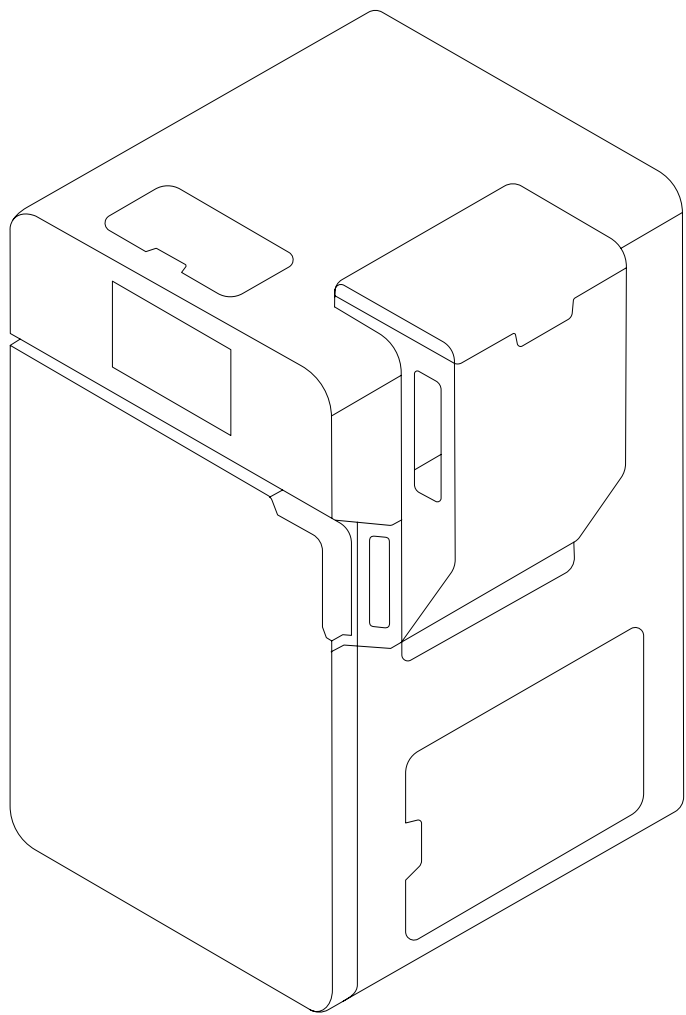


Manual | Fuse 1



Fuse 1

Benchtop Selective Laser Sintering (SLS) 3D printer

Original English instructions

Read this manual carefully and keep it for future reference.

August 2025

REV 04

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1 Table of Contents

1	Preface	6
1.1	Read and retain instructions	6
1.2	Obtaining documentation and information	6
2	Introduction	8
2.1	Intended use	8
2.2	Technical specifications	8
2.3	Product components	10
2.4	Fuse 1 user interface	13
3	Safety	14
3.1	Component and subsystem safety	15
3.2	Personal protective equipment (PPE)	18
3.3	Specification of tools to be used	18
3.4	Sensitive components	18
3.5	Emergency and exceptional situations	19
4	Preparation and setup	21
4.1	Location and environs	21
4.2	Power and networking	22
4.3	Unboxing the machine	22
4.4	Accessing the serial name	23
4.5	Installing the machine	24
4.6	Setting up a network connection	25
4.7	Updating firmware	26
4.8	Registering powder credit	26
4.9	Preparing the optical cleaning kit	28
4.10	Transporting the machine	29
5	Printing	33
5.1	Operational environment	33
5.2	Designing for SLS	33
5.3	Setting up a print	34
5.4	Preparing for a print	35
5.5	Retrieving and cleaning prints with the Fuse Sift	38
5.6	Managing the machine	39

6	Maintenance	40
6.1	Tools and supplies	40
6.2	Inspection and maintenance	41
6.3	Tasks between uses	41
6.4	Periodic maintenance	44
6.5	Intermittent maintenance	48
7	Troubleshooting	52
7.1	Collecting diagnostic logs	52
7.2	Performing a factory reset	52
7.3	Cleaning after a failed print	52
7.4	Troubleshooting errors or abnormal activity	53
8	Disassembly and repair	55
8.1	Tasks	55
9	Recycling and disposal	56
9.1	Disposal of powder	56
9.2	Recycling of powder	56
9.3	Disposal of cleaning agents	56
9.4	Recycling of solvent	56
9.5	Disposal of electronic components	57
9.6	Disposal of packaging waste	57
10	Index	58
11	Glossary	60
12	Product compliance	62



Read and understand this manual and its safety instructions before using the Fuse 1. Failure to do so can result in serious injury or death.



DISCLAIMER

Formlabs has made every effort to make these instructions as clear, complete, and correct as possible. The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation, and testing of the products with respect to the relevant specific application or use thereof. Neither Formlabs nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information that is contained herein. Notify us if you have any suggestions for improvements or amendments or have found errors in this publication.

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support.formlabs.com

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DOCUMENT REVISIONS

Date	Version	Document changes
Jan 2021	REV 01	Initial publication
Apr 2021	REV 02	Minor text updates
Feb 2023	REV 03	Updated safety guidance
Aug 2025	REV 04	Updated shipping and packaging information

1 Preface

Congratulations on purchasing the Fuse 1. On behalf of the Formlabs team, we thank you for your purchase. The Fuse 1 is a Selective Laser Sintering (SLS) 3D printer.

The Fuse 1 fabricates fully-supported parts by heating powdered thermoplastic to just below its melting point, then solidifies it by sintering layers (2D cross sections) together with a laser. These 110 micron thick layers are stacked on top of each other to create 3D parts.

This manual explains how to set up, use, and properly maintain the Fuse 1, as well as provides design guidance for optimizing print results.

The manual is intended for anyone who is installing, operating, maintaining, or otherwise interacting with the Fuse 1. Supervise young or inexperienced users to ensure enjoyable and safe operation.

1.1 Read and retain instructions

Read and understand this manual and its safety instructions before using the Fuse 1. Failure to do so can result in serious injury or death. Keep all safety information and instructions for future reference and provide them to subsequent users of the product. Follow all instructions to avoid fire, explosions, electric shocks, or other hazards that may result in damage to property and/or severe or fatal injuries. The Fuse 1 shall only be used by persons who have fully read and understand the contents of this manual. Ensure that each person who uses the Fuse 1 has read these warnings and instructions and follows them. Formlabs is not liable for cases of material damage or personal injury caused by incorrect handling or non-compliance with the safety instructions. In such cases, the warranty will be voided.

1.2 Obtaining documentation and information

Visit formlabs.com to:

- Access your **Formlabs store** (formlabs.com/store) and **Dashboard** accounts (formlabs.com/dashboard).
- Find **certified service providers** in your region (formlabs.com/company/partners).
- Access the **Terms of Service** (formlabs.com/terms-of-service) and the **Privacy Policy** (formlabs.com/privacy-policy).

Visit support.formlabs.com to:

- Access the latest version of all Formlabs product documentation.
- Contact [Formlabs Support](https://support.formlabs.com) to request documentation, manuals, repair guides, and technical information.
- Submit any comments or feedback regarding what is good and what can be improved. Formlabs values comments from its users.
- Request additional training.

1.2.1 Support and service

Retain a record of the original purchase to request warranty services. Service options depend on the status of the specific product's warranty. Include the serial name of the product when contacting [Formlabs Support](https://support.formlabs.com) or a [certified service provider](#) for product support. Instead of a serial number, Formlabs products have a serial name, which is a unique identifier to track the history of manufacturing, sales, and repair, and to distinguish usage when connected to a

network. The serial name is on the back panel of the machine in the format **AdjectiveAnimal**. Service providers of Formlabs products also provide support and service. To the extent that Formlabs or a certified service provider offers other or extended warranties, the terms of the separate offer may apply.

For products purchased from certified service providers, contact the original service provider for assistance before contacting Formlabs Support.

For any support or service requests, including product information, technical assistance, or assistance with instructions, contact [Formlabs Support](#):

support.formlabs.com

USA

Formlabs, Inc.
35 Medford St.
Somerville, MA, USA, 02143

Germany

Formlabs GmbH
Nalepastrasse 18
12459 Berlin, Germany

1.2.2 **Warranty**

This product is protected under warranty. Formlabs offers a warranty for all Formlabs branded hardware. Unless otherwise expressly stated, the **Terms of Service**, including the **Warranty**, constitute the entire agreement between you and Formlabs with respect to the **Service** and any product you purchase from Formlabs and supersedes all prior or contemporaneous communications, proposals, and agreements, whether electronic, oral, or written, between you and Formlabs.

Read the warranty for more details on the Formlabs warranty for your region:

US

formlabs.com/terms-of-service

EU (EN)

formlabs.com/eu/terms-of-service

EU (DE)

formlabs.com/de/terms-of-service

EU (FR)

formlabs.com/fr/terms-of-service

EU (ES)

formlabs.com/es/terms-of-service

EU (IT)

formlabs.com/it/terms-of-service

2 Introduction

2.1 Intended use

The Fuse 1 is a commercial, precision tool intended for use in the additive manufacture of end-user supplied designs from SLS powder. The final performance characteristics of sintered SLS powder may vary according to your compliance with the instructions for use, application, operating conditions, material combined with, end use, or other factors.



In some cases, the additive manufacturing process may inherently result in variable performance characteristics between manufacturing runs or within a specific part. Such variances may not be apparent and may result in unexpected defects in additively fabricated parts.



You shall independently verify the suitability of additive manufacturing, Selective Laser Sintering (SLS), the Fuse 1, and any specific designs or materials employed for the application and intended purpose before use. In no event shall Formlabs be liable for any loss, death, or bodily injury that you suffer, or that you cause to any third party, in connection with your use of Formlabs products. To the fullest extent legally permitted Formlabs EXPRESSLY DISCLAIMS ANY IMPLIED OR EXPLICIT WARRANTY OF FITNESS for a particular usage, the particular nature and circumstances of said usage being unforeseen and unforeseeable to Formlabs.



Formlabs is not a manufacturer of medical devices. Formlabs provides tools and materials that may be used in many applications, but makes no claims as to the safety or effectiveness of any specific devices made using Formlabs products. Certain Formlabs products, such as those commonly known in the industry as “biocompatible” materials, have been engineered to comply with relevant industry standards. The specific standards and most relevant technical specifications may be identified within the technical data sheets and have been tested according to relevant testing protocols for those standards and specifications. Biocompatible materials are a speciality product, developed for use by medical professionals, and should be used in accordance with the instructions for use.



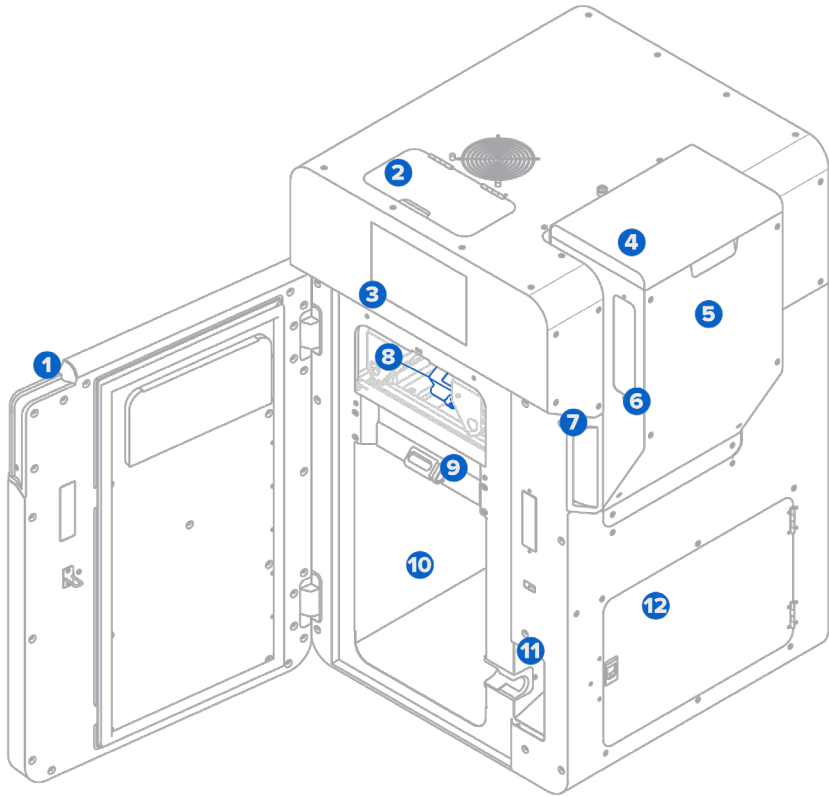
Do not modify. The Fuse 1 is intended for use as-is. Modifying the machine without explicit approval and directions from Formlabs or a certified service provider will void your warranty, and could potentially ruin the machine and cause you bodily harm.

2.2 Technical specifications

Parameter	Unit
Printer	Fuse 1
3D printing technology	Selective Laser Sintering (SLS)

Parameter	Unit
Minimum dimensions for convenient access (W × D × H)	125.5 × 149.5 × 187.0 cm 49.4 × 59.0 × 73.6 in
Printer dimensions (W × D × H)	64.5 × 68.5 × 107 cm (165.5 cm with stand) 25.4 × 27.0 × 42.0 in (65.0 in with stand)
Printer weight	114 kg (without build chamber or powder) 251.3 lb (without build chamber or powder)
Build chamber dimensions (W × D × H)	27.9 × 34.2 × 48.9 cm 11.0 × 13.5 × 19.3 in
Build chamber weight	11 kg (17.6 kg, full with 20% packed powder) 24.3 lb (38.8 lb, full with 20% packed powder)
Build volume (W × D × H)	16.5 × 16.5 × 30.0 cm 6.5 × 6.5 × 11.8 in
Material refresh rate	Print with up to 70% recycled powder
Startup time	60 minutes
Build speed	10 mm/hour 0.39 in/hour
Hopper capacity	17.8 L powder
Operating environment	18–28 °C 68–82 °F
Operating temperature	200 °C 392 °F
Temperature control	Quartz tube heating elements Positive temperature coefficient (PTC) cartridges
Air handling	Pressure-controlled two-stage filtration (Replaceable HEPA and carbon mediums)
Power requirements	EU: 230 VAC, 7.5 A (dedicated circuit) US: 120 VAC, 15 A (dedicated circuit)
Laser specifications	EN 60825-1: 2014 Class 1 laser product 1065 nm Maximum 10 W 4.01 mrad beam divergence (nominal, full angle)
Laser spot size (FWHM)	200 µm 0.0079 in
Radiation information	The Fuse 1 is a Class 1 laser product. Accessible radiation is within Class 1 limits.
Connectivity	Wi-Fi: 2.4 GHz Ethernet: 1000 Mbit USB: 2.0
Wi-Fi connectivity	Protocol: IEEE 802.11 b/g/n Frequency: 2.4 GHz Supported security: WPA/WPA2
Ethernet connectivity	RJ-45 Ethernet (10BASE-T/100BASE-TX/1000BASE-T) LAN port Connect with a shielded Ethernet cable (not included); minimum Cat5, or Cat5e or Cat6 for 1000BASE-T.
USB connectivity	USB (rev 2.0) B port with a USB A-B cable
Printer control	Interactive touchscreen
Powder dispensing system	Automated
Alerts	Touchscreen alerts, SMS/email via Dashboard
Print preparation	PreForm desktop software
File type	STL or OBJ

2.3 Product components

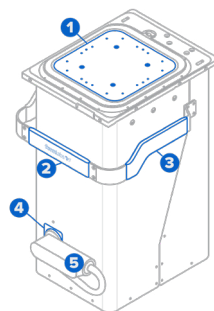


2.3.1 Fuse 1

- 1 **Print enclosure door:** Provides access to the print enclosure and optical cassette tray.
- 2 **IR sensor door:** Provides top-down access to the IR sensor and powder card reader.
- 3 **Touchscreen:** The LCD capacitive touch user interface displays print information, settings, and error messages.
- 4 **Hopper lid:** Prevents debris from entering and powder from leaving the hopper.
- 5 **Hopper:** Stores up to 17.8 L of powder for printing.
- 6 **Hopper window:** Allows for visual check of powder level in the hopper.
- 7 **Door handle:** A grab slot to help close the door.
- 8 **Cassette tray:** Holds the optical cassette in place.
- 9 **Build chamber latch:** Secures a build chamber.
- 10 **Print enclosure:** Houses the build chamber and optics system for printing.
- 11 **Build chamber socket:** Connects the build chamber's plug.
- 12 **Filter cabinet door:** Sealed door for accessing the intake and exhaust filters.

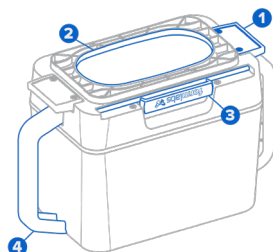
2.3.2 Build chamber

- 1 Print bed: The moving surface (Z-axis) on which powder is deposited and sintered.
- 2 Front handle: Silicone handle for loading and unloading the build chamber.
- 3 Side handles: Silicone handles on each side for moving the build chamber.
- 4 Plug holster: A retainer to keep the plug secure when moving or storing the build chamber.
- 5 Build chamber plug: Main connector for the build chamber's heaters and temperature sensors.



2.3.3 Powder cartridge

- 1 Cartridge wings: Two brackets for locking the cartridge to the mixer.
- 2 Cartridge valve: The primary opening for filling and depositing powder.
- 3 Valve knife: Used to close and open the cartridge valve.
- 4 Handles: For holding and lifting the cartridge.



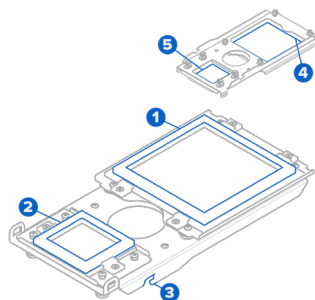
2.3.4 IR sensor

- 1 Sensor window: The exposed surface that allows infrared radiation to enter the sensor.
- 2 Ethernet socket: Used to connect the sensor to the printer and disconnect for cleaning.
- 3 Status light: Indicates if the sensor is seated correctly (green) or incorrectly (yellow).

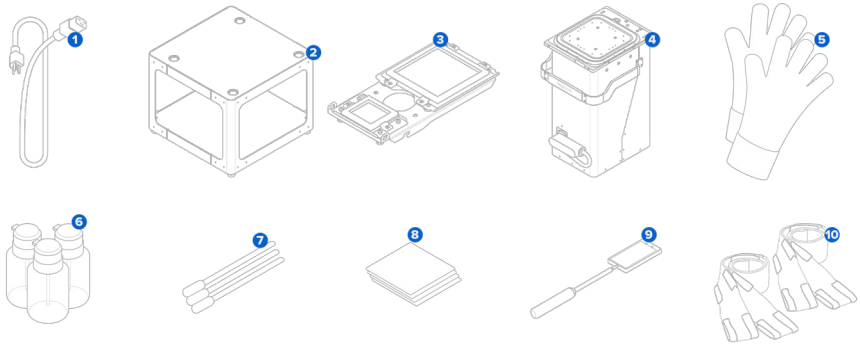


2.3.5 Optical cassette

- 1 Laser window gasket: Seals the top of the laser window from the print enclosure.
- 2 Camera window gasket: Seals the camera window from the print enclosure.
- 3 Tray catch: Two hooks that align the optical cassette to the cassette tray.
- 4 Laser window: Protects the laser during printing. This side requires cleaning after each print.
- 5 Camera window: Protects the camera lens during printing. This side requires cleaning after each print.



2.3.6 Additional Fuse 1 package components



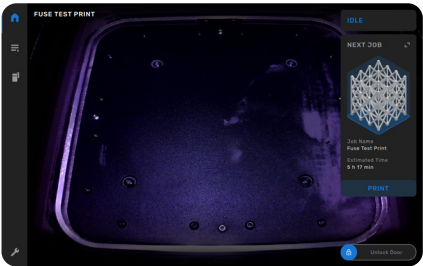
- ❶ **Power cable:** Compatible with both the Fuse 1 and the Fuse Sift.
- ❷ **Stand:** Freestanding platform for the Fuse 1.
- ❸ **Optical cassette:** A set of gasketed windows that protect the laser and camera. Each Fuse 1 includes an optical cassette packaged with the printer.
- ❹ **Build chamber:** The compartment in which powder is deposited and sintered into parts.
- ❺ **Thermal-insulated silicone gloves:** For removing the build chamber while it's still hot.
- ❻ **Push-top dispensers:** For dispensing Alconox, distilled water, and ethanol to clean the optical cassette.
- ❼ **Polyester swabs:** For cleaning the upper laser window, the IR sensor and the IR sensor housing.
- ❽ **PEC*PADs:** For cleaning the cassette's optical windows.
- ❾ **Telescoping mirror:** For inspecting the upper laser window and roof of the print enclosure.
- ❿ **Lifting straps:** For two individuals to lift and move the Fuse 1.

2.4 Fuse 1 user interface

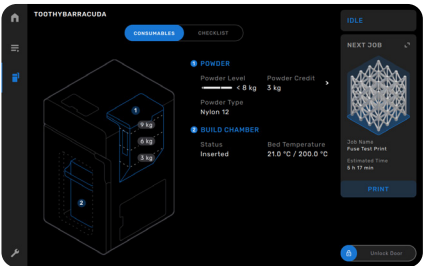
For detailed guidance and visual assistance, visit support.formlabs.com.

The touchscreen displays print information (print job name, time remaining, layers printed), settings, and error messages. The touchscreen serves as the user interface for the printer.

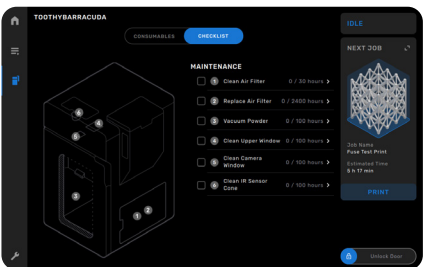
Tap the home icon in the left sidebar to access the **Home** screen. A status card on the right indicates if the Fuse 1 is idle, printing, or cooling. Below the status card is the **Next Job** card, which presents the next print job in the queue. The slider to unlock the print enclosure is located in the bottom-right corner of the touchscreen.



Tap the printer icon in the left sidebar to access the printer status screen. Readouts of the bed temperature, hopper level, powder type, and available credits can be found here.



The Fuse 1 requires periodic maintenance and notifies users when a procedure is due. Each procedure is accompanied by written and visual instructions and organized in a checklist with due tasks highlighted red. When a task is completed, the Fuse 1 keeps track of procedure intervals in the background.



3 Safety



Read and understand this manual and its safety instructions before using the Fuse 1. Failure to do so can result in serious injury or death.



Supervise young or inexperienced users to ensure enjoyable and safe operation. The instructions contain warnings and safety information, as explained below:



DANGER indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.



WARNING indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.



CAUTION indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.



NOTICE indicates information considered important, but not hazard-related.



DANGER: Ethanol is a flammable chemical.



DANGER: CLASS 4 INVISIBLE LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION

WARNING: Class 1 laser product. Only remove the exterior paneling of the printer with authorization from [Formlabs Support](#) or a [certified service provider](#).



ENVIRONMENTAL HAZARD: Unsintered SLS powder is classified as a microplastic, a group of plastics that are hazardous to aquatic life..



MANDATORY ACTION: Refer to instruction manual/booklet.



MANDATORY ACTION: Wear thermal-insulating silicone gloves when handling hot build chambers.



MANDATORY ACTION: Disconnect before carrying out maintenance or repair.



MANDATORY ACTION: Grounding required.

3.1 Component and subsystem safety

3.1.1 General



The Fuse 1 requires a 230 VAC (50 Hz), 7.5 A power supply (EU) or 120 VAC (60 Hz), 15 A power supply (US) for nominal operation. Unless explicitly instructed by **Formlabs Support** or a **certified service provider**, do not disassemble or tamper with the product beyond what is explicitly outlined for typical maintenance. Tampering with, or disassembling the Fuse 1 prior to disconnecting the power cable and waiting approximately ten minutes can subject users to potentially fatal electrical hazards.



The Fuse 1's print enclosure is designed to operate at up to 200 °C (392 °F). Do not handle parts from a build chamber until the print bed temperature has reached ≤ 45 °C (113 °F). Use the provided thermal-insulating silicone gloves when removing a build chamber that has not been allowed to cool down. Failure to follow these procedures will result in serious injuries, including burning and/or scalding of skin.



Due to its size and weight, do not move or reposition the Fuse 1 alone. If the machine needs to be moved, at least two or more individuals should use the lifting straps provided with the printer.



NOTICE

Do not lift or reposition the Fuse 1:

- By grabbing or pulling on the print enclosure door, hopper, hopper lid, filter compartment, filter door, power cable, or any components inside the print enclosure.
- By pushing on any side of the unit while stationary.
- When the build chamber from a previous print is loaded or still cooling in the print enclosure.
- When the print enclosure is still hot from a previous print.

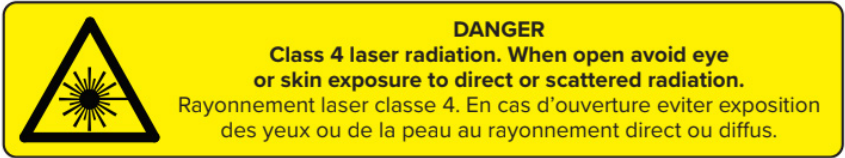


NOTICE



The Fuse 1 requires an operating environment that is low in ambient humidity and static electricity. Due to the sensitive nature of its components and the printing mediums, system reliability and print quality may fluctuate if the ambient temperature and moisture are outside the recommended ranges. Refer to section 4.1 Location and environs for the recommended operating environs. When performing maintenance or testing with the exterior paneling of the machine removed, ground equipment to the grounding stud marked with this protective earth symbol.

3.1.2 **Laser**



The above Class 4 laser warning label is also located in the Fuse 1. It can be seen on the laser module heatsink. It is visible when the rear cover of the printer is opened by an authorized technician.



Class 1 laser product. The laser beam is extremely harmful to the eyes and skin, capable of causing permanent blindness. Avoid direct contact at all times. The Fuse 1 contains redundant interlock systems to automatically shut off the laser when the print enclosure door is open, or if the IR sensor is out of place. If these systems are tampered with or fail, there is a risk of exposure to Class 4 laser light. Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. Only remove the exterior paneling of the machine with authorization from **Formlabs Support** or a **certified service provider**.

Accessible radiation is within Class 1 limits. The laser diode used inside the device has the following specifications:

Parameter	Unit
Diode	1065 nm
Maximum output	10 W
Beam divergence	4.01 mrad (nominal, full angle)
Certification	ISO 11553-1:2020 ISO 11252:2013 ISO 11554:2017

3.1.3 **Powder**



Dry powders can build static electricity charges when subjected to the friction of transfer and mixing operations. Therefore: avoid dust generation and dispersal of dust in air; dust deposits should not be allowed to accumulate on surfaces; clean dust residues at regular intervals; do not use brooms or compressed air hoses to clean surfaces; only use vacuums approved for dust collection that are grounded; use only non-sparking tools; keep powder containers tightly closed when not in use.



NOTICE

Consult the safety data sheet (SDS) as the primary source of information to understand safety and handling of Formlabs powders. Respect Formlabs powder like any household chemical. Follow standard chemical safety procedures and Formlabs powder handling instructions. In general, Formlabs powder is not approved for use with food, drink, or medical applications on the human body. Refer to the safety data sheet (SDS) for each specific powder as well as **support.formlabs.com** for more detail.

3.1.4 Radio interference

Note: 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 their own expense.

Changes or modifications to this product not authorized by Formlabs could void the electromagnetic compatibility (EMC) and wireless compliance and negate your authority to operate the product.

This product has demonstrated EMC compliance under conditions that included the use of compliant peripheral devices and shielded cables between system components. It is important that you use compliant peripheral devices and shielded cables between system components to reduce the possibility of causing interference to radios, televisions, and other electronic devices.

3.1.5 Ethanol



Ethanol is a flammable chemical. Keep away from ignition sources, including open flames, sparks or concentrated sources of heat.



NOTICE

Formlabs does not manufacture ethanol. Consult the chemical manufacturer or supplier for detailed safety information. Carefully follow the safety instructions provided with the ethanol that you purchase. Ethanol can be flammable, even explosive, and should be kept away from heat, fire, or sparks. Any containers holding ethanol should be kept closed or covered when not in use. We also recommend that you wear protective gloves and have good ventilation when working with ethanol.

3.2 Personal protective equipment (PPE)

Refer to the relevant material SDS for recommended protective measures.

3.3 Specification of tools to be used

The Fuse 1 shall only be used with supplied accessories and additional tools recommended by Formlabs or a certified service provider. Third-party accessories and materials may cause damage. Refer to sections **3.2 Personal protective equipment (PPE)** and **6.1 Tools and supplies for more information**.

Purchase additional supplies:

- **Alconox**
The recommended cleaning agent for removing deposits of laurolactam and other off-gassing stains from the printer's optical components. It is the first cleaning agent to be used, followed promptly by distilled water and ethanol.
- **Compliant vacuum that is grounded and bonded (e.g., Class II, Division 2 vacuum)**
Certified for use with materials whose fine particles present an explosive risk when in the vicinity of potentially malfunctioning electrical equipment.
- **Distilled water**
The second agent used for cleaning the printer's optical components.
- **Ethanol (laboratory-grade)**
The last recommended cleaning agent used for components.
- **PEC*PADs**
Disposable lint-free, non-woven microfiber cloths for cleaning the printer's optical components. Do not reuse a PEC*PAD; dispose of after each use, even when cleaning the windows on the optical cassette with the same cleaning agent.
- **Polyester cloth swabs**
Disposable lint-free polyester cloth swabs with either orange or blue plastic handles for cleaning the IR sensor and camera lens. Do not reuse a polyester swab—dispose of after each use.

3.4 Sensitive components

The Fuse 1 has multiple components that are vulnerable to permanent damage if not periodically inspected and properly maintained. Using any tools, cleaning agents, or methods not mentioned in this manual may result in permanent damage to these components.

Follow the maintenance instructions outlined in this manual, pre-print checkpoints on the touchscreen when starting a print, and on **support.formlabs.com** when servicing the following components or any other internal component of the printer.

- **IR sensor**
The Fuse 1 uses an infrared (IR) sensor to monitor conditions inside the print enclosure, and as a secondary interlock measure for the laser. Refer to section **5.4.4 Checking the IR sensor** for more information.

- **Optical windows**

There are two individual optical windows contained within the cassette assembly, both of which need to be inspected after each print and cleaned regularly. They protect the camera and upper laser window. Refer to section **6.3.1 Cleaning the optical cassette** for more information.

- **Upper laser window**

The upper laser window encloses the laser's aperture and galvo-driven mirrors to prevent detrimental accumulation of laurolactam. While the upper laser window is protected by the cassette's optical windows, it may be necessary to inspect and clean it if explicitly instructed to do so by Formlabs or a certified service provider. Refer to section **6.5.5 Cleaning the upper laser window** for more information.

3.5 Emergency and exceptional situations

Formlabs has made every effort to provide updated safety data sheets (SDS) for every powder product, in accordance with the latest government guidelines. Always consult the safety data sheet (SDS) as the primary source of information to understand safety and handling of Formlabs materials and required accessories.

3.5.1

Fire



Do not use water to extinguish an electrical fire. Dousing an electrical fire with water increases the risk of electrocution, and may cause the fire to spread by allowing electricity to conduct across additional flammable surfaces.

If a localized fire develops either inside or outside of the machine, immediately take the following actions.

If the fire is inside the print enclosure:

1. Immediately disconnect the machine from its power source.
2. Open the filter door and locate the emergency chamber door release cable. Pull the cable away from the machine until the print enclosure door unlocks.
3. Use an ABC fire extinguisher to cover the affected area generously.

If the fire is too large to control:

4. Immediately leave the area and close the door of the room behind you.
5. Evacuate the building according to your organization's emergency protocols.
6. Call emergency services once you have reached a safe distance from the fire.

3.5.2

Ethanol



When handling ethanol, always consult the safety data sheet (SDS) from the ethanol supplier as the primary source of information. Handle ethanol with gloves in a well-ventilated area. Keep away from heat, sparks, and open flame. Ethanol evaporates rapidly, so keep containers closed whenever possible.

3.5.3 Powder



In an emergency involving powder, always refer to the safety data sheet (SDS) and/or seek help from a medical professional.

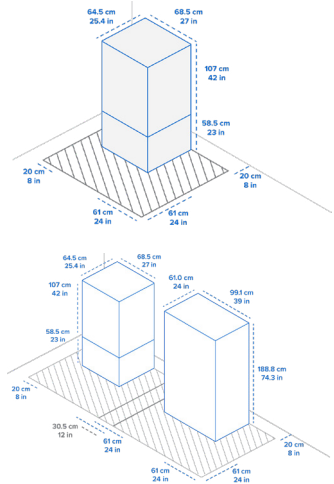
4 Preparation and setup

4.1 Location and environs

Prepare a space to install and operate the Fuse 1 and house the necessary accessories and consumables.

To prepare the workspace:

1. Choose a location separate from any machinery or tooling that generates dust or sparks, such as wood or metal working equipment.
2. Maintain low ambient humidity. When printing with Nylon 12, keep the relative humidity of the environment around the printer, the Fuse Sift and other post-processing tools, and anywhere unsintered powder is stored to 50% or less at all times. Higher humidity will lead to clumping, under-dosing, and print failures. If 50% RH cannot be achieved, remove the debris catcher at the bottom of the printer's hopper (though this will remove protection against debris entering the print chamber). For SLS powders, humidity affects shelf life significantly. For optimal results, follow Formlabs guidelines for storing and handling powder.
3. The Fuse 1, its stand, build chamber, and powder cartridge are free standing components. Reserve the following minimum dimensions for the most convenient access:
 - **Fuse 1:** 149.5 × 125.5 × 187.0 cm (59.0 × 49.4 × 73.6 in)
 - The Fuse 1 footprint is 68.5 × 64.5 × 107.0 cm (27.0 × 25.4 × 42.0 in), 165.5 cm (65.0 in) with stand. Leave at least 20.0 cm (8.0 in) to the left of the printer and 61.0 cm (24.0 in) to the front and right of the printer free for access.
 - Place the Fuse 1 at least 20.0 cm (8.0 in) from nearby walls.
 - **Fuse Sift:** 221.1 × 122.0 × 218.0 cm (87.1 × 48.0 × 85.8 in)
 - The Fuse Sift footprint is 99.1 × 61.0 × 157.0 cm (39.0 × 24.0 × 61.8 in). With the hood open, the Fuse Sift is 188.8 cm (74.3 in) in height. Leave at least 61 cm (24 in) to the left, front, and right of the unit free for access.
 - Place the Fuse Sift at least 20.0 cm (8.0 in) from nearby walls.
 - Do not overlap with the Fuse 1 access footprint by more than 30.5 cm (12.0 in).
4. Ensure proper ventilation is installed.



Sintering nylon powder produces laurolactam; a white powder that accumulates within the print enclosure, filter mediums, and exhaust. Proper ventilation is required whenever the Fuse 1 or Fuse Sift is operating.

5. Purchase additional supplies:
 - Alconox cleaning agent
 - Compliant vacuum that is grounded and bonded (e.g., Class II, Division 2 vacuum)

- Distilled water
- Ethanol (laboratory-grade)
- Non-reactive nitrile gloves
- Particulate filtering respiratory protection (N95 or better)
- PEC*PADs (disposable lint-free microfiber cloths)
- Polyester cloth swabs (disposable lint-free polyester cloth swabs with either orange or blue plastic handles)
- Safety glasses

4.2 Power and networking

For detailed guidance and visual assistance, visit support.formlabs.com.



The Fuse 1 requires a dedicated AC circuit, providing at least 7.5 A at 230 VAC (EU) or 15 A at 120 VAC (US) , as well as reliable grounding. This circuit must be separate from other devices, including the corresponding Fuse Sift, fans, vacuums, power tools, space heaters, or any large appliances. Power surges may disrupt prints and/or permanently damage sensitive components, jeopardizing the reliability of the product.

For uploading print jobs to the Fuse 1 and remotely monitoring the printer, ensure that the machine maintains a constant connection to a secured network. Refer to section **4.6 Setting up a network connection** for more information.

4.3 Unboxing the machine

For detailed guidance and visual assistance, visit support.formlabs.com.

Prior to unboxing, ensure that the suitable workspace has been prepared according to section **4.1 Location and environs**.

4.3.1 Receiving

The standard Fuse 1 package ships on a pallet and contains the Fuse 1 printer, stand, build chamber, and powder cartridge. Additional powder cartridges and accessory boxes ship separately from the printer's packaging.



- Depending on the package you purchase, the accessories may ship together on a pallet. If you are in a building with palletized deliveries, ensure you have access to the loading dock.
- As of June 2025, Fuse 1 generation printers are packaged with the build chamber installed but unplugged within the print enclosure.

	Printer	Stand	Build chamber (if shipped separately)	Powder cartridge	Pallet including product and boxes (if applicable)
Shipping dimensions	80×82×121 cm 32×32×48 in	635×66×229 cm 25×26×9 in	41×48×64 cm 16×19×25 in	41×21×27 cm 16×8×11 in	80×83×130 cm 32×33×52 in
Shipping weight	Printer without build chamber: 120.6 kg 265.9 lb Printer with build chamber: 131.6 kg 290.1	24 kg 53 lb	13.5 kg 29.7 lb	2.3 kg 5 lb	138.4 kg 305.1 lb
Product weight	Printer without build chamber: 114 kg 251.3 lb Printer with build chamber: 125 kg 275.6	23.9 kg 52.6 lb	11 kg 24.3 lb	1.8 kg 4 lb	n/a

4.3.2 Unboxing

The custom packaging the printer arrives in is specially designed to protect the machine during shipping. During unboxing, inspect the product for any damage or missing items. In the case of damage or missing items, contact [Formlabs Support](#) or a [certified service provider](#).



Removing the machine from its packaging requires at least two people that are comfortable lifting large and heavy objects.

To unbox the machine:

1. Position the packaging near the designated area, leaving enough room for two people to comfortably maneuver throughout the area. Stand the packaging upright to ensure it is level.
2. Locate the box containing the stand and assemble the stand according to the included instructions. Check that the stand is level before unboxing the printer.
3. Position the assembled stand in the printer's designated area with the front facing towards the operator. An arrow on the stand's instructions indicates the front.
4. Open the printer's box from the top by removing the lid, then consecutively remove the two C-shaped shells from the left and right sides, and then remove the protective pad from the top of the printer.
5. Open the hopper and remove the power cable, lifting straps, cleaning accessories, optical cassette, and safety insert packed inside.
6. Loop both orange lifting straps under the machine from left-to-right, ensuring that the straps are not crossed. With one person on each side, insert your forearms into each loop so they do not go past your elbows.
7. With your back straight and knees slightly bent, brace against the machine with your palms as you and a second person lift the unit up.
8. Carefully move the printer onto the stand, keeping the four feet aligned with the corresponding recesses on the stand.



If you need to readjust the machine, use the lifting straps to pick it back up. Do not pick up the machine without lifting straps.

9. Remove any additional wrapping and packaging from outside of the printer before connecting the machine to power.



The original packaging is designed to be kept and reused for transporting or shipping the machine for service. Save the complete packaging including any inserts for your convenience.

4.4 Accessing the serial name

For detailed guidance and visual assistance, visit support.formlabs.com.

The serial name is a unique identifier used to track the history of manufacturing, sales, and repair.

The serial name for the Fuse 1 is located on a sticker next to the A/C input on the back panel in the format **AdjectiveAnimal**. For a Fuse 1, the serial name is also available on the touchscreen. To access the serial name on the touchscreen:

1. Tap the wrench icon on the **Home** screen. The **Settings** screen appears.
2. Tap **System**. The **System** screen appears.
3. Tap **Details**. The **Details** screen appears.
4. The serial name is listed in the top-left corner.

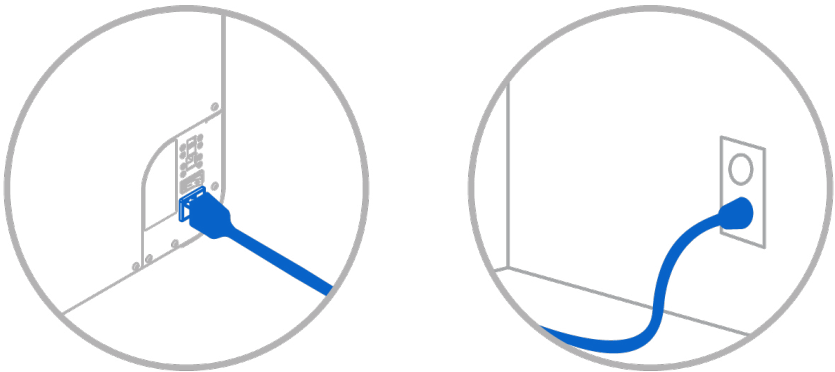
4.5 Installing the machine

For detailed guidance and visual assistance, visit support.formlabs.com.

After selecting a location, connect the printer to a power source to turn on the machine.

4.5.1 Connecting the cables

Plug the included power cable into the power port on the back of the unit and connect the power cable to a dedicated circuit.



Files can be uploaded via Wi-Fi, Ethernet, or USB. For USB, connect the printer to a nearby computer. For Ethernet, connect the printer to your LAN. Refer to section **4.6 Setting up a network connection** for more information.

4.5.2 Installing the Wi-Fi antenna

Install the Wi-Fi antenna to connect the machine to a wireless network.

To install the Wi-Fi antenna, screw the Wi-Fi antenna onto the jack on the back of the unit, next to the power, USB, and Ethernet ports.

4.5.3 Turning on

To turn on the machine:

1. Plug the included power cable into the power port on the back of the unit and connect the power cable to a dedicated circuit.
 2. Flip the breaker switch on the back of Fuse 1 to the ON position to turn on the machine.
 3. As the Fuse 1 initiates, the Formlabs logo with a progress bar appears on the touchscreen, followed by the onboarding process. Follow the on-screen prompts to finish setting up the machine.
- To turn off the machine, refer to section **5.6.4 Turning off**.

4.5.4 Leveling

The printer must be completely level before printing can begin. If prompted, use a flat-head screwdriver to raise or lower each foot of the printer.

To level the machine:

1. Turn on the printer. If necessary, the touchscreen prompts use of the screwdriver.
 - The initial printer setup includes the leveling procedure.
2. Follow the on-screen instructions to adjust the feet under the printer.
3. The printer stand has a through hole under each of the printer's feet. Insert a flat-head screwdriver through the hole and turn to adjust the corresponding foot.
4. Adjust the feet until the touchscreen indicates the printer is level.

4.6 Setting up a network connection

For detailed guidance and visual assistance, visit support.formlabs.com.

Connect the Fuse 1 to a secure network via Wi-Fi or Ethernet, providing it internet access for remote printing, remote troubleshooting, sending diagnostic logs, and receiving firmware updates. The Fuse 1 can connect directly to a computer with a USB cable.

For remote printing and monitoring, the Fuse 1 supports both wired (Ethernet) and wireless (Wi-Fi) connections. Connect PreForm print preparation software to the same local-area network (LAN) as the printer in order to send a print job.

For a Windows operating system, after installing PreForm, check to ensure that Bonjour is properly installed. Bonjour is third-party software that is required to connect over Wi-Fi or Ethernet. Visit support.apple.com for assistance with Bonjour. The USB connection can still be used while the Fuse 1 is connected to a LAN.

When the Fuse 1 is connected to a LAN, its current status and print progress can be monitored with Dashboard: formlabs.com/dashboard.

4.6.1 Connecting with Wi-Fi

The Fuse 1's built-in Wi-Fi (IEEE 802.11 b/g/n) supports WPA/WPA2 security. Use the touchscreen to configure a wireless network connection.

To connect with Wi-Fi:

1. Tap the wrench icon on the **Home** screen. The **Settings** screen appears.
2. Tap **Connectivity > Wi-Fi**. The **Wi-Fi** screen appears.
3. Toggle **Use Wi-Fi** to **ON**. The toggle turns blue.
4. Tap the desired wireless network.
5. If prompted, enter your network password and tap the checkmark to confirm.

4.6.2 Connecting with Ethernet

The rear of the unit is equipped with a RJ-45 Ethernet (10BASE-T/100BASE-TX/1000BASE-T) 1000 Mbit LAN Port. Use a shielded Ethernet cable (not included): minimum Cat5, or Cat5e or Cat6 for 1000BASE-T.

To connect with Ethernet:

1. Plug one end of the Ethernet cable into the Ethernet port on the back of the unit.
2. Connect the other end of the Ethernet cable to your LAN.

4.6.3 Connecting with a manual IP configuration

When connected to an active Ethernet connection or available wireless network, the Fuse 1 can be configured with a static IP address. Use the touchscreen to configure a manual IP connection.

To connect with Wi-Fi or Ethernet using a manual IP configuration:

1. With an established Ethernet or available Wi-Fi connection, tap the wrench icon on the **Home** screen. The **Settings** screen appears.
2. Tap **Connectivity**. The **Connectivity** screen appears.
 - For Wi-Fi networks, tap **Wi-Fi**, then the desired wireless network. A new screen appears. Tap the **Manual IP** button in the lower-left corner. The **Manual IP Settings** screen appears.
 - For Ethernet connections, tap **Ethernet**. The **Manual IP Settings** screen appears.
3. Toggle **Use Manual IP** to **ON**. The toggle turns blue.
4. Enter the appropriate **IP Address**, **Subnet Mask**, **Default Gateway**, and **Name Server**.

4.6.4

Connecting with USB

Use a USB A-to-B cable for connecting a computer directly to the machine.

To connect with USB:

1. Plug one end of the USB cable into the USB port on the back of the unit.
2. Connect the other end of the USB cable to a computer's USB port.

4.7

Updating firmware

Formlabs regularly releases updated firmware to fix bugs and improve functionality. Download the latest firmware version for your Formlabs device with PreForm, then upload and install the firmware file on the machine. Review the [firmware downloads and release notes](#) to learn more about the improvements that come with each version's release.

To update the firmware via PreForm:

1. Open PreForm.
2. Connect the machine to the computer via USB or connect the device to an Ethernet network.
3. Click **File > Devices** in the menu bar. The **Device List** window appears.
4. Click the machine's serial name. The **Device Details** window opens.
5. Click **Update** in the upper-right corner of the **Device Details** window. The **Firmware Update** window opens.
6. Follow the on-screen instructions to download the latest firmware and then upload the file to the machine. To upload firmware, the device must be connected to the computer via USB or the machine must be connected to an Ethernet network.
7. The machine may automatically recognize that you have sent a firmware update. Tap **Continue** on the touchscreen to finish the installation.
8. If you are not prompted to Continue, continue the firmware update manually. Tap **Settings > System > Firmware Update**.
9. After the firmware update installs, confirm the system restart on the touchscreen or wait 30 seconds for an automatic restart.

4.8

Registering powder credit

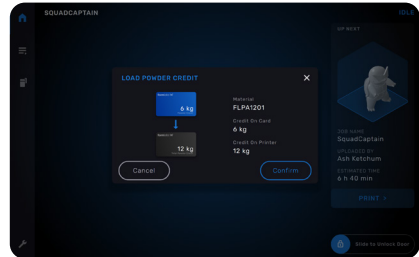
Each package of Formlabs powder includes an ID card. This card contains powder credits which must be loaded onto the printer to authorize and track the amount of powder that is available. Credit is subtracted from the available balance based on the amount of powder that is sintered. Powder that is unsintered can be recaptured by the Fuse Sift for future use and is not deducted from the credit balance.

4.8.1 Loading powder credit

Powder credit is used to identify which Formlabs powder you are using, as well as the amount of new powder that is available for printing. Before starting a print, load powder credits onto the printer.

To load powder credit:

1. Open the IR sensor door on top of the printer. Locate the card holder on the back wall of the top cavity.
2. Insert an unused powder identification card into the card holder. The **Powder Credit** screen appears on the touchscreen. The **Powder Credit** screen displays the amount of available powder credit on the new card and the amount of powder credit currently registered to the printer appears.
3. Tap **Transfer** to register the credit from the identification card onto the printer. The dialog box updates to show the new powder credit totals.
4. After loading the powder credit onto the printer, tap **Done** on the touchscreen. Remove the card from the card holder.
5. Close the IR sensor door.

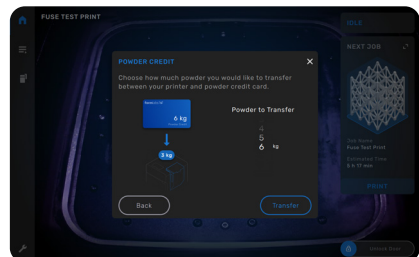
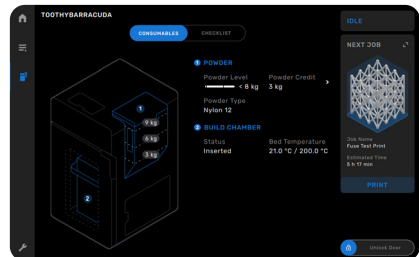


4.8.2 Checking available powder credit

When not loading or unloading powder credit onto the printer, you can check how much credit is available. This information can be found on the Printer Status screen.

To check available powder credit:

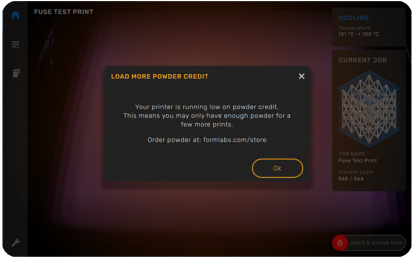
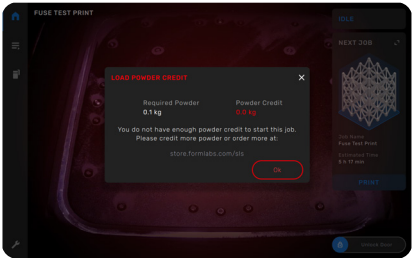
1. Tap the printer icon in the left sidebar on the touchscreen. The **Printer Status** screen appears.
2. All available powder credit for the printer is listed under the **Powder Credit** heading in the **Hopper** section.
3. Tap the > icon next to **Powder Credit**. The **Powder Credit** screen appears. The **Powder Credit** screen shows additional information about powder credits and instructions for loading powder credits.
4. Tap **Done** to close the **Powder Credit** screen.



4.8.3 **Powder credit notifications**

The printer reminds you of low powder credit over time, indicating that you may only have enough powder on hand for several more prints. Upon starting a print, the printer warns you if your credit is low.

- If the printer does not have sufficient powder credits for the current print job, the printer notifies you and does not start the print job. Load additional powder credit onto the printer and restart the print job.
- After a print completes, the printer notifies you if your powder credit total is low. Check the **Printer Status** screen to confirm there is enough powder credit registered to the printer to complete your upcoming prints. If not, you will be unable to start the next print until sufficient powder credits are registered to the printer. Register additional powder credits or order additional powder.



4.9 **Preparing the optical cleaning kit**

The Fuse 1 comes with three push-top dispensers for the Alconox, distilled water, and ethanol used to clean the optical cassette. Each dispenser is dedicated to one cleaning agent. The three cleaning agents must be purchased separately.



Below is a list of Formlabs-approved distributors of the cleaning consumables validated for use with the Fuse 1. Do not use swabs, pre-moistened or dry wipes, surfactants, denaturants, or any other tool, chemical, or cleaning agent that is not explicitly recommended by Formlabs or a certified service provider.

Item	Sources
Alconox (1104-1)	McMaster-Carr
Distilled water	McMaster-Carr
Ethanol	McMaster-Carr
PEC*PADs	B&H
Polyester cloth swabs (TX714A)	Magid

4.9.1 **Mixing Alconox**

Alconox is a powder and must be mixed with distilled water in order to be an effective detergent for cleaning the optical cassette.



Only mix Alconox powder with distilled water. Contaminants from water that is not distilled will collect on optical surfaces, adversely affecting print quality and the operating life of optical components. Do not clean any optical components with Alconox that has been mixed with tap, bottled, filtered, or any other source of water that is not distilled.

To mix Alconox:

1. Locate the dispenser labeled **Alconox**.
2. Unscrew the top of the dispenser and add 2.0 g (0.07 oz) of Alconox powder, followed by 200.0 mL (6.76 fl oz) of distilled water.
 - Each bottle's total volume is 200 mL (6.76 fl oz).
3. Screw the cap back on. Ensure it is locked by twisting the cap counterclockwise until you hear a subtle click.
4. Gently agitate the dispenser until the Alconox powder is completely dissolved. Avoid generating bubbles or foam from rapid shaking.

4.10 Transporting the machine

For detailed guidance and visual assistance, visit support.formlabs.com.

Refer to section **4.3.1 Receiving** for product weight and dimensions. Keep the packaging for transportation or shipping.

The complete packaging kit consists of:

- one (1) pallet, plywood and foam
- one (1) inner C-fold, cardboard and foam
- one (1) outer C-fold, cardboard and foam
- one (1) topper, cardboard and foam
- eight (8) strapping protectors, cardboard
- one (1) optics protector, cardboard and foam
- one (1) protective bag, plastic
- one (1) protective pad, cardboard
- two (2) lifting straps

Made by third parties:

- seven (7) binding straps, nylon

4.10.1 Preparing for transportation

Before repackaging, remove the build chamber and optical cassette. Ensure the printer is clean by vacuuming the print enclosure and air filters, then emptying the hopper.



- Do not ship the printer with any powder inside the print enclosure or hopper. Powder left inside the machine can leak during transit, which may result in additional fees or void the warranty.
- Do not ship the printer without fully securing an optics protector or optical cassette in the cassette tray. Foreign objects or debris can enter the optical cavity during transit and damage sensitive components, which may result in additional fees or void the warranty.

To prepare the machine for transport:

1. Open the print enclosure door.
2. Unplug and remove the build chamber.
3. If you have the cardboard and foam optics protector that shipped in the optical cassette tray, remove the optical cassette.
4. Using the vacuum attached to the Fuse Sift, vacuum the print enclosure and air filters.
5. Close the air filter door and print enclosure door.
6. Open the hopper. Scoop all powder out of the hopper using a clean, dry scoop. The powder can be reintroduced into your powder stream by running it through the sifter on the Fuse Sift.



Powder that comes into contact with fibers or other contaminants (e.g., in a vacuum cleaner) cannot be filtered and should be disposed of.

7. Flip the breaker switch on the back of the unit to the **OFF** position to turn off the machine.
8. Unplug all cables (power, Ethernet, and USB) from the back of the machine.
9. Unscrew the Wi-Fi antenna from the back of the unit.

4.10.2**Packaging**

Thoroughly read and follow the instructions to properly package the machine. Skipping any of the following steps may result in shipping damage and void the warranty.

To package the machine:

1. Open the air filter door and pull the door release to open the print enclosure door. Place the optics protector in the optical cassette tray with the foam side facing up. Close and secure the optical cassette tray. Close the print enclosure door.
2. There is a platform on the pallet with holes that correspond to the printer's feet. This platform is not centered on the pallet. Instead, it is closer to the left side of the pallet than the right, allowing room for the printer's hopper. Place the pallet in front of the machine such that the right side of the pallet is aligned with the right side of the machine.
3. Carefully tilt the machine backward. Have a partner slip the two lifting straps underneath the printer such that the handles are accessible on the left and right sides of the machine. Spread the lifting straps so that one is next to the rear feet of the machine and the other is next to the front feet.



Do not tilt the machine forward when placing the lifting straps. Doing so may damage the print enclosure door.

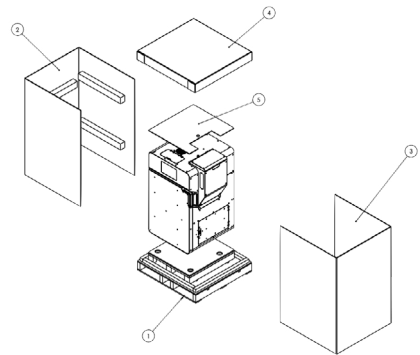
4. Lower the front of the machine so that the machine sits flat.
5. Stand on one side of the printer and route your arms through the lifting straps. There are

- three positions in the straps to route your arms through, depending on your stickers on the side of the machine. Have your partner do the same on the other side of the printer.
- Lift the machine using the lifting straps. Each person should push at an upward angle when lifting to keep the printer steady and level.



The Fuse 1 is a heavy object. Use appropriate precautions and correct lifting form when moving the machine.

- Lift the machine onto the pallet (1), lowering the printer's feet into the proper cutouts in the platform.
- Tilt the machine backwards and remove lifting straps. Lower the front of the printer back onto the pallet.
- Lower the protective bag over the top of the machine. The bag should be flush with the sides of the machine. Tuck any excess bag material between the platform and the bottom of the machine
- Place the protective pad (5) on top of the printer. The cutout in the protective pad fits around the hopper lid.
- Insert two nylon binding straps (commercially available) through the small holes in the pallet underneath the platform on the hopper side of the Fuse 1. Thread through to the hopper side of the Fuse 1 and pull vertically around the printer.
- Tighten and secure the straps over the protective pad.
- Insert two nylon binding straps through the slots in the pallet to the front or the back of the Fuse 1. Thread through to the opposite side of the Fuse 1 and pull vertically around the printer.
- Place one strapping protector over each edge to protect the top of the printer from scratches. Tighten and secure the straps. The printer should be rigidly attached to the pallet.
- Encase the machine with the inner C-fold segment (2), leaving the hopper side open. Orient the C-fold such that the foam runs horizontally and is closer to the top of the C-fold than the bottom. Ensure that the graphics on the exterior of the C-fold are oriented upwards.
- Encase the machine with the outer C-fold segment (3) from the hopper side, such that all four sides of the machine are now covered. The foam on the outer C-fold fits underneath the hopper. The C-fold should be flush with the lip of the pallet on all four sides.
- Place the topper (4) on top of the C-folds. The cutout in the foam aligns with the printer's hopper.



18. Wrap a nylon binding strap horizontally around the C-folds. Position the strap one-third of the way up from the bottom of the C-fold (approximately 50–70 cm/20–28 in). Tighten and secure the strap.
19. Loop two nylon binding straps vertically around the machine, passing them through the pallet using the four small holes in the external sides of the pallet. Place one strapping protector on each of the top edges of the package topper. Tighten and secure the straps.

5 Printing



Always consult the safety data sheet (SDS) as the primary source of information to understand safety and handling of Formlabs materials.

5.1 Operational environment

The operating temperature for the Fuse 1 is 18–28 °C (68–82 °F), with low ambient humidity. For optimal printing, do not exceed these limits. When printing with Nylon 12, keep the relative humidity of the environment around the printer, the Fuse Sift and other post-processing tools, and anywhere unsintered powder is stored to 50% or less at all times. Higher humidity will lead to clumping, under-dosing, and print failures. If 50% RH cannot be achieved, remove the debris catcher at the bottom of the printer’s hopper (though this will remove protection against debris entering the print chamber). For SLS powders, humidity affects shelf life significantly.

5.2 Designing for SLS

For detailed guidance and visual assistance, visit support.formlabs.com.

Selective Laser Sintering (SLS) enables the construction of parts without the use of support structures often required with SLA or FDM printing platforms. This allows parts to be tightly packed into a single print job, however there are some limitations that must be taken into account.

Sintered powder is sensitive to sudden and drastic temperature changes. Allow the build chamber to steadily and fully cool down after a print completes. Parts that are not allowed to properly cool down will warp, and can become brittle and fail under load.

5.2.1 Printing specifications

Parameter	Unit
Build volume (W × D × H)	16.5 × 16.5 × 30.0 cm (with radiused corners) 6.5 × 6.5 × 11.8 in (with radiused corners)
Maximum singular part dimensions (W × D × H)	15.75 × 15.75 × 29.97 cm 6.2 × 6.2 × 11.5 in
Layer thickness	110 μm 0.0043 in
Print initialization time	Up to 60 min

5.2.2 Feature design guidelines

Feature type	Minimum value	Notes
Unsupported wall thickness	0.6 mm/600 μm	An unsupported wall is one that is connected to other walls on fewer than two sides. An unsupported wall with a thickness of 0.6 mm or less may warp or detach from the model during printing. Thinner walls have reduced strength.

Feature type	Minimum value	Notes
Wire/pin diameter	0.8 mm/800 μ m	A wire is a feature whose length is at least two times greater than its width. Wires or pins with a diameter less than 0.8 mm may deform or break during the print. Take extra care when separating printed parts with thin wires from the powder cake, as they can easily be damaged.
Hole diameter	0.8 mm/800 μ m	Holes with a diameter of less than 0.8 mm in the X-, Y-, and Z-axes may close during printing. The accuracy of a hole not only depends on the diameter of the hole, but also on the thickness of the wall through which the hole is printed. The thicker the wall section, the less accurate the hole will be. Through holes must also allow for line-of-sight clearance to ensure all material is cleared during post-processing.
Moving part clearance	0.4 mm/400 μ m	Clearance is the distance between two parts of a model (e.g., the distance between a pair of gears). Parts that are part of an assembly may fuse if clearance is less than 0.4 mm.

5.3 Setting up a print

For detailed guidance and visual assistance, visit support.formlabs.com.

Fuse 1 print jobs can be set up using PreForm, the dedicated print preparation software for Formlabs printers. To start, open OBJ or STL files in PreForm, orient and layout multiple models into a complete build, then send the print job to the machine.

5.3.1 Downloading or updating PreForm

Visit the PreForm product webpage to download the latest version: formlabs.com/software. Learn how to use PreForm from the tutorials available in the software. Click **Help > Show Onboarding Tutorial** from PreForm's menu bar.

5.3.2 Preparing the file for printing

Use PreForm software to process STL or OBJ files. Prepare, save, and upload FORM files to the printer.

5.3.2.1 Adding a model

Import multiple part files into PreForm to print multiple parts in a single build chamber.

To add a model:

1. In the menu bar, click **File > Open**. The **Open File** window opens.
2. Select at least one file.
3. Click **Open**. The selected models appear in PreForm.

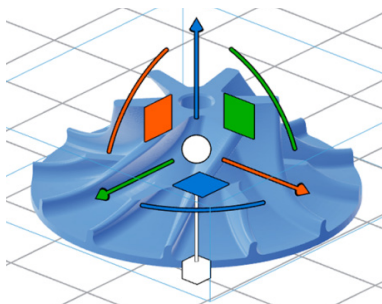
5.3.2.2 Orienting a model

The unsintered powder in the build chamber inherently supports parts, regardless of their orientation. However, depending on the geometry of the parts being printed, certain part orientations may minimize the visibility of print layers or to pack parts more densely into a complete print job.

To orient a model:

1. Select the model using the left mouse button. Manipulators appear over the model.
2. To rotate the entire model around a single axis, click-and-drag along a curved, colored line.
3. To freely rotate a model, click-and-drag the central sphere.
4. To move the model along a single axis, click-and-drag on an individual arrow.
 - To move the model up or down along the Z-axis within the build volume, click-and-drag on the blue arrow.

- To move the model left or right along the X-axis within the build volume, click-and-drag on the orange arrow.
 - To move the model forward or back along the Y-axis within the build volume, click-and-drag on the green arrow.
5. To adjust the scale of the model, click-and-drag the cube below the manipulator.
 6. Alternately, you can enter specific angles using the **Orientation** tool.



5.3.2.3 Uploading a print

After orienting your model(s) and saving your FORM file, upload your print job to the printer. Both the printer and the computer running PreForm must be connected via USB or on the same network in order to upload a print job. Refer to section **4.6 Setting up a network connection** for more information. Once transferred, print jobs must be confirmed on the touchscreen to begin. Refer to section **5.4.5 Starting a print** for more information.

To upload a print job from PreForm to the machine:

1. Click the orange printer icon on the **Home** screen. The **Print** window opens.
2. Click the **Select Device** arrow to select a printer. The **Device List** window opens.
3. Click the name of a printer you wish to select. The **Device Details** window opens.
 - If the printer does not automatically appear in the **Device List**, click **Add** to manually enter the printer's IP address. Ensure that the computer and printer are connected to the same network.
4. Click **Select**.
5. Enter or update the **Job Name**.
6. Click **Upload Job** to send the print job to the printer. Once the progress bar fills and the **Print** window closes, the upload is complete.

5.4 Preparing for a print

For detailed guidance and visual assistance, visit support.formlabs.com.

Starting a print on the Fuse 1 requires several critical maintenance procedures that must be completed before every print. After selecting a print job, the touchscreen guides you through the necessary maintenance procedures.



NOTICE

Thoroughly read and follow the instructions to fully prepare the printer for printing. Skipping any of the following operations may result in a print failure, and potentially damage the machine.

5.4.1 Inserting the build chamber

Before starting a print, insert an empty build chamber into the Fuse 1's print enclosure.

To insert the build chamber:

1. Drag the **Unlock Door** slider on the touchscreen. The print enclosure door unlocks.
2. Open the print enclosure door on the printer.
3. Unlock and open the build chamber latch by pushing the release trigger to the left.

4. Lift the empty build chamber by the side handles with the front handle facing you.
5. Rest the upper lip of the build chamber on the rails on the sides of the print enclosure.
6. Push the build chamber forward until it hits a hard stop at the back of the print enclosure.
7. Lock the build chamber latch by pushing the release trigger and lowering the latch back into the closed position. Release the trigger once the latch is parallel to the print enclosure. An audible click indicates that the latch is locked.
8. Insert the build chamber plug to the adjacent socket, located in the lower-right hand corner next to the print enclosure. An audible click indicates the plug is properly connected.



5.4.2 **Loading the optical cassette**

A clean optical cassette must be inserted into the Fuse 1 before every print. Check that the optical cassette is clean before inserting it into the printer.



NOTICE

Wear clean nitrile gloves when handling the optical cassette. Powder, skin oils, and other contaminants may smudge the windows.

To load the optical cassette:

1. Loosen the thumb screw in the front-center of the ceiling of the print enclosure. The cassette tray swings down into the print enclosure.
2. Remove the used optical cassette, if present.
3. Place the clean optical cassette on the cassette tray.
4. Shut the cassette tray and retighten the thumb screw until it is fully engaged.
5. Close the print enclosure door. Press firmly to ensure that the door is fully latched. If necessary, squeeze the door shut using the cutout on the right side of the printer for leverage.

5.4.3 **Filling the hopper**

Each powder cartridge holds 6 L of powder. The hopper can hold 17.8 L of powder, or three full powder cartridges.



NOTICE

The Fuse 1 must be loaded with powder credits before running a print job. Each container of Formlabs powder comes with an RFID card used to load credits onto the printer. For the first print on the printer, powder is added directly from the container it ships in. Refer to section **4.8 Registering powder credit** for more information.

To fill the hopper:

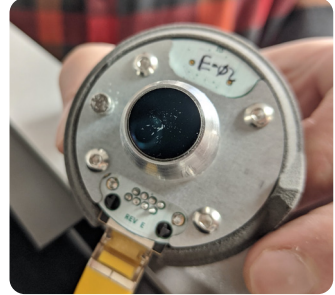
1. Open the hopper lid, located on top of the hopper on the right side of the printer.

2. Place the filled powder cartridge upside down on top of the hopper with the valve handle (marked with the Formlabs logo) facing out.
3. Pull the valve handle out until it stops. Wait for the cartridge to empty.
4. Push the valve handle back in to close the cartridge.
5. Leave the cartridge in place for approximately one minute to let the plume of powder settle. You may continue setting up the printer before removing the empty cartridge from the hopper.

5.4.4

Checking the IR sensor

The Fuse 1 uses an IR sensor to monitor temperature changes inside the print enclosure. Readings from the sensor greatly influence the print quality, accuracy, and reliability of the printer. Any obstruction of the sensor adversely affects prints and is likely to result in a print failure. The image shows a dirty IR sensor that needs to be cleaned.



NOTICE

The IR sensor may be difficult to reach for some users. If necessary, keep a step stool nearby.

To check the IR sensor:

1. Open the IR sensor access door on the top of the printer.
2. Locate the IR sensor, which has a grey cap with an LED in the center. The LED turns green or orange, depending on the status of the IR sensor.
3. Grip the cap and pull the IR sensor off its mount. The IR sensor is held in place with magnets and should come out with little force.
4. Inspect the lens on the underside of the IR sensor.
5. If the lens is clean, reinstall the IR sensor. If the lens looks contaminated, clean it with a new polyester swab or PEC PAD wetted with ethanol and reinstall the IR sensor. Reconnect the IR sensor to the yellow wire inside the IR sensor panel.
6. Place the IR sensor cap into the mount and allow the magnets to secure it. The LED turns green when it is properly aligned.



If the LED turns orange:

- a. Place the cap into the mount until you feel the magnets pull the cap down.
 - b. Rotate the cap until it comes to a halt and cannot rotate any further. If the LED is still orange, it may be necessary to subtly turn the cap in either direction.
7. Close the access door to the IR sensor panel.

5.4.5

Starting a print

Once a print job is uploaded to the Fuse 1, the print card on the right side of the touchscreen displays the next print job in the queue. To start the print, tap **Start Print** on the touchscreen.

If the print is not the next print job in the queue, tap the collapsed menu icon from **Home** to access the **Jobs** screen.

To start a print on the touchscreen:

1. Tap the print job on the **Home** screen, or from **Jobs**. The print job screen appears.
2. Tap **Start Print**. The printer begins heating the build chamber and preparing to print, which takes approximately one hour.

5.5 Retrieving and cleaning prints with the Fuse Sift

For detailed guidance and visual assistance, visit support.formlabs.com.

After a print completes, parts need to cool in the Fuse 1 print enclosure to alleviate thermal stresses before being moved into the Fuse Sift. The Fuse 1 automatically starts cooling parts after printing completes and indicates the recommended time a print should remain inside the print enclosure. This is indicated by an on-screen notification as well as the status card in the top-right of the **Home** screen.



The print enclosure in Fuse series printers is designed to operate at up to 200 °C (392 °F). Do not handle parts from a build chamber until the print bed temperature has reached ≤ 45 °C (113 °F). Use the provided thermal-insulating silicone gloves when removing a build chamber that has not been allowed to cool down. Failure to follow these procedures will result in serious injuries, including burning and/or scalding of skin.



A full build chamber or a build chamber with many printed parts will be heavy. Use appropriate precautions and correct lifting form when moving the build chamber.

5.5.1 Cooling the build chamber in the Fuse 1

After printing has finished, a message on the touchscreen provides you with the recommended cooling time required for each print. All prints are subject to a subsequent cooling phase that allows parts to steadily cool down to ~100 °C (212 °F). Removing a build chamber from the printer before parts have completed their initial cooling may result in warping and deformation.

To cool the build chamber in the Fuse 1:

1. Check the estimated cooling time on the touchscreen or on Dashboard. Allow the print to remain inside the Fuse 1 until the estimated time has elapsed.
2. Once a print has completed the in-printer cooling, open the print enclosure door.
3. Move the build chamber to the Fuse Sift to extract and recover your printed parts.

5.5.2 Cooling the build chamber in the Fuse Sift

After moving the build chamber to the Fuse Sift, allow it to finish cooling before ejecting the powder cake and processing your printed parts.

To cool the build chamber in the Fuse Sift:

1. Check the status of the build chamber on the touchscreen. If the build chamber graphic and icon are highlighted red and the touchscreen displays the status **Hot**, allow the build chamber to continue cooling before ejecting the cake.
2. When the touchscreen displays the status **Cool**, it is safe to recover and process your

printed parts.



Once the build chamber has been allowed ample time to cool down outside of the print enclosure, parts can be removed using the Fuse Sift. For further instructions on cooling the build chamber, unpacking a cake, and extracting parts, refer to section **5 Recovering powder and filling powder cartridges** in the **Fuse Sift manual** or visit support.formlabs.com.

5.6 Managing the machine

For detailed guidance and visual assistance, visit support.formlabs.com.

During and between printing, you can track your printer's usage, manage print jobs, and prepare for future print jobs.

5.6.1 Registering on Dashboard

Dashboard (formlabs.com/dashboard) allows individuals and teams to remotely monitor Formlabs devices, track material usage, and explore past and future Formlabs purchases. Register the Fuse 1 to Dashboard through the touchscreen. Once the printer is registered to Dashboard and **Dashboard Logging** is enabled on the printer, the Fuse 1 sends data to Dashboard as long as the printer's Wi-Fi or Ethernet connections are able to access the internet.

5.6.2 Starting an uploaded print

To start an uploaded print job on the touchscreen:

1. Confirm the build chamber, optical cassette, and required powder have been loaded into the printer.
2. Tap the print job from the **Jobs** screen.

Refer to section **5.4.5 Starting a print** for more information.

5.6.3 Deleting an uploaded print job

To delete an uploaded print job on the touchscreen:

1. Tap the print job from **Jobs**.
2. Tap **Delete**. If prompted, tap **Delete** again to confirm.

5.6.4 Turning off

The Fuse 1 is designed to remain powered on when not in use. Flip the breaker switch on the back of the unit to the **OFF** position to turn off the machine completely and conserve power. When moving or storing the machine, unplug the unit from its power source in addition to flipping the breaker switch.

6 Maintenance

To maintain the most efficient and long-lasting machine, ensure regular conservation. Formlabs provides instructions to advise in installing, operating, and maintaining the machine. It shall only be maintained by a qualified and trained person. Unauthorized disassembly or repair procedures may damage the machine.

There are two groups of maintenance procedures: regular, which should be done after every print, and intermittent maintenance, which only needs to be done occasionally. Please keep a log detailing when each intermittent maintenance procedure was last performed. Prior to starting a print, the machine displays prompts on its touchscreen to notify the operator if any intermittent procedures are past due.



Tampering with, or disassembling the Fuse 1 prior to disconnecting the power cable and waiting approximately ten minutes can subject users to potentially fatal electrical hazards.



Wear personal protective equipment (PPE) when performing maintenance tasks. Use tools only as described.



When removing the exterior paneling, disconnect the machine from its power source before maintenance. Moving parts present crushing and tangling hazards.



- Formlabs provides instructions to advise skilled and unskilled persons in installing, operating, and maintaining the Fuse 1. The Fuse 1 shall only be maintained by a qualified and trained person.
- Do not open the Fuse 1 and/or investigate internal components unless under the guidance of Formlabs Support or a certified service provider. Contact [Formlabs Support](#) or a **certified service provider** for any additional guidance.
- Unauthorized disassembly or repair procedures may damage the machine and void the warranty.

6.1 Tools and supplies

Only use tools, chemicals, or procedures to maintain the Fuse 1 that are outlined in this manual, by prompts on the touchscreen, and on support.formlabs.com.

Do not use any tools, chemicals, or unapproved procedures with the Fuse 1 unless otherwise instructed to do so by Formlabs or a certified service provider.



The cleaning tools used to maintain the Fuse 1 are consumables, and intended for single-use only. Do not reuse a cleaning tool from one component with another.

- **Alconox**

The recommended cleaning agent for removing deposits of laurolactam and other off-gassing stains from the printer's optical components. It is the first cleaning agent to be used, followed promptly by distilled water and ethanol.

- **Compliant vacuum that is grounded and bonded (e.g., Class II, Division 2 vacuum)**
Certified for use with materials whose fine particles present an explosive risk when in the vicinity of potentially malfunctioning electrical equipment. Used to regularly remove loose powder from the workspace of the Fuse 1 and Fuse Sift.
- **Distilled water**
The second agent used for cleaning the printer's optical components.
- **Ethanol**
The last recommended cleaning agent used for cleaning the printer's optical components.
- **PEC*PADs**
Disposable lint-free, non-woven microfiber cloths for cleaning the printer's optical components. Do not reuse a PEC*PAD; dispose of after each use, even when cleaning the windows on the optical cassette with the same cleaning agent.
- **Polyester cloth swabs**
Disposable lint-free polyester cloth swabs with either orange or blue plastic handles for cleaning the IR sensor and camera lens. Do not reuse a polyester swab—dispose of after each use.

6.2 Inspection and maintenance

6.2.1 Before each use

Inspect	Refer to	Section
Installation environment	Operational environment	5.1
Optical cassette	Cleaning the optical cassette	6.3.1
IR sensor lens	Checking the IR sensor	5.4.4

6.2.2 Periodic maintenance

Inspect	Refer to	Section
Camera lens	Cleaning the camera lens	6.4.1
IR sensor housing	Cleaning the IR sensor housing	6.4.2
Exhaust filter	Cleaning the exhaust filter	6.4.3
Intake filter	Cleaning the intake filter	6.4.4
Print enclosure	Cleaning the print enclosure	6.4.5
Exhaust lines	Purging the exhaust lines	6.4.6

6.3 Tasks between uses

Sintering powder results in the production of off-gases and laurolactam, which collect on various components in the print enclosure and air system. In order to preserve the accuracy and reliability of the product, it is important to regularly check and clean several components and assemblies.

6.3.1 Cleaning the optical cassette

Inspect the Fuse 1's optical cassette after every print. If the optical cassette is contaminated or dirty, clean it before using it again. Required supplies:

Standard cleaning

- Ethanol
- Non-reactive nitrile gloves
- PEC*PADs

Full cleaning

- Alconox
- Distilled water
- Ethanol
- Non-reactive nitrile gloves
- PEC*PADs



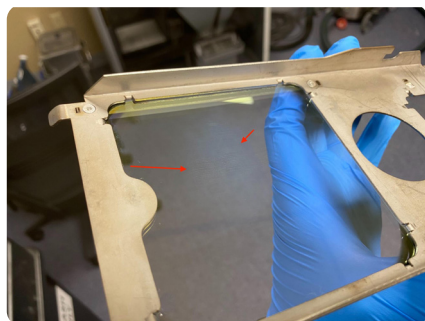
CAUTION



NOTICE

Do not use compressed air or an air gun to clean the print enclosure, build chamber, or any other component. Mobilizing loose powder increases the risk of unintentional inhalation or ingestion.

If you completed the procedure and there are visible streaks, fogging, or deposits on the glass, or sections look foggy, carefully repeat the procedure. Small blemishes or color differences do not affect print success or quality.



Before cleaning: An optical cassette removed from the Fuse 1 after a print job. The optical cassette shows defined streaking and clouding.



After cleaning: An optical cassette after cleaning with Alconox, distilled water, and ethanol to remove the contamination.

To inspect the optical cassette:

1. Remove the optical cassette from the printer.
2. Inspect the optical cassette for signs of loose powder, dust, condensed outgassed compounds, or other contaminants. Look for:
 - Discrete specks of dust or powder
 - Small smudges or fingerprints
 - Cloudiness or reduced clarity
3. If you see that the optical cassette has been contaminated, clean it following the standard optical cassette cleaning procedure below. Expect to need to clean the optical cassette after 5–10 prints.

To clean the optical cassette:

1. Put on a pair of new, clean nitrile gloves. Powder, skin oils, and other contaminants may smudge the windows on the optical cassette.
2. Place the dirty optical cassette with the gaskets facing down on a flat, clean surface.
3. Wet a new PEC*PAD with ethanol.
 - Open the flip top of the ethanol dispenser bottle.
 - Place the PEC*PAD on top of the bottle.
 - Slowly depress the center of the bottle until a light stream of ethanol dispenses onto the PEC*PAD.
 - Repeat until the PEC*PAD is wet, but not soaked, with ethanol.
4. Wipe the bottom of the larger glass window in the optical cassette with the PEC*PAD wetted with ethanol. The bottom of the window is the side without a gasket.
 - Wipe in a single direction, moving across the window until the entire surface has been cleaned.
 - Wipe the glass again with the same PEC*PAD, in a direction that is perpendicular to the first pass.
5. Wet a new PEC*PAD with distilled water in the same fashion as described in **Step 3**.
6. Pick up the optical cassette and wipe the gaskets with the PEC*PAD to remove any contaminants.
7. Allow five minutes for the ethanol on the optical cassette to fully evaporate before inspecting the window and reusing the optical cassette in the printer.
8. Inspect the window. If there are visible streaks or deposits, or sections look foggy, repeat the procedure.

To fully clean the optical cassette (if standard cleaning is insufficient):

1. Put on a pair of new, clean nitrile gloves. Powder, skin oils, and other contaminants may smudge the windows on the optical cassette.
2. Place the dirty optical cassette with the gaskets facing down on a flat, clean surface.
3. Wet a new PEC*PAD with Alconox.
 - Open the flip top of the Alconox dispenser bottle.
 - Place the PEC*PAD on top of the bottle.
 - Slowly depress the center of the bottle until a light stream of Alconox dispenses onto the PEC*PAD.
 - Repeat until the PEC*PAD is wet, but not soaked, with Alconox.
4. Wipe the bottom of the larger glass window in the optical cassette with the PEC*PAD wetted with Alconox. The bottom of the window is the side without a gasket.
 - Wipe in a single direction, moving across the window until the entire surface has been cleaned.
 - Wipe the glass again with the same PEC*PAD, in a direction that is perpendicular to the first pass.
5. Rinse the optical window thoroughly with distilled water dispensed from a squirt bottle. Ensure that all Alconox is fully removed from the optical cassette.
6. Dry the glass with a new PEC*PAD. It may require multiple PEC*PADs to fully dry the entire surface.
7. Wet a new PEC*PAD with ethanol as described in **Step 3**.

8. Wipe the glass in the same fashion as described in **Step 4**.
9. Wipe the top surface of the glass with a new PEC*PAD wetted with ethanol.
10. Allow five minutes for the ethanol on the optical cassette to fully evaporate before inspecting the window and reusing the optical cassette in the printer.
11. Inspect the window. If there are visible streaks or deposits, or sections look foggy, repeat the procedure.

6.4 Periodic maintenance

The Fuse 1 displays prompts on its touchscreen to notify if any periodic maintenance procedures are past due. The standard cycle for the following procedures is every 30–500 hours of printing, specified in the following sections and on the printer's touchscreen.

Task	Frequency	Refer to	Section
Cleaning the camera lens	After 500 hours of printing	Cleaning the camera lens	6.4.1
Cleaning the IR sensor housing	After 100 hours of printing	Cleaning the IR sensor housing	6.4.2
Cleaning the exhaust filter	After 30 hours of printing	Cleaning the exhaust filter	6.4.3
Cleaning the intake filter	After 30 hours of printing	Cleaning the intake filter	6.4.4
Cleaning the print enclosure	After 100 hours of printing	Cleaning the print enclosure	6.4.5
Purging the exhaust lines	After 10–15 full build volume prints or 500 hours of printing, whichever comes first	Purging the exhaust lines	6.4.6



CAUTION



6.4.1

Do not use compressed air or an air gun to clean the print enclosure, build chamber, or any other component. Mobilizing loose powder increases the risk of unintentional inhalation or ingestion.

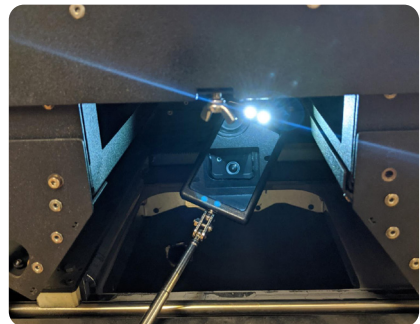
Cleaning the camera lens

The Fuse 1 uses a camera positioned above the print enclosure to monitor ongoing prints. The printer's camera lens must be cleaned periodically to ensure a clear, unobstructed view of the print.

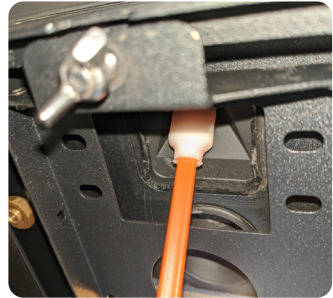
Required supplies:

- Ethanol
- Non-reactive nitrile gloves
- Polyester cloth swabs
- Telescoping mirror

To clean the camera lens:



1. Open the print enclosure door.
2. Loosen the thumb screw in the front-center of the ceiling of the print enclosure. The cassette tray swings down.
3. Slide the optical cassette out of the cassette tray.
4. Return the cassette tray to its closed position without an optical cassette. This provides easier access to the camera lens.
5. Tighten the thumb screw until it fully engages to lock the cassette tray in place.
6. Using the provided telescoping mirror, visually locate the camera lens.
7. Wet a polyester cloth swab with a small amount of ethanol. The swab should not be saturated or dripping ethanol.
8. Wipe the camera lens using the tip of the swab.
9. Wait for the ethanol to evaporate, then visually verify that the lens is clean and clear of streaks or debris.
10. Loosen the thumb screw in the front-center of the ceiling of the print enclosure. The cassette tray swings down.
11. Return a clean optical cassette to the window tray.
12. Return the cassette tray to its closed position. Tighten the thumb screw until it fully engages.
13. Close the print enclosure door. Press firmly to ensure that the door is fully latched. If necessary, squeeze the door shut using the cutout on the right side of the printer for leverage.



6.4.2

Cleaning the IR sensor housing

The IR sensor housing should be cleaned after every five prints. The printer displays a prompt on its touchscreen to notify you if cleaning is needed.

Required supplies:

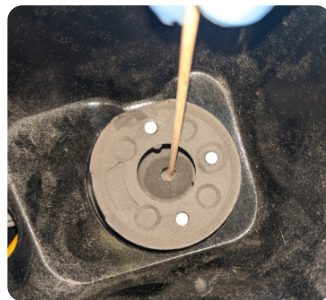
- Ethanol
- Non-reactive nitrile gloves
- Polyester cloth swabs
- Telescoping mirror

To clean the IR sensor housing:

1. Put on a new, clean pair of nitrile gloves.
2. Open the IR sensor access door, located on the top of the printer, next to the hopper.
3. Drag the **Unlock Door** slider on the touchscreen. The print enclosure door unlocks.
4. Open the print enclosure door.
5. Locate the IR sensor cone from below using the telescoping mirror.
6. Remove the IR sensor by picking up the cap and pulling the IR sensor off of its mount. Disconnect the cable from the IR sensor.
7. Set the IR sensor aside on a clean, flat surface. Ensure that the IR sensor side is facing up.



8. Using the provided telescoping mirror, visually locate the IR sensor housing.
9. Wet a polyester cloth swab with a small amount of ethanol. The swab should not be saturated or dripping ethanol.
10. Insert the swab from the top of the IR sensor housing through the small aperture at the top of the cone. Move the swab around in a circle to fully contact the edge of the cone.
11. Visually inspect the cone to ensure no large pieces of debris remain.
12. Reconnect the IR sensor to the yellow wire inside the IR sensor panel and push the cap back into place until the LED turns green.



6.4.3

Cleaning the exhaust filter

The Fuse 1 uses a filter to remove powder and lauro lactam from its exhaust that may be expelled into the workspace. The exhaust filter should be cleaned every 30 hours of printing. Used filters that have experienced 20 prints or 400 hours of printing should be cleaned after every print to extend their lifetime.

To clean the exhaust filter:

1. Disable the Fuse 1's air system before performing maintenance on the exhaust filter.
 - a. Navigate to the filter maintenance procedure by tapping the checklist icon on the **Print Status** screen, or
 - b. Drag the **Unlock Door** slider on the touchscreen.
2. Open the air filter door on the right side of the printer.
3. Disconnect the vacuum hose from the side of the Fuse Sift.
4. Turn on the vacuum by pushing the **Vac** button on the control panel or by tapping the vacuum hose icon on the touchscreen.
5. Vacuum the rectangular air filter as well as the inside door panel.
6. Remove the exhaust filter to clean the back of the filter and the recess behind it.
 - c. Depress the retainer hook at the top of the exhaust filter and disengage it from the pin, then do the same for the bottom one.
 - d. Move the retainer out of the way, then remove the filter using the fabric pull tabs. Set the filter aside.
 - e. Vacuum the rear side of the exhaust filter.
 - f. Vacuum the recess behind the exhaust filter bay.
7. If lauro lactam has accumulated on the fan, clean the fan and the exhaust tube below it.
 - g. Using a 2.5 mm hex driver, loosen and remove the four screws that fasten the fan to its housing.
 - h. If necessary, gently pull out the grommet that the fan wires run through. This allows easier access to both sides of the fan. Do not pull sharply on the fan or its wires.
 - i. Clean the five moving blades on the top of the fan with a small brush.
 - j. Clean the seven fixed blades on the bottom of the fan with a small brush.
 - k. Clean the exhaust tube below the fan using a long, flexible brush, such as a bottle brush.

- l. Reinsert the fan wires into the grommet. Reinsert the wires and grommet into the housing hole next to the fan, ensuring that the exposed section of fan wire is short to avoid tangling.
- m. Reinstall the four fan screws and tighten with a 2.5 mm hex driver.
8. Reinstall the exhaust filter with the black gasket facing away from you, then re-engage the retainer.
9. Turn off the vacuum by pushing the **Vac** button on the control panel or by tapping the vacuum hose icon on the touchscreen.
10. Close the filter door on the right side of the printer.
11. Close the print enclosure door.
12. Reconnect the vacuum hose to the port on the side of the Fuse Sift.

6.4.4

Cleaning the intake filter

The Fuse 1 uses a filter to remove contaminants from air being drawn into the printer. The intake filter should be cleaned every 30 hours of printing. Used filters that have experienced 20 prints or 400 hours of printing should be cleaned after every print to extend their lifetime.

To clean the intake filter:

1. Disable the Fuse 1's air system before performing maintenance on the intake filter.
 - n. Navigate to the filter maintenance procedure by tapping the checklist icon on the **Print Status** screen, or
 - o. Drag the **Unlock Door** slider on the touchscreen.
2. Open the air filter door on the right side of the printer.
3. Disconnect the vacuum hose from the side of the Fuse Sift.
4. Locate the conical intake filter, located on the left side of the filter cabinet.
5. Grip the base of the conical filter and gently twist it counter-clockwise to disengage the snap-fit tabs. Remove the filter from the filter cabinet.
6. Turn on the vacuum by pushing the **Vac** button on the control panel or by tapping the vacuum hose icon on the touchscreen.
7. Vacuum the conical intake filter as well as the surrounding area in the filter cabinet.
8. Reinstall the intake filter by aligning the tabs on the filter with the corresponding openings on the mount inside the cabinet. Twist the filter clockwise to lock it in place.
9. Turn off the vacuum by pushing the **Vac** button on the control panel or by tapping the vacuum hose icon on the touchscreen.
10. Close the filter door on the right side of the printer.
11. Close the print enclosure door.
12. Reconnect the vacuum hose to the port on the side of the Fuse Sift.

6.4.5

Cleaning the print enclosure

During use, powder accumulates on the floor of the print enclosure. Formlabs recommends vacuuming up loose powder every one to two full build volume prints or 50–100 hours of printing, whichever comes first.

To clean the print enclosure:

1. Drag the **Unlock Door** slider on the touchscreen. The print enclosure door unlocks.
2. Open the print enclosure door on the printer.
3. Disconnect the vacuum hose from the side of the Fuse Sift.
4. Turn on the vacuum by pushing the **Vac** button on the control panel or by tapping the

vacuum hose icon on the touchscreen.

5. Vacuum the loose powder on the print enclosure floor. Avoid touching the gaskets around the door with the vacuum hose.
6. Vacuum the air filter.
7. Turn off the vacuum by pushing the **Vac** button on the control panel or by tapping the vacuum hose icon on the touchscreen.
8. Close the print enclosure door.
9. Reconnect the vacuum hose to the port on the side of the Fuse Sift.

6.4.6

Purging the exhaust lines

With typical use, marginal amounts of powder and laurilactam can accumulate in the exhaust lines. It is important to periodically purge the exhaust lines to maintain airflow out of the print enclosure. Purge the exhaust lines after 10–15 full build volume prints or 500 hours of printing, whichever comes first.

Before proceeding, ensure that the build chamber is removed from the print enclosure and that an optical cassette is installed.

To purge the exhaust lines:

1. Drag the **Unlock Door** slider on the touchscreen. The print enclosure door unlocks.
2. Open the print enclosure door on the printer.

Ensure that the print enclosure door is open before continuing. If the print enclosure door remains shut while you purge the exhaust lines, powder may be drawn from the hopper into the print enclosure and cause the next print to fail.

3. Open the air filter door on the right side of the printer.
4. Turn off the printer using the rear breaker switch.
5. Disconnect the vacuum hose from the side of the Fuse Sift.
6. Turn on the vacuum by pushing the **Vac** button on the control panel or by tapping the vacuum hose icon on the touchscreen.
7. Locate the circular exhaust port inside the filter cabinet, to the right of the rectangular exhaust filter.
8. Hold the vacuum hose up to the port for 60 seconds.
9. Locate the circular inner exhaust line port, located on the rear wall of the print enclosure. If a build chamber is inserted into the printer, remove it to access the inner exhaust line port.
10. Hold the vacuum hose up to the port for 60 seconds.
11. Turn off the vacuum by pushing the Vac button on the control panel or by tapping the vacuum hose icon on the touchscreen.
12. Close the filter door on the right side of the printer.
13. Close the print enclosure door.
14. Turn the printer back on.
15. Reconnect the vacuum hose to the port on the side of the Fuse Sift.

6.5

Intermittent maintenance

Task	Frequency	Refer to	Section
Updating the firmware	When PreForm indicates a new firmware version is available.	Updating firmware	4.7
Replacing the optical cassette	After 100,000 layers printed or when the optical cassette is damaged	Replacing the optical cassette	6.5.2
Replacing the intake filter	After 120 full build volume prints or 2,400 hours of printing, whichever comes first, or when the filter is damaged or cannot be sufficiently cleaned	Replacing the intake filter	6.5.3
Replacing the exhaust filter	After 120 full build volume prints or 2,400 hours of printing, whichever comes first, or when the filter is damaged or cannot be sufficiently cleaned	Replacing the exhaust filter	6.5.4
Cleaning the upper laser window	After 1,000 hours of printing or if print quality indicates contaminated optics. Inspect the upper laser window after every 100 hours of printing.	Cleaning the upper laser window	6.5.5
Cleaning the powder troughs	If powder becomes contaminated with fiber or other debris, or instructed to do so by Formlabs Support or a certified service provider.	Cleaning after a failed print	7.3

6.5.1 **Updating the firmware**

For detailed guidance and visual assistance, visit support.formlabs.com.

Formlabs regularly releases updated firmware to fix bugs and improve functionality. Review the PreForm and firmware release notes to learn more about the improvements that come with each version's release.

6.5.2 **Replacing the optical cassette**

When disposing of a damaged optical cassette, remove it from the printer and clean off any laurolactam and powder following the instructions in section **6.3.1 Cleaning the optical cassette**. Once cleaned, the optical cassette can be disposed of with standard waste.

6.5.3 **Replacing the intake filter**

When disposing of a damaged or clogged intake filter, remove it from the printer and clean off

any laurolactam and powder following the instructions in section **6.4.4 Cleaning the intake filter**. Once cleaned, the filter can be disposed of with standard waste.

6.5.4 **Replacing the exhaust filter**

When disposing of a damaged or clogged exhaust filter, remove it from the printer and clean off any laurolactam and powder following the instructions in section **6.4.3 Cleaning the exhaust filter**. Once cleaned, the filter can be disposed of with standard waste.

6.5.5 **Cleaning the upper laser window**

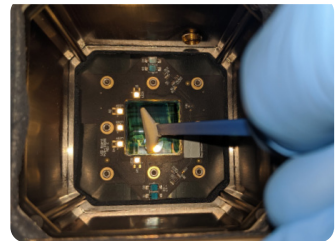
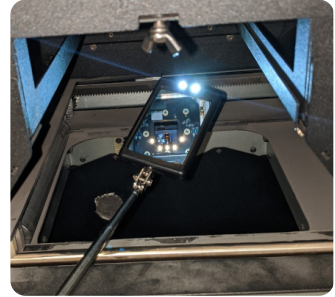
Inspect the upper laser window after every 100 hours of printing. Clean the upper laser window if you see contamination. The expected cleaning interval is every 1,000 hours of printing.

Required supplies:

- Ethanol
- Non-reactive nitrile gloves
- Polyester cloth swabs
- Telescoping mirror

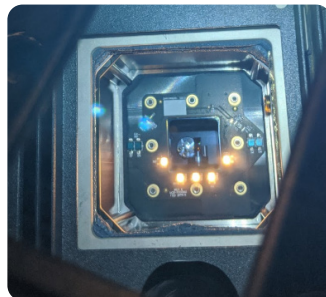
To clean the upper laser window:

1. Put on a new, clean pair of nitrile gloves. Powder, skin oils, and other contaminants may smudge or damage the clean laser window.
2. Drag the **Unlock Door** slider on the touchscreen. The print enclosure door unlocks.
3. Open the print enclosure door.
4. Loosen the thumb screw in the front-center of the ceiling of the print enclosure. The cassette tray swings down.
5. Slide the optical cassette out of the cassette tray.
6. Set the optical cassette aside on a clean, flat surface. Ensure that nothing is directly touching either window of the optical cassette.
7. Return the cassette tray to its closed position without an optical cassette. This provides easier access to the upper laser window.
8. Tighten the thumb screw until it fully engages to lock the cassette tray in place.
9. Using the provided telescoping mirror, visually locate the upper laser window. The upper laser window is located in the enclosure ceiling and corresponds to the larger window in the optical cassette.
10. Inspect the upper laser window with the mirror.
11. Wet a polyester cloth swab with a small amount of ethanol. Using the telescoping mirror to guide your hand, place the tip of the wet swab against the upper window.
12. Pull the swab across the upper laser window in a single direction to clean the surface. Repeat this multiple times, making sure to cover the full width and length of the upper laser



window while wiping in a single direction.

13. Wait five minutes for the ethanol to evaporate before inspecting the upper laser window or reinstalling the optical cassette.
14. Using the telescoping mirror, visually verify the upper laser window is clean and clear of obstruction. If there are streaks or debris on the upper laser window, repeat this cleaning procedure with a new polyester cloth swab.
15. Loosen the thumb screw in the front-center of the ceiling of the print enclosure. The optical tray drops down.
16. Return a clean optical cassette to the cassette tray.
17. Return the cassette tray to its closed position and tighten the thumb screw until it fully engages.
18. Close the print enclosure door. Press firmly to ensure that the door is fully latched. If necessary, squeeze the door shut using the cutout on the right side of the printer for leverage.



7 Troubleshooting

For detailed guidance and visual assistance, visit support.formlabs.com.

7.1 Collecting diagnostic logs

The Fuse 1 maintains diagnostic logs to provide detailed information about the machine that may expedite issue investigation. After experiencing any error or unusual behavior on the Fuse 1, include the diagnostic logs with other relevant observations and details when contacting [Formlabs Support](#) or a [certified service provider](#). The options for sharing diagnostic logs vary depending on the machine's connection type.

7.2 Performing a factory reset



Do not perform a factory reset immediately before contacting **Formlabs Support** or a **certified service provider**. The stored diagnostic information may be helpful to **Formlabs Support** or a **certified service provider** to assist with troubleshooting. A factory reset erases diagnostic information and custom settings, including uploaded jobs and networked connections.

7.3 Cleaning after a failed print

Occasionally, a print may fail to complete. If a print fails due to contaminants in the powder, said contaminants may remain in the powder troughs to the sides of the build chamber. Before starting a new print, clean out the powder troughs to reduce the likelihood of another failed print.

Powder that comes into contact with fibers or other contaminants (e.g., in a vacuum cleaner) cannot be filtered and should be disposed of.

To clear debris or obstructions from the powder troughs:

1. Slide the **Unlock Door** slider on the touchscreen to open the print enclosure.
2. Unplug and remove the build chamber.
3. Flip the breaker switch on the back of Fuse 1 to the **OFF** position to turn off the machine.
4. Locate the powder troughs and flippers, which run along the sides of the print enclosure above the build chamber. The recoater roller deposits powder from the troughs as a layer on the print bed or the previous layer, so any contaminated powder left in the troughs could cause future prints to fail.
5. Disconnect the vacuum hose from the Fuse Sift.
6. Begin vacuuming out powder from the hopper-side powder trough, as well as the surrounding area.
7. If the powder is densely packed within the trough, use a small tool to loosen it.
8. If the hopper-side flipper is lying parallel to the print enclosure ceiling, use your finger to push the flipper down into its well as far as possible.
9. Resume vacuuming in and around the flipper well.
10. Repeat for the trough opposite the hopper.
11. Reconnect the vacuum to the Fuse Sift.
12. Turn the printer back on.

7.4 Troubleshooting errors or abnormal activity

In the case of errors, abnormal activity, or print failures with the Fuse 1, reference the following errors, causes, and proposed solutions. Complete the initial troubleshooting steps and carefully document all results. Contact [Formlabs Support](#) or a [certified service provider](#) for additional guidance. Provide diagnostic logs if requested.

7.4.1 Resolving abnormal functions

Error	Cause	Solution
Unresponsive machine The Fuse 1 does not turn on.	<ul style="list-style-type: none">• The power cable is disconnected• The breaker switch on the machine is set to OFF	<ol style="list-style-type: none">1. Check whether the circuit has power, and that the power cable is securely connected to the outlet.2. Turn off the machine by flipping the breaker switch on the back of the unit to OFF.3. Leave the machine off for at least one minute.4. Turn on the machine by flipping the breaker switch to ON.5. Start a new print. If the machine is still unresponsive after restarting, contact Formlabs Support or a certified service provider for additional guidance.
Unresponsive touchscreen Buttons or controls on the touchscreen do not respond to touch input.	<ul style="list-style-type: none">• One-off firmware glitch• Loose connection with the touchscreen	<ol style="list-style-type: none">1. Power cycle the machine by flipping the breaker switch on the back of the unit to OFF and back to ON.2. Check whether the machine is running the latest firmware and update the firmware if needed. <p>If the touchscreen repeatedly stops responding after trying these steps, contact Formlabs Support or a certified service provider for additional guidance.</p>

7.4.2 Resolving print failures and errors

Print failures can manifest in different ways and originate from different causes. Check the model’s configuration in PreForm, the cleanliness of the optical surfaces, and the printer’s operating condition according to section **6 Maintenance** as well as the proposed solutions below.

If print failures persist after following these steps, contact [Formlabs Support](#) or a [certified service provider](#) for additional guidance. Provide clear, focused photographs of the test print to help diagnose the issue.

Error	Cause	Solution
Hard cake <ul style="list-style-type: none"> • Unsintered powder fused into a stiff cake • Difficulty separating the part from the unsintered powder • Poor underlying surface finish and loss of small negative features 	Bed temperature is too high.	Check whether the IR sensor housing has any lauro lactam built up in the sensor field of view. Refer to section 6.4.2 Cleaning the IR sensor housing for more information.
Warping <ul style="list-style-type: none"> • Large scale curvature of a part or section of parts • Deviation from flatness 	<ul style="list-style-type: none"> • Improper cooling procedure; warping can occur during a print if the part is allowed to cool non-uniformly or if the part is removed while still hot • Parts printed too close to the build chamber walls 	<ol style="list-style-type: none"> 1. Wait for parts to cool to near room temperature prior to removal from the build chamber. 2. Move parts away from the build chamber walls.
Pitting <ul style="list-style-type: none"> • Surface imperfections on the top-most surface on parts, typically on small cross-sectional regions • In some cases, a hole that is deeper or several layers thick 	Bed temperature is too high.	Check whether the IR sensor housing has any lauro lactam built up in the sensor field of view. Refer to section 6.4.2 Cleaning the IR sensor housing for more information.
Melting The powder on the surface of the print is blackened due to melting.	Heaters heated the powder to above its melting temperature.	The heaters or the IR sensor may be malfunctioning. Contact Formlabs Support or a certified service provider for additional guidance and provide diagnostic logs.
Delamination A sintered layer failed to adhere to a previously sintered layer.	<ul style="list-style-type: none"> • Insufficient laser power • Build chamber Z-motor malfunction 	Inspect the optical surfaces.
Fragile parts <ul style="list-style-type: none"> • Parts with excessively low strength • Parts occasionally have a lighter color and a more granular surface texture than normal 	Insufficient sintering due to attenuated laser power.	Inspect the optical surfaces.
Poor, mottled surface finish on vertical surfaces	<ul style="list-style-type: none"> • Ratio of recycled to unused powder is too high • Grain size of recycled powder is higher than unused powder, causing variation in melt temperature and viscosity, leading to uneven sintering in the bulk of the model and poor surface finish on the outside of the model 	<ul style="list-style-type: none"> • Increase powder refresh rate OR • Dispose of degraded powder

8 Disassembly and repair

All steps that involve opening the machine and/or investigating internal components should be done by skilled persons under the guidance of Formlabs Support or a certified service provider. Any damage resulting from attempting disassembly and/or repair without prior authorization from Formlabs Support or a certified service provider is not covered by warranty.

8.1 Tasks

Contact [Formlabs Support](#) or a [certified service provider](#) to receive repair instructions and authorization, including how to disassemble or remove the exterior paneling.

Task	Frequency
Replacing the build chamber piston seal	When advised by Formlabs Support or a certified service provider
Replacing the print enclosure door seal	When advised by Formlabs Support or a certified service provider
Replacing the laser fan mesh	When advised by Formlabs Support or a certified service provider
Replacing the quartz heaters	When advised by Formlabs Support or a certified service provider
Replacing the IR sensor	When advised by Formlabs Support or a certified service provider

Any other maintenance or repair tasks not listed in section **6 Maintenance** requires servicing the machine. Contact [Formlabs Support](#) or a [certified service provider](#) to request in-field service or an RMA (short for “return to manufacturer authorization”).

9 Recycling and disposal

9.1 Disposal of powder

9.1.1 Unsintered powder

Unsintered used SLS powder must be disposed of in accordance with applicable ordinances and environmental regulations for plastic waste. Particular caution must be taken with powdered plastic, as it is a microplastic and poses severe environmental repercussions.



Unsintered SLS powder is classified as a microplastic, a group of plastics that are hazardous to aquatic life. Do not dispose of unsintered used powder into drains or household waste streams. Safe and appropriate disposal methods of unsintered used powder vary by location. Consult the safety data sheet (SDS) from the powder supplier as the primary source of information to understand safe disposal of unsintered material.

9.1.2 Sintered powder or cleaned parts

Discard cleaned parts and sintered powder with household items as trash. Cleaned parts and sintered powder cannot be recycled.

9.2 Recycling of powder

9.2.1 Unsintered powder

Unsintered used SLS powder can be recaptured using the Fuse Sift for use in future prints. The Fuse 1 can print with up to 70% recycled powder.



NOTICE

Formlabs does not operate a recycling program.

9.2.2 Sintered powder or cleaned parts

Discard cleaned parts and sintered powder with household items as trash. Cleaned parts and sintered powder cannot be recycled.

9.3 Disposal of cleaning agents

Safe and appropriate disposal methods of used solvent vary by location.

To safely dispose of used solvent:

1. Consult the safety data sheet (SDS) from the solvent supplier as the primary source of information.
2. Research the approved methods of disposal for your area. This will most likely involve hiring a waste disposal service. For smaller amounts, check with a hazardous disposal service to see if they have any suggestions for removal.
3. Inform your waste disposal service that your bottle contains solvent with small amounts of laurolactam and microplastics. Have a copy of the Formlabs powder safety data sheet (SDS) on hand in case the disposal service attendant needs more information.

9.4 Recycling of solvent

For large volumes of solvent, consider using a solvent recycling system, which offers a cost effective and more environmentally responsible alternative to paying for waste solvent disposal

services. Solvent recycling systems use distillation and fractionation processes to remove solutes from waste solvents, making it possible to reuse the solvent. The recycled solvent may still have small amounts of contaminants in it. Recycling solvent reduces waste disposal costs, emissions that are required to produce solvents, and the cost of purchasing solvent.

9.5 Disposal of electronic components



The symbol on the product, the accessories, or packaging indicates that this device shall not be treated as nor disposed of with household waste. When you decide to dispose of this product, do so in accordance with environmental laws and guidelines. Dispose of the device via a collection point for the recycling of waste of electrical and electronic equipment. By disposing of the device in the proper manner, you help avoid possible hazards for the environment and public health that could otherwise be caused by improper treatment of waste equipment. The recycling of materials contributes to the conservation of natural resources. Therefore do not dispose of your old electrical and electronic equipment with the unsorted municipal waste.

9.6 Disposal of packaging waste

The packaging is made of cardboard and plastic-based materials. Dispose of packaging through waste and recycling facilities. By disposing of the packaging waste in the proper manner, you help avoid possible hazards for the environment and public health.



NOTICE

The original packaging is designed to be kept and reused for transporting or shipping the machine for service. Save the complete packaging including any inserts for your convenience.

10 Index

- A**
Alconox 12, 18, 21, 28, 29, 40, 41, 42, 57, 59
- B**
build chamber 9, 10, 11, 12, 15, 21, 22, 29, 30, 32, 33, 34, 35, 37, 38, 41, 43, 47, 51, 53, 54, 57, 59, 60
- C**
camera 11, 12, 19, 40, 43, 44, 57, 59, 60
 camera lens 11, 19, 40, 43, 44, 57, 60
 camera window 11, 57
clean 12, 16, 19, 28, 29, 30, 35, 36, 40, 41, 42, 43, 44, 45, 46, 48, 49, 50, 51, 57
 cleaning 12, 16, 19, 28, 29, 30, 35, 36, 40, 41, 42, 43, 44, 45, 46, 48, 49, 50, 51, 57
comply 8, 17, 57
 compliance 5, 6, 8, 17, 57, 61
contamination 41, 49, 57
 debris 10, 29, 44, 45, 48, 50, 51, 57
 dust 10, 29, 44, 45, 48, 50, 51, 57
- D**
Dashboard 6, 9, 25, 37, 38, 57
diagnostic logs 5, 25, 51, 52, 53, 57
display 57
disposal 5, 55, 56, 57
- E**
error 10, 13, 51, 57
ethanol 12, 18, 20, 28, 36, 40, 41, 42, 43, 44, 45, 49, 50, 57, 59
ethernet 57
- F**
filter 15, 20, 21, 30, 40, 43, 45, 46, 47, 48, 49, 57
 exhaust filter 40, 43, 45, 46, 47, 48, 49, 57
 intake filter 40, 43, 46, 48, 49, 57
firmware 4, 25, 26, 48, 52, 57
Fuse Sift 4, 12, 21, 22, 26, 30, 37, 38, 40, 45, 46, 47, 51, 55, 57, 59, 60
- H**
hopper 10, 13, 15, 23, 29, 30, 31, 35, 36, 44, 47, 51, 57, 60
- I**
install 21, 24, 26, 57
 installation 26, 57
IR sensor 10, 11, 12, 16, 19, 26, 27, 36, 40, 43, 44, 45, 53, 54, 57, 59, 60
 IR sensor housing 12, 40, 43, 44, 45, 53, 57
- L**
laser 6, 9, 11, 12, 14, 16, 19, 48, 49, 50, 53, 54, 57, 59, 60, 61
laser window
 laser 6, 9, 11, 12, 14, 16, 19, 48, 49, 50, 53, 54, 57, 59, 60, 61
level 10, 13, 14, 23, 24, 25, 31, 57
 leveling 24, 57
- M**
maintenance 5, 13, 14, 15, 18, 19, 34, 39, 40, 43, 45, 46, 48, 54, 57
- N**
nylon 21, 31, 57, 59
- O**
operation 6, 14, 15, 18, 57
optical cassette 10, 11, 12, 19, 23, 28, 29, 30, 35, 38, 40, 41, 42, 43, 44, 47, 48, 49, 50, 57, 60
 optical window 42, 57
optical window 42, 57
- P**
part recovery 57
powder 4, 5, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 26, 27, 28, 29, 30, 32, 33, 35, 36, 37, 38, 40, 41, 43, 45, 46, 47, 48, 49, 51, 53, 55, 57, 59, 60
 powder credit 4, 5, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 26, 27, 28, 29, 30, 32, 33, 35, 36, 37, 38, 40, 41, 43, 45, 46, 47, 48, 49, 51, 53, 55, 57, 59, 60
power 15, 20, 22, 23, 24, 30, 38, 39, 52, 53, 58
PreForm 9, 25, 26, 33, 34, 48, 52, 58, 60
print enclosure 10, 11, 12, 13, 15, 16, 19, 20, 21, 29, 30, 34, 35, 36, 37, 38, 40, 41, 43, 44, 46, 47, 49, 50, 51, 54, 58, 59, 60
print failures 52, 58
 failed print 52, 58
- S**
safety 4, 5, 6, 8, 14, 15, 16, 17, 18, 19, 20, 23, 32, 55, 58, 59, 61
 PPE 4, 5, 6, 8, 14, 15, 16, 17, 18, 19, 20, 23, 32, 55, 58, 59, 61
Safety Data Sheet 58
 SDS 58
shipping 22, 23, 29, 30, 56, 58
 package 22, 23, 29, 30, 56, 58
 packaging 22, 23, 29, 30, 56, 58
 transport 22, 23, 29, 30, 56, 58
 transporting 22, 23, 29, 30, 56, 58
 unboxing 22, 23, 29, 30, 56, 58
specifications 4, 8, 9, 16, 32, 58
spill 58

T

technical data 8, 58

temperature 9, 11, 13, 15, 18, 32, 36, 37, 53, 58,
59

heat 9, 11, 13, 15, 18, 32, 36, 37, 53, 58, 59

touchscreen 9, 13, 19, 23, 24, 25, 26, 27, 34,
35, 37, 38, 39, 43, 44, 45, 46, 47, 49, 51,
52, 58

U

USB 9, 24, 25, 26, 30, 34, 58

V

vacuum 16, 18, 21, 30, 40, 45, 46, 47, 51, 58

11 Glossary

Term	Meaning
Alconox	A general purpose lab cleaning agent that is recommended for cleaning the printer's optical components. It is the first cleaning agent to be used, followed promptly by ethanol and distilled water, respectfully.
Build chamber	An interchangeable component of the Fuse 1 that contains the print bed (representing the Z-axis of 30.0 cm/11.8 in), heaters and temperature sensors, and encapsulates the sintered parts and loose powder from a print. The accompanying plug allows the Fuse 1 and Fuse Sift to monitor the build chamber, and differentiate one build chamber from another.
Build volume	The total cubic dimensions in which 3D models can be printed. The Fuse 1 has a build volume of 16.5 × 16.5 × 30.0 cm (6.5 × 6.5 × 11.8 in).
Cake	The final product of a print, containing both loose unsintered SLS powder and the printed parts.
Computer vision (CV)	A system incorporating a camera and artificial intelligence engine to monitor prints for potential issues, and abort prints if a significant issue is detected.
Distilled water	Water that is free of impurities, and is the second agent used for wiping off residual alconox from the previous cleaning step.
Ethanol	A simple alcohol that is the recommended cleaning agent for removing deposits of laurolactam and other off-gassing stains from the printer's optics.
Flippers	Two paddles, one on the left and right side of the powder handling system, that move powder into position for the recoater roller to pick-up and deposit onto the print bed.
Galvanometer (galvo)	A high-speed precision motor that positions a mirror used for reflecting the laser spot. The Fuse 1 uses two galvos to position the laser spot along the X and Y-axes of the print area.
Hopper	The fixed container on the side of the Fuse 1 that holds powder in a tapered basin for printing.
Interlock	A safety mechanism that automatically shuts off the laser if the print enclosure door is open, or if the IR sensor is misaligned.
Infrared (IR)	Electromagnetic radiation that extends from the nominal edge of the visible spectrum at 700 nanometers (nm) to 1 millimeter (mm).
IR sensor	An electronic device that monitors the temperature in the print enclosure by measuring infrared radiation.
Laser	Short for "Light Amplification" via "Stimulated Emission of Radiation." The laser is the source of sintering energy in the Fuse 1 with a wavelength of 1065 nm, and a maximum output of 10 W. The Fuse 1 is a Class 1 laser product.
Laurolactam	An organic compound used as a monomer to produce nylon. It is also a byproduct of SLS nylon printing.
Layer	A thin individual planar section of an object being printed. The 3D object's geometry is sliced into a large number of 2D layers that are sequentially sintered together, forming the object.

Term	Meaning
Micron (μm)	An SI derived unit of length equalling 1×10^{-6} meter, or one millionth of a meter (or one thousandth of a millimeter, 0.001 mm, or about 0.000039 inch).
Nylon	An industrial thermoplastic that bends before returning to its original form without fracturing, making it suitable for structural, load bearing, or mechanical parts.
Optical cassette	A cassette that contains two glass windows—one for the printer's laser and the other for the printer's camera—a set of corresponding gaskets, and a pass-through for the IR sensor. The windows protect the components behind them from excess wear and off-gassing that results from sintering powder.
PEC*PAD	Disposable lint-free, non-woven microfiber cloths for cleaning the printer's optical components. Do not reuse a PEC*PAD; dispose after each use, even when cleaning the glass windows of the optical cassette with the same cleaning agent.
Personal protective equipment (PPE)	Garments or articles of clothing designed to protect individuals from physical, electrical, heat, chemicals, biohazards, and airborne particulate matter.
Plume	A localized emission of pulverized material.
Powder cartridge	The container in which printing powder is mixed and transported from the Fuse Sift to the printer's hopper. Holds 6 L of powder.
Polyester cloth swab	A disposable lint-free polyester cloth swab with a plastic handle that is used for cleaning the printer's IR sensor and camera lens. Do not reuse a polyester cloth swab; dispose of after each use.
PreForm	Orient and lay out models in PreForm before sending them to the printer. PreForm uses advanced, proprietary calculations to optimize print settings for each model.
Print bed	An aluminum plate onto which printing powder is deposited in 110 micron layers and sintered to form 3D parts.
Print enclosure	The main compartment inside the printer that contains the build chamber, camera and sensors, quartz heaters, and powder dispensing components.
Quartz heater	A heating system consisting of a tungsten element sealed inside quartz tubes that emits infrared radiation.
Recoater roller	A bar that moves from left-to-right to pick up powder from either side of the upper print enclosure, then deposits it as a layer on the print bed or the previous layer.
Selective Laser Sintering (SLS)	An additive manufacturing process that uses a high-powered laser to sinter uniform beads of plastic together, drawing out individual 2D layers (or slices) that eventually form a 3D part.
Surface armor	A print process component of the Fuse 1 that surrounds parts with a semi-sintered shell of material to alleviate thermal inconsistencies which may adversely affect the accuracy of a part.

12 Product compliance

The Fuse 1 complies with the following machinery, electromagnetic, waste, and laser safety standards:

European Machinery Directive 2006/42/EC

- A-Type Standards: EN ISO 12100:2010
- B-Type Standards: EN 60204-1:2018
- C-Type Standards: None

Laser

- ISO 11553-1:2020
- ISO 11252:2013
- ISO 11554:2017

Electromagnetic Compatibility (2014/30/EU)

- IEC 61000-6-2
- IEC 61000-6-4

Chemicals and waste

- Restriction of Hazardous Substances Directive (2011/65/EU)
- (EC) No 1907/2006 Chemical Substances (REACH) Regulation

