IBM System Storage DS5020 Storage Subsystem

# Installation, User's, and Maintenance Guide

**IBM**

> **Note:**
>
> Before using this information and the product it supports, be sure to read the general information in "Safety" on page xi and "Notices" on page 205.

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# Safety

The caution and danger statements that this document contains can be referenced in the multilingual *IBM® Safety Information* document that is provided with your IBM System Storage® DS5020 Storage Subsystem. Each caution and danger statement is numbered for easy reference to the corresponding statements in the translated document.

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

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

**Statement 1:**



**DANGER**

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

To avoid a shock hazard:

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

| To Connect: | To Disconnect: |
|---|---|
| 1. Turn everything OFF. | 1. Turn everything OFF. |
| 2. First, attach all cables to devices. | 2. First, remove power cords from outlet. |
| 3. Attach signal cables to connectors. | 3. Remove signal cables from connectors. |
| 4. Attach power cords to outlet. | 4. Remove all cables from devices. |
| 5. Turn device ON. | |

**Statement 2:**



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

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

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

**Statement 3:**



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



DANGER

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

a

Class 1 Laser statement

Class 1 Laser Product
Laser Klasse 1
Laser Klass 1
Luokan 1 Laserlaite
Apparell À Laser de Calsse 1

IEC 825-11993 CENELEC EN 60 825

**Statement 4:**

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

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

**Statement 5:**

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

2
1
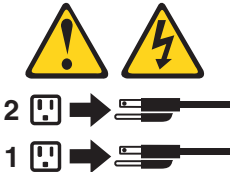
**Statement 8:**

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

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

**Statement 30:**

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

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

**Cable Warning:**

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

# About this document

This document provides instructions for installing and customizing the configuration of your IBM System Storage DS5020 storage subsystem. It also provides maintenance procedures and troubleshooting information.

## Who should read this document

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

## How this document is organized

Chapter 1, "Introduction," on page 1 describes the IBM System Storage DS5020 storage subsystem. This chapter includes an inventory checklist and an overview of the storage subsystem features, operating specifications, and components.

Chapter 2, "Installing the storage subsystem," on page 29 contains information about how to install the DS5020 storage subsystem in a standard rack cabinet and setting the interface options.

Chapter 3, "Cabling the storage subsystem," on page 47 contains Fibre Channel and power cabling information for the DS5020 storage subsystem.

Chapter 4, "Operating the storage subsystem," on page 95 contains information about how to turn the power to the DS5020 storage subsystem on and off, recover from an overheated power supply and fan unit, troubleshoot, and interpret LEDs.

Chapter 5, "Replacing components," on page 123 contains step-by-step instructions about how to install or remove customer replaceable units (CRUs), such as Enhanced Disk Drive Modules (E-DDMs), power supply and fan units, RAID controllers, battery units, midplane, and Small Form-factor Pluggable transceiver (SFP) modules.

Chapter 6, "Hardware maintenance," on page 157 describes problems and symptoms that are specific to the DS5020 storage subsystem. It also provides a parts list for the DS5020 storage subsystem.

Appendix A, "Records," on page 171 provides a table that you can use to record and update important information about your DS5020 storage subsystem, including serial number and device records.

Appendix B, "Rack mounting templates," on page 175 provides the rack mounting templates for installation of the DS5020 storage subsystem. If you want to tear out the templates from the document for use during installation, use these copies of the templates.

Appendix D, "Power cords," on page 187 lists power cord information for the DS5020 storage subsystem.

Appendix E, "Additional DS5020 documentation," on page 191 lists additional DS5020 documents.

# DS5020 and DS4000-family storage subsystem installation tasks - General overview

For educational information about the DS5020 and other IBM System Storage products, go to http://ibmdsseriestraining.com/.

Table 1 provides a sequential list of many installation and configuration tasks that are common to most DS5020 and DS4000-family configurations. When you install and configure your storage subsystem, refer to this table to find the documentation that explains how to complete each task.

*Table 1. Where to find DS5020 and DS4000-family installation and configuration procedures*

|   | Installation task | Where to find information or procedures |
|---|---|---|
| 1 | Plan the installation | • *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx) |
|   |   | • *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later) |
|   |   | • *DS4100 Storage Subsystem Installation, User's, and Maintenance Guide* |
|   |   | • *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide* |
|   |   | • *DS4300 Storage Subsystem Installation, User's, and Maintenance Guide* |
|   |   | • *DS4400 Fibre Channel Storage Server Installation and Support Guide* |
|   |   | • *DS4500 Storage Subsystem Installation, User's, and Maintenance Guide* |
|   |   | • *DS4700 Express Storage Subsystem Installation, User's, and Maintenance Guide* |
|   |   | • *IBM System Storage Quick Start Guide, Quick Reference for the DS4800* |
|   |   | • *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide* |
|   |   | • *IBM System Storage Quick Start Guide, Quick Reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420* |
|   |   | • *IBM System Storage DS5000 Quick Start Guide* |
|   |   | • *DS5000 Installation, User's, and Maintenance Guide* |
|   |   | • *IBM System Storage DS5020 Quick Start Guide* |
|   |   | • *DS5020 Installation, User's, and Maintenance Guide* |

*Table 1. Where to find DS5020 and DS4000-family installation and configuration procedures  (continued)*

|   | Installation task | Where to find information or procedures |
|---|---|---|
| 2 | Mount the DS5020 storage subsystem in the rack | • *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*<br><br>• *IBM System Storage Quick Start Guide, Quick Reference for the DS4800*<br><br>• *DS4700 Express Storage Subsystem Installation, User's, and Maintenance Guide*<br><br>• *IBM System Storage Quick Start Guide, Quick Reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420*<br><br>• *DS4400 and DS4500 Rack Mounting Instructions*<br><br>• *DS4300 Rack Mounting Instructions*<br><br>• *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide*<br><br>• *DS4100 Storage Subsystem Installation, User's and Maintenance Guide*<br><br>• *IBM System Storage DS5000 Installation, User's, and Maintenance Guide*<br><br>• *IBM System Storage DS5020 Installation, User's, and Maintenance Guide* |
| 3 | Mount the storage expansion unit in the rack | • *DS4000 EXP100 Storage Expansion Unit Installation, User's and Maintenance Guide*<br><br>• *DS4000 EXP420 Storage Expansion Enclosures Installation, User's, and Maintenance Guide*<br><br>• *DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide*<br><br>• *DS4000 EXP810 Storage Expansion Enclosures Installation, User's, and Maintenance Guide*<br><br>• *EXP500 Installation and User's Guide*<br><br>• *IBM System Storage Quick Start Guide, Quick Reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420*<br><br>• *DS5000 Installation, User's, and Maintenance Guide*<br><br>• *DS5020 Installation, User's, and Maintenance Guide* |

*Table 1. Where to find DS5020 and DS4000-family installation and configuration procedures  (continued)*

|   | Installation task | Where to find information or procedures |
|---|---|---|
| **4** | Route the storage expansion unit Fibre Channel cables | • *DS4100 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4300 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4400 Fibre Channel Cabling Instructions*<br>• *DS4500 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4700 Express Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *IBM System Storage Quick Start Guide, Quick Reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420*<br>• *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *IBM System Storage Quick Start Guide, Quick Reference for the DS4800*<br>• *DS5000 Installation, User's, and Maintenance Guide*<br>• *DS5020 Installation, User's, and Maintenance Guide* |
| **5** | Route the host server Fibre Channel cables | |
| **6** | Power on the subsystem | |
| **7** | Configure DS5020 network settings | • *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)<br>• *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later)<br>• *DS4100 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4300 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4400 Fibre Channel Storage Server Installation and Support Guide*<br>• *DS4500 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4700 Express Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *IBM System Storage Quick Start Guide, Quick Reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420*<br>• *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *IBM System Storage Quick Start Guide, Quick Reference for the DS4800*<br>*DS5000 Installation, User's, and Maintenance Guide*<br>*DS5020 Installation, User's, and Maintenance Guide* |

*Table 1. Where to find DS5020 and DS4000-family installation and configuration procedures (continued)*

|  | Installation task | Where to find information or procedures |
|---|---|---|
| 8 | Zone the fabric switch (SAN-attached only) | • *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)<br>• *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later)<br>• *DS4000 Storage Manager Copy Services Guide* (describes switch zoning for the Remote Mirror Option)<br>• See also the documentation provided by the switch manufacturer. |
| 9 | Install DS Storage Manager software on the management station | • *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)<br>• *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later)<br>• DS Storage Manager online help (for post-installation tasks) |
| 10 | Install host software (failover drivers) on host server | |
| 11 | Start DS Storage Manager | |
| 12 | Set the DS Storage Manager clock | |
| 13 | Set the DS Storage Manager host default type | |
| 14 | Verify DS5020 subsystem health | • *DS4100 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4200 Express Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4300 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4400 Fibre Channel Storage Server Installation and Support Guide*<br>• *DS4500 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4700 Express Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *DS4800 Storage Subsystem Installation, User's, and Maintenance Guide*<br>• *IBM System Storage DS5020 Installation, User's, and Maintenance Guide* |

*Table 1. Where to find DS5020 and DS4000-family installation and configuration procedures  (continued)*

|  | Installation task | Where to find information or procedures |
|---|---|---|
| 15 | Enable DS Storage Manager premium feature keys | **Copy Services premium features**<br>    *DS4000 Storage Manager Copy Services Guide*<br><br>**FC/SATA Intermix premium feature**<br>• *DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview*<br>• *FDE Best Practices Guide*<br><br>**Storage Partitioning (and general premium features information)**<br>• *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)<br>• *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later) |
| 16 | Configure arrays and logical drives | • *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)<br>• *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later)<br>• DS Storage Manager online help |
| 17 | Configure host partitions | |
| 18 | Verify host access to DS5020 storage subsystem | |
| 19 | Add storage capacity or configure migration of drives | *IBM System Storage Migration Guide* |

# Getting information, help, and service

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

## Before you call

Before you call, take these steps to try to solve the problem yourself:
• Check all cables to make sure that they are connected.
• Check the power switches to make sure that the system is turned on.
• Use the troubleshooting information in your system documentation, and use the diagnostic tools that come with your system.
• Check for technical information, hints, tips, and new device drivers at the IBM support Web site pages that are listed in this section.
• Use an IBM discussion forum on the IBM Web site to ask questions.

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

## Using the documentation

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

## Finding DS5020 and DS4000-family readme files

1. Go to the following Web site:

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

2. Click the link for your storage subsystem (for example, **DS5020**).

3. When the subsystem support page opens, click the **Download** tab.

4. Under the Download tab, click **Storage Manager, firmware, HBA, tools, support & pubs (including readmes)**.

5. Click the applicable tab for the type of readme file that you are looking for:

   - **Firmware**
   - **Storage Mgr**
   - **HBA**
   - **Tools**

   A table displays as you click each tab.

6. In the table, click the applicable link in the **Current version and readmes** column.

7. Click the link for the readme file.

## Web sites

The most current information about DS5020 storage subsystems and DS Storage Manager, including documentation and the most recent software, firmware, and NVSRAM downloads, can be found at the following Web sites.

**DS4000 and DS5000 Midrange Disk Systems**
> Find the latest information about IBM System Storage disk storage systems, including all of the DS4000 and DS5000 storage subsystems:
>
> http://www.ibm.com/systems/support/storage/disk

**IBM System Storage products**
> Find information about all IBM System Storage products:
>
> http://www.ibm.com/systems/storage

**Support for IBM System Storage disk storage systems**
> Find links to support pages for all IBM System Storage disk storage systems, including DS4000 and DS5000 storage subsystems and expansion units:

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

**System Storage DS4000 and DS5000 interoperability matrix**
Find the latest information about operating system and HBA support, clustering support, storage area network (SAN) fabric support, and DS Storage Manager feature support:

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

**Storage Area Network (SAN) support**
Find information about using SAN switches, including links to user guides and other documents:

http://www.ibm.com/systems/support/storage/san

**DS4000 and DS5000 technical support**

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

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

Select your storage subsystem (for example, **DS5020**).

**Premium feature activation**
Activate a DS5020 or DS4000 premium feature by using the online tool:

http://www-912.ibm.com/PremiumFeatures/jsp/keyInput.jsp

**IBM publications center**
Find IBM publications:

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

**Support for System p® servers**
Find the latest information supporting System p AIX® and Linux servers:

http://www.ibm.com/systems/support/supportsite.wss/
brandmain?brandind=5000025

**Support for System x® servers**
Find the latest information supporting System x Intel- and AMD-based servers:

http://www.ibm.com/systems/support/supportsite.wss/
brandmain?brandind=5000008

**Fix delivery center for AIX and Linux on POWER®**
Find the latest AIX and Linux on POWER information and downloads:

http://www-912.ibm.com/eserver/support/fixes/fcgui.jsp

In the **Product family** drop-down menu, select **UNIX servers**. Then select your product and fix type from the subsequent drop-down menus.

**System p and AIX information center**
Find everything you need to know about using AIX with System p and POWER servers:

http://publib.boulder.ibm.com/infocenter/pseries/index.jsp?

## Software service and support

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

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

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

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

## Hardware service and support

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

http://www.ibm.com/planetwide/

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

## Fire suppression systems

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

# Chapter 1. Introduction

This chapter describes the operating specifications, features, and components for the IBM System Storage DS5020 Storage Subsystem (hereafter referred to as *DS5020* or *storage subsystem*).

This chapter also includes an inventory checklist and important information about best practices guidelines and product updates for your DS5020.

## Overview

The IBM System Storage DS5020 storage subsystem (Machine Type 1814-20A) is designed to provide solutions to meet the needs of midrange/departmental storage requirements, delivering high performance, advanced function, high availability, modular and scalable storage capacity, with SAN-attached 8 Gbps Fibre Channel (FC) and 1 Gbps iSCSI connectivity, and support for RAID levels 0, 1, 3, 5, and 6 up to over 49 terabytes (TB) when using 450 GB Fibre Channel hard drives and up to 112 TB when using 1 TB Serial Advanced Technology Attachment (SATA) Enhanced Disk Drive Modules (E-DDMs).

A 3U rack-mountable enclosure houses the DS5020 redundant, dual-active RAID controllers with either two Fibre Channel ports, four Fibre Channel ports, or two Fibre Channel and two iSCSI ports per controller. The DS5020 can be configured for the attachment of host servers and EXP520 and EXP810 storage expansion enclosures and up to 16 4 Gbps Fibre Channel or SATA E-DDMs. The base DS5020 storage subsystem controllers each have four Fibre Channel ports.

The DS5020 supports the attachment of up to six EXP520 and EXP810 storage expansion enclosures, resulting in the capability to connect up to 112 E-DDMs and enabling storage configurations of over 67 TB using 600 GB Fibre Channel or FC-SAS E-DDMs, or 224 TB using 2 TB SATA E-DDMs.

**Note:** In this document, the term *FC-SAS* refers to a SAS drive with a FC-SAS interposer.

The base DS5020 storage subsystem supports up to 32 drives, which includes 16 drives in the DS5020 chassis and 16 more drives in an attached storage expansion enclosure. To attach more than 32 drives, you much purchase the applicable feature option.

To attach additional drives to the DS5020, you can use EXP520 or EXP810 storage expansion enclosures. You can connect EXP520 storage expansion enclosures to the DS5020 without purchasing feature options. To attach an EXP810 storage expansion enclosure or enclosures to the DS5020, you must purchase the Attach EXP810 to DS5020 Activation feature option. Contact your IBM marketing representative or IBM reseller for more information.

To connect 33 - 64 drives in one DS5020 and three EXP520 storage expansion enclosures, you must purchase the DS5020 Drive Attach 33 - 64 feature option. If you need to connect 65 - 112 drives in a DS5020 configuration, you must purchase the DS5020 Drive Attach 65- 112 feature option in addition to the DS5020 Drive Attach 33 - 64 feature option. These two feature options enable you to attach the

additional drives in one DS5020 and six EXP520 storage expansion enclosures. Contact your IBM marketing representative or IBM reseller for more information.

The DS5020 supports configurations of FC disks with or without Full Disk Encryption (FDE), SATA disks with SATA-FC interposers, solid state disks (SSD), FC-SAS disks (SAS disks with FC-SAS interposers), or a mix of disk drives. To install FDE disks in a DS5020, you must purchase the Full Disk Encryption option. In addition, the FC-SAS disk drives are formatted with 520 byte sectors, and support T10 Protection Information (T10 PI) capability for the transfer of drive data. Advanced DS5020 storage management, copy service options, and optional advanced disaster recovery functions are available for the DS5020, including FlashCopy®, VolumeCopy, and Enhanced Remote Mirroring. To install the SSD or FC-SAS disks in the DS5020, the minimum versions of controller firmware installed in the DS5020 must be 7.70.xx.xx or 7.77.xx.xx, respectively.

The DS5020 supports up to four hosts in a redundant direct-attached Fibre Channel configuration. When using Fibre Channel or Ethernet switches, you can redundantly connect up to 512 hosts to the DS5020 FC and iSCSI host ports. You can order up to 128 storage partitions for the DS5020.

DS5020 storage subsystems are equipped with ac power supply and fan units that support both NEBS/ETSI operating environments and standard IT and office environments.

The DS Storage Manager client is also available for the DS5020. This storage management software is designed to help centralize storage management, help simplify partitioning of the DS5020 storage subsystem, and strategically allocate storage capacity to maximize storage space.

## Base DS5020 features

The base DS5020 storage subsystem is a 3U rack-mount enclosure with the following features.

**Note:** Depending on the configuration options that were purchased with your DS5020, your hardware features miht differ slightly from those in this list.

- Dual RAID controllers, one of the configurations in the following list:
  - Controllers with 1 GB memory, two standard 8 Gbps FC host ports, and two standard 4 Gbps FC drive channel ports
  - Controllers with 1 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 8 Gbps FC host card, and two standard 4 Gbps FC drive channel ports
  - Controllers with 1 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 1 GB iSCSI host card, and two standard 4 Gbps FC drive channel ports
  - Controllers with 2 GB memory, two standard 8 Gbps FC host ports, and two standard 4 Gbps FC drive channel ports
  - Controllers with 2 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 8 Gbps FC host card, and two standard 4 Gbps FC drive channel ports
  - Controllers with 2 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 1 GB iSCSI host card, and two standard 4 Gbps FC drive channel ports
- Four or eight 8 Gbps FC Small Form-factor Pluggable transceivers (SFPs)

> **Note:** These SFPs will be included only if the DS5020 controllers purchased have the four additional Fibre Channel host ports

- Four 4 Gbps FC Small Form-factor Pluggable transceivers (SFPs)
- Dual AC power and fan units
- Two PDU power cords that have an IEC C13 plug on one end and an IEC C14 plug on the other end.
- Rack-mounting kit
- IBM *Documentation* CD
- Access to educational information about the DS5020 at http://ibmdsseriestraining.com/.

Contact your IBM sales representative or reseller for more information about the various DS5020 and options.

## Operating system support

For supported operating systems, see the latest DS Storage Manager host software readme file and the IBM DS4000 and DS5000 series products interoperability matrix at the following Web site for additional host operating system support:

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

See "Finding DS5020 and DS4000-family readme files" on page xxiii to learn how to access the DS5020 readme files on the Web.

## FC-SAS defined

In this document, the term *FC-SAS* refers to a SAS drive with a FC-SAS interposer that translates the SAS drive interface to a FC protocol interface. *Contrast with* "SAS defined".

## Fibre Channel defined

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

Using a Fibre Channel arbitrated loop (FC-AL), more than 100 Fibre Channel devices can be supported, compared to 15 small computer system interface (SCSI) devices. The Fibre Channel connection speed from the storage subsystem to storage expansion enclosures is 4 Gbps, and enables data transfer rates up to 400 Mbps half-duplex and 800 Mbps full-duplex on optical interfaces.

## iSCSI defined

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

## SAS defined

The Serial-attached SCSI (SAS) is a data-transfer technology that moves data to and from computer storage devices such as hard drives and tape drives. SAS uses a point-to-point serial protocol instead of the traditional parallel SCSI bus technology. In this document, the term *FC-SAS* refers to a SAS drive with a FC-SAS interposer that translates the SAS drive interface to a FC protocol interface. *See* "FC-SAS defined".

## SATA defined

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

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

## T10 PI defined

The T10 Protection Information (T10 PI) is an extension of the SCSI protocol that protects user data during transfer between a sender and a receiver. Hard disk drives with T10 PI support are formatted with 520-byte sectors instead of the typical 512-byte sectors. The extra 8 bytes are used to store data integrity information. The T10 PI model is an industry standard, and is defined by the T10 Committee. For more details about T10 PI and SCSI, including technical specifications, see the T10 Committee website (http://www.t10.org).

# Inventory checklist

After you unpack the DS5020, verify that you have the following items.

**Note:** Depending on your DS5020 order, your shipping box might contain additional materials not listed in the following checklist. Review the inventory checklist included in the DS5020 shipping box for any additional parts, and use that checklist in combination with the following information.

- **Hardware**
  - E-DDMs or blank trays (16) (Your storage subsystem might come with up to 16 E-DDMs.)
  - RAID controllers (2)
  - AC power supply and fan units (2)
  - Fiber-optic cables (2)
  - Battery units (2)
  - Power cables (2 rack jumper line cords)
  - Diagnostic wrap plug/coupler (1)
  - Serial cable adapter (1)
  - Rack-mounting hardware kit (1), including:
    - Rails (2) (right and left assembly)
    - M5 black hex-head slotted screws (12)
    - M4 screws (4)
    - Washers (8)
  - 8 Gbps SFPs (4 or 8)

    **Note:** The number of 8 Gbps SFPs depends on the storage subsystem configuration. The SFPs are preinstalled in the DS5020 ports.
  - 4 Gbps SFPs (4)

**Note:** The SFPs are for the drive channel ports only, and are preinstalled in the DS5020 drive channel ports.

**Attention:** The DS5020 does not ship with region-specific ac power cords. You must obtain the IBM-approved power cords for your region. See Appendix D, "Power cords," on page 187 for the IBM-approved power cords for your region.

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

    Depending on the DS5020 configuration that you order, your DS5020 includes your choice of host software kits (Windows, AIX, Linux, Netware, SUN Solaris, HP-UX, Linux on POWER, or VMware). The host software kit grants you permission to attach host servers using the applicable operating system to the DS5020. The kit includes a *DS Storage Manager Support* DVD that has the applicable IBM DS Storage Manager host software. The DVD also includes firmware, online help, and publications in Adobe Acrobat Portable Document Format (PDF). (For a list of available IBM DS4000 and DS5000 publications, see Appendix E, "Additional DS5020 documentation," on page 191.)

    If you order more than one host software kit, the additional kits might also be shipped in the DS5020 shipping box.

    **Note:** Depending on your DS5020 configuration, you might need to purchase the applicable host software kit for your host server operating system. Contact your IBM representative or reseller for more information.
  - Activation kit, including a storage partition kit with the number of partitions you ordered
  - *IBM System Storage DS5020 Storage Subsystem Installation, User's, and Maintenance Guide*
  - *IBM System Storage Quick Start Guide for the DS5020*
  - *IBM Safety Information*
  - IBM License Agreement
  - Statement of Limited Warranty
  - Box ID labels (used to label the enclosure IDs on the front of the DS5020)

    **Note:** If you ordered additional premium features or entitlements, the premium features activation or entitlement kits might also be shipped inside the box.

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

A rack mounting template and instructions for installing the support rails and the storage subsystem are provided in "Installing the support rails" on page 35.

To connect your DS5020 to other devices, use the following options:
- IBM SFP module (preinstalled)
- IBM LC-LC Fibre Channel cable

**Note:** You must order these options separately.

# Product updates and support notifications

Be sure to download the latest versions of the DS Storage Manager host software, DS5020 storage subsystem controller firmware, storage expansion enclosure ESM firmware, and drive firmware at the time of the initial installation and when product updates become available.

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

For more information about support notifications or the My Support feature, including instructions on how to register, see the following IBM Support Web page:

http://www.ibm.com/systems/support/storage/subscribe/moreinfo.html

You can also check the **Stay Informed** section of the IBM Disk Support Web site:

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

# Best practices guidelines

To achieve optimal system operation, always follow these best practices guidelines:

- Make sure that your system is in an optimal state before you shut it down. Never turn the power off if any Needs Attention LED is lit; be sure to resolve any error conditions before you shut down the system.
- Back up the data on your storage drives periodically.
- To maintain power redundancy, plug the DS5020 right and left power supply and fan units into two independent external power circuits through ac power distribution units inside a rack cabinet or directly into external receptacles. Similarly, make sure that the right and left power supplies of the storage expansion enclosures attached to the DS5020 are plugged into the same two independent external power circuits as the DS5020. This ensures that the DS5020 and all its attached storage expansion enclosures will have power in the event that only one power circuit is available. In addition, having all the right or all the left power cables plug into the same power circuit enables the devices in the configuration to power on simultaneously during an unattended restoration of power.

    **Note:** Do not overload the circuits that power your storage subsystem and storage expansion enclosures. Use additional pairs of ac power distribution units (PDUs) if necessary. See "Electrical requirements" on page 25 for information about storage subsystem power requirements. Contact your IBM service representative for additional information if needed.

- Before any planned system shutdown or after any system additions, removals, or modifications (including firmware updates, logical drive creations, storage partitioning definitions, hardware changes, and so on), complete the following tasks:

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

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

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

- During any maintenance or attended power-up procedure, carefully follow the power-up sequence listed in "Powering on the storage subsystem" on page 97. Check that each component of the subsystem is powered-on in the proper order during this entire power-up procedure so the controller will be able to optimally access all of your storage subsystems.

- The storage subsystem supports simultaneous power-up to the system components, but always follow the power-up sequence listed in "Powering on the storage subsystem" on page 97 during any attended power-up procedure.

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

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

## Storage subsystem components

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

- Up to sixteen 4 Gbps Fibre Channel or SATA Enhanced Disk Drive Modules (E-DDMs)
- Two RAID controllers
- Two ac power supply and fan units
- Two battery units
- SFP modules

The hot-swap features enable you to remove and replace 4 Gbps Fibre Channel or SATA E-DDMs, power supply and fan units, and controllers without turning off the storage subsystem. You can maintain the availability of your system while a hot-swap device is removed, installed, or replaced.

## Enhanced Disk Drive Modules (E-DDMs)

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



Figure 1. DS5020 hot-swap drive bays

The DS5020 supports Fibre Channel (FC), Fiber Channel Solid State Disk (SSD), Serial Attached SCSI (SAS), and Serial ATA (SATA) E-DDMs intermixed in the storage subsystem drive chassis. The DS5020 supports up to sixteen 4 Gbps FC, 3 Gbps SATA, or FC-SAS E-DDMs. Even though various type of drives can be intermixed in a DS5020 configuration, the RAID arrays can be created only using homogenous type of drives, whether it is FC, SSD, FC-SAS, or SATA. In addition, only drives of the same drive type as the drives configured in a particular array can be used as a hot spare for a failed drive in that array. For example, only an SSD drive can be used as a hot spare in an array that is configured with SSD drives. As another example, only an FDE capable drive can be used as a hot spare in a secure FDE array.

**Note:** The maximum number of SSD disks that can be supported in a DS5020 configuration is 20.

SATA E-DDMs have an ATA translator card that converts the Fibre Channel protocol interface of the DS5020 drive channel or loop into the hard drive SATA protocol interface. It also provides dual paths to the SATA drive for drive CRU path redundancy. Each drive, ATA translator card (also referred to as interposer card), and carrier assembly are called SATA E-DDM CRUs. The Fibre Channel E-DDMs consist of the Fibre Channel and the carrier assembly (drive tray). The FC-SAS E-DDMs have a FC-SAS interposer card that translates the SAS drive interface to a 4 Gbps FC protocol interface of the DS5020 drive channel. Each SAS drive, FC-SAS interposer card (with a 2.5" to 3.5" form factor conversion), and carrier assembly are called FC-SAS E-DDM CRUs.

There are no serviceable parts in an E-DDM CRU. If it fails, it must be replaced in its entirety (E-DDM, ATA translator card/FC-SAS interposer card, bezel, and tray). The DS5020 drive tray is not interchangeable with the drive tray of other DS4000 storage subsystems such as DS4100 or DS4300 storage subsystems. The DS5020 E-DDM option CRUs are not interchangeable with those of the DS4200 Express and EXP420. When replacing an E-DDM CRU, be sure to order and install the correct E-DDM CRU. Using non-supported E-DDM options or FRUs will result in the E-DDM being locked out by the DS5020 controller firmware and might also damage the drive connector in the enclosure midplane.

Install E-DDM CRUs in the 16 drive bays on the front of the storage subsystem from the leftmost slot (slot 1) to the rightmost slot (slot 16). When an E-DDM is installed, the drive and tray slot designation is set automatically. The hardware addresses are based on the enclosure ID, which is set by the controller software, and on the E-DDM physical location in the storage subsystem.

The DS5020 storage subsystem drive channel operates at a 4 Gbps Fibre Channel interface speed. Make sure that the DS5020 enclosure speed switch is set correctly for 4 Gbps Fibre Channel E-DDM CRUs. The DS5020 storage subsystem SATA E-DDM CRUs have an ATA translator card that converts E-DDM 3 Gbps SATA drive interface protocol to a 4 Gbps Fibre Channel interface protocol. Operate these SATA E-DDMs at 4 Gbps Fibre Channel operating speed.

**Note:** Even though the DS5020 has a 2 or 4 Gbps Fibre Channel Link Rate switch that can be used to set the drive channel speed at 2 Gbps, the link rate speed must be set to 4 Gbps. The DS5020 supports only 4 Gbps FC speed in the drive channel. See "Verifying the link rate setting" on page 140 for more information.

**Important:** Do not change the speed of a drive loop while the storage subsystem is powered on. Such a speed change will cause unpredictable results. Also, the drive expansion enclosures must be power cycled for the new speed setting to be correctly recognized.

If you need to change the speed of a drive loop, complete the following steps:

1. Prepare applications for storage system shutdown.
2. Shut down the storage system.
3. Shut down the storage expansion enclosures.
4. Change the storage expansion enclosure speed settings.
5. Power on the storage expansion enclosures.
6. Power on the storage subsystem.
7. Restore storage subsystem host application operations.

The Link Rate switch on the DS5020 storage subsystem and the storage expansion enclosures connected to it must have the same setting.

**Attention:**

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

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

## Controllers

The DS5020 has two hot-swappable and redundant RAID controllers. The controllers are located at the back of the storage subsystem. The left controller is labeled controller A, and the right controller is labeled controller B. One controller will continue to operate if the other controller fails.

The controllers contain the storage subsystem control logic, interface ports, and LEDs. Depending on the DS5020 configuration you purchased, your controllers are one of the following types:

- Controllers with 1 GB memory, two standard 8 Gbps FC host ports, and two standard 4 Gbps FC drive channel ports
- Controllers with 1 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 8 Gbps FC host card, and two standard 4 Gbps FC drive channel ports
- Controllers with 1 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 1 GB iSCSI host card, and two standard 4 Gbps FC drive channel ports
- Controllers with 2 GB memory, two standard 8 Gbps FC host ports, and two standard 4 Gbps FC drive channel ports
- Controllers with 2 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 8 Gbps FC host card, and two standard 4 Gbps FC drive channel ports
- Controllers with 2 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 1 GB iSCSI host card, and two standard 4 Gbps FC drive channel ports

Each controller for the DS5020 has Fibre Channel or iSCSI drive ports for connecting to the storage expansion enclosures and two Ethernet ports for DS5020 subsystem management. See Figure 2 on page 11, Figure 3 on page 12, or Figure 4 on page 12.

The iSCSI ports support both IPv4 and IPv6 TCP/IP addresses, CHAP, and iSNS. Use either Cat5E or Cat6 Ethernet cable types for iSCSI port connections. A Cat6 Ethernet cable provides optimal performance.

Although both controllers (A and B) are identical, they are seated in the DS5020 chassis in opposite orientations. If the controller cannot fully be inserted in the controller bay, flip it 180 degrees and reinsert it. Do not force fit because it might cause damage to the controller unit.

## Connectors, switch, and enclosure ID

The controllers support fiber-optic interfaces for both the host channel and drive channel ports. The controllers also contain two Ethernet ports for storage subsystem management purposes and a serial port that IBM Support uses to perform problem recovery and troubleshooting procedures.

The default IP addresses and subnet masks are shown in Table 2.

*Table 2. Default IP addresses and subnet masks*

| Port | IP address | Subnet mask |
|---|---|---|
| Controller A management port 1 | 192.168.128.101 | 255.255.255.0 |
| Controller A management port 2 | 192.168.129.101 | 255.255.255.0 |
| Controller B management port 1 | 192.168.128.102 | 255.255.255.0 |
| Controller B management port 2 | 192.168.129.102 | 255.255.255.0 |
| Controller A iSCSI port 1 | 192.168.130.101 | 255.255.255.0 |
| Controller A iSCSI port 2 | 192.168.131.101 | 255.255.255.0 |
| Controller B iSCSI port 1 | 192.168.130.102 | 255.255.255.0 |
| Controller B iSCSI port 2 | 192.168.131.102 | 255.255.255.0 |

See "Setting up IP addresses for DS5020 storage controllers" on page 12 for more information.

The enclosure ID, comprised of two seven-segment numbers, is located on the back of each controller next to the controller indicator lights. The two digits that comprise the enclosure ID are referred to as x10 and x1 digits. The enclosure ID provides a unique identifier for each enclosure in the storage subsystem. The storage management software automatically sets the enclosure ID number. You can only change the enclosure ID setting through the DS Storage Manager software. There are no switches on the DS5020 chassis to manually set the enclosure ID. Both controller enclosure ID numbers will be identical under normal operating conditions. The default setting of the enclosure ID is a value of 85.

Storage expansion enclosures in a DS5020 storage subsystem must also have unique enclosure IDs. In addition to having unique enclosure IDs for each storage expansion enclosure (including the DS5020 storage subsystems with drives

installed) in the DS5020 storage subsystem configuration, make sure that the single digit (x1) of the enclosure ID for every storage expansion enclosure in a redundant drive channel/loop pair is unique.

If you do not set the single-digit value of the enclosure IDs to be unique among storage expansion enclosures in a redundant drive channel/loop pair, it will be difficult to troubleshoot the source of errors in the drive channels. For example, with four enclosures attached to a DS4500 in a redundant drive loop pair, the correct enclosure ID settings are x1, x2, x3, and x4 (where x can be any digits that can be set). Examples of incorrect settings would be 11, 21, 31, 41; or 12, 22, 32 62. These examples are incorrect because the x1 digits are the same in all enclosure IDs (either 1 or 2).

If the enclosure IDs in your subsystem configuration are not currently set to have unique single-digit (x1) values for the enclosures in the same redundant drive channel/loop pair, make the changes to the enclosure IDs in the next maintenance schedule. The EXP520 and EXP810 storage expansion enclosures do not require you to reset the power to the configuration to activate new enclosure ID settings.

Figure 2, Figure 3 on page 12, and Figure 4 on page 12 show the three different DS5020 controller configurations that are available. Figure 2 shows the base DS5020 storage subsystem, with two Fibre Channel host ports. For more information about DS5020 controller options and other components, see the "Parts listing" on page 166.
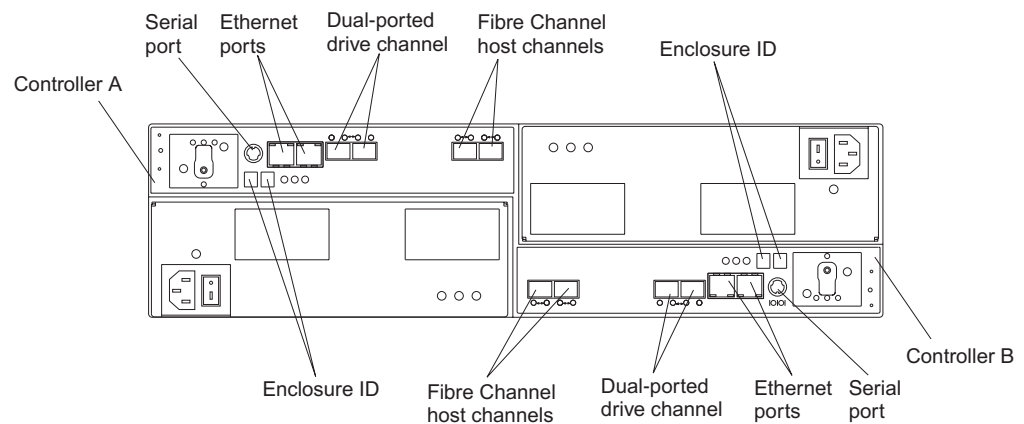


*Figure 2. Back view; controllers with two standard Fibre Channel host expansion channels*

Serial port  Ethernet ports  Dual-ported drive channel  Fibre Channel host channels  Enclosure ID

Controller A

Enclosure ID  Fibre Channel host channels  Dual-ported drive channel  Ethernet ports  Serial port
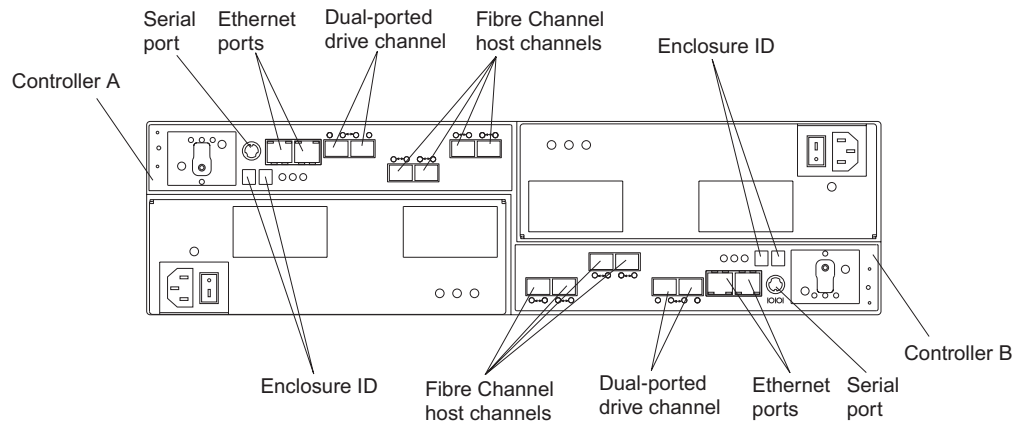
Controller B

*Figure 3. Back view; controllers with two standard and two optional Fibre Channel host expansion channels*

Serial port  Ethernet ports  Dual-ported drive channel  iSCSI host channels  Fibre Channel host channels  Enclosure ID

Controller A

Enclosure ID  Power-fan canister  Fibre Channel host channels  iSCSI host channels  Controller canister  Dual-ported drive channel  Ethernet ports  Serial port
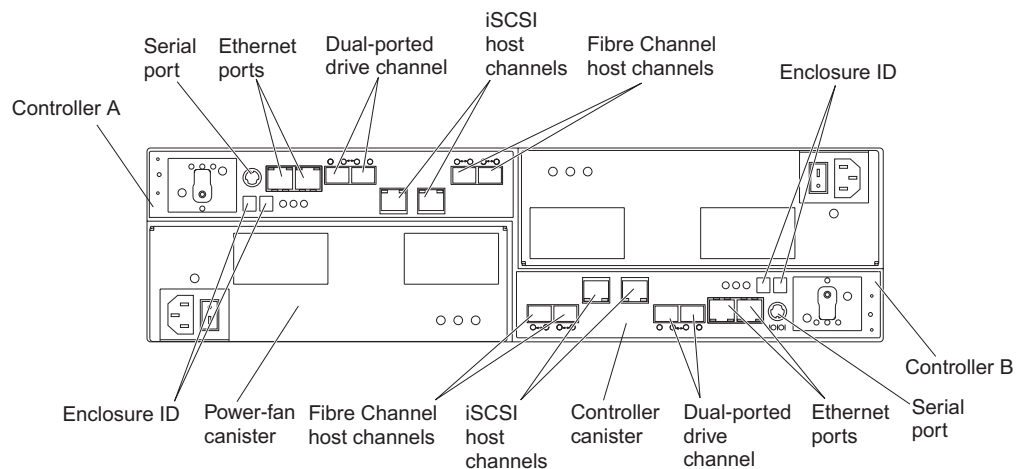
Controller B

*Figure 4. Back view; controllers with two standard Fibre Channel host expansion channels and two optional iSCSI host expansion channels*

## Setting up IP addresses for DS5020 storage controllers

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

- "Steps for setting up the DHCP/BOOTP server and network"
- "Steps for assigning static TCP/IP addresses to the DS5020 controllers" on page 13

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

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

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

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

1. Get the MAC address from each controller blade.
2. Complete whichever of the following steps is applicable for your server:
   - On a DHCP server, create a DHCP record for each of the MAC addresses. Set the lease duration to the longest time possible.
   - On a BOOTP server, edit the `bootptab` file to add in the entries that associate the MAC address tab with the TCP/IP address.
3. Connect the DS5020 storage subsystem Ethernet ports to the network.
4. Turn on the DS5020 storage subsystem.

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

**Steps for assigning static TCP/IP addresses to the DS5020 controllers:** To complete this procedure, you must have the following components:

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

*For a host that is connected to a storage subsystem through a Fibre Channel I/O path:* Complete the following steps to assign static TCP/IP addresses to the DS5020 storage subsystem controllers by way of the host that has Fibre Channel connectivity to the DS5020 Fibre Channel host port.

**Note:** You cannot perform in-band management with a host that has iSCSI connections to the DS5020 until it is configured. Use an out-of-band management connection instead.

1. Install the DS Storage Manager client software in the host, and make sure that the SMagent software is installed and running.
2. Start the DS Storage Manager client software. The Enterprise Management window opens.
3. Add the DS5020 subsystem to the Enterprise Management domain using the IP address of the host that has Fibre Channel connectivity to the DS5020.
4. In the Enterprise Management window, click the name of the default storage subsystem. The Subsystem Management window opens.
5. In the Subsystem Management window, right-click the **Controller** icon and select **Change > Network Configuration** in the drop-down menu. The Change Network Configuration window opens.
6. In the Change Network Configuration window, click the **Controller A** and **Controller B** tabs and type the new TCP/IP addresses in their applicable fields. Click **OK**.
7. Close the Subsystem Management window, wait at least five minutes, then delete the default DS5020 storage subsystem entry in the Enterprise Management window.
8. If applicable, change the IP address of the Ethernet port in the management station to a value that is on the same TCP/IP subnet as the controller Ethernet port IP addresses that you just assigned. Exit DS Storage Manager, then restart.

9. Make Ethernet cabling to the controller management ports. Add a new storage subsystem entry in the Enterprise Management window, using the new assigned IP addresses.

*For a management station that is connected by an Ethernet cable to the storage subsystem controllers:* Complete the following steps to assign static TCP/IP addresses to the DS5020 storage subsystem controllers, using default TCP/IP addresses that are assigned to the DS5020 storage subsystem controllers during manufacturing:

1. Make a direct management connection to the DS5020 storage subsystem, using the default TCP/IP addresses:
   - **Controller A:** 192.168.128.101
   - **Controller B:** 192.168.128.102
   - **Subnet Mask:** 255.255.255.0

   **Note:** For a storage subsystem that has two Ethernet ports per controller, such as the DS4200, DS4700 and DS4800, use the Ethernet port that is labeled #1.

   The default IP addresses of the second Ethernet port are:
   - **Controller A:** 192.168.129.101
   - **Controller B:** 192.168.129.102
   - **Subnet mask:** 255.255.255.0

2. Start the DS Storage Manager client software. The Enterprise Management window opens.

3. Add the DS5020 subsystem to the Enterprise Management domain using the default IP addresses.

4. In the Enterprise Management window, click the name of the default storage subsystem. The Subsystem Management window opens.

5. In the Subsystem Management window, right-click the controller icon and select **Change > Network Configuration** in the pull-down menu. The Change Network Configuration window opens.

6. In the Change Network Configuration window, click the Controller A and Controller B tabs and type the new TCP/IP addresses in their applicable fields. Click **OK**.

7. Close the Subsystem Management window, wait at least five minutes, then delete the default DS5020 storage subsystem entry in the Enterprise Management window.

8. If applicable, change the IP address of the Ethernet port in the management station to a value that is on the same TCP/IP subnet as the controller Ethernet port IP addresses that you just assigned. Exit DS Storage Manager, then restart.

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

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

## AC power supply and fan units

The DS5020 storage subsystem has two removable ac power supply and fan units. Each power supply and fan unit contains one power supply and two fans. The four fans pull air through the drive from front to back across the drives.

The fans provide redundant cooling, which means that if one of the fans in either fan housing fails, the remaining fans continue to provide sufficient cooling to

operate the storage subsystem. The power supplies provide power to the internal components by converting incoming ac voltage to dc voltage. If one power supply is turned off or malfunctions, the other power supply maintains electrical power to the storage subsystem. To preserve the optimal airflow, do not remove a failed power supply and fan unit CRU from the DS5020 chassis until you are ready to replace it with a new CRU.

Figure 5 shows power supply and fan unit components for the DS5020.

**Notes:**

1. Your DS5020 hardware might differ slightly from the following illustration.
2. Although both power supply and fan units (left and right) are identical, they are seated in the DS5020 chassis in opposite orientations. If the power supply and fan unit cannot fully be inserted in the power supply and fan unit bay, flip it 180 degree and reinsert it.
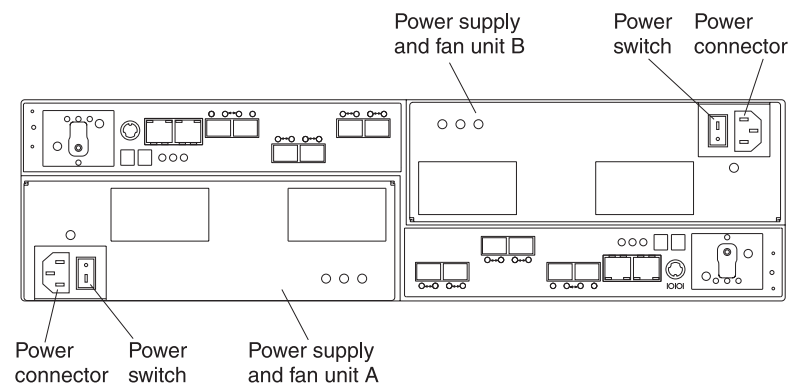


*Figure 5. Power supply and fan unit components for the DS5020*

Figure 6 on page 16 shows a power supply and fan unit and the airflow through the storage subsystem.
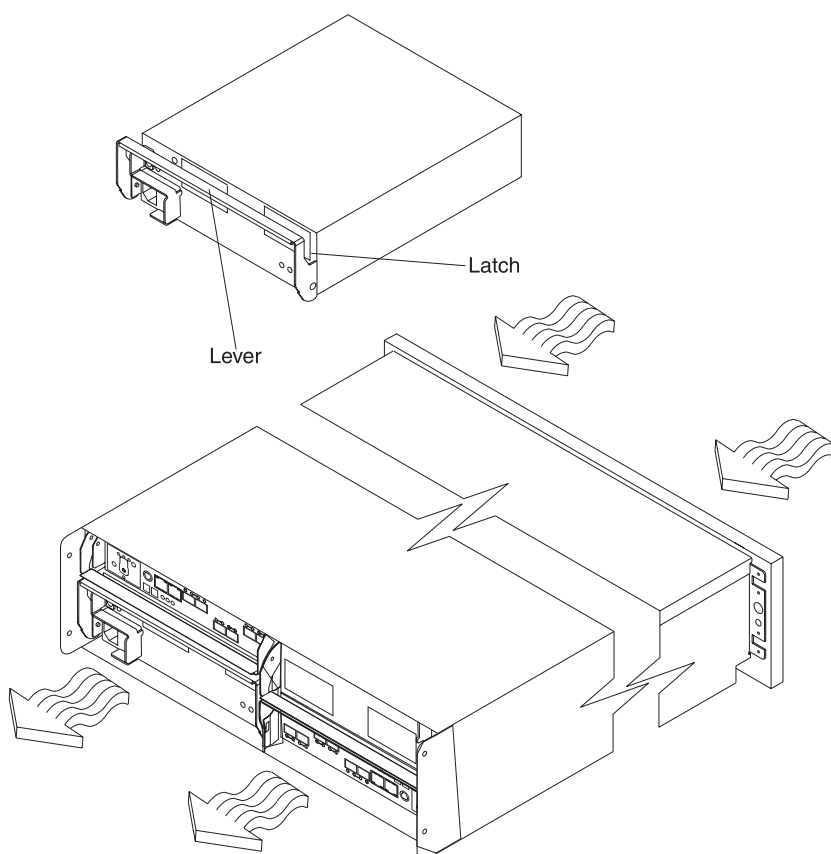
*Figure 6. Power supply and fan unit and airflow*

## Battery units

**Statement 2:**



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

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

**Dispose of the battery as required by local ordinances or regulations.**
Each controller also contains a rechargeable battery unit that is used in the event of a power failure.

Figure 7 shows how the battery unit slides into the battery backup slot in controller A.



Latch

Pull handle

Controller A
backup battery unit

Controller B
backup battery unit
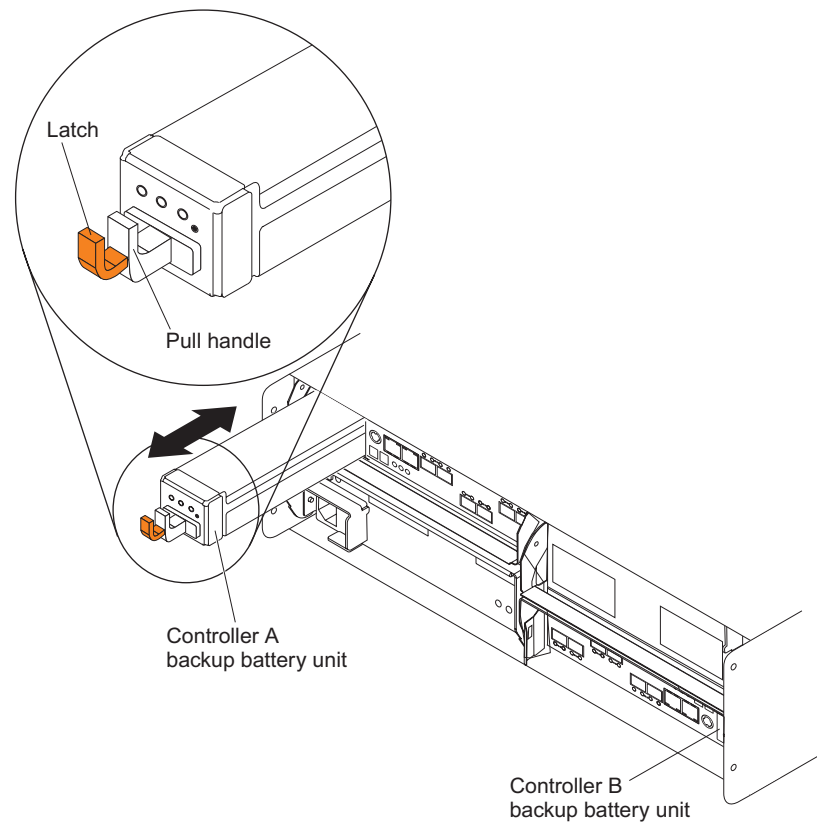
*Figure 7. Backup battery unit*

The backup battery unit provides power to back up the cache memory of each controller onto flash drives in the event of a power failure. Each battery unit contains a sealed, rechargeable SMART lithium ion battery. The battery unit contains enough charge to back up the cached data in each controller to a flash drive in the event of a power failure.

When the unit is powered on the first time or whenever the battery is replaced, the battery chargers will charge the battery to the programmed level. Then, the controller will start a battery learning cycle to determine whether the battery current capacity is sufficient. Data caching starts after the battery is charged to the programmed level. During the battery learn cycle, cache will be active if the battery is in good condition. If the battery fails the learn cycle, it is marked as failed. The battery learning cycle lasts up to three hours. After the first battery learn cycle, the controller will perform a learn cycle every 8 weeks to re-calibrate the battery-charging level.

The battery unit is hot-swappable. You can remove the battery unit for servicing and then reinsert it while the DS5020 continues to perform I/O operations. However, write I/O caching is disabled when the battery is in a failed state or removed from the controller chassis. Replace the failed battery as soon as possible to minimize the time that the write IO caching is disabled.

Information about the condition of the battery unit is conveyed by indicator LEDs on the front of battery unit. ("Battery unit LEDs" on page 106 identifies the indicator LEDs on the battery unit and explains the conditions that each LED indicates.)

## SFP modules

**Statement 3:**



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

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



**DANGER**

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

**Class 1 Laser statement**

Class 1 Laser Product
Laser Klasse 1
Laser Klass 1
Luokan 1 Laserlaite
Apparell À Laser de Calsse 1

IEC 825-11993 CENELEC EN 60 825

The storage subsystem supports a fiber-optic interface for host and storage expansion enclosure connections. You must install a Small Form-factor Pluggable (SFP) module in each interface connector on the controller where a fiber-optic cable is to be installed. Do not install an SFP in any port that will not have a fiber-optic cable attached. Remove any SFP from any port that does not have fiber-optic cables attached.

The DS5020 storage subsystem host ports support 2, 4, and 8 Gbps Fibre Channel speeds. The DS5020 storage subsystem drive ports support only 4 Gbps Fibre Channel speeds.

**Attention:** The maximum operating speed of the Fibre Channel port is determined by two factors: the speed of the SFP module that is installed and the speed of the Fibre Channel connection. For example, a 4 Gbps SFP that is plugged into a 8 Gbps-capable port will limit the speed of that port to a maximum of 4 Gbps. Conversely, an 8 Gbps SFP that is plugged into a 4 Gbps-capable port will limit the speed of the port to a maximum of 4 Gbps. Carefully check the SFP IBM part number, option number, and FRU part number to identify its speed. There are no physical features that distinguish an 8 Gbps SFP from a 4 Gbps SFP.

Figure 8 shows an example of SFP module with fiber-optic cable.

**Note:** The SFP module and the fiber-optic cable shown are for illustrative purposes only. The actual SFP module and the fiber-optic cable shape might look different from the figure shown.
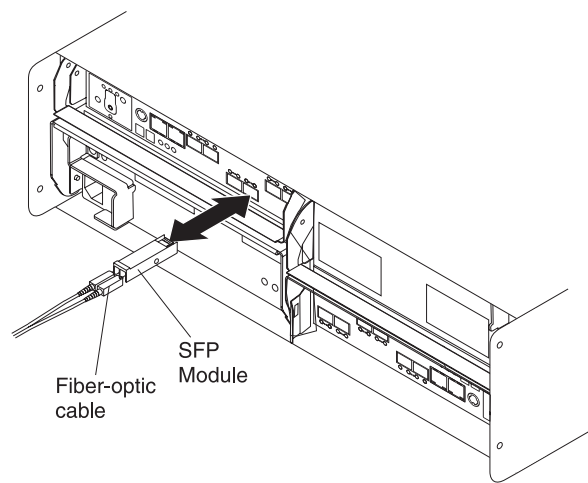


*Figure 8. SFP module and fiber-optic cable*

# Software and hardware compatibility and upgrades

The latest DS5020 controller firmware and NVSRAM, the storage expansion enclosure drive enclosure ESM firmware, and Fibre Channel and SATA drive CRUs firmware must be installed to achieve optimal functionality, manageability, and reliability.

Unless stated otherwise, you can find the latest DS5020 publications, firmware, and host software at the IBM System Storage Support Web site:

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

## Software and firmware support code upgrades

To enable support for the DS5020, you must make sure that your system software and firmware are the correct versions. The minimum versions of DS5020 controller firmware and the IBM DS Storage Manager host software that are used to manage the DS5020 are 7.60.xx.xx and 10.60.xx.xx, respectively. To use the SSD disks in the DS5020, the DS5020 controller firmware and the IBM DS Storage Manager host software should be versions 7.70.xx.xx and 10.70.xx.xx, respectively. To use the FC-SAS disks in the DS5020, the DS5020 controller firmware and the IBM DS Storage Manager host software should be versions 7.77.xx.xx and 10.77.xx.xx,

respectively. To find the latest DS Storage Manager software, storage subsystem controller firmware, ESM, and NVSRAM firmware, check the firmware readme files. See "Finding DS5020 and DS4000-family readme files" on page xxiii to learn how to access the readme files on the Web.

Depending on the controller firmware version for your subsystem, refer to the following guides for instructions that describe how to install the DS5020 controller firmware and Storage Manager host software:

- *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)
- *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later)

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

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

## Determining firmware levels

There are two different methods to determine the DS5020 storage subsystem and firmware versions. Each method uses the DS Storage Manager client that manages the DS5020 storage subsystem.

**Method One:**

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

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

**DS5020 Storage Server**

- NVSRAM version
- Appware version
- Bootware version

**Drives**

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

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

- FC to SAS interposer card firmware version (FC-SAS E-DDMs only)

  **Note:** The FC to SAS interposer card firmware and drive firmware are typically packaged together as a single drive firmware upgrade file.

**ESM**

- ESM card firmware version

**Method Two:**

Complete the applicable procedure to obtain the specified firmware version.

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

You must perform this step for each individual controller.

**To obtain the drive firmware (and ATA translator or FC to SAS interposer card firmware) version:**
Right-click the **Drive** icon in the Physical View pane of the Subsystem Management window and select **Properties**. The Drive Properties window opens and displays the properties for that drive.

You must perform this step for each individual drive.

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

# Specifications

This section provides site specifications for the DS5020 storage subsystem. Before installing, you must either verify that your planned installation site meets these requirements, or prepare the site so that it does meet these requirements. Preparations might involve meeting area requirements, environmental requirements, and electrical requirements for DS5020 storage subsystem installation, service, and operation.

## Area requirements

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

### Dimensions
Figure 9 on page 22 shows the dimensions of the DS5020, which conforms to the 19-inch rack standard.
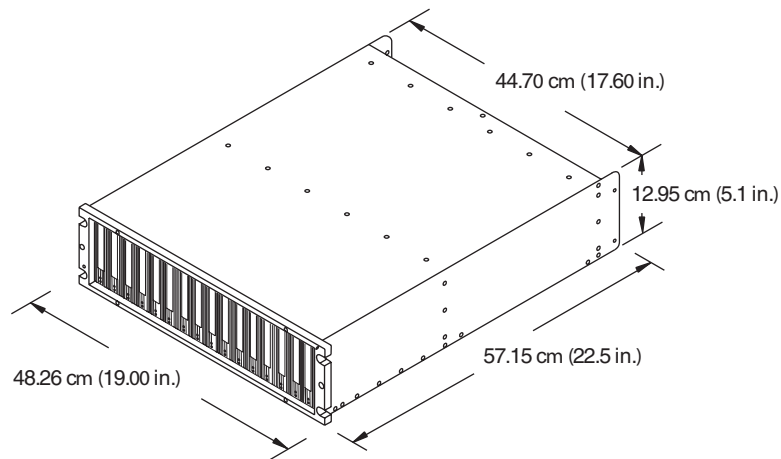
*Figure 9. DS5020 dimensions*

## Weight

The total weight of the storage subsystem depends on the number of components installed. Table 3 lists the maximum, empty, and shipping weights for the storage subsystem in different configurations. Table 4 lists the weight of each component.

*Table 3. DS5020 weights*

| Unit | Weight | | |
| --- | --- | --- | --- |
| | Maximum [1] | Empty [2] | Shipping |
| DS5020 | 40 kg (88 lb) | 16.4 kg (36.1 lb) | 52.2 kg (115.0 lb) |

[1] Chassis with all CRUs and 16 drives.

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

*Table 4. DS5020 component weights*

| Unit | Weight |
| --- | --- |
| Drive | 0.75 kg (1.65 lb) |
| Power supply and fan unit | 3.60 kg (7.95 lb) |
| Controller (including cache battery backup unit) | 2.8 kg (6.1 lb) |
| Battery unit | 0.9 kg (2 lb) |

## Shipping dimensions

Table 5 lists shipping carton dimensions. The height shown includes the height of the pallet.

*Table 5. DS5020 shipping carton dimensions*

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

# Environmental requirements and specifications

This section describes the environmental requirements and specifications for the DS5020 storage subsystem, including temperature and humidity, altitude, airflow and heat dissipation, shock and vibration requirements, and acoustic noise levels.

## Temperature and humidity

Table 6 lists the acceptable temperature and humidity ranges for the DS5020 Storage Subsystem when in storage or in transit. Table 7 lists temperature and humidity ranges for the storage subsystem in typical Information Technology (IT) or office environments. Table 8 lists temperature and humidity ranges for the storage subsystem in a NEBS/ETSI compliant environment.

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

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

*Table 6. Temperature and humidity requirements for storage subsystem when in storage or in transit*

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

*Table 7. Temperature and humidity requirements for storage subsystem in a typical Information Technology (IT) or office environment*

| Condition | Parameter | Requirement |
|---|---|---|
| Temperature | Operating range | 10° - 35° C (50° - 95° F) |
| | Maximum rate of change | 10° C (18° F) per hour |
| Relative humidity (no condensation) | Operating range | 8% to 80% |

*Table 8. Temperature and humidity requirements for storage subsystem in a NEBS/ETSI compliant environment*

| Condition | Parameter | Requirement |
|---|---|---|
| Temperature[1] | Operating range | 5° - 40° C (41° - 104° F) |
| | Short-term[2] | -5° - 50° C (23° - 122° F) |
| | Maximum rate of change | 30° C (54° F) per hour |
| Relative humidity[1] (no condensation) | Operating range | 5% to 85% |
| | Short-term[2] | 5% to 90% (not to exceed 0.024 kg water/kg of dry air) |

*Table 8. Temperature and humidity requirements for storage subsystem in a NEBS/ETSI compliant environment (continued)*

| Condition | Parameter | Requirement |
|-----------|-----------|-------------|

**Notes:**

1. In a NEBS/ETSI compliant environment, conditions are measured at a location 1.5 m (59 in.) above the floor and 400 mm (15.8 in.) in front of the equipment.

2. Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days in one year. (This refers to a total of 360 hours in any given year, but no more than 15 occurrences during that one-year period.)

## Altitude

Table 9 lists the acceptable altitudes for operating, storing, and shipping the DS5020.

*Table 9. DS5020 altitude ranges*

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

## Airflow and heat dissipation

Figure 10 shows the intended airflow for the DS5020. Allow at least 30 inches in front of the storage subsystem and at least 24 inches behind the storage subsystem for service clearance, proper ventilation, and heat dissipation.
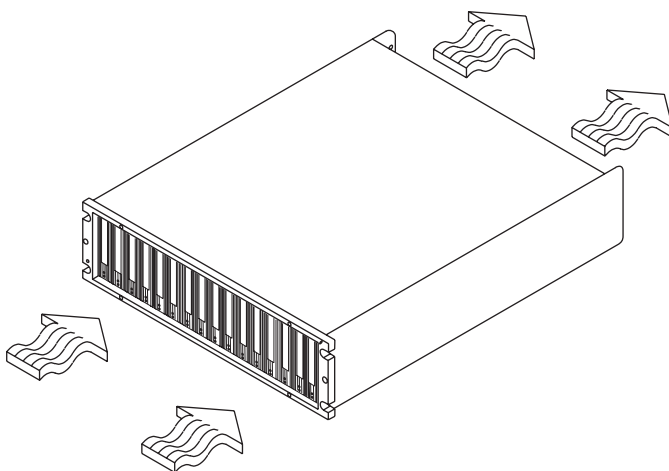


*Figure 10. DS5020 airflow*

Table 10 on page 25 lists the KVA, watts, and Btu calculations. These values assume the power supplies have a 73 percent efficiency and a power factor of 0.99. These tabulated power and heat dissipation values are typical for the storage subsystem. Maximum configuration units are typically operated at higher data rates, have larger random access memory (RAM) capacities, or have different host interface boards.

*Table 10. DS5020 power and heat dissipation*

| Parameter | KVA | Watts (ac) | Btu per hour |
|---|---|---|---|
| DS5020 | 0.496 | 447 | 1529 |

## Shock and vibration requirements

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

**Operational Shock:** The DS5020 will be able to withstand the following shock. Subjecting the equipment to a single shock pulse with the following characteristics will simulate this level of shock:

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

**Operational Vibration (Random):** While in its normal operating position, the DS5020 will continue operating when subjected to a random vibration test using the criteria shown in Table 11. This test uses the indicated spectral power density for 30 minutes in each of the three axes.

*Table 11. Random vibration power spectral density*

| Hz | 5 | 17 | 45 | 48 | 62 | 65 | 150 | 200 | 500 |
|---|---|---|---|---|---|---|---|---|---|
| $g^2/Hz$ | $2.0\text{x}10\text{-}7^{-7}$ | $2.2\text{x}10^{-5}$ | $2.2\text{x}10^{-5}$ | $2.2\text{x}10^{-5}$ | $2.2\text{x}10^{-5}$ | $2.2\text{x}10^{-5}$ | $2.2\text{x}10^{-5}$ | $2.2\text{x}10^{-5}$ | $2.2\text{x}10^{-5}$ |

## Acoustic noise

Table 12 lists the maximum sound levels emitted by the storage subsystem.

*Table 12. DS5020 sound levels*

| Measurement | Level |
|---|---|
| Sound power (normal operation) | 6.4 bels |
| Sound pressure (normal operation) | 68 dBA |

These levels are measured in controlled acoustical environments according to ISO 7779 and are reported in accordance with ISO 9296. The declared sound power levels indicate an upper limit, below which a large portion of machines operate. Sound pressure levels in your location might exceed the average 1-meter values stated because of room reflections and other nearby noise.

# Electrical requirements

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

Consider the following information when preparing the installation site:

- Protective ground – Site wiring must include a protective ground connection to the ac power source.

  **Note:** Protective ground is also known as safety ground or chassis ground.
- Circuit overloading – Power circuits and associated circuit breakers must provide sufficient power and overload protection. To prevent possible damage to the unit, isolate its power source from large switching loads (such as air conditioning motors, elevator motors, and factory loads).

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

*Table 13. DS5020 ac power requirements*

|  | Low Range | High Range |
|---|---|---|
| Nominal Voltage | 90 to 136 VAC | 198 to 264 VAC |
| Frequency (Hertz) | 50 to 60 Hz | 50 to 60 Hz |
| Idle Current | 3.53 A[a] | 2.08 A[b] |
| Maximum Operating Current | 3.71 A[a] | 2.04 A[b] |
| Maximum Surge Current | 5.04 A[a] | 2.67 A[b] |

[a.] Typical voltage: 120 V ac, 60 Hz, assumes 72% power-supply efficiency and 0.99 power factor

[b.] Typical voltage: 240 V ac, 60 Hz, assumes 72% power-supply efficiency and 0.99 power factor

### Power and site wiring requirements

The storage subsystem uses wide-ranging redundant power supplies that automatically accommodate voltages to the ac power source. The ac power supplies operate within the ranges specified in Table 13. The ac power supplies meet standard voltage requirements for both domestic (inside USA) and international (outside USA) operation. They use standard industrial wiring with line-to-neutral or line-to-line power connections.

The agency ratings for the DS5020 storage subsystem are 6 amps at 100 VAC and 2.5 amps at 240 VAC. These are the overall maximum operating currents for the DS5020 storage subsystem with ac power supply and fan unit CRUs.

**AC power recovery:** After a total ac power failure, after normal power is restored, the storage subsystem performs power-up recovery procedures automatically without operator intervention.

**Power cords and receptacles:** The storage subsystem ships with two jumper cords used to connect to the rack PDU. You must purchase the power cords that are appropriate for use in a typical outlet in the destination country. See Appendix D, "Power cords," on page 187 for more information.

## Heat output, airflow, and cooling

See "Airflow and heat dissipation" on page 24 for heat output, airflow, and cooling specifications.

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

When racks that contain many storage subsystems are to be installed together, the following requirements must be met to for the storage subsystems to be cooled adequately:
- Air enters at the front of the rack and leaves at the back. To prevent the air that is leaving the rack from entering the intake of another piece of equipment, you

must position the racks in alternate rows, back-to-back and front-to-front. This arrangement is known as "cold aisle/hot aisle" and is shown in Figure 11.

- Where racks are in rows, each rack must touch the rack that is next to it to reduce the amount of hot air that can flow around from the back of the rack into the intakes of the storage expansion enclosures that are in that rack. Use Suite Attach Kits to completely seal any gaps that remain between the racks. For details about Suite Attach Kits, contact your marketing representative.

- Where racks are in rows front-to-front or back-to-back, a gap of at least 1220 mm (48 in.) must separate the rows across the cold aisle.

- For proper airflow in each rack, the rack filler plates must be installed in unused positions. Also, all the gaps in the front of the racks must be sealed, including the gaps between the storage subsystems.
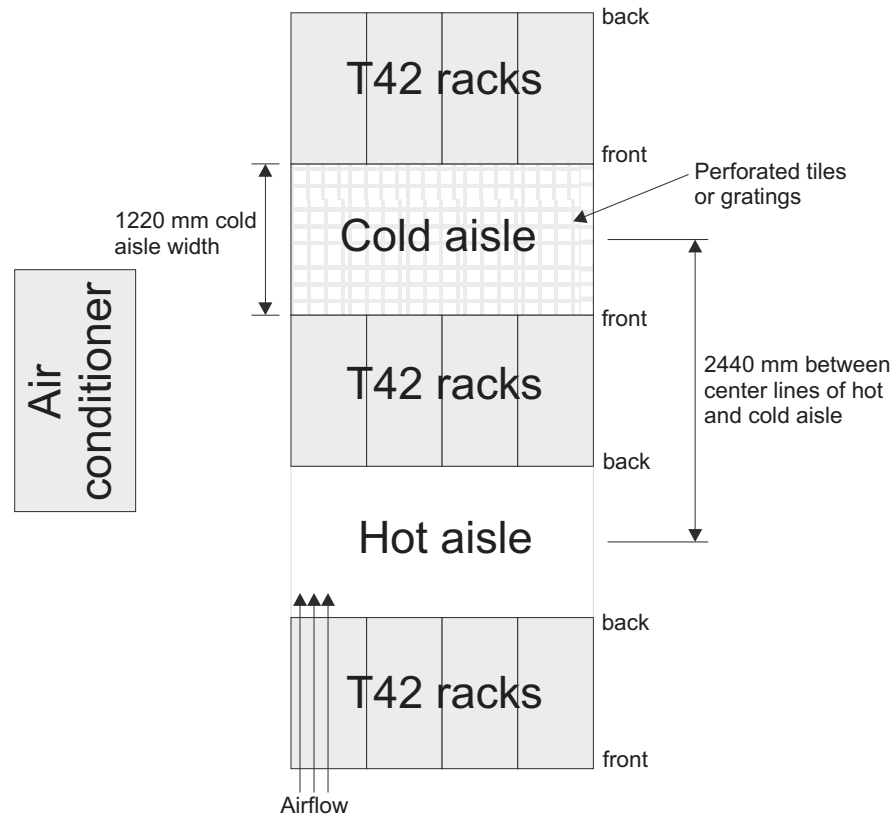


*Figure 11. Example of cold aisle/hot aisle rack configuration*

# Chapter 2. Installing the storage subsystem

This chapter provides the information that you need to install the storage subsystem into a rack cabinet.

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

"Installation overview" provides an overview of the entire storage subsystem installation process. Read this overview before you begin the installation.

## Installation overview

**Statement 4:**

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

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

**Attention:** A fully configured DS5020 weighs up to 40 kg (88 lb). At least two other people should help you lift the DS5020 from the shipping box. If desired, open the sides of the shipping box and remove the CRUs from the DS5020 before you lift it from the shipping box in order to lighten the storage subsystem. See "Removing the CRUs" on page 38.

The following steps summarize the DS5020 installation process. Each step below is detailed in this chapter or next two chapters, Chapter 3, "Cabling the storage subsystem," on page 47 and Chapter 4, "Operating the storage subsystem," on page 95.

1. Review the preparation guidelines. See "Preparing for installation" on page 31.
2. Prepare the installation site. See "Preparing the site" on page 33.
3. Prepare the rack cabinet. See "Preparing the rack cabinet" on page 34.
4. Fold down and open the sides of the shipping box. Without removing the DS5020 from box, you can remove the DS5020 rack mounting rails and hardware from the box. The DS5020 rack mounting rails and hardware are placed on the bottom of the shipping box (under the DS5020 storage subsystem). Install the support rails in the rack cabinet. See "Installing the support rails" on page 35.

5. Before removing the DS5020 from the shipping box, remove the components from the DS5020 chassis to lighten the unit. See "Removing the CRUs" on page 38.

6. Record the serial number, machine type and model number, and RAID controller MAC addresses for your DS5020 storage subsystem in Appendix A, "Records," on page 171.

   The serial number, machine type, and model number are located on the left edge of the front unit as shown in Figure 12.
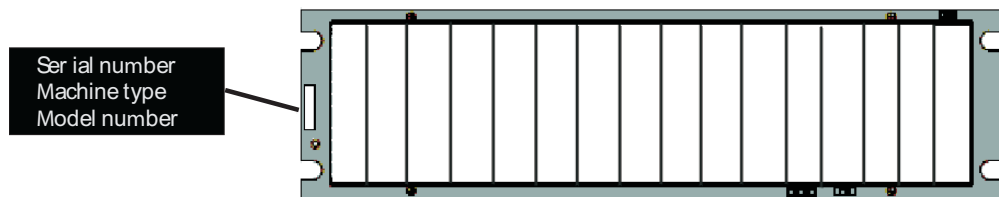


*Figure 12. Example of DS5020 serial number, machine type, and model number location*

   The MAC addresses are located near the Ethernet ports on each RAID controller.

7. Install and secure the DS5020 chassis in the rack cabinet. See "Installing the DS5020 into a rack on the support rails" on page 42.

8. If needed, replace the components in the installed DS5020 chassis. See "Replacing the components" on page 44.

9. Install the storage expansion enclosure or enclosures you will cable to the DS5020 in the rack cabinet. Follow the instructions in the Installation, User's, and Maintenance Guide for your storage expansion enclosure to set up and mount the storage expansion enclosures.

10. Use SFP modules and Fibre Channel cables to cable the DS5020 to the DS4000 storage expansion enclosure or enclosures. See "Connecting storage expansion enclosures to the DS5020" on page 57.

11. Perform one of the following cabling tasks to enable management of the DS5020 configuration:
   - If you are using out-of-band management, cable the DS5020 Ethernet ports to either the management workstation or the host.
   - If you are using in-band management, cable the DS5020 host channels to the Fibre Channel host bus adapters (HBAs) in either the hosts or the Fibre Channel switch that connects to the host HBAs. See "Connecting hosts to the DS5020 using Fibre Channel host ports" on page 84.

12. Connect the power cables for the DS5020. See "Cabling the ac power supply" on page 94.

   **Attention:**

   Before you turn on the power to the DS5020 storage subsystem, it must be populated with at least two E-DDMs.

   If at least two E-DDMs are not installed in the DS5020, an insufficient load to the enclosure power supplies might cause them to intermittently appear as failed, falsely indicating the power supplies are bad. All of the E-DDMs in the DS5020 storage subsystem and the connected storage expansion enclosure or enclosures must contain no prior configuration data.

13. Turn on the power to the attached storage expansion enclosure and the DS5020 storage subsystem using the procedure described in "Powering on the storage subsystem" on page 97.

14. Install the DS Storage Manager host software on the management workstation (for out-of-band management) or on the host (for in-band management).

   Depending on the controller firmware version for your subsystem, refer to the following guides for instructions that describe how to install the DS Storage Manager software:

   - *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)
   - *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later)

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

16. Review and perform the procedures described in "Performing the DS5020 Health Check process" on page 95.

## Handling static-sensitive devices

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

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

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

## Preparing for installation

Before installing the DS5020 storage subsystem, create a detailed plan of how this unit will be used in your storage configuration. The plan might include determining RAID levels, failover requirements, operating systems to be used, and total storage capacity requirements.

The following illustration shows the items that you need to install the DS5020 storage subsystem in the rack cabinet. If any items are missing or damaged, contact your place of purchase.

**Note:** The illustration might differ slightly from your DS5020 hardware. The host-interface cables, Ethernet cables, Fibre Channel signal cables, and iSCSI signal cables are not shown in the following illustration.
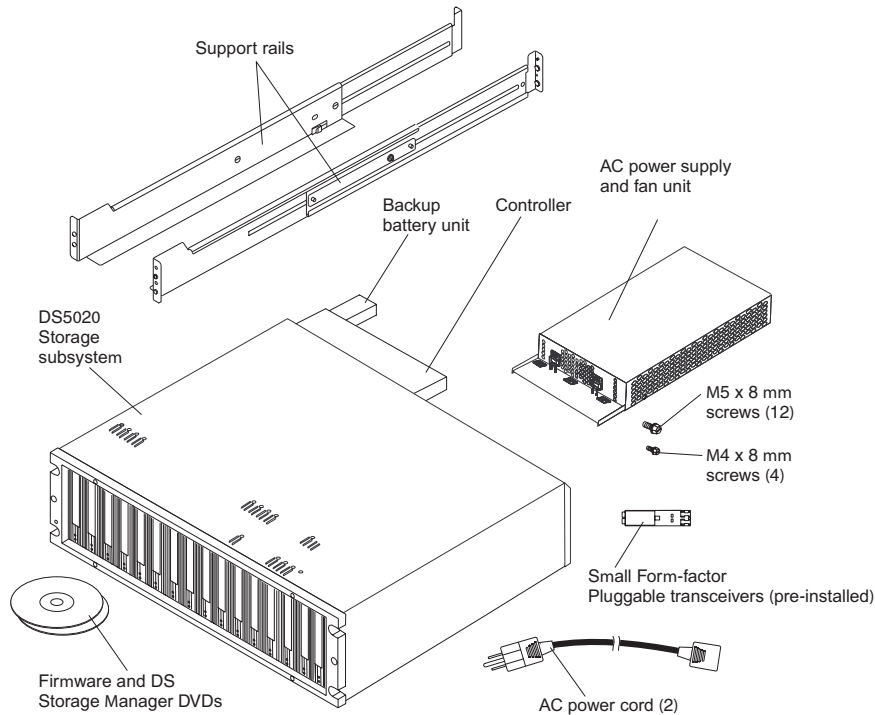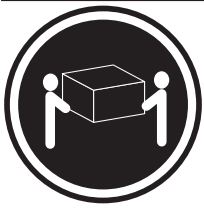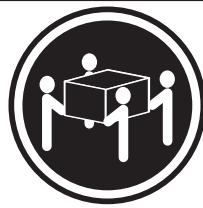


Complete the following steps to prepare the DS5020 storage subsystem for installation into a rack cabinet:

1. Prepare the site to meet all area, environmental, power, and site requirements. For more information, see "Specifications" on page 21.

   **Statement 4:**



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

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

2. Move the shipping box that contains the DS5020 to the site.

3. Remove the mounting rails, mounting hardware, and line jumper cords from the DS5020 shipping box. Do not remove the DS5020 from the shipping box at this time.

**Attention:** The mounting rails, mounting hardware, and line jumper cords might be packed beneath the DS5020 in the shipping box. To remove these items from the shipping box without first removing the DS5020, open the two long sides of the shipping box. Then open and fold flat the two short sides of the shipping box. This enables you to access the mounting rails, mounting hardware, and line jumper cords without first removing the DS5020 from the shipping box.

After you open the DS5020 shipping container and remove the mounting rails, mounting hardware, and line jumper cords, check the remaining contents (see "Inventory checklist" on page 4) without removing the DS5020 from the shipping box. If any items are missing, contact your IBM reseller or representatives before proceeding.

4. Verify that you have the applicable host software kit for your operating system.

   Depending on the DS5020 configuration you order, your DS5020 will ship with either the Microsoft Windows host software attachment kit or with your choice of host software kits (Windows, AIX, Linux, Netware, SUN Solaris, HP-UX, Linux on POWER, or VMware). The host software kit grants you permission to attach host servers using the applicable operating system to the DS5020.

   The kit includes a *DS Storage Manager* DVD that has the applicable IBM DS Storage Manager host software. If you order more than one host software kit, the additional kits might also be shipped in the DS5020 shipping box.

   The DVD also includes the DS5020 storage subsystem controller firmware. For the latest controller firmware, check the IBM support Web site for IBM System Storage products:

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

5. Read the applicable readme files that are included in the Storage Manager host software or DS5020 controller firmware packages for any updated information about hardware, software, or firmware products. See "Finding DS5020 and DS4000-family readme files" on page xxiii to learn how to access the DS5020 and DS4000-family readme files on the Web.

6. Continue with "Preparing the site."

## Tools and hardware required

Gather the tools and equipment you will need for installation. These might include:

- Region-specific power cords required for the DS5020
- 5/16 (8 mm) hex nut driver
- No. 2 Phillips screwdriver
- Anti-static protection (such as a grounding wrist strap)
- Fibre Channel (FC) and Ethernet interface cables and cable straps
- Rack power jumper cords that are shipped with the DS5020
- SFP modules
- Rack-mounting hardware that ships with the DS5020

## Preparing the site

This section lists the floor space requirements and weight information for the storage subsystem. For information about interface cables and connections, see Chapter 3, "Cabling the storage subsystem," on page 47.

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

- Sufficient space to install the storage subsystem
- Enough stability to support the weight of the fully configured storage subsystem and associated systems. See "Weight" on page 22 for weight specifications.

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

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

Continue with "Preparing the rack cabinet."

## Preparing the rack cabinet

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

- Review the documentation that comes with your rack enclosure for safety and cabling considerations.
- Install the storage subsystem in an environment with a temperature of 22° C (72° F). See "Environmental requirements and specifications" on page 23 for details.
- For proper airflow, do not block the air vents; allow for at least 15 cm (6 in.) of air space.
- For optimal rack stability, load the rack starting at the bottom.
- If you install multiple components in the rack, do not overload the power outlets.
- Always connect the storage subsystem to a properly grounded outlet.
- Always connect the IBM-certified rack power distribution units (PDUs) to at least two independent power circuits or sources.

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

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

After you have completed these steps, continue with "Installing the support rails" on page 35.

# Installing the support rails

**Important:** Duplicate copies of the rack mounting templates are provided in Appendix B, "Rack mounting templates," on page 175. If you want to tear out the templates from this document, use the copies in Appendix B, "Rack mounting templates," on page 175.

Use the following templates (Figure 13 and Figure 14 on page 36) to identify the proper locations for inserting M5 screws when mounting the support rails and DS5020 storage subsystem to a rack cabinet. The locations for the M5 screws are highlighted in the templates.

Hold the applicable template up to each side of the rack cabinet at the 3U section where you will install the DS5020. U boundaries are shown as horizontal dashed lines in the rack mounting templates. The highlighted squares on each side of the template mark the positions where you will thread the M5 screws that secure the rails and the DS5020 to the front and rear of the cabinet.

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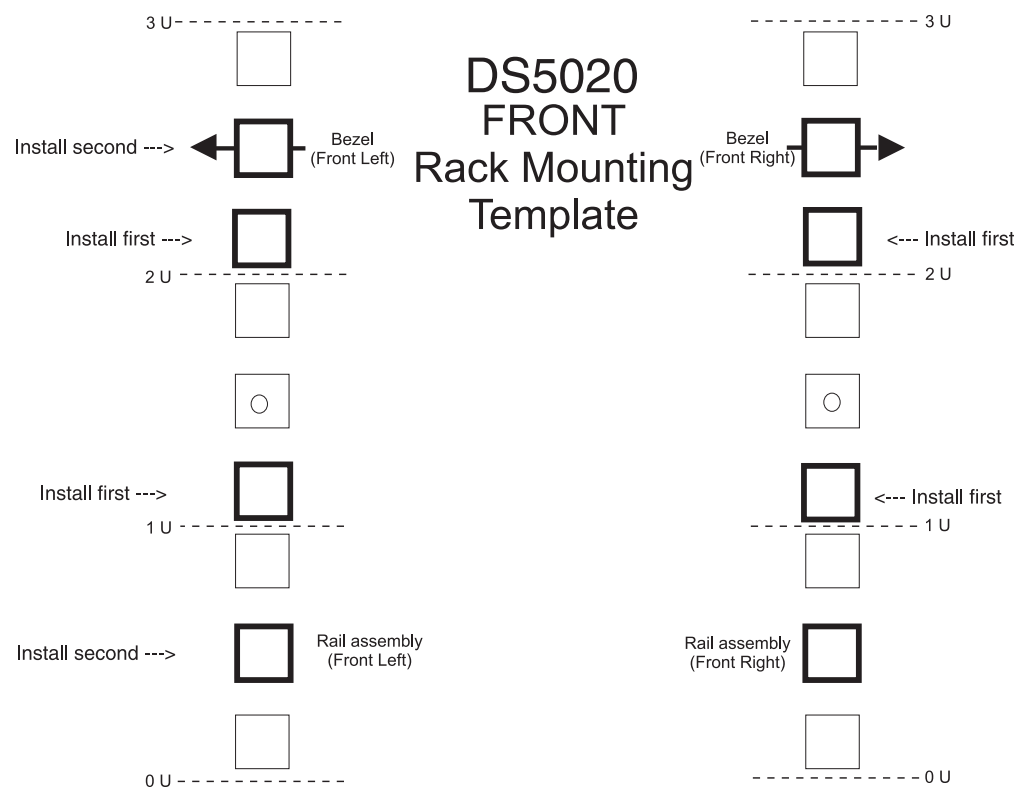


*Figure 13. Front rack mounting template*

DS5020
REAR
Rack Mounting
Template

3U

2U

Rail mounting guide

1U

Rail assembly
(Rear Left)

0U

3U

2U

1U

Rail assembly
(Rear right)

IBM®

Printed in the U.S.A

0U
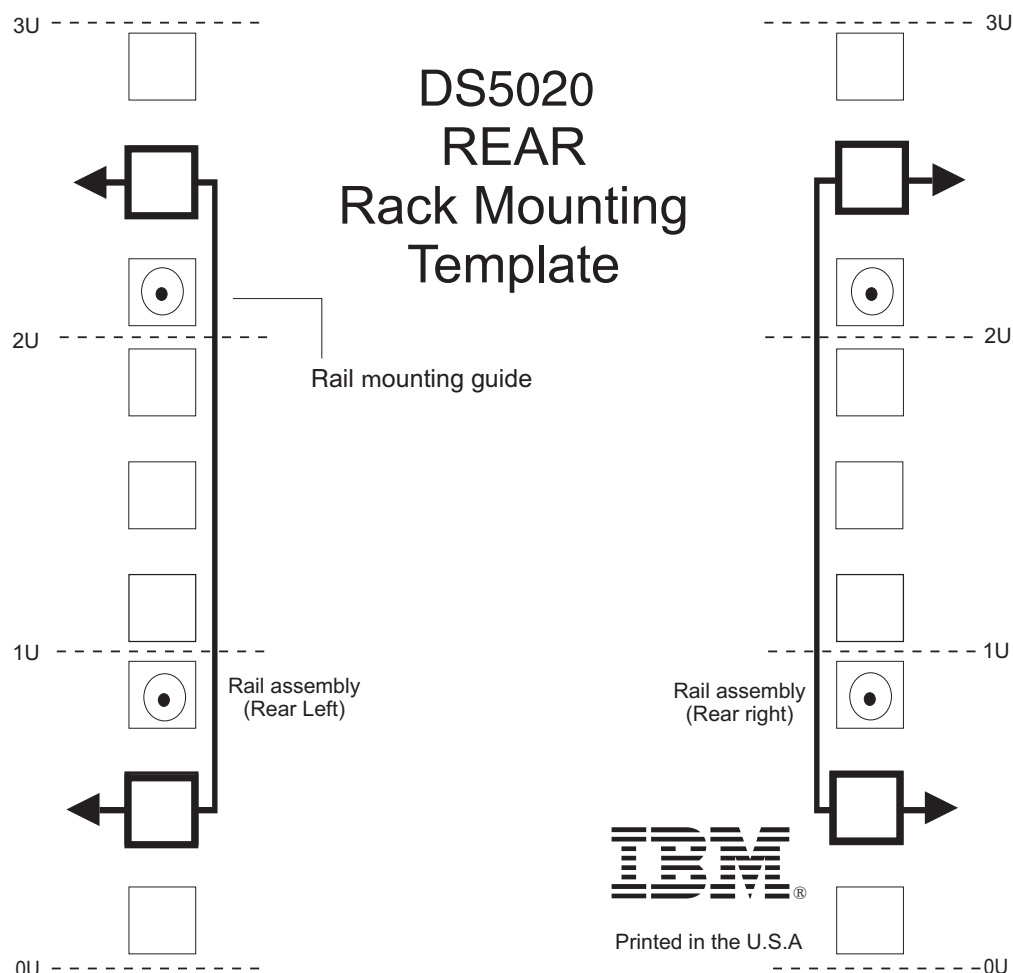
*Figure 14. Rear rack mounting template*

Before installing the DS5020 in a rack cabinet, you must install the rails and rack-mounting hardware that come with your storage subsystem. The DS5020 requires an Electronic Industries Association (EIA) 310-D Type A 19-inch rack cabinet. The distance between EIA rails, from the front to the rear of the rack, is 60.96 cm (24 in.) minimum and 81.28 cm (32 in.) maximum. This rack conforms to the EIA standard. Where you place the support rails in the rack depends on where you intend to position the storage subsystem.

Complete the following steps to install the support rails.

**Note:** Refer to Figure 15 on page 37 while performing these steps.
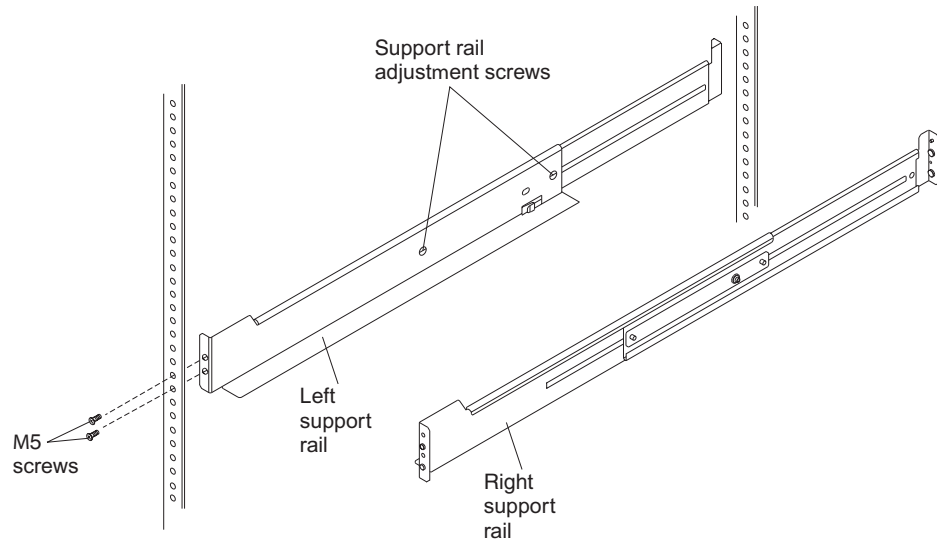
*Figure 15. Installing the support rails*

1. Make sure that the rack cabinet has already been installed.
2. Make sure that a stabilizer has been correctly attached to the bottom front of the rack to prevent the rack from tipping forward while the DS5020 is being installed.

   Refer to the installation and service guide, or equivalent, for the rack as required.
3. Locate the two support rails, eight of the twelve M5 screws, and eight washers that are supplied with the DS5020.

   **Note:** The M5 screws and washers might already be attached to the support rails. If so, remove them from the support rails.
4. The rack-mounted unit is three EIA units high. Decide accordingly where you are going to install the support rails.

   **Important:** Duplicate copies of the rack mounting templates are provided in Appendix B, "Rack mounting templates," on page 175. If you want to tear out the templates from this document, use the copies in Appendix B, "Rack mounting templates," on page 175. Use the preceding templates (Figure 13 on page 35 and Figure 14 on page 36) to identify the proper locations for inserting M5 screws when mounting the support rails and DS5020 storage subsystem to a rack cabinet. The locations for the M5 screws are highlighted in the templates.

   Note the following considerations before you choose where to install the rails:
   - If you are installing the DS5020 into an empty rack, install it into the lowest available position so that the rack does not become unstable.
   - If you are installing more than one DS5020 in the rack, start at the lowest available position, and work upward.
   - If applicable, allow for possible later installation of other units.
   - If necessary, remove the rack power distribution unit before you install the support rails.
   - For procedures and more information, refer to the installation and service guide, or equivalent, for the rack.

- The lip on the rail lines up with the bottom of the storage subsystem (the 0U boundary in Figure 14 on page 36).

5. Using a No. 2 Phillips screwdriver, loosen the two screws on the left support rail that hold the two parts of the rail together. The support rails are marked as left or right.

6. Hold the back of the rail against the inside of the rack-mounting flange. Make sure that the rail mounting guide pins are in the correct holes.

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

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

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

9. Securely tighten the M5 screws.

    **Note:** Be sure to install the screw labeled *install first* in Figure 13 on page 35.

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

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

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

12. Continue with "Removing the CRUs."

# Installing the DS5020

This section provides instructions on installing the DS5020. The installation process includes:

- "Removing the CRUs"
- "Installing the DS5020 into a rack on the support rails" on page 42
- "Replacing the components" on page 44

## Removing the CRUs

This section describes how to remove the CRUs to minimize the weight of the DS5020 before you install it in the rack. However, if you have three or more people available to lift and install the DS5020 in a rack, you might not find it necessary to remove the CRUs before you install the DS5020. If this is the case, you can skip the CRU removal instructions provided in this section. Instead, continue with "Installing the DS5020 into a rack on the support rails" on page 42, and then skip the CRU replacement instructions provided in "Replacing the components" on page 44.

**Attention:** Remove CRUs from the DS5020 chassis to lessen the weight to make it easier to transfer the DS5020 storage subsystem from the shipping box to the rack.

Use the following procedures to remove the CRUs from the DS5020 before installation. Use these instructions after you have completed all applicable site, rack, and preparations (as listed in "Preparing for installation" on page 31) and installed the support rails (as listed in "Installing the support rails" on page 35).

Alternately, you can use these instructions to lighten the DS5020 before removing it from the shipping box. The shipping box opens to provide access to the storage subsystem CRUs.

The DS5020 comes with a rack-mounting hardware kit for installing it in a rack. It is easier to lift the DS5020 and install it in a rack cabinet if you remove all the CRUs first. You will need an anti-static wrist strap and a cart or level surface (to hold the CRUs). Observe the precautions listed in "Handling static-sensitive devices" on page 31.

In the following procedure, you will remove the following CRUs from the storage subsystem before you install it in the rack:

- Controllers
- AC power supply and fan units
- Hot-swap E-DDMs

You do not need to remove the blank trays.

**Statement 4:**



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

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

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

## Removing a controller

Complete the following steps to remove a controller:

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

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

2. Slowly pull the lever away from the chassis to remove the controller from the bay, as shown in Figure 16 on page 40.
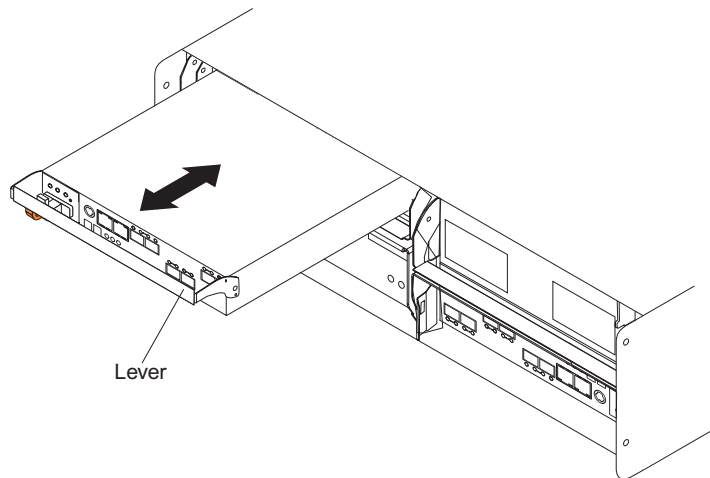
*Figure 16. Removing and replacing a controller*

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

## Removing an ac power supply and fan unit

**Statement 5:**



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



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

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

1. Squeeze the latch and pull the lever open 90° (so that the lever is horizontal) to release the power supply and fan unit from the latch. The latch is a coral colored tab on the lever.
2. Slowly pull the lever away from the chassis to remove the power supply and fan unit, as shown in Figure 17 on page 41.

   **Note:** The lever rotates upward or downward 90°, depending on whether the power supply and fan unit you are removing is in the left or right power supply and fan unit bay.
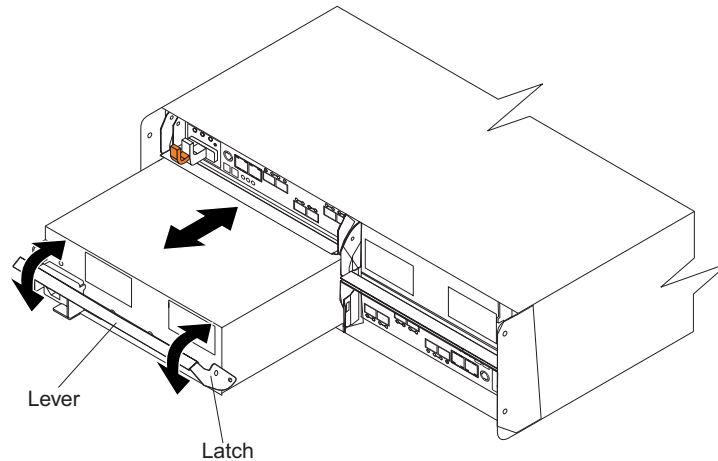
*Figure 17. Removing a power supply and fan unit*

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

## Removing an E-DDM

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

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

1. Use Table 26 on page 174 to record the location and identify your E-DDMs. You must record this information to be able to replace the E-DDMs in their original order before they were removed.
2. Release the latch on the E-DDM CRU by pressing on the inside of the bottom of the tray handle.
3. Lift the closed latch to its open position. (The latch is at a 90° angle to the front of the E-DDM when open.)
4. Pull the E-DDM out of the bay, as shown in Figure 18.
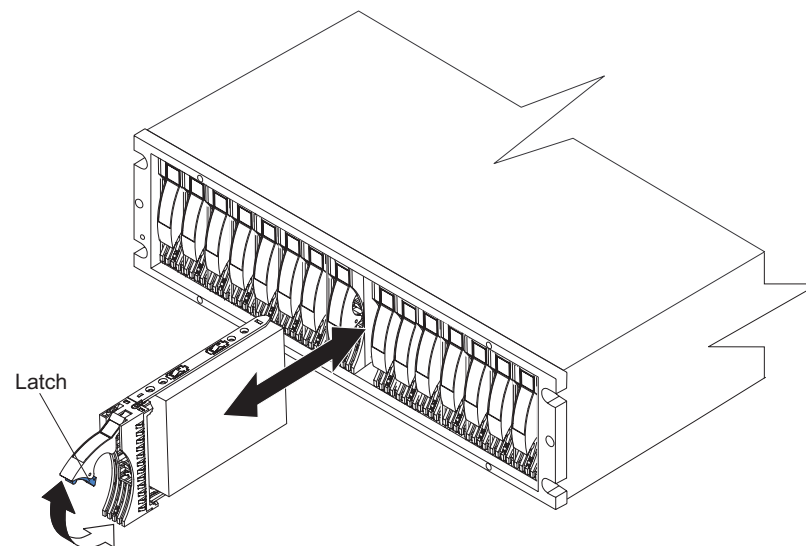


*Figure 18. Removing an E-DDM CRU*

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

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

6. Repeat step 1 through step 4 on page 41 for additional E-DDM CRUs.

## Installing the DS5020 into a rack on the support rails
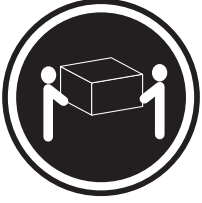
Complete the following steps to install the DS5020 in the rack cabinet.

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

**Statement 4:**

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

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

1. Put the DS5020 on anti-static protection, and keep it on while you perform all of the remaining procedures in this chapter.

2. Using a No. 2 Phillips screwdriver, remove the four M4 screws from the rails (two screws in each rail). If you do not remove these screws, the storage subsystem will not fit securely.

   **Note:** If the screws are shipped in the hardware pack instead of already installed in the rails, skip this step and go to step 3.

3. Place the storage subsystem in the rack.

   **Note:** If you have removed the CRUs from the DS5020, you can lift the unit into the cabinet with the help of one other person. If you have not removed the CRUs before the installation, have at least two other people available to help you lift the DS5020 into the rack.

   a. Move the storage subsystem to the front of the rack mount cabinet.

   b. With help from another person, place the back of the storage subsystem on the support rails, and then slide the unit into the rack as shown in Figure 19 on page 43.
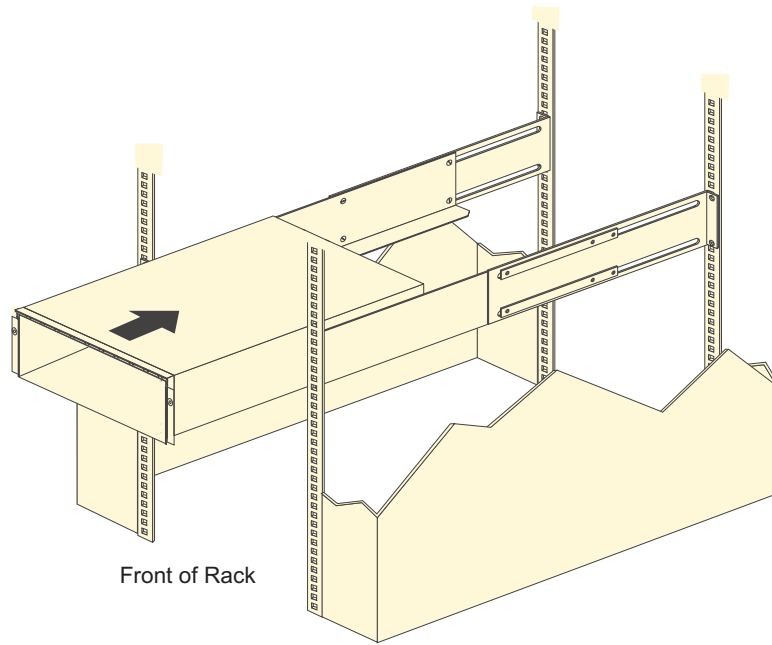
*Figure 19. Installing the DS5020*

4. Secure the storage subsystem. Figure 20 shows how to secure the storage subsystem to the rack.

   a. Align the front mounting holes on each side of the storage subsystem with the mounting holes on the front of the support rails.

   b. Using the M4 screws that you removed in step 2 on page 42, secure the sides in the back of the DS5020 to the rack rails.

   c. Secure the front of the DS5020 using the four M5 screws as shown in Figure 20.
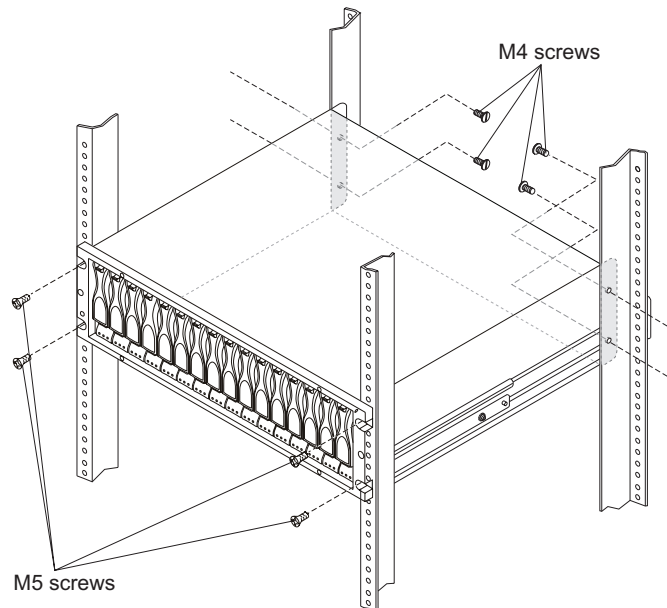


*Figure 20. Securing the DS5020 to the rack cabinet*

5. Continue with one of the following actions:
   - If you did remove the DS5020 CRUs before installation (as described in "Removing the CRUs" on page 38), continue with "Replacing the components."
   - If you did not remove the DS5020 CRUs before installation, continue with Chapter 3, "Cabling the storage subsystem," on page 47.

# Replacing the components

If you removed components from the DS5020 storage subsystem before you installed it into a rack cabinet, use the following procedures to replace the components in the DS5020 after it is installed successfully in a rack cabinet.

## Replacing a controller

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

**Attention:** After you remove an controller, wait 70 seconds before reseating or replacing the controller. Failure to do so might cause undesired events. The left and right controllers are seated in the DS5020 chassis in opposite orientations. If you cannot fully insert the controller into the controller bay, flip it 180° and reinsert it.

1. Slide one controller into the empty slot in the storage subsystem. Be sure that the lever is pulled straight out as you slide the controller in, as shown in Figure 21.
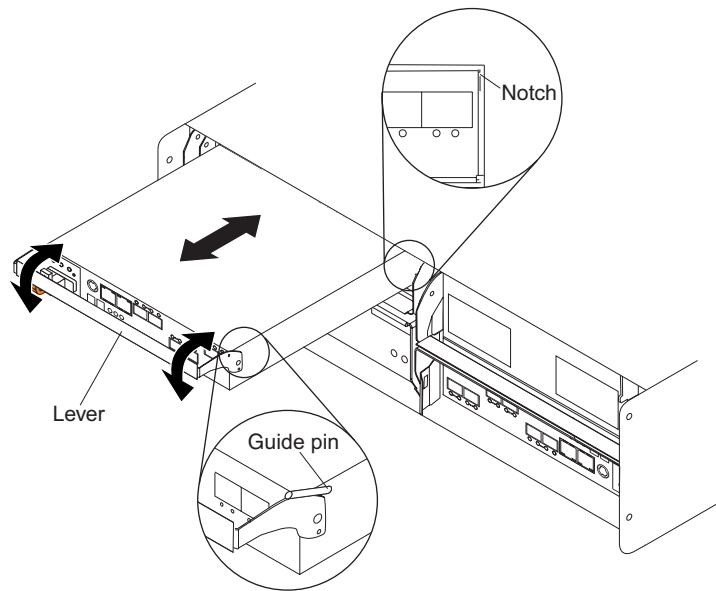


*Figure 21. Removing and replacing a controller*

2. As you slide the controller into the empty slot, make sure the guide pins on the side of the controller fit into the notches. After the guide pins fit into the notches and the controller fits snugly into the bay, push the lever downward or upward 90°, depending on whether the controller is inserted in the A or B controller bay to fully latch it into place. Do not force fit. The controller is designed to prevent it from being inserted into the chassis incorrectly.

   **Attention:** Make sure that the levers lock into place in the storage subsystem chassis.

3. Repeat step 1 on page 44 and step 2 on page 44 to replace the second controller.

## Replacing an ac power supply and fan unit

**Statement 5:**



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



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

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

1. Slide one power supply and fan unit into the storage subsystem. Be sure to replace the power supply and fan units so that the lever on each power supply and fan unit opens toward the interior of the storage subsystem, as shown in Figure 22. Do not force fit. The power supply and fan unit is designed to prevent it from being inserted into the chassis incorrectly.

   **Attention:**  Be sure that the lever is pulled straight out as you slide the power supply and fan unit into the storage subsystem, as shown in Figure 22. The left and right power supply and fan units are seated in the DS5020 chassis in opposite orientations. If you cannot fully insert the power supply and fan unit into the power supply and fan unit bay, flip it 180° and reinsert it.
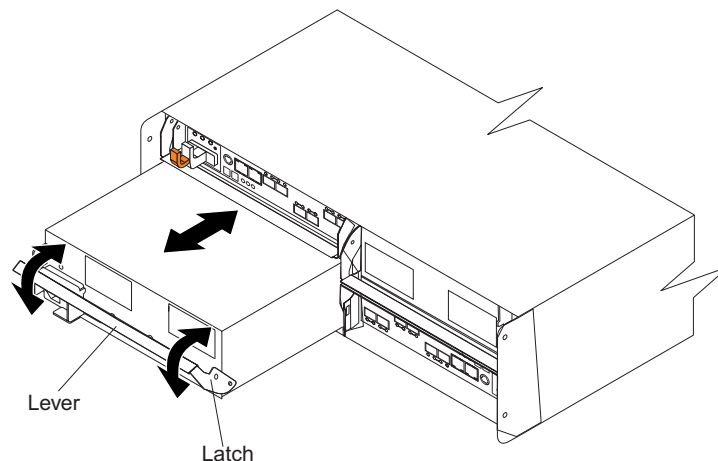


*Figure 22. Replacing a power supply and fan unit*

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

3. Repeat step 1 on page 45 and step 2 to replace the second power supply and fan unit.

## Replacing an E-DDM

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

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

**Note:** Use Table 26 on page 174 to verify the proper replacement locations of your E-DDMs.

1. Lift up on the handle and gently push the E-DDM CRU into the empty bay until the hinge of the tray handle latches beneath the storage subsystem bezel, as shown in Figure 23.
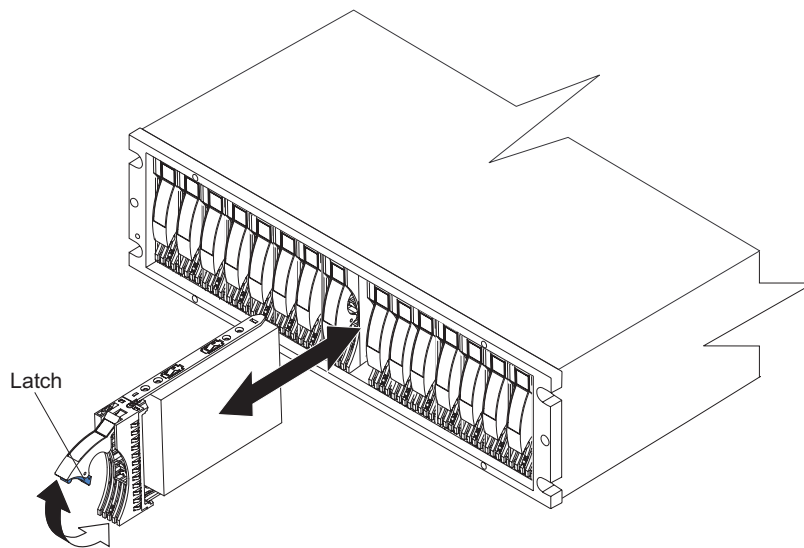


Latch

*Figure 23. Replacing an E-DDM*

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

# Chapter 3. Cabling the storage subsystem

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

This chapter addresses the following cabling and configuration topics:
- "Enclosure ID settings"
- "Fibre Channel loop and ID settings" on page 48
- "Working with SFPs and fiber-optic cables" on page 48
- "Connecting storage expansion enclosures to the DS5020" on page 57
- "Connecting hosts to the DS5020 using Fibre Channel host ports" on page 84
- "Connecting secondary interface cables" on page 80
- "Configuring the storage subsystem" on page 81
- "Installing the storage subsystem configuration" on page 94
- "Cabling the ac power supply" on page 94

## Enclosure ID settings

The enclosure ID, comprised of two seven-segment numbers, is located on the back of each controller next to the indicator lights. It provides a unique identifier for each enclosure in the DS5020 storage subsystem configuration.

The controller *automatically* sets the enclosure ID number. You can change the setting through the storage management software if necessary. Both controller enclosure ID numbers are identical under normal operating conditions. Each storage expansion enclosure (including the DS5020 storage subsystem) in the DS5020 storage subsystem configuration must have a unique storage enclosure ID. In addition, the single digits (x1) of the enclosure IDs of all storage expansion enclosures and the DS5020 storage subsystem in the redundant drive channel/loop pair must be unique.

Although the allowable ranges for enclosure ID settings are 0-99, do not set the enclosure ID to 00 or any number less than 80. The DS5020 enclosure ID is usually set to a value of 85 before it is shipped.

Figure 24 on page 48 shows the enclosure ID areas.

**Note:** Your DS5020 hardware might differ slightly from the following illustration.

Enclosure ID
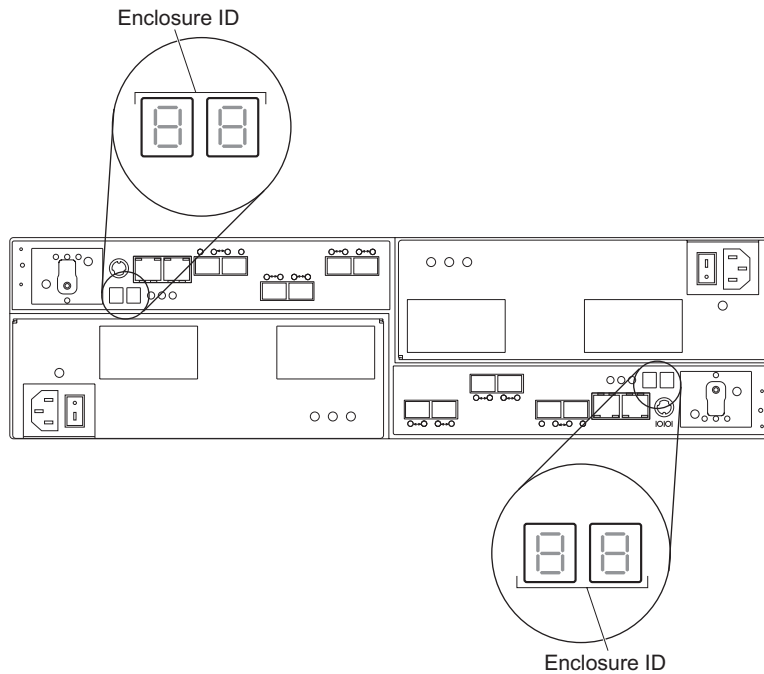
Enclosure ID

*Figure 24. Storage subsystem seven-segment enclosure IDs*

# Fibre Channel loop and ID settings

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

# Working with SFPs and fiber-optic cables

Each RAID controller has up to four single-ported host channel connections (depending on the configuration you ordered) and two dual-ported drive channel connections. A Small Form-factor Pluggable transceiver (SFP) connects each host channel port and drive channel port to hosts and storage expansion enclosures.

**Notes:**

1. IBM SFP options have been tested and approved for the IBM DS storage products. For optimal performance and compatibility, always use IBM SFP options when installing the IBM DS products.
2. The SFPs are preinstalled in the DS5020 if they are purchase at the same time as the DS5020 subsystem.

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

**Statement 3:**



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



DANGER

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

# Handling fiber-optic cables

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

**Attention:** To avoid damage to your fiber-optic cables, follow these guidelines:
- For devices on slide rails, leave enough slack in the cables so they do *not* bend to a diameter of less than 76 mm (3 in.), or a radius less than 38 mm (1.5 in.), when extended or become pinched when retracted.
- Do not overtighten the cable straps or bend the cables to a diameter of less than 76 mm (3 in.), or a radius less than 38 mm (1.5 in.).
- When storing excess or unused fiber-optic cables, do not bend the cables to a diameter of less than 76 mm (3 in.), or a radius less than 38 mm (1.5 in.) or wrap them around themselves. See Figure 25 on page 50.
- Make sure you have a minimum loop diameter of 76 mm (3 in.) and a minimum bend radius of 38 mm (1.5 in.) for fiber-optic cables. Loops or bends smaller than these minimums might cause damage to your fiber-optic cables. Use loop diameters and bend radii that are greater than these minimums.
- Do not route the cable along a folding cable-management arm.
- Route the cable away from places where it can be damaged by other devices in the rack cabinet.
- Do not put excess weight on the cable at the connection point. Be sure that the cable is well supported.
- Do not use plastic cable ties in place of the provided cable straps.
- The supported maximum lengths of OM2 category Fibre Channel cable are:

– 4 Gbps: 150 m (492 ft.) of 50/125 um fiber, 300 m (984 ft.) of 62.5/125 um fiber
– 8 Gbps: 50 m (164 ft.) of 50/125 um fiber, 150 m (492 ft.) of 62.5/125 um fiber



1.5 inch
(38 mm)
radius

3.0 inch
(76 mm)
diameter
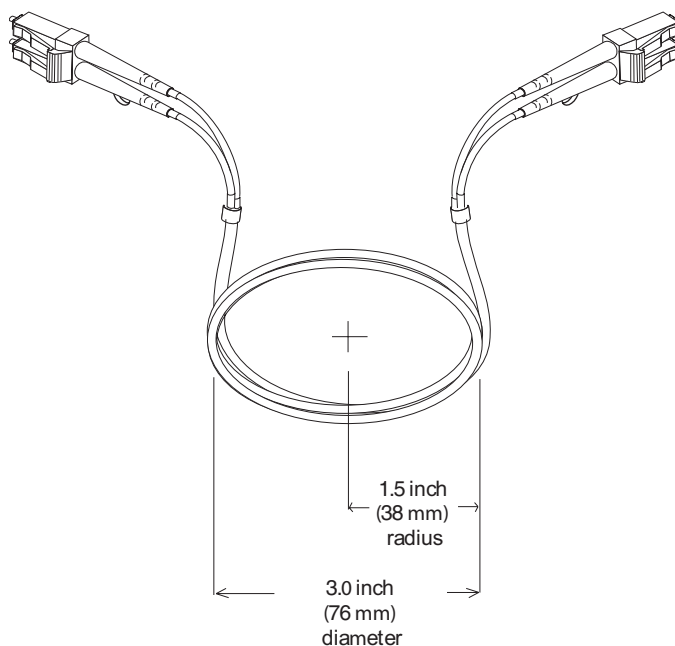
*Figure 25. Bending and looping specifications for fiber-optic cables*

## Installing SFP modules

The DS5020 requires SFP modules. SFP modules convert electrical signals to optical signals that are required for Fibre Channel transmission to and from RAID controllers.

**Note:** The SFPs are preinstalled in the DS5020.

If the SFPs are not preinstalled in your DS5020 hardware, or if you need to replace them, use the information in this section to install the SFPs into the ports. After you install the SFP modules, you can use fiber-optic cables to connect the DS5020 to other Fibre Channel devices.

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

- Do not mix long-wave SFPs and short-wave SFPs on a single storage subsystem. Use only short-wave SFPs. You can use the DS Storage Manager client to view the Storage Subsystem Profile to verify that you are not mixing long-wave and short-wave SFPs.

  **Attention:** Do not use long-wave SFPs or GBICs in any of the Fibre Channel ports in the DS5020 controllers. (Long-wave SFPs and GBICs are not supported for use in the DS5020 or any of the attached storage expansion enclosures.)

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

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

- You can insert or remove the SFP module while the port is powered on.
- Do not install an SFP in any port that will not have a fiber-optic cable attached. Remove any SFP from any port that does not have fiber-optic cables attached.
- The operational or redundant loop performance is not affected when you install or remove an SFP module.
- You must insert the SFP module into a port before you connect the fiber-optic cable.
- You must remove the fiber-optic cable from the SFP module before you remove the SFP module from the port. Refer to "Removing SFP modules" on page 52 for more information.
- The maximum operating speed of the Fibre Channel port is determined by two factors: the speed of the SFP module that is installed and the speed of the Fibre Channel connection. For example, a 4 Gbps SFP that is plugged into an 8 Gbps-capable port will limit the speed of that port to a maximum of 4 Gbps. Conversely, an 8 Gbps SFP that is plugged into a 4 Gbps-capable port will limit the speed of the port to a maximum of 4 Gbps.

  **Attention:** Carefully check the SFP IBM part number, option number, and FRU part number to identify its speed. There are no physical features that distinguish a 4 Gbps SFP from an 8 Gbps SFP.

**Statement 3:**



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

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



**DANGER**

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

**Attention:** When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see "Handling static-sensitive devices" on page 31.

To install an SFP module, complete the following steps:
1. Remove the SFP module from its static-protective package.

2. Remove the protective cap from the SFP module, as shown in Figure 26. Save the protective cap for future use.
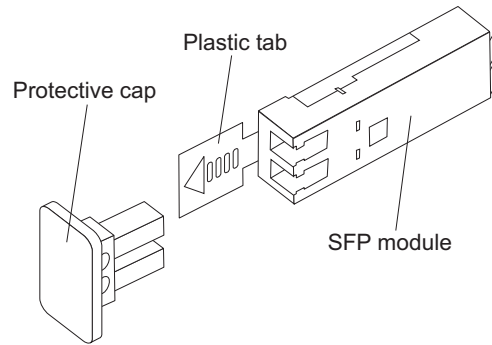


*Figure 26. SFP module and protective cap*

3. Remove the protective cap from the SFP port. Save the protective cap for future use.
4. Insert the SFP module into the host port until it clicks into place. See Figure 27.
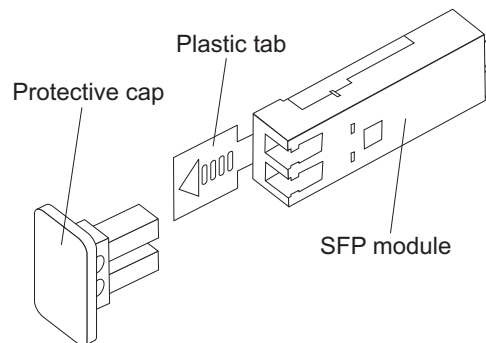


*Figure 27. Installing an SFP module into the host port*

5. Connect an LC-LC Fibre Channel cable. For information about the LC-LC cable, see "Using LC-LC Fibre Channel cables" on page 53.

## Removing SFP modules

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

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

1. Remove the LC-LC Fibre Channel cable from the SFP module. For more information, see "Removing an LC-LC Fibre Channel cable" on page 56.
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 28 on page 53.
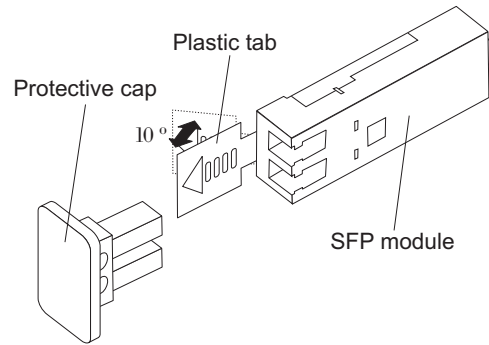
*Figure 28. Unlocking the SFP module latch - plastic variety*

  • For SFP modules that contain wire tabs, unlock the SFP module latch by
    pulling the wire latch outward 90°, as shown in Figure 29.
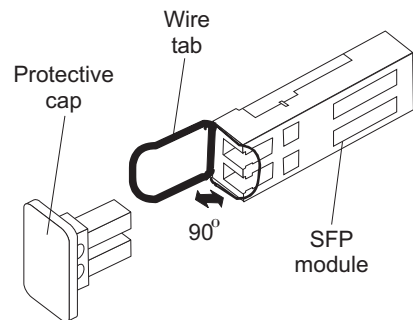


*Figure 29. Unlocking the SFP module latch - wire variety*

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

## Using LC-LC Fibre Channel cables

The LC-LC Fibre Channel cable is a fiber-optic cable that you use to connect
DS5020 Fibre Channel ports into one of the following devices:
• An SFP module installed in a Fibre Channel switch port
• An SFP module of the host bus adapter port
• An SFP module installed in an IBM DS5000 or DS4000 storage expansion
  enclosure

See Figure 30 on page 54 for an illustration of the LC-LC Fibre Channel cable.

For more information about cabling these devices, see the documentation that
comes with the LC-LC Fibre Channel cable.
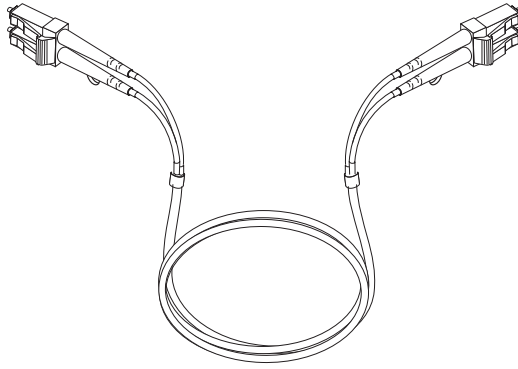
*Figure 30. LC-LC Fibre Channel cable*

## Connecting an LC-LC cable to an SFP module

Complete the following steps to connect an LC-LC Fibre Channel cable to an SFP module:

**Statement 3:**



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

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



**DANGER**

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

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

1. Read the information in "Handling fiber-optic cables" on page 49.
2. If necessary, remove the protective cap from the SFP module, as shown in Figure 26 on page 52. 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 31 on page 55. Save the protective caps for future use.
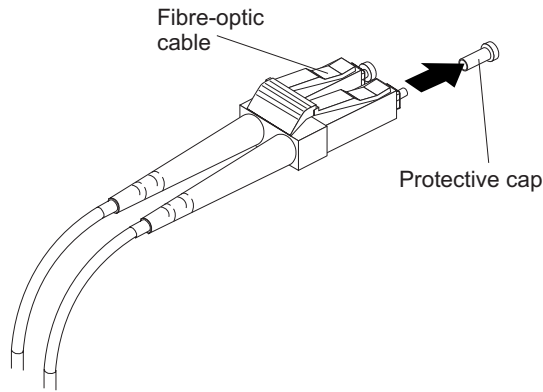
*Figure 31. Removing fiber-optic cable protective caps*

4. Carefully insert this end of the LC-LC cable into an SFP module that is installed in the DS5020. The cable connector is keyed so it will be inserted into the SFP module correctly. Holding the connector, push in the cable until it clicks into place, as shown in Figure 32.
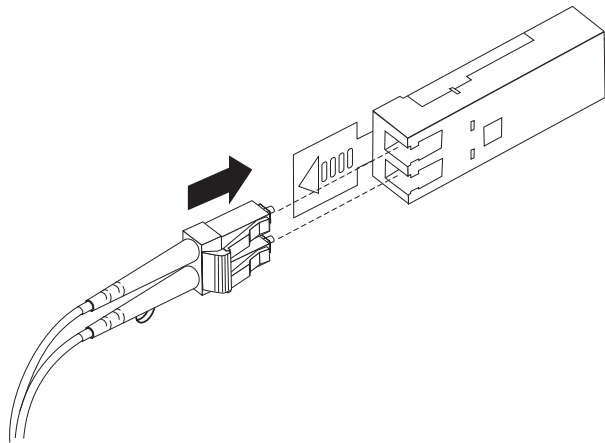


*Figure 32. Inserting an LC-LC Fibre Channel cable into an SFP module*

5. Remove the two protective caps from the other end of the LC-LC cable. Save the protective caps for future use.
6. Connect this end of the LC-LC cable to one of the following devices:
   - An SFP module that is installed in a separate storage expansion enclosure
   - An SFP module that is installed in a Fibre Channel switch port
   - A Fibre Channel host bus adapter port

## Removing an LC-LC Fibre Channel cable

Complete the following steps to remove an LC-LC Fibre Channel cable:

**Attention:** To avoid damaging the LC-LC cable or SFP module, make sure that you observe the following precautions:

- Press and hold the lever to release the latches before you remove the cable from the SFP module.
- Make sure that the levers are in the released position when you remove the cable.
- Do not grasp the SFP module plastic tab when you remove the cable.

1. On the end of the LC-LC cable that connects into the SFP module or host bus adapter, press down and hold the lever to release the latches, as shown in Figure 33.
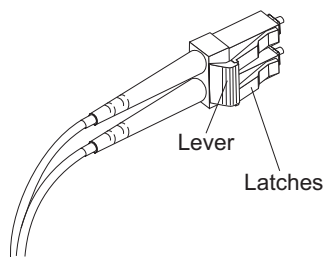


*Figure 33. LC-LC Fibre Channel cable lever and latches*

2. While pressing down the cable lever, carefully pull on the connector to remove the cable from the SFP module, as shown in Figure 34.
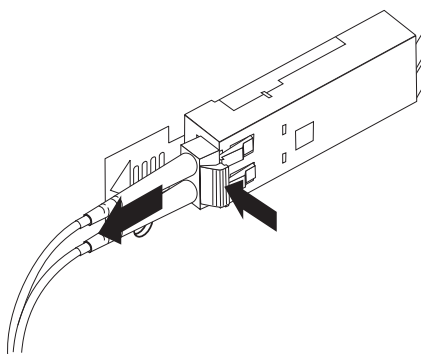


*Figure 34. Removing the LC-LC Fibre Channel cable*

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

# Connecting storage expansion enclosures to the DS5020

**Attention:** Before you turn on the power to the DS5020 storage subsystem, it must be populated with at least two E-DDMs. If at least two E-DDMs are not installed in the DS5020, an insufficient load to the enclosure power supplies might cause them to intermittently appear as failed, falsely indicating the power supplies are bad. All of the E-DDMs in the DS5020 storage subsystem and the connected storage expansion enclosure or enclosures must contain no prior configuration data.

In the initial installation of the DS5020, you can add only new storage expansion enclosures to the DS5020 storage subsystem. This means there must be no existing configuration information about the storage expansion enclosures that you want to install.

The DS5020 supports the attachment of up to six EXP520 and EXP810 storage expansion enclosures, resulting in the capability to connect up to 112 E-DDMs and enabling storage configurations of over 67 TB using 600 GB Fibre Channel or FC-SAS E-DDMs, or 224 TB using 2 TB SATA E-DDMs.

The base DS5020 storage subsystem supports up to 32 drives, which includes 16 drives in the DS5020 chassis and 16 more drives in an attached storage expansion enclosure. To attach more than 32 drives, you much purchase the applicable feature option.

To attach additional drives to the DS5020, you can use EXP520 or EXP810 storage expansion enclosures. You can connect EXP520 storage expansion enclosures to the DS5020 without purchasing feature options. To attach an EXP810 storage expansion enclosure or enclosures to the DS5020, you must purchase the Attach EXP810 to DS5020 Activation feature option. Contact your IBM marketing representative or IBM reseller for more information.

To connect 33 - 64 drives in one DS5020 and three EXP520 storage expansion enclosures, you must purchase the DS5020 Drive Attach 33 - 64 feature option. If you need to connect 65 - 112 drives in a DS5020 configuration, you must purchase the DS5020 Drive Attach 65- 112 feature option in addition to the DS5020 Drive Attach 33 - 64 feature option. These two feature options enable you to attach the additional drives in one DS5020 and six EXP520 storage expansion enclosures. Contact your IBM marketing representative or IBM reseller for more information.

If the storage expansion enclosures that you want to install currently contain logical drives or configured hot spares, and you want them to be a part of the DS5020 storage subsystem configuration, refer to the *IBM System Storage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*. Improper drive migration might cause loss of configuration and other storage subsystem problems. Contact your IBM technical support representative for additional information.

## Redundant drive channel pair

Each controller on the DS5020 has drive channel ports. The storage expansion enclosures that are connected to these ports form a drive channel (also referred to as drive loop). The maximum number of hard drives that can be installed in one drive channel is 112. One drive channel from each controller combines to form a redundant drive channel pair.

Figure 35 shows an example of a redundant drive channel pair. If any component of the drive channel fails, the RAID controllers can still access the storage expansion enclosures in the redundant drive channel pair.

**Note:** In the following drive cabling figures, the DS5020 graphics are simplified to show only the drive ports of each controller.
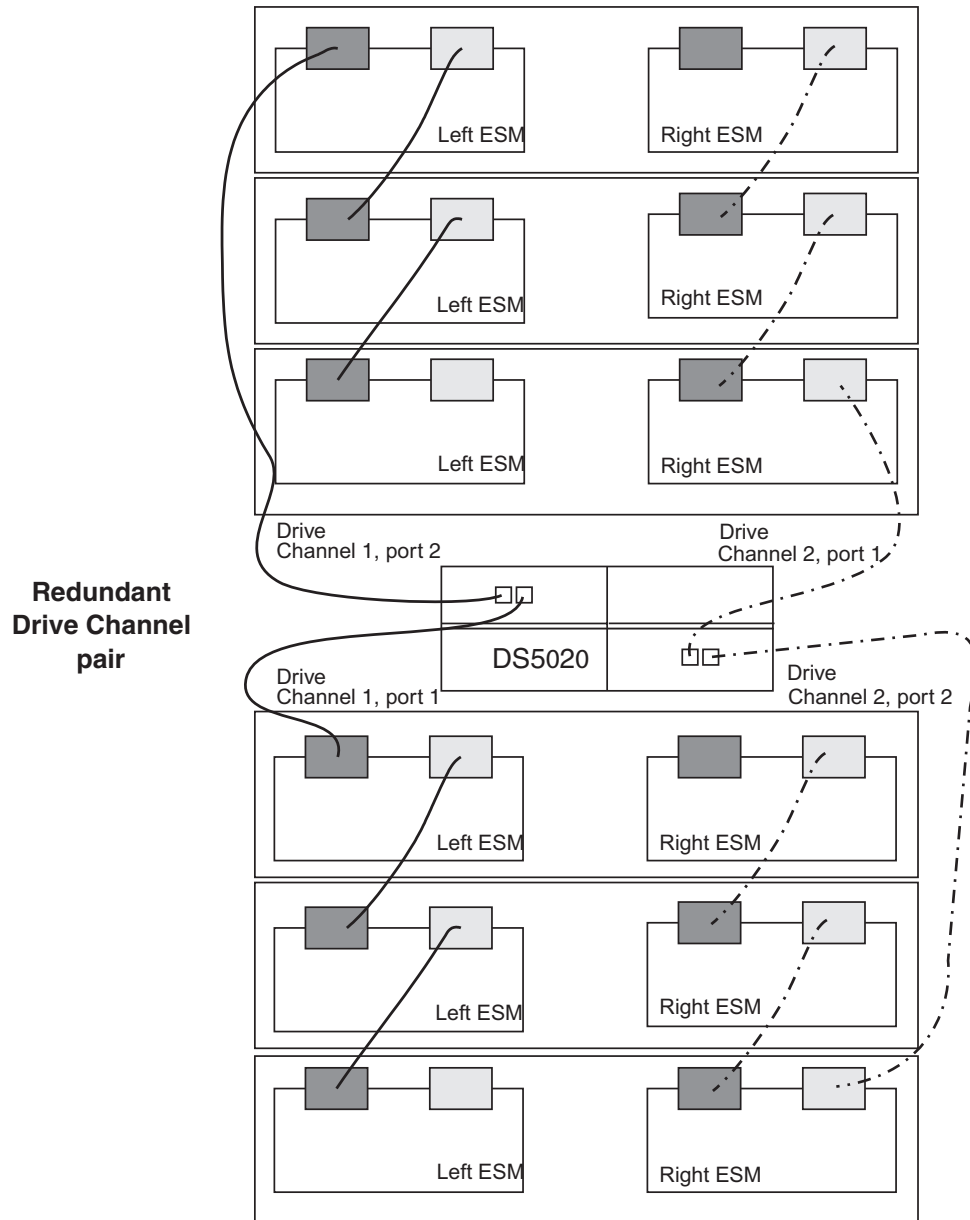


*Figure 35. Example of a redundant drive channel pair*

## Overview of steps to connect storage expansion enclosures to a storage subsystem

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

**Note:** The following procedures are for "cold-case" procedures (in which the DS5020 is powered down when storage expansion enclosures are connected,

as in the case of initial installation). For "hot-case" procedures (in which the DS5020 is powered on when storage expansion enclosures are connected), refer to the *IBM System Storage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*.

1. Follow the instructions in the Installation, User's, and Maintenance Guide for your DS5000 or DS4000 storage expansion enclosure to set up and mount the storage expansion enclosures.

2. Select a cabling topology appropriate for the number of storage expansion enclosures you will connect to the DS5020. If you are connecting external storage expansion enclosures to the DS5020, make sure that the storage expansion enclosures are populated with at least two drives before you turn on the power. In addition, you must have at least two drives in the DS5020 storage subsystem before you power it on.

   "DS5020 storage subsystem drive cabling topologies" describes the schemes for cabling different numbers of storage expansion enclosures to the DS5020 and to each other (if you are connecting more than one storage expansion enclosure).

3. After you select the cabling topology for your configuration, follow the cabling diagram for your chosen topology and perform the steps identified in "DS5020 storage subsystem and supported storage expansion enclosure drive cabling schemes" on page 69.

4. If required, set unique enclosure IDs for all storage expansion enclosures that are cabled to the DS5020. See "Storage expansion enclosure ID settings" on page 80, and then refer to your storage expansion enclosure installation manual for details on setting the enclosure ID.

The DS5020 storage subsystem locates the drives in the storage expansion enclosures after you turn on the power to the configuration. Always connect power to the storage expansion enclosures first and then connect power to the DS5020. After you have powered on the configuration, use the DS Storage Manager client to check the status of the new drives, correct any errors found, and configure the new drives.

**Notes:**

1. EXP810 and EXP520 storage expansion enclosures can be intermixed behind a DS5020 drive channel.

2. To cable EXP810 storage expansion enclosures with a DS5020, you must purchase the Attach EXP810 to DS5020 Activation feature option.

## DS5020 storage subsystem drive cabling topologies

This section provides preferred cabling topologies for cabling storage expansion enclosures to the DS5020 storage subsystem. The cabling topologies include the following:

- "One DS5020 and one storage expansion enclosure" on page 61
- "One DS5020 and two storage expansion enclosures" on page 62
- "One DS5020 and three storage expansion enclosures" on page 64
- "One DS5020 and four storage expansion enclosures" on page 65
- "One DS5020 and up to six storage expansion enclosures" on page 66
- "One DS5020 and two or more storage expansion enclosures in a mixed configuration" on page 68

Each example provides redundant paths to the drives. If one of these examples is suitable for your hardware and application, complete the cabling connections as

described by the graphics. If you have hardware other than what is shown in these examples to include in your topology, use these examples as a starting point for creating your specific topology.

**Important:** The DS5020 supports the connection of a maximum of six storage expansion enclosures per redundant drive channel pair. The DS5020 supports one redundant drive channel pair.

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

Figure 36 and shows the locations of controllers A and B, the single-ported Fibre Channel host channels, Ethernet ports, and dual-ported Fibre Channel drive channels at the back of the DS5020 storage subsystem.

**Note:** Your DS5020 hardware might differ slightly from the following illustration.
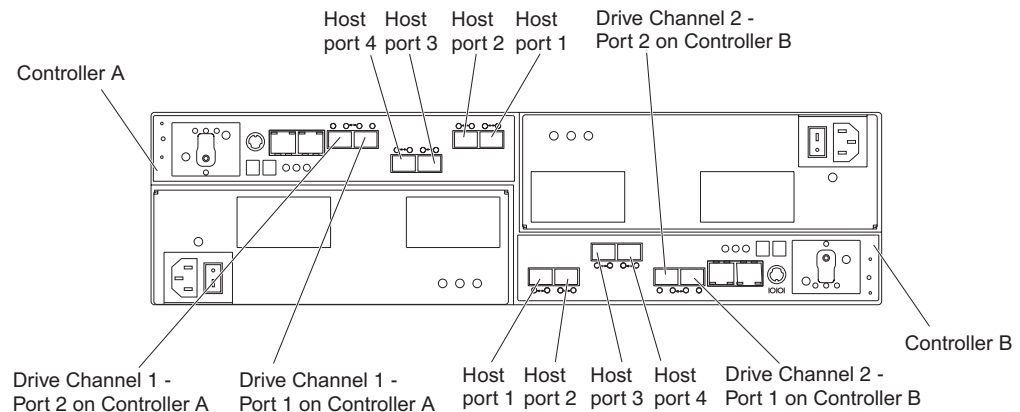


*Figure 36. DS5020 storage subsystem ports and controllers*

**Notes:**

1. EXP810 and EXP520 storage expansion enclosures can be intermixed behind a DS5020 drive channel.
2. To cable EXP810 storage expansion enclosures with a DS5020, you must purchase the Attach EXP810 to DS5020 Activation feature option.

## One DS5020 and one storage expansion enclosure

If you are cabling one DS5020 storage subsystem to one storage expansion enclosure, Figure 37 shows the correct cabling topology.

**Note:** Figure 37 illustrates the drive channel connections between the DS5020 and the storage expansion enclosures. Do not use Figure 37 as the cabling diagram. Follow the instructions in "DS5020 storage subsystem and supported storage expansion enclosure drive cabling schemes" on page 69 for specific cabling instructions.
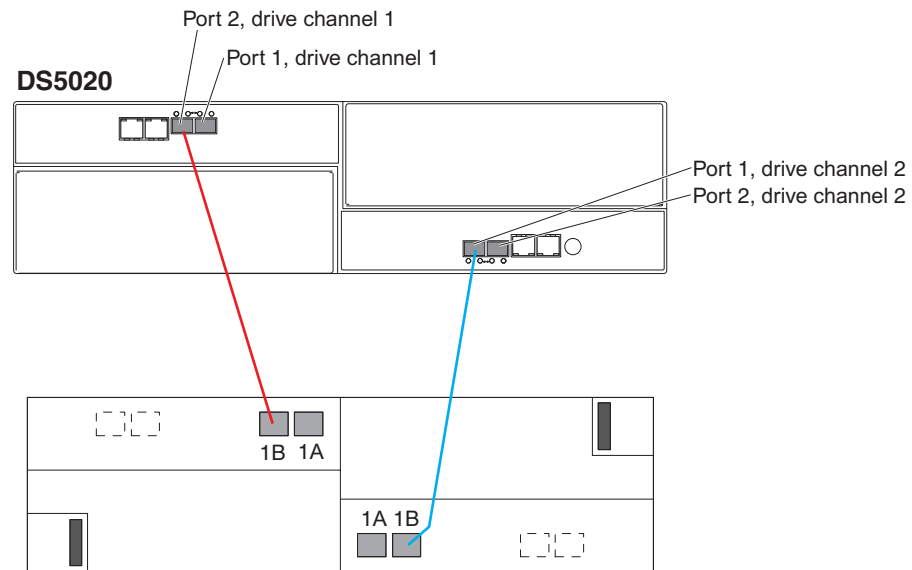


*Figure 37. Cabling for one DS5020 and one storage expansion enclosure*

## One DS5020 and two storage expansion enclosures

If you are cabling one DS5020 storage subsystem and two storage expansion enclosures, connect one storage expansion enclosure per controller drive port as shown in Figure 38. Figure 39 on page 63 shows that you can also connect two expansion enclosures together behind a single controller drive port. Although this is technically correct, use the topology as shown in Figure 38.

As Figure 38 shows, when you connect additional storage expansion enclosures, you can connect them by using the additional port of the drive channel.
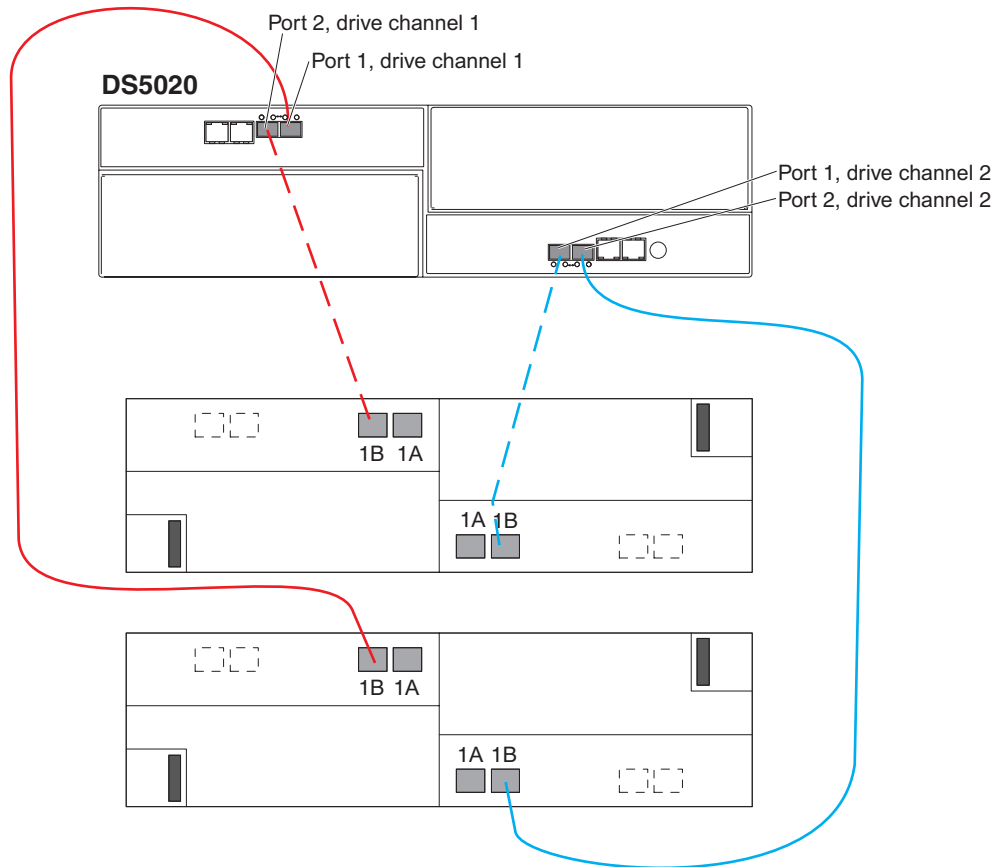


*Figure 38. Cabling for one DS5020 and two storage expansion enclosures*

When you connect additional storage expansion enclosures, you can connect them by continuing the connection from the existing redundant drive channel pair.

**Important:** Do not cable the DS5020 storage subsystem and two storage expansion enclosures as shown in Figure 39. A storage array with the incorrect storage topology might appear to be functional, but incorrect cabling can potentially have unpredictable results.
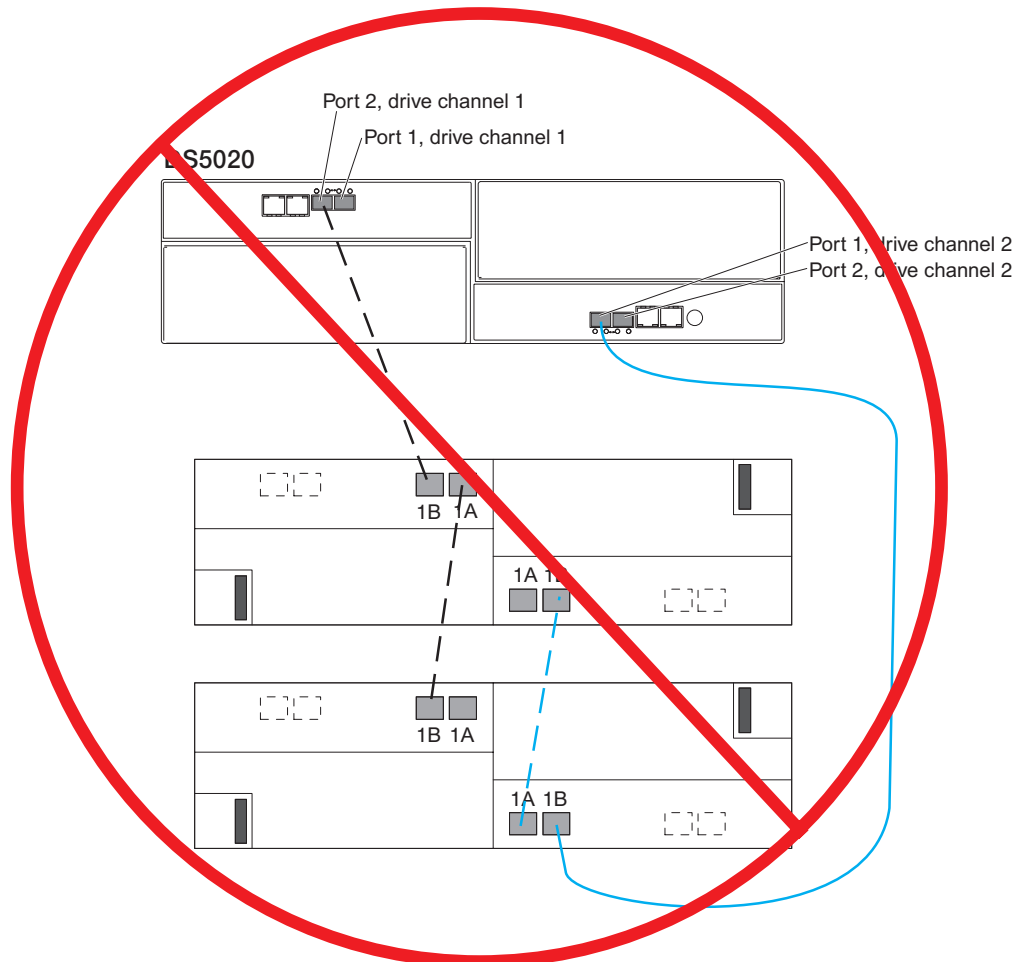


*Figure 39. Incorrect cabling of one DS5020 and two storage expansion enclosures*

## One DS5020 and three storage expansion enclosures

If you are cabling one DS5020 storage subsystem and three storage expansion enclosures, Figure 40 shows the correct cabling topology.
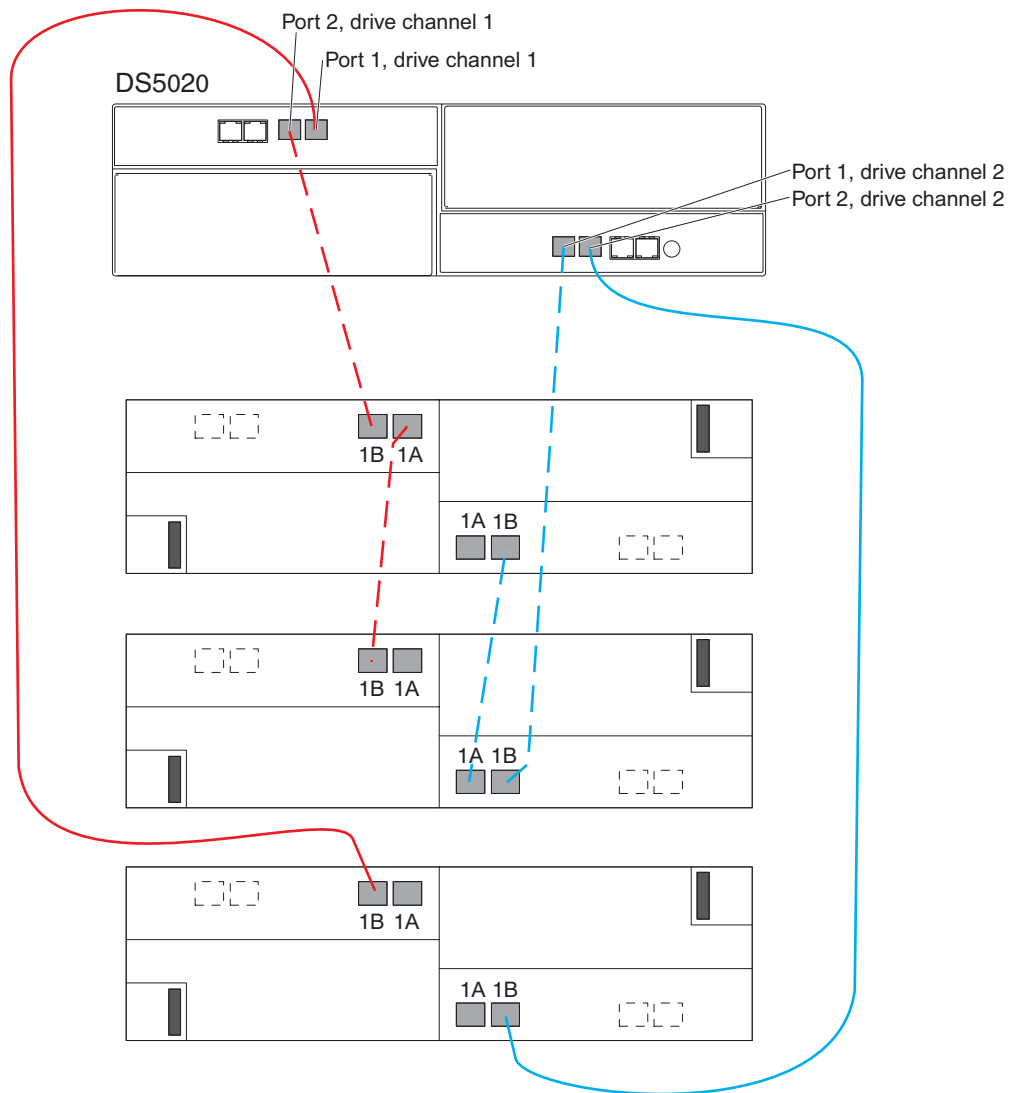


*Figure 40. Cabling for one DS5020 and three storage expansion enclosures*

## One DS5020 and four storage expansion enclosures

If you are cabling one DS5020 storage subsystem and four storage expansion enclosures, Figure 41 shows the correct cabling topology.
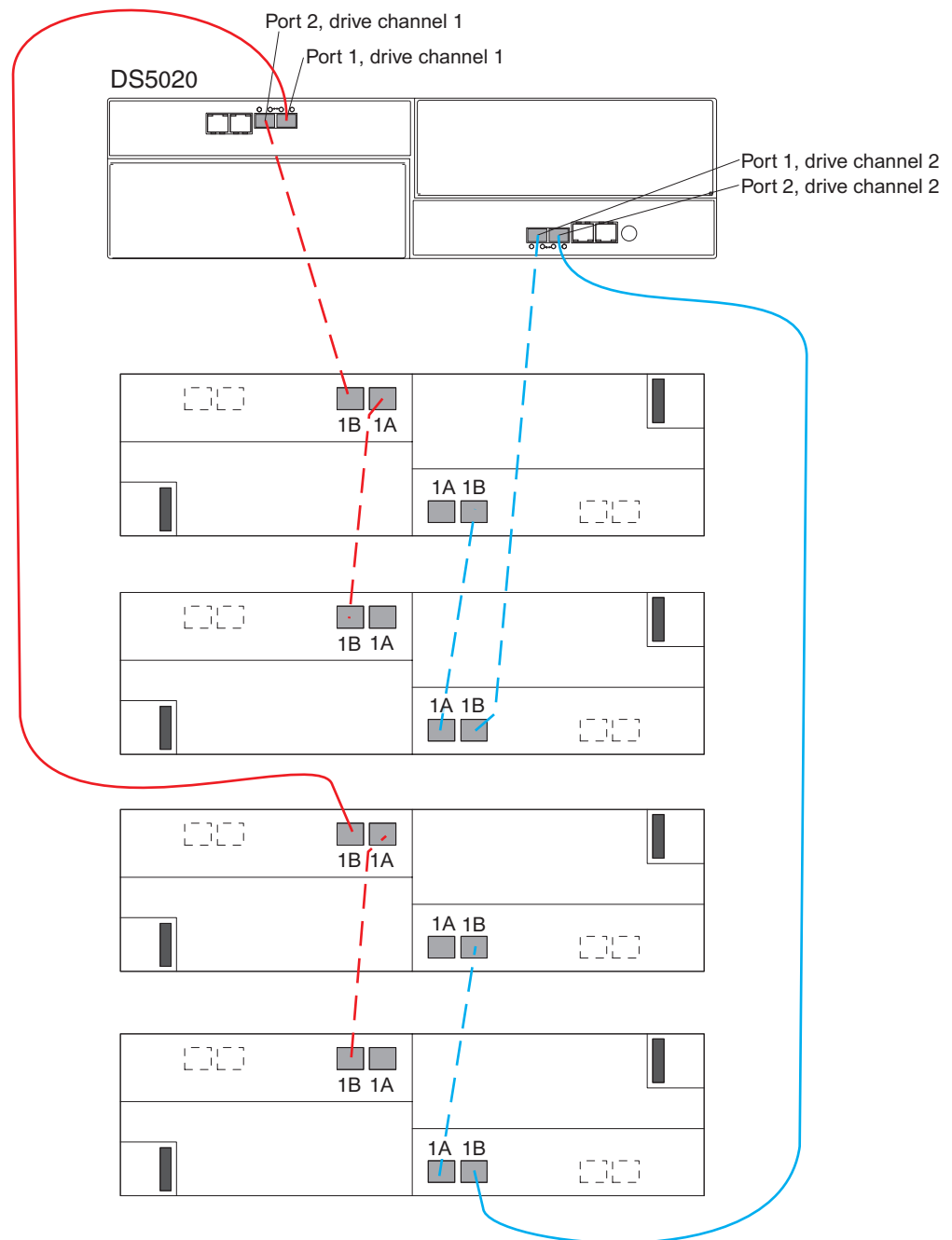


*Figure 41. Cabling for one DS5020 and four storage expansion enclosures*

## One DS5020 and up to six storage expansion enclosures

If you are cabling one DS5020 storage subsystem and up to six storage expansion enclosures, Figure 42 shows the correct cabling topology.
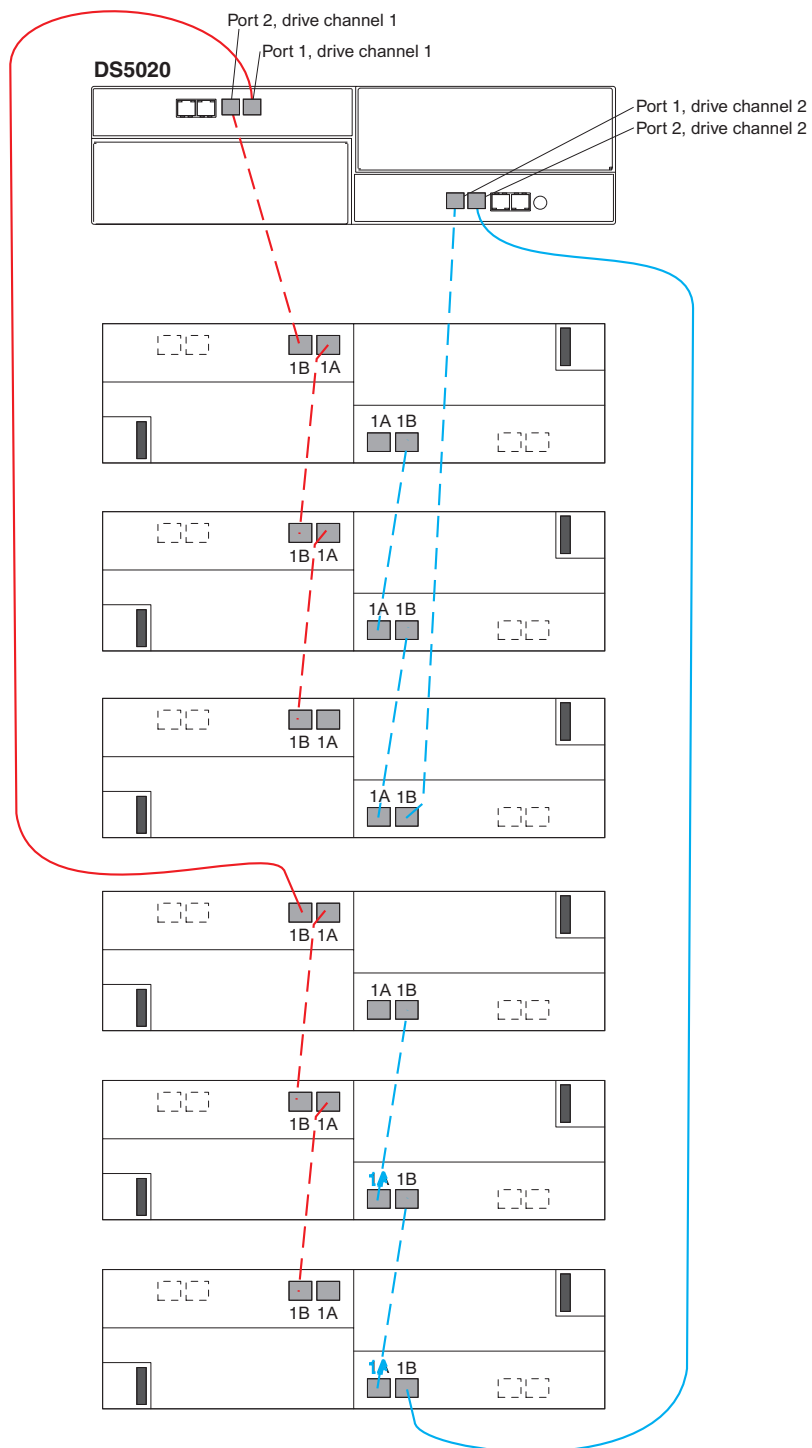


*Figure 42. Cabling for one DS5020 and up to six storage expansion enclosures*

Figure 43 on page 68 shows a cabling topology that is incorrect because all six storage expansion enclosures are connected to a single drive port of the dual-ported drive channel in each controller.

**Important:** Do not cable the storage subsystem and storage expansion enclosures as shown in Figure 43. A storage array with the incorrect storage topology might appear to be functional, but incorrect cabling can potentially have unpredictable results.
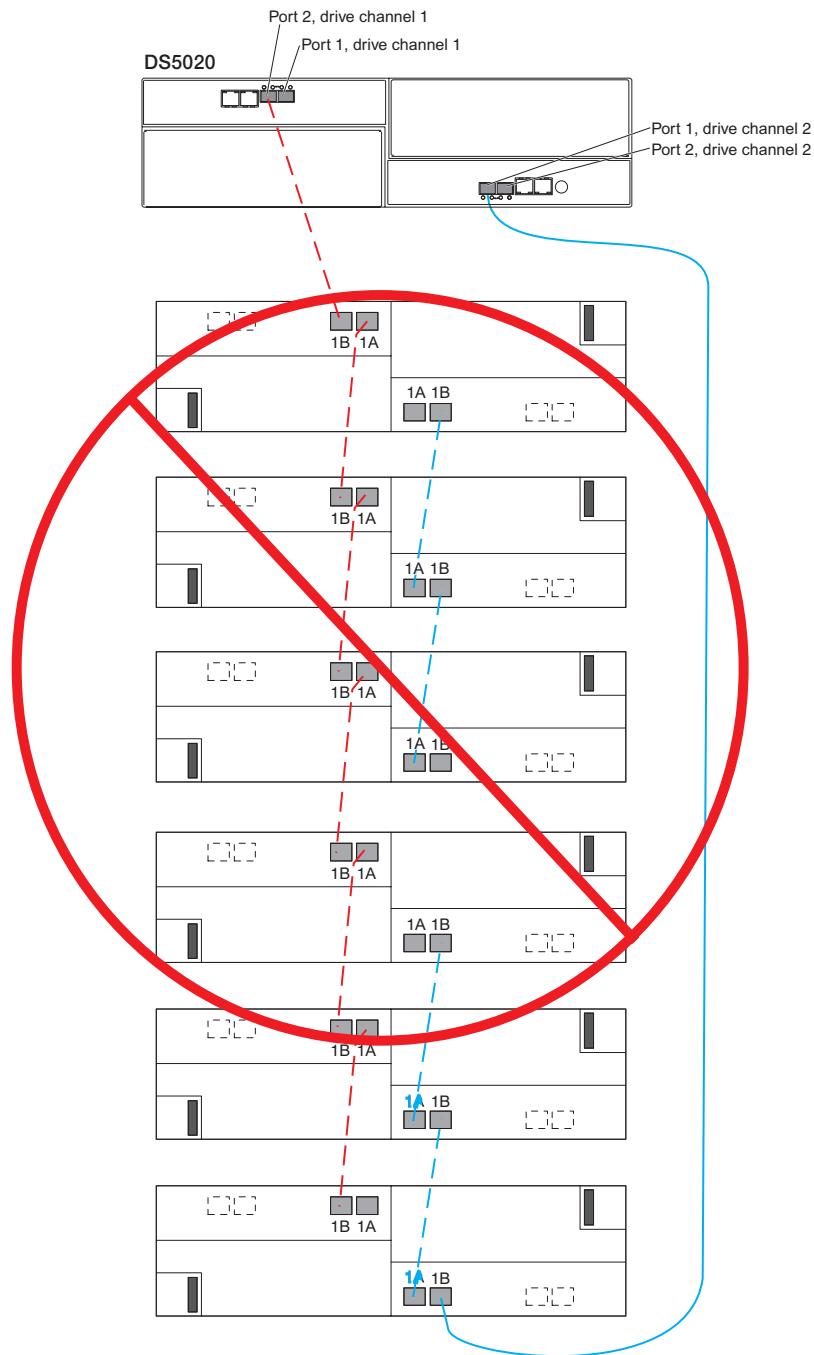


*Figure 43. Cabling for one DS5020 and up to six storage expansion enclosures*

## One DS5020 and two or more storage expansion enclosures in a mixed configuration

A mixed configuration is a configuration in which you have more than one type of storage expansion enclosure. Figure 44 on page 69 shows the cabling topology if you have three EXP520s and three EXP810s attached to the DS5020. (The EXP520s

are denoted in the graphic as **1** while the EXP810s are denoted as **2** .)

Port 2, drive channel 1
Port 1, drive channel 1
DS5020
Port 1, drive channel 2
Port 2, drive channel 2

EXP520
1B 1A
1A 1B

EXP810
1B 1A
1A 1B

EXP520
1B 1A
1A 1B

EXP810
1B 1A
1A 1B

EXP520
1B 1A
1A 1B
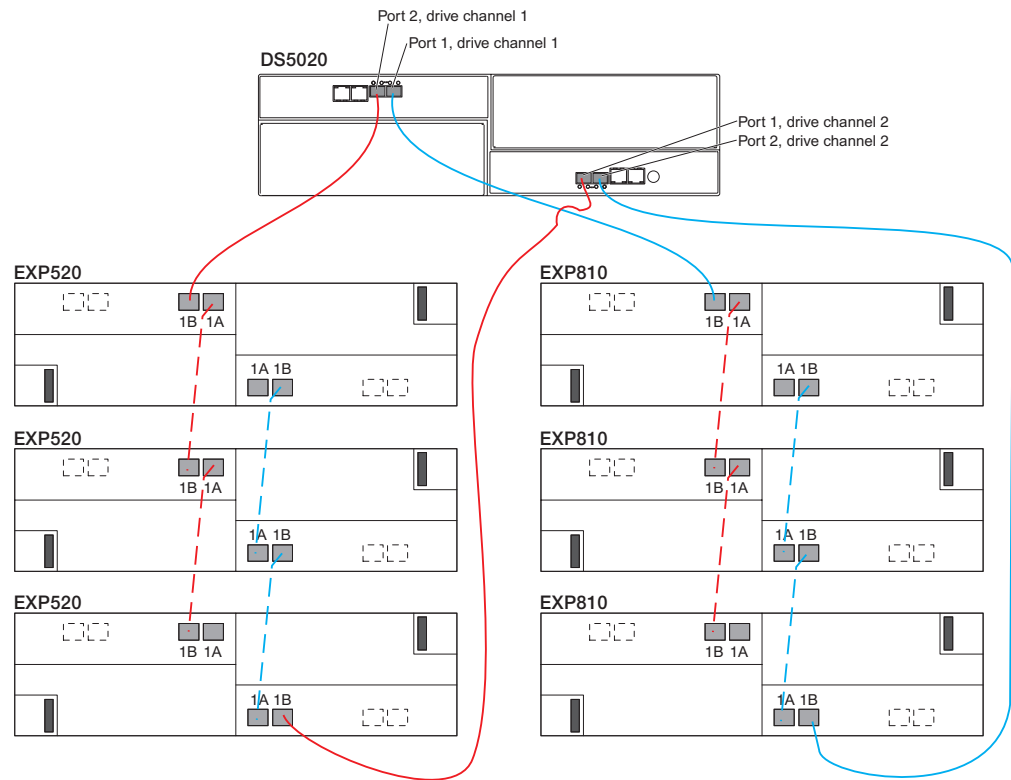
EXP810
1B 1A
1A 1B

*Figure 44. Cabling for one DS5020 and two or more storage expansion enclosures in a mixed environment*

## DS5020 storage subsystem and supported storage expansion enclosure drive cabling schemes

The DS5020 supports only EXP520 and EXP810 storage expansion enclosures. To attach one or more EXP810 storage expansion enclosures to the DS5020 storage subsystem, you must purchase the Attach EXP810 to DS5020 Activation feature option. Contact your IBM marketing representative for more information about purchasing feature options.

The cabling schemes for the EXP520 and EXP810 storage expansion enclosures are the same. This section describes the instructions only for the EXP520; use the same diagrams and procedures to cable the DS5020 to one or more EXP810 storage expansion enclosures.

The following sections show cabling schemes for supported storage expansion enclosures and the DS5020 storage subsystem:

### DS5020 storage subsystem drive cabling rules

Refer to these general rules when you complete the cabling steps in the cabling schemes described in this section.

1. Do not connect a combination of more than six EXP520 or EXP810 storage expansion enclosures to the two ports of a dual-ported drive channel. Failure to observe this limitation might result in loss of data availability. In the DS5020 storage subsystem environment, no more than six EXP520 or EXP810 storage expansion enclosures can be connected to the two ports of a dual-ported drive channel because of the internal drive slots in the DS5020 storage subsystem.

2. Do not connect more than four EXP520 or EXP810 storage expansion enclosures to each port of a dual-ported drive channel.

3. Add storage expansion enclosures to the storage subsystem drive ports in a round-robin fashion. For example, if you have four drive expansion enclosures to be cabled to the storage subsystem, instead of cabling all four drive expansion enclosures to one drive port of a drive channel, distribute the enclosures to all drive ports, which results in one enclosure per drive port of a drive channel.

4. Do not connect more than the maximum number of enclosures per drive channel, which is eight for EXP520s and EXP810s.

5. The DS5020 storage subsystem supports the connection of a maximum of six storage expansion enclosures per redundant drive channel loop and supports one redundant drive channel loop pair. Failure to observe this limitation might result in loss of data availability.

6. The DS5020 currently supports a maximum of 112 drives in six 16-drive storage expansion enclosures per drive channel in each controller. One drive channel from each of controllers A and B must be connected to the same set of storage expansion enclosures to provide drive channel redundancy. Do not connect a combination of more than six storage expansion enclosures to the two ports of a single drive channel.

7. When connecting six storage expansion enclosures to a DS5020, use all ports in both drive channels. See Figure 42 on page 66 for the cabling topology.

8. Connect a maximum of four EXP520s or EXP810s per DS5020 controller drive port.

9. When mixing different types of storage expansion enclosures in the same drive channel pair, the link rate Setting must be the same for each storage expansion enclosure. IBM does not support different enclosure speed settings in the same drive channel.

10. The controller drive ports of the DS5020 storage subsystem controllers must always be connected to ports labeled 1B in both the right and left ESMs of the EXP810s in the redundant drive channel/loop pair that is connected to the DS5020 storage subsystem. Figure 45 on page 71 shows the location of the ports.

11. To attach EXP810 storage expansion enclosures to the DS5020, you must purchase the Attach EXP810 to DS5020 Activation feature option. Contact your IBM marketing representative for more information.

12. To attach 33 - 64 additional drives to the DS5020, you must purchase the DS5020 Drive Attach 33 - 64 feature option. To attach 65 - 112 additional drives to the DS5020. you must purchase the DS5020 Drive Attach 65- 112 feature option in addition to the DS5020 Drive Attach 33 - 64 feature option. Contact your IBM marketing representative for more information.

ESM
port 1B

ESM
port 1A

ESM A

Last EXP810
storage expansion
enclosure

EXP810

ESM B

ESM
port 1A

ESM
port 1A

Other storage
expansion
enclosures

ESM
port 1B

ESM
port 1A

ESM A

First EXP810
storage expansion
enclosure

EXP810

ESM B

Drive channel
port

ESM
port 1A

ESM
port 1B

DS5020
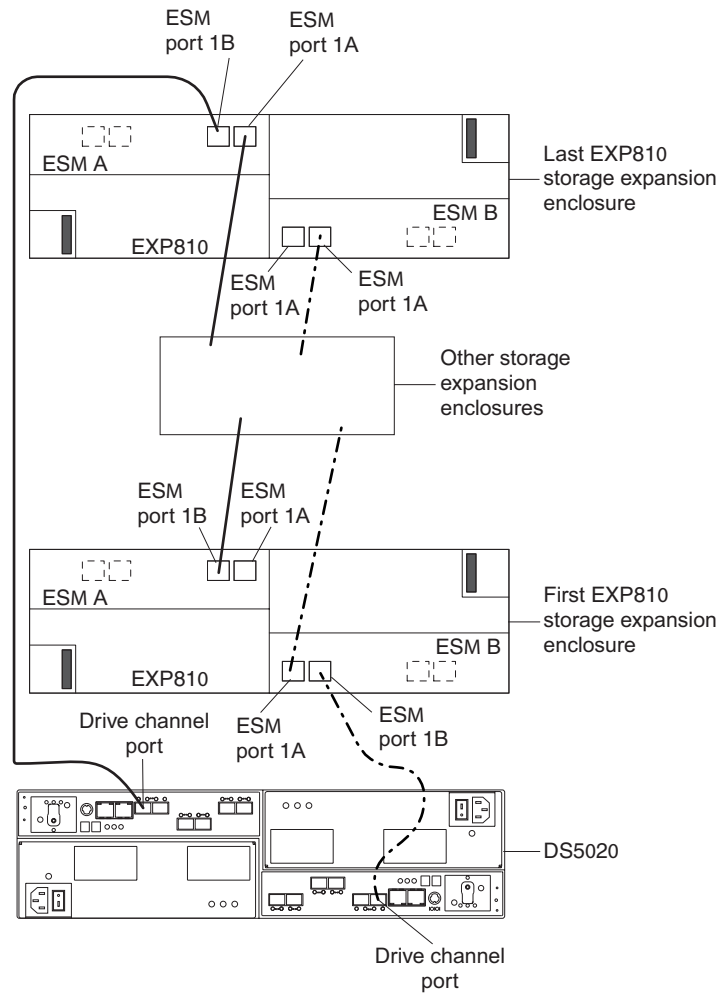
Drive channel
port

*Figure 45. DS5020 drive ports connected to EXP810 ESM ports labeled 1B*

13. The DS5020 supports the intermix of SATA and Fibre Channel E-DDMs within the same drive enclosure.

## One DS5020 and one EXP520 storage expansion enclosure

Figure 46 shows the cabling scheme for one DS5020 storage subsystem and one EXP520 storage expansion enclosure.
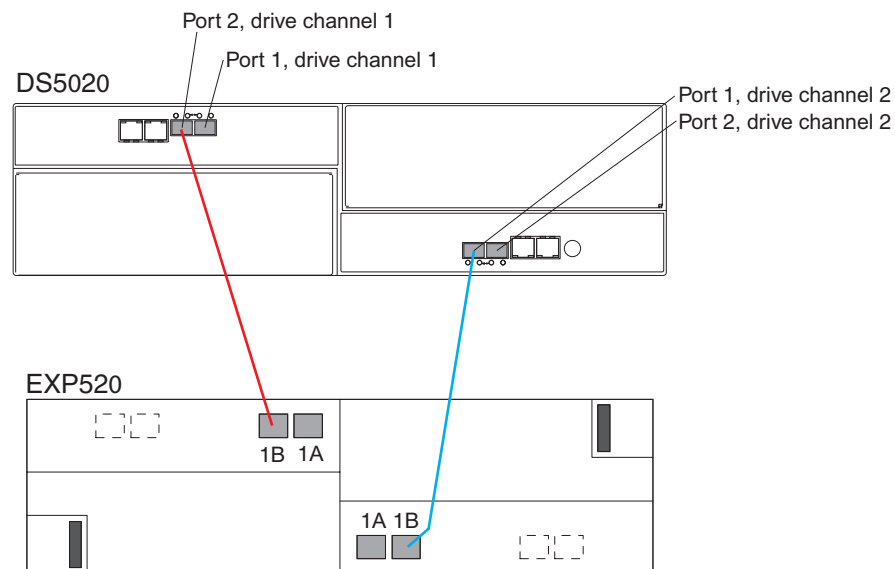


*Figure 46. Cabling for one DS5020 and one EXP520 storage expansion enclosure*

Perform the following steps to create the cabling scheme shown in Figure 46:

1. Connect either port 2 or port 1 of the dual-ported drive channel 1 in controller A on the DS5020 to port 1B on the left ESM of the EXP520.

2. Connect either port 1 or port 2 of the dual-ported drive channel 2 in controller B on the DS5020 to port 1B on the right ESM of the EXP520.

## One DS5020 and two EXP520 storage expansion enclosures

Figure 47 shows the cabling scheme for one DS5020 storage subsystem and two EXP520 storage expansion enclosures behind both ports of a dual-ported drive channel.
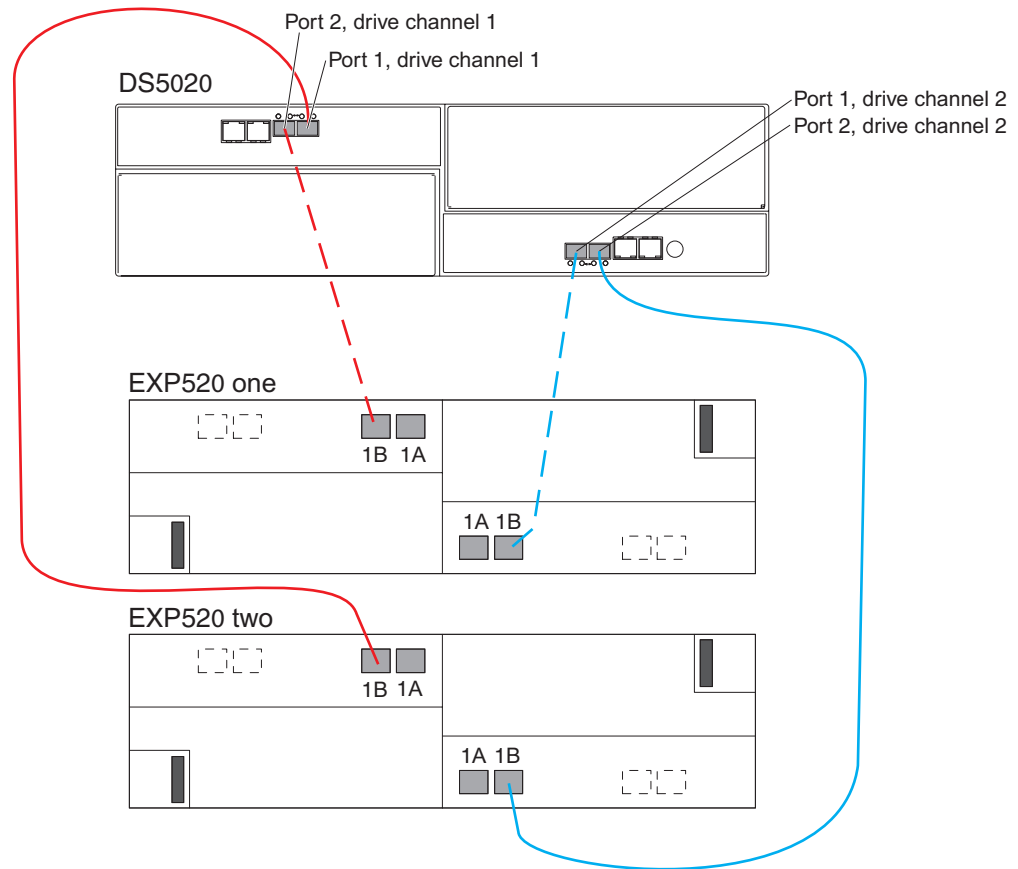


*Figure 47. One DS5020 and two EXP520 storage expansion enclosures behind a pair of DS5020 drive ports*

Perform the following steps to create the cabling scheme shown in Figure 47:

1. Connect port 2 of drive channel 1 on the DS5020 to port 1B on the left ESM in EXP520 one.
2. Connect port 1B on the right ESM in EXP520 one to port 1 of drive channel 2 on the DS5020.
3. Connect port 1 of drive channel 1 on the DS5020 to port 1B on the left ESM in EXP520 two.
4. Connect port 1B on the right ESM in EXP520 two to port 2 of drive channel 2 on the DS5020.

## One DS5020 and three or more EXP520 storage expansion enclosures

To connect three or more storage expansion enclosures to a DS5020 storage subsystem, alternately connect a storage expansion enclosure to one of the drive ports of the dual-ported drive channel then connect to the other port until all of the storage expansion enclosures are attached. Figure 48 shows the cabling scheme for one DS5020 storage subsystem and three EXP520 storage expansion enclosures behind both ports of a dual-ported drive channel.
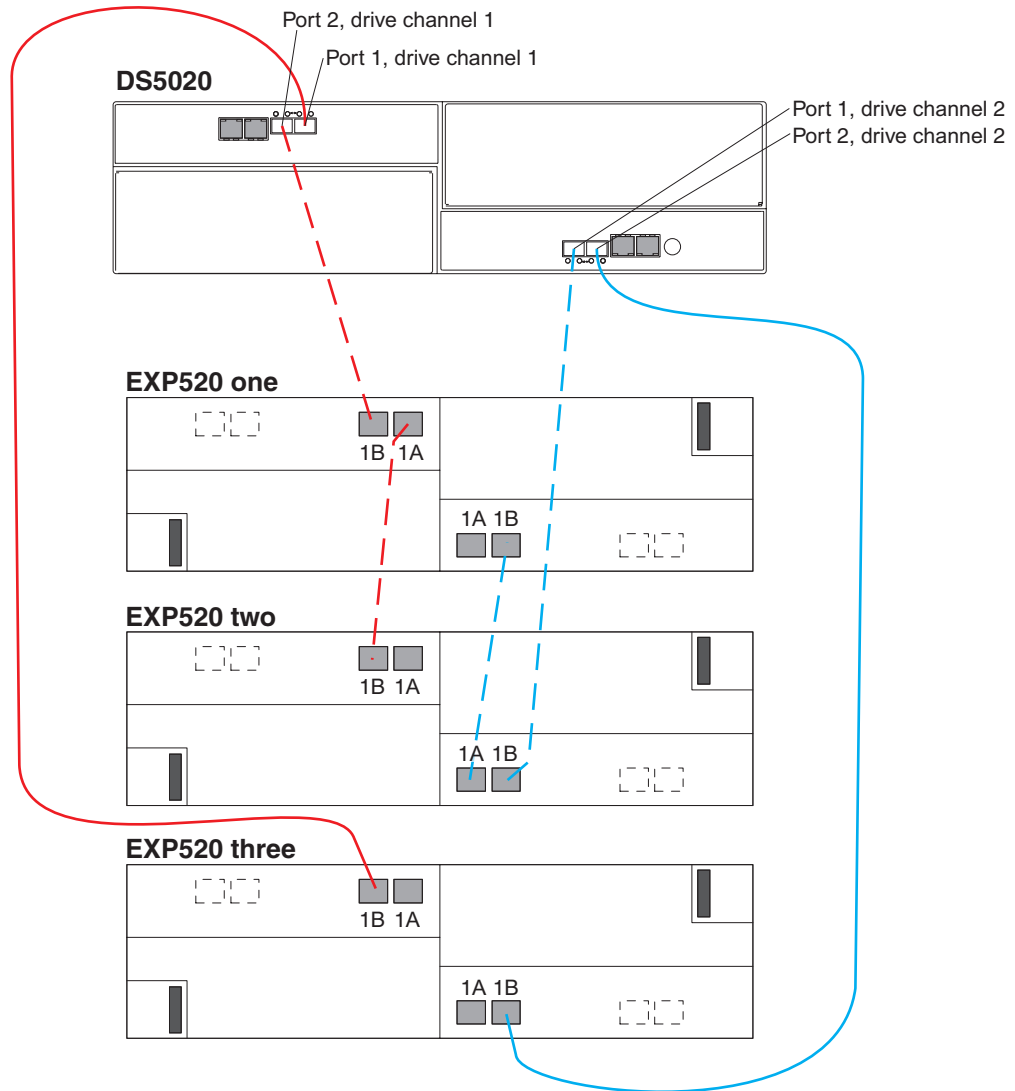


*Figure 48. One DS5020 and three EXP520 storage expansion enclosures behind a pair of DS5020 drive ports*

Perform the following steps to create the cabling scheme shown in Figure 48:

1. Connect port 1A on the left ESM in EXP520 one to port 1B on the left ESM in EXP520 two.

2. Connect port 1A on the right ESM in EXP520 two to port 1B on the right ESM in EXP520 one.

3. Connect port 1B on the left ESM in EXP520 one to port 2 of drive channel 1 on the DS5020.

4. Connect port 1B on the right ESM in EXP520 two to port 1 of drive channel 2 on the DS5020.
5. Connect port 1B on the left ESM in EXP520 three to port 1 of drive channel 1 on the DS5020.
6. Connect port 1B on the right ESM in EXP520 three to port 2 of drive channel 2 on the DS5020.

Figure 49 on page 76 shows the cabling scheme for one DS5020 storage subsystem and four EXP520 storage expansion enclosures behind both ports of a dual-ported drive channel.
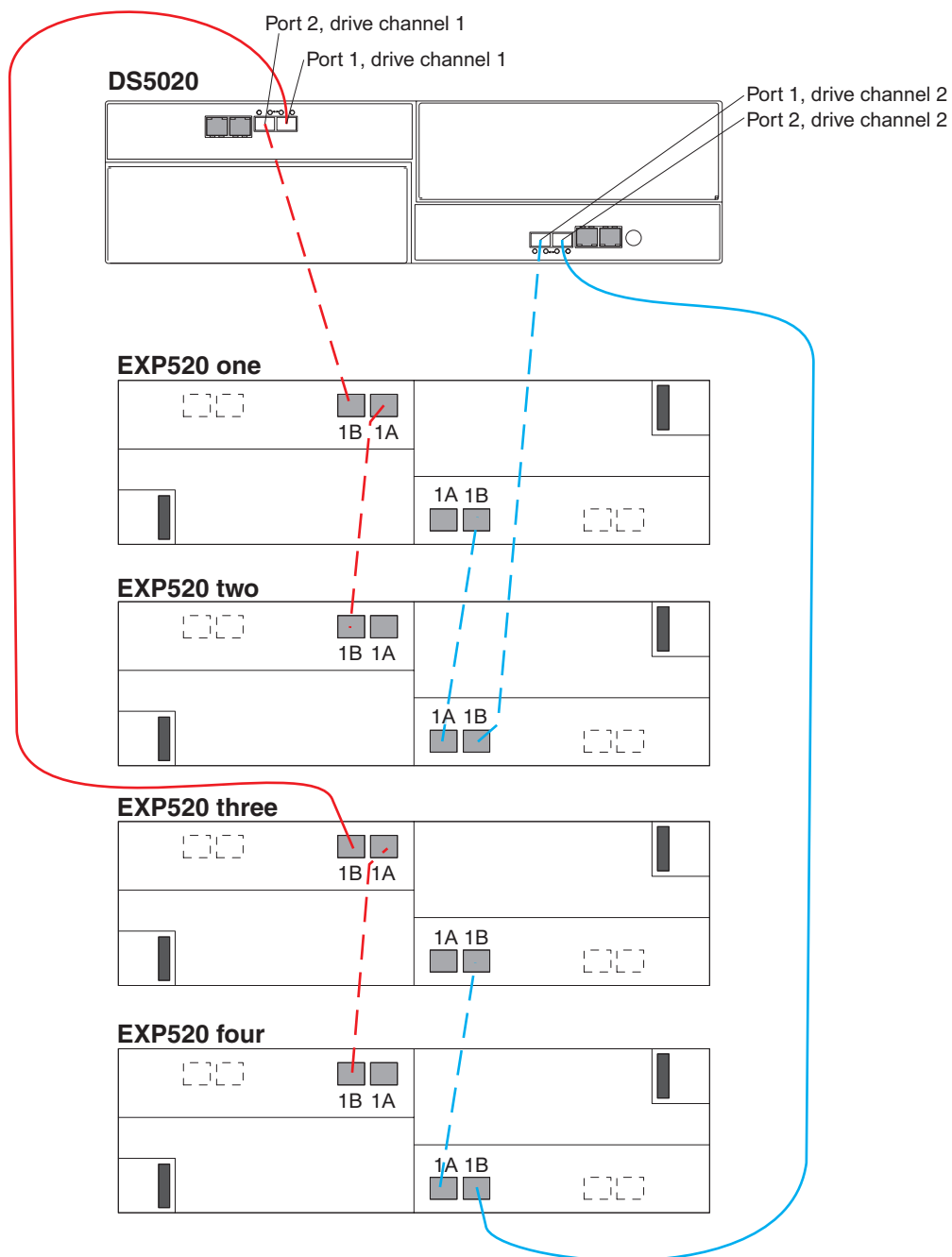
*Figure 49. One DS5020 and four EXP520 storage expansion enclosures behind a pair of DS5020 drive ports*

Perform the following steps to create the cabling scheme shown in Figure 49:

1. Connect port 1A on the left ESM in EXP520 one to port 1B on the left ESM in EXP520 two.

2. Connect port 1A on the right ESM in EXP520 two to port 1B on the right ESM in EXP520 one.

3. Connect port 1B on the left ESM in EXP520 one to port 2 of drive channel 1 on the DS5020.

4. Connect port 1B on the right ESM in EXP520 two to port 1 of drive channel 2 on the DS5020.

5. Connect port 1A on the left ESM in EXP520 three to port 1B on the left ESM in EXP520 four.
6. Connect port 1A on the right ESM in EXP520 four to port 1B on the right ESM in EXP520 three.
7. Connect port 1B on the left ESM in EXP520 three to port 1 of drive channel 1 on the DS5020.
8. Connect port 1B on the right ESM in EXP520 four to port 2 of drive channel 2 on the DS5020.

Figure 50 on page 78 shows the cabling scheme for one DS5020 storage subsystem and a maximum of six EXP520 storage expansion enclosures behind both ports of a dual-ported drive channel.
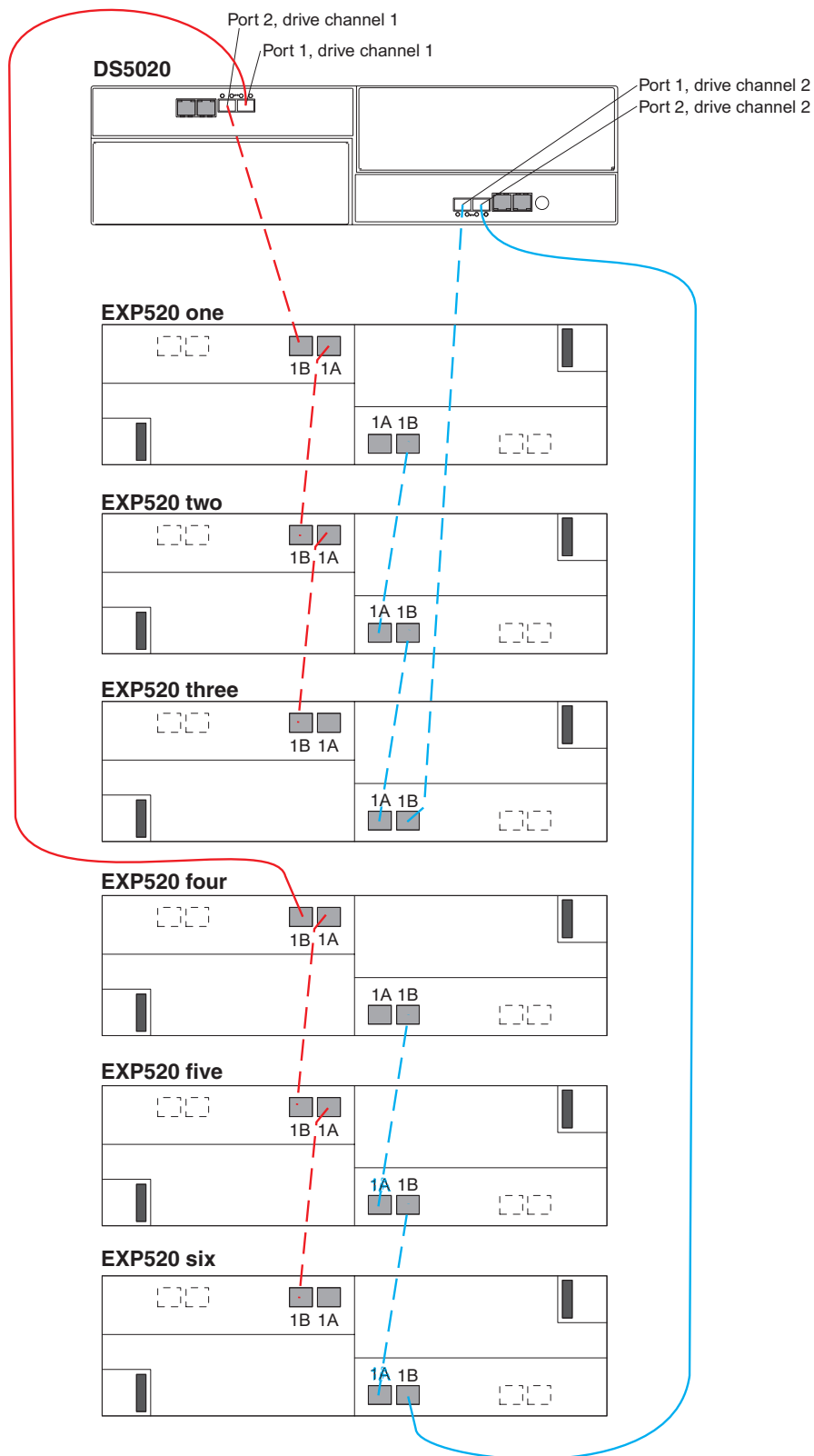
*Figure 50. One DS5020 and a maximum of six EXP520 storage expansion enclosures behind a pair of DS5020 drive ports*

Perform the following steps to create the cabling scheme shown in Figure 50:

1. Connect port 1A on the left ESM in EXP520 one to port 1B on the left ESM in EXP520 two.
2. Connect port 1A on the right ESM in EXP520 two to port 1B on the right ESM in EXP520 one.
3. Connect port 1A on the left ESM in EXP520 two to port 1B on the left ESM in EXP520 three.
4. Connect port 1A on the right ESM in EXP520 three to port 1B on the right ESM in EXP520 two.
5. Connect port 1B on the left ESM in EXP520 one to port 2 of drive channel 1 on the DS5020.
6. Connect port 1B on the right ESM in EXP520 three to port 1 of drive channel 2 on the DS5020.
7. Connect port 1A on the left ESM in EXP520 four to port 1B on the left ESM in EXP520 five.
8. Connect port 1A on the right ESM in EXP520 five to port 1B on the right ESM in EXP520 four.
9. Connect port 1A on the left ESM in EXP520 five to port 1B on the left ESM in EXP520 six.
10. Connect port 1A on the right ESM in EXP520 six to port 1B on the right ESM in EXP520 five.
11. Connect port 1B on the left ESM in EXP520 four to port 1 of drive channel 1 on the DS5020.
12. Connect port 1B on the right ESM in EXP520 six to port 2 of drive channel 2 on the DS5020.

## Storage expansion enclosure settings

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

### Fibre Channel loop and ID settings

When you install an E-DDM in the storage expansion enclosure, the E-DDM tray plugs into a printed circuit board called the *midplane*. The midplane sets the Fibre Channel loop ID automatically, based on the enclosure ID switch setting and the physical location (bay) of the E-DDM.

### Storage expansion enclosure ID settings

EXP520 and EXP810 storage expansion enclosures do not have enclosure ID switches because the controllers automatically set the enclosure ID numbers.

Each storage expansion enclosure in a DS5020 storage subsystem drive loop must have a unique enclosure ID. DS5020 controllers use a combination of the enclosure ID and the number of the physical slot that a hard drive occupies to create a unique Fibre Channel loop address or arbitrated loop physical address (AL_PA) for each drive in a Fibre Channel drive loop. The enclosure ID consists of two digits, a tens digit (x10) and ones digit (x1).

**Attention:** When connecting storage expansion enclosures, you must use the tens digit (x10) enclosure ID setting to distinguish different redundant drive channel pairs and use the ones digit (x1) enclosure ID setting to distinguish storage expansion enclosures IDs within a redundant drive channel.

The DS5020 normally ships with an enclosure ID outside the range of 00–77. However, if your DS5020 enclosure ID was set to a value within the range of 00–77, it might be in conflict with the enclosure ID of one of the drive expansion enclosures that you are trying to attach to the DS5020. If this is the case, the amber ID Conflict LED on the storage expansion enclosure will light after you turn on the power to the storage subsystem.

Give each storage expansion enclosure in a redundant drive channel pair a unique ones digit (x1) ID. This setting will enforce hard AL_PAs (unchangeable between Fibre Channel Loop Initializations [LIPs]) for the drives and facilitate drive loop problem troubleshooting in the event of an error. If the ones digits are not unique, two or more devices will have the same hard AL_PA. In such a case, the DS5020 controller will use soft AL_PAs for the devices that have identical hard AL_PAs.

The problem with soft AL_PAs addressing is that addresses might change between LIPs. This possibility increases the difficulty of troubleshooting drive channel problems, since one cannot easily ascertain whether the same device with a different address or different device might be causing a problem. Set the enclosure IDs in a given drive channel/loop pair to enforce hard AL_PAs addressing.

# Connecting secondary interface cables

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

Use the Ethernet interface ports on the back of the storage subsystem to connect the controllers for direct management of the storage subsystems (see "Direct (out-of-band) management method" on page 83).

**Important:**

1. The serial interface ports are intended to be used by service technicians to perform diagnostic operations on the storage subsystem. Incorrect use of the serial port can result in loss of data access and, in some cases, in loss of data. Do not make connections to the serial port unless you do so under the direct supervision and guidance of IBM support personnel. The serial port connection requires a special PS2 DIN to DB9 male converter. (IBM Service and support personnel, see the Serial cable adapter (RoHS) in "Parts listing" on page 166 for the FRU P/N.)

2. To minimize security risks, do not connect the DS5020 in a public LAN or public subnet. Use a local private network for the DS5020 and the management station Ethernet ports.

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

Connect a pair of Ethernet cables from the storage-management station to the Ethernet ports for controller A (located on the top) and controller B (located on the bottom) on the back of the storage subsystem. Figure 51 shows the location of the ports on the DS5020 storage subsystem. Only one Ethernet port connection from each controller is required to establish a direct (out-of-band) management connection to the DS5020 storage subsystem.

**Notes:**

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

2. Your DS5020 hardware might differ slightly from the following illustration.
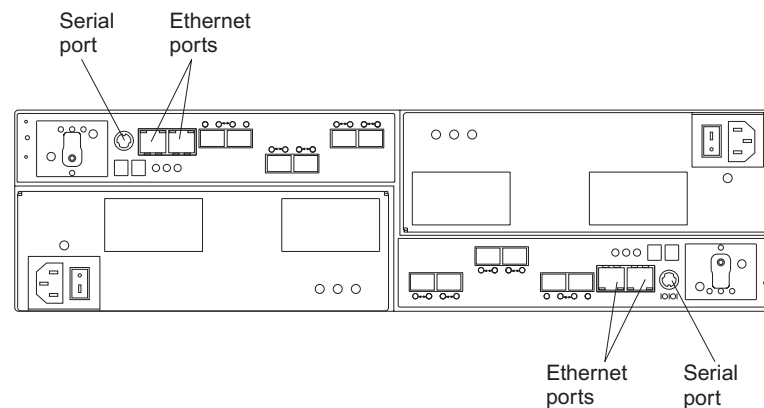


*Figure 51. Ethernet and serial port locations on DS5020*

# Configuring the storage subsystem

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

# Storage subsystem management methods

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

Depending on the controller firmware version for your subsystem, refer to the following guides for more information about setting up in-band or out-of-band management connections:

- *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)
- *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later)

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

## Host-agent (in-band) management method

This method requires host-agent software that you install on the host server. The host-agent software allows the DS Storage Manager client program to manage the DS5020 storage subsystem using the same Fibre Channel connections between the host server and the storage subsystem. You must install at least one management station and a software agent host. The management station can be the host or a workstation on the Ethernet network. A management station will have the client software installed. Figure 52 on page 83 shows the host-agent (in-band) management method.
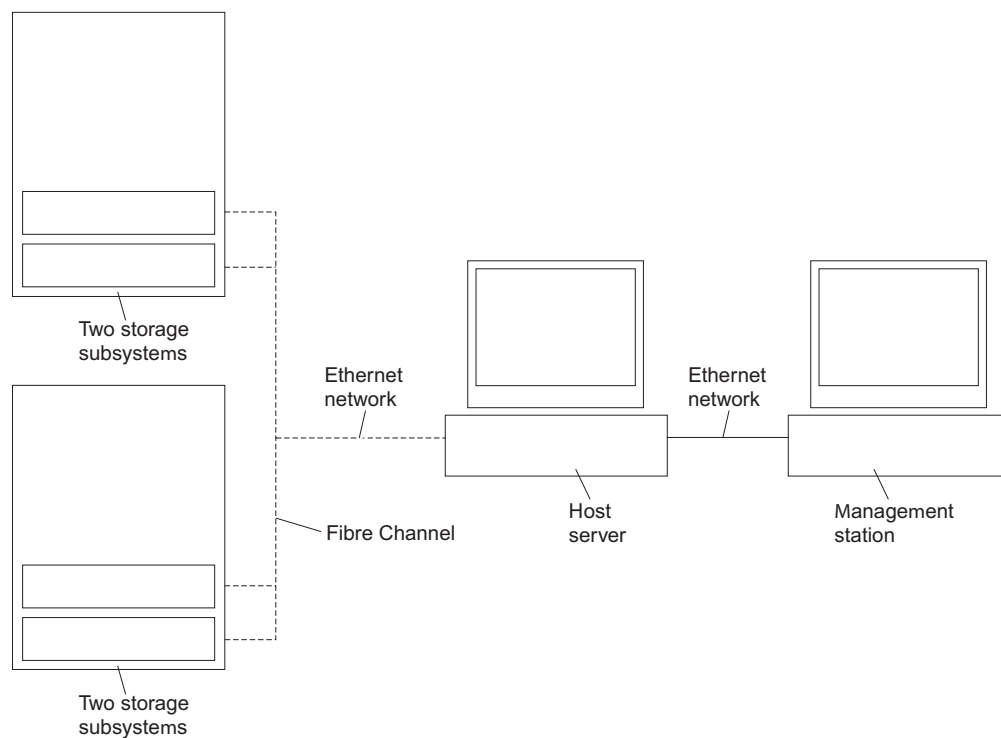
*Figure 52. Host-agent (in-band) managed storage subsystems*

## Direct (out-of-band) management method

This method uses Ethernet connections from a management station to each controller. You must install at least one management station. The management station can be the host or a workstation on the Ethernet network. A management station will have the client software installed. Attach Ethernet cables to each management station (one pair per storage subsystem). You will connect the cables to each storage subsystem controller later when you install the storage subsystem. Figure 53 on page 84 shows the direct (out-of-band) management method.

You can either use the default controller Ethernet IP addresses for out-of-band connection or change the default controller Ethernet IP addresses by using Dynamic Host Configuration Protocol (DHCP) or Storage Manager client. Refer to the *DS Storage Manager Installation, User's and Maintenance Guide* for the applicable operating system for more information about setting the management connections and installing the DS5020 storage subsystem management software.

For a listing of default IP addresses, see "Connectors, switch, and enclosure ID" on page 10.

**Note:** Do not connect the storage subsystem Ethernet ports to a public network or public subnet. Create a private network between the storage subsystem and the management station.
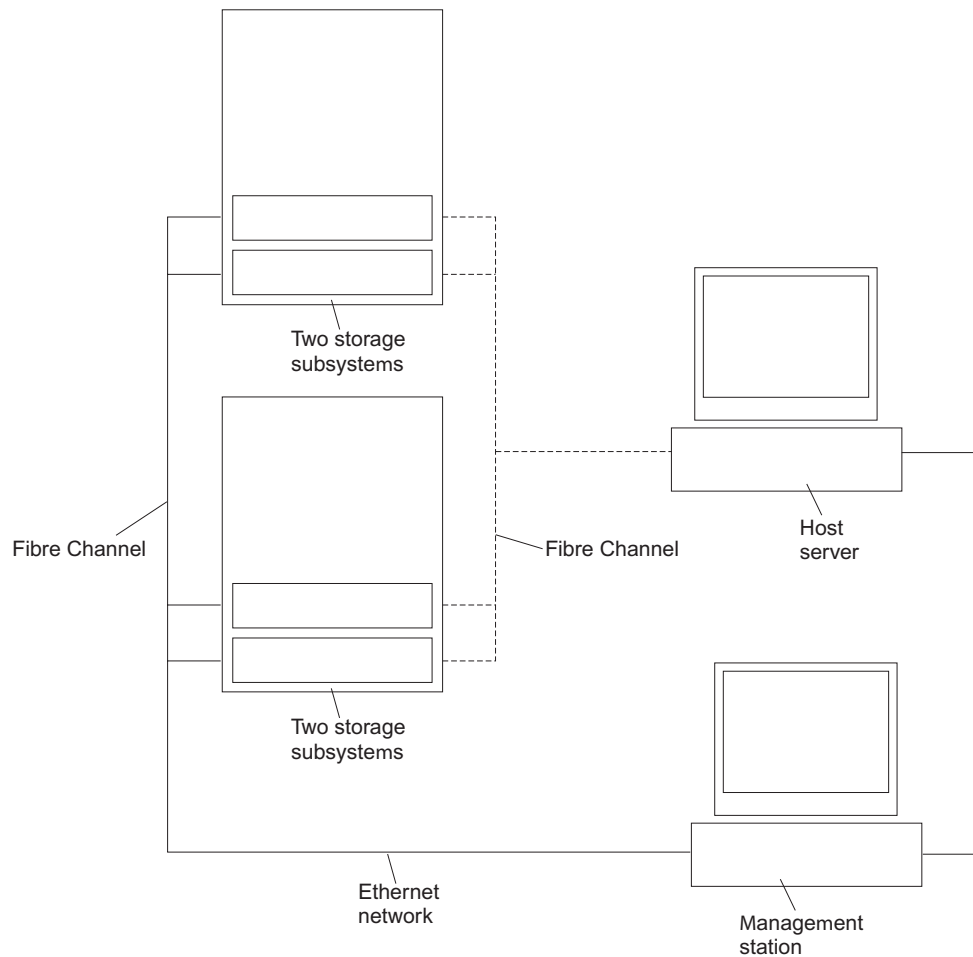
*Figure 53. Direct (out-of-band) managed storage subsystems*

## Connecting hosts to the DS5020 using Fibre Channel host ports

The DS5020 supports redundant direct attached connections to up to four hosts. To Make sure that you have full protection against the loss of any one Fibre Channel path from the host servers to the DS5020 storage subsystem, always use redundant host connections by connecting each host to the applicable single-ported host channels on both RAID controllers A and B. Using the Fibre Channel switches, up to 512 hosts can be redundantly attached to the DS5020 storage subsystem in a Fibre Channel SAN fabric.

To connect a Fibre Channel host adapter to the DS5020 RAID controllers, perform the following steps:

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

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

2. Connect the Fibre Channel cables from the SFP modules in the DS5020 RAID controller host ports to either the SFP modules in the Fibre Channel switch or the SFP modules of the host bus adapters. Figure 54 shows the location on the RAID controllers of the DS5020 storage subsystem where the host-system cables connect.

   **Note:** DS5020 controllers with four Fibre Channel host ports are shown in the following illustration. The host channel configuration in your DS5020 hardware might differ slightly from the following illustration.
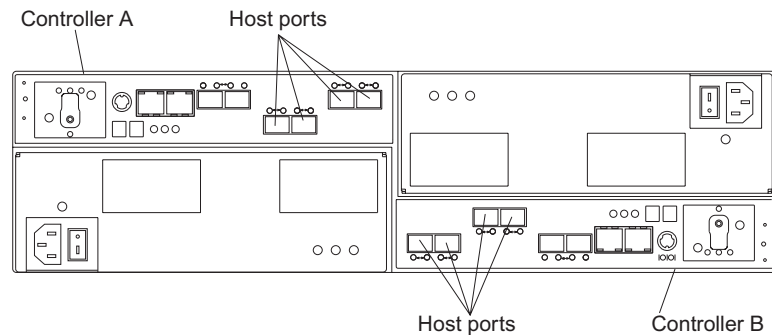


*Figure 54. Location of host cables on RAID controllers on the DS5020*

3. Repeat steps 1 on page 84 and 2 for each additional redundant host connection. You can create two redundant host connections for the DS5020 storage subsystem, as shown in Figure 55 on page 86, or a maximum of four redundant host connections (not shown). With four redundant host connections, you can have a connection to a DS5020 Fibre Channel host bus adapter or to Fibre Channel switch ports.

Host 1, Host Adapter 1 and 2

Host 2, Host Adapter 1 and 2
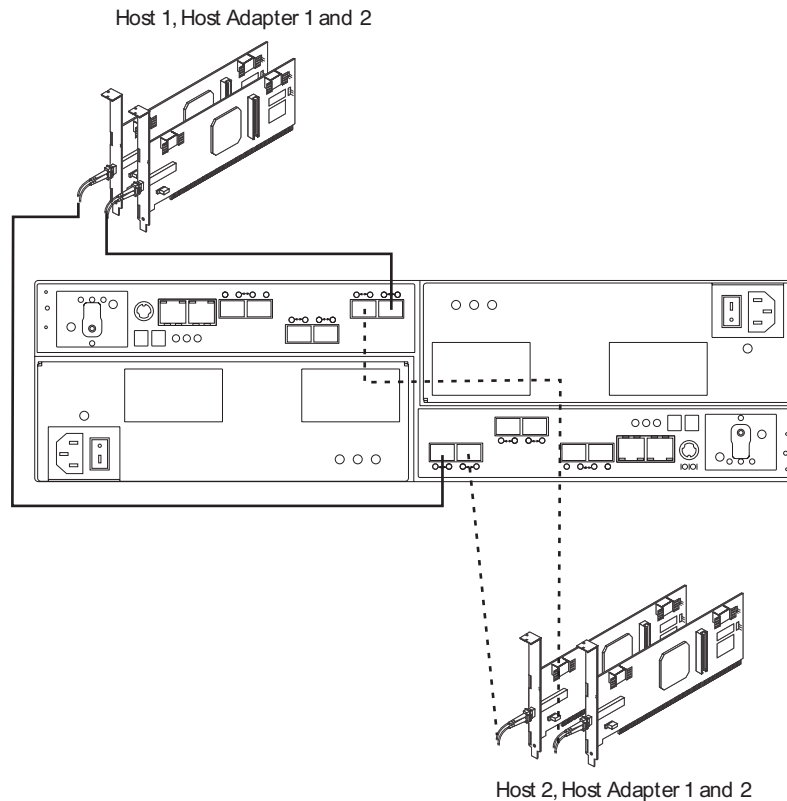
*Figure 55. Cabling diagram for two redundant host connections*

For other examples of redundant host configurations, see "Fibre Channel host loop configurations" on page 87.

## Fibre Channel and iSCSI connections

A DS5020 storage subsystem Fibre Channel connection consists of up to four host Fibre Channel loops and a redundant drive Fibre Channel loop. The host Fibre Channel loops provide the fibre path for host attachment. They can consist of Fibre Channel cables, SFPs, host bus adapters, Fibre Channel switches, and RAID controllers. The redundant drive Fibre Channel loop provides the fibre path from the DS5020 storage subsystem to the hard disk drives (HDDs) in the storage expansion enclosures. The redundant drive Fibre Channel loop consists of the DS5020 storage subsystem, the storage expansion enclosures, Fibre Channel cables, and SFPs.

The DS5020 supports redundant drive channel loop configurations. You can build a redundant drive channel loop by connecting one or more storage expansion enclosures to the redundant RAID controllers. Then, use dual fiber-optic cables to connect one storage expansion enclosure to another in a daisy-chain. For more information, see "Connecting storage expansion enclosures to the DS5020" on page 57.

The DS5020 storage subsystem also supports 1 Gbps iSCSI connectivity. The host iSCSI connections provide an iSCSI path for host attachment. The connections can consist of Cat6 Ethernet cables, host bus adapters with iSCSI initiators, or an Ethernet adapter with Gigabit Ethernet switches and RAID controllers. See "iSCSI configurations" on page 90 for more information about iSCSI configurations.

# Fibre Channel host loop configurations

You must determine how the host systems will connect to the storage subsystem. You can connect up to four host systems directly to the storage subsystem through Fibre Channel host ports, or you can connect more than four hosts to the Fibre Channel storage subsystem through switches. The illustrations in the following sections show common host system configurations when you connect to the DS5020 Fibre Channel host ports. See "iSCSI configurations" on page 90 for more information about host connections through iSCSI.

**Note:** The DS5020 supports up to 128 partitions. Configuration upgrades are available as upgrade options. Contact your IBM reseller or marketing representative for more information.

## Redundant Fibre Channel host loops

This section provides examples of DS5020 host Fibre Channel configurations.

**DS5020 host Fibre Channel SAN configurations:**   This section provides the following examples of DS5020 host Fibre Channel SAN configurations:

- Redundant host direct-attached configurations, as shown in Figure 56 on page 88
- Single SAN fabric configuration, as shown in Figure 57 on page 88
- Dual SAN fabric configuration, as shown in Figure 58 on page 89
- Two storage subsystems in a dual SAN fabric configuration, as shown in Figure 59 on page 89
- Two clusters, as shown in Figure 60 on page 90

**Notes:**

1. Depending on the controller firmware version for your subsystem, refer to the following guides to find out the IBM recommended host to storage subsystem topology for a given combination of installed operating system and multipath device driver:

   - *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)

   - *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later)

2. These configurations have host and drive path failover protection and provide high availability.

3. The following illustrations do not accurately represent the controller locations or port locations in the DS5020 storage subsystem. The illustrations are for illustration purposes only.
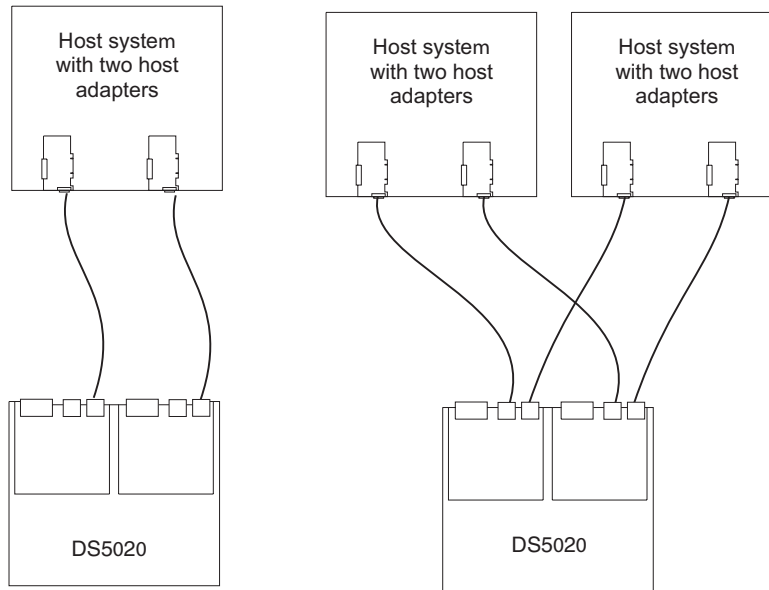
*Figure 56. Examples of redundant host direct attached Fibre Channel SAN configurations*

In Figure 57, the Fibre Channel switches are connected together via the inter-switch link (ISL) to form a single SAN fabric.
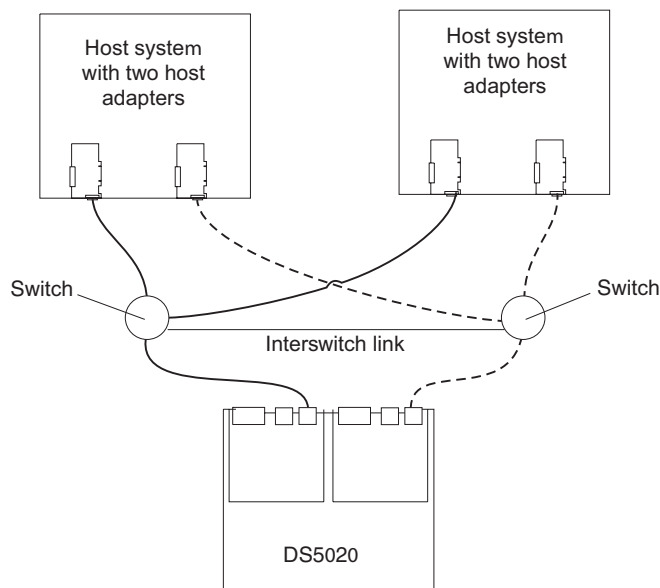


*Figure 57. Example of a single SAN fabric configuration*

In Figure 58 on page 89, the Fibre Channel switches are connected together via the inter-switch link (ISL) to form a dual SAN fabric.
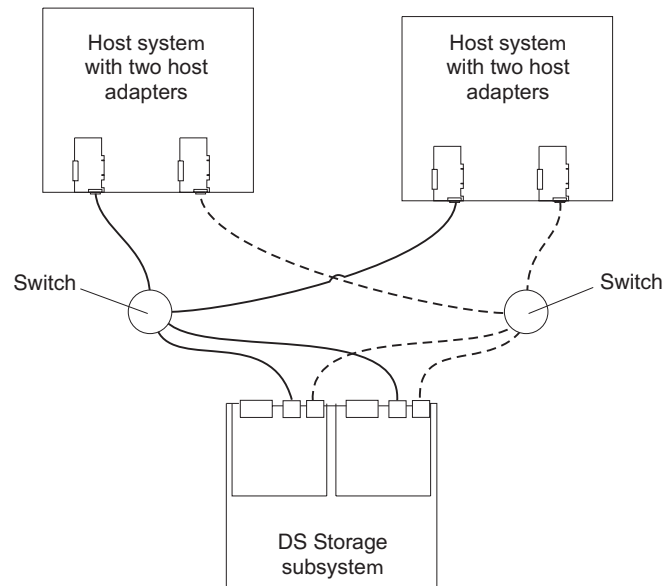
*Figure 58. Example of a dual SAN fabric configuration*

In Figure 59, the Fibre Channel switches are not connected together. Each switch forms its own SAN fabric.
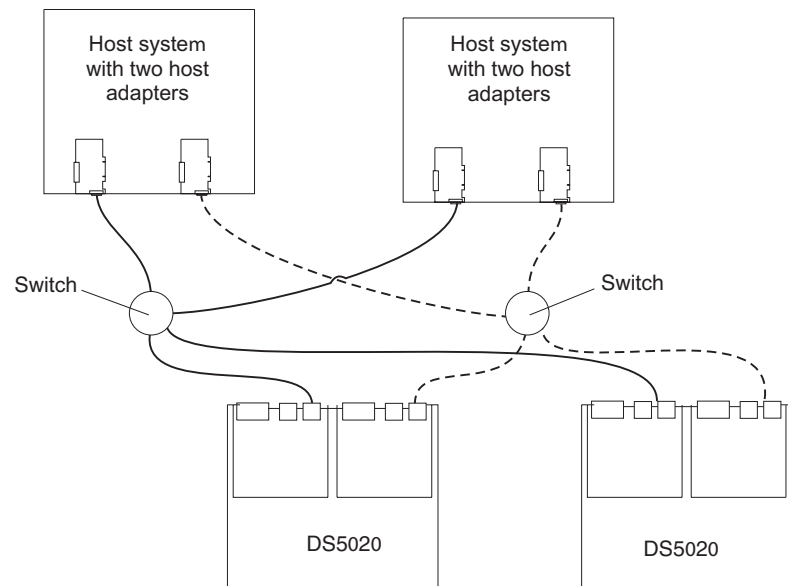


*Figure 59. Example of two storage subsystems in a dual SAN environment*

Figure 60 on page 90 shows an example of a two-cluster configuration.

Host system with two host adapters    Host system with two host adapters    Host system with two host adapters    Host system with two host adapters

Switch    Switch    Switch    Switch
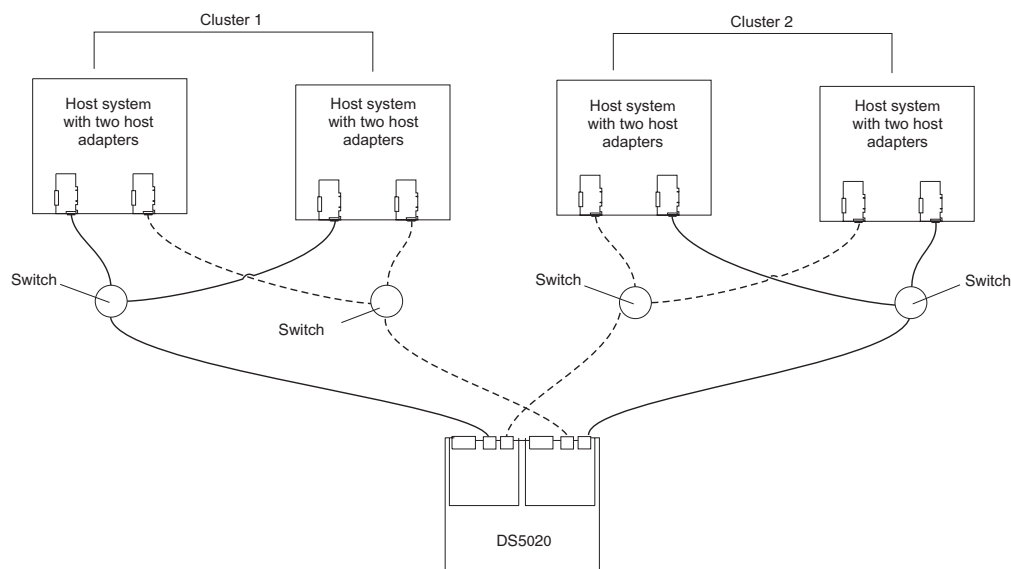
DS5020

*Figure 60. Example of a two-cluster configuration*

## iSCSI configurations

The DS5020 storage subsystem supports 1 Gbps iSCSI connectivity. You must determine how the host systems will connect to the storage subsystem. The illustrations in the following sections show common iSCSI host system configurations.

The iSCSI ports support IPv4 and IPv6 TCP/IP addresses, CHAP, and iSNS. Use either Cat5E or Cat6 Ethernet cable types for iSCSI port connections. A Cat6 Ethernet cable provides optimal performance.

**Note:** The minimum DS5020 configuration is two partitions. The maximum is 128 partitions. Configuration upgrades are available as upgrade options. Contact your IBM reseller or marketing representative for more information.

### DS5020 host iSCSI configurations

This section provides the following examples of DS5020 host iSCSI configurations:

**Notes:**

1. The DS5020 does not support direct connections from the host systems to the iSCSI ports on the storage subsystem.
2. The DS5020 does not support connections to both iSCSI and Fibre Channel ports from the same host system.

3. The following illustrations do not accurately represent the controller locations or port locations in the DS5020. The illustrations are for illustration purposes only.

Figure 61 shows an example of a multiple port, single-host configuration. A system that uses multiple iSCSI ports can provide enhanced performance compared to a single-port iSCSI connection.
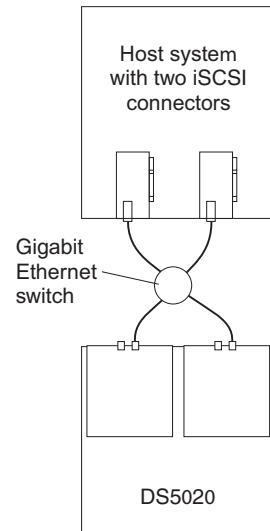


*Figure 61. Example of a single-host, multiple-port configuration*

Figure 62 shows a multiple-host, multiple-port configuration. For cluster configurations, the following illustration is an example of a multiple-host, multiple-port, and redundant path and controller configuration. You can replace the two gigabit Ethernet switches in the illustration with one large gigabit Ethernet switch that has the required number of ports. Virtual local area network (VLAN) can also be used to isolate the two iSCSI networks, instead of a single switch.
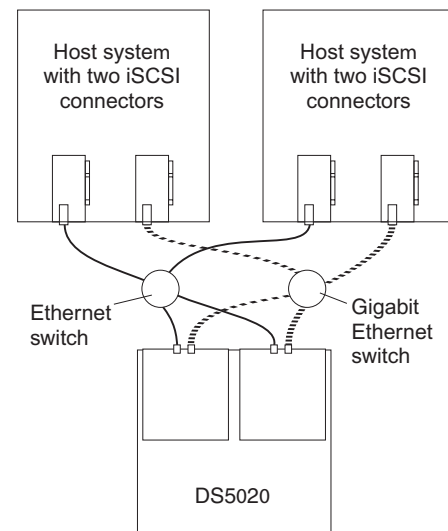


*Figure 62. Example of a multiple-host, multiple-port configuration*

Figure 63 shows iSCSI and Fibre Channel hosts in a multiple-port configuration.
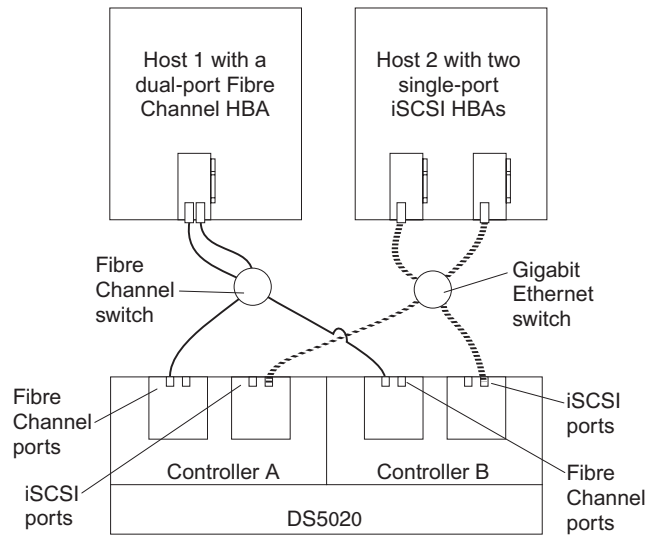


*Figure 63. Example of iSCSI and Fibre Channel hosts, multiple-port configuration*

Figure 64 shows an incorrect configuration of a single host with both iSCSI and Fibre Channel connections.

**Important:** Do not cable the storage subsystem and host systems as shown in Figure 64. A storage subsystem with the incorrect storage topology might appear to be functional, but incorrect cabling can potentially have unpredictable results.
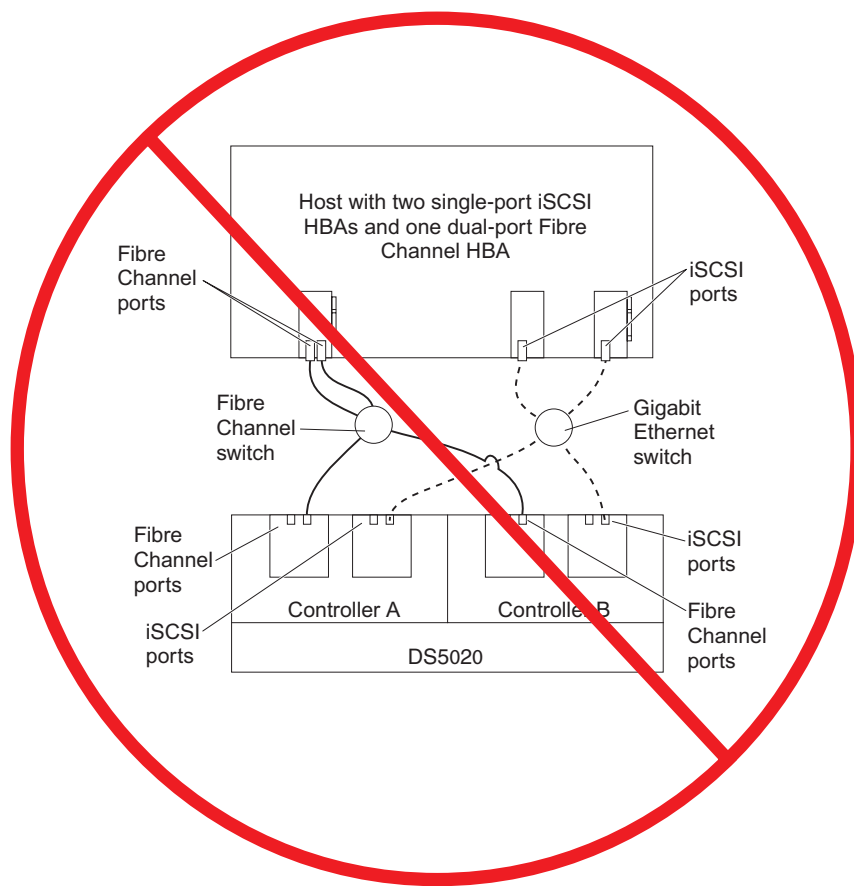


*Figure 64. Example of an incorrect configuration: Single-host, iSCSI and Fibre Channel*

Figure 65 on page 94 shows an example of a multiple-host, multiple-port, multiple-switch configuration.
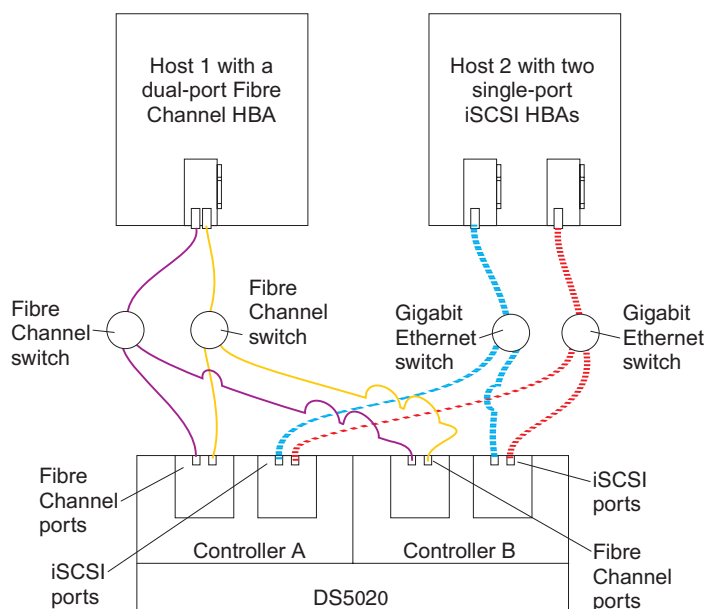
*Figure 65. Example of a multiple-host, multiple-port, multiple-switch configuration*

## Installing the storage subsystem configuration

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

**Notes:**

1. See the documentation provided with your host adapters for installation requirements and procedures.
2. Use the correct host adapter driver. For the latest supported host adapters and drivers, go to the following Web site:

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

Attach fiber-optic interface cables to each host adapter. You will connect the other end of the cables to the controller later in the installation process. For more information about handling fiber-optic cables, see "Handling fiber-optic cables" on page 49.

## Cabling the ac power supply

Complete the following steps to connect the ac power supply cable:

1. Using the supplied strap, tie the power supply cord to the rail to provide strain relief for the power cord.
2. Connect the power cable to the power supply.
3. Plug the supplied power cable into a properly grounded electrical outlet. For maximum protection against power loss, connect each of the two power supplies to a different power source.
4. Continue with "Powering on the storage subsystem" on page 97 for the initial startup of the storage subsystem.

# Chapter 4. Operating the storage subsystem

This chapter describes operating procedures for the DS5020.

For information about the optimal operation of your system, see "Best practices guidelines" on page 6

## Performing the DS5020 Health Check process

The DS5020 Health Check process is a sequence of suggested actions developed by IBM to help users verify and maintain the optimal performance of their DS5020 storage configurations. The information that you collect in these steps also helps provide IBM Service with important information needed for problem troubleshooting during IBM Service calls.

Perform the following Health Check tasks after the initial configuration of your DS5020 storage subsystem, and after all configuration sessions. Set a regular schedule of periodic Health Check evaluations in order to keep your DS5020 code current and to preserve optimal data access and performance.

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

2. Gather and save the following DS5020 storage subsystem event logs for review by IBM Service. Gather these event logs periodically for regular Health Check monitoring regardless of the state of the Recovery Guru. (You can collect all these logs at once and zip them into a single file by clicking **Advanced ▶ Troubleshooting ▶ Collect All Support Data** in the DS Storage Manager Subsystem Management window.)
   - DS5020 storage subsystem management event log (MEL)
   - Storage Subsystem Profile or DS5020 Profile
   - Read-Link Status (RLS) data

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

   **Attention:**   Save these event log files to a server disk that will remain accessible in the event of a DS5020 storage configuration failure. Do not save these event log files only to a LUN in the DS5020 storage subsystem.

3. Use the Storage Subsystem Profile or DS5020 Profile to verify that the following firmware levels are at the latest versions supported for your DS5020 storage subsystem:
   - Controller firmware
   - ESM firmware
   - Drive firmware

   If you discover your firmware is not up-to-date, upgrade the firmware and software to the latest level applicable to your DS5020 storage configuration. See "Web pages" on page 96 for information about where to find the latest firmware and software.

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

Save the storage subsystem profile before performing any controller or ESM firmware upgrades. Save the storage subsystem profile and all *.cfg files to a server disk that will remain accessible in the event of a DS5020 storage configuration failure.

**Note:** When you upgrade firmware, you must upgrade all client package components to the same release level. For example, if you are upgrading your controller firmware from version 6.x to version 7.x, you must also upgrade your Storage Manager client to version 10.x or higher. If your host system uses RDAC, upgrading controller firmware from version 6.x to version 7.x might also require host software updates, such as RDAC updates and HBA driver updates. Refer to the IBM System Storage Web site for detailed instructions.

4. Use the Storage Subsystem Profile or DS5020 Profile to verify that the following functions are enabled:
   - For the DS5020 and all DS4000 models, Media Scan is enabled both at the controller level and at the LUN level.
   - For the DS5020 and all DS4000 models, the read/write cache is enabled. In addition, use the Storage Subsystem Profile to verify that cache is matched between the controllers.

## Web pages

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

For DS5020 and DS4000 information, go to the following Web site:

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

For the latest information about operating system and HBA support, clustering support, SAN fabric support, and Storage Manager feature support, see the System Storage DS5020 and DS4000 Interoperability Matrix at the following Web site:

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

## Hardware responsibilities

In addition to the Health Check steps described above, regular hardware inspection and maintenance helps to support the optimal performance of your DS5020 storage configuration. Periodically inspect the Fibre Channel components of your DS5020 storage configuration.

The following guidelines are suggested:
- Maintain an up-to-date storage subsystem profile for your DS5020 storage configuration. Save the profile to a server disk that will remain accessible in case of a DS5020 storage configuration failure. Do not save the profile only to a LUN in the DS5020 storage subsystem.
- Develop a Change Management plan. Include schedules for updating subsystem firmware and server host software in the plan.

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

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

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

In addition to these inspection and maintenance responsibilities, DS5000 and DS4000 training is available for staff who support DS5000 and DS4000 storage configurations. Although training is not a part of the Health Check process, DS5000 and DS4000 training reduces the potential for configuration problems and contributes to the overall health of the system.

# Powering on the storage subsystem

This section contains instructions for turning the storage subsystem on under normal and emergency situations. When you turn on and turn off the DS5020, be sure to use the startup sequence in this section. If you are turning on the storage subsystem after an emergency shutdown or power outage, see "Restoring power after an unexpected shutdown" on page 115.

## Turning on the storage subsystem

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

  **Attention:**

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

  2. If you are connecting a power cord to a DS5020 storage subsystem or storage expansion enclosure, turn off both of its power switches first. If the main circuit breaker is off, be sure both power switches are off on each storage expansion enclosure in the cabinet before turning on the main circuit breakers.

1. Are the main circuit breakers turned on?

- **Yes -** Turn off **both** power switches on each enclosure that you intend to connect to the power.
- **No -** Turn off **both** power switches on **all** enclosures in the storage subsystem.

2. Make sure that all power cords are connected. See "Cabling the ac power supply" on page 94 for details, depending on the DS5020 configuration you purchased.

   **Note:** If the power cords are not connected, turn off both power switches on all modules in the configuration before connecting power cords or turning on the main circuit breakers.

3. If the main circuit breakers are turned off, turn them on.

4. Verify that the link rate setting on the front of the storage expansion enclosure matches the speed of the drives in the subsystem.

   **Attention:** You must turn on power to each attached storage expansion enclosure before turning on power to the DS5020 storage subsystem to make sure that the controllers recognize all drives in the configuration during the startup process.

5. Turn on both power switches on the back of each storage expansion enclosure attached to the storage subsystem. While each storage expansion enclosure powers up, the green and amber LEDs on the front and back of the storage expansion enclosure turn on and off intermittently. Depending on your configuration, it can take several minutes for each storage expansion enclosure to power on.

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

   **Note:** The drive activity LEDs will flash slowly (once every 2 seconds) until the drive is started by the DS5020 controller.

6. Turn on both power switches on the back of each controller in the storage subsystem.

   Depending on the number of storage expansion enclosures in the configuration, the storage subsystem might take several minutes to power on. The battery self-test might take an additional 15 minutes. The LEDs will flash intermittently until the storage subsystem powers up and completes the battery self-test. The green Battery Charging LED will flash slowly (once every 2 seconds) until the battery is fully charged.

   Before attempting any operations, wait at least five minutes for the storage subsystem to completely power on. A storage subsystem can take up to 10 minutes to power on and up to 15 more minutes to complete its controller battery self-test. During this time, the indicator lights on the front and back of the module flash intermittently.

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

   a. Check all LEDs on each component in the storage expansion enclosures. Make sure that all the LEDs show normal status. For more information

about LED status for storage expansion enclosures, see "Checking the LEDs" on page 104 or the Installation, User's, and Maintenance Guide for your storage expansion enclosure.

b. Check all LEDs on each component in the storage subsystem. Make sure that all the LEDs show normal status. For information about LED status, see "Solving problems" on page 157.

c. Open the DS Storage Manager Subsystem Management window, and display the Physical View for the configuration.

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

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

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

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

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

a. Run the DS Storage Manager Recovery Guru by selecting the Recovery Guru toolbar button in the Subsystem Management window.

b. Complete the recovery procedure.

   If the Recovery Guru directs you to replace a failed component, use the individual LEDs on the storage subsystem to locate the specific failed component. For troubleshooting procedures, see Chapter 6, "Hardware maintenance," on page 157.

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

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

## Installing the DS Storage Manager client

Depending on the controller firmware version for your subsystem, refer to the following guides for instructions to install the DS Storage Manager software:

- *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)
- *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later)

Use that document and the online help to configure the logical drives, partitions, and so on for the RAID controllers. Use your operating system documentation to make the new logical drives accessible to the operating system. Do not proceed with the configuration setup until you have completed the DS Storage Manager installation.

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

- HBA drivers
- Controller firmware version listed at the IBM System Storage Support Web site:

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

- IP addresses for RAID controllers (for in-band management only)
- Additional documentation for switches and HBAs, if needed
- Applicable host kit for your operating system, which includes the *DS Storage Manager* DVD containing the applicable Storage Manager version and storage subsystem controller firmware.

  Depending on the DS5020 configuration you purchased, your DS5020 will ship with either the Microsoft Windows host software attachment kit or with your choice of host software kits (Windows, AIX, Linux, Netware, SUN Solaris, HP-UX, Linux on POWER, or VMware). The host software kit grants you permission to attach host servers using the applicable operating system to the DS5020. The kit includes a *DS Storage Manager Support* DVD that has the applicable IBM DS Storage Manager host software. The DVD also includes correct controller firmware version.

  For the latest controller firmware and the DS Storage Manager host software for your operating systems, check the IBM support web site IBM System Storage products.

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

Before any planned system shutdown or after any system additions, removals, or modifications (including firmware updates, logical drive creations, storage partitioning definitions, hardware changes, and so on), save the storage subsystem profile as explained in the DS Storage Manager guide for your operating system. Save the profile in a location other than the logical drives created for the DS5020.

Always refer to the readme that is included with the DS5020 storage subsystem firmware package (whether the firmware is accessed by the Web or DVD) for any special requirements or restrictions that apply to that particular firmware version. See "Finding DS5020 and DS4000-family readme files" on page xxiii to learn how to access the readme files on the Web.

**Note:** Make sure that you install the DS Storage Manager event monitoring service to enable continuous monitoring of the status of the storage subsystem. For more information about the importance of this information, see "Monitoring status through software."

## Monitoring status through software

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

**Notes:**

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

   For more information, see the Enterprise Management online Help.

**Important:** Depending on the controller firmware version for your subsystem, refer to the following guides for instructions to install the DS Storage Manager:

- *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* (for storage subsystems with controller firmware version earlier than 7.8x.xx.xx)
- *IBM System Storage DS Storage Manager Version 10.8 Installation and Host Support Guide* (for storage subsystems with controller firmware version 7.8x.xx.xx or later)

.

In addition, to download the latest version of the DS Storage Manager host software, the DS5020 storage subsystem controller firmware and NVSRAM, and the latest storage expansion enclosure ESM firmware, go to the following Web site:

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

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

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

Although the storage subsystem has Needs Attention LEDs, these LEDs do not necessarily indicate which component has failed or needs to be replaced, or which type of recovery procedure you must perform. In some cases (such as in the case of a hard disk drive exceeding its PFAs), the Needs Attention LED does not turn on. Only the DS Storage Manager client can detect the failure.

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

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

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

**Attention:** Not following the software-recovery procedures can result in data loss. In addition, always replace a failing component as soon as possible to minimize additional failures that might occur, causing loss of data access.

## Finding controller, storage expansion enclosure, and drive information

You can view a Storage Subsystem Profile to find controller, enclosure, and drive information for the storage subsystem and attached storage expansion enclosures. To view a Storage System Profile, perform the following steps:

1. Open the Storage Subsystem Management window from the DS Storage Manager Enterprise Management window.
2. Select **Storage Subsystem → View → Profile**.

   A Storage Subsystem Profile window opens.
3. Select the Controllers tab.
4. Scroll through the list to find Board ID, Submodel ID, Product ID, and Product revision for the storage subsystem.
5. Select the Enclosures tab.
6. Scroll through the list to find the Product ID for supported storage expansion enclosures.
7. Select the Drives tab.
8. Scroll through the list to find the drive values such as Product ID.

## Firmware updates

**Attention:** Save the storage subsystem profile before performing any controller or ESM firmware upgrades. Save the DS5020 storage subsystem profile and all configuration (*.cfg) files to a server disk that will remain accessible in the event of a DS5020 storage configuration failure. Do not save these files only to a LUN in the DS5020 storage subsystem.

For optimal operation of the DS5020 and its attached storage expansion enclosures, the storage expansion enclosure ESM firmware, the DS5020 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.

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

Always check the readme files that are included with the firmware packages for the most up-to-date information about firmware prerequisites, firmware update instructions, and host I/O restrictions, if any. Apply the necessary updates before configuring the storage subsystem arrays and logical drives. Subscribe to My Support for automatic notifications of firmware or Storage Manager software updates or any important information about your storage subsystems (see "Product updates and support notifications" on page 6).

**Attention:** Read the readme file that is included in each firmware or DS Storage Manager software package for any limitations, subsystem firmware prerequisites, or download-sequence information. For example, the controller firmware code might require the storage expansion enclosure ESM firmware to be upgraded first to a particular version, or the controller firmware download might require the halting of I/Os to the DS5020 logical drives. Failure to observe the limitations, prerequisites, and dependencies in the readme file might result in a loss of data access. See "Finding DS5020 and DS4000-family readme files" on page xxiii to learn how to access the DS5020 readme files on the Web.

Unless the readme file contains special requirements for the sequence in which you upgrade firmware, perform firmware upgrades in the following sequence:

1. ESM firmware for the storage expansion enclosures
2. Controller firmware
3. Controller NVSRAM
4. Drive firmware

## Troubleshooting the storage subsystem

The DS Storage Manager is the best way to monitor the storage subsystem, diagnose a problem, and recover from a hardware failure. Run the DS Storage Manager continuously, and frequently check the configuration status.

Use the following procedure to check the status of and identify a problem with the storage subsystem. If a problem has occurred, use the DS Storage Manager client software and the LEDs on the storage subsystem to help locate a failed component.

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

   The status for each component is either Optimal or Needs Attention.
3. Does any component have a Needs Attention status?

   - **Yes** - Go to step 4.
   - **No** - All components are Optimal. Go to step 6.
4. Select the Recovery Guru toolbar button. Perform the procedure in the Recovery Guru to correct the problem. The Recovery Guru might direct you to replace the failed component. If so, go to step 5.

   **Attention:** If the fault requires you to power off an attached storage expansion enclosure, you might need to reset the power to the DS5020 storage subsystem and all remaining storage expansion enclosures in the storage subsystem. Contact IBM Customer and Technical Support before powering off any attached storage expansion enclosures.
5. If applicable, mute the alarm.
6. Check the indicator LEDs on the front and the back of the storage expansion enclosure.

   A green LED denotes a normal status; an amber LED denotes a hardware fault.
7. Is an amber LED on?

   - **Yes** - Locate and troubleshoot the failed components. See "Checking the LEDs" on page 104.
   - **No** - You are finished with this procedure. If you are still experiencing a problem with this storage subsystem, create, save, and print a storage subsystem profile. This information might be helpful when troubleshooting. Contact IBM Customer and Technical Support for assistance. When the

recovery procedure is completed, select **Recheck** in the Recovery Guru to rerun the Recovery Guru and to make sure that the problem has been corrected.

# Checking the LEDs

The LEDs display the status of the storage subsystem and components. The color of the LED is important.

- Green LEDs indicate a normal operating status
- Amber LEDs (Needs Attention) indicate a possible failure
- Blue LED on a CRU indicates that is safe to remove the component

The DS5020 storage subsystem also has a blue Global Locate LED that is lit when the menu function is selected in the Subsystem Management window, causing the LOCATE command to be sent to the DS5020.

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

## AC power supply and fan unit LEDs

This section describes the primary power supply and fan unit LEDs on the DS5020 storage subsystem.
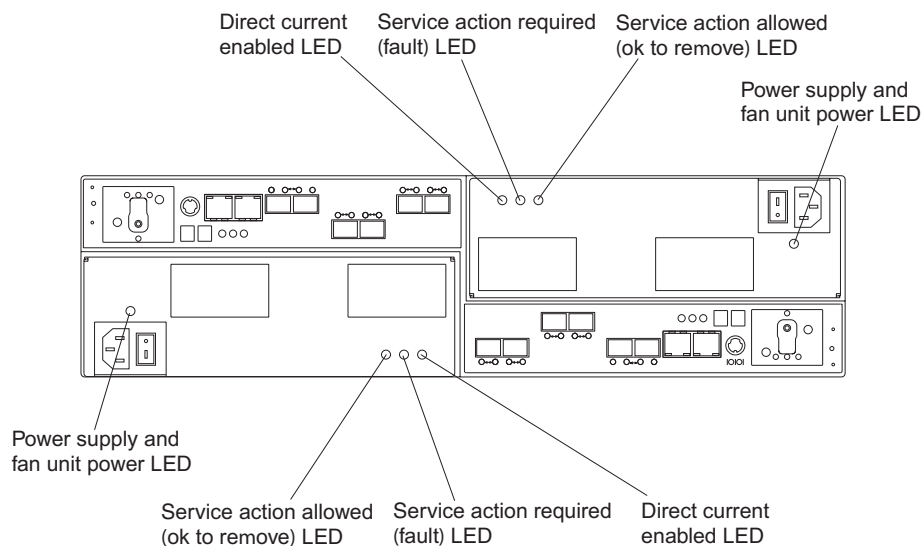


*Figure 66. Power supply and fan unit LEDs*

*Table 14. Power supply and fan unit LEDs*

| LED | Normal Status | Problem Status |
|-----|---------------|----------------|
| Power supply and fan unit power   AC ~ | On | Off |

*Table 14. Power supply and fan unit LEDs  (continued)*

| LED | Normal Status | Problem Status |
|---|---|---|
| Service Action Allowed (OK to Remove) | Off | On |
| Service Action Required (Fault) | Off | On |
| Direct Current Enabled | On | Off |

# Front LEDs

This section describes the primary LEDs and controls on the front of the DS5020 storage subsystem.
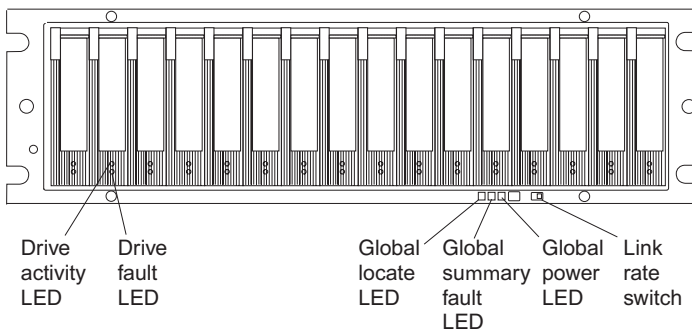


*Figure 67. Front LEDs and controls*

*Table 15. Front LEDs and controls*

| LED | Normal Status | Problem Status |
|---|---|---|
| Drive Activity LED | On (not flashing) - No data is being processed<br><br>Flashing - Data is being processed | Off |
| Drive Fault LED | Off<br><br>Flashing - Drive, volume, or storage array locate function | On (not flashing) |
| Global Locate | On only when you activate the locate function in the DS Storage Manger Subsystem Management window menu. The normal state is off. | N/A |
| Global Summary Fault | Off | On |

*Table 15. Front LEDs and controls (continued)*

| LED | Normal Status | Problem Status |
|---|---|---|
| Global Power  | On | Off |
| Link Rate Switch | Set to the 4 Gbps position. | N/A |

## Battery unit LEDs

This section describes the primary LEDs on the storage subsystem battery units.
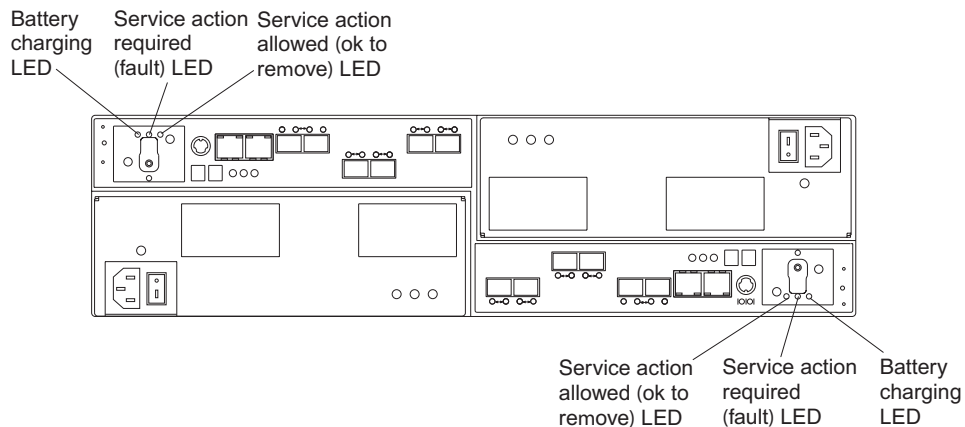


*Figure 68. Battery unit LEDs*

*Table 16. Battery unit LEDs*

| LED | Normal Status | Problem Status |
|---|---|---|
| Service Action Allowed (OK to Remove) | Off | On |
| Service Action Required (Fault) | Off | On |
| Battery Charging | Green means on, ready<br><br>Flashing green means charging | Off |

The Global Power, Global Summary Fault, and Global Locate LEDs are general indicators for the entire DS5020 storage subsystem (or configuration, in the case of the Global Summary Fault). The Global Summary Fault LED turns on if a fault condition is detected in any component in the storage subsystem configuration, including all attached storage expansion enclosures. The Global Power, Global Summary Fault, and Global Locate LEDs shine through the front bezel.

**Attention:** If the Global Summary Fault LED lights, refer to the DS Storage Manager client software to determine the problem with the storage subsystem. Also, inspect the Needs Attention LEDs on the other components in the storage subsystem to help isolate the fault to a specific component.

# Controller LEDs

This section describes the primary LEDs, controls, and connectors on the rear of the storage subsystem controller.

Figure 69, Figure 70 on page 108, and Figure 71 on page 108 show the three different DS5020 controller configurations that are available. Figure 69 shows the base DS5020 storage subsystem, with two Fibre Channel host ports. For more information about DS5020 controller options and other components, see the "Parts listing" on page 166.
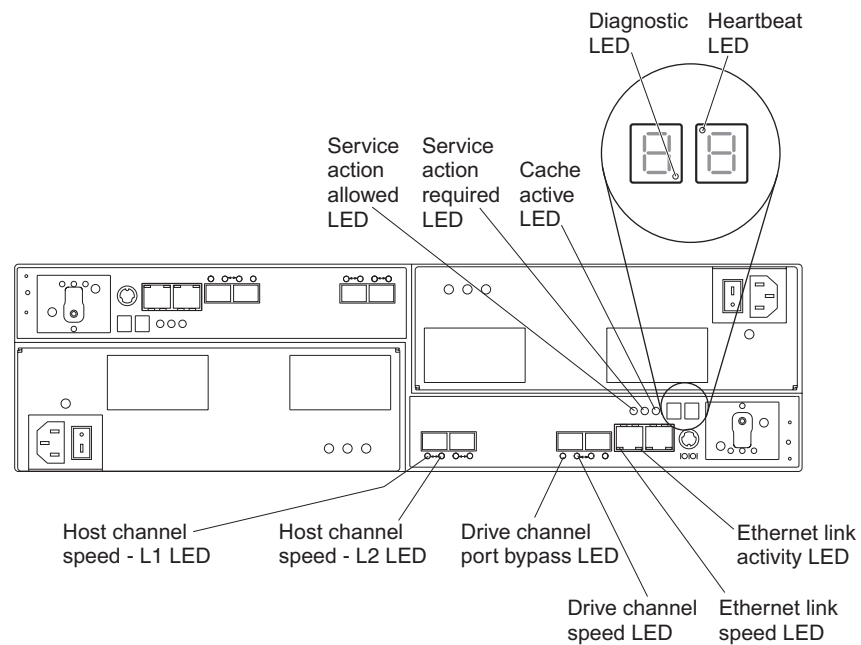


*Figure 69. LEDs, controls, and connectors of controllers with two standard Fibre Channel host expansion channels*
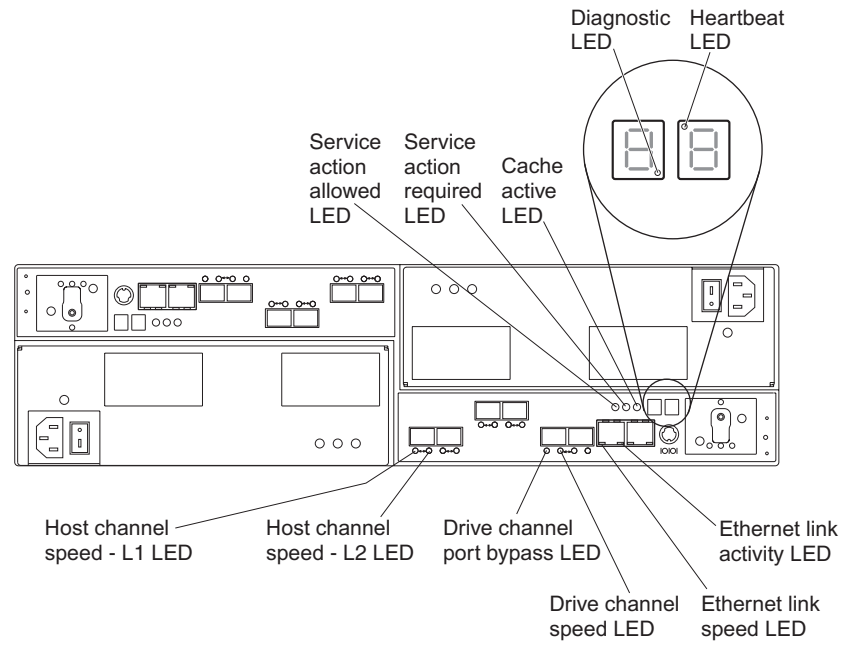
*Figure 70. LEDs, controls, and connectors of controllers with two standard and two optional Fibre Channel host expansion channels*

**Note:** The iSCSI ports have the same LEDs as the management Ethernet ports. As with the Ethernet port LEDs, the iSCSI port LEDs represent link speed and link activity.
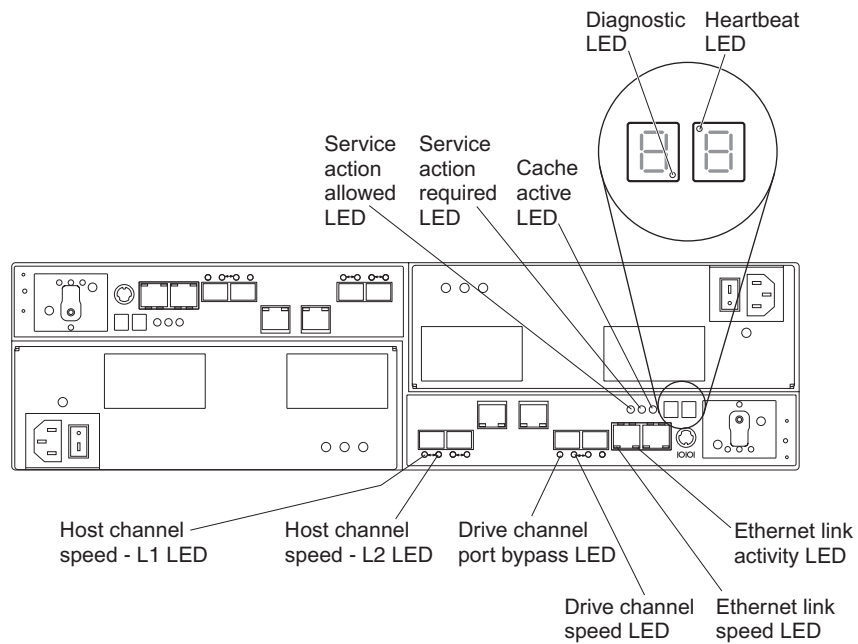


*Figure 71. LEDs, controls, and connectors of controllers with two standard Fibre Channel host expansion channels and two optional iSCSI host expansion channels*

*Table 17. Rear controller LEDs, controls, and connectors*

| LED | Normal Status | Problem Status |
|---|---|---|
| Service Action Allowed (OK to Remove) | Off | On |
| Service Action Required (Fault) | Off | On |
| Cache Active | On - Data is in cache<br><br>Off - Caching is turned off. No data in cache | Not applicable |
| Diagnostic | On - Seven-segment LEDs indicate diagnostic code<br><br>Off - Seven-segment LEDs indicate enclosure ID | Not applicable |
| Heartbeat | Flashing | Off |
| Host Channel Speed - L1 | See Table 18 on page 110. | |
| Host Channel Speed - L2 | See Table 18 on page 110. | |
| Ethernet Link Speed | On - 1 Gbps<br><br>Off - 100 Mbps | Not applicable |
| Ethernet Link Activity | On - link established<br><br>Off - no link established<br><br>Flashing - activity | Not applicable |
| Drive Channel Port Bypass<br><br>(One LED per port)<br>**Note:** The drive channel consists of two FC ports. This LED indicates the drive port bypass status of one of the two FC ports that comprise a drive channel. The other drive channel port has its own Drive Channel Port Bypass LED. | Off<br><br>(Also off if no SFP connected) | On - No valid device detected and port is bypassed |
| Drive Channel Speed - L1 | See Table 18 on page 110. | |
| Drive Channel Speed - L2 | See Table 18 on page 110. | |

The L1 and L2 LEDs for each Fibre Channel host and drive channel combine to indicate the status and the operating speed of each host and drive channel.

*Table 18. Host and drive channel LED definitions*

| L1 | L2 | Definition |
|---|---|---|
| Off | Off | When both LEDs for a host or drive channel are off, this indicates one or more of the following conditions:<br>• The host or drive channel ports are bad or the SFPs are faulty.<br>• An SFP module is inserted with no Fibre Channel cable attached.<br>**Note:** If the SFP is inserted in a drive port with no Fibre Channel attached, the associated drive port bypassed LED will also be lit. In addition, the L1 and L2 LEDs will be unlit.<br>• No SFP module is inserted in one or both of the host or drive ports in the channel. |
| On | Off | The host is operating at 2 Gbps. The drive channel is operating at 1 Gbps.<br>**Note:** This pattern is not applicable in the drive port because the DS5020 does not support 1 Gbps Fibre Channel speed. |
| Off | On | The host is operating at 4 Gbps. The drive channel is operating at 2 Gbps. |
| On | On | The host is operating at 8 Gbps. The drive channel is operating at 4 Gbps. |

## Seven-segment numeric display LEDs

The numeric display consists of two seven-segment LEDs that provide information about enclosure identification and diagnostics. Figure 72 shows the numeric display and the diagnostic LED.
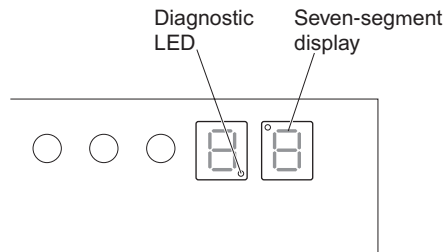


*Figure 72. Numeric display LEDs*

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

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

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

Diagnostic codes in the form of Lx or Hx, where x is a hexadecimal digit, indicate storage subsystem state information. In general, these codes are displayed only when the storage subsystem is in a non-operational state. The storage subsystem might be non-operational due to a configuration problem (such as mismatched

types), or it might be non-operational due to hardware faults. If the storage subsystem is non-operational due to system configuration, the storage subsystem Needs Attention LED is off. If the storage subsystem is non-operational due to a hardware fault, the storage subsystem Needs Attention LED is on. The definitions for Lx diagnostic codes are listed in Table 19.

*Table 19. Numeric display diagnostic codes*

| Value | Controller State | Description |
|-------|------------------|-------------|
| L0 | Suspended | Mismatched controller board ID |
| L1 | Suspended | Missing interconnect canister |
| L2 | Suspended | Persistent memory errors |
| L3 | Suspended | Persistent hardware errors |
| L4 | Suspended | Persistent data protection errors |
| L5 | Suspended | ACS failure |
| L6 | Suspended | Unsupported host card |
| L7 | Suspended | Submodel identifier not set or mismatched |
| L8 | Suspended | Memory configuration error |
| L9 | Suspended | Link speed mismatch |
| LA | Suspended | Reserved |
| LB | Suspended | Host card configuration error |
| LC | Suspended | Persistent cache backup configuration error |
| LD | Suspended | Mixed cache memory DIMMs |
| LE | Suspended | Uncertified cache memory DIMM sizes |
| LF | Suspended | Lockdown with limited SYMbol support |
| LH | Suspended | Controller firmware mismatch |
| LU | Lockdown | Controller is locked down due 5 consecutive incomplete boot process (start-of-day). |

# Powering off the storage subsystem

The DS5020 is designed to run continuously. After you turn it on, do not turn it off. Turn off the power only in the following situations:

- Instructions in a hardware or software procedure require that you turn off the power.
- An IBM technical support representative instructs you to turn off the power.
- A power outage or emergency situation occurs, see "Restoring power after an unexpected shutdown" on page 115.

## Turning off the storage subsystem

Use the following procedure to turn off the power for the DS5020.

**Attention:** Except in an emergency, never turn off the power if any Needs Attention LEDs are on. Correct the fault before you turn off the power. Use the DS Storage Manager client and the Needs Attention LEDs to check the overall status of the DS5020. All LEDs should be green on the front of the storage subsystem. If they are not, use the DS Storage Manager client to diagnose the problem. This ensures that the DS5020 will power on correctly later.

The DS5020 is designed to run continuously. After you turn on the DS5020, do not turn it off. Turn off the power only in the following situations:

- Instructions in a hardware or software procedure require that you turn off the power.
- An IBM technical support representative instructs you to turn off the power.
- A power outage or emergency situation occurs, see "Restoring power after an unexpected shutdown" on page 115.

**Statement 5:**

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

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

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

---

**Power-off overview**

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

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

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

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

---

Use the following procedure to turn off power to one or more storage subsystems for a planned shutdown. To turn off power for an unplanned shutdown, see "Restoring power after an unexpected shutdown" on page 115.

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

1. Stop all I/O activity to each storage subsystem.
2. Remove the front cover from the storage subsystem, if applicable.
3. Determine the status of all storage subsystems and components in the configuration by completing the following steps:
   a. Check all LEDs on each component in the storage expansion enclosures. Make sure that all the LEDs show normal status.
   b. Check all LEDs on each component in the storage subsystem. Make sure that all the LEDs show normal status.
   c. Open the Subsystem Management window for the configuration and display the Physical View for the configuration.
   d. Review the status of the configuration components shown in the Subsystem Management window by selecting the applicable component button for each storage subsystem.

      The status for each component will be either Optimal or Needs Attention.
4. Are the LEDs indicating normal operation, and is the status Optimal on all configuration components?
   - **Yes** - Go to step 6.
   - **No** - Go to step 5.
5. To diagnose and correct the fault, complete the following steps:
   a. Run the Recovery Guru by selecting the Recovery Guru toolbar button in the Subsystem Management window.
   b. Complete the recovery procedure.

      If the Recovery Guru directs you to replace a failed component, use the individual LEDs to locate the failed component.
   c. When the recovery procedure is completed, select **Recheck** in the Recovery Guru. This action reruns the Recovery Guru to make sure that the problem has been fixed.
   d. If the problem has not been fixed, contact your IBM service representative. Do not turn off power until all problems are corrected.
6. Check the Cache Active LED, and verify that it is off.

   If the Cache Active LED is on steady, the cache contains data. Wait for the data to clear from cache memory before turning off the power.
7. Check the LEDs on the storage expansion enclosures to verify that all Drive Active LEDs are on steady (not flashing).

   If one or more LEDs are flashing, data is being written to or from the drives. Wait for all Active LEDs to stop flashing.
8. Turn off the power switch on the back of each controller in the storage subsystem.

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

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

   **CAUTION:**

   **The power switch on the power supply and fan unit does not turn off the electrical current supplied to the device. The DS5020 storage subsystem might also have more than one connection to ac power. To remove all electrical current from the device, ensure that all ac power cords are disconnected from the power supply and fan unit ac input connectors.**

10. Remove (unplug) all of the power cords from the DS5020 power supply connectors.

11. After you perform the necessary maintenance procedures, turn on the power using the procedure in "Turning on the storage subsystem" on page 97.

## Performing an emergency shutdown

**Attention:** Emergency situations might include fire, flood, extreme weather conditions, or other hazardous circumstances. If a power outage or emergency situation occurs, always turn off all power switches on all computing equipment. This helps to safeguard your equipment from potential damage due to electrical surges when power is restored. If the storage subsystem loses power unexpectedly, it might be due to a hardware failure in the power system or in the midplane.

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

1. If you have time, stop all I/O activity to the storage subsystem by shutting down the host or disconnecting the storage subsystem logical drives through the host.

2. Check the LEDs. Make note of any Needs Attention LEDs that are on so you can correct the problem when you turn on the power again.

3. Turn off all power supply switches, starting with the DS5020 storage subsystem first, and followed by the storage expansion enclosures. Then, unplug the power cables from the storage subsystem.



**CAUTION:**

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



**CAUTION:**

**The power switch on the power supply and fan unit does not turn off the electrical current supplied to the device. The DS5020 storage subsystem might also have more than one connection to ac power. To remove all electrical current from the device, ensure that all power cords are disconnected from the power supply and fan unit input connectors.**

## Restoring power after an unexpected shutdown

Use the following procedure to restore power to the storage subsystem in a configuration after an unplanned shutdown.

**Risk of severe electrical shock** – Never turn on the power to any equipment if there is evidence of fire, water, or structural damage. Doing so might cause severe electrical shock

1. After the emergency situation is over or power is restored, visually check the storage subsystem for damage. Is there evidence of damage to any of the storage subsystem components, cables, or equipment attached to the storage subsystem?

   - Yes – Do not continue with this procedure. Contact your IBM service representative for assistance. Depending on the current service agreements, you might need to return the equipment to the factory or local service center for repair.

   - No – Go to step 2.

     **Potential data loss** – Before resetting circuit breakers in the cabinet, make sure that the storage subsystem and storage expansion enclosures power switches are turned off. Resetting circuit breakers after an emergency situation while the storage subsystem and storage expansion enclosure power switches are turned on can cause potential data loss because the configuration components might not be powered on in the correct sequence.

2. After you check the storage subsystem for damage, make sure that the power switches are in the off position; then plug in the DS5020 power cables, if required.

3. Check the system documentation of the hardware devices that you want to turn on and determine the proper startup sequence.

   **Note:** Be sure to turn on all of the storage expansion enclosures and verify that there are not any ESM or power supply and fan unit fault LEDs lit before you turn on the DS5020.

   In addition, consider the following items:
   - The storage subsystem supports simultaneous power-up of the system components, but you must always follow the power-up sequence listed in the "Best practices guidelines" on page 6 section during any attended power-up procedure.
   - A storage subsystem in an optimal state recovers automatically from an unexpected shutdown and unattended simultaneous restoration of power to system components. After power is restored, contact IBM technical support if any of the following conditions occur:
     – The storage subsystem logical drives and subsystems do not display in the Storage Manager graphical user interface (GUI).
     – The storage subsystem logical drives and subsystems do not come online.
     – The storage subsystem logical drives and subsystems seem to be degraded.

4. Turn on the power to each device, based on the startup sequence.

5. Turn on any attached disconnect devices.

6. Turn on both of the power supply switches on the DS5020. The green LEDs on the front and the back of the DS5020 remain lit. If other amber Fault LEDs light, see "Solving problems" on page 157.

# Recovering from an overheated power supply and fan unit

Each storage subsystem contains two power supply and fan units. Each power supply and fan unit contains a built-in temperature sensor designed to prevent it from overheating. Under normal operating conditions, with an ambient air temperature range of 5° C to 40° C (41° F to 104° F), the fans in the power supply and fan units maintain a proper operating temperature inside the module.

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

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

If a fan failure causes overheating or the operating environment becomes too hot (greater than 55° C), the Global Fault LED on the storage expansion enclosure turns on. The power supply and fan unit Fault and Service Action Allowed (SAA) LEDs on the back of the storage subsystem also turn on. "Controller LEDs" on page 107 shows the location of these LEDs.

**Attention:** Because the power supply and fan unit CRU Fault and SAA LEDs are lit when the operating environment temperature is too hot (greater than 55° C), do not assume the power supply and fan unit CRU is bad. Take action to cool down the environment first. When the operating environment temperature is within the specified operating environment range, the power supply and fan unit Fault and SAA LEDs will be unlit if there are no problems with the power supply and fan unit CRU.

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

  Use the following procedure to resume normal operation after a power supply shutdown.

  **Attention:** **Risk of damage from overheating** - The power supplies automatically shut down when the air temperature inside the cabinet reaches 68° C (154° F). If the power supplies shut down, immediately remove all cabinet panels to help cool the cabinet air temperature and to prevent damage to the DS5020 storage subsystem configuration components.

  1. Remove the front cover.
  2. If applicable, mute the alarm.
  3. Did you use the procedure "Troubleshooting the storage subsystem " on page 103 to identify an overheating problem?

- **Yes** - Go to step 4.
- **No** - Perform the procedure "Troubleshooting the storage subsystem " on page 103 to verify that the power supplies have shut down because of an overheating problem, and then go to step 4.

4. Stop I/O activity to the storage subsystem and all attached storage expansion enclosures.

5. Take all or some of the following measures to alleviate the overheating problem:
   - Removing all panels from the cabinet immediately
   - Using external fans to cool the area
   - Shutting down the power to the storage expansion enclosure, using the procedure described in "Performing an emergency shutdown" on page 115

6. Wait for the air temperature in and around the storage subsystem to cool.

   After the temperature inside the power supplies cools to below 65° C (149° F), the storage subsystem is capable of power-up recovery without operator intervention. After the air has cooled, the power supplies turn on automatically. If the power supplies restart automatically, the controllers will reset and return to normal operation.

7. Did the power supply and fan units restart automatically?
   - **Yes** - Go to step 9.
   - **No** - Go to step 8.

8. Turn off the power switch on each controller in the storage subsystem, power off all connected storage expansion enclosures, and flip the disconnected devices to the OFF position. Wait 1 minute and then turn on power to all connected storage expansion enclosures and flip the disconnected devices to the ON position.



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



**CAUTION:**
**The power switch on the power supply and fan unit does not turn off the electrical current supplied to the device. The DS5020 storage subsystem might also have more than one connection to power. To remove all electrical current from the device, ensure that all power cords are disconnected from the power supply and fan unit input connectors.**

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

9. Turn on both power switches on the back of the storage subsystem.

   A storage subsystem can take 10 seconds to power on and up to 15 minutes for the battery self-test to complete. During this time, the LEDs on the front and the back of the modules flash intermittently.

10. Check the status LEDs on the front and back of the storage subsystem.
    a. Note the status of the LEDs on the front and back of each module.

       A green LED indicates a normal status; amber LEDs indicate a hardware fault.
    b. Open the Subsystem Management window for the storage array.
    c. Select the applicable components button for each module in the Physical View of the Subsystem Management window to view the status of its components.

       The status for each component is either Optimal or Needs Attention.
11. Does each module display green LEDs only, and is the status Optimal for each module component?
    - **Yes** - Go to step 13.
    - **No** - Go to step 12.
12. Diagnose and correct the fault.
    a. To run the Recovery Guru, select the Recovery Guru toolbar button in the Subsystem Management window.
    b. Complete the recovery procedure.

       If the Recovery Guru directs you to replace a failed component, locate and troubleshoot that component. See "Checking the LEDs" on page 104.
    c. When the procedure is completed, rerun the Recovery Guru to make sure that the problem has been corrected by selecting Recheck in the Recovery Guru.
    d. If the problem persists, contact IBM Customer and Technical Support.
13. Replace the bezel on the storage expansion enclosure, if applicable.

# Cache memory and cache battery

Each RAID controller in the DS5020 storage subsystem contains either 1 GB or 2 GB of cache memory to store read and write operations. (Both RAID controllers in the DS5020 must have the same amount of cache memory.) The battery unit contains enough charge to back up the cached data in each controller to a flash drive in the event of a DS5020 power failure.

**Attention:** There are different replacement FRU part numbers for the DS5020 controller with certain cache sizes. The DS5020 storage subsystem profile has the information about the installed cache memory size in the DS5020 controllers. Refer to the storage subsystem profile and see "Parts listing" on page 166 for the correct FRU part number for the DS5020 controller.

## Cache memory

*Cache memory* is memory on the RAID controller that is used for intermediate storage of read and write data on the DS5020 RAID controllers. Using cache memory can increase system performance. The data for a read operation from the host might be in the cache memory from a previous operation (thus eliminating the need to access the drive itself), and a write operation is completed when it is written to the cache, rather than to the drives.

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

If caching is enabled and the Cache Active LED never comes on during I/O activity, it indicates one of the following conditions:

- The cache memory from either controller A or controller B has failed.
- The cache sizes in controller A and controller B are not the same.
- The battery has failed. (In this case, one or both of the green Battery LEDs will be off and one or both amber Battery Needs Attention LEDs will be lit.)

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

Figure 73 shows the locations of the Cache Active LEDs on the front of the RAID controllers.
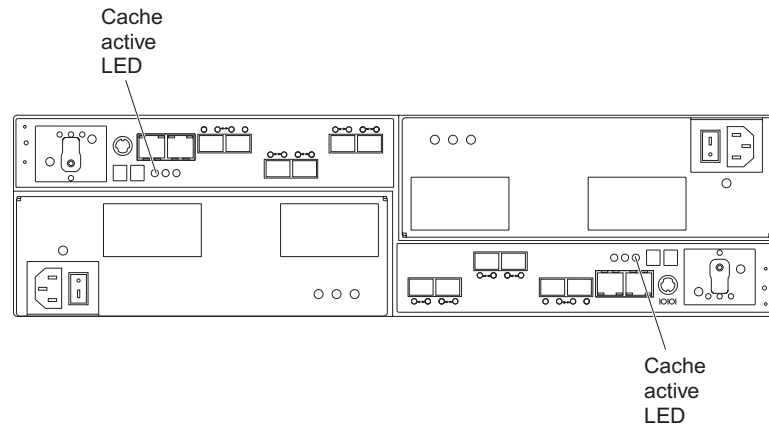


*Figure 73. Cache Active LEDs*

## Subsystem cache battery

The backup battery unit provides power to back up the cache memory of each controller onto flash drives in the event of a power failure. Each battery unit contains a sealed, rechargeable SMART lithium ion battery. The battery unit contains enough charge to back up the cached data in each controller to a flash drive in the event of a power failure.

**Statement 2:**



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

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

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

Replace the battery units in the DS5020 when they are identified as failing by the DS Storage Manager Subsystem Management window, or when the Battery LEDs or Battery Needs Attention LEDs light. These LEDs are located on the power supply and fan units and on the battery unit respectively, as shown in Figure 74 on page 122.

Replace only the battery unit that is indicated as failed by the LEDs or in the DS Storage Manager Subsystem Management window. You do not need to replace both battery units when the Battery LEDs indicate that only one battery unit has failed.

If the battery age expires, do not call IBM technical support to replace the battery. Instead, reset the battery age using the procedure described in the Storage Manager online help. Replace the battery only when it is in a failed state, as indicated by the Storage Manager Recovery Guru.

Each power supply and fan unit has green Battery LEDs on the back that indicates the battery status of each battery unit, as follows:
- The LED is on and remains steady when the battery is fully charged.
- The LED flashes when the battery is charging or performing a self-test.
- The LED is off if the battery or the battery charger has failed.

The battery unit also has a battery failure indicator LED that is located on the battery unit. This LED will light if the battery fails to hold a charge.

The battery performs a learn cycle the first time the storage subsystem is turned on, and again every eight weeks thereafter, to assess the charge capacity of the battery. If the battery fails the learn cycle or takes too much time to reach full charge, the Battery LED turns off (indicating a battery fault) and the DS Storage Manager identifies the battery as failed.

The learn cycle takes up to three hours. During this time, the cache will be active if the battery is in optimal condition. If the learn cycle is interrupted, the current learn cycle will be terminated and the battery will perform a new learn cycle at the next scheduled interval (eight weeks from the current learn cycle). A learn cycle

interruption is caused if you remove the battery from the controller chassis, reset the power to the storage subsystem, or if a storage expansion enclosure or battery overheats.

Data caching starts after the battery is charged to the programmed voltage level, which occurs when the storage subsystem power is first turned on, when a new battery is installed to replace a failed battery, or when the subsystem power is turned on after months of inactivity.

**Attention:** Write caching is suspended while a battery pack is either charging or self-testing.

Figure 74 shows the location of the Battery LEDs.
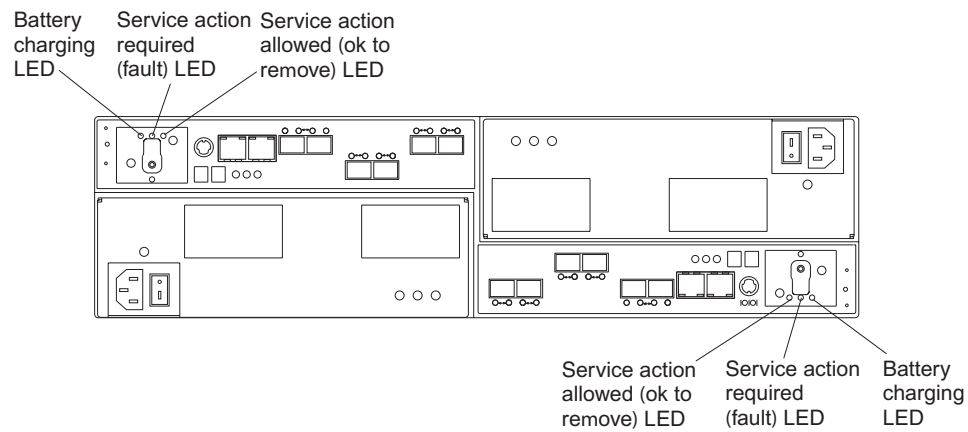


*Figure 74. Battery unit LEDs*

# Chapter 5. Replacing components

This chapter contains information about replacing a controller, E-DDM CRU, power supply and fan unit CRU, battery unit, SFP module, and midplane.

**Attention:** Always replace a failed component as soon as possible. The Recovery Guru menu function in the DS5020 storage subsystem identifies failed components.

## Handling static-sensitive devices

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

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

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

## Service Action Allowed Status LED

Each controller, power supply and fan unit, and battery unit has a blue Service Action Allowed status LED. The purpose of the Service Action Allowed status LED is to help make sure that a component is not removed before it is safe to do so. Do not remove any storage subsystem component unless the Service Action Allowed status LED for that component is lit.

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

The Service Action Allowed status LED automatically turns on or off as conditions change. Wait at least two minutes after you replace each component for the controller to recognize the new component and update the LED status. In most cases when a single component fails, the Service Action Allowed status LED turns on steadily when the Needs Attention status LED is turned on for the component.

## Replacing a controller

**Attention:**  Before you replace a controller, verify the following:

- The replacement controller part number matches the part number of the controller to be replaced. To provide full functionality, the two controllers must have the same cache memory capacity, same number of host ports, same types of host ports (FC or iSCSI), and same FRU part number. Inserting a non-compatible controller causes the controller to be placed in a lockout state by the other controller in the DS5020 chassis.

  **Note:** The DS5020 storage subsystem controller FRU is not compatible with the DS4200 Express or DS4700 storage subsystem controller FRU. See the "Parts listing" on page 166 for more information about compatible controllers.

- Both power supply and fan units must be connected and powered on with no Needs Attention LEDs lit. Make sure that the Power LEDs on each of the power supply and fan units are lit. If either of the power supply and fan units is not optimal, replace that component before you proceed with the controller replacement procedure.

- If you are replacing an optimal controller, first make sure that the other controller is optimal and that the Fibre Channel path from the hosts to the other controller is also optimal.

Each controller has a unique hardware Ethernet address, which is printed on a label on the front.

Before you begin, ensure that you wear an anti-static wrist strap.

Use the following procedure to replace a controller in an DS5020 storage subsystem:

1. Use the DS Storage Manager client software to print a storage subsystem profile. Move logical drive ownership to the other controller. If the controller you are replacing has failed but is still operating, move the failed controller to an Offline state.

**Attention:** Never remove a controller unless the Service Action Allowed status LED is turned on. Doing so can result in a potential loss of data.

2. Locate the failed controller by checking the Needs Attention status LEDs on the controllers in the storage subsystem.

3. Is the Service Action Allowed status LED turned on?

   - Yes – Go to step 4.
   - No – Another component might require attention before you can remove the controller. Use the Recovery Guru function in the DS5020 Subsystem Management window to identify and correct any additional failures. If there are none, proceed with step 4 to replace the controller.

   Electrostatic discharge can damage sensitive components. Touching the storage subsystem or its components without using a proper ground might damage the equipment. To avoid damage, use proper anti-static protection while handling any components.

4. Put on anti-static protection.

5. Unpack the new controller. Save all packing materials in the event you need to return the new controller.

6. Determine whether the replacement controller will serve as controller A or controller B (controller A is inserted in the left controller bay; controller B is inserted in the right controller bay), and then apply the controller labels for host channels, drive channels, and numeric display to the replacement controller. The controller labels and instructions are included with the replacement controller. Make sure that the labels are aligned properly and do not cover any ports or LEDs.

   **Statement 3:**

   

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

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

   

   **DANGER**

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

   **Class 1 Laser statement**

Class 1 Laser Product
Laser Klasse 1
Laser Klass 1
Luokan 1 Laserlaite
Apparell À Laser de Calsse 1

IEC 825-11993 CENELEC EN 60 825

**Attention:** Handle and install fiber-optic cables properly to avoid degraded performance or loss of communications with devices. For specific handling guidelines, see "Handling fiber-optic cables" on page 49.

7. Disconnect all attached interface cables from the failed controller, including the SFP modules. Make sure that you label each cable so that you can reconnect them correctly to the new controller.

Use the following procedure to remove the SFPs from the RAID controller that has failed:

a. Remove the LC-LC Fibre Channel cable from the SFP module. For more information, see "Handling fiber-optic cables" on page 49.

b. Unlock the SFP module latch:

- For SFP modules that contain plastic tabs, unlock the SFP module latch by pulling the plastic tab outward 10°, as shown in Figure 75.
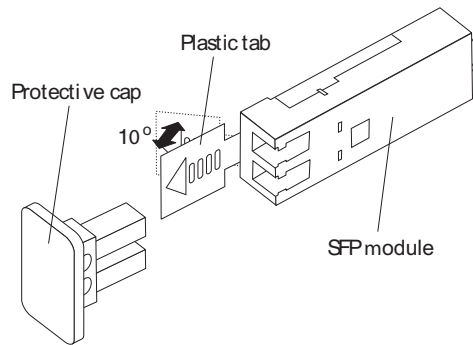


*Figure 75. Unlocking the SFP module latch - plastic variety*

- For SFP modules that contain wire tabs, unlock the SFP module latch by pulling the wire latch outward 90°, as shown in Figure 76.
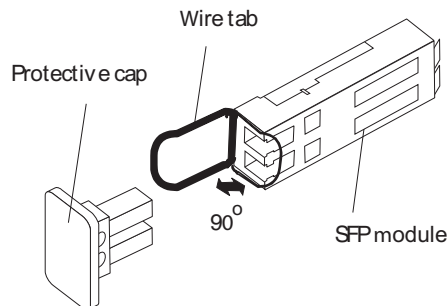


*Figure 76. Unlocking the SFP module latch - wire variety*

c. With the SFP latch in the unlocked position, extract the SFP module.

- For SFP modules that contain plastic tabs, slide the SFP module out of the port.

- For SFP modules that contain wire tabs, grasp the wire latch and pull the SFP module out of the minihub port.

    d. Replace the protective cap on the SFP module.

    e. Place the SFP module into a static-protective package.

    f. Replace the protective cap on the port.

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

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

9. Slowly pull the lever away from the chassis to remove the controller from the bay. Use two hands when releasing the controller levers. Figure 77 shows the controller sliding from the storage subsystem chassis.



Lever
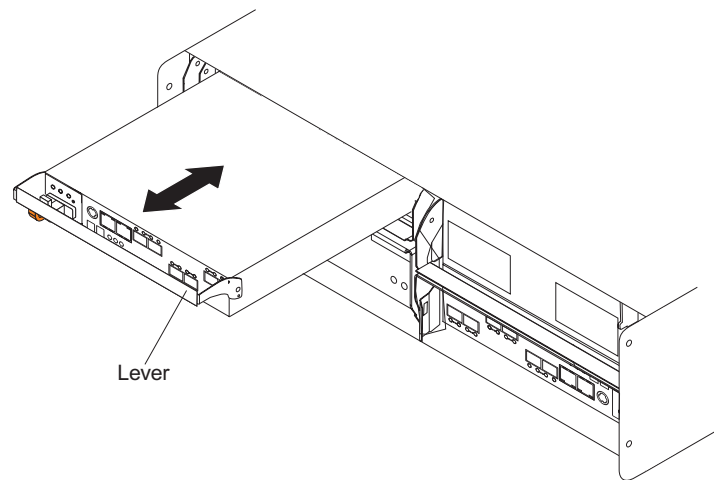
*Figure 77. Removing a controller from the DS5020*

10. If the new controller does not have the cache battery backup unit already installed, follow the instructions in "Replacing a battery unit" on page 148 to remove the cache backup battery from the existing controller unit and insert it into the new controller CRU.

11. Install the new controller.

    a. Slide one controller into the empty slot in the storage subsystem. Be sure that the lever is pulled straight out as you slide the controller in, as shown in Figure 78 on page 128.
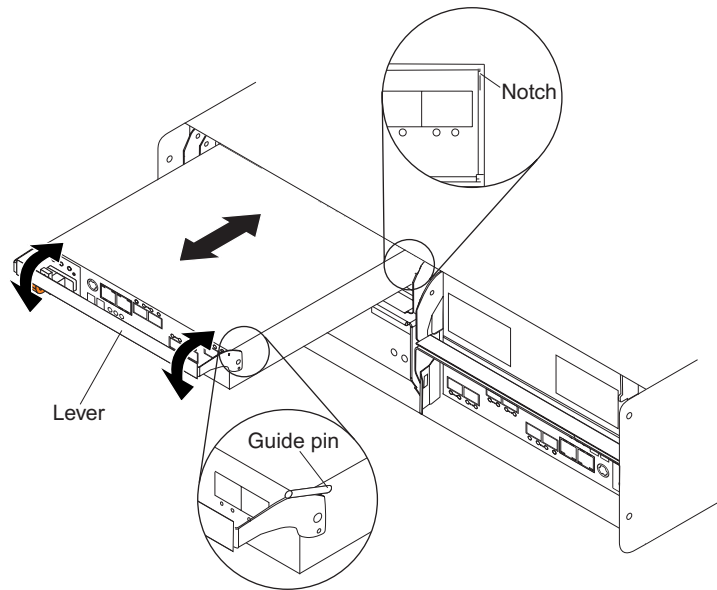
*Figure 78. Installing a controller*

    b. As you slide the controller into the empty slot, make sure the guide pins on the side of the controller fit into the notches. After the guide pins fit into the notches and the controller fits snugly into the bay, push the lever downward or upward 90°, depending on whether the controller is inserted in the A or B controller bay to fully latch it into place. Do not force fit. The controller is designed to prevent it from being inserted into the chassis incorrectly.

    **Attention:** Make sure that the levers lock into place in the storage subsystem chassis.

    c. Repeat step 11a on page 127 and step 11b to replace the second controller.

12. Wait up to 5 minutes for the DS Storage Manager client software to recognize the new controller.

13. Complete any remaining Recovery Guru procedures for controller replacement, if needed.

14. Check the LEDs on the new controller to verify that the controller is fully operational.

15. Remove the anti-static protection.

16. Use the DS Storage Manager client Subsystem Management window to check the status of all components in the storage subsystem.

    • If the new controller is online and the DS Storage Manager client Subsystem Management window indicates normal operation, go to step 19 on page 129.

    • If the new controller is online and the DS Storage Manager client Subsystem Management window indicates a problem status, go to "Troubleshooting the storage subsystem " on page 103.

    • If the new controller is offline, go to step 17.

17. If the newly inserted controller is in an offline state, see the DS Storage Manager client online help for instructions on bringing the controller online.

    If necessary, open the DS Storage Manager Subsystem Management window and place the controller on-line; select the off-line controller and click **Advanced ▶ Recovery ▶ Place controller online**.

18. Verify the state of the LEDs on the newly inserted controller. See "Controller LEDs" on page 107. You can also use the DS Storage Manager client Subsystem Management window to identify any new faults. Do any storage subsystems have a fault (Needs Attention) status?

    - Yes – Select the Recovery Guru toolbar button in the Subsystem Management window, and complete the recovery procedure. If the problem persists, contact your IBM service representative.
    - No – Go to step 19.

19. Use the DS Storage Manager client software to print a new storage subsystem profile.

## Installing hard disk drives

Before you begin, ensure that you wear an anti-static wrist strap.

To install a hot-swap Fibre Channel (FC), Serial Attached SCSI (SAS) hard disk drive or a Serial ATA (SATA) hard drive in an IBM DS3000, DS4000, or DS5000 storage subsystem:

1. Remove the hard disk drive filler, if it exists.
2. Install the hard disk drive starting in drive slot 0 or the next available drive slot.
3. Install additional hard disk drives in the ascending drive slot order.

   **Attention:** To prevent damage to the drive enclosure:

   - For drive enclosures without disk drawers, do not force the drive into the drive slot at an angle. Ensure that you carefully insert each hard disk drive straight into the drive slot (horizontal or vertical).

     The following figure shows correct and incorrect ways of inserting a hard disk drive into a horizontal drive slot. The subsystem shown in the figure is for illustration only.
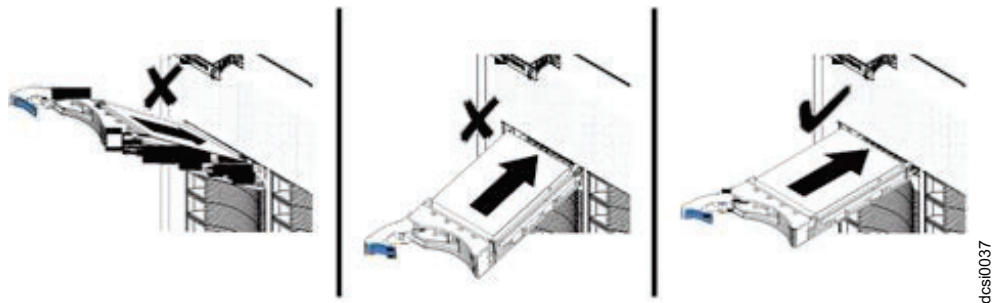


*Figure 79. Inserting a hard disk drive into a drive slot*

   - For drive enclosures with disk drawers, gently press on the back of the drive while pulling the lever downward to push the drive into the connector on the drive drawer board.
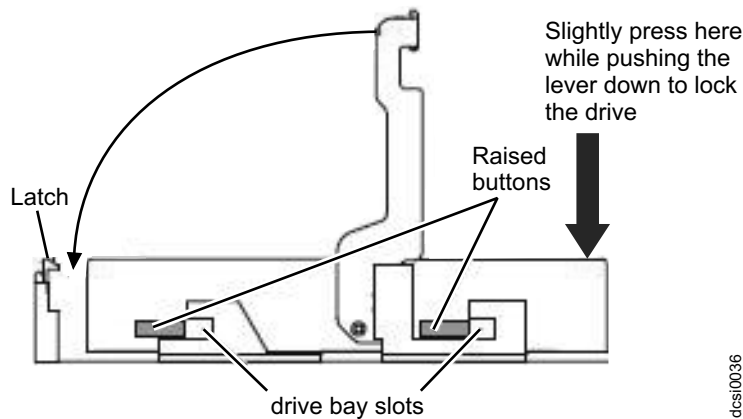
*Figure 80. Inserting a hard disk drive into the connector*

# Working with hot-swap E-DDMs

This section explains how you can increase the storage subsystem capacity by adding more E-DDMs or by replacing existing E-DDMs with ones that have a larger capacity.

Before you begin, complete the following tasks:

- Read the safety and handling guidelines in "Safety" on page xi and in "Handling static-sensitive devices" on page 31.
- Ensure that your current system configuration is working properly.
- Back up all important data before you make changes to data storage devices.
- Ensure that you wear an anti-static wrist strap.

Before you install or remove E-DDM CRUs, review the following information:

- **Blank trays:** A storage subsystem without a full set of E-DDMs (16) contains blank trays in the unused drive bays. Before installing new E-DDMs, you must remove these empty trays. Save the empty trays for future use. Each of the 16 bays must always contain either a blank tray or a hot-swap E-DDM.

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

- **E-DDM CRUs:**
  - The DS5020 storage subsystem supports 4 Gbps Fibre Channel, SATA, and FC-SAS E-DDMs. The link rate setting speed must be set accordingly. See "Verifying the link rate setting" on page 140 for more information.
  - When adding E-DDM CRUs, if you are not installing all 16 E-DDM CRUs into the storage subsystem, install the E-DDM CRUs from left to right consecutively.
  - For optimum performance, never insert an E-DDM into a storage subsystem without first confirming the drive firmware level. In the event of a drive firmware mismatch, schedule down time as soon as possible to upgrade the drive firmware to the same version. For information about supported drive firmware versions, refer to the IBM Storage Systems support Web site:

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

  - Use of non-supported drives in the drive modules can cause the storage subsystem to fail.

- – In configurations with mixed storage expansion enclosures, all storage expansion enclosures on a fibre loop must be operating at the same interface speed.
- – Make sure that the speed of the E-DDM CRU you are adding is supported in the storage subsystem. For example, do not install a 2 Gbps E-DDM CRUs in a storage subsystem that supports only 4 Gbps E-DDMs.
- – E-DDM CRUs are not interchangeable between DS5020/EXP520 and EXP810 storage expansion enclosures, unless you purchase and enable the Attach EXP810 to DS5020 Activation feature option. Contact your IBM marketing representative or IBM reseller for more information.
- – After you remove an E-DDM CRU, wait 70 seconds before replacing or reseating it to allow it to properly spin down. Failure to do so might cause undesired events.
- – When determining what E-DDM CRU to add, there are many factors to base your decision on in addition to the drive capacity. Here is a partial list of the factors that differentiate a drive:
  - - Drive capacity
  - - Drive interface (such as FC, SAS, or SATA)
  - - FDE capability
  - - Media options (such as SSD or spinning media)
  - - T10 PI support

  **Attention:**

  Before you turn on the power to the DS5020 storage subsystem, it must be populated with at least two E-DDMs.

  If at least two E-DDMs are not installed in the DS5020, an insufficient load to the enclosure power supplies might cause them to intermittently appear as failed, falsely indicating the power supplies are bad. All of the E-DDMs in the DS5020 storage subsystem and the connected storage expansion enclosure or enclosures must contain no prior configuration data.
- • **E-DDM CRU labels:** A label is provided on the front of each E-DDM. Use this label to record the location information for each E-DDM before you remove it. Make sure that you keep track of the E-DDMs and their corresponding bays. Also, record the location information in Table 26 on page 174. If you install an E-DDM in the wrong bay, you might lose data.
- • **E-DDM LEDs:** Each E-DDM CRU tray has two associated LEDs, a green Activity LED and an amber Fault LED. These LEDs indicate the status for that drive. See Table 20 for the E-DDM LED states and descriptions.
- • E-DDM CRUs are not interchangeable between the DS5020 and other DS4000 storage subsystems.

*Table 20. Drive LED activity*

| LED | LED state | Descriptions |
|---|---|---|
| Activity LED | Flashing green | The green LED flashes to indicate Fibre Channel activity to the drive. |
| Activity LED | Steady green | The green LED lights to indicate that the drive is properly installed and is spun up by the DS5020 controller. |
| Fault LED | Flashing amber | The amber LED flashes to indicate that a drive has been identified by the software. |

*Table 20. Drive LED activity  (continued)*

| LED | LED state | Descriptions |
|-----|-----------|--------------|
| Fault LED | Steady amber | The amber LED lights to indicate a drive failure due to bad or uncertified drive, or the controller firmware is not at the minimum version required to support the drive. The green activity LED might flash once every 2 seconds, remain steady green, or be unlit. |
| Activity and Fault LEDs | All unlit | Check for and resolve one of the following situations:<br>• DS5020 is turned off.<br>• DS5020 link rate speed is not set correctly. |
| Activity LED | Flashing once every 2 seconds | Check for and resolve one of the following situations:<br>• The controller did not complete the boot process.<br>• Storage subsystem controller firmware is not correct.<br><br>**Note:** Drives are also spun down because they are in a "not compatible state" or "exported state", or because the controller firmware is not at the minimum version required to support the drive. |
| Activity and Fault LEDs | Flashing together in a certain pattern | Drive failure due to the incorrect link rate speed setting or internal drive hardware failures. |

- **Fibre Channel loop IDs:** When you install an E-DDM in the storage subsystem, the drive tray connects into a printed circuit board called the *midplane*. The midplane sets the Fibre Channel loop ID automatically, based on the setting of the enclosure ID switch and the physical location (bay) of the drive CRU.
- **Hot-swap hardware:** The DS5020 contains hardware that enables you to replace a failed E-DDM without turning off the storage subsystem. You can continue to operate your system while an E-DDM is removed or installed. These E-DDMs are known as hot-swap E-DDMs.

## Installing hot-swap E-DDMs

With the exception of the DS5020 storage subsystem initial power on, add E-DDMs while the storage subsystem is turned on and running.

Before you begin, ensure that you wear an anti-static wrist strap.

Complete the following steps to install hot-swap E-DDMs in the storage subsystem:

**Attention:**
- After you remove an E-DDM CRU, wait 70 seconds before replacing or reseating it to allow it to properly spin down. Failure to do so might cause undesired events.
- The DS5020 and EXP810 E-DDMs and FRUs are not compatible with the DS4200 Express and EXP420 EV-DDMs and FRUs.
1. Read the documentation that comes with the E-DDM.
2. Check for Fault LEDs shown in . If any amber LEDs are lit, see .

Bezel    Blank tray

Activity LED    Fault LED    Tray handle    Latch
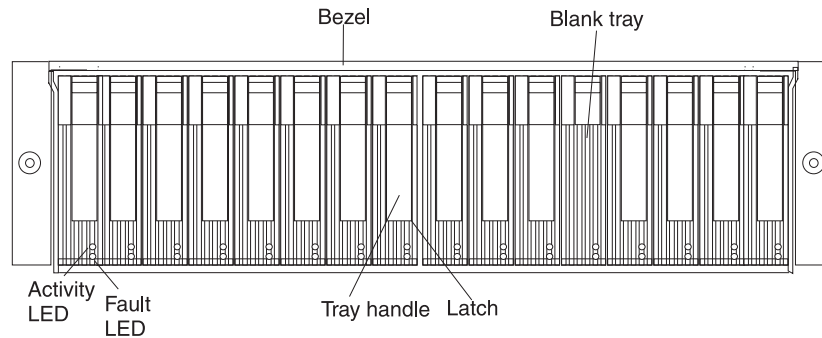
*Figure 81. Hot-swap E-DDM LEDs*

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

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

   a. Release the latch on the drive CRU by pressing on the inside of the bottom of the tray handle.
   b. Pull the handle on the tray out so that it is in the open position, as shown in Figure 82.



Tray handle

Tray latch

*Figure 82. E-DDM CRU handle*

   c. Slide the E-DDM CRU into the empty bay until the hinge of the tray handle latches beneath the storage subsystem bezel or the adjacent E-DDM CRU bezel.

**Note:** Make sure that the EMC gasket does not snag on the bezel.

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

## Replacing hot-swap E-DDMs

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

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

**Attention:**   Failure to replace the E-DDMs in their correct bays might result in loss of data. If you are replacing an E-DDM that is part of a configured array and logical drive, make sure that you install the replacement E-DDM in the correct bay. Check the hardware and software documentation that is provided with your DS5020 to see if there are restrictions regarding E-DDM configurations.

Before you begin, ensure that you wear an anti-static wrist strap.

Complete the following steps to replace a hot-swap E-DDM:

1. Use the DS Storage Management client software to print a new storage system profile.
2. Determine the location of the E-DDM that you want to remove.

   **Attention:**   Never hot-swap an E-DDM CRU when its associated green Activity LED is flashing. Hot-swap an E-DDM CRU only when its associated amber Fault LED is lit and not flashing.
3. Put on anti-static protection.
4. Remove the E-DDM CRU by doing the following:
   a. Release the latch on the E-DDM CRU by pressing on the inside of the bottom of the tray handle, as shown by the arrow in Figure 82 on page 133.
   b. Pull the tray handle out into the open position.
   c. Pull the E-DDM CRU about 1/2 inch out of the bay and wait 70 seconds to allow the E-DDM to properly spin down and the storage subsystem controller to properly recognize that an E-DDM is removed from the configuration. .
   d. Verify that there is proper identification (such as a label) on the E-DDM CRU, and then slide it completely out of the storage subsystem.
5. Unpack the new E-DDM. Save all packing material in case you need to return it.
6. Install the new E-DDM CRU by doing the following:
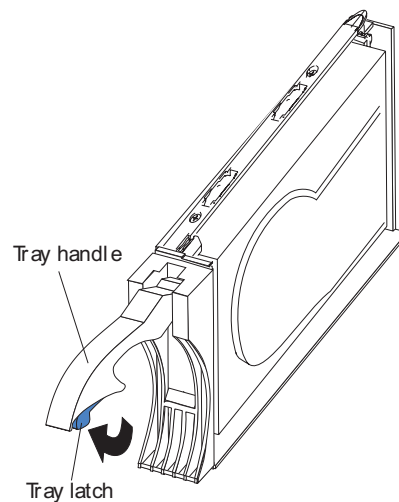   a. Gently push the E-DDM CRU into the empty bay until the hinge of the tray handle latches beneath the storage subsystem enclosure bezel.
   b. Push the tray handle down into the closed (latched) position.
7. Check the E-DDM LEDs by doing the following:
   • When an E-DDM is ready for use, the green Activity LED lights and the amber Fault LED is off.

- If the amber Fault LED lights and is not flashing, remove the E-DDM from the unit and wait 70 seconds; then, install the E-DDM again.

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

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

## Replacing multiple E-DDMs

This section provides guidelines for upgrading the E-DDMs in the storage subsystem. Read the software documentation and this entire section to determine if you should use this procedure, use a modified version of this procedure, or use a different procedure that is provided by your operating system.

**Note:** Instructions that are provided with your software supersede anything stated in this document.

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

Before you begin, ensure that you wear an anti-static wrist strap.

The following are methods for upgrading E-DDMs:

- **Replacing all the E-DDMs at the same time**

  This method requires that you back up the data on the affected E-DDMs and then turn off the DS5020 storage subsystem.

  **Attention:** Turn off the DS5020 storage subsystem before you turn off the attached storage expansion enclosures.

  After replacing all the E-DDMs, you must reconfigure the new E-DDMs and restore data from backup. See the procedure in "Replacing all E-DDMs at the same time" on page 136.

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

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

  In this method, you manually fail each E-DDM, replace it, and wait for the system to restore data to the new E-DDM before installing the next E-DDM. After you install the new E-DDMs, you can configure them to make the additional drive space available. See the procedure in "Replacing the E-DDMs one at a time" on page 138.

  Using this method, you can replace the E-DDMs while the storage expansion enclosures and the DS5020 are running, eliminating the down time that is required if you replace all the E-DDMs at once. However, this method is more risky because you can lose data if the drive restoration or storage subsystem reconfiguration process fails. In addition, the reconstruction process might take a long time. This method works only on redundant logical drives (RAID 1, 3, or 5). You cannot use this method with any drives containing RAID 0 logical drives.

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

The method you use depends on the following considerations:

- Which method most closely matches the drive upgrade procedure in the operating-system or the storage-management software documentation.
- Which RAID level is used on the affected drives. (RAID 0 requires you to replace all the E-DDMs at the same time.)
- How much downtime is acceptable as you swap the E-DDMs.
- The number of E-DDMs in an array. Replacing E-DDMs one at a time is better suited for arrays consisting of 3 to 5 E-DDMs. If you have more than 10 E-DDMs or arrays that are comprised of high capacity SATA E-DDMs, consider replacing all E-DDMs at the same time.
- How much risk of losing data is acceptable. Because the array will be in a degraded state during the RAID array reconstruction and copyback process as result of replacing a drive in the array, any new E-DDM failure will cause the array to fail (causing a loss of data availability and even a loss of data). The duration of the reconstruction and copyback process can be quite long, depending on the size of the RAID array.
- How extensive will the data be changed while the array is in a degraded state during the RAID array reconstruction and copyback process as result of replacing an E-DDM in the array. The more extensive the data changes, the more work that will need to be performed to restore the data in the event that the array failed because of an addition E-DDM failed while the array is in degraded state.

## Replacing all E-DDMs at the same time

Use this procedure to replace all E-DDMs at the same time. You must use this method if you are upgrading E-DDMs containing RAID 0 logical drives. All the data currently on the E-DDMs is lost when you replace the E-DDMs; therefore, you must back up all data that is currently on the E-DDMs. This procedure also requires you to turn off the storage expansion enclosures and the DS5020, which makes the storage subsystem (and any attached storage expansion enclosures) inaccessible to other users.

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

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

1. Read the following information:
   - The information in "Replacing multiple E-DDMs" on page 135, particularly the paragraphs that discuss the differences between the two possible upgrade procedures
   - The information in your software documentation regarding E-DDM upgrades and installation
   - The documentation that comes with the new E-DDMs

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

2. Use the DS Storage Manager software to check the status of the DS5020. Correct any problems that are reported. Upgrade the storage subsystem controller to the level that supports the new E-DDMs, if required.

3. Perform a complete backup of the E-DDMs that you are replacing.

   You need the backup to restore data on the E-DDMs later in this procedure.

   **Attention:** When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see "Handling static-sensitive devices" on page 31.

4. Unpack the new E-DDMs.

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

5. Perform the following steps:

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

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

      2) The green Cache active LEDs are off.

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

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

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

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

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

   

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

   

   **CAUTION:**
   **The power switch on the power supply and fan unit does not turn off the electrical current supplied to the device. The DS5020 storage subsystem might also have more than one connection to power. To remove all electrical current from the device, ensure that all power cords are disconnected from the power supply and fan unit input connectors.**

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

7. Use the procedures in "Replacing hot-swap E-DDMs" on page 134 to remove the E-DDMs that you want to replace. Use the procedures in "Installing hot-swap E-DDMs" on page 132 to install the new E-DDMs into the storage subsystem.

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

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

    b. You must turn on the storage expansion enclosures before the storage subsystem. The controllers might not recognize the correct configuration if the E-DDMs are powered up after the storage subsystem. For instructions on powering up the storage subsystem, see the storage subsystem documentation.

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

9. Turn on the power to each device, based on the power-on sequence in step 8. To turn on power to the storage subsystem and the storage expansion enclosures, turn on the power supply and fan unit switches on the back of the storage subsystem. You must turn on both power supply and fan unit switches to take advantage of the redundant power supplies.

10. Check the green Drive activity LEDs and the amber Drive fault LEDs above the new E-DDM CRUs.

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

**Note:** The Drive fault LEDs might flash intermittently while the E-DDMs spin up.

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

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

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

### Replacing the E-DDMs one at a time

Use this procedure to replace all the E-DDMs one at a time. You cannot use this procedure on RAID 0 logical drives (use the procedure in "Replacing all E-DDMs at the same time" on page 136).

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

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

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

1. Read the following information:
   - "Replacing multiple E-DDMs" on page 135, particularly the paragraphs that discuss the differences between the two possible upgrade procedures
   - Your software documentation regarding E-DDM upgrades and installation
   - The documentation that comes with the new E-DDMs

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

2. Use the DS Storage Manager software to check the status of the unit. Correct any problems that are reported. Upgrade the storage subsystem controller to the level that supports the new E-DDMs, if required.

3. Back up the data in the arrays and logical drives that are configured using the E-DDMs that you are replacing.

   **Attention:** When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see "Handling static-sensitive devices" on page 31.

4. Unpack the new E-DDMs.

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

5. Use the DS Storage Manager software to make sure that the array that was defined using these E-DDMs is in optimal (not degraded) state before manually failing the first E-DDM you want to replace. If the array is in degraded state, use the recovery procedures to bring the array into the optimal state.

   Make sure of the following:
   - You fail only one E-DDM.
   - The software status display shows a failed status for the applicable E-DDM.
   - The amber Drive fault LED (on the front bezel below the E-DDM) is on.

   **Attention:** Removing the wrong E-DDM can cause data loss. Make sure that you remove only the failed E-DDM CRU. To identify the failed E-DDM CRU, look for the lit Drive fault LED.

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

6. Use the procedures in "Replacing hot-swap E-DDMs" on page 134 to remove the failed E-DDM. Use the procedures in "Installing hot-swap E-DDMs" on page 132 to install the new E-DDMs into the storage subsystem.

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

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

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

7. Check the green Drive activity LED and the amber Drive fault LED above the new E-DDM CRUs.

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

   **Note:** The Drive fault LEDs might flash intermittently while the E-DDMs spin up.

   - If the Drive activity LED is off, the E-DDM CRU might not be installed correctly. Remove the E-DDM CRU, wait 30 seconds, and then reinstall it.
   - If the Drive fault LED stays on or the Drive activity LED stays off, the new E-DDM might be faulty or might be an uncertified drive. See the DS Storage Manager software for problem determination. In the case of an uncertified drive, verify that the drive options or drive FRU part number is correct for your storage subsystem.

8. Use the DS Storage Manager software to monitor the status of the new E-DDM and the progress of the data reconstruction. Wait for data reconstruction to finish (the Drive activity LED stops flashing).

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

9. When reconstruction is finished on the new E-DDM, repeat step 5 on page 139 through step 8 for each additional E-DDM that you want to install.

10. Use the DS Storage Manager software to configure the additional space on the new E-DDMs.

## Verifying the link rate setting

**Important:** Make sure that the link rate for the DS5020 is always set to 4 Gbps. The DS5020 supports only 4 Gbps FC drives.

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

A link rate switch is located on the front of the storage subsystem as shown in Figure 84 on page 142. The link rate indicator LEDs are located on the back of the storage subsystem. The link rate switch is only read when the storage subsystem is powered up.

**Note:** Do not mix storage subsystems with different link rate speed settings in the same drive loop.

The DS5020 storage subsystem drive channel operates at a 4 Gbps Fibre Channel interface speed. The DS5020 storage subsystem SATA E-DDM CRUs have an ATA translator card that converts E-DDM 3 Gbps SATA drive interface protocol to a 4 Gbps Fibre Channel interface protocol. The DS5020 FC-SAS E-DDM CRUs have a

FC-SAS interposer card that converts the SAS drive interface protocol to a 4 Gbps FC interface protocol. Set the DS5020 enclosure speed to 4 Gbps when these FC-SAS or SATA E-DDM CRUs are installed and connected to storage expansion enclosures running at 4 Gbps speed. The link rate setting speed must be set accordingly. See "Verifying the link rate setting" on page 140 for more information.

Do not mix 2 GB drives and 4 GB drives in the same storage subsystem. If drives of mixed speeds reside in the storage subsystem, the data transfer rate changes depending on the configuration. Table 21 shows the data transfer rates for drives of different configurations.

**CAUTION:**
**Do not change the link rate setting while the storage subsystem is running. Changing the link rate setting while the storage subsystem is running could cause drives to fail. You must power down the storage subsystem and storage expansion enclosures before changing the link rate setting.**

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

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

*Table 21. Data transfer rates for drive modules*

| Link rate switch setting | Storage subsystem with 2 GB drives | Storage subsystem with 4 GB drives | Storage subsystem with mixed drives |
|---|---|---|---|
| 4 Gbps | Drives do not come online. | Drives work in 4 Gbps mode. | 2 GB drives do not come online.<br><br>4 GB drives work in 4 Gbps mode. |

Before you begin, ensure that you wear an anti-static wrist strap.

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

1. Complete the power-off sequence described in "Turning off the storage subsystem" on page 112 ensuring that the DS5020 storage subsystem is turned off before any attached storage expansion enclosures.
2. Locate the link rate indicator LEDs. Figure 83 on page 142 shows the location of the link rate indicator lights on the back of the storage subsystem.
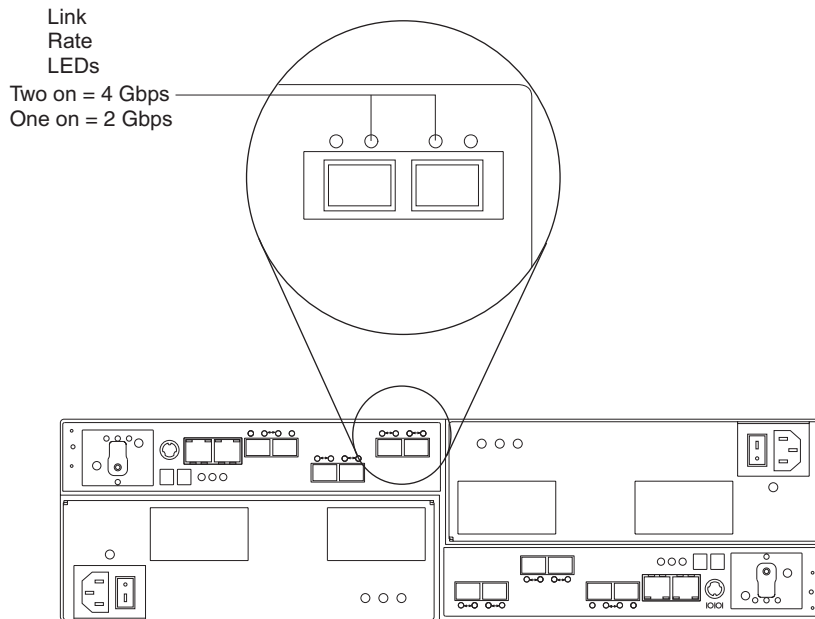
*Figure 83. Link rate LEDs*

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

**Important:** Make sure that the link rate for the DS5020 is always set to 4 Gbps. The DS5020 supports only 4 Gbps FC drives.

3. Is the data transfer rate set correctly?

   **Note:** Make sure that the link rate for the DS5020 is always set to 4 Gbps.
   - **Yes** - Go to step 8 on page 143.
   - **No** - Go to step 5 to change the setting.

   **Attention:** When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see "Handling static-sensitive devices" on page 31.

4. Locate the link rate switch. Figure 83 shows the location of the link rate indicator light on the front of the command module.
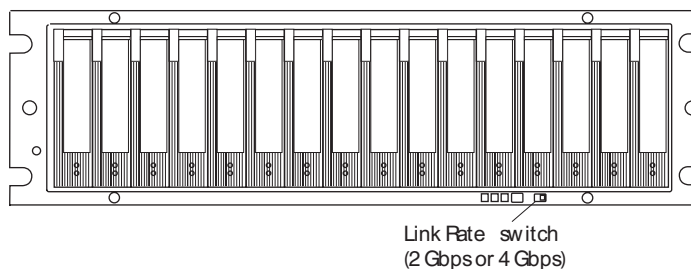


*Figure 84. Link rate switch*

5. Change the link rate switch setting by doing the following:
   a. Put on anti-static protection.
   b. Use a small screwdriver or the tip of a ball point pen to slide the link rate switch to the left or right to set the desired Fibre Channel operating speed.

> **Attention:** Although the link rate LED indicates the correct speed setting, the link rate speed does not change until after you cycle power to the storage subsystem.

6. Repeat step 1 on page 141 through step 5 on page 142 for all of the storage subsystems in the configuration.

7. Perform the power-on sequence as described in "Turning on the storage subsystem" on page 97.

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

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

10. Diagnose and correct the fault.
    a. To run the Recovery Guru, select the Recovery Guru toolbar button in the Subsystem Management window.
    b. Complete the recovery procedure.
    c. When the procedure is completed, rerun the Recovery Guru to make sure that the problem has been corrected by selecting Recheck in the Recovery Guru.

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

## Replacing an ac power supply and fan unit

**Statement 5:**



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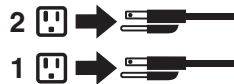


**CAUTION:**
**Disconnect the power cord before replacing the power supply and fan unit.**

The power supply and fan unit is a component that includes both a 600-W power supply unit and two fans. The power supply and fan units provide power and cooling for the DS5020. The power supply and fan units are customer replaceable units (CRUs) and do not require preventive maintenance. Use only the supported power supply and fan units for your specific storage subsystem.

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

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

If any of these conditions occurs, one or both power supplies will shut down. If the power remains off after the condition that causes it to go off, make sure that the environment is optimal (no overheating has occurred, all electrical outlets are working, and so on). For more information, see "Restoring power after an unexpected shutdown" on page 115.

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

If both power supply and fan units fail, or if the power supply and fan units cannot maintain an internal temperature below 68° C (154° F), the power supply and fan units in the unit will automatically shut down (an over-temperature condition). If this occurs, you must cool the unit and restart it. See "Restoring power after an unexpected shutdown" on page 115.

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

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

Before you begin, ensure that you wear an anti-static wrist strap.

Use the following procedure to replace an ac power supply and fan unit. Figure 85 on page 147 illustrates removing and inserting a unit.

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

**Statement 8:**

**CAUTION:**

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



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

1. If needed, use the DS Storage Manager client software to print a storage system profile.
2. Did the Recovery Guru direct you to replace a failed power supply and fan unit?
   - **Yes** - Go to step 3.
   - **No** - Run the Recovery Guru to identify the failed component, and then go to step 3.
3. Put on anti-static protection.
4. Unpack the new power supply and fan unit. Save all packing material in case you need to return the failed power supply and fan unit CRU.

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

5. Using the information provided on the instruction sheet, place the labels on the power supply and fan unit CRU to correctly mark the LEDs.
6. Turn off the power switch on the new unit.
7. Check the Fault LED to locate the failed power supply and fan unit. If a fault is detected, the amber Fault LED is on.
8. Verify that the Service Action Allowed LED is on. Do not remove the power supply and fan unit if the LED is off. For more information about the Service Action Allowed LED, see "Service Action Allowed Status LED" on page 123.

   **Statement 1:**

**DANGER**

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

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

| To Connect: | To Disconnect: |
|---|---|
| 1. Turn everything OFF. | 1. Turn everything OFF. |
| 2. First, attach all cables to devices. | 2. First, remove power cords from outlet. |
| 3. Attach signal cables to connectors. | 3. Remove signal cables from connectors. |
| 4. Attach power cords to outlet. | 4. Remove all cables from devices. |
| 5. Turn device ON. | |

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

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

11. Slowly pull the lever away from the chassis to remove the power supply and fan unit, as shown in Figure 85 on page 147.

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

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

**Attention:** The left and right power supply and fan units are seated in the DS5020 chassis in opposite orientations. If you cannot fully insert the power supply and fan unit into the power supply and fan unit bay, flip it 180° and reinsert it. Make sure that the levers lock into place in the storage subsystem chassis. Do not force fit. The power supply and fan unit is designed to prevent it from being inserted into the chassis incorrectly.

13. Plug in the power cord and turn on the power.
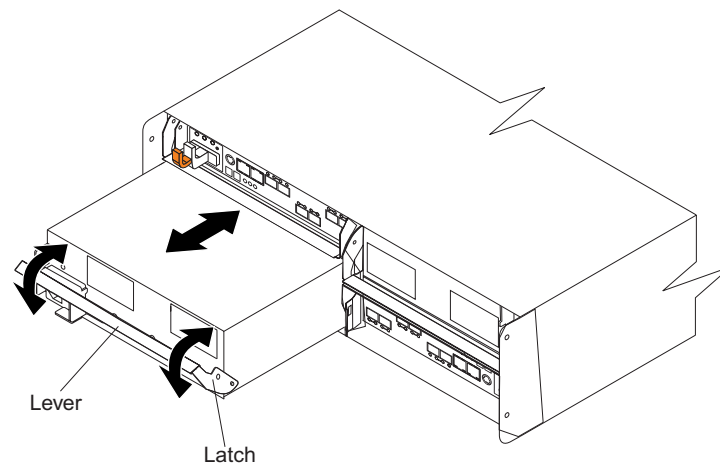14. Check the Power and Fault LEDs on the new unit.



Lever

Latch

*Figure 85. Replacing a power supply and fan unit*

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

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

- **Yes** - Select the Recovery Guru toolbar button in the Subsystem Management window and complete the recovery procedure. If a problem is still indicated, contact IBM Customer and Technical Support.
- **No** - Go to step 20.

20. Create, save, and print a new storage subsystem profile.

## Replacing a battery unit

**Statement 2:**



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

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

**Dispose of the battery as required by local ordinances or regulations.**
Each RAID controller in the DS5020 storage subsystem contains a rechargeable battery unit that backs up data in cache to flash memory in the event of power failure.

Use the following procedure if the DS Storage Manager client instructs you to replace the battery unit because the current battery has failed. You can also use the DS Storage Manager client to check the status of the battery. Because write-caching is disabled when either one of the battery units fail, replace the failed battery unit as soon as possible to minimize any impact due to the disabling of the write-caching function.

Replace only the battery unit that is indicated as failed by the LEDs. You do not need to replace both battery units when the Battery LEDs indicate that only one battery unit has failed. If the battery is identified as failed by the DS Storage Manager and the battery LEDs were are lit in a fault state, use the Service Action Allowed menu function in the DS Storage Manager subsystem window to identify the failed battery for replacement.

**Important:** Unlike the batteries for DS4000 storage subsystems, the DS5020 storage subsystem battery units do not have set expiration dates. Do not replace these batteries after a certain usage period.

**Attention:** When you handle static-sensitive devices, take precautions to avoid damage from static electricity. For details about handling static-sensitive devices, see "Handling static-sensitive devices" on page 31.

Before you begin, ensure that you wear an anti-static wrist strap.

Use the following procedure to replace a battery unit:

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

2. Locate the RAID controller that contains the failed battery unit.

3. Check the LEDs on the battery units to determine which of the two battery units has failed. (See "Battery unit LEDs" on page 106.) Replace only the battery unit that is indicated as failed by the LEDs.

4. Put on anti-static protection.

5. To remove the failed battery unit from the RAID controller, press the orange battery unit latch toward the black battery handle to unlatch the battery from the DS5020 chassis and slowly pull the battery unit from the controller chassis using the handle, as shown in Figure 86.
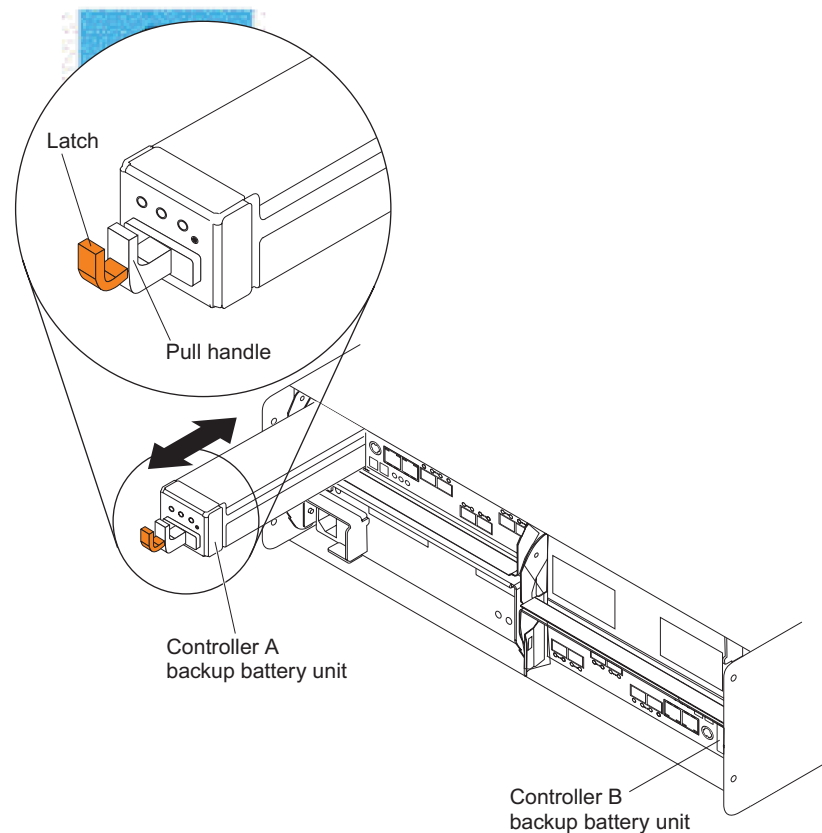


*Figure 86. Removing and replacing a battery unit from the controller chassis*

**Attention:** This product contains a sealed Lithium Ion battery. Discharged Lithium and Lithium Ion batteries are currently designated to be disposed of in normal trash. However, users should contact their municipal waste disposal facility prior to discarding any used battery in normal trash. Alternatively, you can return Lithium, Lithium Ion and Lithium Ion battery packs to IBM for recycling.

In the United States, IBM has established a collection process for reuse, recycling, or proper disposal of used IBM Lithium, Lithium Ion and Lithium Ion battery packs. For information on proper disposal of these batteries, please contact IBM at 1-800-426-4333. Please have the IBM part number listed on the battery available prior to your call.

For information on disposal of sealed Lithium Ion batteries outside the United States, go to www.ibm.com/ibm/environment/products/batteryrecycle.shtml or contact your local waste disposal facility.

6. Place the battery unit that you removed on a level surface.

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

8. Insert the new battery unit into the controller chassis. Make sure the new battery unit is inserted in the correct orientation in the battery unit bay. Press the battery unit fully into the bay until it clicks into place. Do not force fit. The battery unit is designed to prevent it from being inserted into the chassis incorrectly.

   **Note:** The green Battery Charging LED flashes until the battery is fully charged.

9. Once the battery is charged to the optimal state from the reduced-charge shipping state, the battery performs a learn cycle to access the discharge time of the battery. Do not turn off the power to the storage subsystem for at least 24 hours to ensure that the battery finishes charging and completes the first learn cycle.

## Replacing an SFP module

**Statement 3:**



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

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

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

**DANGER**

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

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

**Class 1 Laser statement**

Class 1 Laser Product
Laser Klasse 1
Laser Klass 1
Luokan 1 Laserlaite
Apparell À Laser de Calsse 1

IEC 825-11993 CENELEC EN 60 825

The speed of the SFP module determines the maximum operating speed of the Fibre Channel port in which the SFP is installed. For example, a 4 Gbps SFP that is plugged into a 8 Gbps-capable port will limit the speed of that port to a maximum of 4 Gbps.

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

Before you begin, ensure that you wear an anti-static wrist strap.

Use the following procedure to replace a Small Form-factor Pluggable (SFP) module on the storage subsystem. The SFP module shown in this procedure might look different from those you are using, but the difference will not affect functionality. Figure 87 on page 152 illustrates installing an SFP module.

Electrostatic discharge can damage sensitive components. To prevent electrostatic discharge damage to the storage subsystem, use proper anti-static protection when handling components.

To replace an SFP module, do the following:
1. Use the DS Storage Manager client software to print a new storage subsystem profile.
2. Using the Recovery Guru, identify the failed component that needs to be replaced.
3. Check the Fault LEDs to locate the failed SFP module. If a fault is detected, the amber Fault LED is on.

   **Attention: Potential loss of data access** - To prevent loss of access to data, remove only the SFP module that has a failed status in the storage management software and has Port Bypass LED lit.
4. Put on anti-static protection.
5. Unpack the new SFP module. Verify that it is the same type of module you are replacing. If it is not, contact IBM Customer and Technical Support.

   **Note:** The speed of the SFP module determines the maximum operating speed of the Fibre Channel port in which the SFP is installed. For example, a 4 Gbps SFP that is plugged into an 8 Gbps-capable port will limit the speed of that port to a maximum of 4 Gbps.

**Attention:** Handle and install fiber-optic cables properly to avoid degraded performance or loss of communications with devices. For specific handling guidelines, see "Handling fiber-optic cables" on page 49.

6. Disconnect the interface cables from the SFP module.
7. Remove the failed SFP module from the controller.
8. Install the new SFP module into the controller.
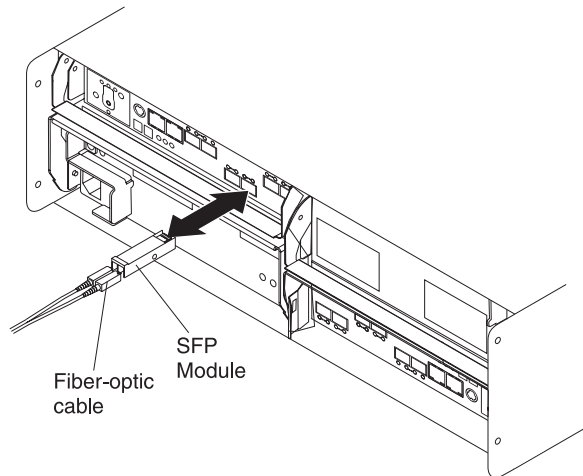9. Reconnect the interface cable.



*Figure 87. Replacing an SFP module*

10. Check the Bypass and Fault LEDs for the new SFP module.
11. Based on the status of the Bypass and Fault LEDs, choose one of the following steps:
    - **Bypass LED** *or* **Fault LED is on** - Reinstall the SFP module and cables, and verify that the SFP module and cables are securely connected. Use the Fibre Channel loopback and the LC-LC connector to perform path diagnostics to make sure that the Fibre Channel cable is good and the SFP on the other end of the Fibre Channel connection is working properly. When finished, go to step 12.
    - **Bypass LED and Fault LED are off** - Go to step 12.
12. Is the problem corrected?
    - **Yes** - Go to step 13.
    - **No -** Contact IBM Support.
13. Complete any remaining Recovery Guru procedures, if needed.
14. Use the DS Storage Manager Subsystem Management window to check the status the status of all components in the storage subsystem.
15. Remove the anti-static protection.
16. Does any component have a Needs Attention status?
    - **Yes** - Select the Recovery Guru toolbar button in the Subsystem Management window, and complete the recovery procedure. If the problem persists, contact IBM Support.
    - **No** - Go to step 17.
17. Use the DS Storage Manager client software to print a new storage subsystem profile.
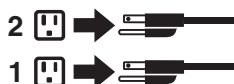
# Replacing a midplane

**Attention:**   Observe handling static-sensitive device precautions stated in "Handling static-sensitive devices" on page 31 when removing components.

Before you begin, ensure that you wear an anti-static wrist strap.

Perform the following steps to replace a midplane:

1. Complete the power-off sequence described in "Turning off the storage subsystem" on page 112 to make sure that the DS5020 storage subsystem is turned off before any attached storage expansion enclosures.

   **Attention:**   The power switch on the power supply and fan unit does not turn off the electrical current supplied to the device. The DS5020 storage subsystem might also have more than one connection to power. To remove all electrical current from the device, make sure that all power cords are disconnected from the power supply and fan unit input connectors.

2. Label and remove the power cords from the power supply and fan units of the DS5020 storage subsystem.

3. Label the Fibre Channel cables that are attached to the rear of the controllers. Labeling the cables simplifies the re-cabling process.

4. Remove the Fibre Channel cables that are attached to the rear of the controllers.

5. Remove both controllers. To remove them do the following:

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

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

   b. Slowly pull the lever away from the storage subsystem chassis to remove the controller from the controller bay, as shown in Figure 16 on page 40. (Remove the controllers from the chassis and place it on electrostatic discharge (ESD) protected surface.)

   c. Repeat steps 5a and 5b for the other controller.

6. Remove both power supply and fan units. To remove them, do the following:

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

b. Slowly pull the lever away from the chassis to remove the power supply and fan unit, as shown in Figure 17 on page 41. (Remove the power supply and fan unit from the chassis and place it on ESD protected surface.)

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

c. Repeat steps 6a and 6b for the other power supply and fan unit.

7. Label the Enhanced Disk Drive Module (E-DDM) CRUs so you know their physical location in the midplane.

8. Remove the E-DDM CRUs and any blank drive CRUs if the storage subsystem has them. See "Removing an E-DDM" on page 41 for instructions. Place E-DDMs on ESD protected surface.

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

9. Use a #1 Phillips screwdriver to loosen the four front cage frame screws on the midplane, as shown in Figure 88.
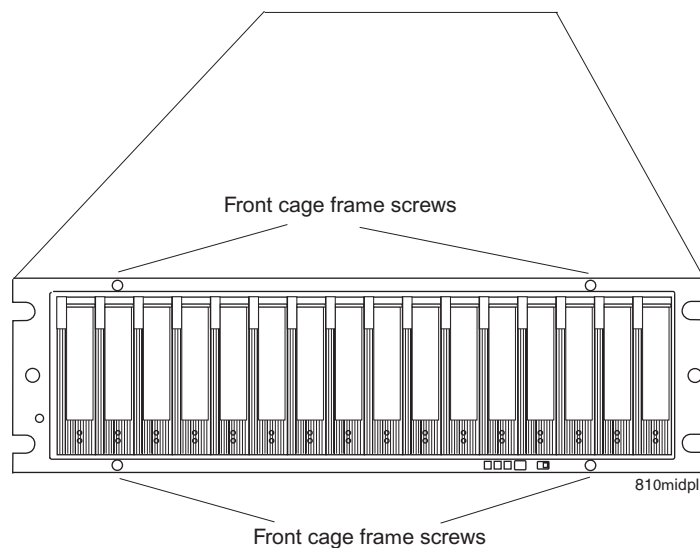


Front cage frame screws

Front cage frame screws

810midpl

*Figure 88. Front cage frame screw locations*

10. On the back of the DS5020, remove the four Phillips screws (two screws on each side) that hold the sides of the DS5020 chassis to the sides of the rails.

11. On the front of the DS5020, remove the four M5 screws (two screws on each side) on the DS5020 chassis that hold the DS5020 to the rails.

   **Attention:** The unit must be removed from the rack and placed on a level ESD protected surface before servicing it.

12.

   **Statement 4:**

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

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

Pull the chassis outward from the front of the rack and remove from the rack. Place it on a level surface. Look for a row of three Phillips screws on top of the chassis and a row of four Phillips screws on the bottom of the chassis, as shown in Figure 89. Remove the seven Phillips screws using the #1 Phillips screwdriver. Save these screws.
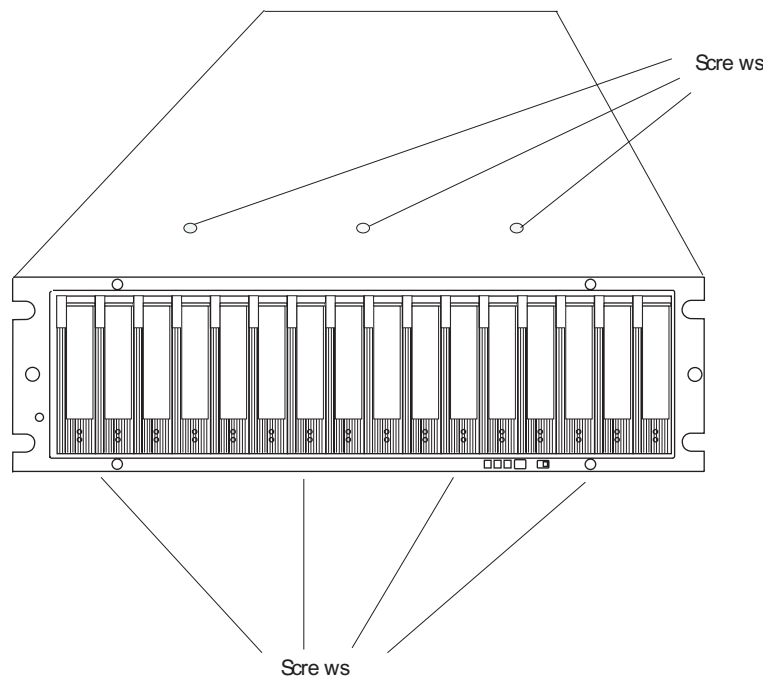


*Figure 89. Screws holding the top and bottom sides of the chassis to the cage frame*

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

    **Note:** The front cage frame might be tightly secured in the chassis. Mount the DS5020 chassis back in the rack using the four M5 screws to hold the DS5020 chassis in place while you pull on the blue handle to separate the front cage frame from the chassis. Remove the DS5020 chassis from the rack and place it on a level surface after you remove the failed front cage frame for the next step.

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

15. Insert the new front cage plane/midplane by aligning it with the storage subsystem front opening and slowly sliding it into the storage subsystem chassis. Make sure that the front cage frame EMC gaskets do not snag between the frame and chassis.

16. Tighten the four front cage frame screws. See Figure 88 on page 154.

17. Install the seven Phillips screws (three on top and four on bottom) that hold the front cage frame to the EXP810 chassis that you removed in step 12 on page 154, as shown in Figure 89 on page 155.

18. Push the chassis all the way back into the rail and install the four M5 screws along the side edges of the DS5020 chassis.

19. Install the four Phillips screws on the back along the sides of the DS5020 chassis that hold the DS5020 to the rails.

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

21. Re-insert the controllers and reconnect the Fibre Channel cables.

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

23. Turn on the power to the attached storage expansion enclosures.

24. Wait at least 3 minutes and then turn on the power to the DS5020 storage subsystem. Verify the status of the configuration using LEDs and the DS Storage Manager client program.

25. After removing the faulty cage frame with midplane assembly, transpose the DS5020 serial number, machine type, and model tag from the faulty cage frame assembly to the Repair Identification (RID) tag on the new cage frame assembly. The RID tag is important in transferring the serial number, machine type, and model from the faulty cage frame assembly to the new cage frame assembly. Make sure that the new RID tag is affixed to the new cage frame assembly before you dispose of the faulty cage frame with midplane assembly. This will so that the warranty coverage is not interrupted.

# Chapter 6. Hardware maintenance

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

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

## General checkout

Use the indicator lights, the diagnostics and test information, the symptom-to-FRU index, and the connected server *Problem Determination and Service Guide* to diagnose problems.

The Recovery Guru of the IBM System Storage DS Storage Manager client program also provides you with additional diagnostic aids.

## Solving problems

This section contains information to help you solve some of the problems you might have with your storage subsystem. Table 22 on page 158 contains the problem symptoms and error messages, along with suggested actions to take to resolve problems.

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

You can use Table 22 on page 158, which contains the problem symptoms and error messages, along with suggested actions as a guide for troubleshooting problems in addition to the DS Storage Manager Recovery Guru in the Subsystem Management window. Do not depend solely on Table 22 on page 158 for a FRU replacement decision.

*Table 22. Symptom-to-FRU index*

| Problem indicator | Component | Possible cause | Possible solutions |
|---|---|---|---|
| Amber LED is lit | Drive CRU (Drive Fault LED) **Note:** The green Drive Activity LED might also be lit. | Drive failure | Replace the failed drive. **Note:** The amber LED on the drive is also lit if the drive slot has a blank drive tray inserted. |
| | | Drive uncertified | Verify the drive option and FRU part number to verify that it is supported by the DS5020 storage subsystem. (For FRU part numbers, see Table 23 on page 166.) |
| | | Controller firmware is not at the minimum version to support the drive | Upgrade the controller firmware to the latest version from the IBM Support web site. |
| | RAID controller (Fault LED) **Note:** Controller Service Action Allowed LED will also be lit. | RAID controller failure | Replace the RAID controller. See your controller documentation for more information. See Chapter 5, "Replacing components," on page 123 for more information. |
| | | Controller was placed offline by a user or the other controller. | Use the menu function in the DS5020 Subsystem Management window to place the controller back online. If the controller continues going to an offline state after being placed online, replace the RAID controller. |
| | | Unsupported controller type. For example, a DS4200 Express FRU is inserted into a DS5020 chassis. | Use the Storage Manager Client Subsystem Management window and Recovery Guru to verify that the correct controller FRU is used. Replace with the correct DS5020 controller FRU. |

*Table 22. Symptom-to-FRU index  (continued)*

| Problem indicator | Component | Possible cause | Possible solutions |
|---|---|---|---|
| Amber LED is lit (continued) | RAID controller (Port Bypass LED) | No incoming signal detected | Reconnect the SFP modules and the Fibre Channel cables. Verify the input and output SFP using the path failure determination instruction in the *DS4000 Problem Determination Guide* and the Fibre Channel loopback and female-female LC connector. Replace either input or output SFP modules or Fibre Channel cables as necessary. |
| | | Incorrect enclosure speed setting | When connecting storage expansion enclosures to the existing operating redundant drive loop with a different speed setting, the port goes into bypass mode because mixing different speed enclosures within the same redundant drive loop/channel is not supported. |
| | | RAID controller failure | If the RAID controller Fault LED is lit, also replace the RAID controller. |
| | Front panel (Global Summary Fault LED) | General machine fault | A Fault LED is lit somewhere on the storage subsystem (check for Amber LEDs on CRUs). |
| | | General machine fault (continued) | Open the DS5020 Storage Subsystem Management window and click the Recovery Guru to see problems in the DS5020 configuration.

Some errors will cause the Global Summary Fault LED to be lit but will not cause any individual CRU Fault LEDs to be lit. (Drive PFA exceeded or nominal temperature exceeded errors are a few examples.) Follow the corrective actions in the Recovery Guru window. |
| | | Fibre Channel connection failure | Check that the CRUs are properly installed. If none of the amber LEDs are lit on any of the CRUs, this indicates an SFP module transmission fault in the storage subsystem. Replace the failed SFP module. See the DS Storage Manager software documentation for more information. |
| | Battery unit fault | Battery unit failure | Verify the failure using DS Storage Manager Client and replace the failing battery. |

*Table 22. Symptom-to-FRU index (continued)*

| Problem indicator | Component | Possible cause | Possible solutions |
|---|---|---|---|
| Amber LED is lit and green LED is off | Power supply CRU | The power switch is turned off or there is an ac power failure. | Replace the failed power supply or turn on all power supply switches. |
| Amber and green LEDs are lit | Power supply CRU<br><br>(Fault and Power LEDs lit; SAA lit; Direct Current Enable LED is not lit) | Power supply failure | Replace the failed power supply. |
| | | Operating environment is too hot | Cool down the environment. |
| | | Fan failure | Replace the power supply and fan unit CRU |
| All amber and green LEDs are slowly flashing | All drive CRUs | The DS5020 controllers are going through start-of-day process (booting up). Wait up to five minutes for the controllers to complete the booting process. If the drive Activity LEDs are not steady lit or momentarily flicker, and the amber LEDs are unlit after waiting more than six minutes, contact IBM support. | |
| All green LEDs are off | All CRUs | Subsystem power is off | Check that all storage subsystem power cables are plugged in and the power switches are on. If applicable, check that the main circuit breakers for the rack are powered on. |
| | | AC power failure | Check the main circuit breaker and ac outlet. |
| | | Power supply failure | Replace the power supply. |
| | | Operating environment is too hot | Cool down the environment. |

*Table 22. Symptom-to-FRU index (continued)*

| Problem indicator | Component | Possible cause | Possible solutions |
|---|---|---|---|
| Amber LED is flashing | Drive CRUs (Fault LED lit) | Drive identity is in process | No corrective action needed. |
| | RAID controller port bypass | A Fibre Channel loop initialization process (LIP) is being generated in the drive loop due to a faulty component. | Use the Read Link Status window in the Storage Manager Client Subsystem Management window and the storage subsystem event logs to isolate the faulty component. |
| | Controller drive port bypass LED | The enclosure speed was set to 4 Gbps but the SFP inserted in the controller drive SFP port does not operate at 4 Gbps. | Use the Recovery Guru menu function in the Storage Manager Client Subsystem Management window to verify the problem and replace the SFP with a 4 Gbps SFP. |
| | General Fault LED (located on the front of the storage subsystem) | An intermittent failure in the DS5020 storage subsystem configuration. The problem could be directly related to the hardware in the configuration (hard drive or bad cable) or indirectly related to the DS5020 storage subsystem configuration (such as a Fibre Channel host bus adapter failure in the host server or the Fibre Channel switch in the SAN causing LUNs to be on a non-preferred path.) | Use the Recovery Guru menu function in the Storage Manager Client Subsystem Management window to diagnose the problem. |

*Table 22. Symptom-to-FRU index (continued)*

| Problem indicator | Component | Possible cause | Possible solutions |
|---|---|---|---|
| One or more green LEDs are off | Power supply CRUs | Power cable is unplugged or switches are turned off. | Make sure that the power cable is plugged in and that the switches are turned on. |
| | All drive CRUs | Midplane failure | Replace the midplane. Contact an IBM technical support representative. |
| | Several CRUs | Hardware failure | Replace the affected CRUs. If this does not correct the problem, replace the RAID controllers, followed by the midplane. Contact an IBM technical support representative. |
| | Front panel | Power supply problem | Make sure that the power cables are plugged in and that the power supplies are turned on. |
| | | Hardware failure | If any other LEDs are lit, replace the midplane. Contact an IBM technical support representative. |

*Table 22. Symptom-to-FRU index (continued)*

| Problem indicator | Component | Possible cause | Possible solutions |
|---|---|---|---|
| Intermittent or sporadic power loss to the storage subsystem | Some or all CRUs | Defective ac power source or improperly connected power cable | Check the ac power source. Reseat all installed power cables and power supplies. If applicable, check the power components (power units or universal power supply). Replace defective power cables. |
| | | Drives are part of an exported array. When the array is exported, the power to the drives in the array is turned off so that they can be removed from the enclosure. | Use the Subsystem Management window in the DS Storage Manager to verify that the drives are indeed part of an exported array. If they are, remove the drives from the storage subsystem as required. **Note:** If the drives are removed, the empty drive slots must be filled with other drives or blank drive trays to ensure optimal air flow. |
| | | Drives are incompatible. Power to incompatible drives is turned off when they are inserted into the drive slots. | Use the Subsystem Management window in the DS Storage Manager to verify that the drives are recognized as incompatible. Replace the incompatible drives with drive options that are supported by the storage subsystem controllers. See the "Parts listing" on page 166 for a list of compatible drives. |
| | | Drive failure | Use the Subsystem Management window in the DS Storage Manager to verify that the drive or drives are recognized as failed by the storage subsystem. Replace the failed drives. See the "Parts listing" on page 166 for a list of compatible drives. |
| | | Power supply failure | Check the power supply Fault LED on the power supply. If the LED is lit, replace the failed CRU. |
| | | Midplane failure | Have the midplane replaced. Contact an IBM technical support representative. |

*Table 22. Symptom-to-FRU index  (continued)*

| Problem indicator | Component | Possible cause | Possible solutions |
|---|---|---|---|
| Unable to access drives | Drives and Fibre Channel loop | Incorrect storage subsystem ID settings | Make sure that the Fibre Channel optical cables are undamaged and properly connected. Check the storage subsystem ID settings.<br>**Note:** Change the switch position only when your storage subsystem is powered off. |
| | | RAID controller failure | Replace one or both RAID controllers. Contact an IBM technical support representative. |
| | | Drive or drives failed | Replace failed drive or drives. |
| Random errors | Storage subsystem | Midplane failure | Have the midplane replaced. Contact an IBM technical support representative. |
| Hard disk drive is not visible in RAID management software | Several CRUs | Drive or drives failed | Replace failed drive or drives. |
| | | Fibre Channel cable failed | Replace Fibre Channel cable. |
| | | SFP failed | Replace SFP. |
| | | RAID controller failure | Replace RAID controller. |
| | | Midplane failure | Have the midplane replaced. Contact an IBM technical support representative. |
| | | Drive CRU has interface problem with the ESM or controller. | Replace the drive CRU. |
| | | Incorrect firmware version | Verify that the DS5020 storage subsystem has the correct firmware version. Refer to "Software and hardware compatibility and upgrades" on page 19. |
| | | A controller has failed in addition to the ESM failure in the drive channel that originates from the functioning controller. | Replace the failed controller and ESM. |

*Table 22. Symptom-to-FRU index  (continued)*

| Problem indicator | Component | Possible cause | Possible solutions |
|---|---|---|---|
| Storage expansion enclosures are not attached to the storage subsystem | Storage subsystem | The DS5020 does not have the necessary feature options to support the storage expansion enclosures. | The base DS5020 storage subsystem supports up to 32 drives, which includes 16 drives in the DS5020 chassis and the 16 more drives if an EXP520 storage expansion enclosure is attached. To attach more than 32 drives, you much purchase the applicable feature option. For example, to attach one or more EXP810 storage expansion enclosures to the EXP520 storage subsystem, you must have the feature option for the EXP810. Contact your IBM marketing representative for more information about purchasing feature options. |

# Parts listing

Figure 90 and provides a parts listing for the DS5020.
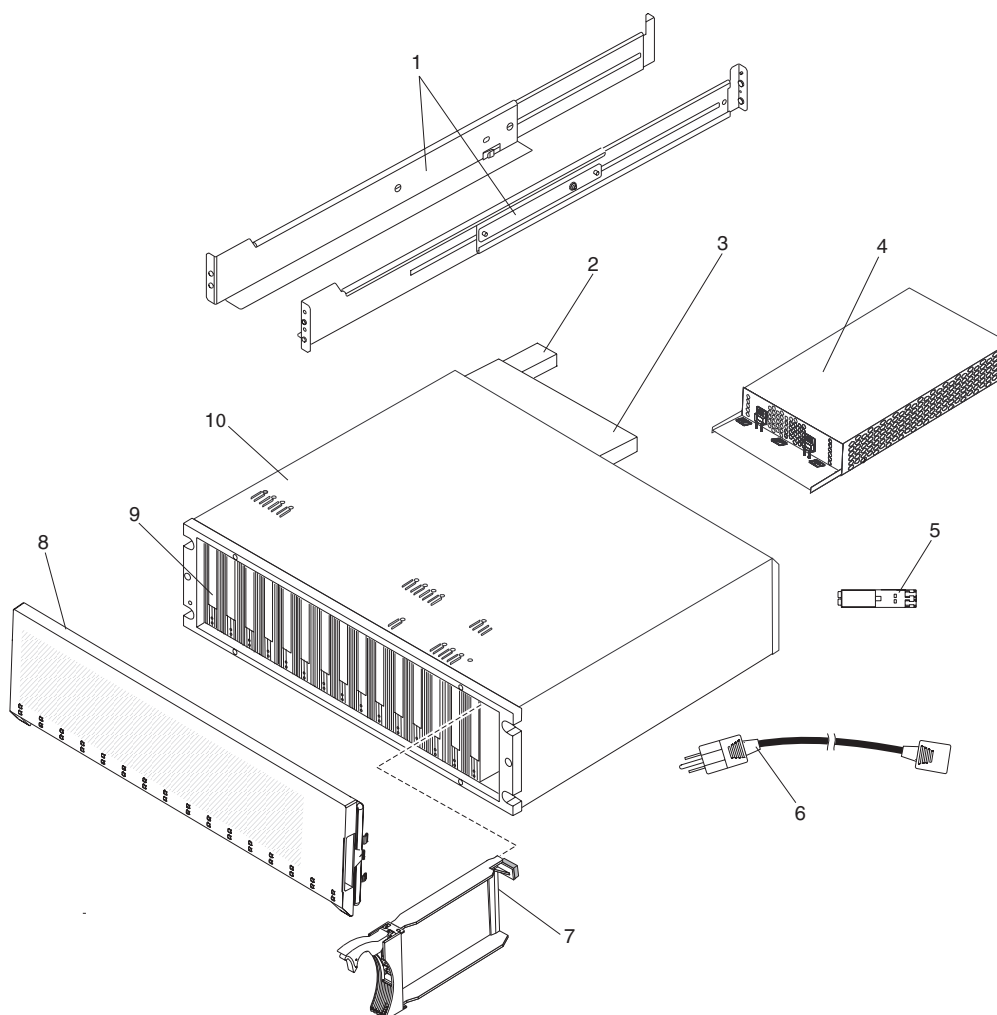


*Figure 90. DS5020 storage subsystem parts list*

*Table 23. Parts listing (DS5020 storage subsystem)*

| Index | DS5020 storage subsystem | CRU P/N |
|-------|--------------------------|---------|
| 1 | Rail kit | 41Y5152 |
| 2 | Battery | 59Y5260 |

*Table 23. Parts listing (DS5020 storage subsystem) (continued)*

| Index | DS5020 storage subsystem | CRU P/N |
|---|---|---|
| **3** | Controller, 1 GB memory, two standard 8 Gbps FC host ports, two standard 4 Gbps FC drive channel ports | 59Y5251 |
| | Controller, 1 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 8 Gbps FC host card, two standard 4 Gbps FC drive channel ports | 59Y5252 |
| | Controller, 1 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 1 GB iSCSI host card, two standard 4 Gbps FC drive channel ports | 59Y5254 |
| | Controller, 2 GB memory, two standard 8 Gbps FC host ports, two standard 4 Gbps FC drive channel ports | 59Y5256 |
| | Controller, 2 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 8 Gbps FC host card, two standard 4 Gbps FC drive channel ports | 59Y5258 |
| | Controller, 2 GB memory, two standard 8 Gbps FC host ports, one optional 2-port 1 GB iSCSI host card, two standard 4 Gbps FC drive channel ports | 59Y5259 |
| **4** | AC power supply and fan unit, 600 W | 59Y5502 |
| **5** | SFP LC (shortwave) transceiver, 8 Gbps | 49Y4123 |
| **6** | AC power cord, 2.8 m | 39M5081 |
| **7** | Empty drive filler panel | 42D3315 |
| **8** | NEBS bezel | 69Y2775 |
| | NEBS filter pack (4) | 42D3283 |

*Table 23. Parts listing (DS5020 storage subsystem) (continued)*

| Index | DS5020 storage subsystem | CRU P/N |
|---|---|---|
| **9** | E-DDM, 4 Gbps FC, 146.8 GB, 15,000 RPM drive module | 40K6823 |
| | E-DDM, 4 Gbps FC, 300 GB, 15,000 RPM drive module | 44X3231 |
| | E-DDM, 4 Gbps FC, 450 GB, 15,000 RPM drive module | 44X3237 |
| | E-DDM, 4 Gbps FC, 600 GB, 15,000 RPM drive module | 59Y5336 |
| | E-DDM, 4 Gbps FC, encryption-capable, 146.8 GB, 15,000 RPM drive module | 44E5638 |
| | E-DDM, 4 Gbps FC, encryption-capable, 300 GB, 15,000 RPM drive module | 44E5642 |
| | E-DDM, 4 Gbps FC, encryption-capable, 450 GB, 15,000 RPM drive module | 44E5646 |
| | E-DDM, 4 Gbps FC, encryption-capable, 600 GB 15,000 RPM drive module | 59Y5341 |
| | E-DDM, 3 Gbps SATA, 750 GB HS, 7,200 RPM drive module | 43W9715 |
| | E-DDM, 3 Gbps SATA, 1 TB, 7,200 RPM drive module | 44X3241 |
| | E-DDM, 3 Gbps SATA, 2 TB HS, 7,200 RPM drive module | 59Y5484 |
| | E-DDM, 4 Gbps FC, Solid State Disk, 300 GB | 49Y4157 |
| | E-DDM, 4 Gbps FC, Solid State Disk, 73 GB | 49Y4156 |
| | E-DDM, FC-SAS, 600 GB 10,000 RPM drive module | 81Y2408 |
| | E-DDM, FC-SAS, 200 GB Solid State Disk drive module | 81Y2430 |
| | E-DDM, FC-SAS, 400 GB Solid State Disk drive module | 81Y2431 |
| | E-DDM, FC-SAS, encryption-capable, 600 GB 10,000 RPM drive module | 81Y2409 |
| | E-DDM, FC-SAS, 300 GB 10,000 RPM drive module | 81Y2406 |
| | E-DDM, FC-SAS, 900 GB 10,000 RPM drive module | 81Y2464 |
| | E-DDM, FC-SAS, 3 TB 7,200 rpm 3.5" Disk drive module | 81Y2458 |
| **9** | DDM Gen 2, FC-SAS, 300 GB 10,000 RPM drive module | 00Y4601 |
| | DDM Gen 2, FC-SAS, 600 GB 10,000 RPM drive module | 00Y4602 |
| | DDM Gen 2, FC-SAS, 900 GB 10,000 RPM drive module | 00Y4603 |

*Table 23. Parts listing (DS5020 storage subsystem) (continued)*

| Index | DS5020 storage subsystem | CRU P/N |
|---|---|---|
| **10** | Cage assembly | 59Y5249 |
| | Cable, fiber-optic, 1 m | 39M5699 |
| | Cable, fiber-optic, 5 m | 39M5700 |
| | Cable, fiber-optic, 25 m | 39M5701 |
| | LC wrap plug assembly | 39M5914 |
| | SFP (shortwave), 4 Gbps | 22R6443 |
| | OM3 fiber optic cable LC to LC 10 meter | 45W2222 |
| | SFP, 8 Gbps | 49Y4123 |
| | Serial cable adapter | 39M5942 |
| | Line cord jumper, high-voltage | 39M5377 |

# Determining basic information of drive FRUs

IBM might ship drive FRUs of higher capacity than that of the drive FRUs they replace. These new drives are programmed in manufacturing to give the same capacity as the drive FRUs being replaced.

The new drive FRUs have different model IDs than the ones printed on the drive manufacturer label. You can determine the model ID and other information of these drives by referring to one of the following windows of the DS Storage Manager software:

- Properties pane in the Hardware tab of the Subsystem Management window
- Storage Subsystem Profile window

You can also use the IBM hologram label to determine the drive capacity and the drive FRU part number. A sample IBM hologram label is shown in the following figure.

*Figure 91. An IBM hologram label example*

# Appendix A. Records

Whenever you add options to your DS5020, be sure to update the information in this appendix. Accurate, up-to-date records make it easier to add other options and provide needed data whenever you contact your IBM technical support representative.

## Identification numbers

Record and retain the following information.

| Product name: | IBM System Storage DS5020 Storage Subsystem |
|---|---|
| Machine type: | 1814 |
| Model number: | 20A |
| Serial number: | |

The serial number is located on the bottom inside surface at the rear and on the left edge at the front of the DS5020.

# Storage subsystem and controller information record

Table 24 provides a data sheet for recording storage subsystem names, management types, Ethernet hardware addresses, and IP addresses. Make a copy of this table and complete the information for your storage subsystems and controllers. Use the information to set up the BOOTP table for the network server and the host or Domain Name System (DNS) table. The information is also helpful if you add storage subsystems after initial installation. Refer to your Storage Manager documentation for detailed instructions about how to obtain the information. For a sample information record, see Table 25 on page 173.

*Table 24. Storage subsystem and controller information record*

| Storage subsystem name | Management method | Controllers-Ethernet and IP addresses, and host name | | Host-IP address and host name |
|---|---|---|---|---|
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# Sample information record

Table 25 shows a sample information record. This network contains storage subsystems that are managed by using both the direct-management and host-agent-management method.

*Table 25. Sample information record*

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

# Installed device records

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

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

*Table 26. Hard disk drive record*

| Bay number | Hard disk drive serial number | Replaced hard disk drive serial number |
|---|---|---|
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# Appendix B. Rack mounting templates

This appendix provides duplicate copies of the rack mounting templates. If you want to tear out the templates from this document, use these copies rather than those provided in "Installing the support rails" on page 35.

Use the following templates (Figure 92 on page 176 and Figure 93 on page 177) to identify the proper locations for inserting M5 screws when mounting the support rails and DS5020 to a rack. The locations for the M5 screws are highlighted in the templates.

The DS5020 is 3 U high. Align the template with the rack at a U boundary. U boundaries are shown as horizontal dashed lines in the rack mounting templates.

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

DS5020
FRONT
Rack Mounting
Template

3 U

Install second --->  Bezel (Front Left)

Install first --->

2 U

Install first --->

1 U

Install second --->  Rail assembly (Front Left)

0 U

3 U

Bezel (Front Right)

<--- Install first

2 U

<--- Install first

1 U

Rail assembly (Front Right)

0 U
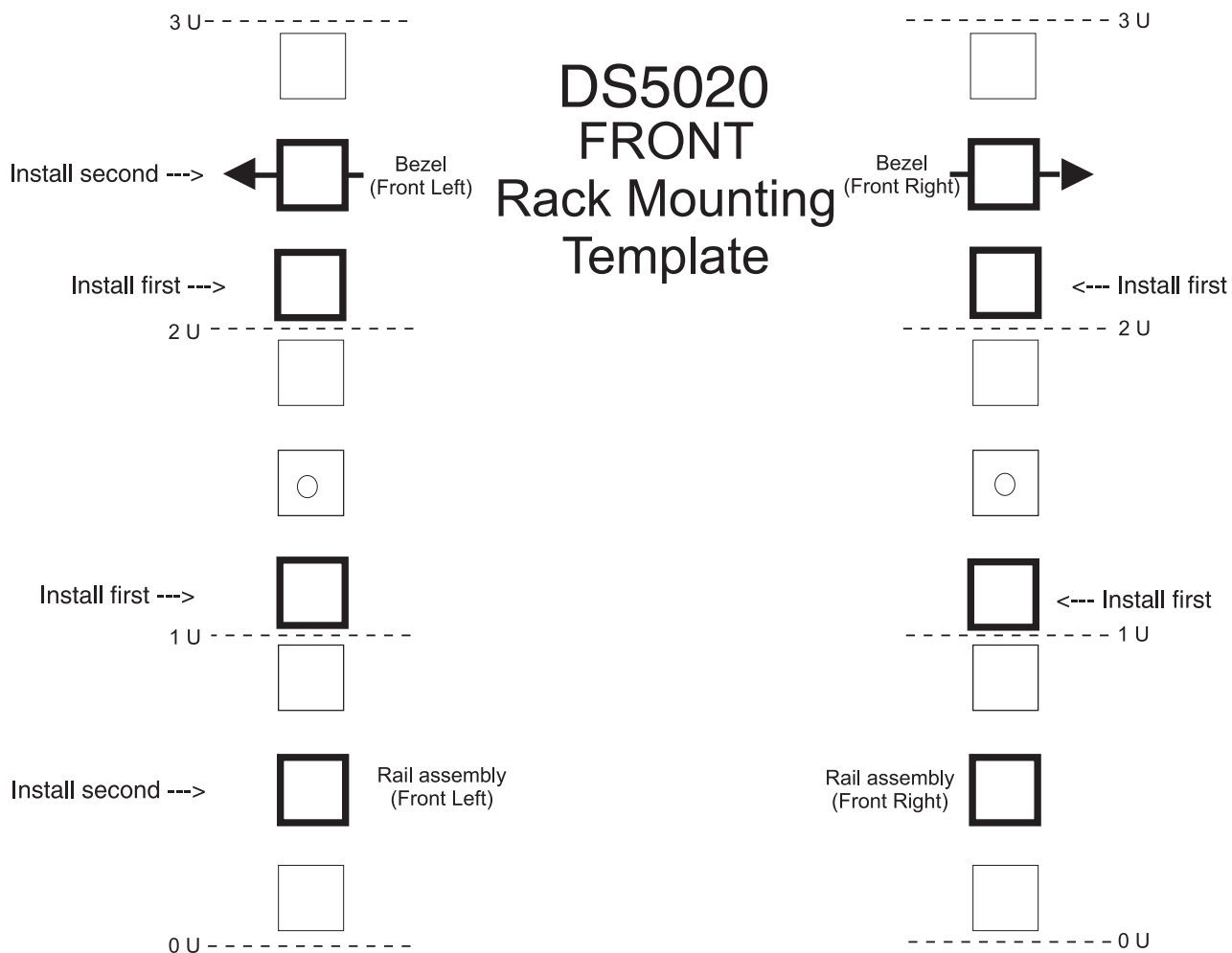
*Figure 92. Front rack mounting template*

DS5020
REAR
Rack Mounting
Template

Rail mounting guide

Rail assembly
(Rear Left)

Rail assembly
(Rear right)

IBM®

Printed in the U.S.A

3U

2U

1U

0U

3U

2U

1U

0U
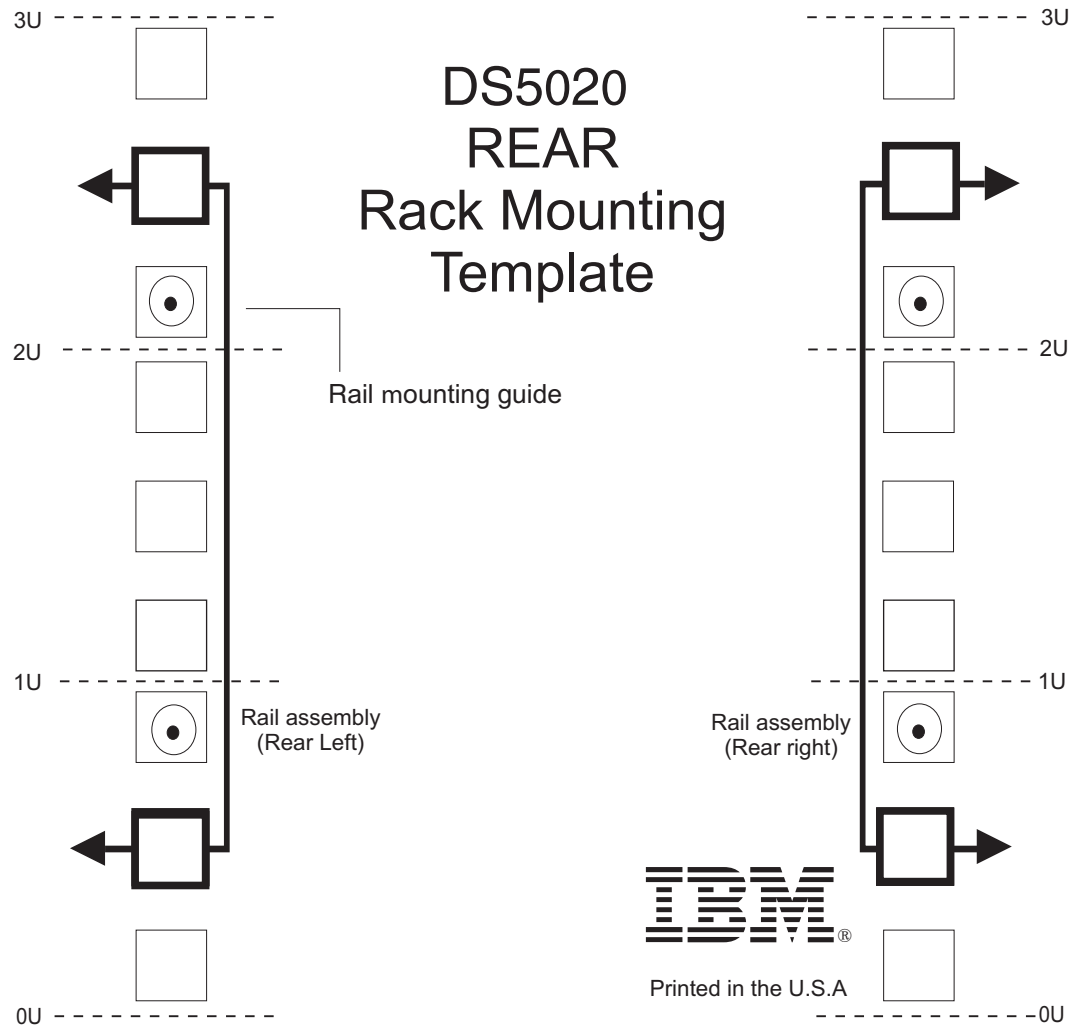
*Figure 93. Rear rack mounting template*

# Appendix C. Specifications for non-IBM rack installation

The following instructions provide safety requirements and rack specifications for installing DS5000 storage subsystems and DS5000 storage expansion enclosures into non-IBM racks.

**Note:** The information in this section applies to 19–inch racks. It is your responsibility, working with your rack manufacturer, to ensure that the non-IBM rack chosen meets the safety requirements and specifications listed in this section.

## General safety requirements for IBM products installed in a non-IBM rack or cabinet

The general safety requirements for IBM products installed in non-IBM racks are:

1. Any product or component that plugs into either an IBM power distribution unit or mains power (via a power cord), or uses any voltage over 42 V ac or 60 V dc (considered to be hazardous voltage) must be Safety Certified by a Nationally Recognized Test Laboratory (NRTL) for the country in which it will be installed.

   Some of the items that require safety certification may include: the rack or cabinet (if it contains electrical components integral to the rack or cabinet), fan trays, power distribution unit, uninterruptible power supplies, multi-outlet strips, or any other products installed in the rack or cabinet that connect to hazardous voltage.

   Examples of OSHA-approved NRTLs for the U.S.:

   * UL
   * ETL
   * CSA (with CSA NRTL or CSA US mark)

   Examples of approved NRTLs for Canada:

   a. UL (Ulc mark)
   b. ETL (ETLc mark)
   c. CSA

   The European Union requires a CE mark and a Manufacturer's Declaration of Conformity (DOC).

   Certified products should have the NRTL logos or marks somewhere on the product or product label. However, proof of certification must be made available to IBM upon request. Proof consists of such items as copies of the NRTL license or certificate, a CB Certificate, a Letter of Authorization to apply the NRTL mark, the first few pages of the NRTL certification report, Listing in an NRTL publication, or a copy of the UL Yellow Card. Proof should contain the manufacturer's name, product type and model, standard to which it was certified, the NRTL name or logo, the NRTL file number or license number, and a list of any Conditions of Acceptance or Deviations. A Manufacturer's Declaration is not proof of certification by an NRTL.

2. The rack or cabinet must meet all electrical and mechanical safety legal requirements for the country in which it is installed.

The rack or cabinet must be free of exposed hazards (such as voltages over 60 V dc or 42 V ac, energy over 240 VA, sharp edges, mechanical pinch points, or hot surfaces).

3. There must be an accessible and unambiguous disconnect device for each product in the rack, including any power distribution unit.

   A disconnect device might consist of either the plug on the power cord (if the power cord is no longer than 1.8 m (6 ft.)), the appliance inlet receptacle (if the power cord is of a detachable type), or a power on/off switch, or an Emergency Power Off switch on the rack, provided all power is removed from the rack or product by the disconnect device.

   If the rack/or cabinet has electrical components (such as fan trays or lights), the rack must have an accessible and unambiguous disconnect device.

4. The rack or cabinet, power distribution unit and multi-outlet strips, and products installed in the rack or cabinet must all be properly grounded to the customer facility ground.

   There must be no more than 0.1 Ohms between the ground pin of the power distribution unit or rack plug and any touchable metal or conductive surface on the rack and on the products installed in the rack. Grounding method must comply with applicable country's electric code (such as NEC or CEC). Ground continuity can be verified by your IBM service personnel, after the installation is completed, and should be verified prior to the first service activity.

5. The voltage rating of the power distribution unit and multi-outlet strips must be compatible with the products plugged into them.

   The power distribution unit or multi-outlet strips current and power ratings are rated at 80 percent of the building supply circuit (as required by the National Electrical Code and the Canadian Electrical Code). The total load connected to the power distribution unit must be less than the rating of the power distribution unit. For example, a power distribution unit with a 30 A connection will be rated for a total load of 24 A (30 A x 80 percent). Therefore, the sum of all equipment connected to the power distribution unit in this example must be lower than the 24 A rating.

   If an uninterruptible power supply is installed, it must meet all the above electrical safety requirements as described for a power distribution unit (including certification by an NRTL).

6. The rack or cabinet, power distribution unit, uninterruptible power supply, multi-outlet strips and all products in the rack or cabinet must be installed according to the manufacturer's instructions, and in accordance with all national, state or province, and local codes and laws.

   The rack or cabinet, power distribution unit, uninterruptible power supply, multi-outlet strips and all products in the rack or cabinet must be used as intended by the manufacturer (per manufacturer's product documentation and marketing literature).

7. All documentation for use and installation of the rack or cabinet, power distribution unit, uninterruptible power supply, and all products in the rack or cabinet, including safety information, must be available on-site.

8. If there is more than one source of power in the rack cabinet, there must be clearly visible safety labels for "Multiple Power Source" (in the languages required for the country in which the product is installed).

9. If the rack or cabinet or any products installed in the cabinet had safety or weight labels applied by the manufacturer, they must be intact and translated into the languages required for the country in which the product is installed.

10. The rack or cabinet configuration must comply with all IBM requirements for "safe to service" (contact your IBM Installation Planning Representative for assistance in determining if the environment is safe).

    There must be no unique maintenance procedures or tools required for service.

11. Elevated service installations, where the product(s) to be serviced are installed between 1.5 m and 3.7 m (5 ft. and 12 ft.) above the floor, require the availability of an OSHA- and CSA-approved nonconductive step ladder. If a ladder is required for service, the customer must supply the OSHA- and CSA-approved nonconductive step ladder (unless other arrangements have been made with the local IBM Service Branch Office). Products installed over 2.9 m (9 ft.) above the floor requires a Special Bid to be completed before they can be serviced by IBM service personnel.

    For products not intended for rack-mounting to be serviced by IBM, the products and parts that will be replaced as part of that service must not weigh over 11.4 kg (25 lb). (Contact your Installation Planning Representative if in doubt).

12. There must not be any special education or training required for safe servicing of any of the product(s) installed in the racks. (Contact your Installation Planning Representative if in doubt).

## Rack specifications

When installing a DS5000 storage subsystem or DS5000 storage expansion enclosure into a non-IBM rack, follow the specifications below.

1. The rack or cabinet must meet the EIA Standard EIA-310-D for 19-inch racks published August 24, 1992. The EIA-310-D standard specifies internal dimensions, for example, the width of the rack opening (width of the chassis), the width of the module mounting flanges, the mounting hole spacing, and the depth of the mounting flanges. The EIA-310-D standard does not control the overall external width of the rack. There are no restrictions on the location of side walls and corner posts relative to the internal mounting space.

    The front rack opening must be 451 mm wide + 0.75 mm (17.75 in. + 0.03 in.), and the rail-mounting holes must be 465 mm + 0.8 mm (18.3 in. + 0.03 in.) apart on center (horizontal width between vertical columns of holes on the two front-mounting flanges and on the two rear-mounting flanges).

571 mm (22.50 in.)

Back, No Door

Drawer Rail
Mounting Flanges

494 mm (19.45 in.)

203 mm (8.0 in.)

719 mm (28.31 in.)

51 mm (2.01 in)

Front, No Door

nonibm_topview

451 mm (17.46 in.)

494 mm (19.45 in.)
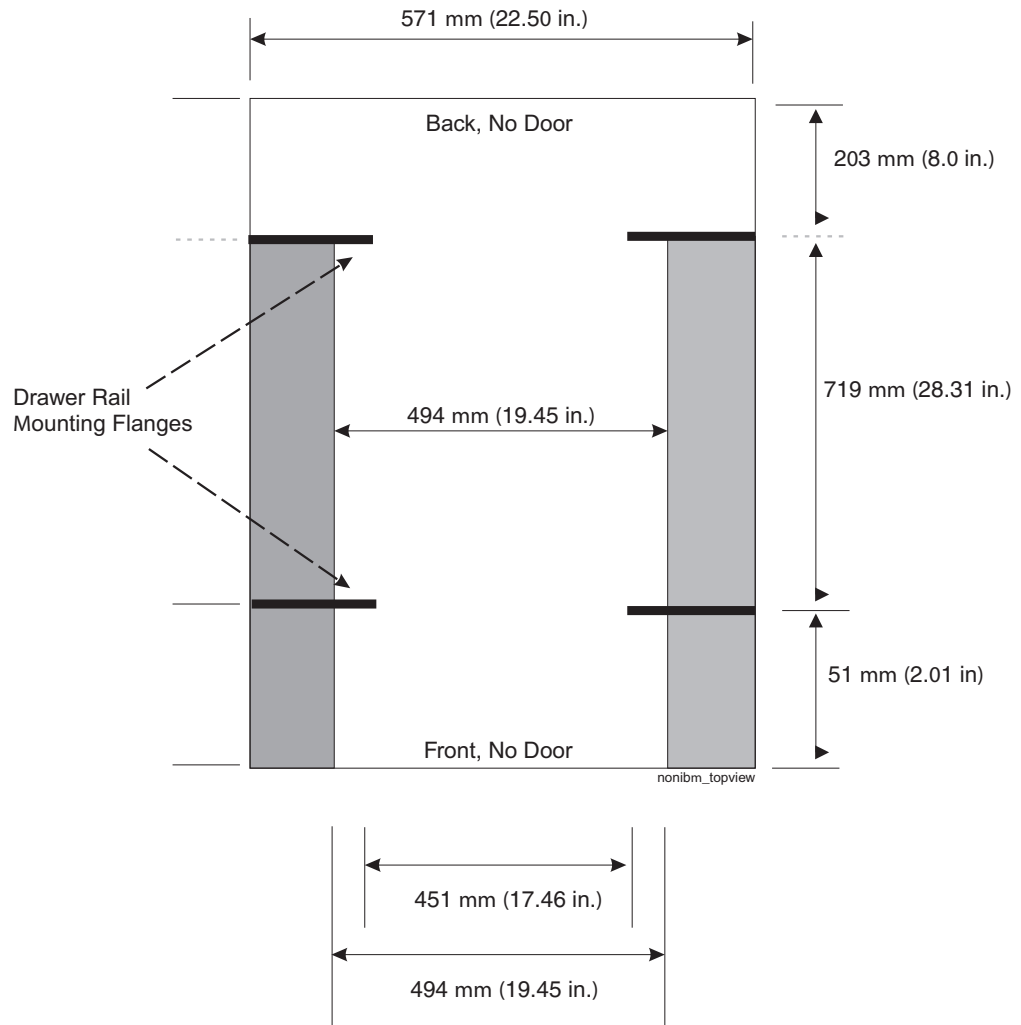
*Figure 94. Top View of non-IBM Rack Specifications Dimensions*

Top view of non-IBM rack specifications dimensions

The vertical distance between mounting holes must consist of sets of three holes spaced (from bottom to top) 15.9 mm (0.625 in.), 15.9 mm (0.625 in.), and 12.67 mm (0.5 in.) on center (making each three hole set of vertical hole spacing 44.45 mm (1.75 in.) apart on center). The front and rear mounting flanges in the rack or cabinet must be 719 mm (28.3 in.) apart and the internal width bounded by the mounting flanges at least 494 mm (19.45 in.), for the IBM Storage System or eServer™ rails to fit in your rack or cabinet (see Figure 94).
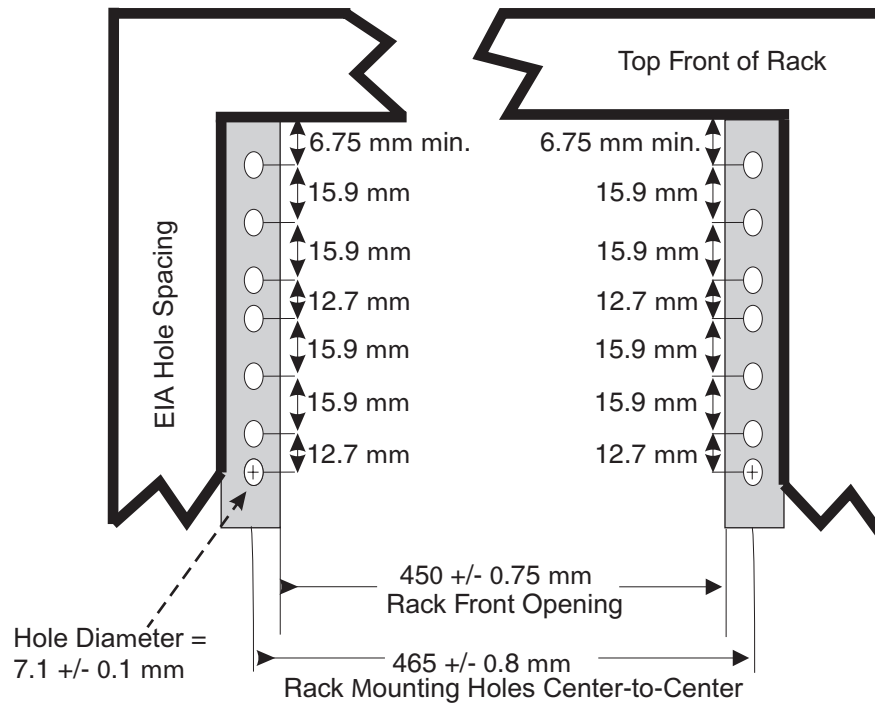
*Figure 95. Rack specifications dimensions, top front view*
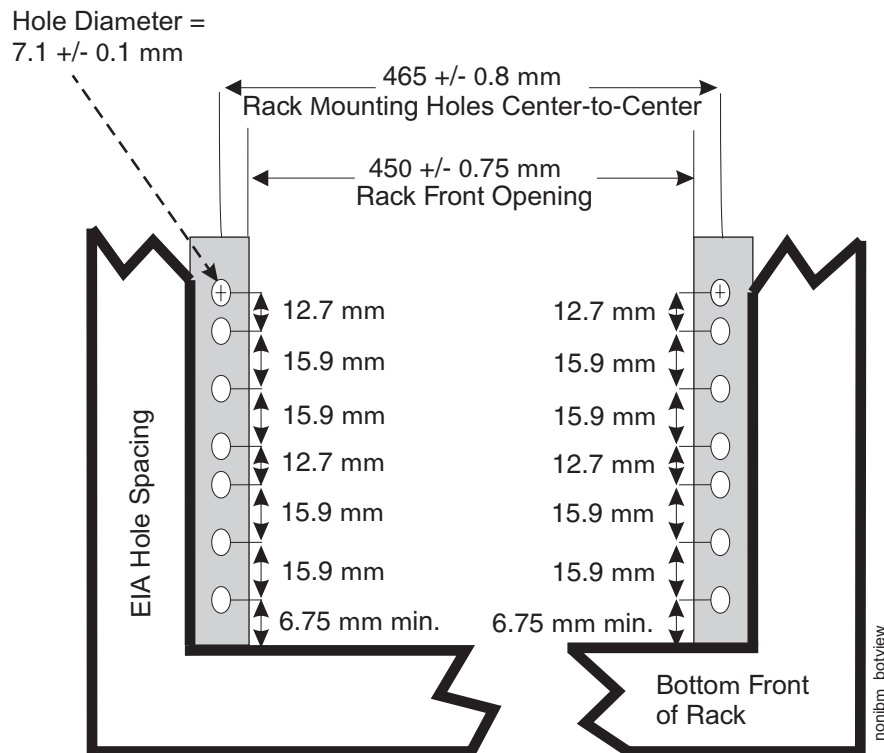


*Figure 96. Rack specifications dimensions, bottom front view*

2. The rack or cabinet must be capable of supporting an average load of 15.9 kg
   (35 lb.) of product weight per EIA unit.

For example, a four EIA drawer will have a maximum drawer weight of 63.6 kg (140 lb.).

3. AC or dc power drawers need to be support based on equipment purchased for the rack or cabinet. It is strongly recommended that you use a power distribution unit that meets the same specifications as each unit already installed in the rack. Each power distribution unit needs a dedicated power line. Rack or cabinet power distribution device(s) must meet the drawer power requirements, as well as that of any additional products that will be connected to the same power distribution device.

   The rack or cabinet power receptacle (power distribution unit, uninterruptible power supply, or multi-outlet strip) must have a compatible plug type for your drawer or device. The customer is responsible for ensuring the power distribution unit is compatible with the rack or cabinet and assumes responsibility for any and all agency certifications required.

4. The rack or cabinet must be compatible with drawer mounting rails, including a secure and snug fit of the rail-mounting pins and screws into the rack or cabinet rail mounting holes. You must use the IBM mounting rails that are shipped with the IBM product to install it in the rack. The mounting rails that ship with IBM products have been designed and tested to safely support the product during operation and service activities as well as to safely support the weight of your drawer or device. The rails must facilitate service access by allowing the drawer to be safely extended, if necessary, forwards, backwards, or both.

   **Note:** If the rack or cabinet has square holes on the mounting flanges, additional hardware might be required.

5. The rack or cabinet must have stabilization feet or brackets installed both in the front and rear of the rack, or have another means of preventing the rack/cabinet from tipping while the drawer or device is pulled into its extreme front or rear service positions.

   Examples of some acceptable alternatives: The rack or cabinet can be securely bolted to the floor, ceiling or walls, or to adjacent racks or cabinets in a long and heavy row of racks or cabinets.

6. There must be adequate front and rear service clearances (in and around the rack or cabinet).

   The rack or cabinet must have sufficient horizontal width clearance in the front and rear to allow the drawer to be fully slid into the front and, if applicable, the rear service access positions (typically this requires 914.4 mm (36 in.) clearance in both the front and rear).

   If present, front and rear doors must be able to open far enough to provide unrestrained access for service or be easily removable. If doors must be removed for service, it is the customer's responsibility to remove them prior to service.

7. The rack or cabinet must provide adequate clearance around the rack drawer.

   There must be adequate clearance around the drawer bezel so that it can be opened and closed, according to the product specifications.

   Front or rear doors must also maintain a minimum of 51 mm (2 in.) front, 203 mm (8 in.) rear, door to mounting flange clearance, and 494 mm (19.4 in.) front, 571 mm (22.5 in.) rear, side-to-side clearance for drawer bezels and cables (see Figure 94 on page 182).

8. The rack or cabinet must provide adequate front-to-back ventilation.

   For optimum ventilation, it is recommended the rack or cabinet not have a front door. If the rack or cabinet has doors, the doors must be fully perforated

so that there is proper front-to-back airflow to maintain the required drawer ambient inlet temperature as specified in the server specifications. The perforations should yield at least 34 percent minimum open area per square inch.

# Appendix D. Power cords

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

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

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

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

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

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

*Table 27. IBM power cords*

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

*Table 27. IBM power cords  (continued)*

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

*Table 27. IBM power cords (continued)*

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

# Appendix E. Additional DS5020 documentation

For educational information about the DS5020 and other IBM System Storage products, go to http://ibmdsseriestraining.com/.

The following tables present an overview of the IBM System Storage DS Storage Manager, storage subsystem, and storage expansion enclosure product libraries, as well as other related documents. Each table lists documents that are included in the libraries and what common tasks they address.

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

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

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

## DS Storage Manager Version 10 library

Table 28 associates each document in the DS Storage Manager Version 10 library with its related common user tasks.

*Table 28. DS Storage Manager Version 10 titles by user tasks*

| Title | User tasks | | | | | |
|---|---|---|---|---|---|---|
| | Planning | Hardware installation | Software installation | Configuration | Operation and administration | Diagnosis and maintenance |
| *IBM System Storage DS5020 Quick Start Guide* | | ✔ | ✔ | ✔ | | |
| *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide for Windows 2000/Server 2003/2008, NetWare, VMWare ESX Server, and Linux* | ✔ | | ✔ | ✔ | | |
| *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide for AIX, UNIX, Solaris, and Linux on POWER* | ✔ | | ✔ | ✔ | | |
| *IBM System Storage DS Storage Manager Copy Services User's Guide* | ✔ | | ✔ | ✔ | ✔ | |

*Table 28. DS Storage Manager Version 10 titles by user tasks  (continued)*

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

# DS5020 storage subsystem library

Table 29 associates each document in the DS5020 storage subsystem library with its related common user tasks.

*Table 29. DS5020 storage subsystem document titles by user tasks*

| Title | User Tasks | | | | | |
|---|---|---|---|---|---|---|
| | **Planning** | **Hardware Installation** | **Software Installation** | **Configuration** | **Operation and Administration** | **Diagnosis and Maintenance** |
| *IBM System Storage DS5020 Storage Subsystem Installation, User's and Maintenance Guide* | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| *IBM System Storage Quick Start Guide, Quick Reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420* | | ✔ | ✔ | ✔ | | |
| *IBM System Storage DS5020 Quick Start Guide* | | ✔ | ✔ | ✔ | | |

# DS4800 storage subsystem library

Table 30 associates each document in the DS4800 storage subsystem library with its related common user tasks.

*Table 30. DS4800 storage subsystem document titles by user tasks*

| Title | User Tasks | | | | | |
|---|---|---|---|---|---|---|
| | **Planning** | **Hardware Installation** | **Software Installation** | **Configuration** | **Operation and Administration** | **Diagnosis and Maintenance** |
| *IBM System Storage DS4800 Storage Subsystem Installation, User's and Maintenance Guide* | ✔ | ✔ | | ✔ | ✔ | ✔ |
| *IBM System Storage Quick Start Guide, Quick Reference for the DS4800* | | ✔ | ✔ | ✔ | | |
| *IBM TotalStorage DS4800 Controller Cache Upgrade Kit Instructions* | ✔ | ✔ | | ✔ | | |

# DS4700 storage subsystem library

Table 31 associates each document in the DS4700 storage subsystem library with its related common user tasks.

*Table 31. DS4700 storage subsystem document titles by user tasks*

| Title | User Tasks | | | | | |
|---|---|---|---|---|---|---|
| | Planning | Hardware Installation | Software Installation | Configuration | Operation and Administration | Diagnosis and Maintenance |
| *IBM System Storage DS4700 Storage Subsystem Installation, User's and Maintenance Guide* | ✔ | ✔ | | ✔ | ✔ | ✔ |
| *IBM System Storage Quick Start Guide, Quick Reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420* | | ✔ | ✔ | ✔ | | |
| *IBM TotalStorage DS4500 Storage Subsystem Installation, User's, and Maintenance Guide* | ✔ | ✔ | | ✔ | | |
| *IBM TotalStorage DS4500 Storage Subsystem Cabling Instructions* | ✔ | ✔ | | | | |
| *IBM TotalStorage DS4500 Rack Mounting Instructions* | ✔ | ✔ | | | | |

# DS4500 storage subsystem library

Table 32 associates each document in the DS4500 storage subsystem library with its related common user tasks.

*Table 32. DS4500 storage subsystem document titles by user tasks*

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

# DS4400 storage subsystem library

Table 33 associates each document in the DS4400 storage subsystem library with its related common user tasks.

*Table 33. DS4400 storage subsystem document titles by user tasks*

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

# DS4300 storage subsystem library

Table 34 associates each document in the DS4300 storage subsystem library with its related common user tasks.

*Table 34. DS4300 storage subsystem document titles by user tasks*

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

# DS4200 Express storage subsystem library

Table 35 associates each document in the DS4200 Express storage subsystem library with its related common user tasks.

*Table 35. DS4200 Express storage subsystem document titles by user tasks*

| Title | User Tasks | | | | | |
|---|---|---|---|---|---|---|
| | **Planning** | **Hardware Installation** | **Software Installation** | **Configuration** | **Operation and Administration** | **Diagnosis and Maintenance** |
| *IBM System Storage DS4200 Express Storage Subsystem Installation, User's and Maintenance Guide* | ✔ | ✔ | | ✔ | ✔ | ✔ |
| *IBM System Storage Quick Start Guide, Quick Reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420* | | ✔ | ✔ | ✔ | | |

# DS4100 Storage subsystem library

Table 36 associates each document in the DS4100 storage subsystem library with its related common user tasks.

*Table 36. DS4100 storage subsystem document titles by user tasks*

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

# DS5000 and DS4000 storage expansion enclosure documents

Table 37 associates each of the following documents with its related common user tasks.

*Table 37. DS5000 and DS4000 storage expansion enclosure document titles by user tasks*

| Title | User Tasks | | | | | |
|---|---|---|---|---|---|---|
| | **Planning** | **Hardware Installation** | **Software Installation** | **Configuration** | **Operation and Administration** | **Diagnosis and Maintenance** |
| *IBM System Storage EXP520 Expansion Enclosure Installation, User's, and Maintenance Guide* | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| *IBM System Storage DS4000 EXP810 Storage Expansion Enclosure Installation, User's, and Maintenance Guide* | ✔ | ✔ | | ✔ | ✔ | ✔ |
| *IBM System Storage Quick Start Guide, Quick Reference for the DS4700 and DS4200, Sections 2, 3, and 4 also for installing the EXP810 and EXP420* | | ✔ | ✔ | ✔ | | |
| *IBM TotalStorage DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide* | ✔ | ✔ | | ✔ | ✔ | ✔ |
| *IBM EXP500 Installation and User's Guide* | ✔ | ✔ | | ✔ | ✔ | ✔ |
| *IBM System Storage DS4000 EXP420 Storage Expansion Enclosure Installation, User's, and Maintenance Guide* | ✔ | ✔ | | ✔ | ✔ | ✔ |
| *IBM System Storage DS4000 Hard Drive and Storage Expansion Enclosures Installation and Migration Guide* | ✔ | ✔ | | | | |

# Other DS5000 and DS4000-related documents

Table 38 associates each of the following documents with its related common user tasks.

*Table 38. DS5000 and DS4000-related document titles by user tasks*

| Title | User Tasks | | | | | |
|-------|-----------|-----------|-----------|---------------|---------------------------|----------------------------|
| | **Planning** | **Hardware Installation** | **Software Installation** | **Configuration** | **Operation and Administration** | **Diagnosis and Maintenance** |
| *IBM Safety Information* | | | | | ✔ | |
| *IBM TotalStorage DS4000 Hardware Maintenance Manual* 1 | | | | | | ✔ |
| *IBM System Storage DS4000 Problem Determination Guide* | | | | | | ✔ |
| *IBM Fibre Channel Planning and Integration: User's Guide and Service Information* | ✔ | ✔ | | | ✔ | ✔ |
| *IBM TotalStorage DS4000 FC2-133 Host Bus Adapter Installation and User's Guide* | | ✔ | | | ✔ | |
| *IBM TotalStorage DS4000 FC2-133 Dual Port Host Bus Adapter Installation and User's Guide* | | ✔ | | | ✔ | |
| *IBM Netfinity® Fibre Channel Cabling Instructions* | | ✔ | | | | |
| *IBM Fibre Channel SAN Configuration Setup Guide* | ✔ | | ✔ | ✔ | ✔ | |

**Notes:**

1. The *IBM TotalStorage DS4000 Hardware Maintenance Manual* does not contain maintenance information for the IBM System Storage DS4100, DS4200, DS4300, DS4500, DS4700, or DS4800 storage subsystems. You can find maintenance information for these products in the *IBM System Storage DSx000 Storage Subsystem Installation, User's, and Maintenance Guide* for the particular subsystem.

# Appendix F. Accessibility

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

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

**Note:** In addition to the keyboard operations that are described in this section, the DS Storage Manager version 9.14 - 10.10 (and later) software installation packages for Windows include a screen reader software interface.

To enable the screen reader, select Custom Installation when using the installation wizard to install Storage Manager 9.14 - 10.10 (or later) on a Windows host/management station. Then, in the Select Product Features window, select Java Access Bridge in addition to the other required host software components.

Table 39 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 39. DS Storage Manager alternate keyboard operations*

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

*Table 39. DS Storage Manager alternate keyboard operations  (continued)*

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

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

CD or DVD drive speed is the variable read rate. Actual speeds vary and are often less than the possible maximum.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for 1024 bytes, MB stands for 1 048 576 bytes, and GB stands for 1 073 741 824 bytes.

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 can vary depending on operating environments.

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

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**Attention:** Airborne particulates (including metal flakes or particles) and reactive gases acting alone or in combination with other environmental factors such as humidity or temperature might pose a risk to the storage subsystem that is described in this document. Risks that are posed by the presence of excessive particulate levels or concentrations of harmful gases include damage that might cause the storage subsystem to malfunction or cease functioning altogether. This specification sets forth limits for particulates and gases that are intended to avoid such damage. The limits must not be viewed or used as definitive limits, because numerous other factors, such as temperature or moisture content of the air, can influence the impact of particulates or environmental corrosives and gaseous contaminant transfer. In the absence of specific limits that are set forth in this document, you must implement practices that maintain particulate and gas levels that are consistent with the protection of human health and safety. If IBM determines that the levels of particulates or gases in your environment have caused damage to the storage subsystem, IBM may condition provision of repair or replacement of storage subsystem or parts on implementation of appropriate remedial measures to mitigate such environmental contamination. Implementation of such remedial measures is a customer responsibility.

*Table 40. Limits for particulates and gases*

| Contaminant | Limits |
|---|---|
| Particulate | • The room air must be continuously filtered with 40% atmospheric dust spot efficiency (MERV 9) according to ASHRAE Standard 52.2[1].<br>• Air that enters a data center must be filtered to 99.97% efficiency or greater, using high-efficiency particulate air (HEPA) filters that meet MIL-STD-282.<br>• The deliquescent relative humidity of the particulate contamination must be more than 60%[2].<br>• The room must be free of conductive contamination such as zinc whiskers. |
| Gaseous | • Copper: Class G1 as per ANSI/ISA 71.04-1985[3]<br>• Silver: Corrosion rate of less than 300 Å in 30 days |

[1] ASHRAE 52.2-2008 - *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

[2] The deliquescent relative humidity of particulate contamination is the relative humidity at which the dust absorbs enough water to become wet and promote ionic conduction.

[3] ANSI/ISA-71.04-1985. *Environmental conditions for process measurement and control systems: Airborne contaminants*. Instrument Society of America, Research Triangle Park, North Carolina, U.S.A.

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## Germany Electromagnetic Compatibility Directive

**Deutschsprachiger EU Hinweis:**

**Hinweis für Geräte der Klasse A EU-Richtlinie zur Elektromagnetischen Verträglichkeit**

Dieses Produkt entspricht den Schutzanforderungen der EU-Richtlinie 2004/108/EG zur Angleichung der Rechtsvorschriften über die elektromagnetische Verträglichkeit in den EU-Mitgliedsstaaten und hält die Grenzwerte der EN 55022 Klasse A ein.

Um dieses sicherzustellen, sind die Geräte wie in den Handbüchern beschrieben zu installieren und zu betreiben. Des Weiteren dürfen auch nur von der IBM empfohlene Kabel angeschlossen werden. IBM übernimmt keine Verantwortung für die Einhaltung der Schutzanforderungen, wenn das Produkt ohne Zustimmung der IBM verändert bzw. wenn Erweiterungskomponenten von Fremdherstellern ohne Empfehlung der IBM gesteckt/eingebaut werden.

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**Deutschland: Einhaltung des Gesetzes über die elektromagnetische Verträglichkeit von Geräten**

Dieses Produkt entspricht dem "Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG)". Dies ist die Umsetzung der EU-Richtlinie 2004/108/EG in der Bundesrepublik Deutschland.

**Zulassungsbescheinigung laut dem Deutschen Gesetz über die elektromagnetische Verträglichkeit von Geräten (EMVG) (bzw. der EMC EG Richtlinie 2004/108/EG) für Geräte der Klasse A**

Dieses Gerät ist berechtigt, in Übereinstimmung mit dem Deutschen EMVG das EG-Konformitätszeichen - CE - zu führen.

Verantwortlich für die Einhaltung der EMV Vorschriften ist der Hersteller:
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**Generelle Informationen:**

**Das Gerät erfüllt die Schutzanforderungen nach EN 55024 und EN 55022 Klasse A.**

## Japan Voluntary Control Council for Interference (VCCI) Class A Statement

この装置は、クラス A 情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。　　　　VCCI-A

**Translation:** This is a Class A product based on the standard of the VCCI Council. If this equipment is used in a domestic environment, radio interference may occur, in which case, the user may be required to take corrective actions.

## Japan Electronics and Information Technology Industries Association (JEITA) Statement

Japanese Electronics and Information Technology Industries Association (JEITA) Confirmed Harmonics Guideline (products less than or equal to 20 A per phase).

高調波ガイドライン適合品　　jiieta1

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# Glossary

This glossary provides definitions for the terminology and abbreviations used in IBM System Storage DS5000 and 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 link and vice versa. Also called an I/O adapter, host adapter, or Fibre Channel 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 Fibre Channel 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 Fibre Channel adapter.

**drive channels.** The DS4200, DS4700, and DS4800 subsystems use dual-port drive channels that, from the physical point of view, are connected in the same way as two drive loops. However, from the point of view of the number of drives and enclosures, they are treated as a single drive loop instead of two different drive loops. A group of storage expansion enclosures are connected to the DS5020 storage subsystems using a drive channel from each controller. This pair of drive channels is referred to as a redundant drive channel pair.

**drive loops.** A drive loop consists of one channel from each controller combined to form one pair of redundant drive channels or a redundant drive loop. Each drive loop is associated with two ports. (There are two drive channels and four associated ports per controller.) For the DS4800, drive loops are more commonly referred to as drive channels. See *drive channels*.

**DRAM.** See *dynamic random access memory*.

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

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

**ECC.** See *error correction coding*.

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

**EISA.** See *Extended Industry Standard Architecture*.

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

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

**environmental service module (ESM) canister.** A component in a storage expansion enclosure that monitors the environmental condition of the

components in that enclosure. Not all storage subsystems have ESM canisters.

**E_port.** See *expansion port*.

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

**ESD.** See *electrostatic discharge*.

**ESM canister.** See *environmental service module canister*.

**automatic ESM firmware synchronization.** When you install a new ESM into an existing storage expansion enclosure in a storage subsystem that supports automatic ESM firmware synchronization, the firmware in the new ESM is automatically synchronized with the firmware in the existing ESM.

**EXP.** See *storage expansion enclosure*.

**expansion port (E_port).** A port that connects the switches for two fabrics.

**Extended Industry Standard Architecture (EISA).** A bus standard for IBM compatibles that extends the Industry Standard Architecture (ISA) bus architecture to 32 bits and allows more than one central processing unit (CPU) to share the bus. See also *Industry Standard Architecture*.

**fabric.** A Fibre Channel entity which interconnects and facilitates logins of N_ports attached to it. The fabric is responsible for routing frames between source and destination N_ports using address information in the frame header. A fabric can be as simple as a point-to-point channel between two N-ports, or as complex as a frame-routing switch that provides multiple and redundant internal pathways within the fabric between F_ports.

**fabric port (F_port).** In a fabric, an access point for connecting a user's N_port. An F_port facilitates N_port logins to the fabric from nodes connected to the fabric. An F_port is addressable by the N_port connected to it. See also *fabric*.

**FC.** See *Fibre Channel*.

**FC-AL.** See *arbitrated loop*.

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

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

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

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

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

**FlashCopy.** A premium feature for the DS5020 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 applicable secondary logical drives, Global Mirroring should be used instead of Global Copy. See also *asynchronous write mode*, *Global Mirroring*, *remote mirroring*, *Metro Mirroring*.

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

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

**GUI.** See *graphical user interface*.

**HBA.** See *host bus adapter*.

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

**heterogeneous host environment.** A host system in which multiple host servers, which use different operating systems with their own unique disk storage subsystem settings, connect to the same DS5020 storage subsystem at the same time. See also *host*.

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

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

**host computer.** See *host*.

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

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

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

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

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

**IC.** See *integrated circuit*.

**IDE.** See *integrated drive electronics*.

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

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

(EISA) further expanded the data path to 32 bits. See also *Extended Industry Standard Architecture*.

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

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

**integrated drive electronics (IDE).** A disk drive interface based on the 16-bit IBM personal computer Industry Standard Architecture (ISA) in which the controller electronics reside on the drive itself, eliminating the need for a separate adapter card. Also known as an Advanced Technology Attachment Interface (ATA).

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

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

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

**IP.** See *Internet Protocol*.

**IPL.** See *initial program load*.

**IRQ.** See *interrupt request*.

**ISA.** See *Industry Standard Architecture*.

**Java Runtime Environment (JRE).** A subset of the Java Development Kit (JDK) for end users and developers who want to redistribute the Java Runtime Environment (JRE). The JRE consists of the Java virtual machine, the Java Core Classes, and supporting files.

**JRE.** See *Java Runtime Environment*.

**label.** A discovered or user entered property value that is displayed underneath each device in the Physical and Data Path maps.

**LAN.** See *local area network*.

**LBA.** See *logical block address*.

**local area network (LAN).** A computer network located on a user's premises within a limited geographic area.

**logical block address (LBA).** The address of a logical block. Logical block addresses are typically used in hosts' I/O commands. The SCSI disk command protocol, for example, uses logical block addresses.

**logical partition (LPAR).** (1) A subset of a single system that contains resources (processors, memory, and input/output devices). A logical partition operates as an independent system. If hardware requirements are met, multiple logical partitions can exist within a system. (2) A fixed-size portion of a logical volume. A logical partition is the same size as the physical partitions in its volume group. Unless the logical volume of which it is a part is mirrored, each logical partition corresponds to, and its contents are stored on, a single physical partition. (3) One to three physical partitions (copies). The number of logical partitions within a logical volume is variable.

**logical unit number (LUN).** An identifier used on a small computer system interface (SCSI) bus to distinguish among up to eight devices (logical units) with the same SCSI ID.

**loop address.** The unique ID of a node in fibre-channel loop topology sometimes referred to as a loop ID.

**loop group.** A collection of storage area network (SAN) devices that are interconnected serially in a single loop circuit.

**loop port.** A node port (N_port) or fabric port (F_port) that supports arbitrated loop functions associated with an arbitrated loop topology.

**LPAR.** See *logical partition*.

**LUN.** See *logical unit number*.

**MAC.** See *medium access control*.

**management information base (MIB).** The information that is on an agent. It is an abstraction of configuration and status information.

**man pages.** In UNIX-based operating systems, online documentation for operating system commands, subroutines, system calls, file formats, special files, stand-alone utilities, and miscellaneous facilities. Invoked by the **man** command.

**MCA.** See *micro channel architecture*.

**media scan.** A media scan is a background process that runs on all logical drives in the storage subsystem for which it has been enabled, providing error detection on the drive media. The media scan process scans all

logical drive data to verify that it can be accessed, and optionally scans the logical drive redundancy information.

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

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

**MIB.** See *management information base*.

**micro channel architecture (MCA).** Hardware that is used for PS/2 Model 50 computers and above to provide better growth potential and performance characteristics when compared with the original personal computer design.

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

**mini hub.** An interface card or port device that receives short-wave fiber channel GBICs or SFPs. These devices enable redundant Fibre Channel connections from the host computers, either directly or through a Fibre Channel switch or managed hub, over optical fiber cables to the DS5020 Storage Server controllers. Each DS5020 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 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 DS5020 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 DS Storage Manager optional Java-based host-agent software, which can be used on Microsoft Windows, Novell NetWare, AIX, HP-UX, Solaris, and Linux on POWER host systems to manage storage subsystems through the host fibre-channel connection.

**SMclient.** The DS 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 DS5020 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 DS Storage Manager utility software that is used on Microsoft Windows, AIX, HP-UX, Solaris, and Linux on POWER host systems to register and map new logical drives to the operating system. In Microsoft Windows, it also contains a utility to flush the cached data of the operating system for a particular drive before creating a FlashCopy.

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

**small form-factor pluggable (SFP).** An optical transceiver that is used to convert signals between

optical fiber cables and switches. An SFP is smaller than a gigabit interface converter (GBIC). See also *gigabit interface converter*.

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

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

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

**SRAM.** See *static random access memory*.

**SSA.** See *serial storage architecture*.

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

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

**Storage Array Identifier (SAI or SA Identifier).** The Storage Array Identifier is the identification value used by the DS Storage Manager host software (SMClient) to uniquely identify each managed storage server. The DS 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 DS Storage Manager client, the Topology view of the Mappings window displays the default host group, the defined host group, the host computer, and host-port nodes. The host port, host computer, and host group topological elements

must be defined to grant access to host computers and host groups using logical drive-to-LUN mappings.

**striping.** Splitting data to be written into equal blocks and writing blocks simultaneously to separate disk drives. Striping maximizes performance to the disks. Reading the data back is also scheduled in parallel, with a block being read concurrently from each disk then reassembled at the host.

**subnet.** An interconnected but independent segment of a network that is identified by its Internet Protocol (IP) address.

**sweep method.** A method of sending Simple Network Management Protocol (SNMP) requests for information to all the devices on a subnet by sending the request to every device in the network.

**switch.** A fibre-channel device that provides full bandwidth per port and high-speed routing of data by using link-level addressing.

**switch group.** A switch and the collection of devices connected to it that are not in other groups.

**switch zoning.** See *zoning*.

**synchronous write mode.** In remote mirroring, an option that requires the primary controller to wait for the acknowledgment of a write operation from the secondary controller before returning a write I/O request completion to the host. See also *asynchronous write mode*, *remote mirroring*, *Metro Mirroring*.

**system name.** Device name assigned by the vendor's third-party software.

**TCP.** See *Transmission Control Protocol*.

**TCP/IP.** See *Transmission Control Protocol/Internet Protocol*.

**terminate and stay resident program (TSR program).** A program that installs part of itself as an extension of DOS when it is executed.

**topology.** The physical or logical arrangement of devices on a network. The three fibre-channel topologies are fabric, arbitrated loop, and point-to-point. The default topology for the disk array is arbitrated loop.

**TL_port.** See *translated loop port*.

**transceiver.** A device that is used to transmit and receive data. Transceiver is an abbreviation of transmitter-receiver.

**translated loop port (TL_port).** A port that connects to a private loop and allows connectivity between the private loop devices and off loop devices (devices not connected to that particular TL_port).

**Transmission Control Protocol (TCP).** A communication protocol used in the Internet and in any network that follows the Internet Engineering Task Force (IETF) standards for internetwork protocol. TCP provides a reliable host-to-host protocol between hosts in packed-switched communication networks and in interconnected systems of such networks. It uses the Internet Protocol (IP) as the underlying protocol.

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

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

**trap recipient.** Receiver of a forwarded Simple Network Management Protocol (SNMP) trap. Specifically, a trap receiver is defined by an Internet Protocol (IP) address and port to which traps are sent. Presumably, the actual recipient is a software application running at the IP address and listening to the port.

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

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

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

**worldwide port name (WWPN).** A unique identifier for a switch on local and global networks.

**worldwide name (WWN).** A globally unique 64-bit identifier assigned to each Fibre Channel port.

**WORM.** See *write-once read-many*.

**write-once read many (WORM).** Any type of storage medium to which data can be written only a single time, but can be read from any number of times. After the data is recorded, it cannot be altered.

**WWN.** See *worldwide name*.

**zoning.** (1) In Fibre Channel environments, the grouping of multiple ports to form a virtual, private, storage network. Ports that are members of a zone can communicate with each other, but are isolated from ports in other zones. (2) A function that allows segmentation of nodes by address, name, or physical port and is provided by fabric switches or hubs.

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