IBM System Storage N series

Universal SAS and ACP Cabling Guide

GC27-3919-02

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Preface

Supported features

IBM System Storage N series storage systems are driven by NetApp Data ONTAP software. Some features described in the product software documentation are neither offered nor supported by IBM. Please contact your local IBM representative or reseller for further details.

Information about supported features can also be found on the N series support website (accessed and navigated as described in Websites).

Websites

IBM maintains pages on the World Wide Web where you can get the latest technical information and download device drivers and updates. The following web pages provide N series information:

- A listing of currently available N series products and features can be found at the following web page:

  www.ibm.com/storage/nas/
- The IBM System Storage N series support website requires users to register in order to obtain access to N series support content on the web. To understand how the N series support web content is organized and navigated, and to access the N series support website, refer to the following publicly accessible web page:

  www.ibm.com/storage/support/nseries/

  This web page also provides links to AutoSupport information as well as other important N series product resources.
- IBM System Storage N series products attach to a variety of servers and operating systems. To determine the latest supported attachments, go to the IBM N series interoperability matrix at the following web page:

  www.ibm.com/systems/storage/network/interophome.html
- For the latest N series hardware product documentation, including planning, installation and setup, and hardware monitoring, service and diagnostics, see the IBM N series Information Center at the following web page:

  publib.boulder.ibm.com/infocenter/nasinfo/nseries/index.jsp

Getting information, help, and service

If you need help, service, or technical assistance or just want more information about IBM products, you will find a wide variety of sources available from IBM to assist you. This section contains information about where to go for additional information about IBM and IBM products, what to do if you experience a problem with your IBM N series product, and whom to call for service, if it is necessary.

Before you call

Before you call, make sure you have taken these steps to try to solve the problem yourself:

- Check all cables to make sure they are connected.
- Check the power switches to make sure the system is turned on.
- Use the troubleshooting information in your system documentation and use the diagnostic tools that come with your system.
- Refer to the N series support website (accessed and navigated as described in Websites) for information on known problems and limitations.

Using the documentation

The latest versions of N series software documentation, including Data ONTAP and other software products, are available on the N series support website (accessed and navigated as described in Websites).

Current N series hardware product documentation is shipped with your hardware product in printed documents or as PDF files on a documentation CD. For the latest N series hardware product documentation PDFs, go to the N series support website.

Hardware documentation, including planning, installation and setup, and hardware monitoring, service, and diagnostics, is also provided in an IBM N series Information Center at the following web page:

publib.boulder.ibm.com/infocenter/nasinfo/nseries/index.jsp

Hardware service and support

You can receive hardware service through IBM Integrated Technology Services. Visit the following web page for support telephone numbers:

www.ibm.com/planetwide/

Firmware updates

IBM N series product firmware is embedded in Data ONTAP. As with all devices, ensure that you run the latest level of firmware. Any firmware updates are posted to the N series support website (accessed and navigated as described in Websites).

Note: If you do not see new firmware updates on the N series support website, you are running the latest level of firmware.

Verify that the latest level of firmware is installed on your machine before contacting IBM for technical support.

How to send your comments

Your feedback helps us to provide the most accurate and high-quality information. If you have comments or suggestions for improving this document, please send them by email to starpubs@us.ibm.com.

Be sure to include the following:

- Exact publication title
- Publication form number (for example, GC26-1234-02)
- Page, table, or illustration numbers
- A detailed description of any information that should be changed

SAS cabling for new storage systems

For new storage system installations, you must understand the cabling rules before cabling the SAS connections for the disk shelves.

Note: Cabling information for hot-adding or replacing SAS disk shelves is in the *Installation and Service Guide* for your disk shelf model on the N series support website (accessed and navigated as described in Websites) at www.ibm.com/storage/support/nseries/.

SAS cabling rules

You can cable SAS disk shelves to storage systems that have SAS HBAs and/or onboard SAS ports by applying the SAS cabling rules.

General SAS cabling rules

You need to know the general SAS cabling rules governing supported configurations, cables, and SAS port connections on the disk shelves.

- All HA pair configurations must use multipath HA, with the following exceptions:
  - N3400 systems use single-path HA.
  - N3150, N3220, and N3240 system models with no external SAS storage can use single-path HA, which requires no external cabling.

    However, the recommended configuration is to enable multipath HA for the internal disks by connecting the SAS ports of one controller module to the SAS ports of the partner.

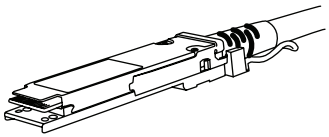
    Note: When a filer is ordered without external shelves, the two QSFP SAS cables and an ACP cable, required to enable multipath HA configuration, can be ordered as FC 9563. However, if the filer is ordered with external shelves, the cables will come with external shelves instead.

    Note: A multipath HA configuration having external shelves requires two ports on each controller for each stack of disk shelves. Even if the stack consists of one disk shelf, two ports on each controller are required.
- All single-controller configurations must use dual-path, with the following exceptions:
  - N3400 systems use single-path.
  - N3150, N3220, and N3240 system models have the internal disks cabled as single-path, but the system can use either single-path or dual-path connectivity to the external shelves; both are supported.

Dual-path provides greater resiliency, but when dual-path is used, Data ONTAP 8.1.x issues occasional warnings to the console because mixed paths are detected. To avoid the warnings, single-path connections to the external SAS storage are a supported option in these configurations.

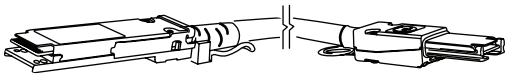
- Cables used for SAS connections include the following:
  - QSFP to QSFP SAS cables are used to connect disk shelves together and to connect disk shelves to the SAS ports on the controller.

    The following illustration shows the QSFP cable connector:



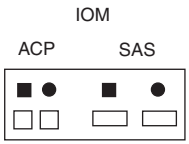
  - QSFP to mini-SAS cables are used for N3600 configurations only, and connect disk shelves to the dual-port mini-SAS HBAs on the controller.

    The following illustration shows the QSFP to mini-SAS cable connectors:



- SAS ports on the disk shelf are designated by a square symbol or a circle symbol.

  Square ports are always cabled to circle ports, and circle ports are always cabled to square ports. Never cable square ports to square ports or circle ports to circle ports. The following illustration shows square and circle port labeling on an IOM.

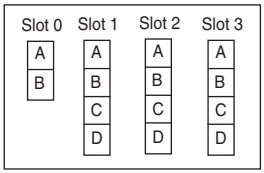


Onboard SAS port rules

Storage systems that have controllers with onboard SAS ports must follow a specific port identification rule.

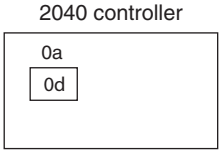
For all systems except N3400, an onboard HBA is defined as occupying PCI slot 0, with each port named with sequentially increasing letters (0a, 0b, 0c, and so on). This is to ensure that the SAS cabling rules apply to all SAS HBAs on a controller, whether in a physical PCI slot (slot 1-N) or on board the base controller.

The following example shows a controller with one onboard SAS HBA in slot 0 and three SAS HBAs in physical PCI slots 1, 2, and 3.



For N3400 systems, the onboard SAS port labeled 0d should be treated as if it were slot 0 port a. Treating the port as 0a enables you to apply all the SAS cabling rules. (Data ONTAP continues to recognize this port as 0d.)

The following example shows the N3400 exception:



Shelf-to-shelf connection rules

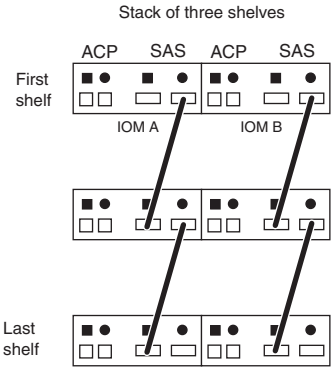
When you have more than one disk shelf in a stack of disk shelves, the shelves in the stack must be connected to each other (daisy-chained).

The disk shelves are daisy-chained in the following way:

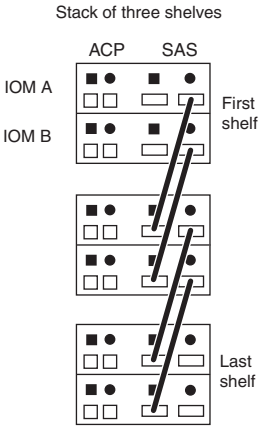
- IOM A circle port is connected to the next IOM A square port.
- IOM B circle port is connected to the next IOM B square port.

Note: Square ports are always cabled to circle ports, and circle ports are always cabled to square ports. Never cable square ports to square ports or circle ports to circle ports.

The following illustration shows a daisy-chained stack of disk shelves with the IOMs arranged side-by-side, similar to how a EXN3500 disk shelf is oriented.



The following illustration shows a daisy-chained stack of disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.



Controller-to-shelf-connection rules

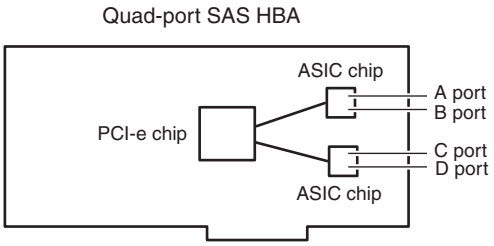
Each controller connects to each stack of disk shelves in the system through the controller SAS ports. These ports can be A, B, C, and D, and can be on a SAS HBA in a physical PCI slot (slot 1-N) or on board the base controller.

Controllers connect to the first and last shelves in a stack. Controller ports A and C connect to the first shelf in a stack and controller ports B and D connect to the last shelf in a stack.

For quad-port SAS HBAs, the controller-to-shelf connection rules ensure resiliency for the storage system based on the ASIC chip design. Ports A and B are on one ASIC chip, and ports C and D are on a second ASIC chip. By using ports A and C to connect to the first shelf in each stack, and using ports

B and D to connect to the last shelf in each stack, the controllers maintain connectivity to the disk shelves if an ASIC chip fails.

The following illustration shows a quad-port SAS HBA with the two ASIC chips and their designated ports:

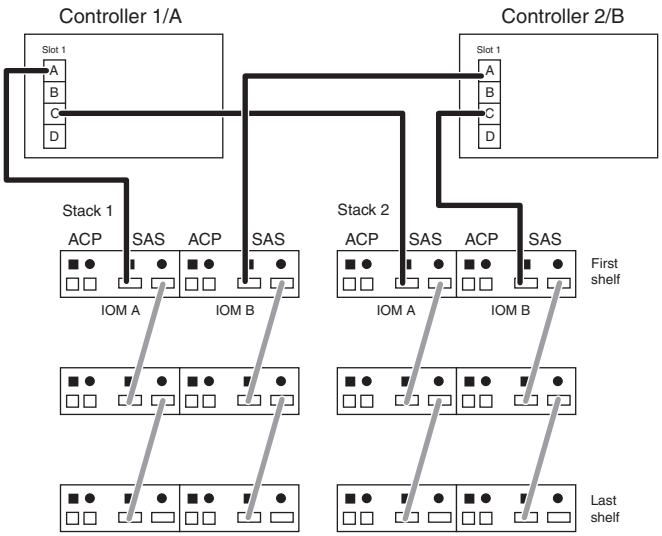


A and C port connections

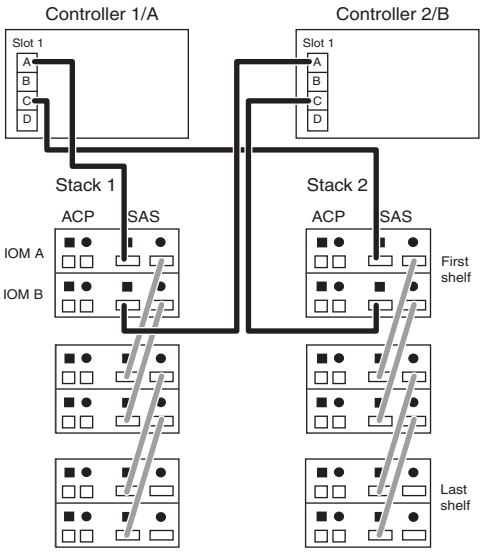
- Controller SAS ports A and C are connected to the first disk shelf square port in each stack of disk shelves.

  The A and C ports on controller 1/A connect to IOM A. The A and C ports on controller 2/B connect to IOM B.

  For example, the following illustration shows how controller ports A and C are connected for disk shelves that have the IOMs arranged side-by-side, similar to how a EXN3500 disk shelf is oriented:

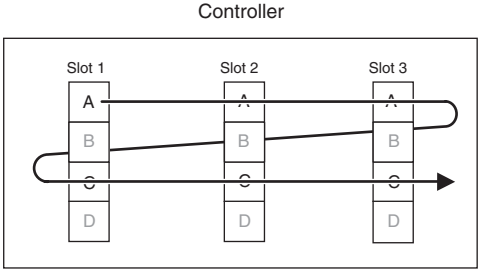


  For example, the following illustration shows how controller ports A and C are connected for disk shelves that have the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented:

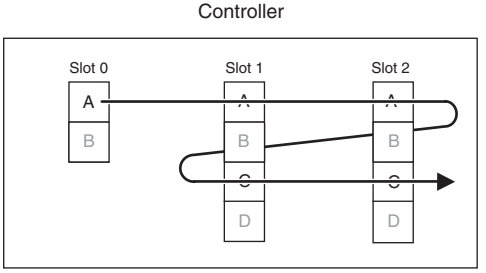


- Controller SAS ports A and C are connected to the disk shelf stacks in sequential order of the PCI slots (slot 0, slot 1, slot 2, and so on) on the controller.

  For example, a controller with slots 1, 2, and 3 occupied with quad-port SAS HBAs is cabled in order of slots and ports 1a, 2a, 3a, 1c, 2c, 3c:



  For example, a controller with slots 0, 1, and 2 occupied (slot 0 being an onboard port and slot 1 and 2 being quad-port SAS HBAs) is cabled in order of slots and ports 0a, 1a, 2a, 1c, 2c:

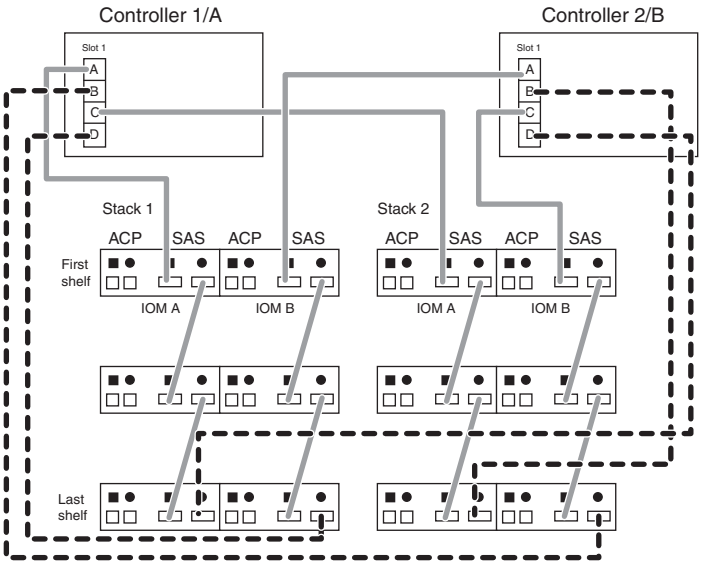


B and D port connections

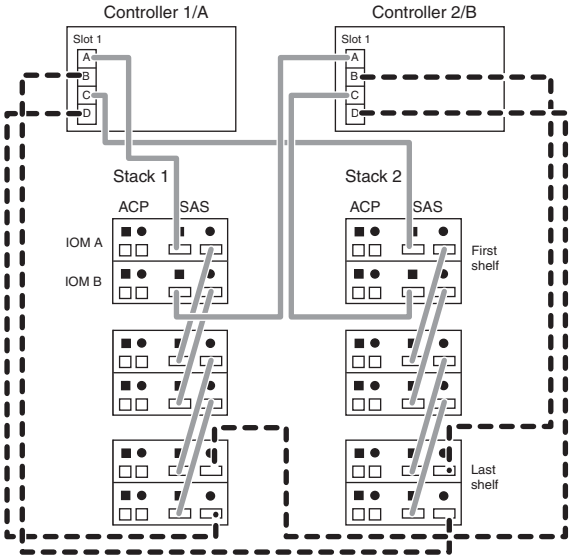
- Controller SAS ports B and D are connected to the last disk shelf circle port in each stack of disk shelves.

  The B and D ports on controller 1/A connect to IOM B. The B and D ports on controller 2/B connect to IOM A.

  For example, the following illustration shows how controller ports B and D are connected for disk shelves that have the IOMs arranged side-by-side, similar to how a EXN3500 disk shelf is oriented:



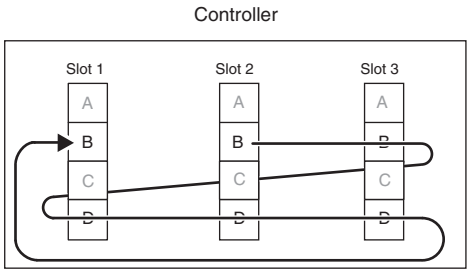
  For example, the following illustration shows how controller ports B and D are connected for disk shelves that have the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented:



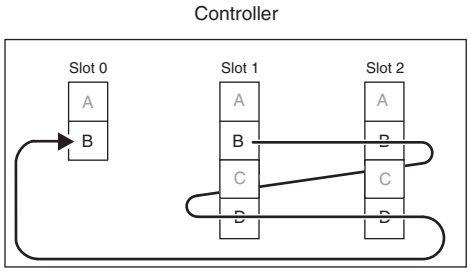
- Controller SAS ports B and D are connected to the disk shelf stacks by offsetting the order of the PCI slots by one so that the first port on the first slot is cabled last.

  The cabling offset ensures system resiliency.

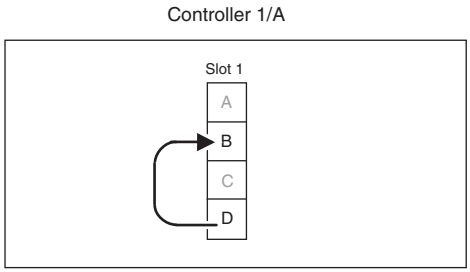
  For example, a controller with three quad-port SAS HBAs in slots 1, 2, and 3 is cabled in order of slots and ports 2b, 3b, 1d, 2d, 3d, 1b:



  For example, a controller with slots 0, 1, and 2 occupied (slot 0 being an onboard port and slot 1 and 2 being quad-port SAS HBAs) is cabled in order of slots and ports 1b, 2b, 1d, 2d, 0b:



A controller with one quad-port HBA is cabled in order of port 1d and then 1b:



Stack cabling sequence

Controllers are cabled to the stacks in sequence of the stacks, such as stack 1, stack 2, stack 3, and so on.

N3400 configurations

For single-controller N3400 configurations, the controller is in Slot B (the bottom slot); therefore, the controller is cabled as if it were controller 2/B. If a second controller is added to make this an HA pair configuration, the new controller is cabled as controller 1/A.

Controller-to-controller rule (N3150, N3220, and N3240 system models only)

On N3150, N3220, and N3240 system models in HA pairs with no external storage, external cables should connect the SAS ports on the two controller modules to enable multipath HA for the internal disks.

Note: When a filer is ordered without external shelves, the two QSFP SAS cables and an ACP cable, required to enable multipath HA configuration, can be ordered as FC 9563. However, if the filer is ordered with external shelves, the cables will come with external shelves instead.

Cabling SAS connections

Cabling the SAS connections involves completing the SAS cabling worksheet to identify the SAS ports that need to be cabled to the disk shelves, and applying the worksheet when following the cabling procedure.

Completing the SAS cabling worksheet

By using the SAS cabling worksheet to list the slots and SAS ports for each controller, you can simplify the cabling task.

About this task

You can reference the appropriate *Sample SAS cabling worksheet* when recording your information.

Procedure

1. Print out a copy of the SAS cabling worksheet template to record your information.
2. Read the cabling worksheet rules and be sure to understand them.
3. Make a list of all SAS A ports and then all SAS C ports on each controller in your configuration. A controller with three quad-port SAS HBAs is listed as 1a, 2a, 3a, 1c, 2c, 3c.

   A controller with one quad-port SAS HBA is listed as 1a, 1c.

   A N3600 with one dual-port SAS HBA is listed as 1a.

   A N3400 is listed as 0a.

   A N6200 series dual enclosure (with two onboard SAS ports and one quad-port) is listed as 0a, 1a, 1c.
4. If you have a N3400 go to Step 5; otherwise, list the remaining ports by completing the following substeps:
   a. Make a list of all SAS B ports and then all SAS D ports on each controller in your configuration (in the grayed-out cells of the worksheet). A controller with three quad-port SAS HBAs is listed as 1b, 2b, 3b, 1d, 2d, 3d.

      A controller with one quad-port SAS HBA is listed as 1b, 1d.

      A N3600 with one dual-port SAS HBA is listed as 1b.

      A N6200 series dual enclosure (with two onboard SAS ports and one quad-port) is listed as 0b, 1b, 1d.
   b. Rewrite the list (on the line below the grayed-out cells) so that the first port in your list is moved to the end of your list: 

      Offsetting the list by one (so that the cabling begins on the second

slot/HBA) ensures system resiliency when cabling your storage system. A controller with three quad-port SAS HBAs is listed as 2b, 3b, 1d, 2d, 3d, 1b.

A controller with one quad-port SAS HBA is listed as 1d, 1b.

A N3600 with one dual-port SAS HBA is listed as 1b.

A N6200 series dual enclosure (with two onboard SAS ports and one quad-port) is listed as 1b, 1d, 0b.

c. Cross out the information in the grayed-out cells. You don't need this information anymore. You will use the offset list below the grayed-out cells to cable your system.

5. Go to *Cabling SAS ports* to cable your storage system.

SAS cabling worksheet rules and template

By understanding the rules for filling out the worksheet template, you can record your controller SAS slot and port information correctly.

Use the following rules when recording your information in the *SAS cabling worksheet*.

Samples of a completed worksheets are shown in the *Sample cabling worksheet* sections.

- Ports are listed in sequence of the slot numbers to which they belong and include the slot number.

  For example, onboard SAS ports belong to slot 0. SAS port A of slot 0 is written as 0a. A single quad-port SAS HBA in a physical PCI slot belongs to slot 1. Additional quad-port SAS HBAs belong to slot 2, slot 3, and so on. SAS port A of slot 1 is written as 1a. SAS port A of slot 2 is written as 2a, and so on.
- If your controller has onboard ports, they are always listed first (since they belong to slot 0) and then followed by the quad-port SAS HBA slots (slot 1, 2, and so on).
- If you have an HA pair , the port list is the same for controller 1/A and controller 2/B.
- Only one controller slot and SAS port is listed in a table cell under a stack number.
- Controller slots and SAS ports are listed in sequence of the stack numbers.

  Note: This worksheet provides space for eight stacks.

  Do not skip any table cells.
- Only fill in controller slots and SAS ports for the number of stacks you have in your configuration.

  For example, if you have only four stacks of disk shelves in your configuration, the columns for stack numbers 5 through 8 remain blank.

- The controller SAS ports B and D rows show two lines for controller 1/A and controller 2/B.

  Use the first line (grayed-out) for recording the port list prior to offsetting the list by one. Use the second line for recording the list with the ports offset by one.
- The worksheet has you connect square ports first, but you can cable circle ports first. However, square ports must only be connected to circle ports and circle ports must only be connected to square ports.
- If your configuration has a single shelf stack, the references to the first shelf and last shelf apply to the one shelf.
- If your configuration has a N3400 with a single controller, list the slot and port information on the Controller 2/B line.

  Single controller N3400 systems have the controller in the bottom (2/B) slot of the chassis.

Controller SAS ports	Controller	Controller SAS ports and stack cabling sequence								Cable to disk shelf IOM
		Stack number (1-8)								
		1	2	3	4	5	6	7	8	
A and C	Controller 1/A									To *first* shelf IOM A ■
	Controller 2/B									To *first* shelf IOM B ■
B and D	Controller 1/A									To *last* shelf IOM B ●
	Controller 2/B									To *last* shelf IOM A ●

Sample SAS cabling worksheet for a N6200 series

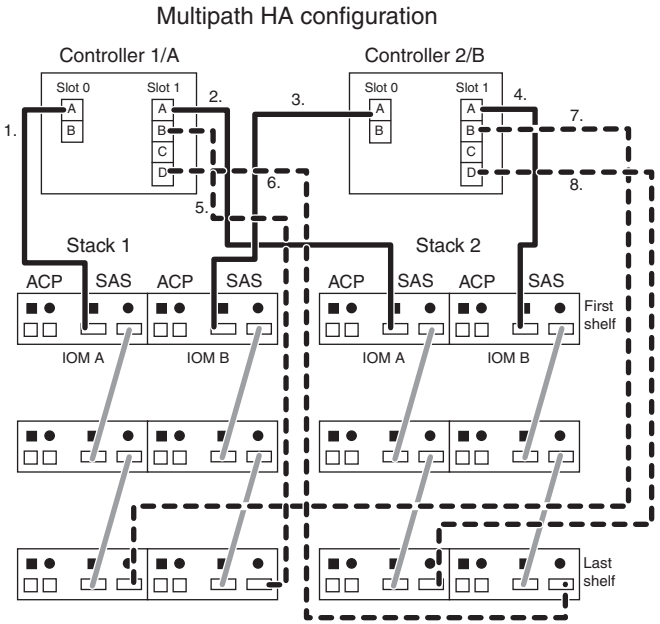
You can reference this sample SAS cabling worksheet when filling in your own worksheet. The sample worksheet shows a N6200 series dual enclosure configuration (two onboard SAS ports and one quad-port SAS HBA) with two stacks of disk shelves.

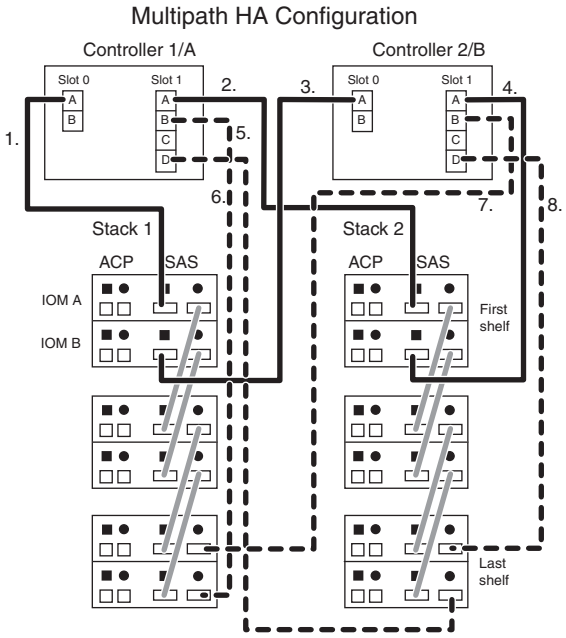
Note: The slots and SAS ports shown in gray text for stack 3 are unused because of the limited number of stacks in this configuration. If there were three stacks, all three slots and SAS ports listed would be used.

Note: The two rows which are grayed-out and crossed-out are the original port lists that were made prior to offsetting the lists by one. The lines below that show the ports offset by one and would be used to cable the system.

Controller SAS ports	Controller	Controller SAS ports and stack cabling sequence								Cable to disk shelf IOM
		Stack number (1-8)								
		1	2	3	4	5	6	7	8	
A and C	Controller 1/A	0a	1a	1c						To *first* shelf IOM A ■
	Controller 2/B	0a	1a	1c						To *first* shelf IOM B ■
B and D	Controller 1/A	~~0b~~	~~1b~~	~~1c~~						To *last* shelf IOM B ●
		1b	1d	0b						
	Controller 2/B	~~0b~~	~~1b~~	~~1c~~						To *last* shelf IOM A ●
		1b	1d	0b						

The following illustrates a cabled N6200 series using the information in the sample worksheet. Two examples are shown. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.





Sample SAS cabling worksheet for an HA pair (non N6200 series, N3150, N3220, and N3240, or N3400)

You can reference this sample SAS cabling worksheet and illustration when filling in your own worksheet. The sample worksheet shows an HA pair configuration with three quad-port SAS HBAs and three stacks of disk shelves.

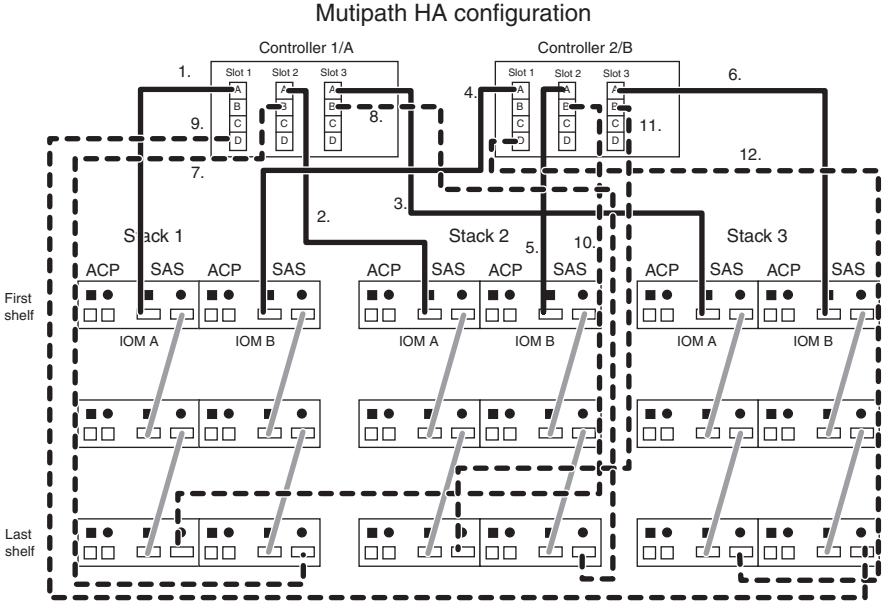
Note: The slots and SAS ports shown in gray text for stacks 4, 5, and 6 are unused because of the limited number of stacks in this configuration. If there were six stacks, all six slots and SAS ports listed would be used.

Note: The two rows which are grayed-out and crossed-out are the original port lists made prior to offsetting the lists by one. The lines below that show the ports offset by one and would be used to cable the system.

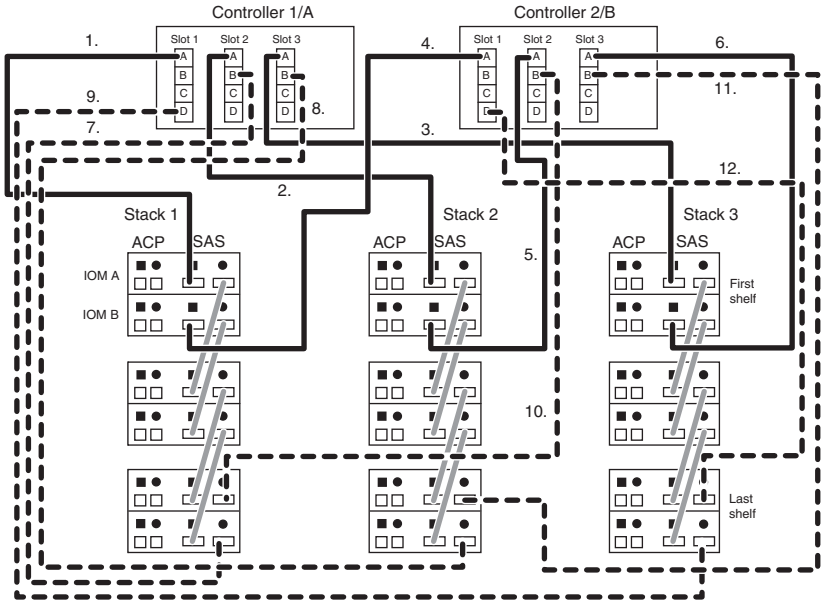
Controller SAS ports	Controller	Controller SAS ports and stack cabling sequence								Cable to disk shelf IOM
		Stack number (1-8)								
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
A and C	Controller 1/A	1a	2a	3a	1c	2c	3c			To *first* shelf IOM A ■
	Controller 2/B	1a	2a	3a	1c	2c	3c			To *first* shelf IOM B ■
B and D	Controller 1/A	~~1b~~	~~2b~~	~~3b~~	~~1d~~	~~2d~~	~~3d~~			To *last* shelf IOM B ●
		2b	3b	1d	2d	3d	1b			
	Controller 2/B	~~1b~~	~~2b~~	~~3b~~	~~1d~~	~~2d~~	~~3d~~			To *last* shelf IOM A ●
		2b	3b	1d	2d	3d	1b			

The following illustrates a cabled HA pair (non N6200 series, N3150, N3220, and N3240, or N3400) using the information in the sample worksheet.

Two examples are shown. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.



Multipath HA configuration



Cabling SAS ports

Cabling the SAS ports involves cabling the shelf-to-shelf connections and the shelf-to-controller connections from the first shelf and last shelf in a stack, and verifying that the SAS connections are correct.

Before you begin

- You should have filled out the *SAS cabling worksheet*.
- Your storage system must be running the minimum software release required to support your model of SAS disk shelves.

  The *IBM System Storage N series Introduction and Planning Guide* on the N series support website (accessed and navigated as described in Websites) at www.ibm.com/storage/support/nseries/ contains support information.
- If your storage system was not shipped in a system cabinet, the controllers and disk shelves must already be installed in a rack.
- If your storage system will be using one or more PCIe SAS HBAs, they must already be installed and available for cabling the disk shelves.
- If you are mixing different disk shelf models in the same stack, you should read the *Storage Subsystem Configuration Guide* TR-3838 and *Storage Subsystem Technical FAQ* on the N series support website (accessed and navigated as described in Websites).

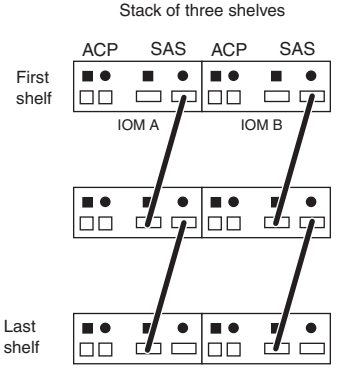
About this task

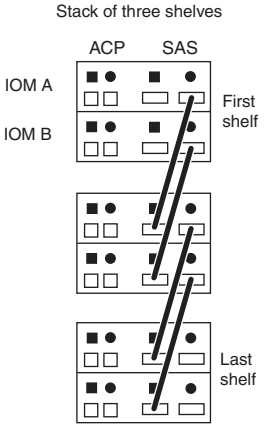
The SAS cable QSFP connectors are keyed; when oriented correctly into a SAS port the QSFP connector clicks into place and the SAS port link LED, LNK, illuminates green. Do not force a connector into a port.

Procedure

1. If you have more than one disk shelf in a stack, cable the shelf-to-shelf SAS connections by completing the following substeps; otherwise, go to Step 2: You use the QSFP to QSFP SAS cables that came with your system.
   a. Connect IOM A circle port to the next IOM A square port.
   b. Connect IOM B circle port to the next IOM B square port.

   The following examples show a stack of three shelves connected shelf-to-shelf. The first example shows shelves that have the IOMs arranged side-by-side, similar to how a EXN3500 disk shelf is oriented. The second example shows shelves that have the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.





2. Use your completed worksheet to cable the SAS A and SAS C connections for each controller.

   Note: If you are cabling a N3600 storage system, use the QSFP to mini-SAS cables for all controller to shelf connections; otherwise, use the QSFP to QSFP SAS cables.
3. Use your completed worksheet to cable the SAS B and SAS D connections for each controller.

   Note: For quad-port SAS HBAs, ports A and C never connect to the same stack of disk shelves and ports B and D never connect to the same stack of disk shelves. This means that you might have unused HBA ports, depending on the number of stacks in your configuration.

   For example, a single-controller with one quad-port SAS HBA and one stack of shelves only uses HBA ports A and D.
4. Verify the SAS connections by entering the applicable command:
   - For 7-Mode, enter the following command at the system console:
     `sasadmin expander_map`

     For HA pairs , you can run this command on either node.
5. The next step depends on the output.

If...	Then...
The output lists all IOMs	The IOMs have connectivity; go to Step 6.
Any IOMs are not shown (either the output does not show an IOM because it is cabled incorrectly, or the output does not show all the IOMs downstream from the incorrectly cabled IOM.)	Repeat Steps 1 through 5 to correct cabling errors, then go to Step 6.

6. Check whether your system has disk autoassignment enabled by using the **`options disk`** command at the console of either controller. If disk autoassignment is enabled, the output shows `disk.auto_assign on`.
7. If your system does not have disk autoassignment enabled, assign disk drive ownership.

   The following substeps are for basic disk ownership assignment for 7-Mode. To specify the disk drives to be assigned or the system to own the disk drives, see the *Data ONTAP Storage Management Guide for 7-Mode* . For 7-Mode HA pairs , you can run these commands from the system console of either node.

   a. Enter the following command to see all of the unassigned disk drives: `disk show -n` The disk drives in the hot-added shelf have the ownership state of **Not Owned** .

b. Enter the following command to assign ownership of the disk drives: `disk assign all` If you need to assign the disk drives to a non-local storage system, you can specify a storage system by using the `-o` *owner_name* option. To determine the *owner_name*, you can run the **`hostname`** command at the console of either controller.

c. Enter the following command to verify the assignments that you made: `disk show -v`

8. The next step depends on whether you are using the ACP capability.

If you are...	Then...
Using the ACP capability	Go to *Cabling ACP connections*.
Not using the ACP capability	Boot the storage system and begin setup. **Attention:** After your system is up and serving data, you cannot move SAS cables nondisruptively.

SAS cabling examples

You can use the SAS cabling examples to see how the SAS cabling rules are applied for common configurations.

Examples of SAS cabling for HA pairs with quad-port HBAs

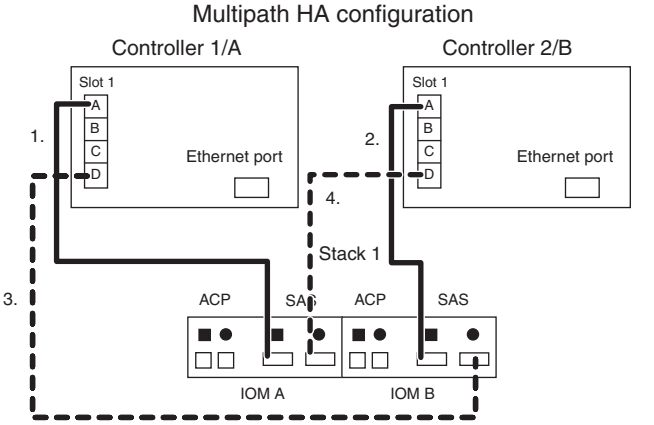
You can reference these examples for multipath HA configurations with quad-port SAS HBAs. The numbered cables show the sequence in which the system should be cabled.

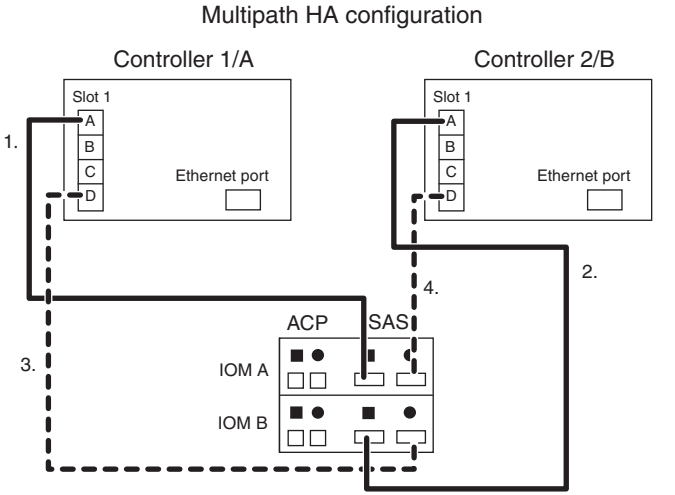
Two examples are shown for each configuration type. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.

Note: These examples do not apply to N3400, N3150, N3220 and N3240, or N6200 series systems.

One quad-port SAS HBA and a single shelf stack

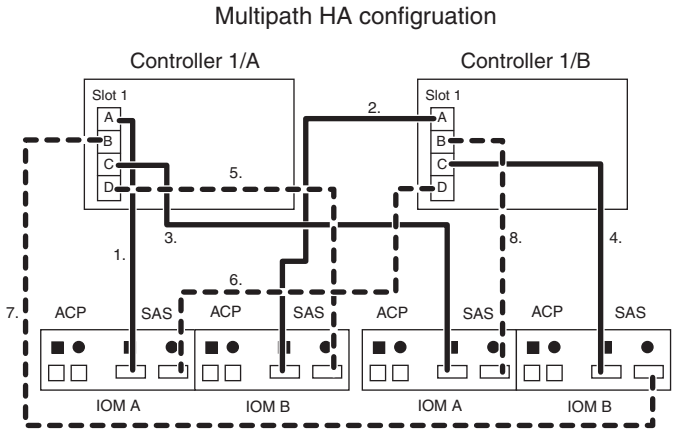
The SAS port cabling sequence for each controller is 1a, 1d.

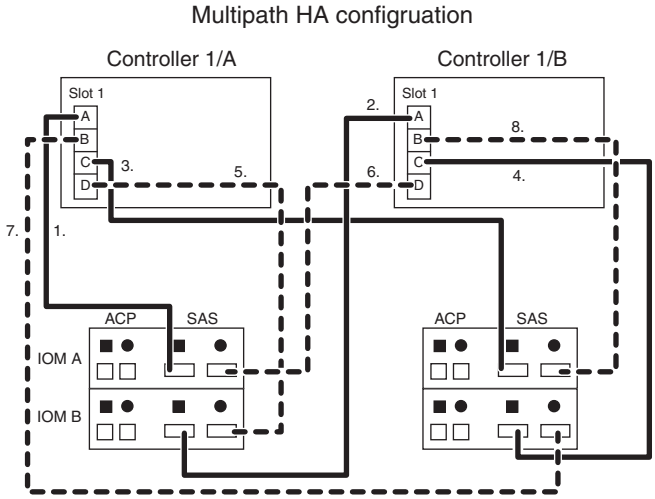




One quad-port SAS HBA and two single shelf stacks

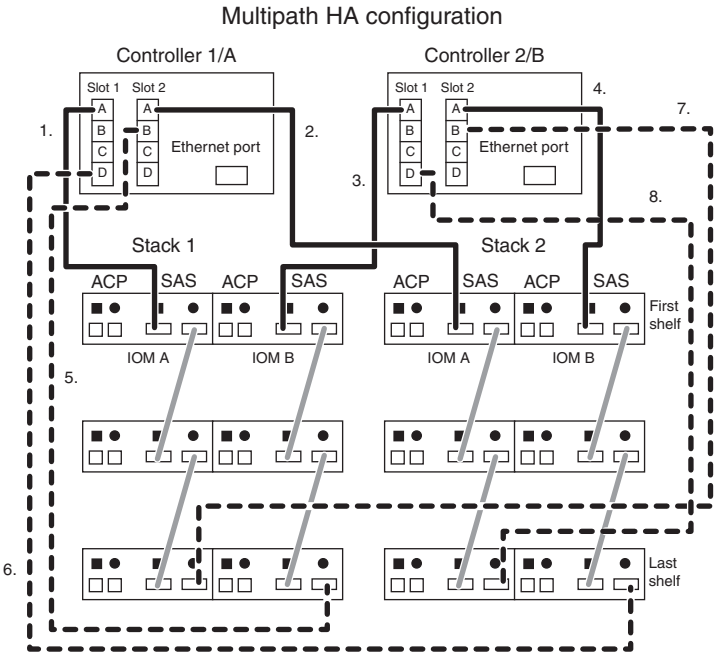
The SAS port cabling sequence for each controller is 1a, 1c, 1d, 1b.

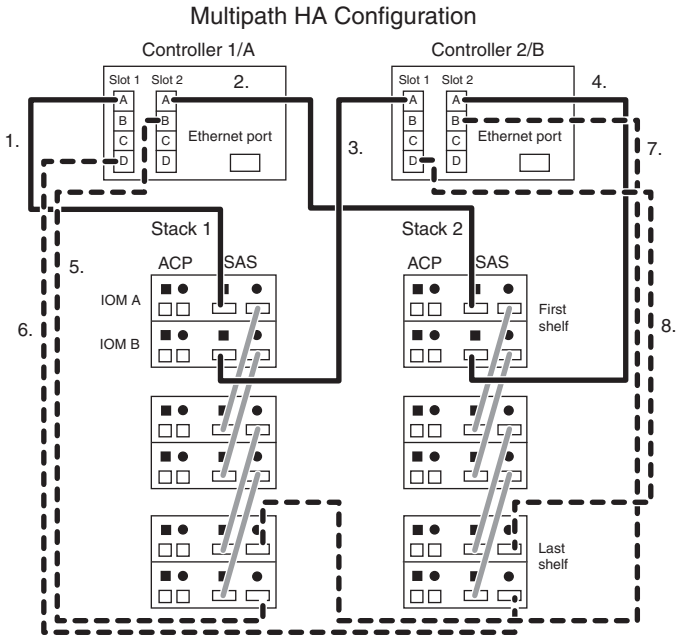




Two quad-port SAS HBAs and two stacks of disk shelves

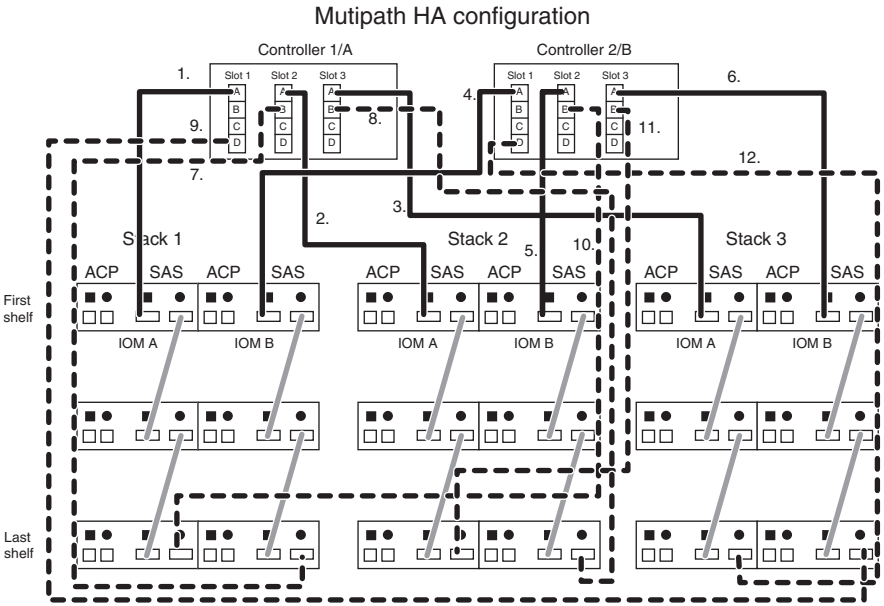
The SAS port cabling sequence for each controller is 1a, 2a, 2b, 1d.

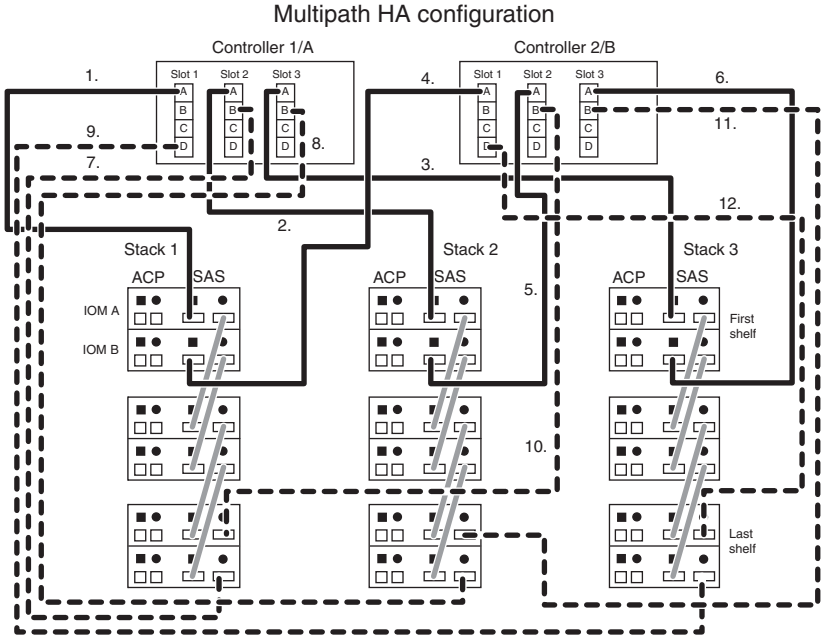




Three quad-port SAS HBAs and three stacks of disk shelves

The SAS port cabling sequence for each controller is 1a, 2a, 3a, 2b, 3b, 1d.





Four quad-port SAS HBAs and four stacks of disk shelves

The SAS port cabling sequence for each controller is 1a, 2a, 3a, 4a, 2b, 3b, 4b, 1d.

Four quad-port SAS HBAs and eight stacks of disk shelves

The SAS port cabling sequence for each controller is 1a, 2a, 3a, 4a, 1c, 2c, 3c, 4c, 2b, 3b, 4b, 1d, 2d, 3d, 4d, 1b.

Five quad-port SAS HBAs and five stacks of disk shelves

The SAS port cabling sequence for each controller is 1a, 2a, 3a, 4a, 5a, 2b, 3b, 4b, 5b, 1d, 2d, 3d, 4d, 1b.

Five quad-port SAS HBAs and 10 stacks of disk shelves

The SAS port cabling sequence for each controller is 1a, 2a, 3a, 4a, 5a, 1c, 2c, 3c, 4c, 5c, 2b, 3b, 4b, 5b,1d, 2d, 3d, 4d, 5d,1b.

Examples of SAS cabling for single-controller configurations with quad-port HBAs

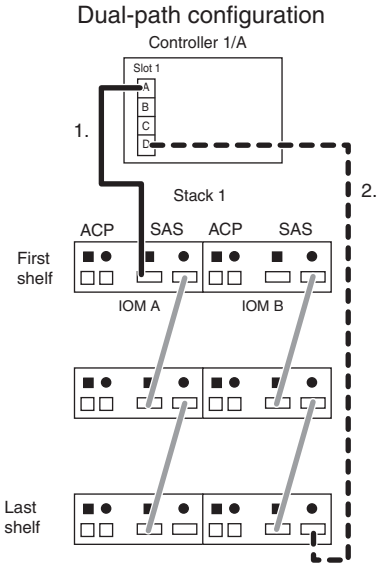
You can reference these SAS cabling examples for single-controller configurations with quad-port SAS HBAs (dual-path configurations). The numbered cables show the sequence in which the system should be cabled.

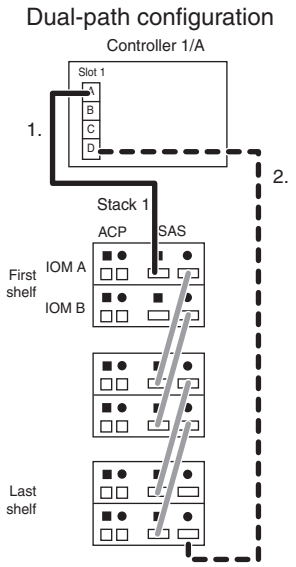
Two examples are shown for each configuration type. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.

Note: These examples do not apply to N3400 , N3220 and N3240, or N6200 series systems.

One quad-port SAS HBA and one stack of disk shelves

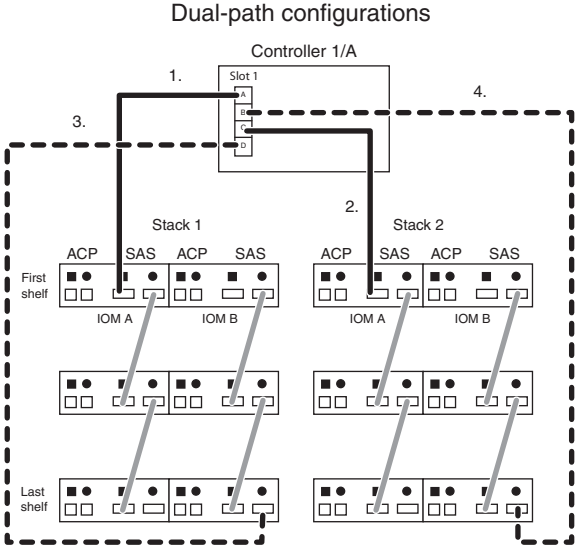
The SAS port cabling sequence is 1a, 1d.

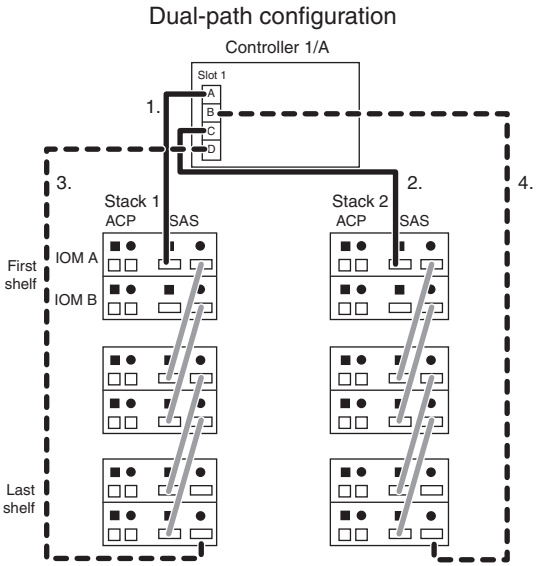




One quad-port SAS HBA and two stacks of disk shelves

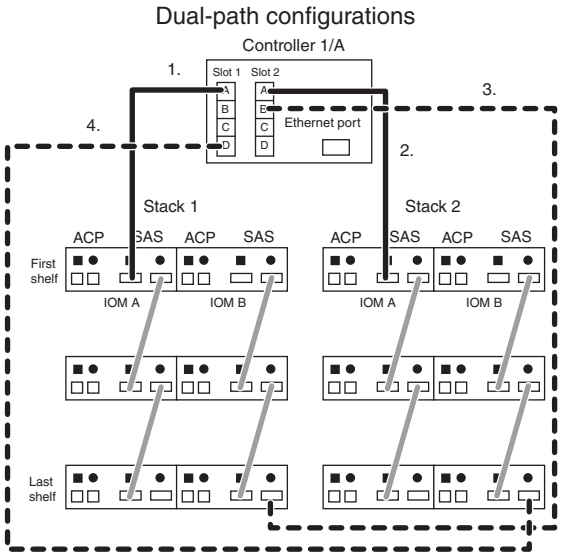
The SAS port cabling sequence is 1a, 1c,1d, 1b.

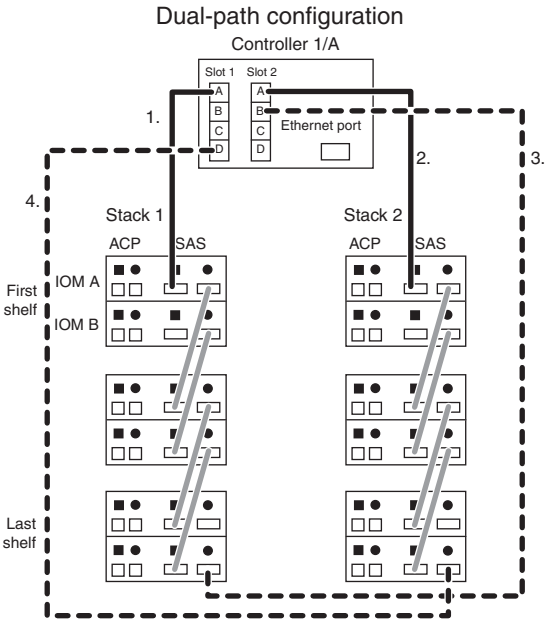




Two quad-port SAS HBAs and two stacks of disk shelves

The SAS port cabling sequence is 1a, 2a, 2b, 1d.





Examples of SAS cabling for N6200 series systems

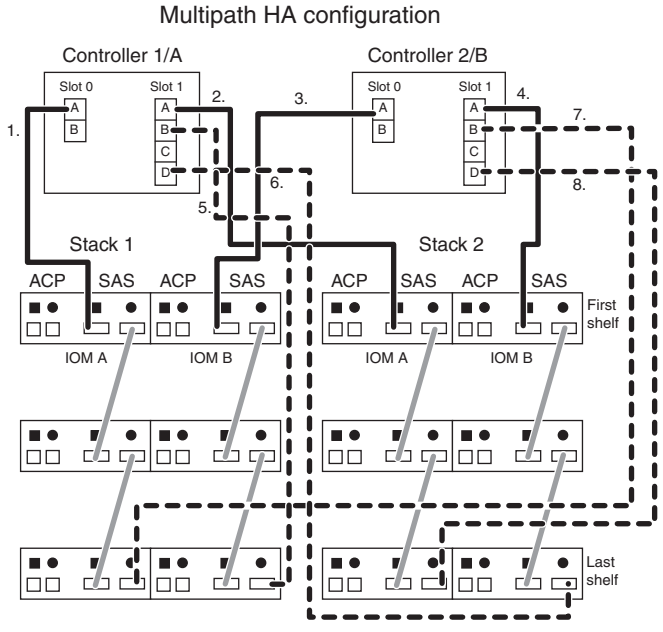
You can reference these SAS cabling examples for N6200 series dual enclosure HA and single enclosure HA configurations. The numbered cables show the sequence in which the system should be cabled.

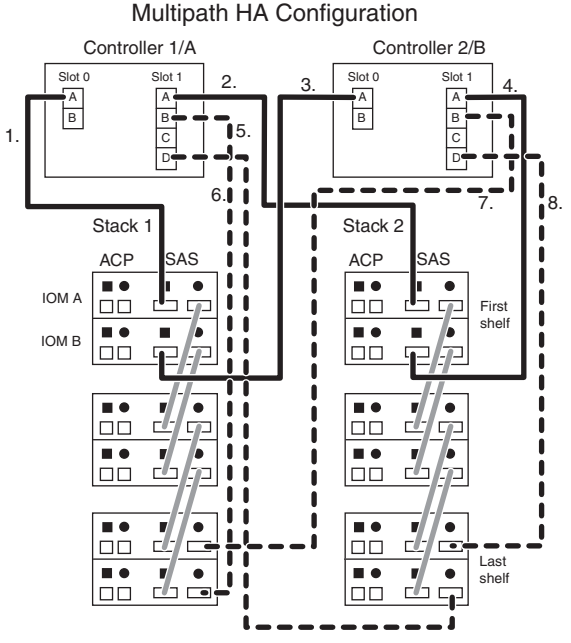
Two examples are shown for each configuration type. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.

Note: You can also view the *FASN6200 series Series System Cabling Examples* document—a more real-world cabling example of a N6200 series system installed in a cabinet—on the N series support website (accessed and navigated as described in Websites) at www.ibm.com/storage/support/nseries.

N6200 series dual enclosure HA configuration

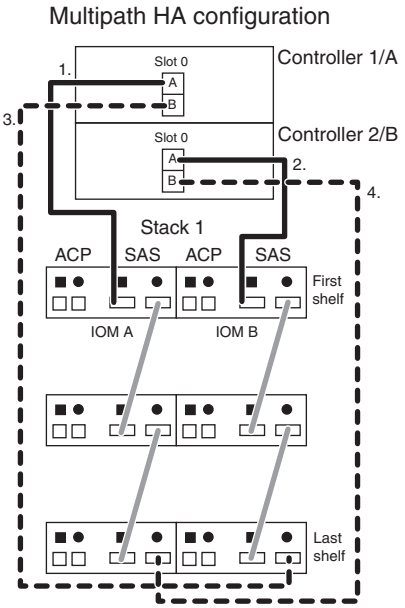
The SAS port cabling sequence for each controller is 0a,1a, 1b,1d.

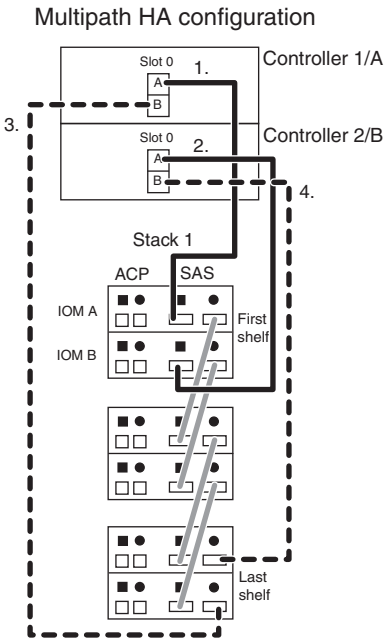




N6200 series single enclosure HA configuration

The SAS port cabling sequence for each controller is 0a, 0b.





Examples of SAS cabling for N3150, N3220, and N3240 system models

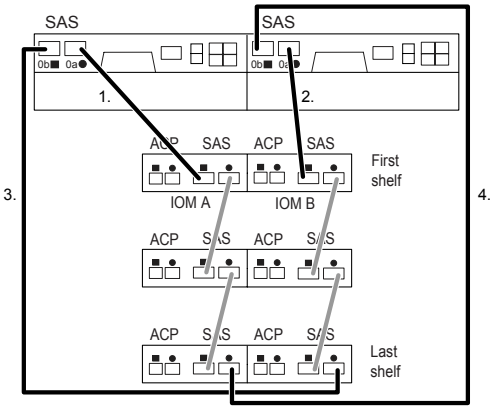
You can reference these SAS cabling examples for N3200 series HA pair and single-controller configurations. The numbered cables show the sequence in which the system should be cabled.

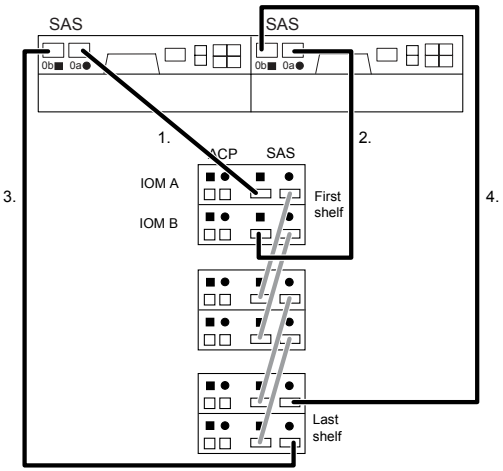
For configurations with external disk shelves, two examples are shown for each configuration type. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.

Note: These examples show a N3150 or a N3220, but the cabling also applies to the N3240, even though the controllers are in a different position in the N3240.

N3150, N3220, and N3240HA pair configuration with one stack of disk shelves (multipath HA)

The SAS port cabling sequence for each controller is 0a, 0b.

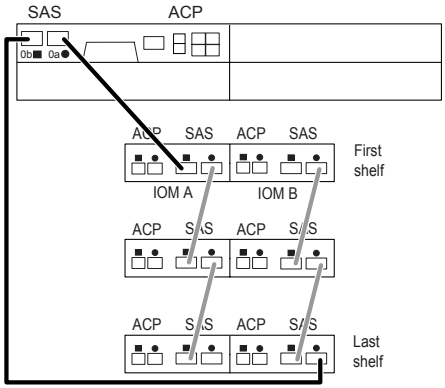


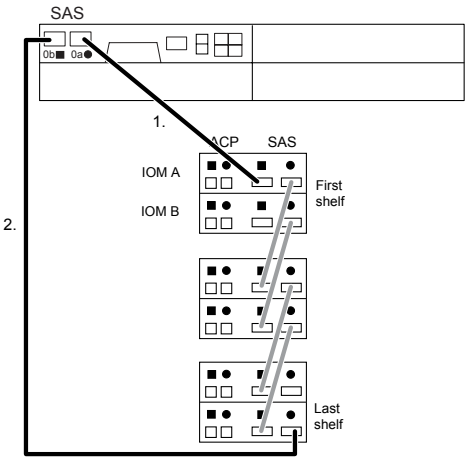


N3150, N3220, and N3240 single-controller configuration with one stack of disk shelves (dual-path)

The SAS port cabling sequence is 0a, 0b.

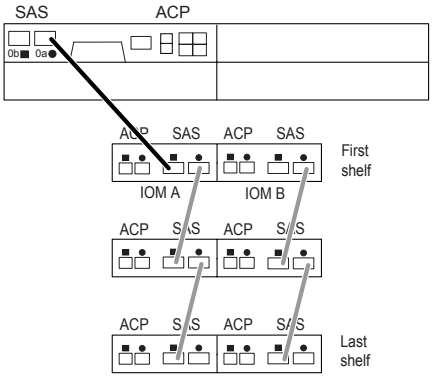
Note: Dual-path provides greater resiliency, but when dual-path is used Data ONTAP 8.1.x issues occasional warnings to the console because mixed paths are detected. To avoid the warnings, single-path connections to the external SAS storage are a supported option in these configurations.

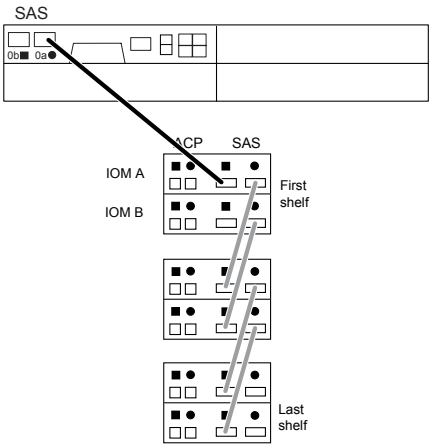




N3150, N3220, and N3240 single-controller configuration with one stack of disk shelves (single-path)

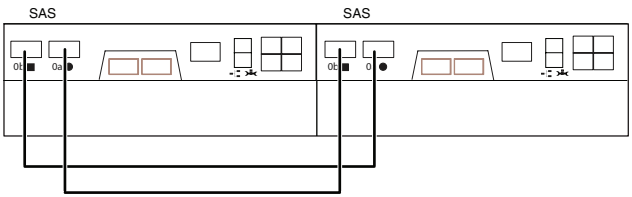
The SAS port cabling sequence is 0a.





N3150 and N3220 HA pair configuration with no external disk shelves (multipath HA)

The SAS port cabling sequence for each controller is 0a, 0b.



Examples of SAS cabling for N3600 systems

You can reference these SAS cabling examples for N3600 HA pair (multipath HA) and single-controller (dual-path) configurations. The numbered cables show the sequence in which the system should be cabled.

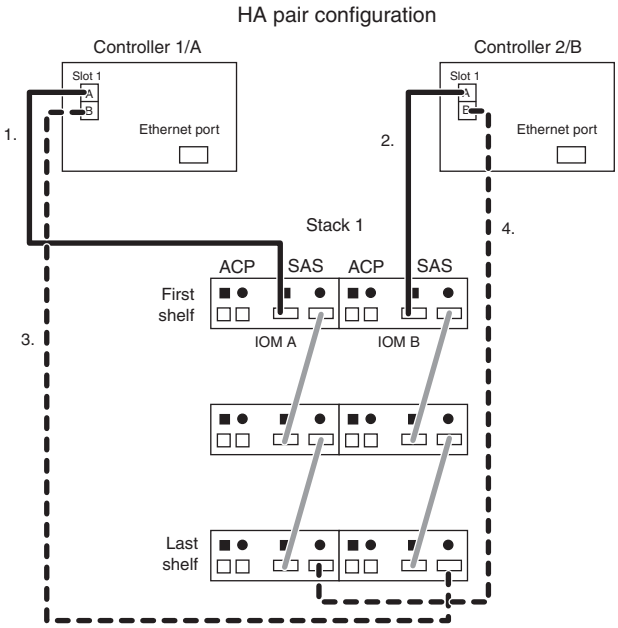
Two examples are shown for each configuration type. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.

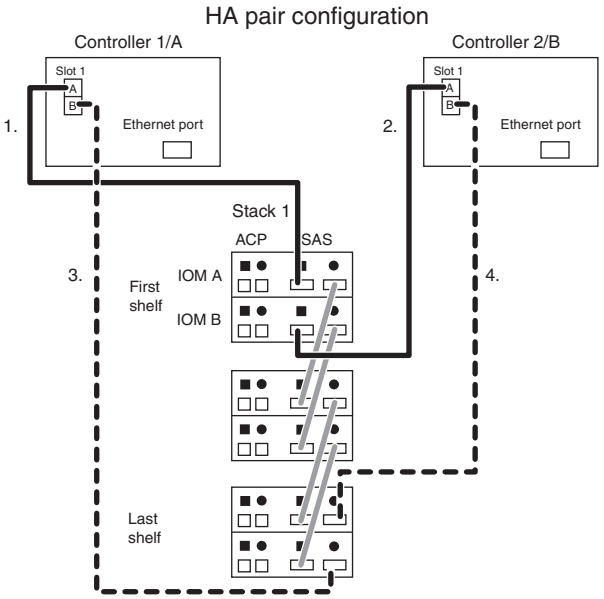
Note: For single-controller N3400 storage systems, the controller is in Slot B (the bottom slot); therefore, the controller is cabled as if it were controller 2/B. If a second controller is added to make this an HA pair configuration, the new controller is cabled as controller 1/A.

Note: Because N3600 systems only have one dual-port SAS HBA on each controller, a maximum of one stack of disk shelves is supported in a multipath HA or dual-path configuration.

N3600 multipath HA configuration

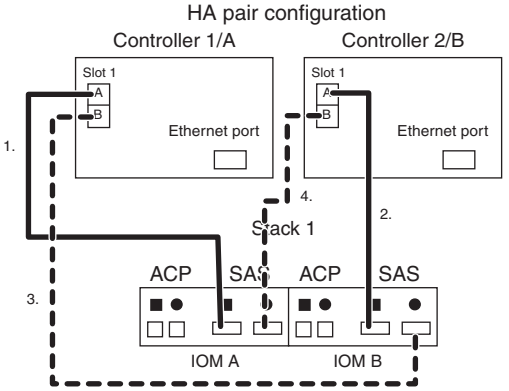
The SAS port cabling sequence for each controller is 1a,1b.

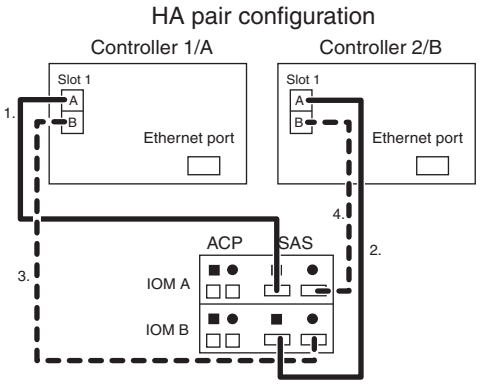




N3600 multipath HA configuration with one disk shelf

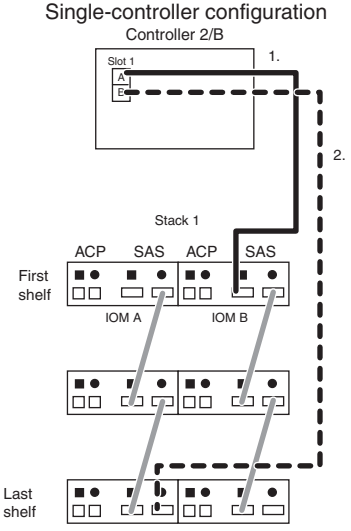
The SAS port cabling sequence for each controller is 1a,1b.



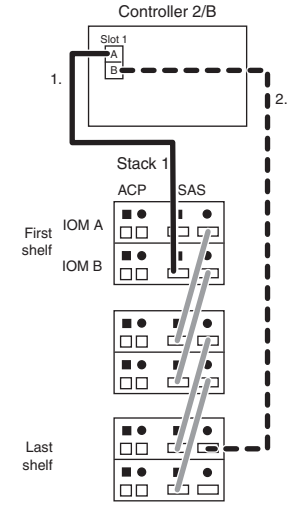


N3600 dual-path configuration

The SAS port cabling sequence is 1a, 1b.



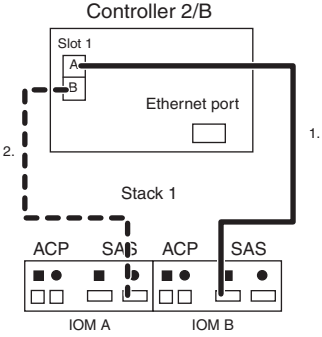
Single-controller configuration

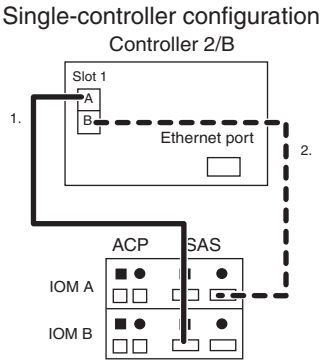


N3600 dual-path configuration with one disk shelf

The SAS port cabling sequence is 1a,1b.

Single-controller configuration





Examples of SAS cabling for N3400 systems

You can reference these SAS cabling examples for N3400 HA pair (single-path HA) and single-controller (single-path) configurations. The numbered cables show the sequence in which the system should be cabled.

Two examples are shown for each configuration type. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.

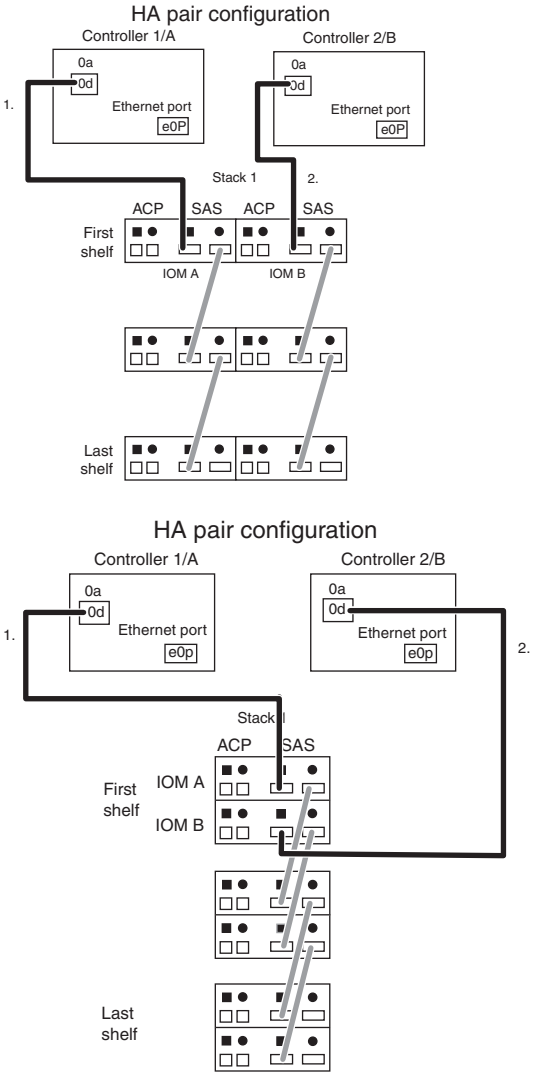
Note: For single-controller N3400 storage systems, the controller is in Slot B (the bottom slot); therefore, the controller is cabled as if it were controller 2/B. If a second controller is added to make this an HA pair configuration, the new controller is cabled as controller 1/A.

Note: The N3400 storage system's onboard SAS port labeled 0d is treated as slot 0 port a (0a) for cabling purposes. When the onboard port is treated as port 0a, all the SAS cabling rules can be applied.

Note: Because N3400 systems only have one SAS port on each controller, a maximum of one stack of disk shelves is supported.

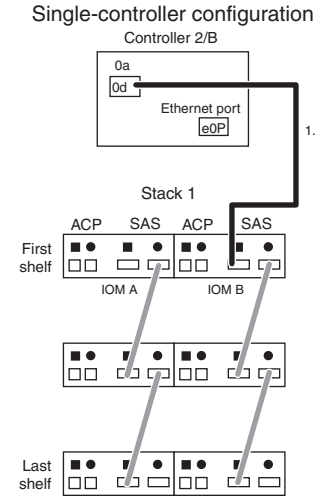
N3400 single-path HA configuration

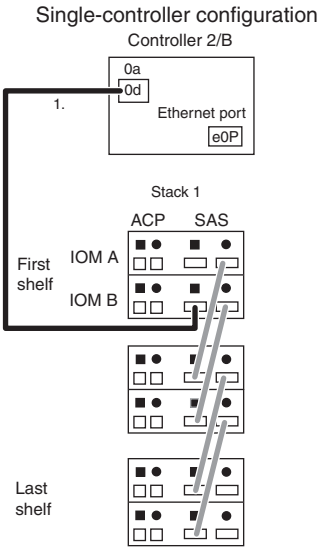
The SAS port cabling sequence for each controller is 0a.



N3400 single-path configuration

The SAS port cabling sequence is 0a.





ACP cabling for new storage systems

After you cable the SAS connections, you have the option to cable the ACP connections. It is recommended that you use the ACP protocol because it enables Data ONTAP to manage and control the SAS disk shelf storage subsystem.

ACP cabling rules

You can cable ACP connections on your storage system by applying the ACP cabling rules.

General ACP cabling rules

General ACP cabling rules apply to all supported storage systems using SAS storage.

- You must use CAT6 Ethernet cables with RJ-45 connectors for ACP connections.
- If your storage system does not have a dedicated onboard network interface for each controller, you must dedicate one for each controller at system setup.

  You can use a quad-port Ethernet card.
- All ACP connections to the disk shelf are cabled through the ACP ports, which are designated by a square symbol or a circle symbol.

ACP connectivity rules

ACP connectivity rules apply to all supported storage systems using SAS storage.

Shelf-to-shelf connections

- All the disk shelves in a stack are daisy-chained when you have more than one shelf in a stack.
- IOM A circle port is connected to the next IOM A square port.

  IOM B circle port is connected to the next IOM B square port.

Intrastack connections

- The last shelf and first shelf in each stack are connected to provide resiliency within each stack of disk shelves.
- The last shelf IOM A circle port is connected to the first shelf IOM B square port.

  This applies to stacks containing one or more disk shelves.

Controller-to-stack connections

- Each storage system controller is connected to each stack of disk shelves through a dedicated Ethernet port.
- Controller 1/A always connects to the first shelf IOM A square port in a stack.

  Controller 2/B always connects to the last shelf IOM B circle port in a stack.

Controller-to-controller connections (N3150, N3220, and N3240 system models with no external SAS shelves)

Each storage system controller is connected to the partner controller through a dedicated wrench icon. This rule applies to N3150, N3220, and N3240 storage systems only.

N3400 storage system connections

For single-controller N3400 storage systems, the controller is in Slot B (the bottom slot); therefore, the controller is cabled as if it were controller 2/B. If a second controller is added to make this an HA pair , the new controller is cabled as controller 1/A.

Cabling ACP connections

How you cable your system for ACP depends on whether you are cabling a storage system with external SAS storage or a system with no external SAS storage.

Cabling ACP on systems with external SAS storage

Cabling ACP on a system with external SAS disk shelves involves connecting disk shelves within a stack, connecting the first and last disk shelves in a stack, connecting the stacks (if you have more than one stack), and connecting the controllers to the stacks.

Before you begin

If your storage system does not have a native onboard ACP port, you must be prepared to designate a network interface for each controller at system setup.

If you are using a four-port Ethernet card for this purpose, this card must already be installed and available in each controller.

Two examples are shown for each configuration type. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs

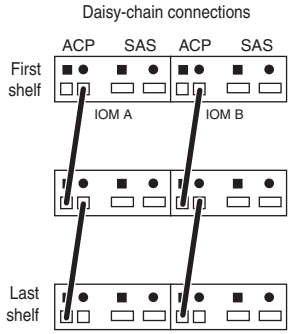
arranged one above the other, similar to how a EXN3000 disk shelf is oriented.

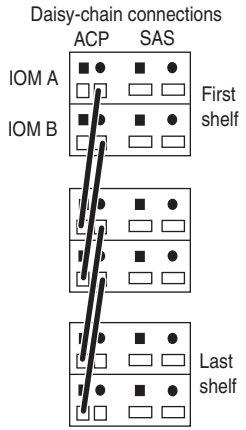
About this task

To cable the ACP connections, you use the Ethernet cables that came with your system.

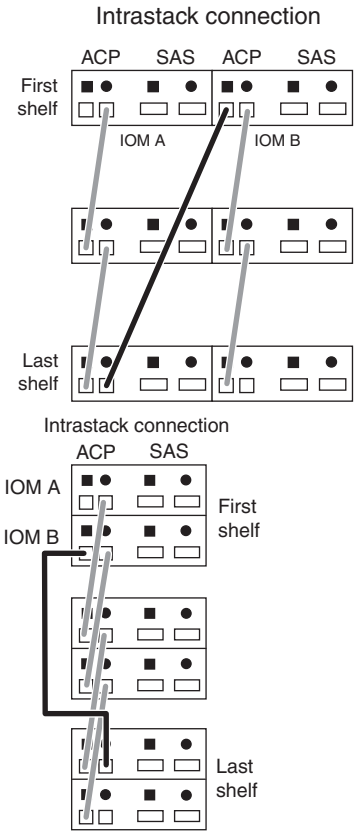
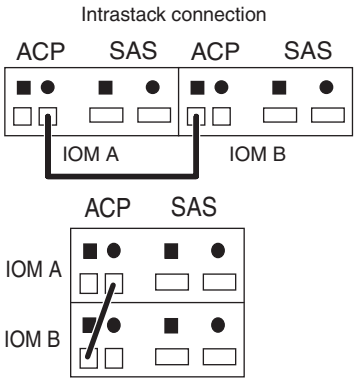
Procedure

1. If you have more than one disk shelf in a stack, cable your shelf-to-shelf ACP connections; otherwise, go to Step 2.
   a. Connect each shelf IOM A circle port to the next shelf IOM A square port until all shelves in each stack are connected.
   b. Connect each shelf IOM B circle port to the next shelf IOM B square port until all shelves in each stack are connected.

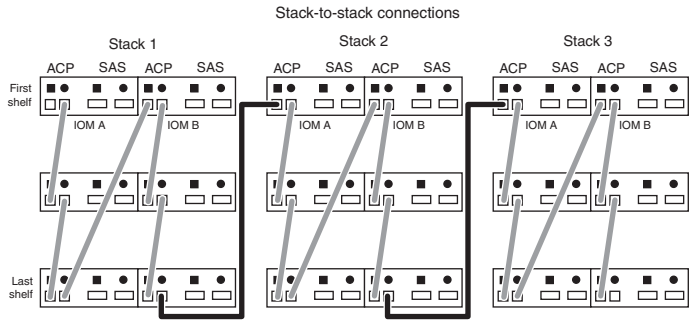


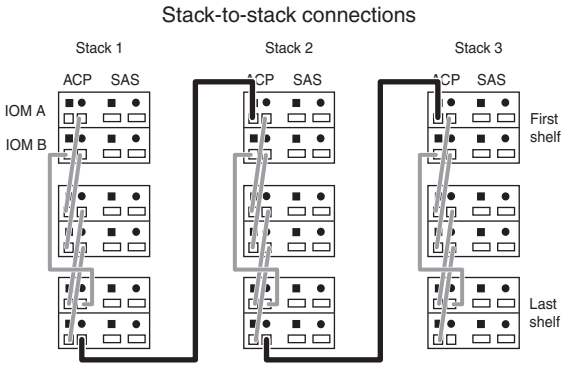


2. Cable the intrastack connection.

If you have...	Then...
More than one disk shelf in a stack of disk shelves	Connect the last shelf IOM A circle port to the first shelf IOM B square port and repeat for all stacks. 
Only one disk shelf in a stack of disk shelves	Connect the IOMs within the disk shelf by connecting the IOM A circle port to the IOM B square of the disk shelf. 

3. If you have more than one stack of disk shelves, cable the stack-to-stack connections; otherwise, go to Step 4.
   a. Beginning with Stack 1, connect the last shelf IOM B circle port to the next stack's first shelf IOM A square port.



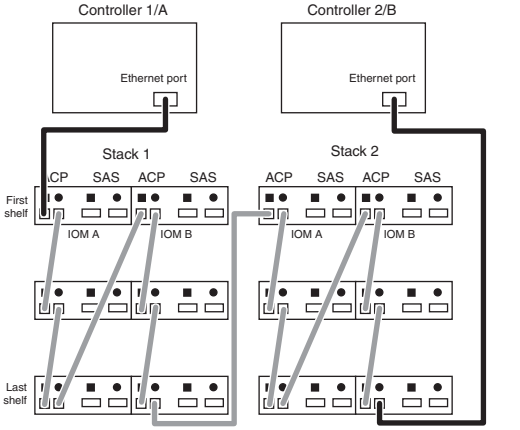


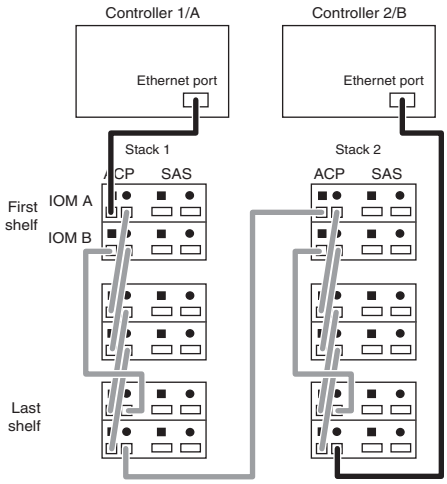
   b. Repeat Substep a until all stacks are connected.
4. Cable controller-to-stack connections.

If your system has a controller...	Then...
1/A	Cable controller 1/A to the first stack first shelf IOM A square port.
2/B	Cable controller 2/B to the last stack last shelf IOM B circle port.

An HA pair with two stacks of disk shelves has the controller-to-stack connections cabled as follows:

Note: N3400 storage systems use the e0P port on each controller.





5. Verify that the ACP cabling is correct by entering the applicable command:
   - For 7-Mode, enter the following command from the system console:`storage show acp`

     If you have an HA pair , run this command on both nodes.
6. The next step depends on what the command output is for each node.

If the result in the output shows ACP connectivity status...	**Then...**
Full Connectivity	ACP cabling is correct. The number of shelf IOMs detected out-of-band (through ACP) and in-band (through SAS) are the same.

If the result in the output shows ACP connectivity status...	Then...
No Connectivity	Repeat Step 4. No ACP ports on the shelf IOMs are connected to the storage controllers.
Partial Connectivity	Repeat Steps 1 through 6 to see what ACP connections were missed. Fewer shelf IOMs are detected out-of-band (through ACP) than in-band (through SAS).
Additional Connectivity	Repeat the “Cabling SAS ports” procedure to see what SAS connections were missed. More shelf IOMs are detected out-of-band (through ACP) than in-band (through SAS).

7. Boot the storage system and begin setup. See the Installation and Setup Instructions that came with your storage system.

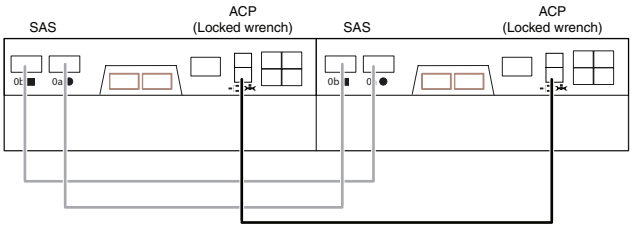
   Note: If your storage system does not have a dedicated ACP onboard Ethernet port on each controller for ACP, you will designate them at setup.
   Attention: After your storage system is up and serving data, you cannot move SAS cables nondisruptively.

Cabling ACP on systems with no external SAS storage

Cabling your N3150, N3220, and N3240 HA pair with internal SAS storage for ACP involves one connection between the two controller modules.

Procedure

Cable the locked wrench ACP port on one controller module to the same port on the partner controller module. The following example shows a N3150 or a N3220, but the cabling also applies to the N3240, even though the controllers are in a different position in the N3240.



ACP cabling examples

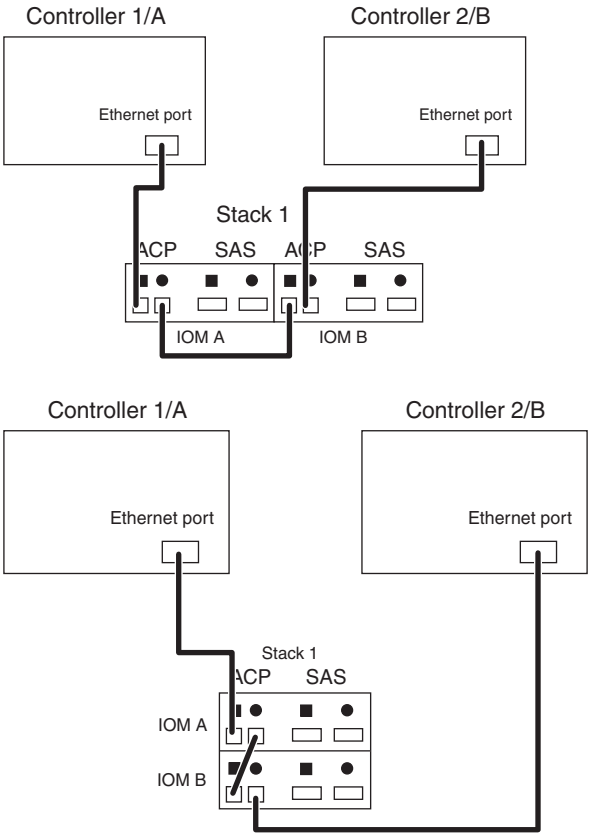
You can use the ACP cabling examples to see how the ACP cabling rules are applied for common system configurations.

Examples of ACP cabling for HA pairs

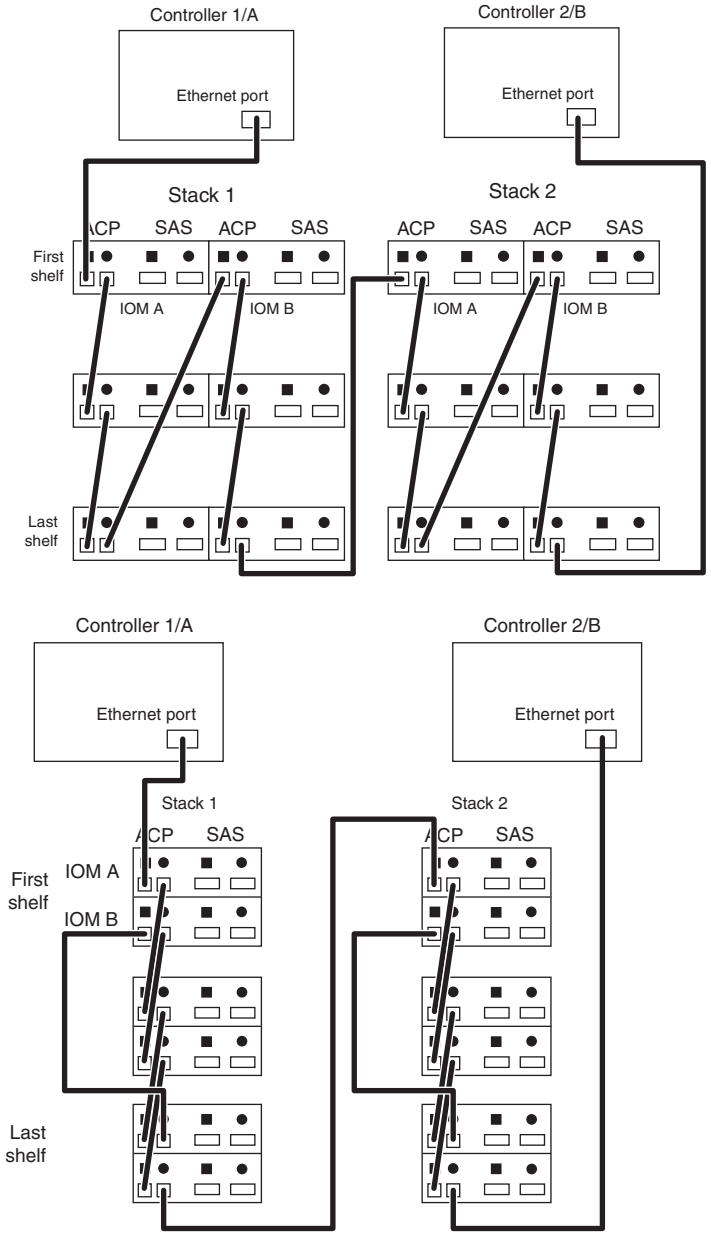
You can use the examples as a reference when cabling the ACP ports for HA pairs with external storage.

Two examples are shown for each configuration type. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.

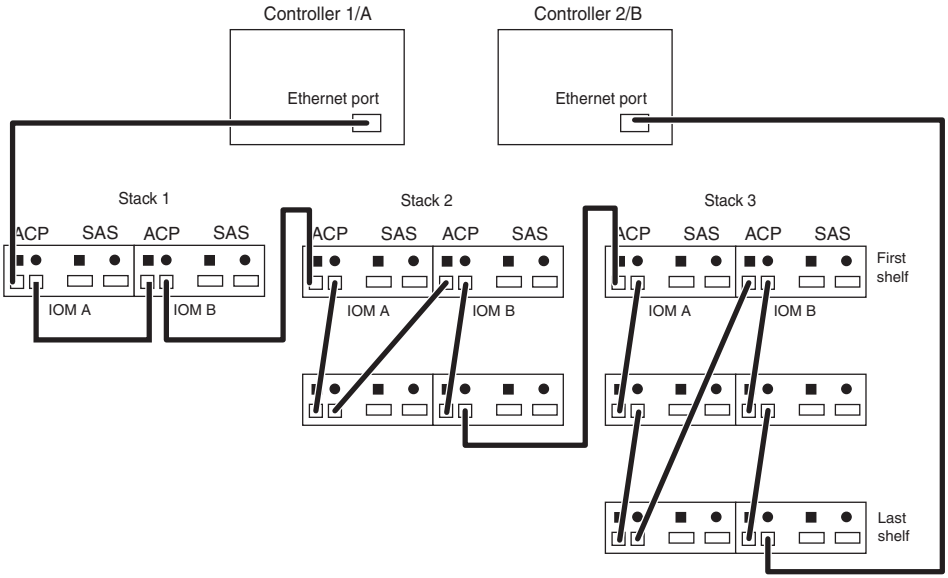
HA pair with one disk shelf

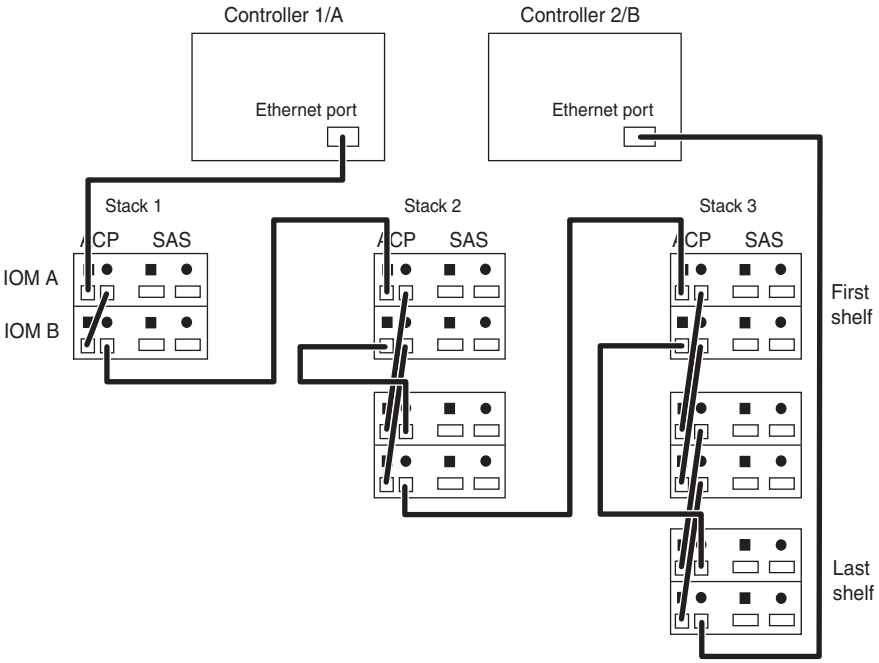


HA pair with two stacks of disk shelves



HA pair with three stacks of disk shelves





Examples of ACP cabling for single-controller configurations

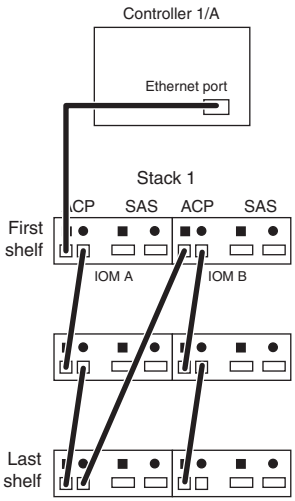
You can use the examples as a reference when cabling the ACP ports for single-controller configurations.

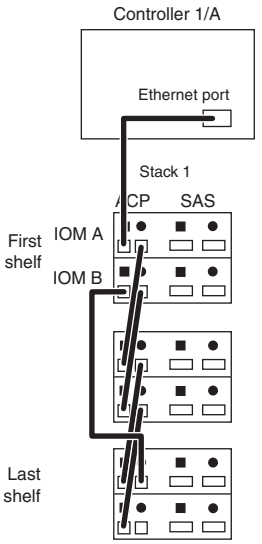
Two examples are shown for each configuration type. One example shows disk shelves with the IOMs arranged side by side, similar to how a EXN3500 disk shelf is oriented. The second example shows disk shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented.

ACP cabling examples for all single-controller configurations except N3400 systems

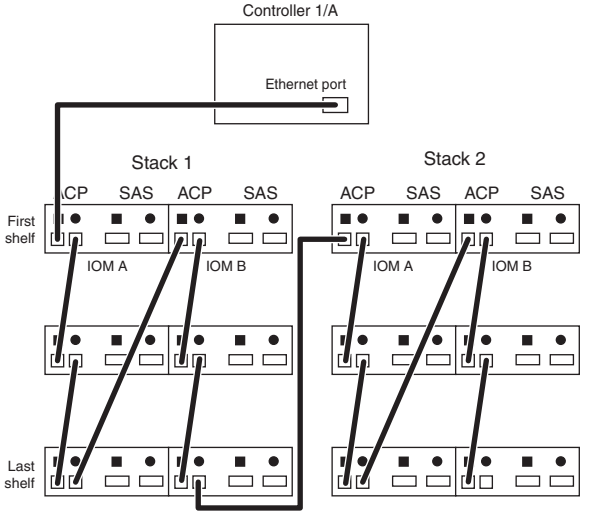
You can use the examples as a reference when cabling the ACP ports for all single-controller configurations, except N3400 systems. For all other single-controller systems, the controller is located in the top slot (referred to as Controller 1/A); therefore, the controller connects to the stack of shelves through the first shelf in the stack.

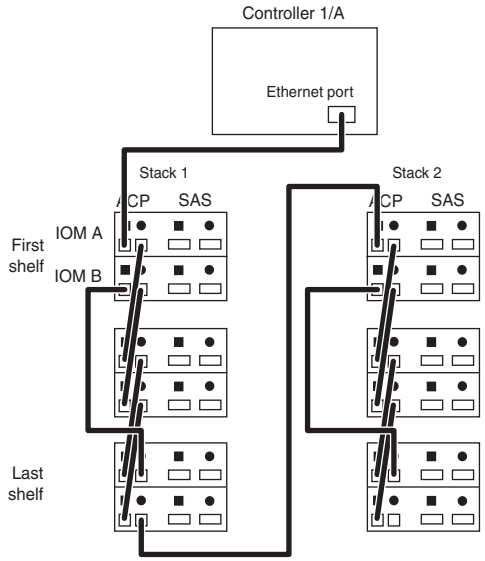
Single-controller configuration with one stack of disk shelves (except N3400 systems)





Single-controller configuration with two stacks of disk shelves (except N3400 systems)

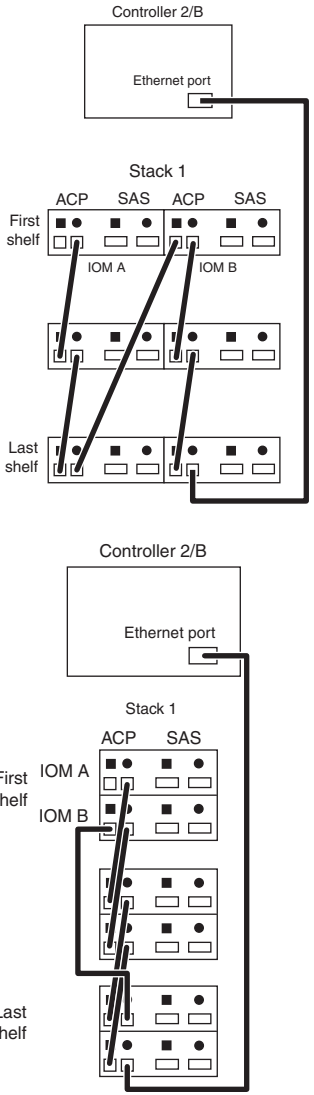




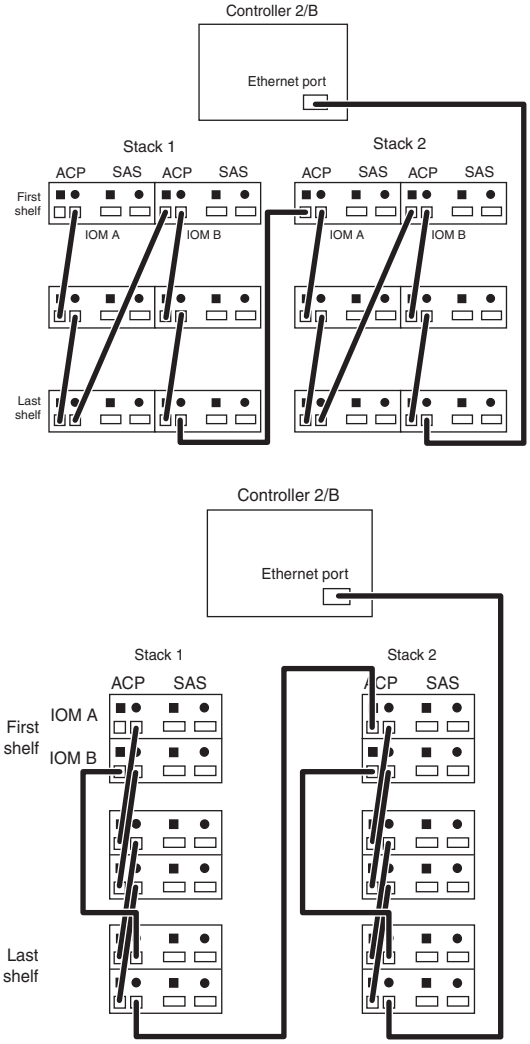
ACP cabling examples for single-controller N3400 systems

You can use the examples as a reference when cabling the ACP ports for single-controller N3400 systems. For single-controller N3400 systems, the controller is located in the bottom slot (referred to as Controller 2/B); therefore, the controller connects to the stack of shelves through the last shelf in the stack.

Single-controller N3400 systems with one stack of disk shelves



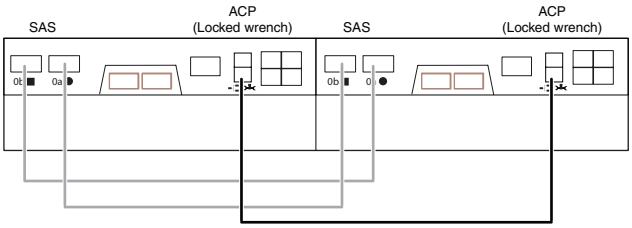
Single-controller N3400 systems with two stacks of disk shelves



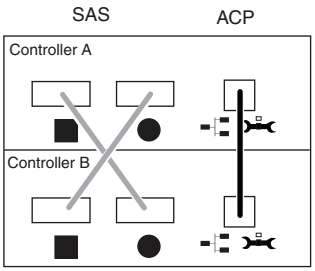
Examples of ACP cabling for N3150, N3220, and N3240 system models with no external storage

You can use the examples as a reference when cabling the ACP connections for N3220 and N3240 HA pairs with no external SAS storage.

N3150 and N3220 HA pairs with no external disk shelves



N3240 HA pairs with no external disk shelves



Glossary

SAS disk shelf and connectivity terminology is defined in the glossary.

ACP Alternate Control Path. A protocol that enables Data ONTAP to manage and control the disk shelf storage subsystem. It uses a separate network from the data path, so management communication is not dependent on the data path being intact and available. Use of ACP requires that all disk shelf IOMs and storage controllers connect through the ACP ports on the IOMs and the designated network interface on each controller.

add-on disk shelf
In a SAS disk shelf environment, a disk shelf that is shipped individually—not shipped as part of a configured storage system.

configured system
In a SAS disk shelf environment, a new storage system that ships with SAS disk shelves and preinstalled SAS HBAs (if applicable).

controller
The component of a storage system that runs the Data ONTAP operating system and controls its disk subsystem. The controller located in the top slot in a storage system chassis can be referred to as *Controller 1* or *Controller A*. The controller located in the bottom slot in the storage system chassis can be referred to as *Controller 2* or *Controller B*.

Controllers are also sometimes called *storage controllers*, *storage appliances*, *appliances*, *storage engines*, *heads*, *CPU modules*, or *controller modules*.

dual-path
A configuration in which a single-controller storage system has two ways to connect to a disk drive. This is the supported configuration for a single-controller configuration.

first shelf connection
In a SAS disk shelf environment, the cabling connection from the controller to the first disk shelf in a stack of disk shelves.

IOM The SAS shelf I/O module that is located in the back of the disk shelf. It connects the individual disk drives to the rest of the storage system and controls the disk shelf operator display panel LEDs. Each disk shelf has two IOMs: IOM A and IOM B. These are also referred to as *SBB A* and *SBB B* on the slot map label on the back of the disk shelf.

last shelf connection
In a SAS disk shelf environment, the cabling connection from the controller to the last disk shelf in a stack of disk shelves.

multipath HA
In an HA pair, a configuration in which each controller has multiple ways to connect to a disk drive. Multipath HA cabling is the most resilient and only supported configuration for HA pairs. This is because it takes full advantage of the resiliency capability of the disk shelves, which means that the node continues to have access to disk drives in the event of cable, HBA, or shelf module failure. A single failure of a cable, HBA, or module does not result in a controller failover.

QSFP The standard SAS cabling connector for all IBM N series SAS systems. QSFP to QSFP SAS cables are used to daisy-chain SAS disk shelf ports and connect to the quad-port SAS host bus adapter (HBA) or onboard SAS ports. QSFP to mini-SAS cables are used to connect disk shelves to the dual-port mini-SAS HBA.

SAS stack
Also referred to as *stack*. A group of one or more SAS disk shelves connected (daisy-chained) together and connected to the controller through the first disk shelf in the stack and the last disk shelf in the stack (as needed). The maximum number of disk shelves in a stack of disk shelves and the number of disk shelf stacks supported in a configuration are dependent on the type of storage system.

shelf-to-shelf connection
In a SAS disk shelf environment, the cabling connection between disk shelves in a stack of more than one disk shelf. Each disk shelf is daisy-chained through its SAS ports and, if you are using the ACP capability, each disk shelf is also daisy-chained through its ACP ports. Sometimes called *daisy-chain* connection.

single-controller configuration
A storage system having one controller.

single path
A configuration in which a single-controller storage system has one way to connect to a disk drive. This configuration has multiple single points of failure and is not a preferred configuration.

single-path HA
A configuration in which each controller in the HA pair configuration has one way to connect to the disk drive. This means that an IOM or cable failure requires a controller failover.

software-based disk ownership
An ownership scheme used by SAS disk drives to store ownership

information on the disk drive rather than having it be determined by the topology of the storage system's physical connections. It provides increased flexibility and control over disk drive use than hardware-based disk ownership.

square and circle symbols
The SAS ports and ACP ports on the disk shelf IOMs are designated by square and circle symbols. All cabling is done in reference to connecting to a square port or a circle port.

SAS connectivity does not use the concept of In ports and Out ports.

storage system
The hardware device running Data ONTAP that receives data from and sends data to native disk shelves, third-party storage, or both. Storage systems include a controller component and an internal or external disk storage subsystem component. Storage systems are sometimes referred to as *filers*, *appliances*, *storage appliances*, *gateways*, or *systems*.

Note: The term *gateway* describes IBM N series storage systems that have been ordered with gateway functionality. Gateways support various types of storage, and they are used with third-party disk storage systems—for example, disk storage systems from IBM, HP®, Hitachi Data Systems®, and EMC®. In this case, disk storage for customer data and the RAID controller functionality is provided by the back-end disk storage system. A gateway might also be used with disk storage expansion units specifically designed for the IBM N series models.

The term *filer* describes IBM N series storage systems that either contain internal disk storage or attach to disk storage expansion units specifically designed for the IBM N series storage systems. Filer storage systems do not support using third-party disk storage systems.

Document update record

You can reference this table for the history of changes made to this document. Changes are not dictated by Data ONTAP releases.

Feature updates	Feature release date
• Updated the rules and exceptions for N3150, N3220, and N3240 system models. • References to the "top" and "bottom" shelves in a stack of disk shelves are now "first" and "last". • Cabling examples now include a version that shows shelves with the IOMs arranged one above the other, similar to how a EXN3000 disk shelf is oriented. • Added N6200 series cabling examples. • Improved the SAS cabling worksheet and added information to assist in filling in the worksheet.	June 2012
Updated with rules and exceptions for N3220 systems.	November 2011

Feature updates	Feature release date
• Initial release of the SAS and ACP cabling information as a stand-alone document and updates. • The SAS disk shelf illustrations are now generic so that they apply to any IBM N series SAS disk shelf. A generic disk shelf is shown as two IOMs side-by-side (no power supplies are shown). • HBAs (1, 2, 3 etc.) are now referred to as slots (1, 2, 3 etc.) • Introduces the new rule for referring to onboard SAS ports as belonging to slot 0 and the N3400 system exception - the single onboard port is 0a. • Introduces the new rule that for single-controller N3400 systems, the controller is in Slot B (the bottom slot); therefore, the controller is cabled as if it were controller 2/B. If a second controller is added to make this an HA pair configuration, the new controller is cabled as controller 1/A. • The term active/active is updated to HA pair throughout. • The term Multipath is updated to Multipath HA.	September 2010
Initial release of the SAS and ACP cabling information was part of the EXN3000 Installation and Service Guide.	September 2009

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