster, it's still a good cut through a pretty thick material.



### G-8 Lens 2 Minutes

Not a speed demon on the Poplar, but it gave a nice, thin-kerfed cut in the same time as the G-2.

## Cutting 1/4" Luan Ply

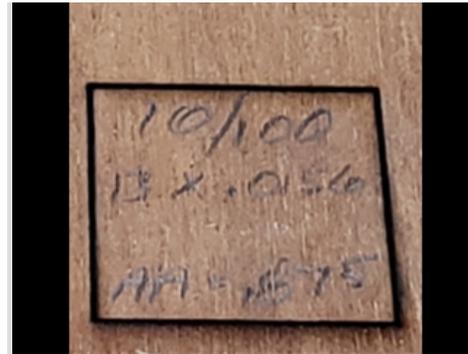
Last, and certainly least, is this subflooring. I had a bunch of left over from my last business, and see it as my "difficult child" when it comes to doing as I ask when laser cutting. It's the toughest of the woods I've tried in my tests so far. If the voids in it are filled at all, it's with a pink substance that I've yet to laser my way through at the same settings I use for the wood itself. Being this tough makes it an ideal test candidate, I think.





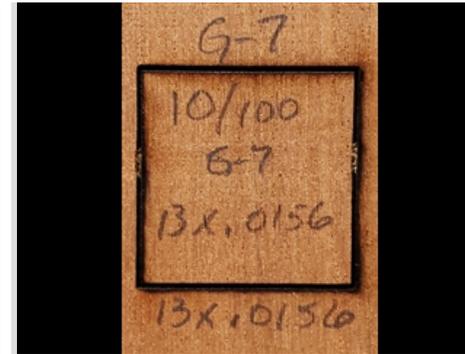
### G-2 Lens 4 Minutes

If you absolutely must through-cut subflooring, it can be done, though not quickly. Still, it's a decent looking, very consistent cut.



### 3-Element Lens 5.2 Minutes

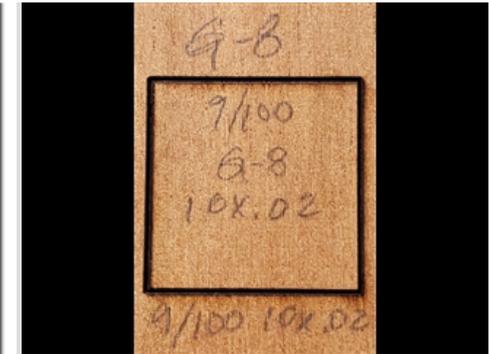
A bit more flaring than I'd like, and a full minute slower. But, again, it can be done if needed. Sometimes, it's about that. Maybe your scroll saw is kaput. Or maybe, like me, you don't have a scroll saw!



### G-7 Lens 5.2 Minutes

Again, as in the Poplar, above, its cut time is on par with the 3-Element. I was kind of glad to see this, as it leads me to consider that there's no problem at all. It just is what it is.

As for the look of it, I'm not happy. I worked my backside off over repeat cuttings, trying to ensure this was in focus, but it doesn't look like it. But, why worry when you have a G-8?!



### G-8 Lens 4.4 Minutes

Well, it did cut through with nearly 25% fewer passes than the 3-Element or the G-7, but the G-2 has 'em all licked, here, time-wise. Quality wise, this and the G-2 look pretty much on par to me.

## So No Clear Winner, But...

The 3-Element ranges roughly between 20-40% slower than the others - a loss of 10 to nearly 25 minutes every hour - so I'll be tucking it away to be used only as a spare. I'll comment more on some of the plusses/minuses of each of these at the end of this article.

## Photo Engraving

As I mentioned earlier, I decided to run with the same settings and photo across all four lenses because this exercise is dedicated to a raw comparison, versus using the same lens with different settings to achieve the best engraving. I hope you will agree that this was the only way to be completely objective.

I chose to use Luan Ply for this because it is more stout than the other light colored woods I have (the Bass and Baltic Birch), and the grain is pretty consistent.

## The Guinea Pig

This finely feathered friend seemed a good subject for the burning, considering the sharp, contrasting tones against a muddy background. The original was 407 pixels square at 72 dpi. Yes, I know, it's not what one would choose to get a good engraving but, again, that wasn't my goal. In the future, I hope to fine tune both a pic and LightBurn's settings to get the best engraving possible with a given lens, and will likely share my experience then.



## The Settings

I thought I'd throw in a screenshot of the LightBurn settings I used for the engravings:

**Cut Settings Editor - LightBurn 0.9.03** ? X

Layer [REDACTED]  
Name

Speed (in/min)   Output  
Max Power (%)   Air Assist  
Min Power (%)

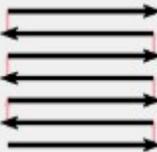
Mode

**Image Settings**

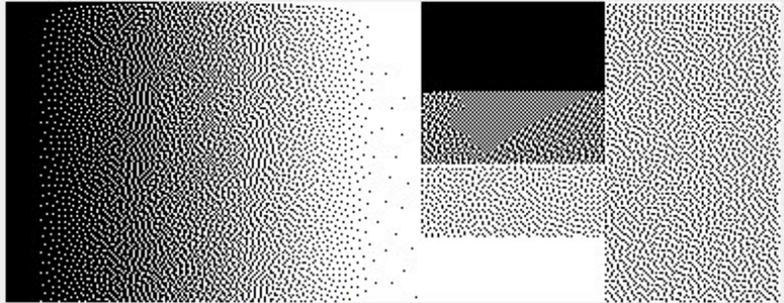
Bi-directional scanning  Negative Image

Overscanning  2.5%

Line Interval (in)   
Scan Angle (deg)   
DPI   
Image Mode   
Number of Passes   
Pass-Through



**Dither Sample**



Jarvis: High quality dithering. Usually the best choice for smooth shaded or photo images.

## LightBurn Settings

For all but Speed and Image Mode, I chose to use what I believe are LightBurn's defaults.

### The Results

Okay... I know that it's almost ridiculous to present these photos here. I've scaled everything to load quickly, so the presentation is much less than ideal. But I don't know that any combo of browser/monitor resolution is going to do a photo justice, making it all relative anyway. Still, the most obvious differences DO show, here, and I carefully try to point them out. Also, keep in mind that my comments are based on the engravings themselves, and not the pics, so I hope you won't deem this exercise to be entirely without merit. And I have made the original adjacent to each for your convenience.



**G-2 Lens**



**Original**

Of the four engravings, this one most closely approaches the blacks present in the original pic, bringing out the light patches in the background's foliage almost to a fault. What I can't explain is the dark area on the bird's belly, just above the bottom margin. It's not in the original or any of the other engravings, so I'm attributing it to a variation in the wood. No other apparent flaws. (C'mon... It's wood, not tile!)



**3-Element Lens**

Like the G-2, the foliage in the background is more prominent than in the original, but I almost like the look of the feathers better in this one. Remember, this is a substantially less powerful lens so, had I slowed it down a bit, it may have looked nearly identical to the G-2.

If you look closely, there is some vertical banding in the area nearest to the left margin. Actually, it's elsewhere, too, but most visible on the left. It's not the lens, because it shows in all of the engravings to varying degrees,



**Original**

especially in the lighter ones. I initially suspected the Jarvis Mode, but, when I did another burn using Grayscale, the bars were still there. I need to further dig into the cause.



**G-7 Lens**

This is so bizarre. Just inches away on the same piece of wood - the same slice of veneer - there is almost no background foliage visible. And it's quite muddy as well. I would have thought that, if anything was going to obliterate details, it would have been the G-2's more powerful beam. Still, this lens seems to have given the best detail in the face.



**Original**

**G-8 Lens**

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This one's tones are nearly identical to the 3-Element, but with slightly more detail in the face. In an attempt to get blacker blacks, I did try one slower, at 80 IPM. But, while I gained even more detail in the face, I lost nearly all of the contrast in the background, and considerable definition in the lower feathers.

**Original**

## Engraving Summary

We all know how important proper photo preparation and settings tweaking are to achieving an ideal result, and there's no doubt that great results can be had with any of these lenses if such care is exercised.

If I was asked to give a recommendation for photo engraving, I might suggest that the smallest, properly focused dot would yield the finest detail. If you again look at the [specs](#) of these lenses, that dot can be had with the G-2 followed by the G-8. The 3-Element and the G-7 on equal footing with the "largest" dot size, but we're still talking about a miniscule, possibly negligible difference for many applications.

## So, Which One(s)?

**The glorious G-2** If you need max power, this lens's 96% transparency says it is the way to go. I haven't done a metals test, but I imagine it might be pointless to even consider marking with any of the others since I have this one. Still, it's not without its drawbacks. For example, if you're working mostly with wood, like me, its short focal length will subject it to sap spatter, ash, smoke, etc., so will require more frequent cleaning than the others. That same short focal length might also leave little room for your air assist mechanism if you're through-cutting. Mine fit, but only with 1/4" to 1/2" to spare. And this may not be the lens for you if you need to shoot a beam around a tall obstacle or into the bottom of a deep pocket.

**The 3-Element** My biggest beef with this one is its relatively poor transparency, which means it will take longer to perform a given task - from 20-40% longer. If you run a production operation, this could significantly hamper your desire to save up for George's new DPSS Laser! I've otherwise been pretty happy with the 3-Element's performance.

**The G-7** Before I knew there was a G-8, this was the lens I badly wanted. At 85% transparency, it is considerably faster than the 3-Element, and has the longer focal length I favor. But, of the six lenses I now have, including two from [JTech](#), this is the most focus-UNfriendly lens of the lot. If you turn it into the laser's barrel much farther than 1/2 turn, you may have a tough time getting it to focus at all. I've read that you can do a barrel mod or addition, but why, when there's a G-8?

**The G-8** I was able to get this one to focus and effectively through-cut anywhere from 1.5" to nearly 3.5". Talk about focal range! Couple that with 90% light transmission, a narrow beam, and a darned small dot, and you pretty much have the best of everything in one lens.

So, if I could have only two of the four, I'd get the G-2 and G-8, and, if only one, the G-8. I like having the G-2's max power for the really tough to mark stuff, but its short focal length will keep me from leaving it attached. My every day lens, then, will be the G-8, as it has what I need for most of what I do.

## Thanks for Reading!

I can't imagine all of the use cases out there, but I truly hope this article will help you in some way.

Length Conversion

<input type="text" value="1"/>	Meter <input type="button" value="v"/>
<input type="text" value="3.28084"/>	Foot <input type="button" value="v"/>

Conversion Widget Compliments of:  
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