

IBM TotalStorage DS4100 Storage Server



Installation, User's, and Maintenance Guide

IBM TotalStorage DS4100 Storage Server



Installation, User's, and Maintenance Guide

Note:

Before using this information and the product it supports, be sure to read the general information in “Notices” on page 127.

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Safety

The caution and danger statements that this document contains can be referenced in the multilingual *IBM® Safety Information* document that is provided with your IBM TotalStorage® DS4100 storage server. Each caution and danger statement is numbered for easy reference to the corresponding statements in the translated document.

- **Danger:** These statements indicate situations that can be potentially lethal or extremely hazardous to you. A danger statement is placed just before the description of a potentially lethal or extremely hazardous procedure, step, or situation.
- **Caution:** These statements indicate situations that can be potentially hazardous to you. A caution statement is placed just before the description of a potentially hazardous procedure step or situation.
- **Attention:** These notices indicate possible damage to programs, devices, or data. An attention notice is placed just before the instruction or situation in which damage could occur.

Before installing this product, read the following danger and caution notices.

Statement 1:



DANGER

Electrical current from power, telephone, and communication cables is hazardous.

To avoid a shock hazard:

- **Do not connect or disconnect any cables or perform installation, maintenance, or reconfiguration of this product during an electrical storm.**
- **Connect all power cords to a properly wired and grounded electrical outlet.**
- **Connect to properly wired outlets any equipment that will be attached to this product.**
- **When possible, use one hand only to connect or disconnect signal cables.**
- **Never turn on any equipment when there is evidence of fire, water, or structural damage.**
- **Disconnect the attached power cords, telecommunications systems, networks, and modems before you open the device covers, unless instructed otherwise in the installation and configuration procedures.**
- **Connect and disconnect cables as described in the following table when installing, moving, or opening covers on this product or attached devices.**

To Connect:	To Disconnect:
<ol style="list-style-type: none">1. Turn everything OFF.2. First, attach all cables to devices.3. Attach signal cables to connectors.4. Attach power cords to outlet.5. Turn device ON.	<ol style="list-style-type: none">1. Turn everything OFF.2. First, remove power cords from outlet.3. Remove signal cables from connectors.4. Remove all cables from devices.

Statement 3:



CAUTION:

When laser products (such as CD-ROMs, DVD drives, fiber optic devices, or transmitters) are installed, note the following:

- Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.
- Use of controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.



DANGER

Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following.

Laser radiation when open. Do not stare into the beam, do not view directly with optical instruments, and avoid direct exposure to the beam.




Class 1 Laser statement

Class 1 Laser Product
Laser Klasse 1
Laser Klasse 1
Luokan 1 Laserlaitte
Appareil À Laser de Classe 1

IEC 825-11993 CENELEC EN 60 825

Statement 4:



		
≥ 18 kg (39.7 lb)	≥ 32 kg (70.5 lb)	≥ 55 kg (121.2 lb)

CAUTION:

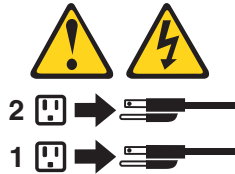
Use safe practices when lifting.

Statement 5:



CAUTION:

The power control button on the device and the power switch on the power supply do not turn off the electrical current supplied to the device. The device also might have more than one power cord. To remove all electrical current from the device, ensure that all power cords are disconnected from the power source.



Statement 8:



CAUTION:

Never remove the cover on a power supply or any part that has the following label attached.



Hazardous voltage, current, and energy levels are present inside any component that has this label attached. There are no serviceable parts inside these components. If you suspect a problem with one of these parts, contact a service technician.

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About this document

This document provides instructions for installing and customizing the configuration of your IBM TotalStorage DS4100 storage server. It also provides hardware maintenance procedures and troubleshooting information.

FAST product renaming

IBM is in the process of renaming some FAST family products. Table 1 identifies each new DS4000 product name with its corresponding FAST product name. Note that this change of **product name only** indicates no change in functionality or warranty. All products listed below with new names are functionally-equivalent and fully-interoperable. Each DS4000 product retains full IBM service as outlined in service contracts issued for analogous FAST products.

Table 1. Mapping of FAST names to DS4000 Series names

Current FAST Product Name	New DS4000 Product Name
IBM TotalStorage FAST Storage Server	IBM TotalStorage DS4000
FAST	DS4000
FAST Family	DS4000 Mid-range Disk System
FAST Storage Manager vX.Y (for example 9.10)	DS4000 Storage Manager vX.y (for example v9.10)
FAST100	DS4100
FAST600	DS4300
FAST600 with Turbo Feature	DS4300 Turbo
FAST700	DS4400
FAST900	DS4500
EXP700	DS4000 EXP700
EXP100	DS4000 EXP100
FAST FlashCopy	FlashCopy for DS4000
FAST VolumeCopy	VolumeCopy for DS4000
FAST Remote Mirror (RM)	Enhanced Remote Mirroring for DS4000
FAST Synchronous Mirroring	Metro Mirroring for DS4000
	Global Copy for DS4000 (New Feature = Asynchronous Mirroring without Consistency Group)
	Global Mirroring for DS4000 (New Feature = Asynchronous Mirroring with Consistency Group)

Who should read this document

This document is intended for system operators and service technicians who have extensive knowledge of fibre channel and network technology.

How this document is organized

Chapter 1, “Introduction,” on page 1 describes the IBM TotalStorage DS4100 storage server. This chapter includes an inventory checklist and an overview of the storage server features, operating specifications, and components.

Chapter 2, “Installing the storage server,” on page 17 contains instructions for installing the storage server in a standard rack cabinet and setting the interface options.

Chapter 3, “Cabling the storage server,” on page 45 contains fibre channel and power cabling information for the storage server.

Chapter 4, “Operating the storage server,” on page 65 contains instructions for power the storage server on or off during either normal or emergency situations. It also contains information on how to check the LEDs on the front and back of the storage server.

Chapter 5, “Installing and replacing components,” on page 79 contains step-by-step instructions for how to install or remove customer replaceable units (CRUs), such as hard disk drives, power supplies, RAID controllers, and fan units.

Chapter 6, “Hardware maintenance,” on page 111 contains problems, symptoms, and error messages that are specific to your storage server.

Appendix A, “Records,” on page 119 provides a table that you can use to record and update important information about your DS4100, including serial number and device records. Whenever you add options to your DS4100, be sure to update the information in this table.

Appendix B, “Rack mounting template,” on page 121 provides the rack mounting templates for installation of the DS4100. If you want to tear out the templates from the document for use during installation, use these copies of the templates.

Appendix C, “Power cords,” on page 125 lists power cord information for the DS4100.

Notices and statements used in this document

The caution and danger statements used in this document also appear in the multilingual *Safety Information* document provided with your IBM DS4100. Each caution and danger statement is numbered for easy reference to the corresponding statements in the safety document.

The following types of notices and statements are used in this document:

- **Note:** These notices provide important tips, guidance, or advice.
- **Important:** These notices provide information or advice that might help you avoid inconvenient or problem situations.
- **Attention:** These notices indicate possible damage to programs, devices, or data. An attention notice is placed just before the instruction or situation in which damage could occur.
- **Caution:** These statements indicate situations that can be potentially hazardous to you. A caution statement is placed just before the description of a potentially hazardous procedure step or situation.

DS4000 Storage Server publications

The following tables present an overview of the DS4500, DS4400, DS4300 Fibre Channel, and DS4100 SATA Storage Server product libraries, as well as other related documents. Each table lists documents that are included in the libraries and what common tasks they address. Click on active links in the tables to access those documents currently available on the Internet. You can access documentation for the other DS4000 products at the following Web site:

www-1.ibm.com/servers/storage/support/disk/

You can also search for IBM publications at the following Web site:

www.ibm.com/shop/publications/order/

DS4500 storage server library

Table 2 associates each document in the DS4500 (previously FASt900) storage server library with its related common user tasks.

Table 2. TotalStorage DS4500 storage server document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM TotalStorage FASt900 Installation and Support Guide, GC26-7530</i>	✓	✓		✓		
<i>IBM TotalStorage FASt900 Fibre Channel Cabling Instructions, 24P8135</i>	✓	✓				
<i>IBM TotalStorage FASt900 Storage Server User's Guide, GC26-7534</i>				✓	✓	✓
<i>IBM TotalStorage FASt FC2-133 Dual Port Host Bus Adapter Installation and User's Guide, GC26-7532</i>		✓			✓	
<i>IBM FASt FC2-133 Host Bus Adapter Installation and User's Guide, 48P9823</i>		✓			✓	
<i>IBM TotalStorage FASt Rack Mounting Instructions, 19K0900</i>	✓	✓				

Table 2. TotalStorage DS4500 storage server document titles by user tasks (continued)

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM FAST Management Suite Java User's Guide, 32P0081</i>					✓	✓
<i>IBM TotalStorage DS4000 Hardware Maintenance Manual, GC26-7702</i>						✓
<i>IBM TotalStorage DS4000 Problem Determination Guide, GC26-7703</i>						✓

DS4400 storage server library

Table 3 associates each document in the DS4400 (previously FAStT700) storage server library with its related common user tasks.

Table 3. TotalStorage DS4400 storage server document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM FAStT700 Fibre Channel Cabling Instructions, 32P0343</i>	✓	✓				
<i>IBM FAStT700 Fibre Channel Storage Server User's Guide, 32P0341</i>				✓	✓	✓
<i>IBM FAStT FC2-133 Dual Port Host Bus Adapter Installation and User's Guide, GC26-7532</i>		✓			✓	
<i>IBM TotalStorage FAStT FC2-133 Host Bus Adapter Installation and User's Guide, 48P9823</i>		✓			✓	
<i>IBM FAStT Management Suite Java User's Guide, 32P0081</i>					✓	✓
<i>IBM TotalStorage DS4000 Hardware Maintenance Manual, GC26-7702</i>						✓
<i>IBM TotalStorage DS4000 Problem Determination Guide, GC26-7703</i>						✓

DS4300 storage server library

Table 4 associates each document in the DS4300 (previously FAStT600) storage server library with its related common user tasks.

Table 4. TotalStorage DS4300 storage server document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM TotalStorage FAStT600 Fibre Channel Storage Server Installation and User's Guide, GC26-7531</i>	✓	✓		✓		
<i>IBM TotalStorage DS4000 Hardware Maintenance Manual, GC26-7702</i>						✓
<i>IBM TotalStorage DS4000 Problem Determination Guide, GC26-7703</i>						✓
<i>IBM TotalStorage FAStT FC2-133 Host Bus Adapter Installation and User's Guide, 48P9823</i>		✓			✓	
<i>IBM TotalStorage FAStT FC2-133 Dual Port Host Bus Adapter Installation and User's Guide, GC26-7532</i>		✓			✓	
<i>IBM TotalStorage FAStT600 Rack Mounting Instructions, 24P8125</i>	✓	✓				
<i>IBM TotalStorage FAStT600 Fibre Channel Cabling Instructions, 24P8126</i>	✓	✓				

DS4100 storage server library

Table 5 on page xxiv associates each document in the DS4100 (previously FAStT100) storage server library with its related common user tasks.

Table 5. TotalStorage DS4100 storage server document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM TotalStorage DS4100 Installation, User's, and Maintenance Guide, GC26-7712</i>	✓	✓		✓		✓
<i>IBM TotalStorage DS4100 Fibre Channel Cabling Instructions, 25R0325</i>	✓	✓				
<i>IBM TotalStorage FAST FC2-133 Dual Port Host Bus Adapter Installation and User's Guide, GC26-7532</i>		✓			✓	
<i>IBM FAST FC2-133 Host Bus Adapter Installation and User's Guide, 48P9823</i>		✓			✓	
<i>IBM TotalStorage DS4000 Hardware Maintenance Manual, GC26-7702</i>						✓
<i>IBM TotalStorage DS4000 Problem Determination Guide, GC26-7703</i>						✓

DS4000-related hardware publications

Table 6 associates each of the following documents related to DS4000 (previously FAStT) operations with its related common user tasks.

Table 6. TotalStorage DS4000-related document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
IBM Safety Information, P48P9741					✓	
<i>IBM TotalStorage FAStT Quick Start Guide</i> , GC26-7662	✓	✓				
<i>IBM TotalStorage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview</i> GC26-7713	✓		✓	✓		
<i>IBM TotalStorage DS4000 EXP100 Storage Expansion Unit Installation, User's, and Maintenance Guide</i> , GC26-7694	✓	✓		✓	✓	✓
<i>Fibre Channel Solutions - IBM FAStT EXP500 Installation and User's Guide</i> , 59P5637	✓	✓		✓	✓	✓
<i>IBM TotalStorage FAStT EXP700 and EXP710 Storage Expansion Units Installation, User's, and Maintenance Guide</i> , GC26-7647	✓	✓		✓	✓	✓
<i>IBM TotalStorage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide</i> , GC26-7704	✓	✓				
<i>IBM Fibre Channel SAN Configuration Setup Guide</i> , 25P2509	✓		✓	✓	✓	

Table 6. TotalStorage DS4000-related document titles by user tasks (continued)

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM FAST Host Adapter Installation and User's Guide, 59P5712</i>		✓			✓	
<i>RS/6000 @server pSeries Fibre Channel Planning and Integration: User's Guide and Service Information, SC23-4329</i>	✓	✓			✓	✓

DS4000 Storage Manager Version 9 publications

Table 7 associates each document in the DS4000 Storage Manager (previously FAST Storage Manager) library with its related common user tasks.

Table 7. TotalStorage DS4000 Storage Manager Version 9 titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM TotalStorage DS4000 Storage Manager Version 9 Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux, GC26-7706</i>	✓		✓	✓		
<i>IBM TotalStorage DS4000 Storage Manager Version 9 Installation and Support Guide for AIX, UNIX, Solaris and Linux on POWER, GC26-7705</i>	✓		✓	✓		
<i>IBM TotalStorage DS4000 Storage Manager Version 9 Copy Services User's Guide, GC26-7707</i>	✓		✓	✓	✓	
<i>IBM TotalStorage FAST Storage Manager Version 9 Concepts Guide, GC26-7661</i>	✓	✓	✓	✓	✓	✓

Getting information, help, and service

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

Before you call

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

- Check all cables to make sure that they are connected.
- Check the power switches to make sure that the system is turned on.
- Use the troubleshooting information in your system documentation and use the diagnostic tools that come with your system.
- Check for technical information, hints, tips, and new device drivers at the following Web site:

www.ibm.com/storage/techsup.htm

- Use an IBM discussion forum on the IBM Web site to ask questions.

You can solve many problems without outside assistance by following the troubleshooting procedures that IBM provides in the online help or in the documents that are provided with your system and software. The information that comes with your system also describes the diagnostic tests that you can perform. Most xSeries and IntelliStation systems, operating systems, and programs come with information that contains troubleshooting procedures and explanations of error messages and error codes. If you suspect a software problem, see the information for the operating system or program.

Using the documentation

Information about the xSeries or IntelliStation system and preinstalled software, if any, is available in the documents that come with your system. This includes printed documents, online documents, readme files, and help files. See the troubleshooting information in your system documentation for instructions on how to use the diagnostic programs. The troubleshooting information or the diagnostic programs might tell you that you need additional or updated device drivers or other software.

Web sites

IBM maintains pages on the World Wide Web where you can get the latest technical information and download device drivers and updates.

- For DS4000 information, go to the following Web site:

www.ibm.com/storage/techsup.htm

The support page has many sources of information and ways for you to solve problems, including:

- Diagnosing problems using the IBM Online Assistant
- Downloading the latest device drivers and updates for your products
- Viewing frequently asked questions (FAQ)
- Viewing hints and tips to help you solve problems
- Participating in IBM discussion forums
- Setting up e-mail notification of technical updates about your products

- You can order publications through the IBM Publications Ordering System at the following web site:
www.elink.ibm.com/public/applications/publications/cgibin/pbi.cgi/
- For the latest information about IBM xSeries products, services, and support, go to the following Web site:
www.ibm.com/eserver/xseries/
- For the latest information about IBM pSeries products, services, and support, go to the following Web site:
www.ibm.com/eserver/pseries/
- For the latest information about the IBM IntelliStation information, go to the following Web site:
www-132.ibm.com/content/home/store_IBMPublicUSA/en_US/IntelliStation_workstations.html
- For the latest information about operating system and HBA support, clustering support, SAN fabric support, and Storage Manager feature support, see the TotalStorage DS4000 Interoperability Matrix at the following Web site:
www.storage.ibm.com/disk/fastt/supserver.htm

Software service and support

Through IBM Support Line, for a fee you can get telephone assistance with usage, configuration, and software problems with xSeries servers, IntelliStation workstations, and appliances. For information about which products are supported by Support Line in your country or region, go to the following Web site:

www.ibm.com/services/sl/products/

For more information about the IBM Support Line and other IBM services, go to the following Web sites:

- www.ibm.com/services/
- www.ibm.com/planetwide/

Hardware service and support

You can receive hardware service through IBM Integrated Technology Services or through your IBM reseller, if your reseller is authorized by IBM to provide warranty service. Go to the following Web site for support telephone numbers:

www.ibm.com/planetwide/

In the U.S. and Canada, hardware service and support is available 24 hours a day, 7 days a week. In the U.K., these services are available Monday through Friday, from 9 a.m. to 6 p.m.

Fire suppression systems

A fire suppression system is the responsibility of the customer. The customer's own insurance underwriter, local fire marshal, or a local building inspector, or both, should be consulted in selecting a fire suppression system that provides the correct level of coverage and protection. IBM designs and manufactures equipment to internal and external standards that require certain environments for reliable operation. Because IBM does not test any equipment for compatibility with fire suppression systems, IBM does not make compatibility claims of any kind nor does IBM provide recommendations on fire suppression systems.

Table 9 on page 14 lists the environmental specifications for the DS4100.

How to send your comments

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- Internet: starpubs@us.ibm.com
- IBMLink from U.S.A.: STARPUBS at SJEVM5
- IBMLink from Canada: STARPUBS at TORIBM
- IBM Mail Exchange: USIB3WD at IBMMAIL

You can also mail your comments by using the Reader Comment Form in the back of this manual or direct your mail to:

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Chapter 1. Introduction

This chapter describes the operating specifications, features, and components for the IBM TotalStorage DS4100 storage server (hereafter referred to as *DS4100* or *storage server*). This chapter also includes a list of hardware that comes with the storage server.

Overview

IBM DS4000 solutions support the large and growing data storage requirements of business-critical applications. These scalable IBM DS4000 solutions offer you data access and protection to meet your existing enterprise storage requirements and prepare for the future.

Designed for data archival, data reference, and near-line storage applications, the DS4100 utilizes the latest Serial Advanced Technology Attachment (SATA) disk drive technology. The DS4100 supports up to fourteen 1.5 Gbps 250 GB SATA disk drive modules, offering up to 3.5 terabytes (TB) of capacity per enclosure.

Note: SATA hard drive CRUs cannot be interchanged with the fibre-channel hard drive CRUs that are supported in other DS4000 storage products.

The DS4100 can be used in storage area networks to satisfy the needs of various fixed content, data-reference applications that require large amounts of storage capacity but do not have the high utilization and access characteristics satisfied by fibre channel disk drive storage. The storage server provides continuous, reliable service, using hot-swap technology for easy replacement without shutting down the system.

IBM currently offers two versions of the DS4100:

- DS4100 base storage server (Machine Type 1724, Model 100)
- DS4100 single-controller storage server (Machine Type 1724, Model 1Sx)

About the DS4100 base storage server

The DS4100 base (dual-controller) storage server (Machine Type 1724, Model 100) is a rack-mountable storage server that comes with two RAID controllers, two power supplies, and two cooling units. It provides dual, redundant controllers, redundant cooling, redundant power, and battery backup of the RAID controller cache. The DS4100 base storage server is designed to provide maximum host and drive-side redundancy, enabling full redundant drive loop support to additional disk storage capacity in the drive expansion enclosures via the drive loop port from each RAID controller. In addition, each RAID controller supports direct attachment of two hosts that contain two fibre channel host bus adapters each. External cables and small form-factor pluggable (SFP) modules connect the storage server to the storage expansion unit and the host servers.

Up to seven DS4000 EXP100 storage expansion units can be connected together with the DS4100 base storage server in a fibre-channel loop, providing connections to a maximum of 112 hard drives. With the DS4100 base storage server, you can configure RAID-protected storage solutions of up to 28 TB (by connecting the DS4100 base storage server to seven drive expansion enclosures with 250 GB SATA hard drives), providing economical and scalable storage for your rapidly growing application needs for limited access, data reference storage capacity. The DS4100 base storage server is designed with redundant 2 Gbps fibre channel

connections for expanding the DS4100 storage capacity to SATA hard drives in external DS4000 EXP100 storage expansion units.

Currently, the only DS4000 storage expansion unit model that can be attached to the DS4100 base storage server is the DS4000 EXP100. Do not connect other DS4000 storage expansion units (such as the DS4000 EXP700 or DS4000 EXP710) to the DS4100 base storage server. Please contact your IBM support representative for information about the availability of future support for connecting other DS4000 storage expansion unit models.

Note: You must make fibre channel connections from the host server fibre channel HBA ports to both controllers in the DS4100 base storage server to ensure full host-side redundancy.

Attention

To ensure proper operation when connecting DS4000 EXP100 expansion units to the DS4100 base storage server, you must verify that the DS4000 EXP100 ESM firmware level is at level 9554 or later. If the ESM firmware level is lower than 9554, disconnect the DS4000 EXP100 and contact IBM support, your IBM reseller, or your IBM representative for assistance.

About the DS4100 single-controller storage server

The DS4100 single-controller storage server (Machine Type 1724, Model 1Sx, where x represents an upper-case alphanumeric character) is a rack-mountable storage server that comes with one RAID controller, one power supply, and two cooling units. It supports up to fourteen hot-swap internal disk drive slots, which support over 3.5 TB of storage capacity when using 250 GB SATA disk drives. External cables and small form-factor pluggable (SFP) modules connect the storage server to the host server fibre channel HBA ports.

Notes:

1. The DS4100 single-controller storage server does not support storage capacity expansion using external DS4000 EXP100 expansion units (or any other models of DS4000 storage expansion units). In addition, it does not offer RAID controller and drive loop redundancy.
2. The cache in the controller of the DS4100 single-controller storage server is used for read operations only. No write operations will be cached.

The following limitations apply to this release of the DS4100 single-controller storage server.

- All factory-delivered DS4100 RAID controllers are shipped with a recent version of controller firmware loaded on the RAID controller, but that firmware version might not match precisely the firmware version the RAID controller you need to replace. When you replace the RAID controller in the DS4100 single-controller storage server, if the firmware version of the replacement RAID controller is determined to be incompatible with the configuration database during the boot process, the DS4100 single-controller storage server will enter a Stop State and will not allow any DS4000 Storage Manager operations to be performed. In this case, you must manually upgrade or downgrade the replacement RAID controller firmware to match the version required by the configuration database. See “Manually upgrading the firmware for the DS4100 single-controller storage server” on page 103.

- The DS4100 single-controller storage server does not support automatic firmware updates. All firmware upgrades and downgrades for the DS4100 single-controller storage server must be performed manually, as described in “Manually upgrading the firmware for the DS4100 single-controller storage server” on page 103.
- All DS4100 single-controller storage server controller firmware updates must be performed off-line.
- You cannot upgrade from the DS4100 single-controller storage server to the DS4100 base storage server. Please contact your IBM reseller or representative for the possible availability of such support in the future.

Fibre channel defined

Fibre channel technology is outlined in the *SCSI-3 Fibre Channel Protocol* (SCSI-FCP) standard. Fibre channel is a high-speed data transport technology that is used for mass storage and networking.

Using a fibre-channel arbitrated loop (FC-AL), more than 100 fibre-channel devices¹ can be supported, compared to 15 small computer system interface (SCSI) devices. The connection from the DS4100 base storage server to the DS4000 EXP100 drive expansion enclosure ports or fibre channel host bus adapter ports is a 2 Gb fibre-channel device that supports data transfer rates up to 200 MBps half-duplex and 400 MBps full-duplex on optical interfaces.

SATA defined

The Serial Advanced Technology Attachment (SATA) interface offers increased data rate performance over Parallel Advanced Technology Attachment (ATA), while maintaining the benefits of ATA. SATA is designed to overcome the performance barriers that have been forecasted for current parallel technologies while maintaining the cost-efficiency of Parallel ATA. SATA specifications allow for thinner, more flexible cables, and lower pin counts. It also enables easier, more flexible cable routing management and the use of smaller connectors than is possible with the existing Parallel ATA technology.

The Serial ATA Working Group introduced the first SATA specification, Serial ATA 1.0, in 2001 (<http://www.serialata.org>).

Product updates

You should download the latest version of the DS4000 Storage Manager host software and the DS4000 storage server controller firmware and drive firmware (and, if you are connecting DS4000 EXP100 expansion units to the DS4100 base storage server storage server, the DS4000 EXP100 ESM firmware, and the DS4000 EXP100 disk drive firmware) at the time of the initial installation and when product updates become available.

To be notified of important product updates, you must first register at the IBM Support and Download Web site:

www-1.ibm.com/servers/storage/disk/

1. For the DS4100, each drive is considered to be a device in a fibre-channel loop, even though the DS4100 drive interface is SATA (not fibre channel). The DS4000 EXP100 ESM and the DS4100 controller and SATA hard drive interposer convert SATA interface protocol to fibre channel protocol.

Go to the **Personalized Support** section of the web page and click **My Support**. On the next page, go to the **We use IBM Registration** section. To register to use this site, click **Register**.

Perform the following steps to receive product updates:

1. Once you have registered, type your user ID and password to log into the site. The Welcome page opens.
2. In the Select a Product Family pull-down menu, scroll down to the listing of hardware topics and select **Computer Storage**. Click **Go**. The Computer Storage page opens.
3. Scroll down to the Disk Storage Systems category and check the box for 1724 (and 1710 if you are connecting DS4000 EXP100 expansion units to the DS4100). Check the boxes for any other DS4000 products for which you would like to receive information. Scroll to the bottom of the page and select **Save and Return**. The main page opens.
4. Select your mail preferences. Select **Flashes and Downloadable files** to receive important information about product updates. Click **Submit**. You should see a confirmation at the bottom of the page that indicates that your profile was successfully updated.

Features at a glance

Table 8 summarizes the features of the storage server. For a list of the operating specifications, such as weight, height, and heat output, see Table 9 on page 14.

Table 8. Features at a glance

<p>General</p> <ul style="list-style-type: none"> • Modular components: <ul style="list-style-type: none"> – High-capacity SATA disk drives – RAID controllers – Power supplies – Cooling fans • Technology: <ul style="list-style-type: none"> – Support for disk arrays – Support for clustering – Fibre channel host interface – Redundant data storage, RAID controllers, and power system (base storage server only) – Hot-swap technology for drives and fans – Hot-swap technology for RAID controllers and power supplies (base storage server only) – DS4100 single-controller has a non-redundant hard disk drive interface, power supply, and RAID controller. However, it does offer a redundant cooling system. <p>Attention: You will lose access to data if you attempt to hot-swap the controller or power-supply components in a DS4100 single-controller storage server.</p>	<ul style="list-style-type: none"> • User interface: <ul style="list-style-type: none"> – Built-in power, activity, and fault light emitting diodes (LEDs) – Identification labeling on customer replaceable units (CRUs), rear LEDs, switches, and connectors – Easy-to-replace drives, power supplies, RAID controllers, and fans <p>Disk drive storage</p> <p>1.5 Gbps SATA hard disk drives Maximum drives per storage server: 14</p> <p>Attached Expansion Units (base storage server only)</p> <p>2 Gbps connections only</p>	<p>RAID controllers</p> <ul style="list-style-type: none"> • Technology and interfaces: <ul style="list-style-type: none"> – Fibre channel: 40-pin fibre channel disk drives – Fibre channel interface: <ul style="list-style-type: none"> - For base storage server: six small form-factor pluggable (SFP) ports for incoming and outgoing fibre-channel cables (three SFP ports on each RAID controller) - For single-controller storage server: three SFP ports for incoming and outgoing fibre-channel cables Note: The SFP port labelled <i>Expansion</i> is not active). – Two 1 Gbps/2 Gbps (auto-negotiated) fibre channel host side connections per controller
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Clustering support

Clustering is a means of sharing array groups among controllers to provide redundancy of controllers and servers. This redundancy is important if a hardware component fails. If a hardware component failure occurs in a cluster, another server takes ownership of the array group.

Clustering requires software specific to your operating system. For more information about clustering, go to the following Web site:

www.pc.ibm.com/us/compat/nos/matrix.shtml

Inventory checklist

After you unpack the DS4100 storage server, verify that you have the following items:

- **Hardware**

- Up to 14 hard disk drives (shipped installed in the DS4100)

Note: The DS4100 base storage server is shipped with no SATA hard disk drives as standard. You can order the unit with up to 14 250 GB SATA drive CRUs installed at the factory. The DS4100 single-controller storage server is shipped with three 250 GB SATA drive CRUs as standard. You can order the unit with up to 11 additional SATA drive CRUs installed at the factory.

- RAID controllers (shipped installed in the DS4100)
 - 2 controllers on the base storage server
 - 1 controller on the single-controller storage server

Note: A blank controller tray is installed in the empty controller slot in the DS4100 single-controller storage server chassis. For proper cooling and EMI shielding, do not remove this blank controller tray.

- Two fan units (shipped installed in the DS4100)
- Power supplies (shipped installed in the DS4100)
 - 2 power supplies on the base storage server
 - 1 power supply on the single-controller storage server

Note: A blank power supply tray is installed in the empty power supply slot in the DS4100 single-controller storage server chassis. For proper cooling and EMI shielding, do not remove this blank power supply tray.

- Line cord jumpers
 - 2 line cord jumpers on the base storage server
 - 1 line cord jumper on the single-controller storage server

Line cord jumpers are power cords used to connect the DS4100 power supply units to the IBM-certified rack power distribution units (PDUs).

- One rack-mounting hardware kit, including:
 - Two rails (right and left assembly)
 - Eight M6 black hex-head slotted screws
 - Eight M6 cage nuts
 - Eight M6 clip nuts

- Up to 14 blank drive trays (shipped installed in the DS4100)

Your DS4100 storage server has 14 hard disk drive slots; any drive slots not containing hard disk drives will contain blank drive trays. Each of the 14 drive slots must always contain either a blank tray or a hard disk drive.

- Box ID labels (used to label the storage server IDs on the front of the DS4100)
- Wrap plug and coupler kit

Attention: The DS4100 does not ship with region-specific power cords. You must obtain the IBM-approved power cords for your region. See Appendix C, “Power cords,” on page 125 for the IBM-approved power cords for your region.

- **Software and documentation**

- *DS4000 Storage Manager Version 9.10 Support CD*, including client software and firmware, and online help and publications in Adobe Acrobat Portable Document Format (PDF)

For a list of available IBM DS4000 publications, see “DS4000 Storage Server publications” on page xx.

- *IBM TotalStorage DS4100 Storage Server Installation, User’s, and Maintenance Guide*
- *IBM TotalStorage DS4100 Fibre Channel Cabling Instructions*
- *IBM Safety Information*
- *IBM TotalStorage Storage Server and Expansion Unit Quick Start Guide*
- IBM License Agreement
- Statement of Limited Warranty

If an item is missing or damaged, contact your IBM reseller or your IBM marketing representative.

If you have not already done so, record your storage server serial number in the table in Appendix A, “Records,” on page 119. The serial number is located on a label at the rear of the DS4100. The machine and model number are found on the product information label above the serial number.

A rack mounting template and instructions for installing the support rails and the storage server are provided in this document in Chapter 2, “Installing the storage server,” on page 17.

To connect your DS4100 to other devices, use the following options:

- IBM SFP module
- IBM LC-LC fibre-channel cable
- IBM LC-SC fibre-channel cable (for host-side connections only)

Note: You must order these options separately.

Best practices guidelines

To ensure optimal operation of your system, always follow these best practices guidelines:

- Back up the data on your storage drives periodically.
- **DS4100 base storage server only:** To maintain power redundancy, plug the DS4100 storage server’s right and the left power supplies into two independent external power circuits through ac distribution units inside a rack cabinet or directly into external receptacles. Similarly, the right and left power supplies of

the DS4000 storage expansion units attached to the DS4100 storage server should be plugged into the same two independent external power circuits as the DS4100. This ensures that the DS4100 storage server and all its attached storage expansion units will have power if only one power circuit is available. In addition, having all the right or all the left power supplies plug into the same power circuit enables the components in the storage subsystem to power on simultaneously during an unattended restoration of power. See Figure 56 on page 62 for an example of redundant power connections.

Note: This guideline cannot be followed for the DS4100 single-controller storage server, which does not offer redundant power supplies. However, you can use Uninterruptible Power Supply (UPS) units with the DS4100 single-controller storage server to provide protection against power brown-outs and short power outages.

- Before any planned system shutdown or after any system additions, removals, or modifications (including logical drive creations, storage partitioning definitions, hardware changes, and so on), save the storage subsystem profile as explained in the DS4000 Storage Manager guide for your operating system. Save the profile in a location other than the logical drives created for the DS4100 storage server.
- Ensure that your system is in an optimal state before you shut it down. Never turn the power off if any fault light is lit; be sure to resolve any error conditions before you shut down the system.
- During any maintenance or attended power-up procedure, carefully follow the power-up sequence listed in “Turning on the storage server” on page 66. Check that each component of the subsystem is powered-on in the proper order during this entire power-up procedure to ensure the controller will be able to optimally access all of your storage subsystems.
- The storage subsystem supports simultaneous power-up to the system components; however, you should always follow the power-up sequence listed in “Turning on the storage server” on page 66 during any attended power-up procedure.
- A storage system in an optimal state should recover automatically from an unexpected shutdown and unattended simultaneous restoration of power to system components. After power is restored, call IBM support if any of the following conditions occur:
 - The storage subsystem logical drives and arrays are not displayed in the DS4000 Storage Manager graphical user interface (GUI).
 - The storage subsystem logical drives and arrays do not come online.
 - The storage subsystem logical drives and arrays seem to be degraded.

Storage server components

The following sections show the components of the DS4100 storage server.

Hot-swappable devices enable you to maintain the availability of your system while you remove, install, or replace a hot-swap device. All DS4100 storage server models support hot-swap SATA hard disk drives and cooling fan CRUs, so you can remove and replace these components without turning off the storage server. In addition, the DS4100 base storage server supports hot-swap RAID controllers and power supplies.

Attention: The DS4100 single-controller storage server does not support hot-swap RAID controllers or power supplies. You will lose access to data if you attempt to remove or replace a functioning (non-failed) RAID controller or power supply in a DS4100 single-controller storage server without first powering down the storage server.

Hot-swap drive bays

The hot-swap drive bays that are accessible from the front of your storage server are shown in Figure 2.

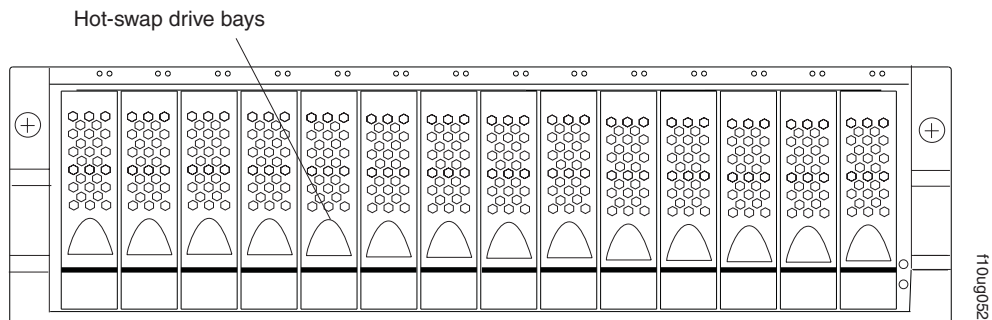


Figure 2. DS4100 hot-swap drive bays

The DS4100 supports up to 14 DS4000 1.5 Gbps SATA hard disk drives. These drives are preinstalled in drive trays. The unit consisting of the drive and the drive carrier assembly is called a *drive CRU*. The SATA drive CRU includes the drive tray, the SATA drive, and the hard disk drive (HDD) interposer card. You install the drive CRUs in the 14 drive bays on the front of the storage server. There are no serviceable parts in a drive CRU. If it fails, it must be replaced in its entirety (drive, interposer, bezel, and tray).

Attention:

1. Never hot-swap a drive CRU when its associated green Activity LED is flashing. Hot-swap a drive CRU only when its associated amber Fault LED lights and is not flashing or when the drive is inactive and its associated green Activity LED lights and is not flashing.
2. The SATA drive and its HDD card are digitally signed together at the factory. Do not swap drives and interposers between drive CRUs. Do not replace one SATA drive with another SATA drive. These actions will result in a drive CRU that cannot be recognized by the storage server RAID controller.
3. After you remove a drive CRU, wait at least 70 seconds before replacing or reseating the drive CRU to allow the drive to properly spin down. Failure to do so may cause undesired events.

Note: If the hard disk drive you want to remove is not in a failed or bypass state, always use the DS4000 Storage Manager client program either to place the drive in a failed state or to place the array that is associated with the drive (or drives) in an offline state before you remove the drive from the enclosure.

Front controls and indicators

This section describes the primary controls on the front of the storage server. The locations of these primary controls are shown in Figure 3 on page 9.

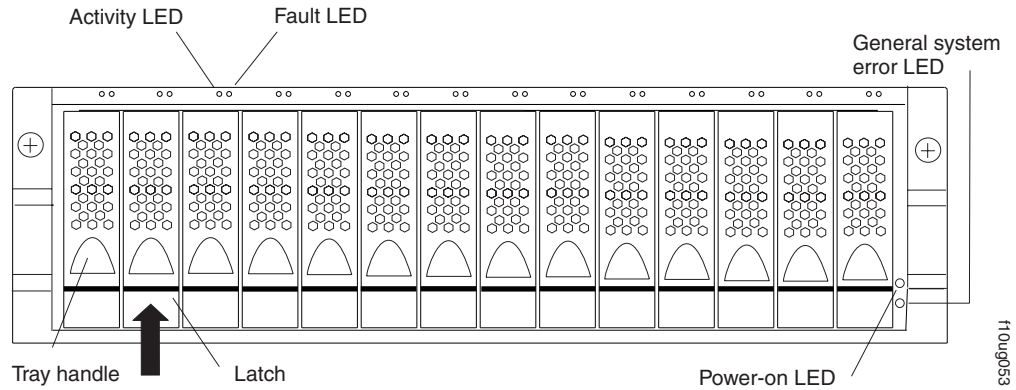


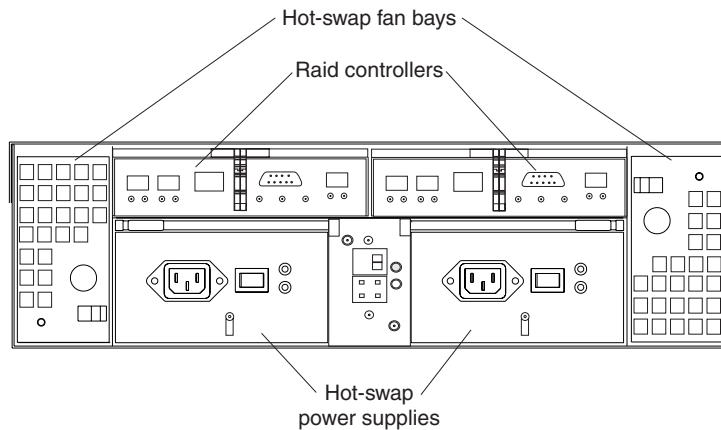
Figure 3. Front controls and indicators

The DS4100 has blank trays in the unused drive bays. To begin installing new drives, you must first remove the blank trays and save them. Each of the 14 bays must always contain either a blank tray or a drive CRU. You can install up to 14 hot-swap drive CRUs in the storage server.

- **Activity LED:** Each drive CRU has an associated Activity LED on the DS4100 chassis. A flashing green LED indicates drive activity. A solid green LED indicates that the drive is properly installed and powered on.
- **Fault LED:** Each drive CRU has an associated Fault LED on the DS4100 chassis. A solid amber LED indicates a drive failure. A flashing amber LED indicates that a drive identify process is in progress.
- **General system error LED:** A solid amber LED indicates a power supply, fan unit, or hard disk drive error. Use the DS4000 Storage Manager client to diagnose and repair the problem. For more information, see “Checking the LEDs” on page 71.
- **Latch:** Use this multipurpose latch to release or lock the drive CRU in place.
- **Power-on LED:** A solid green LED indicates that the storage server has dc power.
- **Tray handle:** Use this multipurpose handle to insert and remove a drive CRU in the bay.

Back view

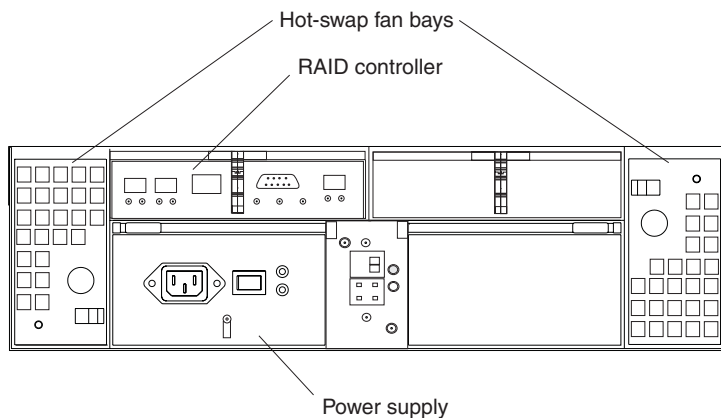
Figure 4 on page 10 shows the components at the back of the DS4100 base storage server.



f10ug021

Figure 4. Back view of DS4100 base storage server

Figure 5 shows the components at the back of the DS4100 single-controller storage server. The DS4100 single-controller storage server has a controller blank instead of a second RAID controller and a power supply blank instead of a second power supply.



f10ug021b

Figure 5. Back view of DS4100 single-controller storage server

RAID controller

Each RAID controller contains three ports for Small Form-Factor Pluggable (SFP) modules that connect to the fibre channel cables. Two of the SFP ports (labelled *Host 1* and *Host 2*) are for host server attachment. The third SFP port (labelled *Expansion*) is used to connect additional expansion units to the storage server.

Note: In the DS4100 single-controller storage server, the third SFP port (labelled *Expansion*) is present but not active.

Each RAID controller also contains a battery to maintain cache data in the event of a power failure. For more information, see “Cache memory and RAID controller battery” on page 75.

Attention: You will lose access to data if you attempt to hot-swap the RAID controller in a DS4100 single-controller storage server.

Hot-swap fans

The storage server has two interchangeable hot-swap and redundant fan CRUs. Each fan CRU contains two fans. If one fan CRU fails, the second

fan CRU continues to operate. You must install both fan CRUs to maintain proper cooling within the storage server, even if one fan CRU is not operational.

Hot-swap power supplies

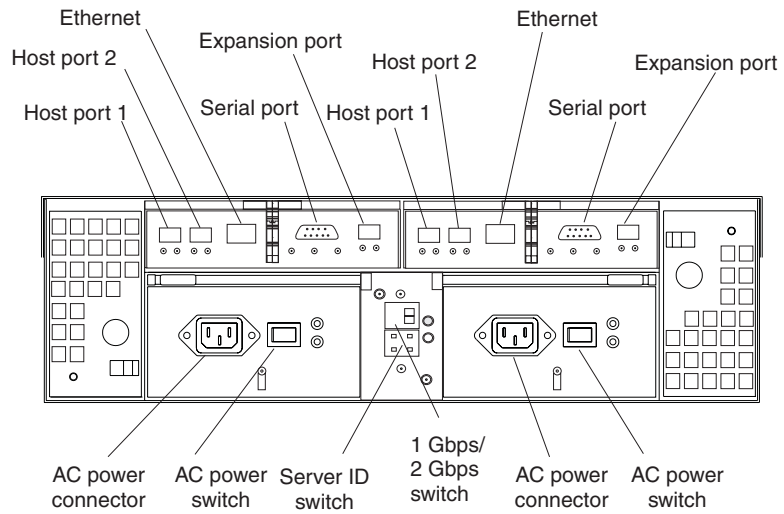
The DS4100 base storage server comes with two hot-swap power supplies. You must install both power supplies to maintain proper cooling.

The DS4100 single-controller storage server storage server comes with one power supply.

Attention: You will lose access to data if you attempt to hot-swap the power supply in a DS4100 single-controller storage server.

Interface ports and switches

Figure 6 shows the ports and switches on the back of the DS4100 base storage server.

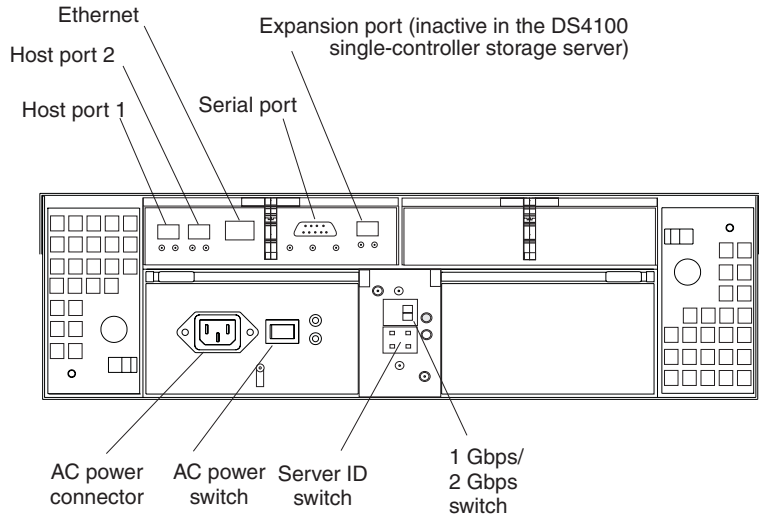


F10ug022

Figure 6. Interface ports and switches for DS4100 base storage server

Figure 7 on page 12 shows the ports and switches on the back of the DS4100 single-controller storage server.

Note: The DS4100 single-controller storage server has a controller blank instead of a second RAID controller and a power supply blank instead of a second power supply.



110uq022scu

Figure 7. Interface ports and switches for DS4100 single-controller storage server

RAID controller

Each RAID controller contains several connectors and LEDs. Each controller has two host ports and one expansion port for connecting the storage server to hosts or expansion units. You first insert SFPs into the ports and then connect the fibre channel cables.

Host ports

The host ports (labelled *Host 1* and *Host 2*) are used to connect a fibre channel cable from the host systems. You first insert an SFP into the port and then connect a fibre channel cable. The two host ports in each controller are independent. They are not connected in the controller module as they would be in a hub configuration. The host port connections can auto-negotiate between 1 Gbps and 2 Gbps.

Ethernet port

The Ethernet port is used for an RJ-45 10BASE-T or 100BASE-T Ethernet connection to each controller. Use the Ethernet connection to directly manage the DS4100.

Expansion port

The expansion port (labelled *Expansion*) is used to connect additional expansion units to the RAID controllers on the DS4100 base storage server. You first insert an SFP into the port and then connect a fibre channel cable.

Note: In the DS4100 single-controller storage server, the expansion port on the RAID controller is not active.

Serial port

The serial port is used by service personnel to perform diagnostic operations on the RAID controllers. Incorrect use of the serial port can result in loss of data access and, in some cases, in loss of data.

Note: The maximum baud rate is 57 600 bps.

Server ID switch (enclosure ID switch)

The server ID (also referred to as *enclosure ID*) switch settings range from 0 through 7. When connecting the DS4100 base storage server to DS4000 EXP100 storage expansion units, only the unique IDs ranging from 00 through 07 can be set.

Attention: When connecting the DS4100 to DS4000 EXP100 storage expansion units, DO NOT use the tens digit (x10) setting. Use only the ones digit (x1) setting to set unique server IDs or enclosure IDs. For more information, see “Server ID (enclosure ID) settings” on page 33.

1 Gbps/2 Gbps switch

The default switch setting is 2 Gbps. This is the *only* speed setting that is allowed for the DS4100.

Attention: Do not remove the metal plate that covers the storage server speed setting. Do not adjust the storage server speed setting.

Storage server operating environment

This section provides general operating information about the DS4100. All components plug directly into the backplane.

DS4100 specifications

Table 9 lists the physical specifications for the DS4100.

Table 9. IBM TotalStorage DS4100 specifications

<p>Size</p> <ul style="list-style-type: none"> • Width: 48.18 cm (18.97 in.) • Height: 13.23 cm (5.21 in.) • Depth: 59.74 cm (23.52 in.) <p>Weight</p> <ul style="list-style-type: none"> • Drive-ready weight (without disk drive modules installed): <ul style="list-style-type: none"> – Model 100: 26.64 kg (58.9 lb) – Model 1Sx: 23.44 kg (51.9 lb) • Fully configured weight (with 14 disk drives installed): <ul style="list-style-type: none"> – Model 100: 40.36 kg (89 lb) – Model 1Sx: 37.16 kg (82 lb) <p>Environment</p> <ul style="list-style-type: none"> • Air temperature <ul style="list-style-type: none"> – Operating: <ul style="list-style-type: none"> - Altitude: 0 - 914 m (3000 ft): 10° - 35° C (50° - 95° F) - Altitude: 914 m - 2133 m (3000 - 7000 ft): 10° - 32° C (50° - 90° F) <p>Important: The recommended operating environment air temperature is 22° C (72° F) or lower.</p> <ul style="list-style-type: none"> – Storage: <ul style="list-style-type: none"> - Altitude: 0 - 914 m (3000 ft): 1° - 60° C (33° - 140° F) - Altitude: 914 m - 2133 m (3000 - 7000 ft): 1° - 57° C (33° - 135° F) • Humidity <ul style="list-style-type: none"> – 8% - 80% – Noncondensing 	<p>Heat dissipation</p> <ul style="list-style-type: none"> • Fully configured storage server (14 1.5 Gbps SATA hard disk drives) <ul style="list-style-type: none"> – 1235 BTU per hour <p>Acoustical noise emission values</p> <p>For open bay (0 drives installed) and typical system configurations (eight hard disk drives installed):</p> <ul style="list-style-type: none"> • Sound power (idling): <ul style="list-style-type: none"> – 5.9 bel (open bay) – 6.1 bel (typical) • Sound power (operating): <ul style="list-style-type: none"> – 5.9 bel (open bay) – 6.2 bel (typical) • Sound pressure (idling): <ul style="list-style-type: none"> – 44 dBA (open bay) – 46 dBA (typical) • Sound pressure (operating): <ul style="list-style-type: none"> – 44 dBA (open bay) – 47 dBA (typical) <p>These levels are measured in controlled acoustical environments according to ISO 7779 and are reported in accordance with ISO 9296. The declared sound power levels indicate an upper limit, below which a large portion of machines operate. Sound pressure levels in your location might exceed the average 1-meter values stated because of room reflections and other nearby noise.</p>
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Notes:

1. The nonoperating environment must not exceed the operating environment limits for longer than 60 days.
2. The storage environment must not exceed the operating environment limits for longer than 1 year.
3. Substantial deviations from the suggested operating range, in either direction, if sustained for extended periods of time, will expose the unit to greater risk of failure from external causes.

The AC power sources must provide the correct voltage, current, and frequency specified on the storage server. The storage server can run without interruption within the limits shown in Table 10 on page 15.

Table 10. IBM TotalStorage DS4100 AC power requirements

	Low Range	High Range
Nominal Voltage	90 to 136 VAC	180 to 264 VAC
Frequency	50 to 60 Hz	50 to 60 Hz
Idle Current	2.50 A ^a	1.33 A ^b
Maximum Operating Current	3.01 A ^a	1.57 A ^b

^a. Typical voltage: 115 V AC, 60 Hz at 77% power-supply efficiency and 0.96 power factor

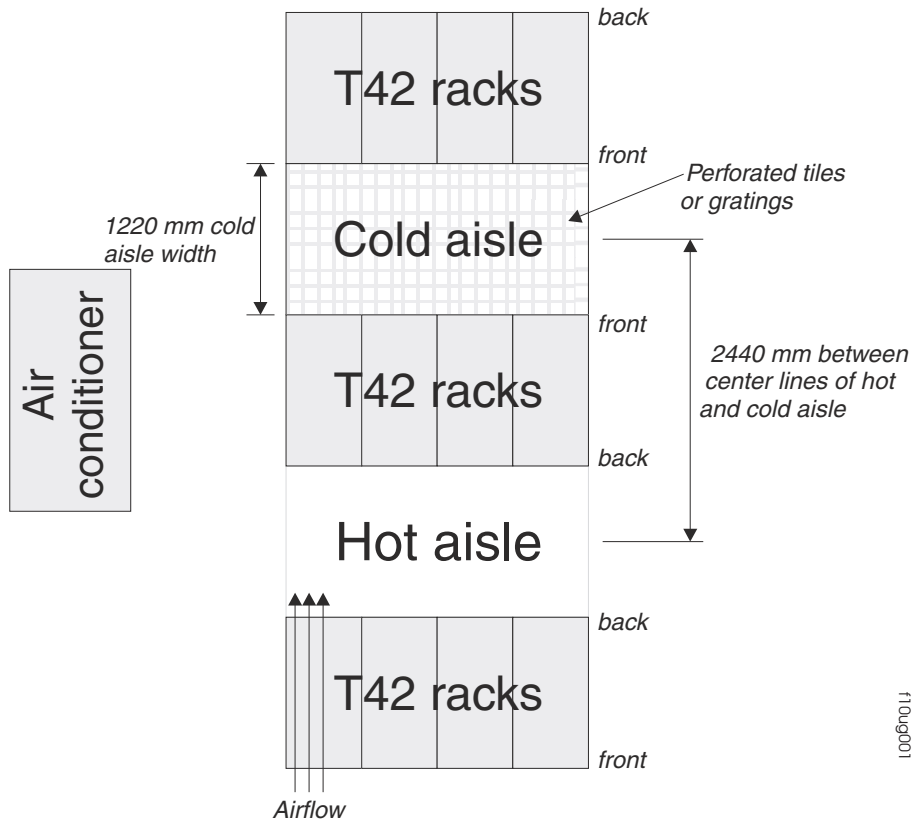
^b. Typical voltage: 230 V AC, 60 Hz at 77% power-supply efficiency and 0.96 power factor

Heat output, airflow, and cooling

The maximum heat output of the DS4100 is 390 watts (1235 BTU/hr). Each DS4100 rack-mounted unit requires an airflow of 2.5 m³ (87 ft³) per minute. The input air temperature to all rack cabinets should be in the range 10° C - 35° C (50° F - 95° F). The recommended operating temperature is 22° C (72° F).

When rack cabinets that contain many DS4100s are to be installed together, the following requirements must be met to ensure that the DS4100s are adequately cooled:

- Air enters at the front of the rack cabinet and leaves at the back. To prevent the air that is leaving the rack cabinet from entering the intake of another piece of equipment, you must position the rack cabinets in alternate rows, back-to-back and front-to-front. This arrangement is known as “cold aisle/hot aisle” and is shown in Figure 8 on page 16.
- Where rack cabinets are in rows, each rack cabinet must touch the rack cabinet that is next to it to reduce the amount of hot air that can flow around from the back of the rack into the intakes of the storage servers that are in that rack cabinet. You should use Suite Attach Kits to completely seal any gaps that remain between the rack cabinets. For details about Suite Attach Kits, contact your marketing representative.
- Where rack cabinets are in rows front-to-front or back-to-back, a gap of at least 1220 mm (48 in.) must separate the rows across the cold aisle.
- To ensure correct airflow in each rack cabinet, the rack filler plates must be installed in unused positions. Also, all the gaps in the front of the rack cabinets must be sealed, including the gaps between the storage servers.



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Figure 8. Example of cold aisle/hot aisle rack cabinet configuration

Chapter 2. Installing the storage server




This chapter provides the information that you need to install the DS4100 into a rack cabinet. This chapter also contains information about cabling, setting interface options, and installing optional cables.

Installation overview

The following steps provide an overview of the installation process you will perform in this chapter. Each step is detailed in the sections following the overview.

Statement 4:



		
≥ 18 kg (39.7 lb)	≥ 32 kg (70.5 lb)	≥ 55 kg (121.2 lb)

CAUTION:

Use safe practices when lifting.

Before you begin: The fully configured DS4100 weighs up to 40.8 kg (85.7 lbs). At least three persons are required to safely lift the DS4100 from the shipping box and to place it in the rack cabinet. If desired, you can open the sides of the shipping box and remove the CRUs from the DS4100 before you lift it from the shipping box in order to reduce the weight of the storage server. See “Removing the CRUs” on page 25.

1. Review the preparation recommendations. See “Preparing for installation” on page 18.
2. Prepare the installation site. See “Preparing the site” on page 19.
3. Prepare the rack cabinet. See “Preparing the rack cabinet” on page 19.
4. Unpack the DS4100 and other hardware from the shipping box.
5. Install the support rails in the rack cabinet. See “Installing the support rails” on page 22.
6. If necessary, remove the CRUs from the DS4100 in order to lighten the DS4100. See “Removing the CRUs” on page 25.
7. Install the DS4100. See “Installing the DS4100 into a rack cabinet” on page 28. If necessary, replace the CRUs in the DS4100. See “Replacing the DS4100 CRUs” on page 29.
8. Set the DS4100 interface options. See “Setting the interface options” on page 32.
9. **DS4100 base storage server only:** If required, cable the DS4100 to other DS4000 EXP100s. See Chapter 3, “Cabling the storage server,” on page 45.

10. Install the DS4000 Storage Manager 9.10 host software. Refer to the *IBM TotalStorage DS4000 Storage Manager 9.10 Installation and Support Guide* for the appropriate operating system for instructions on how to install the DS4000 Storage Manager 9.10 host software.
11. Turn on the DS4100. See “Turning the storage server on and off” on page 65.
12. Use the DS4000 Storage Manager 9.10 host software to verify the configuration.

Handling static-sensitive devices

Attention: Static electricity can damage electronic devices and your system. To avoid damage, keep static-sensitive devices in their static-protective packages until you are ready to install them.

To reduce the possibility of electrostatic discharge (ESD), observe the following precautions:

- Limit your movement. Movement can cause static electricity to build up around you.
- Handle the device carefully, holding it by its edges or its frame.
- Do not touch solder joints, pins, or exposed printed circuitry.
- Do not leave the device where others can handle and possibly damage the device.
- While the device is still in its static-protective package, touch it to an unpainted metal part of the system unit for at least two seconds. This drains static electricity from the package and from your body.
- Remove the device from its package and install it directly into your system unit without setting it down. If it is necessary to set the device down, place it in its static-protective package. Do not place the device on your system unit cover or on a metal table. Take additional care when handling devices during cold weather because heating reduces indoor humidity and increases static electricity.




Preparing for installation

Complete the following steps to prepare the DS4100 for installation into a rack cabinet.

1. Prepare the site to meet all area, environmental, power, and site requirements. For more information, see “Storage server operating environment” on page 13.
2. Move the DS4100 to the site.

Statement 4:



		
≥ 18 kg (39.7 lb)	≥ 32 kg (70.5 lb)	≥ 55 kg (121.2 lb)

CAUTION:**Use safe practices when lifting.**

3. Remove the DS4100 from its shipping container and check the contents (see “Inventory checklist” on page 5). If any items are missing, contact your IBM reseller before proceeding.
4. Assemble the tools and equipment that you will need for installation. These might include:
 - The power cords that are shipped with the DS4100
 - Number 2 Phillips and medium flat-blade screwdrivers
 - Antistatic protection (such as a grounding wrist strap)
 - Fibre channel and Ethernet interface cables and cable straps
 - SFP modules
 - The rack-mounting hardware that ships with the DS4100
 - The *DS4000 Storage Manager Version 9.10 Support CD*, which includes the IBM DS4000 Storage Manager 9.1 software and DS4000 storage server controller firmware 05.42.xx.xx. You use this software to configure the storage subsystems. For the latest controller firmware, check the IBM support web site for DS4000 storage products.
www.ibm.com/servers/storage/disk/
5. Continue with “Preparing the site.”

Preparing the site

This section lists the floor space requirements and weight information for the DS4100. For information on interface cables and connections, see Chapter 3, “Cabling the storage server,” on page 45.

Floor space: The floor area at the installation site must provide the following conditions:

- Enough stability to support the weight of the fully configured DS4100 and associated systems
- Sufficient space to install the DS4100

Weight: The DS4100 total weight depends on the number of DS4000 1.5 Gbps SATA hard disk drives that are installed. A fully configured DS4100 with two fans, two power supplies, two RAID controllers, and up to 14 SATA hard disk drives installed weighs 40.8 kg (85.7 lbs).

Continue with “Preparing the rack cabinet.”

Preparing the rack cabinet

Important: Before you install the DS4100 in a rack cabinet, keep in mind the following considerations:

- Review the documentation that comes with your rack cabinet for safety and cabling considerations.
- Install the DS4100 in a recommended 22° C (72° F) environment.
- To ensure proper airflow, do not block the air vents; 15 cm (6 in.) of air space is sufficient.
- To ensure rack stability, load the rack cabinet starting at the bottom.
- If you install multiple components in the rack cabinet, do not overload the power outlets.

- Always connect the storage server to a properly grounded outlet.
- Always connect the rack power distribution units (PDUs) to at least two different power circuits or sources.

Complete the following steps to prepare the rack cabinet before you install the DS4100:

1. Move, unpack, and level the rack cabinet at the installation site (if needed).
2. Remove the external rack panels.
3. If necessary, stop all I/O activity to the devices in the rack cabinet.
4. If necessary, turn off all storage expansion unit and rack cabinet power. Disconnect existing power, network, and other external cables.
5. Install any additional interface cables and power cables.

After you have completed these steps, continue with “Installing the DS4100.”

Installing the DS4100

This section provides instructions on how to install the DS4100 in a rack cabinet.

Rack mounting template

Attention: Duplicate copies of the rack mounting templates are provided in Appendix B, “Rack mounting template,” on page 121. If you want to tear out the templates from this document for easier use, use the copies in Appendix B, “Rack mounting template,” on page 121 rather than the copies provided in this section.

Use the following templates (Figure 9 on page 21 and Figure 10 on page 22) to identify the proper locations for inserting M6 screws when mounting the support rails and DS4100 to a rack cabinet. The locations for the M6 screws are highlighted in the templates.

The DS4100 is 3 U high. Align the template with the rack at a U boundary. U boundaries are shown as horizontal dashed lines in the rack mounting templates.

Note: The mounting holes that are shown in the following templates are square. The holes in your rack cabinet might be round, square, or threaded.

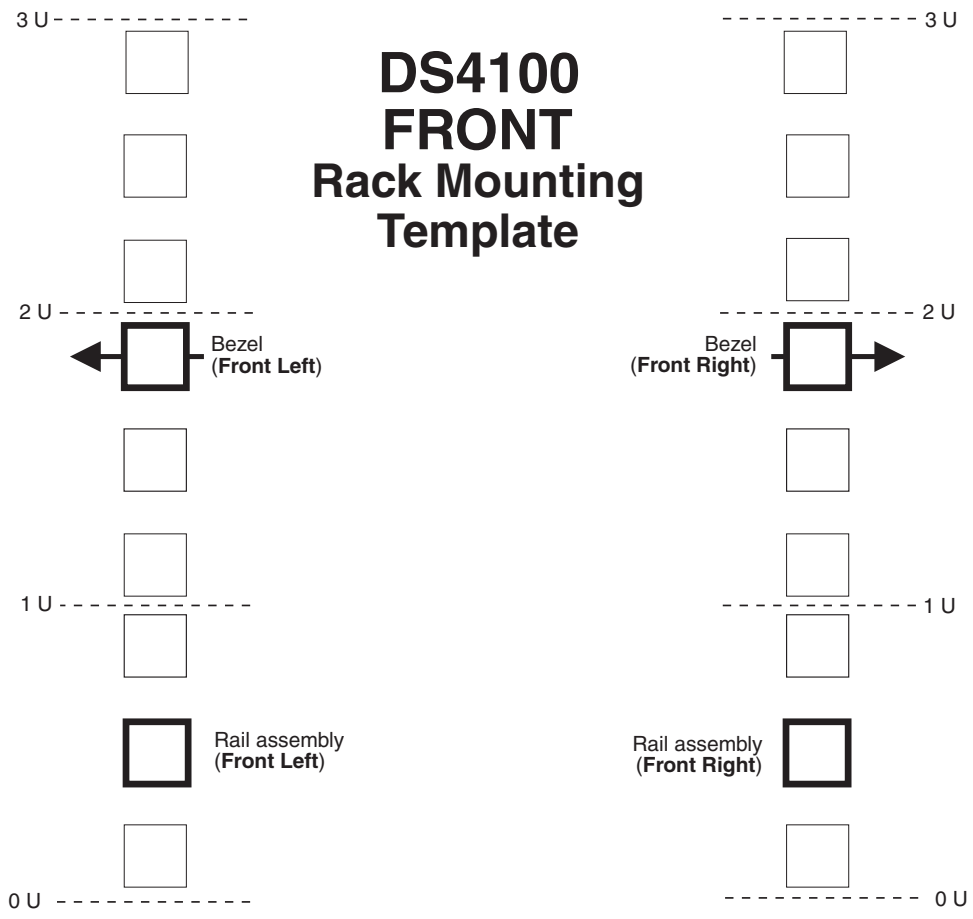


Figure 9. Front rack mounting template

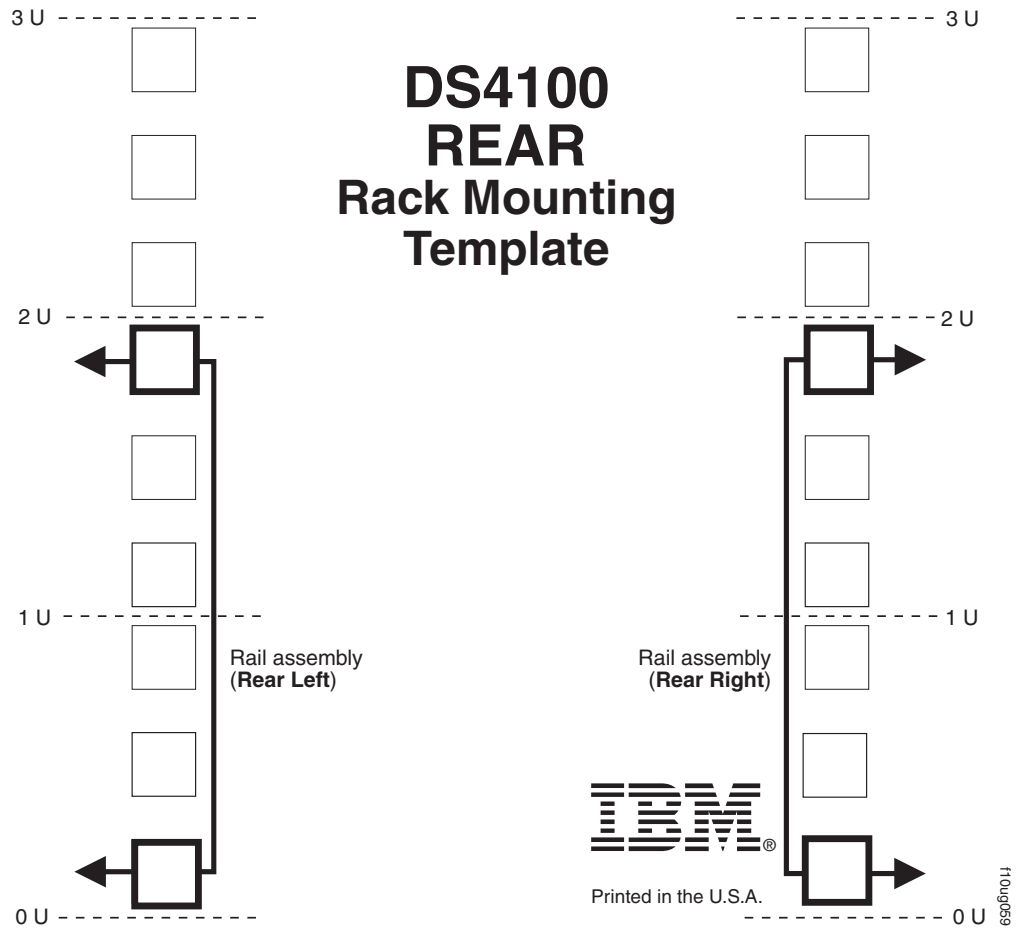


Figure 10. Rear rack mounting template

Installing the support rails

Before installing the DS4100 in a rack cabinet, you must install the rails and rack-mounting hardware that come with your storage server. The DS4100 requires an Electronic Industries Association (EIA) 310-D Type A 19-inch rack cabinet. The distance between EIA rails, from the front to the rear of the rack cabinet, is 60.96 cm (24 in.) minimum and 81.28 cm (32 in.) maximum. This rack cabinet conforms to the EIA standard. Where you place the support rails in the rack cabinet depends on where you intend to position the storage server.

Complete the following steps to install the support rails:

Note: Refer to Figure 12 on page 24 while performing these steps.

1. Ensure that the rack cabinet has already been installed.
2. Ensure that a stabilizer has been correctly attached to the bottom front of the rack cabinet to prevent the rack cabinet from tipping forward while the DS4100 is being installed.

Refer to the installation and service guide, or equivalent, for the rack cabinet as required.

3. Locate the two support rails and six of the eight M6 screws that are supplied with the DS4100.

Attention: Both support rails are shipped with three screws and spacers, called *alignment pins*, already installed at the front of each rail. They have been inserted in the front of each support rail as guides to indicate where *not* to use M6 screws when you attach the front of the support rail to the rack cabinet. See Figure 11.

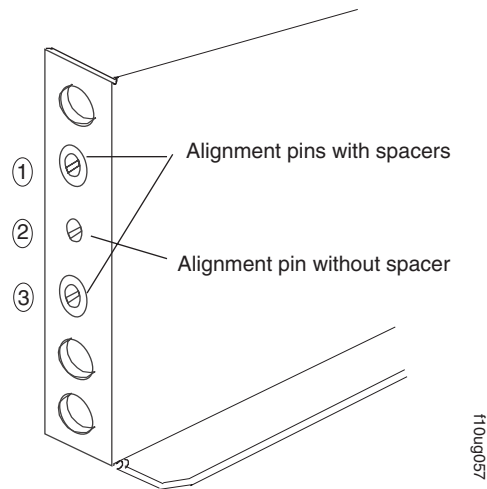


Figure 11. Alignment pins with and without spacers

Depending on which type of rack mounting flange is present on your rack cabinet, you might have to remove some or all of the spacers. For example, if the rack cabinet in which you are installing the support rails has round holes, you will need to remove the spacers from the top and bottom alignment pins so that the rail sits flush with the rack cabinet. See Table 11.

Table 11. Alignment pin requirements for different rack flange hole types

Rack flange type	Pins to remove
Square hole	None
Round hole	1 and 3
Threaded hole	All

- The rack-mounted unit is three EIA units high. Decide accordingly where you are going to install the support rails.

Attention: Use the rack mounting template provided in Figure 9 on page 21 and Figure 10 on page 22 to locate the proper rack mounting holes for installing the support rails into the rack cabinet.

Note the following considerations before you choose where to install the rails:

- If you are installing the DS4100 into an empty rack, install it into the lowest available position so that the rack does not become unstable.
- If you are installing more than one DS4100 in the rack, start at the lowest available position, and work upward.
- If appropriate, allow for possible later installation of other units.
- If necessary, remove the rack power distribution unit before you install the support rails.
- For procedures and more information, refer to the installation and service guide, or equivalent, for the rack cabinet.

- Starting with the left rail, remove and save the 6/32 in. screw (**5**). Loosen the four rail adjustment screws (**2**).

Note: The support rails are not marked as Left or Right. However, each rail can be correctly mounted on only one side of the rack cabinet. The rails should be mounted with the alignment pins at the front of the rack cabinet. Figure 12 shows the installation of the left support rail.

- Hold the front of the rail against the inside of the right rack-mounting flange and loosely tighten the lower M6 screw (**4**). See Figure 9 on page 21 for the location for this screw.
- Extend the rear of the support rail until it makes contact with the rear rack rail.
- From the rear of the rack, thread and tighten two M6 screws (**1**) (see Figure 10 on page 22 for the location for these screws). From the front of the rack cabinet, finish tightening the front M6 screw (**4**).

When you are finished, the rail should be attached to the cabinet using one M6 screw in the front (inserted at the second-to-lowest hole) and two M6 screws at the back.

- Repeat step 5 through step 8 for the right rail.

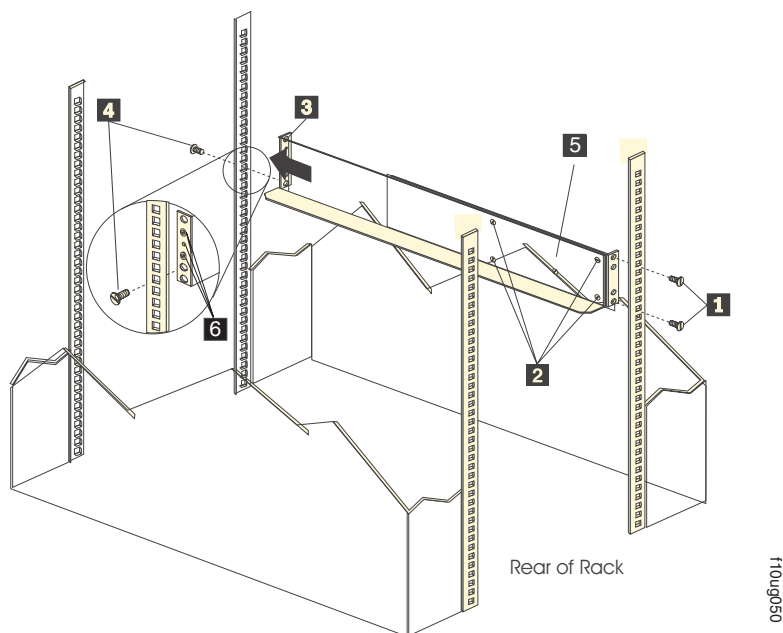


Figure 12. Installing the support rails

- Tighten the rail adjustment screws (**2**) on both rails.
- Continue with “Removing the CRUs” on page 25.

Removing the CRUs

Attention: This section describes how to remove the CRUs in order to minimize the weight of the DS4100 before you install it in the rack cabinet. However, if you have three or more people available to lift and install the DS4100 in a rack cabinet, you might not find it necessary to remove the CRUs before you install the DS4100. If this is the case, you can skip the CRU removal instructions provided in this section. Instead, continue with “Installing the DS4100 into a rack cabinet” on page 28, and then skip the CRU replacement instructions provided in “Replacing the DS4100 CRUs” on page 29.

Use the following procedures to remove the CRUs from the DS4100 before installation. Use these instructions after you have completed all applicable site, rack cabinet, and DS4100 preparations (as discussed in “Preparing for installation” on page 18) and installed the support rails (as discussed in “Installing the support rails” on page 22). Alternately, if necessary, you can use these instructions to lighten the DS4100 before removing it from the shipping box. The shipping box opens to provide access to the storage server CRUs.




The DS4100 comes with a rack-mounting hardware kit for installing it in a rack cabinet. It is easier to lift the DS4100 and install it in a rack cabinet if you remove all the CRUs first. You will need an antistatic wrist strap and a cart or level surface (to hold the CRUs). Observe the precautions listed in “Handling static-sensitive devices” on page 18. In the following procedure, you will remove the following CRUs from the storage server before you install it in the rack cabinet:

- RAID controllers
- Power supplies
- Fans
- Hot-swap hard disk drives

You do not need to remove the blank trays.

Statement 4:



		
≥ 18 kg (39.7 lb)	≥ 32 kg (70.5 lb)	≥ 55 kg (121.2 lb)

CAUTION:

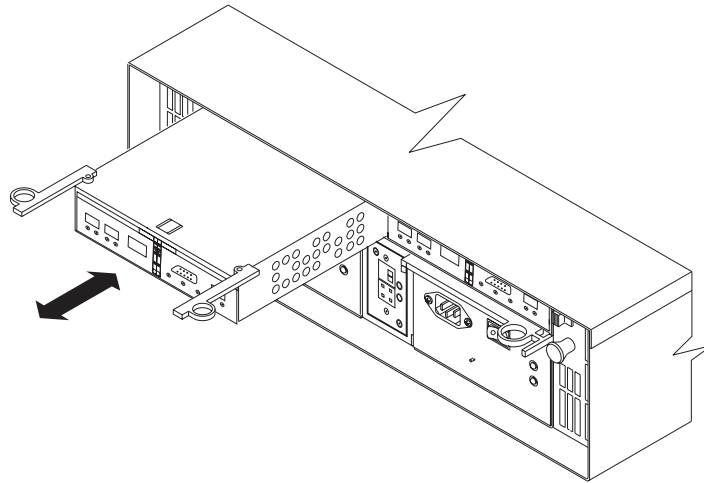
Use safe practices when lifting.

Attention: The storage server comes with a bezel that is attached to the front of the unit. The bezel protects the light pipes that are located above the drive trays. Leave the protective bezel in place until you are instructed to remove it.

Removing a RAID controller

Complete the following steps to remove a RAID controller:

1. Push down on the latch (centered above the RAID controller). Pull both levers at the same time out of the locked position.



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Figure 13. Removing a RAID controller

2. Grasp the pull-rings; then pull on the levers and remove the RAID controller.
3. Place the RAID controller on a level surface.
4. For the DS4100 base storage server, repeat step 1 through step 3 for the second RAID controller.

Note: In the DS4100 single-controller storage server, you do not need to remove the controller blank.

Removing a power supply

Complete the following steps to remove a power supply:

1. Grasp the pull-ring on the power supply lever and squeeze the latch to release it.
2. Pull the lever open 90° and remove the power supply, as shown in Figure 14 on page 27.

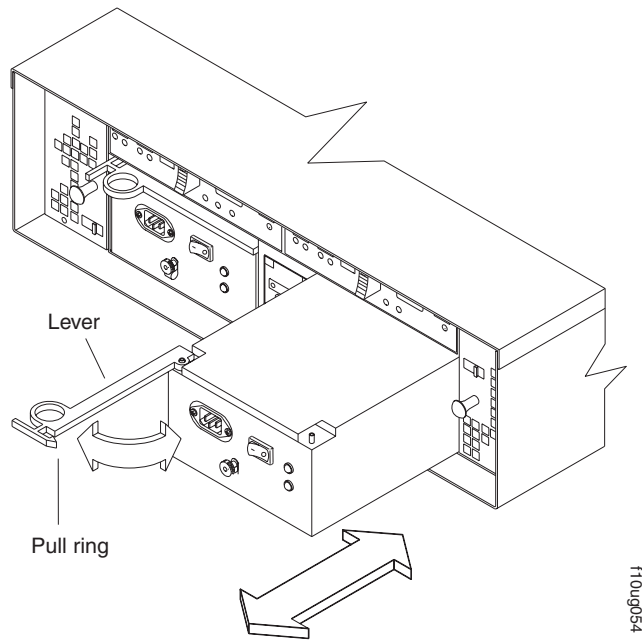


Figure 14. Removing a power supply

3. Place the power supply on a level surface.
4. For the DS4100 base storage server, repeat step 1 through step 3 for the second power supply.

Note: In the DS4100 single-controller storage server, you do not need to remove the power supply blank.

Removing a fan

Complete the following steps to remove a fan:

1. Unlock the latch by moving the latch in the same direction as the latch direction arrow shown on the back of the fan.
2. Grasp the handle and pull the fan unit out of the bay, as shown in Figure 15.

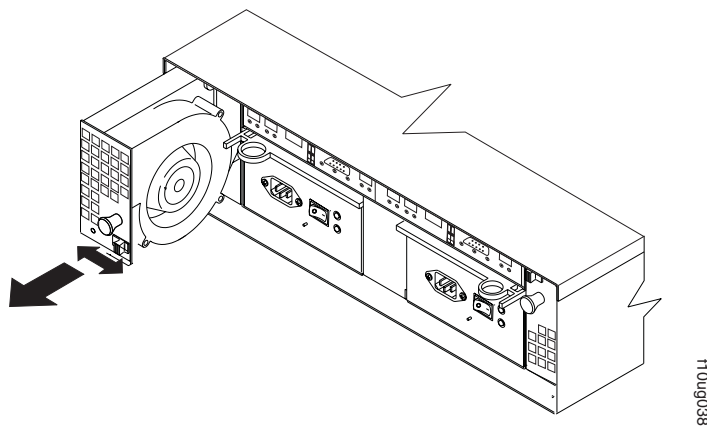


Figure 15. Removing a fan

3. Place the fan unit on a level surface.
4. Repeat step 1 through step 3 for the second fan unit.

Removing a hard disk drive

Complete the following steps to remove a hot-swap hard disk drive:

Note: The hard disk drive comes installed in a drive tray. Do not attempt to detach the hard disk drive from the drive tray.

1. Use Table 19 on page 119 to record the location and identify your DS4000 SATA hard disk drives. You must record this information to be able to replace the hard disk drives in their original order before they were removed.
2. Release the latch on the drive CRU by pinching together the blue line on the tray latch and the finger hole on the tray handle.
3. Pull the tray handle out so that it is in the open position to release the drive CRU. Pull the drive out of the bay, as shown in Figure 16.

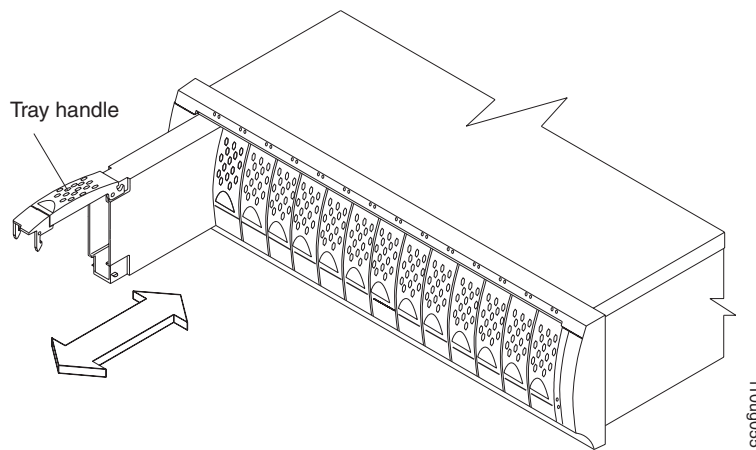


Figure 16. Removing a drive CRU

4. Place the removed drive CRUs horizontally on a level surface, with the printed circuit boards facing down.

Attention: Do not stack drive CRUs on top of one another. Protect the drive CRUs from vibrations or sudden shocks.

5. Repeat step 1 through step 4 for additional drive CRUs.

Continue with “Installing the DS4100 into a rack cabinet.”

Installing the DS4100 into a rack cabinet

Complete the following steps to install the DS4100 in a rack cabinet.

1. Place the DS4100 in the rack cabinet.

Note: If you have removed the CRUs from the DS4100, you should be able to lift the unit into the cabinet with the help of one other person. If you have not removed the CRUs before the installation, you should have at least two other people available to help you lift the unit into the rack cabinet.

- a. Move the DS4100 to the front of the rack-mount cabinet.
- b. With help from another person, place the back of the storage server on the support rails. Slide the unit into the rack cabinet, as shown in Figure 17 on page 29.

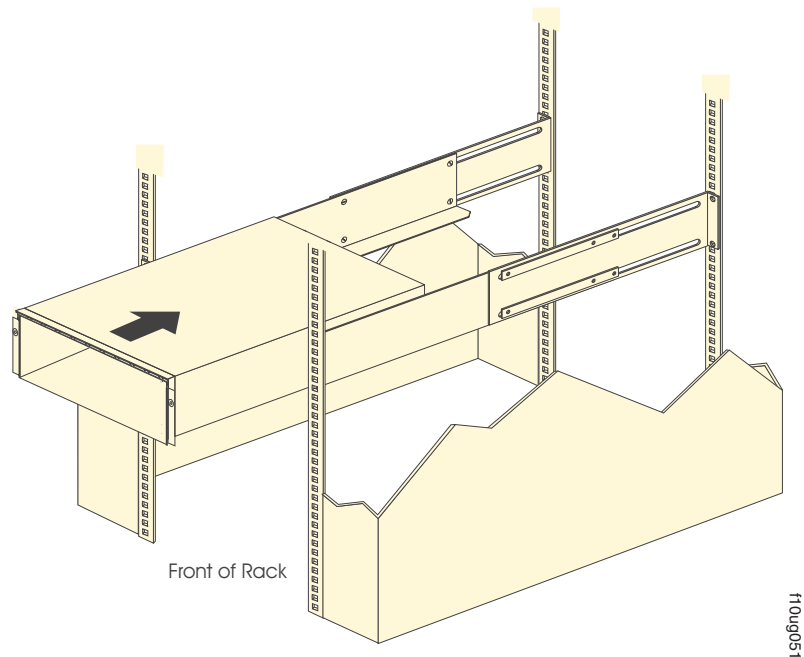


Figure 17. Installing the DS4100

2. The bezel is secured to the front of the DS4100 either by plastic wingnuts or by adhesive tape. Remove and discard the wingnuts or the adhesive tape. The bezel should remain attached to the DS4100 chassis.

Attention: The bottom cross member of the bezel has a tab that must fit beneath the DS4100 chassis and snap into place. The top cross member of the bezel has a recess that must be mated with a metal tab on the bottom of the DS4100 chassis.

3. Secure the DS4100 to the rack cabinet:
 - a. Align the front mounting holes on each side of the storage server with the mounting holes on the front of the support rails.
 - b. Install the bezel.
 - c. Insert an M6 screw into the mounting hole on both sides of the front of the unit (see Figure 9 on page 21). Gently tighten the screws to secure the bezel and the front of the DS4100 to both of the front cabinet rails.

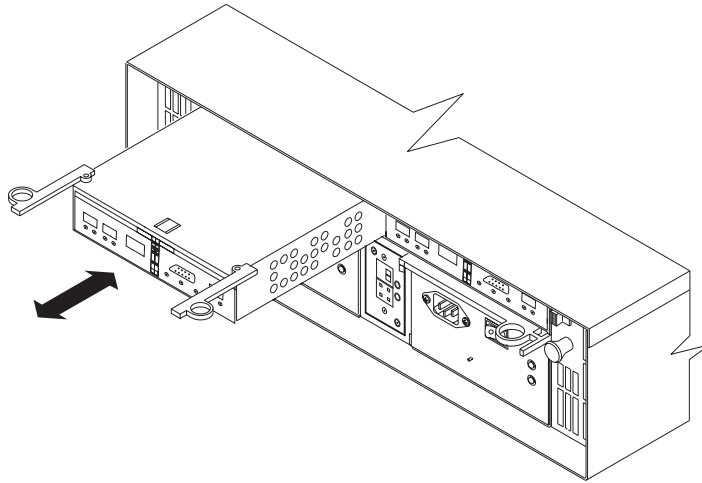
Attention: Do not overtighten. If you overtighten these screws, you could break the bezel.
 - d. From the back of the rack cabinet, insert the two 6/32 in. screws (**5** in Figure 12 on page 24), one on each side, in the holes located on the tab on each side of the unit. Tighten the screws.
4. Continue with one of the following actions:
 - If you did remove the DS4100 CRUs before installation (as described in “Removing the CRUs” on page 25), continue with “Replacing the DS4100 CRUs.”
 - If you did not find it necessary to remove the DS4100 CRUs before installation, continue with “Setting the interface options” on page 32.

Replacing the DS4100 CRUs

Use the following procedures to replace the CRUs in the DS4100 after installation.

Replacing a RAID controller

Complete the following steps to replace the RAID controller that you removed before the installation:



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Figure 18. Replacing a RAID controller

1. Slide the RAID controller all the way into the empty slot.
2. Close both levers until the latch locks into place.
Attention: Make sure that the levers lock into place in the storage server chassis.
3. For the DS4100 base storage server, repeat step 1 and step 2 to replace the second RAID controller.

Replacing a power supply

Complete the following steps to replace the power supplies that you removed before the installation:

1. Slide one power supply into the storage server. Be sure to replace the power supplies so that the lever on each power supply opens toward the interior of the storage server, as shown in Figure 19 on page 31.
Attention: Be sure that the lever is pulled straight out as you slide the power supply into the storage server, as shown in Figure 19 on page 31.

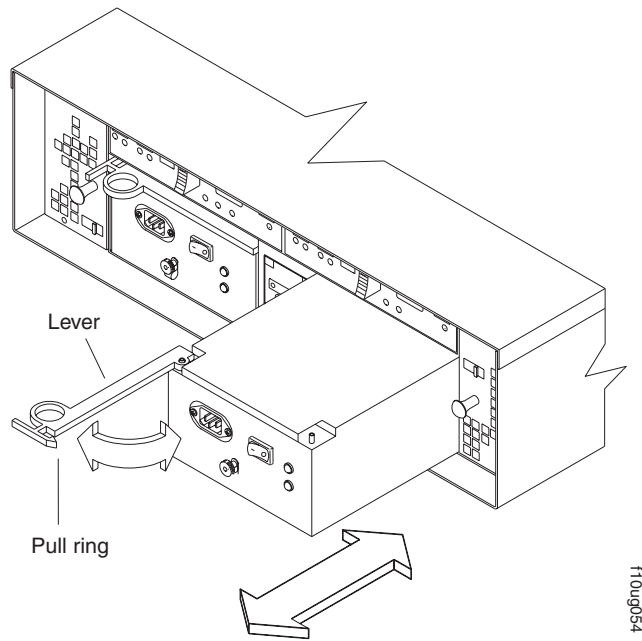


Figure 19. Replacing a power supply

2. Close the lever until the pull-ring latch locks in place. Make sure that the lever locks into place in the storage server chassis. Then gently push the front of the power supply to ensure that it is fully seated.
3. For the DS4100 base storage server, repeat step 1 and step 2 to replace the second power supply.

Replacing a fan

Complete the following steps to replace the fan units that you removed before the installation:

1. Place the fan in front of the fan bay.
2. Ensure that you move the fan latch in the same direction as the arrow before you slide the fan all the way into the bay. If the fan does not go into the bay, rotate it 180° (see Figure 20).

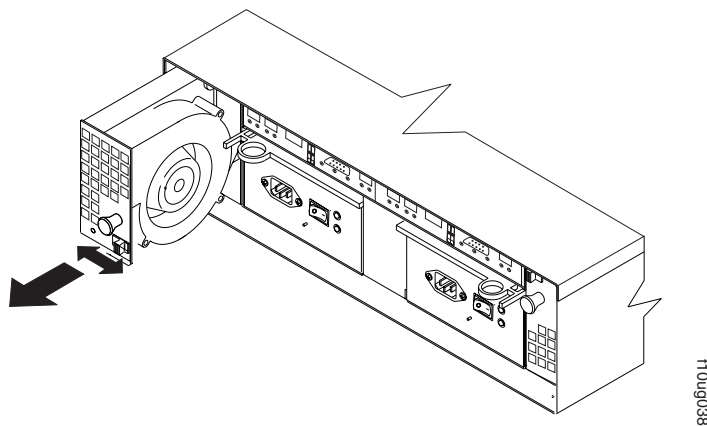


Figure 20. Replacing a fan

3. If the latch does not automatically lock when you have successfully inserted the fan unit into the bay, pull back slightly on the fan and then push it in again until the latch snaps into place.
4. Repeat step 1 through step 3 to replace the second fan.

Replacing a hard disk drive

Complete the following steps to replace the hot-swap hard disk drives that you removed before the installation.

Note: Use Table 19 on page 119 to verify the proper replacement locations of your DS4000 1.5 Gbps SATA hard disk drives.

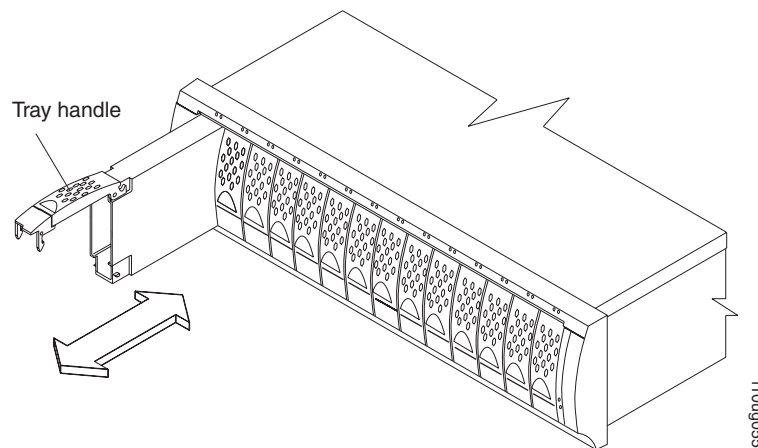


Figure 21. Removing a drive CRU

1. Lift up on the handle and gently push the drive CRU into the empty bay until the hinge of the tray handle latches beneath the storage server bezel.
2. Push the tray handle down until the latch clicks into place.
3. Repeat step 1 and step 2 to replace additional drives.

Setting the interface options

The DS4100 has two server ID switches that identify the DS4100 on a fibre-channel loop and that assign physical addresses to the drives. The server ID switches are located on the back of the storage server, as shown in Figure 22 on page 33.

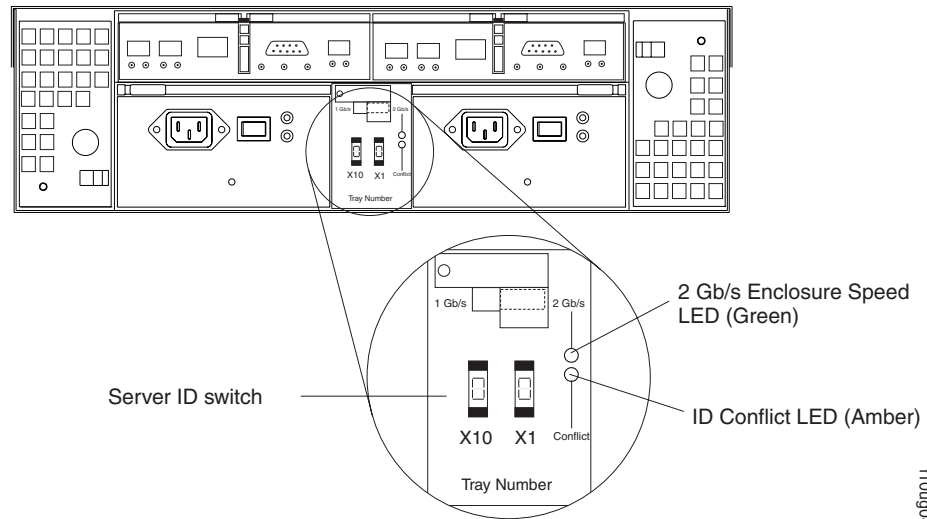


Figure 22. Enclosure ID switches

Fibre channel loop and ID settings

When you install a hard disk drive in the expansion unit, the drive tray plugs into a printed circuit board called the *midplane*. The midplane sets the fibre channel loop ID automatically, based on the enclosure ID switch setting and the physical location (bay) of the hard disk drive.

Server ID (enclosure ID) settings

The DS4100 comes with a server ID switch (also referred to as an *enclosure ID switch*) that is used to identify the DS4100 on a fibre channel loop. The server ID switch is located on the back of the unit, as shown in Figure 22.

Use the small buttons above and below each server ID digit to change the server ID setting. Press the button located above the digit to lower the digit by one. Press the button located below the digit to raise the digit by one.

Note: Some storage servers ship with a panel installed over the server ID switch to prevent the server ID from being changed accidentally. If your storage server has a protective panel over the server ID switch, use a pencil or a small screwdriver to change the server ID.

Each storage expansion unit in a DS4000 storage subsystem drive loop must have a unique enclosure ID. DS4000 controllers use a combination of the enclosure ID and the number of the physical slot that a fibre channel hard drive occupies to create a unique fibre channel loop address or arbitrated loop physical address (AL_PA) for each drive in a fibre channel drive loop. The enclosure ID consists of two digits, a tens digit (x10) and ones digit (x1).

Note: The DS4100 is shipped with 00 as the default server ID setting. If you connect the storage server to a DS4000 EXP100, you must set the DS4000 EXP100 enclosure ID setting to a value other than 00. Each server unit should have a unique ID if it is going to be connected to other drive expansion units through the drive loop ports. The Server ID setting is only

valid for the drive loop. The amber Conflict LED (located on the right-side of the switch) will be lit if another unit in the drive loop has the same ID setting as the server ID.

Attention: When connecting the DS4100 to DS4000 EXP100 storage expansion units, DO NOT use the tens digit (x10) setting. Use only the ones digit (x1) setting to set unique server IDs or enclosure IDs.

Give each drive expansion enclosure in a redundant drive loop a unique ones digit (x1) ID. This setting will enforce hard AL_PAs (unchangeable between fibre channel Loop Initializations [LIPs]) for the drives and facilitate drive loop problem troubleshooting in the event of an error. If the ones digits are not unique, two or more devices will have the same hard AL_PA. In such a case, the controller will use soft AL_PAs for the devices that have identical hard AL_PAs.

The problem with soft addressing is that addresses may change between LIPs. This possibility increases the difficulty of troubleshooting drive loop problems, since one cannot easily ascertain whether the same device with a different address or different device may be causing a problem.

Storage server speed settings

The default switch setting is 2 Gbps. This is the *only* speed setting allowed for the DS4100.

Attention: Do not remove the metal plate that covers the storage server speed setting. Do not adjust the storage server speed setting.

Configuring the storage subsystem

You must configure the storage subsystem configuration after you install the storage server in a rack cabinet. Use the information in the following sections to configure your storage subsystem configuration.

Storage subsystem management methods

Before you configure the storage subsystem, determine which method of storage subsystem management you want to use. You can manage the storage subsystems in either of two ways: host-agent (in-band) management or direct (out-of-band) management.

Important: If the operating system of the host server that the storage subsystem logical drive(s) is mapped to is not Microsoft® Windows NT®, you have to make a direct (out-of-band) management connection to the storage subsystem to set the correct host type first. Then, the server will be able to recognize the storage subsystem correctly for host-agent (in-band) management.

Host-agent (in-band) management method

This method requires host-agent software that you install on the host server. The host-agent software allows the DS4000 Storage Manager client program to manage the DS4000 storage subsystem using the same fibre channel connections between the host server and the storage subsystem. You must install at least one management station and a software agent host. The management station can be the host or a workstation on the Ethernet network. A management station will have the client software installed. Figure 23 on page 35 shows the host-agent (in-band) management method.

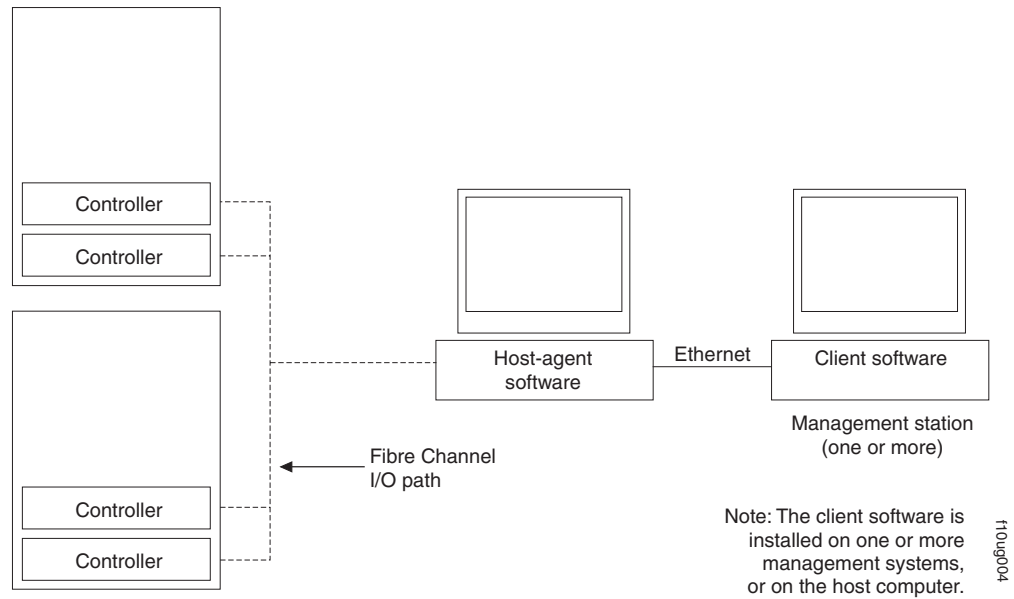


Figure 23. Host-agent (in-band) managed storage subsystems

Direct (out-of-band) management method

This method uses Ethernet connections from a management station to each controller. You must install at least one management station. The management station can be the host or a workstation on the Ethernet network. A management station will have the client software installed. Attach Ethernet cables to each management station (one pair per storage server). You will connect the cables to each storage server controller later when you install the storage server. Figure 24 on page 36 shows the direct (out-of-band) management method.

Note: Do not connect the DS4100 storage server Ethernet ports to a public network or public subnet. It is strongly recommended that you create a private network between the DS4100 storage server and the management station.

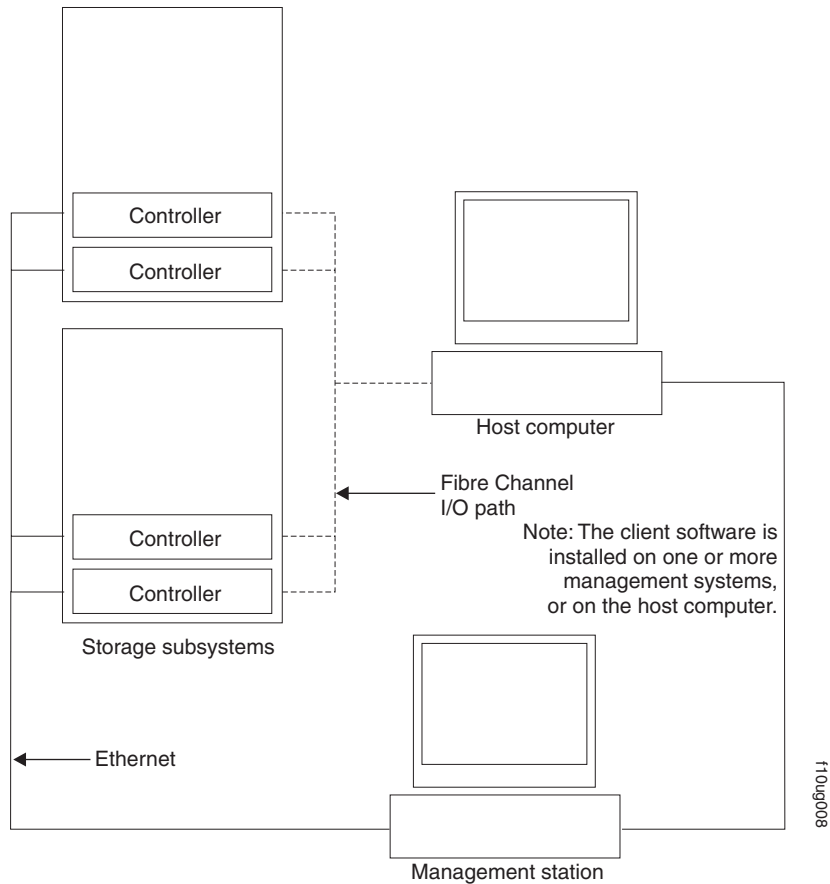


Figure 24. Direct (out-of-band) managed storage subsystems

Fibre channel connections

The storage server fibre channel connection consists of up to four host fibre-channel loops and a redundant drive fibre-channel loop. The host fibre-channel loops provide the fibre path for host attachment. They can consist of fibre-channel cables, SFPs, host bus adapters, fibre-channel switches, and RAID controllers. The redundant drive fibre-channel loop provides the fibre path to the hard disk drives (HDDs). The redundant drive fibre-channel loop consists of fibre channel HDDs and optional storage expansion units, fibre-channel cables, and SFPs.

Exception: The DS4100 single-controller storage server does not support drive loops or expansion units.

The DS4100 base storage server supports redundant disk-drive-loop configurations. Each RAID controller has three SFP ports. These SFP ports are labeled *Host 1*, *Host 2*, and *Expansion*. You can build a redundant drive loop by connecting one or more expansion units to the redundant RAID controllers. Then, use dual fiber-optic cables to connect one expansion unit to another in a daisy-chain. For more information about adding expansion units, see “Connecting expansion units (base storage server only)” on page 57.

Fibre channel loop configurations

You must determine how the host systems will connect to the storage server. You can connect up to two host systems directly to the storage server, or you can

connect more than two hosts to the fibre channel storage server through switches. The illustrations in the following sections show common host system configurations.

Note: The default configuration is one partition. Four-partition, eight-partition, and sixteen-partition configuration upgrades are available as upgrade options. You must perform partition upgrades one increment at a time, which means you cannot upgrade directly from a four-partition configuration to a sixteen-partition configuration; in this case, you would have to upgrade from a four-partition configuration to an eight-partition configuration, and then from the eight-partition configuration to a sixteen-partition configuration. Contact your IBM reseller or marketing representative for more information.

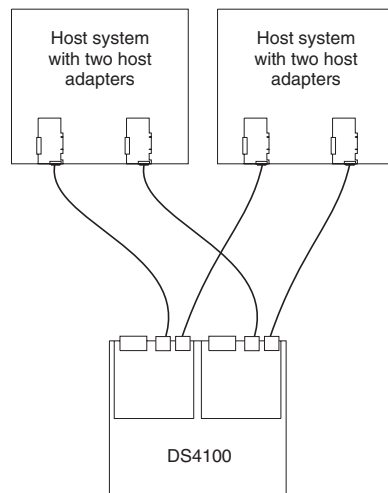
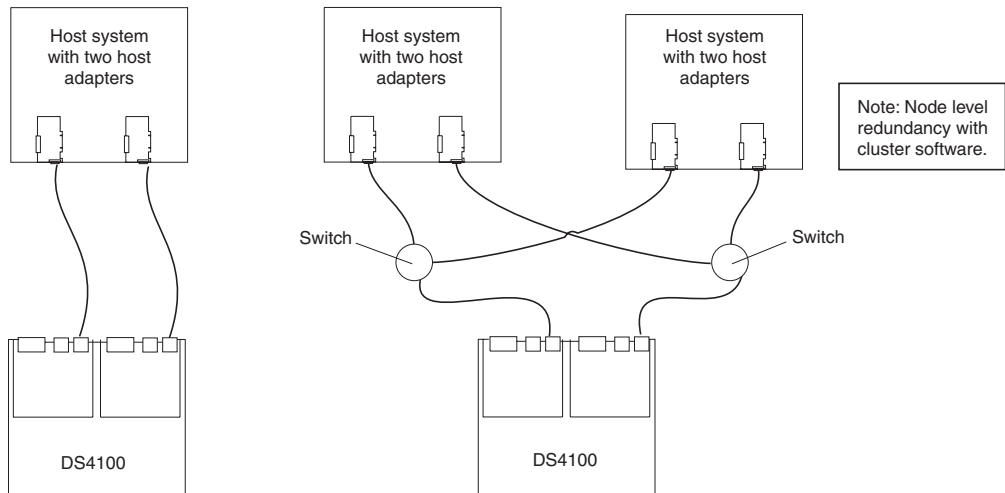
Redundant host and drive loops

This section provides examples of DS4100 host fibre channel configurations.

DS4100 base storage server configurations: This section provides the following examples of DS4100 base storage server host fibre channel configurations.

- Redundant host and drive fibre channel loop configurations, as shown in Figure 25 on page 38
- Single SAN fabric configuration, as shown in Figure 26 on page 39
- Dual SAN fabric configuration, with an additional DS4100 and a DS4000 EXP100 attached, as shown in Figure 27 on page 39
- Two clusters, as shown in Figure 28 on page 40

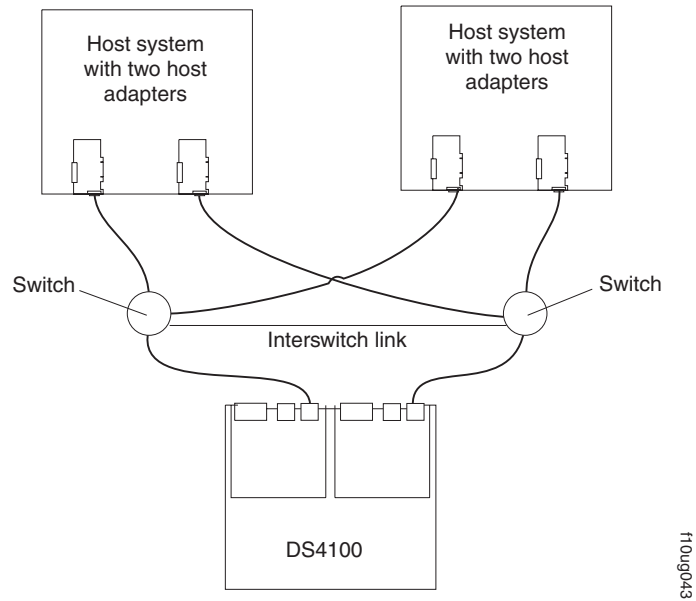
Note: These configurations have host and drive path failover protection and are recommended for high availability.



F10UG028

Figure 25. Examples of redundant host and drive fibre channel loop configurations (base storage server)

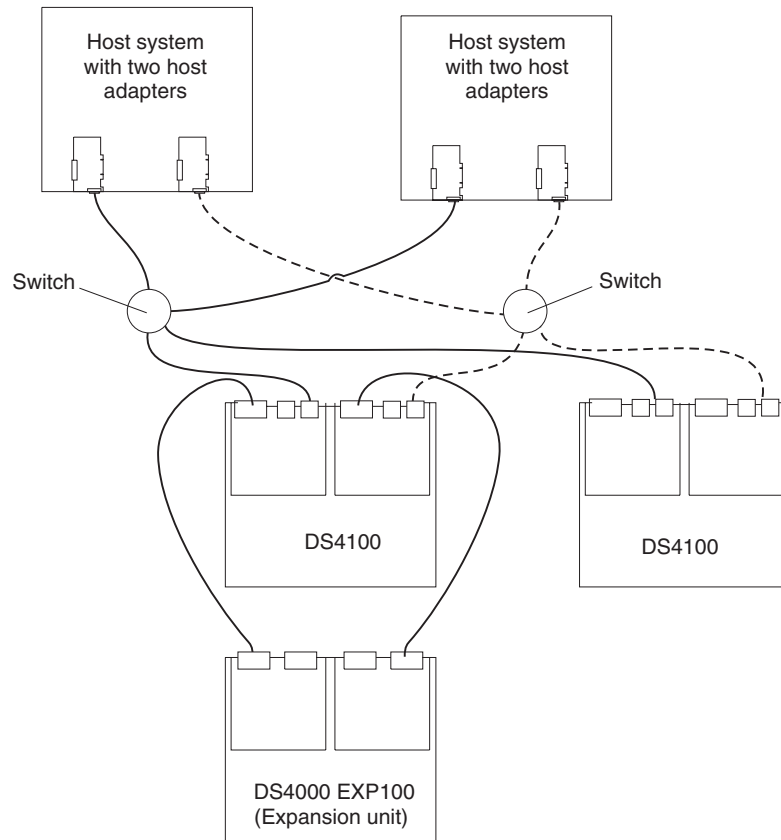
In Figure 26 on page 39, the fibre channel switches are connected together via the inter-switch link (ISL) to form a single SAN fabric.



f10ug043

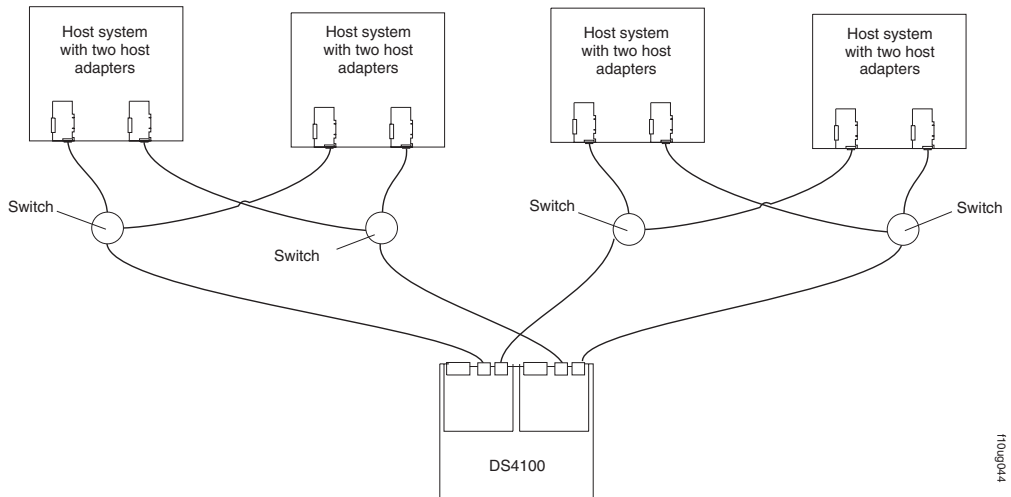
Figure 26. Example of a single SAN fabric configuration (base storage server)

In Figure 27, the fibre channel switches are not connected together. Each switch forms its own SAN fabric.



f10ug042

Figure 27. Example of a dual SAN fabric configuration (base storage server)

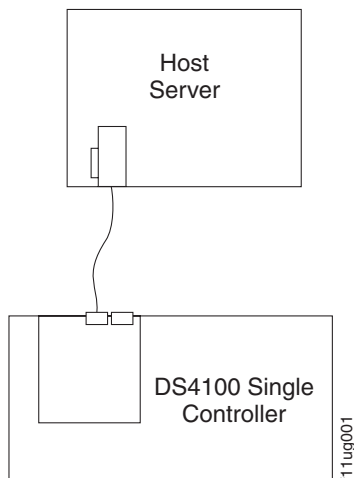


f10ug044

Figure 28. Example of a two-cluster configuration (base storage server)

DS4100 single-controller storage server configurations: This section provides the following examples of DS4100 single-controller storage server host fibre channel configurations.

- Single server configuration with one adapter, as shown in Figure 29
- Single server configuration with two adapters, as shown in Figure 30 on page 41
- Dual server configuration with one adapter on each server, as shown in Figure 31 on page 41
- Dual-server, single-SAN fabric configuration with one adapter on each server, as shown in Figure 32 on page 42
- Dual-server, single-SAN fabric configuration with two adapters on each server, as shown in Figure 33 on page 42



f11ug001

Figure 29. Example of a single server configuration with one adapter (single-controller storage server)

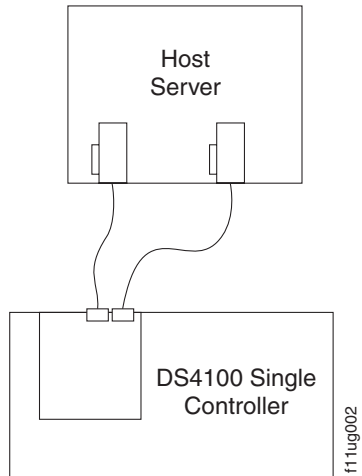


Figure 30. Example of a single server configuration with two adapters (single-controller storage server)

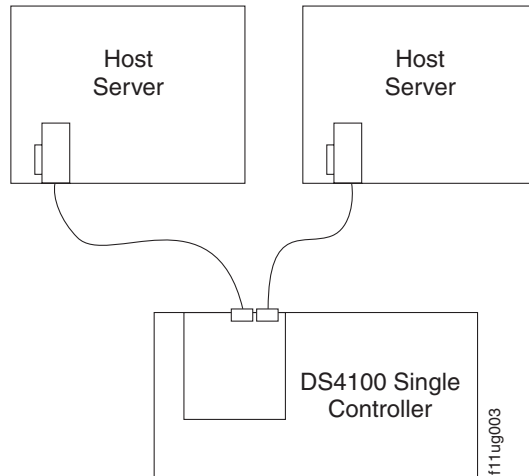


Figure 31. Example of a dual server configuration with one adapter on each server (single-controller storage server)

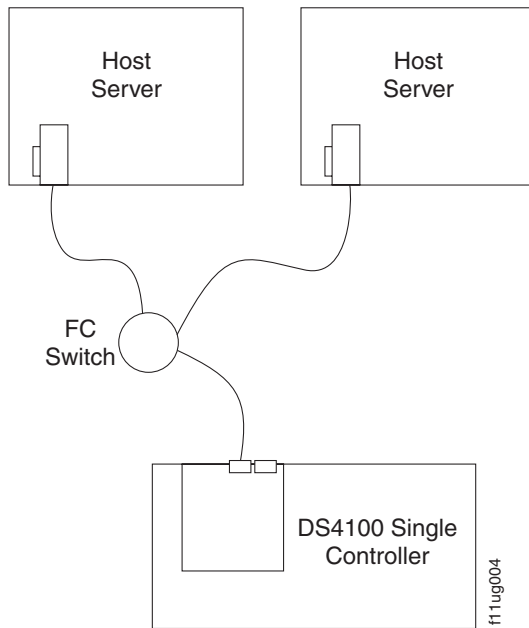


Figure 32. Example of a dual-server, single-SAN fabric configuration with one adapter on each server (single-controller storage server)

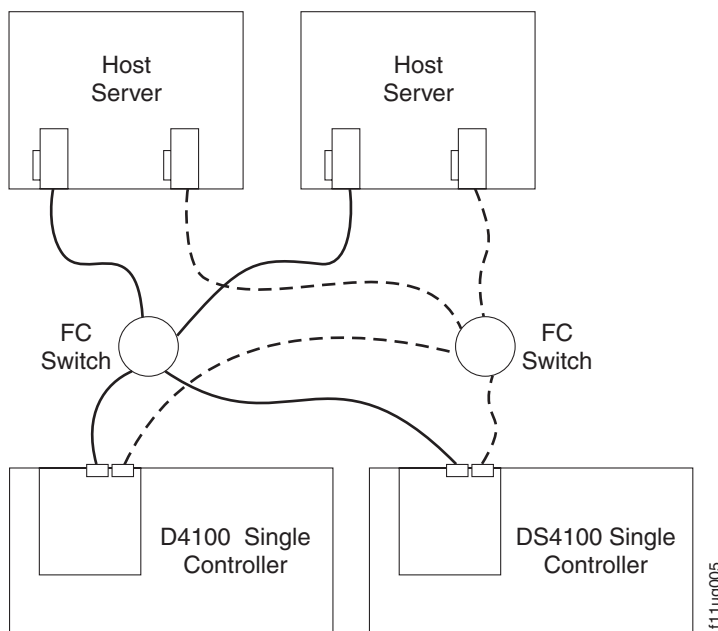


Figure 33. Example of a dual-server, single-SAN fabric configuration with two adapters on each server (single-controller storage server)

Installing the storage subsystem configuration

Using the information gathered in the previous sections, install the host systems and host adapters.

Notes:

1. See the documentation provided with your host adapters for installation requirements and procedures.

2. Use the correct host adapter driver. For the latest supported host adapters and drivers, go to the following Web site:

www.ibm.com/servers/storage/disk/

Attach fiber-optic interface cables to each host adapter. You will connect the other end of the cables to the controller later in the installation process. For more information about handling fiber-optic cables, see “Handling fiber-optic cables” on page 45.

Note: Do not install the DS4000 Storage Manager client at this time, if it is not already installed. Install the storage server completely before you install the software because you cannot test the software installation until the hardware is connected.

Chapter 3. Cabling the storage server

This chapter provides fibre channel and power cabling information for the storage server.

After you attach the storage server power cables, use the instructions that are provided in “Turning the storage server on and off” on page 65 for the initial startup of the storage server.

Working with SFPs and fiber-optic cables

Each RAID controller has two host ports and one expansion port. You use a small-form factor pluggable transceiver (SFP) to connect each host port and expansion port to hosts and expansion units. The SFP is inserted into the port, and then a fiber-optic cable is inserted into the SFP. The other end of the fiber-optic cable connects to an external device. SFPs are laser products.

Statement 3



CAUTION:

When laser products (such as CD-ROMs, DVD drives, fiber optic devices, or transmitters) are installed, note the following:

- Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.
- Use of controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.



Danger

Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following.

Laser radiation when open. Do not stare into the beam, do not view directly with optical instruments, and avoid direct exposure to the beam.

Handling fiber-optic cables

Before you use fiber-optic cables, read the following precautions.

Attention: To avoid damage to the fiber-optic cables, follow these guidelines:

- Do not route the cable along a folding cable-management arm.
- When attaching to a device on slide rails, leave enough slack in the cable so that it does not bend to a radius of less than 38 mm (1.5 in.) when extended or become pinched when retracted.
- Route the cable away from places where it can be snagged by other devices in the rack cabinet.

- Do not overtighten the cable straps or bend the cables to a radius of less than 38 mm (1.5 in.).
- Do not put excess weight on the cable at the connection point. Be sure that the cable is well supported.

Installing SFP modules

The DS4100 host ports require SFP modules. SFP modules are used to convert electrical signals to optical signals that are required for fibre channel transmission to and from RAID controllers. The DS4100 supports two types of SFP modules: one with a plastic latch and one with a wire latch. After you install the SFP modules, you use fiber-optic cables to connect the DS4100 to other fibre channel devices.

Before you install SFP modules and fiber-optic cables, read the following information:

- Do not mix long-wave SFPs and short-wave SFPs on a single storage server. Use either long-wave SFPs or short-wave SFPs. You can use the DS4000 Storage Manager client to view the storage subsystem profile in order to verify that you are not mixing long-wave and short-wave SFPs.
- The SFP module housing has an integral guide key designed to prevent you from inserting the SFP module improperly.
- Use minimal pressure when you insert the SFP module into a port. Forcing the SFP module into a port could cause damage to the SFP module or the port.
- You can insert or remove the SFP module while the port is powered on.
- The operational loop performance is not affected when you install or remove an SFP module.
- You must insert the SFP module into a port before you connect the fiber-optic cable.
- You must remove the fiber-optic cable from the SFP module before you remove the SFP module from the port. See “Removing SFP modules” on page 48 for more information.

To install an SFP module, complete the following steps.

Statement 3:



CAUTION:

When laser products (such as CD-ROMs, DVD drives, fiber-optic devices, or transmitters) are installed, note the following:

- **Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.**
- **Use of controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.**



DANGER

Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following.

Laser radiation when open. Do not stare into the beam, do not view directly with optical instruments, and avoid direct exposure to the beam.

Attention: When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see “Handling static-sensitive devices” on page 18.

1. Remove the SFP module from its static-protective package.
2. Remove the protective cap from the SFP module, as shown in Figure 34. Save the protective cap for future use.

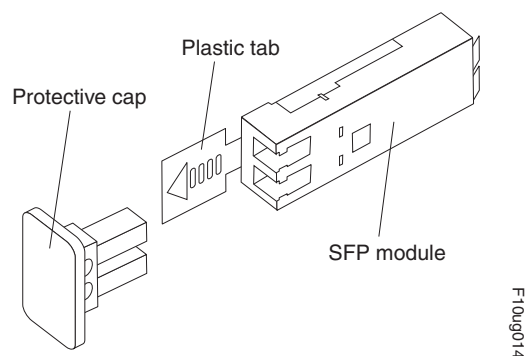


Figure 34. Small Form-Factor Pluggable (SFP) module

3. Remove the protective cap from the host port. Save the protective cap for future use.
4. Insert the SFP module into the host port until it clicks into place. See Figure 35.

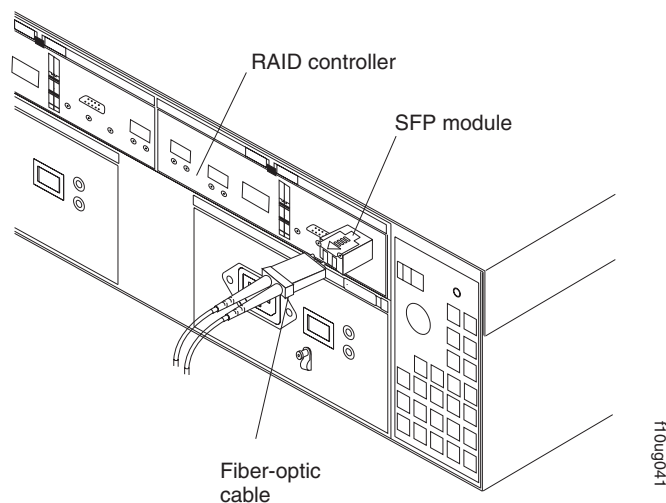


Figure 35. Installing an SFP module into the host port

5. Connect a fibre channel cable.

Removing SFP modules

To remove the SFP module from the host port, perform the following steps.

Attention: To avoid damage to the cable or to the SFP module, make sure you unplug the LC-LC fibre channel cable *before* you remove the SFP module.

1. Remove the LC-LC fibre channel cable from the SFP module. For more information, see “Handling fiber-optic cables” on page 45.
2. Unlock the SFP module latch:
 - For SFP modules that contain plastic tabs, unlock the SFP module latch by pulling the plastic tab outward 10°, as shown in Figure 36.

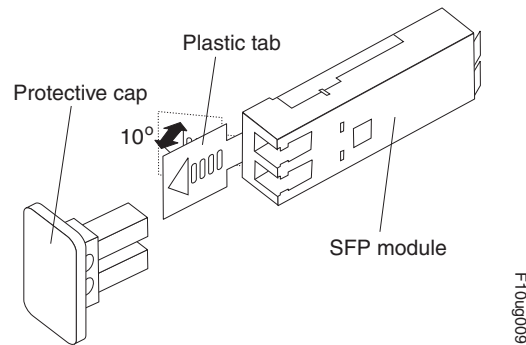


Figure 36. Unlocking the SFP module latch - plastic variety

- For SFP modules that contain wire tabs, unlock the SFP module latch by pulling the wire latch outward 90°, as shown in Figure 37.

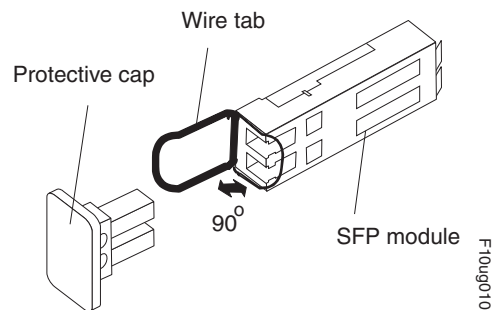


Figure 37. Unlocking the SFP module latch - wire variety

3. With the SFP latch in the unlocked position, extract the SFP module.
 - For SFP modules that contain plastic tabs, slide the SFP module out of the port.
 - For SFP modules that contain wire tabs, grasp the wire latch and pull the SFP module out of the minihub port.
4. Replace the protective cap on the SFP module.
5. Place the SFP module into a static-protective package.
6. Replace the protective cap on the port.

Installing fiber-optic cables

To connect the fiber-optic cables, perform the following steps.

1. Remove the protective cap from the fiber-optic cable. See Figure 38.

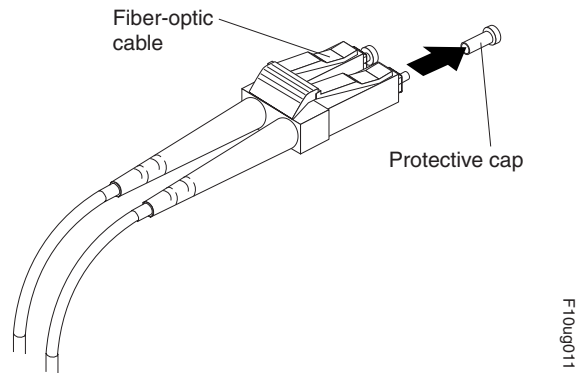


Figure 38. Removing caps from fiber-optic cables

2. Connect the fiber-optic cable to the installed SFP, as shown in Figure 39.

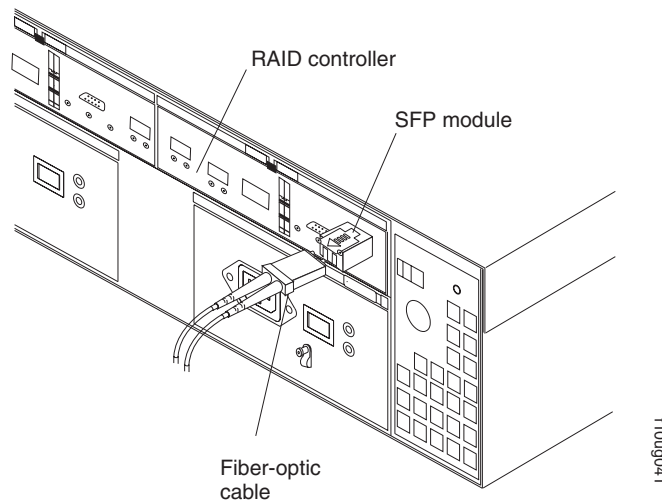


Figure 39. Connecting cables to the installed SFP

3. Check the LEDs on the RAID controller. When the RAID controller is operating properly, the amber Fault LED is off. For information about the status of the RAID controller LEDs, see Table 13 on page 73.
4. To remove the fiber-optic cables, gently pull the fiber-optic cable from the SFP; then replace the protective caps.

Using LC-LC fibre-channel cables

The LC-LC fibre-channel cable is a fiber-optic cable that you use to connect into one of the following devices:

- An SFP module installed in an IBM DS4100
- An SFP module installed in an IBM DS4000 EXP100 expansion unit

See Figure 40 on page 50 for an illustration of the LC-LC fibre-channel cable.

For more information about cabling these devices, see the documentation that comes with the LC-LC fibre-channel cable.

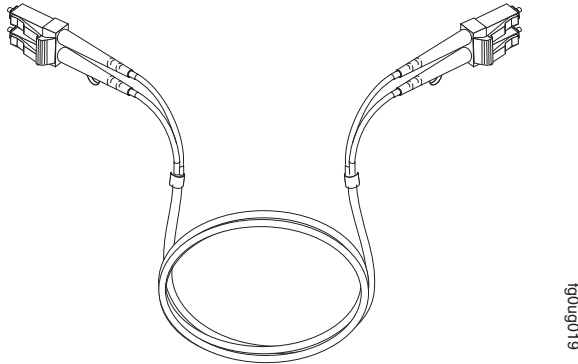


Figure 40. LC-LC fibre-channel cable

Note: If you are connecting the DS4100 to a 1 Gbps device (such as a 1 Gbps fibre channel switch), you must also use an LC-SC fibre-channel cable adapter. For more information about using an LC-SC fibre-channel cable adapter, see “Using LC-SC fibre-channel cable adapters” on page 52.

Connecting an LC-LC cable to an SFP module

Complete the following steps to connect an LC-LC fibre-channel cable to an SFP module:

Statement 3:



CAUTION:

When laser products (such as CD-ROMs, DVD drives, fiber optic devices, or transmitters) are installed, note the following:

- Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.
- Use of controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.



DANGER

Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following.

Laser radiation when open. Do not stare into the beam, do not view directly with optical instruments, and avoid direct exposure to the beam.

1. Read the information in “Handling fiber-optic cables” on page 45.

2. If necessary, remove the protective cap from the SFP module, as shown in Figure 34 on page 47. Save the protective cap for future use.
3. Remove the two protective caps from one end of the LC-LC cable, as shown in Figure 41. Save the protective caps for future use.

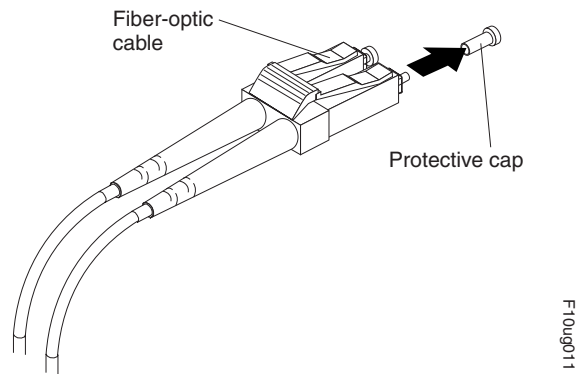


Figure 41. Removing fiber-optic cable protective caps

4. Carefully insert this end of the LC-LC cable into an SFP module that is installed in the DS4100. The cable connector is keyed to ensure it is inserted into the SFP module correctly. Holding the connector, push in the cable until it clicks into place, as shown in Figure 42.

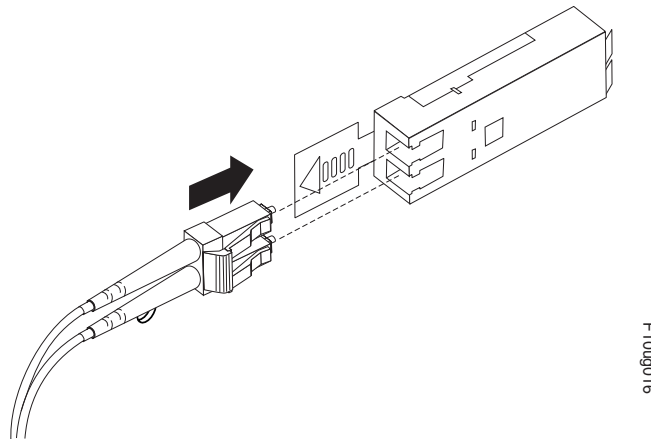


Figure 42. Inserting an LC-LC fibre-channel cable into an SFP module

5. Remove the two protective caps from the other end of the LC-LC cable. Save the protective caps for future use.
6. Connect this end of the LC-LC cable to the SFP module that is installed in a DS4000 EXP100.

Removing an LC-LC fibre-channel cable

Complete the following steps to remove an LC-LC fibre-channel cable:

Attention: To avoid damaging the LC-LC cable or SFP module, make sure that you press and hold the lever to release the latches before you remove the cable from the SFP module. Ensure that the levers are in the released position when removing the cable. When removing the cable from the SFP module, make sure that you do not grasp the SFP module plastic tab.

1. On the end of the LC-LC cable that connects into the SFP module or host bus adapter, press down and hold the lever to release the latches, as shown in Figure 43.

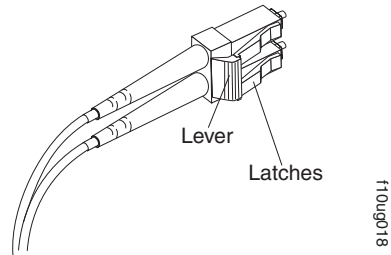


Figure 43. LC-LC fibre-channel cable lever and latches

2. Carefully pull on the connector to remove the cable from the SFP module, as shown in Figure 44.

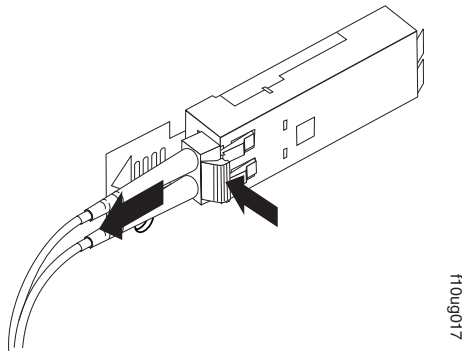


Figure 44. Removing the LC-LC fibre-channel cable

3. Replace the protective caps on the cable ends.
4. Replace the protective cap on the SFP module.

Using LC-SC fibre-channel cable adapters

The LC-SC fibre-channel cable adapter is a fiber-optic cable that is used to connect an LC connector into one of the following devices that require SC connectors:

- 1-Gbps fibre channel switch
- Fibre channel host bus adapter

For more information about connecting to these devices, see the documentation that comes with the LC-SC fibre-channel cable adapter.

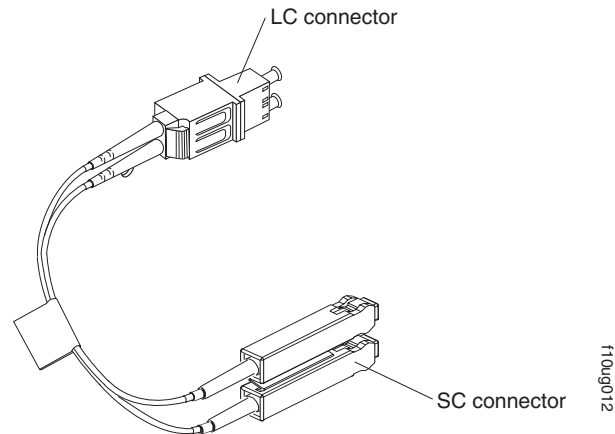


Figure 45. LC-SC fibre-channel cable adapter

The following sections provide the procedures for properly connecting and removing an LC-SC fibre-channel cable.

Connecting an LC-SC cable adapter to a device

Complete the following steps to connect an LC-SC fibre-channel cable adapter to a device:

Statement 3:



CAUTION:

When laser products (such as CD-ROMs, DVD drives, fiber optic devices, or transmitters) are installed, note the following:

- Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.
- Use of controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.



DANGER

Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following.

Laser radiation when open. Do not stare into the beam, do not view directly with optical instruments, and avoid direct exposure to the beam.

1. Read the information in “Handling fiber-optic cables” on page 45.
2. Connect one end of an LC-LC cable to an SFP module in the DS4100. For instructions, see “Using LC-LC fibre-channel cables” on page 49.

3. Remove the two protective caps from the LC connector end of the LC-SC cable adapter as shown in Figure 46. Save the protective caps for future use.

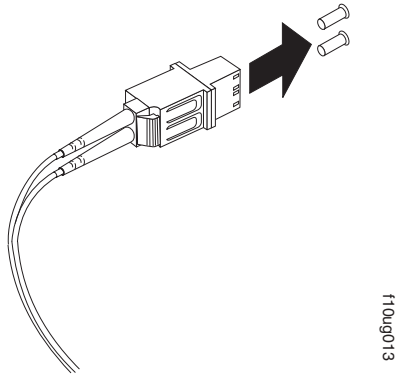


Figure 46. Removing the LC-SC cable adapter protective caps

4. Carefully insert the other end of the LC-LC cable into the LC connector end of the LC-SC cable adapter as shown in Figure 47. Push in the connector until it clicks into place.

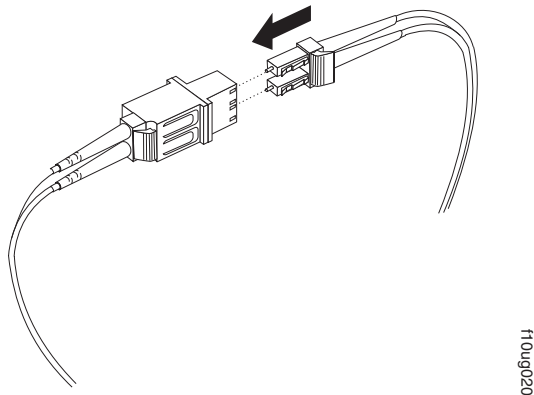


Figure 47. Connecting an LC-LC cable into the LC-SC cable adapter

5. If you are connecting the DS4100 to a 1-Gbps fibre channel switch or fibre channel host bus adapter, connect the SC connector end of the LC-SC cable adapter to a Gigabit Interface Converter (GBIC) that is installed in the 1-Gbps fibre channel switch or fibre channel host bus adapter. For more information about connecting to these devices, see the documentation that comes with the device.

Removing an LC-LC cable from an LC-SC cable adapter

Complete the following steps to remove an LC-LC cable from an LC-SC cable adapter:

Attention: To avoid damaging the LC-LC cable, make sure you press and hold the lever to release the latches before you remove the cable from an LC-SC cable adapter. Ensure that both levers are in the released position when removing the cable. When removing the cable from the SFP module, make sure you do not grasp the SFP module plastic tab.

1. On the end of the cable that connects into the LC connector end of the LC-SC cable adapter, press down and hold the lever to release the latches. Figure 48 shows the location of the lever and latches.

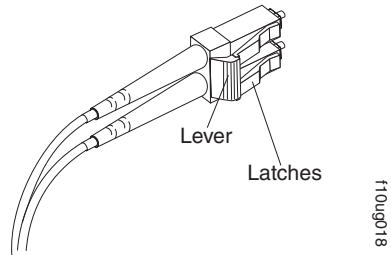


Figure 48. LC-LC fibre-channel cable lever and latches

2. Carefully pull on the connector to remove it. Make sure you grasp the connector and not the cable when removing the LC-LC cable from the LC-SC cable adapter as shown in Figure 49.

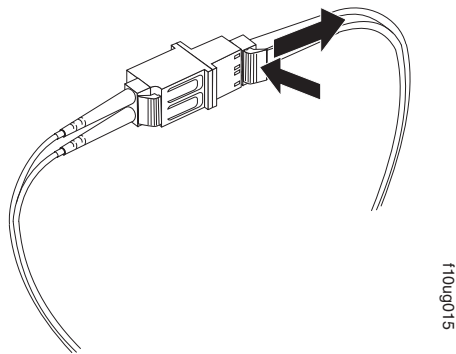


Figure 49. Removing the LC-LC fibre-channel cable from an LC-SC fibre-channel cable adapter

3. Replace the protective caps on the cable ends.

Connecting hosts to the RAID controllers

Complete the procedure that is appropriate to your DS4100 storage server model:

- “Connecting hosts to a DS4100 base storage server” on page 55
- “Connecting hosts to a DS4100 single-controller storage server” on page 56

Connecting hosts to a DS4100 base storage server

To connect a host adapter to the DS4100 base storage server RAID controllers, perform the following steps:

1. Install an SFP in a host port on the RAID controller.
2. Connect the host-system cables to the RAID controller or to switches. Figure 50 on page 56 shows the location on the RAID controllers where the host-system cables connect.

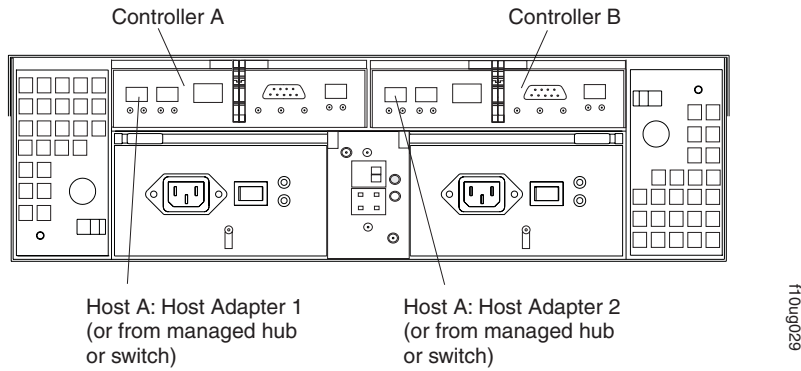


Figure 50. Location of host cables (base storage server)

For examples of redundant, partially-redundant, and non-redundant host and drive loop configurations, see “Fibre channel loop configurations” on page 36.

Connecting hosts to a DS4100 single-controller storage server

To connect a host adapter to the DS4100 single-controller storage server RAID controllers, perform the following steps:

1. Install an SFP in a host port on the RAID controller.
2. Connect the host-system cables to the RAID controller or to switches. Figure 51 shows the location on the RAID controllers where the host-system cables connect.

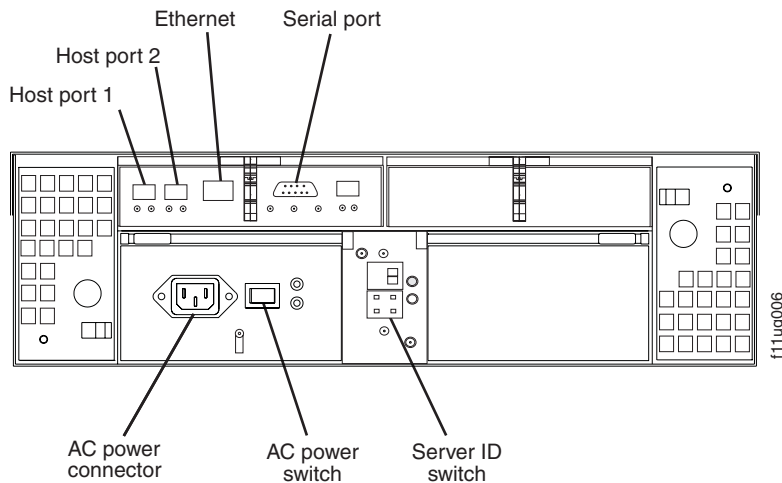


Figure 51. Location of host cables (single-controller storage server)

Connecting secondary interface cables

Use the Ethernet interface ports on the back of the storage server to connect the controllers for direct management of the storage subsystems (see “Direct (out-of-band) management method” on page 35).

This section is applicable to (direct) out-of-band management configurations only. If your configuration uses host-agent (in-band) management, skip this section.

Important:

1. The serial interface ports are intended to be used by service technicians to perform diagnostic operations on the storage server. Incorrect use of the serial port can result in loss of data access and, in some cases, in loss of data.
2. Do not connect the DS4100 in a public LAN or public subnet. Use a local private network for the DS4100 storage server and the management station Ethernet ports.
3. To ensure proper EMI shielding, always use quality shielded serial cables.

Connecting secondary interface cables to a DS4100 base storage server

Connect a pair of Ethernet cables from the storage-management station to the Ethernet ports for Controller A (located on the left) and Controller B (located on the right) on the back of the storage server. Figure 52 shows the location of the ports.

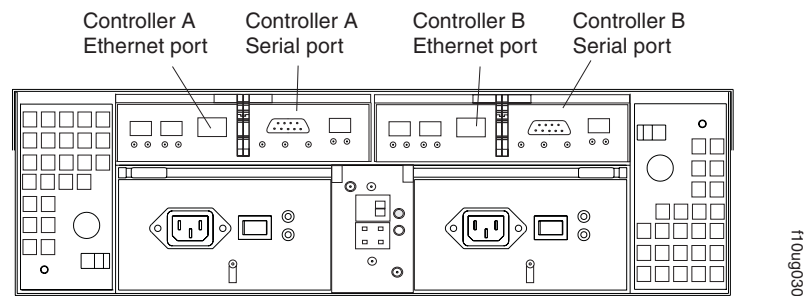


Figure 52. Ethernet and serial port locations

Connecting secondary interface cables to a DS4100 single-controller storage server

Connect an Ethernet cable from the storage-management station to the Ethernet port of the controller.

Connecting expansion units (base storage server only)

Attention: The minimum DS4000 EXP100 ESM firmware level (9554 or later) is required before attaching a DS4000 EXP100 to the DS4100 base storage server. Refer to the section “Replacing a failed hot-swap ESM” in the *IBM TotalStorage DS4000 EXP100 Storage Expansion Unit Installation, User’s, and Maintenance Guide* for details on how to identify ESM firmware levels.

You cannot connect expansion units to the DS4100 single-controller storage server. If you are using the DS4100 single-controller storage server, skip this section. Please contact your IBM support representative for information about the availability of such support in the future.

Attention: In the initial installation of the DS4100, you can add only *new* expansion units to the DS4100 storage server. This means that there must be no existing configuration information on the expansion unit that you want to install. If the expansion unit that you want to install currently contains logical drives or configured hot spares, and you want them to be part of the DS4100 storage server, refer to the *IBM TotalStorage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*. Improper drive migration might cause loss of configuration and other storage server problems. Contact your IBM support representative for additional information.

To connect a single additional expansion unit to the storage server, perform the following steps:

Note: The following procedures are for "cold-case" procedures (the DS4100 is powered down when expansion units are connected, as in the case of a new installation). For "hot-case" procedures (the DS4100 is powered on when expansion units are connected), see "Adding a DS4000 EXP100 to an existing DS4100 configuration (base storage server only)" on page 109. You can also refer to the *IBM TotalStorage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*.

1. Follow the instructions in your expansion unit installation manual to set up and mount the new expansion unit.
2. Use the following procedure and Figure 53 on page 59 to connect a single expansion unit to the storage server:
 - a. Ensure that the enclosure ID switch on the new expansion unit is set to a value different than the value set for the DS4100 and any other expansion units in the loop. Also ensure that the link speeds of the expansion units are set to 2 Gbps. See "Setting the interface options" on page 32.

Note: When connecting the DS4100 to DS4000 EXP100 storage expansion units, do not use the tens digit (x10) setting. Use only the ones digit (x1) setting to set unique server IDs or enclosure IDs. For more information, see "Server ID (enclosure ID) settings" on page 33.

- b. Use a fiber-optic cable to connect to the FC-Expansion Units port on the left RAID controller in the storage server to the In port on the left ESM board of the expansion unit.
 - c. Use a second fiber-optic cable to connect the FC-Expansion Units port on the right RAID controller in the storage server to the Out port on the right ESM board of the expansion unit.

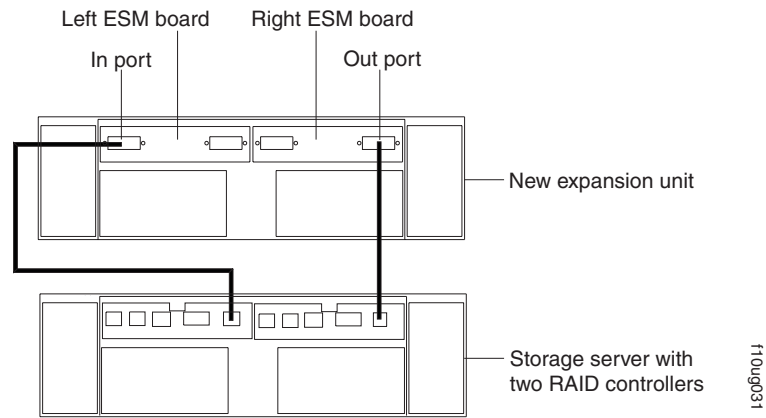


Figure 53. Adding an expansion unit

3. Remove the blank filler trays and insert drive trays. Connect power to the drive expansion unit first and then connect power to the DS4100. After the storage server is powered on, the storage server locates the new drives.
4. Use the DS4000 Storage Manager client to check the status of the new drives, correct any errors found, and configure the new drives.

For more detailed information about how to cable the storage server and expansion units, see the *DS4100 Fibre Channel Cabling Instructions* that come with the storage server.

DS4000 EXP100 loop redundancy (DS4100 base storage server only)

The DS4000 EXP100 provides redundant loop support when the second ESM is configured, and when both loops (called A and B) are connected to a DS4100 storage server model that supports redundant loops. (The DS4100 base storage server supports redundant loops; the DS4100 single-controller storage server does not support redundant loops.) If a cable or SFP module fails on drive loop A, drive loop B provides redundancy, which is an alternate path to your disk drives.

Figure 54 on page 60 shows a redundant loop that you might create with a DS4100 and three DS4000 EXP100s. The numbers provided in Figure 54 on page 60 show the order in which cables should be attached.

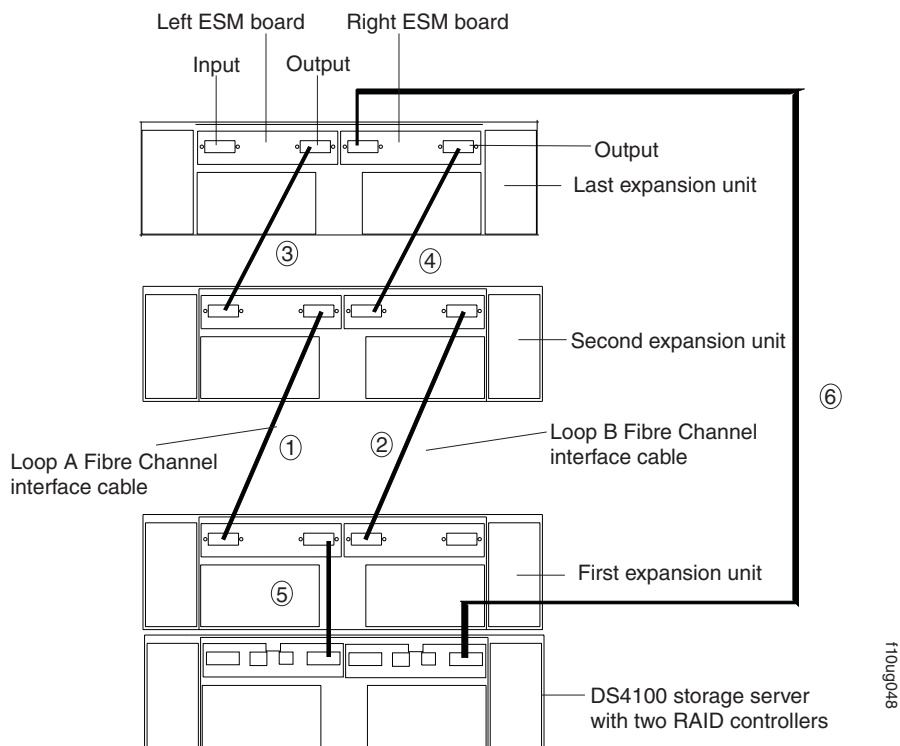


Figure 54. DS4000 EXP100 redundant loop configuration

To create the redundant loop shown in Figure 54, you would perform the following steps:

1. Make two fibre-channel connections from the *First expansion unit* to the *Second expansion unit* (connections 1 and 2).
2. Make two fibre-channel connections from the *Second expansion unit* to the *Last expansion unit* (connections 3 and 4). Currently, you can connect up to three DS4000 EXP100s together in a redundant drive loop. Contact your IBM support representative for information about the availability of future support for connecting more than three DS4000 EXP100 units.
3. Make a fibre-channel connection from the storage server drive port to the **OUT** port in the left ESM of the *First expansion unit* in the redundant drive loop (connection 5).
4. Make a fibre-channel connection from the storage server drive port to the **IN** port in the right ESM of the *Last expansion unit* in the redundant drive loop (connection 6).

IBM SATA disk drives are dual-ported, providing individual access from two fibre-channel loops to the same disk drive. When configuring the ESMs, configure the second ESM the same way that you configured the first ESM. Refer to the *DS4100 Fibre Channel Cabling Instructions* for more information about dual-loop support and implementation.

Each ESM on the DS4000 EXP100 has an SFP module input port and an SFP module output port. As you cable DS4000 EXP100s together, connecting input ports to output ports can improve diagnostic capability. Refer to the *DS4100 Storage Server Fibre Channel Cabling Instructions* for cabling connections between input and output ports.

Power cabling

The DS4100 base storage server uses two standard power cords, and the single-controller storage server uses only one. You can connect the power cords to a primary power unit inside the rack cabinet, such as a properly grounded ac distribution unit, or to an external source, such as a properly grounded electrical outlet.

The DS4100 storage server does not ship with power cords. Refer to Appendix C, “Power cords,” on page 125 for the list of IBM-approved power cords for your region. Depending on your model, the DS4100 storage server does ship with one or two line jumper cords for connecting the DS4100 power supply or power supplies to an IBM-approved rack power distribution unit.

If you have not already done so, attach the power cords by using Figure 55 for the location of the component parts.

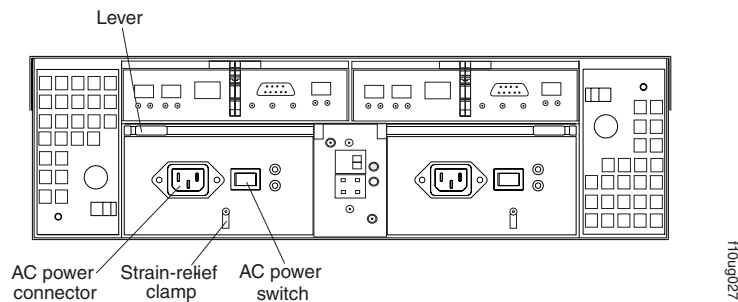


Figure 55. Power cord locations

Perform the following to cable the power cords:

1. Connect the power cord to the power supply.
2. Remove the nut that holds the power cable strain-relief clamp, and then remove the strain-relief clamp.
3. Wrap the strain-relief clamp around the power cord approximately 20 cm (8 in.) from the power supply connection end. Leave some slack between the clamp and the power-supply end of the power cord.
4. Replace the power cable strain-relief clamp, and tighten it securely with the nut.
5. Plug the power cord into a properly grounded electrical outlet.

Note: To maintain power redundancy, plug the storage server’s right and left power supplies into two independent external power circuits through ac distribution units inside a rack cabinet or directly into external receptacles. Similarly, the right and left power supplies of the DS4000 storage expansion units attached to the DS4100 should be plugged into the same two independent external power circuits as the DS4100.

It is recommended that you determine the maximum surge current possible when all devices in the power circuit are started at the same time. Based on the total number of devices on a power circuit, find the maximum (worst-case) specification value in order to prevent the circuit from tripping. When both power supplies are connected and the storage server is powered on, each power supply unit will handle approximately

one-half of the current load. If there is only one power supply unit, it will handle all of the current load. To ensure maximum protection against power loss due to power supply unit failure or a power circuit tripping, both power supply units must be connected and powered on. See Table 10 on page 15 for the DS4100 AC power requirements.

See Figure 56 for an example of redundant power cabling.

Exception: The DS4100 single-controller storage server has only one power supply, so it does not support power redundancy.

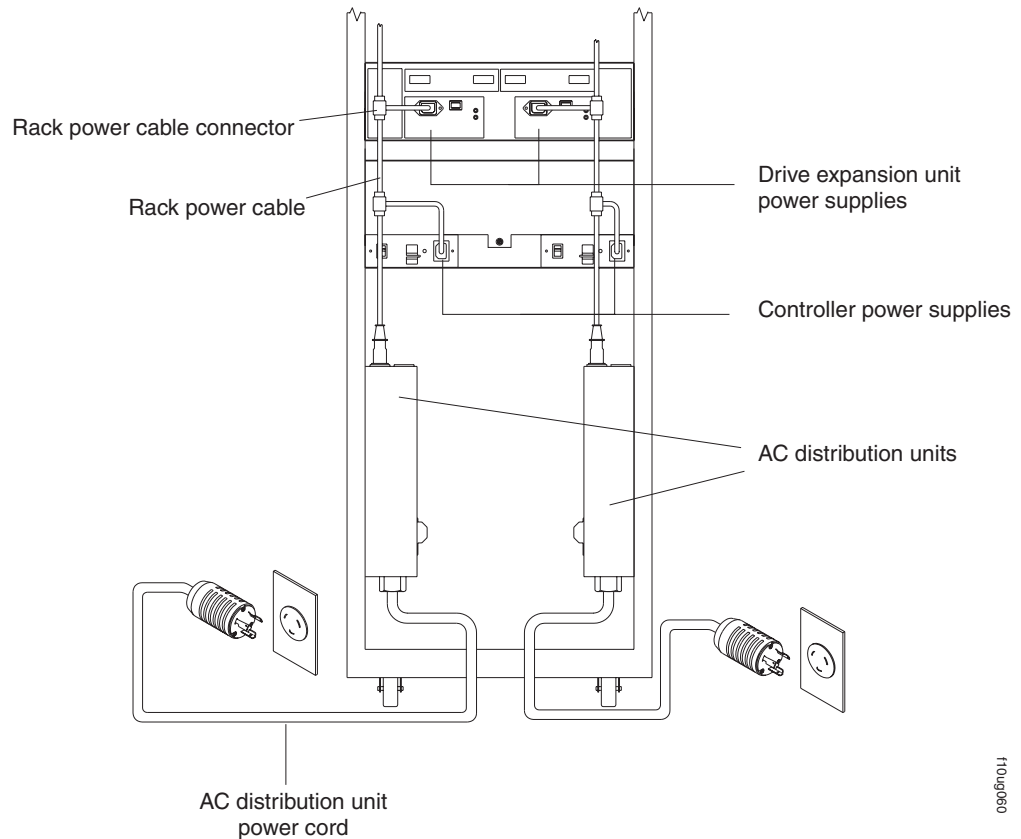


Figure 56. Redundant AC power connections to controllers and drive expansion units

For details about power requirements, see “DS4100 specifications” on page 14.

- Go to “Turning the storage server on and off” on page 65 for the initial startup of the storage server.

Attention: Before you power on the storage server, any storage expansion units should be completely connected to the storage server.

Installing the DS4000 Storage Manager client

Refer to the *IBM TotalStorage DS4000 Storage Manager 9.10 Installation and Support Guide* for the appropriate operating system for instructions on how to install the Storage Manager software. Use that document and the online help to configure the logical drives, partitions, and so on for the RAID controllers. Use your operating

system documentation to make the new logical drives accessible to the operating system. Do not proceed with the configuration set-up you have completed the DS4000 Storage Manager installation.

Assemble any additional items in preparation for software installation. These items might include:

- HBA drivers
- Controller firmware version 05.42.xx.xx
- IP addresses for RAID controllers (for in-band management only)
- Additional documentation for switches and HBAs, if needed
- *DS4000 Storage Manager Version 9.10 Support CD*, which includes the IBM DS4000 Storage Manager 9.1 software and DS4000 storage server controller firmware 05.42.xx.xx. You use this software to configure the storage subsystems. For the latest controller firmware, check the IBM support web site for DS4000 storage products.

www.ibm.com/servers/storage/disk/

Before any planned system shutdown or after any system additions, removals, or modifications (including logical drive creations, storage partitioning definitions, hardware changes, and so on), save the storage subsystem profile as explained in the DS4000 Storage Manager guide for your operating system. Save the profile in a location other than the logical drives created for the DS4100 storage server.

Important: Controller firmware version 05.42.xx.xx is required for the DS4100. However, this version of the controller firmware should be used only for the DS4100. Do not use controller firmware version 05.42.xx.xx for any DS4000 storage servers other than the DS4100. This version of the controller firmware does not support intermix of fibre-channel drive expansion enclosures. Please contact your IBM support representative for information about the availability of such support in the future.

Always refer to the readme that is included with the DS4100 storage server firmware package (whether the firmware is accessed by the Web or CD) for any special requirements or restrictions that apply to that particular firmware version.

Note: Make sure that you install the DS4000 Storage Manager event monitoring service to enable continuous monitoring of the status of the storage server. For more information about the importance of this information, see “Monitoring status through software” on page 70.

Chapter 4. Operating the storage server

To ensure optimal operation of your system, always follow these best practices guidelines:

- Back up the data on your storage drives periodically.
- **DS4100 base storage server only:** To maintain power redundancy, plug the storage server's right and the left power supplies into two independent external power circuits through ac distribution units inside a rack cabinet or directly into external receptacles. Similarly, the right and left power supplies of the DS4000 storage expansion units attached to the DS4100 should be plugged into the same two independent external power circuits as the DS4100. This ensures that the DS4100 and all its attached storage expansion units will have power if only one power circuit is available. In addition, having all the right or all the left power supplies plug into the same power circuit will enable the components in the storage subsystem to power on simultaneously during an unattended restoration of power. See Figure 56 on page 62 for an example of redundant power connections.
- Before any planned system shutdown or after any system additions, removals, or modifications (including logical drive creations, storage partitioning definitions, hardware changes, and so on), save the storage subsystem profile as explained in the DS4000 Storage Manager guide for your operating system. Save the profile in a location other than the logical drives created for the DS4100 storage server.
- Ensure that your system is in an optimal state before you shut it down. Never turn the power off if any fault light is lit; be sure to resolve any error conditions before you shut down the system.
- During any maintenance or attended power-up procedure, carefully follow the power-up sequence listed in "Turning on the storage server" on page 66. You should check that each component of the subsystem is powered-on in the proper order during this entire power-up procedure to ensure that the controller will optimally access all of your storage subsystems.
- The storage subsystem supports simultaneous power-up to the system components; however, you should always follow the power-up sequence listed in "Turning on the storage server" on page 66 during any attended power-up procedure.
- A storage system in an optimal state should recover automatically from an unexpected shutdown and unattended simultaneous restoration of power to system components. After power is restored, call IBM support if any of the following conditions occur:
 - The storage subsystem logical drives and arrays are not displayed in the DS4000 Storage Manager graphical user interface (GUI).
 - The storage subsystem logical drives and arrays do not come online.
 - The storage subsystem logical drives and arrays seem to be degraded.

Turning the storage server on and off

This section contains instructions for turning the storage server on and off under normal and emergency situations.

If you are turning on the storage server after an emergency shutdown or power outage, see "Restoring power after an emergency shutdown" on page 69.

Turning on the storage server

Important: DS4100 base storage server only: You must turn on the storage expansion units and verify that the storage expansion unit fibre channel connections are optimal by checking the indicator lights *before* you turn on the DS4100. The controllers might not recognize the correct configuration if the hard disk drives are powered up after the DS4100. For instructions on how to power up the storage expansion units, refer to the storage expansion unit documentation.

Note: Always wait at least 30 seconds between the time you turn off a power switch and the time you turn on the power again.

Perform the following steps to turn on the power for the initial startup of the storage server:

1. Verify that:
 - a. All communication and power cables are plugged into the back of the storage server and a properly grounded ac electrical outlet.
 - b. All hard disk drives are locked securely in place. For more information, see “Installing hot-swap hard disk drives” on page 80.

Note: At least one drive must be present before you start the DS4100.

Attention: If you are restarting the system after a normal shutdown, wait at least 10 seconds before you turn on the power by using the power-on sequence in step 2.

2. Check the system documentation for the hardware devices that you intend to power up, and then determine the proper startup sequence. Use the following power-on sequence, where applicable:
 - a. Turn on the power to the supporting devices (for example, Ethernet switches and management stations) before the storage server.

Attention: If you will be directly managing the storage array, you must set up the Dynamic Host Configuration Protocol (DHCP) or BOOT-P server before you turn on the power. Setting up the server allows the controllers to obtain the corresponding IP address when you turn on the power to the array module. For more information, see the software installation guide for your operating system.

- b. You must turn on the expansion units before the storage server. The controllers might not recognize the correct configuration if the drives are powered up after the storage server. For instructions on how to power up the expansion units, see the expansion-unit documentation.
 - c. Turn on the power to the storage server; then restart or turn on the power to the host.

Note: Depending on your operating system, you might not have to restart the host. For more information, see the software installation guide for your operating system.

3. Turn on the power to each device, based on the power-on sequence in step 2. To turn on power to the storage server, turn on the power-supply switches on the back of the storage server. You must turn on both power-supply switches to take advantage of the redundant power supplies.
4. Use the DS4000 Storage Manager client and the Fault LEDs to check the overall status of the storage server and its components. All LEDs should be

green on the front of the storage server. If they are not, use the DS4000 Storage Manager client to diagnose the problem (see “Monitoring status through software” on page 70).

Note: The green drive active LED and amber drive fault LED below the drive CRUs might flash intermittently as the drives spin-up. Wait until the storage server is finished powering up before checking the LEDs on the front of the storage server. For more information, see “Checking the LEDs” on page 71.

Turning off the storage server

Attention: Except in an emergency, never turn off the power if any storage server Fault LEDs are on. Correct the fault before you turn off the power. Use the DS4000 Storage Manager client and the Fault LEDs to check the overall status of the storage server and its components. All LEDs should be green on the front of the storage server. If they are not, use the DS4000 Storage Manager client to diagnose the problem (see “Monitoring status through software” on page 70). This ensures that the storage server will power up correctly later. For more information, see Chapter 6, “Hardware maintenance,” on page 111.

The storage server is designed to run continuously, 24 hours a day. After you turn on the storage server, do not turn it off. Turn off the power only when:

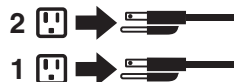
- Instructions in a hardware or software procedure require you to turn off the power.
- A service technician tells you to turn off the power.
- A power outage or emergency situation occurs (see “Performing an emergency shutdown” on page 69).

Statement 5:



CAUTION:

The power control button on the device and the power supply do not turn off the electrical current supplied to the device. The device also might have more than one power cord. To remove all electrical current from the device, ensure that all power cords are disconnected from the power source.



Perform the following steps to turn off the power:

1. Before proceeding, use the DS4000 Storage Manager client to determine the status of the system components and special instructions. The operating system software might require you to perform other procedures before you turn off the power.
2. Use the DS4000 Storage Manager client to check the status of the storage server. Correct problems that are reported before you turn off the power.

3. Stop all I/O activity to the storage server and attached expansion units. Make sure that:
 - All of the green Drive active LEDs on the front of the storage server (and on all attached expansion units) are not flashing.
 - The green Cache active LEDs on the back of the storage server are off.

Attention: To turn off all power to the storage server, you must turn off both power-supply switches and disconnect both power cords. Use the procedure in step 6 for the proper shutdown sequence.

4. Before the storage server is powered off, use the operating system software to either disconnect the storage server logical drives from the host or to flush the logical drive data cache in the host server memory.
5. If applicable, use the operating system software to disconnect the storage server logical drives from the host before the storage server is powered off.
6. Turn off the power to each device based on the following shutdown sequence:
 - a. Turn off power to the host before the storage server. If the host must stay powered on to support an existing network, see the operating system documentation for information about disconnecting the storage server logical drives from the host before the storage server is powered off.
 - b. Turn off power to the storage server before you turn off power to the expansion units. Turn off both power supply switches on the back of the storage server.
 - c. Turn off power to other supporting devices (for example, management stations, fibre-channel switches, or Ethernet switches).

Note: You do not need to perform this step if you are servicing only the storage server.

7. After you perform the necessary maintenance procedures, turn on the power using the procedure in “Turning on the storage server” on page 66.

Restoring power after an unexpected shutdown

The storage server might shut down unexpectedly under any of the following conditions:

Attention: There might be data loss in each of the following cases:

- The internal temperature of the storage server exceeds the maximum operating temperature (an over-temperature condition).

If both fan CRUs fail or are unable to maintain an internal temperature below 70° C (158° F), one or both of the power supplies in the storage server will shut down. If both power supplies shut down, the unit is inoperable.

The DS4000 Storage Manager client warns you if the temperature of the unit is rising before it has risen sufficiently to shut down the power supplies. The first warning comes when the storage server internal temperature exceeds 45° C (113° F). The storage server shuts down if the temperature rises to 70° C (158° F).

- There is a general power failure or a loss of power to the unit.
- You are forced to shut down the storage server without performing the normal shutdown procedures (listed in “Turning off the storage server” on page 67) because of an emergency situation.

Attention: To avoid damage to the hardware, take special care when you restart the system after an unexpected shutdown.

If the storage server shuts down unexpectedly, go to “Restoring power after an over-temperature shutdown.” Otherwise, go to “Restoring power after an emergency shutdown.”

Note: Unattended restoration of power is supported; however, if power restoration is attended, you should follow the best practices guidelines and the power restoration sequence in “Turning on the storage server” on page 66.

Performing an emergency shutdown

Attention: Emergency situations might include fire, flood, extreme weather conditions, or other hazardous circumstances. If a power outage or emergency situation occurs, always turn off all power switches on all computing equipment. This will help safeguard your equipment from potential damage due to electrical surges when power is restored. If the storage server loses power unexpectedly, it might be due to a hardware failure in the power system or midplane (see Chapter 6, “Hardware maintenance,” on page 111).

Use this procedure to shut down the storage server during an emergency:

1. If you have time, stop all I/O activity to the storage server by shutting down the host or disconnecting the storage server logical drives through the host.
2. Check the LEDs (front and back). Make note of any Fault LEDs that are on so you can correct the problem when you turn on the power again.
3. Turn off all power-supply switches; then unplug the power cords from the storage server.

Restoring power after an emergency shutdown

Use this procedure to restart the storage server if you turned off the power-supply switches during an emergency shutdown, or if a power failure or a power outage occurred:

1. After the emergency situation is over or power is restored, check the storage server for damage. If there is no visible damage, continue with step 2; otherwise, have your system serviced.
2. After you have checked for damage, ensure that the power-supply switches are off; then plug in the storage-server power cords.
3. Complete step 2 on page 66 to determine the proper power-on sequence for your system.
4. Complete steps 3 and 4 on page 66 to turn on power to the devices in your system and to check the status of the storage server.

Restoring power after an over-temperature shutdown

Use this procedure to restart the storage server after an unexpected shutdown due to an over-temperature condition:

1. Make sure that the power-supply switches on the back of the storage server are turned off.
2. Do whatever is necessary to cool the unit (replace the fans, use external fans to cool the room, and so on).
3. Check all components and cables for visible damage. *Do not start the storage server if you find evidence of damage.*

4. Complete step 2 on page 66 to determine the proper power-on sequence for your system.
5. When the internal temperature of the storage server is below 35° C (95° F), complete steps 3 and 4 on page 66 to turn on power to the devices in your system and to check the status of the storage server.

Monitoring status through software

Attention

To ensure proper operation when connecting DS4000 EXP100 expansion units to the DS4100, you must verify that the DS4000 EXP100 ESM firmware level is at level 9554 or later. If the ESM firmware level is lower than 9554, disconnect the DS4000 EXP100 and contact IBM support, your IBM reseller, or your IBM representative for assistance. See the *IBM TotalStorage DS4000 EXP100 Expansion Unit Installation and User's Guide* for details on how to determine ESM firmware versions.

Use the DS4000 Storage Manager client to monitor the status of the storage server. Run the software constantly, and check it frequently.

Notes:

1. You can only monitor storage servers that are within the management domain of the storage-management software.
2. If you have not installed the DS4000 Storage Manager Event Monitor service as part of the storage-management software installation, the DS4000 Storage Manager Enterprise Management window must remain open. (If you close the window, you will not receive any alert notifications from the managed storage subsystems.)

For more information, see the Enterprise Management online Help.

Important: Refer to the *IBM TotalStorage DS4000 Storage Manager 9.10 Installation and Support Guide* for the appropriate operating system for instructions on how to install the DS4000 Storage Manager 9.10 host software.

In addition, to download the latest version of the DS4000 Storage Manager 9.10 host software, the DS4100 storage server controller firmware and NVSRAM 05.42.xx.xx, and the latest DS4000 EXP100 R2 ESM firmware (version 9554 or higher), go to the following Web site:

www.ibm.com/storage/techsup.htm

Note: The version of controller firmware determines which version of the DS4000 Storage Manager subsystem management interface is displayed. For example, the interface for DS4000 Storage Manager version 8.42 subsystem management would be displayed when managing a DS4100 storage server with controller version 05.42.xx.xx installed, even if the installed version of the DS4000 Storage Manager client code is actually 9.10.

The DS4000 Storage Manager client provides the best way to diagnose and repair storage-server failures. The software can help you:

- Determine the nature of the failure

- Locate the failed component
- Determine the recovery procedures to repair the failure

Although the storage server has fault LEDs, these lights do not necessarily indicate which component has failed or needs to be replaced, or which type of recovery procedure you must perform. In some cases (such as loss of redundancy in various components), the fault LED does not turn on. Only the DS4000 Storage Manager client can detect the failure.

For example, the recovery procedure for a Predictive Failure Analysis[®] (PFA) flag (impending drive failure) on a drive varies depending on the drive status (hot spare, unassigned, RAID level, current logical drive status, and so on). Depending on the circumstances, a PFA flag on a drive can indicate a high risk of data loss (if the drive is in a RAID 0 volume) or a minimal risk (if the drive is unassigned). Only the DS4000 Storage Manager client can identify the risk level and provide the necessary recovery procedures.

Note: For PFA flags, the General-system-error LED and Drive fault LEDs do not turn on, so checking the LEDs will not notify you of the failure, even if the risk of data loss is high.

Recovering from a storage-server failure might require you to perform procedures other than replacing the component (such as backing up the logical drive or failing a drive before removing it). The DS4000 Storage Manager client gives these procedures.

Attention: Not following the software-recovery procedures can result in data loss.

Checking the LEDs

The LEDs display the status of the storage server and components. Green LEDs indicate a normal operating status; amber LEDs indicate a possible failure.

It is important to check all the LEDs on the front and back of the storage server when you turn on the power. In addition to checking for faults, you can use the LEDs on the front of the storage server to determine if the drives are responding to I/O transmissions from the host.

For information about the LEDs on the front of the storage server, see:

- Figure 57 on page 72
- Table 12 on page 72

For information about the LEDs on the back of the storage server, see:

- Figure 59 on page 74
- Table 13 on page 73
- Table 14 on page 74

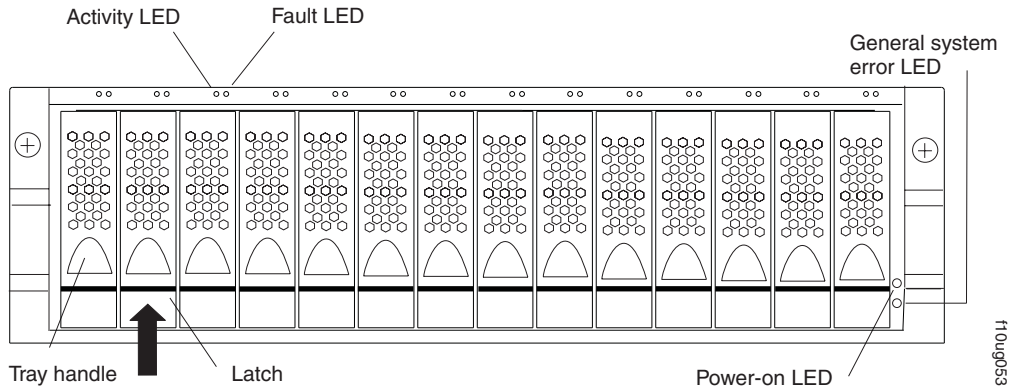


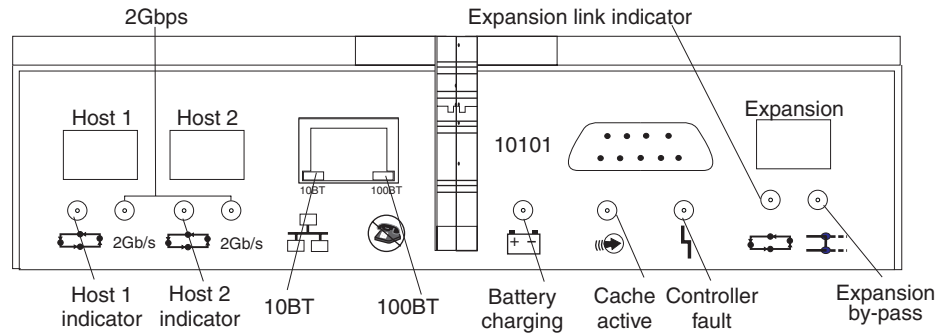
Figure 57. Storage server LEDs (front)

Table 12. Storage server LEDs (front)

LED	Color	Operating states ¹
Drive active	Green	<ul style="list-style-type: none"> • On - Normal operation. • Flashing - The drive is reading or writing data. • Flashing every 5 seconds - The drive has not spun up or the drive is bad. • Off - One of the following situations has occurred: <ul style="list-style-type: none"> – The storage server has no power. – The drive is not properly seated in the storage server.
Drive fault	Amber	<ul style="list-style-type: none"> • Off - Normal operation. • Flashing - The DS4000 Storage Manager client is locating a drive, logical drive, or storage subsystem. • On - The drive has failed, or a user failed the drive.
Power	Green	<ul style="list-style-type: none"> • On - Normal operation. • Off - One of the following situations has occurred: <ul style="list-style-type: none"> – The storage server has no power. – Both power supplies have failed. – There is an over-temperature condition.
General system error	Amber	<ul style="list-style-type: none"> • Off - Normal operation. • On - A storage server component has failed².

¹ Always use the DS4000 Storage Manager client to identify the failure.

² Not all component failures turn on this LED. For more information, see “Monitoring status through software” on page 70.



110ug025

Figure 58. RAID controller LEDs

Table 13. RAID controller LEDs







Icon	LED	Color	Operating states ¹
	Fault	Amber	<ul style="list-style-type: none"> • Off - Normal operation. • On - One of the following situations has occurred: <ul style="list-style-type: none"> – The RAID controller has failed. – The RAID controller was placed offline – The controller battery had failed (in conjunction with the battery LED in off state).
	Host loop	Green	<ul style="list-style-type: none"> • On - Normal operation. • Off - One of the following situations has occurred: <ul style="list-style-type: none"> – The host loop is down, not turned on, or not connected. – A SFP has failed, or the host port is not occupied. – The RAID controller circuitry has failed, or the RAID controller has no power.
	Cache active	Green	<ul style="list-style-type: none"> • On - There is data in the RAID controller cache. • Off - One of the following situations has occurred: <ul style="list-style-type: none"> – There is no data in cache. – There are no cache options selected for this array. – The cache memory has failed, or the battery has failed.
	Battery	Green	<ul style="list-style-type: none"> • On - Normal operation. • Flashing - The battery is recharging or performing a self-test. • Off - The battery or battery charger has failed.

Table 13. RAID controller LEDs (continued)

Icon	LED	Color	Operating states ¹
	Expansion port bypass	Amber	<ul style="list-style-type: none"> • Off - Normal operation. • On - One of the following situations has occurred: <ul style="list-style-type: none"> – An SFP module is inserted in the drive loop port and the fibre-channel cable is not attached to it. – The fibre-channel cable is not attached to an expansion unit. – The attached expansion unit is not turned on. – An SFP has failed, a fibre-channel cable has failed, or an SFP has failed on the attached expansion unit.
	Expansion loop	Green	<ul style="list-style-type: none"> • On - Normal operation. • Off - The RAID controller circuitry has failed, or the RAID controller has no power.
2Gbps	Fibre channel port speed	Green	<ul style="list-style-type: none"> • On - Normal operation (host connection is at 2 Gbps) • Off - Host connection is at 1 Gbps
10BT	10BT	Green	<ul style="list-style-type: none"> • If the Ethernet connection is 10BASE-T: The 10BT LED is on, 100BT LED flashes faintly. • If the Ethernet connection is 100BASE-T: 10BT LED is off, 100BT LED is on. • If there is no Ethernet connection - Both LEDs are off.
100BT	100BT		

¹ Always use the DS4000 Storage Manager client to identify the failure.

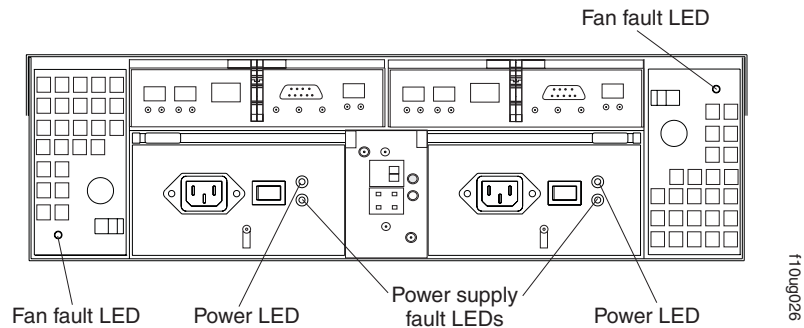


Figure 59. Fan and power supply LEDs

Table 14. Fan LED

LED	Color	Operating states ¹
Fault	Amber	<ul style="list-style-type: none"> • Off - Normal operation. • On - The fan CRU has failed.

Table 14. Fan LED (continued)

LED	Color	Operating states ¹
¹ Always use the DS4000 Storage Manager client to identify the failure.		

Table 15. Power supply LEDs

LED	Color	Operating states ¹
Fault	Amber	<ul style="list-style-type: none"> • Off - Normal operation. • On - One of the following situations has occurred: <ul style="list-style-type: none"> – The power supply has failed. – An over-temperature condition has occurred.
Power	Green	<ul style="list-style-type: none"> • On - Normal operation. • Off - One of the following situations has occurred: <ul style="list-style-type: none"> – The power supply is disconnected. – The power supply is seated incorrectly. – The storage server has no power. – The power supply is turned off.
¹ Always use the DS4000 Storage Manager client to identify the failure.		

Cache memory and RAID controller battery

Each RAID controller in the DS4100 contains 128 MB of cache data. Each controller also contains a rechargeable battery that maintains data in the cache in the event of a power failure. The following sections describe these features and their associated LEDs.

Cache memory

Cache memory is memory on the RAID controller that is used for intermediate storage of read and write data on the DS4100 base storage server RAID controllers. Using cache memory can increase system performance. The data for a read operation from the host might be in the cache memory from a previous operation (thus eliminating the need to access the drive itself), and a write operation is completed when it is written to the cache, rather than to the drives.

Note: In the DS4100 single-controller storage server, the RAID controller cache memory is used for storing read data only. The controller firmware ignores a write-cache enabled setting. This protects data in the event of a controller failure, which would cause the cache to be inaccessible.

See the DS4000 Storage Manager client documentation for information on setting cache memory options.

The RAID controller has a Cache active LED that displays the current status of the cache. The LED is on if there is data in the cache, and it is off if there is no data in the cache.

If caching is enabled and the Cache active LED never comes on during I/O activity, it indicates that the cache memory has failed or the battery has failed (the green Battery LED will be off).

Note: Always use the DS4000 Storage Manager client to check your cache memory settings before assuming a hardware failure.

Figure 60 shows the location of the Cache active LED on the front of the RAID controller.

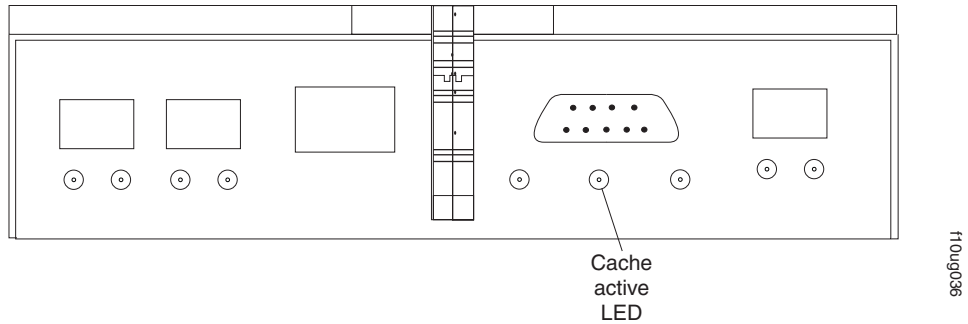


Figure 60. Cache active LED

RAID controller cache battery

Each RAID controller contains a sealed, rechargeable 4-volt lead-acid battery. This battery provides cache backup for up to three days in the event of a power loss.

The service life of the battery is three years, after which time the battery must be replaced. See the DS4000 Storage Manager client for information on how to view and set the battery expiration date.

Each RAID controller has a green Battery LED on the back that indicates the battery status, as follows:

- The LED is on and remains steady when the battery is fully charged.
- The LED flashes when the battery is charging or performing a self-test.
- The LED is off if the battery or the battery charger has failed.

The battery performs a self-test at startup and every 25 hours thereafter (during which time the Battery LED flashes). If necessary, the battery begins recharging at that time. If the battery fails the self-test, the Battery LED turns off, indicating a battery fault.

Data caching starts after the battery completes the startup tests.

Figure 61 on page 77 shows the location of the Battery LED on the front of the RAID controller.

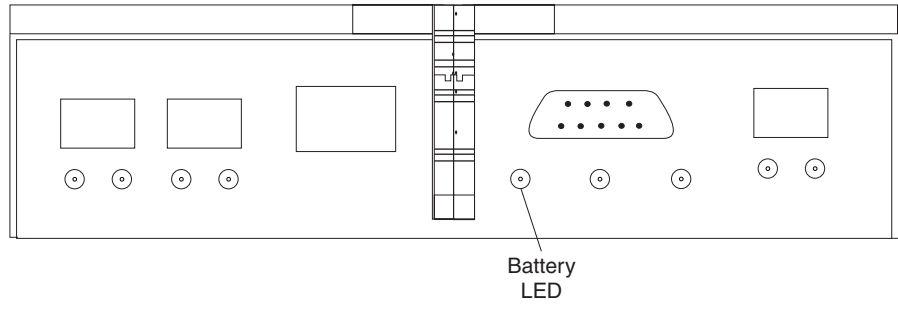


Figure 61. Battery LED

Chapter 5. Installing and replacing components

This chapter provides instructions to help you install or remove customer replaceable units (CRUs), such as hot-swap drives, fans, RAID controllers, and power supplies. This chapter also provides instructions to help you add new DS4000 EXP100 expansion units to existing DS4100 configuration.

For more CRU and Option part number information, see the following Web site:

www-1.ibm.com/servers/storage/support/disk/

Handling static-sensitive devices

Attention: Static electricity can damage electronic devices and your system. To avoid damage, keep static-sensitive devices in their static-protective packages until you are ready to install them.

To reduce the possibility of electrostatic discharge, observe the following precautions:

- Limit your movement. Movement can cause static electricity to build up around you.
- Handle the device carefully, holding it by its edges or its frame.
- Do not touch solder joints, pins, or exposed printed circuitry.
- Do not leave the device where others can handle and possibly damage the device.
- While the device is still in its static-protective package, touch it to an unpainted metal part of the storage server for at least two seconds. This drains static electricity from the package and from your body.
- Remove the device from its package and install it directly into your storage server without setting it down. If it is necessary to set the device down, place it in its static-protective package. Do not place the device on your storage server cover or any metal surface.
- Take additional care when handling devices during cold weather because heating reduces indoor humidity and increases static electricity.

Working with hot-swap hard disk drives

Drives are devices that the system uses to store and retrieve data. This section explains how you can increase the storage-server capacity by adding more drives or replacing existing drives with ones containing a larger capacity.

Before you begin, complete the following tasks:

- Read the safety and handling guidelines in “Safety” on page iii and in “Handling static-sensitive devices” on page 18.
- Ensure that your current system configuration is working properly.
- Back up all important data before you make changes to data storage devices.

Attention: Never hot-swap a drive CRU when its green Activity LED is flashing. Hot-swap a drive CRU only when its amber Fault LED is completely on and not flashing or when the drive is inactive with the green Activity LED on and not flashing.

Attention: After you remove a drive CRU, wait at least 70 seconds before replacing or reseating the drive CRU to allow the drive to properly spin down. Failure to do so may cause undesired events.

Before you install or remove drive CRUs, review the following information:

- **Blank trays:** A storage server without a full set of drives (14) contains blank trays in the unused drive bays. Before installing new drives, you must remove these empty trays. Save the empty trays for future use. Each of the 14 bays must always contain either a blank tray or a hot-swap hard disk drive.

Note: For proper cooling and EMC protection, do not leave a drive slot open without either a blank tray or a hard disk drive CRU inserted.

- **Drive CRUs:** The DS4100 supports up to fourteen IBM 1.5 Gbps SATA hard disk drives.

Note: Do not use fibre-channel hard disk drive CRUs in the DS4100.

These drives come preinstalled in drive trays. This drive-and-tray assembly is called a *drive CRU*. You can install the drive CRUs in the 14 drive bays on the front of the storage server.

- **Drive CRU labels:** A label is provided on the front of each hard disk drive. Use this label to record the location information for each drive before you remove it. Ensure that you keep track of the drives and their corresponding bays. Also, record the location information in Table 19 on page 119. If you install a drive in the wrong bay, you might lose data.
- **Drive LEDs:** Each drive tray has two associated LEDs, a green Activity LED and an amber Fault LED, on the chassis of the DS4100. These LEDs indicate the status for that drive. See Table 16 for the drive LED states and descriptions.

Table 16. Drive LED activity

LED	LED state	Descriptions
Activity LED	Flashing green	The green LED flashes to indicate fibre-channel activity to the drive.
Activity LED	Steady green	The green LED lights to indicate that the drive is properly installed and is spun up by the DS4000 controller.
Fault LED	Flashing amber	The amber LED flashes to indicate that a drive has been identified by the software.
Fault LED	Steady amber	The amber LED lights to indicate a drive failure.
Activity and Fault LEDs	All unlit	The storage server is powered off.

- **Fibre-channel loop IDs:** When you install a drive CRU in the storage server, the drive CRU connects into a printed circuit board called the *midplane*. The midplane automatically sets the fibre-channel loop ID to the default value 00.
- **Hot-swap hardware:** The storage server contains hardware that you can use to replace a failed hard disk drive without turning off the storage server. Therefore, you can continue operating the system while a hard disk drive is removed or installed. These drives are known as *hot-swap* drives.

Installing hot-swap hard disk drives

You can install hard disk drives while the storage server is turned on and running. Complete the following steps to install hot-swap hard disk drives in the storage server:

1. Read the documentation that comes with the hard disk drive.
2. Check for Fault LEDs shown in Figure 62. If any amber LEDs are lit, see Chapter 6, "Hardware maintenance," on page 111.

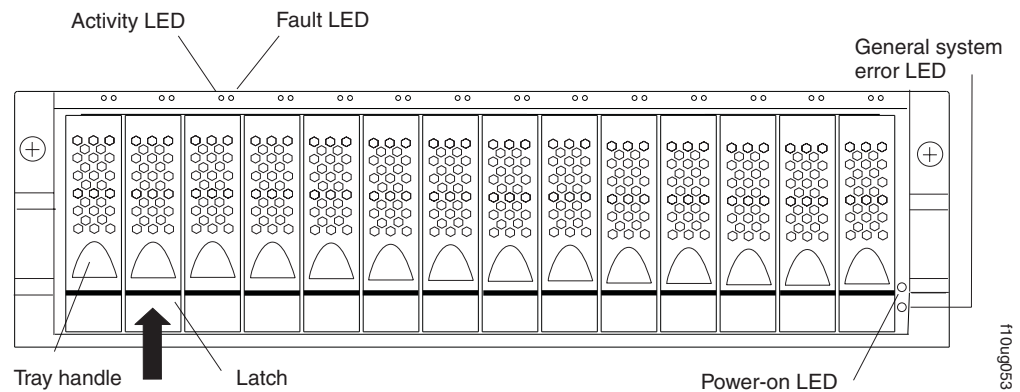


Figure 62. Hot-swap hard disk drive LEDs

3. Determine the bay into which you want to install the drive.
4. Remove the blank tray:

Note: To locate blank drives, look at the Activity LEDs on the front of the storage system. An active drive will have a green light on or flashing. A blank drive will not have any active lights.

- a. Release the latch on the drive CRU by pinching together the blue line on the tray latch and the finger hole on the tray handle, as shown by the arrow in Figure 62.
 - b. Pull the handle on the tray out so that it is in the open position to release the drive CRU, and then pull the blank tray out of the bay.
 - c. Save the blank tray for later use.
5. Install the hard disk drive:

Note: The hard disk drive comes installed in a drive tray. Do not attempt to detach the drive from the tray.

- a. Release the latch on the drive CRU by pinching together the blue line on the tray latch and the finger hole on the tray handle.

- b. Pull the handle on the tray out so that it is in the open position, as shown in Figure 63.

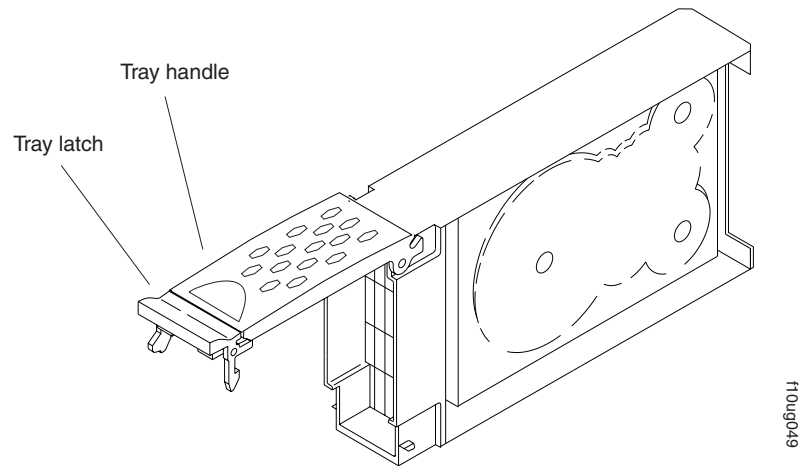


Figure 63. Drive CRU handle

- c. Slide the drive CRU into the empty bay until the hinge of the tray handle latches beneath the storage server bezel.
- d. Push the tray handle down until it latches into place.

Replacing hot-swap hard disk drives

Drive problems include any malfunctions that delay, interrupt, or prevent successful I/O activity between the hosts and the hard disk drives in the storage server. This includes transmission problems between the host controllers, the RAID controllers, and the drives. This section explains how to replace a failed hard disk drive.

Note: If you want to remove a hard disk drive that is not in a failed or bypass state, always use the DS4000 Storage Manager client program either to place the drive in a failed state or to place the array that is associated with the drive (or drives) in an offline state before you remove the drive from the enclosure.

Attention: Failure to replace the hard disk drives in their correct bays might result in loss of data. If you are replacing a hard disk drive that is part of a configured array and logical drive, ensure that you install the replacement hard disk drive in the correct bay. Check the hardware and software documentation that is provided with your DS4000 storage server to see if there are restrictions regarding hard disk drive configurations.

Complete the following steps to replace a hot-swap hard disk drive:

1. Determine the location of the drive that you want to remove.

Attention: Never hot-swap a drive CRU when its green Activity LED is flashing. Hot-swap a drive CRU only when its amber Fault LED is on and not flashing or when the drive is inactive with the green Activity LED on and not flashing.

If the drive is not in a failed state (as indicated by its lit amber LED), manually fail the drive using the Storage Management client before attempting to remove it from the drive slot.

2. Remove the drive CRU:

- a. Release the latch on the drive CRU by pinching together the blue line on the tray latch and the finger hole on the tray handle, as shown by the arrow in Figure 63 on page 82.
 - b. Pull the tray handle out into the open position.
 - c. Lift the drive CRU partially out of the bay.
 - d. To avoid possible damage to the drive, wait at least 70 seconds before fully removing the drive CRU from the storage server to allow the drive to stop (spin down).
 - e. Verify that there is proper identification (such as a label) on the drive CRU, and then slide it completely out of the storage server.
3. Install the new drive CRU:
 - a. Gently push the drive CRU into the empty bay until the hinge of the tray handle latches beneath the storage server bezel.
 - b. Push the tray handle down into the closed (latched) position.
 4. Check the drive LEDs:
 - When a drive is ready for use, the green Activity LED is either on continuously or rapidly flashing, and the amber Fault LED is off.
 - If the amber Fault LED lights and is not flashing, remove the drive from the unit and wait 10 seconds; then, install the drive again.
 5. If the drive is part of a defined RAID array, the array reconstruction (without hot-spare) or copy-back (with hot-spare) operation automatically starts.
 6. Use the DS4000 Storage Manager software GUI to verify that the drive is shown in the Storage Subsystem Management window.

Upgrading drives

You can upgrade drives in the following two ways:

- By adding drives to empty slots in the storage server (see “Installing hot-swap hard disk drives” on page 80)
- By replacing existing drives with larger capacity drives

Adding larger-capacity drives

This section provides guidelines for upgrading the drives in the storage server. Read the software documentation and this entire section to determine if you should use this procedure, use a modified version of this procedure, or use a different procedure that is provided by your operating system. *Instructions that are provided with your software should supersede anything stated in this document.*

Attention: After you remove a drive CRU, wait at least 70 seconds before replacing or reseating the drive CRU to allow the drive to properly spin down. Failure to do so may cause undesired events.

There are two methods for upgrading drives:

- **Replacing all the drives at the same time**

This method requires that you back up the data on the affected drives and then turn off the storage server. After replacing all the drives, you must reconfigure the new drives and restore data from backup. See the procedure in “Replacing all drives at the same time” on page 84.

This is the safest way to exchange drives without losing data. However, this method might take a long time to complete because of the backup, reconfiguration, and restoration processes. In addition, other users are not able

to use the storage server (or any expansion units attached to the storage server) until you finish the procedure. You must use this method on RAID 0 logical drives.

- **Replacing the drives one at a time**

In this method, you manually fail each drive, replace it, and wait for the system to restore data to the new drive before installing the next drive. After you install the new drives, you can configure them to make the additional drive space available. See the procedure in “Replacing the drives one at a time” on page 86.

Using this method, you can replace the drives while the storage server is running, eliminating the down time that is required if you replace all the drives at once. However, this method is more risky because you can lose data if the drive restoration or storage subsystem reconfiguration process fails. In addition, the reconstruction process might take a long time. This method works only on redundant logical drives (RAID 1, 3, or 5). You cannot use this method with any drives containing RAID 0 logical drives.

Consider backing up your data if you use this method. This safeguards your data if the restoration and reconfiguration process fails or the new drive malfunctions.

The method you use depends on the following considerations:

- Which method most closely matches the recommended drive upgrade procedure that is provided in the operating system or the DS4000 Storage Manager client documentation
- Which RAID level is used on the affected drives (RAID 0 requires you to replace all the drives at the same time)
- How much downtime is acceptable as you swap the drives
- How acceptable is the risk of the entire array failing because another drive that is part of the array has failed during the reconstruction process
- The number of drives in an array. Replacing drives one at a time is better suited for arrays consisting of 3 to 5 drives. If you have more than 10 drives, consider replacing all drives at the same time.

Replacing all drives at the same time

Use this procedure to replace all drives at the same time. You must use this method if you are upgrading drives containing RAID 0 logical drives. All the data currently on the drives is lost when you replace the drives; therefore, you must back up all data that is currently on the drives. This procedure also requires you to turn off the storage server, which makes the storage server (and any attached expansion units) inaccessible to other users.

To replace all the drives at the same time, perform the following steps:

1. Read the following information:

- The information in “Adding larger-capacity drives” on page 83, particularly the paragraphs that discuss the differences between the two possible upgrade procedures
- The information in your software documentation regarding drive upgrades and installation
- The documentation that comes with the new drives

Read all precautionary notes, kit instructions, and other information. Kit instructions often contain the most current information regarding the drives and their installation, plus upgrade or servicing procedures. Compare the kit instructions with this procedure to determine if you need to modify this procedure.

2. Use the DS4000 Storage Manager client to check the status of the storage server. Correct any problems that are reported.
3. Perform a complete backup of the drives that you are replacing.

You need the backup to restore data on the drives later in this procedure.

Attention: When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see “Handling static-sensitive devices” on page 79.

4. Unpack the new drives.

Set the drives on a dry, level surface away from magnetic fields. Save the packing material and documentation in case you need to return the drives.

5. Perform the following steps:

- a. Stop all I/O activity to the storage server and attached expansion units.

Make sure that:

- 1) All of the green Drive activity LEDs on the front of the storage server (and on all attached expansion units) are not flashing.
- 2) The green Cache active LEDs are off on the front of the RAID controllers.

- b. If applicable, use the operating system software to disconnect the storage server logical drives from the host before you power off the storage server.

Attention: To turn off all power to the storage server, you must turn off both power-supply switches and disconnect both power cords. Use the procedure in step 6 for the proper shutdown sequence.

6. Turn off the power to each device based on the following shutdown sequence:

- a. Turn off power to the host before you turn off power to the storage server. If the host must stay powered on to support an existing network, see the operating system documentation for information about disconnecting the storage server logical drives from the host before the storage server is powered off.

- b. Turn off power to the storage server before you turn off power to the expansion units. Turn off both power supply switches on the back of the storage server.

- c. Turn off power to other supporting devices (for example, management stations, fibre-channel switches, or Ethernet switches).

Notes:

- 1) You do not need to perform this step if you are servicing only the storage server.

- 2) Depending on your operating system, you might not have to restart the host. For more information, see the software installation guide for your operating system.

7. Use the procedures in 5 on page 24 to remove the drives that you want to replace. Use the procedures in “Installing hot-swap hard disk drives” on page 80 to install the new drives into the storage server.

8. After you install all the new drives, check the system documentation for the hardware devices that you intend to power up, and then determine the proper startup sequence. Use the following power-on sequence, where applicable:

- a. Turn on the power to the supporting devices (for example, Ethernet switches and management stations) before you turn off power to the storage server.

- b. You must turn on the expansion units before the storage server. The controllers might not recognize the correct configuration if the drives are powered up after the storage server. For instructions on powering up the expansion units, see the expansion-unit documentation.
 - c. Turn on the power to the storage server; then restart or turn on the power to the host.
9. Turn on the power to each device, based on the power-on sequence in step 8 on page 85. To turn on power to the storage server, turn on the power-supply switches on the back of the storage server. You must turn on both power-supply switches to take advantage of the redundant power supplies.
10. Check the green Drive activity LED and the amber Drive fault LED below the new drive CRUs.

Make sure that the Drive activity LEDs are on and the Drive fault LEDs are off.

Note: The Drive fault LEDs might flash intermittently while the drives spin up.

- If the Drive activity LED is off, the drive CRU might not be installed correctly. Remove the drive CRU, wait 30 seconds, and then reinstall it.
 - If the Drive fault LED stays on or the Drive activity LED stays off, the new drive might be faulty. See the DS4000 Storage Manager client online Help for problem determination.
11. Use the DS4000 Storage Manager client to configure the new drives. See the DS4000 Storage Manager client online Help for detailed instructions.
 12. Restore the data from backup to all the drives.

Replacing the drives one at a time

Use this procedure to replace all the drives one at a time. You cannot use this procedure on RAID 0 logical drives (use the procedure in “Replacing all drives at the same time” on page 84).

Note: If your storage subsystem has hot spares assigned, you might want to unassign the hot spares while you perform this procedure. If you do not, reconstruction might start on the hot spare before you insert the new drive. The data on the new drive is still rebuilt, but the process takes longer for each drive. Remember to reassign the hot spares when you are finished with this procedure.

To replace the drives one at a time, perform the following steps:

1. Read the following information:
 - “Adding larger-capacity drives” on page 83, particularly the paragraphs that discuss the differences between the two possible upgrade procedures
 - Your software documentation regarding drive upgrades and installation
 - The documentation that comes with the new drivesRead all precautionary notes, kit instructions, and other information. Kit instructions often contain the most current information regarding the drives and their installation, plus upgrade or servicing procedures. Compare the kit instructions with this procedure to determine if you need to modify this procedure.
2. Use the DS4000 Storage Manager client to check the status of the unit. Correct any problems that are reported.
3. Back up the data on the drives that you are replacing.

Attention: When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see “Handling static-sensitive devices” on page 79.

4. Unpack the new drives.

Set the drives on a dry, level surface away from magnetic fields. Save the packing material and documentation in case you need to return the drives.

5. Use the storage management software to ensure that the array that was defined using these drives is in optimal (not degraded) state before manually failing the first drive you want to replace. If the array is in degraded state, use the recovery procedures to bring the array into the optimal state.

Make sure that:

- You fail only one drive
- The software status display shows a failed status for the appropriate drive
- The amber Drive fault LED (on the front bezel below the drive) is on

Attention: Removing the wrong drive can cause data loss. Make sure that you remove only the failed drive CRU. The Drive fault LED below the failed drive CRU should be on.

If you remove an active drive accidentally, wait at least 70 seconds for the drive to properly spin down and then reinstall it.

Because you failed two drives in a RAID array, the array might be marked failed by the controller. This array will not be available to the host for I/O. See the DS4000 Storage Manager client for further recovery instructions. Do not attempt to replace any drives until the array is brought back to optimal state. Call IBM support for help if you are unable to get the array back online.

6. Use the procedures in 5 on page 24 to remove the failed drive. Use the procedures in “Installing hot-swap hard disk drives” on page 80 to install the new drives into the storage server.

The new drive automatically reconstructs the data after you install it in the drive slot.

During data reconstruction, the amber Drive fault LED might come on for a few minutes, then turn off when the green Drive activity LED begins flashing. A flashing Drive activity LED indicates that data reconstruction is in progress.

Note: If your storage subsystem has active hot spares, data might not start copying to the new drive until the data is reconstructed on the hot spare. This increases the time that is required to complete the procedure.

7. Check the green Drive activity LED and the amber Drive fault LED below the new drive CRUs.

Make sure that the Drive activity LEDs are on and the Drive fault LEDs are off.

Note: The Drive fault LEDs might flash intermittently while the drives spin up.

- If the Drive activity LED is off, the drive CRU might not be installed correctly. Remove the drive CRU, wait at least 70 seconds for the drive to properly spin down, and then reinstall it.
- If the Drive fault LED stays on or the Drive activity LED stays off, the new drive might be faulty. See the DS4000 Storage Manager client for problem determination.

8. Use the DS4000 Storage Manager client to monitor the status of the new drive and the progress of the data reconstruction. Wait for data reconstruction to finish (the Drive activity LED stops flashing).

Note: The Drive activity LED will continue to flash after reconstruction is finished if there is I/O activity to that drive. In that case, use the host software to determine if the data reconstruction is finished.

9. When reconstruction is finished on the new drive, repeat step 5 on page 87 through step 8 for each additional drive that you want to install.
10. Use the DS4000 Storage Manager client to configure the additional space on the new drives.

Working with hot-swap cooling fans

The storage server cooling system consists of two fan CRUs, each containing two fans. The fan CRUs circulate air inside the unit by pulling in air through the vents on the front of the drive CRUs and pushing out air through the vents in the back of each fan CRU. See Figure 64.

If two fans fail, or the fans cannot maintain an internal temperature below 70° C (158° F), the power supplies in the unit will automatically shut down (an over-temperature condition). If this occurs, you must cool the unit and restart it. See “Restoring power after an over-temperature shutdown” on page 69.

Attention: The fans in the storage server draw in fresh air and force out hot air. These fans are hot-swappable and redundant; however, when one fan fails, you must replace the fan CRU within 48 hours to maintain redundancy and optimum cooling. When you replace the failed fan CRU, be sure to install the second fan CRU within 10 minutes to prevent any overheating due to the lack of the additional fan CRU.

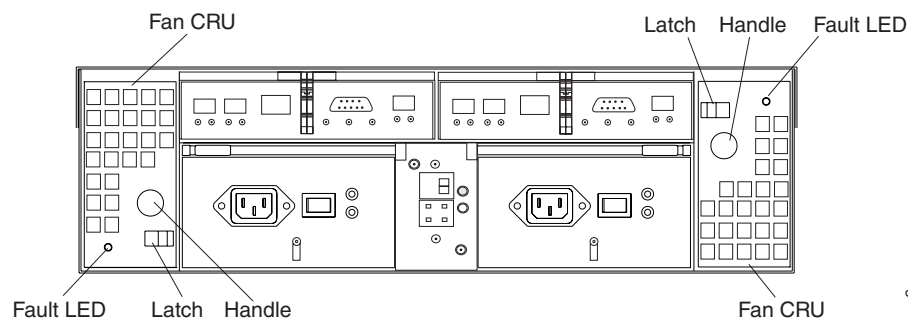


Figure 64. Fan locations

Fan CRUs

The two fan CRUs are hot-swappable and redundant.

Fault LEDs

These amber LEDs light when a fan failure occurs.

Latches and handles

Use the latches and handles to remove or install the fan CRUs.

Attention: Do not run the storage server without adequate ventilation and cooling, because it might cause damage to the internal components and circuitry.

Both fan units must always be in place, even if one is not functioning properly, to maintain proper cooling.

Use the following procedure to replace a hot-swap fan:

1. Check the LEDs on the back of the storage server.
2. If the amber Fault LED is on, remove the fan CRU that has failed.
 - a. Slide the latch to unlock the fan CRU.
 - b. Use the handle (black knob) to pull the fan from the storage server. See Figure 65.

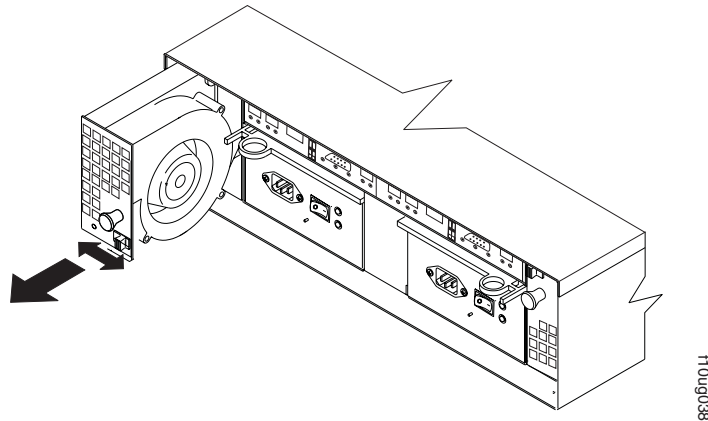


Figure 65. Removing a fan

3. Install the new fan unit.
 - a. Place the fan CRU in front of the fan slot.
 - b. Hold the latch open, and slide the fan all the way into the slot. If the fan does not go into the bay, rotate it 180°. Ensure that the latch is on the side closest to the center of the storage server.
 - c. Release the latch. If the lever remains open, pull back on the fan slightly, and then push it in again until the latch snaps into place.
4. Check the LEDs.

The Fault LEDs turn off after a few seconds. If they remain on, see Chapter 6, “Hardware maintenance,” on page 111.

Working with power supplies

The power supply CRUs provide power to the internal components by converting incoming ac voltage to dc voltage. The DS4100 base storage server power system operates with two power supply CRUs that can be hot-swapped. In the DS4100 base storage server, one power supply CRU can maintain electrical power to the unit if the other power supply is turned off or malfunctions. The power supply CRUs are interchangeable (by reversing the locking levers).

The DS4100 single-controller storage server has only one power supply CRU. You cannot remove or replace a working (non-failed) power supply in the DS4100 single-controller storage server without first powering down the storage subsystem. Before you replace the power supply in the DS4100 single-controller storage server, all I/O activity must be stopped and the storage server must be powered down. Go

to “Turning off the storage server” on page 67 and follow the procedure described there before replacing the power supply on a DS4100 single-controller storage server.

Each power supply CRU has a built-in sensor that detects the following conditions:

- Over-voltage
- Over-current
- Overheated power supply

If any of these conditions occurs, one or both power supplies will shut down. All power remains off until you cycle the power switches (turn the power switches off, wait at least 30 seconds, then turn the power switches on). For more information, see “Restoring power after an unexpected shutdown” on page 68 and “Restoring power after an over-temperature shutdown” on page 69.

The power supplies are customer replaceable units (CRUs) and do not require preventive maintenance.

- Always keep the power supplies in their proper places to maintain proper controller-unit cooling.
- Use only the supported power supplies for your specific storage server.

The power-supply controls on the rear of the storage server are shown in Figure 66.

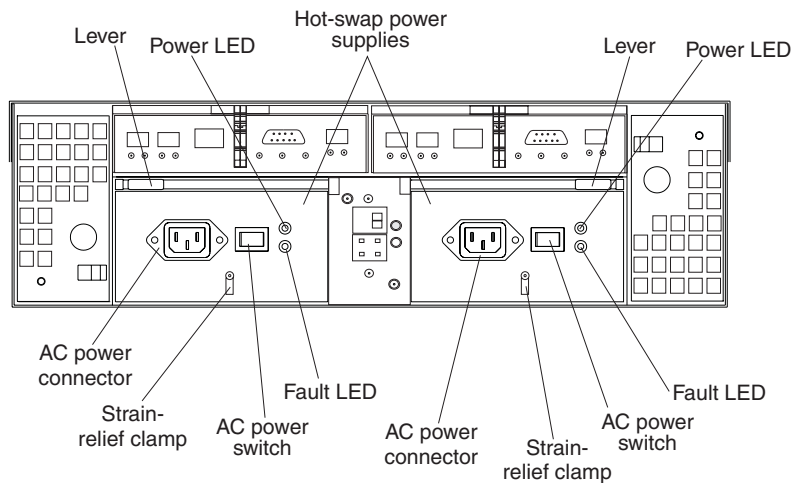


Figure 66. Power supply controls

Levers

Use these locking handles to remove or install a power supply.

Power LED

These green LEDs light when the storage server is turned on and receiving ac power.

Fault LEDs

These amber LEDs light if a power supply failure occurs or if the power supply is turned off.

AC power switches

Use these switches to turn the power supplies on and off. You must turn on both switches to take advantage of the redundant power supplies.

AC power connectors

This connection is for the ac power cord.

Strain-relief clamp

Use this clamp to provide strain relief on the power cord. Secure the clamp tightly with the power-supply clamp-nut.

Removing a power supply

Statement 8:



CAUTION:

Never remove the cover on a power supply or any part that has the following label attached.



Hazardous voltage, current, and energy levels are present inside any component that has this label attached. There are no serviceable parts inside these components. If you suspect a problem with one of these parts, contact a service technician.

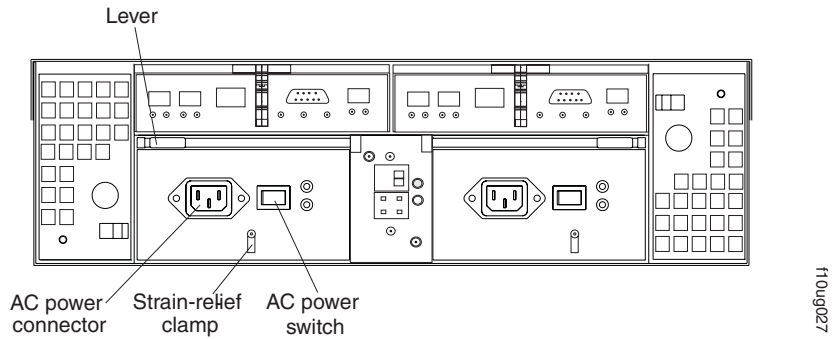
To remove a hot-swap power supply, perform the following steps:

1. **DS4100 single-controller storage server only:**

If you are replacing a working (non-failed) power supply on a DS4100 single-controller storage server, you must stop all I/O activity and turn off power to the storage server before replacing the power supply. Go to “Turning off the storage server” on page 67 and follow the procedure described there before proceeding with the following steps.

If you are replacing a failed power supply on a DS4100 single-controller storage server, you do not need to power down the storage server before replacing the failed power supply.

2. Turn off the ac power switch. See Figure 67 on page 92.



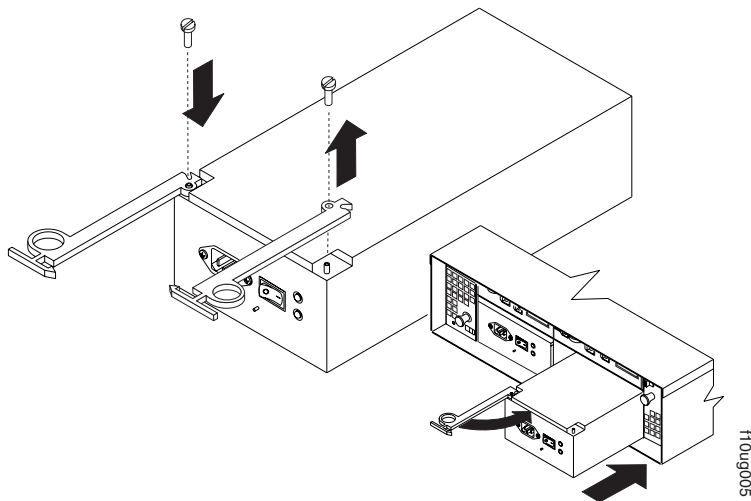
110ug027

Figure 67. Lever for power supply removal

3. Unplug the power cord from the electrical outlet.
4. Disconnect the power cord from the ac power connector on the power supply.
5. Remove the power-supply nut and power-supply cable strain-relief clamp from the rear of the power supply.
6. Remove the power supply from the storage server, as follows:
 - a. Grasp the pull-ring on the power-supply lever and squeeze the latch to release it.
 - b. Pull the lever open and remove the power supply.

Installing a power supply

Note: When you replace a power supply that has failed, ensure that the power supply latch is mounted on the side of the power supply that faces the middle of the storage server. If it is not, remove the lever screw, flip the lever over, and tighten the screw on the opposite side.



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Figure 68. Installing a hot-swap power supply

To install a hot-swap power supply, perform the following steps:

Statement 8:



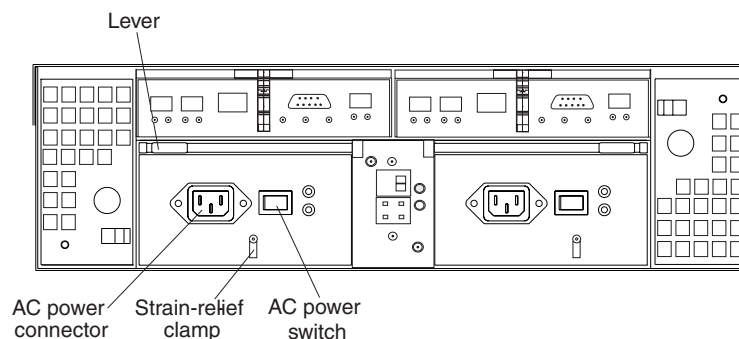
CAUTION:

Never remove the cover on a power supply or any part that has the following label attached.



Hazardous voltage, current, and energy levels are present inside any component that has this label attached. There are no serviceable parts inside these components. If you suspect a problem with one of these parts, contact a service technician.

1. Ensure that the ac power switch is off on the power supply that you are installing.
2. Install the power supply in the storage server, as follows:
 - a. Slide the power supply into the storage server. Make sure that the lever is pulled straight out as you slide the power supply into the storage server.
 - b. Close the lever until the pull-ring latch locks in place. Make sure that the lever locks into place in the storage-server chassis.
3. Wrap the strain-relief clamp around the power cord approximately 20 cm (8 in.) from the power-supply connection end. Leave some slack between the clamp and the power-supply end of the power cord.
4. Replace the power-supply nut and tighten it securely to secure the clamp to the power supply unit.
5. Connect the power cord to the AC power connector. See Figure 69.



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Figure 69. Connecting the power cord to the AC power connector

6. Plug the power cord into a properly grounded electrical outlet.
7. Turn on the power-supply switch.
8. **DS4100 single-controller storage server only:** If you have replaced a working (non-failed) power supply on a DS4100 single-controller storage server, turn on

power to the storage server. Go to “Turning on the storage server” on page 66 and follow the procedure described there before proceeding with the following step.

9. Make sure that the green Power LED on the new power-supply CRU is on and the amber Fault LED is off.
 - If the Power LED is off, the power-supply CRU might not be installed correctly. Remove it and then reinstall it.
 - If the Fault LED is on or the Power LED stays off, test the power source to verify that the outlet is working properly.

For more information about the LEDs, see “Checking the LEDs” on page 71.

Working with RAID controllers

The DS4100 base storage server operates with two RAID controllers that can be hot-swapped.

The DS4100 single-controller storage server has only one RAID controller. If you are replacing a failed RAID controller in the DS4100 single-controller storage server, you do not need to power down the DS4100 before replacing the RAID controller.

If you are replacing a functioning (non-failed) RAID controller in the DS4100 single-controller storage server, do not remove or replace the RAID controller in the DS4100 single-controller storage server without first stopping the host applications, unmounting the logical drives from the host server, and powering down the storage subsystem.

Attention: Before you replace a RAID controller, verify that the replacement RAID controller part number match the part number of the RAID controller be replaced.

Each RAID controller fits into the back of the storage server and has the following components:

- Battery
- Cache memory
- Two host ports and one expansion port

Note: The expansion port is inactive in the DS4100 single-controller storage server.

- One Ethernet port
- One serial port

Each RAID controller has a unique hardware Ethernet address, which is printed on a label on the front. There is also a label giving the cache battery manufacturing and installation dates on the top of the controller unit. Figure 70 on page 95 shows the location of these items.

Important: Please read the following information before replacing a RAID controller.

- *The cache battery is not included with the controller CRU.*
- To provide full functionality in a DS4100 base storage server, the two controllers must have the same memory capacity. To ensure that you replace the failed controller with an appropriate replacement controller, verify that the FRU number of the replacement controller matches the FRU number of the failed controller. There are no protection mechanisms to block out an incorrect CRU from being

inserted into DS4100 controller slots. Unpredictable results can occur when nonmatching controller CRUs are present in the same DS4100 chassis.

- After the new controller in a DS4100 single-controller storage server completes the boot process, its WWNN will change. If you have any applications that rely on the previous WWNNs, such as fibre channel switch zoning definitions, you must update the applications with the new WWNNs.
- All factory-delivered DS4100 RAID controllers are shipped with a recent version of controller firmware loaded on the RAID controller, but that firmware version might not match precisely the firmware version of the failed RAID controller you have replaced. When you replace one of the RAID controllers in the DS4100 base storage server, the newly replaced controller will automatically be updated with the controller firmware version of the existing controller in the DS4100 chassis.

However, when you replace the RAID controller in the DS4100 single-controller storage server, if the firmware version of the replacement RAID controller is determined to be incompatible with the configuration database during the boot process, the DS4100 single-controller storage server will enter a Stop State and will not allow any DS4000 Storage Manager operations to be performed. In this case, you must manually upgrade or downgrade the replacement RAID controller firmware to match the version required by the configuration database. See “Manually upgrading the firmware for the DS4100 single-controller storage server” on page 103.

- **DS4100 single-controller storage server only:** Do not use the RAID controller replacement procedure in this section to upgrade a DS4100 single-controller storage server to a DS4100 base storage server. Currently there is no support for upgrading a DS4100 single-controller storage server. When such support is available in the future, the DS4100 single-controller storage server upgrade kit and the revised edition of this document will provide the upgrade instructions.

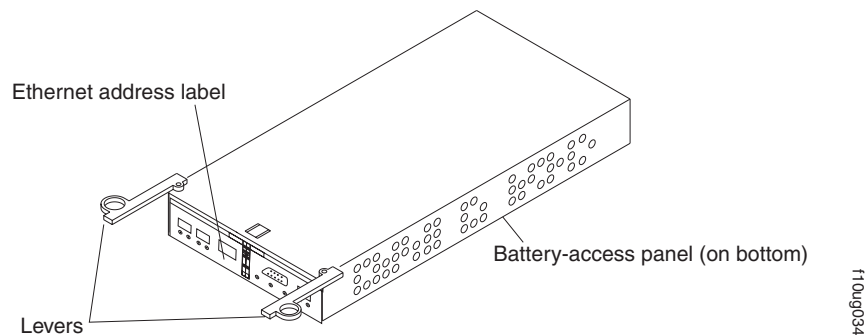


Figure 70. RAID controller levers and labels

In a DS4100 base storage server, you can hot swap one controller while the other is still active. The figures in this procedure show the base storage server. If your storage server is the single-controller storage server, controller slot B will have a blank controller rather than the second controller as shown in these figures.

For information about the RAID controller cache memory and rechargeable battery, see “Cache memory and RAID controller battery” on page 75.

Replacing a RAID controller

When instructed to do so by the DS4000 Storage Manager client, replace a RAID controller that has failed.

The procedure for replacing a failed controller is different for DS4100 single-controller and base (dual-controller) storage servers. If a controller in a DS4100 base storage server fails, you can replace the failed controller without interrupting data processing. The system will automatically update the firmware for the new controller to match the configuration database.

If the controller in a DS4100 single-controller storage server fails, you may need to manually update the firmware level to match the configuration database. If the firmware level of the new controller matches the configuration database, the storage server will boot normally after you install the new controller. If the firmware level does not match the database, the storage server will reach a stop state in the boot process, and you will need to manually update the firmware level to match the configuration database.

Attention: Because the replacement RAID controller has a different WWNN that the original RAID controller, you must perform the following tasks in order to bring the DS4100 single-controller storage server to running (optimal) state after you replace the RAID controller.

- Reboot the host server that has mapped logical drives from the DS4100 single-controller storage server.

Rebooting the host server enables the multipath failover to recognize the logical drives under the new WWNN. In addition, if your multipath driver uses the WWNN of the controller as part of the LUN identification, you may have to reconfigure the LUN failover/failback path information.

- Use DS4000 Storage Manager to rediscover the new RAID controller.

To rediscover the new RAID controller, remove the existing DS4100 single-controller storage server entry in the management domain of the DS4000 Storage Manager client Enterprise Management Window (EMW), and then add the DS4100 single-controller storage server back into the management domain using the in-band or out-of-band management method. See step 6 on page 104.

- Re-enable the premium feature keys.

After you replace the RAID controller in a DS4100 single-controller storage server, all of the enabled premium feature keys are displayed as being out-of-compliance. Use the existing key files to re-enable the premium feature keys.

- If you create zones using the RAID controller WWNN, update your zoning definitions with the new WWNN for the replacement RAID controller.

Important

The replacement RAID controller CRU does not come with a RAID controller cache battery installed, nor does it come with the mounting hardware that holds the battery in place inside the RAID controller. You must remove the cache battery that is inside the existing RAID controller that you are replacing, and install that battery inside the replacement RAID controller CRU, using the battery unit mounting hardware taken from the existing controller. The steps to remove and replace the battery are included in the following procedure.

Note: Avoid operating the DS4100 with controllers of different cache sizes. Operating the storage server with controllers of different cache size will disable caching and might adversely affect performance. Always verify that you replace a failed controller with a controller that has the same FRU part number.

To replace a RAID controller, perform the following steps:

1. **DS4100 single-controller storage server only:**

The DS4100 single-controller storage server has only one RAID controller. If you are replacing a failed RAID controller in the DS4100 single-controller storage server, you do not need to power down the DS4100 before replacing the RAID controller.

If you are replacing a functioning (non-failed) RAID controller in the DS4100 single-controller storage server, do not remove or replace the RAID controller in the DS4100 single-controller storage server without first stopping the host applications, unmounting the logical drives from the host server, and powering down the storage subsystem.

2. Check the DS4000 Storage Manager client for instructions on RAID controller failure-recovery procedures. Follow the steps provided in the software documentation before continuing with the following step.
3. Label each cable that connects to the RAID controller that has failed. This ensures that all cables will be properly reconnected to the new RAID controller.

Attention: Handle and install fiber-optic cables properly to avoid degraded performance or loss of communications with devices. When working with fiber-optic cables, do not pinch them, step on them, or locate them in aisles or walkways. Do not overtighten the cable straps or bend the cables to a radius smaller than 38 mm (1.5 in.).

4. From the RAID controller that has failed, remove the fibre-channel cables from the SFPs. The location of these components is shown in Figure 71.

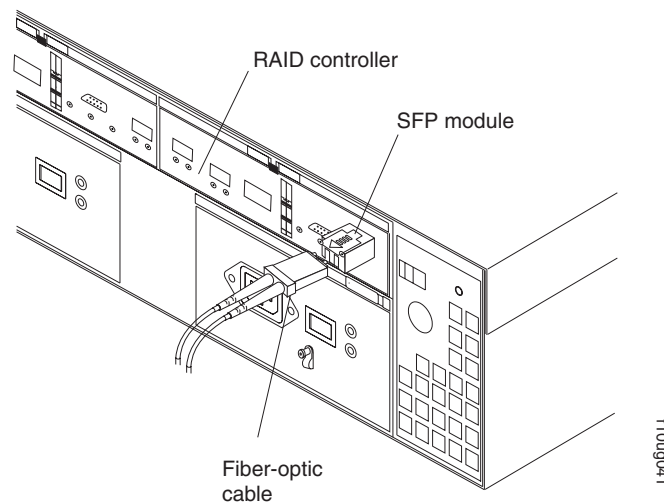


Figure 71. Location of SFPs and fiber-optic cables

After removing the fibre-channel cables, insert the protective caps.

5. Use the following procedure to remove the SFPs from the RAID controller that has failed.
 - a. Remove the LC-LC fibre-channel cable from the SFP module. For more information, see “Handling fiber-optic cables” on page 45.

b. Unlock the SFP module latch:

- For SFP modules that contain plastic tabs, unlock the SFP module latch by pulling the plastic tab outward 10°, as shown in Figure 72.

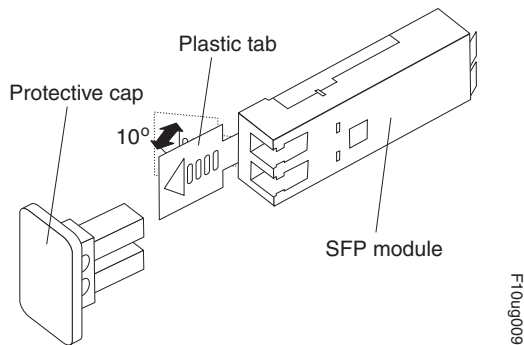


Figure 72. Unlocking the SFP module latch - plastic variety

- For SFP modules that contain wire tabs, unlock the SFP module latch by pulling the wire latch outward 90°, as shown in Figure 73.

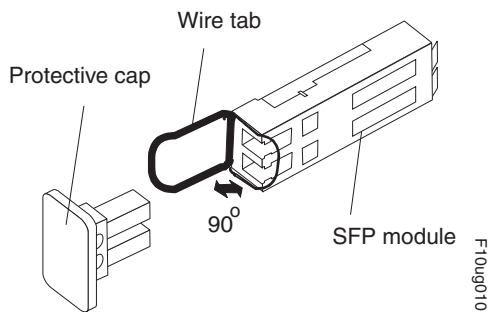
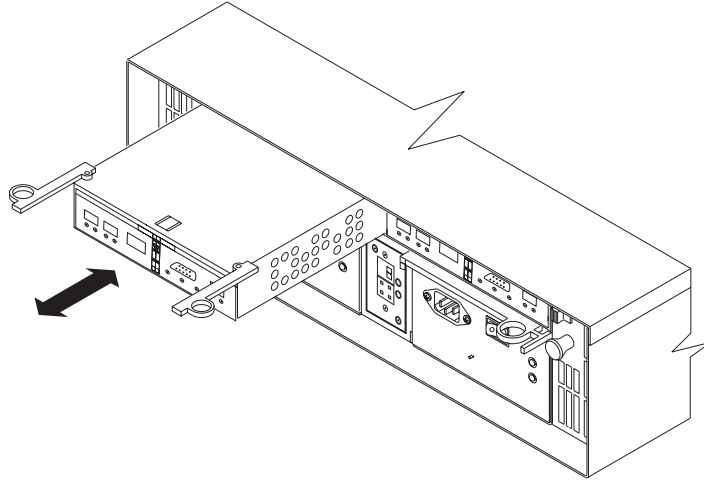


Figure 73. Unlocking the SFP module latch - wire variety

- c. With the SFP latch in the unlocked position, extract the SFP module.
 - For SFP modules that contain plastic tabs, slide the SFP module out of the port.
 - For SFP modules that contain wire tabs, grasp the wire latch and pull the SFP module out of the minihub port.
 - d. Replace the protective cap on the SFP module.
 - e. Place the SFP module into a static-protective package.
 - f. Replace the protective cap on the port.
6. Remove the failed RAID controller (the Fault LED is on), as follows:
- a. Push down on the latch (centered above the RAID controller). Pull both levers at the same time out of the locked position.

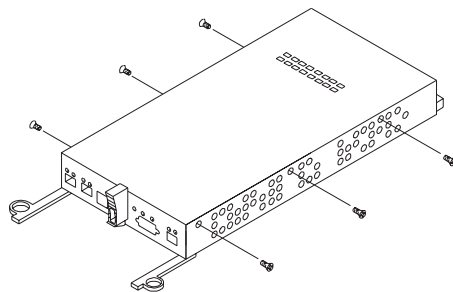


110ug033

Figure 74. Pull-rings for removing a controller

- b. Grasp the pull-rings; then pull on the levers and remove the RAID controller.
7. To access the cache battery, place the RAID controller CRU bottom up on a flat surface. Using a #2 Phillips head screwdriver, remove the six screws (three on each side of the RAID controller) that hold the RAID controller bottom panel to the sides of the RAID controller, as shown in Figure 75.

Attention: Before you move the cache battery from your old controller to your replacement controller, read the detailed instructions in this procedure.



110ug035

Figure 75. Controller battery-access panel screws

8. Slide the RAID controller bottom panel away from the front side of the RAID controller (away from the SFP slots and black center latch) to unlatch it from the side panels.
9. Carefully flip over the RAID controller bottom panel. Disconnect the battery harness on the battery from the two-pin connector on the controller board, as shown in Figure 76 on page 100.

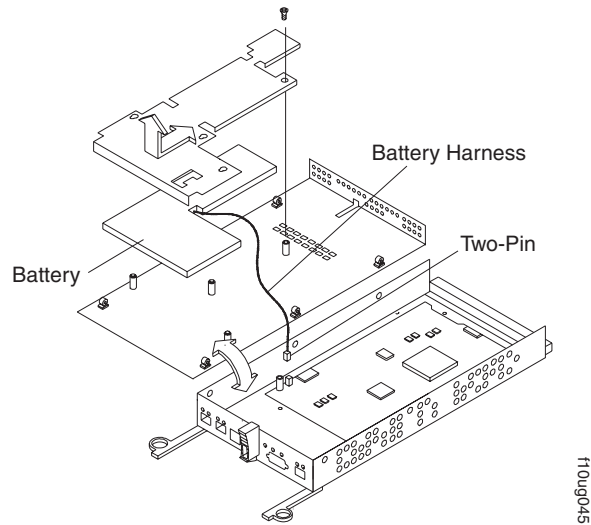


Figure 76. Removing the controller battery

10. Remove the screw that holds the battery access panel. Carefully slide the access panel toward the front to unlatch it from the three pins mounted on the RAID controller bottom panel.
11. Remove the battery unit and place it on a dry, level surface. If this is a battery replacement, then replace the old battery with the new one and go to step 19 on page 101.
12. Unpack the new RAID controller.
Set the RAID controller on a dry, level surface away from magnetic fields.
Save the packing material and documentation in case you need to return the RAID controller.
13. Place the replacement RAID controller CRU bottom up on a flat surface. Using a #2 Phillips head screwdriver, remove the six screws (three on each side of the RAID controller) that hold the RAID controller bottom panel to the sides of the RAID controller, as shown in Figure 75 on page 99.
14. Slide the RAID controller bottom panel away from the front side of the RAID controller (away from the SFP slots and black center latch) to unlatch it from the side panels.
15. Carefully flip over the RAID controller bottom panel.
16. Remove the screw that holds the battery access panel. Carefully slide the access panel toward the front to unlatch it from the three pins mounted on the RAID controller bottom panel.
17. If DHCP/BOOTP was used to automatically set the IP address of the controller, record the MAC address of the upgrade controller and modify the existing DHCP/BOOTP record of the RAID controller to be upgraded with the new MAC address. Failure to modify the DHCP/BOOTP record will result in problems trying to manage the storage server using the existing IP address. This step must be performed before you insert the upgrade controller into the DS4000 storage server.
18. Write the battery replacement information on the label on the battery pack.
 - Installed date – Write today's date

- Replacement Date – Copy the expiration date from the battery label on the old controller.

Note: The preferred method of checking for the battery operating age is through the storage server management software.

19. Position the battery inside the replacement RAID controller.
20. Reassemble the battery access panel to the RAID controller bottom panel by aligning it with the three pins on the RAID controller bottom panel. Slide the battery access panel toward the back until you can reinsert the screw that holds the battery access panel to the RAID controller bottom panel. Do not overtighten.
21. You must reconnect the battery harness to the two-pin connector on the controller board.

Note: The connector is keyed so that there is only one way to attach the harness to the connector. Do not force fit.

22. Flip the RAID controller bottom panel over and carefully place it on the controller sides. Push the RAID controller bottom panel toward the front to latch it to the side panels. If the controller bottom panel is placed correctly, you should be able to access the mounting holes for the six screws that you removed from step 7 on page 99. Reinsert the six screws. Do not overtighten.
23. Install the new RAID controller, as follows:
 - a. Slide the RAID controller all the way into the empty slot.
 - b. Close both levers until the latch locks into place. Power on the storage server, if the storage server is not powered on already.
24. Insert the SFPs according to the instructions in “Installing SFP modules” on page 46.
25. Connect the fibre-channel cables to their original locations, according to the instructions in “Installing fiber-optic cables” on page 48. Connect any secondary cables (such as Ethernet cables) in their original locations.
26. Wait approximately one minute, and then check the green Host Loop LED, green Expansion Loop LED, and amber Fault LED on the new RAID controller.
 - If the Host Loop LED or the Expansion Loop LED is off, the RAID controller might not be inserted correctly. Remove the CRU and reinsert it.
 - If the Fault LED is on, the Host Loop LED and the Expansion Loop LED stay off, or any other Fault LED is on, see the DS4000 Storage Manager client for problem determination.
27. Follow the appropriate procedure for the your DS4100 storage server model:
 - **For the DS4100 base storage server:** When you replace the failed RAID controller, the DS4000 Storage Manager client automatically updates the firmware for the new controller to match the configuration database. After you replace a controller, always use the DS4000 Storage Manager client to verify the firmware levels and NVSRAM files.
Continue with step 28 on page 103.
 - **For the DS4100 single-controller storage server:**
 - **If the firmware version of the replacement DS4100 RAID controller matches the firmware version of the replaced DS4100 RAID controller:**

The startup process should complete within five minutes. After the startup process completes, the new RAID controller can accept I/Os from the host server and is ready to be managed by the DS4000 Storage Manager client.

Note: If the new RAID controller is not recognized by the DS4000 Storage Manager client, use the Enterprise Management Window to rediscover the DS4100, as described in the following steps.

- a. Remove the entry for the DS4100 from the management domain of the DS4000 Storage Manager client.
- b. Wait at least five minutes.
- c. Add the entry for the DS4100 back to the management domain of the DS4000 Storage Manager client.

Before you continue with the next step, use DS4000 Storage Manager to verify the firmware levels. If your firmware levels need to be updated, reload the DS4100 storage server with the latest version of the controller firmware and the single-controller option NVSRAM files.

Note: Reloading the NVSRAM files will clear any modifications you made to the NVSRAM default settings. If required, modify your NVSRAM settings as needed after reloading the NVSRAM.

Continue with step 29 on page 103.

– **If the firmware version of the replacement DS4100 RAID controller does not appear to match the firmware version of the replaced DS4100 RAID controller:**

The startup process will not complete and the RAID controller enters a Suspend State. If you cannot make management connections to the DS4100 controller and you cannot send I/Os to the RAID controller within ten minutes after powering on the DS4100, then you must determine whether the problem is a result of a mismatch between the new RAID controller firmware and the firmware used by the configuration database.

To verify that the DS4100 controller firmware is mismatched, restart the storage server and monitor the drive LEDs. (Always wait at least 30 seconds between the time you turn off a power switch and the time you turn on the power again.) Wait three minutes after powering on the unit and then monitor the drive LEDs in the front of the unit for at least four minutes.

- If the drive LEDs flash one or more times, then the new DS4100 controller does not have the same firmware as the replaced DS4100 controller, but another problem exists. Verify your fibre channel and Ethernet connections, and then perform the actions recommended in step 29 on page 103. If the problem persists, call IBM support.
- If the drive LEDs stay solidly lit, the new DS4100 controller has different firmware than the replaced DS4100 controller. You must correct the controller firmware version mismatch.

Retrieve the replaced DS4100 controller firmware version from your storage subsystem profile and download the appropriate controller firmware files.

Note: If you cannot determine the controller firmware version of the replaced DS4100 RAID controller, call your IBM support representative.

Go to “Manually upgrading the firmware for the DS4100 single-controller storage server.”

28. **For the DS4100 base storage server:** See the DS4000 Storage Manager client online help for instructions on bringing the controller online. The RAID controller replacement procedure for the DS4100 base storage server is completed.

29. **For the DS4100 single-controller storage server:**

Because the replacement RAID controller has a different WWNN than the original RAID controller, you must perform the following tasks in order to bring the DS4100 single-controller storage server to running (optimal) state after you replace the RAID controller.

- Reboot the host server that has mapped logical drives from the DS4100 single-controller storage server.

Rebooting the host server enables the multipath fail-over to recognize the logical drives under the new WWNN. In addition, if your multipath driver uses the WWNN of the controller as part of the LUN identification, you may have to reconfigure the LUN fail-over/failback path information.

- Use DS4000 Storage Manager to rediscover the new RAID controller.

To rediscover the new RAID controller, remove the existing DS4100 single-controller storage server entry in the management domain of the DS4000 Storage Manager client Enterprise Management Window (EMW), and then add the DS4100 single-controller storage server back into the management domain using the in-band or out-of-band management method. See step 6 on page 104.

- Re-enable the premium feature keys.

After you replace the RAID controller in a DS4100 single-controller storage server, all of the enabled premium feature keys are displayed as being out-of-compliance. Use the existing key files to re-enable the premium feature keys.

- If you create zones using the WWNN, update your zoning definitions with the new WWNN for the replacement RAID controller.

If you are able to make a management connection with DS4000 Storage Manager to the replacement RAID controller, then the RAID controller replacement procedure for the DS4100 single-controller storage server is complete.

If none of these actions enables you to make a management connection with DS4000 Storage Manager to the replacement RAID controller, then call IBM support for help.

Manually upgrading the firmware for the DS4100 single-controller storage server

You will need the most recent printout of your storage subsystem profile to perform this procedure. If you do not have a printout available, contact IBM technical support to determine the controller firmware and NVSRAM version numbers recorded in your storage subsystem profile.

Attention: This procedure is not self-contained. Perform this procedure only if directed to do so in step 27 on page 101. At the end of this procedure, continue with step 29 in the RAID controller replacement procedure.

Be sure that the BOOTP server configuration includes the MAC address you recorded for the new controller. Refer to step 17 on page 100.

All factory-delivered DS4100 RAID controllers are shipped with a recent version of controller firmware loaded on the RAID controller, but that firmware version might not match precisely the firmware version of the failed RAID controller you have replaced. When you replace the RAID controller in the DS4100 single-controller storage server, if the firmware version of the replacement RAID controller is determined to be incompatible with the configuration database during the boot process, the DS4100 single-controller storage server will enter a Stop State and will not allow any DS4000 Storage Manager operations to be performed. In this case, you must manually upgrade or downgrade the replacement RAID controller firmware to match the version required by the configuration database. Refer to the storage subsystem profile that you created before replacing the RAID controller, which identifies the appropriate firmware revision.

1. Use the procedure described in “Turning off the storage server” on page 67 to power off the storage server.
2. Label each of the drives in the storage server according to its location in the storage server (1 - 14) so that you can reinstall them correctly.
3. Remove each drive from the storage server.
4. Use the procedure described in “Turning on the storage server” on page 66 to power on the storage server.
5. Use the DS4000 Storage Manager Enterprise Management Window (EMW) to remove the old RAID controller from the management domain.
6. If the configuration is to be performed by DS4000 Storage Manager via an Ethernet connection, the replacement controller needs to be assigned an accessible IP address. Factory-delivered replacement controllers will have a factory default IP address that might not be accessible in customer Ethernet environments.
 - If your IP addresses are set by DHCP, then modify the DHCP record for the replacement RAID controller with the new MAC address.
 - If you do not specify the IP address of the new controller using DHCP, and you did not manually set the old controller static IP address using Storage Manager, then you can use the default IP address 192.168.128.101.
 - If you did set the static IP address of the old controller, first try to make management contact using the existing static IP address. If the existing static IP address does not work, try the default IP address 192.168.128.101.

For details on how to obtain the IP address for the replacement RAID controller, refer to the *IBM TotalStorage DS4000 Storage Manager 9.10 Installation and Support Guide* for the appropriate operating system. Do *not* utilize the serial port for this purpose unless directed by your IBM support representative.

7. Use the EMW to add the new RAID controller to the management domain using the IP address assigned to the new controller. The RAID controller will appear in the EMW as Storage Array Unnamed and the storage space is not available (greyed out).
8. Use the DS4000 Storage Manager Subsystem Management Window (SMW) to change the NVSRAM of the new RAID controller to match the version number stored in your storage subsystem profile. (Refer to your printout.) After 15-20 minutes, the SMW reports a download failure. Click **OK** to ignore the error warning and instructions and proceed with the following step.
9. Use the EMW to remove the RAID controller from the management domain and again add the new controller using the IP address assigned to it by the IP server.

10. Use the SMW to download firmware to the new controller to match the version number shown in your storage subsystem profile. (Refer to your printout.) After 15-20 minutes, the SMW reports a download failure. Click **OK** to ignore the error warning and instructions and proceed with the following step.
11. Use the EMW to remove the RAID controller from the management domain, and again add the new controller using the IP address assigned to the new controller by the IP server.
12. View the storage subsystem profile and confirm that the NVSRAM and controller firmware versions match the versions shown in your storage subsystem profile printout.
13. Use the EMW to remove the RAID controller from the management domain.
14. Use the procedure described in “Turning off the storage server” on page 67 to power off the storage server.
15. Reinstall each drive in the slot from which it was removed.
16. Power on the storage server, using the procedure described in “Turning on the storage server” on page 66.
17. Use the EMW to add the RAID controller back into the management domain using the original IP address (refer to your printout).
18. Verify that the RAID controller is accessible.
19. Continue with 24 on page 101 in the RAID controller replacement procedure.

Replacing the battery in the RAID controller

Each RAID controller contains a rechargeable battery that maintains the data in the cache memory for three days without power to the unit.

Important: If you are replacing the battery in a DS4100 single-controller storage server, complete the following steps before beginning the replacement procedure:

1. Schedule down time for the battery replacement, because the disk will not be available during the procedure.
2. Complete any necessary server preparation tasks.
3. Save the configuration storage subsystem profile.

Note: Before any planned system shutdown or after any system additions, removals, or modifications (including logical drive creations, storage partitioning definitions, hardware changes, and so on), save the storage subsystem profile as explained in the DS4000 Storage Manager guide for your operating system. Save the profile in a location other than the logical drives created for the DS4100 storage server.

4. Stop I/O to the storage server.
5. Unmount any mapped LUNs from the storage server.
6. Power down the DS4100 single-controller storage server, as described in “Turning off the storage server” on page 67.

Use the following procedure if the DS4000 Storage Manager client instructs you to replace the battery because the current battery has failed or is nearing its expiration date. You can also use the DS4000 Storage Manager client to check the status of the battery.

1. Check the DS4000 Storage Manager client online help for instructions on battery replacement procedures. If you are using write-cache mirroring, this

might involve clearing cache memory on the RAID controller that contains the battery that needs to be replaced. This is done by either placing the controller offline before removing it from the DS4100 server or turning off caching in the DS4100 server, using the DS4000 Storage Manager client. Follow the steps given in the software procedure before you continue with this procedure.

Attention: When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see “Handling static-sensitive devices” on page 79.

2. Unpack the new battery.

Set the new battery on a dry, level surface. Save all packing materials in case you need to return the battery.

Note: The battery comes with a new battery label. You will need this label later in the procedure.

3. Review all documentation that comes with the new battery for updated replacement procedures and other information.

4. Use the DS4000 Storage Manager client to locate the RAID controller that contains the failed battery (the RAID controller Fault LED might be on).

Attention: On the DS4100 single-controller storage server, you cannot place the controller offline. Instead, you must power down the DS4100 storage server. For more information on preparation tasks, see the Important note in the beginning of this section.

5. Label each cable that connects to the RAID controller that contains the battery that has failed. This ensures that all cables will be properly reconnected to the RAID controller after you replace the battery.

6. Use the storage management software to take offline the RAID controller that contains the battery that has failed.

Attention: To prevent data loss, you must shutdown the system before you can replace the RAID controller battery. For the proper shutdown sequence, see “Turning off the storage server” on page 67.

7. Remove the fibre-channel cables and the SFPs from the RAID controller that contains the battery that has failed or is nearing its expiration date. For more information, see “Working with SFPs and fiber-optic cables” on page 45.

8. Remove the RAID controller as described in “Replacing a RAID controller” on page 96.

9. To remove the cache battery, place the RAID controller CRU bottom up on a flat surface. Using a #2 Phillips head screwdriver, remove the six screws (three on each side of the RAID controller) that hold the RAID controller bottom panel to the sides of the RAID controller, as shown in Figure 75 on page 99.

10. Slide the RAID controller bottom panel away from the front side of the RAID controller (away from the SFP slots and black center latch) to unlatch it from the side panels.

11. Carefully flip over the RAID controller bottom panel. Disconnect the battery harness on the battery from the two-pin connector on the controller board as shown in Figure 76 on page 100.

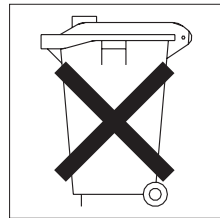
12. Remove the screw that holds the battery access panel. Carefully slide the access panel toward the front to unlatch it from the three pins mounted on the RAID controller bottom panel.

13. Remove the battery unit and place it on a dry, level surface. If this battery is a replacement battery, then replace the old battery with the new one.

14. Write the battery replacement information on the label on the battery pack.

- Installed date – Write today's date
- Replacement Date – Write the date three years from today's date

Note: The preferred method of checking for the battery operating age is through the storage server management software.



CONTAINS
SEALED LEAD
BATTERY.
BATTERY
MUST BE
RECYCLED.

Pb

CAUTION:

This product contains a sealed lead acid battery. The battery must be recycled or disposed of properly. In the United States, IBM has established a collection process for reuse, recycling, or proper disposal of used IBM sealed lead acid batteries. For information on proper disposal of these batteries, please contact IBM at 1-800-426-4333 your IBM representative. For information on disposal of sealed lead acid batteries outside the United States, go to <http://www.ibm.com/ibm/environment/products/batteryrecycle.shtml> or contact your local waste disposal facility. If the battery CRU is physically damaged or leaking electrolyte gel, *do not* ship it to a recycling center. The battery contains sealed lead-acid batteries that might be considered hazardous material. You must handle this unit in accordance with all applicable local and federal regulations.

15. Position the replacement battery inside the RAID controller.
16. Reassemble the battery access panel to the RAID controller bottom panel by aligning it with the three pins on the RAID controller bottom panel. Slide the battery access panel toward the back until you can reinsert the screw that holds the battery access panel to the RAID controller bottom panel. Do not overtighten
17. You must reconnect the battery harness to the two-pin connector on the controller board.

Note: The connector is keyed so that there is only one way to attach the harness to the connector. Do not force fit.

18. Flip the RAID controller bottom panel over and carefully place it on the controller sides. Push the RAID controller bottom panel toward the front to latch it to the side panels. If the controller bottom panel is placed correctly, you should be able to access the mounting holes for the six screws that you removed in step 7 on page 99. Reinsert the six screws. Do not overtighten.
19. Dispose of the used battery CRU according to local and federal regulations, which might include hazardous material handling procedures.

This product contains a sealed lead acid battery. The battery must be recycled or disposed of properly. In the United States, IBM has established a collection process for reuse, recycling, or proper disposal of used IBM sealed lead acid batteries. For information on proper disposal of these batteries, please contact IBM at 1-800-426-4333 your IBM representative. For information on disposal of

sealed lead acid batteries outside the United States, go to <http://www.ibm.com/ibm/environment/products/batteryrecycle.shtml> or contact your local waste disposal facility.

20. Install the RAID controller, as shown in Figure 77.

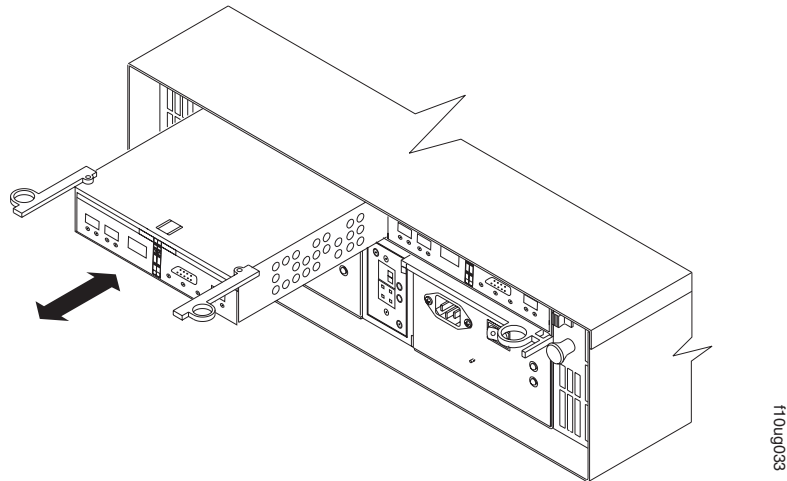


Figure 77. Installing a new RAID controller

- a. Slide the RAID controller all the way into the empty slot.
 - b. Close both levers until the latch locks into place.
21. Install the SFPs and then connect the fibre-channel cables to their original locations.
 22. On the DS4100 single-controller storage server, turn on power to the storage server and attached devices. For the proper power-on sequence, see “Turning on the storage server” on page 66.
 23. On the DS4100 base storage server, wait approximately one minute and then use the DS4000 Storage Manager client to place the controller in online state (it was placed offline in step 6 on page 106).
 24. If the operation fails, repeat the command. If the operation fails again, reseal the controller and repeat this step.

Note: Note that on all DS4100 models, it might take 15 minutes to a few hours for a new battery to become fully charged. The DS4000 Storage Manager client will show the battery as failed until it is fully charged. Controller caching is automatically disabled until the new battery becomes fully charged.

25. Use the DS4000 Storage Manager client to monitor the status of the storage server and to reset the battery age.

Note: On the DS4100 base storage server, there are two cache batteries in the unit (one for each controller). Make sure that you reset the age for the correct battery.

Installing SFPs and fiber-optic cables

Each RAID controller unit has two host ports and one expansion unit port. SFPs are inserted into the ports, and then fibre-channel cables are connected to the SFPs. For information on installing SFPs and fiber-optic cables, see “Working with SFPs and fiber-optic cables” on page 45.

Adding a DS4000 EXP100 to an existing DS4100 configuration (base storage server only)

You can add up to seven DS4000 EXP100 storage expansion units to a DS4100 storage server. However, you do not need to configure the DS4100 with the maximum number of DS4000 EXP100s at the time of initial installation. You can add additional DS4000 EXP100s to an existing DS4100 configuration (up to the maximum number of DS4000 EXP100s supported in a drive loop) as you need more capacity.

Important

There might be a requirement for new firmware to support the maximum number of DS4000 EXP100s in a drive loop. Always add new DS4000 EXP100s when the DS4100 is powered on and in optimal state. Do not add new DS4000 EXP100s when the DS4100 is powered down.

Before you cable DS4000 EXP100s to a loop, refer to the *DS4100 Storage Server Fibre Channel Cabling Instructions* that come with your storage server for specific instructions.

Figure 78 on page 110 shows the process of adding an additional DS4000 EXP100 to an existing DS4100 storage server configuration. Drive loops A and B form one redundant fibre-channel loop.

Note: Always add a new DS4000 EXP100 to the *end* of a drive loop.

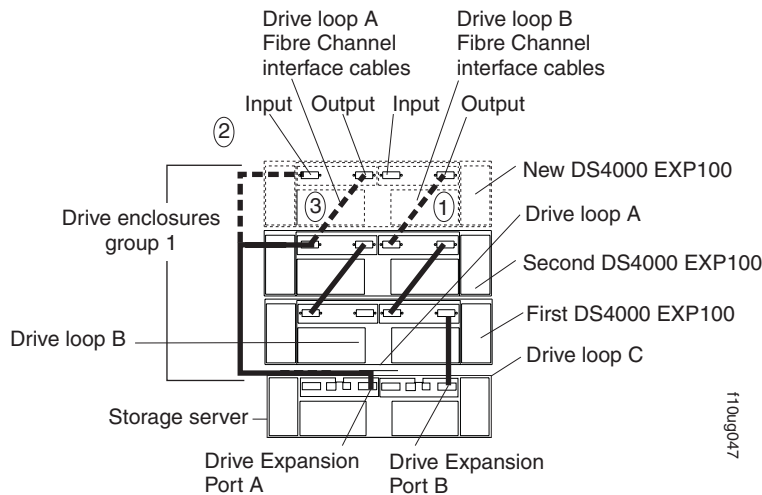


Figure 78. Cabling the DS4100 to a redundant loop

In Figure 78, the existing DS4100 configuration already includes two DS4000 EXP100s. The dashed lines show you how to add a third DS4000 EXP100 to the configuration. To add the new DS4000 EXP100 shown in Figure 78, you would perform the following steps:

1. Verify that the existing configuration is powered on and is in optimal state. Use the DS4000 Storage Manager client to correct any problems before proceeding.
2. Unpack the new DS4000 EXP100 and mount it in the proper position on the rack cabinet.
3. Make the fibre-channel connection marked 1 in Figure 78 (drive loop B). Then power on the new DS4000 EXP100 and verify that it is recognized by the DS4000 Storage Manager software GUI.
4. Make the fibre-channel connection marked 2 in Figure 78.
5. Make the fibre-channel connection marked 3 in Figure 78 (drive loop A).
6. Use the DS4000 Storage Manager client to verify the ESM firmware version of the new EXP100.
 - If the ESM firmware version of the new DS4000 EXP100 is version 953x or lower, disconnect the new DS4000 EXP100 and contact IBM support, your IBM reseller, or your IBM representative for assistance.
 - If the ESM firmware version of the new EXP100 is version 9554 or higher, but does not match exactly the ESM firmware version of the DS4000 EXP100s that were already installed in the DS4100 configuration, then refer to the procedures for resolving ESM firmware mismatches in the *IBM TotalStorage DS4000 EXP100 Expansion Unit Installation, User's, and Maintenance Guide*.

Chapter 6. Hardware maintenance

This chapter contains information to help you solve some of the simpler problems that you might have with your storage server. It contains the problem indicators and error messages along with suggested actions to take to resolve the problem.

For instructions on how to obtain service and technical assistance for your storage server and other IBM products, see “Getting information, help, and service” on page xxvii.

Note: See the *IBM TotalStorage DS4000 Problem Determination Guide* for additional troubleshooting and debugging procedures.

General checkout

Use the status LEDs, Symptom-to-FRU index, and the storage management software to diagnose problems. See “Checking the LEDs” on page 71.

To diagnose a cluster system, use the cluster problem determination procedure in the *IBM TotalStorage DS4000 Problem Determination Guide*.

Note: If power was just applied to the controller unit, the green and amber LEDs might turn on and off intermittently. Wait until the controller unit finishes powering up before you begin to check for faults.

Using the diagnostic hardware

The DS4100 comes with an LC wrap-plug adapter and LC-LC coupler. The wrap-plug adapter and LC-LC coupler are used to perform the loopback test and to identify fibre path problems. See the *IBM TotalStorage DS4000 Problem Determination Guide* for more information.

The loopback test and the sendEcho test are described in the *IBM TotalStorage DS4000 Problem Determination Guide*. In the IBM TotalStorage SAN Integration Server configuration, a loopback adapter (P/N 17P6918) is included to identify path problems on the drive loop when using fibre channel 1.2 m copper cable (P/N 18P5237).

Solving problems

Always use the DS4000 Storage Manager client to diagnose storage server problems and component failures. Also use the symptom-to-FRU index (Table 17 on page 112) to find solutions to problems that have definite symptoms.

See the problem determination maps in the *IBM TotalStorage DS4000 Problem Determination Guide* for more detailed procedures for problem isolation.

Table 17. Symptom-to-FRU index

Problem indicator	Component	Possible cause	Possible solutions
Amber LED on	Drive CRU	Drive failure	Replace the drive that has failed.
	Fan CRU	Fan failure	Replace the fan that has failed.
	RAID controller Fault LED	RAID controller failure	If the RAID controller Fault LED is on, replace the RAID controller. If the RAID controller has been placed offline by the user, use storage management software to place it online. If the controller failed, replace the RAID controller. Attention: In the DS4100 single-controller storage server, the RAID controller Fault LED will <i>not</i> light in the event of a RAID controller failure or removal.
	Expansion or host port bypass LED	SFP port empty	No corrective action is needed if this is a stand-alone storage server with no expansion units attached, and if the system is properly configured. Otherwise, check to make sure that the drive expansion unit is powered on and the fibre channel cables are attached properly.
		Fibre-channel cable is not attached to the expansion unit	Connect the fibre-channel cable to the enclosure port; check other connections.
		No incoming signal detected	Reattach the SFPs and fibre-channel cables. Replace input and output SFPs or cables as necessary.
	Front panel	General system error	Indicates that a Fault LED somewhere on the storage server has turned on. (Check for amber LEDs on CRUs.) Use DS4000 Storage Manager software to diagnose server problems.
Amber LED is off and green LED off	Power-supply CRU	Power switch is turned off or ac power failure	Turn on all power-supply power switches.
Amber and green LEDs on	Power-supply CRU	Power supply failure	Replace the failed power-supply CRU.

Table 17. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
All green LEDs off	All CRUs	Subsystem power is off	Check that all storage-server power cords are plugged in and the power switches are on. If applicable, check that the main circuit breakers for the rack cabinet are turned on.
		AC power failure	Check the main circuit breaker and ac outlet.
		Power supply failure	Replace the power supply.
		Midplane failure	Have the midplane replaced (service technician only).
Amber LED flashing	Drive CRUs	Drive identify is in process	No corrective action is needed.
One or more green LEDs off	Power supply CRUs	Power cord unplugged or switches turned off	Make sure that the power cord is plugged in and the power-supply switches are turned on.
	All drive CRUs	Midplane failure	Have the midplane replaced (service technician only).
	Front panel	Power supply problem	Make sure that the cords are plugged in and power supplies are turned on.
		Hardware failure	If any other LEDs are on, replace the midplane (service technician only).
	Battery	Battery failure	Replace the battery.
	Cache active	The cache is disabled	Use the DS4000 Storage Manager client to enable the logical drive read and write cache settings.
		The cache memory has failed	Replace the RAID controller.
		The cache battery has failed	Use the DS4000 Storage Manager client to check and replace the battery.
	Host loop	Host or switch is off or has failed	Check if host or switch is on. Replace attached devices that have failed.
		Fibre-channel cable has failed	Ensure that the fibre-channel cables are undamaged and properly connected.
SFP has failed		Ensure SFP is seated properly; replace SFP.	
RAID controller has no power or has failed		Ensure that the unit is powered on. Replace RAID controller.	

Table 17. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
One or more green LEDs off (continued)	Expansion loop	Drives are improperly installed or not installed	Ensure that the drives are properly installed.
		RAID controller has no power or has failed	Ensure that the unit is powered on. Replace the RAID controller.
		Impending drive failure	A bad drive or drives can issue LIPs that cause the drive expansion loop to go down momentarily. Use the RLS function in the DS4000 Storage Manager client to determine which drives are bad. Replace the bad drives.
		Externally attached expansion port device has failed	Replace the expansion unit SFP or fibre-channel cable.
Intermittent or sporadic power loss to the storage server	Some or all CRUs	Defective ac power source or partially plugged-in power cord	Check the ac power source; verify that the ac circuit that the storage server connects to is not being overloaded. Reseat all installed power cables and power supplies. If applicable, check the power components. Replace defective power cords.
		Power supply has failed	Check for a Fault LED on the power supply, and replace the failed CRU.
		Midplane has failed	Have the midplane replaced (service technician only).
Unable to access drives	Drives and expansion loop	Fibre-channel cabling has failed.	Ensure that the fibre-channel cables are undamaged and properly connected.
		RAID controller has failed	Replace the RAID controller.
		SFP has failed	Ensure SFP is seated properly; replace SFP.
Random errors	Subsystem	Midplane has failed	Have the midplane replaced (service technician only).

Table 17. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
The DS4000 Storage Manager client Enterprise Management window sees each storage server controller as an independent storage subsystem or a partially managed device.	Controller	No drives are present in the storage server.	Ensure that at least one drive is present in the storage server so that it can be configured properly.
		One controller was replaced incorrectly. The controller firmware versions probably failed to synchronize correctly.	To recover, perform the following steps: <ol style="list-style-type: none"> 1. Remove and reinsert the controller blade. 2. Wait 5 minutes. 3. Delete the controller entry with the incorrect firmware version from the DS4000 Storage Manager Enterprise Management window. 4. Add the controller back to the DS4000 Storage Manager Enterprise Management window using the Add Device menu option in the Enterprise Management window. 5. If the DS4000 Storage Manager client Enterprise Management window still shows each storage server controller as an independent storage subsystem or a partially managed device, repeat this procedure. If the problem still persists, contact IBM support.

Note: If you cannot find the problem in the Symptom-to-FRU index, test the entire system.

Parts listing

Figure 79 on page 116 and the following table provide a parts listing for the DS4100.

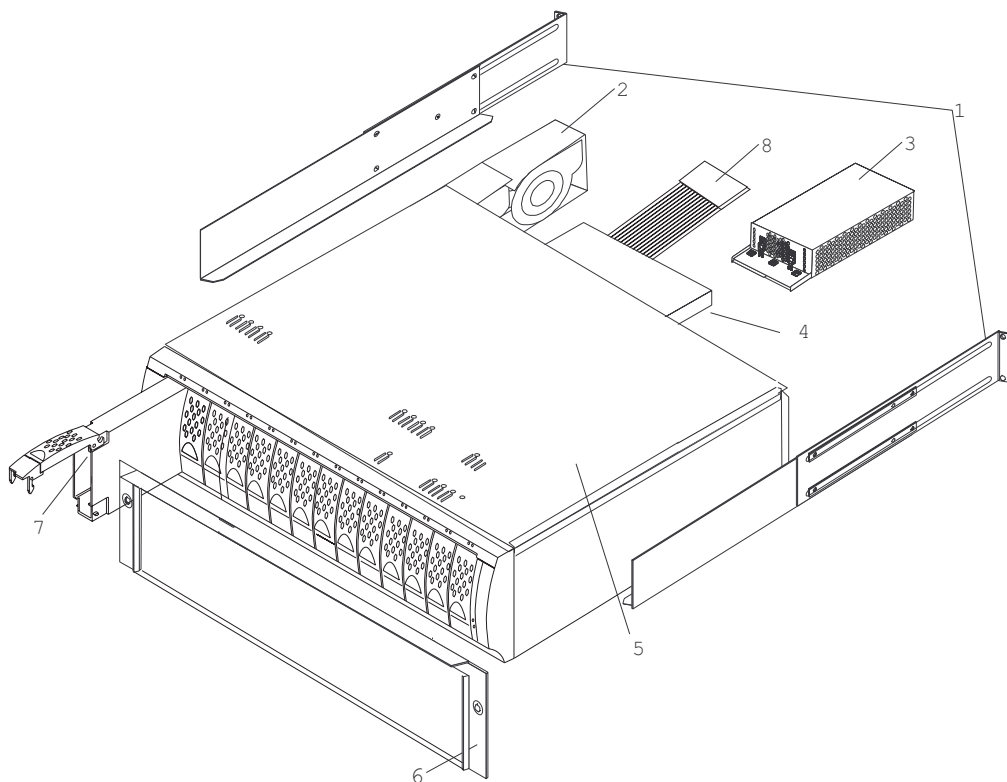


Figure 79. DS4100 parts list

Table 18. Parts listing (TotalStorage DS4100 storage server)

Index	DS4100 storage server	FRU P/N
1	Rail kit	01K6670
2	Fan ASM CRU	19K1293
3	Power supply CRU, 400W	19K1289
4	DS4100 SATA RAID controller	25R0099
5	SATA frame, midplane (base storage server)	25R0211
5	SATA frame, midplane (single-controller storage server)	25R0321
6	DS4100 bezel ASM	25R0217
	SATA tray, blank	90P1348
7	SATA 250 GB drive CRU	90P1349
8	Switch, harness	19K1297
	Miscellaneous hardware kit	24P8813
	Power supply blank tray (single-controller storage server only)	25R0323
	Controller blank tray (single-controller storage server only)	25R0324

Table 18. Parts listing (TotalStorage DS4100 storage server) (continued)

Index	DS4100 storage server	FRU P/N
	Cable, FRU-1M	19K1265
	Cable, FRU-5M	19K1266
	Cable, FRU-25M	19K1267
	Short wave SFP	19K1280
	Long wave SFP	19K1281
	Power cord, 2.8M	6952300
	Power cord, jumper	36L8886
	Battery	24P8062
	Wrap plug (loopback adapter)	17P6918
	LC-SC fibre channel cable adapter	19K1268

Appendix B. Rack mounting template

This appendix provides duplicate copies of the rack mounting templates. If you want to tear out the templates from this document for easier use, use these copies rather than those provided in “Rack mounting template” on page 20.

Use the following templates (Figure 80 on page 122 and Figure 81 on page 123) to identify the proper locations for inserting M6 screws when mounting the support rails and DS4100 in a rack cabinet. The locations for the M6 screws are highlighted in the templates.

The DS4100 is 3 U high. Align the template with the rack at a U boundary. U boundaries are shown as horizontal dashed lines in the rack mounting templates.

Note: The mounting holes that are shown in the following templates are square. The holes in your rack cabinet might be round or square.

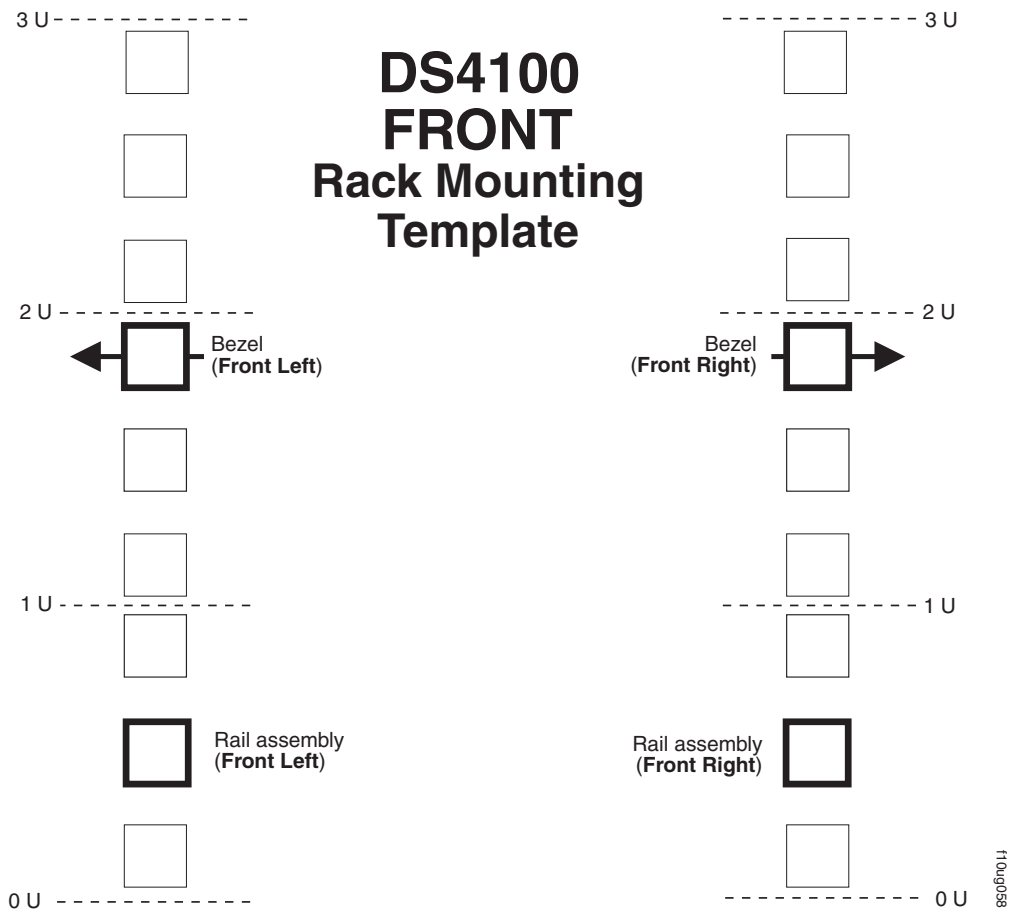
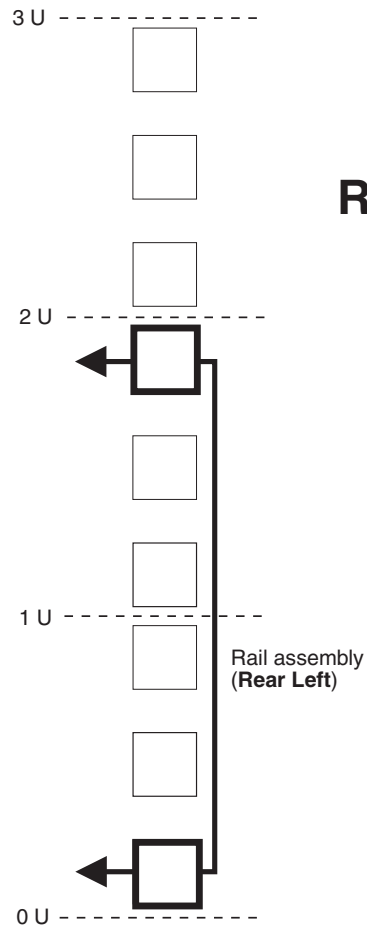


Figure 80. Front rack mounting template



DS4100 REAR Rack Mounting Template

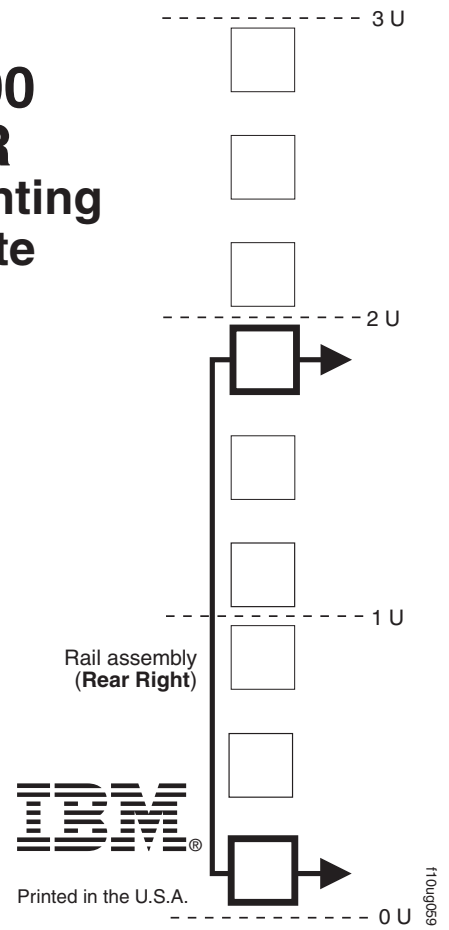


Figure 81. Rear rack mounting template

Appendix C. Power cords

For your safety, IBM provides a power cord with a grounded attachment plug to use with this IBM product. To avoid electrical shock, always use the power cord and plug with a properly grounded outlet.

IBM power cords used in the United States and Canada are listed by Underwriter's Laboratories (UL) and certified by the Canadian Standards Association (CSA).

For units intended to be operated at 115 volts: Use a UL-listed and CSA-certified cord set consisting of a minimum 18 AWG, Type SVT or SJT, three-conductor cord, a maximum of 15 feet in length and a parallel blade, grounding-type attachment plug rated 15 amperes, 125 volts.

For units intended to be operated at 230 volts (U.S. use): Use a UL-listed and CSA-certified cord set consisting of a minimum 18 AWG, Type SVT or SJT, three-conductor cord, a maximum of 15 feet in length and a tandem blade, grounding-type attachment plug rated 15 amperes, 250 volts.

For units intended to be operated at 230 volts (outside the U.S.): Use a cord set with a grounding-type attachment plug. The cord set should have the appropriate safety approvals for the country in which the equipment will be installed.

IBM power cords for a specific country or region are usually available only in that country or region.

IBM power cord part number	Cord specifics	Used in these countries or regions
13F9940	250V/10A 2.8M	Australia, Fiji, Kiribati, Nauru, New Zealand, Papua New Guinea
13F9979	250V/10A 2.8M	Afghanistan, Albania, Algeria, Andorra, Angola, Armenia, Austria, Azerbaijan, Belarus, Belgium, Benin, Bosnia and Herzegovina, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Democratic Republic of), Congo (Republic of), Cote D'Ivoire (Ivory Coast), Croatia (Republic of), Czech Rep, Dahomey, Djibouti, Egypt, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Finland, France, French Guyana, French Polynesia, Gabon, Georgia, Germany, Greece, Guadeloupe, Guinea, Guinea Bissau, Hungary, Iceland, Indonesia, Iran, Kazakhstan, Kyrgyzstan, Laos (Peoples Democratic Republic of), Latvia, Lebanon, Lithuania, Luxembourg, Macedonia (former Yugoslav Republic of), Madagascar, Mali, Martinique, Mauritania, Mauritius, Mayotte, Moldova (Republic of), Monaco, Mongolia, Morocco, Mozambique, Netherlands, New Caledonia, Niger, Norway, Poland, Portugal, Reunion, Romania, Russian Federation Rwanda, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, Slovakia, Slovenia (Republic of), Somalia, Spain, Suriname, Sweden, SSyrian Arab Replublic, Tajikistan, Tahiti, Togo, Tunisia, Turkey, Turkmenistan, Ukraine, Upper Volta, Uzbekistan, Vanuatu, Vietnam, Wallis and Futuna, Yugoslavia (Federal Republic of), Zaire
13F9997	250V/10A 2.8M	Denmark

IBM power cord part number	Cord specifics	Used in these countries or regions
14F0015	250V/10A 2.8M	Bangladesh, Lesotho, Maceo, Maldives, Namibia, Nepal, Pakistan, Samoa, South Africa, Sri Lanka, Swaziland, Uganda
14F0033	250V/10A 2.8M	Abu Dhabi, Bahrain, Botswana, Brunei Darussalam, Channel Islands, Cyprus, Dominica, Gambia, Ghana, Grenada, Guyana, Hong Kong S.A.R. of China, Iraq, Ireland, Jordan, Kenya, Kuwait, Liberia, Malawi, Malaysia, Malta, Myanmar (Burma), Nigeria, Oman, Qatar, Saint Kitts & Nevis, Saint Lucia, Saint Vincent and the Grenadines, Seychelles, Sierra Leone, Singapore, Sudan, Tanzania (United Republic of), Trinidad & Tobago, United Arab Emirates (Dubai), United Kingdom, Yemen, Zambia, Zimbabwe
14F0051	250V/10A 2.8M	Liechtenstein, Switzerland
14F0069	250V/10A 2.8M	Chile, Italy, Libyan Arab Jamahiriya
14F0087	250V/10A 2.8M	Israel
1838574	250V/10A 2.8M	Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Caicos Islands, Canada, Cayman Islands, Costa Rica, Columbia, Cuba, Dominican Republic, Ecuador, El Salvador, Guam, Guatemala, Haiti, Honduras, Jamaica, Japan, Mexico, Micronesia (Federal States of), Netherlands Antilles, Nicaragua, Panama, Peru, Philippines, Taiwan, United States, Venezuela
36L8880	250V/10A 2.8M	Argentina, Paraguay, Uruguay
02K0546	250V/6A 2.8M	PRC (China)
6952300	125V/10A 2.8M	Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Cayman Islands, Costa Rica, Columbia, Cuba, Dominican Republic, Ecuador, El Salvador, Guam, Guatemala, Haiti, Honduras, Jamaica, Mexico, Micronesia (Federal States of), Netherlands Antilles, Nicaragua, Panama, Peru, Philippines, Saudi Arabia, Taiwan, Thailand, Turks and Caicos Islands, United States, Venezuela
6952301	125V/10A 1.8M	

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Glossary

This glossary provides definitions for the terminology and abbreviations used in IBM TotalStorage DS4000 publications.

If you do not find the term you are looking for, see the *IBM Glossary of Computing Terms* located at the following Web site:

www.ibm.com/ibm/terminology

This glossary also includes terms and definitions from:

- *Information Technology Vocabulary* by Subcommittee 1, Joint Technical Committee 1, of the International Organization for Standardization and the International Electrotechnical Commission (ISO/IEC JTC1/SC1). Definitions are identified by the symbol (I) after the definition; definitions taken from draft international standards, committee drafts, and working papers by ISO/IEC JTC1/SC1 are identified by the symbol (T) after the definition, indicating that final agreement has not yet been reached among the participating National Bodies of SC1.
- *IBM Glossary of Computing Terms*. New York: McGraw-Hill, 1994.

The following cross-reference conventions are used in this glossary:

See Refers you to (a) a term that is the expanded form of an abbreviation or acronym, or (b) a synonym or more preferred term.

See also
Refers you to a related term.

Abstract Windowing Toolkit (AWT). A Java graphical user interface (GUI).

accelerated graphics port (AGP). A bus specification that gives low-cost 3D graphics cards faster access to main memory on personal computers than the usual peripheral component interconnect (PCI) bus. AGP reduces the overall cost of creating high-end graphics subsystems by using existing system memory.

access volume. A special logical drive that allows the host-agent to communicate with the controllers in the storage subsystem.

adapter. A printed circuit assembly that transmits user data input/output (I/O) between the internal bus of the

host system and the external fibre-channel (FC) link and vice versa. Also called an I/O adapter, host adapter, or FC adapter.

advanced technology (AT) bus architecture. A bus standard for IBM compatibles. It extends the XT bus architecture to 16 bits and also allows for bus mastering, although only the first 16 MB of main memory are available for direct access.

agent. A server program that receives virtual connections from the network manager (the client program) in a Simple Network Management Protocol-Transmission Control Protocol/Internet Protocol (SNMP-TCP/IP) network-managing environment.

AGP. See *accelerated graphics port*.

AL_PA. See *arbitrated loop physical address*.

arbitrated loop. One of three existing fibre-channel topologies, in which 2 - 126 ports are interconnected serially in a single loop circuit. Access to the Fibre Channel-Arbitrated Loop (FC-AL) is controlled by an arbitration scheme. The FC-AL topology supports all classes of service and guarantees in-order delivery of FC frames when the originator and responder are on the same FC-AL. The default topology for the disk array is arbitrated loop. An arbitrated loop is sometimes referred to as a Stealth Mode.

arbitrated loop physical address (AL_PA). An 8-bit value that is used to uniquely identify an individual port within a loop. A loop can have one or more AL_PAs.

array. A set of fibre-channel hard drives that are logically grouped together to form a redundant array of independent disks (RAID) set.

asynchronous write mode. In remote mirroring, an option that allows the primary controller to return a write I/O request completion to the host server before data has been successfully written by the secondary controller. See also *synchronous write mode*, *remote mirroring*, *Global Copy*, *Global Mirroring*.

AT. See *advanced technology (AT) bus architecture*.

ATA. See *AT-attached*.

AT-attached. Peripheral devices that are compatible with the original IBM AT computer standard in which signals on a 40-pin AT-attached (ATA) ribbon cable followed the timings and constraints of the Industry Standard Architecture (ISA) system bus on the IBM PC AT computer. Equivalent to integrated drive electronics (IDE).

auto-volume transfer/auto-disk transfer (AVT/ADT).

A function that provides automatic failover in case of controller failure on a storage subsystem.

AVT/ADT. See *auto-volume transfer/auto-disk transfer*.

AWT. See *Abstract Windowing Toolkit*.

basic input/output system (BIOS). The personal computer code that controls basic hardware operations, such as interactions with diskette drives, hard disk drives, and the keyboard.

BIOS. See *basic input/output system*.

BOOTP. See *bootstrap protocol*.

bootstrap protocol (BOOTP). In Transmission Control Protocol/Internet Protocol (TCP/IP) networking, an alternative protocol by which a diskless machine can obtain its Internet Protocol (IP) address and such configuration information as IP addresses of various servers from a BOOTP server.

bridge. A storage area network (SAN) device that provides physical and transport conversion, such as fibre channel to small computer system interface (SCSI) bridge.

bridge group. A bridge and the collection of devices connected to it.

broadcast. The simultaneous transmission of data to more than one destination.

cathode ray tube (CRT). A display device in which controlled electron beams are used to display alphanumeric or graphical data on an electroluminescent screen.

client. A computer system or process that requests a service of another computer system or process that is typically referred to as a server. Multiple clients can share access to a common server.

command. A statement used to initiate an action or start a service. A command consists of the command name abbreviation, and its parameters and flags if applicable. A command can be issued by typing it on a command line or selecting it from a menu.

community string. The name of a community contained in each Simple Network Management Protocol (SNMP) message.

concurrent download. A method of downloading and installing firmware that does not require the user to stop I/O to the controllers during the process.

CRC. See *cyclic redundancy check*.

CRT. See *cathode ray tube*.

CRU. See *customer replaceable unit*.

customer replaceable unit (CRU). An assembly or part that a customer can replace in its entirety when any of its components fail. Contrast with *field replaceable unit (FRU)*.

cyclic redundancy check (CRC). (1) A redundancy check in which the check key is generated by a cyclic algorithm. (2) An error detection technique performed at both the sending and receiving stations.

dac. See *disk array controller*.

dar. See *disk array router*.

DASD. See *direct access storage device*.

default host group. A logical collection of discovered host ports, defined host computers, and defined host groups in the storage-partition topology that fulfill the following requirements:

- Are not involved in specific logical drive-to-LUN mappings
- Share access to logical drives with default logical drive-to-LUN mappings

device type. Identifier used to place devices in the physical map, such as the switch, hub, or storage.

DHCP. See *Dynamic Host Configuration Protocol*.

direct access storage device (DASD). A device in which access time is effectively independent of the location of the data. Information is entered and retrieved without reference to previously accessed data. (For example, a disk drive is a DASD, in contrast with a tape drive, which stores data as a linear sequence.) DASDs include both fixed and removable storage devices.

direct memory access (DMA). The transfer of data between memory and an input/output (I/O) device without processor intervention.

disk array controller (dac). A disk array controller device that represents the two controllers of an array. See also *disk array router*.

disk array router (dar). A disk array router that represents an entire array, including current and deferred paths to all logical unit numbers (LUNs) (hdisks on AIX). See also *disk array controller*.

DMA. See *direct memory access*.

domain. The most significant byte in the node port (N_port) identifier for the fibre-channel (FC) device. It is not used in the fibre channel-small computer system interface (FC-SCSI) hardware path ID. It is required to be the same for all SCSI targets logically connected to an FC adapter.

DRAM. See *dynamic random access memory*.

Dynamic Host Configuration Protocol (DHCP). A protocol defined by the Internet Engineering Task Force that is used for dynamically assigning Internet Protocol (IP) addresses to computers in a network.

dynamic random access memory (DRAM). A storage in which the cells require repetitive application of control signals to retain stored data.

ECC. See *error correction coding*.

EEPROM. See *electrically erasable programmable read-only memory*.

EISA. See *Extended Industry Standard Architecture*.

electrically erasable programmable read-only memory (EEPROM). A type of memory chip which can retain its contents without consistent electrical power. Unlike the PROM which can be programmed only once, the EEPROM can be erased electrically. Because it can only be reprogrammed a limited number of times before it wears out, it is appropriate for storing small amounts of data that are changed infrequently.

electrostatic discharge (ESD). The flow of current that results when objects that have a static charge come into close enough proximity to discharge.

environmental services monitor (ESM) canister. A component in a drive enclosure that monitors the environmental condition of the components in that enclosure. Not all storage subsystems have ESM canisters.

E_port. See *expansion port*.

error correction coding (ECC). A method for encoding data so that transmission errors can be detected and corrected by examining the data on the receiving end. Most ECCs are characterized by the maximum number of errors they can detect and correct.

ESD. See *electrostatic discharge*.

ESM canister. See *environmental services monitor canister*.

EXP. See *expansion unit*.

expansion port (E_port). A port that connects the switches for two fabrics.

expansion unit (EXP). A feature that can be connected to a system unit to provide additional storage and processing capacity.

Extended Industry Standard Architecture (EISA). A bus standard for IBM compatibles that extends the Industry Standard Architecture (ISA) bus architecture to 32 bits and allows more than one central processing unit (CPU) to share the bus. See also *Industry Standard Architecture*.

fabric. A Fibre Channel entity which interconnects and facilitates logins of N_ports attached to it. The fabric is responsible for routing frames between source and destination N_ports using address information in the frame header. A fabric can be as simple as a point-to-point channel between two N_ports, or as complex as a frame-routing switch that provides multiple and redundant internal pathways within the fabric between F_ports.

fabric port (F_port). In a fabric, an access point for connecting a user's N_port. An F_port facilitates N_port logins to the fabric from nodes connected to the fabric. An F_port is addressable by the N_port connected to it. See also *fabric*.

DS4000 MSJ. See *DS4000 Management Suite Java*.

DS4000 Management Suite Java (DS4000 MSJ). A diagnostic and configuration utility that can be used on Linux, Microsoft Windows, and Novell NetWare host systems. In Linux, it is also used with the QLRemote agent to define preferred and non-preferred paths for logical drives.

FC. See *fibre channel*.

FC-AL. See *arbitrated loop*.

feature enable identifier. A unique identifier for the storage subsystem, which is used in the process of generating a premium feature key. See also *premium feature key*.

fibre channel (FC). A set of standards for a serial input/output (I/O) bus capable of transferring data between two ports at up to 100 Mbps, with standards proposals to go to higher speeds. FC supports point-to-point, arbitrated loop, and switched topologies.

Fibre Channel-Arbitrated Loop (FC-AL). See *arbitrated loop*.

Fibre Channel Protocol (FCP) for small computer system interface (SCSI). A high-level fibre-channel mapping layer (FC-4) that uses lower-level fibre-channel (FC-PH) services to transmit SCSI commands, data, and status information between a SCSI initiator and a SCSI target across the FC link by using FC frame and sequence formats.

field replaceable unit (FRU). An assembly that is replaced in its entirety when any one of its components fails. In some cases, a field replaceable unit might contain other field replaceable units. Contrast with *customer replaceable unit (CRU)*.

FlashCopy. A premium feature for DS4000 that can make an instantaneous copy of the data in a volume.

F_port. See *fabric port*.

FRU. See *field replaceable unit*.

GBIC. See *gigabit interface converter*

gigabit interface converter (GBIC). A transceiver that performs serial, optical-to-electrical, and electrical-to-optical signal conversions for high-speed networking. A GBIC can be hot swapped. See also *small form-factor pluggable*.

Global Copy. Refers to a remote logical drive mirror pair that is set up using asynchronous write mode without the write consistency group option. This is also referred to as "Asynchronous Mirroring without Consistency Group." Global Copy does not ensure that write requests to multiple primary logical drives are carried out in the same order on the secondary logical drives as they are on the primary logical drives. If it is critical that writes to the primary logical drives are carried out in the same order in the appropriate secondary logical drives, Global Mirroring should be used instead of Global Copy. See also *asynchronous write mode, Global Mirroring, remote mirroring, Metro Mirroring*.

Global Mirroring. Refers to a remote logical drive mirror pair that is set up using asynchronous write mode with the write consistency group option. This is also referred to as "Asynchronous Mirroring with Consistency Group." Global Mirroring ensures that write requests to multiple primary logical drives are carried out in the same order on the secondary logical drives as they are on the primary logical drives, preventing data on the secondary logical drives from becoming inconsistent with the data on the primary logical drives. See also *asynchronous write mode, Global Copy, remote mirroring, Metro Mirroring*.

graphical user interface (GUI). A type of computer interface that presents a visual metaphor of a real-world scene, often of a desktop, by combining high-resolution graphics, pointing devices, menu bars and other menus, overlapping windows, icons, and the object-action relationship.

GUI. See *graphical user interface*.

HBA. See *host bus adapter*.

hdisk. An AIX term representing a logical unit number (LUN) on an array.

host. A system that is directly attached to the storage subsystem through a fibre-channel input/output (I/O) path. This system is used to serve data (typically in the form of files) from the storage subsystem. A system can be both a storage management station and a host simultaneously.

host bus adapter (HBA). An interface between the fibre-channel network and a workstation or server.

host computer. See *host*.

host group. An entity in the storage partition topology that defines a logical collection of host computers that require shared access to one or more logical drives.

host port. Ports that physically reside on the host adapters and are automatically discovered by the DS4000 Storage Manager software. To give a host computer access to a partition, its associated host ports must be defined.

hot swap. To replace a hardware component without turning off the system.

hub. In a network, a point at which circuits are either connected or switched. For example, in a star network, the hub is the central node; in a star/ring network, it is the location of wiring concentrators.

IBMSAN driver. The device driver that is used in a Novell NetWare environment to provide multipath input/output (I/O) support to the storage controller.

IC. See *integrated circuit*.

IDE. See *integrated drive electronics*.

in-band. Transmission of management protocol over the fibre-channel transport.

Industry Standard Architecture (ISA). Unofficial name for the bus architecture of the IBM PC/XT personal computer. This bus design included expansion slots for plugging in various adapter boards. Early versions had an 8-bit data path, later expanded to 16 bits. The "Extended Industry Standard Architecture" (EISA) further expanded the data path to 32 bits. See also *Extended Industry Standard Architecture*.

initial program load (IPL). The initialization procedure that causes an operating system to commence operation. Also referred to as a system restart, system startup, and boot.

integrated circuit (IC). A microelectronic semiconductor device that consists of many interconnected transistors and other components. ICs are constructed on a small rectangle cut from a silicon crystal or other semiconductor material. The small size of these circuits allows high speed, low power dissipation, and reduced manufacturing cost compared with board-level integration. Also known as a *chip*.

integrated drive electronics (IDE). A disk drive interface based on the 16-bit IBM personal computer Industry Standard Architecture (ISA) in which the controller electronics reside on the drive itself, eliminating the need for a separate adapter card. Also known as an Advanced Technology Attachment Interface (ATA).

Internet Protocol (IP). A protocol that routes data through a network or interconnected networks. IP acts as an intermediary between the higher protocol layers and the physical network.

Internet Protocol (IP) address. The unique 32-bit address that specifies the location of each device or workstation on the Internet. For example, 9.67.97.103 is an IP address.

interrupt request (IRQ). A type of input found on many processors that causes the processor to suspend normal processing temporarily and start running an interrupt handler routine. Some processors have several interrupt request inputs that allow different priority interrupts.

IP. See *Internet Protocol*.

IPL. See *initial program load*.

IRQ. See *interrupt request*.

ISA. See *Industry Standard Architecture*.

isolated group. A collection of isolated devices not connected to the storage area network (SAN) but discovered by the SANavigator tool. The isolated group displays with a gray background near the bottom of the Physical and Data Path maps.

Java Runtime Environment (JRE). A subset of the Java Development Kit (JDK) for end users and developers who want to redistribute the Java Runtime Environment (JRE). The JRE consists of the Java virtual machine, the Java Core Classes, and supporting files.

JRE. See *Java Runtime Environment*.

label. A discovered or user entered property value that is displayed underneath each device in the Physical and Data Path maps.

LAN. See *local area network*.

LBA. See *logical block address*.

local area network (LAN). A computer network located on a user's premises within a limited geographic area.

logical block address (LBA). The address of a logical block. Logical block addresses are typically used in hosts' I/O commands. The SCSI disk command protocol, for example, uses logical block addresses.

logical partition (LPAR). (1) A subset of a single system that contains resources (processors, memory, and input/output devices). A logical partition operates as an independent system. If hardware requirements are met, multiple logical partitions can exist within a system. (2) A fixed-size portion of a logical volume. A logical partition is the same size as the physical partitions in its volume group. Unless the logical volume of which it is a

part is mirrored, each logical partition corresponds to, and its contents are stored on, a single physical partition. (3) One to three physical partitions (copies). The number of logical partitions within a logical volume is variable.

logical unit number (LUN). An identifier used on a small computer system interface (SCSI) bus to distinguish among up to eight devices (logical units) with the same SCSI ID.

loop address. The unique ID of a node in a fibre-channel loop topology sometimes referred to as a loop ID.

loop group. A collection of storage area network (SAN) devices that are interconnected serially in a single loop circuit. Loop groups are discovered by the SANavigator tool and displayed with a gray background on the Physical and Data Path maps.

loop port. A node port (N_port) or fabric port (F_port) that supports arbitrated loop functions associated with an arbitrated loop topology.

LPAR. See *logical partition*.

LUN. See *logical unit number*.

MAC. See *medium access control*.

management information base (MIB). The information that is on an agent. It is an abstraction of configuration and status information.

man pages. In UNIX-based operating systems, online documentation for operating system commands, subroutines, system calls, file formats, special files, stand-alone utilities, and miscellaneous facilities. Invoked by the **man** command.

MCA. See *micro channel architecture*.

media scan. A media scan is a background process that runs on all logical drives in the storage subsystem for which it has been enabled, providing error detection on the drive media. The media scan process scans all logical drive data to verify that it can be accessed, and optionally scans the logical drive data also.

medium access control (MAC). In local area networks (LANs), the sublayer of the data link control layer that supports medium-dependent functions and uses the services of the physical layer to provide services to the logical link control sublayer. The MAC sublayer includes the method of determining when a device has access to the transmission medium.

Metro Mirroring. This term is used to refer to a remote logical drive mirror pair which is set up with synchronous write mode. See also *remote mirroring*, *Global Mirroring*.

MIB. See *management information base*.

micro channel architecture (MCA). Hardware that is used for PS/2 Model 50 computers and above to provide better growth potential and performance characteristics when compared with the original personal computer design.

Microsoft Cluster Server (MSCS). MSCS, a feature of Windows NT Server (Enterprise Edition), supports the connection of two servers into a cluster for higher availability and easier manageability. MSCS can automatically detect and recover from server or application failures. It can also be used to balance server workload and provide for planned maintenance.

model. The model identification that is assigned to a device by its manufacturer.

MSCS. See *Microsoft Cluster Server*.

network management station (NMS). In the Simple Network Management Protocol (SNMP), a station that runs management application programs that monitor and control network elements.

NMI. See *non-maskable interrupt*.

NMS. See *network management station*.

non-maskable interrupt (NMI). A hardware interrupt that another service request cannot overrule (mask). An NMI bypasses and takes priority over interrupt requests generated by software, the keyboard, and other such devices and is issued to the microprocessor only in disastrous circumstances, such as severe memory errors or impending power failures.

node. A physical device that allows for the transmission of data within a network.

node port (N_port). A fibre-channel defined hardware entity that performs data communications over the fibre-channel link. It is identifiable by a unique worldwide name. It can act as an originator or a responder.

nonvolatile storage (NVS). A storage device whose contents are not lost when power is cut off.

N_port. See *node port*.

NVS. See *nonvolatile storage*.

NVSRAM. Nonvolatile storage random access memory. See *nonvolatile storage*.

Object Data Manager (ODM). An AIX proprietary storage mechanism for ASCII stanza files that are edited as part of configuring a drive into the kernel.

ODM. See *Object Data Manager*.

out-of-band. Transmission of management protocols outside of the fibre-channel network, typically over Ethernet.

partitioning. See *storage partition*.

PCI local bus. See *peripheral component interconnect local bus*.

PDF. See *portable document format*.

performance events. Events related to thresholds set on storage area network (SAN) performance.

peripheral component interconnect local bus (PCI local bus). A local bus for PCs, from Intel, that provides a high-speed data path between the CPU and up to 10 peripherals (video, disk, network, and so on). The PCI bus coexists in the PC with the Industry Standard Architecture (ISA) or Extended Industry Standard Architecture (EISA) bus. ISA and EISA boards plug into an IA or EISA slot, while high-speed PCI controllers plug into a PCI slot. See also *Industry Standard Architecture*, *Extended Industry Standard Architecture*.

polling delay. The time in seconds between successive discovery processes during which discovery is inactive.

port. A part of the system unit or remote controller to which cables for external devices (such as display stations, terminals, printers, switches, or external storage units) are attached. The port is an access point for data entry or exit. A device can contain one or more ports.

portable document format (PDF). A standard specified by Adobe Systems, Incorporated, for the electronic distribution of documents. PDF files are compact; can be distributed globally by e-mail, the Web, intranets, or CD-ROM; and can be viewed with the Acrobat Reader, which is software from Adobe Systems that can be downloaded at no cost from the Adobe Systems home page.

premium feature key. A file that the storage subsystem controller uses to enable an authorized premium feature. The file contains the feature enable identifier of the storage subsystem for which the premium feature is authorized, and data about the premium feature. See also *feature enable identifier*.

private loop. A freestanding arbitrated loop with no fabric attachment. See also *arbitrated loop*.

program temporary fix (PTF). A temporary solution or bypass of a problem diagnosed by IBM in a current unaltered release of the program.

PTF. See *program temporary fix*.

RAID. See *redundant array of independent disks*.

RAM. See *random-access memory*.

random-access memory (RAM). A temporary storage location in which the central processing unit (CPU) stores and executes its processes. Contrast with *DASD*.

RDAC. See *redundant disk array controller*.

read-only memory (ROM). Memory in which stored data cannot be changed by the user except under special conditions.

recoverable virtual shared disk (RVSD). A virtual shared disk on a server node configured to provide continuous access to data and file systems in a cluster.

redundant array of independent disks (RAID). A collection of disk drives that appears as a single volume to the server and are fault tolerant through mirroring or parity checking.

redundant disk array controller (RDAC). (1) In hardware, a redundant set of controllers (either active/passive or active/active). (2) In software, a layer that manages the input/output (I/O) through the active controller during normal operation and transparently reroutes I/Os to the other controller in the redundant set if a controller or I/O path fails.

remote mirroring. Online, real-time replication of data between storage subsystems that are maintained on separate media. The Enhanced Remote Mirror Option is a DS4000 premium feature that provides support for remote mirroring. See also *Global Mirroring*, *Metro Mirroring*.

ROM. See *read-only memory*.

router. A computer that determines the path of network traffic flow. The path selection is made from several paths based on information obtained from specific protocols, algorithms that attempt to identify the shortest or best path, and other criteria such as metrics or protocol-specific destination addresses.

RVSD. See *recoverable virtual shared disk*.

SAI. See *Storage Array Identifier*.

SA Identifier. See *Storage Array Identifier*.

SAN. See *storage area network*.

SATA. See *serial ATA*.

scope. Defines a group of controllers by their Internet Protocol (IP) addresses. A scope must be created and defined so that dynamic IP addresses can be assigned to controllers on the network.

SCSI. See *small computer system interface*.

segmented loop port (SL_port). A port that allows division of a fibre-channel private loop into multiple segments. Each segment can pass frames around as

an independent loop and can connect through the fabric to other segments of the same loop.

sense data. (1) Data sent with a negative response, indicating the reason for the response. (2) Data describing an I/O error. Sense data is presented to a host system in response to a sense request command.

serial ATA. The standard for a high-speed alternative to small computer system interface (SCSI) hard drives. The SATA-1 standard is equivalent in performance to a 10 000 RPM SCSI drive.

serial storage architecture (SSA). An interface specification from IBM in which devices are arranged in a ring topology. SSA, which is compatible with small computer system interface (SCSI) devices, allows full-duplex packet multiplexed serial data transfers at rates of 20 Mbps in each direction.

server. A functional hardware and software unit that delivers shared resources to workstation client units on a computer network.

server/device events. Events that occur on the server or a designated device that meet criteria that the user sets.

SFP. See *small form-factor pluggable*.

Simple Network Management Protocol (SNMP). In the Internet suite of protocols, a network management protocol that is used to monitor routers and attached networks. SNMP is an application layer protocol. Information on devices managed is defined and stored in the application's Management Information Base (MIB).

SL_port. See *segmented loop port*.

SMagent. The DS4000 Storage Manager optional Java-based host-agent software, which can be used on Microsoft Windows, Novell NetWare, HP-UX, and Solaris host systems to manage storage subsystems through the host fibre-channel connection.

SMclient. The DS4000 Storage Manager client software, which is a Java-based graphical user interface (GUI) that is used to configure, manage, and troubleshoot storage servers and expansion units in a DS4000 storage subsystem. SMclient can be used on a host system or on a storage management station.

SMruntime. A Java compiler for the SMclient.

SMutil. The DS4000 Storage Manager utility software that is used on Microsoft Windows, HP-UX, and Solaris host systems to register and map new logical drives to the operating system. In Microsoft Windows, it also contains a utility to flush the cached data of the operating system for a particular drive before creating a FlashCopy.

small computer system interface (SCSI). A standard hardware interface that enables a variety of peripheral devices to communicate with one another.

small form-factor pluggable (SFP). An optical transceiver that is used to convert signals between optical fiber cables and switches. An SFP is smaller than a gigabit interface converter (GBIC). See also *gigabit interface converter*.

SNMP. See *Simple Network Management Protocol* and *SNMPv1*.

SNMP time-out. The maximum amount of time the SANavigator tool will wait for a device to respond to a request. The specified time applies to one retry only.

SNMP trap event. (1) (2) An event notification sent by the SNMP agent that identifies conditions, such as thresholds, that exceed a predetermined value. See also *Simple Network Management Protocol*.

SNMPv1. The original standard for SNMP is now referred to as SNMPv1, as opposed to SNMPv2, a revision of SNMP. See also *Simple Network Management Protocol*.

SRAM. See *static random access memory*.

SSA. See *serial storage architecture*.

static random access memory (SRAM). Random access memory based on the logic circuit known as flip-flop. It is called static because it retains a value as long as power is supplied, unlike dynamic random access memory (DRAM), which must be regularly refreshed. It is however, still volatile, meaning that it can lose its contents when the power is turned off.

storage area network (SAN). A dedicated storage network tailored to a specific environment, combining servers, storage products, networking products, software, and services. See also *fabric*.

Storage Array Identifier (SAI or SA Identifier). The Storage Array Identifier is the identification value used by the DS4000 Storage Manager host software (SMClient) to uniquely identify each managed storage server. The DS4000 Storage Manager SMClient program maintains Storage Array Identifier records of previously-discovered storage servers in the host resident file, which allows it to retain discovery information in a persistent fashion.

storage management station. A system that is used to manage the storage subsystem. A storage management station does not need to be attached to the storage subsystem through the fibre-channel input/output (I/O) path.

storage partition. Storage subsystem logical drives that are visible to a host computer or are shared among host computers that are part of a host group.

storage partition topology. In the DS4000 Storage Manager client, the Topology view of the Mappings window displays the default host group, the defined host group, the host computer, and host-port nodes. The host port, host computer, and host group topological elements must be defined to grant access to host computers and host groups using logical drive-to-LUN mappings.

subnet. An interconnected but independent segment of a network that is identified by its Internet Protocol (IP) address.

sweep method. A method of sending Simple Network Management Protocol (SNMP) requests for information to all the devices on a subnet by sending the request to every device in the network.

switch. A fibre-channel device that provides full bandwidth per port and high-speed routing of data by using link-level addressing.

switch group. A switch and the collection of devices connected to it that are not in other groups. Switch groups are discovered by the SANavigator tool and displayed with a gray background on the Physical and Data Path maps.

synchronous write mode. In remote mirroring, an option that requires the primary controller to wait for the acknowledgment of a write operation from the secondary controller before returning a write I/O request completion to the host. See also *asynchronous write mode*, *remote mirroring*, *Metro Mirroring*.

system name. Device name assigned by the vendor's third-party software.

TCP. See *Transmission Control Protocol*.

TCP/IP. See *Transmission Control Protocol/Internet Protocol*.

terminate and stay resident program (TSR program). A program that installs part of itself as an extension of DOS when it is executed.

topology. The physical or logical arrangement of devices on a network. The three fibre-channel topologies are fabric, arbitrated loop, and point-to-point. The default topology for the disk array is arbitrated loop.

TL_port. See *translated loop port*.

transceiver. A device that is used to transmit and receive data. Transceiver is an abbreviation of transmitter-receiver.

translated loop port (TL_port). A port that connects to a private loop and allows connectivity between the private loop devices and off loop devices (devices not connected to that particular TL_port).

Transmission Control Protocol (TCP). A communication protocol used in the Internet and in any network that follows the Internet Engineering Task Force (IETF) standards for internetwork protocol. TCP provides a reliable host-to-host protocol between hosts in packet-switched communication networks and in interconnected systems of such networks. It uses the Internet Protocol (IP) as the underlying protocol.

Transmission Control Protocol/Internet Protocol (TCP/IP). A set of communication protocols that provide peer-to-peer connectivity functions for both local and wide-area networks.

trap. In the Simple Network Management Protocol (SNMP), a message sent by a managed node (agent function) to a management station to report an exception condition.

trap recipient. Receiver of a forwarded Simple Network Management Protocol (SNMP) trap. Specifically, a trap receiver is defined by an Internet Protocol (IP) address and port to which traps are sent. Presumably, the actual recipient is a software application running at the IP address and listening to the port.

TSR program. See *terminate and stay resident program*.

uninterruptible power supply. A source of power from a battery that is installed between a computer system and its power source. The uninterruptible power supply keeps the system running if a commercial power failure occurs, until an orderly shutdown of the system can be performed.

user action events. Actions that the user takes, such as changes in the storage area network (SAN), changed settings, and so on.

vendor. Property value that the SANavigator tool uses to launch third-party software. Vendor property might be discovered, but will always remain editable.

worldwide name (WWN). A unique identifier for a switch on local and global networks.

WORM. See *write-once read-many*.

write-once read many (WORM). Any type of storage medium to which data can be written only a single time, but can be read from any number of times. After the data is recorded, it cannot be altered.

WWN. See *worldwide name*.

zoning. A function that allows segmentation of nodes by address, name, or physical port and is provided by fabric switches or hubs.

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