IBM System Storage EXP5060
Storage Expansion Enclosure

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 the "Safety" on page xi and "Notices" on page 171 sections.

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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® EXP5060 storage expansion enclosure. Each caution and danger statement is numbered for easy reference to the corresponding statements in the translated document.

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

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

Statement 1:

DANGER

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

To avoid a shock hazard:

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

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

Statement 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, fibre optic devices, or transmitters) are installed, note the following:
- **Do not remove the covers. Removing the covers of the laser product could result in exposure to hazardous laser radiation. There are no serviceable parts inside the device.**
- **Use of controls or adjustments or performance of procedures other than those specified herein might result in hazardous radiation exposure.**

DANGER

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

Class 1 Laser statement

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

IEC 825-11993 CENELEC EN 60 825

Statement 4:

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

CAUTION:
Use safe practices when lifting.

Statement 5:

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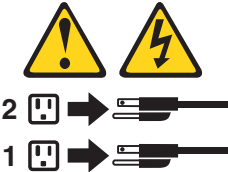
Statement 8:

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

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

Statement 29:

CAUTION:
This equipment is designed to permit the connection of the earthed conductor of the dc supply circuit to the earthing conductor at the equipment.

This equipment is designed to permit the connection of the earthed conductor of the dc supply circuit to the earthing conductor at the equipment. If this connection is made, all of the following conditions must be met:

- **This equipment shall be connected directly to the dc supply system earthing electrode conductor or to a bonding jumper from an earthing terminal bar or bus to which the dc supply system earthing electrode conductor is connected.**
- **This equipment shall be located in the same immediate area (such as, adjacent cabinets) as any other equipment that has a connection between the earthed conductor of the same dc supply circuit and the earthing conductor, and also the point of earthing of the dc system. The dc system shall not be earthed elsewhere.**
- **The dc supply source shall be located within the same premises as this equipment.**
- **Switching or disconnecting devices shall not be in the earthed circuit conductor between the dc source and the point of connection of the earthing electrode conductor.**

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 EXP5060 storage expansion enclosure. It also provides maintenance procedures and troubleshooting information.

Who should read this document

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

How this document is organized

Chapter 1, "Introduction," on page 1 describes the IBM System Storage EXP5060 storage expansion enclosure. This chapter includes an inventory checklist and an overview of the storage expansion enclosure features, operating specifications, and components.

Chapter 2, "Installing the EXP5060," on page 23 contains information on how to install the EXP5060.

Chapter 3, "Cabling the EXP5060," on page 41 contains information on how to cable the EXP5060.

Chapter 4, "Operating the EXP5060," on page 63 contains information on how to power on and off the storage expansion enclosure, recover from an overheated power supply, troubleshoot the storage expansion enclosure, and interpret LEDs.

Chapter 5, "Installing and replacing components," on page 87 contains step-by-step instructions about how to install or remove customer replaceable units (FRUs), such as hard disk drives, power supplies, fan assemblies, environmental service modules (ESMs), drive drawers, and SFP modules.

Chapter 6, "Hardware maintenance," on page 131 describes problems and symptoms that are specific to your storage expansion enclosure. It also provides a parts list for the EXP5060.

Appendix A, "Records," on page 141 provides a table that you can use to record and update important information about your EXP5060, including serial number and device records. Whenever you add options to your EXP5060, be sure to update the information in this table.

Appendix B, "Rack mounting template," on page 145 provides the rack mounting templates for installation of the EXP5060. If you want to tear out the templates from the document for use during installation, use these copies of the templates.

Appendix C, "Specifications for non-IBM rack installation," on page 149 provides safety requirements and rack specifications for installing DS5000 storage subsystems and DS5000 storage expansion enclosures into non-IBM racks.

Appendix D, "Power cords and storage rack PDUs," on page 157 lists power cord information for the EXP5060.

Appendix E, "Additional System Storage DS documentation," on page 163 lists additional DS5000 documents.

Appendix F, "Accessibility," on page 167 details accessibility information.

DS5100 and DS5300 Storage Subsystem installation tasks - General overview

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

See also: The DS5100/5300 Quick Start Guide for your storage subsystem configuration provides an excellent overview of the installation process.

Table 1. Where to find DS5100/5300 installation and configuration procedures

	Installation task	Where to find information or procedures
1	Plan the installation	• *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* • *IBM System Storage DS3000, DS4000, and DS5000 Command Line Interface and Script Commands Programming Guide* • *IBM System Storage Quick Start Guide* for the DS5100/DS5300 storage subsystems. • *IBM System Storage DS5100/DS5300 Installation, User's, and Maintenance Guide*
2	Mount the DS5100 or DS5300 storage subsystem in the rack	• *IBM System Storage Quick Start Guide* for the DS5100/DS5300 storage subsystems. • *IBM System Storage DS5100/DS5300 Installation, User's, and Maintenance Guide*
3	Mount the EXP5060 storage expansion enclosure in the rack	• *IBM System Storage Quick Start Guide* for the DS5100/DS5300 storage subsystems. • *IBM System Storage EXP5060 Installation, User's, and Maintenance Guide*
4	Route the storage expansion enclosure Fibre Channel cables	• *IBM System Storage Quick Start Guide* for the DS5100/DS5300 storage subsystems. • *IBM System Storage EXP5060 Installation, User's, and Maintenance Guide*
5	Route the host server Fibre Channel cables	• *IBM System Storage Quick Start Guide* for the DS5100/DS5300 storage subsystems. • *IBM System Storage EXP5060 Installation, User's, and Maintenance Guide*
6	Power on the subsystem	• *IBM System Storage Quick Start Guide* for the DS5100/DS5300 storage subsystems. • *IBM System Storage EXP5060 Installation, User's, and Maintenance Guide*
7	Configure DS5100 or DS5300 network settings	• *IBM System Storage Quick Start Guide* for the DS5100/DS5300 storage subsystems. • *IBM System Storage EXP5060 Installation, User's, and Maintenance Guide*

	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* • *DS Storage Manager Copy Services Guide* (describes switch zoning for the Remote Mirror Option) • See also the documentation provided by the switch manufacturer
9	Install DS Storage Manager software on the management station	• *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* • DS Storage Manager online help (for post-installation tasks)
10	Install host software (failover drivers) on host server	
11	Start DS Storage Manager	
12	Set the DS Storage Manager clock	
13	Set the DS Storage Manager host default type	
14	Verify DS5100/DS5300 subsystem health	• *IBM System Storage DS5100/DS5300 Installation, User's, and Maintenance Guide*
15	Enable DS Storage Manager premium feature keys	**Copy Services premium features** 　　*IBM System Storage DS Storage Manager Version 10 Copy Services Guide* **FC/SATA Intermix premium feature** 　　*IBM System Storage DS4000/DS5000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview* **Storage Partitioning (and general premium features information)** 　　*IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide*
16	Configure arrays and logical drives	• *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* • DS5100/DS5300 Storage Manager online help
17	Configure host partitions	
18	Verify host access to DS5100/DS5300 storage	

Getting information, help, and service

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

Before you call

Before you call, take these steps to try to solve the problem yourself:

- Check all cables to make sure that they are connected.
- Check the power switches to make sure that the system is turned on.
- Use the troubleshooting information in your system documentation, and use the diagnostic tools that come with your system.
- Check for technical information, hints, tips, and new device drivers at the IBM System Storage Disk Support Web site pages that are listed in this section.
- Use an IBM discussion forum on the IBM Web site to ask questions.

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

Using the documentation

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

Finding Storage Manager software, controller firmware, and README files

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

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

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

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

1. On the **Support for Disk Systems** page, from the **Product** drop-down menu, select your product (for example, **DS5100**). Click **Go**.
2. In the **Support & downloads** box, click **Download**. The **Software and device drivers** page opens.
3. In the **Storage Manager** section of the table, locate your operating system and version level (for example, **IBM DS Storage Manager Software package version 10.60.x5.11 for AIX**), and click on the version link in the right-hand column. The download page for the IBM DS Storage Manager Software package you selected opens.
4. On the download page, in the table under **File link**, click on the **Storage Manager** file link, and wait for the **Select fixes and download method** page to open.

5. On the **Select fixes and download method** page, select the download you want, click **Download using your browser (HTTP)**, and click **Continue**.

6. On the **Download using your browser (HTTP)** page, click on the **Download** file link to the right of the README file. The README will open in your Web browser.

IBM System Storage Productivity Center

The IBM System Storage Productivity Center (SSPC) is an integrated hardware and software solution that provides a single point of entry for managing IBM System Storage DS4000 systems, DS5000 systems, DS8000 systems, IBM System Storage SAN Volume Controller clusters, and other components of your data storage infrastructure. Therefore, you can use the IBM System Storage Productivity Center to manage multiple IBM System Storage product configurations from a single management interface.

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

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

Essential Web sites for DS5100/DS5300 support information

The most up-to-date information about DS5100/DS5300 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:

IBM System Storage Disk Storage Systems
Find links to software and firmware downloads, READMEs, and support pages for all IBM System Storage disk storage systems:

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

IBM System Storage Interoperation Center (SSIC)
Find technical support information for your specific DS5100/DS5300 storage subsystem/host configuration, including the latest recommended firmware versions for your system, by using this interactive Web-based utility:

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

IBM DS5100, DS5300, and BladeCenter Premium Feature Activation
Activate a DS5100/DS5300 premium feature by using this Web-based utility:

www-912.ibm.com/PremiumFeatures

IBM System Storage Support
Find the latest support information for host operating systems, HBAs, clustering, storage area networks (SANs), DS Storage Manager software and controller firmware:

www.ibm.com/systems/support/storage

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

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

Support for IBM System p AIX 5L and Linux servers
Find the latest support information for System p® AIX®, Linux, BladeCenter, and i5/OS servers:

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

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

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

@server **System p and AIX Information Center**
Find everything you need to know about using AIX with System p and POWER® servers:

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

Fix Central
Find fixes and updates for your system's software, hardware, and host operating system:

www.ibm.com/eserver/support/fixes

IBM System Storage products
Find information about all IBM System Storage products:

www.ibm.com/systems/storage

IBM Publications Center
Find IBM publications:

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

Software service and support

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

www.ibm.com/services/sl/products

For more information about the IBM Support Line and other IBM services, go to the following Web sites:
* www.ibm.com/services
* www.ibm.com/planetwide

Hardware service and support

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

www.ibm.com/planetwide

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

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 EXP5060 storage expansion enclosure (hereafter referred to as the *EXP5060* or *storage expansion enclosure*). This chapter also includes a list of hardware that comes with the storage expansion enclosure.

Overview

The IBM System Storage EXP5060 storage expansion enclosure (Machine Type 1818, Model G1A) provides high-capacity SATA disk storage for the DS5100 and DS5300 storage subsystems. The storage expansion enclosure delivers fast, high-volume data transfer, retrieval, and storage functions for multiple drives to multiple hosts. The storage expansion enclosure provides continuous, reliable service, using hot-swap technology for easy replacement without shutting down the system and support redundant, dual-loop configurations. External cables and Small Form-Factor Pluggable (SFP) modules connect the DS5100 or DS5300 storage subsystem to the EXP5060 storage expansion enclosure.

Note: The EXP5060 storage expansion enclosure can be attached only to the DS5100 and DS5300 storage subsystems. Contact your IBM representatives or resellers for information about supporting the EXP5060 on other DS storage subsystems.

The EXP5060 is a rack-mountable enclosure that supports up to 60 SATA Disk Drive Modules (DDMs), offering up to 180 TB of SATA disk space per enclosure using 3 TB SATA DDMs. Coupled with a storage subsystem such as the DS5100 or DS5300, you can configure RAID-protected storage solutions of up to 1440 TB when using 3 TB SATA DDMs and eight EXP5060 storage expansion enclosures, providing scalable storage for your rapidly growing application needs for RAID protected, data reference storage capacity. The *Attach up to 8 EXP5060s* feature pack must be purchased for the DS5100/DS5300 storage subsystem to enable it to be connected to up to 8 EXP5060 storage expansion enclosures.

The EXP5060 uses redundant 4 Gbps fibre channels to make connections to the DS5100 or DS5300 storage subsystem and another EXP5060 storage expansion enclosure in a cascading cabling configuration, offering reliability and performance.

The EXP5060 supports redundant, dual drive channel/loop configurations with DS5100/DS5300 storage subsystems and other EXP5060 enclosures. External cables and small form-factor pluggable (SFP) modules connect the controller to the storage expansion enclosure. EXP5060s attached to supported DS5100 or DS5300 storage subsystems can be used with storage area networks to satisfy the needs of various fixed content, data reference applications that require large amounts of storage capacity but do not have the high utilization and access characteristics satisfied by fibre channel disk drive storage. The storage expansion enclosure provides continuous, reliable service and uses hot-swap technology for easy replacement without the need to shut down the system. Up to eight EXP5060 units can be connected to the DS5100/DS5300 storage subsystems, providing connections to a maximum of 480 hard drives.

Operating system support

For supported operating systems, see the latest DS Storage Manager host software README file and the IBM DS5100/DS5300 products at the following Web site for additional host operating system support:

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

See "Finding Storage Manager software, controller firmware, and README files" on page xx to learn how to access the DS5100 or DS5300 README files on the Web.

Fibre channel defined

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

Using a fibre-channel arbitrated loop (FC-AL), more than 100 fibre-channel devices can be supported, compared to 15 small computer system interface (SCSI) devices. The connection from the DS5100 or DS5300 storage subsystem to the EXP5060 is a 4 Gbps fibre-channel device that supports data transfer rates up to 400 MBps half-duplex and 800 MBps full-duplex on optical interfaces.

SATA defined

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

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

www.serialata.org

Inventory checklist

The following illustration and inventory list show the items that you need to install the storage expansion enclosure in the rack cabinet. If any items are missing or damaged, contact your place of purchase.

Notes:
1. The illustration might differ slightly from your hardware.
2. Depending on your EXP5060 order, your shipping box might contain additional materials that are not shown in the following illustration.
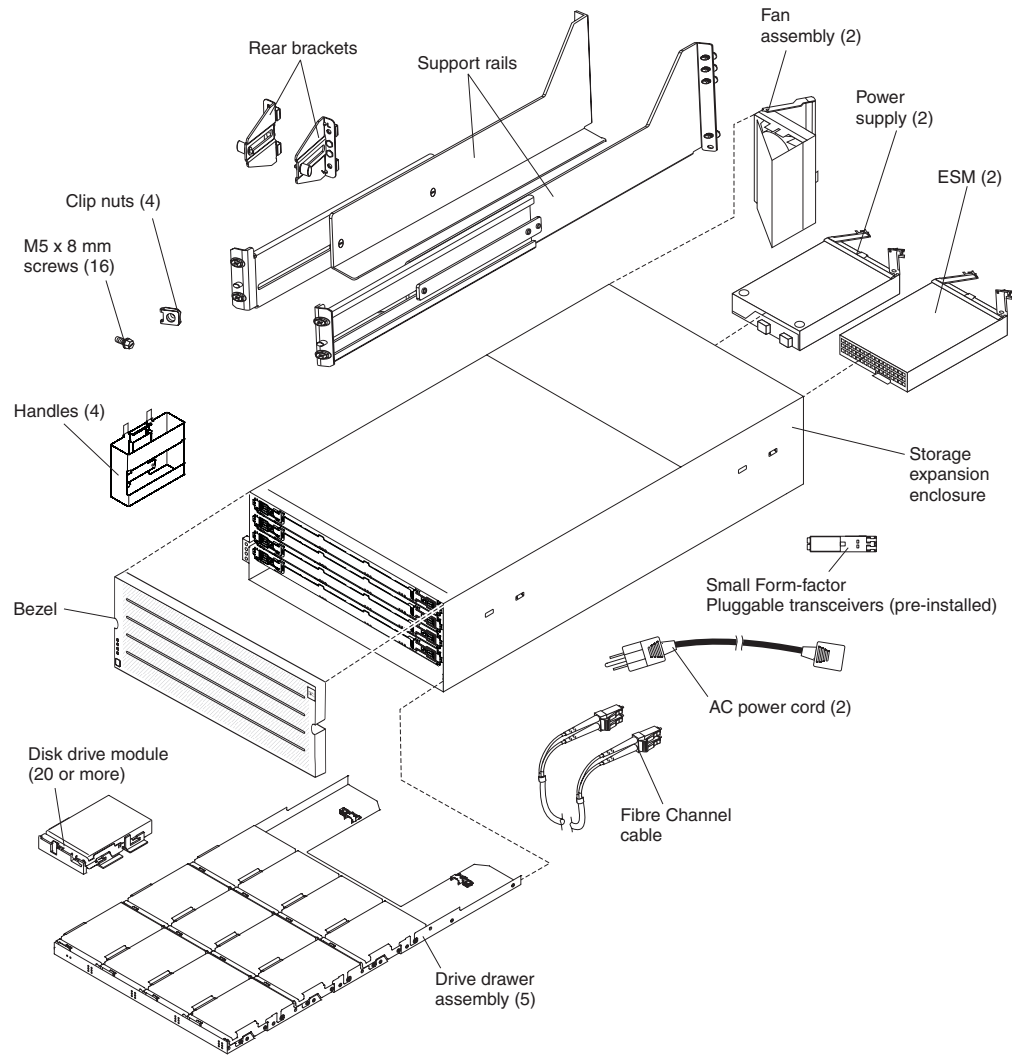
After you unpack the EXP5060, verify that you have the following items:

- 4U-high storage expansion enclosure (1)
  - Drive drawer assemblies (5)
  - Fan assemblies (2)
  - Power supplies (2)
  - ESMs (2)
- Handles (4), packaged in a smaller box inside the shipping box
- DDMs (20 or more, depending on your EXP5060 order), packaged in a smaller box inside the shipping box
- Bezel (1)
- Fibre Channel signal cables (2 or more, depending on your EXP5060 order)
- SFP transceivers (2)
- Rack-mounting hardware kit (1), packaged in a smaller box inside the shipping box, including:
  - Rails (2), right and left assembly
  - Rear brackets (2)
  - M5 black hex-head slotted screws (16)

> **Note:** The screws are either preinstalled in the support rails or packaged in a plastic bag.

– Washers (8)
– Clip nuts (4)

Important: The EXP5060 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 and storage rack PDUs," on page 157 for more information.

EXP5060 components

The EXP5060 has the following removable components. These components, called field replaceable units (FRUs), are accessible from the front or back of the EXP5060.

- Five drive drawers, including the right and left cable chains.
- 20 (minimum) to 60 (maximum) SATA Disk Drive Modules (DDMs)
- Two environmental service modules (ESMs)
- Two power supplies
- Two fan assemblies

The hot-swap features of the EXP5060 enable you to remove and replace SATA DDMs, power supplies, fan assemblies, and ESMs, without turning off the storage expansion enclosure. You can maintain the availability of your system while a hot-swap device is removed, installed, or replaced.

Drive drawers

The EXP5060 storage expansion enclosure has five removable drive drawers that are accessible from the front of the enclosure (see Figure 1). Each drive drawer can contain from 4 to 12 disk drives (see Figure 2 on page 5). With the drive drawers fully populated, the EXP5060 can support up to 60 SATA DDMs.

Note: Drive drawers might be also referred to as drive trays in other publications.
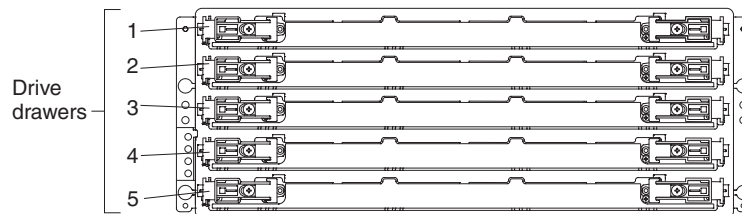
Figure 1. EXP5060 hot-swap drive drawers
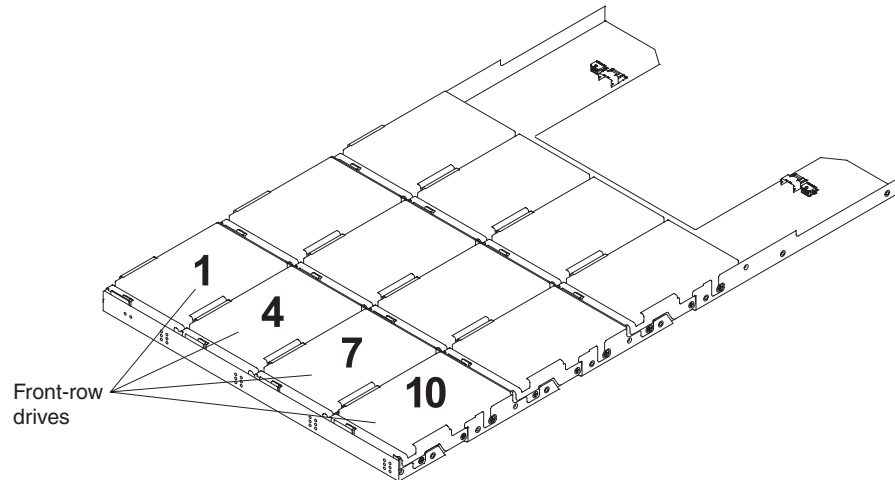
Figure 2. EXP5060 drive drawer

Important: The installation order within each drive drawer is from left to right in rows. Slots 1, 4, 7 and 10 must have a drive installed in these locations to make sure there is sufficient air flow to the drives (see Figure 2). To verify these slots, consult the overlay on the front of each of the five drive drawers. Make sure the four drives in each row are adjacent to each other. The long edge of each drive should touch the drive next to it. To maintain a uniform airflow across all drive drawers, the storage expansion enclosure must be configured with a minimum of 20 drives, with four drives in the front row of each of the five drive drawers.

Disk Drive Modules (DDMs)

The EXP5060 supports up to 60 SATA DDMs in five drive drawers that are accessible from the front of the storage expansion enclosure. The disk drawer planar board has ATA translator circuitry for each of the SATA drives that converts the fibre channel protocol interface of the EXP5060 drive channel/loop into the hard drive SATA protocol interface. It also provides dual paths to the SATA drive for DDM FRU path redundancy. Each SATA hard drive and carrier assembly (drive tray) are called SATA DDM FRUs.

Attention: The EXP5060 SATA DDMs and the SATA EV-DDMs that are used in the EXP5000/EXP810 storage expansion enclosures are not compatible. Do not use the EXP5060 SATA DDMs in the EXP5000/EXP810 storage expansion enclosures. Similarly, do not order the SATA EV-DDMs for the EXP5060.

The EXP5060 storage expansion enclosure drive channel operates at 4 Gbps fibre channel interface speed. The EXP5060 drive drawer planar board has ATA translator circuitry that converts DDM 3 Gbps SATA drive interface protocol to 4 Gbps fibre channel interface protocol.

There are no servicable parts in a DDM FRU. If it fails, it must be replaced in its entirety. When replacing a DDM FRU, be sure to order and install the correct DDM FRU.

Attention:

1. After you remove a drive FRU, wait 90 seconds before replacing or reseating the drive FRU to allow the drive to properly spin down. Failure to do so may cause undesired events.

2. Never hot-swap a drive FRU when its associated green Activity LED is flashing. Hot-swap a drive FRU only when its associated blue Service Action Allowed LED is lit and the drive is inactive.

3. For all 3 TB SATA drives, the ATA translator firmware version must be LW1613 or higher. If you install a 3 TB SATA drive when the firmware version is lower, the drive is marked as 'incompatible'.

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

Environmental Service Modules (ESMs)

The EXP5060 has two hot-swappable and redundant ESM units. The ESMs are located at the back of the storage expansion enclosure. The upper ESM is labeled ESM A, and the lower ESM is labeled ESM B. One ESM will continue to operate if the other ESM fails.

The ESMs contain the storage expansion enclosure control logic, interface ports, and LEDs. Each ESM has four SFP module ports that you could use to connect the storage expansion enclosure to the controller. These four ports allow up to four redundant pairs of drive channel/loop connections between the DS5100/DS5300 controllers and the EXP5060 ESMs. The two SFP ports near the left side of the ESM are labeled 1A and 1B. If only the 1B ports are used for the cabling between the EXP5060 and the DS51000/DS5300 controller drive channel port, this is referred to as non-trunking cabling mode. This results in only one pair of redundant drive channel/loop connections between the EXP5060 and the DS5100DS5300 controller drive channel port. The two SFP ports near the right side of the ESM are labeled 2A and 2B. The 2B ports are used when cabling the EXP5060 to the DS5100/DS5300 in trunking mode. The two 2B ports along with the two 1B ports result in two redundant drive loop/channel pair connections to the DS5100/DS5300 controller for higher bandwidth throughput applications. The 1A or 2A ports are used to connected to ports 1B or 2B of another EXP5060 in a EXP5060 cascading cabling mode behind the same controller drive channel port.

Note: When connecting EXP5060s using the trunking cabling scheme, please refer to the installation, user's, and maintenance guide for the storage subsystem that the EXP5060 is connected to for more information about configuring arrays and logical drives for maximizing throughput of the trunk-cabled EXP5060 enclosures.

The EXP5060 ESMs support automatic ESM firmware synchronization. This function allows a new ESM with a different level of ESM firmware to be automatically synchronized with the ESM firmware version in the existing ESM in the EXP5060 chassis. To enable automatic ESM firmware synchronization:

1. Verify that the DS Storage Manager Event Monitor is installed and running.

2. Verify that the storage subsystem that the EXP5060 is attached to is defined in the Enterprise Management window of the DS Storage Manager client (SMclient).

Connectors, switch, and enclosure ID

The enclosure ID, comprised of a pair of seven-segment numbers, is located on the back of each ESM next to the ESM indicator lights. 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 management software. There are no switches on the EXP5060 chassis to manually set the enclosure ID. If the EXP5060s are cascading behind a pair of drive channels, ensure that the single digit of the enclosure ID is unique. Both ESM enclosure ID numbers will be identical under normal operating conditions. Figure 3 shows the seven-segment numeric display on the storage expansion enclosure. For more information regarding the enclosure ID, see "Enclosure ID settings " on page 41.
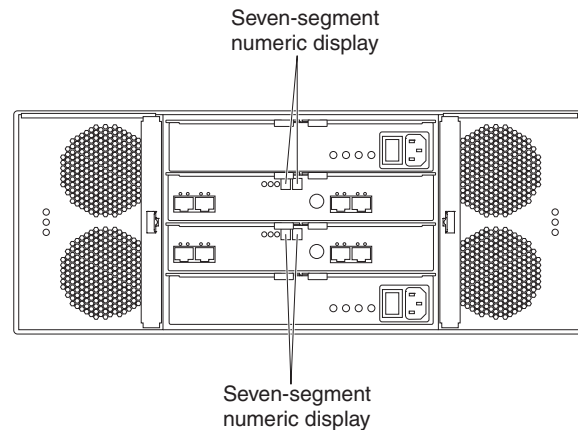
Figure 3. Rear view of seven-segment numeric display

Rear drive channel ports

Figure 4 shows the drive channel ports on the rear of the storage expansion enclosure.
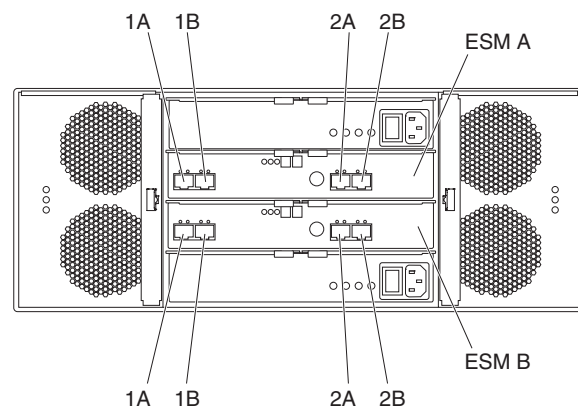
Figure 4. Rear view of drive channel ports

Power supplies

The storage expansion enclosure has two removable power supplies. The power supplies provide power to the internal components. If one power supply is turned off or malfunctions, the other power supply maintains electrical power to the storage expansion enclosure.

Note: To preserve the optimal airflow, do not remove a failed power supply FRU from the EXP5060 chassis until you are ready to replace it with a new FRU.

Figure 5 shows the power supply controls, LEDs, and connectors.
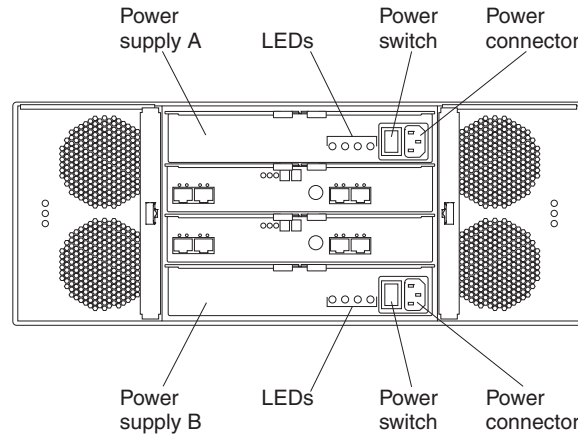
Figure 5. Power supply components

Table 2 describes the power supply components shown in Figure 5.

Table 2. Description of power supply components

Component	Description
LEDs	Power supply status indicators. See "Power supply LEDs" on page 74 for more information.
Power switch	Controls AC power to the power supply
Power connector	Connector for the AC power cord

Fan assemblies

The storage expansion enclosure has two removable fan assemblies. Each fan assembly contains two fans. The fan assemblies pull air through the enclosure from front to back across the drives. The fans provide redundant cooling, which means that if one of the fans fails, the remaining fan assembly continues to provide sufficient cooling to operate the storage expansion enclosure. The fan will operate at maximum speed under the following conditions:

- During the first few minutes after power is applied to the EXP5060 enclosure
- When one of the disk drawers is pulled out or not in the closed/latched position
- When one of the fan assemblies has failed or is removed from the EXP5060 chassis

Note: To preserve the optimal airflow, do not remove a failed fan assembly FRU from the EXP5060 chassis until you are ready to replace it with a new FRU.

Figure 6 on page 9 shows the location of the fan assemblies. See "Fan assembly LEDs" on page 75 for information about the fan assembly status LEDs.

Note: Although both fan assemblies (left and right) are identical, they are seated in the EXP5060 enclosure in opposite orientations. If the fan assembly cannot be fully inserted in the fan assembly bay, rotate it 180 degrees and reinsert

it. In addition, there are notches on the top and bottom of the fan assembly bay. Make sure that the slits on the top and bottom of the fan assembly line up with these two notches before the fan assembly is fully inserted in the fan bay.

Left fan assembly   Right fan assembly

Power supply A

Fan unit LEDs   Fan unit LEDs

Power supply B
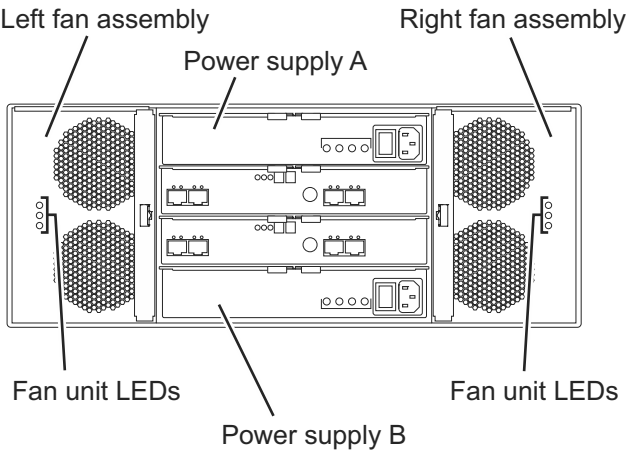
Figure 6. Fan assembly components

Table 3 lists the controller fan assembly components and their corresponding fan canisters. This table applies only to DS Storage Manager version 10.84 and earlier.

Table 3. Fan assembly components and their corresponding fan canisters.

Fan assembly component	Fan canister
Left fan assembly	Fan canister 1
Power supply A	Fan canister 2
Power supply B	Fan canister 3
Right fan assembly	Fan canister 4

Note:

Figure 7 on page 10 shows fan assembly airflow through the storage expansion enclosure.
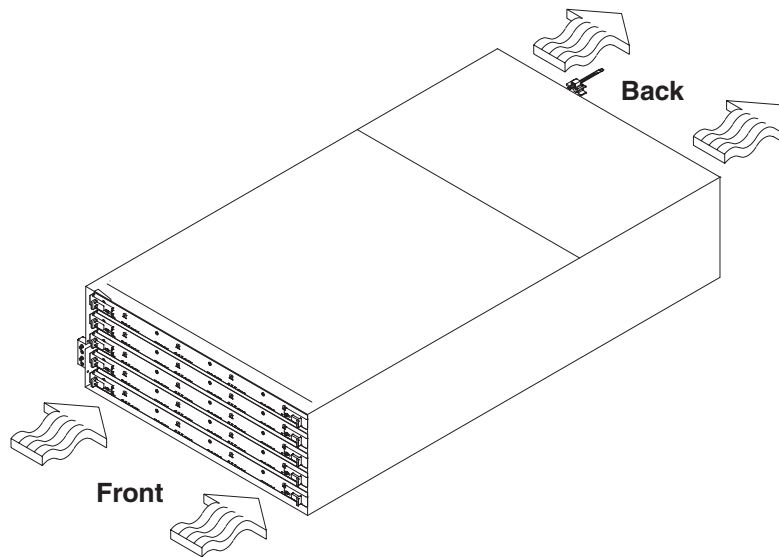
Figure 7. Storage expansion enclosure airflow

Small Form-Factor Pluggable (SFP) modules

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

Figure 8 on page 11 shows an SFP module with fibre optic cable.

Note: The SFP module shown might look different from those shipped with your storage expansion enclosure. The differences does not affect transceiver performance.
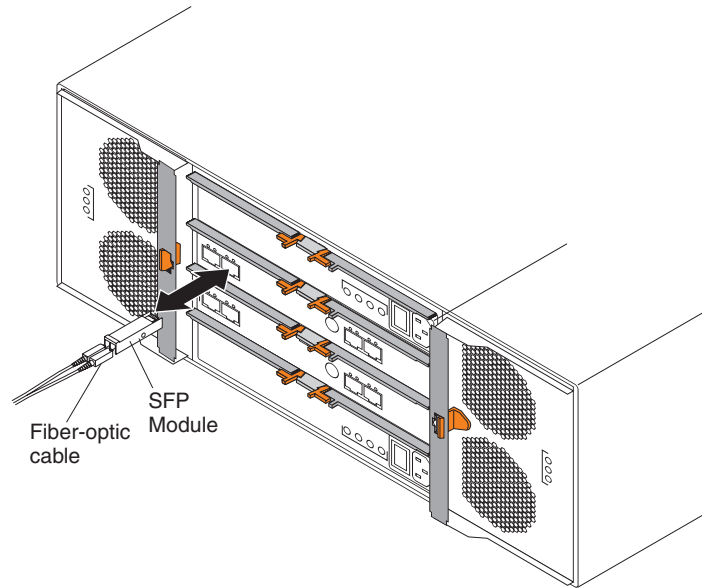
Figure 8. SFP module and fibre optic cable

Software and hardware compatibility and upgrades

The latest DS5000 controller firmware and NVSRAM, drive enclosure ESM firmware, and the fibre channel and SATA drive FRUs firmware must be installed to ensure optimal functionality, manageability, and reliability.

Unless stated otherwise, you can find the latest DS5000 publications, firmware, and host software at the IBM DS5000 System Storage Support Web site:

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

Software and firmware support code upgrades

To enable support for the EXP5060, you *must* ensure that your system's software and firmware are set at the levels shown in Table 4. If you have a 3 TB drive installed, ensure that you installed it at the levels as in Table 5 on page 12.

Table 4. Software and firmware levels for the EXP5060

Software/firmware	Level
DS Storage Manager software	10.60.x5.11 or higher
DS5000 controller firmware and NVSRAM	07.60.13.05 or higher for support with the DS5100 or DS5300
ESM firmware	9916
Drive firmware	You can find the latest software and firmware at the IBM DS5000 System Storage Support Web site: www.ibm.com/servers/storage/support/disk/
ATA Translator firmware	LW1428

Table 5. Software and firmware levels for the EXP5060 with 3 TB SATA drives installed

Software/firmware	Level
DS Storage Manager software	10.77.05.28 or higher
DS5000 controller firmware and NVSRAM	7.77.34.00 or higher
ESM firmware	991C or higher
Drive firmware	You can find the latest software and firmware at the IBM DS5000 System Storage Support Web site: www.ibm.com/servers/storage/support/disk/
ATA Translator firmware	LW1613 or higher

The required EXP5060 ESM and DS5100/DS5300 storage subsystem controller firmware versions and DS Storage Manager version software packages that are required to manage storage subsystems with controller firmware 07.60.13.05 installed are available for download at the IBM System Storage Support Web site:

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

For instructions to install the DS Storage Manager, see the *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide.*

If you need further assistance, please contact your IBM reseller or IBM representative to find out which controller firmware to use for EXP5060 attachment.

For more information about the EXP5060 ESM replacement procedure and problem troubleshooting, please refer to "Replacing an Environmental Service Module (ESM)" on page 113 and "Solving problems" on page 131.

EXP5060 hardware and software compatibility

Table 6 lists the EXP5060 hardware and software compatibility. Currently, the only DS5000 storage subsystems that support EXP5060 attachment are the DS5100 and DS5300. Please contact IBM resellers or representatives for other DS5000 storage subsystem support in the future.

Note: For the latest information about supported servers and operating systems for the EXP5060, refer to the System Storage Interoperation Center at this Web site:

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

Table 6. EXP5060 hardware and software compatibility

Storage subsystem	Storage management software	Firmware
System Storage DS5100 or DS5300 Storage Subsystem	IBM DS Storage Manager Version 10.60.x5.11 or higher	Controller firmware version 07.60.13.05 or higher
System Storage DS5100 or DS5300 Storage Subsystem with 3 TB SATA drives installed	IBM DS Storage Manager Version 10.77.x5.28 or higher	Controller firmware version 07.77.18.00 or higher

Determining firmware levels

There are two different methods to determine the DS5000 storage subsystem and the storage expansion enclosure firmware versions. Each method uses the DS Storage Manager client that manages the DS5000 storage subsystem with the attached storage expansion enclosure.

Method One:

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

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

DS5000 Storage Server
- NVSRAM version
- Firmware version

Drives
- Drive Firmware version
- ATA translator card (interposer) firmware version (SATA DDMs only)

  Note:
  1. In the EXP5060, because the ATA translator circuit is on the EXP5060 disk drawer planar board instead of the interposer card that is part of the SATA EV-DDM drive FRU, the ATA translator firmware and drive firmware are not packaged together as a single drive firmware upgrade file. Make sure that you update both the ATA translator firmware and the drive firmware when you are updating firmware for the drives. Make sure that the correct drive firmware file for the EXP5060 drive DDM is selected for download. The EXP5060 ATA translator firmware upgrade follows the same process through the Storage Manager subsystem management window menu as for the drive firmware. Instead of selecting the drive firmware file for download, select the ATA translator firmware file for download.
  2. You cannot verify and upgrade the ATA translator firmware in a drive slot which does not have a drive installed, or has a drive in an 'unresponsive' state. IBM recommends using spare drives to verify and upgrade the ATA translator firmware in empty drive slots.

ESM
- ESM card firmware version

Method Two:

Complete the appropriate procedure to obtain the specified firmware version.

To obtain the controller firmware version:
Click on the Controller icon in the left pane of the Physical View tab of the

Subsystem Management window. The properties of the controller will be displayed in the right pane of the Physical view tab.

You must perform this step for each individual controller.

To obtain the drive firmware (and ATA translator firmware) version:
Click on the drive icon in the left pane of the Physical View tab of the Subsystem Management window. The properties of the drive will be displayed in the right pane of the Physical view tab. Scroll down to the bottom of the window pane for the drive firmware and ATA Translator firmware version.

You must perform this step for each individual drive.

Note: You cannot verify and upgrade the ATA translator firmware in a drive slot which does not have a drive installed, or has a drive in an 'unresponsive' state. IBM recommends using spare drives to verify and upgrade the ATA translator firmware in empty drive slots.

To obtain the ESM and drive enclosure component firmware versions:
1. In the left pane of the Physical View tab in the Subsystem Management window, click the Drive Enclosure Component icon for the enclosure that you want to check the firmware version. 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.

Receiving product updates and support notifications

Be sure to download the latest versions of the following packages at the time of initial installation and when product updates become available:
- DS Storage Manager host software
- DS5000 storage subsystem controller firmware
- DS5000 drive expansion enclosure ESM firmware
- Drive firmware

Important

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

For more information about how to register for support notifications, see the **Stay Informed** section of the IBM Disk Support Web site:

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

Best practices guidelines

To ensure optimal operation of your system, always follow these best practices guidelines:
- Ensure that your system is in an optimal state before you shut it down. Never turn the power off if any Service Action Required 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 EXP5060 right and left power supplies into two independent external power circuits through distribution units inside a rack cabinet or directly into external receptacles. Similarly, the right and left power supplies of the DS5100/DS5300 storage subsystem that the EXP5060 storage expansion enclosures are attached to should be plugged into the same two independent external power circuits as the EXP5060s. This ensures that the DS5000 storage subsystem and all its attached storage expansion enclosures will have power in the event that only one power circuit is available. In addition, having all the right or all the left power cables plugged into the same power circuit enables the DS5000 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 power distribution units (PDUs) if necessary. Refer to Table 13 on page 18 for information on storage expansion enclosure power requirements. Contact your IBM service representative for additional information if needed.

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

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

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

  For more information on how to complete these tasks, check the DS Storage Manager online help or the DS 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 EXP5060" on page 65. Check that each component of the subsystem is powered-on in the proper order during this entire power-up procedure to ensure the controller will be able to optimally access all of your storage subsystems.

- The storage subsystem supports simultaneous power-up to the system components; however, you should always follow the power-up sequence listed in "Powering on the EXP5060" on page 65 during any attended power-up procedure.

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

  – The storage subsystem logical drives and subsystems are not displayed in the 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.

Specifications

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

environmental requirements, and electrical requirements for storage expansion enclosure 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

The EXP5060 conforms to the 19-inch rack standard. Table 7 shows the dimensions of the EXP5060, with all components installed including the bezel.

Table 7. EXP5060 storage expansion enclosure dimensions

Height	Width	Depth [1]
6.93 in. (17.6 cm)	19 in. (48.3 cm)	34.1 in. (86.6 cm)

[1] Enclosure full depth including a cable bend radius of 2.7 inches is 36.8 inches (93.5 cm).

Weight

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

Table 8. EXP5060 weights

Unit	Weight		
	Maximum [1]	Empty [2]	Shipping [3]
EXP5060 storage expansion enclosure	102.1 kg (225 lb)	56.7 kg (125 lb)	99.79 kg (220 lb)

[1] Chassis with all FRUs and 60 drives.

[2] Chassis without drives but with midplane and all FRUs.

[3] Includes the EXP5060, support rails, power cords, publications, 20 drives, shipping material, and the pallet.

Table 9. EXP5060 component weights

Unit	Weight
EXP5060 storage expansion enclosure with midplane only (all FRUs removed)	19.5 kg (43 lb)
Drive drawer (includes cable chains but no drives)	5.2 kg (11.5 lb)
Disk drive module	0.74 kg (1.64 lb)
Power supply	2.5 kg (5.46 lb)
Fan assembly	0.98 kg (2.16 lb)
ESM	1.65 kg (3.64 lb)

Shipping dimensions

The EXP5060 is shipped on a pallet. Table 10 on page 17 lists shipping carton dimensions.

Table 10. EXP5060 shipping carton dimensions

Width	Depth	Height[1]
24 in. (61 cm)	39.75 in. (101 cm)	29.5 in. (74.9 cm)

[1] The height shown includes the height of the pallet.

Environmental requirements and specifications

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

Temperature and humidity

Table 11 lists the acceptable temperature and humidity ranges for the EXP5060 storage expansion enclosure when in storage or in transit.

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 11. Temperature and humidity requirements for storage expansion enclosure when in storage or in transit

Condition	Parameter	Requirement
Temperature	Operating range	10° - 35° C (50° - 95° F)
	Maximum rate of change	10° C (18° F) per hour
	Storage range	1° - 60° C (33° - 140° F)
	Maximum rate of change	15° C (27° F) per hour
	Transit range	-40° C to 65° C (-40° F to 149° F)
	Maximum rate of change	20° C (36° F) per hour
Relative humidity (no condensation)	Operating range	20% to 80%
	Storage range	10% to 93%
	Transit range	5% to 95%
	Maximum dew point	26° C (79° F)
	Maximum gradient	10% per hour

Altitude

Table 12 lists the acceptable altitudes for operating, storing, and shipping the EXP5060.

Table 12. EXP5060 altitude ranges

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

Table 12. EXP5060 altitude ranges (continued)

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

Airflow and heat dissipation

Figure 9 shows the intended airflow for the EXP5060. 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.
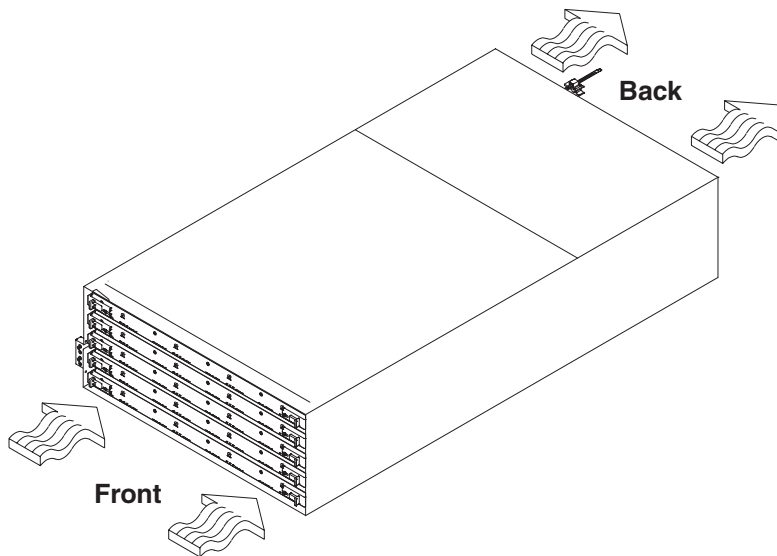
Figure 9. EXP5060 airflow

Table 13 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 13. EXP5060 power and heat dissipation

Parameter	KVA	Watts (ac)	Btu per hour
EXP5060	1.414	1428	4883.76

Shock and vibration requirements

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

Operational Shock: The EXP5060 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 EXP5060 will continue operating when subjected to a random vibration test using

the criteria shown in Table 14. This test uses the indicated spectral power density for 30 minutes in each of the three axes.

Table 14. Random vibration power spectral density

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

Acoustic noise

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

Table 15. EXP5060 sound levels

Measurement	Level
Sound power (normal operation)	6.5 bels
Sound pressure (normal operation)	65 dBA

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

Electrical requirements

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

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

  Note: Protective ground is also known as safety ground or chassis ground.
- Circuit overloading – Power circuits and associated circuit breakers must provide sufficient power and overload protection. To prevent possible damage to the unit, isolate its power source from large switching loads (such as air conditioning motors, elevator motors, and factory loads).
- Power failures – If a total power failure occurs, the unit automatically performs a power-up recovery sequence without operator intervention after power is restored.

Attention: The EXP5060 does not support 90-136V AC sources. It supports 180-240V AC sources only. Ensure that the AC input is appropriate for the EXP5060 before turning the power switches to the on position.

Table 16. EXP5060 ac power requirements

AC Power Requirements	Range
Nominal Voltage	180 to 264 VAC
Frequency (Hertz)	50 to 60 Hz
Idle Current	4.58 A[a]
Maximum Operating Current	5.42 A[a]
Maximum Surge Current	7.78 A[a]

a. Typical voltage: 230 V AC, 60 Hz

Power and site wiring requirements for models with power supply and fan units

The storage expansion enclosure uses wide-ranging redundant power supplies that automatically accommodate voltages to the power source. The power supplies operate within the ranges specified in Table 16 on page 19. The power supplies meet standard voltage requirements for both domestic (inside USA) and international (outside USA) operation. They use standard industrial wiring with line-to-neutral or line-to-line power connections.

The agency voltage and current ratings for the EXP5060 storage expansion enclosure are 200 VAC - 240 VAC and 7.19 A - 8.62 A.

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

Power cords and receptacles: The storage expansion enclosure ships with two jumper cords with IEC C13 plug on one end and IEC C14 plug on the other end that are used to connect to the rack PDU outlets. It is not shipped with the power cords that can be used to connect it directly to an electrical outlet in the destination country. You must purchase the power cords that are appropriate for use in a typical outlet in the destination country. See Appendix D, "Power cords and storage rack PDUs," on page 157 for more information.

Heat output, airflow, and cooling

See "Airflow and heat dissipation" on page 18 for heat output, airflow, and cooling specifications.

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

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

*   Air enters at the front of the rack and leaves at the back. To prevent the air that is leaving the rack from entering the intake of another piece of equipment, you must position the racks in alternate rows, back-to-back and front-to-front. This arrangement is known as *cold aisle and hot aisle* and is shown in Figure 10 on page 21.
*   Where racks are in rows, each rack must touch the rack that is next to it to reduce the amount of hot air that can flow around from the back of the rack into the intakes of the storage expansion enclosures that are in that rack. You should use Suite Attach Kits to completely seal any gaps that remain between the racks. For details about Suite Attach Kits, contact your marketing representative.
*   Where racks are in rows front-to-front or back-to-back, a gap of at least 1220 mm (48 in.) must separate the rows across the cold aisle.
*   To ensure correct airflow in each rack, the rack filler plates must be installed in unused positions. Also, all the gaps in the front of the racks must be sealed, including the gaps between the storage expansion enclosures.
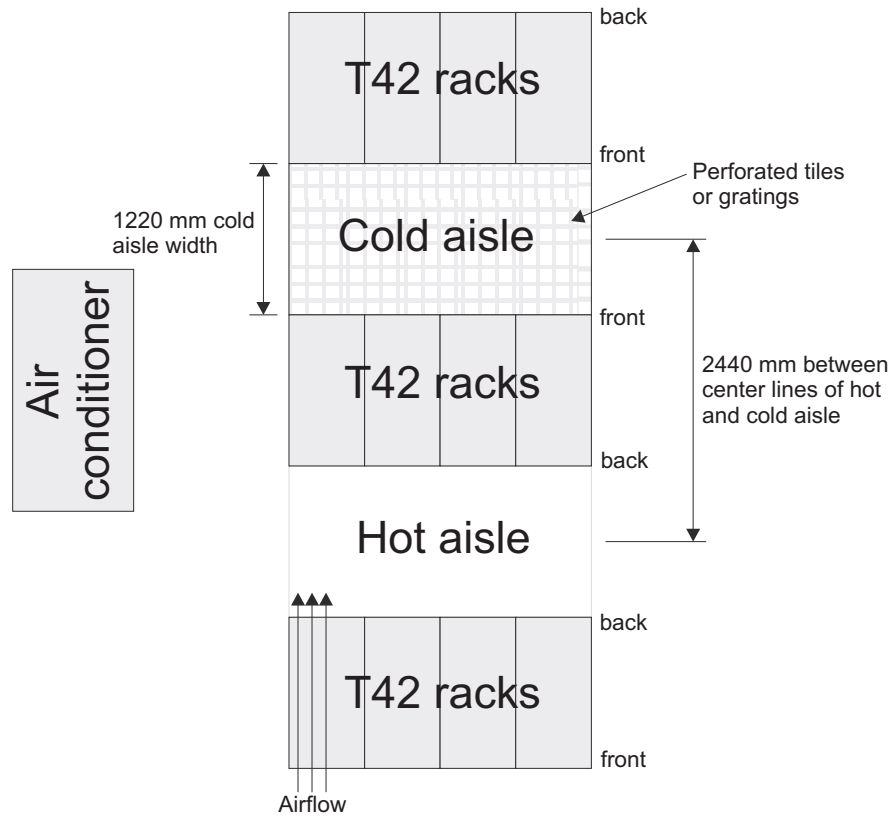
Figure 10. Example of cold aisle/hot aisle rack configuration

Chapter 2. Installing the EXP5060

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

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

Installation overview

This product is to be installed and serviced only by qualified IBM service representatives. The EXP5060 can be ordered pre-installed in the cabinet, or it can be added to an existing cabinet. The installation requires a minimum of two people for a safe installation.

Attention: Refer to "Safety" on page xi for general safety instructions and Appendix C, "Specifications for non-IBM rack installation," on page 149 before performing any installation or service procedures.
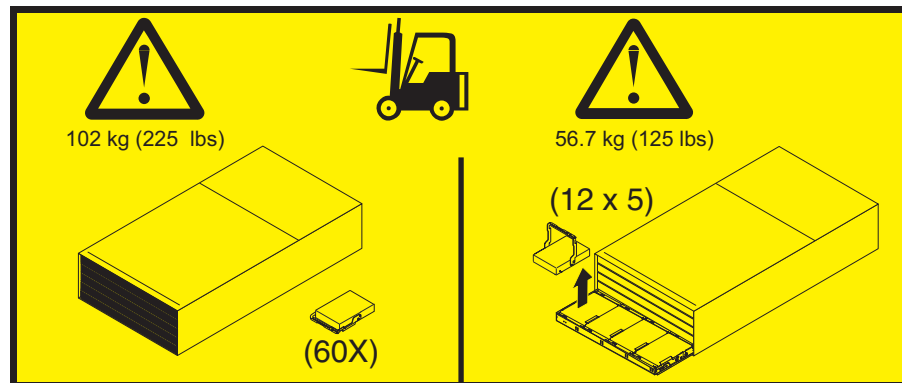
CAUTION:
1. **The weight of this unit in the drive-ready state (without drive modules installed) is 56.7 kg (125 lb). Fully configured (with 60 drive modules installed) the unit weighs 102.1 kg (225 lb). It takes two specially trained IBM personnel with a lifting device to safely lift this unit.**
2. **A fully populated EXP5060 weighs approximately 102.1 kg (225 lb). Before you install it, verify that the additional weight of the chassis does not exceed the rack's weight limit or unbalance the rack cabinet. When you calculate the additional weight, include the weights of all components that can potentially be added, to avoid overloading in the future.**

Ordering the lift tool

Note: The lift tool is required only when you install an additional EXP5060 or when you install or remove the EXP5060 from the cabinet. Make sure that the lift tool is available on location at the time of the installation. The ordering procedures for the lift tool vary depending on your location. You should direct questions about these procedures to your regional representative.

World trade locations

The following ordering procedures are for world trade locations:

- Order the lift tool by using the parts order system, like any other part.
- Use the following part numbers when you order: Lift tool: Part number 09P2481.
- You do not record parts usage.
- Return the lift tool to the parts center after you complete the installation or removal of the EXP5060.

United States locations

In the United States, call UPS Logistics at 800–528–6070 to order the lift tool or visit the MTS/Test Equipment Service Center Web site on the IBM intranet at http://pokgsa.ibm.com/~tstesc/public/ for additional information.

Notes:

1. For the SSR branch and territory, the United States cannot order the lift tool through the parts order system. UPS Logistics are used to ship and return the lift tool. Use the following part numbers when you order: Lift tool: Part number 09P2481.

2. The MTS/Test Equipment Service Center Web site can be accessed only by IBM employees with access to the IBM intranet.

Attention: When you order the lift tool, you will receive an 18–inch load plate.

You must provide the following information when you order the lift tool. This information is necessary to ensure that the lift tool is delivered when you need it. Failure to provide this information might delay the completion of the order request and the shipping request. It might also result in a time and date to return the tool that is different from what you need.

- Phone number and customer contact
- Account code: 98577
- Time and date of delivery
- Accurate destination address with zip code
- Time and date of return pickup

You must return the lift tool at the time that was scheduled with UPS Logistics. If you need to change the scheduled return time or date, contact UPS Logistics. You are responsible for ensuring that all of the paperwork and components are packed and restored in the lift tool shipping container. Make sure that the lift tool is functioning properly before you release the tool to UPS Logistics for return. You are accountable for the lift tool until UPS Logistics picks up the lift tool for return delivery to their parts storage facility. Contact your branch office tools coordinator or your region specialist if you have any questions or concerns.

Installation sequence

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

1. Prepare the installation site and the rack cabinet. Unpack the EXP5060 and other hardware from the shipping box. See "Preparing for installation" on page 26.
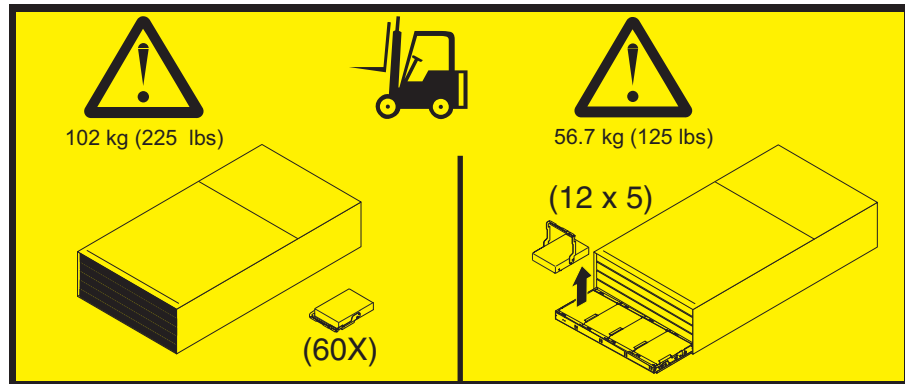
102 kg (225 lbs)   56.7 kg (125 lbs)

(12 x 5)

(60X)

Attention:

a. Because of the size and weight of the storage enclosure as shipped, a lift tool and two trained service technicians are required to push the enclosure out of its custom-designed package and onto the lift tool. If a lift tool is not available, see Appendix G, "Component weights," on page 169 for additional information.

b. Before you move or relocate a rack that contains EXP5060 storage enclosures, see "Relocating the EXP5060" on page 61 for additional information.

Note: For more information about how to use a lift tool, see the documentation that came with the lift tool.

2. Install the support rails in the rack. See "Installing the support rails" on page 29.

3. Install the EXP5060 storage expansion enclosure in the rack. See "Installing the EXP5060 into a rack" on page 35.

4. Install disk drives in the EXP5060 storage expansion enclosure. See "Installing the drives" on page 37.

5. If there other EXP5060 storage expansion enclosures to be installed in the same rack, repeat step 2 to step 4 for the other EXP5060s.

6. Install the DS5100 or DS5300 storage subsystem in the rack if it is not already done. See the *IBM System Storage Quick Start Guide* for the DS5100 and DS5300 storage subsystems or the *IBM System Storage DS5100 and DS5300 Installation, User's, and Maintenance Guide* for installation information.

7. Install the power supply cables to the EXP5060s and also to the DS5100/DS5300, if applicable. Make sure that the EXP5060 power supplies are connected to 180-240V AC sources only. The DS5100 or DS5300 storage subsystem can be connected to either 90-136V or 80-240V AC sources. See "Cabling the power supply" on page 61.

8. Cable the EXP5060 to other EXP5060s or to a DS5100/DS5300. See Chapter 3, "Cabling the EXP5060," on page 41.

9. Install the DS Storage Manager host software to manage the DS5100/DS5300. See "Software and hardware compatibility and upgrades" on page 11 for the appropriate version.

   For instructions to install the DS Storage Manager, see the *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide*.

10. Turn on the EXP5060 (if you have not done so already). See "Powering on the EXP5060" on page 65.

11. Turn on the DS5100 or DS5300 storage subsystem and upgrade the controller firmware. See the *IBM System Storage DS5100 and DS5300 Installation, User's, and Maintenance Guide* for more information.

Handling static-sensitive devices

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

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

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

Preparing for installation

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

Complete the following steps to prepare the storage expansion enclosure 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 15.
2. Move the storage expansion enclosure to the site.
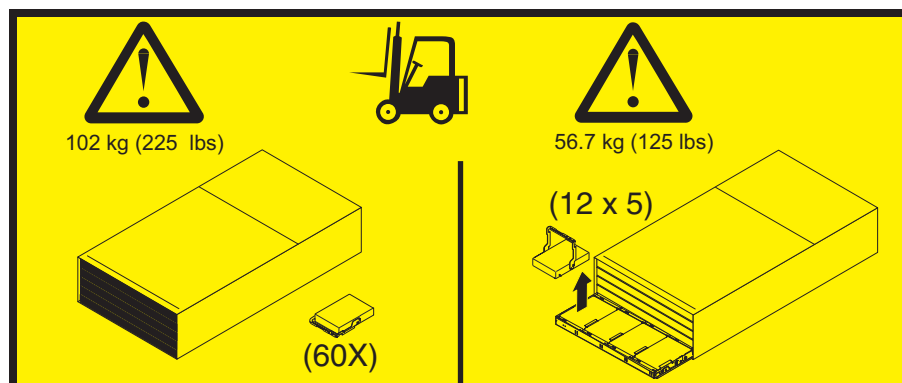
Attention:

    a. Because of the size and weight of the storage enclosure as shipped, a lift tool and two trained service technicians are required to push the enclosure out of its custom-designed package and onto the lift tool. If a lift tool is not available, see Appendix G, "Component weights," on page 169 for additional information.

    b. Before you move or relocate a rack that contains EXP5060 storage enclosures, see "Relocating the EXP5060" on page 61 for additional information.

Note: For more information about how to use a lift tool, see the documentation that came with the lift tool.

3. Remove the storage expansion enclosure from its shipping container and check the contents (see "Unpacking the shipping box"). If any items are missing, contact your IBM reseller before proceeding.

4. Verify that you have the following software:

   - The correct version of the IBM DS Storage Manager software. See "EXP5060 hardware and software compatibility" on page 12.
   - DS5000 controller firmware that ships with the storage expansion enclosure. You use this software to configure the storage subsystems.

     Note: Different DS5000 models may have different firmware versions.

5. Read *Storage System Product Release Notes*® for any updated information about hardware, software, or firmware products.

6. Continue with "Preparing the site" on page 28.

Unpacking the shipping box

Important: Do not remove the storage expansion enclosure from the shipping box until the support rails are installed in the rack cabinet. You must install the support rails in the rack cabinet before you install the storage expansion enclosure.

The disk drive modules (DDMs) that come with the storage expansion enclosure are packaged in a smaller box inside the shipping box. To unpack the shipping box, complete the following steps:

1. Remove the following items from the shipping box. Do not remove the EXP5060 from the shipping box at this time.

   - Box containing the mounting hardware kit
   - Six full or empty boxes of DDMs

     Note: The DDMs are packaged ten per box. The minimum order is 20 DDMs, so at least two of the boxes are full. If you ordered less than the maximum number of 60 DDMs, one or more of the boxes are empty.

   - Box containing storage expansion enclosure handles
   - Box containing the power cords, Fibre Channel signal cables, and documentation

2. Check the items in the preceding list to make sure that you received all the necessary parts. See the "Inventory checklist" on page 2 section for the parts that are included with the storage expansion enclosure.

Tools and hardware required

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

- A portable mechanized lift
- A number 2 Phillips screwdriver
- An M5 hex nut driver
- A medium flat-blade screwdriver
- Anti-static protection (such as a grounding wrist strap)
- The rack power jumper cords that are shipped with the storage expansion enclosure
- Fibre channel (FC) and Ethernet interface cables and cable straps
- SFP modules
- Rack-mounting hardware that ships with the storage expansion enclosure

Preparing the site

This section lists the floor space requirements and weight information for the storage expansion enclosure. For information on interface cables and connections, see Chapter 3, "Cabling the EXP5060," on page 41.

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

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

Weight: The storage expansion enclosure total weight depends on the number of components that are installed. A fully configured storage expansion enclosure with two power supplies, two fan assemblies, two ESMs, and 60 hard disk drives installed weighs up to 225 lbs (102.1 kg). See Appendix G, "Component weights," on page 169 for additional information.

Other: Consider the following important preparation activities:

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

Continue with "Preparing the rack."

Preparing the rack

Important: Before you install the storage expansion enclosure in a rack, keep in mind the following considerations:

- The IBM supported racks for the EXP5060 are models 2101-200 and 7014. Review the documentation that comes with your rack enclosure for safety and cabling considerations.
- When EXP5060 enclosures are to be plant or field integrated into the IBM 2101 Model 200 Storage Solutions Rack, the rack must be configured with PDU power cords rated for 240 volt electrical service using either of rack power cord options

9491, 9492, 6491, or 6492. Refer to Appendix D, "Power cords and storage rack PDUs," on page 157 and the *2101 Model 200 Rack Installation and User's Guide* for details.

- IBM does not support the ruggedized rack feature for the 2101-200 rack when it is used with the EXP5060. The EXP5060 will not fit in the 2101-200 rack if the ruggedized rack feature is installed.
- Do not install the EXP5060 above EIA Unit position 32 in any rack. Installing the EXP5060 above U position 32 requires a ladder and is not supported.
- If you are using a non-IBM rack or cabinet, review the information in Appendix C, "Specifications for non-IBM rack installation," on page 149.
- Do not extend more than one device out of the rack cabinet at the same time.
- Install the storage expansion enclosure in a 25° C (77° F) environment.
- To ensure proper airflow, do not block the air vents; 15 cm (6 in.) of air space is sufficient.
- To ensure rack stability, load the rack starting at the bottom.
- If you install multiple components in the rack, do not overload the power outlets.
- Always connect the storage expansion enclosure to a properly grounded outlet.

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

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

Installing the support rails

Note: Duplicate copies of the rack mounting templates are provided in Appendix B, "Rack mounting template," on page 145. If you want to tear out the templates from this document for easier use, use the copies in Appendix B, "Rack mounting template," on page 145 rather than the copies provided in this section.

Use the following templates (Figure 11 on page 30 and Figure 12 on page 31) to identify the proper locations for inserting M5 screws when mounting the support rails and EXP5060 to a rack. The locations for the M5 screws are highlighted in the templates.

The EXP5060 is 4U 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 round. The holes in your rack might be round, square, or threaded.

4U ----------   ---------- 4U

Install second   Install second

3U ----------   ---------- 3U
← Install first   Install first →

Install second   Install second

FRONT
Rack Mounting
Template

Rail assembly   Rail assembly
(front left)   (front right)

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

← Install first   Install first →

0U ----------   ---------- 0U
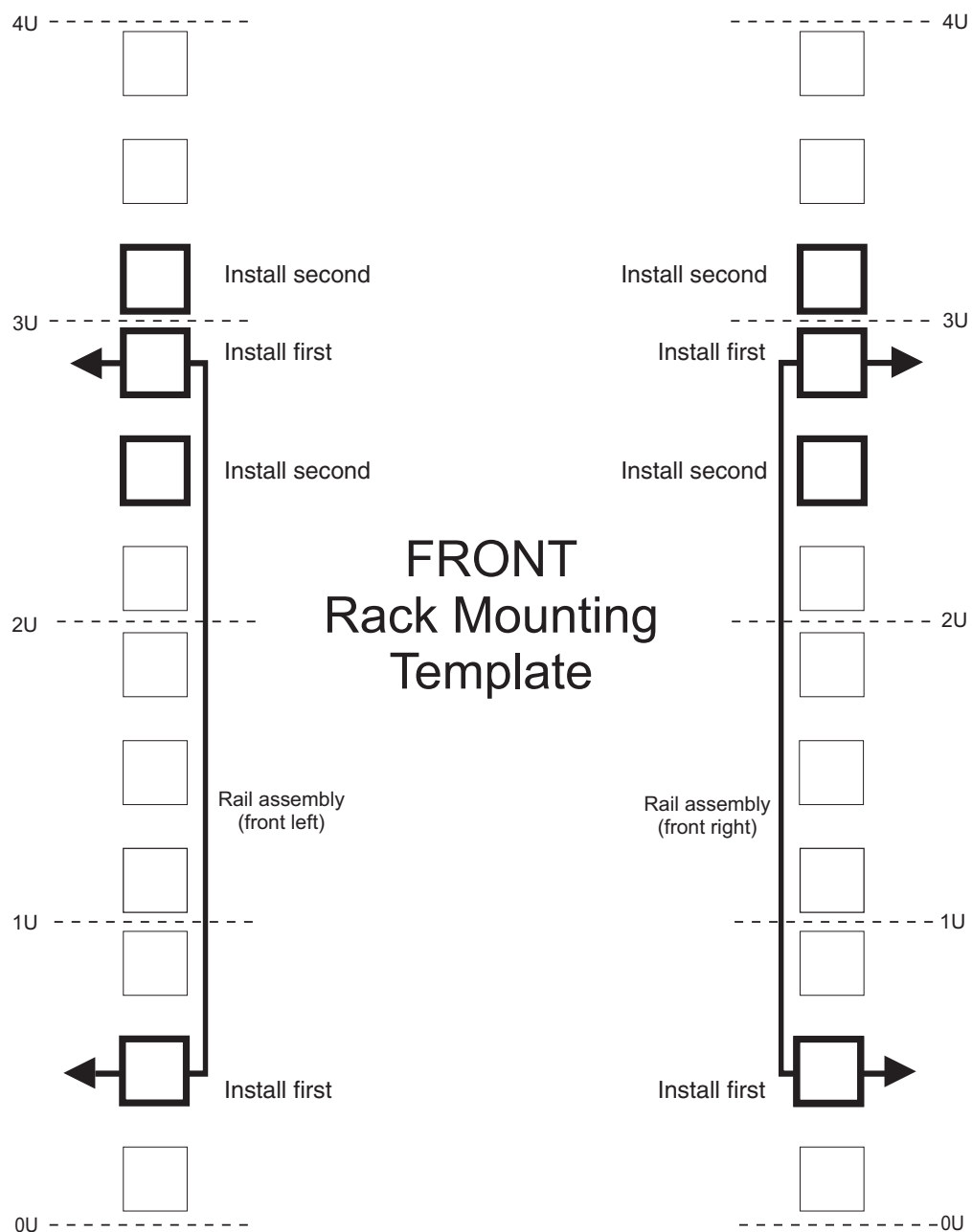
Figure 11. Front rack mounting template

REAR
Rack Mounting
Template

4U

Rear bracket

3U

2U

Rail assembly
(rear left)

1U

Rail mounting guide

0U

4U

Rear bracket

3U

2U

Rail assembly
(rear right)

1U

IBM®

Printed in the U.S.A

0U
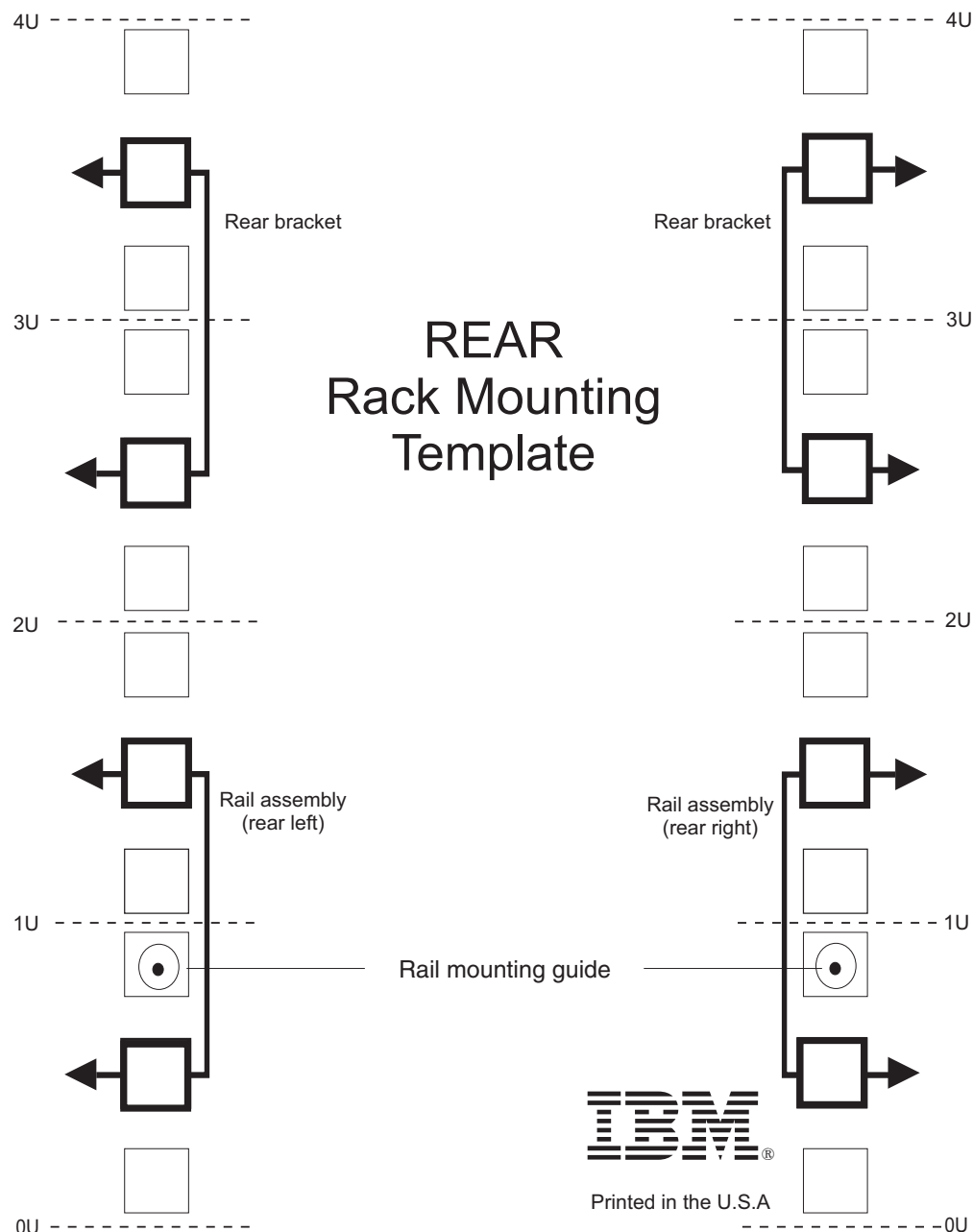
Figure 12. Rear rack mounting template

Before installing the EXP5060 in a rack, you must install the rails and
rack-mounting hardware that come with your storage expansion enclosure. The
EXP5060 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 76 cm (30 in.) minimum and 81.28 cm (32 in.) maximum. This rack conforms to
the EIA standard. Where you place the support rails in the rack depends on where
you intend to position the storage expansion enclosure.

Use the front and rear rack-mounting templates in Figure 11 on page 30 and
Figure 12 to align the support rails and rear brackets with the correct rack holes. If
the support rails will be installed above an existing storage subsystem or storage
expansion enclosure, position the EXP5060 support rails directly above it. If the

support rails will be installed below an existing storage subsystem or storage expansion enclosure, allow 178 mm (7 in.) of vertical clearance for the EXP5060.

Notes:

1. For proper weight distribution, install the support rails as low in the rack cabinet as possible.
2. The rack cabinet must have a minimum depth of 100 cm (40 in.).
3. If you are using a non-IBM rack or cabinet, review the information in Appendix C, "Specifications for non-IBM rack installation," on page 149.

To install the left and right support rails in the rack cabinet, complete the following steps.

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

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

   Note: The screws and washers might already be attached to the support rails. If so, remove them from the support rails.
4. Starting with the left support rail, loosen the two rail adjustment screws with a medium flat-blade screwdriver. The adjustment screws are used to lock the support rails at a certain length.

   Note: The support rails are not marked as left or right. However, each rail can be mounted correctly on only one side of the rack cabinet. The rails should be mounted with the alignment pin at the rear of the rack.
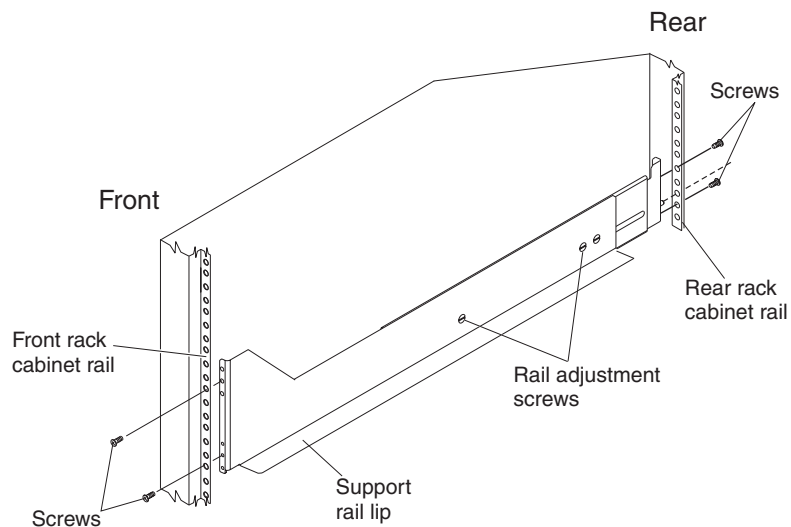
5. Hold the front of the left support rail against the inside of the front rack cabinet support flange, and extend the rear of the support rail until it makes contact with the rear rack cabinet support flange. The alignment pins at the rear of the support rail slide into the mounting holes at the rear of the rack cabinet. The wider end of the support rail must be positioned at the front of the rack cabinet.

6. From the front of the rack cabinet, with the support-rail flanges positioned inside the rack cabinet support rail assemblies, insert two M5 screws with washers through the front of the cabinet and screw them into the support rail front flange. Make sure that you use a washer when you install an M5 screw through a square hole on a rack-mounting flange.

   Attention: Make sure that the screws are tight enough to support the weight of the storage expansion enclosure, but do not completely tighten the screws yet.

7. Make sure that the holes in the rail above and below the top mounting screw are visible through the holes of the rack flange and tighten the two M5 screws to secure the front of the rail to the rack flange.

8. From the rear of the rack cabinet, insert two M5 screws with washers through the rear of the cabinet and screw them into the support rail rear flange.

9. Tighten the two rail adjustment screws with a medium flat-blade screwdriver.

10. Repeat steps 4 on page 32 through 9 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 expansion enclosure to fit unevenly in the rack.

11. Locate the two rear brackets, four M5 screws, four washers, and four clip nuts that are supplied with the storage expansion enclosure.

12. Install the rear brackets at the rear of the rack as shown in the following illustration, using the M5 screws, washers, and clip nuts to secure the brackets to the rack mounting holes. Do not tighten the screws until the EXP5060 is installed in the rack (see 8 on page 36).
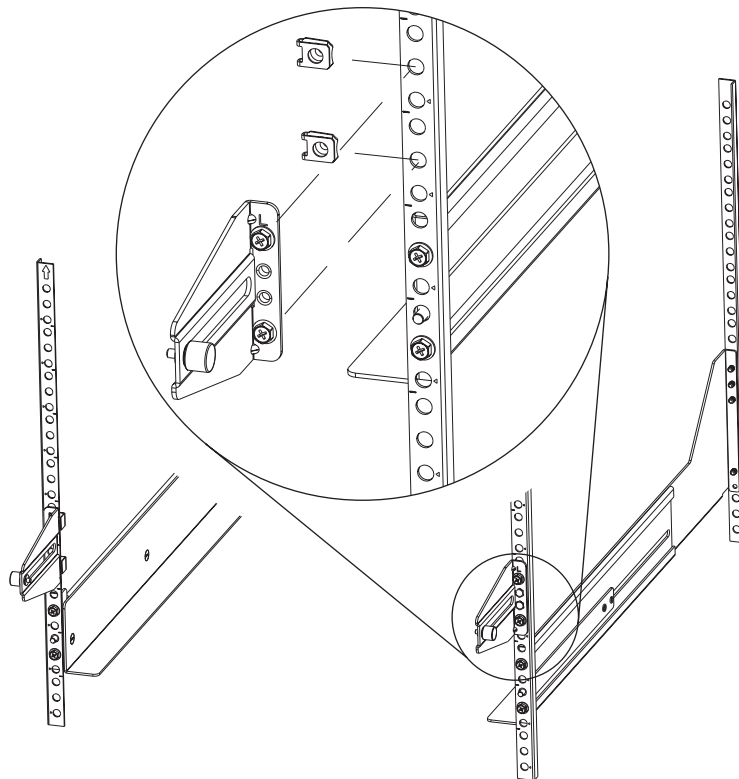
Installing and removing the handles

Install the handles on the storage expansion enclosure before you move the unit onto the lift tool. After you install the storage expansion enclosure in the rack cabinet and remove the handles, store the handles for future use.

Installing the handles

Complete the following steps to install the handles on the storage expansion enclosure:

1. Locate the box of handles.
2. To install a handle on the storage expansion enclosure, place notch at the bottom of the handle in the opening in the storage expansion enclosure chassis, and push the handle in and up until the latch at the top of the handle secures the handle to the chassis.
3. Repeat step 2 for the three remaining handles.

Removing the handles

Before you install the storage expansion enclosure completely into a rack cabinet, you must remove the handles. Complete the following steps to remove the handles from the storage expansion enclosure:

1. To remove a handle to the storage expansion enclosure, release the latch with your thumb and pull down and away from the unit.
2. Repeat step 1 for the three remaining handles.
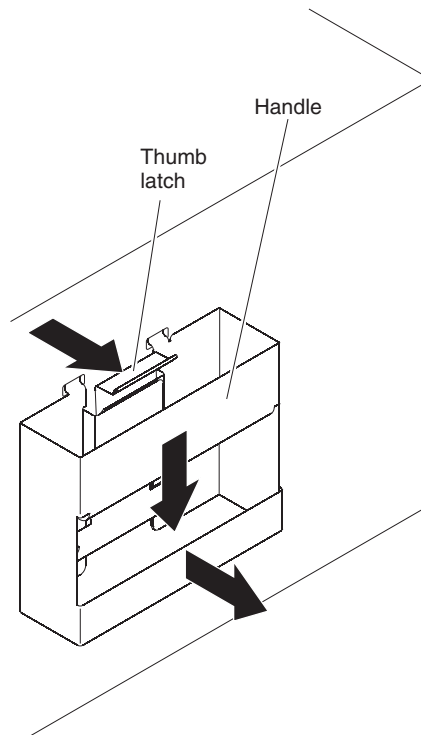
3. Store the handles for future use.

Installing the EXP5060 into a rack

To install the storage expansion enclosure, complete the following steps.

Note: For more information about how to use a lift tool, see the documentation that came with the lift tool.

1. Prepare the storage expansion enclosure for installation:

   a. Position the lift tool so that it is facing one side of the shipping box.

   b. Remove the foam shipping material from the sides and ends of the storage expansion enclosure.

   c. If necessary, cut away sides of the shipping box so that the lift tool has access to the storage expansion enclosure.

   d. Open the plastic bag and tuck it under the storage expansion enclosure. The plastic bag reduces friction and makes it easier to slide the unit off of the shipping box onto the lift tool, and off of the lift tool and into the rack cabinet.

   e. Install the four handles on the sides of the storage expansion enclosure. See "Installing and removing the handles" on page 34 for detailed instructions.
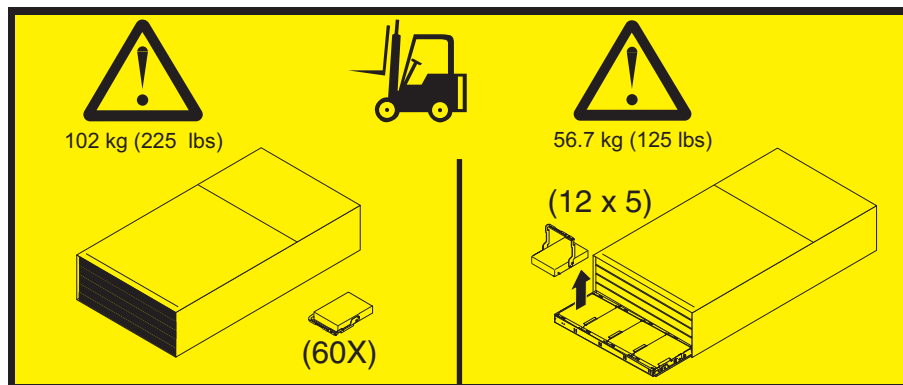
Attention:

   a. Because of the size and weight of the storage expansion enclosure as shipped, a lift tool and a minimum of two trained service technicians are required to push the enclosure out of its custom-designed package and onto the lift tool. For more information about the lift tool, see "Installation overview" on page 23.

   b. Before you move or relocate a rack that contains EXP5060 storage expansion enclosures, see "Relocating the EXP5060" on page 61 for additional information.

2. With the help of a lift tool and a minimum of two trained service technicians, or a lift tool and professional movers, slide the storage expansion enclosure off of the side of the shipping box and onto the lift tool. Align it in front of the rack.

3. Put the rear edge of the storage expansion enclosure on the support rails.

4. Remove the two handles (one on each side) at the rear of the storage expansion enclosure. Do not remove the front handles on both sides of the unit.

5. Slide the storage expansion enclosure halfway into the rack and remove the two handles (one on each side) at the front of the unit.
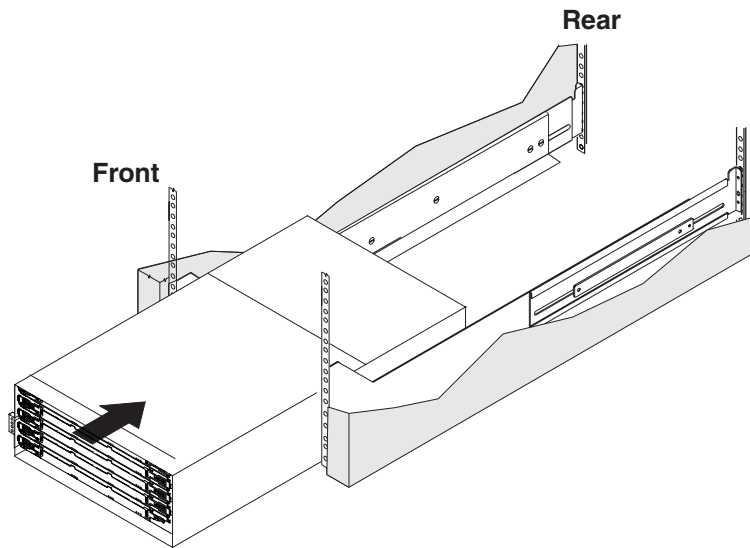
Rear

Front

6. Install and tighten two M5 screws on each side of the rack, above and below the top M5 screws, in the front of the storage expansion enclosure to secure the storage expansion enclosure chassis to the rack flanges.
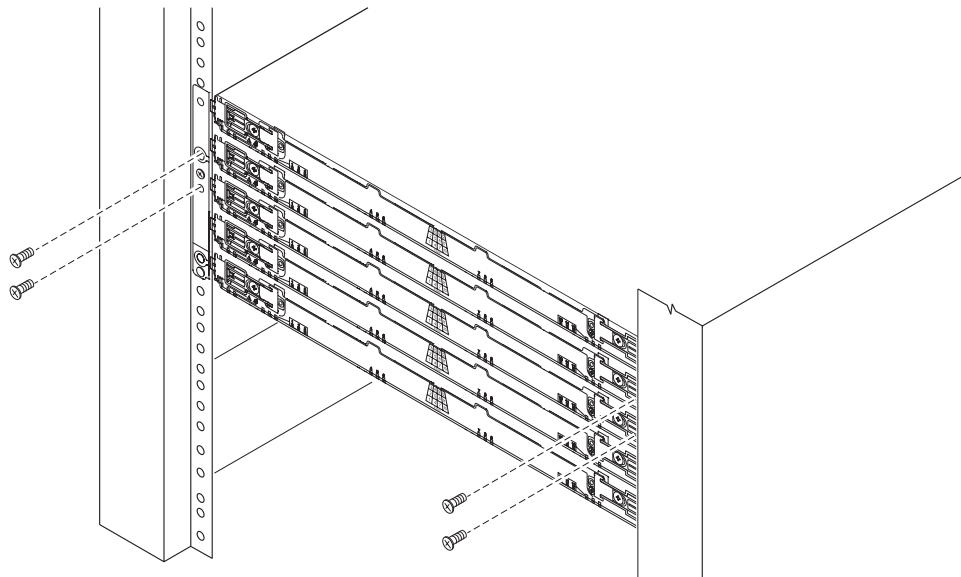
7. Turn the rear-bracket thumbscrews to attach the rear brackets to the sides of the storage expansion enclosure. The screw holes are located about 51 mm (2 in.) from the rack flange.

   Note: To align the thumbscrews with the holes in the unit, you might need to loosen the screws that attach the rear brackets to the rack cabinet.

8. Tighten all of the M5 screws to secure the rear bracket to the rack cabinet.

9. Continue with "Installing the drives" on page 37.

Installing the drives

Attention:

1. **Potential damage to DDMs** - Repeatedly turning the power off and on without waiting for the DDMs to spin down can damage them. Always wait at least 90 seconds from when you turn off the power until you turn it on again.

2. The installation order within each drawer is from left to right in rows. Slots 1, 4, 7 and 10 must have a drive installed in these locations to make sure there is sufficient air flow to the drives (see Figure 13). To verify these slots, consult the overlay on the front of each of the five drive drawers. Make sure the four drives in each row are adjacent to each other. The long edge of each drive should touch the drive next to it. To maintain a uniform airflow across all drive drawers, the storage expansion enclosure must be configured with a minimum of 20 drives, with four drives in the front row of each of the five drive drawers.
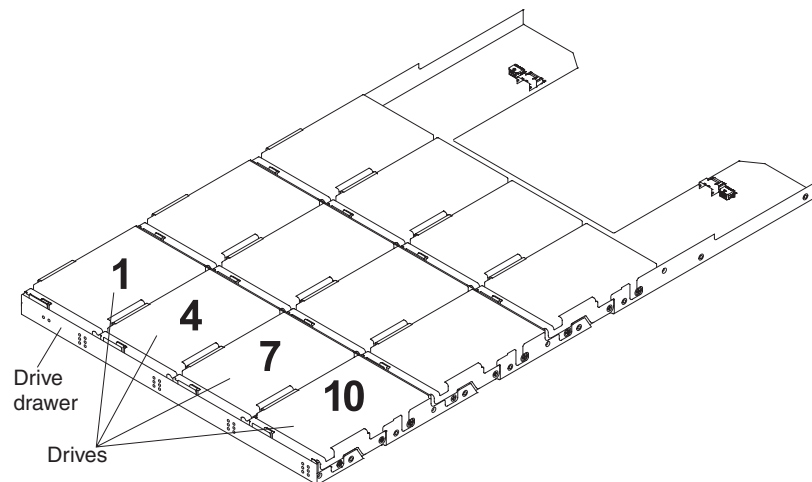
Figure 13. EXP5060 drive drawer with labeled disk drives

Notes:

1. The drive drawers are preinstalled in the EXP5060, but the DDMs are shipped separately from the drive drawers.

2. Make sure that you install the storage expansion enclosure in the rack cabinet before you install DDMs in the storage expansion enclosure.
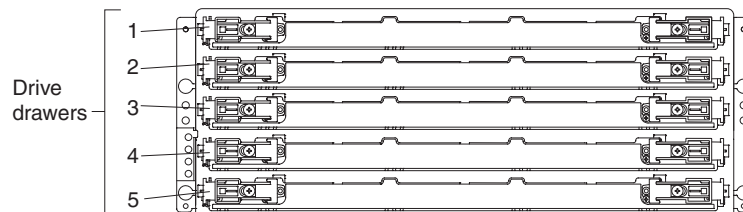
To install the DDMs in the drive drawers, complete the following steps:

1. Starting with the top drive drawer in the storage expansion enclosure, pull the levers on each side of the drive drawer towards the center to release the drawer.
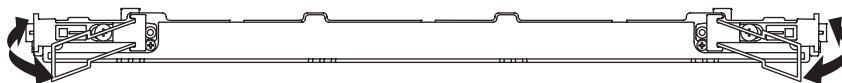
2. Pull the levers out from the storage expansion enclosure until the drawer is fully extended, but do not remove it from the enclosure.

3. Starting with the first DDM, raise the DDM handle to the vertical position.

Latch

Raised buttons
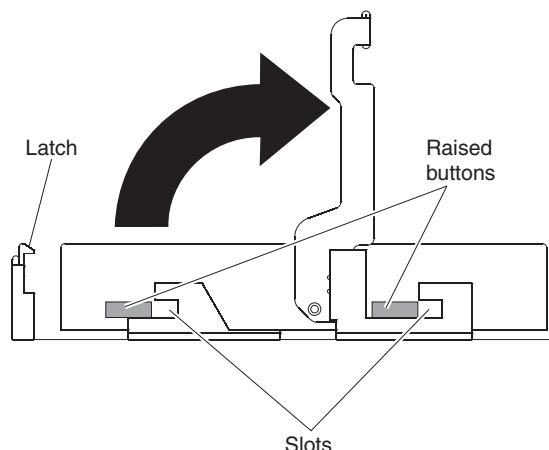
Slots

4. Align the raised buttons on the sides with the matching slots in the DDM channel on the drawer. Lower the DDM down onto the drawer, and rotate the DDM handle until the DDM snaps into place under the DDM release lever.

   Notes:

   a. If the DDM does not seem not fully seated into the drive connector on the disk drawer, apply downward pressure to the rear of the drive as you install it.

   b. If the storage expansion enclosure is turned on, you must wait at least 90 seconds after you install each DDM in the drive drawer. Otherwise, the storage expansion enclosure might not recognize the new DDM, recognize the DDM as failed, or recognize the drive as incompatible. If this happens, unlatch the DDM, wait 90 seconds, and latch the DDM again.

5. Install the other DDMs in rows from left to right until the drive drawer has a minimum of four DDMs in the front row of the drive drawer.

6. Push the drive drawer into the storage expansion enclosure until it clicks and close the levers on each side of the drawer.

   Attention: Make sure you push both levers back against the drive drawer completely so that the drive drawer is closed. If the drive drawer is not completely closed, excess airflow through the unit might cause damage to the DDMs. If the drive drawer is not completely closed, you will not be able to open another drawer. If you try to force open another drawer, both drawers might be damaged.

7. Repeat steps 1 on page 37 through 6 for each drive drawer in the configuration.

8. Position the bezel in front of the storage expansion enclosure as shown in the following illustration.

Front bezel   Latches
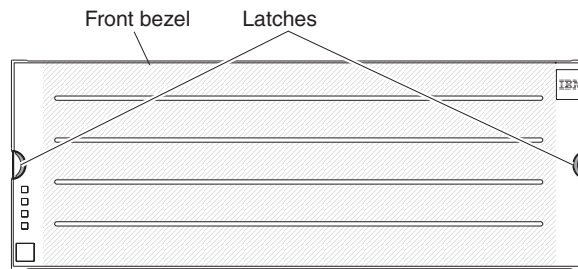
9. Align the tabs on the top and bottom of the bezel with the slots on the front of the storage expansion enclosure, and align the pins on the side of the bezel with the holes in the storage expansion enclosure. Push the bezel into the front of the unit until the latches on both sides of the bezel lock it in place.

10. Continue with "Cabling the EXP5060" on page 42.

Chapter 3. Cabling the EXP5060

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

This chapter addresses the following cabling and configuration topics:

Enclosure ID settings

The enclosure ID, comprised of a pair of seven-segment numbers (referred to x10 and x1 digits), is located on the back of each ESM next to the indicator lights. It provides a unique identifier for each module in the storage subsystem. Each storage expansion enclosure (including the DS5000 storage subsystems with internal drive slots) in the DS5000 storage subsystem configuration must have a unique storage expansion enclosure ID in the DS5000 subsystem configuration. In addition, the single digits (x1) of the enclosure IDs of all enclosures (including the DS5000 storage subsystems with internal drive slots) in the redundant drive channel/loop pair must be unique.

The DS5000 controller firmware and storage expansion enclosure ESM *automatically* set the enclosure ID number. You can change the setting through the storage management software if necessary. Both ESM enclosure ID numbers are identical under normal operating conditions.

If the enclosure IDs in your DS5000 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 using the DS Storage Manager software.

The allowable ranges for enclosure ID settings are 0-99. However, IBM recommends that you do not set the storage expansion enclosure ID to 00 or any number greater than 80 because DS5000 storage subsystem enclosure IDs are set in this range. In addition, you must ensure that the single-digit (x1) of the enclosure ID for every enclosure in a redundant drive loop pair is unique. (This also includes any storage subsystem that has drives installed.)

Figure 14 on page 42 shows the enclosure ID.

Seven-segment
numeric display

Seven-segment
numeric display
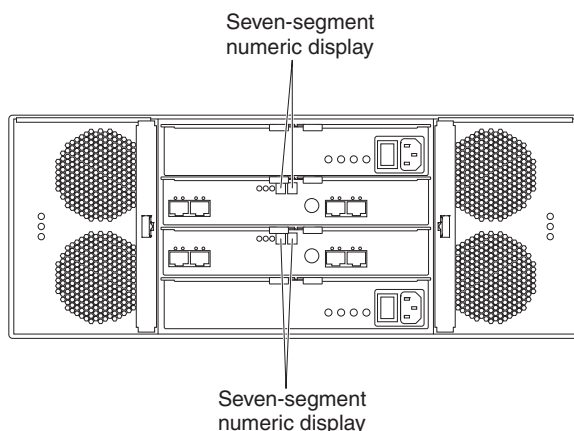
Figure 14. Storage expansion enclosure seven-segment enclosure ID

Fibre channel loop and ID settings

When you install a hard disk drive in the storage expansion enclosure, the drive drawer plugs into a printed circuit board called the *midplane*, which in turn is connected to the ESMs. The EXP5060 ESMs and the DS5100/DS5300 controller set the fibre-channel loop ID automatically based on the enclosure ID setting and the physical location of the hard disk drive.

Cabling the EXP5060

The EXP5060 storage expansion enclosure supports up to four redundant drive loops. A redundant storage expansion enclosure drive loop consists of one or more storage expansion enclosures that are connected to a storage subsystem using two sets of fibre-channel cables. If one fibre-channel drive loop fails, the storage subsystem uses the other drive loop to maintain input/output (I/O) to the storage expansion enclosure drives. Usually, there are two redundant array of independent disks (RAID) controllers in a storage subsystem. Use the *Installation, User's and Maintenance Guide* or *System Storage Quick Start Guide* that ships with your storage subsystem for the specific information about cabling the storage expansion enclosure to a storage subsystem. Before cabling the storage expansion enclosure, read the following information:

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

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

- **Fibre-channel cable restrictions:** RAID controllers use specific IBM fibre-channel options. Refer to the *IBM System Storage DS5000 Hardware*

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

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

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

Installing SFP modules

The storage expansion enclosure requires SFP modules. SFP modules convert electrical signals to optical signals that are required for fibre channel transmission to and from RAID controllers. After you install the SFP modules, you use fibre-optic cables to connect the storage expansion enclosure to a DS5000 storage subsystem or other storage expansion enclosures.

Important: 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.

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

- Do not mix long-wave SFPs and short-wave SFPs on a single storage subsystem. Use either long-wave SFPs or short-wave SFPs. You can use the DS Storage Manager client to view the storage subsystem profile in order to verify that you are not mixing long-wave and short-wave SFPs.

  Attention: In addition, do not use long-wave SFPs in any of the FC ports in the FC drive loops. (Long-wave SFPs are not supported for use in the drive ports of 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.
- 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 fibre-optic cable.
- You must remove the fibre-optic cable from the SFP module before you remove the SFP module from the port. Refer to "Removing SFP modules" on page 45 for more information.
- Make sure that you use the correct speed Fibre channel SFPs. There is no physical identification to indicate the speed capability of an SFP other than the SFP label. Use the part number indicated on the SFP label to determine the speed capability of the SFP.

Statement 3:

CAUTION:
When laser products (such as CD-ROMs, DVD drives, fibre 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 26.

Complete the following steps to install an SFP module:

1. Remove the SFP module from its static-protective package.
2. Remove the protective cap from the SFP module, as shown in Figure 15. Save the protective cap for future use.
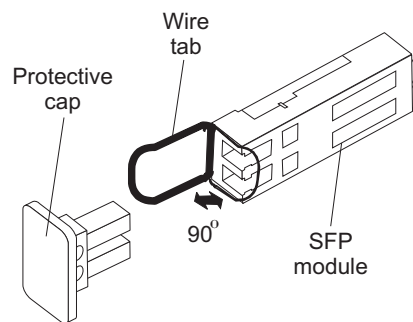
Figure 15. SFP module and protective cap

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 16 on page 45.
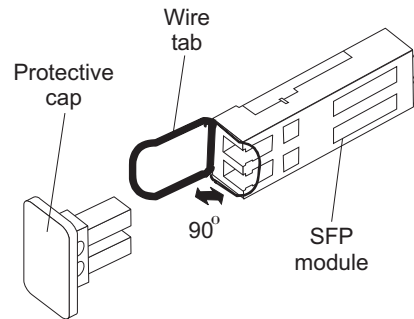
Figure 16. Installing an SFP module into the host port

5. Connect an LC-LC fibre-channel cable. For information about the LC-LC cable, see "Using LC-LC fibre-channel cables" on page 47.

Removing SFP modules

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

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

1. Remove the LC-LC fibre-channel cable from the SFP module. For more information, see "Handling fibre-optic cables" on page 46.
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 17.
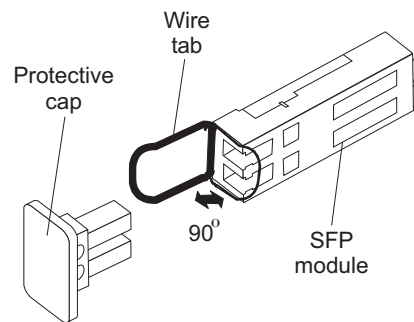
Figure 17. Unlocking the SFP module latch - plastic variety

   - For SFP modules that contain wire tabs, unlock the SFP module latch by pulling the wire latch outward 90°, as shown in Figure 18 on page 46.
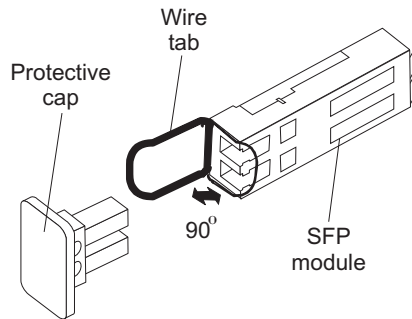
Figure 18. Unlocking the SFP module latch - wire variety

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

Handling fibre-optic cables

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

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

*   For devices on slide rails, leave enough slack in the cables so they do *not* bend to a diameter of less than 76 mm (3 in.), or a radius less than 38 mm (1.5 in.), when extended or become pinched when retracted.
*   Do not overtighten the cable straps or bend the cables to a diameter of less than 76 mm (3 in.), or a radius less than 38 mm (1.5 in.).
*   When storing excess or unused fibre-optic cables, do not bend the cables to a diameter of less than 76 mm (3 in.), or a radius less than 38 mm (1.5 in.) or wrap them around themselves. See Figure 19 on page 47.
*   Loop diameter of 76 mm (3 in.) and bend radius of 38 mm (1.5 in.) for fibre optic cable are IBM DS5000 recommended minimums. Loops or bends smaller than this recommendation may cause damage to your fibre optic cables. It is best practice to use loop diameters and bend radii that are greater than these recommended minimums.
*   Do not route the cable along a folding cable-management arm.
*   Route the cable away from places where it can be damaged by other devices in the rack cabinet.
*   Do not put excess weight on the cable at the connection point. Be sure that the cable is well supported.
*   Do not use plastic cable ties in place of the provided cable straps.
*   The following are the supported maximum cable lengths:
    *   1 Gbps: 500 meters 50/125 um fibre, 300 meters 62.5/125 um fibre

- 2 Gbps: 300 meters 50/125 um fibre, 150 meters 62.5/125 um fibre
- 4 Gbps: 150 meters 50/125 um fibre, 70 meters 62.5/125 um fibre

1.5 inch
(38 mm)
radius

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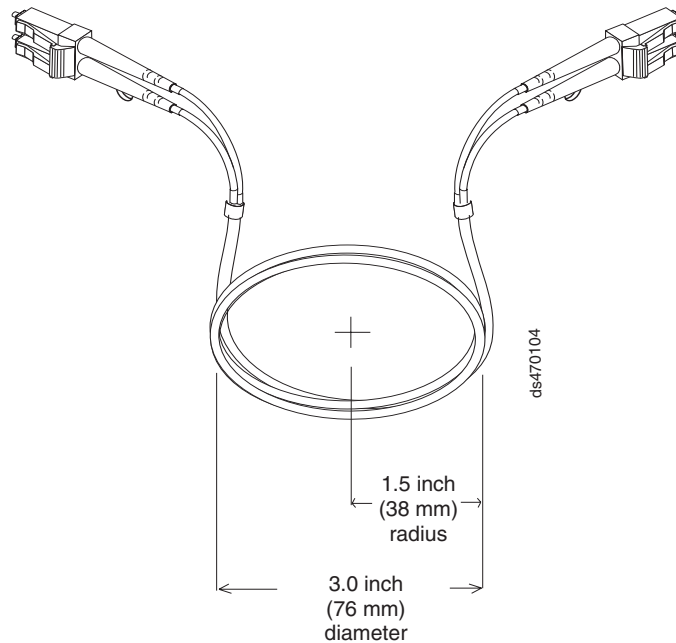
Figure 19. Recommended bending and looping specifications for fibre-optic cables

Using LC-LC fibre-channel cables

The LC-LC fibre-channel cable is a fibre-optic cable that you use to connect into one of the following devices:

- An SFP module installed in an IBM storage expansion enclosure
- An SFP module installed in a DS5000 storage subsystem

See Figure 20 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.
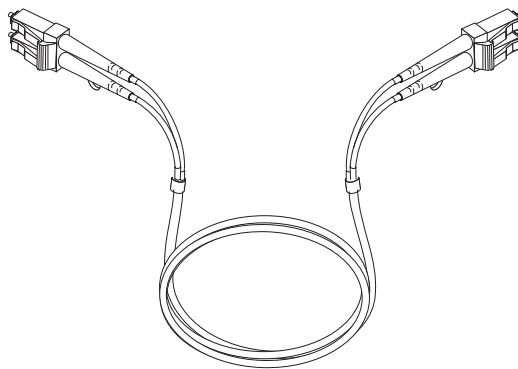
Figure 20. LC-LC fibre-channel cable

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, fibre optic devices, or transmitters) are installed, note the following:

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

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

DANGER

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

1. Read the information in "Handling fibre-optic cables" on page 46.
2. If necessary, remove the protective cap from the SFP module, as shown in Figure 15 on page 44. 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 21. Save the protective caps for future use.
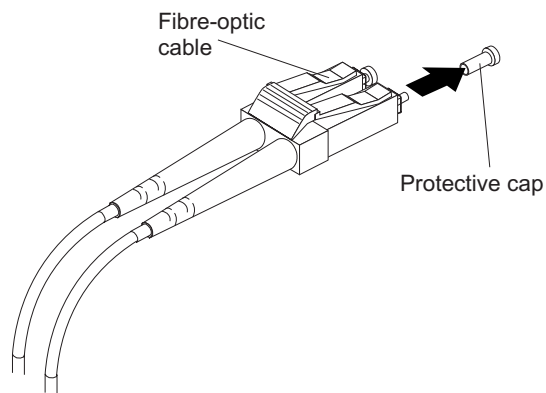
Figure 21. Removing fibre-optic cable protective caps

4. Carefully insert this end of the LC-LC cable into an SFP module that is installed in the EXP5060. The cable connector is keyed to ensure it is inserted into the SFP module correctly. Holding the connector, push in the cable until it clicks into

place, as shown in Figure 22.
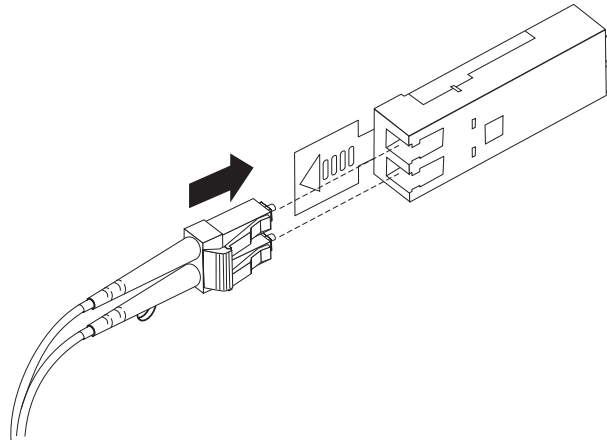
Figure 22. Inserting an LC-LC fibre-channel cable into an SFP module

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 an SFP module that is installed in a separate EXP5060 or other DS5000 storage expansion enclosures.

Removing an LC-LC fibre-channel cable

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

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

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

1. On the end of the LC-LC cable that connects into the SFP module or host bus adapter, press down and hold the lever to release the latches, as shown in Figure 23.
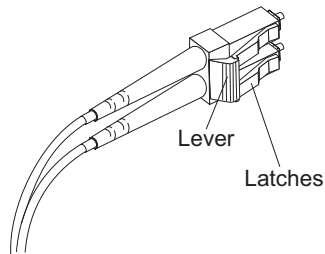
Figure 23. LC-LC fibre-channel cable lever and latches

2. Carefully pull on the connector to remove the cable from the SFP module, as shown in Figure 24 on page 50.
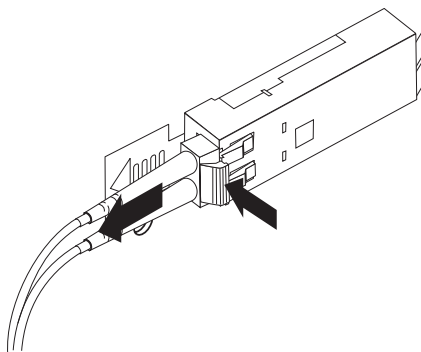
Figure 24. Removing the LC-LC fibre-channel cable

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

EXP5060 cabling configurations

In this release, you can cable the EXP5060 storage expansion enclosure to a DS5100 or DS5300 storage subsystem only.

Note: Connections to other storage subsystems might be supported in the future. To verify your storage subsystems compatibility with the EXP5060, check the Installation, User's, and Maintenance Guide for your storage subsystem and the IBM Disk Support Web site:

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

The EXP5060 has four Fibre channel drive ports per ESM for connecting to the IBM DS storage subsystem controllers and to other EXP5060 enclosures. The EXP5060 supports two cabling schemes between the DS storage subsystem controller drive ports and the EXP5060 drive channels. The supported cabling schemes are referred to as non-trunking and trunking.

Note: The *IBM System Storage DS5100 and DS5300 Storage Subsystem Installation, User's, and Maintenance Guide* contains more detailed cabling instructions for the different number of EXP5060s that can be cabled to the DS Storage subsystem.

Complete the following steps to cable the EXP5060 to a DS5100 or DS5300 storage subsystem:

1. Install an SFP module in the drive mini hub port on the back of the Storage Subsystem.
2. Connect an LC-LC fibre-optic cable into the SFP module, as shown in Figure 25 on page 51.
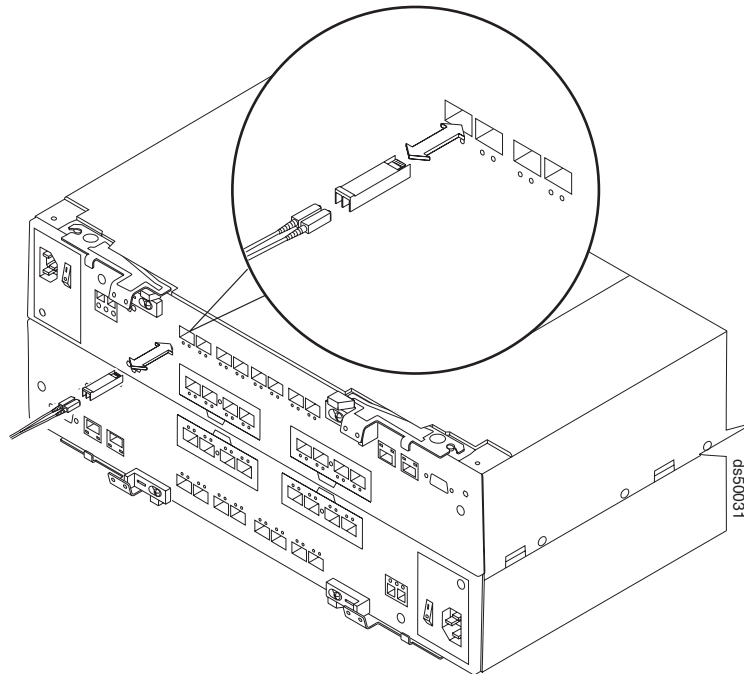
Figure 25. Installing an SFP module and LC-LC cable in a supported DS5000 storage subsystem

3. Install an SFP module in the SFP port on the back of the EXP5060; then, connect the other end of the LC-LC cable into the SFP module, as shown in Figure 26.

Fiber-optic cable
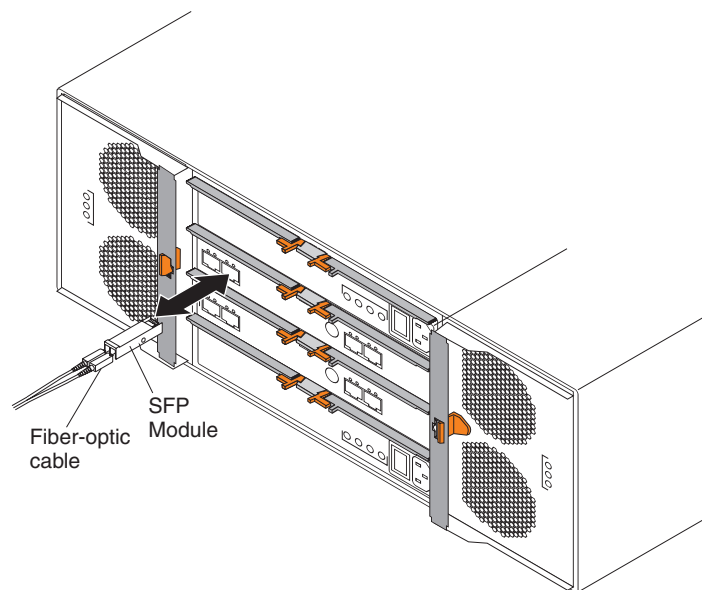
SFP Module

Figure 26. Installing an SFP module and connecting an LC-LC cable to the EXP5060

Note: Only disk drive modules ordered as feature codes of 1818-G1A, and delivered pre-installed in the EXP5060, or as SSR-installable upgrades to EXP5060s will be supported.

Non-trunking cabling

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

Figure 27 shows an example of a DS5100/DS5300 subsystem that is cabled to two EXP5060s using a non-trunking cabling scheme. The storage subsystem drive ports P8 and P6 of controller A are connected to EXP5060 ESM A drive channel ports label 1B. Similarly, the storage subsystem drive ports P1 and P3 of controller B are connected to the EXP5060 ESM B drive channel ports labeled 1B.
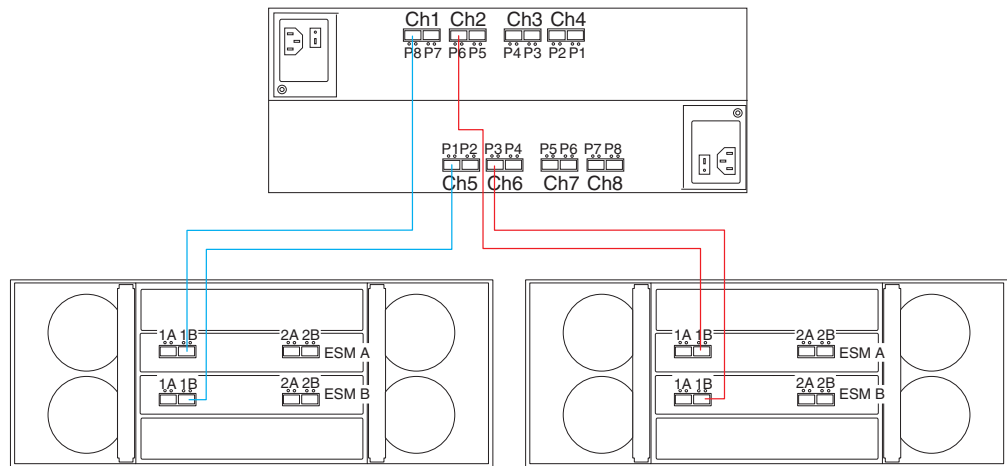
Figure 27. Example of EXP5060 storage expansion enclosure with non-trunking cabling

Port 1A of the EXP5060 ESMs are used to connect more than one EXP5060 enclosure behind a storage subsystem controller drive port. Figure 28 shows an example of connecting two EXP5060s behind controller A drive ports P8 and P6 and controller B drive ports P1 and P3.

Note: This is an example to illustrate the capability to connect more than one EXP5060 behind a storage subsystem controller drive port. This is not the recommended cabling scheme when you have only four EXP5060s in a storage subsystem configuration.
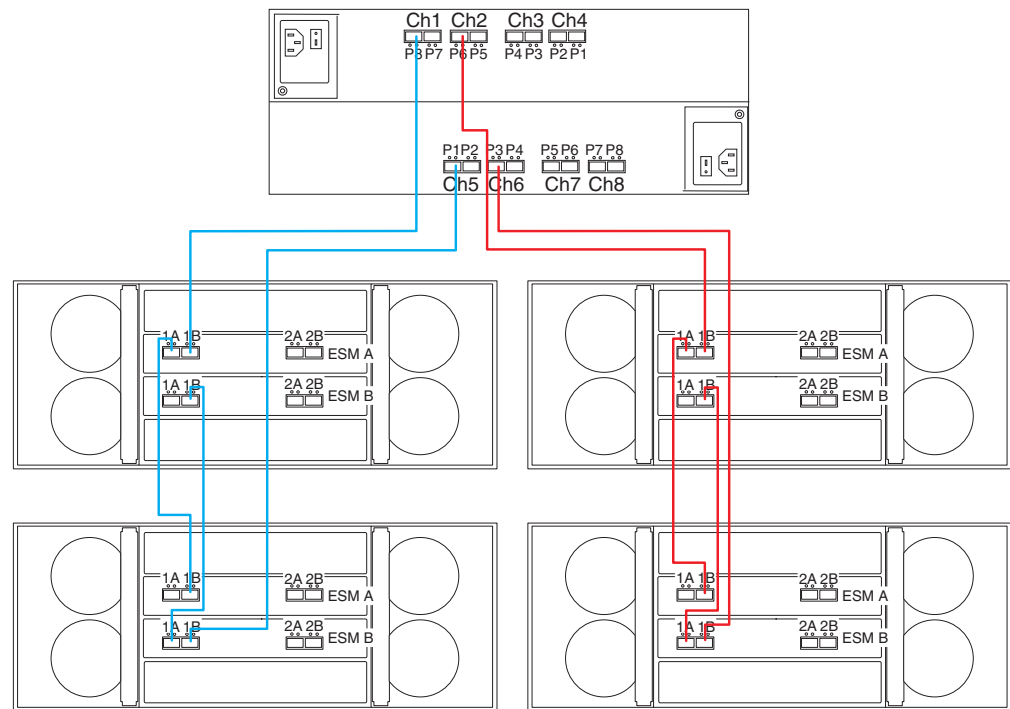
Figure 28. Example of cascading EXP5060s in non-trunking cabling scheme

EXP5060 storage expansion enclosures can also be connected to a supported DS5000 storage subsystem in mixed configurations along with EXP5000 and EXP810 storage expansion enclosures.

Figure 29, Figure 30 on page 55, and Figure 32 on page 57 show examples of the intermixing the EXP5060 and EXP5000 in the same controller drive ports, same controller drive channel, and different controller drive channel, respectively. The maximum number of EXP5000s that can be connected in the same drive port or drive channel with the EXP5060 is 3.

Figure 31 on page 56 and Figure 32 on page 57 show the recommended cabling configuration when intermixing the EXP5060 and EXP5000 in the same storage subsystem configuration.
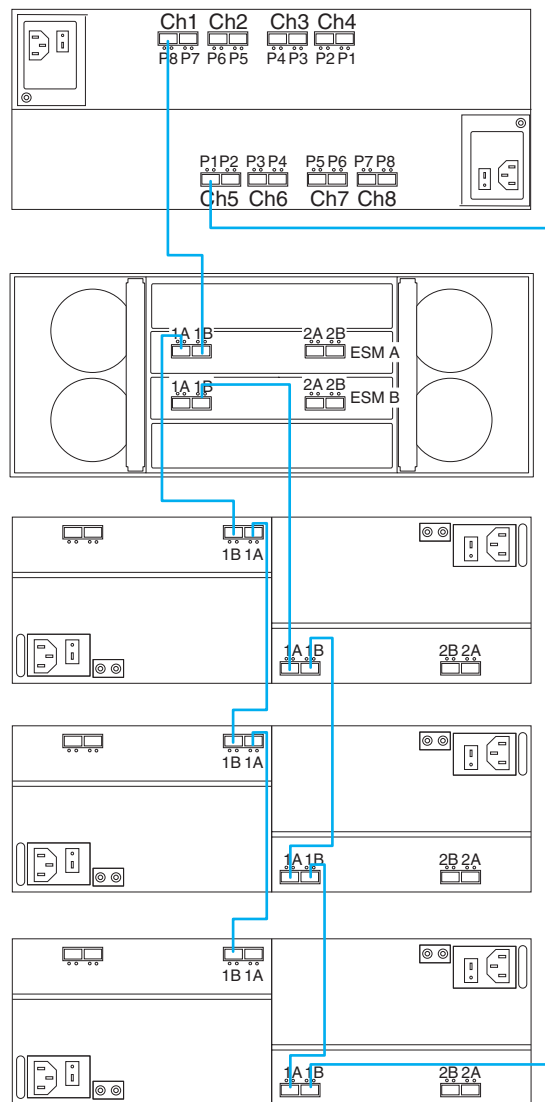
Figure 29. Preferred EXP5060 and EXP5000 intermixing behind the same controller drive channel port
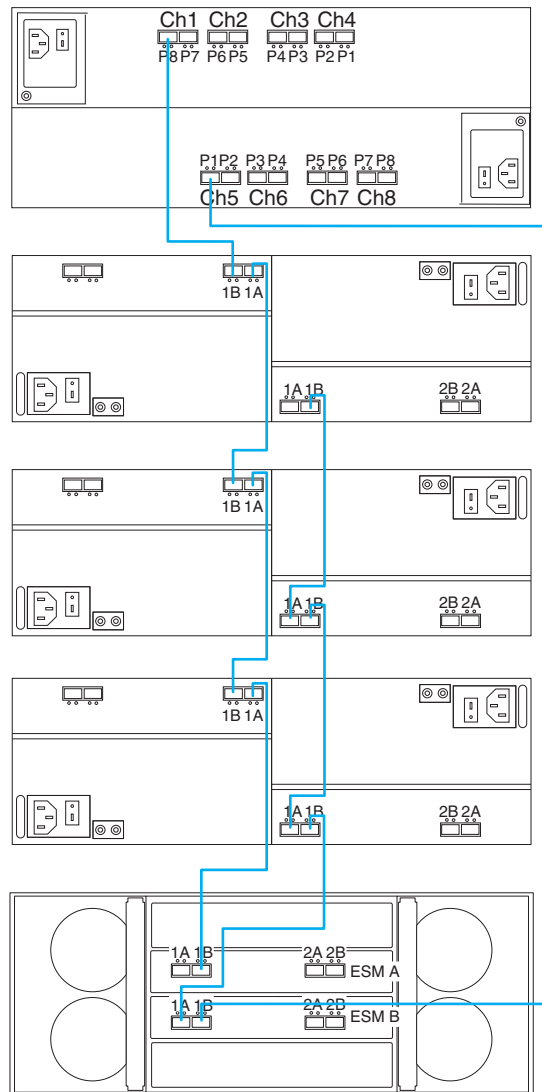
Figure 30. EXP5060 and EXP5000 intermixing behind the same controller drive channel port
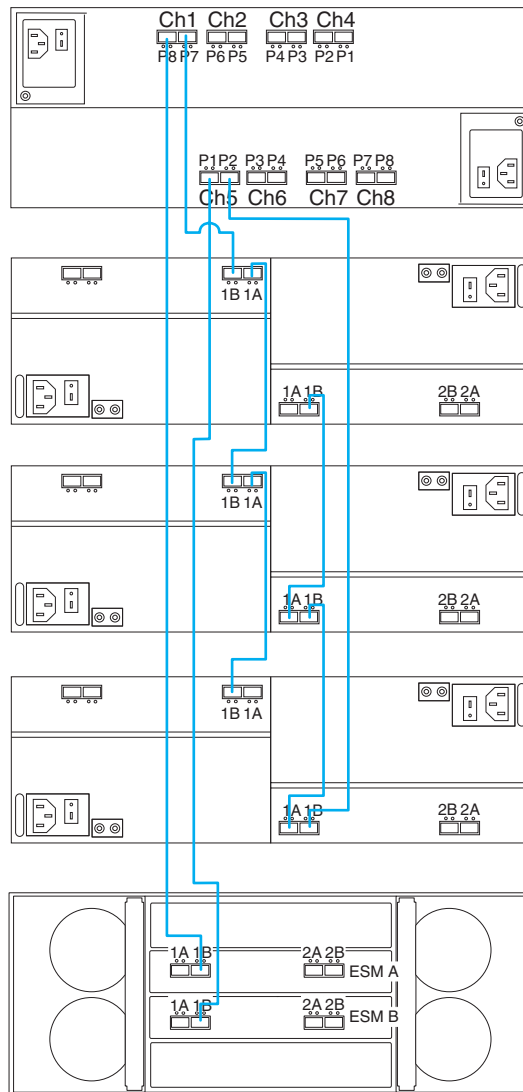
Figure 31. EXP5060 and EXP5000 intermixing behind different controller drive channel ports that are connected in the same controller drive channel
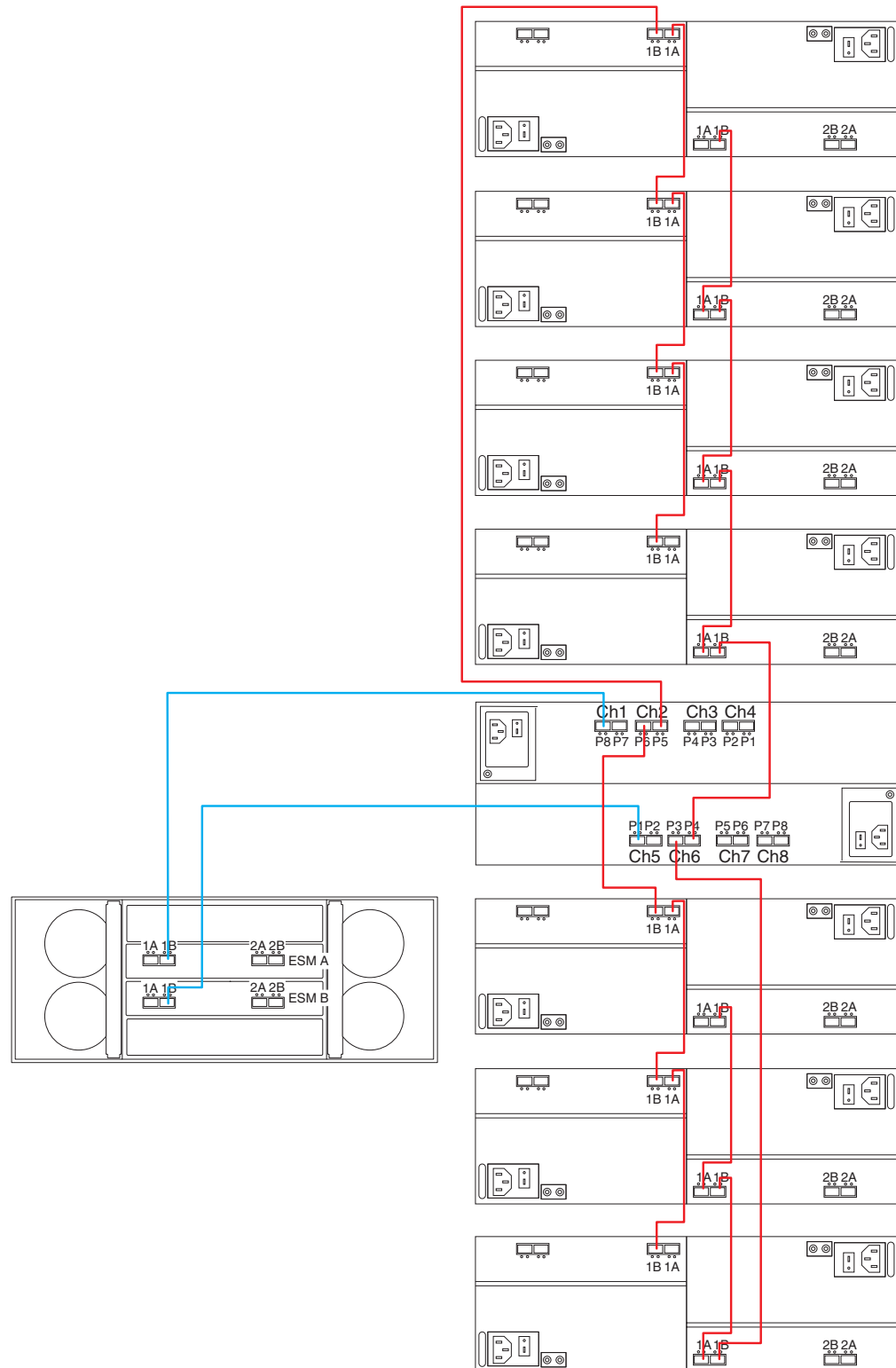
Figure 32. EXP5060 and EXP5000 in different controller drive channels

Drive-side trunking cabling

The EXP5060 is shipped with trunking cabling functionality enabled. Trunking
cabling is the cabling scheme where the controller drive ports are connected to the

EXP5060 drive channel ports labeled 1B and 2B on both ESMs of the EXP5060. This cabling scheme results in two connections between the storage subsystem controller and each of the EXP5060 ESMs forming two pairs of redundant drive loops. With two pairs of redundant drive loops, up to four drives can be accessed concurrently in a single EXP5060 enclosure. This cabling scheme is recommended when there is a need to maximize throughput (for large sequential read I/Os) between the storage subsystem controllers and the drives in the EXP5060 enclosures. The controller firmware that supports trunking is 7.60.13.05 or later.

Notes:

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

2. Please refer to the installation, user's, and maintenance guide for the storage subsystem that the EXP5060 is connected to for more information about configuring arrays and logical drives for maximizing throughput of the trunk-cabled EXP5060 enclosures.

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

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

- The cabling configuration must be homogenous for the two ESMs in a given EXP5060 enclosure. For example, if ESM A of the EXP5060 is connected using the trunking cabling scheme, then ESM B of the same EXP5060 must also be connected using the trunking cabling scheme.

- There must not be more than two Fibre channel cables connecting any two ESMs from two EXP5060s or between the ESM and the controller.

- The two trunked Fiber channel connections between the EXP5060 ESM and the controller must be in the same controller drive channel.

- A given ESM must not be a member of more than two connected device pairs.

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

1. Port 1B of the EXP5060 ESM A can only be connected to an even-numbered drive channel port in the DS5100/DS5300 controller A (port 8, 6, 4, 2) or port 1A of the adjacent EXP5060 ESM A.

2. Port 1B of the EXP5060 ESM B can only be connected to an odd-numbered drive channel port in the DS5100/DS5300 controller A (port 1, 3 ,5,7) or port 1A of the adjacent EXP5060 ESM B.

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

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

5. Port 1A of EXP5060 ESM A can only be connected to port 1B of adjacent EXP5060 ESM A.

6. Port 1A of EXP5060 ESM B can only be connected to port 1B of adjacent EXP5060 ESM B.

7. Port 2A of EXP5060 ESM A can only be connected to port 2B of adjacent EXP5060 ESM A

8. Port 2A of EXP5060 ESM B can only be connected to port 2B of adjacent EXP5060 ESM B.

If the ports are not connected using the above rules, Fibre Trunk miswire and enclosure path redundancy loss critical events will be generated. Figure 33 shows an example of the DS5100/DS5300 subsystem that is cabled to two EXP5060s using the trunking cabling scheme. Port P8 and P7 of controller A drive channel 1 are used to connect to ESM A ports 1B and 2B of the EXP5060 on the left. Similarly, ports P1 and P2 of controller B drive channel 5 are used to connect to ESM B ports 1B and 2B of the EXP5060 on the left.
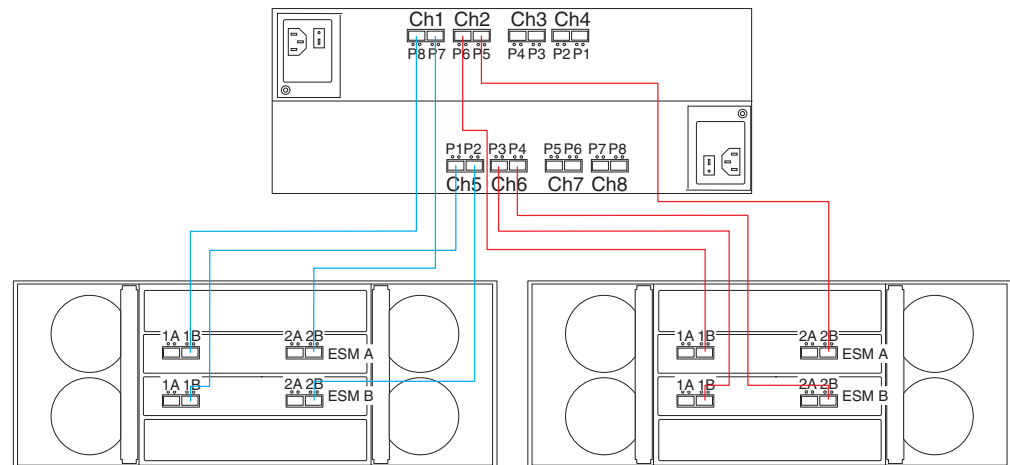
Figure 33. EXP5060 in trunking cabling scheme

Figure 34 on page 60 shows an example of improperly wired trunking. This example shows a violation of trunking cabling rule 3, that port 2B of EXP5060 ESM A can only be connected to an odd-numbered drive channel port in DS5100/DS5300 controller A (port 7, 5, 3, 1). This controller drive port must be part of the same drive channel of controller A as the ESM port is connected to in rule 1. As shown in Figure 34 on page 60, port 2B of ESM A is incorrectly connected to port 5 of drive channel 2 instead port 7 of drive channel 1.
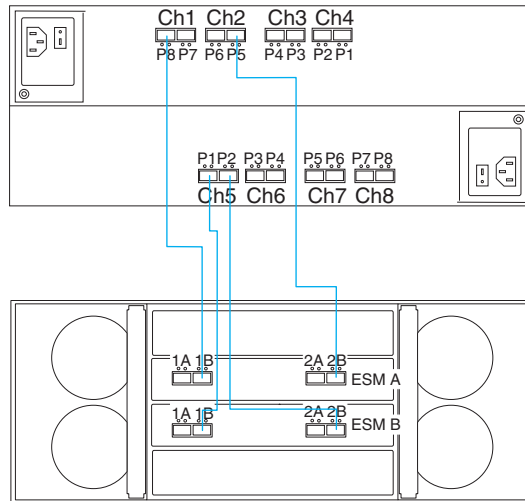
Figure 34. An example of trunking cabling that is improperly wired

Cascading the EXP5060 behind a drive channel is also supported using the trunking cabling scheme. Figure 35 shows an example of cascading EXP5060s in the trunking cabling scheme.
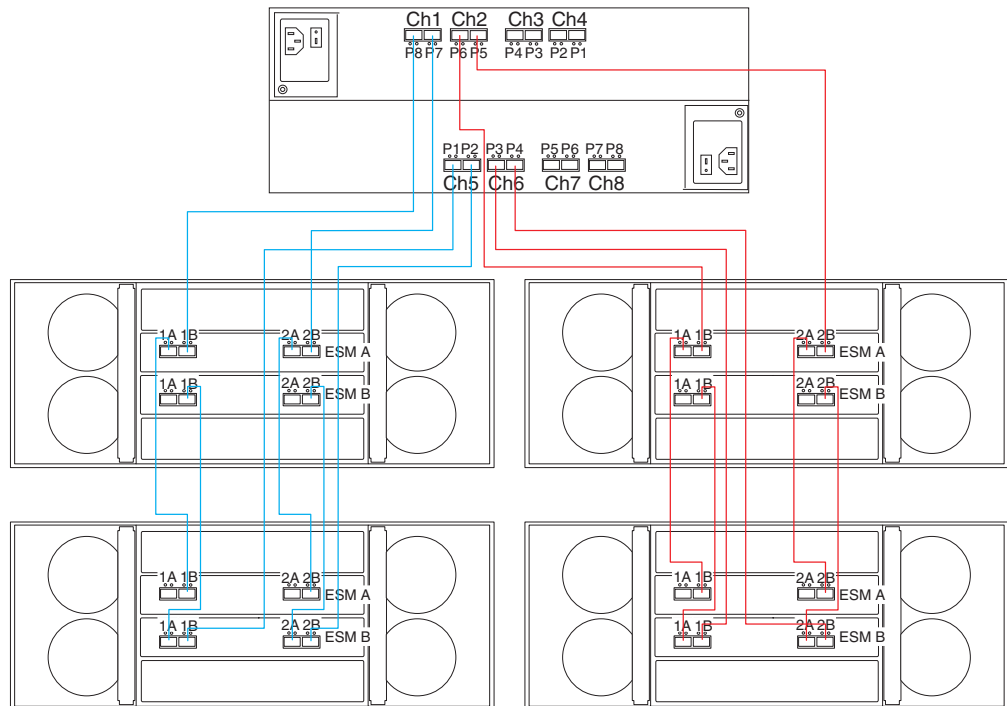
Figure 35. Cascading EXP5060s in trunking cabling scheme

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

Cabling the power supply

Complete the following steps to connect the power supply cable.

Attention: The EXP5060 requires 200-240V AC power. Make sure that it is connected only to the correct AC supply voltage. If there are multiple EXP5060s to be connected, check the AC source and the rack Power Distribution Unit current ratings to make sure that they are sufficient to support the EXP5060 operating and surge current requirements.

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. Continue with "Powering on the EXP5060" on page 65 for the initial startup of the storage expansion enclosure.

Relocating the EXP5060

Before you move an EXP5060 storage expansion enclosure with populated hard drive drawers, either by itself or as part of the rack that it is mounted in, you must obtain a rack relocation kit. Follow the instructions provided with the relocation kit to avoid potential damage to the EXP5060:

- You must remove the drives from the EXP5060 and place them in the boxes that come with the relocating kit.
- You must label the drives using the labels that come with the relocating kit.
- A lift tool must be used if the EXP5060 is going to be removed from the rack.

Chapter 4. Operating the EXP5060

This chapter describes operating procedures for the storage expansion enclosure.

To ensure optimal operation of your system, see "Best practices guidelines" on page 14.

Performing the EXP5060 Health Check process

The DS5000 Health Check process is a sequence of suggested actions developed by IBM to help users verify and maintain the optimal performance of their DS5000 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 DS5000 Storage Subsystem, and after all configuration sessions. It is also recommended that you set a regular schedule of periodic health check evaluations in order to keep your DS5000 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 DS5000 storage subsystem event logs for review by IBM Service. These event logs should be gathered periodically for regular health check monitoring regardless of the state of the Recovery Guru. (You can collect all these logs at once and zip them into a single file by clicking **Advanced ▸ Troubleshooting ▸ Collect All Support Data** in the DS Storage Manager Subsystem Management window.)

   • DS5000 storage subsystem management event log (MEL)

   • Storage Subsystem Profile or DS5000 Profile

   • Read-Link Status (RLS) data

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

   Attention: Save these event log files to a server disk that will remain accessible in the event of a DS5000 storage configuration failure. Do not save these event log files only to a LUN in the DS5000 Storage Subsystem.

3. Use the Storage Subsystem Profile or DS5000 Profile to verify that the following firmware levels are at the latest versions supported for your DS5000 Storage Subsystem:

   • Controller firmware

   • ESM firmware

   • Drive firmware

   If you discover your firmware is not up-to-date, upgrade the firmware and software to the latest level appropriate to your DS5000 storage configuration. See "Web pages" on page 64 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 DS5000 storage configuration failure.

Note: When you upgrade firmware, you must upgrade all client package components to the same release level. For example, if you are upgrading your controller firmware from version 5.x to version 6.x, you must also upgrade your DS Storage Manager client to version 9.x or higher. If your host system uses RDAC, upgrading controller firmware from version 5.x to version 6.x might also require host software updates, such as RDAC updates and HBA driver updates. Refer to the IBM DS5000 Web site for detailed instructions.

4. Use the Storage Subsystem Profile or DS5000 Profile to verify that the following functions are enabled:

- For all DS5000 models, Media Scan should be enabled both at the controller level and at the LUN level.
- For all DS5000 models, the read/write cache should be enabled. In addition, use the Storage Subsystem Profile to verify that cache is matched between the controllers.

Web pages

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

For DS5000 information, go to the following Web site:

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

For the latest information about operating system and HBA support, clustering support, SAN fabric support, and DS Storage Manager feature support, see the System Storage DS5000 System Storage Interoperation Center at the following Web site:

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 DS5000 storage configuration. You should periodically inspect the fibre channel components of your DS5000 storage configuration.

IBM suggests you follow these guidelines:

- Maintain an up-to-date storage subsystem profile for your DS5000 storage configuration. Save the profile to a server disk that will remain accessible in case of a DS5000 storage configuration failure. Do not save the profile only to a LUN in the DS5000 Storage Subsystem.
- Develop a Change Management plan. The plan should include schedules for updating subsystem firmware and server host software.

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

- Create and maintain a cabling diagram of the current SAN configuration. Keep this diagram updated as you make configuration changes, and keep the cabling diagram available for review.
- Create and maintain a list of other components that are being used within the cabling diagram (such as the host system, fibre channel switches, and other SAN attachments).
- Ensure that all ESMs are properly seated.
- Ensure that all drives are properly seated.
- Ensure that all SFP modules are properly seated.
- Confirm fibre channel cable loop size. (IBM specifications call for at least 3-inch diameter cable loops, but it is recommended that you use 6-inch diameter cable loops or longer.)
- Ensure proper fibre channel cable management.
- Ensure proper air flow and temperature for all components in your EXP5060 storage configuration.

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

In addition to these inspection and maintenance responsibilities, IBM also strongly recommends DS5000 training for staff that supports DS5000 storage configurations. Although training is not a part of the Health Check process, DS5000 training reduces the potential for configuration problems and contributes to the overall health of the system.

Powering on the EXP5060

When you turn on and turn off the EXP5060, be sure to use the startup sequence in this section.

Attention: *Before* you first power on the DS5000 storage subsystem with a newly installed EXP5060, you *must* perform the DS5000 controller firmware upgrade described in "Firmware updates" on page 67. In addition, you might have to regenerate the premium feature key files to re-enable the premium feature key that is enabled from the factory after the controller firmware upgrade.

Turning on the EXP5060

This section contains instructions for turning the EXP5060 on and off under normal and emergency situations.

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

Attention:

1. **Potential damage to DDMs** - Repeatedly turning the power off and on without waiting for the DDMs to spin down can damage them. Always wait at least 90 seconds from when you turn off the power until you turn it on again.

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

To turn the EXP5060 on and off complete the following steps:

1. Are the main circuit breakers turned on?

   - **Yes -** Turn off *both* power switches on each storage expansion enclosure that you intend to connect to the power.

   - **No -** Turn off *both* power switches on **all** storage expansion enclosures in the storage subsystem.

2. Connect the power cords to the power supplies on each storage expansion enclosure.

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

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

   Attention: You must turn on power to each attached storage expansion enclosure before turning on power to the storage subsystem to ensure that the controllers complete the startup process. If the controllers do not find any drives present during the initial power on sequence, the storage subsystem will not complete the startup process. This will prevent controllers from communicating with each other, and any factory-installed premium features will not be activated correctly.

5. Turn on both power switches on 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 Service Action Required or enclosure ID LEDs light on any of the storage expansion enclosures. To verify the fibre channel connections between the drive expansion enclosures, make sure that no Port Bypass LEDs for connections to other storage expansion enclosures are lit. Only the Port Bypass LED of the ESM port that connects directly to the storage subsystem drive port should be lit.

6. Turn on the power switch on the back of the DS5000 storage subsystem. See Figure 5 on page 8 for location of the power switch.

   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. 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 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. Ensure that all the LEDs show normal status. For more information on LED status for storage expansion enclosures, see "Checking the LEDs" on page 69 or the Installation, User's, and Maintenance Guide for your DS5000 storage expansion enclosure.

b. Check all LEDs on each component in the storage subsystem. Ensure that all the LEDs show normal status. For information about LED status, see "Solving problems" on page 131.

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 appropriate component button for each storage subsystem.

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

   • **Yes** - End of procedure.

   • **No** - Go to step 9.

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

a. Run the 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 131.

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

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

Firmware updates

Attention: Save the storage subsystem profile before performing any controller or ESM firmware upgrades. Save the DS5000 storage subsystem profile and all configuration (*.cfg) files to a server disk that will remain accessible in the event of a DS5000 storage configuration failure. Do not save these files only to a LUN in the DS5000 Storage Subsystem.

To ensure the optimal operation of the DS5000 storage subsystem and its attached storage expansion enclosures, the storage expansion enclosure ESM firmware, the DS5000 controller firmware, the hard drive firmware, and the NVSRAM (for controllers only) must be up- to-date. Go to the following Web site to get the latest updates:

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

Refer to "Software and hardware compatibility and upgrades" on page 11 for software and hardware compatibility information and requirements.

Apply the necessary updates before configuring the storage subsystem arrays and logical drives. Subscribe to My Support for automatic notifications of firmware or DS

Storage Manager software updates or any important information about your DS5000 subsystems (see "Receiving product updates and support notifications" on page 14).

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 DS5000's logical drives. Failure to observe the limitations, prerequisites, and dependencies in the README file might result in a loss of data access. See "Finding Storage Manager software, controller firmware, and README files" on page xx to learn how to access the DS5000 README files on the Web.

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

1. Drive firmware
2. Controller NVSRAM
3. Controller firmware
4. ESM firmware for the storage expansion enclosures

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 expansion enclosures and DS5000 storage subsystems to which it is attached. To view a Storage System Profile, perform the following steps:

1. Open the DS 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 DS5000 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.

Troubleshooting the storage expansion enclosure

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

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

1. Open the Subsystem Management Window.

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

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

3. Does any component have a Needs Attention status?
   - **Yes** - Go to step 4.
   - **No** - All components are Optimal. Go to step 6.

4. Select the **Recovery Guru** toolbar button. Perform the procedure in the Recovery Guru to correct the problem. The Recovery Guru might direct you to replace the failed component. If so, go to step 5.

   Attention: If the fault requires you to power off an attached storage expansion enclosure, you might need to cycle the power on the DS5000 storage subsystem and all remaining storage expansion enclosures in the storage subsystem. Contact IBM Customer and Technical Support before powering off any attached storage expansion enclosures.

5. Mute the alarm, if needed.

6. Check the indicator LEDs on the front and the back of the storage expansion enclosure.

   A green LED denotes a normal status; an amber LED denotes a hardware fault.

7. Is an amber LED on?
   - **Yes** - Locate and troubleshoot the failed components. See "Checking the LEDs."
   - **No** - You are finished with this procedure. If you are still experiencing a problem with this storage subsystem, create, save, and print a storage subsystem profile. This information might be helpful when troubleshooting. Contact IBM Customer and Technical Support for assistance. When the recovery procedure is completed, select **Recheck** in the Recovery Guru to rerun the Recovery Guru and to ensure that the problem has been corrected.

Checking the LEDs

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

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

Front LEDs

This section describes the LEDs on the front of the storage expansion enclosure for all models.
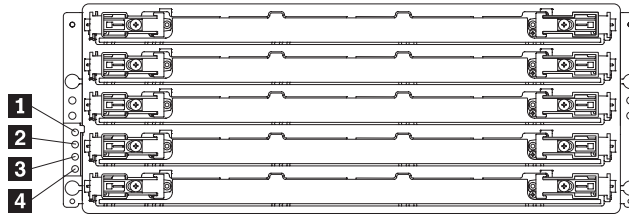
Figure 36. Front LEDs

Table 17. Front LEDs

Number	LED	Normal Status	Problem Status
1	Locate ![locate icon]	On or flashing (Blue): Indicates the enclosure you want to locate	N/A **Note:** The blue Locate LED is found only on the front of the storage expansion enclosure. Do not confuse this LED with the blue Service Action Allowed (SAA) LEDs found on expansion enclosure components.
2	Service Action Required (Fault) !	Off	On (Amber): A drive drawer is not fully closed or a fault exists within the enclosure
3	Over-Temperature	Off	On (Amber): Indicates an over-temperature condition within the enclosure
4	Power	On (Green)	Off: No power in the enclosure

Environmental Service Module LEDs

This section describes the LEDs on the environmental service modules.
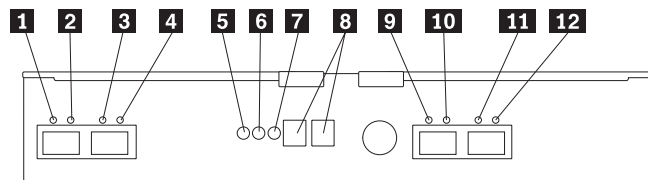
Figure 37. ESM LEDs

Table 18. ESM LEDs

Number	LED	Normal Status	Problem Status
1	ESM Link Fault (Port 1A Bypass)	Off This LED is also off when there is no SFP installed in the SFP socket.	On (Amber): A link error has occurred. Flashing (Amber): one of the following conditions has occurred: • The enclosure is currently running at a fibre channel rate of 4 Gb/s, but the installed SFP is only rated for 2 Gb/s. Install a 4 Gb/s rated SFP. • There is a hardware problem with the SFP or the link that prevents the port from being successfully inserted into the fibre channel loop. This could be caused by a failed SFP or failed ESMs. • There is a trunking connection problem with the associated SFP port. See the seven-segment display code to determine the nature of the problem.
2, 3	Loop Up/Rate Select	On (Green) **Note:** Both LEDs light to indicate that the fibre channel loop to ports 1A and 1B is up. These LEDs are not associated with a specific SFP port and their status indicates the overall fibre channel loop status.	Off: A link error has occurred

Table 18. ESM LEDs (continued)

Number	LED	Normal Status	Problem Status
4	ESM Link Fault (Port 1B Bypass)	Off This LED is also off when there is no SFP installed in the SFP socket.	On (Amber): A link error has occurred Flashing (Amber): one of the following conditions has occurred: • The enclosure is currently running at a fibre channel rate of 4 Gb/s, but the installed SFP is only rated for 2 Gb/s. Install a 4 Gb/s rated SFP. • There is a hardware problem with the SFP or the link that prevents the port from being successfully inserted into the fibre channel loop. This could be caused by a failed SFP or failed ESMs. • There is a trunking connection problem with the associated SFP port. See the seven-segment display code to determine the nature of the problem.
5	ESM Service Action Allowed	Off	On (Blue): The ESM can be removed
6	ESM Service Action Required (Fault)	Off	On (Amber): A fault exists within the ESM
7	ESM Power	On (Green)	Off: No power to the ESM
8	Seven-segment numeric display	See "Seven-segment numeric display" on page 77 for more information	

Table 18. ESM LEDs (continued)

Number	LED	Normal Status	Problem Status
9	ESM Link Fault (Port 2A Bypass)	Off This LED is also off when there is no SFP installed in the SFP socket.	On (Amber): A link error has occurred. Flashing (Amber): one of the following conditions has occurred: • The enclosure is currently running at a fibre channel rate of 4 Gb/s, but the installed SFP is only rated for 2 Gb/s. Install a 4 Gb/s rated SFP. • There is a hardware problem with the SFP or the link that prevents the port from being successfully inserted into the fibre channel loop. This could be caused by a failed SFP or failed ESMs. • There is a trunking connection problem with the associated SFP port. See the seven-segment display code to determine the nature of the problem.
10, 11	Loop Up/Rate Select	On (Green) **Note:** Both LEDs light to indicate that the fibre channel loop to ports 2A and 2B is up. These LEDs are not associated with a specific SFP port and their status indicates the overall fibre channel loop status.	Off: A link error has occurred

Table 18. ESM LEDs (continued)

Number	LED	Normal Status	Problem Status
12	ESM Link Fault (Port 2B Bypass)	Off This LED is also off when there is no SFP installed in the SFP socket.	On (Amber): A link error has occurred Flashing (Amber): one of the following conditions has occurred: • The enclosure is currently running at a fibre channel rate of 4 Gb/s, but the installed SFP is only rated for 2 Gb/s. Install a 4 Gb/s rated SFP. • There is a hardware problem with the SFP or the link that prevents the port from being successfully inserted into the fibre channel loop. This could be caused by a failed SFP or failed ESMs. • There is a trunking connection problem with the associated SFP port. See the seven-segment display code to determine the nature of the problem.

Power supply LEDs

This section describes the storage expansion enclosure power supply LEDs.
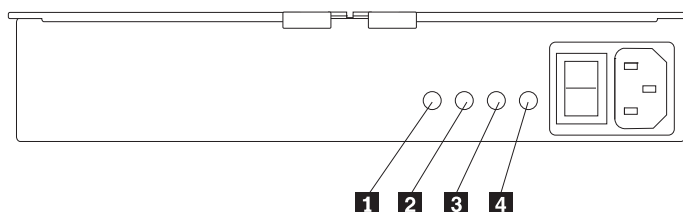
Figure 38. Power supply LEDs

Table 19. Power supply LEDs

Number	LED	Normal Status	Problem Status
1	Power DC Power DC	On (Green)	Off: No DC power from power supply. The power supply is faulty.
2	Service Action Allowed OK	Off	On (Blue): The power supply can be removed

Table 19. Power supply LEDs (continued)

Number	LED	Normal Status	Problem Status
3	Service Action Required (Fault) !	Off	On (Amber): A fault exists within the power supply
4	Power AC Power AC ∿	On (Green)	Off: No AC power to power supply

Fan assembly LEDs

This section describes the storage expansion enclosure fan assembly LEDs.
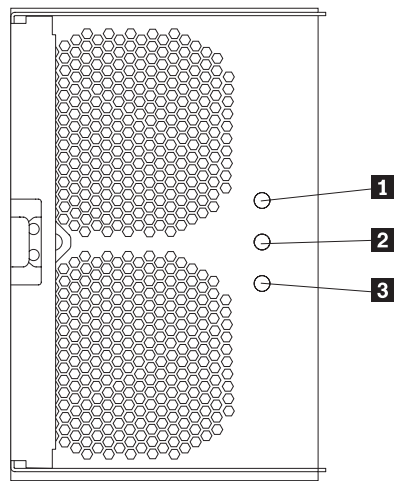
Figure 39. Fan assembly LEDs

Table 20. Fan assembly LEDs

Number	LED	Normal Status	Problem Status
1	Power	On (Green)	Off: No power to fan assembly
2	Service Action Required (Fault) !	Off	On (Amber): A fault exists within the fan assembly
3	Service Action Allowed	Off	On (Blue): The fan assembly can be removed

Drive drawer LEDs

This section describes the LEDs on storage expansion enclosure drive drawers.
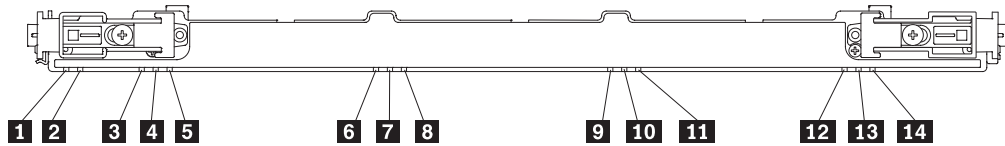
Figure 40. Drive drawer LEDs

Table 21. Drive drawer LEDs

Number	LED	Normal Status	Problem Status
1	Service Action Allowed ↩OK	Off	On (Blue): The drive drawer can be removed The drawer Service Action Allowed LED is also lit when a Service Action Allowed LED on one of the drives in the drawer is lit.
2	Service Action Required (Fault) !	Off	On (Amber): A fault exists within the drive drawer
3 - 14	Drive Activity (for drives 1 to 12 in the drawer) **Note:** The associated disk drive is indicated by a number (1 to 12) that is displayed inside the Drive Activity icon.	On (Green): Power is on, drive is operating normally Flashing (Green): Indicates drive I/O activity	Off: No power to the drive or a drive is not installed

Disk drive LEDs

This section describes the service LEDs on the disk drives. The drive power/drive activity LEDs are located on the front of the drive drawer. See "Drive drawer LEDs" on page 75 for more information.
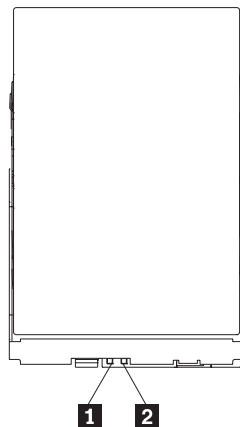
Figure 41. Disk drive LEDs

Table 22. Disk drive LEDs

Number	LED	Normal Status	Problem Status
1	Service Action Allowed	Off	On (Blue): The disk drive can be removed
2	Service Action Required (Fault)	Off	On (Amber): A fault exists within the disk drive

Table 23. Drive state indicated by the LEDs

Drive State	Drive Power LED (Green)	Drive Service Action Required LED (Amber)	Drive Service Action Allowed LED (Blue)
Power is not applied	Off	Off	Off
Normal operation: The power is turned on but there is no drive I/O activity	On	Off	Off
Normal operation: Drive I/O activity is occurring	Flashing	Off	Off
Service Action Required: A fault condition exists and the drive is offline	On	On	On
Power is applied but drives are spun-down because they are offline, are part of an "Exported - Ready to import" array, or are incompatible or not certified.	Off	Off	On

Seven-segment numeric display

The numeric display consists of two seven-segment LEDs that provide information about enclosure identification and diagnostics. Figure 42 on page 78 shows the numeric display and the diagnostic LED.

Seven-
segment
display

Diagnostic LED
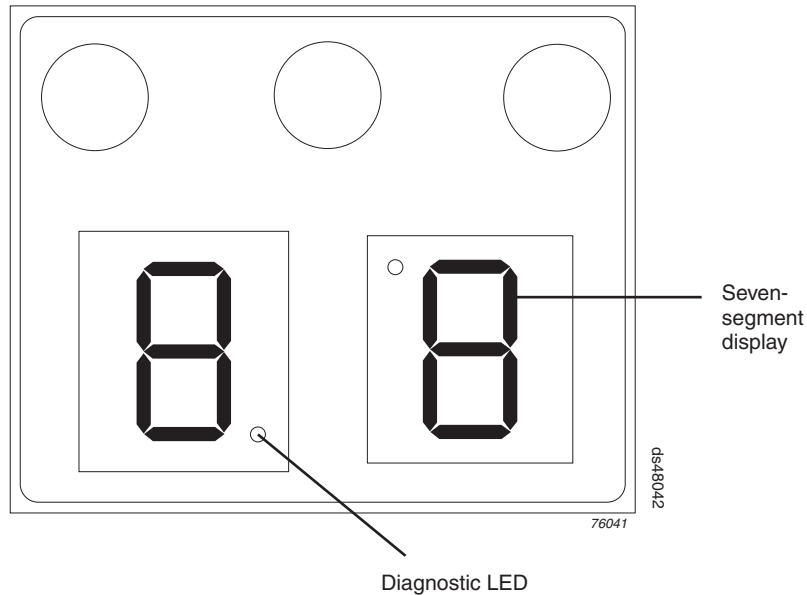
Figure 42. Numeric display LEDs

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

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

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

The numeric display indicates that the information displayed is diagnostic by illuminating a Diagnostic LED that appears as a decimal point between the display numbers (Figure 42). If an error has occurred and the Diagnostic LED on the display is on, the numeric display shows diagnostic code. The diagnostic LED turns off when the numeric display shows the storage subsystem enclosure ID. The numeric display shows diagnostic codes as the enclosure starts after each power cycle or reset (Table 24 on page 79). After diagnostics are complete, the current storage subsystem enclosure ID is displayed.

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

The definitions for the diagnostic codes are listed in Table 24 on page 79. The Priority column indicates the precedence of the diagnostic code relative to other diagnostic codes. If multiple failures exist, the diagnostic code with the highest

priority will be displayed. Priority 1 is the highest priority. The ESM Operational column indicates whether the ESM is still operational if this failure occurs.

Table 24. Numeric display diagnostic codes

Code	Priority	ESM Operational?	Description
–	n/a	Booting	ESM Boot Firmware is booting up (diagnostic indicator not set).
.8, 8., or 88	1	No	This ESM is being held in reset by the other ESM.
AA	n/a	Booting	ESM-A application firmware is booting up (diagnostic indicator not set).
bb	n/a	Booting	ESM-B application firmware is booting up (diagnostic indicator not set).
L0	3	No	Mismatched ESM/controller module types. Remove one module.
L2	2	No	Persistent ESM memory errors. Replace the ESM.
L3	2	No	Persistent ESM hardware errors. Replace the ESM.
L9	5	Yes	Over temperature condition detected (ESM or power supply).
H0	2	No	ESM SOC (Fibre Channel Interface) failure. Replace the ESM.
H1	8	Yes	SFP speed mismatch (2 Gb/s SFP installed). Look for SFP with flashing amber bypass LED. Replace the SFP.
H2	4	Degraded	Invalid/incomplete ESM configuration (bad factory defaults or ESM VPD information).
H3	7	No	Maximum ESM reboot attempts exceeded.
H4	6	Yes	This ESM cannot communicate with the alternate ESM.
H5	2	No	Midplane harness failure detected in enclosure.
H6	2	No	Catastrophic ESM firmware failure detected.
H7	n/a	n/a	Reserved.
H8	10	Yes	SFP installed in Duplicate SFP slot when connected to non-SOC component (for example an HBA). Corrective Action: The SFP in the slot with a flashing LED must be removed.
H9	9	Degraded	Non-catastrophic hardware failure: ESM is operational in a degraded mode. Corrective Action: Replace the ESM.
J0	3	No	ESM module is incompatible with the enclosure: ESM is likely running the wrong firmware. Corrective Action: Replace the ESM with a spare ESM having the correct firmware.
J1	11	Yes	Trunking Error: Trunk links are connected to two different components. Both links are non-operational. Corrective Action: Examine both links indicated by flashing LEDs and change the cabling to match the standard trunking cabling diagram.
J2	12	Yes	Trunking Error: Cross-connected trunk port pair. One of three situations has occurred: 1. A trunked pair from the local component is not connected to a trunked pair of SFP ports on the remote end. 2. A trunked pair from the remote component is not connected to a trunked pair of SFP ports on the local component. 3. Both the local and remote connections for an interconnecting pair of links are not connected to trunked pairs of SFP ports. Corrective Action: Examine both links indicated by flashing LEDs and change the cabling to match the standard trunking cabling diagram.

Table 24. Numeric display diagnostic codes (continued)

Code	Priority	ESM Operational?	Description
J3	13	Yes	Trunking Error: Three or more trunk links are connected from one component to another. At most two links are supported from one component to another. Corrective Action: Examine all links indicated by flashing LEDs and change the cabling to match the standard trunking cabling diagram.
J4	14	Yes	Trunking Warning: Trunk pair Primary and Duplicate are swapped. Corrective Action: Both links indicated by flashing bypass LEDS are operational but must be swapped on one end.
J5	15	Yes	Trunking Warning: Trunk pair operational but is cabled incorrectly. At least one "Out" link is connected to an "In" link or vice versa. Corrective Action: Both links indicated by flashing bypass LEDS are operational, but the cabling must be changed so that Primary Out is connected to Primary In and Duplicate Out is connected to Duplicate In.

Powering off the storage expansion enclosure

The storage expansion enclosure 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 83.

Turning off the EXP5060

Use the following procedure to turn off the power for the EXP5060.

Attention: Except in an emergency, never turn off the power if any Service Action Required LEDs are on. Correct the fault before you turn off the power. Use the DS Storage Manager client and the Service Action Required LEDs to check the overall status of the EXP5060. All LEDs should be green on the front of the storage expansion enclosure. If they are not, use the DS Storage Manager client to diagnose the problem. This ensures that the EXP5060 will power on correctly later.

The EXP5060 is designed to run continuously. After you turn on the EXP5060, 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 83.

Statement 5:

CAUTION:
The power control button on the device and the power switch on the power supply do not turn off the electrical current supplied to the device. The device also might have more than one power cord. To remove all electrical current from the device, ensure that all power cords are disconnected from the power source.
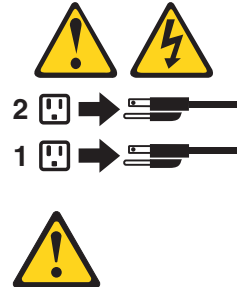
Attention: Turning off and turning on power without waiting for the storage expansion enclosure disk drives to spin down can damage the drives and might cause data loss. Always wait at least 90 seconds from when you turn off the power until you turn on the power again.

Power-off overview

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

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

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

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

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

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

Use the following procedure to turn off power to one or more storage expansion enclosures for a planned shutdown. To turn off power for an unplanned shutdown, see "Restoring power after an unexpected shutdown" on page 83.

Before proceeding, use the DS Storage Manager client to determine the status of the system components and special instructions. The operating system software might require you to perform other procedures before you turn off the power. To turn off the EXP5060, complete the following steps:

1. Stop all I/O activity to each storage expansion enclosure.
2. Remove the bezel from the front of the storage expansion enclosure.

3. Determine the status of all storage expansion enclosures and components in the configuration by completing the following steps:

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

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

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

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

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

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

   • **Yes** - Go to step 6.

   • **No** - Go to step 5.

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

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

   b. Complete the recovery procedure.

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

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

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

6. Check the Cache Active LED on the controller FRU in the storage subsystem enclosure, 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 both the 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 does not turn off the electrical current supplied to the device. The EXP5060 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 input connectors.

10. Remove (unplug) all of the power cords from the EXP5060 power supply connectors.

11. After you perform the necessary maintenance procedures, turn on the power using the procedure in.

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 EXP5060 loses power unexpectedly, it might be due to a hardware failure in the power system or in the midplane of the EXP5060.

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

1. If you have time, stop all I/O activity to the storage expansion enclosure.

2. Check the LEDs. Make note of any Service Action Required 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 DS5000 storage subsystem first, and followed by the storage expansion enclosures. Then, unplug the power cables from the EXP5060.

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.
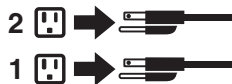
Restoring power after an unexpected shutdown

Complete the following steps to restart the EXP5060 if you turned off the power supply switches during an emergency shutdown, or if a power failure or power outage occurred:

1. After the emergency situation is over or power is restored, check the EXP5060 for damage. If there is no visible damage, continue with step 2. Otherwise, have your system serviced.

2. After you check the EXP5060 for damage, ensure that the power switches are in the off position; then plug in the EXP5060 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 no ESM, power supply, or fan assembly Service Action Required LEDs lit before you turn on the DS5000 storage subsystem.

In addition, consider the following items:
- The storage subsystem supports simultaneous power-up of the system components; however, you should always follow the power-up sequence listed in the "Turning on the storage subsystem section" of the appropriate *DS5000 Storage Subsystem Installation, User's, and Maintenance Guide* during any attended power-up procedure.
- A storage subsystem in an optimal state should recover automatically from an unexpected shutdown and unattended simultaneous restoration of power to system components. After power is restored, contact IBM technical support if any of the following conditions occur:
  - The storage subsystem logical drives and subsystems do not display in the 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.

4. Turn on the power to each device, based on the startup sequence.

   Note: All of the EXP5060 storage expansion enclosures must be powered on before the DS5000 storage subsystem.

5. The green LEDs on the front and the back of the EXP5060 and DS5000 storage subsystem should remain lit. If other amber Service Action Required LEDs light, see "Solving problems" on page 131.

Recovering from an overheated power supply

Each EXP5060 storage expansion enclosure contains two power supplies, two ESMs, and two fan assemblies. There are a total of 14 temperature sensors in the EXP5060 to prevent it from overheating. The distribution of the temperature sensors are as follows:
- 1 in each Power Supply
- 1 in each ESM
- Two per drive drawer

Under normal operating conditions, with an ambient air temperature range of 10° C to 35° C (50° F to 95° F), the fans in the fan assemblies maintain a proper operating temperature inside the EXP5060 chassis.

If the power supply temperature sensor reaches 60°C (140° F), the power supply shuts down automatically. If both power supplies shut down because of overheating, the storage expansion enclosure has no power, and all indicator lights are off. The following conditions can cause the power supplies to overheat:
- An unusually high room temperature
- Fan failures in the fan assemblies
- Defective circuitry in the power supply
- Blocked air vents
- Failures in other devices in the subsystem or rack

If the operating environment or hardware problems like fan assembly failures cause the ESM or the drive drawer temperature sensors to exceed 63°C (145° F) or drop below 10°C (50°F), a Nominal Temperature Exceeded critical MEL event is generated in the subsystem Major Event Log (MEL). In addition, if the operating environment or hardware problems like fan assembly failures cause the ESM or the drive drawer temperature sensors to exceed 65°C 149° F) or drop below 0°C (32°F), the Over-Temperature LED on the storage expansion enclosure turns on. A Maximum Temperature Exceeded critical MEL event is generated in the subsystem Major Event Log. The Service Action Allowed (SAA) LEDs on the power supplies and fan assemblies on the back of the storage expansion enclosure might also turn on. See "Fan assembly LEDs" on page 75 and "Power supply LEDs" on page 74 for the location of these LEDs.

Attention: Because the power supply FRU and fan assembly FRU Service Action Required and Service Action Allowed LEDs are lit when the operating environment temperature causes the temperature sensor exceed the maximum limit threshold, do not assume the power supply and fan assembly FRUs are 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 assembly Service Action Required and Service Action Allowed LEDs will turn off if there are no problems with the power supply and fan assembly FRUs.

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 power supply temperature sensor reaches 60° C (140° 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 storage subsystem components.

1. Remove the front cover.

2. If applicable, mute the alarm.

3. Did you use the procedure "Troubleshooting the storage expansion enclosure " on page 68 to identify an overheating problem?

   - **Yes** - Go to step 4.

   - **No** - Perform the procedure "Troubleshooting the storage expansion enclosure " on page 68 to verify that the power supplies have shut down because of an overheating problem, and then go to step 4.

4. Stop I/O activity to all attached storage expansion enclosures.

5. Take all or some of the following measures to alleviate the overheating problem:

   - Remove all panels from the cabinet immediately.

   - Use external fans to cool the area.

   - Shut down the power to the storage expansion enclosure, using the procedure described in "Performing an emergency shutdown" on page 83.

6. Wait for the air temperature in and around the storage expansion enclosure to cool.

   After the temperature inside the power supplies cools to below 55° C (131° F), the storage expansion enclosure is capable of power-up recovery without operator intervention. After the air has cooled, the power supplies should turn on automatically. If the power supplies restart automatically, the controllers will reset and return to normal operation.

7. Did the power supplies restart automatically?

- **Yes** - Go to step 9.
- **No** - Go to step 8.

8. To cycle the power, turn off both power switches on the back of each storage expansion enclosure, wait two minutes, turn on both power switches.

   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 minutes to power on and up to 15 minutes for the battery self-test to complete. During this time, the LEDs on the front and the back of the modules flash intermittently.

10. Check the status of the storage subsystem and each storage expansion enclosure and its components.

    a. Note the status of the LEDs on the front and back of each module.

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

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

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

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

11. Does each module display green LEDs only, and is the status Optimal for each module component? If 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 69.

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

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

Chapter 5. Installing and replacing components

This chapter contains information about installing and replacing storage expansion enclosure FRUs.

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. Before replacing components, see "Handling static-sensitive devices" on page 26.

Service action allowed status LED

Each drive drawer, disk drive, ESM, power supply, and fan assembly has a blue Service Action Allowed status LED. The purpose of the Service Action Allowed status LED is to help ensure that a component is not removed before it is safe to do so. Do not remove any EXP5060 component unless the component's Service Action Allowed status LED is lit.

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

Adding the EXP5060 to an existing configuration

Note: The term *drive loop or drive loop pair* used in this publication might be referred to as a *drive channel or drive channel pair* when referring to a DS5100 or DS5300 Storage Subsystem in the *DS5100 and DS5300 Storage Subsystem Installation, User's and Maintenance Guide* and other DS5000 Storage Subsystem publications. The terms have identical meanings.

There are many ways to add an EXP5060 to an existing storage subsystem configuration depending on the availability of drive channels and drive channel ports. The preferred methods to add an EXP5060 to an existing storage subsystem are as follows:

- If there are available non-device connected drive channels in each of the controllers, add the EXP5060 to the controller drive channel pair using the even-numbered port of the dual-ported drive channel in controller A and the odd-numbered port of the dual-ported drive channel in controller B. See Figure 43 on page 88.

- If there are no drive channels that have do not devices attached, add the EXP5060 enclosure to the controller dual-ported drive channel that has the second port not connected as shown in Figure 44.
- If there are no unconnected drive channel ports in the controller, cascade the EXP5060 behind an existing EXP5060 as shown in Figure 45 on page 89.
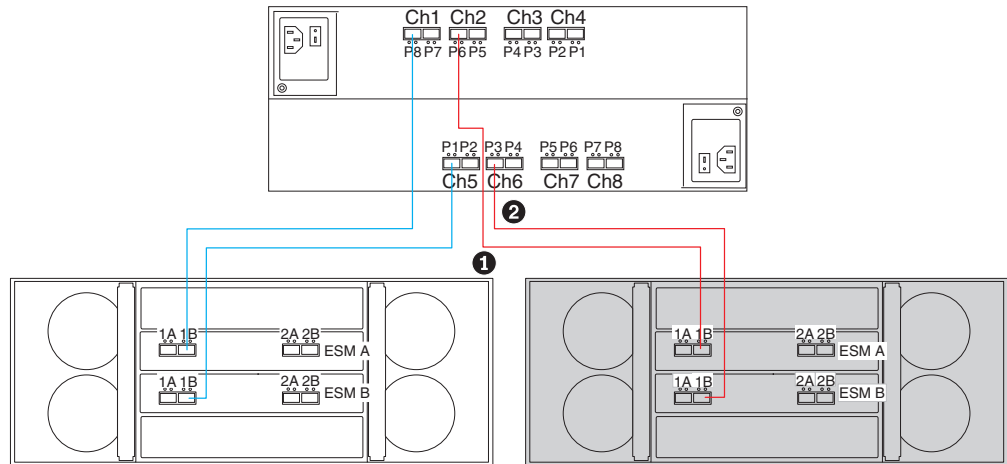
Figure 43. Adding the EXP5060 to a new drive channel (non-trunking cabling scheme)
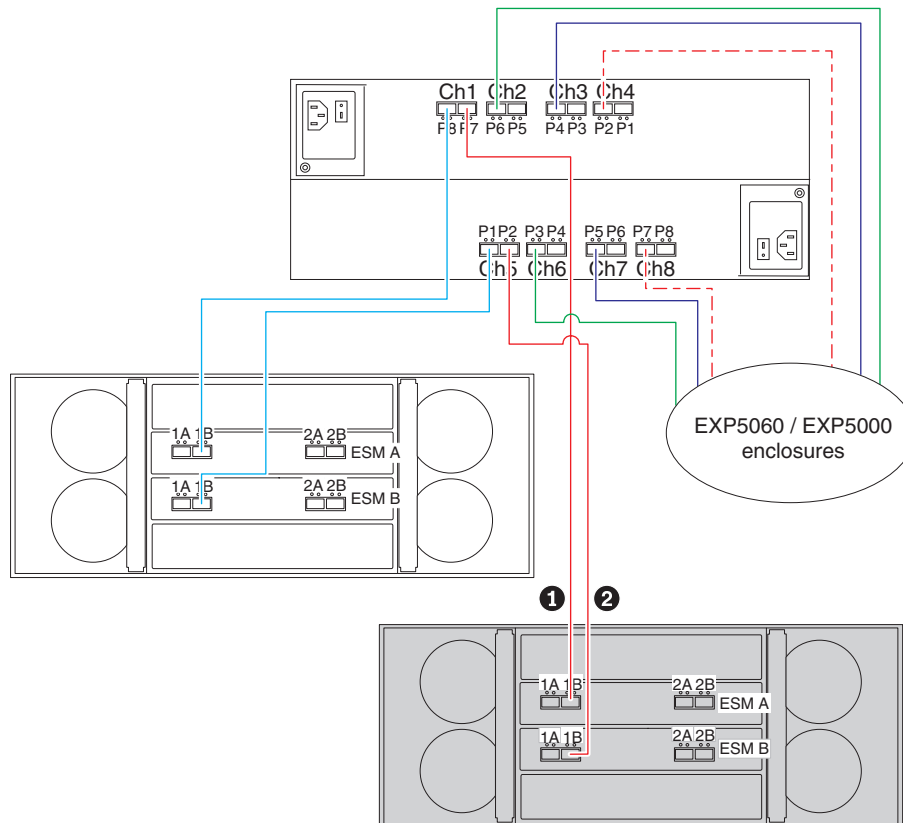
Figure 44. Adding the EXP5060 to the second port of a dual-ported drive channel (non-trunking cabling scheme)
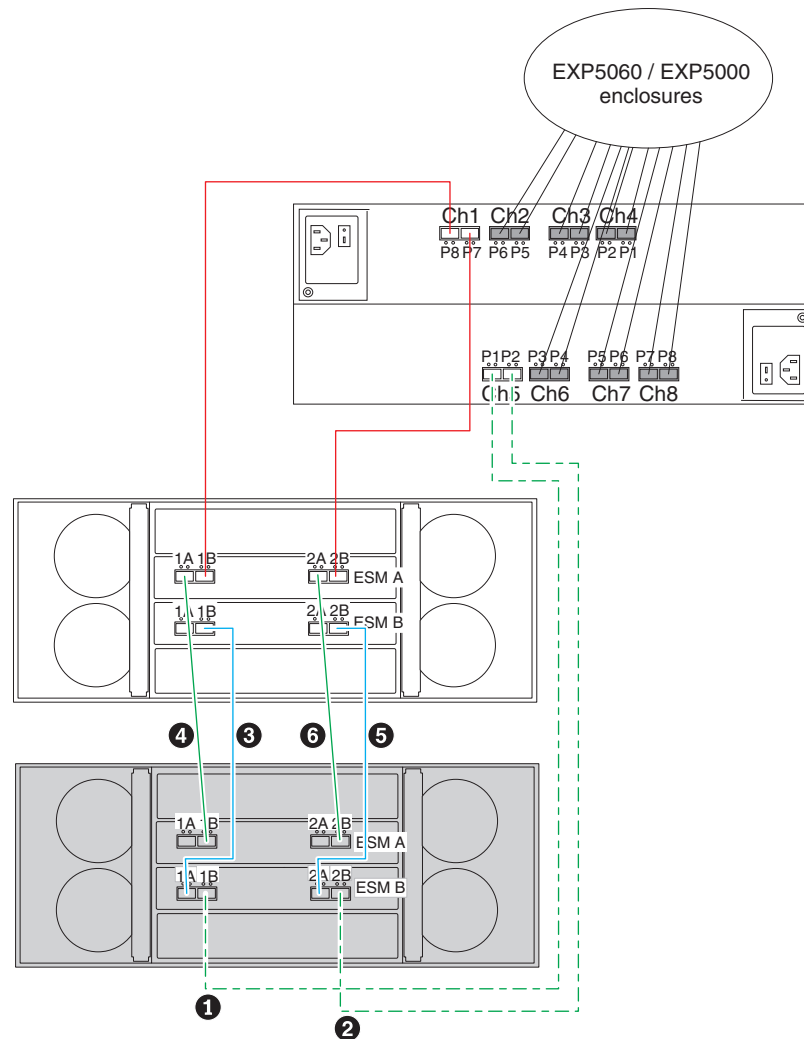
Figure 45. Cascading the EXP5060 behind another EXP5060 (trunking cabling scheme)

To add an EXP5060 to an existing EXP5060 configuration, perform the following tasks.

1. If this is the eighth EXP5060 to be installed in a storage subsystem configuration or the addition of multiple EXP5060s will cause the total number of EXP5060s in a storage subsystem configuration to exceed 8, you must purchase the *Attach eight EXP5060s* feature pack. Purchase the feature pack and schedule down time for activating the feature pack because feature pack installation must be done while the storage subsystem is in the quiescent state and does not receive I/Os. When the *Attach eight EXP5060s* feature pack is activated, proceed to the next step.

2. Unpack and install the EXP5060(s) in the rack.

3. Power on the EXP5060(s).

4. Cable the EXP5060(s) to the existing DS subsystem configuration using one of the cabling scenarios described in this section as shown in Figure 43 on page 88 to Figure 45. Make the cabling connections in the order shown in the figures using a number in a circle with black background format. If there are multiple enclosures to be added, perform the cabling changes to add only one enclosure at a time.

> **Note:** In Figure 45 on page 89, the connections labeled 1 and 2 indicate moving the existing connections from the controller drive ports to port 2B of the existing enclosure to port 2B of the new enclosure.

5. Using the Storage Manager program, verify and update the EXP5060 ESM firmware.

6. Insert one disk drive at time into the EXP5060 drawer drive slots. Wait at least 90 seconds between drive insertions, or until the drive is recognized in the Physical View of the DS Storage Manager Subsystem Management Window. Make sure that the drive spins up and is recognized in the Subsystem Management window Physical View before you insert the next drive.

Working with hot-swap DDMs

This section explains how you can increase the storage expansion enclosure capacity by adding more DDMs or by replacing existing 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 26.
- 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 DDM FRUs, review the following information:

- **DDM FRUs:**
  - When adding DDM FRUs, if you are not installing all 60 DDM FRUs into the EXP5060, install the DDM FRUs in each drive drawer in the front row (slots 1, 4, 7, and 10). To maintain uniform airflow across all drive drawers, the storage expansion enclosure must be configured with a minimum of 20 drives, with four drives in the front row of each of the five drive drawers (slots 1, 4, 7, and 10).
  - Use of non-supported drives in the storage expansion enclosures can cause the storage expansion enclosures to fail.
  - If you are using drives with capacity of 3 TB or higher, then the software and firmware version must be as prescribed in Table 5 on page 12. To know how to upgrade your translator firmware, refer to "Supporting 3 TB SATA Disk Drive Modules" on page 101.
  - After you remove an DDM FRU, wait 90 seconds before replacing or reseating it to allow it to properly spin down. Failure to do so may cause undesired events.

> **Attention**
>
> Before you power on a DS5000 storage subsystem without any internal drive slots, the DS5000 must be cabled to at least one storage expansion enclosure that is populated with a minimum number of DDMs for that enclosure type. If there are no drives in the configuration when the DS5000 storage subsystem is powered up, it will not complete the booting process, preventing it from being managed successfully by the Storage Manger.
>
> Additionally, if at least four DDMs are not installed in each storage expansion enclosure drive drawer, the resulting insufficient load to the storage expansion enclosure power supply FRUs might cause the storage expansion enclosure power supply FRUs to intermittently appear as failed and then reappear in an optimal state, falsely indicating that the power supply FRUs are bad. In certain enclosure types, having an insufficient number of drives installed will also affect the air flow through the enclosure.

- **Drive LEDs:** Each DDM FRU tray has three associated LEDs, a green drive power/drive activity LED, an amber Service Action Required LED, and a blue Service Action Allowed LED. These LEDs indicate the status for that DDM. See Table 25 for the drive LED states and descriptions.
- DDM FRUs are not interchangeable between the EXP5060 and other DS5000 storage expansion enclosures such as EXP810s.

Table 25. 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 DS5000 controller.
Service Action Required LED	Flashing amber	The amber LED flashes to indicate that a drive has been identified by the software.
Service Action Required LED	Steady amber	The amber LED lights to indicate a drive failure. The drive can also be put in a failed state if the drive is not certified for the DS5000 storage subsystem that the EXP5060 is connected to. Use the DS5000 storage subsystem Management window to verify that this is the case and replace the drive with the drive option or FRU that is certified for that particular DS5000 storage subsystem.
Activity and Service Action Required LEDs	All unlit	Check for and resolve the following situation: • EXP5060 is turned off.
Activity LED	Off	Check for and resolve one of the following situations: • Drives are part of an exported array. Once the array is exported, the drives in the array are spun down in preparation for being removed from the enclosure. • Drives are failed by the storage subsystem controllers. • Failed drive drawer.
Activity and Service Action Required LEDs	Flashing together in a certain pattern	Drive failure due to internal drive hardware failures.

Table 25. Drive LED activity (continued)

LED	LED state	Descriptions
Service Action Allowed LED	On (Blue)	The disk drive can be safely removed.

- **Fibre-channel loop IDs:** When you install a DDM in the storage expansion enclosure, the drive drawer 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 and the physical location of the DDM FRU.
- **Hot-swap hardware:** The EXP5060 contains hardware that enables you to replace a failed DDM without turning off the storage expansion enclosure. You can continue to operate your system while a DDM is removed or installed. These DDMs are known as hot-swap DDMs.

Installing hot-swap hard disk drives

With the exception of the DS5000 storage subsystem initial power on, you should add DDMs while the storage expansion enclosure is turned on and running.

Attention: After you remove a DDM FRU, wait for 90 seconds before replacing or reseating it to allow it to properly spin down. Failure to do so may cause undesired events.

Before you begin, ensure that you wear an anti-static wrist strap.

Complete the following steps to install hot-swap DDMs in the storage expansion enclosure:

1. Read the documentation that comes with the DDM.
2. If you are using drives with capacity of 3 TB or higher, ensure that the software and firmware version is as prescribed in Table 5 on page 12 for the drive to be recognized. To know how to upgrade your translator firmware, refer to "Supporting 3 TB SATA Disk Drive Modules" on page 101.
3. Check for Service Action Required LEDs described in "Drive drawer LEDs" on page 75 and "Disk drive LEDs" on page 76. If any amber LEDs are lit, see "Solving problems" on page 131.
4. Determine the drive drawer and position into which you want to install the DDM.
5. Remove the bezel from the front of the storage expansion enclosure. See "Replacing the bezel" on page 107 for the steps to remove the bezel.
6. Open the drive drawer by completing the following steps:
   a. Release the levers on each side of the drawer by pulling both levers towards the center.
   b. Pull on the extended levers to pull the drive drawer out to its full extension without removing it from the storage expansion enclosure.

   Note: The fan assemblies spin-up to increase airflow through the enclosure when a drive drawer is open. This is normal and does not indicate a fault. Fan speed will return to normal after the drive drawer is closed.

Figure 46. Opening the drive drawer

7. Install the DDM by completing the following steps:

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

    a. Raise the drive handle to the vertical position, as shown in Figure 47.
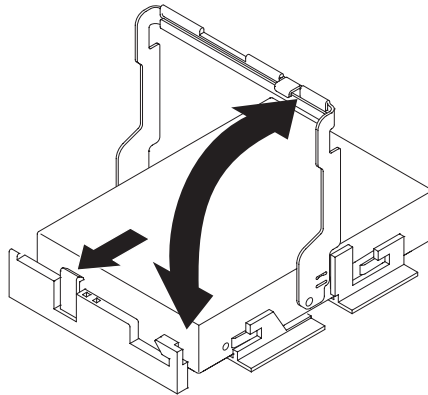
Figure 47. Raising the drive handle

    b. Align the two raised buttons on each side over the matching gap in the drive channel on the drawer, as shown in Figure 48.

Raised
buttons
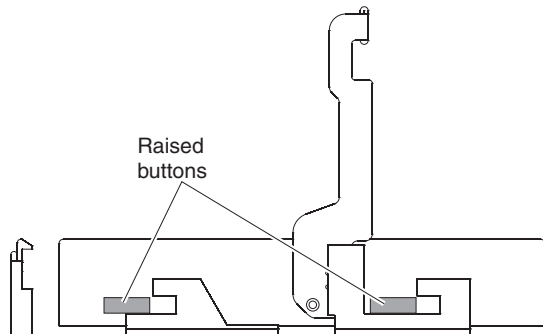
Figure 48. Aligning the drive

    c. Lower the drive straight down; then, rotate the drive handle down until the drive snaps into place under the drive release lever. See Figure 49 on page 94.
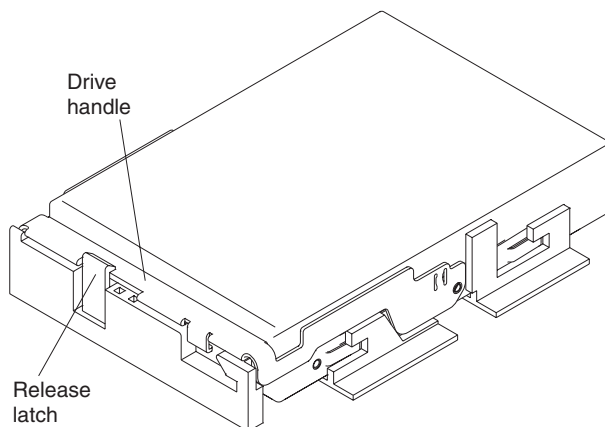
Figure 49. Locking the drive in place

8. Push the drive drawer all the way back into the storage expansion enclosure, closing the levers on each side of the drive drawer.

9. Install the bezel on the front of the storage expansion enclosure. See "Replacing the bezel" on page 107 for the steps to install the bezel.

Replacing hot-swap hard disk drives

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

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

Attention: Failure to replace the DDMs in their correct drawer and position might result in loss of data. If you are replacing a DDM that is part of a configured array and logical drive, ensure that you install the replacement DDM in the correct drawer and position. Check the hardware and software documentation that is provided with your DS5000 to see if there are restrictions regarding DDM configurations.

Before you begin, ensure that you wear an anti-static wrist strap.

Complete the following steps to replace a hot-swap DDM:

1. Use the DS5000 Storage Management client software to print a new storage system profile.

2. Determine the location of the DDM that you want to remove.

   Attention: Never hot-swap an DDM FRU when its associated green activity LED is flashing. Hot-swap an DDM FRU only when its associated blue Service Action Allowed LED is lit.

3. Put on anti-static protection.

4. Remove the bezel from the front of the storage expansion enclosure. See "Replacing the bezel" on page 107 for the steps to remove the bezel.

5. Open the drive drawer by completing the following steps:

   a. Release the levers on each side of the drawer by pulling both levers towards the center.

b. Pull on the extended levers to pull the drive drawer out to its full extension
       without removing it from the storage expansion enclosure.

       Note: The fan assemblies spin-up to increase airflow through the
                 enclosure when a drive drawer is open. This is normal and does not
                 indicate a fault. Fan speed will return to normal after the drive
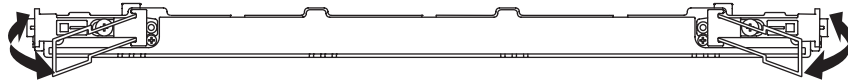   drawer is closed.

6. Remove the DDM by completing the following steps:

    a. Press the drive release lever and raise the drive handle to the vertical
        position.

    b. Wait 90 seconds to allow the drive to properly spin down and the storage
        subsystem controller to properly recognize that an DDM is removed from
        the configuration.

    c. Verify that there is proper identification (such as a label) on the DDM FRU,
        and then lift the drive up and remove it from the drive drawer.

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

    Attention: The DS5000 and EXP5060 DDM options and FRUs are not
    compatible with DS4000™ and EXP810 DDM.

8. Install the new DDM FRU by completing the following steps:

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

    a. Raise the drive handle to the vertical position.

    b. Align the two raised buttons on each side over the matching gap in the
        drive channel on the drawer.

    c. Lower the drive straight down; then, rotate the drive handle down until the
        drive snaps into place under the drive release lever.

9. Push the drive drawer all the way back into the storage expansion enclosure,
    closing the levers on each side of the drive drawer.

10. Check the DDM LEDs for the following:

    *   When an 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 (the Service Action Allowed
        LED might also be lit), remove the DDM from the unit and wait 90 seconds;
        then, install the DDM again. If the problem persists, use the DS Storage
        Manager to verify the drive state and contact IBM support if necessary.

    *   If the Service Action Allowed LED is lit and the Service Action Required LED
        is not lit, use the DS Storage Manager to check the drive state. The drive
        might be part of an exported array - ready for import, and also might be
        incompatible or uncertified. Use the Recovery Guru to diagnose the
        problem.

11. Use the DS Storage Manager subsystem management window to verify that
    the DDM is shown in the Storage Subsystem Management window.

12. Install the bezel on the front of the storage expansion enclosure. See
    "Replacing the bezel" on page 107 for the steps to install the bezel.

Replacing multiple DDMs

This section provides guidelines for upgrading the DDMs in the storage expansion
enclosure. Read the software documentation and this entire section to determine
whether you should use this procedure, use a modified version of this procedure, or
use a different procedure that is provided by your operating system.

Note: Instructions that are provided with your software should supersede anything stated in this document. If you are using drives with capacity of 3 TB or higher, ensure that the software and firmware version is as prescribed in Table 5 on page 12 for the drive to be recognized.

Before you begin, ensure that you wear an anti-static wrist strap.

The following are methods for upgrading DDMs:

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

  This method requires that you back up the data on the affected DDMs and then turn off the EXP5060 and the DS5000 storage subsystem.

  Attention: Turn off the DS5000 storage subsystem before you turn off the EXP5060.

  After replacing all the DDMs, you must reconfigure the new DDMs and restore data from backup. See the procedure in "Replacing all DDMs at the same time" on page 97.

  This is the safest way to exchange 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 DDMs one at a time**

  In this method, you manually fail each DDM, replace it, and wait for the system to restore data to the new DDM before installing the next DDM. After you install the new DDMs, you can configure them to make the additional DDM space available. See the procedure in "Replacing the drives one at a time" on page 99.

  Using this method, you can replace the DDMs while the EXP5060 and the DS5000 are running, eliminating the down time that is required if you replace all of them 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, 5, or 6). 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 DDM malfunctions.

The method you use depends on the following considerations:

- Which method most closely matches the recommended drive upgrade procedure that is provided in the operating system or the storage-management software documentation.
- Which RAID level is used on the affected drives. (RAID 0 requires you to replace all the drives at the same time.)
- How much downtime is acceptable as you swap the DDMs.
- The number of DDMs in an array. Replacing DDMs one at a time is better suited for arrays consisting of 3 to 5 DDMs. If you have more than 10 DDMs, consider replacing all of them 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 a result of replacing a DDM in the array, any new 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, drive native interface (SATA or FC), and capacity (up to 3 TB).

- How extensive are the changes to the data while the array is in a degraded state during the RAID array reconstruction and copyback process as result of replacing an DDM in the array. The more extensive the data changes, the more work that will need to be performed to restore the data in the event that the array failed because of an additional DDM failed while the array is in degraded state.

Replacing all DDMs at the same time

Use this procedure to replace all DDMs at the same time. You must use this method if you are upgrading DDMs containing RAID 0 logical drives. All the data currently on the DDMs is lost when you replace them; therefore, you must back up all data that is currently on the DDMs. This procedure also requires you to turn off the EXP5060 and the DS5000, which makes the storage subsystem (and any attached storage expansion enclosures) inaccessible to other users.

Before you begin, ensure that you wear an anti-static wrist strap.

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

1. Read the following information:
   - The information in "Replacing multiple DDMs" on page 95, particularly the paragraphs that discuss the differences between the two possible upgrade procedures
   - The information in your software documentation regarding DDM upgrades and installation
   - The documentation that comes with the new DDMs

     Read all precautionary notes, kit instructions, and other information. Kit instructions often contain the most current information regarding the 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 DS5000. Correct any problems that are reported.

3. Perform a complete backup of the DDMs that you are replacing.

   You need the backup to restore data on the 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 26.

4. Unpack the new DDMs.

   Set the 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 EXP5060s) are not flashing.

      2) The green Cache active LEDs are off. Refer to the *IBM System Storage DS5100 and DS5300 Storage Subsystem Installation, User's, and Maintenance Guide* for the location of the Cache active LEDs.

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

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

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

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

b. Turn off power to the storage subsystem before you turn off power to the EXP5060. Turn off both power supply switches on the back of the storage subsystem.

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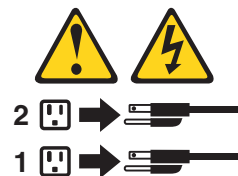
c. Turn off power to other supporting devices (for example, management stations, fibre-channel switches, or Ethernet switches).

7. Use the procedures in "Replacing hot-swap hard disk drives" on page 94 to remove the DDMs that you want to replace. Use the procedures in "Installing hot-swap hard disk drives" on page 92 to install the new DDMs into the EXP5060.

8. After you install all the new 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 drives are powered up after the storage subsystem. For instructions on powering up the storage subsystem, see the storage subsystem documentation.

c. Turn on the power to the 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 on page 98. To turn on power to the storage subsystem and the EXP5060s, turn on the power-supply switches on the back of the storage subsystem. You must turn on both power-supply switches to take advantage of the redundant power supplies.

10. Check the green Drive activity LEDs and the amber Drive fault LEDs above the new drive FRUs.

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

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

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

Replacing the drives one at a time

Use this procedure to replace all the drives one at a time. You cannot use this procedure on RAID 0 logical drives (use the procedure in "Replacing all DDMs at the same time" on page 97).

Note: If your storage subsystem has hot spares assigned, you might want to unassign the hot spares while you perform this procedure. If you do not, reconstruction might start on the hot spare before you insert the new drive. The data on the new DDM is still rebuilt, but the process takes longer for each DDM. Remember to reassign the hot spares when you are finished with this procedure.

Attention: After you remove a DDM FRU, wait 90 seconds before replacing or reseating it to allow it to properly spin down. Failure to do so may cause undesired events.

Before you begin, ensure that you wear an anti-static wrist strap.

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

1. Read the following information:
   - "Replacing multiple DDMs" on page 95, particularly the paragraphs that discuss the differences between the two possible upgrade procedures
   - Your software documentation regarding drive upgrades and installation
   - The documentation that comes with the new drives

     Read all precautionary notes, kit instructions, and other information. Kit instructions often contain the most current information regarding the drives and their installation, plus upgrade or servicing procedures. Compare the kit instructions with this procedure to determine if you need to modify this procedure.

2. Use the DS Storage Manager software to check the status of the unit. Correct any problems that are reported.

3. Back up the data in the arrays and logical drives that are configured using the 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 26.

4. Unpack the new DDMs.

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

5. Use the DS Storage Manager software to ensure that the array that was defined using these DDMs is in optimal (not degraded) state before manually failing the first 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 DDM.
   - The software status display shows a failed status for the appropriate DDM.
   - The amber Drive fault LED (on the front bezel below the DDM) is on.

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

   If you remove an active DDM accidentally, wait at least 30 seconds and then reinstall it. Because you failed two 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 DDMs until the array is brought back to optimal state.

6. Use the procedures in "Replacing hot-swap hard disk drives" on page 94 to remove the failed drive. Use the procedures in "Installing hot-swap hard disk drives" on page 92 to install the new DDMs into the EXP5060.

   The new 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 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 DDM FRUs.

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

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

9. When reconstruction is finished on the new DDM, repeat step 5 on page 100 through step 8 on page 100 for each additional DDM that you want to install.

10. Use the DS Storage Manager software to configure the additional space on the new DDMs.

Supporting 3 TB SATA Disk Drive Modules

Follow instructions in this document to upgrade the ATA translator card and other firmware in the EXP5060 to support a 3 TB SATA Disk Drive Module (DDM).

> **Important**
>
> Upgrade the ATA translator firmware during scheduled downtime. Before starting the ATA translator firmware download process, stop all I/O to the controllers and drives of the associated storage subsystems. Then, unmount any file systems for all logical drives in the subsystem.
>
> For multiple 3 TB SATA DDMs that are marked as 'incompatible', you must upgrade the ATA translator firmware one drive slot at a time. For details, see "Firmware upgrade procedures" on page 102.

Refer to Table 5 on page 12 to know the software and firmware version required for use of 3 TB SATA drive FRU PN 81Y2460 and feature code 4742 PN 81Y2461 in the EXP5060.

Determining firmware levels

To determine the firmware version of the DS5100/DS5300 storage subsystem and the EXP5060, use the DS Storage Manager client that manages the storage subsystem with the attached storage expansion enclosure:

- In the **Subsystem Management** window, click **Storage Subsystem** > **View** > **Profile**. The subsystem profile window opens.
- In the **Subsystem Management** window, click **Advanced** > **Maintenance** > **Firmware Inventory**. The subsystem profile window opens.
- On the Physical tab of the **Subsystem Management** window, click each component to view its properties.

Important: For drive slots that contain a 3 TB SATA DDM, you can determine the ATA translator firmware version only for drive slots that are in 'Optimal' or 'incompatible' state.

> **Note:** When a 3 TB SATA drive is installed in an EXP5060 Expansion Enclosure and the ATA translator firmware version is earlier than LW1613, the drive is marked 'incompatible'. If the firmware version is LW1613 or later, the drive is marked as 'Optimal'.
>
> You can determine the ATA translator firmware version of a drive slot only when a drive is in that slot. Also , the controller does not list the ATA translator firmware version of drive slots with drives in 'unresponsive' state.

Recommendations:

1. If you use 3 TB SATA DDMs to replace existing SATA DDMs, determine the ATA translator firmware version of the existing drives before you replace them. See "Determining firmware levels" on page 101.

2. Before you install a 3 TB SATA DDM into an empty drive slot, insert an unassigned hot-spare drive of 2 TB or smaller capacity into the drive slot. Then, determine the ATA translator firmware version. See "Determining firmware levels" on page 101.

Firmware upgrade procedures

Important: Before you upgrade ATA translator firmware, ensure that you have DS Storage Manager software, DS5100/5300 controller firmware, and EXP5060 environmental service module (ESM) firmware versions as prescribed in Table 5 on page 12.

The firmware upgrade procedure for a new 3 TB SATA DDM varies depending on the existing drive configuration of your EXP5060.

Note: Any updates to the ATA translator firmware for use with a 3 TB SATA DDM must be made during scheduled downtime. However, you do not have to stop host I/O operations to upgrade your controller firmware or to upgrade the environmental service module (ESM) firmware one enclosure at a time. For more details about upgrading your ESM and controller firmware, see Installation and Host Support Guide - IBM Storage Manager V10 (http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-5075652 &brandind=5000028).

Determining the ATA translator firmware upgrade procedure

Follow these instructions to determine the firmware upgrade procedure that applies to your configuration:

1. No firmware upgrade is required if the ATA translator firmware version on all the existing drive slots that will receive a new 3 TB SATA DDM is LW1613 or later. In this case, you can swap the old DDMs with the new 3 TB SATA DDMs.

   Recommendation: If any ATA translator firmware or drive firmware version is not the latest as recommended on the support portal, schedule downtime to upgrade it.

2. If you are adding 3 TB SATA DDMs into empty drive slots, and you have a 2 TB or smaller SATA DDM to use as a spare, follow the instructions in "Adding 3 TB SATA DDMs to empty drive slots with an available spare" on page 103.

3. If you are adding 3 TB SATA DDMs into empty drive slots, and you do *not* have 2 TB or smaller SATA DDM to use as a spare, then you must follow this procedure: "Adding 3 TB SATA DDMs to empty drive slots without an available spare" on page 103.

4. If you are replacing an existing SATA DDM with a 3 TB SATA DDM, follow these steps:

   a. Determine the version of the ATA translator firmware for the drive slots. See "Determining firmware levels" on page 101.

   b. If the ATA translator firmware version is earlier than LW1613, upgrade the ATA translator firmware to the version specified on the IBM support portal (LW1613 or later) with the old DDM installed. Complete the procedure "Upgrading the ATA translator firmware in an EXP5060" on page 104.

c. If the ATA translator firmware version of the drive slot is as specified on the support portal, you only need to swap the old SATA DDM with the new 3 TB SATA DDM.

Adding 3 TB SATA DDMs to empty drive slots without an available spare

> **Important**
>
> You must upgrade the ATA translator firmware for *only one* 3 TB SATA DDM at a time. An attempt to upgrade multiple drives simultaneously can result in a firmware download timeout error requiring a reboot of the controller to clear the error.

Follow these instructions to install 3 TB SATA DDMs in empty slots of a EXP5060, if the ATA translator firmware version is unknown, and you do *not* have an available 2 TB or smaller SATA DDM as a spare.

Schedule downtime for the upgrade and complete the procedure "Upgrading the ATA translator firmware in an EXP5060" on page 104.

Adding 3 TB SATA DDMs to empty drive slots with an available spare

Follow these instructions to install 3 TB SATA DDMs in empty slots of a EXP5060, if you have a 2 TB or smaller SATA DDM as a spare. If you need to upgrade the ATA translator firmware, follow these steps to upgrade one 3 TB SATA DDM at a time.

1. Determine the ATA translator firmware version for each empty slot that you want to upgrade for a 3 TB SATA DDM. After you determine the ATA translator firmware version, move the spare to the next empty slot to determine its version. See "Determining firmware levels" on page 101.

   Note: After you disengage the drive, wait for at least 90 seconds for the drive to fully spin down, and then remove it from the slot.

2. If all the empty drive slots have ATA translator firmware version LW1613 or later, you only need to install the new 3 TB SATA DDM into these drive slots. The newly installed 3 TB SATA DDMs spin up and are marked 'Optimal' in the **Subsystem Management** window. Otherwise, replace the drive and wait for it to spin up. If it does not spin up, attempt replacing the drive again. Contact IBM Support if the drive fails to spin up, even after replacing twice.

3. If the ATA translator firmware version in any of the empty drive slots is lower than specified, schedule downtime for the ATA translator firmware upgrade using the spare 2 TB and smaller capacity SATA drives. Complete the task "Upgrading the ATA translator firmware in an EXP5060" on page 104. You can upgrade multiple drive slots if you are using 2 TB or smaller sized drives. Only after the ATA translator firmware version is upgraded, install the 3 TB SATA DDM drives.

4. After upgrading the drive slot ATA translator firmware, remove the spare 2 TB or smaller capacity drives that you used during the upgrade. Insert the new 3 TB drives in these drive slots. The newly installed 3 TB SATA DDMs spin up and are 'Optimal' in the **Subsystem Management** window. Otherwise, replace the drive and wait for it to spin up. If it does not spin up, attempt replacing the drive again. Contact IBM Support if the drive fails to spin up, even after replacing twice and the DS Storage Manager software, DS5100/5300 controller firmware, and EXP5060 environmental service module(ESM) firmware versions are as prescribed in Table 5 on page 12.

Upgrading the ATA translator firmware in an EXP5060

Follow this procedure to install 3 TB SATA DDMs in drive slots of the EXP5060 in any of the following situations:

- The ATA translator firmware version of one or more empty drive slots is not known. See "Determining firmware levels" on page 101.
- The ATA translator firmware version of one or more drive slots is known to be earlier than specified on the support portal.
- You want to upgrade the ATA translator firmware version of one or more drive slots to the latest specified on the support portal.

Important:

1. Schedule downtime to upgrade the ATA translator firmware.
2. Upgrade the ATA translator firmware for *only one* 3 TB SATA DDM at a time. An attempt to upgrade multiple drives simultaneously can result in a firmware download timeout error requiring a reboot of the controller to clear the error. The steps that follow are about upgrading one slot at a time.
3. **Recommended**: When upgrading ATA translator firmware in an EXP5060, upgrade the drive firmware and ATA translator firmware of all the drives in the EXP5060 to the latest version as specified on the support portal

Complete these steps to upgrade the ATA translator firmware for one 3 TB SATA DDM at a time.

1. Ensure you have a drive inserted in the drive slot for which you want to upgrade ATA translator firmware.
2. Schedule downtime for the upgrade.
3. Open the **Subsystem Management** window.
4. Select **Advanced > Maintenance > Download > Download Drive/ATA Translator firmware**. The **Download Drive and ATA Translator firmware** window opens.

    Important: Before you start the download process for the ATA translator firmware, complete these tasks:

    a. Stop all host I/O operations on your subsystem.

    b. Stop all I/O to the controllers and drives of the associated storage subsystem.

    c. Unmount any file systems for all logical drives in the subsystem.

5. Review the information, and click **Next**. The **Download Drive and ATA Translator Firmware - Add Packages** window opens.
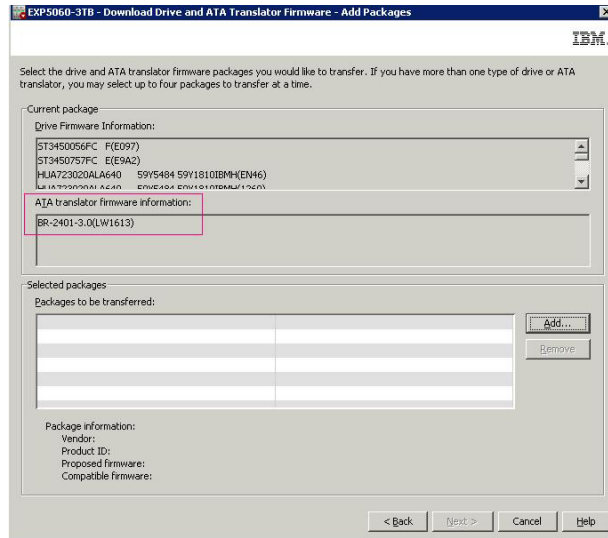
Figure 50. ATA translator firmware information

6. Click **Add**. The **ATA Translator firmware file selection** window opens.

7. Browse to the firmware file, select it, and click **OK**.

8. Click **Next**. The **Download Drive and ATA Translator Firmware - Select Devices** window opens.

9. Select the drive slot for which you want to upgrade the ATA translator firmware.

    Attention: Do not select multiple drive slots. Only if you have 2 TB or smaller capacity drives installed in the drive slots, you can select multiple slots and upgrade firmware for all slots at the same time.

10. Click **Finish** to initiate the firmware update process. The **Confirm download** window opens.

11. Enter Yes, and click **OK**. The **Download Drive and ATA Translator Firmware - Progress** window opens.

12. After the upgrade is complete, click **Close** to return to the **Subsystem Management** window.

The newly installed 3 TB SATA DDM is now marked 'Optimal' in the **Subsystem Management** window.

If you have more 3 TB SATA DDMs to install, repeat this procedure.

Scenarios

The following scenarios are for common situations that you might encounter when replacing or adding 3 TB SATA DDMs in EXP5060s. The scenarios contain details about appropriate actions to take to verify and upgrade the ATA translator firmware.

Scenario 1: Replacing a 3 TB SATA DDM

Situation
> Lloyd wants to replace a 3 TB SATA DDM in an EXP5060 with a new 3 TB SATA DDM. He knows that the ATA translator firmware version is already as recommended on the support portal.

Action

> Lloyd swaps the old 3 TB SATA DDM with the new 3 TB SATA DDM in the drive slot which has ATA translator firmware version as recommended on the support portal. For the other drive slots, Lloyd determines the ATA translator firmware version and checks the support portal. He finds that the version is not as recommended. He plans to upgrade *all* the drive slots on the EXP5060 with the latest drive firmware and ATA translator firmware, so he schedules downtime to upgrade the firmware.

Scenario 2: Replacing a 2 TB or smaller SATA DDM

Situation

> Meghna wants to replace a 2 TB SATA DDM in an EXP5060 with a new 3 TB SATA DDM. She does not know the ATA translator firmware version of the drive slot.

Action

> Meghna uses the DS Storage Manager client to check the ATA translator firmware version of the drive slot. She determines that the ATA translator firmware version is earlier than what is recommended on the support portal. Meghna schedules downtime to upgrade the firmware. Although she is required to upgrade the firmware for only one drive slot, she plans to upgrade *all* the drive slots on the EXP5060 with the latest drive firmware and ATA translator firmware. After the firmware is upgraded, Meghna swaps the 2 TB SATA DM with the new 3 TB SATA DDM.

Scenario 3: Adding 3 TB SATA DDMs to empty slots with an available spare

Situation a

> Carlos wants to add three new 3 TB SATA DDM to three empty drive slots in an EXP5060. He does not know the ATA translator firmware version of the empty drive slots. He has a 2 TB unassigned hot spare drive available.

Action

> Carlos uses the hot spare to fill the first empty drive slot, and determines that the ATA translator firmware version of that drive slot is as recommended on the support portal. He moves the unassigned hot spare to the second and third empty slots one at a time, and determines the ATA translator firmware version of these slots as recommended. Carlos removes the unassigned hot spare from the EXP5060, and inserts the three new 3 TB SATA DDM into the three empty drive slots.

Situation b

> Bob wants to add three new 3 TB SATA DDM to three empty drive slots in an EXP5060. He does not know the existing ATA translator firmware version of the empty drive slots. He has a 2 TB unassigned hot spare drive.

Action

> Bob uses the unassigned hot spare to fill the first empty drive slot,

and determines that the ATA translator firmware in that drive slot is as recommended on the support portal. Then, he moves the hot spare to the second and third empty slots one at a time, and determines that the ATA translator firmware version of these drive slots is *earlier* than the recommended ATA translator firmware . He removes the hot spare from the EXP5060, and schedules downtime to upgrade the firmware. He plans to upgrade the ATA translator firmware for the second and third drive slots as required, one drive slot at a time. Although the firmware upgrade is required for only those two drive slots, Bob plans to upgrade *all* the drive slots in the EXP5060 with the latest drive firmware and ATA translator firmware. After the firmware is upgraded, Bob inserts the three new 3 TB SATA DDMs into the three empty drive slots.

Scenario 4: Adding 3 TB SATA DDMs to empty slots without an available spare

Situation

Anna wants to add three new 3 TB SATA DDM to three empty drive slots in an EXP5060. She does not know the existing ATA translator firmware version of the empty drive slots, and does not have a 2 TB or smaller DDM to use as a spare.

Action

Anna schedules downtime for the upgrade and upgrades the ATA translator firmware using one 3 TB SATA DDM at a time.

Replacing the bezel

Use this procedure to remove and replace the bezel on the front of the storage expansion enclosure. You must remove the bezel before you can access the drives drawers and disk drive modules.

1. Remove the bezel by completing the following steps:

   a. At the front of the storage expansion enclosure, remove the bezel by pressing inward on the latches (see Figure 51).

Figure 51. Removing the bezel

   b. Pull the bezel toward you to remove it from the enclosure.

2. Install the bezel by completing the following steps:

   a. Orient the bezel to the front of the storage expansion enclosure (see Figure 51).

   b. Press the bezel inward until both latches lock the bezel in place.

Replacing a power supply

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.
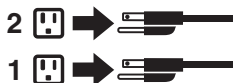
CAUTION:
Disconnect the power cord before replacing the power supply.

The power supplies provide power for the EXP5060. The power supplies are customer replaceable units (FRUs) and do not require preventive maintenance. Use only the supported power supplies for your specific storage expansion enclosure.

Each power supply 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 is resolved, 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 83.

If both power supplies fail, or if the fan assemblies cannot maintain an internal temperature below 60° C (140° F), the power supplies 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 83.

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

Use the following procedure to replace a failed power supply. See "Replacing a fan assembly" on page 112 to replace a failed fan assembly.

Statement 8:

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

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

1. 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?
   - **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. Save all packing material in case you need to return the failed power supply FRU.
5. Turn off the power switch on the new power supply.
6. Check the Service Action Required LED to locate the failed power supply. If a fault is detected, the amber Service Action Required LED is on.
7. Verify that the Service Action Allowed LED is on. Do not remove the power supply if the LED is off. For more information on the Service Action Allowed LED, see "Service action allowed status LED" on page 87.

   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.	

8. Turn off the power switch, and unplug the power cord from the failed power supply.

   Important: To ensure optimal airflow through the chassis, replace a failed power supply within 5 minutes of removal.

9. Squeeze the latches together and pull the levers open to release the power supply from the enclosure. The latches are the orange colored tabs on the levers (see Figure 52 on page 111).

Cam

Cam
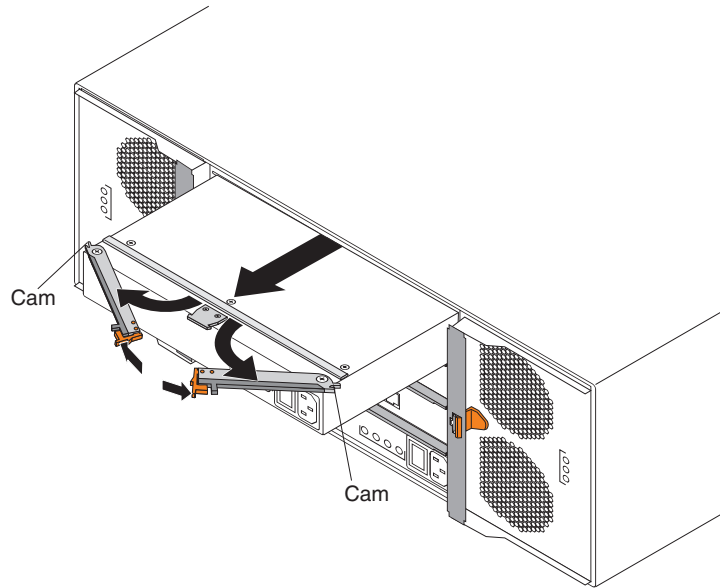
Figure 52. Replacing a power supply

10. Slowly pull on the levers to slide the power supply out of the power supply bay.

11. Slide the new power supply FRU into the empty bay. As you slide the power supply into the empty bay, make sure that the cams on both levers fit into the corresponding slots in the enclosure (see Figure 52).

12. After the cams fit into the slots and power supply fits snugly in the bay, rotate the levers inward to lock the power supply in place. Then gently push on the levers to ensure that they are latched.

13. Plug in the power cord and turn on the power.

14. Check the Power and Fault LEDs on the new power supply.

15. Based on the status of the Power and Service Action Required LEDs, choose one of the following steps:

  - **Service Action Required LED is on and power LEDs are off** - The new power supply might be installed incorrectly. The power supply switch may not be turned on. The power cord plug may not be fully inserted into the power outlet or the power supply ac socket. There is not any power to the outlet that the power supply is connected to. The power cord may be faulty. Go to step 16.

  - **Service Action Required LED is off and power LEDs are on** - The new power supply is installed correctly. Go to step 17.

16. Perform the following task or task(s) to resolve the problem:

  - Ensure that the power switch is turned to the on position.

  - Ensure that there is power at the outlet and no circuit breaker has tripped.

  - Ensure that the power cord is working and fully seated into the electrical outlet and the power supply socket.

  - Reinstall the power supply.

    If the above tasks do not resolve the problem, contact IBM Customer and Technical Support.

17. Complete any remaining Recovery Guru procedures, if needed.

18. Check the status of each storage expansion enclosure in the storage subsystem.

19. Do any components have a Service Action Required 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 fan assembly

Use this procedure to replace a failed fan assembly. To preserve the optimal airflow, do not remove a failed fan assembly FRU from the storage expansion enclosure until you are ready to replace it with a new FRU.

Attention:
- To prevent damage from overheating, replace a failed fan assembly FRU within 5 minutes of removal. If replacing it will take longer than 5 minutes, stop all I/O activity to the storage expansion enclosure and turn off the power until you complete the replacement.
- If one of the fan assemblies has failed, the remaining fan assembly will operate at maximum fan speed.

1. Remove the fan assembly to be replaced by completing the following steps:
   a. At the rear of the storage expansion enclosure, remove the fan assembly (see Figure 53) by pressing on the locking tab holding the fan assembly handle in place; then, pull the fan assembly handle toward you.
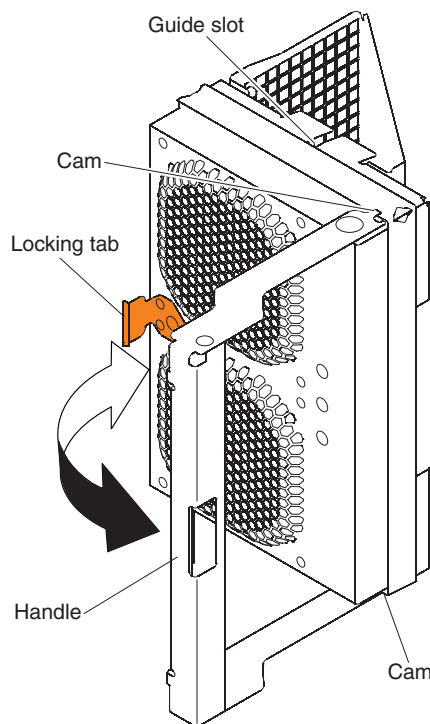

Figure 53. Removing a fan assembly

   b. Use the fan assembly handle to pull the fan assembly out of the enclosure.
2. Install a new fan assembly FRU by completing the following steps:

> **Attention:** If you are performing this procedure with the power turned on, you must reinstall the fan assembly within 10 minutes. Otherwise, the equipment could overheat.

  a. Orient the fan assembly to the fan assembly bay and push the fan assembly all the way into the bay.

> **Note:** Although both fan assemblies (left and right) are identical, they are seated in the EXP5060 enclosure in opposite orientations. If the fan assembly cannot be fully inserted in the fan assembly bay, rotate it 180 degrees and reinsert it.

  b. Make sure that cams on the fan assembly handle engage the corresponding slots in the enclosure; then, rotate the fan assembly handle to the closed position.

  c. Press the fan assembly handle in until it latches in place.

Replacing an Environmental Service Module (ESM)

This section describes the removal and replacement procedure for a failed hot-swap ESM. Always verify the FRU part number of the replacement ESM to verify that it is compatible with the existing ESM in the EXP5060 chassis. Inserting non-compatible ESM FRU may cause lost of data availability.

The EXP5060 storage expansion enclosures support the ESM auto code synchronization functionality. When a new ESM is installed into an existing storage expansion enclosure in a DS5000 storage subsystem that supports ESM auto code synchronization, firmware is automatically synchronized in the new ESM with the firmware in the existing ESM. This function requires that the DS5000 storage subsystem be defined in the Enterprise Management window of the DS Storage Manager client program installed in a management station. Additionally, the DS Storage Manager client program must be opened and running, or the IBM DS Storage Manager Event Monitor service must be running when the new ESM is inserted.

For more information on how to start this service, see the *IBM System Storage DS Storage Manager Version 10 Installation and Host Support Guide* for your operating system.

Do not perform to the following steps until you have installed the DS Storage Manager client program, defined the affected DS5000 storage subsystem in the Enterprise Management window, and either have the DS Storage Manager client program running or the Event Monitor service started.

Attention:

- After you remove an ESM, wait at least 70 seconds before reseating or replacing the ESM so that the DS5000 storage subsystem controller properly recognizes that an ESM is removed from the configuration. Failure to do so may cause undesired events.
- The EXP5060 ESM FRU is not the same as the EXP810 ESM FRU. The EXP810 ESM will not fit into the EXP5060 ESM slot. Verify that the ESM FRU PN is correct before replacing an ESM.

Complete the following steps to remove a failed ESM:

1. Start the DS Storage Manager client program. In the Enterprise Management window, open the Subsystem Management window for the DS5000 storage subsystem that includes the EXP5060 enclosure that requires the ESM replacement.

2. Check the DS Storage Manager online help for ESM failure-recovery procedures. Follow the steps provided in the failure-recovery procedures before continuing to step 3.

3. Save the DS5000 profile by performing the following steps:

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

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

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

      Important: Do not store DS5000 profiles in the same location as the logical drives that are defined on your DS5000 configuration. If you do, and the logical drives fail, you will lose data.

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

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

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

6. Remove the SFP modules and the fibre-channel cables from the failed ESM.

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

7. Squeeze the latches together and pull the levers open to release the ESM from the enclosure. The latches are the orange colored tabs on the levers (see Figure 54 on page 115).

   Important: To ensure optimal airflow through the chassis, replace a failed ESM within 5 minutes of removal.
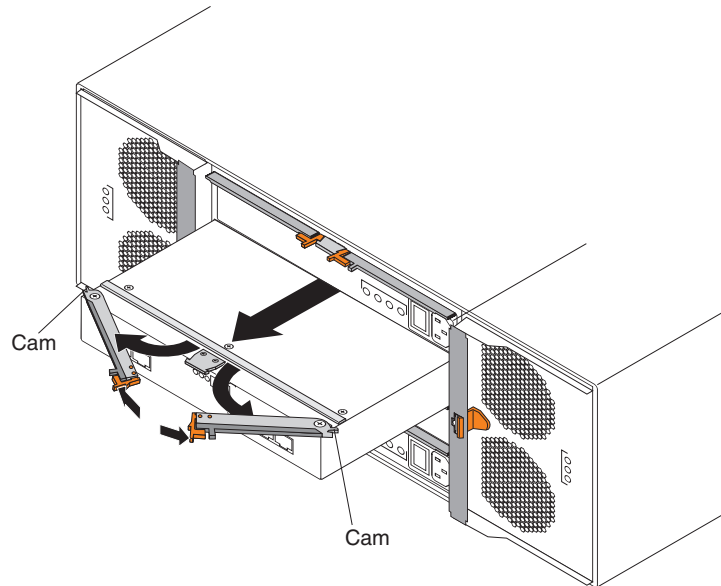
Figure 54. Removing and replacing an Environmental Service Module (ESM)

8. Slowly pull on the levers to slide the ESM out of the enclosure.

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

10. Install the new ESM by sliding it into the empty bay. Be sure that the levers are pulled open as you slide the ESM into the storage expansion enclosure. As you slide the ESM into the empty bay, make sure the cams on the levers fit into the corresponding slots on the sides of the ESM bay.

11. After the cams fit into the slots and ESM fits snugly in the bay, rotate the levers inward to lock the ESM in place. Then gently push on the levers to ensure that they are latched.

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

13. Check the Power and Fault LEDs on the new ESM for the following:

    - If the Power LED is off, the ESM might not be inserted correctly.

    - If the Service Action Required LED is lit, if the Power LED is off, or if any other Fault LEDs are lit, see "Solving problems" on page 131 or call IBM Support.

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

15. Use the DS Storage Manager Client to open a Subsystem Management window to the DS5000 on which the EXP5060 ESM was replaced. Click on the **Recovery Guru** or the **Environment Status** icon of the drive expansion enclosure on which you replaced the ESM.

    If there is an ESM firmware mismatch, wait up to 15 minutes for the DS5000 Client program to perform ESM code synchronization.

    Note: The ESM firmware download will take up to 5 minutes in typical workload condition.

    If there is no ESM firmware mismatch, the upgrade process is complete.

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

Replacing an SFP module

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

Attention:
* Refer to the FRU option P/N on the SFP to identify the maximum operating speed of the SFP and to request the correct FRU replacement.
* The EXP5060 is not supported at 2 Gbps data rate operation attached to the DS5000; therefore, 2 Gbps SFPs are not supported in the EXP5060.

Use the following procedure to replace a Small Form-factor Pluggable (SFP) module on the storage expansion enclosure. The SFP module shown in this procedure might look different from those you are using, but the difference will not affect functionality. Figure 55 on page 117 illustrates installing an SFP module.

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

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 Port Bypass LEDs to locate the failed SFP module. If a fault is detected, the amber Port Bypass 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.

    Attention:
    * The EXP5060 is not supported at 2 Gbps data rate operation attached to the DS5000; therefore, 2 Gbps SFPs are not supported in the EXP5060.
    * The speed of the SFP module determines the maximum operating speed of the fibre channel port in which the SFP is installed. For example, a 2-Gbps SFP that is plugged into a 4-Gbps-capable port will limit the speed of that port to a maximum of 2 Gbps.
    * Handle and install fibre-optic cables properly to avoid degraded performance or loss of communications with devices. For specific handling guidelines, see "Handling fibre-optic cables" on page 46.
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.
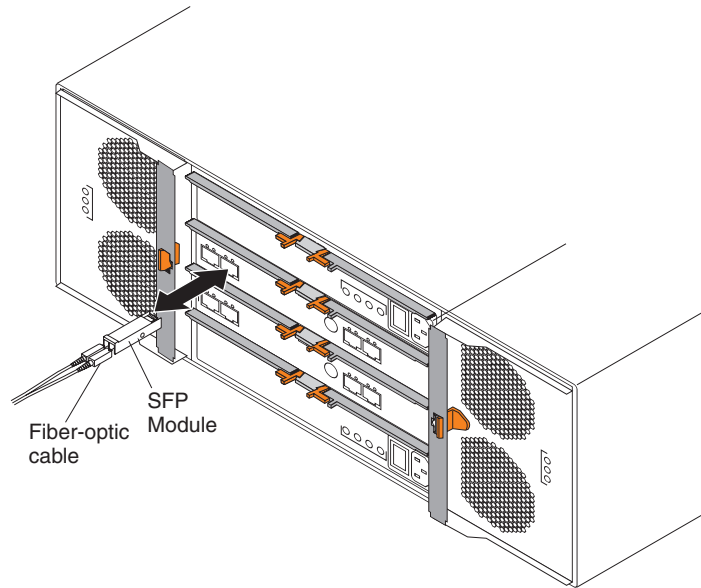
Figure 55. Replacing an SFP module

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

Use this procedure to replace a failed drive drawer FRU. The disk drives in the drawer to be replaced must be removed and reinstalled in the replacement drive drawer. Ensure you use the new drive drawer FRU (PN - 94Y8476), if you want to replace a drive with a 3 TB drive. The new drive drawer FRU is updated with the

ATA translator firmware version LW1613 and is a replacement for drive drawer FRU (PN - 59Y5311). See "Replacing hot-swap hard disk drives" on page 94 for the steps to remove a DDM.

Attention:

1. If you use a new 3 TB drive in the old drive drawer FRU (PN - 59Y5311), then the drive will be in an 'Incompatible' state and cause failure of the array.

2. **Potential hardware damage** - Electrostatic discharge can damage sensitive components. To prevent electrostatic discharge damage to the storage expansion enclosure, use proper anti-static protection when handling components.

3. **Potential loss of data access** - If the logical drives and arrays have already been assigned and created, the location of the drives in the drive drawer is critical. Record the location of the drives before removing the drives from the drawer.

4. **Potential loss of data access** - Replacing a drawer will cause all of the drives in the replaced drawer to be unavailable to the controllers in the storage subsystem. If the arrays that have drives in the to-be-replaced drawer were created without drawer loss protection, you must schedule down time to replace the drawer because these arrays will fail when the drawer is replaced. Examples of arrays without drawer loss protection:

   - Raid 6 arrays with more than two drives in the to-be-replaced drawer
   - Raid 1, 3, or 5 arrays with more than one drive in the to-be-replaced drawer
   - Raid 0 array

1. Prepare the drive drawer for removal by completing the following steps:

   a. If possible, stop the I/O activity to the storage expansion enclosure. If it is not possible to stop the I/O activity, perform the drive drawer replacement during a period of low I/O activity.

   b. Is power applied to the storage expansion enclosure?

      - **Yes** - Go to step 1c.
      - **No** - Go to step 3 on page 119.

   c. If the controller firmware is 07.60.xx.xx, use the Storage Manager Subsystem Management window to prepare the drive drawer for removal:

      1) Open the Subsystem Management window for the DS5100 or DS5300 storage subsystem that the EXP5060 is connected to.

      2) Select **Advanced -> Troubleshooting -> Prepare for Removal**. A Prepare for Removal window displays.

      3) In the Prepare for Removal window, click the pull down list to select the appropriate enclosure; then, click the component pull down list to select the drive drawer that will be removed.

      4) Click the **Prepare for Removal** button.

      5) When the controller processes the request successfully, a confirmation window is displayed. Click **OK** to close this window and the Prepare for Removal window.

         Note: Prepare for Removal turns on the blue Service Action Allowed LED located on the front of drive drawer, the Service Action Allowed LEDs located on each side of the drawer in the back, and lights the Service Action Allowed LED on all the installed drives in the drawer. It also prevents the controller from accessing the drives in the drawer.

d. If the controller firmware is 07.77.xx.xx or higher, Open the script window and execute the following SMcli script command:

set enclosure *[enclosureID]* **drawer** *[drawerID]* **serviceAllowedIndicator=off;**

Where:

- *[enclosureID]* is the identifier of the storage expansion enclosure that contains the replaced drive drawer. Drive tray ID values are 0 to 99.
- *[drawerID]* is the identifier of the replaced drive drawer. Drawer ID values are 1 to 5.

This command turns on the Service Action Allowed LED located on the front of the drive drawer, the Service Action Allowed LEDs located on each side of the drawer in the back, and lights the Service Action Allowed LED on all the installed drives in the drawer. It also prevents the controller from accessing the drives in the drawer.

2. Remove the bezel from the front of the storage expansion enclosure. See "Replacing the bezel" on page 107 for the steps to remove the bezel.

3. Put on anti-static protection.

4. Remove the cable chains from the rear of the drive drawer to be removed by completing the following steps:

a. At the rear of the drive tray, remove the right fan assembly. See "Replacing a fan assembly" on page 112 for the steps to remove a fan assembly. Figure 56 shows the area with the fan assembly removed.

Attention: If you are performing this procedure with the power turned on, you must reinstall the fan assembly within 10 minutes. Otherwise, the equipment could overheat.
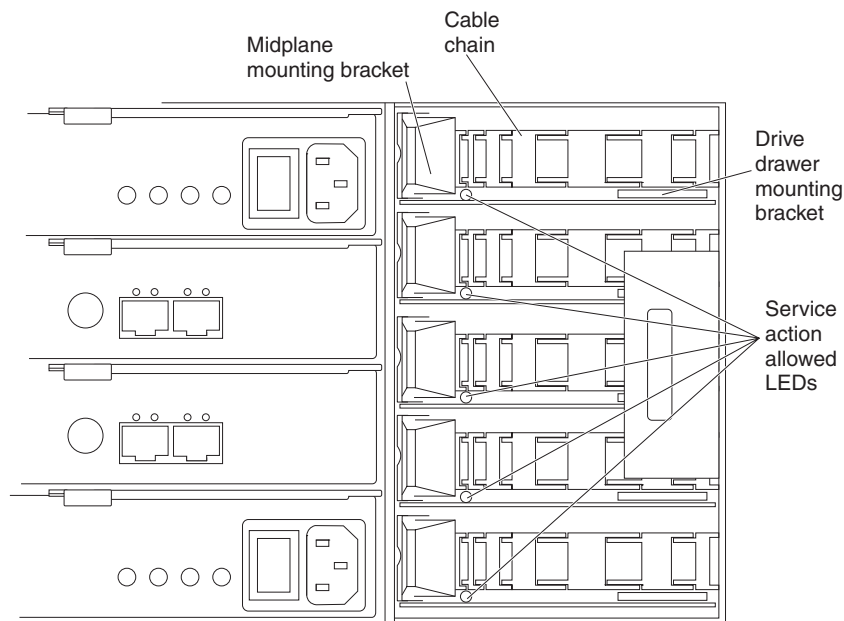
Figure 56. Rear view of the storage expansion enclosure with the right fan assembly removed

Notes:

1) Each cable chain has a vertical mounting bracket that connects to the midplane and a horizontal mounting bracket that connects to the drive drawer.

2) The left and right cable chains are not interchangeable.

b. If power is applied and you performed step 1c on page 118, locate the drive drawer with the Service Action Allowed LED lit. If power is not applied, manually determine which cable chain you must disconnect. The top cable chain is attached to drive drawer 1. The bottom cable chain is attached to drive drawer 5.

CAUTION:
Verify that you have identified the correct drive drawer before removing the cable chains. Removing the wrong drawer cable chains might cause loss of data access.

c. Disconnect the right cable chain mounting bracket from the midplane. Insert your finger into the orange circle (see Figure 57), and pull the mounting bracket completely out of the storage expansion enclosure. If necessary, use a flashlight to see the orange circle.

Note: The vertical side of the cable chain (the end that is connecting the midplane) should be removed before the horizontal side of the cable chain (the end that is connecting to the drive drawer).

Orange circle

Figure 57. Vertical mounting bracket that connects to the midplane

d. Disconnect the right cable chain mounting bracket from the drive drawer. Insert your finger into the orange circle (see Figure 58 on page 121), and pull the mounting bracket completely out of the drive tray. Remove the right cable chain.

Orange circle
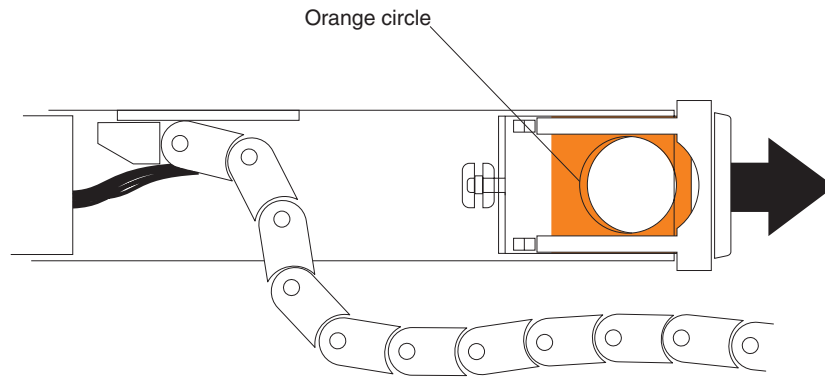
Figure 58. Horizontal mounting bracket that connects to the drive drawer

    e. Reinstall the right fan assembly. Wait until the fan speed slows down and the green Power LED is lit before proceeding to ensure that the right fan assembly is operating correctly before removing the left fan assembly. See "Replacing a fan assembly" on page 112 for the steps to install a fan assembly.

    f. Remove the left fan assembly. See "Replacing a fan assembly" on page 112 for the steps to remove a fan assembly.

      Attention: If you are performing this procedure with the power turned on, you must reinstall the fan assembly within 10 minutes. Otherwise, the equipment could overheat.
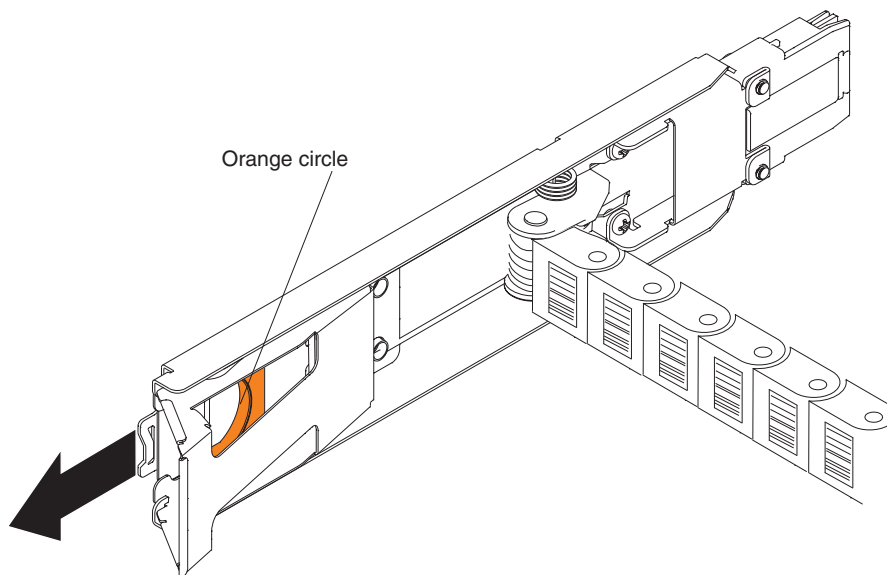
    g. Disconnect the left cable chain mounting bracket from the midplane. Insert your finger into the orange circle, and pull the mounting bracket completely out of the storage expansion enclosure.

    h. Disconnect the left cable chain mounting bracket from the drive drawer. Insert your finger into the orange circle, and pull the mounting bracket completely out of the storage expansion enclosure. Remove the left cable chain.

    i. Reinstall the left fan assembly. See "Replacing a fan assembly" on page 112 for the steps to install a fan assembly.

      Attention: If you are performing this procedure with the power turned on, you must reinstall the fan assemblies before you remove the drive drawer. Otherwise, the equipment could overheat.

5. Remove the drive drawer by completing the following steps:

    a. At the front of the storage expansion enclosure, pull the handles on the drive drawer to be removed until the drive drawer stops. The drive drawer should not come completely out of the enclosure at this time.

    b. Label all of the disk drives in the drawer before you remove them, so that the drives can be reinstalled in the same slot in the replacement drive drawer.

      Attention: If the logical unit numbers (LUNs) have already been assigned and created, the location of the drives in drive drawer is critical. You must record the location of the drives before removing them in the next step.

    c. Remove all of the disk drive modules from the drive drawer. See "Replacing hot-swap hard disk drives" on page 94 for the steps to remove a DDM.

    d. Slide the drive drawer release lever (see Figure 59 on page 122) on both sides of the drive drawer toward you, and remove the drive drawer from

the enclosure.
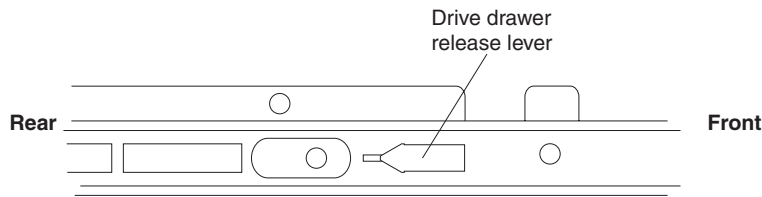
Figure 59. Drive drawer release lever on the side of the drive drawer

6. Install a new drive drawer FRU by completing the following steps:

   Attention: Damage might occur if the lock-out tumbler is in the middle of the drawer guide.

   a. At the front of the storage expansion enclosure, install the new drive drawer into the slot, making sure the lock-out tumbler is located on the top of the drawer guide. The lock-out tumbler is a small alignment piece that is attached to the frame. Figure 60 shows the location of the lock-out tumbler as shown from the front of the enclosure.
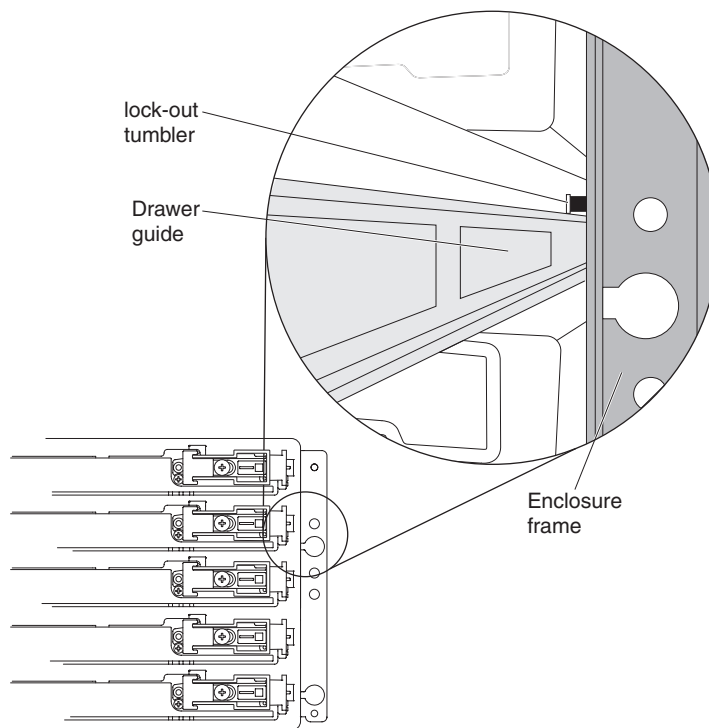
Figure 60. Lock-out tumbler located above the drawer guide

   b. Push the drive drawer all the way in until the latch fully engages.

7. Install the cable chains on the rear of the drive drawer by completing the following steps:

   a. Remove the left fan assembly. See "Replacing a fan assembly" on page 112 for the steps to remove a fan assembly.

   b. Connect the left cable chain mounting bracket to the drive drawer. Use a flashlight, if necessary, so that you can see the connector on the mounting bracket connect to the disk drawer connector.

c. Connect the left cable chain mounting bracket to the midplane.

d. Reinstall the left fan assembly. Wait until the fan speed slows down before proceeding to ensure that the left fan assembly is operating correctly before removing the right fan assembly. See "Replacing a fan assembly" on page 112 for the steps to install a fan assembly.

e. Remove the right fan assembly. See "Replacing a fan assembly" on page 112 for the steps to remove a fan assembly.

f. Use the handle to pull the right fan assembly out of the storage expansion enclosure.

g. Connect the right cable chain mounting bracket to the drive drawer. Use a flashlight, if necessary, so that you can see the connector on the mounting bracket connect to the disk drawer connector.

h. Connect the right cable chain mounting bracket to the midplane.

i. Reinstall the right fan assembly.

8. Install the disk drives in the new drive drawer FRU by completing the following steps:

a. Open the drive drawer by pulling the handles on the drive drawer towards you until the drive drawer stops.

b. Install the drives you that you removed previously in the drive drawer, one disk drive at a time. Wait at least 90 seconds or until each drive is recognized in the DS Storage Manager Physical View before inserting the next drive. If you do not wait until the drive is recognized by the DS Storage Manager, one or more drives will be marked as failed/bypassed or incompatible. If this occurs, you must remove the failed/bypassed drive, reinsert it, and wait at least 90 seconds or until it is recognized by the DS Storage Manager. See "Installing hot-swap hard disk drives" on page 92 for the steps to install the drives.

   Attention: You must add the drives to the same location in the drive drawer that they were in before the drive drawer was replaced.

c. Push the drive drawer all the way in until the latch fully engages.

9. Install the bezel on the front of the storage expansion enclosure. See "Replacing the bezel" on page 107 for the steps to install the bezel.

10. Remove the anti-static protection.

11. Is the storage expansion enclosure power turned on?

   • **No** - You are finished with the procedure, and you can turn on the power.

   • **Yes** - Go to step 12

12. The Service Action Allowed LED on the replaced drive drawer should be turned off automatically by the controllers. If it is not turned off automatically, open the script window for the DS5100/DS5300 that the EXP5060 with the replaced drawer is connected to and execute the following SMcli script command:

   set enclosure *[enclosureID]* **drawer** *[drawerID]* **serviceAllowedIndicator=off;**

   Where:

   • *[enclosureID]* is the identifier of the storage expansion enclosure that contains the replaced drive drawer. Drive tray ID values are 0 to 99.

   • *[drawerID]* is the identifier of the replaced drive drawer. Drawer ID values are 1 to 5.

   This command turns off the blue Service Action Allowed LED that is located on the drive drawer and allows the controller to access the storage expansion enclosure.

13. Use the DS Storage Manager to verify that the new drive drawer is operating correctly and to verify that the installed ATA Translator firmware is correct. If the ATA Translator firmware is outdated, schedule down time to update the ATA Translator firmware. Updating the ATA Translator firmware is an off line process.

Replacing an enclosure chassis

The replacement chassis package includes a RID tag and a power supply module. You can either ship this power supply module or your existing power supply module back to IBM along with the old enclosure chassis.

Complete the following steps to replace the enclosure chassis.

1. Schedule downtime for the storage subsystem configuration, and:
   a. Stop all applications in the servers, and either unmount or remove the drive letters of the mapped LUNs from the storage subsystem.
   b. Use the storage manager to collect support data of the subsystem. Save this information in a location other than the mapped LUNs from the storage subsystem.
   c. Power off the enclosure with the controllers CRUs/FRU first. Then, power off the drive expansion enclosures.
2. Remove the bezel of the EXP5060 enclosure with the enclosure chassis you want to replace.
3. Label the drive drawers of the EXP5060 enclosure.
4. Label and remove the fan assembly modules.
   a. At the rear of the storage expansion enclosure, remove the fan assembly (see Figure 61 on page 125) by pressing on the locking tab holding the fan assembly handle in place; then, pull the fan assembly towards you.

Guide slot

Cam

Locking tab

Handle

Cam
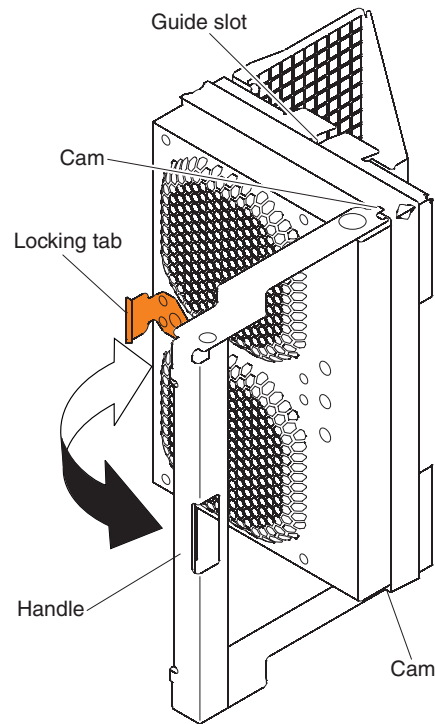
Figure 61. Removing a fan assembly

      b. Use the fan assembly handle to pull the fan assembly out of the enclosure.

5. Unplug the power cord, label the power supply modules, remove them by pressing the latches together, and pull the levers open to release the power supply from the enclosure. Then, slowly pull the levers to slide the power supply out of the power supply bay. The latches are the orange colored tabs on the levers.

6. Label all connections to the ESMs, disconnect all connections, and squeeze to remove the ESM modules.

7. Remove the five sets of cable chains that connect the disk drawers to the midplane in the EXP5060 enclosure. Complete the following steps to remove each set of cable chains:
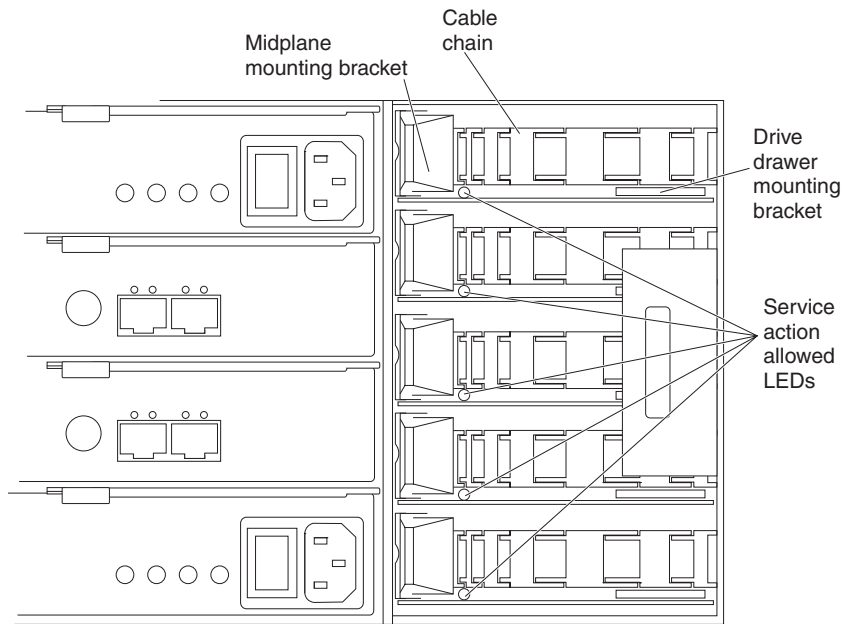
Figure 62. Rear view of the storage expansion enclosure with the right fan assembly removed

> **Note:** Each cable chain has a vertical mounting bracket that connects to the midplane and a horizontal mounting bracket that connects to the drive drawer. Also, the left and right cable chains are not interchangeable.

a. Disconnect the right cable chain mounting bracket from the midplane. Hold the orange handle (See Figure 63 on page 127) and pull the mounting bracket out of the storage expansion enclosure. If necessary, use a flashlight to locate the orange circle.

> **Note:** The vertical side of the cable chain (the end that connects to the midplane) should be removed before the horizontal side of the cable chain (the end connects to the drive drawer).
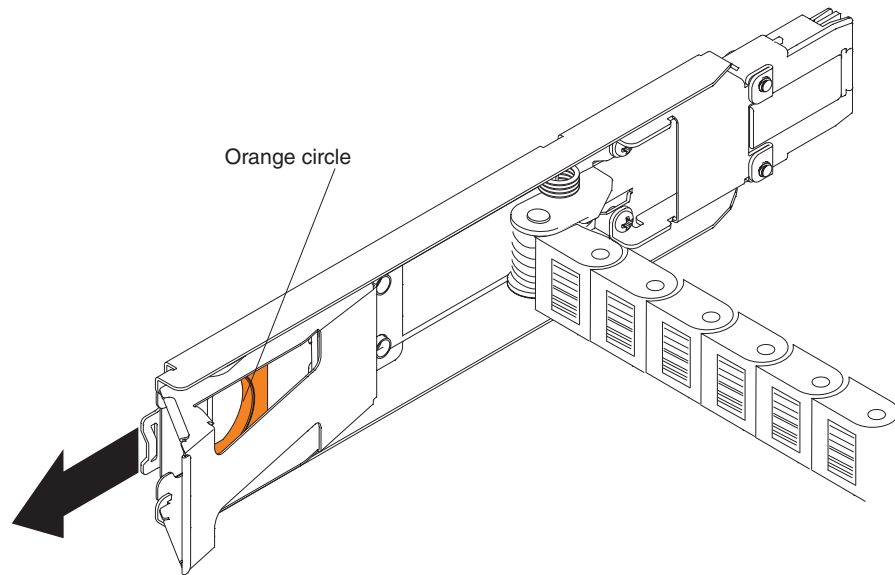
Figure 63. Vertical mounting bracket that connects to the midplane

b. Disconnect the right cable chain mounting bracket from the drive drawer. Hold the orange handle (See Figure 64), and pull the mounting bracket out of the drive tray.
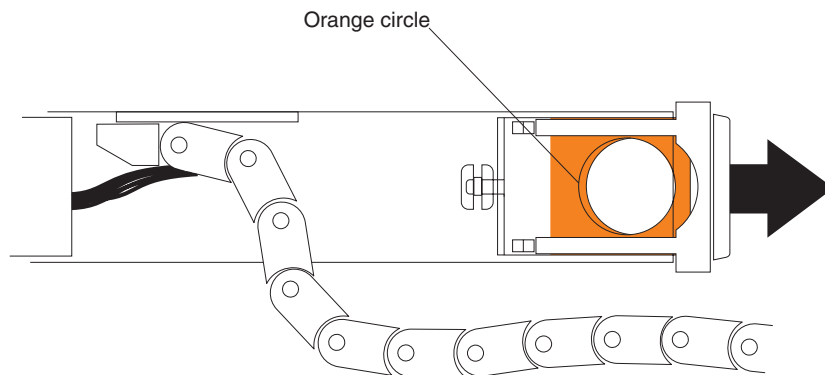
Figure 64. Horizontal mounting bracket that connects to the drive drawer

c. Disconnect the left cable chain mounting bracket from the midplane. Hold the orange handle and pull the mounting bracket out of the storage expansion enclosure.

d. Disconnect the left cable chain mounting bracket from the drive drawer. Hold the orange handle and pull the mounting bracket out of the storage expansion enclosure.

8. Remove the drive drawers by completing the following steps.

CAUTION:
Hold disk drawers with both hands on each side between the second and third row of drives. Place the removed disk drawer on a flat and static-free surface. Do not stack disk drawers or hold the disk drawer such that it would to bend. The disk drawers fully loaded with 3.5" drives might be heavy for one person, so we recommend that more than one personnel should move the disk drawer. Do not use excessive force while removing the boards. You might damage the disk drawer or the disk drawer guides.

a. Release the levers on each side of the drawer by pulling both levers towards the center. At the front of the storage expansion enclosure, pull the handles on the drive drawer to be removed until the drive drawer stops. The drive drawer should not come completely out of the enclosure at this time.

b. Slide the drive drawer release lever (see Figure 65) on both sides of the drive drawer toward you, and remove the drive drawer from the enclosure.
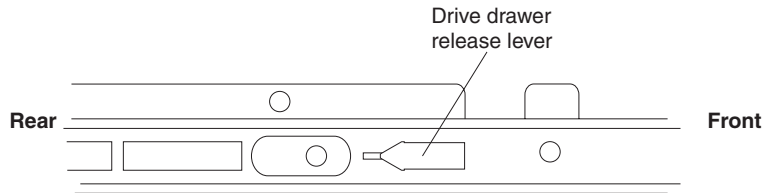
Figure 65. Drive drawer release lever on the side of the drive drawer

Important: To remove second to fifth disk drawers, you have to lift the lockout tumblers on the right side of the enclosure. The tumblers prevent more than one disk drive drawer from being pulled out simultaneously.
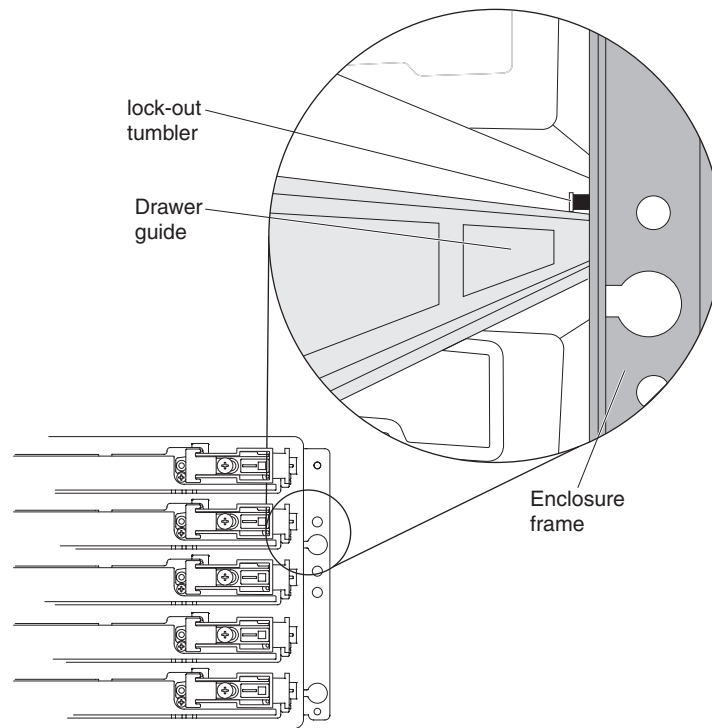
Figure 66. Lock-out tumbler located above the drawer guide

9. Loosen the thumbscrews that attach the rear brackets to the enclosure (one on each side of the enclosure).

10. On the front of the enclosure, remove the four M5 screws that attach it to the chassis (two screws on each side).
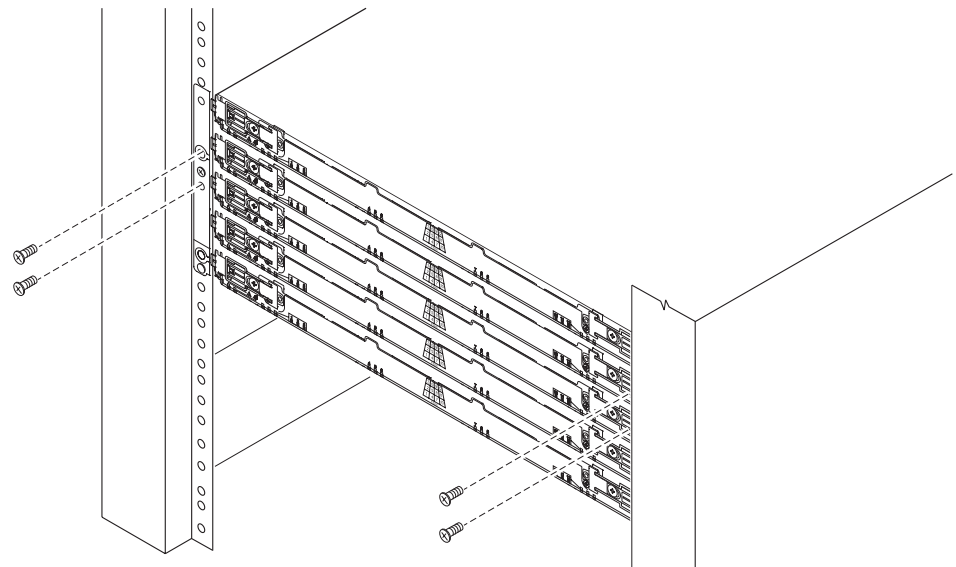
11. Remove the empty enclosure from the rack.

    CAUTION:
    You would need more than one personnel.

12. Insert the new enclosure into the rack.

13. Secure the new enclosure in the rack by tightening the four M5 screws in the front of the chassis and the two thumbscrews on the rear brackets.

14. Insert the disk drawers into the enclosure one by one by completing the following steps. Ensure that the correct disk drawer is inserted in the disk drawer slots. Caution: Hold the disk drawer with both hands between the second and third row of the drives on either side. Ensure that you do not bend the disk drawer board or scrape it with other objects.

    a. At the front of the storage expansion enclosure, install the new drive drawer into the slot, making sure the lock-out tumbler is located on the top of the drawer guide. The lock-out tumbler is a small alignment piece that is attached to the frame. Figure 66 on page 129 shows the location of the lock-out tumbler as shown from the front of the enclosure.

    b. Push the drive drawer all the way in until the latch fully engages.

15. Connect the cable chains to the disk drawers and the midplane by completing the following steps.

    a. Connect the left cable chain mounting bracket to the drive drawer. Use a flashlight, if necessary, so that you can see the connector on the mounting bracket connect to the disk drawer connector.

    b. Connect the left cable chain mounting bracket to the midplane connector.

    c. Connect the right cable chain mounting bracket to the drive drawer.

    d. Connect the right cable chain mounting bracket to the midplane connector.

16. Install the right and left fan modules.

17. Install the ESMs (or Controllers) modules and reconnect all of the connections.

18. Install the power supply modules and connect the power cords to the power supply modules.

19. Install the bezel.

20. Power on the drive expansion enclosures and then the controller enclosure.

21. Use the DS Storage Manager to verify that subsystem and the new enclosure are operated optimally. Use the Recovery Guru for guidance to fix any problems. Contact IBM Support if the problem persists.

22. Fill-out the RID tag and attach it to the new enclosure.

23. Pack the old chassis and the power supply module for shipping back to IBM.

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 xix.

General checkout

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

The PD maps found in the *IBM System Storage DS5000 Problem Determination Guide* provide you with additional diagnostic aids.

Solving problems

This section contains information to help you solve some of the problems you might have with your storage expansion enclosure. Table 26 on page 132 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 26 on page 132, 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 Table 26 on page 132 for a FRU replacement decision.

Table 26. Symptom-to-FRU index

Problem indicator	Component	Possible cause	Possible solutions
Amber LED is lit	Drive FRU (Drive Service Action Required LED)	Drive failure	Replace the failed drive.
	ESM (Service Action Required LED)	ESM failure	Replace the ESM. See your controller documentation for more information. See Chapter 5, "Installing and replacing components," on page 87 for more information.
	ESM (Port Bypass LED)	No incoming signal detected	Reconnect the SFP modules and the fibre-channel cables. Verify the input and output SFP and the FC loopback and female-female LC connector. Replace either input or output SFP modules or fibre channel cables as necessary.
		ESM failure	If the ESM Link Fault and Service Action Required LEDs are lit, replace the ESM.
	Front panel (Global Service Action Required LED)	General machine fault	A Service Action Required LED is lit somewhere on the storage expansion enclosure (check for Amber LEDs on FRUs).
		One of the drive drawers is not fully closed	Use the Storage Manager to identify the drive drawer that was not closed and close it. Pull the drawer out about 1 inch; then, push it in until it clicks in place. Check all drive drawers in the enclosure.
		Fibre-channel connection failure	Check that the FRUs are properly installed. If none of the amber LEDs are lit on any of the FRUs, this indicates an SFP module transmission fault in the storage expansion enclosure. Replace the failed SFP module. See the DS Storage Manager software documentation for more information.
Amber LED is lit and green LED is off	Power supply FRU	Power supply failure or power switch is turned off or there is a power failure.	Replace the failed power supply, turn on all power supply switches, or check the main or the rack power unit circuit breaker.

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

Problem indicator	Component	Possible cause	Possible solutions
Amber and green LEDs are lit	Power supply FRU (Service Action Required and Power LEDs lit; Service Action Allowed lit; Direct Current LED is not lit)	Power supply failure	Replace the failed power supply.
		Operating environment is too hot	Cool down the environment.
	Fan assembly FRU	Fan failure	Replace the fan assembly FRU.
	Drive FRUs	Drive not certified	Verify that the drive option or FRU P/N is listed in the support list for the appropriate DS5000 storage subsystems. **Note:** In certain cases, only the amber LED is lit, and the green activity LED is not lit. Use the Recovery Guru to better identify the cause of the drive failure.
		Drive failure	Use the Storage Manager Subsystem Management window to identify the failed drive; then, replace the drive.
All green LEDs are off	All FRUs	Subsystem power is off	Check that all storage expansion enclosure power cables are plugged in and the power switches are on. If applicable, check that the main circuit breakers for the rack are powered on.
		ac power failure	Check the main circuit breaker and ac outlet.
		Power supply failure	Replace the power supply.
		Operating environment is too hot	Cool down the environment.

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

Problem indicator	Component	Possible cause	Possible solutions
Amber LED is flashing or flashing	Drive FRUs (Service Action Required LED lit)	Drive identity is in process	No corrective action needed.
	ESM port bypass	An FC loop initialization process (LIP) is being generated in the drive loop due to a faulty component.	Use the Read Link Status window in the DS Storage Manager Client Subsystem Management window and the storage subsystem event logs to isolate the faulty component.
		EXP5060 Fibre channel ports operate at 4 Gbps but the SFP inserted in the ESM SFP port does not operate at 4 Gbps	Use the Recovery Guru menu function in the DS Storage Manager Client Subsystem Management window to verify the problem and replace the SFP with a 4 Gbps SFP.
		Failed ESM or SFPs	The ESM cannot complete the Fibre channel loop within 30 seconds when the port has a valid Fibre channel connection plug-in. First check the SPF and replace the SPFs. If the problem persists, replace the ESM.
		Trunking cabling issue	Check the Recovery Guru in the Storage Manager guide for the procedure to troubleshoot any incorrect trunking cabling. The seven segment numeric display might also display a diagnostic code identifying the problem. See the *IBM System Storage DS5100 and DS5300 Installation, User's, and Maintenance Guide* for trunking cabling information
	Front panel (Global Service Action Required LED)	One or multiple FRUs has intermittent problems.	Use the Recovery Guru menu function in the DS Storage Manager Client Subsystem Management window and the DS5000 storage subsystem Major Event Log to troubleshoot the problem.

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

Problem indicator	Component	Possible cause	Possible solutions
One or more green LEDs are off	Power supply FRUs	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 FRUs	The EXP5060 is connected to an unsupported DS5000 storage subsystem.	Verify that the EXP5060 is connected to a supported DS5000 storage subsystem. Use the steps "Finding controller, storage expansion enclosure, and drive information" on page 68 to identify which storage subsystem is connected. Replace the incorrect storage subsystem with a correct one.
		Bad disk drawer	Use the Storage Manger to verify the drive drawer failure and replace the drawer.
		The disk drawer cable chains are not installed correctly.	This condition might occur after a disk drawer is replaced and the disk drawer cable chains are not fully inserted in the disk drawer or the midplane sockets. Use the instructions in "Replacing a drive drawer" on page 117 to reseat the left and right disk drawer cable chains.
		Drive FRUs are not fully inserted in the drive drawers.	Verify that the drives are seated correctly in the drive drawers. Remove and reinsert the drive FRUs if required.
		Midplane failure	Contact an IBM technical support representative.
One or more green LEDs are off (continued)	Several FRUs	Hardware failure	Replace the affected FRUs. If this does not correct the problem, replace the ESMs, followed by the midplane. Contact an IBM technical support representative.
		The DS5000 was not powered on, or all fibre-channel connections between the EXP5060 and the storage subsystem failed.	Perform one of the following actions: • Power on the storage subsystem. • Verify that the fibre-channel connections between the EXP5060 and the storage subsystem are made.
	Front panel	Power supply problem	Make sure that the power cables are plugged in and that the power supplies are turned on.
		Hardware failure	If any other LEDs are lit, replace the midplane. Contact an IBM technical support representative.

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

Problem indicator	Component	Possible cause	Possible solutions
Blue LED Lit (no Amber LED lit)	Front panel	The enclosure is being located by the Storage Manager	Stop locating the enclosure from the Storage Manager
	Component Drive	Drives are part of an array that is in "exported - Ready to import" state. Once the array is exported, the drives in the array are spun down in preparation for being removed from the enclosure.	Use the Storage Manager to import the array or remove the drives from the enclosure.
		Drives are incompatible. Incompatible drives are spun down when they are inserted into the drive slots. The associated drive SAR LED might also be lit.	Use the Storage Manager to verify the incompatible drives and remove the drives from the enclosure.
	Component ESM, Disk Drawer, Power Supply	Component Blue SAA LED was turned on by the "Prepare for Removal" menu function in the Storage Manager Subsystem Management window	Turn off the SAA LED by using the appropriate script command in the script window: • The script command to turn off a drive drawer SAA LED is **set enclosure [enclosureID] drawer [drawerID] serviceAllowedIndicator=off;** • The script command to turn off an ESM or Power Supply SAA LED is **set enclosure [enclosureID] (powerFan [(top | bottom)] | esm [(top | bottom)]) | serviceAllowedIndicator=off;**
Blue LED Lit with associate Amber LED (SAR) lit	Disk drive, ESM, drive drawer, power supply, fan assembly	Failed component	Use the Recovery Guru in the Storage Manager Subsystem Management window to identify the failure and replace the failed component.

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

Problem indicator	Component	Possible cause	Possible solutions
Intermittent or sporadic power loss to the storage expansion enclosure	Some or all FRUs	Defective ac power source or improperly connected power cable	Check the ac power source. Reseat all installed power cables and power supplies. If applicable, check the power components (power units or universal power supply). Replace defective power cables.
		Power supply failure	Check the power supply Fault LED on the power supply. If the LED is lit, replace the failed FRU.
		Midplane failure	Contact an IBM technical support representative.
Unable to access drives	Drives and fibre-channel loop	Incorrect storage expansion enclosure ID settings	Ensure that the fibre-channel optical cables are undamaged and properly connected. Check the storage expansion enclosure ID settings. **Note:** For information on how to change the storage expansion enclosure ID if required, refer to the online Help in the DS Storage Manager GUI.
		ESM failure	Replace one or both ESMs. Contact an IBM technical support representative.
		Drive or drives failed	Replace failed drive or drives.
		Drive is not certified	Check the DS5000 product Web site for the correct drive option P/N or FRU P/N certified for your DS5000 storage subsystem.
Random errors	Subsystem	Midplane failure	Contact an IBM technical support representative.
Hard disk drive not visible in RAID management software	Several FRUs	Drive or drives failed	Replace failed drive or drives.
		FC cable failed	Replace FC cable.
		SFP failed	Replace SFP.
		ESM failure	Replace ESM.
		Midplane failure	Contact an IBM technical support representative.
		Incorrect firmware version	Verify that the DS5000 storage subsystem has been upgraded to the correct firmware version. Refer to "Firmware updates" on page 67.

Parts listing

Figure 67 and the following table provide a parts listing for the EXP5060.
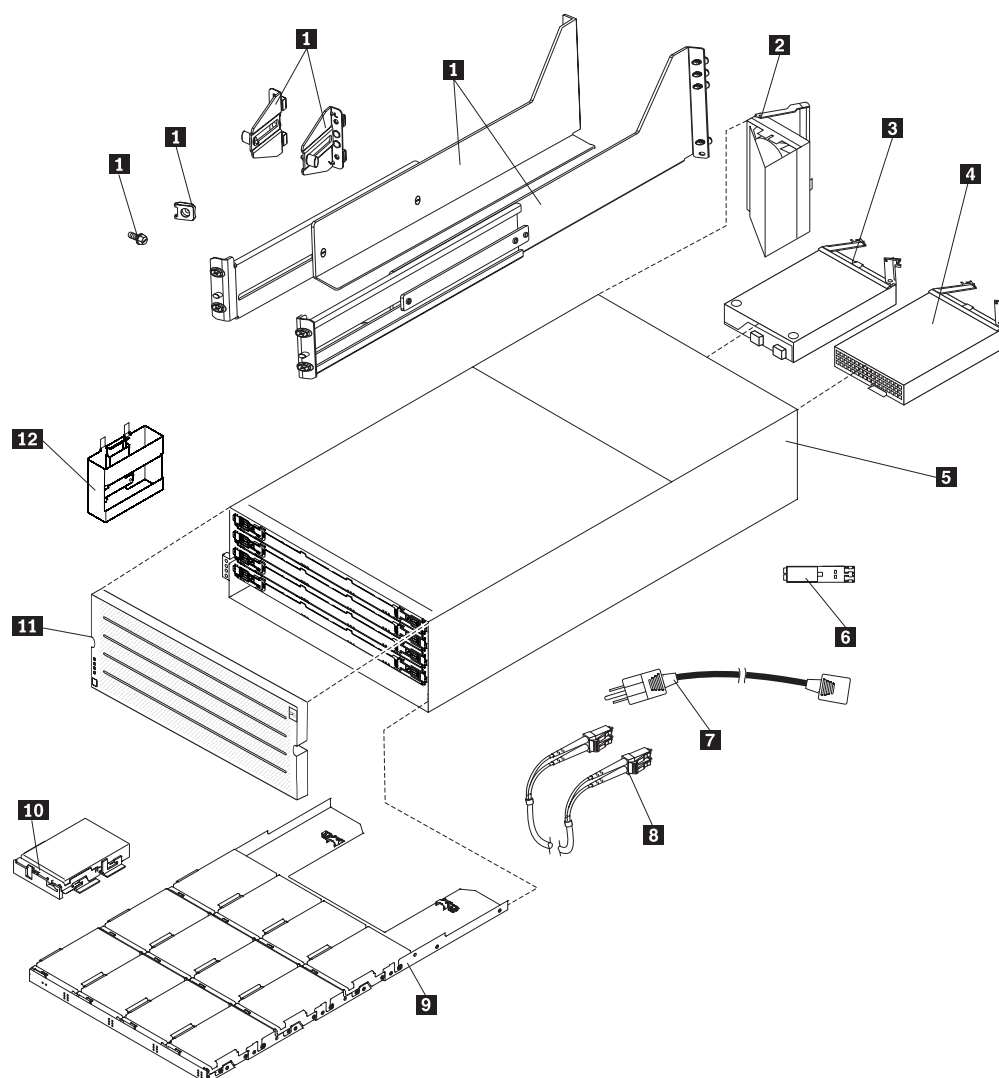
Figure 67. EXP5060 storage expansion enclosure parts list

Table 27. Parts listing (EXP5060 storage expansion enclosure)

Index	EXP5060 storage expansion enclosure	FRU P/N
1	Rail kit	59Y5414
2	Fan assembly	59Y5310
3	Power supply	59Y5313
4	ESM	59Y5314
5	Chassis assembly, includes midplane, fan cables, and system LED cable	59Y5404
6	SFP module, short wave, 4 GB	81Y9920
7	AC power cord, 2.8M, UL/CSA	39M5081
8	Cable, FRU-1M	39M5699

Table 27. Parts listing (EXP5060 storage expansion enclosure) (continued)

Index	EXP5060 storage expansion enclosure	FRU P/N
8	Cable, FRU-5M	39M5700
8	Cable, FRU-25M	39M5701
9	Drive drawer assembly, includes right and left cable chains	94Y8476
10	1 TB, 3 Gbps SATA, 7200 RPM disk drive module	44X3241
	2 TB, 3 Gbps SATA, 7200 RPM disk drive module	59Y5485
	3 TB, 3.5 Gbps SATA, 7200 RPM disk drive module	81Y2460
11	Bezel	59Y5315
12	Handle	59Y5526
	AC power cord jumper	39M5377
	HDD carrier	69Y2773

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 68. An IBM hologram label example

Appendix A. Records

Whenever you add options to your storage expansion enclosure, 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 EXP5060 Storage Expansion Enclosure
Machine type:	1818
Model number:	G1A
Serial number:	

The serial number is located on the bottom inside surface at the rear and on the bottom right at the front of the EXP5060.

Storage subsystem and controller information record

Table 28 provides a data sheet for recording storage subsystem names, management types, Ethernet hardware addresses, and IP addresses. Make a copy of this table and complete the information for your storage subsystems and controllers. Use the information to set up the BOOTP table for the network server and the host or Domain Name System (DNS) table. The information is also helpful if you add storage subsystems after initial installation. Refer to your DS Storage Manager documentation for detailed instructions about how to obtain the information. For a sample information record, see Table 29 on page 143.

Table 28. Storage subsystem and controller information record

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

Sample information record

Table 29 shows a sample information record. This network contains storage subsystems that are managed by using both the direct-management and host-agent-management method.

Table 29. Sample information record

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

Installed device records

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

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

Table 30. Hard disk drive record

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

Appendix B. Rack mounting template

This appendix provides duplicate copies of the rack mounting templates. If you want to tear out the templates from this document for easier use, use these copies rather than those provided in "Installing the support rails" on page 29.

Use the following templates (Figure 69 on page 146 and Figure 70 on page 147) to identify the proper locations for inserting M5 screws when mounting the support rails and EXP5060 to a rack. The locations for the M5 screws are highlighted in the templates.

The EXP5060 is 4 U high. Align the template with the rack at a U boundary. U boundaries are shown as horizontal dashed lines in the rack mounting templates.

Note: The mounting holes that are shown in the following templates are square. The holes in your rack might be round or square.
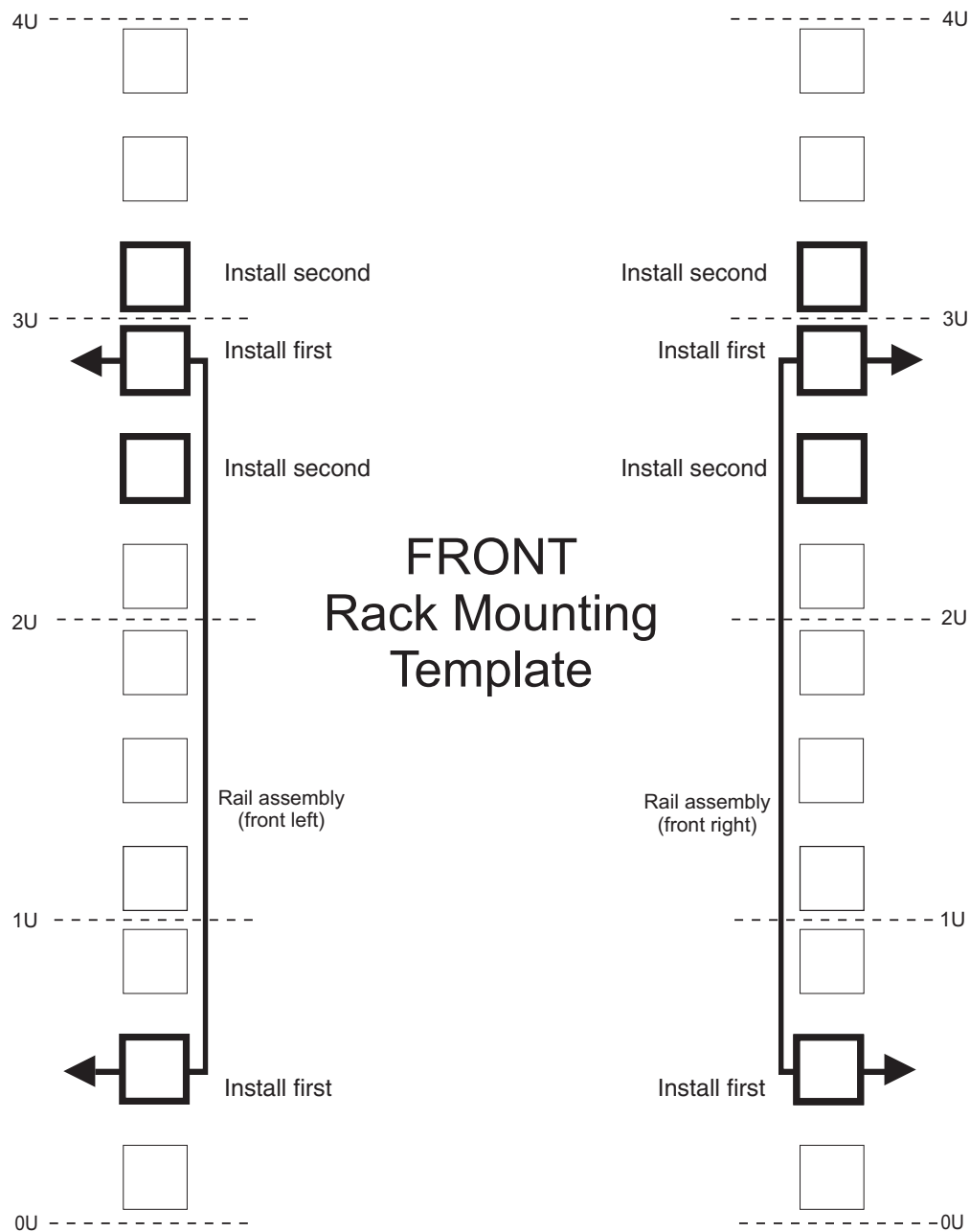
4U

Install second

3U

Install first

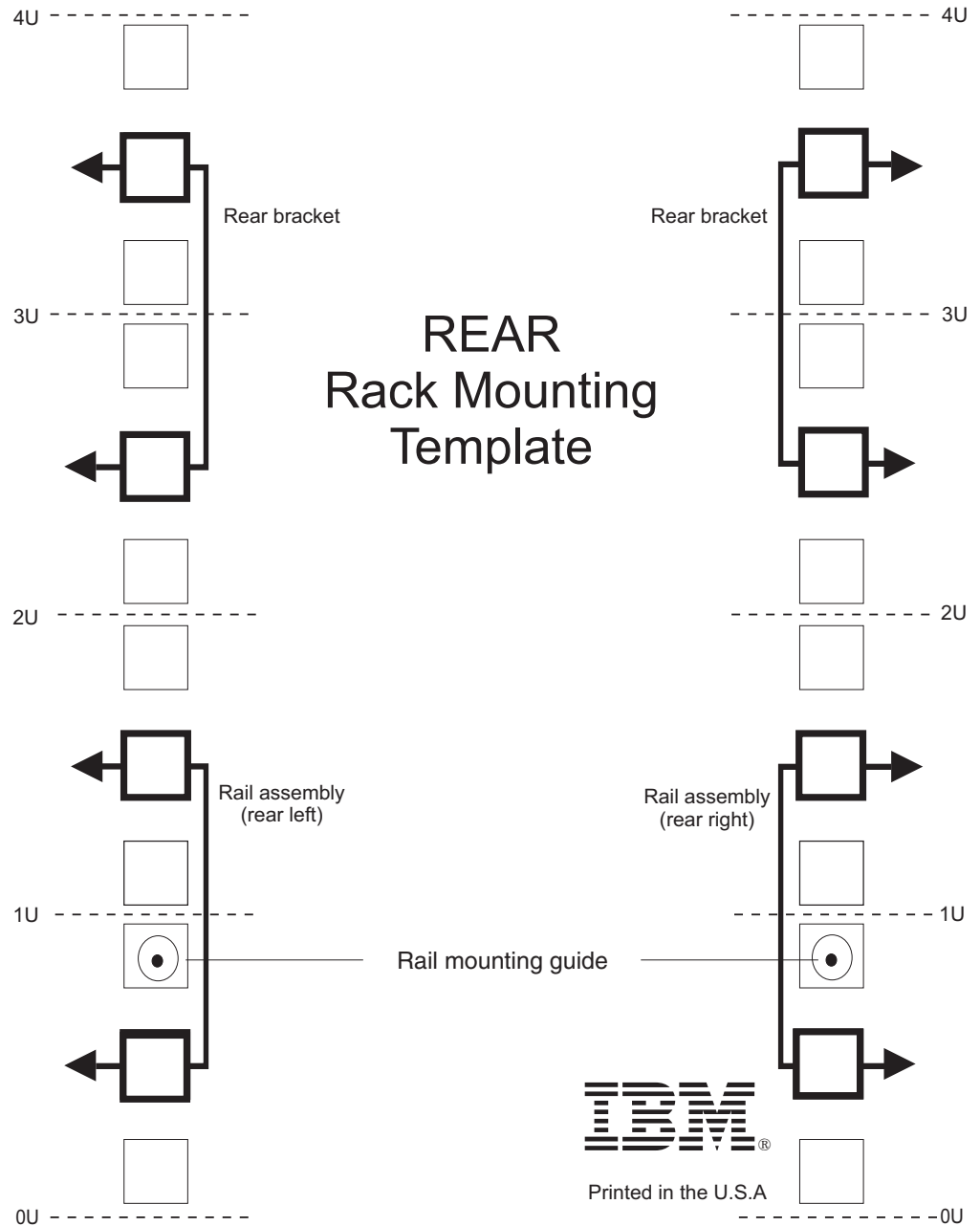Install second

FRONT
Rack Mounting
Template

2U

Rail assembly
(front left)

1U

Install first

0U

4U

Install second

3U

Install first

Install second

2U

Rail assembly
(front right)

1U

Install first

0U

Figure 69. Front rack mounting template

4U

Rear bracket

3U

REAR
Rack Mounting
Template

Rear bracket

3U

2U

2U

Rail assembly
(rear left)

Rail assembly
(rear right)

1U

Rail mounting guide

1U

IBM®

Printed in the U.S.A

0U

0U

Figure 70. 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 may consist of either the plug on the power cord (if the power cord is no longer than 1.8 m (6 ft.)), the appliance inlet receptacle (if the power cord is of a detachable type), or a power on/off switch, or an Emergency Power Off switch on the rack, provided all power is removed from the rack or product by the disconnect device.

   If the rack/or cabinet has electrical components (such as fan trays or lights), the rack must have an accessible and unambiguous disconnect device.

4. The rack or cabinet, power distribution unit and multi-outlet strips, and products installed in the rack or cabinet must all be properly grounded to the customer facility ground.

   There must be no more than 0.1 Ohms between the ground pin of the power distribution unit or rack plug and any touchable metal or conductive surface on the rack and on the products installed in the rack. Grounding method must comply with applicable country's electric code (such as NEC or CEC). Ground continuity can be verified by your IBM service personnel, after the installation is completed, and should be verified prior to the first service activity.

5. The voltage rating of the power distribution unit and multi-outlet strips must be compatible with the products plugged into them.

   The power distribution unit or multi-outlet strips current and power ratings are rated at 80 percent of the building supply circuit (as required by the National Electrical Code and the Canadian Electrical Code). The total load connected to the power distribution unit must be less than the rating of the power distribution unit. For example, a power distribution unit with a 30 A connection will be rated for a total load of 24 A (30 A x 80 percent). Therefore, the sum of all equipment connected to the power distribution unit in this example must be lower than the 24 A rating.

   If an uninterruptible power supply is installed, it must meet all the above electrical safety requirements as described for a power distribution unit (including certification by an NRTL).

6. The rack or cabinet, power distribution unit, uninterruptible power supply, multi-outlet strips and all products in the rack or cabinet must be installed according to the manufacturer's instructions, and in accordance with all national, state or province, and local codes and laws.

   The rack or cabinet, power distribution unit, uninterruptible power supply, multi-outlet strips and all products in the rack or cabinet must be used as intended by the manufacturer (per manufacturer's product documentation and marketing literature).

7. All documentation for use and installation of the rack or cabinet, power distribution unit, uninterruptible power supply, and all products in the rack or cabinet, including safety information, must be available on-site.

8. If there is more than one source of power in the rack cabinet, there must be clearly visible safety labels for "Multiple Power Source" (in the languages required for the country in which the product is installed).

9. If the rack or cabinet or any products installed in the cabinet had safety or weight labels applied by the manufacturer, they must be intact and translated into the languages required for the country in which the product is installed.

10. The rack or cabinet configuration must comply with all IBM requirements for "safe to service" (contact your IBM Installation Planning Representative for assistance in determining if the environment is safe).

There must be no unique maintenance procedures or tools required for service.

11. Elevated service installations, where the product(s) to be serviced are installed between 1.5 m and 3.7 m (5 ft. and 12 ft.) above the floor, require the availability of an OSHA- and CSA-approved nonconductive step ladder. If a ladder is required for service, the customer must supply the OSHA- and CSA-approved nonconductive step ladder (unless other arrangements have been made with the local IBM Service Branch Office). Products installed over 2.9 m (9 ft.) above the floor requires a Special Bid to be completed before they can be serviced by IBM service personnel.

    For products not intended for rack-mounting to be serviced by IBM, the products and parts that will be replaced as part of that service must not weigh over 11.4 kg (25 lb). (Contact your Installation Planning Representative if in doubt).

12. There must not be any special education or training required for safe servicing of any of the product(s) installed in the racks. (Contact your Installation Planning Representative if in doubt).

Rack specifications

When installing a 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).
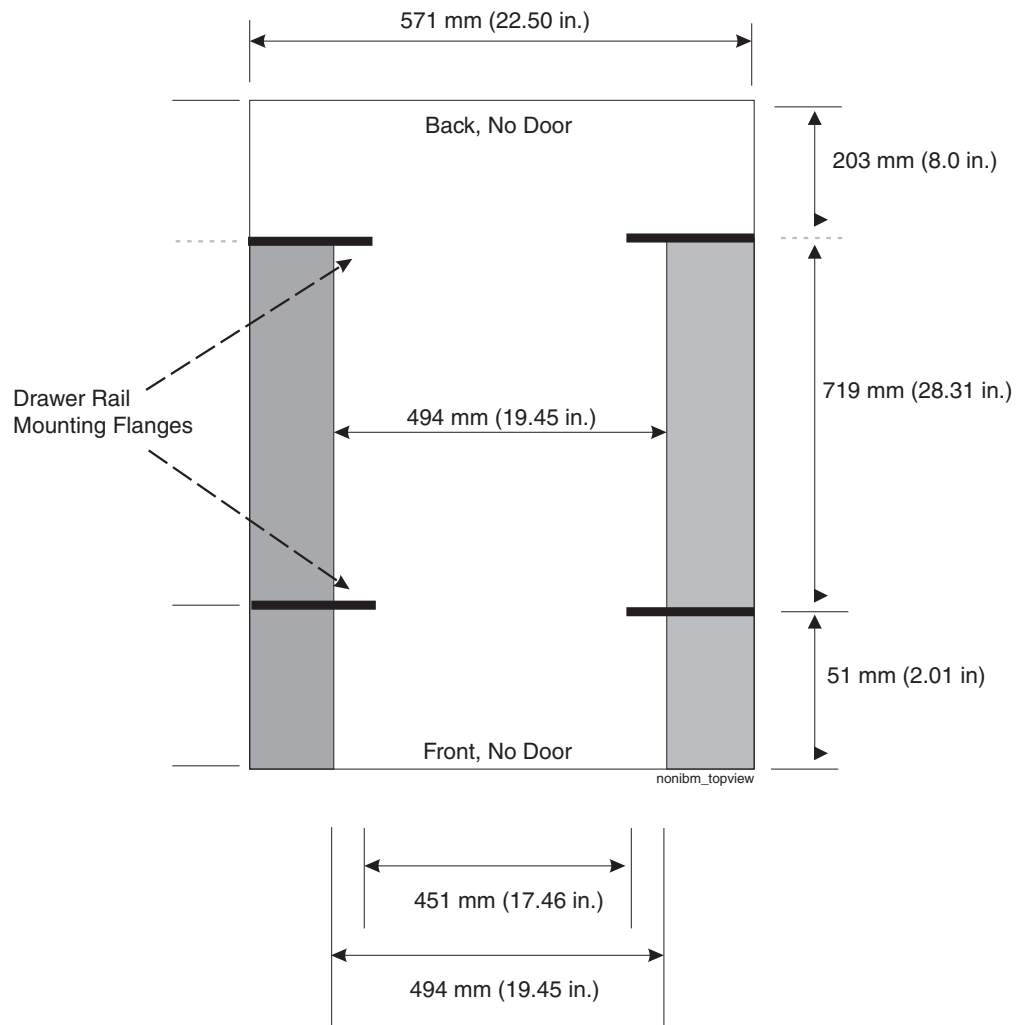
Figure 71. Top View of non-IBM Rack Specifications Dimensions

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 71).
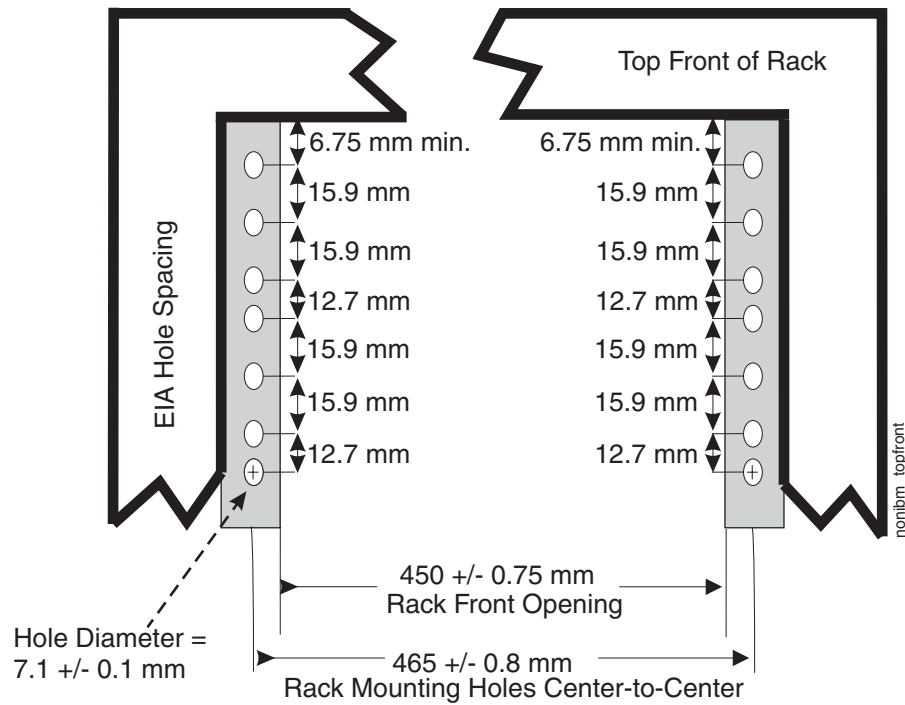
Figure 72. Rack specifications dimensions, top front view
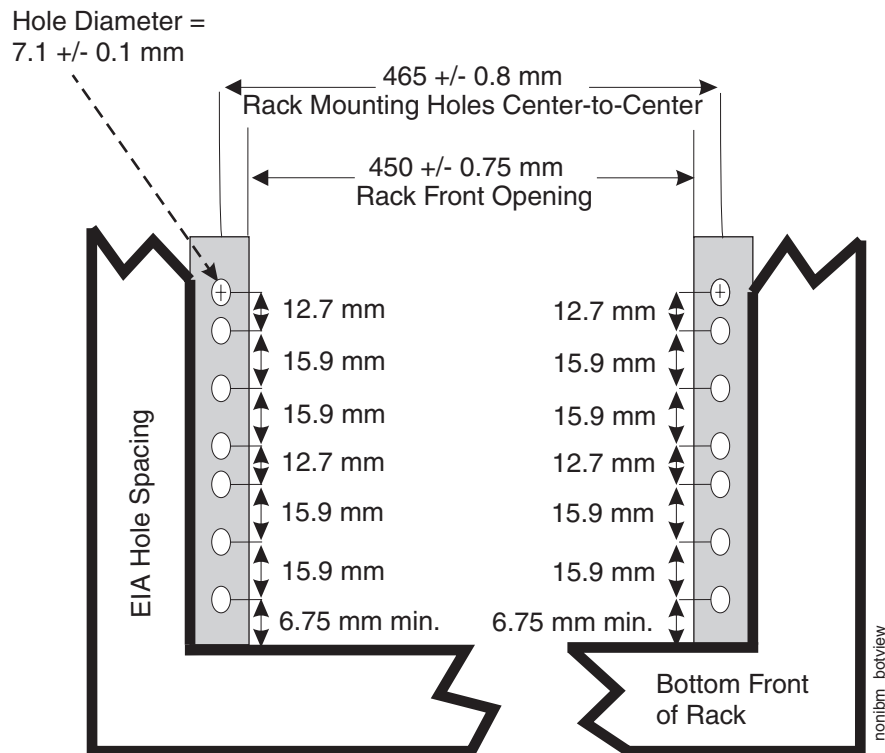
Figure 73. Rack specifications dimensions, bottom front view

2. When installing a EXP5060 storage expansion enclosure into a non-IBM rack, contact your Installation Planning Representative to ensure a safe installation into your environment for rack mounting loads and floor loading. Weight for one

EXP5060 fully loaded is 102.27 kg (255 lbs). The load per EIA unit that a standard EIA rack enclosure must be able to support is 25.49 kg (56.2 lbs) per unit.

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 may be required.

5. The rack or cabinet must have stabilization feet or brackets installed both in the front and rear of the rack, or have another means of preventing the rack/cabinet from tipping while the drawer or device is pulled into its extreme front or rear service positions.

   Examples of some acceptable alternatives: The rack or cabinet may be securely bolted to the floor, ceiling or walls, or to adjacent racks or cabinets in a long and heavy row of racks or cabinets.

6. There must be adequate front and rear service clearances (in and around the rack or cabinet).

   The rack or cabinet must have sufficient horizontal width clearance in the front and rear to allow the drawer to be fully slid into the front and, if applicable, the rear service access positions (typically this requires 914.4 mm (36 in.) clearance in both the front and rear).

   If present, front and rear doors must be able to open far enough to provide unrestrained access for service or be easily removable. If doors must be removed for service, it is the customer's responsibility to remove them prior to service.

7. The rack or cabinet must provide adequate clearance around the rack drawer.

   There must be adequate clearance around the drawer bezel so that it can be opened and closed, according to the product specifications.

   Front or rear doors must also maintain a minimum of 51 mm (2 in.) front, 203 mm (8 in.) rear, door to mounting flange clearance, and 494 mm (19.4 in.) front, 571 mm (22.5 in.) rear, side-to-side clearance for drawer bezels and cables (see Figure 71 on page 152).

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 and storage rack PDUs

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).

Attention: The EXP5060 does not support 90-136V AC sources. It supports 180-240V AC sources only. Ensure that the AC input is appropriate for the EXP5060 before turning the power switches to the on position.

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

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

IBM power cords for a specific country or region are usually available only in that country or region.
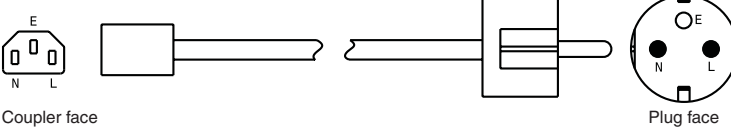
Table 31. IBM power cords

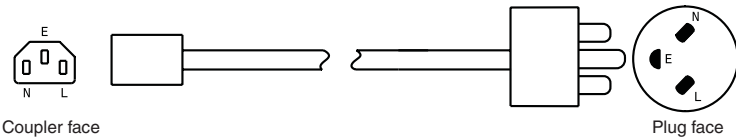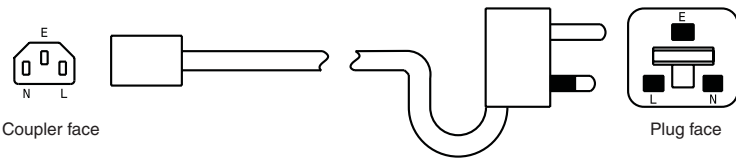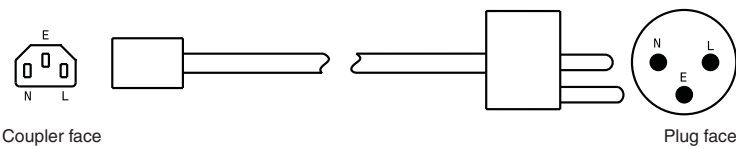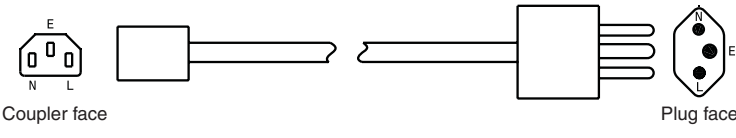| IBM power cord part number	Feature code	Description	Used in these countries or regions
39Y7917	9820	Power Cord (250v, 10A, 2.8m)	Coupler face Plug face Afghanistan, Albania, Algeria, Andorra, Angola, Armenia, Austria, Azerbaijan, Belarus, Belgium, Benin, Bosnia and Herzegovina, Bulgaria, Burkina Faso, 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

Table 31. IBM power cords (continued)
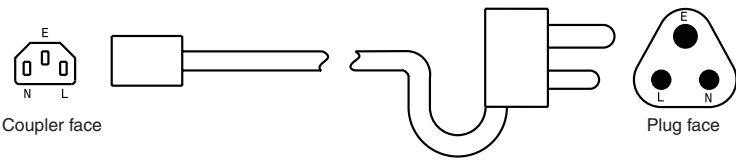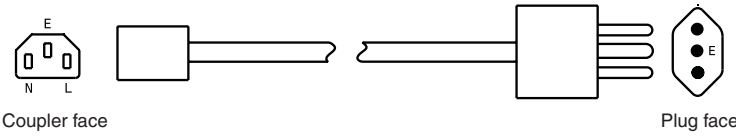
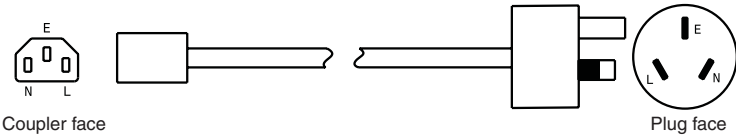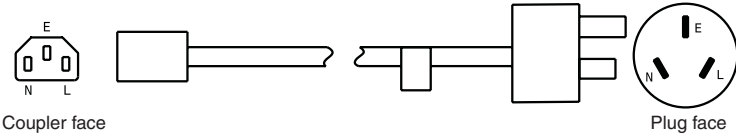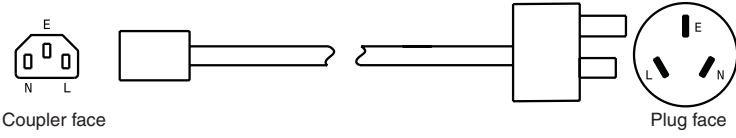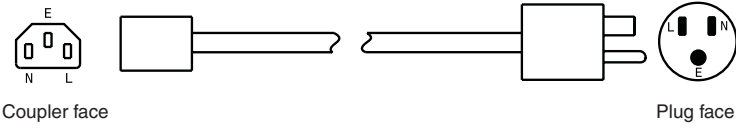| IBM power cord part number	Feature code	Description	Used in these countries or regions
39Y7918	9821	Power Cord (250v, 10A, 2.8m)	Coupler face Plug face Denmark
39Y7923	9825	Power Cord (250v, 10A, 2.8m)	Coupler face Plug face Abu Dhabi, Bahrain, Botswana, Brunei Darussalam, Channel Islands, Cyprus, 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)	Coupler face Plug face Israel
39Y7919	9828	Power Cord (250v, 10A, 2.8m)	Coupler face Plug face Liechtenstein, Switzerland
39Y7922	9829	Power Cord (250v, 10A, 2.8m)	Coupler face Plug face Bangladesh, Lesotho, Maceo, Maldives, Namibia, Nepal, Pakistan, Samoa, South Africa, Sri Lanka, Swaziland, Uganda
39Y7921	9830	Power Cord (250v, 10A, 2.8m)	Coupler face Plug face Chile, Italy, Libyan Arab Jamahiriya

Table 31. IBM power cords (continued)
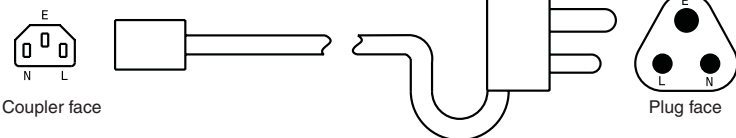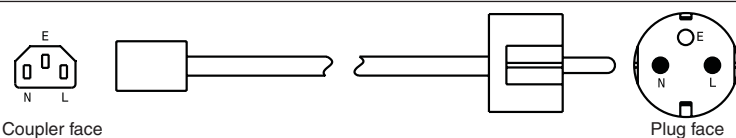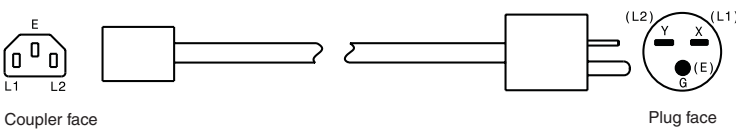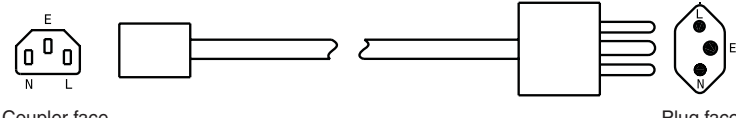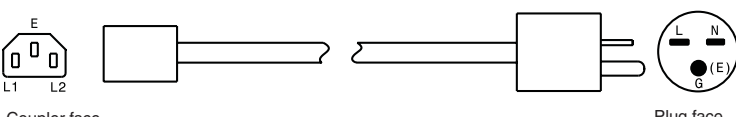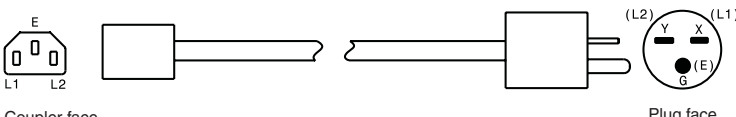
IBM power cord part number	Feature code	Description	Used in these countries or regions
39M7924	9831	Power Cord (250v, 10A, 2.8m)	Coupler face Plug face Australia, Fiji, Kiribati, Nauru, New Zealand, Papua New Guinea
39Y7930	9834	Power Cord (250v, 10A, 2.8m)	Coupler face Plug face Argentina, Paraguay, Uruguay
39Y7928	9840	Power Cord (250v, 10A, 2.8m)	Coupler face Plug face China
39M2830	9841	Power Cord 1.8m long	Coupler face Plug face Taiwan
39Y7927	9843	Power Cord (250v, 10A, 2.8m)	Coupler face Plug face India
39Y7925	9845	Power Cord (250v, 12A, 2.8m)	Coupler face Plug face Korea (Democratic Peoples Republic of)
n/a	9860	240v Power Cord (250V, 10A, 2.8m)	Coupler face Plug face Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Canada, Cayman Islands, Costa Rica, Columbia, Cuba, Dominican Republic, Ecuador, El Salvador, Guam, Guatemala, Haiti, Honduras, Jamaica, Mexico, Micronesia (Federal States of), Netherlands Antilles, Nicaragua, Panama, Peru, Philippines, Saudi Arabia, Thailand, Turks and Caicos Islands, United States, Venezuela.

Table 31. IBM power cords (continued)

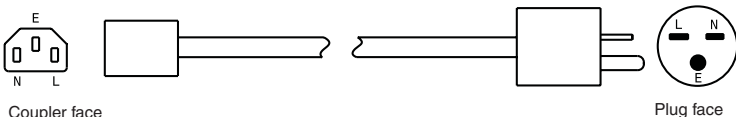| IBM power cord part number	Feature code	Description	Used in these countries or regions
n/a	9861	240v Power Cord (250V, 10A, 2.8m)	Coupler face Plug face Taiwan
n/a	9862	240v Power Cord (250V, 10A, 2.8m)	Coupler face Plug face Brazil
n/a	9864	240v Power Cord (250V, 12A, 4.3m)	Coupler face Plug face Japan
n/a	9866	240v Power Cord (250V, 10A, 1.8m)	Coupler face Plug face U.S./Chicago

Storage rack PDUs

Table 32 lists the AC power distribution units (PDUs) that are applicable to EXP5060 enclosures installed in IBM 2101 or 7014 storage racks.

When EXP5060 enclosures are to be plant or field integrated into the IBM 2101 Model 200 Storage Solutions Rack, the rack must be configured with PDU power cords rated for 240 volt electrical service using either of rack power cord options 9491, 9492, 6491, or 6492. Refer to the *2101 Model 200 Rack Installation and User's Guide* for details.

Table 32. IBM storage rack PDUs

Feature code	PDU	Description	Storage rack
7109	Intelligent PDU+, 1 EIA Unit, Universal, UTG0247 Connector	This feature is for an intelligent AC power distribution unit (PDU+) that will allow you to monitor the amount of power being used by the devices that are plugged in to this PDU+. This AC power distribution unit provides twelve C13 power outlets. It receives power through a UTG0247 connector. It can be used for many different countries and applications by varying the PDU to Wall Power Cord, which must be ordered separately. Each PDU requires one PDU to Wall Power Cord. Supported power cords include the following features: , #6491 and #6492	• 7014 model T00 • 7014 model S25 • 7014 model T42 • 7014 model B42

Table 32. IBM storage rack PDUs (continued)

Feature code	PDU	Description	Storage rack
7188	Two Side-Mount, Single-Phase Base PDUs	This feature supplies two additional (optional) Single-Phase Base PDUs. The pair of PDUs provide power for six dual-powered storage or SAN components. This feature replaces feature #6271 for 2101-200 IPO rack orders requiring the optional PDUs feature. Each PDU contains six 200-240 Vac electrical outlets with an electrical current rating of 48 amperes per PDU when using the #949x set of power cord features.	• 2101-200 • 7014 model T00 • 7014 model S25 • 7014 model T42 • 7014 model B42
7189	Power Distribution Unit (Worldwide) - 1 EIA Unit, Universal, UTG0247 Connector	This AC power distribution unit provides six C19 power outlets. It receives power through a UTG0247 connector. Both horizontal and vertical mounting are supported. It can be used for many different countries and applications by varying the PDU to Wall Power Cord, which must be ordered separately. Each PDU requires one PDU to Wall Power Cord. Supported power cords include the following features: #6491 and #6492	• 7014 model B42
7190	Two iPDUs - Plant	This feature provides two Intelligent Power Distribution Units (iPDUs). The pair of iPDUs provide power for six dual-powered storage or SAN components. A power cord feature (#985x) or (#949x) which supplies two power cords, based on the country, must be specified. Each iPDU is side mounted and contains six 200-240 Vac electrical outlets with an electrical current rating of 48 amperes per iPDU when using the #949x or #649x set of power cord features.	• 2101-200
7192	Two iPDUs - Plant/Field	This feature supplies two additional (optional) Intelligent Power Distribution Units (iPDUs). The pair of iPDUs provide power for six dual-powered storage or SAN components. A power cord feature (#985x) or (#949x) which supplies two power cords, based on country, must be specified. Each iPDU is side mounted and contains six 200-240 V ac electrical power outlets with an electrical current rating of 48 amperes per PDU when using the #949x or #649x set of power cord features.	• 2101-200
7196	Power Distribution Unit, 3 Phase (US) - 1 EIA Unit, Universal, Fixed Power Cord	This AC power distribution unit provides six C19 power outlets. Fixed power cord (IEC309 60A plug (3P+G). This PDU requires 3-phase electrical service. US only.	• 7014 model B42
9188	Base Power Distribution Unit	This feature provides two Power Distribution Units (PDUs). The pair of Base PDUs provide for six dual-powered storage or SAN components. A power cord feature (#985x) or (#949x) which supplies two power cords, based on the country, must be specified. Each PDU is side mounted and contains six 200-240 V ac electrical outlets with an electrical current rating of 48 Amps per PDU using the #949x set of power cord features.	• 2101-200

Appendix E. Additional System Storage DS documentation

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 33 associates each document in the DS Version 10 Storage Manager library with its related common user tasks.

Table 33. 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 DS Storage Manager Version 10 Installation and Host Support Guide (all operating systems)	✔		✔	✔		
IBM System Storage DS Storage Manager Command Line Interface and Script Commands Programming Guide				✔	✔	✔
IBM System Storage DS Storage Manager Copy Services User's Guide	✔		✔	✔	✔	
IBM System Storage DS4000/DS5000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview	✔	✔	✔	✔		

DS5100 and DS5300 Storage Subsystem library

Table 34 associates each document in the DS5100 and DS5300 Storage Subsystem library with its related common user tasks.

Table 34. DS5100 and DS5300 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	**Hardware Installation**	**Software Installation**	**Configuration**	**Operation and Administration**	**Diagnosis and Maintenance**
IBM System Storage DS5100 and DS5300 Storage Subsystem Installation, User's and Maintenance Guide	✔	✔		✔	✔	✔
IBM System Storage Quick Start Guide, Quick Reference for DS5100 and DS5300 Storage Subsystems, and for the EXP5060 Storage Expansion Enclosure		✔	✔	✔		
IBM System Storage DS5000 EXP5060 Storage Expansion Enclosure Installation, User's, and Maintenance Guide						
Installing or replacing a DS5000 Cache and Flash Memory Card	✔	✔		✔		
Installing or replacing a DS5000 Host Interface Card	✔	✔		✔		

Other DS and DS-related documents

Table 35 associates each of the following documents with its related common user tasks.

Table 35. DS5000 and DS5000–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 DS5000 Hardware Maintenance Manual [1]						✔
IBM System Storage DS5000 Problem Determination Guide						✔
IBM Fibre Channel Planning and Integration: User's Guide and Service Information	✔	✔			✔	✔
IBM TotalStorage DS5000 FC2-133 Host Bus Adapter Installation and User's Guide		✔			✔	
IBM TotalStorage DS5000 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	✔		✔	✔	✔	

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 36 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 36. DS4000 Storage Manager alternate keyboard operations

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

Table 36. DS4000 Storage Manager alternate keyboard operations (continued)

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

Appendix G. Component weights

Because of the size and weight of the EXP5060 storage enclosure, a lift tool and two trained service technicians are required to install the enclosure in a rack or remove the enclosure from a rack. If a lift tool is not available, you must reduce the weight of the storage enclosure before you lift it, as follows:

- Remove one power supply and make sure that the hard disk drive drawers are empty; then, three trained service technicians can lift the storage enclosure.
- Make sure that the hard disk drive drawers are empty. Remove two power supplies, two fan assemblies, two environmental services modules, and a minimum of three of the five unpopulated hard disk drive drawers; then, two trained service technicians can lift the storage enclosure.

The total weight of the storage expansion enclosure depends on the number of components installed. Table 37 lists the unit weights for the storage expansion enclosure and expansion enclosure components.

Note: Two trained service technicians can lift up to 70 lb, and three trained service technicians can lift up to 121.2 lb.

Table 37. EXP5060 component weights

Unit or Component	Weight
EXP5060 storage expansion enclosure	
Drive-ready weight: 5 drive drawers, 60 drive blanks, 2 ESMs, 2 power supplies, and 2 fan assemblies	125 lb (56.7 kg) No drive blanks or drives
Maximum system weight: 5 drive drawers, 60 1 TB disk drive modules, 2 ESMs, 2 power supplies, 2 fan assemblies, and bezel	225 lb (102.1 kg)
Storage expansion enclosure components	
Chassis with midplane only	43 lb (19.5 kg)
Rails (left and right)	8.2 lb (3.71 kg)
1 TB disk drive module	1.64 lb (0.74 kg)
ESM	3.64 lb (1.65 kg)
Fan assembly	2.16 lb (0.98 kg)
Power supply	5.46 lb (2.5 kg)
Drive drawer assembly, includes right and left cable chains but no drive blanks or drives	11.5 lb (5.2 kg)

[1] Shipping weight includes rails but excludes other shipped items like power cords, cables, and user documents.

Notices

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Important notes

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

CD or DVD drive speed is the variable read rate. Actual speeds vary and are often less than the possible maximum.

When referring to processor storage, real and virtual storage, or channel volume, KB stands for 1024 bytes, MB stands for 1 048 576 bytes, and GB stands for 1 073 741 824 bytes.

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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Particulate contamination

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 expansion enclosure 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 expansion enclosure 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 expansion enclosure, IBM may condition provision of repair or replacement of storage expansion enclosure or parts on implementation of appropriate remedial measures to mitigate such environmental contamination. Implementation of such remedial measures is a customer responsibility.

Table 38. Limits for particulates and gases

Contaminant	Limits
Particulate	• The room air must be continuously filtered with 40% atmospheric dust spot efficiency (MERV 9) according to ASHRAE Standard 52.2[1]. • Air that enters a data center must be filtered to 99.97% efficiency or greater, using high-efficiency particulate air (HEPA) filters that meet MIL-STD-282. • The deliquescent relative humidity of the particulate contamination must be more than 60%[2]. • The room must be free of conductive contamination such as zinc whiskers.
Gaseous	• Copper: Class G1 as per ANSI/ISA 71.04-1985[3] • Silver: Corrosion rate of less than 300 Å in 30 days

[1] ASHRAE 52.2-2008 - *Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*. Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

[2] The deliquescent relative humidity of particulate contamination is the relative humidity at which the dust absorbs enough water to become wet and promote ionic conduction.

[3] ANSI/ISA-71.04-1985. *Environmental conditions for process measurement and control systems: Airborne contaminants*. Instrument Society of America, Research Triangle Park, North Carolina, U.S.A.

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Germany Electromagnetic Compatibility Directive

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Glossary

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

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

See also
          Refers you to a related term.

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

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

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

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

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

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

AGP.   See *accelerated graphics port*.

AL_PA.   See *arbitrated loop physical address*.

arbitrated loop.   One of three existing fibre-channel topologies, in which 2 - 126 ports are interconnected serially in a single loop circuit. Access to the Fibre

Channel Arbitrated Loop (FC-AL) is controlled by an arbitration scheme. The FC-AL topology supports all classes of service and guarantees in-order delivery of FC frames when the originator and responder are on the same FC-AL. The default topology for the disk array is arbitrated loop. An arbitrated loop is sometimes referred to as a Stealth Mode.

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

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

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

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

ATA.   See *AT-attached*.

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

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

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

AWT.   See *Abstract Windowing Toolkit*.

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

BIOS.   See *basic input/output system*.

BOOTP.   See *bootstrap protocol*.

bootstrap protocol (BOOTP).   In Transmission Control Protocol/Internet Protocol (TCP/IP) networking, an alternative protocol by which a diskless machine can obtain its Internet Protocol (IP) address and such

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configuration information as IP addresses of various servers from a BOOTP server.

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

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

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

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

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

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

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

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

CRC.   See *cyclic redundancy check*.

CRT.   See *cathode ray tube*.

CRU.   See *customer replaceable unit*.

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

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

dac.   See *disk array controller*.

dar.   See *disk array router*.

DASD.   See *direct access storage device*.

data striping.   See *striping*.

default host group.   A logical collection of discovered host ports, defined host computers, and defined host groups in the storage-partition topology that fulfill the following requirements:
- Are not involved in specific logical drive-to-LUN mappings
- Share access to logical drives with default logical drive-to-LUN mappings

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

DHCP.   See *Dynamic Host Configuration Protocol*.

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

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

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

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

DMA.   See *direct memory access*.

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

drive channels.   The DS4200, DS4700, DS4800, and DS5000 subsystems use dual-port drive channels that, from the physical point of view, are connected in the same way as two drive loops. However, from the point of view of the number of drives and enclosures, they are treated as a single drive loop instead of two different drive loops. A group of storage expansion enclosures are connected to the DS4000/DS5000 storage subsystems using a drive channel from each controller. This pair of drive channels is referred to as a redundant drive channel pair.

drive loops.   A drive loop consists of one channel from each controller combined to form one pair of redundant drive channels or a redundant drive loop. Each drive loop is associated with two ports. Drive loops are more commonly referred to as drive channels. See *drive channels*.

DRAM. See *dynamic random access memory*.

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

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

ECC. See *error correction coding*.

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

EISA. See *Extended Industry Standard Architecture*.

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

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

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

E_port. See *expansion port*.

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

ESD. See *electrostatic discharge*.

ESM canister. See *environmental service module canister*.

automatic ESM firmware synchronization. When you install a new ESM into an existing storage expansion enclosure in a DS4000 storage subsystem that supports automatic ESM firmware synchronization, the firmware in the new ESM is automatically synchronized with the firmware in the existing ESM.

EXP. See *storage expansion enclosure*.

expansion port (E_port). A port that connects the switches for two fabrics.

Extended Industry Standard Architecture (EISA). A bus standard for IBM compatibles that extends the

Industry Standard Architecture (ISA) bus architecture to 32 bits and allows more than one central processing unit (CPU) to share the bus. See also *Industry Standard Architecture*.

fabric. A fibre channel entity which interconnects and facilitates logins of N_ports attached to it. The fabric is responsible for routing frames between source and destination N_ports using address information in the frame header. A fabric can be as simple as a point-to-point channel between two N-ports, or as complex as a frame-routing switch that provides multiple and redundant internal pathways within the fabric between F_ports.

fabric port (F_port). In a fabric, an access point for connecting a user's N_port. An F_port facilitates N_port logins to the fabric from nodes connected to the fabric. An F_port is addressable by the N_port connected to it. See also *fabric*.

FC. See *Fibre Channel*.

FC-AL. See *arbitrated loop*.

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

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

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

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

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

FlashCopy. A premium feature for DS5000 that can make an instantaneous copy of the data in a volume.

F_port. See *fabric port*.

FRU. See *field replaceable unit*.

GBIC. See *gigabit interface converter*

gigabit interface converter (GBIC). A transceiver that performs serial, optical-to-electrical, and

electrical-to-optical signal conversions for high-speed networking. A GBIC can be hot swapped. See also *small form-factor pluggable*.

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

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

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

GUI.   See *graphical user interface.*

HBA.   See *host bus adapter*.

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

heterogeneous host environment.   A host system in which multiple host servers, which use different operating systems with their own unique disk storage subsystem settings, connect to the same DS5000 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 DS5000 Storage Manager software. To give a host computer access to a partition, its associated host ports must be defined.

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

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

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

IC.   See *integrated circuit*.

IDE.   See *integrated drive electronics*.

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

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

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

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

integrated drive electronics (IDE).   A disk drive interface based on the 16-bit IBM personal computer Industry Standard Architecture (ISA) in which the controller electronics reside on the drive itself, eliminating the need for a separate adapter card. Also known as an Advanced Technology Attachment Interface (ATA).

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

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

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

IP.   See *Internet Protocol*.

IPL.   See *initial program load*.

IRQ.   See *interrupt request*.

ISA.   See *Industry Standard Architecture*.

Java Runtime Environment (JRE).   A subset of the Java Development Kit (JDK) for end users and developers who want to redistribute the Java Runtime Environment (JRE). The JRE consists of the Java virtual machine, the Java Core Classes, and supporting files.

JRE.   See *Java Runtime Environment*.

label.   A discovered or user entered property value that is displayed underneath each device in the Physical and Data Path maps.

LAN.   See *local area network*.

LBA.   See *logical block address*.

local area network (LAN).   A computer network located on a user's premises within a limited geographic area.

logical block address (LBA).   The address of a logical block. Logical block addresses are typically used in hosts' I/O commands. The SCSI disk command protocol, for example, uses logical block addresses.

logical partition (LPAR).   (1) A subset of a single system that contains resources (processors, memory, and input/output devices). A logical partition operates as an independent system. If hardware requirements are met, multiple logical partitions can exist within a system. (2) A fixed-size portion of a logical volume. A logical partition is the same size as the physical partitions in its volume group. Unless the logical volume of which it is a part is mirrored, each logical partition corresponds to, and its contents are stored on, a single physical partition. (3) One to three physical partitions (copies). The number of logical partitions within a logical volume is variable.

logical unit number (LUN).   An identifier used on a small computer system interface (SCSI) bus to distinguish among up to eight devices (logical units) with the same SCSI ID.

loop address.   The unique ID of a node in fibre-channel loop topology sometimes referred to as a loop ID.

loop group.   A collection of storage area network (SAN) devices that are interconnected serially in a single loop circuit.

loop port.   A node port (N_port) or fabric port (F_port) that supports arbitrated loop functions associated with an arbitrated loop topology.

LPAR.   See *logical partition*.

LUN.   See *logical unit number*.

MAC.   See *medium access control*.

management information base (MIB).   The information that is on an agent. It is an abstraction of configuration and status information.

man pages.   In UNIX-based operating systems, online documentation for operating system commands, subroutines, system calls, file formats, special files, stand-alone utilities, and miscellaneous facilities. Invoked by the **man** command.

MCA.   See *micro channel architecture*.

media scan.   A media scan is a background process that runs on all logical drives in the storage subsystem for which it has been enabled, providing error detection on the drive media. The media scan process scans all logical drive data to verify that it can be accessed, and optionally scans the logical drive redundancy information.

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

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

MIB.   See *management information base*.

micro channel architecture (MCA).   Hardware that is used for PS/2 Model 50 computers and above to provide better growth potential and performance characteristics when compared with the original personal computer design.

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

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

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

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

MSCS. See *Microsoft Cluster Server*.

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

NMI. See *non-maskable interrupt*.

NMS. See *network management station*.

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

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

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

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

N_port. See *node port*.

NVS. See *nonvolatile storage*.

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

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

ODM. See *Object Data Manager*.

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

partitioning. See *storage partition*.

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

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

PDF. See *portable document format*.

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

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

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

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

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

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

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

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

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

PTF. See *program temporary fix*.

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

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

RAID set. See *array*.

RAM. See *random-access memory*.

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

RDAC. See *redundant disk array controller*.

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

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

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

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

remote mirroring. Online, real-time replication of data between storage subsystems that are maintained on separate media. The Enhanced Remote Mirror Option is a DS5000 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 DS5000 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 DS5000 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 DS5000 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 DS5000 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 DS5000 Storage Manager host software (SMClient) to uniquely identify each managed storage server. The DS5000 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 DS5000 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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