



AFF A320 systems

ONTAP Systems

NetApp
October 26, 2021

Table of Contents

- AFF A320 System Documentation 1
 - Install and setup 1
 - Maintain 16

AFF A320 System Documentation

Install and setup

Start here: Choose your installation and setup experience

You can choose from different content formats to guide you through installing and setting up your new storage system.

- [Quick steps](#)

A printable PDF of step-by-step instructions with live links to additional content.

- [Video steps](#)

Video step-by-step instructions.

- [Detailed steps](#)

Online step-by-step instructions with live links to additional content.

Quick guide - AFF A320

This guide gives graphic instructions for a typical installation of your system from racking and cabling, through initial system bring-up. Use this guide if you are familiar with installing NetApp systems.

Access the *Installation and Setup Instructions* PDF poster:

[AFF A320 Systems Installation and Setup Instructions](#)

Videos - AFF A320

There are two videos; one showing how to rack and cable your system and one showing an example of using the System Manager Guided Setup to perform initial system configuration.

Video one of two: Hardware installation and cabling

The following video shows how to install and cable your new system.

[NetApp video: AFF A320 Installation and setup](#)

Video two of two: Performing end-to-end software configuration

The following video shows end-to-end software configuration for systems running ONTAP 9.2 and later.

[NetApp video: Software configuration for vSphere NAS datastores for FAS/AFF systems running ONTAP 9.2](#)

Detailed guide - AFF A320

This guide gives detailed step-by-step instructions for installing a typical NetApp system. Use this guide if you want more detailed installation instructions.

Prepare for installation

To install your AFF A320 system, you need to create an account, register the system, and get license keys. You also need to inventory the appropriate number and type of cables for your system and collect specific network information.

You need to have access to the Hardware Universe for information about site requirements as well as additional information on your configured system. You might also want to have access to the Release Notes for your version of ONTAP for more information about this system.

[NetApp Hardware Universe](#)

[Find the Release Notes for your version of ONTAP 9](#)

You need to provide the following at your site:

- Rack space for the storage system
- Phillips #2 screwdriver
- Additional networking cables to connect your system to your network switch and laptop or console with a Web browser
- A laptop or console with an RJ-45 connection and access to a Web browser
 1. Unpack the contents of all boxes.
 2. Record the system serial number from the controllers.










3. Set up your account:
 - a. Log in to your existing account or create an account.
 - b. Register your system.

[NetApp Product Registration](#)

4. Inventory and make a note of the number and types of cables you received.

The following table identifies the types of cables you might receive. If you receive a cable not listed in the table, see the Hardware Universe to locate the cable and identify its use.

[NetApp Hardware Universe](#)

Type of cable...	Part number and length	Connector type	For...
100 GbE cable (QSFP28)	X66211A-05 (112-00595), 0.5m X66211A-1 (112-00573), 1m X66211A-2 (112-00574), 2m X66211A-5 (112-00574), 5m		Storage, cluster interconnect/HA, and Ethernet data (order-dependent)
40 GbE cable	X66211A-1 (112-00573), 1m; X66211A-3 (112-00543), 3m; X66211A-5 (112-00576), 5m		Storage, cluster interconnect/HA, and Ethernet data (order-dependent)
Ethernet cable - MPO	X66200-2 (112-00326), 2m X66250-5 (112-00328), 5m X66250-30 (112-00331), 30m		Ethernet cable (order dependent)
Optical cables	SR: X6553-R6 (112-00188), 2m X6554-R6 (112-00189), 15m X6537-R6 (112-00091), 30m LR: X66250-3 (112-00342), 2m X66260-5 (112-00344), 5m X66260-30 (112-00354), 30m		FC configurations (order-dependent)
RJ-45 (order dependent)	X6585-R6 (112-00291), 3m X6562-R6 (112-00196), 5m		Management network
Micro-USB console cable	Not applicable		Console connection used during software setup if laptop or console does not support network discovery.
Power cables	Not applicable		Powering up the system

5. Download and complete the *Cluster configuration worksheet*.

Install the hardware

You need to install your system in a 4-post rack or NetApp system cabinet, as applicable.

1. Install the rail kits, as needed.
2. Install and secure your system using the instructions included with the rail kit.



You need to be aware of the safety concerns associated with the weight of the system.



3. Attach cable management devices (as shown).



4. Place the bezel on the front of the system.

Cable controllers to your network

You can cable the controllers to your network by using the two-node switchless cluster method or by using the cluster interconnect network.

Option 1: Cable a two-node switchless cluster

The optional data ports, optional NIC cards, and management ports on the controller modules are connected to switches. The cluster interconnect/HA ports are cabled on both controller modules.

You must have contacted your network administrator for information about connecting the system to the switches.

Be sure to check the illustration arrow for the proper cable connector pull-tab orientation.



As you insert the connector, you should feel it click into place; if you do not feel it click, remove it, turn it around and try again.

1. You can use the graphic or the step-by-step instructions to complete the cabling between the controllers and to the switches:



Step	Perform on each controller module
1	<p>Cable the cluster/HA ports to each other with the 100 GbE (QSFP28) cable:</p> <ul style="list-style-type: none"> • e0a to e0a • e0d to e0d <div data-bbox="669 1402 1487 1745"> <p>The diagram shows two controller modules. Blue circles highlight the 'e0a' and 'e0d' ports on each module. Blue lines connect the corresponding ports between the two modules, labeled 'Cluster interconnect and HA cables'. A blue cable icon is shown above the diagram.</p> </div>

Step**Perform on each controller module****2**

If you are using your onboard ports for a data network connection, connect the 100GbE or 40GbE cables to the appropriate data network switches:

- e0g and e0h



100 GbE cables



40 GbE cables

To 40 GbE or 100 GbE
data network switches
(optional, configuration-dependent)

**3**

If you are using your NIC cards for Ethernet or FC connections, connect the NIC card(s) to the appropriate switches:



100 GbE cables

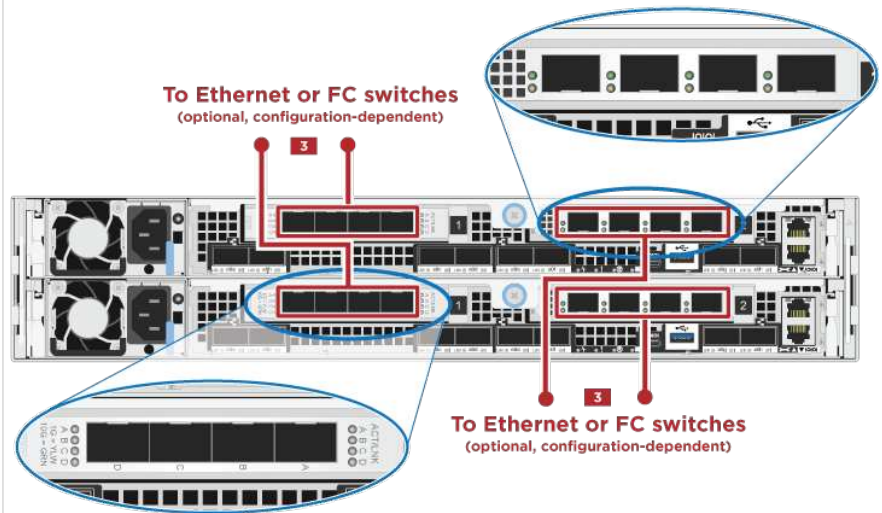


40 GbE cables



FC cables

To Ethernet or FC switches
(optional, configuration-dependent)



To Ethernet or FC switches
(optional, configuration-dependent)

Step	Perform on each controller module
4	<p>Cable the e0M ports to the management network switches with the RJ45 cables.</p>  <p>Ethernet cables</p>
	DO NOT plug in the power cords at this point.

2. Cable your storage: [Cabling controllers to drive shelves](#)

Option 2: Cabling a switched cluster

The optional data ports, optional NIC cards, and management ports on the controller modules are connected to switches. The cluster interconnect/HA ports are cabled on to the cluster/HA switch.

You must have contacted your network administrator for information about connecting the system to the switches.

Be sure to check the illustration arrow for the proper cable connector pull-tab orientation.



As you insert the connector, you should feel it click into place; if you do not feel it click, remove it, turn it around and try again.

1. You can used the graphic or the step-by step instructions to complete the cabling between the controllers and to the switches:

[drw a320 switched network cabling composite animated gif] |

Step	Perform on each controller module
<div data-bbox="183 216 245 258" data-label="Text">1</div>	<p data-bbox="513 216 1354 285">Cable the cluster/HA ports to the cluster/HA switch with the 100 GbE (QSFP28) cable:</p> <ul data-bbox="537 317 1143 401" style="list-style-type: none"> • e0a on both controllers to the cluster/HA switch • e0d on both controllers to the cluster/HA switch <div data-bbox="561 432 1484 873" data-label="Diagram"> </div>
<div data-bbox="183 957 245 999" data-label="Text">2</div>	<p data-bbox="513 957 1476 1026">If you are using your onboard ports for a data network connection, connect the 100GbE or 40GbE cables to the appropriate data network switches:</p> <ul data-bbox="537 1058 716 1100" style="list-style-type: none"> • e0g and e0h <div data-bbox="561 1110 1484 1562" data-label="Diagram"> </div>

Step	Perform on each controller module
<div data-bbox="183 159 245 197" data-label="Text">3</div>	<p data-bbox="513 159 1446 222">If you are using your NIC cards for Ethernet or FC connections, connect the NIC card(s) to the appropriate switches:</p> <div data-bbox="513 275 1481 989" data-label="Image"> <p>The diagram illustrates the connection of Network Interface Cards (NICs) to switches. At the top, three types of cables are shown: 100 GbE (blue, multi-fiber), 40 GbE (blue, standard RJ45), and FC (blue, SFP+). Below, a server rack is shown with two controller modules. Red lines and callouts indicate connections from the NICs on these modules to external switches. The callouts are labeled 'To Ethernet or FC switches (optional, configuration-dependent)'. A red box with the number '3' is placed near the connection points on the server modules.</p> </div>
<div data-bbox="183 1062 245 1100" data-label="Text">4</div>	<p data-bbox="513 1062 1406 1125">Cable the e0M ports to the management network switches with the RJ45 cables.</p> <div data-bbox="513 1188 1481 1535" data-label="Image"> <p>The diagram shows the connection of the e0M (Ethernet over Management) ports to management network switches. An Ethernet cable is shown at the top. Below, a server rack is shown with two controller modules. Purple lines and callouts indicate connections from the e0M ports on these modules to management network switches. The callout is labeled 'To management network switches'. A purple box with the number '4' is placed near the connection points on the server modules.</p> </div>
<div data-bbox="183 1608 245 1682" data-label="Image"> </div>	<p data-bbox="513 1608 1073 1640">DO NOT plug in the power cords at this point.</p>

2. Cable your storage: [Cabling controllers to drive shelves](#)

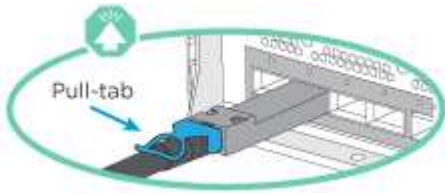
Cable controllers to drive shelves

You must cable the controllers to your shelves using the onboard storage ports.

Option 1: Cable the controllers to a single drive shelf

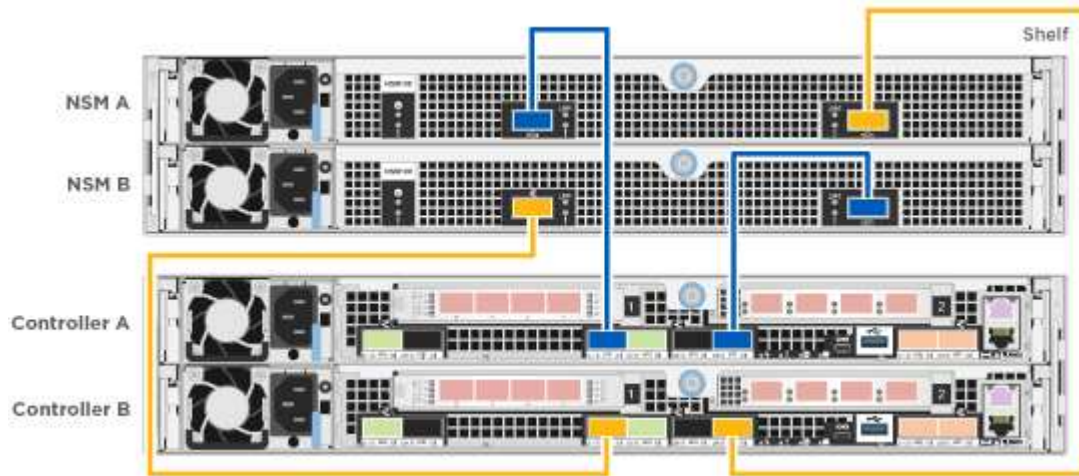
You must cable each controller to the NSM modules on the NS224 drive shelf.

Be sure to check the illustration arrow for the proper cable connector pull-tab orientation.



As you insert the connector, you should feel it click into place; if you do not feel it click, remove it, turn it around and try again.

1. You can use the graphic or the step-by-step instructions to cable your controllers to a single shelf.



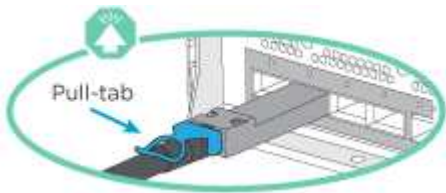
Step	Perform on each controller module
<div data-bbox="183 153 245 195" data-label="Text">1</div>	<div data-bbox="513 153 878 195" data-label="Text">Cable controller A to the shelf</div> <div data-bbox="513 216 1479 846" data-label="Diagram"> <p>100 GbE cables</p> <p>NSM A</p> <p>NSM B</p> <p>Controller A</p> <p>Controller B</p> <p>Shelf</p> </div>
<div data-bbox="183 924 245 966" data-label="Text">2</div>	<div data-bbox="513 924 886 966" data-label="Text">Cable controller B to the shelf:</div> <div data-bbox="513 987 1479 1686" data-label="Diagram"> <p>100 GbE cables</p> <p>NSM A</p> <p>NSM B</p> <p>Controller A</p> <p>Controller B</p> <p>Shelf</p> </div>

2. To complete setting up your system, see [Completing system setup and configuration](#).

Option 2: Cable the controllers to two drive shelves

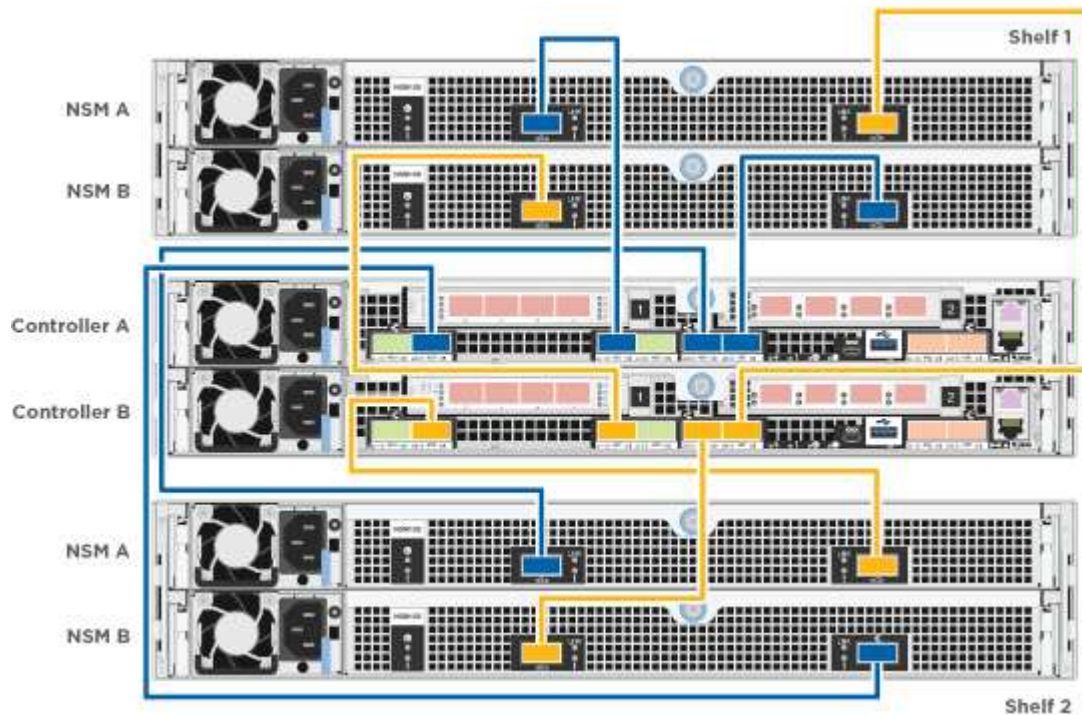
You must cable each controller to the NSM modules on both NS224 drive shelves.

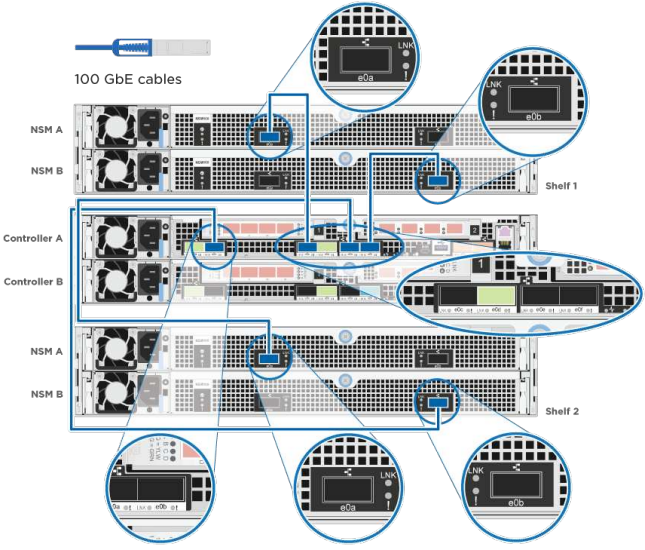
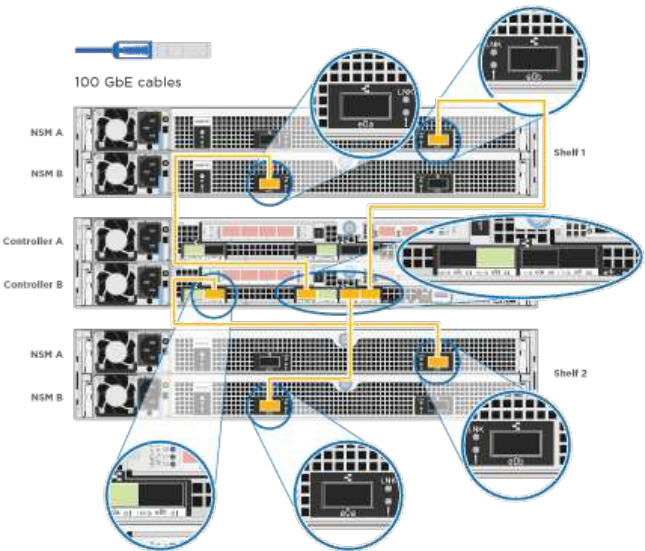
Be sure to check the illustration arrow for the proper cable connector pull-tab orientation.



As you insert the connector, you should feel it click into place; if you do not feel it click, remove it, turn it around and try again.

1. You can use the following graphic or the written steps to cable your controllers to two drive shelves.



Step	Perform on each controller module
<div data-bbox="183 155 245 197" data-label="Text">1</div>	<p data-bbox="841 159 1247 191">Cable controller A to the shelves:</p> 
<div data-bbox="183 795 245 837" data-label="Text">2</div>	<p data-bbox="841 800 1247 831">Cable controller B to the shelves:</p> 

- To complete setting up your system, see [Completing system setup and configuration](#).

Complete system setup and configuration

You can complete the system setup and configuration using cluster discovery with only a connection to the switch and laptop, or by connecting directly to a controller in the system and then connecting to the management switch.

Option 1: Completing system setup and configuration if network discovery is enabled

If you have network discovery enabled on your laptop, you can complete system setup and configuration using automatic cluster discovery.

1. Plug the power cords into the controller power supplies, and then connect them to power sources on different circuits.

The system begins to boot. Initial booting may take up to eight minutes

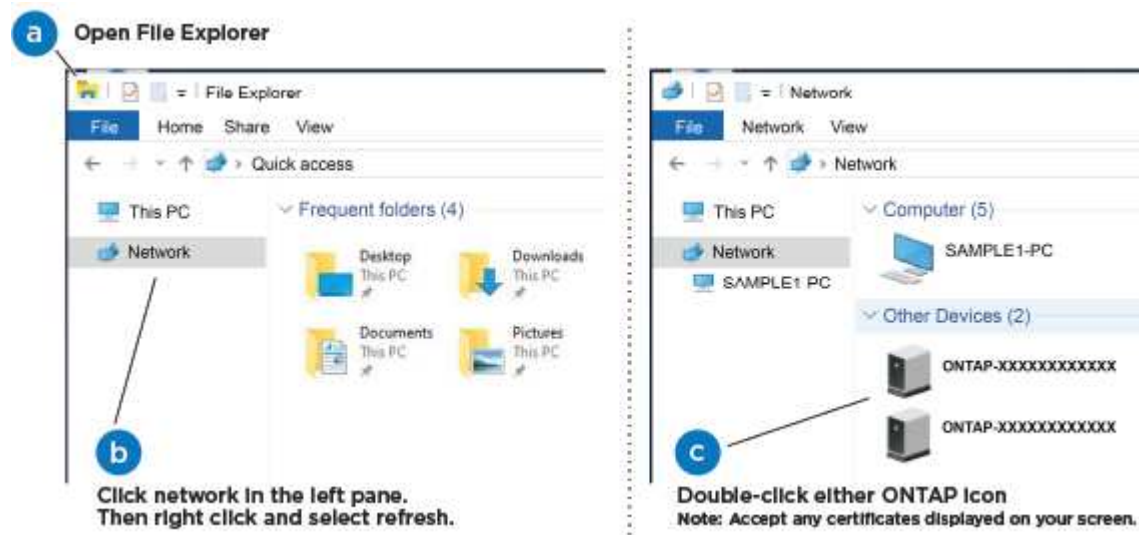
2. Make sure that your laptop has network discovery enabled.

See your laptop's online help for more information.

3. Use the following graphic to connect your laptop to the Management switch.

Connecting your laptop to the Management switch

4. Select an ONTAP icon listed to discover:



- a. Open File Explorer.
- b. Click network in the left pane.
- c. Right click and select refresh.
- d. Double-click either ONTAP icon and accept any certificates displayed on your screen.



XXXXX is the system serial number for the target node.

System Manager opens.

5. Use System Manager guided setup to configure your system using the data you collected in the *NetApp ONTAP Configuration Guide*.

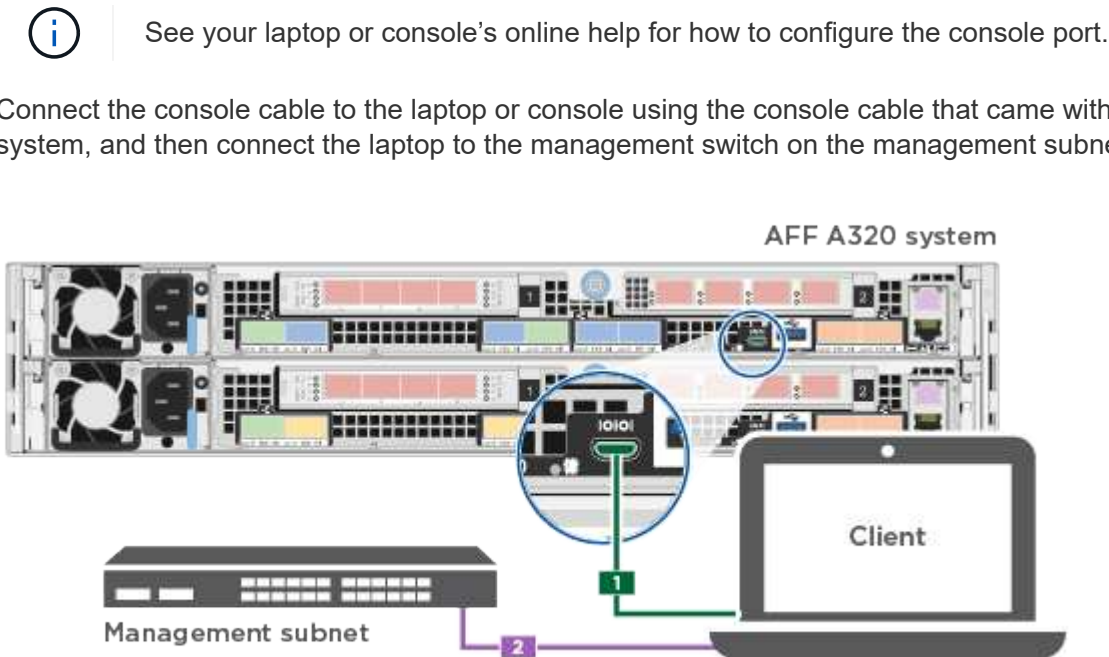
ONTAP Configuration Guide

6. Verify the health of your system by running Config Advisor.
7. After you have completed the initial configuration, go to the [ONTAP & ONTAP System Manager Documentation Resources](#) page for information about configuring additional features in ONTAP.

Option 2: Completing system setup and configuration if network discovery is not enabled

If network discovery is not enabled on your laptop, you must complete the configuration and setup using this task.

- 1. Cable and configure your laptop or console:
 - a. Set the console port on the laptop or console to 115,200 baud with N-8-1.
 - b. Connect the console cable to the laptop or console using the console cable that came with your system, and then connect the laptop to the management switch on the management subnet.



- c. Assign a TCP/IP address to the laptop or console, using one that is on the management subnet.
- 2. Use the following graphic to set one or more drive shelf IDs:
- 3. Plug the power cords into the controller power supplies, and then connect them to power sources on different circuits.

The system begins to boot. Initial booting may take up to eight minutes

- 4. Assign an initial node management IP address to one of the nodes.

If the management network has DHCP...	Then...
Configured	Record the IP address assigned to the new controllers.
Not configured	<div><div><div>a. Open a console session using PuTTY, a terminal server, or the equivalent for your environment.</div><div><div><div>i</div><div>Check your laptop or console’s online help if you do not know how to configure PuTTY.</div></div><div>b. Enter the management IP address when prompted by the script.</div></div></div></div>

5. Using System Manager on your laptop or console, configure your cluster:

- a. Point your browser to the node management IP address.



The format for the address is `https://x.x.x.x`.

- b. Configure the system using the data you collected in the *NetApp ONTAP Configuration guide*.

[ONTAP Configuration Guide](#)

6. Verify the health of your system by running Config Advisor.

7. After you have completed the initial configuration, go to the [ONTAP & ONTAP System Manager Documentation Resources](#) page for information about configuring additional features in ONTAP.

Maintain

Boot media

Replace the boot media - AFF A320

The boot media stores a primary and secondary set of system (boot image) files that the system uses when it boots. Depending on your network configuration, you can perform either a nondisruptive or disruptive replacement.

You must have a USB flash drive, formatted to FAT32, with the appropriate amount of storage to hold the `image_xxx.tgz`.

You also must copy the `image_xxx.tgz` file to the USB flash drive for later use in this procedure.

- The nondisruptive and disruptive methods for replacing a boot media both require you to restore the `var` file system:
 - For nondisruptive replacement, the HA pair must be connected to a network to restore the `var` file system.
 - For disruptive replacement, you do not need a network connection to restore the `var` file system, but the process requires two reboots.
- You must replace the failed component with a replacement FRU component you received from your provider.
- It is important that you apply the commands in these steps on the correct node:
 - The *impaired* node is the node on which you are performing maintenance.
 - The *healthy node* is the HA partner of the impaired node.

Check onboard encryption keys as needed - AFF A320

Prior to shutting down the impaired node and checking the status of the onboard encryption keys, you must check the status of the impaired node, disable automatic giveback, and check what version of ONTAP the system is running.

If you have a cluster with more than two nodes, it must be in quorum. If the cluster is not in quorum or a healthy node shows false for eligibility and health, you must correct the issue before shutting down the impaired node.

Steps

1. Check the status of the impaired node:
 - If the impaired node is at the login prompt, log in as `admin`.
 - If the impaired node is at the LOADER prompt and is part of HA configuration, log in as `admin` on the healthy node.
 - If the impaired node is in a standalone configuration and at LOADER prompt, contact NetApp Support. mysupport.netapp.com
2. If AutoSupport is enabled, suppress automatic case creation by invoking an AutoSupport message:

```
system node autosupport invoke -node * -type all -message  
MAINT=number_of_hours_downh
```

The following AutoSupport message suppresses automatic case creation for two hours: `cluster1:*>`

```
system node autosupport invoke -node * -type all -message MAINT=2h
```
3. Check the version of ONTAP the system is running on the impaired node if up, or on the partner node if the impaired node is down, using the `version -v` command:
 - If `<Ino-DARE>` is displayed in the command output, the system does not support NVE, proceed to shut down the controller.
 - If `<Ino-DARE>` is not displayed in the command output, and the system is running ONTAP 9.6 or later, go to go to the next section.

Check NVE or NSE on systems running ONTAP 9.6 and later

Before shutting down the impaired node, you need to verify whether the system has either NetApp Volume Encryption (NVE) or NetApp Storage Encryption (NSE) enabled. If so, you need to verify the configuration.

1. Verify whether NVE is configured for any volumes in the cluster: `volume show -is-encrypted true`

If any volumes are listed in the output, NVE is configured and you need to verify the NVE configuration. If no volumes are listed, check whether NSE is configured.
2. Verify whether NSE is configured: `storage encryption disk show`
 - If the command output list the drive details with Mode & Key ID information, NSE is configured and you need to verify the NSE configuration.
 - If no disks are shown, NSE is not configured.
 - If NVE and NSE are not configured, it's safe to shut down the impaired node.

Verify NVE configuration


1. Display the key IDs of the authentication keys that are stored on the key management servers: `security key-manager query`
 - If the `Key Manager type` displays `external` and the `Restored` column displays `yes`, it's safe to shut down the impaired node.
 - If the `Key Manager type` displays `onboard` and the `Restored` column displays `yes`, you need to

complete some additional steps.

- If the Key Manager type displays `external` and the Restored column displays anything other than `yes`, you need to complete some additional steps.
 - If the Key Manager type displays `onboard` and the Restored column displays anything other than `yes`, you need to complete some additional steps.
2. If the Key Manager type displays `onboard` and the Restored column displays `yes`, manually backup the OKM information:
 - a. Go to advanced privilege mode and enter `y` when prompted to continue: `set -priv advanced`
 - b. Enter the command to display the key management information: `security key-manager onboard show-backup`
 - c. Copy the contents of the backup information to a separate file or your log file. You'll need it in disaster scenarios where you might need to manually recover OKM.
 - d. Return to admin mode: `set -priv admin`
 - e. Shut down the impaired node.
 3. If the Key Manager type displays `external` and the Restored column displays anything other than `yes`:
 - a. Restore the external key management authentication keys to all nodes in the cluster: `security key-manager external restore`

If the command fails, contact NetApp Support.

mysupport.netapp.com
 - b. Verify that the Restored column equals `yes` for all authentication keys: `security key-manager key query`
 - c. Shut down the impaired node.
 4. If the Key Manager type displays `onboard` and the Restored column displays anything other than `yes`:
 - a. Enter the onboard security key-manager sync command: `security key-manager onboard sync`



Enter the customer's onboard key management passphrase at the prompt. If the passphrase cannot be provided, contact NetApp Support. mysupport.netapp.com
 - b. Verify the Restored column shows `yes` for all authentication keys: `security key-manager key query`
 - c. Verify that the Key Manager type shows `onboard`, manually backup the OKM information.
 - d. Go to advanced privilege mode and enter `y` when prompted to continue: `set -priv advanced`
 - e. Enter the command to display the key management backup information: `security key-manager onboard show-backup`
 - f. Copy the contents of the backup information to a separate file or your log file. You'll need it in disaster scenarios where you might need to manually recover OKM.
 - g. Return to admin mode: `set -priv admin`
 - h. You can safely shutdown the node.

Verify NSE configuration

1. Display the key IDs of the authentication keys that are stored on the key management servers: `security key-manager query`
 - If the Key Manager type displays `external` and the Restored column displays `yes`, it's safe to shut down the impaired node.
 - If the Key Manager type displays `onboard` and the Restored column displays `yes`, you need to complete some additional steps.
 - If the Key Manager type displays `external` and the Restored column displays anything other than `yes`, you need to complete some additional steps.
 - If the Key Manager type displays `external` and the Restored column displays anything other than `yes`, you need to complete some additional steps.
2. If the Key Manager type displays `onboard` and the Restored column displays `yes`, manually backup the OKM information:
 - a. Go to advanced privilege mode and enter `y` when prompted to continue: `set -priv advanced`
 - b. Enter the command to display the key management information: `security key-manager onboard show-backup`
 - c. Copy the contents of the backup information to a separate file or your log file. You'll need it in disaster scenarios where you might need to manually recover OKM.
 - d. Return to admin mode: `set -priv admin`
 - e. You can safely shutdown the node.
3. If the Key Manager type displays `external` and the Restored column displays anything other than `yes`:
 - a. Enter the onboard security key-manager sync command: `security key-manager external sync`

If the command fails, contact NetApp Support.

mysupport.netapp.com
 - b. Verify that the Restored column equals `yes` for all authentication keys: `security key-manager key query`
 - c. You can safely shutdown the node.
4. If the Key Manager type displays `onboard` and the Restored column displays anything other than `yes`:
 - a. Enter the onboard security key-manager sync command: `security key-manager onboard sync`

Enter the customer's onboard key management passphrase at the prompt. If the passphrase cannot be provided, contact NetApp Support.

mysupport.netapp.com
 - b. Verify the Restored column shows `yes` for all authentication keys: `security key-manager key query`
 - c. Verify that the Key Manager type shows `onboard`, manually backup the OKM information.

- d. Go to advanced privilege mode and enter `y` when prompted to continue: `set -priv advanced`
- e. Enter the command to display the key management backup information: `security key-manager onboard show-backup`
- f. Copy the contents of the backup information to a separate file or your log file. You'll need it in disaster scenarios where you might need to manually recover OKM.
- g. Return to admin mode: `set -priv admin`
- h. You can safely shutdown the node.

Shut down the node - AFF A320

After completing the NVE or NSE tasks, you need to complete the shutdown of the impaired node.

Steps

1. If the impaired node isn't at the LOADER prompt:

If the impaired node displays...	Then...
Waiting for giveback...	Press Ctrl-C, and then respond <code>y</code> when prompted.
System prompt or password prompt (enter system password)	<p>Take over or halt the impaired node:</p> <ul style="list-style-type: none"> For an HA pair, take over the impaired node from the healthy node: <code>storage failover takeover -ofnode `impaired_node_name`</code> <p>When the impaired node shows Waiting for giveback..., press Ctrl-C, and then respond <code>y</code>.</p>

2. From the LOADER prompt, enter: `printenv` to capture all boot environmental variables. Save the output to your log file.



This command may not work if the boot device is corrupted or non-functional.

Remove the controller module, replace the boot media and transfer the boot image to the boot media - AFF A320

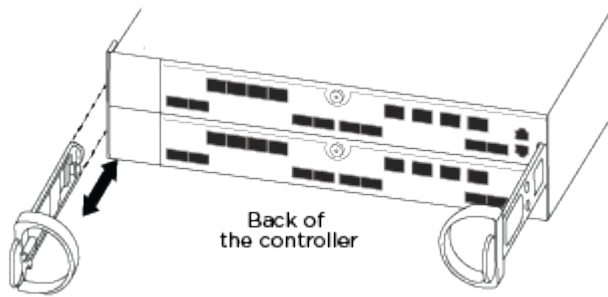
To replace the boot media, you must remove the impaired controller module, install the replacement boot media, and transfer the boot image to a USB flash drive.

Step 1: Remove the controller module

To access components inside the controller module, you must remove the controller module from the chassis.

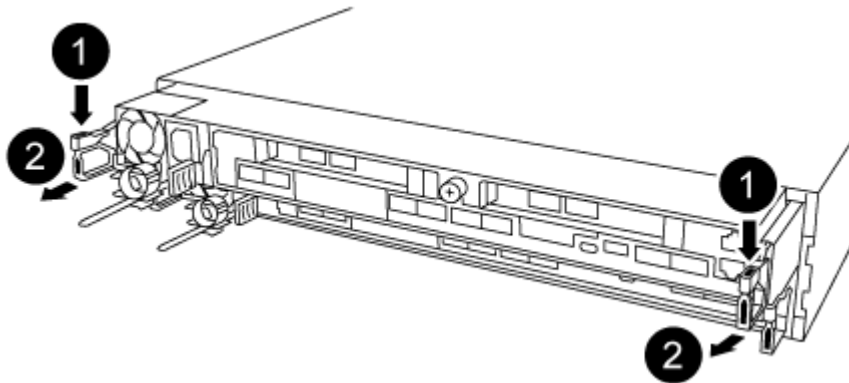
1. If you are not already grounded, properly ground yourself.
2. Unplug the controller module power supply from the power source.

3. Loosen the hook and loop strap binding the cables to the cable management device, and then unplug the system cables and SFPs (if needed) from the controller module, keeping track of where the cables were connected.



Leave the cables in the cable management device so that when you reinstall the cable management device, the cables are organized.

4. Remove and set aside the cable management devices from the left and right sides of the controller module.
5. Remove the controller module from the chassis:



- a. Insert your forefinger into the latching mechanism on either side of the controller module.
- b. Press down on the orange tab on top of the latching mechanism until it clears the latching pin on the chassis.

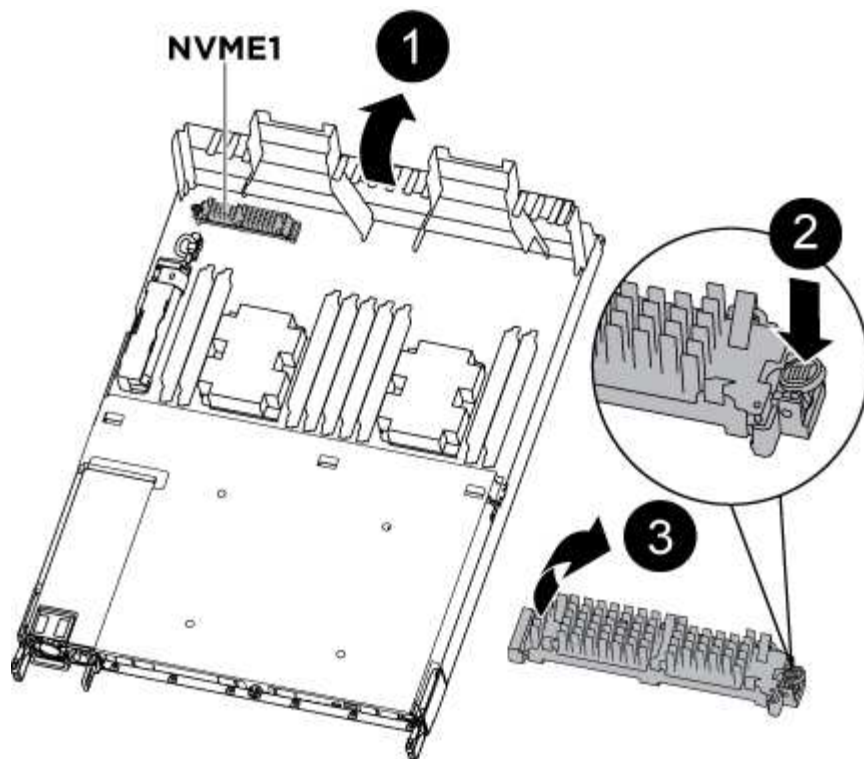
The latching mechanism hook should be nearly vertical and should be clear of the chassis pin.

- c. Gently pull the controller module a few inches toward you so that you can grasp the controller module sides.
- d. Using both hands, gently pull the controller module out of the chassis and set it on a flat, stable surface.

Step 2: Replace the boot media

You must locate the boot media in the controller module, and then follow the directions to replace it.

1. Open the air duct and locate the boot media using the following illustration or the FRU map on the controller module:
2. Locate and remove the boot media from the controller module:



- a. Press the blue button at the end of the boot media until the lip on the boot media clears the blue button.
- b. Rotate the boot media up and gently pull the boot media out of the socket.

1. Check the boot media to make sure that it is seated squarely and completely in the socket.

If necessary, remove the boot media and reseal it into the socket.

3. Lock the boot media in place:

- a. Rotate the boot media down toward the motherboard.
- b. Placing a finger at the end of the boot media by the blue button, push down on the boot media end to engage the blue locking button.
- c. While pushing down on the boot media, lift the blue locking button to lock the boot media in place.

4. Close the air duct.

Step 3: Transfer the boot image to the boot media using a USB flash drive

The replacement boot media that you installed does not have a boot image, so you need to transfer a boot image using a USB flash drive.

- You must have a USB flash drive, formatted to MBR/FAT32, with at least 4GB capacity
- A copy of the same image version of ONTAP as what the impaired controller was running. You can download the appropriate image from the Downloads section on the NetApp Support Site
 - If NVE is enabled, download the image with NetApp Volume Encryption, as indicated in the download button.
 - If NVE is not enabled, download the image without NetApp Volume Encryption, as indicated in the download button.
- If your system is an HA pair, you must have a network connection.

- If your system is a stand-alone system you do not need a network connection, but you must perform an additional reboot when restoring the var file system.

1. Download and copy the appropriate service image from the NetApp Support Site to the USB flash drive.
 - a. Download the service image to your work space on your laptop.
 - b. Unzip the service image.



If you are extracting the contents using Windows, do not use winzip to extract the netboot image. Use another extraction tool, such as 7-Zip or WinRAR.

There are two folders in the unzipped service image file:

- boot
 - efi
- c. Copy the efi folder to the top directory on the USB flash drive.

The USB flash drive should have the efi folder and the same Service Image (BIOS) version of what the impaired controller is running.

- d. Remove the USB flash drive from your laptop.
2. If you have not already done so, close the air duct.
 3. Align the end of the controller module with the opening in the chassis, and then gently push the controller module halfway into the system.
 4. Reinstall the cable management device and recable the system, as needed.

When recabling, remember to reinstall the media converters (SFPs or QSFPs) if they were removed.

5. Plug the power cable into the power supply and reinstall the power cable retainer.
6. Insert the USB flash drive into the USB slot on the controller module.

Make sure that you install the USB flash drive in the slot labeled for USB devices, and not in the USB console port.

7. Complete the reinstallation of the controller module:
 - a. Make sure the latch arms are locked in the extended position.
 - b. Using the latch arms, push the controller module into the chassis bay until it stops.



Do not push down on the latching mechanism at the top of the latch arms. Doing so will raise the locking mechanism and prohibit sliding the controller module into the chassis.

- c. Press down and hold the orange tabs on top of the latching mechanism.
- d. Gently push the controller module into the chassis bay until it is flush with the edges of the chassis.



The latching mechanism arms slide into the chassis.

The controller module begins to boot as soon as it is fully seated in the chassis.

- e. Release the latches to lock the controller module into place.
- f. If you have not already done so, reinstall the cable management device.
8. Interrupt the boot process by pressing Ctrl-C to stop at the LOADER prompt.

If you miss this message, press Ctrl-C, select the option to boot to Maintenance mode, and then halt the node to boot to LOADER.

9. Although the environment variables and bootargs are retained, you should check that all required boot environment variables and bootargs are properly set for your system type and configuration using the `printenv bootarg name` command and correct any errors using the `setenv variable-name <value>` command.

- a. Check the boot environment variables:

- `bootarg.init.boot_clustered`
- `partner-sysid`
- `bootarg.init.flash_optimized` for AFF C190/AFF A220 (All Flash FAS)
- `bootarg.init.san_optimized` for AFF A220 and All SAN Array
- `bootarg.init.switchless_cluster.enable`

- b. If External Key Manager is enabled, check the bootarg values, listed in the `kenv ASUP` output:

- `bootarg.storageencryption.support <value>`
- `bootarg.keymanager.support <value>`
- `kmip.init.interface <value>`
- `kmip.init.ipaddr <value>`
- `kmip.init.netmask <value>`
- `kmip.init.gateway <value>`

- c. If Onboard Key Manager is enabled, check the bootarg values, listed in the `kenv ASUP` output:

- `bootarg.storageencryption.support <value>`
- `bootarg.keymanager.support <value>`
- `bootarg.onboard_keymanager <value>`

- d. Save the environment variables you changed with the `savenv` command

- e. Confirm your changes using the `printenv variable-name` command.


10. From the LOADER prompt, boot the recovery image from the USB flash drive: `boot_recovery`

The image is downloaded from the USB flash drive.

11. When prompted, either enter the name of the image or accept the default image displayed inside the brackets on your screen.
12. After the image is installed, start the restoration process:
 - a. Record the IP address of the impaired node that is displayed on the screen.
 - b. Press `y` when prompted to restore the backup configuration.

- c. Press `y` when prompted to overwrite `/etc/ssh/ssh_host_dsa_key`.
13. From the partner node in advanced privilege level, start the configuration synchronization using the IP address recorded in the previous step: `system node restore-backup -node local -target -address impaired_node_IP_address`
14. If the restore is successful, press `y` on the impaired node when prompted to use the restored copy?.
15. Press `y` when you see confirm backup procedure was successful, and then press `y` when prompted to reboot the node.
16. Verify that the environmental variables are set as expected.
 - a. Take the node to the LOADER prompt.

 From the ONTAP prompt, you can issue the command `system node halt -skip-lif-migration-before -shutdown true -ignore-quorum-warnings true -inhibit-takeover true`.
 - b. Check the environment variable settings with the `printenv` command.
 - c. If an environment variable is not set as expected, modify it with the `setenv environment-variable-name changed-value` command.
 - d. Save your changes using the `savenv` command.
 - e. Reboot the node.
17. With the rebooted impaired node displaying the `Waiting for giveback...` message, perform a giveback from the healthy node:

If your system is in...	Then...
An HA pair	<p>After the impaired node is displaying the <code>Waiting for giveback...</code> message, perform a giveback from the healthy node:</p> <ol style="list-style-type: none"> a. From the healthy node: <code>storage failover giveback -ofnode partner_node_name</code> <p>The impaired node takes back its storage, finishes booting, and then reboots and is again taken over by the healthy node.</p> <div style="display: flex; align-items: center;">  <div> <p>If the giveback is vetoed, you can consider overriding the vetoes.</p> <p>ONTAP 9 High-Availability Configuration Guide</p> </div> </div> <ol style="list-style-type: none"> b. Monitor the progress of the giveback operation by using the <code>storage failover show-giveback</code> command. c. After the giveback operation is complete, confirm that the HA pair is healthy and that takeover is possible by using the <code>storage failover show</code> command. d. Restore automatic giveback if you disabled it using the <code>storage failover modify</code> command.

18. Exit advanced privilege level on the healthy node.

Restore OKM, NSE, and NVE as needed - AFF A320

Once environment variables are checked, you must complete steps specific to systems that have Onboard Key Manager (OKM), NetApp Storage Encryption (NSE) or NetApp Volume Encryption (NVE) enabled.

1. Determine which section you should use to restore your OKM, NSE, or NVE configurations: If NSE or NVE are enabled along with Onboard Key Manager you must restore settings you captured at the beginning of this procedure.
 - If NSE or NVE are enabled and Onboard Key Manager is enabled, go to [Restore NVE or NSE when Onboard Key Manager is enabled](#).
 - If NSE or NVE are enabled for ONTAP 9.6, go to [Restore NSE/NVE on systems running ONTAP 9.6 and later](#).

Restore NVE or NSE when Onboard Key Manager is enabled

Steps

1. Connect the console cable to the target node.
2. Use the `boot_ontap` command at the LOADER prompt to boot the node.
3. Check the console output:

If the console displays...	Then...
The LOADER prompt	Boot the node to the boot menu: <code>boot_ontap menu</code>
Waiting for giveback....	<ol style="list-style-type: none">a. Enter <code>Ctrl-C</code> at the promptb. At the message: Do you wish to halt this node rather than wait [y/n]? , enter: <code>y</code>c. At the LOADER prompt, enter the <code>boot_ontap menu</code> command.

4. At the Boot Menu, enter the hidden command, `recover_onboard_keymanager` and reply `y` at the prompt
5. Enter the passphrase for the onboard key manager you obtained from the customer at the beginning of this procedure.
6. When prompted to enter the backup data, paste the backup data you captured at the beginning of this procedure, when asked. Paste the output of `security key-manager backup show` OR `security key-manager onboard show-backup` command



The data is output from either `security key-manager backup show` or `security key-manager onboard show-backup` command.

Example of backup data:

```

-----BEGIN BACKUP-----
TmV0QXBwIEtleSBCbG9iAAEAAAAEAAAAcAEAAAAAADuD+byAAAAACEAAAAAAAAA
QAAAAAAAAABvOIH0AAAAAMh7qDLRyH1DBz12piVdy9ATSFMT0C0TIYFss4PDjTaV
dzRYkLd1PhQLxAWJwOlyqSr8qY1SEBgm1IWgE5DLRqkiAAAAAAAAACgAAAAAAAA
3WTh7gAAAAAAAAAAAAAAAAIAAAAAAgAZJEIWvdeHr5RCAvHGclo+wAAAAAAAAAA
lgAAAAAAAAAoAAAAAAAAAEOTcR0AAAAAAAAAAAAAAAACAAAAAAJAGr3tJA/
LRzUQRHwv+1aWvAAAAAAAAAACQAAAAAAAAAgAAAAAAAAACdhTcvAAAAAJ1PXeBf
ml4NBsSyV1B4jc4A7cvWEFY6ILG6hc6tbKLAHZuvfQ4rIbYAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
.
.
.
.
H4nPQM0nrDRYRa9SCv8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAA
-----END BACKUP-----

```

7. At the Boot Menu select the option for Normal Boot.

The system boots to Waiting for giveback... prompt.

8. Move the console cable to the partner node and login as "admin".

9. Confirm the target node is ready for giveback with the `storage failover show` command.

10. Giveback only the CFO aggregates with the `storage failover giveback -fromnode local -only-cfo-aggregates true` command.

- If the command fails because of a failed disk, physically dis-engage the failed disk, but leave the disk in the slot until a replacement is received.
- If the command fails because of an open CIFS sessions, check with customer how to close out CIFS sessions.



Terminating CIFS can cause loss of data.

- If the command fails because the partner "not ready", wait 5 minutes for the NVMEMs to synchronize.
- If the command fails because of an NDMP, SnapMirror, or SnapVault process, disable the process. See the appropriate Documentation Center for more information.

11. Once the giveback completes, check the failover and giveback status with the `storage failover show` and `storage failover show-giveback` commands.

Only the CFO aggregates (root aggregate and CFO style data aggregates) will be shown.

12. Move the console cable to the target node.

- a. If you are running ONTAP 9.6 or later, run the `security key-manager onboard sync`:
- b. Run the `security key-manager onboard sync` command and then enter the passphrase when prompted.

- c. Enter the `security key-manager key query` command to see a detailed view of all keys stored in the onboard key manager and verify that the `Restored` column = `yes/true` for all authentication keys.



If the `Restored` column = anything other than `yes/true`, contact Customer Support.

- d. Wait 10 minutes for the key to synchronize across the cluster.

13. Move the console cable to the partner node.
14. Give back the target node using the `storage failover giveback -fromnode local` command.
15. Check the giveback status, 3 minutes after it reports complete, using the `storage failover show` command.

If giveback is not complete after 20 minutes, contact Customer Support.

16. At the clustershell prompt, enter the `net int show -is-home false` command to list the logical interfaces that are not on their home node and port.

If any interfaces are listed as `false`, revert those interfaces back to their home port using the `net int revert` command.

17. Move the console cable to the target node and run the `version -v` command to check the ONTAP versions.
18. Restore automatic giveback if you disabled it by using the `storage failover modify -node local -auto-giveback true` command.

Restore NSE/NVE on systems running ONTAP 9.6 and later

Steps

1. Connect the console cable to the target node.
2. Use the `boot_ontap` command at the `LOADER` prompt to boot the node.
3. Check the console output:

If the console displays...	Then...
The login prompt	Go to Step 7.
Waiting for giveback...	<ol style="list-style-type: none">a. Log into the partner node.b. Confirm the target node is ready for giveback with the <code>storage failover show</code> command.

4. Move the console cable to the partner node and give back the target node storage using the `storage failover giveback -fromnode local -only-cfo-aggregates true local` command.
 - If the command fails because of a failed disk, physically dis-engage the failed disk, but leave the disk in the slot until a replacement is received.
 - If the command fails because of an open CIFS sessions, check with customer how to close out CIFS sessions.



Terminating CIFS can cause loss of data.

- If the command fails because the partner "not ready", wait 5 minutes for the NVMEMs to synchronize.
 - If the command fails because of an NDMP, SnapMirror, or SnapVault process, disable the process. See the appropriate Documentation Center for more information.
5. Wait 3 minutes and check the failover status with the `storage failover show` command.
 6. At the clustershell prompt, enter the `net int show -is-home false` command to list the logical interfaces that are not on their home node and port.

If any interfaces are listed as `false`, revert those interfaces back to their home port using the `net int revert` command.

7. Move the console cable to the target node and run the `version -v` command to check the ONTAP versions.
8. Restore automatic giveback if you disabled it by using the `storage failover modify -node local -auto-giveback true` command.
9. Use the `storage encryption disk show` at the clustershell prompt, to review the output.
10. Use the `security key-manager key query` command to display the key IDs of the authentication keys that are stored on the key management servers.
 - If the `Restored` column = `yes/true`, you are done and can proceed to complete the replacement process.
 - If the `Key Manager type` = `external` and the `Restored` column = anything other than `yes/true`, use the `security key-manager external restore` command to restore the key IDs of the authentication keys.



If the command fails, contact Customer Support.

- If the `Key Manager type` = `onboard` and the `Restored` column = anything other than `yes/true`, use the `security key-manager onboard sync` command to re-sync the Key Manager type.

Use the `security key-manager key query` command to verify that the `Restored` column = `yes/true` for all authentication keys.

11. Connect the console cable to the partner node.
12. Give back the node using the `storage failover giveback -fromnode local` command.
13. Restore automatic giveback if you disabled it by using the `storage failover modify -node local -auto-giveback true` command.

Return the failed part to NetApp - AFF A320

After you replace the part, you can return the failed part to NetApp, as described in the RMA instructions shipped with the kit. Contact technical support at [NetApp Support](#), 888-463-8277 (North America), 00-800-44-638277 (Europe), or +800-800-80-800 (Asia/Pacific) if you need the RMA number or additional help with the replacement procedure.

Chassis

Replace the chassis - AFF A320

To replace the chassis, you must move the fans and controller modules from the impaired chassis to the new chassis of the same model as the impaired chassis.

All other components in the system must be functioning properly; if not, you must contact technical support.

- You can use this procedure with all versions of ONTAP supported by your system.
- This procedure is written with the assumption that you are moving the controller modules to the new chassis, and that the chassis is a new component from NetApp.
- This procedure is disruptive. For a two-node cluster, you will have a complete service outage and a partial outage in a multi-node cluster.

Shut down the controllers - AFF A320

You must shut down the node or nodes in the chassis prior to moving them to the new chassis.

About this task

- If you have a cluster with more than two nodes, it must be in quorum. If the cluster is not in quorum or a healthy node shows `false` for eligibility and health, you must correct the issue before shutting down the impaired node.

[ONTAP 9 System Administration Reference](#)

- If AutoSupport is enabled, suppress automatic case creation by invoking an AutoSupport message:
`system node autosupport invoke -node * -type all -message MAINT=number_of_hours_downh`

The following AutoSupport message suppresses automatic case creation for two hours: `cluster1:*> system node autosupport invoke -node * -type all -message MAINT=2h`

Steps

1. If your system has two controller modules, disable the HA pair.

If your system is running clustered ONTAP with...	Then...
Two nodes in the cluster	<code>cluster ha modify -configured false storage failover modify -node node0 -enabled false</code>
More than two nodes in the cluster	<code>storage failover modify -node node0 -enabled false</code>

2. Halt the node, pressing `y` when you are prompted to confirm the halt: `system node halt -node node_name`

The confirmation message looks like the following:


```
Warning: Rebooting or halting node
"node_name" in an HA-enabled cluster may result in client disruption or
data access
failure. To ensure continuity of service, use the "storage
failover takeover" command. Are you sure you want to halt node
"node_name"? {y|n}:
```



You must perform a clean system shutdown before replacing the chassis to avoid losing unwritten data in the nonvolatile memory (NVMEM). If the NVMEM LED is flashing, there is content in the NVMEM that has not been saved to disk. You need to reboot the node and start from the beginning of this procedure. If repeated attempts to cleanly shut down the node fail, be aware that you might lose any data that was not saved to disk.

3. Where applicable, halt the second node to avoid a possible quorum error message in an HA pair configuration: `system node halt -node second_node_name -ignore-quorum-warnings true`

Move and replace hardware - AFF A320

Step 1: Remove the controller modules

To replace the chassis, you must remove the controller modules from the old chassis.

1. If you are not already grounded, properly ground yourself.
2. Release the power cable retainers, and then unplug the cables from the power supplies.
3. Loosen the hook and loop strap binding the cables to the cable management device, and then unplug the system cables and SFPs (if needed) from the controller module, keeping track of where the cables were connected.

Leave the cables in the cable management device so that when you reinstall the cable management device, the cables are organized.

4. Remove and set aside the cable management devices from the left and right sides of the controller module.
5. Remove the controller module from the chassis:
 - a. Insert your forefinger into the latching mechanism on either side of the controller module.
 - b. Press down on the orange tab on top of the latching mechanism until it clears the latching pin on the chassis.

The latching mechanism hook should be nearly vertical and should be clear of the chassis pin.

- c. Gently pull the controller module a few inches toward you so that you can grasp the controller module sides.
 - d. Using both hands, gently pull the controller module out of the chassis and set it on a flat, stable surface.
6. Repeat these steps for the other controller module in the chassis.

Step 2: Move the fans

To move the fan modules to the replacement chassis when replacing the chassis, you

must perform a specific sequence of tasks.

1. If you are not already grounded, properly ground yourself.
2. Remove the bezel (if necessary) with two hands, by grasping the openings on each side of the bezel, and then pulling it toward you until the bezel releases from the ball studs on the chassis frame.
3. Press down the release latch on the fan module cam handle, and then rotate the cam handle downward.

The fan module moves a little bit away from the chassis.

4. Pull the fan module straight out from the chassis, making sure that you support it with your free hand so that it does not swing out of the chassis.

CAUTION:

The fan modules are short. Always support the bottom of the fan module with your free hand so that it does not suddenly drop free from the chassis and injure you.

5. Set the fan module aside.
6. Repeat the preceding steps for any remaining fan modules.
7. Insert the fan module into the replacement chassis by aligning it with the opening, and then sliding it into the chassis.
8. Push firmly on the fan module cam handle so that it is seated all the way into the chassis.

The cam handle raises slightly when the fan module is completely seated.

9. Swing the cam handle up to its closed position, making sure that the cam handle release latch clicks into the locked position.

The fan LED should be green after the fan is seated and has spun up to operational speed.

10. Repeat these steps for the remaining fan modules.

Step 3: Replace a chassis from within the equipment rack or system cabinet

You must remove the existing chassis from the equipment rack or system cabinet before you can install the replacement chassis.

1. Remove the screws from the chassis mount points.
2. With two people, slide the old chassis off the rack rails in a system cabinet or equipment rack, and then set it aside.
3. If you are not already grounded, properly ground yourself.
4. Using two people, install the replacement chassis into the equipment rack or system cabinet by guiding the chassis onto the rack rails in a system cabinet or equipment rack.
5. Slide the chassis all the way into the equipment rack or system cabinet.
6. Secure the front of the chassis to the equipment rack or system cabinet, using the screws you removed from the old chassis.
7. If you have not already done so, install the bezel.

Step 4: Install the controller modules

After you install the controller modules into the new chassis, you need to boot it to a state where you can run the diagnostic test.

For HA pairs with two controller modules in the same chassis, the sequence in which you install the controller module is especially important because it attempts to reboot as soon as you completely seat it in the chassis.

1. Align the end of the controller module with the opening in the chassis, and then gently push the controller module halfway into the system.



Do not completely insert the controller module in the chassis until instructed to do so.

2. Recable the console to the controller module, and then reconnect the management port.
3. Plug the power cables into the power supplies and reinstall the power cable retainers.
4. Complete the reinstallation of the controller module:
 - a. Make sure the latch arms are locked in the extended position.
 - b. Using the latch arms, push the controller module into the chassis bay until it stops.
 - c. Press down and hold the orange tabs on top of the latching mechanism.
 - d. Gently push the controller module into the chassis bay until it is flush with the edges of the chassis.



The latching mechanism arms slide into the chassis.

The controller module begins to boot as soon as it is fully seated in the chassis.

- e. Release the latches to lock the controller module into place.
 - f. Recable the power supply.
 - g. If you have not already done so, reinstall the cable management device.
 - h. Interrupt the normal boot process by pressing `Ctrl-C`.
5. Repeat the preceding steps to install the second controller into the new chassis.

Complete the restoration and replacement process - AFF A320

Step 1: Verify and set the HA state of the chassis

You must verify the HA state of the chassis, and, if necessary, update the state to match your system configuration.

1. In Maintenance mode, from either controller module, display the HA state of the local controller module and chassis: `ha-config show`

The HA state should be the same for all components.

2. If the displayed system state for the chassis does not match your system configuration:
 - a. Set the HA state for the chassis: `ha-config modify chassis HA-state`

The value for HA-state can be one of the following:

- ha
- non-ha

b. Confirm that the setting has changed: `ha-config show`

3. If you have not already done so, recable the rest of your system.
4. Reinstall the bezel on the front of the system.

Step 2: Run diagnostics

After you have replaced a component in your system, you should run diagnostic tests on that component.

Your system must be at the LOADER prompt to start diagnostics.

All commands in the diagnostic procedures are issued from the node where the component is being replaced.

1. If the node to be serviced is not at the LOADER prompt, reboot the node: `system node halt -node node_name`

After you issue the command, you should wait until the system stops at the LOADER prompt.

2. At the LOADER prompt, access the special drivers specifically designed for system-level diagnostics to function properly: `boot_diags`
3. Select **Scan System** from the displayed menu to enable running the diagnostics tests.
4. Select **Test system** from the displayed menu to run diagnostics tests.
5. Select the test or series of tests from the various sub-menus.
6. Proceed based on the result of the preceding step:
 - If the test failed, correct the failure, and then rerun the test.
 - If the test reported no failures, select Reboot from the menu to reboot the system.

Step 2: Return the failed part to NetApp

After you replace the part, you can return the failed part to NetApp, as described in the RMA instructions shipped with the kit. Contact technical support at [NetApp Support](#), 888-463-8277 (North America), 00-800-44-638277 (Europe), or +800-800-80-800 (Asia/Pacific) if you need the RMA number or additional help with the replacement procedure.

Controller module

Replace the controller module - AFF A320

You must review the prerequisites for the replacement procedure and select the correct one for your version of the ONTAP operating system.

- All drive shelves must be working properly.
- The healthy node must be able to take over the node that is being replaced (referred to in this procedure as the “impaired node”).

- If your system is in a MetroCluster configuration, you must review the section [Choosing the correct recovery procedure](#) to determine whether you should use this procedure.

If this is the procedure you should use, note that the controller replacement procedure for a node in a four or eight node MetroCluster configuration is the same as that in an HA pair. No MetroCluster-specific steps are required because the failure is restricted to an HA pair and storage failover commands can be used to provide nondisruptive operation during the replacement.

- You must replace the failed component with a replacement FRU component you received from your provider.
- You must be replacing a controller module with a controller module of the same model type. You cannot upgrade your system by just replacing the controller module.
- You cannot change any drives or drive shelves as part of this procedure.
- In this procedure, the boot device is moved from the impaired node to the *replacement* node so that the *replacement* node will boot up in the same version of ONTAP as the old controller module.
- It is important that you apply the commands in these steps on the correct systems:
 - The *impaired* node is the node that is being replaced.
 - The *replacement* node is the new node that is replacing the impaired node.
 - The *healthy* node is the surviving node.
- You must always capture the node's console output to a text file.

This provides you a record of the procedure so that you can troubleshoot any issues that you might encounter during the replacement process.

Replace the controller module hardware - AFF A320

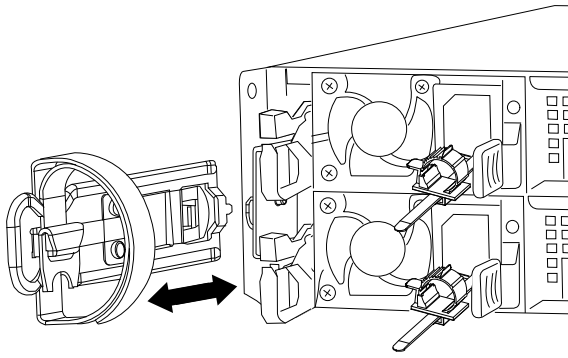
To replace the controller module hardware, you must remove the impaired node, move FRU components to the replacement controller module, install the replacement controller module in the chassis, and then boot the system to Maintenance mode.

Step 1: Remove the controller module

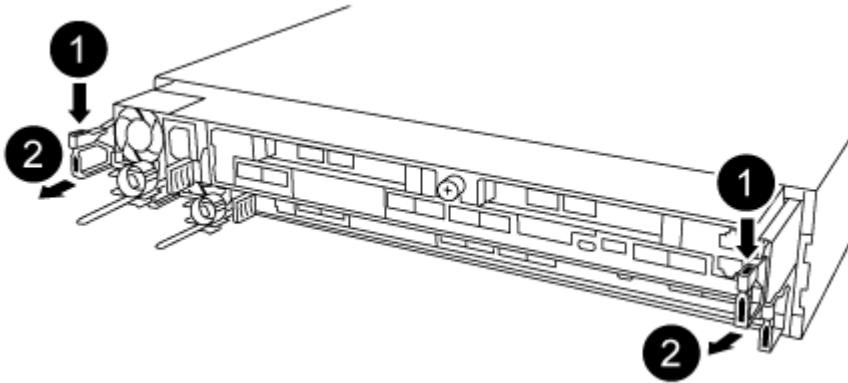
To access components inside the controller module, you must remove the controller module from the chassis.

You can use the following animations or the written steps to remove the controller module from the chassis.

The following animation shows removing the cables and cable management arms from the impaired controller module:



The following animation shows removing the impaired controller module from the chassis:



1. If you are not already grounded, properly ground yourself.
2. Unplug the controller module power supply from the power source.
3. Loosen the hook and loop strap binding the cables to the cable management device, and then unplug the system cables and SFPs (if needed) from the controller module, keeping track of where the cables were connected.

Leave the cables in the cable management device so that when you reinstall the cable management device, the cables are organized.

4. Remove and set aside the cable management devices from the left and right sides of the controller module.
5. Remove the controller module from the chassis:

- a. Insert your forefinger into the latching mechanism on either side of the controller module.
- b. Press down on the orange tab on top of the latching mechanism until it clears the latching pin on the chassis.

The latching mechanism hook should be nearly vertical and should be clear of the chassis pin.

- c. Gently pull the controller module a few inches toward you so that you can grasp the controller module sides.
- d. Using both hands, gently pull the controller module out of the chassis and set it on a flat, stable surface.

Step 2: Move the power supplies

You must move the power supply from the impaired controller module to the replacement controller module when you replace a controller module.

1. Rotate the cam handle such that it can be used to pull power supply out of the controller module while pressing the blue locking tab.

CAUTION:

The power supply is short. Always use two hands to support it when removing it from the controller module so that it does not suddenly swing free from the controller module and injure you.

2. Move the power supply to the new controller module, and then install it.
3. Using both hands, support and align the edges of the power supply with the opening in the controller module, and then gently push the power supply into the controller module until the locking tab clicks into place.

The power supplies will only properly engage with the internal connector and lock in place one way.

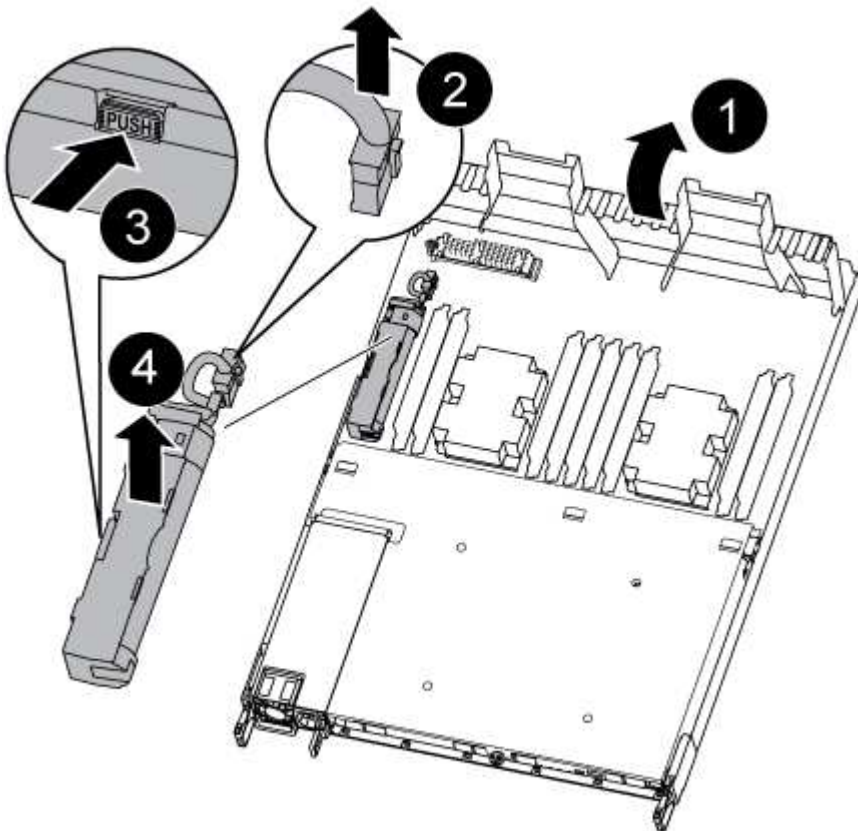


To avoid damaging the internal connector, do not use excessive force when sliding the power supply into the system.

Step 3: Move the NVDIMM battery

To move the NVDIMM battery from the impaired controller module to the replacement controller module, you must perform a specific sequence of steps.

You can use the following animation or the written steps to move the NVDIMM battery from the impaired controller module to the replacement controller module.



1. Locate the NVDIMM battery in the controller module.

2. Locate the battery plug and squeeze the clip on the face of the battery plug to release the plug from the socket, and then unplug the battery cable from the socket.
3. Grasp the battery and press the blue locking tab marked PUSH, and then lift the battery out of the holder and controller module.
4. Move the battery to the replacement controller module.
5. Align the battery module with the opening for the battery, and then gently push the battery into slot until it locks into place.

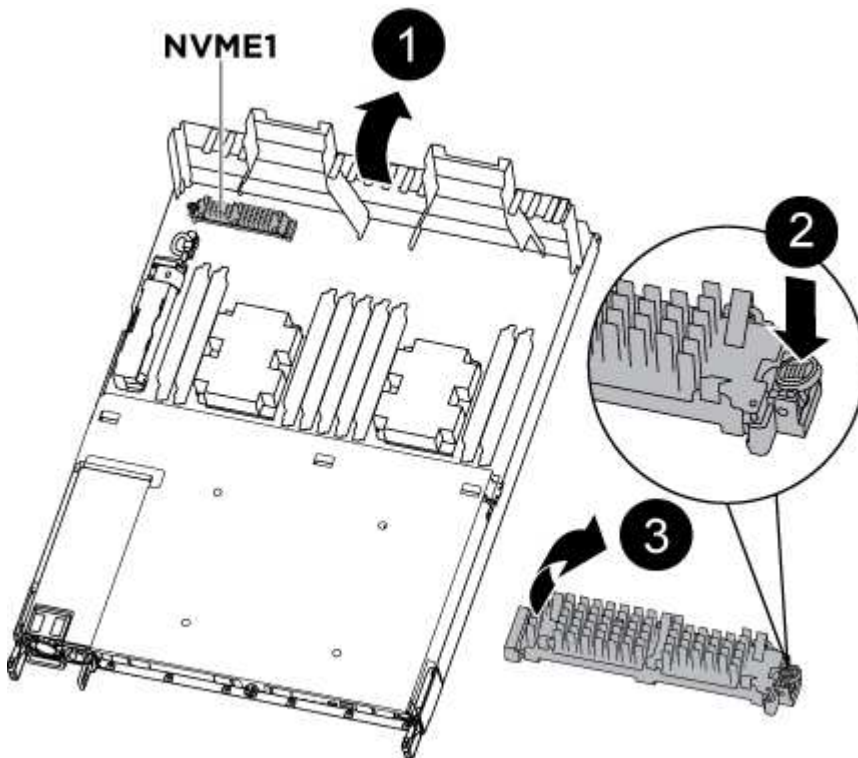


Do not plug the battery cable back into the motherboard until instructed to do so.

Step 4: Move the boot media

You must locate the boot media, and then follow the directions to remove it from the impaired controller module and insert it into the replacement controller module.

You can use the following animation or the written steps to move the boot media from the impaired controller module to the replacement controller module.



1. Open the air duct and locate the boot media using the following illustration or the FRU map on the controller module:
2. Locate and remove the boot media from the controller module:
 - a. Press the blue button at the end of the boot media until the lip on the boot media clears the blue button.
 - b. Rotate the boot media up and gently pull the boot media out of the socket.
3. Move the boot media to the new controller module, align the edges of the boot media with the socket housing, and then gently push it into the socket.
4. Check the boot media to make sure that it is seated squarely and completely in the socket.

If necessary, remove the boot media and reseal it into the socket.

5. Lock the boot media in place:

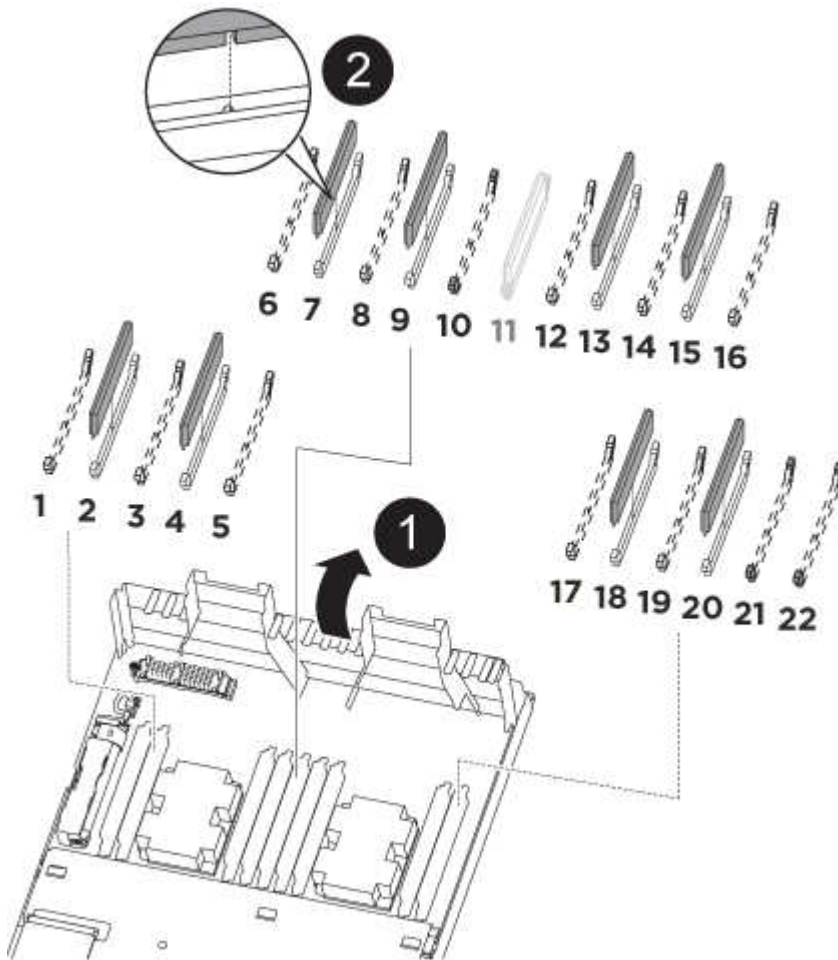
- a. Rotate the boot media down toward the motherboard.
- b. Placing a finger at the end of the boot media by the blue button, push down on the boot media end to engage the blue locking button.
- c. While pushing down on the boot media, lift the blue locking button to lock the boot media in place.

Step 5: Move the DIMMs

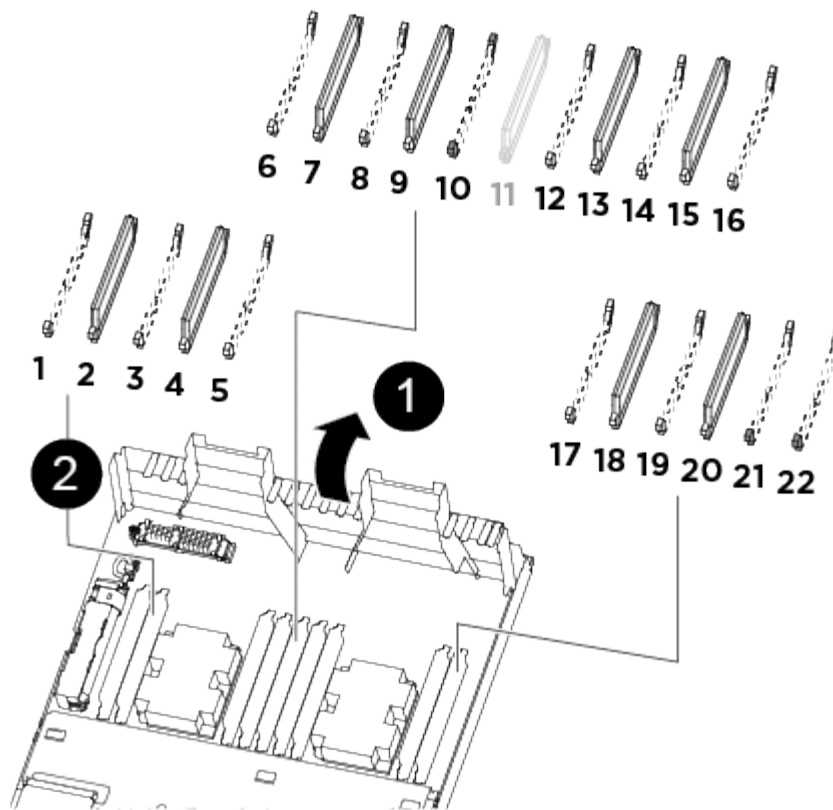
You need to locate the DIMMs, and then move them from the impaired controller module to the replacement controller module.

You must have the new controller module ready so that you can move the DIMMs directly from the impaired controller module to the corresponding slots in the replacement controller module.

You can use the following animation or the written steps to move the DIMMs from the impaired controller module to the replacement controller module.



1. Locate the DIMMs on your controller module.



1	Air duct
2	<ul style="list-style-type: none"> • System DIMMs slots: 2,4, 7, 9, 13, 15, 18, and 20 • NVDIMM slot: 11 <div data-bbox="922 1220 976 1276"> <i>i</i> </div> <div data-bbox="1036 1220 1430 1283"> The NVDIMM looks significantly different than system DIMMs. </div>

2. Note the orientation of the DIMM in the socket so that you can insert the DIMM in the replacement controller module in the proper orientation.
3. Verify that the NVDIMM battery is not plugged into the new controller module.
4. Move the DIMMs from the impaired controller module to the replacement controller module:



Make sure that you install the each DIMM into the same slot it occupied in the impaired controller module.

- a. Eject the DIMM from its slot by slowly pushing apart the DIMM ejector tabs on either side of the DIMM, and then slide the DIMM out of the slot.



Carefully hold the DIMM by the edges to avoid pressure on the components on the DIMM circuit board.

- b. Locate the corresponding DIMM slot on the replacement controller module.

- c. Make sure that the DIMM ejector tabs on the DIMM socket are in the open position, and then insert the DIMM squarely into the socket.

The DIMMs fit tightly in the socket, but should go in easily. If not, realign the DIMM with the socket and reinsert it.

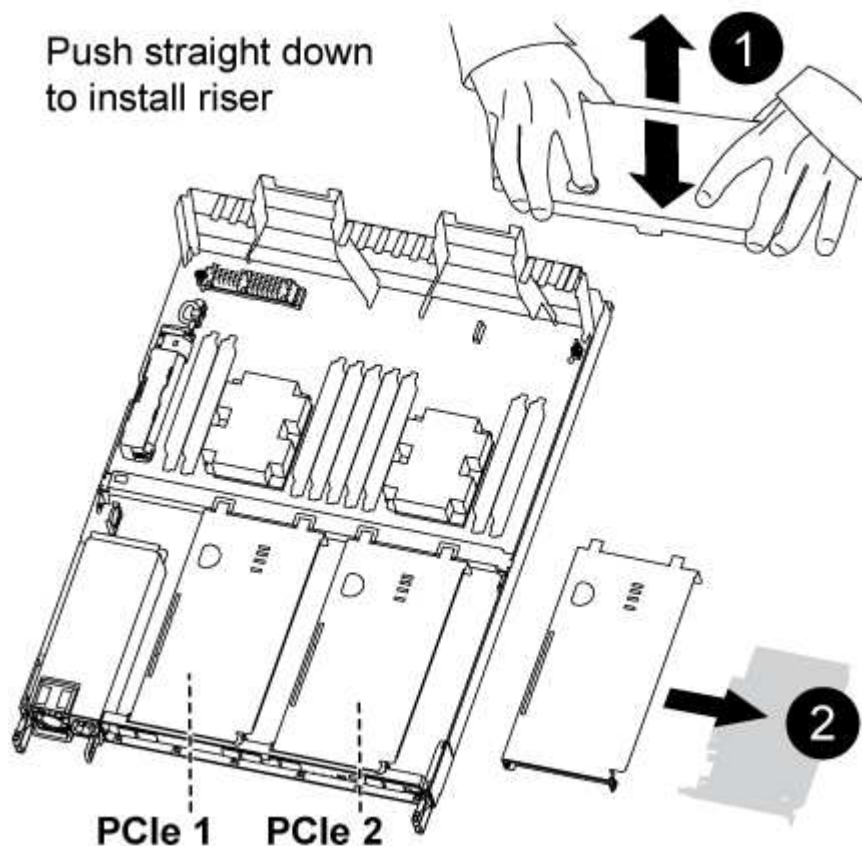
- d. Visually inspect the DIMM to verify that it is evenly aligned and fully inserted into the socket.
 - e. Repeat these substeps for the remaining DIMMs.
5. Plug the NVDIMM battery into the motherboard.

Make sure that the plug locks down onto the controller module.

Step 6: Move the PCIe risers

You must move the PCIe risers, with the PCIe cards installed in them, from the impaired controller module to the replacement controller module.

You can use the following animation or the written steps to move the PCIe risers from the impaired controller module to the replacement controller module.



1. Remove the cover over the PCIe risers by unscrewing the blue thumbscrew on the cover, slide the cover toward you, rotate the cover upward, lift it off the controller module, and then set it aside.
2. Remove the empty risers from the replacement controller module.
 - a. Place your forefinger into the hole on the left side of the riser module and grasp the riser with your thumb.

- b. Lift the riser straight up and out of the bay, and then set it aside.
 - c. Repeat these substeps for the second riser.
3. Move the PCIe risers from the impaired controller module to the same riser bays on the replacement controller module:
 - a. Remove a riser from the impaired controller module and move it to the replacement controller module.
 - b. Lower the riser straight into the bay, so that it is square with the bay and the pins of the riser slide into the guide holes at the rear of the bay.
 - c. Seat the riser into the motherboard socket straight down into the socket by applying even downward pressure along the edges of the riser until it seats.

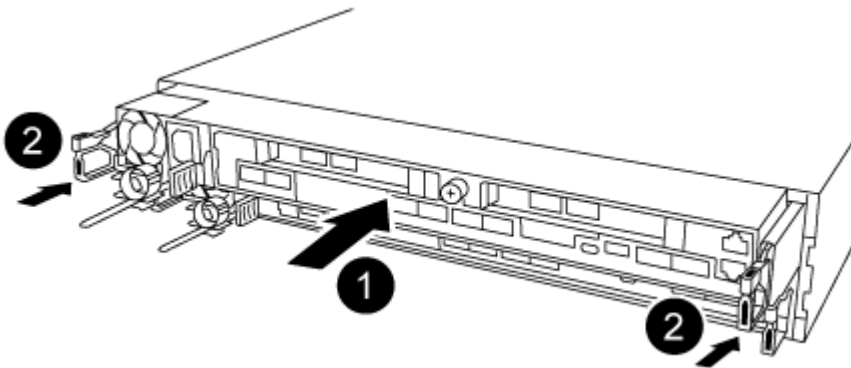
The riser should seat smoothly with little resistance. Reseat the riser in the bay if you encounter significant resistance seating the riser into the socket.

- d. Repeat these substeps for the second riser.
- e. Reinstall the cover over the PCIe risers.

Step 7: Install the controller module

After all of the components have been moved from the impaired controller module to the replacement controller module, you must install the replacement controller module into the chassis, and then boot it to Maintenance mode.

You can use the following animation or the written steps to install the replacement controller module in the chassis.



1. If you have not already done so, close the air duct at the rear of the controller module and reinstall the cover over the PCIe cards.
2. Align the end of the controller module with the opening in the chassis, and then gently push the controller module halfway into the system.



Do not completely insert the controller module in the chassis until instructed to do so.

3. Cable the management and console ports only, so that you can access the system to perform the tasks in the following sections.



You will connect the rest of the cables to the controller module later in this procedure.

4. Complete the reinstallation of the controller module:
 - a. Make sure the latch arms are locked in the extended position.
 - b. Using the latch arms, push the controller module into the chassis bay until it stops.
 - c. Press down and hold the orange tabs on top of the latching mechanism.
 - d. Gently push the controller module into the chassis bay until it is flush with the edges of the chassis.



The latching mechanism arms slide into the chassis.

The controller module begins to boot as soon as it is fully seated in the chassis.

- e. Release the latches to lock the controller module into place.
- f. Recable the power supply.
- g. If you have not already done so, reinstall the cable management device.
- h. Interrupt the normal boot process by pressing `Ctrl-C`.

Restore and verify the system configuration - AFF A320

After completing the hardware replacement and booting to Maintenance mode, you verify the low-level system configuration of the replacement controller and reconfigure system settings as necessary.

Step 1: Set and verify the system time after replacing the controller module

You should check the time and date on the replacement controller module against the healthy controller module in an HA pair, or against a reliable time server in a stand-alone configuration. If the time and date do not match, you must reset them on the replacement controller module to prevent possible outages on clients due to time differences.

About this task

It is important that you apply the commands in the steps on the correct systems:

- The *replacement* node is the new node that replaced the impaired node as part of this procedure.
- The *healthy* node is the HA partner of the *replacement* node

Steps

1. If the *replacement* node is not at the LOADER prompt, halt the system to the LOADER prompt.
2. On the healthy node, check the system time: `show date`

The date and time are given in GMT.

3. At the LOADER prompt, check the date and time on the *replacement* node: `show date`

The date and time are given in GMT.

4. If necessary, set the date in GMT on the replacement node: `set date mm/dd/yyyy`
5. If necessary, set the time in GMT on the replacement node: `set time hh:mm:ss`
6. At the LOADER prompt, confirm the date and time on the *replacement* node: `show date`

The date and time are given in GMT.

Step 2: Verify and set the HA state of the controller module

You must verify the HA state of the controller module and, if necessary, update the state to match your system configuration.

1. In Maintenance mode from the new controller module, verify that all components display the same HA state: `ha-config show`

The HA state should be the same for all components.

2. If the displayed system state of the controller module does not match your system configuration, set the HA state for the controller module: `ha-config modify controller ha-state`

The value for HA-state can be one of the following:

- ha
 - mcc
 - mcc-2n
 - non-ha
3. If the displayed system state of the controller module does not match your system configuration, set the HA state for the controller module: `ha-config modify controller ha-state`
 4. Confirm that the setting has changed: `ha-config show`

Step 3: Run diagnostics

After you have replaced a component in your system, you should run diagnostic tests on that component.

Your system must be at the LOADER prompt to start diagnostics.

All commands in the diagnostic procedures are issued from the node where the component is being replaced.

1. If the node to be serviced is not at the LOADER prompt, reboot the node: `system node halt -node node_name`

After you issue the command, you should wait until the system stops at the LOADER prompt.

2. At the LOADER prompt, access the special drivers specifically designed for system-level diagnostics to function properly: `boot_diags`
3. Select **Scan System** from the displayed menu to enable running the diagnostics tests.
4. Select **Test system** from the displayed menu to run diagnostics tests.
5. Select the test or series of tests from the various sub-menus.
6. Proceed based on the result of the preceding step:
 - If the test failed, correct the failure, and then rerun the test.
 - If the test reported no failures, select Reboot from the menu to reboot the system.



During the boot process, you might see the following prompts:

- A prompt warning of a system ID mismatch and asking to override the system ID.
- A prompt warning that when entering Maintenance mode in an HA configuration you must ensure that the healthy node remains down.
You can safely respond `y` to these prompts.

Return the failed part to NetApp

After you replace the part, you can return the failed part to NetApp, as described in the RMA instructions shipped with the kit. Contact technical support at [NetApp Support](#), 888-463-8277 (North America), 00-800-44-638277 (Europe), or +800-800-80-800 (Asia/Pacific) if you need the RMA number or additional help with the replacement procedure.

Replace a DIMM - AFF A320

You must replace a DIMM in the controller module when your system registers an increasing number of correctable error correction codes (ECC); failure to do so causes a system panic.

All other components in the system must be functioning properly; if not, you must contact technical support.

You must replace the failed component with a replacement FRU component you received from your provider.

Shut down the node

To shut down the impaired node, you must determine the status of the node and, if necessary, take over the node so that the healthy node continues to serve data from the impaired node storage.

About this task

If you have a cluster with more than two nodes, it must be in quorum. If the cluster is not in quorum or a healthy node shows false for eligibility and health, you must correct the issue before shutting down the impaired node.

[ONTAP 9 System Administration Reference](#)

Steps

1. If AutoSupport is enabled, suppress automatic case creation by invoking an AutoSupport message:

```
system node autosupport invoke -node * -type all -message  
MAINT=number_of_hours_downh
```

The following AutoSupport message suppresses automatic case creation for two hours: `cluster1:*>`

```
system node autosupport invoke -node * -type all -message MAINT=2h
```

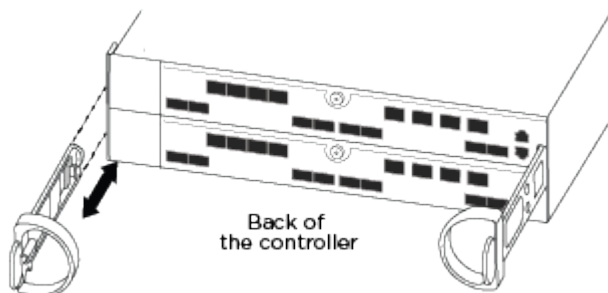
2. Disable automatic giveback from the console of the healthy node: `storage failover modify -node local -auto-giveback false`
3. Take the impaired node to the LOADER prompt:

If the impaired node is displaying...	Then...
The LOADER prompt	Go to the next step.
Waiting for giveback...	Press Ctrl-C, and then respond <i>y</i> when prompted.
System prompt or password prompt (enter system password)	<p>Take over or halt the impaired node:</p> <ul style="list-style-type: none"> For an HA pair, take over the impaired node from the healthy node: <code>storage failover takeover -ofnode <i>impaired_node_name</i></code> <p>When the impaired node shows Waiting for giveback..., press Ctrl-C, and then respond <i>y</i>.</p>

Remove the controller module

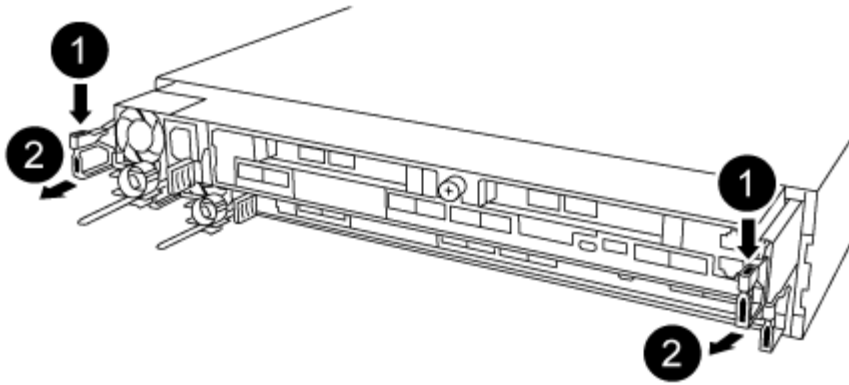
To access components inside the controller module, you must remove the controller module from the chassis.

1. If you are not already grounded, properly ground yourself.
2. Unplug the controller module power supply from the power source.
3. Loosen the hook and loop strap binding the cables to the cable management device, and then unplug the system cables and SFPs (if needed) from the controller module, keeping track of where the cables were connected.



Leave the cables in the cable management device so that when you reinstall the cable management device, the cables are organized.

4. Remove and set aside the cable management devices from the left and right sides of the controller module.
5. Remove the controller module from the chassis:



- a. Insert your forefinger into the latching mechanism on either side of the controller module.
- b. Press down on the orange tab on top of the latching mechanism until it clears the latching pin on the chassis.

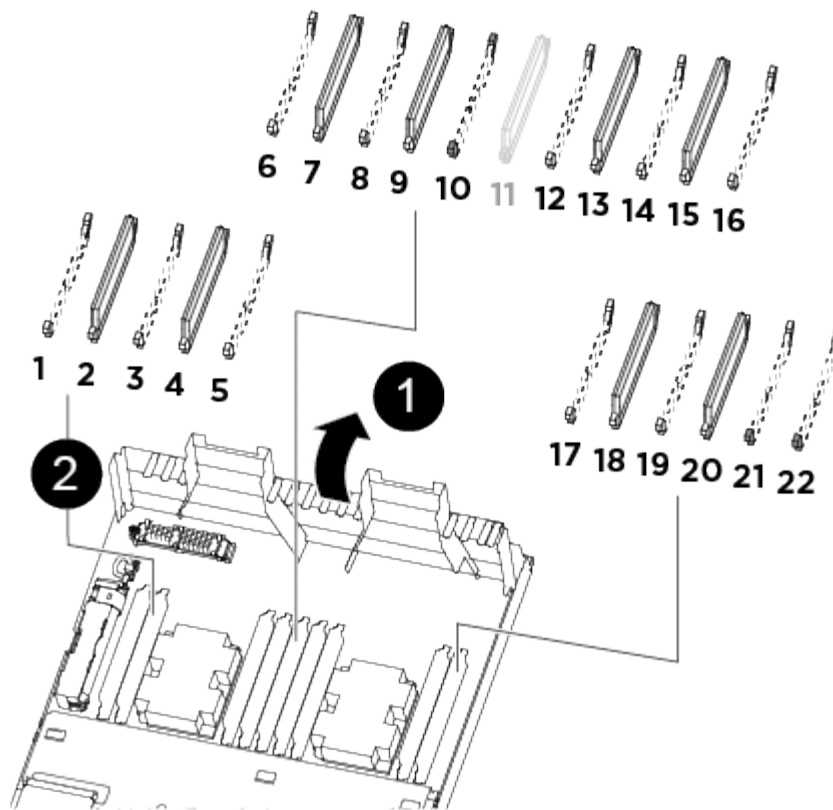
The latching mechanism hook should be nearly vertical and should be clear of the chassis pin.

- c. Gently pull the controller module a few inches toward you so that you can grasp the controller module sides.
- d. Using both hands, gently pull the controller module out of the chassis and set it on a flat, stable surface.

Replace system DIMMs

Replacing a system DIMM involves identifying the target DIMM through the associated error message, locating the target DIMM using the FRU map on the air duct or the lit LED on the motherboard, and then replacing the DIMM.

1. Rotate the air duct to the open position.
2. Locate the DIMMs on your controller module.



1	Air duct
2	<ul style="list-style-type: none"> • System DIMMs slots: 2,4, 7, 9, 13, 15, 18, and 20 • NVDIMM slot: 11 <div data-bbox="922 1220 976 1276" style="display: inline-block; vertical-align: middle;"> <i>i</i> </div> <div data-bbox="1036 1220 1430 1283" style="display: inline-block; vertical-align: middle;"> The NVDIMM looks significantly different than system DIMMs. </div>

- Note the orientation of the DIMM in the socket so that you can insert the replacement DIMM in the proper orientation.
- Eject the DIMM from its socket by slowly pushing apart the two DIMM ejector tabs on either side of the DIMM, and then slide the DIMM out of the socket.



Carefully hold the DIMM by the edges to avoid pressure on the components on the DIMM circuit board.

- Remove the replacement DIMM from the antistatic shipping bag, hold the DIMM by the corners, and align it to the slot.

The notch among the pins on the DIMM should line up with the tab in the socket.

- Make sure that the DIMM ejector tabs on the connector are in the open position, and then insert the DIMM squarely into the slot.

The DIMM fits tightly in the slot, but should go in easily. If not, realign the DIMM with the slot and reinsert it.



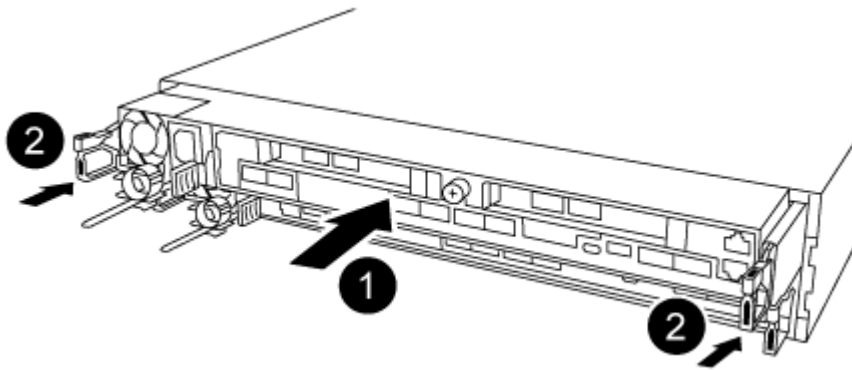
Visually inspect the DIMM to verify that it is evenly aligned and fully inserted into the slot.

7. Push carefully, but firmly, on the top edge of the DIMM until the ejector tabs snap into place over the notches at the ends of the DIMM.
8. Close the air duct.

Install the controller module

After you have replaced the component in the controller module, you must re-install the controller module into the chassis, and then boot it to Maintenance mode.

1. If you have not already done so, close the air duct at the rear of the controller module and reinstall the cover over the PCIe cards.
2. Align the end of the controller module with the opening in the chassis, and then gently push the controller module halfway into the system.



Do not completely insert the controller module in the chassis until instructed to do so.

3. Cable the management and console ports only, so that you can access the system to perform the tasks in the following sections.



You will connect the rest of the cables to the controller module later in this procedure.

4. Complete the reinstallation of the controller module:
 - a. Make sure the latch arms are locked in the extended position.
 - b. Using the latch arms, push the controller module into the chassis bay until it stops.
 - c. Press down and hold the orange tabs on top of the latching mechanism.
 - d. Gently push the controller module into the chassis bay until it is flush with the edges of the chassis.



The latching mechanism arms slide into the chassis.

The controller module begins to boot as soon as it is fully seated in the chassis.

- e. Release the latches to lock the controller module into place.
- f. Recable the power supply.

- g. If you have not already done so, reinstall the cable management device.
- h. Interrupt the normal boot process by pressing `Ctrl-C`.

Run diagnostics

After you have replaced a system DIMM in your system, you should run diagnostic tests on that component.

Your system must be at the LOADER prompt to start diagnostics.

All commands in the diagnostic procedures are issued from the node where the component is being replaced.

1. If the node to be serviced is not at the LOADER prompt, reboot the node: `system node halt -node node_name`

After you issue the command, you should wait until the system stops at the LOADER prompt.

2. At the LOADER prompt, access the special drivers specifically designed for system-level diagnostics to function properly: `boot_diags`
3. Select **Scan System** from the displayed menu to enable running the diagnostics tests.
4. Select **Stress-Test system** from the displayed menu.
5. Select an option from the displayed sub-menu and run the test.
6. Proceed based on the result of the preceding step:
 - If the test failed, correct the failure, and then rerun the test.
 - If the test reported no failures, select Reboot from the menu to reboot the system.

Restore the controller module to operation after running diagnostics

After completing diagnostics, you must recable the system, give back the controller module, and then reenabling automatic giveback.

1. Recable the system, as needed.

If you removed the media converters (QSFPs or SFPs), remember to reinstall them if you are using fiber optic cables.

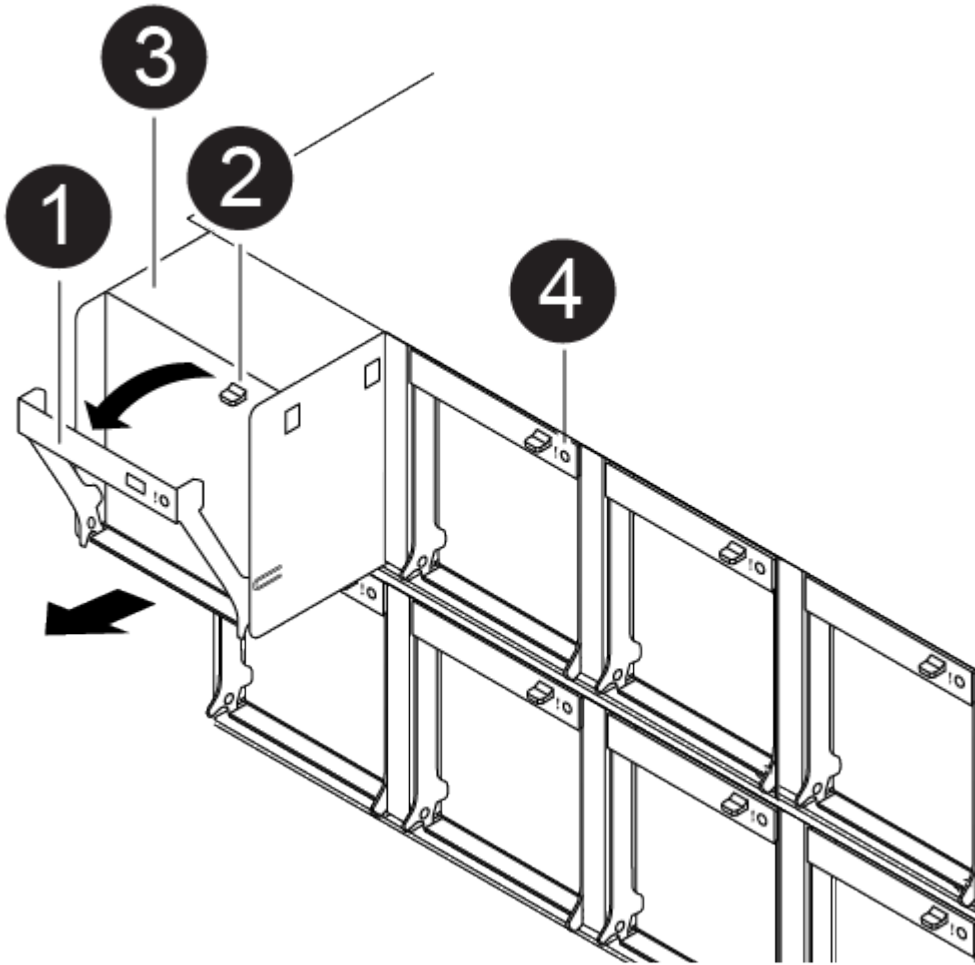
2. Return the node to normal operation by giving back its storage: `storage failover giveback -ofnode impaired_node_name`
3. If automatic giveback was disabled, reenabling it: `storage failover modify -node local -auto-giveback true`

Return the failed part to NetApp

After you replace the part, you can return the failed part to NetApp, as described in the RMA instructions shipped with the kit. Contact technical support at [NetApp Support](#), 888-463-8277 (North America), 00-800-44-638277 (Europe), or +800-800-80-800 (Asia/Pacific) if you need the RMA number or additional help with the replacement procedure.

Hot-swap a fan module - AFF A320

To swap out a fan module without interrupting service, you must perform a specific sequence of tasks.



1. If you are not already grounded, properly ground yourself.
2. Remove the bezel (if necessary) with two hands, by grasping the openings on each side of the bezel, and then pulling it toward you until the bezel releases from the ball studs on the chassis frame.
3. Identify the fan module that you must replace by checking the console error messages and looking at the Attention LED on each fan module.
4. Press down the release latch on the fan module cam handle, and then rotate the cam handle downward.

The fan module moves a little bit away from the chassis.

5. Pull the fan module straight out from the chassis, making sure that you support it with your free hand so that it does not swing out of the chassis.



The fan modules are short. Always support the bottom of the fan module with your free hand so that it does not suddenly drop free from the chassis and injure you.

6. Set the fan module aside.

7. Insert the replacement fan module into the chassis by aligning it with the opening, and then sliding it into the chassis.
8. Push firmly on the fan module cam handle so that it is seated all the way into the chassis.

The cam handle raises slightly when the fan module is completely seated.

9. Swing the cam handle up to its closed position, making sure that the cam handle release latch clicks into the locked position.

The Attention LED should not be lit after the fan is seated and has spun up to operational speed.

10. Align the bezel with the ball studs, and then gently push the bezel onto the ball studs.

Replace an NVDIMM - AFF A320

You must replace the NVDIMM in the controller module when your system registers that the flash lifetime is almost at an end or that the identified NVDIMM is not healthy in general; failure to do so causes a system panic.

All other components in the system must be functioning properly; if not, you must contact technical support.

You must replace the failed component with a replacement FRU component you received from your provider.

Shut down the impaired controller

You can shut down or take over the impaired controller using different procedures, depending on the storage system hardware configuration.

Shut down the node

To shut down the impaired node, you must determine the status of the node and, if necessary, take over the node so that the healthy node continues to serve data from the impaired node storage.

About this task

If you have a cluster with more than two nodes, it must be in quorum. If the cluster is not in quorum or a healthy node shows false for eligibility and health, you must correct the issue before shutting down the impaired node.

[ONTAP 9 System Administration Reference](#)

Steps

1. If AutoSupport is enabled, suppress automatic case creation by invoking an AutoSupport message:

```
system node autosupport invoke -node * -type all -message  
MAINT=number_of_hours_downh
```

The following AutoSupport message suppresses automatic case creation for two hours: `cluster1:*>`

```
system node autosupport invoke -node * -type all -message MAINT=2h
```

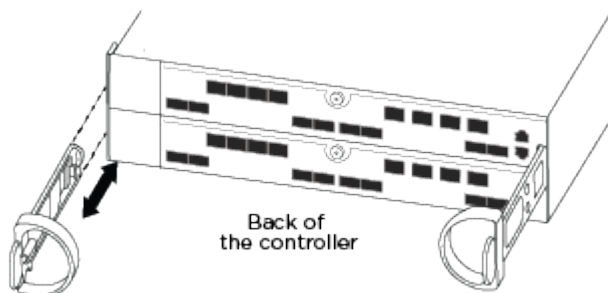
2. Disable automatic giveback from the console of the healthy node: `storage failover modify -node local -auto-giveback false`
3. Take the impaired node to the LOADER prompt:

If the impaired node is displaying...	Then...
The LOADER prompt	Go to the next step.
Waiting for giveback...	Press Ctrl-C, and then respond <i>y</i> when prompted.
System prompt or password prompt (enter system password)	<p>Take over or halt the impaired node:</p> <ul style="list-style-type: none"> For an HA pair, take over the impaired node from the healthy node: <code>storage failover takeover -ofnode <i>impaired_node_name</i></code> <p>When the impaired node shows Waiting for giveback..., press Ctrl-C, and then respond <i>y</i>.</p>

Remove the controller module

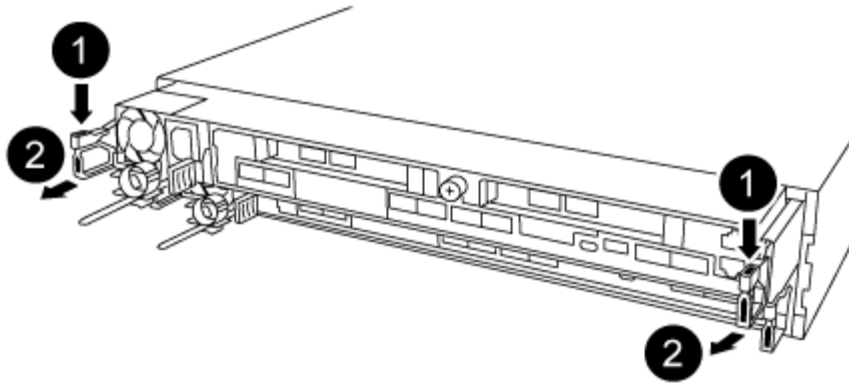
To access components inside the controller module, you must remove the controller module from the chassis.

1. If you are not already grounded, properly ground yourself.
2. Unplug the controller module power supply from the power source.
3. Loosen the hook and loop strap binding the cables to the cable management device, and then unplug the system cables and SFPs (if needed) from the controller module, keeping track of where the cables were connected.



Leave the cables in the cable management device so that when you reinstall the cable management device, the cables are organized.

4. Remove and set aside the cable management devices from the left and right sides of the controller module.
5. Remove the controller module from the chassis:



- a. Insert your forefinger into the latching mechanism on either side of the controller module.
- b. Press down on the orange tab on top of the latching mechanism until it clears the latching pin on the chassis.

The latching mechanism hook should be nearly vertical and should be clear of the chassis pin.

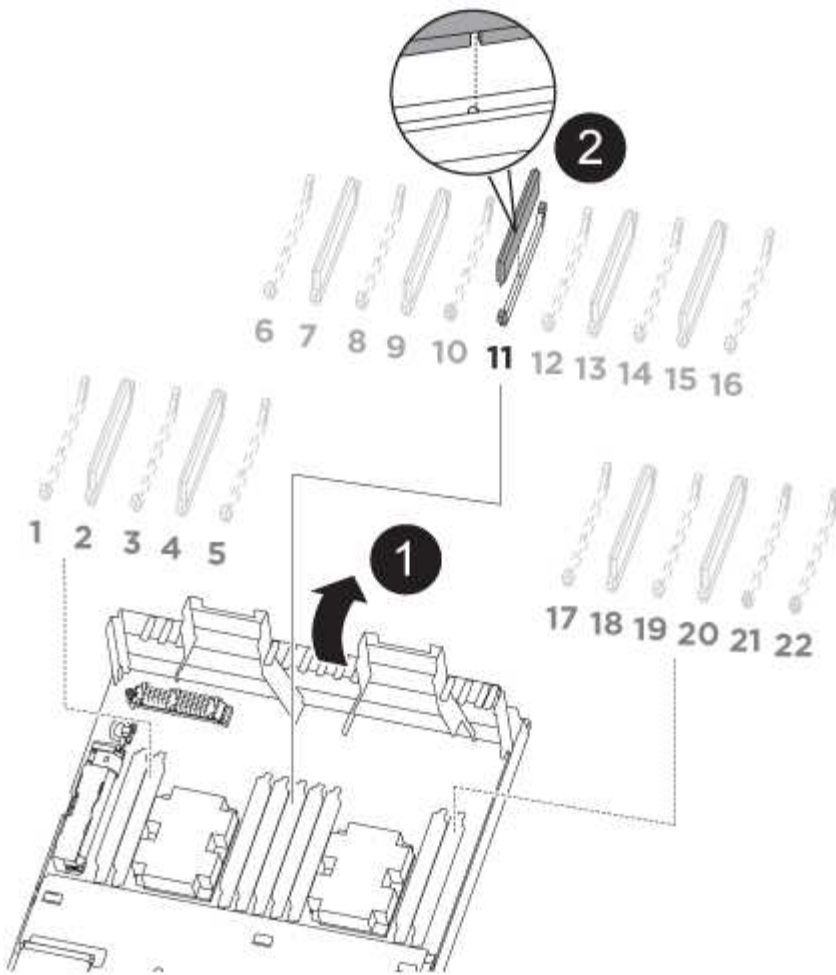
- a. Gently pull the controller module a few inches toward you so that you can grasp the controller module sides.
- b. Using both hands, gently pull the controller module out of the chassis and set it on a flat, stable surface.

Replace the NVDIMM

To replace the NVDIMM, you must locate it in the controller module using the NVDIMM map label on top of the air duct or locating it using the LED next to the NVDIMM, and then replace it following the specific sequence of steps.



The NVDIMM LED blinks while destaging contents when you halt the system. After the destage is complete, the LED turns off.



1. Open the air duct and then locate the NVDIMM in slot 11 on your controller module.



The NVDIMM looks significantly different than system DIMMs.

2. Note the orientation of the NVDIMM in the socket so that you can insert the NVDIMM in the replacement controller module in the proper orientation.
3. Eject the NVDIMM from its slot by slowly pushing apart the two NVDIMM ejector tabs on either side of the NVDIMM, and then slide the NVDIMM out of the socket and set it aside.



Carefully hold the NVDIMM by the edges to avoid pressure on the components on the NVDIMM circuit board.

4. Remove the replacement NVDIMM from the antistatic shipping bag, hold the NVDIMM by the corners, and then align it to the slot.

The notch among the pins on the NVDIMM should line up with the tab in the socket.

5. Locate the slot where you are installing the NVDIMM.
6. Insert the NVDIMM squarely into the slot.

The NVDIMM fits tightly in the slot, but should go in easily. If not, realign the NVDIMM with the slot and reinsert it.



Visually inspect the NVDIMM to verify that it is evenly aligned and fully inserted into the slot.

7. Push carefully, but firmly, on the top edge of the NVDIMM until the ejector tabs snap into place over the notches at the ends of the NVDIMM.
8. Close the air duct.

Install the controller module

After you have replaced the component in the controller module, you must re-install the controller module into the chassis, and then boot it to Maintenance mode.

1. If you have not already done so, close the air duct at the rear of the controller module and reinstall the cover over the PCIe cards.
2. Align the end of the controller module with the opening in the chassis, and then gently push the controller module halfway into the system.



Do not completely insert the controller module in the chassis until instructed to do so.

3. Cable the management and console ports only, so that you can access the system to perform the tasks in the following sections.



You will connect the rest of the cables to the controller module later in this procedure.

4. Complete the reinstallation of the controller module:
 - a. Make sure the latch arms are locked in the extended position.
 - b. Using the latch arms, push the controller module into the chassis bay until it stops.
 - c. Press down and hold the orange tabs on top of the latching mechanism.
 - d. Gently push the controller module into the chassis bay until it is flush with the edges of the chassis.



The latching mechanism arms slide into the chassis.

The controller module begins to boot as soon as it is fully seated in the chassis.

- e. Release the latches to lock the controller module into place.
- f. Recable the power supply.
- g. If you have not already done so, reinstall the cable management device.
- h. Interrupt the normal boot process by pressing `Ctrl-C`.

Run diagnostics

After you have replaced the NVDIMM in your system, you should run diagnostic tests on that component.

Your system must be at the `LOADER` prompt to start diagnostics.

All commands in the diagnostic procedures are issued from the node where the component is being replaced.

1. If the node to be serviced is not at the LOADER prompt, reboot the node: `system node halt -node node_name`

After you issue the command, you should wait until the system stops at the LOADER prompt.

2. At the LOADER prompt, access the special drivers specifically designed for system-level diagnostics to function properly: `boot_diags`
3. Select **Scan System** from the displayed menu to enable running the diagnostics tests.
4. Select **Test Memory** from the displayed menu.
5. Select **NVDIMM Test** from the displayed menu.
6. Proceed based on the result of the preceding step:
 - If the test failed, correct the failure, and then rerun the test.
 - If the test reported no failures, select Reboot from the menu to reboot the system.

Restore the controller module to operation after running diagnostics

After completing diagnostics, you must recable the system, give back the controller module, and then reenable automatic giveback.

1. Recable the system, as needed.

If you removed the media converters (QSFPs or SFPs), remember to reinstall them if you are using fiber optic cables.

2. Return the node to normal operation by giving back its storage: `storage failover giveback -ofnode impaired_node_name`
3. If automatic giveback was disabled, reenable it: `storage failover modify -node local -auto-giveback true`

Return the failed part to NetApp

After you replace the part, you can return the failed part to NetApp, as described in the RMA instructions shipped with the kit. Contact technical support at [NetApp Support](#), 888-463-8277 (North America), 00-800-44-638277 (Europe), or +800-800-80-800 (Asia/Pacific) if you need the RMA number or additional help with the replacement procedure.

Replace the NVDIMM battery - AFF A320

To replace the NVDIMM battery, you must remove the controller module, remove the battery, replace the battery, and then reinstall the controller module.

All other components in the system must be functioning properly; if not, you must contact technical support.

Shut down the node

To shut down the impaired node, you must determine the status of the node and, if necessary, take over the node so that the healthy node continues to serve data from the

impaired node storage.

About this task

If you have a cluster with more than two nodes, it must be in quorum. If the cluster is not in quorum or a healthy node shows false for eligibility and health, you must correct the issue before shutting down the impaired node.

ONTAP 9 System Administration Reference

Steps

- 1. If AutoSupport is enabled, suppress automatic case creation by invoking an AutoSupport message:

```
system node autosupport invoke -node * -type all -message  
MAINT=number_of_hours_downh
```

The following AutoSupport message suppresses automatic case creation for two hours: `cluster1:>`

```
system node autosupport invoke -node * -type all -message MAINT=2h
```

- 2. Disable automatic giveback from the console of the healthy node: `storage failover modify -node local -auto-giveback false`
- 3. Take the impaired node to the LOADER prompt:

If the impaired node is displaying...	Then...
The LOADER prompt	Go to the next step.
Waiting for giveback...	Press Ctrl-C, and then respond <code>y</code> when prompted.
System prompt or password prompt (enter system password)	<div>Take over or halt the impaired node:<ul style="list-style-type: none">• For an HA pair, take over the impaired node from the healthy node: <code>storage failover takeover -ofnode <i>impaired_node_name</i></code></div> <div>When the impaired node shows Waiting for giveback..., press Ctrl-C, and then respond <code>y</code>.</div>

Remove the controller module

To access components inside the controller module, you must remove the controller module from the chassis.

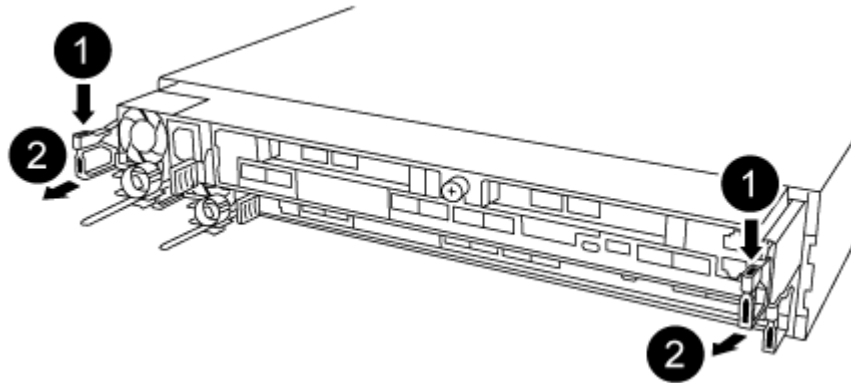
- 1. If you are not already grounded, properly ground yourself.
- 2. Unplug the controller module power supply from the power source.
- 3. Loosen the hook and loop strap binding the cables to the cable management device, and then unplug the system cables and SFPs (if needed) from the controller module, keeping track of where the cables were connected.

[drw a320 controller cable unplug animated gif] |

../media/drw_a320_controller_cable_unplug_animated_gif.png

Leave the cables in the cable management device so that when you reinstall the cable management device, the cables are organized.

4. Remove and set aside the cable management devices from the left and right sides of the controller module.
5. Remove the controller module from the chassis:



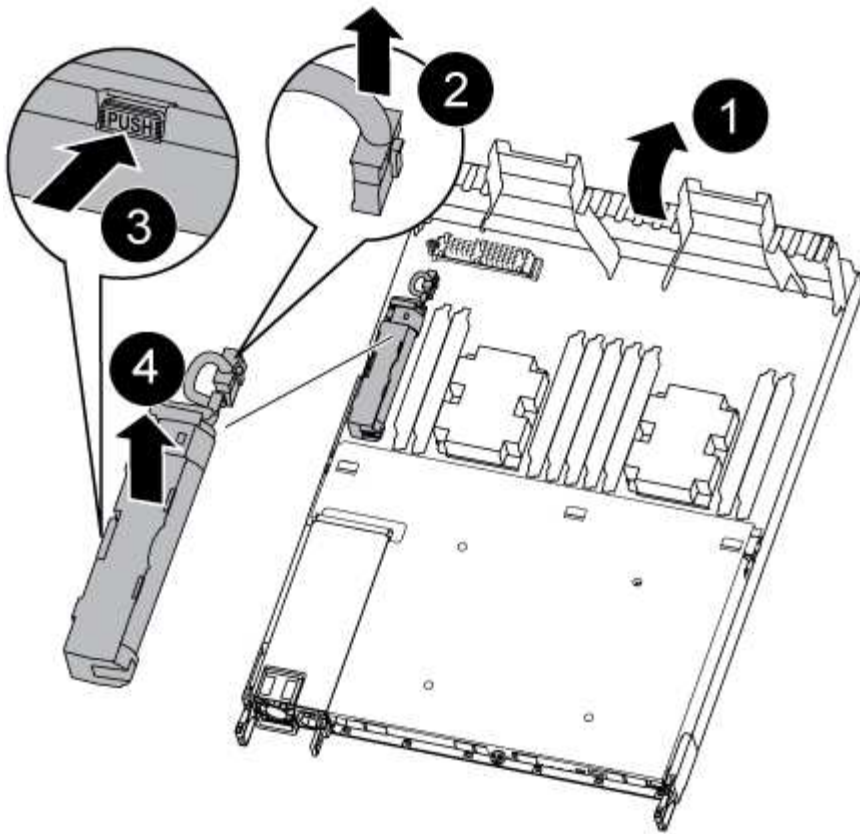
- a. Insert your forefinger into the latching mechanism on either side of the controller module.
- b. Press down on the orange tab on top of the latching mechanism until it clears the latching pin on the chassis.

The latching mechanism hook should be nearly vertical and should be clear of the chassis pin.

- a. Gently pull the controller module a few inches toward you so that you can grasp the controller module sides.
- b. Using both hands, gently pull the controller module out of the chassis and set it on a flat, stable surface.

Replace the NVDIMM battery

To replace the NVDIMM battery, you must remove the failed battery from the controller module and install the replacement battery into the controller module.

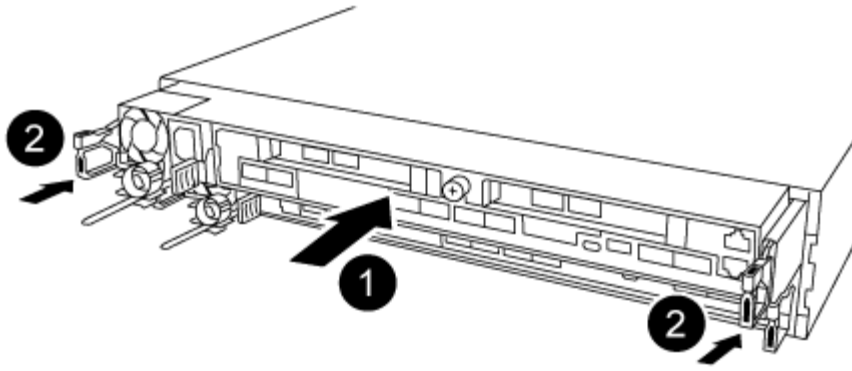


1. Open the air duct and locate the NVDIMM battery.
2. Locate the battery plug and squeeze the clip on the face of the battery plug to release the plug from the socket, and then unplug the battery cable from the socket.
3. Grasp the battery and press the blue locking tab marked PUSH, and then lift the battery out of the holder and controller module.
4. Remove the replacement battery from its package.
5. Align the battery module with the opening for the battery, and then gently push the battery into slot until it locks into place.
6. Plug the battery plug back into the controller module, and then close the air duct.

Install the controller module

After you have replaced the component in the controller module, you must re-install the controller module into the chassis, and then boot it to Maintenance mode.

1. If you have not already done so, close the air duct at the rear of the controller module and reinstall the cover over the PCIe cards.
2. Align the end of the controller module with the opening in the chassis, and then gently push the controller module halfway into the system.



Do not completely insert the controller module in the chassis until instructed to do so.

3. Cable the management and console ports only, so that you can access the system to perform the tasks in the following sections.



You will connect the rest of the cables to the controller module later in this procedure.

4. Complete the reinstallation of the controller module:
 - a. Make sure the latch arms are locked in the extended position.
 - b. Using the latch arms, push the controller module into the chassis bay until it stops.
 - c. Press down and hold the orange tabs on top of the latching mechanism.
 - d. Gently push the controller module into the chassis bay until it is flush with the edges of the chassis.



The latching mechanism arms slide into the chassis.

The controller module begins to boot as soon as it is fully seated in the chassis.

- e. Release the latches to lock the controller module into place.
- f. Recable the power supply.
- g. If you have not already done so, reinstall the cable management device.
- h. Interrupt the normal boot process by pressing `Ctrl-C`.

Run diagnostics

After you have replaced a component in your system, you should run diagnostic tests on that component.

Your system must be at the `LOADER` prompt to start diagnostics.

All commands in the diagnostic procedures are issued from the node where the component is being replaced.

1. If the node to be serviced is not at the `LOADER` prompt, reboot the node: `system node halt -node node_name`

After you issue the command, you should wait until the system stops at the `LOADER` prompt.

2. At the `LOADER` prompt, access the special drivers specifically designed for system-level diagnostics to

function properly: `boot_diags`

3. Select **Scan System** from the displayed menu to enable running the diagnostics tests.
4. Select **Test system** from the displayed menu to run diagnostics tests.
5. Proceed based on the result of the preceding step:
 - If the scan show problems, correct the issue, and then rerun the scan.
 - If the scan reported no failures, select Reboot from the menu to reboot the system.

Restore the controller module to operation after running diagnostics

After completing diagnostics, you must recable the system, give back the controller module, and then reenable automatic giveback.

1. Recable the system, as needed.

If you removed the media converters (QSFPs or SFPs), remember to reinstall them if you are using fiber optic cables.

2. Return the node to normal operation by giving back its storage: `storage failover giveback -ofnode impaired_node_name`
3. If automatic giveback was disabled, reenable it: `storage failover modify -node local -auto-giveback true`

Return the failed part to NetApp

After you replace the part, you can return the failed part to NetApp, as described in the RMA instructions shipped with the kit. Contact technical support at [NetApp Support](#), 888-463-8277 (North America), 00-800-44-638277 (Europe), or +800-800-80-800 (Asia/Pacific) if you need the RMA number or additional help with the replacement procedure.

Replace a PCIe card - AFF A320

To replace a PCIe card, you must disconnect the cables from the cards, remove the SFP and QSFP modules from the cards before removing the riser, reinstall the riser, and then reinstall the SFP and QSFP modules before cabling the cards.

- You can use this procedure with all versions of ONTAP supported by your system
- All other components in the system must be functioning properly; if not, you must contact technical support.

Shut down the impaired node

To shut down the impaired node, you must determine the status of the node and, if necessary, take over the node so that the healthy node continues to serve data from the impaired node storage.

About this task

If you have a cluster with more than two nodes, it must be in quorum. If the cluster is not in quorum or a healthy

node shows false for eligibility and health, you must correct the issue before shutting down the impaired node.

ONTAP 9 System Administration Reference

Steps

1. If AutoSupport is enabled, suppress automatic case creation by invoking an AutoSupport message:
`system node autosupport invoke -node * -type all -message MAINT=number_of_hours_downh`

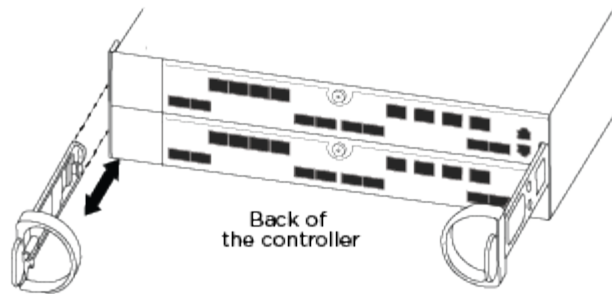
The following AutoSupport message suppresses automatic case creation for two hours: `cluster1:*> system node autosupport invoke -node * -type all -message MAINT=2h`
2. Disable automatic giveback from the console of the healthy node: `storage failover modify -node local -auto-giveback false`
3. Take the impaired node to the LOADER prompt:

If the impaired node is displaying...	Then...
The LOADER prompt	Go to the next step.
Waiting for giveback...	Press Ctrl-C, and then respond <code>y</code> when prompted.
System prompt or password prompt (enter system password)	<div>Take over or halt the impaired node:<ul style="list-style-type: none">• For an HA pair, take over the impaired node from the healthy node: <code>storage failover takeover -ofnode <i>impaired_node_name</i></code></div> <div>When the impaired node shows Waiting for giveback..., press Ctrl-C, and then respond <code>y</code>.</div>

Remove the controller module

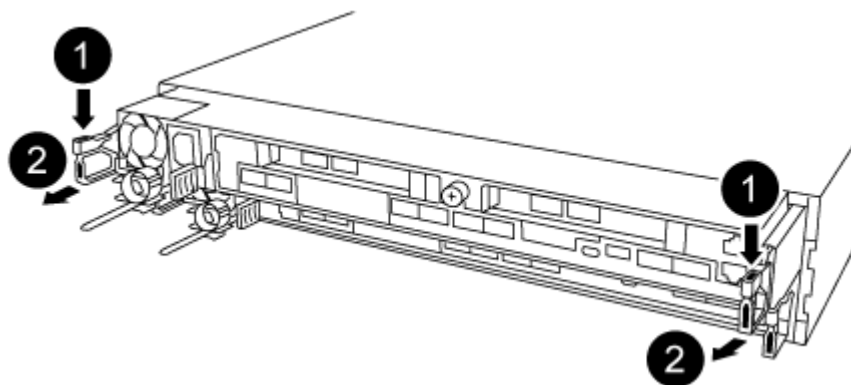
To access components inside the controller module, you must remove the controller module from the chassis.

1. If you are not already grounded, properly ground yourself.
2. Unplug the controller module power supply from the power source.
3. Loosen the hook and loop strap binding the cables to the cable management device, and then unplug the system cables and SFPs (if needed) from the controller module, keeping track of where the cables were connected.



Leave the cables in the cable management device so that when you reinstall the cable management device, the cables are organized.

4. Remove and set aside the cable management devices from the left and right sides of the controller module.
5. Remove the controller module from the chassis:



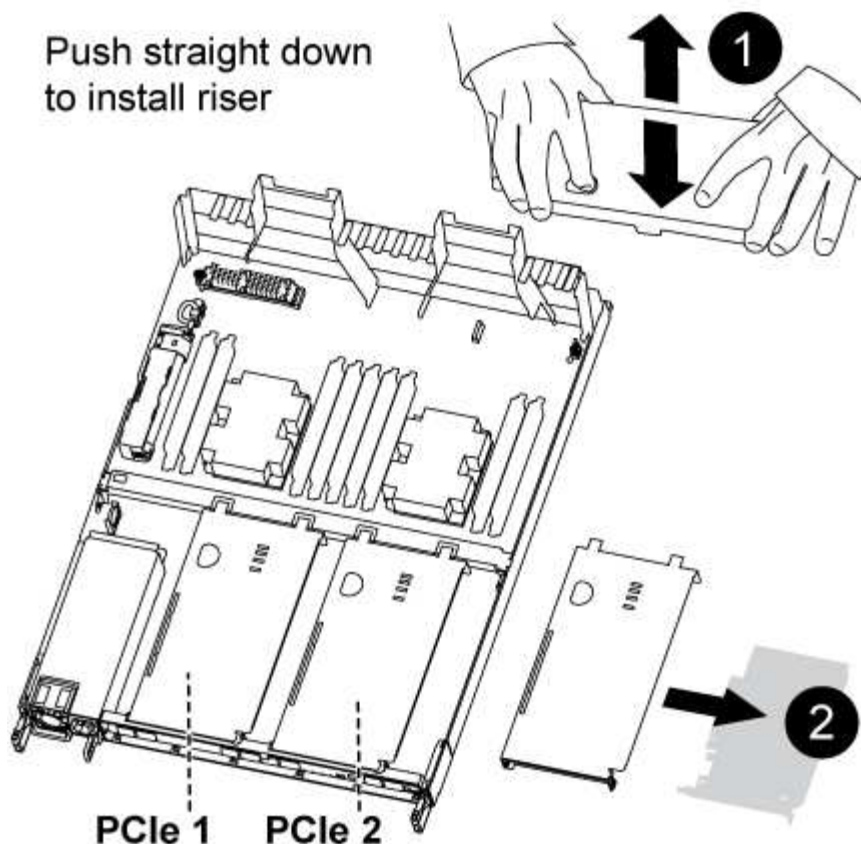
- a. Insert your forefinger into the latching mechanism on either side of the controller module.
- b. Press down on the orange tab on top of the latching mechanism until it clears the latching pin on the chassis.

The latching mechanism hook should be nearly vertical and should be clear of the chassis pin.

- a. Gently pull the controller module a few inches toward you so that you can grasp the controller module sides.
- b. Using both hands, gently pull the controller module out of the chassis and set it on a flat, stable surface.

Replace a PCIe card

You must remove the PCIe riser containing the failed PCIe card from the controller module, remove the failed PCIe card from the riser, install the replacement PCIe card in the riser, and then reinstall the riser into the controller module.



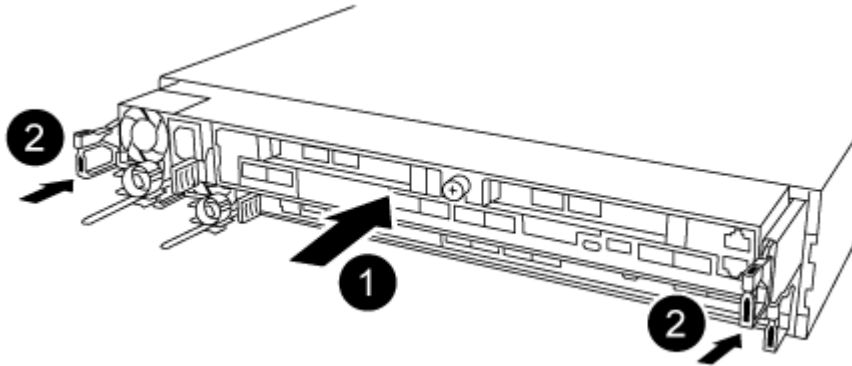
1. Remove the cover over the PCIe risers by unscrewing the blue thumbscrew on the cover, slide the cover toward you, rotate the cover upward, lift it off the controller module, and then set it aside.
2. Remove the riser with the failed PCIe card:
 - a. Remove any SFP or QSFP modules that might be in the PCIe cards.
 - b. Place your forefinger into the hole on the left side of the riser module and grasp the riser with your thumb.
 - c. Lift the riser straight out of the socket and set it aside.
3. Replace the card in the riser:
 - a. Place the riser on a stable surface, and then turn the riser so that you can access the PCIe card.
 - b. Place your thumbs just below the bottom edge of the PCIe card on either side of the socket, and then gently push up to release the card from the socket.
 - c. Slide the card out of the riser and set it aside.
 - d. Align the replacement card bezel with the edge of the riser and the outside edge of the card with the alignment guide on the left side of the riser.
 - e. Gently slide the card until the card connector aligns with the riser socket, and then gently push the card down into the socket.
4. Reinstall the riser in the controller module:
 - a. Align the riser over the opening so that the front edges of the riser are directly over the openings on the riser bay.
 - b. Aligning the back edge of the riser so that the pins on the underside of the riser are over the holes in the sheet metal at the back riser bay.
 - c. Apply even downward pressure to seat the riser straight down into the socket on the controller module.

- d. Reinstall the PCIe riser cover on the controller module.

Install the controller module

After you have replaced the component in the controller module, you must re-install the controller module into the chassis, and then boot it to Maintenance mode.

1. If you have not already done so, close the air duct at the rear of the controller module and reinstall the cover over the PCIe cards.
2. Align the end of the controller module with the opening in the chassis, and then gently push the controller module halfway into the system.



Do not completely insert the controller module in the chassis until instructed to do so.

3. Cable the management and console ports only, so that you can access the system to perform the tasks in the following sections.



You will connect the rest of the cables to the controller module later in this procedure.

4. Complete the reinstallation of the controller module:
 - a. Make sure the latch arms are locked in the extended position.
 - b. Using the latch arms, push the controller module into the chassis bay until it stops.
 - c. Press down and hold the orange tabs on top of the latching mechanism.
 - d. Gently push the controller module into the chassis bay until it is flush with the edges of the chassis.



The latching mechanism arms slide into the chassis.

The controller module begins to boot as soon as it is fully seated in the chassis.

- e. Release the latches to lock the controller module into place.
- f. Recable the power supply.
- g. If you have not already done so, reinstall the cable management device.
- h. Interrupt the normal boot process by pressing `Ctrl-C`.

Restore the controller module to operation

After completing diagnostics, you must recable the system, give back the controller module, and then reenabling automatic giveback.

1. Recable the system, as needed.

If you removed the media converters (QSFPs or SFPs), remember to reinstall them if you are using fiber optic cables.

2. Return the node to normal operation by giving back its storage: `storage failover giveback -ofnode impaired_node_name`
3. If automatic giveback was disabled, reenabling it: `storage failover modify -node local -auto-giveback true`

Return the failed part to NetApp

After you replace the part, you can return the failed part to NetApp, as described in the RMA instructions shipped with the kit. Contact technical support at [NetApp Support](#), 888-463-8277 (North America), 00-800-44-638277 (Europe), or +800-800-80-800 (Asia/Pacific) if you need the RMA number or additional help with the replacement procedure.

Replace a power supply - AFF A320

Replacing a power supply (PSU) involves disconnecting the target PSU from the power source, unplugging the power cable, removing the old PSU and installing the replacement PSU, and then reconnecting the replacement PSU to the power source.

- The power supplies are redundant and hot-swappable.
- This procedure is written for replacing one power supply at a time.



It is a best practice to replace the power supply within two minutes of removing it from the chassis. The system continues to function, but ONTAP sends messages to the console about the degraded power supply until the power supply is replaced.

- Power supplies are auto-ranging.

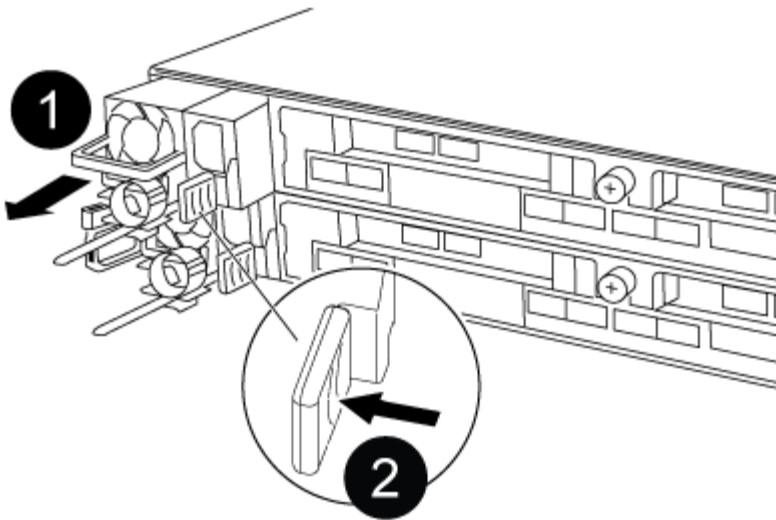


Figure 1. Steps

1. If you are not already grounded, properly ground yourself.
2. Identify the power supply you want to replace, based on console error messages or through the LEDs on the power supplies.
3. Disconnect the power supply:
 - a. Open the power cable retainer, and then unplug the power cable from the power supply.
 - b. Unplug the power cable from the power source.
4. Remove the power supply:
 - a. Rotate the cam handle so that it can be used to pull the power supply out of the chassis.
 - b. Press the blue locking tab to release the power supply from the chassis.
 - c. Using both hands, pull the power supply out of the chassis, and then set it aside.
5. Using both hands, support and align the edges of the power supply with the opening in the controller module, and then gently push the power supply into the controller module until the locking tab clicks into place.

The power supplies will only properly engage with the internal connector and lock in place one way.



To avoid damaging the internal connector, do not use excessive force when sliding the power supply into the system.

6. Rotate the cam handle so that it is flush against the power supply.
7. Reconnect the power supply cabling:
 - a. Reconnect the power cable to the power supply and the power source.
 - b. Secure the power cable to the power supply using the power cable retainer.

Once power is restored to the power supply, the status LED should be green.

8. After you replace the part, you can return the failed part to NetApp, as described in the RMA instructions shipped with the kit. Contact technical support at [NetApp Support](https://www.netapp.com/support), 888-463-8277 (North America), 00-800-44-638277 (Europe), or +800-800-80-800 (Asia/Pacific) if you need the RMA number or additional help with the replacement procedure.

Replace the real-time clock battery - AFF A320

You replace the real-time clock (RTC) battery in the controller module so that your system's services and applications that depend on accurate time synchronization continue to function.

- You can use this procedure with all versions of ONTAP supported by your system
- All other components in the system must be functioning properly; if not, you must contact technical support.

Shut down the node

To shut down the impaired node, you must determine the status of the node and, if necessary, take over the node so that the healthy node continues to serve data from the impaired node storage.

About this task

If you have a cluster with more than two nodes, it must be in quorum. If the cluster is not in quorum or a healthy node shows false for eligibility and health, you must correct the issue before shutting down the impaired node.

[ONTAP 9 System Administration Reference](#)

Steps

1. If AutoSupport is enabled, suppress automatic case creation by invoking an AutoSupport message:

```
system node autosupport invoke -node * -type all -message  
MAINT=number_of_hours_downh
```

The following AutoSupport message suppresses automatic case creation for two hours: `cluster1:*>`

```
system node autosupport invoke -node * -type all -message MAINT=2h
```

2. Disable automatic giveback from the console of the healthy node: `storage failover modify -node local -auto-giveback false`
3. Take the impaired node to the LOADER prompt:

If the impaired node is displaying...	Then...
The LOADER prompt	Go to the next step.
Waiting for giveback...	Press Ctrl-C, and then respond <code>y</code> when prompted.
System prompt or password prompt (enter system password)	<p>Take over or halt the impaired node:</p> <ul style="list-style-type: none">• For an HA pair, take over the impaired node from the healthy node: <code>storage failover takeover -ofnode <i>impaired_node_name</i></code> <p>When the impaired node shows Waiting for giveback..., press Ctrl-C, and then respond <code>y</code>.</p>

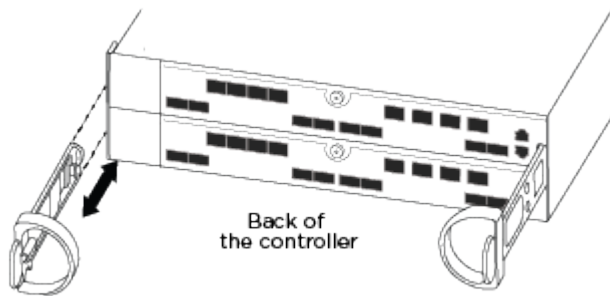
Replace the RTC battery

You need to locate the RTC battery inside the controller module, and then follow the specific sequence of steps.

Remove the controller module

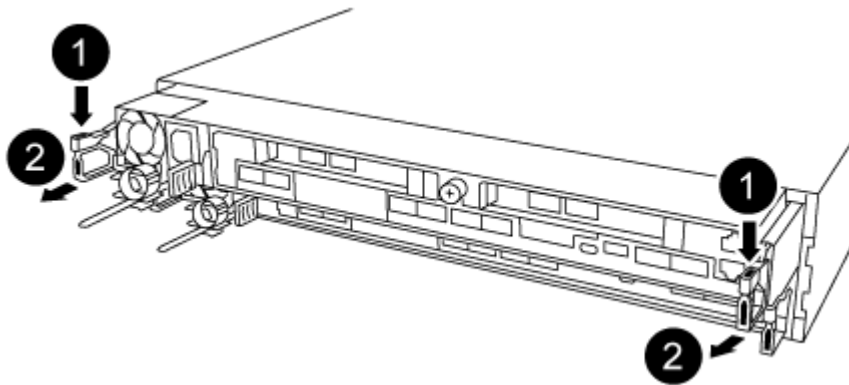
To access components inside the controller module, you must remove the controller module from the chassis.

1. If you are not already grounded, properly ground yourself.
2. Unplug the controller module power supply from the power source.
3. Loosen the hook and loop strap binding the cables to the cable management device, and then unplug the system cables and SFPs (if needed) from the controller module, keeping track of where the cables were connected.



Leave the cables in the cable management device so that when you reinstall the cable management device, the cables are organized.

4. Remove and set aside the cable management devices from the left and right sides of the controller module.
5. Remove the controller module from the chassis:



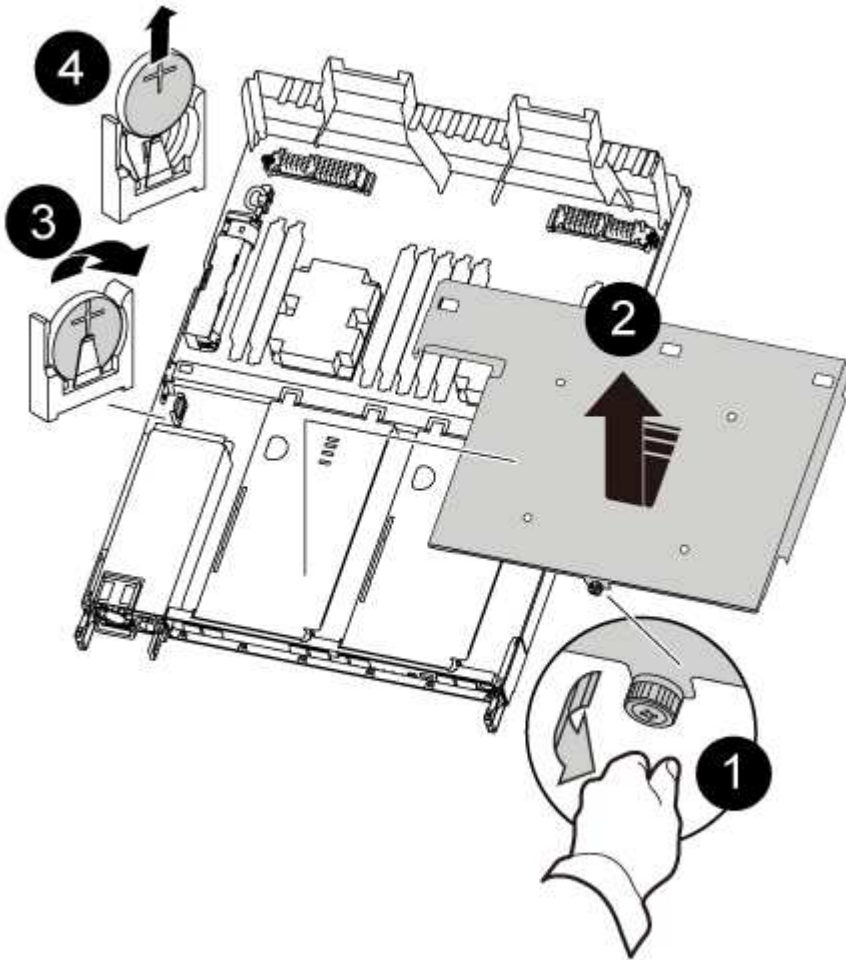
- a. Insert your forefinger into the latching mechanism on either side of the controller module.
- b. Press down on the orange tab on top of the latching mechanism until it clears the latching pin on the chassis.

The latching mechanism hook should be nearly vertical and should be clear of the chassis pin.

- a. Gently pull the controller module a few inches toward you so that you can grasp the controller module sides.

- b. Using both hands, gently pull the controller module out of the chassis and set it on a flat, stable surface.

Replace the RTC battery



1. Remove the PCIe cover.
 - a. Unscrew the blue thumbscrew located above the onboard ports at the back of the controller module.
 - b. Slide the cover toward you and rotate the cover upward.
 - c. Remove the cover and set it aside.
2. Locate, remove, and then replace the RTC battery:
 - a. Using the FRU map, locate the RTC battery on the controller module.
 - b. Gently push the battery away from the holder, rotate it away from the holder, and then lift it out of the holder.



Note the polarity of the battery as you remove it from the holder. The battery is marked with a plus sign and must be positioned in the holder correctly. A plus sign near the holder tells you how the battery should be positioned.

- c. Remove the replacement battery from the antistatic shipping bag.
- d. Note the polarity of the RTC battery, and then insert it into the holder by tilting the battery at an angle and pushing down.

3. Visually inspect the battery to make sure that it is completely installed into the holder and that the polarity is correct.
4. Reinstall the PCIe cover on the controller module.

Reinstall the controller module and setting time/date after RTC battery replacement

After you replace a component within the controller module, you must reinstall the controller module in the system chassis, reset the time and date on the controller, and then boot it.

1. If you have not already done so, close the air duct or controller module cover.
2. Align the end of the controller module with the opening in the chassis, and then gently push the controller module halfway into the system.

Do not completely insert the controller module in the chassis until instructed to do so.

3. Recable the system, as needed.

If you removed the media converters (QSFPs or SFPs), remember to reinstall them if you are using fiber optic cables.

4. If the power supplies were unplugged, plug them back in and reinstall the power cable retainers.
5. Complete the reinstallation of the controller module:
 - a. Make sure the latch arms are locked in the extended position.
 - b. Using the latch arms, push the controller module into the chassis bay until it stops.



Do not push down on the latching mechanism at the top of the latch arms. Doing so will raise the locking mechanism and prohibit sliding the controller module into the chassis.

- c. Press down and hold the orange tabs on top of the latching mechanism.
- d. Gently push the controller module into the chassis bay until it is flush with the edges of the chassis.



The latching mechanism arms slide into the chassis.

The controller module begins to boot as soon as it is fully seated in the chassis.

- e. Release the latches to lock the controller module into place.
 - f. If you have not already done so, reinstall the cable management device.
 - g. Halt the controller at the LOADER prompt.
6. Reset the time and date on the controller:
 - a. Check the date and time on the healthy node with the `show date` command.
 - b. At the LOADER prompt on the target node, check the time and date.
 - c. If necessary, modify the date with the `set date mm/dd/yyyy` command.
 - d. If necessary, set the time, in GMT, using the `set time hh:mm:ss` command.
 - e. Confirm the date and time on the target node.

7. At the LOADER prompt, enter `bye` to reinitialize the PCIe cards and other components and let the node reboot.
8. Return the node to normal operation by giving back its storage: `storage failover giveback -ofnode impaired_node_name`
9. If automatic giveback was disabled, reenable it: `storage failover modify -node local -auto-giveback true`

Return the failed part to NetApp

After you replace the part, you can return the failed part to NetApp, as described in the RMA instructions shipped with the kit. Contact technical support at [NetApp Support](#), 888-463-8277 (North America), 00-800-44-638277 (Europe), or +800-800-80-800 (Asia/Pacific) if you need the RMA number or additional help with the replacement procedure.

Copyright Information

Copyright © 2021 NetApp, Inc. All rights reserved. Printed in the U.S. No part of this document covered by copyright may be reproduced in any form or by any means-graphic, electronic, or mechanical, including photocopying, recording, taping, or storage in an electronic retrieval system-without prior written permission of the copyright owner.

Software derived from copyrighted NetApp material is subject to the following license and disclaimer:

THIS SOFTWARE IS PROVIDED BY NETAPP "AS IS" AND WITHOUT ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY DISCLAIMED. IN NO EVENT SHALL NETAPP BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

NetApp reserves the right to change any products described herein at any time, and without notice. NetApp assumes no responsibility or liability arising from the use of products described herein, except as expressly agreed to in writing by NetApp. The use or purchase of this product does not convey a license under any patent rights, trademark rights, or any other intellectual property rights of NetApp.

The product described in this manual may be protected by one or more U.S. patents, foreign patents, or pending applications.

RESTRICTED RIGHTS LEGEND: Use, duplication, or disclosure by the government is subject to restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFARS 252.277-7103 (October 1988) and FAR 52-227-19 (June 1987).

Trademark Information

NETAPP, the NETAPP logo, and the marks listed at <http://www.netapp.com/TM> are trademarks of NetApp, Inc. Other company and product names may be trademarks of their respective owners.