IBM

Installation, User's and Maintenance Guide

IBM

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 139.

First Edition (August 2006)

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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 System Storage™ EXP420 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:
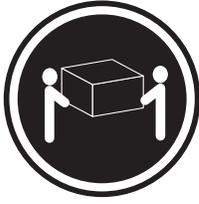
≥ 18 kg (39.7 lb)	≥ 32 kg (70.5 lb)	≥ 55 kg (121.2 lb)

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.
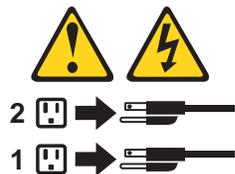
Statement 8:

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.

Cable Warning:

WARNING: Handling the cord on this product or cords associated with accessories sold with this product, will expose you to lead, a chemical known to the State of California to cause cancer, and birth defects or other reproductive harm. **Wash hands after handling.**

About this document

This document provides instructions for installing and customizing the configuration of your IBM® System Storage DS4000 EXP420 storage expansion enclosure. It also provides maintenance procedures and troubleshooting information.

Who should read this document

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

How this document is organized

Chapter 1, "Introduction," on page 1 describes the IBM System Storage EXP420 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 EXP420," on page 19 contains information on how to install the EXP420.

Chapter 3, "Cabling the EXP420," on page 37 contains information on how to cable the EXP420.

Chapter 4, "Operating the EXP420," on page 53 contains information on how to power on and off the storage expansion enclosure, recover from an overheated power supply and fan unit, troubleshoot the storage expansion enclosure, and interpret LEDs.

Chapter 5, "Installing and replacing devices," on page 73 contains step-by-step instructions about how to install or remove customer replaceable units (CRUs), such as Enhanced Value Disk Drive Modules (EV-DDMs), power supply and fan units, environmental service modules (ESMs), midplane, and SFP modules.

Chapter 6, "Hardware maintenance," on page 101 describes problems and symptoms that are specific to your storage expansion enclosure. It also provides a parts list for the EXP420.

Appendix A, "Records," on page 109 provides a table that you can use to record and update important information about your EXP420, including serial number and device records. Whenever you add options to your EXP420, be sure to update the information in this table.

Appendix B, "Rack mounting template," on page 113 provides the rack mounting templates for installation of the EXP420. If you want to tear out the templates from the document for use during installation, use these copies of the templates.

Appendix C, "Power cords," on page 117 lists power cord information for the EXP420.

Appendix D, "Additional DS4000 documentation," on page 121 lists additional DS4000 documents.

Appendix E, "Accessibility," on page 131 details accessibility information.

Appendix F, "European Directive About Product Recycling and Disposal," on page 133 details the European directive about product recycling.

DS4000 Storage Subsystem installation tasks - General overview

Table 1 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 1. 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 Server Installation, User's, and Maintenance Guide* • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4300 Fibre Channel Storage Server Installation and User's Guide* • *DS4400 Fibre Channel Storage Server Installation and Support Guide* • *DS4500 Fibre Channel Storage Server Installation and Support 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 Installation, User's, and Maintenance Guide* • *DS4700 Installation, User's, and Maintenance Guide* • *DS4400 and DS4500 Rack Mounting Instructions* • *DS4300 Rack Mounting Instructions* • *DS4200 Express Installation, User's, and Maintenance Guide* • *DS4100 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 1. 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 Fibre Channel Cabling Instructions* • *DS4200 Express Installation, User's, and Maintenance Guide* • *DS4300 Fibre Channel Cabling Instructions* • *DS4400 Fibre Channel Cabling Instructions* • *DS4500 Fibre Channel Cabling Instructions* • *DS4700 Installation, User's, and Maintenance Guide* • *DS4800 Installation, User's, and Maintenance Guide*
5	Route the host server Fibre Channel cables	• *DS4100 Fibre Channel Cabling Instructions* • *DS4200 Express Installation, User's, and Maintenance Guide* • *DS4300 Fibre Channel Cabling Instructions* • *DS4400 Fibre Channel Cabling Instructions* • *DS4500 Fibre Channel Cabling Instructions* • *DS4700 Installation, User's, and Maintenance Guide* • *DS4800 Installation, User's, and Maintenance Guide*
6	Power up the subsystem	• *DS4100 Storage Server Installation, User's, and Maintenance Guide* • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4300 Fibre Channel Storage Server Installation and User's Guide* • *DS4400 Fibre Channel Storage Server Installation and Support Guide* • *DS4500 Fibre Channel Storage Server Installation and Support Guide* • *DS4700 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*
7	Configure DS4000 network settings	• *DS4100 Storage Server Installation, User's, and Maintenance Guide* • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4300 Fibre Channel Storage Server Installation and User's Guide* • *DS4400 Fibre Channel Storage Server Installation and Support Guide* • *DS4500 Fibre Channel Storage Server Installation and Support Guide* • *DS4700 Storage Subsystem Installation, User's, and Maintenance Guide* • *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*

Table 1. Where to find DS4000 installation and configuration procedures (continued)

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

Table 1. Where to find DS4000 installation and configuration procedures (continued)

	Installation task	Where to find information or procedures
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.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-132.ibm.com/content/home/store_IBMPublicUSA/
  en_US/IntelliStation_workstations.html

* For the latest information about operating system and HBA support, clustering support, SAN fabric support, and Storage Manager feature support, see the TotalStorage® DS4000 Interoperability Matrix at the following Web site:

  www.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.

How to send your comments

Your feedback is important in helping us to provide the most accurate and high-quality information. If you have comments or suggestions for improving this publication, you can send us comments electronically by using these addresses:
- Internet: starpubs@us.ibm.com
- IBMLink™ from U.S.A.: STARPUBS at SJEVM5
- IBMLink from Canada: STARPUBS at TORIBM
- IBM Mail Exchange: USIB3WD at IBMMAIL

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

International Business Machines Corporation
Information Development
Dept. GZW
9000 South Rita Road
Tucson, AZ 85744–0001
U.S.A.

Chapter 1. Introduction

This chapter describes the operating specifications, features, and components for the IBM System Storage EXP420 storage expansion enclosure (hereafter referred to as *EXP420* or *storage expansion enclosure*). This chapter also includes a list of hardware that comes with the storage expansion enclosure.

Overview

The IBM System Storage DS4000 EXP420 storage expansion enclosure (Machine Type 1812, Models 8VA and 8VH) provides high-capacity, SATA disk interface storage. The storage expansion enclosure delivers fast, high-volume data transfer, retrieval, and storage functions for multiple drives to multiple hosts. The storage expansion enclosure provides continuous, reliable service, using hot-swap technology for easy replacement without shutting down the system and support redundant, dual-loop configurations. External cables and Small Form-Factor Pluggable (SFP) modules connect the DS4000 storage subsystem to the storage expansion enclosure.

The EXP420 is a rack-mountable enclosure that supports up to 16 500 GB SATA Enhanced Value Disk Drive Modules (EV-DDMs), offering up to 8.0 TB when using 500 GB SATA EV-DDMs. Coupled with a DS4000 storage subsystem such as the DS4200 Express, you can configure RAID-protected storage solutions of up to 56 TB, providing economical and scalable storage for your rapidly growing application needs for limited access, data reference storage capacity.

The EXP420 uses the latest fibre channel and SATA technology and is designed with redundant 2 or 4 Gbps fibre channel connections to the DS4000 storage subsystem offering reliability and performance.

Note: In this initial release, you cannot intermix the EXP420 with any other storage expansion enclosures in the same DS4000 storage subsystem configuration. In addition, the only DS4000 storage subsystems that the EXP420 can be attached to are the DS4200 Express models 7VA and 7VH. Contact your IBM representative or reseller for information about intermix functionality or additional DS4000 storage subsystem support in the future.

The EXP420 supports redundant, dual drive channel/loop configurations with the DS4200 Express Storage Subsystems and other EXP420 storage expansion enclosures. External cables and small form-factor pluggable (SFP) modules connect the controller to the storage expansion enclosure. EXP420s attached to supported DS4000 storage subsystems 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 storage expansion enclosure provides continuous, reliable service and uses hot-swap technology for easy replacement without the need to shut down the system. Up to six EXP420 enclosures can be connected together in a redundant fibre-channel drive channel/loop pair in a DS4200 Express Storage Subsystem configuration, providing connections to a maximum of 112 hard drives.

Operating system support

Microsoft® Windows® 2000 Server and Advance Server, Microsoft Windows 2003 Server and Enterprise Edition, HP HP-UX, Sun®Solaris, IBM AIX®, RedHat

Enterprise Linux® Server, SuSE Linux Enterprise Server, Linux on Power, Netware and VMWare ESX server are the supported operating systems for host servers that have mapped LUNs created in the DS4000 storage subsystems with EXP420 drive expansion enclosures. See the latest DS4000 Storage Manager host software readme file and the IBM DS4000 series products interoperability matrix at the following Web site for additional host operating system support:

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

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 can be supported, compared to 15 small computer system interface (SCSI) devices. The connection from the DS4000 storage subsystem to the EXP420 is either a 2 Gbps or 4 Gbps fibre-channel interface speed that supports data transfer rates up to 400 MBps half-duplex and 800 MBps full-duplex on optical interfaces.

SATA defined

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

The Serial ATA Working Group introduced the first SATA specification, Serial ATA 1.0, in 2001. The Web site is:

www.serialata.org.

Inventory checklist

The EXP420 ships with the following items:
- Power cables (2 jumper line cords)
- Rack-mounting hardware kit (1), including:
    - Rails (2) (right and left assembly)
    - M5 black hex-head slotted screws (12)
    - Washers (8)
- Blank trays (16) (Your storage expansion enclosure might come with up to 16 SATA EV-DDMs.)
- 4 Gbps SFPs (2) (already installed in the EXP420 ESM ports)
- Box ID labels (used to label the enclosure IDs on the front of the EXP420)

A rack mounting template and instructions for installing the support rails and the storage expansion enclosure are provided in "Installing the support rails" on page 23.

To connect your EXP420 to DS4000 storage subsystems (such as the DS4200 Express) or other EXP420 storage expansion enclosures, IBM LC-LC fibre-channel cables are required. Two additional IBM 4 Gbps SFP modules are required to connect the EXP420 to more than one DS4000 storage expansion enclosure as part of a multiple DS4000 storage expansion enclosure and storage subsystem configuration.

Note: You must order these options separately.

EXP420 components

The EXP420 has the following removable components. These components, called customer replaceable units (CRUs), are accessible from the front or back of the EXP420.

- Up to 16 SATA Enhanced Value Disk Drive Modules (EV-DDMs)
- Two environmental service modules (ESMs)
- Two power supply and fan units

Enhanced Value Disk Drive Modules (EV-DDMs)

This section shows the location of EXP420 hot-swappable EV-DDMs. The hot-swap features of the EXP420 enable you to remove and replace SATA EV-DDMs, power supply and fan units, and ESMs without turning off the storage expansion enclosure. You can maintain the availability of your system while a hot-swap device is removed, installed, or replaced.

Attention:

- You cannot mix storage expansion enclosures with different fibre channel speed settings in the same drive channel/loop. All of the enclosures in a redundant drive channel/loop pair must have the same enclosure speed setting. In addition, the enclosure speed setting must be set at the *lowest* operating enclosure speed.
- EV-DDM options and FRUs for the EXP420 and DS4200 Express Storage Subsystem are not the same as the Enhanced Disk Drive Modules (E-DDMs) and FRU options for the EXP810 and DS4700 Storage Subsystem. Verify that the EV-DDM option and FRU part numbers are correct before inserting into the EXP420 or DS4200 Express drive slots. The disk drive module CRUs for EXP810 storage expansion enclosures and DS4700 Storage Subsystems appear as uncertified drives when inserted into EXP420 storage expansion enclosures and DS4200 Express Storage Subsystems and vice versa.

The hot-swap drive bays that are accessible from the front of your storage expansion enclosure are shown in Figure 1.
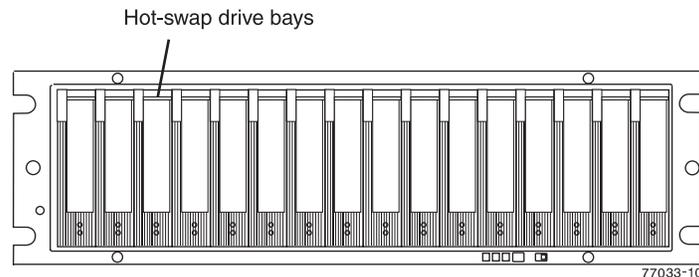
Figure 1. EXP420 hot-swap drive bays

The EXP420 supports up to 16 SATA EV-DDMs. Each SATA hard drive, ATA translator card (also referred to as interposer card), and carrier assembly (drive tray) are called EV-DDM CRUs. The ATA translator card converts the fibre channel protocol interface of the DS4200 Express drive channel/loop into the SATA protocol interface. It also provides dual paths to the SATA drive for EV-DDM CRU path redundancy. Install EV-DDM CRUs in the 16 drive bays on the front of the storage expansion enclosure from the leftmost (slot 1) to rightmost (slot 16).

The EXP420 storage expansion enclosure drive channel operates at either 2 or 4 Gbps fibre channel interface speed. The EXP420 SATA EV-DDM CRUs have an ATA translator card that converts EV-DDM 3 Gbps SATA drive interface protocol to either 2 Gbps or 4 Gbps fibre channel interface protocol. It is recommended that the EXP420 enclosure speed is set to 4 Gbps when these SATA EV-DDM CRUs are installed and connected to storage expansion enclosures running at 4 Gbps speed. The Link Rate setting speed must be set accordingly. See "Verifying the Link Rate setting " on page 86 for more information. The enclosure speed of the DS4200 Express Storage Subsystem that the EXP420s are connected to must also be set to 4 Gbps.

There are no serviceable parts in a EV-DDM CRU. If it fails, it must be replaced in its entirety (EV-DDM, ATA translator (interposer) card, bezel, and tray). The EXP420 EV-DDM option/FRU is not interchangeable with the drive tray of other storage expansion enclosures. When replacing a EV-DDM CRU, be sure to order and install the correct EV-DDM CRU.

Note: To determine whether you have installed a correct EV-DDM CRU, check its Product ID. In this release, the EV-DDM's Product ID should be ST350064INS 42D0392 39M0181 IBMV. See "Finding controller, storage expansion enclosure, and drive information" on page 58 for details on how to locate an EV-DDM's Product ID.

Attention:
1. After you remove a EV-DDM CRU, wait 70 seconds before replacing or reseating the EV-DDM CRU to allow the drive to properly spin down. Failure to do so may cause undesired events.
2. Never hot-swap a EV-DDM CRU when its associated green Activity LED is flashing. Hot-swap a EV-DDM CRU only when its associated amber Fault LED lights is not flashing or when the drive is inactive and its associated green Activity LED lights is not flashing.

Note: If the EV-DDM you want to remove is not in a failed or bypass state, always use the Storage Manager client program either to place the EV-DDM in a failed state or to place the array that is associated with the EV-DDM (or EV-DDMs) in an offline state before you remove it from the enclosure.

Environmental Service Modules (ESMs)

The EXP420 has two hot-swappable and redundant ESM units. The ESMs are located at the back of the storage expansion enclosure. The left ESM is labeled ESM A, and the right ESM is labeled ESM B. One ESM will continue to operate if the other ESM fails.

The ESMs contain the storage expansion enclosure control logic, interface ports, and LEDs. Each ESM has four SFP module ports that you could use to connect the storage expansion enclosure to the controller. However, only the two ESM SFP

ports (labeled 1A and 1B) near the center of the storage expansion enclosure are used. The SFP ports labeled 2A and 2B are reserved for future use.

The EXP420 ESMs support automatic ESM firmware synchronization. This function allows a new ESM with a different level of ESM firmware to be automatically synchronized with the ESM firmware version in the existing ESM in the EXP420 chassis. To enable automatic ESM firmware synchronization:

1. Verify that the Storage Manager Event Monitor is installed and running.
2. Verify that the DS4000 storage subsystem that the EXP420 is attached to is defined in the Enterprise Management window of the Storage Manager client (SMclient).

Although both ESM units (A and B) are identical, they are seated in the EXP420 chassis in opposite orientations. See Figure 2. If the ESM can not fully be inserted in the ESM bay, flip it 180 degrees and reinsert it.

Connectors, switch, and enclosure ID

The ESMs support fiber optic interfaces for both the host channels and drive channels. The two interface ports located near the enclosure ID are reserved for future use. Do not plug any SFPs into these ports.

The enclosure ID, comprised of a pair of seven-segment numbers, is located on the back of each ESM next to the ESM indicator lights. It provides a unique identifier for each module in the storage array. The storage management software automatically sets the enclosure ID number. You can only change the enclosure ID setting through the DS4000 storage management software. There are no switches on the EXP420 chassis to manually set the enclosure ID. Both ESM enclosure ID numbers will be identical under normal operating conditions.

Figure 2 shows the ESMs.
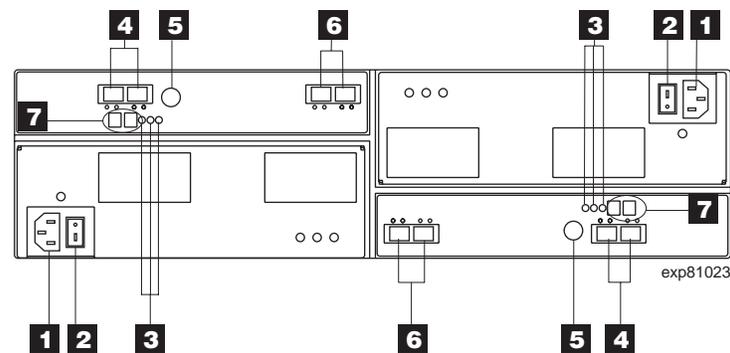
Figure 2. Back view; power switch, enclosure ID, and connectors

Table 2. Description of Figure 2

Number	Description
1	Power connector
2	Power switch
3	ESM indicator lights
4	Reserved for future use
5	Serial port

Number	Description
6	SFP interface connectors
7	Enclosure ID

Rear drive channel ports

Figure 3 shows the drive channel ports on the storage expansion enclosure.
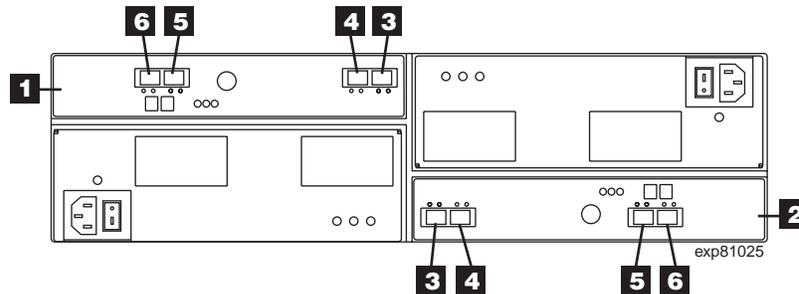
Figure 3. Rear view of drive channel ports

Table 3. Description of Figure 3

Number	Description
1	ESM A
2	ESM B
3	Port 1A
4	Port 1B
5	Port 2A (Reserved for future use)
6	Port 2B (Reserved for future use)

Power supply and fan units

The storage expansion enclosure has two removable power supply and fan units. Each power supply and fan unit contains one power supply and two fans. The four fans pull air through the drive from front to back across the drives.

The fans provide redundant cooling, which means that if one of the fans in either fan housing fails, the remaining fans continue to provide sufficient cooling to operate the storage expansion enclosure. The power supplies provide power to the internal components by converting incoming AC voltage to DC voltage.

If one power supply is turned off or malfunctions, the other power supply maintains electrical power to the storage expansion enclosure and the two fan modules in the turned off or malfunctioned power supply-fan unit. (All four fan modules function at all times even if one power supply and fan unit is switched off unless the fan module malfunctions.) To preserve the optimal airflow, do not remove a failed power supply and fan unit CRU from the EXP420 chassis until you are ready to replace it with a new CRU.

Figure 4 on page 7 shows power supply and fan unit components.

Note: Although both power supply and fan units (left and right) are identical, they are seated in the EXP420 chassis in opposite orientations. If the power supply and fan unit cannot fully be inserted in the power supply and fan unit bay, flip it 180 degree and reinsert it.
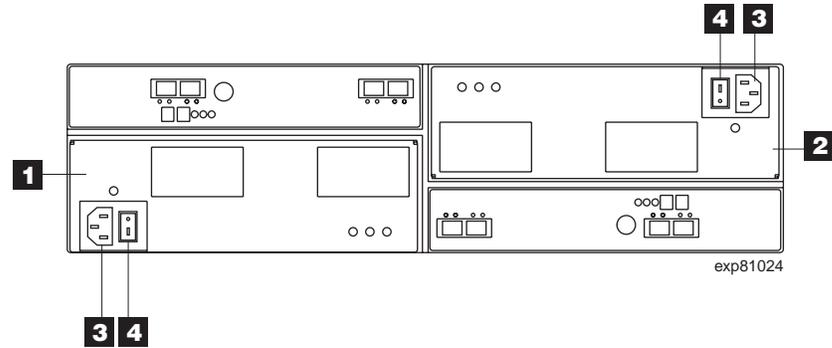
Figure 4. Power supply and fan unit components

Table 4. Description of Figure 4

Number	Description
1	Power supply and fan unit A
2	Power supply and fan unit B
3	Power connector
4	Power switch

Figure 5 on page 8 shows a power supply and fan unit and the airflow through the storage expansion enclosure.
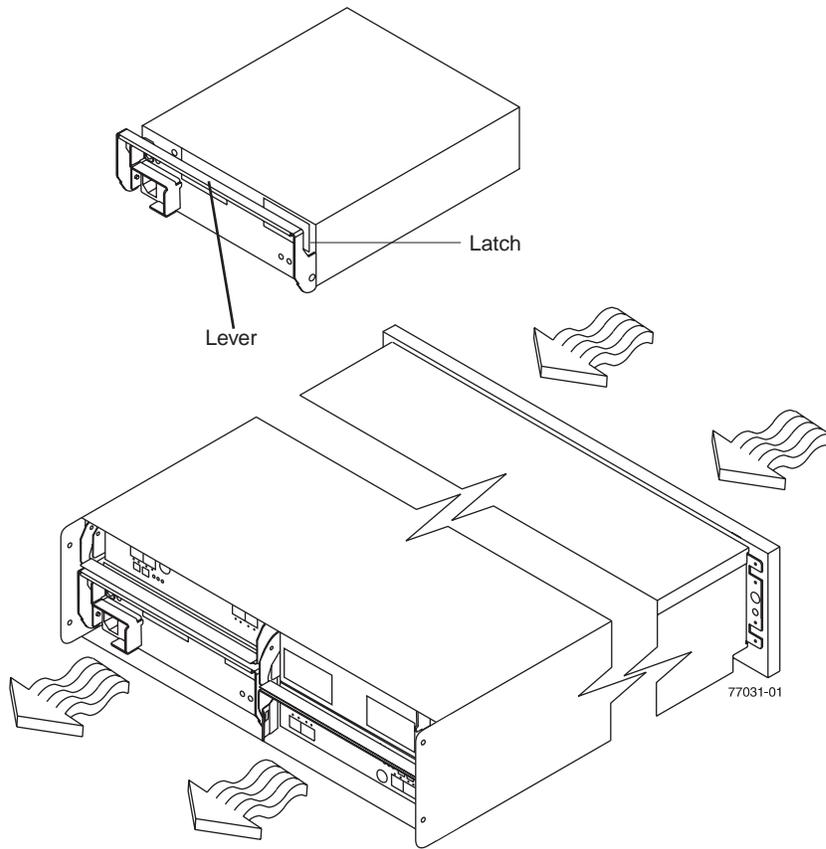
Figure 5. Power supply and fan unit and airflow

Small Form-Factor Pluggable (SFP) modules

The storage expansion enclosure supports fiber optic host interface cables. You must install a Small Form-factor Pluggable (SFP) module in each interface connector on the controller where a fiber optic cable is to be installed.

Attention: The speed of the SFP module determines the maximum operating speed of the fibre channel port in which the SFP is installed. For example, a 2-Gbps SFP that is plugged into a 4-Gbps-capable port will limit the speed of that port to a maximum of 2 Gbps. Carefully check the SFP's IBM part number, option number, and FRU part number to identify its speed. There are no physical features that distinguish a 4 Gbps from a 2 Gbps SFP.

Figure 6 on page 9 shows an SFP module with fiber optic cable.

Note: The SFP module shown might look different from those shipped with your storage expansion enclosure. The differences does not affect transceiver performance.
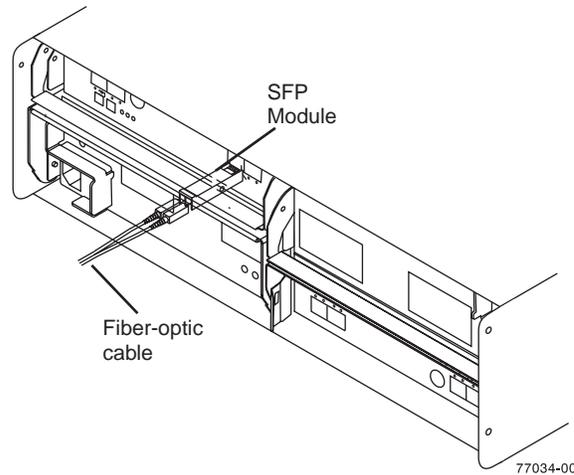
Figure 6. SFP module and fiber optic cable

Software and hardware compatibility and upgrades

The latest DS4000 controller firmware and NVSRAM, the EXP420 drive enclosure ESM firmware, and the fibre channel drive CRUs firmware must be installed to ensure optimal functionality, manageability, and reliability.

Software and firmware support code upgrades

To enable support for the EXP420, you *must* ensure that your system's software and firmware are at the levels shown in Table 5:

Table 5. Software and firmware levels for the EXP420

Software/firmware	Level
DS4000 Storage Manager software	9.16.xx.62 or later
DS4200 Express controller firmware and NVSRAM	06.16.86.xx or later. This controller firmware does not support EXP100 attachment.
ESM firmware	986x or later
Drive firmware	You can find the latest software and firmware at the IBM DS4000 System Storage Support Web site: www.ibm.com/servers/storage/support/disk/

To manage the DS4200 Express with controller firmware 06.16.86.xx installed, the DS4000 Storage Manager version 9.16 Release 2 or later software packages are included on the DS4000 Storage Manager host software for the appropriate OS CD or on the IBM Support Web site.

You can also find the latest software and firmware at the IBM DS4000 System Storage Support Web site:

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

See the *IBM System Storage DS4000 Storage Manager 9.16 Installation and Support Guide* for your operating system for instructions that describe how to install the DS4000 Storage Manager 9.16 host software.

The DS4200 Express Storage Subsystem that supports EXP420 attachment is shipped with controller firmware version 06.16.86.xx or higher.

If you need further assistance, please contact IBM technical support, your IBM reseller, or IBM representative to find out which controller firmware to use for EXP420 attachment.

For more information about the EXP420 ESM replacement procedure and problem troubleshooting, please refer to "Replacing an Environmental Service Module (ESM)" on page 94 and "Solving problems" on page 101.

EXP420 hardware and software compatibility

Table 6 lists the EXP420 hardware and software compatibility. Currently, the only DS4000 storage subsystem that supports EXP420 attachment is the DS4200 Express Storage Subsystem. Please contact IBM resellers or representatives for other DS4000 storage subsystem support in the future.

Note: For the latest information about supported servers and operating systems for the EXP420, refer to the interoperability matrix at this Web site:

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

Table 6. EXP420 hardware and software compatibility

Storage server	Storage management software	Firmware
System Storage DS4200 Express Storage Subsystem	IBM DS4000 Storage Manager Version 9.16.xx.62 or later	Controller firmware: version 06.16.86.xx or higher

Determining firmware levels

There are two different methods to determine the DS4000 storage subsystem and the EXP420 firmware versions. Each method uses the DS4000 Storage Manager client that manages the DS4000 storage subsystem with the attached EXP420 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 Profile For Storage Subsystem to locate the following information.

Note: The Profile For Storage Subsystem window 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 Server
- NVSRAM version
- Appware version
- Bootware version

Drives
- Drive firmware version
- ATA translator card firmware version

> **Note:** The ATA translator card firmware and drive firmware are typically packaged together as a single drive firmware upgrade file.

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 drive enclosure.

To obtain the drive 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 drive enclosure.
>
> You must perform this step for each drive expansion enclosure.

Product updates

> ┌─ **Important** ───
> │ In order to keep your system up to date with the latest firmware and other product updates, use the information below to register and use the **My support** Web site.
> └──

Download the latest versions of the DS4000 Storage Manager host software, DS4000 storage server controller firmware, DS4000 drive expansion enclosure ESM firmware, and drive firmware at the time of the initial installation and when product updates become available.

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

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

In the Additional Support section of the Web page, click **My support**. On the next page, if you have not already done so, register to use the site by clicking **Register now**.

Perform the following steps to receive product updates:

1. After you have registered, type your user ID and password to log into the site. The **My support** page opens.
2. Click **Add products**. A pull-down menu displays.
3. In the pull-down menu, select **Storage**. Another pull-down menu displays.
4. In the new pull-down menu, and in the subsequent pull-down menus that display, select the following topics:
   - **Computer Storage**
   - **Disk Storage Systems**
   - **TotalStorage DS4000 Midrange Disk Systems & FAStT Stor Srvrs**

   Note: During this process a check list displays. Do not check any of the items in the check list until you complete the selections in the pull-down menus.
5. When you finish selecting the menu topics, place a check in the box for the machine type of your DS4000 series product, as well as any other attached DS4000 series product(s) for which you would like to receive information, then click **Add products**. The My Support page opens again.
6. On the My Support page, click the **Edit profile** tab, then click **Subscribe to email**. A pull-down menu displays.
7. In the pull-down menu, select **Storage**. A check list displays.
8. Place a check in each of the following boxes:
   a. **Please send these documents by weekly email**
   b. **Downloads and drivers**
   c. **Flashes**
   d. Any other topics that you may be interested in

   Then, click **Update**.
9. Click **Sign out** to log out of My Support.

Best practices guidelines

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

- Ensure that your system is in an optimal state before you shut it down. Never turn the power off if any Needs Attention LED is lit; be sure to resolve any error conditions before you shut down the system.
- Back up the data on your storage drives periodically.
- To maintain power redundancy, plug the EXP420 right and left power supply and fan units into two independent external power circuits through AC distribution units inside a rack cabinet or directly into external receptacles. Similarly, the right and left power supplies of the DS4000 storage subsystem that the EXP420 storage expansion enclosures are attached to should be plugged into the same two independent external power circuits as the EXP420s. This ensures that the DS4000 storage subsystem and all its attached storage expansion enclosures will have power in the event that only one power circuit is available. In addition,

having all the right or all the left power cables plugged into the same power circuit enables the DS4000 devices in the configuration to power on simultaneously during an unattended restoration of power. See Figure 34 on page 48 for an example of redundant power connections.

> **Note:** Do not overload the circuits that power your storage subsystem and storage expansion enclosures. Use additional pairs of power distribution units (PDUs) if necessary. Refer to Table 12 on page 16 for information on storage expansion enclosure power requirements. Contact your IBM service representative for additional information if needed.

- Before any planned system shutdown or after any system additions, removals, or modifications (including firmware updates, logical drive creations, storage partitioning definitions, hardware changes, and so on), save the storage subsystem profile as explained in the DS4000 Storage Manager guide for your operating system. Save the profile in a location other than in the logical drives created for the DS4000 storage subsystem.
- During any maintenance or attended power-up procedure, carefully follow the power-up sequence listed in "Powering on the EXP420" on page 55. Check that each component of the subsystem is powered-on in the proper order during this entire power-up procedure to ensure the controller will be able to optimally access all of your storage subsystems.
- The storage subsystem supports simultaneous power-up to the system components; however, you should always follow the power-up sequence listed in "Powering on the EXP420" on page 55 during any attended power-up procedure.
- A storage system in an optimal state should recover automatically from an unexpected shutdown and unattended simultaneous restoration of power to system components. After power is restored, call IBM support if any of the following conditions occur:
  - The storage subsystem logical drives and subsystems are not displayed in the DS4000 Storage Manager graphical user interface (GUI).
  - The storage subsystem logical drives and subsystems do not come online.
  - The storage subsystem logical drives and subsystems seem to be degraded.

Specifications

This section provides site specifications for the EXP420 storage expansion enclosure. Before installing a storage expansion enclosure, you must either verify that your planned installation site meets these requirements, or prepare the site so that it does meet these requirements. Preparations might involve meeting area requirements, environmental requirements, and electrical requirements for EXP420 installation, service, and operation.

Area requirements

The floor space at the installation site must provide enough strength to support the weight of the storage subsystem and associated equipment; sufficient space to install, operate, and service the storage subsystem; and sufficient ventilation to provide a free flow of air to the unit.

Dimensions

Figure 7 on page 14 shows the dimensions of the EXP420, which conforms to the 19-inch rack standard.
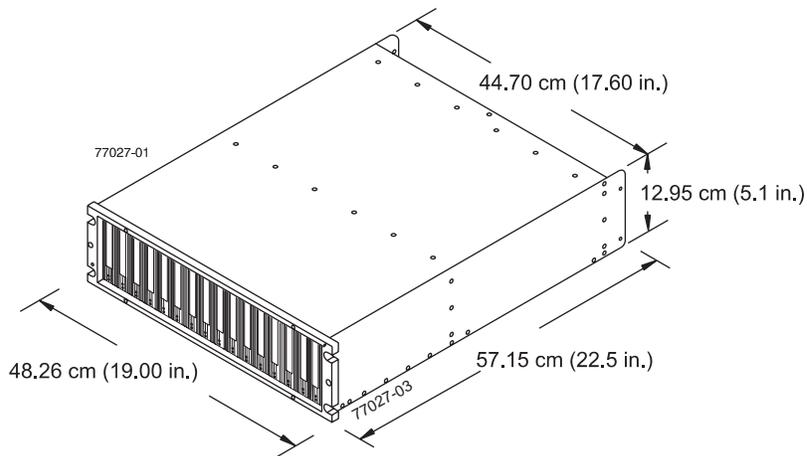
Figure 7. EXP420 dimensions

Weight

The total weight of the storage expansion enclosure depends on the number of components installed. Table 7 lists the maximum, empty, and shipping weights for the storage subsystem in different configurations. Table 8 lists the weight of each component.

Table 7. EXP420 weights

Unit	Weight		
	Maximum [1]	Empty [2]	Shipping
EXP420	38.1 kg (84 lb)	16.4 kg (36.1 lb)	50.5 kg (111.0 lb)

[1] Chassis with all CRUs and 16 drives.

[2] Chassis without CRUs and drives but with front cage frame and midplane.

Table 8. EXP420 component weights

Unit	Weight
Drive	0.75 kg (1.65 lb)
Power supply and fan unit	3.60 kg (7.95 lb)
ESM	1.88 kg (4.15 lb)

Shipping dimensions

Table 9 lists shipping carton dimensions. The height shown includes the height of the pallet.

Table 9. EXP420 shipping carton dimensions

Height	Width	Depth
45.7 cm (18.0 in.)	62.6 cm (24.5 in.)	80.7 cm (31.75 in.)

Environmental requirements and specifications

This section describes the environmental conditions that are prerequisite to installing the unit, and heat and sound conditions that are generated by normal operation of the storage expansion enclosure.

Temperature and humidity

Table 10 lists the acceptable temperature and humidity ranges in which the storage subsystem is designed to operate.

Important: The recommended operating environment air temperature is 22° C (72° F) or lower.

Table 10. Temperature and humidity requirements

Condition	Parameter	Requirement
Temperature	Operating range	10° - 35° C (50° - 95° F)
	Maximum rate of change	10° C (18° F) per hour
	Storage range	-10° - 65° C (14° - 149° F)
	Maximum rate of change	15° C (27° F) per hour
	Transit range	-40° C to 65° C (-40° F to 149° F)
	Maximum rate of change	20° C (36° F) per hour
Relative humidity (no condensation)	Operating range	8% to 80%
	Storage range	8% to 90%
	Transit range	5% to 95%
	Maximum dew point	26° C (79° F)
	Maximum gradient	10% per hour

Note: Substantial deviations from the suggested temperature and humidity ranges, in either direction, if sustained for extended periods of time, will expose the unit to greater risk of failure from external causes.

Altitude

Table 11 lists the acceptable altitudes for operating, storing, and shipping the EXP420.

Table 11. EXP420 altitude ranges

Environment	Altitude
Operating	30.5 m (100 ft.) below sea level to 3000 m (9842 ft.) above sea level
Storage	30.5 m (100 ft.) below sea level to 3000 m (9842 ft.) above sea level
Transit	30.5 m (100 ft.) below sea level to 12,000 m (40,000 ft.) above sea level

Airflow and heat dissipation

Figure 8 on page 16 shows the intended airflow for the EXP420. Allow at least 30 inches in front of the storage subsystem and at least 24 inches behind the storage subsystem for service clearance, proper ventilation, and heat dissipation.
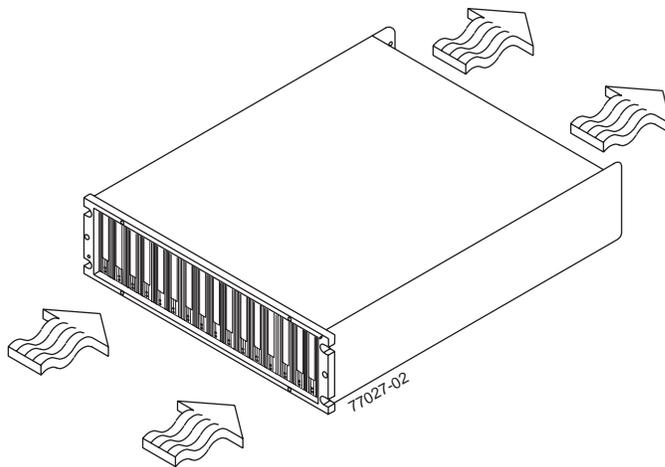
Figure 8. EXP420 airflow

Table 12 lists the KVA, watts, and Btu calculations. These values assume the power supplies have a 73 percent efficiency and a power factor of 0.99. These tabulated power and heat dissipation values are typical for the storage subsystem. Maximum configuration units are typically operated at higher data rates, have larger random access memory (RAM) capacities, or have different host interface boards.

Table 12. EXP420 power and heat dissipation

Parameter	KVA	Watts (AC)	Btu per hour
EXP420	0.454	443	1516

Acoustic noise

Table 13 lists the maximum sound levels emitted by the storage subsystem.

Table 13. EXP420 sound levels

Measurement	Level
Sound power (normal operation)	6.5 bels
Sound pressure (normal operation)	68 dBA

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.

Electrical requirements

This section provides information regarding site power and wiring, storage subsystem AC power requirements, and power cord routing instructions.

Consider the following information when preparing the installation site:
- Protective ground – Site wiring must include a protective ground connection to the AC power source.

  Note: Protective ground is also known as safety ground or chassis ground.
- Circuit overloading – Power circuits and associated circuit breakers must provide sufficient power and overload protection. To prevent possible damage to the unit,

isolate its power source from large switching loads (such as air conditioning motors, elevator motors, and factory loads).

- Power failures – If a total power failure occurs, the unit automatically performs a power-up recovery sequence without operator intervention after power is restored.

Table 14. EXP420 AC power requirements

	Low Range	High Range
Nominal Voltage	90 to 136 VAC	180 to 264 VAC
Frequency (Hertz)	50 to 60 Hz	50 to 60 Hz
Idle Current	3.86 A[a]	2.05 A[b]
Maximum Operating Current	4 A/4.54 A[a][c]	2.12 A/2.41 A[b][c]
Maximum Surge Current	5.04 A[a]	2.67 A[b]

[a.] Typical voltage: 115 V AC, 60 Hz, assumes 73% power-supply efficiency and 0.99 power factor

[b.] Typical voltage: 230 V AC, 60 Hz, assumes 73% power-supply efficiency and 0.99 power factor

[c.] The higher number in this range applies when all of the drives are placed in Selfseek mode.

Site wiring and power

The storage expansion enclosure uses wide-ranging redundant power supplies that automatically accommodate voltages to the AC power source. The power supplies operate within the range of 90 VAC to 264 VAC, at a minimum frequency of 50 Hz and a maximum frequency of 60 Hz. The power supplies meet standard voltage requirements for both domestic (inside USA) and international (outside USA) operation. They use standard industrial wiring with line-to-neutral or line-to-line power connections.

The agency ratings for the EXP420 storage expansion enclosure are 6 amps at 100 VAC and 2.5 amps at 240 VAC. These are the overall maximum operating currents for this system.

AC power recovery

After normal power is restored after a total AC power failure, the EXP420 storage expansion enclosure performs power-up recovery procedures automatically without operator intervention.

Power cords and receptacles

The EXP420 ships with two jumper cords used to connect to the rack PDU. You must purchase the power cords that are appropriate for use in a typical outlet in the destination country. See Appendix C, "Power cords," on page 117 for more information.

Heat output, airflow, and cooling

See "Airflow and heat dissipation" on page 15 for heat output, airflow, and cooling specifications.

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 disk enclosure unit should be kept near 22° C (72° F), or lower, to provide better reliability.

When racks that contain many EXP420s are to be installed together, the following requirements must be met to ensure that the EXP420s 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 and hot aisle* and is shown in Figure 9.
- 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 storage 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 storage expansion enclosures.
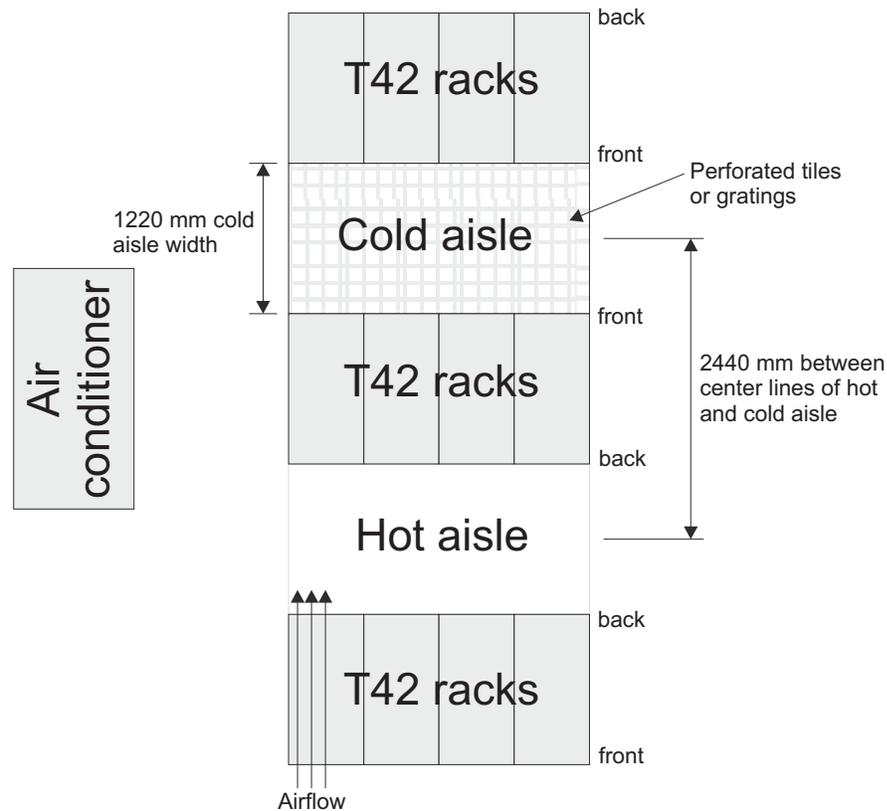
Figure 9. Example of cold aisle/hot aisle rack configuration

Chapter 2. Installing the EXP420

This chapter provides the information that you need to prepare the EXP420 for installation into a rack cabinet.

Before you begin the installation, review the safety information in "Safety" on page xi.

"Installation overview" provides an overview of the EXP420 installation process. Read this overview before you begin the installation.

Installation overview

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

1. Prepare the installation site and the rack cabinet. Unpack the EXP420 and other hardware from the shipping box. See "Preparing for installation" on page 21.

   Statement 4:

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

   CAUTION:
   Use safe practices when lifting.

   Attention: The EXP420 weighs up to 40 kg (88 lb). At least two other people should help you lift the EXP420 from the shipping box. For safety reasons, IBM strongly recommends that you open the sides of the shipping box and remove the CRUs from the EXP420 before you lift it from the shipping box to lighten the storage expansion enclosure before moving it from the box to its place in the rack. See "Removing the CRUs" on page 26.

2. Install the support rails in the rack. The rails are placed on the bottom of the shipping box underneath the storage expansion enclosure. To access the support rails without removing the storage expansion enclosure from the shipping box, open the *sides* of the shipping box. See "Installing the support rails" on page 23.

3. If necessary, remove the CRUs from the EXP420. See "Removing the CRUs" on page 26.

4. Record the serial number, machine type, and model number for your EXP420.

   The serial number, machine type, and model number are located on the left edge of the front unit as shown in Figure 10 on page 20.

Serial number
Machine type
Model number
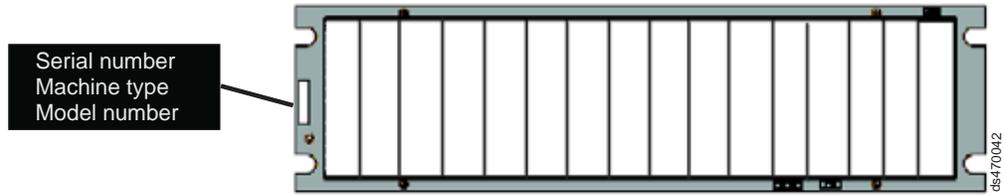
Figure 10. Example of EXP420 serial number, machine type, and model number location

5. Install the EXP420. See "Installing the EXP420 into a rack" on page 30. If necessary, replace the CRUs in the EXP420. See "Replacing the EXP420 CRUs" on page 32.

6. Cable the EXP420 to other EXP420s or to a DS4000 storage subsystem such as the DS4200 Express. See Chapter 3, "Cabling the EXP420," on page 37.

7. Install the DS4000 Storage Manager 9.16 (version 9.16.xx.62 or later) host software. Refer to the *IBM System Storage DS4000 Storage Manager 9.16 Installation and Support Guide* for the appropriate operating system for instructions on how to install the DS4000 Storage Manager 9.16 host software.

8. Turn on the EXP420 (if you have not done so already). See "Powering on the EXP420" on page 55.

9. Turn on the DS4000 Storage Subsystem and use the DS4000 Storage Manager 9.16 host software to verify the configuration and upgrade the controller firmware if needed. If the controller firmware is not at version 06.16.86.xx or later, the EXP420 enclosures might be shown in the DS4000 subsystem management window with empty drive slots and enclosure ID of 99.

   Note: If your DS4000 storage subsystem shipped preloaded with controller firmware 06.16.xx.xx, you do not need to upgrade the firmware, although it is still recommended that you upgrade to the latest version of the firmware for your specific storage subsystem model.

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

Before installing the EXP420, create a detailed plan of how this unit will be used in your storage configuration. The plan should include determining RAID levels, fallover requirements, operating systems to be used, and total storage capacity requirements.

Complete the following steps to prepare the EXP420 for installation into a rack cabinet.

1. Prepare the site to meet all area, environmental, power, and site requirements. For more information, see "Specifications" on page 13.
2. Move the EXP420 to the site.

   Statement 4:

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

   CAUTION:
   Use safe practices when lifting.
3. Verify that you have the following software:
   - IBM DS4000 Storage Manager 9.16 software.
   - DS4000 controller firmware that ships with the EXP420. You use this software to configure the storage subsystems.
4. Read *Storage System Product Release Notes for Version 9.16* for any updated information about hardware, software, or firmware products.
5. Continue with "Preparing the site" on page 22.

Tools and hardware required

Gather the tools and equipment you will need for installation. These might include:
- The rack power jumper cords that are shipped with the EXP420
- Number 2 Phillips screwdriver
- 5/16 (8 mm) hex nut driver
- Antistatic protection (such as a grounding wrist strap)
- Fibre Channel (FC) and Ethernet interface cables and cable straps
- SFP modules
- Rack-mounting hardware that ships with the EXP420

Preparing the site

This section lists the floor space requirements and weight information for the EXP420. For information on interface cables and connections, see Chapter 3, "Cabling the EXP420," on page 37.

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

- Enough stability to support the weight of the fully configured EXP420 and associated systems
- Sufficient space to install the EXP420

Weight: The EXP420 total weight depends on the number of fibre channel hard disk drives that are installed. A fully configured EXP420 with two power supply and fan units, two ESMs, and up to 16 fibre channel hard disk drives installed weighs 40 kg (88 lbs).

Other: Consider these important preparation activities:

- Install uninterruptible power supply (UPS) devices.
- Install host bus adapters (HBAs), switches, or other devices, if applicable.
- Route interface cables from the hosts or switches to the installation area.
- Route main power cords to the installation area.

Continue with "Preparing the rack."

Preparing the rack

Important: Before you install the EXP420 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 EXP420 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 storage expansion enclosure to a properly grounded outlet.

Complete the following steps to prepare the rack before you install the EXP420:

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 drive 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 EXP420" on page 26.

Installing the support rails

Attention: Duplicate copies of the rack mounting templates are provided in Appendix B, "Rack mounting template," on page 113. If you want to tear out the templates from this document for easier use, use the copies in Appendix B, "Rack mounting template," on page 113 rather than the copies provided in this section.

Use the following templates (Figure 11 and Figure 12 on page 24) to identify the proper locations for inserting M5 screws when mounting the support rails and EXP420 to a rack. The locations for the M5 screws are highlighted in the templates.

The EXP420 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.
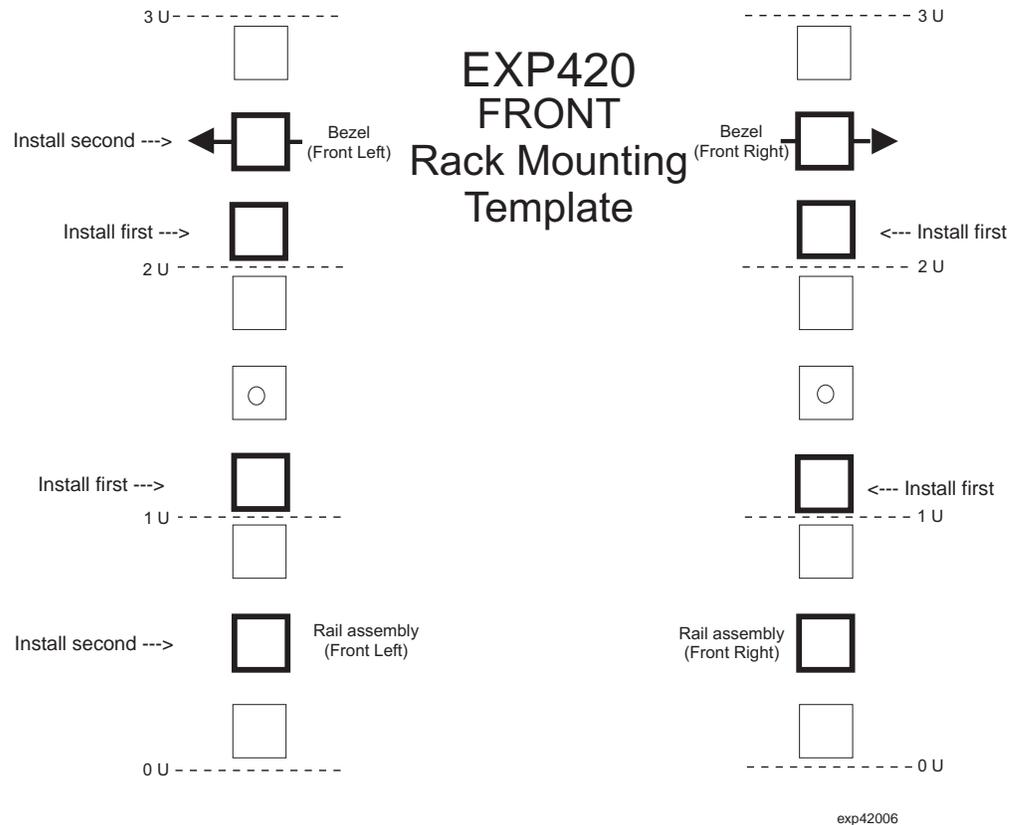
Figure 11. Front rack mounting template

EXP420
REAR
Rack Mounting
Template

3U — — — — — — — — — — — — — — — — — — — 3U

Rail mounting guide

2U — — — — — — — — — — — — — — 2U

Rail assembly
(Rear Left)

Rail assembly
(Rear right)

1U — — — — — — — — — — — — — — 1U

IBM®

Printed in the U.S.A

0U — — — — — — — — — — — — — — — — 0U
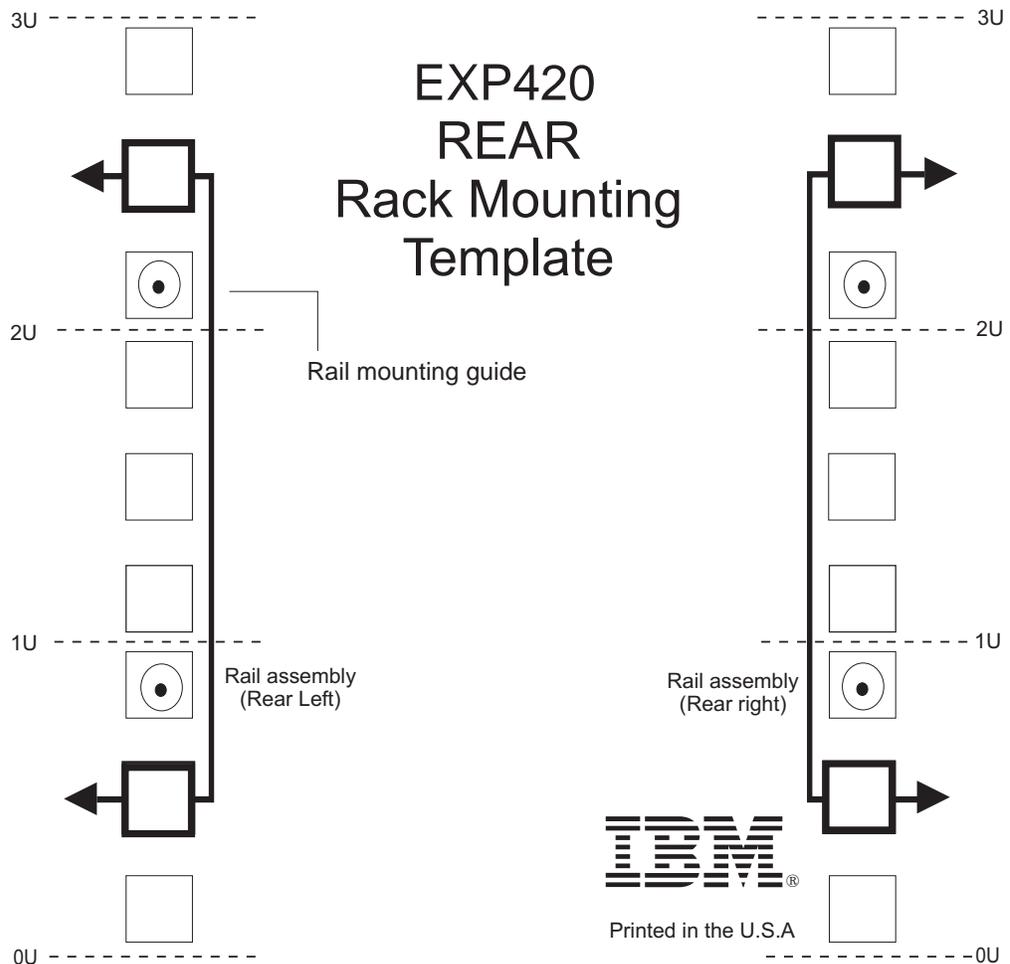
exp42007

Figure 12. Rear rack mounting template

Before installing the EXP420 in a rack, you must install the rails and rack-mounting hardware that come with your storage expansion enclosure. The EXP420 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 storage expansion enclosure.

Complete the following steps to install the support rails:

Note: Refer to Figure 13 on page 26 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 EXP420 is being installed.

   Refer to the installation and service guide, or equivalent, for the rack as required.
3. Locate the two support rails, eight of the twelve M5 screws, and eight washers that are supplied with the EXP420.

Note: The M5 screws and washers may already be attached to the support rails. If so, remove them from the support rails.

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 11 on page 23 and Figure 12 on page 24 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 EXP420 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 EXP420 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. Using a #2 Phillips screwdriver, loosen the two screws on the left support rail that hold the two parts of the rail together (**5**).

   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 back of the rack. Figure 13 on page 26 shows the installation of the left support rail.

6. Hold the back of the rail against the inside of the rack-mounting flange. Make sure the rail mounting guide pins are in the correct holes. See Figure 12 on page 24 for illustration.

7. Using the 5/16 (8 mm) hex nut driver, securely tighten the two M5 screws (**2**).

   Note: Make sure you use a washer when installing an M5 screw through a *square* hole on the rack-mounting flange.

8. Extend the rail to the front of the rack until it makes contact with the front rack-mounting flange (**3**).

9. Securely tighten the two M5 screws (**1**).

   Note: Be sure to install the screws labeled *install first* in Figure 11 on page 23.

10. Securely tighten the two screws on the left support rail that hold the two parts of the rail together (**5**).

11. Repeat step 5 through step 10 for the right support rail.

    Note: Because the mounting holes on the rack are not always the same size as the mounting screws, the lip (**6**) of each of the support rails may not line up evenly. Make minor adjustments as needed to ensure that the lip of the left and right support rails are lined up evenly on the racks. Failure to do so will cause the storage expansion enclosure to fit unevenly in the rack.

1

3

4

5

2

6

Rear of Rack
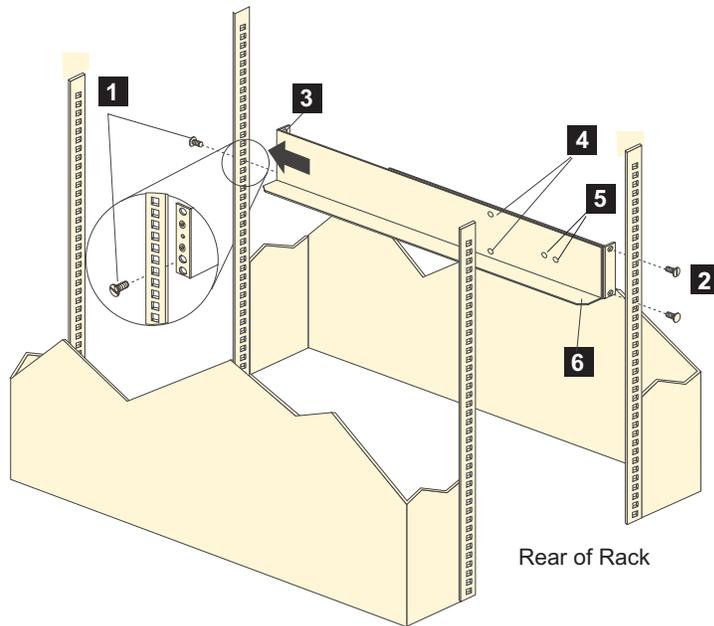
Figure 13. Installing the support rails

12. Continue with "Removing the CRUs."

Installing the EXP420

This section provides instructions on installing the EXP420. The installation process includes:

- "Removing the CRUs"
- "Installing the EXP420 into a rack" on page 30
- "Replacing the EXP420 CRUs" on page 32

Removing the CRUs

This section describes how to remove the CRUs in order to minimize the weight of the EXP420 before you install it in the rack. However, if you have three or more people available to lift and install the EXP420 in a rack, you might not find it necessary to remove the CRUs before you install the EXP420. If this is the case, you can skip the CRU removal instructions provided in this section. Instead, continue with "Installing the EXP420 into a rack" on page 30, and then skip the CRU replacement instructions provided in "Replacing the EXP420 CRUs" on page 32.

Use the following procedures to remove the CRUs from the EXP420 before installation. Use these instructions after you have completed all applicable site, rack, and EXP420 preparations (as discussed in "Preparing for installation" on page 21) and installed the support rails (as discussed in "Installing the support rails" on page 23). Alternately, if necessary, you can use these instructions to lighten the EXP420 before removing it from the shipping box. The shipping box opens to provide access to the storage expansion enclosure CRUs.

The EXP420 comes with a rack-mounting hardware kit for installing it in a rack. It is easier to lift the EXP420 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 20

page 20. In the following procedure, you will remove the following CRUs from the storage expansion enclosure before you install it in the rack:

- ESMs
- Power supply and fan units
- Hot-swap EV-DDMs

You do not need to remove the blank trays.

Statement 4:
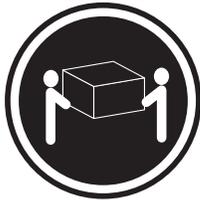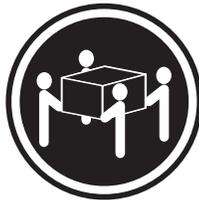
≥ 18 kg (39.7 lb)	≥ 32 kg (70.5 lb)	≥ 55 kg (121.2 lb)

CAUTION:
Use safe practices when lifting.

Attention: The storage 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. Squeeze the ESM latch and pull the lever open 90° (so that the lever is horizontal) to release the ESM from the latch. The ESM latch is a coral colored tab on the lever.

   Note: The lever rotates upward or downward 90°, depending on whether the ESM you are removing is the right or left ESM CRU.

2. Slowly pull the lever away from the chassis to remove the ESM from the bay, as shown in Figure 14 on page 28.
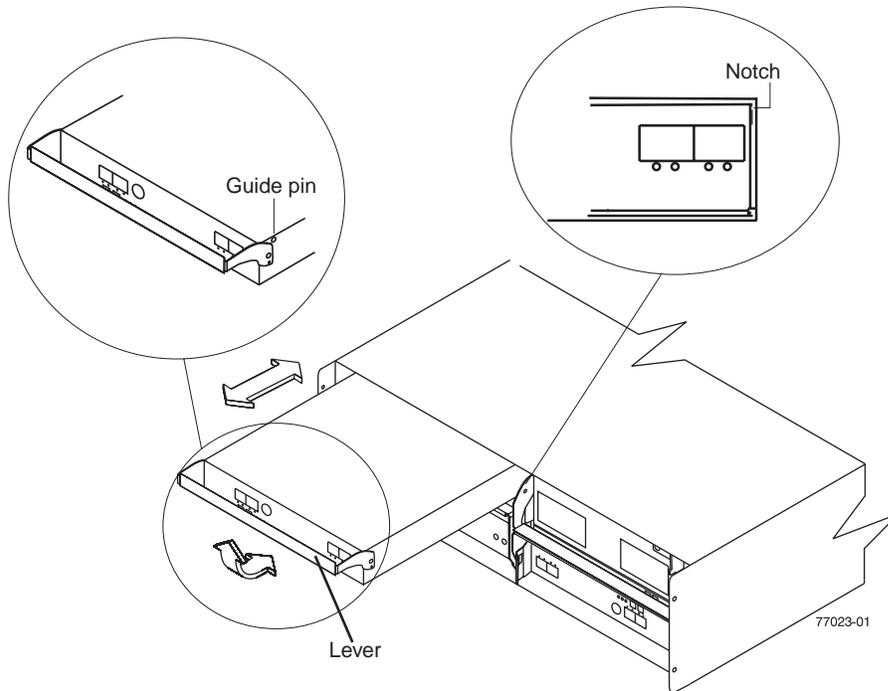
Figure 14. Removing and replacing an Environmental Service Module (ESM)

3. Place the ESM on a level surface.
4. Repeat step 1 on page 27 through step 3 for the second ESM.

Removing a power supply and fan unit

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.

CAUTION:
Disconnect the power cord before removing the power supply and fan unit.

Complete the following steps to remove a power supply and fan unit:

1. Squeeze the latch and pull the lever open 90° (so that the lever is horizontal) to release the power supply and fan unit from the latch. The latch is a coral colored tab on the lever.

2. Slowly pull the lever away from the chassis to remove the power supply and fan unit, as shown in Figure 15.

   Note: The lever rotates upward or downward 90°, depending on whether the power supply and fan unit you are removing is in the left or right power supply and fan unit bay.

Lever
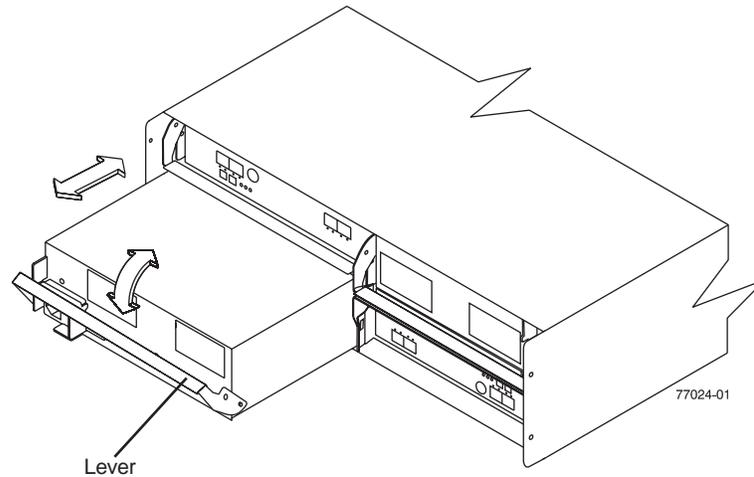
Figure 15. Removing a power supply and fan unit

3. Place the power supply and fan unit on a level surface.
4. Repeat step 1 on page 28 through step 3 for the second power supply and fan unit.

Removing an EV-DDM

Complete the following steps to remove a hot-swap EV-DDM:

Note: The EV-DDM comes installed in a drive tray. Do not attempt to detach the EV-DDM from the tray.

Attention: After you remove a EV-DDM CRU, wait 70 seconds before replacing or reseating it to allow it to properly spin down. Failure to do so may cause undesired events.

1. Use Table 30 on page 112 to record the location and identify your EV-DDMs. You must record this information to be able to replace the EV-DDMs in their original order before they were removed.
2. Release the latch on the EV-DDM CRU by pressing on the inside of the bottom of the tray handle.
3. Lift the closed latch to its open position. (The latch is at a 90° angle to the front of the drive when open.)
4. Pull the EV-DDM out of the bay, as shown in Figure 16 on page 30.
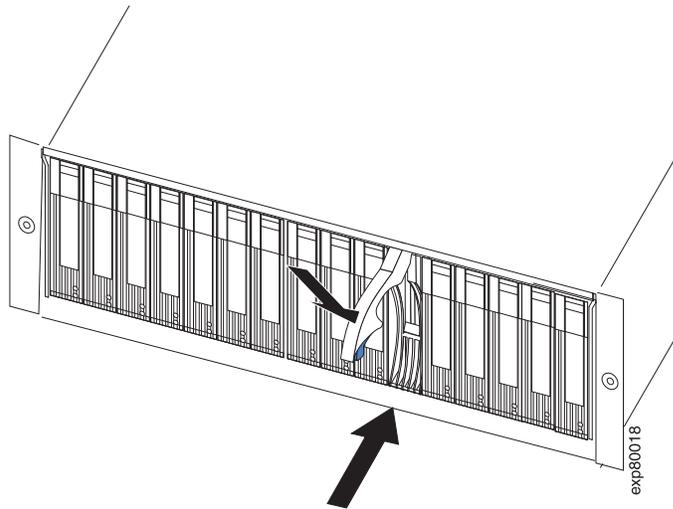
Figure 16. Removing a EV-DDM CRU

5. Place the EV-DDM CRU horizontally on a level surface.

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

6. Repeat step 1 on page 29 through step 4 on page 29 for additional EV-DDM CRUs.

Continue with "Installing the EXP420 into a rack."

Installing the EXP420 into a rack

Complete the following steps to install the EXP420 in the rack.

CAUTION:
Do not install modules or other equipment in the top half of a rackmount cabinet while the bottom half is empty. Doing so can cause the cabinet to become top-heavy and tip over. Always install hardware in the lowest available position in the cabinet.

Statement 4:
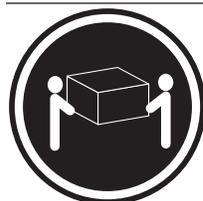
≥ 18 kg (39.7 lb)	≥ 32 kg (70.5 lb)	≥ 55 kg (121.2 lb)
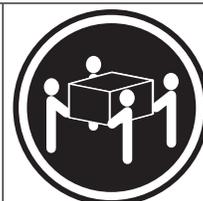
CAUTION:
Use safe practices when lifting.

1. Put on antistatic protection, and keep it on while performing all of the remaining procedures in this chapter.
2. Remove the four screws from the rails (two screws in each rail). See **4** in Figure 13 on page 26. If you do not remove these screws, the storage expansion enclosure will not fit securely.
3. Place the storage expansion enclosure in the rack.

   Note: If you have removed the CRUs from the EXP420, 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 storage expansion enclosure to the front of the rackmount cabinet.
   b. With help from another person, place the back of the storage expansion enclosure on the support rails, and then slide the unit into the rack as shown in Figure 17.

Front of Rack
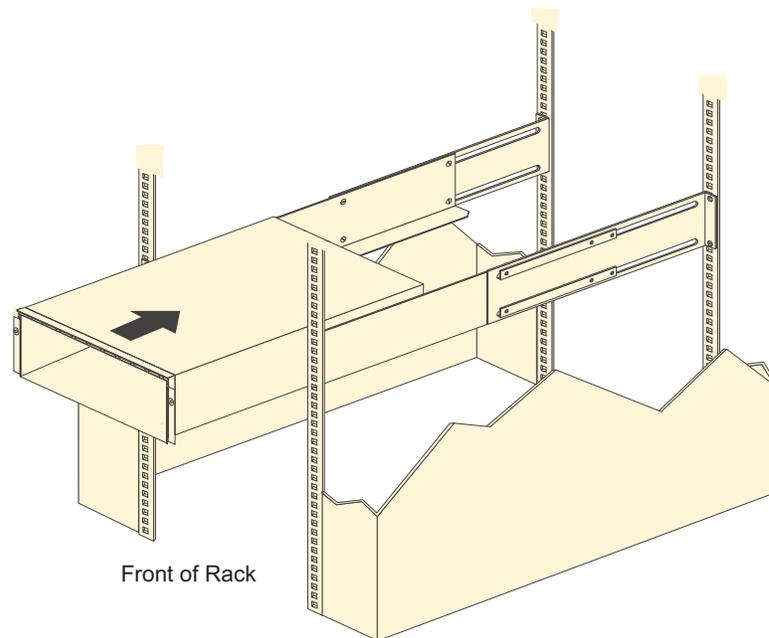
Figure 17. Installing the EXP420

4. Secure the storage expansion enclosure. Figure 18 on page 32 shows how to secure the storage expansion enclosure to the rack.
   a. Align the front mounting holes on each side of the storage expansion enclosure with the mounting holes on the front of the support rails.
   b. Using the screws that you removed in step 2, secure the sides in the back of the EXP420 storage expansion enclosure to the rack rails.
   c. Secure the front of the storage expansion enclosure using the four M5 screws as shown in Figure 18 on page 32.
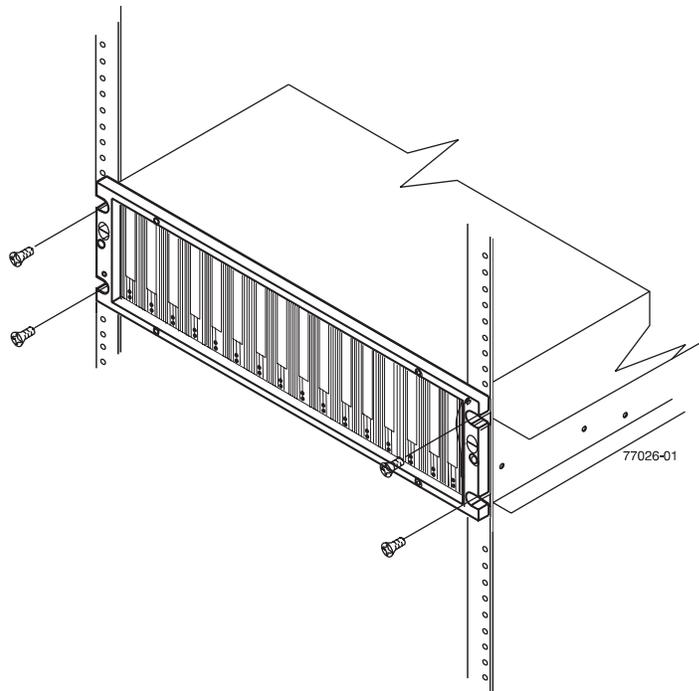
Figure 18. Securing the storage expansion enclosure to the rack

5. Continue with one of the following actions:
   - If you did remove the EXP420 CRUs before installation (as described in "Removing the CRUs" on page 26), continue with "Replacing the EXP420 CRUs."
   - If you did not find it necessary to remove the EXP420 CRUs before installation, continue with "Cabling the EXP420" on page 38.

Replacing the EXP420 CRUs

Use the following procedures to replace the CRUs in the EXP420 after the EXP420 is installed successfully in a rack.

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. The left and right ESMs are seated in the EXP420 chassis in opposite orientations. If you cannot fully insert the ESM into the ESM bay, flip it 180° and reinsert it.

1. Slide one ESM into the empty slot in the storage expansion enclosure. Be sure that the lever is pulled straight out as you slide the ESM in, as shown in Figure 19 on page 33.
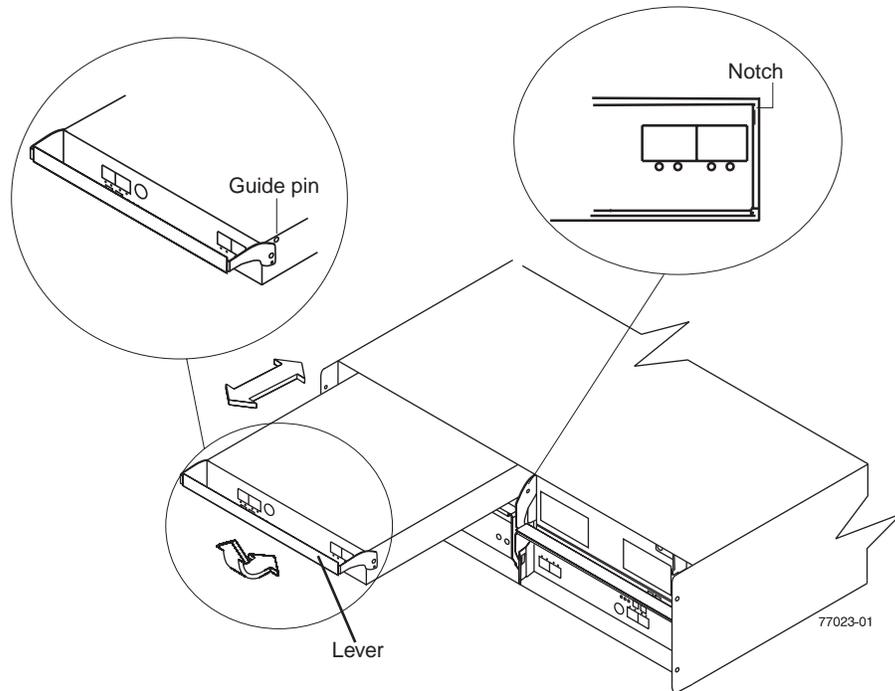
Figure 19. Removing and replacing an Environmental Service Module (ESM)

2. As you slide the ESM into the empty slot, make sure the guide pins on the side of the ESM fit into the notches. After the guide pins fit into the notches and ESM fits snugly into the bay, push the lever downward or upward 90°, depending on whether the ESM is inserted in the A or B ESM bay to fully latch it into place.

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

3. Repeat step 1 on page 32 and step 2 to replace the second ESM.

Replacing a power supply and fan unit

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.

CAUTION:
Disconnect the power cord before replacing the power supply and fan unit.

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

1. Slide one power supply and fan unit into the storage expansion enclosure. Be sure to replace the power supply and fan units so that the lever on each power supply and fan unit opens toward the interior of the storage expansion enclosure, as shown in Figure 47 on page 93.

   Attention: Be sure that the lever is pulled straight out as you slide the power supply and fan unit into the storage expansion enclosure, as shown in Figure 20. The left and right power supply and fan units are seated in the EXP420 chassis in opposite orientations. If you cannot fully insert the power supply and fan unit into the power supply and fan unit bay, flip it 180° and reinsert it.

Lever
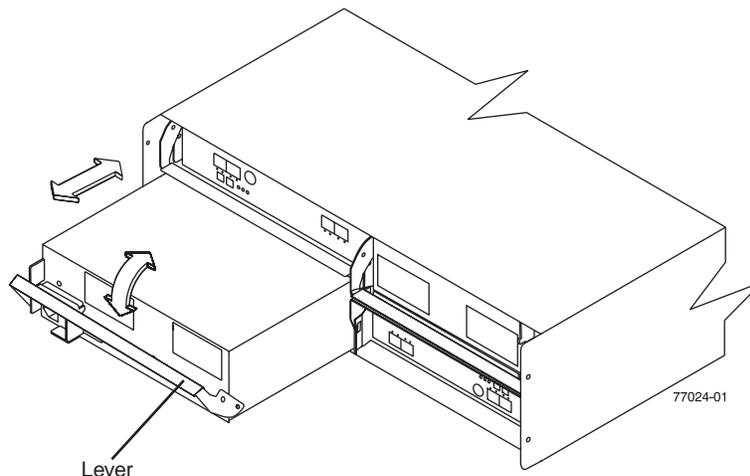
Figure 20. Replacing a power supply and fan unit

2. As you slide the power supply and fan unit into the empty slot, make sure the guide pins on the side of the power supply and fan unit fit into the notches along the sides of the power supply and fan unit bay. After the guide pins fit into the notches and power supply and fan unit fits snugly into the slot, push the lever upward or downward 90° depending on whether the power supply fan is inserted in the left or right bay to fully latch it into place. Then gently push the front of the power supply and fan unit to ensure that it is fully seated.

3. Repeat step 1 and step 2 to replace the second power supply and fan unit.

Replacing an EV-DDM

Complete the following steps to replace the hot-swap EV-DDMs that you removed before the installation.

Attention: After you remove a EV-DDM CRU, wait 70 seconds before replacing or reseating it to allow it to properly spin down. Failure to do so may cause undesired events.

Note: Use Table 30 on page 112 to verify the proper replacement locations of your EV-DDMs.

1. Lift up on the handle and gently push the EV-DDM CRU into the empty bay until the hinge of the tray handle latches beneath the storage expansion enclosure bezel, as show in Figure 21 on page 35.
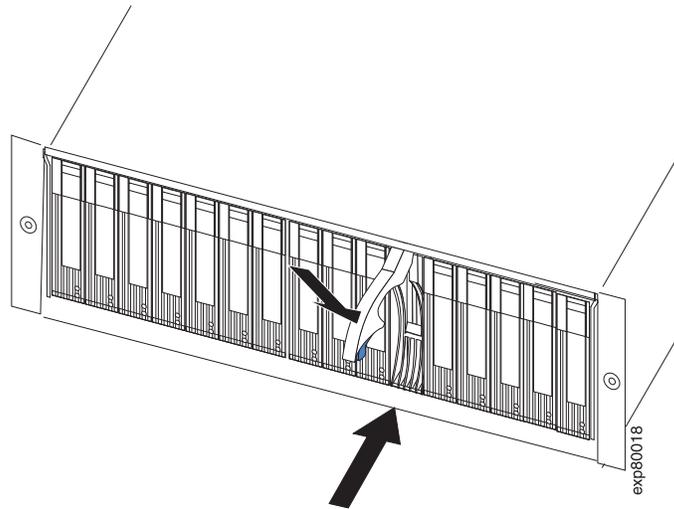
Figure 21. Replacing an EV-DDM

2. Push the tray handle down until the latch clicks into place.
3. Repeat step 1 on page 34 and step 2 to replace additional EV-DDMs.

Chapter 3. Cabling the EXP420

After the storage expansion enclosure is installed in its permanent location, you must cable it to hosts and other storage devices, depending on your hardware configuration.

This chapter addresses the following cabling and configuration topics:

- "Enclosure ID settings "
- "Fibre-channel loop and ID settings" on page 38
- "Cabling the EXP420" on page 38
- "Installing SFP modules" on page 38
- "Removing SFP modules" on page 40
- "Handling fiber-optic cables" on page 41
- "Using LC-LC fibre-channel cables" on page 42
- "Cabling the EXP420 to a storage subsystem" on page 45
- "EXP420 loop redundancy" on page 47
- "Cabling the power supply" on page 51

Enclosure ID settings

The enclosure ID, comprised of a pair of seven-segment numbers, is located on the back of each ESM next to the indicator lights. It provides a unique identifier for each module in the storage subsystem.

The DS4000 controller firmware and EXP420 ESM *automatically* set the enclosure ID number. You can change the setting through the storage management software if necessary. Both ESM enclosure ID numbers are identical under normal operating conditions.

The allowable ranges for enclosure ID settings are 0-99. However, IBM recommends that you do not set the enclosure ID to 00 or any number greater than 80 because the DS4200 Express Storage Subsystem enclosure IDs are set in this range.

Figure 22 shows the enclosure ID.
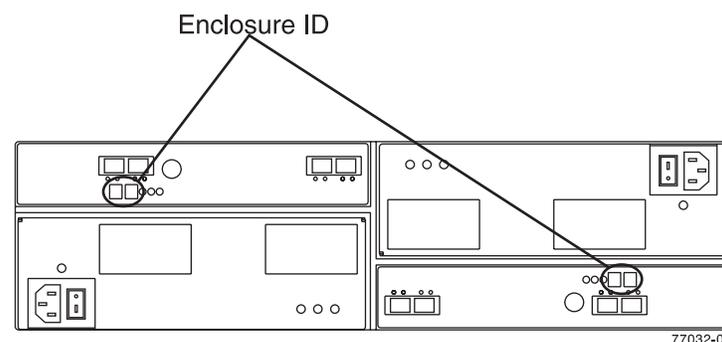
Figure 22. Storage expansion enclosure seven-segment enclosure ID

Fibre-channel loop and ID settings

When you install a hard disk drive in the storage 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.

Cabling the EXP420

The EXP420 supports two redundant drive loops. A redundant EXP420 drive loop consists of one or more storage expansion enclosures that are connected to a 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 EXP420 drives. Usually, there are two redundant array of independent disks (RAID) controllers in a storage subsystem. Use the *Fibre Channel Cabling Instructions* that ships with your storage subsystem for the specific information about cabling the EXP420. Before cabling the storage expansion enclosure, read the following information:

- **Fibre-channel loop/channel:** A fibre-channel loop (or fibre channel drive channel as it is called in certain DS4000 storage subsystem documentation) consists of EXP420 drive expansion enclosures that are connected to each other and to one or more RAID controllers. A loop/drive channel can support multiple RAID controllers, multiple EXP420 drive 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 EXP420 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 EXP420 storage expansion enclosures to one or more RAID controllers.

- **Fibre-channel cable restrictions:** RAID controllers use specific IBM fibre-channel options. Refer to the *IBM System Storage DS4000 Hardware Maintenance Manual, Problem Determination Guide,* or your IBM representatives or resellers for the cable option that is required for your configuration.

- **Power cabling:** The EXP420 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 EXP420, do not connect both the left and right power supplies to the same power circuit or power source.

Installing SFP modules

The EXP420 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 EXP420 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 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 FC ports in the FC 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 40 for more information.

- The speed of the SFP module determines the maximum operating speed of the fibre channel port in which the SFP is installed. For example, a 2-Gbps SFP that is plugged into a 4-Gbps-capable port will limit the speed of that port to a maximum of 2 Gbps.

  Attention: Carefully check the SFP's IBM part number, option number, and FRU part number to identify its speed. There are no physical features that distinguish a 4 Gbps from a 2 Gbps SFP.

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 20.

Complete the following steps to install an SFP module:

1. Remove the SFP module from its static-protective package.
2. Remove the protective cap from the SFP module, as shown in Figure 23. Save the protective cap for future use.
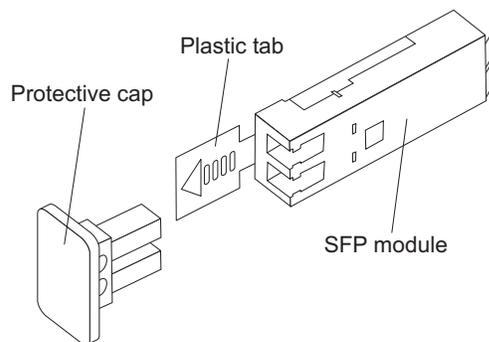
Figure 23. SFP module and protective cap

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 24.
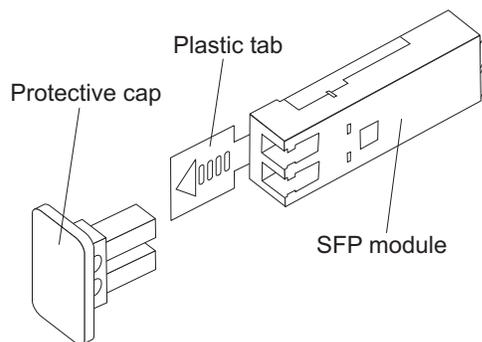
Figure 24. Installing an SFP module into the host port

5. Connect an LC-LC fibre-channel cable. For information about the LC-LC cable, see "Using LC-LC fibre-channel cables" on page 42.

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."
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 25.
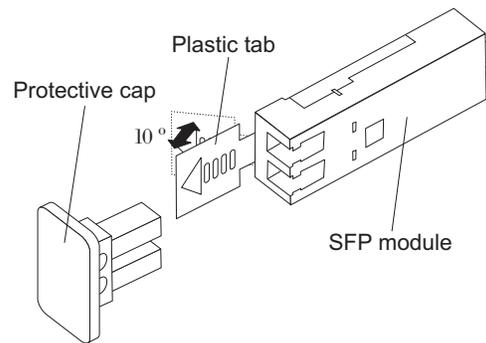
Figure 25. Unlocking the SFP module latch - plastic variety

   - For SFP modules that contain wire tabs, unlock the SFP module latch by pulling the wire latch outward 90°, as shown in Figure 26.
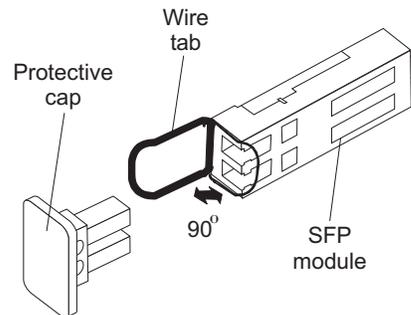
Figure 26. Unlocking the SFP module latch - wire variety

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.

- For devices on slide rails, leave enough slack in the cables so they do **not** bend to a diameter of less than 76 mm (3 in.), or a radius less than 38 mm (1.5 in.), when extended or become pinched when retracted.
- Route the cable away from places where it can be damaged by other devices in the rack cabinet.
- Do not use plastic cable ties in place of the provided cable straps.
- Do not overtighten the cable straps or bend the cables to a diameter of less than 76 mm (3 in.), or a radius 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.
- The following are the recommended maximum cable lengths.
    - 1 Gbps: 500 meters 50/125 um fiber, 300 meters 62.5/125 um fiber
    - 2 Gbps: 300 meters 50/125 um fiber, 150 meters 62.5/125 um fiber
    - 4 Gbps: 150 meters 50/125 um fiber, 70 meters 62.5/125 um fiber

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 EXP420 Storage Expansion Enclosure
- An SFP module installed in a DS4300 or DS4500 Fibre Channel Storage Server

See Figure 27 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.
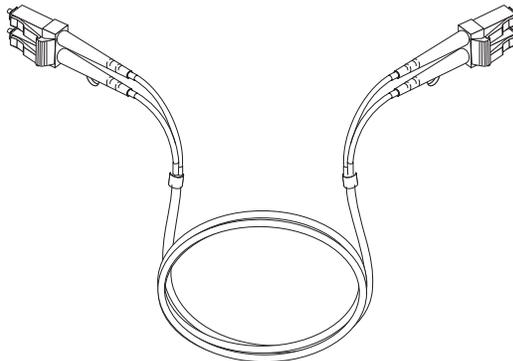
Figure 27. LC-LC fibre-channel cable

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 41.

2. If necessary, remove the protective cap from the SFP module, as shown in Figure 23 on page 40. 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 28. Save the protective caps for future use.
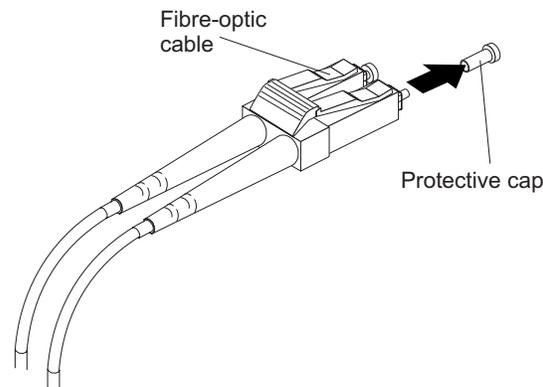
Figure 28. Removing fiber-optic cable protective caps

4. Carefully insert this end of the LC-LC cable into an SFP module that is installed in the EXP420. 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 29 on page 44.
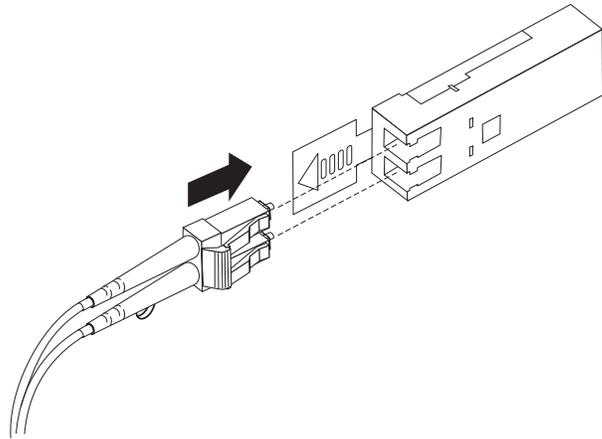
Figure 29. Inserting an LC-LC fibre-channel cable into an SFP module

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 EXP420
   - An SFP module that is installed in 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 30.
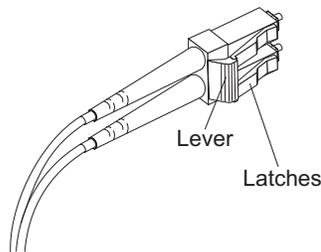
Lever

Latches

Figure 30. 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 31 on page 45.
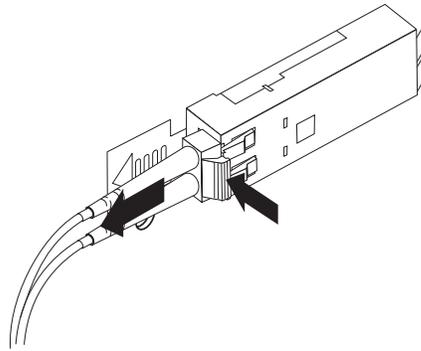
Figure 31. Removing the LC-LC fibre-channel cable

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

Cabling the EXP420 to a storage subsystem

In this release, you can cable the EXP420 storage expansion enclosure to a DS4200 Express Storage Subsystem only.

Note: Connections to other storage subsystems might be supported in the future. To verify your storage subsystems compatibility with the EXP420, check the Installation, User's, and Maintenance Guide for your storage subsystem and the IBM DS4000 storage system support Web site: www.ibm.com/servers/storage/support/disk/

For cabling topologies and specific cabling schemes for the EXP420 and the DS4200 Express Storage Subsystem, see the *IBM System Storage DS4200 Storage Subsystem Installation, User's, and Maintenance Guide.*

Complete the following steps to cable the EXP420 to a supported DS4000 storage subsystem:

1. Install an SFP module in the drive mini hub port on the back of the storage subsystem.
2. Connect an LC-LC fiber-optic cable into the SFP module, as shown in Figure 32 on page 46.

Attention:

- In a DS4200 Express Storage Subsystem environment, no more than six EXP420 storage expansion enclosures can be connected to the two ports of a dual-ported drive channel because of the internal drive slots in the DS4200 Express Storage Subsystem. Failure to observe this limitation might result in loss of data availability.

- Do not connect more than four EXP420 storage expansion enclosures to *each* port of a dual-ported drive channel in the DS4000 storage subsystem controller.

- It is recommended that you add storage expansion enclosures to the DS4200 Express drive ports in a round-robin fashion. For example, if you have four EXP420s to be cabled to the DS4200 Express, instead of cabling all four EXP420s to one drive port of a drive channel, distribute the enclosures to all drive ports, which results in two enclosures per drive port of a drive channel.

- **The controller drive ports of the DS4000 storage subsystem controllers must always be connected to the ports labeled 1B in both right and left ESMs of the EXP420s in the redundant drive channel/loop pair that is connected to the DS4000 storage subsystem. (Figure 34 on page 48 shows the location of the ports.)**

- Refer to the *IBM System Storage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide* and the *IBM System Storage Subsystem Installation, User's, and Maintenance Guide* of your particular DS4000 storage subsystem for any special cabling requirements.

Note: Figure 32 is for illustrative purposes only. The actual SFP module on your particular DS4000 storage subsystem might appear differently than the one shown in the figure.
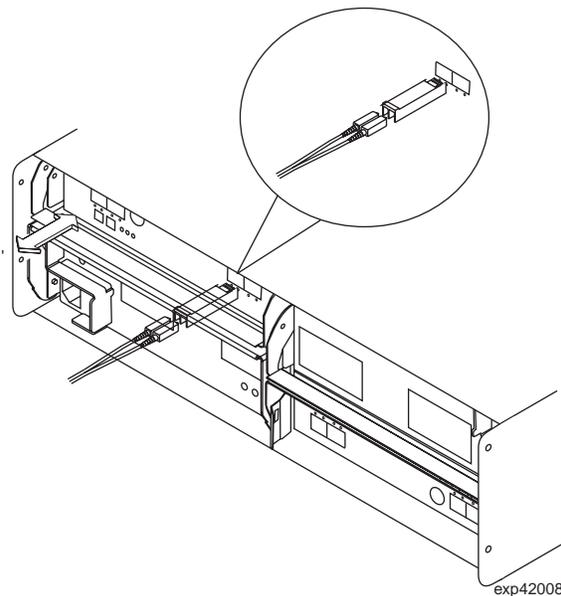
exp42008

Figure 32. Installing an SFP module and LC-LC cable in a supported DS4000 storage subsystem

3. Install an SFP module in the SFP port on the back of the EXP420; then, connect the other end of the LC-LC cable into the SFP module, as shown in Figure 33 on page 47.

Note: Figure 33 is for illustrative purposes only. The actual SFP module on your particular DS4000 storage expansion enclosure might appear differently than the one shown in the figure.
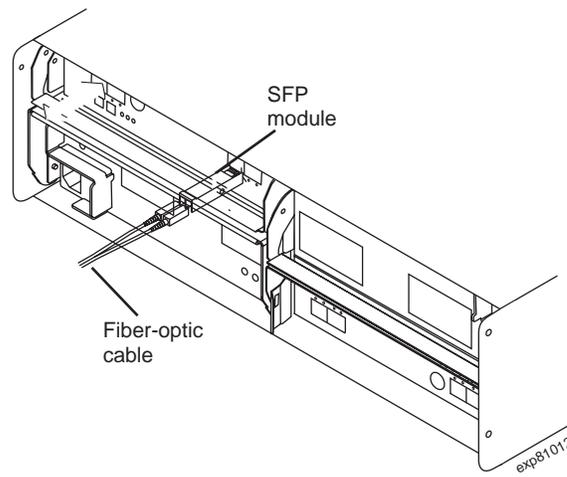
Figure 33. Installing an SFP module and connecting an LC-LC cable to the EXP420

EXP420 loop redundancy

Note: The term *drive loop* or *drive loop* pair used in this publication might be referred to as a *drive channel* or *drive channel pair* in other DS4000 Storage Subsystem publications. The terms have identical meanings.

The EXP420 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.

Notes:
1. The EXP420 supports SATA EV-DDMs.
2. You cannot mix storage expansion enclosures with different speed settings in the same drive loop.

Example of a correct redundant drive loop

Figure 34 on page 48 shows a redundant drive loop that you might create with a DS4200 Express Storage Subsystem and four EXP420s. The numbers provided in Figure 34 on page 48 show the order in which cables should be attached. **Note that the controller port is connected to the port labeled 1B on both the right and left ESMs.**

Note: For specific information about cabling a storage expansion enclosure to a DS4000 storage subsystem, see the appropriate *DS4000 Installation, User's, and Maintenance Guide*.
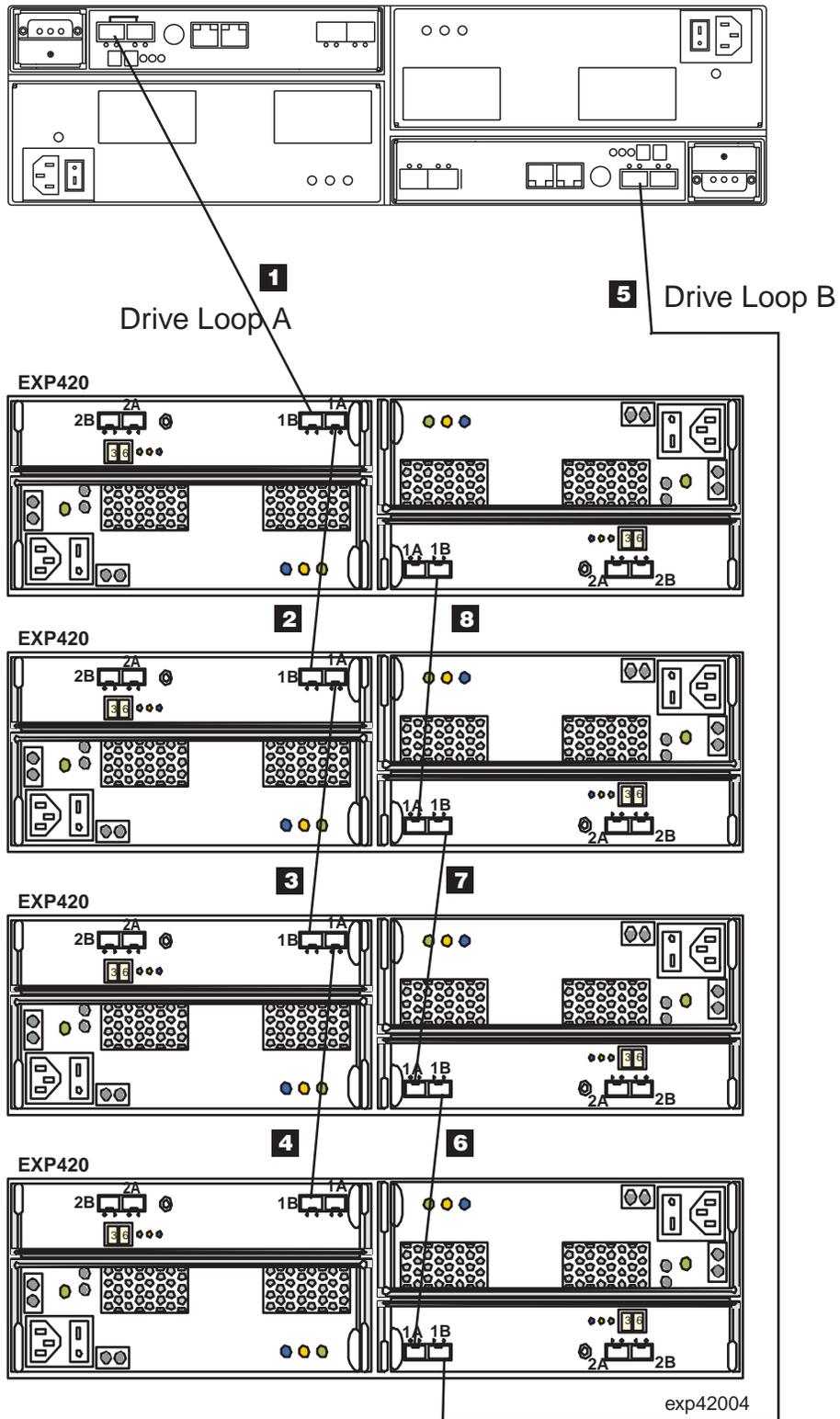
Figure 34. Correct EXP420 redundant drive loop configuration

To create drive loop A (of the DS4200 Express redundant drive loop) shown in Figure 34, you would perform the following steps:

1. Make a fibre-channel connection from the *DS4200 Express Storage Subsystem* to port 1B of the *first storage expansion enclosure* (connection **1**).

2. Make a fibre-channel connection from port 1A of the *first storage expansion enclosure* to port 1B of the *second storage expansion enclosure* (connection **2**).

3. Make a fibre-channel connection from port 1A of the *second storage expansion enclosure* to port 1B of the *third storage expansion enclosure* (connection **3**).

4. Make a fibre-channel connection from port 1A of the *third storage expansion enclosure* to port 1B of the *fourth storage expansion enclosure* (connection **4**).

To create drive loop B (of the DS4200 Express redundant drive loop) shown in Figure 34 on page 48, you would perform the following steps:

1. Make a fibre-channel connection from the *DS4200 Express Storage Subsystem* to port 1B of the *last storage expansion enclosure* (connection **5**).

2. Make a fibre-channel connection from port 1A of the *last storage expansion enclosure* to port 1B of the *third storage expansion enclosure* (connection **6**).

3. Make a fibre-channel connection from port 1A of the *third storage expansion enclosure* to port 1B of the *second storage expansion enclosure* (connection **7**).

4. Make a fibre-channel connection from port 1A of the *second storage expansion enclosure* to port 1B of the *first storage expansion enclosure* (connection **8**).

Example of an incorrect redundant drive loop

Figure 35 on page 50 shows an example of an incorrect redundant drive loop created with a DS4200 Express Storage Subsystem and four EXP420s. The redundant drive loop is not correct because the controller port is connected to the port labeled 1A instead of 1B on both the right and left ESMs. The numbers provided in Figure 35 on page 50 show the order in which cables were attached.

Note: For specific information about cabling a storage expansion enclosure to a DS4000 storage subsystem, see the appropriate *DS4000 Installation, User's, and Maintenance Guide*.
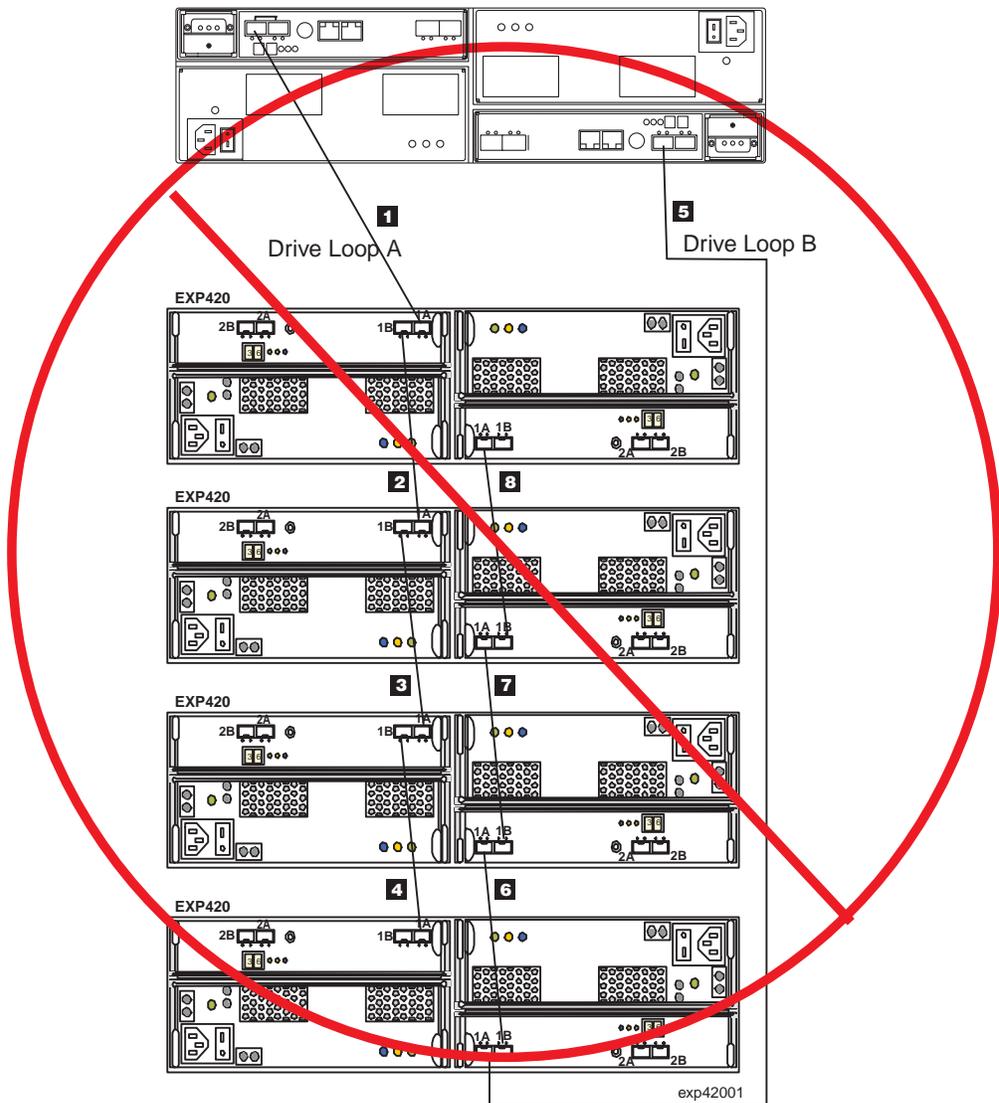
Figure 35. Incorrect EXP420 redundant drive loop configuration

The following list describes the incorrect fibre-channel connections for drive loop A (of the DS4200 Express redundant drive loop) shown in Figure 35.

1. The fibre-channel connection from the *DS4200 Express Storage Subsystem* is incorrectly connected to port 1A of the *first storage expansion enclosure* (connection **1**).

2. The fibre-channel connection from port 1B of the *first storage expansion enclosure* is incorrectly connected to port 1A of the *second storage expansion enclosure* (connection **2**).

3. The fibre-channel connection from port 1B of the *second storage expansion enclosure* is incorrectly connected to port 1A of the *third storage expansion enclosure* (connection **3**).

4. The fibre-channel connection from port 1B of the *third storage expansion enclosure* is incorrectly connected to port 1A of the *fourth storage expansion enclosure* (connection **4**).

The following list describes the incorrect fibre-channel connections for drive loop B (of the DS4200 Express redundant drive loop) shown in Figure 35 on page 50, you would perform the following steps:

1. The fibre-channel connection from the *DS4200 Express Storage Subsystem* is incorrectly connected to port 1A of the *last storage expansion enclosure* (connection **5**).

2. The fibre-channel connection from port 1B of the *last storage expansion enclosure* is incorrectly connected to port 1A of the *third storage expansion enclosure* (connection **6**).

3. The fibre-channel connection from port 1B of the *third storage expansion enclosure* is incorrectly connected to port 1A of the *second storage expansion enclosure* (connection **7**).

4. The fibre-channel connection from port 1B of the *second storage expansion enclosure* is incorrectly connected to port 1A of the *first storage expansion enclosure* (connection **8**).

Cabling the power supply

Complete the following steps to connect the power supply cable:

1. Using the supplied strap, tie the power supply cord to the rail to provide strain relief for the power cord.

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 "Powering on the EXP420" on page 55 for the initial startup of the storage expansion enclosure.

Chapter 4. Operating the EXP420

This chapter describes operating procedures for the EXP420.

To ensure optimal operation of your system, see "Best practices guidelines" on page 12.

Performing the DS4000 Health Check process

The DS4000 Health Check process is a sequence of suggested actions developed by IBM to help users verify and maintain the optimal performance of their DS4000 storage configurations. The information that you collect in these steps also helps provide IBM Service with important information needed for problem troubleshooting during IBM Service calls.

Perform the following Health Check tasks after the initial configuration of your DS4000 Storage Subsystem, and after all configuration sessions. It is also recommended that you set a regular schedule of periodic Health Check evaluations in order to keep your DS4000 code current and to preserve optimal data access and performance.

1. Monitor the Recovery Guru in the Storage Manager client for any obvious storage subsystem errors or problem conditions.

2. Gather and save the following DS4000 storage subsystem event logs for review by IBM Service. These event logs should be gathered periodically for regular Health Check monitoring regardless of the state of the Recovery Guru. (You can collect all these logs at once and zip them into a single file by clicking **Advanced ▶ Troubleshooting ▶ Collect All Support Data** in the DS4000 Storage Manager Subsystem Management window.)

   - DS4000 storage subsystem management event log (MEL)
   - Storage Subsystem Profile or DS4000 Profile
   - Read-Link Status (RLS) data

   In addition, you should also collect event logs for the host servers that have mapped logical drives from the storage subsystem.

   Attention: Save these event log files to a server disk that will remain accessible in the event of a DS4000 storage configuration failure. Do not save these event log files only to a LUN in the DS4000 Storage Subsystem.

3. Use the Storage Subsystem Profile or DS4000 Profile to verify that the following firmware levels are at the latest versions supported for your DS4000 Storage Subsystem:

   - Controller firmware
   - ESM firmware
   - Drive firmware
   - ATA translator (interposer) firmware

   If you discover your firmware is not up-to-date, upgrade the firmware and software to the latest level appropriate to your DS4000 storage configuration. See "Web pages" on page 54 for information about where to find the latest firmware and software.

   Attention: You must resolve Recovery Guru errors or problems before upgrading firmware.

Save the storage subsystem profile before performing any controller or ESM firmware upgrades. Save the storage subsystem profile and all *.cfg files to a server disk that will remain accessible in the event of a DS4000 storage configuration failure.

Note: When you upgrade firmware, you must upgrade all client package components to the same release level. For example, if you are upgrading your controller firmware from version 5.x to version 6.x, you must also upgrade your Storage Manager client to version 9.x or higher. If your host system uses RDAC, upgrading controller firmware from version 5.x to version 6.x might also require host software updates, such as RDAC updates and HBA driver updates. Refer to the IBM DS4000 Web site for detailed instructions.

4. Use the Storage Subsystem Profile or DS4000 Profile to verify that the following functions are enabled:

   - For all DS4000 models, Media Scan should be enabled both at the controller level and at the LUN level.
   - For all DS4000 models, the read/write cache should be enabled. In addition, use the Storage Subsystem Profile to verify that cache is matched between the controllers.

Web pages

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/

For the latest information about operating system and HBA support, clustering support, SAN fabric support, and Storage Manager feature support, see the System Storage DS4000 Interoperability Matrix at the following Web site:

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

Hardware responsibilities

In addition to the Health Check steps described above, regular hardware inspection and maintenance helps to support the optimal performance of your DS4000 storage configuration. You should periodically inspect the fibre channel components of your DS4000 storage configuration.

IBM suggests you follow these guidelines:

- Maintain an up-to-date storage subsystem profile for your DS4000 storage configuration. Save the profile to a server disk that will remain accessible in case of a DS4000 storage configuration failure. Do not save the profile only to a LUN in the DS4000 Storage Subsystem.
- Develop a Change Management plan. The plan should include schedules for updating subsystem firmware and server host software.

   Note: Some updates might require storage subsystem downtime.
- Use IBM-approved fibre channel cables for all situations. Note in your configuration documentation whether any cables are not IBM-approved.

- Create and maintain a cabling diagram of the current SAN configuration. Keep this diagram updated as you make configuration changes, and keep the cabling diagram available for review.
- Create and maintain a list of other components that are being used within the cabling diagram (such as the host system, fibre channel switches, and other SAN attachments).
- Ensure that all ESMs are properly seated.
- Ensure that all drives are properly seated.
- Ensure that all SFP modules are properly seated.
- Confirm fibre channel cable loop size. (IBM specifications call for at least 3-inch cable loops, but it is recommended that you use 6-inch cable loops or longer.)
- Ensure proper fibre channel cable management.
- Ensure proper air flow and temperature for all components in your EXP420 storage configuration.

Note: You can find details on many of these inspection and maintenance responsibilities in the appropriate sections of this document.

In addition to these inspection and maintenance responsibilities, IBM also strongly recommends DS4000 training for staff that supports DS4000 storage configurations. Although training is not a part of the Health Check process, DS4000 training reduces the potential for configuration problems and contributes to the overall health of the system.

Powering on the EXP420

When you turn on and turn off the EXP420, be sure to use the startup sequence in this section.

Turning on the EXP420

This section contains instructions for turning the EXP420 on and off under normal and emergency situations.

The following procedure covers two situations:
- The entire storage subsystem has been shut down. (The main circuit breakers for the cabinet are off.)
- Some storage expansion enclosures are being powered on while others remain online. (The main circuit breakers for the cabinet are on.) You might encounter this if you are adding an additional storage expansion enclosure to increase storage capacity.

   Attention:

   1. **Potential damage to EV-DDMs** - Repeatedly turning the power off and on without waiting for the EV-DDMs to spin down can damage them. Always wait at least 70 seconds from when you turn off the power until you turn it on again.

   2. If you are connecting a power cord to a storage expansion enclosure, turn off both of its power switches first. If the main circuit breaker is off, be sure both power switches are off on each storage expansion enclosure in the cabinet before turning on the main circuit breakers.

1. Are the main circuit breakers turned on?
   - **Yes -** Turn off *both* power switches on each storage expansion enclosure that you intend to connect to the power.

- **No -** Turn off *both* power switches on **all** storage expansion enclosures and storage subsystems in the DS4000 storage subsystem configuration.
2. Connect the power cords to the power supplies on each storage expansion enclosure.
3. If the main circuit breakers are turned off, turn them on.
4. Verify that the link rate setting on the front of the storage expansion enclosure matches the speed of the drives in the subsystem.

   Attention: You must turn on power to each attached storage expansion enclosure before turning on power to the storage subsystem to ensure that the controllers complete the startup process. If the controllers do not find any drives present during the initial power on sequence, the storage subsystem will not complete the startup process. This will prevent controllers from communicating with each other, and any factory-installed premium features will not be activated correctly.
5. Turn on both power switches on the back of each storage expansion enclosure. Turn on both power switches on each storage expansion enclosure attached to the storage subsystem. While each storage expansion enclosure powers up, the green and amber LEDs on the front and back of the storage expansion enclosure turn on and off intermittently. Depending on your configuration, it can take several minutes for each storage expansion enclosure to power up.

   Check the LEDs on the front and back of all the storage expansion enclosures. Verify that no Needs Attention or enclosure ID LEDs light on any of the storage expansion enclosures. To verify the fibre channel connections between the drive expansion enclosures, make sure that no Port Bypass LEDs for connections to other storage expansion enclosures are lit. Only the Port Bypass LED of the ESM port that connects directly to the storage subsystem drive port should be lit.
6. Turn on both power switches on the back of the DS4000 storage subsystem.

   Depending on the number of storage expansion enclosures in the configuration, the storage subsystem might take several minutes to power up. The battery self-test might take an additional 15 minutes. The LEDs will blink intermittently until the storage subsystem powers up and completes the battery self-test. Before attempting any operations, wait at least five minutes for the storage subsystem to completely power up. A storage subsystem can take up to 10 minutes to power on and up to 15 minutes to complete its controller battery self-test. During this time, the indicator lights on the front and back of the module blink intermittently.

exp81024
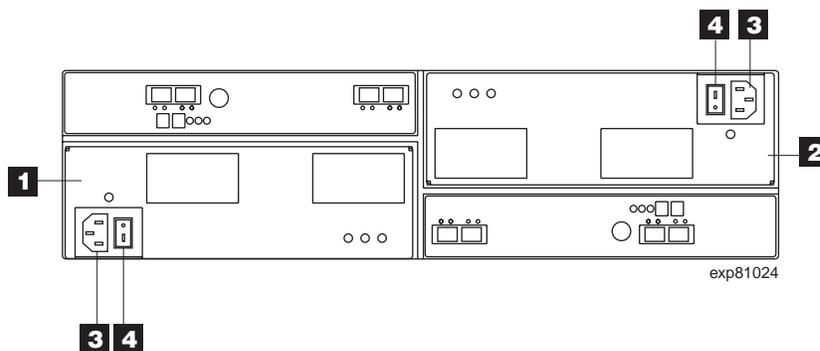
Figure 36. Power supply switches and connectors

Table 15. Description of Figure 36 on page 56

Number	Description
1	Power supply and fan unit A
2	Power supply and fan unit B
3	Power connector
4	Power switch

7. Determine the status of all storage subsystems and components in the configuration by completing the following steps:

    a. Check all LEDs on each component in the storage expansion enclosures. Ensure that all the LEDs show normal status. For more information on LED status for storage expansion enclosures, see "Checking the LEDs" on page 60 or the Installation, User's, and Maintenance Guide for your DS4000 storage expansion enclosure.

    b. Check all LEDs on each component in the storage subsystem. Ensure that all the LEDs show normal status. For information about LED status, see "Solving problems" on page 101.

    c. Open the DS4000 Storage Manager Subsystem Management Window, and display the Physical View for the configuration.

        The status for each component will be either Optimal or Needs Attention.

    d. Review the status of the configuration components shown in the Subsystem Management Window by selecting the appropriate component button for each storage subsystem.

8. Are the LEDs indicating normal operation, and is the status Optimal on all the configuration components?

    *   Yes — End of procedure.
    *   No — Go to step 9.

9. Diagnose and correct the fault by completing the following steps:

    a. Run the DS4000 Storage Manager Recovery Guru by selecting the Recovery Guru toolbar button in the Subsystem Management Window.

    b. Complete the recovery procedure.

        If the Recovery Guru directs you to replace a failed component, use the individual LEDs on the storage subsystem to locate the specific failed component. For troubleshooting procedures, see Chapter 6, "Hardware maintenance," on page 101.

    c. When the recovery procedure is completed, select Recheck in the Recovery Guru. This action reruns the Recovery Guru to ensure that the problem has been corrected.

    d. If the problem persists, contact your IBM service representative.

Firmware updates

Attention: Save the storage subsystem profile before performing any controller or ESM firmware upgrades. Save the DS4000 storage subsystem profile and all configuration (*.cfg) files to a server disk that will remain accessible in the event of a DS4000 storage configuration failure. Do not save these files only to a LUN in the DS4000 Storage Subsystem.

To ensure the optimal operation of the DS4000 storage subsystem and its attached storage expansion enclosures, the storage expansion enclosure ESM firmware, the

DS4000 controller firmware, the hard drive firmware, and the NVSRAM (for controllers only) must be up-to-date. Go to the following Web site to get the latest updates:

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

Refer to "Software and hardware compatibility and upgrades" on page 9 for software and hardware compatibility information and requirements.

Apply the necessary updates before configuring the storage subsystem arrays and logical drives. Subscribe to My Support for automatic notifications of firmware or Storage Manager software updates or any important information about your DS4000 subsystems (see "Product updates" on page 11).

Attention: Read the Readme file that is included in each firmware or DS4000 Storage Manager software package for any limitations, subsystem firmware prerequisites, or download-sequence information. For example, the controller firmware code might require the storage expansion enclosure ESM firmware to be upgraded first to a particular version, or the controller firmware download might require the halting of I/Os to the DS4000's logical drives. Failure to observe the limitations, prerequisites, and dependencies in the Readme file might result in a loss of data access.

Unless the Readme file contains special requirements for the sequence in which you upgrade firmware, you should perform firmware upgrades in the following sequence:
1. ESM firmware for the storage expansion enclosures
2. Controller firmware
3. Controller NVSRAM
4. Drive firmware and ATA translator card firmware

Finding controller, storage expansion enclosure, and drive information

You can view a Storage Subsystem Profile to find controller, enclosure, and drive information for the EXP420 and the DS4200 Express Storage Subsystem to which it is attached. To view a Storage System Profile, perform the following steps:
1. Open the DS4200 Express Storage Subsystem Management window from the DS4000 Storage Manager Enterprise Management window.
2. Select **Storage Subsystem → View → Profile**.
   A Storage Subsystem Profile window opens.
3. Select the Controllers tab.
4. Scroll through the list to find Board ID, Submodel ID, Product ID, and Product revision for the DS4200 Express Storage Subsystem as shown in Table 16.

Table 16. Board ID, Submodel ID, Product ID, and Product Revision for the DS4200 Express Storage Subsystem

Controller value	Current value in this release
Board ID	3992
Submodel ID	51
Product ID	1814 FAStT
Product revision	2916

5. Select the Enclosures tab.
6. Scroll through the list to find the Product ID for supported storage expansion enclosures as shown in Table 17.

Table 17. Product ID for supported storage expansion enclosures compatible with the DS4200 Express Storage Subsystem

Enclosure value	Current value in this release
Product ID	EXP420

7. Select the Drives tab.
8. Scroll through the list to find the EV-DDM values such as Product ID.

Table 18. Product ID for EV-DDMs for the DS4200 Express Storage Subsystem

EV-DDM value	Current value in this release
Product ID	ST350064INS 42D0392 39M0181 IBMV

Troubleshooting the storage expansion enclosure

The DS4000 Storage Manager is the best way to monitor the storage expansion enclosure, diagnose a problem, and recover from a hardware failure. You should run the DS4000 Storage Manager continuously, and check the status of the storage array frequently.

Use the following procedure to check the status of and identify a problem with the storage expansion enclosure.

1. Open the Subsystem Management Window.
2. Select the component button for each storage expansion enclosure in this storage subsystem, and view the status of each of the components.

   The status for each component is either Optimal or Needs Attention.
3. Does any component have a Needs Attention status?
   - **Yes** - Go to step 4.
   - **No** - All components are Optimal. Go to step 6.
4. Select the Recovery Guru toolbar button. Perform the procedure in the Recovery Guru to correct the problem. The Recovery Guru might direct you to replace the failed component. If so, go to step 5.

   Attention: If the fault requires you to power off an attached storage expansion enclosure, you might need to cycle the power on the DS4000 storage subsystem and all remaining storage expansion enclosures in the storage subsystem. Contact IBM Customer and Technical Support before powering off any attached storage expansion enclosures.
5. Mute the alarm, if needed.
6. Check the indicator LEDs on the front and the back of the storage expansion enclosure.

   A green LED denotes a normal status; an amber LED denotes a hardware fault.
7. Is an amber LED on?
   - **Yes** - Locate and troubleshoot the failed components. See "Checking the LEDs" on page 60.
   - **No** - You are finished with this procedure. If you are still experiencing a problem with this storage subsystem, create, save, and print a storage subsystem profile. This information might be helpful when troubleshooting.

Contact IBM Customer and Technical Support for assistance. When the recovery procedure is completed, select **Recheck** in the Recovery Guru to rerun the Recovery Guru and to ensure that the problem has been corrected.

Checking the LEDs

The LEDs display the status of the storage expansion enclosure and components. Green LEDs indicate a normal operating status; amber LEDs (Needs Attention) indicate a possible failure; a blue LED indicates that is safe to remove a component. The blue LED also indicates that the storage expansion enclosure is being identified or located.

It is important to check all the LEDs on the front and back of the storage expansion enclosure when you turn on the power. During power up, the indicator LEDs blink intermittently as the storage expansion enclosure and components complete the power-up process. In addition to checking for faults, you can use the LEDs on the front of the storage expansion enclosures to determine if the drives are responding to I/O transmissions from the host.

Power supply and fan unit LEDs

This section describes the primary LEDs on the storage expansion enclosure power supply and fan units.
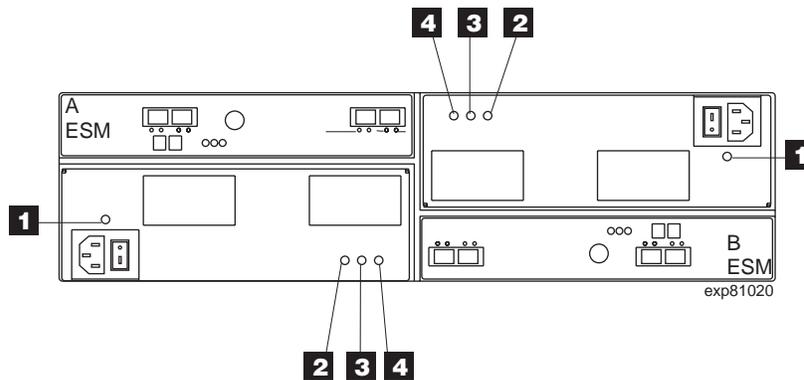
Figure 37. Power supply and fan unit LEDs

Table 19. Power supply and fan unit LEDs

Number	LED	Normal Status	Problem Status
1	Power supply and fan unit Power	On	Off
2	Service Action Allowed (OK to Remove)	Off	On
3	Service Action Required (Fault)	Off	On

Table 19. Power supply and fan unit LEDs (continued)

Number	LED	Normal Status	Problem Status
4	Direct Current Enabled	On	Off

Front LEDs

This section describes the primary LEDs and controls on the front of the storage expansion enclosure. The front view shows the following components:

- Front Frame - Metal cage frame containing global indicator lights and a link rate switch.
- Drives - Up to 16 removable drives, which are numbered 1 through 16 from left to right. When a drive is installed, the drive and tray slot designation is set automatically. The hardware addresses are based on the enclosure ID switch setting on the ESM and on the drive's physical location in the storage expansion enclosure.

  Note: The drives in your storage expansion enclosure might differ slightly in appearance from those shown. The variation does not affect the function of the drives.

exp81021
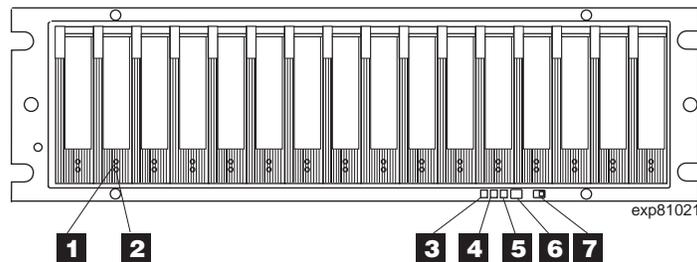
Figure 38. Front LEDs

Table 20. Front LEDs and controls

Number	LED	Normal Status	Problem Status
1	Drive Activity LED	On (not blinking) - No data is being processed Blinking - data is being processed	Off
2	Drive Fault LED	Off Blinking - Drive, volume, or storage array locate function	On (not blinking) **Note:** In certain ESM firmware versions, the Drive Fault LED is lit when no drive is inserted in the drive slot.
3	Global Locate	On	N/A
4	Global Summary Fault	Off	On

Table 20. Front LEDs and controls (continued)

Number	LED	Normal Status	Problem Status
5	Global Power	On	Off
6	Reset Alarm Mute Button	N/A	N/A
7	Link Rate Switch	The Link Rate switch should be set to 2 Gbps or 4 Gbps, depending on your configuration.	N/A

Rear LEDs

This section describes the primary LEDs, controls, and connectors on the rear of the storage expansion enclosure. The back view shows the following components:

- Fans and power supplies - Two removable power supply and fan unit CRUs, each containing one power supply and two fans
- ESMs - Two removable environmental service modules (ESMs)
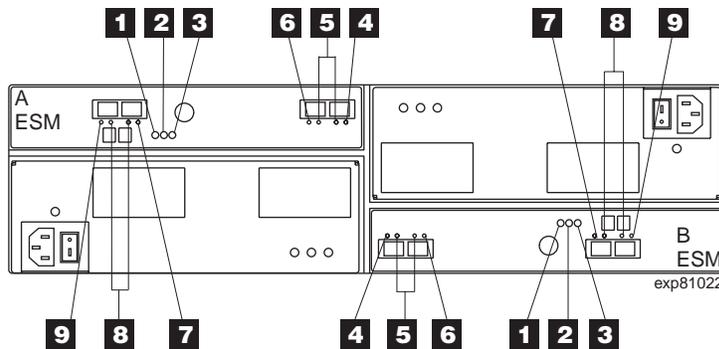
Figure 39. Rear LEDs, controls, and connectors

Table 21. Rear LEDs, controls, and connectors

Number	LED	Normal Status	Problem Status
1	ESM Power	On	Off
2	ESM Fault	Off	On
3	ESM Service Action Allowed (OK to Remove)	Off	On
4	ESM Port 1 In Bypass (This port is labeled 1A)	Off - Cable connected On - No cable connected	On, blinking for 30 seconds

Table 21. Rear LEDs, controls, and connectors (continued)

Number	LED	Normal Status	Problem Status
5	ESM Ports 1 & 2 2 or 4 Gbps Data Rate	One LED is lit if 2 Gbps Both LEDs are lit if 4 Gbps	N/A
6	ESM Port 2 In Bypass (This port is labeled 1B)	Off - Cable connected On - No cable connected	On, blinking for 30 seconds
7	ESM Port 3 In Bypass (This port is labeled 2A)	Off - Cable connected On - No cable connected	On, blinking for 30 seconds
8	ESM Ports 3 & 4 2 or 4 Gbps data rate	One LED is lit if 2 Gbps Both LEDs are lit if 4 Gbps	N/A
9	ESM Port 4 In Bypass (This port is labeled 2B)	Off - Cable connected On - No cable connected	On, blinking for 30 seconds

Seven-segment numeric display

The numeric display consists of two seven-segment LEDs that provide information about enclosure identification and diagnostics. Figure 40 shows the numeric display and the diagnostic LED.

Diagnostic LED
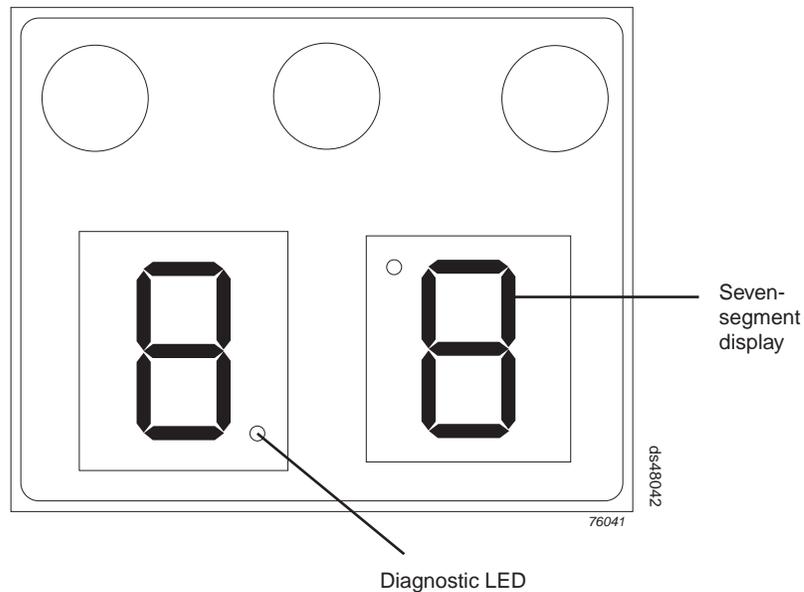
Figure 40. Numeric display LEDs

When you power on the storage expansion enclosures, the seven-segment LEDs show 88 before the boot firmware starts to run. After the boot code starts, - - is displayed.

When the application code starts, the ESMs display either aa or bb depending on whether it is ESM A or B.

When the storage expansion enclosure is operating normally, the numeric display shows the enclosure identification (enclosure ID) of the storage expansion enclosure.

If an error has occurred and the Needs Attention LED is on, the numeric display shows diagnostic information. The numeric display indicates the information is diagnostic by illuminating an LED that appears as a decimal point between the display numbers. The diagnostic LED tuns off when the numeric display shows the storage subsystem enclosure ID. The numeric display shows various diagnostic codes as the enclosures perform the startup process after each power cycle or reset. After diagnostics are complete, the current storage subsystem enclosure ID is displayed.

Diagnostic codes in the form of Lx or Hx, where x is a hexadecimal digit, indicate storage expansion enclosure state information. In general, these codes are displayed only when the storage expansion enclosure is in a non-operational state. The storage expansion enclosure might be non-operational due to a configuration problem (such as mismatched types), or it might be non-operational due to hardware faults. If the storage expansion enclosure is non-operational due to system configuration, the storage expansion enclosure Needs Attention LED is off. If the storage expansion enclosure is non-operational due to a hardware fault, the storage expansion enclosure Needs Attention LED is on. The definitions for Lx diagnostic codes are listed in Table 22.

Table 22. Numeric display diagnostic codes

Value	Storage expansion enclosure State	Description	SANtricity View
L0	Suspend	Mismatched ESM types	Needs Attention condition for board type mismatch
L2	Suspend	Persistent memory errors	Needs Attention condition for offline ESM
L3	Suspend	Persistent hardware errors	Needs Attention condition for offline ESM
L9	Suspend	Over temperature	
H0	Suspend	SOC Fibre Channel Interface Failure	
H1	Suspend	SFP Speed Mismatch	
H2	Suspend	Invalid/Incomplete Configuration	Needs Attention condition for offline ESM
H3	Suspend	Maximum Reboot Attempts Exceeded	Needs Attention condition for offline ESM
H4	Suspend	Cannot Communicate with other ESM	Needs Attention condition for offline ESM
H5	Suspend	Midplane Harness Failure	Needs Attention condition for offline ESM

Table 22. Numeric display diagnostic codes (continued)

Value	Storage expansion enclosure State	Description	SANtricity View
H6	Suspend	Firmware Failure	Needs Attention condition for offline ESM
H8	Suspend	SFP(s) Present in Currently Unsupported Slot	
88	Reset	ESM is held in reset by the other ESMs	

Powering off the EXP420

The EXP420 is designed to run continuously. After you turn it on, 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 unexpected shutdown" on page 68.

Turning off the EXP420

Use the following procedure to turn off the power for the EXP420. Figure 36 on page 56 shows the location of the power switches on a storage expansion enclosure.

Attention: Except in an emergency, never turn off the power if any Needs Attention LEDs are on. Correct the fault before you turn off the power. Use the DS4000 Storage Manager client and the Needs Attention LEDs to check the overall status of the EXP420. All LEDs should be green on the front of the storage expansion enclosure. If they are not, use the DS4000 Storage Manager client to diagnose the problem. This ensures that the EXP420 will power up correctly later.

The EXP420 is designed to run continuously. After you turn on the EXP420, 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 unexpected shutdown" on page 68.

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.
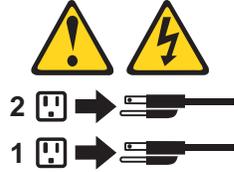
Attention: Turning off and turning on power without waiting for the storage expansion enclosure disk drives to spin down can damage the drives and might cause data loss. Always let at least 70 seconds elapse from when you turn off the power until you turn on the power again.

Power-off overview

Review the following information before you continue with the power-off procedure below.

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

1. Turn off power to the host before the 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.

2. Turn off power to the storage subsystem before you turn off power to the storage expansion enclosures. Turn off both power supply switches on the back of the storage subsystem.

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

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

Use the following procedure to turn off power to one or more storage expansion enclosures for a planned shutdown. To turn off power for an unplanned shutdown, see "Restoring power after an unexpected shutdown" on page 68.

Before proceeding, use the Storage Manager client to determine the status of the system components and special instructions. The operating system software might require you to perform other procedures before you turn off the power.

To turn off the EXP420, perform the following steps:

1. Stop all I/O activity to each storage expansion enclosure.
2. Remove the front cover from the storage expansion enclosure, if applicable.
3. Determine the status of all storage expansion enclosures and components in the configuration by completing the following steps:

   a. Check all LEDs on each component in the storage expansion enclosures. Ensure that all the LEDs show normal status.

b. Check all LEDs on each component in the storage subsystem. Ensure that all the LEDs show normal status.

c. Open the Subsystem Management Window for the configuration and display the Physical View for the configuration.

d. Review the status of the configuration components shown in the Subsystem Management Window by selecting the appropriate component button for each storage subsystem.

   The status for each component will be either Optimal or Needs Attention.

4. Are the LEDs indicating normal operation, and is the status Optimal on all configuration components?

   - **Yes** - Go to step 6.
   - **No** - Go to step 5.

5. To diagnose and correct the fault, complete the following steps:

   a. Run the Recovery Guru by selecting the Recovery Guru toolbar button in the Subsystem Management Window.

   b. Complete the recovery procedure.

      If the Recovery Guru directs you to replace a failed component, use the individual LEDs to locate the failed component.

   c. When the recovery procedure is completed, select **Recheck** in the Recovery Guru. This action reruns the Recovery Guru to ensure that the problem has been fixed.

   d. If the problem has not been fixed, contact your IBM service representative. Do not turn off power until all problems are corrected.

6. Check the Cache Active LED, and verify that it is off.

   If the Cache Active LED is on steady, the cache contains data. Wait for the data to clear from cache memory before turning off the power.

7. Check the LEDs on the storage expansion enclosures to verify that all Drive Active LEDs are on steady (not blinking).

   If one or more LEDs are blinking, data is being written to or from the EV-DDMs. Wait for all active LEDs to stop blinking.

8. Turn off the AC power switch on the back of each controller in the storage subsystem.

   Note: Until the power switch on each controller is turned off, power still remains turned on for the both controllers; therefore, the seven-segment display on each controller stays on until the power switch on each controller is turned off.

9. Turn off both power switches on the back of each storage expansion enclosure in the configuration.

10. After you perform the necessary maintenance procedures, turn on the power using the procedure in "Turning on the EXP420 " on page 55.

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 EXP420 loses power unexpectedly, it might be due to a hardware failure in the power system or in the midplane of the EXP420.

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

1. If you have time, stop all I/O activity to the storage expansion enclosure.
2. Check the LEDs. Make note of any Needs Attention LEDs that are on so you can correct the problem when you turn on the power again.
3. Turn off all power supply switches, starting with the DS4000 storage subsystem first, and followed by the storage expansion enclosures. Then, unplug the power cables from the EXP420.

Restoring power after an unexpected shutdown

Complete the following steps to restart the EXP420 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 EXP420 for damage. If there is no visible damage, continue with step 2. Otherwise, have your system serviced.
2. After you check the EXP420 for damage, ensure that the power switches are in the off position; then plug in the EXP420 power cables, if required.
3. Check the system documentation of the hardware devices that you want to turn on and determine the proper startup sequence.

   Note: Be sure to turn on all of the storage expansion enclosures and verify that there are not any ESM or power supply and fan unit fault LEDs lit before you turn on the DS4000 storage subsystem.

   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 Storage Subsystem Installation, User's, and Maintenance Guide* during any attended power-up procedure.
   - A storage subsystem 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 subsystems do not display in the Storage Manager graphical user interface (GUI).
     - The storage subsystem logical drives and subsystems do not come online.
     - The storage subsystem logical drives and subsystems seem to be degraded.
4. Turn on the power to each device, based on the startup sequence.

   Note: All of the EXP420 storage expansion enclosures must be powered on before the DS4000 storage subsystem.
5. The green LEDs on the front and the back of the EXP420 and DS4000 storage subsystem should remain lit. If other amber Fault LEDs light, see "Solving problems" on page 101.

Recovering from an overheated power supply and fan unit

Each EXP420 storage expansion enclosure contains two power supply and fan units. Each power supply and fan unit contains a built-in temperature sensor designed to prevent it from overheating. Under normal operating conditions, with an ambient air temperature range of 10° C to 35° C (50° F to 95° F), the fans in the power supply and fan units maintain a proper operating temperature inside the module.

If the internal temperature reaches 65° C (149° F), the power supply shuts down automatically. If both power supplies shut down because of overheating, the module has no power, and all indicator lights are off.

The following factors can cause the power supplies to overheat:
- An unusually high room temperature
- Fan failures in the power supply and fan units
- Defective circuitry in the power supply
- Blocked air vents
- Failures in other devices in the configuration or cabinet

If a fan failure causes overheating, the Global Fault LED on the storage expansion enclosure turns on. The power-fan canister Fault LED on the back of the storage expansion enclosure also turns on. "Rear LEDs" on page 62 shows the location of these LEDs.

If the module temperature exceeds 45° C (113° F), the storage management software displays a Needs Attention icon in the Subsystem Management Window. If event monitoring is enabled, and event notification is configured, the software issues the following two critical problem notifications:
- If *one* power supply shuts down, the storage management software displays a Needs Attention status in the Subsystem Management Window.
- If *both* power supplies shut down, the module shuts down, and the storage management software displays a Not Responding status in the Array Management Window.

  Use the following procedure to resume normal operation after a power supply shutdown. Figure 41 on page 70 shows the location of the power switches on the storage expansion enclosure.

  Attention: Risk of damage from overheating - The power supplies automatically shut down when the air temperature inside the cabinet reaches 65° C (149° F). If the power supplies shut down, immediately remove all cabinet panels to help cool the cabinet air temperature and to prevent damage to the DS4000 storage subsystem configuration components.

1. Remove the front cover.
2. If applicable, mute the alarm.
3. Did you use the procedure "Troubleshooting the storage expansion enclosure " on page 59 to identify an overheating problem?
   - **Yes** - Go to step 4.
   - **No** - Perform the procedure "Troubleshooting the storage expansion enclosure " on page 59 to verify that the power supplies have shut down because of an overheating problem, and then go to step 4.
4. Stop I/O activity to all attached storage expansion enclosures.

5. Take all or some of the following measures to alleviate the overheating problem:
   - Removing all panels from the cabinet immediately.
   - Using external fans to cool the area.
   - Shutting down the power to the storage expansion enclosure, using the procedure described in "Performing an emergency shutdown" on page 67.
6. Wait for the air temperature in and around the storage expansion enclosure to cool.

   After the temperature inside the power supplies cools to below 65° C (149° F), the storage expansion enclosure is capable of power-up recovery without operator intervention. After the air has cooled, the power supplies should turn on automatically. If the power supplies restart automatically, the controllers will reset and return to normal operation.
7. Did the power supplies restart automatically?
   - **Yes** - Go to step 9.
   - **No** - Go to step 8.
8. To cycle the power, turn off both power switches on the back of each storage expansion enclosure, wait two minutes, and turn on both power switches.

   While the storage expansion enclosure powers up, the LEDs on the front and the back of the module blink intermittently. Depending on your configuration, the storage expansion enclosure can take between 20 seconds and several minutes to power on.
9. Turn on both power switches on the back of the storage subsystem.

   A storage subsystem can take 10 minutes to power on and up to 15 minutes for the battery self-test to complete. During this time, the LEDs on the front and the back of the modules blink intermittently.
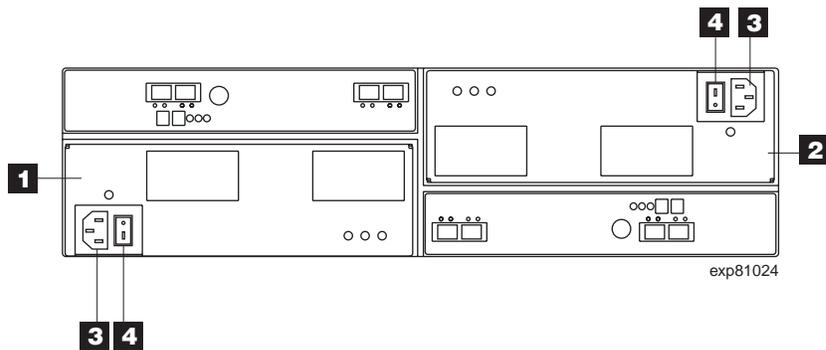
Figure 41. Power supply switches

Table 23. Description of Figure 41

Number	Description
1	Power supply and fan unit A
2	Power supply and fan unit B
3	Power connector
4	Power switch

10. Check the status of each storage expansion enclosure and its components.
    a. Note the status of the LEDs on the front and back of each module.

A green LED indicates a normal status; amber LEDs indicate a hardware fault.

b. Open the Subsystem Management Window for the storage array.

c. Select the appropriate components button for each module in the Physical View of the Subsystem Management Window to view the status of its components.

The status for each component is either Optimal or Needs Attention.

11. Does each module display green LEDs only, and is the status Optimal for each module component?

- **Yes** - Go to step 13.
- **No** - Go to step 12.

12. Diagnose and correct the fault:

a. To run the Recovery Guru, select the Recovery Guru toolbar button in the Subsystem Management Window.

b. Complete the recovery procedure.

If the Recovery Guru directs you to replace a failed component, locate and troubleshoot that component. See "Checking the LEDs" on page 60.

c. When the procedure is completed, rerun the Recovery Guru to ensure that the problem has been corrected by selecting **Recheck** in the Recovery Guru.

d. If the problem persists, contact IBM Customer and Technical Support.

13. Replace the bezel on the storage expansion enclosure, if applicable.

Chapter 5. Installing and replacing devices

This chapter contains information about installing and replacing the EV-DDM CRU, power supply and fan unit CRU, ESM CRU, SFP module, and midplane.

Handling static-sensitive devices

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

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

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

Service Action Allowed Status LED

Each ESM and power supply and fan unit has a blue Service Action Allowed status LED. The purpose of the Service Action Allowed status LED is to help ensure that a component is not removed before it is safe to do so. Do not remove any EXP420 component unless the component's Service Action Allowed status LED is lit.

> **Attention**
>
> Never remove an ESM or power supply and fan unit unless the Service Action Allowed status LED is turned on. Doing so can result in a potential loss of data availability. If the Needs Attention LED is lit and the associated Service Action Allowed status LED is *not* lit, then you must perform additional diagnostics *before* you can remove the indicated component. Use the Recovery Guru instructions in the DS4000 Storage Manager Subsystem Management window or refer to the appropriate component replacement instructions in this chapter for the additional diagnostics required in this case.

The Service Action Allowed status LED automatically turns on or off as conditions change. Wait at least two minutes after you replace each component for the controller to recognize the new component and update the LED status. In most

cases when a single component fails, the Service Action Allowed status LED turns on steadily when the Needs Attention status LED is turned on for the component.

Adding the EXP420 to an existing and configured redundant drive channel/loop pair

Note: The term *drive loop or drive loop pair* used in this publication might be referred to as a *drive channel or drive channel pair* in other DS4000 Storage Subsystem publications. The terms have identical meanings.

You can add up to six EXP420s to a redundant fibre-channel loop pair. Before you cable your EXP420 to a drive loop, refer to the *Fibre Channel Cabling Instructions* that came with your storage subsystem for specific instructions.

Attention: The EXP420 storage expansion enclosure drive channel operates at either 2 or 4 Gbps fibre channel interface speed. The EXP420 SATA EV-DDM CRUs have an ATA translator card that converts EV-DDM 3 Gbps SATA drive interface protocol to either 2 Gbps or 4 Gbps fibre channel interface protocol. It is recommended that the EXP420 enclosure speed is set to 4 Gbps when these SATA EV-DDM CRUs are installed and connected to storage expansion enclosures running at 4 Gbps speed. The Link Rate setting speed must be set accordingly. See "Verifying the Link Rate setting " on page 86 for more information. The enclosure speed of the DS4200 Express Storage Subsystem that the EXP420s are connected to must also be set to 4 Gbps.

Attention

Before you power on the DS4200 Express Storage Subsystem, the DS4200 Express must be cabled to at least one storage expansion enclosure 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 DS4200 Express, 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:

https://www-912.ibm.com/PremiumFeatures/

Additionally, if at least two drives are not installed in each attached storage expansion enclosure, the resulting insufficient load to the storage expansion enclosure power supply CRUs might cause the drive expansion enclosure power supply CRUs to intermittently appear as failed and then reappear in an optimal state, falsely indicating that the power supply CRUs are bad.

Figure 42 on page 75 shows an example of a DS4000 storage subsystem configured with redundant drive loop pairs.
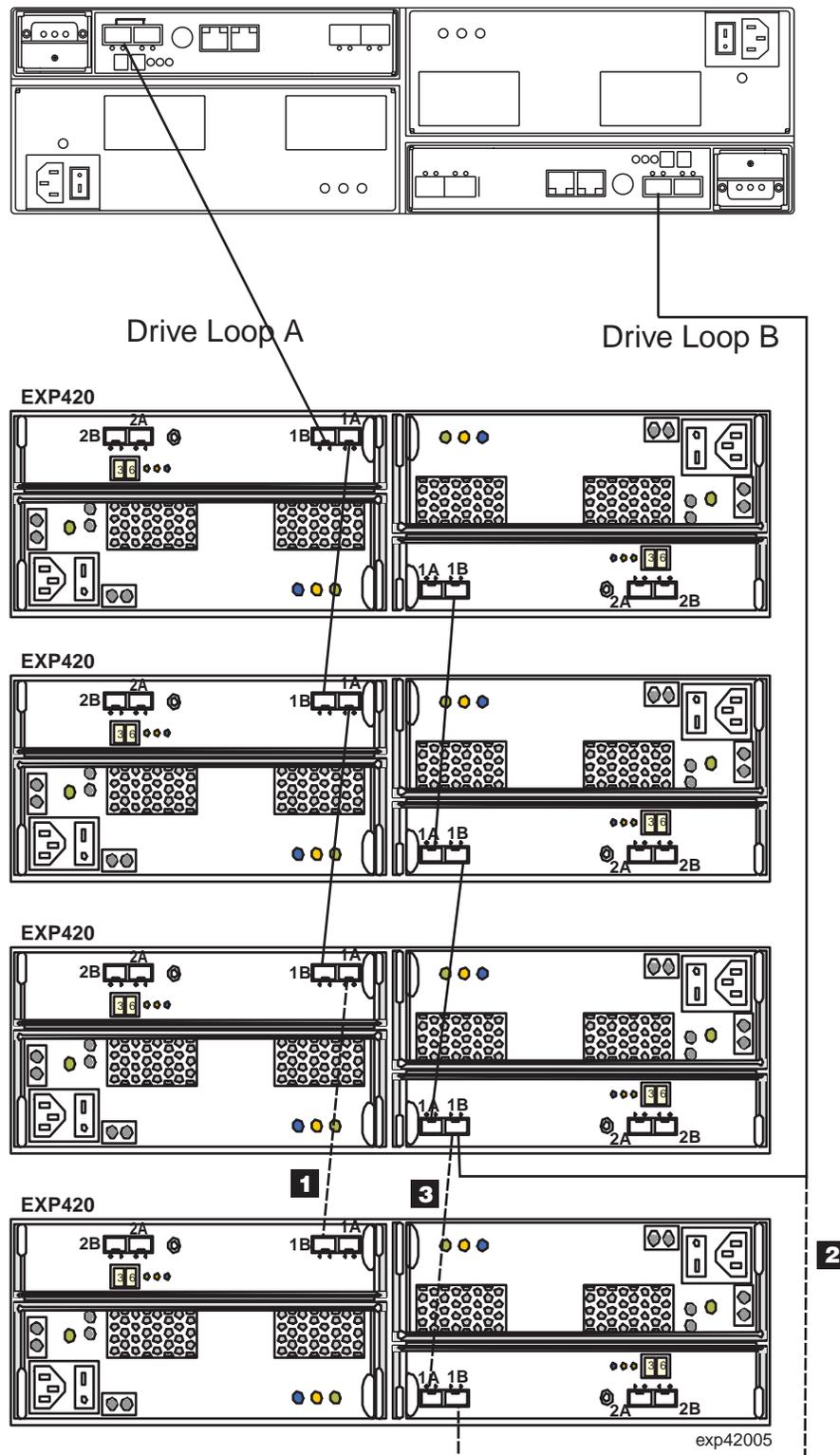
Figure 42. Cabling the EXP420 to an existing and configured drive loop

The dashed lines in Figure 42 show how to add a new EXP420 to an existing DS4200 Express configuration with EXP420s. To add the new EXP420 shown in Figure 42, perform the following steps:

1. Unpack and install the EXP420 drive expansion enclosure. Do not insert any drive CRUs into the enclosure drive slots.
2. Verify that the Link Rate speed is at the correct setting. You cannot add storage expansion enclosures with different Link Rate speed settings in the same redundant drive loop.
3. Power on the EXP420 storage expansion enclosure.
4. Make the fibre-channel connection marked **1** in Figure 42 on page 75 (drive loop A) by connecting port 1A of the existing EXP420 to port 1B of the new EXP420. Then verify that it is recognized by the Storage Manager software GUI.
5. Move the existing fibre-channel connection marked **2** in Figure 42 on page 75 from the existing EXP420 enclosure ESM port IB to the new EXP420 enclosure ESM port 1B.
6. Make the fibre-channel connection marked **3** in Figure 42 on page 75 (drive loop B) by connecting port 1A of the new EXP420 to port 1B of the existing EXP420.
7. 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 EXP420 ESM firmware.

   Attention: For error-free operation, the ESM firmware in the EXP420 ESM modules must be at the same level. If the ESM version does not match, wait at least 10 minutes for the ESM automatic code synchronization to occur. Otherwise, manually update the ESM firmware using the menu function in the DS4000 Subsystem Management window.
8. Insert the drives into the drive slots two at a time. Wait until the drives have spun up and been recognized by the DS4000 before inserting the next two drives from the Physical View of the Subsystem Management window.
9. Repeat step1 to step 8 for each drive expansion enclosure you want to add.

Note: Always add a new EXP420 to the *end* of a drive loop. Always add new drive expansion enclosures to the existing drive loop one at a time while the DS4000 storage subsystem is running and in an optimal state. See the *DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide* for more information.

Working with hot-swap EV-DDMs

This section explains how you can increase the storage expansion enclosure capacity by adding more EV-DDMs or by replacing existing ones 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 20.
- 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 EV-DDM CRUs, review the following information:
- **Blank trays:** A storage expansion enclosure without a full set of EV-DDMs (16) contains blank trays in the unused drive bays. Before installing new EV-DDMs, you must remove these empty trays. Save the empty trays for future use. Each of the 16 bays must always contain either a blank tray or a hot-swap EV-DDM.

For proper cooling and EMC protection, do not leave a drive slot open without either a drive blank or a EV-DDM CRU inserted.

- **EV-DDM CRUs:**
  - In this release, 2 or 4 Gbps fibre channel EV-DDMs are supported. The Link Rate setting speed must be set accordingly. See "Verifying the Link Rate setting " on page 86 for more information.
  - IBM recommends that when adding EV-DDM CRUs, if you are not installing all 16 EV-DDM CRUs into the EXP420, install the EV-DDM CRUs from left to right consecutively.
  - For optimum performance, never insert a EV-DDM into a storage expansion enclosure without first confirming the drive firmware level. Contact IBM Support for information on supported drive firmware levels.
  - Use of non-supported drives in the drive expansion enclosures can cause the storage expansion enclosure to fail.
  - In configurations with mixed drive expansion enclosures, all enclosures on a fibre loop must be operating at the same interface speed.
  - Ensure that the speed of the drive CRU you are adding is supported in the storage expansion enclosure. For example, do not install a 2 Gbps drive CRU in a storage expansion enclosure that supports only 4 Gbps drives.

    Note: The EXP420 SATA EV-DDM CRUs have an ATA translator card that converts EV-DDM 3 Gbps SATA drive interface protocol to either 2 or 4 Gbps fibre channel interface protocol.

  - Drive CRUs are not interchangeable between EXP810s and EXP420s.
  - After you remove a EV-DDM CRU, wait 70 seconds before replacing or reseating it to allow it to properly spin down. Failure to do so may cause undesired events.

Attention

Before you power on the DS4200 Express Storage Subsystem, the DS4200 Express must be cabled to at least one storage expansion enclosure populated with at least two EV-DDMs. If at least two drives are not installed in each attached storage expansion enclosure when you power on the DS4200 Express, 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:

https://www-912.ibm.com/PremiumFeatures/

Additionally, if at least two drives are not installed in each attached storage expansion enclosure, the resulting insufficient load to the storage expansion enclosure power supply CRUs might cause the drive expansion enclosure power supply CRUs to intermittently appear as failed and then reappear in an optimal state, falsely indicating that the power supply CRUs are bad.

- **EV-DDM CRU labels:** A label is provided on the front of each EV-DDM. Use this label to record the location information for each EV-DDM before you remove it. Ensure that you keep track of the EV-DDMs and their corresponding bays. Also, record the location information in Table 30 on page 112. If you install an EV-DDM in the wrong bay, you might lose data.

- **Drive LEDs:** Each EV-DDM CRU tray has two associated LEDs, a green Activity LED and an amber Fault LED. These LEDs indicate the status for that drive. See Table 24 for the drive LED states and descriptions.
- EV-DDM CRUs are not interchangeable between the EXP420 and other DS4000 storage expansion enclosures such as EXP710s.

Table 24. 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. The green activity LED will be flashing one every 2 seconds if the DS4000 storage subsystem is spinning down the drive. The drive can also be put in a failed state if the drive is not certified for the DS4000 storage subsystem that the EXP420 is connected to. Use the DS4000 Storage Subsystem Management window to verify that this is the case and replace the drive with the drive option or CRU/FRU that is certified for that particular DS4000 storage subsystem.
Activity and Fault LEDs	All unlit	Check for and resolve one of the following situations: • EXP420 is turned off. • EXP420 enclosure speed is not set correctly. • EXP420 is not connected to a supported DS4000 storage subsystem (such as a DS4700 instead of DS4200 Express)..
Activity and Fault LEDs	Flashing together in a certain pattern	Drive failure due to the incorrect EXP420 enclosure speed setting or internal drive hardware failures.

- **Fibre-channel loop IDs:** When you install a EV-DDM in the storage 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 EXP420 contains hardware that enables you to replace a failed EV-DDM without turning off the storage expansion enclosure. You can continue to operate your system while a EV-DDM is removed or installed. These drives are known as hot-swap EV-DDMs.

Installing hot-swap EV-DDMs

With the exception of the DS4000 storage subsystem initial power up, IBM recommends that you add EV-DDMs while the storage expansion enclosure is turned on and running. Complete the following steps to install hot-swap EV-DDMs in the storage expansion enclosure:

Attention:

- After you remove a EV-DDM CRU, wait 70 seconds before replacing or reseating it to allow it to properly spin down. Failure to do so may cause undesired events.
- The DS4200 Express and EXP420 EV-DDMs and FRUs are not compatible with DS4700 and EXP810 E-DDMs and FRUs.

1. Read the documentation that comes with the EV-DDM.
2. Check for Fault LEDs shown in Figure 43. If any amber LEDs are lit, see "Solving problems" on page 101.
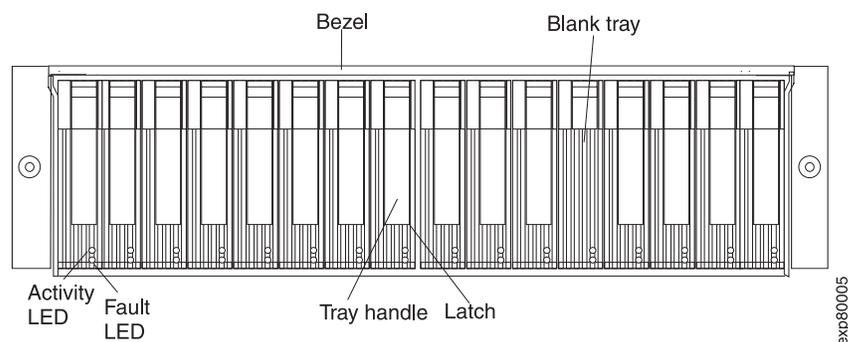
Figure 43. Hot-swap EV-DDM LEDs

3. Determine the bay into which you want to install the EV-DDM.
4. Remove the blank tray by performing the following steps:
   a. Release the latch on the drive CRU by pressing on the inside of the bottom of the tray handle.
   b. Lift the closed latch to its open position. (The latch is at a 90° angle to the front of the drive when open.)
   c. Pull the blank tray out of the bay.
   d. Save the blank tray for later use.
5. Install the EV-DDM by performing the following steps:

   Note: The EV-DDM comes installed in a drive tray. Do not attempt to detach the drive from the tray.

   a. Release the latch on the EV-DDM CRU by pressing on the inside of the bottom of 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 80.

Tray handle

Tray latch

exp80012
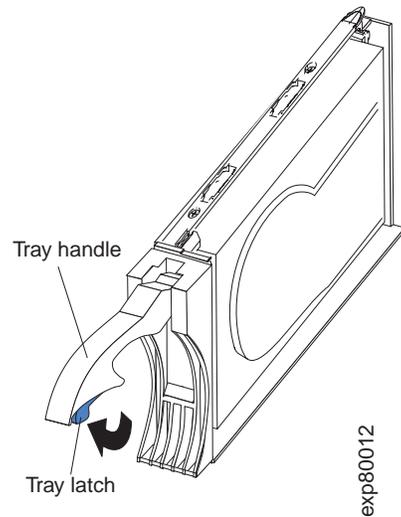
Figure 44. EV-DDM CRU handle

   c. Slide the EV-DDM CRU into the empty bay until the hinge of the tray handle
      latches beneath the storage expansion enclosure bezel or the adjacent drive
      CRU bezel.

      Note: Make sure that the EMC gasket does not snag on the bezel.
   d. Push the tray handle down until it latches into place.

Replacing hot-swap EV-DDMs

Drive problems include any malfunctions that delay, interrupt, or prevent successful
I/O activity between the hosts and the EV-DDMs in the storage expansion
enclosure. This includes transmission problems between the host controllers, the
ESMs, and the EV-DDMs. This section explains how to replace a failed EV-DDM.

Note: If you want to remove a EV-DDM that is not in a failed or bypass state,
always use the Storage Manager client program either to place the EV-DDM
in a failed state or to place the array that is associated with the EV-DDM (or
EV-DDMs) in an offline state before you remove it from the enclosure.

Attention: Failure to replace the EV-DDMs in their correct bays might result in
loss of data. If you are replacing an EV-DDM that is part of a configured array and
logical drive, ensure that you install the replacement EV-DDM 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.

Complete the following steps to replace a hot-swap EV-DDM:
1. Use the DS4000 Storage Management client software to print a new storage
   system profile.
2. Determine the location of the EV-DDM that you want to remove.
   Attention: Never hot-swap a EV-DDM CRU when its associated green Activity
   LED is flashing. Hot-swap a EV-DDM CRU only when its associated amber
   Fault LED is lit and not flashing.
3. Put on antistatic protection.
4. Remove the EV-DDM CRU by performing the following steps:

     a. Release the latch on the EV-DDM CRU by pressing on the inside of the bottom of the tray handle, as shown by the arrow in Figure 44 on page 80.

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

     c. Pull the EV-DDM CRU about 1/2 inch out of the bay and wait 70 seconds to allow it to properly spin down and the storage subsystem controller to properly recognize that an EV-DDM is removed from the configuration.

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

5. Unpack the new EV-DDM. Save all packing material in case you need to return it.

   Attention: The DS4700 and EXP810 E-DDM options and FRUs are not compatible with DS4200 Express and EXP420 EV-DDM options and FRUs.

6. Install the new EV-DDM CRU by performing the following steps:

     a. Gently push the EV-DDM CRU into the empty bay until the hinge of the tray handle latches beneath the storage expansion enclosure bezel.

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

7. Check the drive LEDs for the following:

   • When a EV-DDM 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 EV-DDM from the unit and wait 70 seconds; then, install it again.

   **Attention:** After you remove a EV-DDM CRU, wait 70 seconds before replacing or reseating the EV-DDM CRU to allow it to properly spin down. Failure to do so may cause undesired events.

8. Use the DS4000 Storage Manager subsystem management window to verify that the EV-DDM is shown in the Storage Subsystem Management window.

Replacing multiple EV-DDMs

This section provides guidelines for upgrading the EV-DDMs in the storage expansion enclosure. Read the software documentation and this entire section to determine whether 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 EV-DDM CRU, wait 70 seconds before replacing or reseating the EV-DDM CRU to allow it to properly spin down. Failure to do so may cause undesired events.

The following are two methods for upgrading drives:

• **Replacing all the EV-DDMs at the same time**

   This method requires that you back up the data on the affected EV-DDMs and then turn off the EXP420 and the DS4000 storage subsystem.

   Attention: Turn off the DS4000 storage subsystem before you turn off the EXP420.

   After replacing all the EV-DDMs, you must reconfigure them and restore data from backup. See the procedure in "Replacing all EV-DDMs at the same time" on page 82.

This is the safest way to exchange EV-DDMs without losing data. However, this method might take a long time to complete because of the backup, reconfiguration, and restoration processes. In addition, other users are not able to use the storage subsystem (or any storage expansion enclosures attached to the storage subsystem) until you finish the procedure. You must use this method on RAID 0 logical drives.

- **Replacing the EV-DDMs one at a time**

  In this method, you manually fail each EV-DDM, replace it, and wait for the system to restore data to the new EV-DDM before installing the next one. After you install the new EV-DDMs, you can configure them to make the additional drive space available. See the procedure in "Replacing the EV-DDMs one at a time" on page 84.

  Using this method, you can replace the EV-DDMs while the EXP420 and the DS4000 are running, eliminating the down time that is required if you replace all the EV-DDMs 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 EV-DDMs.
- The number of EV-DDMs in an array. Replacing EV-DDMs one at a time is better suited for arrays consisting of 3 to 5 EV-DDMs. If you have more than 10 EV-DDMs, consider replacing all EV-DDM 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 EV-DDM 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.
- How extensive are the changes to data while the array is in a degraded state during the RAID array reconstruction and copyback process as result of replacing an EV-DDM in the array. The more extensive the data changes, the more work that will need to be performed to restore the data in the event that the array failed because of an additional EV-DDM failed while the array is in degraded state.

Replacing all EV-DDMs at the same time

Use this procedure to replace all EV-DDMs at the same time. You must use this method if you are upgrading EV-DDMs containing RAID 0 logical drives. All the data currently on the EV-DDMs is lost when you replace them; therefore, you must back up all data that is currently on the EV-DDMs. This procedure also requires you to turn off the EXP420 and the DS4000, which makes the storage subsystem (and any attached storage expansion enclosures) inaccessible to other users.

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

To replace all the EV-DDMs at the same time, perform the following steps:

1. Read the following information:
   - The information in "Replacing multiple EV-DDMs" on page 81, 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. Perform a complete backup of the drives that you are replacing.

   You need the backup to restore data on the EV-DDMs 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 20.

4. Unpack the new EV-DDMs.

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

5. Perform the following steps:
   a. Stop all I/O activity to the storage subsystem and attached storage expansion enclosures. Make sure that:
      1) All of the green Drive activity LEDs on the front of the storage subsystem (and on all attached EXP420s) are not flashing.
      2) The green Cache active LEDs are off. Refer to the *IBM System Storage DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* for the location of the Cache active LEDs.
   b. If applicable, use the operating system software to disconnect the storage subsystem logical drives from the host before you power off the storage subsystem.

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

6. Turn off the power to each device based on the following shutdown sequence:
   a. Turn off power to the host before you turn off power to the storage 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 storage subsystem before you turn off power to the EXP420. 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).

7. Use the procedures in "Replacing hot-swap EV-DDMs" on page 80 to remove the EV-DDMs that you want to replace. Use the procedures in "Installing hot-swap EV-DDMs" on page 78 to install the new EV-DDMs into the EXP420.

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

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

   b. You must turn on the storage expansion enclosures before the storage subsystem. The controllers might not recognize the correct configuration if the EV-DDMs 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 storage subsystem; then restart or turn on the power to the host.

9. Turn on the power to each device, based on the power-on sequence in step 8. To turn on power to the storage subsystem and the EXP420s, 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.

10. 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 EV-DDM CRU might not be installed correctly. Remove the EV-DDM CRU, wait 30 seconds, and then reinstall it.
   - If the Drive fault LED stays on or the Drive activity LED stays off, the new EV-DDM might be faulty. See the DS4000 Storage Manager software for problem determination.

11. Use the DS4000 Storage Manager software to configure the new EV-DDMs. See the DS4000 Storage Manager software online Help for detailed instructions.

12. Restore the data from backup to all the EV-DDMs.

Replacing the EV-DDMs one at a time

Use this procedure to replace all the EV-DDMs one at a time. You cannot use this procedure on RAID 0 logical drives (use the procedure in "Replacing all EV-DDMs at the same time" on page 82).

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 EV-DDM. The data on the new EV-DDM is still rebuilt, but the process takes longer for each EV-DDM. Remember to reassign the hot spares when you are finished with this procedure.

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

To replace the EV-DDMs one at a time, perform the following steps:

1. Read the following information:

   - "Replacing multiple EV-DDMs" on page 81, 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 EV-DDMs

     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. 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 20.

4. Unpack the new EV-DDMs.

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

5. Use the DS4000 Storage Manager software to ensure that the array that was defined using these EV-DDMs is in optimal (not degraded) state before manually failing the first EV-DDM 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 of the following:

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

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

   If you remove an active EV-DDM accidentally, wait at least 30 seconds and then reinstall it. Because you failed two EV-DDMs in a RAID array, the array might be marked failed by the controller. This array will not be available to the host for I/O. See the DS4000 Storage Manager software for further recovery instructions. Do not attempt to replace any EV-DDMs until the array is brought back to optimal state.

6. Use the procedures in "Replacing hot-swap EV-DDMs" on page 80 to remove the failed EV-DDM. Use the procedures in "Installing hot-swap EV-DDMs" on page 78 to install the new EV-DDMs into the EXP420.

   The new EV-DDM 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 EV-DDM until the data is reconstructed on the hot spare. This increases the time that is required to complete the procedure.

7. Check the green Drive activity LED and the amber Drive fault LED above the new EV-DDM 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 EV-DDMs spin up.

- If the Drive activity LED is off, the EV-DDM CRU might not be installed correctly. Remove the EV-DDM CRU, wait 30 seconds, and then reinstall it.
- If the Drive fault LED stays on or the Drive activity LED stays off, the new EV-DDM might be faulty. See the DS4000 Storage Manager software for problem determination.

8. Use the DS4000 Storage Manager software to monitor the status of the new EV-DDM 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 EV-DDM. In that case, use the host software to determine if the data reconstruction is finished.

9. When reconstruction is finished on the new EV-DDM, repeat step 5 on page 85 through step 8 for each additional EV-DDM that you want to install.

10. Use the DS4000 Storage Manager software to configure the additional space on the new EV-DDMs.

Verifying the Link Rate setting

If a link rate problem is indicated, use the following procedure to verify the Link Rate setting.

A Link Rate switch is located on the front of the storage expansion enclosure as shown in Figure 46 on page 88. The Link Rate indicator LEDs are located on the back of the storage expansion enclosure. The Link Rate switch enables you to select the data transfer rate between the ESMs and the drives to either 2 Gbps or 4 Gbps. The Link Rate switch is only read when the storage expansion enclosure is powered up.

Notes:

1. Do not mix storage expansion enclosures with different Link Rate speed settings in the same drive loop.

2. The EXP420 storage expansion enclosure drive channel operates at either 2 or 4 Gbps fibre channel interface speed. The EXP420 SATA EV-DDM CRUs have an ATA translator card that converts EV-DDM 3 Gbps SATA drive interface protocol to either 2 Gbps or 4 Gbps fibre channel interface protocol. It is recommended that the EXP420 enclosure speed is set to 4 Gbps when these SATA EV-DDM CRUs are installed and connected to storage expansion enclosures running at 4 Gbps speed. The Link Rate setting speed must be set accordingly. See Table 25 on page 87 for more information. The enclosure speed of the DS4200 Express Storage Subsystem that the EXP420s are connected to must also be set to 4 Gbps.

Do not mix 2 GB drives and 4 GB drives in the same storage expansion enclosure. If drives of mixed speeds reside in the storage expansion enclosure, the data transfer rate changes depending on the configuration. Table 25 shows the data transfer rates for drives of different configurations.

Attention: Do not change the Link Rate setting while the storage subsystem is running. Changing the Link Rate setting while the storage subsystem is running could cause drives to fail. You must power down the storage subsystem and storage expansion enclosures before changing the Link Rate setting.

Table 25. Data transfer rates for drive modules

Link Rate Switch Setting	Storage Expansion Enclosures with 2 GB Drives	Storage Expansion Enclosures with 4 GB Drives	Storage Expansion Enclosures with Mixed Drives
2 Gbps	Drives function in 2 Gbps mode.	Drives work in 2 Gbps mode.	All drives work in 2 Gbps mode.
4 Gbps	Drives do not come online.	Drives work in 4 Gbps mode.	2 GB drives do not come online. 4 GB drives work in 4 Gbps mode.

Use the following procedure to check the current setting of the data transfer rate and change it, if necessary.

Attention: All devices on the loop must have the same data transfer rate, which means that you must set the link rate on the storage expansion enclosure to the same rate as the storage subsystem to which it is connected. Information about supported DS4000 storage subsystems can be obtained from the certified Compatibility Matrix, which can be found at the following Internet location:

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

1. Complete the power-off sequence described in "Turning off the EXP420 " on page 65 ensuring that the DS4000 storage subsystem is turned off before any attached storage expansion enclosures.
2. Locate the Link Rate indicator LEDs. Figure 45 on page 88 shows the location of the Link Rate indicator lights on the back of the storage expansion enclosure.
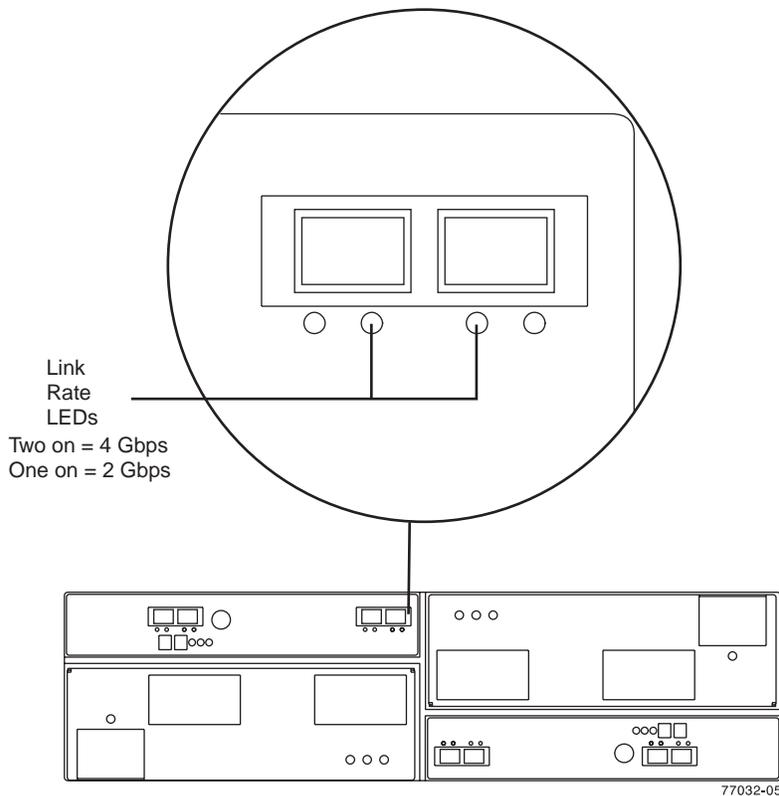
Figure 45. Link rate LEDs

If both Link Rate indicator LEDs are on, the data transfer rate is set for 4 Gbps. If one Link Rate indicator light is on, the data transfer rate is set for 2 Gbps.

3. Is the data transfer rate set correctly?
   - **Yes** - Go to step 8 on page 89.
   - **No** - Go to step 5 to change the setting.

   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 20.

4. Locate the Link Rate switch. Figure 45 shows the location of the Link Rate indicator light on the front of the command module.
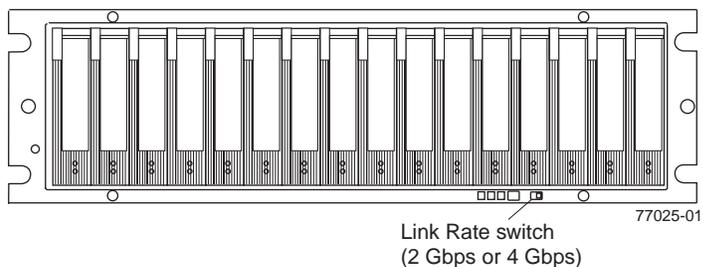
Figure 46. Link rate switch

5. Change the Link Rate switch setting by performing the following steps:
   a. Put on antistatic protection.

b. Use a small screwdriver or the tip of a ball point pen to slide the Link Rate switch to the left or right to set the desired fibre channel operating speed.

   Attention: Although the Link Rate LED indicates the correct speed setting, the link rate speed does not change until after you cycle power to the storage expansion enclosure.

6. Repeat step 1 on page 87 through step 5 on page 88 for all of the EXP420 enclosures in the DS4000 configuration.

7. Perform the power-on sequence as described in "Turning on the EXP420 " on page 55.

8. Check the indicator lights on the front and back of all of the storage subsystem and expansion drive modules. All the green indicator LEDs should be on, and the amber indicator LEDs should be off. (No LEDs are displayed on blank drives.)

9. Are **only** the green indicator LEDs on?
   - **Yes** - The drive is working correctly.
   - **No** - If an amber Fault indicator LED is on, go to 10.

10. Diagnose and correct the fault by performing the following steps:
    a. To run the Recovery Guru, select the Recovery Guru toolbar button in the Subsystem Management Window.
    b. Complete the recovery procedure.
    c. When the procedure is completed, rerun the Recovery Guru to ensure that the problem has been corrected by selecting **Recheck** in the Recovery Guru.

11. If the problem persists, contact IBM Customer and Technical Support.

Replacing a power supply and fan unit

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.

CAUTION:
Disconnect the power cord before replacing the power supply and fan unit.

The power supply and fan unit is a component that includes both a 600-W power supply unit and two fans. The power supply and fan units provide power and cooling for the EXP420. The power supply and fan units are customer replaceable

units (CRUs) and do not require preventive maintenance. Use only the supported power supply and fan units for your specific storage subsystem.

Each power supply and fan unit has a built-in sensor that detects the following conditions:
- Over-voltage
- Over-current
- Overheated power supply

If any of these conditions occurs, one or both power supplies will shut down. If the power remains off after the condition that causes it to go off, make sure that the environment is optimal (no overheating has occurred, all electrical outlets are working, and so on). For more information, see "Restoring power after an unexpected shutdown" on page 68.

The storage subsystem cooling system consists of two fans in each of the two power supply and fan unit CRUs. The power supply and fan units circulate air from the front to the back of the unit.

If both power supply and fan units fail, or if the power supply and fan units cannot maintain an internal temperature below 70° C (158° F), the power supply and fan units in the unit will automatically shut down (an over-temperature condition). If this occurs, you must cool the unit and restart it. See "Restoring power after an unexpected shutdown" on page 68.

Attention: The fans in the power supply and fan units draw in fresh air and force out hot air. The power supply and fan units are hot-swappable and redundant; however, if the fans in one power supply and fan unit fail, you must replace the entire failed power supply and fan unit within 72 hours to maintain redundancy and optimum cooling. Do not remove the failed power-supply fan unit until you have the replacement power supply and fan unit. When you do remove the failed power supply and fan unit, be sure to install the second power supply and fan unit within 10 minutes to prevent any overheating due to the interruption to the air flow that cools the storage expansion enclosure.

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

Use the following procedure to replace a power supply and fan unit. Figure 47 on page 93 illustrates removing and inserting a unit.

Attention: **Potential damage to a component -** To prevent damage from overheating, replace a failed power supply and fan unit CRU within 15 minutes of removal. If replacing it will take longer than 15 minutes, stop all I/O activity to the storage expansion enclosure and turn off the power until you complete the replacement.

Statement 8:

CAUTION:
Never remove the cover on a power supply and fan unit 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. If needed, use the DS4000 Storage Manager client software to print a storage system profile.

2. Did the Recovery Guru direct you to replace a failed power supply and fan unit?

   • **Yes** - Go to step 3.
   • **No** - Run the Recovery Guru to identify the failed component, and then go to step 3.

3. Put on antistatic protection.

4. Unpack the new power supply and fan unit. Save all packing material in case you need to return the failed power supply and fan unit CRU.

   Note: The new power supply and fan unit CRU comes with an instruction sheet and label sheet. The instruction sheet provides instructions on placing the appropriate labels on the power supply and fan unit CRU to mark the LEDs correctly. The label sheet contains the peel-off labels that you actually place on the power supply and fan unit CRU.

5. Using the information provided on the instruction sheet, place the labels on the power supply and fan unit CRU to correctly mark the LEDs.

6. Turn off the power switch on the new unit.

7. Check the Fault LED to locate the failed power supply and fan unit. If a fault is detected, the amber Fault LED is on.

8. Verify that the Service Action Allowed LED is on. Do not remove the power supply and fan unit if the LED is off. For more information on the Service Action Allowed LED, see "Service Action Allowed Status LED" on page 73.

   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.	

9. Turn off the power switch, and unplug the power cord from the failed power supply and fan unit.

10. Squeeze the latch and pull the lever open 90° (so that the lever is horizontal) to release the power supply and fan unit from the latch. The latch is a coral colored tab on the lever.

11. Slowly pull the lever away from the chassis to remove the power supply and fan unit, as shown in Figure 47 on page 93.

    Note: The lever rotates upward or downward 90°, depending on whether the power supply and fan unit you are removing is in the right or left power supply and fan unit bay.

12. Slide the new unit into the empty slot. As you slide the power supply and fan unit into the empty slot, make sure the guide pins on the side of the power supply and fan unit fit into the notches. After the guide pins fit into the notches and power supply and fan unit fits snugly into the slot, push the lever downward or upward 90° to fully latch the power supply and fan unit into place, depending on whether you are inserting the power supply and fan unit into the right or left power supply and fan unit bay. Then gently push the front of the power supply and fan unit to ensure that it is fully seated.

Attention: The left and right power supply and fan units are seated in the EXP420 chassis in opposite orientations. If you cannot fully insert the power supply and fan unit into the power supply and fan unit bay, flip it 180° and reinsert it. Make sure that the levers lock into place in the storage expansion enclosure chassis.

13. Plug in the power cord and turn on the power.
14. Check the Power and Fault LEDs on the new unit.
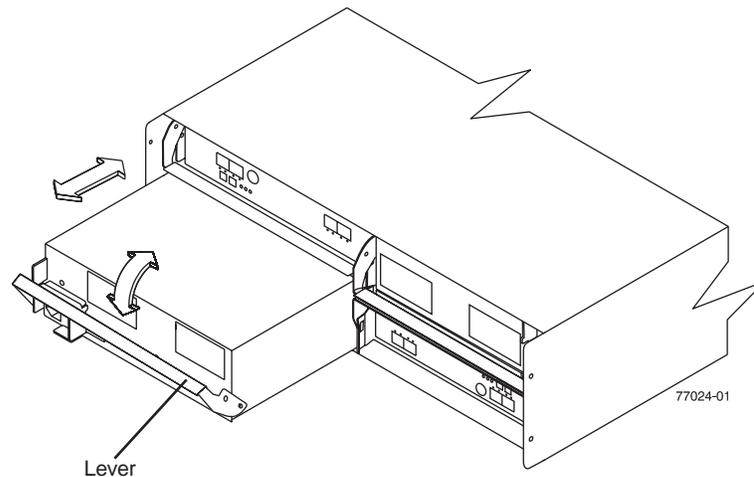
Figure 47. Replacing a power supply and fan unit

15. Based on the status of the Power and Fault LEDs, choose one of the following steps:
    - **Fault LED is on and AC and DC power LED are off** - The new unit might be installed incorrectly. The power supply and fan unit switch may not be turned on. The power cord plug may not be fully inserted into the power outlet or the power supply and fan unit AC socket. There is not any power to the outlet that the power supply and fan unit is connected to. The power cord may be faulty. Go to step 16.
    - **Fault and AC power LED is on but the DC power LED is off** - The power supply and fan unit is faulty. Turn the power supply and fan unit power switch to off and contact IBM Customer and Technical Support for another power supply and fan unit.
    - **AC and DC Power LED is on and Fault LED is off** - Go to step 17.
16. Perform the following task or task(s) to resolve the problem:
    - Ensure that the power switch is turned to the on position.
    - Ensure that there is power at the AC outlet and no circuit breaker has tripped.
    - Ensure that the power cord is working and fully seated into the electrical outlet and the power supply and fan unit AC socket.
    - Reinstall the power supply and fan unit.

      If the above tasks do not resolve the problem, contact IBM Customer and Technical Support.
17. Complete any remaining Recovery Guru procedures, if needed.
18. Check the status of each storage expansion enclosure in the storage subsystem.
19. Do any components have a Needs Attention LED?

- **Yes** - Select the Recovery Guru toolbar button in the Subsystem Management Window and complete the recovery procedure. If a problem is still indicated, contact IBM Customer and Technical Support.
- **No** - Go to step 20.
20. Create, save, and print a new storage subsystem profile.

Replacing an Environmental Service Module (ESM)

This section describes the removal and replacement procedure for a failed hot-swap ESM. Always verify the FRU part number of the replacement ESM to verify that it is compatible with the existing ESM in the EXP420 chassis. Inserting non-compatible ESM FRU may cause lost of data availability.

The EXP420 storage expansion enclosures support the ESM auto code synchronization functionality. When a new ESM is installed into an existing storage expansion enclosure in a DS4000 storage subsystem that supports ESM auto code synchronization, firmware is automatically synchronized in the new ESM with the firmware in the existing ESM. This function requires that the DS4000 storage subsystem be defined in the Enterprise Management window of the DS4000 Storage Manager client program installed in a management station. Additionally, the DS4000 Storage Manager client program must be opened and running, or the IBM DS4000 Storage Manager 9 Event Monitor service must be running when the new ESM is inserted.

Refer to the *DS4000 Storage Manager 9.1 Installation and Support Guide* for your operating system for more information on how to start this service. Do not perform to the following steps until you have installed the DS4000 Storage Manager client program, defined the affected DS4000 storage subsystem in the Enterprise Management window, and either have the DS4000 Storage Manager client program running or the Event Monitor service started.

Attention:
- After you remove an ESM, wait at least 70 seconds before reseating or replacing the ESM so that the DS4000 storage subsystem controller properly recognizes that an ESM is removed from the configuration. Failure to do so may cause undesired events.
- **The EXP420 ESM FRU is not the same as the EXP810 ESM FRU. The EXP810 ESM will be locked down when inserted in the EXP420 chassis. Verify that the ESM FRU PN is correct before replacing an ESM.**

Complete the following steps to remove a failed ESM:
1. Start the DS4000 Storage Manager client program. In the Enterprise Management window, open the Subsystem Management window for the DS4000 storage subsystem that includes the EXP420 enclosure that requires the ESM replacement.
2. Check the DS4000 Storage Manager 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 **Storage Subsystem** → **View** → **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 configuration. If you do, and the logical drives fail, you will lose data.

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

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

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

6. 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.

7. Squeeze the ESM latch. The ESM latch is a coral colored tab on the lever.

8. While squeezing the latch, pull the lever open 90° (so that the lever is horizontal). Pull the lever away from the chassis to remove the ESM from the EXP420 midplane, as shown in Figure 48.

   Note: The lever rotates upward or downward 90°, depending on whether the ESM you are removing is in the right or left ESM bay.
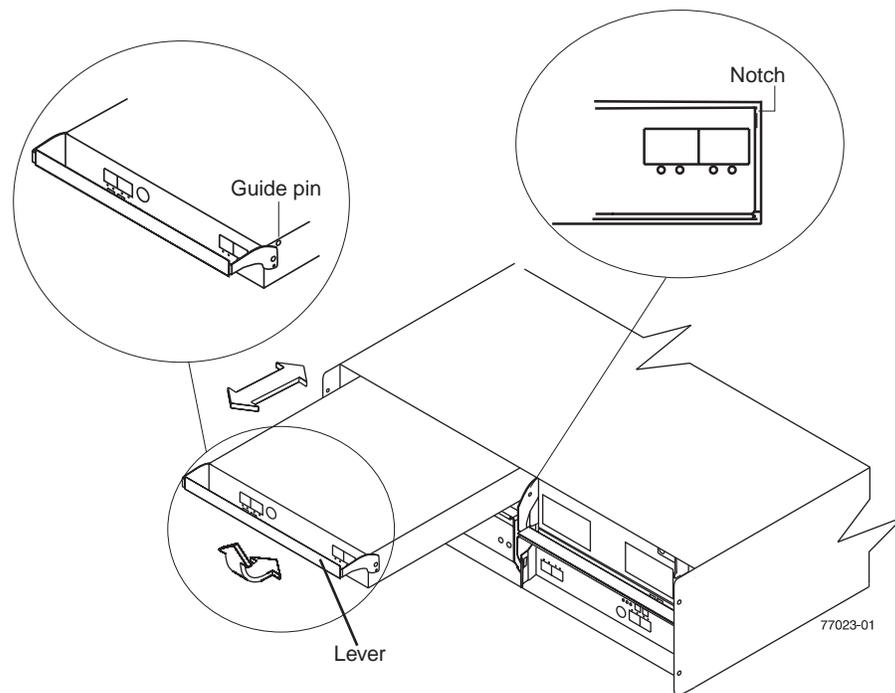

Figure 48. Removing and replacing an Environmental Service Module (ESM)

9. Unpack the new ESM CRU. Save all packing material in case you need to return the failed ESM CRU.

   Note: The new ESM CRU comes with an instruction sheet and label sheet. The instruction sheet provides instructions on placing the appropriate

labels on the ESM CRU to correctly mark the LEDs and SFP ports. The label sheet contains the peel-off labels that you actually place on the ESM CRU.

10. Using the information provided on the instruction sheet, place the labels on the ESM CRU to correctly mark the LEDs and SFP ports.

11. 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 storage expansion enclosure. As you slide the ESM into the empty slot, make sure the guide pins on the side of the ESM fit into the notches on the sides of the ESM bay. After the guide pins fit into the notches and ESM fits snugly into the bay, push the lever upward or downward 90° to fully latch the ESM into place, depending on whether you are inserting the ESM into the right or left ESM bay.

    Attention: The left and right ESMs are seated in the EXP420 chassis in opposite orientations. If you cannot fully insert the ESM into the ESM bay, flip it 180° and reinsert it. Make sure that the levers lock into place in the storage expansion enclosure chassis.

12. Reinsert the SFP modules and reconnect the fibre-channel cables to their original locations.

13. Check the Power and Fault LEDs on the new ESM for the following:
    • 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 or call IBM Support.

14. 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.

15. Use the DS4000 Storage Manager 9 Client to open a Subsystem Management window to the DS4000 on which the EXP420 ESM was replaced. Click on the **Recovery Guru** or the **Environment Status** icon of the drive expansion enclosure on which you replaced the ESM.

    If there is an ESM firmware mismatch, wait up to 15 minutes for the DS4000 Client program to perform ESM code synchronization.

    Note: The ESM firmware download will take up to 5 minutes in typical workload condition.
    If there is no ESM firmware mismatch, the upgrade process is complete.

16. If there is an ESM firmware mismatch, you must make corrections to match the ESM firmware by using the ESM firmware download function in the DS4000 Storage Manager Client Subsystem Management window.

Replacing an SFP module

The speed of the SFP module determines the maximum operating speed of the fibre channel port in which the SFP is installed. For example, a 2-Gbps SFP that is plugged into a 4-Gbps-capable port will limit the speed of that port to a maximum of 2 Gbps.

Attention: Refer to the FRU option P/N on the SFP to identify the maximum operating speed of the SFP and to request the correct FRU replacement.

Use the following procedure to replace a Small Form-factor Pluggable (SFP) module on the storage expansion enclosure. The SFP module shown in this procedure might look different from those you are using, but the difference will not affect functionality. Figure 49 on page 97 illustrates installing an SFP module.

Electrostatic discharge can damage sensitive components. To prevent electrostatic discharge damage to the storage expansion enclosure, use proper antistatic protection when handling components.

1. Use the DS4000 Storage Manager client software to print a new storage subsystem profile.

2. Using the Recovery Guru, identify the failed component that needs to be replaced.

3. Check the Fault LEDs to locate the failed SFP module. If a fault is detected, the amber Fault LED is on.

   Attention: Potential loss of data access - To prevent loss of access to data, remove only the SFP module that has a failed status in the storage management software and has Port Bypass LED lit.

4. Put on antistatic protection.

5. Unpack the new SFP module. Verify that it is the same type of module you are replacing. If it is not, contact IBM Customer and Technical Support.

   Attention:

   • The speed of the SFP module determines the maximum operating speed of the fibre channel port in which the SFP is installed. For example, a 2-Gbps SFP that is plugged into a 4-Gbps-capable port will limit the speed of that port to a maximum of 2 Gbps.

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

6. Disconnect the interface cables from the SFP module.

7. Remove the failed SFP module from the controller.

8. Install the new SFP module into the controller.
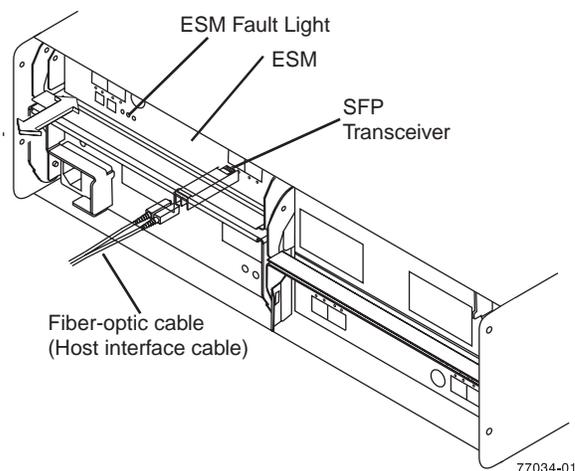
9. Reconnect the interface cable.

Figure 49. Replacing an SFP module

10. Check the Bypass and Fault LEDs for the new SFP module.

11. Based on the status of the Bypass and Fault LEDs, choose one of the following steps:

- **Bypass LED** *or* **Fault LED is on** - Reinstall the SFP module and cables, and verify that the SFP module and cables are securely connected. Use the fibre channel loopback and the LC-LC connector to perform path diagnostics to ensure that the FC cable is good and the SFP on the other end of the fibre channel connection is working properly. When finished, go to step 12.
- **Bypass LED and Fault LED are off** - Go to step 12.

12. Is the problem corrected?
    - **Yes** - Go to step 13.
    - **No -** Contact IBM Support.
13. Complete any remaining Recovery Guru procedures, if needed.
14. Use the DS4000 Storage Manager Subsystem Management Window to check the status the status of all components in the storage subsystem.
15. Remove the antistatic protection.
16. Does any component have a Needs Attention status?
    - **Yes** - Select the Recovery Guru toolbar button in the Subsystem Management Window, and complete the recovery procedure. If the problem persists, contact IBM Support.
    - **No** - Go to step 17.
17. Use the DS4000 Storage Manager client software to print a new storage subsystem profile.

Replacing a midplane

Perform the following steps to replace a midplane:
1. Complete the power-off sequence described in "Turning off the EXP420 " on page 65 ensuring that the DS4000 storage subsystem is turned off before any attached storage expansion enclosures.
2. Power off the EXP420 storage expansion enclosure that will have its midplane replaced.
3. Remove the power cords from the power supply and fan units of the EXP420 storage expansion enclosure.
4. Label the fibre channel cables that are attached to the rear of the ESMs. Labeling the cables simplifies the re-cabling process.
5. Remove the fibre channel cables that are attached to the rear of the ESMs.
6. Remove both ESMs. To remove them perform the following steps:
   a. Squeeze the ESM latch and pull the lever open 90° (so that the lever is horizontal) to release the ESM from the latch. The ESM latch is a coral colored tab on the lever.

      Note: The lever rotates upward or downward 90°, depending on whether the ESM you are removing is the right or left ESM CRU.
   b. Slowly pull the lever away from the EXP420 chassis to remove the ESM from the ESM bay, as shown in Figure 14 on page 28. (You do not have to actually remove them from the ESM bays.)
   c. Repeat steps 6a and 6b for the other ESM.
7. Remove both power supply and fan units. To remove them perform the following steps:

a. Squeeze the latch and pull the lever open 90° (so that the lever is horizontal) to release the power supply and fan unit from the latch. The latch is a coral colored tab on the lever.

b. Slowly pull the lever away from the chassis to remove the power supply and fan unit, as shown in Figure 15 on page 29. (You do not have to actually remove them from the power supply and fan unit bays.)

   Note: The lever rotates upward or downward 90°, depending on whether the power supply and fan unit you are removing is in the right or left power supply and fan unit bay.

c. Repeat steps 7a and 7b for the other power supply and fan unit.

8. Label the EV-DDM CRUs so you know their physical location in the midplane.

9. Remove the EV-DDM CRUs. See "Removing an EV-DDM" on page 29 for instructions.

   Attention: Do not stack EV-DDM CRUs on top of each other. Protect the EV-DDM CRUs from vibrations or sudden shocks.

10. Use a #1 Phillips screwdriver to loosen the four front cage frame screws on the midplane, as shown in Figure 50.
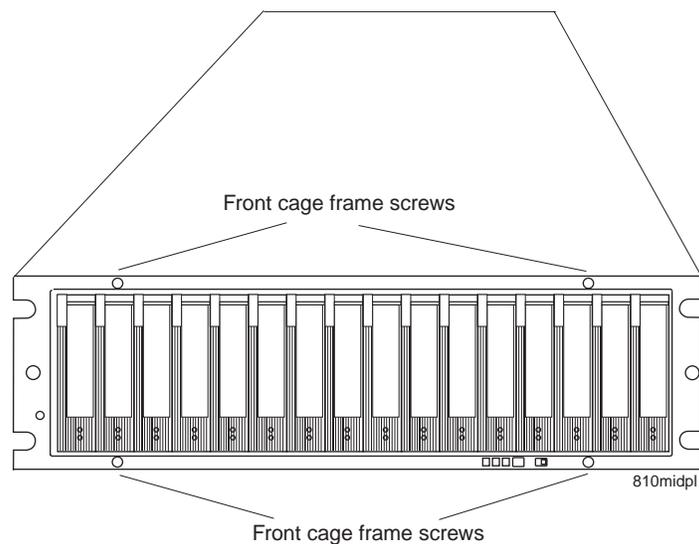
Figure 50. Replacing a midplane

11. Grab the blue handle in the center of the front cage frame and pull it outward to slide the front cage frame out approximately two inches. Grab the two sides of the front cage frame and remove it from the chassis.

12. Unpack the new front cage frame with the midplane. Save the packaging materials in case you need to return it.

13. Insert the new midplane by aligning it with the EXP420 front opening and slowly sliding it into the EXP420 chassis. Make sure that the front cage frame EMC gaskets do not snag between the frame and chassis.

14. Tighten the four front cage frame screws.

15. Insert the EV-DDM CRUs. Be sure you insert them in the correct slots. Use the labels you put on them before you removed them to guide you.

16. Re-insert the ESMs and reconnect the fibre channel cables.

17. Re-insert the power supply and fan units and reconnect the power supply cords.

18. Power on the EXP420.
19. Wait at least 3 minutes and then power on the DS4000 storage subsystem.
    Verify the status of the configuration using LEDs and the DS4000 Storage
    Manager client program.

Chapter 6. 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.

For instructions on how to obtain service and technical assistance for your storage subsystem and other IBM products, see "Getting information, help, and service" on page xxi.

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 storage expansion enclosure. Table 26 on page 102 contains the problem symptoms and error messages, along with suggested actions to take to resolve problems.

Always use the DS4000 Storage Manager client to diagnose storage subsystem problems and component failures and find solutions to problems that have definite symptoms.

You can use Table 26 on page 102, which contains the problem symptoms and error messages, along with suggested actions as a guide for troubleshooting problems in addition to the DS4000 Storage Manager Recovery Guru in the Subsystem Management window. Do not depend solely Table 26 on page 102 for a FRU replacement decision.

See the problem determination maps in the *DS4000 Problem Determination Guide* for more detailed procedures for problem isolation.

Table 26. Symptom-to-FRU index

Problem indicator	Component	Possible cause	Possible solutions
Amber LED is lit	Drive CRU (Drive Fault LED)	Drive failure	Replace the failed drive. **Note:** The amber LED on the drive might also be lit if the drive slot has a blank drive tray inserted in certain ESM firmware versions.
	Drive CRUs	Drive not certified	Verify that the drive option or FRU/CRU P/N is listed in the support list for the appropriate DS4000 storage subsystems.
	ESM (Fault LED)	ESM failure	Replace the ESM. See your controller documentation for more information. See Chapter 5, "Installing and replacing devices," on page 73 for more information.
	ESM (Port Bypass LED)	No incoming signal detected	Reconnect the SFP modules and the fibre-channel cables. Verify the input and output SFP using the path failure determination instruction in the *DS4000 Problem Determination Guide* and the FC loopback and female-female LC connector. Replace either input or output SFP modules or fibre channel cables as necessary.
		Incorrect enclosure speed setting	When connecting the EXP420 to the existing operating redundant drive loop with a different speed setting, the port goes into bypass mode because mixing different speed enclosures within the same redundant drive loop/channel is not supported.
		ESM failure	If the ESM Fault and Service Action LEDs are lit, replace the ESM.
	Front panel (Global Summary Fault LED)	General machine fault	A Fault LED is lit somewhere on the storage 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 storage expansion enclosure. Replace the failed SFP module. See the DS4000 Storage Manager software documentation for more information.

Table 26. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
Amber LED is lit and green LED is off	Power supply CRU	Power supply failure or power switch is turned off or there is an AC power failure.	Replace the failed power supply, turn on all power supply switches, or check the main or the rack power unit circuit breaker.
Amber and green LEDs are lit	Power supply CRU (Fault and Power LEDs lit; Direct Current Enabled LED is not lit)	Power supply failure	Replace the failed power supply.
	Drive CRUs	Drive not certified	Verify that the drive option or FRU/CRU P/N is listed in the support list for the appropriate DS4000 storage subsystems. **Note:** In certain cases, only the amber LED is lit, and the green activity LED is not lit. Use the Recovery Guru to better identify the cause of the drive failure.
All green LEDs are off	All CRUs	Subsystem power is off	Check that all storage 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.

Table 26. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
Amber LED is flashing	Drive CRUs (Fault LED lit)	Drive identity is in process	No corrective action needed.
	ESM port bypass	A fibre channel 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.
	ESM SFP port bypass LED	The enclosure speed was set to 4 Gbps but the SFP inserted in the ESM SFP port does not operate at 4 Gbps.	Use the Recovery Guru menu function in the Storage Manager Client Subsystem Management window to verify the problem and replace the SFP with a 4 Gbps SFP.
		SFPs are inserted into unused ESM ports labeled 2A and 2B.	Verify the port connections in the back of the EXP420 and make corrections (using port 1A and 1B) if required.
	Front panel (Global Summary Fault LED)	One or multiple CRUs has intermittent problems.	Use the Recovery Guru menu function in the Storage Manager Client Subsystem Management window and the DS4000 storage subsystem Major Event Log to troubleshoot the problem.

Table 26. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
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	The EXP420 is connected to an unsupported DS4000 storage subsystem such as a DS4700 instead of a DS4200 Express.	Verify that the EXP420 is connected to a DS4200 Express. Use the steps "Finding controller, storage expansion enclosure, and drive information" on page 58 to identify which storage subsystem is connected. Replace the incorrect storage subsystem (such as a DS4700) with a correct one (DS4200 Express).
		The enclosure speed is not the same as other storage expansion enclosures and DS4000 storage subsystem in the same redundant drive channel pair.	Verify that all of the storage expansion enclosures and DS4000 storage subsystem enclosure speeds are the same. Use the procedure in "Verifying the Link Rate setting " on page 86 to correct the problem.
		Incorrect SFPs are used such as a 2 Gbps SFP used when the EXP420 enclosure speed is set to 4 Gbps.	Verify and replace the SFPs with the correct speed SFPs.
		The EXP420 is not cabled or incorrectly cabled to other storage expansion enclosures or DS4000 storage subsystem. For example, ESM ports labeled 2A and 2B were used instead of ports labeled 1A and 1B.	Verify and correct the incorrect cabling if required.
		Drive CRUs are not fully inserted in the drive slots.	Verify that the drives are seated correctly in the drive slots. Remove and reinsert the drive CRUs if required.
		Midplane failure	Replace the midplane. Contact an IBM technical support representative.

Table 26. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
One or more green LEDs are off (continued)	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 EXP420 and the storage subsystem failed.	Perform one of the following actions: • Power on the storage subsystem. • Verify that the fibre-channel connections between the EXP420 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.
Green LED slowly flashing one per 2 seconds	Drive CRUs	The DS4000 was not powered on, or all fibre-channel connections between the EXP420 and the DS4000 storage subsystem failed.	Perform one of the following actions: • Power on the storage subsystem. • Verify that the fibre-channel connections between the EXP420 and the storage subsystem are made. • Ensure that all the EXP810s in the same redundant drive loop/channel pair have the same enclosure speed setting.
Intermittent or sporadic power loss to the storage 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.

Table 26. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
Unable to access drives	Drives and fibre-channel loop	Incorrect storage expansion enclosure ID settings	Ensure that the fibre-channel optical cables are undamaged and properly connected. Check the storage expansion enclosure ID settings. **Note:** Change the switch position only when your storage 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.
		Drive is not certified	Check the DS4000 product Web site for the correct drive option P/N or FRU P/N certified for your DS4000 storage subsystem.
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.
		Incorrect firmware version	Verify that the DS4000 storage subsystem has the correct firmware version. Refer to "Software and firmware support code upgrades" on page 9.

Parts listing

Figure 51 on page 108 and the following table provide a parts listing for the EXP420.
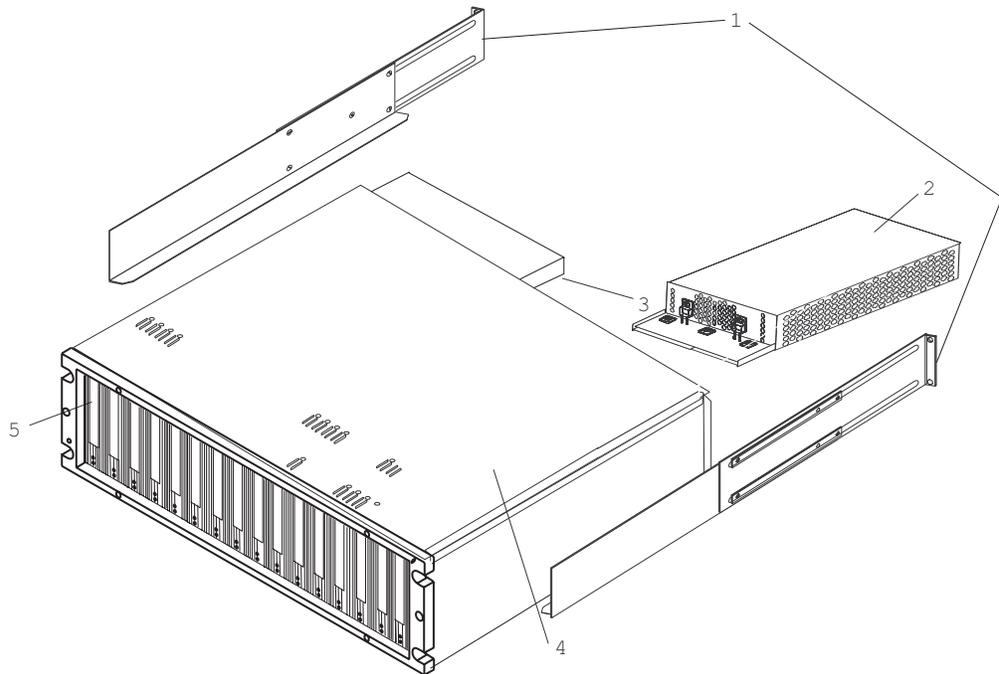
Figure 51. EXP420 storage expansion enclosure parts list

Table 27. Parts listing (EXP420 storage expansion enclosure)

Index	EXP420 storage expansion enclosure	FRU P/N
1	Rail kit	41Y5152
2	Power supply FRU, 600 W	41Y5155
3	ESM	41Y0725
4	Frame, Midplane	41Y0724
5	SATA 500 GB drive with Cuiser interposer	42D0392
	Blank drive module	42D0374
	Cable, FRU-1M	39M5699
	Cable, FRU-5M	39M5700
	Cable, FRU-25M	39M5701
	FRU, SFP LC (shortwave) 4 Gbps	22R6443
	Power cord, 2.8M	39M5081
	Power cord, jumper	39M5377

Appendix A. Records

Whenever you add options to your EXP420, 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 System Storage DS4000 EXP420 Storage Expansion Enclosure
Machine type:	1812
Model number:	8VA, 8VH
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 EXP420.

Storage subsystem and controller information record

Table 28 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 29 on page 111.

Table 28. 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 29 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 29. 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 30. Hard disk drive record

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

Appendix B. Rack mounting template

This appendix provides duplicate copies of the rack mounting templates. If you want to tear out the templates from this document for easier use, use these copies rather than those provided in "Installing the support rails" on page 23.

Use the following templates (Figure 52 on page 114 and Figure 53 on page 115) to identify the proper locations for inserting M5 screws when mounting the support rails and EXP420 to a rack. The locations for the M5 screws are highlighted in the templates.

The EXP420 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.

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

EXP420
FRONT
Install second ---> ◄ [ ] Bezel   Rack Mounting Bezel   [ ] ►
                         (Front Left)   Template   (Front Right)

Install first ---> [ ]   [ ] <--- Install first
2 U - - - - - - - - - -   - - - - - - - - - - - 2 U

[ ]   [ ]

[○]   [○]

Install first ---> [ ]   [ ] <--- Install first
1 U - - - - - - - -   - - - - - - - - - 1 U

[ ]   [ ]

Install second ---> [ ] Rail assembly   Rail assembly [ ]
                          (Front Left)   (Front Right)

[ ]   [ ]
0 U - - - - - - - - - - -   - - - - - - - - - - - 0 U

exp42006
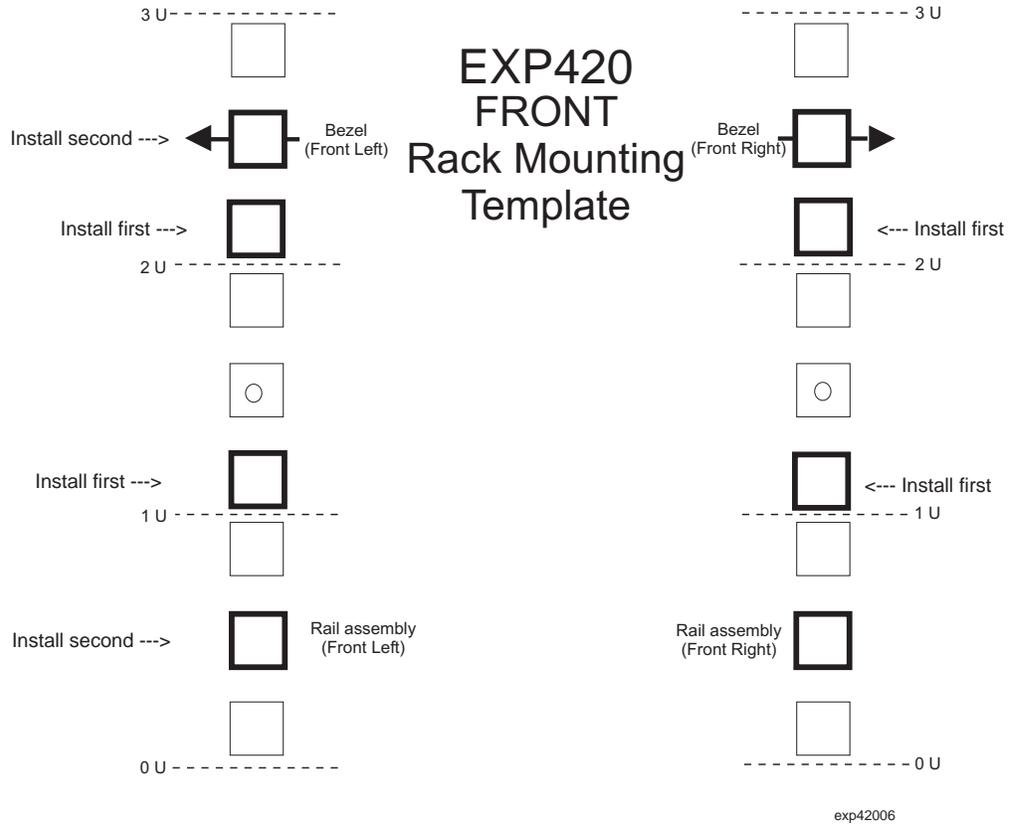
Figure 52. Front rack mounting template

EXP420
REAR
Rack Mounting
Template

3U

2U

1U

0U

3U

2U

1U

0U

Rail mounting guide

Rail assembly
(Rear Left)

Rail assembly
(Rear right)

IBM®

Printed in the U.S.A

exp42007
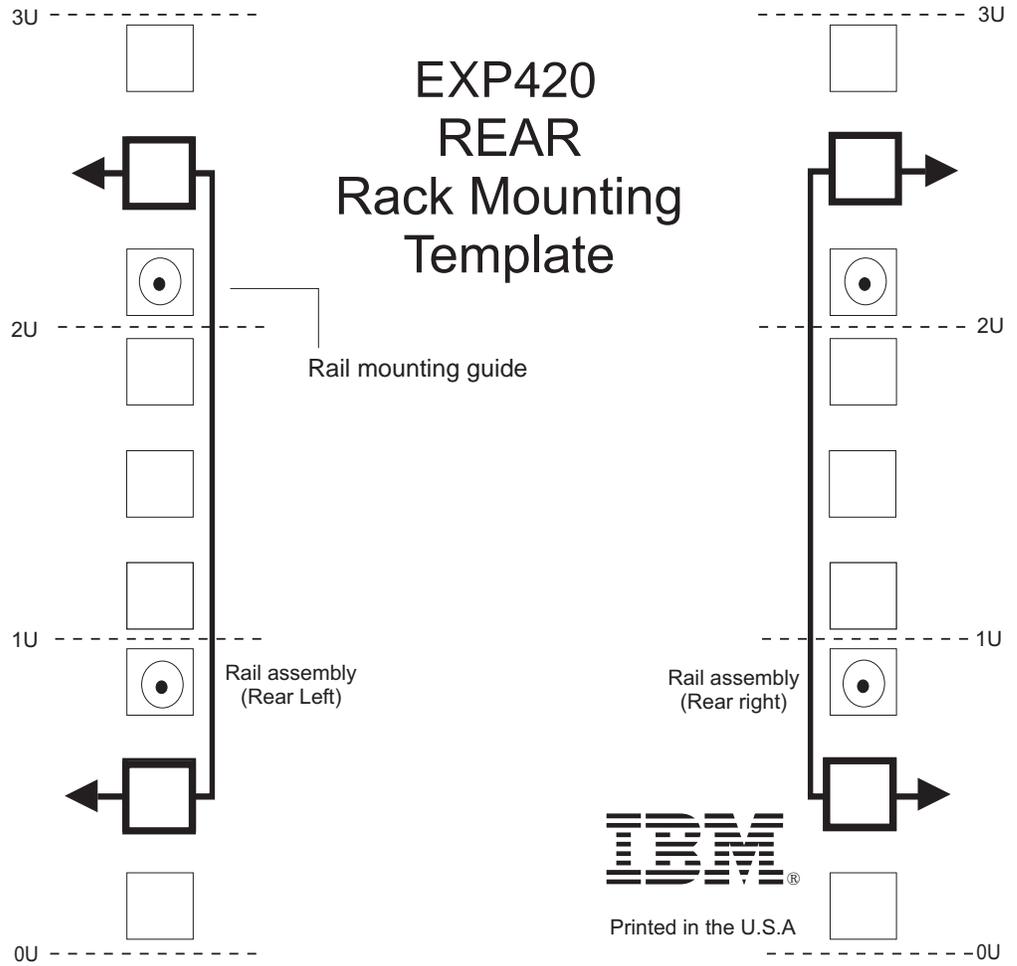
Figure 53. Rear rack mounting template

Appendix C. Power cords

For your safety, IBM provides a power cord with a grounded attachment plug to use with this IBM product. To avoid electrical shock, always use the power cord and plug with a properly grounded outlet.

IBM power cords used in the United States and Canada are listed by Underwriter's Laboratories (UL) and certified by the Canadian Standards Association (CSA).

For units intended to be operated at 115 volts: Use a UL-listed and CSA-certified cord set consisting of a minimum 18 AWG, Type SVT or SJT, three-conductor cord, a maximum of 15 feet in length and a parallel blade, grounding-type attachment plug rated 15 amperes, 125 volts.

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

For units intended to be operated at 230 volts (outside the U.S.): Use a cord set with a grounding-type attachment plug. The cord set should have the appropriate safety approvals for the country in which the equipment will be installed.

IBM power cords for a specific country or region are usually available only in that country or region.

Table 31. IBM power cords

IBM power cord part number	Feature code	Description	Used in these countries or regions
39Y7931	9800	Power Cord (125v, 10A, 4.3m)	Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Cayman Islands, Costa Rica, Columbia, Cuba, Dominican Republic, Ecuador, El Salvador, Guam, Guatemala, Haiti, Honduras, Jamaica, Mexico, Micronesia (Federal States of), Netherlands Antilles, Nicaragua, Panama, Peru, Philippines, Saudi Arabia, Thailand, Turks and Caicos Islands, United States, Venezuela

Table 31. IBM power cords (continued)

IBM power cord part number	Feature code	Description	Used in these countries or regions
39Y7917	9820	Power Cord (250v, 10A, 2.8m)	Afghanistan, Albania, Algeria, Andorra, Angola, Armenia, Austria, Azerbaijan, Belarus, Belgium, Benin, Bosnia and Herzegovina, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Democratic Republic of), Congo (Republic of), Cote D'Ivoire (Ivory Coast), Croatia (Republic of), Czech Rep, Dahomey, Djibouti, Egypt, Equatorial Guinea, Eritrea, Estonia, Ethiopia, Finland, France, French Guyana, French Polynesia, Gabon, Georgia, Germany, Greece, Guadeloupe, Guinea, Guinea Bissau, Hungary, Iceland, Indonesia, Iran, Kazakhstan, Kyrgyzstan, Laos (Peoples Democratic Republic of), Latvia, Lebanon, Lithuania, Luxembourg, Macedonia (former Yugoslav Republic of), Madagascar, Mali, Martinique, Mauritania, Mauritius, Mayotte, Moldova (Republic of), Monaco, Mongolia, Morocco, Mozambique, Netherlands, New Caledonia, Niger, Norway, Poland, Portugal, Reunion, Romania, Russian Federation Rwanda, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia, Slovakia, Slovenia (Republic of), Somalia, Spain, Suriname, Sweden, SSyrian Arab Republic, Tajikistan, Tahiti, Togo, Tunisia, Turkey, Turkmenistan, Ukraine, Upper Volta, Uzbekistan, Vanuatu, Vietnam, Wallis and Futuna, Yugoslavia (Federal Republic of), Zaire
39Y7918	9821	Power Cord (250v, 10A, 2.8m)	Denmark

Table 31. IBM power cords (continued)

IBM power cord part number	Feature code	Description	Used in these countries or regions
39Y7923	9825	Power Cord (250v, 10A, 2.8m)	Abu Dhabi, Bahrain, Botswana, Brunei Darussalam, Channel Islands, Cyprus, Dominica, Gambia, Ghana, Grenada, Guyana, Hong Kong, Iraq, Ireland, Jordan, Kenya, Kuwait, Liberia, Malawi, Malaysia, Malta, Myanmar (Burma), Nigeria, Oman, Qatar, Saint Kitts & Nevis, Saint Lucia, Saint Vincent and the Grenadines, Seychelles, Sierra Leone, Singapore, Sudan, Tanzania (United Republic of), Trinidad & Tobago, United Arab Emirates (Dubai), United Kingdom, Yemen, Zambia, Zimbabwe
39Y7920	9827	Power Cord (250v, 10A, 2.8m)	Israel
39Y7919	9828	Power Cord (250v, 10A, 2.8m)	Liechtenstein, Switzerland
39Y7922	9829	Power Cord (250v, 10A, 2.8m)	Bangladesh, Lesotho, Maceo, Maldives, Namibia, Nepal, Pakistan, Samoa, South Africa, Sri Lanka, Swaziland, Uganda
39Y7925	9845	Power Cord (250v, 12A, 2.8m)	Korea (Democratic Peoples Republic of)
39Y7921	9830	Power Cord (250v, 10A, 2.8m)	Chile, Italy, Libyan Arab Jamahiriya
39M7924	9831	Power Cord (250v, 10A, 2.8m)	Australia, Fiji, Kiribati, Nauru, New Zealand, Papua New Guinea
39Y7930	9834	Power Cord (250v, 10A, 2.8m)	Argentina, Paraguay, Uruguay
39Y7928	9840	Power Cord (250v, 10A, 2.8m)	China
39M2830	9841	Power Cord 1.8m long	Taiwan
39Y7929	9842	Power Cord (125v, 10A, 2.8m)	Brazil
39Y7927	9843	Power Cord (250v, 10A, 2.8m)	India
39Y7926	9844	Power Cord (125v, 10A, 4.3m)	Japan
N/A	9986	Power Cord (125v, 10A, 1.8m) - US/Chicago	

Appendix D. 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 32 associates each document in the DS4000 Storage Manager Version 9 library with its related common user tasks.

Table 32. DS4000 Storage Manager Version 9.1 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	✔	✔	✔	✔	✔	✔

DS4800 Storage Subsystem library

Table 33 associates each document in the DS4800 Storage Subsystem library with its related common user tasks.

Table 33. 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 Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage DS4800 Installation and Cabling Overview		✔				
IBM TotalStorage DS4800 Controller Cache Upgrade Kit Instructions	✔	✔		✔		

DS4700 Storage Subsystem library

Table 34 associates each document in the DS4700 Storage Subsystem library with its related common user tasks.

Table 34. 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 Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage DS4700 Storage Subsystem Fibre Channel Cabling Guide		✔				

DS4500 Fibre Channel Storage Server library

Table 35 associates each document in the DS4500 (previously FAStT900) Fibre Channel Storage Server library with its related common user tasks.

Table 35. DS4500 Fibre Channel Storage Server document titles by user tasks

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

DS4400 Fibre Channel Storage Server library

Table 36 associates each document in the DS4400 (previously FAStT700) Fibre Channel Storage Server library with its related common user tasks.

Table 36. DS4400 Fibre Channel Storage Server 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 Fibre Channel Storage Server library

Table 37 associates each document in the DS4300 (previously FAStT600) Fibre Channel Storage Server library with its related common user tasks.

Table 37. DS4300 Fibre Channel Storage Server document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM TotalStorage DS4300 Fibre Channel Storage Server Installation and User's Guide	✔	✔		✔		
IBM TotalStorage DS4300 Rack Mounting Instructions	✔	✔				
IBM TotalStorage DS4300 Fibre Channel 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 38 associates each document in the DS4200 Express Storage Subsystem library with its related common user tasks.

Table 38. 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 Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage DS4200 Express Storage Subsystem Fibre Channel Cabling Guide		✔				

DS4100 SATA Storage Server library

Table 39 associates each document in the DS4100 (previously FAStT100) SATA Storage Server library with its related common user tasks.

Table 39. DS4100 SATA Storage Server document titles by user tasks

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

DS4000 Storage Expansion Enclosure documents

Table 40 associates each of the following documents with its related common user tasks.

Table 40. 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 Enclosures Installation, User's, and Maintenance Guide	✔	✔		✔	✔	✔
IBM TotalStorage DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide	✔	✔		✔	✔	✔
Fibre Channel Solutions - IBM DS4000 EXP500 Installation and User's Guide	✔	✔		✔	✔	✔
IBM System Storage DS4000 EXP420 Storage Expansion Enclosures 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 41 associates each of the following documents with its related common user tasks.

Table 41. 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						✔
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 TotalStorage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview	✔	✔	✔	✔		
IBM Netfinity® Fibre Channel Cabling Instructions		✔				
IBM Fibre Channel SAN Configuration Setup Guide	✔		✔	✔	✔	

Appendix E. 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 42 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 42. 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 42. 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.

Appendix F. European Directive About 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 `http://www.ibm.com/ibm/ environment/products/prp.shtml`.
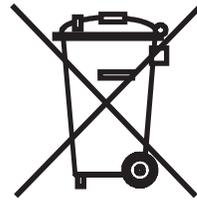
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This appliance is labelled in accordance with European Directive 2002/96/EC concerning waste electrical and electronic equipment (WEEE). The Directive determines the framework for the return and recycling of used appliances as applicable throughout 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.

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Remarque : Cette marque s'applique uniquement aux pays de l'Union Européenne et à la Norvège.

L'étiquette du système respecte la Directive européenne 2002/96/EC en matière de Déchets des Equipements Electriques et Electroniques (DEEE), qui détermine les dispositions de retour et de recyclage applicables aux systèmes utilisés à travers l'Union européenne. Conformément à la directive, ladite étiquette précise que le produit sur lequel elle est apposée ne doit pas être jeté mais être récupéré en fin de vie.

Appendix G. Battery Return Program

This product may contain sealed lead acid, nickel cadmium, nickel metal hydride, lithium, or 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 `http://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.

In Taiwan, the following applies:

Please recycle batteries.

廢電池請回收

Appendix H. Cable Warning

WARNING: Handling the cord on this product or cords associated with accessories sold with this product, will expose you to lead, a chemical known to the State of California to cause cancer, and birth defects or other reproductive harm. **Wash hands after handling.**

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Important notes

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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Some software may differ from its retail version (if available), and may not include user manuals or all program functionality.

Product recycling and disposal

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IBM encourages owners of information technology (IT) equipment to responsibly recycle their equipment when it is no longer needed. IBM offers a variety of programs and services to assist equipment owners in recycling their IT products.

Information on product recycling offerings can be found on IBM's Internet site at 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.

Battery return program

This product may contain a sealed lead acid, nickel cadmium, nickel metal hydride, lithium, or 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, see http://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 battery packs from IBM equipment. For information on proper disposal of these batteries, contact IBM at 1-800-426-4333. Have the IBM part number listed on the battery available prior to your call.

In the Netherlands, the following applies.

For Taiwan: Please recycle batteries.

Contact Information

This section provides contact information for IBM Taiwan Product Service.

台灣IBM 產品服務聯絡方式：
台灣國際商業機器股份有限公司
台北市松仁路7號3樓
電話：0800-016-888

Electronic emission notices

This section gives the electronic emission notices or statements for the United States and other countries or regions.

Federal Communications Commission (FCC) statement

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.

中华人民共和国 "A类" 警告声明

声 明

此为A级产品，在生活环境中，该产品可能会造成无线电干扰。在这种情况下，可能需要用户对其干扰采取切实可行的措施。

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.

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.

Taiwan Class A warning statement

警告使用者：
這是甲類的資訊產品，在
居住的環境中使用時，可
能會造成射頻干擾，在這
種情況下，使用者會被要
求採取某些適當的對策。

Japanese Voluntary Control Council for Interference (VCCI) statement

　この装置は、情報処理装置等電波障害自主規制協議会（ＶＣＣＩ）の基準に
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引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求
されることがあります。

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.

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, HP-UX, and Solaris host systems to manage storage subsystems through the host fibre-channel connection.

SMclient. The DS4000 Storage Manager client software, which is a Java-based graphical user interface (GUI) that is used to configure, manage, and troubleshoot storage servers and 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, HP-UX, and Solaris host systems to register and map new logical drives to the operating system. In Microsoft Windows, it also contains a utility to flush the cached data of the operating system for a particular drive before creating a FlashCopy.

small computer system interface (SCSI). A standard hardware interface that enables a variety of peripheral devices to communicate with one another.

small form-factor pluggable (SFP). An optical transceiver that is used to convert signals between optical fiber cables and switches. An SFP is smaller than a gigabit interface converter (GBIC). See also *gigabit interface converter*.

SNMP. See *Simple Network Management Protocol* and *SNMPv1*.

SNMP 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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Installation, User's and Maintenance Guide

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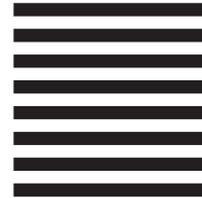Phone No.

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