



# Maintain

## ONTAP Systems

NetApp  
May 06, 2022

This PDF was generated from <https://docs.netapp.com/us-en/ontap-systems/c190/bootmedia-replace-overview.html> on May 06, 2022. Always check docs.netapp.com for the latest.

# Table of Contents

- Maintain ..... 1
  - Boot media ..... 1
  - Chassis ..... 16
  - Controller ..... 24
  - Replace a DIMM - AFF C190 ..... 42
  - Replace SSD Drive or HDD Drive - AFF C190 ..... 50
  - Replace the NVMEM battery - AFF C190 ..... 54
  - Swap out a power supply - AFF C190 ..... 61
  - Replace the real-time clock battery ..... 63

# Maintain

## Boot media

### Overview of boot media replacement - AFF C190

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` file.

- 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 controller:
  - The *impaired* controller is the controller on which you are performing maintenance.
  - The *healthy* controller is the HA partner of the impaired controller.

### Check onboard encryption keys - AFF C190

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

Prior to shutting down the impaired controller and checking the status of the onboard encryption keys, you must check the status of the impaired controller, disable automatic giveback, and check the version of ONTAP that 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 controller shows false for eligibility and health, you must correct the issue before shutting down the impaired controller; see the [NetApp Encryption overview with the CLI](#).

#### Steps

1. Check the status of the impaired controller:
  - If the impaired controller is at the login prompt, log in as `admin`.
  - If the impaired controller is at the LOADER prompt and is part of HA configuration, log in as `admin` on the healthy controller.
  - If the impaired controller is in a standalone configuration and at LOADER prompt, contact [mysupport.netapp.com](https://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 controller if up, or on the partner controller if the impaired controller is down, using the `version -v` command:
  - If `<Ino-DARE>` or `<1Ono-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 the next section.
4. If the impaired controller is part of an HA configuration, disable automatic giveback from the healthy controller: `storage failover modify -node local -auto-giveback false` or `storage failover modify -node local -auto-giveback-after-panic false`

## Check NVE or NSE on systems running ONTAP 9.6 and later

Before shutting down the impaired controller, 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 in use 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 and in use.

2. Verify whether NSE is configured and in use: `storage encryption disk show`
  - If the command output lists the drive details with Mode & Key ID information, NSE is configured and you need to verify the NSE configuration and in use.
  - If no disks are shown, NSE is not configured.
  - If NVE and NSE are not configured, no drives are protected with NSE keys, it's safe to shut down the impaired controller.

## Verify NVE configuration

1. Display the key IDs of the authentication keys that are stored on the key management servers: `security key-manager key-query`



After the ONTAP 9.6 release, you may have additional key manager types. The types are KMIP, AKV, and GCP. The process for confirming these types is the same as confirming external or onboard key manager types.

- If the Key Manager type displays `external` and the Restored column displays `yes`, it's safe to shut down the impaired controller.
- 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.
  1. If the Key Manager type displays `onboard` and the Restored column displays `yes`, manually back up 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 controller.
  2. 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](https://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 controller.
  3. 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](https://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`, and then manually back up 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 shut down the controller.

## Verify NSE configuration

1. Display the key IDs of the authentication keys that are stored on the key management servers: `security key-manager key-query -key-type NSE-AK`



After the ONTAP 9.6 release, you may have additional key manager types. The types are KMIP, AKV, and GCP. The process for confirming these types is the same as confirming external or onboard key manager types.

- If the Key Manager type displays `external` and the Restored column displays `yes`, it's safe to shut down the impaired controller.
- 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.
  1. If the Key Manager type displays `onboard` and the Restored column displays `yes`, manually back up 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 shut down the controller.
  2. 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](https://mysupport.netapp.com)
    - b. Verify that the Restored column equals `yes` for all authentication keys: `security key-manager key-query`
    - c. You can safely shut down the controller.
  3. 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.

- 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`, and then manually back up 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 shut down the controller.

## Shut down the controller - AFF C190

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

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

### Steps

- a. Take the impaired controller to the LOADER prompt:

If the impaired controller displays...	Then...
The LOADER prompt	Go to Remove controller module.
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 controller from the healthy controller: <code>storage failover takeover -ofnode impaired_node_name</code></p> <p>When the impaired controller shows Waiting for giveback..., press Ctrl-C, and then respond <code>y</code>.</p>

1. 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.

## Replace the boot media - AFF C190

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

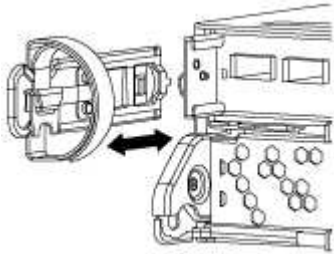
To access components inside the controller module, you must first remove the controller module from the system, and then remove the cover on the controller module.

#### Steps

1. If you are not already grounded, properly ground yourself.
2. 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.

3. Remove and set aside the cable management devices from the left and right sides of the controller module.



4. Squeeze the latch on the cam handle until it releases, open the cam handle fully to release the controller module from the midplane, and then, using two hands, pull the controller module out of the chassis.



5. Turn the controller module over and place it on a flat, stable surface.
6. Open the cover by sliding in the blue tabs to release the cover, and then swing the cover up and open.





## 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. Locate the boot media using the following illustration or the FRU map on the controller module:
2. Press the blue button on the boot media housing to release the boot media from its housing, and then gently pull it straight out of the boot media socket.



Do not twist or pull the boot media straight up, because this could damage the socket or the boot media.

3. Align the edges of the replacement boot media with the boot media socket, 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. Push the boot media down to engage the locking button on the boot media housing.
6. Close the controller module cover.

## Step 3: Transfer the boot image to the boot media

You can install the system image to the replacement boot media using a USB flash drive with the image installed on it. However, you must restore the `var` file system during this procedure.

- You must have a USB flash drive, formatted to 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.

## Steps

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.
2. Reinstall the cable management device and recable the system, as needed.

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

3. 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.

4. Push the controller module all the way into the system, making sure that the cam handle clears the USB flash drive, firmly push the cam handle to finish seating the controller module, push the cam handle to the closed position, and then tighten the thumbscrew.

The controller begins to boot as soon as it is completely installed into the chassis.

5. Interrupt the boot process to stop at the LOADER prompt by pressing Ctrl-C when you see `Starting AUTOBOOT press Ctrl-C to abort...`

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

6. Boot the recovery image:

**`boot_recovery ontap_image_name.tgz`**



If the `image.tgz` file is named something other than `image.tgz`, such as `boot_recovery_9_4.tgz`, you need to include the different file name in the `boot_recovery` command.

The system boots to the boot menu and prompts you for the boot image name.

7. Enter the boot image name that is on the USB flash drive:

**`image_name.tgz`**

After `image_name.tgz` is installed, the system prompts you to restore the backup configuration (the `var` file system) from the healthy controller.

8. Restore the `var` file system:

If your system has...	Then...
A network connection	<p>a. Press <b>y</b> when prompted to restore the backup configuration.</p> <p>b. Set the healthy controller to advanced privilege level:</p> <pre>set -privilege advanced</pre> <p>c. Run the restore backup command:</p> <pre>system node restore-backup -node local -target -address impaired_node_IP_address</pre> <p>d. Return the controller to admin level:</p> <pre>set -privilege admin</pre> <p>e. Press <b>y</b> when prompted to use the restored configuration.</p> <p>f. Press <b>y</b> when prompted to reboot the controller.</p>
No network connection	<p>a. Press <b>n</b> when prompted to restore the backup configuration.</p> <p>b. Reboot the system when prompted by the system.</p> <p>c. Select the <b>Update flash from backup config</b> (sync flash) option from the displayed menu.</p> <p>If you are prompted to continue with the update, press <b>y</b>.</p>

9. Verify that the environmental variables are set as expected.

- a. Take the controller 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 `saveenv` command.
- e. Reboot the controller.

10. The next step depends on your system configuration:

If your system is in...	Then...
A stand-alone configuration	You can begin using your system after the controller reboots.

If your system is in...	Then...
An HA pair	<p>After the impaired controller is displaying the <code>Waiting for Giveback...</code> message, perform a giveback from the healthy controller:</p> <p>a. Perform a giveback from the healthy controller:</p> <pre><b>storage failover giveback -ofnode partner_node_name</b></pre> <p>This initiates the process of returning ownership of the impaired controller's aggregates and volumes from the healthy controller back to the impaired controller.</p> <div style="display: flex; align-items: center;">  <div> <p>If the giveback is vetoed, you can consider overriding the vetoes.</p> <p><a href="#">ONTAP 9 High-Availability Configuration Guide</a></p> </div> </div> <p>b. Monitor the progress of the giveback operation by using the <code>`storage failover show-giveback`</code> command.</p> <p>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.</p> <p>d. Restore automatic giveback if you disabled it by using the <code>storage failover modify</code> command.</p>

## Boot the recovery image - AFF C190

You must boot the ONTAP image from the USB drive, restore the file system, and verify the environmental variables.

### Steps

1. From the LOADER prompt, boot the recovery image from the USB flash drive:

```
boot_recovery
```

The image is downloaded from the USB flash drive.

2. When prompted, either enter the name of the image or accept the default image displayed inside the brackets on your screen.
3. Restore the `var` file system:

If your system has...	Then...
A network connection	<p>a. Press <b>y</b> when prompted to restore the backup configuration.</p> <p>b. Set the healthy controller to advanced privilege level:</p> <pre>set -privilege advanced</pre> <p>c. Run the restore backup command:</p> <pre>system node restore-backup -node local -target -address <i>impaired_node_IP_address</i></pre> <p>d. Return the controller to admin level:</p> <pre>set -privilege admin</pre> <p>e. Press <b>y</b> when prompted to use the restored configuration.</p> <p>f. Press <b>y</b> when prompted to reboot the controller.</p>
No network connection	<p>a. Press <b>n</b> when prompted to restore the backup configuration.</p> <p>b. Reboot the system when prompted by the system.</p> <p>c. Select the <b>Update flash from backup config</b> (sync flash) option from the displayed menu.</p> <p>If you are prompted to continue with the update, press <b>y</b>.</p>

4. Ensure that the environmental variables are set as expected:
  - a. Take the controller to the LOADER prompt.
  - 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 `saveenv` command.
5. The next depends on your system configuration:
  - If your system has onboard keymanager, NSE or NVE configured, go to [Restore OKM, NSE, and NVE as needed](#)
  - If your system does not have onboard keymanager, NSE or NVE configured, complete the steps in this section.
6. From the LOADER prompt, enter the `boot_ontap` command.

If you see...	Then...
The login prompt	Go to the next Step.

If you see...	Then...
Waiting for giveback...	<ol style="list-style-type: none"> <li>Log into the partner controller.</li> <li>Confirm the target controller is ready for giveback with the <code>storage failover show</code> command.</li> </ol>

- Connect the console cable to the partner controller.
- Give back the controller using the `storage failover giveback -fromnode local` command.
- At the cluster prompt, check the logical interfaces with the `net int -is-home false` command.

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

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

## Restore OKM, NSE, and NVE as needed - AFF C190

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.

- 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

- Connect the console cable to the target controller.
- Use the `boot_ontap` command at the LOADER prompt to boot the controller.
- Check the console output:

If the console displays...	Then...
The LOADER prompt	Boot the controller to the boot menu: <code>boot_ontap menu</code>

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

- At the Boot Menu, enter the hidden command, `recover_onboard_keymanager` and reply `y` at the prompt
- Enter the passphrase for the onboard key manager you obtained from the customer at the beginning of this procedure.
- 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
3WTh7gAAAAAAAAAAAAAAAAAIAAAAAAAGAZJEIWvdeHr5RCaVHGclo+wAAAAAAAAA
lgAAAAAAAAAoAAAAAAAAAEOTcR0AAAAAAAAAAAAAAAAACAAAAAAAAJAGr3tJA/
LRzUQRHwv+1aWvAAAAAAAAAACQAAAAAAAAAGAAAAAAAAACdhTcvAAAAAJ1PXeBf
ml4NBsSyV1B4jc4A7cvWEFY6ILG6hc6tbKLAHZuvfQ4rlbYAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA...
H4nPQM0nrDRYRa9SCv8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAA
-----END BACKUP-----
```

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

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

- Move the console cable to the partner controller and login as "admin".
- Confirm the target controller is ready for giveback with the `storage failover show` command.
- 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 disengage 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 controller.

- 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 controller.

14. Give back the target controller 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 controller 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 controller 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 controller.



2. Use the `boot_ontap` command at the LOADER prompt to boot the controller.
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"> <li>a. Log into the partner controller.</li> <li>b. Confirm the target controller is ready for giveback with the <code>storage failover show</code> command.</li> </ol>

4. Move the console cable to the partner controller and give back the target controller storage using the `storage failover giveback -fromnode local -only-cfo-aggregates true local` command.
  - If the command fails because of a failed disk, physically disengage 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 controller 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 controller 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 controller.
12. Give back the controller 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 C190

Return the failed part to NetApp, as described in the RMA instructions shipped with the kit. See the [Part Return & Replacements](#) page for further information.

# Chassis

## Overview of chassis replacement - AFF C190

To replace the chassis, you must move the power supplies, hard drives, and controller module or modules from the impaired chassis to the new chassis, and swap out the impaired chassis from the equipment rack or system cabinet with 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 all drives and controller module or 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 C190

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

### About this task

- If you have a cluster with more than two controllers, it must be in quorum. If the cluster is not in quorum or a healthy controller shows `false` for eligibility and health, you must correct the issue before shutting down the impaired controller; see the [Administration overview with the CLI](#).
- 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 controllers in the cluster	<code>cluster ha modify -configured false storage failover modify -node node0 -enabled false</code>
More than two controllers in the cluster	<code>storage failover modify -node node0 -enabled false</code>

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

The confirmation message looks like the following:

Warning: This operation will cause controller "node-name" to be marked as unhealthy. Unhealthy nodes do not participate in quorum voting. If the controller goes out of service and one more controller goes out of service there will be a data serving failure for the entire cluster. This will cause a client disruption. Use "cluster show" to verify cluster state. If possible bring other nodes online to improve the resiliency of this cluster.

Do you want to continue? {y|n}:



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

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

Answer `y` when prompted.

## Move and replace hardware - AFF C190

Move the power supplies, hard drives, and controller module or modules from the impaired chassis to the new chassis, and swap out the impaired chassis from the

equipment rack or system cabinet with the new chassis of the same model as the impaired chassis.

### Step 1: Move the power supply

Moving out a power supply when replacing a chassis involves turning off, disconnecting, and removing the power supply from the old chassis and installing and connecting it on the replacement chassis.

1. If you are not already grounded, properly ground yourself.
2. Turn off the power supply and disconnect the power cables:
  - a. Turn off the power switch on the power supply.
  - b. Open the power cable retainer, and then unplug the power cable from the power supply.
  - c. Unplug the power cable from the power source.
3. Squeeze the latch on the power supply cam handle, and then open the cam handle to fully release the power supply from the mid plane.
4. Use the cam handle to slide the power supply out of the system.



When removing a power supply, always use two hands to support its weight.

5. Repeat the preceding steps for any remaining power supplies.
6. Using both hands, support and align the edges of the power supply with the opening in the system chassis, and then gently push the power supply into the chassis using the cam handle.

The power supplies are keyed and can only be installed one way.



Do not use excessive force when sliding the power supply into the system. You can damage the connector.

7. Close the cam handle so that the latch clicks into the locked position and the power supply is fully seated.
8. Reconnect the power cable and secure it to the power supply using the power cable locking mechanism.

### Step 2: Remove the controller module

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

1. If you are not already grounded, properly ground yourself.
2. 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.

3. Remove and set aside the cable management devices from the left and right sides of the controller module.



4. Squeeze the latch on the cam handle until it releases, open the cam handle fully to release the controller module from the midplane, and then, using two hands, pull the controller module out of the chassis.



5. Set the controller module aside in a safe place, and repeat these steps if you have another controller module in the chassis.

### Step 3: Move drives to the new chassis

You need to move the drives from each bay opening in the old chassis to the same bay opening in the new chassis.

1. Gently remove the bezel from the front of the system.
2. Remove the drives:
  - a. Press the release button at the top of the carrier face below the LEDs.
  - b. Pull the cam handle to its fully open position to unseat the drive from the midplane, and then gently slide the drive out of the chassis.

The drive should disengage from the chassis, allowing it to slide free of the chassis.



When removing a drive, always use two hands to support its weight.



Drives are fragile. Handle them as little as possible to prevent damage to them.

3. Align the drive from the old chassis with the same bay opening in the new chassis.

4. Gently push the drive into the chassis as far as it will go.

The cam handle engages and begins to rotate upward.

5. Firmly push the drive the rest of the way into the chassis, and then lock the cam handle by pushing it up and against the drive holder.

Be sure to close the cam handle slowly so that it aligns correctly with the front of the drive carrier. It clicks when it is secure.

6. Repeat the process for the remaining drives in the system.

#### **Step 4: 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 the help of two or three people, slide the old chassis off the rack rails in a system cabinet or L brackets in an equipment rack, and then set it aside.
3. If you are not already grounded, properly ground yourself.
4. Using two or three 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 L brackets in an 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 5: Install the controller module**

After you install the controller module and any other components into the new chassis, you need to boot it to a state where you can run the interconnect 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. Repeat the preceding steps if there is a second controller to install in the new chassis.
4. Complete the installation of the controller module
  - a. With the cam handle in the open position, firmly push the controller module in until it meets the midplane and is fully seated, and then close the cam handle to the locked position.



Do not use excessive force when sliding the controller module into the chassis to avoid damaging the connectors.

- b. If you have not already done so, reinstall the cable management device.
  - c. Bind the cables to the cable management device with the hook and loop strap.
  - d. Repeat the preceding steps for the second controller module in the new chassis.
5. Connect the power supplies to different power sources, and then turn them on.
6. Boot each controller to Maintenance mode:
  - a. As each controller starts the booting, press `Ctrl-C` to interrupt the boot process when you see the message `Press Ctrl-C for Boot Menu`.



If you miss the prompt and the controller modules boot to ONTAP, enter `halt`, and then at the `LOADER` prompt enter `boot_ontap`, press `Ctrl-C` when prompted, and then repeat this step.

- b. From the boot menu, select the option for Maintenance mode.

## Restore and verify the configuration - AFF C190

You must verify the HA state of the chassis and run System-Level diagnostics.

### Step 1: Verify and setting 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. The next step depends on your system configuration.

If your system is in...	Then...
A stand-alone configuration	a. Exit Maintenance mode:  <b>halt</b>  b. Go to <a href="#">"Completing the replacement process."</a>
An HA pair with a second controller module	Exit Maintenance mode: <b>halt</b>  The LOADER prompt appears.

## Step 2: Run system-level diagnostics

After installing a new chassis, you should run interconnect diagnostics.

Your system must be at the LOADER prompt to start System Level Diagnostics.

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

1. If the controller to be serviced is not at the LOADER prompt, perform the following steps:
  - a. Select the Maintenance mode option from the displayed menu.
  - b. After the controller boots to Maintenance mode, halt the controller:

**halt**

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



During the boot process, you can safely respond `y` to prompts:

2. Repeat the previous step on the second controller if you are in an HA configuration.



Both controllers must be in Maintenance mode to run the interconnect test.

3. At the LOADER prompt, access the special drivers specifically designed for system-level diagnostics to function properly:

**boot\_diags**

During the boot process, you can safely respond `y` to the prompts until the Maintenance mode prompt (`*>`) appears.

4. Enable the interconnect diagnostics tests from the Maintenance mode prompt:

**sldiag device modify -dev interconnect -sel enable**

The interconnect tests are disabled by default and must be enabled to run separately.

5. Run the interconnect diagnostics test from the Maintenance mode prompt:



```
sldiag device run -dev interconnect
```

You only need to run the interconnect test from one controller.

6. Verify that no hardware problems resulted from the replacement of the chassis:

```
sldiag device status -dev interconnect -long -state failed
```

System-level diagnostics returns you to the prompt if there are no test failures, or lists the full status of failures resulting from testing the component.

7. Proceed based on the result of the preceding step.

If the system-level diagnostics tests...	Then...
Were completed without any failures	<p>a. Clear the status logs:</p> <pre>sldiag device clearstatus</pre> <p>b. Verify that the log was cleared:</p> <pre>sldiag device status</pre> <p>The following default response is displayed:</p> <div>SLDIAG: No log messages are present.</div> <p>c. Exit Maintenance mode on both controllers:</p> <pre>halt</pre> <p>The system displays the LOADER prompt.</p> <div> You must exit Maintenance mode on both controllers before proceeding any further.</div> <p>d. Enter the following command on both controllers at the LOADER prompt:</p> <pre>bye</pre> <p>e. Return the controller to normal operation:</p>

If your system is running ONTAP...	Then...
With two nodes in the cluster	<p>Issue these commands:</p> <pre>node::&gt; cluster ha modify -configured true</pre> <pre>node::&gt; storage failover modify -node node0 -enabled true</pre>
With more than two nodes in the cluster	<p>Issue this command:</p> <pre>node::&gt; storage failover modify -node node0 -enabled true</pre>
In a stand-alone configuration	You have no further steps in this particular task. You have completed system-level diagnostics.
Resulted in some test failures	<p>Determine the cause of the problem.</p> <ol style="list-style-type: none"> <li>Exit Maintenance mode: <pre>halt</pre> </li> <li>Perform a clean shutdown, and then disconnect the power supplies.</li> <li>Verify that you have observed all of the considerations identified for running system-level diagnostics, that cables are securely connected, and that hardware components are properly installed in the storage system.</li> <li>Reconnect the power supplies, and then power on the storage system.</li> <li>Rerun the system-level diagnostics test.</li> </ol>

### Step 3: Return the failed part to NetApp

Return the failed part to NetApp, as described in the RMA instructions shipped with the kit. See the [Part Return & Replacements](#) page for further information.

## Controller

### Overview of controller module replacement - AFF C190

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.
- If your system is in an HA pair, the healthy controller must be able to take over the controller that is being

replaced (referred to in this procedure as the “impaired controller”).

- This procedure includes steps for automatically or manually reassigning drives to the *replacement* controller, depending on your system’s configuration.
- You should perform the drive reassignment as directed in the procedure.
- 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 controller to the *replacement* controller so that the *replacement* controller 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* controller is the controller that is being replaced.
  - The *replacement* controller is the new controller that is replacing the impaired controller.
  - The *healthy* controller is the surviving controller.
- You must always capture the controller’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.

## Shut down the controller - AFF C190

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

### About this task

- If you are using NetApp Storage Encryption, you must have reset the MSID using the instructions in the “Returning SEDs to unprotected mode” section of the *ONTAP 9 NetApp Encryption Power Guide*.

#### [ONTAP 9 NetApp Encryption Power Guide](#)

- If you have a SAN system, you must have checked event messages (event log show) for impaired controller SCSI blade.

Each SCSI-blade process should be in quorum with the other nodes in the cluster. Any issues must be resolved before you proceed with the replacement.

- 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 controller shows false for eligibility and health, you must correct the issue before shutting down the impaired controller; see the [Administration overview with the CLI](#).
- If you have a MetroCluster configuration, you must have confirmed that the MetroCluster Configuration State is configured and that the nodes are in an enabled and normal state (`metrocluster node show`).

### 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 controller: `storage failover modify -node local -auto-giveback false`
3. Take the impaired controller to the LOADER prompt:

If the impaired controller is displaying...	Then...
The LOADER prompt	Go to Remove controller module.
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 controller from the healthy controller:</p> <pre>storage failover takeover -ofnode impaired_node_name</pre> <p>When the impaired controller shows Waiting for giveback..., press Ctrl-C, and then respond <code>y</code>.</p>

## Replace the controller module hardware - AFF C190

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

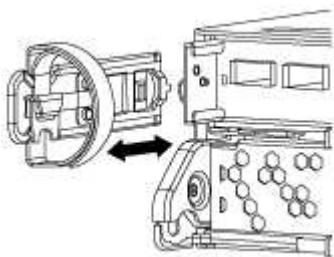
### Step 1: Remove controller module

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

1. If you are not already grounded, properly ground yourself.
2. 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.

3. Remove and set aside the cable management devices from the left and right sides of the controller module.



4. If you left the SFP modules in the system after removing the cables, move them to the new controller module.
5. Squeeze the latch on the cam handle until it releases, open the cam handle fully to release the controller module from the midplane, and then, using two hands, pull the controller module out of the chassis.



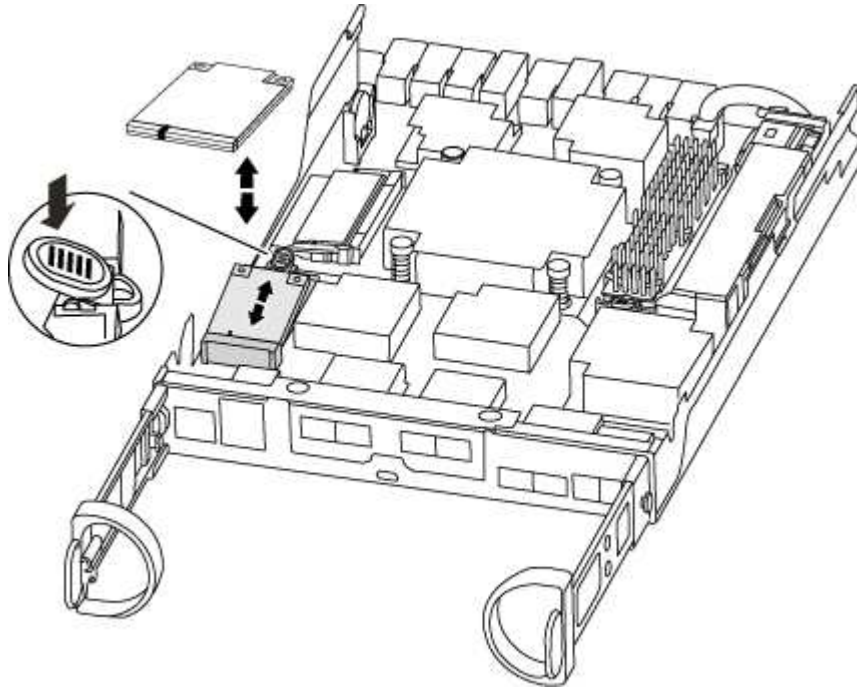
6. Turn the controller module over and place it on a flat, stable surface.
7. Open the cover by sliding in the blue tabs to release the cover, and then swing the cover up and open.



## Step 2: Move the boot media

You must locate the boot media and follow the directions to remove it from the old controller module and insert it in the new controller module.

1. Locate the boot media using the following illustration or the FRU map on the controller module:



2. Press the blue button on the boot media housing to release the boot media from its housing, and then gently pull it straight out of the boot media socket.



Do not twist or pull the boot media straight up, because this could damage the socket or the boot media.

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. Push the boot media down to engage the locking button on the boot media housing.

## Step 3: Move the NVMEM battery

To move the NVMEM battery from the old controller module to the new controller module, you must perform a specific sequence of steps.

1. Check the NVMEM LED:
  - If your system is in an HA configuration, go to the next step.
  - If your system is in a stand-alone configuration, cleanly shut down the controller module, and then check the NVRAM LED identified by the NV icon.

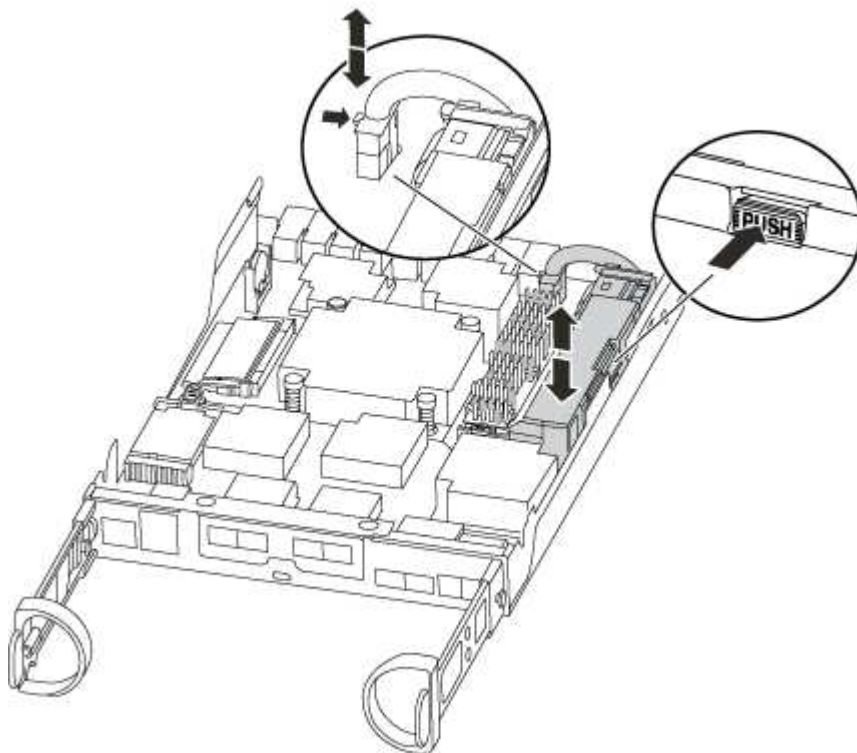


The NVRAM LED blinks while destaging contents to the flash memory when you halt the system. After the destage is complete, the LED turns off.

- If power is lost without a clean shutdown, the NVMEM LED flashes until the destage is complete, and then the LED turns off.
- If the LED is on and power is on, unwritten data is stored on NVMEM.

This typically occurs during an uncontrolled shutdown after ONTAP has successfully booted.

2. Locate the NVMEM battery in the controller module.



3. 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.
4. Grasp the battery and press the blue locking tab marked PUSH, and then lift the battery out of the holder and controller module.
5. Move the battery to the replacement controller module.
6. Loop the battery cable around the cable channel on the side of the battery holder.
7. Position the battery pack by aligning the battery holder key ribs to the "V" notches on the sheet metal side wall.
8. Slide the battery pack down along the sheet metal side wall until the support tabs on the side wall hook into the slots on the battery pack, and the battery pack latch engages and clicks into the opening on the side wall.

## Step 4: Move the DIMMs

To move the DIMMs, you must follow the directions to locate and move them from the old controller module into 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.

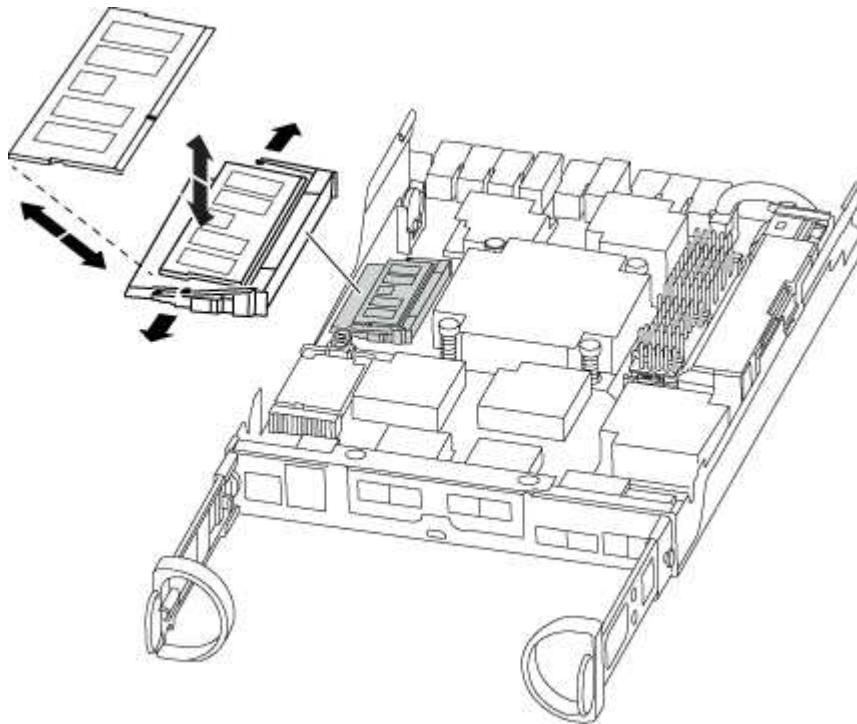
1. Locate the DIMMs on your controller module.
2. Note the orientation of the DIMM in the socket so that you can insert the DIMM in the replacement controller module in the proper orientation.
3. Eject the DIMM from its slot by slowly pushing apart the two DIMM ejector tabs on either side of the DIMM, 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.

The number and placement of system DIMMs depends on the model of your system.

The following illustration shows the location of system DIMMs:



4. Repeat these steps to remove additional DIMMs as needed.
5. Verify that the NVMEM battery is not plugged into the new controller module.
6. Locate the slot where you are installing the DIMM.
7. 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.



8. Repeat these steps for the remaining DIMMs.
9. Locate the NVMEM battery plug socket, and then squeeze the clip on the face of the battery cable plug to insert it into the socket.

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

### Step 5: Install the controller module

After you install the components from the old controller module into the new controller module, you must install the new controller module into the system chassis and boot the operating system.

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.



The system might update system firmware when it boots. Do not abort this process. The procedure requires you to interrupt the boot process, which you can typically do at any time after prompted to do so. However, if the system updates the system firmware when it boots, you must wait until after the update is complete before interrupting the boot process.

1. If you have not already done so, replace the cover on the controller module.
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. The controller module begins to boot as soon as it is fully seated in the chassis. Be prepared to interrupt the boot process.
  - a. With the cam handle in the open position, firmly push the controller module in until it meets the midplane and is fully seated, and then close the cam handle to the locked position.



Do not use excessive force when sliding the controller module into the chassis to avoid damaging the connectors.

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

- b. If you have not already done so, reinstall the cable management device.
- c. Bind the cables to the cable management device with the hook and loop strap.
- d. Interrupt the boot process **only** after determining the correct timing:

You must look for an Automatic firmware update console message. If the update message appears, do not press `Ctrl-C` to interrupt the boot process until after you see a message confirming that the update is complete.

Only press `Ctrl-C` when you see the message `Press Ctrl-C for Boot Menu`.



If the firmware update is aborted, the boot process exits to the LOADER prompt. You must run the `update_flash` command and then exit LOADER and boot to Maintenance mode by pressing `Ctrl-C` when you see Starting AUTOBOOT press `Ctrl-C` to abort.

If you miss the prompt and the controller module boots to ONTAP, enter `halt`, and then at the LOADER prompt enter `boot_ontap`, press `Ctrl-C` when prompted, and then boot to Maintenance mode.



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 controller remains down. You can safely respond `y` to these prompts.

e. Select the option to boot to Maintenance mode from the displayed menu.

## Restore and verify the system configuration - AFF C190

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 system time after replacing the controller

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`
  - `mccip`
  - `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 system-level diagnostics

You should run comprehensive or focused diagnostic tests for specific components and subsystems whenever you replace the controller.

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

1. If the controller to be serviced is not at the LOADER prompt, reboot the controller:

**halt**

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**

During the boot process, you can safely respond **y** to the prompts until the Maintenance mode prompt (**\*>**) appears.

3. Display and note the available devices on the controller module:

**sldiag device show -dev mb**

The controller module devices and ports displayed can be any one or more of the following:

- `bootmedia` is the system booting device.
- `cna` is a Converged Network Adapter or interface not connected to a network or storage device.
- `fcal` is a Fibre Channel-Arbitrated Loop device not connected to a Fibre Channel network.
- `env` is motherboard environmentals.
- `mem` is system memory.
- `nic` is a network interface card.
- `nvr` is nonvolatile RAM.
- `nvmm` is a hybrid of NVRAM and system memory.
- `sas` is a Serial Attached SCSI device not connected to a disk shelf.

4. Run diagnostics as desired.

If you want to run diagnostic tests on...	Then...
Individual components	<p>a. Clear the status logs:</p> <pre><b>sldiag device clearstatus</b></pre> <p>b. Display the available tests for the selected devices:</p> <pre><b>sldiag device show -dev dev_name</b></pre> <p><i>dev_name</i> can be any one of the ports and devices identified in the preceding step.</p> <p>c. Examine the output and, if applicable, select only the tests that you want to run:</p> <pre><b>sldiag device modify -dev dev_name -selection only</b></pre> <p>-selection only disables all other tests that you do not want to run for the device.</p> <p>d. Run the selected tests:</p> <pre><b>sldiag device run -dev dev_name</b></pre> <p>After the test is complete, the following message is displayed:</p> <div data-bbox="672 1079 1484 1178" style="border: 1px solid #ccc; border-radius: 10px; padding: 10px; background-color: #f9f9f9;"> <pre>*&gt; &lt;SLDIAG:_ALL_TESTS_COMPLETED&gt;</pre> </div> <p>e. Verify that no tests failed:</p> <pre><b>sldiag device status -dev dev_name -long -state failed</b></pre> <p>System-level diagnostics returns you to the prompt if there are no test failures, or lists the full status of failures resulting from testing the component.</p>

If you want to run diagnostic tests on...	Then...
Multiple components at the same time	<p>a. Review the enabled and disabled devices in the output from the preceding procedure and determine which ones you want to run concurrently.</p> <p>b. List the individual tests for the device:</p> <pre>sldiag device show -dev dev_name</pre> <p>c. Examine the output and, if applicable, select only the tests that you want to run:</p> <pre>sldiag device modify -dev dev_name -selection only</pre> <p>-selection only disables all other tests that you do not want to run for the device.</p> <p>d. Verify that the tests were modified:</p> <pre>sldiag device show</pre> <p>e. Repeat these substeps for each device that you want to run concurrently.</p> <p>f. Run diagnostics on all of the devices:</p> <pre>sldiag device run</pre> <div data-bbox="699 1129 756 1186">  </div> <div data-bbox="818 1129 1442 1192"> <p>Do not add to or modify your entries after you start running diagnostics.</p> </div> <p>After the test is complete, the following message is displayed:</p> <pre>*&gt; &lt;SLDIAG:_ALL_TESTS_COMPLETED&gt;</pre> <p>g. Verify that there are no hardware problems on the controller:</p> <pre>sldiag device status -long -state failed</pre> <p>System-level diagnostics returns you to the prompt if there are no test failures, or lists the full status of failures resulting from testing the component.</p>

5. Proceed based on the result of the preceding step.

If the system-level diagnostics tests...	Then...
Were completed without any failures	<p>a. Clear the status logs:</p> <pre><b>sldiag device clearstatus</b></pre> <p>b. Verify that the log was cleared:</p> <pre><b>sldiag device status</b></pre> <p>The following default response is displayed:</p> <div data-bbox="672 533 1484 632" style="border: 1px solid #ccc; padding: 10px; margin: 10px 0;"> <pre>SLDIAG: No log messages are present.</pre> </div> <p>c. Exit Maintenance mode:</p> <pre><b>halt</b></pre> <p>The system displays the LOADER prompt.</p> <p>You have completed system-level diagnostics.</p>
Resulted in some test failures	<p>Determine the cause of the problem.</p> <p>a. Exit Maintenance mode:</p> <pre><b>halt</b></pre> <p>b. Perform a clean shutdown, and then disconnect the power supplies.</p> <p>c. Verify that you have observed all of the considerations identified for running system-level diagnostics, that cables are securely connected, and that hardware components are properly installed in the storage system.</p> <p>d. Reconnect the power supplies, and then power on the storage system.</p> <p>e. Rerun the system-level diagnostics test.</p>

## Recable the system and reassign disks - AFF C190

Continue the replacement procedure by recabling the storage and confirming disk reassignment.

### Step 1: Recable the system

After running diagnostics, you must recable the controller module's storage and network connections.

Steps

- 1. Recable the system.
- 2. Verify that the cabling is correct by using [Active IQ Config Advisor](#).
  - a. Download and install Config Advisor.
  - b. Enter the information for the target system, and then click Collect Data.
  - c. Click the Cabling tab, and then examine the output. Make sure that all disk shelves are displayed and all disks appear in the output, correcting any cabling issues you find.
  - d. Check other cabling by clicking the appropriate tab, and then examining the output from Config Advisor.

Step 2: Verifying the system ID change on an HA system

If the storage system is in an HA pair, the system ID of the new controller module is automatically assigned to the disks when the giveback occurs at the end of the procedure. You must confirm the system ID change when you boot the *replacement* controller and then verify that the change was implemented.

This procedure applies only to systems running ONTAP in an HA pair.

- 1. If the *replacement* controller is in Maintenance mode (showing the `*>` prompt, exit Maintenance mode and go to the LOADER prompt:

```
halt
```

- 2. From the LOADER prompt on the *replacement* controller, boot the controller, entering **y** if you are prompted to override the system ID due to a system ID mismatch.
- 3. Wait until the `Waiting for giveback...` message is displayed on the *replacement* controller console and then, from the healthy controller, verify that the new partner system ID has been automatically assigned:

```
`storage failover show`
```

In the command output, you should see a message that the system ID has changed on the impaired controller, showing the correct old and new IDs. In the following example, node2 has undergone replacement and has a new system ID of 151759706.

```
node1> `storage failover show`
```

Node	Partner	Takeover Possible	State Description
node1	node2	false	System ID changed on partner (Old: 151759755, New: 151759706), In takeover
node2	node1	-	Waiting for giveback (HA mailboxes)

- 4. From the healthy controller, verify that any coredumps are saved:
  - a. Change to the advanced privilege level:



```
set -privilege advanced
```

You can respond **y** when prompted to continue into advanced mode. The advanced mode prompt appears (\*>).

- b. Save any coredumps:

```
system node run -node local-node-name partner savecore
```

- c. Wait for the `savecore` command to complete before issuing the giveback.

You can enter the following command to monitor the progress of the savecore command:

```
system node run -node local-node-name partner savecore -s
```

- d. Return to the admin privilege level:

```
set -privilege admin
```

5. Give back the controller:

- a. From the healthy controller, give back the replaced controller's storage:

```
storage failover giveback -ofnode replacement_node_name
```

The *replacement* controller takes back its storage and completes booting.

If you are prompted to override the system ID due to a system ID mismatch, you should enter **y**.



If the giveback is vetoed, you can consider overriding the vetoes.

[Find the High-Availability Configuration content for your version of ONTAP 9](#)

- b. After the giveback has been completed, confirm that the HA pair is healthy and that takeover is possible: `storage failover show`

The output from the `storage failover show` command should not include the System ID changed on partner message.

6. Verify that the disks were assigned correctly: `storage disk show -ownership`

The disks belonging to the *replacement* controller should show the new system ID. In the following example, the disks owned by node1 now show the new system ID, 1873775277:

```
node1> `storage disk show -ownership`
```

Disk Reserver	Aggregate Pool	Home	Owner	DR	Home	Home ID	Owner ID	DR	Home	ID
1.0.0	aggr0_1	node1	node1	-		1873775277	1873775277	-		
1873775277	Pool0									
1.0.1	aggr0_1	node1	node1			1873775277	1873775277	-		
1873775277	Pool0									
.										
.										
.										

7. Verify that the expected volumes are present for each controller:

```
vol show -node node-name
```

8. If you disabled automatic takeover on reboot, enable it from the healthy controller:

```
storage failover modify -node replacement-node-name -onreboot true
```

## Complete system restoration - AFF C190

To restore your system to full operation, you must restore the NetApp Storage Encryption configuration (if necessary), and install licenses for the new controller, and return the failed part to NetApp, as described in the RMA instructions shipped with the kit.

### Step 1: Installing licenses for the *replacement* controller in ONTAP

You must install new licenses for the *replacement* node if the impaired node was using ONTAP features that require a standard (node-locked) license. For features with standard licenses, each node in the cluster should have its own key for the feature.

#### About this task

Until you install license keys, features requiring standard licenses continue to be available to the *replacement* node. However, if the impaired node was the only node in the cluster with a license for the feature, no configuration changes to the feature are allowed. Also, using unlicensed features on the node might put you out of compliance with your license agreement, so you should install the replacement license key or keys on the *replacement* node as soon as possible.

#### Before you begin

The licenses keys must be in the 28-character format.

You have a 90-day grace period in which to install the license keys. After the grace period, all old licenses are invalidated. After a valid license key is installed, you have 24 hours to install all of the keys before the grace period ends.

#### Steps

1. If you need new license keys, obtain replacement license keys on the [NetApp Support Site](#) in the My Support section under Software licenses.



The new license keys that you require are automatically generated and sent to the email address on file. If you fail to receive the email with the license keys within 30 days, you should contact technical support.

2. Install each license key: `system license add -license-code license-key, license-key...`
3. Remove the old licenses, if desired:
  - a. Check for unused licenses: `license clean-up -unused -simulate`
  - b. If the list looks correct, remove the unused licenses: `license clean-up -unused`

## Step 2: Restoring Storage and Volume Encryption functionality

After replacing the controller module or NVRAM module for a storage system that you previously configured to use Storage or Volume Encryption, you must perform additional steps to provide uninterrupted Encryption functionality. You can skip this task on storage systems that do not have Storage or Volume Encryption enabled.

### Step

1. Restore Storage or Volume Encryption functionality by using the appropriate procedure in [NetApp Encryption overview with the CLI](#).
2. Use one of the following procedures, depending on whether you are using onboard or external key management:
  - [Restore onboard key management encryption keys](#)
  - [Restore external key management encryption keys](#)

## Step 3: Verifying LIFs and registering the serial number

Before returning the *replacement* node to service, you should verify that the LIFs are on their home ports, and register the serial number of the *replacement* node if AutoSupport is enabled, and reset automatic giveback.

### Steps

1. Verify that the logical interfaces are reporting to their home server and ports: `network interface show -is-home false`  
  
If any LIFs are listed as false, revert them to their home ports: `network interface revert`
2. Register the system serial number with NetApp Support.
  - If AutoSupport is enabled, send an AutoSupport message to register the serial number.
  - If AutoSupport is not enabled, call [NetApp Support](#) to register the serial number.
3. If automatic giveback was disabled, reenable it: `storage failover modify -node local -auto-giveback true`

## Step 4: Return the failed part to NetApp

Return the failed part to NetApp, as described in the RMA instructions shipped with the kit. See the [Part Return & Replacements](#) page for further information.

# Replace a DIMM - AFF C190

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.

## Step 1: Shut down the impaired controller

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

### About this task

- If you are using NetApp Storage Encryption, you must have reset the MSID using the instructions in the “Returning SEDs to unprotected mode” section of the *ONTAP 9 NetApp Encryption Power Guide*.
- [ONTAP 9 NetApp Encryption Power Guide](#)
- If you have a SAN system, you must have checked event messages (event log show) for impaired controller SCSI blade.
- Each SCSI-blade process should be in quorum with the other nodes in the cluster. Any issues must be resolved before you proceed with the replacement.
- 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 controller shows false for eligibility and health, you must correct the issue before shutting down the impaired controller; see the [Administration overview with the CLI](#).
  - If you have a MetroCluster configuration, you must have confirmed that the MetroCluster Configuration State is configured and that the nodes are in an enabled and normal state (`metrocluster node show`).

### 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 controller: `storage failover modify -node local -auto-giveback false`
3. Take the impaired controller to the LOADER prompt:

If the impaired controller is displaying...	Then...
The LOADER prompt	Go to Remove controller module.

If the impaired controller is displaying...	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 controller from the healthy controller:</p> <pre>storage failover takeover -ofnode impaired_node_name</pre> <p>When the impaired controller shows Waiting for giveback..., press Ctrl-C, and then respond <code>y</code>.</p>

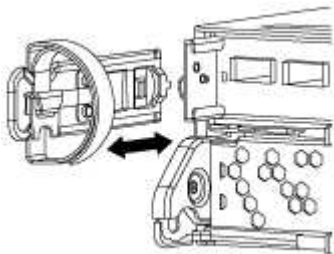
## Step 2: Remove controller module

To access components inside the controller module, you must first remove the controller module from the system, and then remove the cover on the controller module.

1. If you are not already grounded, properly ground yourself.
2. 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.

3. Remove and set aside the cable management devices from the left and right sides of the controller module.



4. Squeeze the latch on the cam handle until it releases, open the cam handle fully to release the controller module from the midplane, and then, using two hands, pull the controller module out of the chassis.



5. Turn the controller module over and place it on a flat, stable surface.
6. Open the cover by sliding in the blue tabs to release the cover, and then swing the cover up and open.



### Step 3: Replace the DIMMs

To replace the DIMMs, you need to locate them inside the controller module, and then follow the specific sequence of steps.

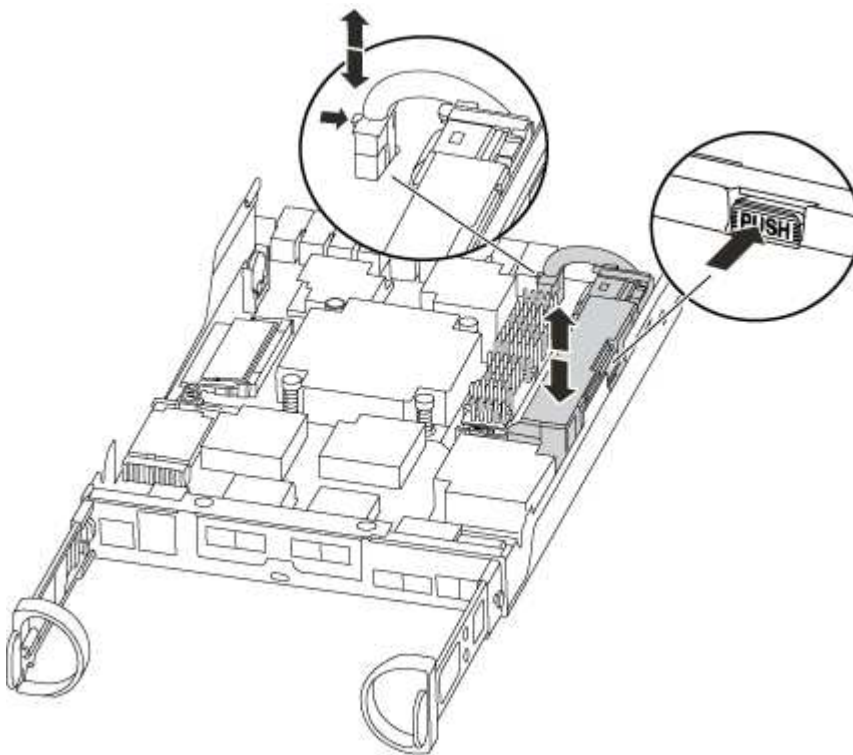
If you are replacing a DIMM, you need to remove it after you have unplugged the NVMEM battery from the controller module.

1. Check the NVMEM LED on the controller module.

You must perform a clean system shutdown before replacing system components to avoid losing unwritten data in the nonvolatile memory (NVMEM). The LED is located on the back of the controller module. Look for the following icon:



2. If the NVMEM LED is not flashing, there is no content in the NVMEM; you can skip the following steps and proceed to the next task in this procedure.
3. If the NVMEM LED is flashing, there is data in the NVMEM and you must disconnect the battery to clear the memory:
  - a. Locate the battery, press the clip on the face of the battery plug to release the lock clip from the plug socket, and then unplug the battery cable from the socket.



- b. Confirm that the NVMEM LED is no longer lit.
  - c. Reconnect the battery connector.
4. Return to [Step 3: Replace the DIMMs](#) of this procedure to recheck the NVMEM LED.
  5. Locate the DIMMs on your controller module.



Each system memory DIMM has an LED located on the board next to each DIMM slot. The LED for the faulty blinks every two seconds.

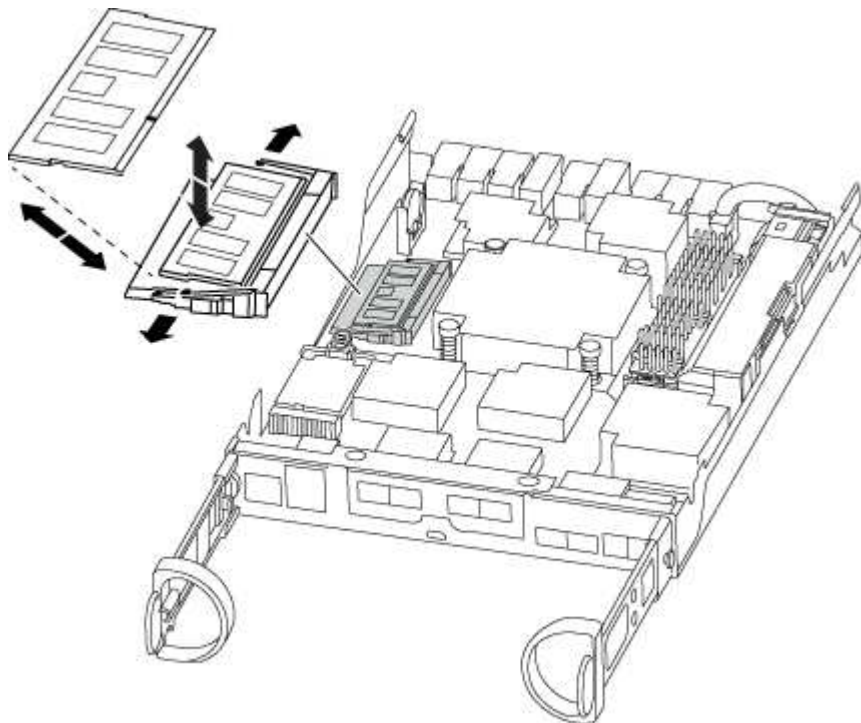
6. Note the orientation of the DIMM in the socket so that you can insert the replacement DIMM in the proper orientation.
7. Eject the DIMM from its slot by slowly pushing apart the two DIMM ejector tabs on either side of the DIMM, and then slide the DIMM out of the slot.



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

The number and placement of system DIMMs depends on the model of your system.

The following illustration shows the location of system DIMMs:



8. 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.

9. 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.

10. 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.
11. Locate the NVMEM battery plug socket, and then squeeze the clip on the face of the battery cable plug to insert it into the socket.

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



12. Close the controller module cover.

## Step 4: Reinstall the controller module

After you replace components in the controller module, you must reinstall it into the chassis.

1. If you have not already done so, replace the cover on the controller module.
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. Complete the reinstallation of the controller module. The controller module begins to boot as soon as it is fully seated in the chassis. Be prepared to interrupt the boot process.
  - a. With the cam handle in the open position, firmly push the controller module in until it meets the midplane and is fully seated, and then close the cam handle to the locked position.



Do not use excessive force when sliding the controller module into the chassis to avoid damaging the connectors.

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

- b. If you have not already done so, reinstall the cable management device.
- c. Bind the cables to the cable management device with the hook and loop strap.
- d. When you see the message `Press Ctrl-C for Boot Menu`, press `Ctrl-C` to interrupt the boot process.



If you miss the prompt and the controller module boots to ONTAP, enter `halt`, and then at the `LOADER` prompt enter `boot_ontap`, press `Ctrl-C` when prompted, and then boot to Maintenance mode.

- e. Select the option to boot to Maintenance mode from the displayed menu.

## Step 5: Run system-level diagnostics

After installing a new DIMM, you should run diagnostics.

Your system must be at the `LOADER` prompt to start System Level Diagnostics.

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

1. If the controller to be serviced is not at the `LOADER` prompt, perform the following steps:
  - a. Select the Maintenance mode option from the displayed menu.
  - b. After the controller boots to Maintenance mode, halt the controller: `halt`

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



During the boot process, you can safely respond `y` to prompts:

- A prompt warning that when entering Maintenance mode in an HA configuration, you must ensure that the healthy controller remains down.
2. At the LOADER prompt, access the special drivers specifically designed for system-level diagnostics to function properly: `boot_diags`

During the boot process, you can safely respond `y` to the prompts until the Maintenance mode prompt (`*>`) appears.

3. Run diagnostics on the system memory: `sldiag device run -dev mem`
4. Verify that no hardware problems resulted from the replacement of the DIMMs: `sldiag device status -dev mem -long -state failed`

System-level diagnostics returns you to the prompt if there are no test failures, or lists the full status of failures resulting from testing the component.

5. Proceed based on the result of the preceding step:

If the system-level diagnostics tests...	Then...
Were completed without any failures	<ol style="list-style-type: none"><li>a. Clear the status logs: <code>sldiag device clearstatus</code></li><li>b. Verify that the log was cleared: <code>sldiag device status</code>  The following default response is displayed:  SLDIAG: No log messages are present.</li><li>c. Exit Maintenance mode: <code>halt</code>  The controller displays the LOADER prompt.</li><li>d. Boot the controller from the LOADER prompt: <code>bye</code></li><li>e. Return the controller to normal operation:</li></ol>

If your controller is in...	Then...
An HA pair	Perform a give back: <code>storage failover giveback -ofnode replacement_node_name</code> <b>Note:</b> If you disabled automatic giveback, re-enable it with the storage failover modify command.
A stand-alone configuration	Proceed to the next step. No action is required.  + You have completed system-level diagnostics.

<p>Resulted in some test failures</p>	<p>Determine the cause of the problem:</p> <ol style="list-style-type: none"> <li>Exit Maintenance mode: <code>halt</code> <p>After you issue the command, wait until the system stops at the LOADER prompt.</p> </li> <li>Turn off or leave on the power supplies, depending on how many controller modules are in the chassis: <ul style="list-style-type: none"> <li>If you have two controller modules in the chassis, leave the power supplies turned on to provide power to the other controller module.</li> <li>If you have one controller module in the chassis, turn off the power supplies and unplug them from the power sources.</li> </ul> </li> <li>Verify that you have observed all the considerations identified for running system-level diagnostics, that cables are securely connected, and that hardware components are properly installed in the storage system.</li> <li>Boot the controller module you are servicing, interrupting the boot by pressing <code>Ctrl-C</code> when prompted to get to the Boot menu: <ul style="list-style-type: none"> <li>If you have two controller modules in the chassis, fully seat the controller module you are servicing in the chassis. <p>The controller module boots up when fully seated.</p> </li> <li>If you have one controller module in the chassis, connect the power supplies, and then turn them on.</li> </ul> </li> <li>Select Boot to maintenance mode from the menu.</li> <li>Exit Maintenance mode by entering the following command: <code>halt</code> <p>After you issue the command, wait until the system stops at the LOADER prompt.</p> </li> <li>Rerun the system-level diagnostic test.</li> </ol>
---------------------------------------	---

## Step 6: Return the failed part to NetApp

Return the failed part to NetApp, as described in the RMA instructions shipped with the kit. See the [Part Return & Replacements](#) page for further information.

# Replace SSD Drive or HDD Drive - AFF C190

You can replace a failed drive nondisruptively while I/O is in progress. The procedure for replacing an SSD is meant for non-spinning drives and the procedure for replacing an HDD is meant for spinning drives.

When a drive fails, the platform logs a warning message to the system console indicating which drive has failed. In addition, both the fault LED on the operator display panel and the fault LED on the failed drive are illuminated.

## Before you begin

- Follow best practice and install the current version of the Disk Qualification Package (DQP) before replacing a drive.
- Identify the failed disk drive by running the `storage disk show -broken` command from the system console.

The failed drive appears in the list of failed drives. If it does not, you should wait, and then run the command again.



Depending on the drive type and capacity, it can take up to several hours for the drive to appear in the list of failed drives.

- Determine whether SED authentication is enabled.

How you replace the disk depends on how the disk drive is being used. If SED authentication is enabled, you must use the SED replacement instructions in the [ONTAP 9 NetApp Encryption Power Guide](#). These Instructions describe additional steps you must perform before and after replacing an SED.

- Make sure the replacement drive is supported by your platform. See the [NetApp Hardware Universe](#).
- Make sure all other components in the system are functioning properly; if not, you must contact technical support.

## About this task

Drive firmware is automatically updated (nondisruptively) on new drives that have non current firmware versions.

When replacing several disk drives, you must wait one minute between the removal of each failed disk drive and the insertion of the replacement disk drive to allow the storage system to recognize the existence of each new disk.

## Procedure

Replace the failed drive by selecting the option appropriate to the drives that your platform supports.

You may also choose to watch the [Replace failed drive video](#) that shows an overview of the embedded drive replacement procedure.

## Option 1: Replace SSD

1. If you want to manually assign drive ownership for the replacement drive, you need to disable automatic drive assignment replacement drive, if it is enabled



You manually assign drive ownership and then reenables automatic drive assignment later in this procedure.

- a. Verify whether automatic drive assignment is enabled: `storage disk option show`

You can enter the command on either controller module.

If automatic drive assignment is enabled, the output shows `on` in the “Auto Assign” column (for each controller module).

- b. If automatic drive assignment is enabled, disable it: `storage disk option modify -node node_name -autoassign off`

You must disable automatic drive assignment on both controller modules.

2. Properly ground yourself.
3. Physically identify the failed drive.

When a drive fails, the system logs a warning message to the system console indicating which drive failed. Additionally, the attention (amber) LED on the drive shelf operator display panel and the failed drive illuminate.



The activity (green) LED on a failed drive can be illuminated (solid), which indicates that the drive has power, but should not be blinking, which indicates I/O activity. A failed drive has no I/O activity.

4. Remove the failed drive:
  - a. Press the release button on the drive face to open the cam handle.
  - b. Slide the drive out of the shelf using the cam handle and supporting the drive with your other hand.

5. Wait a minimum of 70 seconds before inserting the replacement drive.

This allows the system to recognize that a drive was removed.

6. Insert the replacement drive:
  - a. With the cam handle in the open position, use both hands to insert the replacement drive.
  - b. Push until the drive stops.
  - c. Close the cam handle so that the drive is fully seated into the mid plane and the handle clicks into place.

Be sure to close the cam handle slowly so that it aligns correctly with the face of the drive.

7. Verify that the drive's activity (green) LED is illuminated.

When the drive's activity LED is solid, it means that the drive has power. When the drive's activity LED

is blinking, it means that the drive has power and I/O is in progress. If the drive firmware is automatically updating, the LED blinks.

8. If you are replacing another drive, repeat Steps 3 through 7.
9. If you disabled automatic drive assignment in Step 1, then, manually assign drive ownership and then reenable automatic drive assignment if needed.

- a. Display all unowned drives: `storage disk show -container-type unassigned`

You can enter the command on either controller module.

- b. Assign each drive: `storage disk assign -disk disk_name -owner owner_name`

You can enter the command on either controller module.

You can use the wildcard character to assign more than one drive at once.

- c. Reenable automatic drive assignment if needed: `storage disk option modify -node node_name -autoassign on`

You must reenale automatic drive assignment on both controller modules.

10. 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.

## Option 2: Replace HDD

1. If you want to manually assign drive ownership for the replacement drive, you need to disable automatic drive assignment replacement drive, if it is enabled



You manually assign drive ownership and then reenale automatic drive assignment later in this procedure.

- a. Verify whether automatic drive assignment is enabled: `storage disk option show`

You can enter the command on either controller module.

If automatic drive assignment is enabled, the output shows `on` in the “Auto Assign” column (for each controller module).

- b. If automatic drive assignment is enabled, disable it: `storage disk option modify -node node_name -autoassign off`

You must disable automatic drive assignment on both controller modules.

2. Properly ground yourself.
3. Gently remove the bezel from the front of the platform.
4. Identify the failed disk drive from the system console warning message and the illuminated fault LED on the disk drive
5. Press the release button on the disk drive face.

Depending on the storage system, the disk drives have the release button located at the top or on the left of the disk drive face.

For example, the following illustration shows a disk drive with the release button located on the top of the disk drive face:

The cam handle on the disk drive springs open partially and the disk drive releases from the midplane.

6. Pull the cam handle to its fully open position to unseat the disk drive from the midplane.
7. Slide out the disk drive slightly and allow the disk to safely spin down, which can take less than one minute, and then, using both hands, remove the disk drive from the disk shelf.
8. With the cam handle in the open position, insert the replacement disk drive into the drive bay, firmly pushing until the disk drive stops.



Wait a minimum of 10 seconds before inserting a new disk drive. This allows the system to recognize that a disk drive was removed.



If your platform drive bays are not fully loaded with drives, it is important to place the replacement drive into the same drive bay from which you removed the failed drive.



Use two hands when inserting the disk drive, but do not place hands on the disk drive boards that are exposed on the underside of the disk carrier.

9. Close the cam handle so that the disk drive is fully seated into the midplane and the handle clicks into place.

Be sure to close the cam handle slowly so that it aligns correctly with the face of the disk drive..

10. If you are replacing another disk drive, repeat Steps 4 through 9.
11. Reinstall the bezel.
12. If you disabled automatic drive assignment in Step 1, then, manually assign drive ownership and then reenables automatic drive assignment if needed.

- a. Display all unowned drives: `storage disk show -container-type unassigned`

You can enter the command on either controller module.

- b. Assign each drive: `storage disk assign -disk disk_name -owner owner_name`

You can enter the command on either controller module.

You can use the wildcard character to assign more than one drive at once.

- c. Reenable automatic drive assignment if needed: `storage disk option modify -node node_name -autoassign on`

You must reenables automatic drive assignment on both controller modules.

13. 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 NVMEM battery - AFF C190

To replace an NVMEM battery in the system, you must remove the controller module from the system, open it, replace the battery, and close and replace the controller module.

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

### Step 1: Shut down the impaired controller

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

#### About this task

- If you are using NetApp Storage Encryption, you must have reset the MSID using the instructions in the “Returning SEDs to unprotected mode” section of the *ONTAP 9 NetApp Encryption Power Guide*.

#### [ONTAP 9 NetApp Encryption Power Guide](#)

- If you have a SAN system, you must have checked event messages (event log show) for impaired controller SCSI blade.

Each SCSI-blade process should be in quorum with the other nodes in the cluster. Any issues must be resolved before you proceed with the replacement.

- 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 controller shows false for eligibility and health, you must correct the issue before shutting down the impaired controller; see the [Administration overview with the CLI](#).
- If you have a MetroCluster configuration, you must have confirmed that the MetroCluster Configuration State is configured and that the nodes are in an enabled and normal state (`metrocluster node show`).

#### 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 controller: `storage failover modify -node local -auto-giveback false`
3. Take the impaired controller to the LOADER prompt:



If the impaired controller is displaying...	Then...
The LOADER prompt	Go to Remove controller module.
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 controller from the healthy controller:</p> <pre>storage failover takeover -ofnode impaired_node_name</pre> <p>When the impaired controller shows Waiting for giveback..., press Ctrl-C, and then respond <i>y</i>.</p>

## Step 2: Remove controller module

To access components inside the controller module, you must first remove the controller module from the system, and then remove the cover on the controller module.

1. If you are not already grounded, properly ground yourself.
2. 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.

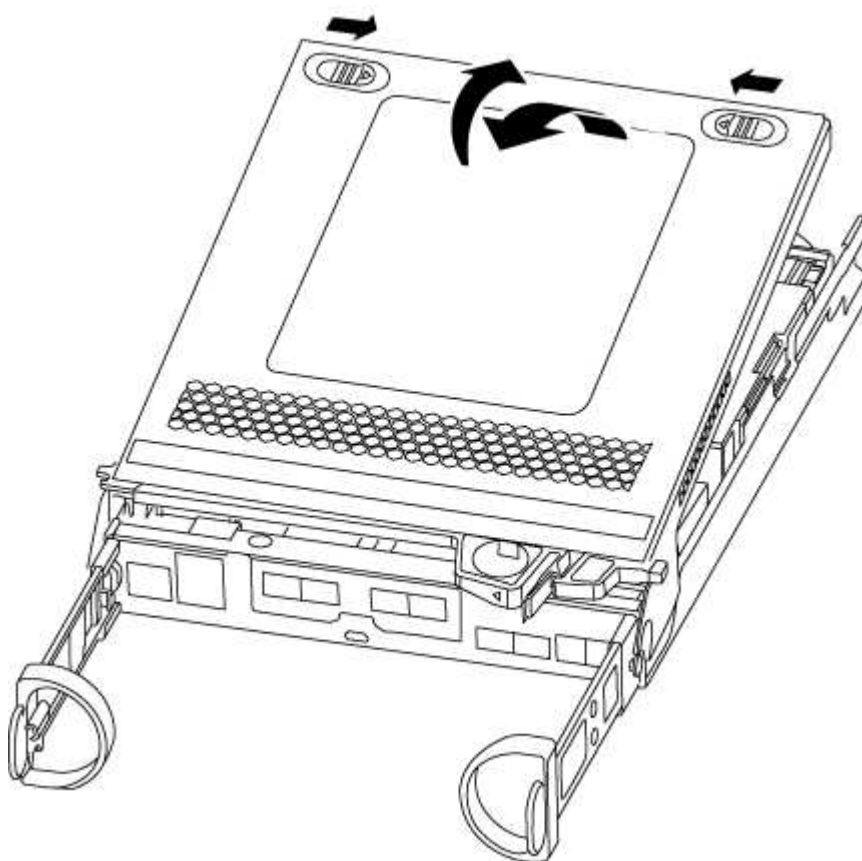
3. Remove and set aside the cable management devices from the left and right sides of the controller module.



4. Squeeze the latch on the cam handle until it releases, open the cam handle fully to release the controller module from the midplane, and then, using two hands, pull the controller module out of the chassis.



5. Turn the controller module over and place it on a flat, stable surface.
6. Open the cover by sliding in the blue tabs to release the cover, and then swing the cover up and open.



### Step 3: Replace the NVMEM battery

To replace the NVMEM battery in your system, you must remove the failed NVMEM battery from the system and replace it with a new NVMEM battery.

1. Check the NVMEM LED:

- If your system is in an HA configuration, go to the next step.
- If your system is in a stand-alone configuration, cleanly shut down the controller module, and then check the NVRAM LED identified by the NV icon.



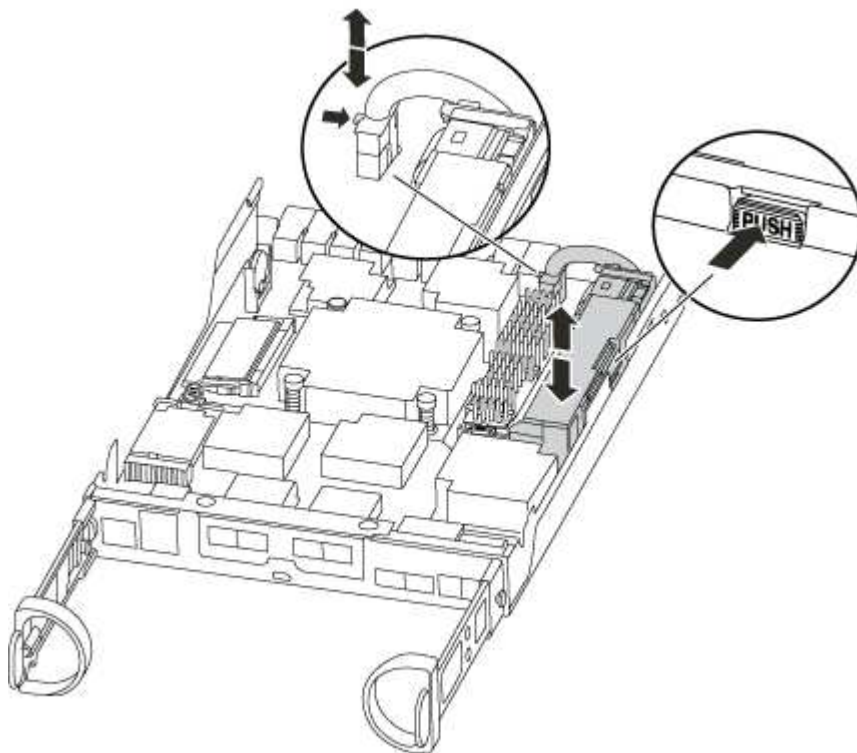
The NVRAM LED blinks while destaging contents to the flash memory when you halt the system. After the destage is complete, the LED turns off.



- If power is lost without a clean shutdown, the NVMEM LED flashes until the destage is complete, and then the LED turns off.
- If the LED is on and power is on, unwritten data is stored on NVMEM.

This typically occurs during an uncontrolled shutdown after ONTAP has successfully booted.

2. Locate the NVMEM battery in the controller module.



3. 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.
4. Remove the battery from the controller module and set it aside.
5. Remove the replacement battery from its package.
6. Loop the battery cable around the cable channel on the side of the battery holder.

7. Position the battery pack by aligning the battery holder key ribs to the “V” notches on the sheet metal side wall.
8. Slide the battery pack down along the sheet metal side wall until the support tabs on the side wall hook into the slots on the battery pack, and the battery pack latch engages and clicks into the opening on the side wall.
9. Plug the battery plug back into the controller module.

## Step 4: Reinstall the controller module

After you replace components in the controller module, you must reinstall it into the chassis.

1. If you have not already done so, replace the cover on the controller module.
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. Complete the reinstallation of the controller module. The controller module begins to boot as soon as it is fully seated in the chassis. Be prepared to interrupt the boot process.
  - a. With the cam handle in the open position, firmly push the controller module in until it meets the midplane and is fully seated, and then close the cam handle to the locked position.



Do not use excessive force when sliding the controller module into the chassis to avoid damaging the connectors.

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

- b. If you have not already done so, reinstall the cable management device.
  - c. Bind the cables to the cable management device with the hook and loop strap.
  - d. When you see the message `Press Ctrl-C for Boot Menu`, press **Ctrl-C** to interrupt the boot process.



If you miss the prompt and the controller module boots to ONTAP, enter **halt**, and then at the LOADER prompt enter **boot\_ontap**, press **Ctrl-C** when prompted, and then boot to Maintenance mode.

- e. Select the option to boot to Maintenance mode from the displayed menu.

## Step 5: Run system-level diagnostics

After installing a new NVMEM battery, you should run diagnostics.

Your system must be at the LOADER prompt to start System Level Diagnostics.

All commands in the diagnostic procedures are issued from the controller where the component is being

replaced.

1. If the controller to be serviced is not at the LOADER prompt, perform the following steps:
  - a. Select the Maintenance mode option from the displayed menu.
  - b. After the controller boots to Maintenance mode, halt the controller: `halt`

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



During the boot process, you can safely respond `y` to prompts:

- A prompt warning that when entering Maintenance mode in an HA configuration, you must ensure that the healthy controller remains down.
2. At the LOADER prompt, access the special drivers specifically designed for system-level diagnostics to function properly: `boot_diags`


During the boot process, you can safely respond `y` to the prompts until the Maintenance mode prompt (`*>`) appears.

3. Run diagnostics on the NVMEM memory: `sldiag device run -dev nvmem`
4. Verify that no hardware problems resulted from the replacement of the NVMEM battery: `sldiag device status -dev nvmem -long -state failed`

System-level diagnostics returns you to the prompt if there are no test failures, or lists the full status of failures resulting from testing the component.

5. Proceed based on the result of the preceding step:

If the system-level diagnostics tests...	Then...
Were completed without any failures	<div>a. Clear the status logs: <code>sldiag device clearstatus</code></div> <div>b. Verify that the log was cleared: <code>sldiag device status</code></div> <div>The following default response is displayed:</div> <div>SLDIAG: No log messages are present.</div> <div>c. Exit Maintenance mode: <code>halt</code></div> <div>The controller displays the LOADER prompt.</div> <div>d. Boot the controller from the LOADER prompt: <code>bye</code></div> <div>e. Return the controller to normal operation:</div>

If your controller is in...	Then...
An HA pair	<p>Perform a give back: <code>storage failover giveback -ofnode replacement_node_name</code></p> <div data-bbox="654 279 711 338">  </div> <p>If you disabled automatic giveback, re-enable it with the storage failover modify command.</p>
A stand-alone configuration	<p>Proceed to the next step.</p> <p>No action is required.</p> <p>You have completed system-level diagnostics.</p>
Resulted in some test failures	<p>Determine the cause of the problem:</p> <ol style="list-style-type: none"> <li>Exit Maintenance mode: <code>halt</code></li> </ol> <p>After you issue the command, wait until the system stops at the LOADER prompt.</p> <ol style="list-style-type: none"> <li>Turn off or leave on the power supplies, depending on how many controller modules are in the chassis: <ul style="list-style-type: none"> <li>If you have two controller modules in the chassis, leave the power supplies turned on to provide power to the other controller module.</li> <li>If you have one controller module in the chassis, turn off the power supplies and unplug them from the power sources.</li> </ul> </li> <li>Verify that you have observed all the considerations identified for running system-level diagnostics, that cables are securely connected, and that hardware components are properly installed in the storage system.</li> <li>Boot the controller module you are servicing, interrupting the boot by pressing <code>Ctrl-C</code> when prompted to get to the Boot menu: <ul style="list-style-type: none"> <li>If you have two controller modules in the chassis, fully seat the controller module you are servicing in the chassis.</li> </ul> <p>The controller module boots up when fully seated.</p> <ul style="list-style-type: none"> <li>If you have one controller module in the chassis, connect the power supplies, and then turn them on.</li> </ul> </li> <li>Select Boot to maintenance mode from the menu.</li> <li>Exit Maintenance mode by entering the following command: <code>halt</code></li> </ol> <p>After you issue the command, wait until the system stops at the LOADER prompt.</p> <ol style="list-style-type: none"> <li>Rerun the system-level diagnostic test.</li> </ol>

## Step 6: Return the failed part to NetApp

Return the failed part to NetApp, as described in the RMA instructions shipped with the kit. See the [Part Return & Replacements](#) page for further information.

## Swap out a power supply - AFF C190

Swapping out a power supply involves turning off, disconnecting, and removing the old power supply and installing, connecting, and turning on the replacement power supply.

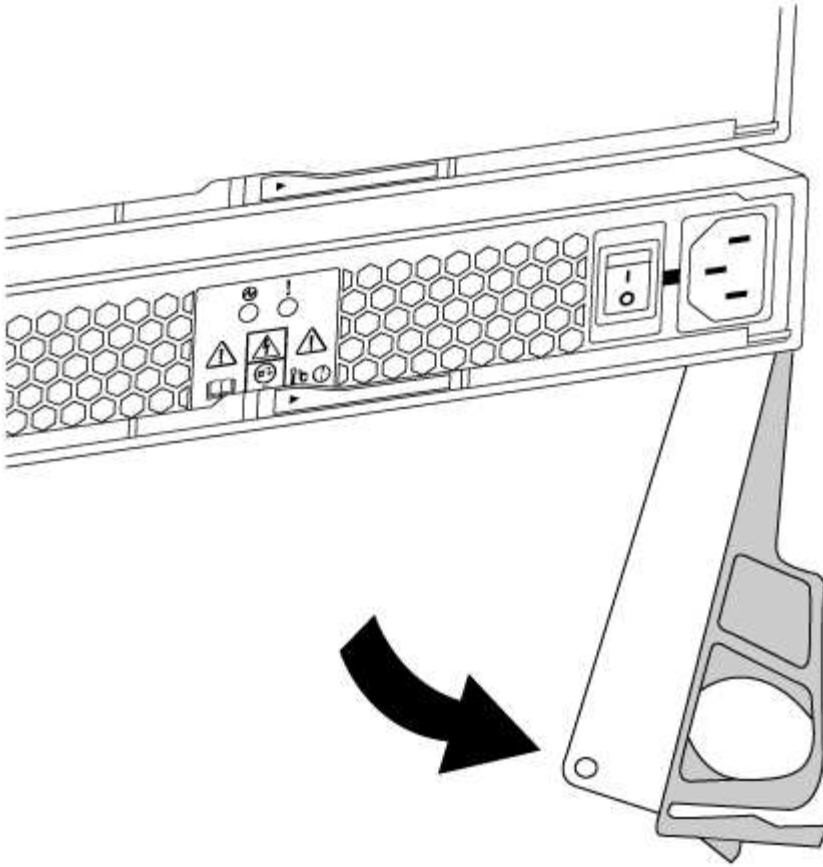
All other components in the system must be functioning properly; if not, you must contact technical support.

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



Cooling is integrated with the power supply, so you must replace the power supply within two minutes of removal to prevent overheating due to reduced airflow. Because the chassis provides a shared cooling configuration for the two HA nodes, a delay longer than two minutes will shut down all controller modules in the chassis. If both controller modules do shut down, make sure that both power supplies are inserted, turn both off for 30 seconds, and then turn both on.

- Power supplies are auto-ranging.
  1. Identify the power supply you want to replace, based on console error messages or through the LEDs on the power supplies.
  2. If you are not already grounded, properly ground yourself.
  3. Turn off the power supply and disconnect the power cables:
    - a. Turn off the power switch on the power supply.
    - b. Open the power cable retainer, and then unplug the power cable from the power supply.
    - c. Unplug the power cable from the power source.
  4. Squeeze the latch on the power supply cam handle, and then open the cam handle to fully release the power supply from the mid plane.



5. Use the cam handle to slide the power supply out of the system.



When removing a power supply, always use two hands to support its weight.

6. Make sure that the on/off switch of the new power supply is in the Off position.
7. Using both hands, support and align the edges of the power supply with the opening in the system chassis, and then gently push the power supply into the chassis using the cam handle.

The power supplies are keyed and can only be installed one way.



Do not use excessive force when sliding the power supply into the system. You can damage the connector.

8. Close the cam handle so that the latch clicks into the locked position and the power supply is fully seated.
9. 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.

1. Turn on the power to the new power supply, and then verify the operation of the power supply activity LEDs.

The power supply LEDs are lit when the power supply comes online.



2. Return the failed part to NetApp, as described in the RMA instructions shipped with the kit. See the [Part Return & Replacements](#) page for further information.

## Replace the real-time clock battery

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.

### Step 1: Shut down the impaired controller

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

#### About this task

- If you are using NetApp Storage Encryption, you must have reset the MSID using the instructions in the "Returning SEDs to unprotected mode" section of the *ONTAP 9 NetApp Encryption Power Guide*.

[ONTAP 9 NetApp Encryption Power Guide](#)

- If you have a SAN system, you must have checked event messages (event log show) for impaired controller SCSI blade.

Each SCSI-blade process should be in quorum with the other nodes in the cluster. Any issues must be resolved before you proceed with the replacement.

- 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 controller shows false for eligibility and health, you must correct the issue before shutting down the impaired controller; see the [Administration overview with the CLI](#).
- If you have a MetroCluster configuration, you must have confirmed that the MetroCluster Configuration State is configured and that the nodes are in an enabled and normal state (`metrocluster node show`).

#### 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 controller: `storage failover modify -node local -auto-giveback false`
3. Take the impaired controller to the LOADER prompt:

If the impaired controller is displaying...	Then...
The LOADER prompt	Go to Remove controller module.
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 controller from the healthy controller:</p> <pre>storage failover takeover -ofnode impaired_node_name</pre> <p>When the impaired controller shows Waiting for giveback..., press Ctrl-C, and then respond <i>y</i>.</p>

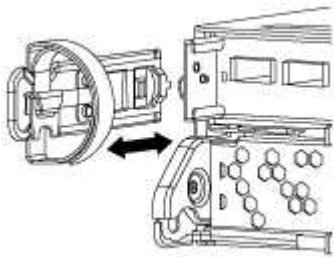
## Step 2: Remove controller module

To access components inside the controller module, you must first remove the controller module from the system, and then remove the cover on the controller module.

1. If you are not already grounded, properly ground yourself.
2. 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.

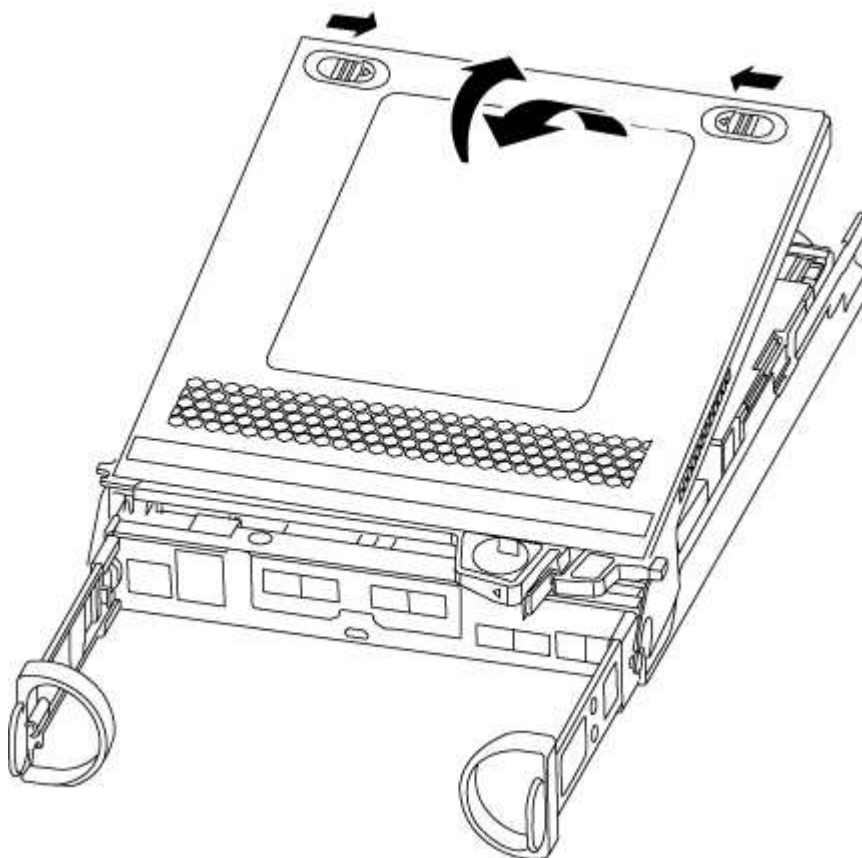
3. Remove and set aside the cable management devices from the left and right sides of the controller module.



4. Squeeze the latch on the cam handle until it releases, open the cam handle fully to release the controller module from the midplane, and then, using two hands, pull the controller module out of the chassis.



5. Turn the controller module over and place it on a flat, stable surface.
6. Open the cover by sliding in the blue tabs to release the cover, and then swing the cover up and open.



### Step 3: Replace the RTC battery

To replace the RTC battery, you need to locate it inside the controller module, and then follow the specific sequence of steps.

1. Locate the RTC battery.
2. 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.

3. Remove the replacement battery from the antistatic shipping bag.
4. Locate the empty battery holder in the controller module.
5. Note the polarity of the RTC battery, and then insert it into the holder by tilting the battery at an angle and pushing down.
6. Visually inspect the battery to make sure that it is completely installed into the holder and that the polarity is correct.

## Step 4: Reinstall the controller module and set 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. The controller module begins to boot as soon as it is fully seated in the chassis.
  - a. With the cam handle in the open position, firmly push the controller module in until it meets the midplane and is fully seated, and then close the cam handle to the locked position.



Do not use excessive force when sliding the controller module into the chassis to avoid damaging the connectors.

- b. If you have not already done so, reinstall the cable management device.
  - c. Bind the cables to the cable management device with the hook and loop strap.
  - d. 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 controller with the `show date` command.

- b. At the LOADER prompt on the target controller, 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 controller.
7. At the LOADER prompt, enter `bye` to reinitialize the PCIe cards and other components and let the controller reboot.
8. Return the controller 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`

## Step 5: Complete the replacement process

Return the failed part to NetApp, as described in the RMA instructions shipped with the kit. See the [Part Return & Replacements](#) page for further information.

## Copyright Information

Copyright © 2022 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.