

IBM TotalStorage DS4400
Fibre Channel Storage Server



Installation and Support Guide

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Fibre Channel Storage Server



Installation and Support Guide

Note

Before using this information and the product it supports, be sure to read the general information under “Notices” on page 57.

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Safety

Before installing this product, read the Safety Information.

قبل تركيب هذا المنتج، يجب قراءة الملاحظات الأمنية

Antes de instalar este produto, leia as Informações de Segurança.

在安装本产品之前，请仔细阅读 **Safety Information** (安全信息)。

安裝本產品之前，請先閱讀「安全資訊」。

Prije instalacije ovog produkta obavezno pročitajte Sigurnosne Upute.

Před instalací tohoto produktu si přečtěte příručku bezpečnostních instrukcí.

Læs sikkerhedsforskrifterne, før du installerer dette produkt.

Lees voordat u dit product installeert eerst de veiligheidsvoorschriften.

Ennen kuin asennat tämän tuotteen, lue turvaohjeet kohdasta Safety Information.

Avant d'installer ce produit, lisez les consignes de sécurité.

Vor der Installation dieses Produkts die Sicherheitshinweise lesen.

Πριν εγκαταστήσετε το προϊόν αυτό, διαβάστε τις πληροφορίες ασφάλειας (safety information).

לפני שתתקינו מוצר זה, קראו את הוראות הבטיחות.

A termék telepítése előtt olvassa el a Biztonsági előírásokat!

Prima di installare questo prodotto, leggere le Informazioni sulla Sicurezza

製品の設置の前に、安全情報をお読みください。

본 제품을 설치하기 전에 안전 정보를 읽으십시오.

Пред да се инсталира овој продукт, прочитајте информацијата за безбедност.

Les sikkerhetsinformasjonen (Safety Information) før du installerer dette produktet.

Przed zainstalowaniem tego produktu, należy zapoznać się z książką "Informacje dotyczące bezpieczeństwa" (Safety Information).

Antes de instalar este produto, leia as Informações sobre Segurança.

Перед установкой продукта прочтите инструкции по технике безопасности.

Pred inštaláciou tohto zariadenia si pečítajte Bezpečnostné predpisy.

Pred namestitvijo tega proizvoda preberite Varnostne informacije.

Antes de instalar este producto lea la información de seguridad.

Läs säkerhetsinformationen innan du installerar den här produkten.

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 IBM Part Number 33F8354 or 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

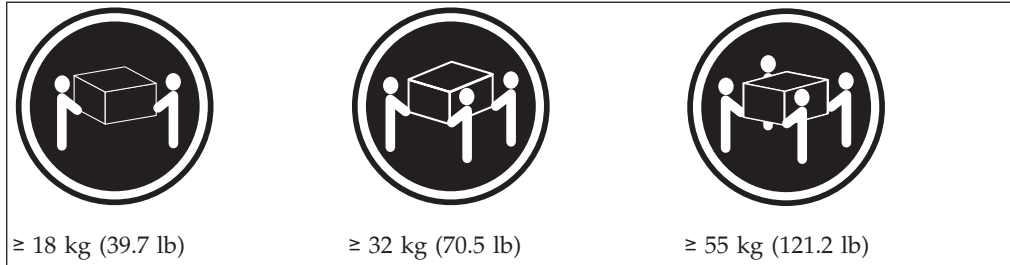
Some laser products contain an embedded Class 3A or Class 3B laser diode. Note the following.

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

Statement 4:



CAUTION:

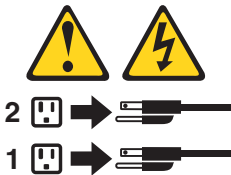
Use safe practices when lifting.

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.

About this book

This book provides instructions for setting up, installing, and connecting your IBM® TotalStorage™ DS4400 Fibre Channel Storage Server. This installation guide is intended for system operators and service technicians who have extensive knowledge of Fibre Channel and network technology.

FAST product renaming

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

Table 1. Mapping of FAST names to DS4000 Series names

| Current FAST Product Name | New DS4000 Product Name |
|---|--|
| IBM TotalStorage FAST Storage Server | IBM TotalStorage DS4000 |
| FAST | DS4000 |
| FAST Family | DS4000 Mid-range Disk System |
| FAST Storage Manager vX.Y (for example v9.10) | DS4000 Storage Manager vX.Y (for example v9.10) |
| FAST100 | DS4100 |
| FAST600 | DS4300 |
| FAST600 with Turbo Feature | DS4300 Turbo |
| FAST700 | DS4400 |
| FAST900 | DS4500 |
| EXP700 | DS4000 EXP700 |
| EXP710 | DS4000 EXP710 |
| EXP100 | DS4000 EXP100 |
| FAST FlashCopy | FlashCopy for DS4000 |
| FAST VolumeCopy | VolumeCopy for DS4000 |
| FAST Remote Mirror (RM) | Enhanced Remote Mirroring for DS4000 |
| FAST Synchronous Mirroring | Metro Mirroring for DS4000 |
| | Global Copy for DS4000 (New Feature = Asynchronous Mirroring without Consistency Group) |
| | Global Mirroring for DS4000 (New Feature = Asynchronous Mirroring with Consistency Group) |

Who should read this document

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

How this book is organized

Chapter 1, “Introduction and installation,” on page 1 introduces the IBM DS4400 Fibre Channel Storage Server and contains set up instructions. This chapter also includes an overview of the IBM DS4400 Fibre Channel Storage Server features and components.

Chapter 2, “Connecting the DS4400 Storage Server,” on page 15 provides information about the components that connect the DS4400 Storage Server to the Fibre Channel network and instructions for connecting the DS4400 Storage Server to other Fibre Channel devices.

Chapter 3, “Starting the DS4400 Storage Server,” on page 43 provides information about connecting the power cords, turning the power on and off, checking the indicator lights, and installing the IBM Storage Manager software.

“Accessibility,” on page 55 provides information about DS4000 Storage Manager accessibility features.

“Notices” on page 57 provides product notices.

Notices and statements in this book

The caution and danger statements used in this book also appear in the multilingual *Safety Information* book provided with your IBM DS4400 Fibre Channel Storage Server. Each caution and danger statement is numbered for easy reference to the corresponding statements in the safety book.

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

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

DS4000 installation process overview

Attention: For the latest product information, go to the following Web site:
www.ibm.com/servers/storage/support/disk/

The following flow chart gives an overview of the DS4000 hardware and the DS4000 Storage Manager software installation process. Lined arrows in the flow chart indicate consecutive steps in the hardware and software installation process. Labeled arrows indicate which current documents provide detailed information about those steps.

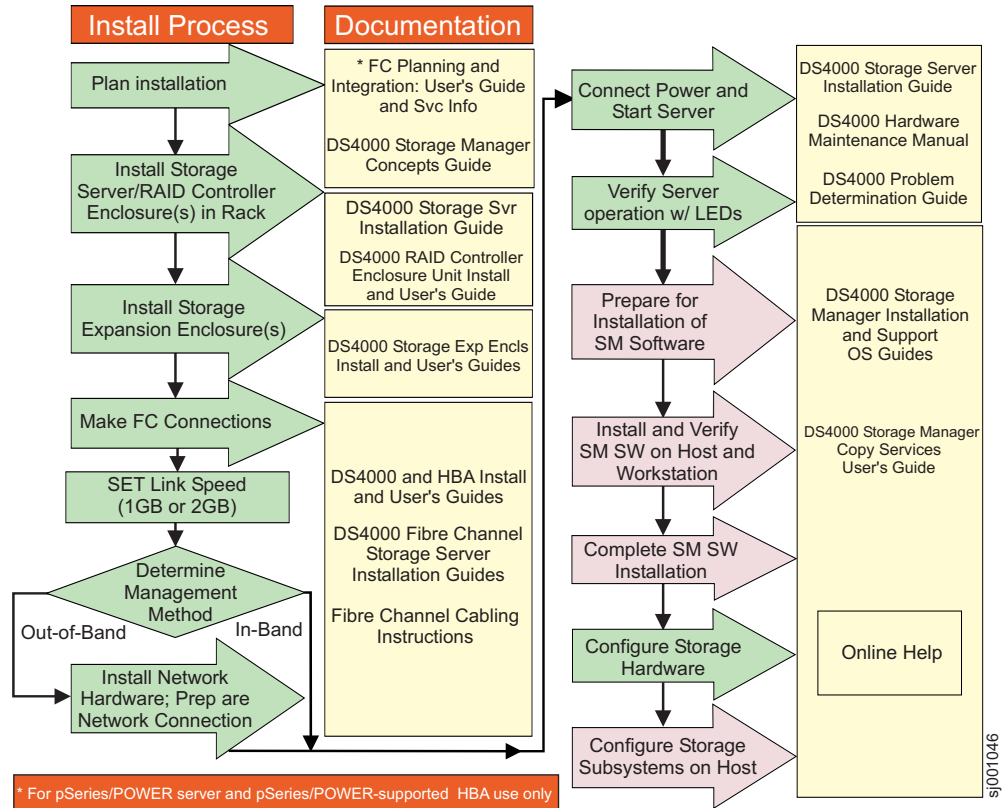


Figure 1. Installation process flow by current publications

DS4000 Storage Server publications

The following tables present an overview of the DS4500, DS4400, DS4300 Fibre Channel, and DS4100 SATA Storage Server product libraries, as well as other related documents. Each table lists documents that are included in the libraries and what common tasks they address.

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

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

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

DS4500 storage server library

Table 2 on page xviii associates each document in the DS4500 (previously FAST900) storage server library with its related common user tasks.

Table 2. TotalStorage DS4500 Fibre Channel Storage Server document titles by user tasks

| Title | User Tasks | | | | | |
|--|------------|-----------------------|-----------------------|---------------|------------------------------|---------------------------|
| | Planning | Hardware Installation | Software Installation | Configuration | Operation and Administration | Diagnosis and Maintenance |
| <i>IBM TotalStorage DS4500 Installation and Support Guide, GC26-7727</i> | ✓ | ✓ | | ✓ | | |
| <i>IBM TotalStorage DS4500 Fibre Channel Cabling Instructions, GC26-7729</i> | ✓ | ✓ | | | | |
| <i>IBM TotalStorage DS4500 Storage Server User's Guide, GC26-7726</i> | | | | ✓ | ✓ | ✓ |
| <i>IBM TotalStorage DS4500 Rack Mounting Instructions, GC26-7728</i> | ✓ | ✓ | | | | |

DS4400 storage server library

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

Table 3. TotalStorage DS4400 Fibre Channel Storage Server document titles by user tasks

| Title | User Tasks | | | | | |
|--|------------|-----------------------|-----------------------|---------------|------------------------------|---------------------------|
| | Planning | Hardware Installation | Software Installation | Configuration | Operation and Administration | Diagnosis and Maintenance |
| <i>IBM DS4400 Fibre Channel Storage Server User's Guide, GC26-7730</i> | ✓ | ✓ | | ✓ | ✓ | ✓ |
| <i>IBM DS4400 Fibre Channel Storage Server Installation and Support Guide, GC26-7731</i> | ✓ | ✓ | | ✓ | ✓ | |
| <i>IBM DS4400 Fibre Channel Cabling Instructions, GC26-7732</i> | ✓ | ✓ | | | | |

DS4300 storage server library

Table 4 associates each document in the DS4300 (previously FASSt600) storage server library with its related common user tasks.

Table 4. TotalStorage DS4300 Fibre Channel Storage Server document titles by user tasks

| Title | User Tasks | | | | | |
|---|------------|-----------------------|-----------------------|---------------|------------------------------|---------------------------|
| | Planning | Hardware Installation | Software Installation | Configuration | Operation and Administration | Diagnosis and Maintenance |
| IBM TotalStorage DS4300 Fibre Channel Storage Server Installation and User's Guide, GC26-7722 | ✓ | ✓ | | ✓ | | |
| IBM TotalStorage DS4300 Rack Mounting Instructions, GC26-7724 | ✓ | ✓ | | | | |
| IBM TotalStorage DS4300 Fibre Channel Cabling Instructions, GC26-7725 | ✓ | ✓ | | | | |
| IBM TotalStorage DS4300 SCU Base Upgrade Kit, GC26-7740 | | ✓ | ✓ | | | |
| IBM TotalStorage DS4300 SCU Turbo Upgrade Kit, GC26-7741 | | ✓ | ✓ | | | |
| IBM TotalStorage DS4300 Turbo Models 6LU/6LX Upgrade Kit, GC26-7723 | | ✓ | ✓ | | | |

DS4100 storage server library

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

Table 5. TotalStorage DS4100 SATA Storage Server document titles by user tasks

| Title | User Tasks | | | | | |
|--|------------|-----------------------|-----------------------|---------------|------------------------------|---------------------------|
| | Planning | Hardware Installation | Software Installation | Configuration | Operation and Administration | Diagnosis and Maintenance |
| <i>IBM TotalStorage DS4100 Installation, User's and Maintenance Guide, GC26-7733</i> | ✓ | ✓ | | ✓ | ✓ | ✓ |
| <i>IBM TotalStorage DS4100 Cabling Guide, 24P8973</i> | | ✓ | | | | |

DS4000 Storage Manager Version 9 publications

Table 6 associates each document in the DS4000 Storage Manager (previously FAStT Storage Manager) library with its related common user tasks.

Table 6. TotalStorage DS4000 Storage Manager Version 9 titles by user tasks

| Title | User tasks | | | | | |
|---|------------|-----------------------|-----------------------|---------------|------------------------------|---------------------------|
| | Planning | Hardware installation | Software installation | Configuration | Operation and administration | Diagnosis and maintenance |
| <i>IBM TotalStorage DS4000 Storage Manager Version 9 Installation and Support Guide for Windows 2000/Server 2003, NetWare, ESX Server, and Linux, GC26-7706</i> | ✓ | | ✓ | ✓ | | |
| <i>IBM TotalStorage DS4000 Storage Manager Version 9 Installation and Support Guide for AIX, HP-UX, Solaris and Linux on POWER, GC26-7705</i> | ✓ | | ✓ | ✓ | | |
| <i>IBM TotalStorage DS4000 Storage Manager Version 9 Copy Services User's Guide, GC26-7707</i> | ✓ | | ✓ | ✓ | ✓ | |
| <i>IBM TotalStorage DS4000 Storage Manager Version 9 Concepts Guide, GC26-7734</i> | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Other DS4000 and DS4000-related documents

Table 7 associates each of the following documents with its related common user tasks.

Table 7. TotalStorage DS4000 and DS4000–related document titles by user tasks

| Title | User Tasks | | | | | |
|--|------------|-----------------------|-----------------------|---------------|------------------------------|---------------------------|
| | Planning | Hardware Installation | Software Installation | Configuration | Operation and Administration | Diagnosis and Maintenance |
| <i>IBM Safety Information, P48P9741</i> | | | | | ✓ | |
| <i>IBM TotalStorage DS4000 Quick Start Guide, GC26-7738</i> | ✓ | ✓ | | | | |
| <i>IBM TotalStorage DS4000 Hardware Maintenance Manual, GC26-7702</i> | | | | | | ✓ |
| <i>IBM TotalStorage DS4000 Problem Determination Guide, GC26-7703</i> | | | | | | ✓ |
| <i>IBM Fibre Channel Planning and Integration: User's Guide and Service Information, SC23-4329</i> | ✓ | ✓ | | | ✓ | ✓ |
| <i>IBM TotalStorage DS4000 FC2-133 Host Bus Adapter Installation and User's Guide, GC26-7736</i> | | ✓ | | | ✓ | |
| <i>IBM TotalStorage DS4000 FC2-133 Dual Port Host Bus Adapter Installation and User's Guide, GC26-7737</i> | | ✓ | | | ✓ | |
| <i>IBM TotalStorage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview GC26-7713</i> | ✓ | ✓ | ✓ | ✓ | | |
| <i>Fibre Channel Solutions - IBM DS4000 EXP500 Installation and User's Guide, 59p5637</i> | ✓ | ✓ | | ✓ | ✓ | ✓ |

Table 7. TotalStorage DS4000 and DS4000–related document titles by user tasks (continued)

| Title | User Tasks | | | | | |
|--|------------|-----------------------|-----------------------|---------------|------------------------------|---------------------------|
| | Planning | Hardware Installation | Software Installation | Configuration | Operation and Administration | Diagnosis and Maintenance |
| <i>IBM TotalStorage DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide, GC26-7735</i> | ✓ | ✓ | | ✓ | ✓ | ✓ |
| <i>IBM TotalStorage DS4000 Hard Drive and Storage Expansion Enclosures Installation and Migration Guide, GC26-7704</i> | ✓ | ✓ | | | | |
| <i>IBM DS4000 Management Suite Java User's Guide, 32P0081</i> | | | | | ✓ | ✓ |
| <i>IBM Netfinity® Fibre Channel Cabling Instructions, 19K0906</i> | | ✓ | | | | |
| <i>IBM Fibre Channel SAN Configuration Setup Guide, 25P2509</i> | ✓ | | ✓ | ✓ | ✓ | |

Getting information, help and service

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

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 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 DS4000 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 servers, 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.

Web sites

The most up-to-date information about DS4000 storage servers and DS4000 Storage Manager, including documentation and the most recent software, firmware, and NVSRAM downloads, can be found at the following Web sites.

DS4000 Fibre Channel storage servers

Find the latest information about IBM TotalStorage disk storage systems, including all of the DS4000 storage servers:

<http://www.ibm.com/servers/storage/disk/index.html>

IBM TotalStorage products

Find information about all IBM TotalStorage products:

www.storage.ibm.com/

TotalStorage DS4000 interoperability matrix

Find the latest information about operating system and HBA support, clustering support, storage area network (SAN) fabric support, and DS4000 Storage Manager feature support:

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

DS4000 Storage Manager readme files

Find the latest readme files for DS4000 Storage Manager:

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

Click the link for your DS4000 storage server. When the page opens, click the Download tab. Click the link for **Current recommended Firmware and Storage Manager**. In the tables, find the Storage Manager listing for your operating system and click the **v9.1x** link in the Current Version column.

Storage Area Network (SAN) support

Find information about using SAN switches, including links to user guides and other documents:

www.ibm.com/servers/storage/support/san/index.html

DS4000 technical support

Find DS4000 downloads, hints and tips, documentation, parts information, HBA and Fibre Channel support:

<http://www.ibm.com/servers/storage/support/disk/>

Premium feature activation

Enable a premium feature on a DS4000 storage server by using the online tool:

www.storage.ibm.com/pfeatures.html

IBM publications center

Find IBM publications:

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

How to send your comments

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

- E-mail

Submit your comments electronically to:

starpubs@us.ibm.com

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

- Mail

Fill out the Readers' Comments form (RCF) at the back of this document and return it by mail or give it to an IBM representative. If the RCF has been removed, you can address your comments to:

International Business Machines Corporation
Information Development
Department GZW
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Chapter 1. Introduction and installation

Thank you for purchasing an IBM TotalStorage DS4000 series product. IBM DS4000 series solutions are designed to support the large and growing data storage requirements of business-critical applications. These scalable DS4000 series solutions provide data access and protection to meet existing enterprise storage requirements and future needs.

Fibre Channel is a technology similar to a high-speed network that connects large amounts of disk storage to a server or cluster of servers. Fibre Channel technology helps increase performance, scalability, availability, and the distance that attached storage subsystems can be from network servers. The IBM DS4400 Fibre Channel Storage Server (machine type 1742, models 1RU and 1RX) supports Fibre Channel disk drives to maximize performance and redundancy.

Fibre Channel technology supports applications that require large amounts of disk storage shared by two or more servers. With Fibre Channel, higher throughput rates over longer distances (up to 10 km) are possible than with small computer system interface (SCSI) or Serial Storage Architecture (SSA) technology.

The IBM DS4400 Fibre Channel Storage Server (referred to throughout this book as DS4400 Storage Server) is a high-performance unit that provides dual, redundant RAID controllers with Fibre Channel interfaces to both the host and drive loops. The DS4400 Storage Server has redundant cooling, redundant power, and battery backup of the controller cache.

Designed to provide maximum host and drive-side redundancy, the DS4400 Storage Server supports direct attachment of up to four hosts containing two host adapters each. Using external Fibre Channel switches in conjunction with the DS4400 Storage Server, you can attach up to 256 hosts with two adapters each to a DS4400 Storage Server using controller firmware version 06.xx.xx.xx or higher.

The DS4400 Storage Server functions with at least one external fibre channel or SATA storage expansion enclosure containing fibre channel hard drives. The DS4400 Storage Server supports a maximum of 224 hard drives when using DS4000 EXP700, DS4000 EXP710, or DS4000 EXP100 storage expansion enclosures. If the fibre channel drives are configured using EXP500 storage expansion enclosures only, a maximum of 220 hard drives are supported.

In order to attach DS4000 EXP100 or EXP710 storage expansion enclosures to a DS4400 Storage Server, the DS4400 Storage Server controller firmware must be at version 06.xx.xx.xx or higher. In addition, you must purchase the FC/SATA Enclosure Intermix premium option to combine EXP100s with EXP700s or EXP710s in the same DS4400 Storage Server configuration.

This chapter provides descriptions of the primary components of the DS4400 Storage Server and contains setup instructions. The DS4400 Storage Server is used with rack-mounted storage expansion enclosures. Figure 2 on page 2 shows the IBM DS4400 Fibre Channel Storage Server.

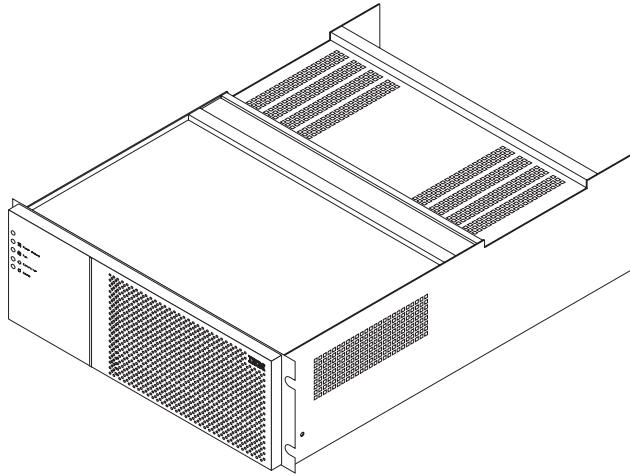


Figure 2. IBM DS4400 Fibre Channel Storage Server

Inventory checklist

The IBM DS4400 Fibre Channel Storage Server comes with the following hardware:

- Two power cords
- One rack-mounting hardware kit:
 - Two rails (right and left)
 - Eight black M6 hex-head screws
 - Eight clip nuts
 - Eight cage nuts

The IBM DS4400 Fibre Channel Storage Server comes with the following software and documentation:

- A Storage Manger version 9.1 support for Linux CD, a Storage Manger version 9.1 support for Netware CD, and a Storage Manager version 9.1 CD support for Microsoft Windows 2000 and Windows Server 2003, each including:
 - Storage Manager version 9.1 host software for appropriate OS.
 - Controller firmware and NVSRAM, storage expansion enclosure ESM firmware, and supported FC HBA drivers.
 - Publications in Adobe Acrobat Portable Document Format (PDF).
- Rack mounting assembly kit including:
 - *Rack Mounting Instructions*
 - *Rack Mounting Template*
 - White tape dots
- *IBM DS4400 Fibre Channel Cabling Instructions*

To connect the DS4400 Storage Server to other devices, you might need the following hardware options, which are purchased separately:

- IBM Small Form-Factor Pluggable (SFP) Module
- IBM LC-LC Fibre Channel Cable
- IBM LC-SC Fibre Channel Cable Adapter
- IBM DS4400 Mini Hub

DS4400 Storage Server components

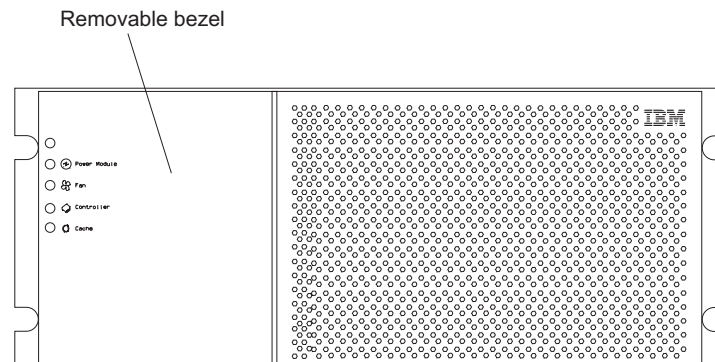
The DS4400 Storage Server has the following removable components, called customer replaceable units (CRUs). All CRUs are accessible from the front or back of the DS4400 Storage Server.

- Bezel (front cover)
- RAID controller (comes with two)
- Battery
- Storage server fan
- Power supply (comes with two)
- Host mini hub (comes with two, four maximum)
- Drive mini hub (comes with two, four maximum)
- Fan and communications module
- Small Form-Factor Pluggable (SFP) module (must be purchased separately)

Attention: The DS4400 controller units are not compatible with the controller units from FAST500 or DS4500 Fibre Channel storage servers. DS4500 controller units normally have the metallic gold latch handle. Do not mix FAST500 or DS4500 controller units with IBM DS4400 controller units in the same storage server units. The DS4400 or FAST500 controller units are not keyed, while the DS4500 controller units are keyed to prevent them from being mistakenly inserted in the non-supported storage server units. Do not force the controller units or the backplane might be damaged. Before installing new controller units, check that you have the correct controller unit type, and contact IBM support if you have any doubts.

Figure 3 on page 4 shows the DS4400 Storage Server front bezel. The bezel is a removable front cover with holes for viewing status lights and for boosting air circulation. Figure 3 on page 4 also shows the IBM DS4400 Storage Server without the front bezel, exposing the following components:

- **Storage server fan** - A removable unit that contains two cooling fans and indicator lights.
- **Battery** - A removable unit that contains the cache battery, battery charger circuitry, and status indicator lights for the controllers.
- **Controllers** - Two removable units that each contain one RAID controller with 1 Gb cache memory and status indicator lights.



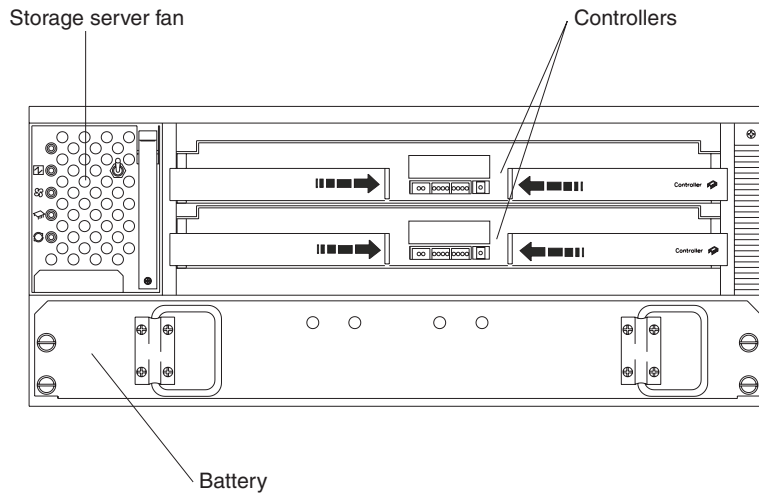


Figure 3. IBM DS4400 Fibre Channel Storage Server - front view

Figure 4 shows the DS4400 Storage Server back view and the following components:

- **Host-side and drive-side mini hubs** - Up to eight removable mini hubs with indicator lights to which you can insert Small Form-Factor Pluggable (SFP) modules and connect fiber-optic host and drive interface cables to the DS4400 Storage Server (the standard DS4400 configuration includes two host and two drive mini hubs).
- **Power supplies** - Two removable units that each contain a power supply and an indicator light.
- **Fan and communications module** - A removable unit that contains the power supply cooling fans, an indicator light, and Ethernet ports.

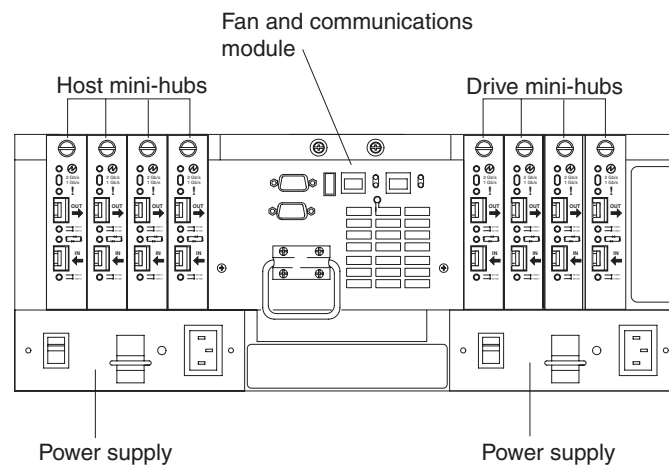


Figure 4. IBM DS4400 Fibre Channel Storage Server - back view

Product updates

Important

In order to keep your system up to date with the latest firmware and other product updates, use the information below to register and use the **My support** web site.

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

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

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

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

Perform the following steps to receive product updates:

1. After you have registered, type your user ID and password to log into the site. The **My support** page opens.
 2. Click **add products**. A pull-down menu displays.
 3. In the pull-down menu, select **Storage**. Another pull-down menu displays.
 4. In the new pull-down menu, and in the subsequent pull-down menus that display, select the following topics:
 - **Computer Storage**
 - **Disk Storage Systems**
 - **TotalStorage DS4000 Midrange Disk Systems & FAStT Stor Svrs**
- Note:** During this process a check list displays. Do not check any of the items in the check list until you complete the selections in the pull-down menus.
5. When you finish selecting the menu topics, place a check in the box for the machine type of your DS4000 series product, as well as any other attached DS4000 series product(s) for which you would like to receive information, then click **Add products**. The **My support** page opens again.
 6. On the **My support** page, click the **Edit profile** tab, then click **Subscribe to email**. A pull-down menu displays.
 7. In the pull-down menu, select **Storage**. A check list displays.
 8. Place a check in each of the following boxes:
 - a. **Please send these documents by weekly email**
 - b. **Downloads and drivers**
 - c. **Flashes**and any other topics that you may be interested in, and then click **Update**.
 9. Click **Sign out** to log out of My Support.

Operating specifications

Table 8 summarizes the operating specifications of the DS4400 Storage Server.

Table 8. IBM DS4400 Fibre Channel Storage Server operating specifications

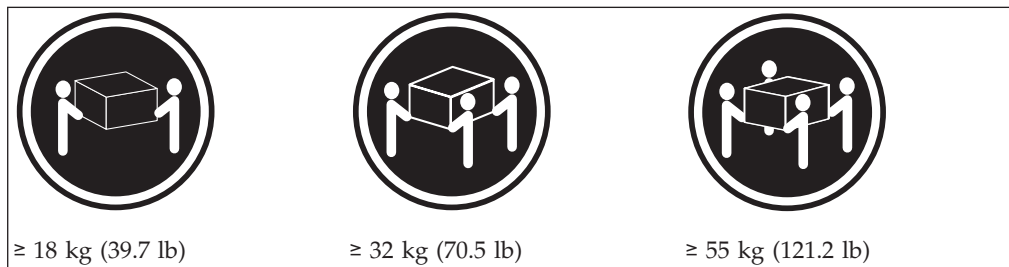
| | | |
|--|---|--|
| <p>Size (with front panel and without mounting rails):</p> <ul style="list-style-type: none"> • Depth: 63.5 cm (25 in.) • Height: 17.45 cm (6.87 in.) • Width: 48.2 cm (18.97 in.) <p>Weight:</p> <p>Typical DS4400 Storage Server fully configured: 43.99 kg (97 lbs)</p> <p>Electrical input:</p> <ul style="list-style-type: none"> • Sine-wave input (50 to 60 Hz) is required • Input voltage: <ul style="list-style-type: none"> – Low range: <ul style="list-style-type: none"> - Minimum: 90 V ac - Maximum: 136 V ac – High range: <ul style="list-style-type: none"> - Minimum: 198 V ac - Maximum: 257 V ac – Input kilovolt-amperes (kVA) approximately: 0.214 kVA | <p>Environment:</p> <ul style="list-style-type: none"> • Air temperature: <ul style="list-style-type: none"> – Altitude: 0 to 914 m (3000 ft): 10° to 35° C (50° to 95° F) – Altitude: 914 m (3000 ft) to 2133 m (7000 ft): 10° to 32° C (50° to 90° F) • Humidity: 10% to 80% non-condensing | <p>Acoustical noise emissions values: For typical system configurations:</p> <ul style="list-style-type: none"> • Sound power (idling and operating): 6.5 bels • Sound pressure (idling and operating): 65 dBA <p>These levels are measured in controlled acoustical environments according to ISO 7779 and are reported in accordance with ISO 9296. The declared sound power levels indicate an upper limit, below which a large portion of machines operate. Sound pressure levels in your location might exceed the average 1-meter values stated because of room reflections and other nearby noise.</p> |
|--|---|--|

Preparing for installation

Use the following procedure to prepare the DS4400 Storage Server for installation into a rack cabinet.

1. Prepare the site to meet all area, environmental, power, and site requirements. For more information, see “Operating specifications” on page 7.
2. Move the DS4400 Storage Server and its rack cabinet to the site.

Statement 4:



CAUTION:

Use safe practices when lifting.

3. Remove the DS4400 Storage Server from its shipping container and check the contents (see “Inventory checklist” on page 2). If any items are missing, contact your IBM reseller before proceeding.
4. Assemble the tools and equipment you will need for installation. These might include:
 - Power cords (comes with the DS4400 Storage Server)
 - Number two Phillips and medium flat-blade screwdrivers
 - Antistatic protection (such as a grounding wrist strap)
 - Fibre Channel (FC) and Ethernet interface cables and cable straps
 - Rack-mounting hardware (comes with the DS4400 Storage Server)
 - IBM Storage Manager software to configure the storage subsystems (comes with the DS4400 Storage Server)

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 package until you are ready to install them.

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

- Limit your movement. Movement can cause static electricity to build up around you.
- Handle the device carefully, holding it by its edges or its frame.
- Do not touch solder joints, pins, or exposed printed circuitry.
- Do not leave the device where others can handle and possibly damage the device.

- While the device is still in its static-protective package, touch it to an unpainted metal part of the system unit for at least two seconds. (This drains static electricity from the package and from your body.)
- Remove the device from its package and install it directly into your system unit without setting it down. If it is necessary to set the device down, place it in its static-protective package. Do not place the device on your system unit cover or on a metal table.
- Take additional care when handling devices during cold weather because heating reduces indoor humidity and increases static electricity.

Installing the DS4400 Storage Server in a rack cabinet

The DS4400 Storage Server comes with a rack-mounting hardware kit for installation into a rack cabinet. It is easier to lift the DS4400 Storage Server and install it in a rack cabinet if you remove all CRUs first. A fully loaded DS4400 Storage Server with a storage server fan, battery, fan and communications module, two RAID controllers, two power supplies, and eight mini hubs installed weighs 43.99 kg (97 lbs). If you remove all the CRUs, you reduce the overall weight.

For detailed instructions about removing the CRUs and installing the DS4400 Storage Server in a rack cabinet, refer to the *Rack Mounting Template* and *Rack Mounting Instructions* that come with the DS4400 Storage Server. If you have not already done so, read “Preparing for installation” on page 8 before you begin.

Installing additional hardware

You might need to install additional hardware if your Fibre Channel network is configured for the following:

- Host-agent (in-band) management of storage subsystem
- Direct (out-of-band) management of storage subsystem
- Cluster server environment

Use the information in the following sections to determine the additional hardware that you need.

Installing hardware for host-agent (in-band) management

If you are using the host-agent (in-band) method to manage storage subsystems, the host-agent software is installed on the host computer. You must install at least one management station and host computer; then, attach the Ethernet cables from the host computer to the management station. Figure 5 shows host-agent (in-band) managed storage subsystems.

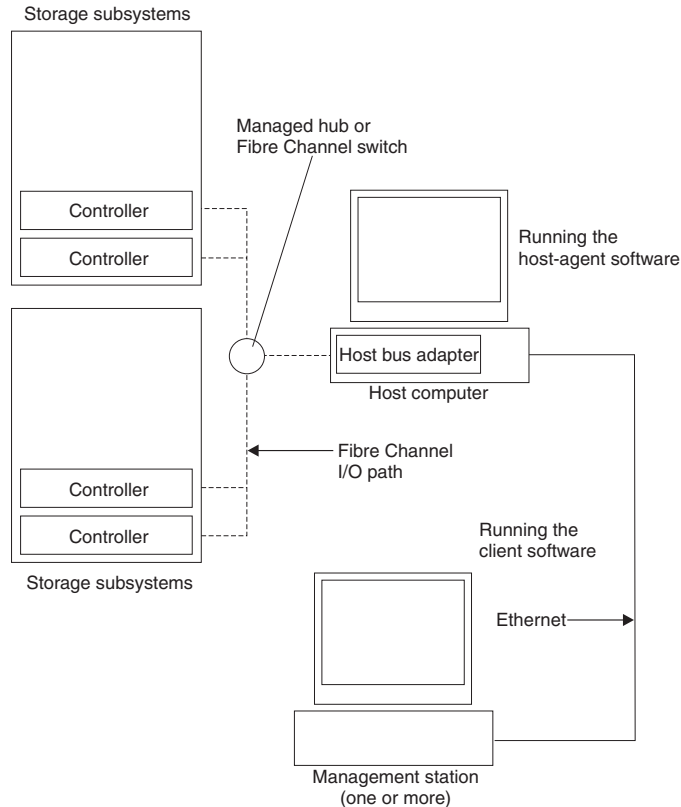


Figure 5. Host agent (in-band) managed storage subsystems

You will connect fiber-optic cables to each controller later in the installation process.

After you install the hardware, if your Fibre Channel network environment is configured for cluster servers, go to "Installing hardware for cluster servers" on page 11.

If you are installing storage expansion enclosures in a rack cabinet, go to "Installing storage expansion enclosures in a rack cabinet" on page 13. Otherwise, go to Chapter 2, "Connecting the DS4400 Storage Server," on page 15.

Installing hardware for direct (out-of-band) management

If you are using the direct (out-of-band) method to manage storage subsystems, use Ethernet connections from a management station to each controller. You must install at least one management station and then attach Ethernet cables to each management station and two Ethernet cables per DS4400 Storage Server. Figure 6 shows direct (out-of-band) managed storage subsystems.

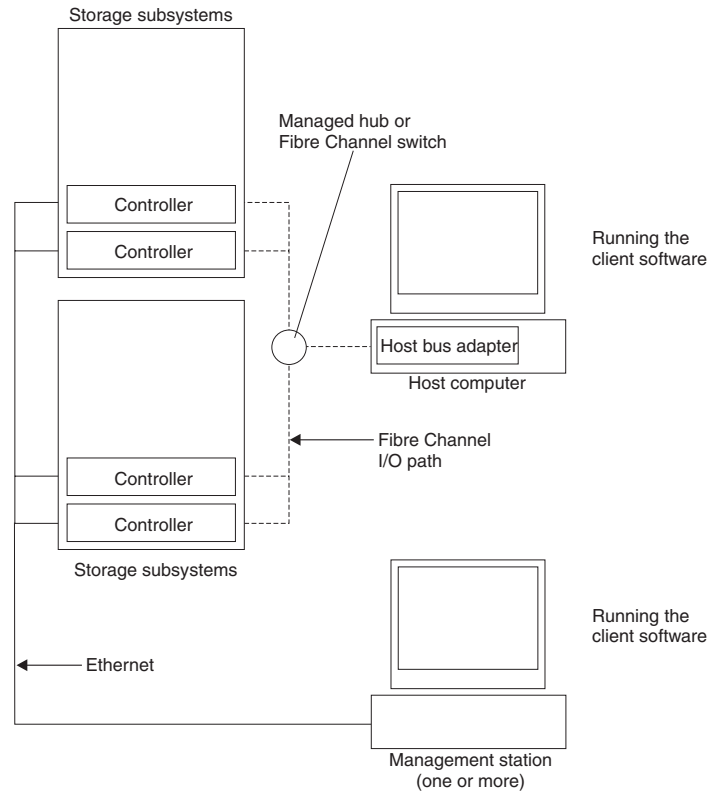


Figure 6. Direct (out-of-band) managed storage subsystems

You will connect fiber-optic and Ethernet cables to each controller later in the installation process.

After you install the hardware, if your Fibre Channel network environment is configured for cluster servers, go to “Installing hardware for cluster servers.”

If you are installing storage expansion enclosures in a rack cabinet, go to “Installing storage expansion enclosures in a rack cabinet” on page 13. Otherwise, go to Chapter 2, “Connecting the DS4400 Storage Server,” on page 15.

Installing hardware for cluster servers

If the Fibre Channel network environment into which you are installing the storage subsystem is configured for cluster servers, you must install two host bus adapters per cluster node. For complete information about installing host bus adapters, refer to the *IBM TotalStorage DS4000 FC2-133 Dual Port Host Bus Adapter Installation and User's Guide*.

Figure 7 on page 12 shows Fibre Channel connections using a dual-path configuration for fully redundant environments.

Note: The interlink is used as the clustering heartbeat path.

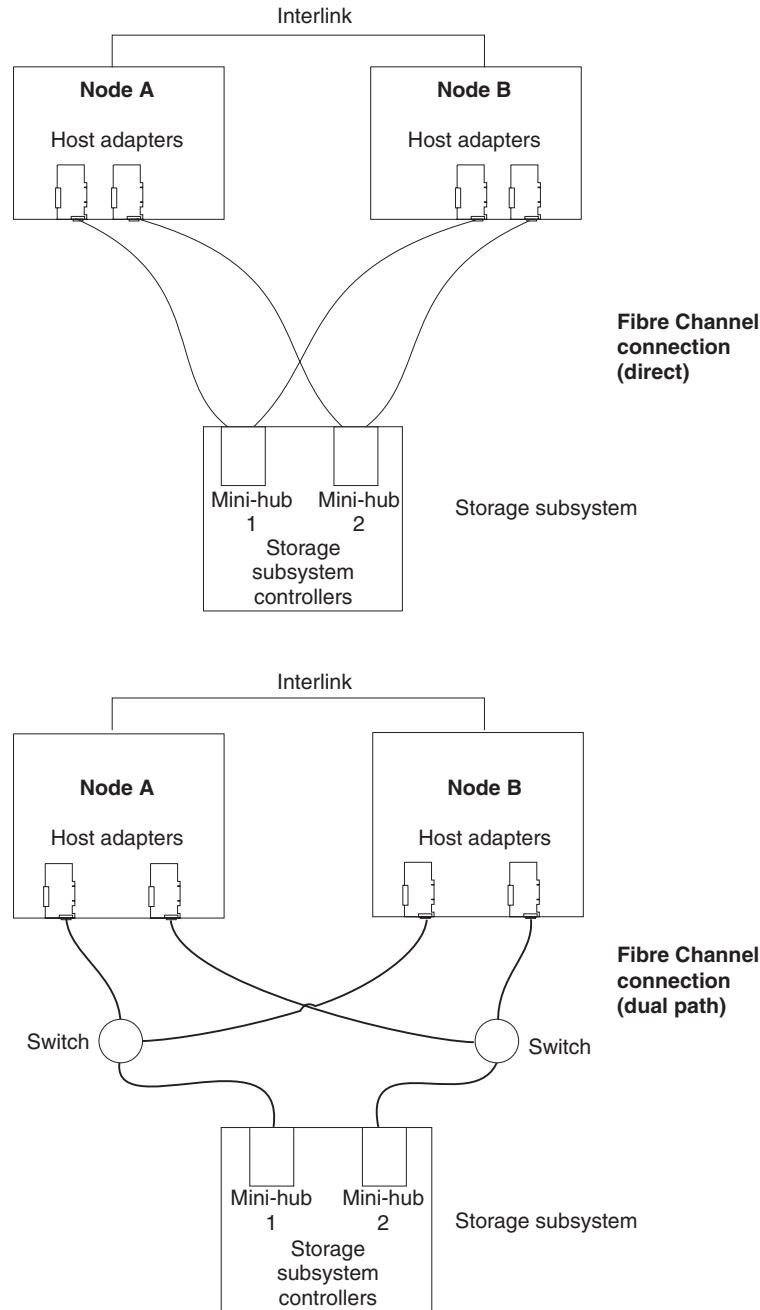


Figure 7. Installing host adapters in storage subsystems on a Fibre Channel network

Before you install the host adapters, note the following about the cluster server Fibre Channel network environment:

- When using a dual-path configuration, each node has two paths to the storage server providing greater redundancy protection if a connection problem occurs. Install two single-channel host adapters in each node.
- Use the correct host adapter device driver. Refer to the *IBM Storage Manager Installation and Support Guide* that is appropriate for your operating system and

refer to the README file for information on supported host adapters and device drivers. This information is found on the Storage Manager installation CD or at <http://www.ibm.com/pc/support/>.

Make sure each host adapter and controller has a unique Fibre Channel ID.

Refer to the documentation provided with your host adapters for installation requirements and procedures.

After you install the cluster server hardware, continue with “Installing storage expansion enclosures in a rack cabinet” or go to Chapter 2, “Connecting the DS4400 Storage Server,” on page 15.

Installing storage expansion enclosures in a rack cabinet

Install the storage expansion enclosures that you are attaching to the DS4400 Storage Server in a rack cabinet. Preparing the storage expansion enclosures for installation in a rack cabinet might involve any or all of the following tasks:

- Moving the storage expansion enclosures to the installation site
- Unpacking the storage expansion enclosures from their shipping cartons
- Checking the shipping contents
- Removing all customer replaceable units (CRUs)

For detailed instructions on installing the storage expansion enclosures in a rack cabinet, refer to the documentation that comes with each device. After you install the storage expansion enclosures, go to Chapter 2, “Connecting the DS4400 Storage Server,” on page 15.

Chapter 2. Connecting the DS4400 Storage Server

This chapter provides information about connecting the DS4400 Storage Server to other Fibre Channel devices. It contains information about the interface connections and installing SFP modules and fiber-optic cables. This chapter also provides detailed information about configuring drive loops and connecting the DS4400 Storage Server to hosts and storage expansion enclosures.

DS4400 Storage Server mini-hub interface connections

The interfaces that connect the host computers and storage expansion enclosures to the storage server are called mini hubs. When fully configured, the back of the DS4400 Storage Server can accommodate four host mini hubs and four drive mini hubs. Each mini hub is a removable unit. A mini hub provides the Fibre Channel interface between a controller and a host or storage expansion enclosure. Each mini hub has two ports. A Small Form-Factor Pluggable (SFP) module connects into each mini-hub port; then, a fiber-optic cable connects into the SFP module. Figure 8 shows the mini-hub interface connections.

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

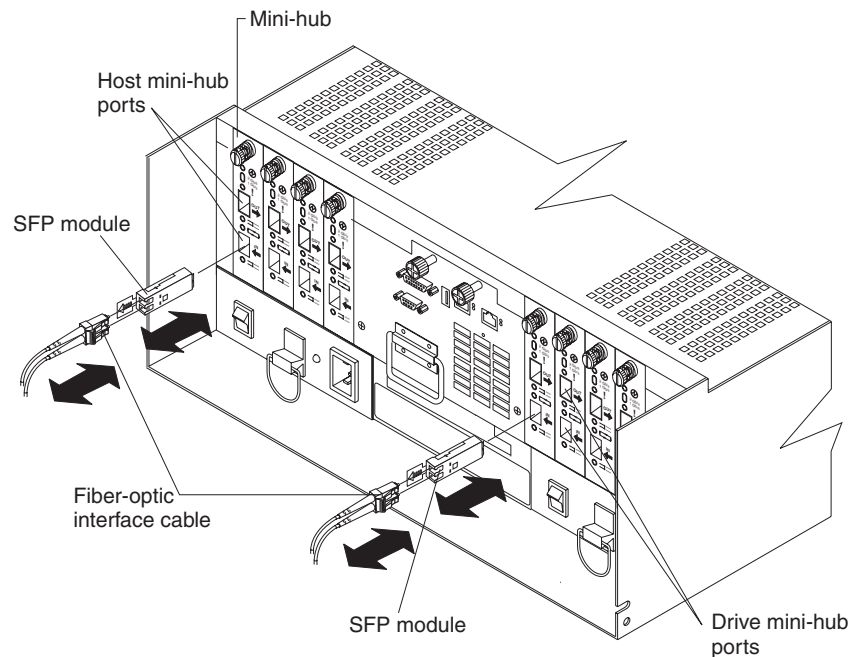


Figure 8. DS4400 mini-hub interface connections

DS4400 Storage Server interface ports

The SFP mini-hub ports are used for data transfer between hosts or storage expansion enclosures and RAID controllers in the DS4400 Storage Server. Ethernet ports are available for storage subsystem-management. The DS4400 Storage Server interface ports are shown in Figure 9 on page 16.

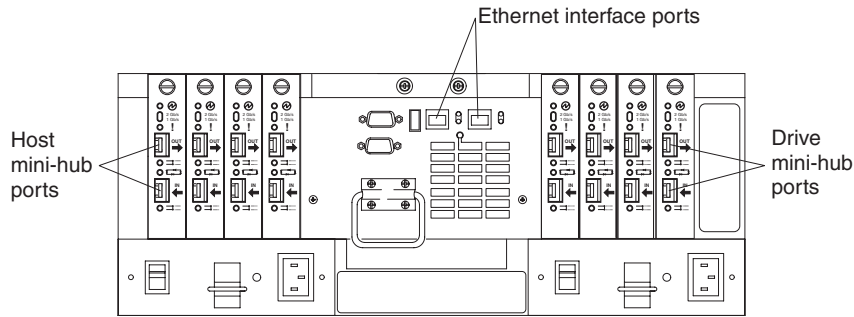


Figure 9. DS4400 Storage Server interface ports

Host interface ports

The DS4400 Storage Server comes with host-side mini hubs 1 and 2 installed. Host mini hubs connect to the controller in pairs. Mini hubs 1 and 3 connect to the top controller (Controller A) and mini hubs 2 and 4 connect to the bottom controller (Controller B), as shown in Figure 10. To ensure redundancy, you must connect each host to both controllers through the appropriate mini hub.

Attention: If one of the two ports in the host mini-hub is connected to the Fibre Channel (FC) switch, the other port must be left empty. This restriction is not applicable when directly connecting the FC HBA ports to the host side mini-hub ports.

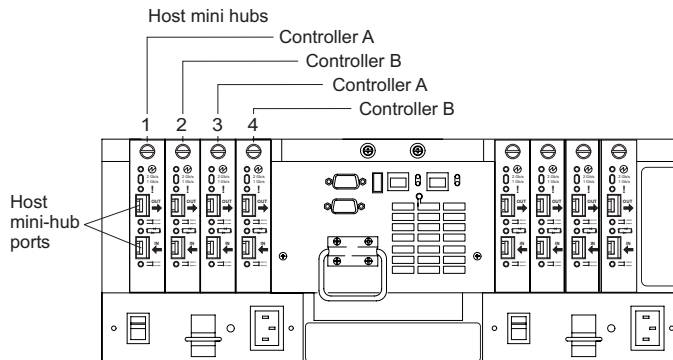


Figure 10. Host mini-hub ports

Drive interface ports

The DS4400 Storage Server comes with drive-side mini hubs 1 and 2 installed. Each drive mini hub connects to Controller A and Controller B and represents a single drive loop. The drive loops must be set up in pairs to support redundant drive loop configurations (two data paths per storage expansion enclosure). DS4400 Storage Servers use only redundant drive-loop configurations. See Figure 11 on page 17 for an illustration of the drive-side mini-hub interface ports.

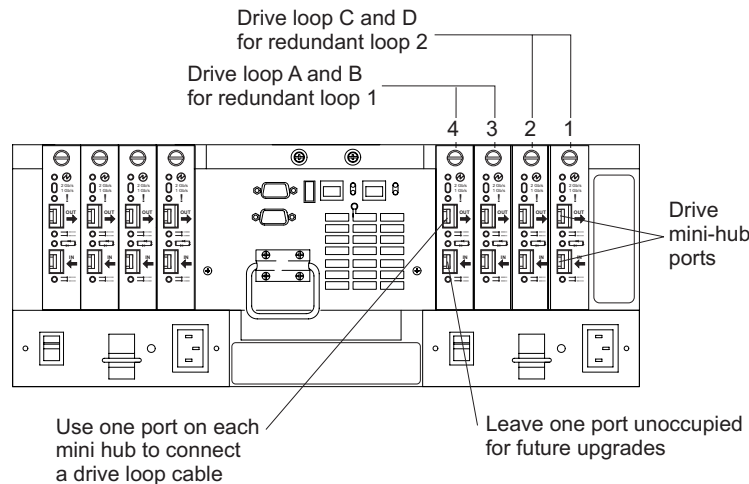


Figure 11. Drive mini-hub ports

The maximum number of storage expansion enclosures that can be connected per pair of redundant drive loops depends on the IBM DS4000 storage expansion enclosure models used. The following DS4000 storage expansion enclosure types are supported by the DS4400 Storage Server:

- FAStT EXP500
- DS4000 EXP700
- DS4000 EXP710
- DS4000 EXP100

If the drives are configured using only DS4000 EXP700, EXP710, or EXP100 storage expansion enclosures, the DS4400 Storage Server supports a maximum of 224 hard drives.

If the drives are configured using only FAStT EXP500 storage expansion enclosures, the DS4400 Storage Server supports a maximum of 220 hard drives.

Attention: In order to attach DS4000 EXP100 or DS4000 EXP710 storage expansion enclosures to a DS4400 Storage Server, the DS4400 Storage Server controller firmware must be at version 06.xx.xx.xx or higher. In addition, you must purchase the FC/SATA Enclosure Intermix premium option to combine DS4000 EXP100s with DS4000 EXP700s or DS4000 EXP710s in the same DS4400 Storage Server configuration.

For detailed information about how to cable the storage server and storage expansion enclosures, see the *DS4400 Fibre Channel Cabling Instructions* that come with the storage server.

Intermixing storage expansion enclosure models

Storage expansion enclosure models can be mixed in the same redundant drive loop or the same pair of redundant drive loops. As described in the following sections, you can intermix FAStT EXP500s and DS4000 EXP700s, and you can also intermix DS4000 EXP100s, EXP710s, and EXP700s.

You *cannot* mix DS4000 EXP100s or DS4000 EXP710s with FAStT EXP500s in any DS4000 storage server configuration. If a DS4000 EXP100 or DS4000 EXP710 is attached to the DS4400 Storage Server in one drive loop, no FAStT EXP500s can be present either in the same drive loop or in the other drive loop.

Note: This restriction exists because the FAStT EXP500 storage expansion enclosure operates at 1 Gbps only, while the DS4000 EXP100 and DS4000 EXP710 storage expansion enclosures do not operate at 1 Gbps. The DS4400 Storage Server does not support mixed drive loop speeds.

Intermixing FAStT EXP500s and DS4000 EXP700s: You can intermix FAStT EXP500 and DS4000 EXP700 storage expansion enclosure models in the same redundant pair of drive loops.

Attention: If you are intermixing FAStT EXP500s and DS4000 EXP700s, it is strongly recommended that you do not cable the FAStT EXP500 and DS4000 EXP700 storage expansion enclosure models in the same redundant drive loop pair. Instead, you should cable the FAStT EXP500 storage expansion enclosures together using one pair of redundant drive loops, and you should the DS4000 EXP700 storage expansion enclosures together using the other pair of redundant drive loops.

Note: You might need to purchase two additional drive mini hubs to implement this cabling scheme.

If you are intermixing FAStT EXP500s and DS4000 EXP700s, your drive loop configuration must meet the following requirements:

- The maximum Fibre Channel transfer speed in all of the DS4000 EXP700s must be set to 1 Gbps because the maximum FC transfer speed of the IBM FAStT EXP500 storage expansion enclosures is 1 Gbps. Otherwise, a drive channel mini hub data rate mismatch error will be generated.
- The maximum Fibre Channel transfer speed in all the DS4400 Storage Server drive-side mini hubs must be set to 1 Gbps.

Attention: If you change the DS4000 EXP700 storage expansion enclosure or DS4400 Storage Server enclosure link speed setting, you must power-cycle the storage server. See “Turning off the power” on page 46 and “Turning on the power” on page 45 for the proper DS4000 configuration power-down and power-up sequences. For more information, see the *IBM TotalStorage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*.

If you intermix FAStT EXP500s and DS4000 EXP700s within a single drive loop, see Table 9 for the possible combinations of FAStT EXP500 and DS4000 EXP700 storage expansion enclosures per drive loop.

Table 9. Possible combinations of FAStT EXP500 and DS4000 EXP700 storage expansion enclosures per drive loop

| Number of FAStT EXP500 units | Number of DS4000 EXP700 units | Total number of storage expansion enclosures | Total number of drives |
|------------------------------|-------------------------------|--|------------------------|
| 0 | 8 | 8 | 112 |
| 1 | 7 | 8 | 108 |
| 2 | 6 | 8 | 104 |
| 3 | 6 | 9 | 114 |
| 4 | 5 | 9 | 110 |
| 5 | 4 | 9 | 106 |
| 6 | 3 | 9 | 102 |
| 7 | 3 | 10 | 112 |

Table 9. Possible combinations of FAStT EXP500 and DS4000 EXP700 storage expansion enclosures per drive loop (continued)

| Number of FAStT EXP500 units | Number of DS4000 EXP700 units | Total number of storage expansion enclosures | Total number of drives |
|------------------------------|-------------------------------|--|------------------------|
| 8 | 2 | 10 | 108 |
| 9 | 1 | 10 | 104 |
| 10 | 0 | 10 | 100 |
| 11 | 0 | 11 | 110 |

Important: These large configurations are for capacity purposes and might not provide the best performance.

For full details on the requirements for intermixing FAStT EXP500 and DS4000 EXP700 storage expansion enclosures, refer to the *IBM TotalStorage DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide*. You can also refer to the *IBM TotalStorage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*.

Intermixing DS4000 EXP710s and DS4000 EXP700s: You can intermix DS4000 EXP710s and DS4000 EXP700s in the same drive loop with a DS4400 Storage Server, but all DS4000 EXP710s must be grouped together.

Important

The requirements for intermixing DS4000 EXP710s and EXP700s state that all DS4000 EXP710s in a redundant drive loop must be grouped together. IBM does not support intermixed drive loop configurations in which all DS4000 EXP710s are not grouped together.

Attention: The minimum DS4000 EXP700 ESM firmware requirement for intermixing DS4000 EXP710s and EXP700s is version 9326. Verify that the ESM firmware for all DS4000 EXP700s is at version 9326 or higher before intermixing DS4000 EXP700s with EXP710s.

In order to attach DS4000 EXP710 storage expansion enclosures to a DS4400 Storage Server, the DS4400 Storage Server controller firmware must be at version 06.xx.xx.xx or higher.

A fully configured DS4400 Storage Server supports a maximum of 16 IBM DS4000 EXP700 or EXP710 storage expansion enclosures (8 storage expansion enclosures per drive-loop pair), or 224 drives, using dual pairs of redundant drive loops.

For full details on the requirements for intermixing DS4000 EXP710s and EXP700s, refer to the *IBM TotalStorage DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide*. You can also refer to the *IBM TotalStorage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*.

Intermixing DS4000 EXP100s with DS4000 EXP710s and EXP700s: You can intermix DS4000 EXP100s SATA storage expansion enclosures with either DS4000

EXP710s, DS4000 EXP700s, or both EXP710s and EXP700s, in the same pair of redundant drive loops with a DS4400 Storage Server, but all DS4000 EXP710s must be grouped together.

Important

The requirements for intermixing DS4000 EXP100s with either DS4000 EXP710s, DS4000 EXP700s, or both EXP710s and EXP700s state that you must group the same enclosure types together.

In order to attach DS4000 EXP100 or EXP710 storage expansion enclosures to a DS4400 Storage Server, the DS4400 Storage Server controller firmware must be at version 06.xx.xx.xx or higher. In addition, you must purchase the FC/SATA Enclosure Intermix premium option to combine EXP100s with EXP700s or EXP710s in the same DS4400 Storage Server configuration.

For more information on the cabling requirements and best practices for intermixing EXP100s with EXP700s or EXP710s in the same DS4000 Storage Server configuration, refer to the *IBM TotalStorage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview* that ships with the FC/SATA Enclosure Intermix premium feature. You can also refer to the *IBM TotalStorage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*

Attention: The minimum DS4000 EXP100 ESM firmware requirement for intermixing DS4000 EXP100s with DS4000 EXP710s or EXP700s is version 9554. Before intermixing DS4000 EXP100s with DS4000 EXP700s or EXP710s, you must verify that the ESM firmware for all DS4000 EXP100s is at version 9554 or higher. As discussed in “Intermixing DS4000 EXP710s and DS4000 EXP700s” on page 19, you must also verify that the ESM firmware for all DS4000 EXP700s is at version 9326 or higher.

A fully configured DS4400 Storage Server supports a maximum of 16 IBM DS4000 EXP700, EXP710, or EXP100 storage expansion enclosures (8 storage expansion enclosures per drive-loop pair), or 224 drives, using dual pairs of redundant drive loops.

Ethernet interface ports

There are two Ethernet interface ports, one for each controller (Controller A and Controller B). Use the Ethernet ports to directly manage storage subsystems. Figure 12 shows the location of these ports.

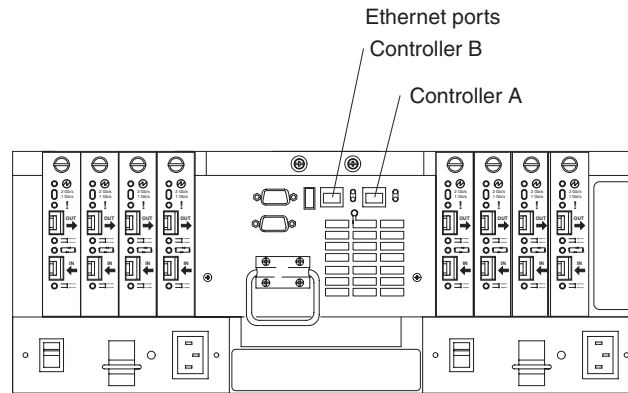


Figure 12. Ethernet ports

Installing SFP modules

The DS4400 Storage Server mini hubs require Small Form-Factor Pluggable (SFP) Modules. SFP modules are used to convert electrical signals to optical signals that are required for Fibre Channel transmission to and from RAID controllers. After you install the SFP modules, you will use fiber-optic cables to connect the DS4400 Storage Server to other Fibre Channel devices.

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

- The SFP module housing has an integral guide key designed to prevent you from inserting the SFP module improperly.
- Use minimal pressure when inserting the SFP module into a mini-hub port. Forcing the SFP module into a port could cause damage to the SFP module or the port.
- You can insert or remove the SFP module while the port is powered on.
- The operational loop performance is not affected when you install or remove an SFP module.
- You must insert the SFP module into a mini-hub port before you connect the fiber-optic cable.
- You must remove the fiber-optic cable from the SFP module before you remove the SFP module from the mini hub. Refer to “Removing SFP modules” on page 23 for more information.
- Do not mix long-wave SFPs and short-wave SFPs on a single storage server. Use either long-wave SFPs or short-wave SFPs. You can use the DS4000 Storage Manager client to view the Storage Subsystem Profile in order to verify that you are not mixing long-wave and short-wave SFPs.

To install an SFP module, complete the following steps.

Statement 3:



CAUTION:

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

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



DANGER

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

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

Attention: When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see “Handling static-sensitive devices” on page 8.

1. Remove the SFP module from its static-protective package.
2. Remove the protective cap from the SFP module, as shown in Figure 13. Save the protective cap for future use.

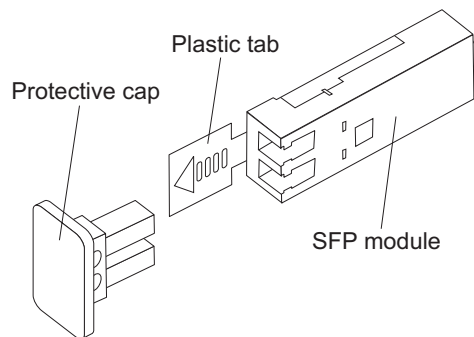


Figure 13. Small Form-Factor Pluggable (SFP) Module

3. Remove the protective cap from the mini-hub port. Save the protective cap for future use.
4. Insert the SFP module into the mini-hub port until it clicks into place.

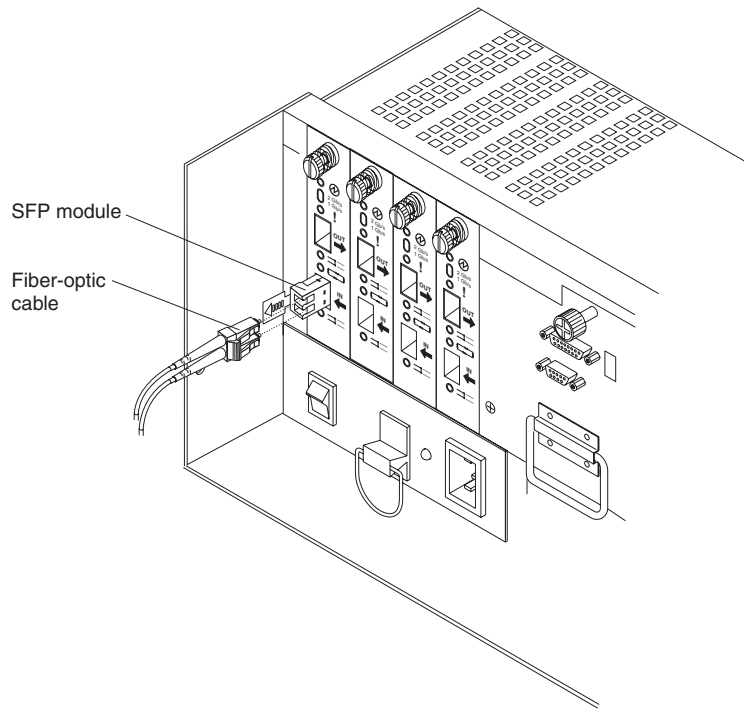


Figure 14. Installing an SFP module in a mini hub

5. Connect an LC-LC Fibre Channel cable. For information about the LC-LC cable, see “Using LC-LC Fibre Channel cables” on page 25.

Removing SFP modules

To remove the SFP module from the mini hub, do the following:

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

1. Remove the LC-LC Fibre Channel cable from the SFP module. For more information, see “Handling fiber-optic cables” on page 24 and “Using LC-LC Fibre Channel cables” on page 25.
2. Unlock the SFP module latch:
 - For SFP modules that contain plastic tabs, unlock the SFP module latch by pulling the plastic tab outward 10°, as shown in Figure 15 on page 24.

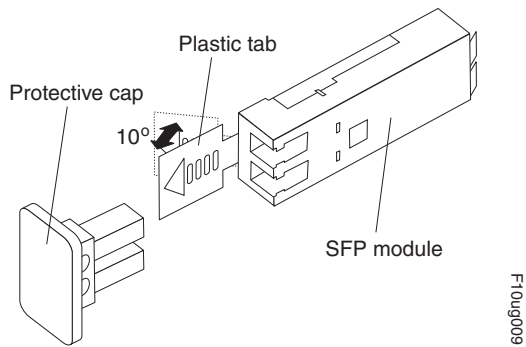


Figure 15. Unlocking the SFP module latch - plastic variety

- For SFP modules that contain wire tabs, unlock the SFP module latch by pulling the wire latch outward 90°, as shown in Figure 16.

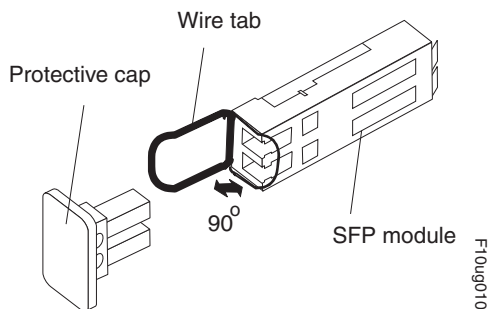


Figure 16. Unlocking the SFP module latch - wire variety

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 8.

3. With the SFP latch in the unlocked position, slide the SFP module out of the mini-hub port.
4. Replace the protective cap on the SFP module.
5. Place the SFP module into a static-protective package.
6. Replace the protective cap on the mini-hub port.

Handling fiber-optic cables

Before using fiber-optic cables, read the following precautions.

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

- Do not route the cable along a folding cable-management arm.
- When attaching to a device on slide rails, leave enough slack in the cable so that it does not bend to a radius of less than 38 mm (1.5 in.) when extended or become pinched when retracted.
- Route the cable away from places where it can be snagged by other devices in the rack.
- Do not overtighten the cable straps or bend the cables to a radius of less than 38 mm (1.5 in.).
- Do not put excess weight on the cable at the connection point. Be sure that the cable is well supported.

Using LC-LC Fibre Channel cables

The LC-LC Fibre Channel cable is a fiber-optic cable that is used to connect into one of the following devices:

- SFP module installed in a DS4400 Storage Server mini hub
- SFP module installed in an IBM Fibre Channel switch
- Optical interface connector on an IBM DS4000 FC-2 Host Bus Adapter (Part number 19K1246)

For more information about connecting to these devices, see the documentation that comes with the device.

Figure 17 shows an LC-LC Fibre Channel cable.

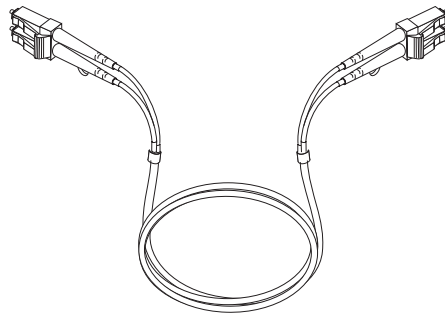


Figure 17. LC-LC Fibre Channel cable

The following sections provide the procedures for properly connecting and removing an LC-LC Fibre Channel cable.

Note: If you are connecting a DS4400 Storage Server to a EXP500 storage expansion enclosure or to an IBM DS4000 host adapter, you must also use an LC-SC Fibre Channel cable adapter. For more information about using the Fibre Channel cable adapter, see “Using LC-SC Fibre Channel cable adapters” on page 28.

Connecting an LC-LC cable to an SFP module

To connect an LC-LC Fibre Channel cable to an SFP module, complete the following steps.

Statement 3:



CAUTION:

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

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



DANGER

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

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

1. Read the information in “Handling fiber-optic cables” on page 24.
2. If necessary, remove the protective cap from the SFP module, as shown in Figure 13 on page 22. 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 18. Save the protective caps for future use.

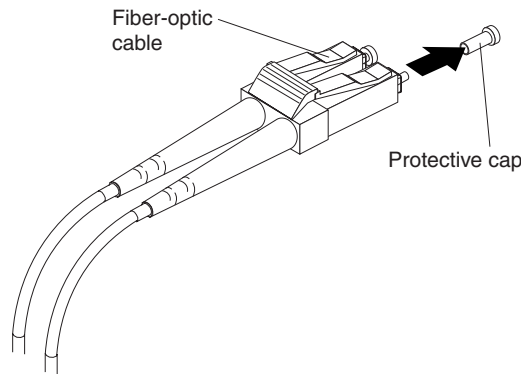


Figure 18. Removing fiber-optic cable protective caps

4. Carefully insert that same end of the LC-LC cable into an SFP module that is installed in a DS4400 Storage Server mini hub. The cable connector is keyed to ensure it is inserted into the SFP module correctly. Holding the connector, push in the cable until it clicks into place.

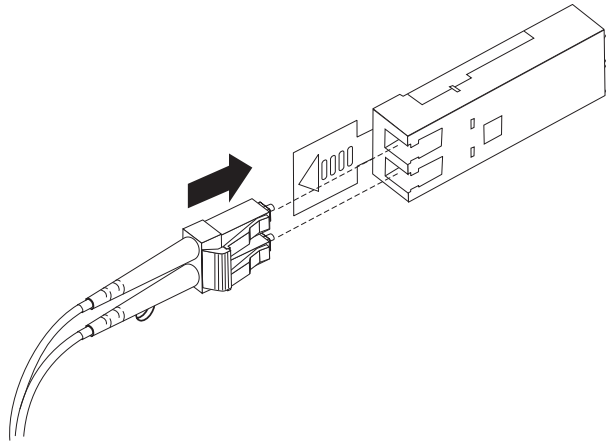


Figure 19. Inserting an LC-LC Fibre Channel cable into an SFP module

Figure 20 shows an LC-LC Fibre Channel cable connecting into an SFP module that is installed in a DS4400 Storage Server mini hub.

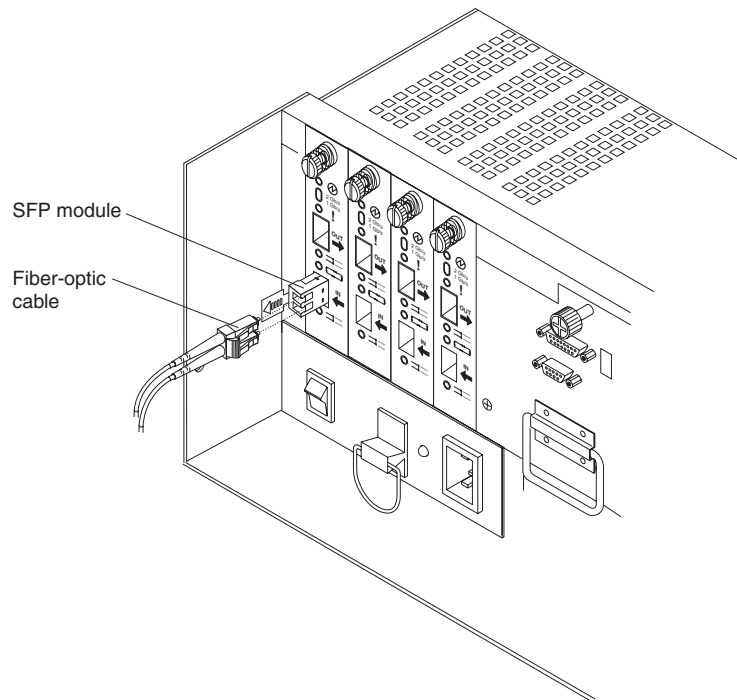


Figure 20. Inserting an LC-LC Fibre Channel cable into an installed SFP module

5. Remove the two protective caps from the other end of the LC-LC cable, as shown in Figure 18 on page 26. Save the protective caps for future use.
6. Connect the LC-LC Fibre Channel cable to one of the following devices:
 - SFP module that is installed in an IBM Fibre Channel switch
 - Optical interface connector on an IBM DS4000 FC-2 Host Bus Adapter (Part Number 19K1246)
 - LC-SC Fibre Channel cable adapter (For information about using an LC-SC cable adapter, see “Using LC-SC Fibre Channel cable adapters” on page 28.)

For more information about connecting to these devices, see the documentation that comes with the device.

Removing an LC-LC Fibre Channel cable

To remove an LC-LC Fibre Channel cable, do the following:

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

1. On the end of the LC-LC cable that connects into the SFP module or host bus adapter, press down and hold the lever to release the latches, as shown in Figure 21. Carefully pull on the connector to remove the cable from the SFP module, as shown in Figure 22.

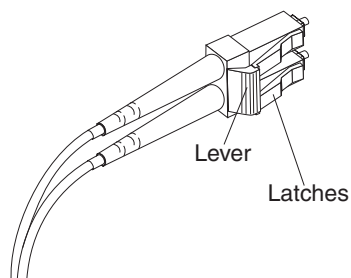


Figure 21. LC-LC Fibre Channel Cable lever and latches

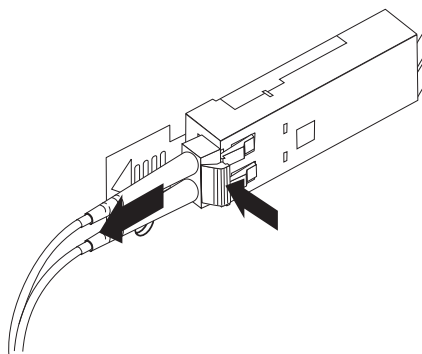


Figure 22. Removing the LC-LC Fibre Channel cable

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

Using LC-SC Fibre Channel cable adapters

The LC-SC Fibre Channel Cable Adapter is a fiber-optic cable that is used to connect the LC connector into one of the following devices that require SC connectors:

- DS4000 host adapter (Part number 00N6881)
- FAST EXP500 storage expansion enclosure (Machine type 3560)

- 1 Gb Fibre Channel switch (Machine type 2109)
- Managed hub (Machine type 3534)

For more information about connecting to these devices, see the documentation that comes with the device.

Figure 23 shows an LC-SC Fibre Channel cable.

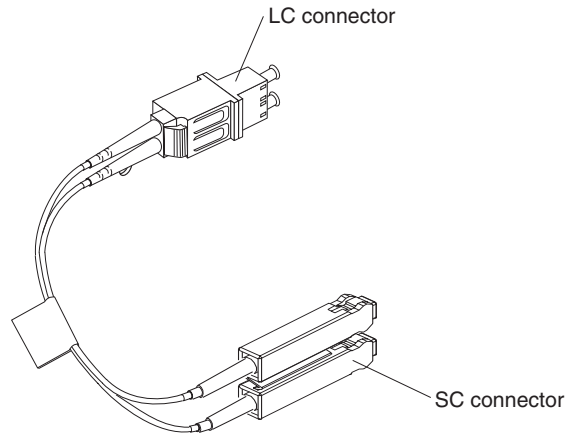


Figure 23. LC-SC Fibre Channel cable

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

Connecting an LC-SC cable to a device

To connect an LC-SC cable to a device, 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.

1. Read the information in “Handling fiber-optic cables” on page 24.
2. Connect an LC-LC cable to an SFP module in the DS4400 Storage Server mini hub. For instructions, see “Connecting an LC-LC cable to an SFP module” on page 25.
3. Remove the two protective caps from the LC connector end of the LC-SC cable, as shown in Figure 24. Save the protective caps for future use.

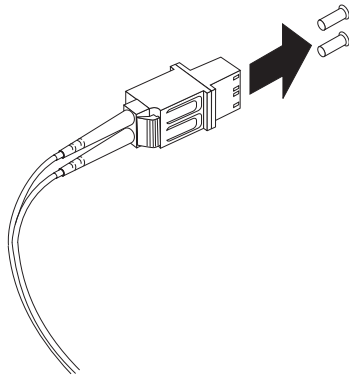


Figure 24. Removing the LC-SC cable adapter protective caps

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

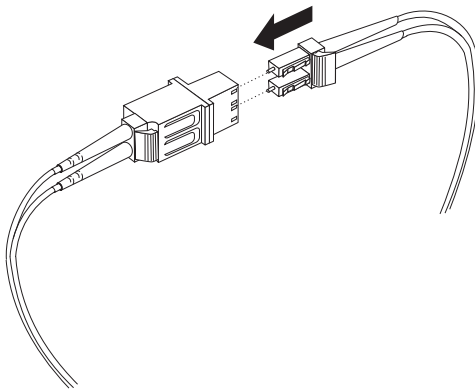


Figure 25. Connecting an LC-LC cable into the LC-SC cable adapter

5. Connect the SC connector end of the LC-SC cable to one of the following devices:
 - Optical interface connector on an IBM DS4000 FC-2 Host Bus Adapter (Part number 19K1246)
 - GBIC installed in a FAST EXP500 storage expansion enclosure (Machine type 3560)

- 1 Gb Fibre Channel switch (Machine type 2109)

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

To remove an LC-LC cable from an LC-SC cable adapter, do the following:

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 26 shows the location of the lever and latches.

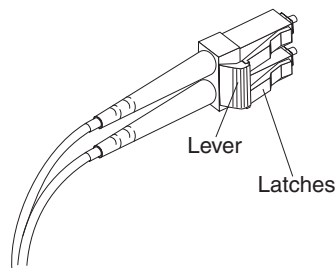


Figure 26. LC-LS Fibre Channel Cable lever and latches

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.

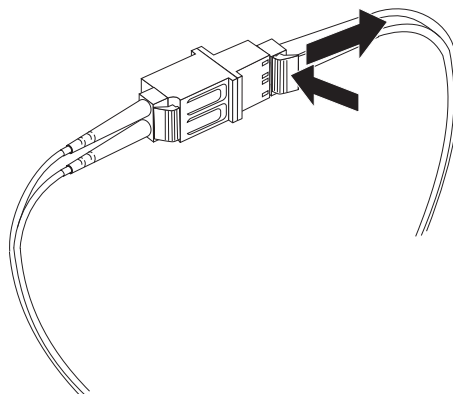


Figure 27. Removing the LC-LC Fibre Channel cable from an LC-SC Fibre Channel cable adapter

3. Replace the protective caps on the cable ends.

DS4400 Storage Server and storage expansion enclosure cabling overview

The DS4400 Storage Server supports two redundant drive loops. A redundant drive loop consists of one or more storage expansion enclosures connected to a controller using two sets of Fibre Channel cables. If one data path fails, the controller uses the other data path to maintain the connection to the drive group.

Figure 28 shows a storage subsystem containing one storage server and two redundant drive loops with four storage expansion enclosures each. Each storage expansion enclosures group uses redundant drive loops to connect to the DS4400 Storage Server. Loop A and loop B make up one redundant pair of drive loops. Loop C and loop D make up a second redundant pair.

Attention: To prevent loss of storage expansion enclosure redundancy, connect the storage expansion enclosures as shown in Figure 28.

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

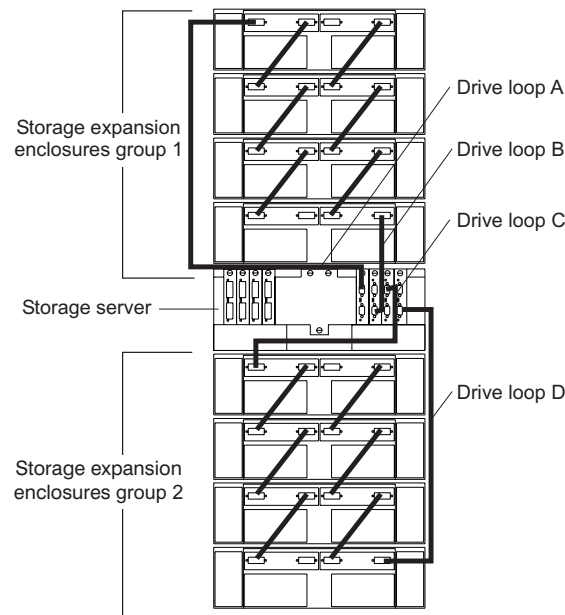


Figure 28. Redundant drive loop cabling overview

Configuring the drive loops

The procedure and illustrations in this section show an example of how to connect one storage expansion enclosure group of four storage expansion enclosures into a redundant drive loop. Instructions for how to connect a second redundant storage expansion enclosure group of four storage expansion enclosures into a redundant drive loop are also included in this procedure.

To complete this procedure, you will need two fiber-optic cables per storage expansion enclosure. Handle and install fiber-optic cables properly to avoid degraded performance or loss of communications with devices. Do not overtighten the cable straps or bend the cables to a radius less than 38 mm (1.5 in.).

1. Connect the first two storage expansion enclosures to drive loop A, as shown in Figure 29.

Starting with the first storage expansion enclosure, connect a fiber-optic cable from the In port on the left environmental services module (ESM) board to the Out port on the left ESM board in the second (next) storage expansion enclosure.

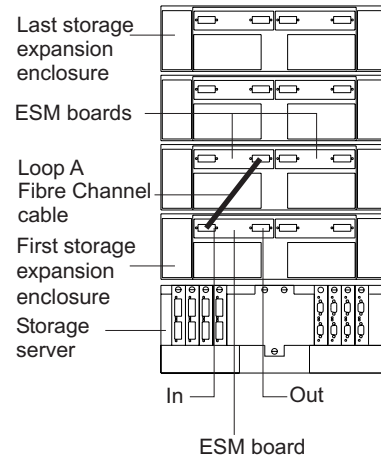


Figure 29. Connecting two storage expansion enclosures into drive loop A

For the location of the ports on the storage expansion enclosure ESM board, see Figure 30.

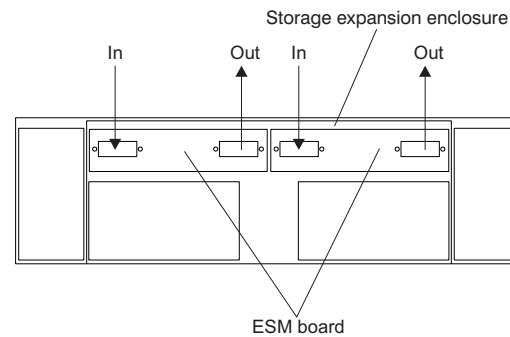


Figure 30. Storage expansion enclosure environmental services module (ESM) board in and out ports

2. Connect the same first two storage expansion enclosures to drive loop B, as shown in Figure 31 on page 34.

Starting with the first storage expansion enclosure, connect a fiber-optic cable from the In port on the right ESM board to the Out port on the right ESM board in the second (next) storage expansion enclosure.

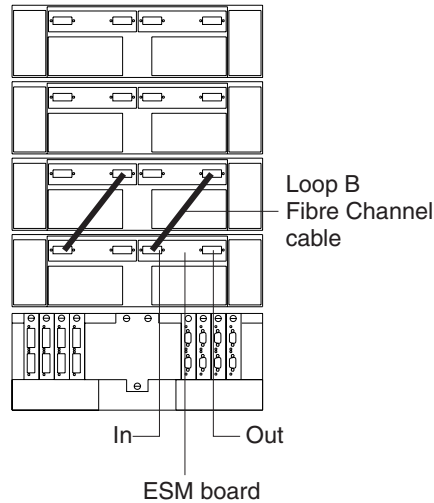


Figure 31. Connecting two storage expansion enclosures into redundant drive loop B

If you want to connect more storage expansion enclosures into drive loops A and B, continue with Step 3; otherwise, go to “Connecting a redundant drive loop to the DS4400 Storage Server” on page 35.

3. Connect additional storage expansion enclosures to drive loops A and B, as shown in Figure 32.

Starting with the second storage expansion enclosure, connect each additional storage expansion enclosure into drive loops A and B in the same manner. Leave the In port on the last storage expansion enclosure in the loop and the Out port on the first storage expansion enclosure unoccupied.

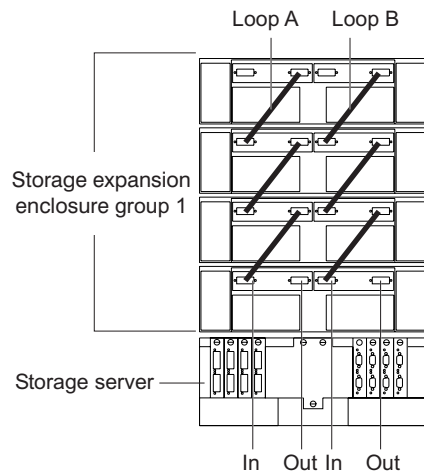


Figure 32. Connecting additional storage expansion enclosures to drive loops A and B

If you want to connect a second storage expansion enclosure group, go to Step 4; otherwise, go to “Connecting a redundant drive loop to the DS4400 Storage Server” on page 35.

4. Repeat Step 1 on page 33 through Step 3 to connect a second redundant storage expansion enclosure group. Figure 33 on page 35 shows a second redundant storage expansion enclosure group (loop C and loop D on storage expansion enclosure group 2).

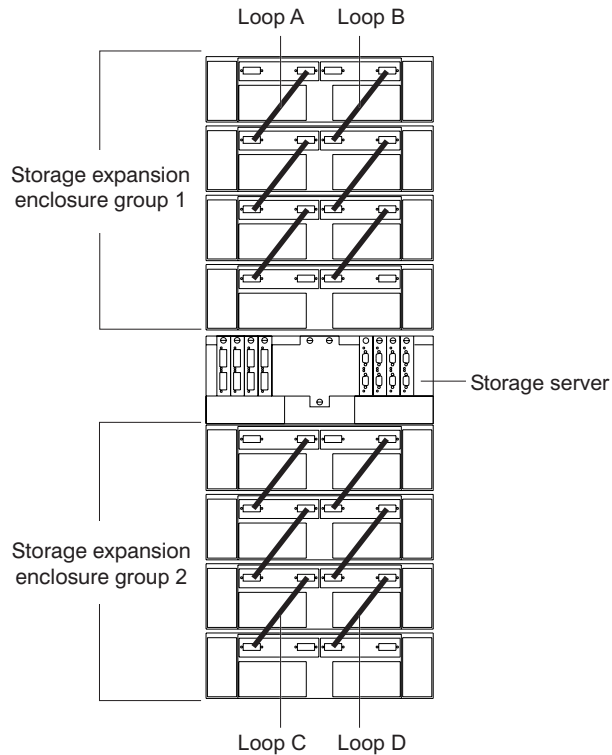


Figure 33. Connecting a second redundant storage expansion enclosure group (loops C and D)

5. Continue with "Connecting a redundant drive loop to the DS4400 Storage Server."

Connecting a redundant drive loop to the DS4400 Storage Server

Use the following procedure to connect a redundant drive loop to the DS4400 Storage Server. You will need two fiber-optic cables for each redundant pair of loops (for example, loop A and loop B) that you are connecting to the DS4400 Storage Server.

1. Connect drive loop A to the DS4400 Storage Server, as shown in Figure 34 on page 36.

Starting with the last storage expansion enclosure in loop A, connect the In port on the left ESM board to the Out (upper) port on drive mini hub 4 on the DS4400 Storage Server.

Leave the Out port on the left ESM board on the first storage expansion enclosure and the In (lower) connector on drive mini hub 4 unoccupied.

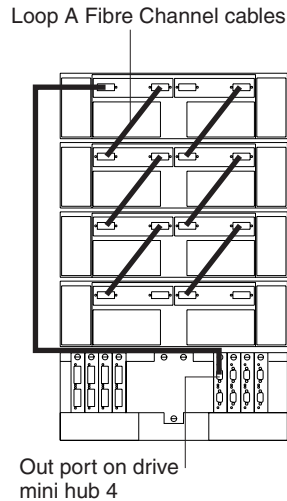


Figure 34. Connecting drive loop A to the DS4400 Storage Server

2. Connect drive loop B to the DS4400 Storage Server, as shown in Figure 35. Starting with the first storage expansion enclosure in the loop, connect the Out port on the right ESM board to the In (lower) port on drive mini hub 3. Leave the In port on the right ESM board on the last storage expansion enclosure and the Out (upper) port on drive mini hub 3 unoccupied.

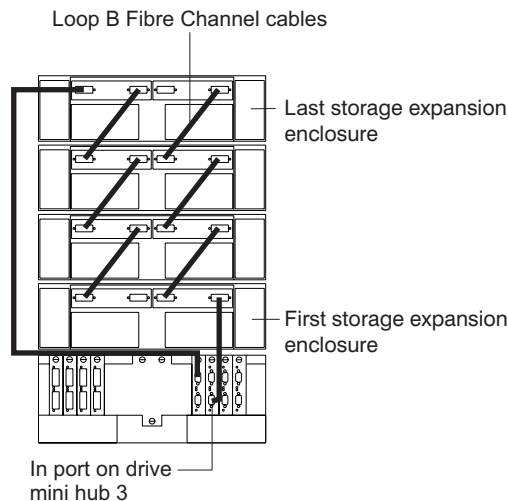


Figure 35. Connecting redundant drive loops to the DS4400 Storage Server

To connect a second redundant storage expansion enclosure group to the DS4400 Storage Server, continue with Step 3; otherwise, go to “Connecting hosts directly to the DS4400 Storage Server” on page 37.

3. Connect drive loop C to the DS4400 Storage Server, as shown in Figure 36 on page 37. Starting with the first storage expansion enclosure in storage expansion enclosure group 2, connect the In port on the left ESM board to the Out (upper) port on drive mini hub 2.

Leave the Out port on the left ESM board on the last storage expansion enclosure in storage expansion enclosure group 2 and the In (lower) port on the drive mini hub 2 unoccupied.

4. Connect drive loop D to the DS4400 Storage Server, as shown in Figure 36.

Starting with the last storage expansion enclosure in storage expansion enclosure group 2, connect the Out port on the right ESM board to the In (lower) port on mini hub 1.

Leave the In port on the right ESM board on the first storage expansion enclosure in storage expansion enclosure group 2 and the Out (upper) port on drive mini hub 1 unoccupied.

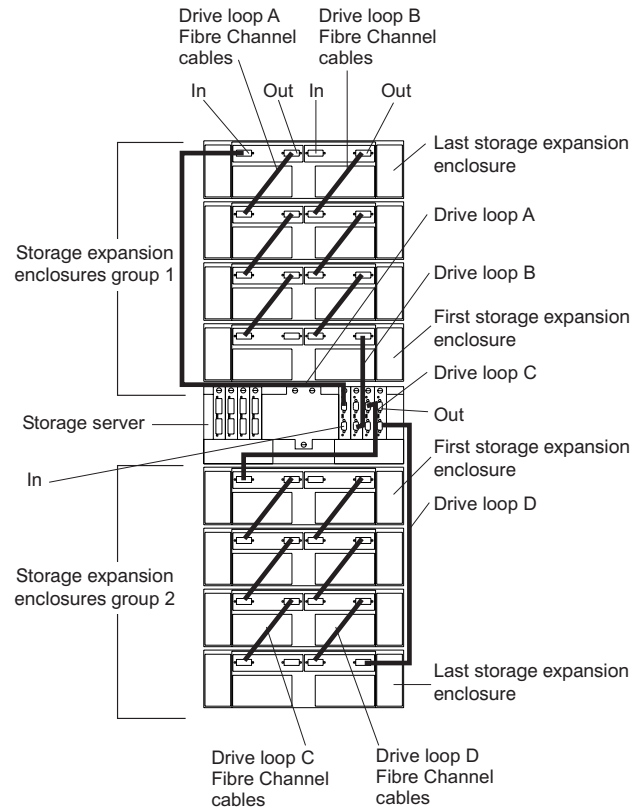


Figure 36. Connecting two redundant storage expansion enclosure groups

Connecting hosts directly to the DS4400 Storage Server

Use this procedure to connect up to four hosts, with two host adapters each, directly to the DS4400 Storage Server. If you are connecting five or more hosts to the DS4400 Storage Server, go to “Connecting hosts using external devices” on page 38.

Before proceeding, make sure that you connect fiber-optic cables to all host adapters that you are connecting to the DS4400 Storage Server.

Important: Host mini hub 1 and mini hub 3 correspond to Controller A (top) and mini hub 2 and mini hub 4 correspond to Controller B (bottom). To ensure redundancy, connect each host to both controllers. You can use either the upper or lower ports on either mini hub.

The example in the following procedure uses the upper ports for Hosts 1 and 4 and the lower ports for Hosts 2 and 3.

1. Connect the first host (Host 1) to the DS4400 Storage Server, as shown in Figure 37.

Connect Host Adapter 1 (HA1) from Host 1 to a port on host mini hub 1. Connect HA2 from Host 1 to mini hub 2.

To connect a second host, continue with Step 2; otherwise, go to “Setting the Link Rate Interface switch” on page 41.

2. Connect a second host (Host 2) to the DS4400 Storage Server, as shown in Figure 37.

Attach HA1 from Host 2 to the unoccupied port on mini hub 1. Attach HA2 from Host 2 to the unoccupied port on mini hub 2.

To connect a third host, continue with Step 3; otherwise, go to “Setting the Link Rate Interface switch” on page 41.

3. Connect a third host (Host 3) to the DS4400 Storage Server, as shown in Figure 37.

Attach HA1 from Host 3 to mini hub 3. Attach HA2 from Host 3 to mini hub 4.

To connect a fourth host, continue with Step 4; otherwise, go to “Setting the Link Rate Interface switch” on page 41.

4. Connect a fourth host (Host 4) to the DS4400 Storage Server, as shown in Figure 37.

Attach HA1 and HA2 from Host 4 to the two unoccupied ports on mini hub 3 and mini hub 4.

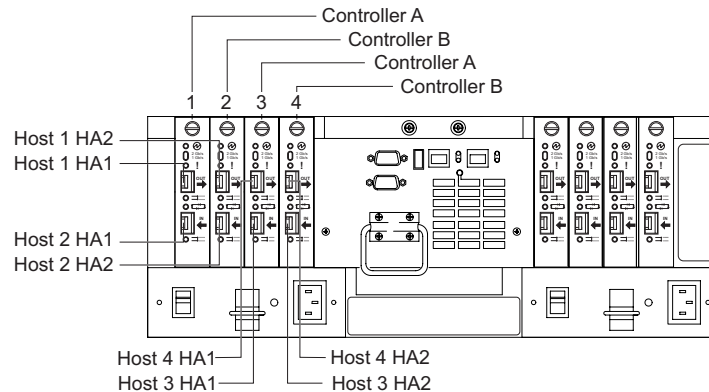


Figure 37. Connecting hosts directly to the controller

5. Go to “Setting the Link Rate Interface switch” on page 41.

Connecting hosts using external devices

Use the information in this section to connect five or more hosts to the DS4400 Storage Server. When you use external Fibre Channel switches, the DS4400 Storage Server supports up to 64 hosts (128 host adapters, 64 host adapters per controller) and two host adapters for each host.

Important: Host mini hub 1 and host mini hub 3 correspond to Controller A (top). Mini hub 2 and mini hub 4 correspond to Controller B (bottom). To ensure redundancy, connect each host to both controllers. You can use either the upper or lower connectors on either mini hub.

You connect additional hosts to the DS4400 Storage Server by adding host-side mini hubs and Fibre Channel switches, (one Fibre Channel switch for each mini hub).

Attention: If one of the two ports in the host mini-hub is connected to the Fibre Channel (FC) switch, the other port must be left empty. This restriction is not applicable when directly connecting the FC HBA ports to the host side mini-hub ports.

Figure 38 shows an example of dual path configuration using Fibre Channel switches. Host 1 contains two host bus adapters that are connected to host mini hubs. To configure a host with dual path redundancy, connect the first host bus adapter (HA1) to SW1 and connect the second host bus adapter (HA2) to SW2. Then, connect SW1 to host mini hub 1 and SW2 to host mini hub 2.

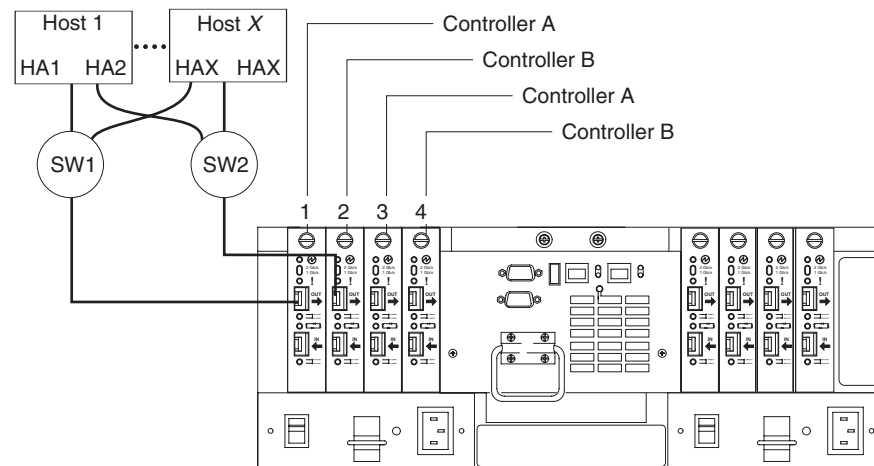


Figure 38. Using two Fibre Channel switches to connect a host

You can directly attach up to four Fibre Channel switches (one per mini hub) to a DS4400 Storage Server. Figure 39 shows an example of attaching four Fibre Channel switches.

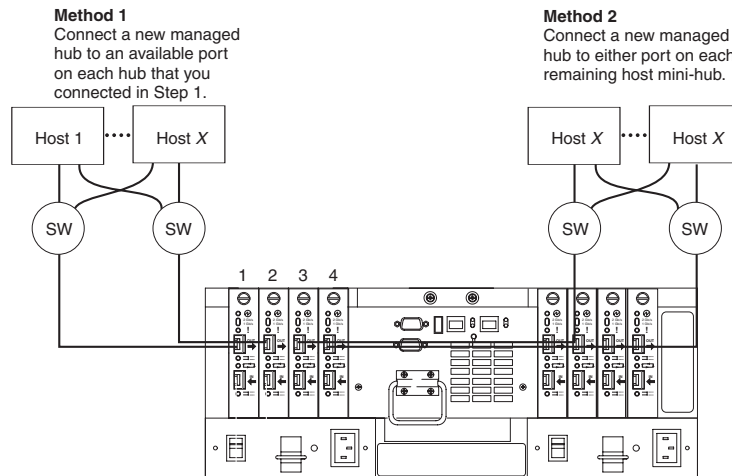


Figure 39. Using four Fibre Channel switches to connect multiple hosts

Most Fibre Channel switches support eight to sixteen hosts. If your configuration requires more hosts than four Fibre Channel switches can support, you must add cascading switches, as shown in Figure 40.

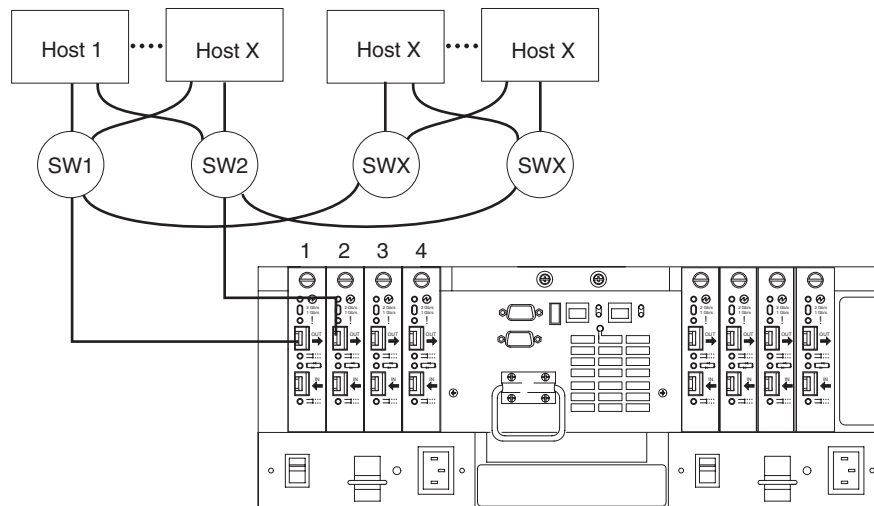


Figure 40. Adding hosts using cascading switches

Setting the Link Rate Interface switch

Each DS4400 Storage Server mini hub has a Link Rate Interface switch that is used to select the host-side or drive-side mini-hub data transfer rates. The switch settings are labeled 2 Gb per second and 1 Gb per second. Use a device with a point such as a small flat-blade screwdriver or ballpoint pen to set the host-side or drive-side mini-hub Link Rate Interface switch. See Figure 41.

The Speed indicator light is green when the data transfer rate of the Fibre Channel loop is 2 Gb per second. The Speed indicator light is off when the data transfer rate is 1 Gb per second. Figure 41 shows the location of the Link Rate switch and indicator light.

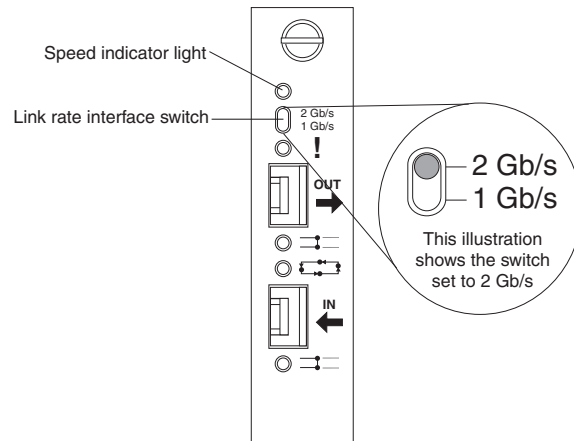


Figure 41. Mini-hub Link Rate Interface switch and Speed indicator light

Setting data transfer rates on host-side mini hubs

To set the Link Rate Interface switch on the host-side mini hubs, complete the following steps.

Note: Host-side mini-hub ports must be connected to devices that have the same data transfer rate.

1. Verify the data transfer rate of the devices on the loop or the Fibre Channel switch port.
2. Set the data transfer rate on the host bus adapter based on the data transfer rate of the devices on the loop or the Fibre Channel switch port.
3. Set the Link Rate Interface switch to match the data transfer rate of the host bus adapter.

Setting data transfer rates on drive-side mini hubs

On the drive-side mini hubs, set the Link Rate Interface switch to 2 Gb per second or 1 Gb per second based on the data transfer rate of the storage expansion enclosures.

Note: All storage expansion enclosures on the loop and drive-side mini-hub ports must be connected to devices that have the same data transfer rate.

To set the data transfer rate on drive-side mini hubs, do the following:

1. Verify the data transfer rate of the storage expansion enclosure on the loop.
2. Set the link rate interface switch to match the data rate of the storage expansion enclosure.

Connecting Ethernet cables

To manage a storage subsystem using the direct (out-of-band) method, connect a pair of Ethernet cables from the management station to the Ethernet ports for Controller A or Controller B on the back of the DS4400 Storage Server. For an illustration of direct (out-of-band) management, see Figure 6 on page 11.

Figure 42 shows the location of the Ethernet ports.

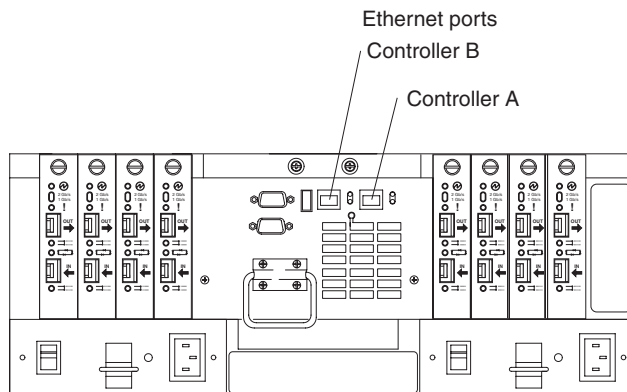


Figure 42. Ethernet port locations

Chapter 3. Starting the DS4400 Storage Server

After you install the DS4400 Storage Server in a rack cabinet and connect it to the Fibre Channel Arbitrated Loop, you are ready to complete the installation. This chapter describes how to connect the power cords, turn on and off the power, check the indicator lights, and install the Storage Manager software.

Power cabling

The DS4400 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 DS4400 storage server does not ship with power cords. Refer to “Power cords” on page 60 for the list of IBM-approved power cords for your region. The DS4400 storage server ships with two line jumper cords for connecting the DS4400 power supplies to an IBM-approved rack power distribution unit.

If you have not already done so, attach the power cords by using Figure 43 for the location of the component parts.

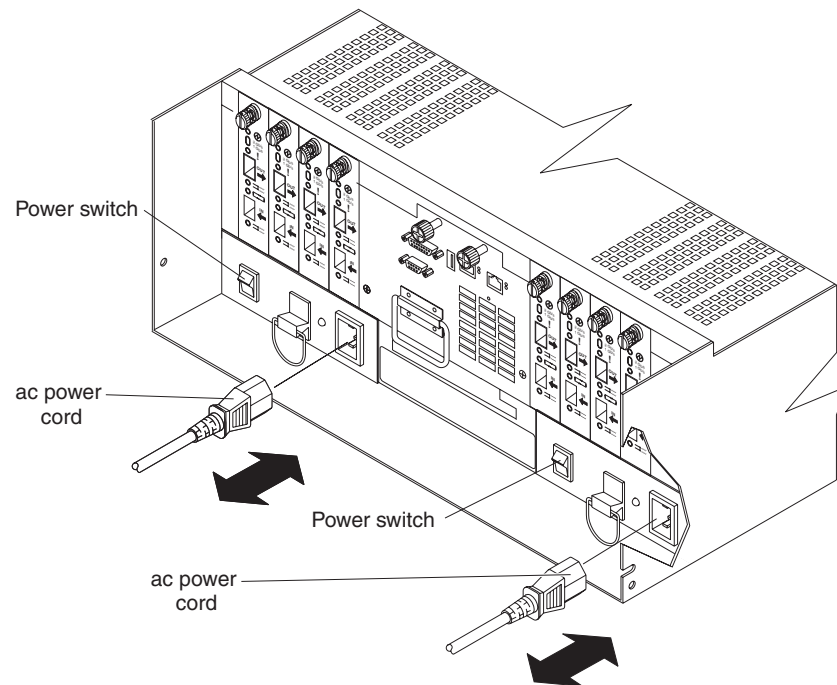


Figure 43. Connecting the power cords

Perform the following to cable the power cords:

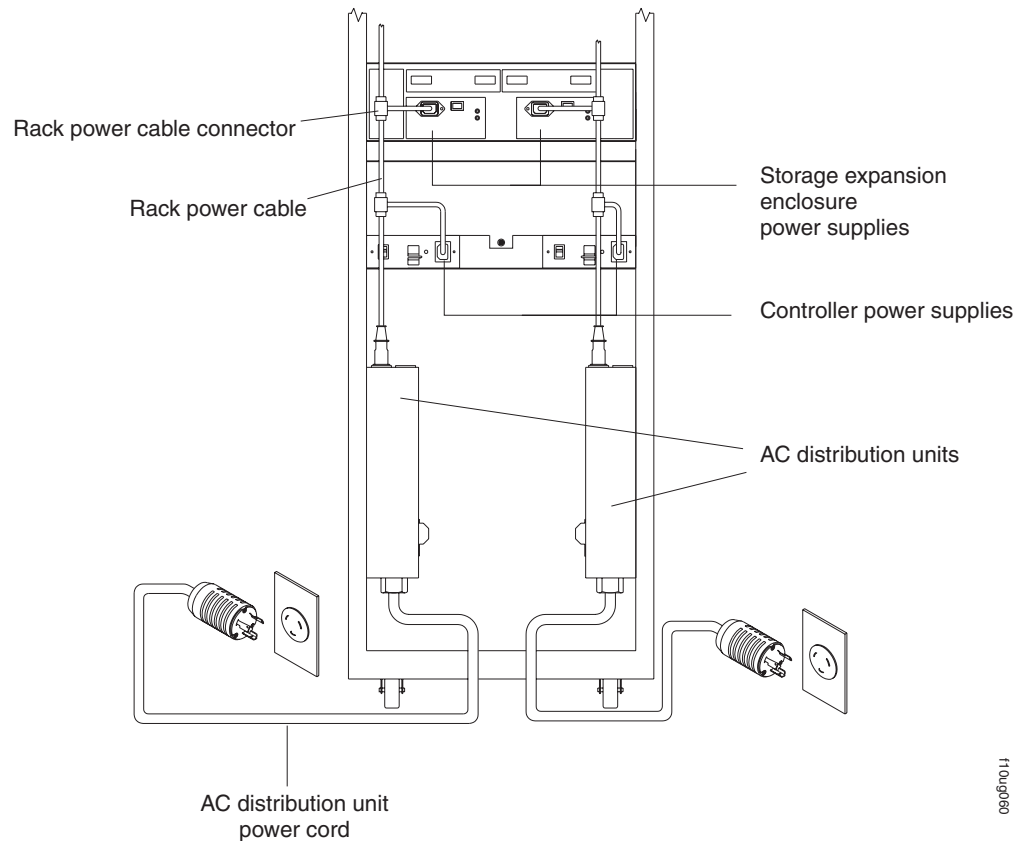
1. Connect the power cord to the power supply.
2. Remove the nut that holds the power cable strain-relief clamp, and then remove the strain-relief clamp.

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

Note: To maintain power redundancy, plug the storage server's right and left power supplies into two independent external power circuits through ac distribution units inside a rack cabinet or directly into external receptacles. Similarly, the right and left power supplies of the DS4000 storage expansion enclosures attached to the DS4400 should be plugged into the same two independent external power circuits as the DS4400.

It is recommended that you determine the maximum surge current possible when all devices in the power circuit are started at the same time. Based on the total number of devices on a power circuit, find the maximum (worst-case) specification value in order to prevent the circuit from tripping. When both power supplies are connected and the storage server is powered on, each power supply unit will handle approximately one-half of the current load. If there is only one power supply unit, it will handle all of the current load. To ensure maximum protection against power loss due to power supply unit failure or a power circuit tripping, both power supply units must be connected and powered on. See Table 8 on page 7 for the DS4400 AC power requirements.

See Figure 44 on page 45 for an example of redundant power cabling.



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Figure 44. Redundant AC power connections to controllers and storage expansion enclosures

6. Go to “Turning on the power” for the initial startup of the storage server.

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

Turning on the power

Important: You must turn on the storage expansion enclosures *before* you turn on the DS4400 Storage Server. The controllers might not recognize the correct configuration if the hard disk drives are powered up after the DS4400 Storage Server. For instructions on powering up the storage expansion enclosures, refer to the storage expansion enclosure documentation.

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

Use the following procedure to turn on the power for the DS4400 Storage Server.

1. Verify that all communication and power cables are plugged into the back of the DS4400 Storage Server and to a properly grounded ac electrical outlet.
2. Check the system documentation for the hardware devices that you intend to power up, and then determine the proper startup sequence. Use the following power-on sequence, where applicable:
 - a. Turn on the power to the supporting devices (for example, Ethernet switches, Fibre Channel switches, and management stations) *before* the storage server.

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

- b. You must turn on the storage expansion enclosures *before* the DS4400 Storage Server. The controllers might not recognize the correct configuration if the drives are powered up after the storage server. For instructions on powering up the storage expansion enclosures, refer to the storage expansion enclosure documentation.
- c. Turn on the power to the storage server.
- d. Restart or turn on the power to the host.

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

- 3. Turn on power to each device using the power-on sequence as outlined in the previous step. When turning on power to the DS4400 Storage Server, turn on both of the power-supply switches on the back of the DS4400 Storage Server. You must turn on both power-supply switches to take advantage of the redundant power supplies.
- 4. Use the storage-management software and the Fault indicator lights to check the overall status of the DS4400 Storage Server and its components.

Turning off the power

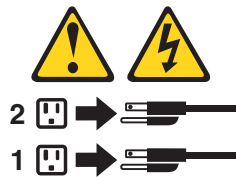
Attention: The DS4400 Storage Server is designed to run continuously, 24 hours a day. Except in an emergency, never turn off the power even if any DS4400 Storage Server fault indicator lights are lit. Use the proper troubleshooting or servicing procedure to correct the fault before turning off the power. This ensures that the DS4400 Storage Server powers up correctly later.

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.



Use the following procedure to turn off power to the DS4400 Storage Server.

1. Make sure that all amber fault indicator lights on the DS4400 Storage Server are off. If any fault indicator lights are on, use the storage-management software to determine the status of the system components and correct any problems before turning off the power.
2. The operating system software might require you to perform other procedures before you turn off the power. Use the storage-management software to check the status of the storage server. Correct problems that are reported before you turn off the power.
3. Prepare the DS4400 Storage Server for shutdown, as follows:
 - a. Stop all I/O activity to the DS4400 Storage Server and attached storage expansion enclosures.

Note: If a parity check is in progress, it might take a long time for the drive indicator lights to stop blinking.

- b. Use the operating-system software to disconnect the DS4400 Storage Server logical drives from the host before the storage server is powered off.
- c. Make sure that the fast write cache indicator light on each DS4400 Storage Server front panel and all drive active indicator lights on each storage expansion enclosure front panel are off (not blinking).
- d. Disconnect the DS4400 Storage Server and storage expansion enclosures from the hosts.

Attention: To turn off all power to the storage server, you must turn off both power-supply switches and disconnect both power cords. Use the procedure in step 4 for the proper shutdown sequence.

4. To turn off the power to each device, use the following shutdown sequence.

Note: You do not need to perform this step if you are servicing only the DS4400 Storage Server.

- a. Turn off power to the host before the storage server. If the host must stay powered on to support an existing network, refer to the operating system documentation for information about disconnecting the storage server logical drives from the host before the storage server is powered off.
- b. Turn off power to the storage server *before* you turn off power to the storage expansion enclosures. Turn off both power supply switches on the back of the storage server.
- c. Turn off power to other supporting devices (for example, management stations, Fibre Channel switches, or Ethernet switches).

Turning on the DS4400 Storage Server alarm

The DS4400 Storage Server has an audible alarm. This alarm is controlled by a switch that is located on the storage server fan. You can enable this alarm by removing the bezel and setting the switch in the up position, as shown in Figure 45 on page 48.

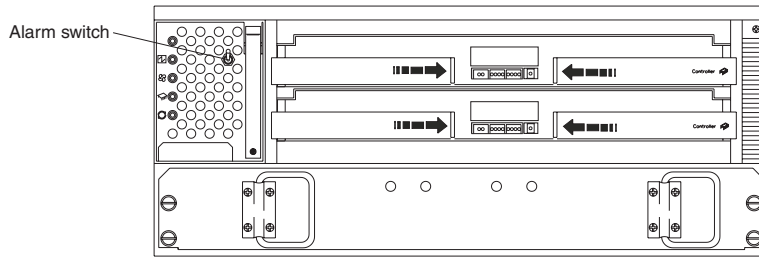


Figure 45. DS4400 Storage Server alarm switch

DS4400 Storage Server indicator lights

The indicator lights on the front of the DS4400 Storage Server are shown in Figure 46 through Figure 49 on page 50.

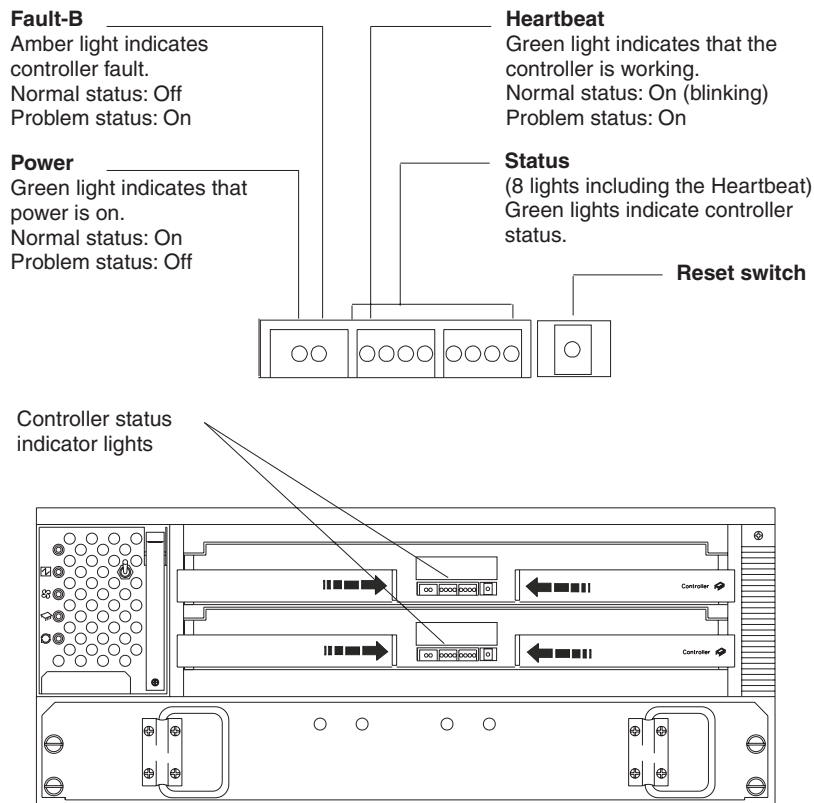


Figure 46. RAID controller indicator lights

The RAID controller status lights might blink when I/O activity is in progress. If the Heartbeat light blinks continuously, then the other status lights will glow in various patterns to show the status or an error condition. The pattern shown depends on whether the controller is active (online) or passive (offline). For more information, refer to *IBM DS4400 TotalStorage Fibre Channel Storage Server User's Guide* and the *IBM Storage Manager Installation and Support Guide* for your operating system.

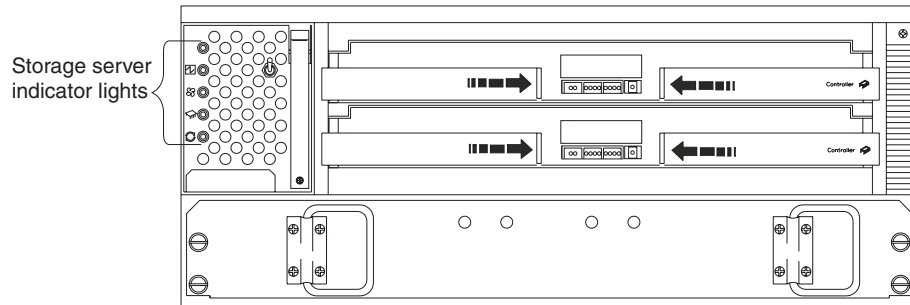


Figure 47. DS4400 Storage Server indicator lights

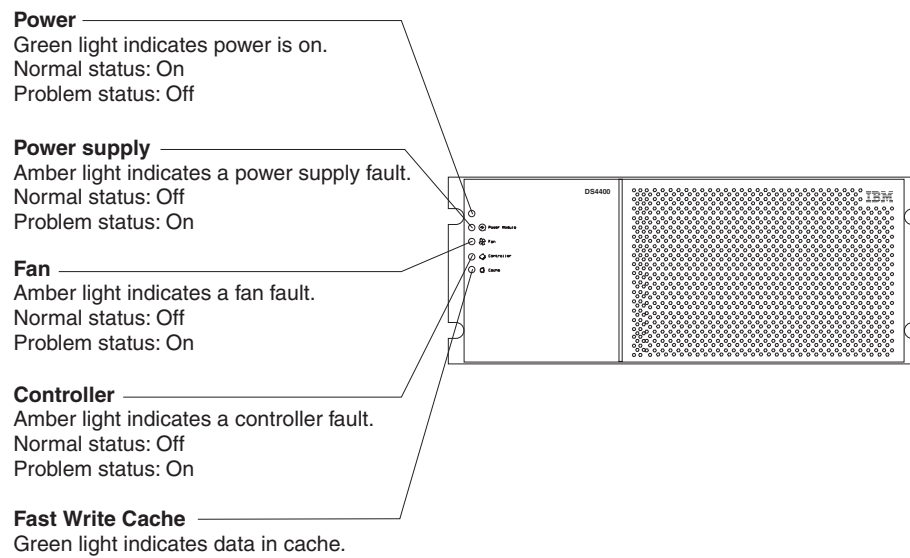


Figure 48. DS4400 Storage Server indicator lights

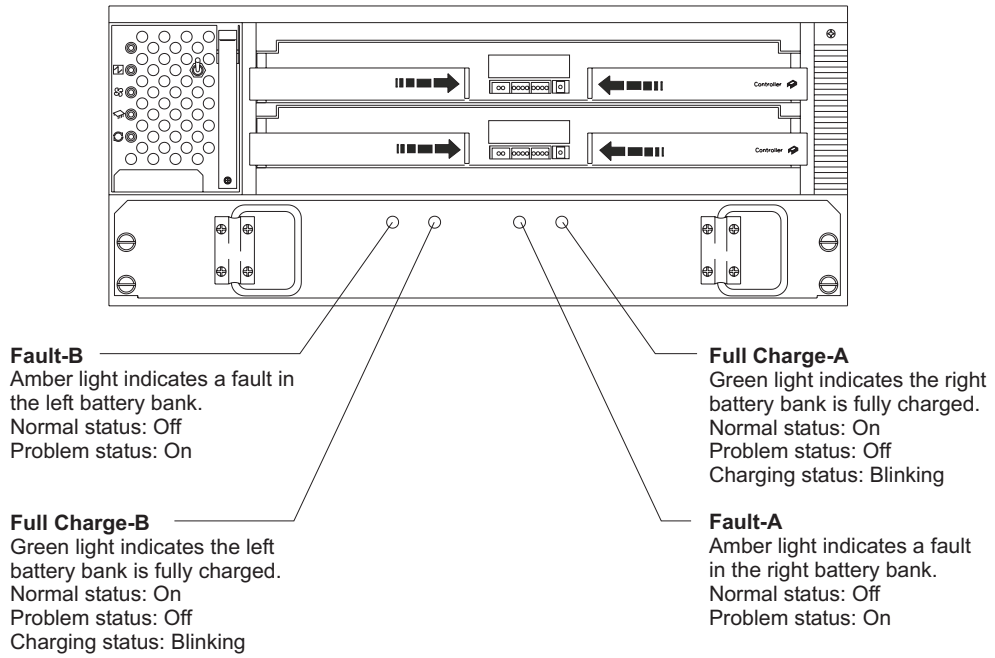


Figure 49. Battery indicator lights

The indicator lights on the back of the DS4400 Storage Server are shown in Figure 50 and Figure 51 on page 51.

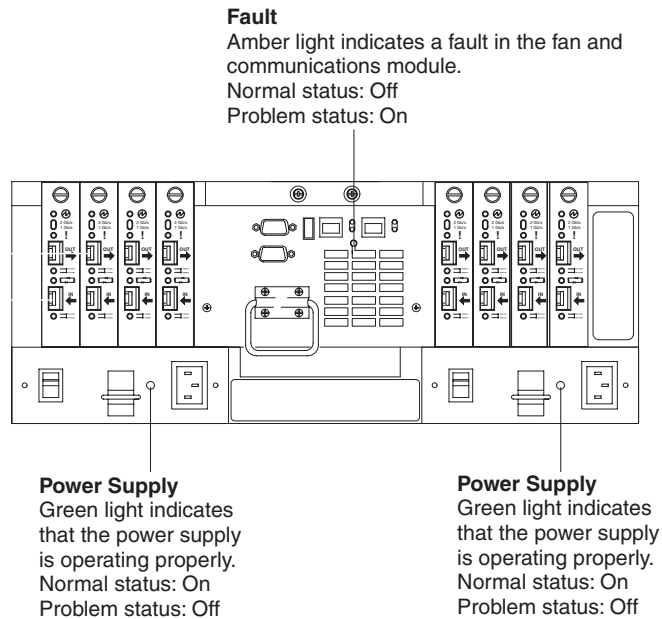


Figure 50. Power supply and fan and communications module indicator lights

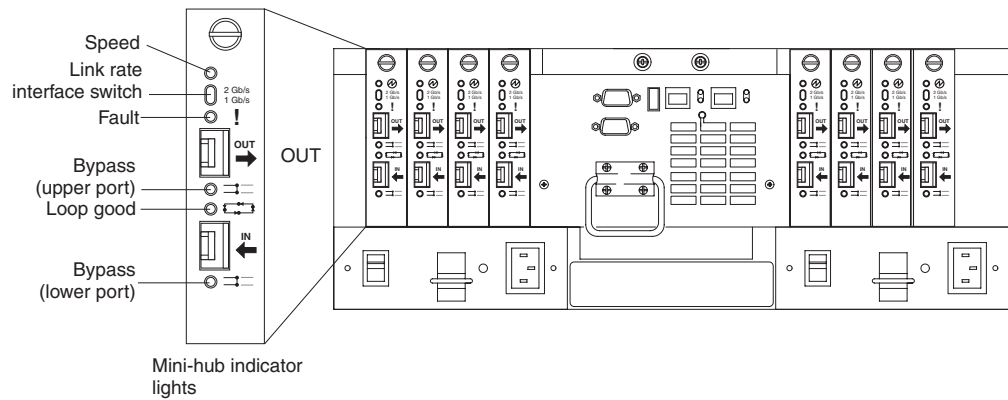


Figure 51. Mini-hub indicator lights

Table 10 describes the mini-hub indicator lights.

Table 10. Mini-hub indicator lights

| Icon | Indicator light | Color | Normal operation | Problem indicator | Condition indicated |
|------|---------------------|-------|-----------------------------|-------------------|--|
| None | Speed | Green | On for 2 Gb Off for 1 Gb | None | Light on indicates data transfer rate of 2 Gb per second. Light off indicates data transfer rate of 1 Gb per second. |
| ! | Fault | Amber | Off | On | There is a fault in the mini hub. |
| ⏏ | Bypass | Amber | Off | On | The upper mini-hub port is bypassed. |
| ↔ | Loop good | Green | On | Off | The drive loop is operational. |
| ⏏ | Bypass (lower port) | Amber | Off | On | The lower mini-hub port is bypassed. |

Installing the DS4000 Storage Manager client

Refer to the *IBM TotalStorage DS4000 Storage Manager 9.10 Installation and Support Guide* for the appropriate operating system for instructions on how to install the Storage Manager software. Use that document and the online help to configure the logical drives, partitions, and so on for the RAID controllers. Use your operating system documentation to make the new logical drives accessible to the operating system. Do not proceed with the configuration set-up until you have completed the DS4000 Storage Manager installation.

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

- HBA drivers
- Controller firmware
- IP addresses for RAID controllers (for in-band management only)

- Additional documentation for switches and HBAs, if needed
- *DS4000 Storage Manager Version 9.10 Support CD*, which includes the IBM DS4000 Storage Manager 9.1 software and DS4000 storage server controller firmware. You use this software to configure the storage subsystems. For the latest controller firmware, check the IBM support web site for DS4000 storage products.
www.ibm.com/servers/storage/support/disk/

Before any planned system shutdown or after any system additions, removals, or modifications (including logical drive creations, storage partitioning definitions, hardware changes, and so on), save the storage subsystem profile as explained in the DS4000 Storage Manager guide for your operating system. Save the profile in a location other than the logical drives created for the DS4400 storage server.

Note: Make sure that you install the DS4000 Storage Manager event monitoring service to enable continuous monitoring of the status of the storage server.

Firmware updates

In order to ensure the optimal operation of the DS4400 storage server and its attached storage expansion enclosures, the storage expansion enclosure ESM firmware, the DS4400 storage server controller firmware, the hard drive firmware, and the NVSRAM (for controllers only) must be up to date. Go to the following Web site to get the latest updates.

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

Apply the necessary updates before configuring the DS4400 arrays and logical drives. Subscribe to My Support for automatic notifications of firmware or storage manager software updates or any important information about your DS4000 subsystems (see “Product updates” on page 5).

Attention: Read the Readme file that is included in each firmware or DS4000 Storage Manager software package for any limitations, subsystem firmware prerequisites, or download-sequence information. For example, the controller firmware code might require the storage expansion enclosure ESM firmware to be upgraded first to a particular version, or the controller firmware download might require the halting of I/Os to the DS4400 storage server’s logical drives. Failure to observe the limitations, prerequisites, and dependencies in the Readme file might result in a loss of data access.

Best practices guidelines

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

- Back up the data on your storage drives periodically.
- To maintain power redundancy, plug the DS4400 storage server’s right and the left power supplies into two independent external power circuits through ac distribution units inside a rack cabinet or directly into external receptacles. Similarly, the right and left power supplies of the DS4000 storage expansion enclosures attached to the DS4400 storage server should be plugged into the same two independent external power circuits as the DS4400. This ensures that the DS4400 storage server 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 supplies plug into the same power circuit enables the components in the storage subsystem to power on simultaneously during an unattended restoration of power.

- Before any planned system shutdown or after any system additions, removals, or modifications (including logical drive creations, storage partitioning definitions, hardware changes, and so on), save the storage subsystem profile as explained in the DS4000 Storage Manager guide for your operating system. Save the profile in a location other than the logical drives created for the DS4400 storage server.
- Ensure that your system is in an optimal state before you shut it down. Never turn the power off if any fault light is lit; be sure to resolve any error conditions before you shut down the system.
- During any maintenance or attended power-up procedure, carefully follow the sequences listed in “Turning off the power” on page 46 and “Turning on the power” on page 45 for the proper DS4000 configuration power-down and power-up sequences. 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.
- A storage system in an optimal state should recover automatically from an unexpected shutdown and unattended simultaneous restoration of power to system components. After power is restored, call IBM support if any of the following conditions occur:
 - The storage subsystem logical drives and arrays are not displayed in the DS4000 Storage Manager graphical user interface (GUI).
 - The storage subsystem logical drives and arrays do not come online.
 - The storage subsystem logical drives and arrays seem to be degraded.
- Using the DS4000 Storage Manager client, save the DS4000 subsystem configuration profile to a disk that is not affected every time you make changes (such as logical drive creation or modification, or storage partitioning changes) to the DS4000 subsystem configuration.

Appendix. Accessibility

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

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

Table 11 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 11. 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. |
| 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. |

Table 11. DS4000 Storage Manager alternate keyboard operations (continued)

| Short cut | Action |
|---|--|
| Ctrl+Spacebar (Contiguous/Non-contiguous) AMW Logical/Physical View | <p>Select multiple drives in the Physical View.</p> <p>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.</p> <p>If you press Spacebar alone when multiple drives are selected then all selections are removed.</p> <p>Use the Ctrl+Spacebar combination to deselect a drive when multiple drives are selected.</p> <p>This behavior is the same for contiguous and non-contiguous selection of drives.</p> |
| 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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CD-ROM drive speeds list the variable read rate. Actual speeds vary and are often less than the maximum possible.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for approximately 1000 bytes, MB stands for approximately 1000000 bytes, and GB stands for approximately 1000000000 bytes.

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

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

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

Industry Canada Class A emission compliance statement

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

Avis de conformité à la réglementation d'Industrie Canada

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

Australia and New Zealand Class A statement

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

United Kingdom telecommunications safety requirement

Notice to Customers

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

European Union EMC Directive conformance statement

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

This product has been tested and found to comply with the limits for Class A Information Technology Equipment according to CISPR 22/European Standard EN

55022. The Limits for Class A equipment were derived for commercial and industrial environments to provide reasonable protection against interference with licensed communication equipment.

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

Taiwan electrical emission statement

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Power cords

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

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

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

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

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

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

| IBM power cord part number | Used in these countries and regions |
|----------------------------|---|
| 13F9940 | Argentina, Australia, China (PRC), New Zealand, Papua New Guinea, Paraguay, Uruguay, Western Samoa |
| 13F9979 | Afghanistan, Algeria, Andorra, Angola, Austria, Belgium, Benin, Bulgaria, Burkina Faso, Burundi, Cameroon, Central African Rep., Chad, China (Macau S.A.R.), Czech Republic, Egypt, Finland, France, French Guiana, Germany, Greece, Guinea, Hungary, Iceland, Indonesia, Iran, Ivory Coast, Jordan, Lebanon, Luxembourg, Malagasy, Mali, Martinique, Mauritania, Mauritius, Monaco, Morocco, Mozambique, Netherlands, New Caledonia, Niger, Norway, Poland, Portugal, Romania, Senegal, Slovakia, Spain, Sudan, Sweden, Syria, Togo, Tunisia, Turkey, former USSR, Vietnam, former Yugoslavia, Zaire, Zimbabwe |
| 13F9997 | Denmark |
| 14F0015 | Bangladesh, Burma, Pakistan, South Africa, Sri Lanka |
| 14F0033 | Antigua, Bahrain, Brunei, Channel Islands, China (Hong Kong S.A.R.), Cyprus, Dubai, Fiji, Ghana, India, Iraq, Ireland, Kenya, Kuwait, Malawi, Malaysia, Malta, Nepal, Nigeria, Polynesia, Qatar, Sierra Leone, Singapore, Tanzania, Uganda, United Kingdom, Yemen, Zambia |
| 14F0051 | Liechtenstein, Switzerland |
| 14F0069 | Chile, Ethiopia, Italy, Libya, Somalia |
| 14F0087 | Israel |
| 1838574 | Thailand |
| 6952301 | Bahamas, Barbados, Bermuda, Bolivia, Brazil, Canada, Cayman Islands, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Japan, Korea (South), Liberia, Mexico, Netherlands Antilles, Nicaragua, Panama, Peru, Philippines, Saudi Arabia, Suriname, Taiwan, Trinidad (West Indies), United States of America, Venezuela |

Glossary

This glossary provides definitions for the terminology and abbreviations used in IBM TotalStorage DS4000 publications.

If you do not find the term you are looking for, see the *IBM Glossary of Computing Terms* located at the following Web site:

www.ibm.com/ibm/terminology

This glossary also includes terms and definitions from:

- *Information Technology Vocabulary* by Subcommittee 1, Joint Technical Committee 1, of the International Organization for Standardization and the International Electrotechnical Commission (ISO/IEC JTC1/SC1). Definitions are identified by the symbol (I) after the definition; definitions taken from draft international standards, committee drafts, and working papers by ISO/IEC JTC1/SC1 are identified by the symbol (T) after the definition, indicating that final agreement has not yet been reached among the participating National Bodies of SC1.
- *IBM Glossary of Computing Terms*. New York: McGraw-Hill, 1994.

The following cross-reference conventions are used in this glossary:

See Refers you to (a) a term that is the expanded form of an abbreviation or acronym, or (b) a synonym or more preferred term.

See also
Refers you to a related term.

Abstract Windowing Toolkit (AWT). A Java graphical user interface (GUI).

accelerated graphics port (AGP). A bus specification that gives low-cost 3D graphics cards faster access to main memory on personal computers than the usual peripheral component interconnect (PCI) bus. AGP reduces the overall cost of creating high-end graphics subsystems by using existing system memory.

access volume. A special logical drive that allows the host-agent to communicate with the controllers in the storage subsystem.

adapter. A printed circuit assembly that transmits user data input/output (I/O) between the internal bus of the host system and the external fibre-channel (FC) link and vice versa. Also called an I/O adapter, host adapter, or FC adapter.

advanced technology (AT) bus architecture. A bus standard for IBM compatibles. It extends the XT bus architecture to 16 bits and also allows for bus mastering, although only the first 16 MB of main memory are available for direct access.

agent. A server program that receives virtual connections from the network manager (the client program) in a Simple Network Management Protocol-Transmission Control Protocol/Internet Protocol (SNMP-TCP/IP) network-managing environment.

AGP. See *accelerated graphics port*.

AL_PA. See *arbitrated loop physical address*.

arbitrated loop. One of three existing fibre-channel topologies, in which 2 - 126 ports are interconnected serially in a single loop circuit. Access to the Fibre Channel-Arbitrated Loop (FC-AL) is controlled by an arbitration scheme. The FC-AL topology supports all classes of service and guarantees in-order delivery of FC frames when the originator and responder are on the same FC-AL. The default topology for the disk array is arbitrated loop. An arbitrated loop is sometimes referred to as a Stealth Mode.

arbitrated loop physical address (AL_PA). An 8-bit value that is used to uniquely identify an individual port within a loop. A loop can have one or more AL_PAs.

array. A collection of fibre-channel or SATA hard drives that are logically grouped together. All the drives in the array are assigned the same RAID level. An array is sometimes referred to as a "RAID set." See also *redundant array of independent disks (RAID)*, *RAID level*.

asynchronous write mode. In remote mirroring, an option that allows the primary controller to return a write I/O request completion to the host server before data has been successfully written by the secondary controller. See also *synchronous write mode*, *remote mirroring*, *Global Copy*, *Global Mirroring*.

AT. See *advanced technology (AT) bus architecture*.

ATA. See *AT-attached*.

AT-attached. Peripheral devices that are compatible with the original IBM AT computer standard in which signals on a 40-pin AT-attached (ATA) ribbon cable followed the timings and constraints of the Industry Standard Architecture (ISA) system bus on the IBM PC AT computer. Equivalent to integrated drive electronics (IDE).

auto-volume transfer/auto-disk transfer (AVT/ADT). A function that provides automatic failover in case of controller failure on a storage subsystem.

AVT/ADT. See *auto-volume transfer/auto-disk transfer*.

AWT. See *Abstract Windowing Toolkit*.

basic input/output system (BIOS). The personal computer code that controls basic hardware operations, such as interactions with diskette drives, hard disk drives, and the keyboard.

BIOS. See *basic input/output system*.

BOOTP. See *bootstrap protocol*.

bootstrap protocol (BOOTP). In Transmission Control Protocol/Internet Protocol (TCP/IP) networking, an alternative protocol by which a diskless machine can obtain its Internet Protocol (IP) address and such configuration information as IP addresses of various servers from a BOOTP server.

bridge. A storage area network (SAN) device that provides physical and transport conversion, such as fibre channel to small computer system interface (SCSI) bridge.

bridge group. A bridge and the collection of devices connected to it.

broadcast. The simultaneous transmission of data to more than one destination.

cathode ray tube (CRT). A display device in which controlled electron beams are used to display alphanumeric or graphical data on an electroluminescent screen.

client. A computer system or process that requests a service of another computer system or process that is typically referred to as a server. Multiple clients can share access to a common server.

command. A statement used to initiate an action or start a service. A command consists of the command name abbreviation, and its parameters and flags if applicable. A command can be issued by typing it on a command line or selecting it from a menu.

community string. The name of a community contained in each Simple Network Management Protocol (SNMP) message.

concurrent download. A method of downloading and installing firmware that does not require the user to stop I/O to the controllers during the process.

CRC. See *cyclic redundancy check*.

CRT. See *cathode ray tube*.

CRU. See *customer replaceable unit*.

customer replaceable unit (CRU). An assembly or part that a customer can replace in its entirety when any of its components fail. Contrast with *field replaceable unit (FRU)*.

cyclic redundancy check (CRC). (1) A redundancy check in which the check key is generated by a cyclic algorithm. (2) An error detection technique performed at both the sending and receiving stations.

dac. See *disk array controller*.

dar. See *disk array router*.

DASD. See *direct access storage device*.

data striping. See *striping*.

default host group. A logical collection of discovered host ports, defined host computers, and defined host groups in the storage-partition topology that fulfill the following requirements:

- Are not involved in specific logical drive-to-LUN mappings
- Share access to logical drives with default logical drive-to-LUN mappings

device type. Identifier used to place devices in the physical map, such as the switch, hub, or storage.

DHCP. See *Dynamic Host Configuration Protocol*.

direct access storage device (DASD). A device in which access time is effectively independent of the location of the data. Information is entered and retrieved without reference to previously accessed data. (For example, a disk drive is a DASD, in contrast with a tape drive, which stores data as a linear sequence.) DASDs include both fixed and removable storage devices.

direct memory access (DMA). The transfer of data between memory and an input/output (I/O) device without processor intervention.

disk array controller (dac). A disk array controller device that represents the two controllers of an array. See also *disk array router*.

disk array router (dar). A disk array router that represents an entire array, including current and deferred paths to all logical unit numbers (LUNs) (hdisks on AIX). See also *disk array controller*.

DMA. See *direct memory access*.

domain. The most significant byte in the node port (N_port) identifier for the fibre-channel (FC) device. It is not used in the fibre channel-small computer system interface (FC-SCSI) hardware path ID. It is required to be the same for all SCSI targets logically connected to an FC adapter.

DRAM. See *dynamic random access memory*.

Dynamic Host Configuration Protocol (DHCP). A protocol defined by the Internet Engineering Task Force that is used for dynamically assigning Internet Protocol (IP) addresses to computers in a network.

dynamic random access memory (DRAM). A storage in which the cells require repetitive application of control signals to retain stored data.

ECC. See *error correction coding*.

EEPROM. See *electrically erasable programmable read-only memory*.

EISA. See *Extended Industry Standard Architecture*.

electrically erasable programmable read-only memory (EEPROM). A type of memory chip which can retain its contents without consistent electrical power. Unlike the PROM which can be programmed only once, the EEPROM can be erased electrically. Because it can only be reprogrammed a limited number of times before it wears out, it is appropriate for storing small amounts of data that are changed infrequently.

electrostatic discharge (ESD). The flow of current that results when objects that have a static charge come into close enough proximity to discharge.

environmental service module (ESM) canister. A component in a storage expansion enclosure that monitors the environmental condition of the components in that enclosure. Not all storage subsystems have ESM canisters.

E_port. See *expansion port*.

error correction coding (ECC). A method for encoding data so that transmission errors can be detected and corrected by examining the data on the receiving end. Most ECCs are characterized by the maximum number of errors they can detect and correct.

ESD. See *electrostatic discharge*.

ESM canister. See *environmental service module canister*.

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*.

FAST MSJ. See *FAST Management Suite Java*.

FAST Management Suite Java (FAST MSJ). A diagnostic and configuration utility that can be used on Linux, Microsoft Windows, and Novell NetWare host systems. In Linux, it is also used with the QLRemote agent to define preferred and non-preferred paths for logical drives.

FC. See *fibre channel*.

FC-AL. See *arbitrated loop*.

feature enable identifier. A unique identifier for the storage subsystem, which is used in the process of generating a premium feature key. See also *premium feature key*.

fibre channel (FC). A set of standards for a serial input/output (I/O) bus capable of transferring data between two ports at up to 100 Mbps, with standards proposals to go to higher speeds. FC supports point-to-point, arbitrated loop, and switched topologies.

Fibre Channel-Arbitrated Loop (FC-AL). See *arbitrated loop*.

Fibre Channel Protocol (FCP) for small computer system interface (SCSI). A high-level fibre-channel mapping layer (FC-4) that uses lower-level fibre-channel (FC-PH) services to transmit SCSI commands, data, and status information between a SCSI initiator and a SCSI target across the FC link by using FC frame and sequence formats.

field replaceable unit (FRU). An assembly that is replaced in its entirety when any one of its components fails. In some cases, a field replaceable unit might contain other field replaceable units. Contrast with *customer replaceable unit (CRU)*.

FlashCopy. A premium feature for DS4000 that can make an instantaneous copy of the data in a volume.

F_port. See *fabric port*.

FRU. See *field replaceable unit*.

GBIC. See *gigabit interface converter*

gigabit interface converter (GBIC). A transceiver that performs serial, optical-to-electrical, and electrical-to-optical signal conversions for high-speed networking. A GBIC can be hot swapped. See also *small form-factor pluggable*.

Global Copy. Refers to a remote logical drive mirror pair that is set up using asynchronous write mode without the write consistency group option. This is also referred to as "Asynchronous Mirroring without Consistency Group." Global Copy does not ensure that write requests to multiple primary logical drives are carried out in the same order on the secondary logical drives as they are on the primary logical drives. If it is critical that writes to the primary logical drives are carried out in the same order in the appropriate secondary logical drives, Global Mirroring should be used instead of Global Copy. See also *asynchronous write mode*, *Global Mirroring*, *remote mirroring*, *Metro Mirroring*.

Global Mirroring. Refers to a remote logical drive mirror pair that is set up using asynchronous write mode with the write consistency group option. This is also referred to as "Asynchronous Mirroring with Consistency Group." Global Mirroring ensures that write requests to multiple primary logical drives are carried out in the same order on the secondary logical drives as they are on the primary logical drives, preventing data on the secondary logical drives from becoming inconsistent with the data on the primary logical drives. See also *asynchronous write mode*, *Global Copy*, *remote mirroring*, *Metro Mirroring*.

graphical user interface (GUI). A type of computer interface that presents a visual metaphor of a real-world scene, often of a desktop, by combining high-resolution graphics, pointing devices, menu bars and other menus, overlapping windows, icons, and the object-action relationship.

GUI. See *graphical user interface*.

HBA. See *host bus adapter*.

hdisk. An AIX term representing a logical unit number (LUN) on an array.

host. A system that is directly attached to the storage subsystem through a fibre-channel input/output (I/O) path. This system is used to serve data (typically in the form of files) from the storage subsystem. A system can be both a storage management station and a host simultaneously.

host bus adapter (HBA). An interface between the fibre-channel network and a workstation or server.

host computer. See *host*.

host group. An entity in the storage partition topology that defines a logical collection of host computers that require shared access to one or more logical drives.

host port. Ports that physically reside on the host adapters and are automatically discovered by the DS4000 Storage Manager software. To give a host computer access to a partition, its associated host ports must be defined.

hot swap. To replace a hardware component without turning off the system.

hub. In a network, a point at which circuits are either connected or switched. For example, in a star network, the hub is the central node; in a star/ring network, it is the location of wiring concentrators.

IBMSAN driver. The device driver that is used in a Novell NetWare environment to provide multipath input/output (I/O) support to the storage controller.

IC. See *integrated circuit*.

IDE. See *integrated drive electronics*.

in-band. Transmission of management protocol over the fibre-channel transport.

Industry Standard Architecture (ISA). Unofficial name for the bus architecture of the IBM PC/XT personal computer. This bus design included expansion slots for plugging in various adapter boards. Early versions had an 8-bit data path, later expanded to 16 bits. The "Extended Industry Standard Architecture" (EISA) further expanded the data path to 32 bits. See also *Extended Industry Standard Architecture*.

initial program load (IPL). The initialization procedure that causes an operating system to commence operation. Also referred to as a system restart, system startup, and boot.

integrated circuit (IC). A microelectronic semiconductor device that consists of many interconnected transistors and other components. ICs are constructed on a small rectangle cut from a silicon crystal or other semiconductor material. The small size of these circuits allows high speed, low power dissipation, and reduced manufacturing cost compared with board-level integration. Also known as a *chip*.

integrated drive electronics (IDE). A disk drive interface based on the 16-bit IBM personal computer Industry Standard Architecture (ISA) in which the controller electronics reside on the drive itself,

eliminating the need for a separate adapter card. Also known as an Advanced Technology Attachment Interface (ATA).

Internet Protocol (IP). A protocol that routes data through a network or interconnected networks. IP acts as an intermediary between the higher protocol layers and the physical network.

Internet Protocol (IP) address. The unique 32-bit address that specifies the location of each device or workstation on the Internet. For example, 9.67.97.103 is an IP address.

interrupt request (IRQ). A type of input found on many processors that causes the processor to suspend normal processing temporarily and start running an interrupt handler routine. Some processors have several interrupt request inputs that allow different priority interrupts.

IP. See *Internet Protocol*.

IPL. See *initial program load*.

IRQ. See *interrupt request*.

ISA. See *Industry Standard Architecture*.

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 data also.

medium access control (MAC). In local area networks (LANs), the sublayer of the data link control layer that supports medium-dependent functions and uses the services of the physical layer to provide services to the logical link control sublayer. The MAC sublayer includes the method of determining when a device has access to the transmission medium.

Metro Mirroring. This term is used to refer to a remote logical drive mirror pair which is set up with synchronous write mode. See also *remote mirroring*, *Global Mirroring*.

MIB. See *management information base*.

micro channel architecture (MCA). Hardware that is used for PS/2 Model 50 computers and above to

provide better growth potential and performance characteristics when compared with the original personal computer design.

Microsoft Cluster Server (MSCS). MSCS, a feature of Windows NT Server (Enterprise Edition), supports the connection of two servers into a cluster for higher availability and easier manageability. MSCS can automatically detect and recover from server or application failures. It can also be used to balance server workload and provide for planned maintenance.

mini hub. An interface card or port device that receives short-wave fiber channel GBICs or SFPs. These devices enable redundant fibre channel connections from the host computers, either directly or through a fibre channel switch or managed hub, over optical fiber cables to the DS4000 Storage Server controllers. Each DS4000 controller is responsible for two mini hubs. Each mini hub has two ports. Four host ports (two on each controller) provide a cluster solution without use of a switch. Two host-side mini hubs are shipped as standard. See also *host port*, *gigabit interface converter (GBIC)*, *small form-factor pluggable (SFP)*.

mirroring. A fault-tolerance technique in which information on a hard disk is duplicated on additional hard disks. See also *remote mirroring*.

model. The model identification that is assigned to a device by its manufacturer.

MSCS. See *Microsoft Cluster Server*.

network management station (NMS). In the Simple Network Management Protocol (SNMP), a station that runs management application programs that monitor and control network elements.

NMI. See *non-maskable interrupt*.

NMS. See *network management station*.

non-maskable interrupt (NMI). A hardware interrupt that another service request cannot overrule (mask). An NMI bypasses and takes priority over interrupt requests generated by software, the keyboard, and other such devices and is issued to the microprocessor only in disastrous circumstances, such as severe memory errors or impending power failures.

node. A physical device that allows for the transmission of data within a network.

node port (N_port). A fibre-channel defined hardware entity that performs data communications over the fibre-channel link. It is identifiable by a unique worldwide name. It can act as an originator or a responder.

nonvolatile storage (NVS). A storage device whose contents are not lost when power is cut off.

N_port. See *node port*.

NVS. See *nonvolatile storage*.

NVSRAM. Nonvolatile storage random access memory. See *nonvolatile storage*.

Object Data Manager (ODM). An AIX proprietary storage mechanism for ASCII stanza files that are edited as part of configuring a drive into the kernel.

ODM. See *Object Data Manager*.

out-of-band. Transmission of management protocols outside of the fibre-channel network, typically over Ethernet.

partitioning. See *storage partition*.

parity check. (1) A test to determine whether the number of ones (or zeros) in an array of binary digits is odd or even. (2) A mathematical operation on the numerical representation of the information communicated between two pieces. For example, if parity is odd, any character represented by an even number has a bit added to it, making it odd, and an information receiver checks that each unit of information has an odd value.

PCI local bus. See *peripheral component interconnect local bus*.

PDF. See *portable document format*.

performance events. Events related to thresholds set on storage area network (SAN) performance.

peripheral component interconnect local bus (PCI local bus). A local bus for PCs, from Intel, that provides a high-speed data path between the CPU and up to 10 peripherals (video, disk, network, and so on). The PCI bus coexists in the PC with the Industry Standard Architecture (ISA) or Extended Industry Standard Architecture (EISA) bus. ISA and EISA boards plug into an IA or EISA slot, while high-speed PCI controllers plug into a PCI slot. See also *Industry Standard Architecture*, *Extended Industry Standard Architecture*.

polling delay. The time in seconds between successive discovery processes during which discovery is inactive.

port. A part of the system unit or remote controller to which cables for external devices (such as display stations, terminals, printers, switches, or external storage units) are attached. The port is an access point for data entry or exit. A device can contain one or more ports.

portable document format (PDF). A standard specified by Adobe Systems, Incorporated, for the electronic distribution of documents. PDF files are compact; can be distributed globally by e-mail, the Web, intranets, or CD-ROM; and can be viewed with

the Acrobat Reader, which is software from Adobe Systems that can be downloaded at no cost from the Adobe Systems home page.

premium feature key. A file that the storage subsystem controller uses to enable an authorized premium feature. The file contains the feature enable identifier of the storage subsystem for which the premium feature is authorized, and data about the premium feature. See also *feature enable identifier*.

private loop. A freestanding arbitrated loop with no fabric attachment. See also *arbitrated loop*.

program temporary fix (PTF). A temporary solution or bypass of a problem diagnosed by IBM in a current unaltered release of the program.

PTF. See *program temporary fix*.

RAID. See *redundant array of independent disks (RAID)*.

RAID level. An array's RAID level is a number that refers to the method used to achieve redundancy and fault tolerance in the array. See also *array, redundant array of independent disks (RAID)*.

RAID set. See *array*.

RAM. See *random-access memory*.

random-access memory (RAM). A temporary storage location in which the central processing unit (CPU) stores and executes its processes. Contrast with *DASD*.

RDAC. See *redundant disk array controller*.

read-only memory (ROM). Memory in which stored data cannot be changed by the user except under special conditions.

recoverable virtual shared disk (RVSD). A virtual shared disk on a server node configured to provide continuous access to data and file systems in a cluster.

redundant array of independent disks (RAID). A collection of disk drives (*array*) that appears as a single volume to the server, which is fault tolerant through an assigned method of data striping, mirroring, or parity checking. Each array is assigned a RAID level, which is a specific number that refers to the method used to achieve redundancy and fault tolerance. See also *array, parity check, mirroring, RAID level, striping*.

redundant disk array controller (RDAC). (1) In hardware, a redundant set of controllers (either active/passive or active/active). (2) In software, a layer that manages the input/output (I/O) through the active controller during normal operation and transparently reroutes I/Os to the other controller in the redundant set if a controller or I/O path fails.

remote mirroring. Online, real-time replication of data between storage subsystems that are maintained on

separate media. The Enhanced Remote Mirror Option is a DS4000 premium feature that provides support for remote mirroring. See also *Global Mirroring, Metro Mirroring*.

ROM. See *read-only memory*.

router. A computer that determines the path of network traffic flow. The path selection is made from several paths based on information obtained from specific protocols, algorithms that attempt to identify the shortest or best path, and other criteria such as metrics or protocol-specific destination addresses.

RVSD. See *recoverable virtual shared disk*.

SAI. See *Storage Array Identifier*.

SA Identifier. See *Storage Array Identifier*.

SAN. See *storage area network*.

SATA. See *serial ATA*.

scope. Defines a group of controllers by their Internet Protocol (IP) addresses. A scope must be created and defined so that dynamic IP addresses can be assigned to controllers on the network.

SCSI. See *small computer system interface*.

segmented loop port (SL_port). A port that allows division of a fibre-channel private loop into multiple segments. Each segment can pass frames around as an independent loop and can connect through the fabric to other segments of the same loop.

sense data. (1) Data sent with a negative response, indicating the reason for the response. (2) Data describing an I/O error. Sense data is presented to a host system in response to a sense request command.

serial ATA. The standard for a high-speed alternative to small computer system interface (SCSI) hard drives. The SATA-1 standard is equivalent in performance to a 10 000 RPM SCSI drive.

serial storage architecture (SSA). An interface specification from IBM in which devices are arranged in a ring topology. SSA, which is compatible with small computer system interface (SCSI) devices, allows full-duplex packet multiplexed serial data transfers at rates of 20 Mbps in each direction.

server. A functional hardware and software unit that delivers shared resources to workstation client units on a computer network.

server/device events. Events that occur on the server or a designated device that meet criteria that the user sets.

SFP. See *small form-factor pluggable*.

Simple Network Management Protocol (SNMP). In the Internet suite of protocols, a network management protocol that is used to monitor routers and attached networks. SNMP is an application layer protocol. Information on devices managed is defined and stored in the application's Management Information Base (MIB).

SL_port. See *segmented loop port*.

SMagent. The DS4000 Storage Manager optional Java-based host-agent software, which can be used on Microsoft Windows, Novell NetWare, HP-UX, and Solaris host systems to manage storage subsystems through the host fibre-channel connection.

SMclient. The DS4000 Storage Manager client software, which is a Java-based graphical user interface (GUI) that is used to configure, manage, and troubleshoot storage servers and storage expansion enclosures in a DS4000 storage subsystem. SMclient can be used on a host system or on a storage management station.

SMruntime. A Java compiler for the SMclient.

SMutil. The DS4000 Storage Manager utility software that is used on Microsoft Windows, HP-UX, and Solaris host systems to register and map new logical drives to the operating system. In Microsoft Windows, it also contains a utility to flush the cached data of the operating system for a particular drive before creating a FlashCopy.

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

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

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

SNMP trap event. (1) (2) An event notification sent by the SNMP agent that identifies conditions, such as thresholds, that exceed a predetermined value. See also *Simple Network Management Protocol*.

SNMPv1. The original standard for SNMP is now referred to as SNMPv1, as opposed to SNMPv2, a revision of SNMP. See also *Simple Network Management Protocol*.

SRAM. See *static random access memory*.

SSA. See *serial storage architecture*.

static random access memory (SRAM). Random access memory based on the logic circuit known as

flip-flop. It is called static because it retains a value as long as power is supplied, unlike dynamic random access memory (DRAM), which must be regularly refreshed. It is however, still volatile, meaning that it can lose its contents when the power is turned off.

storage area network (SAN). A dedicated storage network tailored to a specific environment, combining servers, storage products, networking products, software, and services. See also *fabric*.

Storage Array Identifier (SAI or SA Identifier). The Storage Array Identifier is the identification value used by the DS4000 Storage Manager host software (SMClient) to uniquely identify each managed storage server. The DS4000 Storage Manager SMClient program maintains Storage Array Identifier records of previously-discovered storage servers in the host resident file, which allows it to retain discovery information in a persistent fashion.

storage 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 packet-switched communication networks and in interconnected systems of such networks. It uses the Internet Protocol (IP) as the underlying protocol.

Transmission Control Protocol/Internet Protocol (TCP/IP). A set of communication protocols that provide peer-to-peer connectivity functions for both local and wide-area networks.

trap. In the Simple Network Management Protocol (SNMP), a message sent by a managed node (agent function) to a management station to report an exception condition.

trap recipient. Receiver of a forwarded Simple Network Management Protocol (SNMP) trap. Specifically, a trap receiver is defined by an Internet Protocol (IP) address and port to which traps are sent.

Presumably, the actual recipient is a software application running at the IP address and listening to the port.

TSR program. See *terminate and stay resident program*.

uninterruptible power supply. A source of power from a battery that is installed between a computer system and its power source. The uninterruptible power supply keeps the system running if a commercial power failure occurs, until an orderly shutdown of the system can be performed.

user action events. Actions that the user takes, such as changes in the storage area network (SAN), changed settings, and so on.

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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