IBM TotalStorage DS4000 EXP100
Storage Expansion Enclosure

IBM

Installation, User's and Maintenance Guide

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Storage Expansion Enclosure

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 143.

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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 EXP100 Storage Expansion Enclosure. 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:
1. Turn everything OFF.	1. Turn everything OFF.
2. First, attach all cables to devices.	2. First, remove power cords from outlet.
3. Attach signal cables to connectors.	3. Remove signal cables from connectors.
4. Attach power cords to outlet.	4. Remove all cables from devices.
5. Turn device ON.	

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 Klass 1
Luokan 1 Laserlaite
Apparell À Laser de Calsse 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.

2

1
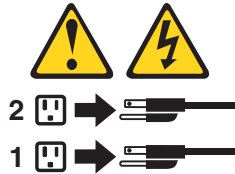
Statement 8:

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.

About this document

This document provides instructions for installing and customizing the configuration of your IBM® TotalStorage® DS4000 EXP100 Storage Expansion Enclosure. It also provides maintenance procedures and troubleshooting information.

FAStT product renaming

IBM has renamed some FAStT family products. Table 1 identifies each DS4000 product name with its corresponding previous FAStT 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 FAStT products.

Table 1. Mapping of FAStT names to DS4000 Series names

Previous FAStT Product Name	Current DS4000 Product Name
IBM TotalStorage FAStT Storage Server	IBM TotalStorage DS4000
FAStT	DS4000
FAStT Family	DS4000 Mid-range Disk System
FAStT Storage Manager vX.Y (for example v9.10)	DS4000 Storage Manager vX.Y (for example v9.10)
FAStT100	DS4100
FAStT600	DS4300
FAStT600 with Turbo Feature	DS4300 Turbo
FAStT700	DS4400
FAStT900	DS4500
EXP700	DS4000 EXP700
EXP710	DS4000 EXP710
EXP100	DS4000 EXP100
FAStT FlashCopy	FlashCopy for DS4000
FAStT VolumeCopy	VolumeCopy for DS4000
FAStT Remote Mirror (RM)	Enhanced Remote Mirroring for DS4000
FAStT 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, Serial ATA (SATA) and network technology.

How this document is organized

Chapter 1, "Introduction," on page 1 describes the IBM TotalStorage EXP100 Storage Expansion Enclosure. This chapter includes an inventory checklist and an overview of the storage expansion enclosure features, operating specifications, and components.

Chapter 2, "Installing the EXP100," on page 29 contains instructions for the following tasks:

- Install the storage expansion enclosure in a standard rack cabinet
- Set the interface options
- Cable the storage expansion enclosure
- Route the power cord
- Power the storage expansion enclosure on or off during either normal or emergency situations

Chapter 3, "Installing and replacing devices," on page 65 contains step-by-step instructions for how to install or remove customer replaceable units (CRUs), such as hard disk drives, power supplies, environmental services modules (ESMs), and fan units.

Chapter 4, "Hardware maintenance," on page 101 describes problems and symptoms that are specific to your storage expansion enclosure. It also provides a parts for list for the EXP100.

Appendix A, "Upgrading R1-level firmware (DS4300 and DS4500 only)," on page 109 contains information on how to enable EXP100 R2 full high-availability support by upgrading the EXP100 ESM firmware, the DS4000 controller firmware, and NVSRAM.

Appendix B, "Records," on page 117 provides a table that you can use to record and update important information about your EXP100, including serial number and device records. Whenever you add options to your EXP100, be sure to update the information in this table.

Appendix C, "Rack mounting template," on page 121 provides the rack mounting templates for installation of the EXP100. If you want to tear out the templates from the document for use during installation, use these copies of the templates.

Appendix D, "Power cords," on page 125 lists power cord information for the EXP100.

Appendix E, "Additional DS4000 documentation," on page 127 lists the documents that are available in the IBM TotalStorage DS4000 Storage Manager and DS4000 Storage Subsystem product libraries, and other related documents.

Appendix F, "Product Recycling and Disposal," on page 137 provides information regarding the European Directive About Product Recycling and Disposal, an environmental directive that is in effect throughout the European Union.

Appendix H, "Accessibility," on page 141 provides information about alternate keyboard navigation, which is a DS4000 Storage Manager accessibility feature. Accessibility features help a user who has a physical disability, such as restricted mobility or limited vision, to use software products successfully.

DS4000 Storage Subsystem installation tasks - General overview

Table 2 provides a sequential list of many installation and configuration tasks that are common to most DS4000 configurations. When you install and configure your DS4000 storage subsystem, refer to this table to find the documentation that explains how to complete each task.

See also: The *DS4000 Storage Server and Storage Expansion Enclosure Quick Start Guide* provides an excellent overview of the installation process.

Table 2. Where to find DS4000 installation and configuration procedures

	Installation task	Where to find information or procedures
1	Plan the installation	• *DS4000 Storage Manager Concepts Guide* • *DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER* • *DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux* • *DS4100 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4300 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4400 Fibre Channel Storage Server Installation and Support Guide* • *DS4500 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4700 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*
2	Mount the DS4000 storage subsystem in the rack	• *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4700 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4400 and DS4500 Rack Mounting Instructions* • *DS4300 Rack Mounting Instructions* • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4100 Storage Subsystem Installation, User's and Maintenance Guide*
3	Mount the DS4000 EXP storage expansion unit in the rack	• *DS4000 EXP100 Storage Expansion Unit Installation, User's and Maintenance Guide* • *DS4000 EXP420 Storage Expansion Enclosures Installation, User's, and Maintenance Guide* • *DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide* • *DS4000 EXP810 Storage Expansion Enclosures Installation, User's, and Maintenance Guide* • *FAStT EXP500 Installation and User's Guide*

Table 2. Where to find DS4000 installation and configuration procedures (continued)

	Installation task	Where to find information or procedures
4	Route the storage expansion unit Fibre Channel cables	• *DS4100 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4300 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4400 Fibre Channel Cabling Instructions* • *DS4500 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4700 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*
5	Route the host server Fibre Channel cables	• *DS4100 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4300 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4400 Fibre Channel Cabling Instructions* • *DS4500 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4700 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*
6	Power up the subsystem	• *DS4100 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4300 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4400 Fibre Channel Storage Server Installation and Support Guide* • *DS4500 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4700 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*

Table 2. Where to find DS4000 installation and configuration procedures (continued)

	Installation task	Where to find information or procedures
7	Configure DS4000 network settings	• *DS4100 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4300 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4400 Fibre Channel Storage Server Installation and Support Guide* • *DS4500 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4700 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*
8	Zone the fabric switch (SAN-attached only)	• *DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER* • *DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux* • *DS4000 Storage Manager Copy Services Guide* (describes switch zoning for the Remote Mirror Option) • See also the documentation provided by the switch manufacturer
9	Install DS4000 Storage Manager software on the management station	• *DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER* • *DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux* • DS4000 Storage Manager online help (for post-installation tasks)
10	Install host software (failover drivers) on host server	
11	Start DS4000 Storage Manager	
12	Set the DS4000 Storage Manager clock	
13	Set the DS4000 Storage Manager host default type	

Table 2. Where to find DS4000 installation and configuration procedures (continued)

	Installation task	Where to find information or procedures
14	Verify DS4000 subsystem health	• *DS4100 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4300 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4400 Fibre Channel Storage Server Installation and Support Guide* • *DS4500 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4700 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*

15	Enable DS4000 Storage Manager premium feature keys	**Copy Services premium features**
		   DS4000 Storage Manager Copy Services Guide
		
		FC/SATA Intermix premium feature
		   DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview
		
		Storage Partitioning (and general premium features information)
		   • *DS4000 Storage Manager Concepts Guide*
		   • *DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER*
		   • *DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux*

16	Configure arrays and logical drives	• *DS4000 Storage Manager Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER*
17	Configure host partitions	• *DS4000 Storage Manager Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux*
18	Verify host access to DS4000 storage	• DS4000 Storage Manager online help

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-03.ibm.com/servers/storage/support/disk/
- 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/servers/storage/support/disk/

  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.ibmlink.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.ibm.com/pc/intellistation/

- 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-03.ibm.com/servers/storage/disk/ds4000/interop-matrix.html

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 6 on page 22 lists the environmental specifications for the EXP100.

How to send your comments

Your feedback is important to help us provide the highest quality information. If you have any comments about this document, you can submit them in one of the following ways:

E-mail

Submit your comments by e-mail to:

starpubs@us.ibm.com

Be sure to include the name and order number of the document and, if applicable, the specific location of the text that you are commenting on, such as a page number or table number.

Mail

Fill out the Readers' Comments form (RCF) at the back of this document and return it by mail or give it to an IBM® representative.

If the RCF has been removed, send your comments to:

International Business Machines Corporation
Information Development
Department GZW
9000 South Rita Road
Tucson, Arizona
USA
85744-0001

Be sure to include the name and order number of the document and, if applicable, the specific location of the text that you are commenting on, such as a page number or table number.

Chapter 1. Introduction

This chapter describes the operating specifications, features, and components for the IBM TotalStorage® EXP100 Storage Expansion Enclosure (hereafter referred to as EXP100 or "expansion enclosure"). This chapter also lists the hardware that comes with the expansion enclosure, and lists the ESM and controller firmware that is required to enable support for the EXP100.

This chapter contains the following sections:
- "Overview"
- "Software, hardware and firmware compatibility and upgrades" on page 3
- "Inventory checklist" on page 14
- "EXP100 components" on page 14
- "EXP100 bays" on page 14
- "Controls, indicators and connectors" on page 17
- "EXP100 operating environment" on page 21
- "ESM failover architecture" on page 24

Overview

The IBM TotalStorage DS4000 EXP100 Storage Expansion Enclosure is designed for data archival, data reference, and near-line storage applications and enables the attachment of Serial Advanced Technology Attachment (SATA) disk drives for DS4000 storage subsystems such as the DS4100, DS4300, DS4400, DS4500, and DS4800.

This section contains the following information:
- "EXP100 storage expansion enclosure - description"
- "Host server operating system support" on page 2
- "Fibre Channel defined" on page 3
- "Serial ATA defined" on page 3
- "New features" on page 3

EXP100 storage expansion enclosure - description

The EXP100 is a rack-mountable storage expansion enclosure that supports up to fourteen 1.5 Gbps 400 GB SATA disk drive modules, offering up to 5.6 terabytes (TB) of capacity per expansion enclosure.

Note: There are two EXP100 machine types:
  - 1710 (model 10X or 10U)
  - 1724 (model 1X*x*, where *x* is an alphanumeric character)

Coupled with DS4000 storage subsystems such as the DS4100, DS4300, DS4400, DS4500, and DS4800, you can configure RAID-protected storage solutions of up to 89.6 TB, providing economical and scalable storage for your rapidly growing application needs for limited-access, data-reference storage capacity.

The EXP100 utilizes the latest SATA disk drive technology and is designed with redundant 2 Gbps Fibre Channel connections to the DS4000 storage subsystem, offering reliability and performance.

The EXP100 supports redundant, dual-loop configurations with the DS4000s and other EXP100 units. External cables and small form-factor pluggable (SFP) modules connect the controller to the expansion enclosure. EXP100s attached to supported DS4000s can be used with 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 expansion enclosure provides continuous, reliable service and uses hot-swap technology for easy replacement without the need to shut down the system. Up to eight EXP100 units can be connected together in a Fibre Channel loop, providing connections to a maximum of 112 hard drives.

Important

There are three types of EXP100 Environmental Storage Canister (ESM) CRU firmware - R1, R2, and R3. The current EXP100 release is shipped with R3 ESM firmware, which enables the support of the 400 GB SATA drive option (P/N 39M4570) 400 GB CRU/FRU (P/N 39M4575), and the 250 GB SATA drive CRU/FRU (P/N 40K6837).

In addition to these firmware types, there are four different release levels of DS4000 controller firmware/NVSRAM that are associated with the three EXP100 ESM firmware types.

Before you install and configure your EXP100, read the detailed information about these DS4000 firmware release levels and EXP100 ESM CRU firmware types in "Software, hardware and firmware compatibility and upgrades" on page 3. The information in that section is essential to successfully completing an EXP100 installation.

Host server operating system support

On host servers that have mapped LUNs created in the DS4000, with EXP100 storage expansion enclosures, the following operating systems are supported:

- Microsoft® Windows® 2000 Server and Advance Server
- Microsoft ® Windows® 2003 Server and Enterprise Edition
- Sun® Solaris
- HP-UX
- IBM AIX®
- NetWare
- VMWareESX Server
- RedHat Enterprise Linux Server
- SuSE Linux Enterprise Server

For information about supported operating system versions, and additional host operating system support, see the latest DS4000 Storage Manager host software readme file and the IBM DS4000 series products interoperability matrix at the following Web sites:

- **Interoperability matrix:** www-03.ibm.com/servers/storage/disk/ds4000/interop-matrix.html
- **Storage Manager readme files:** http://www-03.ibm.com/servers/storage/support/disk/

To find the Storage Manager readme files, click the name of your storage subsystem, then select the **Download** tab. Click **Storage Manager, firmware, HBA and tools (including readmes)**. Make sure that the appropriate controller firmware version is selected, then click the link in the **Current version and readmes column**.

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 devices[1] can be supported, compared to 15 small computer system interface (SCSI) devices. The connection from the DS4000 to the EXP100 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.

Serial ATA 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. See the following Web site for more information:

www.serialata.org

New features

DS4000 controller firmware version 6.19.xx.xx supports the intermix of EXP100 and EXP810 expansion enclosures with Fibre Channel or SATA drives behind DS4300 and DS4500 storage subsystems. (Please check the DS4000 readme files on the Web for information about future support for other DS4000 storage subsystems.)

See "Fifth Release" on page 10, for information about new features supported on EXP100 configurations with the latest Storage Manager software, DS4000 controller firmware, and ESM firmware.

Software, hardware and firmware compatibility and upgrades

The latest DS4000 controller firmware and NVSRAM, EXP100 expansion enclosure ESM firmware, and SATA drive CRU firmware must be installed to ensure optimal functionality, manageability, and reliability.

You can find the latest DS4000 controller firmware and NVSRAM, EXP100 expansion enclosure ESM firmware, and Storage Manager software packages at the IBM DS4000 System Storage Support Web site:

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1. For the DS4000, each drive is considered to be a device in a Fibre Channel loop, even though the EXP100 drive interface is SATA (not Fibre Channel). The ESM and the interposer convert SATA interface protocol to Fibre Channel protocol.

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

The software and firmware are also included on the *DS4000 Storage Manager version 9* CD that is shipped with the EXP100. However, always check the Web site to be certain that you have the latest versions.

This section contains the following information:
- "Storage Manager software support for the EXP100"
- "Current firmware support for the EXP100"
- "EXP100 ESM CRU types, firmware, and release levels explained" on page 5
- "ESM failover support considerations" on page 11
- "Determining firmware levels" on page 11
- "How to receive the latest product updates" on page 12

Storage Manager software support for the EXP100

Upgrade the host management software to DS4000 Storage Manager version 9.19, or later, in the host servers and in the management station.

You can find the latest DS4000 controller firmware and NVSRAM, EXP100 expansion enclosure ESM firmware, and Storage Manager software packages at the IBM DS4000 System Storage Support Web site:

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

The software and firmware are also included on the *DS4000 Storage Manager version 9* CD that is shipped with the EXP100. However, always check the Web site to be certain that you have the latest versions.

Note: To enable functionality that is specific to DS4000 Storage Manager Version 9.1x, you must install controller firmware versions 06.1x.xx.xx on the DS4000 storage subsystem. See the next section for detailed information about firmware.

Current firmware support for the EXP100

Even though your DS4000 storage subsystem is shipped with the latest firmware available at the time of shipping, always check the IBM DS4000 System Storage Support Web site (listed below) to ensure latest controller firmware and ESM firmware for your DS4000 storage subsystem. This is to ensure the compatibility of your DS4000 storage subsystem with the replacement drive CRUs in the event of SATA hard drive failures.

Note:

In addition to the controller firmware and ESM firmware, upgrade the SATA drive CRUs to the latest drive firmware.

You can find the latest DS4000 controller firmware and NVSRAM, EXP100 expansion enclosure ESM firmware, and Storage Manager software packages at the IBM DS4000 System Storage Support Web site:

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

The software and firmware are also included on the *DS4000 Storage Manager version 9* CD that is shipped with the EXP100. However, always check the Web site to be certain that you have the latest versions.

Table 3 shows the minimum DS4000 controller firmware and ESM firmware versions that are recommended for use with the EXP100.

Important: These are only minimum firmware versions. To complete an accurate installation and configuration, you must also read the information in the next section, "EXP100 ESM CRU types, firmware, and release levels explained." This is especially important if you are intermixing an EXP100 with other expansion enclosure types behind a single storage subsystem, because you might need to upgrade to newer controller and/or ESM firmware versions.

Table 3. Minimum firmware versions recommended for use with the EXP100

DS4000 storage subsystem	Controller firmware	EXP100 ESM firmware
DS4100, DS4300, DS4400, DS4500	06.12.1x.xx	956x
DS4800	06.15.16.xx	

Notes:

1. All DS4000 storage subsystems that support EXP100s are shipped with the 06.12.xx.xx, 06.15.xx.xx, or 06.19.xx.xx firmware that is required for EXP100s. However, to connect both SATA and Fibre Channel drives in the same DS4000 storage subsystem, you need to purchase and install the Fibre Channel/SATA Intermix Premium Feature.

2. DO NOT install controller versions 5.41.5x.xx or 5.41.1x.xx in DS4000 storage subsystems. The R2 FHA controller firmware version 5.41.5x.xx and the R1 LHA controller firmware version 5.41.1x.xx have been replaced by controller firmware versions 6.12.xx.xx or higher.

For DS4300 and DS4500 storage subsystems only: If you need to upgrade the controller firmware from version 05.41.1x.xx to version 06.12.xx.xx or later, you must first upgrade the firmware using the required "stepping-stone" version of the controller firmware, 05.41.5x.xx. You can find these "stepping-stone" controller firmware files on the *DS4000 Storage Manager version 9* CD that is shipped with EXP100, or by contacting your IBM support representative. On the CD, the firmware files are located in the appropriate directory for your DS4000 storage subsystem, in the `\Controller\05.41.1x_upgrade` directory.

After you install the "stepping-stone" firmware version 05.41.5x.xx, check the support Web site and upgrade the DS4000 controller to the latest firmware version 6.12.1x.xx, or later, that is posted on the Web site.

EXP100 ESM CRU types, firmware, and release levels explained

Understanding the information in this section is essential to completing an accurate EXP100 installation.

> **ATTENTION:**
>
> The firmware in your new EXP100 ESM CRUs might not be compatible with the firmware of your existing ESM module in the EXP100 expansion enclosure. You MUST ensure ESM firmware compatibility before you replace any ESM CRUs in the EXP100 expansion enclosure. Please refer to Table 5 on page 7 for information on the CRU part number and the ESM firmware level that is compatible with your EXP100 expansion enclosure. A loss of data access and, in some cases, a loss of data will result if an ESM with incompatible firmware is installed in the same EXP100 expansion enclosure.
>
> **DO NOT rely solely on the CRU part number of the installed ESM to determine the ESM firmware level.** Instead, use the procedure described in"Determining firmware levels" on page 11 to determine the current firmware level of the existing ESM in the EXP100 expansion enclosure and ensure that the new replacement ESM is compatible with the installed ESM. The existing ESM firmware might have been previously updated.

For more information about the EXP100 ESM replacement procedure, ESM firmware upgrades, and problem troubleshooting, please refer to the following sections in this document:

- "Replacing a failed hot-swap ESM" on page 87
- "Upgrading ESM firmware after adding the EXP100 to an existing drive loop" on page 70
- "Solving problems" on page 101
- "Troubleshooting" on page 97

If you need further assistance, please contact IBM technical support, your IBM reseller, or IBM representative to find out which EXP100 CRU is compatible with the ESM firmware of your existing ESM expansion enclosure.

EXP100 ESM CRU types

There are three types of EXP100 ESM CRUs - R1, R2, and R3, which are described as follows:

- **R1** refers to EXP100 ESMs that offer Limited High-Availability (LHA) support and are only compatible with ESM firmware version 953x and earlier. **R1 is no longer supported.**
- **R2** refers to EXP100 ESMs that offer Full High-Availability (FHA) support and are compatible with ESM firmware version 9554.
- **R3** refers to EXP100 ESMs that offer Full High-Availability (FHA) support and are compatible with ESM firmware version 956x and later. The current EXP100 release is shipped with R3 ESM firmware, which enables the support of the 400 GB SATA drive option (P/N 39M4570) 400 GB CRU/FRU (P/N 39M4575), and the 250 GB SATA drive CRU/FRU (P/N 40K6837.

Table 4. Compatible ESM firmware version by CRU part number

EXP100 ESM type	CRU part number	Compatible ESM firmware version
EXP100 **R1** ESM (not supported)	24P8814	953x or earlier
EXP100 **R2** ESM	25R0156	9554
EXP100 **R3** ESM (current)	39M6004	956x or later

Note: The following features are supported only when the EXP100 ESM firmware is at R3 level, and the DS4000 controller firmware at 6.12.1x.xx or higher (for DS4100, DS4300, DS4400, and DS4500) or at 6.15.16.xx or higher (for DS4800):

- Storage Manager premium copy services FlashCopy®, VolumeCopy, and Enhanced Remote Mirroring
- EXP100 expansion enclosure and HDD migration between DS4000 storage subsystems

Before adding a new EXP100 to your configuration, see "Determining firmware levels of the new and existing EXP100s" on page 65 for more information about matching the firmware levels.

EXP100 release levels

There are also *five different EXP100/DS4000 firmware release levels* that incorporate the various DS4000 controller firmware versions with their associated R1, R2 and R3 EXP100 ESM CRU types.

Table 5 shows how each release level relates to its EXP100 CRU part number, ESM and controller firmware versions, and supported DS4000 storage subsystems.

Detailed explanations of the four release levels follow the table.

Table 5. EXP100 firmware release levels, CRU types, and supported DS4000s

Firmware release level	EXP100 ESM type	CRU part number	ESM firmware version	Supported DS4000s	Controller firmware versions	High-availability support
"First release" on page 8 (No longer supported)	R1	24P8814 (250 GB)	953x or earlier	DS4300 DS4500	05.41.1x.xx	Low (LHA)
"Second release" on page 8 (Upgrade to fourth release recommended)	R2	25R0156 (250 GB)	9554	DS4300 DS4500	05.41.5x.xx	Full (FHA)
				DS4100	05.42.xx.xx	
"Third release" on page 9 (Upgrade to fourth release recommended)	R2	25R0156 (250 GB)	9554	DS4800	06.15.15.xx 06.14.xx.xx	Full (FHA)
				DS4100 DS4300 DS4500	6.10.xx.xx 06.12.0x.xx	
"Fourth release" on page 10 (Current release)	R3	39M6004 (400 GB) and 39M6004 (250 GB)	956x or later	DS4800	06.15.16.xx or later	Full (FHA)
				DS4100 DS4300 DS4400 DS4500	06.12.15.xx or later	
"Fifth Release" on page 10 (Current release)	R3	39M6004 (400 GB) and 39M6004 (250 GB)	956x or later	DS4300 DS4500	06.19.xx.xx	Full (FHA)

Important:

1. If the version of the ESM firmware in your EXP100 storage expansion enclosure is not 956x or later, you must schedule time to upgrade the EXP100 ESM firmware to the latest version posted on the Web as soon as possible. This is to ensure that you take advantage of the quality enhancements and the compatibility and availability of the EXP100 ESM and SATA drive FRUs/CRUs in the future.

2. If the EXP100 ESM firmware is 953x or earlier, you must schedule down time for ESM firmware upgrades. In addition, you must upgrade the EXP100 ESM to the intermediate version of 9554 first before upgrading the ESM firmware to 956x or later.

3. SATA hard drive CRUs cannot be interchanged with the Fibre Channel hard drive CRUs that are supported in other DS4000 series storage products.

If you need further assistance, contact IBM technical support, your IBM reseller, or your IBM representative to find out which EXP100 CRU is compatible with the ESM firmware of your existing ESM module.

First release: The first release of the DS4000 controller firmware and NVSRAM was for DS4300 and DS4500 storage subsystems only, to support the attachment of the EXP100 storage expansion enclosure. The controller firmware version is 05.41.1x.xx, and the associated EXP100 ESM firmware version is 953x.

This release has the following characteristics:

- The coexistence (intermix) of Fibre Channel drives and SATA drives in a DS4000 storage subsystem is *not* supported. This requires that the DS4000 storage subsystem go through a special controller upgrade process to load the 05.41.1x.xx firmware, because the DS4000 storage subsystem will not see any EXP100 enclosures or SATA drives until the controller firmware version 05.41.1x.xx is loaded.

- The EXP100 ESM has only Limited High Availability (LHA) support. Each ESM physically controls seven even-numbered or odd-numbered drives. If the Fibre Channel cabling to an ESM fails, the drives that belong to the ESM with the cabling failure will fail-over to the surviving ESM only if the ESM remains inserted in the EXP100 drive enclosure chassis. If the ESM fails or is removed from the chassis, the controller will not be able to recognize any of the drives that were managed by the failed or removed ESM and will mark them as failed.

Second release: The second release of the DS4000 controller firmware/NVSRAM added support for DS4100 storage subsystems, in addition to the DS4500 and the DS4300 storage subsystems, for attachment of the EXP100. The controller firmware version is 05.42.xx.xx for the DS4100 storage subsystem and 05.41.5x.xx for the DS4500 and the DS4300 storage subsystems. The associated EXP100 ESM firmware must be at version 9554.

This release has the following characteristics:

- The coexistence (intermix) of Fibre Channel drives and SATA drives in a DS4000 storage subsystem is still not supported. This requires that the DS4000 storage subsystem go through a special controller upgrade process to load the 05.41.5x.xx firmware, because the DS4000 storage subsystem will not see any EXP100 enclosures or SATA drives until the controller firmware version 05.41.5x.xx is loaded.

Note: The DS4100 subsystem is shipped only with the controller firmware version 05.42.xx.xx, which supports SATA drives. Therefore, the special controller firmware installing procedure described above is not applicable to the DS4100.

* The EXP100 ESM now supports Full High Availability (FHA). With this functionality, in the event of ESM or Fibre Channel cabling failure, the drives that belong to the failed ESM will fail-over to the surviving ESM, whether or not the ESM remains inserted in the EXP100 drive enclosure chassis. In either case, with FHA, the controller can recognize any of the drives that were managed by the failed ESM.

* Upgrading the EXP100 ESM firmware from 953x to 9554 requires the controller firmware version 05.41.1x.xx. It is not possible to upgrade the EXP100 ESM from any pre-9554 version to the 9554 version if the controller firmware of the attached DS4000 storage subsystem is version 05.41.5x.xx or version 05.42.xx.xx. In addition, you should not insert an ESM with firmware version 9554 into an EXP100 that contains an ESM with firmware version 953x installed. If you do, the Storage Manager Subsystem Management window will show the EXP100 with all slots empty, and will mark the drives in those slots as failed.

Third release: The third release of the DS4000 controller firmware/NVSRAM provided SATA support for the DS4100, DS4300, DS4400, DS4500, and DS4800 storage subsystems to support the attachment of the EXP100. The latest controller firmware versions for this release is 06.12.0x.xx (for the DS4100, DS4300, DS4400, and DS4500 storage subsystems), and 06.15.15.xx (for the DS4800 storage subsystems). The associated EXP100 ESM firmware version is still 9554.

This release had the following characteristics:

* The coexistence (intermix) of Fibre Channel expansion enclosures and SATA expansion enclosures in a DS4000 storage subsystem is now supported, with the purchase and enablement of the DS4000 Storage Manager FC/SATA Intermix Premium Feature. If the controller firmware installed in the DS4000 storage subsystem is version 06.1x.xx.xx, no separate controller firmware or firmware installation procedures are required to support FC/SATA Intermix; Fibre Channel drives only; or SATA drives only. You can follow the documented controller firmware and NVSRAM firmware upgrade procedures in the appropriate *IBM System Storage DS4000 Storage Manager Installation and Support Guide* for your host operating system. However, in order to intermix Fibre Channel and SATA expansion enclosures in a DS4000 subsystem, you must purchase and enable the DS4000 Storage Manager FC/SATA Intermix Premium Feature.

    Note: If you want to intermix Fibre Channel and SATA expansion enclosures in an existing DS4000 configuration with non-06.1x.xx.xx controller firmware installed, that currently supports a single drive technology (either Fibre Channel or SATA expansion enclosures), you need to upgrade the controller firmware to version 06.1x.xx.xx and enable the FC/SATA Intermix premium feature before you attach the other type of expansion enclosure.

* If you are upgrading a DS4300 or DS4500 subsystem from controller firmware version 05.41.1x.xx to 06.1x.xx.xx, you cannot upgrade directly from 05.41.1x.xx to 06.1x.xx.xx. Instead, you must first upgrade to the intermediate controller firmware version 05.41.5x.xx. In this case, contact your IBM support representative to obtain the necessary 05.41.5x.xx controller firmware files.

* The EXP100 ESM now supports Full High Availability (FHA). With this functionality, in the event of ESM or Fibre Channel cabling failure, the drives that belong to the failed ESM will fail-over to the surviving ESM, whether or not the

ESM remains inserted in the EXP100 drive enclosure chassis. In either case, with FHA, the controller can recognize any of the drives that were managed by the failed ESM.

- Upgrading the EXP100 ESM firmware from 953x to 9554 requires the controller firmware version 05.41.1x.xx. It is not possible to upgrade the EXP100 ESM from any pre-9554 version to the 9554 version if the controller firmware of the attached DS4000 storage subsystem is version 05.41.5x.xx or version 05.42.xx.xx. In addition, do not insert an ESM with firmware version 9554 into an EXP100 that contains an ESM with firmware version 953x installed. If you do, the Storage Manager Subsystem Management window will show the EXP100 with all slots empty.
- Upgrading controller firmware from version 05.xx.xx.xx to version 06.xx.xx.xx requires that there be no I/O activity to the DS4000 storage subsystems. You must schedule down time for the upgrade. However, upgrading controller firmware from one 06.xx.xx.xx version to a different 06.xx.xx.xx version does not require that I/O activity be stopped.

Note: This release also includes the controller firmware version 6.16.xx.x.

Fourth release: The fourth release of the DS4000 controller firmware/NVSRAM supports both the EXP100 400 GB SATA CRU option and the 250 GB CRU option for attachment to the DS4100, DS4300, DS4400, DS4500, and DS4800 storage subsystems.

IBM recommends that you upgrade the DS4000 controller firmware and EXP100 ESM firmware to the versions in this release to take advantage of quality enhancements and to ensure the compatibility of ESM and SATA drive CRUs in the future.

The latest controller firmware version for this release is 06.12.16.xx or later (for the DS4100, DS4300, DS4400, and DS4500) and 06.15.16.xx or later for the DS4800. The associated EXP100 ESM firmware version is 956x.

This release has the following characteristics:

- Support of the 400 GB drive option/CRU in addition to the 250 GB drive CRU.
- Upgrading the EXP100 ESM firmware from version 953x to version 956x is not supported. You must schedule down time to upgrade the ESM firmware to an intermediate version, 9554, before you can upgrade to the 956x version.

  Note: If you insert an ESM with firmware version 9554 into an EXP100 that contains an ESM with firmware version 956x installed, you must upgrade the 9554 version to version 956x immediately. Also, do not insert an ESM with firmware version 9554 into an EXP100 that contains an ESM with firmware version 953x installed. If you do, the Storage Manager Subsystem Management window will show the EXP100 with all slots empty.

- Upgrading controller firmware from version 05.xx.xx.xx to version 06.xx.xx.xx requires that there be no I/O activity to the DS4000 storage subsystems. You must schedule down time for the upgrade. However, upgrading controller firmware from one 06.xx.xx.xx version to a different 06.xx.xx.xx version does not require that I/O activity be stopped.

Fifth Release: The fifth firmware release supports intermixing the EXP100 and the EXP810 (with Fibre Channel or SATA drives) behind DS4300 and DS4500 storage subsystems.

If you want to intermix the EXP100 with an EXP810 behind a DS4300 or DS4500 storage subsystem, you must upgrade the DS4000 controller firmware and EXP100 ESM firmware to the versions in this release.

The latest controller firmware version for this release is 06.19.xx.xx or later (for the DS4300 and DS4500). The associated EXP100 ESM firmware version is 956x.

ESM failover support considerations

Upgrading to DS4000 EXP100 R3 enables full failover support in case of loss of connectivity due to bad components in the drive paths or due to ESM failure. It also provides support for the 400 GB SATA drive option/CRU/FRU and the 250G SATA drive CRU/FRU along with quality enhancements.

Without DS4000 EXP100 R3 support, each ESM in the DS4000 EXP100 drive expansion enclosure manages only half of the drives in the enclosure. The ESM on the left side manages drives at odd-numbered slots (1, 3, 5, 7, 9, 11, 13), and the ESM on the right side manages drives at even-numbered slots (2, 4, 6, 8, 10, 12, 14). As a result, half of the EXP100 drives could become inaccessible to the controllers if an ESM fails. You can avoid this situation by upgrading your firmware to enable DS4000 EXP100 R3 support.

Recommendation: IBM strongly recommends upgrading firmware to R3 support.

Important: For full ESM failover capability, the controller firmware must be either version 5.41.5x.xx or version 06.xx.xx.xx (or later), and the ESM firmware must be version 9554, 956x, or later. After you upgrade your EXP100 ESM firmware to version 9554 (EXP100 R2) or version 956x (EXP100 R3), which support full high-availability, you *cannot* downgrade the ESM firmware back to version 953x (EXP100 R1), which supports only limited high-availability.

Attention: See the instructions and configuration guidelines in "ESM failover architecture" on page 24 before you create arrays using drives in DS4000 EXP100 enclosures.

Determining firmware levels

There are two different methods to determine the DS4000 storage subsystem and the EXP100 firmware versions. Each method uses the DS4000 Storage Manager client that manages the DS4000 storage subsystem with the attached EXP100 expansion enclosure.

Method One:

Go to the Subsystem Management window and select **View → Storage Subsystem Profile**. When the Storage Subsystem Profile window opens, select the All tab and scroll through the Profile For Storage Subsystem to locate the following information.

Note: The Profile For Storage Subsystem contains all the profile information for the entire subsystem. Therefore, it may be necessary to scroll through a large amount of information to locate the firmware version numbers.

DS4000 storage subsystem
- NVSRAM version
- Appware version
- Bootware version

Drives
  - Firmware version

ESM
  - ESM card firmware version

Method Two:

Complete the appropriate procedure to obtain the specified firmware version.

To obtain the controller firmware version:
Right click the Controller icon in the Physical View pane of the Subsystem Management window and select Properties. The Controller Enclosure properties window opens and displays the properties for that controller.

You must perform this step for each individual controller.

To obtain the drive firmware version:
Right Click the Drive icon in the Physical View pane of the Subsystem Management window and select Properties. The Drive Properties window opens and displays the properties for that drive.

You must perform this step for each individual drive.

To obtain the ESM firmware version:
1. In the Physical View pane of the Subsystem Management window, click the Drive Enclosure Component icon (which is the icon furthest to the right.) The Drive Enclosure Component Information window opens.
2. Click the ESM icon in the left pane. The ESM information displays in the right pane of the Drive Enclosure Component Information window.
3. Locate the firmware version of each ESM in the storage expansion enclosure.

To obtain the storage expansion enclosure component firmware version:
1. Click the Drive Enclosure Component icon (which is the right most icon) in the Drive Enclosure frame in the Physical View pane of the Subsystem Management window. The Drive Enclosure Component Information window opens.
2. Click the ESM icon in the left pane. The ESM information displays in the right pane of the Drive Enclosure Component Information window.
3. Locate the firmware version of each ESM in the storage expansion enclosure.

You must perform this step for each storage expansion enclosure.

How to receive the latest product updates

You should download the latest version of the DS4000 Storage Manager host software, the DS4000 controller firmware, the EXP100 ESM firmware and the 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.ibm.com/servers/storage/support/disk/

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 either the 1710 or 1724 1X*x* (where *x* is an alphanumeric character), and the DS4000 series controller that the EXP100 connects to. Check boxes for any other DS4000 series 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.

Inventory checklist

The EXP100 ships with the following items:

- Power cables (2 jumper line cords; the 10U also includes 2 9 ft U.S. line cords)
- One rack-mounting hardware kit, including:
  - Two rails (right and left assembly)
  - Eight M6 black hex-head slotted screws
- 14 blank trays (your expansion enclosure might come with up to 14 hard disk drives)
- Box ID labels (used to label the enclosure IDs on the front of the EXP100)
- DS4000 Storage Manager version 9 CD

A rack mounting template and instructions for installing the support rails and the expansion enclosure are provided in this book. See Chapter 2, "Installing the EXP100," on page 29.

To connect your EXP100 to other devices, use the following options:

- IBM SFP module
- IBM LC-LC Fibre Channel cable

Note: You must order these options separately.

EXP100 components

The EXP100 has the following removable components. These components, called customer replaceable units (CRUs), are accessible from the front or back of the EXP100.

- Up to fourteen 1.5 Gbps SATA hard disk drives
- Two environmental services modules (ESMs)
- Two power supplies
- Two fans

EXP100 bays

This section shows the location of EXP100 hot-swap CRU bays and describes the function of each CRU. The hot-swap features of the EXP100 enable you to remove and replace 1.5 Gbps SATA hard disk drives, power supplies, ESMs, and fan units without turning off the expansion enclosure. You can maintain the availability of your system while a hot-swap device is removed, installed, or replaced.

Hot-swap drive bays

The hot-swap drive bays that are accessible from the front of your expansion enclosure are shown in Figure 1 on page 15.
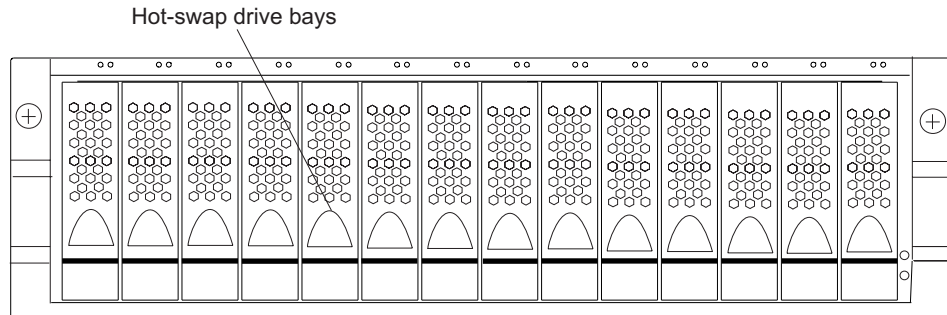
Hot-swap drive bays

Figure 1. EXP100 hot-swap drive bays

The EXP100 supports up to 14 1.5 Gbps SATA hard disk drives. These drives are preinstalled in drive trays. This drive and 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 expansion enclosure. 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. 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.

2. 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.

3. 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 expansion enclosure ESM.

4. The 400 GB SATA drive options and CRU (P/N 39M4575) and the 250 GB SATA CRU (P/N 40K6837) require ESM firmware level 956x or later.

   Recommendation: IBM strongly recommends that you check and maintain the DS4000 storage subsystem controller firmware and EXP100 ESM firmware at the latest levels posted on the IBM DS4000 storage subsystem support Web site, even if you do not have any 400 GB drive options in your DS4000 configuration. This ensures compatibility when existing SATA hard drives need to be replaced with the new drive options or SATA drive CRUs.

Note: If the hard disk drive you want to remove is not in a failed or bypass state, always use the 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 storage expansion enclosure.

Fan, ESM, and power supply bays

The locations of the EXP100 hot-swap fan bays, hot-swap ESM bays, and hot-swap power supply bays are shown in
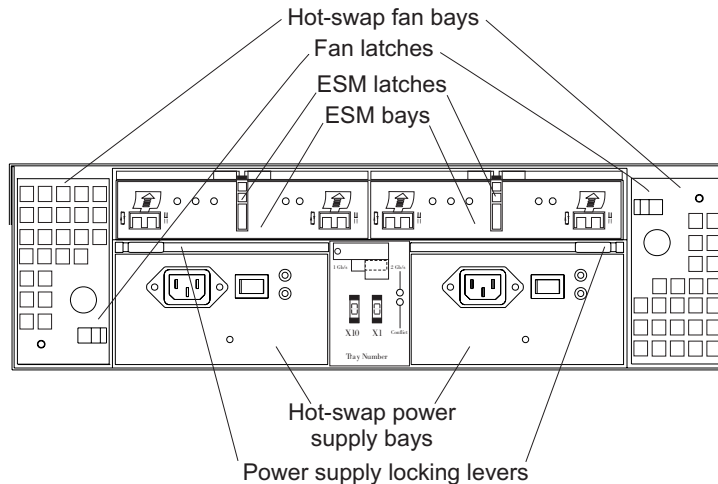
Figure 2. Hot-swap fan, ESM, and power supply bays

- **Hot-swap fan bays:** The EXP100 has two interchangeable hot-swap and redundant fan units. These two fan units are located in the hot-swap fan bays. Each fan unit contains two fans. If one fan unit fails, the second fan unit continues to operate. You must install both fan units to maintain proper cooling within your expansion enclosure, even if one fan unit is not operational.

  The fan CRUs have locking latches that secure them to the fan bays. You must unlock the latches before you can remove the fan from the expansion enclosure. When you replace a fan, you must align it properly for the side in which it is being replaced. See Figure 2.

- **ESM bays:** The EXP100 has two hot-swappable ESMs. The ESMs are located in the ESM bays. The ESMs provide a 1.5 Gbps Serial ATA interface to the drives and monitor the overall status of the expansion enclosure. Each ESM has two SFP module connector Fibre Channel ports that you use to connect your expansion enclosure to the DS4000, or to connect two or more EXP100 units together. The ESMs provide redundancy when both of them are configured into redundant Fibre Channel loops.

  Attention: See "ESM failover architecture" on page 24 for more information about ESM redundancy and failover configurations.

  After you remove an ESM, wait 70 seconds before reseating or replacing the ESM. Failure to do so may cause undesired events.

  The ESMs have locking latches that secure them to the ESM bays. You must unlock the latches before you can remove the ESM from the expansion enclosure.

- **Hot-swap power supply bays:** The EXP100 has two hot-swap and redundant power supplies. The power supplies are located in the hot-swap power supply bays. You must install both power supplies in your expansion enclosure, even if one power supply is not operational.

  The power supplies have locking levers that secure them to the power supply bays. You must unlock the levers before you can remove the power supply from the expansion enclosure. The power supplies are interchangeable, but you must mount the lever on the interior corner of the power supply CRU (that is, when viewed from the back of the unit, the power supply CRU in the left power supply bay has the lever mounted on the right side, and the one in the right power supply bay has the lever mounted on the left side). See Figure 45 on page 86.

Controls, indicators and connectors

This section describes front controls and indicators, and rear controls, indicators and connectors, including power supplies, fans, and ESMs.

Front controls and indicators

This section describes the primary controls on the front of the expansion enclosure. The locations of these primary controls are shown in Figure 3.
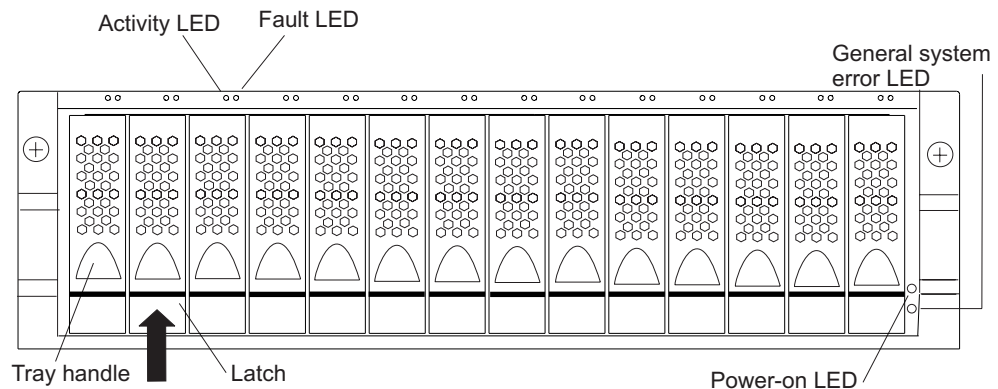
Figure 3. Front controls and indicators

The EXP100 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 expansion enclosure.

- **Activity LED:** Each drive CRU has an associated Activity LED on the EXP100 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 EXP100 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 that the unit has a power supply, fan unit, or hard disk drive error.

- **Latch:** Use this multipurpose latch to release or lock the drive CRU in place.

- **Power-on LED:** A solid green LED indicates that the expansion enclosure has dc power.

- **Tray handle:** Use this multipurpose handle to insert and remove a drive CRU in the bay.

Rear controls, indicators, and connectors

You access the two hot-swap power supply CRUs, the two hot-swap fan CRUs, and the two ESMs from the back of the expansion enclosure. These components contain several controls, indicators, and connectors.

Power supply controls, indicators, and connectors

The EXP100 has two 400-Watt hot-swappable, redundant power supplies. If one power supply fails, the remaining power supply can support all 14 disk drives running continuously. Each power supply has a Power LED and a Fault LED on the back of the EXP100. The green Power LED indicates that the power supply is detecting ac power. The amber Fault LED lights if the power supply is unable to

deliver dc power. Both power supplies must be installed to meet Electromagnetic Compatibility (EMC) and cooling requirements. Figure 4 shows the power supply and the locations of the controls, indicators, and connectors.
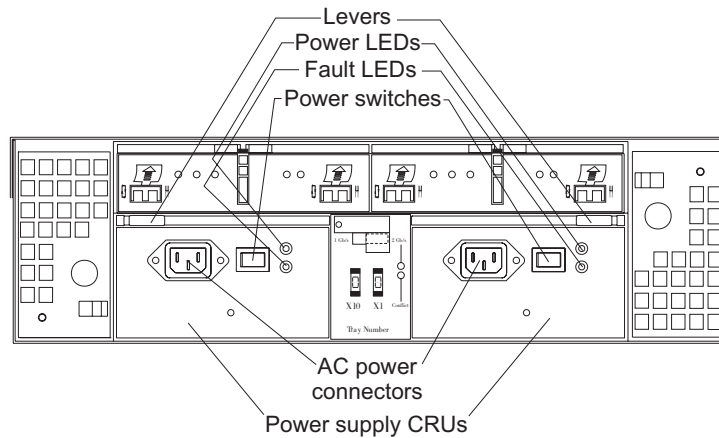
Figure 4. Power supply controls, indicators, and connectors

- **Hot-swap power supply CRUs:** The two hot-swap power supplies are located on the back of the EXP100. You must install both power supply CRUs, even if one power supply is not working.
- **Levers:** Unlock these levers when you remove or install a power supply CRU.
- **Power LEDs:** These green Power LEDs light when the expansion enclosure is turned on and receiving ac power.
- **Fault LED:** The amber Fault LEDs light if a power supply failure occurs. The Fault LED for one power supply might also light if it is powered off while the other power supply is powered on.
- **Power switches:** Use these switches to turn the power supplies on and off. You must turn on both switches to use the redundant power supplies.
- **AC power connectors:** To provide ac power to the expansion enclosure, you must connect the power cables to the ac power connectors that are located on the back of the EXP100.

Fan controls and indicators

The EXP100 has two hot-swappable and redundant fan units, as shown in Figure 5 on page 19. The fan units are located at the back of the expansion enclosure. One fan will continue to operate if the other fan fails. You can remove and replace the fan unit while the EXP100 is powered on and accessing drives.

Each fan has a temperature sensor built into the air inlet. This sensor maintains fan speed to provide the necessary air flow. If the speed of one of the fans drops to a level that is too low or stops, the Fault LED located on the back of the fan unit lights, and the General system error LED on the front of the EXP100 lights. For the locations of the LEDs on the front of the expansion enclosure, see Figure 3 on page 17. For the LEDs on the back of the expansion enclosure, see Figure 5 on page 19.

Attention: The fans in your expansion enclosure draw in fresh air and force out hot air. These fans are hot-swappable and redundant; however, when one fan fails, the fan unit must be replaced within 48 hours to maintain redundancy and optimum cooling. When you remove the failed unit, be sure to install the replacement fan unit within 10 minutes to prevent overheating.
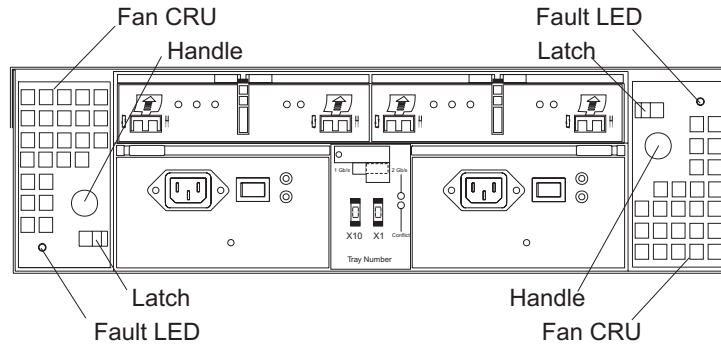
Figure 5. Fan controls and indicators

- **Fan CRUs:** The two fan CRUs are located at the back of the expansion enclosure. These fan units are hot-swappable and redundant.
- **Latches and handles:** Use the latches and handles to remove or install the fan CRUs.
- **Fault LED:** The amber fan Fault LED lights if a fan failure occurs.

ESMs and user controls

The EXP100 has two hot-swappable and redundant ESM units. The ESMs are located at the back of the expansion enclosure. One ESM will continue to operate if the other ESM fails. The ESMs contain the expansion enclosure control logic, interface ports, and LEDs. Each ESM has two SFP module ports that you use to connect the expansion enclosure to the controller. The EXP100 ESMs and user controls are shown in Figure 6 on page 20.

Attention:

- With the combination of controller firmware version 05.41.5x.xx, 6.1x.xx.xx, or later, and ESM firmware versions 9554, 956x, or later, the EXP100 provides full failover capability. If one ESM within the EXP100 expansion enclosure fails, the surviving ESM provides data paths to all 14 drives in the EXP100 expansion enclosures.

  Therefore, for full failover capability, ensure that you have the latest firmware levels. Keep in mind that R1 LHA - to - R3 FHA firmware upgrades must be performed when there are no I/Os to the DS4000, so you must schedule down time for the upgrade process.

- The 400 GB SATA drive options require ESM firmware level 956x or later. IBM strongly recommends that you check and maintain the DS4000 storage subsystem controller firmware and EXP100 ESM firmware at the latest levels posted on the IBM DS4000 storage subsystem support Web site. This ensures compatibility when existing SATA hard drives need to be replaced with the new drive options or SATA drive CRUs.

See "ESM failover architecture" on page 24 for a more detailed explanation of the failover architecture. Also, see "Current firmware support for the EXP100" on page 4 for the latest firmware information.
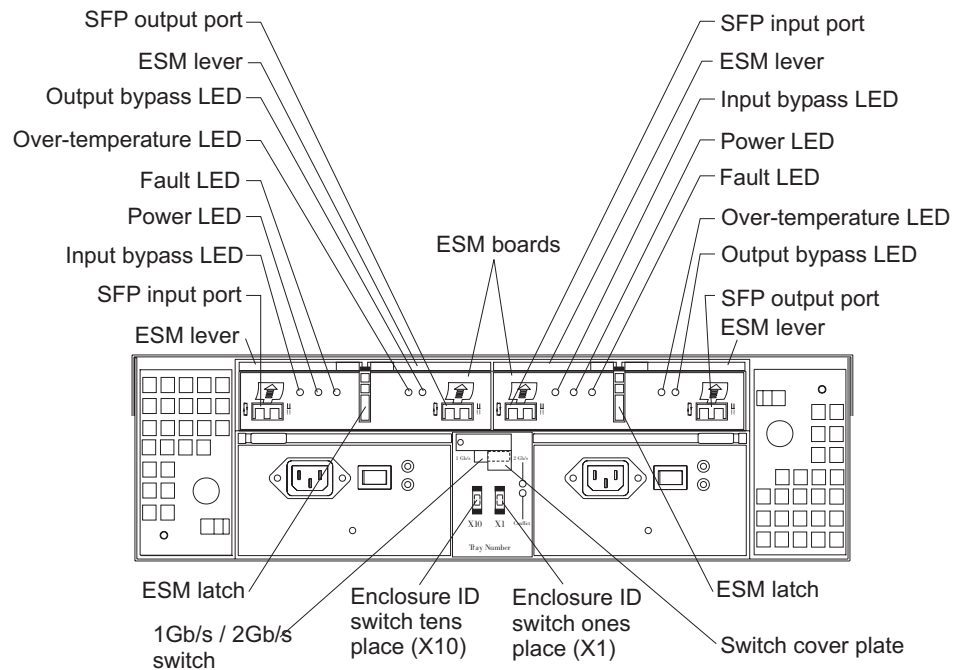
Figure 6. ESMs and user controls

The following list describes each of the user control features that are shown in Figure 6.

- **SFP module input and output ports:** Each ESM has two SFP module connector ports that you use to connect the expansion enclosure to the DS4000, or to connect two or more EXP100 expansion enclosures together. Install an SFP module into the input and output ports. Use Fibre Channel cables to connect the expansion enclosure to the DS4000 or to additional expansion enclosures.
- **ESM latch:** The ESM latch secures the ESM to the expansion enclosure.
- **ESM levers:** Unlock the ESM latch before you use the ESM levers to remove the ESM from the expansion enclosure. When you install the ESM into the bay, use the ESM levers to guide the unit into the ESM bay.
- **Fault LED:** The amber ESM Fault LED lights when an ESM failure occurs. The Fault LED also lights for approximately 15 seconds when you power on the expansion enclosure.
- **Input/output bypass LEDs:** These amber LEDs light when a faulty SFP module or fiber-optic cable is installed. Both ports on the ESM are bypassed when an ESM fault occurs and the ESM Fault LED and the Input and Output bypass LEDs light. This LED also lights if an SFP module is installed and is not connected to another device.
- **Power LED:** The green Power LED lights when there is power to the ESM.
- **Over-temperature LED:** The amber over-temperature LED lights if the expansion enclosure overheats.
- **Enclosure ID switches:** Two enclosure ID switches are located between the power supplies at the rear of the EXP100. These switches identify the EXP100 on a Fibre Channel loop. To set the values, use the end of a paper clip or a small flat-blade precision screwdriver to press the small, recessed buttons on each switch. The top (-) buttons decrease the value and the bottom (+) buttons increase the value, as shown in Figure 7 on page 21, which displays an example

value of 77. (Using both switches, you can set the Enclosure ID value from 0 to 77.)
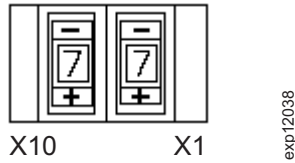
Figure 7. Enclosure ID Switch

- **1 Gbps, 2 Gbps switch:**

   The default switch setting is 2 Gbps. This is the *only* speed setting that is allowed for the EXP100.

   Attention: Do not remove the metal plate that covers the expansion enclosure speed setting. Do not adjust the expansion enclosure speed setting.

EXP100 operating environment

This section provides general operating information about the EXP100.

EXP100 specifications

Table 6 lists the specifications for the EXP100.

Table 6. IBM TotalStorage EXP100 Storage Expansion Enclosure specifications

Size	Heat dissipation
• **Width**: 48.1 cm (18.97 in.) • **Height**: 13.2 cm (5.21 in.) • **Depth**: 59.7 cm (23.52 in.) • Drive-ready weight (without disk drive modules installed): 25.9 kg (57 lb) • Fully configured weight (with 14 disk drives installed): 40.2 kg (88.4 lb)	• Fully configured expansion enclosure (14 1.5 Gbps SATA hard disk drives) – 1088 BTU per hour **Acoustical noise emission values** For open bay (0 drives installed) and typical system configurations (eight hard disk drives installed):

Electrical input
• Sine-wave input (50 - 60 Hz) is required
• Input voltage low range:
  – Minimum: 90 V ac
  – Maximum: 127 V ac
• Input voltage high range:
  – Minimum: 198 V ac
  – Maximum: 257 V ac
• Input kilovolt-amperes (kVA), approximately:
  – Minimum configuration: 0.06 kVA
  – Maximum configuration: 0.39 kVA
	• Sound power (idling):
	  – 5.9 bel (open bay)
	  – 6.1 bel (typical)
	• Sound power (operating):
	  – 5.9 bel (open bay)
	  – 6.2 bel (typical)
	• Sound pressure (idling):
	  – 44 dBA (open bay)
	  – 46 dBA (typical)
	• Sound pressure (operating):
	  – 44 dBA (open bay)
	  – 47 dBA (typical)

Environment
• Air temperature
  – Operating:
    - 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)
  – Storage:
    - Altitude: 0 - 914 m (3000 ft): 1° - 60° C (33° - 140° F)
    - Altitude: 914 m (3000 ft):
• Humidity
  – 8% - 80%
  – noncondensing
	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.

Notes:

1. In general, disk subsystem reliability tends to decrease as the ambient temperature of the environment in which it is being used increases. The ambient temperature in the immediate area of the storage expansion enclosure should be kept near 22 degrees C (72 degrees F), or lower, to provide better reliability.

2. The nonoperating environment must not exceed the operating environment limits for longer than 60 days.

3. The storage environment must not exceed the operating environment limits for longer than 1 year.

4. 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.

Heat output, airflow, and cooling

The maximum heat output of the EXP100 is 390 watts (1088 BTU/hr). Each EXP100 rack-mounted unit requires an airflow of 2.5 m^3 (87 ft^3) per minute. The input air temperature to all racks should be in the range 10° C - 35° C (50° F - 95° F).

Note: In general, disk subsystem reliability tends to decrease as the ambient temperature of the environment in which it is being used increases. The ambient temperature in the immediate area of the storage expansion enclosure should be kept near 22 degrees C (72 degrees F), or lower, to provide better reliability.

When racks that contain many EXP100s are to be installed together, the following requirements must be met to ensure that the EXP100s are adequately cooled:

- Air enters at the front of the rack and leaves at the back. To prevent the air that is leaving the rack from entering the intake of another piece of equipment, you must position the racks 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 24.

- Where racks are in rows, each rack must touch the rack 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 expansion enclosures that are in that rack. You should use Suite Attach Kits to completely seal any gaps that remain between the racks. For details about Suite Attach Kits, contact your marketing representative.

- Where racks 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, the rack filler plates must be installed in unused positions. Also, all the gaps in the front of the racks must be sealed, including the gaps between the expansion enclosures.
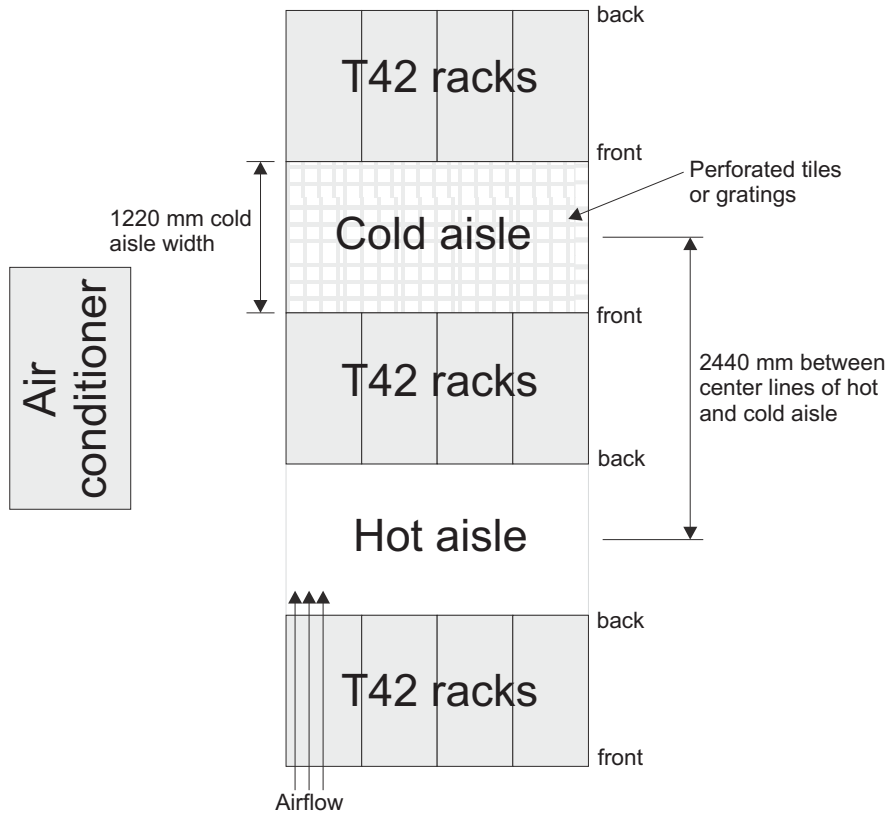
Figure 8. Example of cold aisle/hot aisle rack configuration

Shock and vibration requirements

Operational Shock: The EXP100 is able to withstand a free-fall drop from 0.5 inches onto a hard surface. Subjecting the equipment to a single shock pulse with the following characteristics simulates this level of shock:

- Velocity change = 20 inches per second
- Wave form = Triangular, 10g @ 3.75 ms

Operational Vibration (Random): While in its normal operating position, the EXP100 continues operating when subjected to a random vibration test using the criteria shown in Table 7. This test uses the indicated spectral power density for 30 minutes in each of the three axes.

Table 7. Random Vibration Power Spectral Density

Hertz	5	17	45	48	62	65	150	200	500
g^2/Hz	2.0x10^{-7}	2.2x10^{-5}	2.2x10^{-5}	2.2x10^{-5}	2.2x10^{-5}	2.2x10^{-5}	2.2x10^{-5}	2.2x10^{-5}	2.2x10^{-5}

ESM failover architecture

This section provides information about the ESM failover architecture for the EXP100, including guidelines for creating array configurations that offer maximum protection of data access in the event of ESM failure.

Understanding ESM failover architecture

With full high-availability (FHA) support, the EXP100 R2 or R3 storage expansion enclosure architecture provides full drive failover and fail-back support for a loss of connectivity due to failed components in the drive paths (such as failed SFPs, Fibre Channel cables, ESMs, and so on). In normal operation, each ESM in the EXP100 chassis manages only one-half of the drives in the EXP100 chassis even though each ESM can access all of the drives as shown in Figure 9. The left ESM manages drives at odd-numbered slots (1, 3, 5, 7, 9, 11, 13); the right ESM manages drives at even-numbered slots (2, 4, 6, 8, 10, 12, 14).

Note: In contrast to the EXP100 R2 and R3 expansion enclosures, which have ESM firmware installed that supports full high-availability, EXP100 R1 expansion enclosures have low high-availability (LHA) firmware installed. Therefore, EXP100 R1 units do not provide SATA hard drive failover or fail-back support for a loss of connectivity due to bad components in the Fibre Channel drive paths to the ESM (such as failed SFPs or Fibre Channel cables). They also do not provide failover or fail-back support for the loss of an ESM that is in a failed/fault state or that is removed from the EXP100 expansion enclosure chassis. In this case, the controller displays the drive slots that are controlled by this ESM as empty, and treats the drives inserted in those slots as failed/missing. For more information about the differences between the different types of EXP100s, see Table 5 on page 7.

Figure 9 shows a high-level block diagram of the EXP100 ESM failover architecture.
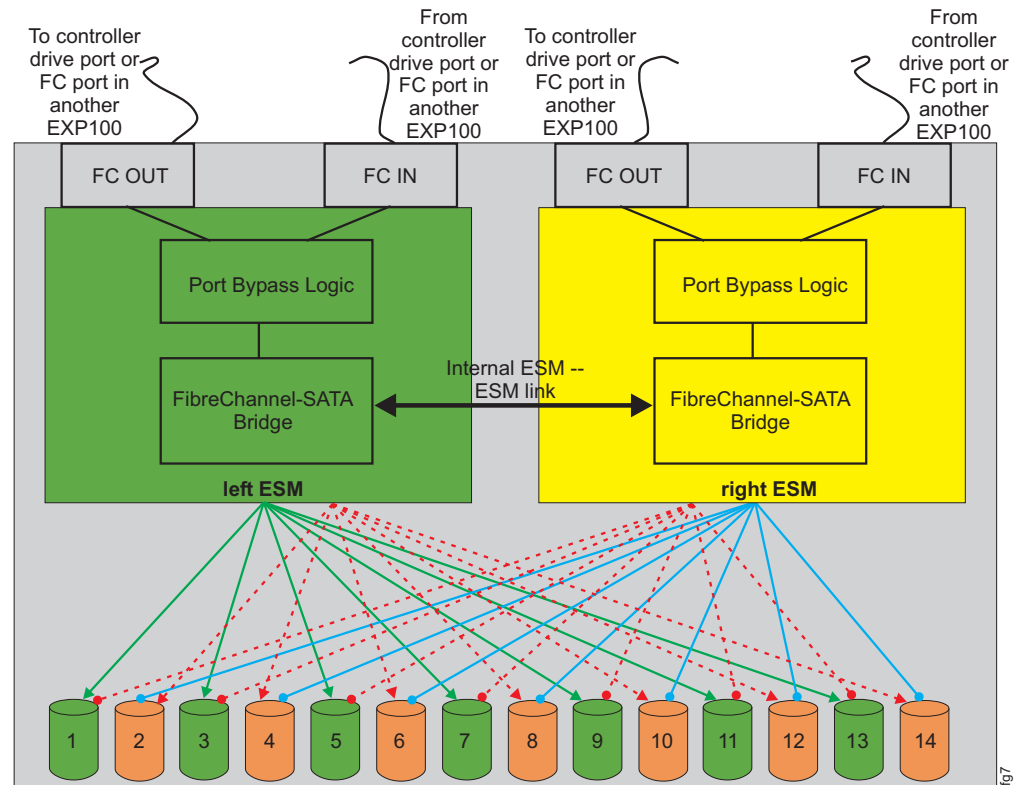
Note: Solid lines show normal operation paths. Dashed lines show alternate paths when normal paths fail.

Figure 9. EXP100 ESM and drive paths

If there are failures in the Fibre Channel data path to an ESM in the EXP100 storage expansion enclosure, the DS4000 controller reroutes its data to the ESM that it still can access by way of the Fibre Channel path. Then, the ESM routes the data to the ESM that had Fibre Channel connection problems using the internal ESM-ESM data path. This ESM in turn transfers the data to the disk drives that it had controlled. Furthermore, if one of the ESMs fails, the other ESMs assume control of all the drives and routes data to the drives of the failed ESM using the dashed alternate paths shown in Figure 9 on page 25.

Unless there are failures in both ESMs or there are failures in the Fibre Channel connections to both ESMs in the EXP100 chassis, the controller and ESM firmware work together to ensure that there is no loss of data availability. Figure 10 shows that if the Fibre Channel connection to the left ESM is bad, then the data to drive 1, which is controlled by the left ESM, is routed through the right ESM Fibre Channel input connection to the right ESM, then through the internal ESM-ESM link to the left ESM, and then to drive 1.
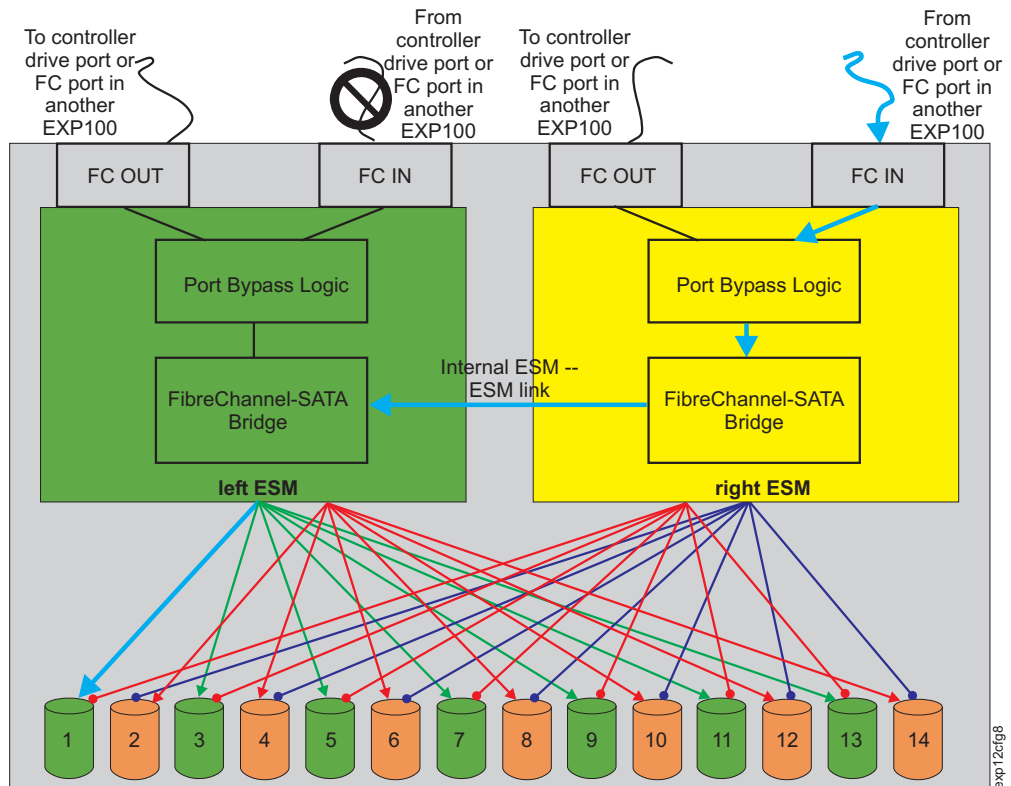
Figure 10. The right ESM and controller firmware recover from a loss of connectivity to the input port of the left ESM

However, if one of the ESMs fails, the surviving ESM manages I/Os to all of the drives in the EXP100 chassis, as shown in Figure 11 on page 27.
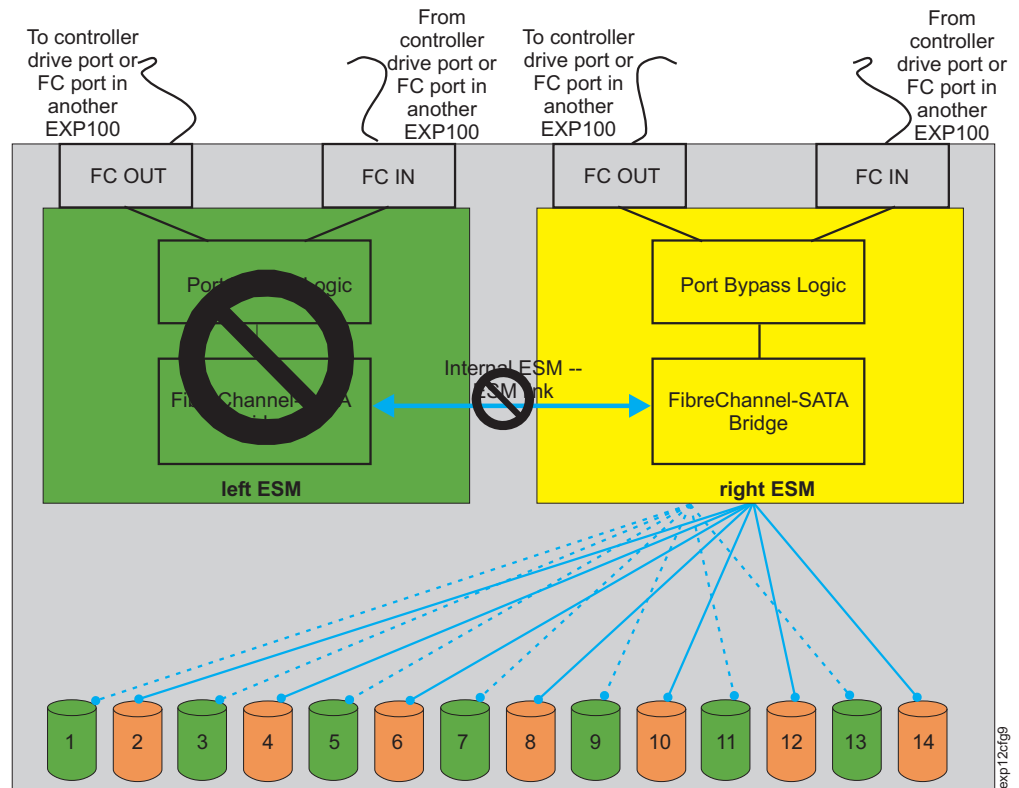
Figure 11. Right ESM reroutes I/Os along dashed alternate paths

To protect against multiple failures like failures in both ESMs, failures in the Fibre Channel connections to both ESMs in the EXP100 chassis, or a failure in the whole EXP100 chassis, you should follow the guidelines outlined in the next section.

Configuration guidelines

- To protect against hard drive failure, reserve at least one drive in each EXP100 enclosure as a global hot-spare drive.
- The best way to protect against the loss of data availability due to ESM or EXP100 failure is to orthogonally stripe the array over multiple expansion enclosures. The disadvantage of this method lies in the number of EXP100 expansion enclosures that you need for this type of striping.

  To orthogonally stripe the array over multiple expansion enclosures, you must have one EXP100 expansion enclosure available for every drive that is to be defined in a RAID array. This means you would need two EXP100 expansion enclosures to create a two-drive RAID-1. For a five-drive RAID-5 array, you would need five EXP100 expansion enclosures (and so on, up to the maximum number of EXP100s that are supported with a particular storage subsystem – eight expansion enclosures for the DS4300 and 16 expansion enclosures for the DS4500).

  Figure 12 on page 28 and Figure 13 on page 28 show examples of arrays that are orthogonally striped over multiple EXP100 expansion enclosures. If an ESM in a EXP100 failed, or even if the entire EXP100 expansion enclosure failed, the defined arrays would enter a Degraded (but not Failed) state. Consequently, no direct data availability impact would occur in this situation, and ESM replacement could be used to restore the system to a fully optimal state without any loss of access to data.

For example, in Figure 12, an 8-drive RAID-1 array would be comprised of A1, B1, C1, and so on, through H1. In Figure 13, an 8-drive RAID-1 array would be comprised of A1, B2, C1, and so on, through H2. Similarly, in Figure 12, an 8-drive RAID-5 array would be comprised of A1, B1, C1, and so on, through H1. In Figure 13, an 8-drive RAID-5 array would be comprised of A1, B2, C1, and so on, through H2.
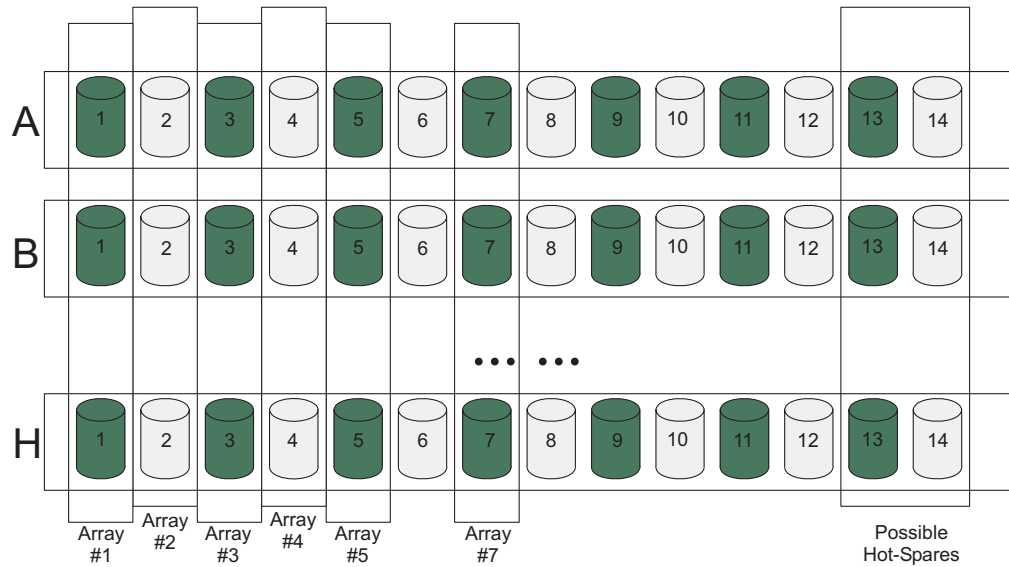
Figure 12. Orthogonally striped RAID arrays – Option 1
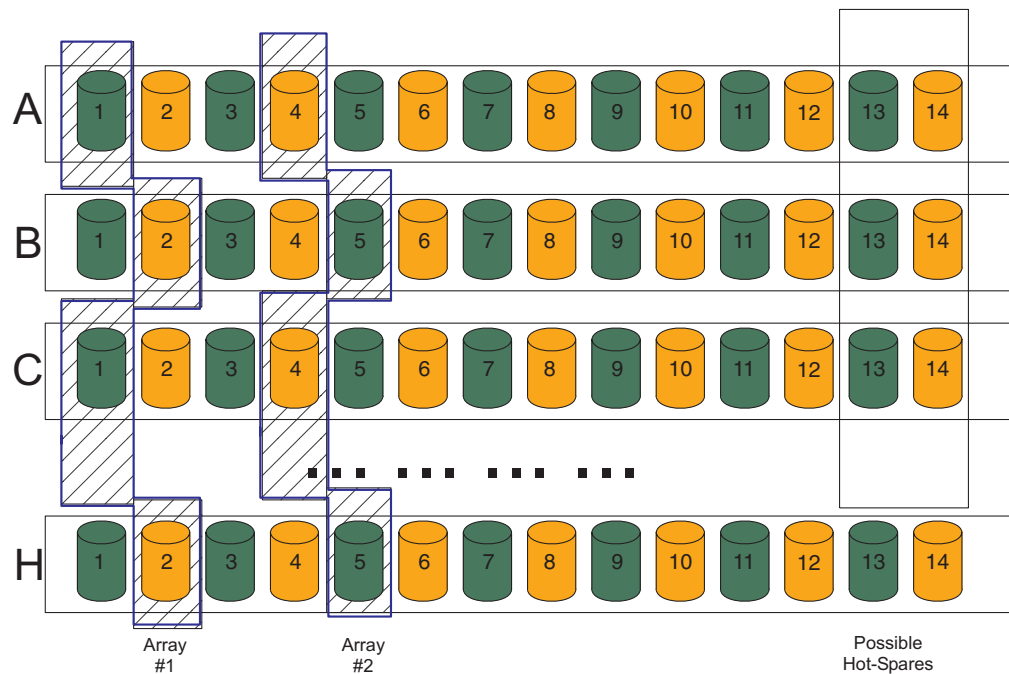
Figure 13. Orthogonally striped RAID arrays – Option 2

Chapter 2. Installing the EXP100

This chapter provides the information that you need to prepare the EXP100 for installation into a rack cabinet. This chapter also contains information about cabling, setting interface options, and installing optional cables.

The following sequence summarizes the installation steps you will perform in this chapter.

1. Prepare the installation site and the rack cabinet. Unpack the EXP100 and other hardware from the shipping box. See "Preparing for installation" on page 30.

   Statement 4:

18-32 kg (39.7-70.5 lbs)	32-55 kg (70.5-121.2 lbs)	≥55 kg (≥121.2 lbs)

   CAUTION:
   Use safe practices when lifting.

   Attention: The EXP100 weighs up to 40.2 kg (88.4 lb). At least two other people should help you lift the EXP100 from the shipping box. If desired, open the sides of the shipping box and remove the CRUs from the EXP100 before you lift it from the shipping box in order to lighten the expansion enclosure. See "Removing the CRUs" on page 37.

2. Install the support rails in the rack. See "Installing the support rails" on page 34.

3. If necessary, remove the CRUs from the EXP100. See "Removing the CRUs" on page 37.

4. Install the EXP100. See "Installing the EXP100 into a rack" on page 40. If necessary, replace the CRUs in the EXP100. See "Replacing the EXP100 CRUs" on page 41.

5. Set the EXP100 interface options. See "Setting the interface options" on page 44.

6. Cable the EXP100 to other EXP100s or to a DS4000. See "Cabling the EXP100" on page 46.

7. Install the DS4000 Storage Manager 9.1 host software. Refer to the IBM System Storage DS4000 Storage Manager 9 Installation and Support Guide for the appropriate operating system for instructions on how to install the DS4000 Storage Manager 9.1 host software.

8. Upgrade the controller firmware in the DS4000 storage subsystem to the correct version for your specific storage subsystem configuration, as indicated in the DS4000 readme files located at the following Web site:

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

   Note: If your DS4000 storage subsystem shipped preloaded with controller firmware, you might not need to upgrade the firmware. However, it is still recommended to upgrade to the latest version of the firmware for you specific storage subsystem model. In addition, for FC/SATA Intermix

configurations, see the firmware information that is listed in the *IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview*

9. Turn on the EXP100. See "Turning the EXP100 on and off" on page 59.
10. Turn on the DS4000 storage subsystem and use the DS4000 Storage Manager 9.1 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, 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 EXP100 for installation into a rack cabinet.

1. Prepare the site to meet all area, environmental, power, and site requirements. For more information, see "EXP100 operating environment" on page 21.
2. Move the EXP100 to the site.

   Statement 4:

18-32 kg (39.7-70.5 lbs)	32-55 kg (70.5-121.2 lbs)	≥55 kg (≥121.2 lbs)

   CAUTION:
   Use safe practices when lifting.

3. Remove the EXP100 from its shipping container and check the contents (see "Inventory checklist" on page 14). 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 EXP100
   - Number 2 Phillips and medium flat-blade screwdrivers
   - Antistatic protection (such as a grounding wrist strap)
   - Fibre Channel (FC) and Ethernet interface cables and cable straps
   - SFP modules
   - The rack-mounting hardware that ships with the EXP100
   - IBM DS4000 Storage Manager 9.1 software and DS4000 controller firmware that ships with the EXP100. You use this software to configure the storage subsystems.

     Note: Different models may have different firmware versions, see Table 3 on page 5.
5. Continue with "Preparing the site."

Preparing the site

This section lists the floor space requirements and weight information for the EXP100. For information on interface cables and connections, see "Cabling the EXP100" on page 46.

Floor space: The floor area at the installation site must provide the following conditions:
- Enough stability to support the weight of the fully configured EXP100 and associated systems
- Sufficient space to install the EXP100

Weight: The EXP100 total weight depends on the number of 1.5 Gbps SATA hard disk drives that are installed. A fully configured EXP100 with two fans, two power supplies, two ESMs, and up to 14 SATA hard disk drives installed weighs 40.2 kg (88.4 lbs).

Continue with "Preparing the rack."

Preparing the rack

Important: Before you install the EXP100 in a rack, keep in mind the following considerations:
- Review the documentation that comes with your rack enclosure for safety and cabling considerations.
- Install the EXP100 in a maximum 35° C (95° 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 starting at the bottom.
- If you install multiple components in the rack, do not overload the power outlets.
- Always connect the expansion enclosure to a properly grounded outlet.

Complete the following steps to prepare the rack before you install the EXP100:
1. Move, unpack, and level the rack 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.

4. If necessary, turn off all storage expansion enclosure and rack 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 EXP100."

Installing the EXP100

This section provides instructions on how to install the EXP100 in a rack.

Rack mounting template

Attention: Duplicate copies of the rack mounting templates are provided in Appendix C, "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 C, "Rack mounting template," on page 121 rather than the copies provided in this section.

Use the following templates (Figure 14 on page 33 and Figure 15 on page 34) to identify the proper locations for inserting M6 screws when mounting the support rails and EXP100 to a rack. The locations for the M6 screws are highlighted in the templates.

The EXP100 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 might be round, square, or threaded.

3 U - - - - - - - - - - - -   - - - - - - - - - - - - 3 U

EXP100
FRONT
Rack Mounting
Template

2 U - - - - - - - - - - - -   - - - - - - - - - - - - 2 U

← ☐ Bezel
    (Front Left)

Bezel
(Front Right) ☐ →

1 U - - - - - - - - - - - -   - - - - - - - - - - - - 1 U

☐ Rail assembly
   (Front Left)

Rail assembly
(Front Right) ☐

0 U - - - - - - - - - - - -   - - - - - - - - - - - - 0 U
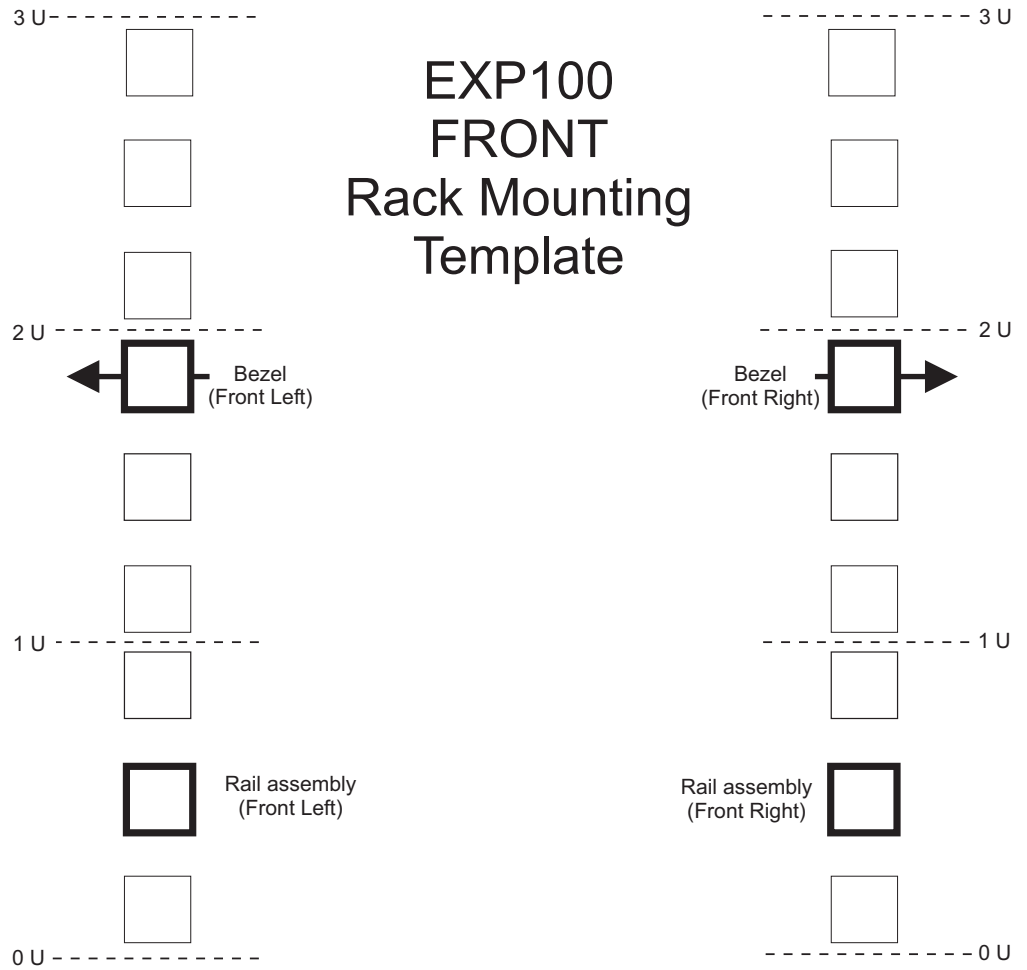
Figure 14. Front rack mounting template

EXP100
REAR
Rack Mounting
Template

3U

2U

1U

Rail assembly
(Rear Left)

0U

3U

2U

1U

Rail assembly
(Rear right)

IBM®

Printed in the U.S.A

0U
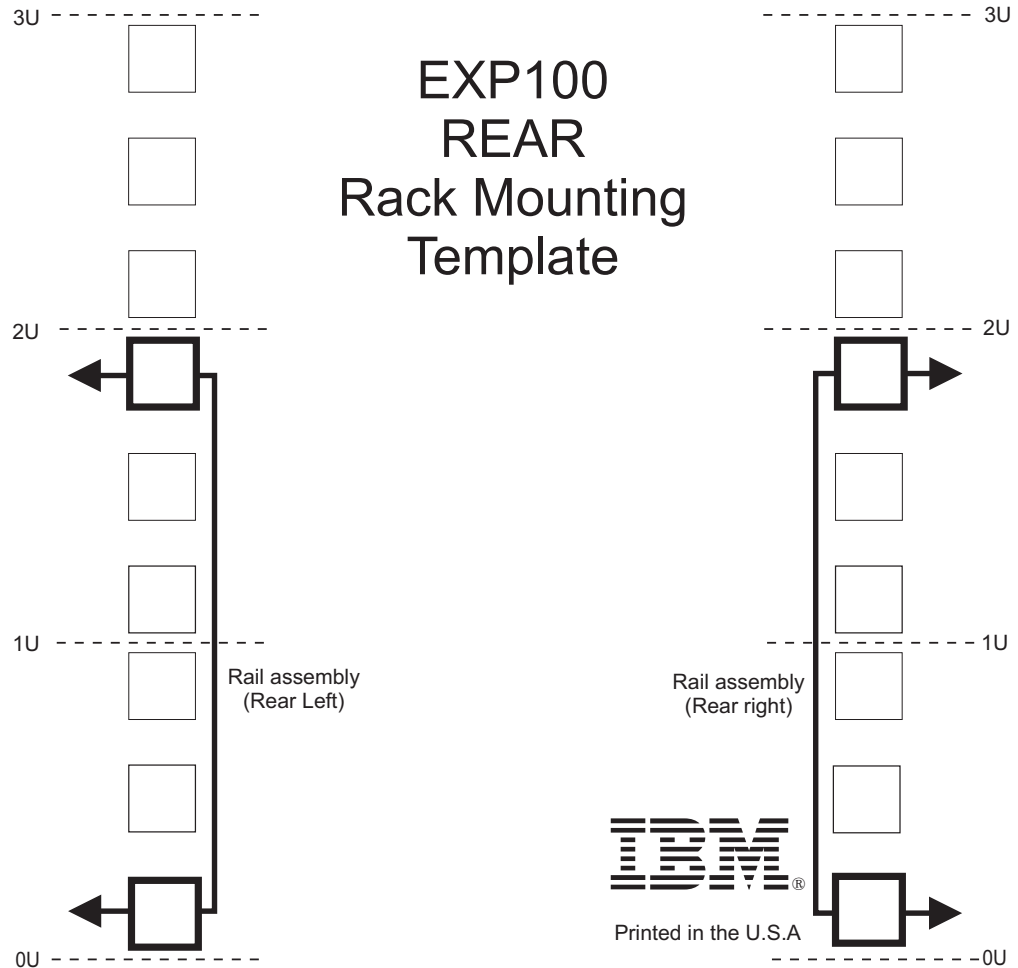
Figure 15. Rear rack mounting template

Installing the support rails

Before installing the EXP100 in a rack, you must install the rails and rack-mounting hardware that come with your expansion enclosure. The EXP100 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, is 60.96 cm (24 in.) minimum and 81.28 cm (32 in.) maximum. This rack conforms to the EIA standard. Where you place the support rails in the rack depends on where you intend to position the expansion enclosure.

Complete the following steps to install the support rails:

Note: Refer to Figure 17 on page 36 while performing these steps.

1. Ensure that the rack has already been installed.
2. Ensure that a stabilizer has been correctly attached to the bottom front of the rack to prevent the rack from tipping forward while the EXP100 is being installed.

   Refer to the installation and service guide, or equivalent, for the rack as required.
3. Locate the two support rails and six of the eight M6 screws that are supplied with the EXP100.

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. See Figure 16.
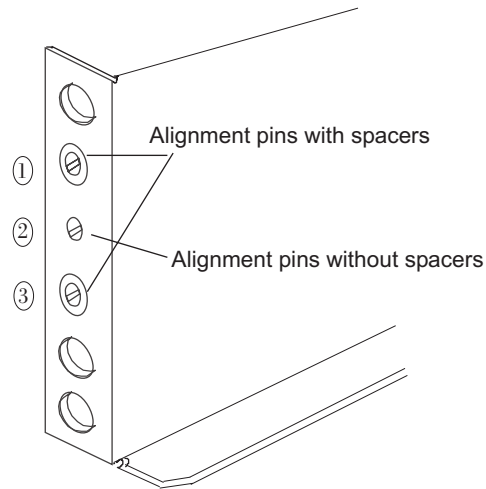
Figure 16. Alignment pins with and without spacers

Depending on which type of rack mounting flange is present on your rack, you might have to remove some or all of the alignment pins. For example, if the rack 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. See Table 8.

Table 8. 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

4. 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 14 on page 33 and Figure 15 on page 34 to locate the proper rack mounting holes for installing the support rails into the rack.

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

   - If you are installing the EXP100 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 EXP100 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.

5. 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. Figure 17 shows the installation of the left support rail.

6. 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 14 on page 33 for the location for this screw.

7. Extend the rear of the support rail until it makes contact with the rear rack rail.

8. From the rear of the rack, thread and tighten two M6 screws (**1**) (see Figure 15 on page 34 for the location for these screws). From the front of the rack, finish tightening the front M6 screw (**4**).

   When you are the 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.

9. Repeat step 5 through step 8 for the right rail.
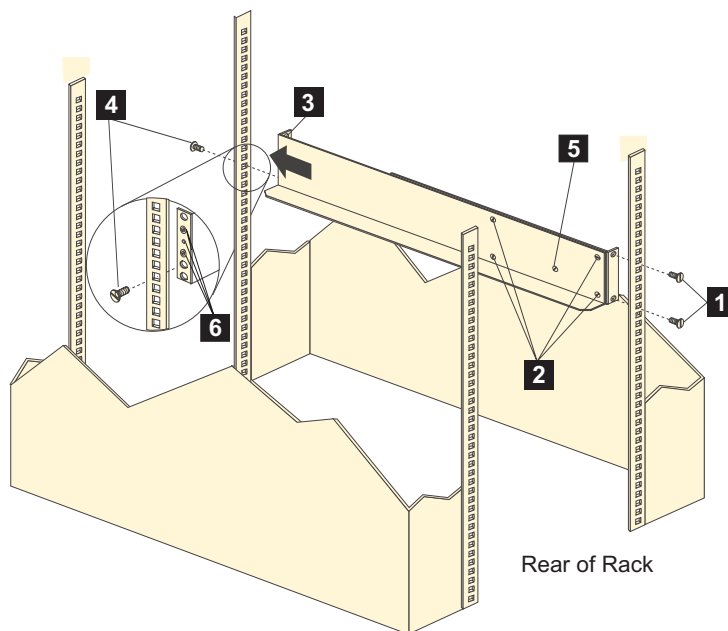
Figure 17. Installing the support rails

10. Tighten the rail adjustment screws **2** on both rails.
11. Continue with "Removing the CRUs" on page 37.

Removing the CRUs

Attention: This section describes how to remove the CRUs in order to minimize the weight of the EXP100 before you install it in the rack. However, if you have three or more people available to lift and install the EXP100 in a rack, you might not find it necessary to remove the CRUs before you install the EXP100. If this is the case, you can skip the CRU removal instructions provided in this section. Instead, continue with "Installing the EXP100 into a rack" on page 40, and then skip the CRU replacement instructions provided in "Replacing the EXP100 CRUs" on page 41.

Use the following procedures to remove the CRUs from the EXP100 before installation. Use these instructions after you have completed all applicable site, rack, and EXP100 preparations (as discussed in "Preparing for installation" on page 30) and installed the support rails (as discussed in "Installing the support rails" on page 34). Alternately, if necessary, you can use these instructions to lighten the EXP100 before removing it from the shipping box. The shipping box opens to provide access to the expansion enclosure CRUs.

The EXP100 comes with a rack-mounting hardware kit for installing it in a rack. It is easier to lift the EXP100 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 30. In the following procedure, you will remove the following CRUs from the expansion enclosure before you install it in the rack:

- ESMs
- Power supplies
- Fans
- Hot-swap hard disk drives

You do not need to remove the blank trays.

Statement 4:

18-32 kg (39.7-70.5 lbs)	32-55 kg (70.5-121.2 lbs)	≥55 kg (≥121.2 lbs)

svc00146

CAUTION:
Use safe practices when lifting.

Attention: The expansion enclosure 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 an ESM
Complete the following steps to remove an ESM:

Attention: After you remove an ESM, wait 70 seconds before reseating or replacing the ESM. Failure to do so may cause undesired events.

1. Push down on the ESM latch. While holding down the ESM latch, grasp the pull rings and pull out on the levers to disconnect the ESM from the EXP100 midplane.

2. Remove the ESM from the bay, as shown in Figure 18.
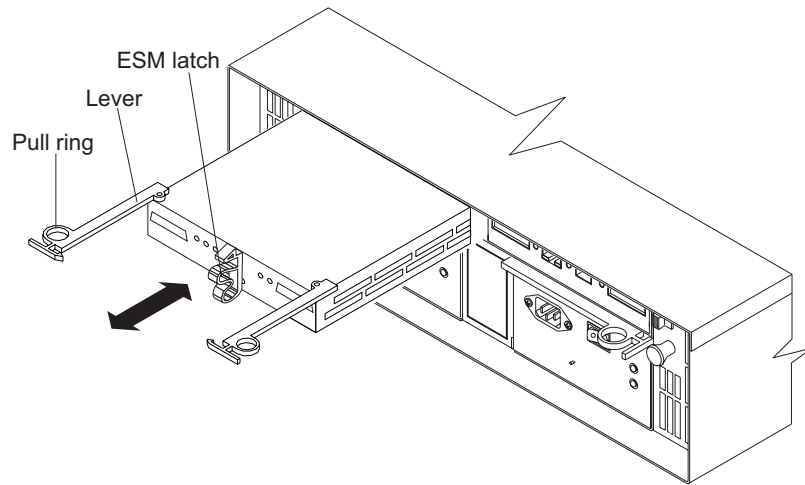
Figure 18. Removing an ESM

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

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 19.
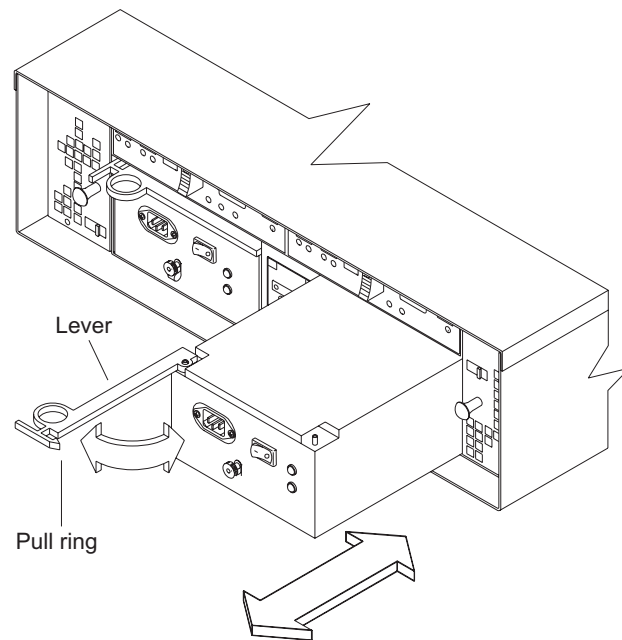
Figure 19. Removing a power supply

3. Place the power supply on a level surface.
4. Repeat step 1 through step 3 for the second power supply.

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 20.
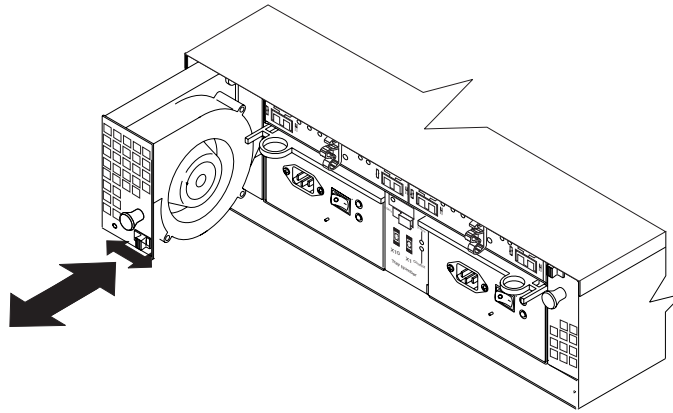
Figure 20. Removing a fan unit

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 drive from the tray.

Attention: After you remove a drive CRU, wait 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.

1. Use Table 23 on page 120 to record the location and identify your 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 21 on page 40.

Tray handle
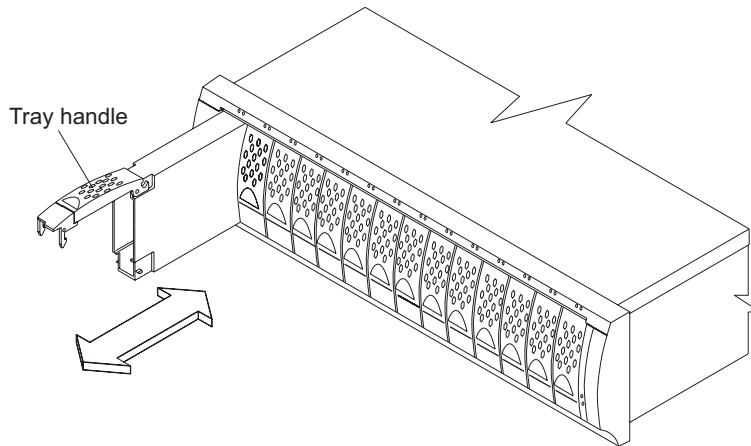
Figure 21. Removing a drive CRU

4. Place the drive CRU horizontally on a level surface.

   Attention: Do not stack drive CRUs on top of one another.

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

Continue with "Installing the EXP100 into a rack."

Installing the EXP100 into a rack

Complete the following steps to install the EXP100 in the rack.

1. Place the EXP100 in the rack.

   Note: If you have removed the CRUs from the EXP100, 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.

   a. Move the EXP100 to the front of the rack-mount cabinet.

   b. With help from another person, place the back of the expansion enclosure on the support rails. Slide the unit into the rack, as shown in Figure 22 on page 41.

Front of Rack
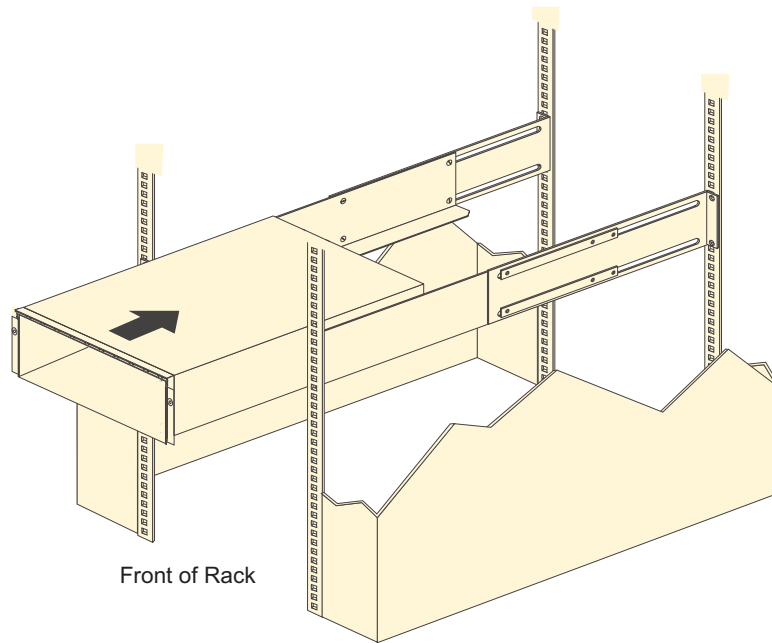
Figure 22. Installing the EXP100

2. The bezel is secured to the front of the EXP100 either by plastic wingnuts or by adhesive tape. Remove and discard the wingnuts or the adhesive tape. The bezel should remain attached to the EXP100 chassis.

    Attention: The bottom cross member of the bezel has a tab that must fit beneath the EXP100 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 EXP100 chassis.

3. Secure the EXP100 to the rack:

    a. Align the front mounting holes on each side of the expansion enclosure with the mounting holes on the front of the support rails.

    b. Install the bezel.

    c. Insert an M6 screw into the upper mounting hole on both sides of the front of the unit (see Figure 14 on page 33). Gently tighten the screws to secure the bezel and the front of the EXP100 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, insert the two 6/32 in. screws (**5** in Figure 17 on page 36), one on each side, in the holes on the side of the unit. Tighten the screws.

4. Continue with one of the following actions:

    *   If you did remove the EXP100 CRUs before installation (as described in "Removing the CRUs" on page 37), continue with "Replacing the EXP100 CRUs."

    *   If you did not find it necessary to remove the EXP100 CRUs before installation, continue with "Setting the interface options" on page 44.

Replacing the EXP100 CRUs

Use the following procedures to replace the CRUs in the EXP100 after installation.

Replacing an ESM

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

Attention: After you remove an ESM, wait 70 seconds before reseating or replacing the ESM. Failure to do so may cause undesired events.

1. Slide one ESM into the empty slot in the expansion enclosure. Be sure that the levers are pulled straight out as you slide the ESM in, as shown in Figure 23.
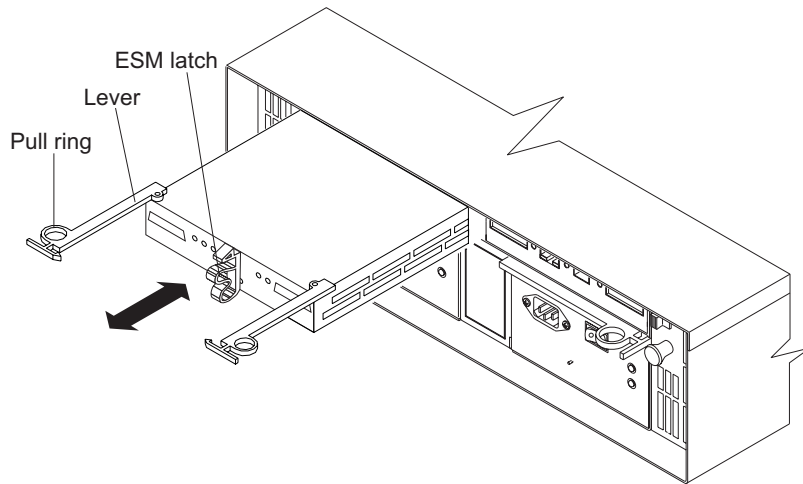
Figure 23. Replacing an ESM

2. After you install the ESM into the bay, the ESM latch locks into place. Close the levers until the pull-ring latches lock in place.

   Attention: Make sure that the levers lock into place in the expansion enclosure chassis.

3. Repeat step 1 and step 2 to replace the second ESM.

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 expansion enclosure. Be sure to replace the power supplies so that the lever on each power supply opens toward the interior of the expansion enclosure, as shown in Figure 24 on page 43.

   Attention: Be sure that the lever is pulled straight out as you slide the power supply into the expansion enclosure, as shown in Figure 24 on page 43.
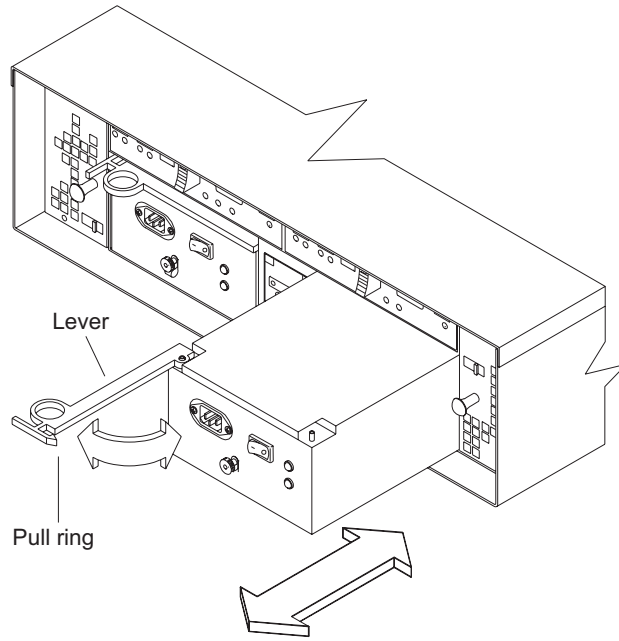
Figure 24. Replacing a power supply

2. Close the lever until the pull-ring latch locks in place. Make sure that the lever locks into place in the expansion enclosure chassis. Then gently push the front of the power supply to ensure that it is fully seated.

3. 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 25).
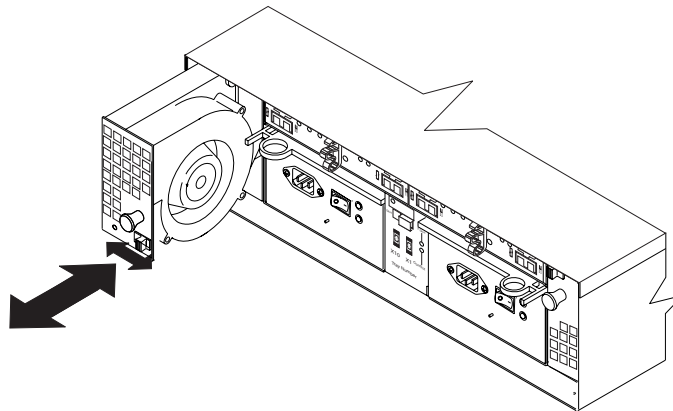
Figure 25. Replacing a fan

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.

Attention: After you remove a drive CRU, wait 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: Use Table 23 on page 120 to verify the proper replacement locations of your 1.5 Gbps SATA hard disk drives.

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 expansion enclosure 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 EXP100 has two enclosure ID switches that identify the EXP100 on a Fibre Channel loop and that assign physical addresses to the drives. The enclosure ID switches are located on the back of the expansion enclosure, as shown in Figure 26.
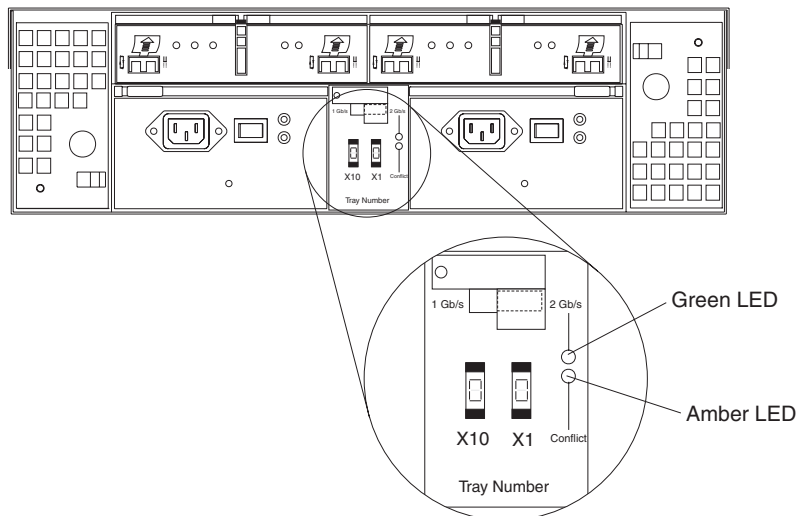
Figure 26. Enclosure ID switches

Fibre Channel loop and ID settings

When you install a hard disk drive in the expansion enclosure, 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.

Enclosure ID settings

Enclosure ID switch settings (values 0 - 7) set various addresses and IDs. Use enclosure ID switch X1 to set the ones position, and use enclosure ID switch X10 to set the tens position. The settings of the two enclosure ID switches, when used together, provide a two-digit ID of the expansion enclosure. The storage

management software uses the enclosure ID to provide a correlation between the storage management graphics and the physical expansion enclosure. The ID indicates which physical unit corresponds to the storage management software status.

Use the end of a paper clip to push the buttons on the enclosure ID switches X10 and X1 to set the enclosure ID of the EXP100 to any value from 0 - 77. See Figure 27 on page 46. Each expansion enclosure that is connected to a DS4000 should have a unique ID. The ID must be different from all other expansion enclosures that are connected to the DS4000 storage subsystem, including the storage subsystem (if it has internal drive slots). For example, with four enclosures attached to a DS4000 in a redundant drive loop pair, the correct enclosure ID settings should be x1, x2, x3, and x4 (where x can be any digits that can be set). Examples of incorrect settings would be 11, 21, 31, 41; or 12, 22, 32 62. These examples are incorrect because the x1 digits are the same in all enclosure IDs (either 1 or 2).

Note: If the enclosure IDs are not unique, an error will be posted in the DS4000 storage subsystem Major Event Log (MEL). Also, the Enclosure ID Conflict LED will be lit on the enclosure with the same enclosure ID.

In addition, 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.

Requirement: You must give each enclosure (including the storage subsystem, if it has internal drives slots) in a redundant drive loop a unique ones (x1) digit 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 ID is 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. Use the enclosure ID tens (x10) digit setting for the storage expansion enclosures in the second redundant drive loop. (This was previously a best practice recommendation, but it is now a requirement.)

The problem with soft AL_PA addressing is that AL_PA addresses may change between LIPs. This possibility increases the difficulty of troubleshooting drive loop problems because it is not easy to ascertain whether the same device with a different address or a different device may be causing a problem. In addition, if you do not set the single digit of each enclosure ID in a redundant drive loop/channel pair to be unique among enclosures (including the storage subsystem, if it has internal drive slots), then drive loop errors might be randomly posted in the Major Event Log (MEL). This is especially true when EXP100s are intermixed with EXP810s behind a DS4300 or DS4500 storage subsystem.

Important: Changing enclosure IDs on 14-drive enclosures with the mechanical enclosure ID switch (such as EXP100s) requires the power cycle of the DS4000 subsystem and all enclosures in the configuration to activate the new settings. If the enclosure IDs in your DS4000 subsystem configuration are not currently set to have unique single digit values for the enclosures in the same redundant drive loop pair, make the changes to the enclosure IDs in the next maintenance schedule. This will prevent unnecessary downtime when you add enclosures of different type (especially EXP810s) to the existing enclosures in the redundant drive loop pair.
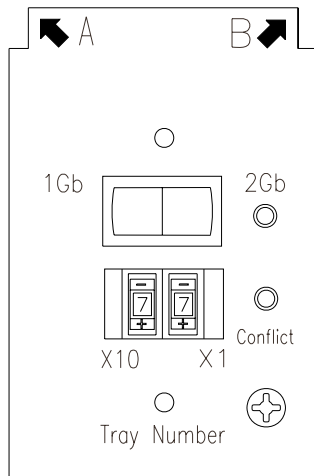
Figure 27. Enclosure ID settings

Expansion enclosure speed settings

The default switch setting is 2 Gbps. This is the *only* speed setting allowed for the EXP100.

Attention: Do not remove the metal plate that covers the expansion enclosure speed setting. Do not adjust the expansion enclosure speed setting.

Cabling the EXP100

The EXP100 supports two redundant drive loops. A redundant EXP100 drive loop consists of one or more expansion enclosures that are connected to a DS4000 storage subsystem using two sets of Fibre Channel cables. If one Fibre Channel drive loop fails, the storage subsystem uses the other drive loop to maintain input/output (I/O) to the EXP100 drives. Usually, there are two redundant array of independent disks (RAID) controllers in a DS4000 storage subsystem. Use the *Fibre Channel Cabling Instructions* that ships with your storage subsystem for the specific information about cabling the EXP100. Before cabling the expansion enclosure, read the following information:

- **Fibre Channel loop:** A Fibre Channel loop consists of EXP100 storage expansion enclosures that are connected to each other and to one or more RAID controllers. A loop can support multiple RAID controllers, multiple EXP100 expansion enclosures, and other addressable entities such as system-management logic chips. Refer to your storage subsystem documentation for information about controller-dependent hardware configuration. Some controllers might have restrictions on the maximum number of disk drives that can be supported on a loop, cabling restrictions, and other requirements.

- **SFP module ports:** The EXP100 supports large, complex, and redundant disk drive loop configurations. Each ESM has two SFP module ports. Each SFP module has an input and output port. A loop is created by connecting one or more EXP100 expansion enclosures to one or more RAID controllers.

- **Fibre Channel cable restrictions:** RAID controllers use specific IBM Fibre Channel options. Refer to the *IBM TotalStorage DS4000 Hardware Maintenance*

Manual, the *IBM DS4000 Problem Determination Guide*, or your IBM representatives or resellers for the cable option that is required for your configuration.

- **Power cabling:** The EXP100 uses two standard power cables. You can connect the power cables to a primary power unit inside the rack, such as a properly grounded ac distribution unit or uninterruptible power supply. You can also connect the power cable to an external source, such as a properly grounded electrical outlet.

  Note: To ensure maximum availability of power to your EXP100, do not connect both the left and right power supplies to the same power circuit or power source.

Installing SFP modules

The EXP100 requires SFP modules. SFP modules convert electrical signals to optical signals that are required for Fibre Channel transmission to and from RAID controllers. After you install the SFP modules, you use fiber-optic cables to connect the EXP100 to a DS4000.

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

- Do not mix long-wave SFPs and short-wave SFPs on a single DS4000 storage subsystem. 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.

  Attention: In addition, do not use long-wave SFPs or GBICs in any of the Fibre Channel ports in the Fibre Channel drive loops. (Long-wave SFPs and GBICs are not supported for use in the drive ports of storage expansion enclosures. Long-wave SFPs and GBICs are only supported in the host ports of the DS4000 storage subsystem).

- The SFP module housing has an integral guide key that is designed to prevent you from inserting the SFP module improperly.

- Use minimal pressure when inserting an SFP module into an SFP port. Forcing the SFP module into a port could cause damage to the SFP module or to the port.

- You can insert or remove the SFP module while the port is powered on.

- The operational or redundant 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. Refer to "Removing SFP modules" on page 50 for more information.

Complete the following steps to install 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.

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 30.
1. Remove the SFP module from its static-protective package.
2. Remove the protective cap from the SFP module, as shown in Figure 28. Save the protective cap for future use.
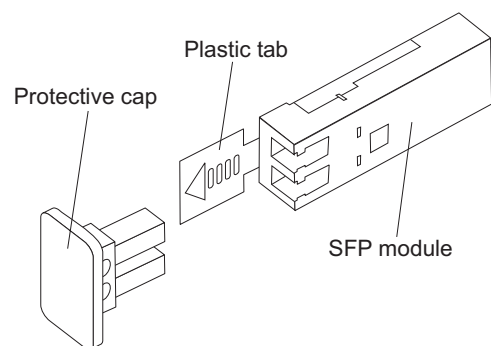
Figure 28. SFP module and protective cap

3. Remove the protective cap from the SFP port. Save the protective cap for future use.
4. Insert the SFP module into the host port until it clicks into place. See Figure 29 on page 50.
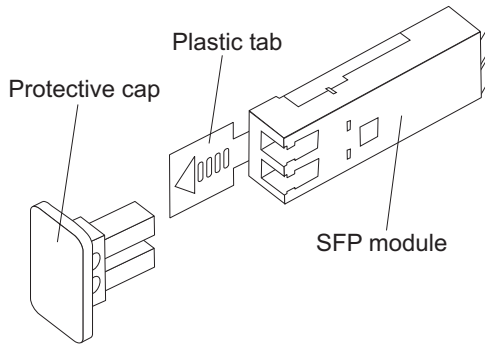
Figure 29. Installing an SFP module into the host port

5. Connect an LC-LC Fibre Channel cable. For information about the LC-LC cable, see "Using LC-LC Fibre Channel cables" on page 51.

Removing SFP modules

Complete the following steps to remove the SFP module from the host port:

Attention: To avoid damage to the cable or to the SFP module, make sure that 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 51.
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 30.
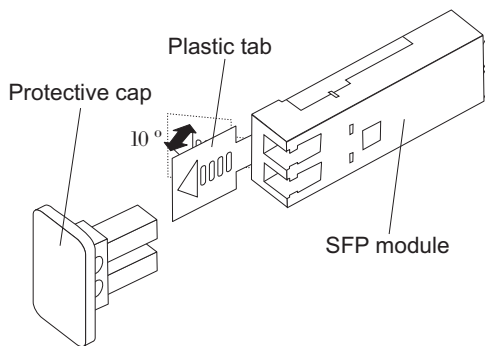
Figure 30. Unlocking the SFP module latch - plastic variety

   - For SFP modules that contain wire tabs, unlock the SFP module latch by pulling the wire latch outward 90°, as shown in Figure 31 on page 51.
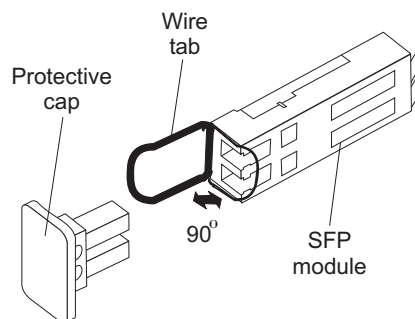
Figure 31. Unlocking the SFP module latch - wire variety

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 mini-hub 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 host port.

Handling fiber-optic cables

Attention: To avoid damage to your fiber-optic cables, follow these guidelines:
- Do not route the cable along a folding cable-management arm.
- When connecting cables 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.
- 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.

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 EXP100 Storage Expansion Enclosure
- An SFP module installed in an IBM DS4000 Storage Subsystem

See Figure 32 on page 52 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.
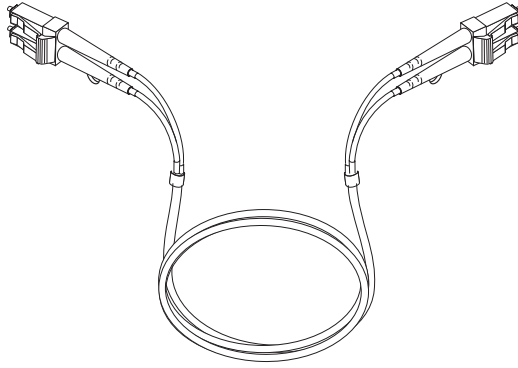
Figure 32. LC-LC Fibre Channel cable

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 51.
2. If necessary, remove the protective cap from the SFP module, as shown in Figure 28 on page 49. 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 33 on page 53. Save the protective caps for future use.
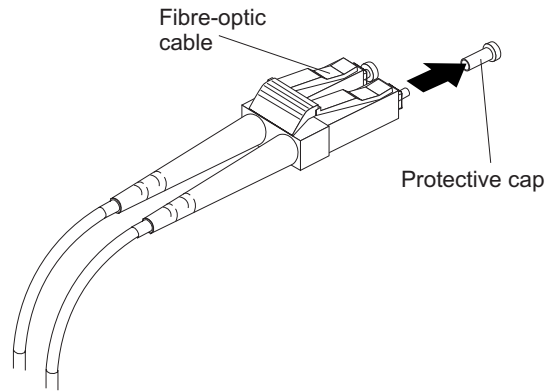
Figure 33. Removing fiber-optic cable protective caps

4. Carefully insert this end of the LC-LC cable into an SFP module that is installed in the EXP100. 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 34.
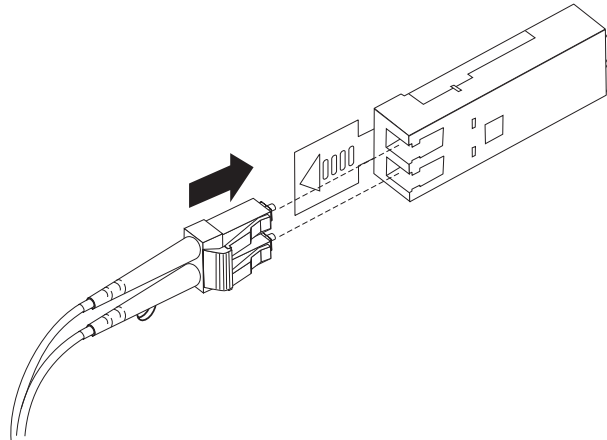
Figure 34. Inserting an LC-LC Fibre Channel cable into an SFP module

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 one of the following devices:
   - An SFP module that is installed in a separate EXP100
   - An SFP module that is installed in a DS4000 storage subsystem like a DS4300 or DS4500.

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 observe the following precautions:

- 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 you remove the cable.
- Do not grasp the SFP module plastic tab when you remove the cable.

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 35.
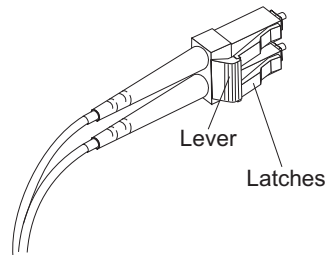
Figure 35. LC-LC Fibre Channel cable lever and latches

2. Carefully pull on the connector to remove the cable from the SFP module, as shown in Figure 36.
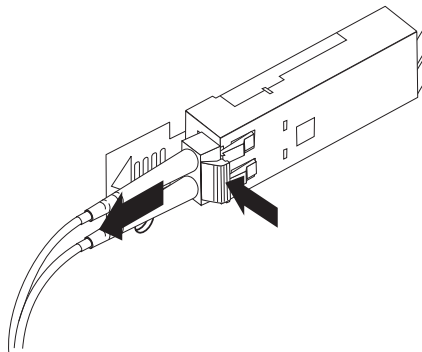
Figure 36. Removing the LC-LC Fibre Channel cable

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

Cabling the EXP100 to a DS4000 storage subsystem

You can cable the EXP100 to any one of the following storage subsystems:

- DS4100
- DS4300
- DS4400
- DS4500
- DS4800

To cable the expansion enclosure to any DS4000 storage subsystem, you need optional LC-LC fiber-optic cables.

Attention: Before you begin the cabling steps, read the following notes:

- Be familiar with the information in the preceding sections: "Installing SFP modules" on page 48, "Handling fiber-optic cables" on page 51, and "Using LC-LC Fibre Channel cables" on page 51.
- When the DS4100, DS4300, or DS4500 storage subsystem is connected to an EXP100, the storage subsystem must not have Fibre Channel drives inserted in its slots unless the Fibre Channel-SATA Intermix premium feature option is purchased and is installed in the storage subsystem. All the slots in the DS4300 must have blank drive trays to ensure proper cooling.
- The DS4500 supports two redundant drive loops with four drive mini-hubs. Because each drive mini-hub supports only one drive loop, you can use only one of the two ports in each of the DS4500 drive mini-hubs. Do not insert SFPs in the unused mini-hub ports.

Complete the following steps to cable the EXP100 to a DS4000 storage subsystem:

1. On the DS4000 storage subsystem, install an SFP into a drive port (DS4100, DS4300, or DS4800) or drive mini-hub port (DS4400 or DS4500).
2. Connect an LC-LC fiber-optic cable to the installed SFP, as shown in Figure 37, Figure 38 on page 56 and Figure 39 on page 56.
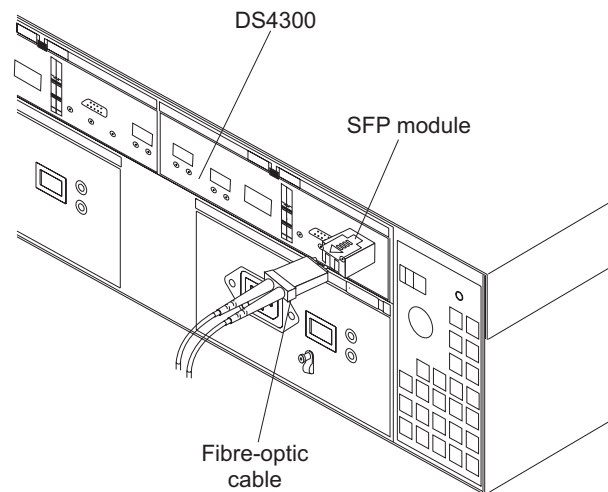
Figure 37. Connecting cables to the installed SFP on a DS4300
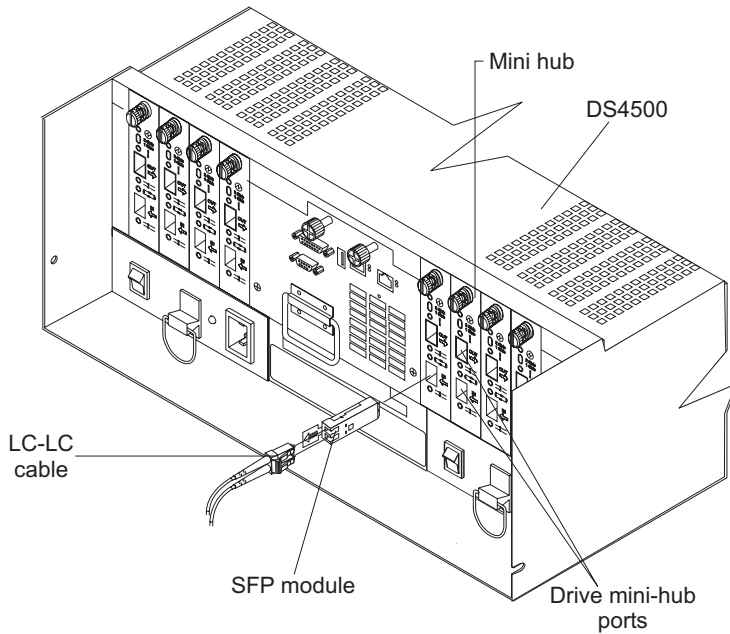
Figure 38. Connecting cables to the installed SFP on a DS4500
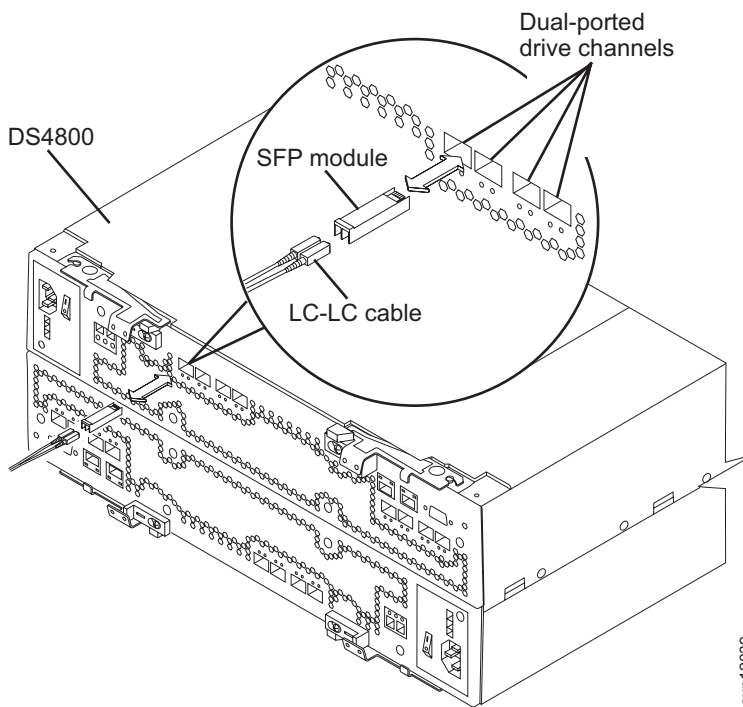
Figure 39. Connecting cables to the installed SFP on a DS4800

3. Insert an SFP module into the SFP port located on the back of the EXP100; then, connect the other end of the LC-LC cable to the SFP module, as shown in Figure 40 on page 57.
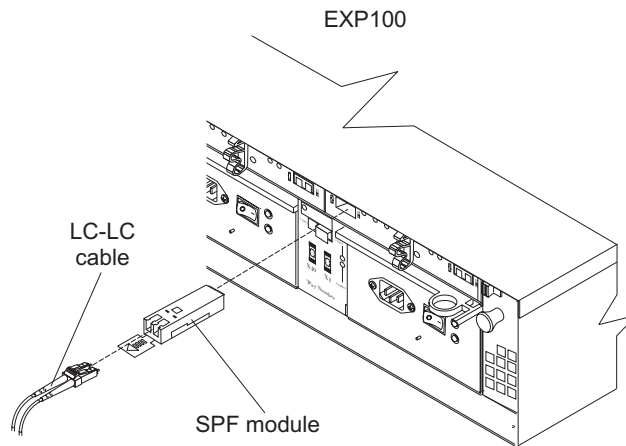
Figure 40. Installing an SFP module and connecting an LC-LC cable to the EXP100

EXP100 loop redundancy

The EXP100 provides redundant loop support when the second ESM is configured, and when both loops (called A and B) are connected to a DS4000 that supports 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 41 on page 58 shows a redundant loop that you might create with a DS4300 storage subsystem and four EXP100s. The numbers provided in Figure 41 on page 58 show the order in which cables should be attached.
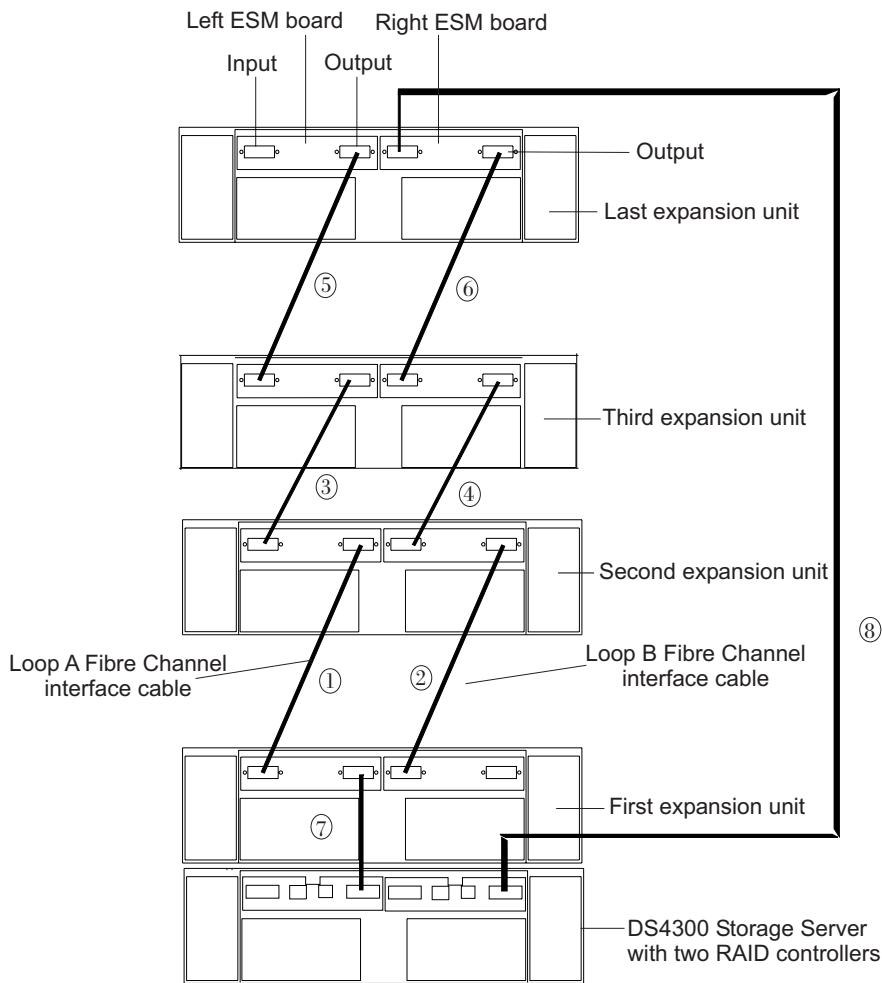
Figure 41. EXP100 redundant loop configuration

To create the redundant loop shown in Figure 41, you would perform the following steps:

1. Make two Fibre Channel connections from the *First expansion enclosure* to the *Second expansion enclosure* (connections 1 and 2).
2. Make two Fibre Channel connections from the *Second expansion enclosure* to the *Third expansion enclosure* (connections 3 and 4).
3. Continue making Fibre Channel connections in this manner until you have connected all new expansion enclosures (connections 5 and 6 in this case). You can connect up to eight EXP100s together in a redundant drive loop.
4. Make a Fibre Channel connection from the DS4000 drive port to the **OUT** port in the left ESM of the *First expansion enclosure* in the redundant drive loop.
5. Make a Fibre Channel connection from the DS4000 drive port to the **IN** port in the right ESM of the *Last expansion enclosure* in the redundant drive loop.

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 *Fibre Channel Cabling Instructions* that come with your DS4000 storage subsystem for more information about dual-loop support and implementation.

Each ESM has an SFP module input port and an SFP module output port. When you cable EXP100s together, if you connect the input ports to the output ports, it can improve diagnostic capability. Refer to your DS4000 storage subsystem documentation and the *Fibre Channel Cabling Instructions* for cabling connections between input and output ports.

Cabling the power supply

Complete the following steps to connect the power supply cable:

1. Wrap the strain-relief clamp around the power cable approximately 20 cm (8 in.) from the power supply connection end.
2. Attach the power supply nut and tighten it securely.
3. Connect the power cable to the power supply.
4. Plug the supply power cable into a properly grounded electrical outlet. For maximum protection against power loss, connect each of the two power supplies to a different power source.
5. Continue with "Turning the EXP100 on and off" for the initial startup of the expansion enclosure.

Turning the EXP100 on and off

When you turn on and turn off the EXP100, be sure to use the startup sequence in this section.

Turning on the EXP100

Before you turn on the EXP100 or any other part of the storage subsystem, read the following information:

> **ATTENTION:**
>
> Before you power on the DS4000 storage subsystem, the EXP100 must be
> populated with at least two drives. If at least two drives are not installed in
> each attached storage expansion enclosure when you power on the DS4000,
> your standard storage partition key will be lost and will need to be regenerated
> using instructions on the IBM DS4000 Solutions and Premium Features Web
> site:
>
> www-912.ibm.com/PremiumFeatures/
>
> All of the drives in each connected EXP100 unit must contain no prior
> configuration data. Additionally, if at least two drives are not installed in each
> attached EXP100, the resulting insufficient load to the EXP100 power supply
> CRUs might cause the EXP100 power supply CRUs to intermittently appear
> as failed and then reappear in an optimal state, falsely indicating that the
> power supply CRUs are bad.
>
> If this is the first time that you power on the DS4000 after you received it from
> the factory, ensure that the EXP100 storage expansion enclosure with at least
> two drives is connected to the DS4000 and is powered on before you power
> on the DS4000. Failure to do this will prevent the DS4000 from booting up
> with the factory installed premium features enabled correctly.
>
> In addition, consider the following items:
> - The storage subsystem supports simultaneous power-up of the system
>   components; however, you should always follow the power-up sequence
>   listed in the "Turning on the storage subsystem section" of the appropriate
>   DS4000 *User's Guide* 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, contact IBM technical support
>   if any of the following conditions occur:
>   - The storage subsystem logical drives and arrays do not display in the
>   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.

Use the following startup sequence to turn on the power for the initial startup of the
EXP100:

1. Verify that the following conditions exist:
   - All communication and power cables are plugged into the back of the
     expansion enclosure and that all power cables are connected to an ac power
     outlet.
   - All SATA drive CRUs are locked securely in place in the drive slots of the
     EXP100 expansion enclosure chassis.
   - The enclosure IDs on the EXP100 expansion enclosures are set correctly.
     (See "Setting the interface options" on page 44 for more information.)
2. Check the system documentation for all the hardware devices that you intend to
   turn on and 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 on power to the DS4000 storage subsystem.

b. You must turn on the EXP100 expansion enclosures before the DS4000. The DS4000 controllers might not recognize the correct configuration if expansion enclosures for the drive are powered up after the DS4000. For instructions on powering up the DS4000, see the DS4000 documentation.

c. Turn on the power to the DS4000; then restart or turn on the power to the host servers.

Important: Before you turn on the DS4000 storage subsystem, you must be aware of the information in the **Attention** section that immediately precedes these steps.

3. Turn on both power supply switches on the back of the unit. The EXP100 might take a few seconds to turn on. During this time, you might see the amber and green LEDs on the EXP100 flash intermittently. When the startup sequence is complete, only the green LEDs on the front and back light. If other amber LEDs remain lit, see "Solving problems" on page 101.

Attention: If you are restarting the system after a normal shutdown, wait at least 10 seconds before you turn on the power supply switches.

Turning off the EXP100

Use this procedure to turn off the power for the EXP100.

Attention: Except in an emergency, never turn off the power if any Fault LEDs are lit on the EXP100. Correct the fault before you turn off the power, using the proper troubleshooting or servicing procedure. This ensures that the EXP100 will start correctly later.

Do not turn off the power for the EXP100 without first turning off the power for the attached DS4000. If you do turn off the power for the EXP100 before you turn off the power for the attached DS4000, you might lose data access to the configured arrays and logical drives. The DS4000 cannot communicate with the drives in powered-off EXP100 units. As a result, it marks these drives as Failed, which in turn might cause the array or logical drive to be placed in Failed state.

The EXP100 is designed to run continuously. After you turn on the EXP100, do not turn it off. Turn off the power only in the following situations:

• Instructions in a hardware or software procedure require that you turn off the power.

• An IBM technical support representative instructs you to turn off the power.

• A power outage or emergency situation occurs, see "Restoring power after an emergency" on page 62.

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.
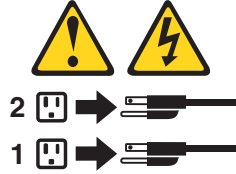
Complete the following steps to turn off the power:

1. 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 DS4000 storage subsystem . If the host must stay powered on to support an existing network, see the operating system documentation for information about disconnecting the storage subsystem logical drives from the host before the storage subsystem is powered off.

   b. Turn off power to the DS4000 storage subsystem before you turn off power to the EXP100. Turn off both power supply switches on the back of the storage subsystem.

   c. Turn off power to other supporting devices (for example, management stations, Fibre Channel switches, or Ethernet switches).

2. Make sure that all I/O activity has stopped.

3. Make sure that all amber Fault LEDs are off. If any Fault LEDs light (drives, power supplies, or fans), correct the problem before you turn off the power.

   Note: Be sure to turn off the EXP100 after or at the same time as you turn off the DS4000 storage subsystem.

4. Turn off both power supply switches on the back of the EXP100.

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 helps to safeguard your equipment from potential damage due to electrical surges when power is restored. If the EXP100 loses power unexpectedly, it might be due to a hardware failure in the power system or in the midplane of the EXP100.

Complete the following steps to shut down the system during an emergency:

1. Stop all activity and check all of the LEDs. Make a note of any Fault LEDs that are lit so that you can correct the problem when you turn on the power.

2. Turn off all power supply switches; then, unplug the power cables from the EXP100.

Restoring power after an emergency

Complete the following steps to restart the EXP100 if you turned off the power supply switches during an emergency shutdown, or if a power failure or power outage occurred:

1. After the emergency situation is over or power is restored, check the EXP100 for damage. If there is no visible damage, continue with step 2; otherwise, have your system serviced.
2. After you check the EXP100 for damage, ensure that the power switches are in the off position; then plug in the EXP100 power cables.
3. Check the system documentation of the hardware devices that you want to turn on and determine the proper startup sequence.

    Attention:

    a. Be sure to turn on the EXP100 before you turn on the DS4000.
    b. Before you power on the DS4000 storage subsystem, the EXP100 must be populated with at least two drives. If at least two drives are not installed in each attached expansion enclosure when you power on the DS4000, your standard storage partition key will be lost and will need to be regenerated using instructions on the IBM DS4000 Solutions and Premium Features Web site:

        www-912.ibm.com/PremiumFeatures/

        All of the drives in each connected EXP100 unit must contain no prior configuration data. Additionally, if at least two drives are not installed in each attached EXP100, the resulting insufficient load to the EXP100 power supply CRUs might cause the EXP100 power supply CRUs to intermittently appear as failed and then reappear in an optimal state, falsely indicating that the power supply CRUs are bad.
    c. In addition, consider the following items:
        • The storage subsystem supports simultaneous power-up of the system components; however, you should always follow the power-up sequence listed in the "Turning on the storage subsystem section" of the appropriate DS4000 *User's Guide* 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, contact IBM technical support if any of the following conditions occur:
            – The storage subsystem logical drives and arrays do not display in the 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.
4. Turn on the power to each device, based on the startup sequence.
5. Turn on both of the power supply switches on the EXP100. The green LEDs on the front and the back of the EXP100 should remain lit. If other amber Fault LEDs light, see "Solving problems" on page 101.

Chapter 3. Installing and replacing devices

This chapter contains information about installing and replacing the ESM CRU, the power supply CRU, and the fan CRU.

Adding a new EXP100 to an existing and configured drive loop

You can add up to eight EXP100s to a redundant Fibre Channel loop. DS4100s and DS4300s support one redundant drive loop. DS4400s, DS4500s, and DS4800s support up to two redundant drive loops. Before you cable your EXP100 to a loop, refer to the *Fibre Channel Cabling Instructions* that came with your DS4000 storage subsystem for specific instructions.

This section contains the following topics:
- "Determining firmware levels of the new and existing EXP100s"
- "Adding the EXP100 to the existing drive loop" on page 68
- "Upgrading ESM firmware after adding the EXP100 to an existing drive loop" on page 70

Determining firmware levels of the new and existing EXP100s

New EXP100 storage expansion enclosures are shipped from the factory with R3 ESM firmware installed. However, there might be storage enclosures in warehouse depots and at resellers that were shipped before the R3 release.

In the event that your new EXP100s have different ESM firmware versions than the existing EXP100s, you must make corrections to match the ESM firmware as soon as background firmware operations, such as rebuilds and copybacks, have completed. Use the options described in Table 14 on page 90 for your particular upgrade procedure. In certain cases, you must schedule down time for the upgrade because there can be no I/O activity, including background firmware operations, to the storage subsystem at the time of the upgrade.

For more information about the different types of EXP100 ESM firmware, see "EXP100 ESM CRU types, firmware, and release levels explained" on page 5.

Refer to Table 9 to find out whether the ESM firmware in your new EXP100 is compatible with the ESM firmware in your existing EXP100.

Table 9. New EXP100 expansion enclosure and existing EXP100 expansion enclosure firmware compatibility

If the firmware version of the *new* EXP100 enclosure is:	Then you must ensure that the firmware in the *existing* EXP100 expansion enclosures in the drive loop is:
R1	R1
R2	R2 or R3
R3	R2 or R3

Table 9. New EXP100 expansion enclosure and existing EXP100 expansion enclosure firmware compatibility (continued)

If the firmware version of the *new* EXP100 enclosure is:	Then you must ensure that the firmware in the *existing* EXP100 expansion enclosures in the drive loop is:

Notes:

1. If the new EXP100 ESM firmware version is not R1, you cannot add the new expansion enclosure unless you first upgrade the existing ESMs to the same ESM firmware release version (R2 or R3) of the new EXP100. See "Upgrading ESM firmware after adding the EXP100 to an existing drive loop" on page 70 for more information.

2. You can add the EXP100 with R3 firmware into an existing drive loop that has the R2 firmware. However, you must do it only after you upgrade the controller firmware to the R3 level. In addition, you must schedule the R2 to R3 ESM firmware upgrade at the earliest time to ensure optimal operating conditions.

3. You can add the EXP100 with R2 firmware into an existing drive loop that has the R3 firmware. However, you must schedule the ESM and controller upgrade to the R3 firmware version at the earliest time to ensure optimal operating conditions.

4. If the new EXP100 with R1 ESMs and your drive loop already contains EXP100s with R2 or R3 ESMs, you cannot attach the new EXP100 to the drive loop. This is because you cannot downgrade the R2 or R3 firmware in the existing DS4000 storage subsystem controllers and EXP100 ESMs to the R1 level or upgrade the ESM firmware from the R1 to R3 (or R2) level with the controller firmware versions that support the R3 or R2 EXP100. If this is the case, contact IBM technical support, your IBM reseller, or your IBM representative.

Perform the following steps before you add a new EXP100 expansion enclosure to an existing EXP100 drive loop.

1. Use the procedure described in "Determining firmware levels" on page 11 to find out the ESM firmware version of the existing EXP100 enclosure.

   Note: *Do not* rely solely on the CRU part number of an already installed ESM to determine the ESM firmware version, because the existing ESM firmware might have been previously updated.

2. Determine the ESM firmware level of the ESMs in this EXP100 expansion enclosure. There are two methods to determine the ESM firmware level. Use either method (a) or method (b), as follows:

   a. **Use the CRU/FRU number on the ESM faceplate.** When you open the packaging box, you can verify the ESM firmware level of the new EXP100 expansion enclosure ESMs without removing the ESM CRUs from the expansion enclosure. See Table 10:

Table 10. ESM firmware level by CRU part number

If the CRU part number is:	Then the ESM firmware level is:
24P8814	EXP100 **R1** ESM
25R0156	EXP100 **R2** ESM
39M6004	EXP100 **R3** ESM

   b. **Find the serial number on the EXP100 expansion enclosure packaging.** The serial number can help you to determine the ESM firmware version of the new EXP100 expansion enclosure. See Table 11 on page 67:

Table 11. New EXP100 expansion enclosure ESM firmware version by serial number and packaging label

If the serial number begins with...	Then the new EXP100 expansion enclosure ESM firmware level is...
13	R2 or R3 **Notes:** 1. The EXP100 is produced at the factory with the R3 level. However, the warehouse and resellers might have EXP100s with serial numbers beginning with 13, which have the R2 code installed. 2. If the *IBM System Storage DS4000 EXP100 Storage Expansion Enclosure FRU Release Note*, GC26-7797-00 (P/N 39M6040) is included in the package containing an EXP100 expansion enclosure, then its firmware level is R3.
23 (and a white square R2 label is affixed to the box)	R2
23 (and a white square R2 label is *not* affixed to the box)	R1

3. Review "Upgrading ESM firmware after adding the EXP100 to an existing drive loop" on page 70 for details about ESM compatibility and the upgrade procedure for your combination of existing and new EXP100 ESM firmware versions.

   Attention: If you have received an EXP100 with R2 or R3 ESMs, and your drive loop already contains EXP100s with R1 ESMs, you cannot connect the new R2 or R3 expansion enclosure *until* you upgrade the R1 firmware in the existing EXP100 ESMs and DS4000 server storage subsystem controller to the R3 version. However, if you have received an EXP100 with R1 ESMs, and your drive loop already contains EXP100s with R2 or R3 ESMs, you *cannot* attach the new EXP100 (because you cannot downgrade the R2 or R3 firmware in existing DS4000 controllers and EXP100 ESMs to the R1 level). If this is the case, contact IBM technical support, your IBM reseller, or your IBM representative.

   - If you *cannot* perform the applicable ESM firmware upgrade procedure described in "Upgrading ESM firmware after adding the EXP100 to an existing drive loop" on page 70, or if no upgrade procedure is possible (as in the case of adding an EXP100 with R1 ESM firmware version to a drive loop that already contains EXP100s with R2 or R3 ESM firmware), please contact IBM technical support, your IBM reseller, or your IBM representative.

   - If you *can* perform the applicable ESM firmware upgrade procedure, connect the new EXP100 expansion enclosure as described in the "Adding the EXP100 to the existing drive loop" on page 68. **Continue with Step 4.**

4. After you add the new EXP100 expansion enclosure, you must match the precise ESM firmware versions of the new and existing EXP100 expansion enclosures. Always upgrade the enclosures that have earlier firmware versions to match the enclosures that have the latest firmware version. When you are finished, all enclosures should have that firmware version.

   You might also have to upgrade the DS4000 controller firmware to support the latest EXP100 ESM firmware version.

Important: Depending on the firmware version loaded in the existing drive loop, you might have to suspend all I/O activity, including background firmware operations such as hot spare rebuilds or copybacks, to the DS4000 storage subsystem before applying the firmware updates.

Adding the EXP100 to the existing drive loop

After completing the steps in "Determining firmware levels of the new and existing EXP100s" on page 65, complete the steps in this section to add the new EXP100 to the existing drive loop.

Important: When a DS4100, DS4300, or DS4500 storage subsystem is connected to an EXP100, the storage subsystem must not have Fibre Channel drives inserted in its slots unless the Fibre Channel-SATA Intermix premium feature option is purchased and is installed in the storage subsystem. All the slots in the DS4300 must have blank drive trays to ensure proper cooling.

For other important information about intermixing an EXP100 expansion enclosure with other types of expansion enclosures, see the *IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview*.

Figure 42 on page 69 shows an example of a DS4500 configured with four drive loops. Drive loops A and B form one redundant Fibre Channel loop. Drive loops C and D form the second redundant Fibre Channel loop.
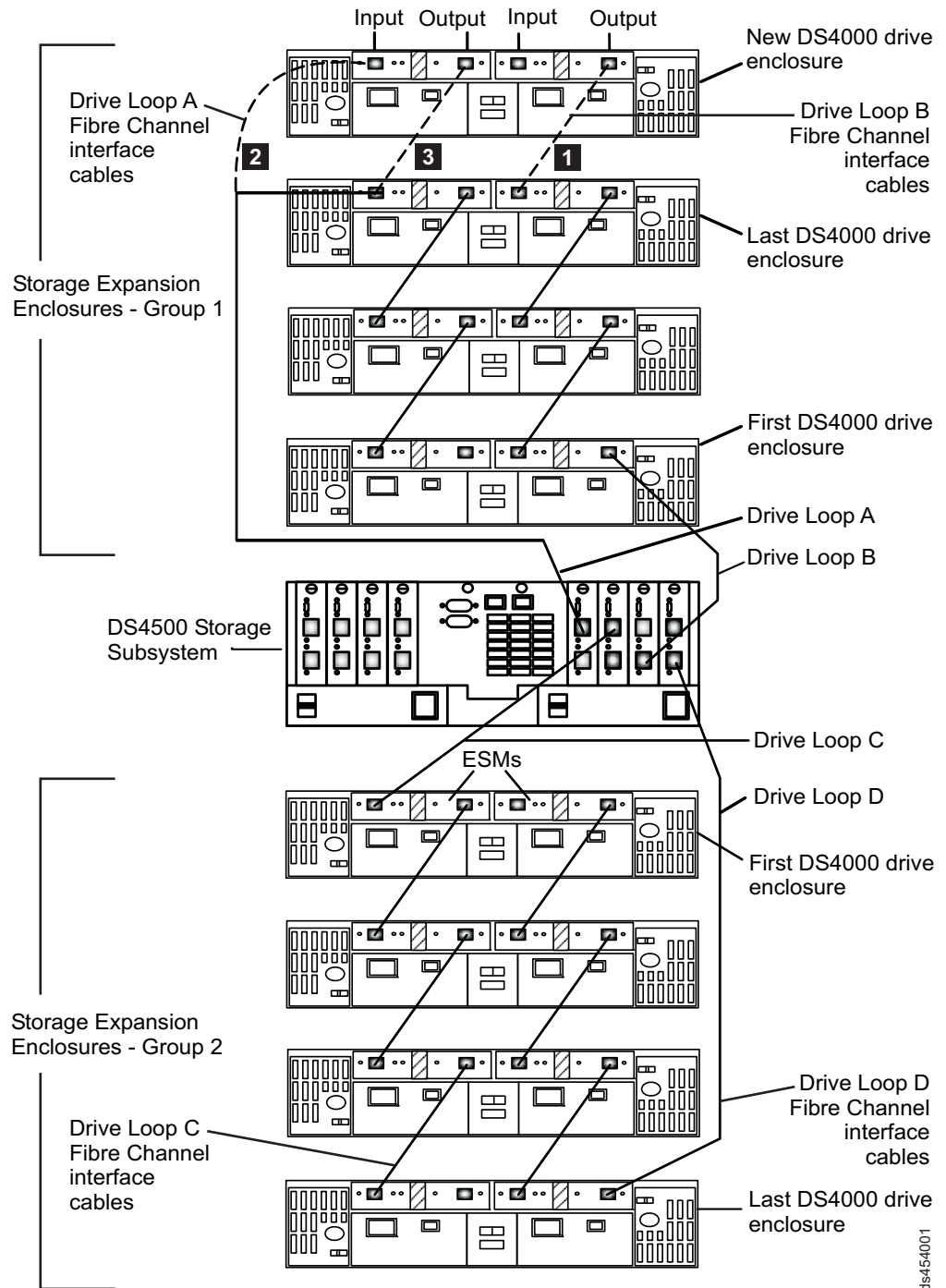
Figure 42. Cabling the EXP100 to two redundant loops

The numbers corresponding to the dashed lines in Figure 42 show how to add a new EXP100 to an existing DS4500 configuration with EXP100s attached, as described in the following steps.

To add the new EXP100 shown in Figure 42, perform the following steps:

1. Unpack and install the EXP100 expansion enclosure. Do not insert any drive CRUs into the expansion enclosure drive slots.

2. Make the Fibre Channel connection marked (**1**) in Figure 42 (drive loop B).

3. Power on the new EXP100 and verify that it is recognized by the Storage Manager software GUI.

4. Make the Fibre Channel connection marked (**2**) in Figure 42 on page 69.

5. Make the Fibre Channel connection marked (**3**) in Figure 42 on page 69 (drive loop A).

6. You can use either the Storage Subsystem Profile information or the Drive Enclosure Component icon in the Physical View of the Subsystem Management window to verify the EXP100 ESM firmware.

   Attention: For error-free operations, the ESM firmware in the EXP100 ESM modules must be at the same level. Refer to Table 12 on page 72 for the steps that are required to upgrade or downgrade the ESM firmware in the new EXP100 expansion enclosures to match the firmware in the ESMs of the existing expansion enclosures. Always upgrade the ESM firmware to the latest version that is on the IBM support Web site to ensure compatibility with replacement drive CRU/FRU or new SATA drive options:

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

7. Insert the drives into the drive slots two at a time. Wait until the drives have spun up and been recognized by the DS4500 before inserting the next two drives from the Physical View of the Subsystem Management window.

8. Repeat step1 on page 69 to step 7 for each EXP100 expansion enclosure that you want to add.

   Note: Always add a new EXP100 to the *end* of a drive loop. Always add new expansion enclosures to the existing drive loop one at a time while the DS4400 is running and in an optimal state.

If the ESM firmware in the new EXP100 does not match the ESM firmware in the EXP100s of the existing drive loop, you need to upgrade firmware. Continue to "Upgrading ESM firmware after adding the EXP100 to an existing drive loop."

Upgrading ESM firmware after adding the EXP100 to an existing drive loop

When you add a new EXP100 to an EXP100 drive loop that has already been configured, you must verify the compatibility of ESM firmware versions in both the existing and new EXP100s. See "Determining firmware levels" on page 11 for more information on how to determine your current ESM card firmware version.

In the event that new EXP100s have different ESM firmware versions than the existing EXP100s, you must make corrections to match the ESM firmware immediately. Use the options described in Table 12 on page 72 for your particular upgrade procedure. In certain cases, you must schedule down time for the upgrade because there can be no I/Os to the DS4000 storage subsystem at the time of the upgrade.

> **Attention**
>
> To successfully upgrade the DS4000 controller firmware to version 06.xx.xx.xx, you *must* first upgrade the EXP100 ESM firmware to version 955x or higher, or verify that the ESM firmware is already at this level. DO NOT upgrade the controller firmware to version 05.41.5x.xx when the EXP100 ESM firmware is at version 953x or lower, because the installed controller firmware level MUST be at 05.41.1x.xx in order to upgrade the ESM firmware from version 953x (or lower) to 955x (or higher).
>
> Please note that you cannot upgrade the DS4000 controller firmware from version 05.41.1x.xx to 06.1x.xx.xx directly without first upgrading to version 05.41.5x.xx.
>
> **Note:** If the EXP100 ESM firmware version is 953x or earlier, suspend all host server I/O to the DS4000s that use EXP100 storage expansion enclosures while you perform EXP100 ESM firmware or SATA hard drive firmware upgrades. Stop clustering services such as Microsoft MSCS if the cluster disks and quorum disks are defined using the disks that are in the EXP100 expansion enclosures whose ESMs or SATA hard drives are being updated with new firmware.
>
> If the EXP100 ESM firmware version is 9554, 956x, or later, the EXP100 ESM firmware upgrade can be performed with host server I/O present. The SATA drive firmware upgrades, however, require that I/O be suspended regardless of EXP100 ESM version.

Table 12. ESM firmware upgrade procedures for new EXP100s

ESM firmware version of the existing EXP100s	ESM firmware version of the new (added) EXP100s	Firmware upgrade procedure for ESMs in the new (added) EXP100
EXP100 R1 ESM firmware version 953x or earlier	EXP100 R1 ESM firmware version 953x or earlier (but a different R1 version than the existing EXP100s)	In this case, you have added an EXP100 with R1 ESM firmware version 953x or earlier to an EXP100 drive loop that already contains EXP100s with a different level of R1 ESM firmware version 953x or earlier. It is recommended that you upgrade both the controller firmware and ESM firmware to the EXP100 R3 version to enable EXP100 failover capability support. Please see Appendix A, "Upgrading R1-level firmware (DS4300 and DS4500 only)," on page 109 for more detailed instructions about the upgrade process. If you decide not to upgrade the configuration to EXP100 R3, you still must correct the ESM firmware mismatch, as described in the following steps. **Important:** Perform this ESM firmware upgrade during periods when you are not using the DS4000. Schedule downtime for the upgrade. If you upgrade the ESM firmware with I/Os, drives might be randomly marked as Failed which will cause the RAID arrays to fail. 1. In the Subsystem Management window, select **Advanced → Download → Environmental (ESM) card firmware**. 2. When the Download Environmental (ESM) Card Firmware window opens, follow the online help to download the ESM firmware to the EXP expansion enclosure with the new ESM. **Note:** When you specify the file name of the firmware file to download, you might need to select All Files in the Files of type pull-down menu to display the correct file name for the ESM firmware file. If you do, then a warning window opens. Click **OK** when the warning window opens to continue. 3. When the ESM firmware download completes, verify that the ESM firmware mismatch error in the Subsystem Management window has been corrected.

Table 12. ESM firmware upgrade procedures for new EXP100s (continued)

ESM firmware version of the existing EXP100s	ESM firmware version of the new (added) EXP100s	Firmware upgrade procedure for ESMs in the new (added) EXP100
EXP100 R1 ESM firmware version 953x or earlier	EXP100 R2 (with ESM firmware version 9554) or EXP100 R3 (with ESM firmware version 956x)	In this case, you have added an EXP100 with R2 ESM firmware version 9554 or an EXP100 with R3 ESM firmware version 956x or later to an EXP100 drive loop that already contains EXP100s with R1 ESM firmware version 953x or earlier. This configuration is not supported. You cannot downgrade the new EXP100 R2 or R3 ESM firmware with the existing EXP100 R1 ESM firmware file. It is recommended that you upgrade both the DS4000 controller and the EXP100 ESM firmware to EXP100 R3 firmware version to enable EXP100 full high-availability (FHA) R3 support. See Appendix A, "Upgrading R1-level firmware (DS4300 and DS4500 only)," on page 109 to upgrade the EXP100 ESM firmware. If you can not perform the upgrade immediately, do not proceed with any additional configuration tasks using the new EXP100 expansion enclosure with EXP100 R2 or R3 ESM firmware. Disconnect the new EXP100 expansion enclosure with EXP100 R2 ESM firmware from the existing EXP100 drive loop. Schedule downtime to upgrade the existing EXP100 expansion enclosures and DS4000 to full failover-support EXP100 R3 ESM and controller firmware. Then, re-attach the EXP100 expansion enclosures with EXP100 R2 or R3 ESM firmware. (If you are re-attaching the EXP100s with EXP100 R2 ESM firmware, you must also upgrade their ESM firmware to the R3 version.) **Note:** If you need further assistance, contact IBM technical support, your IBM reseller, or your IBM representative. **Important:** Perform this ESM firmware upgrade during periods when you are not using the DS4000. Schedule downtime for the upgrade. If you upgrade the ESM firmware with I/Os, drives might be randomly marked as Failed which will cause the RAID arrays to fail.

Table 12. ESM firmware upgrade procedures for new EXP100s (continued)

ESM firmware version of the existing EXP100s	ESM firmware version of the new (added) EXP100s	Firmware upgrade procedure for ESMs in the new (added) EXP100
EXP100 R2 with ESM firmware version 9554 or EXP100 R3 with ESM firmware version 956x or later	EXP100 R2 ESM firmware version 9554 or EXP100 R3 with ESM firmware version 956x or later (but a different R2 or R3 version than the existing EXP100s)	In this case, you have added an EXP100 with R2 or R3 ESM firmware version 955x or later to an EXP100 drive loop that already contains EXP100s with a different level of R2 or R3 ESM firmware version 955x or later. The ESM firmware must be at the latest version posted at the IBM support Web site to ensure compatibility with SATA drive CRU/FRU or new SATA drive options. Use the following procedure to correct the ESM firmware mismatch. **Note:** Even though the EXP100 R2 or R3 ESM firmware supports concurrent ESM firmware download, it is recommended that you download the ESM firmware during a period of low DS4000 I/O activity. In addition, you should upgrade both the DS4000 controller firmware and the EXP100 ESM firmware to the latest versions that are available on the Web, to take advantage of enhancements and to ensure the availability and compatibility of the EXP100 FRUs in the future. 1. In the Subsystem Management window, select **Advanced → Download → Environmental (ESM) card firmware**. 2. When the Download Environmental (ESM) card firmware window opens, follow the online help to download the ESM firmware to the EXP expansion enclosure with the new ESM. **Note:** When you specify the file name of the firmware file to download, you might need to select All Files in the Files of Type pull-down menu to display the correct file name for the ESM firmware file. If you do, then a warning window opens. Click **OK** to continue when the warning window opens. 3. When the ESM firmware download completes, verify that the ESM firmware mismatch error in the Subsystem Management window has been corrected.
EXP100 R2 with ESM firmware version 9554 or EXP100 R3 with ESM firmware version 956x or later	EXP100 R1 ESM firmware version 953x and earlier	In this case, you have added an EXP100 with R1 ESM firmware version 953x or earlier to an EXP100 drive loop that already contains EXP100s with R2 or R3 ESM firmware version 955x or later. This configuration is not supported. The DS4000 controller firmware (version 05.41.5x.xx or 06.xx.xx.xx) cannot upgrade the ESM (with R1 firmware) in the new EXP100 expansion enclosure to the EXP100 R2 or R3 ESM firmware version. DO NOT proceed with any additional configuration tasks using the new EXP100 expansion enclosure with EXP100 R1 ESM firmware. Disconnect the new EXP100 expansion enclosure with EXP100 R1 ESM firmware from the existing EXP100 drive loop and contact your IBM technical support, IBM reseller, or IBM representative for further assistance.

Working with hot-swap hard disk drives

This section explains how you can increase the expansion enclosure capacity by adding more hard disk drives or by replacing existing drives with ones that have a larger capacity. Before you begin, complete the following tasks:

- Read the safety and handling guidelines in "Safety" on page xi and in "Handling static-sensitive devices" on page 30.
- Ensure that your current system configuration is working properly.
- Back up all important data before you make changes to data storage devices.

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

- **Blank trays:** An expansion enclosure 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.

  Important:
  1. For proper cooling and EMC protection, do not leave a drive slot open without either a drive blank or a drive CRU inserted.
  2. Before you insert the new SATA drive option or drive CRU/FRU into the DS4000 configuration, you must ensure that the installed DS4000 controller and EXP100 ESM have the minimum controller and ESM firmware versions that are required for the new SATA drive. Always check the documentation that is included with the new drive to find out the minimum controller and ESM firmware versions, or any prerequisite tasks, for DS4000 controller and EXP100 ESM.

- **Drive CRUs:** The EXP100 supports IBM 1.5 Gbps SATA hard disk drives only.

  Note: Do not use Fibre Channel hard disk drive CRUs in the EXP100.

  Attention: After you remove a drive CRU, wait 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.

- **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 23 on page 120. 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 EXP100. These LEDs indicate the status for that drive. See Table 13 for the drive LED states and descriptions.

Table 13. 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.

Table 13. Drive LED activity (continued)

LED	LED state	Descriptions
Activity and Fault LEDs	All unlit	Check for and resolve one of the following situations: • EXP100 is turned off • EXP100 is not connected to the DS4000 • DS4000 does not have the correct firmware version

- **Fibre-channel loop IDs:** When you install a hard disk drive in the expansion enclosure, the drive tray connects into a printed circuit board called the *midplane*. The midplane sets the Fibre Channel loop ID automatically, based on the setting of the enclosure ID switch and the physical location (bay) of the drive CRU.
- **Hot-swap hardware:** The EXP100 contains hardware that enables you to replace a failed hard disk drive without turning off the expansion enclosure. You can continue to operate your system while a hard disk drive is removed or installed. These drives are known as hot-swap hard disk drives.

Notes for installing the 250 GB SATA drive CRU/FRU (P/N 40K6837)

The 250 GB SATA CRU P/N 90P1349 is being replaced by CRU P/N 40K6837, which requires a certain minimum level of the DS4000 storage subsystem controller firmware and the EXP100 drive expansion enclosure ESM firmware.

Prior to installing the hard drive in your DS4000 configuration, your DS4000 storage subsystem firmware must be at the required versions. If a firmware upgrade is required to install the new drive CRU/FRU, complete one of the following actions according to the state of your DS4000 storage subsystem:

1. **DS4000 storage subsystem in Optimal state:** Upgrade to the latest firmware version that is required to maintain this minimum level for your DS4000 storage subsystem. To download the latest firmware, go to the IBM DS4000 System Storage Support Web site, and then click on the appropriate link for each of your DS4000 storage subsystems:

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

2. **DS4000 storage subsystem in Needs Attention state:** Contact your IBM support representative for additional instructions.

Important: If you are installing P/N 90P1349, IBM recommends that you update immediately to the latest levels of firmware that support the 250 GB SATA CRU (P/N 40K6837). If upgrading firmware after installing the 250 GB CRU P/N 90P1349, upgrade to the latest firmware version required to maintain this minimum level for your DS4000 storage subsystem. To download the latest firmware, go to the IBM DS4000 System Storage support Web site (listed above).

Installing hot-swap hard disk drives

You can install hard disk drives while the expansion enclosure is turned on and running.

Important: If you are installing the 250 GB SATA drive CRU/FRU (P/N 40K6837), read the information in "Notes for installing the 250 GB SATA drive CRU/FRU (P/N 40K6837)" before you perform this procedure.

Complete the following steps to install hot-swap hard disk drives in the expansion enclosure.

Attention: After you remove a drive CRU, wait 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.

1. Before you insert the new SATA drive option or drive CRU/FRU into the DS4000 configuration, you must ensure that the installed DS4000 controller and EXP100 ESM have the minimum controller and ESM firmware versions that are required for the new SATA drive. Always check the documentation that is included with the new drive to find out the minimum controller and ESM firmware versions, or any prerequisite tasks, for DS4000 controller and EXP100 ESM.

2. Check for Fault LEDs shown in Figure 43. If any amber LEDs are lit, see "Solving problems" on page 101.
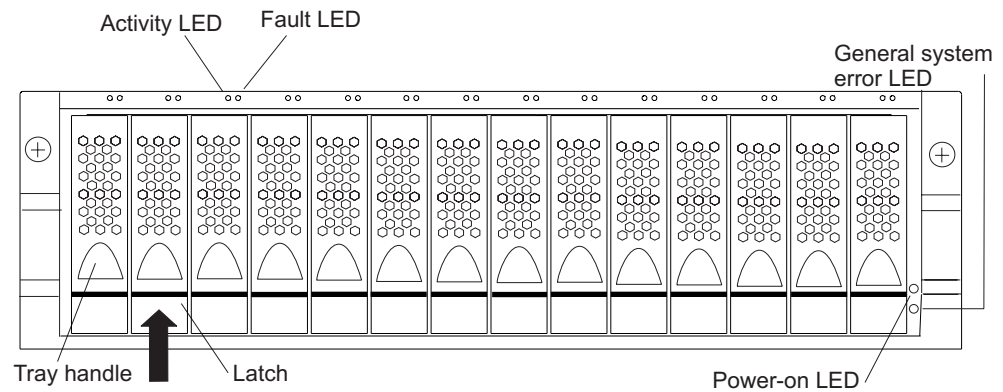
Figure 43. Hot-swap hard disk drive LEDs

3. Determine the bay into which you want to install the drive.

4. Remove the blank 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, as shown by the arrow in Figure 43.

    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 44 on page 78.

Tray handle

Tray latch
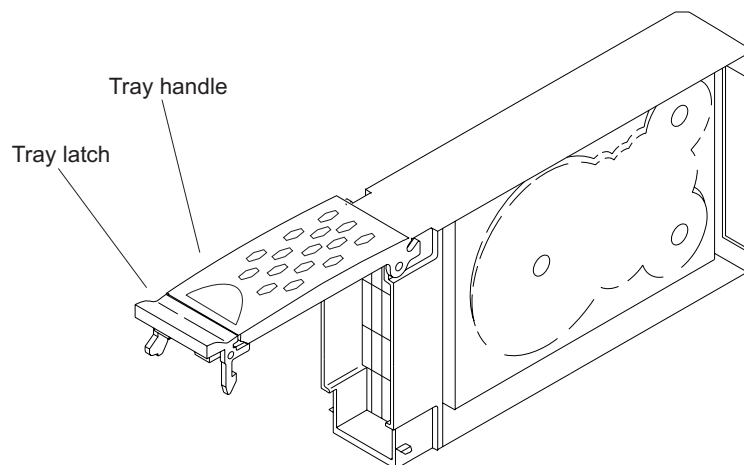
Figure 44. Drive CRU handle

   c. Slide the drive CRU into the empty bay until the hinge of the tray handle latches beneath the expansion enclosure bezel.

   d. Push the tray handle down until it latches into place.

Recommendation: If you are installing more than two drives, IBM recommends that you install the drives two at a time, as follows:

1. Insert two drives.
2. Wait five to eight minutes until the drives are recognized and displayed in the Storage Manager Subsystem Management window.
3. Then, insert the next two drives.

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 expansion enclosure. This includes transmission problems between the host controllers, the ESMs, 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 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 expansion enclosure.

Attention:

1. Before you insert the new SATA drive option or drive CRU/FRU into the DS4000 configuration, you must ensure that the installed DS4000 controller and EXP100 ESM have the minimum controller and ESM firmware versions that are required for the new SATA drive. Always check the documentation that is included with the new drive to find out the minimum controller and ESM firmware versions, or any prerequisite tasks, for the DS4000 controller and EXP100 ESM.

2. 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 to see if there are restrictions regarding hard disk drive configurations.

If you are replacing a drive with the 250 GB SATA drive CRU/FRU (P/N 40K6837), read the information in "Notes for installing the 250 GB SATA drive CRU/FRU (P/N 40K6837)" on page 76 before you perform this procedure.

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 associated green Activity LED is flashing. Hot-swap a drive CRU only when its associated amber Fault LED is lit and not flashing.

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 44 on page 78.

   b. Pull the tray handle out into the open position.

   c. Lift the drive CRU partially out of the bay.

      Attention: After you remove a drive CRU, wait 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.

   d. Verify that there is proper identification (such as a label) on the drive CRU, and then slide it completely out of the expansion enclosure.

3. Put on the antistatic strap, and unpack the drive CRU.

4. Install the new drive CRU:

   Attention: After you remove a drive CRU, wait 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.

   a. Gently push the drive CRU into the empty bay until the hinge of the tray handle latches beneath the expansion enclosure bezel.

   b. Push the tray handle down into the closed (latched) position.

5. Check the drive LEDs:

   • When a drive is ready for use, the green Activity LED lights 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.

6. Use the Storage Manager software GUI to verify that the drive is shown in the Storage Subsystem Management window.

Replacing multiple drives

This section provides guidelines for upgrading the drives in the expansion enclosure. 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.

Note: 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.
- Before you insert the new SATA drive option or drive CRU/FRU into the DS4000 configuration, you must ensure that the installed DS4000 controller and EXP100 ESM have the minimum controller and ESM firmware versions that are required for the new SATA drive. Always check the documentation that is included with the new drive to find out the minimum controller and ESM firmware versions, or any prerequisite tasks, for DS4000 controller and EXP100 ESM.

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 EXP100 and the DS4000.

  Attention: Turn off the DS4000 before you turn off the EXP100.

  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 81.

  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 DS4000 storage subsystem (or any expansion enclosures attached to the storage subsystem) 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 83.

  Using this method, you can replace the drives while the EXP100 and the DS4000 are 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 storage-management software 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
- 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 six drives, consider replacing all drives at the same time.
- How much risk of losing data is acceptable. Because the array will be in a degraded state during the RAID array reconstruction and copyback process as result of replacing a drive in the array, any new drive failure will cause the array to fail (causing a loss of data availability and even a loss of data). The duration of the reconstruction and copyback process can be quite long, depending on the size of the RAID array.

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 EXP100 and the DS4000 storage subsystem, which makes the storage subsystem (and any attached expansion enclosures) inaccessible to other users.

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 insert the new SATA drive option or drive CRU/FRU into the DS4000 configuration, you must ensure that the installed DS4000 controller and EXP100 ESM have the minimum controller and ESM firmware versions that are required for the new SATA drive. Always check the documentation that is included with the new drive to find out the minimum controller and ESM firmware versions, or any prerequisite tasks, for DS4000 controller and EXP100 ESM.

To replace all the drives at the same time, perform the following steps:
1. Read the following information:
   - The information in "Replacing multiple drives" on page 80, 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 software to check the status of the DS4000. Correct any problems that are reported.
3. Use the DS4000 Storage Manager software to ensure that the installed DS4000 controller and EXP100 ESM have the minimum controller and ESM firmware versions that are required for the new SATA drive. Always check the

documentation that is included with the new drive to find out the minimum controller and ESM firmware versions, or any prerequisite tasks, for DS4000 controller and EXP100 ESM.

4. 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 30.

5. Put on the antistatic strap and 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.

6. Perform the following steps:

   a. Stop all I/O activity to the DS4000 storage subsystem and attached expansion enclosures. Make sure that:

      1) All of the green Drive activity LEDs on the front of the DS4000 storage subsystem (and on all attached EXP100s) are not flashing.

      2) The green Cache active LEDs are off. Depending on the model, the cache active LEDs are either in the front (DS4500) or the back (DS4300) of the storage subsystem.

   b. If applicable, use the operating system software to disconnect the DS4000 storage subsystem logical drives from the host before you power off the storage subsystem.

   Attention: To turn off all power to the DS4000 storage subsystem, you must turn off both power-supply switches and disconnect both power cords. Use the procedure in step 7 for the proper shutdown sequence.

7. 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 DS4000 storage subsystem. If the host must stay powered on to support an existing network, see the operating system documentation for information about disconnecting the DS4000 storage subsystem logical drives from the host before the storage subsystem is powered off.

   b. Turn off power to the DS4000 storage subsystem before you turn off power to the EXP100. Turn off both power supply switches on the back of the DS4000 storage subsystem.

   c. Turn off power to other supporting devices (for example, management stations, Fibre Channel switches, or Ethernet switches).

8. Use the procedures in "Replacing hot-swap hard disk drives" on page 78 to remove the drives that you want to replace. Use the procedures in "Installing hot-swap hard disk drives" on page 76 to install the new drives into the EXP100.

9. 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 DS4000 storage subsystem.

   b. You must turn on the expansion enclosures before the DS4000 storage subsystem. The controllers might not recognize the correct configuration if

the drives are powered up after the storage subsystem. For instructions on powering up the storage subsystem, see the storage subsystem documentation.

   c. Turn on the power to the DS4000 storage subsystem; then restart or turn on the power to the host.

10. Turn on the power to each device, based on the power-on sequence in step 9 on page 82. To turn on power to the DS4000 storage subsystem and the EXP100s, turn on the power-supply switches on the back of the storage subsystem. You must turn on both power-supply switches to take advantage of the redundant power supplies.

11. Check the green Drive activity LEDs and the amber Drive fault LEDs above 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, 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 software for problem determination.

12. Use the DS4000 Storage Manager software to configure the new drives. See the DS4000 Storage Manager software online Help for detailed instructions.

13. 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 81).

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.

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 insert the new SATA drive option or drive CRU/FRU into the DS4000 configuration, you must ensure that the installed DS4000 controller and EXP100 ESM have the minimum controller and ESM firmware versions that are required for the new SATA drive. Always check the documentation that is included with the new drive to find out the minimum controller and ESM firmware versions, or any prerequisite tasks, for DS4000 controller and EXP100 ESM.

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

1. Read the following information:
   - "Replacing multiple drives" on page 80, 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 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 software to check the status of the unit. Correct any problems that are reported.

3. Use the DS4000 Storage Manager software to ensure that the installed DS4000 controller and EXP100 ESM have the minimum controller and ESM firmware versions that are required for the new SATA drive. Always check the documentation that is included with the new drive to find out the minimum controller and ESM firmware versions, or any prerequisite tasks, for DS4000 controller and EXP100 ESM.

4. Back up the data in the arrays and logical drives that are configured using 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 30.

5. Put on the antistatic strap and 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.

6. Use the DS4000 Storage Manager 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 at least 70 seconds 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. Contact IBM support for further recovery instructions. Do not attempt to replace any drives until the array is brought back to optimal state.

7. Use the procedures in "Replacing hot-swap hard disk drives" on page 78 to remove the failed drive. Use the procedures in "Installing hot-swap hard disk drives" on page 76 to install the new drives into the EXP100.

   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.

8. Check the green Drive activity LED and the amber Drive fault LED above 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, 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 software for problem determination.

9. Use the DS4000 Storage Manager software 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 (for example, from a logical drive Media Scan operation). In that case, use the host software to determine if the data reconstruction is finished.

10. When reconstruction is finished on the new drive, repeat step 6 on page 84 through step 9 for each additional drive that you want to install.

11. Use the DS4000 Storage Manager software to configure the additional space on the new drives.

Working with hot-swap power supplies

The power supplies are CRUs and do not require preventive maintenance.

- Use only the supported power supplies for your specific expansion enclosure.
- Both power supplies must always be installed to maintain proper cooling and to protect against power loss.

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.

Removing the failed hot-swap power supply

Complete the following steps to remove the failed hot-swap power supply:

1. Turn the power supply switch to the off position.
2. Unplug the power supply cable from the electrical outlet.
3. Disconnect the power cable from the power supply ac connector.
4. Remove the nut and clamp from the rear of the power supply.
5. Remove the power supply from the expansion enclosure:
   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.

Replacing the failed hot-swap power supply

This section describes the procedure for replacing the failed hot-swap power supply.

Note: Before you replace the failed power supply, ensure that the new power supply lever is attached to the side of the power supply that faces the middle of the expansion enclosure. If it is not, remove the lever screw, flip the lever over, and tighten the screw on the opposite side as shown in Figure 45.
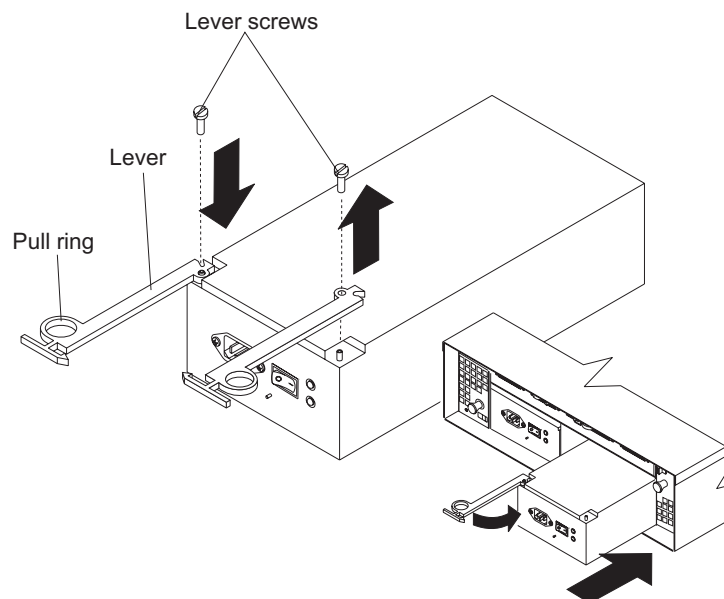
Figure 45. Moving the power supply lever and replacing the failed hot-swap power supply

Complete the following steps to replace the failed hot-swap 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.

1. Ensure that the ac power switch on the power supply that you are installing is in the off position.

2. Install the power supply in the expansion enclosure:

   a. Slide the power supply into the expansion enclosure. Be sure that the lever is pulled straight out as you slide the power supply into the expansion enclosure (see Figure 45 on page 86).

   b. Close the lever until the pull-ring latch locks in place. Make sure that the lever locks into place in the expansion enclosure chassis.

3. Wrap the strain relief clamp around the power cable approximately 20 cm (8 in.) from the power supply connection end.

4. Attach the power supply nut and tighten it securely.

5. Connect the power cable to the power supply ac connector. See Figure 46.
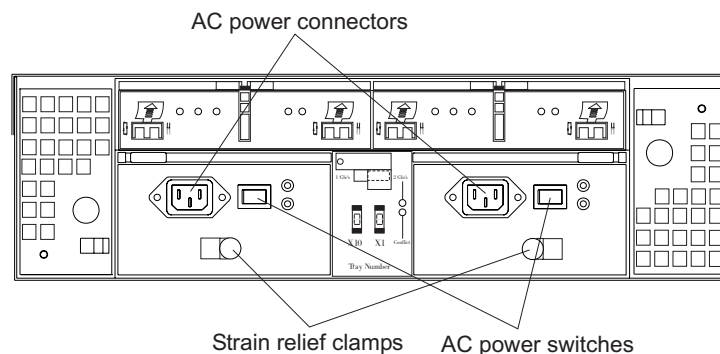
Figure 46. Connecting the power supply

6. Plug the supply power cable into a properly grounded electrical outlet.

7. Turn the power supply switch to the on position.

Replacing a failed hot-swap ESM

This section describes the removal and replacement procedure for a failed hot-swap ESM.

Receiving the replacement ESM CRU

If you need to replace a failed hot-swap ESM CRU in an EXP100, you must first verify that the replacement ESM CRU firmware is compatible with the firmware of the existing ESM module in the DS4000 EXP100 expansion enclosure. A loss of data access and, in some cases, a loss of data will result if ESM CRUs with incompatible firmware are installed in the same DS4000 EXP100 expansion enclosure. Note the following:

- Do *not* insert a replacement ESM CRU into the DS4000 EXP100 expansion enclosure until ESM firmware compatibility is confirmed.
- Do *not* rely solely on the CRU part number of the installed ESM to determine the ESM firmware level because the firmware in the existing EXP100 ESMs may have already been updated to newer ESM firmware versions.

Perform the following steps before you replace an ESM CRU in an EXP100.

1. Determine the ESM firmware version of the existing ESM CRU in the EXP100 expansion enclosure. Use the procedure described in "Determining firmware levels" on page 11.

   Note: *Do not* rely on the CRU part number of an already installed ESM to determine the ESM firmware version, because the existing ESM firmware might have been previously updated.

2. Find the ESM CRU part number on the CRU shipping box. Use Table 4 on page 6 to determine the ESM firmware version of the replacement ESM CRU based on its part number. You can also use Table 14 on page 90 to learn more about ESM CRU compatibility.

3. If the firmware version of the replacement ESM CRU is:

   - *Not compatible* with the firmware version of the existing ESM module in the DS4000 EXP100 expansion enclosure, *do not open the ESM CRU box*. You cannot replace an ESM CRU with firmware that is incompatible with the firmware of the existing ESM module in the DS4000 EXP100 expansion enclosure. Contact IBM technical support, your IBM reseller, or your IBM representative for an EXP100 CRU that is compatible with the ESM firmware of the existing ESM module.

   - *Compatible* with the firmware version of the existing ESM module in the DS4000 EXP100 expansion enclosure, then replace the failed hot-swap ESM CRU as described in "Steps for replacing a hot-swap ESM" on page 94. **Continue with step 4.**

4. After you have replaced the failed ESM CRU with the compatible replacement ESM CRU, you must verify that the precise firmware versions match. For example, you might have removed an ESM CRU with R1 ESM firmware version 953x or earlier and replaced it with an ESM CRU with a different level of R1 ESM firmware version 953x or earlier; or you might have removed an ESM CRU with R2 ESM firmware version 955x or later and replaced it with an ESM CRU with a different level of R2 ESM firmware version 955x or later.

   Continue to the next section, "Upgrading firmware when replacing a failed hot-swap ESM" on page 89, and perform the upgrade procedure that is appropriate for your configuration.

If you need further assistance, please contact IBM technical support, your IBM reseller, or your IBM representative to find out which EXP100 CRU is compatible with the ESM firmware of your existing ESM module.

Upgrading firmware when replacing a failed hot-swap ESM

If you find that there is an ESM firmware mismatch when you replace an ESM (see Table 15 on page 97), you must make corrections to match the ESM firmware as soon as background firmware operations, such as rebuilds and copybacks, have completed. Refer to Table 14 on page 90 for your particular upgrade procedure. In certain cases, you must schedule down time for the upgrade because there can be no I/O activity, including background firmware operations, to the storage subsystem at the time of the upgrade.

See "EXP100 ESM CRU types, firmware, and release levels explained" on page 5 for more information about the different firmware release levels. Also, see "Determining firmware levels" on page 11 for more information on how to determine your current ESM card firmware version.

Table 14. ESM firmware upgrade procedures for replacing ESMs

Existing ESM CRU firmware	New ESM CRU firmware	Upgrade procedure
EXP100 R1 ESM firmware version 953A or earlier	EXP100 R1 ESM firmware version 953A or earlier (but a different R1 version than the existing ESM firmware)	It is recommended that you upgrade both the controller firmware and ESM firmware to either the same R1 ESM (953A or earlier) version or the R3 ESM version (956x or later). IBM strongly recommends that you upgrade to R3 ESM because this code level contains quality enhancements and Full High Availability EXP100 function. See "EXP100 ESM CRU types, firmware, and release levels explained" on page 5 for more information. **CAUTION:** **If you plan to upgrade the ESM firmware to the R3 version, you must upgrade the ESM to the intermediate ESM firmware version 9554 first before upgrading to the R3 ESM version (956x or later).** If you decide *not* to upgrade the configuration, you still must correct the ESM firmware mismatch, as described in the following steps. **Important:** Perform this ESM firmware upgrade during periods when you are not using the DS4000 storage subsystem. Schedule downtime for the upgrade. If you upgrade the ESM firmware with I/O activity to the storage subsystem, including background firmware operations, drives might be randomly marked as Failed, causing the RAID arrays to fail. **Note:** ESM firmware mismatch conditions must be corrected as soon as soon as background firmware operations, such as rebuilds and copybacks, have completed. 1. In the Subsystem Management window, select **Advanced → Download → Environmental (ESM) card firmware**. 2. When the Download Environmental (ESM) card firmware window opens, follow the online help to download the ESM firmware to the EXP100 enclosure with the new ESM. **Note:** When you specify the file name of the firmware file to download, you might need to select All Files in the Files of type pull-down menu to display the correct file name for the ESM firmware file. If you do, then a warning window opens. Click **OK** when the warning window opens to continue. 3. When the ESM firmware download completes, verify that the ESM firmware mismatch error in the Subsystem Management window has been corrected.

Table 14. ESM firmware upgrade procedures for replacing ESMs (continued)

Existing ESM CRU firmware	New ESM CRU firmware	Upgrade procedure
EXP100 R1 ESM firmware version 953A or earlier	EXP100 R2 ESM firmware version 9554 or EXP100 R3 ESM firmware version 956x and later	You cannot downgrade the new EXP100 R2 or R3 ESM firmware to the existing EXP100 R1 ESM firmware file. If the new R2 or R3 ESM is inserted in an EXP100 that contains an existing R1 ESM, the new R2 or R3 ESM will not be locked down by the DS4000 storage subsystem controller firmware. You might see all drive slots in the enclosure marked as *empty slots*. Remove the newly inserted ESM from the EXP100 chassis. Contact IBM technical support, your IBM reseller, or your IBM representative for the EXP100 R1 CRU (P/N 24P8814) that is compatible with the ESM firmware of the existing ESM module. **Note:** If there are any failed arrays because more than one drive in a given array failed, contact IBM technical support for recovery instructions.
EXP100 R2 ESM firmware version 955x	EXP100 R2 ESM firmware version 955x or later (but a different R2 version than the existing ESM firmware)	It is possible to upgrade the ESM to the same R2 level. However, it is recommended that you upgrade both controller and ESM firmware to the latest R3 level that is posted in the IBM System Storage Support Web site, to ensure drive and ESM compatibility in the future. Use the following procedure to correct the ESM firmware mismatch. **Important:** Even though the EXP100 R2 firmware supports concurrent ESM firmware download, it is recommended that you download the ESM firmware during a period of low DS4000 storage subsystem I/O activity. All other background firmware operations, such as hot spare rebuilds or copybacks, *must be* completed before upgrading the firmware. **Note:** ESM firmware mismatch conditions must be corrected as soon as soon as background firmware operations, such as rebuilds and copybacks, have completed. 1. In the Subsystem Management window, select **Advanced → Download → Environmental (ESM) card firmware**. 2. When the Download Environmental (ESM) Card Firmware window opens, follow the online help to download the ESM firmware to the EXP100 enclosure with the new ESM. **Note:** When you specify the file name of the firmware file to download, you might need to select All Files in the Files of type pull-down menu to display the correct file name for the ESM firmware file. If you do, then a warning window opens. Click **OK** when the warning window opens to continue. 3. When the ESM firmware download completes, verify that the ESM firmware mismatch error in the Subsystem Management window has been corrected.

Table 14. ESM firmware upgrade procedures for replacing ESMs (continued)

Existing ESM CRU firmware	New ESM CRU firmware	Upgrade procedure
EXP100 R3 ESM firmware version 956x and later	EXP100 R3 ESM firmware version 956x or later (but a different R3 version than the existing ESM firmware)	Use the following procedure to correct the ESM firmware mismatch. **Important:** Even though the EXP100 R3 firmware supports concurrent ESM firmware download, it is recommended that you download the ESM firmware during a period of low DS4000 storage subsystem I/O activity. All other background firmware operations, such as hot spare rebuilds or copybacks, *must be* completed before upgrading the firmware. **Note:** ESM firmware mismatch conditions must be corrected as soon as soon as background firmware operations, such as rebuilds and copybacks, have completed. 1. In the Subsystem Management window, select **Advanced → Download → Environmental (ESM) card firmware**. 2. When the Download Environmental (ESM) Card Firmware window opens, follow the online help to download the ESM firmware to the EXP100 enclosure with the new ESM. **Note:** When you specify the file name of the firmware file to download, you might need to select All Files in the Files of type pull-down menu to display the correct file name for the ESM firmware file. If you do, then a warning window opens. Click **OK** when the warning window opens to continue. 3. When the ESM firmware download completes, verify that the ESM firmware mismatch error in the Subsystem Management window has been corrected.
EXP100 R2 ESM firmware version 955x or EXP100 R3 ESM firmware version 956x and later	EXP100 R1 ESM firmware version 953A and earlier	This is an unsupported configuration. You cannot upgrade the EXP100 R1 ESM firmware with the EXP100 R2 or R3 ESM firmware file. The new ESM will be locked down by the DS4000 storage subsystem controller firmware. Remove the down-level ESM CRU. Contact IBM technical support, your IBM reseller, or your IBM representative for the correct CRU 25R0156 (ESM firmware 9554) or CRU 39M6004 (ESM firmware 956x or later.).

Table 14. ESM firmware upgrade procedures for replacing ESMs (continued)

Existing ESM CRU firmware	New ESM CRU firmware	Upgrade procedure
EXP100 R2 ESM firmware	EXP100 R3 ESM firmware version 956x or later	You can only upgrade the ESM firmware version of both ESMs to 956x or later. Downgrading the EXP100 ESM with a higher ESM firmware version to a lower firmware version is not supported. Contact IBM technical support, your IBM reseller, or IBM representative for the correct EXP100 FRU/CRU with the ESM firmware version 9554 (P/N 25R0156).

Otherwise, use the following procedure to correct the ESM firmware mismatch.

Important: Even though the EXP100 R3 firmware supports concurrent ESM firmware download, it is recommended that you download the ESM firmware during a period of low DS4000 storage subsystem I/O activity. All other background firmware operations, such as hot spare rebuilds or copybacks, must be completed before upgrading the firmware.

Note: ESM firmware mismatch conditions must be corrected as soon as soon as background firmware operations, such as rebuilds and copybacks, have completed.

1. In the Subsystem Management window, select **Advanced —> Download —> Environmental (ESM) card firmware**.

2. When the Download Environmental (ESM) Card Firmware window opens, follow the online help to download the ESM firmware to the EXP100 enclosure with the new ESM.

   Note: When you specify the file name of the firmware file to download, you might need to select All Files in the Files of type pull-down menu to display the correct file name for the ESM firmware file. If you do, then a warning window opens. Click OK when the warning window opens to continue.

3. When the ESM firmware download completes, verify that the ESM firmware mismatch error in the Subsystem Management window has been corrected.

Table 14. ESM firmware upgrade procedures for replacing ESMs (continued)

Existing ESM CRU firmware	New ESM CRU firmware	Upgrade procedure
EXP100 R3 ESM firmware version 956x or later	EXP100 R2 ESM firmware version 9554	You can only upgrade the ESM firmware version of both ESMs to 956x or later. Downgrading the EXP100 ESM with a higher ESM firmware version to a lower firmware version of 9554 is not supported. Use the following procedure to correct the ESM firmware mismatch. **Important:** Even though the EXP100 R3 firmware supports concurrent ESM firmware download, it is recommended that you download the ESM firmware during a period of low DS4000 storage subsystem I/O activity. All other background firmware operations, such as hot spare rebuilds or copybacks, must be completed before upgrading the firmware. **Note:** ESM firmware mismatch conditions must be corrected as soon as soon as background firmware operations, such as rebuilds and copybacks, have completed. 1. In the Subsystem Management window, select **Advanced —> Download —> Environmental (ESM) card firmware**. 2. When the Download Environmental (ESM) Card Firmware window opens, follow the online help to download the ESM firmware to the EXP100 enclosure with the new ESM. **Note:** When you specify the file name of the firmware file to download, you might need to select All Files in the Files of type pull-down menu to display the correct file name for the ESM firmware file. If you do, then a warning window opens. Click OK when the warning window opens to continue. 3. When the ESM firmware download completes, verify that the ESM firmware mismatch error in the Subsystem Management window has been corrected.

Complete the following steps to remove a failed ESM:

Steps for replacing a hot-swap ESM

Attention: After you remove an ESM, wait 70 seconds before reseating or replacing the ESM. Failure to do so may cause undesired events.

For CRU part numbers for the two ESM firmware version, see Table 5 on page 7.

1. Start the DS4000 Storage Manager client program. In the Enterprise Management window, open the Subsystem Management window for the DS4000 that includes the EXP100 expansion enclosure that requires the ESM replacement.

2. Check the storage management software online help for ESM failure-recovery procedures. Follow the steps provided in the failure-recovery procedures before continuing to step 3.

3. Save the DS4000 profile by performing the following steps:

   a. In the Subsystem Management Menu, select **View → Storage Subsystem Profile**. The Storage Subsystem Profile window opens.

   b. In the Storage Subsystem Profile window, click **Save As**. The Save Profile window opens.

c. In the Save Profile window, select or enter the file directory and file name. Click **Save** to save the profile. The Save Profile window closes.

Important: Do not store DS4000 profiles in the same location as the logical drives that are defined on your DS4000. If you do, and the logical drives fail during the subsequent migration, you will lose data.

d. Click **Close** to close the Storage Subsystem Profile window.

4. In the Physical View pane of the Subsystem Management window, click the **Drive Enclosure Component** icon (which is the right most icon) in the Drive Enclosure frame of the EXP100 which includes the ESM that you want to replace. The Drive Enclosure Component Information window opens.

5. Click the **ESM** icon in the left pane. The ESM information displays in the right pane of the Drive Enclosure Component Information window.

6. Locate the firmware version of each ESM in the EXP100 expansion enclosure.

7. Use Table 5 on page 7 to verify that the firmware of the new ESM module is compatible with the existing ESM in the EXP100 expansion enclosure.

If the firmware versions are not compatible, DO NOT proceed further. Contact IBM technical support, your IBM resellers or IBM representatives for the EXP100 CRU that is compatible with the ESM firmware of the existing ESM module.

If the firmware versions are compatible, continue with step 13 on page 96.

Important: Do not mix EXP100 R1 ESMs and EXP100 R2 ESMs in the same EXP100 expansion enclosure chassis.

8. Label each cable to ensure that all cables are properly connected to the new ESM.

9. Label the SFP modules when you remove them. You must install the SFP modules in the same positions on the new ESM.

10. Remove the SFP modules and the Fibre Channel cables from the failed ESM.

Attention: Be careful not to bend the Fibre Channel cables at a sharp angle or pinch them with objects. This can decrease the performance or cause data loss.

11. Push down on the ESM latch. While holding down the ESM latch, grasp the pull rings and pull out on the levers to disconnect the ESM from the EXP100 midplane. The ESM levers will pop out of the locked position, as shown in Figure 47.

Latch
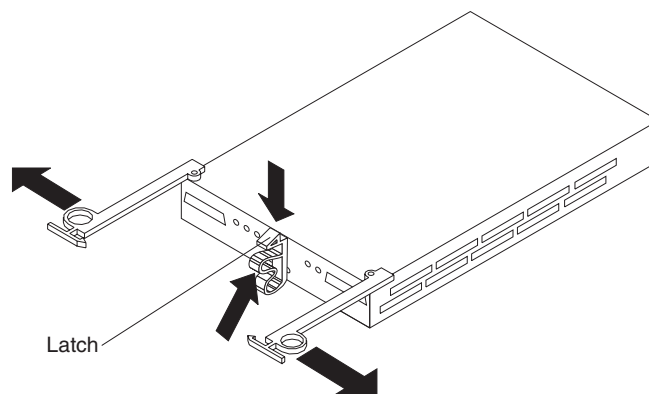
Figure 47. Removing the failed ESM

12. Remove the ESM.

13. Install the new ESM by sliding it into the empty slot. Be sure that the levers are pulled straight out as you slide the ESM into the expansion enclosure. When you install the ESM into the bays, the ESM latch locks into place.

14. Close the levers until the pull-ring latch locks in place. Make sure that the levers lock into place in the expansion enclosure chassis.

15. Reconnect the SFP modules and the Fibre Channel cables to their original locations.

16. Check the Power and Fault LEDs on the new ESM:
    - If the Power LED is off, the ESM might not be inserted correctly.
    - If the Fault LED is lit, if the Power LED is off, or if any other Fault LEDs are lit, see "Solving problems" on page 101.

17. Check the input and output bypass LEDs at both ends of the reconnected cables. If the input and output bypass LEDs are lit, reconnect the cables and SFP modules.

18. Use the DS4000 Storage Manager 9 Client to open a Subsystem Management window to the DS4000 on which the EXP100 ESM was replaced. Click on the **Recovery Guru** or the **Environment Status** icon of the expansion enclosure on which you replaced the ESM.

    If there is an ESM firmware mismatch, proceed to step 19. If there is no ESM firmware mismatch, the upgrade process is complete.

19. If there is an ESM firmware mismatch, you must make corrections to match the ESM firmware immediately. Refer to Table 12 on page 72 for your particular upgrade procedure. In certain cases, you must schedule down time for the upgrade because there can be no I/Os to the DS4000 storage subsystem at the time of the upgrade. See "Determining firmware levels" on page 11 for more information on how to determine your current ESM card firmware version.

Troubleshooting

Use Table 15 and Table 16 on page 98 to determine the causes and corrective actions for EXP100 ESM incompatibility issues.

Table 15. Troubleshooting ESM incompatibility issues

Problem	Possible cause	Corrective action
After inserting the replacement ESM, all of the drive slots in the EXP100 enclosure into which the replacement ESM was inserted are shown in the Physical view of the Storage Subsystem Management window as empty slots. These drive slots were shown with optimal drives before the replacement ESM was inserted.	An EXP100 R2 or R3 ESM was inserted into an EXP100 enclosure that already contains an EXP100 R1 ESM.	Remove the newly inserted ESM. Contact IBM technical support, your IBM reseller, or your IBM representative for the EXP100 R1 ESM CRU part number 24P8814.
A drive or drives are marked failed after the replacement ESM was inserted and cause the array to be placed in a degraded state	The cause could be either an ESM firmware version mismatch or a drive failure.	Verify that there are no ESM firmware version incompatibilities. If the ESM firmware versions are compatible, right click the failed drive and select Reconstruct. If the drive reconstruction is successful and the drive becomes optimal, the drive is OK. If the drive is bad, it will fail during the reconstruction and you must replace it.
Multiple drives are marked failed during the firmware download which cause the array to be placed in a failed state	The cause of the problem cannot be determined.	Contact IBM technical support for instructions on how to revive the array and troubleshoot the problem.
An ESM drive firmware mismatch error is shown in the Recovery Guru.	The replacement ESM module might have a firmware version that is incompatible with the one in the existing ESM module.	You must upgrade the ESM firmware of both ESM modules to the same level immediately. See Table 16 on page 98 for corrective actions.

Table 16. Existing EXP100 ESM and new EXP100 ESM firmware compatibility levels

Existing EXP100 ESM firmware version	New EXP100 ESM firmware version	Corrective action
956x or later (R3 ESM)	956x or later (but is a different version than the existing R3 ESM)	You can upgrade the ESM firmware with I/Os although it is recommended that you update the ESM firmware during a period of low DS4000 I/O activity.
953A or earlier (R1 ESM)	953A or earlier (but is a different version than the existing R1 ESM)	You must schedule down time for the ESM firmware upgrade. Upgrade to either the same R1 ESM (953A or earlier) version or the R3 ESM version (956x or later). All I/Os must be stopped. If there are any I/Os during the ESM firmware upgrade, drives might randomly be marked failed. IBM strongly recommends that you upgrade to R3 ESM because this code level contains quality enhancements and Full High Availability EXP100 function. **CAUTION:** **If you plan to upgrade the ESM firmware to the R3 version, you must upgrade the ESM to the intermediate ESM firmware version 9554 first before upgrading to the R3 ESM version (956x or later).**
9554 (R2 ESM) or 956x and later (R3 ESM)	953A or earlier (R1 ESM)	You cannot upgrade the ESM firmware version. Contact IBM technical support, your IBM reseller, or IBM representative for the correct CRU 25R0156 (ESM firmware 9554) or CRU 39M6004 (ESM firmware 956x or later).
9554 (R2 ESM)	956x or later (R3 ESM)	You can only upgrade the ESM firmware version of both ESMs to 956x or later. Downgrading the EXP100 ESM with a higher ESM firmware version to a lower firmware version is *not* supported. Contact IBM technical support, your IBM reseller, or IBM representative for the correct EXP100 FRU/CRU with the ESM firmware version 9554 (P/N 25R0156).

Table 16. Existing EXP100 ESM and new EXP100 ESM firmware compatibility levels (continued)

Existing EXP100 ESM firmware version	New EXP100 ESM firmware version	Corrective action
956x or later (R3 ESM)	9554 (R2 ESM)	You can only upgrade the ESM firmware version of both ESMs to 956x or later. Downgrading the EXP100 ESM with a higher ESM firmware version to a lower firmware version of 9554 is *not* supported. You can upgrade the ESM firmware with I/Os although it is recommended that you update the ESM firmware during a period of low DS4000 I/O activity.

Replacing a failed hot-swap cooling fan

Attention: Do not run the expansion enclosure without adequate ventilation and cooling. Improper ventilation might cause damage to the internal components and circuitry.

The fans are interchangeable and replaceable, and do not require preventive maintenance. The fans help maintain proper air circulation across the components inside the expansion enclosure. Air flows through the expansion enclosure from the front to the back.

You can hot-swap the fans, provided that you complete the exchange within 10 minutes. This time limit applies only to the total time that a fan is out of the expansion enclosure, beginning when you remove the failed unit and ending when you reseat the new one. This does not include the time it takes you to perform this entire procedure (checking LEDs, unpacking the new fan, and so on).

For any period of time exceeding 10 minutes, both fan units must always be in place, even if one is not functioning properly. This is necessary to maintain proper cooling.

Complete the following steps to replace a hot-swap fan:
1. Check the LEDs on the back of the expansion enclosure.
2. If the fan amber Fault LED is lit, remove the failed fan:
   a. Slide the latch in the same direction as the arrow to unlock the fan.
   b. Use the handle (black knob) to pull the fan from the fan bay, as shown in Figure 48 on page 100.
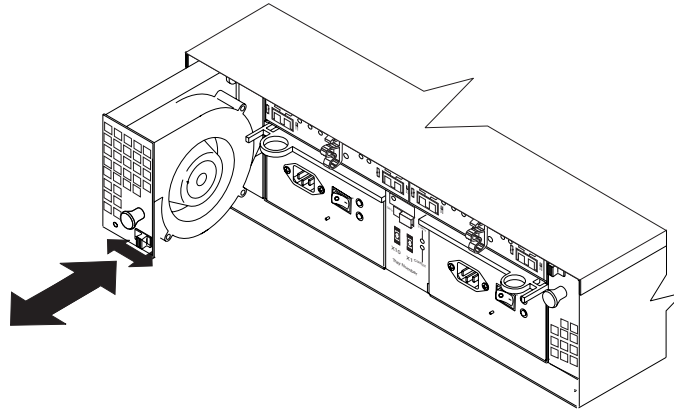
Figure 48. Replacing a hot-swap cooling fan

3. Install the new fan:

   a. Place the fan in front of the fan bay.

   b. Ensure that you move the 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°.

   c. If the latch does not automatically lock when you have successfully inserted the fan unit into the bay, pull back on the fan slightly, and then push it in again until the latch snaps into place.

4. Check the LEDs.

5. The Fault LEDs are no longer lit after a few seconds; if they remain on, see "Solving problems" on page 101.

Chapter 4. Hardware maintenance

This chapter contains information to help you solve some of the simpler problems that you might have with your storage subsystem. It contains the problem indicators and error messages along with suggested actions to take to resolve the problem.

General checkout

Use the indicator lights, the diagnostics and test information, the symptom-to-FRU index, and the connected server HMM to diagnose problems.

The PD maps found in the *IBM System Storage DS4000 Problem Determination Guide* provide you with additional diagnostic aids.

Solving problems

This section contains information to help you solve some of the problems you might have with your expansion enclosure. Table 17 on page 102 contains the problem symptoms and error messages, along with suggested actions to take to resolve problems.

Table 17. Symptom-to-FRU index

Problem indicator	Component	Possible cause	Possible solutions
Amber LED is lit	Drive CRU	Drive failure	Replace the failed drive.
	Fan CRU	Fan failure	Replace the failed fan.
	ESM over-temperature LED	Subsystem has overheated	Check fans for faults. Replace the failed fan if necessary.
		Environment is too hot	Check the ambient temperature around the expansion enclosure. Cool as necessary.
		Defective LED or hardware failure	If you cannot detect a fan failure or overheating problem, replace the ESM.
	ESM Fault LED	ESM failure	Replace the ESM. See your controller documentation for more information.
	ESM Bypass LED	No incoming signal detected	Reconnect the SFP modules and the Fibre Channel cables. Replace input and output SFP modules or cables as necessary.
		ESM failure	If the ESM Fault LED is lit, also replace the ESM.
	Front panel	General machine fault	A Fault LED is lit somewhere on the expansion enclosure (check for Amber LEDs on CRUs).
		Fibre Channel connection failure	Check that the CRUs are properly installed. If none of the amber LEDs are lit on any of the CRUs, this indicates an SFP module transmission fault in the expansion enclosure. Replace the failed SFP module. See your storage manager software documentation for more information.
	ESM ID conflict	This expansion enclosure has the same ID as one of the other expansion enclosures or storage subsystems in the drive loops.	Change the enclosure ID switches to set a unique ID for this expansion enclosure.
Amber LED is lit and green LED is off	Power supply CRU	The power switch is turned off or there is an ac power failure.	Replace the failed power supply or turn on all power supply switches.
Amber and green LEDs are lit	Power supply CRU	Power supply failure	Replace the failed power supply.
All amber and green LEDs are off	All drive CRUs	Check for and resolve one of the following situations: • EXP100 is turned off • EXP100 is not connected to the DS4000 • DS4000 does not have the correct firmware version	

Table 17. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
All green LEDs are off	All CRUs	Subsystem power is off	Check that all expansion enclosure power cables are plugged in and the power switches are on. If applicable, check that the main circuit breakers for the rack are powered on.
		AC power failure	Check the main circuit breaker and ac outlet.
		Power supply failure	Replace the power supply.
		Midplane failure	Contact an IBM technical support representative to service the expansion enclosure.
Amber LED is flashing	Drive CRUs	Drive identity is in process	No corrective action needed.
	ESM port bypass	An FC loop initialization process (LIP) is being generated in the drive loop due to a faulty component.	Use the Read Link Status window in the Storage Manager Client Subsystem Management window and the storage subsystem event logs to isolate the faulty component.
One or more green LEDs are off	Power supply CRUs	Power cable is unplugged or switches are turned off	Make sure that the power cable is plugged in and that the switches are turned on.
	All drive CRUs	Midplane failure	Replace the midplane. Contact an IBM technical support representative.
	Several CRUs	Hardware failure	Replace the affected CRUs. If this does not correct the problem, replace the ESMs, followed by the midplane. Contact an IBM technical support representative.
		The DS4000 was not powered on, or all Fibre Channel connections between the EXP100 and the storage subsystem failed.	Perform one of the following actions: • Power on the storage subsystem. • Verify that the Fibre Channel connections between the EXP100 and the storage subsystem are made.
	Front panel	Power supply problem	Make sure that the power cables are plugged in and that the power supplies are turned on.
		Hardware failure	If any other LEDs are lit, replace the midplane. Contact an IBM technical support representative.

Table 17. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
Intermittent or sporadic power loss to the expansion enclosure	Some or all CRUs	Defective ac power source or improperly connected power cable	Check the ac power source. Reseat all installed power cables and power supplies. If applicable, check the power components (power units or universal power supply). Replace defective power cables.
		Power supply failure	Check the power supply Fault LED on the power supply. If the LED is lit, replace the failed CRU.
		Midplane failure	Have the midplane replaced. Contact an IBM technical support representative.
Unable to access drives	Drives and Fibre Channel loop	Incorrect enclosure ID settings	Ensure that the Fibre Channel optical cables are undamaged and properly connected. Check the enclosure ID settings. **Note:** Change the switch position only when your expansion enclosure is powered off.
		ESM failure	Replace one or both ESMs. Contact an IBM technical support representative.
		Drive or drives failed	Replace failed drive or drives.
Random errors	Subsystem	Midplane failure	Have the midplane replaced. Contact an IBM technical support representative.
Hard disk drive not visible in RAID management software	Several CRUs	Drive or drives failed	Replace failed drive or drives.
		FC cable failed	Replace FC cable.
		SFP failed	Replace SFP.
		ESM failure	Replace ESM.
		Midplane failure	Have the midplane replaced. Contact an IBM technical support representative.
		Drive CRU is not signed correctly	The drive and the interposer card in the drive CRU must be digitally signed together.
		Incorrect firmware version	Verify that the DS4000 storage subsystem has been upgraded to the correct firmware version. Refer to Table 5 on page 7.

Use Table 18 on page 105 to determine the causes and corrective actions for EXP100 ESM incompatibility issues.

Table 18. Troubleshooting ESM incompatibility issues

Problem	Possible cause	Corrective action
After inserting the replacement ESM, all of the drive slots in the EXP100 expansion enclosure into which the replacement ESM was inserted are shown in the Physical view of the Storage Subsystem Management window as empty slots. These drive slots were shown with optimal drives before the replacement ESM was inserted.	An EXP100 R2 or R3 ESM was inserted into an EXP100 expansion enclosure that already contains an EXP100 R1 ESM.	Remove the newly inserted ESM. Contact IBM technical support, your IBM reseller, or IBM representative for the EXP100 R1 ESM CRU part number 24P8814.
An ESM drive firmware mismatch error is shown in the Recovery Guru.	The replacement ESM module might have a firmware version that is incompatible with the one in the existing ESM module.	You must upgrade the ESM firmware of both ESM modules to the same level as immediately. If the firmware version of the ESM modules in the EXP100 expansion enclosure are: • 9554 or later: You can upgrade the ESM firmware with I/Os. However, it is recommended that you update the ESM firmware during a period of low DS4000 utilization. • 953A or earlier: You must schedule down time for the ESM firmware upgrade to 9554 and stop all I/Os. If there are any I/Os during the ESM firmware upgrade, drives might randomly be marked failed. • The existing ESM is at 9554 or later and the new ESM is 953A or earlier: You cannot upgrade the ESM firmware version. Contact IBM technical support, your IBM reseller, or IBM representative.
A drive or drives are marked failed after the replacement ESM was inserted and cause the array to be placed in a degraded state	The cause could be either an ESM firmware version mismatch or a drive failure.	Verify that there are no ESM firmware version incompatibilities. If the ESM firmware versions are compatible, right click the failed drive and select **Reconstruct**. If the drive reconstruction is successful and the drive becomes optimal, the drive is OK. If the drive is bad, it will fail during the reconstruction and you must replace it.
Multiple drives are marked failed during the firmware download which cause the array to be placed in a failed state	The cause of the problem cannot be determined.	Contact IBM technical support for instructions on how to revive the array and to troubleshoot the problem.

Parts listing

Figure 49 and the following table provide a parts listing for the EXP100.
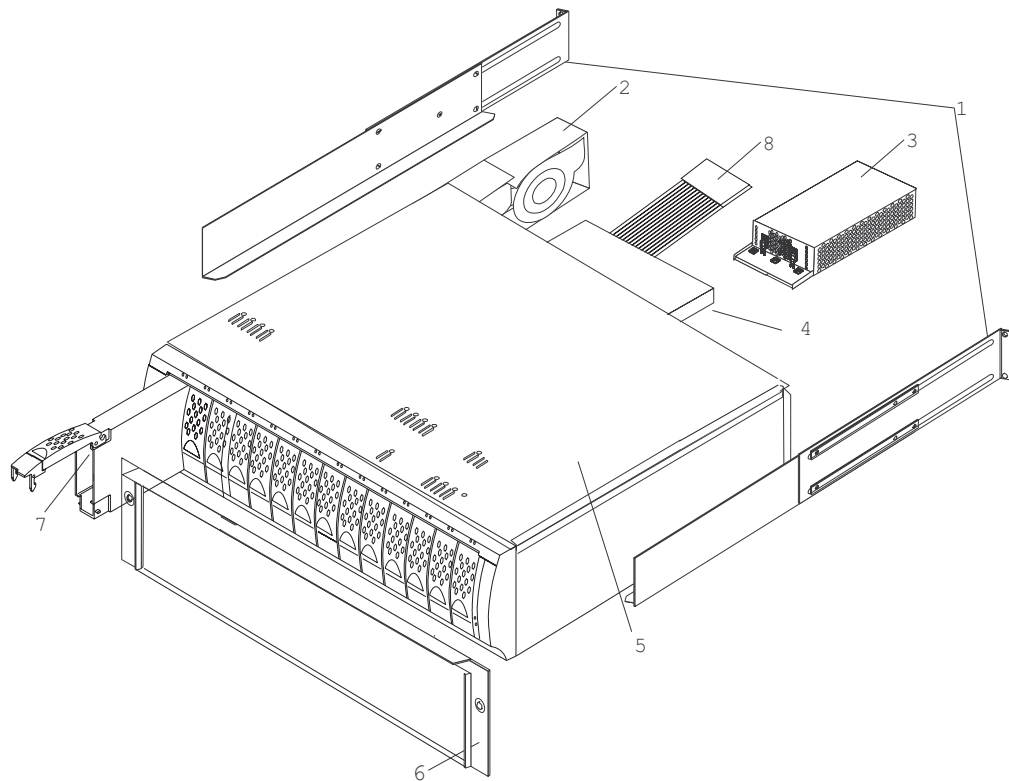
Figure 49. EXP100 storage expansion enclosure parts list

Table 19. Parts listing (EXP100 storage expansion enclosure)

Index	EXP100 storage expansion enclosure	FRU P/N
1	rail kit	01K6670
2	blower ASM FRU	19K1293
3	power supply FRU, 400 W	19K1289
4	SATA ESM (R1 firmware - 953A or earlier)	24P8814
4	SATA ESM (R2 firmware - 9554)	25R0156
4	SATA ESM (R3 firmware - 956x or later)	39M6004
5	SATA Frame, Midplane	24P8815
5	SATA Frame, Midplane (1724, model 1X*x* only)	25R0342
6	bezel ASM FRU	24P8812
	SATA tray, blank	90P1348

Table 19. Parts listing (EXP100 storage expansion enclosure) (continued)

Index	EXP100 storage expansion enclosure	FRU P/N
7	SATA 250 GB drive CRU	90P1349 or 40K6837 (see note at end of table)
7	SATA 400 GB drive CRU	39M4575
8	switch, harness	19K1297
	miscellaneous hardware kit	24P8813
	cable, FRU-1M	19K1265
	cable, FRU-5M	19K1266
	cable, FRU-25M	19K1267
	FRU, SFP LC (shortwave)	19K1280
	power cord, 2.8M	6952300
	power cord, jumper	36L8886
Note: The drive CRU with P/N 40K6837 is a replacement of the drive CRU P/N 90P139. These two CRUs are functionally equivalent. However, the 40K6837 requires the minimum controller and EXP00 ESM firmware as stated in Table 5 on page 7.		

Appendix A. Upgrading R1-level firmware (DS4300 and DS4500 only)

This section describes how to enable EXP100 R2 full high-availability support by upgrading the EXP100 R1 ESM firmware, the DS4000 R1 controller firmware, and NVSRAM.

> **IMPORTANT**
>
> **The information in this section ONLY applies to models DS4300 and DS4500 with the R1 controller version of the firmware.** It is **NOT** applicable to DS4100, DS4400, or DS4800 (or DS4300 and DS4500 with firmware version 06.xx.xx.xx or higher). It is also **NOT** applicable to upgrading DS4300, DS4400, and DS4500 storage subsystems from the down-level firmware versions 05.3x.xx.xx or 05.40.xx.xx to the firmware versions required for EXP100 drive enclosure attachment support. After you upgrade your EXP100 ESM firmware to support EXP100 R2 full high-availability (version 955x or higher), you *cannot* downgrade the firmware back to EXP100 R1 limited high-availability (version 953x).

Overview

Upgrading to EXP100 R2 full high-availability support enables full failover in case of loss of connectivity due to bad components in the drive paths, or due to ESM failure.

Without EXP100 R2 full high-availability support, each ESM in the EXP100 expansion enclosure manages only half of the drives in the expansion enclosure. The ESM on the left side manages drives at odd-numbered slots (1, 3, 5, 7, 9, 11, 13), and the ESM on the right side manages drives at even-numbered slots (2, 4, 6, 8, 10, 12, 14). As a result, half of the EXP100 drives could become inaccessible to the controllers if an ESM fails. You can avoid this situation by upgrading your firmware to enable EXP100 R2 full high-availability support.

The EXP100 R2 full high-availability support also enables EXP100 ESM firmware download with I/O (this is known as *concurrent download*).

Note: The upgrade must be done without I/Os to the DS4000 so you must schedule down time for this upgrade. Please refer to the latest version of the IBM EXP100 R1 to R2 ESM firmware upgrade readme file for any updates to the required controller firmware levels and the upgrade steps in this appendix.

Upgrading the firmware to enable EXP100 R2 full high-availability support

To find out the latest versions of the EXP100 R2 ESM and DS4000 firmware files that you need to download for the upgrade, see the IBM EXP100 R1 to R2 ESM firmware upgrade readme file.

Important: The R1 - to - R2 ESM firmware upgrade, as described in this section, is a two-step process.

1. First you must upgrade from R1 firmware level to the R2 firmware level, which is a "stepping stone" to R3 firmware. This means upgrading the ESM from R1 level firmware (953x) to R2 level firmware (9554), and upgrading the DS4000 storage subsystem controller firmware from 05.41.1x.xx to controller firmware version, 05.41.5x.xx.

2. Then you must upgrade the ESM from the R2 "stepping stone" to the latest R3 ESM and controller firmware. This means upgrading the ESM from R2 level firmware (9554) to R3 level firmware (956x), and upgrading the controller firmware from version 05.41.5x.xx to version 6.12.1x.xx.

Complete the following procedures to upgrade to EXP100 R2 full high-availability support ("stepping stone" to R3 firmware):

- "Checking current firmware levels"
- "Preparing for the upgrade" on page 111
- "Downloading the ESM firmware and csb file" on page 113
- "Downloading the controller firmware and NVSRAM" on page 114
- "Completing the upgrade" on page 115

If you have any questions, please call your IBM technical support representative.

Checking current firmware levels

Before you begin the upgrade, ensure that the firmware levels listed in Table 20 are currently installed.

Table 20. Required current firmware levels

Model	Firmware / NVSRAM versions
DS4300	Firmware: SNAP_05411xxx.dlp NVSRAM: N1722F600R841V03.dlp
DS4500	Firmware: FW_05411xxx_yyyyyyyy.dlp NVSRAM: N1742F900R841V05.dlp
EXP100 expansion enclosure	ESM firmware: 9534 or earlier

If you do not have the most current levels, go to the following Web site and download them:

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

Install the firmware and NVSRAM using the steps that are described in "Downloading the controller firmware and NVSRAM" on page 114.

To find out how to check your current firmware levels, see "Determining firmware levels" on page 11.

Important:

- You cannot use the upgrade procedures in this section to upgrade a DS4000 from Fibre Channel controller firmware (version 05.40.xx.xx or earlier) to SATA controller firmware (version 05.41.xx.xx). You must already have SATA firmware installed before you attempt the upgrade.
- After you upgrade your firmware to support EXP100 R2 full high-availability, you *cannot* downgrade the firmware back to EXP100 R1 limited high-availability.

- You cannot use this procedure if you have a DS4100 or DS4400 with firmware version 05.42.xx.xx or 06.xx.xx.xx, respectively. In addition, you do not need to go though this procedure if you have a DS4300 or DS4500 controller with firmware versions 05.41.5x.xx or 06.xx.xx.xx

Preparing for the upgrade

You must review and complete all of the steps in this section before you complete the upgrade procedures.

Before you begin: Ensure that you have the latest version of the DS4000 Storage Manager installed on your DS4000 management station. You can download the latest version from the following IBM DS4000 support Web site:

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

For more information about Storage Manager, see the appropriate *IBM System Storage DS4000 Storage Manager Installation and Support Guide* for your host operating system.

Complete the following steps to prepare your system for the firmware upgrade procedures:

Backup your logical drives
> Complete a full backup of all logical drives that are defined in the DS4000.

Stop I/O using one of the following methods
> Stop all I/O. If you do not stop I/O, then drives might be marked as Failed during the download. This can cause the array (or arrays) to be degraded or failed.

> Use *one* of the following methods to stop I/O from the host server (or servers) to the logical drives. The methods are listed in order from the most desirable to the least desirable option.

> **Note:** If you are using in-band management to manage the DS4000 storage subsystem, you cannot use method 1 or method 2.

> 1. Shut down all host servers that have logical drives mapped to them (recommended method).

>   This method might not be feasible if you are using the host server as the DS4000 management station. In that case, method 2 is the best choice.

> 2. Stop all programs, services or processes in the host servers that access the logical drives. Make sure that you stop any running background programs, services or processes that write data to the logical drives. (For example, Microsoft MSCS is a background program that periodically writes to the Quorum disk.)

>   If you use this method, also use method 3 to flush I/O from the server cache to disks.

> 3. Unmount the file systems to flush I/O from the server cache to disks.

>   **Note:** In a Microsoft Windows environment, remove the drive letter or the mount points of the mapped LUNs, instead of unmounting the file systems.

> 4. Remove the logical drive-to-host mappings, using the DS4000 Storage Manager client.

Note: Do *not* remove the mapping of the logical drive named "Access," if it is defined.

5. Disconnect the Fibre Channel connections to the DS4000 host ports, using one of the following methods:
   - Physically unplug the Fibre Channel cable connectors from the SFP sockets.
   - Set the Fibre Channel switch ports to an Offline state.

6. Place the DS4000 arrays in an Offline state.

Note: If you use methods 3 on page 111, 4 on page 111, 5 or 6, the programs, services or processes that use the logical drives might go into a Failed state because they cannot access the logical drives.

Verify that I/O has stopped

You need to make sure that I/O has stopped before you continue. Complete the following steps to verify that I/O has stopped:

1. Open the Enterprise Management window of the Storage Manager Client for the DS4000 subsystem that you want to upgrade.

2. In the Enterprise Management window, right-click the name of the DS4000 that you want to upgrade, and select **Manage Device**. The Subsystem Management window opens.

3. In the Subsystem Management window, select **Storage Subsystem –> Monitor Performance**. The Performance Monitor window opens.

4. In the Performance Monitor window, click **Start** to start monitoring.

5. Wait a minimum of 15 minutes, then check the Performance Monitor window. In the Total I/O column, you should see values of 0, or values less than 10.

   If there is any I/O, go back to **Stop I/O** and choose a different method of stopping I/O.

Save the storage subsystem profile

Saving a profile is necessary to restore a storage subsystem configuration in the event of a catastrophic failure. Save your storage subsystem profile by completing the following steps:

1. In the Subsystem Management Menu, select **View → Storage Subsystem Profile**. The Storage Subsystem Profile window opens.

2. In the Storage Subsystem Profile window, click **Save As**. The Save Profile window opens.

3. In the Save Profile window, select or enter the file directory and file name. Click **Save** to save the profile. The Save Profile window closes.

   Important: Do *not* store DS4000 profiles in the same location as the logical drives that are defined on your DS4000. If you do, and the logical drives fail during the subsequent migration, you will lose data.

4. Click **Close** to close the Storage Subsystem Profile window.

Verify current firmware levels

Verify that the DS4000 controller firmware and NVSRAM are at the levels that are listed in Table 20 on page 110. If they are not, go to the following Web site and download the current levels:

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

Install the firmware and NVSRAM in the DS4000 using the steps that are described in "Downloading the controller firmware and NVSRAM" on page 114.

To find out how to verify your current firmware levels, see "Determining firmware levels" on page 11.

Verify current EXP100 ESM status

In the DS4000 Storage Manager Subsystem Management window, verify that all EXP100 ESMs are optimal in the configuration that you are upgrading, and there are not any lost drive path redundancy errors. Correct any problems using the suggested instructions in the DS4000 Storage Manager Recovery Guru window.

To verify, either click the Recovery Guru icon in the Subsystem Management window, or click the Enclosure Status icon in each expansion enclosure with the red X mark overlay, as displayed in the Physical View.

When you are done, continue to "Downloading the ESM firmware and csb file."

Downloading the ESM firmware and csb file

> **Attention**
> This version of EXP100 ESM firmware requires that you download an additional csb file *after* you download the ESM firmware file. If you download the csb file first, then drives may be marked failed or might not display in the Physical View of the Storage Subsystem Management window. You could lose data access or data.

Before you begin: To find out the latest versions of the ESM firmware and csb file that you need to download, see the IBM EXP100 R1 to R2 ESM firmware upgrade readme file.

Downloading the ESM firmware

Complete the following steps to download the ESM firmware to the EXP100:

1. In the Subsystem Management window, select **Advanced → Download → Environment Card (ESM) firmware**. The Download Environmental (ESM) Card Firmware window opens.
2. In the Download Environmental (ESM) Card Firmware window, select all of the expansion enclosures to be updated with new firmware, then click **Browse** to open the Select Environmental (ESM) Card Firmware File window.
3. In the Select Environmental (ESM) Card Firmware File window, select the directory that contains the ESM firmware file, then select the name of the ESM firmware file. Click **OK** to close the window and continue.

    Note: You might need to select All Files (*.*) in the "Files of type" pull-down menu to display the correct file name for selection. If you do, then a warning window opens. Click **OK** when the warning window opens. You will need to select the file with the name esm955x.dl.
4. In the Download Environmental (ESM) Card Firmware window, click **Start**. When the Confirm Download window opens, type *yes* and click **OK**. The ESM

firmware download begins. During the download, the status field of the Download Environmental (ESM) Card Firmware window displays the progress of each expansion enclosure.

When the status field of each expansion enclosure displays a status of Complete, the ESM firmware download is complete. Keep the Download Environmental (ESM) Card Firmware window open, and continue to "Downloading the csb file."

Downloading the csb file
Complete the following steps to download the csb file:

1. In the Download Environmental (ESM) Card Firmware window, select all of the expansion enclosures to be updated with new firmware, then click **Browse** to open the Select Environmental (ESM) Card Firmware File window.

2. In the Select Environmental (ESM) Card Firmware File window, select the directory that contains the ESM firmware file, then select the name of the csb file. Click **OK** to close the window and continue.

   Note: You might need to select All Files (*.*) in the "Files of type" pull-down menu to display the correct file name for selection. If you do, then a warning window opens. Click **OK** when the warning window opens. You will need to select the file with the namecsb_ibm_0411.dl.

3. In the Download Environmental (ESM) Card Firmware window, click **Start**. When the Confirm Download window opens, type *yes* and click **OK**. The download begins. During the download, the status field of the Download Environmental (ESM) Card Firmware window displays the progress of each expansion enclosure.

When the status field of each expansion enclosure displays Complete, the csb file download is complete. Click **Cancel** to close the Download Environmental (ESM) Card Firmware window and continue to "Downloading the controller firmware and NVSRAM."

Downloading the controller firmware and NVSRAM

Before you begin: To find out the latest versions of the controller firmware and NVSRAM files that you need to download, see the IBM EXP100 R1 to R2 ESM firmware upgrade readme file.

Complete the following procedures to download the controller firmware and NVSRAM.

Downloading the controller firmware
Complete the following steps to download the controller firmware to the DS4000:

1. In the Subsystem Management window, select **Storage Subsystem →
Download → Firmware**. The Download Firmware window opens.

2. Select the directory that contains the controller firmware file, and select the name of the controller firmware file to be downloaded. Click **OK** to continue.

3. When the Confirm Download window opens, click **Yes**. The download begins, and the Downloading window displays the progress.

4. When the download completes, click **Done** to close the Downloading window and return to the Subsystem Management window.

Continue to "Downloading the NVSRAM" on page 115.

Downloading the NVSRAM

Complete the following steps to download the NVSRAM to the DS4000:

1. In the Subsystem Management window, select **Storage Subsystem →
   Download → NVSRAM**. The Download NVSRAM window opens.
2. Select the directory that contains the NVSRAM, and select the name of the
   NVSRAM file to be downloaded. Click **OK** to continue.
3. When the Confirm Download window opens, click **Yes**. The download begins,
   and the Downloading window displays the progress.
4. When the download completes, click **Done** to close the Downloading window
   and return to the Subsystem Management window.

Continue to "Completing the upgrade."

Completing the upgrade

When you have finished all of the download procedures, complete the following
steps:

1. Undo the tasks that you performed to quiesce I/O.
2. Restore I/O to the logical drives.

When you are finished, you have completed upgrading your firmware to enable
EXP100 R3 support.

Problem recovery

During the upgrade, you might encounter the following problems. Perform the
indicated actions to resolve them.

Problems	Actions
During the DS4000 controller firmware or NVSRAM download process, you see an error window stating that the download may be completed but the Storage Manager client was not able to communicate with the controller to verify the download.	Follow the error recovery procedure that is shown in the Error window. If the problem persists, contact IBM support.
During the EXP100 csb or ESM firmware download, you see an error window stating that the download to an expansion enclosure failed. This expansion enclosure is marked with the word Failed in its status field. If there are other expansion enclosures that were in the pending state to receive the new ESM firmware, those expansion enclosures will have the word Cancelled in their status fields.	Restart the ESM firmware download to the expansion enclosure(s) that have the Cancelled status. Then, use the Recovery Guru icon in the Subsystem Management window to make sure that there is not any ESM Loss of Path Redundancy error. Follow the listed recovery procedure in the window to fix the problems and retry the download to the expansion enclosure(s) that had the status of Failed. If the problem persists, contact IBM support.
Drive(s) are marked Failed during the firmware download, causing the array to be placed in Degraded state.	After all of the firmware downloads have completed, right-click the failed drive and select **Reconstruct**. If the drive reconstructs and becomes optimal, then the drive is OK. If the drive fails during the reconstruction, then it is bad. In that case, replace the drive.

Problems	Actions
Multiple drives are marked Failed during the firmware download, causing the array to be placed in Failed state, or drive slots with inserted drives will show as empty slots in the Physical view of the Subsystem Management window.	Please contact IBM support for instructions to revive the failed array(s).

Appendix B. Records

Whenever you add options to your EXP100, be sure to update the information in this appendix. Accurate, up-to-date records make it easier to add other options and provide needed data whenever you contact your IBM technical support representative.

Identification numbers

Record and retain the following information.

Product name:	IBM TotalStorage DS4000 EXP100 Storage Expansion Enclosure
Machine type:	1710
Model number:	10U, 10X
Serial number:	

–OR–

Product name:	IBM TotalStorage DS4000 EXP100 Storage Expansion Enclosure
Machine type:	1724
Model number:	1X*x* (where *x* is an alphanumeric character)
Serial number:	

The serial number is located on the bottom inside surface at the rear and on the bottom right at the front of the EXP100.

Storage subsystem and controller information record

Table 21 provides a data sheet for recording storage subsystem names, management types, Ethernet hardware addresses, and IP addresses. Make a copy of this table and complete the information for your storage subsystems and controllers. Use the information to set up the BOOTP table for the network server and the host or Domain Name System (DNS) table. The information is also helpful if you add storage subsystems after initial installation. Refer to your Storage Manager documentation for detailed instructions about how to obtain the information. For a sample information record, see Table 22 on page 119.

Table 21. Storage subsystem and controller information record

Storage subsystem name	Management method	Controllers-Ethernet and IP addresses, and host name		Host-IP address and host name

Sample information record

Table 22 shows a sample information record. This network contains storage subsystems that are managed by using both the direct-management and host-agent-management method.

Table 22. Sample information record

Storage subsystem name	Management method	Controllers-Ethernet and IP addresses, and host name		Host-IP address and host name
		Controller A	**Controller B**	
Finance	Direct	Hardware Ethernet address = 00a0b8020420	Hardware Ethernet address = 00a0b80000d8	
		IP address = 192.168.128.101	IP address = 192.168.128.102	
		Host = Denver_a	Host = Denver_b	
Engineering	Host-agent			IP address = 192.168.2.22
				Host = Atlanta

Installed device records

Use the following table to record the number of the hard disk drives that you replaced and the corresponding bay number.

Attention: If you replace a hard disk drive in the wrong drive bay it might cause a loss of data.

Table 23. Hard disk drive record

Bay Number	Hard disk drive serial number	Replaced hard disk drive serial number

Appendix C. 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 32.

Use the following templates (Figure 50 on page 122 and Figure 51 on page 123) to identify the proper locations for inserting M6 screws when mounting the support rails and EXP100 to a rack. The locations for the M6 screws are highlighted in the templates.

The EXP100 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 might be round or square.

EXP100
FRONT
Rack Mounting
Template

3 U

3 U

2 U

2 U

Bezel
(Front Left)

Bezel
(Front Right)

1 U

1 U

Rail assembly
(Front Left)

Rail assembly
(Front Right)

0 U

0 U
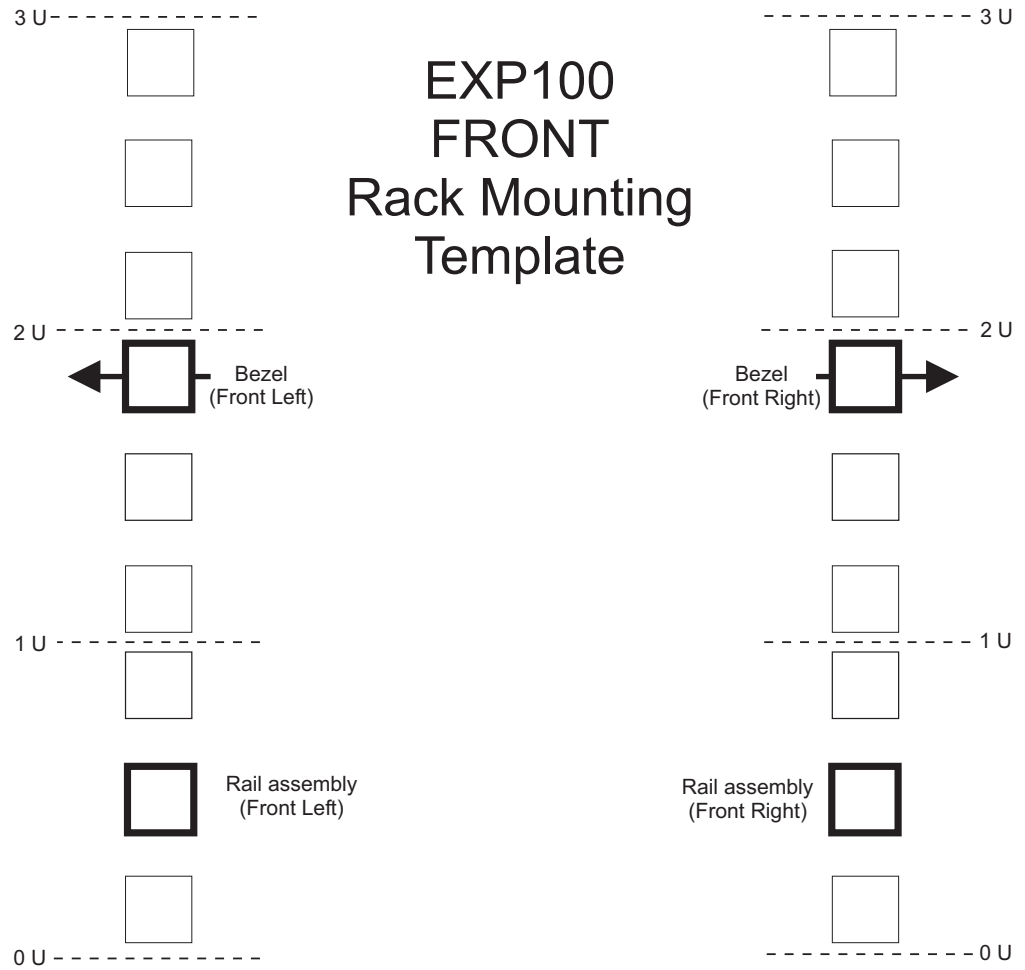
Figure 50. Front rack mounting template

3U - - - - - - - - - - - -

EXP100
REAR
Rack Mounting
Template

3U - - - - - - - - - - -

2U - - - - - - - - - - - -

Rail assembly
(Rear Left)

2U - - - - - - - - - - -

1U - - - - - - - - - - - -

Rail assembly
(Rear right)

1U - - - - - - - - - - -

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0U - - - - - - - - - - - -

0U - - - - - - - - - - -
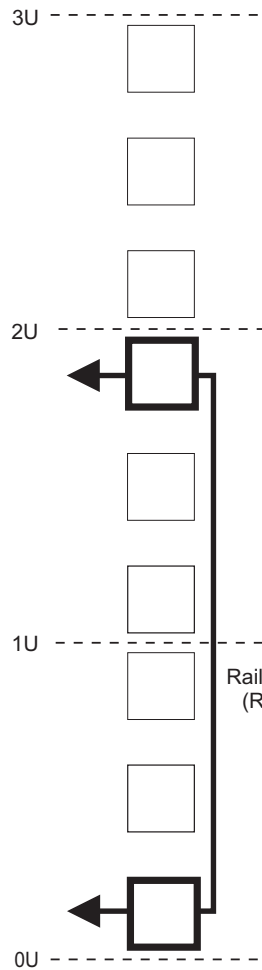
Figure 51. Rear rack mounting template

Appendix D. 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.
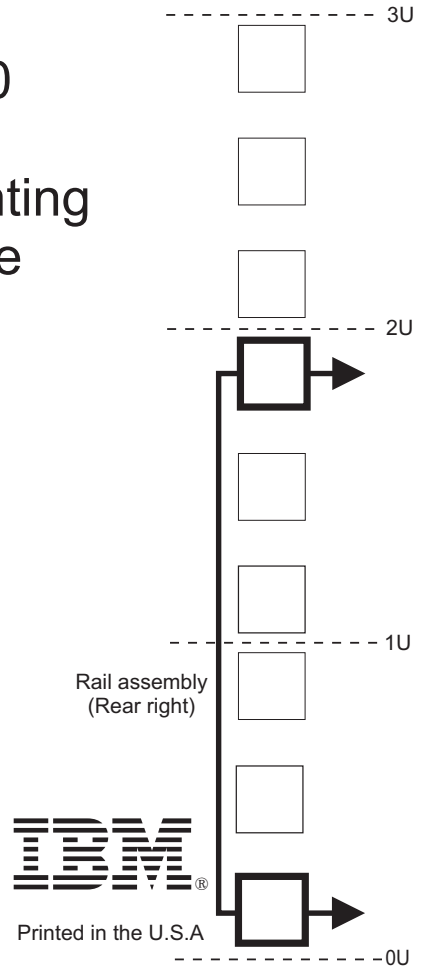
For units intended to be operated at 230 volts (U.S. use): Use a UL-listed and CSA-certified cord set consisting of a minimum 18 AWG, Type SVT or SJT, three-conductor cord, a maximum of 15 feet in length and a tandem blade, grounding-type attachment plug rated 15 amperes, 250 volts.

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	Used in these countries or regions
13F9940	Argentina, Australia, China (PRC), New Zealand, Papua New Guinea, Paraguay, Uruguay, Western Samoa
13F9979	Afghanistan, Algeria, Andorra, Angola, Austria, Belgium, Benin, Bulgaria, Burkina Faso, Burundi, Cameroon, Central African Rep., Chad, Czech Republic, Egypt, Finland, France, French Guiana, Germany, Greece, Guinea, Hungary, Iceland, Indonesia, Iran, Ivory Coast, Jordan, Lebanon, Luxembourg, Macau S.A.R. of China, Malagasy, Mali, Martinique, Mauritania, Mauritius, Monaco, Morocco, Mozambique, Netherlands, New Caledonia, Niger, Norway, Poland, Portugal, Romania, Senegal, Slovakia, Spain, Sudan, Sweden, Syria, Togo, Tunisia, Turkey, former USSR, Vietnam, former Yugoslavia, Zaire, Zimbabwe
13F9997	Denmark
14F0015	Bangladesh, Burma, Pakistan, South Africa, Sri Lanka
14F0033	Antigua, Bahrain, Brunei, Channel Islands, Cyprus, Dubai, Fiji, Ghana, Hong Kong S.A.R. of China, India, Iraq, Ireland, Kenya, Kuwait, Malawi, Malaysia, Malta, Nepal, Nigeria, Polynesia, Qatar, Sierra Leone, Singapore, Tanzania, Uganda, United Kingdom, Yemen, Zambia
14F0051	Liechtenstein, Switzerland
14F0069	Chile, Ethiopia, Italy, Libya, Somalia
14F0087	Israel
1838574	Thailand

IBM power cord part number	Used in these countries or regions
6952301	Bahamas, Barbados, Bermuda, Bolivia, Brazil, Canada, Cayman Islands, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Japan, Korea (South), Liberia, Mexico, Netherlands Antilles, Nicaragua, Panama, Peru, Philippines, Saudi Arabia, Suriname, Taiwan, Trinidad (West Indies), United States of America, Venezuela

Appendix E. Additional DS4000 documentation

The following tables present an overview of the IBM System Storage DS4000 Storage Manager, Storage Subsystem, and Storage Expansion Enclosure product libraries, as well as other related documents. Each table lists documents that are included in the libraries and what common tasks they address.

You can access the documents listed in these tables at both of the following Web sites:

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

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

DS4000 Storage Manager Version 9 library

Table 24 associates each document in the DS4000 Storage Manager Version 9 library with its related common user tasks.

Table 24. DS4000 Storage Manager Version 9 titles by user tasks

Title	User tasks					
	Planning	Hardware installation	Software installation	Configuration	Operation and administration	Diagnosis and maintenance
IBM System Storage DS4000 Storage Manager Version 9 Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux	✔		✔	✔		
IBM System Storage DS4000 Storage Manager Version 9 Installation and Support Guide for AIX, UNIX, Solaris and Linux on POWER	✔		✔	✔		
IBM System Storage DS4000 Storage Manager Version 9 Copy Services User's Guide	✔		✔	✔	✔	
IBM TotalStorage DS4000 Storage Manager Version 9 Concepts Guide	✔	✔	✔	✔	✔	✔

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Table 24. DS4000 Storage Manager Version 9 titles by user tasks (continued)

Title	User tasks					
	Planning	**Hardware installation**	**Software installation**	**Configuration**	**Operation and administration**	**Diagnosis and maintenance**
IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview	✔	✔	✔	✔		

DS4800 Storage Subsystem library

Table 25 associates each document in the DS4800 Storage Subsystem library with its related common user tasks.

Table 25. DS4800 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM System Storage DS4800 Storage Subsystem Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage DS4800 Storage Subsystem Installation and Cabling Overview		✔				
IBM TotalStorage DS4800 Controller Cache Upgrade Kit Instructions	✔	✔		✔		

DS4700 Storage Subsystem library

Table 26 associates each document in the DS4700 Storage Subsystem library with its related common user tasks.

Table 26. DS4700 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM System Storage DS4700 Storage Subsystem Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage DS4700 Storage Subsystem Fibre Channel Cabling Guide		✔				

DS4500 Storage Subsystem library

Table 27 associates each document in the DS4500 (previously FAStT900) Storage Subsystem library with its related common user tasks.

Table 27. DS4500 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM TotalStorage DS4500 Storage Subsystem Installation, User's, and Maintenance Guide	✔	✔		✔	✔	✔
IBM TotalStorage DS4500 Storage Subsystem Cabling Instructions	✔	✔				
IBM TotalStorage DS4500 Rack Mounting Instructions	✔	✔				

DS4400 Storage Subsystem library

Table 28 associates each document in the DS4400 (previously FAStT700) Storage Subsystem library with its related common user tasks.

Table 28. DS4400 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
IBM TotalStorage DS4400 Fibre Channel Storage Server User's Guide	✔	✔		✔	✔	✔
IBM TotalStorage DS4400 Fibre Channel Storage Server Installation and Support Guide	✔	✔		✔	✔	
IBM TotalStorage DS4400 Fibre Channel Cabling Instructions	✔	✔				

DS4300 Storage Subsystem library

Table 29 associates each document in the DS4300 (previously FAStT600) Storage Subsystem library with its related common user tasks.

Table 29. DS4300 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM TotalStorage DS4300 Storage Subsystem Installation, User's, and Maintenance Guide	✔	✔		✔	✔	✔
IBM TotalStorage DS4300 Rack Mounting Instructions	✔	✔				
IBM TotalStorage DS4300 Storage Subsystem Cabling Instructions	✔	✔				
IBM TotalStorage DS4300 SCU Base Upgrade Kit		✔	✔			
IBM TotalStorage DS4300 SCU Turbo Upgrade Kit		✔	✔			
IBM TotalStorage DS4300 Turbo Models 6LU/6LX Upgrade Kit		✔	✔			

DS4200 Express Storage Subsystem library

Table 30 associates each document in the DS4200 Express Storage Subsystem library with its related common user tasks.

Table 30. DS4200 Express Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM System Storage DS4200 Express Storage Subsystem Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage DS4200 Express Storage Subsystem Cabling Guide		✔				

DS4100 Storage Subsystem library

Table 31 associates each document in the DS4100 (previously FAStT100) Storage Subsystem library with its related common user tasks.

Table 31. DS4100 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM TotalStorage DS4100 Storage Server Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM TotalStorage DS4100 Storage Server Cabling Guide		✔				

DS4000 Storage Expansion Enclosure documents

Table 32 associates each of the following documents with its related common user tasks.

Table 32. DS4000 Storage Expansion Enclosure document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM System Storage DS4000 EXP810 Storage Expansion Enclosure Installation, User's, and Maintenance Guide	✔	✔		✔	✔	✔
IBM TotalStorage DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide	✔	✔		✔	✔	✔
IBM DS4000 EXP500 Installation and User's Guide	✔	✔		✔	✔	✔
IBM System Storage DS4000 EXP420 Storage Expansion Enclosure Installation, User's, and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage DS4000 Hard Drive and Storage Expansion Enclosures Installation and Migration Guide	✔	✔				

Other DS4000 and DS4000-related documents

Table 33 associates each of the following documents with its related common user tasks.

Table 33. DS4000 and 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					✔	
IBM TotalStorage DS4000 Quick Start Guide	✔	✔				
IBM TotalStorage DS4000 Hardware Maintenance Manual [1]						✔
IBM System Storage DS4000 Problem Determination Guide						✔
IBM Fibre Channel Planning and Integration: User's Guide and Service Information	✔	✔			✔	✔
IBM TotalStorage DS4000 FC2-133 Host Bus Adapter Installation and User's Guide		✔			✔	
IBM TotalStorage DS4000 FC2-133 Dual Port Host Bus Adapter Installation and User's Guide		✔			✔	
IBM Netfinity® Fibre Channel Cabling Instructions		✔				
IBM Fibre Channel SAN Configuration Setup Guide	✔		✔	✔	✔	

Notes:

1. The *IBM TotalStorage DS4000 Hardware Maintenance Manual* does not contain maintenance information for the IBM System Storage DS4200, DS4300, DS4500, DS4700, or DS4800 storage subsystems. You can find maintenance information for these products in the *IBM System Storage DSx000 Storage Subsystem Installation, User's, and Maintenance Guide* for the particular subsystem.

Appendix F. Product Recycling and Disposal

This unit must be recycled or discarded according to applicable local and national regulations. IBM encourages owners of information technology (IT) equipment to responsibly recycle their equipment when it is no longer needed. IBM offers a variety of product return programs and services in several countries to assist equipment owners in recycling their IT products. Information on IBM product recycling offerings can be found on IBM's Internet site at `www.ibm.com/ibm/environment/products/prp.shtml`.

Esta unidad debe reciclarse o desecharse de acuerdo con lo establecido en la normativa nacional o local aplicable. IBM recomienda a los propietarios de equipos de tecnología de la información (TI) que reciclen responsablemente sus equipos cuando éstos ya no les sean útiles. IBM dispone de una serie de programas y servicios de devolución de productos en varios países, a fin de ayudar a los propietarios de equipos a reciclar sus productos de TI. Se puede encontrar información sobre las ofertas de reciclado de productos de IBM en el sitio web de IBM `www.ibm.com/ibm/environment/products/prp.shtml`.
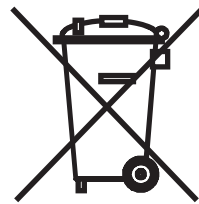
Notice: This mark applies only to countries within the European Union (EU) and Norway.

Appliances are labeled in accordance with European Directive 2002/96/EC concerning waste electrical and electronic equipment (WEEE). The Directive determines the framework for the return and recycling of used appliances as applicable throughout the European Union. This label is applied to various products to indicate that the product is not to be thrown away, but rather reclaimed upon end of life per this Directive.

In accordance with the European WEEE Directive, electrical and electronic equipment (EEE) is to be collected separately and to be reused, recycled, or recovered at end of life. Users of EEE with the WEEE marking per Annex IV of the WEEE Directive, as shown above, must not dispose of end of life EEE as unsorted municipal waste, but use the collection framework available to customers for the return, recycling and recovery of WEEE. Customer participation is important to minimize any potential effects of EEE on the environment and human health due to the potential presence of hazardous substances in EEE. For proper collection and treatment, contact your local IBM representative.

Appendix G. Battery Return Program

This product may contain sealed lead acid, nickel cadmium, nickel metal hydride, lithium, or a lithium ion battery. Consult your user manual or service manual for specific battery information. The battery must be recycled or disposed of properly. Recycling facilities may not be available in your area. For information on disposal of batteries outside the United States, go to `www.ibm.com/ibm/environment/products/batteryrecycle.shtml` or contact your local waste disposal facility.

In the United States, IBM has established a return process for reuse, recycling, or proper disposal of used IBM sealed lead acid, nickel cadmium, nickel metal hydride, and other battery packs from IBM Equipment. For information on proper disposal of these batteries, contact IBM at 1-800-426-4333. Please have the IBM part number listed on the battery available prior to your call.
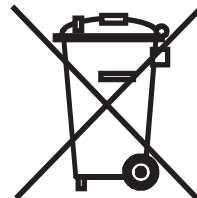
For Taiwan:

Please recycle batteries

廢電池請回收

For the European Union:

For California:

Perchlorate Material - special handling may apply. See `www.dtsc.ca.gov/hazardouswaste/perchlorate`.

The foregoing notice is provided in accordance with California Code of Regulations Title 22, Division 4.5 Chapter 33. Best Management Practices for Perchlorate Materials. This product/part may include a lithium manganese dioxide battery which contains a perchlorate substance.

Appendix H. Accessibility

This section provides information about alternate keyboard navigation, which is a DS4000 Storage Manager accessibility feature. Accessibility features help a user who has a physical disability, such as restricted mobility or limited vision, to use software products successfully.

By using the alternate keyboard operations that are described in this section, you can use keys or key combinations to perform Storage Manager tasks and initiate many menu actions that can also be done with a mouse.

Note: In addition to the keyboard operations that are described in this section, the DS4000 Storage Manager 9.14, 9.15, and 9.16 software installation packages for Windows include a screen reader software interface. To enable the screen reader, select Custom Installation when using the installation wizard to install Storage Manager 9.14, 9.15, or 9.16 on a Windows host/management station. Then, in the Select Product Features window, select Java Access Bridge in addition to the other required host software components.

Table 34 defines the keyboard operations that enable you to navigate, select, or activate user interface components. The following terms are used in the table:

- *Navigate* means to move the input focus from one user interface component to another.
- *Select* means to choose one or more components, typically for a subsequent action.
- *Activate* means to carry out the action of a particular component.

Note: In general, navigation between components requires the following keys:
  - **Tab** - Moves keyboard focus to the next component or to the first member of the next group of components
  - **Shift-Tab** - Moves keyboard focus to the previous component or to the first component in the previous group of components
  - **Arrow keys** - Move keyboard focus within the individual components of a group of components

Table 34. DS4000 Storage Manager alternate keyboard operations

Short cut	Action
F1	Open the Help.
F10	Move keyboard focus to main menu bar and post first menu; use the arrow keys to navigate through the available options.
Alt+F4	Close the management window.
Alt+F6	Move keyboard focus between dialogs (non-modal) and between management windows.

Table 34. DS4000 Storage Manager alternate keyboard operations (continued)

Short cut	Action
Alt+ underlined letter	Access menu items, buttons, and other interface components by using the keys associated with the underlined letters. For the menu options, select the Alt + underlined letter combination to access a main menu, and then select the underlined letter to access the individual menu item. For other interface components, use the Alt + underlined letter combination.
Ctrl+F1	Display or conceal a tool tip when keyboard focus is on the toolbar.
Spacebar	Select an item or activate a hyperlink.
Ctrl+Spacebar (Contiguous/Non-contiguous) AMW Logical/Physical View	Select multiple drives in the Physical View. To select multiple drives, select one drive by pressing Spacebar, and then press Tab to switch focus to the next drive you want to select; press Ctrl+Spacebar to select the drive. If you press Spacebar alone when multiple drives are selected then all selections are removed. Use the Ctrl+Spacebar combination to deselect a drive when multiple drives are selected. This behavior is the same for contiguous and non-contiguous selection of drives.
End, Page Down	Move keyboard focus to the last item in the list.
Esc	Close the current dialog (does not require keyboard focus).
Home, Page Up	Move keyboard focus to the first item in the list.
Shift+Tab	Move keyboard focus through components in the reverse direction.
Ctrl+Tab	Move keyboard focus from a table to the next user interface component.
Tab	Navigate keyboard focus between components or select a hyperlink.
Down arrow	Move keyboard focus down one item in the list.
Left arrow	Move keyboard focus to the left.
Right arrow	Move keyboard focus to the right.
Up arrow	Move keyboard focus up one item in the list.

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Processor speeds indicate the internal clock speed of the microprocessor; other factors also affect application performance.

CD-ROM drive speeds list the variable read rate. Actual speeds vary and are often less than the maximum possible.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for approximately 1000 bytes, MB stands for approximately 1 000 000 bytes, and GB stands for approximately 1 000 000 000 bytes.

When referring to hard disk drive capacity or communications volume, MB stands for 1 000 000 bytes, and GB stands for 1 000 000 000 bytes. Total user-accessible capacity may vary depending on operating environments.

Maximum internal hard disk drive capacities assume the replacement of any standard hard disk drives and population of all hard disk drive bays with the largest currently supported drives available from IBM.

Maximum memory may require replacement of the standard memory with an optional memory module.

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Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio

communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. IBM is not responsible for any radio or television interference caused by using other than recommended cables and connectors or by using other than recommended cables and connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Chinese class A compliance statement

Attention: This is a class A statement. In a domestic environment, this product might cause radio interference in which case the user might be required to take adequate measures.

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声 明
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Industry Canada Class A emission compliance statement

This Class A digital apparatus complies with Canadian ICES-003.

Avis de conformité à la réglementation d'Industrie Canada

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

Australia and New Zealand Class A statement

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

United Kingdom telecommunications safety requirement

Notice to Customers

This apparatus is approved under approval number NS/G/1234/J/100003 for indirect connection to public telecommunication systems in the United Kingdom.

European Union EMC Directive conformance statement

This product is in conformity with the protection requirements of EU Council Directive 89/336/EEC on the approximation of the laws of the Member States relating to electromagnetic compatibility. IBM cannot accept responsibility for any failure to satisfy the protection requirements resulting from a nonrecommended modification of the product, including the fitting of non-IBM option cards.

This product has been tested and found to comply with the limits for Class A Information Technology Equipment according to CISPR 22/European Standard EN 55022. The limits for Class A equipment were derived for commercial and industrial environments to provide reasonable protection against interference with licensed communication equipment.

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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 collection of fibre-channel or SATA hard drives that are logically grouped together. All the drives in the array are assigned the same RAID level. An array is sometimes referred to as a ″RAID set.″ See also *redundant array of independent disks (RAID)*, *RAID level*.

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*.

data striping. See *striping*.

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.

drive channels. The DS4200, DS4700, and DS4800 subsystems use dual-port drive channels that, from the physical point of view, are connected in the same way as two drive loops. However, from the point of view of the number of drives and enclosures, they are treated as a single drive loop instead of two different drive loops. A group of storage expansion enclosures are connected to the DS4000 storage subsystems using a drive channel from each controller. This pair of drive channels is referred to as a redundant drive channel pair.

drive loops. A drive loop consists of one channel from each controller combined to form one pair of redundant drive channels or a redundant drive loop. Each drive loop is associated with two ports. (There are two drive channels and four associated ports per controller.) For the DS4800, drive loops are more commonly referred to as drive channels. See *drive channels*.

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 service module (ESM) canister. A component in a storage expansion 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 service module canister*.

automatic ESM firmware synchronization. When you install a new ESM into an existing storage expansion enclosure in a DS4000 storage subsystem that supports automatic ESM firmware synchronization, the firmware in the new ESM is automatically synchronized with the firmware in the existing ESM.

EXP. See *storage expansion enclosure*.

expansion port (E_port). A port that connects the switches for two fabrics.

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*.

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.

heterogeneous host environment.   A host system in which multiple host servers, which use different operating systems with their own unique disk storage subsystem settings, connect to the same DS4000 storage subsystem at the same time. See also *host*.

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*.

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 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 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 redundancy information.

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.

mini hub. An interface card or port device that receives short-wave fiber channel GBICs or SFPs. These devices enable redundant Fibre Channel connections from the host computers, either directly or through a Fibre Channel switch or managed hub, over optical fiber cables to the DS4000 Storage Server controllers. Each DS4000 controller is responsible for two mini hubs. Each mini hub has two ports. Four host ports (two on each controller) provide a cluster solution without use of a switch. Two host-side mini hubs are shipped as standard. See also *host port, gigabit interface converter (GBIC), small form-factor pluggable (SFP)*.

mirroring. A fault-tolerance technique in which information on a hard disk is duplicated on additional hard disks. See also *remote mirroring*.

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*.

parity check. (1) A test to determine whether the number of ones (or zeros) in an array of binary digits is odd or even. (2) A mathematical operation on the numerical representation of the information communicated between two pieces. For example, if parity is odd, any character represented by an even number has a bit added to it, making it odd, and an information receiver checks that each unit of information has an odd value.

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 (RAID)*.

RAID level.   An array's RAID level is a number that refers to the method used to achieve redundancy and fault tolerance in the array. See also *array, redundant array of independent disks (RAID)*.

RAID set.   See *array*.

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 (*array*) that appears as a single volume to the server, which is fault tolerant through an assigned method of data striping, mirroring, or parity checking. Each array is assigned a RAID level, which is a specific number that refers to the method used to achieve redundancy and fault tolerance. See also *array, parity check, mirroring, RAID level, striping*.

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, AIX, HP-UX, Solaris, and Linux on POWER 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 storage expansion enclosures 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, AIX, HP-UX, Solaris, and Linux on POWER 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 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 know 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 expansion enclosure (EXP). A feature that can be connected to a system unit to provide additional storage and processing capacity.

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.

striping. Splitting data to be written into equal blocks and writing blocks simultaneously to separate disk drives. Striping maximizes performance to the disks. Reading the data back is also scheduled in parallel, with a block being read concurrently from each disk then reassembled at the host.

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 zoning. See *zoning*.

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 packed-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.

worldwide port name (WWPN). A unique identifier for a switch on local and global networks.

worldwide name (WWN). A globally unique 64-bit identifier assigned to each Fibre Channel port.

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. (1) In Fibre Channel environments, the grouping of multiple ports to form a virtual, private, storage network. Ports that are members of a zone can communicate with each other, but are isolated from ports in other zones. (2) 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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