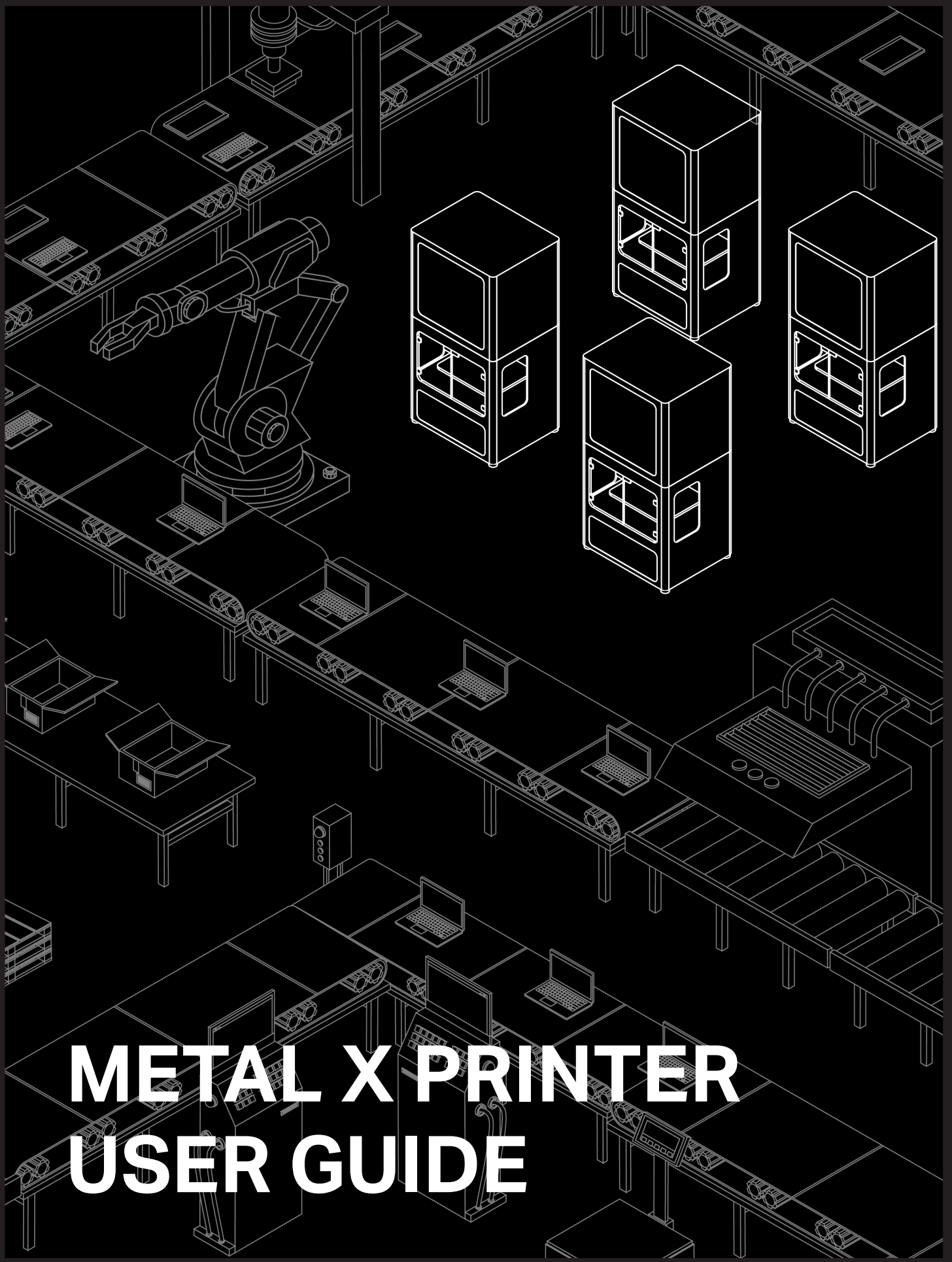

METAL X PRINTER USER GUIDE

Markforged

480 Pleasant St
Watertown MA 02472
USA

https://support.markforged.com
support@markforged.com

For the latest PDF version of this document, visit our support website.

Changes are periodically made to the information herein which will be incorporated in revised editions of this publication.

Markforged may make changes or improvements to the product(s) described in this publication at any time and without notice.

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USER GUIDE

USER NOTES

FCC COMPL.IANCE

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 his or her own expense.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

SAFETY NOTES

TABLETOP USE ONLY

The Metal X printer is approved for tabletop use only. Set up the printer on a sturdy level surface with sufficient access on all sides (see the ***Facilities Guide***). The printer is not approved for free-standing floor use.

POWER DISCONNECT ACCESS

Take care to set up your Metal X printer so that the disconnecting device (power switch on the rear face of the printer) is accessible at all times. Note that the power cord can be disconnected as a backup if the power switch becomes inoperable or inaccessible.

CLEANING/DECONTAMINATION

The camera and print chamber interior can be wiped down using ***light mineral oil only***. Follow instructions in the next section (***Reducing Burn Risks***) when doing so. Do not use any other cleaning solvents or chemicals on the inner or outer surfaces of the printer.

REDUCING BURN RISKS

- Do not touch the nozzles and print head when hot, unless explicitly instructed to do so in the user or service manuals
- During a print run, leave all doors closed
- Do not touch the heating elements in the upper chamber when the Metal X is running
- Avoid touching the print bed when hot
- Note that newly printed parts can be hot. Handle with care

ALWAYS FOLLOW SAFETY INSTRUCTIONS

Failing to use the Metal X printer in the manner specified by the manufacturer may lead to unsafe operating conditions. Follow all safety instructions posted on the unit and in the written documentation.

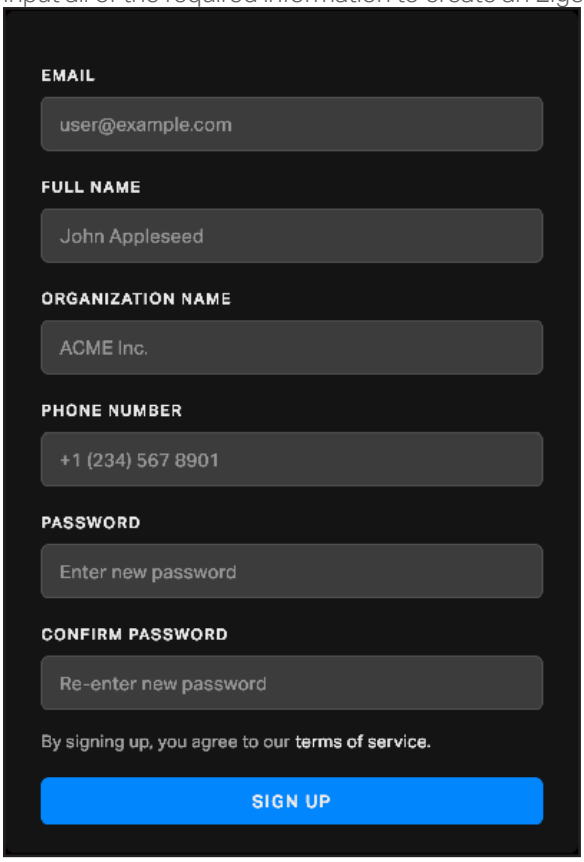
Note: Consult the Safety Sheet *included with your device for an explanation of the safety icons used in this manual.*

CREATING EIGER ORGANIZATIONS

Before you can print to your printer, you will need to create an organization in Eiger, our software for setting up and slicing parts. You will need your printer's ID and access key to complete this process. Note that a printer can only be assigned to a single Eiger organization, and a user can only belong to a single organization.

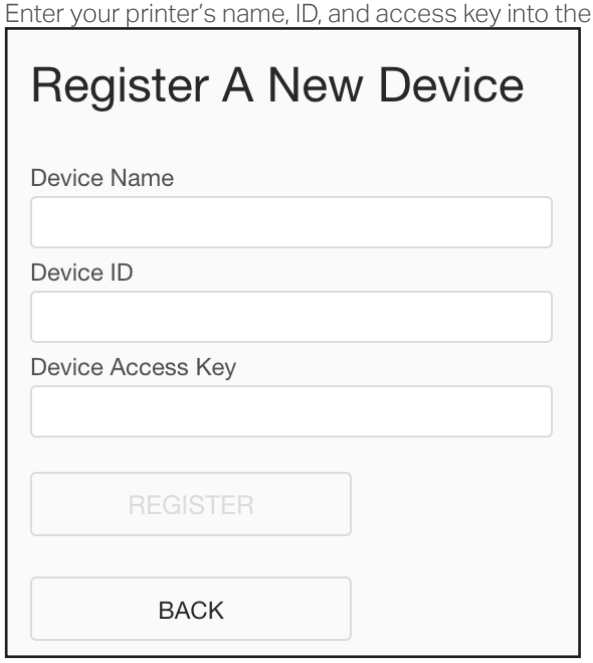
CREATE NEW ORGANIZATION

1. Navigate to *https://www.eiger.io/register* in a Google Chrome browser.
2. Input all of the required information to create an Eiger organization.



3. You will receive an email from Eiger after creating your organization. Please click on the link within the email to complete the sign-up process.
4. After logging in, Eiger will prompt you to register a device. Find your printer's ID and access key on the stickers provided with your Markforged printer, or on the Printer Info screen. You can find the Printer Info screen by selecting the menu icon from the dashboard of your printer and navigating to **Settings > System Info**.

5. Enter your printer's name, ID, and access key into the fields on the screen and click **Register**.



ADD PRINTER TO EXISTING ORGANIZATION

If you already have an existing organization, you can add a new printer to it at any time with the ID and access key. You can find this information by selecting the menu icon from the dashboard and navigating to **Settings > System Info**.

1. Sign into your Eiger account in a Google Chrome browser.
2. Navigate to *https://www.eiger.io/devices*.
3. Select the **Register Device** button on the screen.
4. Enter a new name for your printer, along with its, ID and access key, into the fields on the screen and click **Register**.

CONNECTING YOUR PRINTER

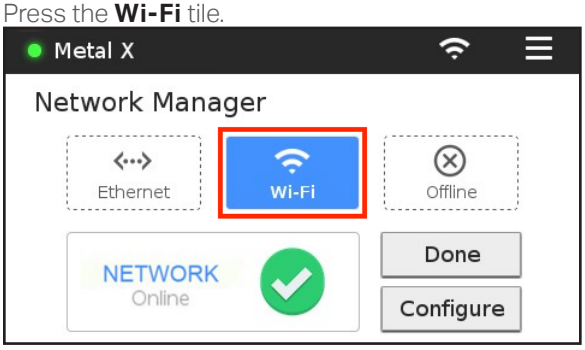
BEFORE YOU GET STARTED

If you powered up your printer before adding your printer to your Eiger account, you will need to power cycle the printer before it can connect to your account.

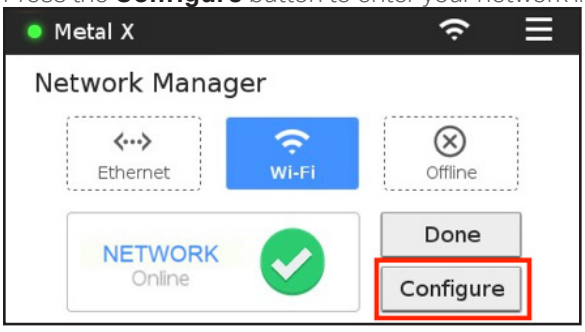
CONNECT VIA WI-FI

1. Select the Wi-Fi icon from the dashboard.

2. Press the **Wi-Fi** tile.



3. Press the **Configure** button to enter your network information.



4. Choose a network from the **Network Name** drop-down menu and enter your network password, if necessary.

5. Press **Save** and wait for your printer to finish connecting.

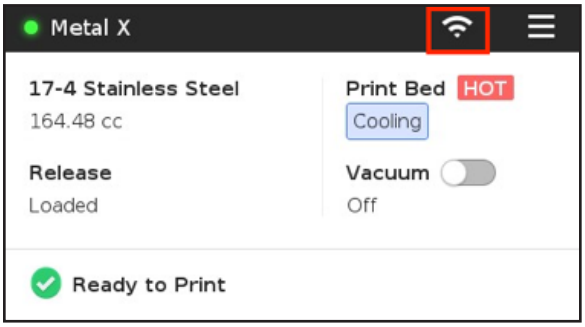
CONNECT VIA ETHERNET (LAN)

1. Plug your Ethernet cable into the Ethernet port.
   Note: Make sure your LAN (Local Area Network) uses DHCP.
2. Select the Ethernet icon from the dashboard.

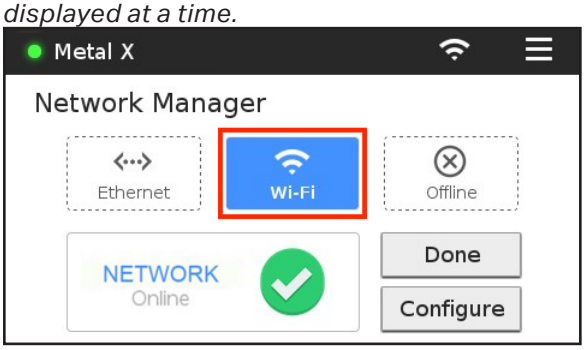
OBTAIN YOUR PRINTER'S MAC ADDRESS

Your printer does not inherently have a way to view its IP address, but it does allow you to find the MAC address for either Ethernet or Wi-Fi.

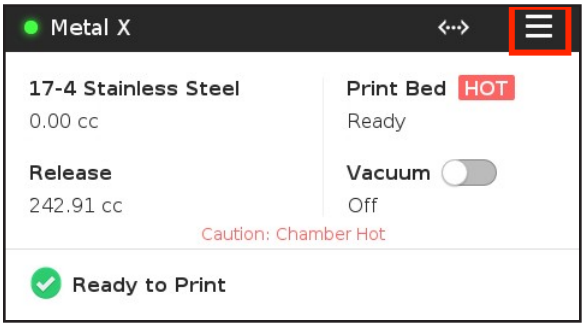
1. Select the Wi-Fi icon from the dashboard.



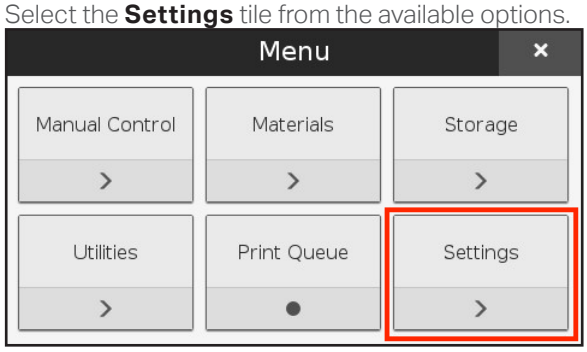
2. Press either the **Ethernet** tile or the **Wi-Fi** tile, depending on which MAC address you'd like to access. *Note: Your printer will display the MAC address of whichever connection option is currently enabled, even if the printer is unable to connect to the Internet. Only one MAC address can be displayed at a time.*



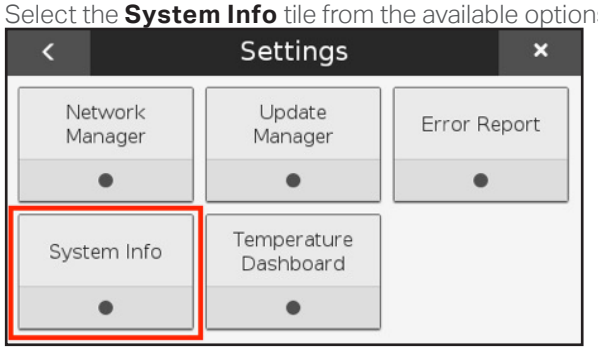
3. When the **Network** status reads **Online**, press the **Done** button.
4. Select the menu icon from the dashboard.



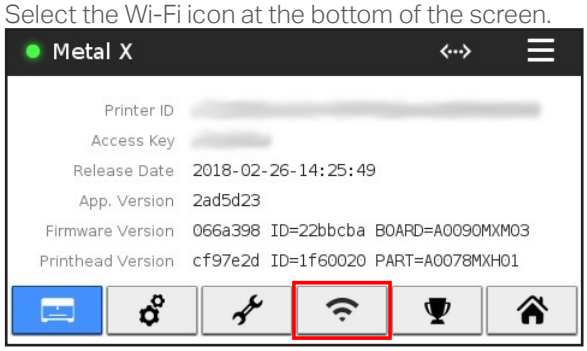
5. Select the **Settings** tile from the available options.



6. Select the **System Info** tile from the available options.



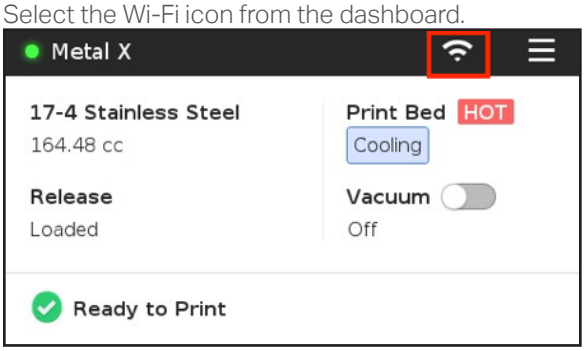
7. Select the Wi-Fi icon at the bottom of the screen.



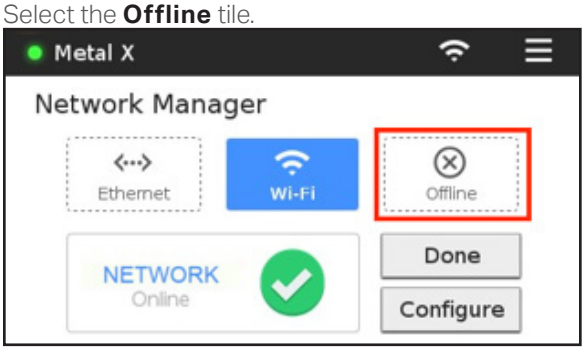
8. View your MAC address for the enabled connection option.

DISABLE WI-FI AND ETHERNET

1. Select the Wi-Fi icon from the dashboard.



2. Select the **Offline** tile.



3. Select **Done**.

NETWORK REQUIREMENTS

Markforged devices communicate on the 2.4GHz Wi-Fi band. For assistance with setting up your network, contact your internal IT team.

DHCP

Markforged products support DHCP only. Static IP functionality is not supported.

PORTS/HOSTNAMES

Markforged products must have access to the following hostnames and ports:

HOSTNAME	PORT	PROTOCOL	REQUIRED?	REASON
s3.amazonaws.com	443	TCP	yes	device operation
mfeiger-production.s3.amazonaws.com	443	TCP	yes	device operation
cdn.eiger.io	443	TCP	yes	device operation
www.eiger.io	443	TCP	yes	device operation
*.pool.ntp.org	123	UDP	yes	network time protocol
ipv4.connman.net	80	TCP	no	online status check
data.logentries.com	443	TCP	no	remote logging
data.logentries.com	10000	TCP	no	legacy remote logging

BROWSER

Markforged products require the use of Google Chrome. WebSockets must be enabled.

If you are unable to connect to your printer due to network issues, you will still be able to print offline via USB.

SHUTDOWN PROCEDURE

We recommend that you keep your Metal X printer powered on at all times. If it becomes necessary to power off your printer, follow the instructions below:

1. Unload metal and release filament. For more information, see the relevant sections of this *User Guide*.
   Note: If you attempt to power on the printer with print material already loaded, the temperature change will likely cause the material to break, potentially jamming the print head.
2. Use the switch on the back of printer to power off your Metal X.

UPDATING FIRMWARE

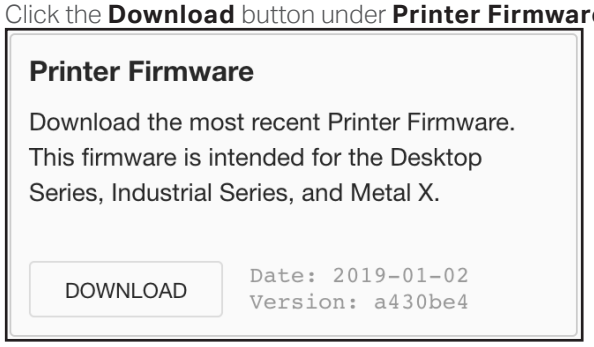
Your printer should always run the most up-to-date firmware. When a firmware update is available, a banner will appear at the bottom of the dashboard. Select the banner to begin the update utility. You can also access the utility via the Update Manager (see below).

UPDATE FIRMWARE VIA USB

Your Metal X printer can be updated via USB. You will need a different USB thumb drive than the one that came with your printer. The USB drive should be FAT32-formatted, and the update will need to be placed in the root folder of the drive.

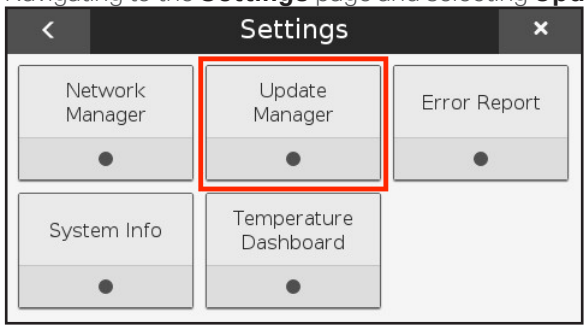
Note: The update must be the only file in the root directory, otherwise the firmware update will fail.

1. Log into your *eiger.io* account and navigate to the **About Eiger** page.
2. Click the **Download** button under **Printer Firmware** to download the USB update.



3. Copy the USB update to the root directory of an otherwise empty FAT32-formatted USB drive. Insert the USB drive into your printer.
4. Begin the update process by either:

- Selecting the blue **Update Available** banner at the bottom of the screen, if shown.
- Navigating to the **Settings** page and selecting **Update Manager**.

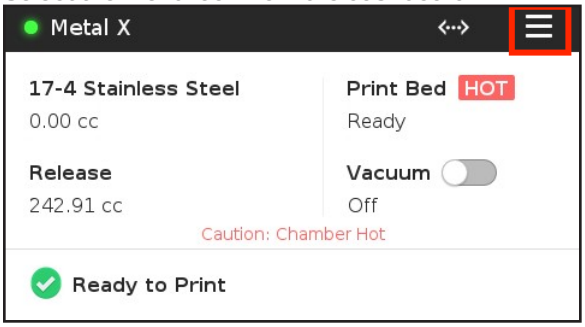


5. When the Update Manager appears, Press **Update**. The update will take a few minutes to install and your printer will restart at the end. Do not turn your printer off during the update process.

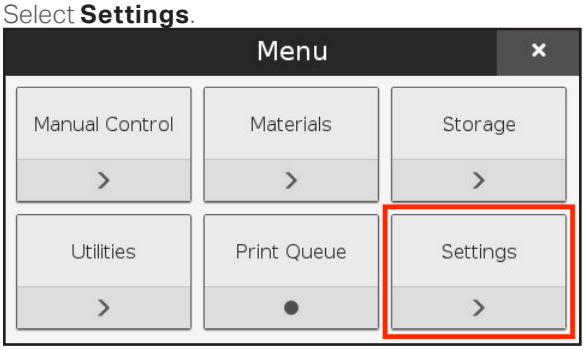
UPDATE FIRMWARE VIA CLOUD UPDATE

Your Metal X printer can be updated via Wi-Fi or Ethernet. Before beginning, make sure your printer is connected to a wired or wireless network. The process should take 5-10 minutes. For more information, see *Connecting Your Printer*.

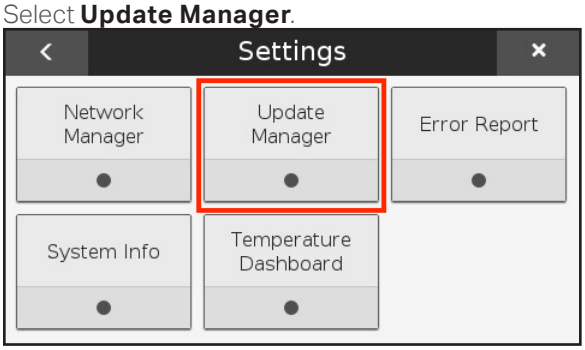
1. Select the menu icon from the dashboard.



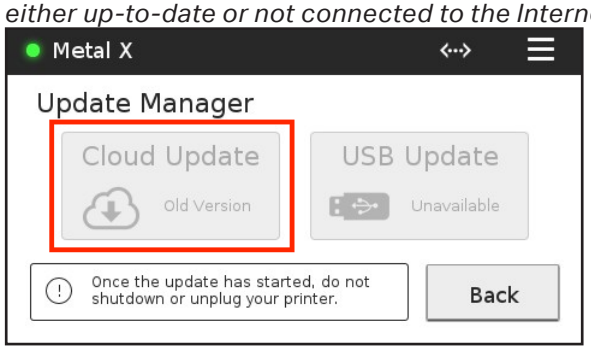
2. Select **Settings**.



3. Select **Update Manager**.



4. Press the **Cloud Update** tile if it is available. The update will take a few minutes to install, after which your printer will restart. Do not turn your printer off during the update process.
*Note: An update is available if the **Cloud Update** tile is blue. If the icon is gray, your system is either up-to-date or not connected to the Internet.*



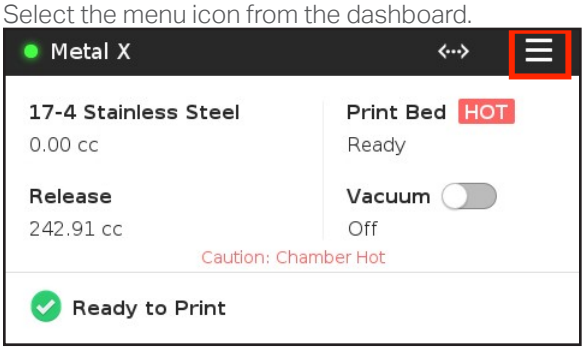
LEVELING THE PRINT BED

Supplies

- 2.5mm hex key from accessory kit

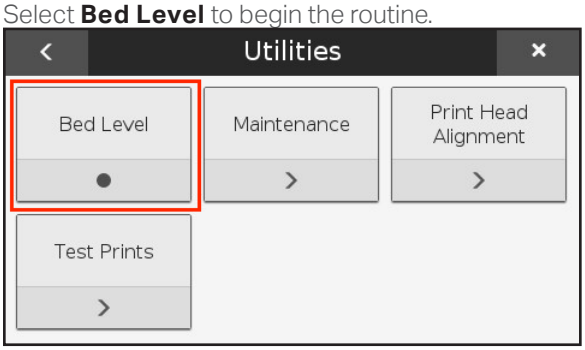
For optimal print quality the print bed must be properly leveled. Afterward the bed should remain level under normal printer use, and you should not need to run the leveling utility as part of routine maintenance. However, the utility must be run during initial printer installation and any time the machine is moved.

1. Select the menu icon from the dashboard.

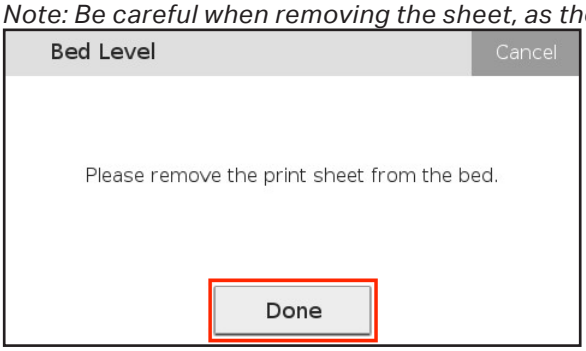


2. Select **Utilities**.

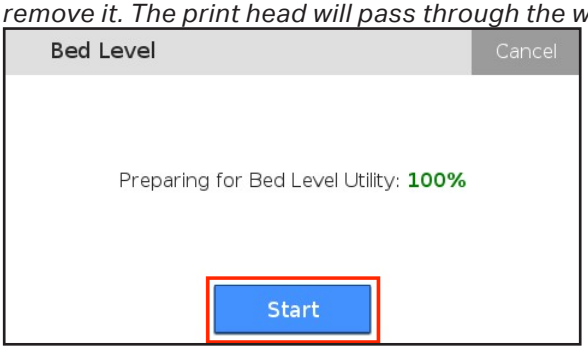
3. Select **Bed Level** to begin the routine.



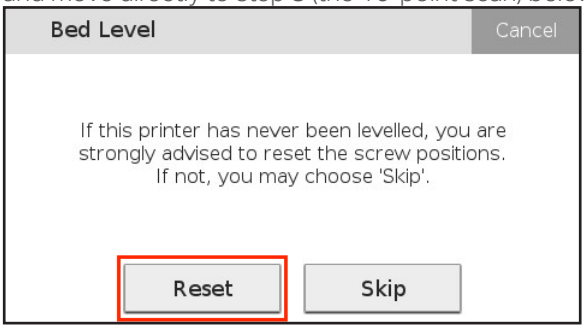
4. Remove the print sheet from the print bed and select **Done**.
Note: Be careful when removing the sheet, as the print bed and sheet may be hot at this step.



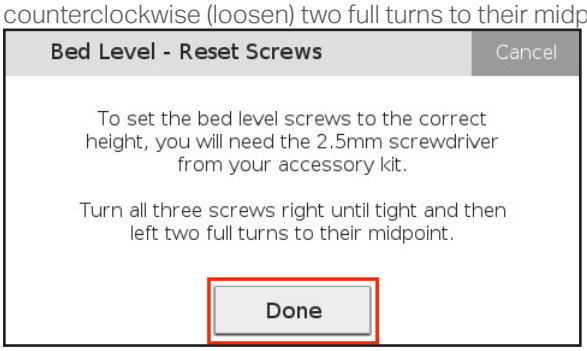
5. The print bed will begin to rise in preparation for the leveling process. When it reaches its maximum height and the progress bar reads 100%, press **Start**.
Note: If your nozzle accumulates some residue during the heating process, you do not need to remove it. The print head will pass through the wiping station during this utility.



6. If the Metal X is newly installed and the bed has never been leveled, press **Reset**. Otherwise, press **Skip** and move directly to step 8 (the 16-point scan) below.

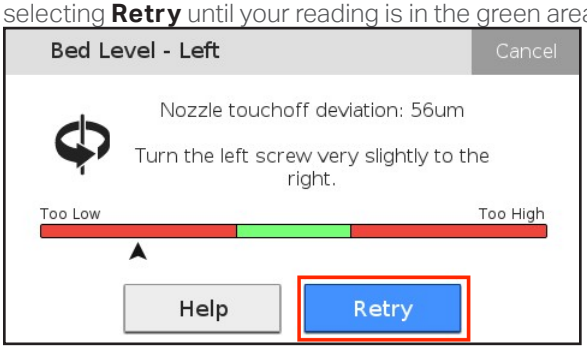


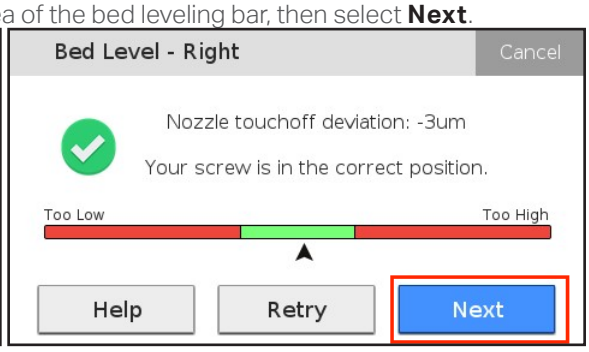
7. Using the 2.5mm hex key, turn all three bed leveling screws clockwise until tight, and then counterclockwise (loosen) two full turns to their midpoint height. To continue, press **Done**.



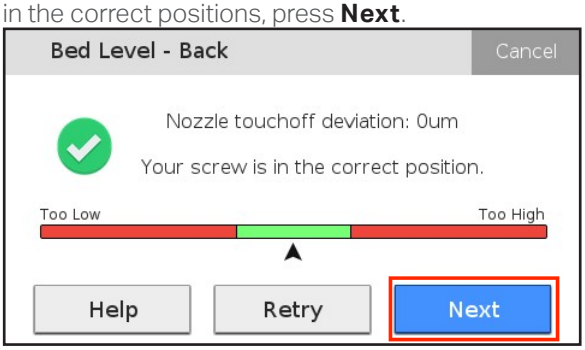
8. The printer will now scan its bed at 16 different points. **Do not touch the print bed or frame.** When the progress bar reaches 100%, press **Next**.

9. The print head will touch off on the rightmost end of the bed and state the current leveling of the right-hand bed leveling screw. If you are not within +/- 20µm (20 micrometers) of deviation (i.e. not in the green area of the leveling bar), use your hex key to adjust the height of the bed at that corner. The touchscreen will specify which direction to rotate the hex key. After making a slight adjustment, select **Retry** to have the print head touch off on the point again and update your readings. Continue adjusting the screw and selecting **Retry** until your reading is in the green area of the bed leveling bar, then select **Next**.

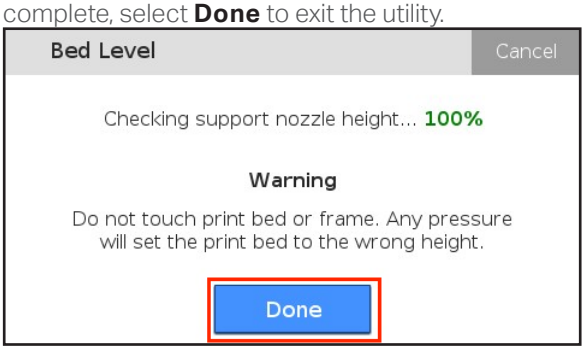




10. Follow the same adjustment instructions for the left and back bed leveling screws. When the screws are in the correct positions, press **Next**.



11. The printer will complete a final reading to verify that the bed is fully level. When the check is 100% complete, select **Done** to exit the utility.



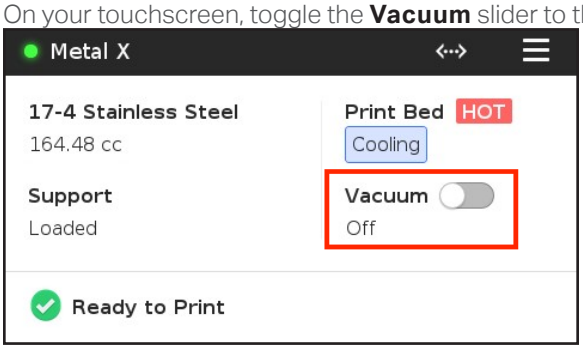
APPLYING A PRINT SHEET

Note: See Safety Notes *for additional instructions.*

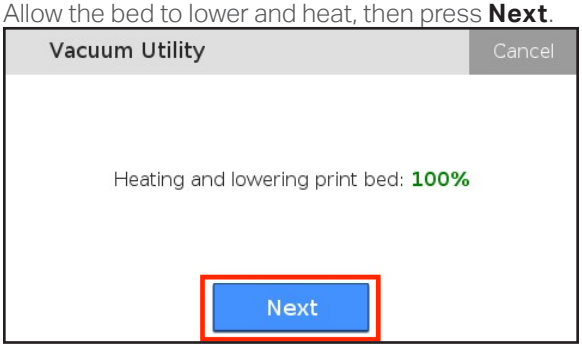
Supplies

- Print sheet
- Sheet press
- Brush from accessory kit

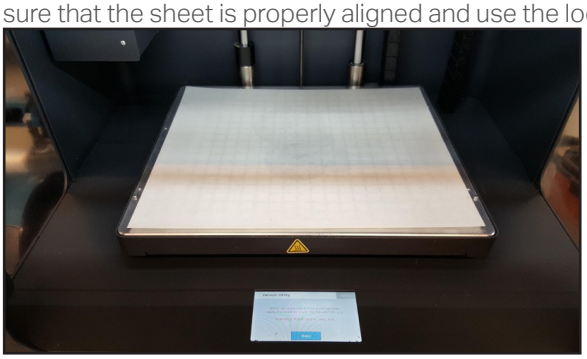
1. Using the brush from the Metal X accessory kit, brush all metal and support debris from the print bed. *Note: Keeping the print bed channels clean allows for a quality vacuum seal between the print bed and the print sheet.*
2. On your touchscreen, toggle the **Vacuum** slider to the **On** position.

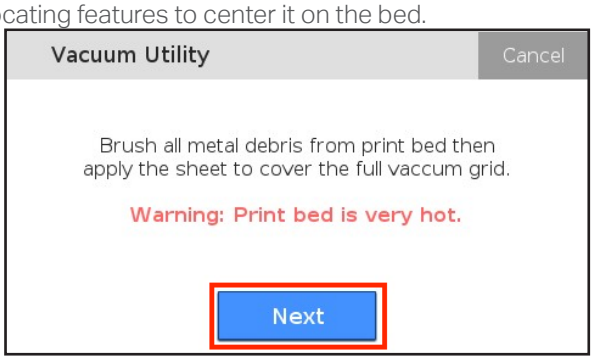


3. Allow the bed to lower and heat, then press **Next**.

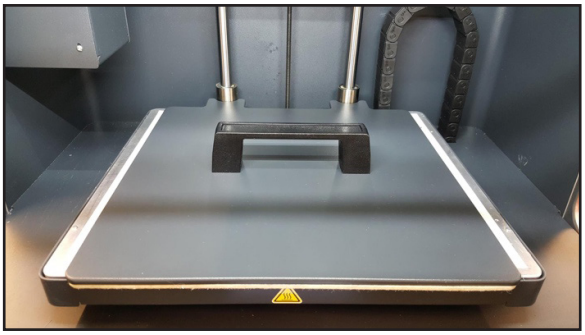


4. Apply the sheet to cover the full vacuum grid and press **Next**. Avoid touching the hot print bed. Make sure that the sheet is properly aligned and use the locating features to center it on the bed.

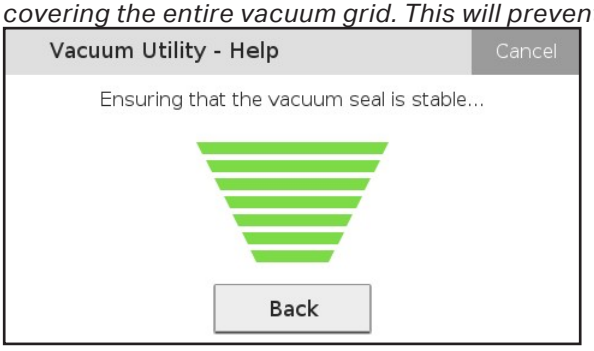




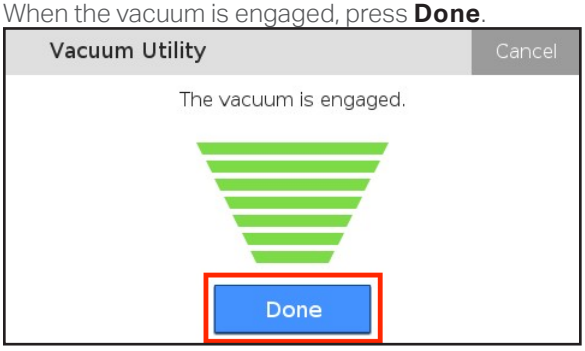
5. Place the sheet press on top of the print sheet. The sheet press aligns with the Z-rails at the rear of the chamber.



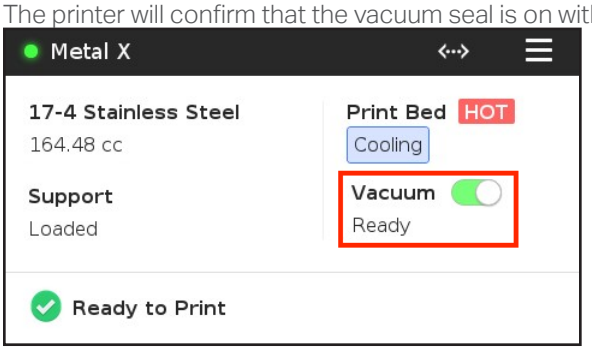
6. Wait a moment to allow the vacuum to create an engaged, stable vacuum seal.
Note: If the vacuum is taking a significant amount of time to engage, the print sheet may not be covering the entire vacuum grid. This will prevent the vacuum from creating a proper seal.



7. When the vacuum is engaged, press **Done**.

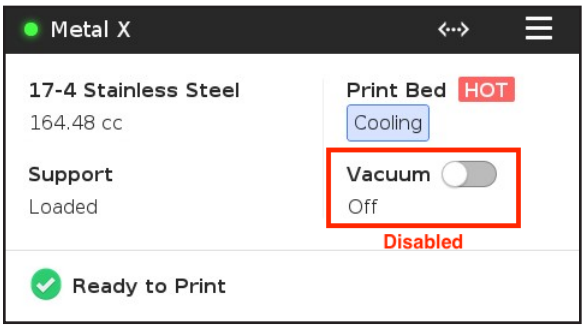


8. The printer will confirm that the vacuum seal is on with the **Vacuum** toggle highlighted green.



TURN OFF VACUUM SEAL

The vacuum seal can be disabled by toggling the **Vacuum** slider on your printer's dashboard. When the slider turns grey instead of green, the seal is disabled.



LOADING METAL FILAMENT

Note: See Safety Notes *section for additional instructions.*

Supplies

- Scale accurate to 1g (if performing metered load)
- Brush pan

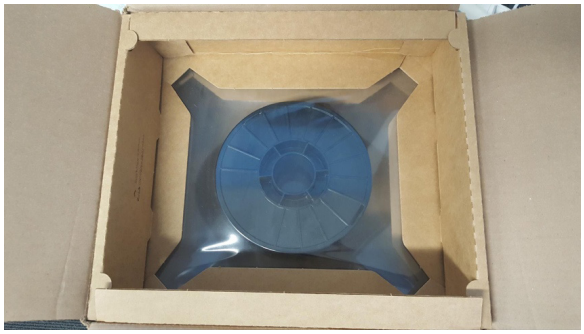
WHEN A SPOOL RUNS OUT

It is normal for a small piece of filament to droop down and break off when the printer reaches the end of a spool of print material. (The chances of this causing a print error, while not quite zero, are extremely low.) When this happens, discard the excess filament and follow the directions below to swap out the empty spool.

BEFORE LOADING MATERIAL

It is important to complete a visual inspection of metal filament spools before loading material. Carefully remove the new spool from its packaging.

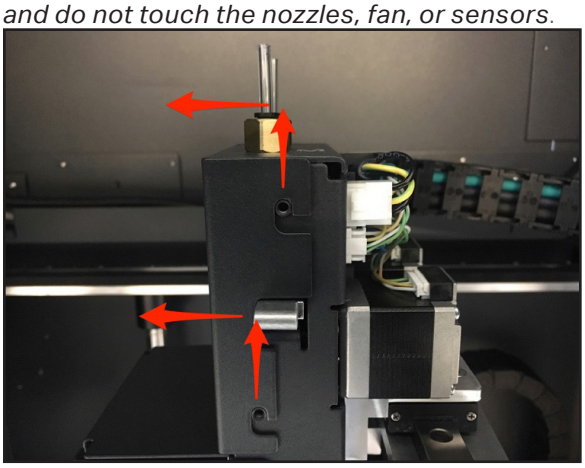
Note: The material is brittle, and the spool should be placed vertically at all times once removed from its packaging. Check the spool to ensure that the filament is not broken. If your material is damaged, please contact Markforged Support.



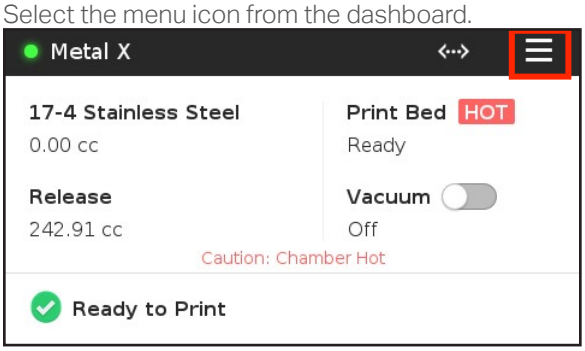
METERED LOAD

Material metering is a process carried out by your printer to track how much material is used during printing, and to therefore determine how much material you have left on a spool. In order for material metering to work, the printer has to be told how much material is on the spool when the filament is loaded into the printer. With your Metal X, you can use the Metered Load routine to tell the printer how much material you are starting with. From there, the printer will keep track of the rest and can even warn you when your print may require more filament than you have loaded.

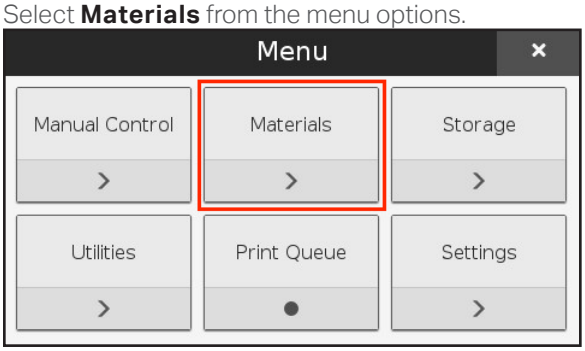
1. Manually move your print head to the center of the printing area, then remove the print head cover by sliding it up, forward, and off the mounting screws.
   Note: Always take extra care when working near the print head. Hold the print head from the top and do not touch the nozzles, fan, or sensors.



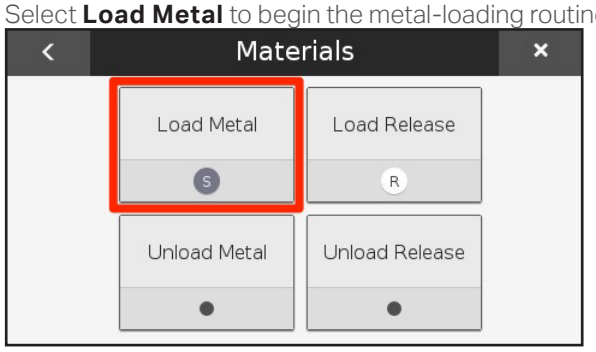
2. Select the menu icon from the dashboard.



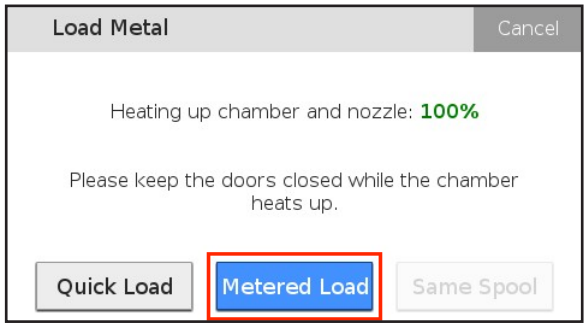
3. Select **Materials** from the menu options.



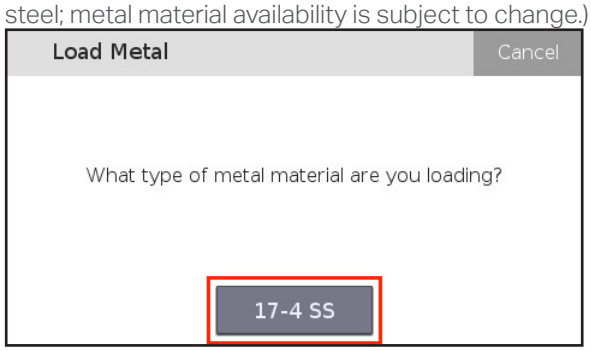
4. Select **Load Metal** to begin the metal-loading routine.



5. Select **Metered Load**.



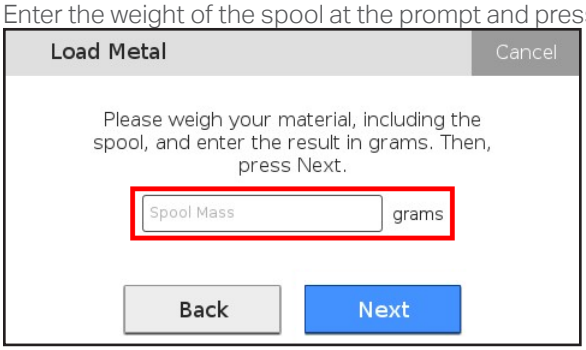
6. Select the type of metal material that you are loading. (Example images in this section use 17-4 stainless steel; metal material availability is subject to change.)

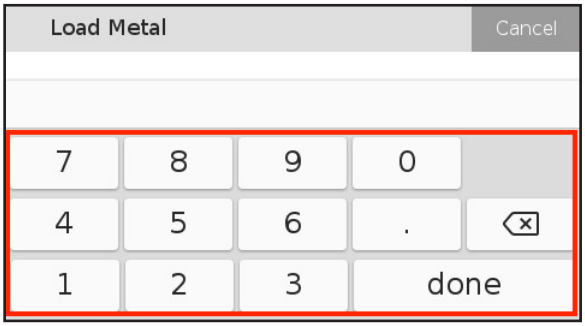


7. Indicate whether you are loading a full or partial spool.
*Note: Only select **Full Spool** if you are loading an entirely new spool of material; if any material on the spool has been used, please select **Partial Spool**.*
8. If you selected **Full Spool**, skip to step 9. If you selected **Partial Spool**, please follow the additional steps below to provide your printer with accurate weight information:

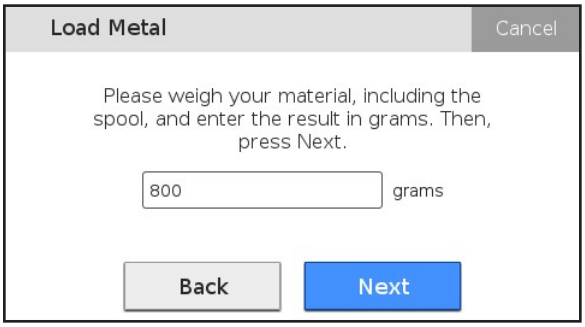
- Remove your material spool from its packaging. (Do not unspool the material.)

- Weigh the spool of material in an upright position and note the weight in grams.
  Note: The printer will automatically subtract the weight of the plastic spool to obtain the weight of the remaining material itself.
- Enter the weight of the spool at the prompt and press **Done**.

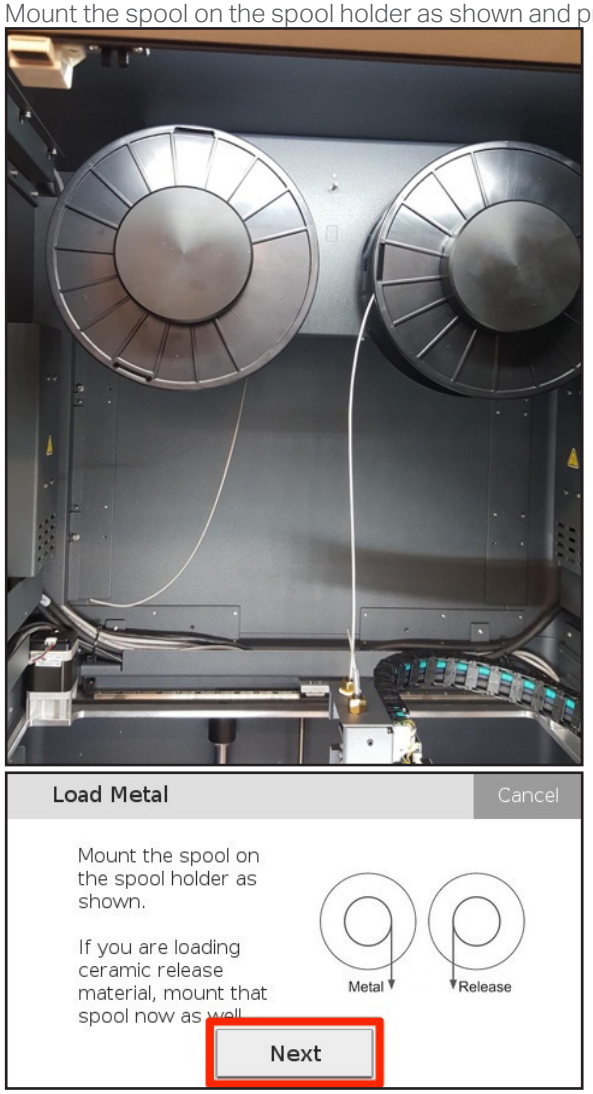




- Press **Next**.

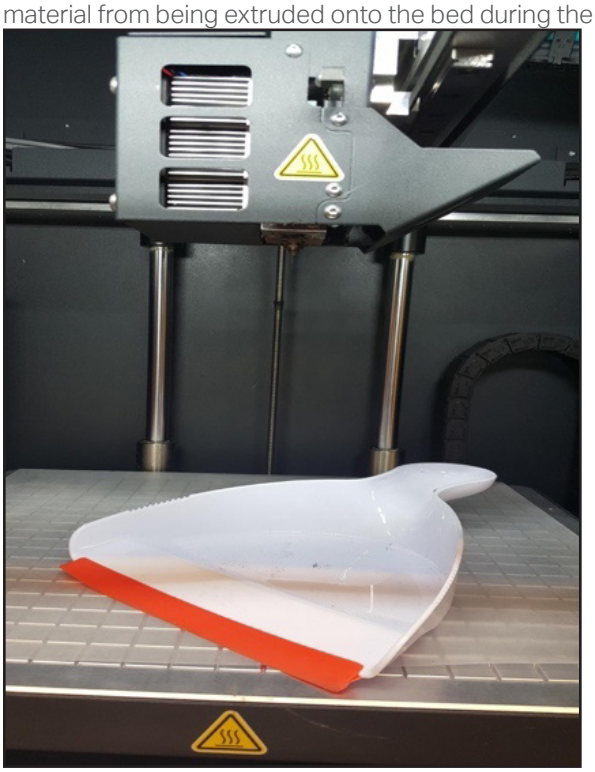


9. Mount the spool on the spool holder as shown and press **Next**.



10. Close the door and wait for the spools to warm up. You can skip this step if they have already been in the chamber for more than five minutes. When ready, press **Next**.
Note: This wait time is critical; the heated metal filament is more flexible and easier to work with.

11. Retrieve the brush pan from your accessory kit and position it under the print head. This will prevent material from being extruded onto the bed during the next step. Then press **Next**.



12. Remove any material expelled from the print head, then press **Next**.

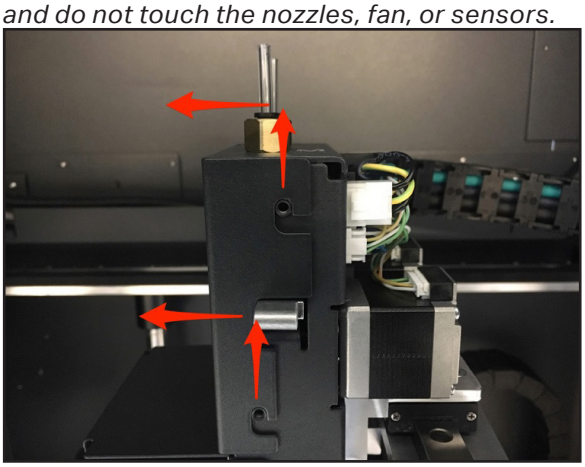
13. Feed the material into the frontmost inlet on the print head, marked "M," until the extruder is loaded and the material is drawn into the print head. When the filament has extruded onto the brush pan for five seconds, press **Stop**. Press **Done** to exit the utility or **Retry** to continue extruding material.

14. Remove the brush pan from the print bed and discard the extruded print material.
*Note: **Never** leave foreign objects in the print chamber or on the heated print bed.*
15. Replace the print head cover.

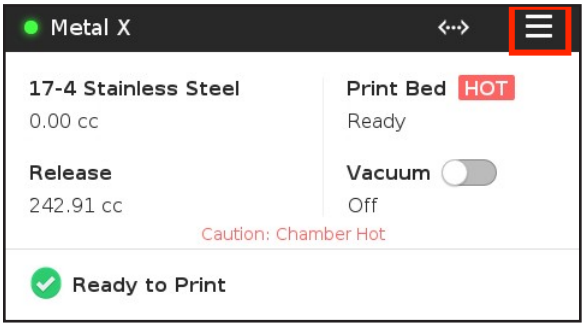
QUICK LOAD

If you do not want your printer to track the amount of material that is left, or don't have a scale handy, you can instead run the Quick Load routine. If you do so, your printer will not track material usage, and will be unable to alert you when your printer is running low on material. Instead, it will pause the print when material runs out, and alert you by email.

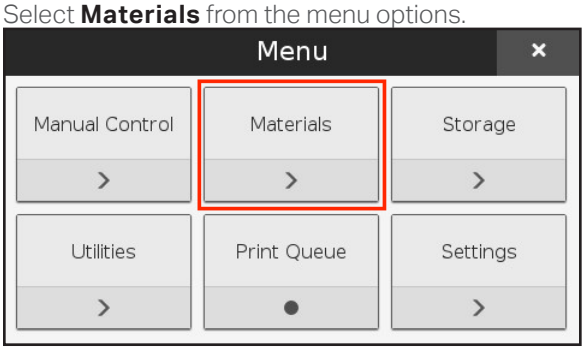
1. Manually move your print head to the center of the printing area, then remove the print head cover by sliding it up, forward, and off the mounting screws.
Note: Always take extra care when working near the print head. Hold the print head from the top and do not touch the nozzles, fan, or sensors.



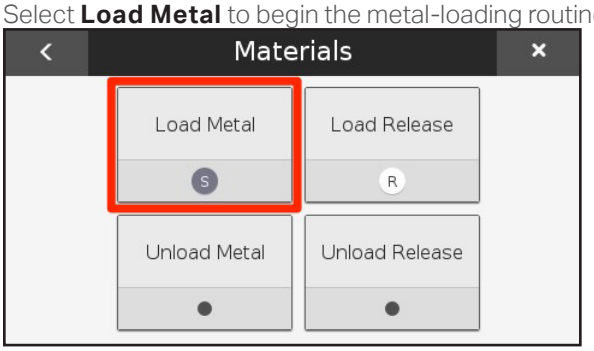
2. Select the menu icon from the dashboard.



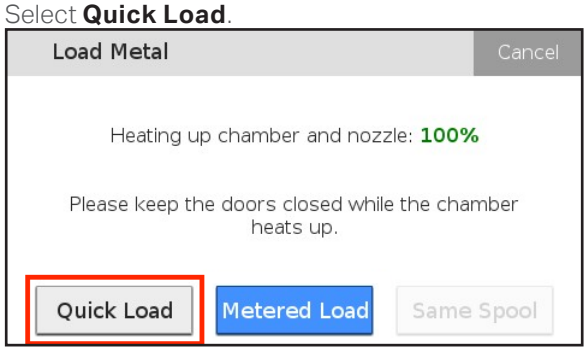
3. Select **Materials** from the menu options.



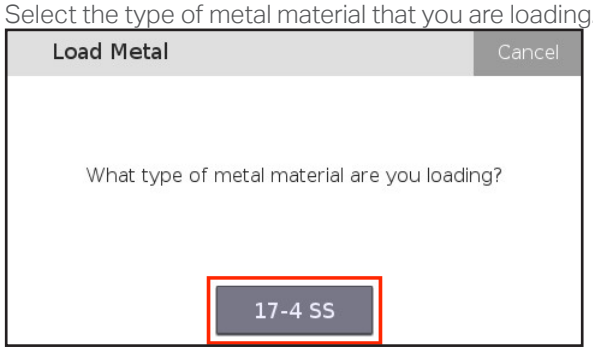
4. Select **Load Metal** to begin the metal-loading routine.



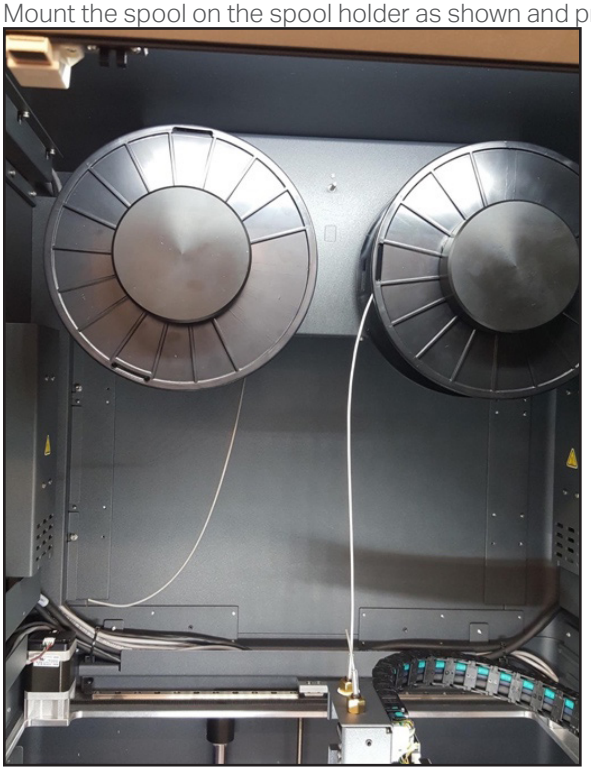
5. Select **Quick Load**.



6. Select the type of metal material that you are loading.

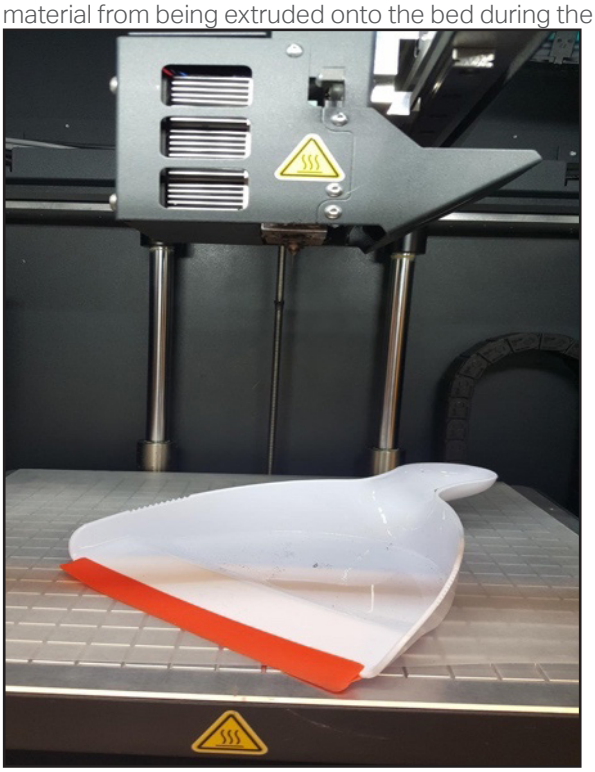


7. Mount the spool on the spool holder as shown and press **Next**.

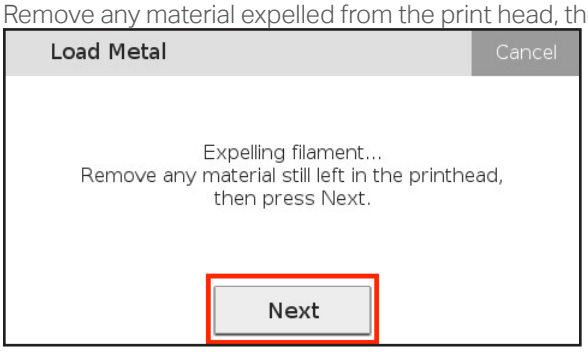


8. Close the door and wait for the spools to warm up. You can skip this step if they have already been in the chamber for more than five minutes. When ready, press **Next**.
Note: This wait time is critical and allows the metal material to be loaded properly.

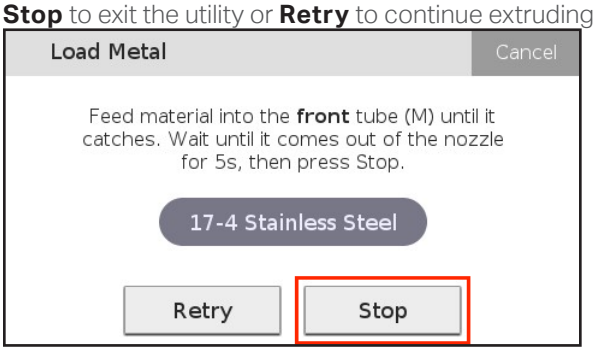
9. Retrieve the brush pan from your accessory kit and position it under the print head. This will prevent material from being extruded onto the bed during the next step. Then press **Next**.



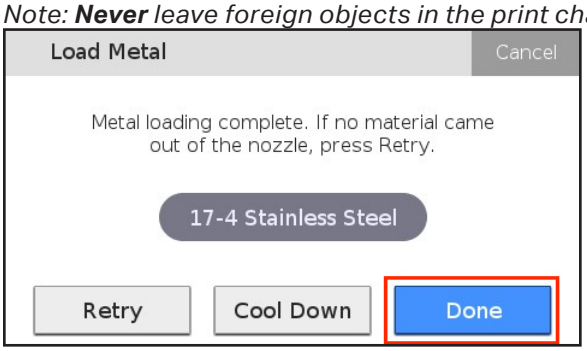
10. Remove any material expelled from the print head, then press **Next**.



11. Feed the material into the frontmost inlet on the print head (marked "M") until the extruder begins to draw material through the print head. When the filament begins to extrude from the nozzle, press **Stop**. Press **Stop** to exit the utility or **Retry** to continue extruding material.



12. Remove the brush pan from the print bed and discard the extruded release material.
*Note: **Never** leave foreign objects in the print chamber or on the heated print bed.*



13. Replace the print head cover.

LOADING RELEASE FILAMENT

Note: See Safety Notes *for additional instructions.*

Supplies

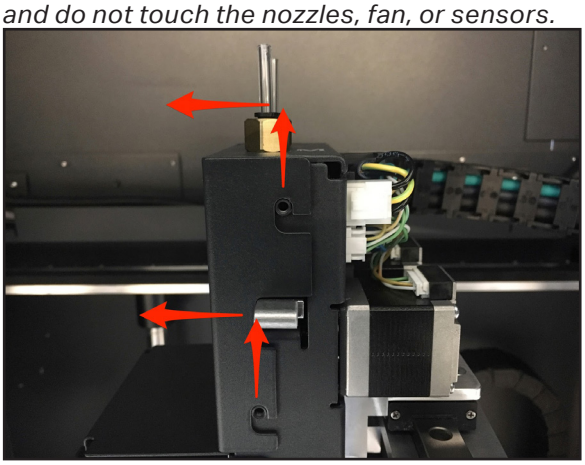
- Scale accurate to 1g (if performing metered load)
- Brush pan

Release material is not as fragile as metal print material and doesn't require the same precautions during storage.

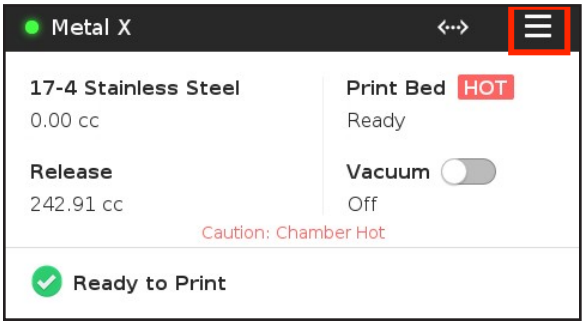
METERED LOAD

Material metering is a process carried out by your printer to track how much material is used during printing, and to therefore determine how much material you have left on a spool. In order for material metering to work, the printer has to be told how much material is on the spool when the filament is loaded into the printer. With your Metal X, you can use the Metered Load routine to tell the printer how much material you are starting with. From there, the printer will keep track of the rest and can even warn you when your print may require more release filament than you have loaded.

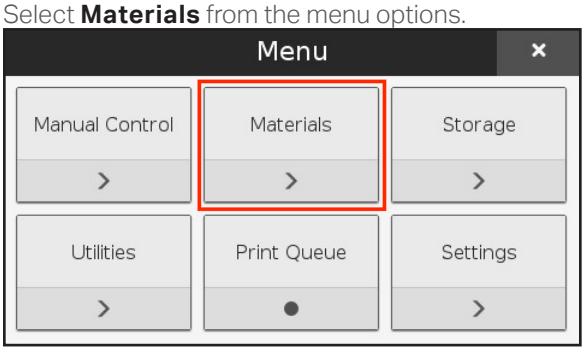
1. Manually move your print head to the center of the printing area, then remove the print head cover by sliding it up, forward, and off the locating features.
   Note: Always take extra care when working near the print head. Hold the print head from the top and do not touch the nozzles, fan, or sensors.



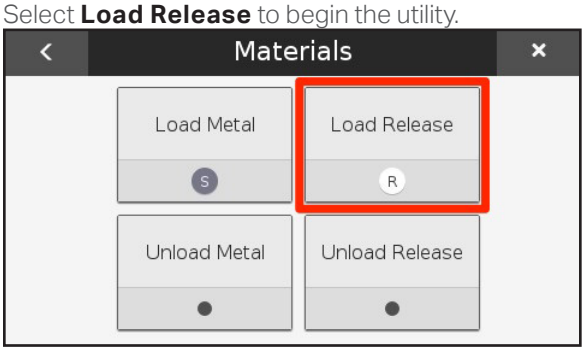
2. Select the menu icon from the dashboard.



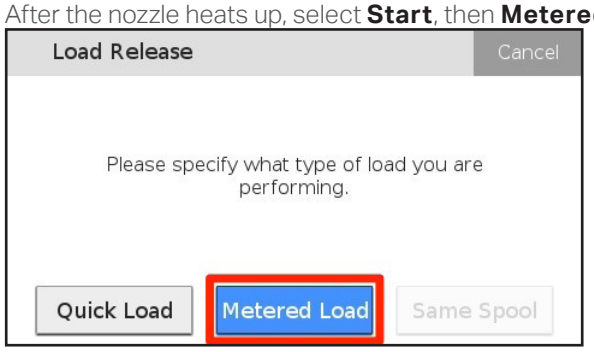
3. Select **Materials** from the menu options.



4. Select **Load Release** to begin the utility.



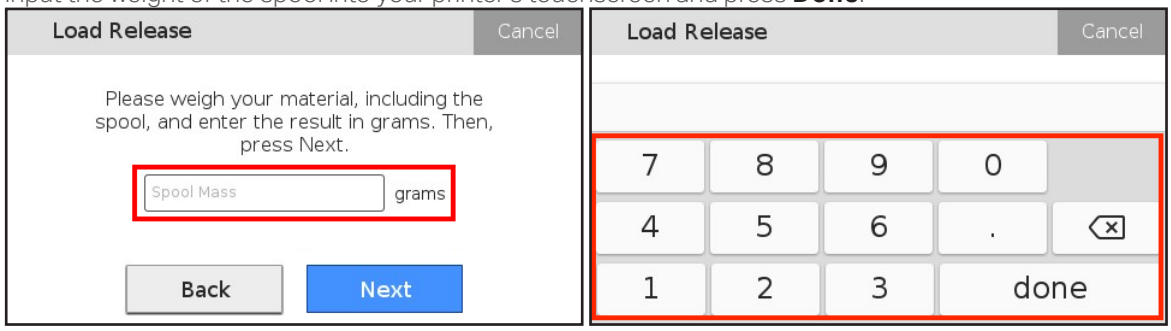
5. After the nozzle heats up, select **Start**, then **Metered Load** on the printer's touchscreen.



6. Select the type of spool that you are loading.
*Note: Only select **Full Spool** if you are loading a new 200cc spool of material. For any other options, please select **Partial Spool**.*

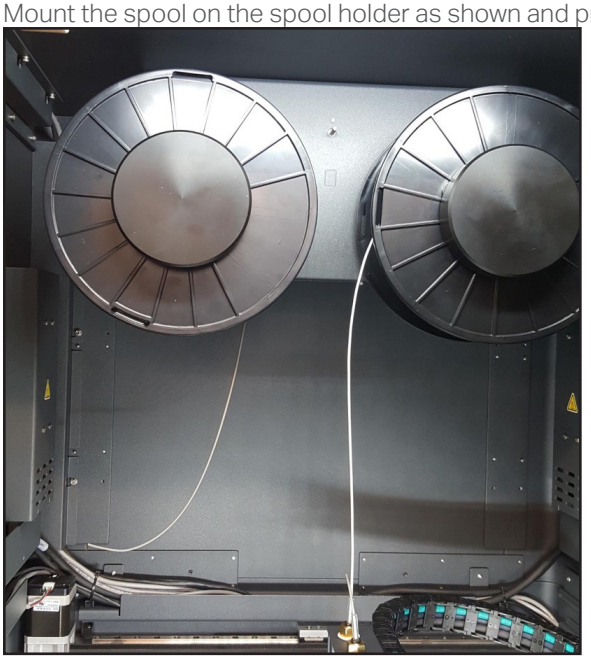
7. If you selected **Full Spool**, skip to step 8. If you selected **Partial Spool**, please follow the additional steps below to provide your printer with accurate weight information:

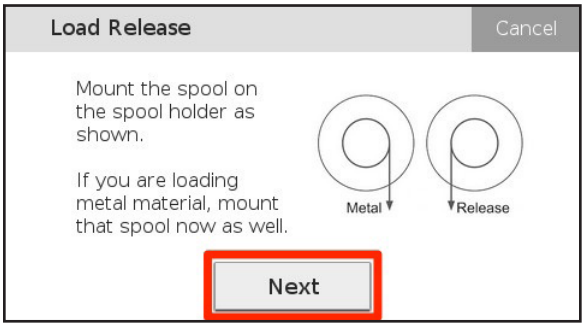
- Remove your material spool from its packaging but do not unspool it.
- Weigh the spool of material, in grams.
Note: The printer will automatically subtract the weight of the plastic spool to obtain the weight of the material itself.
- Input the weight of the spool into your printer's touchscreen and press **Done**.



- Press **Next**.

8. Mount the spool on the spool holder as shown and press **Next**.





9. Retrieve the brush pan from your accessory kit and hold it under the print head. This will prevent material from being extruded onto the bed. Then press **Next**.

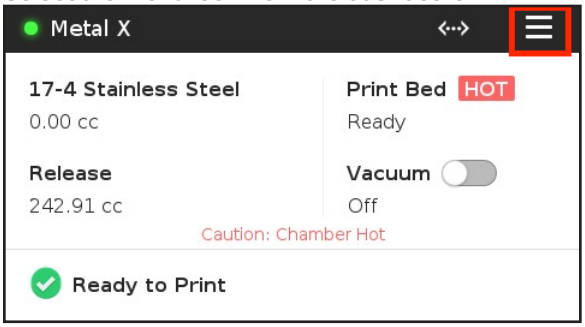
10. Feed the material into the rear brass inlet until the extruder is loaded. When the release material extrudes from the nozzle for a few seconds, press **Stop**. Press **Stop** to exit the utility or press **Retry** to continue extruding material.
Note: The filament extrudes very slowly and will take about a minute and a half to extrude. This process takes markedly longer than loading metal filament.

11. Remove the brush pan from the print bed. Never leave foreign objects in the print chamber.
12. Replace the print head cover.

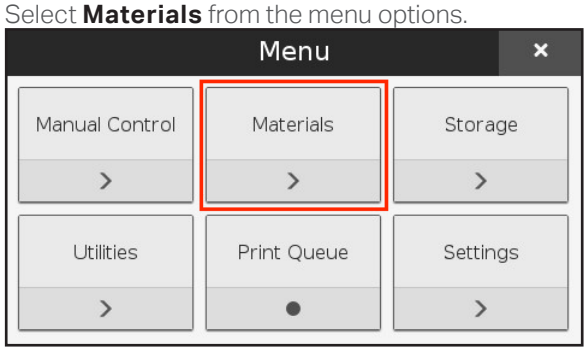
QUICK LOAD

If you do not want your printer to track the amount of material that is left, or don't have a scale handy, the printer allows you to run a Quick Load routine. If you use the Quick Load routine when loading filament, your printer will be unable to alert you when your printer is running low on material.

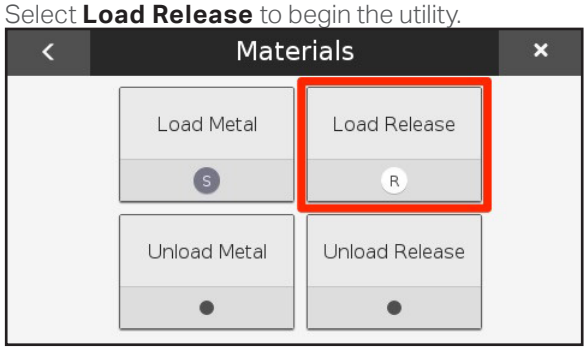
1. Manually move your print head to the center of the printing area, then remove the print head cover by sliding it up, forward, and off the locating features.
Note: Always take extra care when working near the print head. Hold the print head from the top and do not touch the nozzles, fan, or sensors.
2. Select the menu icon from the dashboard.



3. Select **Materials** from the menu options.

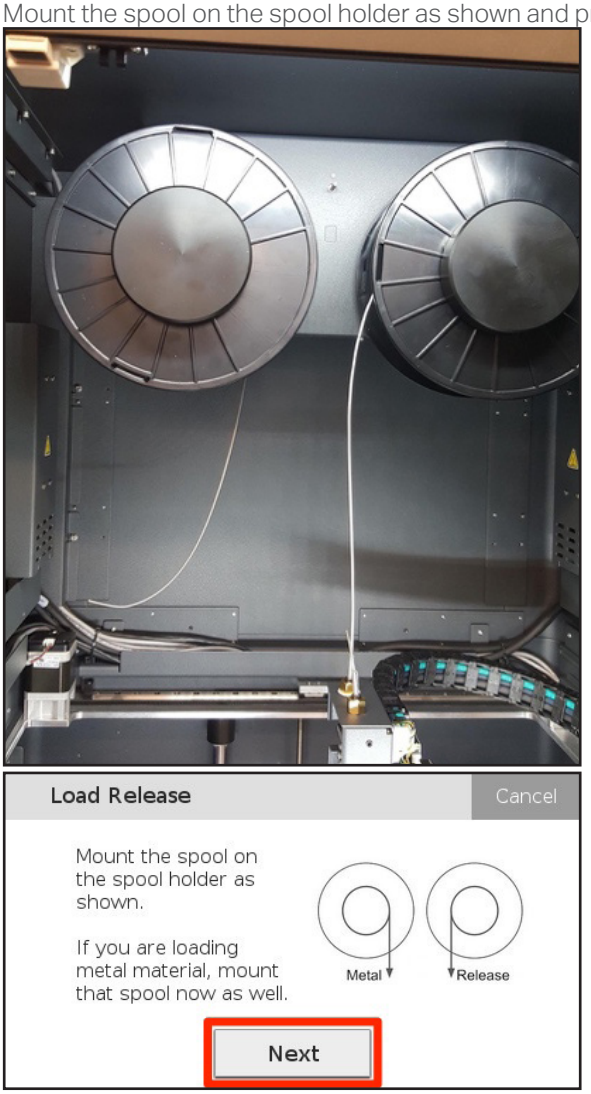


4. Select **Load Release** to begin the utility.

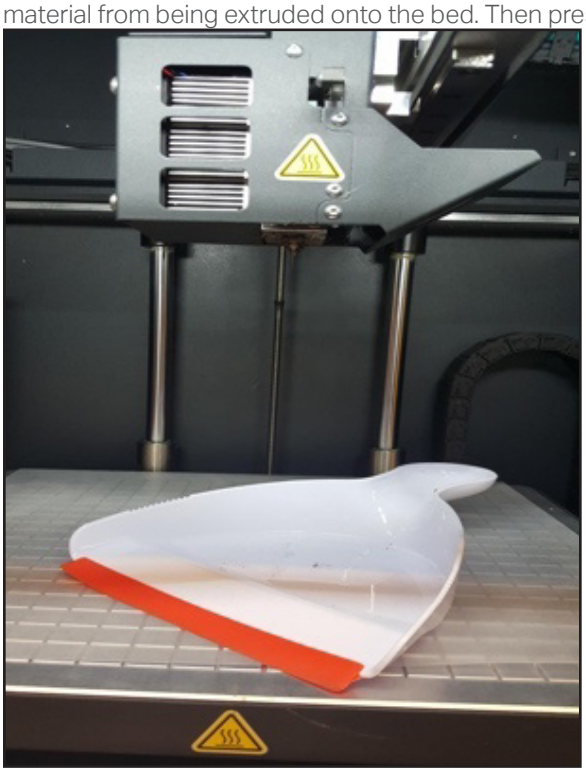


5. Select **Quick Load**.

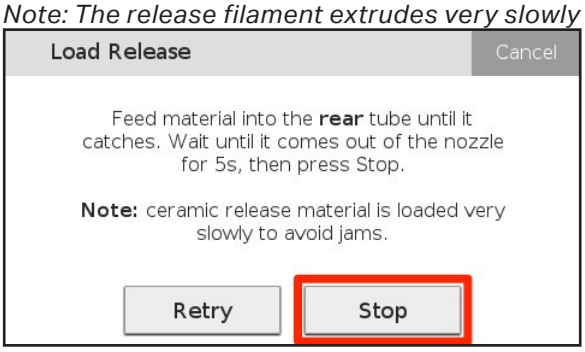
6. Mount the spool on the spool holder as shown and press **Next**.



7. Retrieve the brush pan from your accessory kit and position it under the print head. This will prevent material from being extruded onto the bed. Then press **Next**.



8. Feed the material into the rear brass inlet until the extruder is loaded. When the release material extrudes from the nozzle for a few seconds, press **Stop**. Press **Stop** to exit the utility or press **Retry** to continue extruding material.
   Note: The release filament extrudes very slowly and will take longer than loading metal filament.

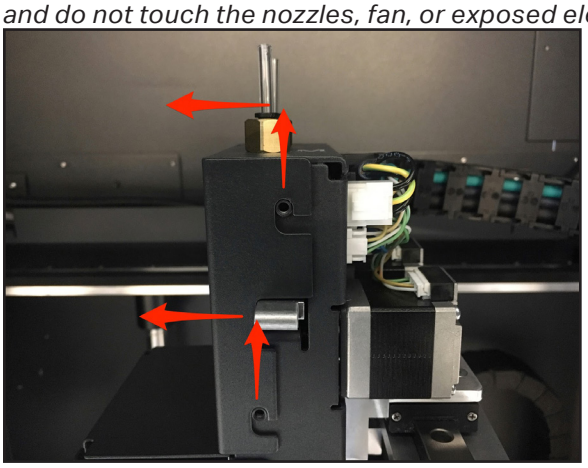


9. Remove the brush pan from the print bed. Never leave foreign objects in the print chamber.
10. Replace the print head cover.

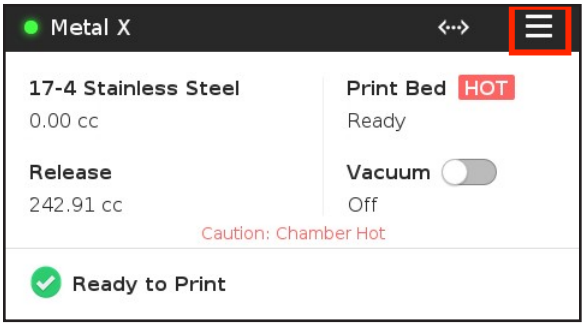
UNLOADING METAL FILAMENT

Note: See Safety Notes *for additional instructions.*

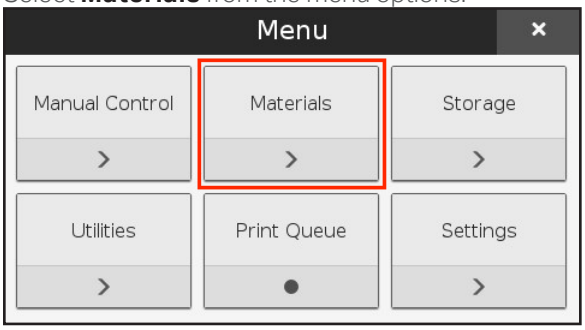
1. Manually move your print head to the center of the printing area, then remove the print head cover by sliding it up, forward, and off the locating features.
   Note: Always take extra care when working near the print head. Hold the print head from the top and do not touch the nozzles, fan, or exposed electronics.



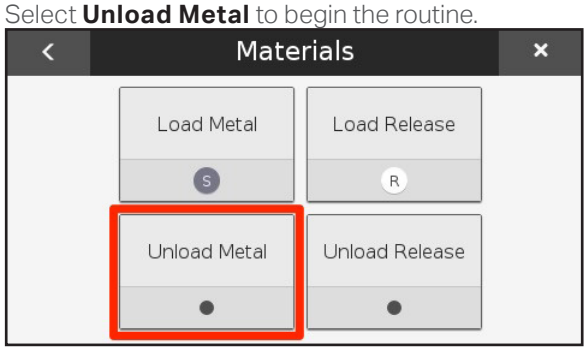
2. Select the menu icon from the dashboard.



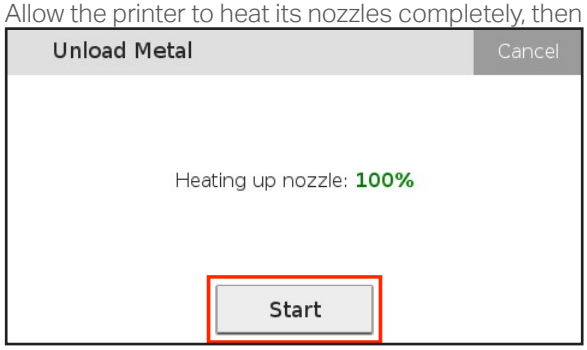
3. Select **Materials** from the menu options.



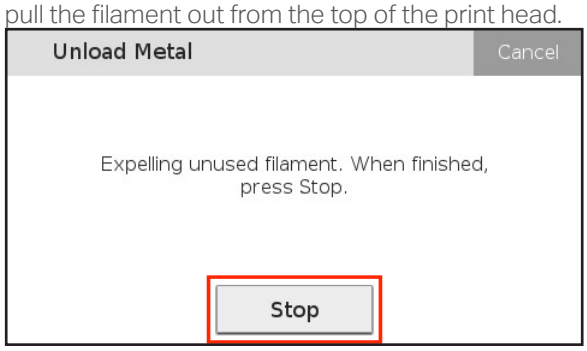
4. Select **Unload Metal** to begin the routine.



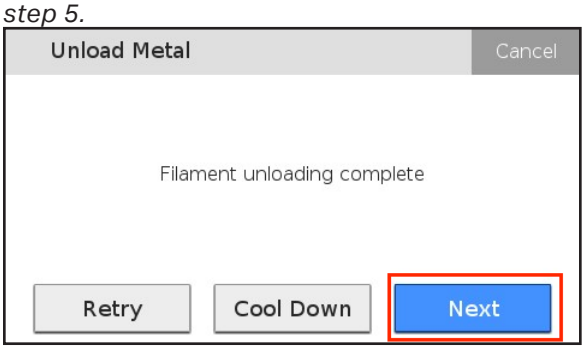
5. Allow the printer to heat its nozzles completely, then select **Start**.



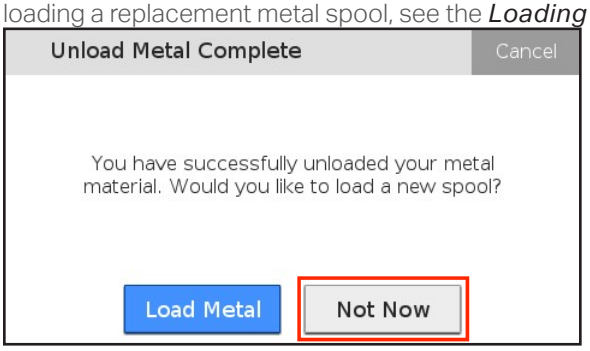
6. Allow a few seconds for the printer to expel used filament and select **Stop**. You should be able to gently pull the filament out from the top of the print head.



7. Press **Cool Down** to cool the print head, or **Next** if you wish to load a new spool of metal material.
*Note: f you cannot pull the metal filament out of the print head, press **Retry** and continue from step 5.*

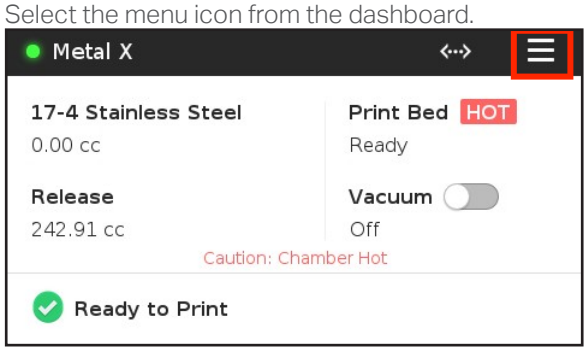


8. Press **Load Metal** to load a different metal spool or **Not Now** to exit the routine. For instructions on loading a replacement metal spool, see the *Loading Metal Filament* section.

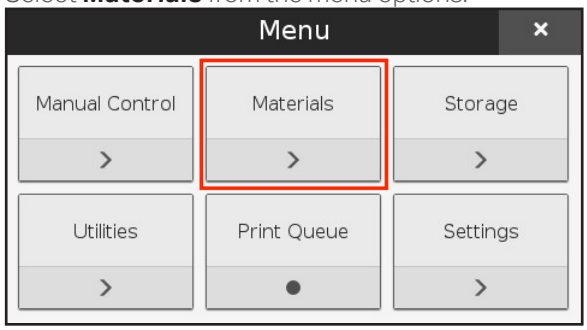


UNLOADING RELEASE FILAMENT

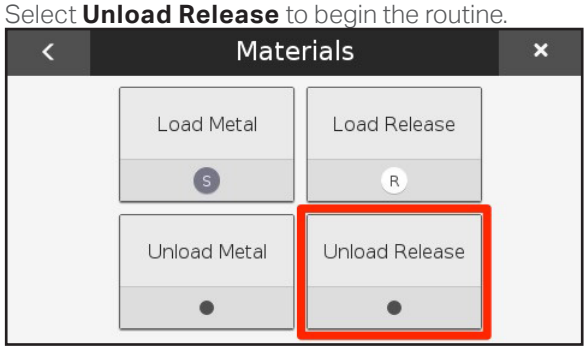
1. Manually move your print head to the center of the printing area, then remove the print head cover by sliding it up, forward, and off the locating features.
   Note: Always take extra care when working near the print head. Hold the print head from the top and do not touch the nozzles, fan, or sensors.
2. Select the menu icon from the dashboard.



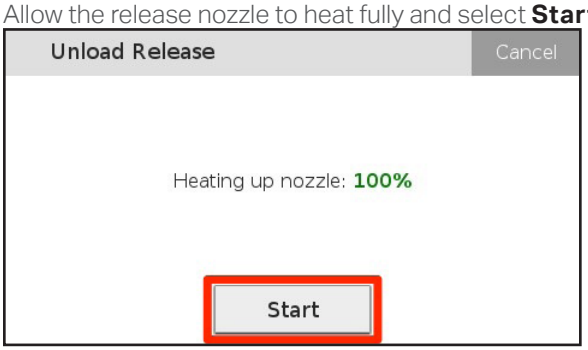
3. Select **Materials** from the menu options.



4. Select **Unload Release** to begin the routine.

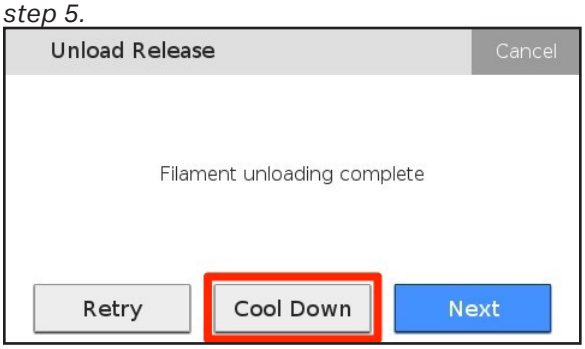


5. Allow the release nozzle to heat fully and select **Start**.



6. Allow a few seconds for the printer to expel used filament, then select **Stop**. You should be able to gently pull the filament out from the **top** of the print head.

7. Press **Cool Down** to cool the print head, or **Next** if you wish to load a new spool of release material.
*Note: If you cannot pull the release filament out of the print head, press **Retry** and continue from step 5.*



8. Select **Load Release** to load a different release spool or **Not Now** to exit the routine. For instructions on loading a replacement spool, please see the *Loading Release Filament* section.

MATERIAL STORAGE / DISPOSAL

Improperly stored or handled print material can suffer damage, leading to reduced part quality, interrupted and failed prints, and unnecessary waste of time and materials. This article outlines proper care and storage of metal print material.

HUMIDITY

Unlike Markforged plastic material, Markforged metal filament isn't particularly sensitive to environmental humidity. However, you should avoid operating your printer or storing your print material in extreme conditions.

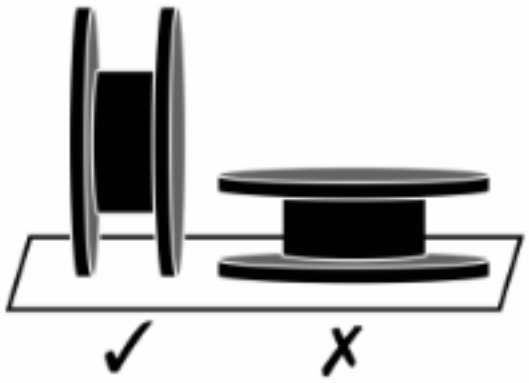
Consult the ***Metal X System Facilities Guide*** for printer environmental requirements.

TEMPERATURE

While the metal print material is fairly robust against environmental humidity, it is quite sensitive to changes in ***temperature***, growing increasingly brittle at low temperatures and potentially beginning to thermally debind in high heat. We recommend storing material and operating the printer within the temperature range given in the ***Facilities Guide*** (19-30°C, 66-85°F). Spools should be kept under 40° Celsius for long-term storage.

Do not store spools in direct sunlight, even inside their original packaging.

IMPACT / ORIENTATION



Metal filament is quite brittle at room temperature, while release filament is slightly less so but can unwind when mishandled. To avoid tangles, always store spools —both full and partial—in a **vertical orientation** with as little slack in the spool as possible. To avoid breakage, avoid sharp shocks to the spool.

Note: Do not drop the spool. If you drop a metal spool that is no longer in its original padded packaging, you should assume that the material is compromised (cracked or broken) and ***not*** usable.

To prevent tangles, unspooling, and breakage when moving a spool, we recommend using painter's tape to secure the end of the filament to the spool.

***Note regarding release material**: It is especially important to store spools of release filament in a vertical orientation, to avoid unspooling.*

SEAL / ORIGINAL PACKAGING

Keep spools in their original sealed packaging until ready to use. Metal spools in their original packaging can be stored horizontally or vertically, though they should be handled with care. Once spools have been removed from their original packaging, store them vertically.

Avoid exposing print material to dust, dirt, and debris. Cover material in storage to prevent exposure to contaminants.

SHELF LIFE

When stored safely in its original packaging at a moderate temperature, metal material can potentially be kept safely on the shelf for a year. However, we recommend against over-purchasing or using old material.

STORAGE INSIDE PRINTER

The upper chamber of the Metal X is warmed to make for more flexible, less brittle material. A spool can be safely stored in the upper chamber of an idle printer; leaving the spool on the spindle within the printer's upper chamber will not cause damage to the material.

DISPOSAL

Please contact your local waste management facility to learn of their preferred method of disposal for this type of item.

PRINTING A METAL PART

Make sure the print sheet is set up on the print bed before you start printing. Follow the instructions in *Adjust Part Orientation*, below, then continue on to one of the following subsections based on your printer's status:

- *Print to Online, Available Printer*
- *Print to Online, Busy Printer*
- *Print to Offline Printer*

IMPORTANT NOTE ABOUT PART SIZES

It is important to distinguish between the maximum printable size for printed parts from the Metal X, and the maximum sinterable size for parts going into the Sinter-1.

The Metal X is able to print parts larger than the setter plate of the Sinter-1. However, a printed part, including its *raft*, must fit entirely on the setter plate when sintering. For very large parts, Eiger offers an **External Sintering** setting.

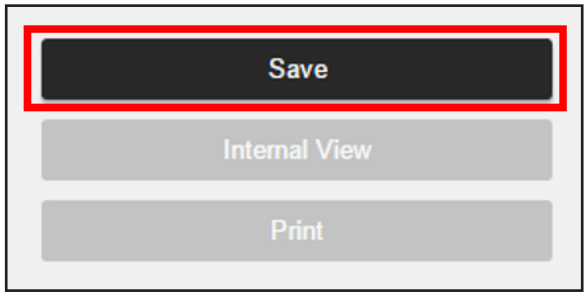
See the *Metal X Design Guide* for information on designing your parts for successful printing, washing, and sintering with the Metal X System.

IMPORTANT NOTE ABOUT MATERIAL BUILDUP

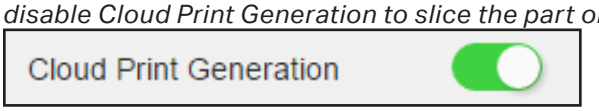
Note that some material buildup on the side of the nozzle is normal during the first few layers of a print (the raft). There is no need to pause or cancel your print when you observe this behavior, which should resolve after the initial layers and should not cause problems with the part itself. In case of error, the printer will pause automatically and prompt you for input.

ADJUST PART ORIENTATION

1. Open your part in Eiger and configure it as needed. Change the part's orientation on the print bed by clicking on a face of the part in the main view (which will make that face the base of the print), or by selecting **Manual Rotation** and entering the desired values.
2. Press **Save**.

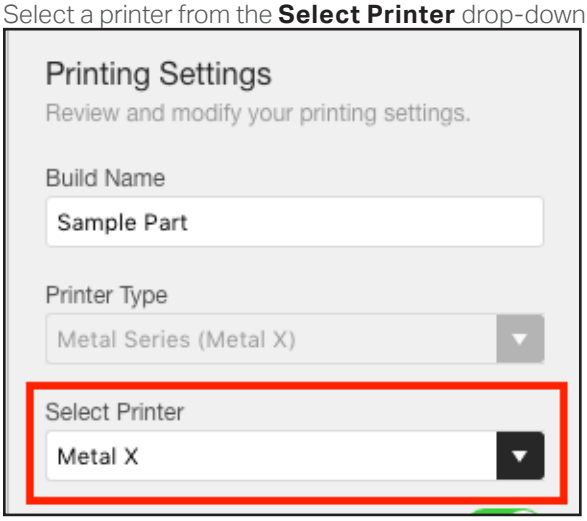


3. You can inspect and edit layers in the **Internal View**. When you are finished examining the layers, click the **Print** button at the bottom right corner of the screen.
4. Move the part to the desired position on the print bed.
5. Enable or disable the **Cloud Print Generation** toggle button as desired. Cloud Print Generation refers to generating the .MFP print (i.e. *slicing* the part) remotely on our servers instead of in your browser. This means you can minimize the browser while the print is being generated.
   Note: If you send a very large and complex part to be sliced using Cloud Print Generation, the process will time out after 15 minutes. In the rare event that you need to print such a part, disable Cloud Print Generation to slice the part on your local machine instead.

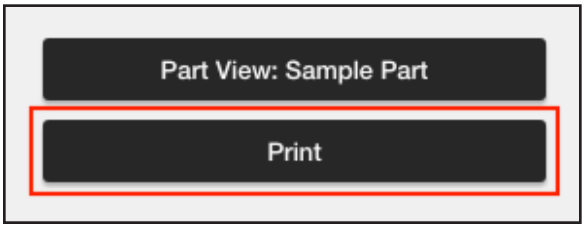


PRINT TO ONLINE, AVAILABLE PRINTER

1. Select a printer from the **Select Printer** drop-down menu, listed under **Available**.

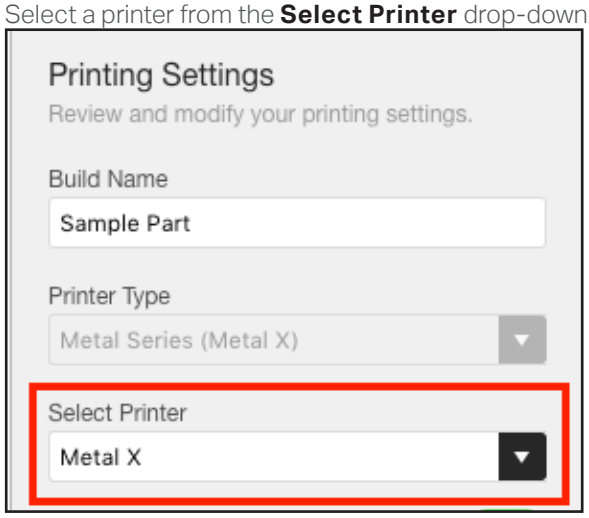


2. Press the Print button.

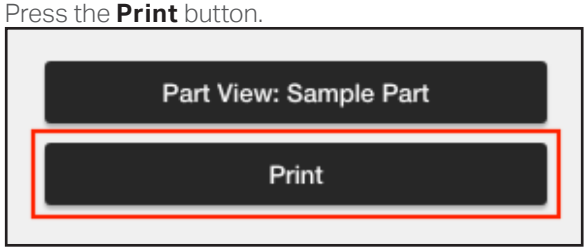


PRINT TO ONLINE, BUSY PRINTER

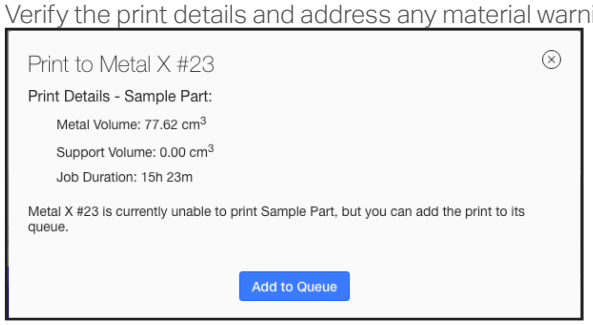
1. Select a printer from the **Select Printer** drop-down menu, listed under **Busy**.



2. Press the **Print** button.



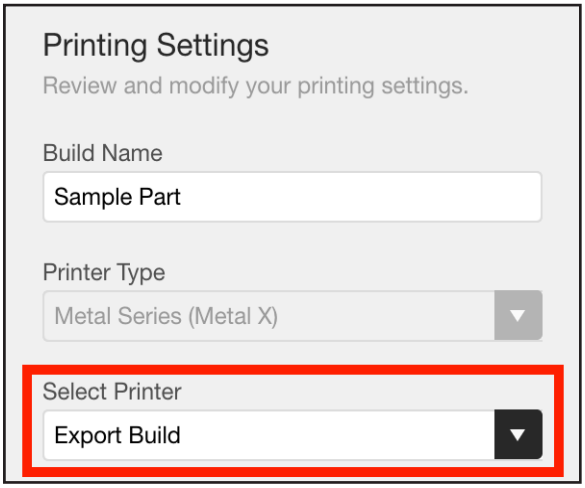
3. Verify the print details and address any material warnings listed in the pop-up window.



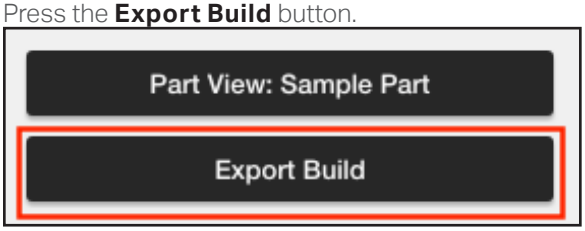
4. Select **Add to Queue** to add the print to the end of that printer's queue, or select **Print Next** to add the print to the top of that printer's print job queue.

PRINT TO OFFLINE PRINTER

1. Select **Export Build** from the drop-down menu in the **Printing Settings** panel at the right side of the screen.

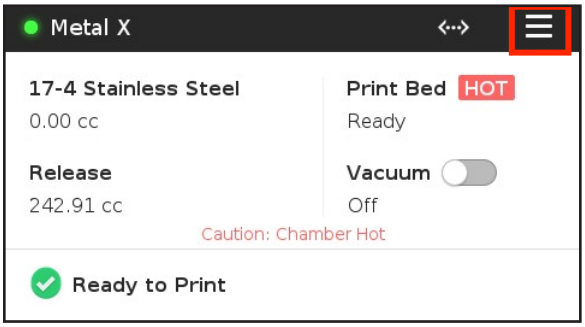


2. Press the **Export Build** button.

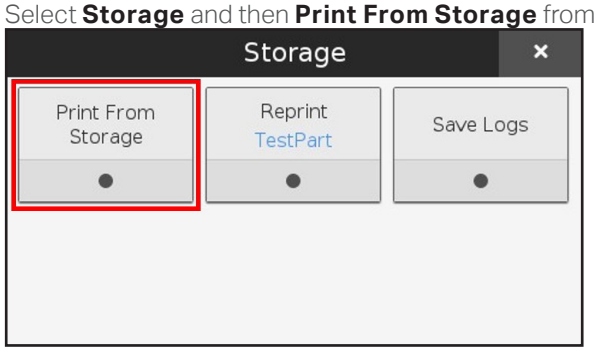


3. Save the file that downloads to a FAT32-formatted USB drive and plug the USB drive into your printer. *Note: **Do not** use the factory reset USB drive that came with your printer. The USB port can be found on the right side of the printer.*

4. Select the menu icon from the dashboard.



5. Select **Storage** and then **Print From Storage** from the menu options.

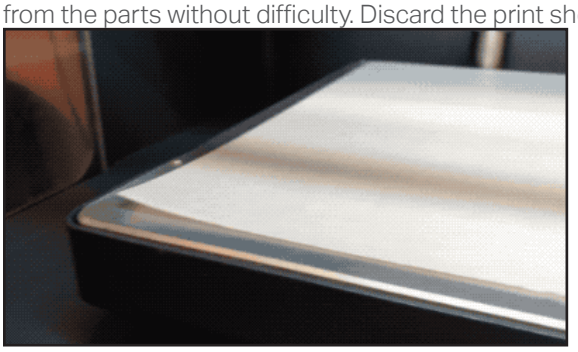


6. Select the part file on the screen to initiate the print.

SAFELY REMOVING METAL PARTS

METAL PART REMOVAL

1. Once a part has finished printing on the Metal X, the print bed will begin cooling automatically. The cooldown cycle should be thought of as a regular part of the print process.
2. You will receive an email notification when the print bed is completely cooled. Alternatively, you can select **Skip Cooling** on the touchscreen to cancel the cooldown process, though **we recommend always cooling the part on the print bed** before removing the part to avoid part warping and potential operator injury. Once the cooldown is completed or cancelled, the print bed vacuum seal will automatically disengage.
   Note: See Safety Notes *for additional instructions.*
3. You can assign the print a 1-5 star quality rating on the touchscreen, which will be viewable in the **Print History** feature in Eiger.
4. Select **Clear Bed** to change the printer's status to **Ready** in the Eiger queue.
   Note: At this point the part and print bed should be safe to handle, but may still feel warm to the touch, especially the print bed.
5. Carefully slide the print sheet and printed parts off of the print bed.
6. Gently remove the part(s) from the print sheet. You should be able to peel the flexible print sheet away from the parts without difficulty. Discard the print sheet.



PART HANDLING AFTER REMOVAL

Printed parts should be handled carefully. Though the parts are not brittle, rough handling or falls can damage them. A dropped or roughly handled part may contain invisible micro-fractures that can compromise part strength. Make sure to set the warm part down only on an *insulated surface* to avoid damaging the part by cooling it too rapidly.

Newly printed *green parts* must be washed in a Markforged Wash-1 debinding station. For more information on loading parts into the Wash-1 station, please see the *Loading Green Parts* section of the *Wash-1 User Guide*.

CLEARING METAL MATERIAL JAMS

Supplies

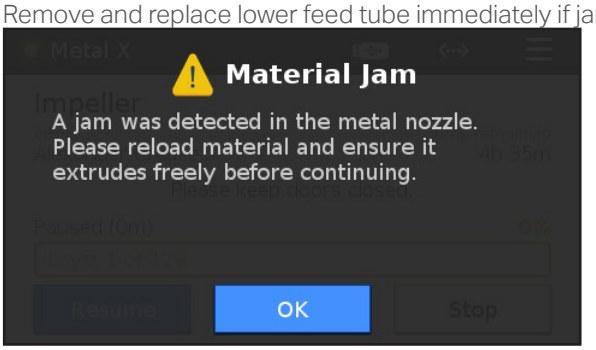
- Tweezers
- Anti-Seize
- Wire brush (included in accessory kit)
- Nozzle wrench (included in accessory kit)
- Purge rod (included in accessory kit)
- 2mm hex key
- 2.5mm hex key
- Replacement metal nozzle
- Replacement feed tube(s)

A printer jam occurs when buildup in the print head material pathway prevents proper extrusion from the nozzle.

In the event of a printer jam, follow these steps one at a time, as needed, to locate and correct the cause of the jam. The majority of printer jams can be resolved without canceling your print in progress.

After each section of this troubleshooting workflow, resume the print. If the jam has been remedied, you are finished troubleshooting. If not, proceed to the next section. The

- Unload and reload print material; clean nozzle tip.
- Remove nozzle; clear material pathway using purge rod; reinstall old nozzle.
- Install replacement nozzle.
- Remove and replace lower feed tube immediately if jam persists, otherwise after print completes.

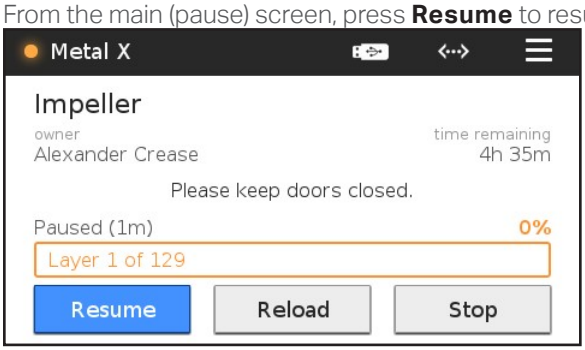


UNLOAD AND RELOAD PRINT MATERIAL

Begin troubleshooting your printer jam by unloading and reloading the filament.

1. Follow the instructions in the ***Unloading Metal Filament*** section to clear the loaded metal filament from the print head.

2. Follow the instructions in the *Loading Metal Filament* section to reload the material.
3. From the main (pause) screen, press **Resume** to resume the paused print job.

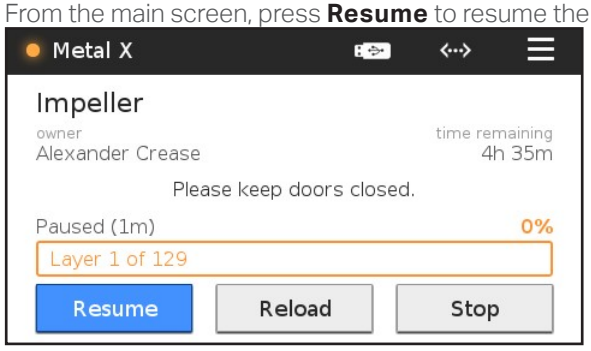


If reloading print material does not resolve the jam, proceed to the next section: clearing the material pathway using the purge rod.

CLEAR MATERIAL PATHWAY USING PURGE ROD

1. Follow the instructions in the *Unloading Metal Filament* section to clear the loaded metal filament from the print head.
2. While the nozzle is hot, use the torque wrench to carefully remove it from the print head. Set the nozzle aside, taking care not to touch the hot nozzle with your bare hands.
3. While pressing down on the front release arm, use the thin metal purge rod to carefully push all the way through the inlet tube, idler wheel assembly, and outlet tube, and out through the opening on the underside of the print head. Then withdraw the purge rod.
4. Carefully clean the nozzle tip with the included wire brush.
5. Carefully apply Anti-Seize to the threads of the metal nozzle.
6. Using the nozzle wrench, tighten the metal nozzle partway, then unscrew it completely to distribute Anti-Seize across the threads. Finally, ***fully*** tighten the nozzle with the nozzle wrench until the wrench clicks.
7. Follow the instructions in the *Loading Metal Filament* section to feed metal filament back into the print head. Ensure that material passes through the nozzle.

8. From the main screen, press **Resume** to resume the paused print job.



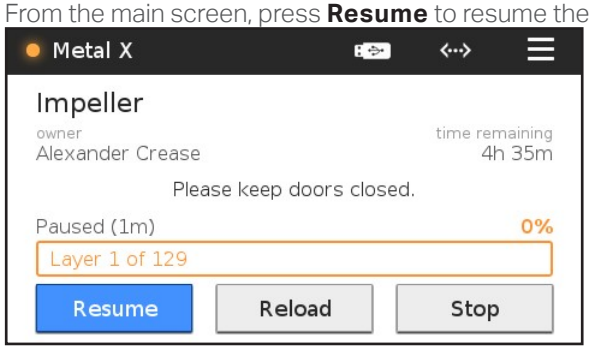
If using the purge rod effectively clears the material jam, allow the print to complete, then replace the lower feed tube (see below).

If using the purge rod does not resolve the jam, proceed to the next step and install a replacement nozzle.

INSTALL REPLACEMENT NOZZLE

While your print job is paused, you will be unable to run the Remove Nozzle utility. It is necessary to *manually* remove the nozzle to complete this step. Unloading the metal print material will heat the nozzle enough to safely remove it without damaging the print head.

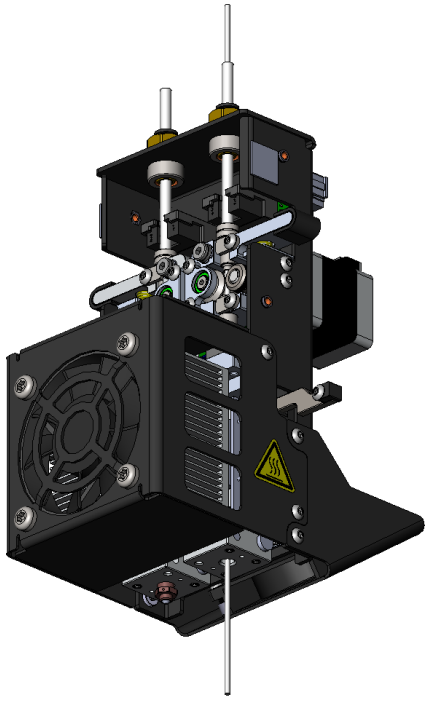
1. Follow the instructions in the *Unloading Metal Filament* section to clear the loaded metal filament from the print head. **Do not attempt to manually move the print head.**
2. While the nozzle is hot, use the torque wrench to carefully remove it from the print head. Set the old nozzle aside, taking care not to touch the hot nozzle with your bare hands.
3. Carefully apply Anti-Seize to the threads of the replacement nozzle.
4. Using the nozzle wrench, tighten the metal nozzle partway, then unscrew it completely to distribute Anti-Seize across the threads. Finally, ***fully*** tighten the nozzle with the nozzle wrench until the wrench clicks.
5. From the main screen, press **Resume** to resume the paused print job.



If replacing the nozzle effectively resolves the jam, complete the print as usual, then replace the lower feed tube (see below) and discard your old nozzle.

If replacing the nozzle does not resolve the jam, immediately replace the lower feed tube in the print head. **This will cancel your unfinished print.** At this point, you have the option of reinstalling your original metal nozzle or continuing to use the replacement.

REMOVE AND REPLACE LOWER FEED TUBE

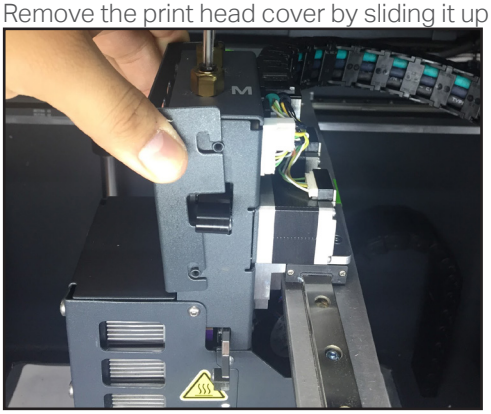


Using the purge rod should clear the material pathway enough to continue printing and finish your print run. However, the purge rod can leave a layer of print material residue on the inner surface of the lower feed tube, which can lead to additional print jams later. Therefore, you should **always replace the lower feed tube after using the purge rod** — either immediately or after your print completes successfully.

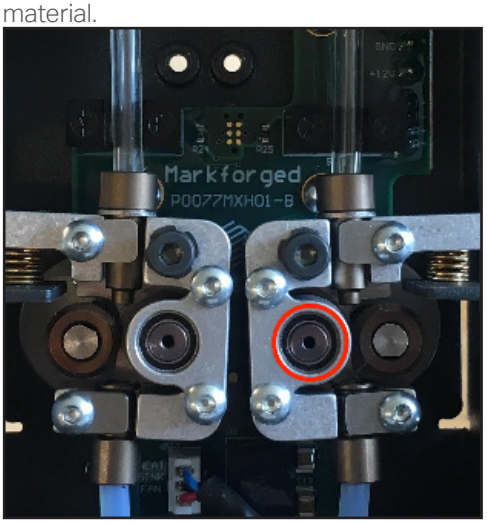
Note that, during this procedure, you must insert the purge rod into the material pathway (see diagram above) *before* powering down the printer in order to confirm that the entire pathway is clear of print material. Failure to do so can lead to pieces of filament becoming lodged in the print head mechanism. Once the printer is powered down, it is safe to remove the purge rod and continue with the procedure.

1. Follow the instructions in the *Unloading Metal Filament* and *Unloading Release Filament* sections to clear both metal and release filament from the print head.

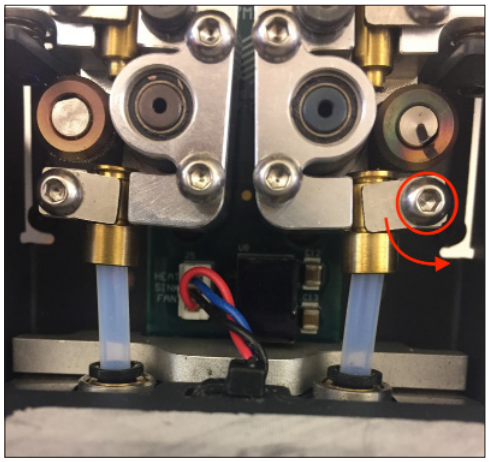
2. While the metal nozzle is hot, use the torque wrench to carefully remove it from the print head. Set the old nozzle aside, taking care not to touch the hot nozzle with your bare hands.
3. Remove the print head cover by sliding it up and then away from the print head, off its locating features.



4. While pressing down on the front release arm, use the thin metal purge rod to carefully push all the way through the inlet tube, idler wheel assembly, and outlet tube, and out throughout the opening on the underside of the print head. **Do not remove the purge rod at this time.**
5. Power down the printer with the purge rod still passing through the material pathway, then remove the purge rod.
6. Inspect the idler wheel in the extruder mechanism within the print head and verify that it is free of material.



7. Using a 2mm hex key, loosen but do not remove the fitting clamp screw. Flip the fitting clamp to clear the idler output connector for removal.

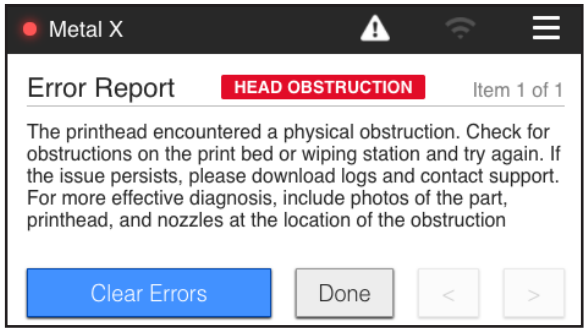


8. Remove the idler output connector from the tube using tweezers or thin pliers.
9. Once the brass connector is removed, push down on the black push-to-connect fitting to release the lower feed tube; simultaneously, using tweezers or small pliers, pull upwards on the tube to remove it from the fitting.
10. Insert the new feed tube into the fitting until it can no longer be pushed down.
11. Insert the idler output connector on top of the tube.
12. Flip the fitting clamp to tighten the idler output connector and tighten the screw. You may need to loosen the screw using a 2mm hex key before being able to flip up the clamp.
13. Replace the print head cover.

14. Carefully remove the incomplete part and print sheet from the print bed. Clean and reinstall the print bed. ***Caution: The print bed may be hot***.
15. Power on the printer. (Steps 13-14 are necessary to prevent damage to the print head, ensuring that the print head is sufficiently warm before reinstalling the metal nozzle.)
16. Run the **Replace Nozzles** utility, following instructions in the *Replacing the Metal Nozzle* section.
17. You may now reprint your part from Eiger.

If the material jam persists after completing this troubleshooting workflow, contact Markforged Support.

PRINT HEAD OBSTRUCTION



The Head Obstruction firmware error displays when the metal nozzle movement does not correspond to the motion commands. This can be caused by an obstruction between the metal nozzle and the part. In order to avoid this error, please make sure to do the following:

- Keep the wiping station brushes clean and empty the wiping station regularly. If the station is not clean, material may build up on your metal nozzle and hit the part on the print bed. This is more likely to be a problem during longer prints. For more information, please review the ***Wiping Station*** subsection of *Cleaning Your Metal X Printer*, below.
- **Only use each print sheet once.** Reusing sheets may cause issues with the vacuum seal causing prints to fail.
- Finally, try to include fewer distinct parts in your builds. This will improve part quality and make print head obstructions less likely as the head transitions from part to part.

If the Head Obstruction error message appears, the print run will terminate automatically—you will not be able to complete the print. Instead, you will need to clear the print bed, clear the firmware errors, and install a new print sheet for the next print.

CLEANING YOUR METAL X PRINTER

Do not use any cleaning fluids on your Metal X printer unless specifically directed in this document. Be careful of hot surfaces and components when cleaning in the build chamber.

CAMERA

Over time, the camera mounted in the print chamber will build up wax on its lens, leading to foggy images. If the lens is not cleaned occasionally, the camera's images will cease to be useful for monitoring parts and diagnosing print failures.

Do not use any harsh solvent to clean the camera lens. Instead, use a dry Kimwipe or other lint-free wipe, and note that it may take some time to fully remove the wax. Alternatively, apply light mineral oil, and thoroughly wipe away the oil along with the wax buildup. Do not remove the camera or lens from the printer.

WIPING STATION

Lengthy pieces of extruded material left on the wiping station brushes can in turn get caught in the print head fan, potentially damaging the unit. You can occasionally clear any excess print material out of the wiping station brushes with a fingertip, knocking the material down into the wiping station itself. Regularly dispose of accumulated material by dumping the contents of the wiping station into an appropriate waste container.

For more information on wiping station maintenance, see *Replacing Wiping Station Brushes*.

BUILD CHAMBER COVER

Do not use Windex or other ammonia- or alcohol-based cleaners on the polycarbonate cover of the build chamber. Instead, apply light mineral oil and thoroughly wipe the doors clean.

TOUCHSCREEN

The capacitive touchscreen of the Metal X will accumulate excess print material around its edges over time. Because the metal material is conductive, this buildup can cause the touchscreen to become unresponsive. To prevent this, you should occasionally clean around the edges of the touchscreen, between the screen itself and its metal housing, using a folded piece of paper.

PRINT BED AND BUILD CHAMBER

As long as you always use a new print sheet when printing and use the brush pan to catch excess filament when loading new spools, it should not be necessary to clean the print bed beyond removing debris. Regularly vacuum the bed and chamber using your HEPA Shop-Vac.

PRINT HEAD AND NOZZLES

The print head travels regularly to the wiping station between layers of the print process, removing excess

material from the nozzles. We likewise encourage you to clean the nozzles with a brass brush when loading material.

Note that some material buildup on the side of the nozzle is normal during the first few layers of a print (i.e. the raft). There is no need to pause or cancel your print when you observe this behavior, which should resolve after the initial layers and should not cause problems with the part itself. In case of error, the printer will pause automatically and prompt you for input.

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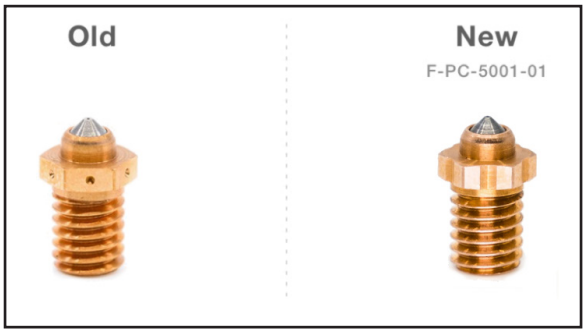
REPLACING THE METAL NOZZLE

Note: Markforged is now shipping upgraded metal nozzles to enable printing at 50µm layer height and improve overall print quality. These new nozzles are distinguished by a vertical groove on each of the six faces of the hex feature (see image below). If an older nozzle with a dimple on each face of the hex feature is currently installed in your printer, you should replace it as soon as possible. Future enhancements to the Metal X and to Eiger will only function properly with the new nozzle installed.

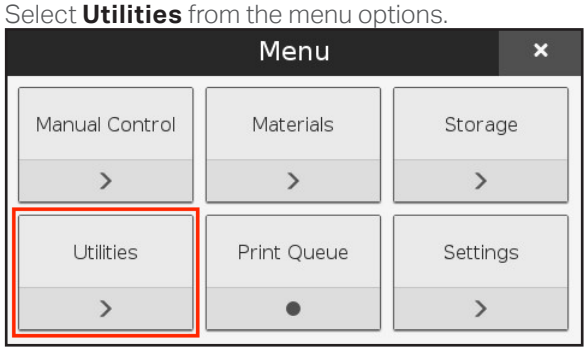


Supplies

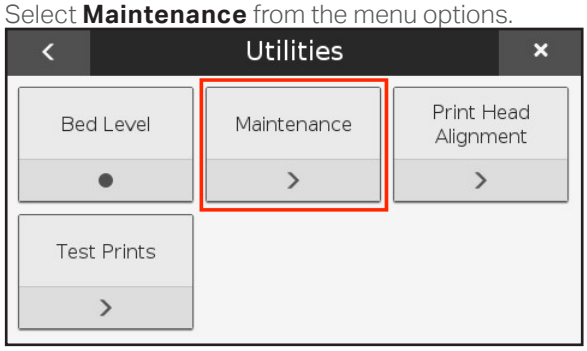
- Nozzle wrench (included in accessory kit)
- Brush pan (included in accessory kit)
- Anti-Seize
- Tweezers (recommended)

1. Select the menu icon from the dashboard.

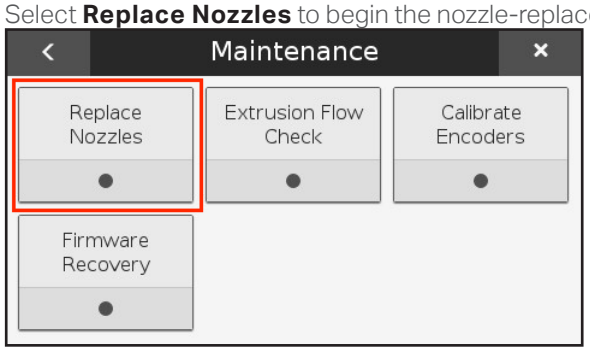
2. Select **Utilities** from the menu options.



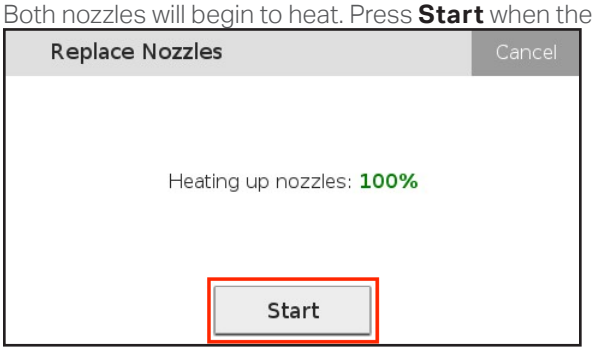
3. Select **Maintenance** from the menu options.



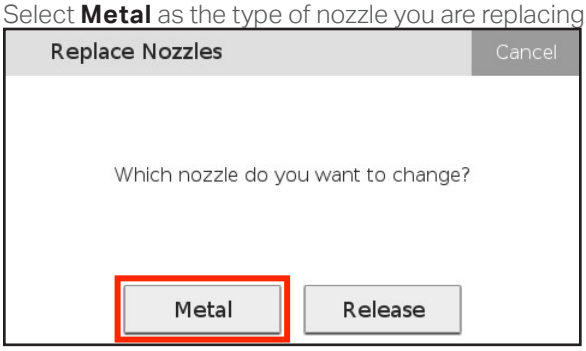
4. Select **Replace Nozzles** to begin the nozzle-replacement routine.



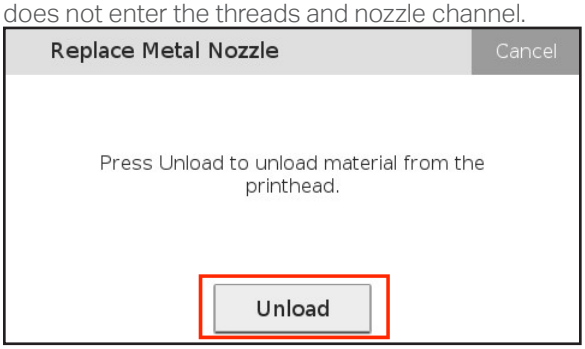
5. Both nozzles will begin to heat. Press **Start** when the nozzles are 100% heated.



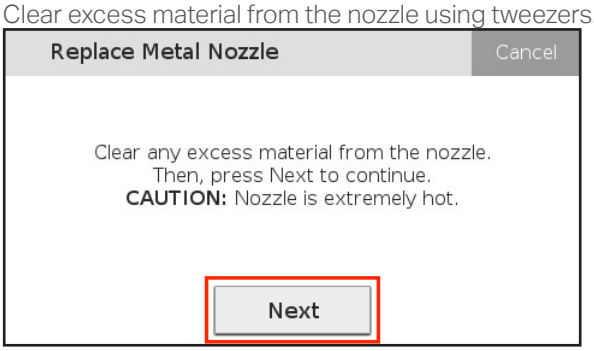
6. Select **Metal** as the type of nozzle you are replacing.



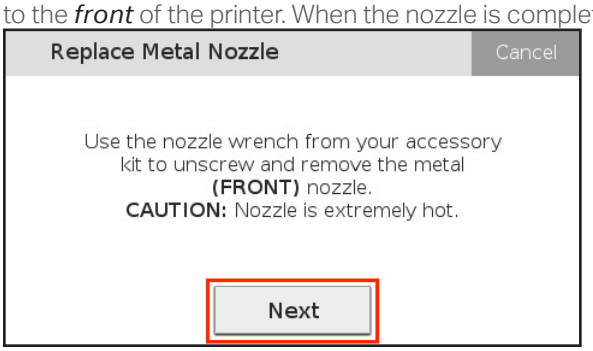
7. Select **Unload** to retract the metal material from the print head. Doing so will ensure that excess material does not enter the threads and nozzle channel.



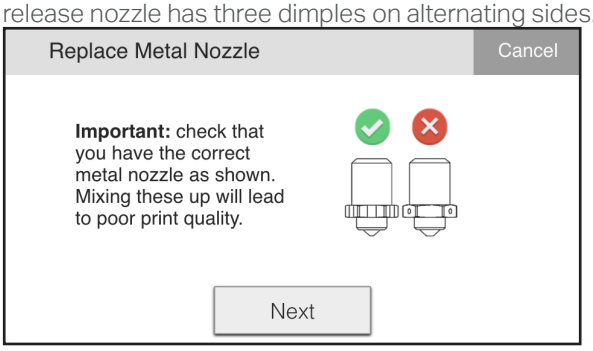
8. Clear excess material from the nozzle using tweezers. Keep in mind that both nozzles are quite hot.



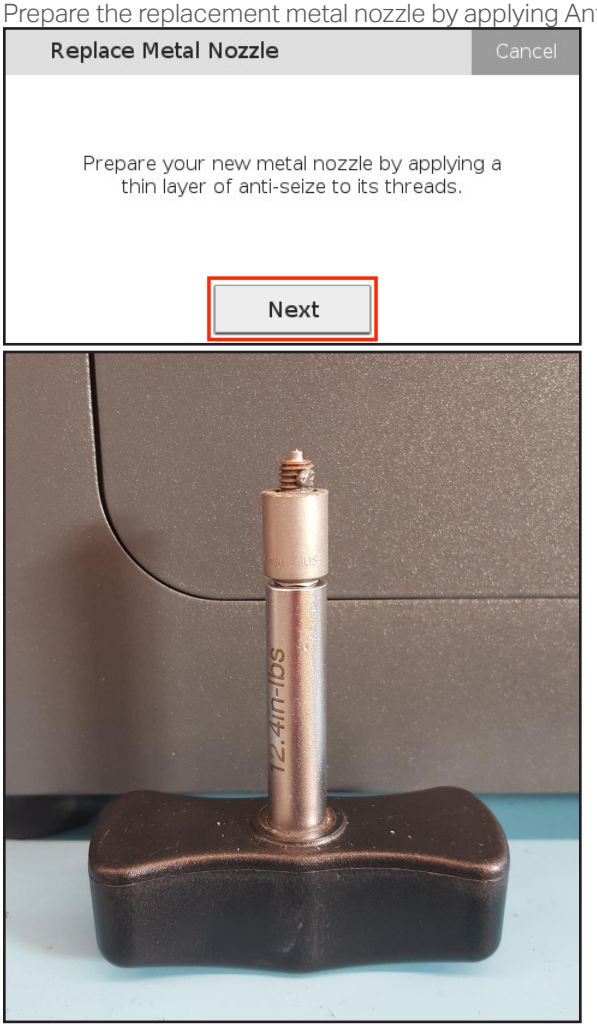
9. Using the included nozzle wrench, unscrew the metal nozzle. Note that the metal nozzle is the one closest to the *front* of the printer. When the nozzle is completely removed, select **Next**.



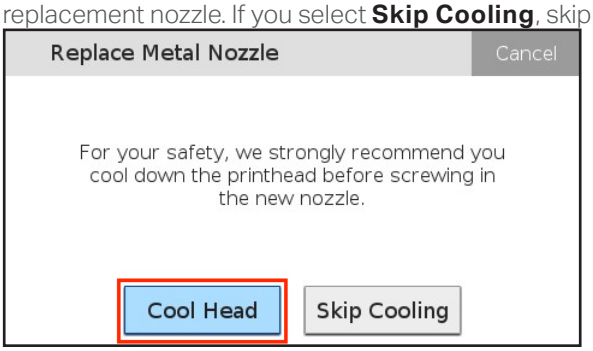
10. Check your replacement metal nozzle to ensure that you are inserting the correct type of nozzle. The most up-to-date metal nozzle has a vertical groove on each of the six sides of the hex feature, while the release nozzle has three dimples on alternating sides.



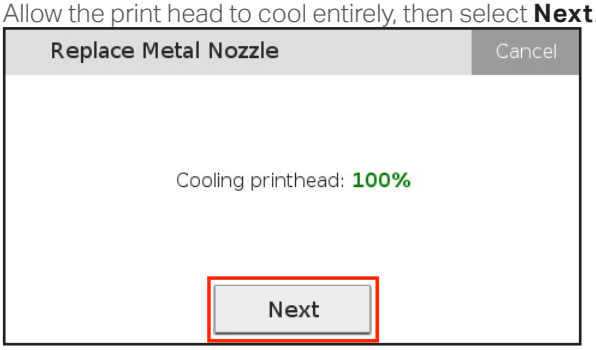
11. Prepare the replacement metal nozzle by applying Anti-Seize to its threads, then press **Next**.



12. For your safety, we recommend that you select **Cool Head** to cool the print head before installing the replacement nozzle. If you select **Skip Cooling**, skip to step 14.

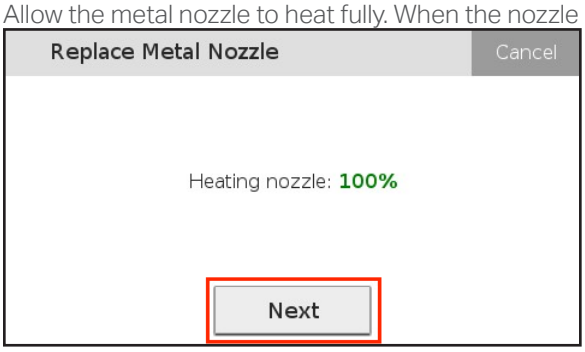


13. Allow the print head to cool entirely, then select **Next**.

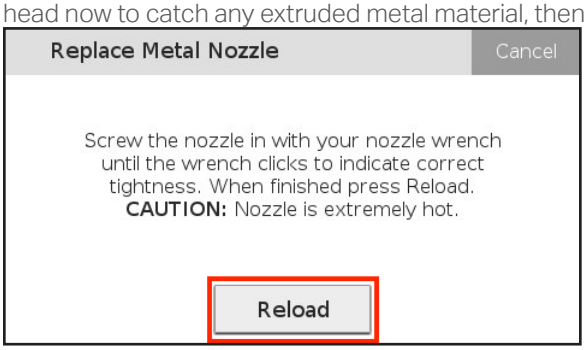


14. Using the nozzle wrench, tighten the metal nozzle partway, then unscrew it completely to distribute Anti-Seize across the threads. Finally, screw the nozzle in finger-tight again. Select **Next**.
Note: Do not use the nozzle wrench to fully tighten the nozzle until after it is fully heated in the next step.

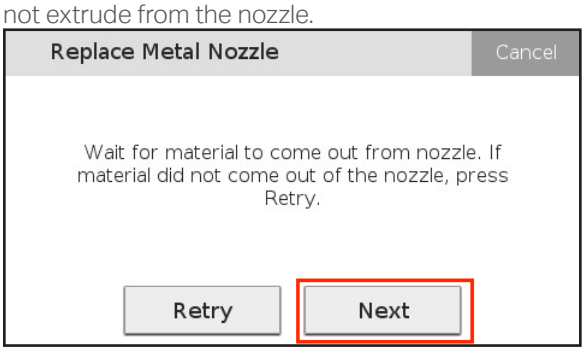
15. Allow the metal nozzle to heat fully. When the nozzle is 100% heated, select **Next**.



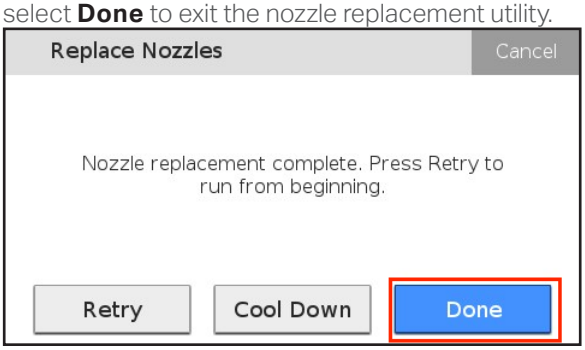
16. Tighten the nozzle with the nozzle wrench until the wrench clicks. Position the brush pan under the print head now to catch any extruded metal material, then select **Reload**.



17. The metal filament should now reload, and a small amount of material should extrude from the metal nozzle. After five seconds of extrusion, press **Next** to stop the process. Press **Retry** if the material does not extrude from the nozzle.



18. When the process is complete and the metal filament successfully reloaded and extruded, select **Done** to exit the nozzle replacement utility.

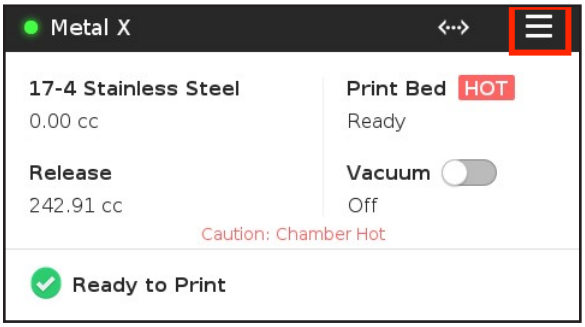


REPLACING THE RELEASE NOZZLE

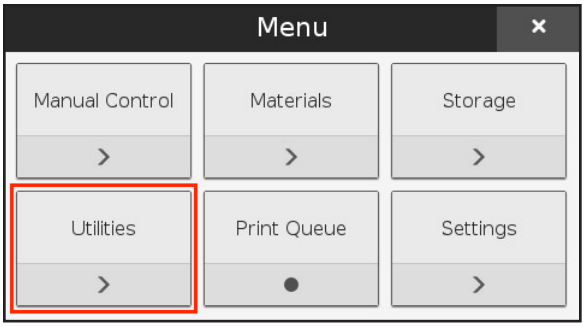
Supplies

- Nozzle wrench (included in accessory kit)
- Brush pan (included in accessory kit)
- Anti-Seize
- Tweezers (recommended)

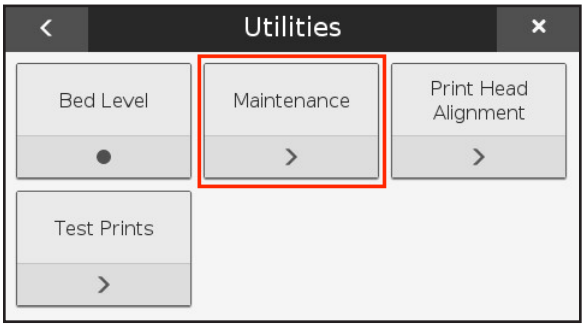
1. Select the menu icon from the dashboard.



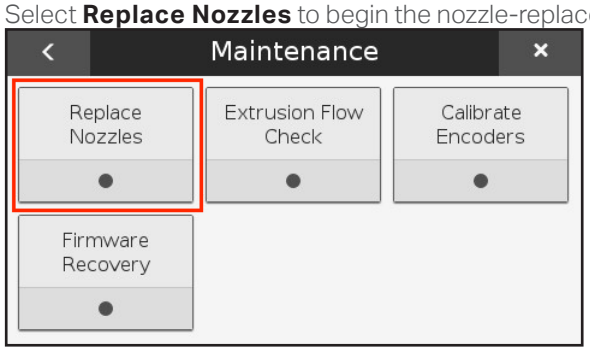
2. Select **Utilities**.



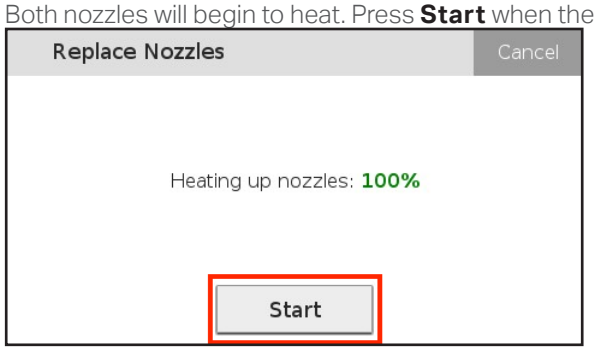
3. Select **Maintenance**.



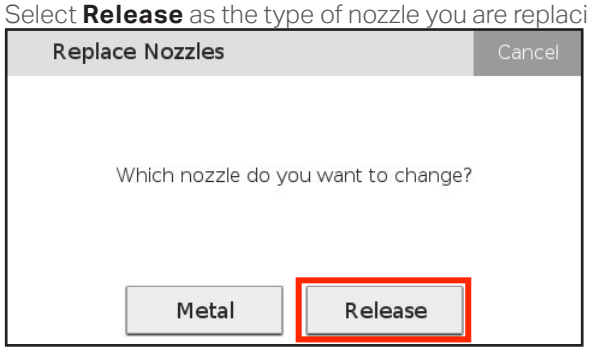
4. Select **Replace Nozzles** to begin the nozzle-replacement routine.



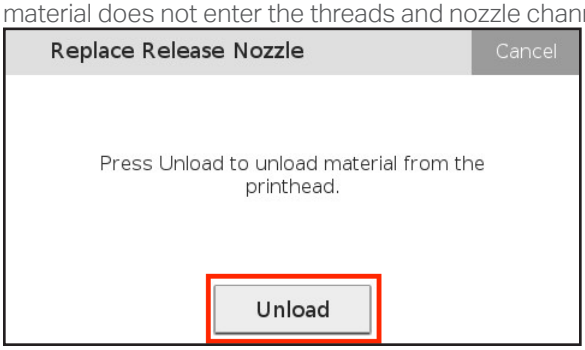
5. Both nozzles will begin to heat. Press **Start** when the nozzles are 100% heated.



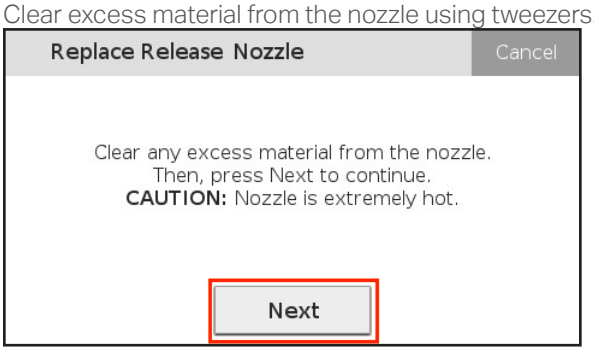
6. Select **Release** as the type of nozzle you are replacing.



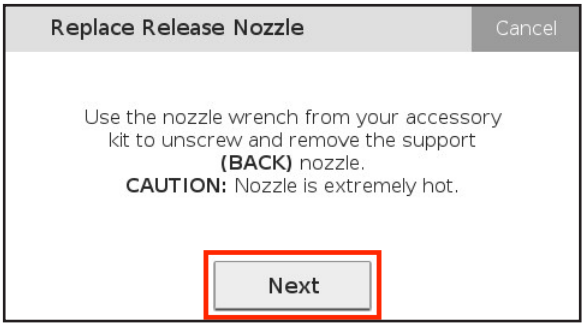
7. Select **Unload** to unload the release material from the print head. Doing so will ensure that excess material does not enter the threads and nozzle channel.

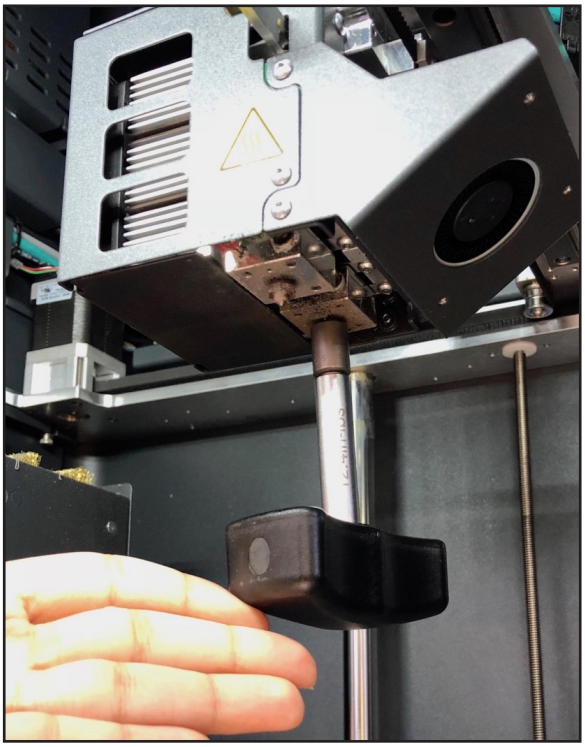


8. Clear excess material from the nozzle using tweezers. Keep in mind that both nozzles are quite hot.

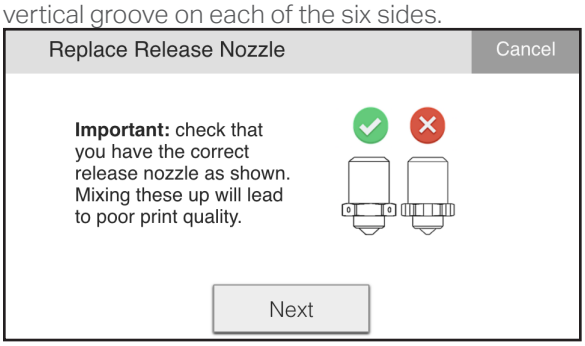


9. Unscrew the release nozzle using the included nozzle wrench. Note that the release nozzle is the one closest to the rear of the print head, furthest from you. When the nozzle is completely removed, select **Next**.



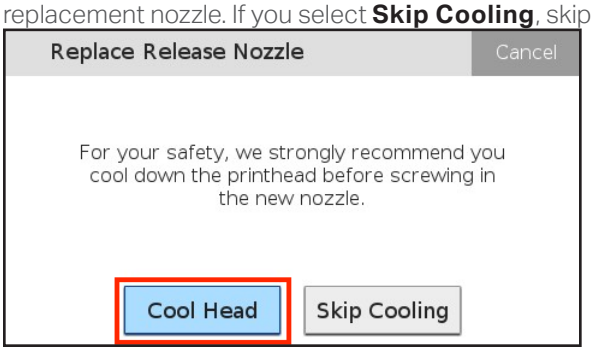


10. Check your replacement release nozzle to ensure that you are inserting the correct type of nozzle. The release nozzle has three dimples on alternating sides of the hex feature, while the metal nozzle has a vertical groove on each of the six sides.

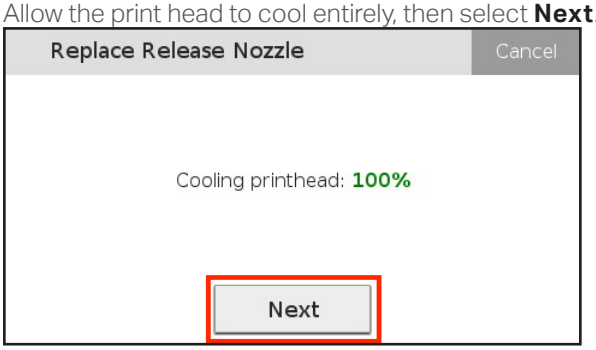


11. Prepare the replacement release nozzle by applying Anti-Seize to its threads and press **Next**.

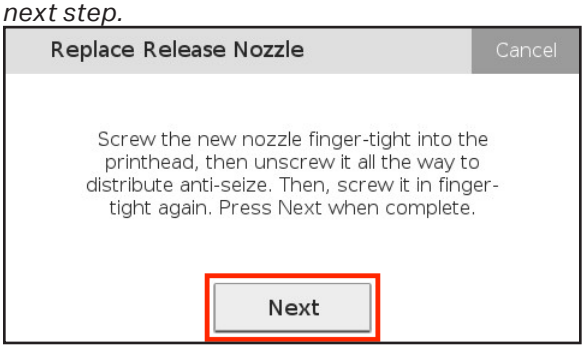
12. For your safety, we recommend that you select **Cool Head** to cool the print head before installing the replacement nozzle. If you select **Skip Cooling**, skip to step 14.



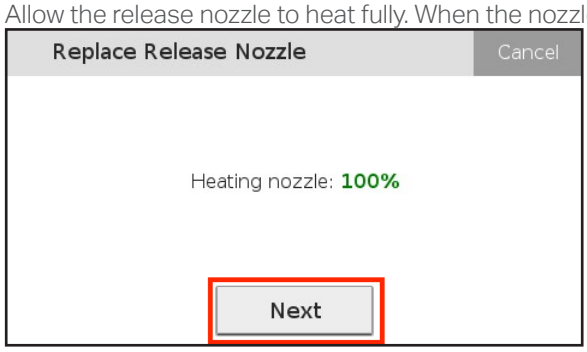
13. Allow the print head to cool entirely, then select **Next**.



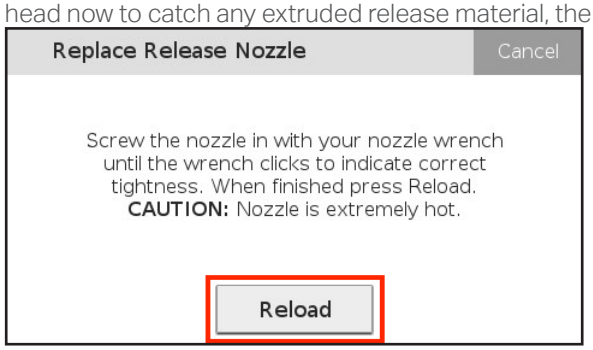
14. Using the nozzle wrench, tighten the release nozzle partway, then unscrew it completely to distribute Anti-Seize across the threads. Finally, screw the nozzle in finger-tight again. Select **Next**.
Note: Do not use the nozzle wrench to fully tighten the nozzle until after it is fully heated in the next step.



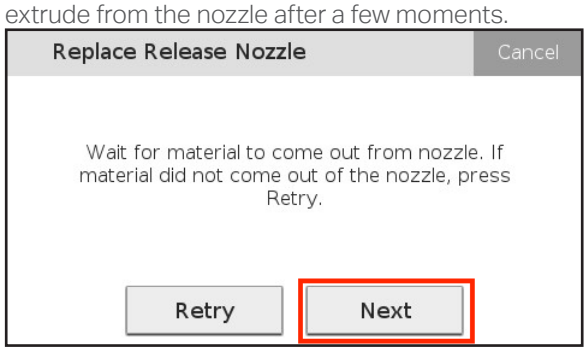
15. Allow the release nozzle to heat fully. When the nozzle heats to 100%, select **Next**.



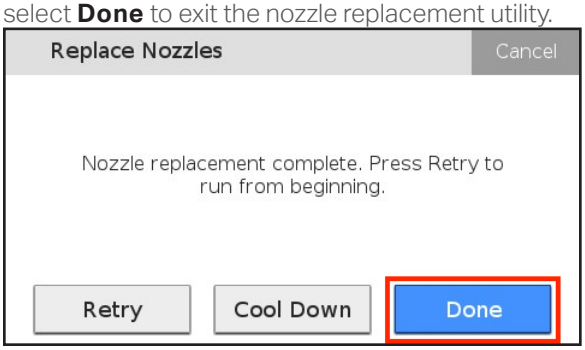
16. Tighten the nozzle with the nozzle wrench until the wrench clicks. Position the brush pan under the print head now to catch any extruded release material, then select **Reload**.



17. The filament should now reload, and a small amount of material should extrude from the release nozzle. If the material begins to extrude, press **Next** to stop the process. Press **Retry** if the material does not extrude from the nozzle after a few moments.



18. When the process is complete and the filament has been successfully reloaded and extruded, select **Done** to exit the nozzle replacement utility.

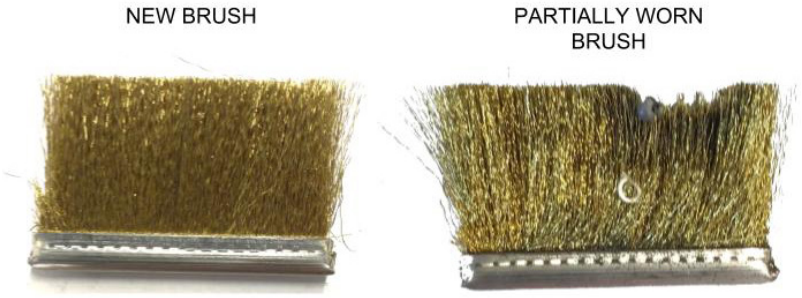


REPLACING WIPING STATION BRUSHES

Supplies

- 2mm hex key

The wiping station brushes wear down asymmetrically, with the bristles closest to the print head wearing most quickly. When a brush is half-worn, it should be turned around in its bracket to make use of the remaining bristles. Note that the metal and release nozzles have dedicated brushes; do not swap them after use.



1. Cool down the machine and lower the print bed to reduce the risk of burns during brush replacement.
2. Loosen the screws attaching the wiping station to the printer frame.
   Note: One or two turns will suffice. ***Do not*** *remove the screws.*
3. Lift the wiping station from its mounting screws and remove it from the machine.
4. Using a 2mm hex key, unscrew and remove the brush bracket from the wiping station. Set the two screws aside.

5. If the brushes are only half worn, turn them around and reinstall them in the bracket. If they're completely worn, remove them from the bracket and dispose of them, then install new brushes in the bracket.
6. Reinstall the brush bracket using the two (2) M3 button head cap screws and a 2mm hex key.
7. Securely mount the wiping station by sliding it over the mounting screws, then pushing the station down and tightening the screws.

ADJUSTING BELT TENSION

Supplies

- 3mm hex key
- Tuning device or mobile device equipped with tuning app (see below)

The print head on your printer is moved using a system of motors, pulleys, and belts. For optimal operation, it is important that belt tension is maintained at the correct level. High belt tension will contribute to premature bearing wear; low belt tension can lead to reduced printing accuracy and/or dislocation.

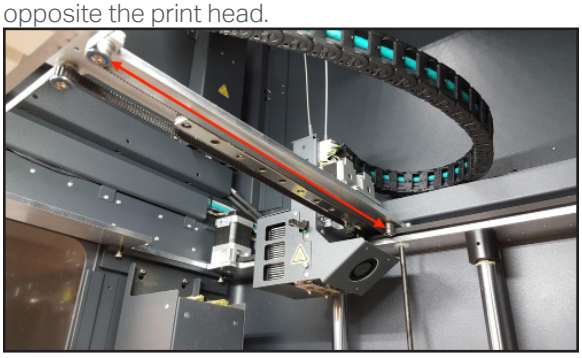
Belt tension is adjusted at the factory using a calibrated meter to measure the audio frequency of the belt when it is plucked, as there is a direct relationship between belt tension and frequency.

Since belts may stretch over time, it is recommended that users occasionally (every 100 prints) measure belt tension and adjust as necessary. This can be done with any device that allows you to measure audible frequencies in hertz (Hz). One inexpensive option is to use a smartphone equipped with the free version of either the Fine Tuner app (for iOS) or the Fine Chromatic Tuner app (for Android). These applications are designed to tune musical instruments, but they can also be used as accurate frequency meters. (

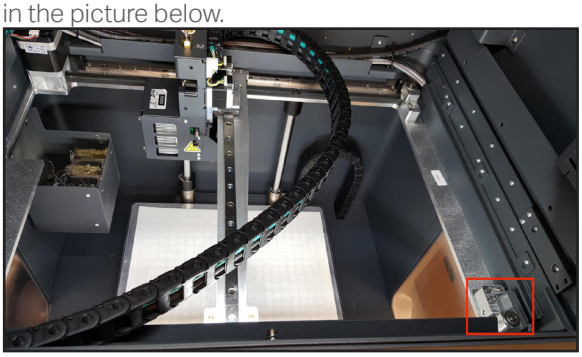
The following instructions refer to using a phone app to tune the belt. If you are using a dedicated tuner device, follow proper procedures for its operation.

Note: To ensure accurate measurements, always take frequency adjustments in quiet surroundings.

1. Install and open a tuner app on your mobile device.
2. Power off the printer.
3. Manually move the print head to a position that allows space for plucking the belt underneath the Y-rail opposite the print head.



4. Place the microphone close to, but not touching, the belt opposite the print head. Pluck the center of the belt as if it were a guitar string. Using a 3mm hex key, adjust the belt tensioner until a frequency of 82-84Hz is read by the app. The belt tensioner is located on the front right corner of the printer, as seen in the picture below.



Once the belt is properly tuned, you may proceed with normal printer operation.

ADJUSTING RELEASE NOZZLE XY OFFSET

Most users will only need to adjust their XY Offset during initial setup and in the rare event of installing a new print head. In unusual cases where the metal and release nozzles on the print head may become misaligned, the XY Offset utility will print a test part that can be used to identify offset issues.

The utility is fully automatic and requires no operator intervention once it begins. Unlike the previous version of the XY Offset utility, there

RUNNING THE XY OFFSET UTILITY

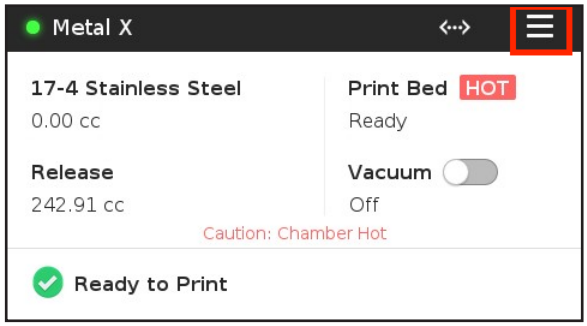
1. Prepare the printer for a print by applying a print sheet to the print bed and establishing a proper vacuum seal. For information, see *Applying a Print Sheet*.
2. Select the menu icon from the dashboard.
3. Select **Utilities** from the menu.
4. Select **Print Head Alignment** from the menu.
5. Select **Release Nozzle XY Offsets**.
6. Press **Confirm** to begin the test print.

When the test print completes, it can be discarded along with the print sheet.

CALIBRATING STEPPER ENCODERS

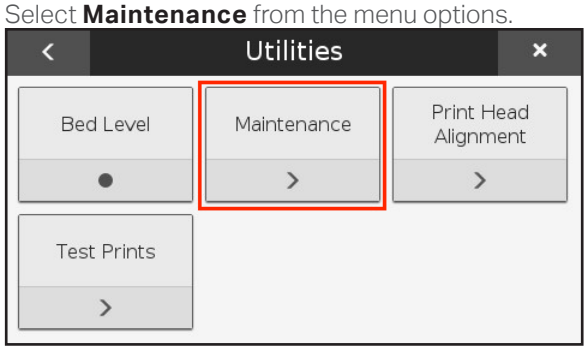
The Stepper Motor Calibration utility should be run whenever you change the belt tension, or as a troubleshooting step when you experience repeated dislocations. The utility must also be run in the unlikely event of a pulley or motherboard replacement.

1. Select the menu icon from the dashboard.

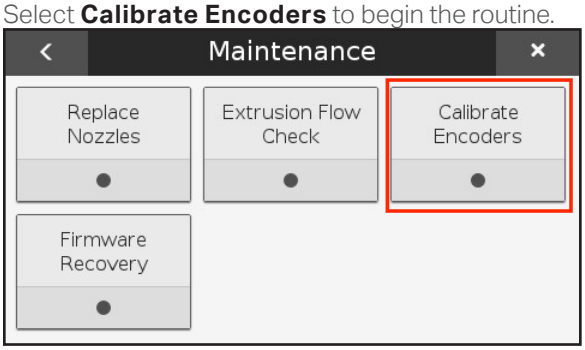


2. Select **Utilities** from the menu options.

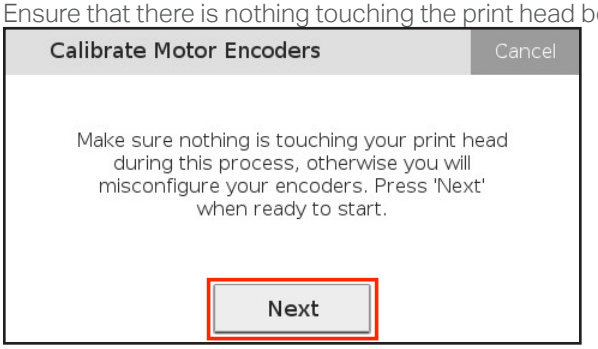
3. Select **Maintenance** from the menu options.



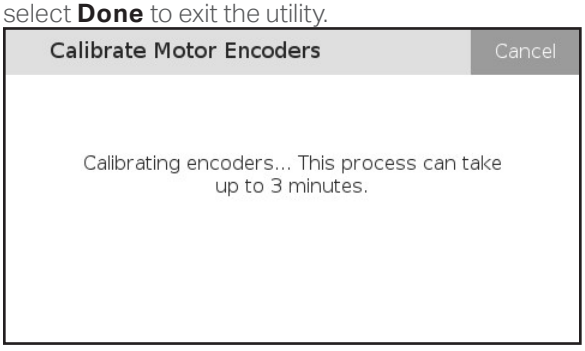
4. Select **Calibrate Encoders** to begin the routine.

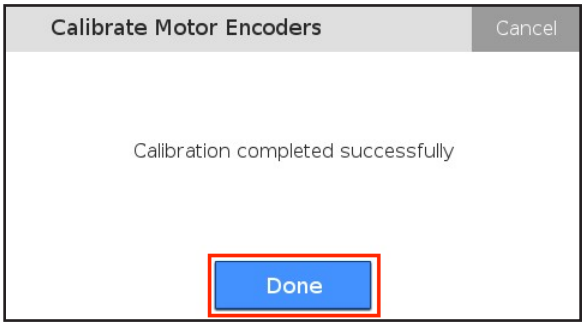


5. Ensure that there is nothing touching the print head before selecting **Next**.



6. Allow the printer to calibrate its encoders for a few minutes. When the calibration is completed, select **Done** to exit the utility.





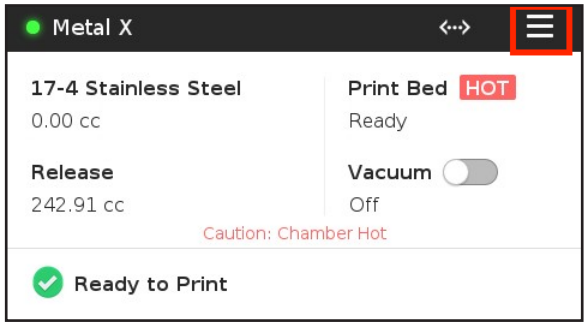
MANUAL CONTROL

The Manual Control system allows the user to control the height and temperature of the print bed, as well as the temperature of both nozzles.

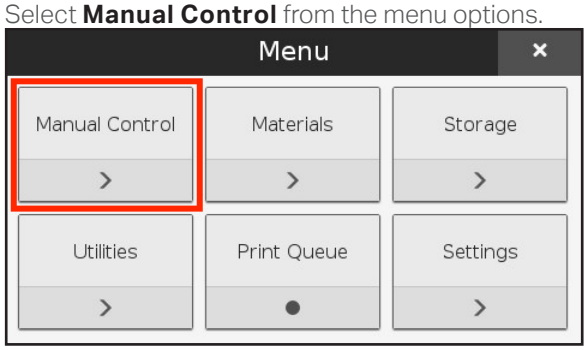
Warning

- Always take extra care when working near the print head or print bed as many of their components can reach high temperatures. Allow the Metal X to cool down before opening the print chamber doors, or before reaching inside the printer.
- The Metal X has moving parts that can cause damage or injury. Do not place items beneath the print bed as they can get pinched or be crushed.

1. Select the menu icon from the dashboard.

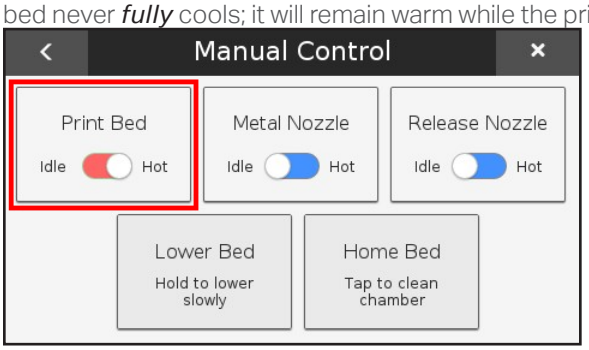


2. Select **Manual Control** from the menu options.

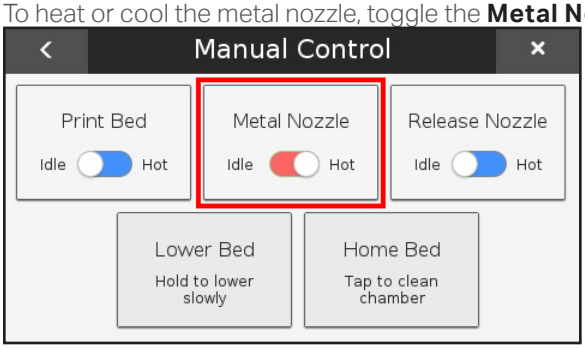


NOZZLE TEMPERATURE

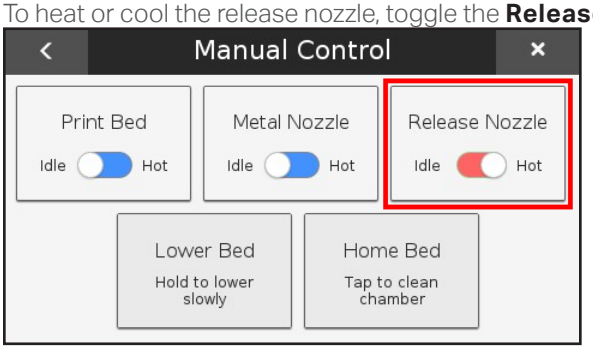
- To heat or cool the print bed, toggle the **Print Bed** slider to the **Hot** or **Idle** position. Note that the print bed never ***fully*** cools; it will remain warm while the printer is powered up.



- To heat or cool the metal nozzle, toggle the **Metal Nozzle** slider to the **Hot** or **Idle** position.



- To heat or cool the release nozzle, toggle the **Release Nozzle** slider to the **Hot** or **Idle** position.

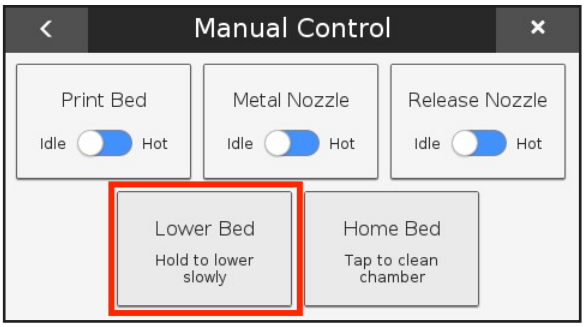


PRINT BED HEIGHT

The Metal X print bed cannot be moved in any direction by hand; doing so requires the use of the Manual Control system, which moves at a slow pace to ensure your safety.

To lower the print bed, press and hold the **Lower Bed** button. The print bed will lower slowly as long as you hold down the button, or until it reaches its minimum height.

To raise the print bed to its full height, press **Home Bed**.



EXTRUSION FLOW CHECK

Warning: The nozzles and extruded material will become hot during this test. Be careful not to touch the nozzle or extruded material with your bare hands. Use the included tweezers and brush pan to handle the material.

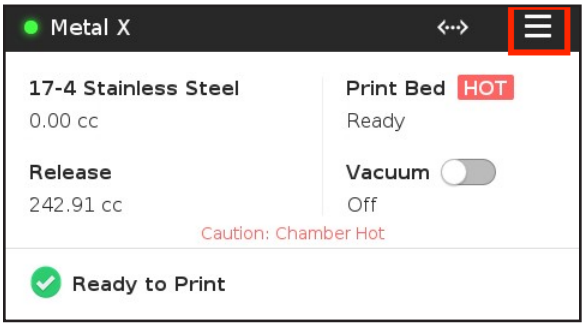
The purpose of this test is to determine how well the extrusion system is performing. The test extrudes a known quantity of material. Based on the behavior of the machine during the test, the printer will determine whether you're having extrusion problems.

Supplies

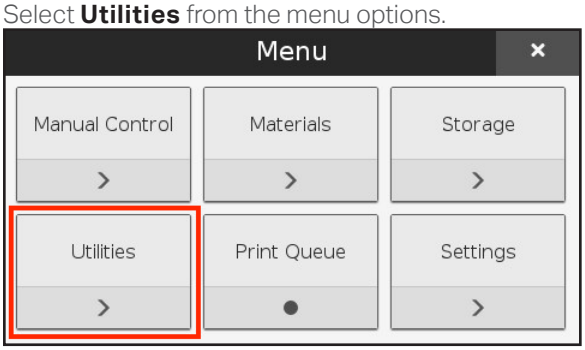
- Tweezers
- Brush pan from accessory kit

EXTRUSION FLOW CHECK FOR METAL CHANNEL

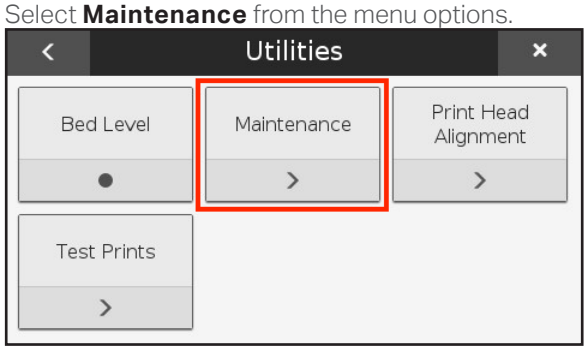
1. Select the menu icon from the dashboard.



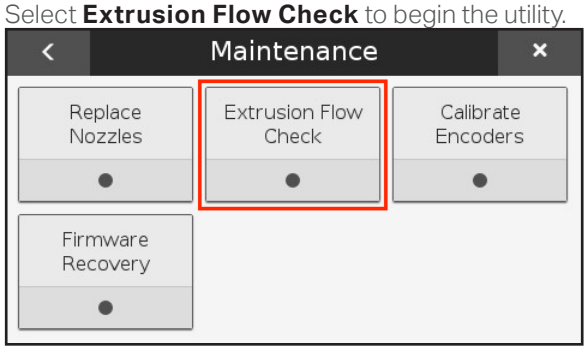
2. Select **Utilities** from the menu options.



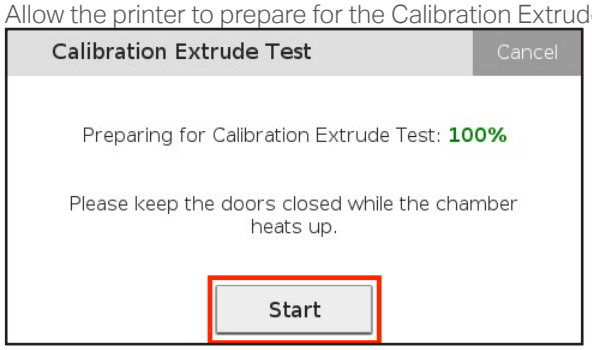
3. Select **Maintenance** from the menu options.



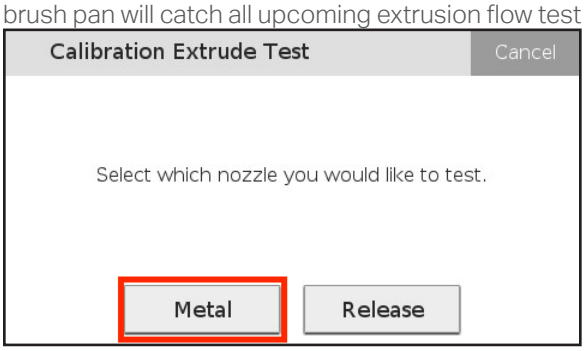
4. Select **Extrusion Flow Check** to begin the utility.



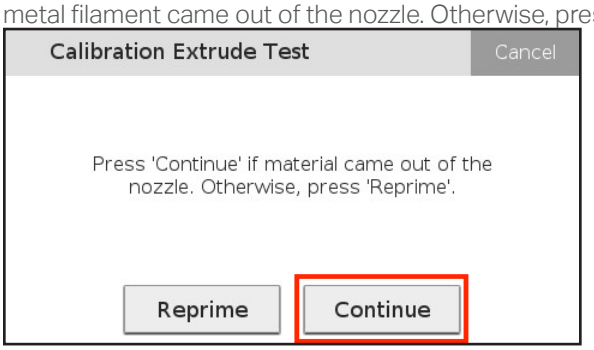
5. Allow the printer to prepare for the Calibration Extrude Test. When it reaches 100%, press **Start**.



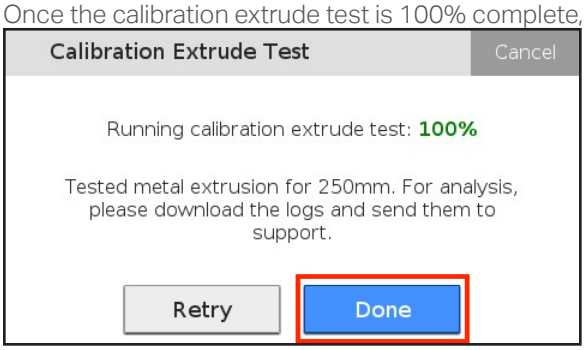
6. Select **Metal** as the nozzle that will be tested and place a brush pan underneath the print head. This brush pan will catch all upcoming extrusion flow test filament.



7. The printer will then prime the nozzle and a small amount of filament will be extruded. Press **Continue** if metal filament came out of the nozzle. Otherwise, press **Reprime**.



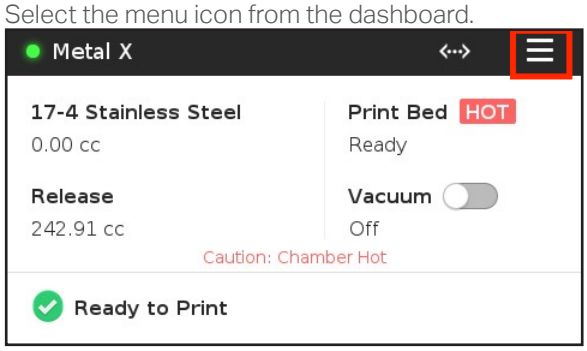
8. Allow the printer to run the Calibration Extrude Test. This will take over 30 seconds and extrude material. Once the calibration extrude test is 100% complete, select **Done**.



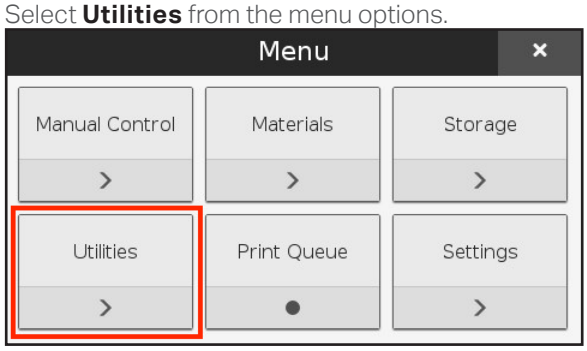
9. Download your printer logs and contact Markforged Support.

EXTRUSION FLOW CHECK FOR RELEASE MATERIAL

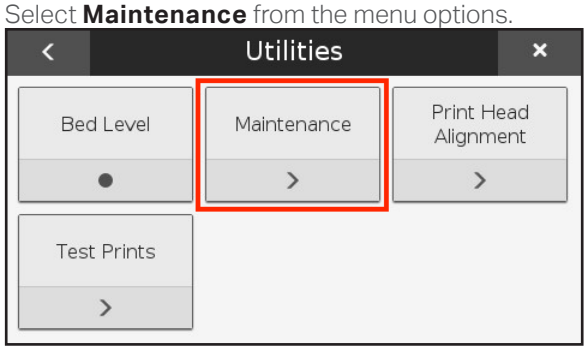
1. Select the menu icon from the dashboard.



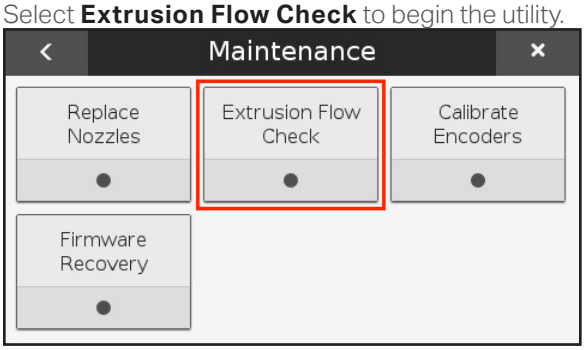
2. Select **Utilities** from the menu options.



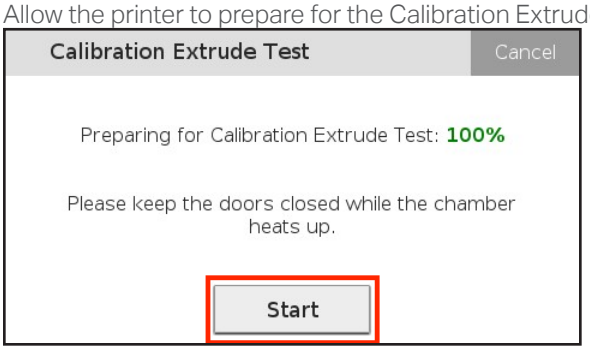
3. Select **Maintenance** from the menu options.



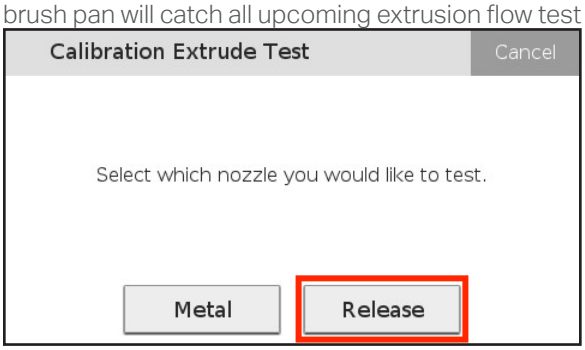
4. Select **Extrusion Flow Check** to begin the utility.



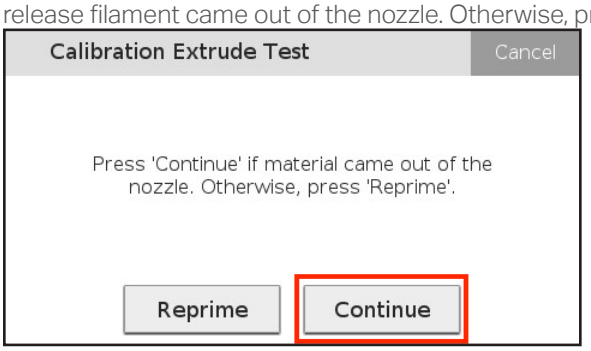
5. Allow the printer to prepare for the Calibration Extrude Test. When it reaches 100%, press **Start**.



6. Select **Release** as the nozzle that will be tested and place a brush pan underneath the print head. This brush pan will catch all upcoming extrusion flow test filament.



7. The printer will then prime the nozzle and a small amount of filament will be extruded. Press **Continue** if release filament came out of the nozzle. Otherwise, press **Reprime**.



8. Allow the printer to run the Calibration Extrude Test. Release filament extrudes very slowly; this test will take a few minutes to complete. Once the calibration extrude test is 100% complete, select **Done**.
9. Download your printer logs and contact Markforged Support.