

# Pic-Convert™ Board Instructions

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This is the fifth version of the Pic-Convert board and now has fully isolated inputs and provides a power supply to make the solution completely industrial. This DAC+PWM board solution has been developed with Jeff and John at picengrave.com for use with their picengrave software for laser image engraving. This board uses the STEP and DIRECTION signals from a spare axis to output a PWM signal (or analog) to a laser driver for laser power control. This allows software controlled CNC machines (like Mach3) to adjust the laser power on the fly for image engraving applications.

With the board you will now adjust your laser power by MOVING the axis you selected to hook up. There is also an enable signal to turn the laser on and off.

## Features

- Convert Step and Direction signals into PWM or analog output for laser drivers.
- PWM output for PWM modulated drivers.
- Analog output for analog modulated drivers.
- Output Enable Relay to control output with M03/M05 command.
- Fully isolated inputs allow for more industrial applications.

## Contents of the box

In the box for the Pic-Convert™ there should be the circuit board with enclosure and 7 volt 1 amp wall power supply for connecting power.

## Safety

This board is designed to work in conjunction with high power lasers. When using lasers always make sure you take the appropriate precautions for safety including the use of protective eyewear and shielding. Always use caution when operating CNC equipment.

## Using the board

There are two ways in which to use the Pic-Convert™ board:

1. Connecting it to a laser driver that uses PWM to modulate the laser intensity.
2. Connecting it to a laser driver that uses ANALOG to modulate the laser intensity.

## Set-Up Video

<https://youtu.be/Jqj29GKFXdo>

## Input Specifications

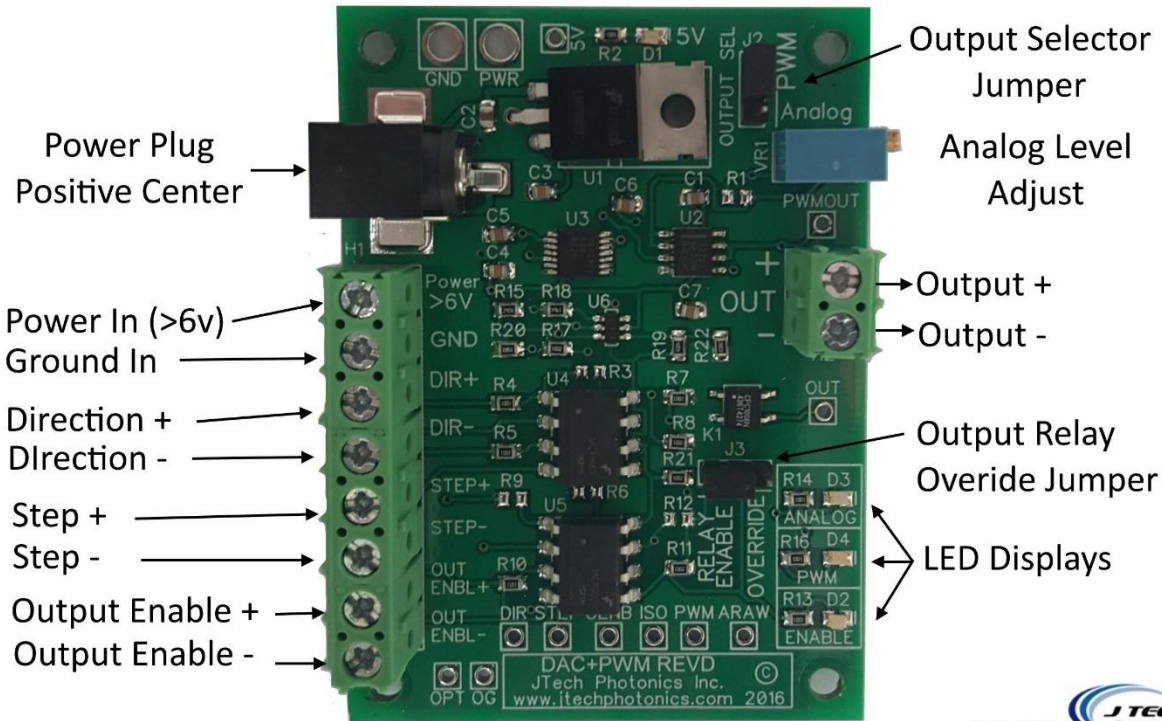
The Pic-Convert™ board requires DC voltage signals for step, direction, and enable pins. We recommend using 5 volt signals. The inputs are all opto-isolated and can handle up to 24 volts.

## Power Specifications

The Pic-Convert™ comes with a provided 7V power adapter. If you want to use a different power supply, the board requires a voltage higher than +6V. You can use a power supply that is larger (up to 24volts), but make sure the regulator does not get too hot. A 9V or 12V supply should be easy to find.

## Connection Overview

# Pic-Convert™ Connections



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### INPUTS (left side of the board):

- Direction + : Direction encoder signal for the axis chosen in control software.
- Direction - : Connect to the GND signal for your Breakout board or controller.
- Step + : Step encoder signal for the axis chosen in control software.
- STEP - : Connect to the GND signal for your Breakout board or controller.
- Output Enable + : This will enable the output of PWM or Analog on the OUT header.
- Output Enable - : Connect to the GND signal for your Breakout board or controller.

### OUTPUTS (right side of the board):

- OUT: Output for the PWM (or analog) signal.

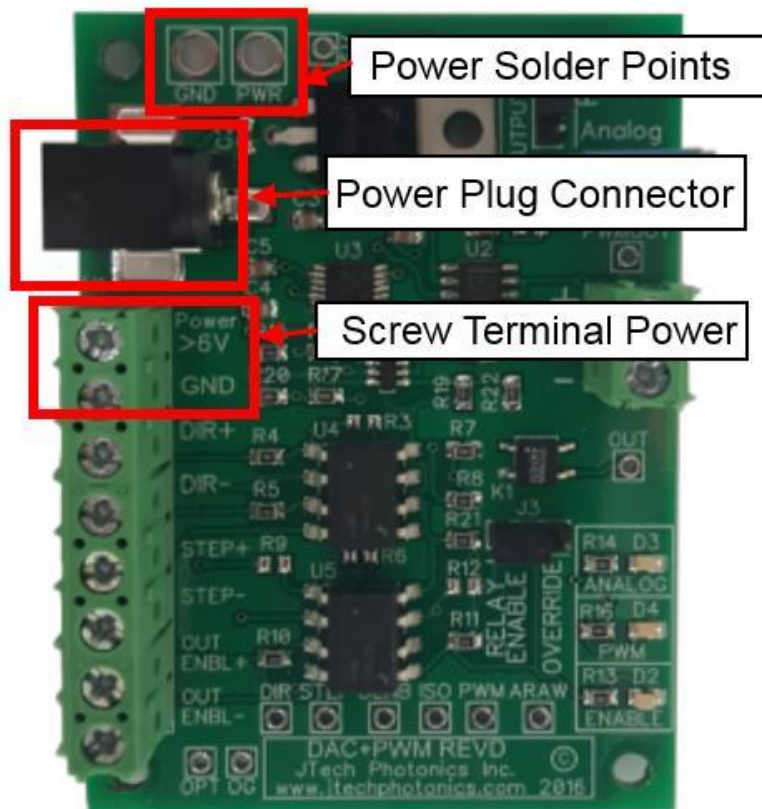
## Power Overview

The board requires  $>+6v$ . We have provided a 7V wall style power adapter with the board. We recommend using this adapter as it provides a clean isolated power source.

You can also use a power supply that is larger (up to 24volts), but make sure the regulator does not get too hot. The regulator is the IC right next to the barrel power connector. If needed for higher voltage operation, a heatsink can be added via the screw hole on the package.

There are three ways to power the Pic-Convert™ board:

1. Barrel type connector power supply. Either use the enclosed plug to wire connector provided
2. Screw Terminals connections.
3. Solder points for wire connection.



## Jumper Settings

The jumpers come pre-set at the factory for PWM and Relay Enabled.

J2: To enable PWM output, set to PWM (top two) on both J2.  
To enable ANALOG output, set to Analog (bottom two) on both J2.

J4: To enable relay control input signals, jumper on left two (Relay Enable).  
To override the output relay, jumper on right two (OVERRIDE).

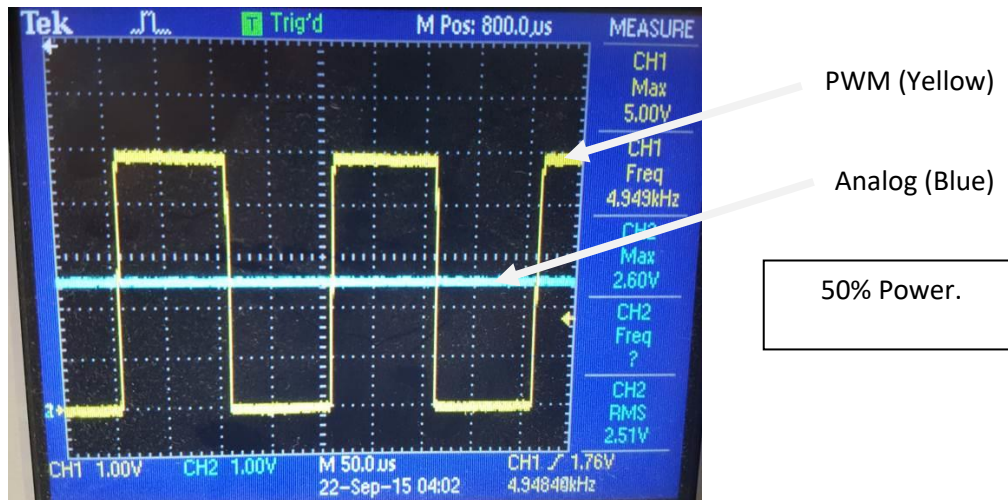
### Theory of Operation:

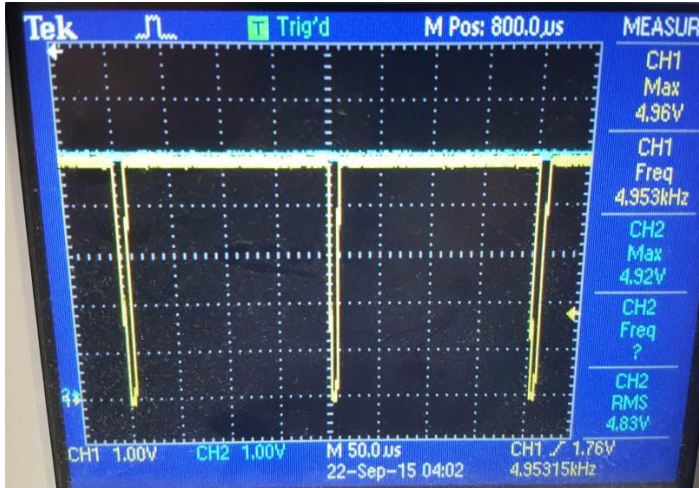
This board takes the step and direction output of an axis on your controller and turns it into a PWM duty cycle (or analog) based on the position of the axis. You can choose any extra axis your controller has, or you can use the Z axis. If you use the Z axis, just remember to either disable your motors or take off the motor connections before you run it.

Now your laser can be controlled ON and OFF with the ENABLE input on the Pic-Convert™ board. You can use the spindle enable command in mach 3 for this.

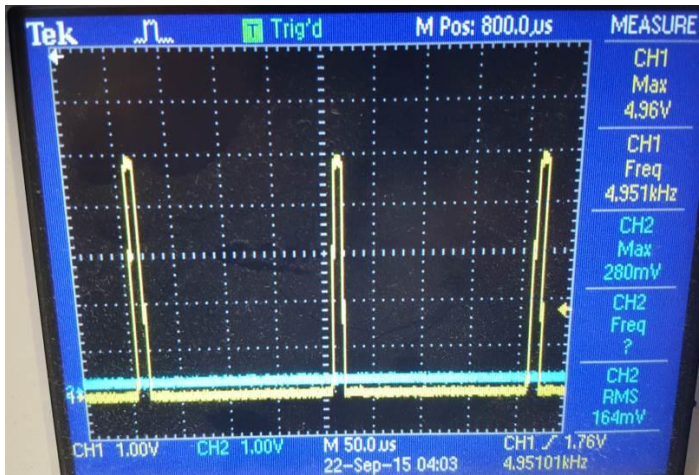
Then, control the power with the axis commands. “Movement” on the axis will create a signal to the laser to control the power level. You will learn how to set up what movements will create what power levels in the next few sections of the manual.

You can see in the next few pictures what the signal to the laser will look like at different power levels.





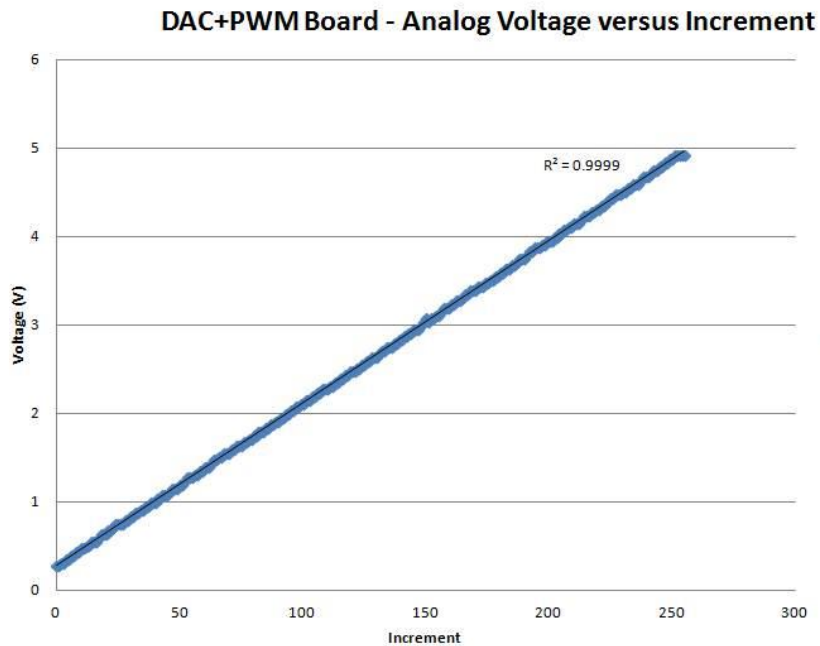
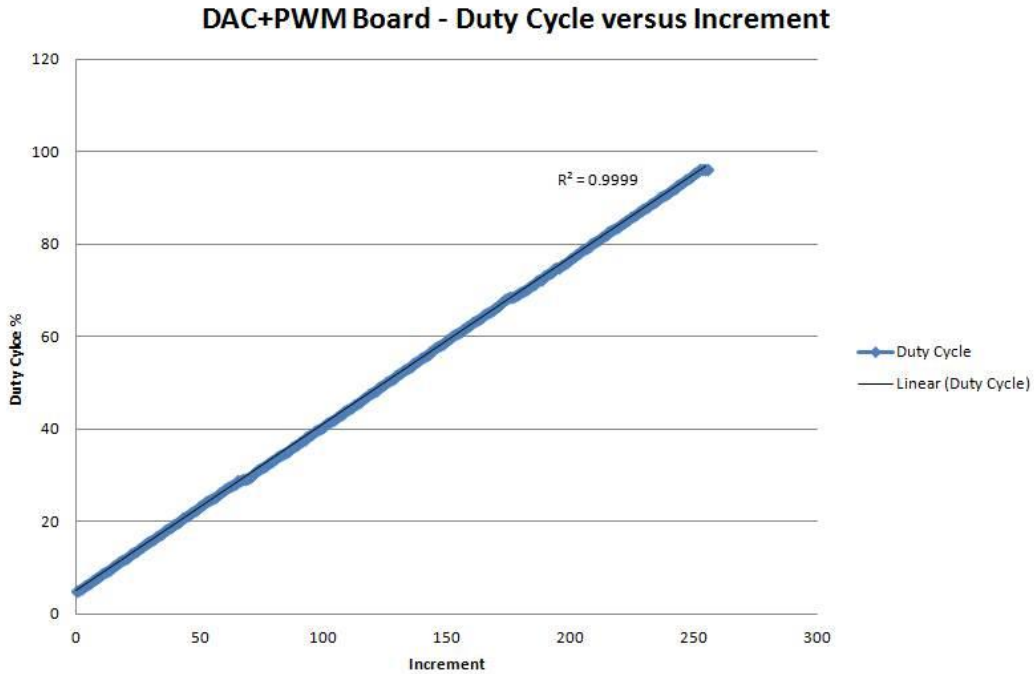
100% Power.



1% Power.

## Linearity

The Pic-Convert™ board provides a duty cycle or analog voltage output based on an increment from the step and direction output on your controller. It is imperative that this output is linear for the 256 shades of greyscale will show exactly on your image. Here is the output for both versus increment. It is 99.99% linear in both applications.



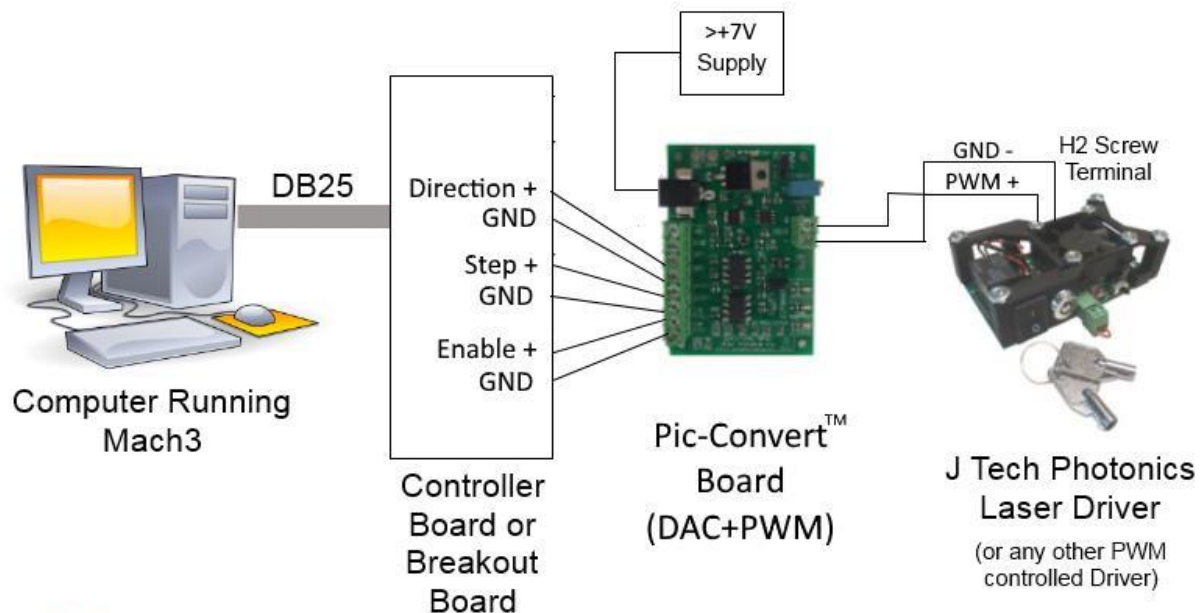
## Set Up for PWM Output (J Tech Photonics Driver Example)

In order to use the Pic-Convert™ board for a PWM output you will need to get the step and direction signals for the axis you are using. You can either get them from your breakout board or you can use a dual breakout board to get the signals. You can get a dual breakout board from our store if you need to find one.

Once you have these signals, connect them to the appropriate input screw terminals on the Pic-Convert™ board. You can also use another output to control the relay to enable the output of the board with the M03/M05 command. This adds an extra safety precaution that the laser will not be enabled without the appropriate command from the controller. Connect this to the "OUT ENABLE" screw terminal.

Make sure the jumpers on J2 are set correctly for PWM operation. **THE BOARD WILL START AT 50% OUTPUT UPON APPLYING POWER TO THE BOARD. YOU NEED TO SEND A COMMAND TO SET IT TO ZERO WHEN IT TURNS ON.** We recommend jogging the axis until you see no light coming out of the laser. It will now be ready to start engraving your file.

# Pic-Convert™ Board Set-Up PWM Laser Driver Operation



## Setup for Analog Output with Power Enable Control

This setup is similar to the PWM connections. You will still need the Step and Direction signals for your axis of choice. You will connect them the same as in the previous example.

Set the Jumper J2 to ANALOG (lower on J2). If you want relay power control then choose it on J3.

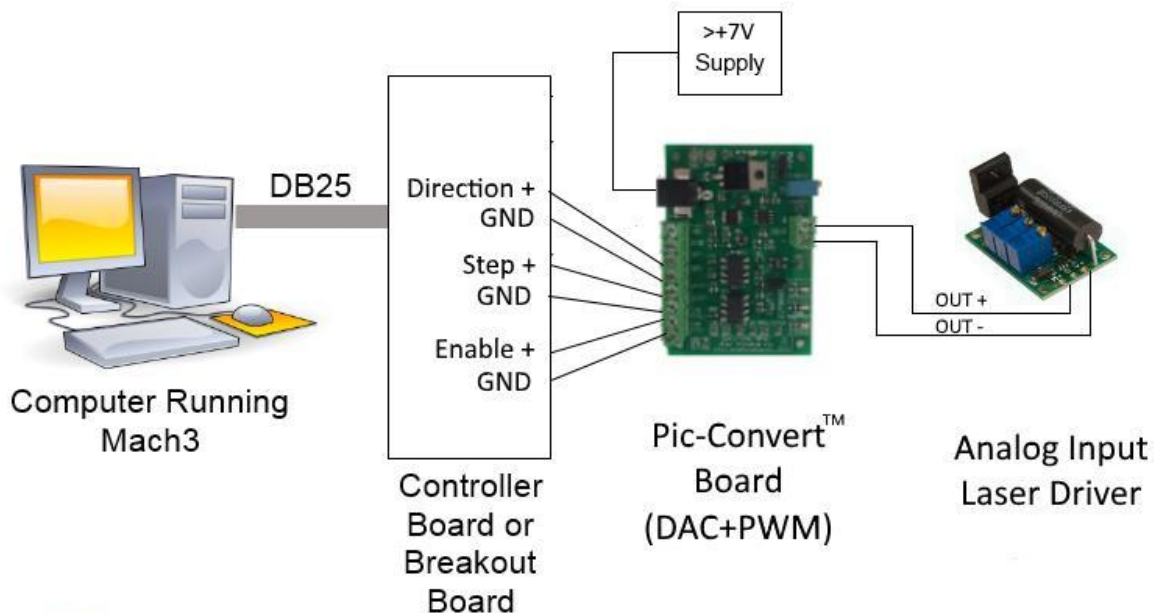
Connect the controller output M03/M05 signal to the "Driver Enable" input if you want to control the pass through power.

Connect the modulation input of the laser driver to the output screw terminal on the Pic-Convert™ board.

**THE BOARD WILL START AT 50% OUTPUT UPON APPLYING POWER TO THE BOARD. YOU NEED TO SEND A COMMAND TO SET IT TO ZERO WHEN IT TURNS ON.** We recommend jogging the axis until you see no light coming out of the laser. It will now be ready to start engraving your file.

# Pic-Convert™ Board Set-Up

## Analog Laser Driver Operation



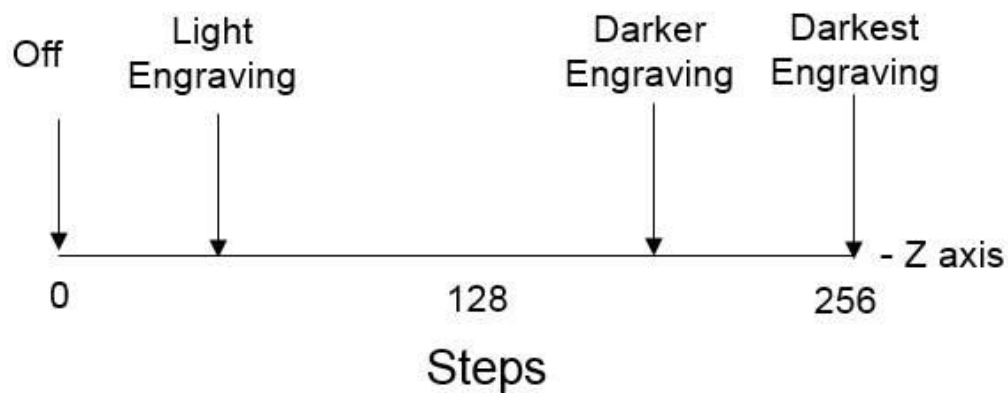
Copyright 2016, J Tech Photonics, Inc.



## General Software Settings

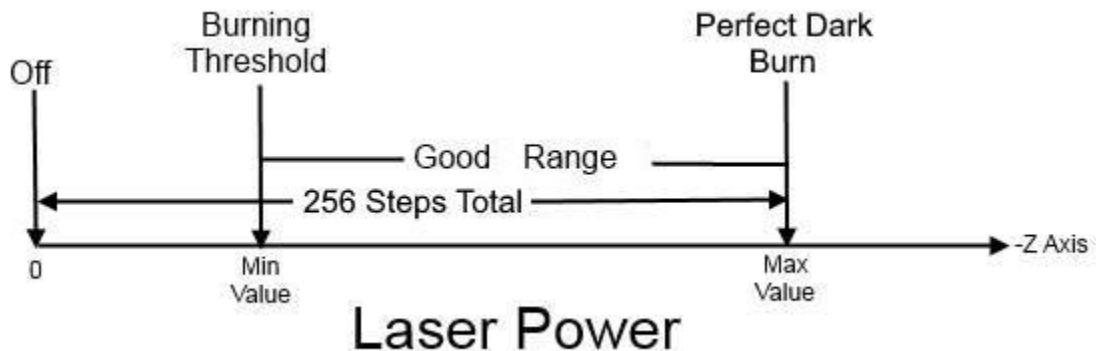
Like in the theory section, we saw that the board has different levels for each position on the axis. Depending on how you have your steps per inch (or mm) set will determine the distance you will need to achieve your proper engraving.

In this example we have it set on the Z axis:



You will need to set your machine to get the perfect settings. The board is 8 bits, so there will be 256 steps in this range. Your feedrate will determine the "darkness" level at the maximum steps. Faster = lighter and slower = darker.

To get the "perfect" results for your material, you can first find the minimum value for just starting to burn the material. This level will be your minimum value for PicLaser SW. Your max level will be 256 steps from 0. If your steps are 10000 per inch, then your increment will be 0.0001" and your maximum level is -0.0255. Here is what it looks like conceptually:



So, if your wood starts to burn at -0.002", then your minimum value will be -0.002" and your maximum value will be 256 increments more at -0.0255". This will give you the full "grey scale" levels you need.

## Mach3 Setup

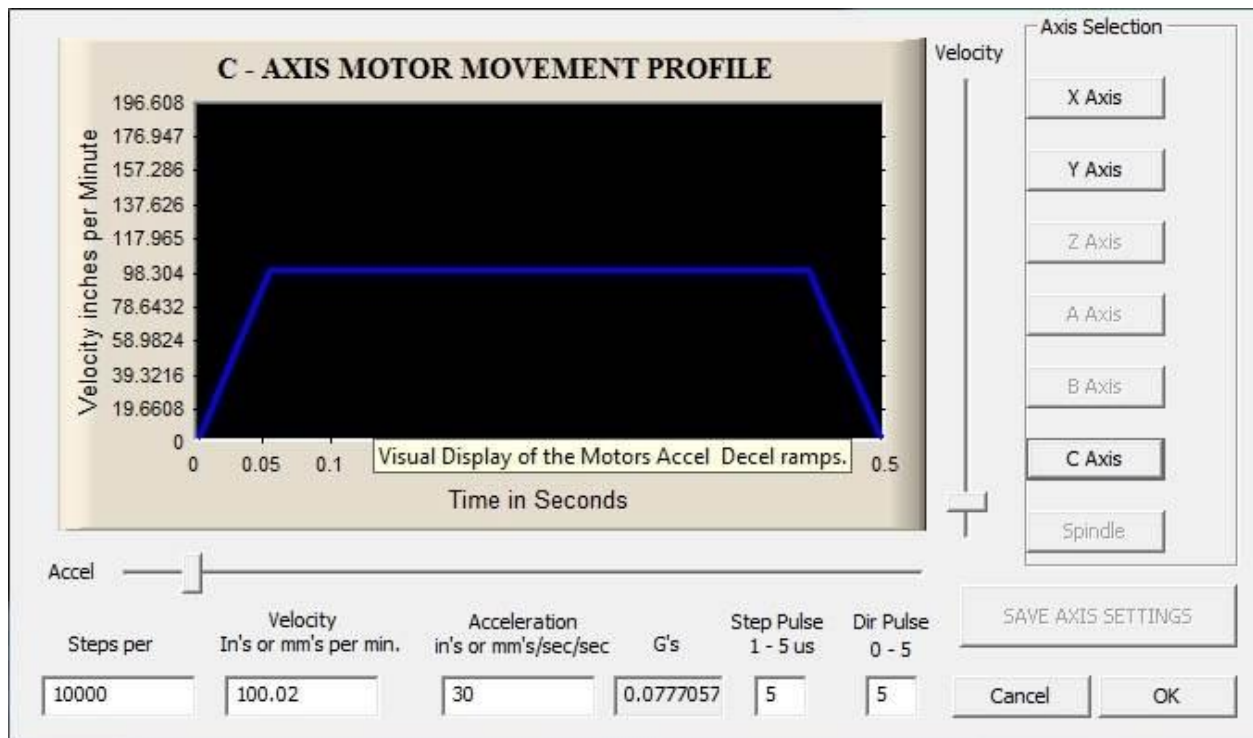
Here are some standard settings in Mach3 that Jeff at picengrave.com suggests from his experience with the Pic-Convert™ board. Units are in **INCHES**.

Steps per inch: 10000  
Velocity: Calculated by your machine controller  
Accel: 30  
Step Pulse: 5  
Direction Pulse: 5

This makes your incremental move distance = 0.0001"

Jeff recommends using the "A" axis because it has keyboard jogging enabled and a digital readout on the mach3 default screen

This example is for the C axis, but it can be also "A", "B", or "Z" as well:



## PicLaser Setup

Using the details from the mach3 setup, we can use them to enter details into the PicLaser program. Use YOUR correct AXIS that you set up in your controller. It can be Z, A, B, or C. (Using the A Axis is recommended because it has keyboard jogging and a digital readout on the mach3 screen.)

Units are in inches and example using the Z axis:

Max laser value: -0.0255  
Min laser value: 0  
Laser Off Command: M05 (if using the output relay)  
Laser Off Command: Z0 (if overriding the output relay, can be A,B,C, or Z)  
Laser Control Command: Z (Can be A, B, C, or Z)  
Output setting: Std Gcode  
Machine Codes: G90 G64 (absolute mode, constant velocity)

We are running this with a 2.8W laser kit at 90 inches/min. The focus for us is about 0.006 inches, so we use this for the pixel resolution.

The screenshot shows the PicLaser Lite software interface. At the top, the title bar reads "PicLaser Lite - Ver.JT1.1.04 - Registered to: JAY JOHNSON". Below the title bar are several buttons: "Select File", "Load File", "Hide Settings", "End Program", and "Help".

The main interface is divided into two main sections:

- Original Image:** This section displays the details of the selected image file, "Porsche6x6.bmp". The details include:
  - File Name: Porsche6x6.bmp
  - File Size: 344.6 KB
  - File Width: 396 Pixels
  - File Height: 297 Pixels
  - Horiz. Resolution: 72 Pixels/Inch
  - Vert. Resolution: 72 Pixels/Inch
  - Image Width: 5.500 inch
  - Image Height: 4.125 inch
  - Total Image Pixels: 117,612
- Engraved Image:** This section displays the dimensions and settings for the engraved image:
  - Width - inch: 2.376
  - Height - inch: 1.782
  - Num. Gcode Lines: (empty)
  - Gcode File Size - KB: (empty)
  - Gcode File Directory: C:\Gcode\

The right side of the interface contains a settings panel titled "Click Labels or Values to Change". This panel includes the following settings:

- Feed Rate: 090 inch/min. (with a "Metric" checkbox)
- Pixel Resolution: 0.0060 inch (with a "Start Comments" checkbox and a "%" input field)
- Max. Laser Value: -.0255 inch (with an "End Comments" input field)
- Min. Laser Value: .0000 inch
- Laser Off Command: M05
- Laser Control Command: Z
- Left - 45°
- Vertical
- Horizontal
- Engrave Outline
- No. Passes: 1
- GRBL (radio button)
- Std. Gcode (radio button, selected)
- J-Tech (radio button)
- File Extension: .gcode
- File Directory: C:\Gcode\
- Save Settings (button)
- Machine Setup Codes: G90 G64

## FIRST Start Up

The digital potentiometer DAC chip on the PicConvert board **starts out at 50% level** when you add power to the board. If you have the output relay in OVERIDE then the output of your laser will be at 50% when it powers up. This could be potentially bad.

When you first start the board it is advised to use the “enable” input to control the output of the PicConvert board. This way, you can set your output level to zero before the laser turns on.

To set your output to zero using the settings from the example above:

1. Send a move command on your axis of choice to set maximum (-0.0255).
2. Then send a move command to minimum (0).

This will put the output to zero. Alternatively, you can **jog your axis** in the decreasing direction to obtain the same result. Do this until your laser no longer is on. The A axis has keyboard jogging for this.

## Troubleshooting

Here are some frequent troubleshooting questions and answers.

**1. The Enable LED doesn't work.**

Solution: The LED had a manufacturing issue and will be solved in the next revision.

**2. On startup the PWM LED is bright and the Analog is dim.**

Solution: That is the way it is supposed to be. The board starts at 50%. You need to jog the axis to lower or increase the value.

**3. I am loosing steps in my picture. There are lines missing.**

Solution: Your step pulse size is too small. Use at least 5 us for the step pulse and direction pulse. Refer to our mach 3 settings in the previous section.

**4. My power adapter is not the right plug.**

Solution: Either use a plug changer for the adapter or use another power supply over 7V that has the correct plug. See the input power section for options.

**5. My engraving is always totally black.**

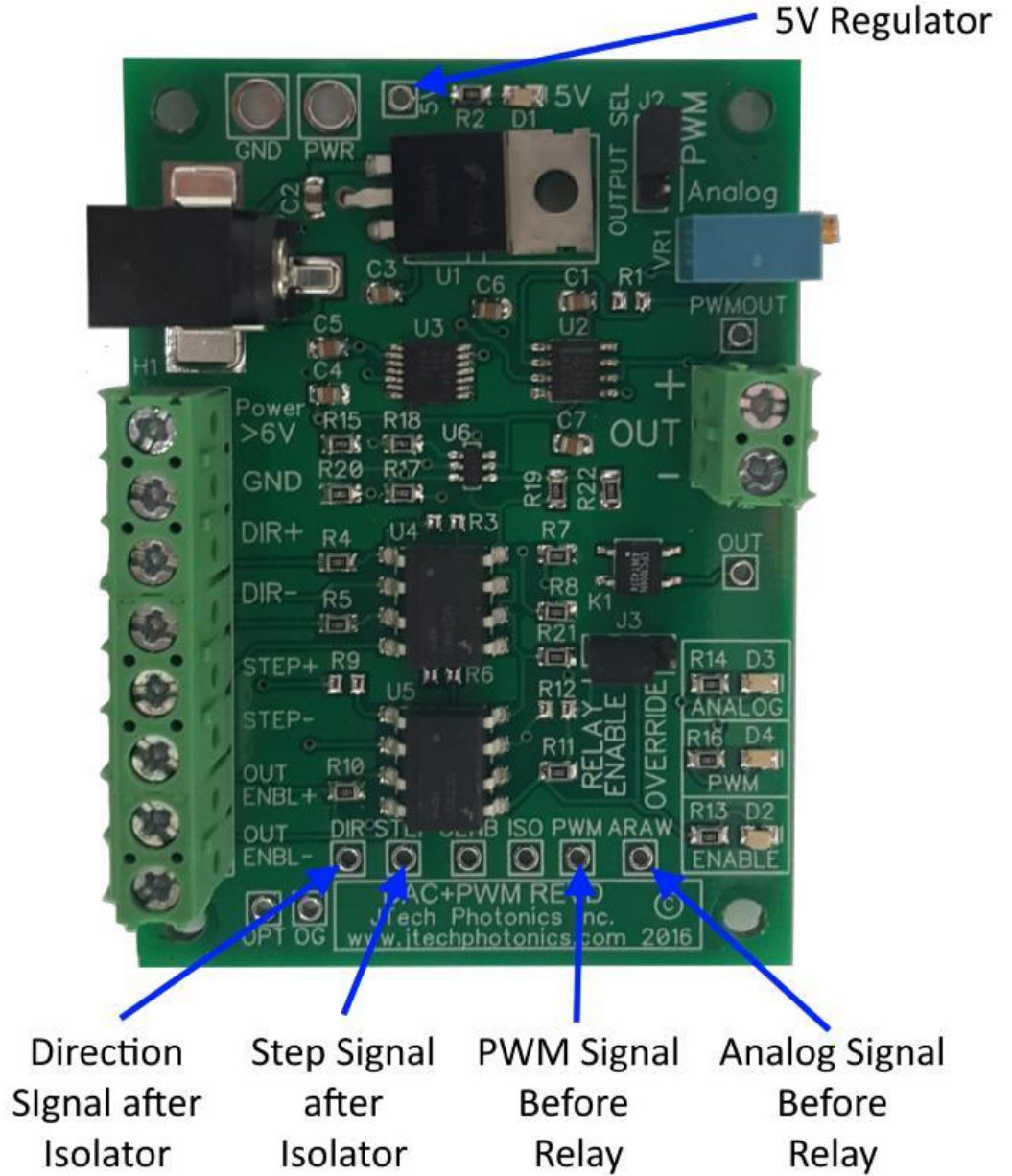
Solution: You have not set the board to zero before starting. You need to either send a zero command or jog to get the laser to a minimum level. You can turn the board on and the laser so you can see the laser is at a minimum level before starting. If the laser starts at full power, then the board will always modulate at full power. It needs to be set to zero so it can modulate between zero and full power with 256 steps.

**6. I can't get the board to do anything. I think my connections are correct. How can I verify them?**

Solution: Make sure your step, direction, and enable signals are all coming out of your break out board or controller to the PicConvert board with a meter. Then, check the test points on the PicConvert board to see if the signals got through the opto isolators.

A picture showing the test points is below.

# Test Points



## Frequently Asked Questions:

### **Why do I need to have my steps per inch be so large?**

The steps per inch needs to be something like 10,000 because we want the increment to be very small. The axis is not really “moving” but rather just the step and direction pulses are getting produced. The smaller the increment the faster the computer can produce the pulses.

### **Why is the maximum value a negative number?**

This is because using a CNC the Z axis is normally for a mill or a router which has a maximum value as a “depth”. Depth is normally a negative because you are taking out material.

### **Can I make my maximum value a positive number?**

Sure, if your machine is set up correctly. All the Pic-Convert™ board needs is the step and direction signals. If your image comes out inverted, then you have them set backwards.

### **Can I use an axis besides the Z axis? I have the A axis available on my machine.**

Sure. Set it up for the other axis like seen in the setup documentation.

### **My Parallel port card can't turn on the enable relay. What do I do?**

You might need to look into a breakout board that has more ability to drive a signal. Some break out boards have a “spindle interface” which have more power than standard lines.

### **I want to use a 5V power supply. Will this work?**

Most of the other USB or wall adapters at 5V will not provide the voltage needed. Use more than a 6 volt supply and you will be fine. If you really want to use a 5V supply, then let us know and we will tell you how to modify the board. It will require soldering skills.

### **I am adjusting my max value to larger than 256 increments and it is burning better. Can I adjust my max over 256 levels? Does the DAC board compute anything for this?**

Everything is all based on steps and direction. The Pic-Convert™ board doesn't compute anything, it is just taking the step and direction from the mach3 controller and turning it into a PWM duty cycle.

The digital potentiometer on the DAC board has 256 “levels”. On startup it is in the middle of the range. Now, if the program says, “go to zero”, then the output of the controller puts the DIRECTION pin to Zero (this tells the digital potentiometer to DECREMENT the count). The controller then puts out the appropriate steps to get the axis to 0. If the machine axis is located at -0.0255” and the steps are set to 10,000 then the controller will put out 255 “pulses” on the STEP pin. The DAC board will then DECREMENT the count by 255 levels. This will put it at 0.

If the G Code program says now to go to -0.0128" then the DIRECTION pin will go positive. This tells the DAC to INCREMENT the count. Then, the controller will put out 128 pulses on the STEP pin. The DAC will increment the count 128 levels. This will change the duty cycle on the PWM output by 50%.

If you make the range in the controller more than 255 levels then the digital potentiometer on the DAC board will get to the end and stop, even though the controller might still be sending steps to it. Example: If you set the range from Min = 0 to Max = -0.075", and you keep the steps per inch in mach3 at 10,000, then your controller will think your range is set to 750 levels. So, your picture will come out mostly black and white because 495 levels will have the DAC board at the complete maximum of its range. So, let's say the program says to go to -0.075" from a starting position of 0. The DIRECTION pin will go high which will INCREMENT the count. The controller will put out pulses on the STEP pin. The DAC will increment and increase the DUTY CYCLE (increasing laser power) with each step pulse. After 256 pulses, the digital potentiometer on the DAC board is MAXED out and the DUTY CYCLE is now 100% (laser at FULL power). Now it continues for another 495 more pulses. The digital potentiometer is still MAXED out for all of it. Then, let's say the next pixel is slightly less dark at 0.065". It will set the DIRECTION pin low (DECREMENT the count) and put out 100 steps on the STEP pin. Now the digital potentiometer will DECREASE the duty cycle by 100 levels, which puts the DUTY CYCLE now at 61% (almost at half power). This pixel was just supposed to be a little lighter than the last, but it is now 39% lighter than the last pixel. Now, let's say the next pixel is supposed to be a little lighter again, maybe at 0.04". The DIRECTION pin is still low and another 250 steps go out on the STEP pin. The digital pot will DECREASE the count until it hits ZERO after just 155 steps because it is already at 155 level from the last pixel move. It continues to put out steps even though the DAC is at 0. The laser is now OFF even though the pixel was supposed to be just slightly lighter than the last.

So, if you set the min and max values in Pic Laser Lite without adjusting your steps per inch, your picture will be mostly black and white because your machine is operating on a different range than the DAC board.

### **Why do I need to make the acceleration so fast?**

You are not really moving any axis, so it can be super-fast. You are just trying to get the step and direction signals to the Pic-Convert™ board fast. The faster the computer thinks the axis is moving the faster you can get the signals.

### **Why is my machine pausing after each pixel?**

It needs to be in "constant velocity" mode. In Mach3 this is the G64 command.

### **Why does it sometimes come out darker for different materials?**

Each material will need its own federate settings because of the different material properties. Some wood is softer and burns easier and some are hard and burn slower. Grain patterns are especially hard to engrave and will come out with "lines" where the grain is lighter. Try engraving at a 45 degree angle to help with this effect.

### **How does federate effect my engravings?**

Depending on the speed you will get different levels of darkness:

SLOWER = DARKER

FASTER = LIGHTER

### **What power should the laser be set to?**

We recommend setting the laser to the manufacturer's recommendation for the laser. For our lasers it is what the driver was set to when you got your laser from us. For the 2W kit it is 1amp. For the 2.8W kit it is 1.5amps. For the 3.8W kit it is 2.5amps.

### **This is frustrating to get to work. Why is this so difficult?**

This is an advanced method for engraving images and takes some time to master. Mach 3 has a lot of settings and your CNC is probably different than ours, so you need to understand the differences by looking at the manual and figuring out what is needed for your machine. It might take some time, but the process has been proven to work. Be patient, read the instructions, and take breaks if you become frustrated. If you need help, please give us an email at [customerservice@jtechphotonics.com](mailto:customerservice@jtechphotonics.com) and we will try and assist you.