

SL series 3D Printer

User's Manual

Z RAPID Technologies Co., Ltd.

Ver. 1.0

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1 Introduction

1.1 What is Stereolithography (SL)?

Stereolithography is a three-dimensional printing process that produces a solid plastic model. Using proprietary software, CAD output data is sliced into very thin cross sections. The resulting slice sections are then transformed into files to be used at the SL series Production Systems. A laser generating a small, intense beam of Ultraviolet (UV) light is moved by a computer-controlled optical scanning system across the top of a vat containing liquid resin. The laser draws each layer of the part from the data provided by the build data file.

As the laser contacts the resin, the beam photo polymerizes the resin into a solid. When a layer is completed, an elevator lowers the part deeper into the vat, covering it with resin. Leveling and recoating systems establish the thickness and flatness of the liquid layer. When the resin surface is stable, the laser draws the next layer of the part. As each layer is drawn, it adheres to the previous layer, creating a solid part. This process continues until the final layer has been drawn. The part is then removed from the SL Production System, cleaned and post-cured with high intensity UV energy to complete the polymerization process. The part may then be finished by various methods including sanding,

sandblasting, painting or dyeing.

Z Rapid standard range of SL Production Systems include SL300, SL450 and SL600 (see Figures 1,2 and 3).



Figure 1.SL300



Figure 2.SL450



Figure 3.SL600

Note: *Outlook of actual machines may vary from the above pictures.*

1.2 SL Characteristic

- **High speed printing**
- **High quality printed parts**
- **User-friendly**
- **Highly automated**

1.3 The SL Process

There are three major steps in stereolithography - CAD Preparation, Print Process and Post Processing.

1.3.1 CAD Preparation

CAD preparation includes the CAD Design and the CAD Interface. These

two steps take the design image from a three-dimensional CAD image, directly to slice & support generation software, which then prepares the specially-formatted computer image files(.slc) for use in stereolithography. There are normally two files: Part.slc for the part and s_part.slc for the support structures of the part.

1.3.2 Print Process

Turn on the machine and copy all the SLC files into the PC. Add Part.slc file into the Zero build software. The s_part.slc will be added automatically. Position the parts on the build plate grid in the software. Click the Build button in Zero to begin print.

1.3.3 Post Processing

After the part has been built it requires post processing. This includes cleaning, removing the supports and ultraviolet (UV) post curing. It may also include final finishing, such as sanding, sandblasting, polishing, buffing, painting or dyeing.



2 Hardware of SL

2.1 Hardware Introduction

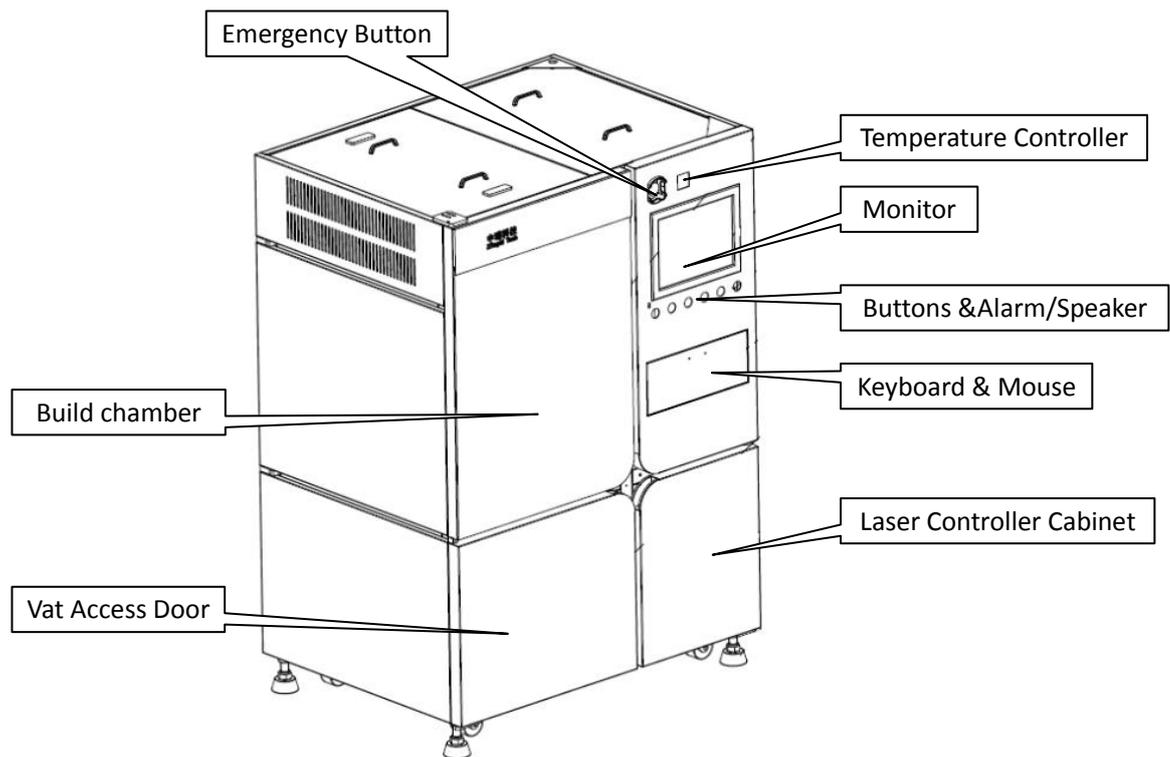


Figure 4. Hardware Introduction

Note: *Illustration above (see Figure 4) is based on SL300 and SL450, however, positions of indicated parts are similar on the SL600.*

2.1.1 Build Chamber

The build chamber (see Figure 5) is the working space of the SL Production Systems and it encompasses the build plate, recoater, resin vat, etc.

The build plate is the platform upon which the parts are printed.

The recoater sweeps the resin during printing.

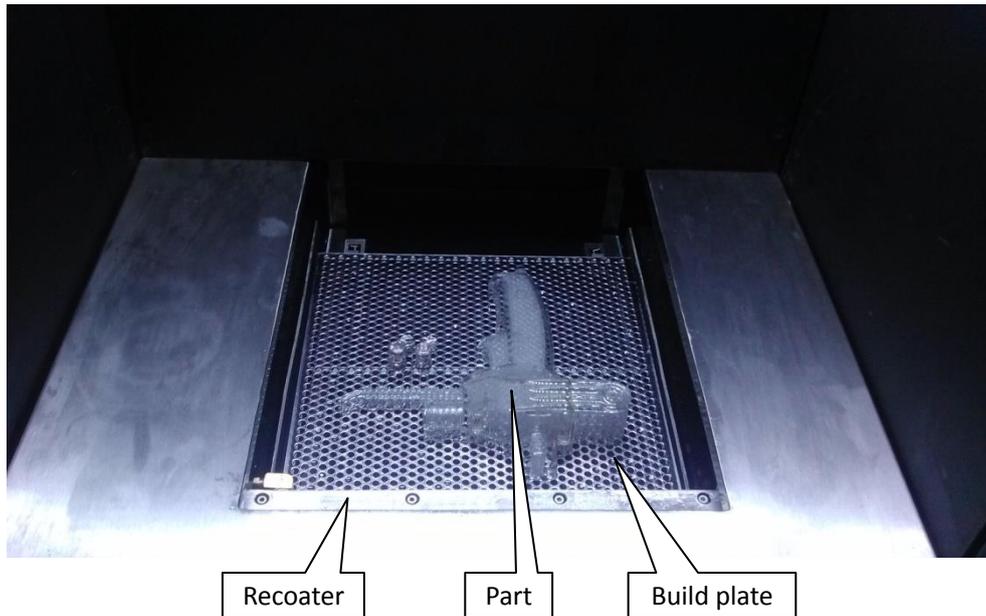


Figure 5.The Build Chamber

The resin vat (see Figure 6) is located below the build plate and contains resin.

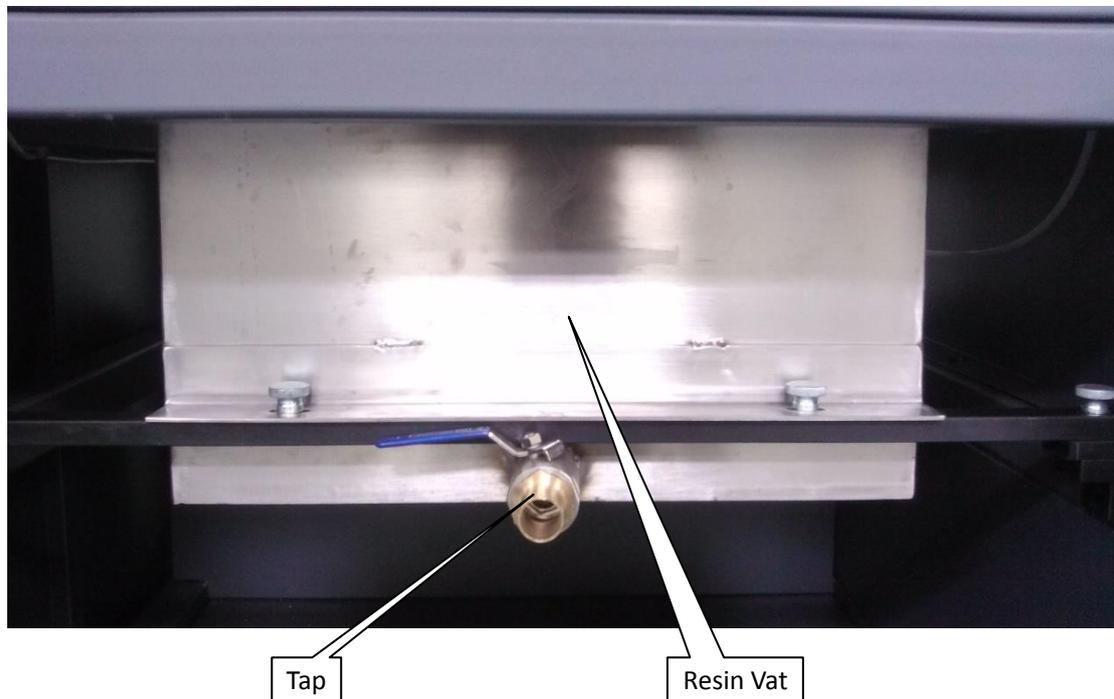


Figure 6.The Resin Vat

Note: *Open the vat access door, to locate the tap for draining out resin.*

2.1.2 Emergency Button

In the case of emergencies, push the emergency button (see Figure 7) to stop the motion system immediately. To restart the system, rotate the button clockwise as indicated.



Figure 7. The Emergency Button

2.1.3 Temperature Controller

To control the temperature of the build chamber.



Figure 8. The Temperature Controller

Note: The standard recommended temperature setting is 32 °C. However,

for resin which does not require heating, shut off the heater system.

2.1.4 Monitor

The monitor on the SL series 3D printer has a touch screen feature.

2.1.5 Buttons & Alarm/Speaker

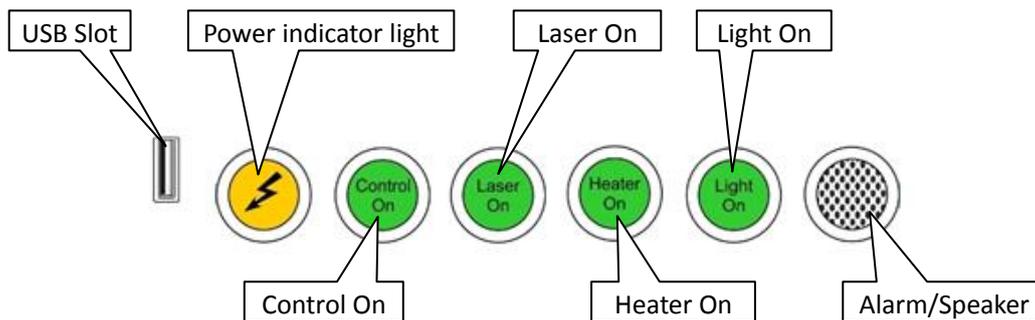


Figure 9. Buttons & Alarm/Speaker

- a) **USB Slot** – Insert USB to copy SLC files to computer.
- b) **Power indicator light** – Indicates machine is on standby/220V.
- c) **Control On** – On/Off button for 24v DC on PC, Control system, etc.
- d) **Laser On** – On/Off button for the laser controller.
- e) **Heater On** – On/Off button for the heater system.
- f) **Light On** – On/Off button for the LED lights in the build chamber.
- g) **Alarm/Speaker** – “Beeps” driven by motion controller.

Note: *Push On/Off buttons to activate functions. Lit buttons indicates functions are On/in operation. Push the lit button to turn the function off.*

2.1.6 Laser Controller Cabinet

The laser controller (see Figure 10) is located in the laser controller

cabinet.

Two models of laser systems are used in the SL series 3D printer; RFH Laser (Figure 10) and Inngu Laser (Figure 11). Identify the model of the laser system on your SL 3D printer and refer to the corresponding operation instructions.

Operating instructions for the RFH Laser and Inngu Laser are detailed in [Appendix 1](#) and [Appendix 2](#) respectively.



Figure 10. RFH Laser Controller Panel



Figure 11. Inngu Laser Controller Panel

Caution: *Avoid looking directly into the beam of the laser or the reflection of the laser beam as that may cause injury to your eyes. Please put on protective goggles when operating the laser.*

Important: *The laser system is the integral part of the SL System and*

must only be operated (besides turning on/off) by trained technical personnel under guidance of our technical support engineers.

2.1.7 Main Power Switch

The main power switch (see Figure 12) is located at the back of machine.

Turn clockwise to switch on and anti-clockwise to switch off.



Figure 12. Main Power Switch

Important: *Please ensure that the machine is properly grounded before switching on or it may damage the laser system or the electrical components.*

2.2 Start/Stop SL

2.2.1 Start SL

- a) Turn main power switch clockwise to switch on.
- b) Power indicator light will turn on. Push the Control On button to power on the control system and the monitor will turn on.
- c) The standard recommended temperature setting is 32°C. However, for resin which does not require heating, shut off the heater system.

-
- d) Turn on the laser controller as described in Appendix 1–RFH Laser or Appendix 2–Inggu Laser according to the model of your laser system.

2.2.2 Stop SL

- a) Push the Heater On button to turn function off if temperature control system is in use. Push the Light On button to turn off the LED lights in the build chamber.
- b) Shut down the OS.
- c) Turn off the laser controller as described in Appendix 1–RFH Laser or Appendix 2–Inggu Laser according to the model of your laser system.
- d) Push the Laser On button to turn off the laser system.
- e) Push the Control On button to turn off the control system.
- f) Turn the main power switch anti-clockwise to shut down the machine.

Note: *Please shut down the machine as the above method if it is not to be in use for a prolonged period of time. When not in use for a short period, do not turn the laser power off, just push the LDD/Diode and QSW/QS-On buttons on the laser controller. The resin should also be drained from the vat into storage containers. To preserve the resin, these containers should be stored away from sunlight and in a temperature and humidity controlled place.*



3 Software of SL

3.1 Software Introduction

Zero build software comes pre-installed in the computer system supplied with the SL series 3D printer. You will see the Zero icon  on the desktop of OS. Double click on the icon and the Zero interface window (see Figure 13) pops up.

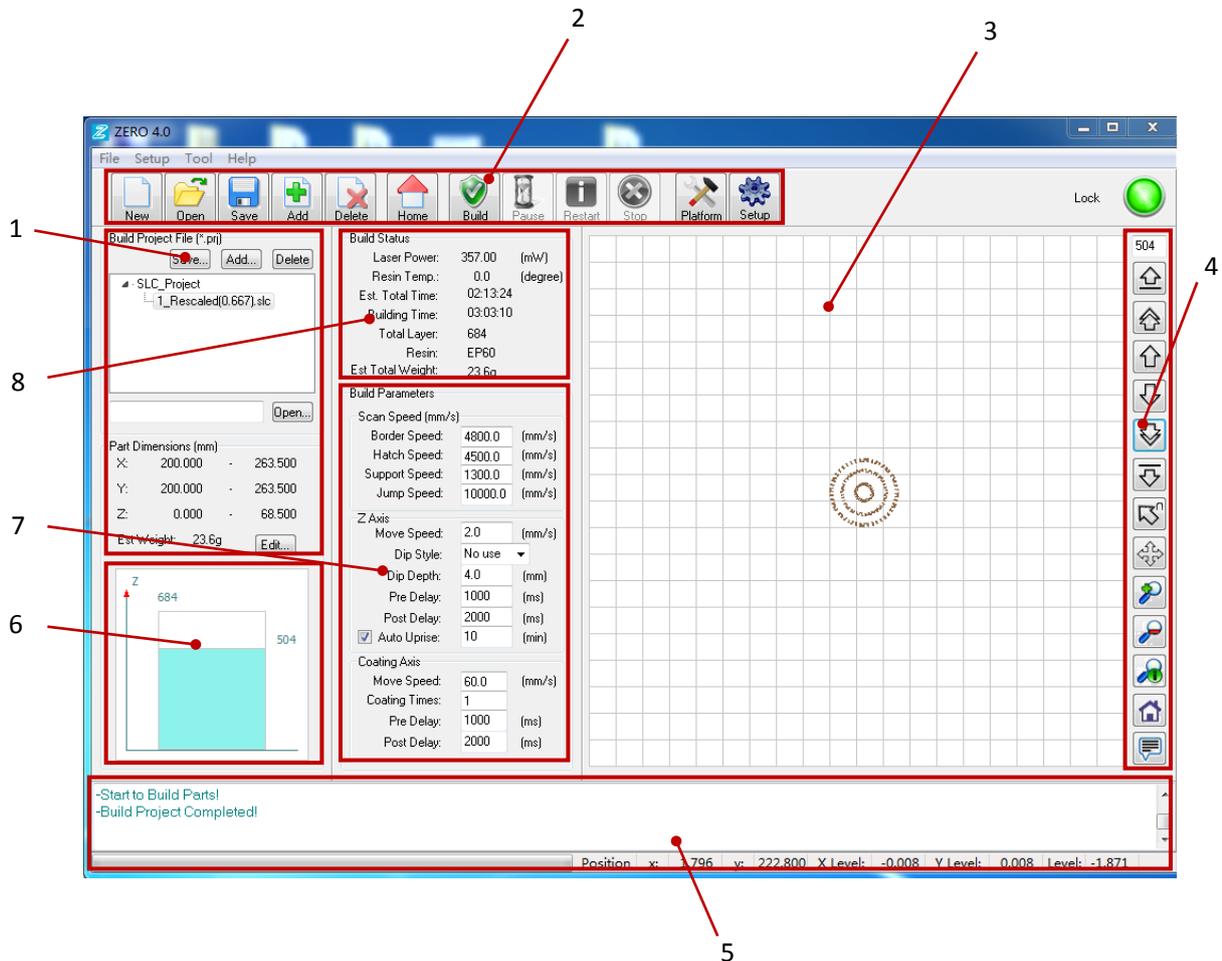


Figure 13.Zero Interface (Ctrl + click on numbering for feature details)

1 -Build Project File Frame: Add/Delete SLC files, Placement of part on build platform, and viewing file information.

Add: Add SLC file. Zero supports adding multiple files simultaneously.

Note: *Press and hold Shift or Ctrl keys and left-click the mouse to select multiple files at a time.*

Delete: Delete the selected SLC files.

Save: Save the added files as a project. The project will contain the part placement information for convenience when repeating the print project.

Open: Open a project file.

Part Dimensions: Display the dimensions of the selected SLC file/part.

Est. Weight: Estimated weight of the parts to be printed from the selected SLC file.

Edit: Click Edit button and the CopiesEdit window (see Figure 14) pops up.

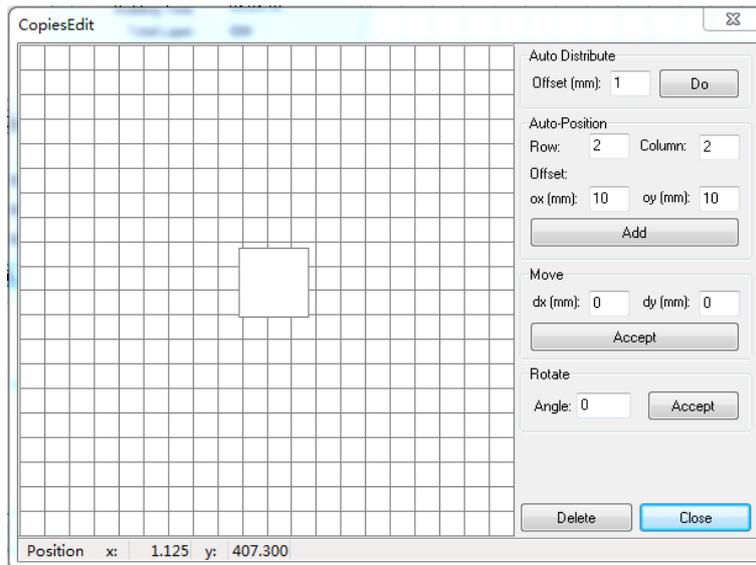


Figure 14.CopiesEdit Window

Note: The block in the grid represents the added SLC file/part. The grid in the CopiesEdit window represents the build plate. Left click the mouse and hold to drag the block/part to place it on the build plate for printing. It is recommended that you centralize the parts on the build plate for printing.

- a) *Auto Distribute:* The software will automatically centralize the added files/parts to be printed on the build plate. Offset refers to the distance between the parts. Click on the Do button to execute the Auto Distribute command.
- b) *Auto-Position:* To array and make multiple copies of a selected part. The values in the Row and Column window indicate the number of parts per row and per column respectively. Offset is used for setting the distances between the parts. Click on the Add button to execute the Auto-Position command.
- c) *Move:* To move the selected file/part. The value in the dx window is

the distance in the X direction and the value in the dy window is the distance in the Y direction. Click on the Accept button to confirm.

d) Rotate: To rotate the selected file/part. Set the required angle for rotation and click on the Accept button to confirm.

e) Delete: To delete copies of the original part. This function will not delete original part.

f) Close: Close the window, and automatically save any changes made.

2- Tools Bar



Figure 15.Tools Bar

New: New project.

Open: Open project.

Save: Save project.

Add: Add SLC files/parts.

Delete: Delete the selected file/part.

Home: Click on the Home button to return the motion system (build plate, recoater, and resin plunger) to their respective home positions.

Build: Click on the Build button and the BuildWarn window (see Figure 16) pops up.

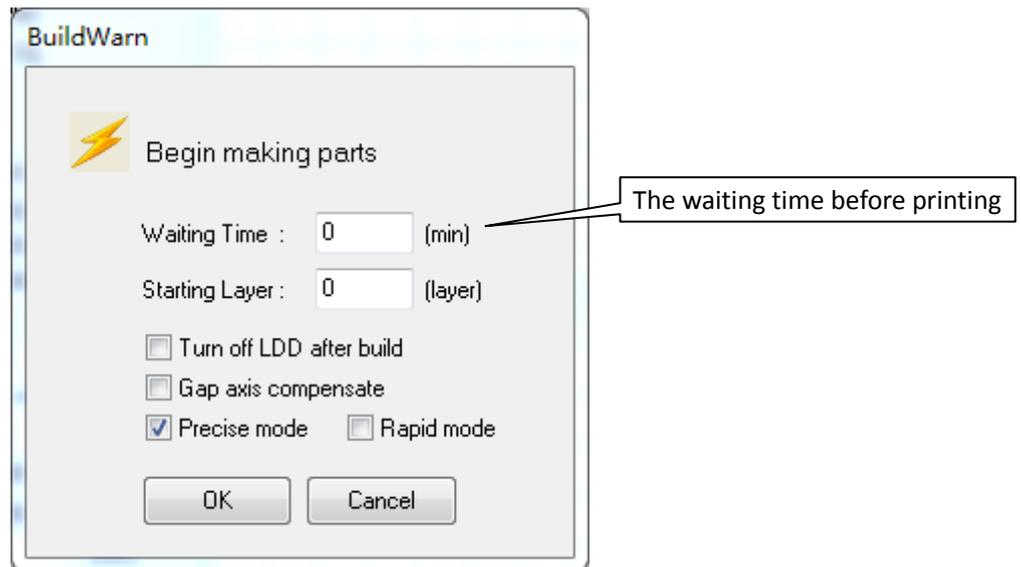


Figure 16.Build Warn Window

a) **Gap axis compensate:** There is a gap, about 0.15mm, between recoater and resin level. This may cause the height of the finished part to be in excess of 0.15mm. The actual required height of the part is maintained by ticking the “Gap axis compensate” feature.

Note: *Do not select this function if printing with raft or if finished part needs to be polished.*

b) **Precise mode:** High resolution printing function.

c) **Rapid mode:** Quick printing function.

Pause: Pause printing.

Restart: Restart printing.

Stop: Stop printing.

Setup: Setup the parameters of the machine.

Platform: Manual control of the motion system. Click on the platform button and the Platform window (see Figure 17) pops up.

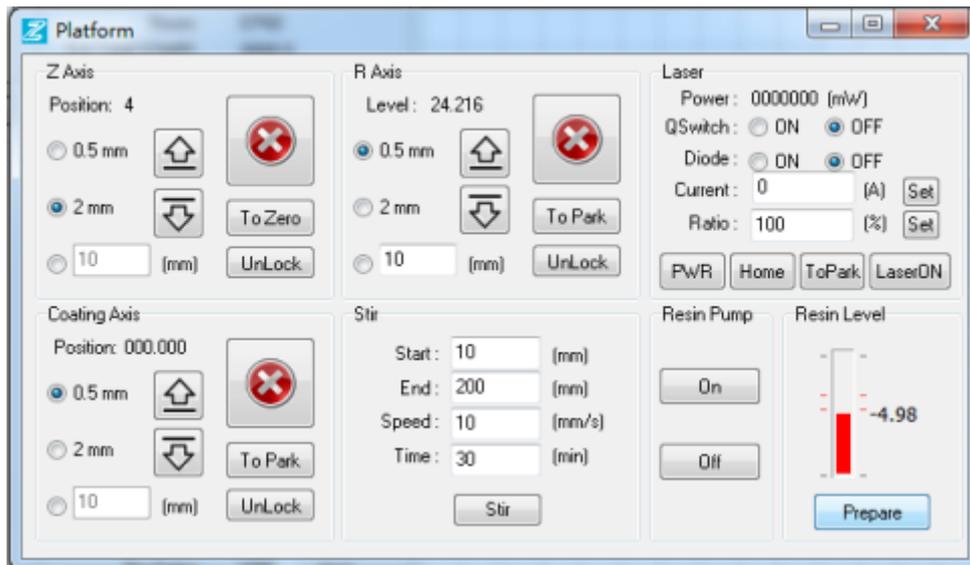


Figure 17.Platform Window

Z Axis: Control the movement of build plate, upwards or downwards.

- Position in Z/Coating Axis indicates the relative position of the build plate/recoater to home position.
- Go to zero position.

R Axis: Control the movement of resin plunger (used to adjust the resin level), upwards or downwards.

- Level in R Axis indicates the resin level value measured by sensor.

Coating Axis: Control the movement of recoater (used to sweep the resin), forwards or backwards.

Stir: Move the build plate upwards and downwards in the vat to stir the resin (see details in Figure 18).

Laser: To measure & display the laser power, turn on/off the QSwitch & Diode, set the current/ratio of the laser, move the laser to Home/To Park positions, etc. (see details in Figure 19).

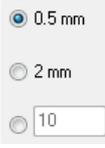
Resin Level: Resin level indicator. When the resin level is low, the

indicator bar will turn red. Top up the resin till the indicator bar turns blue (see details in Figure 20).

Note:

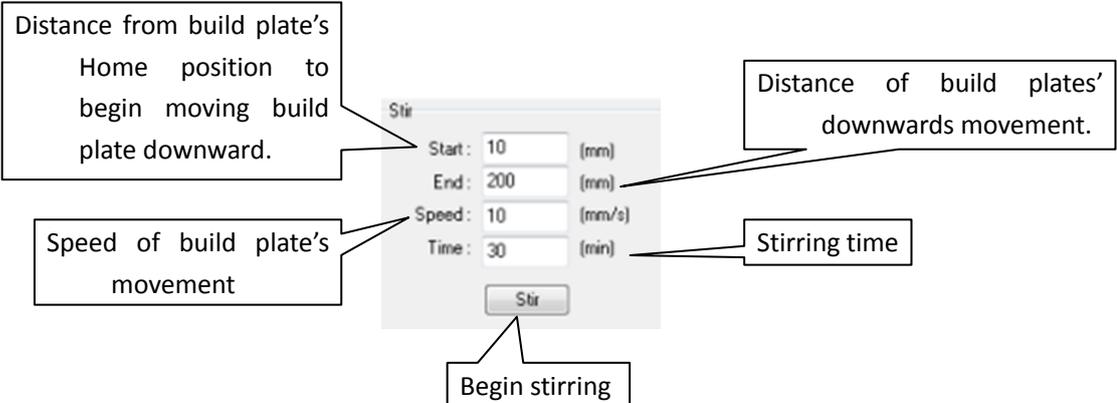
a)  For **Z/R Axis**, this button controls the build plate/resin plunger upwards. In the **Coating Axis**, the button moves the recoater backwards (away from the user).

b)  For **Z/R Axis**, this button controls the build plate/resin plunger downwards. In the **Coating Axis**, the button moves the recoater forwards (towards the user).

c)  To move the build plate/resin plunger/recoater to specified distances (0.5mm, 2mm or user-specified distance).

d)  This button in the Z Axis/R Axis/Coating Axis control is for stopping the movement of the respective axes.

e)  To disable the respective motors.

f)  The Stir control panel includes the following fields and buttons:

- Start:** 10 (mm) - Distance from build plate's Home position to begin moving build plate downward.
- End:** 200 (mm) - Distance of build plates' downwards movement.
- Speed:** 10 (mm/s) - Speed of build plate's movement.
- Time:** 30 (min) - Stirring time.
- Stir** button - Begin stirring.

Figure 18. Stir in Platform

g)

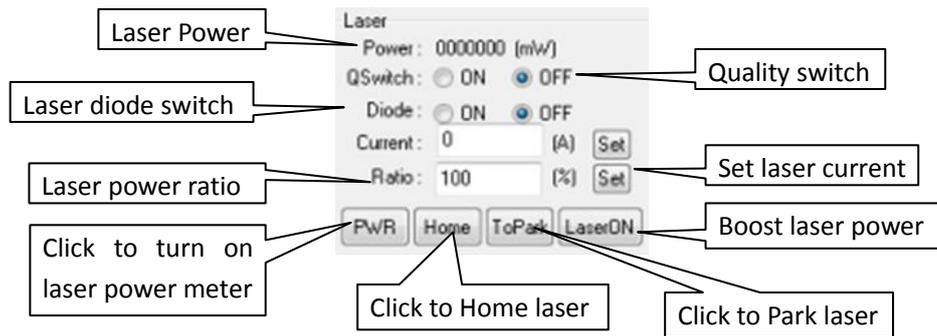
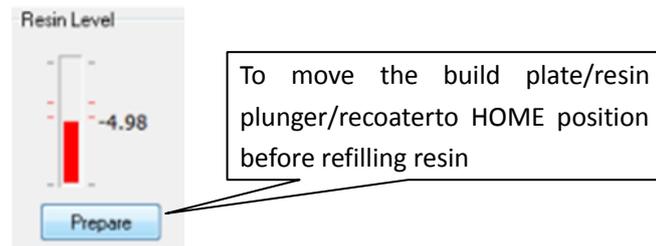


Figure 19.Laser in Platform

h)



To move the build plate/resin plunger/recoaterto HOME position before refilling resin

Figure 20.Resin Level in Platform

3-View block: View the slice image of the SLC files.

4-View Bar:

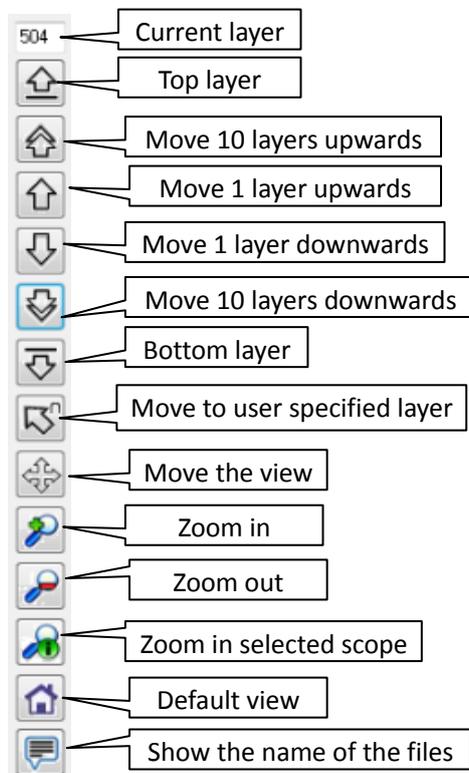


Figure 21.View Bar

5-Status Frame: Show the current status of the software and machine.

- **Position-x/y** - Values are the current coordinates of the mouse in the view grid.
- **X/Y Level** - Values indicate the level of the build plate in the X/Y directions.
- **Level** - Value denotes the resin level.

6-Layer Frame: Shows the total layers of build project and layer currently printing.

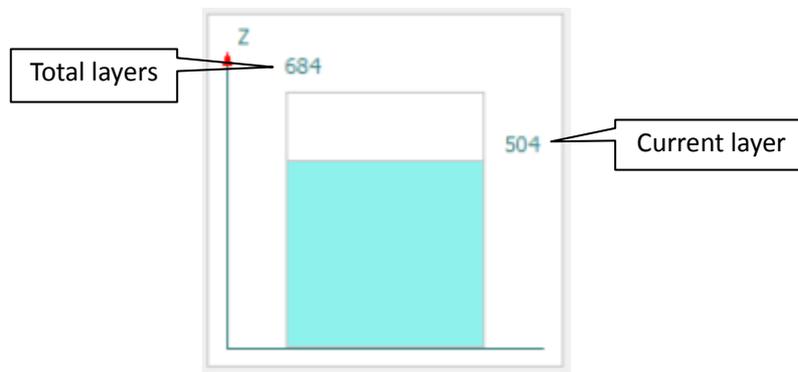


Figure 22.Layer Frame

7-Build Parameters: Including Scan Speed Parameters, Z Axis Parameters, Coating Axis Parameters.

a) **Scan Speed**

- **Border Speed:** The speed of the laser when scanning borders during build.
- **Hatch Speed:** The speed of the laser when hatching during build.
- **Support Speed:** The speed of laser when building supports.

-
- Jump Speed: The speed of the laser when jumping from one part to another part during build.

b) Z Axis

- Move Speed: The speed the build plate moves during printing.
- Dip Style: The dip style of the build plate.
- Dip Depth: The dip depth of the build plate when printing support.
- Pre Delay: The delay before the build plate moves after laser scans a layer.
- Post Delay: The delay before the build plate moves up for scanning the next layer.
- Auto Uprise: To set timing for the build plate to be raised automatically after build is completed.

c) Coating Axis

- Move Speed: The speed the recoater moves during printing.
- Coating Times: The number of times the recoater sweeps the resin during printing.
- Pre Delay: The delay before the recoater moves after the build plate moves down.
- Post Delay: The delay time after the recoater stops and

before the laser begin scanning.

8-Build Status: Showing current build status, including Laser Power, Resin Temp., Est. Total Time, Building Time, Total Layer, Resin, and Est. Total Weight.

3.2 Printing Step

- a) Click on  to add SLC files.
- b) Click the edit (see Figure 23) button in Build Project File to position parts for printing.

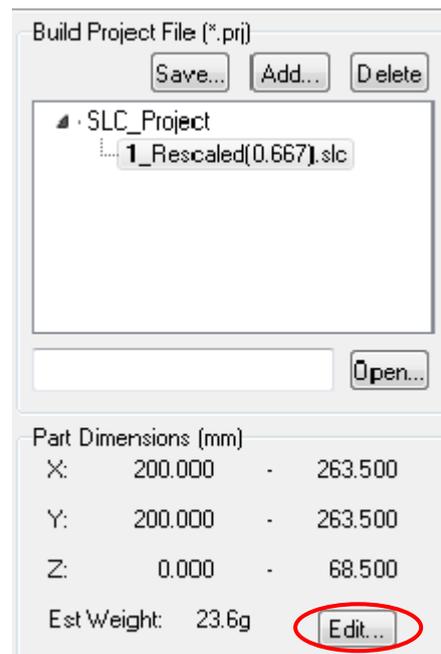


Figure 23. Build Project File Frame

- c) Click on , start to print.
- d) The alarm/speaker will beep 10 seconds after printing is completed. Wait (the default delay time is 10 minutes) for the build plate to automatically rise up then remove the finished part for post

processing.

- e) Check the resin level indicator in the Platform window and top up resin if level is low.

Note: *Please clean the build platform to remove remnants of cured resin after each print job, as these remnants will affect the next print job if left on the platform.*



4 Post Processing

After the part has been printed, it requires post processing. This includes cleaning, removing the supports and ultraviolet (UV) post curing. It may include final finishing, such as sanding, sandblasting, polishing, buffing, painting or dyeing.

Note:

- a) *Always wear proper protective clothing (goggles, gloves and lab coat) when working with resin.*
- b) *Drain excess liquid resin from the finished part for several minutes.*
- c) *Parts can be ruined by excessive exposure to air, moisture, cleaning solvent or light.*

4.1 Cleaning the parts

You may use ethyl alcohol (concentration above 85%) to wash the parts, and then use a compressed air-blower to complete the cleaning process. Do not soak the printed parts in ethyl alcohol for a prolonged period as that will damage them.

4.2 Post Curing

Put clean parts into the PCA (Post-Curing Apparatus). Post-curing normally takes approximately 10-15 minutes depending on size of

printed part.

4.3 Sandblasting & polishing

You may sandblast or polish the surface of the printed part if required.

This improves the quality of the surface finishing and dimension. For polishing, you may use sandpaper (600 to 800 grit size) with water to polish the parts.



5 Troubleshooting

Symptom	Cause	Solution
Recoater or build plate doesn't move.	<ol style="list-style-type: none"> 1. Emergency button depressed. 2. Poor connection at the plug. 	<ol style="list-style-type: none"> 1. Rotate emergency button clockwise. 2. Check the plug.
No laser beam.	The laser is not turned on.	Turn on the laser.
Excessive noise during printing.	<ol style="list-style-type: none"> 1. Rails or ball screw are dirty, or not lubricated. 2. Moving parts or motor is loose due to vibration. 	<ol style="list-style-type: none"> 1. Clean and lubricate according to Z Rapid technical support instructions. 2. Contact Z Rapid technical support.
Heater does not work.	<ol style="list-style-type: none"> 1. Fuse has blown. 2. Loose cables. 	<ol style="list-style-type: none"> 1. Replace fuse. 2. Secure all connections under guidance of Z Rapid technical support.
Vacuum pump does not work.	<ol style="list-style-type: none"> 1. Loose power cable. 2. Tube connecting vacuum pump is loose. 	<ol style="list-style-type: none"> 1. Check plugs and wiring. 2. Check tube connection.
The computer cannot boot.	<ol style="list-style-type: none"> 1. Computer virus. 2. Loose cables. 	<ol style="list-style-type: none"> 1. Reinstall the OS and restore backup supplied by Z Rapid technical support. 2. Secure connections.
Blank screen.	OS hibernation.	Disable hibernation function in OS.



6 Contact Us

Z Rapid Technologies Co., Ltd

Tel: 0512-63398240/63398241

0512-63398242/63398243

Website: www.zero-tek.com (Leave a message on our website)

Fax: 0512-63398290

Email: tech@zero-tek.com

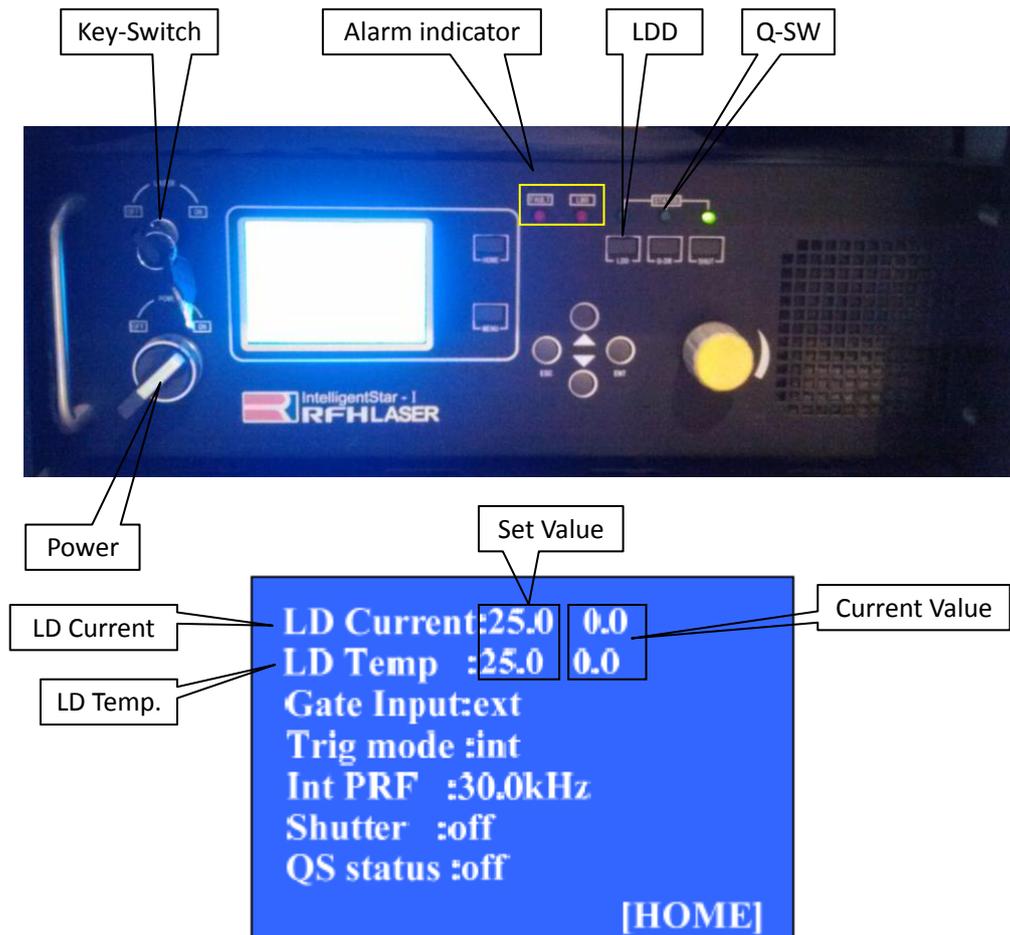
Address: No.13, Tongan Road West, Suzhou, Jiangsu Province, P.R.C



Appendix 1 RFH Laser System

The basic operation of the RFH laser

1. Turn On/Off the laser



Appendix figure 1.Laser Controller Display

a) Turn on the laser

- Push Laser On button to turn on the laser system.
- Open the laser controller cabinet door. On the laser controller, turn on the power button and turn the key-switch to the On position.

Wait for about 10 minutes for laser to stabilize. Check to verify the

laser device temperature (see Appendix figure 1 -LD Temp in HOME)

on the laser controller display panel.

- When the current temperature reaches close to the set temperature, then push LDD button. When the LDD current (LD Current in HOME) reaches the set value, push the Q-SW button.

Important: *Do not perform any operations when the Alarm indicator (red light) on the laser controller panel is on. Wait till the red light is off before attempting to operate the laser controller.*

Tips: *If the red light does not turn off, please shut down the laser system and restart it after 10 seconds. Please contact Z Rapid technical support if the red light continues to be lit.*

Note: *The key-switch enables (ON) and disables (OFF) all the buttons, except Power on the panel.*

b) Turn off the laser

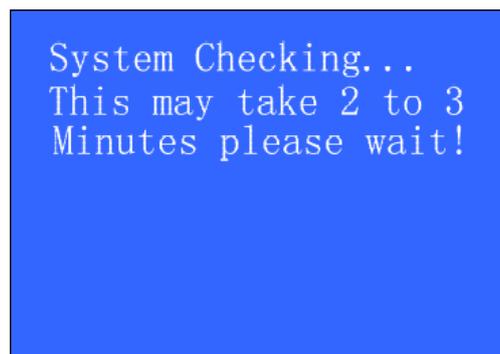
- On the laser controller panel, push the QSW button to turn it off.
- Push the LDD button.
- Wait till the value of LD current is 0 then rotate POWER to the off position.

2. Self-Test

The system performs a self-test automatically when the laser starts up.

When no laser is detected or you encounter some other problems with the laser, you should do the self-test then contact and provide the error code to Z Rapid technical support for assistance.

The system will start the self-test when the “LASER” key is switched to the “OFF” position and the power supply is switched on. A continuous “beeping” sound will be heard during the self-test and will cease when the self-test is finished. The mechanical carriage returns to zero position after the test. If no errors are found after the test, the system may be started by switching the key to the position of “ON”.



Appendix figure 2. Self-test

It takes two to three minutes for the test. In the event the self-test is interrupted and stops before it is completed, the laser might not be detected when you switch the key to the “ON” position to re-start the system. If there is no other error, this can be corrected by performing another self-test.

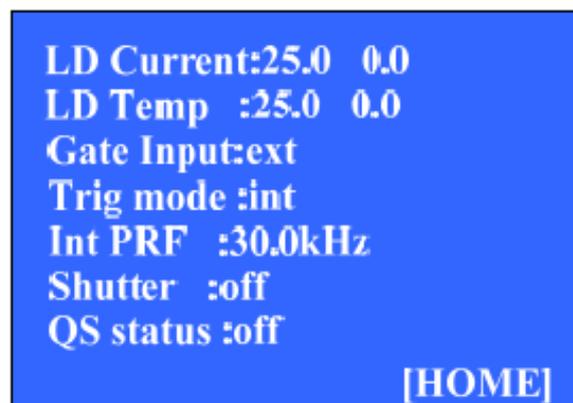
Note: *If the LASER key is on the position of “ON” and the power supply is switched on, the self-test will be skipped, and the system starts up immediately.*

If an error is detected by the self-test, kindly contact Z Rapid technical support and provide the error code obtained from the self-test for us to resolve the problem.

3. Adjusting the laser power

The laser power has the attenuating property and the power value is important for solidifying the parts. If necessary, under guidance by Z Rapid technical support, you may change some parameters to adjust the laser power.

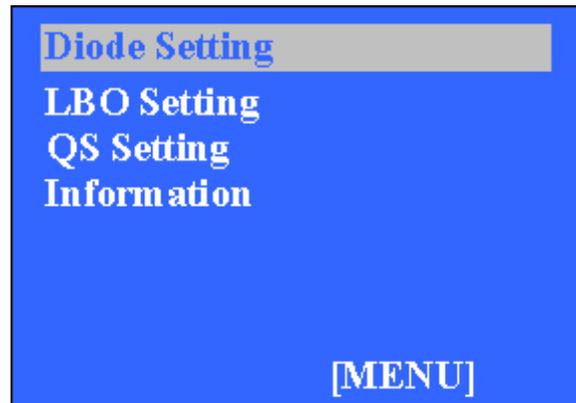
Press the HOME button to enter the Main Display menu. This displays the default mode upon system start-up.



Appendix figure 3. HOME Interface

(Parameters displayed may differ from those in your laser settings)

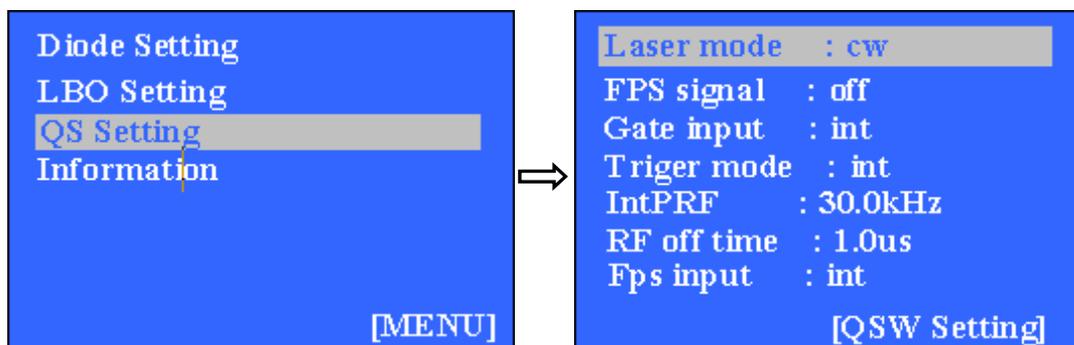
Enter Menu interface by pressing MENU button.



Appendix figure 4. MENU Interface

In the MENU window, use the up and down button to move the cursor to select functions. Place the cursor on the selected function and press ENTER button to display that function's sub-menu.

Setting parameters in the QS Setting interface.

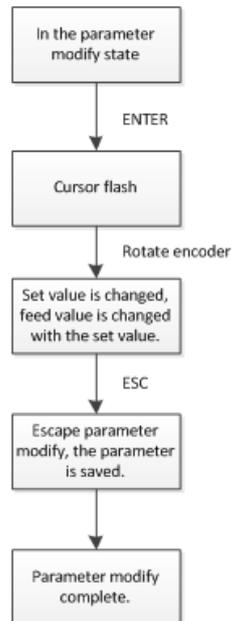


Appendix figure 5. QS Setting

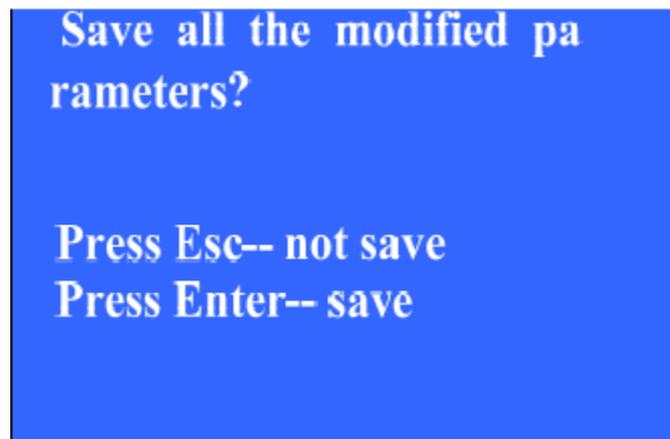
(Parameters displayed may differ from those in your laser settings)

The laser power can be adjusted in QS Setting interface by either changing the IntPRF or RF off time.

If the parameters need to be modified, refer to the procedure below:



In the MENU window, press the ESC button and you will be asked if modified parameters should be saved, as shown below:



Appendix Figure 6

ENTER: Confirm to save changes and parameters will be stored into the ROM of the system.

ESC: Changes will not be saved and are temporary. After the system is shut down and rebooted, the parameters revert to the original settings before modification.

Upon completion of the above operations, the system returns to the HOME window.

Note: *In the MENU page, press HOME button to return to HOME window. This operation will not save the modified parameters into the ROM of the system. If modifications need to saved, press ESC button in the MENU window to display the “Save all the modified parameters?” page (Figure 6) and then press the Enter button to confirm saving the modifications.*



Appendix 2 Inngu Laser System

The basic operation of Inngu Laser

1. Turn On/Off the laser



Appendix figure 7. Inngu laser controller

1) Turn On the laser

- a) Ensure that the surrounding temperature is between 15°C and 30°C before turning on the laser.
- b) Turn on the laser's main power switch, which is a red switch located at the back of the laser controller, to power on the laser system. Please preheat for about 10 minutes if the laser has not been switched on for a prolonged period of time, and then turn on the key switch. Please ensure that the emergency button is not in use before you turn on the main power switch.
- c) Turn on the key switch and the laser will be ready for use after completing the self-check.
- d) Push down the DIODE-ON button and the LED lights up.
- e) Push down the QS-ON button and the LED lights up.

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- f) Push down the SHT-ON button and the LED lights.
 - g) Push the CURRENT up button to increase the current to the required level. The laser power will be stable after preheating for 20 minutes.
- 2) Turn off the laser
- a) Push the CURRENT down button to decrease the current to zero.
 - b) Push down the DIODE-ON button and the LED goes off.
 - c) Push down the QS-ON button and the LED goes off.
 - d) Push down the SHT-ON button and the LED goes off.
 - e) Turn off the key switch.
 - f) You should not turn off the main power switch of the laser if it is used regularly so that the core temperature of the laser is maintained. This will prolong the life-span of the laser.

2. List of Front Panel Controls

Num.	Description	Function
1	QS-EXT	Select the Q-switch triggering mode, either External or Internal. When lit on, it is External triggering
2	QS-ON	Turn ON or OFF Q-switch. When lit on, Q-switch is power on.
3	SHT-ON	Turn ON or OFF mechanic shutter inside of laser head. When lit on, shutter is open.
4	PULSE RATE	Adjust the laser internal triggering repetition rate up and down by depressing the up and down arrow.
5	CURRENT	Adjust the diode pump current by depressing the up and down arrow.
6	RESET	Reset the laser controller when any interlock is activated.
7	REM/LOC	Select the laser to be controller by remote computer or locally through front panel (optional features).
8	EXIT	Exit of sub-menu and back to the home screen of display.
9	ENTER	After change the settings in the menu, by pushing the ENTER to activate the settings.

10	FUNCTION	By using the up and down arrow to select the menu or sub-menu at the display.
11	ADJUST	By using the up and down arrow to change the settings through software.
12	EMERGENCY OFF	Shut down the laser in case of emergency.
13	POWER ON	LED light on indicates the laser controller is power on.
14	KEY SWITCH	Turn on the laser controller by using the key switch.
15	LCD DISPLAY	Display the laser running status and menu.

