

Viper Pro

quick start guide

Thank you for purchasing the Viper Pro system .
Before using this equipment, please read this guide
carefully to enjoy optimum performance and longer
service life.

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To prepare and build a part, see Quick System Overview on page 11.

The Viper Pro system runs on 200-240 VAC / 50-60Hz, single phase power 30A for the single resin delivery module and 50A for the dual and extra large resin delivery module.

See “Facility Requirements Guide: Viper Pro SLA System” for complete Viper Pro system electrical, mechanical, environmental, and network requirements.

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what's inside?



What's Inside?

This *Viper Pro Quick Start Guide* includes the following topics:

New Features

This section describes the new features in the Viper Pro, such as the RDM, Intelligent Resin Container, Recoater, and Scanning System; these features are improvements over the other SLA models.

Hazard Messages

This section describes the safety messages included in this manual.

Other Useful Documents

Here you'll find a listing of other documents that may be helpful to you as you use the Viper Pro.

Quick System Overview

This section gives you a quick look at everything on the Viper Pro.

Operator Interface

This section describes xx



RDM Installation and Removal

This section describes how to install and remove the Resin Delivery Module (RDM). It also provides blade removal and off-line temperature information.

Software Overview

This section gives an overview of how to use the software that is connected to the Viper Pro. It includes the pictures of software screens, as well as information on how to open, start, complete, and remove a build.

Debris Filtering

This section tells you how to filter debris from the Viper Pro.

Image Projection Module

This section gives information on geometric calibrations and laser calibrations, xx (et al.)

Safety

Read this section before you start a Viper Pro build. It tells you how to handle resin properly and how to avoid damage and injury when running the Viper Pro.



For more detailed material safety information, see (xx: other manuals to consult? and their part number). To verify that your facility was properly prepared for the Viper Pro, see *Facility Requirements Guide: Viper Pro SLA System*. Your 3D Systems Viper Pro accessory kit includes both guides. They are also available in the /Docs folder on your Viper Pro software CD-ROM. See Other Useful Documents on page 10.

Maintenance

This section lists Viper Pro maintenance procedures that must be performed to ensure high part yield and low Viper Pro down time. You can perform some maintenance procedures. Semi-annual preventive maintenance requires a certified 3D Systems Customer Support Representative. xx: Brian Ward to give important information?

Glossary

Are you wondering what stereolithography is all about? Do you have questions about the SmartSweep Recoating Process? In this section, we've covered the definitions that you need to operate the Viper Pro.

Troubleshooting

If you run into difficulty with your Viper Pro system, look for solutions in this section first. You'll find descriptions of some common problems that can occur and suggestions of corrective actions. This section also defines error messages that you might see on the computer display and tells you what to do if you see a message.



quick start guide

what's inside?



Customer Support

Have you read everything and you still can't figure it out? Give us a call! This section tells you how. We're glad to help!

Legal Notices

This section explains our legal stance; please read it!



New Features

The Viper Pro has the following features that are improvements over SLA models:

Resin Delivery Module

Single Resin Delivery Module

The Viper Pro is capable of building with only one resin delivery module while the second delivery module is inactive. As mentioned in the previous paragraph, the second module can be warmed up offline while the first is building. A single resin delivery module can upgrade to a dual resin delivery module in less than two days.

Dual Resin Delivery Module

The Viper Pro can also build parts in two separate build zones. Each zone is independently capable of supporting its own active resin delivery module and motion axis control, allowing controlled builds in both zones simultaneously and allowing those builds to use different resins.

Extra Large Resin Delivery Module

The Viper Pro can operate so that two build zones combine into a single larger build zone to create larger parts that figure into a single contiguous envelope. The extra large resin delivery module allows for a build zone of 1500mm x 750mm x 500mm.



Intelligent Resin Container

Each container holds an electronic storage device that has information about the resin that is in the bottle. This information allows the Viper Pro to make sure that the user does *not* use the wrong material, use the material incorrectly, use an empty container, or use an expired container.

Resin Change Time Reduction

Not only can you now change resin time in less than ten minutes, you can also swap the resin delivery module easily without coming into contact with resin. All components that come in contact with resin in the resin delivery module are removed with the module itself. You can remove the resin delivery module easily and quickly and replace it with another active resin delivery module, without having to clean any wet resin surface. This new feature significantly reduces resin swap time. In addition, you may warm up a resin delivery module offline, allowing you to swap one resin delivery module for another that is ready to use.

Recoating Module

Scanning System

The scanning system makes the laser draw.



Hazard Messages

You will find four types of safety hazard message in this Viper Pro Quick Start Guide:

Also see the Safety section for descriptions of safety labels on your Viper Pro.



Damage Hazard

Machine damage, part damage, and/or data loss can result if you ignore this type of hazard message.



Electric Shock Hazard

Injury or death from electric shock can result if you ignore this type of hazard message.



UV Radiation Hazard

Eye injury or blindness can result if you ignore this type of hazard message.



Irritant Hazard

Bodily irritation or allergic reaction can result if you ignore this type of hazard message.



Other Useful Documents

The following documents will help your Viper Pro system to achieve its maximum proficiency. You can find them in the \Documentation folder of your Viper Pro Software CD.

Viper Pro Client Online Help

Run the Viper Pro software, then select Help > Help Topics in the software window or the 3-D Print Preview window to launch Viper Pro Client online Help. The online Help provides detailed instructions on how to use the Viper Pro software to set up, run, and manage print jobs.

Viper Pro Material Handling Guide

This multi-language document has everything that you need to know in order to handle and dispose of Viper Pro material safely. It also includes relevant regulatory guidelines for material disposal worldwide.

Viper Pro Facility Requirements Guide

To see what preparation you must do for your site prior to installing the Viper Pro, read *Facility Requirements Guide: Viper Pro SLA System*. A pdf copy is installed on your system for reference.

Viper Pro Material Safety Data Sheets (MSDSs)

These online copies of the printed Viper Pro model material MSDS ship with Viper Pro materials. Make sure that everyone in your facility who handles Viper Pro materials reads these MSDS and follows the safety guidelines in them. To order extra copies of these MSDS, request them from 3D Systems.



quick start guide

quick system overview



Quick System Overview

picture with callouts here?



quick start guide

quick system overview





quick start guide

quick system overview





quick start guide

quick system overview





Operator Interface

The operator interface has a 17-inch high-resolution flat panel display with USB port for the keyboard. The standard keyboard is black with a port for the USB mouse. The mouse has a slide-out mouse accessory. There is one auxiliary USB port and a small shelf that hold a portable memory stick/CD-ROM/DVD. Note that the CD-ROM/DVD will not be provided but must be available to enable a customer to transfer large files or to load s/w when the machine is not connected to a network.

There is a control panel with a separate emergency stop for safety. The e-stop is tied to safety circuitry and removes power from the motion system, heaters, laser, and other things when pressed.

The chamber light switch is a lighted switch that turns the chamber light on and off when pressed by stating CHAMBER LIGHT.

The laser-on indicator light shows when the laser contractor is on and then the laser may be on by indicating LASER ON.

The lighted switch for system start-up is SYSTEM ENABLE.

SYSTEM SECURE indicates that all interlocks are closed.

All cabling and wiring is enclosed in the hardware.

The support arm must allow for the vertical location of the op interface to change as between an operator's sitting and standing position. Tools can change the vertical location.



RDM Installation and Removal

Installation

Before installing the Resin Delivery Module (RDM), make sure that the power is turned off.

Usually, the user needs only to install or remove the RDM when changing resin.

Assuming the RDM is outside the Viper Pro, the following steps describe how to install the RDM.



Irritant Hazard

Bodily irritation or allergic reaction can result if you ignore this type of hazard message.

Before installing the module, note that the RDM is very heavy and may require more than one person to remove or install it. While wearing protective clothing, disposable nitrile gloves, and goggles, follow these steps:

- 1 Open the RDM door; roll the RDM to the side of the machine in which you want to place it.
- 2 Make sure that the connecting cables are out of the way of the RDM before you attempt to place the RDM in the machine.
- 3 Make sure that the elevator is down before you move the RDM into the machine.
- 4 With a cleared path, push in the RDM until the locking pin located on the outer side of the machine pushes up and then goes into place in the hole. (See Figure 1., “Locking Pin,” on page 17) When the locking pin attaches properly, the RDM will also hit the bumper at the back of the machine.



Figure 1. Locking Pin

- 5 xx: Include a picture with callouts of the RDM? Show software.
- 6 Once the RDM is in the machine, connect the cables. There are two black power cords--the heater and the RDM I/O connector. Plug the three-pronged power cord into the outlet and place the connector into the top of the keys. (See Figure 2., "Open I/O Connector," on page 18 and Figure 3., "I/O Connector with Cable," on page 18.) When properly placed, the connector lines up with the keys. You cannot install the I/O connector incorrectly.



Figure 2. Open I/O Connector



Figure 3. I/O Connector with Cable

- 7 Make sure that the white switch is in the ON position. (See Figure 4., “White Switch,” on page 19.)



Figure 4. White Switch

8 Close the Viper Pro door.



Blade Removal and Installation

Off-line Temperature

Resin Handling

The RDM allows the user to change resin and start the next build within ten minutes, with no tools and no user protection needed. Gloves, however, may be required to detach the Zephyr recoater blade. This new handling method ensures that all parts that come into contact with resin under normal operation must be a part of the active RDM. Parts on other modules may inadvertently come into contact with resin, but provisions for managing that particular contact are in place; the user does not need to worry about such contact.

The RDM allows the user, via a screen, to strain the debris that inevitably accumulates in the machine so that it can be removed in a similar manner to the removal of build platforms. It also removes the higher viscosity resin that settles on the bottom of the delivery module, circulates the resin to help prevent gel formation, and stirs the resin to achieve uniform viscosity.

Table 1 lists the required build envelopes that represent all RDM and platform elevator configurations that the Viper Pro supports. Each RDM and platform elevator design minimizes the amount of resin that the Viper Pro requires. The center of the build area for each RDM aligns as closely as possible to the central scanning axis of the image projection module:



In handling the RDM, please note that no resin that has been exposed to the RDM can be re-introduced into the new resin supply container. The build platform can accommodate up to two 10kg resin supply containers. The RDM has an overflow compartment that also functions as a reservoir for resin level control. This compartment contains any accidental dispensing of the full 10kg resin container without allowing overspilled resin. It can also capture resin surface debris. An empty resin container can be used for overflow storage.

The manual valve, of 2 in. pipe, is the same shape as the bottom of the surface, which makes the resin delivery module fully drainable. Therefore, there are no trapped volumes of liquid.

Table 1: Build Envelope, Maximum Part Size

	Width (mm) (left to right)	Depth (mm) (front to rear)	Height (mm) (top to bottom)
Small RDM	650	750	50
Medium RDM	650	750	275
Large RDM	650	750	550
Extra Large RDM	1500	750	500

There are two operating modes for the RDM:



Stand-by Mode

In this mode, the RDM is offline and operates independently from the Viper Pro machine, permitting offline resin and module temperature stabilization when it is connected with line power to the power umbilical. The resin can warm effectively in this mode, allowing the user to build a part while warming resin for future use.

Build Mode

In this mode, the RDM is online and connects to the Viper Pro for power and I/O for full interoperability. The Viper Pro machine monitors and controls the resin temperature while connected with the active RDM. When the RDM is online, it can pump and circulate resin.

Resin Heating

The RDM can be heated either outside the Viper Pro's enclosure, via the stand-by mode, or in the enclosure. Resin can be heated from a room temperature of 20°C to 26°C up to a maximum temperature of 45°C, via accelerated heating; and 34°C, via gradual heating.

Auto Resin Refill System

The auto resin refill system is behind the auto resin refill door. This system adds resin to the RDM from a resin container placed within the auto resin refill slot. When the diode laser leveling system senses that the resin level is too low, it uses lifters to raise the RDM. If the resin level is still too low, the auto resin refill system will display the message, "Resin Autofill in Progress," and will add resin from the container. If the resin refill container is empty, the control computer will wait until a new resin refill container is installed or until resin is added manually. The build starts after resin is added to the RDM.



Empty Resin Container Removal

When the resin container is empty and needs additional resin, perform the following procedure. It is important to verify the type of resin currently in the RDM before proceeding with these steps. While wearing protective clothing, disposable nitrile gloves, and goggles, perform the following steps:

- 1 Open the front machine door that corresponds to the resin's build zone until the vent hold, on the topmost end of the bottle, is visible.
- 2 Place the vent cap on the vent hole and screw tightly to prevent the resin from spilling.
- 3 Pull the RDM release lever, located to the left of the resin bin toward you. See Figure 5., "Release Lever," on page 24.



Release Lever

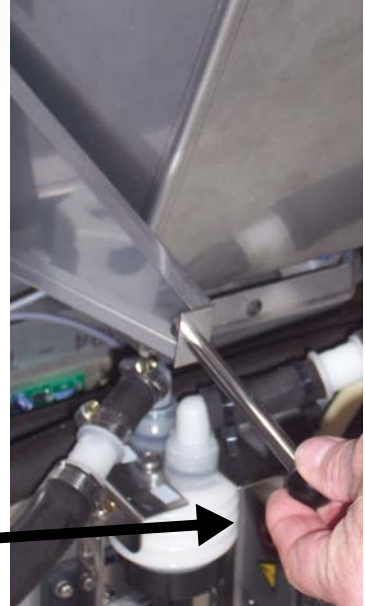


Figure 5. Release Lever

- 4 When the resin has properly drained, release the inner latch and lift until the resin container is visible.
- 5 Push the container release button, (See Figure 6., “Container Release Button,” on page 25) located on the lower right corner of the resin bin.



Figure 6. Container Release Button

- 6 Lift out the resin container.
- 7 Using a disposable paper towel, wipe all resin from the container seal assembly.
- 8 To remove the container, carefully lift it from the container slot, place the vent cap back on, dispose of the container according to local regulations.

Partially Empty Resin Container Removal

When the resin container is empty and needs additional resin, perform the following procedure. It is important to verify the type of resin currently in the RDM before proceeding with these steps. While wearing protective clothing, disposable nitrile gloves, and goggles, perform the following steps:



- 1 Open the front machine door that corresponds to the resin's build zone until the vent hold, on the topmost end of the bottle, is visible.
- 2 Place the vent cap on the vent hole and screw tightly to prevent the resin from spilling.
- 3 Pull the RDM lever, located to the left of the resin bin, (Figure 5., "Release Lever," on page 24) toward you.
- 4 When the resin has properly drained, release the inner latch and lift until the resin container is visible.
- 5 Push the container release button, (Figure 6., "Container Release Button," on page 25) located on the lower right corner of the resin bin.
- 6 Lift out the resin container.
- 7 Using a disposable paper towel, wipe all resin from the container seal assembly.
- 8 To remove the container, carefully lift it from the container slot, place the vent cap back on, dispose of the container according to local regulations.



Figure 7. Container Lifted



Resin Containers



Figure 8. Resin Containers

New Containers

Before starting this procedure, make sure that the container slot is empty. If a container is present, refer to the previous section, “Removing Empty Resin Containers,” before continuing. While wearing protective clothing, disposable nitrile gloves, and goggles, perform the following steps:

- 1 Open the resin refill door until it is completely inverted.



- 2 Release the inner door latch and open the container holder door.
- 3 Place a resin container into the container slot and remove the container lid and the induction seal.
- 4 Close the container holder cover until the inner cover latch has been properly locked.

**Caution!**

If the O-ring is not seated correctly inside the neck of the resin container, or the door is not properly latched, a resin spill is likely.

- 5 Lift the resin refill door until the vent cap faces up and the refill door is nearly closed.
- 6 Remove the vent cap and place it on the cap retainer for storage.
- 7 Using the puncture tool, place a small vent hole in the center of the vent spout.
- 8 When the vent hole has been made, return the puncture tool to the holding clips.
- 9 Close the resin container door firmly until it latches securely.

Leveling Bottle

A leveling bottle, contained in the right receptacle, is connected to the leveling pump. It moves resin from the leveling container, as required by the machine.



Figure 9. Refill Bottle

Refill Bottle

The refill bottles, contained in the middle and left receptacle, are connected to the refill pump. Each bottle moves resin from the refill container. See Figure 9., “Refill Bottle,” on page 30.



Partially Full Containers

Before starting this procedure, make sure that the container slot is empty. If a container is present, refer to the previous section, “Removing Empty Resin Containers,” before continuing. While wearing protective clothing, disposable nitrile gloves, and goggles, perform the following steps:

- 1 Open the resin refill door until it is completely inverted.
- 2 Release the inner door latch and open the container holder door.
- 3 Place a resin container into the container slot and remove the container lid and the induction seal.
- 4 Close the container holder cover until the inner cover latch has been properly locked.



Caution!

If the O-ring is not seated correctly inside the neck of the resin container, or the door is not properly latched, a resin spill is likely.

- 5 Lift the resin refill door until the vent cap faces up and the refill door is nearly closed.
- 6 Remove the vent cap and place it on the cap retainer for storage.
- 7 Using the puncture tool, place a small vent hole in the center of the vent spout.
- 8 When the vent hole has been made, return the puncture tool to the holding clips.
- 9 Close the resin container door firmly until it latches securely.



Resin Leveling and Refill System

The Viper Pro contains a resin-leveling system that monitors the resin level within the RDM. When the resin falls below the prescribed range, the 3D Print Software notifies the user to add resin. The Viper Pro adds resin using the Auto Resin Refill System.

Resin Leveling System

A small diode laser and sensor monitors the resin level. Located at the rear of the RDM, the sensor reads the diode laser as it reflects off the current resin level and provides feedback regarding the level within the RDM. To maintain the resin level properly in relation to the laser and platform, an electronic assembly controls the RDM lifters. These lifters move the module up or down, according to the fluctuation of the resin level within the RDM. If the electronic assembly does not raise the RDM to meet the optimum resin level, the 3D Print Software notifies the user to add resin or to remove resin.

To add resin manually, refer to “Adding Resin Manually.” To add resin automatically, refer to “Auto Resin Refill System.”

Resin Manual Addition

The following procedure allows the user to add resin manually to the RDM. If the message, “Add resin until prompted to stop,” appears on your monitor, you must add resin to the RDM.



Caution!

Before adding resin, you must verify which type of resin is currently in use. Do not mix resin types!



While wearing protective clothing, disposable nitrile gloves, and goggles, follow these steps:

- 1 Open the right or left Process Chamber door for the Viper Pro to access the RDM.
- 2 One beam profiler is at the left front corner of the rim; the other is at the right rear corner of the rim. Refer to “Beam Profilers” for more information.
- 3 Using the same type of resin that is currently in the RDM, slowly pour the resin in the corner of the module.



Caution!

Be careful with resin! Pour resin into the corner nearest the Z-stage, or rear of the RDM, to help the system to recognize quickly whether the overall resin temperature needs to be adjusted. To reduce bubbles, pour the resin slowly.

- 4 When the message, “Stop adding resin. Press any key to continue,” is displayed, an audible beep will sound. Stop pouring the resin immediately.
- 5 Remove the protective towels from the beam profilers.
- 6 Close the chamber door.
- 7 Press any key, or the spacebar, to continue.

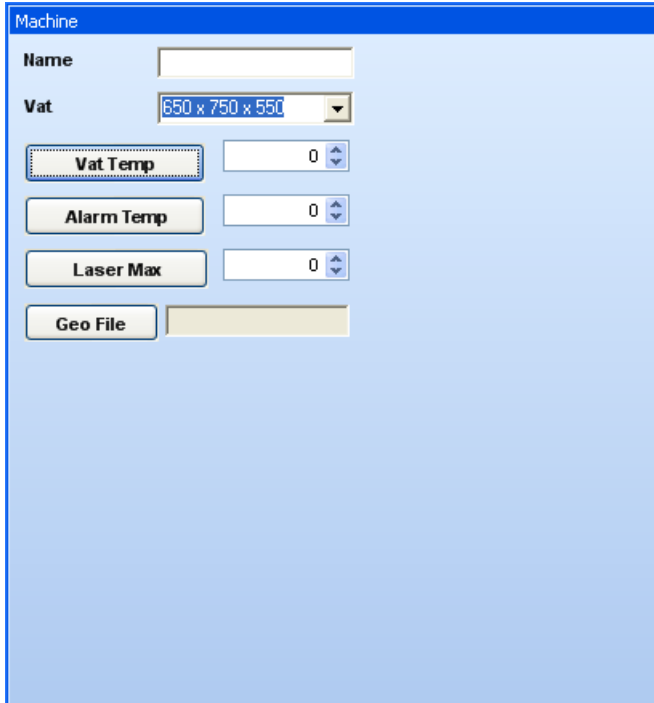


RDM Removal

The RDM is made of stainless steel and has casters for moving and maneuvering it while installing or removing it from the frame. There are also handles on the RDM that help the user to transport and maneuver it into and out of the Viper Pro.



RDM Temperature (possible software explanation to be added)



The screenshot shows a software window titled "Machine" with a blue header. It contains several configuration fields:

- Name:** An empty text input field.
- Vat:** A dropdown menu currently displaying "650 x 750 x 550".
- Vat Temp:** A button with a dotted border next to a numeric input field set to "0".
- Alarm Temp:** A button next to a numeric input field set to "0".
- Laser Max:** A button next to a numeric input field set to "0".
- Geo File:** A button next to an empty text input field.

Figure 10. RDM Temperature

To set the RDM temperature, contact a qualified 3D Field Service Technician.



Moving The Recoater and Elevator to Start Positions

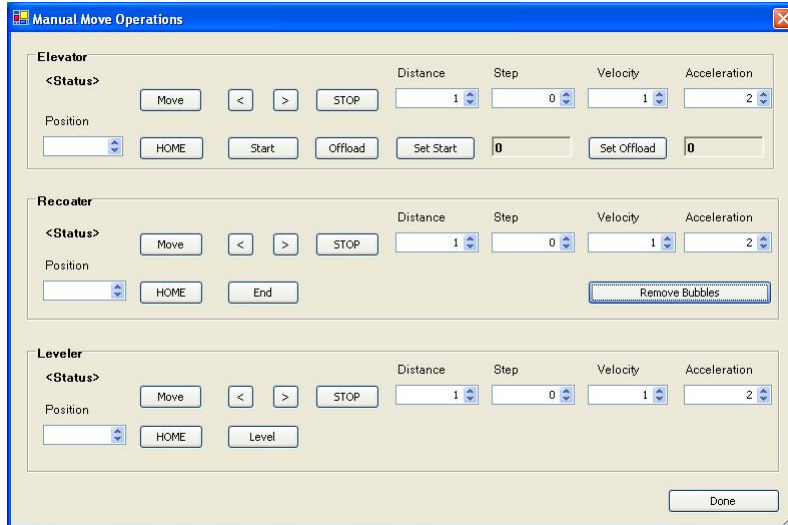


Figure 11. Manual Move Operations Screen

Platform Installation (possible software included in this stage)— picture included?

The RDM must be in the machine before this process starts. When correctly installed, the platform sits on the elevator platform mount.

- 1 Make sure that the elevator motion stage is at its highest setting.



- 2 Sit the platform on two L-shaped guides in the rear of the RDM.
- 3 Push the platform against the front platform guides.
- 4 The notches in the platform need to engage into the front platform guides
- 5 Go to the Control Panel, select a part, and start a build.
- 6 When correctly installed and started, the elevator main stage moves to the Build Start position.

Platform Release

After the build is complete, select “drain platform.” This function raises the elevator motion stage to the top and the locking mechanism disengages. The user can then reach in, move the platform backward, release the locking tab, and then slide the platform back and remove it.

Is the RDM Full?

Recoating with the Vacuum On

Levelling the resin for a build

Pumping Material to and from the Level Reservoir

Controlling the Chamber Temperature

Building the Support Layers

Building the Part Layers



Recoating to the Park Position

Allowing the Elevator to Unload

Ending the Build

Blade Installation

Do we need pictures? See pp. 34-36 of hardware manual.Recoating Process

The recoating process combines elevator and recoater blade movements to apply liquid resin to the top of the part so that the next layer can be built.

Recoater Blades

The recoater blade is on a rail system above the resin delivery module.



Zephyr Recoating System

The Zephyr recoating system, an improved recoater that is used on the Viper Pro and its SLA predecessors, is part of the rim assembly. The hollow blade provides a reservoir for the resin. There window on one face of the blade allows the user to view the level of resin inside the reservoir. The blade is attached at both ends to precision anti-friction linear guides, which attach to the rim. Two belts drive the Zephyr recoating system. A vacuum system attaches to the recoater blade to maintain the level of resin within the blade. 3D Systems Customer Support Engineers will adjust the blade for proper part building during installation and setup of the Viper Pro.



Software Overview

Main Page

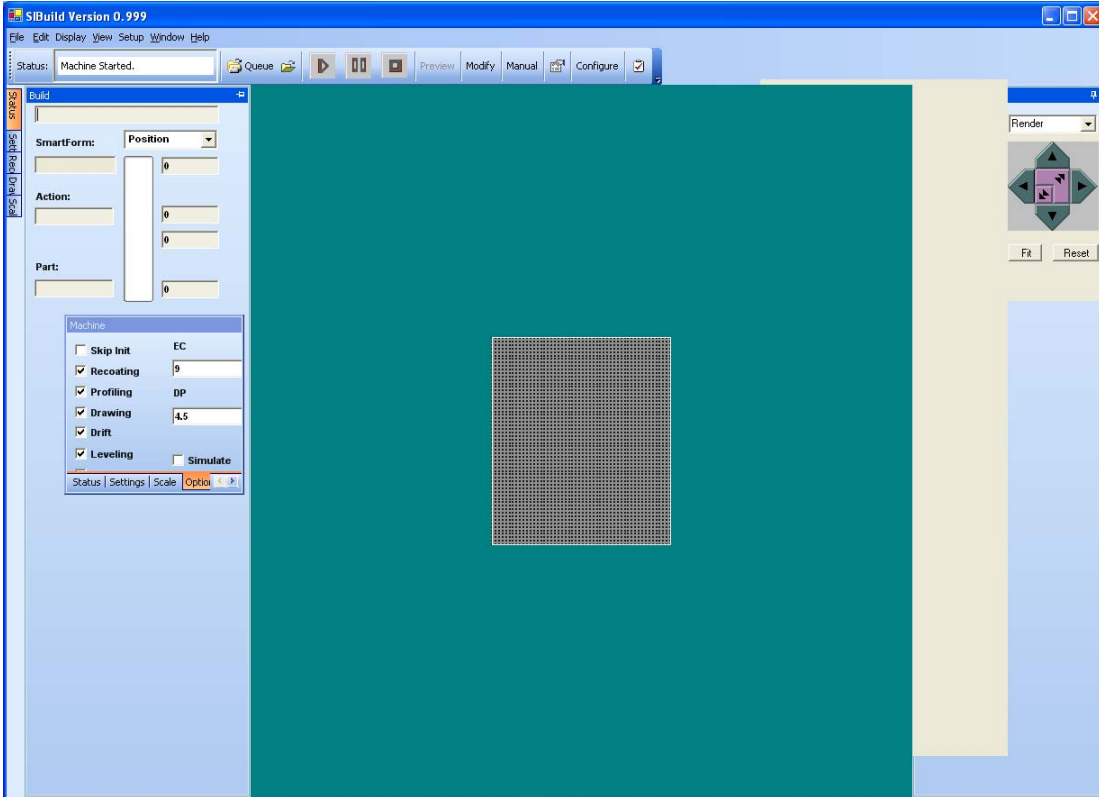


Figure 12. Main Screen of the 3DPrint Software

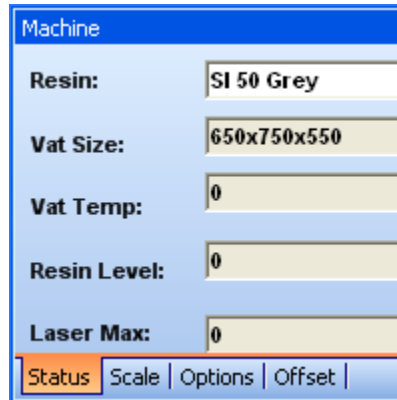


Build Open (Is this the same as loading a part?)

To load a part, follow these steps:

Open a BFF file.

Look at the machine screen:



The screenshot shows a software window titled "Machine" with a blue header. Below the header, there are five rows of settings, each with a label on the left and a text input field on the right. The settings are: Resin: SI 50 Grey; Vat Size: 650x750x550; Vat Temp: 0; Resin Level: 0; Laser Max: 0. At the bottom of the window, there is a navigation bar with four tabs: "Status" (highlighted in orange), "Scale", "Options", and "Offset".

Machine	
Resin:	SI 50 Grey
Vat Size:	650x750x550
Vat Temp:	0
Resin Level:	0
Laser Max:	0
Status Scale Options Offset	

Figure 13. Machine Setting

Select options.



Machine

Machine Scale Factors

X	<input type="text" value="1.0"/>
Y	<input type="text" value="1.0"/>
Z	<input type="text" value="1.0"/>

Status | **Scale** | Options | Offset |

Figure 14. Machine Scale Settings

Put appropriate ED and DP.



Machine	
<input type="checkbox"/> Skip Init	EC
<input checked="" type="checkbox"/> Recoating	9
<input checked="" type="checkbox"/> Profiling	DP
<input checked="" type="checkbox"/> Drawing	4.5
<input checked="" type="checkbox"/> Drift	
<input checked="" type="checkbox"/> Leveling	<input type="checkbox"/> Simulate

Status | Scale | Options | Offset |

Figure 15. Machine Options Setting

Select options.

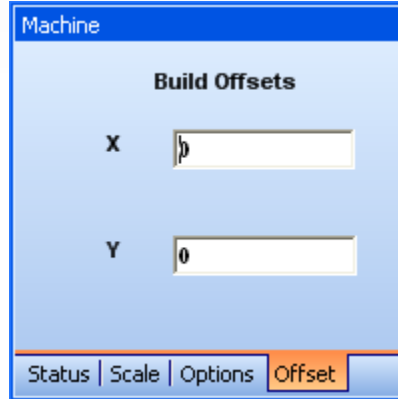


Figure 16. Machine Build Offsets Setting

How to get these in? Hmmmm.

PLAY

STOP

PAUSE

Figure 17. The Screen That Allows You to Open a Build



Build Start

Figure 18. The Screen That Allows You to Start a Build

Build Complete

Figure 19. The Screen That Allows You to Complete a Build

Build Remove

Figure 20. The Screen That Allows You to Remove a Build



Gel and Debris Filtering

Resin life is adversely affected by partially-polymerized material in the RDM, both in debris, such as broken supports and crash remains, and in gel. In order to maintain the longest possible resin life, the user should remove as much debris as possible, either continuously or periodically. Gel should be kept apart from neighboring gel, to avoid viscosity increase.

Both debris, defined here as any solid material 0.015 in. or larger, and gel, or partially polymerized material, are a continuum of sorts. Debris can be anything from broken supports to the large scraped-off remains of a full-on blade crash. Gel continually forms, both in the bulk of the RDM, and around debris that has settled to the bottom of the RDM. Gel may agglomerate into larger masses, may gradually increase in molecular weight because of chain growth, and may or may not settle to the bottom of the RDM, depending on the specific resin and the state of the gel. Debris removal avoids some gel formation, although not all gel is related to larger debris. Gel can be very difficult to actually remove, as it isn't easily separated from viscous resin, is slippery, and can clog filters and sieves.



Caution!

Do not leave debris in the machine and do not allow debris to bypass the debris-catching device.

Gel must be kept apart from its neighboring gel, which requires continuous resin movement in the RDM. When installed in the RDM, the resin should circulate continuously. When offline the material does not circulate, nor does it need to. Circulation while online allows the resin to take up oxygen from the RDM surface, improving resin life by keeping the RDM temperature uniform.



Debris Filtering

Debris is removed periodically, as a maintenance-like action. At least once per month, a debris removal tray should be used. This removal process may be repeated more than once each month, if the user desires.

Basically, this process involves a tray that has a couple of filters. As the tray is lifted, the fluid goes through the filter and the debris is removed. In more detail, these are the steps involved:

Recoater Module

The recoating system consists of the platform and platform supports, recoater blade, and elevator. The Buildstation Control Software operates the recoating system as needed to build on the SLA system.

Platform and Platform Supports

The platform supports hold the platform while it moves up and down during part building. The platform is made of perforated stainless steel and has special locking slots to secure it to the platform supports.

NOTE: Verify that the platform has been thoroughly cleaned and dried before placing the platform into the platform support frame.

The platform support for the Viper Pro is a frame with two sliding clips on the front and two locating points on the back. Install the platform onto the platform support assembly by making sure that the back side of the platform engages the locating points on the platform support. Once the platform has been installed properly, slide the clips over the recessed area on the front of the platform to secure it. (xx: Figure 16 on page 34 of hardware manual?)



Recoater Module

The recoating system consists of the platform and platform supports, recoater blade, and elevator. The Buildstation Control Software operates the recoating system as needed to build on the SLA system.

Platform and Platform Supports

The platform supports hold the platform while it moves up and down during part building. The platform is made of perforated stainless steel and has special locking slots to secure it to the platform supports.

NOTE: Verify that the platform has been thoroughly cleaned and dried before placing the platform into the platform support frame.

The platform support for the Viper Pro is a frame with two sliding clips on the front and two locating points on the back. Install the platform onto the platform support assembly by making sure that the back side of the platform engages the locating points on the platform support. Once the platform has been installed properly, slide the clips over the recessed area on the front of the platform to secure it. (xx: Figure 16 on page 34 of hardware manual?)

Recoating Process

The recoating process combines elevator and recoater blade movements to apply liquid resin to the top of the part so that the next layer can be built.

Recoater Blades

The recoater blade is on a rail system above the resin delivery module.



IMAGE PROJECTION MODULE

The image projection module (IPM) on the Viper Pro provides energy to cure the liquid photopolymer resin within the resin delivery module. This module mounts to the process frame in a statically determinant manner with three points of support. Fastening the hardware installation will not deflect the IPM's optics plate. All optics components are mounted to a single optics plate or substrate. The IPM must be aligned before installing it onto the Viper Pro.

Geometric Calibration on the Plane

For geometric calibration on the plane, please contact a 3D Systems Field Service Engineer.

Laser Power Calibration

Laser power calibration requires a 3D Systems Field Service Engineer.

Laser Power Reading

In the Build Screen, a window tells you the power that the system needs to build.

Pin Hole Definition

There are four pin holes in the profiler: 1/2 mil, 1 mil, 2 mil, and 4 mil. The system selects the appropriate pin hole based on laser power.



Beam Rest Position

The beam hits a piece of plastic and glows.



Lasers

Optical Input

The IPM has one laser beam source or laser head. The input beam corresponds to the output of a typical diode pumped, Nd/YVO₄ laser that has been frequency tripled to a wavelength of 355nm. The IPM can accept a beam power of up to 2W, with a repetition rate of 67kHz for the laser. The laser head is kinematically mounted to the optics plate. A safety shutter, controllable by Viper Pro system electronics, helps to contain the laser beam as closely as possible to the beam's exit point from the laser head. The IPM manages any power level changes, including adjusting the power to zero. The laser is always set for constant power during operation at a maximum of 1000W at the resin delivery module.

Optical Output

The IPM has two separately controlled image projection systems, or scanners, that can be selected by use of a two-position mirror mechanism that directs the beam to and from the laser head to the selected scanner. The minimum power output of the IPM is 1W, with a maximum input of 2W. The image projection surface, or image plane, for each scanner can be configured to different sizes, ranging from 650mm x 350mm to 1500mm x 750mm. Table 1 lists the different image project surface sizes for the resin delivery module:

The projection height can range from 900mm to 1100mm, where the working diameter of the beam is dynamically adjusted on the image plane. The working diameter of the beam can be dynamically adjusted on the image plane, ranging from 125µm to 750µm, within a maximum time of 1 sec.



Laser position accuracy on the image plane is $\pm 25\mu\text{m}$ average error over each image plane. The laser position resolution on each image plane is $10\mu\text{m}$ or greater. The scanners generate a beam speed on each image plane ranging from 0 mm/sec up to 5000 mm/sec, while positioning the beam at $\pm 25\mu\text{m}$ accuracy. It is capable of speeds up to 15,000 mm/sec at $\pm 100\mu\text{m}$ accuracy.

The IPM also provides real-time spot size correction. While drawing the working beam, the machine can adjust the diameter setting, within 1msec, on either image plane to the beam diameter.

The power monitoring of the IPM includes a fast detector, capable of 1ns resolution, and a slow detector, which is accurate to 1%. The IPM can control optical beam power on each image plane to $\pm 5\%$ of the commanded value. It also provides ellipticity between (xx: what are the units here?) 0.9 and 1.1 on each image plane. Sensors that can detect and measure beam properties, or profilers, are on the process frame. These sensors monitor beam diameter, ellipticity, and power, and actively calibrate each scanner's pointing, in order to compensate for position drift. The pointing drift monitoring capability is $10\mu\text{Rad}$ resolution, once per minute; the exposure accuracy is $\pm 5\%$. The IPM is assembled as a module without requiring additional alignment or adjustments.

Laser System

The laser system consists of the following three functional sub-systems--the laser head, the controller and power supply, and the laser head cooling. Total power consumption is less than 800W; the warranty for the three components is 5000 hours.

Laser System Power Supply

In the Viper Pro, the laser power supply is located in the power distribution cabinet; it can be accessed through the rear control module access panel.



The controller and power supply is in 19 in. rack packaging. It provides all control and power interconnect with the laser head and monitors cooling system performance.

xx: picture?

Laser Head

The output wavelength for the laser head is 354.7nm. The UV power is 1.5W. Picture?

Laser Cooling System

The Viper Pro system uses a self-contained, or closed, coolant delivery system that mechanically interfaces to the laser head heat sources. All liquid lines use dry-dry quick-disconnect couplings.

A 3D Systems Customer Support Engineer should perform any other servicing of the chiller or heat exchanger.

Beam Profilers

The SLA system contains two beam profilers that are located near the front and rear of the resin delivery module. The profilers determine the actual X and Y axis location of the laser beam relative to the build zone. The profilers then feed this X and Y axis location information to the control computer where real-time accuracy adjustments can be made to account for changes that may occur layer to layer.



Safety

General

Always follow the safety procedures. Do not, in any way, risk injury by working dangerously. Safety is a part of work, and not an obstacle to it.

Laser Safety

The Viper Pro is a Class I Laser Device by the Center for Devices and Radiological Health (CDRH). Class I devices are not considered harmful and require no special safety precautions. In normal operation, the laser beam is completely confined and the viewing windows in the Process Module block UV radiation.

Control Switches

The locations of control switches are described in the chapter, *SLA System Hardware*. Master and Emergency power shut-off switches are located as described in the following sections.

Master Power Shut-off

The Viper Pro has a master circuit breaker switch located on the back of the power input module.

Emergency Shut-off

The Viper Pro has an Emergency Shut-off button on the front panel of the Control Module/Bay in each build chamber and in the optics compartment.



Caution!

This method of power shut-off is not recommended and should only be used in an emergency.

To restart the system after an emergency shut-off:

- Rotate the Emergency OFF button clockwise to reset it, then press the ON button. For the location of the Power On button, see the *Power Up* section in the chapter, *SLA System Hardware*.

Control Panel Laser LED

An LED light displays the current status of the laser (on/off). For more information see the *Control Panel* section in the chapter, *SLA System Hardware*.

ID/Certification Labels

A label on the Viper Pro certifies laser safety conformance to the Code of Federal Regulations (CFR). This label also gives power and ID information. This label is on the front door in the upper right corner of the Viper Pro.

Safety Warning Labels

On the Viper SLA system, labels are affixed on the frame behind the vat door and near the aperture at the top of the process chamber. These labels conform to the requirements for Class IIIb and Class IV lasers. Refer to Figures 26, 27, 28, and 29 for their locations.

Xx: The previously-mentioned figures are on pp. 70-73 of the hardware manual. We need digital pics.



Safety Interlock Switches

Safety interlock switches protect the user from possible UV laser radiation exposure when certain doors or panels are opened. Figures 26, 27, 28, and 29 show these switches.

Chemical Safety Warnings



Irritant Hazard

Always wear chemical-resistant gloves, goggles, and protective clothing when handling resin. Avoid skin contact. Avoid breathing resin fumes.

- Always wear approved goggles, nitrile gloves and protective clothing when working near resins or with partially cured parts. Epoxy resin is less viscous and splashes more easily than acrylate resin.
- Wearing contact lenses when working with resins is not recommended.
- Always wear chemical-resistant gloves whenever handling resins or partially cured parts. Recommended gloves are 100% Nitrile. Do NOT wear latex gloves.
- Always work in a well ventilated area when using resins. Avoid breathing vapors.
- Always wash skin thoroughly with abrasive soap and COLD water after working with resins. DO NOT USE HOT WATER OR SOLVENTS to wash hands, as it will result in absorption through the skin.
- Use extreme care when handling solvents used to remove excess resin from uncured parts. These solvents (e.g., denatured alcohol, isopropyl alcohol) are very flammable.



- Keep all resins away from heat, sparks and flame. Resin containers may rupture when exposed to extreme heat. **Use National Fire Protection Association Class B extinguishers such as carbon dioxide, dry chemical, or foam.**

Resin Characteristics

The photopolymers used in stereolithography may be hazardous if handled improperly. Repeated skin contact with resins may cause sensitization. Consult the manufacturer's Material Safety Data Sheet (MSDS) for information on specific resins. For further information on this and related topics, consult the 3D Systems' *Resin Handling and Safety Guide*.

Resin Storage

Resin should be stored in opaque, non-reactive containers, according to the guidelines given in the MSDS included with the resin. Protect resin from sunlight and ambient room light. Resin may be stored in vats with the lid securely fastened. Pouring resin back into the original containers is acceptable, but be sure to leave several inches of air above the resin in the sealed container. This will leave room for expansion and also inhibits spontaneous polymerization for some resins. Always label resin by type and usage history.

Never mix different resins.

Resin Disposal

Do not dump used resin down any drains. Follow disposal rules established by company, local, state, and federal authorities.



Resin Spill Containment

Your company has the responsibility to define what constitutes a major spill. Personnel who are involved in cleaning up major spills of resin should wear NIOSH/ MSHA approved respirators designed for use with organic chemical vapors. In addition, each person should wear protective goggles, rubber boots, and 100% nitrile gloves to minimize exposure to resin, which can cause eye, skin, and respiratory irritation, as well as possible skin allergies and respiratory reactions.

Caution



Resin is combustible. Care should be taken during resin containment and cleanup operations.

A supply of dikes and control booms should be stocked so they are available to contain the affected area in the event of a major resin spill. The spilled resin should then be absorbed on inert absorbent material and placed into drums for transfer to an approved waste disposal site. After cleaning up the spill, individuals should wash thoroughly with soap and cold water. All clothing should be washed before reuse. Avoid exposure to sunlight until skin and clothing have been cleaned of resin. Refer to the MSDS before using any chemicals. Repeated or prolonged skin contact may cause sensitization. Vapor may be harmful.

First Aid and Protective Equipment

The following paragraphs provide general first aid procedures and recommendations for protective equipment to minimize the risks from resin exposure. If professional medical attention is necessary, take the Material Safety Data Sheet (MSDS) for the exact resin involved to the attending physician.



Skin Contact

Wear 100% nitrile gloves and lab coats to avoid skin contact. Should resin come in contact with skin, wash thoroughly with soap and **cold** water and immediately remove contaminated clothing and shoes. If skin is irritated, get medical attention. Dry-clean contaminated clothing. Discard contaminated shoes and leather products.

Eye Contact

Safety goggles should be worn to prevent accidental splashes into the eyes. If resin comes in contact with the eye, flush immediately with large amounts of water for 15 minutes, avoid sunlight, fluorescent light, and other ultraviolet light, and obtain immediate medical attention. Eye wash facilities and a first aid kit should be readily available and close to the resin.

Contact Lenses

If resin splashes into the eye when contact lenses are worn, flush the eye with water immediately. Verify that flushing has removed the contact lens from the eye. Protect eyes from light and obtain immediate medical attention. Discard contact lenses that come into contact with liquid resin.

Fume Inhalation

Remove the person to fresh air. Give artificial respiration or cardiopulmonary resuscitation (CPR) if required. If breathing is difficult, give oxygen. Obtain immediate medical attention.



Maintenance

Cleaning the Viper Pro

Clean the Viper Pro's outer surfaces and inside the waste drawer periodically as described in the following paragraphs.

(xx: Add caution graphic) Caution: Do not remove any outer panels when cleaning the Viper Pro. Panels must only be removed by a qualified 3D Systems Customer Support Representative.

Cleaning Viper Pro Surfaces

Clean Viper Pro outer surfaces as needed following these guidelines:

Remove dust from the outer surfaces of the Viper Pro by wiping with a clean, dry, lint-free cloth.

Caution: dust and clean the outside surfaces only. Do not dust inside the build chamber or feed slots.

Remove dirt and grease from the Viper Pro by spraying all-purpose cleaner on a clean cloth and gently wiping.

Caution: use only non-abrasive, alcohol-free cleaners to clean surfaces. Do not use all-purpose cleaners that contain petroleum-based polishing agents such as liquid wax. Spray the cleaner on the cloth, not on the surface.



Caution!

Do not use any cleaning solvents on the build chamber window; doing so may damage its protective coating.



Caution!

Remove dirt, grease, and build material residue from operator panel buttons, display window, and feed slot windows by spraying an ammonia-based cleaner, such as Windex® on a clean lint-free cloth. Then, gently wipe the buttons and windows.



Caution!

Remove the build platform before cleaning the operator control panel buttons; doing so will prevent the machine from initiating any actions when buttons are pressed.

Scheduling Preventive Maintenance

Your Viper Pro must have preventive maintenance (PM) performed by a qualified 3D Systems Customer Support Representative. Contact 3D Systems after either one year of build time, or after xxxx ??

Any other scheduled maintenance stuff?



Glossary

Acousto-Optic Modulator (AOM)

An electronic device which diffracts laser light to interrupt the laser beam as an on/off switch.

Beam profile

A pattern of circles or numbers representing the spatial distribution of laser beam power. This power distribution automatically calculates drawing speeds to determine whether the laser should be adjusted or replaced, and to indicate whether the optics should be adjusted, replaced, or cleaned.

Beam profiler

A UV-sensitive detector over which the laser beam is moved to generate beam profiles. Two beam profilers are mounted in the process chamber in opposing corners of the rim.

Border

A vector that defines the perimeter of a layer. Hatch and fill vectors are drawn between borders.

Build computer

See Control computer.



Build file(s)

The data file(s) produced by the *3D Lightyear File Preparation Software* and used by the controller to build parts. The Viper Pro build file names have a .BFF extension.

Buildstation Control Software

Controller software which controls the building of stereolithography parts on an SLA system.

Build style

A template file that defines slicing and part building parameters.

Bullet

The characteristic shape of the solid plastic created by a stationary laser beam on the surface of photocurable resin.

CAD

Computer Aided Design. The process of designing products by interaction with a computer rather than by the traditional method of hand drawing on paper.

CAD resolution

The internal approximation of surfaces within a CAD model.

CAD units

Units of measurement used to construct the CAD model, such as millimeters or inches.



CAE

Computer Aided Engineering. The process of solving engineering problems by interaction with a computer. Computer Aided Design is a subset of CAE.

CAM

Computer Aided Manufacturing. Managing and directing manufacturing operations with the assistance of computers.

CDRH

Center for Devices and Radiological Health.

CFR

Code of Federal Regulations.

Chamber temperature

The controlled temperature in the process chamber.

Control module

One of the two modules that comprise the SLA 3500 and Viper SLA systems.

Control computer

The computer mounted in the SLA system cabinet that controls the building of stereolithographic parts; the control computer is also known as the controller.



Controller

See Control computer.

Cure

The process of turning liquid resin into a solid by exposure to UV light.

Cure depth

The thickness or depth of a line of cured resin. The cure depth of any line is determined by the laser beam power and distribution, laser draw speed, and resin characteristics.

Curl

A characteristic type of part deformation.

Draining

Allowing resin to drip from the finished part into the vat when the elevator is at its top position.

Drawing speed

The speed at which the laser traces over the surface of the resin to form solid plastic lines and surfaces. The laser drawing speed varies depending on the depth of solidification requested, laser beam power and distribution, and resin characteristics.



Dynamic mirrors

Motor driven scanning mirrors with encoder feedback that direct the laser beam to any point on the surface of the resin.

Elevator

The hardware components that raise and lower the platform and part in the vertical (Z) axis. Also called Z-stage.

Exposure

The total light energy absorbed by a point on the resin surface. Exposure increases with higher laser power and decreases with higher drawing speed.

Fill vectors (skin fill)

Overlapping parallel vectors that comprise the horizontal surfaces (skins) of stereolithographic parts.

Green part

A stereolithographic part prior to UV post-curing, but after laser curing in the resin delivery module.

Hatch

A vector that is drawn between layer borders and comprises the interior of the part.



Hatch spacing

A parameter that specifies the perpendicular distance between adjacent hatch vectors.

Laser

Light Amplification by Stimulated Emission of Radiation. The device that generates the light energy required to polymerize photocurable resin.

Layer

Thin horizontal section of laser solidified resin.

Layer thickness

The depth of a solidified layer of resin, as requested by the user.

Leveling

The process whereby the surface of the resin is adjusted to the correct distance from the dynamic mirrors.

Line

A line of cured plastic generated by overlapping bullets. See also vector.

Linewidth

The horizontal width of a laser cured resin line.



Monomer

A low molecular weight chemical species, which is a building block of polymers.

MSDS

Material Safety Data Sheet. Federal government mandated information about the chemical makeup of any chemical substance, such as resin. Usually includes identification of toxic substances and safe handling guidelines.

NIOSH

National Institute for Occupational Safety and Health.

Photoinitiator

A chemical in photopolymers that reacts with photons and catalyzes the polymerization process.

Photopolymer

A chemical substance composed of photoinitiators and monomers that polymerizes when exposed to light energy.

Photopolymerization

The process whereby light energy converts monomers into a polymer.

Platform

The perforated base on which parts are built by the SLA system.



Platform locators

Pins that secure and position the edges of the platform.

Platform supports

L-shaped brackets that support the platform and attach it to the elevator.

Polymer

A material built up from a series of smaller units (monomers). The molecular size of the polymer helps to determine the mechanical properties of the plastic material.

Polymerization

The process of linking small molecules (monomers) into larger molecules (polymers) comprised of many monomer units.

Post-Curing Apparatus (PCA) equipment

A device which generates ultraviolet energy used to cure green stereolithographic parts.

Post-process

The process of cleaning, curing, and finishing stereolithographic parts.

Process chamber

The chamber in which the resin vat, elevator, and beam profilers are located.



Process module

The largest of the two modules which make up the Viper Pro. The SLA 5000 and SLA 7000 systems are made up of just one module which combines all functions. ??? xx The process module is where the actual part building takes place.

Recoating

The process of adding a layer of liquid resin with a user specified thickness on top of the previously cured layer.

Recoat style

A style file that defines parameters associated with recoating during the stereolithographic process.

Recoater assembly

The assembly of an SLA system that either applies resin to, or removes excess resin from, the part as the recoater blade moves across the vat.

Recoater blade

The part of the recoater assembly that contacts the resin.

Resin

Another name for the photopolymer chemical used in stereolithography.



Resin Delivery Module

The metal container inside the process chamber in the SLA system that holds the resin in which the object is formed.

Safety shutter

A mechanical device that blocks the laser beam when an interlock switch is activated or when closed via the computer user interface.

Scan speed

See Draw speed.

Sensitization

An allergic response to a chemical stimulus, such as resin, generally resulting from repeated skin contact.

Skin (skin fill)

See Fill vectors.

SLA system

See Stereolithography apparatus.

Stereolithography apparatus

The equipment used to produce stereolithographic parts.



Slice resolution

A slice parameter that specifies the number of slice units assigned to each CAD unit of measure.

SmartSweep recoating process

A feature used to reduce the build times by sweeping only over that portion of the vat where a part is being built instead of sweeping the full area of the resin delivery module. See Sweep.

Stereolithography

A three dimensional imaging process that forms plastic objects by solidifying successive layers of photocurable resin.

Stereolithography file (STL)

The tessellated (triangulated) CAD input file.

Supports

Structures designed on the CAD system or by *3D Lightyear File Preparation Software* to support a part above the elevator platform, provide a rigid foundation on which the object may be built, and attach and support layer sections.

Sweep

A pass of the recoater blade from the front of the resin delivery module to the rear or from rear to front. The act of removing excess resin from the upper surface of the part or adding a layer of fresh resin during the recoat process. See Recoating and also see SmartSweep recoating process.



Tessellate

To represent CAD surfaces in polygonal format.

Trapped Volume

During building, a volume of resin within the part that cannot flow out to the surrounding liquid.

Triangle normal

A line perpendicular to a triangle starting at its center and pointing away from the mass of the part. Triangle normals are used to differentiate between inside and outside surfaces of a solid.

Ultraviolet (UV)

Electromagnetic radiation having a wavelength shorter than visible light, (i.e., below 390 nanometers).

Vector

A directed line segment represented by starting and ending coordinates as defined in a stereolithography slice or build file.

Workstation

The high powered personal computer with graphics capabilities, running the *3D Lightyear File Preparation Software* which creates the build files.



Zephyr Recoating System

A recoater blade system that uses an internal vacuum cavity to deposit resin on the part, improving trapped volume sweeping.

Z-Stage

See Elevator.

3D Lightyear File Preparation Software

Software used to verify STL files, orient parts, select build style parameters, generate supports, and create the files that are used for building on the SLA system.

3dverify software

A function in *3D Lightyear File Preparation Software* that verifies and fixes STL files.



Troubleshooting

Power Outages

If you are present when a power outage occurs, or if you discover that the main power is off, complete the following steps:

- 1 Switch the power OFF at the Viper Pro's electronic cabinet so that it does not automatically start when the power is restored, preventing damage from power flickers and surges.
- 2 When the power is restored and stable, switch the Viper Pro power ON at the file cabinet.

Viper Pro Shutdown

If you do not plan on operating the Viper Pro on a regular basis and want to shut it down for an extended period of time, shut down Windows and turn off the main disconnect.

Note: It takes a substantial amount of time for the Viper Pro to warm up after a full shutdown/power off.

Error Messages

The following list describes categories of error messages:



Table 1: Message Errors

MESSAGE	CAUSE	ACTION
MATERIAL ERROR!	Resin Not Detected!	If the material container is installed, this material cannot be added into the RDM through the RDM's on-board delivery system. The resin warranty is void if material is added manually to the RDM.
UNKNOWN MATERIAL ERROR!	Resin Not Recognized!	This material cannot be added into the RDM through the RDM's on-board delivery system. The resin warranty is void if material is added manually to the RDM.
STOP! INCORRECT MATERIAL ERROR!	Resin Container Installed is Wrong Type!	This RDM contains < > You are attempting to install < > This material cannot be added into the RDM through the RDM's on-board delivery system. The resin warranty is void if the material is added manually to the RDM.
EMPTY CONTAINER ERROR!	RFID Tag Closed!	All contents of this container have been depleted from the container and added into the RDM through the RDM's on-board delivery system. The resin warranty is void if the material is added manually to the RDM.

**Table 1: Message Errors**

MESSAGE	CAUSE	ACTION
EXPIRED MATERIAL ERROR!	Container Material Past Expiration Date!	The material in this container has passed its expiration date. This material cannot be added into the RDM through the RDM's on-board delivery system. The resin warranty is void if the material is manually added to the RDM.
MATERIAL QUANTITY ERROR	Quantity of Material and Recorded Quantity Do Not Match!	The quantity of material in this container does not match its last recorded quantity. This material cannot be added into the RDM through the RDM's on-board delivery system. The resin warranty is void if the material is added manually to the RDM.



Customer Support

If you receive an unrecoverable error message, or if you need to contact us for another problem, you may contact our Customer Support Hotline. Before you call Customer Support with a problem or question, please make sure that you have the following information:

- The serial number of the Viper Pro (located on the rear panel)
- A brief description of the problem, including the exact error message
- When the problem occurred; for example, when you submitted a job, during the beginning or the end of a build, or after power off recovery

Customer Support Hotline

Please contact your Customer Support Hotline at one of the following numbers:

- In North America, call 1-800-793-3669.
- In Asia and the Pacific Rim, call +852 2923 5077.
- In Europe, call +49 (0) 6151 357-357.
- In the United Kingdom, call +44 1442 282665.
- In France, call (+33) 1 69 35 17 x10.



quick start guide

legal notices



Legal Notices

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This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by 3D Systems could void your authority to operate this equipment.



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