



Xserve RAID

User's Guide

Includes hardware setup and expansion, basics of using RAID, and important safety information for Xserve RAID systems

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About This Guide

Congratulations on purchasing Xserve RAID, a breakthrough storage solution that delivers superior capacity, performance, and data protection.

This guide contains instructions for installing the Xserve RAID system in a rack and exchanging components, as well as an introduction to RAID (redundant array of independent disks) technology and a guide to planning storage with your Xserve RAID system.

If you are new to RAID, this guide will help you become familiar with this technology and the ways you can use it to increase the performance and reliability of your data storage.

If you are already familiar with RAID, use this guide as a reference for implementing your storage strategy with Xserve RAID.

For details of hardware installation, setup, and component exchange, see

- Chapter 1, “Introducing Xserve RAID,” on page 9
- Chapter 2, “Preparing to Install Xserve RAID in a Rack,” on page 19
- Chapter 3, “Mounting Xserve RAID in a Rack,” on page 23
- Chapter 4, “Connecting Xserve RAID to a Host System and a Network,” on page 37
- Chapter 5, “Using the Xserve RAID System,” on page 45
- Chapter 6, “Installing or Replacing Components,” on page 49

For explanations of RAID levels and their implementation on the Xserve RAID system, see

- Chapter 7, “RAID Overview,” on page 57
- Chapter 8, “Planning RAID Storage for the Xserve RAID System,” on page 63

In addition, see the procedural instructions in the document “Using RAID Admin to Manage the Xserve RAID System,” which is included on the CD that came with your system.

Introducing Xserve RAID

Your new Xserve RAID storage system provides high availability and scalable capacity and performance. Key features of Xserve RAID include

- 3U enclosure (5.25 inches high)
- rack optimized
- dual independent RAID controllers, each with a minimum of 128 megabytes (MB) of RAM cache
- up to 14 hot-swappable ATA-100 Apple Drive Modules
- dual hot-swappable power supplies
- dual AC power connections
- dual hot-swappable cooling modules
- dual 2-gigabit (Gb) copper fibre channel ports, supporting point-to-point and switch fabric connections
- dual Ethernet ports for remote management of the system
- dual serial ports for uninterruptible power supply (UPS) communications
- Mac OS X compatibility (version 10.2.4 or later)
- PCI host bus adapter card (sold separately) with dual fibre channel connectors for host system
- optional dual battery backup for controller cache
- optional service parts kit
- optional drive modules

The Xserve RAID system is designed to be mounted in a rack.

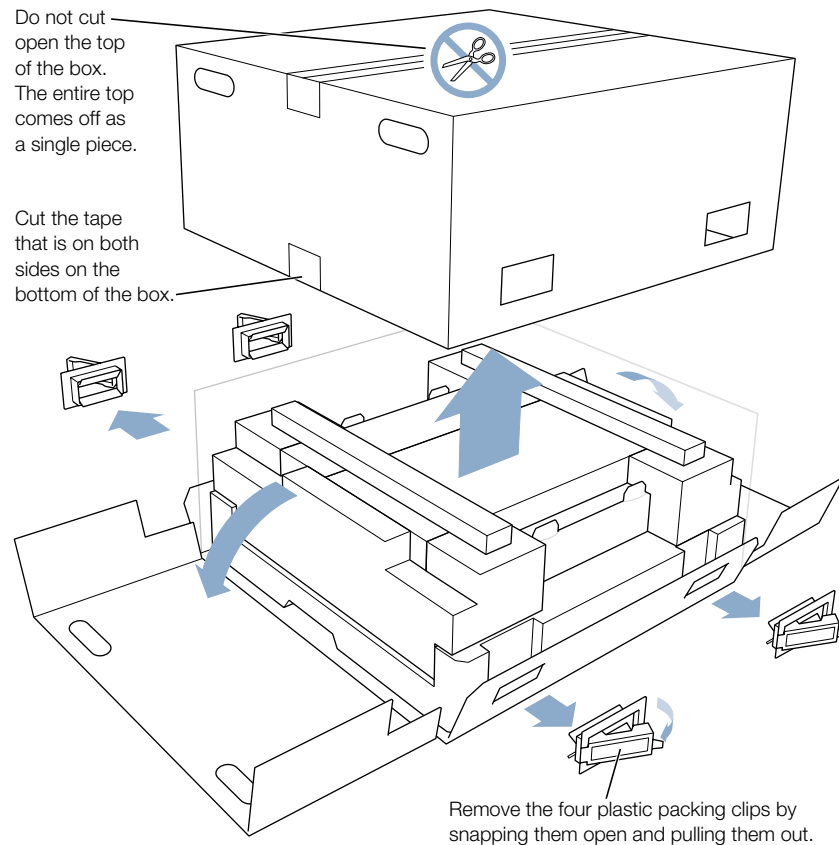
Important Two people are required to unpack, lift, or mount the Xserve RAID system in a rack. Do not attempt to lift or move the system without help from a second person.

Unpacking the System

The Xserve RAID system is shipped in special packaging to facilitate simple and safe removal from the carton. As noted previously, always work with a second person to lift or move the system.

Follow the steps below to open the carton and remove the system from its packaging.

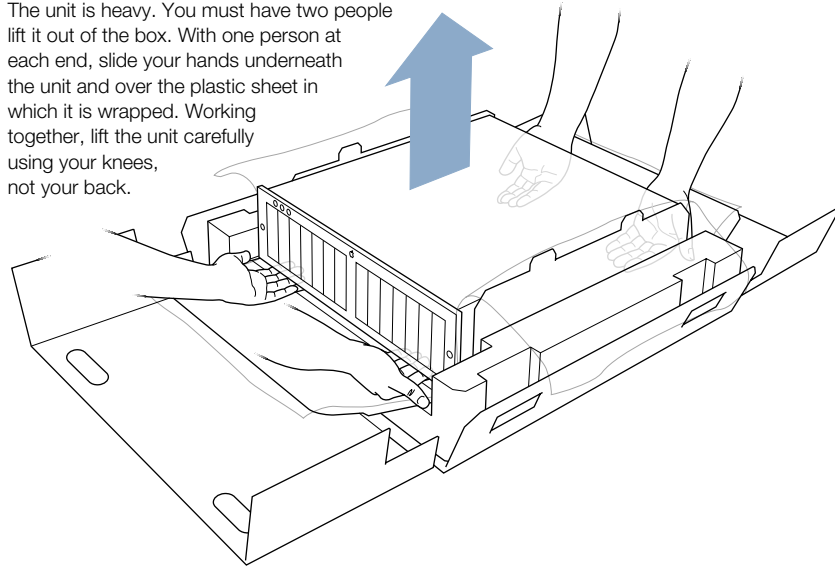
- 1 Locate a sturdy table, cart, or other flat surface on which to place the system.
The destination surface should be as close as possible to the system's carton.
- 2 With one person on each side of the carton, remove the four packing clips on each side of the carton by pulling the plastic tab at the end of each packing clip, then removing it from the carton.
- 3 Cut the tape at the bottom of the carton.



- 4 Lift off the top section of the carton and set it aside.
The system is in the lower part of the carton, beneath two smaller boxes.

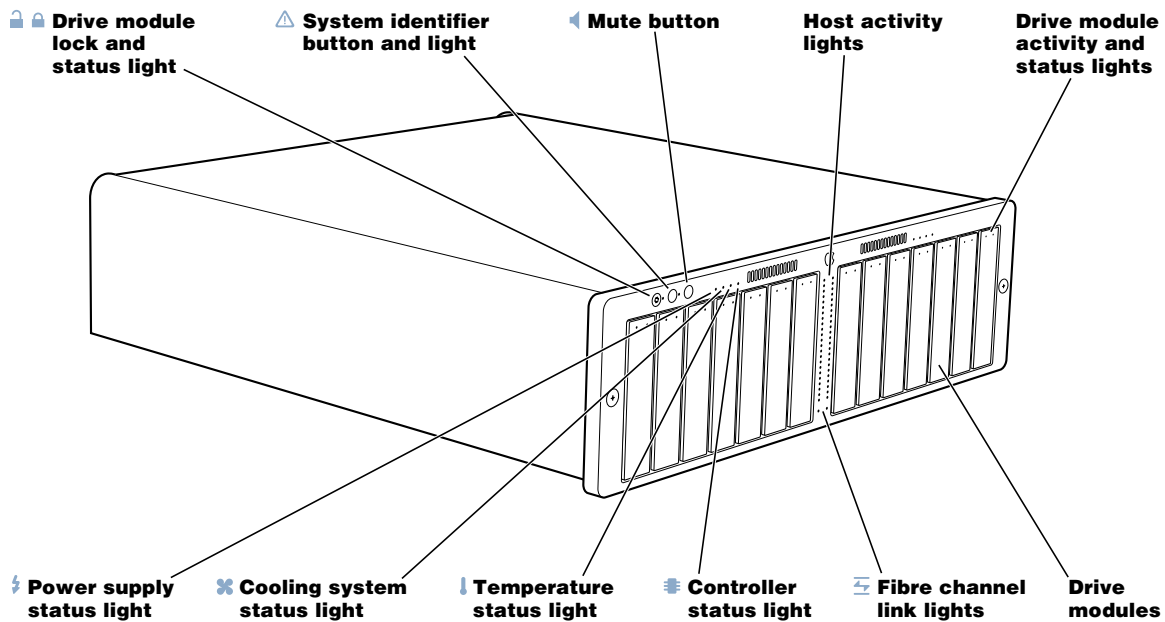
- 5 Remove the protective foam and the two boxes on top of the system.
- 6 Fold back the plastic covering on the unit and fold down the carton at the front and back of the system.
- 7 With one person at the front of the system and one at the back, carefully slide your hands between the system and its plastic cover where there are openings in the supporting foam, lift the system out of the carton, and put it on the table or other surface.

The unit is heavy. You must have two people lift it out of the box. With one person at each end, slide your hands underneath the unit and over the plastic sheet in which it is wrapped. Working together, lift the unit carefully using your knees, not your back.



- 8 Remove the protective film that covers the front of the system.
- 9 If there is a plastic bracket that covers the center part of the system's back panel, remove it. This bracket holds the components securely in place during shipping.
- 10 Remove the mounting hardware and power cords from the two separate boxes, as well as the system's documentation.
- 11 Write down the system serial number you see on the back panel. Also copy the Ethernet Media Access Control (MAC) number from the label on each control module (at the top and bottom in the center of the system). You will need these numbers when setting up and working with the monitoring and admin software.

Your System at a Glance—Front Panel



  **Drive module lock and lock status light**

The lock secures the drive modules in the system. It can be locked and unlocked with the enclosure key supplied with the system (or a 3 mm. hex key).

 **System identifier button and light**

The system identifier light turns on if a problem is detected. You can also turn it on manually by pressing the button. This indicator is useful for locating a particular unit in a rack with multiple systems. A duplicate is on the back panel. (See “Using Status Lights and Other Indicators” on page 46 for more information.)

 **Mute button**

Press to turn off the audible alarm that signals an error condition. (You can also turn off the alarm using the system’s monitoring and admin software.)

Fibre channel activity lights

Two vertical rows of 23 lights indicate fibre channel activity. (See “Using Status Lights and Other Indicators” on page 46 for more information.)

Drive module activity and status lights

Each drive module has two lights showing disk activity and drive status. See “Using Status Lights and Other Indicators” on page 46 for details.

 **Power supply status light**

Indicates power supply operation: green is OK, red is failure. (See “Using Status Lights and Other Indicators” on page 46 for more information.)

 **Cooling system status light**

Indicates cooling module operation: green is OK, red is failure.

 **Temperature status light**

Indicates temperature status: green is OK, red is failure.

 **Controller status light**

Indicates RAID controller operation: green is OK, red is failure. (See “Using Status Lights and Other Indicators” on page 46 for more information.)

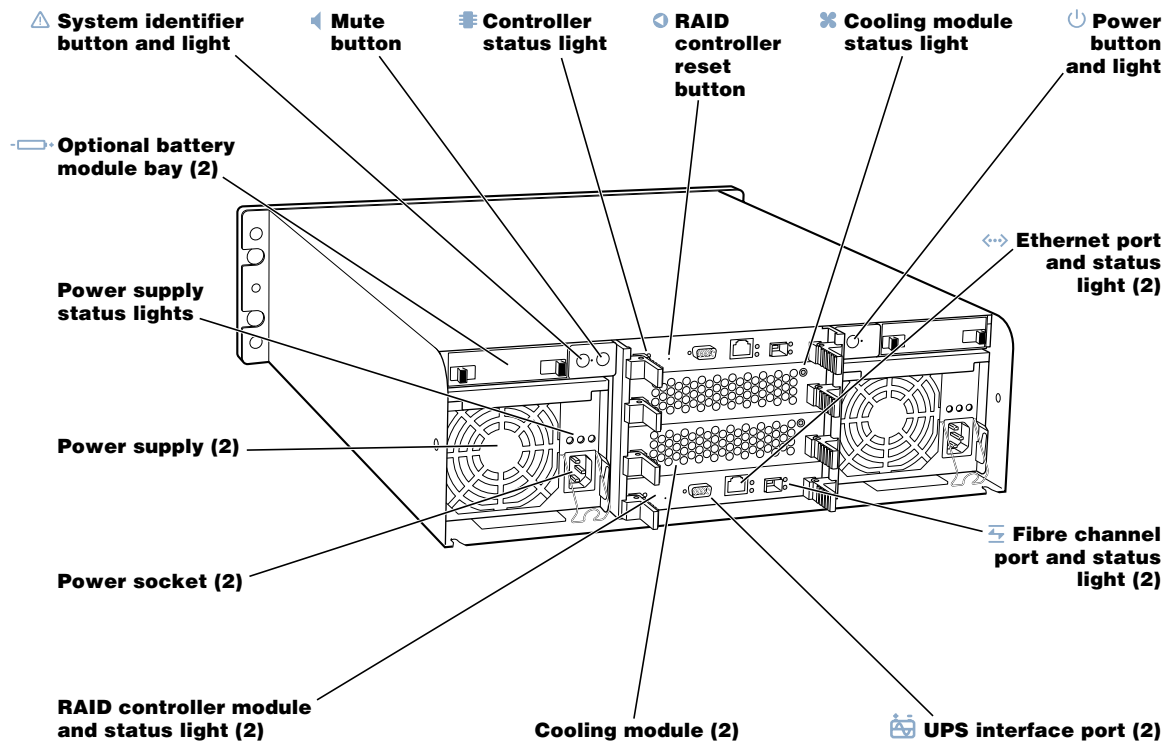
 **Fibre channel link lights**

Two lights indicate that a fibre channel connection is active for each RAID controller.

Drive modules

You can install up to 14 drive modules, in two groups of 7 modules each. You can remove and install these modules while the system is running. (See “Installing or Replacing an Apple Drive Module” on page 49 for more information.)

Your System at a Glance—Back Panel



**System identifier button and light**

The system identifier light turns on if a problem is detected. You can also turn it on manually by pressing the button. This indicator is useful for locating a particular unit in a rack with multiple systems. A duplicate system identifier button and light are on the front panel. (See “Using Status Lights and Other Indicators” on page 46 for more information.)

**Mute button**

Press to turn off the audible alarm that signals an error condition. (You can also turn off the alarm using the system’s monitoring and admin software.)

**RAID controller card, status lights, and reset button**

The top controller manages the seven drive modules on the left side of the system (when facing the unit); the bottom controller manages the seven drive modules on the right. Use the reset button to restore the factory settings.

**Cooling module and status light**

A redundant, hot-swappable cooling module cools the system.

**Power button and light**

Press to turn on the system.

**Battery module bay and cover**

You can install optional battery modules to protect data in each RAID controller’s cache. A cover protects the two battery spaces if battery modules are not installed.

**Power supply and status lights**

A redundant, hot-swappable power supply provides power for the entire system. (See “Using Status Lights and Other Indicators” on page 46 for more information.)

**Ethernet port and status light**

Use the Ethernet port to connect to a network and manage the system remotely.

Power socket (in each power supply)

Connect the power cord here. The cord is held in place by a special clip.

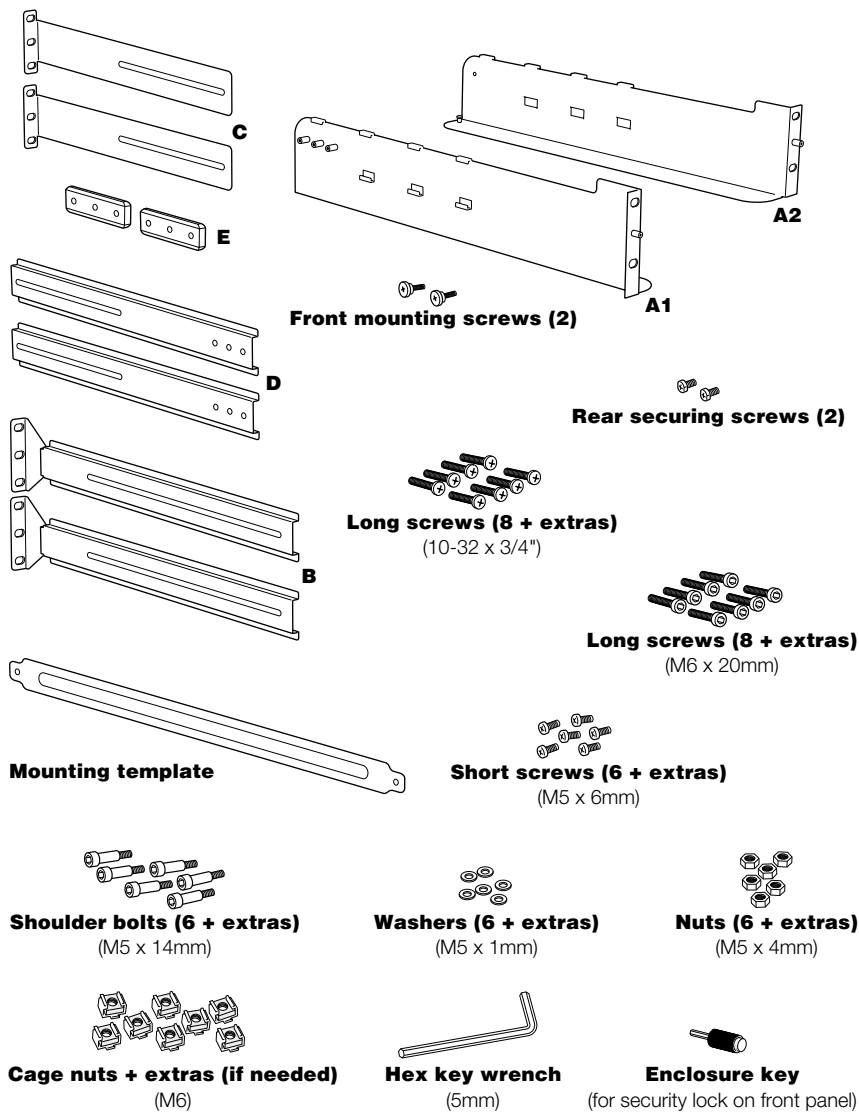
**UPS interface port**

Connect an uninterruptible power supply (UPS) to this port.

**Fibre channel port and status light**

Use this port to connect each group of seven drive modules to a host bus adapter card located in a server or desktop system using a fibre channel cable.

Your System at a Glance—Mounting Hardware



L-shaped brackets (A1 and A2)

Two large L-shaped brackets attach to the front of the four-post rack and support the system.

Bracket extenders for a 24- to 29-inch rack (B)

These extenders attach to the brackets A1 and A2 and to the rear rail of the standard four-post rack.

Bracket extenders for a 29- to 36-inch rack (C and D)

Connect these two extenders and attach them to the brackets A1 and A2 and to the rear rail of the deep four-post rack.

Solid bar for connecting bracket extension pieces (E)

Use this bar to fasten extenders C and D for a deep rack.

Screws, nuts, washers, and hex key wrench for mounting the system

Use this hardware to secure the system to the rack and to connect the bracket extenders. See “Assemble the Brackets and Extenders” on page 27 for more information.

Mounting template

Use this template to help mount the brackets squarely to the rack. See “Assemble the Brackets and Extenders” on page 27 for more information.

Preparing to Install Xserve RAID in a Rack

Before you install the system in a rack, carefully consider the placement of the unit in its rack and several other factors in the infrastructure that will keep the system operating efficiently.

Guidelines for Installation

To ensure safe and smooth operation of your Xserve RAID system, it's essential that you choose an appropriate location for the system in its rack, and provide an appropriate operating environment and adequate power for all components in the rack. In addition, the system requires special handling because of its weight.

As you plan for installation, follow these guidelines to ensure that the system and its environment are safely and appropriately positioned for efficient operation and service.

Precautions for Handling the System

When configured with a full set of drive modules, the system weighs approximately 100 pounds. Take the following precautions to avoid problems or potential injury as you handle the Xserve RAID system.

- Never try to unpack, lift, or carry the system by yourself. Always have another person available to help move or lift it.
- Prepare a flat, sturdy surface before removing the system from its packaging. The table or cart that will hold the system should be as close as possible to the system's carton.
- Both people should follow these guidelines to lift or move the system:
 - Stand with your legs shoulder-width apart to maintain balance.
 - Breathe deeply and tighten your stomach muscles to increase support for lifting.
 - Bend at your hips and knees, not at your waist.
 - Use your leg muscles to lift.

- Lift with a smooth motion; don't jerk the load up or down.
- Keep the system close to your body and at waist level to lessen the load on your back.
- Maintain body alignment while lifting, so that your back, ears, shoulders, and hips are in line and your eyes and feet are facing the system.
- To turn while holding the system, use your feet; don't twist your back or torso.

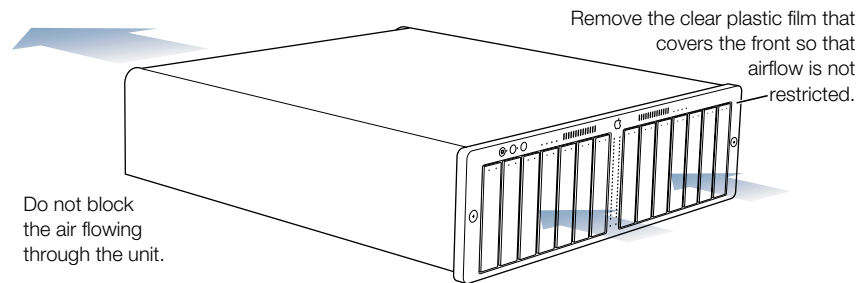
Choosing the System's Location in the Rack

The Xserve RAID system is designed for use in a four-post rack or cabinet. The rack must be 19 inches wide; it can vary in depth from 24 to 36 inches.

Important Do not try to install an Xserve RAID system in a two-post, or telco-style, rack. The system cannot be mounted safely in a two-post rack.

When determining where to place the system in a four-post rack, keep the following points in mind:

- Because of the system's weight, you may want to install it at or below the middle of the rack.
- Measure the height needed in the rack (3U, or 5.25 inches at minimum).
- Also measure the depth of the rack and the distance between the back panel of the system and the rear rail of the rack. This measurement will help you determine which of the bracket extenders to use when mounting the system in the rack.
- Air to cool the system flows from front to back. Be sure not to cover any of the ventilation holes in the front or back panels of the unit. Consistent airflow is essential to keep the system operating efficiently.



- Allow room at the front and back of the system for service. Leave at least 36 inches clear in front of the system, so that you can easily swap drive modules and remove the system from the rack if necessary. Leave 24 to 30 inches clear behind the system to install or exchange components.

- For a rack that has multiple devices, you may want to prepare a list of all equipment in the rack and the requirements for each unit. Such a list should include the following information:

Component	Power needed	Clear area front / back	Height in rack	Temperature range	Other
Xserve RAID					
Server 1					
Server 2					

Managing Cables

Your Xserve RAID system uses three to six cables and two power cords. It's a good idea to determine how these cables and cords will be arranged at the rear of the system and where the cables will be routed to connect to a host system. See "Connecting Xserve RAID to a Host System or Switch" on page 38 for details about connecting cables.

Rack Stability

The rack must be stable and strong enough to hold the Xserve RAID system and the other devices installed.

- Check the documentation for the rack to make certain that it can support all its components.
 - Important** Do not exceed the weight limit recommended for your rack.
- Make certain that all components are secured in the rack.
- When installing the system in a cabinet that has casters, verify that you can secure the casters to keep the cabinet from moving as you mount the system. If the cabinet does not have a brake, make sure you can place the back of the cabinet against a wall as you install the system at the front.

Electrical Power

If you plan to install the system in a rack that contains other components, be sure that the circuitry and power connections are sufficient for the combined power needs of all components. To plan for safe and adequate power to the system, follow these guidelines:

- Check the documentation for all components in the rack to determine their power requirements. Then make sure that the available power supply for the rack is sufficient for the planned components.
- If you need assistance determining the power needs of the components in the rack, consult an electrical expert who is familiar with your facility.

- If there are devices in the system's location that use large amounts of power, use surge protectors or power conditions as part of the installation.

Important When planning for electrical power, make sure you have more power than the total power requirements specified for all components. Also make certain that the power load is distributed evenly among circuits to the rack's location. Consult an electrician or other expert if you need assistance with planning for the power needs of your components.

- Make sure that the power connections for the system and all other components are grounded (according to local and national standards). Consult an electrician if you need assistance with grounding.
- See Appendix A, "Specifications," on page 83 for more information about electrical power requirements for the system.

Operating Environment

The operating environment for the system's rack must meet certain requirements:

- Verify that the temperature range of the rack's location is within the limits established for the system and all other components.
- Make certain that the rack's location has adequate ventilation to maintain the necessary temperature range. This is particularly important for a rack that is enclosed in a cabinet.
- If multiple components are installed in the rack, consider additional cooling to assure efficient operation of the system and other equipment.

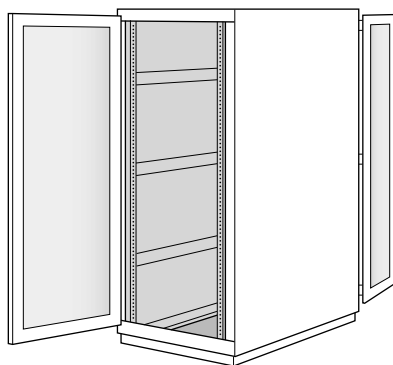
Security

To ensure the security of the system and rack, note the following:

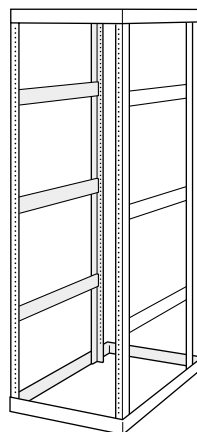
- Determine that the rack's location is secure and that only authorized staff members or technicians can gain access to this location.
- If using a cabinet that is not stored in a secure room, be sure that the cabinet can be locked securely and that access to it is limited to authorized staff.
- Develop a plan for distributing and controlling keys to the rack's location and access codes that will allow others to manage the system over the network. Keep the plan updated with names of key staff and relevant emergency information and procedures.
- Store a copy of essential system access information in a safe place away from the system's location.
- Store the Xserve RAID documentation and related materials in a central location and inform key staff of that location. Also post electronic documents on network locations to which users of the system will have access.

Mounting Xserve RAID in a Rack

The Xserve RAID system is specifically designed for rack mounting. It is not designed for use as a desktop system. You can install the system in a four-post cabinet or rack that is 19 inches wide and between 24 and 36 inches deep. The system is 5.25 inches (3U) high.

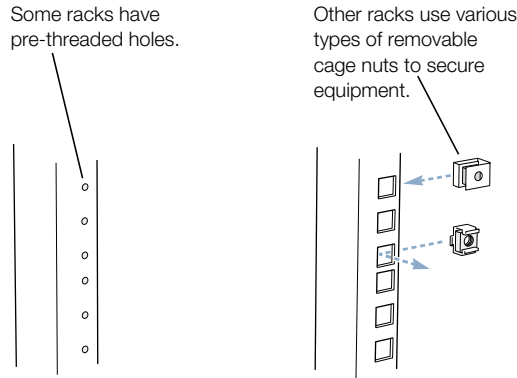


Four-post cabinet rack



Four-post open rack

The brackets and screws necessary to attach the system to a four-post rack with threaded holes are included with your system. If your rack has square, unthreaded holes, you may need to insert cage nuts (some are provided with the system) into the appropriate holes before attaching the system to the rack.



Important Any rack used for Xserve RAID should meet the specifications of the American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA) standard ANSI/EIA-310-D-92, International Electrotechnical Commission (IEC) 297, and Deutsche Industrie Norm (DIN) 41494. See the documentation for the rack to determine whether it is compatible with these standards.

Getting Ready to Install the System

Before working with the system, mounting hardware, and rack, make the following preparations.

Important Check the rack's documentation for any special requirements.

- Arrange to work with another person as you prepare the system and install it in a rack.
- Assemble the tools, brackets, and fasteners you'll need for the installation. (All except the screwdriver and pliers or wrench are provided with the system.) You will need
 - a medium-sized Phillips screwdriver. If you have a power screwdriver, use it.
 - a pair of pliers or a small wrench
 - the large L-shaped brackets and (depending on the depth of your rack) one or two bracket extenders
 - the hardware supplied with the system to assemble the extenders and secure the system to the rack. See "Assemble the Brackets and Extenders" on page 27 for details.

Note: Several sets of screws are provided with the system. These screws are designed for racks with prethreaded holes. Check the documentation for your rack and use the appropriate set of screws; most racks use one of the sizes. If screws are provided with your rack, you can use those as well.

- To measure and mark the position of the system in the rack, you can use the metal mounting template that came with the system. You can also use a pen or pencil and some masking tape or similar tape to mark the position on the rack.
- Clear a table, cart, or other flat surface near the rack. You'll need to put the system on it temporarily during installation, and you can use it to lay out the brackets and screws you'll use to attach the system to the rack.

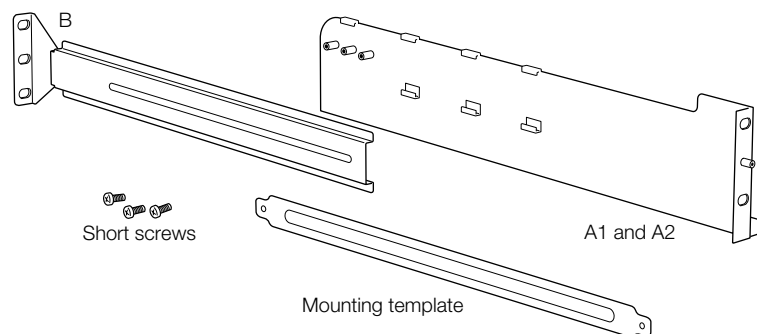
Determine the Position for the System in the Rack

Review the guidelines for positioning the system in the rack (see “Choosing the System’s Location in the Rack” on page 20). Then follow these steps to measure and mark a specific location.

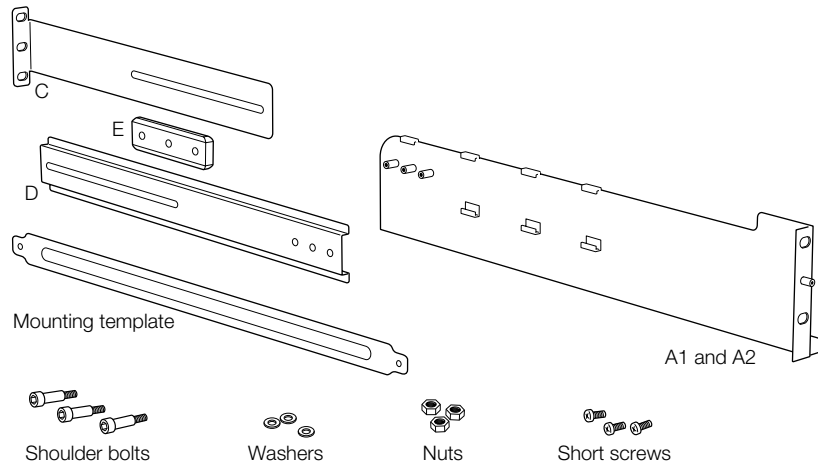
- 1 Determine the exact position where you want to attach the bottom edge of the system and mark it on one side of the rack. To be sure there is room for the system at this position in the rack, the space available must be at least 5.25 inches from bottom to top.

The distance between holes may vary somewhat on racks made by different manufacturers.

- 2 Use the template included with the system to mark the same spot on the other side of the rack.
- 3 Measure the depth of the rack.
 - If your rack is 24 to 29 inches deep, use brackets A1 and A2 and the medium-length extenders with a three-hole lip at one end (item B in the illustration below).



- If your rack is 29 to 36 inches deep, combine the shorter extender with a three-hole lip at the one end (item C in the illustration below) and the longest piece (with no lip; item D in the illustration), using the solid bar (item E in the illustration). This combination creates an extender long enough to reach the rear of a deep rack.



For a rack exactly 29 inches deep, try the A and B combination of bracket and extender; if that does not fit, use the A, C, D, and E combination.

Prepare the System for Installation

Follow these steps to prepare the system hardware for installation.

- 1 With a second person, unpack the system from its carton and place it on the table or cart. Follow the instructions in “Unpacking the System” on page 10.
- 2 Write down the serial number on the system’s back panel and the two Ethernet MAC numbers on the RAID controller modules (at the center of the back panel).

You will need these numbers when you set up and use the Xserve RAID software.

Installing the System

To install the system in the rack, you

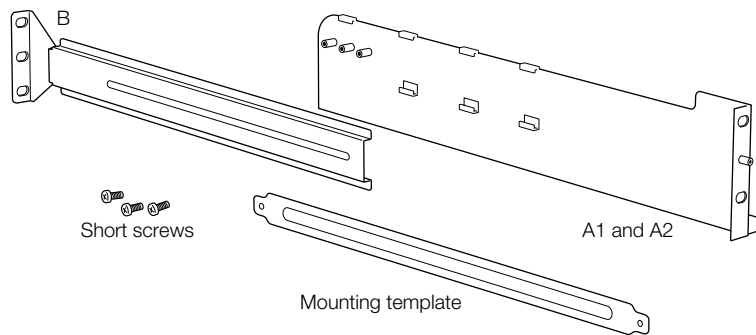
- assemble the brackets
- attach the brackets to the rack
- rest the system on the brackets and secure it to the rack

Assemble the Brackets and Extenders

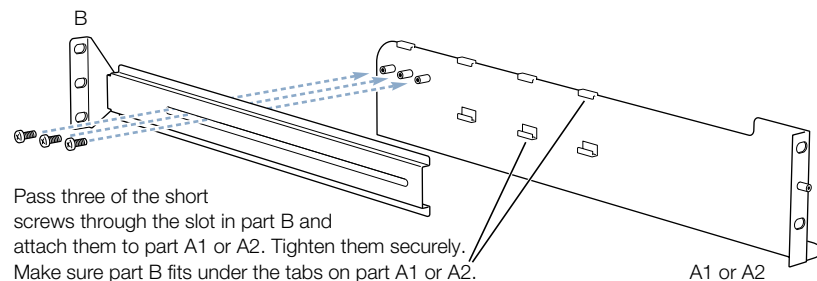
Follow these steps to assemble the brackets and extenders for the depth of your rack.

For a Rack 24 to 29 Inches Deep

- 1 Gather the two large brackets (items A1 and A2) and the two longer extenders (item B in the illustration below), along with the necessary screws:
 - six short screws for assembling two brackets and extenders
 - four long screws for securing the brackets to the rack
 - two mounting screws for attaching the system to the rack

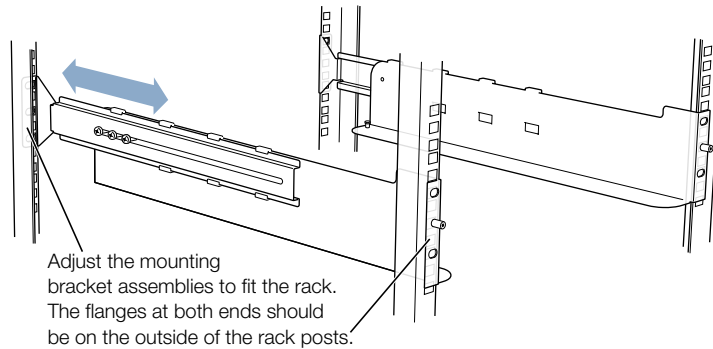


- 2 Place the cut-out area of the extender (B) over the three posts that extend from the wider side of the bracket A.



- 3 Fasten the bracket and extender together using three short screws and tighten the screws. Note that you can still slide the extender backward and forward.

- 4 Fit the assembled pieces into the rack so that the extender's lip is near the rear rail and the lip of bracket A points toward the outer edge of the rack at the front rail.

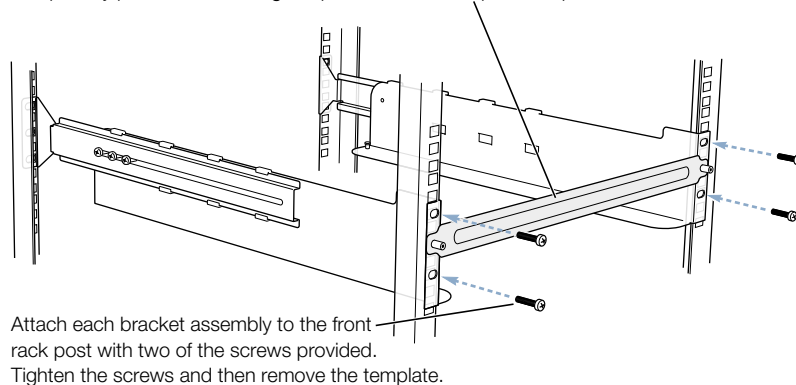


The orientation of bracket A determines on which side of the rack it belongs. The lower part of this L-shaped bracket faces inward (to support the system). The posts on the upper part of the bracket face outward and the extender is on the outside of the bracket. (In the illustration, bracket A1 goes on the left as you face the rack; A2 goes on the right of the system.)

- 5 Hold one of the A brackets against one rail on the front of the rack at the position you marked, then place the metal template over the post on the front of the bracket.
- 6 Have the other person hold the second A bracket at the position marked on the other front rail and place the metal template over the post on the front of the second bracket.

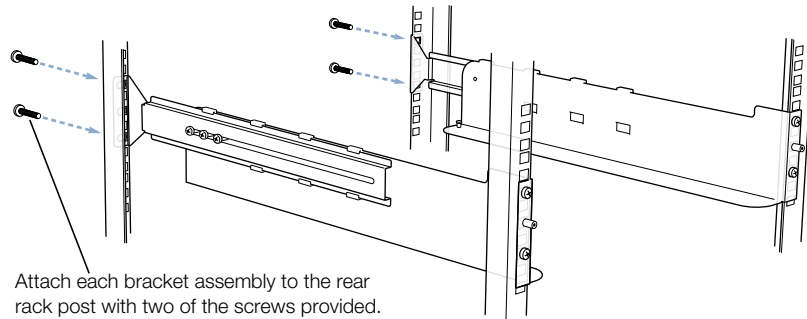
Important The brackets must be attached to the rails at a 90-degree angle to ensure that the Xserve RAID system is mounted securely. Use the template to guide you in attaching the brackets correctly.

Temporarily place the mounting template over the two posts on parts A1 and A2.



- 7 Securely fasten two long screws in the top and bottom holes of bracket A on each of the rack's front rails.
- 8 With one person on each side of the rack, slide the extender backward until its lip is even with the rear rail of the rack.
- 9 At the back of the rack, use two long screws to secure the extender to the rear rail.

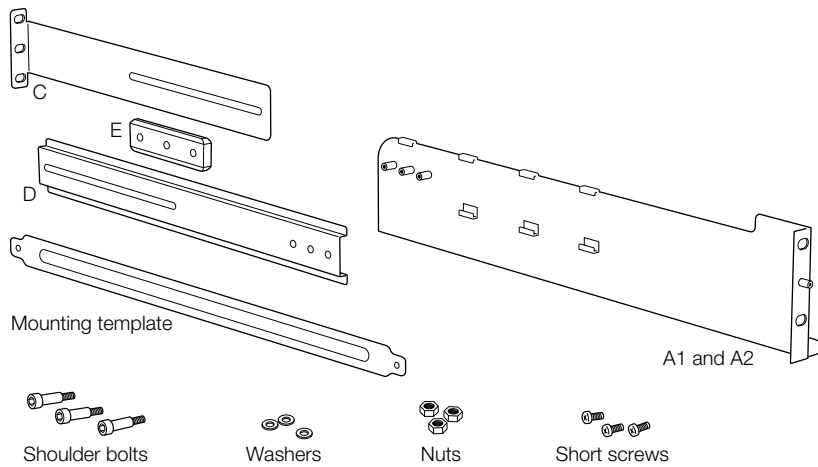
Put the screws in the top and bottom holes in the extender. (If the rack's holes do not line up with the top and bottom holes in the extender, put the screws in holes that are aligned with the extender, but be sure to attach both screws.)



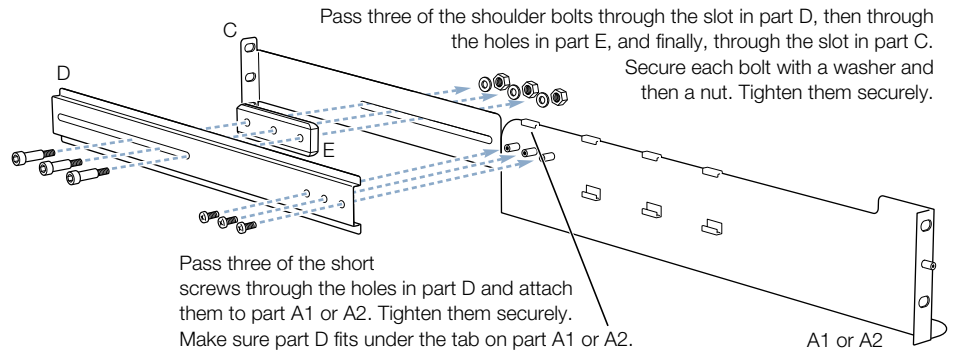
Repeat this procedure for the second bracket and extender.

For a Rack 29 to 36 Inches Deep

- 1 Gather the two brackets (A1 and A2), the two shorter extenders (item C in the illustration below), the two flat pieces (item D in the illustration), the two solid bars (item E in the illustration), and the necessary screws and nuts:
 - six short screws for assembling two brackets and extenders
 - six shoulder bolts, six washers, and six nuts for joining the brackets and extenders
 - four long screws for securing the brackets to the rack
 - two mounting screws for attaching the system to the rack
 - the L-shaped hex key wrench supplied with the system (for connecting the extenders)



- 2** Join the shorter extender (C) and the flat piece (D) by placing the solid bar (E) between them as shown in the illustration below.

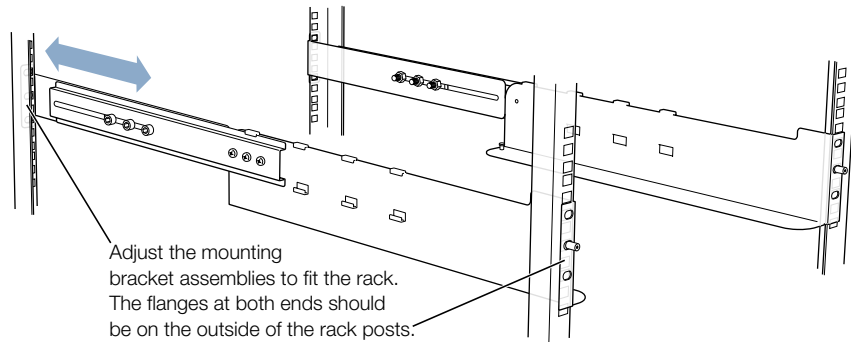


- a** Fit the solid bar into the indentations in the two flat pieces.
- b** Place the cut-out area of the extender C and piece D over solid bar E.
- c** Use three shoulder bolts, washers, and nuts to fasten pieces C and D over solid bar E.

Use the pliers or wrench to hold the nuts as you tighten the bolts with the hex key wrench. Note that even with the nuts tight you can slide the extender forward and backward.

- 3** Place the three holes of piece D over the three posts that extend from the wide side of bracket A1 or A2.
- 4** Use three short screws to fasten piece C to bracket A1 or A2. Tighten these screws all the way.

- 5 Fit the assembled pieces into the rack so that the extender's lip is near the rear rail and the lip of bracket A points toward the outer edge of the rack at the front rail.



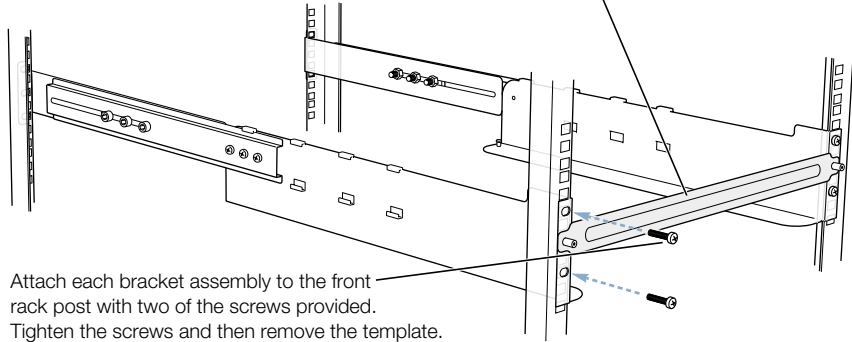
The orientation of bracket A determines on which side of the rack it belongs. The lower part of this L-shaped bracket faces inward (to support the system). The posts on the upper part of the bracket face outward, and the extender is on the outside of the bracket. (In the illustration, bracket A1 goes on the left as you face the rack; A2 goes on the right of the system.)

- 6 Hold one of the A brackets against one rail on the front of the rack at the position you marked, then place the metal template over the post on the front of the bracket.
- 7 Have the other person hold the second A bracket at the position marked on the other front rail and place the metal template over the post on the front of the second bracket.

Important The brackets must be attached to the rails at a 90-degree angle to ensure that the Xserve RAID system is mounted securely. Use the template to guide you in attaching the brackets correctly.

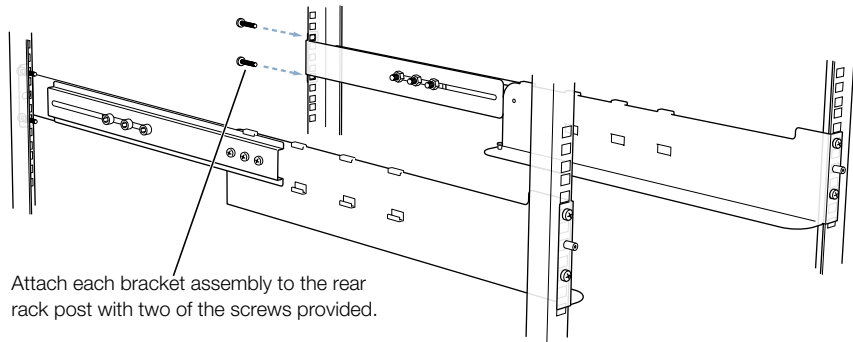
- Securely fasten two long screws in the top and bottom holes of bracket A on each of the rack's front rails.

Temporarily place the mounting template over the two posts on parts A1 and A2.



- With one person on each side of the rack, slide the extender backward until its lip is even with the rear rail of the rack.
- At the back of the rack, use two long screws to secure the extender to the rear rail.

Put the screws in the top and bottom holes in the extender. (If the rack's holes do not line up with the top and bottom holes in the extender, put the screws in holes that are aligned with the extender, but be sure to attach both screws.)



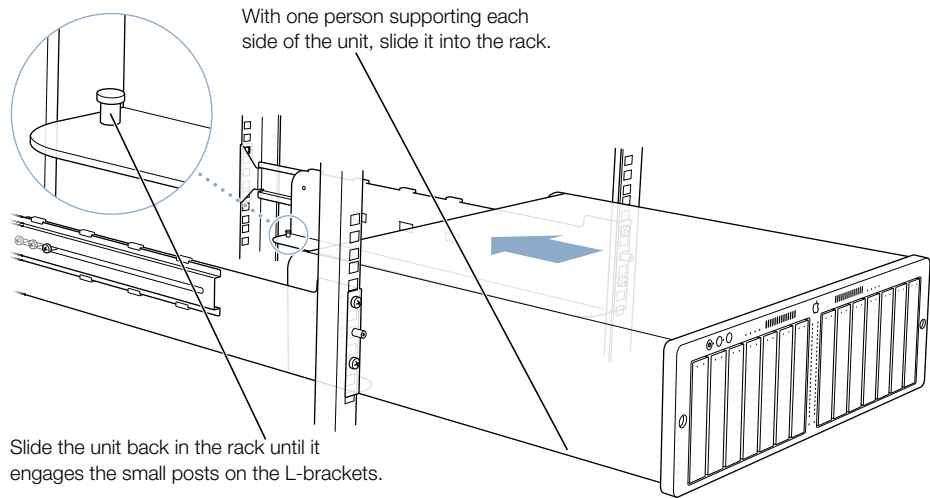
Repeat this assembly procedure for the second bracket and extender pieces.

Mount the System in the Rack

When the brackets are secured to the rack, you can put the system in the rack.

Follow these steps to mount the Xserve RAID system in the rack.

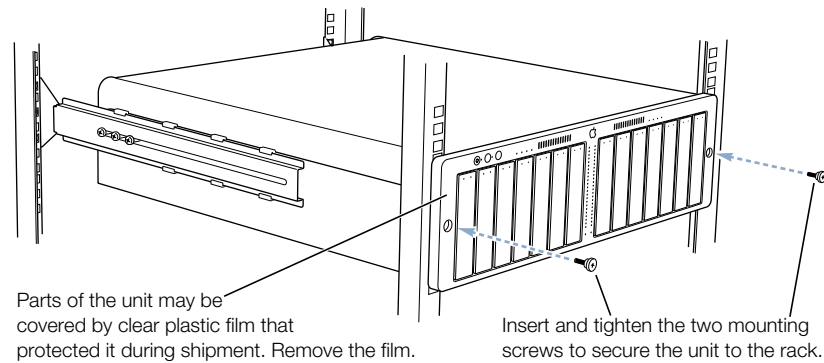
- 1 With one person on each side of the system, lift it so that the bottom of the unit is level with the lower part of the bracket.
- 2 Slide the system into the rack.



- 3 Use the two rack screws to secure the system to the front rail of the rack.

Important Be sure to tighten the rack screws so that the system is firmly attached to the rack.

You can use the Phillips screwdriver to tighten these screws.



Secure the System in the Rack or Cabinet

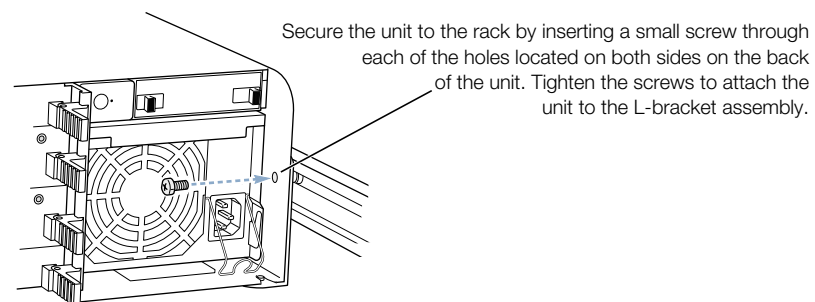
Once you have mounted the system and attached it to the front of the rack, you must secure it at the back.

Follow these steps to secure the system at the back.

- 1 At the back of the system, locate the small hole in the lip that extends beyond the back panel on the side of the enclosure.

This hole is next to the mounting bracket.

- 2 Insert a small, rear-securing screw on the inside of the lip, guide it into the threaded hole in the mounting bracket, and tighten the screw.



- 3 Insert and tighten a small screw on the other side of the system.

Once the system is mounted and secured in the rack, you can connect it to a host server or computer.

Note: The user-serviceable parts described in this manual can be installed or replaced while the system is mounted in the rack. See Chapter 6, “Installing or Replacing Components,” on page 49 for details.

Moving the Xserve RAID System

If you need to move the system after you have mounted it in a rack or cabinet, you must follow the precautions listed below.

Warning Make certain that the system is securely fastened to the rack or cabinet and that all components are firmly in place before attempting to move the rack or cabinet. If the system or components are not secure, moving the system could result in injury or damage to the hardware.

Before moving a rack or cabinet that contains the Xserve RAID system:

- If feasible, remove the system from the rack and remount it after moving the rack or cabinet; always use two people to hold or carry the system.
- If you cannot remove the system, carefully secure the rack screws on the front and rear of the system.
- Check the fastening tabs or handle on each component on the back panel to be sure that all are firmly closed and in place.

Connecting Xserve RAID to a Host System and a Network

Xserve RAID provides two groups of up to seven drive modules, each with a dedicated RAID controller. This flexible design allows you to connect the storage system to a single host using two fibre channel cables, or to dual hosts using one cable to each host.

To establish communication with a host, you can purchase the Apple Fibre Channel PCI Card or use a compatible fibre channel card that supports the Xserve RAID system. Xserve RAID is compatible with the Xserve system and Power Mac G4 models with a processor speed of at least 800 MHz. It requires Mac OS X version 10.2.4 or later, or Mac OS X Server v10.2.4 or later. For the latest list of compatible host systems, check the Apple website: www.apple.com/xserve.

To complete the host connection, you need to

- install the host bus adapter card in a host server or computer
- connect the Xserve RAID system to the fibre channel card in a host system or to a switch using fibre channel cables
- connect to an Ethernet network
- connect the two power cords to the Xserve RAID system

As an option, you can also connect an uninterruptible power supply (UPS).

Installing the Host Bus Adapter Card in the Host System

The Apple Fibre Channel PCI Card is a 7-inch PCI card that you can install in the Xserve system or Power Mac G4 models with a processor speed of 800 MHz or faster. This adapter card has two fibre channel connectors, which you use to connect the card to the Xserve RAID system.

Consult the documentation that came with your server or computer for instructions on installing the adapter card.

Important In an Xserve system, you must install the Apple Fibre Channel PCI Card in the upper PCI slot. This card has been FCC certified only for installation in the upper slot.

Alternatively, you may be able to connect the Xserve RAID system to a fibre channel card from another manufacturer. See the specifications and documentation for the card to determine if it is compatible with Xserve RAID.

Connecting Xserve RAID to a Host System or Switch

The Xserve RAID system uses high-speed fibre channel communication to send and receive data. Each fibre channel connection transmits data in both directions simultaneously at speeds up to 2 gigabits (Gb) per second.

About Fibre Channel Connections and Cables

The fibre channel transmission technology is designed to move large amounts of data between two devices, such as a RAID storage system and a server, or between one host and a switch that connects multiple hosts.

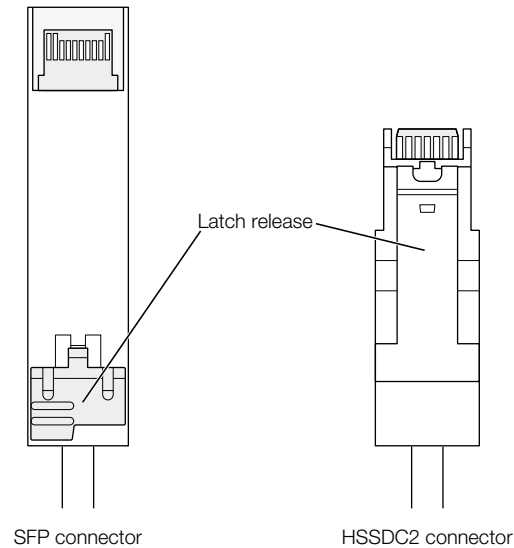
Fibre channel cables can be copper wire or optical fiber, and cabling between devices can be as long as 10 kilometers (km). Two copper fibre channel cables are included with the Apple Fibre Channel PCI Card. Each of these cables connects to one of the two RAID controllers in the Xserve RAID system and to a host system or a switch.

Xserve RAID supports the use of 1 Gb and 2 Gb fibre channel switches and hubs. For best performance, use a 2 Gb switch.

Note: If you do not purchase the Apple Fibre Channel PCI Card, you need to supply two copper fibre channel cables (up to 10 meters long) to connect to a host system or switch.

Connecting the System to Xserve or a Power Mac G4

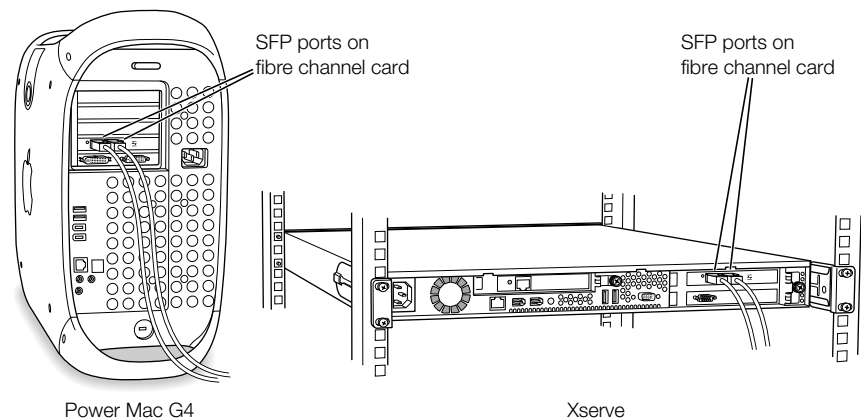
The fibre channel cables supplied with the Apple Fibre Channel PCI Card have different connectors—an SFP connector and an HSSDC2 connector—at each end, as shown in the illustration below.



Follow these steps to connect the system to Xserve or a Power Mac G4.

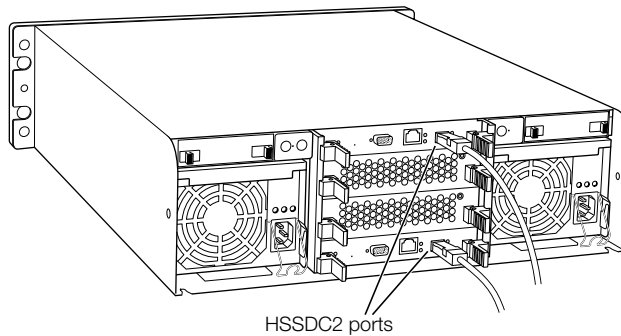
- 1 If necessary, install the adapter card in the server or computer.
- 2 Connect the SFP connectors on both fibre channel cables to the connectors on the card.

The plastic latch should be on top as you insert the SFP connector into the card.



- 3 Connect the HSSDC2 connector at the other end of each cable to the connector on each of the RAID controllers in the Xserve RAID system.

The latch on the cable's connector should be at the top as you insert it.

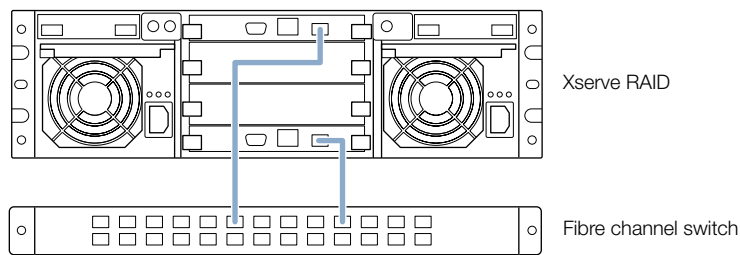


Connecting Xserve RAID to a Switch or Hub

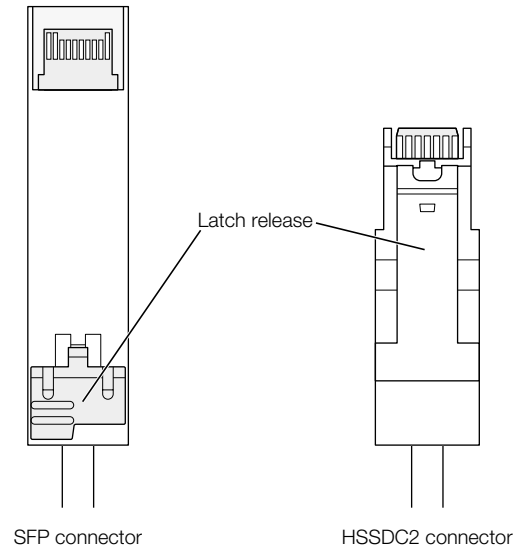
You can connect the system to a switch or hub that has fibre channel ports. (See “Xserve RAID Hardware Connections” on page 79 for an example of this type of connection.)

If you connect the Xserve RAID system to a fibre channel switch or hub, you may supply your own cables.

- 1 Verify that the switch or hub is compatible with Xserve RAID.
Check the Xserve website for a list of compatible switches: www.apple.com/xserve.
- 2 Connect the SFP connectors on both fibre channel cables to the corresponding connectors on the switch or hub.



If the switch or hub doesn't accept an SFP connector, use a fibre channel cable with a connector that is compatible with it.



- 3 Connect the HSSDC2 connectors on the cables to the RAID controllers on the Xserve RAID system.

The latch on the cable's connector should be at the top as you insert it into the controller.

Removing Cables From the Xserve RAID and Host Systems

The connectors on fibre channel cables may require special handling when you remove them from the RAID controller or fibre channel card. Follow these steps to remove a fibre channel cable.

- 1 Push the cable's connector inward slightly, then squeeze the latch release and gently remove the cable.
- 2 If you have difficulty squeezing the latch release, use a small flat tool, such as a tiny screwdriver or the end of the cover for the card opening, to depress the latch release.

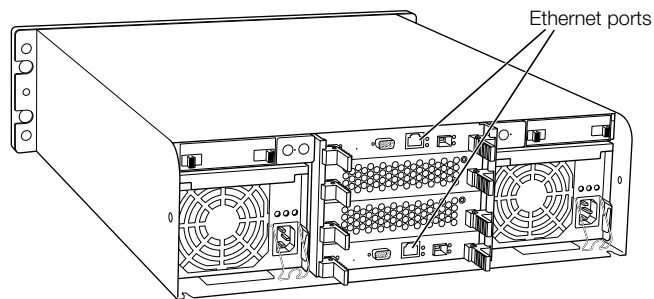
Connecting to a Network

To allow remote setup and management of Xserve RAID, you need to make a standard Ethernet connection to a network hub or server. You use this connection to configure your RAID storage system and to administer the system with the software tools provided with it. See the document “Using RAID Admin and Disk Utility” on the CD that came with your system for details on using the management software.

Ideally, you should connect each Ethernet port to a separate network to provide redundant monitoring capability.

Follow these steps to make the network connection.

- 1 Connect an Ethernet cable to the Ethernet port on each of the RAID controller modules on the back panel of the Xserve RAID system.



- 2 Connect the other end of each cable to a network hub or other network device.

Connecting Power to the System

The final step in preparing the system is connecting a power cord to each power supply on the back panel of Xserve RAID.

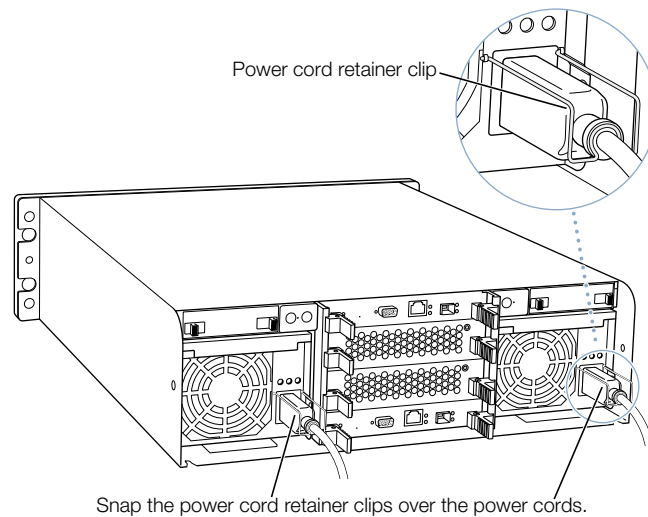
Follow these steps to connect the two power cords.

- 1 Lift the small support clip on the system's back panel, then connect one of the power cords to the socket at the lower right of one power supply.

Note: Be sure to use the power cords supplied with the system to ensure that the clip holds them securely and avoids accidental removal of a cord. If you received more than two power cords, use the ones with plugs compatible with the electrical supply for your location.

- 2 Secure the support clip to hold the power cord in place.

The half-circle at the front center of the clip goes over the cord.



- 3 Connect the second power cord and secure the clip on the cord.
- 4 Plug the cords into a power strip, outlet, or other power source.

Note: For additional protection, connect each of the power cords to a different electrical circuit, preferably on different power grids.

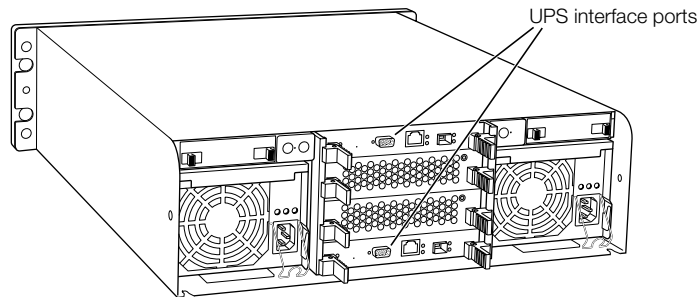
Connecting an Uninterruptible Power Supply

To protect the system's operation during an interruption in power, you may want to install an uninterruptible power supply (UPS) in or near the rack that holds your Xserve RAID system. The UPS unit must have a serial interface that supports the basic signaling protocol.

You can obtain a UPS unit through the Apple online store at www.apple.com.

Follow these steps to connect a UPS unit to the system.

- 1 If necessary, install the UPS unit in the rack, using the instructions supplied with the unit.
- 2 Connect one end of a serial cable to the appropriate port on the UPS.
The cable must be configured to support the basic signalling protocol.
- 3 Connect the DB-9 connector at the other end of the serial cable to the UPS interface on either of the RAID controllers.



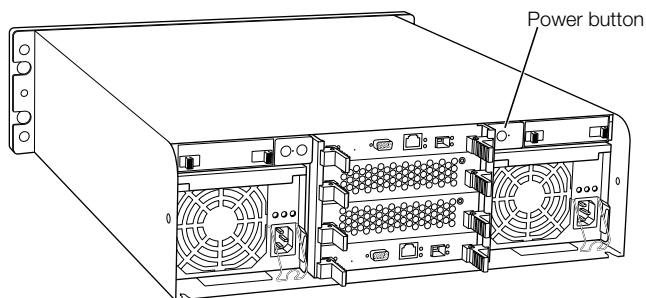
- 4 Plug one of the system's power cords into the UPS.
If you connect two UPS units to the system, plug one power cord into each UPS unit.

Using the Xserve RAID System

After you've connected to the host system or switch, you can turn on Xserve RAID and use the RAID Admin software to configure it.

Starting Up the System

When you plug the power cords into Xserve RAID, the system begins its internal diagnostics. During this time (about 30 seconds), you cannot use the power button to turn on the system.



When the diagnostics are complete, the small light next to the power button blinks. Press the power button when the light blinks and wait about 1 minute for the system to initialize.

Status lights on the front and back panels indicate network connection, system activity, and drive module use. See “Using Status Lights and Other Indicators” on page 46 for more information.

Detailed instructions for configuring RAID storage and management software are provided in the document “Using RAID Admin and Disk Utility” on the CD that came with your system.

Turning Off the System

You can shut down the Xserve RAID system using the admin software or the power button on the system's back panel. Both methods are designed to avoid data loss. Do not pull out the power cords to turn off the system.

Important Before shutting down, be sure you have unmounted the drives from your OS.

Shutting Down From a Remote System Using Software

From the host system or a remote computer, use the RAID Admin application to shut down the system.

Follow these steps to shut down the system.

- 1 Use the RAID Admin shutdown command to shut down.

This command stops data flow over the fibre channel connection.

Note: When you shut down, the system is in standby mode. To turn off all power to the system, you must disconnect the power cords.

Important Before removing or replacing a RAID controller, use the admin software or power button to shut down, and disconnect the power cords.



Shutting Down With the Power Button









You can turn off the system by pressing and holding the power button on the back panel for 5 seconds.

Using Status Lights and Other Indicators

The Xserve RAID system has a number of built-in sensors that detect and report essential information, such as power, temperature, and the condition of several key components. You can monitor the system's operation using the lights on the unit or using the remote monitoring tools.

The purpose of each system status light is listed in the table below.

Icon	Indicator	Color	Description
	Power	White	On and OK Blinking indicates standby mode
	Security lock	Yellow	Lock is engaged

Icon	Indicator	Color	Description
	System identifier	Yellow (solid or blinking)	Indicates a hardware error in the system or that someone has turned on the light manually; check the monitoring software for more information.
	RAID controller (one for each group of seven drive modules)	Green Red	OK Failure
	Power supply	(See chart below)	(See chart below)
	Battery module	Green Red	OK Failure
	Cooling module	Green Red	OK Failure
	Temperature	Green Red	OK Over temperature
	Host activity	Blue	Two rows of 23 LEDs show level of fibre channel activity on each host channel
	Fibre channel link	Green	Two LEDs indicate a link is established
	Drive module (left LED)	Blinking blue No light	Disk activity No disk activity
	Drive module (right LED)	Green Yellow/green flash Yellow Red	Good Rebuilding Drive to be serviced (prefailure condition) Problem or failure
	Drive module (blank)	No color	No hard disk in the module
	Mute button	(No LED)	Press to turn off the audible alarm that signals an error condition

The system's two power supplies each have three LEDs that indicate status. These indicators are listed in the table below.

Power Supply Condition	Green LED	Yellow LED	Red LED
No AC power to either power supply	Off	Off	Off
Power supply failure or no AC power to this power supply	Off	Off	On
AC power present and standby outputs on	Blinking	Off	Off
Power supply DC outputs on and OK	On	Off	Off
Current limit	On	Off	Blinking
Predictive failure	On	Blinking/on	Off

If the System Has a Problem

If you discover a problem with the Xserve RAID system, you can assess the situation and often solve the problem from a remote computer. You can use the RAID Admin application from a Mac OS X computer to see the status of several system attributes. For more information about this software and other monitoring tools, see the document "Using RAID Admin and Disk Utility" on the CD that came with your system.

If you have access to the system itself, you can use the buttons and indicator lights on the front and back panels to change the system's status. These include

- Power (back panel): Press to turn the system on. Press and hold for 5 seconds to turn power off.
- Mute (front and back panel): Press to turn off the alarm that signals an error condition. Check the management software for information about the problem; see the document "Using RAID Admin and Disk Utility" on the CD that came with your system for details.
- System identifier (front and back panel): This light helps you determine which system in a multiple-unit rack has a problem. The light turns on when the system has a problem; it can also be turned on manually. Press the button next to this light to turn the light off when it's on or on when it's off.

If you need to exchange components in the system, see Chapter 6, "Installing or Replacing Components," on page 49 for instructions.

The Apple Support website has the latest troubleshooting information and software updates: www.apple.com/support.

Installing or Replacing Components

Your Xserve RAID system is designed so that you can install or exchange drive modules, power supplies, and cooling modules while the system is operating. All of these components, as well as the RAID controller modules and optional battery modules, are designed as field-replaceable units.

About Replacing Components

To maintain proper airflow within the Xserve RAID system, follow these guidelines for removing or replacing components.

- When you remove any component when the system is operating, replace that component or install a new one within 10 minutes.
- If a component fails and you don't have a replacement available, leave that component in the system until you receive a replacement.

Installing or Replacing an Apple Drive Module

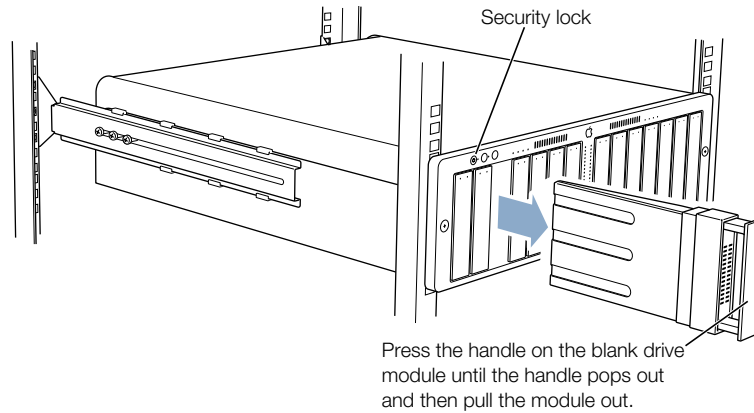
The drive modules in the Xserve RAID system are hot-swappable; that is, you can remove one and replace it with another drive while the system is operating.

Important If your drive module belongs to an unprotected RAID set or a degraded RAID set, you will lose data if you remove the drive. See the document “Using RAID Admin and Disk Utility” on the CD that came with your system for more information about RAID sets and avoiding data loss.

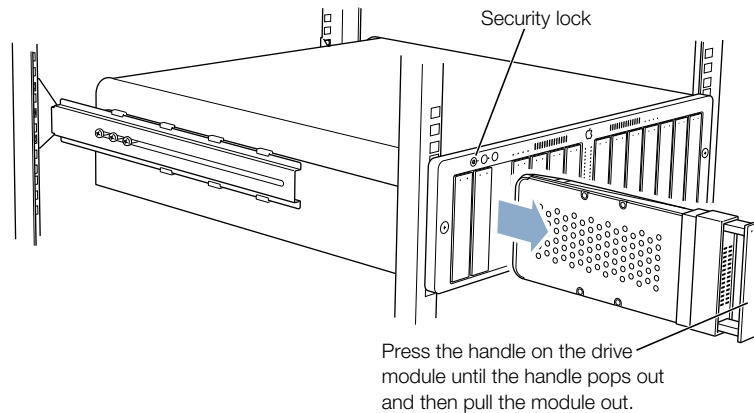
Follow these steps to install or replace a drive module.

- 1 If necessary, use the enclosure key to unlock the security lock on the system's front panel. The lock's light indicates that the drive modules are locked.

- 2 Remove the blank drive module or the drive currently installed.
 - If there is no drive installed, press the handle of the blank drive module so that it pops out, then pull the blank drive module out of the front panel.



- If there is a drive module already in the bay:
 - a Make sure the drive currently in the bay is not part of a RAID set, or you could lose data.
 - b Press the handle on the front of the drive module so that the handle pops out.
 - c Grasp the handle and pull the drive module out of its bay and set it aside.



- 3 Press to open the handle of the replacement drive module (if necessary) and slide it into the empty bay until the module is firmly seated.

- 4 If the handle is not flush with the front of the system, gently press it. If it still is not flush, pull the module out and reseal it.

The drive isn't fully seated until the handle is flush with the front of the system.

The disk status light turns green to indicate normal operation.

Important Be sure to save the blank drive module if you removed one. A blank module should always be placed in an empty drive bay to maintain proper airflow through the system.

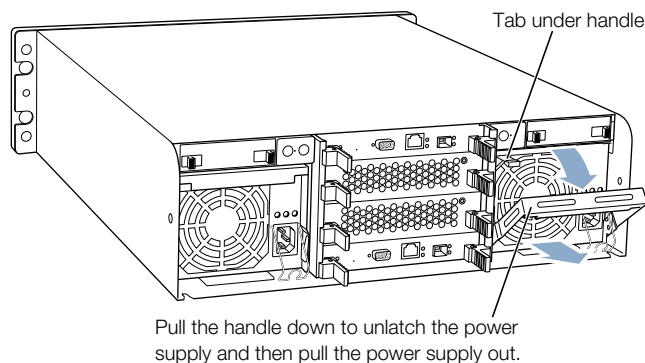
Replacing a Power Supply

Each power supply in the Xserve RAID system is hot-swappable, so you can safely replace the unit while the system is operating. When one power supply has been removed from the system (or has failed), the other one provides power for the entire system.

Important When you remove a power supply from the system, be sure to replace it with a working power supply as soon as possible to prevent the drive modules from overheating.

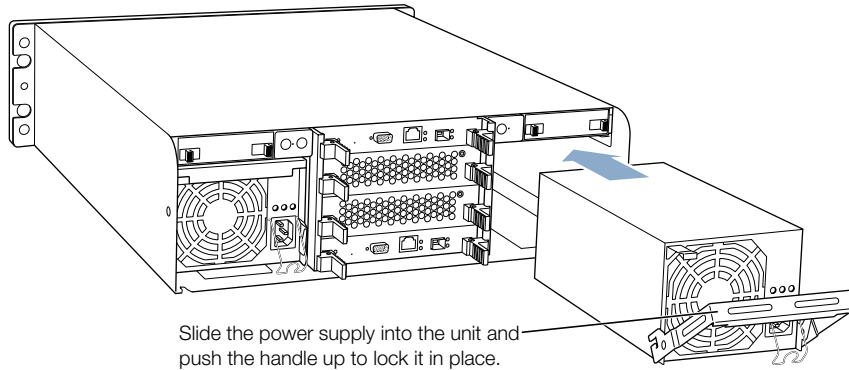
Follow these steps to replace a power supply.

- 1 Remove the packaging from the new power supply and set it near the back of the system.
- 2 Unplug the power cord on the power supply you want to replace from the power source.
- 3 Lift the clip that holds the power cord in place, then remove the cord from the back of the power supply.
- 4 Locate the small tab on the left side of the handle at the top of the power supply and press this tab down. Fold the handle down and then pull firmly outward to remove the power supply. Set it aside.



Warning Do not reach inside the system when removing a power supply or when the unit is out of the system.

- 5 Hold the new power supply by the handle and carefully slide it into the system until it clicks into place, then push the handle upward and fold it into place at the top of the unit.



- 6 Attach the power cord to the back of the new power supply and secure the clip that holds the cord in place.
- 7 Plug the cord into the power source.

Note: Keep the packaging and the old power supply. You will need to return the failed component to Apple when you receive a replacement.

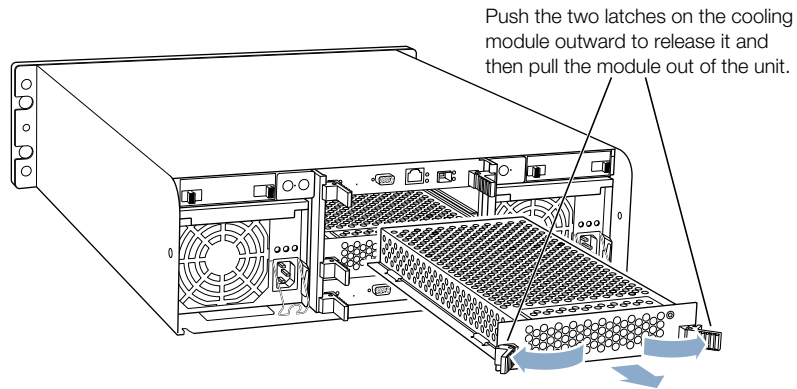
Replacing a Cooling Module

Each cooling module in the Xserve RAID system is hot-swappable, so you can safely replace this unit while the system is operating. When one cooling module is out of the system (or has failed), the other one provides cooling for the entire system.

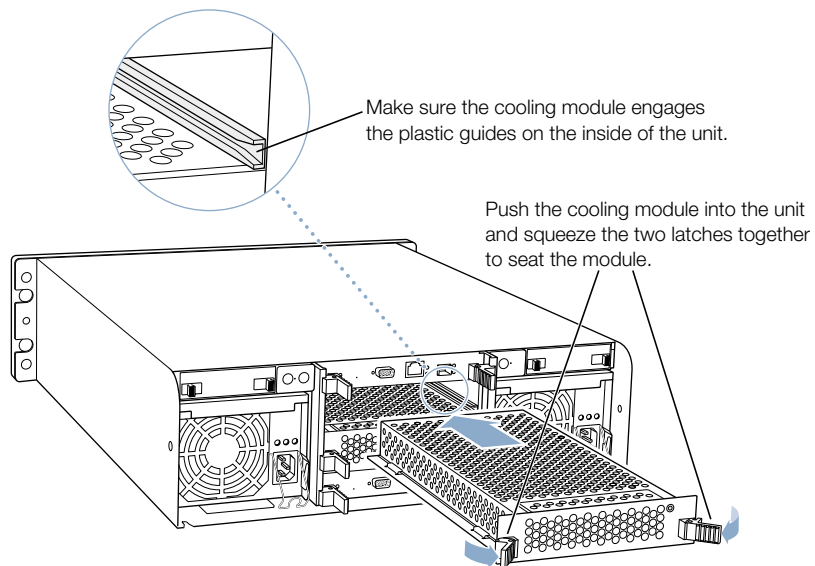
Important When you remove a cooling module from the system, be sure to replace it as soon as possible to prevent an over-temperature condition, which causes the system to shut down.

Follow these steps to replace a cooling module.

- 1 Press the two latches on the front of the cooling module apart and use them to pull the unit out of the system. If the latches have small tabs on the inside surface, slide those tabs toward you to open the latches fully.



- 2 Remove the packaging from the new cooling module. Hold the unit by the latches and carefully slide it into the system until it clicks into place.



- 3 Press in the two latches to seat the module in the system. If the latches have small tabs on the inside, slide the tabs away from you and then close the tabs.

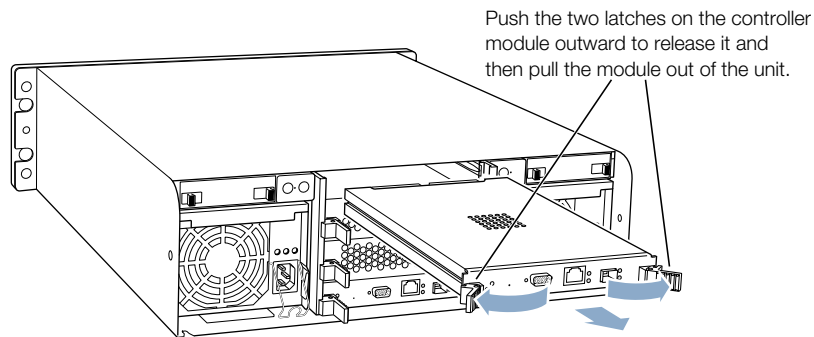
Note: Keep the packaging and the old cooling module. You will need to return the failed component to Apple when you receive a replacement.

Replacing a RAID Controller Module

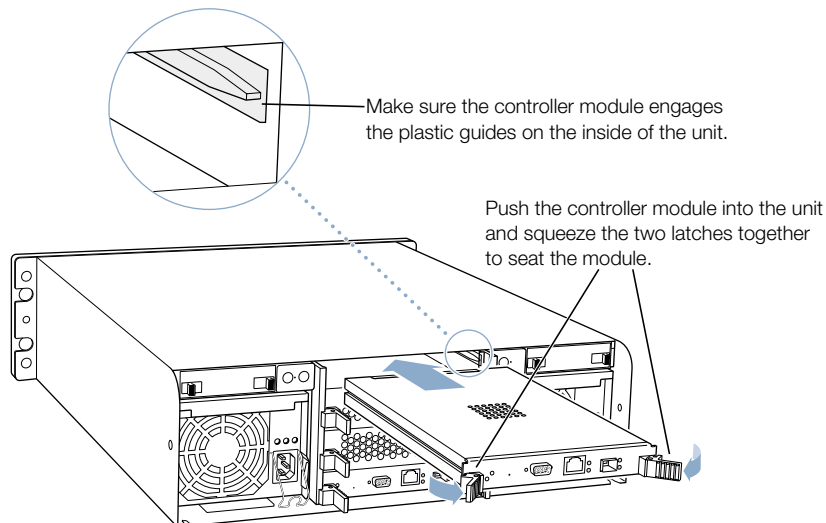
You must shut down the system before removing a RAID controller module (by unmounting all drives on the controller you are not changing, then shutting down and removing the power cords). See the document “Using RAID Admin and Disk Utility” on the CD that came with your system for shutdown instructions. When a controller module is out of the system (or has failed), the drive modules controlled by that card are not active and do not lose data stored on the drives.

Follow these steps to replace a RAID controller module.

- 1 Push the two latches on the front of the module apart and use them to pull the unit out of the system. If the latches have small tabs on the inside surface, slide those tabs toward you to open the latches fully.



- 2 Remove the packaging from the new controller module. Hold the module by the latches and carefully slide it into the system until it clicks into place.



- 3 Push the two latches together to fully seat the module in the system. If the latches have small tabs on the inside, slide the tabs away from you and then close the tabs.

Note: Keep the packaging and the old controller module. You will need to return the failed component to Apple when you receive a replacement.

Installing or Replacing a Battery Module

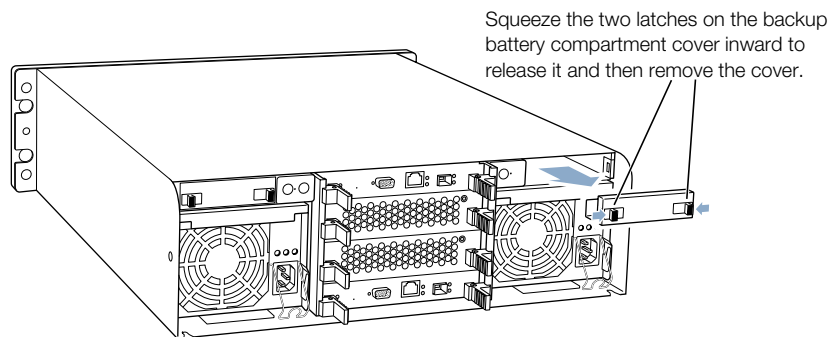
You can obtain optional battery modules to protect data in the Xserve RAID controllers' cache in the event of a power interruption.

The system's power supplies charge the battery modules when they are installed in the system. You can check a battery's charge when the module is out of the system by pressing the button on the underside of the module. All four green LEDs light up when the battery module is fully charged. Do not remove a battery module to check its charge; use the RAID Admin software for that purpose. (See the document "Using RAID Admin and Disk Utility" on the CD that came with your system for details.)

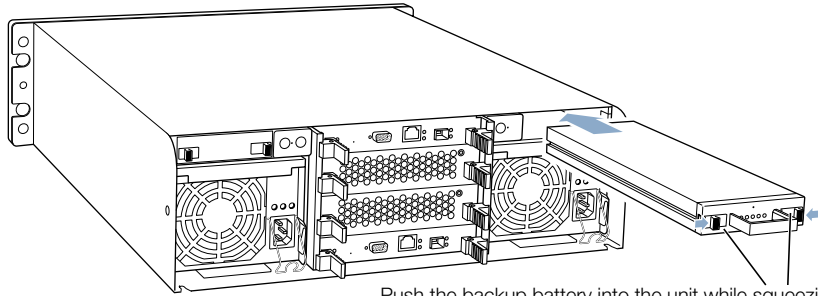
If no battery modules are installed in the system, the module compartments have covers that you must remove to install the battery modules.

Follow these steps to install or replace a battery module.

- 1 Remove the cover or installed module using one of these procedures:
 - To remove the cover, squeeze the latches together and pull off the cover.
 - To remove a battery module, squeeze the latches together, place your fingers inside the handle, and firmly pull the unit out of the system.



- 2 Remove the packaging from the new battery module. Hold the battery module by the handle and carefully slide it into the system until it clicks into place.



Push the backup battery into the unit while squeezing the two latches together. Release the latches when the battery is in position to lock the module in place.

Be sure to save the battery compartment cover for use when no module is installed.

Warning There is risk of explosion if a battery module is replaced by an incorrect type.

The battery module is certified only as a component for use with this or other equipment for which the suitability of the combination has been determined by a Nationally Recognized Testing Laboratory.

Warning Dispose of used battery modules according to your local environmental guidelines. Do not puncture or incinerate.

Obtaining Additional Replacement Components

If you need an additional component for the system, you can obtain it from an Apple-authorized dealer. Apple Drive Modules are available at the Apple website: www.apple.com.

Information about replacement parts and optional components is available at www.apple.com/xserve.

RAID Overview

Xserve RAID provides a powerful, versatile, and cost-effective answer to the growing storage requirements of graphics and video production companies, email and web services, educational file sharing, and other businesses.

You can configure the Xserve RAID system in a variety of ways, using up to 14 drives in two groups of 7 drives. Each group has a separate RAID controller. The Xserve RAID hardware can support RAID levels 0, 1, 0+1, 3, or 5, and you can use the RAID software in Mac OS X to create the hybrid levels 10, 30, or 50. See “About RAID Storage” on page 58 for descriptions of RAID levels and storage methods.

Setting Up the Xserve RAID System

This manual includes an explanation of the RAID technology and instructions for configuring your Xserve RAID system. The setup procedure involves these steps:

- installing the hardware and setting up network and host connections
- determining the RAID levels, the number of RAID sets, and the configurations for your storage needs
- installing or rearranging Apple Drive Modules in the Xserve RAID system for the configuration you’ve selected, if necessary
- configuring RAID sets using the RAID Admin software supplied with the system (and possibly also using Disk Utility in Mac OS X to augment sets)
- formatting the Xserve RAID sets with a file system on the host system using Disk Utility

Installing Xserve RAID Hardware and Software

Follow the instructions in Chapter 3, “Mounting Xserve RAID in a Rack,” on page 23 and Chapter 4, “Connecting Xserve RAID to a Host System and a Network,” on page 37 for hardware installation and connections. These include

- installing the system in a rack or cabinet

- installing the Apple Fibre Channel PCI Card in a host system and connecting it to the Xserve RAID system using fibre channel cables
- connecting to an Ethernet network

You use the RAID Admin software to configure RAID storage on your system. Use the Xserve RAID CD, supplied with the system, to install RAID Admin on any computer or server that you want to use for remote administration of the system. See the document “Using RAID Admin and Disk Utility” on the CD that came with your system for details.

About RAID Storage

RAID, or Redundant Array of Independent Disks, is a data-storage technology that spreads data across multiple drives. This technology provides several benefits over a single large hard disk, including

- data redundancy for protection and availability
- higher performance as a result of reading or writing on several drives simultaneously
- scalability for expansion of storage

These benefits are especially useful in a server environment where downtime is very expensive, drive performance is critical to server performance, and the opportunity to increase storage capacity quickly and easily is essential.

How RAID Works

In a RAID system, either a hardware controller or software manages the reading and writing of data. The Xserve RAID system uses two hardware controllers, which each manage up to seven drive modules. By segmenting and writing or reading data on multiple drives simultaneously, the RAID controller achieves fast and highly efficient storage and access.

The controller can also duplicate all information stored for maximum data protection. Another protection method, *parity*, provides the ability to rebuild data. Parity protects stored information without requiring data duplication. When data is protected by duplication or parity, it is still available if a drive fails. Duplicated data is simply retrieved from the second storage site; parity-protected data is reconstructed using the parity formula. You can remove and replace a failed disk (known as “hot swapping”), and the controller then rebuilds the data using the information on the remaining drives.

The way the controller stores and retrieves data on the Xserve RAID system is determined by the RAID level and storage method you choose. See “Data Storage Methods” on page 59 and “RAID Levels” on page 60 for more information about these choices.

Once you have defined a group of drive modules as a RAID set, the controller groups those drives into “logical disks.” On the Xserve RAID system, each logical disk appears to the host system and the RAID Admin software as one disk, regardless of the number of actual drives in that logical unit. See “Xserve RAID Schemes” on page 66 for examples of RAID sets you can configure on the Xserve RAID system. Each controller in the Xserve RAID system can have a maximum of three logical disks.

You can also use the Apple RAID software built into Mac OS X (part of Disk Utility, located in Applications/Utilities) to augment RAID storage on the system. See the document “Using RAID Admin and Disk Utility” on the CD that came with your system for more about using this software with the RAID sets you establish.

Data Storage Methods

The controller stores and retrieves data on a RAID system using one of two methods, “striping” or mirroring. You can also combine these methods in some RAID sets.

Data Striping

Data striping is the foundation of RAID. Multiple hard disk drives in a RAID group, referred to as a *set* or *array*, are divided (partitioned) into stripes. The controller spreads stripes across the disks in alternating sections on each drive.

In environments with intensive input-output (I/O) requirements, such as servers, performance is optimized by writing data across stripes large enough that each data record can be written entirely to one stripe. This technique ensures that each drive will be working on a different I/O operation and the number of simultaneous I/O operations performed by the array is maximized.

In data-intensive environments such as digital video editing, performance is optimized by writing data across small stripes so that each record spans all drives. This method ensures that access to large records is very fast because data is transferred in parallel across multiple drives.

Data Mirroring

To mirror data, the RAID controller creates equal partitions on two different disks. One partition is primary; the other is the mirrored partition. The primary and mirrored partitions are synchronized; that is, anything written to one disk is also written to the other. Mirrored data is very secure because if one disk fails, the data is available from the other disk. Because mirroring involves duplicating all data, two mirrored drives store half as much data as drives that are not mirrored.

RAID Levels

The Xserve RAID system supports several RAID levels. Each level has a different architecture and provides varying degrees of performance and fault tolerance. Each level has characteristics to achieve maximum performance or redundancy depending on the data environment. Understanding the differences among RAID levels will help you set up your Xserve RAID system to best meet your data performance and security needs.

RAID 0: Data striping without fault tolerance

Also referred to as *striping*, RAID level 0 is a performance-oriented mapping technique for disk sets. Uniform subsets of the array's logical volume, called *stripes*, are mapped in regular sequence to a set's drives, or elements. Using either independent or parallel access, RAID 0 provides high I/O performance at low cost. But RAID 0 offers no redundancy, so it is not recommended for use with the Xserve RAID system. (RAID 0 can be combined with other techniques to provide data redundancy, regeneration, and reconstruction, however.)

This level of RAID should never be used in mission-critical environments. It may be acceptable as a working environment or "scratch disk."

RAID 0 is easy to configure and has a simple structure; it requires a minimum of two drives.

RAID 1: Mirroring

RAID level 1, mirroring, has been used longer than any other RAID level and remains popular because of its simplicity and high levels of reliability and availability. Mirroring uses two drives or multiple drive pairs. Each drive in a pair stores identical data. RAID 1 may use parallel access for high transfer rates but more commonly uses independent access for high transaction rates. RAID 1 provides very high data reliability and improved performance for read-intensive applications, but this level has a high capacity cost because it retains a full copy of your data on each drive in a pair. RAID 1 has the highest Error Checking/Correction (ECC) disk overhead of all RAID variants—100 percent.

Common applications of RAID 1 are accounting and payroll, or any application requiring high data availability. RAID 1 requires a minimum of two drives. In a RAID 1 configuration, the capacity of the smallest drive is the maximum storage area. Additional drives provide more redundancy, and thus more protection, but no additional capacity.

RAID 0+1: High data-transfer performance

RAID 0+1 is a combination of level 0 (striping) and level 1 (mirroring). The RAID controller sets up mirrored pairs of drives and adds striping across the pairs. This RAID level gives the high performance of striping and the reliability of mirrored data, but it has the disadvantage of requiring double the drive capacity and is therefore fairly expensive.

RAID 0+1 requires a minimum of four drives.

RAID 3: Parallel transfer with parity on dedicated disk

RAID level 3 adds redundant information to a striped set of drives with parallel access, allowing regeneration and reconstruction in the event of a disk failure. The parity data is stored on one disk dedicated to this purpose. RAID 3 provides high transfer rates and high reliability and availability, at a lower cost than RAID levels that incorporate mirroring.

RAID 3 requires a minimum of three drives.

RAID 5: Independent data disks with distributed parity

By distributing the parity information across all drives in a set, RAID level 5 alleviates the write bottleneck intrinsic to RAID 3, and achieves high reliability and data availability. However, RAID 5 can result in asymmetrical performance—better read than write. For this reason, RAID 5 is often augmented with related storage technologies such as caching.

RAID 5 offers the highest read data transaction rate of all levels along with a medium write rate. The low ratio of ECC parity disks to data disks offers hardware efficiency. Disk failure has a moderate impact on the total transfer rate, and this level also incorporates the most complex controller design.

RAID 5 requires a minimum of three drives.

Preconfigured Level 5 on the Xserve RAID System

The Xserve RAID system is preconfigured with RAID 5. The speed and capacity of the system's hardware and RAID controllers make this level an optimum configuration for most storage needs. Apple recommends that you use this preconfigured RAID 5 setup.

Hardware and Software RAID

In addition to the RAID levels described above, which you create with the RAID Admin application on the CD that came with your system, you can use Apple RAID (part of Disk Utility in Mac OS X) to augment level 1, 3, or 5. These software-configured variations are known as RAID 10, 30, and 50.

RAID 10

RAID level 10 uses software to stripe data across the two controllers for redundancy or enhanced performance.

To create a RAID 10 configuration, you use RAID Admin first and Disk Utility second. See the document “Using RAID Admin and Disk Utility” on the CD that came with your system for instructions. After you've used Disk Utility to set RAID 10, this configuration appears as one disk on the host system.

RAID 30

RAID level 30 essentially combines RAID 3's dedicated parity (reliability) and RAID 0's striping (performance). RAID 30 requires at least six drives. This level provides high reliability; one drive in each data pair could fail and data would still be available.

To create a RAID 30 configuration, you use RAID Admin and Disk Utility. See the document "Using RAID Admin and Disk Utility" on the CD that came with your system for instructions.

RAID 50

RAID level 50 combines RAID 5's distributed parity (reliability) and RAID 0's striping (performance). This level requires at least six drives and offers high data-transfer performance.

To create a RAID 50 configuration, you use RAID Admin and Disk Utility. See the document "Using RAID Admin and Disk Utility" on the CD that came with your system for instructions.

What's Next?

With this overview of RAID technology, you can plan the Xserve RAID configuration that best suits your needs. The next chapter provides detailed examples of the configuration options for each RAID level on the Xserve RAID system.

Planning RAID Storage for the Xserve RAID System

Before you use the RAID Admin and Disk Utility software to set up your RAID storage, it's a good idea to become familiar with the variety of configurations, or schemes, available for the Xserve RAID system. This chapter describes these schemes and illustrates how each RAID level is applied to a set of drives.

Tools for Configuring the Xserve RAID System

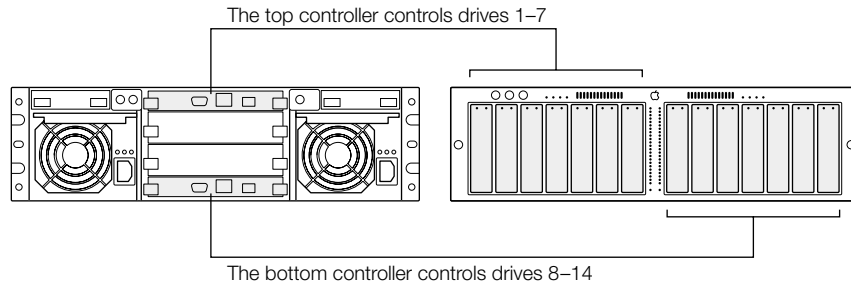
You use the RAID Admin software on the CD that came with your system to create the RAID sets you want on the system. RAID Admin provides tools to configure hardware RAID levels 0, 1, 3, 5, and 0+1. In addition, you can use Apple RAID (part of Disk Utility, located in Applications/Utilities) to create RAID levels 10, 30, or 50 after you have set up RAID sets with RAID Admin.

You can also use RAID Admin to monitor the status of the Xserve RAID system.

For instructions on using these tools, see the document "Using RAID Admin and Disk Utility" on the CD that came with your system.

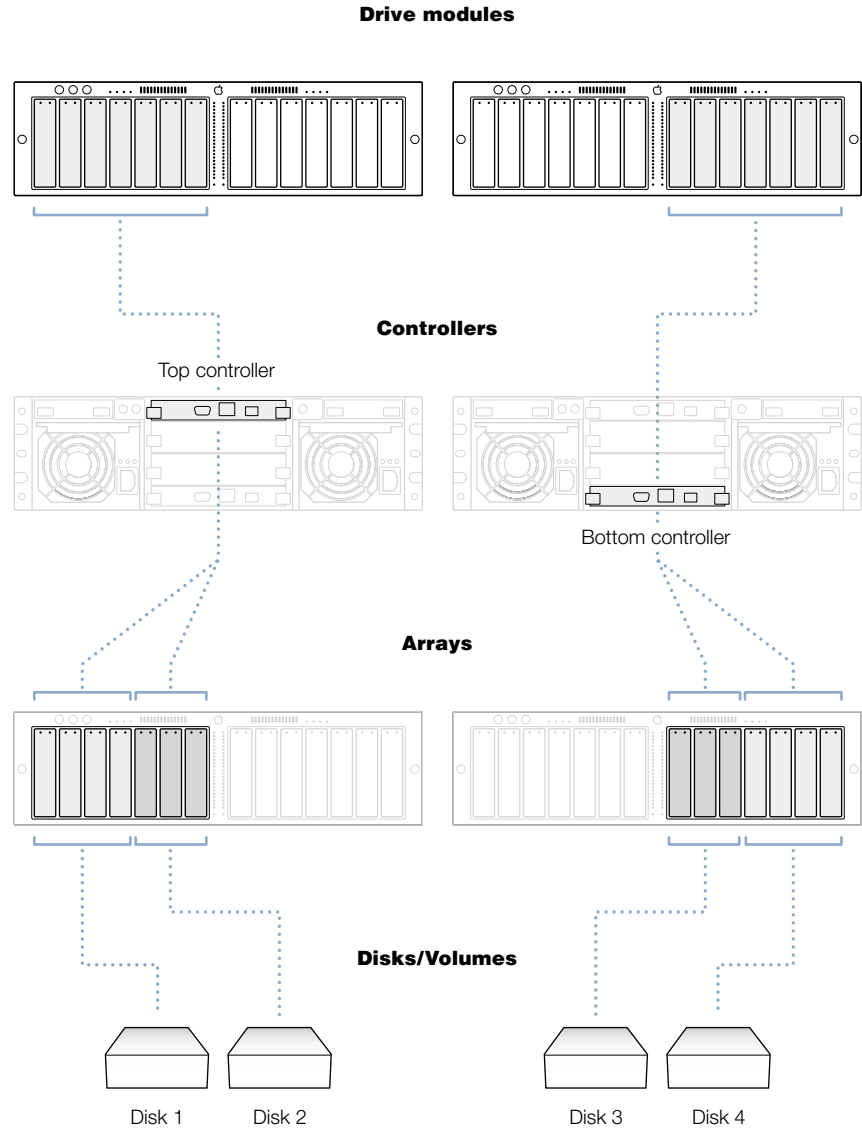
RAID Controllers and Drive Modules

The Xserve RAID system has two RAID controllers, each of which controls the drive modules on one side of the system. The drive modules are numbered 1 to 7 on the left side of the system and 8 to 14 on the right side (when viewing the system from the front).



When planning the arrangement of drive modules and RAID levels for your system, it's useful to know how the RAID controllers map to the drive modules, as well as how a RAID set appears on the host system.

The illustration below provides a graphic representation of all this information.



Xserve RAID Schemes

A RAID scheme refers to how the storage device's RAID sets are configured with different RAID levels. You can configure the Xserve RAID system with a variety of storage schemes.

The illustrations show examples of the three standard versions of Xserve RAID hardware—4 drive modules, 7 drive modules, and 14 drive modules. An additional illustration shows examples of Xserve RAID systems connected to a host system or fibre channel switch.

A System With Four Drive Modules

You can use the following RAID levels on an Xserve RAID system with four drive modules:

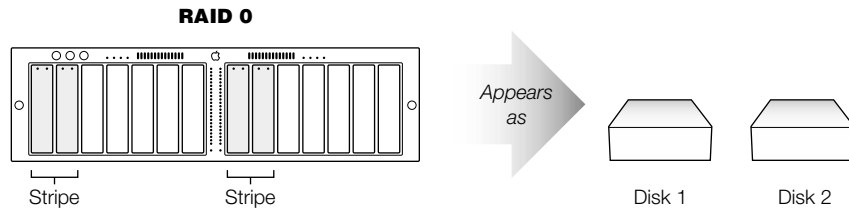
- RAID 0
- RAID 1
- RAID 3
- RAID 5
- RAID 0+1
- RAID 10

Note: This list is representative but does not include all possible schemes.

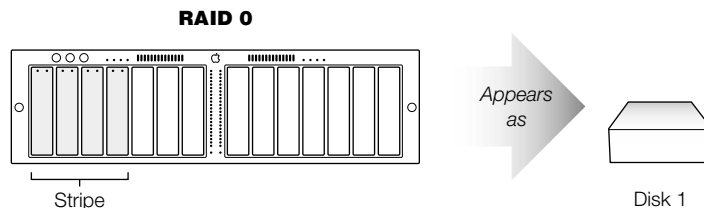
RAID 0 Schemes

You can use RAID 0 in several ways, depending on how you divide the drive modules between the RAID controllers.

If two modules are on each controller, two drives can be striped together for each controller.

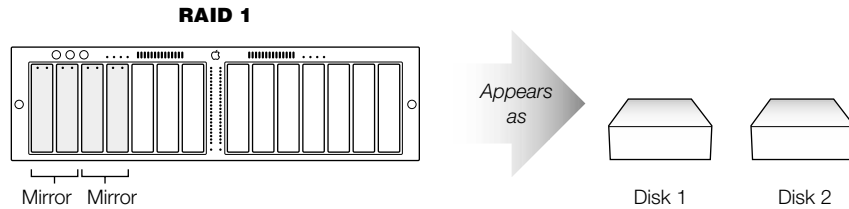


If all the drive modules are on one RAID controller, the drives can be striped together.

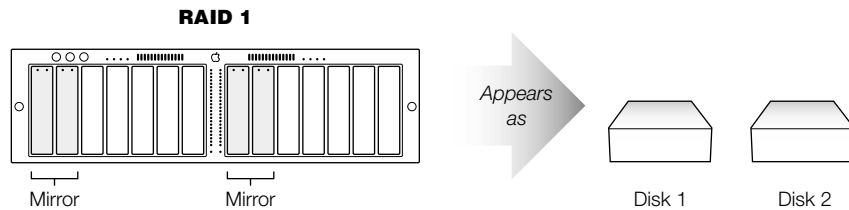


RAID 1 Schemes

You can use RAID 1 several ways on a four-drive system, depending on how you divide the drive modules between the RAID controllers and how you mirror the data on the drives. If all the modules are on one controller, you can have two RAID sets on one controller.



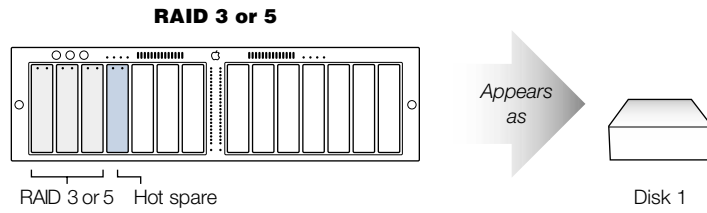
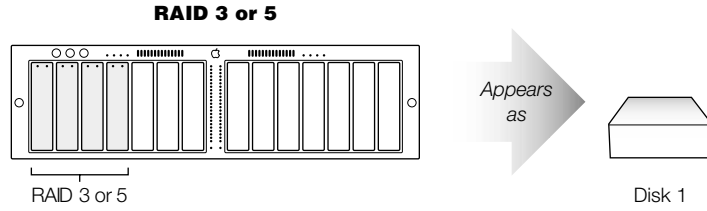
If two modules are on each controller, you can create one RAID set on each side.



RAID 3 and 5 Schemes

You can configure the system using RAID 3 or 5 with or without a drive module designated as a hot spare. (A hot spare is a drive that remains ready to replace any other drive that fails. The RAID controller automatically rebuilds data from the failed drive on the hot spare.)

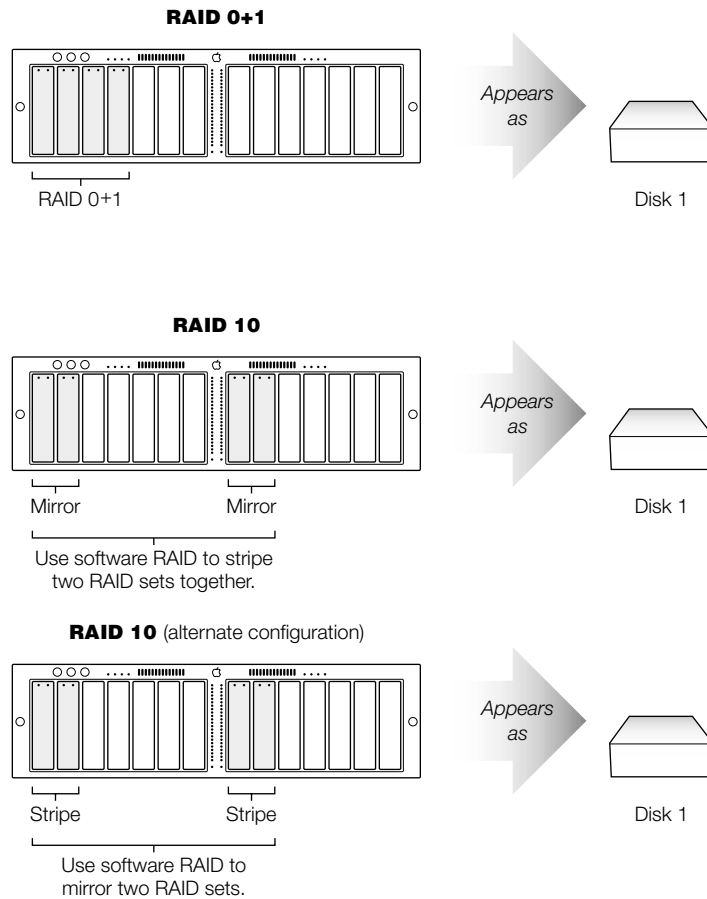
You can use RAID 3 or 5 with four drive modules only on one Xserve RAID controller.



RAID 0+1 and RAID 10 Schemes

On the Xserve RAID system, RAID 0+1 is a stripe of mirrored pairs. An example of this configuration is shown at the top of the illustration below.

Using a combination of the hardware controller and software, you configure the system using RAID 10 with two drive modules on each controller. The drive modules on each side can be either striped together or mirrored.



A System With Seven Drive Modules

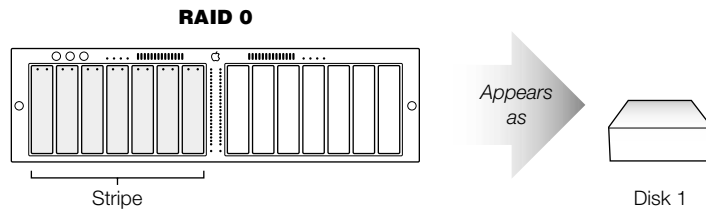
You can use the following RAID levels on an Xserve RAID system with seven drive modules:

- RAID 0
- RAID 1
- RAID 3
- RAID 5
- RAID 30
- RAID 50

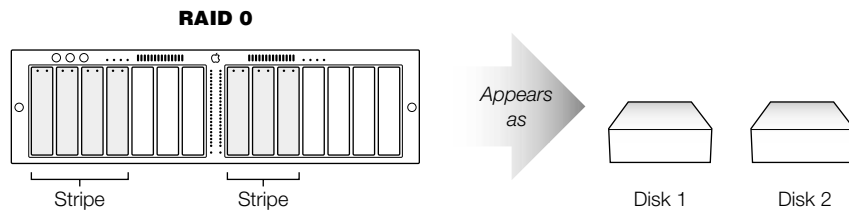
Note: This list is representative but does not include all possible schemes.

RAID 0 Schemes

You can use RAID 0 several ways, depending on how you divide the drive modules across the RAID controllers. If all of the modules are on one RAID controller, all drives can be striped together.

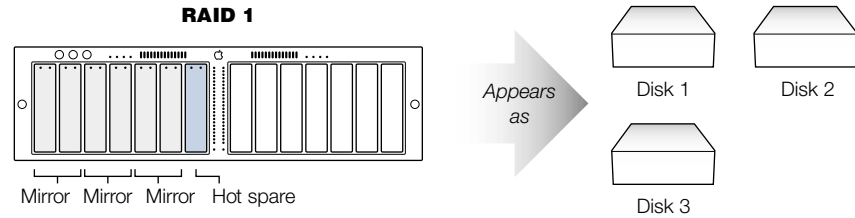


If four modules are on one controller and three modules are on the other, the drives on each controller can be striped together.

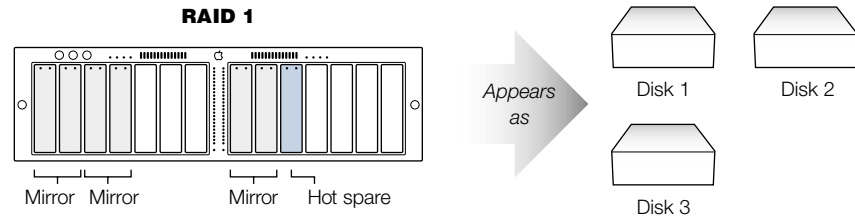


RAID 1 Schemes

You can use RAID 1 several ways, depending on how you divide the drive modules between the RAID controllers, how you choose to mirror the drives, and where you put the module you use as a hot spare. The *hot spare* is a drive that the RAID controller automatically uses to rebuild data if another drive fails. The hot spare is only available to mirrored pairs on the same controller. If all the drive modules are on one controller, the drives can be mirrored in pairs, and the hot spare will be available to all three pairs.

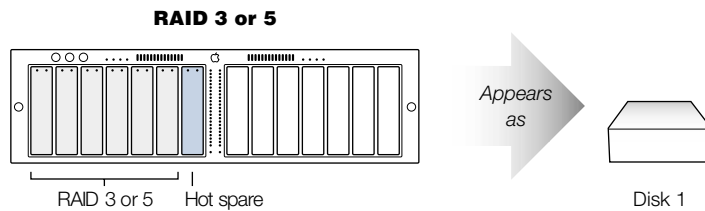
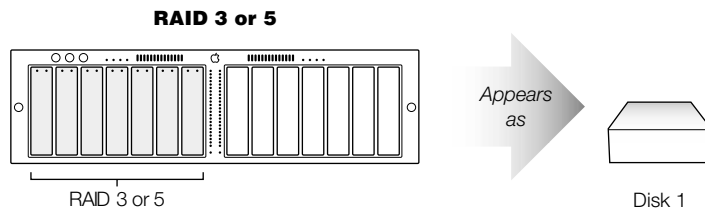
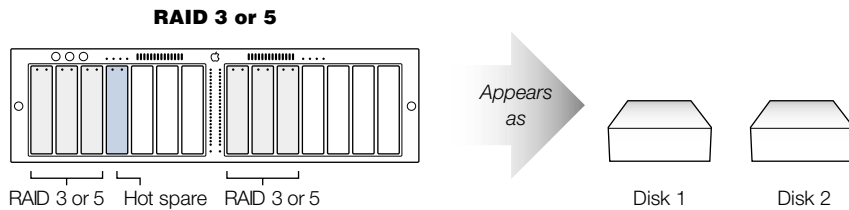
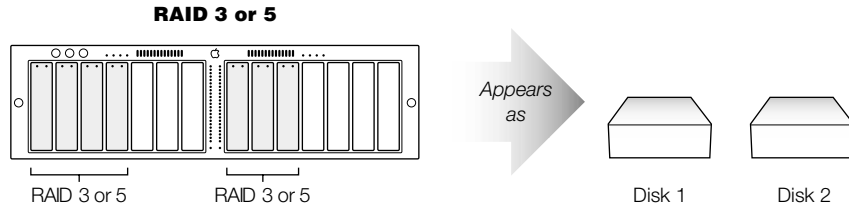


If four modules are on the first controller and three modules are on the second controller, the drives on each controller can be mirrored in pairs, with one module as a hot spare for the pair on the second controller.



RAID 3 and 5 Schemes

You can use RAID 3 or 5 with or without a drive module designated as a hot spare. You can use RAID 3 or 5 with four drive modules on one controller and three on the other or with all the modules on one RAID controller. If a hot spare is used, it serves all arrays on the controller where the spare is located.



A System With 14 Drive Modules

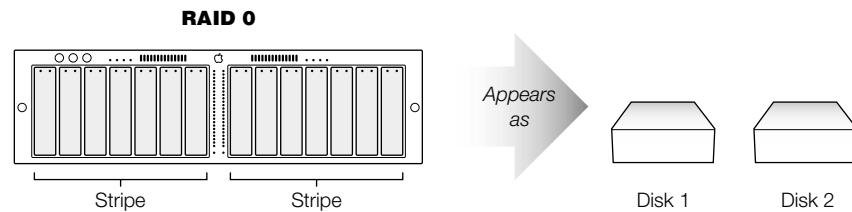
On a system with 14 drive modules, you can use these RAID levels.

- RAID 0
- RAID 00
- RAID 1
- RAID 10
- RAID 0+1
- RAID 3
- RAID 5
- RAID 30
- RAID 50

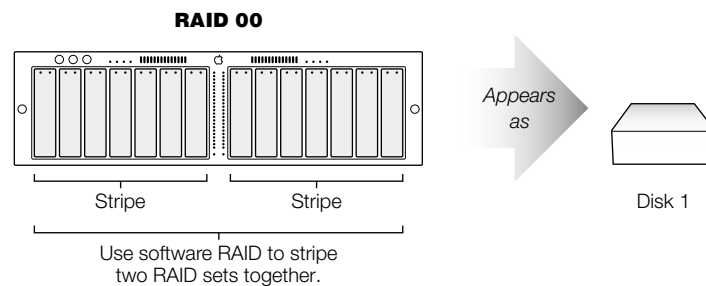
Note: This list is representative but does not include all possible schemes.

RAID 0 and RAID 00 Schemes

With seven drive modules on each controller, you can stripe each side into a RAID set.

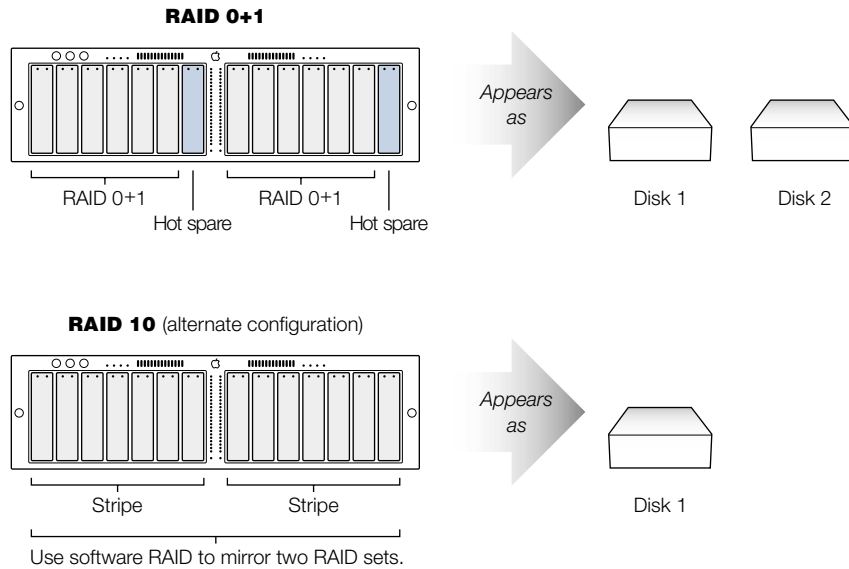


Using software RAID (Disk Utility), you can stripe the two RAID sets together.



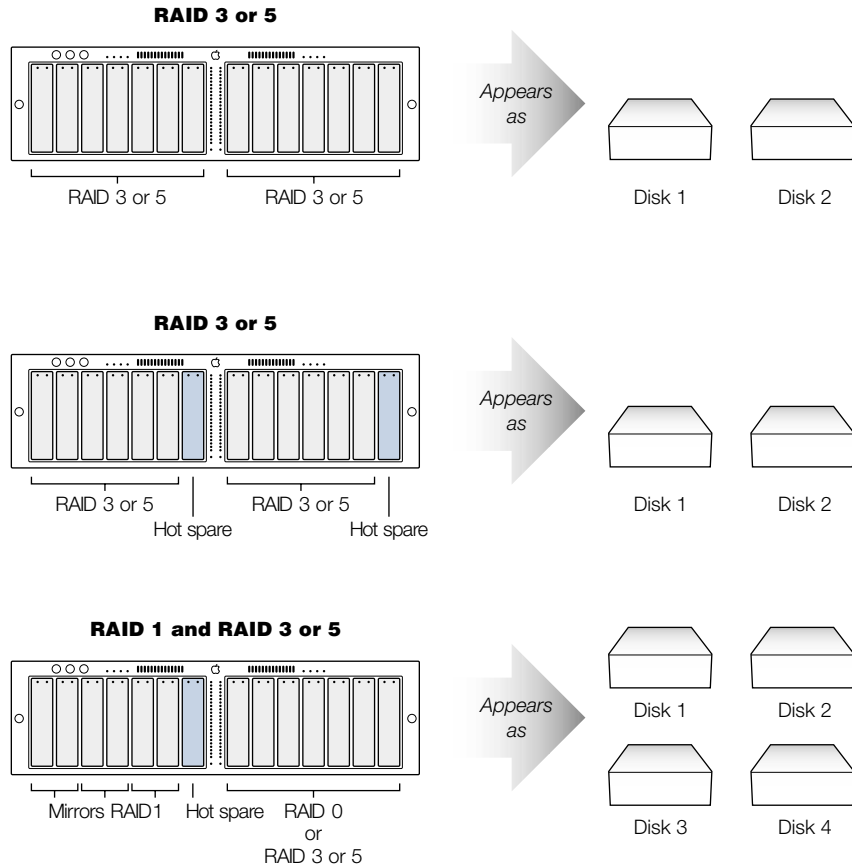
RAID 0+1 and RAID 10 Schemes

With seven drive modules on each controller, you can create 0+1 configurations with a hot spare on each controller or you can use Disk Utility to mirror the two sides in a RAID 10 configuration.

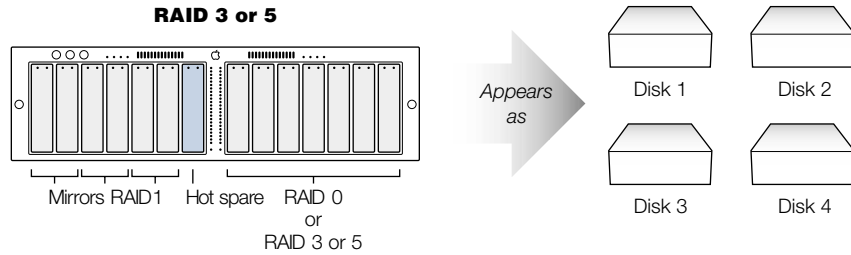


RAID 3 and 5 Schemes

You can use RAID 3 or 5 with or without a drive module designated as a hot spare on each controller, or you can create four RAID sets and use Disk Utility to stripe or mirror the sets on the same or separate controllers.

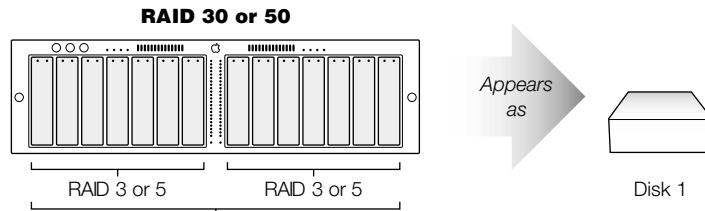


You can also set up three mirrored pairs and one hot spare with RAID 1 on one controller, and stripe all the drives together on the other controller using RAID 0, 3, or 5. (The spare is only for the drives on the controller where the spare is located.)

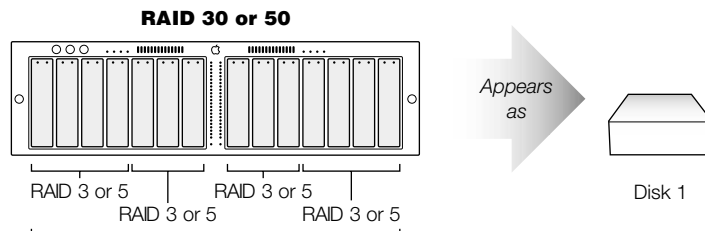


RAID 30 and 50 Schemes

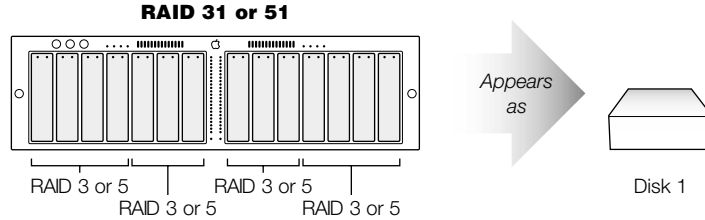
You can configure two RAID 5 sets using the RAID controller and then use software (Disk Utility) to stripe those two sets.



Use software RAID to stripe two RAID 3 or 5 sets, which appear as one maximum capacity RAID set.



You can use software RAID to stripe like pairs on the same or separate controllers.



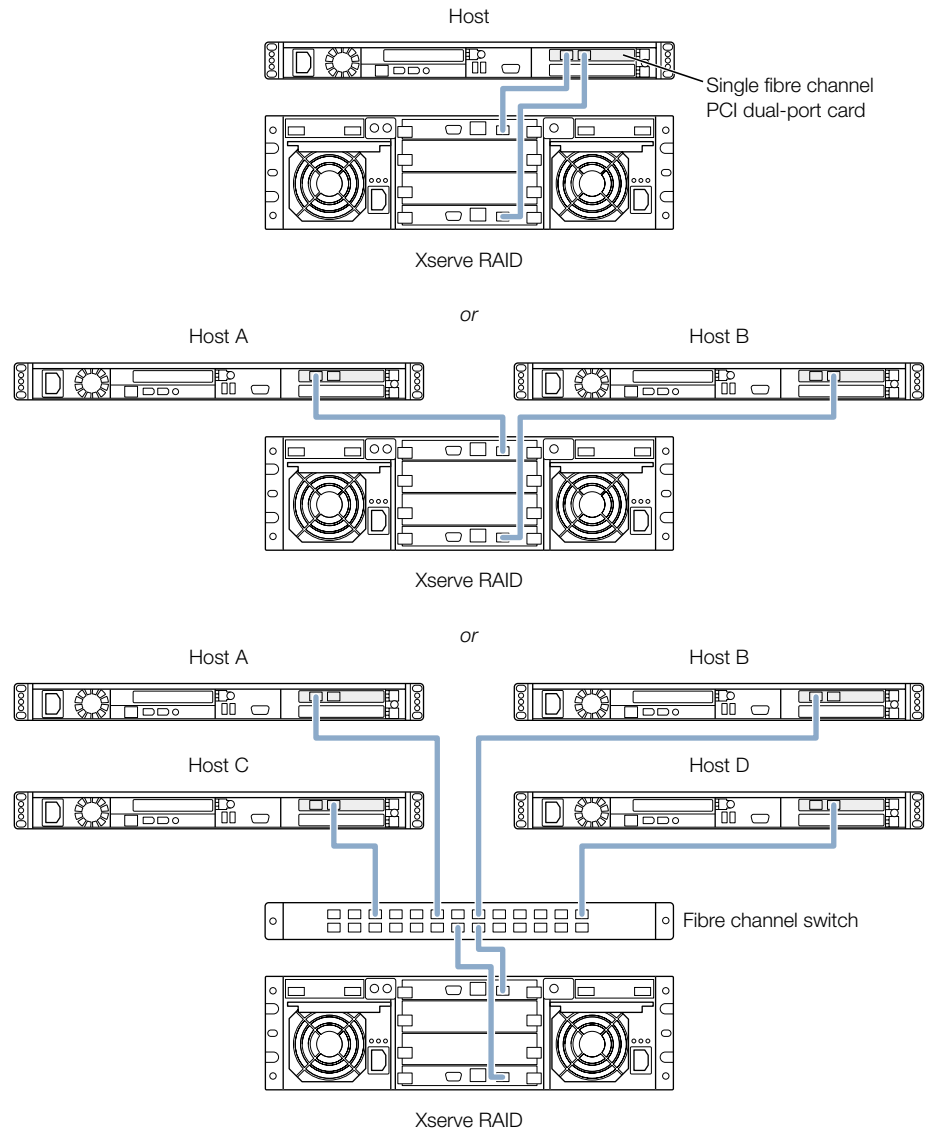
You can use software RAID to mirror like pairs on the same or separate controllers.

Storage Capacities for Xserve RAID Schemes

RAID Level	Capacity
RAID 0	Total of all drives
RAID 1	Total of one drive
RAID 0+1	One-half the total capacity of all drives (sum of RAID 1 member sets)
RAID 3	Total of all drives minus one drive (parity disk)
RAID 5	Total of all drives minus one drive (distributed parity)
RAID 10	One-half the total of all drives
RAID 30	Total of all drives minus two drives
RAID 50	Total of all drives minus two drives

Xserve RAID Hardware Connections

The Xserve RAID system offers three standard hardware configurations—a system with 4 Apple drive modules, 7 drive modules, or 14 drive modules. You can connect any of these systems to a host or fibre channel switch in several ways. The examples below show several of the possible connections.



Connecting a Four-Drive System to a Host Computer or Switch

You can connect your Xserve RAID to a host computer using one fibre channel cable if your drive modules are on one RAID controller.

If your drive modules are spread across both RAID controllers, two on each controller, connect both controllers to the host computer using two fibre channel cables.

Connecting a Seven-Drive System to a Host Computer or Switch

You can connect your system to a host computer or switch using one fibre channel cable if your drive modules are on one RAID controller.

If your drive modules are spread across both RAID controllers, two on each controller, connect both controllers to the host computer using two fibre channel cables.

Connecting a 14-Drive System to a Host Computer or Switch

You can connect your system to a host computer or a fibre channel switch using one fibre channel cable connected to each RAID controller.



Glossary

Common RAID Terms

Array: A grouping of disk drives; also known as a *set*. Any number of drives can be configured together to form a RAID array. The same RAID level is applied to all drives in an array.

Hot spare: A feature of the RAID controller that detects a drive failure and automatically uses an available drive to rebuild the data from the failed drive. (Not all RAID sets include a hot spare.)

Mirroring: A storage method in which the same data is stored twice on two or more different drives. The data is stored on a primary disk or partition, then “mirrored” to other disks or partitions.

Parity: A method of storing information that allows all data to be rebuilt if a drive fails. Parity is more efficient than mirroring because it does not involve duplication of data.

Partitioning: The division of a disk into smaller segments. The segments appear as individual disk drives to the host, while maintaining the RAID properties of the set.

RAID set: A specific number of drives grouped together with a single characteristic (for example, RAID 0, RAID 5). A RAID set can encompass all drive modules on a controller or be a subset of the total. There can be up to three RAID sets on a controller. A RAID set appears to a host system as an individual disk drive.

Striping: The breaking up of data so that it can be stored across multiple disk drives. For example, if you divide an 80 KB file into five 16 KB pieces, each piece is a stripe.

Specifications

RAID Controller Specifications

- 2 gigabit-per-second (Gb/sec.) fibre channel port
- Seven independent ATA-100 drive channels
- Minimum 128 megabytes (MB) of PC-100 SO-DIMM RAM
- Two 66 megahertz (MHz) PCI buses
- Hardware parity generation
- Support for RAID 0, 1, 3, 5, 0+1
- RAID Now (RAID creation during initialization)
- Variable rebuild rate
- Tag command queuing
- Hot sparing

Fibre Channel PCI Card Specifications

- 2 Gb/sec. fibre channel communication per channel using dual controllers (one for each group of seven drive modules)
- Fibre channel connection using either copper or optical cable; two copper cables supplied with the Apple Fibre Channel PCI Card (sold separately)
- Cable connectors: HSSDC2 for the system's controller modules; SFP for the host bus adapter card

Apple Drive Module Specifications

- ATA-100
- Hot-swappable modules (compatible with Xserve)
- Temperature sensor
- SMART drive support

Dimensions and Operating Environment

Dimensions

- *Height:* 133 mm (5.25 in.) (3U)
- *Width:* 483 mm (19.0 in.) with mounting brackets
- *Depth:* 442 mm (17.4 in.)
- *Drive module weight:* 2 lbs. (0.9 kg)
- *Weight:* 60–100 lbs. (27–45 kg), depending on configuration
Weight depends on the number of drive modules installed in the system.

Operating environment

- *Operating temperature:* 10° to 35° C (50° to 95° F)
- *Storage temperature:* –40° to 47° C (–40° to 116.6° F)
- *Relative humidity:* 20% to 80% (noncondensing)
- *Altitude maximum:* 3048 meters (10,000 feet)

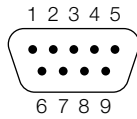
Ethernet Specifications

- IEEE 802.3 compliant
- *Maximum cable length:* 100 meters (m) (328 ft)
- *Connectors:* RJ-45 for 10Base-T and 100Base-TX
- *Media, 10Base-T:* Category 3 or higher UTP on 2 pairs up to 100 m
- *Media, 100Base-TX:* Category 5 UTP on 2 pairs up to 100 m
- *Channel speeds:* IEEE Auto Negotiation of 10Base-T and 100Base-TX

UPS Interface Specifications

- DB-9 interface, compatible with APC uninterruptible power supply
- UPS interface pinouts:

- 9-pin D connector



- Pin signals
 - 1: (CD) UPS battery low (20%) <from UPS to Xserve RAID>
 - 2: Not used
 - 3: Not used
 - 4: (DTR) handshake option <from Xserve RAID to UPS>
 - 5: Ground
 - 6: Not used
 - 7: (RTS) reserved
 - 8: (CTS) Line fail—switch to UPS battery <from UPS to Xserve RAID>
 - 9: (RI) reserved
- Serial cable to UPS should be number 940-0020B (or comparable cable) for APC basic signaling

Power Supply Specifications

AC line input

- 450 watt (W) total power capacity for each power supply (system uses a maximum of 450 W total)
- 100–127/200–240 volts (V) AC; 7.6/3.8 amps (A); 50/60 hertz (Hz) per power cord
- Fully redundant, load-sharing
- Hot-swappable
- Monitoring of fan, power, and AC operation
- Power factor correction

Cooling Module Specifications

- Temperature sensor
- 12V operation
- Hot-swappable
- Fan speed monitoring

Battery Module (Optional) Information

You can install two optional battery modules to maintain data in the RAID controller's cache. These batteries are available from an Apple-authorized dealer.

- Charges from system's power supply when installed and system is turned on
- Support for two battery modules

Safety, Maintenance, and Ergonomics

Important Safety Information

For your own safety and that of your equipment, always take the following precautions.

Important The only way to disconnect power completely is to unplug the two power cords. Make sure at least one end of each power cord is within easy reach so that you can unplug the Xserve RAID when you need to.

Disconnect the power plugs (by pulling the plug, not the cord) if any of the following conditions exists:

- the power cord or plug becomes frayed or otherwise damaged
- you spill something into the case
- your Xserve RAID system is exposed to rain or any other excess moisture
- your system has been dropped or the case has been otherwise damaged
- you want to clean the case (use only the recommended procedure described later)

Be sure that you always do the following:

- Keep your system away from sources of liquids, such as washbasins, bathtubs, shower stalls, and so on.
- Protect your system from dampness or wet weather, such as rain, snow, and so on.
- Read all the installation instructions carefully before you plug your system into a wall socket or power strip.
- Keep these instructions handy for reference by you and others.
- Follow all instructions and warnings dealing with your system.

Electrical equipment may be hazardous if misused. Operation of this product, or similar products, must always be supervised by trained personnel. Do not allow children access to the interior of any electrical product and do not permit them to handle any cables.

This system is certified as a component for use only with equipment for which the suitability of the combination has been determined by a Nationally Recognized Testing Laboratory.

Handling Your System

Follow these guidelines for handling your Xserve RAID system and its components:

- When lifting or moving the system, always have two people carry it and place the unit on a sturdy, flat surface.

Important Do not attempt to lift or move the system by yourself. The weight of the unit requires two people to lift and support it.

- When connecting or disconnecting a cable, always hold the cable by its connector (the plug, not the cord).
- Before removing or replacing a RAID controller module, be sure to shut down the controller using the RAID Admin application. Failure to do so could result in data loss. Certain components—drive modules, power supply, and cooling modules—are designed to be installed or removed while the system is turned on and operating.
- Never force a connector into a port. If the connector and port do not join with reasonable ease, they probably don't match. Make sure that the connector matches the port and that you have positioned the connector correctly in relation to the port.
- To remove a fibre channel cable from the RAID controller, push in on the connector slightly, then squeeze the release latch and pull out the connector. If the cable does not pull out easily, use a small flat tool, such as a tiny screwdriver or the cover from the card slot on the host system, to squeeze the release latch.
- Don't spill food or liquid on the system or other components. If you do, turn your system off immediately and unplug it before cleaning up the spill. Depending on what you spilled and how much of it got into your equipment, you may have to arrange for an Apple-authorized service provider to inspect or repair the system.
- Protect the system and its components from direct sunlight and rain or other moisture.
- Keep all ventilation openings clear and unobstructed. Without proper air circulation, the unit's temperature can rise high enough to cause the system to shut down.

Power Supply

The power supplies in your system are high-voltage components and should not be opened for any reason, even when the system is off. If a power supply needs service, contact your Apple-authorized dealer or service provider.

Cleaning Your Equipment

Follow these general rules when cleaning the outside of your system:

- Use a damp, soft, lint-free cloth to clean the exterior. Avoid getting moisture in any openings.
- Don't use aerosol sprays, solvents, or abrasives.
- To clean the case, shut down the system completely and then disconnect the power plugs. (Pull the plug, not the cord.)

Apple and the Environment

Apple recognizes its responsibility to minimize the environmental impacts of its operations and products. For more information, go to www.apple.com/about/environment.

Health-Related Information About Computer Use

In most instances, you will probably set up and administer your system from a remote location, such as a computer on the system's network. Whether you work at a remote computer or at the system rack for extended periods, take care to avoid muscle soreness, eye fatigue, or other discomforts associated with computer use.

If feasible in the system location, use an adjustable chair that provides firm, comfortable support. The back of the chair should support your lower back (lumbar region). Follow the manufacturer's instructions for adjusting the backrest to fit your body properly.

Communications Regulation Information

FCC Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio-frequency energy, and if not installed and used in accordance with Apple's instructions, may cause harmful interference with radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his or her own expense.

Important Changes or modifications to this product not authorized by Apple Computer, Inc., could void the EMC compliance and negate your authority to operate the product.

This product was tested for EMC compliance under conditions that included the use of Apple peripheral devices and Apple shielded cables and connectors between system components. It is important that you use Apple peripheral devices and shielded cables and connectors between system components to reduce the possibility of causing interference to radios, television sets, and other electronic devices. You can obtain Apple peripheral devices and the proper shielded cables and connectors through an Apple-authorized dealer. For non-Apple peripheral devices, contact the manufacturer or dealer for assistance.

Industry Canada Statement

Complies with the Canadian ICES-003 Class A specifications.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

European Union Statement

Complies with European Directive 89/336/EEC.

CISPR 22 & EN55022 Statement

Warning This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

VCCI Class A Statement

この装置は、情報処理装置等電波障害自主規制協議会（VCCI）の基準に基づくクラスA情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。

High-Risk Activities Warning

This system is not intended for use in the operation of nuclear facilities, aircraft navigation or communications systems, or air traffic control machines, or for any other uses where the failure of the system could lead to death, personal injury or severe environmental damage.

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