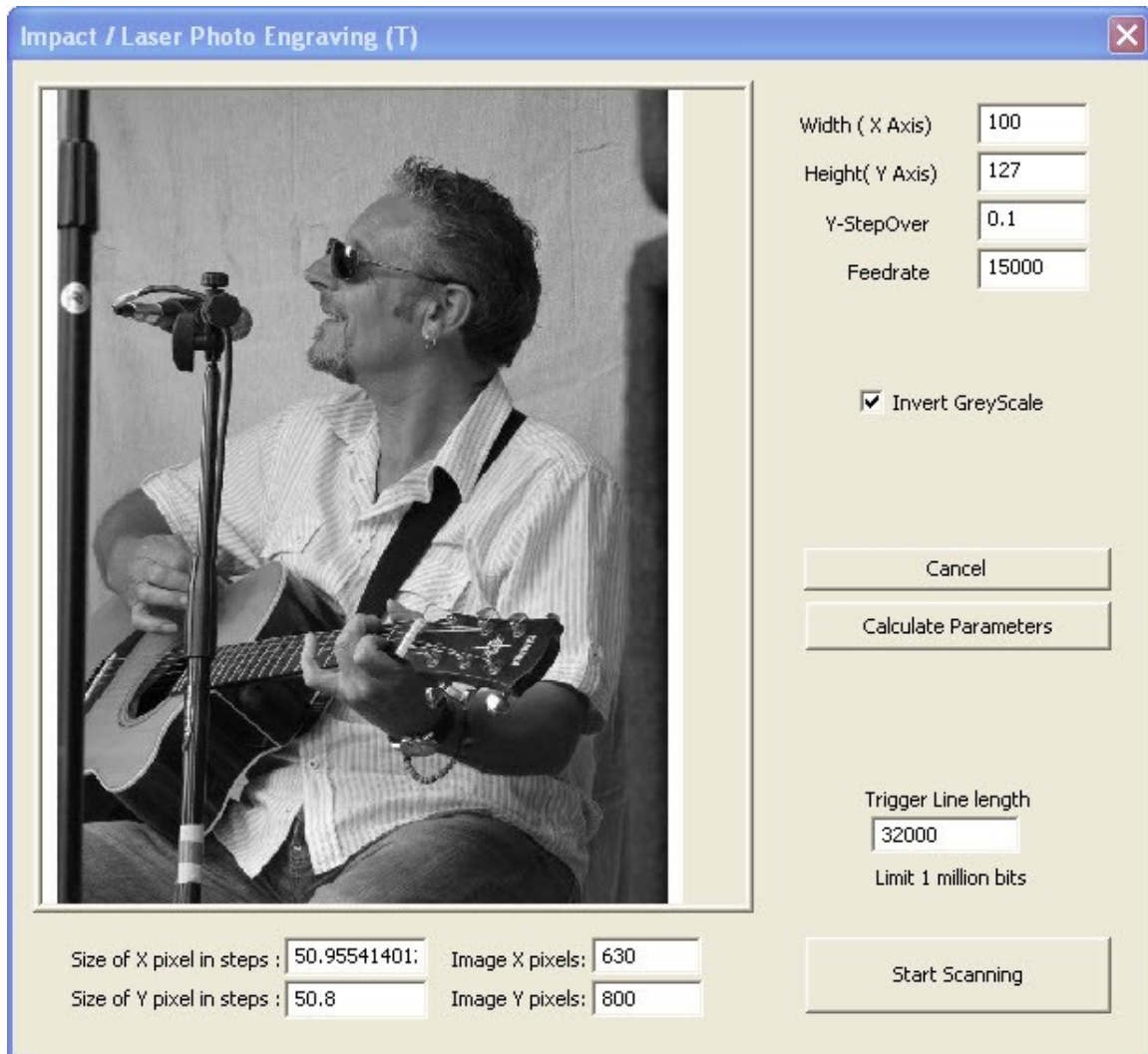


An insight into Art Fenerty's
Impact / Laser Engraver plugin.
By Tweakie.



Introduction:

When Art first wrote this plugin, a few years back, there was little interest in it's use but with the increase in laser ownership it is now starting to come into it's own. More users have resulted in more testing and the inevitable bugs are starting to be discovered and removed.

Art, although busy with his Gearotic Motion, spent precious time towards the end of November 2010 rewriting some of the code to correct the previously known issues and as a result his latest version is now a real pleasure to use.

He has also made the source code freely available so that we can customize our user interface and if required, make subtle changes to the way in which the code is executed etc.

There have been a number of requests, through the forum, for some documentation on how to use this plugin so I have taken on the task of producing this brief and extremely basic 'walk through' which I will update as I learn more. Although much of the information applies equally to Impact Engraving this document is biased towards and primarily aimed at Laser Engraving. Please note that all units expressed here are metric unless otherwise stated.

Loading and Configuration:

Download the latest version from the Mach support plugins page <http://www.machsupport.com/plugins.php> and run the Engraving.m3p file. This will automatically load Engraving.dll into the Mach3 / Plugins folder. Run Mach and under Config / Config Plugins check Enabled the Engraving-Impact-Laser-Version-....

Close Mach and on restart Impact/Laser Engraving v... will appear in the menu bar.

Under Config / Ports and Pins / Output Signals check Enabled the Digit Trig and enter the Port # and Pin Number used to connect the computer to the laser.

Check the Active Low. (Without going into all the details here, the computer LPT printer port can sink more current than it can source therefore it is prudent to use the Active Low mode of operation for driving external devices).

It is important that the output pin # used here must not be enabled elsewhere in your setup or Mach configuration.

Setting up:

It is best to initially start with a basic setup and once everything is working then, if necessary, fine tune the settings for best performance.

Under Config / Ports and Pins select and apply a Kernel Speed of 25000Hz.

Under Config / Motor Tuning for the X Axis check that you have entered the correct Steps per Unit then set and save the highest Velocity and Acceleration your X Axis is comfortable operating at somewhere between 4,000 minimum and 20,000 maximum units per min. Avoid the temptation to set anything faster at this stage, I will try explain later in this document the advantages, disadvantages and limitations of speed.

Connecting to the laser:

Because each installation will be different it is beyond the scope of this document to give exact connexion details but the specified parallel port pin# which has been associated to the Digital Trigger and configured Active Low should be connected to the laser's Active Low trigger input.

It is perhaps worth noting here that the 5Volt TTL standard has, in many instances, now been replaced with 3.3Volt TTL and it is important to check that the computer's LPT port does in fact output the correct voltage level for the laser's TTL trigger input.

Safety:

You and you alone are responsible for your own safety - lasers can be dangerous and in an instant, cause serious harm. Ensure that you fully understand the dangers involved and that you have taken all necessary safety precautions to prevent injury to yourself or others. Always use protective eyewear.

Use:

Line up the job with the starting point which is in the lower left hand corner and check Z axis dimension for correct focus. Zero all axis DRO's. Select Impact/Laser Engraving in the menu bar then select Engrave Photo. Locate the .bmp / .jpg / .png file you wish to engrave and select Open. The user interface window will now open and display the selected image. You must now enter the desired Width (X Axis) : Height (Y Axis) : Y Stepover and Feedrate. Check Invert Grey Scale if required. (see Invert Grey Scale).

Click on Calculate Parameters to update the steps per pixel readouts.

The image will be correctly proportioned (aspect ratio) when the Size of X pixel in steps is approx equal to the Size of Y pixel in steps so you may need to adjust the Width or Height to get it right, clicking on Calculate Parameters after each adjustment.

When you are satisfied that everything is correct then select Start Scanning and Yes in the popup window. Scanning will now start when clicking on the Cycle Start button on the main Mach screen and it will continue until the image is completed.

To abort the operation press the keyboard spacebar or click on the Feed Hold button and when the scanning stops click on the Reset button to exit the routine. Obviously it will be necessary to click on the now flashing Reset button one more time before proceeding. If you don't do it this way then a 'Previous SEQ not yet complete' error is triggered.

Plugin Operation:

The loaded image is converted to 8 bit greyscale which allows each pixel to have a value of between 0 and 255. The plugin then scans the image, line by line, starting at the lower left hand corner and converts the value of each pixel it encounters into a series of output pulses on the Digital Trigger pin. The exact timing of these output pulses is dependant on a number of factors including the pixel value, axis speed, axis steps per pixel and the kernel speed. Art has explained it to me twice now but I still don't fully understand exactly how the pulses are calculated but understanding is perhaps unimportant because it works and that is all that really matters.

The scan commences by the X Axis accelerating from zero to the specified speed which is maintained for the whole of the line and then decelerating to zero again at the end of the line. During these periods of acceleration / deceleration the output pulse rate is reduced pro-rata with speed to prevent excessive burn or cut depth at the edges (see Edges).

Invert Grey Scale:

Under normal circumstances the laser will be turned on for the white parts of the image and turned off for the black parts. If engraving onto the surface of a piece of wood the image produced will be a negative (the white areas will be black and the black areas white) so Invert Image is selected to turn the laser on for the black parts and off for the white parts and thus produce the correct image as shown here on this engraving laminate.



Different materials, of course, produce different results and as just mentioned a laser pulse will darken a piece of wood but it will lighten a piece of slate or stone therefore the material being worked on will determine if the image needs to be inverted or not. A little bit of trial and error is all that is needed here to become an expert.

Edges:

As already mentioned, the frequency of the output pulses is reduced as axis speed is reduced at the start and finish of each line and this can sometimes result in the outside vertical edges of the work becoming visually ragged in appearance. The easiest way to prevent this is to create side borders or dead bands as part of the original artwork which are just wide enough to allow for the acceleration / deceleration of the X axis and 5mm each side is usually more than enough. The shade of these bands (black or white) is chosen so there will be no output pulses from the plugin at any time when the axis is not moving at it's full velocity. The image in the illustration on page 1 shows these side bands which are white and because Invert Grey Scale is checked the laser will not fire in these areas.

Image quality:

It is best to use images that exhibit a high level of contrast as these will produce better results from the physical laser engraving process.

I still have a lot to learn here but my setup is, at present, only able to re-produce 5 shades of grey so on occasion I still get the dreaded horizontal banding, but I am encountering it less and less now. One day I will learn how to avoid banding completely but don't hold your breath. As for the 5 shades of grey, Art has explained the possible reasons for this but I have a lot more experimentation to do before I am certain just where the bottleneck is occurring after all, in theory, I should be able to re-produce 255 shades of grey, shouldn't I ?

Many of the photo manipulation software's (mentioning no names) have image processing plugins which can produce some quite stunning effects and of course, there are a couple of stand alone, image dithering, software's intended solely for laser image use. These software's produce an image which has, what appears to be, a random dot pattern but like this Mach plugin the dots are not placed at random, they are mathematically calculated and if you dare to change the scale or aspect ratio of a processed image the dot patterns can start to show and we return to the banding issue again.

I am not aware of any 'free to try' versions of these programs but there are a number of pre-processed images, available for download, on the various USA and UK laser supplier's websites and the Aztec Queen below is one such image. This has been engraved onto Obechi, again with Invert Greyscale checked so the laser burns the black areas of the original image.

Unlike the purpose built laser machines which have a requirement for multiples of either 250dpi or 300dpi images (depending on their axis steps per unit) the Mach plugin is really not that fussy. Obviously I have not tried every possible combination of image size / pixel density / stepover etc but so far it has handled everything I have thrown at it without complaint. I have no idea what the dpi of this image was nor do I need to care as the results speak for themselves. It is perhaps worth mentioning here that the final colour of the image has a strong relationship to the type of wood used, some woods engrave to a really black image and others just a light brown. Increasing the power density usually does the trick, but not always.



Some things that don't work:

There are infinite combinations of settings within Mach and obviously I have not been able to try them all but these points have been found so far.

1) The plugin has been written for use with the computers parallel port and it will not work with external motion controllers such as the Galil etc.

2) Satisfactory results cannot be obtained if Sherline 1/2 Pulse mode has been selected. This results in a ghost image.

3) I have been unable to get reliable results when using the spindle speed control output of a PWM signal (controlling laser maximum current) at the same time as running the plugin. This does not mean to say that it will not work just that I have not succeeded.

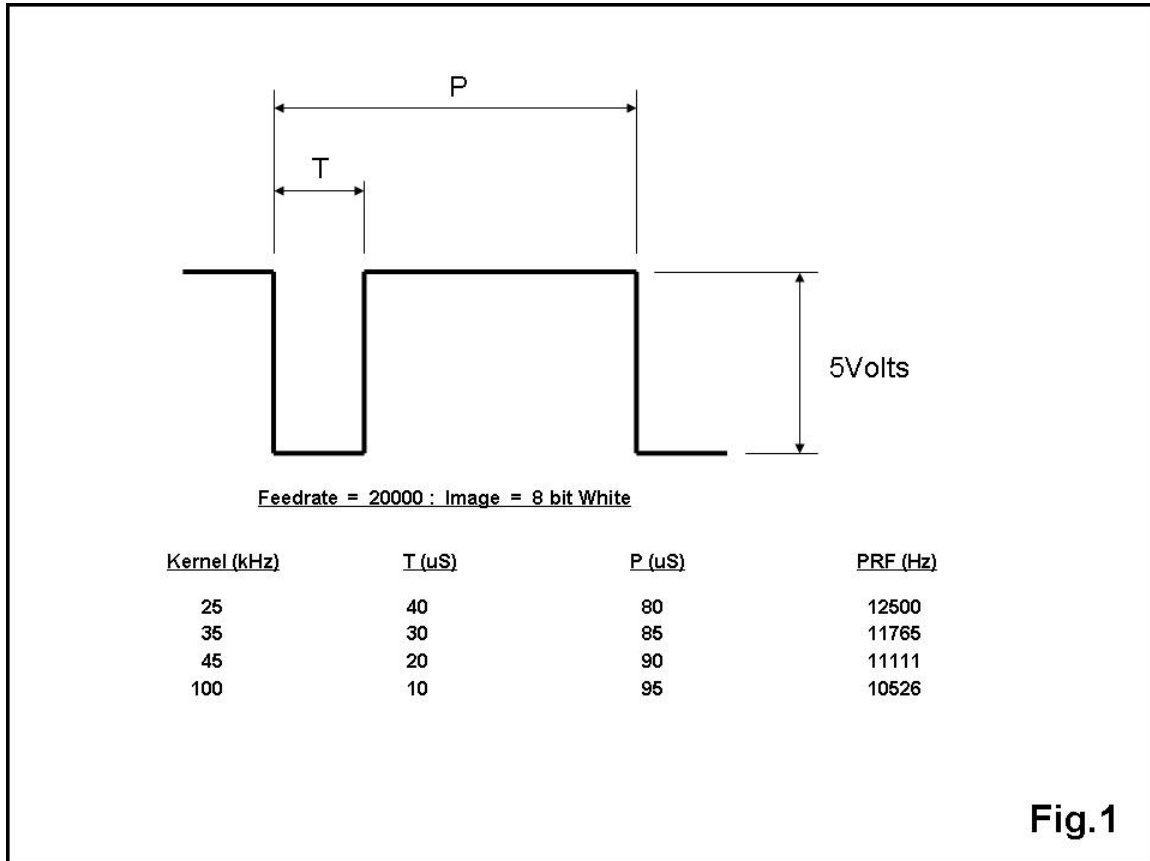
A stand alone PWM source or analogue dc control for laser maximum current works beautifully.

4) The X Axis scale DRO should not be used. If set to anything other than 1.0000 it will create multiple images (This could perhaps be used to good effect but it may need some experimentation).

Fine Tuning:

Obviously we all want our machines to operate at the fastest possible speed and jobs to be completed in the minimum amount of time but there are many constraints and fastest is not always best. Maximum Axis speed is related to Steps per Unit and Kernel Speed but as Kernel Speed is increased then the width of the plugin's output pulse decreases and a gain in one direction can be offset by a loss in another.

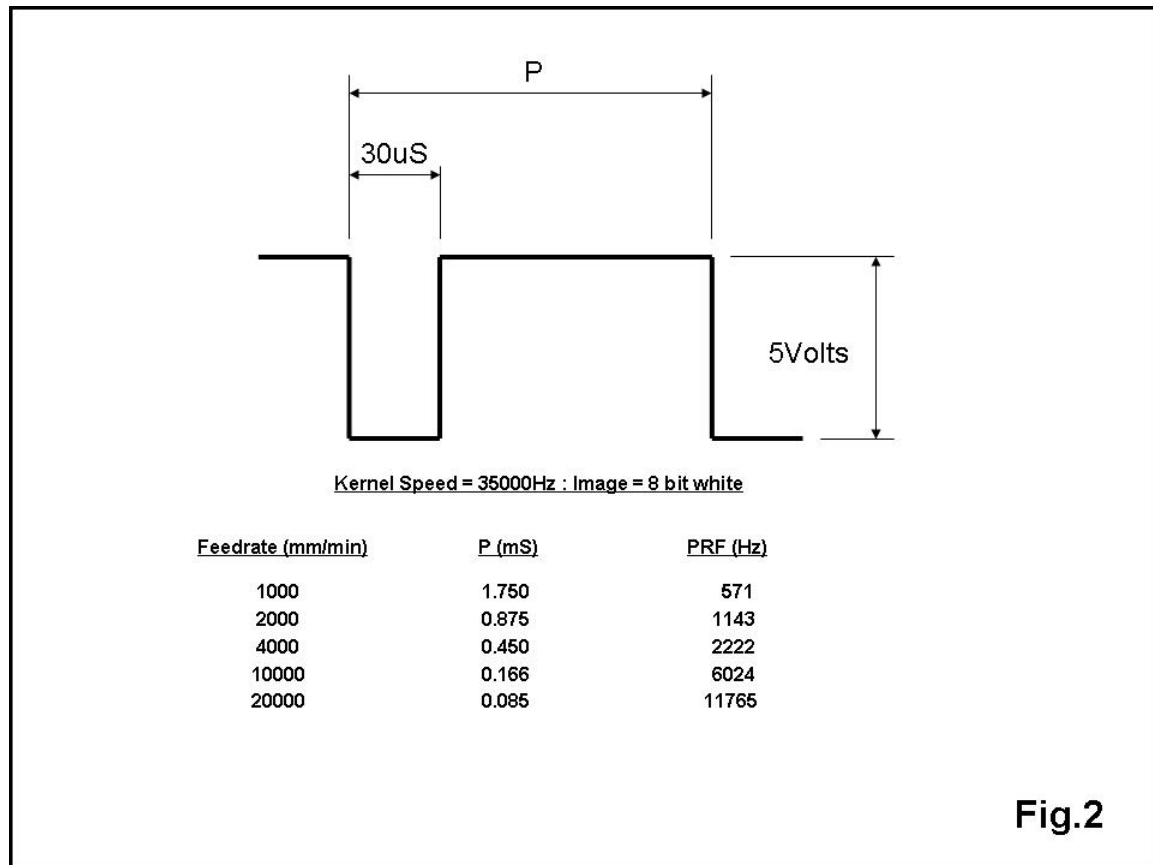
Fig.1 illustrates the relationship between the pulse width (T) and the Kernel Speed setting.



Ideally the plugin should be operated at the kernel speed of 25kHz but depending of your machines Steps Per Unit a sufficiently fast enough axis speed may not be achievable. This is where compromise comes into effect and a happy medium has to be found remembering that the quality of the finished work should take precedence over speed.

At a kernel speed of 35kHz each pulse will be 30uS wide and the maximum density of pulses (pulse repetition frequency) that can be achieved will then be dependant on federate which is in turn dependant on steps per unit. This is quite a balancing act really with every parameter being tightly linked to each other. Increasing the kernel speed to obtain a higher federate may be inevitable in some circumstances but if it works at a kernel speed of 25kHz then stick with it.

Fig.2 shows the relationship between federate and pulse repetition frequency.



There will be upper frequency limitations on the TTL input to the laser but this may vary from one type of PSU to another and the Chinese manufacturers of the DC units are very guarded at giving out any details although a maximum pulse repetition frequency (PRF) of 20kHz is assumed for the PWM input of most power supply units.

The controller for my RF laser is, for example, currently operating at a PRF of 5kHz (which is the manufacturers recommendations) and although I can increase this in 5kHz steps up to 20kHz that in turn causes other limitations on the available range of PWM that can be used without overdriving the tube and shortening it's life expectancy.

Obviously some individual experimentation is necessary because the setup that works well with one machine is unlikely to work well with every other machine.

Engraving.dll Changelog:

(T) Version 1.2 (May 2011).

Redundant 40uS runtime check box removed from UI.

Laser always turned off before final homing move to origin.

Homing move can no longer be diagonal.

BMP set as first choice for file load.

Various version numbers rationalised to v1.2.