

TB326 (Rev4) – Acorn and AcornSix PWM Laser Setup

Objective: This document will guide Acorn and AcornSix users in the setup of their Laser machines. It will outline the output wiring for common Lasers used with the Acorn and Wizard configurations.



Laser and PWM Primer

- Pulse-Width Modulation (PWM) is a process of delivering digital pulses of varying “pulse widths” to the Laser, rapidly turning it on and off.
- PWM output allows for the controller to deliver varying amounts of power to the Laser, reducing the average power while keeping peak power constant.
- The pulse widths (the duration of time the Laser is on) combined with the duty cycle (the percentage of each pulse cycle the Laser is on) of the output give the controller more precise control over the Laser cutting process, reducing potential heat damage caused to the material and optimizing the cutting process for workloads of differing materials and thickness.
- Centroid Velocity Modulation Feature is where the Laser Power is adjusted automatically based on actual machine velocity to prevent burning in the corners or on any slow down area.
- For more information about Pulse-Width Modulation basic see: https://en.wikipedia.org/wiki/Pulse-width_modulation

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Requirements:

Acorn (Rev3 or newer) or AcornSix

Acorn CNC12 v5.0+ Mill or Router

Download the latest version of CNC12 here:

https://www.centroidcnc.com/centroid_diy/centroid_cnc_software_downloads.html

Supporting Documents:

- **Tech Bulletin 314** Instructions to Add Door Interlock Logic
 - This document details adding safety door logic via Wizard or PLC

- **Typical Hookup schematics**
 - [S15049](#): Jtech Photonics Laser
 - [S15056](#): Jtech Photonics Laser, Generic VFD Enable-Direction
 - [S15057](#): Jtech Photonics Laser, BLDC Spindle Control
 - [S15061](#): OPT Laser
 - [S15062](#): NEJE Laser
 - [S15063](#): Comcrow D-B500F Laser
 - [S15192](#): AcornSix, Jtech Photonics Laser
 - [S15217](#): AcornSix, NEJE Laser

Supporting Video.

<https://youtu.be/bMN7kDUnpWE?si=1p1q0dF3h1oox0jP>

PWM Output for Spindles and Lasers Basics

- **Acorn:** 5 volt PWM output signal on Acorn is DB25 pin14 (H6) and OUT2 (H10). OUT2 is also connected to Relay 2 via the ribbon cable. When Acorn PWM output is used, Acorn relay 2 must be disabled. See schematic [S15049](#) for guidance on where to cut ribbon cable leading to Relay 2.

- **AcornSix:** 5 volt PWM output signal on AcornSix is provided for Lasers by a dedicated terminal on H9 labeled PWM2. Unlike the Acorn, this PWM output is not connected to Output2, so that output is free to use while utilizing PWM, and PWMOutput does not need to be assigned.

- PWM is based on 0-100 OR 0-1000 S command

User selects the PWM range of 0-100 or 0-1000 in the Acorn Wizard

- M37 turns ON Laser (PWM) Output

M38 Turns Laser output OFF

M37 will also activate the canned Acorn Wizard outputs:

- Laser Enable
- Laser Reset
- Laser Cooling Fan

After 0.5s LaserReset will turn off. At this point the Laser controller will look at the PWM signal from OUT2.

M38 will wait 30s to allow J Tech (or other) Laser controller to cool, then performs a M95 /37 /38 to turn off both LaserEnable and PWMSelect.

- Centroid's PWM Velocity Modulation feature adjusts the PWM output based on velocity of the machine tool so over-burning is avoided in the corners and turn-arounds.

G37 is used to turn ON and OFF PWM Velocity Modulation.

G37 ON = PWM VM ON, G37 OFF = PWM VM OFF

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Acorn Wizard PWM Setup:

PWM setup controls are located in the Acorn Wizard.

Note: In addition to the custom setup PWM controls found at the top of the PWM Setup menu, the Wizard also has preset buttons for common J Tech configurations and these presets have matching schematics to follow. ([S15049](#),[S15056](#),[S15057](#))

Custom PWM Setup

Mill CNC Control Configuration Wizard

Primary System

- Axis Drive Type
- Input Definitions
- Output Definitions

Axis

- Configuration
- Homing and Travel
- Axes Pairing
- Advanced

Spindle

- Spindle #1
- Rigid Tapping
- PWM Setup**

Touch Devices

- Probe
- Tool Touch Off

Control Peripheral

- Input Devices
- Wireless MPG

DB25 Connector

- Mapping

ATC

- ATC Setup

Preferences

- CNC Control

PWM Setup

PWM Enable ☒ Yes

Base Frequency (Hz) (min value = 1, max value = 24,000)

PWM S command range: 0-1000 or 0-100 ☒ 1000

PWM minimum S command power level to start Laser

Inverse Output ☒ No

Laser cooling fan delay timer seconds

Common J Tech Laser Configuration Presets

I will configure the pwm outputs myself ☒ No

Jtech Laser (Dedicated Laser Machine, No spindle motor) ☒ No

Jtech Laser with PWM BLDC spindle ☒ No

Jtech Laser with analog output AC spindle motor controlled by VFD ☒ No

Presets with matching schematics

When using one of the presets **be sure to follow the corresponding hookup schematic exactly** as these presets configure the Acorn Wizard inputs and outputs to match the schematic!

Setting Up Custom Laser Outputs using the Wizard

Acorn Laser Outputs

Output Type: Mill

LaserEnable

LaserReset

NoFaultOut

PWM Output

Click and drag

Acorn Integrated Outputs 1-8

	Definition
1 OUT1	OUTPUT1
2 OUT2	OUTPUT2
3 OUT3	OUTPUT3
4 OUT4	OUTPUT4
5 OUT5	OUTPUT5
6 OUT6	OUTPUT6
7 OUT7	OUTPUT7
8 OUT8	OUTPUT8

Click and Drag an Output function definition from list to the Output number Definition box to assign a function to an output

Acorn Integrated Outputs 1-8

	Definition
1 OUT1	NoFaultOut
2 OUT2	PWM Output
3 OUT3	
4 OUT4	LaserEnable
5 OUT5	
6 OUT6	
7 OUT7	LaserReset
8 OUT8	

Click and Drag an Output function definition from list to the Output number Definition box to assign a function to an output

For preset Laser setups, like J tech schematics [S15049](#), [S15056](#), and [S15057](#), the Wizard will place the Laser outputs in their appropriate slots automatically. To assign them yourself, simply click and drag the outputs into the desired output slots.

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AcornSix Laser Outputs

Note: AcornSix does not need PWM Output assigned to an output since AcornSix handles PWM through the dedicated PWM2 terminal on H9.

The screenshot displays the 'Acorn Integrated Outputs 1-16' configuration window. On the left, a list of output functions is shown, with 'LaserEnable' and 'LaserReset' highlighted. A green arrow points from 'LaserEnable' to the 'OUT4' slot in the 'Definition' table. Another green arrow points from 'LaserReset' to the 'OUT7' slot. A third green arrow points from 'PWMSelect' to the 'OUT9' slot. The 'Definition' table has 16 rows, each with an output number and a definition box. The 'Definition' table is titled 'Acorn Integrated Outputs 1-16'.

Output Type: Mill

Click and drag

	Definition
1 OUT1	
2 OUT2	
3 OUT3	
4 OUT4	LaserEnable
5 OUT5	
6 OUT6	
7 OUT7	LaserReset
8 OUT8	
9 OUT9	PWMSelect
10 OUT10	
11 OUT11	
12 OUT12	
13 OUT13	
14 OUT14	
15 OUT15	
16 OUT16	

Click and Drag an Output function definition from list to the Output number Definition box to assign a function to an output

The AcornSix wizard also handles preset J tech Laser setups listed on the PWM Setup tab automatically. For custom Laser setups, click and drag the outputs to the desired output slots.

PWM related I/O in the Wizard

a.) PWMOutput: For Acorn, the PWM signal is OUT2 (H10)/DB25 pin14 (H6). (Remember to cut OUT2 on the ribbon cable as shown in the schematic) to the Output 2 Relay.

AcornSix has a dedicated PWM output, Use H9 terminal labeled PWM2 and See schematic #[S15192](#)

b.) LaserEnable: Used to either send or prevent sending the PWM signal to the Laser. When active, the Laser diode will pulse with the PWM signal sent to it. When inactive, no signal is sent to the Laser, preventing the diode from pulsing while keeping power supplied to the board.

c.) LaserReset: Momentary output to Reset Laser. Used to send a reset signal to the Laser controller, see J Tech schematic [S15049](#) as an example.

d.) PWMSelect: Output to move PWM signal from Spindle to Laser. PWMSelect is used when the PWM signal is required to be sent to different devices. For example, a machine that has both a Spindle Motor and a Laser that require PWM to run. PWM from output 2 is connected to the COM of the relay PWMSelect is assigned to. To use with Standard Layout, Spindle PWM should be connected to NC side of Relay and Laser should be connected to NO side of relay. When PWMSelect is deactivated, PWM is being sent to Spindle. When PWMSelect is activated, the PWM signal is being sent to Laser. Follow Schematic J-TECH Photonics Laser, BLDC Spindle Control #[S15057](#).

e.) LaserCooling_Fan: This output can be used to activate an external Laser cooling fan. It automatically turns on with M37 (Laser ON) and turns off with M38 (Laser OFF). There is a delay timer if you wish for the Cooling fan to stay on for an amount of time after the Laser has turned off. The delay timer that will keep the fan on for the set amount of seconds after M38 is issued. The default value for the timer is 0 seconds.

Laser cooling fan delay timer

seconds

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Acorn Example Hookup: Using schematic [S15061](#) OPT Laser (PLH3D-6W) as an example, let's see how to assign the Laser outputs to match the schematic.

- To setup up the PWM output, navigate to PWM Setup tab in the wizard under the Spindle section. Set PWM Enable to ON (this will automatically set PWMOutput in OUTPUT2 in the Output Definitions tab). Also set the base frequency to the recommended value for the particular Laser; for the PLH3D-6W a value between 5-10kHz is recommended. The PWM minimum S command, Inverse Output, and Laser cooling fan timer can be set as desired, but will be left at default for the example.

The screenshot shows the 'PWM Setup' configuration window. It contains several settings with corresponding input fields or buttons:

- PWM Enable:** A green button labeled 'Yes' is selected.
- Base Frequency (Hz):** A text input field contains '5000'. To the right, it says '(min value = 1, max value = 24,000)'.
- PWM S command range: 0-1000 or 0-100:** A green button labeled '1000' is selected.
- PWM minimum S command power level to start Laser:** A text input field contains '0'.
- Inverse Output:** A red button labeled 'No' is selected.
- Laser cooling fan delay timer:** A text input field contains '0' followed by the unit 'seconds'.

Below these settings is a section titled 'Common J Tech Laser Configuration Presets' with four options, each with a 'No' button selected:

- I will configure the pwm outputs myself
- Jtech Laser (Dedicated Laser Machine, No spindle motor)
- Jtech Laser with PWM BLDC spindle
- Jtech Laser with analog output AC spindle motor controlled by VFD

- The Laser will be cut off from power whenever the E-Stop is pressed or another fault is present. Along with hard-wiring power to Laser through the E-Stop, NoFaultOut output also disconnects the power in the relay when NoFaultOut is LOW. Assign NoFaultOut to OUTPUT1 in the Output Definitions tab.

- OUT4 from the relay controls whether the PWM signal is sent to the Laser or not. This allows for the controller to choose when the Laser diode is active through the LaserEnable output while still providing power to the Laser. Assign LaserEnable to OUTPUT4 in the Output Definitions tab.

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Output Type: Mill

Acorn Integrated Outputs 1-8

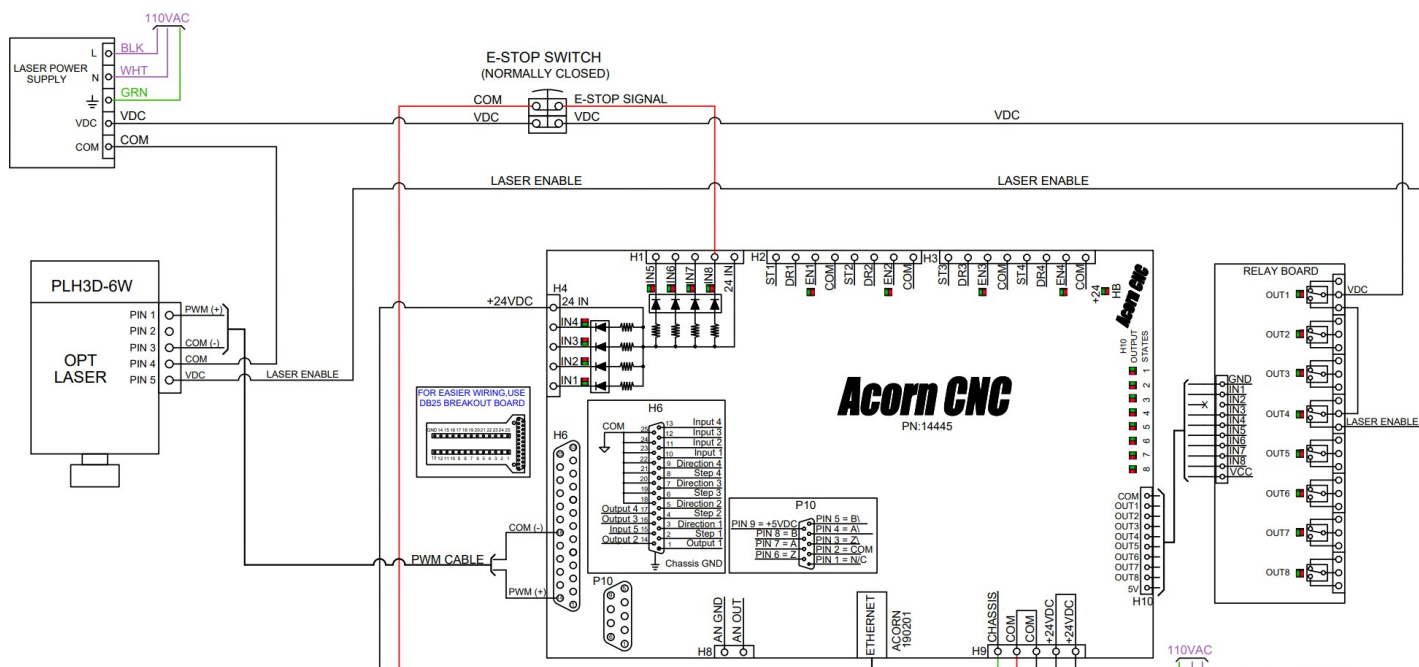
Output	Definition
1 OUT1	NoFaultOut
2 OUT2	PWM Output
3 OUT3	
4 OUT4	LaserEnable
5 OUT5	
6 OUT6	
7 OUT7	
8 OUT8	

Click and Drag an Output function definition from list to the Output number Definition box to assign a function to an output

Available functions (from scroll list):

- AirBlowNozzle
- AmberLight
- ATC_CarouselForward
- ATC_CarouselIn
- ATC_CarouselOut
- ATC_CarouselReverse
- ATCAirBlowActivate
- Axis1BrakeRelease
- Axis2BrakeRelease
- Axis3BrakeRelease
- Axis4BrakeRelease
- ChargePump
- DriveResetOut
- DustCollectionOn
- Flood
- G540SpinFwdOff
- G540SpinRevOff
- GreenLight
- LaserCooling_Fan
- LaserReset
- LubePump
- Mist
- OrientSpindle
- Oscillation On
- PWMSelect
- RedLight
- SafetyDoorLockOpen
- SpindleBrakeRelease
- SpindleCooling
- SpindleCoolingFan

Acorn_rev4 has LED indicators for the Inputs and Outputs



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AcornSix Example Hookup: Using AcornSix schematic [S15217](#) NEJE Laser as an example, follow these steps for setting up a Laser using the AcornSix Wizard.

- In the PWM Setup tab under the Spindle section of the Wizard, PWM should already be enabled and grayed-out since AcornSix always has PWM enabled through its dedicated PWM terminal. The default base frequency of 4883 Hz works for the NEJE, so can be left at default. The PWM minimum S command, Inverse Output, and Laser cooling fan timer can be set as desired, but will be left at default for this example.

PWM Setup

PWM Enable

Yes

Base Frequency (Hz)

4883hz

PWM S command range: 0-1000 or 0-100

1000

PWM minimum S command power level to start Laser

0

Inverse Output

No

Laser cooling fan delay timer

0

seconds

Common J Tech Laser Configuration Presets

I will configure the pwm outputs myself

Yes

Jtech Laser (Dedicated Laser Machine, No spindle motor)

No

Jtech Laser with PWM BLDC spindle

No

Jtech Laser with analog output AC spindle motor controlled by VFD

No

- The Laser will be cut off from power whenever the E-Stop is pressed or another fault is present. Along with hard-wiring power to Laser through the E-Stop, NoFaultOut output also disconnects the power in the relay when NoFaultOut is LOW. Assign NoFaultOut to OUTPUT1 in the Output Definitions tab.

- OUT4 from the relay controls whether the PWM signal is sent to the Laser or not. This allows for the controller to choose when the Laser receives the PWM signal via the LaserEnable output. Assign LaserEnable to OUTPUT4 in the Output Definitions tab.

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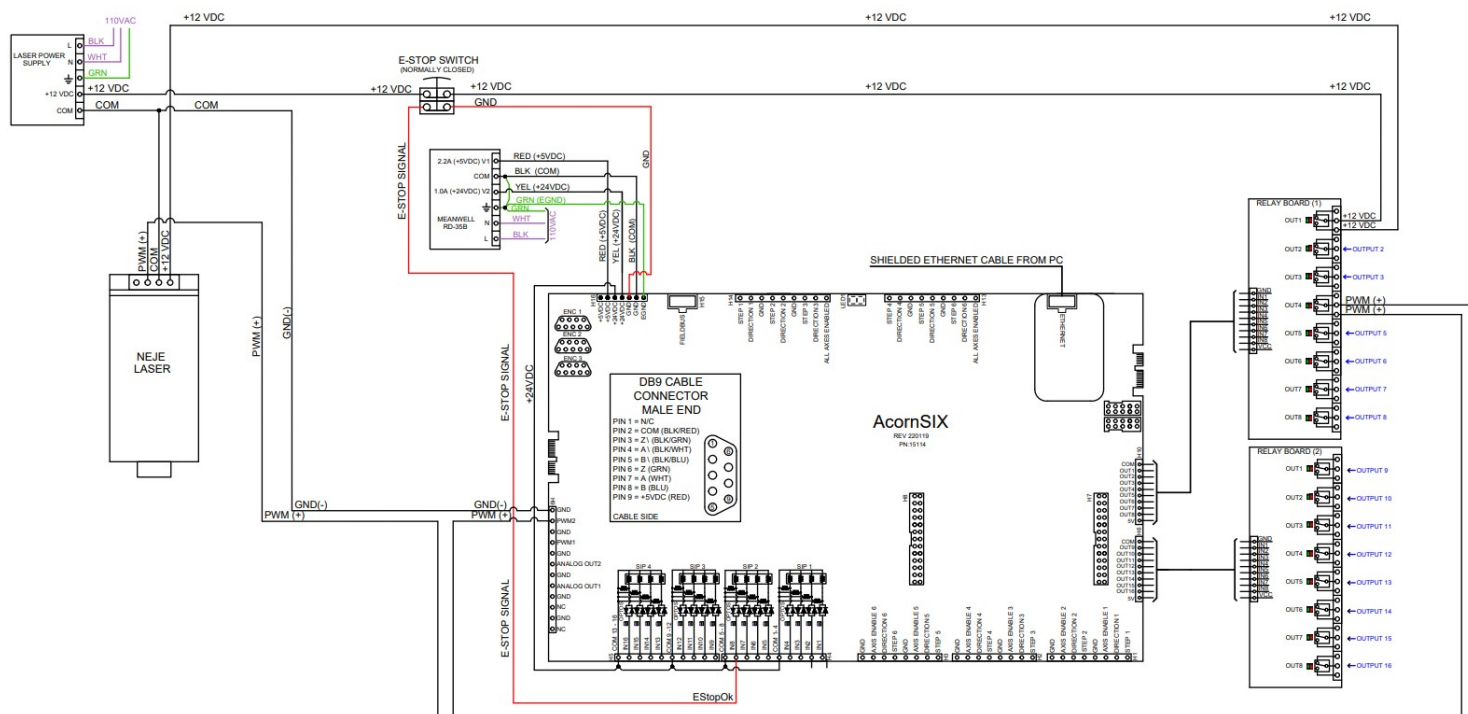
Output Type: Mill

AirBlowNozzle
AmberLight
ATC_CarouselForward
ATC_CarouselIn
ATC_CarouselOut
ATC_CarouselReverse
ATCAirBlowActivate
Axis1BrakeRelease
Axis2BrakeRelease
Axis3BrakeRelease
Axis4BrakeRelease
Axis5BrakeRelease
Axis6BrakeRelease
ChargePump
DriveResetOut
DustCollectionOn
Flood
G540SpinFwdOff
G540SpinRevOff
GreenLight
LaserCooling_Fan
LaserReset
LubePump
Mist
OrientSpindle
Oscillation On
PWM Output
PWMSelect
RedLight
SafetyDeadlockOpen

Acorn Integrated Outputs 1-16

	Definition
1 OUT1	NoFaultOut
2 OUT2	
3 OUT3	
4 OUT4	LaserEnable
5 OUT5	
6 OUT6	
7 OUT7	
8 OUT8	
9 OUT9	
10 OUT10	
11 OUT11	
12 OUT12	
13 OUT13	
14 OUT14	
15 OUT15	
16 OUT16	

Click and Drag an Output function definition from list to the Output number Definition box to assign a function to an output



ZigZagSyncTest Instruction

These two test programs are included with the CNC12 Mill and Router v5.0+ installation in the laser folder: cncm\ncfiles\laser

ZigZagLaserSyncTest-X_Axis.cnc

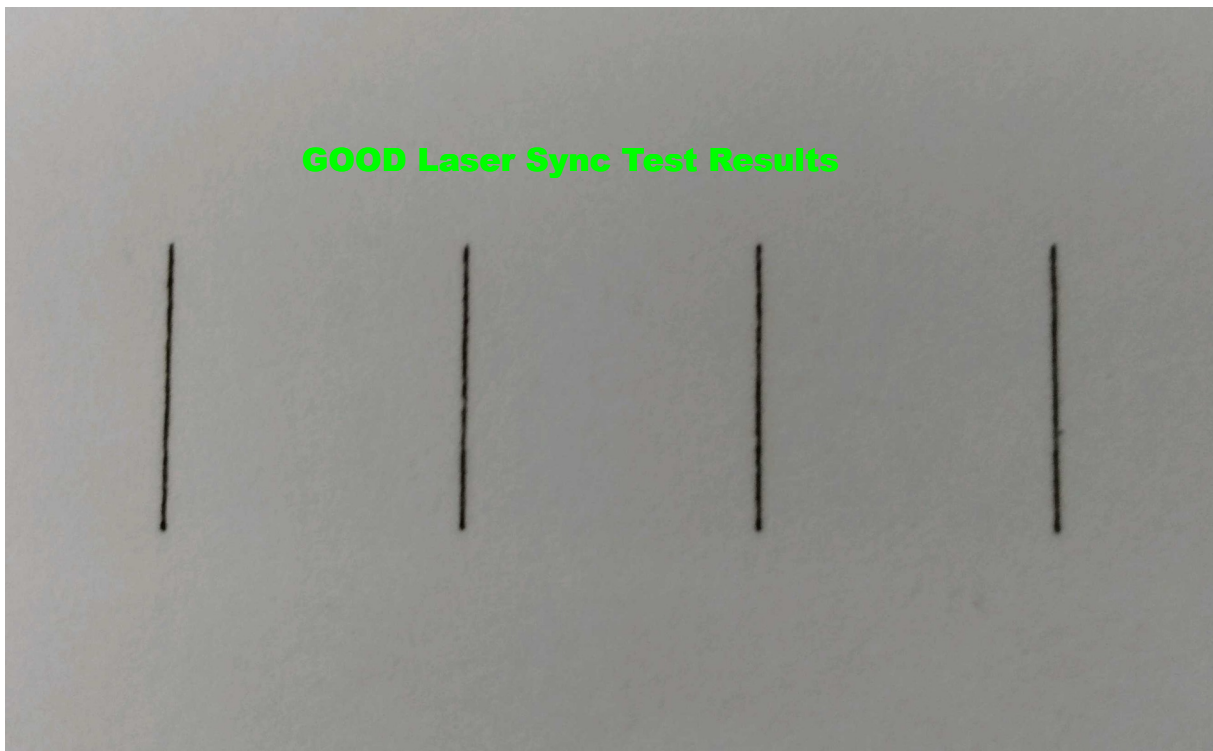
ZigZagLaserSyncTest-Y_Axis.cnc

Purpose:

These two programs were created to test for and adjust backlash in your Laser table axes.

The program will create four lines in either the X or Y direction by moving back and forth in that axis and firing the Laser in short 0.006 inch pulses at specific points while moving in each direction.

Below is an example of what is expected from running ZigZagLaserSyncTest-X_Axis.cnc.



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Backlash in an axis will produce a line that looks similar to the below image when examined under magnification.



As you can see, the dots are not aligned down the axis, which shows that the machine has backlash in the X axis and is losing motion when changing directions. Since each “dot” is 0.006 inches long we can make an educated guess at the backlash adjustment need to align the “dot”

See this video for a detailed example of this procedure.

<https://youtu.be/bMN7kDUnpWE?si=UVaGYfOsIT4-bjh3>

Use the Wizard to adjust the backlash compensation for that axis and run the program again to verify or determine if more or less compensation is needed.

Axis Configuration				
	Axis 1	Axis 2	Axis 3	Axis 4
Linear or Rotary	Linear	Linear	Linear	Rotary
Label	X	Y	Z	N
Steps / Revolution	1600	1600	1600	1600
Overall Turns Ratio <small>turns/in. or rev/deg or turns/rev</small>	5	5	5	0.25
Lash Comp. <small>inches</small>	0	0	0	0
Max Rate <small>in./min or deg/min or rev/min</small>	50	50	50	360
Fast Jog Plus Direction <small>in./min or deg/min or rev/min</small>	50	50	50	360
Fast Jog Minus Direction <small>in./min or deg/min or rev/min</small>	50	50	50	360
Slow Jog <small>in./min or deg/min or rev/min</small>	10	10	10	36
Accel / Decel <small>seconds</small>	0.5	0.5	0.5	0.5
Direction Reversal	N	N	N	N
Drive Enable Delay <small>milliseconds</small>	250	250	250	250

TB326 (Rev4) – Acorn and AcornSix PWM Laser Setup

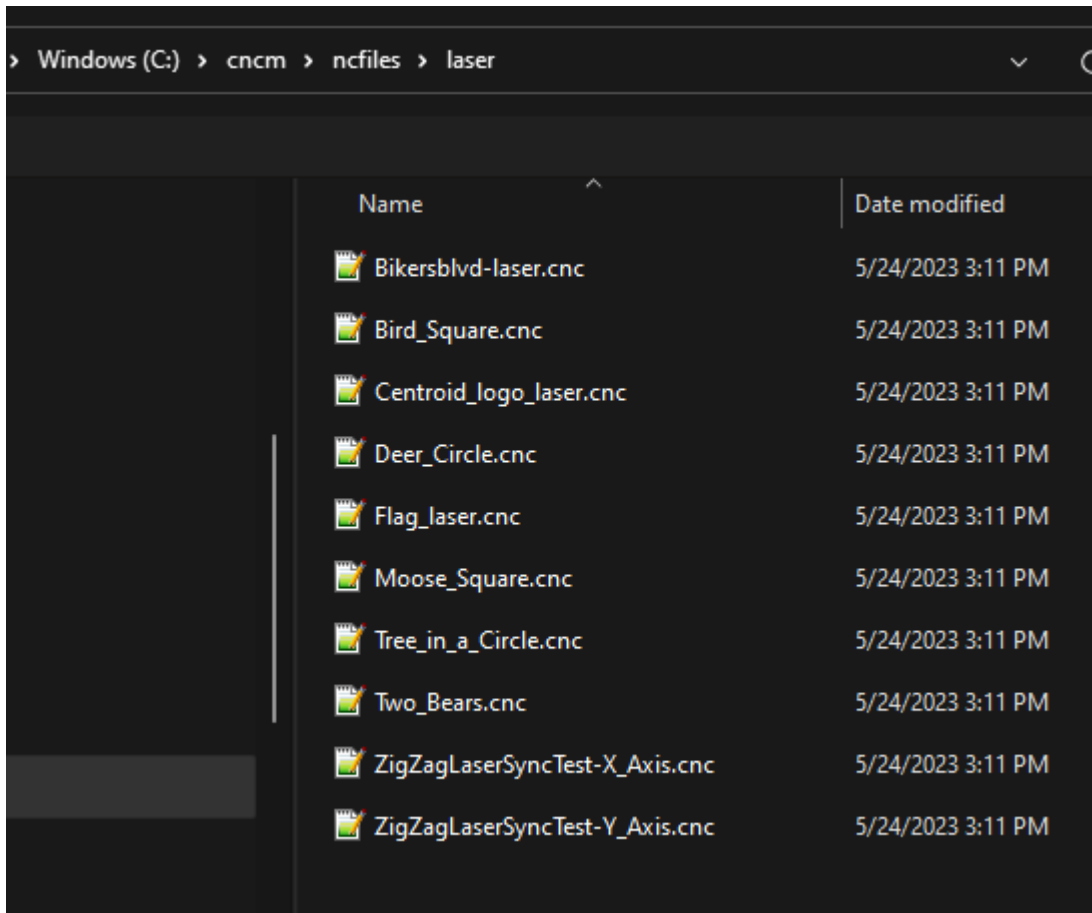
Example Centroid Laser G code.

Sample G code

```
G21 ; select metric units
G90 ; absolute positioning
G0 X0 Y0 ; rapid to X0Y0
Z0 ; Move to Z zero
G37 ON ; PWM Laser Power Velocity Modulation ON
M3S0 ; Laser power off
M37 ; Laser on
G0 X-74 Y-36.5 F2000
M3 S0
G1 X-73.833 S207
X-73.667 S203
X-73.333 S201
X-73.167 S203
X-73 S209
X-72.667 S213
X-72.5 S211
X-72.333 S215
X-72.167 S217
X-71.833 S215
X-71.667 S213
X-71.5 S205
X-71.333 S211
X-71.167 S207
X-71 S200
X-70.667 S203
X-70.5 S196
X-70.333 S190
X-70.167 S192
X-70 S194
X-69.333 S200
X-69.167 S198
X-69 S196
X-68.833 S198
X-68.667 S203
X-68.5 S207
X-68.333 S205.....
```

TB326 (Rev4) – Acorn and AcornSix PWM Laser Setup

The CNC12 Installer comes with a few sample Laser G code programs located in the folder cncm\ncfiles\laser



TB326 (Rev4) – Acorn and AcornSix PWM Laser Setup

LaserGRBL Post Processor Header and Footer info for Centroid Acorn Laser compatible G code.

HEADER

G21 ; select metric units
G90 ; absolute positioning
G0 X0 Y0 ; rapid to X0Y0
Z0 ; Move to Z zero
G37 ON ; Auto Laser power Velocity Modulation ON
M3S0 ; Laser power off
M37 ; Laser on

MULTIPLE PASSES

;(Uncomment these lines below if you want to sink Z axis)
;G91 (use relative coordinates)
;G0 Z-1 (sinks the Z axis, 1mm)
;G90 (use absolute coordinates)

FOOTER

S0
G90 ; Absolute positioning
M38 ; Laser cool down time
;END

Document History

Revision 1 created on 2023-10-20 by 490

Revision 2 created on 2023-11-28 by km

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