IBM System Storage DS5100 or DS5300 Storage
Subsystem

IBM

Installation, User's, and Maintenance Guide

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Subsystem

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Installation, User's, and Maintenance Guide

> **Note:**
>
> Before using this information and the product it supports, be sure to read the general information in the "Safety" on page iii and "Notices" on page 275 sections.

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® DS5100 or DS5300 Storage Subsystem. 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 2:

CAUTION:
When replacing the lithium battery, use only an equivalent type battery recommended by the manufacturer. If your system has a module containing a lithium battery, replace it only with the same module type made by the same manufacturer. The battery contains lithium and can explode if not properly used, handled, or disposed of.

Do not:
- **Throw or immerse into water**
- **Heat to more than 100° C (212° F)**
- **Repair or disassemble**

Dispose of the battery as required by local ordinances or regulations.

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
Appareil À Laser de Classe 1

IEC 825-11993 CENELEC EN 60 825

Statement 4:

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

CAUTION:
Use safe practices when lifting.

Statement 5:

CAUTION:
**The power control button on the device and the power switch on the power
supply do not turn off the electrical current supplied to the device. The device
also might have more than one power cord. To remove all electrical current
from the device, ensure that all power cords are disconnected from the power
source.**
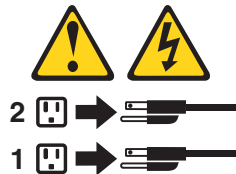
Statement 8:

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

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

Statement 30:

CAUTION:
To reduce the risk of electric shock or energy hazards:
- **This equipment must be installed by trained service personnel in a restricted-access location, as defined by the NEC and IEC 60950-1, First Edition, The Standard for Safety of Information Technology Equipment.**
- **Connect the equipment to a reliably grounded safety extra low voltage (SELV) source. An SELV source is a secondary circuit that is designed so that normal and single fault conditions do not cause the voltages to exceed a safe level (60 V direct current).**
- **The branch circuit overcurrent protection must be rated 20 A.**
- **Use 12 American Wire Gauge (AWG) or 2.5 mm2 copper conductor only, not exceeding 4.5 meters in length.**
- **Incorporate a readily available approved and rated disconnect device in the field wiring.**

CAUTION:
This unit has more than one power source. To remove all power from the unit, all dc MAINS must be disconnected.

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.**

Contents

Figures

Tables

About this document

This document provides instructions for installing and customizing the configuration of your IBM System Storage DS5100 or DS5300 Storage Subsystem. It also provides hardware 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 DS5100 or DS5300. This chapter includes an inventory checklist and an overview of the storage subsystem features, operating specifications, and components.

Chapter 2, "Installing the storage subsystem," on page 35 contains instructions for installing the DS5100 or DS5300 in a standard rack cabinet and setting the interface options.

Chapter 3, "Cabling the storage subsystem," on page 49 contains fibre channel and power cabling information for the DS5100 or DS5300.

Chapter 4, "Operating the storage subsystem," on page 151 contains instructions for powering the DS5100 or DS5300 on or off during either normal or emergency situations. It also contains information on how to check the LEDs on the front and back of the storage subsystem.

Chapter 5, "Replacing components," on page 189 contains step-by-step instructions for how to install or remove field replaceable units (FRUs), such as power supply and fan units, RAID controllers, host interface cards, and interconnect-battery units.

Chapter 6, "Hardware maintenance," on page 231 contains problems, symptoms, and error messages that are specific to the DS5100 or DS5300. It also contains the parts listing for the DS5100 or DS5300.

Appendix A, "Additional System Storage DS documentation," on page 245 provides references to other DS5100 or DS5300 publications.

Appendix B, "Records," on page 257 provides a table that you can use to record and update important information about your DS5100 or DS5300, including serial number, model and machine type, and MAC addresses.

Appendix C, "Rack mounting templates," on page 259 provides the rack mounting templates for installation of the DS5100 or DS5300. If you want to tear out the templates from the document for use during installation, use these copies of the templates.

Appendix E, "Power cords," on page 271 lists power cord information for the DS5100 or DS5300.

Appendix F, "Accessibility," on page 273 provides information about System Storage DS® Storage Manager accessibility features.

DS4000, DS5100, and DS5300 installation tasks - general overview

Table 1 provides a sequential list of many installation and configuration tasks that are common to most DS4000, DS5100, and DS5300 configurations. When you install and configure your DS4000, DS5100, and DS5300, refer to this table to find the documentation that explains how to complete each task.

See also: The DS4000, DS5100, and DS5300 Quick Start Guides for your storage subsystem configuration provides an excellent overview of the installation process.

Table 1. Where to find DS4000, DS5100, and DS5300 installation and configuration procedures

	Installation task	Where to find information or procedures

1	Plan the installation	• *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide*
		
		• *IBM System Storage DS3000, DS4000, and DS5000 Command Line Interface and Script Commands Programming Guide*
		
		• *IBM System Storage Quick Start Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4200 and DS4700
		
		• *IBM System Storage DSxxxx Installation, User's, and Maintenance Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4700
		  – DS4500
		  – DS4400
		  – DS4300
		  – DS4200
		  – DS4100

2	Mount the DS4000, DS5100, and DS5300 storage subsystem in the rack	• *IBM System Storage Quick Start Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4200 and DS4700
		
		• *IBM System Storage DSxxxx Installation, User's, and Maintenance Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4700
		  – DS4200
		  – DS4100
		
		• *DS4400 and DS4500 Rack Mounting Instructions*
		
		• *DS4300 Rack Mounting Instructions*

Table 1. Where to find DS4000, DS5100, and DS5300 installation and configuration procedures (continued)

	Installation task	Where to find information or procedures

3	Mount the DS4000, DS5100, and DS5300 EXP storage expansion unit in the rack	• *IBM System Storage Quick Start Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4200 and DS4700
		• *IBM System Storage EXPxxx Installation, User's, and Maintenance Guide* for the following storage expansion enclosures:
		  – EXP5060
		  – EXP5000
		  – EXP810
		  – EXP700 and EXP710
		  – EXP500
		  – EXP420
		  – EXP100

4	Route the storage expansion enclosure Fibre Channel cables	• *IBM System Storage Quick Start Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4200 and DS4700
		• *IBM System Storage EXPxxx Installation, User's, and Maintenance Guide* for the following storage expansion enclosures:
		  – EXP5060
		  – EXP5000
		  – EXP810
		  – EXP700 and EXP710
		  – EXP500
		  – EXP420
		  – EXP100

5	Route the host server Fibre Channel cables	• *IBM System Storage Quick Start Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4200 and DS4700
		• *IBM System Storage DSxxxx Installation, User's, and Maintenance Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4700
		  – DS4500
		  – DS4300
		  – DS4200
		  – DS4100
		• *IBM TotalStorage DS4400 Fibre Channel Cabling Instructions*

	Installation task	Where to find information or procedures

6	Power on the subsystem	• *IBM System Storage Quick Start Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4200 and DS4700
		• *IBM System Storage DSxxxx Installation, User's, and Maintenance Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4700
		  – DS4500
		  – DS4400
		  – DS4300
		  – DS4200
		  – DS4100

7	Configure DS4000, DS5100, and DS5300 network settings	• *IBM System Storage DSxxxx Installation, User's, and Maintenance Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4700
		  – DS4500
		  – DS4400
		  – DS4300
		  – DS4200
		  – DS4100

8	Zone the fabric switch (SAN-attached only)	• *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* • *IBM System Storage DS Storage Manager Version 10 Copy Services Guide* (describes switch zoning for the Remote Mirror Option) • See also the documentation provided by the switch manufacturer
9	Install DS Storage Manager software on the management station	• *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* • DS Storage Manager online help (for post-installation tasks)
10	Install host software (failover drivers) on host server	
11	Start DS Storage Manager	
12	Set the DS Storage Manager clock	
13	Set the DS Storage Manager host default type	

Table 1. Where to find DS4000, DS5100, and DS5300 installation and configuration procedures (continued)

	Installation task	Where to find information or procedures

14	Verify DS4000, DS5100, and DS5300 subsystem health	• *IBM System Storage DSxxxx Installation, User's, and Maintenance Guide* for the following storage subsystems:
		  – DS5100 or DS5300
		  – DS4800
		  – DS4700
		  – DS4500
		  – DS4400
		  – DS4300
		  – DS4200
		  – DS4100

15	Enable DS Storage Manager premium feature keys	**Copy Services premium features**
		    IBM System Storage DS Storage Manager Copy Services Guide
		
		FC/SATA Intermix premium feature
		    IBM System Storage DS4000/DS5000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview
		
		Storage Partitioning (and general premium features information)
		    • *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide*

16	Configure arrays and logical drives	• *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* • DS4000, DS5100, and DS5300 Storage Manager online help
17	Configure host partitions	
18	Verify host access to DS4000, DS5100, and DS5300 storage	

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 system, and whom to call for service, if it is necessary.

Before you call

Before you call, take 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 IBM System Storage Disk Support Web site pages that are listed in this section.

- 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 DS Storage Manager 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 subsystems, 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 your IBM system and preinstalled software, if any, is available in the documents that come with your system; this includes printed books, online documents, README files, and help files. See the troubleshooting information in your system documentation for instructions for using the diagnostic programs. The troubleshooting information or the diagnostic programs might tell you that you need additional or updated device drivers or other software.

Finding Storage Manager software, controller firmware, and README files

DS Storage Manager software and controller firmware versions are available on the product DVD and can also be downloaded from the Web.

Important: Before you install DS Storage Manager software, consult the README. Updated README files contain the latest device driver versions, firmware levels, limitations, and other information not found in this document.

Storage Manager README files are found on the Web, at the following address:

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

1. On the **Support for IBM System Storage and TotalStorage products** page, from the **Product family** drop-down menu, select **Disk systems**. From the **Product** drop-down menu, select your product (for example, **DS5100 Midrange Disk System**). Click **Go**.
2. In the **Support & downloads** box, again click **Download**. The **Software and device drivers** page opens.
3. In the **Storage Manager** section of the table, locate your operating system and version level (for example, **IBM DS5100 or DS5300 Storage Manager v10.xx.xx.xx for AIX - IBM System Storage**), and click on the version link in the right-hand column. The DS5100 or DS5300 Storage Manager download page opens.
4. On the download page, in the table under **File details**, click on the ***.txt** file link, and the README will open in your Web browser.

IBM System Storage Productivity Center

The IBM System Storage Productivity Center (SSPC) is an integrated hardware and software solution that provides a single point of entry for managing IBM System Storage DS4000, DS5100, DS5300, and DS8000 systems, IBM System Storage SAN Volume Controller clusters, and other components of your data storage

infrastructure. Therefore, you can use the IBM System Storage Productivity Center to manage multiple IBM System Storage product configurations from a single management interface.

To learn how to incorporate the DS Storage Manager with the IBM System Storage Productivity Center, see the IBM System Storage Productivity Center Information Center at the following Web site:

publib.boulder.ibm.com/infocenter/tivihelp/v4r1/index.jsp

Essential Web sites for DS4000, DS5100, and DS5300 support information

For the most up-to-date information about DS4000, DS5100, and DS5300 storage subsystems and DS Storage Manager, including documentation and the most recent software, firmware, and NVSRAM downloads, go to the following Web sites.

IBM System Storage Disk Storage Systems
Go to www.ibm.com/systems/support/storage/disk for links to software and firmware downloads, readme files, and support pages for all IBM System Storage disk storage systems, including DS5100 or DS5300.

IBM System Storage Interoperation Center (SSIC)
Go to www.ibm.com/systems/support/storage/config/ssic/index.jsp for technical support information for your DS4000, DS5100, and DS5300 storage subsystem/host configuration, including the latest firmware versions.

IBM DS3000, DS4000, DS5000, and BladeCenter Premium Feature Activation
To activate a DS5100 or DS5300 premium feature, go to www-912.ibm.com/PremiumFeatures.

IBM System Storage Productivity Center
For the latest documentation supporting the IBM System Storage Productivity Center, a new system that is designed to provide a central management console for IBM System Storage DS4000, DS5000, DS8000, and SAN Volume Controller, go to publib.boulder.ibm.com/infocenter/tivihelp/v4r1/index.jsp.

IBM System Storage Support
Go to www.ibm.com/systems/support/storage to find the latest support information for host operating systems, HBAs, clustering, storage area networks (SANs), DS Storage Manager software and controller firmware.

Storage Area Network (SAN) Support
For information about using SAN switches, including links to SAN user guides and other documents, go to www.ibm.com/systems/support/storage/san.

Fix Central
Go to www.ibm.com/eserver/support/fixes for fixes and updates for software, hardware, and host operating systems.

IBM System Storage products
Go to www.ibm.com/systems/storage for information about all IBM System Storage products.

IBM Publications Center
For IBM publications, go to www.ibm.com/shop/publications/order/.

Software service and support

Through IBM Support Line, for a fee you can get telephone assistance with usage, configuration, and software problems. 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.

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

IBM Taiwan product service contact information:
    IBM Taiwan Corporation
    3F, No 7, Song Ren Rd.
    Taipei, Taiwan
    Telephone: 0800-016-888

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.

Chapter 1. Introduction

This chapter describes the operating specifications, features, and components for the IBM System Storage DS5100 or DS5300 (Machine Type 1818) Storage Subsystem (hereafter referred to as *DS5100 or DS5300* or *storage subsystem*).

This chapter also includes an inventory checklist and important information on best practices guidelines and product updates for your DS5100 or DS5300.

Overview

The DS5100 or DS5300 supports the large and growing data storage requirements of business-critical applications. The storage subsystem offers you data access and protection to meet your existing enterprise storage requirements and prepare for the future.

The DS5100 or DS5300 is designed to provide solutions to meet the needs of midrange/departmental storage requirements, delivering high performance, advanced function, high availability, modular and scalable storage capacity, with SAN-attached 4-Gbps fibre channel (FC) connectivity, and support for RAID levels 0, 1, 3, 5, and 6.

The DS5100 or DS5300 supports attachment of EXP5000 and EXP5060 storage expansion enclosures. The DS5100 or DS5300 supports configurations of FC, Solid State, or Serial Advanced Technology Attachment (SATA) disks, or a mix of these types of disk drives. For details on the maximum number of disk drives supported, maximum storage capacity, and other features of the storage subsystem, see "Features at a glance" on page 2.

The DS5100 or DS5300 has two slots per controller for Host Interface Cards (HICs). The supported HICs are four-port 4 Gbps Fibre Channel (FC), four-port 8 Gbps Fibre Channel (FC), two-port 1 Gbps iSCSI, and two-port 10 Gbps iSCSI. Any combination of HICs in the controller is supported with the following two conditions:

1. The 1 Gbps and the 10 Gbps HIC should not be installed on the same storage subsystem.
2. Each controller must have the same type HICs in identical slot positions. For example, if controller A has 4 Gbps FC and 10 Gbps iSCSI HICs in HIC slots 1 and 2, respectively, controller B should also have 4 Gbps FC and 10 Gbps iSCSI HICs in HIC slots 1 and 2, respectively.

Advanced DS5100 and DS5300 storage management, copy service options, and optional advanced disaster recovery functions are available for the DS5100 or DS5300, including FlashCopy®, VolumeCopy, and Enhanced Remote Mirroring.

The DS Storage Manager client is also available for the DS5100 or DS5300. This storage management software is designed to help centralize storage management, help simplify partitioning of the DS5100 or DS5300 series storage into as many as 512 virtual servers, and strategically allocate storage capacity to maximize storage space.

Models

The DS5100 or DS5300 Storage Subsystem includes these models:
- DS5100 (Model type 51A)

- DS5300 (Model type 53A)

Both models are primarily the same; however, cache memory size and internal processor bus speed differ. See Table 6 on page 19 for details. For additional details about the various options you can order depending on the model, contact your IBM sales representatives or reseller for information.

Fibre channel defined

Fibre channel technology is outlined in the *SCSI-3 Fibre Channel Protocol* (SCSI-FCP) standard. Fibre channel is a high-speed data transport technology that is used for mass storage and networking. Using a fibre-channel arbitrated loop (FC-AL), more than 100 fibre-channel devices[1] can be supported, compared to 15 small computer system interface (SCSI) devices.

The optical fibre channel connection from the DS5100 or DS5300 to fibre channel host bus adapter ports, or from the DS5100 or DS5300 to DS5100 or DS5300 storage expansion enclosure ports (such as an EXP5000), is a 4-Gbps fibre channel connection that supports a data transfer rate up to 400 MBps at half-duplex and 800 MBps at full-duplex.

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, and can be found at the following Web site:

http://www.serialata.org.

iSCSI defined

The Internet Small Computer System Interface (iSCSI) is an IP-based standard for linking data storage devices over a network and transferring data by carrying SCSI commands over IP networks.

Features at a glance

Table 2 on page 3 summarizes the features of the storage subsystem. For a list of the operating specifications, such as weight, height, and heat output, see "Specifications" on page 27.

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1. For the DS5100 or DS5300, each drive is considered to be a device in a fibre channel loop, even though the DS5100 or DS5300 might connect with SATA as well as fibre channel drives.

Table 2. Features at a glance

General		Attached storage expansion enclosures

General

- Modular components:
  - RAID controllers (2)
  - Power supply-cooling fan units (2)
  - Interconnect-battery unit (1)
- Technology:
  - Support for RAID 0, 1, 3, 5 and 6 disk arrays
  - Support of Full Disk Encryption (FDE) disk drives. (Requires Premium Feature Key)
  - Storage capacity up to 480 TB
  - A maximum of 20 Solid State disk drives are supported per DS5100/DS5300 subsystem
  - DS5300 supports up to 448 physical FC or combinations of FC, Solid State, and SATA disk drives, or up to 480 physical SATA disk drives attached to storage subsystem (requires the Attach up to eight EXP5060 feature pack to support 480 disk drives in eight EXP5060s)
  - DS5100 supports up to 448 physical FC or combinations of FC, Solid State, and SATA disk drives, or up to 480 physical SATA disk drives attached to storage subsystem (requires the Attach up to 448 drives feature pack to increase the maximum number of drives supported in a DS5100 subsystem from 224 to 448 and the Attach up to eight EXP5060 feature pack to support 480 disk drives in eight EXP5060s)
  - Controller cache size of 4 GB per controller on the DS5100; 8 GB of cache memory per controller on the DS5300
  - Cache memory upgradable to 32 GB per controller for a total of 64 GB per storage subsystem
  - Support for clustering
  - Fibre channel and iSCSI host interface
  - Support for FC or Serial Advanced Technology Attachment (SATA) disks, or a mix of both types of disks via optional DS5100 or DS5300 Fibre Channel/SATA Enclosure Intermix feature
  - Redundant controllers and power supply/cooling system
  - Hot-swap technology for controllers, power supply and fan units, cache battery, and interconnect-battery unit

- User interface:
  - Built-in power, activity, and fault (Needs Attention) light emitting diodes (LEDs)
  - Identification labeling on field replaceable units (FRUs), rear LEDs, switches, and connectors
  - Easy-to-replace power supply and fan units, RAID controllers, cache battery, and interconnect-battery unit

RAID controllers

- Fibre channel interface. Each controller has 16 small form-factor pluggable (SFP) ports for incoming and outgoing fibre-channel cables:
  - 8 SFP ports per controller for storage expansion enclosure connections
  - Up to 8 SFP ports per controller for host connections
- iSCSI interface. Each controller supports up to four 1 Gbps iSCSI host ports, or up to four 10 Gbps iSCSI host ports.
- Host interface card. Each controller supports up to two host interface cards. Support for:
  - 4 Gbps FC
  - 8 Gbps FC
  - 1 Gbps iSCSI
  - 10 Gbps iSCSI
- Support for any combination of HICs, if both controllers have the same type HICs in identical slot positions.

Attached storage expansion enclosures

- Sixteen dual-ported drive channel connections (8 per RAID controller) enabled to support 4 Gbps fibre channel connections
- Supports attachment of 4 Gbps EXP5000 storage expansion enclosures
- Supports attachment of 4 Gbps EXP5060 storage expansion enclosures

Options:

- FlashCopy
- VolumeCopy
- Enhanced Remote Mirroring

Clustering support

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

Clustering requires software specific to your operating system. For more information about clustering, see www.ibm.com/servers/storage/disk/ds4000/interop-matrix.html.

Inventory checklist

After you unpack the DS5100 or DS5300, verify that you have the following items. See "Storage subsystem components" on page 7 for the locations of hardware components on the DS5100 or DS5300.

Note: Depending on your DS5100 or DS5300 order, your shipping box might contain additional materials not listed in the following checklist. Review the inventory checklist included in the DS5100 or DS5300 shipping box for any additional parts, and use that checklist in combination with the following information.

- **Hardware**
  - One DS5100 or DS5300 bezel (front cover)
  - Two RAID controllers (shipped installed in the DS5100 or DS5300)
  - Two power supply and fan units (shipped installed in the DS5100 or DS5300)
  - One interconnect-battery unit with two cache-backup battery packs (shipped installed in the DS5100 or DS5300)
  - Two line cord jumpers

    Line cord jumpers are power cables with an IEC C13 plug on one end and an IEC C14 plug on the other end that are used to connect the DS5100 or DS5300 RAID controller units to the IBM-certified rack power distribution units (PDUs) installed in the rack cabinet.
  - Sixteen 4 Gbps SFP modules (These SFP modules are already installed in the DS5100 or DS5300 drive ports.)
  - Depending on the number and the type of host interface cards purchased, up to sixteen 4 Gbps SFP or 8 Gbps SFP, or up to eight 10 Gbps SFP+ modules will also be shipped installed in the host interface cards.
  - One rack-mounting hardware kit, including:
    - Two rails (right and left assemblies)
    - Eight M5 black hex-head screws
  - Wrap plug and coupler kit

    Use the wrap plug and coupler kit for FC link diagnostics. See the *IBM System Storage Problem Determination Guide* for more information.

  Attention: The DS5100 or DS5300 Storage Subsystem does not ship with region-specific power cords. You must obtain the IBM-approved power cords for your region. See Appendix E, "Power cords," on page 271 for the IBM-approved power cords for your region.

- **Software and documentation**
  - Host software attachment kit

    Depending on your order, your DS5100 or DS5300 ships with either the Microsoft Windows host software attachment kit or with your choice of host software kits (Windows, AIX®, Linux, Mac OS, SUN Solaris, HP-UX, Linux on POWER®, or VMware). The host software kit grants you permission to attach host servers using the appropriate operating system to the DS5100 or DS5300. The kit includes a *DS Storage Manager Support* DVD that has the appropriate IBM DS Storage Manager host software. The DVD also contains includes firmware, online help, and publications in Adobe Acrobat Portable

Document Format (PDF). (For a list of available IBM DS5100 or DS5300 publications, see Appendix A, "Additional System Storage DS documentation," on page 245.)

If you order more than one host software kit, the additional kits may also be shipped in the DS5100 or DS5300 shipping box.

– A storage partition premium feature activation kit based on your order.
– *IBM System Storage DS5100 or DS5300 Storage Subsystems Installation, User's, and Maintenance Guide*
– *IBM System Storage Quick Start Guide for the DS5100 or DS5300*
– *IBM Safety Information*
– IBM License Agreement
– Statement of Limited Warranty

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

If you have not already done so, record your storage subsystem serial number, machine type and model number, and RAID controller MAC addresses in Appendix B, "Records," on page 257. The serial number, machine type, and model number are located on top of the DS5100 or DS5300. The MAC addresses are located near the Ethernet ports on each RAID controller, as shown in Figure 148 on page 258. You may not be able to easily access this information after you install the DS5100 or DS5300.

Rack mounting templates for installing the support rails are provided in this document in Appendix C, "Rack mounting templates," on page 259.

To connect your DS5100 or DS5300 to other devices, use the following options:
• IBM SFP module
• IBM LC-LC fibre-channel cable
• IBM LC-SC fibre-channel cable (for host-side connections only)

Note: You might need to order these options separately.

Receiving product updates and support notifications

Be sure to download the latest versions of the following packages at the time of initial installation and when product updates become available:
• DS Storage Manager host software
• DS5100 and DS5300 storage subsystem controller firmware
• DS5100 and DS5300 drive expansion enclosure ESM firmware
• Drive firmware

Important

Keep your system up-to-date with the latest firmware and other product updates by subscribing to receive support notifications.

For more information about how to register for support notifications, see http://www.ibm.com/systems/support and click **My notifications**.

Also, see http://www.ibm.com/systems/support/storage/disk and check the **Stay Informed** section.

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.
- Collect All Support Data from the storage subsystem periodically and after any changes in the subsystem configuration.
- To maintain power redundancy, plug the DS5100 or DS5300 right and left RAID controller 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 DS5100 or DS5300 storage expansion enclosures attached to the DS5100 or DS5300 should be plugged into the same two independent external power circuits as the DS5100 or DS5300. This ensures that the DS5100 or DS5300 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 plug into the same power circuit enables the DS5100 or DS5300 devices in the configuration to power on simultaneously during an unattended restoration of power. See Figure 102 on page 150 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 the Installation, User's, and Maintenance Guide for your storage expansion enclosures 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), complete the following tasks:

  1. Save the storage subsystem profile
  2. Save the storage subsystem configuration
  3. Save the Collect All Support Data (CASD)

  Make sure that you save the files in a location other than in the logical drives that were created for the storage subsystem.

  For more information on how to complete these tasks, check the DS Storage Manager online help or the Storage Manager guide for your operating system.

- During any maintenance or attended power-up procedure, carefully follow the power-up sequence listed in "Turning on the storage subsystem" on page 155. Check that each component of the subsystem is powered-on in the proper order during this entire power-up procedure to ensure the controller will be able to optimally access all of your storage subsystems.
- The storage subsystem supports simultaneous power-up to the system components; however, you should always follow the power-up sequence listed in "Turning on the storage subsystem" on page 155 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, call IBM support if any of the following conditions occur:
  - The storage subsystem logical drives and arrays are not displayed in the DS Storage Manager graphical user interface (GUI).
  - The storage subsystem logical drives and arrays do not come online.
  - The storage subsystem logical drives and arrays seem to be degraded.

Storage subsystem components

The DS5100 or DS5300 storage subsystem directs and manages the I/O activity between a host and the drives in a RAID array. Figure 1 shows the DS5100 or DS5300 with front bezel in place.

Note: The illustrations in this document might differ slightly from your hardware.
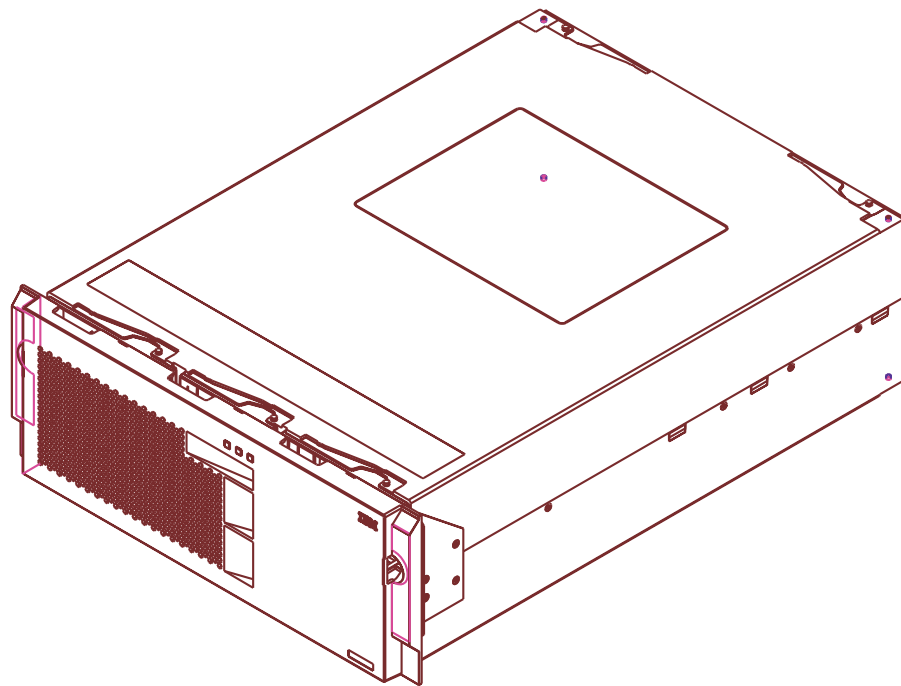
Figure 1. DS5100 or DS5300 Storage Subsystem

The storage subsystem comprises has five components. The components, and the quantity of each component in the storage subsystem, are the following:
- RAID controllers (two)
- Power supply and fan units (two)
- Interconnect-battery unit (one)

The power supply and fan unit and interconnect-battery unit are located behind the front bezel. The controllers are located in the rear of the storage subsystem. All components are secured in the storage subsystem by quick release latches, enabling each component to be removed by disengaging the latch and sliding the component from the storage subsystem chassis. Figure 2 on page 8 shows the positions of the components in the DS5100 or DS5300.

All DS5100 or DS5300 models support hot-swap RAID controllers, power supply and fan units, cache-protected batteries, and interconnect-battery units, so you can remove and replace these components without turning off the storage subsystem. Hot-swappable devices enable you to maintain the availability of your system while you remove, install, or replace a hot-swap device.

Attention

Refer to the component replacement sections in Chapter 5, "Replacing components," on page 189, or refer to the DS Storage Manager Recovery Guru, for instructions and prerequisites before performing any FRU replacements. Failure to meet prerequisites or follow replacement instructions might result in a loss of data access.
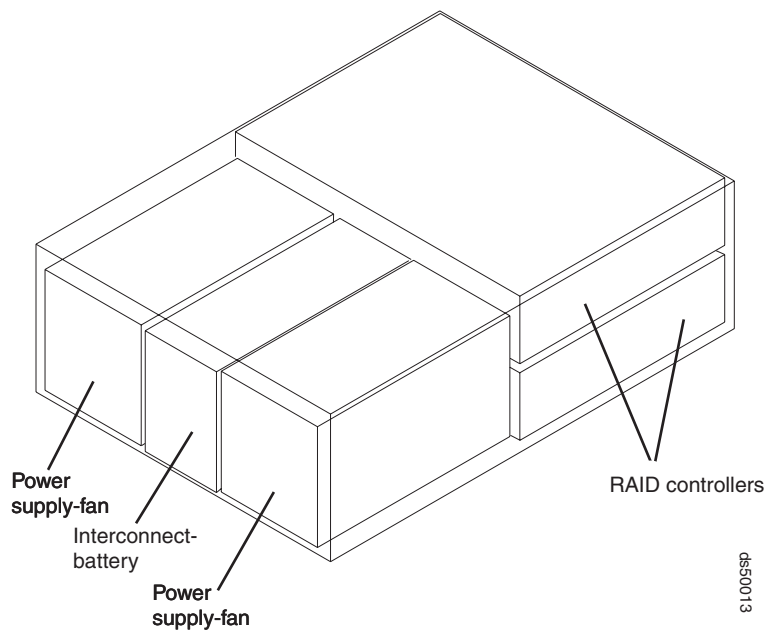
Figure 2. Location of components in the storage subsystem

The storage subsystem provides flexibility in configuring a RAID array. A minimal storage subsystem configuration would consist of one DS5100 or DS5300 and one storage expansion enclosure. The storage expansion enclosure can contain as few as two disk drives. The maximum number of disk drives a DS5100 or DS5300 can support is listed in "Features at a glance" on page 2.

Currently, the DS5100 or DS5300 supports the EXP5000 and EXP5060 storage expansion enclosures.

> **Important**
>
> The EXP5000 (1818-D1A) is the storage expansion enclosure specifically designed for the DS5100 or DS5300 (1818-51A and 1818-53A) and along with the EXP5060 (1818-G1A), is the storage expansion enclosure supported behind the DS5100 or DS5300 with the exception noted below. This is a critical requirement due to the following:
>
> - Only the EXP5000 will be supported with future enhancements of the DS5100 or DS5300 such as disk encryption and solid stated disks.
> - Only the EXP5000 will provide clients consistent warranty and support terms and conditions (including geo-specific, SSR installation and support for the entire system, and code upgrades within the initial warranty period).
>
> The *only* exception is that for client investment protection, existing EXP810s can be migrated from currently installed DS4700s or DS4800s to attach to a DS5100 or DS5300. An RPQ approval is required for support of all migration configurations. With approved migration of EXP810s to a DS5100 or DS5300, special consideration needs to be made as to proper firmware levels (as documented in the *DS4000/DS5000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*), and careful coordination of differences in warranty and maintenance terms that will affect your customer. RPQ requests can be submitted through the normal RPQ request process.
>
> Purchase of new EXP810s to attach to DS5100 or DS5300 will not be supported or configurable in eConfig.
>
> **Note:** Disk drive modules that can be ordered in bulk or individually as customer installable parts for the EXP810 are not supported for use in the EXP5000. Only disk drive modules ordered as feature codes of 1818-D1A, and delivered pre-installed in the EXP5000, or as SSR-installable upgrades to EXP5000s will be supported.

See Table 3 for the maximum number of storage expansion enclosures that can be attached to the DS5100 or DS5300 by storage expansion enclosure type.

Table 3. Maximum number of storage expansion enclosures

Enclosure type	Maximum number of enclosures in a redundant DS5100 or DS5300 drive channel pair	Maximum number of enclosures in a DS5100 or DS5300 subsystem
EXP5000	7	28

Table 3. Maximum number of storage expansion enclosures (continued)

Enclosure type	Maximum number of enclosures in a redundant DS5100 or DS5300 drive channel pair	Maximum number of enclosures in a DS5100 or DS5300 subsystem
EXP5060 **Notes:** 1. Requires firmware version 7.60.13.05, or higher. 2. Maximum configuration requires the Attach up to eight EXP5060 feature. 3. The Attach up to eight EXP5060 feature activation requires IO to the subsystem be quiesce. 4. The Attach up to eight EXP5060 feature pack does not support any other type of enclosure besides the EXP5060. Disconnect any EXP5000/EXP810 expansion enclosures before activating the Attach up to eight EXP5060 feature pack.	2	8
EXP5000 and EXP5060	1 EXP5060 3 EXP5000	Varies depending on the number of EXP5060 and EXP5000 expansion enclosures that are connected to each of the four DS5100/DS5300 drive channels.

Controllers

The DS5100 or DS5300 has two RAID controllers. Both controllers are identical and interchangeable. The controllers install from the rear of the storage subsystem. The upper controller is controller A; the lower controller is controller B. All connections to the hosts and the drives in the storage configuration are through the controllers. Figure 3 on page 11 shows the controllers in the DS5100 or DS5300.

Note: Although both RAID controller units (A and B) in the DS5100 or DS5300 are identical, they are seated in the DS5100 or DS5300 chassis in opposite orientations. As shown in Figure 3 on page 11, the controller units must be inserted in the DS5100 or DS5300 so that the latches of each controller are on the exterior of the DS5100 or DS5300 chassis. The latches on controller A line up with the top side of the DS5100 or DS5300 chassis; the latches on controller B line up with the bottom side of the DS5100 or DS5300 chassis.
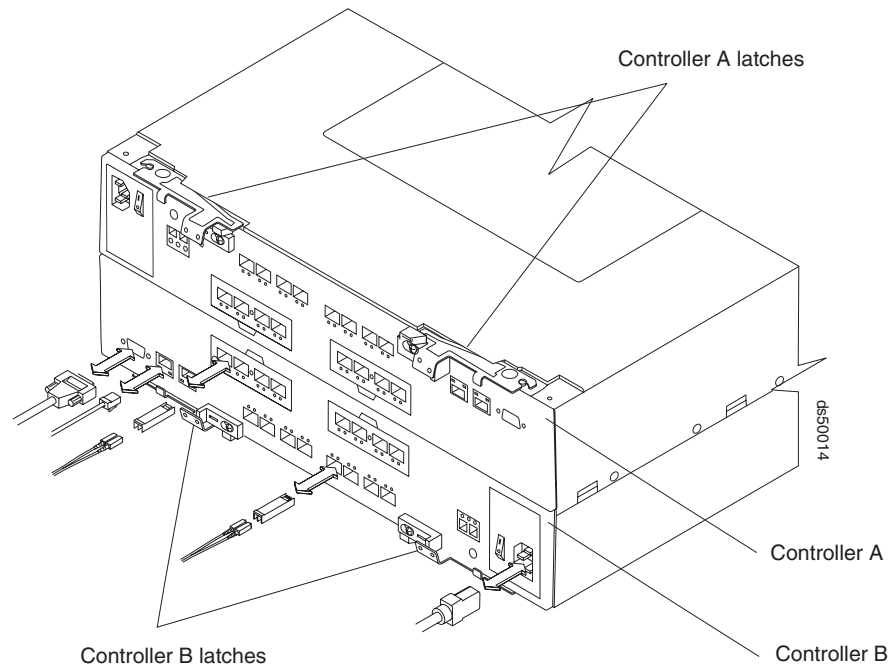
Figure 3. Controllers in the storage subsystem

Information about the condition of the controllers is conveyed by indicator LEDs on the back of each controller. ("RAID controller LEDs" on page 169 identifies the indicator LEDs on the RAID controller and explains the conditions that each LED indicates.)

Controller cable connections

Each controller provides the following connections:

- Four dual-ported fibre channel drive channels
- Up to eight single-ported Fibre Channel host channels, up to four RJ-45 or SFP+ iSCSI host ports, or four single-ported FC host channels and two RJ-45 or SFP+ iSCSI host ports, depending on the types of host interface cards (HICs) installed in the controllers.
- Two RJ-45 Management Ethernet ports.
- One RS-232 serial port.
- AC power.

Figure 4 on page 12, Figure 5 on page 12, and Figure 6 on page 13 identify the connectors on the back of each controller.
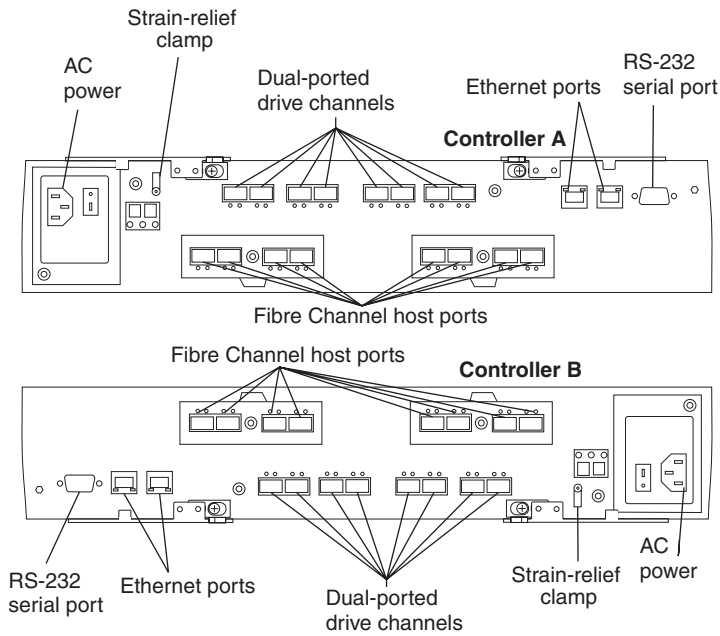
Figure 4. Fibre Channel Controller connections
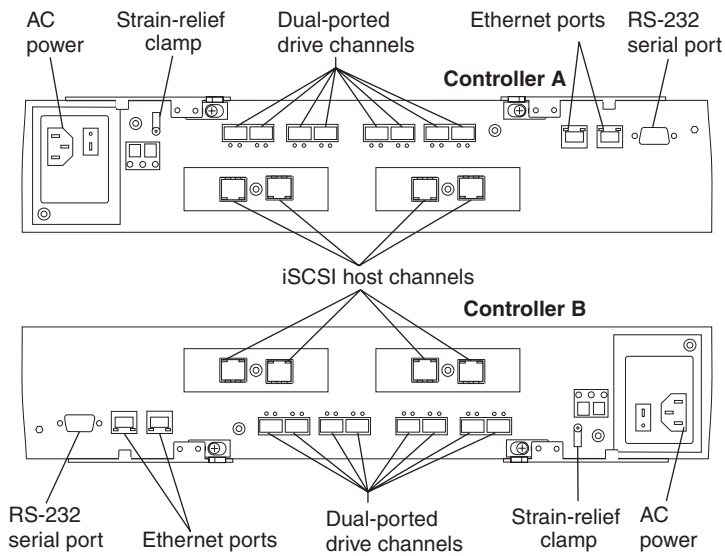
Figure 5. 1 Gbps iSCSI Controller connections
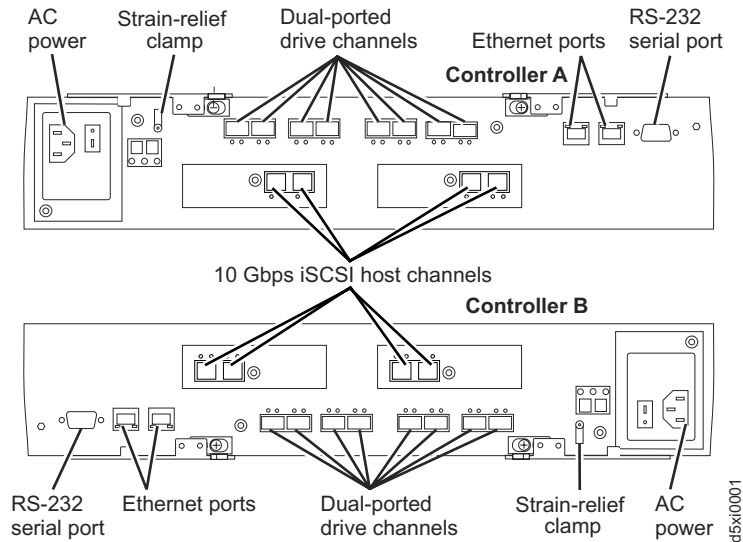
Figure 6. 10 Gbps iSCSI Controller connections

Dual-ported drive channels

Each controller has four drive channels; each drive channel has two fibre channel ports. The drive channels are used to connect storage expansion enclosures to the RAID controllers on the DS5100 or DS5300.

Attention: Before you power on the DS5100 or DS5300, the storage subsystem must be cabled to at least one storage expansion enclosure populated with the minimum number of drives for the storage expansion enclosure. Otherwise, the DS5100 or DS5300 controllers do not successfully complete the power-on process and operate optimally.

Two drive channels (one from each controller) are used to form a redundant drive channel pair. Each drive channel pair supports up to a maximum of 112 drives in seven IBM DS5100 or DS5300 storage expansion enclosures. (See Table 3 on page 9 for more information.)

Host channels

Each DS5100 and DS5300 controller supports two host interface cards. The DS5100 or DS5300 controller supports 4 Gbps and 8 Gbps FC, 1 Gbps iSCSI, or 10 Gbps iSCSI host interface cards. With the exception that the 1 Gbps iSCSI and 10 Gbps iSCSI HICs must not be installed in the same storage subsystem, these cards can be mixed within a controller provided that the same type of card is installed in the same host interface card slot in both controllers. The 4 Gbps and 8 Gbps FC host interface cards contain four single-port host fibre channel ports per card for a maximum of eight FC ports per controller. The 1 Gbps and 10 Gbps iSCSI host interface cards contain two two-port iSCSI ports for a maximum of four iSCSI ports per controller.

Attention:

1. If there is only one host interface card (HIC) per controller, install the HIC in slot 1 or the controller will lock down during the boot process.

2. The controller will enter the lockdown state if the 1 Gbps and 10 Gbps HIC are installed in the same controller.

Figure 7 and Table 4 show the slot number of the host Interface card slots in the DS5100 or DS5300 controller. Slot 1 of controller B is not located directly below slot 1 of controller A.
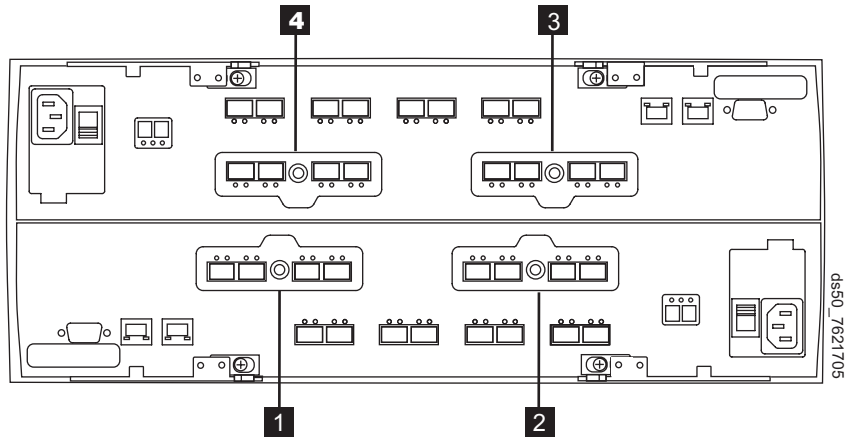
Figure 7. Host interface card slots on controllers A and B

Table 4. Description of numbered locations in the figure that shows host interface card slots on controllers A and B

Number	Description
1	Host interface card - slot 1 - controller B
2	Host interface card - slot 2 - controller B
3	Host interface card - slot 1 - controller A
4	Host interface card - slot 2 - controller A

The controllers perform link speed negotiation on each host channel fibre channel port (also referred to as auto-negotiation). Host channels contained in a:

- Four Gbps host interface card can operate at either 1, 2, or 4 Gbps fibre channel speeds
- Eight Gbps host interface card can operate at either 2, 4, or 8 Gbps fibre channel speeds
- One Gbps iSCSI host interface card can operate at 1 Gbps or 100 Mbps Ethernet speeds. However, the 1 Gbps speed should be the operating speed for the iSCSI ports in the production environment.
- The 10 Gbps iSCSI HIC port does not auto-negotiate the operating speed. You must use the iSCSI port setting menu function in the subsystem management window to change the speed. However, the 10 Gbps iSCSI host interface card is supported and operates only at 10 Gbps Ethernet speed with 10 Gbps SFP+ optical modules. *Do not* set the speed to 1 Gbps as shown in the iSCSI port setting window.

The controllers interact with the fibre channel host bus adapter ports in the host server or the fibre channel switch to determine the fastest compatible speed between the controllers and the host or switch. The fastest compatible speed becomes the operating speed of the link. If the host or switch on the other end of the link are either fixed-speed or not capable of

negotiating, the controllers automatically detect the operating speed of the other host or switch and set the controller link speed accordingly. Link speed negotiation for a given host channel is limited to link speeds supported by the small form-factor pluggable (SFP) module on that channel.

Similarly, the controllers interact with the 1 Gbps iSCSI host bus adapter ports in the host server or the Ethernet switch to determine the fastest compatible speed between the controllers and the host or switch. The fastest compatible speed becomes the operating speed of the link. If the host or switch on the other end of the link are either fixed-speed or not capable of negotiating, the controllers automatically detect the operating speed of the other host or switch and set the controller link speed accordingly. However, the 10 Gbps host port does not negotiate for the optimal link speed. It must be manually configured to operate at 10 Gbps speed using the iSCSI port setting menu function in the subsystem management window. Table 5 shows the default IP addresses of the iSCSI host ports.

The iSCSI ports support Internet Storage Naming Service (iSNS) in Microsoft Windows environment and Challenge Handshake Authentication Protocol (CHAP).

The controllers enter into auto-negotiation at these points in time:
- Start-of-day
- Detection of a link-up event after a previous link-down event

If the auto-negotiation process fails, the controllers consider the link to be down until negotiation is again attempted at one of these points in time.

Ethernet ports

The Ethernet connections provide for out-of-band management configurations to a host. The Ethernet ports are used for an RJ-45 10BASE-T or 100BASE-T Ethernet connection to each controller. Use the Ethernet connection to directly manage the DS5100 or DS5300.

Use one Ethernet port for daily management of the DS5100 or DS5300. Reserve the other port for use by service personnel or for subsystem monitoring hardware that may be available in the future.

The two Ethernet ports must be connected into networks with two separate subnet masks. Otherwise, the following Recovery Guru error will be generated:

```
Ethernet Configuration conflict. Both Ethernet ports for a given
DS5100 or DS5300 controller have been assigned IP addresses
from the same subnet.
```

You can also make out-of-band management connections to the DS5100 or DS5300 controllers using the default IP addresses. See Table 5 for the default IP addresses and subnet masks for the management ports and iSCSI ports (if installed). See "Setting up IP addresses for DS5100 or DS5300 storage controllers" on page 16 for more information.

Table 5. Default IP addresses and subnet masks

Port	IP address	Subnet Mask
Controller A Management port 1	192.168.128.101	255.255.255.0
Controller A Management port 2	192.168.129.101	255.255.255.0

Table 5. Default IP addresses and subnet masks (continued)

Port	IP address	Subnet Mask
Controller B Management port 1	192.168.128.102	255.255.255.0
Controller B Management port 2	192.168.129.102	255.255.255.0
Controller A iSCSI port 1	192.168.130.101	255.255.255.0
Controller A iSCSI port 2	192.168.131.101	255.255.255.0
Controller A iSCSI port 3	192.168.132.101	255.255.255.0
Controller A iSCSI port 4	192.168.133.101	255.255.255.0
Controller B iSCSI port 1	192.168.130.102	255.255.255.0
Controller B iSCSI port 2	192.168.131.102	255.255.255.0
Controller B iSCSI port 3	192.168.132.102	255.255.255.0
Controller B iSCSI port 4	192.168.133.102	255.255.255.0

RS-232 serial port

> The RS-232 serial connection provides a diagnostic port *for use by service personnel only* to perform diagnostic operations on the RAID controllers.

> **Attention:**   Incorrect use of the serial port can result in loss of data access and, in some cases, in loss of data. *Do not* make any connections to the serial port unless you do so under the direct guidance of IBM support personnel.

> **Note:** The maximum baud rate is 115 200 bps. The default baud rate setting from the factory is 38 400 bps.

Setting up IP addresses for DS5100 or DS5300 storage controllers

After you install DS Storage Manager (as described in the DS Storage Manager Installation and Support Guide for your host operating system), complete one of the following procedures to set up IP addresses:

- "Steps for setting up the DHCP/BOOTP server and network"
- "Steps for assigning static TCP/IP addresses to the controllers with the DS Storage Manager client host software" on page 17
- "Steps for assigning static TCP/IP addresses to the controllers with the controller serial port" on page 18

Steps for setting up the DHCP/BOOTP server and network: To complete this procedure, you must have the following components:

- A DHCP or BOOTP server
- A network management station (NMS) for Simple Network Management Protocol (SNMP) traps
- A host that is connected to a storage subsystem through a fibre-channel I/O path
- A management station that is connected by an Ethernet cable to the storage subsystem controllers

Note: You can avoid DHCP/BOOTP server and network tasks either by using the default controller IP addresses, or by assigning static IP addresses to the controller, as described in the next section.

Complete the following steps to set up the DHCP/BOOTP server and network:

1. Get the MAC address from each controller blade.
2. Complete whichever of the following steps is appropriate for your server:
   - On a DHCP server, create a DHCP record for each of the MAC addresses. Set the lease duration to the longest time possible.
   - On a BOOTP server, edit the bootptab file to add in the entries that associate the MAC address tab with the TCP/IP address.
3. Connect the storage subsystem Ethernet ports to the network.
4. Boot the storage subsystem.

The DHCP server automatically assigns new IP addresses to the controller Ethernet port.

Steps for assigning static TCP/IP addresses to the controllers with the DS Storage Manager client host software: To complete this procedure, you must have the following components:

- A host that is connected to a storage subsystem through a fibre-channel I/O path
- A management station that is connected by an Ethernet cable to the storage subsystem controllers

Complete the following steps to assign static TCP/IP addresses to the DS5100 or DS5300 storage subsystem controllers, using default TCP/IP addresses that are assigned to the DS5100 or DS5300 storage subsystem controllers during manufacturing:

1. Make a direct management connection to the DS5100 or DS5300, using the default TCP/IP addresses:
   - **Controller A:** 192.168.128.101
   - **Controller B:** 192.168.128.102
   - **Subnet Mask:** 255.255.255.0

   Note: For a DS5100 or DS5300 that has two Ethernet ports per controller, use the Ethernet port that is labeled #1.
2. Start the DS Storage Manager client software. The Enterprise Management window opens.
3. Add the DS5100 or DS5300 to the Enterprise Management domain using the default IP addresses.
4. In the Enterprise Management window, click on the name of the default storage subsystem. The Subsystem Management window opens.
5. In the Subsystem Management window, right-click the controller icon and select **Change —> Network Configuration** in the pull-down menu. The Change Network Configuration window opens.
6. In the Change Network Configuration window, click on the Controller A and Controller B tabs and type the new TCP/IP addresses in their appropriate fields. Click **OK**.
7. Close the Subsystem Management window, wait at least five minutes, then delete the default storage subsystem entry in the Enterprise Management window. The default storage subsystem entry still displays, but shows an "unresponsive" icon.
8. If applicable, change the IP address of the Ethernet port in the management station to a value that is on the same TCP/IP subnet as the controller Ethernet port IP addresses that you just assigned. Exit DS Storage Manager, then restart.

9. Add a new storage subsystem entry in the Enterprise Management window, using the new assigned IP addresses.

Steps for assigning static TCP/IP addresses to the controllers with the controller serial port: To complete this procedure, you must have the following components:

- A null modem cable with DB-9 female connectors on both ends, used to connect the host serial port to the controller serial port.
- A terminal emulation software application, such as Procomm or Microsoft Windows Hyperterm, installed in the host system.

  Notes:
  1. The terminal session setting must have these values: 38400 BAUD; 8 data bits; 1 stop bit; no parity.
  2. If the controller BAUD rate setting is different from the terminal setting, send a "break" character to cause the controller to switch to the next available BAUD rate setting. Repeat sending the "break" character until the "Press space to set the BAUD rate" message is displayed.

- Controller firmware version 7.77.xx.xx or higher and its associated NVSRAM files installed.

Complete the following steps to view and assign new IP address to the controller management port:

1. Press **Enter**. If this character (->) is displayed, type **Exit** and press **Enter**. Otherwise, continue to next step.
2. In the terminal emulator session, send the "break" character (For example, use **CNTL+BREAK** for Microsoft Windows Hyperterm or **ALT+B** for Procomm).
3. Enter the uppercase letter *S* and press **Enter** when the following message is displayed: Press within 5 seconds: <S> for Service Interface, <BREAK> for baud rate
4. Enter the password **DSStorage** (case sensitive) within 60 seconds of when this message is displayed: Enter Password to access Service Interface (60 sec timeout).

   Note: If the controller does not have controller firmware version 7.77.xx.xx or higher and its associated NVSRAM files installed, this password will not be accepted, and you must follow one of the two methods to change the IP configuration of controller Ethernet ports that are described in the "Steps for assigning static TCP/IP addresses to the controllers with the DS Storage Manager client host software" on page 17.

5. When the following menu is displayed, enter 1 or 2 to display or change IP configuration, respectively.

   ```
   Service Interface Main Menu
   ===============================
   1) Display IP Configuration
   2) Change IP Configuration
   3) Reset Storage Array Administrator Password
   Q) Quit Menu
   ```

   If option 2 is chosen, follow the prompt to set the IP configuration for the port that you selected. You must reboot the controller for the settings to take effect.

> **Note:**
>
> To manage storage subsystems through a firewall, configure the firewall to open port 2463 to TCP data.

Controller memory

Each RAID controller has data cache memory. The processor memory stores the controller firmware, while the data cache is a buffer used to temporarily store hard disk drive data during data read and write operations. A Cache Active LED on the controller turns on when the cache contains data that has not been written to hard disk drives. The Cache Active LED turns off when the cache does not contain unwritten data.

Table 6 lists the technical specifications for the RAID controllers.

Table 6. RAID controller specifications

Category	Criteria	Specification
Memory	Cache size	Memory cache size varies based on model: • DS5100 (Model 51A): 4 GB per controller for a total of 8 GB • DS5300 (Model 53A): 8 GB per controller for a total of 16 GB Upgradeable to 32 GB per controller for a total of 64 GB per storage subsystem

Table 6. RAID controller specifications (continued)

Category	Criteria	Specification
Interface	Fibre channel or iSCSI host port	Two host interface cards per controller for a total of 8 fibre channel host ports or four iSCSI host ports per controller. Support for: • Two 4 Gbps FC host interface cards per controller • Two 8 Gbps FC host interface cards per controller • One 4 Gbps FC host interface card and one 8 Gbps FC host interface card per controller. • Two 1 Gbps iSCSI host interface cards per controller. • Two 10 Gbps iSCSI host interface cards per controller. • Any combination of 4 Gbps FC, 8 Gbps FC, or *either* 1 Gbps iSCSI *or* 10 Gbps iSCSI host interface cards. **Important:** Do not intermix a 1 Gbps and a 10 Gbps iSCSI host interface card in the same storage subsystem. When mixing 1 Gbps iSCSI or 10 Gbps iSCSI, 4 Gbps FC, and 8 Gbps FC host interface cards in a controller, you must use the same combination in the same host interface card slots in the other controller. For example, in controller A, if host interface card slot 1 contains a 4 Gbps host interface card and host interface card slot 2 contains an 8 Gbps host interface card, then host interface card slot 1 in controller B must contain a 4 Gbps host interface card and host interface card slot 2 must contain an 8 Gbps host interface card. Otherwise, the controller is in the lockdown state during the boot process. Two Ethernet ports per controller (for out-of-band management)
	Fibre channel drive expansion port	8 fiber-optic ports per controller **Note:** Each DS5100 or DS5300 controller drive channel has two ports. There are four drive channels per DS5100 or DS5300 controller.

Table 6. RAID controller specifications (continued)

Category	Criteria	Specification
Storage expansion enclosure support	Redundant drive channel pairs	4 per controller
	Maximum number of drives per redundant drive channel pair	112 drives per redundant drive channel pair (Seven storage expansion enclosures with 16 drives each). See Table 3 on page 9.
	Maximum number of drives supported by one DS5100	224 drives standard. Supports up to 480 drives with purchase of the Attach up to 448 drives feature pack and the Attach up to eight EXP5060 feature pack. A premium feature is available to provide support for up to 448 drives.
	Maximum number of drives supported by one DS5300	448 drives standard. Supports up to 480 drives with the purchase of the Attached up to eight EXP5060 feature pack.
Data transfer rates	Fibre channel host	Up to 8 Gb/sec maximum when 8 Gbps FC host interface cards are used. • Supports 1, 2, and 4 Gbps auto-negotiated FC speeds when using 4 Gbps host interface cards • Supports 2, 4, and 8 Gbps auto-negotiated FC speeds when using 8 Gbps host interface cards
	iSCSI host	1 Gb/sec maximum 10GBASE-SR) when 1 Gbps iSCSI HICs are used. 10 Gb/sec maximum when 10 Gbps iSCSI HICs are used.
	Fibre channel drives	4 Gbps
	SATA drives	3 Gbps
	Solid State Drives	4Gbps
	Ethernet management ports	10BASE-T 100BASE-T 1000BASE-T

Power supply and fan units

The DS5100 or DS5300 have two power supply and fan units. Each power supply and fan unit contains a power supply, a fan, and a battery charger. Each power supply provides power to the controllers by converting incoming ac voltage to the appropriate dc voltages. If one power supply and fan unit is turned off or malfunctions, the remaining power supply and fan unit can maintain electrical power and cooling to the storage subsystem.

Note: Contact IBM for information about possible future dc-to-dc power supply support.

Install the power supply and fan units from the front of the storage subsystem. Figure 8 shows how a power supply and fan unit slides into the storage subsystem. The levers that secure the left power supply and fan unit into the storage subsystem are shown in the released position. The levers that secure the right power supply and fan unit into the storage subsystem are shown in the latched position.

Note: Although both power supply and fan units in the DS5100 or DS5300 chassis are identical, they are seated in the DS5100 or DS5300 chassis in opposite orientations. The left and right power supply and fan units are installed so that the LED column of each power supply and fan unit is located towards the interior of the DS5100 or DS5300, along the side of the interconnect-battery unit.
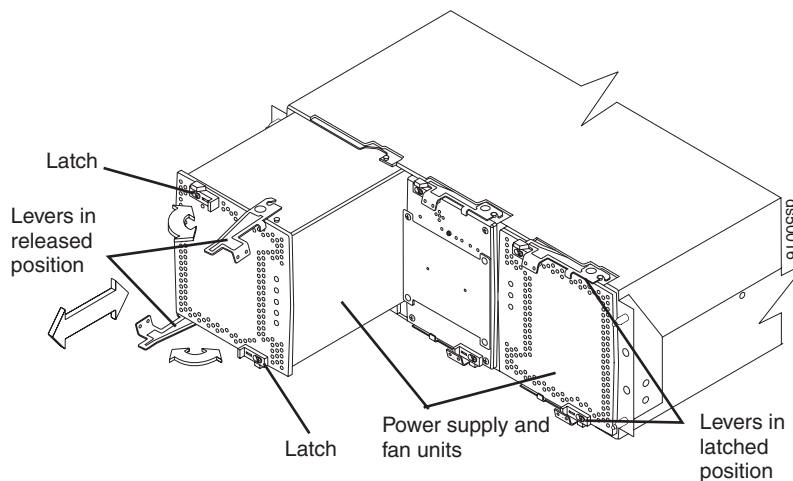
Figure 8. Power supply and fan unit

Information about the condition of the power supplies, fans, and battery charger is conveyed by indicator lights (LEDs) on the front of each of the power supply and fan units and on the interconnect-battery unit. You must remove the front bezel to see the LEDs. ("Power supply and fan unit LEDs" on page 175 identifies the indicator LEDs on a power supply and fan unit and explains the conditions that each LED indicates.)

Note: The order of the LEDs on the power supply and fan unit is different depending on whether the power supply and fan unit is installed in the left or right bay.

In the DS5100 or DS5300, the right power supply and fan unit is linked to controller A, and the left power supply and fan unit is linked to controller B. To increase protection against power loss, always make sure that both power supply and fan units are operational.

Interconnect-battery unit

The interconnect-battery unit is a removable midplane that provides cross-coupled signal connection between the controllers. The control output from each controller is connected to the control input in the alternate controller. An audible alarm is mounted on the interconnect-battery unit display board. A mute switch for the audible alarm is also mounted on the same board. The interconnect-battery unit also provides the electrical communication path between the power supply and fan

units and allows their power supplies to load-share and to charge the cache-backup battery packs. There are two cache-backup battery packs mounted inside the interconnect-battery unit.

Attention: Because the interconnect-battery unit provides electrical signal connections between the controllers, removing the interconnect-battery unit interrupts the communications between the controller units in the DS5100 or DS5300, resulting in a loss of communication between controllers A and B. Data access is limited to only controller A when the interconnect-battery unit is removed. Controller B is in an offline state while controller A performs all controller operations. To prevent any problems as a result of this condition, controller B must be placed offline before you remove the interconnect-battery unit. See "Replacing the interconnect-battery unit" on page 209 for more information. Failure to observe the instructions and prerequisites described in "Replacing the interconnect-battery unit" on page 209 might result in a loss of data access.

Figure 9 shows how the interconnect-battery unit slides into the front of the storage subsystem. The levers securing the interconnect-battery units to the storage subsystem are shown in the released position.
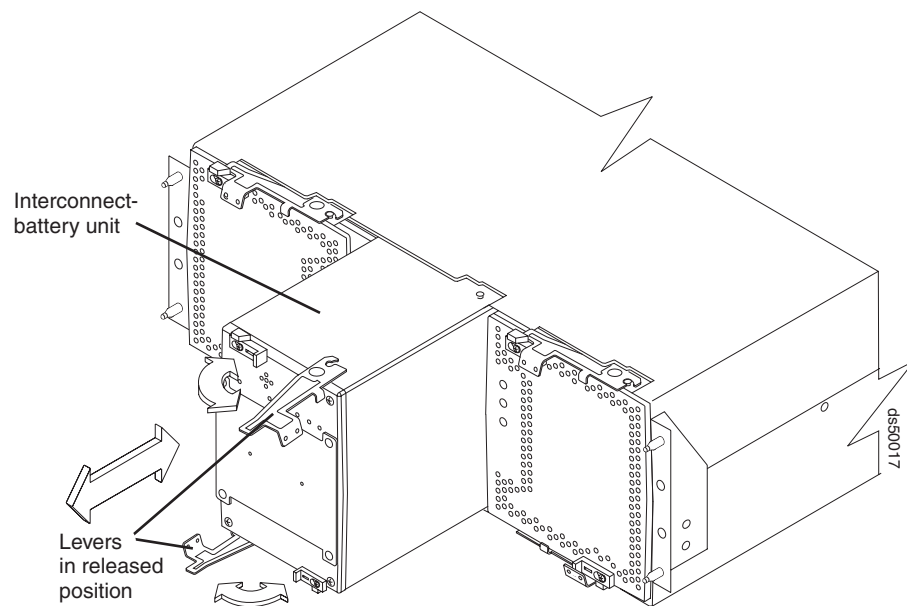
Figure 9. Interconnect-battery unit

The interconnect-battery unit contains two battery packs that maintain power for up to thirty minutes to allow the controller to flush all cache data to the USB flash memory modules, which are installed on each controller. Each battery pack contains sealed, rechargeable lithium ion batteries.

The battery chargers in the power supply and fan units perform a battery test and learn when the storage subsystem is started and on a regularly scheduled interval thereafter. Data caching is suspended during periods when the controllers perform battery tests and learn cycles only if the battery charge capacity drops below the minimum required charge level for backing up cache during the power down event.

The interconnect-battery unit is hot-swappable. You can remove the interconnect-battery unit for servicing and then reinsert it while the DS5100 or DS5300 continues to perform I/O operations.

Note: Data caching is suspended when the interconnect-battery unit is removed from the chassis.

Attention

Never remove the interconnect-battery unit unless directed to do so by an IBM support representative. Removing the interconnect-battery unit after a controller or a power supply and fan unit has already been removed results in a loss of data access. Refer to "Replacing the interconnect-battery unit" on page 209 for complete information about the conditions required for safe removal of the interconnect-battery unit. *Do not* replace the interconnect-battery unit without first meeting the requirements described in "Replacing the interconnect-battery unit" on page 209.

Information about the condition of the interconnect-battery unit is conveyed by indicator LEDs on the front of interconnect-battery unit. ("Interconnect-battery unit LEDs" on page 176 identifies the indicator LEDs on the interconnect-battery unit and explains the conditions that each LED indicates.)

You must remove the front bezel in order to see all of the interconnect-battery unit LEDs. With the bezel in place, only the following interconnect-battery unit LEDs are visible:
- Power
- Overall DS5100 or DS5300 Configuration Needs Attention
- Locate/Identify

Note: The displayed order of the Overall DS5100 or DS5300 Configuration Needs Attention and Locate/Identify LEDs on the interconnect-battery unit are reversed when the bezel is removed. See "Front bezel LEDs" on page 168 and "Interconnect-battery unit LEDs" on page 176.

SFP modules

The storage subsystem supports fiber-optic interface cables. You must install a Small Form-factor Pluggable (SFP) module in each interface connector on the controller where a fibre optic cable is to be installed. Do not install an SFP in any port that will not have a fibre optic cable attached. Additionally, it is best practice that you remove any SFP from any port that does not have fibre optic cables attached.

Figure 10 on page 25 shows an SFP module with fiber-optic cable. Note that the SFP module shown might look different from those shipped with your unit. The differences do not affect module performance.

Attention: Currently, the DS5100 or DS5300 supports only short-wave/multimode SFPs. In DS5100 or DS5300 configurations, you may use long-wave SFPs only in fibre channel switches that connect DS5100 or DS5300s over long distances. In addition, there are not any visual markings to identify the maximum operating speeds of the SFPs aside from the option and FRU part number on the SFP label.
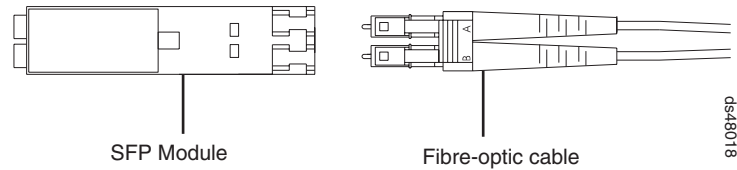
Figure 10. SFP module with fiber-optic cable

SFP+ modules

The 10 Gbps iSCSI host interface card supports fiber-optic interface cables. You must install a 10 Gbps Small Form-factor Pluggable (SFP+) module in each interface connector on the HIC port where a fibre optic cable is to be installed.

Attention:

1. SFP+ modules are not the same as SFP modules that are used for the controller FC host and drive ports. SFP+ modules are not interchangeable with SFP modules.

2. For SFP+ modules, you must use *OM3 fiber* 50u MMF fibre channel cables. The OM3 fiber 50u MMF fibre channel cables are not interchangeable with the OM2 fiber 50u MMF fibre channel cables that are used for FC host and drive ports.

When installing and removing SPF+ modules, and handling fibre-optic cables for SPF+ modules, follow the same procedures as for SPF modules. See "Working with SFPs, SFP+s, and fiber-optic cables" on page 49.

Software and hardware compatibility and upgrades

The latest DS5100 or DS5300 controller firmware and NVSRAM, the storage expansion enclosure drive enclosure ESM firmware, and fibre channel and SATA drive FRUs firmware must be installed to ensure optimal functionality, manageability, and reliability.

See www.ibm.com/systems/support/storage/disk for the latest DS5100 or DS5300 publications, firmware, and host software.

See Table 7 for the minimum controller firmware level required by some options.

Table 7. Minimum controller firmware level required by some options

Option	Minimum controller firmware version
8 Gbps FC host interface card	7.50.xx.xx
1 Gbps iSCSI host interface card or Solid State drives	7.60.13.05
10 Gbps iSCSI host interface card	7.77.14.00
Full Disk Encryption hard disk drives	7.50.13.xx
EXP5060 storage expansion enclosure	7.60.13.05

Software and firmware support code upgrades

To enable support for the DS5100 or DS5300, you *must* ensure that your system has the correct versions. To find the latest DS Storage Manager software, storage

subsystem controller firmware, ESM, and NVSRAM firmware, check the firmware README files. See "Finding Storage Manager software, controller firmware, and README files" on page xxviii to learn how to access the README files on the Web.

For instructions to install the DS Storage Manager host software, see the *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* for your operating system.

Note: For the latest information about supported servers and operating systems, refer to the System Storage Interoperation Center at this Web site:

www.ibm.com/systems/support/storage/config/ssic/index.jsp

Determining firmware levels

There are two different methods to determine the DS5100 or DS5300 firmware versions. Each method uses the DS Storage Manager client that manages the DS5100 or DS5300.

Method One:

1. In the Subsystem Management window, click the **Summary** tab.
2. In the Monitor section, click **View Storage Subsystem Profile**. The **Storage Subsystem Profile** window opens. Scroll through the data to locate the following information:

Note: The Storage Subsystem Profile window shows information for the entire subsystem. Therefore, you might have to scroll through a large amount of information to locate the firmware version numbers.

DS5100 or DS5300 Storage Subsystem

- NVSRAM version
- Firmware version

Drives

- Firmware version
- ATA translator card firmware version (SATA E-DDMs only)

    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 for Storage Manager version 10.50.xx.xx and earlier.

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 (and ATA translator card 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 and drive enclosure component firmware versions:

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.

If you have Storage Manager version 10.60.xx.xx:

In the Physical View pane of the Subsystem Management window, click on any component, such as Controller (for Controller firmware), Drive (for drive and ATA translator firmware), or View enclosure component (for ESM firmware and ESM configuration settings) in the left pane of this window. The component properties are listed in the right pane of this window.

Repeat this step for each component.

Specifications

This section provides site specifications for the DS5100 or DS5300. Before installing a storage subsystem, 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 DS5100 or DS5300 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 11 on page 28 shows the dimensions of the DS5100 or DS5300, which conform to the 19-inch rack standard.
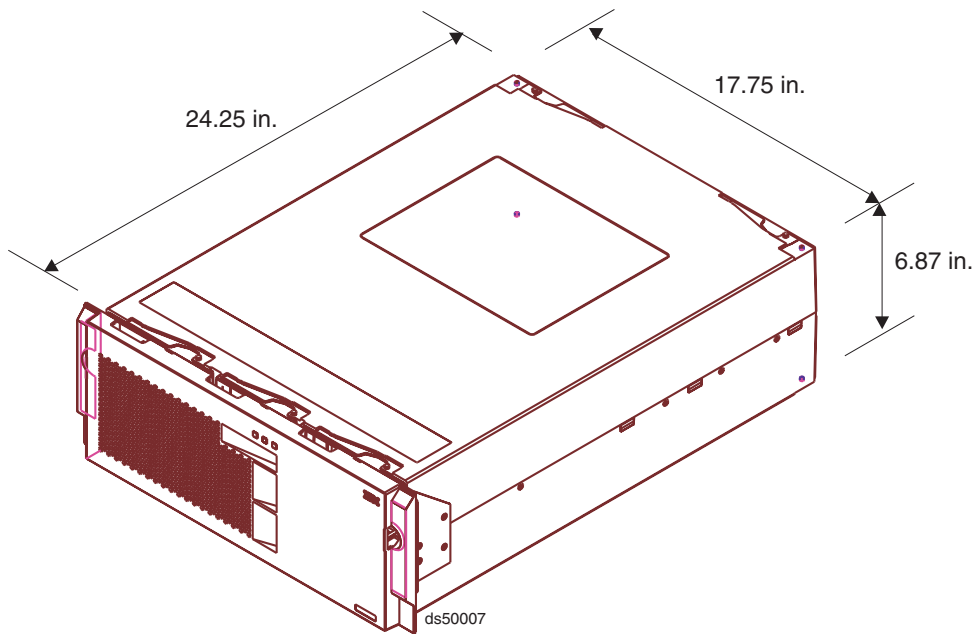
Figure 11. DS5100 or DS5300 Storage Subsystem dimensions

Weight

The total weight of the storage subsystem depends on the number of components installed. Table 8 lists the maximum, empty, and shipping weights for the storage subsystem in different configurations. Table 9 lists the weight of each component.

Table 8. DS5100 or DS5300 Storage Subsystem weights

Unit	Weight		
	Maximum [1]	Empty [2]	Shipping [3]
DS5100 or DS5300 Storage Subsystem	36.8 kg (81.1 lb)	13.2 kg (29.0 lb)	49.4 kg (109 lb)

[1] Maximum weight indicates a storage subsystem with two battery modules installed. Each battery module weighs 1.1 kg (2.5 lb).

[2] Empty weight indicates a storage subsystem with all components removed.

[3] Shipping weight indicates the maximum weight of the storage subsystem and all shipping material.

Table 9. DS5100 or DS5300 component weights

Unit	Weight
RAID controller	6.24 kg (13.8 lb)
Power supply and fan unit	3.7 kg (8.2 lb)
Interconnect-battery unit	4.1 kg (9.0 lb)
Battery module	1.1 kg (2.5 lb)

Shipping dimensions

Table 10 on page 29 lists shipping carton dimensions. The height shown includes the height of the pallet.

Table 10. DS5100 or DS5300 shipping carton dimensions

Height	Width	Depth
44.4 cm (17.5 in.)	62.2 cm (24.5 in.)	78.7 cm (31.0 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 unit.

Temperature and humidity

Table 11 lists the acceptable temperature and humidity ranges in which the storage subsystem is designed to operate.

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

Table 11. Temperature and humidity requirements

Condition	Parameter	Requirement
Temperature [1]	Operating range	10° - 35° C (50° - 95° F)
	Maximum rate of change	10° C (18° F) per hour
	Storage range	1° - 60° C (33° - 140° 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	20% to 80%
	Storage range	10% to 93%
	Transit range	5% to 95%
	Maximum dew point	26° C (79° F)
	Maximum gradient	10% per hour

Notes:

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

Altitude

Table 12 lists the acceptable altitudes for operating, storing, and shipping the DS5100 or DS5300.

Table 12. DS5100 or DS5300 altitude ranges

Environment	Altitude
Operating	30.5 m (100 ft.) below sea level to 3048 m (10,000 ft.) above sea level

Table 12. DS5100 or DS5300 altitude ranges (continued)

Environment	Altitude
Storage	30.5 m (100 ft.) below sea level to 3048 m (10,000 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 12 shows the intended airflow for a DS5100 or DS5300. 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.
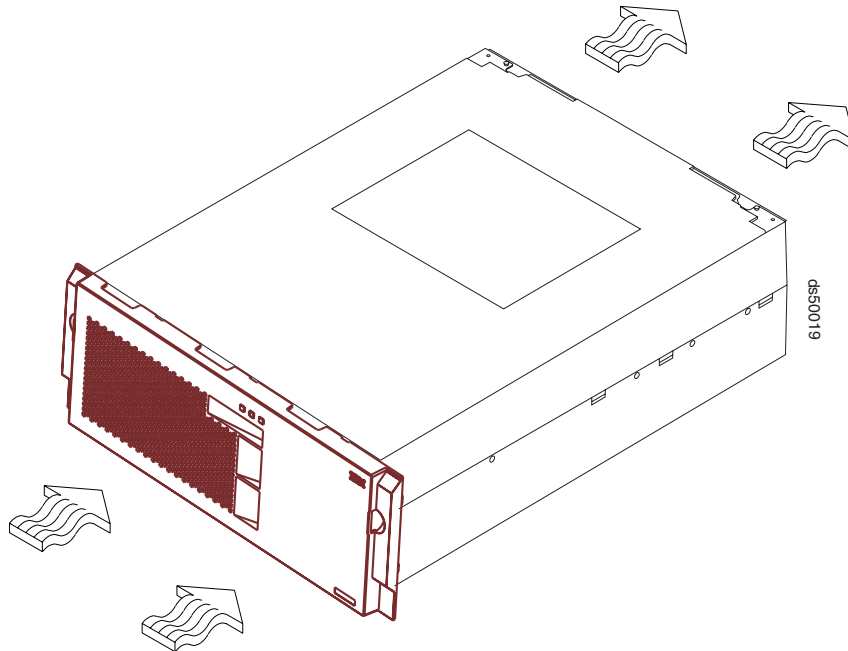
Figure 12. DS5100 or DS5300 airflow

Table 13 lists the KVA, watts, and Btu calculations for the DS5100 or DS5300. 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 13. DS5100 or DS5300 power and heat dissipation

Parameter	KVA	Watts (ac)	Btu per hour
RAID controller 90Vrms	.644	636	2175

Shock and vibration requirements

Operational shock and operational vibration requirements are shown in this section.

Operational Shock: The DS5100 or DS5300 withstands the following shock. Subjecting the equipment to a single shock pulse with the following characteristics will simulate this level of shock:

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

Operational Vibration (Random): While in its normal operating position, the DS5100 or DS5300 continues operating when subjected to a random vibration test using the criteria shown in Table 14. This test uses a dwell time of 15 minutes at any frequency where vigorous or resonant excitation occurs.

Table 14. DS5100 or DS5300 operational vibration specifications

Parameter	Value
Frequency sweep	5 Hz - 150 Hz - 5 Hz
Wave form	Sinusoidal, 0.25 g

Acoustic noise

Table 15 lists the maximum sound levels emitted by the storage subsystem.

Table 15. DS5100 or DS5300 sound levels

Measurement	Level
Sound power (normal operation)	6.0 bels
Sound pressure (normal operation)	60 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 DS5100 or DS5300 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 16. IBM System Storage DS5100 or DS5300 ac power requirements

	Low Range	High Range
Nominal Voltage	110	220
Voltage	90 to 132 VAC	198 to 264 VAC
Frequency (Hertz)	50 to 60 Hz	50 to 60 Hz
Minimum Operating Current	3.49 A[1]	1.842 A[2]
Maximum Operating Current	7.055 A[1]	3.182 A[2]
Maximum Surge Current	8.4 A[1]	18.2 A[2]

[1.] Typical voltage: 120 V ac, 60 Hz, assumes 75% power-supply efficiency and 0.99 power factor

[2.] Typical voltage: 240 V ac, 60 Hz, assumes 75% power-supply efficiency and 0.99 power factor

Site wiring and power

The storage subsystem 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 DS5100 or DS5300 is 5 amps at 100 VAC and 2.25 amps at 240 VAC. These are the overall maximum currents for this system.

AC power recovery

After normal power is restored after a total ac power failure, the DS5100 or DS5300 performs power-up recovery procedures automatically without operator intervention.

Power cords and receptacles

The DS5100 or DS5300 ships with the line jumper cords used to connect the DS5100 or DS5300 to rack power distribution units (PDUs). If you need the ac power cords to connect the DS5100 or DS5300 to wall receptacle outlets, you must purchase the appropriate power cords for your country or region as described in Appendix E, "Power cords," on page 271.

Heat output, airflow, and cooling

The maximum heat output of the storage subsystem is 557 watts (1905 BTU/hr). Each storage subsystem rack-mounted unit requires an airflow of 2.5 m^3 (87 ft.^{3}) per minute. The input air temperature to all rack cabinets should be in the range 10° C - 35° C (50° F - 95° F). The best practice operating temperature is 22° C (72° F).

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

- Air enters at the front of the rack cabinet and leaves at the back. To prevent the air that is leaving the rack cabinet from entering the intake of another piece of equipment, you must position the rack cabinets in alternate rows, back-to-back and front-to-front. This arrangement is known as *cold aisle/hot aisle* and is shown in Figure 13 on page 33.

- Where rack cabinets are in rows, each rack cabinet must touch the rack cabinet that is next to it. This reduces the amount of hot air that can flow around from the back of the rack into the intakes of the storage subsystems that are in that rack cabinet. You should use Suite Attach Kits to completely seal any gaps that remain between the rack cabinets. For details about Suite Attach Kits, contact your marketing representative.
- Where rack cabinets are in rows front-to-front or back-to-back, a gap of at least 1220 mm (48 in.) must separate the rows across the cold aisle.
- To ensure correct airflow in each rack cabinet, the rack filler plates must be installed in unused positions. Also, all the gaps in the front of the rack cabinets must be sealed, including the gaps between the storage subsystems.
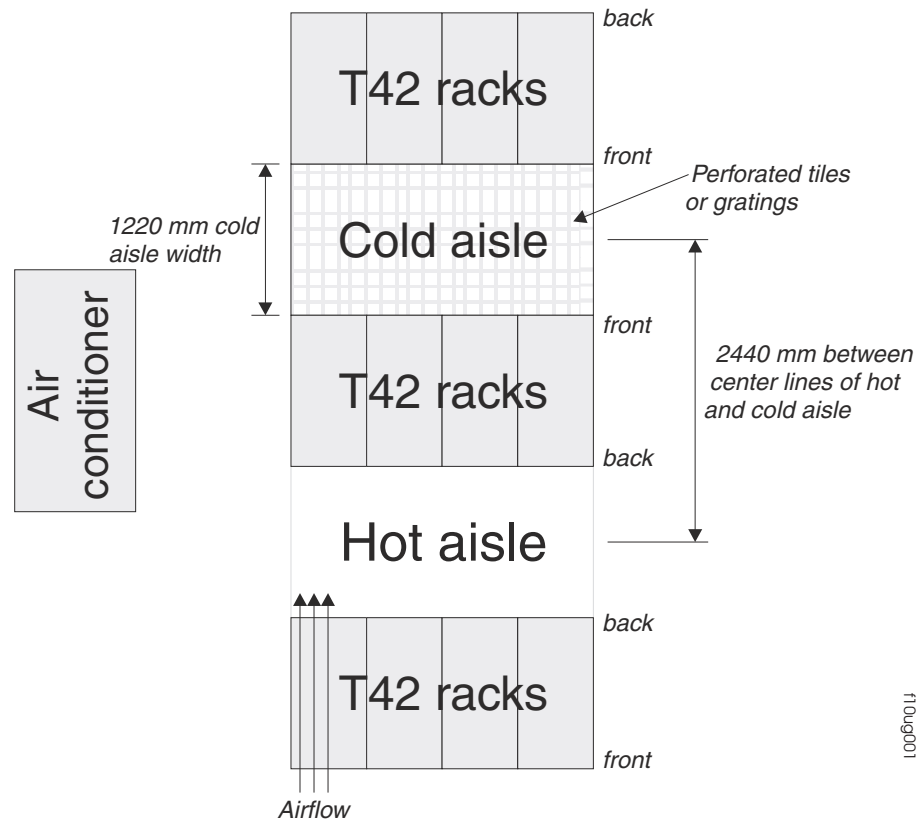
Figure 13. Example of cold aisle/hot aisle rack cabinet configuration

Chapter 2. Installing the storage subsystem

This chapter provides the information that you need to install the storage subsystem into a rack cabinet.
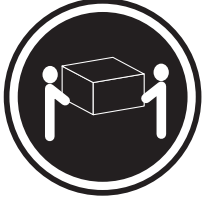
Before you begin the installation, review the safety information in "Safety" on page iii.

Chapter 2, "Installing the storage subsystem" provides an overview of the entire storage subsystem installation process. Read this overview before you begin the installation.

Installation overview

Statement 4:

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

CAUTION:
Use safe practices when lifting.

Attention: A fully configured DS5100 or DS5300 weighs 36.8 kg (81.1 lb). At least two other people should help you lift the DS5100 or DS5300 from the shipping box.

The following steps summarize the DS5100 or DS5300 installation process.

1. Review the preparation best practices. See "Preparing for installation" on page 37.
2. Prepare the installation site. See "Preparing the site" on page 39.
3. Prepare the rack cabinet. See "Preparing the rack cabinet" on page 39.
4. Fold down and open the sides of the shipping box. Without removing the DS5100 or DS5300 from box, you can remove the DS5100 or DS5300 rack mounting rails and hardware from the box, which is placed on the bottom of the shipping box underneath the DS5100 or DS5300 enclosure. Install the support rails in the rack cabinet. See "Installing the support rails" on page 40.
5. Record the serial number, machine type and model number, and MAC addresses for the RAID controller management port and iSCSI port (if installed) for your DS5100 or DS5300 in Appendix B, "Records," on page 257.

   The serial number, machine type, and model number are located on top of each the DS5100 or DS5300 subsystem unit. The MAC addresses are located near the management and iSCSI ports on each RAID controller, as shown in

Figure 148 on page 258. You may not be able to easily access this information after you install the DS5100 or DS5300.

6. Install and secure the DS5100 or DS5300 chassis in the rack cabinet. See "Installing the DS5100 or DS5300 on the support rails" on page 45.

7. Install in the rack cabinet the storage expansion enclosure or enclosures you will cable to the DS5100 or DS5300. Follow the instructions in the Installation, User's, and Maintenance Guide for your storage expansion enclosure to set up and mount the storage expansion enclosures.

> **Attention**
>
> Before you power on the DS5100 or DS5300, the storage subsystem must be cabled to at least one storage expansion enclosure populated with the minimum number of drives for the storage expansion enclosure. Otherwise, the DS5100 or DS5300 controllers do not successfully complete the power-on process and operate optimally.
>
> All drives in the connected storage expansion enclosure or enclosures must contain no prior configuration data. Additionally, if at least two drives are not installed in each EXP5000 attached storage expansion enclosure, or at least four drives in each EXP5060 storage expansion enclosure, the resulting insufficient load to the storage expansion enclosure power supplies might cause the drive expansion enclosure power supplies to intermittently appear as failed and then reappear in an optimal state, falsely indicating that the power supplies are bad.

8. Use SFP modules and fibre channel cables to cable the DS5100 or DS5300 to the storage expansion enclosure or enclosures. See "Connecting storage expansion enclosures to the DS5100 or DS5300" on page 64.

9. Perform one of the following cabling tasks to enable management of the DS5100 or DS5300 configuration:
    - If you are using out-of-band management, cable the DS5100 or DS5300 Ethernet ports to either the management workstation or the host. See "Connecting secondary interface cables" on page 135.
    - If you are using in-band management, cable the DS5100 or DS5300 host channels to the fibre channel host bus adapters (HBAs) in either the hosts or the fibre channel switch that connects to the host HBAs. See either "Connecting hosts directly to the DS5100 or DS5300 Fibre Channel host ports" on page 132, or "Connecting hosts to the DS5100 or DS5300 iSCSI ports" on page 134.

10. Connect the power cables for the DS5100 or DS5300. See "Connecting the power cables" on page 147.

11. Power on the attached storage expansion enclosures and the DS5100 or DS5300 using the procedure described in "Turning on the storage subsystem" on page 155.

12. Install the DS Storage Manager host software on the management workstation (for out-of-band management) or on the host (for in-band management). For instructions to install the DS Storage Manager host software, see the *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide*for the appropriate operating system.

13. Use the DS Storage Manager host software to verify the configuration.

14. Review and perform the procedures described in "Performing the DS4000, DS5100, and DS5300 Health Check process" on page 152.

Handling static-sensitive devices

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

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

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

Preparing for installation

Before installing the DS5100 or DS5300, create a detailed plan of how this unit will be used in your storage configuration. The plan should include determining RAID levels, failover requirements, operating systems to be used, and total storage capacity requirements.

Complete the following steps to prepare the DS5100 or DS5300 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 27.
2. Move the shipping box that contains the DS5100 or DS5300 to the site.

   Attention: The DS5100 or DS5300 shipping box weighs up to 53.8 kg (118.4 lb).

Statement 4:

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

CAUTION:
Use safe practices when lifting.

3. Remove the mounting rails, mounting hardware, and line jumper cords from the DS5100 or DS5300 shipping box. Do not remove the DS5100 or DS5300 from the shipping box at this time.

   Attention: The mounting rails, mounting hardware, and line jumper cords may be packed beneath the DS5100 or DS5300 in the shipping box. To remove these items from the shipping box without first removing the DS5100 or DS5300, open the two long sides of the shipping box. Then open and fold flat the two short sides of the shipping box. This enables you to access the mounting rails, mounting hardware, and line jumper cords without first removing the DS5100 or DS5300 from the shipping box.

   After you open the DS5100 or DS5300 shipping container and remove the mounting rails, mounting hardware, and line jumper cords, check the remaining contents (see "Inventory checklist" on page 4) without removing the DS5100 or DS5300 from the shipping box. If any items are missing, contact your IBM reseller before proceeding.

4. Assemble the tools and equipment that you will need for installation. These include the following:

   - Region-specific power cords required for the DS5100 or DS5300.
   - 5/16 (8 mm) hex nut driver.
   - Medium flat-blade screwdriver.
   - Anti-static protection (such as a grounding wrist strap).
   - Fibre channel and Category 5a or Category 6 Ethernet interface cables and cable straps.
   - SFP modules.
   - The line cord jumper power cords that are shipped with the DS5100 or DS5300.
   - The rack-mounting hardware that ships with the DS5100 or DS5300.
   - The appropriate host software kit for your operating system.

     The DS5100 or DS5300 ships with your choice of host software kits (Windows, AIX, Linux, Mac OS, SUN Solaris, HP-UX, Linux on POWER, or VMware). The host software kit grants you permission to attach host servers using the appropriate operating system to the DS5100 or DS5300.

The kit includes a *DS Storage Manager Support* DVD that has the appropriate IBM DS Storage Manager host software. If you order more than one host software kit, the additional kits may also be shipped in the DS5100 or DS5300 shipping box.

The DVD also includes the DS Storage Subsystem controller firmware. Controller firmware can be downloaded from the IBM support Web site for DS5100 or DS5300 storage products:

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

Note: Depending on your DS5100 or DS5300 model, you may need to purchase the appropriate host software kit for your host server operating system. Contact your IBM representative or reseller for more information.

5. Continue with "Preparing the site."

Preparing the site

This section lists the floor space requirements and weight information for the storage subsystem. For information on interface cables and connections, see Chapter 3, "Cabling the storage subsystem," on page 49.

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

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

Ensure that all requirements, such as floor space, air conditioning, and electrical service, have been met. Other site preparation activities include the following tasks:

- To ensure that there is enough room to move around the cabinet and install modules, clear space at the installation area.
- Install uninterruptible power supply (UPS) devices.
- If applicable, install host servers with fibre channel host bus adapters (HBAs), fibre channel switches, or other devices.
- Route interface cables from the fibre channel HBA ports in the hosts or fibre channel switches to the installation area.
- Route main power cords to the installation area.

Continue with "Preparing the rack cabinet."

Preparing the rack cabinet

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

- Review the documentation that comes with your rack enclosure for safety and cabling considerations.
- If you are using a non-IBM rack or cabinet, review the information in Appendix D, "Specifications for non-IBM rack installation," on page 263.
- Do not extend more than one device out of the rack cabinet at the same time.
- Install the storage subsystem in a 22° C (72° F) environment. See "Environmental requirements and specifications" on page 29 for details.
- To ensure proper airflow, do not block the air vents; ensure at least 15 cm (6 in.) of air space.

- 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 subsystem to a properly grounded outlet.
- Always connect the IBM-certified rack power distribution units (PDUs) to at least two independent power circuits or sources.
- If you are installing EXP5060 expansion enclosures and storage subsystems, install the EXP5060 expansion enclosures first, starting at the bottom of the rack.

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

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 support rails."

Installing the support rails

Attention: Duplicate copies of the rack mounting templates are provided in Appendix C, "Rack mounting templates," on page 259. If you want to tear out the templates from this document for easier use, use the copies provided in Appendix C, "Rack mounting templates," on page 259 instead of the copies in this section.

Use the following templates and instructions to identify the proper locations for inserting M5 screws when mounting the support rails and DS5100 or DS5300 to a rack cabinet. The locations for the M5 screws are highlighted in the templates.

Hold the appropriate template up to each side of the rack cabinet at the 4–U section where you will install the DS5100 or DS5300. The highlighted squares on each side of the template mark the positions where you will thread the M5 screws that secure the rails and the DS5100 or DS5300 to the front and rear of the cabinet.

The DS5100 or DS5300 is 4 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 shown in the following rack mounting templates are square. The holes in your rack might be round, square, or threaded. Use the washers supplied under the heads of the M5 screws when mounting to racks with square holes.

FRONT
Rack Mounting
Template

4 U

3 U

Rail assembly
(Front left)

2 U

1 U

Rail assembly
(Front left)

0 U

Front

4 U

3 U

Rail assembly
(Front right)

2 U

1 U

Rail assembly
(Front right)

0 U
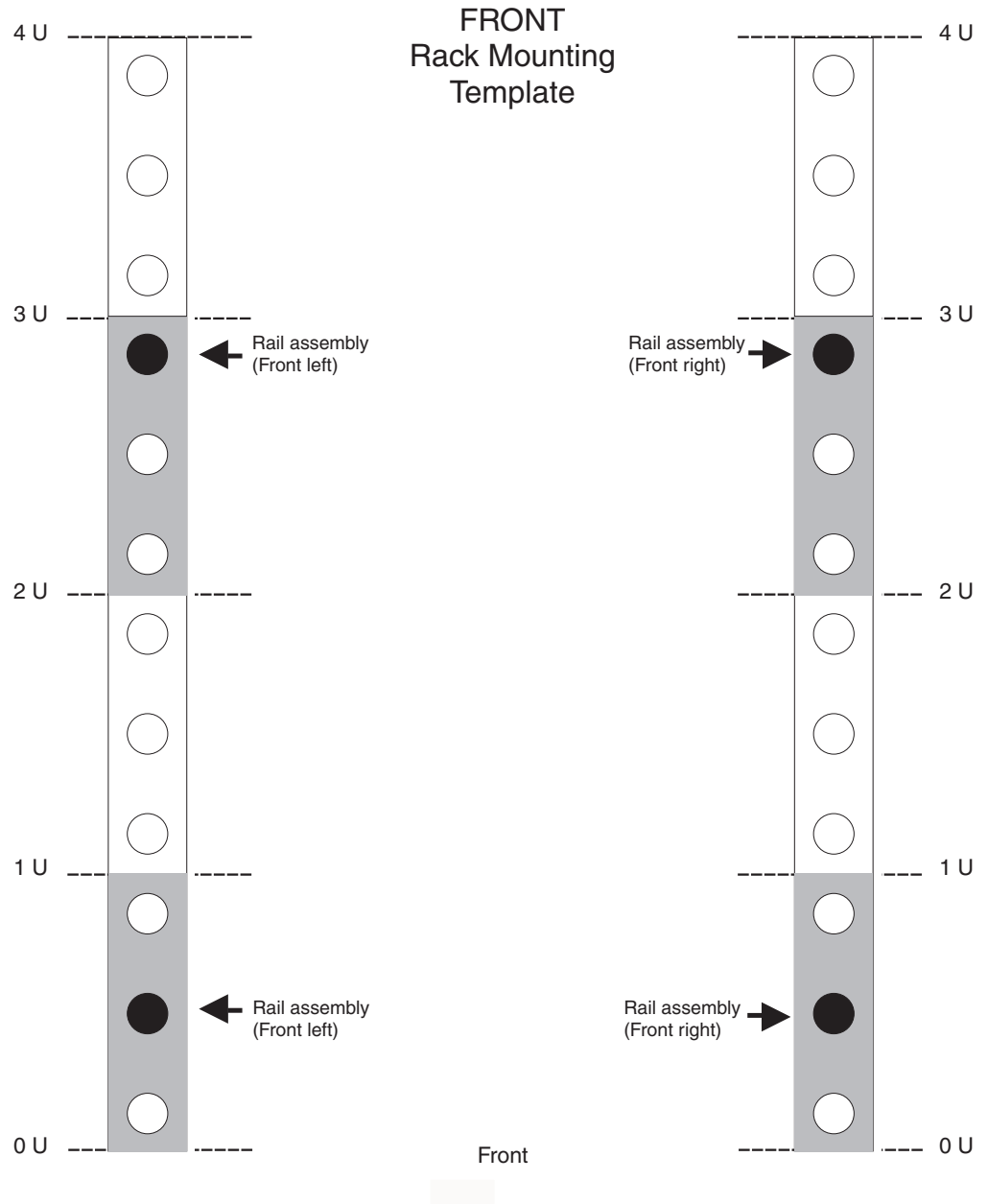
Figure 14. DS5100 or DS5300 front rack mounting template

REAR
Rack Mounting
Template

4 U
3 U
2 U
1 U
0 U

Rail assembly
(Rear left)

Rail assembly
(Rear right)

4 U
3 U
2 U
1 U
0 U

IBM
Printed in the U.S.A
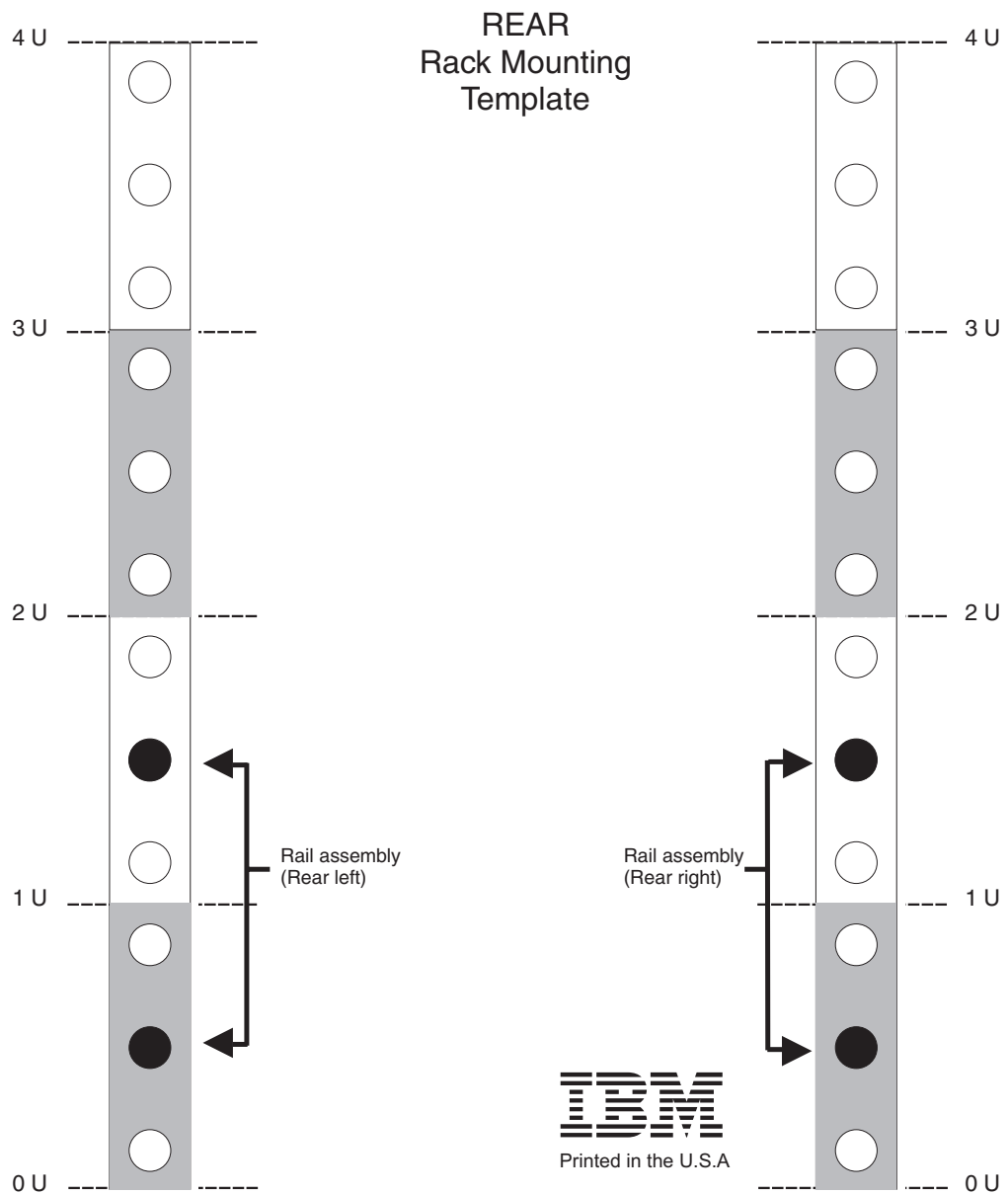
Figure 15. DS5100 or DS5300 rear rack mounting template

Before installing the DS5100 or DS5300 in a rack cabinet, you must install the rails
and rack-mounting hardware that come with your storage subsystem. The DS5100
or DS5300 requires an Electronic Industries Association (EIA) 310-D Type A 19-inch
rack cabinet.

The distance between EIA rails, from the front to the rear of the rack cabinet, is
60.96 cm (24 in.) minimum and 81.28 cm (32 in.) maximum. This rack cabinet
conforms to the EIA standard. Where you place the support rails in the rack cabinet
depends on where you intend to position the storage subsystem.

Note: If you are using a non-IBM rack or cabinet, review the information in
Appendix D, "Specifications for non-IBM rack installation," on page 263.

Figure 16 shows the support rail assembly for the DS5100 or DS5300.
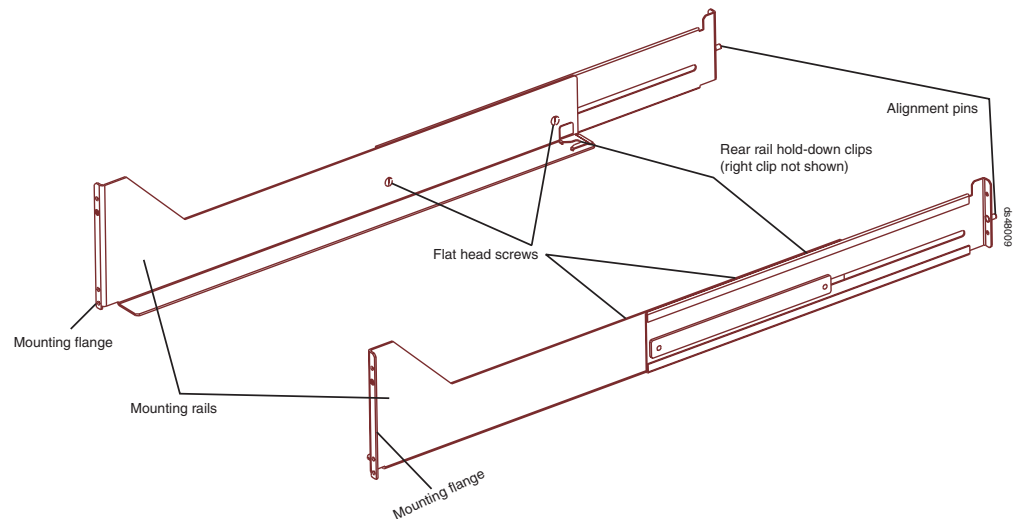
Figure 16. DS5100 or DS5300 support rail assembly

Complete the following steps to install the support rails:

Note: Refer to Figure 16 while performing these steps.

1. Ensure that the rack cabinet has already been installed.

2. Ensure that a stabilizer has been correctly attached to the bottom front of the rack cabinet to prevent the rack cabinet from tipping forward while the DS5100 or DS5300 is being installed.

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

3. If you have not yet done so, remove the mounting rails, mounting hardware, and line jumper cords from the DS5100 or DS5300 shipping box, which is on the bottom of the shipping box beneath the DS5100 or DS5300 chassis. Do not remove the DS5100 or DS5300 from the shipping box at this time.

   Attention: The mounting rails, mounting hardware, and line jumper cords may be packed beneath the DS5100 or DS5300 in the shipping box. To remove these items from the shipping box without first removing the DS5100 or DS5300, open the two long sides of the shipping box. Then open and fold flat the two short sides of the shipping box. This enables you to access the mounting rails, mounting hardware, and line jumper cords without first removing the DS5100 or DS5300 from the shipping box.

4. Locate the two support rails and six of the eight M5 screws that are supplied with the DS5100 or DS5300.

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

   Attention: Use the rack mounting templates in this chapter or in Appendix C, "Rack mounting templates," on page 259 to locate the proper rack mounting holes for installing the support rails into the rack cabinet.

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

   - Plan the installation so that each DS5100 or DS5300 subsystem and its associated storage expansion enclosures are mounted together in the same rack, or in adjacent racks if necessary.

- When you install the DS5100 or DS5300 and associated storage expansion enclosures into a rack cabinet, install each device in the lowest available position and work upwards so that the rack does not become unstable.

  Note: If you are installing more than one DS5100 or DS5300, install each DS5100 or DS5300 and its associated storage expansion enclosures in a separate rack cabinet.
- If appropriate, allow for possible later installation of other units.
- If necessary, remove the rack power distribution units (PDUs) before you install the support rails.
- For procedures and more information, refer to the installation and service guide, or equivalent, for the rack cabinet.

6. Starting with the left rail, use a medium flat-blade screwdriver to loosen the two flat-head rail adjustment screws. See Figure 16 on page 43.

7. Hold the front of the left rail against the *inside* of the front rack-mounting flange, and then extend the rear of the support rail until it makes contact with the rear rack mounting flange. The alignment pins at the rear of the rail should slide into the holes at the rear of the rack.

8. From the front of the rack, with the rail mounting flanges *inside* of the front rack-mounting flange, use the 5/16 (8 mm) hex nut driver to thread and loosely tighten the lower M5 screw only. Use the front rack mounting template or use the copy in Appendix C, "Rack mounting templates," on page 259) to locate the proper rack mounting hole for installing this screw.

   Attention: Do not completely tighten the screw until you have installed the DS5100 or DS5300 in the rack cabinet.

9. From the rear of the rack, thread and loosely tighten two M5 screws using the 5/16 (8 mm) hex nut driver. Use the rear rack mounting template or use the copy in Appendix C, "Rack mounting templates," on page 259) to locate the proper rack mounting holes for installing these screws. Do not completely tighten the screws until you have installed the DS5100 or DS5300 in the rack cabinet.

   When you are finished installing the left rail, the rail should be attached to the cabinet using one M5 screw in the front and two M5 screws at the back. All three M5 screws should be loosely tightened.

10. Repeat step 6 through step 9 for the right rail.

11. Tighten the rail adjustment screws on both rails.

12. Continue with "Installing the DS5100 or DS5300."

Installing the DS5100 or DS5300

The DS5100 or DS5300 contains two controllers, two power supply and fan units, and one interconnect-battery unit. The RAID controllers are located at the back of the unit. The two power supply and fan units and the interconnect-battery unit are located behind the front bezel.

Figure 17 on page 45 shows the front bezel of the DS5100 or DS5300, a front view without the cover, and a back view. Figure 17 on page 45 also shows the locations of the components that are referenced during this installation procedure.
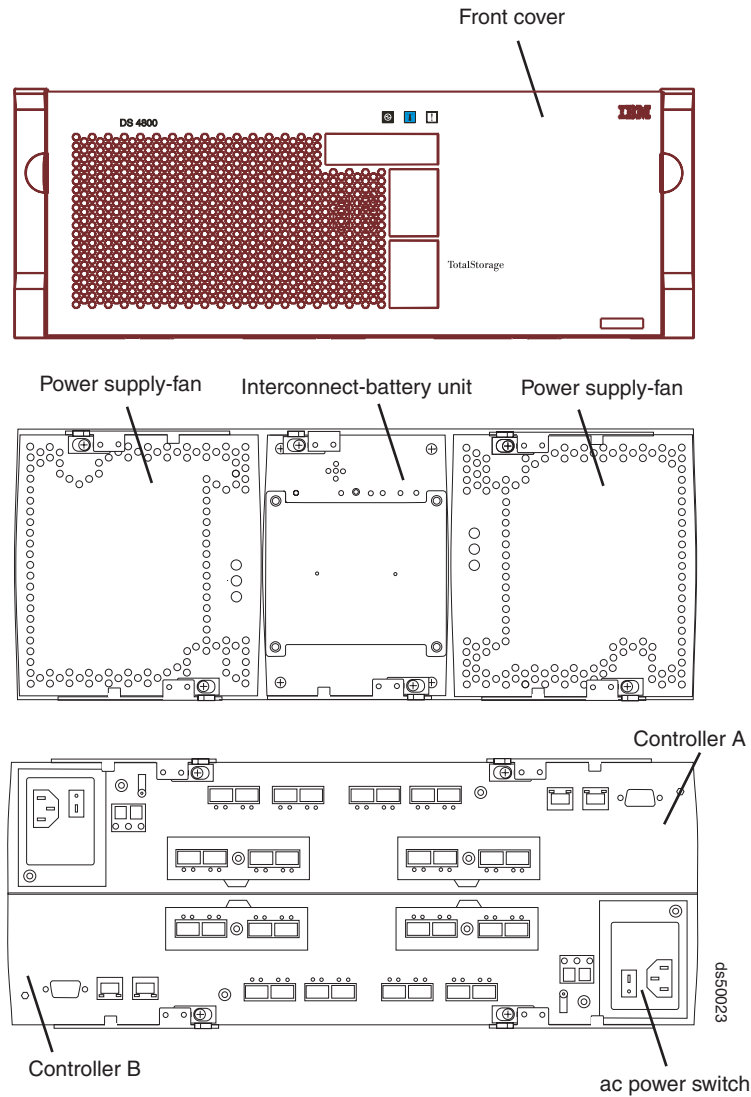
Figure 17. DS5100 or DS5300 front views and back view

Note: The illustrations in this document might differ slightly from your hardware.

Assemble these items before proceeding with the installation.

- Anti-static protection, such as a grounded wrist strap
- Cart or other surface to hold the DS5100 or DS5300 and its components
- Two M5 screws
- Tie wraps or other cable management devices (optional)

Installing the DS5100 or DS5300 on the support rails

This section provides instructions on how to install the DS5100 or DS5300 in a rack cabinet.

Attention: If you have not yet done so, record the serial number, machine type and model number, and MAC addresses for your DS5100 or DS5300 in Appendix B, "Records," on page 257. The serial number, machine type, and model number are located on top of each storage subsystem. The MAC addresses are located near the Ethernet ports on each RAID controller, as shown in Figure 148 on page 258.

Use the following procedure to install the DS5100 or DS5300 on support rails in a rack cabinet. To mount a storage subsystem in the rack cabinet, all support rails must be installed in their correct locations. If you need to install the rails, see "Installing the support rails" on page 40.

CAUTION:
Never install components 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 to tip over. Always install hardware in the lowest available position in the cabinet.

Before installing the storage subsystem in the cabinet, ensure that there are no obstructions, either in the cabinet or outside the cabinet, that would make ready removal and replacement of any of the components impossible. Check for obstructions at the front and rear of the cabinet.

Operational Shock
> The DS5100 or DS5300 withstands a free-fall drop from 0.5 inches onto a hard surface. Subjecting the equipment to a single shock pulse with the following characteristics will simulate this level of shock:
>
> Velocity change = 20 inches per second ; Wave form = Triangular,25g @3.75 ms

Operational Vibration (Sweep)
> While in its normal operating position, the DS5100 or DS5300 continues operating when subjected to the following vibration sweep. The test will include a dwell time of 15 minutes at any frequency where vigorous or resonant excitation occurs.
> * Frequency sweep = 5 Hz – 150 Hz – 5 Hz
> * Wave form = Sinusoidal, 0.25g

Note: You should have at least two other people available to help you lift the unit from the shipping box and into the rack cabinet

1. Remove the empty DS5100 or DS5300 from the shipping box and set the storage subsystem in the cabinet. Figure 18 on page 47 shows the correct orientation of the empty storage subsystem to the cabinet and support rail.

   The following steps will help you safely install the DS5100 or DS5300 on the support rails:

   a. If you have installed a screw in the upper mounting hole at the front of each support rail, remove the upper screws. These two screws are used later to secure the front of the storage subsystem to the rack.

   b. Move the empty storage subsystem from the shipping box and to the front of the cabinet.

   c. With help from another person, place the back of the storage subsystem on the support rails, and then slide the storage subsystem into the cabinet.

Attention: When you slide the storage subsystem into the cabinet, verify that the back of the DS5100 or DS5300 is secured by the hold-down clips located at the back of each rail. With the M5 rail screws loosely threaded, you can make minor adjustments to the rails to ensure that the subsystem latches in the hold-down clips. The hold-down clips are shown in Figure 16 on page 43.

Screw   Mounting hole   Support rail
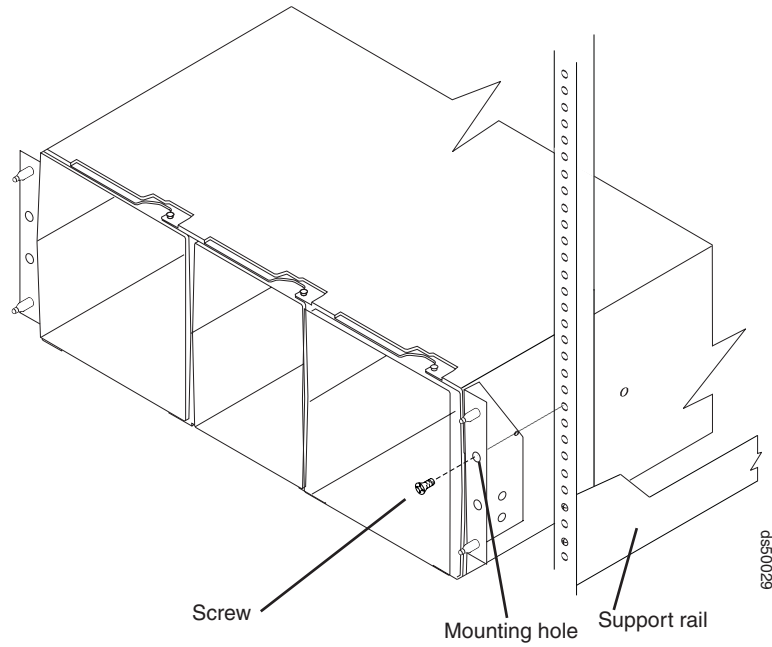
Figure 18. Securing the DS5100 or DS5300 to the rack cabinet

2. Secure the storage subsystem to the cabinet. Figure 18 shows how to secure the DS5100 or DS5300 to the vertical members of the cabinet.

   The following steps will help you safely secure the DS5100 or DS5300 in the rack cabinet:

   a. Align the front mounting holes on the storage subsystem flanges with the mounting holes on the cabinet.

   b. Using the 5/16 (8 mm) hex nut driver, insert one M5 screw into the hole on each flange, and tighten the screws completely to secure the front of the storage subsystem to the cabinet.

3. At the front and the rear of the rack cabinet, use the 5/16 (8 mm) hex nut driver to finish tightening the other three M5 screws for each rail.

4. Continue with Chapter 3, "Cabling the storage subsystem," on page 49.

Chapter 3. Cabling the storage subsystem

After the storage subsystem is installed in its permanent location, you must cable it to hosts, drives, and other external devices, depending on your hardware configuration. This chapter provides fibre channel and power cabling information for the storage subsystem. It also provides information about configuring the storage subsystem.

This chapter addresses the following cabling and configuration topics:
- "Working with SFPs, SFP+s, and fiber-optic cables"
- "Connecting storage expansion enclosures to the DS5100 or DS5300" on page 64
- "Connecting hosts directly to the DS5100 or DS5300 Fibre Channel host ports" on page 132
- "Connecting secondary interface cables" on page 135
- "Configuring the storage subsystem" on page 136
- "Installing the storage subsystem configuration" on page 147
- "Connecting the power cables" on page 147

Working with SFPs, SFP+s, and fiber-optic cables

Each RAID controller has Fibre Channel drive channel connections. Depending on the type of host interface card installed, it also has Fibre Channel host connections. You use a small-form factor pluggable transceiver (SFP) to connect each host channel port and drive channel port to hosts and storage expansion enclosures.

In addition, a 10 Gbps host interface card has optical host connections. Use a 10 Gbps small-form factor pluggable transceiver (SFP+) to connect each port of a 10 Gbps host interface card to a 10 Gbps Ethernet switch.

The SFP or SFP+ is inserted into the port, and then a fiber-optic cable is inserted into the SFP or SFP+. The other end of the fiber-optic cable connects to an external device. SFPs and SFP+s are laser products.

Note: For 10 Gbps connections, use 50/125 um *OM3 fiber* cables.

Statement 3:

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

• **Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.**

• **Use of controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.**

DANGER

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

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

Handling fibre-optic cables

Note: IBM Fibre Channel (FC) cable options have been tested and approved for the IBM DS storage products. For optimal performance and compatibility, always use IBM FC cable options when installing the IBM DS products.

Attention: To avoid damage to your fibre-optic cables, follow these guidelines:

• 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.

• 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.).

• When storing excess or unused fibre-optic cables, do not bend the cables to a diameter of less than 76 mm (3 in.), or a radius less than 38 mm (1.5 in.) or wrap them around themselves. See Figure 19 on page 51.

• Loop diameter of 76 mm (3 in.) and bend radius of 38 mm (1.5 in.) for fibre-optic cables are best practices minimums. Loops or bends smaller than this may cause damage to your fibre-optic cables. It is best practice to use loop diameters and bend radii that are greater than these minimums.

• Do not route the cable along a folding cable-management arm.

• Route the cable away from places where it can be damaged by other devices in the rack cabinet.

• Do not put excess weight on the cable at the connection point. Be sure that the cable is well supported.

• Do not use plastic cable ties in place of the provided cable straps.

• The following are the supported maximum cable lengths:

- 1 Gbps: 500 meters 50/125 um OM2 fiber, 300 meters 62.5/125 um OM1 fiber
- 2 Gbps: 300 meters 50/125 um OM2 fiber, 150 meters 62.5/125 um OM1 fiber
- 4 Gbps: 150 meters 50/125 um OM2 fiber, 70 meters 62.5/125 um OM1 fiber
- 8 Gbps: 150 meters (492 ft) of 50/125 um OM3 fiber, 50 meters (164 ft.) of 50/125 um OM2 fiber, 21 meters (68 ft.) of 62.5/125 um OM1 fiber.
- 10 Gbps: 300m (984ft) of 50/125 um OM3 fiber

1.5 inch
(38 mm)
radius

3.0 inch
(76 mm)
diameter
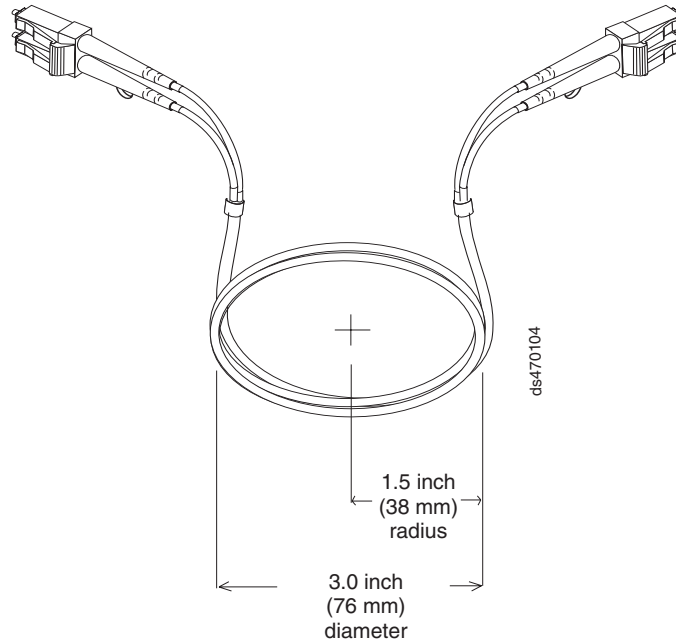
Figure 19. Best practice bending and looping specifications for fibre-optic cables

Installing SFP or SFP+ modules

The DS5100 or DS5300 Fibre Channel host and drive channel ports require SFP modules. The DS5100 or DS5300 10 Gbps iSCSI host port requires SFP+ modules. SFP and SFP+ modules are used to convert electrical signals to optical signals that are required for fibre channel (SFP) or optical iSCSI (SFP+) transmission to and from RAID controllers. The DS5100 or DS5300 supports two types of SFP modules: one with a plastic latch and one with a wire latch. The SFP+ modules only come with a wire latch. After you install the SFP or SFP+ modules, use fiber-optic cables to connect the DS5100 or DS5300 to other optical devices.

Notes:

1. The 1 Gbps iSCSI host port comes with an on-board RJ-45 interface module. No additional hardware is required.
2. IBM SFP and SFP+ options have been tested and approved for the IBM DS storage products. For optimal performance and compatibility, always use IBM SFP and SFP+ options when installing the IBM DS products.

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

- Use only short-wave/multimode SFPs in DS5100 or DS5300 host or drive ports. In DS5100 or DS5300 configurations, you may use long-wave SFPs only in fibre channel switches that connect DS5100 or DS5300s over long distances.

- The SFP or SFP+ module housing has an integral guide key designed to prevent you from inserting the SFP or SFP+ module improperly.
- Use minimal pressure when you insert the SFP or SFP+ module into a port. Forcing the SFP or SFP+ module into a port could cause damage to the SFP or SFP+ module or the port.
- You can insert or remove the SFP or SFP+ module while the port is powered on.
- Do not install an SFP in any port that will not have a fibre optic cable attached. Additionally, it is a best practice that you remove any SFP from any port that does not have fibre optic cables attached.
- The operational loop performance is not affected when you install or remove an SFP module.
- You must insert the SFP or SFP+ module into a port before you connect the fiber-optic cable.
- You must remove the fiber-optic cable from the SFP or SFP+ module before you remove the SFP or SFP+ module from the fibre channel port. See "Removing SFP or SFP+ modules" on page 54 for more information.
- The speed of the SFP or SFP+ module determines the maximum operating speed of the fibre channel port in which the SFP or SFP+ is installed.
- The SFP part number (printed on the manufacturing label attached to the SFP) identifies the speed at which the SFP module operates. Verify that you use SFPs with the correct speed requirements in your environment.

    Note: You can also use the management software for the DS5100 or DS5300 or the fibre channel switches to display the properties of the SFPs used in your configurations.

- The SFP or SFP+ FRU part number is printed on the manufacturing label attached to the SFP or SFP+. Use this FRU PN information if you order a replacement of a failed SFP or SFP+ module.

To install an SFP or SFP+ module, complete the following steps.

Statement 3:

CAUTION:
When laser products (such as CD-ROMs, DVD drives, fiber-optic devices, or transmitters) are installed, note the following:
- **Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.**
- **Use of controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.**

DANGER

> **Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following.**
>
> **Laser radiation when open. Do not stare into the beam, do not view directly with optical instruments, and avoid direct exposure to the beam.**

Attention: When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see "Handling static-sensitive devices" on page 37.
1. Remove the SFP or SFP+ module from its static-protective package.
2. Remove the protective cap from the SFP or SFP+ module, as shown in Figure 20. Save the protective cap for future use.
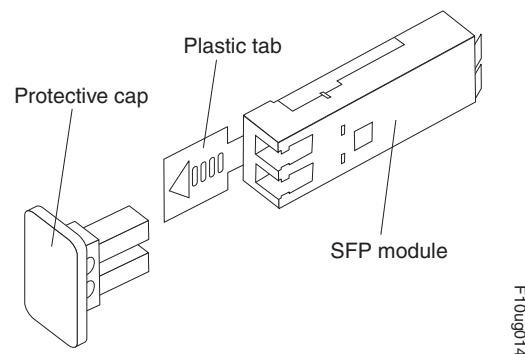
Figure 20. Small Form-Factor Pluggable (SFP or SFP+) module

3. Remove the protective cap from the fibre channel port. Save the protective cap for future use.
4. Insert the SFP or SFP+ module into the fibre channel port until it clicks into place. See Figure 21 on page 54.

Note: The alignment of the fibre channel ports on controller A are opposite those of controller B. Before inserting an SFP or SFP+ module into a port, verify that the SFP or SFP+ module is rotated correctly to match the alignment of the port on the RAID controller. Do not force-fit. For fibre channel ports in controller A, SFPs or SFP+s should be inserted with the exposed printed circuit facing up (as shown in Figure 21). For fibre channel ports in controller B, SFPs or SFP+s should be inserted with the exposed printed circuit facing down.
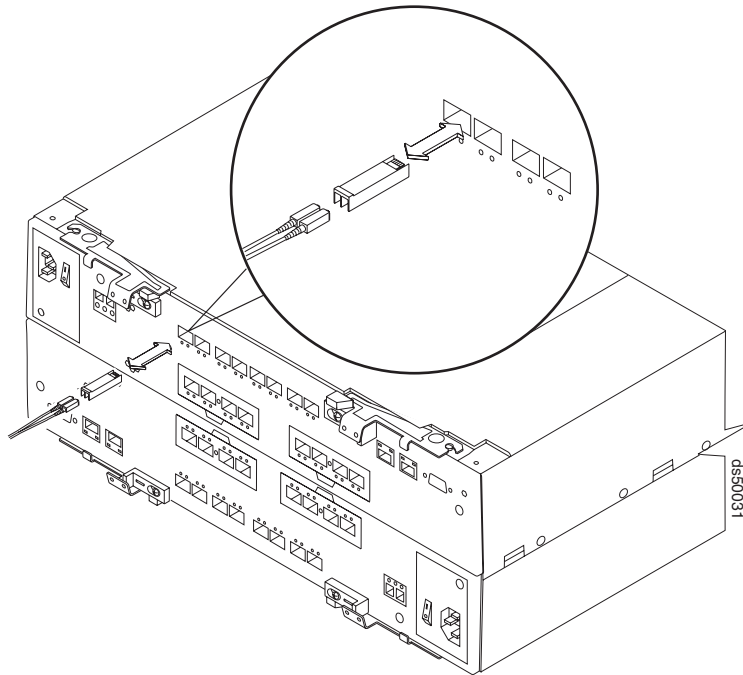
Figure 21. Replacing an SFP or SFP+ module

5. Connect a fibre channel cable.

Removing SFP or SFP+ modules

To remove the SFP or SFP+ module from the fibre channel port, perform the following steps.

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

1. Remove the LC-LC fibre channel cable from the SFP or SFP+ module. For more information, see "Handling fibre-optic cables" on page 50.
2. Unlock the SFP or 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 22 on page 55.
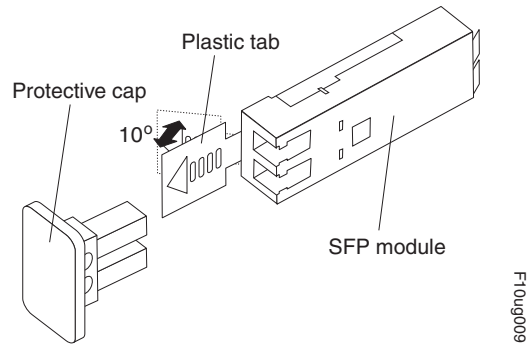
Figure 22. Unlocking the SFP module latch - plastic variety

- For SFP or SFP+ modules that contain wire tabs, unlock the SFP or SFP+ module latch by pulling the wire latch outward 90°, as shown in Figure 23.
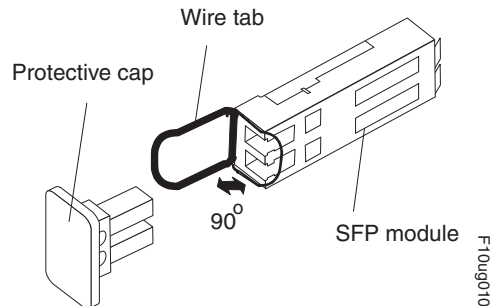
Figure 23. Unlocking the SFP or SFP+ module latch - wire variety

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

Installing fiber-optic cables

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

1. Remove the protective cap from the fiber-optic cable. See Figure 24 on page 56.
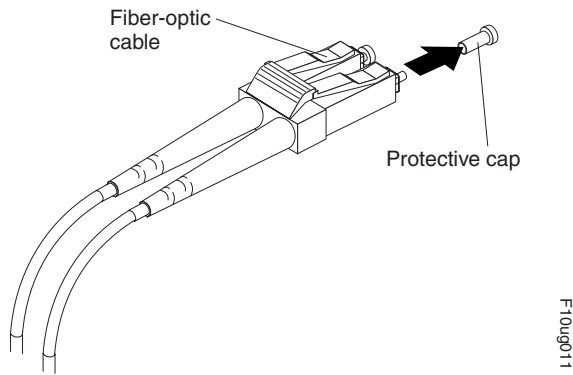
Figure 24. Removing caps from fiber-optic cables

2. Connect the fiber-optic cable to the installed SFP or SFP+, as shown in Figure 25.
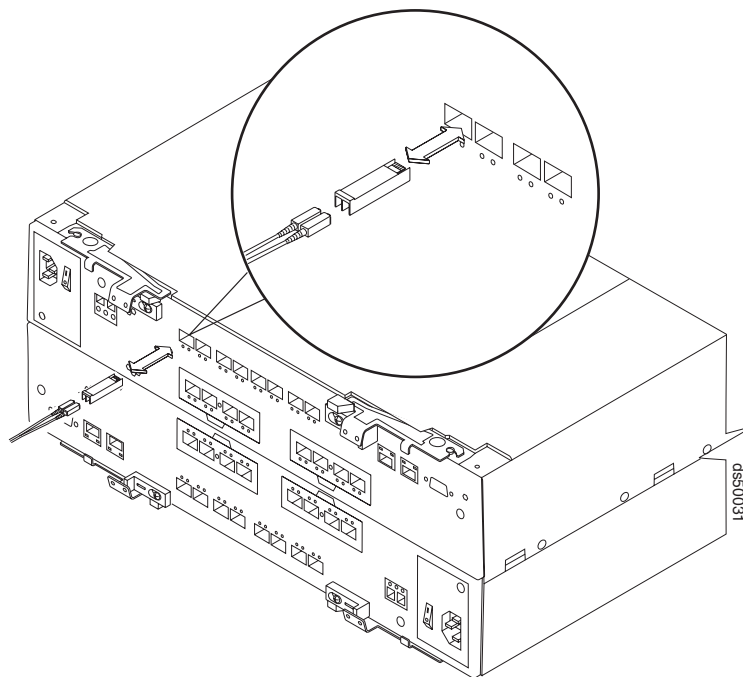
Figure 25. Connecting fiber-optic cable to SFP or SFP+

3. Check the LEDs on the RAID controller. When the RAID controller is operating properly, the amber Needs Attention LED is off. For information about the status of the RAID controller LEDs, see "RAID controller LEDs" on page 169.
4. To remove the fiber-optic cables, gently pull the fiber-optic cable from the SFP or SFP+; then replace the protective caps.

Using LC-LC fibre-channel cables

The LC-LC fibre-channel cable is a fiber-optic cable that you use to connect DS5100 or DS5300 fibre channel ports to one of the following devices:

*   An SFP module installed in a fibre channel switch port
*   An SFP module of the host bus adapter port

- An SFP module installed in an IBM DS5100 or DS5300 storage expansion enclosure

Use an *OM3 fiber* LC-LC fibre-channel cable to connect a DS5100/DS5300 10 Gbps host port to a port in a 10 Gbps Ethernet switch.

See Figure 26 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.
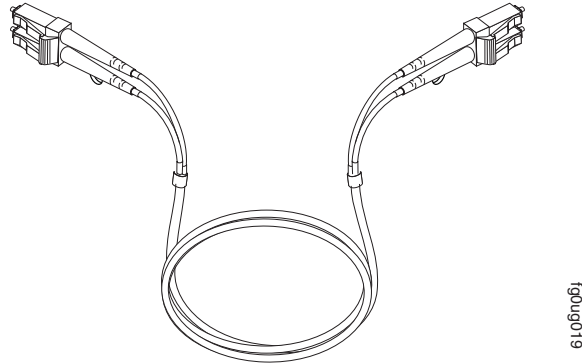
Figure 26. LC-LC fibre-channel cable

Note: If you are connecting the DS5100 or DS5300 host ports to a 1 Gbps device (such as a 1 Gbps fibre channel switch), you must also use an LC-SC fibre-channel cable adapter. For more information about using an LC-SC fibre-channel cable adapter, see "Using LC-SC fibre-channel cable adapters" on page 60.

Connecting an LC-LC cable to an SFP or SFP+ module

Complete the following steps to connect an LC-LC fibre-channel cable to an SFP or 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 fibre-optic cables" on page 50.
2. If necessary, remove the protective cap from the SFP or SFP+ module, as shown in Figure 27. 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 27. Save the protective caps for future use.
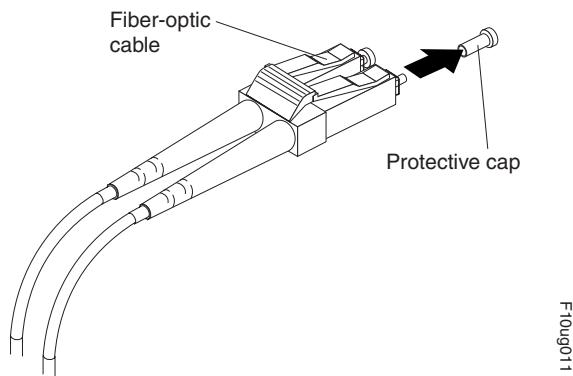
Figure 27. Removing fiber-optic cable protective caps

4. Carefully insert this end of the LC-LC cable into an SFP or SFP+ module that is installed in the DS5100 or DS5300. The cable connector is keyed to ensure it is inserted into the SFP or SFP+ module correctly. Holding the connector, push in

the cable until it clicks into place, as shown in Figure 28.
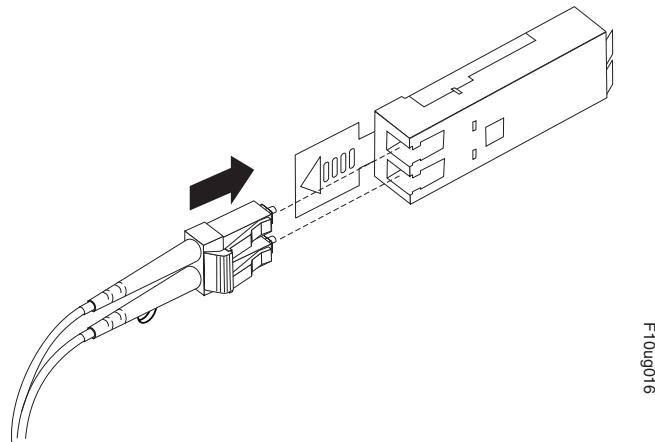
Figure 28. Inserting an LC-LC fibre-channel cable into an SFP or SFP+ module

5. Remove the two protective caps from the other end of the LC-LC cable. Save the protective caps for future use.
6. Connect this end of the LC-LC cable to the SFP or SFP+ module that is installed in one of the following devices.
   - DS5100 or DS5300 storage expansion enclosure
   - Fibre channel switch
   - Host bus adapter

Removing an LC-LC fibre-channel cable

Attention: To avoid damaging the LC-LC cable or SFP 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 or SFP+ module.
- Ensure that the levers are in the released position when you remove the cable.
- Do not grasp the SFP or SFP+ module plastic tab when you remove the cable.

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

1. On the end of the LC-LC cable that connects into the SFP or SFP+ module or host bus adapter, press down and hold the lever to release the latches, as shown in Figure 29.
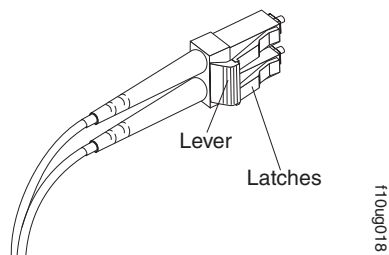
Figure 29. LC-LC fibre-channel cable lever and latches

2. Carefully pull on the connector to remove the cable from the SFP or SFP+ module, as shown in Figure 30.
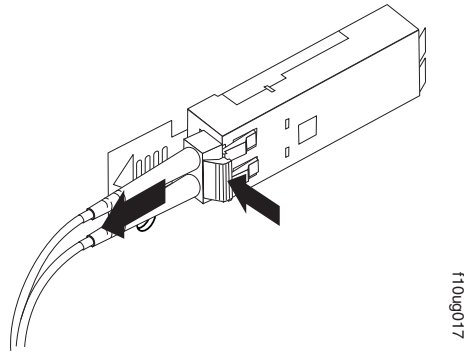
Figure 30. Removing the LC-LC fibre-channel cable

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

Using LC-SC fibre-channel cable adapters

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

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

Attention:

1. The DS5100 or DS5300 does not support the attachment of storage expansion enclosures that operate at 1 Gbps, such as the EXP500. For more information about connecting to these devices, see the documentation that comes with the LC-SC fibre-channel cable adapter.
2. You cannot connect 8 Gbps devices to a 1 Gbps fibre channel storage area network. 8 Gbps SFPs cannot operate at 1 Gbps because they are limited to data rates of 2 Gbps, 4 Gbps, and 8 Gbps. Be aware of the data rates of SFPs before attaching to a 1 Gbps fibre channel switch.
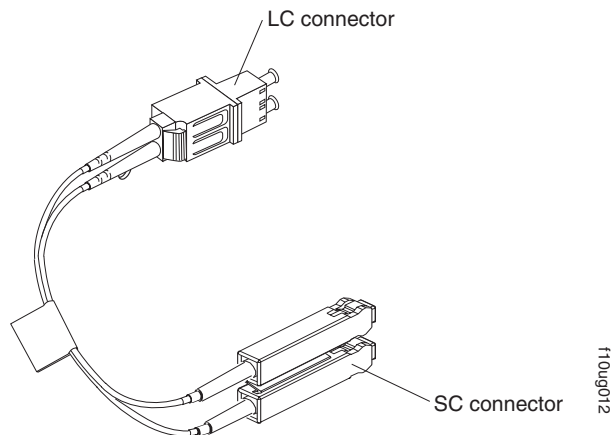
Figure 31. LC-SC fibre-channel cable adapter

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

Connecting an LC-SC cable adapter to a device

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.

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

1. Read the information in "Handling fibre-optic cables" on page 50.
2. Connect one end of an LC-LC cable to an SFP module in the DS5100 or DS5300. For instructions, see "Using LC-LC fibre-channel cables" on page 56.
3. Remove the two protective caps from the LC connector end of the LC-SC cable adapter as shown in Figure 32. Save the protective caps for future use.
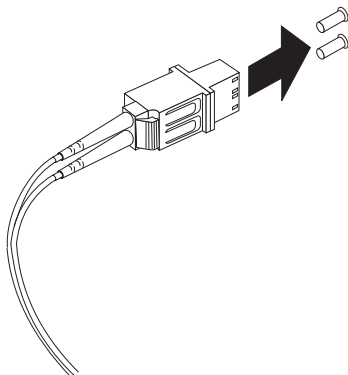
Figure 32. Removing the LC-SC cable adapter protective caps

4. Carefully insert the other end of the LC-LC cable into the LC connector end of the LC-SC cable adapter as shown in Figure 33 on page 63. Push in the

connector until it clicks into place.
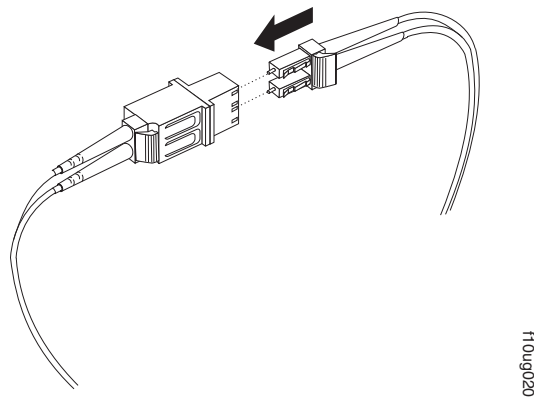
Figure 33. Connecting an LC-LC cable into the LC-SC cable adapter

5. If you are connecting the DS5100 or DS5300 to a 1 Gbps fibre channel switch
   or fibre channel host bus adapter, connect the SC connector end of the LC-SC
   cable adapter to a Gigabit Interface Converter (GBIC) that is installed in the 1
   Gbps fibre channel switch or fibre channel host bus adapter. For more
   information about connecting to these devices, see the documentation that
   comes with the device.

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

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

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

1. On the end of the cable that connects into the LC connector end of the LC-SC
   cable adapter, press down and hold the lever to release the latches. Figure 34
   shows the location of the lever and latches.
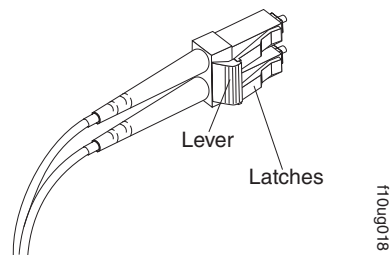
Figure 34. LC-LC fibre-channel cable lever and latches

2. Carefully pull on the connector to remove it. Make sure you grasp the connector
   and not the cable when removing the LC-LC cable from the LC-SC cable
   adapter as shown in Figure 35 on page 64.
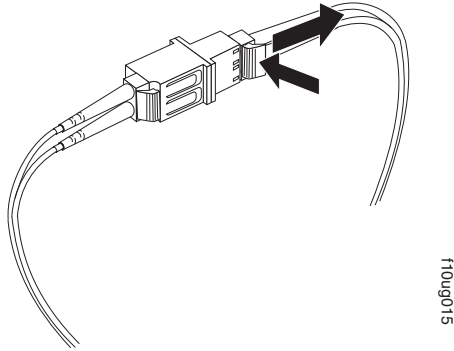
Figure 35. Removing the LC-LC fibre-channel cable from an LC-SC fibre-channel cable adapter

3. Replace the protective caps on the cable ends.

Connecting storage expansion enclosures to the DS5100 or DS5300

> **Attention**
> Before you power on the DS5100 or DS5300, the storage subsystem must be cabled to at least one storage expansion enclosure populated with the minimum number of drives for the storage expansion enclosure. Otherwise, the DS5100 or DS5300 controllers do not successfully complete the power-on process and operate optimally.
>
> All drives in the connected storage expansion enclosure or enclosures must contain no prior configuration data. Additionally, if at least two drives are not installed in each EXP5000 attached storage expansion enclosure, the resulting insufficient load to the storage expansion enclosure power supplies might cause the drive expansion enclosure power supplies to intermittently appear as failed and then reappear in an optimal state, falsely indicating that the power supplies are bad. In addition, the EXP5060 storage expansion enclosures require four drives per drawer (20 drives total) for optimal cooling and power distribution.

If the storage expansion enclosures that you want to install currently contain logical drives or configured hot spares, and you want them to be part of the DS5100 or DS5300 configuration, refer to the *IBM System Storage DS4000/DS5000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*. Improper drive migration might cause loss of configuration and other storage subsystem problems. Contact your IBM support representative for additional information.

Redundant drive channel pair

For the DS5100 or DS5300, each drive channel (see the *Glossary* definitions for *drive channels* and *drive loops*) is associated with two ports, and there are four drive channels and eight associated ports per controller. The total number of drives per drive channel varies depending on the storage expansion enclosure. See Table 17 on page 65. One channel from each controller combines to form a pair of redundant drive channels.

Table 17. Maximum number of drives per drive channel by enclosure type

Storage expansion enclosure	Maximum number of drives	Number of storage expansion enclosures
EXP5000	112	7 EXP5000
EXP5060	120	2 EXP5060
EXP5000 and EXP5060	108	1 EXP5060 and 3 EXP5000

In Figure 36, drive channel 1 of controller A and drive channel 5 of controller B combine to form a DS5100 or DS5300 drive channel pair. If any component of drive channel 1 fails, the RAID controllers can still access the storage expansion enclosures in drive channel 1 through drive channel 5. Similarly, drive channel 2 of controller A and drive channel 6 of controller B combine to form the second of the two DS5100 or DS5300 drive channel pairs. If any component of drive channel 2 fails, the RAID controllers can still access the storage expansion enclosures in drive channel 2 through drive channel 6.

Figure 36 shows the storage expansion enclosures in each drive channel pairs connected to only one drive port in the two-ported drive channel. For example, in drive channel pair 1, only port 8 of channel 1 and port 1 of channel 5 are used.

Note: In the following drive cabling figure, the DS5100 or DS5300 graphic is simplified to show only the drive ports of each controller. The storage expansion enclosures are simplified to show only the ESM FC ports.
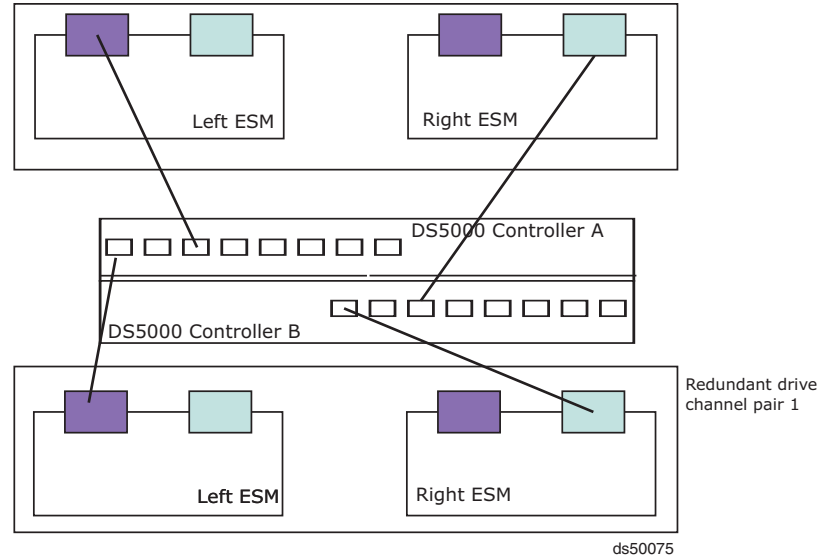
Figure 36. Example of redundant drive channel pairs

Non-trunking cabling

Non-trunking cabling is the cabling scheme where the controller drive ports are connected to the EXP5000 or EXP5060 drive channel ports labeled 1B on both ESMs of the EXP5000 or EXP5060 storage expansion enclosures, forming a pair of redundant connections between the storage subsystem and the storage expansion enclosure. This is the cabling that is supported when intermixing the EXP5060 and EXP5000 or EXP810 storage expansion enclosures behind the same drive channel or drive channel port.

Figure 37 shows an example of a DS5100/DS5300 storage subsystem that is cabled to two EXP5000s using a non-trunking cabling scheme. P8 and P6 of controller A are connected to EXP5000 ESM A drive channel ports label 1B. Similarly, the storage subsystem drive ports P1 and P3 of controller B are connected to the EXP5000 ESM B drive channel ports labeled 1B.
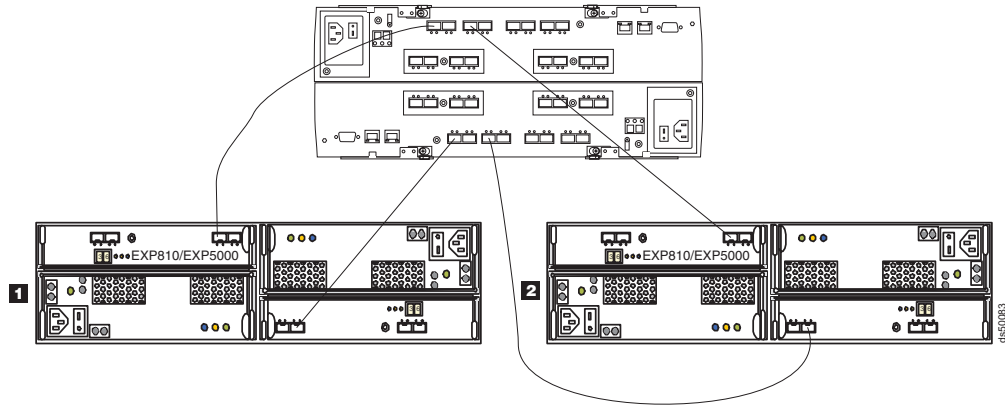
Figure 37. One DS5100 or DS5300 and two EXP5000 storage expansion enclosures using a non-trunking cabling scheme

Figure 38 shows an example of a DS5100/DS5300 subsystem that is cabled to two EXP5060s using a non-trunking cabling scheme. The storage subsystem drive ports P8 and P6 of controller A are connected to EXP5060 ESM A drive channel ports label 1B. Similarly, the storage subsystem drive ports P1 and P3 of controller B are connected to the EXP5060 ESM B drive channel ports labeled 1B.
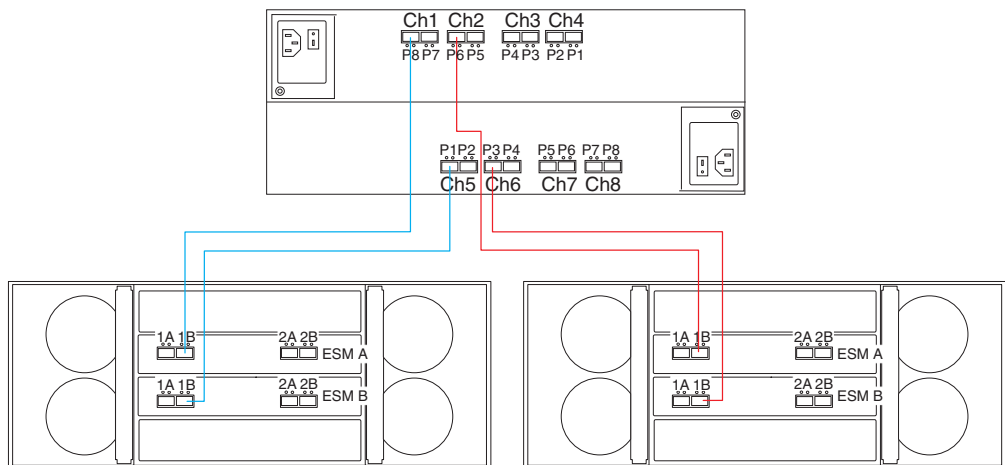
Figure 38. Example of EXP5060 storage expansion enclosure with non-trunking cabling

The EXP5060 storage expansion enclosure requires firmware version 7.60.13.05, or higher.

Port 1A of the EXP5000 or EXP5060 ESMs are used to connect more than one EXP5000 or EXP5060 enclosure behind a storage subsystem controller drive port. Figure 39 on page 67 shows an example of a DS5100/DS5300 subsystem that is cabled to two EXP5000s behind the same DS5100/DS5300 drive channel port using a non-trunking cabling scheme.
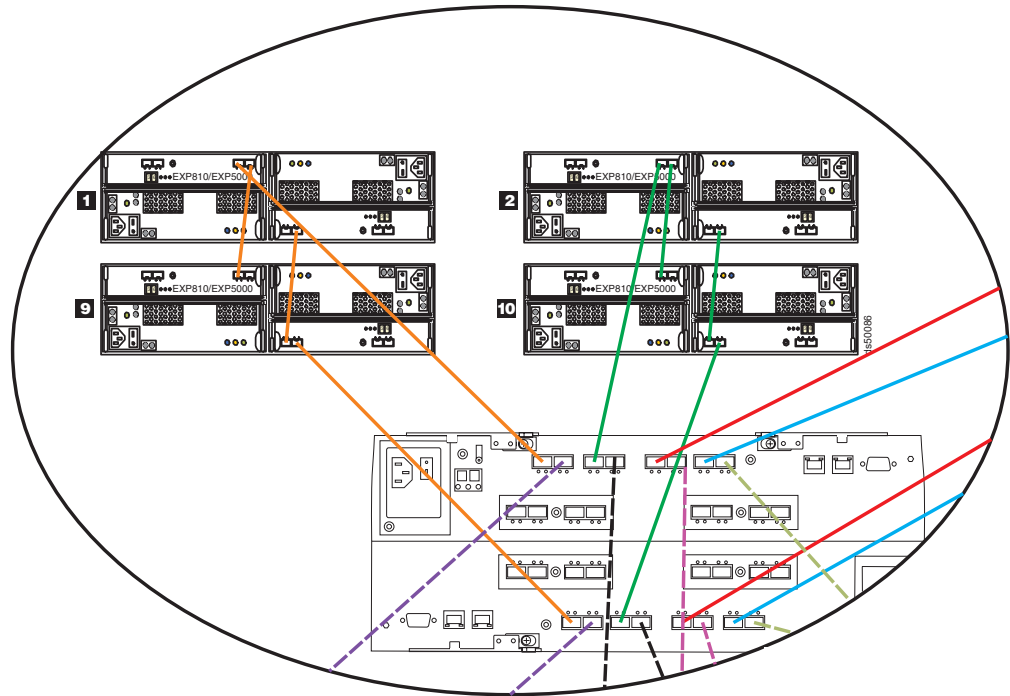
Figure 39. One DS5100 or DS5300 cabled to two EXP5000s behind the same DS5100/DS5300 drive channel port using a non-trunking cabling scheme

Figure 40 on page 68 shows an example of connecting two EXP5060s behind controller A drive ports P8 and P6 and controller B drive ports P1 and P3.

Note: This is an example to illustrate the capability to connect more than one EXP5060 behind a storage subsystem controller drive port. This is not the recommended cabling scheme when you have only two EXP5060s in a storage subsystem configuration.
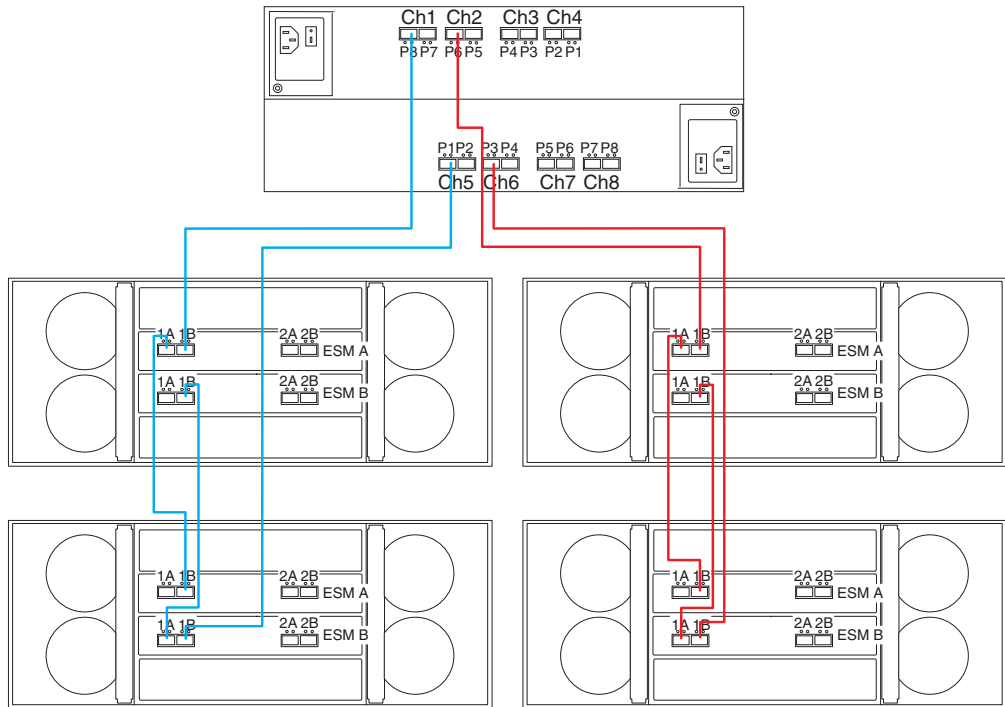
Figure 40. Example of cascading EXP5060s in non-trunking cabling scheme

EXP5060 and EXP5000/EXP810 storage expansion enclosures can also be intermixed in the same DS5100/DS5300 storage subsystem. Figure 41 on page 69, Figure 42 on page 70, Figure 43 on page 71, and Figure 44 on page 72 show examples of the intermixing the EXP5060 and EXP5000 in the same controller drive ports, the same controller drive channel, and a different controller drive channel. The maximum number of EXP5000 that can be connected in the same drive port or drive channel with the EXP5060 is 3. The only exception to this is when the Attach up to eight EXP5060 feature pack is activated. Once the DS5100/DS5300 is activated with this feature pack, the EXP5060 is the only storage expansion enclosures that can be connected to the DS5100/DS5300 storage subsystem.

Figure 42 on page 70 and Figure 43 on page 71 show the recommended cabling configuration when intermixing the EXP5060 and EXP5000 in the same storage subsystem configuration, which is on separate drive channel ports or drive channels.
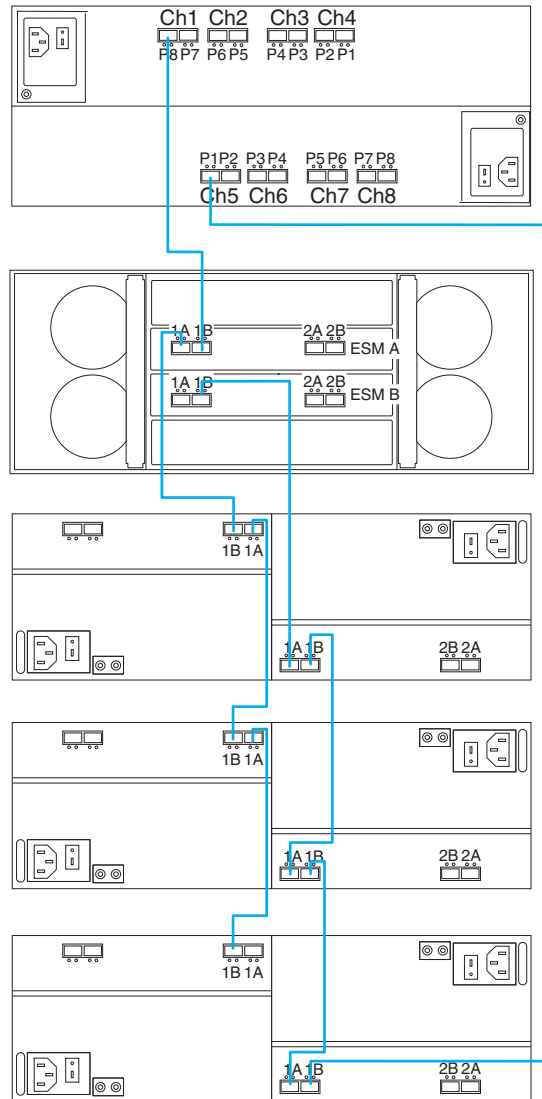
Figure 41. Preferred EXP5060 and EXP5000 intermixing behind the same controller drive channel port
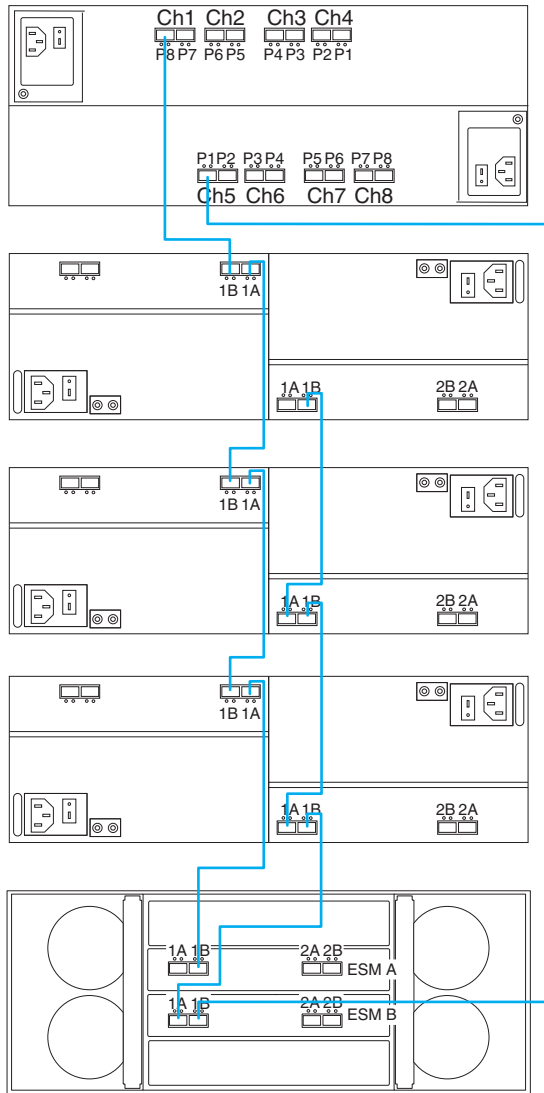
Figure 42. EXP5060 and EXP5000 intermixing behind the same controller drive channel port
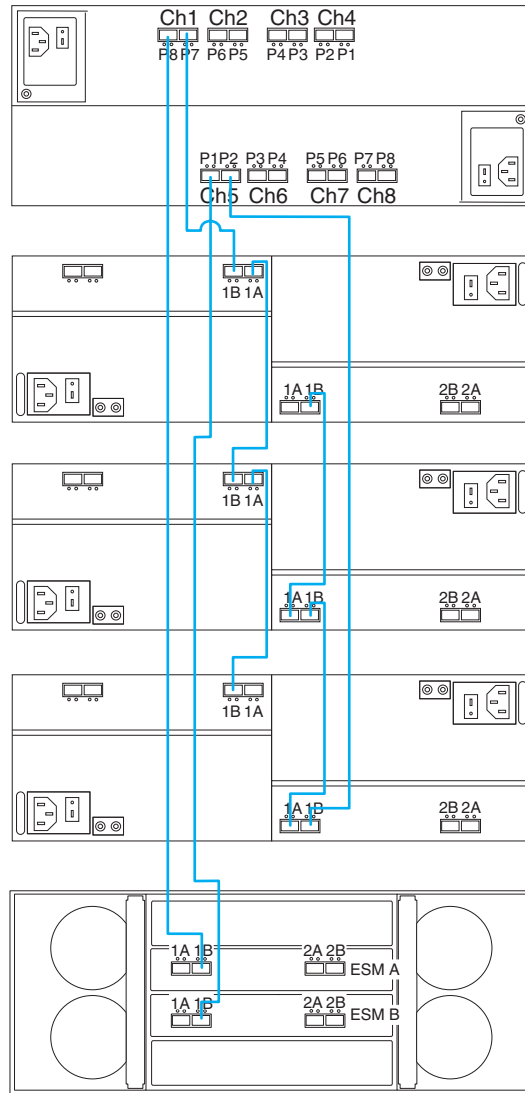
Figure 43. EXP5060 and EXP5000 intermixing behind different controller drive channel ports that are connected in the same controller drive channel
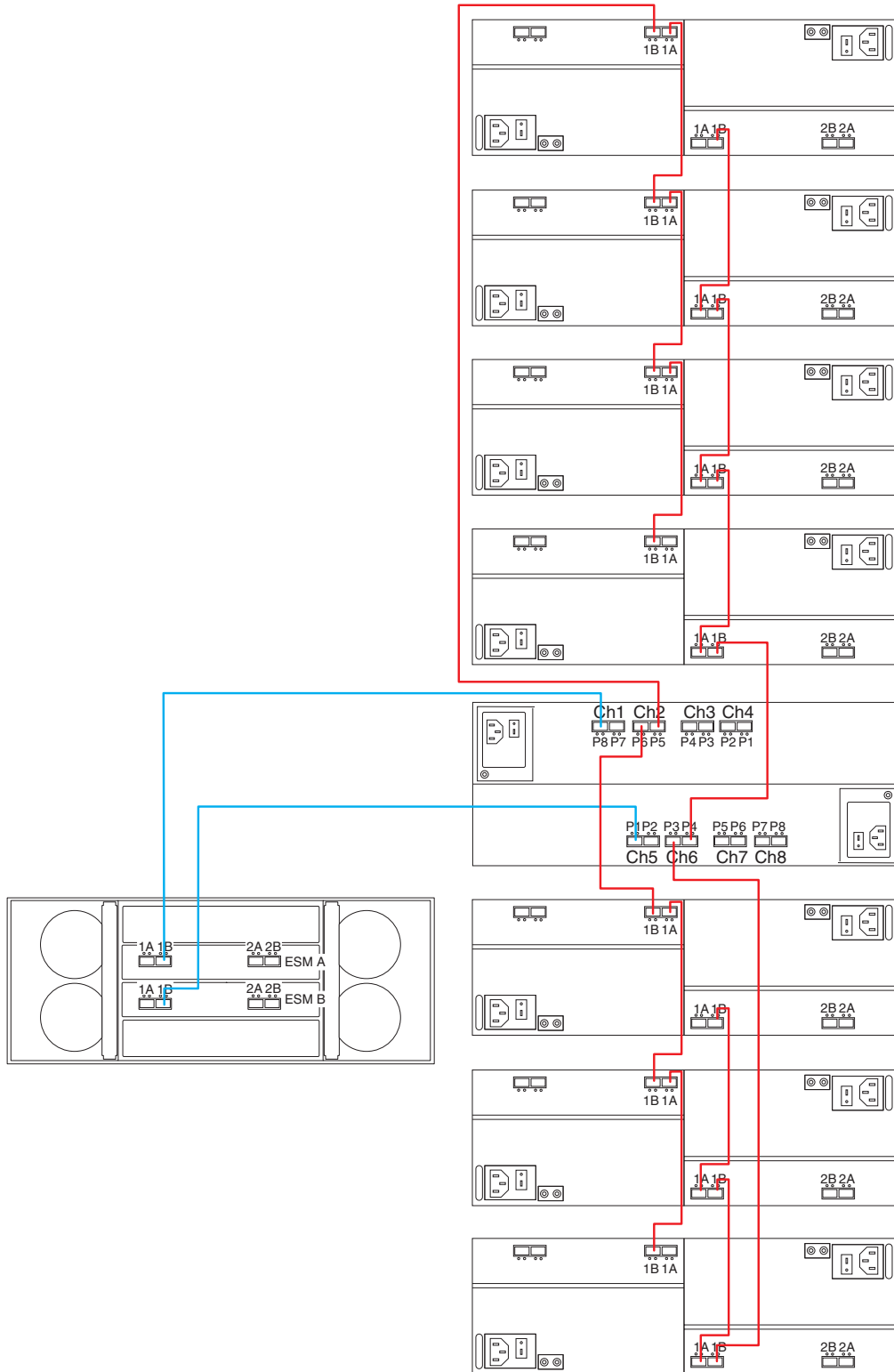
Figure 44. EXP5060 and EXP5000 in different controller drive channels

Drive-side trunking cabling

Notes:

1. The EXP5060 storage expansion enclosure requires firmware version 7.60.13.05, or higher for drive-side trunking cabling.

2. The actual improvement in throughput depends on your logical drive configuration and workload. In addition, this cabling scheme is also recommended because it provides additional redundancy between the storage subsystem controllers and EXP5060 ESMs. There is no way to disable the EXP5060 trunking cabling functionality besides not making connections to the second set of ESM ports labeled 2A and 2B.

3. Only the EXP5060 storage expansion enclosure supports drive-side trunking. There is no drive-side trunking support for the EXP5000/EXP810 storage expansion enclosure.

The EXP5060 is shipped with trunking cabling functionality enabled. Trunking cabling is the cabling scheme where the controller drive ports are connected to the EXP5060 drive channel ports labeled 1B and 2B on both ESMs of the EXP5060. This cabling scheme results in two connections between the storage subsystem controller and each of the EXP5060 ESMs forming two pairs of redundant drive loops. With two pairs of redundant drive loops, up to four drives can be accessed concurrently in a single EXP5060 enclosure. This cabling scheme is recommended when there is a need to maximize throughput (for large sequential read I/Os) between the storage subsystem controllers and the drives in the EXP5060 enclosures.

In addition to making the additional Fibre Channel connections to support drive-side trunking, consider the following before creating and using the RAID arrays to maximize throughput.

- Make sure that both controllers access the enclosure to use all bandwidth provided by trunk connections.
- Balance drives access by a controller across all available drive channels by making sure that a controller is accessing an equal number of drives from all drive channels.
- Balance drives access by a controller across both ESMs in a EXP5060 storage enclosure by ensuring that the number of drives in odd slots and even slots used by a controller is equal.
- Create RAID arrays so that the drives in one disk drawer can be accessed by only one controller to avoid drive loop contention in the disk drawer. Share the EXP5060 enclosures between controllers instead of sharing disk drawers within an EXP5060 between controllers.

Because there are two EXP5060 ESM ports that each controller connects to, two of the controller drive ports must be used to connect to each EXP5060 ESM. The following cabling rules must be followed for making correct trunking cabling connections:

- The cabling configuration must be homogenous on a given drive channel/loop. All point-to-point connections between each set of enclosures in a drive channel (controller-to-ESM and ESM-to-ESM) must be cabled using either the trunking or non-trunking cabling scheme. Having some connections in the same drive channel/loop in a trunking scheme and some connections in a non-trunking scheme is not supported.
- The cabling configuration must be homogenous for the two ESMs in a given EXP5060 enclosure. For example, if ESM A of the EXP5060 is connected using

the trunking cabling scheme, then ESM B of the same EXP5060 must also be connected using the trunking cabling scheme.

- There must not be more than two Fibre channel cables connecting any two ESMs from two EXP5060s or between the ESM and the controller.
- The two trunked Fiber channel connections between the EXP5060 ESM and the controller must be in the same controller drive channel.
- A given ESM must not be a member of more than two connected device pairs.
- Intermixing enclosures with trunked and non-trunked cabling in the same storage subsystem is supported.
- Connect the EXP5060 and EXP5000/EXP810 storage expansion enclosures in separate drive channels in each controller to enable drive-side trunking with the EXP5060 storage expansion enclosure.

In addition to the general rules, following are specific rules for trunking cabling between the DS5100/DS5300 and the EXP5060:

1. Port 1B of the EXP5060 ESM A can only be connected to an even-numbered drive channel port in the DS5100/DS5300 controller A (port 8, 6, 4, 2) or port 1A of the adjacent EXP5060 ESM A.
2. Port 1B of the EXP5060 ESM B can only be connected to an odd-numbered drive channel port in the DS5100/DS5300 controller A (port 1, 3 ,5,7) or port 1A of the adjacent EXP5060 ESM B.
3. Port 2B of the EXP5060 ESM A can only be connected to an odd-numbered drive channel port in DS5100/DS5300 controller A (port 7, 5, 3, 1) or port 2A of the adjacent EXP5060 ESM A. This controller drive port must be part of the same drive channel of controller A as the ESM port that it is connected to in rule 1.
4. Port 2B of the EXP5060 ESM B can only be connected to an even-numbered drive channel port in DS5100/DS5300 controller A (port 2, 4, 6, 8) or port 2A of the adjacent EXP5060 ESM B. This controller drive port must be part of the same drive channel of controller B as the ESM port that it is connected to in rule 2.
5. Port 1A of EXP5060 ESM A can only be connected to port 1B of adjacent EXP5060 ESM A.
6. Port 1A of EXP5060 ESM B can only be connected to port 1B of adjacent EXP5060 ESM B.
7. Port 2A of EXP5060 ESM A can only be connected to port 2B of adjacent EXP5060 ESM A
8. Port 2A of EXP5060 ESM B can only be connected to port 2B of adjacent EXP5060 ESM B.

If the ports are not connected using the above rules, Fibre Trunk miswire and enclosure path redundancy loss critical events will be generated. Figure 45 on page 75 shows an example of the DS5100/DS5300 subsystem that is cabled to two EXP5060s using the trunking cabling scheme. Port P8 and P7 of controller A drive channel 1 are used to connect to ESM A ports 1B and 2B of the EXP5060 on the left. Similarly, ports P1 and P2 of controller B drive channel 5 are used to connect to ESM B ports 1B and 2B of the EXP5060 on the left.
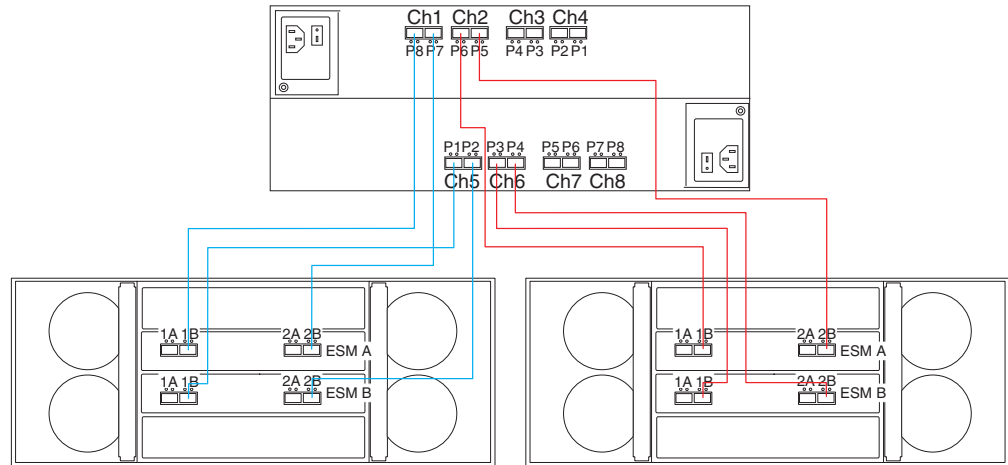
Figure 45. EXP5060 in trunking cabling scheme

Figure 46 shows an example of improperly wired trunking. This example shows a violation of trunking cabling rule 3, that port 2B of EXP5060 ESM A can only be connected to an odd-numbered drive channel port in DS5100/DS5300 controller A (port 7, 5, 3, 1). This controller drive port must be part of the same drive channel of controller A as the ESM port is connected to in rule 1. As shown in Figure 46, port 2B of ESM A is incorrectly connected to port 5 of drive channel 2 instead port 7 of drive channel 1.
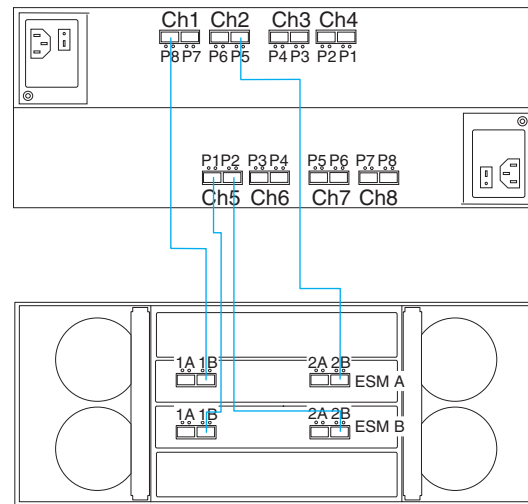
Figure 46. An example of trunking cabling that is improperly wired

Cascading the EXP5060 behind a drive channel is also supported using the trunking cabling scheme. However, the two cascaded EXP5060s will have only four possible data paths to access the drives in their enclosures instead of eight data paths as in the non-cascaded trunking cabling scheme with two EXP5060s. Figure 47 on page 76 shows an example of cascading EXP5060s in the trunking cabling scheme.
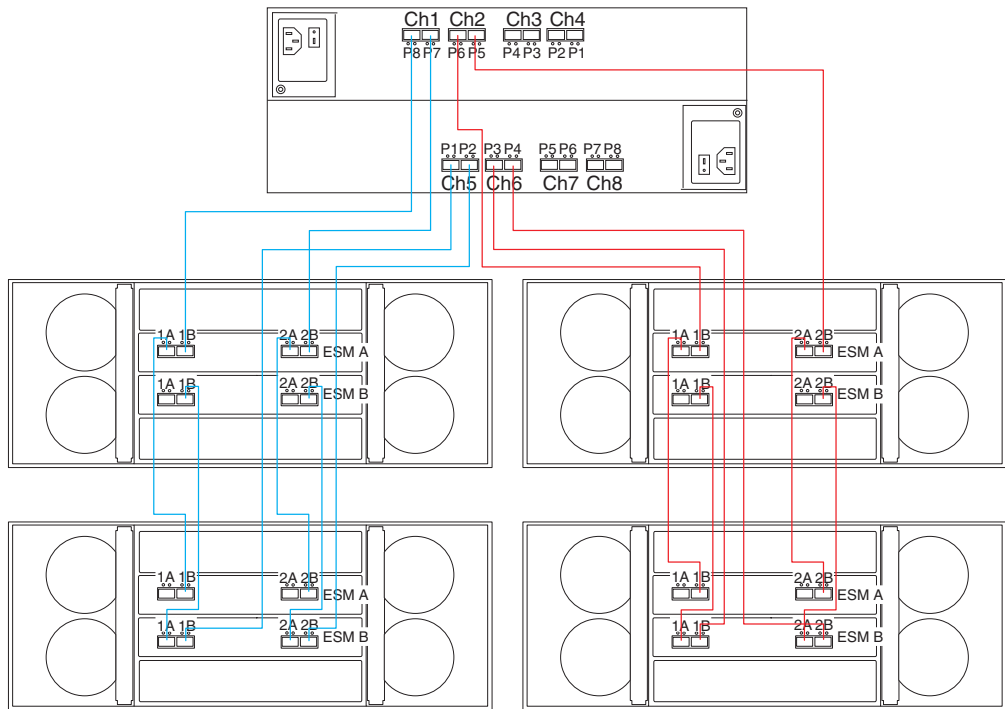
Figure 47. Cascading EXP5060s in trunking cabling scheme

The trunking cabling scheme is supported for EXP5060s behind a controller drive channel only. It is not supported when intermixing EXP5000 and EXP5060s behind a drive channel. A trunk incompatible ESM critical event will be generated if you try to cable the EXP5060 to the EXP5000 using the trunking cabling scheme.

Overview of steps to connect storage expansion enclosure to a storage subsystem

To connect storage expansion enclosures to the storage subsystem, perform the following steps:

Note: The following procedures are for *cold-case* procedures (in which the DS5100 or DS5300 is powered down when storage expansion enclosures are connected, as in the case of initial installation). For *hot-case* procedures (in which the DS5100 or DS5300 is powered on when storage expansion enclosures are connected), refer to the *IBM System Storage DS4000/DS5000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*.

1. Follow the instructions in the *Installation, User's, and Maintenance Guide* for your specific storage expansion enclosure, for setting up and mounting the storage expansion enclosures.

2. Select a cabling topology appropriate for the number of storage expansion enclosures you will connect to the DS5100 or DS5300. (You must connect at least one storage expansion enclosure, populated with at least two drives, before you power on the DS5100 or DS5300.)

   "DS5100 or DS5300 drive cabling topologies" on page 81 describes the schemes for cabling different numbers of storage expansion enclosures to the DS5100 or DS5300 and to each other (that is, if you are connecting more than one storage expansion enclosure).

The DS5100 or DS5300 locates the drives in the storage expansion enclosures after you power on the configuration. Always connect power to the storage expansion enclosures first and then connect power to the DS5100 or DS5300. After you have powered on the configuration, use the DS Storage Manager client to check the status of the new drives, correct any errors found, and configure the new drives.

DS5100 or DS5300 drive cabling best practices and rules

Add storage expansion enclosures to the DS5100 or DS5300 drive ports in a round-robin fashion. For example, if you have four EXP5000s to be cabled to the DS5100 or DS5300, instead of cabling all four EXP5000s to one drive port of a drive channel, distribute the enclosures to all drive ports, which results in one enclosure per drive port of a drive channel. Table 18 on page 78 and Table 19 on page 78 show the number of storage expansion enclosures per port and drive channel when connecting EXP5060 expansion enclosure to the DS5100/DS5300. Table 20 on page 78 shows the number of storage expansion enclosures per port and drive channel when connecting EXP5000 storage expansion enclosures to the DS5100/DS5300.

Table 18. Number of EXP5060 storage expansion enclosures per port and drive channel (non trunking cabling)

Number of enclosures	Channel 1		Channel 2		Channel 3		Channel 4		Table 19
	Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1	Controller A
1	1	0	0	0	0	0	0	0	
2	1	0	1	0	0	0	0	0	
3	1	0	1	0	1	0	0	0	
4	1	0	1	0	1	0	1	0	
5	1	1	1	0	1	0	1	0	
6	1	1	1	1	1	0	1	0	
7	1	1	1	1	1	1	1	0	
8	1	1	1	1	1	1	1	1	
	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Controller B
	Channel 5		Channel 6		Channel 7		Channel 8		

Table 19. Number of EXP5060 storage expansion enclosures per port and drive channel (trunking cabling)

Number of enclosures	Channel 1		Channel 2		Channel 3		Channel 4		
	Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1	Controller A
1	1	1	0	0	0	0	0	0	
2	1	1	1	1	0	0	0	0	
3	1	1	1	1	1	1	0	0	
4	1	1	1	1	1	1	1	1	
5	2	2	1	1	1	1	1	1	
6	2	2	2	2	1	0	1	0	
7	2	2	2	2	2	2	1	1	
8	2	2	2	2	2	2	2	2	
	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Controller B
	Channel 5		Channel 6		Channel 7		Channel 8		

Table 20. Number of storage expansion enclosures per port and drive channel

Number of enclosures	Channel 1		Channel 2		Channel 3		Channel 4		
	Port 8	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1	Controller A

Table 20. Number of storage expansion enclosures per port and drive channel (continued)

Number of enclosures	Channel 1		Channel 2		Channel 3		Channel 4		
1	1	0	0	0	0	0	0	0	
2	1	0	1	0	0	0	0	0	
3	1	0	1	0	1	0	0	0	
4	1	0	1	0	1	0	1	0	
5	1	1	1	0	1	0	1	0	
6	1	1	1	1	1	0	1	0	
7	1	1	1	1	1	1	1	0	
8	1	1	1	1	1	1	1	1	
9	2	1	1	1	1	1	1	1	
10	2	1	2	1	1	1	1	1	
11	2	1	2	1	2	1	1	1	
12	2	1	2	1	2	1	2	1	
13	2	2	2	1	2	1	2	1	
14	2	2	2	2	2	1	2	1	
15	2	2	2	2	2	2	2	1	
16	2	2	2	2	2	2	2	2	
17	3	2	2	2	2	2	2	2	
18	3	2	3	2	2	2	2	2	
19	3	2	3	2	3	2	2	2	
20	3	2	3	2	3	2	3	2	
21	3	3	3	2	3	2	3	2	
22	3	3	3	3	3	2	3	2	
23	3	3	3	3	3	3	3	2	
24	3	3	3	3	3	3	3	3	
25	4	3	3	3	3	3	3	3	
26	4	3	4	3	3	3	3	3	
27	4	3	4	3	4	3	3	3	
28	4	3	4	3	4	3	4	3	
	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7	Port 8	Controller B
	Channel 5		Channel 6		Channel 7		Channel 8		

EXP5000 storage expansion enclosure cabling rules

Refer to these general rules when cabling the storage subsystem to the EXP5000 storage expansion enclosure.

1. Do not connect a combination of more than seven EXP5000 storage expansion enclosures to the two ports of a dual-ported drive channel. Failure to observe this limitation might result in loss of data availability.

2. Do not connect more than four EXP5000 storage expansion enclosures to any port of a dual-ported drive channel.

3. The DS5100 or DS5300 controller drive port must always be connected to the EXP5000 port labeled 1B. Because the left and right EXP5000 ESMs (ESMs A and B) are inserted in the ESM bays in different orientations, you must look for the port labeled 1B before making the fibre channel connections. Figure 48 shows the port labels on the EXP5000.
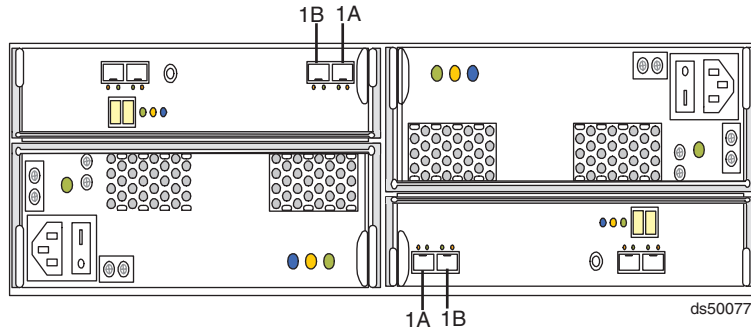
Figure 48. EXP5000 port labels

4. The EXP5000 does not support drive-side trunking. Do not make any connections to port 2A and 2B of the EXP5000 ESM ports.

EXP5060 storage expansion enclosure cabling rules

Refer to these general rules when cabling the storage subsystem to the EXP5060 storage expansion enclosure.

1. Do not connect a combination of more than two EXP5060 storage expansion enclosures to the two ports of a dual-ported drive channel. Failure to observe this limitation might result in loss of data availability.

   Note: Maximum configuration requires purchase of an Attached up to eight EXP5060 feature pack.

2. Do not connect more than two EXP5060 storage expansion enclosures to any port of a dual-ported drive channel.

3. The DS5100 or DS5300 controller drive port must always be connected to the EXP5060 ESM port labeled 1B in non-trunking configurations and EXP5060 ESM ports labels 1B and 2B in drive-side trunking configurations. Figure 49 shows the port labels on the EXP5060.
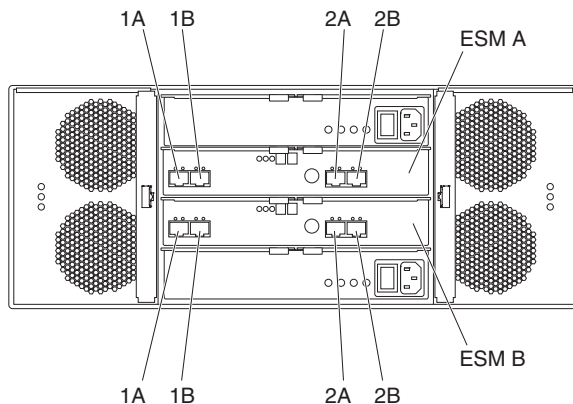
Figure 49. EXP5060 port labels

4. Intermixing enclosures with trunked and non-trunked cabling in the same storage subsystem is supported.

5. See "Drive-side trunking cabling" on page 73 and review the rules and considerations.

6. Do not cable the EXP5060 storage expansion enclosures in a cascading scheme unless all drive channel ports are used to support the additional EXP5060s.

7. Connect the EXP5060 and EXP5000/EXP810 storage expansion enclosures in separate drive channels in each controller to enable drive-side trunking with the EXP5060 storage expansion enclosure.

DS5100 or DS5300 drive cabling topologies

The following sections provide preferred cabling topologies for cabling storage expansion enclosures to the DS5100 or DS5300. Each example provides redundant paths to the drives. If one of these examples is suitable for your hardware and application, complete the cabling connections as described in the tables. If you have hardware to include in your topology other than what is shown in these examples, use the examples as a starting point for creating your specific topology.

Attention: For the maximum number of storage expansion enclosures supported per redundant drive channel pair, see Table 3 on page 9.

If you are using fiber-optic cables, install SFP modules into the ports that will receive the cables before installing the cables.

Figure 50 on page 82 and Figure 51 on page 83 show the locations of controllers A and B, the single-ported Fibre Channel host channels, single-ported iSCSI host channels, Ethernet ports, and dual-ported drive channels, at the back of the DS5100 or DS5300.
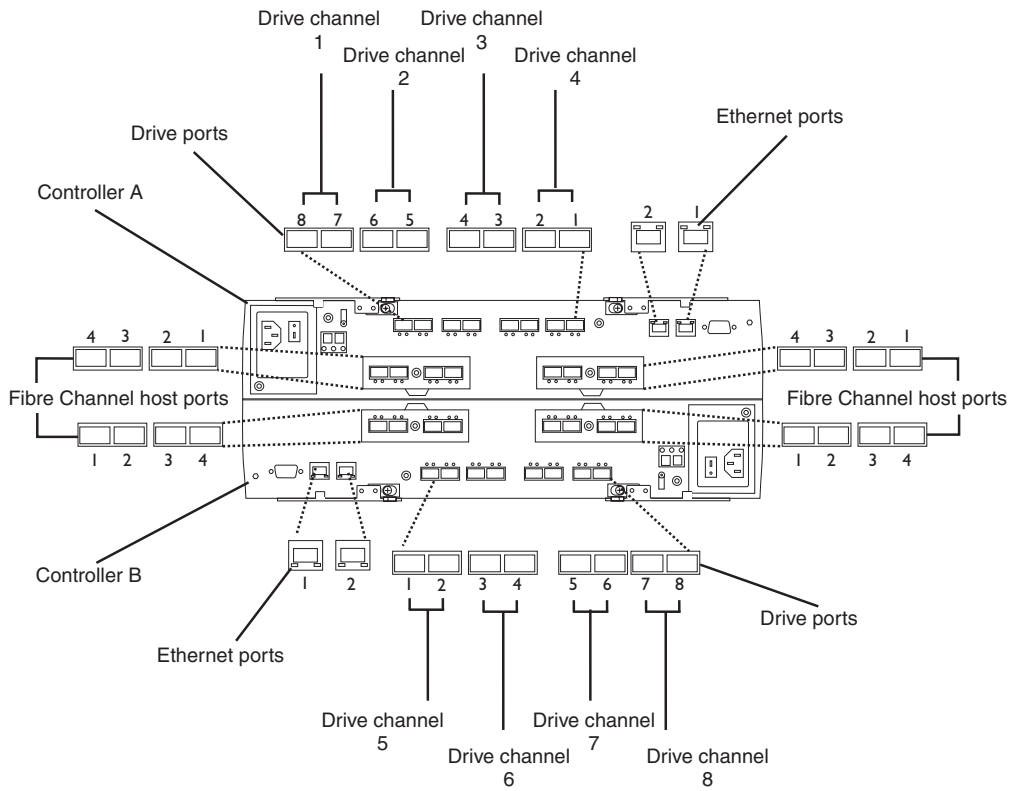
Figure 50. DS5100 or DS5300 ports and controllers with Fibre Channel host connections
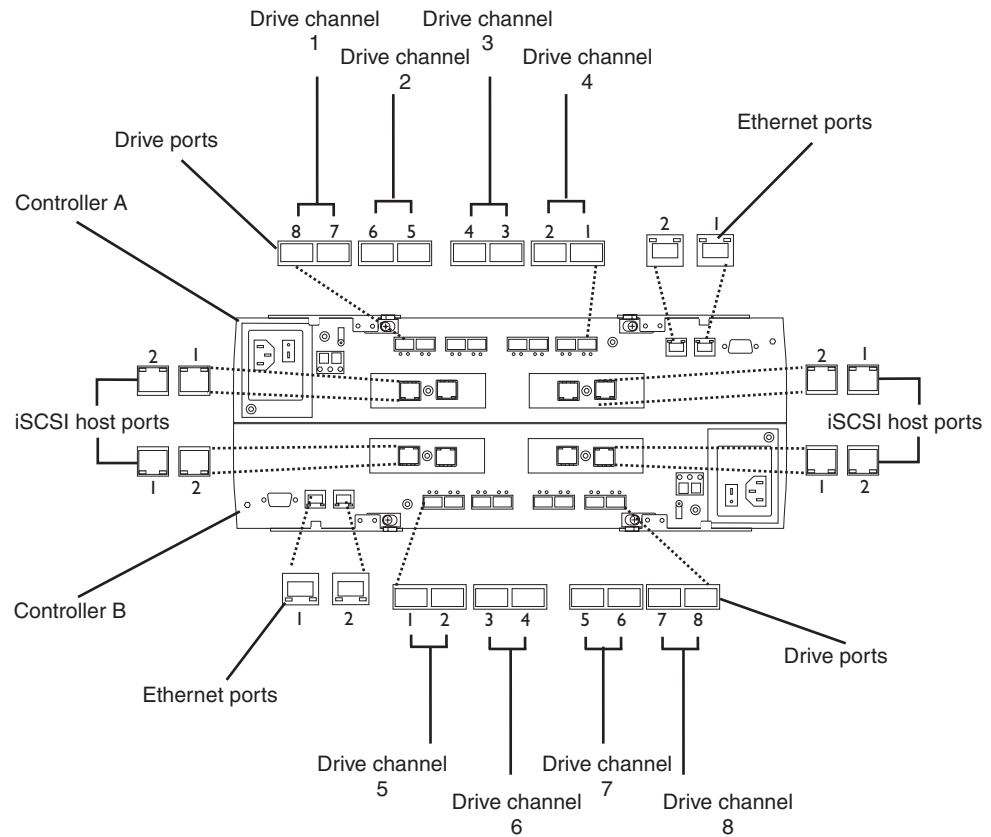
Figure 51. DS5100 or DS5300 ports and controllers with iSCSI host connections

Table 21 provides a list of the drive channels that are associated with each of the controller drive ports.

Table 21. DS5100 or DS5300 drive ports and drive channels

Drive Channel Number	Controller	Drive Port Numbers
1	A	8 and 7
2	A	6 and 5
3	A	4 and 3
4	A	2 and 1
5	B	1 and 2
6	B	3 and 4
7	B	5 and 6
8	B	7 and 8

Note: In the following drive cabling figures, the DS5100 or DS5300 graphics are simplified to show only the drive ports of each controller. In addition, the storage expansion enclosures are simplified to show only the ESM FC ports.

The following sections show some of the supported cabling configurations.

- "One DS5100 or DS5300 and one EXP5000 storage expansion enclosure" on page 84
- "One DS5100 or DS5300 and two EXP5000 storage expansion enclosures" on page 85

- "One DS5100 or DS5300 and four EXP5000 storage expansion enclosures" on page 86
- "One DS5100 or DS5300 and eight EXP5000 storage expansion enclosures" on page 86
- "One DS5100 or DS5300 and sixteen EXP5000 storage expansion enclosures" on page 88
- "One DS5100 or DS5300 and one EXP5060 storage expansion enclosure" on page 106
- "One DS5100 or DS5300 and two EXP5060 storage expansion enclosures" on page 106
- "One DS5100 or DS5300 and three EXP5060 storage expansion enclosures" on page 107
- "One DS5100 or DS5300 and four EXP5060 storage expansion enclosures" on page 108
- "One DS5100 or DS5300 and eight EXP5060 storage expansion enclosures" on page 110
- "One DS5100 or DS5300 and one EXP5060 intermixed with a maximum of three EXP810/EXP5000 storage expansion enclosures" on page 112
- "DS5100 or DS5300 storage subsystem and one EXP5060 intermixed with a maximum of seven EXP810/EXP5000 storage expansion enclosures" on page 116

The following sections show some of the supported drive-side trunking cabling configurations.
- "One storage subsystem and one EXP5060 storage expansion enclosure" on page 117
- "One storage subsystem and two EXP5060 storage expansion enclosures" on page 118
- "One storage subsystem and four EXP5060 storage expansion enclosures" on page 119
- "One storage subsystem and eight EXP5060 storage expansion enclosures" on page 121

Note: The cabling schemes in this section are not all inclusive and do not show every possible cabling scenario. Use the schemes as guidance, along with rules and best practices in "DS5100 or DS5300 drive cabling best practices and rules" on page 77 as well as Table 20 on page 78, to cable your DS5100 or DS5300 and EXP5000s.

One DS5100 or DS5300 and one EXP5000 storage expansion enclosure

If you are cabling one DS5100 or DS5300 to one EXP5000 storage expansion enclosure, Figure 52 on page 85 shows the cabling scheme.
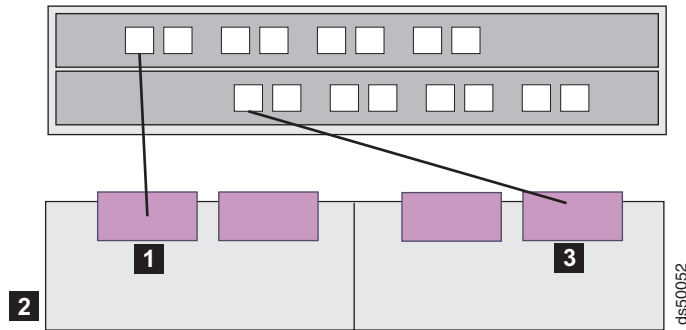
Figure 52. One DS5100 or DS5300 and one EXP5000 storage expansion enclosure

Table 22 describes Figure 52.

Table 22. Description of the figure that shows the DS5100 or DS5300 and one EXP5000 storage expansion enclosure

Number	Description
1	Drive channel 1
3	Drive channel 5
2	Storage expansion enclosure 1

1. To create drive channel 1, connect drive port 8 of controller A to port 1B on the left ESM of enclosure 1 (1).
2. To create drive channel 5, connect drive port 1 of controller B to port 1B on the right ESM of enclosure 1 (3).

One DS5100 or DS5300 and two EXP5000 storage expansion enclosures

Figure 53 shows the cabling scheme for one DS5100 or DS5300 and two EXP5000 storage expansion enclosures.
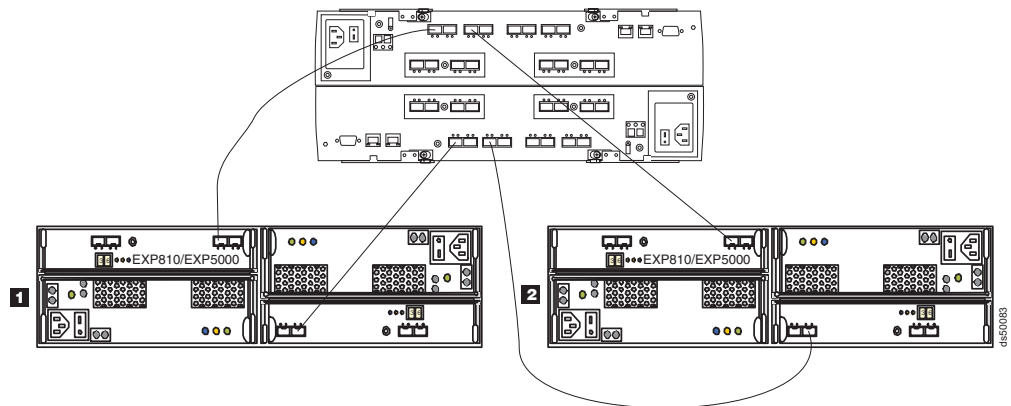
Figure 53. One DS5100 or DS5300 and two EXP5000 storage expansion enclosures

Perform the following steps to connect two EXP5000 storage expansion enclosures to one DS5100 or DS5300:

1. Connect port 8 of drive channel 1 on the DS5100 or DS5300 to port 1B on the left ESM of the first EXP5000 (1).
2. Connect port 1 of drive channel 5 on the DS5100 or DS5300 to port 1B on the right ESM of the first EXP5000 (1).

3. Connect port 6 of drive channel 2 on the DS5100 or DS5300 to port 1B on the left ESM of the second EXP5000 (2).

4. Connect port 3 of drive channel 6 on the DS5100 or DS5300 to port 1B on the right ESM of the second EXP5000 (2).

One DS5100 or DS5300 and four EXP5000 storage expansion enclosures

Figure 54 shows the cabling scheme for one DS5100 or DS5300 and four EXP5000 storage expansion enclosures.
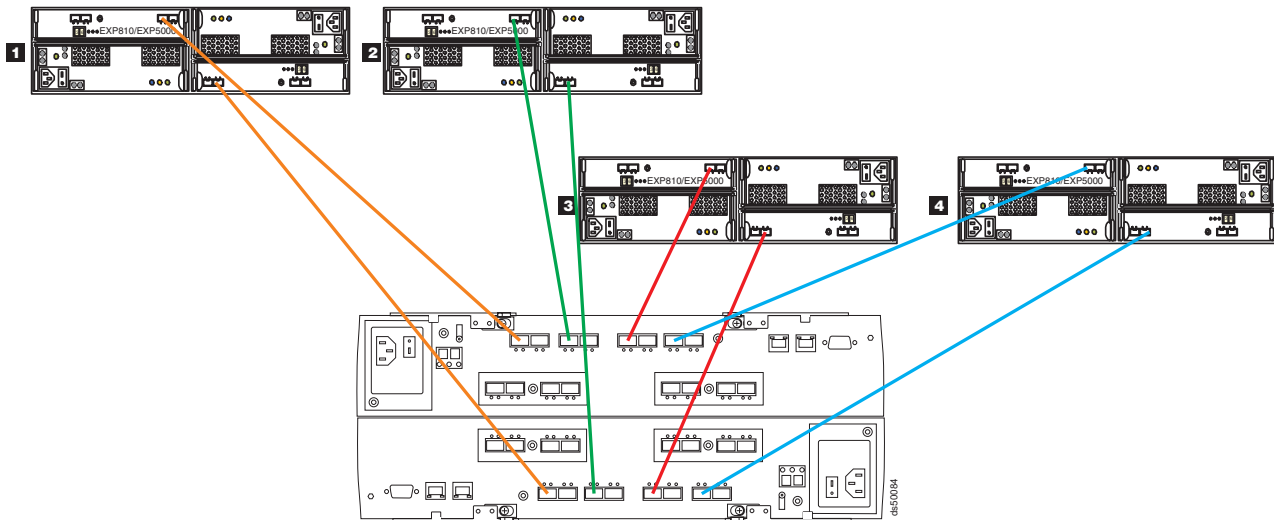
Figure 54. One DS5100 or DS5300 and four EXP5000 storage expansion enclosures

Perform the following steps to connect four EXP5000 storage expansion enclosures to one DS5100 or DS5300:

1. Connect port 8 of drive channel 1 on the DS5100 or DS5300 to port 1B on the left ESM of the first EXP5000 (1).

2. Connect port 1 of drive channel 5 on the DS5100 or DS5300 to port 1B on the right ESM of the first EXP5000 (1)

3. Connect port 6 of drive channel 2 on the DS5100 or DS5300 to port 1B on the left ESM of the second EXP5000 (2).

4. Connect port 3 of drive channel 6 on the DS5100 or DS5300 to port 1B on the right ESM of the second EXP5000 (2).

5. Connect port 4 of drive channel 3 on the DS5100 or DS5300 to port 1B on the left ESM of the third EXP5000 (3).

6. Connect port 5 of drive channel 7 on the DS5100 or DS5300 to port 1B on the right ESM of the third EXP5000 (3).

7. Connect port 2 of drive channel 4 on the DS5100 or DS5300 to port 1B on the left ESM of the fourth EXP5000 (4).

8. Connect port 7 of drive channel 8 on the DS5100 or DS5300 to port 1B on the right ESM of the fourth EXP5000 (4).

One DS5100 or DS5300 and eight EXP5000 storage expansion enclosures

Figure 55 on page 87 shows the cabling scheme for one DS5100 or DS5300 and eight EXP5000 storage expansion enclosures. Each EXP5000 is connected to a redundant pair of drive channel ports in this configuration.
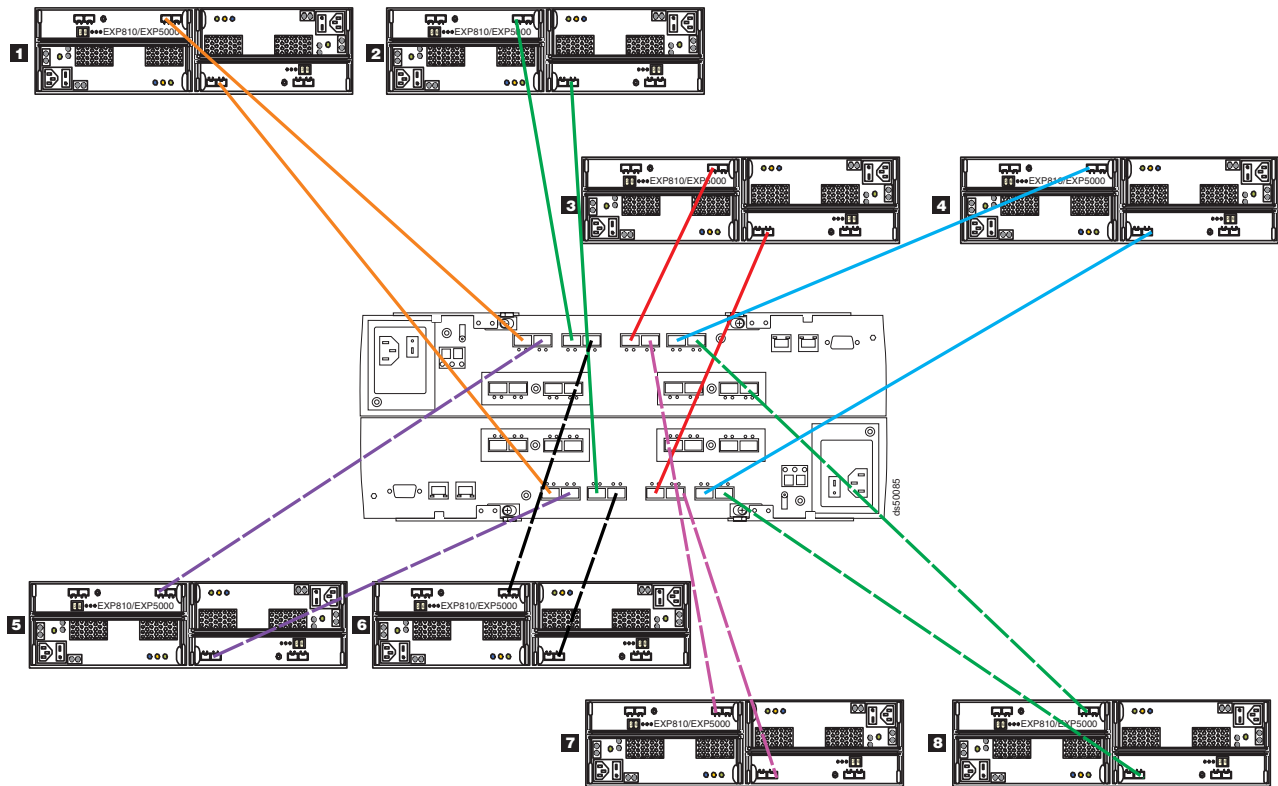
Figure 55. One DS5100 or DS5300 and eight EXP5000 storage expansion enclosures

Perform the following steps to connect eight EXP5000 storage expansion enclosures to one DS5100 or DS5300:

1. Connect port 8 of drive channel 1 on the DS5100 or DS5300 to port 1B on the left ESM of the first EXP5000 (1).

2. Connect port 1 of drive channel 5 on the DS5100 or DS5300 to port 1B on the right ESM of the first EXP5000 (1)

3. Connect port 6 of drive channel 2 on the DS5100 or DS5300 to port 1B on the left ESM of the second EXP5000 (2).

4. Connect port 3 of drive channel 6 on the DS5100 or DS5300 to port 1B on the right ESM of the second EXP5000 (2).

5. Connect port 4 of drive channel 3 on the DS5100 or DS5300 to port 1B on the left ESM of the third EXP5000 (3).

6. Connect port 5 of drive channel 7 on the DS5100 or DS5300 to port 1B on the right ESM of the third EXP5000 (3).

7. Connect port 2 of drive channel 4 on the DS5100 or DS5300 to port 1B on the left ESM of the fourth EXP5000 (4).

8. Connect port 7 of drive channel 8 on the DS5100 or DS5300 to port 1B on the right ESM of the fourth EXP5000 (4).

9. Connect port 7 of drive channel 1 on the DS5100 or DS5300 to port 1B on the left ESM of the fifth EXP5000 (5).

10. Connect port 2 of drive channel 5 on the DS5100 or DS5300 to port 1B on the right ESM of the fifth EXP5000 (5).

11. Connect port 5 of drive channel 2 on the DS5100 or DS5300 to port 1B on the left ESM of the sixth EXP5000 (6).

12. Connect port 4 of drive channel 6 on the DS5100 or DS5300 to port 1B on the right ESM of the sixth EXP5000 (6).

13. Connect port 3 of drive channel 3 on the DS5100 or DS5300 to port 1B on the left ESM of the seventh EXP5000 (7).

14. Connect port 6 of drive channel 7 on the DS5100 or DS5300 to port 1B on the right ESM of the seventh EXP5000 (7).

15. Connect port 1 of drive channel 4 on the DS5100 or DS5300 to port 1B on the left ESM of the eighth EXP5000 (8).

16. Connect port 8 of drive channel 8 on the DS5100 or DS5300 to port 1B on the right ESM of the eighth EXP5000 (8).

The end result is one EXP5000 per drive port on the DS5100 or DS5300.

One DS5100 or DS5300 and sixteen EXP5000 storage expansion enclosures

Figure 56 shows the cabling scheme for one DS5100 or DS5300 and sixteen EXP5000 storage expansion enclosures. The figure shows only a cross-section of the cabling scheme. Each redundant pair of drive channel ports in this configuration has two EXP5000 expansion enclosures connected in a cascading scheme.
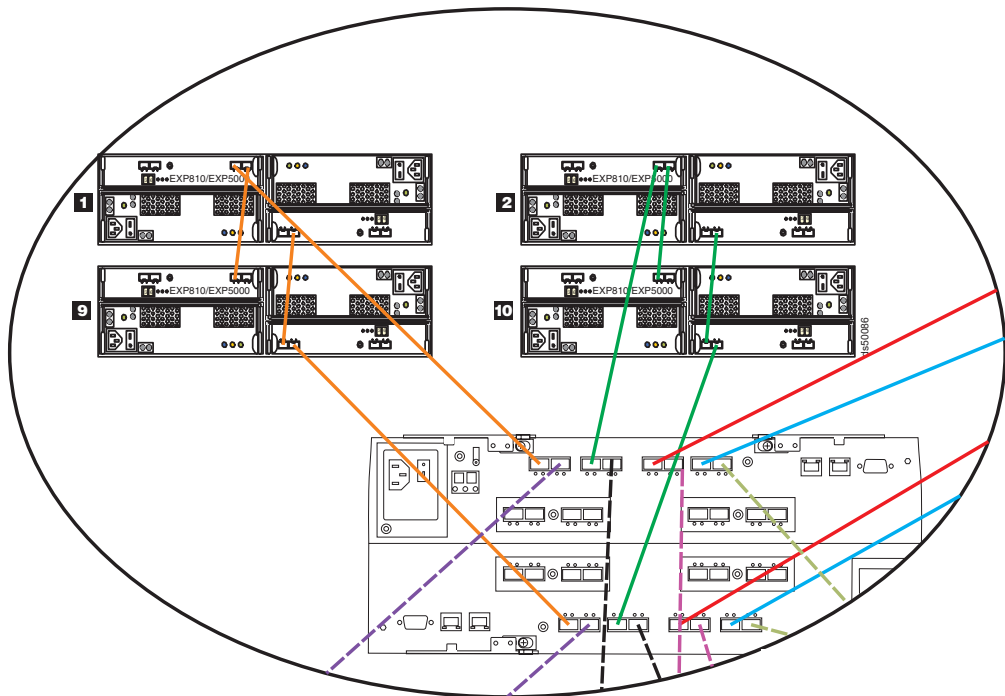
Figure 56. One DS5100 or DS5300 and sixteen EXP5000 storage expansion enclosures

Perform the following steps to connect sixteen EXP5000 storage expansion enclosures to one DS5100 or DS5300:

1. Perform the steps in "One DS5100 or DS5300 and eight EXP5000 storage expansion enclosures" on page 86.

   The result is one EXP5000 per drive port on the DS5100 or DS5300.

2. Perform the steps to cascade or daisy-chain an additional EXP5000 to an existing EXP5000:

   a. Add the ninth EXP5000 after the first EXP5000 (see 9 in Figure 56.)

b. Connect port 1A on the left ESM of the first EXP5000 (1) to port 1B on the left ESM of the ninth EXP5000 (9).

c. Connect port 1B on the right ESM of the first EXP5000 (1) to port 1A on the right ESM of the ninth EXP5000 (9).

d. Move the connection between port 1B on the right ESM of the first EXP5000 (1) and port 1 of drive channel 5 on the DS5100 or DS5300 to port 1B of the ninth EXP5000.

3. Repeat 2 on page 88 to connect the remainder of the EXP5000s to port 1B on the right ESM of the ninth EXP5000 (9).

The end result is two EXP5000 storage expansion enclosures per redundant pair of drive channel ports for a total of 16 storage expansion enclosures.

One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures

Figure 57 shows the cabling scheme for one DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures.
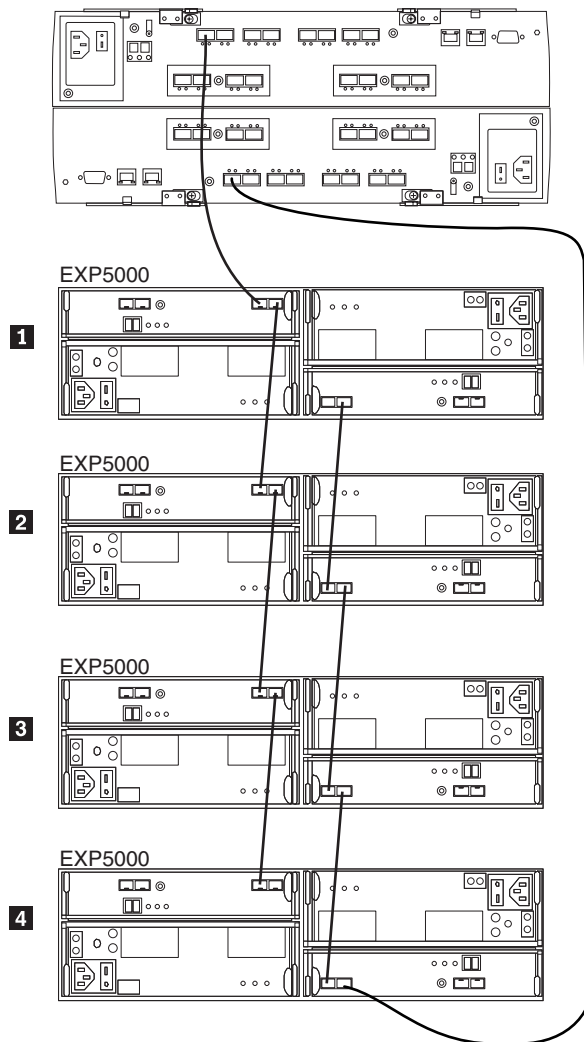
Figure 57. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 1 to 4

Table 23. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 1 to 4

	Controller A								Controller B								Storage Expansion Enclosure 1			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
1	X																	X		

	Storage Expansion Enclosure 1				Storage Expansion Enclosure 2			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
Cable	1A	1B	1A	1B	1A	1B	1A	1B
2	X					X		
3				X			X	

	Storage Expansion Enclosure 2				Storage Expansion Enclosure 3			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
Cable	1A	1B	1A	1B	1A	1B	1A	1B
4	X					X		
5				X			X	

	Storage Expansion Enclosure 3				Storage Expansion Enclosure 4			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
Cable	1A	1B	1A	1B	1A	1B	1A	1B
6	X					X		
7				X			X	

	Controller A								Controller B								Storage Expansion Enclosure 4			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
8									X											X

Figure 58. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 5 to 7

Table 24. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 5 to 7

Cable	Controller A								Controller B								Storage Expansion Enclosure 5			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
9		X																X		

Cable	Storage Expansion Enclosure 5				Storage Expansion Enclosure 6			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
	1A	1B	1A	1B	1A	1B	1A	1B
10	X					X		
11				X			X	

Cable	Storage Expansion Enclosure 6				Storage Expansion Enclosure 7			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
	1A	1B	1A	1B	1A	1B	1A	1B
12	X					X		
13				X			X	

Cable	Controller A								Controller B								Storage Expansion Enclosure 7			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
14										X										X
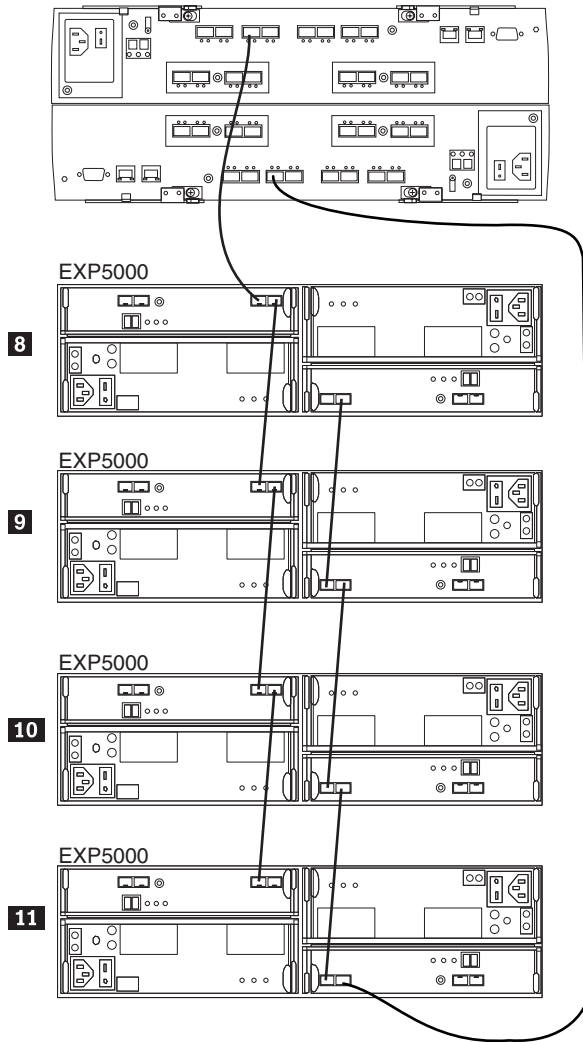
Figure 59. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 8 to 11

Table 25. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 8 to 11

Cable	Controller A Ch1		Ch2		Ch3		Ch4		Controller B Ch5		Ch6		Ch7		Ch8		Storage Expansion Enclosure 8 ESM A (Left)		ESM B (Right)	
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
15			X															X		

Cable	Storage Expansion Enclosure 8 ESM A (Left)		ESM B (Right)		Storage Expansion Enclosure 9 ESM A (Left)		ESM B (Right)	
	1A	1B	1A	1B	1A	1B	1A	1B
16	X					X		
17				X			X	

Cable	Storage Expansion Enclosure 9 ESM A (Left)		ESM B (Right)		Storage Expansion Enclosure 10 ESM A (Left)		ESM B (Right)	
	1A	1B	1A	1B	1A	1B	1A	1B
18	X					X		
19				X			X	

Cable	Storage Expansion Enclosure 10 ESM A (Left)		ESM B (Right)		Storage Expansion Enclosure 11 ESM A (Left)		ESM B (Right)	
	1A	1B	1A	1B	1A	1B	1A	1B
20	X					X		
21				X			X	

Cable	Controller A Ch1		Ch2		Ch3		Ch4		Controller B Ch5		Ch6		Ch7		Ch8		Storage Expansion Enclosure 11 ESM A (Left)		ESM B (Right)	
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
22											X									X

Figure 60. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 12 to 14

Table 26. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 12 to 14

Cable	Controller A								Controller B								Storage Expansion Enclosure 12			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
23				X														X		

Cable	Storage Expansion Enclosure 12				Storage Expansion Enclosure 13			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
	1A	1B	1A	1B	1A	1B	1A	1B
24	X					X		
25				X			X	

Cable	Storage Expansion Enclosure 13				Storage Expansion Enclosure 14			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
	1A	1B	1A	1B	1A	1B	1A	1B
26	X					X		
27				X			X	

Cable	Controller A								Controller B								Storage Expansion Enclosure 14			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
28												X								X

*Figure 61. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures -
Enclosures 15 to 18*

Table 27. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 15 to 18

Cable	Controller A								Controller B								Storage Expansion Enclosure 15			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
29					X													X		

Cable	Storage Expansion Enclosure 15				Storage Expansion Enclosure 16			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
	1A	1B	1A	1B	1A	1B	1A	1B
30	X					X		
31				X			X	

Cable	Storage Expansion Enclosure 16				Storage Expansion Enclosure 17			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
	1A	1B	1A	1B	1A	1B	1A	1B
32	X					X		
33				X			X	

Cable	Storage Expansion Enclosure 17				Storage Expansion Enclosure 18			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
	1A	1B	1A	1B	1A	1B	1A	1B
34	X					X		
35				X			X	

Cable	Controller A								Controller B								Storage Expansion Enclosure 18			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
36													X							X

Figure 62. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 19 to 21

Table 28. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 19 to 21

| | Controller A | | | | | | | | Controller B | | | | | | | | Storage Expansion Enclosure 19 | | | |
| | Ch1 | | Ch2 | | Ch3 | | Ch4 | | Ch5 | | Ch6 | | Ch7 | | Ch8 | | ESM A (Left) | | ESM B (Right) | |
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
37						X												X		

| | Storage Expansion Enclosure 19 | | | | Storage Expansion Enclosure 20 | | | |
| | ESM A (Left) | | ESM B (Right) | | ESM A (Left) | | ESM B (Right) | |
Cable	1A	1B	1A	1B	1A	1B	1A	1B
38	X					X		
39				X			X	

| | Storage Expansion Enclosure 20 | | | | Storage Expansion Enclosure 21 | | | |
| | ESM A (Left) | | ESM B (Right) | | ESM A (Left) | | ESM B (Right) | |
Cable	1A	1B	1A	1B	1A	1B	1A	1B
40	X					X		
41				X			X	

| | Controller A | | | | | | | | Controller B | | | | | | | | Storage Expansion Enclosure 21 | | | |
| | Ch1 | | Ch2 | | Ch3 | | Ch4 | | Ch5 | | Ch6 | | Ch7 | | Ch8 | | ESM A (Left) | | ESM B (Right) | |
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
42													X							X

Figure 63. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 22 to 25

Table 29. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 22 to 25

	Controller A								Controller B								Storage Expansion Enclosure 22			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
43							X											X		

	Storage Expansion Enclosure 22				Storage Expansion Enclosure 23			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
Cable	1A	1B	1A	1B	1A	1B	1A	1B
44	X					X		
45				X			X	

	Storage Expansion Enclosure 23				Storage Expansion Enclosure 24			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
Cable	1A	1B	1A	1B	1A	1B	1A	1B
46	X					X		
47				X			X	

	Storage Expansion Enclosure 24				Storage Expansion Enclosure 25			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
Cable	1A	1B	1A	1B	1A	1B	1A	1B
48	X					X		
49				X			X	

	Controller A								Controller B								Storage Expansion Enclosure 25			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
50															X					X

*Figure 64. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures -
Enclosures 26 to 28*

Table 30. One DS5100 or DS5300 and 28 EXP5000 storage expansion enclosures - Enclosures 26 to 28

	Controller A								Controller B								Storage Expansion Enclosure 26			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
51								X										X		

	Storage Expansion Enclosure 26				Storage Expansion Enclosure 27			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
Cable	1A	1B	1A	1B	1A	1B	1A	1B
52	X					X		
53				X			X	

	Storage Expansion Enclosure 27				Storage Expansion Enclosure 28			
	ESM A (Left)		ESM B (Right)		ESM A (Left)		ESM B (Right)	
Cable	1A	1B	1A	1B	1A	1B	1A	1B
54	X					X		
55				X			X	

	Controller A								Controller B								Storage Expansion Enclosure 28			
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Left)		ESM B (Right)	
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	1A	1B
56																X				X

One DS5100 or DS5300 and one EXP5060 storage expansion enclosure

Figure 65. Cabling for DS5100 or DS5300 storage subsystem with one EXP5060 storage expansion enclosure without trunking

Table 31. Cabling for DS5100 or DS5300 storage subsystem with one EXP5060 storage expansion enclosure without trunking

	Controller A Connection								Controller B Connection								Storage Expansion Enclosure Connection							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
Storage Expansion Enclosure 1																								
1	X																	X						
2									X													X		

One DS5100 or DS5300 and two EXP5060 storage expansion enclosures

Figure 66. Cabling for DS5100 or DS5300 storage subsystem with two EXP5060 storage expansion enclosures without trunking

Table 32. Cabling for DS5100 or DS5300 storage subsystem with two EXP5060 storage expansion enclosures without trunking

	Controller A Connection								Controller B Connection								Storage Expansion Enclosure Connection							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
Storage Expansion Enclosure 1																								
1	X																	X						
2									X													X		
Storage Expansion Enclosure 2																								
3			X															X						
4											X											X		

One DS5100 or DS5300 and three EXP5060 storage expansion enclosures

Figure 67. Cabling for DS5100 or DS5300 storage subsystem with three EXP5060 storage expansion enclosures without trunking

Table 33. Cabling for DS5100 or DS5300 storage subsystem with three EXP5060 storage expansion enclosures without trunking

	Controller A Connection								Controller B Connection								Storage Expansion Enclosure Connection							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
Storage Expansion Enclosure 1																								
1	X																	X						
2									X													X		
Storage Expansion Enclosure 2																								
3			X															X						
4											X											X		
Storage Expansion Enclosure 3																								
5					X													X						
6													X									X		

One DS5100 or DS5300 and four EXP5060 storage expansion enclosures

Figure 68. Cabling for DS5100 or DS5300 storage subsystem with four EXP5060 storage expansion enclosures without trunking

Table 34. Cabling for DS5100 or DS5300 storage subsystem with four EXP5060 storage expansion enclosures without trunking

	Controller A Connection								Controller B Connection								Storage Expansion Enclosure Connection							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
Storage Expansion Enclosure 1																								
1	X																	X						
2									X													X		
Storage Expansion Enclosure 2																								
3			X															X						
4											X											X		
Storage Expansion Enclosure 3																								
5					X													X						

Table 34. Cabling for DS5100 or DS5300 storage subsystem with four EXP5060 storage expansion enclosures without trunking (continued)

Cable	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Controller A Connection									**Controller B Connection**								**Storage Expansion Enclosure Connection**							
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
6													X									X		
Storage Expansion Enclosure 4																								
7							X											X						
8															X							X		

One DS5100 or DS5300 and eight EXP5060 storage expansion enclosures

Figure 69. Cabling for DS5100 or DS5300 storage subsystem with eight EXP5060 storage expansion enclosures without trunking

Table 35. Cabling for DS5100 or DS5300 storage subsystem with eight EXP5060 storage expansion enclosures without trunking

	Controller A Connection								Controller B Connection								Storage Expansion Enclosure Connection							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
Storage Expansion Enclosure 1																								
1	X																	X						
2									X													X		
Storage Expansion Enclosure 2																								
3			X															X						
4											X											X		
Storage Expansion Enclosure 3																								
5					X													X						
6													X									X		
Storage Expansion Enclosure 4																								
7							X											X						
8															X							X		
Storage Expansion Enclosure 5																								
9		X																X						
10										X												X		
Storage Expansion Enclosure 6																								
11				X														X						
12												X										X		
Storage Expansion Enclosure 7																								
13						X												X						
14														X								X		
Storage Expansion Enclosure 8																								
15								X										X						
16																X						X		

One DS5100 or DS5300 and one EXP5060 intermixed with a maximum of three EXP810/EXP5000 storage expansion enclosures

The following illustrations show examples of cabling one DS5100 or DS5300 storage subsystem and one EXP5060 intermixed with a maximum of three EXP810/EXP5000 storage expansion enclosures connected in the same drive channel.

Note: EXP5060 drive-side trunk cabling is not supported when EXP5060 and EXP5000/EXP810 storage expansion enclosures are cabled in the same drive channel.
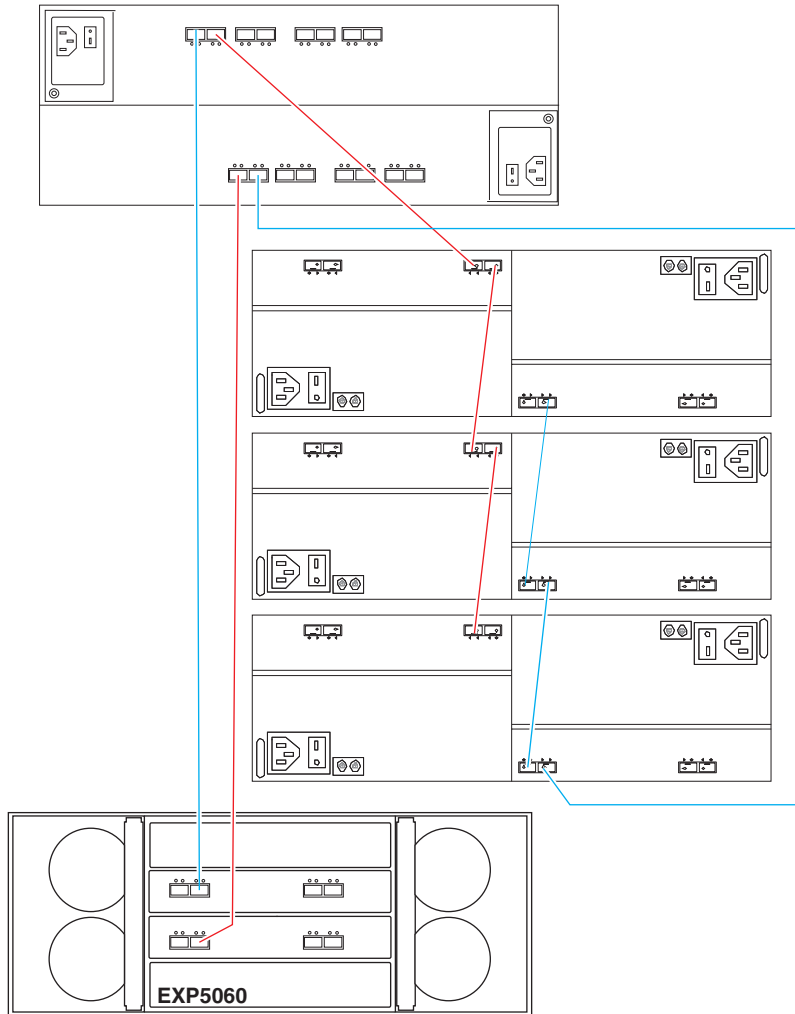
Figure 70. Cabling for DS5100 or DS5300 storage subsystem and one EXP5060 intermixed with a maximum of three EXP810/EXP5000 storage expansion enclosures without trunking (example 1)

Note: The EXP5060 and the EXP5000/EXP810 storage expansion enclosures are connected to different ports of the same drive channel in each controller.
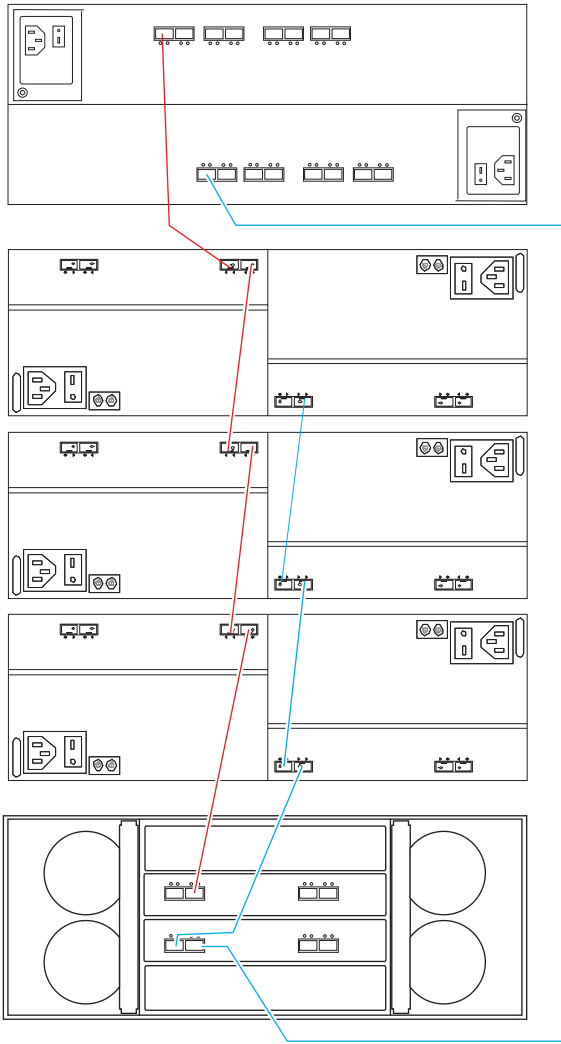
Figure 71. Cabling for DS5100 or DS5300 storage subsystem and one EXP5060 intermixed with a maximum of three EXP810/EXP5000 storage expansion enclosures without trunking (example 2)

Note: The EXP5060 and the EXP5000/EXP810 storage expansion enclosures are connected to the same port of the same drive channel in each controller. Group together the EXP5000/EXP810 storage expansion enclosures.
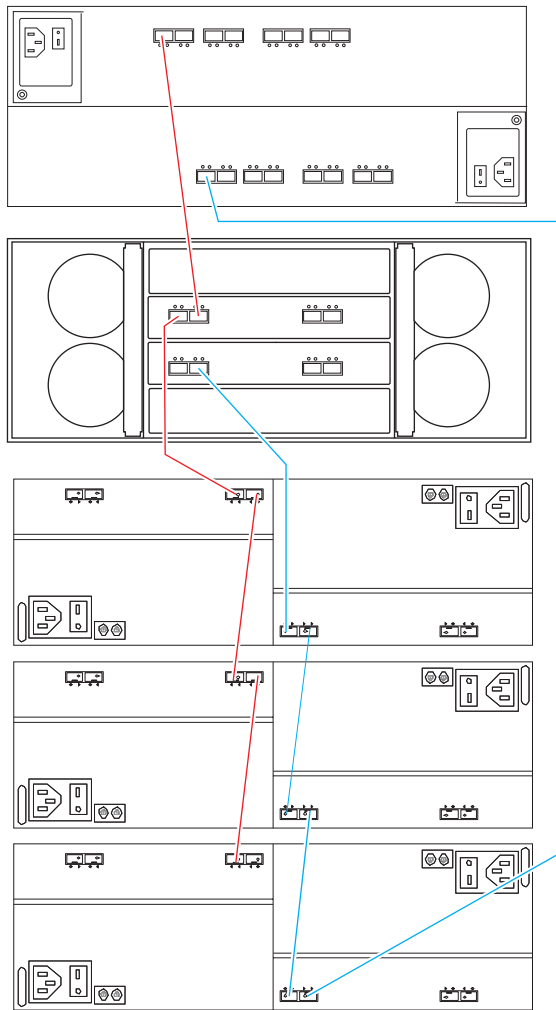
Figure 72. Cabling for DS5100 or DS5300 storage subsystem and one EXP5060 intermixed with a maximum of three EXP810/EXP5000 storage expansion enclosures without trunking (example 3)

Note: The EXP5060 and the EXP5000/EXP810 storage expansion enclosures are connected to the same port of the same drive channel in each controller. Group together the EXP5000/EXP810 storage expansion enclosures. Cable the configuration as illustrated if there are less than 3 EXP5000/EXP810 storage expansion enclosures to be connected with the EXP5060 initially because it allows the addition of EXP5000 enclosures and still be able to have the EXP5000 enclosures cabled together.

DS5100 or DS5300 storage subsystem and one EXP5060 intermixed with a maximum of seven EXP810/EXP5000 storage expansion enclosures
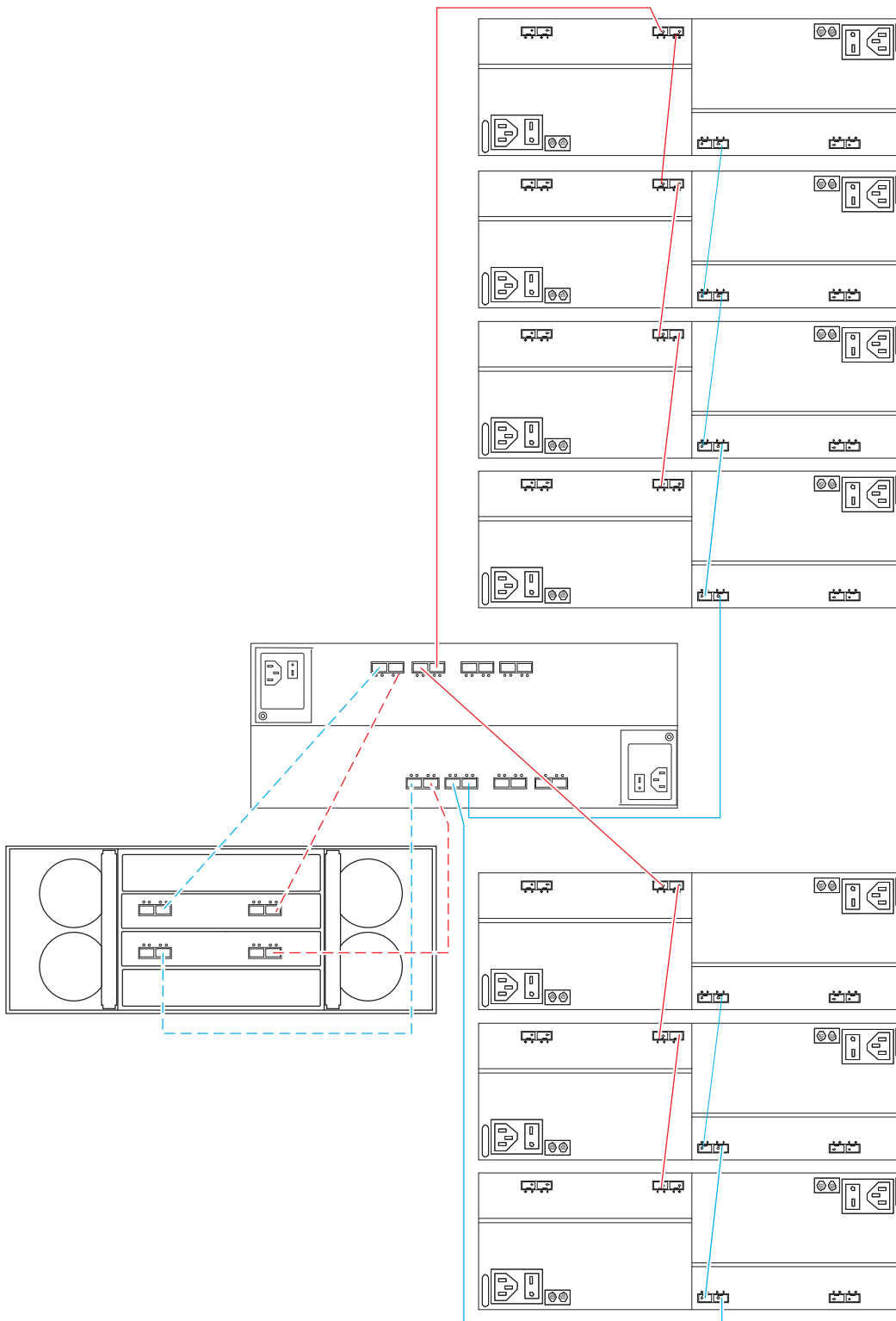
Figure 73. Cabling for DS5100 or DS5300 storage subsystem and one EXP5060 intermixed with a maximum of seven EXP810/EXP5000 storage expansion enclosures and drive-side trunking

Drive-side trunking cabling configurations

The following notes describe information about drive-side trunking that you must consider.

- Drive-side trunking is supported only with the EXP5060 storage expansion enclosure.
- Connect the EXP5060 and EXP5000/EXP810 storage expansion enclosures in separate drive channels in each controller to enable drive-side trunking with the EXP5060 storage expansion enclosure.
- Intermixing enclosures with trunked and standard cabling in the same storage subsystem is supported.
- Benefits are that drive-side trunking doubles the number of fibre connections, maintains throughput potential, and simplifies cabling.

Use the cabling configuration examples in this section as a guide to configure your storage array to receive the benefits of drive-side trunking. Drive-side trunking requires that the ESMs have four ports to support trunked cascading connections to other storage expansion enclosures. These cascading connections only apply when eight storage expansion enclosures are connected to the storage subsystem.

See "Drive-side trunking cabling" on page 73 for more information.

One storage subsystem and one EXP5060 storage expansion enclosure:
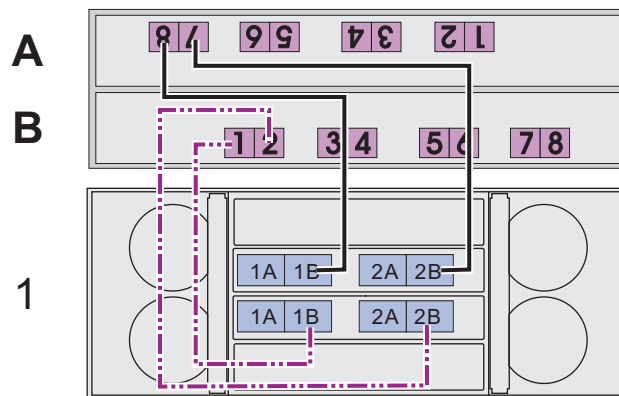
Figure 74. Cabling for DS5100 or DS5300 storage subsystem with one EXP5060 storage expansion enclosure with drive-side trunking

Table 36. Cabling for the first EXP5060 storage expansion enclosure with drive-side trunking

	Controller A								Controller B								Storage Expansion Enclosure 1							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1	X																	X						
2		X																	X					
3									X													X		
4										X														X

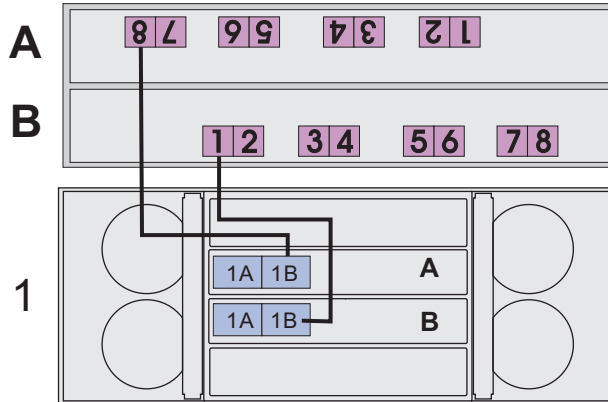**One storage subsystem and two EXP5060 storage expansion enclosures:**

Figure 75. Cabling for DS5100 or DS5300 storage subsystem with two EXP5060 storage expansion enclosures and drive-side trunking

Table 37. Cabling for the first EXP5060 storage expansion enclosure with drive-side trunking

	Controller A								Controller B								Storage Expansion Enclosure 1							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1	X																	X						
2		X																		X				
3									X														X	
4										X														X

Table 38. Cabling for the second EXP5060 storage expansion enclosure with drive-side trunking

	Controller A								Controller B								Storage Expansion Enclosure 2							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1			X															X						
2				X																X				
3											X												X	
4												X												X

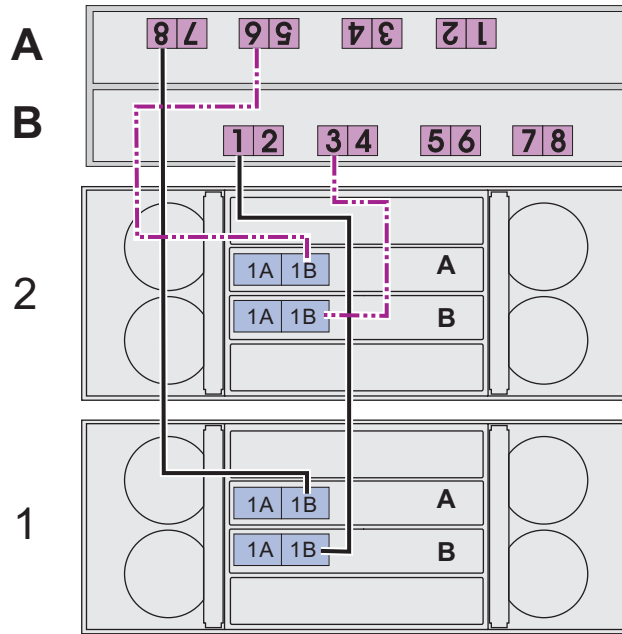**One storage subsystem and four EXP5060 storage expansion enclosures:**
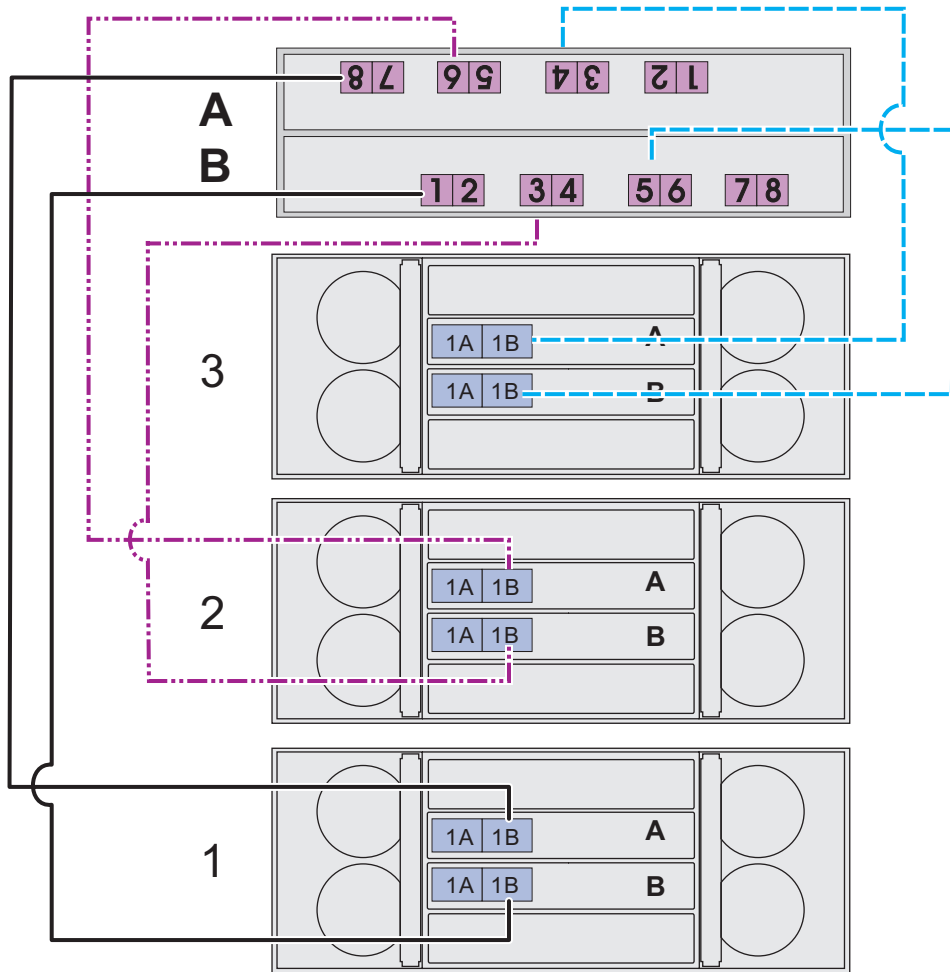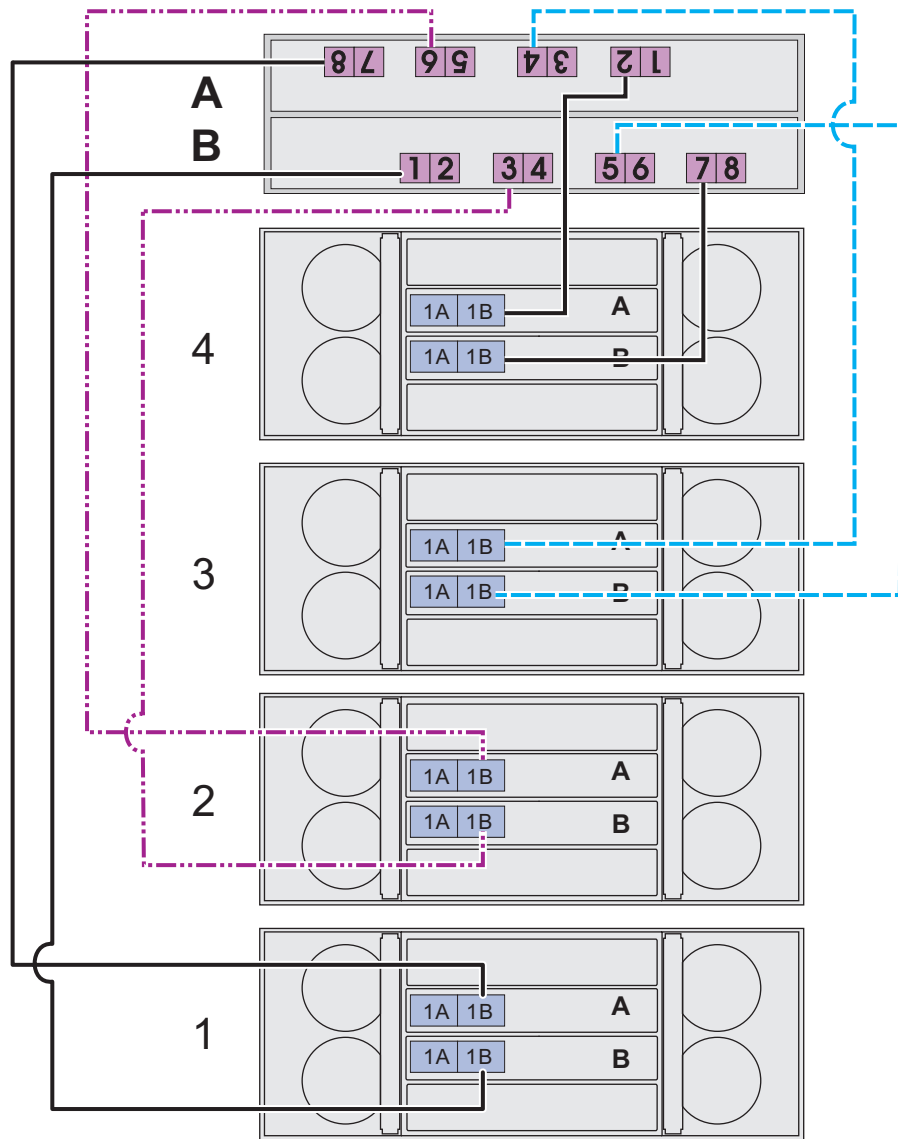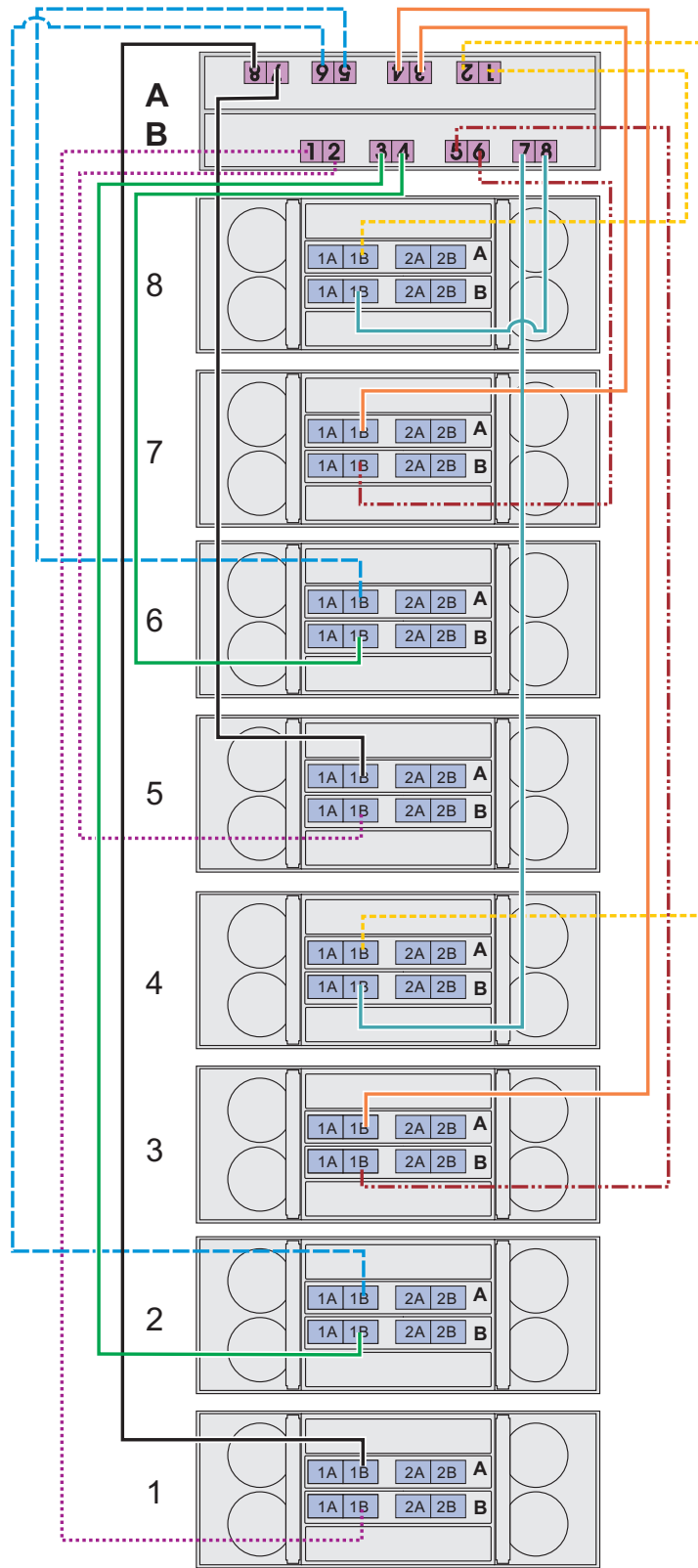

Figure 76. Cabling for DS5100 or DS5300 storage subsystem with four EXP5060 storage
expansion enclosures and drive-side trunking

Table 39. Cabling for the first EXP5060 storage expansion enclosure with drive-side trunking

	Controller A								Controller B								Storage Expansion Enclosure 1							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1	X																	X						
2		X																		X				
3									X													X		
4										X														X

Table 40. Cabling for the second EXP5060 storage expansion enclosure with drive-side trunking

	Controller A								Controller B								Storage Expansion Enclosure 2							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1			X															X						
2				X																X				
3											X											X		
4												X												X

Table 41. Cabling for the third EXP5060 storage expansion enclosure with drive-side trunking

	Controller A								Controller B								Storage Expansion Enclosure 3							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1					X													X						
2						X														X				
3													X									X		
4														X										X

Table 42. Cabling for the fourth EXP5060 storage expansion enclosure with drive-side trunking

	Controller A								Controller B								Storage Expansion Enclosure 4							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1							X											X						
2								X												X				
3															X							X		
4																X								X

One storage subsystem and eight EXP5060 storage expansion enclosures:
To connect eight EXP5060 storage expansion enclosures to a DS5100/DS5300
storage subsystem using drive-trunking cabling, you must connect the EXP5060s in
four pairs of two cascading EXP5060s each to the DS5100/DS5300 drive channel
ports. These connections are shown in the following illustrations:

- See Figure 77 on page 122 and Table 43 on page 123 for storage expansion
  enclosures 1 and 2
- See Figure 78 on page 124 and Table 44 on page 125 for storage expansion
  enclosures 3 and 4
- See Figure 79 on page 126 and Table 45 on page 127 for storage expansion
  enclosures 5 and 6
- See Figure 80 on page 128 and Table 46 on page 129 for storage expansion
  enclosures 7 and 8

Make the connections described in Table 43 on page 123 through Table 46 on page
129 to connect the ESM A ports 1B and 2B of the first EXP5060 in a cascading
EXP5060 pair to the controller A drive channel ports and to connect ESM B ports
1B and 2B of the second EXP5060 in a cascading EXP5060 pair to the controller B
drive channel ports.

Then you must connect the EXP5060 ESMs in a cascading EXP5060 pair together.
To do this, connect the ESM B ports 1A and 2A of the second EXP5060 to ESM B
ports 1B and 2B of the first EXP5060 in a cascading EXP5060 pair. Then, connect
ESM A ports 1B and 2B of the second EXP5060 to ESM A ports 1A and 2A of the
first EXP5060 in the cascading pair.

See also "Drive-side trunking cabling" on page 73 for more information.
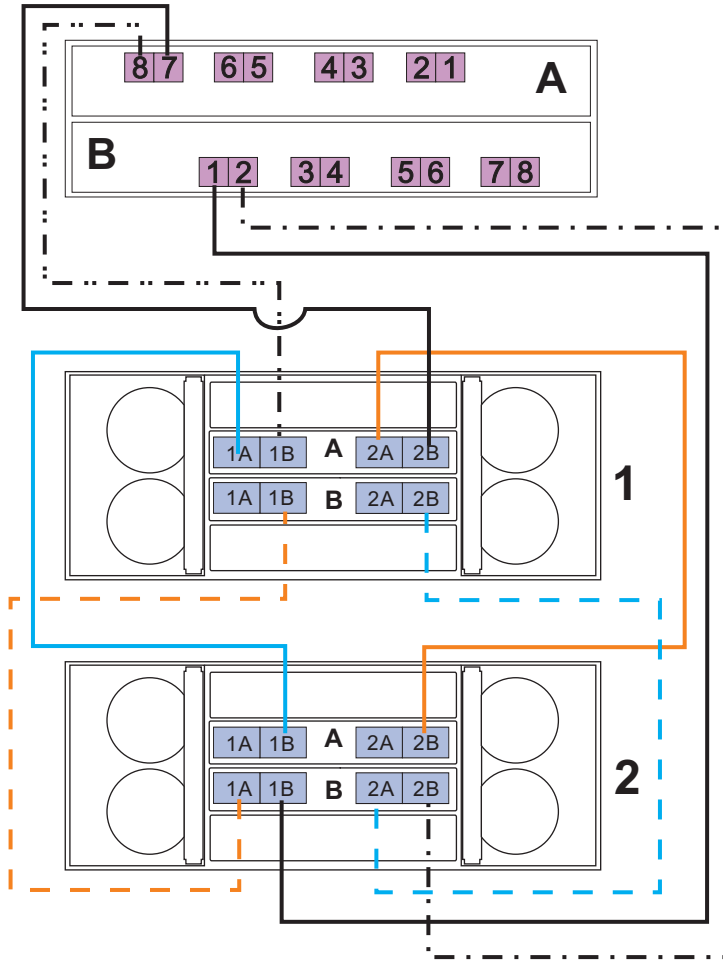
Figure 77. Cabling for eight EXP5060s, storage expansion enclosures 1 and 2 with drive-side trunking

Table 43. Cabling for eight EXP5060s, storage expansion enclosures 1 and 2 with drive-side trunking

Cable	Controller A								Controller B								Storage Expansion Enclosure 1							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1	X																	X						
2		X																	X					

Cable	Storage Expansion Enclosure 1								Storage Expansion Enclosure 2							
	ESM A (Top)				ESM B (Bottom)				ESM A (Top)				ESM B (Bottom)			
	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B
3	X									X						
4			X									X				
5						X								X		
6								X								X

Cable	Controller A								Controller B								Storage Expansion Enclosure 2							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
7									X													X		
8										X														X

Figure 78. Cabling for eight EXP5060s, storage expansion enclosures 3 and 4 with drive-side trunking

Table 44. Cabling for eight EXP5060s, storage expansion enclosures 3 and 4 with drive-side trunking

	Controller A								Controller B								Storage Expansion Enclosure 3							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1			X															X						
2				X																	X			

	Storage Expansion Enclosure 3								Storage Expansion Enclosure 4							
	ESM A (Top)				ESM B (Bottom)				ESM A (Top)				ESM B (Bottom)			
Cable	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B
3	X								X							
4			X									X				
5						X								X		
6								X							X	

	Controller A								Controller B								Storage Expansion Enclosure 4							
	Ch1		Ch2		Ch3		Ch4		Ch5		Ch6		Ch7		Ch8		ESM A (Top)				ESM B (Bottom)			
Cable	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
7											X											X		
8												X												X

Figure 79. Cabling for eight EXP5060s, storage expansion enclosures 5 and 6 with drive-side trunking

Table 45. Cabling for eight EXP5060s, storage expansion enclosures 5 and 6 with drive-side trunking

Cable	Controller A Ch1 8	7	Ch2 6	5	Ch3 4	3	Ch4 2	1	Controller B Ch5 1	2	Ch6 3	4	Ch7 5	6	Ch8 7	8	Storage Expansion Enclosure 5 ESM A (Top) 1A	1B	2A	2B	ESM B (Bottom) 1A	1B	2A	2B
1					X													X						
2						X													X					

Cable	Storage Expansion Enclosure 5 ESM A (Top) 1A	1B	2A	2B	ESM B (Bottom) 1A	1B	2A	2B	Storage Expansion Enclosure 6 ESM A (Top) 1A	1B	2A	2B	ESM B (Bottom) 1A	1B	2A	2B
3	X								X							
4			X								X					
5					X								X			
6							X								X	

Cable	Controller A Ch1 8	7	Ch2 6	5	Ch3 4	3	Ch4 2	1	Controller B Ch5 1	2	Ch6 3	4	Ch7 5	6	Ch8 7	8	Storage Expansion Enclosure 6 ESM A (Top) 1A	1B	2A	2B	ESM B (Bottom) 1A	1B	2A	2B
7													X									X		
8														X										X

Figure 80. Cabling for eight EXP5060s, storage expansion enclosures 7 and 8 with drive-side trunking

Table 46. Cabling for eight EXP5060s, storage expansion enclosures 7 and 8 with drive-side trunking

Cable	Controller A Ch1		Ch2		Ch3		Ch4		Controller B Ch5		Ch6		Ch7		Ch8		Storage Expansion Enclosure 7 ESM A (Top)				ESM B (Bottom)			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
1							X										X							
2								X													X			

Cable	Storage Expansion Enclosure 7 ESM A (Top)				ESM B (Bottom)				Storage Expansion Enclosure 8 ESM A (Top)				ESM B (Bottom)			
	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B	1A	1B	2A	2B
3	X									X						
4			X									X				
5						X								X		
6								X								X

Cable	Controller A Ch1		Ch2		Ch3		Ch4		Controller B Ch5		Ch6		Ch7		Ch8		Storage Expansion Enclosure 8 ESM A (Top)				ESM B (Bottom)			
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	1A	1B	2A	2B	1A	1B	2A	2B
7															X							X		
8																X								X

Cabling the storage expansion enclosures to a storage subsystem

Complete the following steps to cable the storage expansion enclosures to a DS5100 or DS5300:

1. Install an SFP module in the drive mini hub port on the back of the Storage Subsystem, as shown in Figure 81 on page 130.

2. Connect an LC-LC fiber-optic cable into the SFP module, as shown in Figure 82 on page 130.
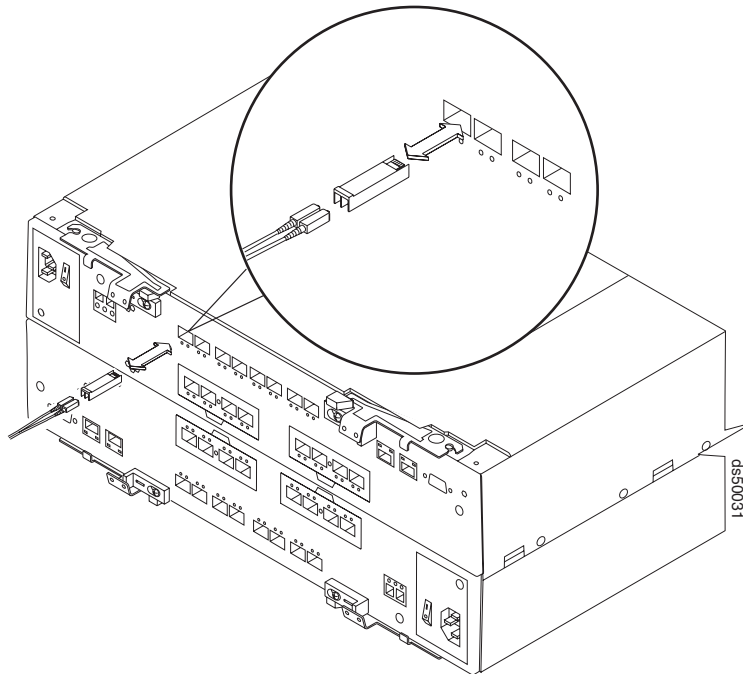
Figure 81. Installing an SFP module and LC-LC cable in a DS5100 or DS5300

Install an SFP module in the SFP port on the back of the storage expansion enclosures; then, connect the other end of the LC-LC cable into the SFP module, as shown in Figure 82.
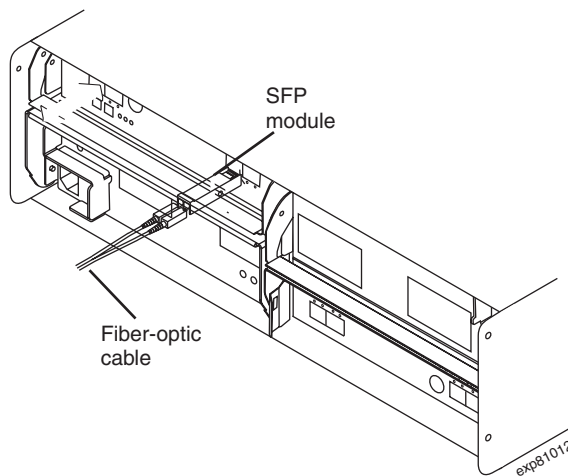
Figure 82. Installing an SFP module and connecting an LC-LC cable to the storage expansion enclosures

For important information about connection rules and best practices, see "DS5100 or DS5300 drive cabling best practices and rules" on page 77.

Storage expansion enclosure settings

This section provides information about storage expansion enclosure settings. For additional detail, refer to the *Installation, User's, and Maintenance Guide* for your storage expansion enclosure.

DS5100 or DS5300 storage expansion enclosure ID settings

DS5100 or DS5300 storage expansion enclosures have an enclosure ID that is used to identify the DS5100 or DS5300 storage expansion enclosure on a fibre channel loop. The enclosure ID is located on the back of the unit. The enclosure ID is set by the software. For details on enclosure ID settings, refer to the *Installation, User's and Maintenance Guide* for the particular storage expansion enclosure.

Note: If the enclosure ID has not been automatically set, you have to set it manually through the software. To set the enclosure ID, see the Storage Manager Online Help.

Each storage expansion enclosure in a DS5100 or DS5300 drive loop must have a unique enclosure ID. DS5100 or DS5300 controllers use a combination of the enclosure ID and the number of the physical slots that a hard drive occupies to create a unique fibre channel loop address, or arbitrated loop physical address (AL_PA), for each drive in a fibre channel drive loop. The enclosure ID consists of two digits, a tens digit (x10) and a ones digit (x1). The enclosure IDs of EXP5000s are automatically adjusted to be unique values by the EXP5000 ESM and the controller firmware.

Attention: When connecting storage expansion enclosures, use the tens digit (x10) enclosure ID setting to distinguish different redundant loops and use the ones digit (x1) enclosure ID setting to distinguish storage expansion enclosures IDs within a redundant loop. If you do not set the single digit value of the enclosure IDs to be unique among storage expansion enclosures (including the DS5100 or DS5300 with drives installed) in a redundant drive channel/loop pair, then drive loop errors might be randomly posted in the DS5100 or DS5300 subsystem Major Event Log (MEL) when you intermix different types of storage expansion enclosures in a redundant drive loop pair. For example, in a DS5100 or DS5300 configuration with 16 storage expansion enclosures distributed equally behind the four controller drive ports, Table 47 shows the best practice enclosure ID settings for the enclosures connected to the first four drive ports.

Table 47. Best practice enclosure ID settings scheme

	Enclosure ID behind the first controller drive port	Enclosure ID behind the second controller drive port	Enclosure ID behind the third controller drive port	Enclosure ID behind the fourth controller drive port
Enclosure 1	01	05	11	15
Enclosure 2	02	06	12	16
Enclosure 3	03	07	13	17
Enclosure 4	04		14	

The DS5100 or DS5300 normally ships with an enclosure ID outside the range of 00–77. However, if your DS5100 or DS5300 enclosure ID was set to a value within the range of 00–77, it may be in conflict with the enclosure ID of one of the storage expansion enclosures that you are trying to attach to the DS5100 or DS5300. If this is the case, the amber ID Conflict LED on the storage expansion enclosure will light up after you power on the storage subsystem.

Give each storage expansion enclosure in a redundant drive channel pair a unique ones digit (x1) ID. This setting will enforce hard AL_PAs (unchangeable between fibre channel Loop Initializations [LIPs]) for the drives and facilitate drive channel

problem troubleshooting in the event of an error. If the ones digits are not unique, two or more devices will have the same hard AL_PA. In such a case, the DS5100 or DS5300 controller will use soft AL_PAs for the devices that have identical hard AL_PAs.

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

Fibre channel loop and ID settings

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

DS Storage Manager client host port numbering

The following notes describe the host port numbering convention used by the DS Storage Manager client to identify the host ports in controller A and controller B. The DS Manager client host port numbering is different from the port numbering on the HIC face plate.

- Host ports are numbered from right to left in controller A, starting with 1, 2, and so on for each port. The right-most port of the HIC in slot 1 is identified as port 1 by the Storage Manager.
- Host ports are numbered from left to right in controller B, starting with 1, 2, and so on for each port. The left-most port of the HIC in slot 1 is identified as port 1 by the Storage Manager.
- Currently, the last port in either controller A or B is identified as either port 2, 4, 6 or 8, depending on the number and type of host cards installed.
- The exception is that the iSCSI port configuration window starts counting with the iSCSI port only. In the case of mixed FC and iSCSI HICs with the iSCSI HIC installed in slot 2, the iSCSI port configuration window identifies them as ports 1 and 2, regardless of the number of Fibre Channel host ports in the HIC installed in slot 1.

Connecting hosts directly to the DS5100 or DS5300 Fibre Channel host ports

The DS5100 or DS5300 supports redundant direct connections to up to eight hosts. To ensure full protection against the loss of any one fibre channel path from the host servers to the DS5100 or DS5300, always use redundant host connections by connecting each host to the appropriate single-ported host channels on both RAID controllers A and B.

To connect a host adapter to the DS5100 or DS5300 RAID controllers, perform the following steps:

1. Install SFP modules in host ports on RAID controllers A and B.

   Note: The alignment of the single-ported host channels on controller A are opposite those of controller B. Before inserting an SFP module into a host port, verify that the SFP module is rotated correctly to match the alignment of the host port on the RAID controller. Do not force-fit.

2. Connect the fibre channel cables from the SFP modules in the DS5100 or DS5300 RAID controller host ports to either the SFP modules in the fibre channel switch or the SFP modules of the host bus adapters.

   Note: When cabling directly from host bus adapters to host ports, be sure to attach 8 Gbps devices to 8 Gbps host ports and 4 Gbps devices to 4 Gbps host ports.

   Figure 83 shows the location on the RAID controllers where the host-system cables connect.
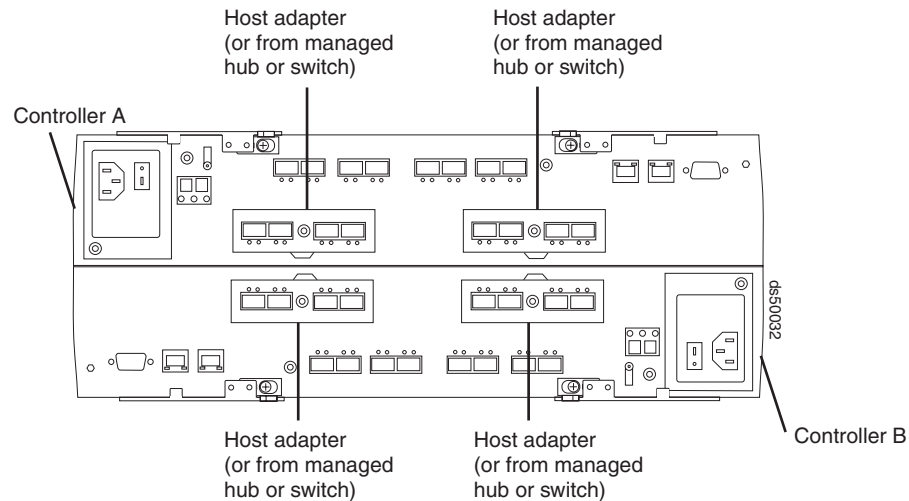
Figure 83. Location of host cables on RAID controllers

3. Repeat steps 1 on page 132 and 2 for each additional redundant host connection. You can create a maximum of eight redundant host connections, as shown in Figure 84 on page 134.

   Note: Figure 84 on page 134 shows that the host ports are connected to eight sets of FC host bus adapters (HBAs). You can replace one or all of these sets of FC HBAs with FC switches as required.
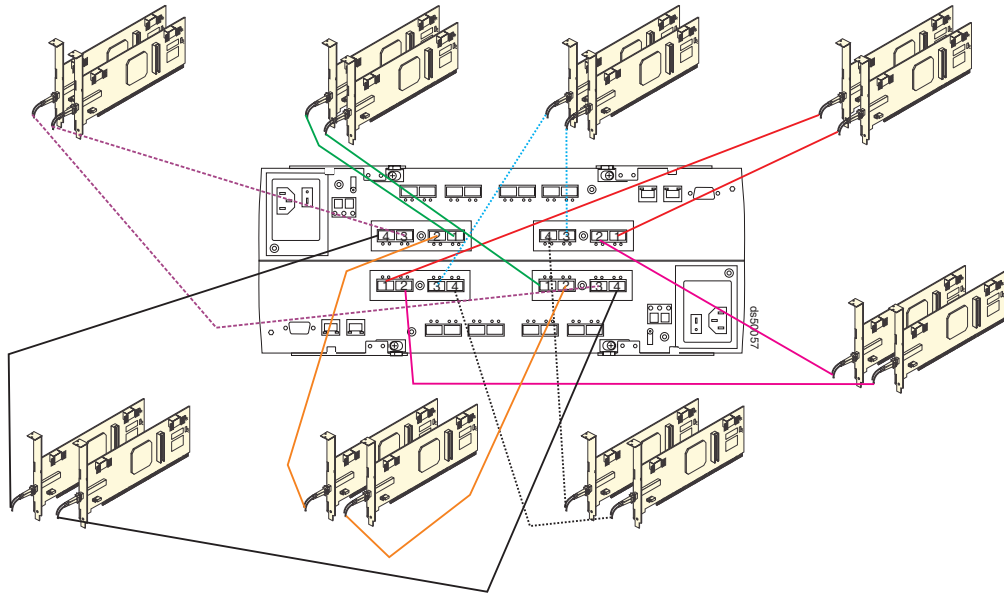
Figure 84. Cabling diagram for eight redundant host connections

For examples of redundant, partially redundant, and non-redundant host and drive channel configurations, see "Fibre channel host loop configurations" on page 139.

Connecting hosts to the DS5100 or DS5300 iSCSI ports

The DS5100 or DS5300 supports redundant connections to the host with iSCSI HBAs or iSCSI software initiators. To ensure full protection against the loss of any path from the host servers, always use redundant host connections by connecting each host to the appropriate Ethernet switches with connections to both RAID controllers A and B iSCSI host ports.

To connect a 1 Gbps iSCSI host adapter to the DS5100 or DS5300 RAID controllers, complete the following steps:

1. Connect the Category 6 Ethernet cables from the RAID controller iSCSI host ports to the Ethernet switch.
2. Connect the Category 6 Ethernet cables from the iSCSI host bus adapter ports or the Ethernet ports of the server using an iSCSI software initiator to the same Ethernet switch or one that is in the same Ethernet network as the RAID controller iSCSI host ports.

To connect a 10 Gbps iSCSI host adapter to the DS5100 or DS5300 RAID controllers, complete the following steps:

1. Connect the OM3 fiber channel cables from the RAID controller 10Gbps iSCSI host ports to the Ethernet switch. The Ethernet switch must have a 10 Gbps capable Ethernet port with a 10 Gbps SFP+ module interface to connect with the 10 Gbps iSCSI host ports.
2. Connect the iSCSI host bus adapter ports installed in the server, or the Ethernet ports of the server, using an iSCSI software initiator to the same Ethernet switch or one that is in the same Ethernet network as the RAID controller 10 Gbps iSCSI host ports.
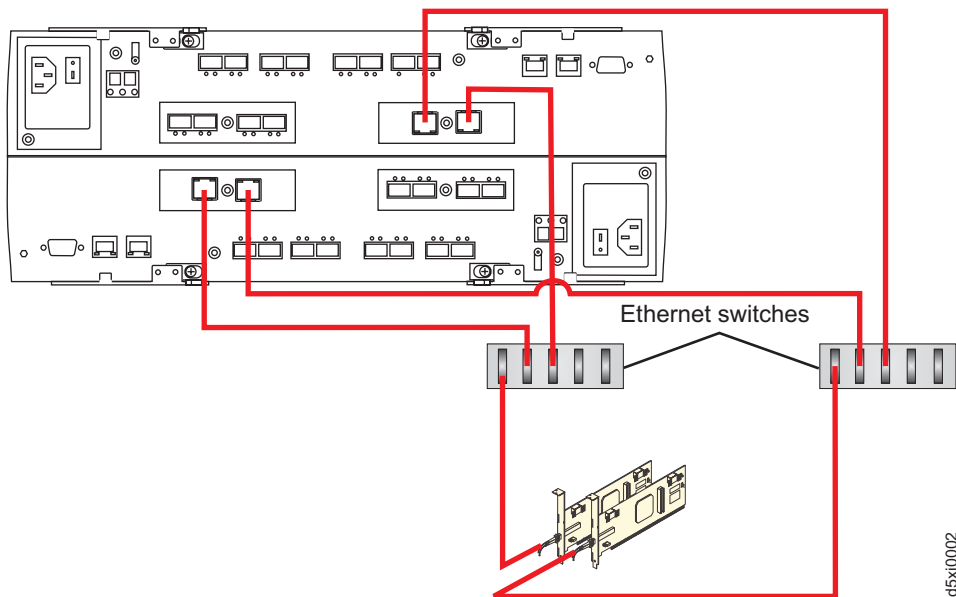
Figure 85. Cabling diagram for redundant iSCSI host connections

Connecting secondary interface cables

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

Use the Ethernet interface ports on the back of the storage subsystem to connect the controllers for direct management of the storage subsystem (see "Direct (out-of-band) management method" on page 137).

Important:

1. The serial interface ports are intended to be used by service technicians to perform diagnostic operations on the storage subsystem. Incorrect use of the serial port can result in loss of data access and, in some cases, in loss of data. Do not make connections to the serial port unless you do so under the direct supervision and guidance of IBM support personnel.

2. To minimize security risks, do not connect the DS5100 or DS5300 in a public LAN or public subnet. Use a local private network for the DS5100 or DS5300 and the management station Ethernet ports.

3. To ensure proper EMI shielding, always use quality braided and shielded serial cables.

Connect a pair of Ethernet cables from the storage-management station to the Ethernet ports for controller A (located on the top) and controller B (located on the bottom) on the back of the storage subsystem. Figure 86 on page 136 shows the location of the ports. Only one Ethernet port connection from each controller is required to establish a direct (out-of-band) management connection to the DS5100 or DS5300.

Note: The alignment of the Ethernet and serial ports on controller A are opposite those of controller B. Before inserting an Ethernet or serial cable, verify that the cable connection is rotated correctly to match the alignment of the port on the RAID controller. Do not force-fit.
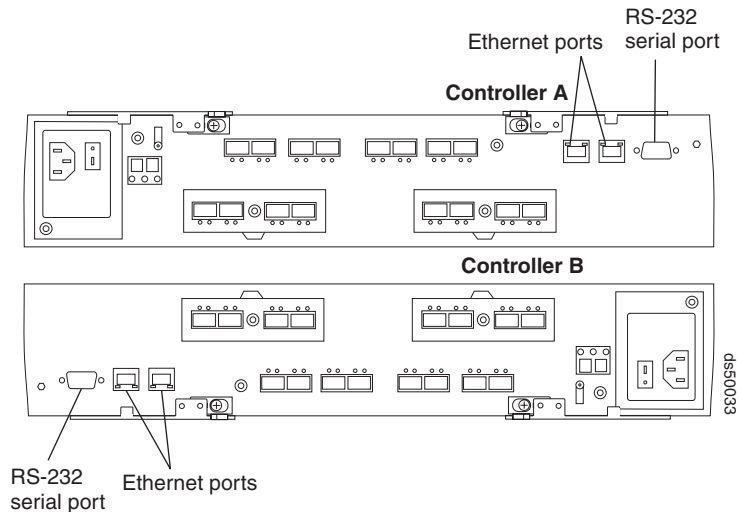
Figure 86. Ethernet and serial port locations

Configuring the storage subsystem

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

Storage subsystem management methods

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

For more information on setting up in-band or out-of-band management connections, refer to the *DS Storage Manager Installation and Support Guide* for the operating system of the host computer that will be used to manage the storage subsystem.

Important: If the operating system of the host server to which the storage subsystem logical drives are mapped is not Microsoft Windows 2000 or Server 2003, then you first have to make a direct (out-of-band) management connection to the storage subsystem to set the correct host type. The server will then be able to recognize the storage subsystem correctly for host-agent (in-band) management.

Host-agent (in-band) management method

This method requires host-agent software that you install on the host server. The host-agent software allows the DS Storage Manager client program to manage the DS5100 or DS5300 using the same fibre channel connections between the host server and the storage subsystem. You must install at least one management station and a software agent host. The management station can be the host or a

workstation on the Ethernet network. A management station will have the client software installed. Figure 87 shows the host-agent (in-band) management method.

Table 48 describes Figure 87.
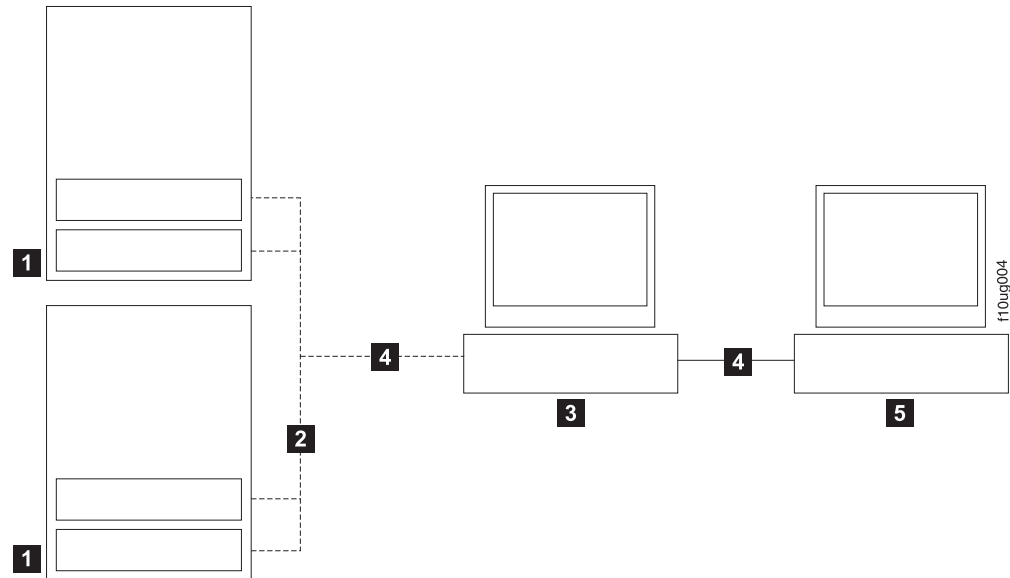
Figure 87. Host-agent (in-band) managed storage subsystems

Table 48. Description of numbered locations in the figure that shows host-agent (in-band) managed storage subsystems

Number	Description
1	Two storage subsystems
2	Fibre channel I/O path
3	Host server
4	Ethernet network
5	Management station

Direct (out-of-band) management method

This method uses Ethernet connections from a management station to each controller. You must install at least one management station. The management station can be the host or a workstation on the Ethernet network. A management station will have the client software installed. Attach Ethernet cables to each management station (one pair per storage subsystem). You will connect the cables to each storage subsystem controller later when you install the storage subsystem. Figure 88 on page 138 shows the direct (out-of-band) management method.

You can either use the default controller Ethernet IP addresses for out-of-band connection or change the default controller Ethernet IP addresses by using Dynamic Host Configuration Protocol (DHCP) or Storage Manager client. Refer to the *DS Storage Manager Installation, User's and Maintenance Guide* for the appropriate operating system for more information on setting the management connections and installing the DS5100 or DS5300 management software.

For a listing of default IP addresses, see Ethernet ports on page 15.

Note: Do not connect the storage subsystem Ethernet ports to a public network or public subnet. Create a private network between the storage subsystem and the management station.

Table 49 describes Figure 88.
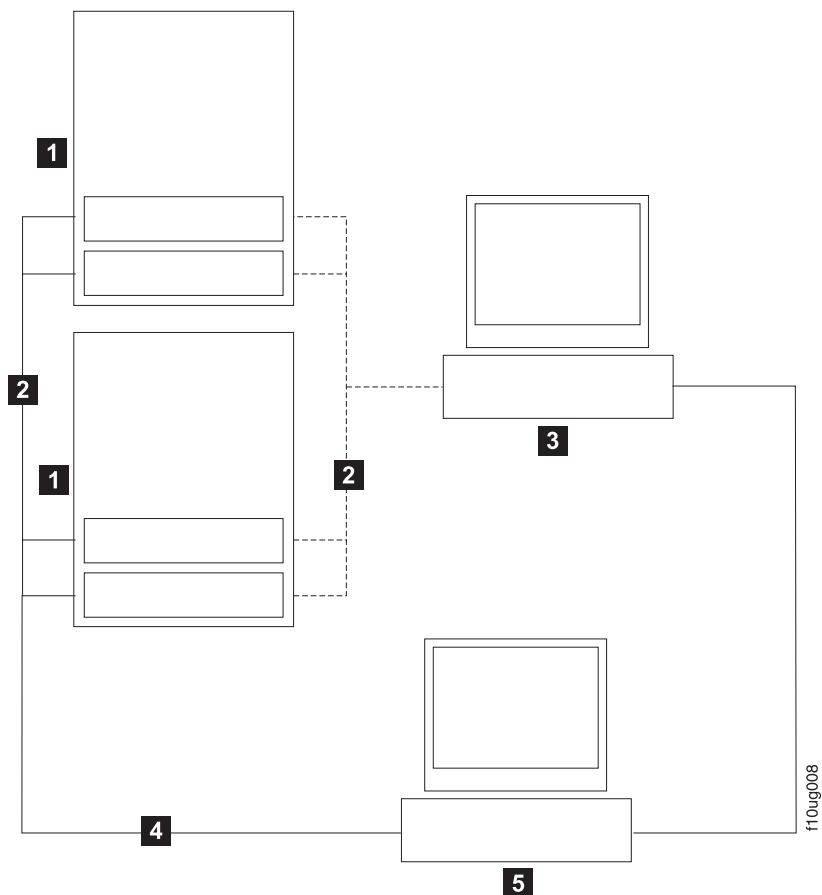
Figure 88. Direct (out-of-band) managed storage subsystems

Table 49. Description of numbered locations in the figure that shows direct (out-of-band) managed storage subsystems

Number	Description
1	Two storage subsystems
2	Fibre channel I/O path
3	Host server
4	Ethernet network
5	Management station

Fibre channel and iSCSI host connections

The storage subsystem fibre channel connection consists of up to four host fibre-channel loops and a redundant drive fibre-channel loop. The host fibre-channel loops provide the fibre path for host attachment. They can consist of fibre-channel

cables, SFPs, host bus adapters, fibre-channel switches, and RAID controllers. The redundant drive fibre-channel loop provides the fibre path from the DS5100 or DS5300 to the hard disk drives (HDDs) in the storage expansion enclosures. The redundant drive fibre-channel loop consists of the DS5100 or DS5300, the storage expansion enclosures, fibre-channel cables, and SFPs.

The DS5100 or DS5300 supports redundant drive channel pair configurations. You can build a redundant drive channel pair by connecting one or more storage expansion enclosures to the redundant RAID controllers. Then, use dual fiber-optic cables to connect one storage expansion enclosure to another in a daisy-chain. For more information, see "Connecting storage expansion enclosures to the DS5100 or DS5300" on page 64.

The DS5100 or DS5300 also supports 1 Gbps or 10 Gbps iSCSI connectivity. The host iSCSI connections provide an iSCSI path for host attachment. The connections can consist of Cat6 Ethernet cables or OM3 fibre-channel cables, host bus adapters with iSCSI initiators, or an Ethernet adapter software iSCSI initiators, Gigabit and/or 10 Gigabit Ethernet switches and RAID controllers. See "iSCSI configurations" on page 143 for more information about iSCSI configurations.

Note: A host cannot be connected to a DS5100 or DS5300 through both the FC and iSCSI host ports.

Fibre channel host loop configurations

You must determine how the host systems will connect to the storage subsystem. You can connect up to four host systems directly to the storage subsystem, or you can connect more than two hosts to the fibre channel storage subsystem through switches. The illustrations in the following sections show common host system configurations.

Note: The minimum DS5100 or DS5300 configuration is eight partitions. Up to 512 partition configuration upgrades are available as upgrade options. Contact your IBM reseller or marketing representative for more information.

Redundant host and drive loops

This section provides examples of DS5100 or DS5300 host fibre channel configurations.

DS5100 or DS5300 host configurations: This section provides the following examples of DS5100 or DS5300 host fibre channel configurations:

- Redundant host and drive fibre channel loop configurations, as shown in Figure 89 on page 140
- Single SAN fabric configuration, as shown in Figure 91 on page 141
- Dual SAN fabric configuration, with an additional DS5100 or DS5300 attached, as shown in Figure 92 on page 141
- Two clusters, as shown in Figure 93 on page 142

Notes:

1. These configurations have host and drive path failover protection and are best practices for high availability.
2. For the IBM recommended host to storage subsystem topology for a given combination of installed operating system and multipath device driver, see the *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide*.

3. The following illustrations do not accurately represent the controller locations in the DS5100 or DS5300.

Figure 89 is an example of one host system to one, and two host systems without switches to one. Figure 90 is an example of a redundant SAN fabric channel configuration.
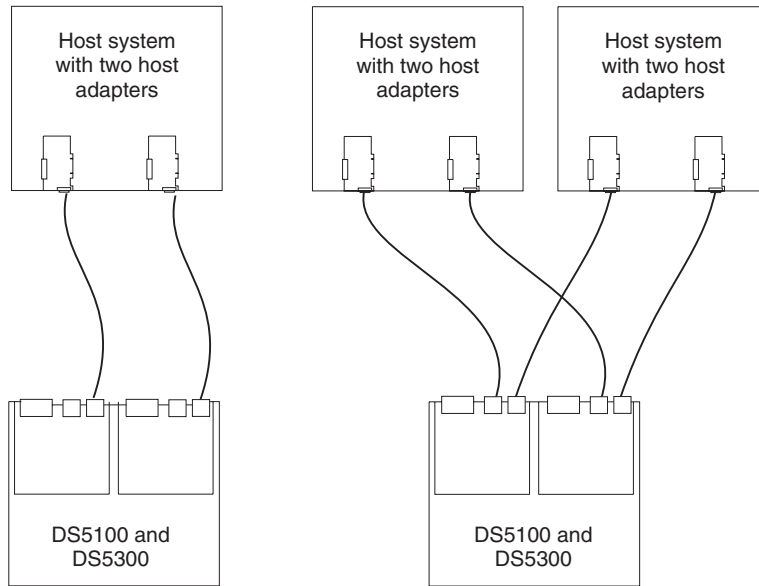
Figure 89. Examples of redundant host direct attached fibre channel configurations
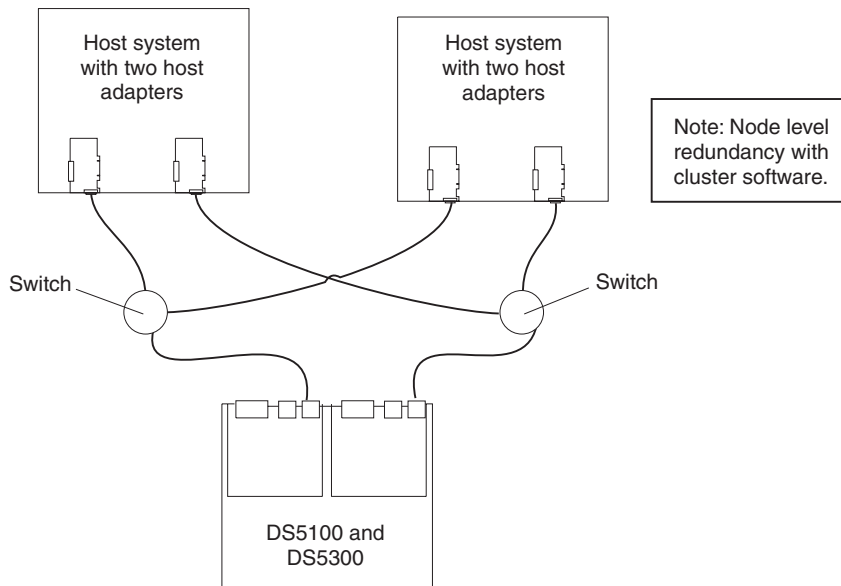
Figure 90. Example of redundant SAN fabric fibre channel configuration

Figure 91 on page 141 gives an example of two host systems with fibre channel switches connected by an interswitch link, forming a single SAN fabric configuration.
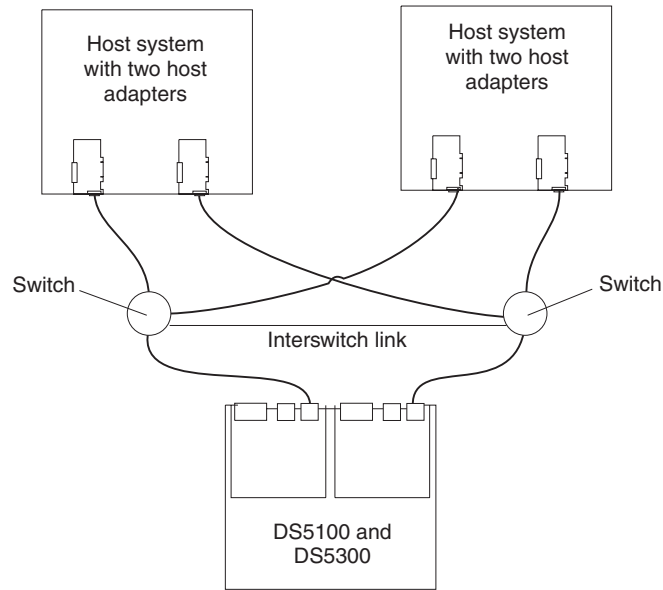
Figure 91. Example of a single SAN fabric configuration

In Figure 92, the fibre channel switches are connected together.
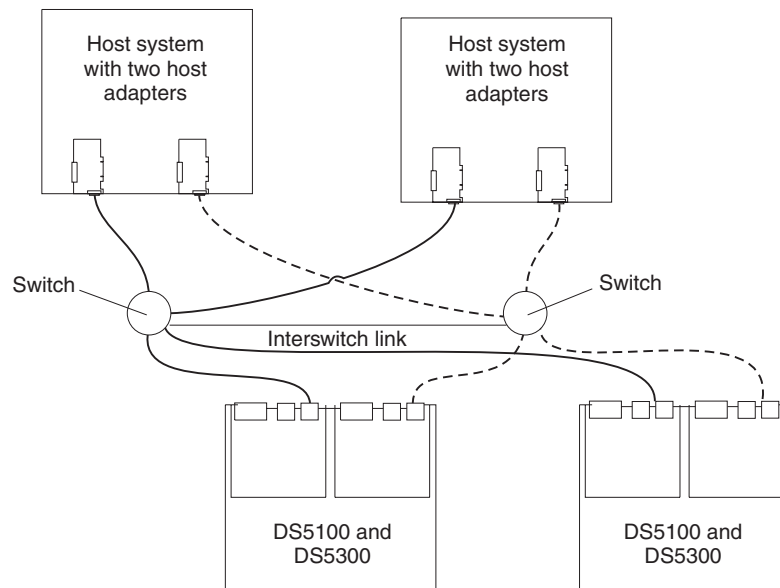
Figure 92. Example of two storage subsystems in a single SAN fabric environment

Figure 93 on page 142 gives an example of one and four host systems configured into two clusters; each cluster comprised of two host systems and two fibre channel switches
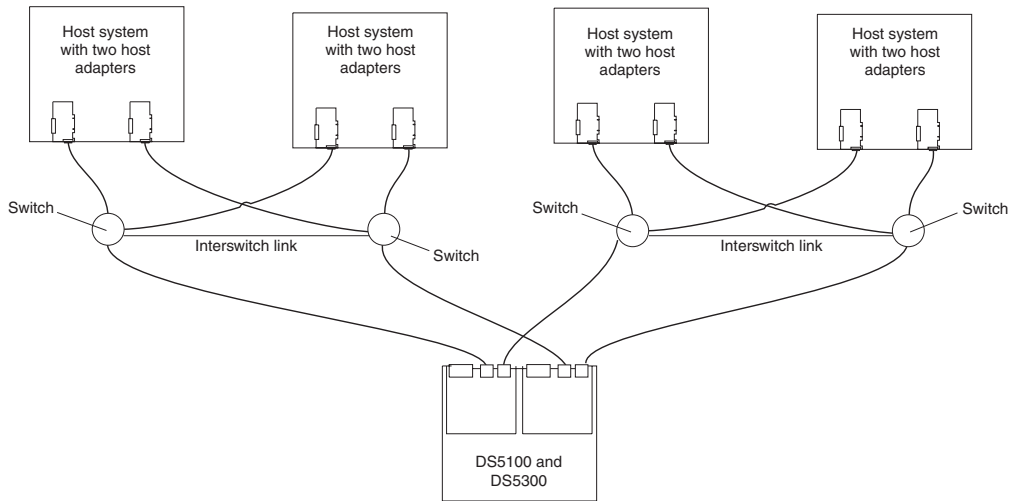
Figure 93. Example of a two-cluster configuration
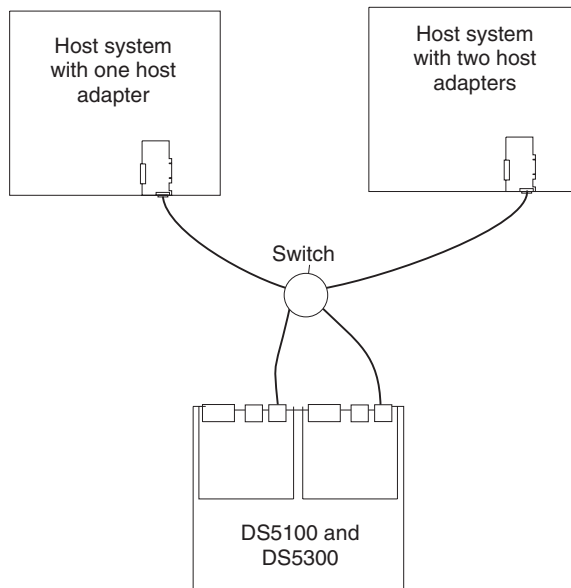
Figure 94. Example of a single SAN fabric configuration with one FC switch
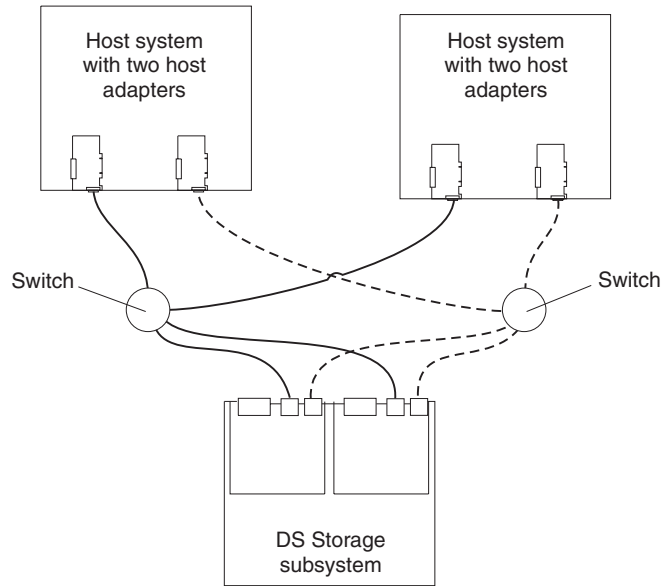
Figure 95. Example of a dual SAN fabric configuration with two FC switches

iSCSI configurations

The DS5100 or DS5300 supports 1 Gbps iSCSI connectivity. You must determine how the host systems will connect to the storage subsystem. The illustrations in the following sections show common iSCSI host system configurations.

The iSCSI ports support IPv4 and IPv6 TCP/IP addresses, CHAP, and iSNS. Use either Category 5E or Category 6 Ethernet cable types for iSCSI port connections. A Category 6 Ethernet cable provides optimal performance.

Note: The minimum DS5100 or DS5300 configuration is eight partitions. The maximum is 512 partitions. Configuration upgrades are available as upgrade options. Contact your IBM reseller or marketing representative for more information.

Host iSCSI configurations

This section provides the following examples of DS5100 or DS5300 host iSCSI configurations:

- Single-host, multiple-port configuration, as shown in Figure 96 on page 144
- Multiple-host, multiple-port configuration, as shown in Figure 97 on page 145
- iSCSI and Fibre Channel hosts, multiple-port configuration, as shown in Figure 98 on page 145
- Example of an incorrect configuration: Single-host, iSCSI and Fibre Channel, as shown in Figure 99 on page 146
- Multiple-host, multiple-port, multiple-switch configuration, as shown in Figure 100 on page 147

Attention: The DS5100 or DS5300 does not support both a 1 Gbps iSCSI HIC and a 10 Gbps iSCSI HIC in the same storage subsystem.

Notes:

1. The DS5100 or DS5300 does not support direct connections from the host systems to the iSCSI ports on the storage subsystem.
2. The DS5100 or DS5300 does not support connections to both iSCSI and Fibre Channel ports from the same host system.
3. The following illustrations do not accurately represent the controller locations or port locations in the DS5100 or DS5300. The illustrations are for illustration purposes only.

Figure 96 shows an example of a multiple port, single-host configuration. A system that uses multiple iSCSI ports can provide enhanced performance compared to a single-port iSCSI connection.
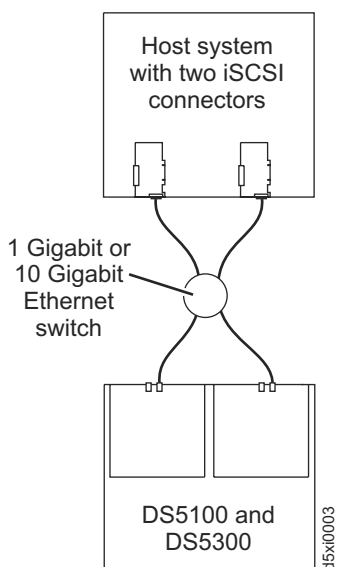
Figure 96. Example of a single-host, multiple-port configuration

Figure 97 on page 145 shows a multiple-host, multiple-port configuration. For cluster configurations, the following illustration is an example of a multiple-host, multiple-port, and redundant path and controller configuration. You can replace the two gigabit Ethernet switches in the illustration with one large gigabit Ethernet switch that has the required number of ports. Virtual local area network (VLAN) can also be used to isolate the two iSCSI networks, instead of a single switch.
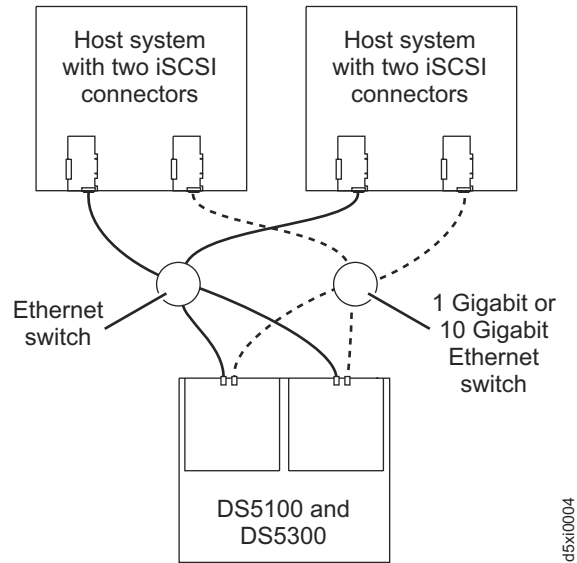
Figure 97. Example of a multiple-host, multiple-port configuration

Figure 98 shows iSCSI and Fibre Channel hosts in a multiple-port configuration.
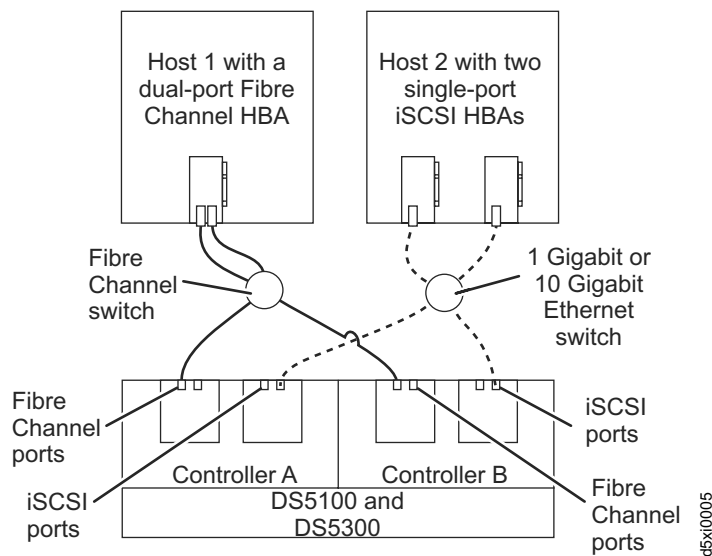
Figure 98. Example of iSCSI and Fibre Channel hosts, multiple-port configuration

Figure 99 on page 146 shows an incorrect configuration of a single host with both iSCSI and Fibre Channel connections.

Important: Do not cable the storage subsystem and host systems as shown in Figure 99 on page 146. A storage subsystem with the incorrect storage topology might appear to be functional, but incorrect cabling can potentially have unpredictable results.

Figure 99. Example of an incorrect configuration: Single-host, iSCSI and Fibre Channel

Figure 100 on page 147 shows an example of a multiple-host, multiple-port, multiple-switch configuration.
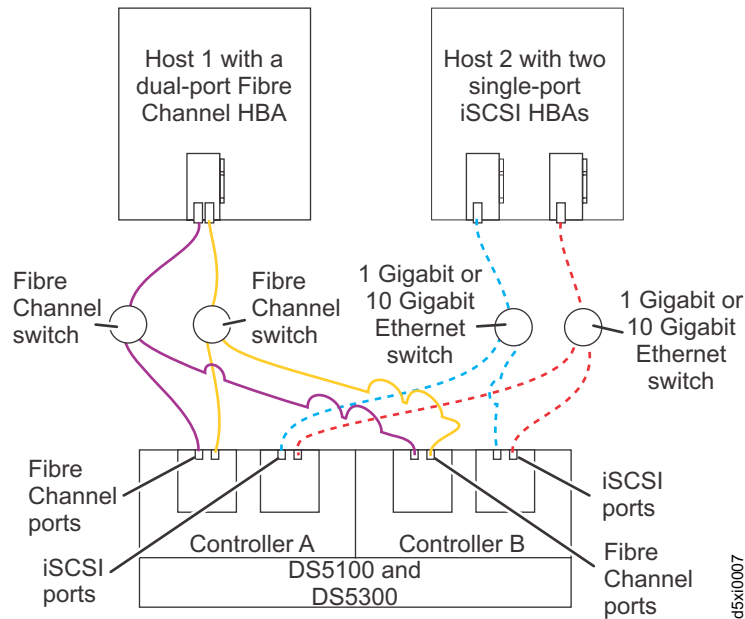
Figure 100. Example of a multiple-host, multiple-port, multiple-switch configuration

Installing the storage subsystem configuration

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

Notes:

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

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

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

Attach fiber-optic interface cables to each host adapter. You will connect the other end of the cables to the controller later in the installation process. For more information about handling fiber-optic cables, see "Handling fibre-optic cables" on page 50.

Connecting the power cables

This section describes the procedure for connecting power cables to the storage subsystem.

The DS5100 or DS5300 uses two standard power cords. You can connect the power cords to a primary power unit inside the rack cabinet, such as a properly grounded ac distribution unit, or to an external source, such as a properly grounded electrical outlet.

The DS5100 or DS5300 does not ship with the power cords used to connect the DS5100 or DS5300 to the electrical outlets outside the rack cabinet. Refer to Appendix E, "Power cords," on page 271 for the list of IBM-approved power cords

for your region. The DS5100 or DS5300 does ship with two line jumper cords for connecting the DS5100 or DS5300 RAID controller units to IBM-approved rack PDUs.

Use the following procedure to connect the power cables to the storage subsystem. Before you connect power cords, turn off all power switches on all modules in the cabinet. If your cabinet contains components that you do not want to power off, turn off all power switches on the components of the storage configuration you are currently installing.

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.

1. Verify that the main circuit breakers in the cabinet are turned off.
2. If you have not already done so, turn off all power switches on each storage subsystem and storage expansion enclosure in the cabinet. Figure 101 shows the locations of the power switches and connectors on the storage subsystem.
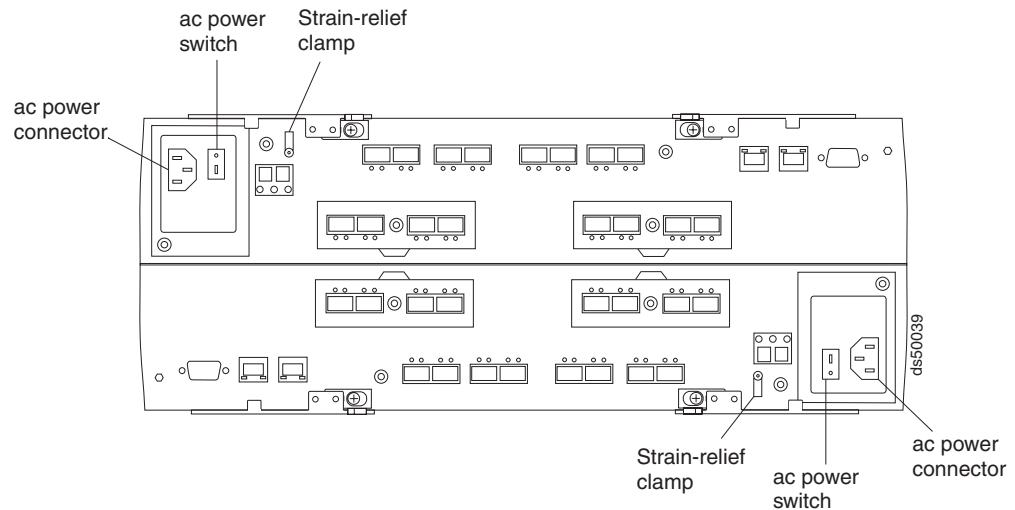
Figure 101. AC power switch and ac power connector

3. Connect the line jumper power cords to the ac power connectors on the RAID controllers.

4. On each RAID controller, remove the nut that holds the power cable strain-relief clamp, and then remove the strain-relief clamp.

5. Wrap the strain-relief clamp around the line jumper power cord approximately 20 cm (8 in.) from the RAID controller connection end. Leave some slack between the clamp and the RAID controller end of the line jumper power cord.

6. Replace the strain-relief clamp, and then tighten it securely with the nut.

7. Connect the other end of the line jumper cords to two independent IBM-approved power distribution units in the rack cabinet. Connecting each RAID controller to independent power sources maintains power redundancy. If applicable, repeat this step for each additional storage subsystem and storage expansion enclosure.

8. Connect the right and left power supplies of the attached storage expansion enclosures to the same IBM-approved power distribution units in the rack cabinet. For more information, refer to the *Installation, User's, and Maintenance Guide* for your DS4000® or DS5100 or DS5300 storage expansion enclosures.

9. If you have not already done so, connect the primary power cables from the rack cabinet to the external power source.

Note: To maintain power redundancy, plug the PDUs that power the storage subsystem's right and left RAID controllers and the right and left power supplies of the DS4000 or DS5100 or DS5300 storage expansion enclosures into two independent external power circuits through ac distribution units inside a rack cabinet or directly into external receptacles.

Determine the maximum surge current possible when all devices in the power circuit are started at the same time. Based on the total number of devices on a power circuit, find the maximum (worst-case) specification value in order to prevent the circuit from tripping. When both RAID controllers are connected and the storage subsystem is powered on, each RAID controller unit will handle approximately one-half of the current load. To ensure maximum protection against power loss due to RAID controller unit failure or a power circuit tripping, both RAID controller units must be connected and powered on. See Table 16 on page 32 for the DS5100 or DS5300 ac power requirements.

Do not overload the circuits that power your storage subsystem and storage expansion enclosures. Use additional pairs of IBM-approved power distribution units (PDUs) if necessary.

See Figure 102 on page 150 for an example of redundant power cabling.

Rack power cable connector

Rack power cable

Storage expansion
enclosure
power supplies

Controller power supplies

ac distribution units

ac distribution unit
power cord

f10ug060
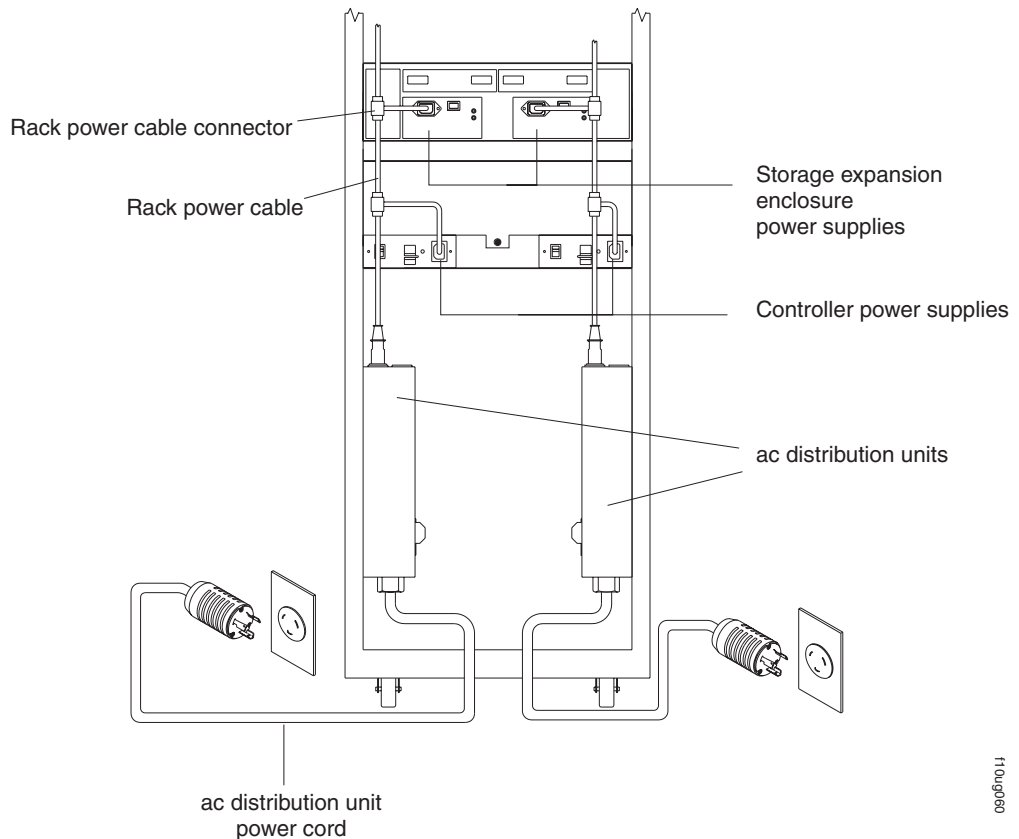
*Figure 102. Redundant ac power connections to controllers and storage expansion
enclosures*

For details about power requirements, see "Electrical requirements" on
page 31.

10. Go to "Turning on the storage subsystem" on page 155.

Attention:

Before you power on the DS5100 or DS5300, the storage subsystem must be
cabled to at least one storage expansion enclosure populated with the
minimum number of drives for the storage expansion enclosure. Otherwise, the
DS5100 or DS5300 controllers do not successfully complete the power-on
process and operate optimally.

All drives in the connected storage expansion enclosure or enclosures must
contain no prior configuration data. Additionally, if at least two drives are not
installed in each EXP5000 attached storage expansion enclosure, or at least
four drives in each EXP5060 storage expansion enclosure, the resulting
insufficient load to the storage expansion enclosure power supplies might
cause the drive expansion enclosure power supplies to intermittently appear as
failed and then reappear in an optimal state, falsely indicating that the power
supplies are bad.

Chapter 4. Operating the storage subsystem

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 storage subsystem's right and left RAID controller 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 or DS5100 or DS5300 storage expansion enclosures attached to the DS5100 or DS5300 should be plugged into the same two independent external power circuits as the DS5100 or DS5300. This ensures that the DS5100 or DS5300 and all its attached storage expansion enclosures will have power if only one power circuit is available. In addition, having all the right or all the left power cables plug into the same power circuit will enable the components in the storage subsystem to power on simultaneously during an unattended restoration of power. See Figure 102 on page 150 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 the *Installation, User's, and Maintenance Guide* for your storage expansion enclosures for information on 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 DS Storage Manager guide for your operating system. Save the profile in a location other than the logical drives created for the DS5100 or DS5300.

- During any maintenance or attended power-up procedure, carefully follow the power-up sequence listed in "Turning on the storage subsystem" on page 155 You should check that each component of the subsystem is powered-on in the proper order during this entire power-up procedure to ensure that the controller will optimally access all of your storage subsystems.

- The storage subsystem supports simultaneous power-up to the system components; however, you should always follow the power-up sequence listed in "Turning on the storage subsystem" on page 155 during any attended power-up procedure.

- A storage system in an optimal state should recover automatically from an unexpected shutdown and unattended simultaneous restoration of power to system components. After power is restored, call IBM support if any of the following conditions occur:

  - The storage subsystem logical drives and arrays are not displayed in the DS Storage Manager graphical user interface (GUI).
  - The storage subsystem logical drives and arrays do not come online.
  - The storage subsystem logical drives and arrays seem to be degraded.

Performing the DS4000, DS5100, and DS5300 Health Check process

The DS4000, DS5100, and DS5300 Health Check process is a sequence of suggested actions developed by IBM to help users verify and maintain the optimal performance of their 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 storage subsystem, and after all configuration sessions. Also, set a regular schedule of periodic Health Check evaluations in order to keep your 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 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 Storage Manager Subsystem Management window.)

   - Storage subsystem management event log (MEL)
   - Storage Subsystem 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 storage configuration failure. Do not save these event log files only to a LUN in the storage subsystem.

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

   - Controller firmware
   - ESM firmware
   - Drive firmware

   If you discover your firmware is not up-to-date, upgrade the firmware and software to the latest level appropriate to your storage configuration. See "Web pages" on page 153 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 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, DS5100, and DS5300 Web site for detailed instructions.

4. Use the Storage Subsystem Profile to verify that the following functions are enabled:
   - For all DS4000, DS5100, and DS5300 models, Media Scan should be enabled both at the controller level and at the LUN level.
   - For all DS4000, DS5100, and DS5300 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, DS5100, and DS5300 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 DS4000, DS5100, and DS5300 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 storage configuration. You should periodically inspect the Fibre Channel components of your storage configuration.

IBM suggests you follow these guidelines:
- Maintain an up-to-date storage subsystem profile for your storage configuration. Save the profile to a server disk that will remain accessible in case of a storage configuration failure. Do not save the profile only to a LUN in the 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 best practice to use 6-inch cable loops or longer.)
- Ensure proper Fibre Channel cable management.

- Ensure proper air flow and temperature for all components in your storage configuration.

Note: You can find details on many of these inspection and maintenance responsibilities in this publication.

In addition to these inspection and maintenance responsibilities, it is best practice to train staff that support storage configurations. Although training is not a part of the Health Check process, training reduces the potential for configuration problems and contributes to the overall health of the system.

Removing and replacing the front bezel

The storage subsystem is equipped with a front bezel, which you must remove in order to access the power supply and fan units and interconnect-battery unit, or to view the indicator LEDs on the front of those units.

Figure 103 shows the following steps to remove and replace the front bezel:

1. Remove the front bezel by grasping the sides and pulling the cover toward you.
2. Install the front bezel by aligning the pins on the storage subsystem chassis with the spring-steel retainers on the cover, and then press the cover toward the chassis until the pins snap into place.
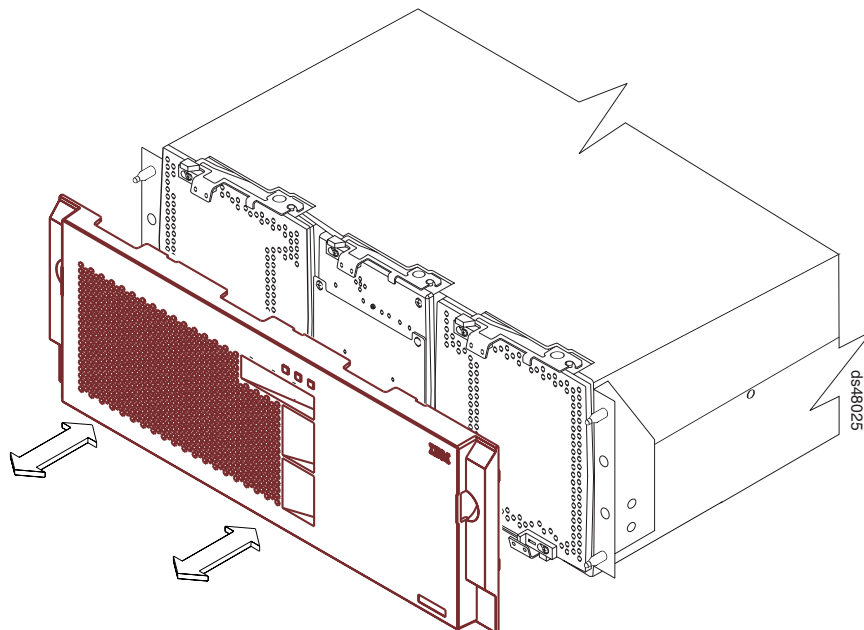
Figure 103. Installing the front bezel

Turning the storage subsystem on and off

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

If you are turning on the storage subsystem after an emergency shutdown or power outage, see "Restoring power after an unexpected shutdown" on page 160.

Turning on the storage subsystem

Power-on overview

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

Check the system documentation for the hardware devices that you intend to power on, and then determine the proper startup sequence. Use the following power-on sequence, where applicable:

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

   Attention: If you will use out-of-band (direct) configuration management (using the Ethernet), you must set up the Dynamic Host Configuration Protocol (DHCP) or BOOTP server before you turn on the power. Setting up the server allows the controllers to obtain the corresponding IP address when you turn on the power to the storage subsystem. To configure the server, you need the controller's Media Access Control (MAC) address. The MAC addresses appear on labels near the Ethernet ports on each controller.[2] For more information, see the software installation guide for your operating system.

2. **Important:** You *must* turn on the storage expansion enclosures and verify that the storage expansion enclosure fibre channel connections are optimal by checking the indicator LEDs *before* you turn on the DS5100 or DS5300. The controllers might not recognize the correct configuration if the storage expansion enclosure hard disk drives are powered up after the DS5100 or DS5300. For instructions on how to power on the storage expansion enclosures, refer to the storage expansion enclosure documentation.

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

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

Use this procedure to turn on power to a storage configuration at the initial startup or after a normal shutdown. To restore power after an unplanned shutdown, see "Restoring power after an unexpected shutdown" on page 160.

Important:

1. If needed, remove the front bezel, as described in "Removing and replacing the front bezel" on page 154.

2. Ensure that all power cords are connected, as described in "Connecting the power cables" on page 147.

   Note: If the power cords are not connected, turn off both power switches on all modules in the configuration before connecting power cords or turning on the main circuit breakers.

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2. You can also make out-of-band management connections to the DS5100 or DS5300 controller using the default IP addresses. The default IP addresses for the controller A Ethernet ports 1 and 2 are 192.168.128.101 and 192.168.129.101, respectively. The default IP addresses for the controller B Ethernet ports 1 and 2 are 192.168.128.102 and 192.168.129.102, respectively. The default subnet mask for all four Ethernet ports is 255.255.255.0.

Attention: If you are restarting the system after a normal shutdown, wait at least 60 seconds before you turn on the power.

3. Turn on the main circuit breakers in the cabinet.

   Attention: You *must* turn on power to each attached storage expansion enclosure *before* turning on power to the DS5100 or DS5300 to ensure that the controllers complete the startup process. If the DS5100 or DS5300 controllers do not find any drives present during the initial power on sequence, the startup process does not complete. This will prevent controllers A and B from communicating with each other, and any factory-installed premium features will not be activated correctly.

4. 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 on.

   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 DS5100 or DS5300 drive port should be lit.

   Note: The drive activity LEDs will flash slowly (once every 2 seconds) until the drive is started by the DS5100 or DS5300 controller.

5. Turn on the ac power switch on the back of each controller in the storage subsystem. Figure 104 shows the location of the ac power switches on the controllers.
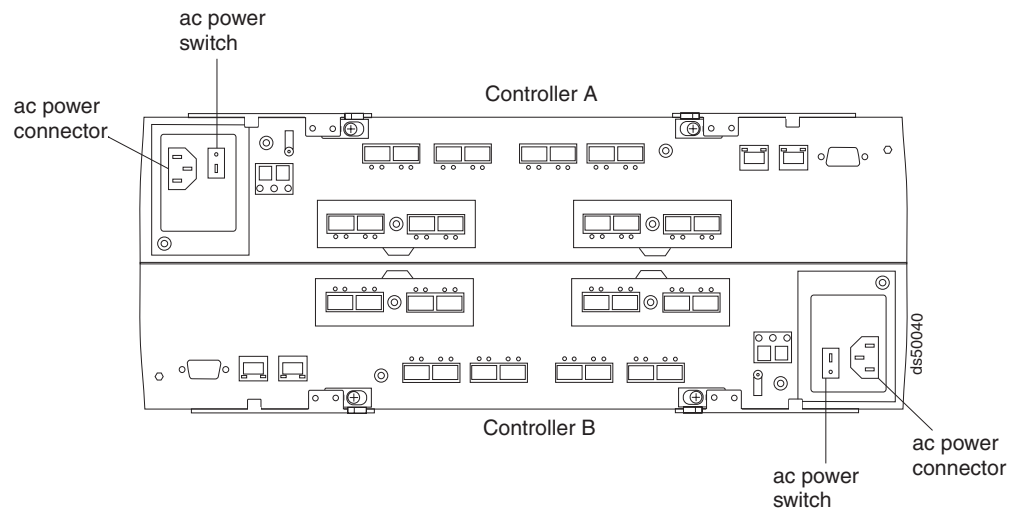
Figure 104. AC power switches on the controllers

Depending on the number of storage expansion enclosures in the configuration, the DS5100 or DS5300 might take several minutes to power up. The battery self-test might take an additional 15 minutes. The LEDs will flash 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 on.

The DS5100 or DS5300 spins up all the drives in the storage expansion enclosures during the startup process.

6. 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 the *Installation, User's, and Maintenance Guide* for your 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 "Checking the LEDs" on page 167.

   c. Open the DS Storage Manager Subsystem Management window, and display the Physical View for the configuration.

      The status for each component is 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.

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

   • Yes – End of procedure. Replace front bezel, as described in "Removing and replacing the front bezel" on page 154.

   • No – Go to step 8.

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

   a. Run the DS 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 failed component. (For procedures to replace a failed component, see Chapter 5, "Replacing components," on page 189.)

   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.

Turning off the storage subsystem

Attention: Except in an emergency, never turn off the power if any storage subsystem's Needs Attention LEDs are on. Correct the fault before you turn off the power. Use the DS Storage Manager client and the Needs Attention LEDs to check the overall status of the storage subsystem and its components. All LEDs should be green on the front of the storage subsystem. If they are not, use the DS Storage Manager client to diagnose the problem (see "Monitoring status through software" on page 164). This ensures that the storage subsystem will power on correctly later.

The storage subsystem is designed to run continuously, 24 hours a day. After you turn on the storage subsystem, do not turn it off except in the following situations:

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

• A service technician tells you to turn off the power.

- A planned power outage or emergency situation occurs (see "Performing an emergency shutdown" on page 160).

Statement 5:

CAUTION:
The power control button on the device and the power supply do not turn off the electrical current supplied to the device. The device also might have more than one power cord. To remove all electrical current from the device, ensure that all power cords are disconnected from the power source.
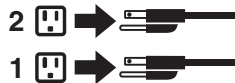
Attention: Turning the power off and on without waiting for the storage expansion enclosure disk drives to spin down, can damage the drives and might cause data loss. Wait *at least* 70 seconds after turning the power off before turning it on, again.

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 subsystems for a planned shutdown. To turn off power for an unplanned shutdown, see "Performing an emergency shutdown" on page 160.

Before proceeding, use the DS 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.

1. Stop all I/O activity to the storage subsystems.

2. 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.

   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 "Checking the LEDs" on page 167.

   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 is either Optimal or Needs Attention.

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

   • Yes – Go to step 5.

   • No – Go to step 4.

4. 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 on the storage subsystem 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.

5. Check the back of the storage subsystem, and verify that the Cache Active LED 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.

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

   If one or more LEDs are flashing, data is being written to or from the drives. Wait for all Active LEDs to stop flashing.

7. Turn off the ac power switch on the back of each controller in the storage subsystem. (Figure 101 on page 148 shows the location of the ac power switch on a controller.)

   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.

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

   Note: After you power off the storage subsystem, the controller remains powered on for three to four minutes to flush any data in cache memory to the flash memory modules.

9. After you perform the necessary maintenance procedures, turn on the power using the procedure in "Turning on the storage subsystem" on page 155.

Restoring power after an unexpected shutdown

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

Attention: There might be a loss of access to data in each of the following cases.

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

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

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

- In the DS5100 or DS5300, the right power supply and fan unit is linked to controller A, and the left power supply and fan unit is linked to controller B. If one power supply and fan unit has shut down and the controller that is linked to the *other* power supply and fan unit is removed, the DS5100 or DS5300 is inoperable. To increase protection against power loss, always make sure that both power supply and fan units are plugged in and are operational.

- There is a general power failure or a loss of power to the unit.

- You are forced to shut down the storage subsystem without performing the normal shutdown procedures (listed in "Turning off the storage subsystem" on page 157) because of an emergency situation.

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

Note: Unattended restoration of power is supported; however, if power restoration is attended, you should follow the best practices guidelines and the power restoration sequence in "Turning on the storage subsystem" on page 155.

Performing an emergency shutdown

Emergency situations might include fire, flood, extreme weather conditions, or other hazardous circumstances. If a power outage or emergency situation occurs, always turn off all power switches on all computing equipment. This will help safeguard your equipment from potential damage due to electrical surges when power is restored. If the storage subsystem loses power unexpectedly, it might be due to a hardware failure in the power system or midplane (see Chapter 6, "Hardware maintenance," on page 231).

Use the following procedure to shut down the storage subsystem during an emergency:

1. If you have time, stop all I/O activity to the storage subsystem by shutting down the host or disconnecting the storage subsystem logical drives through the host.

2. Check the LEDs (front and back). 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; then unplug the power cords from the storage subsystem.

Restoring power after an emergency shutdown

Use the following procedure to restore power to the storage subsystem in a configuration after an unplanned shutdown.

Risk of severe electrical shock – Never turn on the power to any equipment if there is evidence of fire, water, or structural damage. Doing so might cause severe electrical shock.

1. Visually check the equipment for damage. Is there evidence of damage to any of the storage subsystem components, cables, or equipment attached to the storage subsystem?

   * Yes – Do not continue with this procedure. Contact your IBM service representative for assistance. Depending on the current service agreements, you might need to return the equipment to the factory or local service center for repair.
   * No – Go to step 2.

   Potential data loss – Before resetting circuit breakers in the cabinet, ensure that the storage subsystem and storage expansion enclosures power switches are turned off. Resetting circuit breakers after an emergency situation while the storage subsystem and storage expansion enclosure power switches are turned on can cause potential data loss because the configuration components might not be powered on in the correct sequence. See "Turning on the storage subsystem" on page 155 for details about the correct power-on sequence.

2. Do whatever is necessary to cool the unit (replace the fans, use external fans to cool the room, and so on).

3. Verify the main circuit breakers in the cabinet are turned off.

4. Verify that the ac power switch on each DS5100 or DS5300 is turned off. (Figure 101 on page 148 shows the location of the ac power switch on each controller.)

5. Verify that both power switches on all storage expansion enclosures in the configuration are turned off.

6. Turn on the main circuit breakers in the cabinet.

7. Turn on both power switches on the back of each storage expansion enclosure.

   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 acknowledge each storage expansion enclosure.

8. Verify that no ESM port bypass LEDs are lit on any storage expansion enclosures.

   If any ESM port bypass LEDs are lit, reseat the ESMs and check the ESM port bypass LEDs again.

   If the ESM port bypass LEDs remain lit, then reseat the SFP modules and the fibre channel cables at both ends of the connections.

   If the problem is not resolved, use the fibre channel wrap-plug and coupler to attempt to isolate the problem to the ESM port, SFP, or fibre channel cable. See the *IBM System Storage Problem Determination Guide* for information on performing wrap plug tests.

9. Turn on the ac power switch on the back of each controller in the storage subsystem. Figure 101 on page 148 shows the location of the ac power switch

on the controller. The storage subsystem might take several minutes to power on, depending on the number of attached storage expansion enclosures. The battery self-test might take an additional 15 minutes. The LEDs will flash intermittently until the storage subsystem powers up and completes the battery self-test.

10. Determine the status of all storage subsystems and their 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 DS5100 or DS5300. Ensure that all the LEDs show normal status. For information about LED status, see "Checking the LEDs" on page 167.

    c. Open the Subsystem Management window, 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.

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

    • Yes – End of procedure.

    • No – Go to step 12.

12. Diagnose and correct the fault by completing 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 on the storage subsystem to locate the specific failed component. (For more on troubleshooting the storage subsystem, see "Troubleshooting the storage subsystem" on page 166.)

    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.

Responding to the audible alarm

Attention: The DS5100 or DS5300 ships with the audible alarm option disabled. You can enable the audible alarm with the DS Storage Manager client. If the audible alarm is enabled, you must remove the DS5100 or DS5300 bezel in order to mute the alarm.

The alarm provides an audible warning of potentially serious problems with the storage subsystem. The storage subsystem is shipped with the alarm disabled. You can enable or disable the Audible Alarm feature using the DS Storage Manager Subsystem Management window graphical user interface (GUI). Any change you make takes effect after approximately five minutes. If you enable the alarm, the DS5100 or DS5300 alarm will sound upon the next detection of a storage subsystem failure.

Note: The alarm will not sound when it is enabled if it detects a subsystem failure that has been detected by the controllers prior to the enabling of the alarm.

The GUI indicates alarm status for the storage subsystem as follows:

- Alarm control (enabled/disabled)
- Alarm state (inactive/sounding/muted)

The GUI provides the following alarm controls for the storage subsystem:

- Enable/disable alarm. (Error status is displayed if an attempt is made to enable an alarm that is not present.)
- Mute alarm.

The alarm sounds and the Overall Configuration Needs Attention turns on when one of the following conditions occur:

- Hardware malfunction in a storage subsystem – This includes an overheating condition or a component failures (controllers, power supplies, or fans).
- Transmission failures – This includes I/O transmission problems with the SFP modules or cables.

When a subsystem failure is detected after the alarm has been enabled, the alarm sounds until one of the following occurs:

- The alarm is muted using the DS Storage Manager Subsystem Management window GUI.
- The alarm is muted using the Mute button on the interconnect-battery unit.
- The problem that is indicated by the lit Overall Configuration Needs Attention LED is resolved.

If the alarm sounds, check the storage subsystem for faults. For troubleshooting procedures, see "Troubleshooting the storage subsystem" on page 166.

Installing the DS Storage Manager client

For instructions to install the DS Storage Manager software, see the *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* for the appropriate operating system. Use that document and the online help to configure the logical drives, partitions, and so on for the RAID controllers. Use your operating system documentation to make the new logical drives accessible to the operating system. Do not proceed with the configuration setup until you have completed the DS Storage Manager installation.

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

- HBA drivers.
- Controller firmware version listed at the IBM DS5100 or DS5300 System Storage Support Web site:

  www.ibm.com/systems/support/storage/disk
- IP addresses for RAID controllers (for out-of-band management only).
- Additional documentation for switches and HBAs, if needed.
- *DS Storage Manager Support* DVD, which includes the storage subsystem controller firmware.
- The DS5100 or DS5300 controller firmware should be updated to the correct version. See "Software and hardware compatibility and upgrades" on page 25 for version information. The latest level of DS5100 or DS5300 controller firmware is available for download from the IBM support Web site for DS5100 or DS5300 storage products.

- Appropriate host kit for your operating system.

  Depending on the model, your DS5100 or DS5300 ships with either the Microsoft Windows host software attachment kit or with your choice of host software kits (Windows, AIX, Linux, Mac OS, SUN Solaris, HP-UX, Linux on POWER, or VMware). The host software kit grants you permission to attach host servers using the appropriate operating system to the DS5100 or DS5300. The kit includes a *DS Storage Manager Version 10 Support* DVD that has the appropriate IBM DS Storage Manager host software. The DVD also contains includes appropriate controller firmware version.

  For the latest controller firmware, check the IBM support Web site for DS5100 or DS5300 storage products.

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

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 DS Storage Manager guide for your operating system. Save the profile in a location other than the logical drives created for the DS5100 or DS5300.

Always refer to the README that is included with the DS5100 or DS5300 firmware package (whether the firmware is accessed by the Web or DVD) for any special requirements or restrictions that apply to that particular firmware version. See "Finding Storage Manager software, controller firmware, and README files" on page xxviii to learn how to access the DS5100 or DS5300 README files on the Web.

Note: Make sure that you install the DS Storage Manager event monitoring service to enable continuous monitoring of the status of the storage subsystem. For more information about the importance of this information, see "Monitoring status through software."

Monitoring status through software

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

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

   For more information, see the Enterprise Management online Help.

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

In addition, to download the latest version of the DS Storage Manager host software, the DS5100 or DS5300 controller firmware and NVSRAM, and the latest DS5100 or DS5300 ESM firmware, go to the following Web site:

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

Note: The version of controller firmware determines which version of the DS Storage Manager interface is displayed.

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

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

Although the storage subsystem has Needs Attention LEDs, these LEDs do not necessarily indicate which component has failed or needs to be replaced, or which type of recovery procedure you must perform. In some cases (such as in the case of a hard disk drive exceeding its PFAs), the Needs Attention LED does not turn on. Only the DS Storage Manager client can detect the failure.

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

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

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

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

Finding controller, storage expansion enclosure, and drive information

You can view a Storage Subsystem Profile to find controller, enclosure, and drive information for the storage subsystem and attached storage expansion enclosures. To view a Storage System Profile, perform the following steps:

1. Open the Storage Subsystem Management window from the DS 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 storage subsystem.
5. Select the Enclosures tab.
6. Scroll through the list to find the Product ID for supported storage expansion enclosures.
7. Select the Drives tab.
8. Scroll through the list to find the drive values such as Product ID.

Firmware updates

Attention: Save the storage subsystem profile before performing any controller or ESM firmware upgrades. Save the storage subsystem profile and all configuration (*.cfg) files to a server disk that will remain accessible in the event of a DS5100 or DS5300 storage configuration failure. Do not save these files only to a LUN in the DS5100 or DS5300.

In order to ensure the optimal operation of the DS5100 or DS5300 and its attached storage expansion enclosures, the storage expansion enclosure ESM firmware, the DS5100 or DS5300 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/systems/support/storage/disk

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 the DS5100 or DS5300 (see "Receiving product updates and support notifications" on page 5).

Attention: Read the README file that is included in each firmware or DS 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 DS5100 or DS5300's logical drives. Failure to observe the limitations, prerequisites, and dependencies in the README file might result in a loss of data access. See "Finding Storage Manager software, controller firmware, and README files" on page xxviii to learn how to access the DS5100 or DS5300 README files on the Web.

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. Drive firmware
2. Controller NVSRAM
3. Controller firmware
4. ESM firmware for the storage expansion enclosures

Troubleshooting the storage subsystem

The DS Storage Manager client software enables you to monitor the storage subsystem, diagnose problems, and recover from failures. For best configuration operation, run the DS Storage Manager client software continuously, and frequently check the configuration status.

Use the following procedure to check the status of the storage subsystem. If a problem has occurred, use the DS Storage Manager client software and the LEDs on the storage subsystem to help locate a failed component.
1. If applicable, turn off the alarm.
2. If another fault occurs, the alarm sounds again. Use the DS Storage Manager client software to print a storage subsystem profile.

3. Using the Enterprise Management window, view the status storage subsystem. Do any components in the storage subsystem indicate Needs Attention?
   - Yes – Go to step 4.
   - No – All components are Optimal. Go to step 8.
4. Open the Subsystem Management window, and display the Physical View for the components in the storage subsystem.
5. View the status of the storage subsystem by selecting the **View Storage Subsystem** button and expanding the Overall Component Information when the Status window opens.

   Using the Overall Component Information view, you can see the status of the following components:
   - Interconnect-battery unit and battery packs in the component
   - SFPs
   - Power supply and fan units
   - Temperature sensors

   The status for each component is either Optimal, Charging (applicable to battery packs only), or Needs Attention.
6. Do any components have a Needs Attention status?
   - Yes – Go to step 7.
   - No – All components are Optimal. Go to step 8.
7. 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 10, otherwise continue with step 8.
8. Check the LEDs on the storage subsystem to determine if a fault has occurred in the storage subsystem.

   For the definition of the LED statuses, see "Checking the LEDs."
9. Are any Needs Attention LEDs indicating a fault condition?
   - Yes – Go to step 10.
   - No – You are finished with this procedure.

   If you are still experiencing a problem with this storage subsystem, go to step 11.
10. Replace the failed component. For instructions on replacing the controllers, power supply and fan units, interconnect-battery, battery pack, and SFP modules, see Chapter 5, "Replacing components," on page 189.
11. If the problem has not been fixed, contact your IBM service representative.

    Print a storage subsystem profile, and save the storage subsystem support data. The profile and support data are helpful when troubleshooting storage subsystem problems. (For information about printing a storage subsystem profile and saving the support data, refer to the Subsystem Management window online help.)

Checking the LEDs

The LEDs display the status of the storage subsystem 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.

It is important to check all the LEDs on the front and back of the storage subsystem when you turn on the power. 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.

Front bezel LEDs

You must remove the front bezel in order to see all of the interconnect-battery unit LEDs. With the bezel in place, only the following LEDs are visible:

- Power
- Overall Configuration Needs Attention
- Locate/Identify

Important: The displayed order of the Overall Configuration Needs Attention and Locate/Identify LEDs on the interconnect-battery unit are reversed when the bezel is removed. See "Interconnect-battery unit LEDs" on page 176.

Table 50 describes Figure 105.
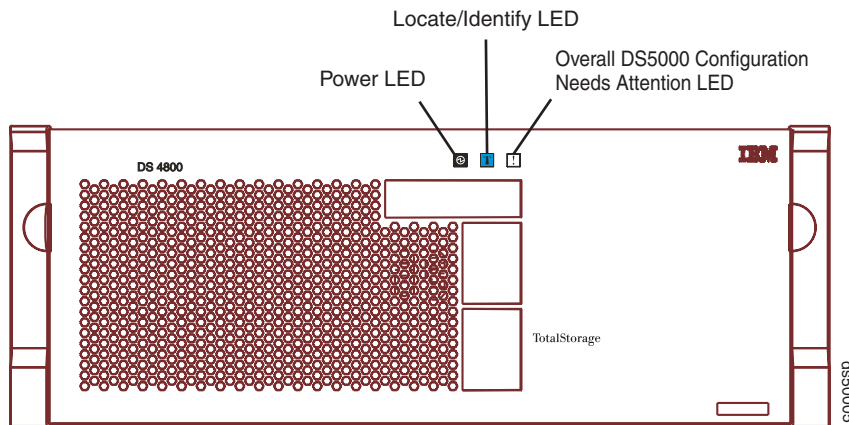
Figure 105. Front bezel LEDs

Table 50. Description of the figure that shows locations of the front bezel LEDs

LED	Color	Normal Status	Problem Status	Procedure
Power	Green LED	On = Storage subsystem is powered on	Off = Storage subsystem is powered off	
Locate/Identify	Blue LED **Note:** This LED is shown as white (and displayed in a different order) on the interconnect-battery unit when the DS5100 or DS5300 bezel is removed. See "Interconnect-battery unit LEDs" on page 176.	Off	On = Storage subsystem locate	

LED	Color	Normal Status	Problem Status	Procedure
Overall Configuration Needs Attention	Amber LED	Off	On = There are one or more failures in the storage subsystem configuration. The cause of failure could be one of the components in the chassis or one of the components in the attached DS5100 or DS5300 storage expansion enclosures.	"Troubleshooting the storage subsystem" on page 166

RAID controller LEDs
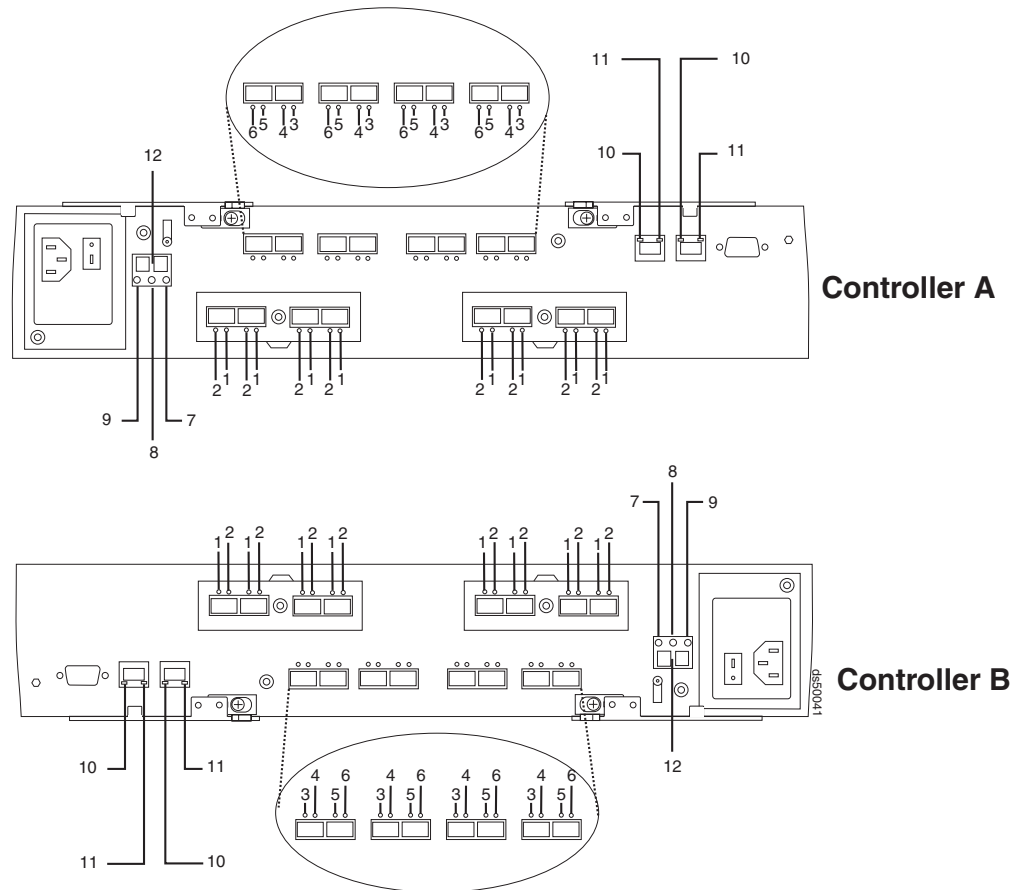
Figure 106. Fibre Channel RAID controller LEDs
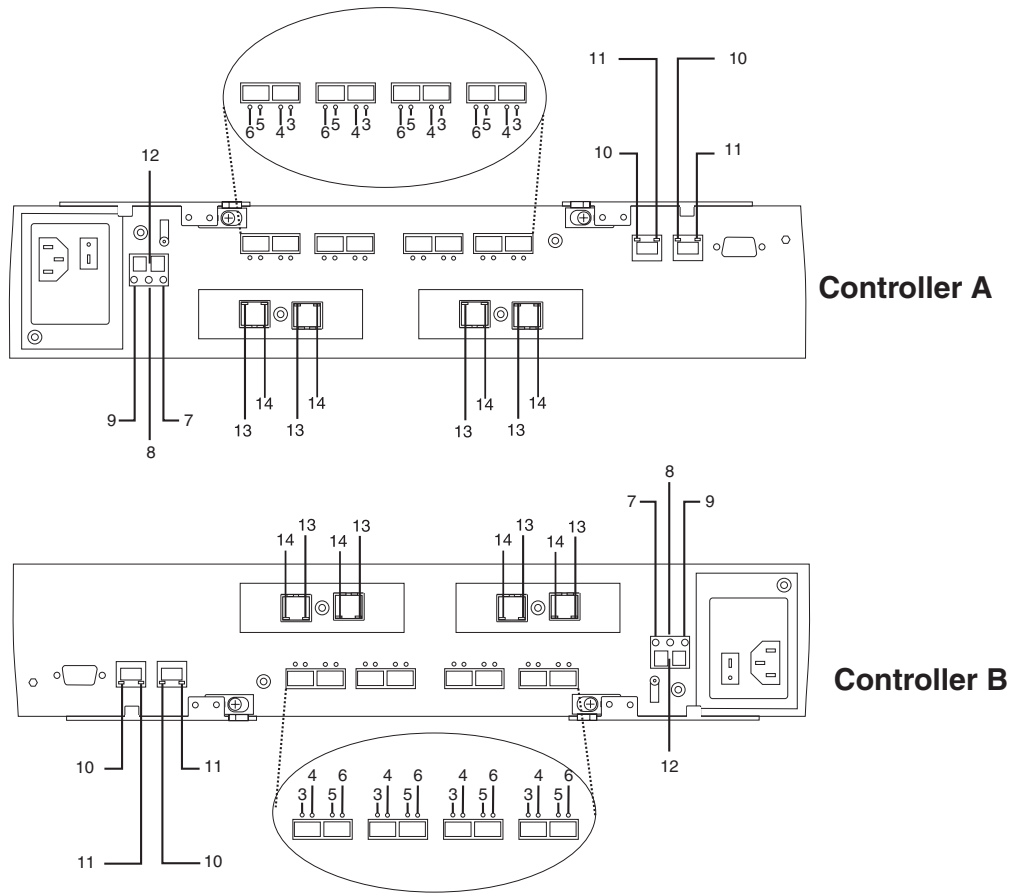
Figure 107. 1 Gbps iSCSI RAID controller LEDs

Table 51. RAID controller LEDs

Legend	LED	Color	Normal Status	Problem Status	Procedure
1	Fibre Channel host Channel Speed – L1	Green LED	See Table 52 on page 173.		
2	Fibre Channel host Channel Speed – L2	Green LED			

Table 51. RAID controller LEDs (continued)

Legend	LED	Color	Normal Status	Problem Status	Procedure
3	Drive Port Bypass (one LED per port) **Note:** The drive channel consists of two FC ports. This LED indicates the drive port bypass status of one of the two FC ports that made up a drive channel. The LED marked 6 shows the status of the other port.	Amber LED	Off	On = Bypass problem • An SFP module is inserted in the port and the connected fibre channel is either absent or not properly connected. • The storage expansion enclosure connected to this port is not powered on. • There is a problem with the fibre channel connection between this port and the fibre channel port of the connected ESM in the storage expansion enclosure.	
4	Drive Channel Speed – L1	Green LED	See Table 52 on page 173.		
5	Drive Channel Speed – L2	Green LED			

Table 51. RAID controller LEDs (continued)

Legend	LED	Color	Normal Status	Problem Status	Procedure
6	Drive Port Bypass (one LED per port) **Note:** The drive channel consists of two FC ports. This LED indicates the drive port bypass status of one of the two FC ports that made up a drive channel. The LED marked 3 shows the status of the other port.	Amber LED	Off	On = Bypass problem • An SFP module is inserted in the port and the connected fibre channel is either absent or not properly connected. • The storage expansion enclosure connected to this port is not powered on. • There is a problem with the fibre channel connection between this port and the fibre channel port of the connected ESM in the storage expansion enclosure.	
7	Service Action Allowed	Blue LED	Off	On = Safe to remove	"Replacing a controller" on page 193
8	Needs Attention	Amber LED	Off	On = Controller needs attention There is a controller fault or a controller is offline.	Troubleshooting the storage subsystem
9	Cache Active	Green LED	On = Data in cache Off = No data in cache	Not applicable	
10	Ethernet Link Speed	Green LED	Off = 10BASE-T On = 100BASE-T	Not applicable	

Table 51. RAID controller LEDs (continued)

Legend	LED	Color	Normal Status	Problem Status	Procedure
11	Ethernet Link Activity	Green LED	Off = No link established On = Link established Flashing = Activity	LED is off when a Ethernet cable is connected:	• Check to see whether there are problems with the Ethernet cables or switch. • Verify that the Ethernet controller is not offline. • Verify that the controller Ethernet port has not been disabled. • Verify that the controller Ethernet port is not bad.
12	Numeric Display (enclosure ID and Diagnostic Display)	Green/yellow seven-segment display	Diagnostic LED = flashing: Controller enclosure ID is displayed Diagnostic LED = on: Diagnostic code is displayed The Diagnostic LED is located on the Numeric Display. See "Seven-segment numeric display LEDs" on page 174.		
13	iSCSI Host Link Speed	Green LED	Off = 100BASE-T On = 1000BASE-T	Not applicable	
14	iSCSI Host Link Activity	Green LED	Off = No link established On = Link established Flashing = Activity	LED is off when a iSCSI cable is connected:	• Check to see whether there are problems with the iSCSI cables or iSCSI switch. • Verify that the controller is not offline. • Verify that the switch port that the controller iSCSI port is connected to has not been disabled. • Verify that the controller iSCSI port is not bad using the Ethernet port loopback.

The L1 and L2 LEDs for each host and drive channel combine to indicate the status and the operating speed of each host or drive channel.

Table 52. Host and drive channel LED definitions

L1	L2	Definition
Off	Off	When both LEDs for a host or drive channel are off, this indicates one or more of the following conditions: • The host or drive channel ports are bad. • An SPF module is inserted with no fibre channel cable attached. • No SFP module is inserted in one or both of the host or drive ports in the channel.

Table 52. Host and drive channel LED definitions (continued)

L1	L2	Definition
On	Off	The host channel is operating at 1 Gbps for host channels on a 4 Gbps HIC or is operating at 2 Gbps for host channels on a 8 Gbps HIC. This is not a valid condition for drive channels.
Off	On	The host or drive channel is operating at 2 Gbps. For the host channels on the 8 Gbps HIC, the port is operating at 4 Gbps
On	On	The host or drive channel is operating at 4 Gbps. For the host channels on the 8 Gbps HIC, the port is operating at 8 Gbps

Seven-segment numeric display LEDs

The seven-segment numeric display LEDs provide information about enclosure identification and diagnostics. Figure 108 shows the numeric display LEDs and the heartbeat and diagnostic LEDs.
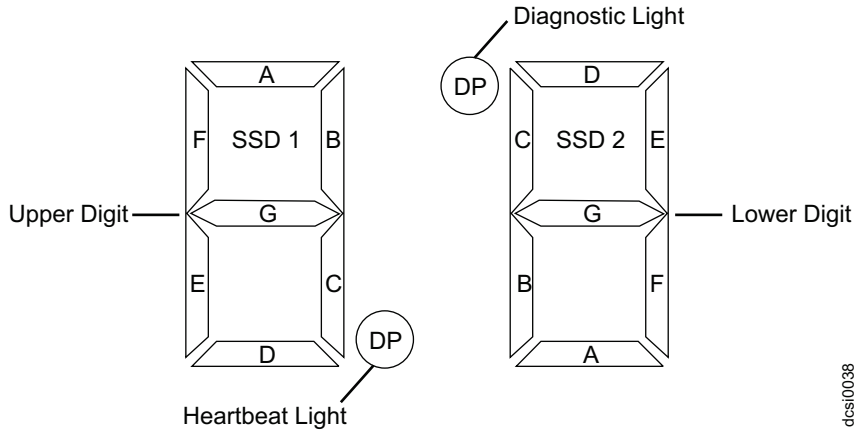
Figure 108. Numeric display LEDs

When you turn on the power to the storage or storage enclosure, the numeric display LEDs cycle through various codes as the controller or ESM firmware starts to boot. If the diagnostic LED is illuminated and the heartbeat LED is turned off, it indicates that diagnostic information is displayed on the numeric display. When the controller completes the boot process and is operating normally, the diagnostic LED turns off, the heartbeat LED flashes, and the numeric display changes to show the enclosure identification (enclosure ID) for that individual enclosure.

If an error occurs during the boot process and the Needs Attention LED is on, the numeric display shows diagnostic information as sequence of 2-digit diagnostic code. The number of time each 2-digit code is displayed during a sequence is fixed and under hardware control. Each sequence minimally consists of a two-digit category code, followed by a two-digit detail code that is specific to the category. Longer sequences can be displayed if more than one event is to be reported. This nominally consists of a series of category-detail sequences with a delimiter between each category-detail sequence. The entire display goes blank at the end of the sequence (all segments off, the diagnostic light off), and then the sequence repeats.

For more information about the diagnostic codes and their possible causes, see the "Seven-segment display sequence codes and their causes" section of this document.

Power supply and fan unit LEDs

The LED positions on the right and left power supply and fan units are in mirror positions. The LED positions for the left power supply and fan unit are aligned vertically on the right side of the unit. The LED positions for the right power supply and fan unit are aligned vertically, on the left side of the unit. On the left power supply and fan unit, from top to bottom, the LEDs are: Service Action Allowed LED, Needs Attention LED, and the Power LED. On the right power supply and fan unit, from bottom to top, the LEDs are: Service Action Allowed LED, Needs Attention LED, and the Power LED.

Note: The right power supply and fan unit is linked with RAID controller A. The left power supply and fan unit is linked with RAID controller B in the DS5100 or DS5300.
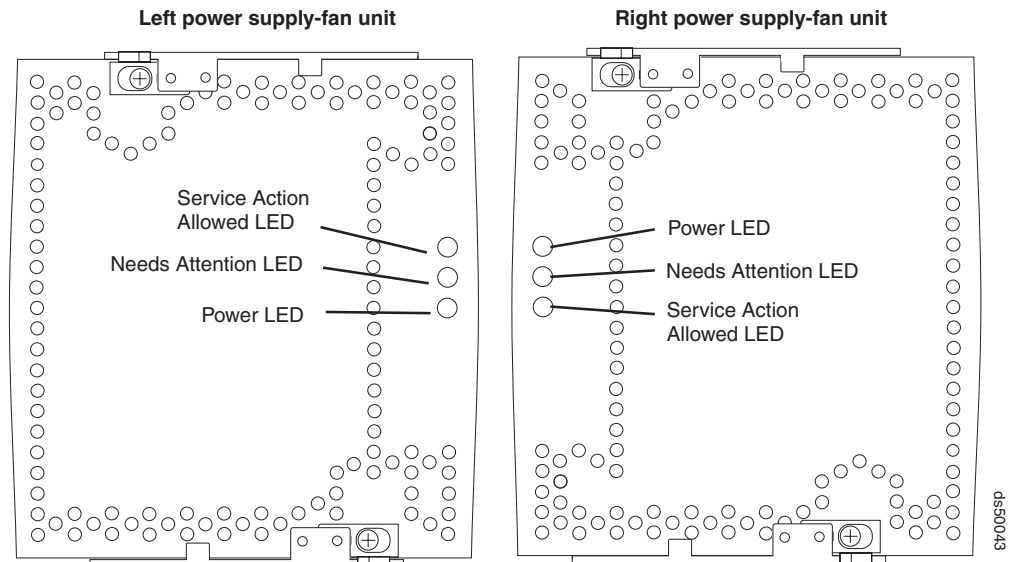
Figure 109. Power supply and fan unit LEDs

Table 53. Power supply and fan unit LEDs

LED	Color	Normal Status	Problem Status	Procedure
Power	Green LED	On = Power supply and fan unit is providing power	Off = Power supply and fan unit is not providing power	Examine the power supply and fan unit, connected PDUs, and connected power circuits for any of the following conditions: • The power supply and fan unit power switch is off. • A circuit breaker has tripped in the controller linked to this power supply and fan unit is linked. (The right power supply and fan unit is linked to controller A; the left power supply and fan unit is linked to controller B.) • The connected PDUs are turned off or have been tripped. • There is no power at the wall circuit. • The power supply and fan unit is bad.
Needs Attention	Amber LED	Off	On = Power supply and fan unit needs attention	"Troubleshooting the storage subsystem" on page 166
Service Action Allowed	Blue LED	Off	On = Safe to remove	"Resetting the controller circuit breakers" on page 181 "Replacing a power supply and fan unit" on page 205

Interconnect-battery unit LEDs
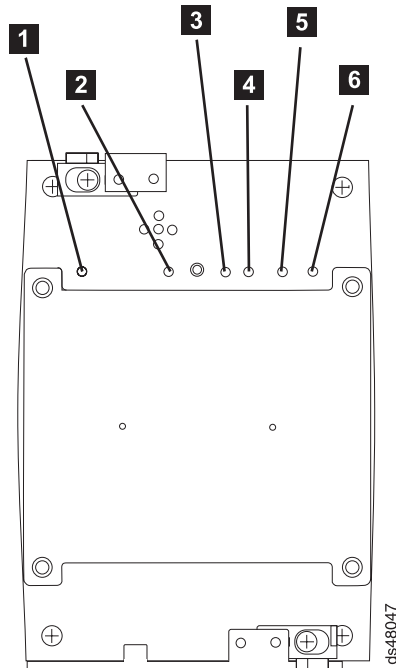
Figure 110. Interconnect-battery unit LEDs

Table 54. Interconnect-battery unit LEDs

Legend	LED	Color	Normal Status	Problem Status/Procedure
1	Battery Needs Attention	Amber LED	Off	On = Battery failed See "Replacing a backup battery pack" on page 213.
2	Power	Green LED	On = storage subsystem is powered on	Off = storage subsystem is powered off If the storage subsystem is powered on but this LED remains off, examine the power supply and fan units, the connected PDUs, and the connected power circuits for any of the following conditions: • Both power supply and fan units are not turned on. • A circuit breaker has tripped. • The connected PDUs are turned off or have been tripped. • There is no power at the wall circuit. • The interconnect-battery unit is bad.

Table 54. Interconnect-battery unit LEDs (continued)

Legend	LED	Color	Normal Status	Problem Status/Procedure
3	Overall Configuration Needs Attention	Amber LED	Off	On = A component in the storage subsystem configuration has developed a fault. Inspect the Needs Attention LEDs on the other components in the Storage Subsystem and in all connected storage expansion enclosures to isolate the fault. However, it is best practice to use the DS Storage Manager Subsystem Management window to identify the cause of the problem and use the Recovery Guru to help fix the problems. Some of the problems may not cause the Needs Attention LED on the individual FRU to light, but they will cause this Overall Configuration Needs Attention LED to light. For example, a hard disk drive that exceeds its PFA errors will cause this LED to light, but the drive Needs Attention LED for the individual drive in the attached storage expansion enclosure will not light. See "Troubleshooting the storage subsystem" on page 166.
4	Locate/ Identify	White LED **Note:** This LED is shown as blue (and displayed in a different order) when the DS5100 or DS5300 bezel is installed. See "Front bezel LEDs" on page 168.	Off	On = storage subsystem locate
5	Service Action Allowed	Blue LED	Off	On = Safe to remove See "Replacing the interconnect-battery unit" on page 209.
6	Battery Needs Attention	Amber LED	Off	On = Battery failed See "Replacing a backup battery pack" on page 213.

The Power, Overall Configuration Needs Attention, and Locate LEDs are general indicators for the entire storage subsystem (or configuration, in the case of the Overall Configuration Needs Attention), not specifically for the interconnect-battery unit. The Overall Configuration Needs Attention LED turns on if a fault condition is detected in any component in the storage subsystem configuration, including all attached storage expansion enclosures. The Power, Overall Configuration Needs Attention, and Locate LEDs shine through the front bezel.

Attention: If the Overall Configuration Needs Attention LED lights, refer to the DS Storage Manager client software to determine the problem with the storage subsystem. Also, inspect the Needs Attention LEDs on the other components in the storage subsystem to help isolate the fault to a specific component.

Recovering from an overheated power supply and fan unit

The storage subsystem has two power supply and fan units. Each power supply and fan unit contains a power supply, a cooling fan, a battery charger, and a built-in temperature sensor designed to prevent the power supplies from overheating. Under normal operating conditions, with an ambient air temperature range of 10° C to 35° C (50° F to 95° F), the cooling fans maintain a proper operating temperature inside the storage subsystem.

Several factors can cause the power supplies to overheat. These factors include the following:
- Unusually high room temperature
- Fan failure
- Defective circuitry in the power supply
- Blocked air vent
- Failure in other devices installed in the cabinet

If the internal temperature rises above 70° C (158° F), one or both power supplies automatically shut down. If one power supply shuts down, the DS Storage Manager client software displays a Needs Attention status in the Subsystem Management window, the alarm sounds (if enabled), and the Overall Configuration Needs Attention LED on the front bezel of the storage subsystem turns on.

If a common environmental stress causes both power supplies to shut down, the storage subsystem shuts down, and the DS Storage Manager client software displays a Not Responding status in the Subsystem Management window.

If event monitoring is enabled and event notification is configured, the software also issues critical event notifications.
- Nominal temperature exceeded – The storage subsystem temperature exceeds the normal operating range.
- Maximum temperature exceeded – The storage subsystem temperature exceeds 70° C (158° F).

Use the following procedure to resume normal operation after a power supply shutdown.

Attention: Power supplies automatically shut down when air temperature inside the cabinet reaches 70° C (158° F) or above. If the power supplies have shut down, immediately remove all cabinet panels to help cool the cabinet air temperature and prevent damage to the storage subsystem.

Note: If both power supply and fan units have shut down, start with step 4 below.

1. If applicable, turn off the alarm.
2. Use the DS Storage Manager client software to print a storage subsystem profile.
3. In the DS Storage Manager client Subsystem Management window, select **Advanced ▶ Troubleshooting ▶ View Event Log** to display the critical events. Look for one of the following critical event entries:

   * `Event 281B - Nominal temperature exceeded`
   * `Event 281C- Maximum temperature exceeded`

4. Try alleviating the overheating problem by doing the following:

   * Removing all panels from the cabinet.
   * Cooling the area using external fans.
   * Shutting down the power to the storage subsystem or storage expansion enclosures (Follow the power-down procedure described in "Turning off the storage subsystem" on page 157.)

5. Stop all I/O activity to the storage subsystem and to all attached storage expansion enclosures.
6. Wait until the ambient air temperature around the storage subsystem cools.

   The storage subsystem is capable of power-up recovery without operator intervention after the temperature inside the power supply and fan unit cools to below 70° C (158° F). After the air has cooled, the power supplies should turn on automatically. If the power supplies restart automatically, the controllers reset and return to normal operation.

7. Did the power supplies restart automatically?

   * Yes – Go to step 9.
   * No – Go to step 8.

8. Turn off the power switch on each controller in the storage subsystem and then power off all connected storage expansion enclosures. Wait 1 minute and then turn on power to all connected storage expansion enclosures and then to the storage subsystem. If the power supplies go into operation, go to step 9. If not, call your IBM service representative.
9. Check the status LEDs on the front and back of the storage subsystem.

   For information about storage subsystem LEDs, see "Checking the LEDs" on page 167.

10. Are the LEDs on the storage subsystem indicating normal status?

    * Yes – Go to step 11.
    * No – Go to step 12.

11. Use the DS Storage Manager client software to check the status of all storage subsystems in the configuration. Is the status Optimal for each storage subsystem?

    * Yes – End of procedure. Resume normal operation.
    * No – Go to step 12.

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

    a. Select the Recovery Guru toolbar button in the Subsystem Management window to run the Recovery Guru.
    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.

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

d. If the problem has not been fixed contact your IBM service representative.

Print a storage subsystem profile and save the storage subsystem support data. The profile and support data will be helpful when troubleshooting storage subsystem problems. (For information about printing a storage subsystem profile and saving the support data, refer to the Subsystem Management window online help.)

Resetting the controller circuit breakers

Each storage subsystem controller has one circuit breaker that provides over-current protection to the power supply in a power supply and fan unit. The circuit breaker is mounted inside the controller, in line with the internal power cable. The circuit breaker provides protection for ac input.

The internal power cable runs from the ac connector on a controller to the power supply in a power supply and fan unit. Power to the right power supply and fan unit (as viewed from the front of the storage subsystem) is routed through the top controller (controller A); power to the left power supply and fan unit is routed through the bottom controller (controller B).

If a circuit breaker has tripped, the condition might appear as if a power supply and fan unit has failed. The power supply is no longer providing power to the storage subsystem. A tripped circuit breaker is indicated when all of the following conditions are present:

- The Overall Configuration Needs Attention LED on the storage subsystem front bezel is turned on.
- The controller Needs Attention LEDs are not turned on.
- The power supply and fan unit Needs Attention LEDs are not turned on.
- The Service Action Allowed LED is turned on for the power supply and fan unit connected to the controller with the open circuit breaker.
- The DS Storage Manager client shows the power supply and fan unit has failed.

Use the following procedure to reset the circuit breaker.

Tools and Equipment
- Anti-static protection
- Nonconducting stylus

Electrostatic discharge can damage sensitive components – Touching the storage subsystem or its components without using a proper ground might damage the equipment. To avoid damage, use proper anti-static protection while handling any components.

1. If the alarm is sounding, turn off the alarm.
2. Check to ensure that the external power cables are completely plugged into the controllers and into the power source.
3. Put on anti-static protection.

4. Remove the front bezel by grasping the sides and pulling the cover toward you.
5. Check the Needs Attention LED on each power supply and fan unit. (Figure 111 shows the left power supply and fan unit Service Action Allowed LED is the top, or first, LED, and the Needs Attention LED is the second LED. On the right power supply and fan unit the Service Action Allowed LED is the bottom LED, and the Needs Attention LED is the next LED above it.)

Left power supply-fan unit   **Right power supply-fan unit**

Service Action Allowed LED

Needs Attention LED

Needs Attention LED

Service Action Allowed LED
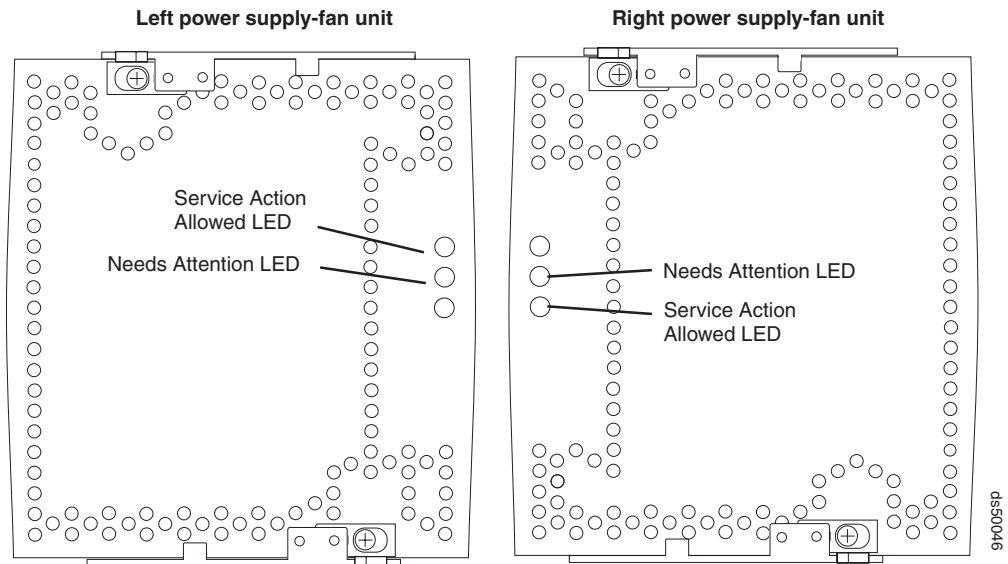
Figure 111. Power supply and fan unit Needs Attention LEDs

Is a power supply and fan unit Needs Attention LED on?

- Yes – A power supply and fan unit has failed. To replace the failed power supply and fan unit, see "Replacing a power supply and fan unit" on page 205.
- No – Go to step 6 on page 183.

Attention: Fiber-optic cables are fragile. Bending, twisting, folding, or pinching fiber optic cables can cause damage to the cables, degraded performance, or data loss. To prevent damage, do not twist, fold, pinch, or step on the cables. Do not bend the cables in less than a 2-inch radius.

Note: You do not need to remove the interface cables from the controllers to reset the circuit breakers; however, it is best practice to remove the cables to make this procedure easier. If you choose to remove the interface cables, ensure that you label each cable so that you can reconnect them correctly to the controller. Figure 112 on page 183 and Figure 113 on page 183 identify all of the connectors on the back of the controller.
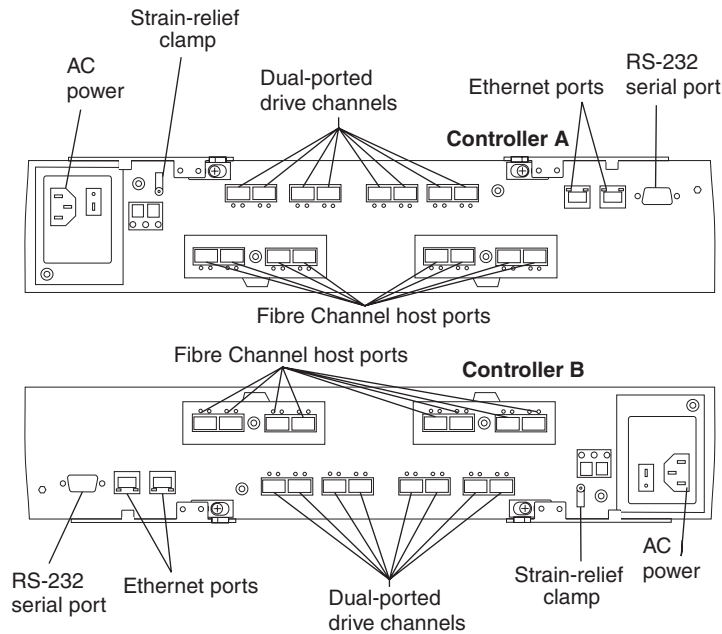
Figure 112. RAID controller connections with Fibre Channel host connections
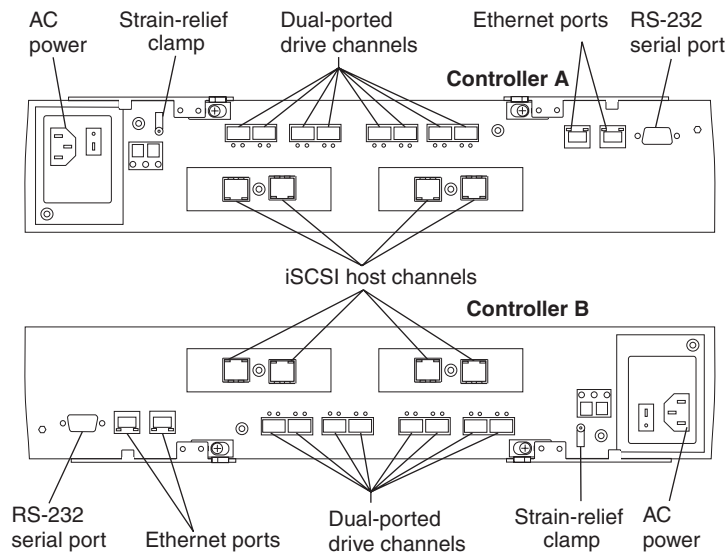
Figure 113. RAID controller connections with iSCSI host connections

6. Use the DS Storage Manager client software to take the controller offline. After the controller is offline, the Service Action Allowed LED turns on, and you can safely remove the controller.

7. Slide the controller with the open circuit breaker from the storage subsystem. You do not need to completely remove the controller. Only slide it out far enough to reveal the holes over the circuit breakers.

   a. Using your index fingers, simultaneously push the latches to release the levers, and rotate the levers to disengage them from the locking pins.

   b. Use the levers to slide the controller from the storage subsystem chassis. (Figure 114 on page 184 shows a controller sliding from the storage

subsystem chassis.)
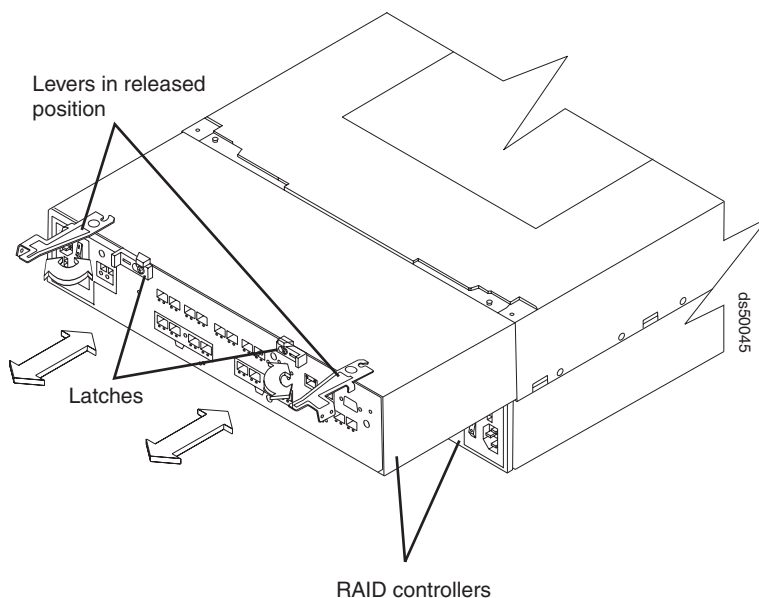
Figure 114. Removing the controller from the storage subsystem

8. Insert a nonconducting stylus through the appropriate hole in the cover of the
   controller and press down gently. Figure 115 shows the location of the circuit
   breaker access hole in the controller B cover.

   Note: When controllers A and B are inserted in the controller slots, the
   location of the circuit breaker access hole is as follows. On controller A,
   the circuit breaker access hole is located on the left side on the bottom
   of the controller. On controller B, the circuit breaker access hole is
   located on the right side on the top of the controller (as shown in
   Figure 115).
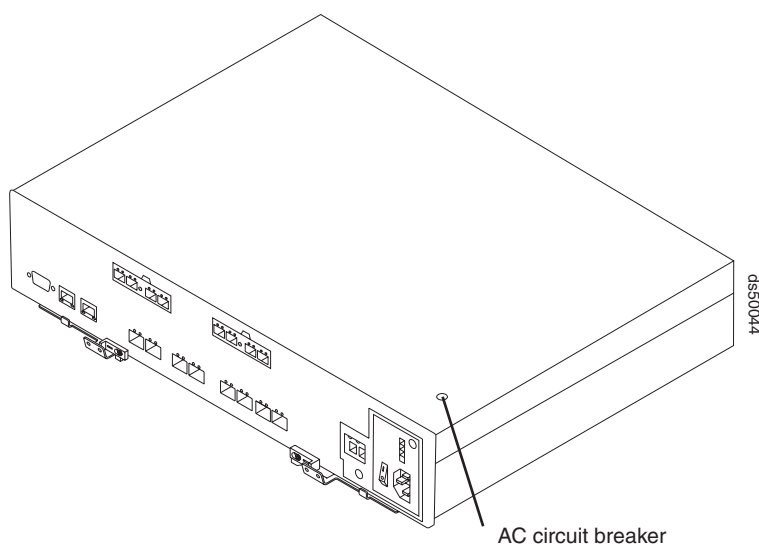
Figure 115. Circuit breaker access hole

9. Reset the circuit breaker that tripped by pressing down with the stylus on the rocker switch.

10. Slide the controller into the storage subsystem chassis.

    a. Holding both levers, slowly push the controller until the notches in both the left and right levers are aligned with the pins on the DS5100 or DS5300 enclosure so that the controller is pulled evenly into the DS5100 or DS5300 chassis, ensuring full electrical connection contact on all interface pins.

       Attention: Verify that the controller does not snag any other DS5100 or DS5300 cables when you slide it into the controller bay.

    b. Press the controller fully into the slot, engaging the pins on the enclosure.

    c. Hold open both latches and push both left and right levers simultaneously to the closed position. Release the latches. When you release the latches, you should hear both latches snap over the levers, indicating that the component is locked in place.

11. If you removed the interface cables, reconnect all host interface cables and drive interface cables, including the SFP modules.

12. Wait up to 5 minutes for the DS Storage Manager client software to recognize the controller.

13. Complete any remaining Recovery Guru procedures for controller replacement, if needed.

14. Based on the Host Channel Speed, Drive Channel Speed, and Needs Attention LED status, proceed to one of the following steps:

    • All channel speed LEDs are on and the Needs Attention LED is off – Go to step 16.

   • All channel speed LEDs are off or the Needs Attention LED is on – Verify the controller has been installed correctly. Remove and reinstall the controller. Go to step 15.

       Note: If a host channel or drive channel does not have a cable connected, the channel speed LEDs are not illuminated.

15. Did this action correct the problem?

    • Yes – Go to step 16.

    • No – If the problem has not been fixed, contact your IBM service representative.

16. Remove the anti-static protection.

17. Install the front bezel by aligning the pins on the storage subsystem chassis with the spring-steel retainers on the cover and then pressing the cover toward the chassis until the pins snap into place.

18. Using the Enterprise Management window, view the status of the storage subsystems. Do any storage subsystems indicate Needs Attention?

    • Yes – Go to step 19.

    • No – All components display Optimal status. You are finished with this procedure.

19. Use the Subsystem Management window to check the status of all storage subsystems in the configuration.

20. Do any storage subsystems have a Overall Configuration Needs Attention status?

a. Yes – Select the Recovery Guru toolbar button in the Subsystem Management window, and complete the recovery procedure. If the problem persists, contact your IBM service representative.

b. No – Contact your IBM service representative. Print a storage subsystem profile, and save the storage subsystem support data. The profile and support data are helpful when troubleshooting storage subsystem problems. (For information about printing a storage subsystem profile and saving the support data, refer to the Subsystem Management window online help.)

Cache memory and cache battery

Each RAID controller in the DS5100 or DS5300 contains cache memory to store read and write operations. (Both RAID controllers in the DS5100 or DS5300 must have the same amount of cache memory.) The interconnect-battery unit contains two Lithium Ion battery packs that can maintain power to the RAID controller caches for up to thirty minutes to flush cache memory to flash memory modules in the event that the DS5100 or DS5300 lose power.

Important:

Do not replace the battery until it is marked failed by the controller. If the batteries are shown as expired, use the reset battery age function in the SM client subsystem management window to reset the age.

Attention: There are different replacement FRU part numbers for the controller with certain cache sizes. The storage subsystem profile has the information on the installed cache memory size in the controllers. Refer to the storage subsystem profile and see "Parts list" on page 238 for the correct FRU part number for the controller.

Cache memory

Cache memory is memory on the RAID controller that is used for intermediate storage of read and write data on the DS5100 or DS5300 RAID controllers. Using cache memory can increase system performance. The data for a read operation from the host might be in the cache memory from a previous operation (thus eliminating the need to access the drive itself), and a write operation is completed when it is written to the cache, rather than to the drives.

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

If caching is enabled and the Cache Active LED never comes on during I/O activity, it indicates one of the following conditions:
- The cache memory from either controller A or controller B failed.
- The cache sizes in controller A and controller B are not the same.
- The battery failed. (In this case, one or both of the green Battery LEDs will be off and one or both amber Battery Needs Attention LEDs will be lit.)

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

Figure 116 shows the locations of the Cache Active LEDs on the front of the RAID controllers.
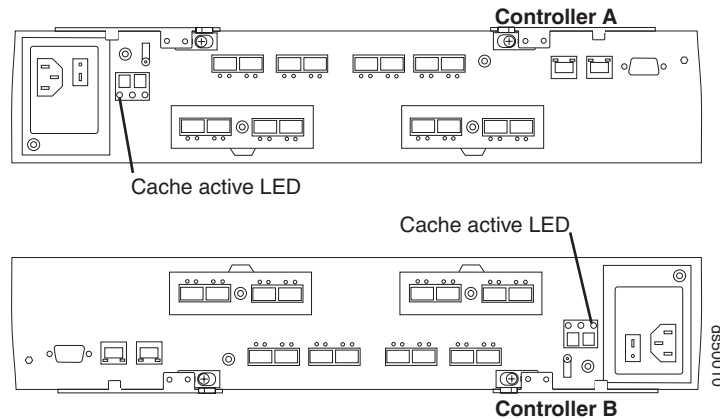
Figure 116. Cache Active LEDs

Subsystem cache battery

The DS5100 or DS5300 interconnect-battery unit contains two battery packs that provide backup power to maintain any cached data not written to disks in the event of a power loss. The battery packs can provide power to the data caches in the RAID controllers for up to thirty minutes for the controllers to flush cache memory to flash memory modules in the event of power loss.

Statement 2:

CAUTION:
When replacing the lithium battery, use only an equivalent type battery recommended by the manufacturer. If your system has a module containing a lithium battery, replace it only with the same module type made by the same manufacturer. The battery contains lithium and can explode if not properly used, handled, or disposed of.

Do not:
- **Throw or immerse into water**
- **Heat to more than 100° C (212° F)**
- **Repair or disassemble**

Dispose of the battery as required by local ordinances or regulations.

Replace the battery packs in the DS5100 or DS5300 interconnect-battery unit when they are identified as failing by the DS Storage Manager Subsystem Management window, or when the Battery LEDs or Battery Needs Attention LEDs light. (These LEDs are located on the power supply and fan units and on the interconnect-battery unit respectively, as shown in Figure 117 on page 188.)

Replace only the battery pack that is indicated as failed by the LEDs or in the DS Storage Manager Subsystem Management window. You do not need to replace both battery packs when the Battery LEDs indicate that only one battery pack failed.

In the event that the battery age expires, do not call on IBM technical support to replace the battery. Instead, reset the battery age using the procedure described in the Storage Manager online help. You should only replace the battery when it is in a failed state, as reported by the Storage Manager Recovery Guru.

The interconnect-battery unit also has a battery failure indicator LED for each battery pack that is located on the interconnect-battery unit. This LED will light if the battery fails to hold a charge.

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

Data caching starts after the battery completes the startup tests.

Figure 117 shows the location of the Battery Needs Attention LEDs on the interconnect-battery unit.
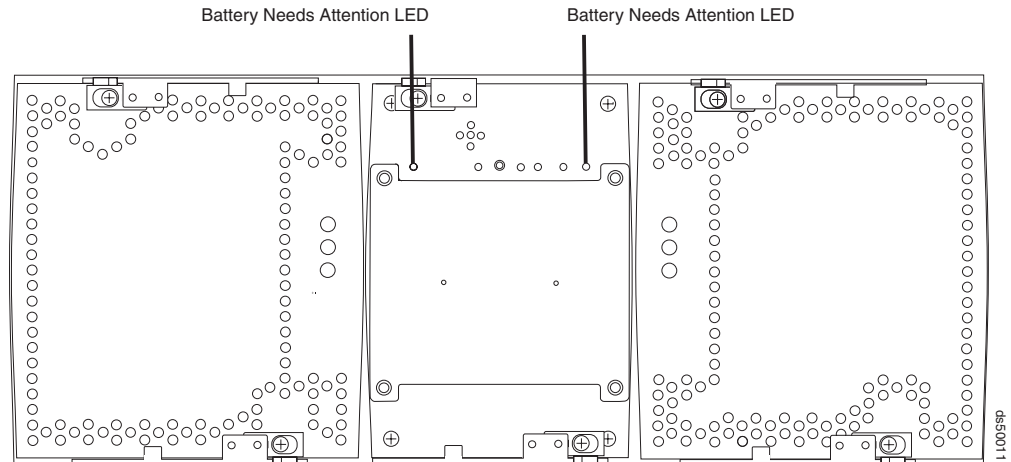

Figure 117. Battery LEDs

Chapter 5. Replacing components

This chapter lists replacement parts and explains the procedures for replacing a controller, a power supply and fan unit, an interconnect-battery unit, and an SFP module. Before using the procedures in this chapter, perform the appropriate troubleshooting steps described in "Troubleshooting the storage subsystem" on page 166, and in the Recovery Guru.

The following list shows the components that you can replace on site. To order parts, contact your IBM service representative.

- RAID controllers
- Power supply and fan units (containing power supplies, fans, and battery chargers)
- Interconnect-battery unit (containing the midplane and batteries for the cache backup)
- SFP modules
- Interface cables
- Ethernet cables

Attention: Never remove the interconnect-battery unit unless directed to do so by an IBM Service representative. Refer to "Replacing the interconnect-battery unit" on page 209 for complete information about the conditions required for safe removal of the interconnect-battery unit. Also, make sure you replace the interconnect-battery unit within 15 minutes. If you take longer, it may result in overheating of the chassis.

Instructions are also provided to help you add new DS5100 or DS5300 storage expansion enclosures to existing DS5100 or DS5300 configuration.

You can perform all replacement procedures in this chapter as hot-swap procedures. Hot swap refers to the ability to remove and replace a storage subsystem component while the storage subsystem is under power and processing data. The DS5100 or DS5300 has three major components you can replace on site: the controller, power supply and fan unit, and interconnect-battery unit. In a fully configured storage subsystem, the controllers and power supply and fan units are redundant. If any one of these redundant components fails, the component can be replaced without powering off the storage subsystem, and without interrupting data processing.

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

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

Handling static-sensitive devices

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

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

- Limit your movement. Movement can cause static electricity to build up around you.

- Handle the device carefully, holding it by its edges or its frame.
- Do not touch solder joints, pins, or exposed printed circuitry.
- Do not leave the device where others can handle and possibly damage the device.
- While the device is still in its static-protective package, touch it to an unpainted metal part of the storage 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 controller, power supply and fan unit, and battery 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 storage subsystem component unless the component's Service Action Allowed status LED is lit.

> **Attention**
> Never remove a controller, power supply and fan unit, or interconnect-battery unit unless the Service Action Allowed status LED is turned on. Doing so can result in a potential loss of data. 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 DS Storage Manager Subsystem Management window or refer to the appropriate component replacement instructions 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.

Single component failures

When a single component in the DS5100 or DS5300 fails, the following list indicates the behavior of the Service Action Allowed status LED lights:

- If a controller or power supply and fan unit fails and needs to be replaced, the amber Needs Attention status LED on that component turns on to indicate that a service action is required. If there are no data availability dependencies or other conditions that dictate that the component should not be removed, the blue Service Action Allowed status LED turns on. Do not remove any components other than the component indicated by the lit blue Service Action Allowed status LED.
- The interconnect-battery unit contains the midplane that communicates between controllers A and B in the DS5100 or DS5300. If the interconnect-battery unit needs to be replaced, the Service Action Allowed status LED does *not* automatically turn on. Before the interconnect-battery unit Service Action Allowed

status LED can turn on, you must use the DS Storage Manager client to place controller B offline. (Controller A is the controller designated to receive all I/O activity when the interconnect-battery unit is removed from the storage subsystem.) By placing controller B offline, you route all controller and I/O activity through controller A. This maintains data availability while the interconnect-battery unit is removed, preventing any problems that would normally arise from the loss of communication between controllers A and B.

Attention: Before you remove the interconnect-battery unit, you must verify that controller A is in an optimal state, and the power supply and fan unit FRU that is connected to controller A (the right power supply) is optimal. *Never* remove the interconnect-battery unit when controller A or the power supply and fan unit FRUs are not in an optimal state.

Multiple component failures

When multiple components in the DS5100 or DS5300 fails, the behavior of the Service Action Allowed and Needs Attention LEDs can vary from situation to situation. In some cases, multiple Service Action Allowed status LEDs light when their corresponding Needs Attention LEDs are lit. In other cases, none of the Service Action Allowed status LEDs light when their corresponding Needs Attention LEDs are lit. This variance exists because the ability to remove a component depends on the different data availability dependencies of the storage subsystem components.

If replacing any one of the multiple components that have their Needs Attention LEDs lit will cause the DS5100 or DS5300 to shut down, the Service Action Allowed status LEDs will *not* light on any of the components that need attention. For example, if both the right power supply and fan unit (which is linked to controller A) and controller B need attention, then neither of the Service Action Allowed status LEDs on these components would light. Removing the controller B before replacing the failed right power supply and fan unit would cause controller A to lose power, resulting in a loss of data availability. (This linkage exists because the power distribution from each power supply and fan unit runs through the controller physically connected to that power supply and fan unit.)

However, if replacing any one of the multiple components that have their Needs Attention LEDs lit will *not* cause the DS5100 or DS5300 to shut down, then the Service Action Allowed status LEDs will light on all of the components that need attention. For example, if the right power supply and fan unit (which is linked to controller A) and controller A both need attention, then the Service Action Allowed status LEDs on both of these components would light, indicating that either component can be replaced first.

Important: In this situation (in which replacing any one of the multiple components that have their Needs Attention LEDs lit will *not* cause the DS5100 or DS5300 to shut down), after you remove one failed component, the Service Action Allowed status LEDs on the remaining components that need attention might turn off. This change in the Service Action Allowed status LEDs indicates that removing additional components now might cause the storage subsystem to shut down.

For example, if both power supply and fan units have failed, the Needs Attention and the Service Action Allowed status LEDs would be lit for both components. However, when you remove one power supply and fan unit from the system, the Service Action Allowed status LED on the remaining power supply and fan unit turns off, indicating that you now

cannot remove the second power supply and fan unit (because the storage subsystem requires that at least one power supply and fan unit, functioning or not, must be present in the storage subsystem at all times).

Releasing and locking a component lever

Each component is secured into the storage subsystem chassis by two cam lock levers mounted to the component. The lever engages with a pin on the storage subsystem chassis to pull the component securely into the chassis. The levers are locked in place by spring-loaded latches. The control components have the levers on the same side. The power supply and fan units and the interconnect-battery unit have the one lever mounted to the top of the component and one lever mounted to the bottom of the component. Figure 118 shows a component lever and the latch that secures the lever. The top view shows the lever in the closed and latched position. The bottom view shows the lever in the released position.
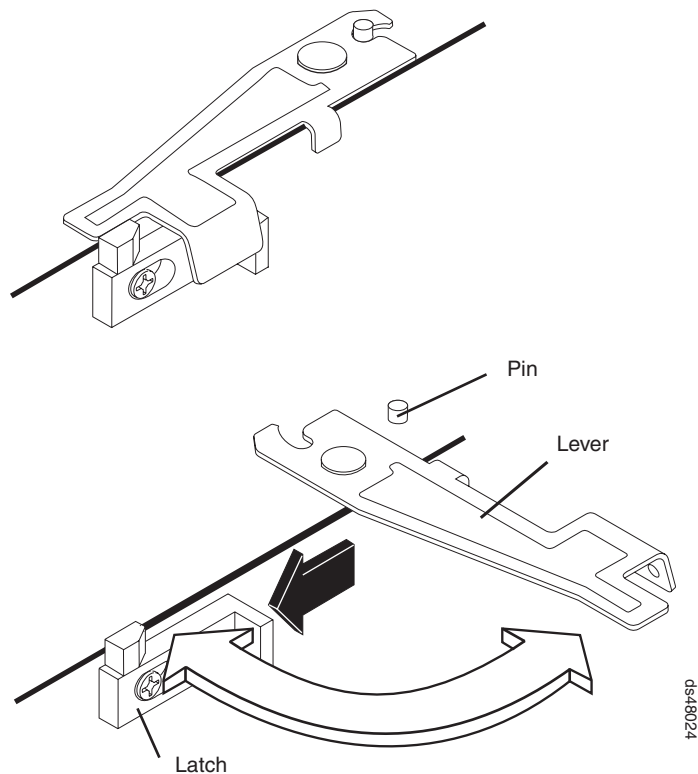
Figure 118. Component lever and latch

To release both latches on a component and remove the component, complete the following:

1. Push the latches to the side until the latches release the levers. Do not proceed with the next step until you have released both levers from the latches.
2. Rotate both levers out simultaneously. Ensure that the levers are completely free of the pins. Then place one hand under the component and use the levers to pull the component from the DS5100 or DS5300.

Before you begin, ensure that you wear an anti-static wrist strap.

To replace a component and lock the latches, complete the following:

1. With both levers rotated out perpendicular to the face of the component, slide the back of the component into the appropriate slot.

2. Push the component into the slot and, when the component is almost fully installed, verify that the notches in both levers are aligned with the pins on the storage subsystem. Verify this alignment to ensure that the component is pulled evenly into the storage subsystem, ensuring full electrical connection contact on all interface pins.

3. Press the component fully into the slot, engaging the pins on the storage subsystem.

4. Hold open both latches and rotate both levers simultaneously to the closed position. Release the latches. When you release the latches, you should hear both latches snap over the levers. This indicates that the component is locked in place.

Replacing a controller

Attention: Before you replace a RAID controller, verify the following:

- The replacement RAID controller part number matches the part number of the RAID controller to be replaced. To provide full functionality, the two controllers should have the same memory capacity.

- Both power supply and fan units must be connected and powered on with no lighted Needs Attention LEDs. Ensure that the Power LEDs on each of the power supply and fan units are lit. If either of the power supply and fan units is not optimal, it is best practice to replace that component before you proceed with the controller replacement procedure.

- If you are replacing a functional controller, first make sure that the other RAID controller is optimal and that the fibre channel path from the hosts to the other RAID controller is also optimal.

- Be aware that each RAID controller has a unique hardware Ethernet address, which is printed on a label on the front.

- Ensure that you wear an anti-static wrist strap.

Use the following procedure to replace a controller in a DS5100 or DS5300.

1. Ensure you are ready with all the required instruments and components, including a Phillips screwdriver to unscrew the thumbscrews. Also, make sure that the power supply is not switched off for more than 15 minutes. If the power supply is off for more than 15 minutes, it may lead to overheating of the chassis.

2. Use the DS Storage Manager client software to save a storage subsystem configuration and the subsystem Collect All Support Data (CASD) bundle.

3. If you are:

   - Replacing a failed controller, locate the failed controller by checking the Needs Attention status LEDs on the controllers in the storage subsystem (see Figure 119 on page 194). Skip to step 5 on page 194.

   - Replacing a functional controller as requested by the IBM Support personnel, go to step 4.

4. Prepare the controller for removal by performing the following steps:

   a. Using the DS Storage Manager client software, on the Subsystem Management window menu bar, click **Advanced ▶ Trouble Shooting ▶ Prepare for Removal**.

b. On the Prepare for removal dialog window, in the Enclosure drop down menu, select **Controller Enclosure**.

c. In the Component drop down menu, select the controller you want to remove.

   Available controller options are controller in slot A or controller in slot B.

d. Click the **Prepare for removal** button.

   The Service Action Allowed LED turns on (turns blue) on the controller you selected to remove.
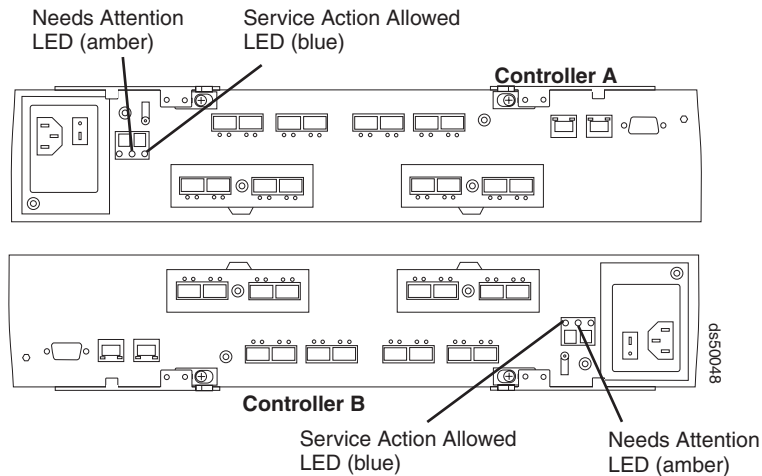
e. Go to step 6.

Figure 119. RAID controller Needs Attention and Service Action Allowed LEDs

5. Is the Service Action Allowed LED turned on?

   Figure 119 shows the location of the Service Action Allowed status LED on the back of a controller.

   Attention: Never remove a controller unless the Service Action Allowed status LED is turned on. Doing so can result in a potential loss of data.

   - Yes – Go to step 6.
   - No – Another component requires attention before you can remove the controller. Normally, this situation indicates that a power supply and fan unit is either powered off or failed. Ensure that both power supply and fan units are powered on and in an optimal state. If the Service Action Allowed LED of the failed controller is unlit and both power supply and fan units are in an optimal state, contact your IBM support representative.

   Electrostatic discharge can damage sensitive components. Touching the storage subsystem or its components without using a proper ground might damage the equipment. To avoid damage, use proper anti-static protection while handling any components.

6. Put on anti-static protection.

7. (If applicable) Unpack the new controller. Save all packing materials in the event you need to return the new controller.

8. (If applicable) Determine whether the replacement controller will serve as controller A or controller B. (Controller A is inserted in the top controller bay; controller B is inserted in the bottom controller bay.) Then apply the controller labels for host channels, drive channels, power inputs, and numeric display to

the replacement controller. The controller labels and instructions are included with the replacement controller. Make sure that the labels are aligned properly and do not cover any ports or LEDs.

Attention: Handle and install fiber-optic cables properly to avoid degraded performance or loss of communications with devices. For specific handling guidelines, see "Handling fibre-optic cables" on page 50.

9. Disconnect all attached interface cables from the controller you are upgrading or replacing, including the SFP modules. Ensure that you label each cable so that you can reconnect them correctly to the new or upgraded controller. Figure 120 shows the location of the connectors on the back of a controller.
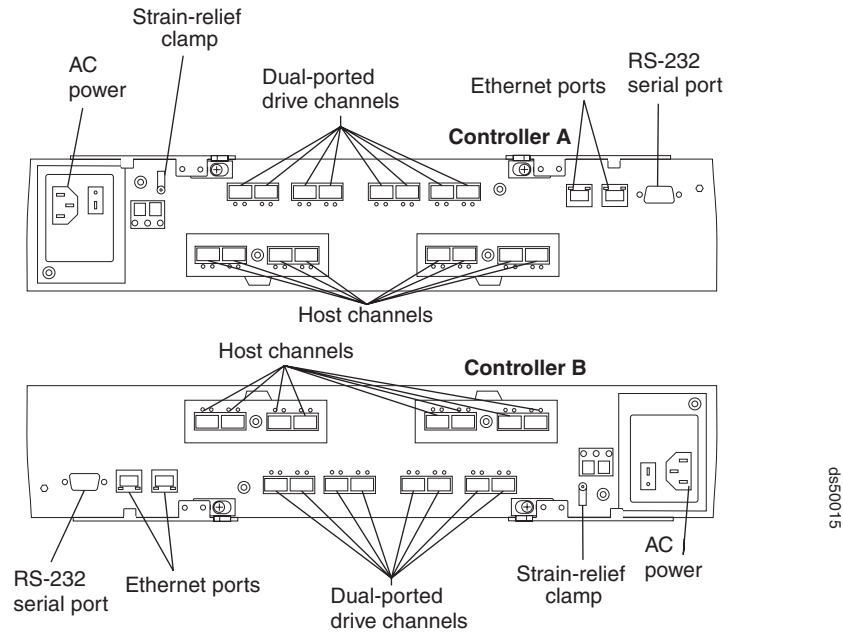
Figure 120. Connectors on the back of each controller. Each host channel is different, dependent on the host interface card.

Use the following procedure to remove the SFPs from the RAID controller that you are replacing or upgrading:

a. Remove the LC-LC fibre-channel cable from the SFP module. For more information, see "Handling fibre-optic cables" on page 50.

b. Unlock the SFP or 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 121 on page 196.
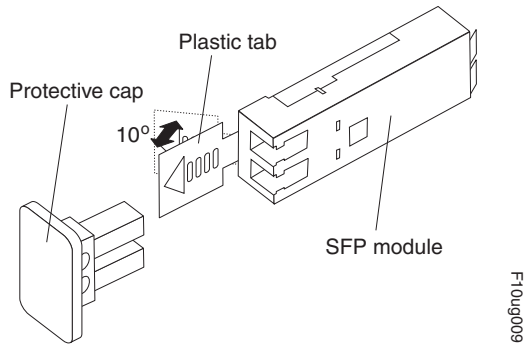
Figure 121. Unlocking the SFP module latch - plastic variety

- For SFP or SFP+ modules that contain wire tabs, unlock the SFP or SFP+ module latch by pulling the wire latch outward 90°, as shown in Figure 122.
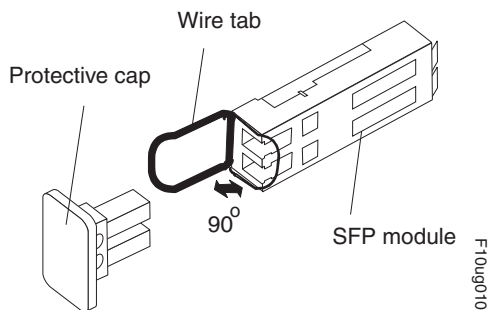
Figure 122. Unlocking the SFP module latch - wire variety

   c. With the SFP or SFP+ latch in the unlocked position, extract the SFP or SFP+ module.

- For SFP modules that contain plastic tabs, slide the SFP module out of the port.
- For SFP or SFP+ modules that contain wire tabs, grasp the wire latch and pull the SFP module out of the minihub port.

   d. Replace the protective cap on the SFP module.

   e. Place the SFP or SFP+ module into a static-protective package.

   f. Replace the protective cap on the port.

10. Remove the strain-relief nut and cable strain-relief clamp from the RAID controller.

11. Unplug the power cord from the electrical outlet and then disconnect the power cord from the ac power connector on the controller.

12. Release the controller levers and remove the controller. Figure 123 on page 197 shows the controller sliding from the storage subsystem chassis.

Figure 123. Removing a controller from the DS5100 or DS5300

13. Remove the following cards from the controller you removed in step 12 on page 196 and install in the new (replacement) controller. Use the same slots in the new controller:

    - Host interface card

      For instructions on how to remove and replace host interface cards, see steps 12 -24 "Replacing a DS5100 or DS5300 host interface card" on page 199 or refer to the following publication: *Installing or replacing a DS5000 host interface card*.
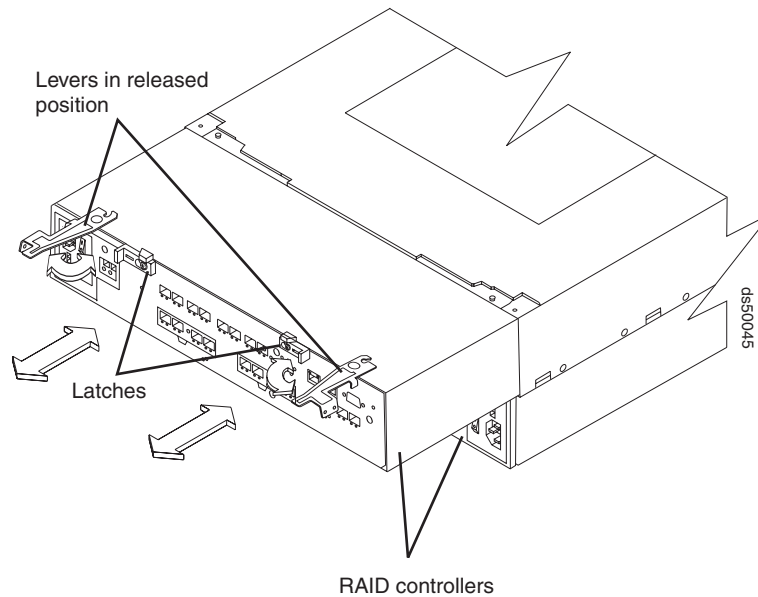
    - Cache memory card
    - Flash memory card

      For instructions on how to remove and replace these cards, refer to the following publication: *Installing or replacing a DS5000 cache or flash memory card*.

14. Find the label on the top of the new or upgraded controller and record its media access control (MAC) address.

15. Install the new or replacement controller by performing the following:

    a. Carefully position the controller at the back of the storage subsystem chassis. Ensure that the controller can slide into the storage subsystem chassis without obstruction.

    b. With the left and right levers rotated out perpendicular to the face of the controller, slide the back of the controller into the appropriate slot.

    c. Push on both sides of the controller so that it slides into the slot evenly. *Stop inserting the controller when it is about 1 inch from being fully inserted into the slot.* With the controller not fully inserted in the slot, attach all the SFPs and cables that you disconnected from the failed controller in step 9 on page 195.

       1) Replace the SFPs into the appropriate ports. See "Installing SFP or SFP+ modules" on page 51.

       2) Reconnect all cables, including all host and drive channel cables and secondary cables (such as Ethernet connections).

d. Holding both levers, slowly push the controller until the notches in both the left and right levers are aligned with the pins on the DS5100 or DS5300 enclosure so that the controller is pulled evenly into the DS5100 or DS5300 chassis, ensuring full electrical connection contact on all interface pins.

Attention: Verify that the controller does not snag any other DS5100 or DS5300 cables when you slide it into the controller bay.

e. Press the controller fully into the slot, engaging the pins on the enclosure.

f. Hold open both latches and push both left and right levers simultaneously to the closed position. Release the latches. When you release the latches, you should hear both latches snap over the levers, indicating that the component is locked in place.

16. Wrap the strain-relief clamp around the power cord approximately 20 cm (8 in.) from the controller connection end. Leave some slack between the clamp and the controller end of the power cord. Replace the strain-relief nut and tighten it securely to secure the clamp to the controller unit.

17. Connect the power cord to the ac power connector of the controller you replaced or upgraded. Plug the power cord into a properly grounded electrical outlet.

18. Wait up to 5 minutes for the DS Storage Manager client software to recognize the controller you replaced or upgraded.

19. Complete any remaining Recovery Guru procedures for controller replacement, if needed.

20. Check the LEDs on the controller to verify that the controller is fully operational. See "RAID controller LEDs" on page 169.

The LEDs come on and go off intermittently for approximately 60 seconds or possibly longer. After this time, you are able to discover the controller through the DS Storage Manager software.

21. Remove the anti-static protection.

22. Use the DS Storage Manager client Subsystem Management window to check the status of all components in the storage subsystem.

- If the controller you replaced or upgraded is online and the DS Storage Manager client Subsystem Management window indicates normal operation, go to step 25 on page 199.

- If the controller you replaced or upgraded is online and the DS Storage Manager client Subsystem Management window indicates a problem status, go to "Troubleshooting the storage subsystem" on page 166.

- If the controller you replaced or upgraded is offline, go to step 23.

23. If the newly inserted controller is in an offline state, see the DS Storage Manager client online help for instructions on bringing the controller online.

If necessary, open the DS Storage Manager Subsystem Management window and place the controller online; select the offline controller and click **Advanced ▶ Recovery ▶ Place controller online**.

24. Verify the state of the LEDs on the newly inserted controller. See "RAID controller LEDs" on page 169. You can also use the Storage Manager client Subsystem Management window to identify any new faults. Do any storage subsystems have a fault (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 your IBM service representative.

- No – Go to step 25 on page 199.

25. Use the DS Storage Manager client software to print a new storage subsystem profile.

Replacing a DS5100 or DS5300 host interface card

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.	

Attention:
- **Possible hardware damage:** To prevent electrostatic discharge damage to the enclosure, use proper anti-static protection when handling enclosure components.

Replacing a failed host interface card consists of removing the controller, inserting the host interface card, and reinstalling the controller.

While you replace a failed host interface card in one controller, make sure that the other controller is optimal and the fibre channel path from the hosts to the controller is also optimal.

Before you begin, ensure that you wear an anti-static wrist strap.

To replace a failed DS5100 or DS5300 host interface card, perform the following steps:

1. Verify that you have all the items you need before beginning the installation or replacement procedure, including a Phillips screwdriver to unscrew the thumbscrews. While you perform the procedure, ensure that the power supply is not switched off for more than 15 minutes. If power supply is off for more than 15 minutes, it may lead to overheating of the chassis.

2. Put on anti-static protection.

3. Using the DS Storage Manager and the Fibre Channel switch management GUI, make sure that there is an optimal path from the host servers to the controller that is *not* having a host interface card replaced. Otherwise a loss of data access will occur when you remove the controller for host interface card replacement.

4. Use the DS Storage Manager client program to save the full subsystem configuration (Storage Subsystem -> Configuration -> Save) and collect all support data (Advanced -> Troubleshooting -> Collect all support data).

5. Label each fiber-optic cable attached to the controller that you are going to remove so that you can reconnect the fiber-optic cables correctly after the controller is reinstalled.

6. Record the information from the seven-segment display on the rear of the controller, take the controller offline, and wait for the Service Action Allowed LED on the controller to turn on.

7. Turn off the power switch on the controller you are going to remove.

8. Unplug the power cord from the controller, and set the power cord aside.

9. Disconnect all of the host interface cables from the controller.

10. Disconnect all of the drive interface cables from the controller.

11. Remove the controller by performing the following steps:

    a. Unlock and rotate the release handles out to release the controller.

    b. Using the release handles and then your hands, pull the controller out of the controller enclosure.

Table 55 describes the numbered locations identified in Figure 124.
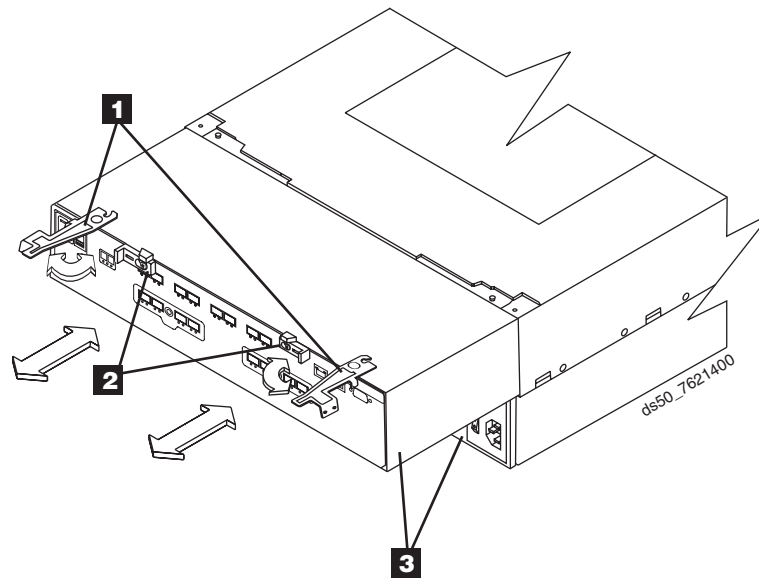
Figure 124. Removing and reinstalling a controller

Table 55. Description of numbered locations in the figure that shows removing and reinstalling a controller

Number	Description
1	Release handles
2	Locking mechanisms (push in the direction of the arrow to release)
3	Controllers

12. Set the controller on a flat, static-free surface with the release handles down and the host interface ports up.
13. Remove the three thumbscrews that secure the top cover to the controller.
14. Remove the top cover as shown in Figure 125 on page 202.

Table 56 describes the numbered locations identified in Figure 125.
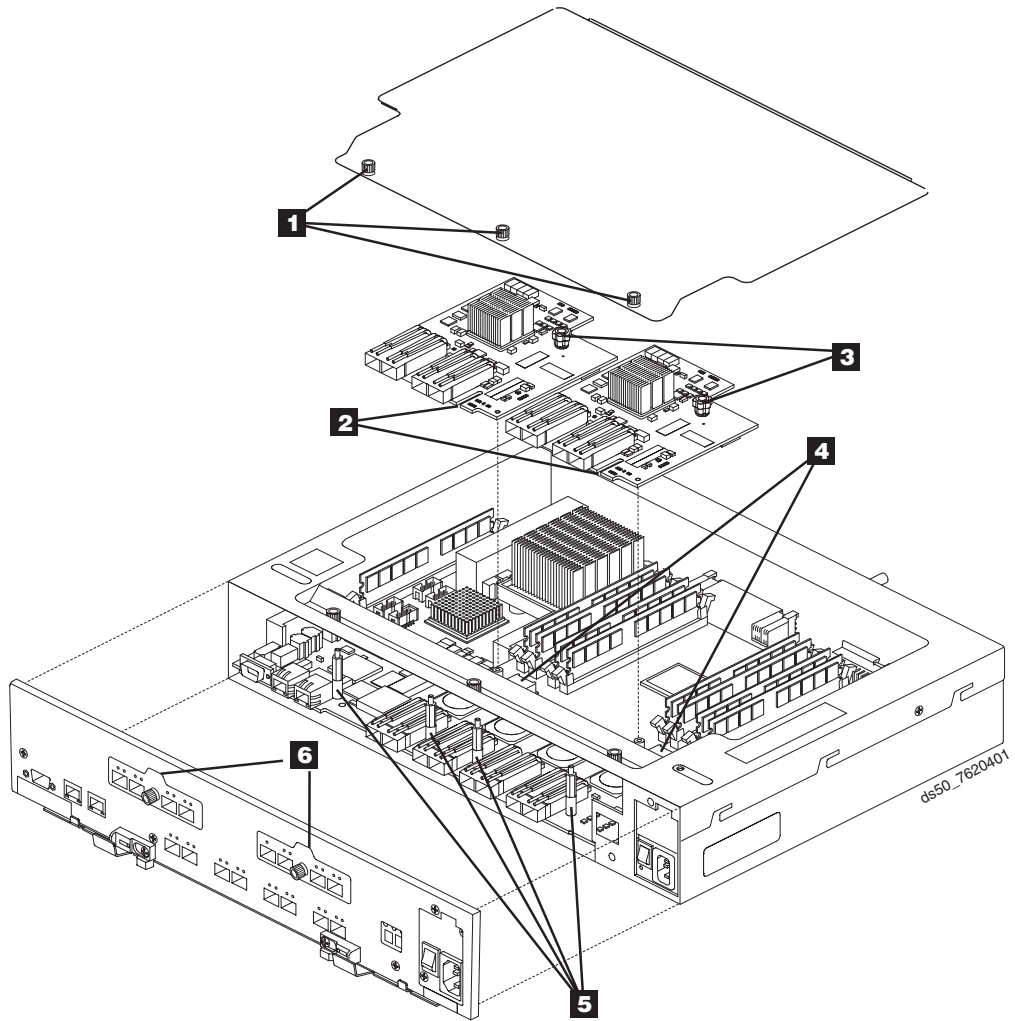
Figure 125. Removing controller cover and replacing host interface card

Table 56. Description of numbered locations in the figure that shows removing a controller cover and replacing a host interface card

Number	Description
1	Cover thumbscrews
2	Two host interface cards with alignment slots
3	Host interface card thumbscrews
4	Controller card sockets for connecting the host interface cards
5	Host interface card alignment pins
6	Host interface card port covers

15. Locate the host interface card that you want to replace. See Figure 126 on page 203, and Table 57 on page 203, which describes the numbered locations identified in Figure 126 on page 203.
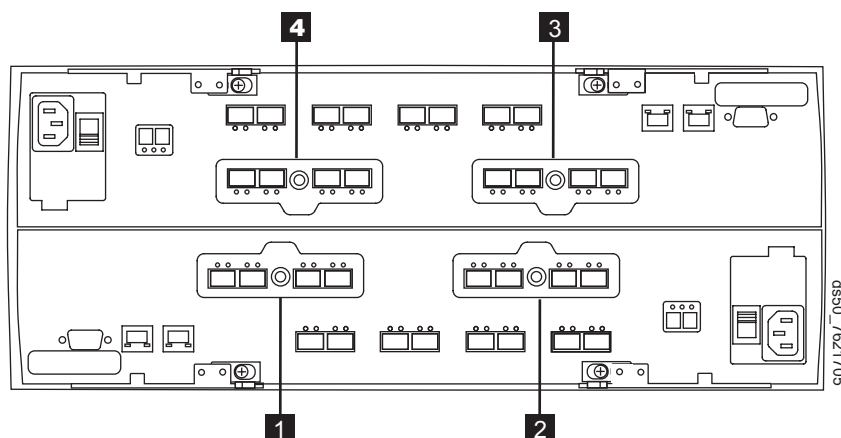
Figure 126. Host interface card slots on controllers A and B

Table 57. Description of numbered locations in the figure that shows host interface card slots on controllers A and B

Number	Description
1	Host interface card - slot 1 - controller B
2	Host interface card - slot 2 - controller B
3	Host interface card - slot 1 - controller A
4	Host interface card - slot 2 - controller A

16. Loosen the thumbscrew on the host interface card that secures it to the controller card.

17. Gently lift the host interface card to disengage the host interface pins from the connector on the controller card. Pull away from the front to remove.

   Note: The connector is located on the corner of the host interface card next to the thumbscrew. Note how the card fits against the two guide posts. These guide posts help align the connecting hardware.

18. Using the thumbscrews, remove the host interface card port cover and keep it.

19. Place the host interface card that you removed on a static-free surface.

20. Install the new host interface card by performing the following steps:

   a. Using the thumbscrew, remove the blank host interface card port cover.

   b. Align the new host interface card with the guide posts.

   c. Gently push down on the connector to seat the pins into the connector socket.

21. Tighten the thumbscrew to securely fasten the host interface card to the controller card. Do not overtighten the thumbscrew.

22. Reinstall the host interface card port cover you removed in step 18 using the thumbscrew. See Figure 125 on page 202 for an illustration of a host interface card port cover.

23. Replace the top cover.

24. Make sure that all of the thumbscrews that secure the top cover are tight.

25. Slide the controller all the way into the enclosure. Rotate the release handles inward to lock the controller into place.

26. Reconnect all of the host interface cables to the appropriate host interface ports.

27. Reconnect all of the drive interface cables from the storage expansion enclosure ESMs to the controller.

   Note: Make sure you connect the host interface cables to the appropriate host interface ports and the drive interface cables to the appropriate drive interface ports. Incorrectly cabling host interface cables to drive interface ports and drive interface cables to host interface ports can cause problems when you restart the controller after inserting it into the chassis.

28. Plug in the power cord to the controller or controllers.

29. Turn on the power switch on the controller or controllers.

30. Look at the LEDs on the controller to verify the controller is rebooting correctly. Figure 127 shows the locations of the LEDs. Table 58 describes the numbered locations identified in Figure 127.
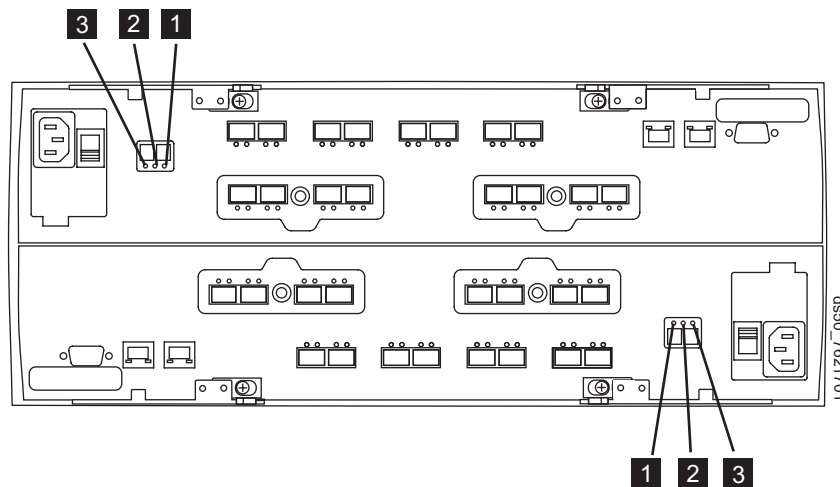
Figure 127. Controller Service Action LEDs

Table 58. Description of numbered locations in the figure that shows the controller Service Action LEDs

Number	Description
1	Controller Service Action Allowed LED (Blue)
2	Controller Service Action Required LED (Amber)
3	Numeric Display LED

The LEDs come on and go off intermittently for approximately 60 seconds (possibly longer) and the Numeric Display LED flashes various codes. After the Numeric Display LED displays a number that matches the previously recorded enclosure IDs, you are able to discover the controller through the DS Storage Manager software.

After the controller completes the boot process, a number appears in the Numeric Display LED. This number is the controller's enclosure ID, and it should match the enclosure ID in the Numeric Display LED on the other

(non-replaced) controller. If the numbers (enclosure IDs) are different, refer to *DS5000 Installation, User's, and Maintenance Guide* for troubleshooting information.

31. Look at the Service Action Required LED on the controller, and look at all of the controller enclosure's Service Action Required LEDs. Based on the LED status, perform one of these actions:

    - All of the Service Action Required LEDs are off, and the Subsystem Management window indicates an Optimal status – Go to step 34.

    - Any of the controller enclosure's Service Action Required LEDs is on – Check that the controller has been installed correctly. Reinstall the controller if necessary. Go to step 32.

32. Open the DS Storage Manager client and ensure that the storage subsystem is optimal. Redistributed LUNs if necessary. If your storage subsystem does not have an Optimal status, click the Recovery Guru toolbar button in the Subsystem Management window to determine if any other actions are required.

33. Did this action correct the problem?

    - Yes – Go to 34.

    - No – If the problem has not been resolved, contact IBM Support.

34. Remove the anti-static protection.

35. Check the status of all of the storage expansion enclosures in the storage subsystem configuration.

36. Does any component have a Needs Attention status?

    - Yes – Click the Recovery Guru toolbar button in the Subsystem Management window, and complete the recovery procedure. If the problem is not resolved, contact IBM Support.

    - No – Go to step 37.

37. Use the DS Storage Manager client to create, save, and print a new storage subsystem profile as well as collect and save all support data.

Replacing a power supply and fan unit

The power supply and fan unit is a component that includes both a 400-W power supply unit and two fans. The power supply and fan units provide power and cooling for the DS5100 or DS5300. The power supply and fan units are customer replaceable units (FRUs) 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 160.

The storage subsystem cooling system consists of two fans in each of the two power supply and fan units. 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 160.

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 48 hours to maintain redundancy and optimum cooling. Do not remove the failed power supply and fan unit from the DS5100 or DS5300 chassis 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 15 minutes to prevent any overheating due to the interruption to the air flow that cools the chassis.

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

Before you begin, ensure that you wear an anti-static wrist strap.

Use the following procedure to replace a power supply and fan unit. Each power supply and fan unit contains a power supply, cooling fan, battery charger, and temperature sensor. If any of these components fail, you must replace power supply and fan unit. The power supply, fan, battery charger, and temperature sensor are not individually replaceable components within the power supply and fan unit.

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. Use the DS Storage Manager client software to print a storage subsystem profile.
2. Locate the storage subsystem that contains the failed power supply and fan unit by checking the Overall Configuration Needs Attention LED on the front

bezel of the storage subsystem. (Figure 128 shows the location of the Overall Configuration Needs Attention LED on the front bezel.)
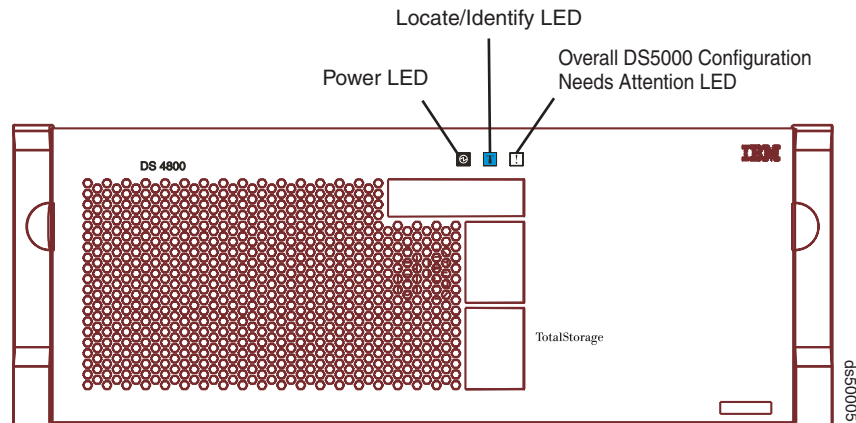

Figure 128. Overall Configuration Needs Attention LED on the DS5100 or DS5300 front bezel

3. Remove the front bezel by grasping the sides and pulling the cover toward you.
4. Locate the failed power supply and fan unit by checking that the power supply and fan unit Needs Attention LED that is turned on. (Figure 129 shows the LEDs on the power supply and fan unit.)
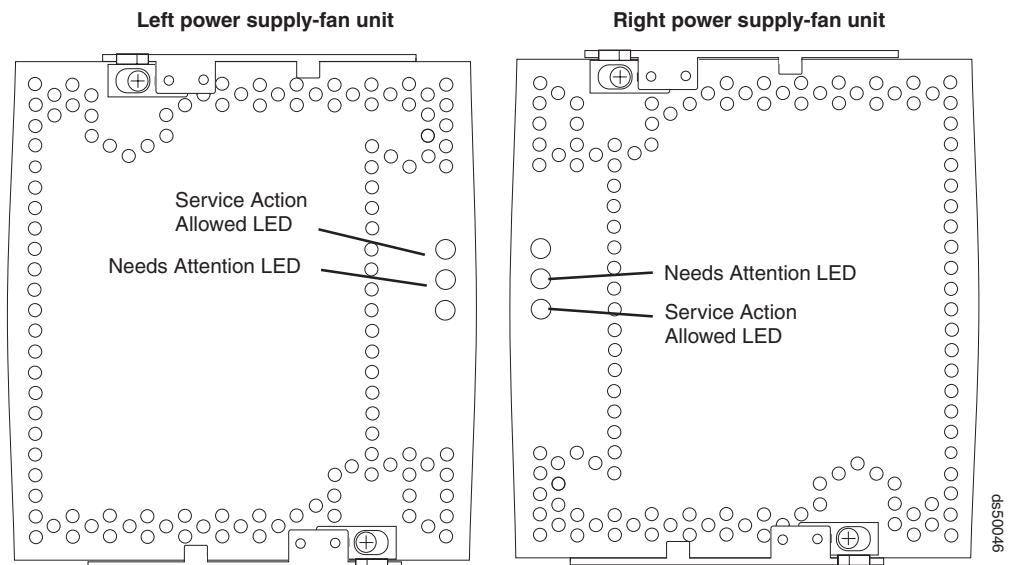
Figure 129. Power supply and fan unit LEDs

> **Attention:** Never remove a power supply and fan unit unless the Service Action Allowed status LED is turned on.

5. Is the Service Action Allowed status LED turned on? (Figure 129 shows the location of the Service Action Allowed status LED on the power supply and fan unit.)
    *   Yes – Go to step 6 on page 208.
    *   No – Another component requires attention before you can remove the power supply and fan unit. Normally, this indicates that a RAID controller is either powered off or failed. Ensure that both RAID controllers are optimal. If

the Service Action Allowed status LED of the failed power supply and fan unit is not lit when both RAID controllers are optimal, contact your IBM support representative.

Attention: Electrostatic discharge can damage sensitive components. Touching the storage subsystem or its components without using a proper ground might damage the equipment. To avoid damage, use proper anti-static protection while handling any components.

6. Put on anti-static protection.
7. Unpack the new power supply and fan unit.

   Save all packing materials in the event you need to return the new power supply and fan unit.
8. Apply the appropriate label to the LED column for the replacement power supply and fan unit. The labels and instructions are included with the replacement power supply and fan unit. Make sure that the labels are aligned properly and do not cover any LEDs.
9. Unlatch the top and bottom levers on the failed power supply and fan unit. Rotate both levers out simultaneously and remove the failed power supply and fan unit. (Figure 130 shows a power supply and fan unit sliding from the storage subsystem chassis.)
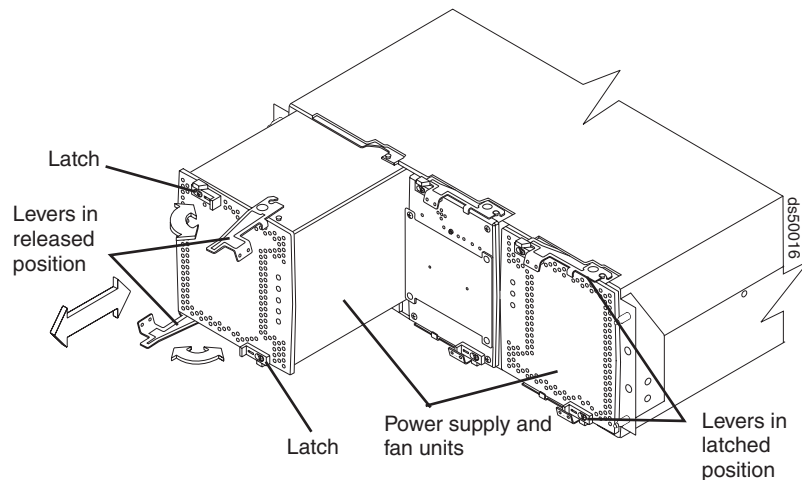

Figure 130. Removing a power supply and fan unit from the DS5100 or DS5300

10. Install the new power supply and fan unit.
   a. Carefully position the power supply and fan unit in the storage subsystem chassis. The power supply and fan unit has a relief formed along one long edge of the component. The component relief fits onto a rail cast into the storage subsystem chassis. Ensure that the component relief fits onto the rail before attempting to slide the controller into the storage subsystem chassis.
   b. With the left and right levers rotated out perpendicular to the face of the power supply and fan unit, slide the back of the power supply and fan unit into the appropriate slot.
   c. Holding both levers, slowly push the power supply and fan unit until the notches in both the left and right levers are aligned with the pins on the DS5100 or DS5300 enclosure so that the power supply and fan unit is pulled evenly into the DS5100 or DS5300 chassis, ensuring full electrical connection contact on all interface pins.

Attention: Verify that the power supply and fan unit does not snag any other DS5100 or DS5300 cables when you slide it into the bay.

   d. Press the power supply and fan unit fully into the slot, engaging the pins on the enclosure.

   e. Hold open both latches and push both left and right levers simultaneously to the closed position. Release the latches. When you release the latches, you should hear both latches snap over the levers, indicating that the power supply and fan unit is locked in place.

11. Wait up to 5 minutes for the DS Storage Manager client software to recognize the new power supply and fan unit.

12. Complete any remaining Recovery Guru procedures for power supply and fan unit replacement, if needed.

13. Did this correct the problem?
    - Yes – Go to step 14.
    - No – Verify the following:
        - Both power supply and fan unit switches on the back of the storage subsystem are turned on.
        - The circuit breaker for the electrical outlet that connects to has not been tripped.
        - The circuit breaker in the RAID controller that the power supply and fan unit is linked to has not been tripped. (The right power supply and fan unit is linked to controller A; the left power supply and fan unit is linked to controller B.) See "Resetting the controller circuit breakers" on page 181.

    If the problem persists after you have checked the above, contact your IBM service representative.

14. Remove the anti-static protection.

15. Install the front bezel by aligning the pins on the storage subsystem chassis with the spring-steel retainers on the cover, and then press the cover toward the chassis until the pins snap into place.

16. Use the DS Storage Manager Subsystem Management window to check the status of components in the storage subsystem.

17. Do any storage subsystems have a fault (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 your IBM service representative.
    - No – Go to step 18.

18. Use the DS Storage Manager client software to print a new storage subsystem profile.

Replacing the interconnect-battery unit

Use the following procedure to replace the interconnect-battery unit.

Attention:

Never remove the interconnect-battery unit unless directed to do so by an IBM service representative. In addition, do not replace the interconnect-battery unit in any of the following situations:
- The controller A is not in optimal state.
- The FC paths from the hosts to the host ports in controller A are not optimal.

- The drive paths from controller A to the storage expansion enclosures are not optimal.
- The right power supply and fan unit is not powered on or not optimal.

The reason not to replace the interconnect-battery unit in any of the above situations is because controller A is the designated controller to receive all I/Os when the interconnect-battery unit is removed from the storage subsystem. Use the DS Storage Manager client Subsystem Management window and the appropriate SAN monitoring tools to ensure that there are no problems with controller A or with the connection from the host to controller A.

Also note that LUN Failover between controllers is disabled during this procedure because controller B must be placed offline before the interconnect-battery unit is removed from the storage subsystem. It is best practice to perform the interconnect-battery unit replacement procedure during off-peak I/O traffic hours.

Before removing the interconnect-battery unit, you *must* use the DS Storage Manager client to place controller B offline. Controller A must display Optimal status before removing the interconnect-battery unit. Do *not* remove the interconnect-battery unit if controller A does not display Optimal status.

Electrostatic discharge can damage sensitive components. Touching the storage subsystem or its components without using a proper ground might damage the equipment. To avoid damage, use proper anti-static protection while handling any components. While you replace the battery unit, make sure that the power supply is not switched off for more than 15 minutes. If the power supply is off for more than 15 minutes, it may result in overheating of the chassis.

1. Locate the failed interconnect-battery unit by checking the Overall Configuration Needs Attention LED on the front bezel of the storage subsystem. (Figure 131 shows the location of the Overall Configuration Needs Attention LED on the front bezel.)
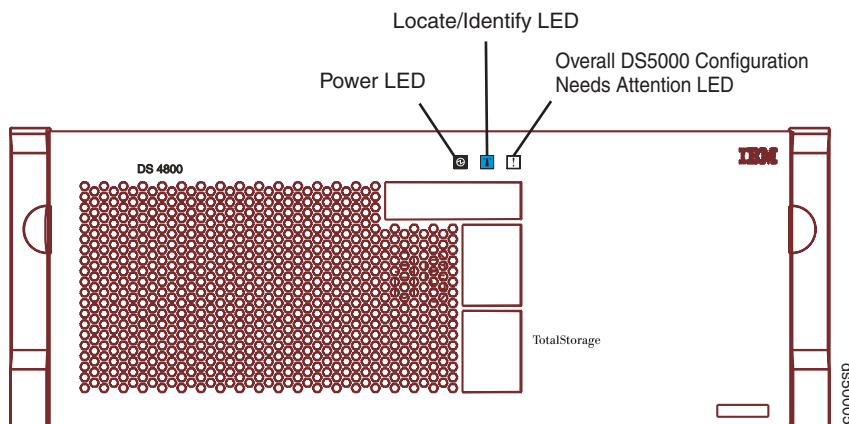

Figure 131. Overall Configuration Needs Attention LED on the DS5100 or DS5300 front bezel

2. Use the DS Storage Manager client to place controller B offline.

   Attention: Controller A must display Optimal status before removing the interconnect-battery unit. Do *not* remove the interconnect-battery unit if controller A does not display Optimal status.

3. Remove the front bezel by grasping the sides and pulling the cover toward you.

Attention: Never remove a power supply and fan unit unless the Service Action Allowed status LED is turned on.

4. Is the Service Action Allowed status LED turned on? (Figure 132 shows the location of the Service Action Allowed status LED on the interconnect-battery unit.)

   • Yes – Go to step 5.

   • No – Make sure that the right power supply and fan unit is connected, powered on, and in optimal state.

   If the right power supply and fan unit is connected, powered on, and in optimal state and Service Action Allowed status LED remains unlit, run the Recovery Guru to determine what other components might require attention. If the Recovery Guru does not indicate any other component problems, contact your IBM support representative.
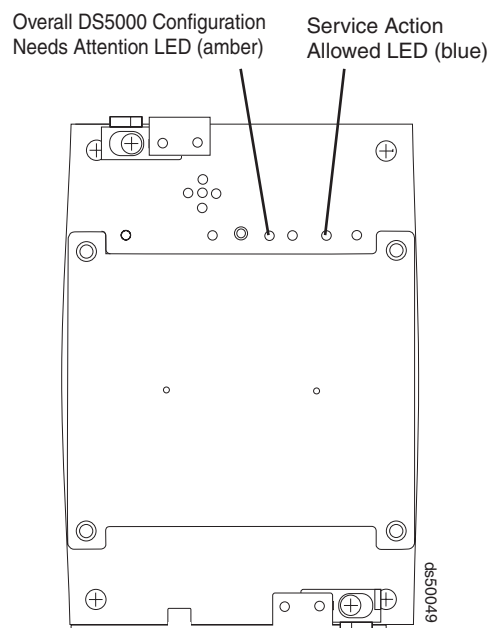

Figure 132. Interconnect-battery unit Needs Attention and Service Action Allowed LEDs

5. Put on anti-static protection.

6. Unpack the interconnect-battery unit.

   Save all packing materials in the event you need to return the new interconnect-battery unit.

7. Unlatch both the top and bottom levers of the interconnect-battery unit and rotate both levers straight out simultaneously to remove the failed interconnect-battery unit. (Figure 133 on page 212 shows the interconnect-battery unit sliding from the storage subsystem chassis.)
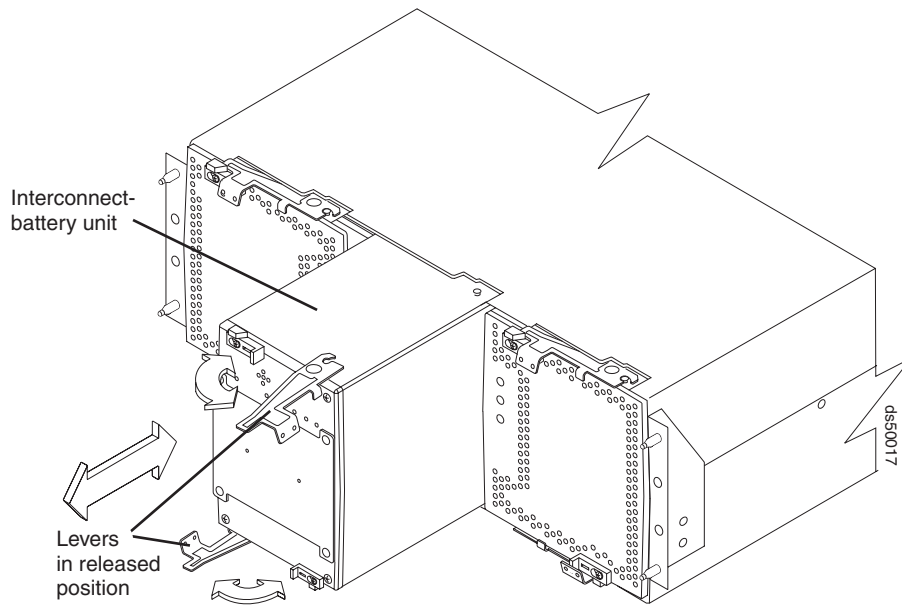
Figure 133. Removing an interconnect-battery unit from the DS5100 or DS5300

8. Remove both battery packs from the failed interconnect-battery unit and replace the battery packs in the replacement interconnect-battery unit. See "Replacing a backup battery pack" on page 213 for instructions on how to remove and replace the battery packs from an interconnect-battery unit.

9. Install the new interconnect-battery unit by performing the following steps:

   a. Carefully position the interconnect-battery unit in the storage subsystem chassis.

   The interconnect-battery unit has a pin on the connector end of the component. The pin fits onto a relief cast into the storage subsystem chassis. (You can see the relief by peering into the slot for the interconnect-battery unit.) Ensure that the interconnect-battery unit pin is aligned with the relief in the storage subsystem chassis before attempting to slide the interconnect-battery unit into the storage subsystem chassis.

   b. With the top and bottom levers rotated out perpendicular to the face of the interconnect-battery unit, slide the back of the unit into the appropriate slot.

   c. Holding both levers, slowly push the interconnect-battery unit until the notches in both the left and right levers are aligned with the pins on the DS5100 or DS5300 enclosure so that the interconnect-battery unit is pulled evenly into the DS5100 or DS5300 chassis, ensuring full electrical connection contact on the interface pin.

   Attention: Verify that the interconnect-battery unit does not snag any other DS5100 or DS5300 cables when you slide it into the bay.

   d. Press the interconnect-battery unit fully into the slot, engaging the pins on the enclosure.

   e. Hold open both latches and push both left and right levers simultaneously to the closed position. Release the latches. When you release the latches, you should hear both latches snap over the levers, indicating that the interconnect-battery unit is locked in place.

10. Wait up to 5 minutes for the DS Storage Manager client software to recognize the new interconnect-battery unit.

11. Use the DS Storage Manager client to place controller B online.
12. Complete any remaining Recovery Guru procedures for interconnect-battery unit replacement, if needed.
13. Did this correct the problem?
    - Yes – Go to step 14.
    - No – If the problem has not been fixed, contact your IBM service representative.
14. Remove the anti-static protection.
15. Install the front bezel by aligning the pins on the storage subsystem chassis with the spring-steel retainers on the cover and then press the cover toward the chassis until the pins snap into place.
16. Use the Subsystem Management window to check the status of all components in the storage subsystem.
17. Do any storage subsystems have a fault (Needs Attention) status?
    - Yes – Select the Recovery Guru toolbar button in the DS Storage Manager Subsystem Management window, and complete the recovery procedure. If the problem persists, contact your IBM support representative.
    - No – Go to step 18.
18. Use the DS Storage Manager client software to print a new storage subsystem profile.

Replacing a backup battery pack

Use the following procedure if the DS Storage Manager client instructs you to replace the battery because the current battery has failed. You can also use the DS Storage Manager client to check the status of the battery. Because write-caching is disabled when either one of the backup battery packs fail, it is best practice to replace the failed battery pack as soon as possible to minimize any impact due to the disabling of the write-caching function.

Replace only the battery pack that is indicated as failed by the LEDs. You do not need to replace both battery packs when the Battery LEDs indicate that only one battery pack has failed.

Note: Unlike the batteries for other DS Storage Subsystems, the Storage Subsystem battery packs do not have set expiration dates. Do not replace these batteries after a certain usage period.

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 189.

Before you begin, ensure that you wear an anti-static wrist strap.

Use the following procedure to replace a backup battery pack in the interconnect-battery unit:
1. Use the DS Storage Manager client software to print a storage subsystem profile.
2. Locate the storage subsystem that contains the interconnect-battery unit with the failed battery by checking the Overall Configuration Needs Attention LED on the front bezel of the storage subsystem. (Figure 134 on page 214 shows the location of the Overall Configuration Needs Attention LED on the front
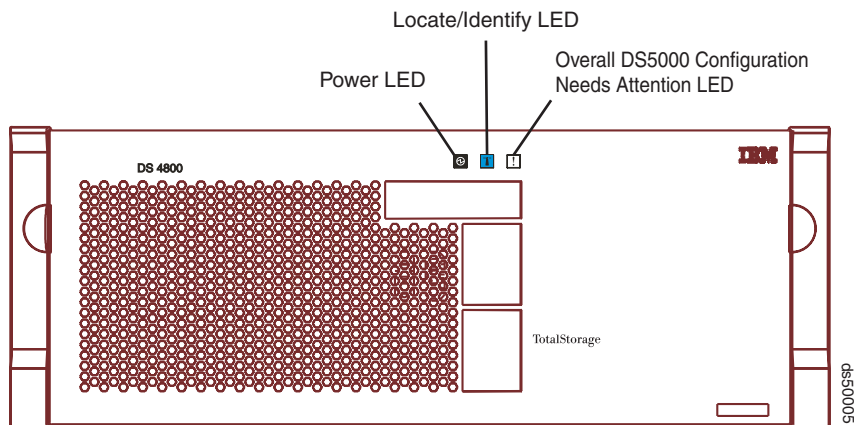
bezel.)

Locate/Identify LED

Overall DS5000 Configuration
Needs Attention LED

Power LED

Figure 134. Overall Configuration Needs Attention LED on the DS5100 or DS5300 front bezel

3. Remove the front bezel by grasping the sides and pulling the cover toward you.

4. Check the LEDs on the power supply and fan units to determine which of the two battery packs has failed. (See Figure 117 on page 188.) Replace only the battery pack that is indicated as failed by the LEDs.

5. Unpack the new battery pack. Set the new battery pack on a dry, level surface.

   Save all packing materials in the event you need to return the new battery pack.

6. Remove the battery access cover from the front of the interconnect-battery unit by removing the thumb screws that secure the cover to the component. Figure 135 on page 215 shows the access cover and mounting screws on the interconnect-battery unit.
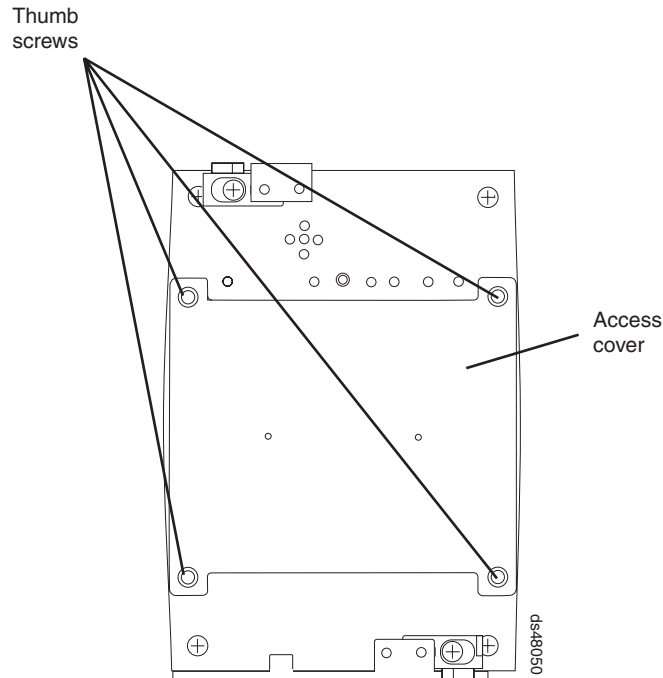
Thumb screws

Access cover

ds48050

Figure 135. Battery access cover on the interconnect-battery unit

7. Remove the failed battery pack by sliding it out of the interconnect-battery unit.

   Note: There are two battery packs in the interconnect-battery unit. The right and left Battery Needs Attention LEDs on the interconnect-battery unit correspond to each of the two battery packs. Be sure to remove the failed battery, as indicated by the lit amber Battery Needs Attention LED.

   The battery pack is mounted to a sheet metal bracket. The sheet metal bracket has a flange formed on the end of the bracket closest to the access in the interconnect-battery unit. Grasp the flange to slide the battery pack from the interconnect-battery unit.
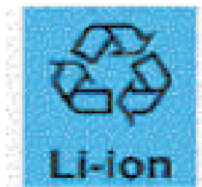
CAUTION:
This product contains a sealed Lithium Ion battery. Discharged Lithium and Lithium Ion batteries are currently designated to be disposed of in normal trash. However, users should contact their municipal waste disposal facility prior to discarding any used battery in normal trash. Alternatively, IBM recommends users may return Lithium, Lithium Ion and Lithium Ion battery packs to IBM for recycling.

In the United States, IBM has established a collection process for reuse, recycling, or proper disposal of used IBM Lithium, Lithium Ion and Lithium Ion battery packs. For information on proper disposal of these batteries, please contact IBM at 1-800-426-4333. Please have the IBM part number listed on the battery available prior to your call.

For information on disposal of sealed Lithium Ion batteries outside the United States, go to http://www.ibm.com/ibm/environment/products/ batteryrecycle.shtml or contact your local waste disposal facility.

8. Install the replacement battery pack. Carefully position the battery pack to ensure that the battery pack will slide correctly into the interconnect-battery unit. The flat side of the battery pack should face towards the outside of the chassis. Make sure that the battery bracket slides properly into the slots for the battery. Slide the battery pack into the interconnect-battery unit. Push the battery pack firmly into the interconnect-battery unit to ensure that the battery pack completely engages with the connectors in the interconnect-battery unit.

9. Reinstall the battery access cover onto the front of the interconnect-battery unit.

10. Once you have replaced the battery pack, you must reset the battery age through the DS Storage Manager client, by performing these three steps:
    - First, you must select the **Controller enclosure components** icon in the Physical View of the Storage Manager client. The Controller enclosure components dialog will be displayed.
    - Next, you must select the **Batteries** icon, and then select **Reset**. You will be asked to Confirm Reset. Select **Yes** to confirm that you want to reset the battery age.
    - Now, the battery age clock is reset to 0.

11. Remove the anti-static protection.

12. Install the front bezel by aligning the pins on the storage subsystem chassis with the spring-steel retainers on the cover and then press the cover toward the chassis until the pins snap into place.

13. Use the Subsystem Management window to check the status of all components in the storage subsystem.

14. Do any storage subsystems have a fault (Needs Attention) status?
    - Yes – Select the Recovery Guru toolbar button in the DS Storage Manager Subsystem Management window, and complete the recovery procedure. If the problem persists, contact your IBM service representative.
    - No – Go to step 15.

15. Use the DS Storage Manager client software to print a new storage subsystem profile.

    Note: Note that it might take from 15 minutes to a few hours for a new battery to become fully charged. The DS Storage Manager client will show the battery as charging until it is fully charged. Controller caching is automatically disabled until the new battery becomes fully charged.

16. After 24 hours, check the Needs Attention and Battery LEDs to ensure that the battery is working properly.

    If the replacement battery indicates a fault, contact your IBM support representative.

Replacing a SFP module

Use the following procedure to replace a SFP module in a controller. The SFP module shown in this procedure might look different from those you are using, but the difference does not affect SFP module performance.

Electrostatic discharge can damage sensitive components. To prevent electrostatic discharge damage to the storage subsystem, use proper anti-static protection when handling the DS5100 or DS5300 components.

Attention: Removing a SFP module that has not failed can cause data loss. To prevent data loss, remove only the SFP module that has a Bypass LED on or that displays a failed status in the DS Storage Manager client software.

Before you begin, ensure that you wear an anti-static wrist strap.

1. Use the DS Storage Manager client software to print a new storage subsystem profile.
2. Locate the storage subsystem that has the failed SFP module by checking the Overall Configuration Needs Attention LED on the front bezel of the storage subsystem. (Figure 136 shows the location of the Overall Configuration Needs Attention LED on the front bezel.)
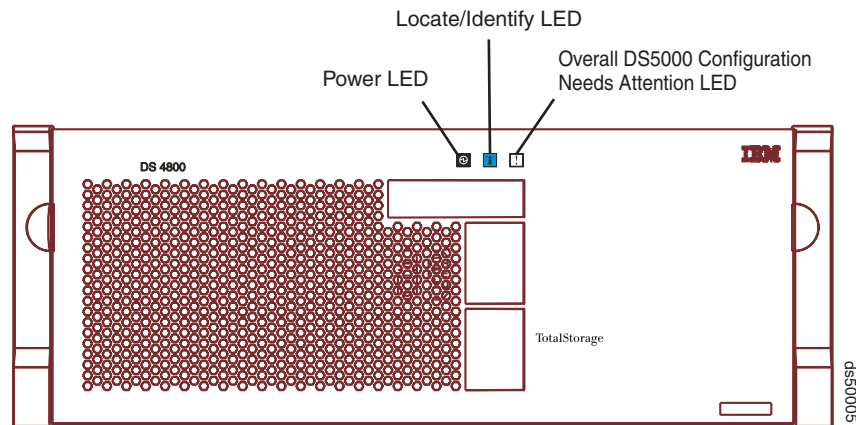

Figure 136. Overall Configuration Needs Attention LED on the DS5100 or DS5300 front bezel

3. Locate the failed SFP module by checking the SFP Bypass LED and Needs Attention LED on the controllers. If a fault is detected, the LEDs are lit. Figure 137 on page 218 shows the location of the controller SFP Bypass LED and Needs Attention LED on the controller.
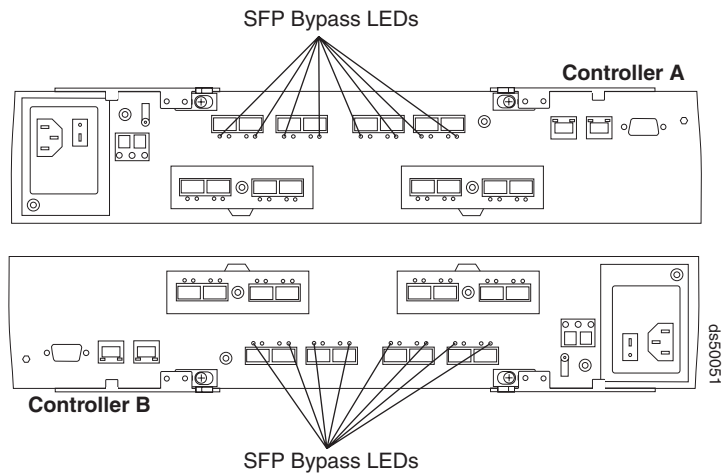
Figure 137. Needs Attention and SFP Model Bypass LEDs

4. Put on anti-static protection.

5. Unpack the new SFP module. Verify that it is the same type of module you are replacing. Save all packing materials in the event you might need to return the new SFP module.

   Attention: Handle and install fiber-optic cables properly to avoid degraded performance or loss of communications with devices. For specific handling guidelines, see "Handling fibre-optic cables" on page 50.

6. Disconnect the interface cable from the SFP module. (Figure 138 shows the SFP module, interface cable, and the rear of a controller.)
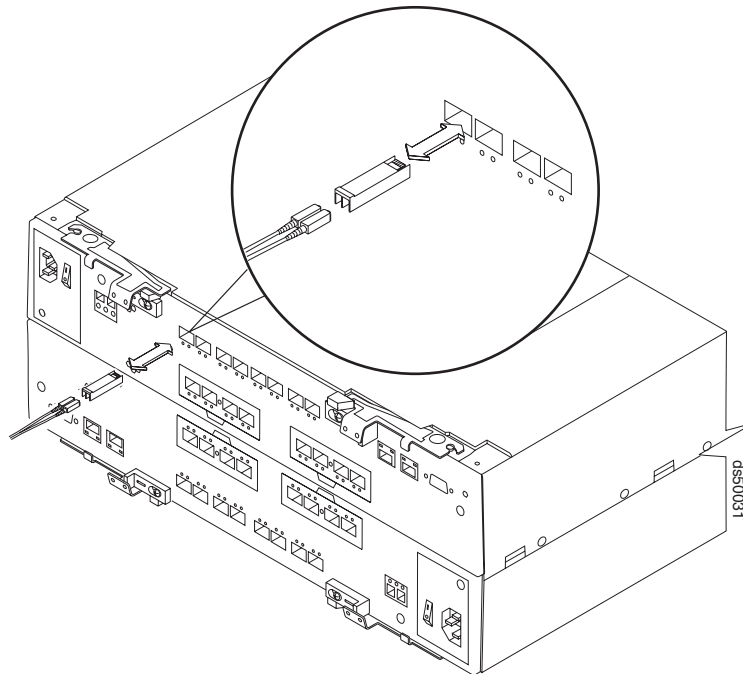

Figure 138. Replacing a SFP or SFP+ module

7. Remove the failed SFP module from the controller.

8. Install the new SFP module into the controller.

9. Reconnect the interface cable.

10. Check the Bypass and Needs Attention LEDs for the new SFP module.

Based on the status of the Bypass and Needs Attention LEDs, choose one of the following steps:

- Bypass LED or Needs Attention LED is illuminated – The SFP module and cables might be installed incorrectly, or the cable might not be securely connected. Reinstall the SFP module and cable, check the cable connection, and then go to step 11.
- Bypass LED and Needs Attention LED are off – Go to step 12.

11. Is the problem corrected?

- Yes – Go to step 12.
- No – Contact your IBM support representative.

12. Remove the anti-static protection.

13. Use the DS Storage Manager Subsystem Management window to check the status of all components in the storage subsystem.

14. Do any storage subsystems have a Needs Attention (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 your IBM service representative.
- No – Go to step 15.

15. Use the DS Storage Manager client software to print a new storage subsystem profile.

Replacing a SFP+ module

Before you begin, ensure that you wear an anti-static wrist strap.

Use the following procedure to replace a SFP+ module in a controller.

Note: A SFP+ module looks the same as a SFP module, so the module type must be identified by the FRU part number. Ensure that the FRU part number on the new SFP+ module is correct for the failed 10GbE SFP+ module that is to be replaced.

Electrostatic discharge can damage sensitive components. To prevent electrostatic discharge damage to the storage subsystem, use proper anti-static protection when handling the DS5100 or DS5300 components.

Attention: Removing a SFP+ module that has not failed can cause data loss. To prevent data loss, remove only the SFP+ module that has a port Link LED that is unlit, or that displays a failed status in the DS Storage Manager client software.

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

2. Locate the storage subsystem that has the failed SFP+ module by checking the Overall Configuration Needs Attention LED on the front bezel of the storage subsystem. (Figure 136 on page 217 shows the location of the Overall Configuration Needs Attention LED on the front bezel.)

3. Locate the failed SFP+ module by checking the SFP+ port Link LED on the 10 Gbps iSCSI Host Interface Card and the Needs Attention LED on the controllers. If a fault is detected, the SFP+ port Link LED is unlit and the Needs Attention LED is lit.

Note: Before replacing the SFP+ module in the 10 GbE HIC port, it is best practice to confirm that the SFP+ module is bad by analyzing it with an optical loopback. *With an optical loopback inserted*, observe the status of the SFP+ port Link LED and perform the following checks:

- If the SFP+ port Link LED is unlit, the 10 Gbps SFP+ module is bad and should be replaced.
- If the SFP+ port Link LED is lit, verify that the port is connected to an active 10 Gb Ethernet switch port, and that the problem is not caused by another component or connection in the link. For example, verify the following conditions:
  - The cable is plugged in at the switch port.
  - The SFP+ module is correctly inserted in the switch port.
  - The switch port is enabled.

Figure 137 on page 218 shows the location of the controller SFP+ port Link LED and Needs Attention LED on the controller.

4. Unpack the new SFP+ module. Verify that it is the same type of module you are replacing by comparing the Part Number information on the labels that are attached to the new and failed SFP+ modules. Save all packing materials in the event you might need to return the new SFP+ module.

   Attention: Handle and install fiber-optic cables properly to avoid degraded performance or loss of communications with devices. For specific handling guidelines, see "Handling fibre-optic cables" on page 50.

5. Disconnect the interface cable from the SFP+ module. (Figure 138 on page 218 shows the SFP+ module, interface cable, and the rear of a controller.)

6. Remove the failed SFP+ module from the controller.

7. Install the new SFP+ module into the controller.

8. Reconnect the interface cable.

9. Check the Link and Needs Attention LEDs for the new SFP+ module and the controller.

   Based on the status of the Link and Needs Attention LEDs, choose one of the following steps:

   a. 10 GB HIC port link LED is unlit or Needs Attention LED is lit – The SFP+ module and cables might be installed incorrectly, the cable might not be securely connected, or the cable is faulty. Reinstall the SFP+ module and *with an optical loopback inserted*, observe the status of the 10 GB HIC port link LED and choose one of the following steps:

      - If the 10 GB HIC port link LED is unlit, the new SFP+ module might not be the correct type, or is faulty. Check and order the new SFP+ module as appropriate.
      - If the 10 GB HIC port link LED is lit, another component in the link is faulty. Check the cable connection and the switch port status of the SFP+ module, then go to step 10.

   b. 10 GB HIC Port Link LED is lit and Needs Attention LED is unlit – Go to step 11.

10. Is the problem corrected?

    - Yes – Go to step 11.
    - No – Contact your IBM support representative.

11. Remove the anti-static protection.

12. Use the DS Storage Manager Subsystem Management window to check the status of all components in the storage subsystem.

13. Do any storage subsystems have a Needs Attention (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 your IBM service representative.
    - No – Go to step 14.
14. Use the DS Storage Manager client software to print a new storage subsystem profile.

Installing SFPs and fiber-optic cables

Each RAID controller unit has single-ported host channels and dual-ported drive channels. SFPs are inserted into the ports, and then fibre-channel cables are connected to the SFPs.

For information on installing SFPs and fiber-optic cables, see "Working with SFPs, SFP+s, and fiber-optic cables" on page 49.

Removing and disposing of the lithium batteries

When you disassemble the storage subsystem for disposal, use the information in this section to locate, remove, and dispose of the lithium batteries that are on the system boards in Controller A and Controller B.

Statement 2:

CAUTION:
When replacing the lithium battery, use only an equivalent type battery recommended by the manufacturer. If your system has a module containing a lithium battery, replace it only with the same module type made by the same manufacturer. The battery contains lithium and can explode if not properly used, handled, or disposed of.

Do not:
- **Throw or immerse into water**
- **Heat to more than 100°C (212°F)**
- **Repair or disassemble**

**Dispose of the battery as required by local ordinances or regulations.**

Before you begin, ensure that you wear an anti-static wrist strap.

To remove the batteries for disposal, complete the following steps:

1. Locate the battery compartment on the system board in Controller A.

   Notes:

   a. The top of the battery compartment is labeled "Li", and the compartment is located near the end of the controller system board with the external host connectors.

   b. If a Fibre channel or iSCSI host interface daughter card is installed on the controller, you must remove the card to gain access to the battery compartment.

2. Insert the flat blade of a small screwdriver into the slot on the battery-compartment cover.
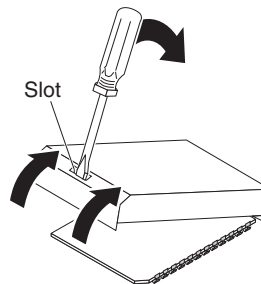
3. Move the screwdriver as shown in the illustration until the cover is released from the battery-compartment base.

4. Lift the contact tab; then, slide the battery out of the battery compartment.
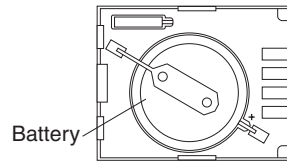
Battery

5. Repeat Steps 1 through 4 to locate and remove the lithium battery in Controller B; then, continue with Step 6.
6. Dispose of the batteries as required by local ordinances or regulations.

   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 batteries. For information on proper disposal of these batteries, contact IBM at 1-800-426-4333.

Replacing the cache memory DIMM

Before you replace/install cache memory DIMM or cache backup memory device, you must remove the controller. The following procedure lists steps to remove the controllers.

Note: Before you remove the controllers, make sure that you set controller A to Offline, as described in the following steps, to ensure that all the data currently in the cache for controller A is successfully written to disk prior to the upgrade. This step also ensures that the data currently in the cache for controller B is successfully written to disk before you turn off the power to both controllers.

Attention: To prevent electrostatic discharge damage to the enclosure, use proper anti-static protection when handling enclosure components.

1. Do one of the following to gather support data about your updated storage subsystem:
   - Use the IBM DS Storage Manager to collect and save a support bundle of your storage subsystem. From the Subsystem Management Window toolbar, select **Monitor > Health > Collect Support Data**. Specify a location on your system where you want to save the support bundle.
   - From the Command Line Interface, run the `save storageArray supportData` command to gather comprehensive support data about the storage subsystem. For more information about this command, refer to the *IBM System Storage DS3000, DS4000, and DS5000 - Command Line Interface and Script Commands Programming Guide* . Running this command can temporarily impact performance on your storage subsystem.
2. Use the Locate function in the IBM DS Storage Manager to identify the controllers to upgrade.
3. Put on anti-static protection.
4. Label each host interface cable, drive interface cable, and Ethernet cable that is attached to each controller so that you can reconnect the cables correctly after the controllers are reinstalled.

Attention: To prevent degraded performance, do not twist, fold, pinch, or step on the fiber-optic cables. Do not bend the fiber-optic cables tighter than a 5-cm (2-in.) radius.

5. Stop all host I/O operations.

6. Do one of the following to take controller A offline.

   - From the Hardware pane in the Subsystem Management Window, right-click the picture of the controller you want to take offline, and then select **Advanced > Place > Offline.**

   - From the Command Line Interface, run the following command:

   ```
   smCLI <DNS-network-name-or-IP-address> -c "set controller [(a | b)]
   availability=offline"
   ```

   This command ensures that all the data currently in cache on both controllers is successfully written to disk prior to the upgrade and ensures that no data is stored on the cache backup memory devices.

   Attention: Wait for the blue Controller Service Action Allowed LED on controller A to come on before you turn off the power to either controller; otherwise, possible data loss or corruption might occur.

7. Wait for the Controller Service Action Allowed LED to come on.

8. Turn off the Power switch on both of the controllers.

9. Wait until all LEDs and seven-segment display activity on the rear of the controller enclosure stop, and then unplug the power cords from both controllers, and set the power cords aside.

10. Disconnect all of the following cables from both controllers.

    - Host interface cables
    - Drive interface cables
    - Ethernet cables

11. Remove both controllers from the controller enclosure.

    a. Unlock and rotate the release handles out, to release the controller.

    b. Using the release handles and your hands, pull the controller out of the controller enclosure.

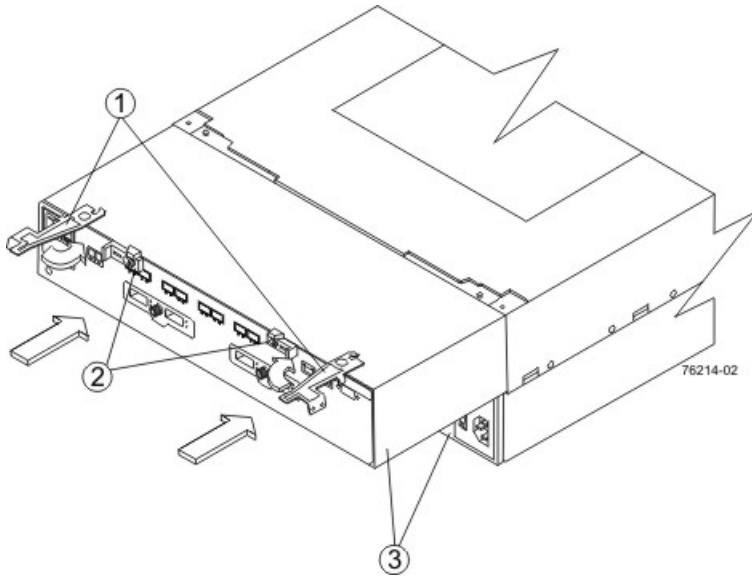   c. Set the controller on a flat, static-free surface with the thumbscrews that secure the top cover facing up.

Figure 139. Removing a controller

1- Release handle 2 - Locking mechanism 3 - Controller

12. Remove the cover on both controllers.

    a. Loosen the thumbscrews that secure the cover to the controller.
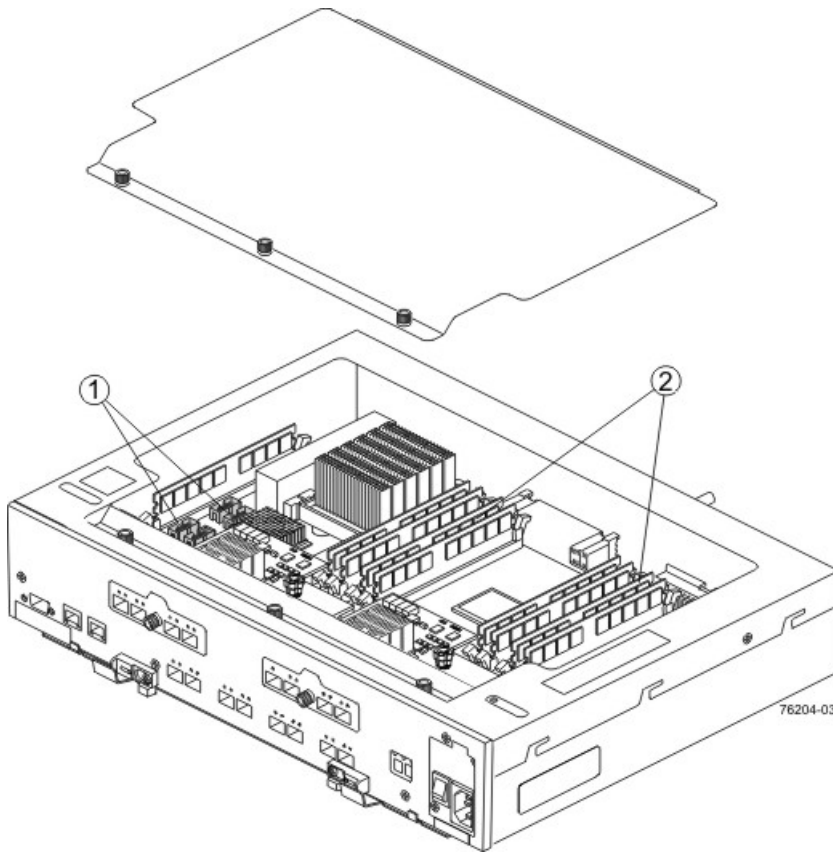
    b. Lift the cover off of the controller.

Figure 140. Controller top cover, internal parts, and faceplate

1 - cache backup memory device slot Locations 2 - cache memory DIMM slot Locations

13. Go to "Upgrading / Replacing a cache backup memory device in the controller" on page 228.

Upgrading / Replacing a cache memory DIMM in the controller

If you are upgrading the cache memory DIMMs in one controller, you must increase the capacity of the cache memory DIMMs in the other controller in the controller enclosure. You also must increase the capacity of the cache backup memory devices in both controllers.

Make sure that the size of the cache memory DIMMs that you are upgrading in both controllers are of equal capacity. The following table lists the cache memory DIMM configurations.

Table 59. cache memory DIMM configurations

Total cache memory per Controller (GB)	Number of cache memory DIMMs per Controller	Capacity of Each cache memory DIMM (GB)	Cache DIMM Slots Populated
4	4	1	2, 4, 5, 7
8	8	1	All
16	8	2	All
32	8	4	All

1. Locate the cache memory DIMMs that you want to upgrade, or identify the location to add the new cache memory DIMMs.
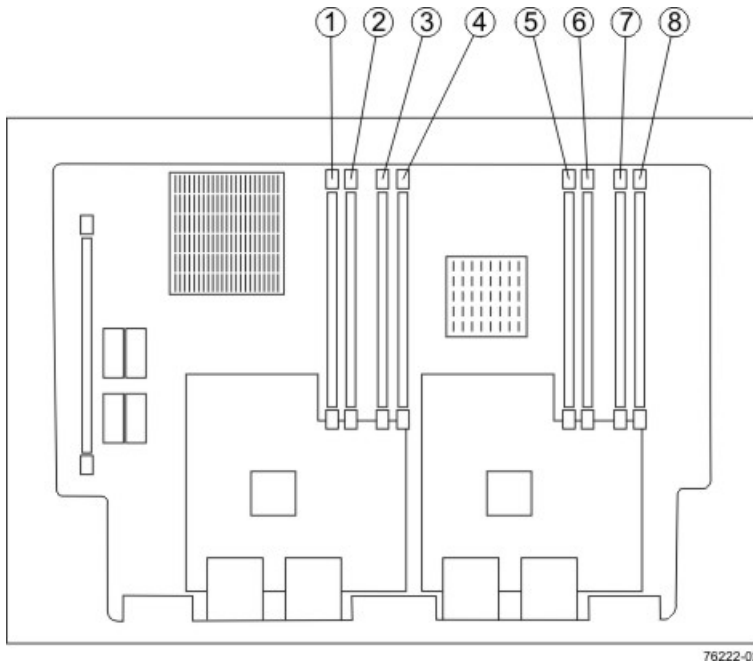

Figure 141. Numbers indicate cache memory DIMM locations

2. If you are adding an cache memory DIMM go to step 4. Go to the next step if you are upgrading a cache memory DIMM.
3. Remove the cache memory DIMMs from their slots on the controller card .
   a. Pull back on each ejector handle to disengage the cache memory DIMM pins from the slot on the controller card.
   b. Lift the cache memory DIMM out of the slot.
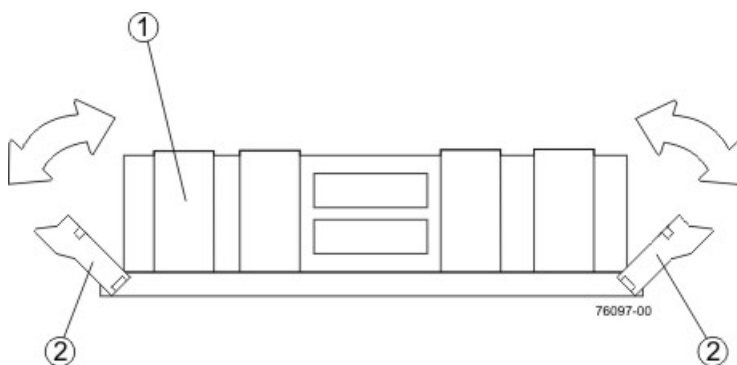   c. Place the cache memory DIMM that you removed on an a flat, static-free surface.

Figure 142. Removing a cache memory DIMM

1 - cache memory DIMM 2 - Handles
4. Install the new cache memory DIMM.
   a. Align the new cache memory DIMM in the slot.
   b. Gently push down on the cache memory DIMM to seat the pins into the slot.

The ejector handles rise up as the cache memory DIMM is inserted into the slot. When these handles are in the vertical position, the cache memory DIMM is fully engaged and is locked in place.

5. Repeat this procedure for the other controller.

6. Go to Upgrading a cache backup memory device in the Controller.

Upgrading / Replacing a cache backup memory device in the controller

The cache backup memory device provides a backup for the cache memory DIMM. The size of the cache backup memory device must equal the capacity of the cache memory DIMM. You must increase the size of the cache backup memory device in both controllers. The following table lists the cache backup memory device configurations..

Table 60. cache backup memory device configurations

Total cache backup memory device per Controller (GB)	Number of cache backup memory devices per Controller	Capacity of each cache backup memory device (GB)	Cache backup memory device slots populated
4	1	4	USB 3
8	2	4	USB 3, USB 4
16	4	4	All
32	4	8	All

1. Locate the cache backup memory device that you want to upgrade, or identify the location to add the new cache backup memory device.
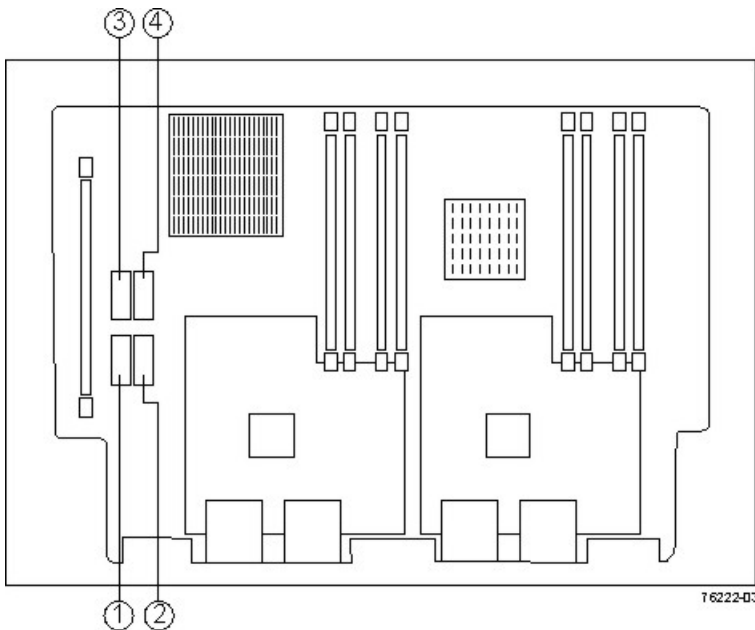

*Figure 143. Numbers indicate cache backup memory device Locations*

2. If you are installing a new cache memory device, go to step 4 on page 229. Go to the next step if you are upgrading a device.

3. Remove the cache backup memory device from the connector on the controller card.

   a. Gently pull back on the latch that secures one edge of the cache backup memory device to the connector on the controller card.

   b. Lift the cache backup memory device from the connector.

4. Install the new cache backup memory device.

   a. Carefully align the cache backup memory device with the connector on the controller card so that the pins do not bend when you install the cache backup memory device.

   b. Install the cache backup memory device into an empty socket location by gently pressing down on the cache backup memory device until it snaps into place.

5. Repeat this procedure for the other controller and reinstall the controller in the enclosure.

Reinstalling the controller in the enclosure

1. Reinstall the top covers on both controllers, and tighten all of the thumbscrews that secure the top cover.

2. Slide both controllers all of the way into the controller enclosure. Rotate the release handles in, to lock each controller into place.

3. Reconnect the following cables to the appropriate ports on both controllers.

   • Ethernet cables

   • Host interface cables

   • Drive interface cables

4. Plug in the power cords to both of the controllers.

5. Turn on the Power switches on both of the controllers. Controller B comes up in Write-Through mode. Controller A comes up in an Offline state.

6. Bring controller A online. In the Subsystem Management Window, right-click the controller, and then select **Advanced > Place > Online**, or use the following CLI command.

   `set controller [a] availability=online;`

7. Check the LEDs on the controller to ensure that the controllers are rebooting correctly.
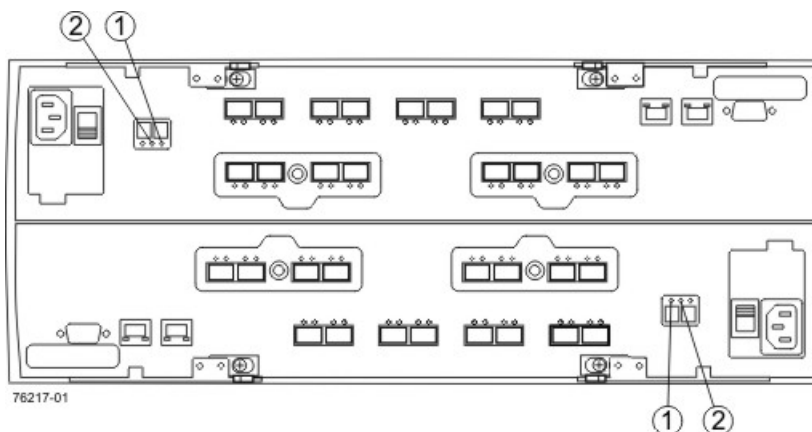
1. Controller Service Action Allowed LED (Blue) 2. Controller Service Action Required LED (Amber)
Figure 144. Controller Service Action LEDs

The LEDs come on and go off intermittently for approximately 60 seconds (possibly longer).

The seven-segment display shows the sequence `OS+ Sd+ blank-` to indicate that the controller is performing Start-of-day (SOD) processing. After the controller successfully completes rebooting, the seven-segment display shows the enclosure ID matching the seven-segment display on the second controller. After this time, you can discover the controller with the new battery by using the IBM DS Storage Manager.

8. All of the Service Action Required LEDs are off, and the Subsystem Management Window indicates an Optimal status, go to step 10. Else go to the next step.

9. Perform one of the following actions (based on the Recovery Guru display):

   - The Recovery Guru displays the following message: **REC_CACHE_BACKUP_DEVICE_INSUFFICIENT_CAPACITY** – The controllers might require an additional power cycle to initialize the new cache backup memory devices. Turn off the Power switches on both controllers. Wait until all LED and seven-segment display activity stop, and then turn on the Power switches to both controllers.

   - The Recovery Guru does not display an insufficient capacity message – Check that the controller has been installed correctly. Reinstall the controller if necessary.

   If the problem is still not solved, contact IBM Technical Support.

10. Using the LEDs and the IBM DS Storage Manager, check the status of the enclosures in the storage subsystem.

11. If any component has a Needs Attention status, Click **Recovery Guru** in the Subsystem management Window, and complete the recovery procedure. If the problem is not resolved, contact your Technical Support representative.

12. Remove the anti-static protection.

13. Gather support data about your storage subsystem by using one of these methods:

   - Use the IBM DS Storage Manager to collect and save a support bundle of your storage subsystem. From the Subsystem management window, select **Monitor** > **Health** > **Collect Support Data**. Then name and specify a location on your system where you want to store the support bundle.

   - Use the command line interface (CLI) to run the `save storageArray supportData` command to gather comprehensive support data about the storage subsystem. For more information about this command, refer to the *IBM System Storage DS3000, DS4000, and DS5000 - Command Line Interface and Script Commands Programming Guide*. Running this command can temporarily impact performance on your storage subsystem.

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 xxvii.

General checkout

Use the status LEDs, Symptom-to-FRU index, and the DS Storage Manager client software to diagnose problems. See "Solving problems."

To diagnose a cluster system, use the cluster problem determination procedure in the *IBM System Storage Problem Determination Guide*.

Note: If power was just applied to the storage subsystem, the green and amber LEDs might turn on and off intermittently. Wait up to five minutes for the storage subsystem to finish powering up before you begin to check for faults.

Using the diagnostic hardware

The DS5100 or DS5300 comes with an LC wrap-plug adapter and LC-LC coupler. The wrap-plug adapter and LC-LC coupler are used to perform the loopback test and to identify fibre path problems. See the *IBM System Storage Problem Determination Guide* for more information.

The loopback test and the sendEcho test are described in the *IBM System Storage Problem Determination Guide*. In the IBM System Storage SAN Integration Server configuration, a loopback adapter (P/N 17P6918) is included to identify path problems on the drive loop when using fibre channel 1.2 m copper cable (P/N 18P5237).

Solving problems

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

You can use the symptom-to-FRU index (Table 61 on page 232) as a guide for troubleshooting problems in addition to the DS Storage Manager Recovery Guru in the Subsystem Management window. Do not depend solely on Table 61 on page 232 for FRU replacement decision.

Attention: Do not remove any power supply and fan units, controllers, or interconnect-battery units from the storage subsystem unless the Service Action Allowed LED for the component is lit. Always use the appropriate procedure in Chapter 5, "Replacing components," on page 189 to prevent an inadvertent shutdown of the storage subsystem as a result of removing the storage subsystem components in the wrong sequence.

Table 61. Symptom-to-FRU index

Problem indicator	Component	Possible cause	Possible solutions
Amber Needs Attention LED on Amber	RAID controller Needs Attention LED	RAID controller offline	If you have placed the controller offline, use the DS Storage Manager client software to place it online.
			If one controller has been placed offline by the other controller, contact IBM support. (This is the case if you use the DS Storage Manager client software to make repeated attempts to bring an offline controller online, but the controller keeps reverting back to an offline state.)
		RAID controller failure	If the RAID controller Needs Attention LED is on and the Service Action Allowed LED for that RAID controller is lit, replace the RAID controller.
			If the Service Action Allowed LED for the RAID controller is not lit, perform additional diagnostics to identify other component failures. Replace the other failed components before replacing the RAID controller.
	Drive bypass LED	Fibre-channel cable is not attached to the storage expansion enclosure.	Connect the fibre-channel cable to the enclosure port; check other connections.
		No incoming signal detected.	Reattach the SFPs and fibre-channel cables.
			Verify that the fibre channel cables are in good condition. For specific handling guidelines, see "Handling fibre-optic cables" on page 50.
			Verify the SFPs are working properly. Use the wrap-plug coupler kit that ships with the storage subsystem and the wrap-plug instructions in the *Problem Determination Guide*.
			Replace input and output SFPs or cables as necessary.
	Overall Configuration Needs Attention LED (located on interconnect-battery unit)	General system error	Indicates that a Needs Attention LED somewhere in the storage subsystem configuration, including all attached storage expansion enclosures, has turned on. (Check for amber LEDs on components as well as all attached storage expansion enclosures.) Use the DS Storage Manager software to diagnose server problems.
	Various components	Multiple component failures	Do not randomly replace components in the storage subsystem. This might result in a subsystem shutdown, causing a loss of data availability. Use the DS Storage Manager client program to identify the failed components. Identify and replace the failed power supply and fan unit components first before fixing any other failed components.

Table 61. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
All green LEDs off	All FRUs	Subsystem power is off.	Check that all power cords are plugged in and all power switches are on. If applicable, check that the main circuit breakers for the rack cabinet are turned on.
		AC power failure	Check the main circuit breaker and ac outlet.
		Both power supply and fan units have failed.	Replace the power supply and fan units.
		Both controller circuit breakers have tripped.	Reset the controller circuit breakers.
Amber LED is on, green LED is off, blue LED is off, and Overall Storage Subsystem Needs Attention LED is on	Power supply and fan unit • Amber Needs Attention LED on • Blue Service Action Allowed LED off • Green Power LED off	• Power switch on a power supply and fan unit is turned off. • An electrical outlet circuit breaker has been tripped. • There has been an ac power failure. • The circuit breaker in the RAID controller associated with this PSF has been tripped.	Check the power supply and fan unit power switches, circuit breakers, and ac power source. If none of these sources are the cause of the fault, then do not replace the failed power supply and fan unit until you have performed additional diagnostics to determine why the Service Action Allowed LED on the power supply and fan unit is not lit. Call IBM Support if needed.
	Interconnect-battery unit • Amber Battery Needs Attention LED on the interconnect-battery unit is on • Green Battery LED on the power supply and fan unit is off	Battery failure	Verify the failure using DS Storage Manager Client and replace the failing battery.
	Interconnect-battery unit • Green Power LED on interconnect-battery unit is off • Amber Battery Needs Attention LED on the interconnect-battery unit is on	Interconnect-battery unit failure or midplane failure	Call IBM support.

Table 61. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
Amber LED is on, green LED is off, blue LED is off, and Overall Storage Subsystem Needs Attention LED is on (continued)	RAID controller • Amber Controller Needs Attention LED is on.	Controller failure or controller placed offline	Use DS Storage Manager client software to place the controller online. If the failure persists, do *not* replace the controller unit. Instead, perform additional diagnostics (such as checking the power supply and fan unit components) to determine what additional failures have caused the associated Service Action Allowed LED on the controller not to light.
Amber LED is on and blue LED is on, and Overall Storage Subsystem Needs Attention LED is on	Power supply and fan unit • Amber Needs Attention LED on. • Blue Service Action Allowed LED on.	Power supply and fan unit failure or power supply failure	Use DS Storage Manager client software to verify the failure and replace the power supply and fan unit.
	RAID controller • Amber Controller Needs Attention LED is on. • Blue Controller Service Action Allowed LED is on.	RAID controller offline	If you have placed the controller offline, use the DS Storage Manager client software to place it online.
			If one controller has been placed offline by the other controller, contact IBM support. (This is the case if you use the DS Storage Manager client software to make repeated attempts to bring an offline controller online, but the controller keeps reverting back to an offline state.)
		RAID controller failure	If the RAID controller Needs Attention LED is on and the Service Action Allowed LED for that RAID controller is lit, replace the RAID controller. If the Service Action Allowed LED for the RAID controller is not lit, perform additional diagnostics to identify other component failures. Replace the other failed components before replacing the RAID controller.
	Interconnect-battery unit • Amber Needs Attention LED is on. • Blue Service Action Allowed LED is on.	Interconnect-battery unit failure	Contact IBM Support.

Table 61. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
One or more Green LEDs off	Controller Cache LED off	Caching is not enabled or was disabled because: • The cache memory in controllers A and B is mismatched. • The battery is charging or performing a diagnostic test. • One of the cache backup battery packs has failed. Or, there are no I/Os being sent to the storage subsystem.	Enable write-caching using the DS Storage Manager client program. Or: • Use the DS Storage Manager client program to verify the cache memory for both controllers. • The performs battery diagnostic tests and recharges every 25 hours. The test duration time varies depending on the recharging requirement, but the duration should be less than 15 minutes. • Replace the failing battery. If there are no I/Os being sent to the storage subsystem, generate I/Os to send to the storage subsystem.
	Battery LED off and power supply and fan unit Power LED off	The battery is missing.	Verify that the battery is missing. The DS5100 or DS5300 ships with both cache battery packs installed. Call IBM support if a cache battery pack is missing and you did not remove any of the cache battery packs from the storage subsystem.
	L1 and L2 (Link Speed) LEDs for a host port	Fibre channel cable is not attached to the host port or the FC device that should be connected to this host port.	Connect the fibre channel cable to the enclosure port; check other connections.
		No FC signal detected.	Reattach the SFPs and fibre-channel cables. Verify that the fibre channel cables are in good condition and that there are no cable management issues. For specific handling guidelines, see "Handling fibre-optic cables" on page 50. Verify the SFPs are working properly. Use the wrap-plug coupler kit that ships with the storage subsystem and the wrap-plug instructions in the *Problem Determination Guide*. Replace input and output SFPs or cables as necessary.

Table 61. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
One or more Green LEDs off (continued)	L1 and L2 (Link Speed) LEDs of drive port	SFP module failure or SFP module not seated properly.	Reseat the SFP. Verify the SFPs are working properly. Use the wrap-plug coupler kit that ships with the storage subsystem and the wrap-plug instructions in the *Problem Determination Guide*. Replace SFPs as necessary.
	10 Gbps host port Link LED	Fibre-optic cable is attached, or cable failure.	Reattach the SFP+s and fibre-channel cables. Verify that the fibre channel cables are in good condition and that there are no cable management issues. For specific handling guidelines, see "Handling fibre-optic cables" on page 50. Replace SFP+s or cables as necessary.
		Switch port incorrectly configured, not optimally configured, or not enabled.	Check switch port status.
		10 Gbps SFP+ module failure or SFP+ module not seated properly.	Reseat the SFP+ Verify that the SFP+s are working properly. Use the fibre-channel optical loopback check. Replace the SFP+s as necessary.
Only one Blue Service Action Allowed LED is lit with no other amber Needs Attention LEDs lit	Interconnect-battery unit	A command from the Subsystem Management window placed the interconnect-battery unit in Identify/Locate mode.	Stop the Identify/Locate action in the Subsystem Management window.
Only one Blue Service Action Allowed LED is lit and the amber Needs Attention LED for the same component is lit	Power supply and fan unit, controller, or interconnect-battery unit	The component indicated by both the blue (Service Action Allowed) LED and the amber (Needs Attention) LED has failed and can be replaced.	

Table 61. Symptom-to-FRU index (continued)

Problem indicator	Component	Possible cause	Possible solutions
Unable to access drives	Expansion drive channel	Fibre-channel cabling has failed.	Ensure that the fibre-channel cables are undamaged and properly connected. For specific handling guidelines, see "Handling fibre-optic cables" on page 50.
		RAID controller has failed.	Replace the RAID controller.
		An SFP module has failed.	Ensure the SFP module is seated properly; replace the SFP module.
		You have connected more storage expansion enclosures to the ports of the drive channel than allowed. Even though the drive channel is dual-ported, the storage subsystem currently does not support more than 112 drives per drive channel.	Power down the storage subsystem and its storage expansion enclosures. Recable the storage expansion enclosures and do not exceed the maximum number of storage expansion enclosures allowed per drive channel.
The DS Storage Manager client Enterprise Management window sees each storage subsystem controller as an independent storage subsystem or a partially managed device.	Controller	If this condition occurs after you have replaced a controller, the controller firmware for the replacement controller probably failed to synchronize with the firmware on the existing controller.	To recover, perform the following steps: 1. Remove and reinsert the controller blade. 2. Wait 5 minutes. 3. Delete the controller entry with the incorrect firmware version from the DS Storage Manager Enterprise Management window. 4. Add the controller back to the DS Storage Manager Enterprise Management window using the **Add Device** menu option in the Enterprise Management window. 5. If the DS Storage Manager client Enterprise Management window still shows each storage subsystem controller as an independent storage subsystem or a partially managed device, contact IBM support for instructions on how to force firmware synchronization in the replacement controller.
		The DS5100 or DS5300 has been powered on without a connection to at least one storage expansion enclosure populated with at least two drives.	If this is the case, power off the storage subsystem and connect at least one storage expansion enclosure populated with at least two drives.
		The attached storage expansion enclosures and/or drives in the attached storage expansion enclosures are not certified or not supported by the storage subsystem.	The storage subsystem will not recognize non-IBM storage expansion enclosures and drive models. If you are positive that storage expansion enclosures and drives are of IBM models, obtain the Subsystem Profile and call IBM support.
Random errors	Subsystem	Midplane has failed	Contact IBM Support.

Note: If you cannot find the problem in the Symptom-to-FRU index, test the entire system.

Parts list

Figure 145 and the following table provide a parts list for the DS5100 or DS5300.
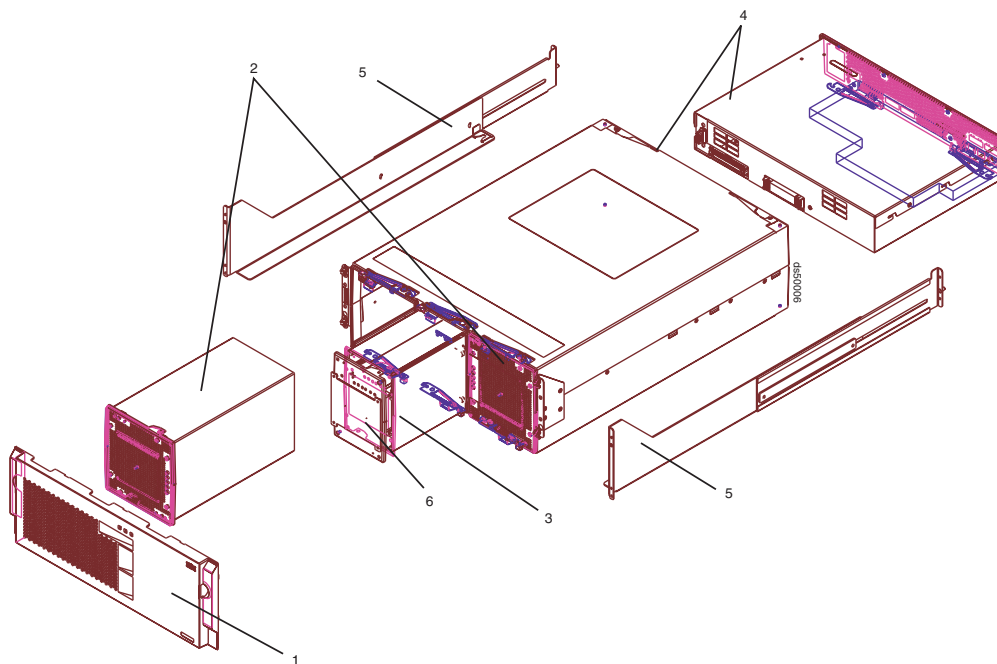

Figure 145. DS5100 or DS5300 parts list

Table 62. Parts list (System Storage DS5100 or DS5300 Storage Subsystem)

Index	DS5100 or DS5300 Storage Subsystem	FRU P/N
1	DS5100 or DS5300 bezel assembly	46C4483
2	DS5100 or DS5300 power supply and fan unit	46C8871
3	DS5100 or DS5300 interconnect-battery unit (with plate and without batteries)	46C8875
4	DS5100 RAID controller, Model 51A	49Y4133
	DS5300 RAID controller, Model 53A	49Y4134
5	DS5100 or DS5300 mounting rail assembly	23R0538
6	DS5100 or DS5300 battery cover/plate with 4 screws	46C8886
	DS5100 or DS5300 battery	46C8872
	DS5100 and DS5300 4 Gbps FC host interface card	46C4482
	DS5100 and DS5300 8 Gbps FC host interface card	49Y4124
	DS5100 and DS5300 1 Gbps iSCSI host interface card	59Y5095
	DS5100 and DS5300 10 Gbps iSCSI host interface card	81Y2445
	DS5100 and DS5300 1 GB cache memory	46C8888
	2 GB cache memory	59Y5097

Table 62. Parts list (System Storage DS5100 or DS5300 Storage Subsystem) (continued)

Index	DS5100 or DS5300 Storage Subsystem	FRU P/N
	4 GB cache memory	59Y5098
	DS5100 and DS5300 4 GB flash memory	46C8890
	8 GB flash memory	59Y5099
	LC wrap plug assembly	39M5914
	LC-SC fibre channel cable adapter	23R0539
	Power cord, 2.8–meter (9–ft.)	39M5247
	Power cord, line jumper, high voltage	39M5377
	4 Gbps SFP module	22R6443
	8 Gbps SFP module	49Y4123
	10 Gbps SFP+ module	81Y2493
	Cable, 1–meter fiber-optic	39M5699
	Cable, 5–meter fiber-optic	39M5700
	Cable, 10–meter OM3 fiber-optic	45W2222
	Cable, 25–meter fiber-optic	39M5701
	1 Gbps iSCSI host interface card port cover plate with opening	59Y5432
	10 Gbps iSCSI host interface card port cover plate with opening	94Y8404
	FC host interface card port cover plate with opening	49Y4158
	Blank host interface card port cover plate	69Y2769

Seven-segment display sequence codes and their causes

If an error occurs during the controller or ESM boot process and the Needs Attention LED is on, the numeric display shows diagnostic information as a sequence of 2-digit diagnostic code. The following figure shows the seven-segment alphanumeric characters.

Numbers	0	1	2	3	4	5	6	7	8	9
7-Segment Font	0	1	2	3	4	5	6	7	8	9

Letters	A	b	C	d	E	F	H	L	n	O	o	P	r	S	U	u
7-Segment Font	A	b	C	d	E	F	H	L	n	O	o	P	r	S	U	u

Similar Letters and Numbers			
Upper-Case Letter "O"	0	0	Number "0"
Upper-Case Letter "S"	5	5	Number "5"
Lower-Case Letter "b"	b	6	Number "6"

Figure 146. Seven-segment alphanumeric characters

The following table lists the sequence category codes and their associated detail codes.

Startup errors and operational states are displayed in sequences. The numeric display not only helps to identify a component failure, but also provides information about the controller state in which the error occurred. The following table lists the different sequences and the corresponding errors.

Table 63. Seven-segment display sequence code definitions

Category	Category Code	Detail Codes
		(Notation is described in Notes at the end of this table)
Startup Error	SE+	• SE+ Power-on default • dF+ Power-on diagnostic fault • Sx Power-on validation error
Operational Error	OE+	Lx+ Lockdown codes (See note 3)
Operational State	OS+	• OL+ Offline (See note 11.) • bb+ Battery backup (operating on batteries) • CF+ Component failure (See note 12)

Table 63. Seven-segment display sequence code definitions (continued)

Category	Category Code	Detail Codes
Component Failure	CF+	• dx+ Processor/Cache DIMM (x = location. See note 6.) • Cx+ Cache DIMM (x = location. See note 7.) • Px+ Processor DIMM (x = location. See note 8.) • Hx+ Host card (x = location) • Fx+ Flash drive (x = location) • b1+ Base controller card
Diagnostic Failure	dE+	Lx+ Lockdown code (See note 3)
Category Delimiter	dash+	Separator between category-detail code pairs (See notes 4 and 9)
End-Of-Sequence Delimiter	blank-	End-of-sequence indicator (See notes 5 and 10)

Notes:

1. xy+ Indicates that the diagnostic LED is lit.

2. xy- Indicates that the diagnostic LED is turned off.

3. Lx+ Lockdown codes (See Table 65 on page 243)

4. dash+ All segments are off except the middle segments and the diagnostic light is on.

5. blank- All segments are off and the diagnostic light is off.

6. dx+ Used when there is a single memory system for processor and data cache.

7. Cx+ Used when there are separate processor and data cache memory systems.

8. Px+ Used when there are separate processor and data cache memory systems.

9. Category-Detail separator is used when there is more than one category-detail pair in the sequence. For examples, see Table 64

10. End-of-sequence indicator is automatically inserted by hardware at the end of the sequence. Example: SE+ 88+ blank- (repeat)

11. If an enclosure ID is being displayed, this sequence is programmed to display. The controller is then held in reset.

12. The enclosure ID is nominally displayed during normal operation. This operational state is displayed if an internal controller component failure occurs while the controller is online. An additional detail code identifies the failed component as defined for the Component Failure category. This sequence will continue to display even if the controller is later placed offline (held in reset) to service the failed component.

Table 64. Repeating sequences on the seven-segment display and corresponding errors

Repeating Sequence	Startup and Operational Error
Controller power-on failure:	
SE+ 88+ blank-	• Initial phase of normal power-on controller insertion • Insertion of a controller while held in reset
Operational failure:	

Table 64. Repeating sequences on the seven-segment display and corresponding errors (continued)

Repeating Sequence	Startup and Operational Error
xy- (static controller enclosure ID)	Normal operation, where xy is the ID of the enclosure
OS+ Sd+ blank-	During start-of-day (SOD) processing that is processing when the controller reaches a fully powered-up state
OS+ OL+ blank-	Controller is placed in reset while displaying the enclosure ID
OS+ bb+ blank-	Controller is operating on batteries (cache backup)
OS+ OH+ blank-	The processor temperature exceeds the warning level
Component failure when the controller is operational:	
OS+ CF+ HX+ blank-	The host interface card failed
OS+ CF+ Fx+ blank-	The flash drive failed
Power-on diagnostic failure:	
SE+ dF+ blank-	Failure of a component that is not a field replaceable unit is detected
SE+ dF+ dash+ CF+ Px+ blank-	Failure of a processor DIMM is detected
SE+ dF+ dash+ CF+ Cx+ blank-	Failure of a cache memory DIMM is detected
SE+ dF+ dash+ CF+ dx+ blank-	Failure of a processor DIMM or a cache memory DIMM is detected
SE+ dF+ dash+ CF+ Hx+ blank	Failure of a host interface card is detected
SE+ LC+ dash+ CF+ Fx+ blank-	An incorrect number of cache backup devices are detected
Controller is suspended and no other errors to report:	
OE+ Lu+ blank-	All lockdown conditions, where Lu is the lockdown code as shown in the table of diagnostic codes
Controller is suspended because of component errors:	
OE+ L2+ dash+ CF+ CX+ blank-	Persistent processor or cache DIMM error correcting code (ECC) errors are detected
OE+ L2+ dash+ CF+ CX+ blank-	Persistent processor or cache DIMM ECC errors are detected
OE+ L2+ dash+ CF+ CX+ blank-	Persistent processor or cache DIMM ECC errors are detected
Controller is suspended as a result of persistent cache backup configuration errors:	
OE+ LC+ blank-	During cache restore, the write-protect switch is set
OE+ LC+ dd+ blank-	The memory size is changed with invalid data in the flash drives
Controller is suspended as a result of diagnostic errors:	
dE+ L2+ dash+ CF+ Cx + blank-	A cache memory diagnostic failure is detected
dE+ L3+ dash+ CF+ b1 + blank-	A base controller diagnostic failure is detected

Table 64. Repeating sequences on the seven-segment display and corresponding errors (continued)

Repeating Sequence	Startup and Operational Error
`dE+ L3+ dash+ CF+ b2 + blank-`	A base controller IOC diagnostic failure is detected

The following table lists the ESM diagnostic codes.

Table 65. Controller numeric display diagnostic codes

Value	Description
L0	Mismatched controller board ID
L1	Missing interconnect canister
L2	Persistent memory errors
L3	Persistent hardware errors
L4	Persistent data protection errors
L5	ACS failure
L6	Unsupported host card
L7	Submodel identifier not set or mismatched
L8	Memory configuration error
L9	Link speed mismatch
LA	Reserved
LB	Host card configuration error
LC	Persistent cache backup configuration error
LD	Mixed cache memory DIMMs
LE	Uncertified cache memory DIMM sizes
LF	Lockdown with limited SYMbol support
LH	Controller firmware mismatch

Determining basic information of drive FRUs

IBM might ship drive FRUs of higher capacity than that of the drive FRUs they replace. These new drives are programmed in manufacturing to give the same capacity as the drive FRUs being replaced.

The new drive FRUs have different model IDs than the ones printed on the drive manufacturer label. You can determine the model ID and other information of these drives by referring to one of the following windows of the DS Storage Manager software:
- Properties pane in the Hardware tab of the Subsystem Management window
- Storage Subsystem Profile window

You can also use the IBM hologram label to determine the drive capacity and the drive FRU part number. A sample IBM hologram label is shown in the following figure.

Refer to the drive properties given here.

Do not refer to the drive properties given here.

Figure 147. An IBM hologram label example

Appendix A. Additional System Storage DS documentation

For educational information about the DS5020 and other IBM System Storage products, go to http://ibmdsseriestraining.com/.

The following tables present an overview of the IBM System Storage DS 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/

DS Storage Manager Version 10 library

Table 66 associates each document in the DS Storage Manager Version 10 library with its related common user tasks.

Table 66. DS Storage Manager Version 10 titles by user tasks

Title	User tasks					
	Planning	Hardware installation	Software installation	Configuration	Operation and administration	Diagnosis and maintenance
IBM System Storage Quick Start Guide for the DS5100 and DS5300, and for the EXP5000		✔	✔	✔		
IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide	✔	✔	✔	✔	✔	✔
IBM System Storage DS Storage Manager Copy Services User's Guide	✔		✔	✔	✔	
IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview	✔	✔	✔	✔		

Table 66. DS Storage Manager Version 10 titles by user tasks (continued)

Title	User tasks					
	Planning	Hardware installation	Software installation	Configuration	Operation and administration	Diagnosis and maintenance
IBM System Storage Hard Drive and Storage Expansion Enclosures Installation and Migration Guide	✔	✔				
IBM System Storage DS3000, DS4000, and DS5000 Command Line Interface and Script Commands Programming Guide				✔	✔	✔

DS5100 or DS5300 Storage Subsystem library

Table 67 associates each document in the DS5100 or DS5300 Storage Subsystem library with its related common user tasks.

Table 67. DS5100 or DS5300 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 DS5100 or DS5300 Storage Subsystem Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage Quick Start Guide, Quick Reference for DS5100 or DS5300 Storage Subsystems, and for the EXP5000 Storage Expansion Enclosure		✔	✔	✔		
IBM System Storage DS5000 EXP5000 Storage Expansion Enclosure Installation, User's, and Maintenance Guide						
Installing or replacing a DS5000 Cache and Flash Memory Card	✔	✔		✔		

Table 67. DS5100 or DS5300 Storage Subsystem document titles by user tasks (continued)

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
Installing or replacing a DS5000 Host Interface Card	✔	✔		✔		

DS5020 Storage subsystem library

Table 68 associates each document in the DS5020 Storage subsystem library with its related common user tasks.

Table 68. DS5020 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 DS5020 Storage Subsystem Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage Quick start guide, Quick reference for the DS5020 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420		✔	✔	✔		
IBM System Storage DS5020 Quick Start Guide		✔	✔	✔		
IBM System Storage DS5020 Installation, User's, and Maintenance Guide	✔	✔	✔	✔	✔	✔

DS5100 or DS5300 storage subsystem library

Table 69 associates each document in the DS5100 or DS5300 storage subsystem library with its related common user tasks.

Table 69. DS5100 or DS5300 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 DS5100 or DS5300 Storage Subsystem Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage Quick start guide, Quick reference for the DS4800		✔	✔	✔		
IBM TotalStorage DS4800 Controller Cache Upgrade Kit Instructions	✔	✔		✔		

DS4700 storage subsystem library

Table 70 associates each document in the DS4700 storage subsystem library with its related common user tasks.

Table 70. DS4700 storage subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
IBM System Storage DS4700 Storage Subsystem Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage Quick start guide, Quick reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420		✔	✔	✔		
IBM TotalStorage DS4500 Storage Subsystem Installation, User's, and Maintenance Guide	✔	✔		✔		
IBM TotalStorage DS4500 Storage Subsystem Cabling Instructions	✔	✔				
IBM TotalStorage DS4500 Rack Mounting Instructions	✔	✔				

DS4500 storage subsystem library

Table 71 associates each document in the DS4500 storage subsystem library with its related common user tasks.

Table 71. DS4500 storage subsystem document titles by user tasks

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

DS4400 storage subsystem library

Table 72 associates each document in the DS4400 storage subsystem library with its related common user tasks.

Table 72. DS4400 storage subsystem document titles by user tasks

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

DS4300 storage subsystem library

Table 73 associates each document in the DS4300 Storage Subsystem library with its related common user tasks.

Table 73. DS4300 storage subsystem document titles by user tasks

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

DS4200 Express storage subsystem library

Table 74 associates each document in the DS4200 Express storage subsystem library with its related common user tasks.

Table 74. DS4200 Express storage subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
IBM System Storage DS4200 Express Storage Subsystem Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage Quick start guide, Quick reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420		✔	✔	✔		

DS4100 Storage subsystem library

Table 75 associates each document in the DS4100 Storage subsystem library with its related common user tasks.

Table 75. DS4100 storage subsystem document titles by user tasks

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

DS4000 and DS4000 storage expansion enclosure documents

Table 76 associates each of the following documents with its related common user tasks.

Table 76. DS4000 and 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 EXP520 Expansion Enclosure Installation, User's, and Maintenance Guide	✔	✔	✔	✔	✔	✔
IBM System Storage DS4000 EXP810 Storage Expansion Enclosure Installation, User's, and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage Quick start guide, Quick reference for the DS5020 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420		✔	✔	✔		
IBM TotalStorage DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide	✔	✔		✔	✔	✔
IBM EXP500 Installation and User's Guide	✔	✔		✔	✔	✔
IBM System Storage DS4000 EXP420 Storage Expansion Enclosure Installation, User's, and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage DS4000 Hard Drive and Storage Expansion Enclosures Installation and Migration Guide	✔	✔				

Other DS4000 and DS4000-related documents

Table 77 associates each of the following documents with its related common user tasks.

Table 77. 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 Hardware Maintenance Manual [1]						✔
IBM System Storage DS4000 Problem Determination Guide						✔
IBM Fibre Channel Planning and Integration: User's Guide and Service Information	✔	✔			✔	✔
IBM TotalStorage DS4000 FC2-133 Host Bus Adapter Installation and User's Guide		✔			✔	
IBM TotalStorage DS4000 FC2-133 Dual Port Host Bus Adapter Installation and User's Guide		✔			✔	
IBM Netfinity® Fibre Channel Cabling Instructions		✔				
IBM Fibre Channel SAN Configuration Setup Guide	✔		✔	✔	✔	

Notes:

1. The *IBM TotalStorage DS4000 Hardware Maintenance Manual* does not contain maintenance information for the IBM System Storage DS4100, DS4200, DS4300, DS4500, DS4700, or DS4800 Storage subsystems. You can find maintenance information for these products in the *IBM System Storage DSx000 Storage Subsystem Installation, User's, and Maintenance Guide* for the particular subsystem.

Appendix B. Records

Whenever you add options to your DS5100 or DS5300, 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. The machine type, model number, and serial number are located on top of each RAID controller unit. The RAID controller MAC addresses are located near the Ethernet ports on each RAID controller, the iSCSI port MAC addresses are near the iSCSI ports, as shown in Figure 148 on page 258.

Product name:	IBM System Storage DS5100 or DS5300 Storage Subsystem
Machine type:	1818
Model number:	
Serial number:	
RAID controller MAC addresses:	
Controller firmware version:	

Port name	MAC address	IP address	Subnet mask
Controller A management port 1			
Controller A management port 2			
Controller B management port 1			
Controller B management port 2			
Controller A iSCSI port 1			
Controller A iSCSI port 2			
Controller A iSCSI port 3			
Controller A iSCSI port 4			
Controller B iSCSI port 1			
Controller B iSCSI port 2			
Controller B iSCSI port 3			
Controller B iSCSI port 4			

iSCSI port
MAC address label

MAC address label (Controller A)

MAC address label (Controller B)
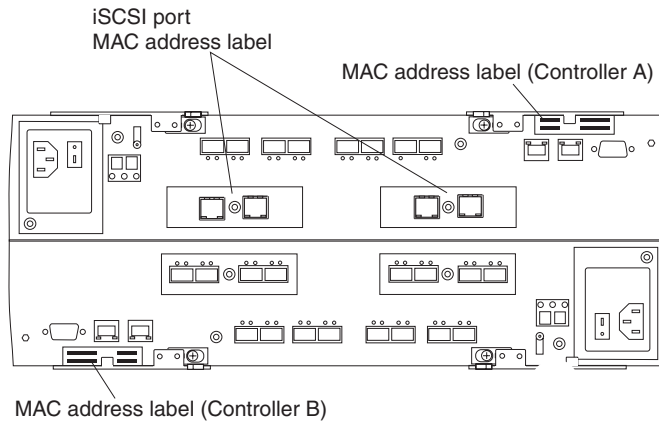
Figure 148. Location of MAC address labels

Appendix C. Rack mounting templates

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 40.

Use the following templates (Figure 149 on page 260 and Figure 150 on page 261) to identify the proper locations for inserting M5 screws when mounting the support rails and DS5100 or DS5300 in a rack cabinet. The locations for the M5 screws are highlighted in the templates.

The DS5100 or DS5300 is 4 U high. Align the template with the rack at a U boundary. U boundaries are shown as horizontal dashed lines in the rack mounting templates.

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

FRONT
Rack Mounting
Template

4 U

3 U

Rail assembly
(Front left)

2 U

1 U

Rail assembly
(Front left)

0 U

Front

4 U

3 U

Rail assembly
(Front right)

2 U

1 U

Rail assembly
(Front right)

0 U
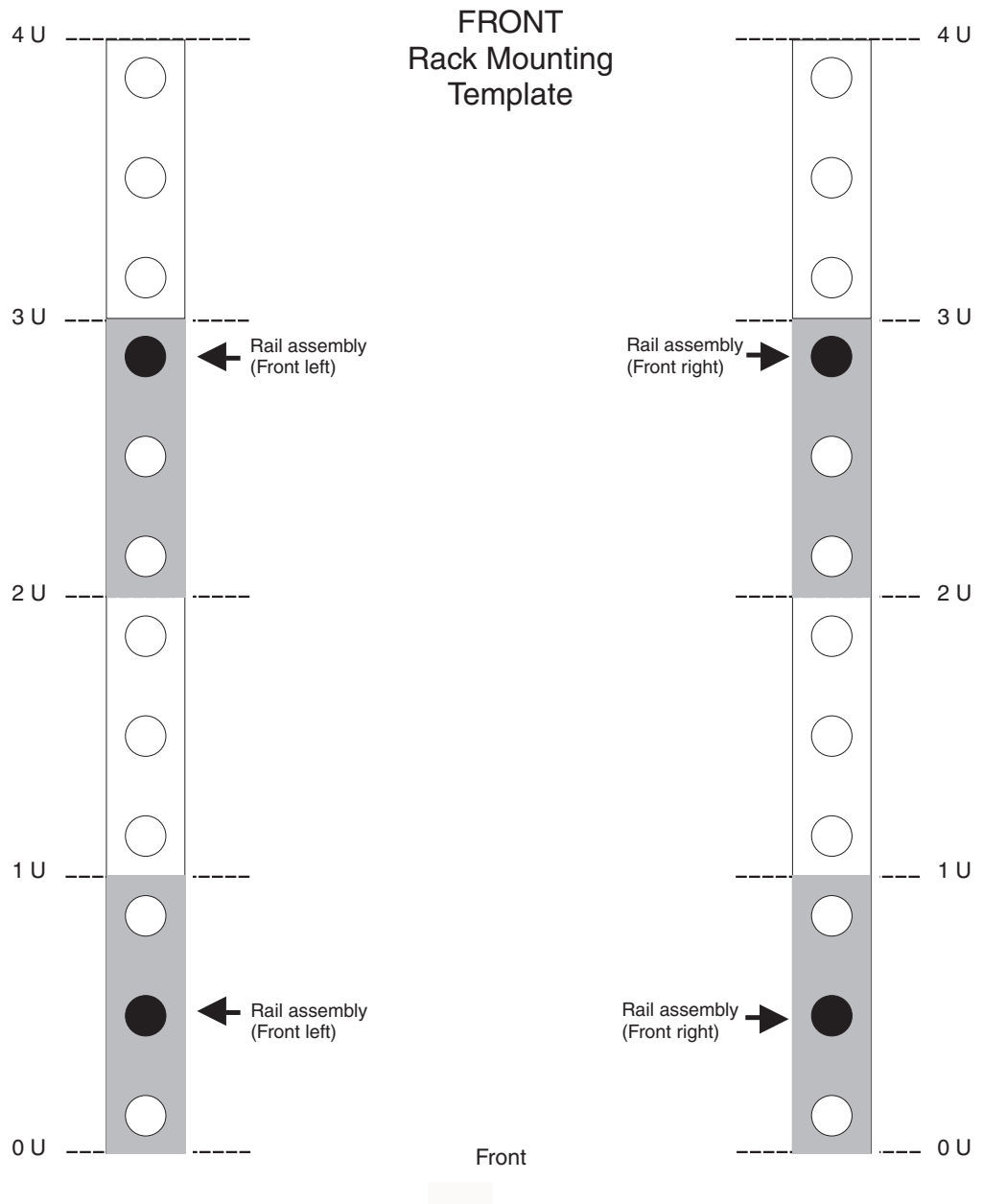
Figure 149. DS5100 or DS5300 front rack mounting template

REAR
Rack Mounting
Template

4 U

3 U

2 U

Rail assembly
(Rear left)

1 U

0 U

4 U

3 U

2 U

Rail assembly
(Rear right)

1 U

0 U

IBM
Printed in the U.S.A
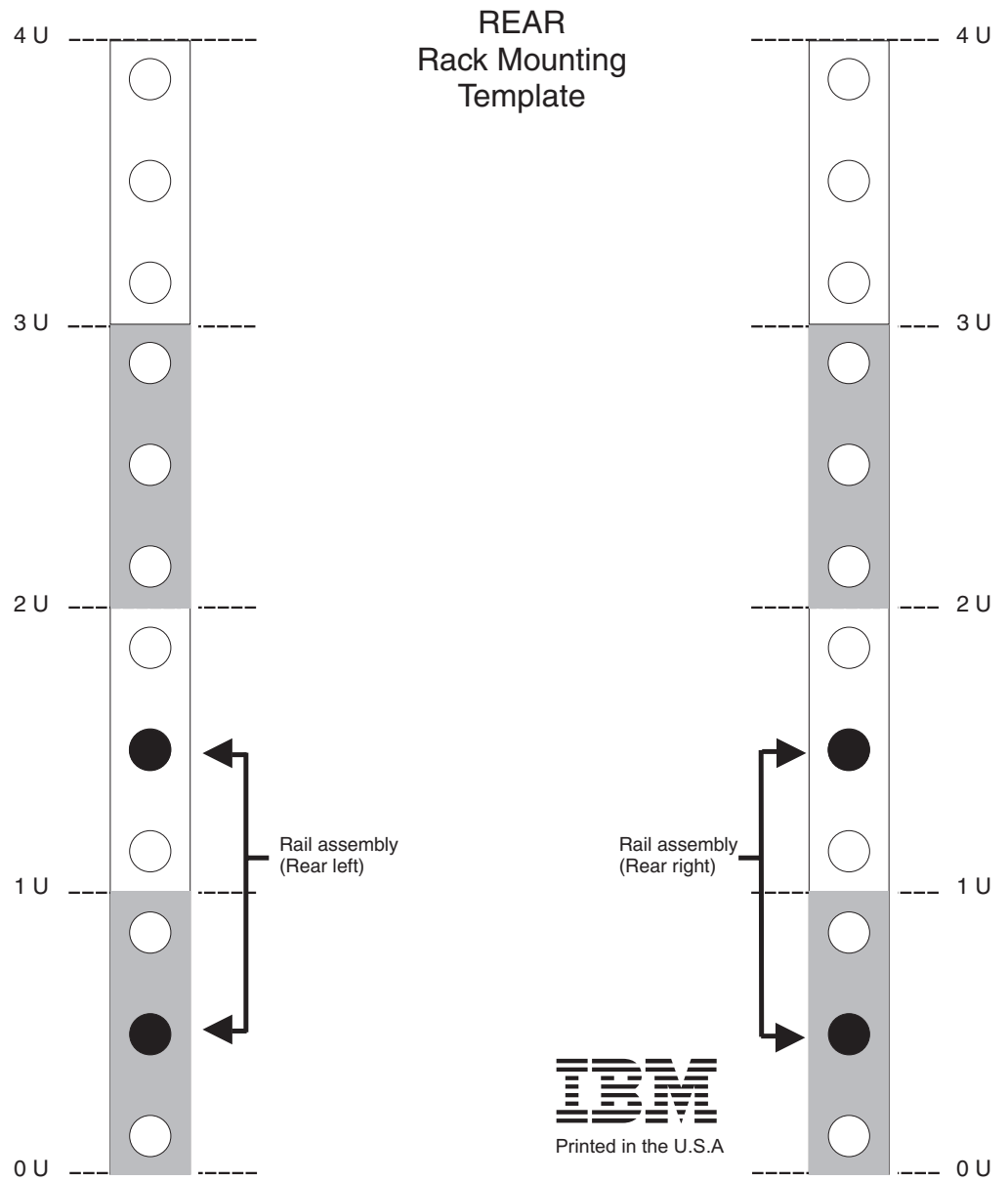
Figure 150. DS5100 or DS5300 rear rack mounting template

Appendix D. Specifications for non-IBM rack installation

The following instructions provide safety requirements and rack specifications for installing the DS5100 or DS5300 storage subsystem and DS5100 or DS5300 storage expansion enclosure into an non-IBM rack.

Note: The information in this section applies to 19–inch racks. It is your responsibility, working with your rack manufacturer, to ensure that the non-IBM rack chosen meets the safety requirements and specifications listed in this section.

General safety requirements for IBM products installed in a non-IBM rack or cabinet

The general safety requirements for IBM products installed in non-IBM racks are:

1. Any product or component that plugs into either an IBM power distribution unit or mains power (via a power cord), or uses any voltage over 42 V ac or 60 V dc (considered to be hazardous voltage) must be Safety Certified by a Nationally Recognized Test Laboratory (NRTL) for the country in which it will be installed.

   Some of the items that require safety certification may include: the rack or cabinet (if it contains electrical components integral to the rack or cabinet), fan trays, power distribution unit, uninterruptible power supplies, multi-outlet strips, or any other products installed in the rack or cabinet that connect to hazardous voltage.

   Examples of OSHA-approved NRTLs for the U.S.:

   * UL
   * ETL
   * CSA (with CSA NRTL or CSA US mark)

   Examples of approved NRTLs for Canada:

   a. UL (Ulc mark)
   b. ETL (ETLc mark)
   c. CSA

   The European Union requires a CE mark and a Manufacturer's Declaration of Conformity (DOC).

   Certified products should have the NRTL logos or marks somewhere on the product or product label. However, proof of certification must be made available to IBM upon request. Proof consists of such items as copies of the NRTL license or certificate, a CB Certificate, a Letter of Authorization to apply the NRTL mark, the first few pages of the NRTL certification report, Listing in an NRTL publication, or a copy of the UL Yellow Card. Proof should contain the manufacturer's name, product type and model, standard to which it was certified, the NRTL name or logo, the NRTL file number or license number, and a list of any Conditions of Acceptance or Deviations. A Manufacturer's Declaration is not proof of certification by an NRTL.

2. The rack or cabinet must meet all electrical and mechanical safety legal requirements for the country in which it is installed.

   The rack or cabinet must be free of exposed hazards (such as voltages over 60 V dc or 42 V ac, energy over 240 VA, sharp edges, mechanical pinch points, or hot surfaces).

3. There must be an accessible and unambiguous disconnect device for each product in the rack, including any power distribution unit.

A disconnect device may consist of either the plug on the power cord (if the power cord is no longer than 1.8 m (6 ft.)), the appliance inlet receptacle (if the power cord is of a detachable type), or a power on/off switch, or an Emergency Power Off switch on the rack, provided all power is removed from the rack or product by the disconnect device.

If the rack/or cabinet has electrical components (such as fan trays or lights), the rack must have an accessible and unambiguous disconnect device.

4. The rack or cabinet, power distribution unit and multi-outlet strips, and products installed in the rack or cabinet must all be properly grounded to the customer facility ground.

There must be no more than 0.1 Ohms between the ground pin of the power distribution unit or rack plug and any touchable metal or conductive surface on the rack and on the products installed in the rack. Grounding method must comply with applicable country's electric code (such as NEC or CEC). Ground continuity can be verified by your IBM service personnel, after the installation is completed, and should be verified prior to the first service activity.

5. The voltage rating of the power distribution unit and multi-outlet strips must be compatible with the products plugged into them.

The power distribution unit or multi-outlet strips current and power ratings are rated at 80 percent of the building supply circuit (as required by the National Electrical Code and the Canadian Electrical Code). The total load connected to the power distribution unit must be less than the rating of the power distribution unit. For example, a power distribution unit with a 30 A connection will be rated for a total load of 24 A (30 A x 80 percent). Therefore, the sum of all equipment connected to the power distribution unit in this example must be lower than the 24 A rating.

If an uninterruptible power supply is installed, it must meet all the above electrical safety requirements as described for a power distribution unit (including certification by an NRTL).

6. The rack or cabinet, power distribution unit, uninterruptible power supply, multi-outlet strips and all products in the rack or cabinet must be installed according to the manufacturer's instructions, and in accordance with all national, state or province, and local codes and laws.

The rack or cabinet, power distribution unit, uninterruptible power supply, multi-outlet strips and all products in the rack or cabinet must be used as intended by the manufacturer (per manufacturer's product documentation and marketing literature).

7. All documentation for use and installation of the rack or cabinet, power distribution unit, uninterruptible power supply, and all products in the rack or cabinet, including safety information, must be available on-site.

8. If there is more than one source of power in the rack cabinet, there must be clearly visible safety labels for "Multiple Power Source" (in the languages required for the country in which the product is installed).

9. If the rack or cabinet or any products installed in the cabinet had safety or weight labels applied by the manufacturer, they must be intact and translated into the languages required for the country in which the product is installed.

10. The rack or cabinet configuration must comply with all IBM requirements for "safe to service" (contact your IBM Installation Planning Representative for assistance in determining if the environment is safe).

There must be no unique maintenance procedures or tools required for service.

11. Elevated service installations, where the product(s) to be serviced are installed between 1.5 m and 3.7 m (5 ft. and 12 ft.) above the floor, require the availability of an OSHA- and CSA-approved nonconductive step ladder. If a ladder is required for service, the customer must supply the OSHA- and CSA-approved nonconductive step ladder (unless other arrangements have been made with the local IBM Service Branch Office). Products installed over 2.9 m (9 ft.) above the floor requires a Special Bid to be completed before they can be serviced by IBM service personnel.

    For products not intended for rack-mounting to be serviced by IBM, the products and parts that will be replaced as part of that service must not weigh over 11.4 kg (25 lb). (Contact your Installation Planning Representative if in doubt).

12. There must not be any special education or training required for safe servicing of any of the product(s) installed in the racks. (Contact your Installation Planning Representative if in doubt).

Rack specifications

When installing a DS5100 or DS5300 storage subsystem or DS5100 or DS5300 storage expansion enclosure into a non-IBM rack, follow the specifications below.

1. The rack or cabinet must meet the EIA Standard EIA-310-D for 19-inch racks published August 24, 1992. The EIA-310-D standard specifies internal dimensions, for example, the width of the rack opening (width of the chassis), the width of the module mounting flanges, the mounting hole spacing, and the depth of the mounting flanges. The EIA-310-D standard does not control the overall external width of the rack. There are no restrictions on the location of side walls and corner posts relative to the internal mounting space.

    The front rack opening must be 451 mm wide + 0.75 mm (17.75 in. + 0.03 in.), and the rail-mounting holes must be 465 mm + 0.8 mm (18.3 in. + 0.03 in.) apart on center (horizontal width between vertical columns of holes on the two front-mounting flanges and on the two rear-mounting flanges).
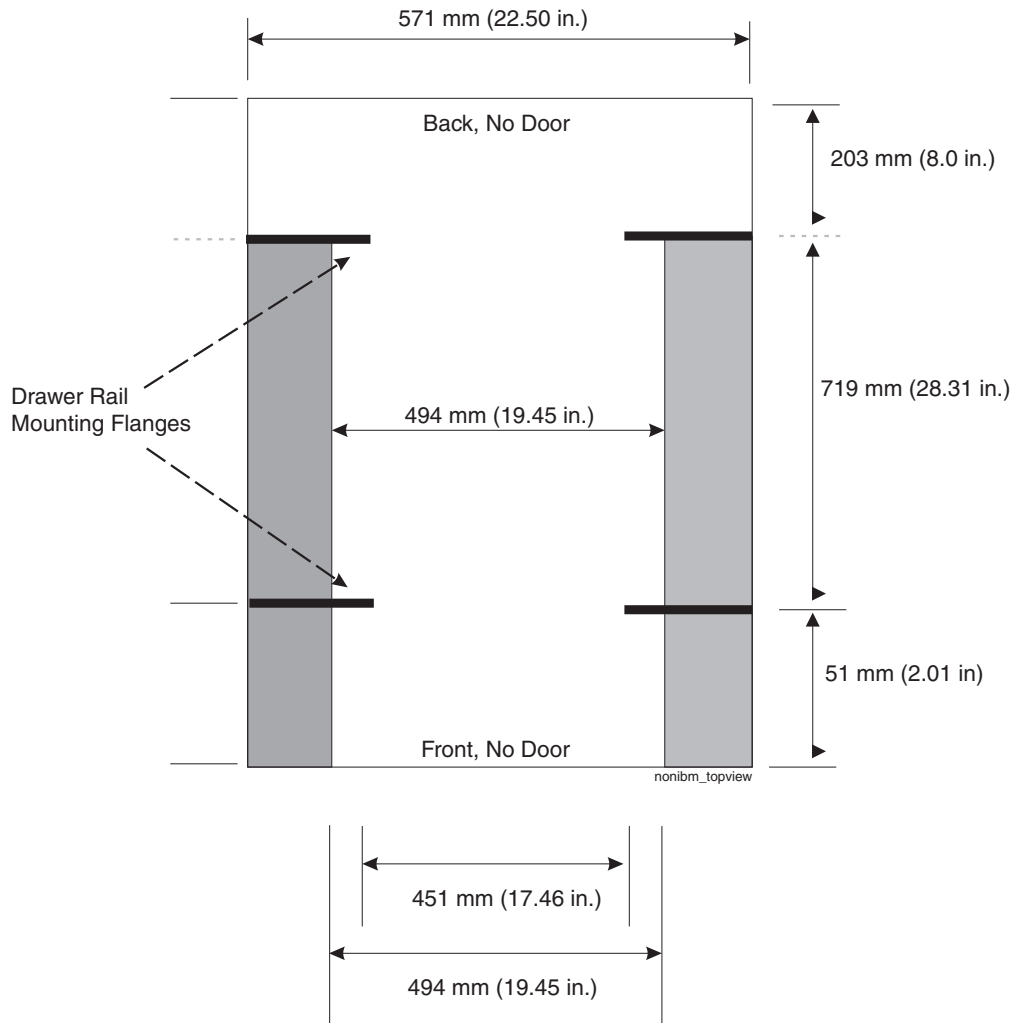
Figure 151. Top View of non-IBM Rack Specifications Dimensions

Top view of non-IBM rack specifications dimensions

The vertical distance between mounting holes must consist of sets of three holes spaced (from bottom to top) 15.9 mm (0.625 in.), 15.9 mm (0.625 in.), and 12.67 mm (0.5 in.) on center (making each three hole set of vertical hole spacing 44.45 mm (1.75 in.) apart on center). The front and rear mounting flanges in the rack or cabinet must be 719 mm (28.3 in.) apart and the internal width bounded by the mounting flanges at least 494 mm (19.45 in.), for the IBM Storage System or eServer™ rails to fit in your rack or cabinet (see Figure 151).
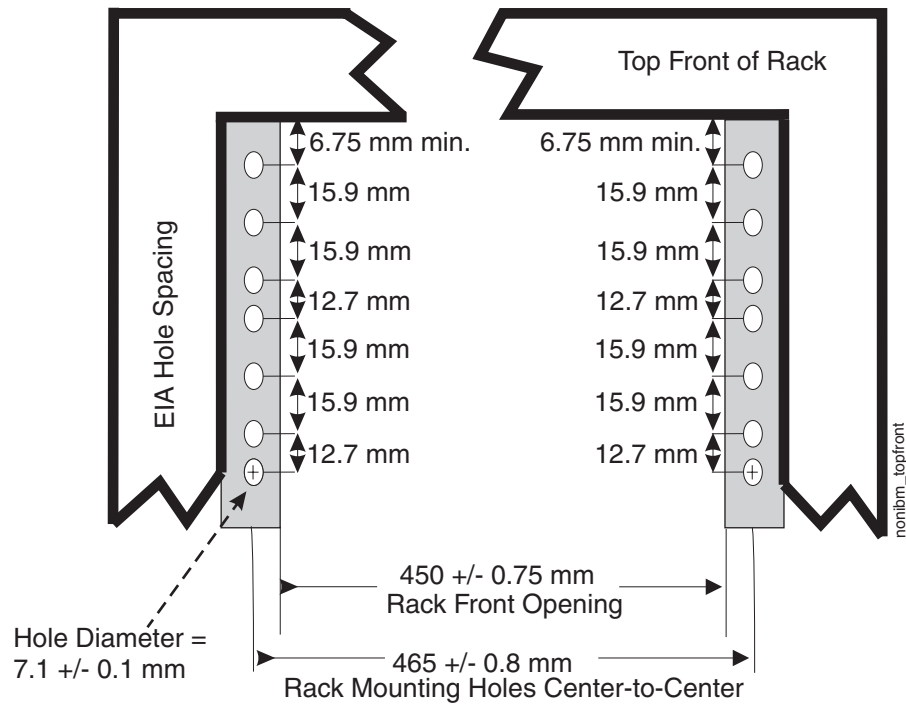
Figure 152. Rack specifications dimensions, top front view
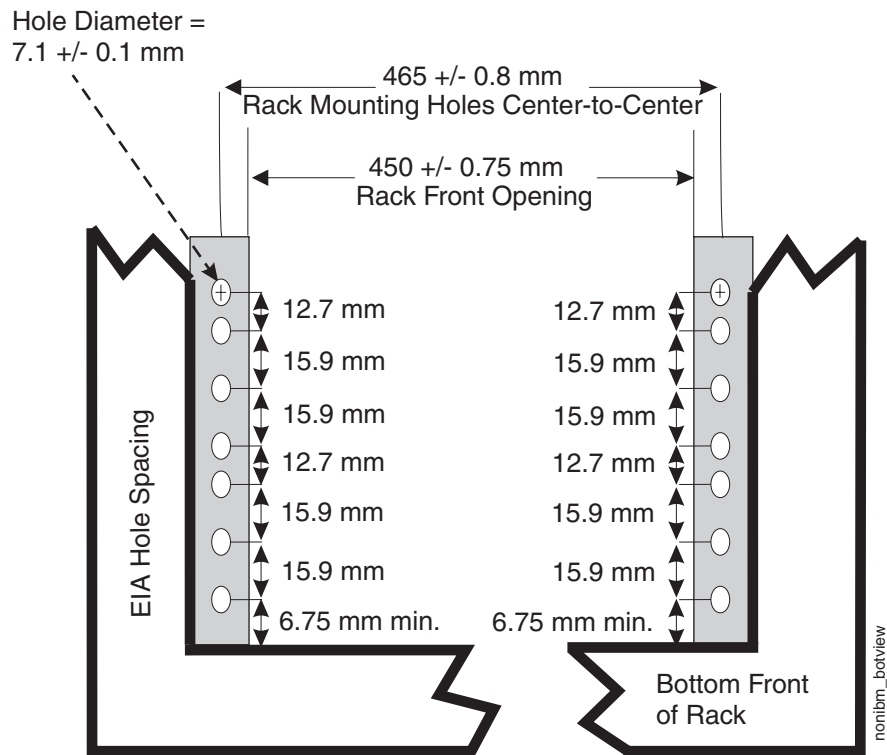
Figure 153. Rack specifications dimensions, bottom front view

2. The rack or cabinet must be capable of supporting an average load of 15.9 kg (35 lb.) of product weight per EIA unit.

For example, a four EIA drawer will have a maximum drawer weight of 63.6 kg (140 lb.).

3. AC or dc power drawers need to be support based on equipment purchased for the rack or cabinet. It is best practice to use a power distribution unit that meets the same specifications as each unit already installed in the rack. Each power distribution unit needs a dedicated power line. Rack or cabinet power distribution device(s) must meet the drawer power requirements, as well as that of any additional products that will be connected to the same power distribution device.

The rack or cabinet power receptacle (power distribution unit, uninterruptible power supply, or multi-outlet strip) must have a compatible plug type for your drawer or device. The customer is responsible for ensuring the power distribution unit is compatible with the rack or cabinet and assumes responsibility for any and all agency certifications required.

4. The rack or cabinet must be compatible with drawer mounting rails, including a secure and snug fit of the rail-mounting pins and screws into the rack or cabinet rail mounting holes. You must use the IBM mounting rails that are shipped with the IBM product to install it in the rack. The mounting rails that ship with IBM products have been designed and tested to safely support the product during operation and service activities as well as to safely support the weight of your drawer or device. The rails must facilitate service access by allowing the drawer to be safely extended, if necessary, forwards, backwards, or both.

   Note: If the rack or cabinet has square holes on the mounting flanges, additional hardware may be required.

5. The rack or cabinet must have stabilization feet or brackets installed both in the front and rear of the rack, or have another means of preventing the rack/cabinet from tipping while the drawer or device is pulled into its extreme front or rear service positions.

   Examples of some acceptable alternatives: The rack or cabinet may be securely bolted to the floor, ceiling or walls, or to adjacent racks or cabinets in a long and heavy row of racks or cabinets.

6. There must be adequate front and rear service clearances (in and around the rack or cabinet).

   The rack or cabinet must have sufficient horizontal width clearance in the front and rear to allow the drawer to be fully slid into the front and, if applicable, the rear service access positions (typically this requires 914.4 mm (36 in.) clearance in both the front and rear).

   If present, front and rear doors must be able to open far enough to provide unrestrained access for service or be easily removable. If doors must be removed for service, it is the customer's responsibility to remove them prior to service.

7. The rack or cabinet must provide adequate clearance around the rack drawer.

   There must be adequate clearance around the drawer bezel so that it can be opened and closed, according to the product specifications.

   Front or rear doors must also maintain a minimum of 51 mm (2 in.) front, 203 mm (8 in.) rear, door to mounting flange clearance, and 494 mm (19.4 in.) front, 571 mm (22.5 in.) rear, side-to-side clearance for drawer bezels and cables (see Figure 151 on page 266).

8. The rack or cabinet must provide adequate front-to-back ventilation.

   For optimum ventilation, it is best practice that the rack or cabinet not have a front door. If the rack or cabinet has doors, the doors must be fully perforated so that there is proper front-to-back airflow to maintain the required drawer ambient

inlet temperature as specified in the server specifications. The perforations should yield at least 34 percent minimum open area per square inch.

Appendix E. Power cords

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

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

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

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

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

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

IBM power cord part number	Cord specifics	Used in these countries or regions
13F9940	250V/10A 2.8M	Australia, Fiji, Kiribati, Nauru, New Zealand, Papua New Guinea
39Y7917	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, Syrian Arab Republic, Tajikistan, Tahiti, Togo, Tunisia, Turkey, Turkmenistan, Ukraine, Upper Volta, Uzbekistan, Vanuatu, Vietnam, Wallis and Futuna, Yugoslavia (Federal Republic of), Zaire
39Y7918	250V/10A 2.8M	Denmark

IBM power cord part number	Cord specifics	Used in these countries or regions
39Y7922	250V/10A 2.8M	Bangladesh, Lesotho, Macao, Maldives, Namibia, Nepal, Pakistan, Samoa, South Africa, Sri Lanka, Swaziland, Uganda
39Y7923	250V/10A 2.8M	Abu Dhabi, Bahrain, Botswana, Brunei Darussalam, Channel Islands, Cyprus, Dominica, Gambia, Ghana, Grenada, Guyana, Hong Kong S.A.R. of China, Iraq, Ireland, Jordan, Kenya, Kuwait, Liberia, Malawi, Malaysia, Malta, Myanmar (Burma), Nigeria, Oman, Qatar, Saint Kitts & Nevis, Saint Lucia, Saint Vincent and the Grenadines, Seychelles, Sierra Leone, Singapore, Sudan, Tanzania (United Republic of), Trinidad & Tobago, United Arab Emirates (Dubai), United Kingdom, Yemen, Zambia, Zimbabwe
39Y7919	250V/10A 2.8M	Liechtenstein, Switzerland
39Y7921	250V/10A 2.8M	Chile, Italy, Libyan Arab Jamahiriya
39Y7920	250V/10A 2.8M	Israel
39Y7931	250V/10A 2.8M	Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Caicos Islands, Canada, Cayman Islands, Costa Rica, Columbia, Cuba, Dominican Republic, Ecuador, El Salvador, Guam, Guatemala, Haiti, Honduras, Jamaica, Japan, Mexico, Micronesia (Federal States of), Netherlands Antilles, Nicaragua, Panama, Peru, Philippines, Taiwan, United States, Venezuela
36L8880	250V/10A 2.8M	Argentina, Paraguay, Uruguay
02K0546	250V/6A 2.8M	PRC (China)
6952300	125V/10A 2.8M	Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Cayman Islands, Costa Rica, Columbia, Cuba, Dominican Republic, Ecuador, El Salvador, Guam, Guatemala, Haiti, Honduras, Jamaica, Mexico, Micronesia (Federal States of), Netherlands Antilles, Nicaragua, Panama, Peru, Philippines, Saudi Arabia, Taiwan, Thailand, Turks and Caicos Islands, United States, Venezuela
6952301	125V/10A 1.8M	

Appendix F. Accessibility

This section provides information about alternate keyboard navigation, which is a DS 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 DS Storage Manager version 9.14 - 10.10 (and later) 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 - 10.10 (or later) 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 78 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 78. 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 78. DS4000 Storage Manager alternate keyboard operations (continued)

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

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Important notes

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

CD or DVD drive speed is the variable read rate. Actual speeds vary and are often less than the possible maximum.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for 1024 bytes, MB stands for 1 048 576 bytes, and GB stands for 1 073 741 824 bytes.

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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 that are available from IBM.

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Attention: Airborne particulates (including metal flakes or particles) and reactive gases acting alone or in combination with other environmental factors such as humidity or temperature might pose a risk to the storage subsystem that is described in this document. Risks that are posed by the presence of excessive particulate levels or concentrations of harmful gases include damage that might cause the storage subsystem to malfunction or cease functioning altogether. This specification sets forth limits for particulates and gases that are intended to avoid such damage. The limits must not be viewed or used as definitive limits, because numerous other factors, such as temperature or moisture content of the air, can influence the impact of particulates or environmental corrosives and gaseous contaminant transfer. In the absence of specific limits that are set forth in this document, you must implement practices that maintain particulate and gas levels that are consistent with the protection of human health and safety. If IBM determines that the levels of particulates or gases in your environment have caused damage to the storage subsystem, IBM may condition provision of repair or replacement of storage subsystem or parts on implementation of appropriate remedial measures to mitigate such environmental contamination. Implementation of such remedial measures is a customer responsibility.

Table 79. Limits for particulates and gases

Contaminant	Limits
Particulate	• The room air must be continuously filtered with 40% atmospheric dust spot efficiency (MERV 9) according to ASHRAE Standard 52.2[1]. • Air that enters a data center must be filtered to 99.97% efficiency or greater, using high-efficiency particulate air (HEPA) filters that meet MIL-STD-282. • The deliquescent relative humidity of the particulate contamination must be more than 60%[2]. • The room must be free of conductive contamination such as zinc whiskers.
Gaseous	• Copper: Class G1 as per ANSI/ISA 71.04-1985[3] • Silver: Corrosion rate of less than 300 Å in 30 days

[1] ASHRAE 52.2-2008 - *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

[2] The deliquescent relative humidity of particulate contamination is the relative humidity at which the dust absorbs enough water to become wet and promote ionic conduction.

[3] ANSI/ISA-71.04-1985. *Environmental conditions for process measurement and control systems: Airborne contaminants*. Instrument Society of America, Research Triangle Park, North Carolina, U.S.A.

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Germany Electromagnetic Compatibility Directive

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Glossary

This glossary defines the special terms, abbreviations, and acronyms used in this publication and other related 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:

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The following cross-reference conventions are used in this glossary:

See Refers you to (a) a term that is the expanded form of an abbreviation or acronym, or (b) a synonym or more preferred term.

See also
Refers you to a related term.

Abstract Windowing Toolkit (AWT). A Java graphical user interface (GUI).

accelerated graphics port (AGP). A bus specification that gives low-cost 3D graphics cards faster access to main memory on personal computers than the usual peripheral component interconnect (PCI) bus. AGP reduces the overall cost of creating high-end graphics subsystems by using existing system memory.

access volume. A special logical drive that allows the host-agent to communicate with the controllers in the storage subsystem.

adapter. A printed circuit assembly that transmits user data input/output (I/O) between the internal bus of the host system and the external fibre-channel (FC) link and vice versa. Also called an I/O adapter, host adapter, or FC adapter.

advanced technology (AT) bus architecture. A bus standard for IBM compatibles. It extends the XT bus architecture to 16 bits and also allows for bus mastering, although only the first 16 MB of main memory are available for direct access.

agent. A server program that receives virtual connections from the network manager (the client program) in a Simple Network Management Protocol-Transmission Control Protocol/Internet Protocol (SNMP-TCP/IP) network-managing environment.

AGP. See *accelerated graphics port*.

AL_PA. See *arbitrated loop physical address*.

arbitrated loop. One of three existing fibre-channel topologies, in which 2 - 126 ports are interconnected serially in a single loop circuit. Access to the Fibre

Channel Arbitrated Loop (FC-AL) is controlled by an arbitration scheme. The FC-AL topology supports all classes of service and guarantees in-order delivery of FC frames when the originator and responder are on the same FC-AL. The default topology for the disk array is arbitrated loop. An arbitrated loop is sometimes referred to as a Stealth Mode.

arbitrated loop physical address (AL_PA). An 8-bit value that is used to uniquely identify an individual port within a loop. A loop can have one or more AL_PAs.

array. A collection of fibre-channel or SATA hard drives that are logically grouped together. All the drives in the array are assigned the same RAID level. An array is sometimes referred to as a "RAID set." See also *redundant array of independent disks (RAID)*, *RAID level*.

asynchronous write mode. In remote mirroring, an option that allows the primary controller to return a write I/O request completion to the host server before data has been successfully written by the secondary controller. See also *synchronous write mode*, *remote mirroring*, *Global Copy*, *Global Mirroring*.

AT. See *advanced technology (AT) bus architecture*.

ATA. See *AT-attached*.

AT-attached. Peripheral devices that are compatible with the original IBM AT computer standard in which signals on a 40-pin AT-attached (ATA) ribbon cable followed the timings and constraints of the Industry Standard Architecture (ISA) system bus on the IBM PC AT computer. Equivalent to integrated drive electronics (IDE).

auto-volume transfer/auto-disk transfer (AVT/ADT). A function that provides automatic failover in case of controller failure on a storage subsystem.

AVT/ADT. See *auto-volume transfer/auto-disk transfer*.

AWT. See *Abstract Windowing Toolkit*.

basic input/output system (BIOS). The personal computer code that controls basic hardware operations, such as interactions with diskette drives, hard disk drives, and the keyboard.

BIOS. See *basic input/output system*.

BOOTP. See *bootstrap protocol*.

bootstrap protocol (BOOTP). In Transmission Control Protocol/Internet Protocol (TCP/IP) networking, an alternative protocol by which a diskless machine can obtain its Internet Protocol (IP) address and such

configuration information as IP addresses of various servers from a BOOTP server.

bridge.   A storage area network (SAN) device that provides physical and transport conversion, such as fibre channel to small computer system interface (SCSI) bridge.

bridge group.   A bridge and the collection of devices connected to it.

broadcast.   The simultaneous transmission of data to more than one destination.

cathode ray tube (CRT).   A display device in which controlled electron beams are used to display alphanumeric or graphical data on an electroluminescent screen.

client.   A computer system or process that requests a service of another computer system or process that is typically referred to as a server. Multiple clients can share access to a common server.

command.   A statement used to initiate an action or start a service. A command consists of the command name abbreviation, and its parameters and flags if applicable. A command can be issued by typing it on a command line or selecting it from a menu.

community string.   The name of a community contained in each Simple Network Management Protocol (SNMP) message.

concurrent download.   A method of downloading and installing firmware that does not require the user to stop I/O to the controllers during the process.

CRC.   See *cyclic redundancy check*.

CRT.   See *cathode ray tube*.

CRU.   See *customer replaceable unit*.

customer replaceable unit (CRU).   An assembly or part that a customer can replace in its entirety when any of its components fail. Contrast with *field replaceable unit (FRU)*.

cyclic redundancy check (CRC).   (1) A redundancy check in which the check key is generated by a cyclic algorithm. (2) An error detection technique performed at both the sending and receiving stations.

dac.   See *disk array controller*.

dar.   See *disk array router*.

DASD.   See *direct access storage device*.

data striping.   See *striping*.

default host group.   A logical collection of discovered host ports, defined host computers, and defined host groups in the storage-partition topology that fulfill the following requirements:

- Are not involved in specific logical drive-to-LUN mappings
- Share access to logical drives with default logical drive-to-LUN mappings

device type.   Identifier used to place devices in the physical map, such as the switch, hub, or storage.

DHCP.   See *Dynamic Host Configuration Protocol*.

direct access storage device (DASD).   A device in which access time is effectively independent of the location of the data. Information is entered and retrieved without reference to previously accessed data. (For example, a disk drive is a DASD, in contrast with a tape drive, which stores data as a linear sequence.) DASDs include both fixed and removable storage devices.

direct memory access (DMA).   The transfer of data between memory and an input/output (I/O) device without processor intervention.

disk array controller (dac).   A disk array controller device that represents the two controllers of an array. See also *disk array router*.

disk array router (dar).   A disk array router that represents an entire array, including current and deferred paths to all logical unit numbers (LUNs) (hdisks on AIX). See also *disk array controller*.

DMA.   See *direct memory access*.

domain.   The most significant byte in the node port (N_port) identifier for the fibre-channel (FC) device. It is not used in the fibre channel-small computer system interface (FC-SCSI) hardware path ID. It is required to be the same for all SCSI targets logically connected to an FC adapter.

drive channels.   The DS4200, DS4700, DS4800, DS5100, and DS5300 subsystems use dual-port drive channels that, from the physical point of view, are connected in the same way as two drive loops. However, from the point of view of the number of drives and enclosures, they are treated as a single drive loop instead of two different drive loops. A group of storage expansion enclosures are connected to the storage subsystems using a drive channel from each controller. This pair of drive channels is referred to as a redundant drive channel pair.

drive loops.   A drive loop consists of one channel from each controller combined to form one pair of redundant drive channels or a redundant drive loop. Each drive loop is associated with two ports. Drive loops are more commonly referred to as drive channels. See *drive channels*.

DRAM. See *dynamic random access memory*.

Dynamic Host Configuration Protocol (DHCP). A protocol defined by the Internet Engineering Task Force that is used for dynamically assigning Internet Protocol (IP) addresses to computers in a network.

dynamic random access memory (DRAM). A storage in which the cells require repetitive application of control signals to retain stored data.

ECC. See *error correction coding*.

EEPROM. See *electrically erasable programmable read-only memory*.

EISA. See *Extended Industry Standard Architecture*.

electrically erasable programmable read-only memory (EEPROM). A type of memory chip which can retain its contents without consistent electrical power. Unlike the PROM which can be programmed only once, the EEPROM can be erased electrically. Because it can only be reprogrammed a limited number of times before it wears out, it is appropriate for storing small amounts of data that are changed infrequently.

electrostatic discharge (ESD). The flow of current that results when objects that have a static charge come into close enough proximity to discharge.

environmental service module (ESM) canister. A component in a storage expansion enclosure that monitors the environmental condition of the components in that enclosure. Not all storage subsystems have ESM canisters.

E_port. See *expansion port*.

error correction coding (ECC). A method for encoding data so that transmission errors can be detected and corrected by examining the data on the receiving end. Most ECCs are characterized by the maximum number of errors they can detect and correct.

ESD. See *electrostatic discharge*.

ESM canister. See *environmental service module canister*.

automatic ESM firmware synchronization. When you install a new ESM into an existing storage expansion enclosure in a DS4000 storage subsystem that supports automatic ESM firmware synchronization, the firmware in the new ESM is automatically synchronized with the firmware in the existing ESM.

EXP. See *storage expansion enclosure*.

expansion port (E_port). A port that connects the switches for two fabrics.

Extended Industry Standard Architecture (EISA). A bus standard for IBM compatibles that extends the

Industry Standard Architecture (ISA) bus architecture to 32 bits and allows more than one central processing unit (CPU) to share the bus. See also *Industry Standard Architecture*.

fabric. A fibre channel entity which interconnects and facilitates logins of N_ports attached to it. The fabric is responsible for routing frames between source and destination N_ports using address information in the frame header. A fabric can be as simple as a point-to-point channel between two N-ports, or as complex as a frame-routing switch that provides multiple and redundant internal pathways within the fabric between F_ports.

fabric port (F_port). In a fabric, an access point for connecting a user's N_port. An F_port facilitates N_port logins to the fabric from nodes connected to the fabric. An F_port is addressable by the N_port connected to it. See also *fabric*.

FC. See *Fibre Channel*.

FC-AL. See *arbitrated loop*.

feature enable identifier. A unique identifier for the storage subsystem, which is used in the process of generating a premium feature key. See also *premium feature key*.

Fibre Channel (FC). A set of standards for a serial input/output (I/O) bus capable of transferring data between two ports at up to 100 Mbps, with standards proposals to go to higher speeds. FC supports point-to-point, arbitrated loop, and switched topologies.

Fibre Channel Arbitrated Loop (FC-AL). See *arbitrated loop*.

Fibre Channel Protocol (FCP) for small computer system interface (SCSI). A high-level fibre-channel mapping layer (FC-4) that uses lower-level fibre-channel (FC-PH) services to transmit SCSI commands, data, and status information between a SCSI initiator and a SCSI target across the FC link by using FC frame and sequence formats.

field replaceable unit (FRU). An assembly that is replaced in its entirety when any one of its components fails. In some cases, a field replaceable unit might contain other field replaceable units. Contrast with *customer replaceable unit (CRU)*.

FlashCopy. A premium feature for DS4000 that can make an instantaneous copy of the data in a volume.

F_port. See *fabric port*.

FRU. See *field replaceable unit*.

GBIC. See *gigabit interface converter*

gigabit interface converter (GBIC). A transceiver that performs serial, optical-to-electrical, and

electrical-to-optical signal conversions for high-speed networking. A GBIC can be hot swapped. See also *small form-factor pluggable*.

Global Copy.   Refers to a remote logical drive mirror pair that is set up using asynchronous write mode without the write consistency group option. This is also referred to as "Asynchronous Mirroring without Consistency Group." Global Copy does not ensure that write requests to multiple primary logical drives are carried out in the same order on the secondary logical drives as they are on the primary logical drives. If it is critical that writes to the primary logical drives are carried out in the same order in the appropriate secondary logical drives, Global Mirroring should be used instead of Global Copy. See also *asynchronous write mode*, *Global Mirroring*, *remote mirroring*, *Metro Mirroring*.

Global Mirroring.   Refers to a remote logical drive mirror pair that is set up using asynchronous write mode with the write consistency group option. This is also referred to as "Asynchronous Mirroring with Consistency Group." Global Mirroring ensures that write requests to multiple primary logical drives are carried out in the same order on the secondary logical drives as they are on the primary logical drives, preventing data on the secondary logical drives from becoming inconsistent with the data on the primary logical drives. See also *asynchronous write mode*, *Global Copy*, *remote mirroring*, *Metro Mirroring*.

graphical user interface (GUI).   A type of computer interface that presents a visual metaphor of a real-world scene, often of a desktop, by combining high-resolution graphics, pointing devices, menu bars and other menus, overlapping windows, icons, and the object-action relationship.

GUI.   See *graphical user interface.*

HBA.   See *host bus adapter*.

hdisk.   An AIX term representing a logical unit number (LUN) on an array.

heterogeneous host environment.   A host system in which multiple host servers, which use different operating systems with their own unique disk storage subsystem settings, connect to the same DS4000 storage subsystem at the same time. See also *host*.

host.   A system that is directly attached to the storage subsystem through a fibre-channel input/output (I/O) path. This system is used to serve data (typically in the form of files) from the storage subsystem. A system can be both a storage management station and a host simultaneously.

host bus adapter (HBA).   An interface between the fibre-channel network and a workstation or server.

host computer.   See *host*.

host group.   An entity in the storage partition topology that defines a logical collection of host computers that require shared access to one or more logical drives.

host port.   Ports that physically reside on the host adapters and are automatically discovered by the DS4000 Storage Manager software. To give a host computer access to a partition, its associated host ports must be defined.

hot swap.   To replace a hardware component without turning off the system.

hub.   In a network, a point at which circuits are either connected or switched. For example, in a star network, the hub is the central node; in a star/ring network, it is the location of wiring concentrators.

IBMSAN driver.   The device driver that is used in a Novell NetWare environment to provide multipath input/output (I/O) support to the storage controller.

IC.   See *integrated circuit*.

IDE.   See *integrated drive electronics*.

in-band.   Transmission of management protocol over the fibre-channel transport.

Industry Standard Architecture (ISA).   Unofficial name for the bus architecture of the IBM PC/XT personal computer. This bus design included expansion slots for plugging in various adapter boards. Early versions had an 8-bit data path, later expanded to 16 bits. The "Extended Industry Standard Architecture" (EISA) further expanded the data path to 32 bits. See also *Extended Industry Standard Architecture*.

initial program load (IPL).   The initialization procedure that causes an operating system to commence operation. Also referred to as a system restart, system startup, and boot.

integrated circuit (IC).   A microelectronic semiconductor device that consists of many interconnected transistors and other components. ICs are constructed on a small rectangle cut from a silicon crystal or other semiconductor material. The small size of these circuits allows high speed, low power dissipation, and reduced manufacturing cost compared with board-level integration. Also known as a *chip*.

integrated drive electronics (IDE).   A disk drive interface based on the 16-bit IBM personal computer Industry Standard Architecture (ISA) in which the controller electronics reside on the drive itself, eliminating the need for a separate adapter card. Also known as an Advanced Technology Attachment Interface (ATA).

Internet Protocol (IP). A protocol that routes data through a network or interconnected networks. IP acts as an intermediary between the higher protocol layers and the physical network.

Internet Protocol (IP) address. The unique 32-bit address that specifies the location of each device or workstation on the Internet. For example, 9.67.97.103 is an IP address.

interrupt request (IRQ). A type of input found on many processors that causes the processor to suspend normal processing temporarily and start running an interrupt handler routine. Some processors have several interrupt request inputs that allow different priority interrupts.

IP. See *Internet Protocol*.

IPL. See *initial program load*.

IRQ. See *interrupt request*.

ISA. See *Industry Standard Architecture*.

Java Runtime Environment (JRE). A subset of the Java Development Kit (JDK) for end users and developers who want to redistribute the Java Runtime Environment (JRE). The JRE consists of the Java virtual machine, the Java Core Classes, and supporting files.

JRE. See *Java Runtime Environment*.

label. A discovered or user entered property value that is displayed underneath each device in the Physical and Data Path maps.

LAN. See *local area network*.

LBA. See *logical block address*.

local area network (LAN). A computer network located on a user's premises within a limited geographic area.

logical block address (LBA). The address of a logical block. Logical block addresses are typically used in hosts' I/O commands. The SCSI disk command protocol, for example, uses logical block addresses.

logical partition (LPAR). (1) A subset of a single system that contains resources (processors, memory, and input/output devices). A logical partition operates as an independent system. If hardware requirements are met, multiple logical partitions can exist within a system. (2) A fixed-size portion of a logical volume. A logical partition is the same size as the physical partitions in its volume group. Unless the logical volume of which it is a part is mirrored, each logical partition corresponds to, and its contents are stored on, a single physical partition. (3) One to three physical partitions (copies). The number of logical partitions within a logical volume is variable.

logical unit number (LUN). An identifier used on a small computer system interface (SCSI) bus to distinguish among up to eight devices (logical units) with the same SCSI ID.

loop address. The unique ID of a node in fibre-channel loop topology sometimes referred to as a loop ID.

loop group. A collection of storage area network (SAN) devices that are interconnected serially in a single loop circuit.

loop port. A node port (N_port) or fabric port (F_port) that supports arbitrated loop functions associated with an arbitrated loop topology.

LPAR. See *logical partition*.

LUN. See *logical unit number*.

MAC. See *medium access control*.

management information base (MIB). The information that is on an agent. It is an abstraction of configuration and status information.

man pages. In UNIX-based operating systems, online documentation for operating system commands, subroutines, system calls, file formats, special files, stand-alone utilities, and miscellaneous facilities. Invoked by the **man** command.

MCA. See *micro channel architecture*.

media scan. A media scan is a background process that runs on all logical drives in the storage subsystem for which it has been enabled, providing error detection on the drive media. The media scan process scans all logical drive data to verify that it can be accessed, and optionally scans the logical drive redundancy information.

medium access control (MAC). In local area networks (LANs), the sublayer of the data link control layer that supports medium-dependent functions and uses the services of the physical layer to provide services to the logical link control sublayer. The MAC sublayer includes the method of determining when a device has access to the transmission medium.

Metro Mirroring. This term is used to refer to a remote logical drive mirror pair which is set up with synchronous write mode. See also *remote mirroring*, *Global Mirroring*.

MIB. See *management information base*.

micro channel architecture (MCA). Hardware that is used for PS/2 Model 50 computers and above to provide better growth potential and performance characteristics when compared with the original personal computer design.

Microsoft Cluster Server (MSCS). MSCS, a feature of Windows NT Server (Enterprise Edition), supports the connection of two servers into a cluster for higher availability and easier manageability. MSCS can automatically detect and recover from server or application failures. It can also be used to balance server workload and provide for planned maintenance.

mini hub. An interface card or port device that receives short-wave fiber channel GBICs or SFPs. These devices enable redundant fibre channel connections from the host computers, either directly or through a fibre channel switch or managed hub, over optical fiber cables to the DS4000 Storage Server controllers. Each DS4000 controller is responsible for two mini hubs. Each mini hub has two ports. Four host ports (two on each controller) provide a cluster solution without use of a switch. Two host-side mini hubs are shipped as standard. See also *host port, gigabit interface converter (GBIC), small form-factor pluggable (SFP)*.

mirroring. A fault-tolerance technique in which information on a hard disk is duplicated on additional hard disks. See also *remote mirroring*.

model. The model identification that is assigned to a device by its manufacturer.

MSCS. See *Microsoft Cluster Server*.

network management station (NMS). In the Simple Network Management Protocol (SNMP), a station that runs management application programs that monitor and control network elements.

NMI. See *non-maskable interrupt*.

NMS. See *network management station*.

non-maskable interrupt (NMI). A hardware interrupt that another service request cannot overrule (mask). An NMI bypasses and takes priority over interrupt requests generated by software, the keyboard, and other such devices and is issued to the microprocessor only in disastrous circumstances, such as severe memory errors or impending power failures.

node. A physical device that allows for the transmission of data within a network.

node port (N_port). A fibre-channel defined hardware entity that performs data communications over the fibre-channel link. It is identifiable by a unique worldwide name. It can act as an originator or a responder.

nonvolatile storage (NVS). A storage device whose contents are not lost when power is cut off.

N_port. See *node port*.

NVS. See *nonvolatile storage*.

NVSRAM. Nonvolatile storage random access memory. See *nonvolatile storage*.

Object Data Manager (ODM). An AIX proprietary storage mechanism for ASCII stanza files that are edited as part of configuring a drive into the kernel.

ODM. See *Object Data Manager*.

out-of-band. Transmission of management protocols outside of the fibre-channel network, typically over Ethernet.

partitioning. See *storage partition*.

parity check. (1) A test to determine whether the number of ones (or zeros) in an array of binary digits is odd or even. (2) A mathematical operation on the numerical representation of the information communicated between two pieces. For example, if parity is odd, any character represented by an even number has a bit added to it, making it odd, and an information receiver checks that each unit of information has an odd value.

PCI local bus. See *peripheral component interconnect local bus*.

PDF. See *portable document format*.

performance events. Events related to thresholds set on storage area network (SAN) performance.

peripheral component interconnect local bus (PCI local bus). A local bus for PCs, from Intel, that provides a high-speed data path between the CPU and up to 10 peripherals (video, disk, network, and so on). The PCI bus coexists in the PC with the Industry Standard Architecture (ISA) or Extended Industry Standard Architecture (EISA) bus. ISA and EISA boards plug into an IA or EISA slot, while high-speed PCI controllers plug into a PCI slot. See also *Industry Standard Architecture*, *Extended Industry Standard Architecture*.

polling delay. The time in seconds between successive discovery processes during which discovery is inactive.

port. A part of the system unit or remote controller to which cables for external devices (such as display stations, terminals, printers, switches, or external storage units) are attached. The port is an access point for data entry or exit. A device can contain one or more ports.

portable document format (PDF). A standard specified by Adobe Systems, Incorporated, for the electronic distribution of documents. PDF files are compact; can be distributed globally by e-mail, the Web, intranets, or CD-ROM; and can be viewed with the

Acrobat Reader, which is software from Adobe Systems that can be downloaded at no cost from the Adobe Systems home page.

premium feature key. A file that the storage subsystem controller uses to enable an authorized premium feature. The file contains the feature enable identifier of the storage subsystem for which the premium feature is authorized, and data about the premium feature. See also *feature enable identifier*.

private loop. A freestanding arbitrated loop with no fabric attachment. See also *arbitrated loop*.

program temporary fix (PTF). A temporary solution or bypass of a problem diagnosed by IBM in a current unaltered release of the program.

PTF. See *program temporary fix*.

RAID. See *redundant array of independent disks (RAID)*.

RAID level. An array's RAID level is a number that refers to the method used to achieve redundancy and fault tolerance in the array. See also *array, redundant array of independent disks (RAID)*.

RAID set. See *array*.

RAM. See *random-access memory*.

random-access memory (RAM). A temporary storage location in which the central processing unit (CPU) stores and executes its processes. Contrast with *DASD*.

RDAC. See *redundant disk array controller*.

read-only memory (ROM). Memory in which stored data cannot be changed by the user except under special conditions.

recoverable virtual shared disk (RVSD). A virtual shared disk on a server node configured to provide continuous access to data and file systems in a cluster.

redundant array of independent disks (RAID). A collection of disk drives (*array*) that appears as a single volume to the server, which is fault tolerant through an assigned method of data striping, mirroring, or parity checking. Each array is assigned a RAID level, which is a specific number that refers to the method used to achieve redundancy and fault tolerance. See also *array, parity check, mirroring, RAID level, striping*.

redundant disk array controller (RDAC). (1) In hardware, a redundant set of controllers (either active/passive or active/active). (2) In software, a layer that manages the input/output (I/O) through the active controller during normal operation and transparently reroutes I/Os to the other controller in the redundant set if a controller or I/O path fails.

remote mirroring. Online, real-time replication of data between storage subsystems that are maintained on separate media. The Enhanced Remote Mirror Option is a DS4000 premium feature that provides support for remote mirroring. See also *Global Mirroring*, *Metro Mirroring*.

ROM. See *read-only memory*.

router. A computer that determines the path of network traffic flow. The path selection is made from several paths based on information obtained from specific protocols, algorithms that attempt to identify the shortest or best path, and other criteria such as metrics or protocol-specific destination addresses.

RVSD. See *recoverable virtual shared disk*.

SAI. See *Storage Array Identifier*.

SA Identifier. See *Storage Array Identifier*.

SAN. See *storage area network*.

SATA. See *serial ATA*.

scope. Defines a group of controllers by their Internet Protocol (IP) addresses. A scope must be created and defined so that dynamic IP addresses can be assigned to controllers on the network.

SCSI. See *small computer system interface*.

segmented loop port (SL_port). A port that allows division of a fibre-channel private loop into multiple segments. Each segment can pass frames around as an independent loop and can connect through the fabric to other segments of the same loop.

sense data. (1) Data sent with a negative response, indicating the reason for the response. (2) Data describing an I/O error. Sense data is presented to a host system in response to a sense request command.

serial ATA. The standard for a high-speed alternative to small computer system interface (SCSI) hard drives. The SATA-1 standard is equivalent in performance to a 10 000 RPM SCSI drive.

serial storage architecture (SSA). An interface specification from IBM in which devices are arranged in a ring topology. SSA, which is compatible with small computer system interface (SCSI) devices, allows full-duplex packet multiplexed serial data transfers at rates of 20 Mbps in each direction.

server. A functional hardware and software unit that delivers shared resources to workstation client units on a computer network.

server/device events. Events that occur on the server or a designated device that meet criteria that the user sets.

SFP. See *small form-factor pluggable*.

SFP+. See *small form-factor pluggable*.

Simple Network Management Protocol (SNMP). In the Internet suite of protocols, a network management protocol that is used to monitor routers and attached networks. SNMP is an application layer protocol. Information on devices managed is defined and stored in the application's Management Information Base (MIB).

SL_port. See *segmented loop port*.

SMagent. The DS4000 Storage Manager optional Java-based host-agent software, which can be used on Microsoft Windows, Novell NetWare, AIX, HP-UX, Solaris, and Linux on POWER host systems to manage storage subsystems through the host fibre-channel connection.

SMclient. The DS4000 Storage Manager client software, which is a Java-based graphical user interface (GUI) that is used to configure, manage, and troubleshoot storage servers and storage expansion enclosures in a DS4000 storage subsystem. SMclient can be used on a host system or on a storage management station.

SMruntime. A Java compiler for the SMclient.

SMutil. The DS4000 Storage Manager utility software that is used on Microsoft Windows, AIX, HP-UX, Solaris, and Linux on POWER host systems to register and map new logical drives to the operating system. In Microsoft Windows, it also contains a utility to flush the cached data of the operating system for a particular drive before creating a FlashCopy.

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

small form-factor pluggable (SFP or 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). An SFP+ is an enhanced standard SFP. 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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