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Laser Cutter V2

CURRENT MACHINE STATUS: Available for use

Project Details

This laser cutter was kindly donated to the CCHS by James Muraca on the 01/08/2015.

Do not attempt to modify or repair the machine in any way without approval of the committee and/or the “project champions” (Brian Gilbert and Tim Eastwood as of 22/2/2016). Proper documentation of any work on the machine is expected by all parties involved. Details around the ongoing modification/upgrade/maintenance of this machine are managed via the CCHS Trello board, “Laser Cutter V2”.

Reporting a Problem / Contacting the Project Champions

You can report an issue with the Laser Cutter by emailing the Committee (committee@hackmelbourne.org), by posting on any of the mailing lists or by informing a Duty Officer at the hacker space in person who can pass on the message for you. The current project champions are both committee members so can also be contacted by these means.

Basic Safety Rules

First and foremost - if anything is going wrong, hit the big red emergency stop button.

- Review the entire instruction document and ensure you are familiar with it prior to cutting
- Always follow every instruction for each procedure in this document (power on / off etc)
- Do not attempt to operate the laser cutter with any of the panels open – ever
- Do not attempt to defeat the safety interlocks
- Do not attempt to operate the machine if it has been tagged “DO NOT USE”
- Do not attempt to continue operating the machine if a fault occurs during use
- Only laser cut approved materials
- Do not operate the laser cutter without water pump /chiller, exhaust fan, and air compressor running (it should not allow you to anyway)
- Never leave the laser cutter unattended while switched on, regardless of whether it is actively cutting
- Always use common sense around the laser cutter
- Remember the laser cutter contains components which are **highly lethal** if improperly used – show the machine the required level of respect at all times!

When laser-cutting there is the potential for the material to catch fire. If this happens, press the emergency stop before opening the lid. If there is a small fire and if it's safe to do so, try smothering it with a sheet of acrylic. If the fire is too large to extinguish safely by hand use one of the Space's fire extinguishers and make sure you notify the committee so it can be replaced/recharged. If everything has gone horribly wrong close the lid of the cutter, evacuate the building and call 000.

Please:

If any un-correctable fault occurs, PLEASE tag the machine with a DO NOT USE tag and **inform the committee** or speak to the Duty Officer present at the space. Don't try and continue to use the machine

or do anything dumb like bypass the safety interlocks... even if you think you know what you're doing. Don't just act natural and wander away like nothing happened for someone else to deal with...

Power On Procedure

Ensure you have prepared your g-code before powering up the laser cutter.

1. Check power cables to Laser Cutter, Air Compressor and Chiller unit are securely plugged in and switched on at the wall
2. Check the Key is in the DISARMED position
3. Lift the cover over the cutting bed and ensure that there are no obstructions or any visible faults / damage. Place your piece on the cutting bed, aligning it to the **rear-left corner**
4. Ensure that all panels are properly shut and locked – there are 5 in total
5. Turn on the Exhaust Fan
6. Check plumbing connections are secure, then turn on the chiller unit (red switch on the front)
7. Twist the E-Stop button clockwise to disengage if needed
8. Turn on the Main Power – the Main Power button should illuminate, the LCD screen should turn on and the air compressor will start running.
9. Turn the Key to the ARMED position – be aware the laser is now armed and may be activated by software
10. Verify that the LCD screen displays “READY TO CUT” and the “ready” LED is lit – otherwise check the Error Messages reference section below and rectify as needed

Power Off Procedure

1. Turn the Key to DISARMED
2. Turn the Main Power OFF – this should also turn off the Air Compressor
3. If not using the Cutter again, turn off the Chiller
4. If not using the Cutter again, turn off the Exhaust Fan
5. Ensure all material has been removed from the cutting bed and that you are leaving the machine in a clean state ready for the next person to use
6. If not using the Cutter again, shut down the laptop and close its lid

LCD Error Messages

“READY TO CUT” – machine is ready to cut and laser is armed

“CLOSE COVER(S)” – ensure all 5 covers are properly closed and locked shut*

“E-STOP PRESSED” – twist the E-Stop clockwise to disengage*

“KEY OFF” – turn the Key to the ON position*

“CHECK FLOW RATE” – ensure the chiller is powered on and that liquid is flowing through the laser tube

“CHECK TEMPERATURE 1” – the temperature of the coolant is outside acceptable limits, check the chiller is powered on and that liquid is flowing through the laser tube

“CHECK TEMPERATURE 2” – as above

*these status messages are not displayed as the laser cutter is not yet fitted with double pole interlock switches to accommodate this feature

If a Fault Occurs

- Follow the power-down procedure
- If you plan on opening the side cover (marked “Dangerous Voltage Inside”) you should do so only after disconnecting all mains supplies and you should have the permission of the

committee and/or project champions. The HV (high-voltage) power supply **can kill you** if mishandled.

- If the fault is “KEY OFF”, “E-STOP PRESSED” or “CLOSE COVER(S)”, the cause is pretty clear. If none of these actually happened, there may be a fault with the interlock wiring or switches.
- If the fault is “CHECK FLOW” or “CHECK TEMPERATURE X”, check that the Chiller is operating normally by observing the presence and flow of water through the laser tube (you should see tiny bubbles moving through). If the tube is cool to the touch (not a temperature issue) and you can clearly see the coolant flowing, there may be a fault with one or more sensors.

Do not attempt to repair the machine yourself without the approval of the committee and/or the project champions. See the “Reporting a Problem / Contacting the Project Champions” section.

Mirror Alignment

1. First align the laser tube to the centre of the rear mirror.
2. Next, align the laser to the centre of the Y (front-left) mirror with the Y axis fully-forward.
3. Now, move the Y axis all the way to the rear and see where the laser lands on the Y mirror. Move the rear mirror to bring it back to centre by loosening the bolts mounting the mirror holder to the chassis.
4. Repeat steps 2 + 3 until the laser hits the Y mirror at centre when the Y axis is in any position.
5. Now align the laser to the X mirror (front right). Ensure it hits centre with the X axis in any position.
6. You may need to adjust the Y mirror mounting if the X axis is off-centre at different positions.
7. Align the X mirror to deflect the laser through the centre of the end-effector / lense.

Use temperature sensitive receipt paper with the laser at minimal power to align the mirrors and ensure it doesn't burn. If you have never aligned the mirrors before **you are not permitted to do so unless approved by a project champion.**

Flashing Firmware

Flash the firmware using the standard procedure for uploading a sketch to an arduino. The Laser Cutter USB cable is used to do this.

Maintenance

Check the water in the chiller is clean / replace with fresh distilled water /check water level
Clean the bed area and underneath the bed area

General Machine Information

There are three controller boards on the cutter; a high-voltage power supply, an Arduino Mega and an Arduino Uno. The high-voltage supply is positioned behind a plastic casing and is labelled with warnings – under no circumstances must this be tampered with, modified or altered. The high-voltage supply casing also houses the ammeter and potentiometer for adjusting the current to the laser tube. This **must not ever be touched** – it is already set to an absolute maximum safe current limit. Altering this will not make the machine cut better or cut thicker materials, it will just burn out the laser tube. Laser power is set in the software. The tube may deteriorate with age and lose power. Do not adjust the potentiometer to compensate as again, this will burn out the tube.

To protect the laser tube and the hackers using the machine, a separate controller has been installed to monitor the state of the machine and intervene when certain conditions fall outside acceptable ranges. It will in future perform other functions such as interfacing with access control systems and data logging to monitor the condition and performance of the laser tube during its lifespan.

There is a flow sensor (<http://tronixlabs.com.au/sensors/water-flow/adafruit-liquid-flow-meter-plastic-1-2-nps-threaded/>) and two temperature sensors fitted to the machine for monitoring the flow of coolant. In the event these fall outside normal values, the controller will open a relay and interrupt the interlock circuit which is part of the HV supply.

At the time of writing, the interlock switches interrupt the HV interlock circuit directly. As a result, the LCD **does not** display the "CLOSE COVER(S)", "KEY OFF" and "E-STOP PRESSED" messages as double-pole interlock switches are required to achieve this without relying solely on the safety microcontroller to interrupt the laser, which we're not prepared to do.

The machine is fitted with two end stop switches for homing. In Marlin these are recognised as the X_MIN and Y_MIN. This means that the REAR LEFT corner of the cutting bed is the HOME, or 0,0 coordinate.

The main controller is an Arduino mega with a partial RAMPS shield. It is fitted only with the components required to run two stepper drivers, the Laser control outputs and the end stops.

Little is known about the stepper motors currently installed as no data sheets could be found for the parts. The old stepper drivers were rated at 1.5A. The X stepper motor is particularly small so current has been adjusted to provide enough power to prevent skipping.

Mains wiring has been replaced throughout the unit to improve safety and comply with best practices. The grounding has been tested between the pin at the mains inlet plug and various points on the chassis surrounding mains wiring connections and the power supplies and found to be low-resistance and reliably connected.

Potential Future Upgrades

Better exhaust system
Better pump with higher flow rate

Specifications

Original Manufacturer: Redsail

Model: M400 / 3040

Laser Tube: Sealed CO2 40 watts max

OEM Manual (do not use, use this document instead):

<http://www.manualslib.com/manual/804295/Redsail-Rs3040a.html?page=14#manual>

Other Components:

- Genuine Arduino Mega 2560 + Partial RAMPS + 2x Pololu Stepstick Drivers
- Arduino Uno with 20x4 Character LCD + I2C backpack
- 12V, 2.5Amp PSU
- Unknown brand / model HV PSU
- Various switches and wiring upgrades / modifications
- Other components (stepper motors, mechanical parts) remain OEM

Component Diagram

Diagram TBA... I don't possess the skills required to make a nice diagram :)

PSU Wiring:

K+/K-

Laser Test button (not functional on this power supply, does nothing)

G/IN/5V

Power control potentiometer

D+/D-

Safety interlock (close circuit to enable laser)

5V/L

+5VDC from controller board to fire the laser, accepts PWM @ ~490hz (arduino default)

Tutorials

Please see other documents linked on the CCHS Laser Cutter V2 Wiki page for tutorials on how to set up CamBam and Pronterface and how to draw, export and cut using that software.

http://www.hackmelbourne.org/wiki/doc:tools:laser_cutter2