

IBM System Storage DS4000



Hard Drive and Storage Expansion Enclosure Installation and Migration Guide

IBM System Storage DS4000



Hard Drive and Storage Expansion Enclosure Installation and Migration Guide

Note:

Before using this information and the product it supports, be sure to read the general information in “Notices” on page 181.

Third Edition (April 2007)

This edition applies to DS4000 Storage Manager Version 9.23 software release levels and to all subsequent releases and modifications until otherwise indicated in new editions.

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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 every IBM System Storage™ DS4000 Storage Subsystem. Each caution and danger statement is numbered for easy reference to the corresponding statements in the translated document.

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

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

Statement 1:



DANGER

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

To avoid a shock hazard:

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

To Connect:	To Disconnect:
<ol style="list-style-type: none">1. Turn everything OFF.2. First, attach all cables to devices.3. Attach signal cables to connectors.4. Attach power cords to outlet.5. Turn device ON.	<ol style="list-style-type: none">1. Turn everything OFF.2. First, remove power cords from outlet.3. Remove signal cables from connectors.4. Remove all cables from devices.

Statement 3:



CAUTION:

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

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



DANGER

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

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




Class 1 Laser statement

Class 1 Laser Product
Laser Klasse 1
Laser Klasse 1
Luokan 1 Laserlaitte
Appareil À Laser de Classe 1

IEC 825-11993 CENELEC EN 60 825

Statement 4:



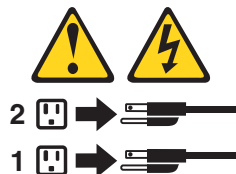
		
≥ 18 kg (39.7 lb)	≥ 32 kg (70.5 lb)	≥ 55 kg (121.2 lb)

CAUTION:
Use safe practices when lifting.

Statement 5:



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



Statement 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.



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.

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About this document

This document describes procedures for adding new Fibre Channel or SATA hard drives or new IBM System Storage DS4000 drive expansion enclosures containing new Fibre Channel or SATA hard drives to an existing IBM DS4000 Storage Subsystem configuration. This document also describes the procedure for migrating either Fibre Channel hard drives or IBM System Storage DS4000 storage expansion enclosures containing Fibre Channel hard drives from one DS4000 storage subsystem to another.

FAST product renaming

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

Table 1. Mapping of FAST names to DS4000 series names

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

Who should read this document

This document is intended for system administrators who are familiar with the IBM System Storage DS4000 storage subsystem components, terminology, and DS4000 Storage Subsystem administrative tasks.

Illustrations

Illustrations contained in this document depict general visual characteristics of the DS4000 Storage Subsystem, storage expansion unit, and Fibre Channel drive hardware cited. They are not intended for use as detailed DS4000 storage hardware images.

Using this document

Before you proceed to complete any storage addition or migration procedures detailed in this publication, familiarize yourself with the principles, prerequisite instructions in Chapter 2, "Prerequisites to adding capacity and hard drive migration," on page 45, as well as the following storage addition or migration procedures applicable to your specific needs.

- Chapter 3, "Adding or migrating hard drives," on page 61
- Chapter 4, "Adding or migrating storage expansion enclosures," on page 75
- Chapter 5, "Upgrading a storage subsystem in a functioning configuration," on page 121

Your familiarity with the principles, preliminary procedures, and detailed steps described in this document is critical to prevent loss of data availability, and in some cases, loss of data. If you have questions about the procedures described in this document, please contact the IBM Help Center in your geography for assistance.

Important:

1. Do not mix SATA and Fibre Channel drives in the same enclosure (DS4700 and EXP810).
2. Do not place SATA drives in a Fibre Channel enclosure (DS4300, EXP700, EXP710).
3. Do not place Fibre Channel drives in a SATA enclosure (DS4100, DS4200 Express, or EXP420).
4. Do not mix SATA drive expansion enclosures (EXP100) and Fibre Channel drive enclosures (EXP700 and EXP710) in the same drive loop or the same DS4000 Storage Subsystem unless you purchase the Fibre Channel/SATA intermix premium feature entitlement and upgrade the controller firmware to 06.10.11.xx or higher.
5. Do not mix EXP500 storage expansion enclosures with EXP710 and EXP810 storage expansion enclosures in a DS4000 Storage Subsystem configuration.
6. Do not mix storage expansion enclosures running at different FC speeds in the same redundant drive channel/loop pair. Please refer to the *Installation, User's, and Maintenance Guide* for your particular DS4000 storage subsystem for specific information about which storage expansion enclosure model types and FC speeds are supported, and whether you can attach expansion enclosures with different FC speeds behind it.
7. Always check the documentation that is shipped with the storage expansion enclosures, the DS4000 controller firmware readme files, the *Installation, User's,*

and Maintenance Guide for your specific DS4000 Storage Subsystem and storage expansion enclosure, and this guide for the following information:

- The latest storage subsystem/storage expansion enclosure compatibility
- Any requirements of the installed microcode and firmware to support the DS4000 Storage Subsystem and storage expansion enclosure

Product updates

Important

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

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

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

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

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

Perform the following steps to receive product updates:

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

Note: During this process a check list displays. Do not check any of the items in the check list until you complete the selections in the pull-down menus.

5. When you finish selecting the menu topics, place a check in the box for the machine type of your DS4000 series product, as well as any other attached DS4000 series product(s) for which you would like to receive information, then click **Add products**. The My Support page opens again.
6. On the My Support page, click the **Edit profile** tab, then click **Subscribe to email**. A pull-down menu displays.
7. In the pull-down menu, select **Storage**. A check list displays.
8. Place a check in each of the following boxes:
 - a. **Please send these documents by weekly email**
 - b. **Downloads and drivers**

c. **Flashes**

d. Any other topics that you may be interested in

Then, click **Update**.

9. Click **Sign out** to log out of My Support.

Getting information, help, and service

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

Before you call

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

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

You can solve many problems without outside assistance by following the troubleshooting procedures that IBM provides in the DS4000 Storage Manager online help or in the documents that are provided with your system and software. The information that comes with your system also describes the diagnostic tests that you can perform. Most 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.

Web sites

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

DS4000 Midrange Disk Systems

Find the latest information about IBM System Storage disk storage systems, including all of the DS4000 storage subsystems:

www-1.ibm.com/servers/storage/disk/ds4000/

IBM System Storage products

Find information about all IBM System Storage products:

www.storage.ibm.com/

Support for IBM System Storage disk storage systems

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

www-304.ibm.com/jct01004c/systems/support/supportsite.wss/brandmain?brandind=5345868

System Storage DS4000 interoperability matrix

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

www-1.ibm.com/servers/storage/disk/ds4000/interop-matrix.html

DS4000 Storage Manager readme files

1. Go to the following Web site:
www-304.ibm.com/jct01004c/systems/support/supportsite.wss/brandmain?brandind=5345868
2. In the Product family drop-down menu, select **Disk systems**, and in the Product drop-down menu, select your Storage Subsystem (for example, **DS4800 Midrange Disk System**). Then click **Go**.
3. When the subsystem support page opens, click the **Install/use** tab, then click the **DS4000 Storage Manager Pubs and Code** link. The Downloads page for the subsystem opens.
4. When the download page opens, ensure that the **Storage Mgr** tab is selected. A table displays.
5. In the table, find the entry that lists the Storage Manager package for your operating system, then click on the corresponding **v9.xx** link in the "Current version and readmes" column. The Storage Manager page for your operating system opens.
6. Click the link for the readme file.

Storage Area Network (SAN) support

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

DS4000 technical support

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

www-304.ibm.com/jct01004c/systems/support/supportsite.wss/brandmain?brandind=5345868In the Product family drop-down menu, select **Disk systems**, and in the Product drop-down menu, select your Storage Subsystem (for example, **DS4800 Midrange Disk System**). Then click **Go**.

Premium feature activation

Generate a DS4000 premium feature activation key file by using the online tool:

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

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Chapter 1. Introduction

Scalability is a primary attribute of the IBM System Storage DS4000 Storage Subsystem family. In most cases, you can expand a DS4000 Storage Subsystem from its minimum to its maximum capacity configuration when the need arises. To expand DS4000 Storage Subsystem configurations you can purchase additional equipment or, in some cases, migrate equipment from DS4000 Storage Subsystem configurations previously deployed.

The typical DS4000 Storage Subsystem drive connects to both Controller A and Controller B. Taken together, these connections represent dual drive loops or a redundant drive loop pair. You must connect drive loops in pairs to enable redundant drive loop configurations (two data paths per drive enclosure).

Note: In the DS4200 Express, DS4700 Express, and the DS4800 Storage Subsystem publications, these redundant drive loop pairs are referred to as redundant drive channel pairs. In addition, the DS4200 Express, DS4700 Express, and DS4800 have two ports per drive channel. Even though you can cable two different Fibre Channel cable loops per drive channel, these two physically cabled Fibre Channel loops are viewed logically as a single drive channel or loop by the DS4200, DS4700 Express, or DS4800 controller.

Table 2 provides a list of the maximum allowable number of drives and drive loop pairs for each DS4000 Storage Subsystem by machine type and model number. It also specifies storage expansion enclosure license requirements.

Important:

Do not intermix Fibre Channel devices (such as the DS4300 Storage Subsystem and EXP700 and EXP710 storage expansion enclosure) and SATA devices (such as the DS4100 Storage Subsystem and EXP100 storage expansion enclosure) in the same storage subsystem environment unless you purchase the Fibre Channel/SATA intermix premium feature entitlement and upgrade the DS4000 Storage Subsystem controller firmware to 06.10.11.xx or higher. See “IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature” on page 25 for more information.

Table 2. Maximum allowable drives and drive loop pairs in DS4000 storage servers

Product name	Machine type	Model number	Maximum number of drives	Maximum number of drive loop/channel pairs	Storage expansion unit license requirement
IBM System Storage DS4100 Storage Subsystem (Single Controller model)	1724	1SC, 1Sx	14	0	None. The DS4100 Single Controller Storage Subsystem does not support storage expansion enclosure attachment.

Table 2. Maximum allowable drives and drive loop pairs in DS4000 storage servers (continued)

Product name	Machine type	Model number	Maximum number of drives	Maximum number of drive loop/channel pairs	Storage expansion unit license requirement
IBM System Storage DS4100 Storage Subsystem	1724	100	56	1	None
IBM System Storage DS4200 Express Storage™ Subsystem	1814	7VA, 7VH	112	1	Supports no storage expansion enclosures. Must purchase 1–3 and 4–6 storage expansion enclosure attachment entitlements to connect up to the maximum number of storage expansion enclosures.
IBM System Storage DS4300 Fibre Channel Storage Subsystem	1722	60X 60U	56	1	Purchase storage expansion enclosure entitlements in increments up to three storage expansion enclosures per DS4300 Storage Subsystem.
IBM System Storage DS4300 Fibre Channel Storage Subsystem (with Turbo option) ⁴ and ⁵			112	1	None. The DS4300 (with Turbo option) includes a seven storage expansion unit entitlement.
IBM System Storage DS4300 Fibre Channel Storage Subsystem (Single Controller model)		6LU 6LX	14	0	None. The DS4300 Single Controller Storage Subsystem does not support storage expansion enclosure attachment.

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Table 2. Maximum allowable drives and drive loop pairs in DS4000 storage servers (continued)

Product name	Machine type	Model number	Maximum number of drives	Maximum number of drive loop/channel pairs	Storage expansion unit license requirement
IBM System Storage DS4400 Fibre Channel Storage Subsystem ²	1742	1RU	224	2	None
		1RX			
IBM System Storage DS4500 Fibre Channel Storage Subsystem ²	1742	90X	224	2	None
		90U			
IBM System Storage DS4700 Express Fibre Channel Storage Subsystem ³	1814	70A 70H 70S 70T	112	1	Supports no storage expansion enclosures. Must purchase 1–3 and 4–6 storage expansion enclosure attachment entitlements to connect up to the maximum number of storage expansion enclosures.
		72A 72H 72S 72T	112	1	Comes with 1–3 storage expansion enclosure attachments (64 drives total). Must purchase 4–6 storage expansion enclosure attachments to get 112 drives.
IBM System Storage DS4800 Fibre Channel Storage Subsystem ²	1815	80x ²	224	2	Comes with entitlement to attach up to 112 drives, must purchase additional entitlements to attach up to 224 drives.
		82x, 84x 88x ²	224	2	None

Table 2. Maximum allowable drives and drive loop pairs in DS4000 storage servers (continued)

Product name	Machine type	Model number	Maximum number of drives	Maximum number of drive loop/channel pairs	Storage expansion unit license requirement
IBM System Storage FAStT200 Fibre Channel Storage Subsystem	3542	1RU	38	1	None
		1RX			
IBM System Storage FAStT200 High Availability (HA) Fibre Channel Storage Subsystem ¹		2RU	66	1	None
		2RX			
IBM System Storage FAStT500 Fibre Channel Storage Subsystem ²	3552	1RU	224	2	None
		1RX			

Notes:

1. The maximum number of drives supported by the FAStT200 HA Storage Subsystem (models 2RU and 2RX) assumes attachment to four 14-drive storage expansion enclosures containing 56 Fibre Channel drives.
2. The maximum number of drives supported by FAStT500, DS4400, DS4500, and DS4800 Storage Subsystems assumes their attachment to 16 14-drive storage expansion enclosures. In addition, for the DS4500 and DS4800 storage subsystem, the maximum number of drives can also be supported by connecting 14 16-drive storage expansion enclosures.
3. For the DS4200 Express and DS4700 Express storage subsystems, the maximum number of drives can also be supported by connecting six 16-drive storage expansion enclosures.
4. For the DS4300 Turbo option with Fibre Channel drives installed in the DS4300 chassis, the maximum number of drives is supported by connecting seven 14-drive storage expansion enclosures.
5. For the DS4300 Turbo option with zero drives installed in the DS4300 chassis (and the internal drive slots disabled by special script applied to the DS4300 controllers), the maximum of drives can be supported by connecting eight EXP100s or seven EXP810s that have SATA drive CRUs (E-DDMs) installed.
6. There are two cases in which the maximum number of drives in a drive loop/channel will be less than the supported maximum of 112 drives. These cases arise when you are intermixing one of the following combinations:
 - a. Two or more storage expansion enclosures that have different drive slots capacities
 - b. A DS4000 storage subsystem that has internal drive slots with storage expansion enclosures that have different drive slots capacities

These two cases arise because IBM does not support partially filled storage enclosures; that is, where some slots are left empty in order to ensure that the maximum number of drives in the drive loop does not exceed 112. See the intermixing EXP500 and EXP700 or EXP100, EXP810 and EXP710 sections for more information.

Intermixing storage expansion enclosures

This section contains information on the following topics:

- Intermixing EXP500 and EXP700 storage expansion enclosures
- Intermixing EXP700 or EXP100 and EXP710 storage expansion enclosures
- Intermixing EXP100, EXP710 and EXP810 storage expansion enclosures

For important information about using the Fibre Channel and SATA Intermix premium feature, including configuration and setup requirements, see “IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature” on page 25.

For hardware compatibility, ensure that the environmental service module (ESM) firmware for each storage expansion enclosure and the storage server controller firmware are either at or above the levels that are recommended in Table 22 on page 49 and Table 23 on page 53.

DS4000 Storage Subsystems support the addition of external drive enclosures, which can provide the following:

- Additional storage capacity (as in the case of DS4400, DS4500, and DS4800 Storage Subsystems)
- Expansion of a storage subsystem’s capacity beyond that of a given DS4000 Storage Subsystem chassis (as in the case of DS4100 and DS4300 Storage Subsystems)

When increasing the capacity of your storage subsystem in either of these ways, you might choose to add external drive enclosures of the same model and type or of different types. IBM does not support the combination of every DS4000 external drive enclosure type and model in every DS4000 Storage Subsystem configuration. In addition, not all controller firmware versions support all available storage expansion enclosures or storage subsystems. Restrictions on the connection of drive enclosures that differ by model and type to DS4000 Storage Subsystems are documented in this section.

Table 3 indicates, by model, which DS4000 expansion enclosures can coexist in the same redundant drive loop of a DS4000 Storage Subsystem.

Table 3. Mixed DS4000 expansion enclosure compatibility in storage subsystems by model

DS4000 expansion enclosure	DS4000 EXP100 (SATA)	DS4000 EXP420	DS4000 EXP500 (Fibre Channel)	DS4000 EXP700 (Fibre Channel)	DS4000 EXP710 (Fibre Channel)	DS4000 EXP810 (Fibre Channel / SATA)
IBM System Storage DS4000 EXP100 (SATA)	✓ 1			✓ 2	✓ 2	✓ 8
IBM System Storage DS4000 EXP420 (SATA)		✓ 9				

Table 3. Mixed DS4000 expansion enclosure compatibility in storage subsystems by model (continued)

IBM System Storage DS4000 EXP500 (Fibre Channel)			✓ 4 (1 Gbps only)	✓ 3 (1 Gbps only)		
IBM System Storage DS4000 EXP700 (Fibre Channel)	✓ 2		✓ 3 (1 Gbps only)	✓ 3	✓ 5	
IBM System Storage DS4000 EXP710 (Fibre Channel)	✓ 2			✓ 5	✓ 5	✓ 6
IBM System Storage DS4000 EXP810 (Fibre Channel / SATA)	✓ 8				✓ 6	✓ 6

Table 3. Mixed DS4000 expansion enclosure compatibility in storage subsystems by model (continued)

- 1** Requires controller firmware 06.10.11.xx or higher (DS4300 with Turbo option, DS4400, and DS4500), 06.12.03.xx or higher (DS4300 dual controller standard/base, DS4100 base), 06.14.xx.xx and 06.15.xx.xx (DS4800), or 06.23.xx.xx or higher (DS4700 and DS4800). Controller firmware 06.16.xx.xx does not support EXP100.
Note: There are versions of 05.41.xx.xx controller firmware that also provide DS4000 EXP100 support for DS4300 (with dual controller standard/base or Turbo option), DS4400, and DS4500 Storage Subsystems or versions of 05.42.xx.xx controller firmware that also provide DS4000 EXP100 support for DS4100 Storage Subsystems. However, IBM recommends that you use controller firmware version 06.12.xx.xx or higher for the DS4100, DS4300 (with base or Turbo option), DS4400, and DS4500 Storage Subsystems, instead.
- 2** Supported only with Fibre Channel/SATA intermix entitlement purchase and controller firmware version 06.12.xx.xx or higher. In addition, the storage subsystem must also be in the DS4000 Storage Subsystem list that supports the FC/SATA intermix premium feature. (**Note:** Controller firmware 6.12.xx.xx is the highest version that supports EXP700s.)
- 3** Requires controller firmware 05.2x.xx.xx–05.40.xx.xx.
- 4** Requires controller firmware 04.xx.xx.xx or 05.xx.xx.xx.
- 5** Requires controller firmware 06.10.11.xx or higher.
- 6** Requires controller firmware 06.16.xx.xx or higher for DS4800 and DS4700 Express subsystems. The EXP810 supports SATA drives with controller firmware version 06.16.8x.xx or higher.
- 8** Requires controller firmware version 06.19.xx.xx or higher with DS4300 and DS4500 subsystems, and version 06.23.xx.xx or higher with DS4700 and DS4800 subsystems. (**Note:** You must purchase the Fibre Channel/SATA Intermix premium feature when intermixing EXP100s with EXP810s that have Fibre Channel drive CRUs (E-DDMs) installed.)
- 9** EXP420 is supported as drive expansion enclosure attachment to DS4200 only. Requires controller firmware 06.16.8x.xx or 06.16.9x.xx.

Table 4 indicates what DS4000 expansion enclosures can attach to DS4000 Storage Subsystems by model.

Table 4. DS4000 expansion enclosure compatibility with DS4000 Storage Subsystems by model

DS4000 storage device	DS4000 EXP100 (SATA)	DS4000 EXP420 (SATA)	DS4000 EXP500 (Fibre Channel)	DS4000 EXP700 (Fibre Channel)	DS4000 EXP710 (Fibre Channel)	DS4000 EXP810 (Fibre Channel and SATA)
DS4100 Storage Subsystem (base model, SATA)	<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ↙ 2 3 </div>					
DS4100 Storage Subsystem (Single Controller model, SATA)						

Table 4. DS4000 expansion enclosure compatibility with DS4000 Storage Subsystems by model (continued)

DS4200 Storage Subsystem (SATA)		✓				
DS4300 Storage Subsystem (Single Controller model, Fibre Channel)						
DS4300 Storage Subsystem (Turbo option, Fibre Channel)	✓ 2 3 6			✓ 2	✓ 4	✓ 6
DS4300 Storage Subsystem (base model, Fibre Channel)	✓ 1 3 6			✓ 2	✓ 4	
DS4400 Storage Subsystem (Fibre Channel, SATA)	✓ 2 3		✓ (1 Gbps only)	✓ 2	✓ 4	
DS4500 Storage Subsystem (Fibre Channel, SATA)	✓ 2 3 6		✓ (1 Gbps only)	✓ 2	✓ 4	✓ 6
DS4700 Express Storage Subsystem (Fibre Channel)	✓ 2 3 6				✓ 4	✓ 5
DS4800 Storage Subsystem (Fibre Channel, SATA)	✓ 2 3 6				✓ 4	✓ 5
FASiT200 Storage Subsystem (Fibre Channel)			✓ (1 Gbps only)	✓ (1 Gbps only)		

Table 4. DS4000 expansion enclosure compatibility with DS4000 Storage Subsystems by model (continued)

FAST500 Storage Subsystem (Fibre Channel)			↙ (1 Gbps only)	↙ (1 Gbps only)		
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1 The DS4300 base will support FC/SATA intermix only when the controller firmware is of version 06.12.xx.xx or higher and the Fibre Channel/SATA intermix entitlement is purchased.

In addition, although the DS4300 Storage Subsystem (base model) will support Fibre Channel or SATA drives with controller firmware version 05.41.xx.xx, it will not support both in a mixed environment. It will, however, support SATA drives in an attached storage enclosure (only), but never in the DS4300 Storage Subsystem, itself. In addition, before the DS4300 Storage Subsystem (base model) will support a DS4000 EXP100 drive enclosure, it is necessary to remove all Fibre Channel drives from the DS4300 chassis.

2 The intermix of DS4000 EXP700 and EXP710 Fibre Channel drive enclosures with DS4000 EXP100 SATA drive enclosures in a given DS4000 Storage Subsystem is supported only with Fibre Channel/SATA intermix entitlement purchase and controller firmware version 06.10.11.xx or higher. The DS4700 Express and DS4800 Storage Subsystems do not support the attachment of EXP700 drive expansion enclosures. You must upgrade the EXP700 drive expansion enclosure to EXP710 before attaching to a DS4700 Express or DS4800 Storage Subsystem.

3 DS4000 Storage Subsystems require the following firmware to manage EXP100 expansion enclosures:

DS4100 base

Either 5.42.xx.xx or 06.12.1x.xx. Version 6.12.1x.xxx is recommended.

DS4300 base or Turbo and DS4500

Either 05.41.5x.xx or 06.1x.xx.xx and higher. Version 06.23.xx.xx and higher is recommended.

DS4400

06.1x.xx.xx. Version 06.12.xx.xx is recommended.

DS4700 Express

06.23.xx.xx and higher.

DS4800

Either 06.15.xx.xx, or 06.23.xx.xx and higher. Version 6.23.xx.xx and higher is recommended. **Note:** 6.16.xx.xx does not support EXP100).

4 Requires controller firmware version 06.1x.xx.xx or higher. Version 06.23.xx.xx is recommended for DS4300 dual controller standard/base or Turbo and DS4500 (also see footnote 6). DS4400 requires controller firmware version 06.12.xx.xx. For DS4700 Express and DS4800, version 06.23.xx.xx or higher recommended (also see footnotes 5 and 6).

5 Requires controller firmware 06.16.18.xx or higher for DS4800 and 06.16.4x.xx or higher for DS4700 Express. Also, see footnote 6 for the controller firmware requirement for intermix EXP810s and EXP100s.

6 With DS4300 and DS4500 subsystems, controller firmware version 06.19.xx.xx or higher is required to intermix EXP100s and EXP810s. With DS4700 Express and DS4800 subsystems, version 06.23.xx.xx or higher is required to intermix EXP100s and EXP810s. Controller firmware versions 06.19.xx.xx or higher do not support DS4000 EXP500 or EXP700 storage expansion enclosures. (**Note:** EXP700 enclosures can be upgraded using the *DS4000 EXP700 Models 1RU/1RX Switched-ESM Option Upgrade Kits* enabling them to be supported in DS4000 storage subsystems with controller firmware version 06.19.xx.xx or higher installed.)

Table 5. Storage expansion enclosures supported by controller firmware versions

Controller firmware version	EXP storage expansion enclosures					
	EXP100	EXP420	EXP500	EXP700	EXP710	EXP810
5.3x.xx.xx	No	No	Yes	Yes	No	No
5.40.xx.xx	No	No	Yes	Yes	No	No
5.41.xx.xx	Yes	No	No	No	No	No
5.42.xx.xx	Yes	No	No	No	No	No
6.00.xx.xx	No	No	No	Yes	Yes	No
6.10.xx.xx	No	No	No	Yes	No	No
6.12.xx.xx	Yes	No	No	Yes	Yes	No
6.14.xx.xx	Yes	No	No	No	Yes	No
6.15.xx.xx	Yes	No	No	No	Yes	No
6.16.2x.xx	No	No	No	No	Yes	Yes
6.16.8x.xx/ 6.16.9x.xx	No	Yes	No	No	Yes	Yes
6.19.xx.xx	Yes	No	No	No	Yes	Yes
6.23.xx.xx	Yes	Yes	No	No	Yes	Yes

Currently, IBM supports the following storage expansion enclosure models: EXP100, EXP420, EXP500, EXP700, EXP710, and EXP810. Table 6 lists those drive expansion enclosure models that are considered of the same storage enclosure type for the purpose of grouping together in an intermixed SATA/Fibre Channel storage expansion enclosure loop configuration.

Note: The EXP420 and EXP500 are not listed in Table 6 because they are not supported in an intermixed SATA/Fibre Channel storage expansion enclosure loop configuration.

Table 6. DS4000 drive expansion enclosure models compatible in intermixed loop configurations only when contiguously grouped

Group-compatible EXP100 models	Group-compatible EXP700 models	Group-compatible EXP710 and EXP810 models
1710-10X	1740-1RU	1740-710 , 1812-81A ²
1710-10U	1740-1RX	1740-1RU ¹ , 1812-81H ²
1724-1XP		1740-1RX ¹

1. Consider this EXP700 model as an EXP710 for grouping purposes; only after it is upgraded with the DS4000 EXP700 field upgrade to switched ESMs.
2. EXP810 FC/SATA Intermix is supported at the enclosure level only. You cannot intermix Fibre Channel and SATA drives within the same enclosure. DS4700 Express and DS4800 storage subsystems do not support the intermix of EXP810 expansion enclosures (either Fibre Channel or SATA E-DDMs) with EXP100 expansion enclosures.

You can mix DS4000 System Storage EXP500 (which operates only at 1 Gbps) and DS4000 System Storage EXP700 (which operates at either 1 Gbps or 2 Gbps) storage expansion enclosures in the same redundant drive loop pair in all DS4400 and DS4500 Storage Subsystem configurations. However, you must set the

EXP700 to 1 Gbps. There is no restriction to the physical sequence of mixed EXP700 and EXP500 expansion enclosures in the same redundant drive loop pair. You cannot mix these enclosures in the same redundant drive loop pair in DS4100, DS4200, DS4300, DS4700, and DS4800 Storage Subsystem configurations. See “Intermixing EXP500 and EXP700 storage expansion enclosures” on page 12 for more information.

Not all available DS4000 storage subsystems support all available DS4000 storage expansion enclosures. For example, the DS4700 Express Storage Subsystem supports only the DS4000 EXP100, EXP710 and EXP810 storage expansion enclosures. The DS4200 Express storage subsystem supports only the DS4000 EXP420 storage expansion enclosure. See Table 3 on page 5 for more information.

Although you can intermix the EXP700 and EXP100 storage expansion enclosures with EXP710 storage expansion enclosures in the same redundant drive loop pair in a DS4000 Storage Subsystem configuration, you must group together all DS4000 EXP710 storage expansion enclosures in the redundant drive loop. See “Intermixing EXP700 or EXP100 and EXP710 storage expansion enclosures” on page 14 and Table 6 on page 10 for additional information.

Currently, the EXP810 drive expansion enclosures can be intermixed in the same redundant drive channel/loop pair with the EXP100 (controller firmware version 06.19.xx) and EXP710 drive expansion enclosures only. The EXP810 enclosure speed switch must be set at 2Gbps. In addition, all of the EXP100s in the redundant drive loop must be grouped together, followed by (or preceding) the group of EXP710s and EXP810s. See “Intermixing EXP100, EXP710 and EXP810 storage expansion enclosures” on page 19 and Table 6 on page 10 for additional information.

Do not intermix the EXP500 (which operates only at 1 Gbps) and EXP710, EXP810 or EXP100 (which operates only at 2 Gbps) storage expansion enclosures in the same redundant drive loop pair. Also, do not attach these storage expansion enclosures to the same controller.

Although there are no restrictions against cabling either DS4000 EXP100 and DS4000 EXP700 or DS4000 EXP810 and DS4000 EXP710 storage expansion enclosures together, for ease of future maintenance and possible troubleshooting, IBM recommends that, if possible, you plan your configuration to allow for grouping all DS4000 drive expansion enclosures by type in a DS4000 Storage Subsystem redundant drive loop.

Attention: Even though IBM supports intermixing different drive expansion enclosure models in the same redundant drive loop, IBM recommends use of a single drive expansion enclosure model (for example, EXP100, EXP500, EXP700, EXP710, or EXP810) in a given redundant drive loop.

Important:

Do not change the speed of a drive loop while the DS4000 Storage Subsystem is powered on. Such a speed change will cause unpredictable results. Also, the drive expansion enclosures must be power cycled for the new speed setting to be correctly recognized.

To change the speed of a drive loop:

- ___ Step 1. Prepare applications for DS4000 Storage Subsystem shutdown.

- ___ Step 2. Shut down the DS4000 Storage Subsystem.
- ___ Step 3. Shut down the DS4000 storage expansion enclosures.
- ___ Step 4. Change the storage expansion enclosure speed settings.
- ___ Step 5. Power on the DS4000 storage expansion enclosures.
- ___ Step 6. Power on the DS4000 Storage Subsystem.
- ___ Step 7. Restore DS4000 Storage Subsystem host application operations.

Note: For additional information on turning a storage server on and off, see the *DS4000 Storage Subsystem Installation, User's, and Maintenance Guide*. For more information on these guides, see the following Web site:

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

See “DS4000 Storage Subsystem drive loop schemes” on page 26 and “Setting enclosure IDs” on page 34 for details on cabling DS4000 Storage Subsystems and storage expansion enclosures together as well as setting their enclosure IDs.

Intermixing EXP500 and EXP700 storage expansion enclosures

When connecting the EXP500 and EXP700 enclosures in the same DS4000 Storage Subsystem, although the EXP700 storage expansion enclosure is capable of operating at 2 Gbps, you must set the Fibre Channel speed of drive loops in a mixed storage expansion enclosure environment to the lowest Fibre Channel speed supported by all hardware in the loop, which is 1 Gbps.

If one of the drive loops in a DS4000 Storage Subsystem configuration is set to 1 Gbps, you must set all of the drive loops to 1 Gbps. This speed restriction applies to all four drive loops in either the DS4400 or DS4500 Storage Subsystem configuration, even where some of the drive loops consist only of EXP700 storage expansion enclosures that might otherwise operate at 2 Gbps.

Figure 1 on page 13 illustrates cabling of DS4000 System Storage EXP500 and EXP700 storage expansion enclosures in a mixed configuration.

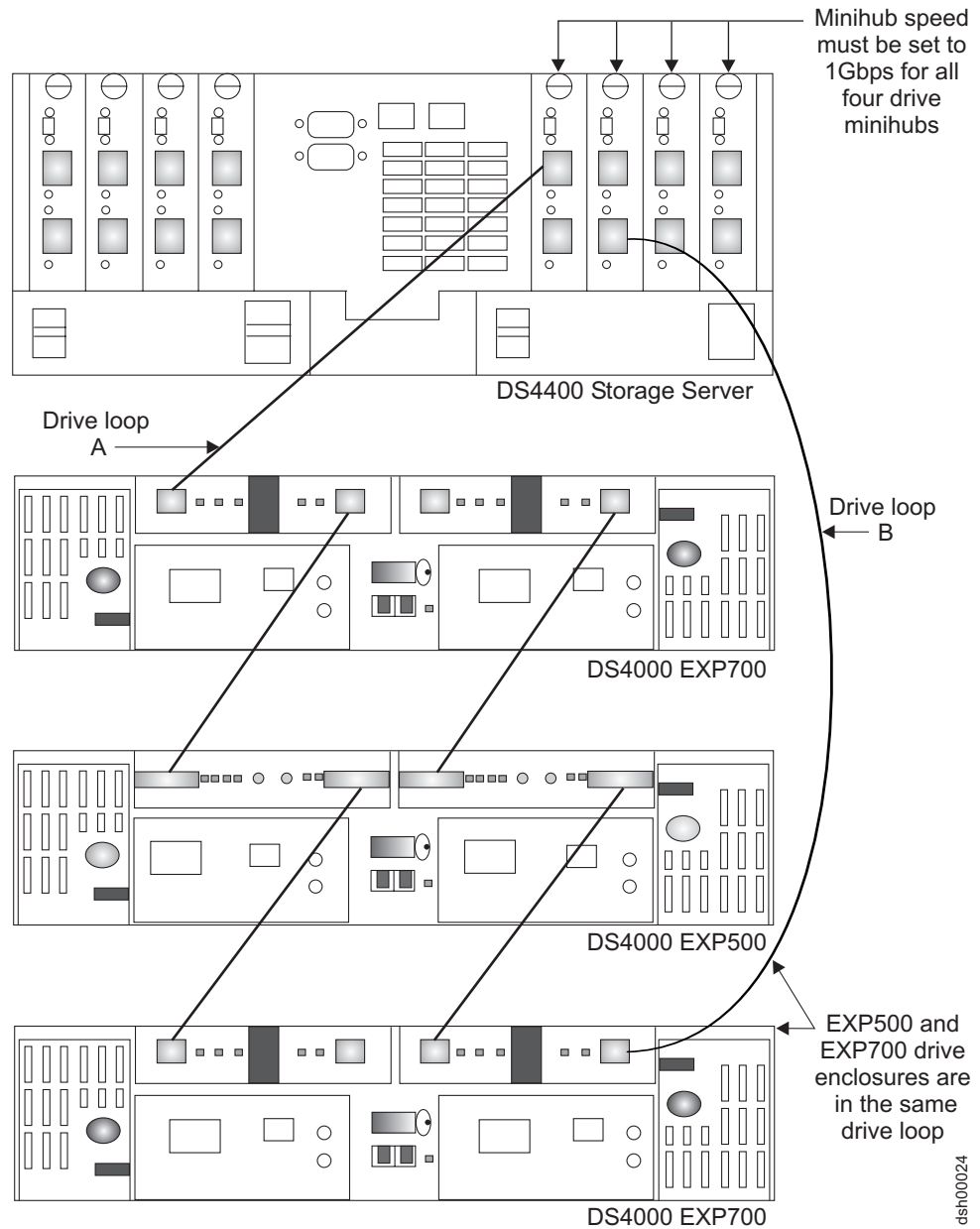


Figure 1. DS4000 EXP500 and EXP700 cabling in a mixed configuration

There are maximum limits to the number of Fibre Channel hard drives that you can configure in redundant drive loop pairs. The maximum number of drives dictates a fixed number of supported EXP500 and EXP700 drive enclosure combinations. Table 7 on page 14 lists the numbers of EXP500 and EXP700 storage expansion enclosures that you can combine for use in a single redundant drive loop pair. Table 7 on page 14 assumes that a DS4000 Storage Subsystem is generally capable of addressing the maximum of 112 Fibre Channel hard drives for each redundant drive loop pair.

Important:

IBM supports only those EXP500 and EXP700 Storage Expansion Unit combinations listed in Table 7 on page 14.

Table 7. Supported EXP500 and EXP700 enclosure combinations per redundant drive loop pair

Total number of EXP500 enclosures per redundant drive loop pair	Total number of EXP700 enclosures per redundant drive loop pair	Maximum number of storage expansion enclosures per redundant drive loop pair	Maximum number of drives per redundant drive loop pair
11	0	11	110
10	0	10	100
9	1	10	104
8	2	10	108
7	3	10	112
6	3	9	102
5	4	9	106
4	5	9	110
3	6	9	114
2	6	8	104
1	7	8	108
0	8	8	112

Note: The combination of three EXP500 and six EXP700 storage expansion enclosures has the maximum number of 114 drives per redundant drive loop pair. You can have this maximum number of hard drives per drive loop pair only in this mixed EXP500 and EXP700 configuration.

Intermixing EXP700 or EXP100 and EXP710 storage expansion enclosures

Attention: Please read this section carefully. Before intermixing EXP700/EXP710 and EXP100 drive expansion enclosures in a DS4000 Storage Subsystem, you must purchase IBM System Storage DS4000 SATA and Fibre Channel storage expansion enclosure intermix entitlement. You must also check the controller firmware requirements in Table 3 on page 5 for intermix compatibility.

It is possible to intermix EXP700 or EXP100, and EXP710 storage expansion enclosures in the same drive loop. To do so, however, you must group all of the EXP710 storage expansion enclosures together to enable the EXP710 Reliability and Serviceability (RAS) features and to optimize the data transferring between the EXP710. These intermixing requirements must also be met if you are upgrading some (but not all) of the EXP700 storage expansion enclosures in a drive loop with the EXP700 Models 1RU/1RX Switched-ESM Option Upgrade Kit (P/N 25R0166). Once upgraded, these EXP700 drive expansion enclosures are considered EXP710 drive expansion enclosures, even though the machine type and models might be still be shown as EXP700 machine types and models.

Important:

IBM does not support any configuration in which EXP710 drive expansion enclosures are not grouped together.

Figure 2 through Figure 4 on page 17 show three acceptable EXP700 and EXP710 intermixing cabling configurations in which all EXP710 storage expansion enclosures are grouped together. Note that in Figure 4 on page 17, the EXP710 storage expansion enclosures are grouped together, even though the EXP700 storage expansion enclosures are not grouped together.

Although illustrations Figure 2 through Figure 6 on page 19 incorporate the DS4000 DS4300 Storage Subsystem for the sake of example, other DS4000 storage servers might be acceptable replacements. The DS4000 EXP100 would also intermix successfully with an EXP710 when substituted for an EXP700 in an equivalent loop configuration.

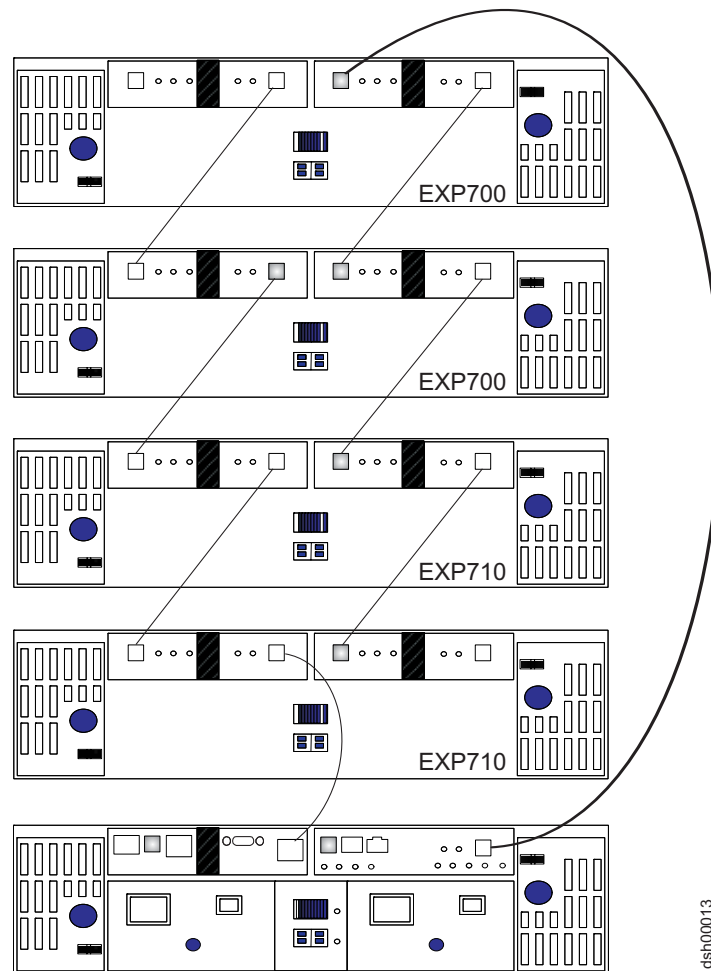
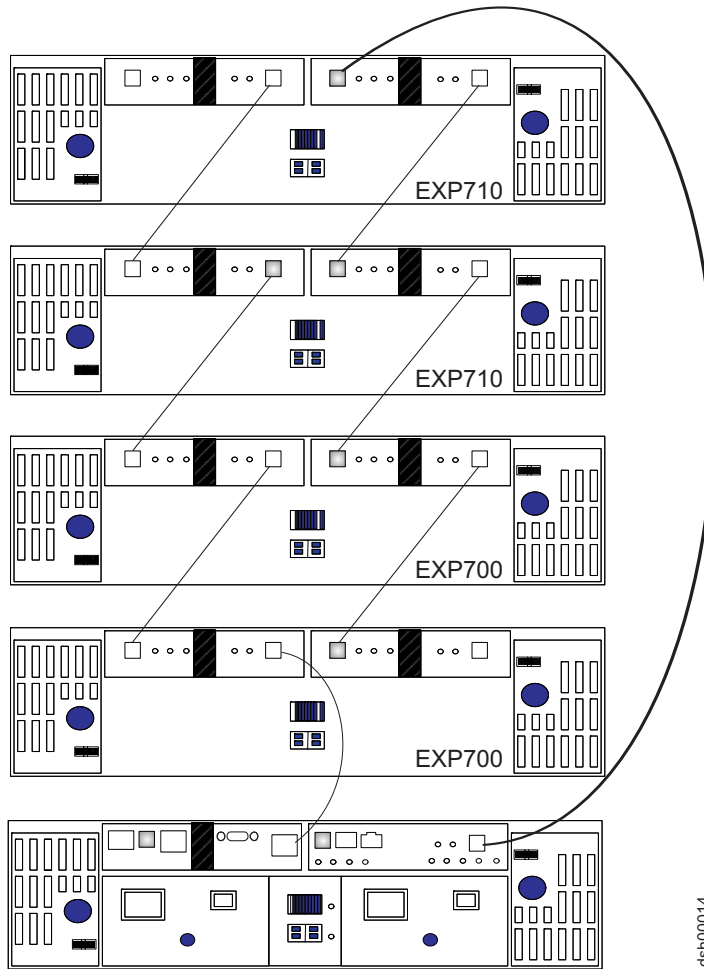
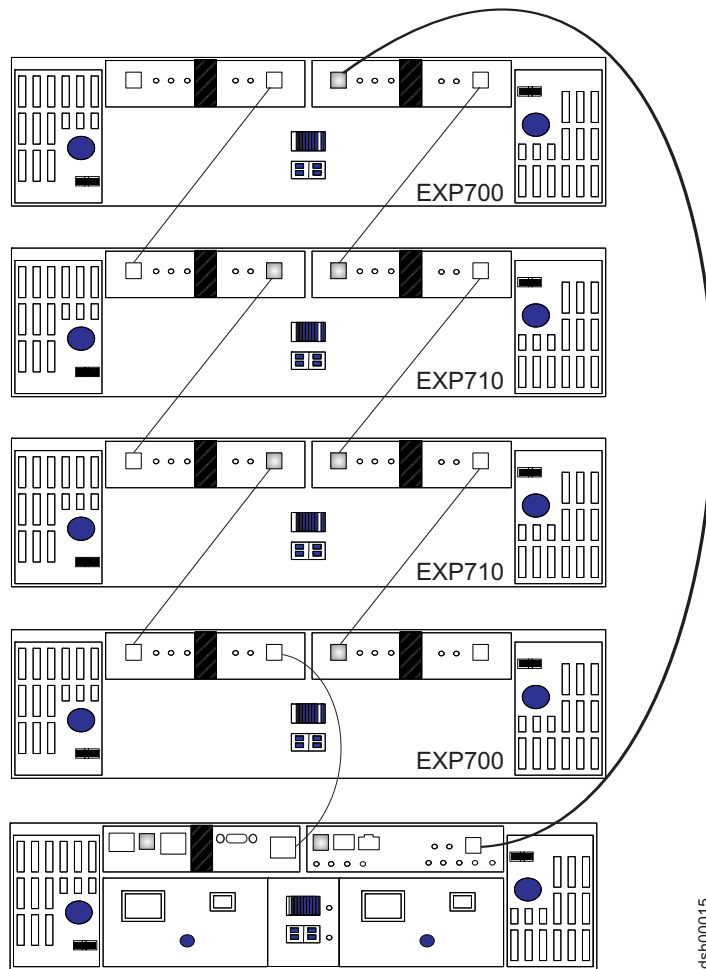


Figure 2. Acceptable intermixed EXP700 (or EXP100) and EXP710 loop configuration (1 of 3)



dsh00014

Figure 3. Acceptable intermixed EXP700 (or EXP100) and EXP710 loop configuration (2 of 3)



dsh00015

Figure 4. Acceptable (**not recommended**) intermixed EXP700 (or EXP100) and EXP710 loop configuration (3 of 3)

In Figure 5 on page 18 and Figure 6 on page 19, the intermixed configurations shown are not supported because the EXP710 storage expansion enclosures in the redundant drive loop are not grouped together. When substituting a DS4000 EXP100 for an EXP700 enclosure in an equivalent drive loop cabling configuration, the intermixed drive loop cabling is also not supported.

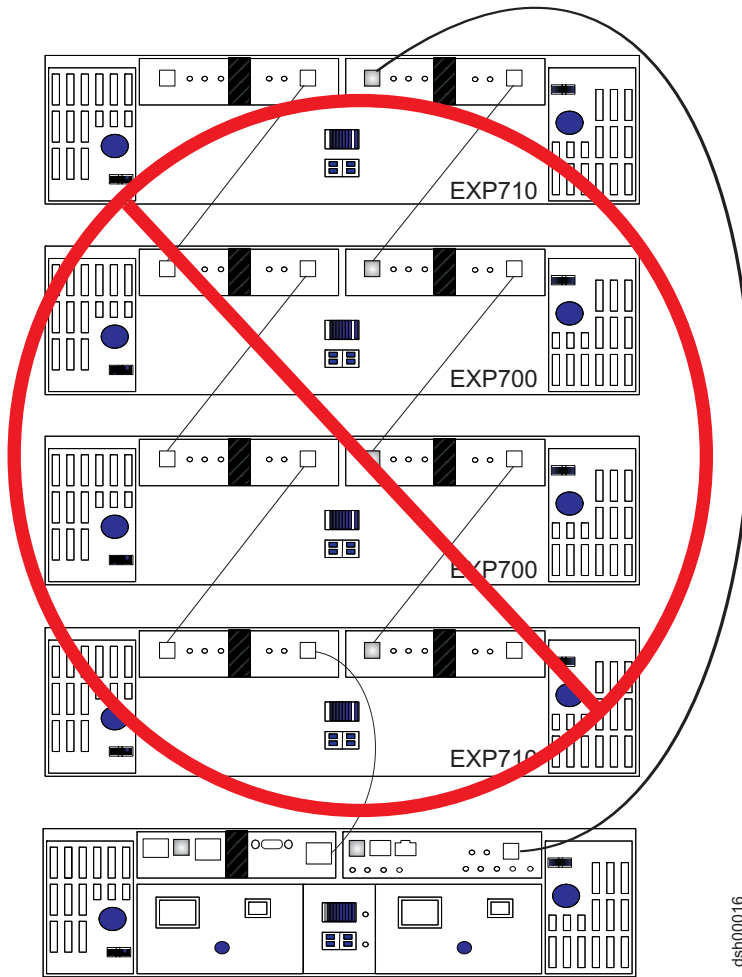
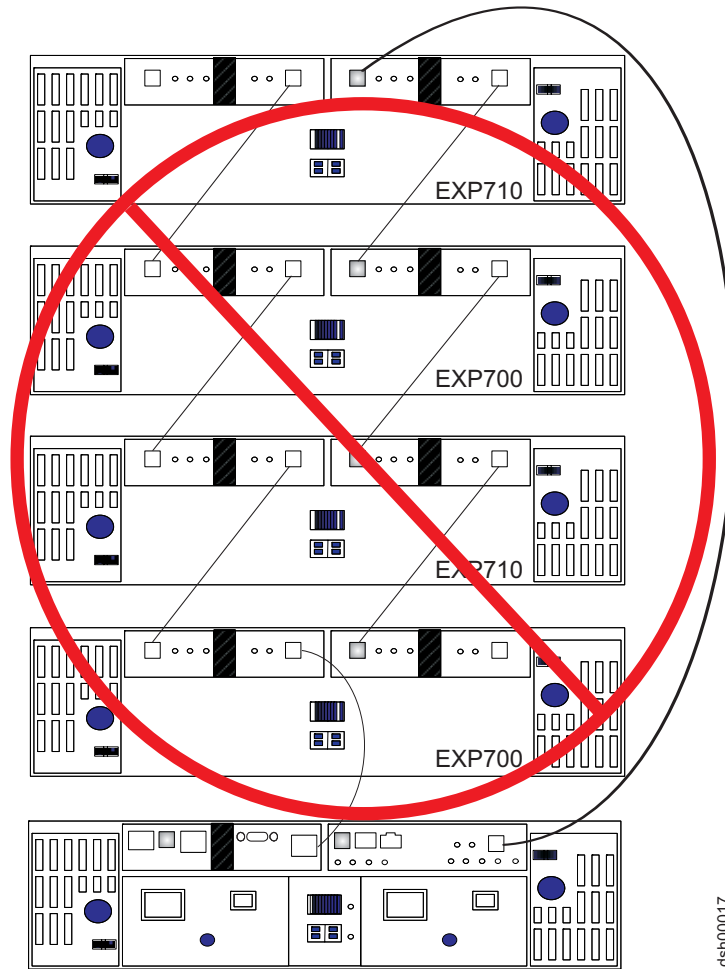


Figure 5. Unacceptable intermixed EXP700 (or EXP100) and EXP710 loop configuration (1 of 2)



dsh00017

Figure 6. Unacceptable intermixed EXP700 (or EXP100) and EXP710 loop configuration (2 of 2)

Intermixing EXP100, EXP710 and EXP810 storage expansion enclosures

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|
|

With controller firmware 6.23.xx.xx.xx, DS4300, DS4500, DS4700, and DS4800 storage subsystems support the intermixing of the EXP810 with EXP710s and EXP100s.

Even though storage expansion enclosures (EXP710s and EXP810s) do not need to be grouped by drive enclosure type, IBM recommends that you *do* group them by enclosure type in a redundant drive channel pair; this simplifies maintenance and troubleshooting. In addition, the EXP810 Link Rate switch must be set at 2 Gbps.

Notes:

1. The Link Rate setting only becomes effective after the EXP710 and EXP100 are powered up. Do not change the setting while the EXP810 is operational. Schedule a time to shut down the entire DS4000 configuration to change the Link Rate speed setting.
2. There are specific restrictions that you must follow when intermixing EXP100s with EXP710s and EXP810s in a DS4700 or DS4800 configuration. Please refer to the following section:
"Intermixing EXP100s with EXP710s and EXP810s in a DS4700 or DS4800 configuration" on page 31

There are maximum limits to the number of Fibre Channel hard drives that you can configure in redundant drive channel pairs. The maximum number of drives dictates a fixed number of supported EXP100 and/or EXP710 and EXP810 drive enclosure combinations. Table 8 lists the numbers of EXP100 and/or EXP710 and EXP810 storage expansion enclosures that you can combine for use in a single redundant drive channel/loop pair. Table 8 also assumes that a DS4000 Storage Subsystem is generally capable of addressing the maximum of 112 Fibre Channel hard drives for each redundant drive channel/loop pair.

Table 8. Supported EXP810 and EXP710, and/or EXP100 enclosure combinations per redundant drive channel/loop pair in a DS4000 subsystem with no internal drive slots configuration

Total number of EXP810 enclosures per redundant drive channel/loop pair	Total number of EXP710 and/or EXP100 enclosures per redundant drive channel/loop pair	Maximum number of storage expansion drives per redundant drive channel/loop pair	Maximum number of drives in mixed EXP100, EXP710, and EXP810 drive channel/loop pair
0	8	8	112
1	6	7	100
2	5	7	102
3	4	7	104
4	3	7	106
5	2	7	108
6	1	7	110
7	0	7	112

IBM recommends that you *do not* mix EXP100s and/or EXP710s and EXP810s together in the same redundant drive channel/loop pair if you plan to operate the EXP810 at a higher speed. Therefore, IBM recommends that you connect all of the EXP710s and/or EXP100s to a redundant drive channel pair and all of the EXP810s to the other (second) redundant drive channel pair in a DS4800 storage subsystem configuration.

Table 9 on page 21 shows the supported EXP810 and EXP710 storage expansion enclosures combinations per redundant drive channel/loop pair in a DS4700 Express configuration. The table assumes that a DS4700 Express storage subsystem is generally capable of addressing the maximum of 112 Fibre Channel hard drives for each redundant drive channel/loop pair.

(The DS4700 Express (with its internal drives) is already counted as one enclosure against the maximum number of enclosures that can be in a redundant channel/loop pair.)

Table 9. Supported EXP810 and EXP710/EXP100 enclosure combinations per redundant drive channel/loop pair in a DS4700 Express configuration

Number of EXP810s	Total number of drives in EXP810s	Number of EXP710s/EXP100s	Total number of drives in EXP710s/EXP100s	Total number of drives in the DS4700 Express	=	Total number of drives in a mixed EXP710/EXP100 and EXP810 drive loop
0	0	6	84	16	=	100
1	16	5	70	16	=	102
2	32	4	56	16	=	104
3	48	3	42	16	=	106
4	64	2	28	16	=	108
5	80	1	14	16	=	110
6	96	0	0	16	=	112

Attention:

1. Do not connect a combination of more than eight EXP710/EXP100 or seven EXP810 storage expansion enclosures to the two ports of a dual-ported drive channel. Failure to observe this limitation might result in loss of data availability.
2. Do not connect more than four EXP810 storage expansion enclosures to each port of the dual-ported drive channel. There are no restrictions to four or less storage expansion enclosures connected per drive port for the EXP710 and the EXP100 storage expansion enclosures; however, IBM recommends using the same rule for the EXP710/EXP100 enclosures to maximize drive channel performance.
3. It is recommended that you add storage expansion enclosures to the DS4800 drive ports in a round-robin fashion. For example, if you have four EXP810s needing to be cabled to the DS4800, instead of cabling all four EXP810s to one drive port of a drive channel, you should distribute the enclosures to all drive ports, which results in one enclosure per drive port of a drive channel.
4. Do not connect more than the recommended maximum number of enclosures per drive channel (eight for 14-drive and seven for 16-drive enclosures). When mixing 14-drive and 16-drive enclosures, the maximum number of expansion enclosures is seven per redundant drive channel pair.
5. DS4800 supports storage expansion enclosures operating at different Fibre Channel speeds (for example, 2 Gbps or 4 Gbps) only when they are installed in separate redundant drive channel pairs. DS4800 does not support a mix of storage expansion enclosures operating at different Fibre Channel speeds in the same redundant drive channel pair.
6. Even though you can intermingle EXP710 and EXP810 storage expansion enclosures in the same redundant drive channel pair, it is recommended that you cable storage together expansion enclosures of the same type to facilitate maintenance and troubleshooting in the event of failures. For instance, if you have EXP710s and EXP810s in the same redundant drive channel pair, it is preferred that you group the EXP710s together and the EXP810s together.

Table 10 shows the supported EXP810, EXP710, and EXP100 storage expansion enclosures combinations per redundant drive channel/loop pair in a DS4300 Turbo configuration. The table assumes that a DS4300 storage subsystem is generally capable of addressing the maximum of 112 Fibre Channel hard drives for each redundant drive channel/loop pair.

Table 10. Possible combinations of 14-drive and 16-drive storage expansion enclosures per drive loop for DS4300 dual controller Turbo models only

Number of EXP810s (16 drives/unit)	Total number of drives in EXP810s	Number of EXP710/EXP100s (14 drives/unit)	Total number of drives in EXP710/EXP100s	Total number of drives in the DS4300		Total number of drives in a mix EXP710s and EXP810s drive loop
0	0	7	98	14	=	112
1	16	5	70	14	=	100
2	32	4	56	14	=	102
3	48	3	42	14	=	104
4	64	2	28	14	=	106
5	80	1	14	14	=	108
6	96	0	0	14	=	110

Figure 7 and Figure 8 on page 24 illustrate acceptable cabling of EXP710 and EXP810 storage expansion enclosures in a mixed configuration.

Figure 9 on page 25 shows a recommended cabling example of the EXP810 and EXP710 enclosures in the same drive channel pair in a DS4800 configuration. All of the EXP810 are cabled together to one port of the dual-port drive channel in each of the controllers. Similarly all of the EXP710s are cabled together to the other port of the dual-port drive channel.

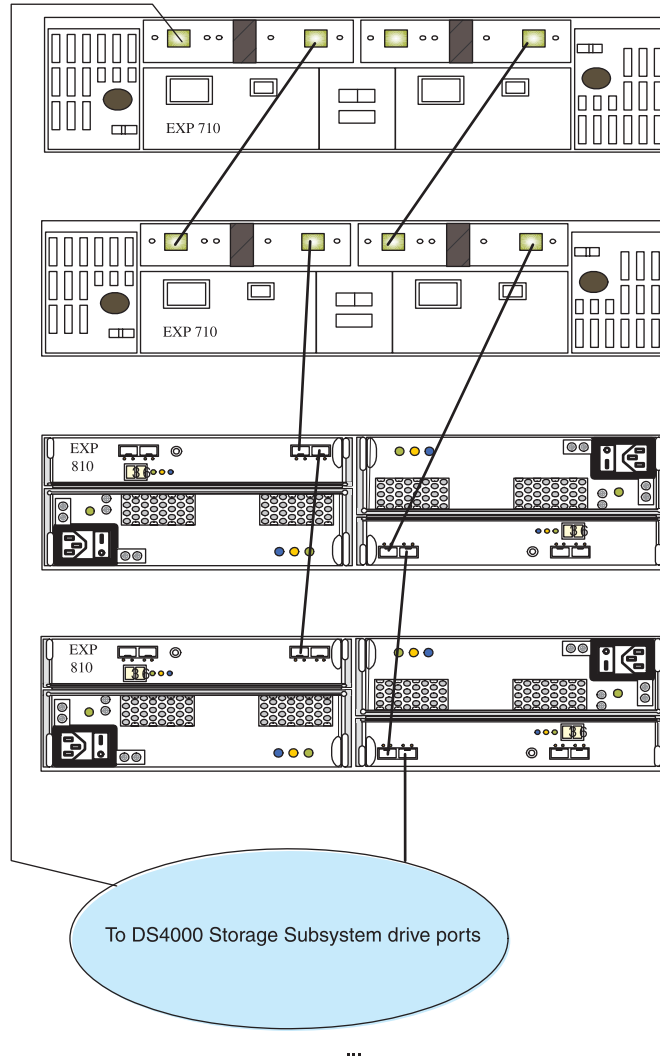


Figure 7. Acceptable intermixed DS4000 EXP710 and EXP810 loop configuration

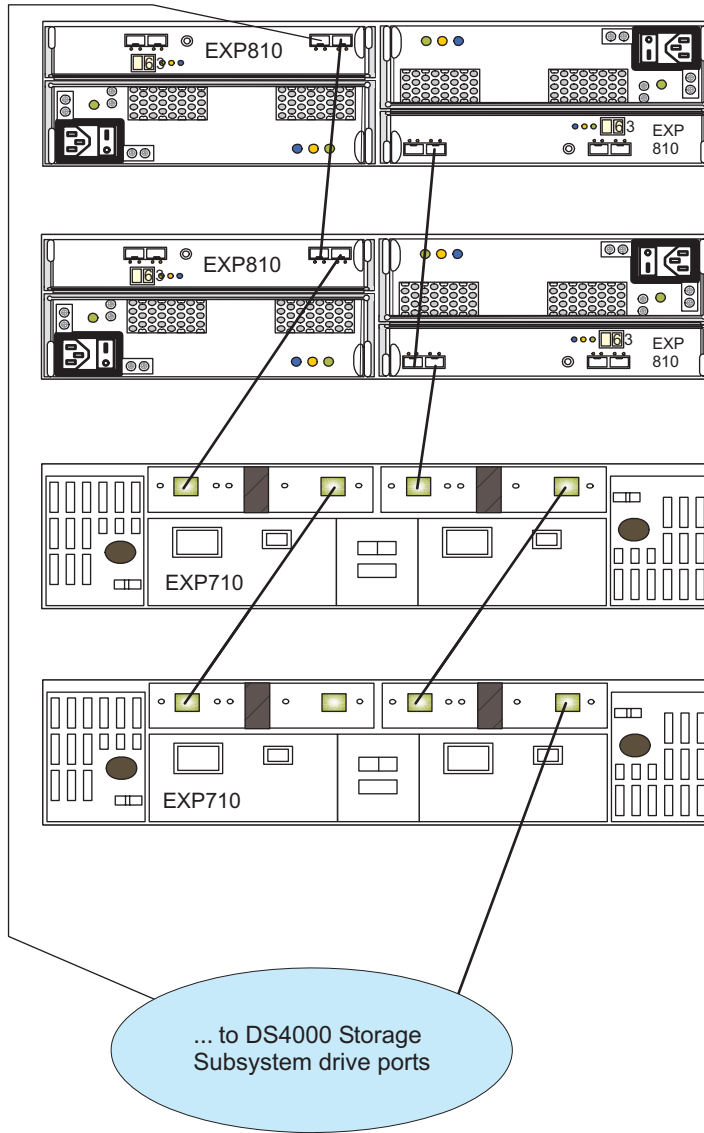


Figure 8. Acceptable intermixed DS4000 EXP710 and EXP810 loop configuration

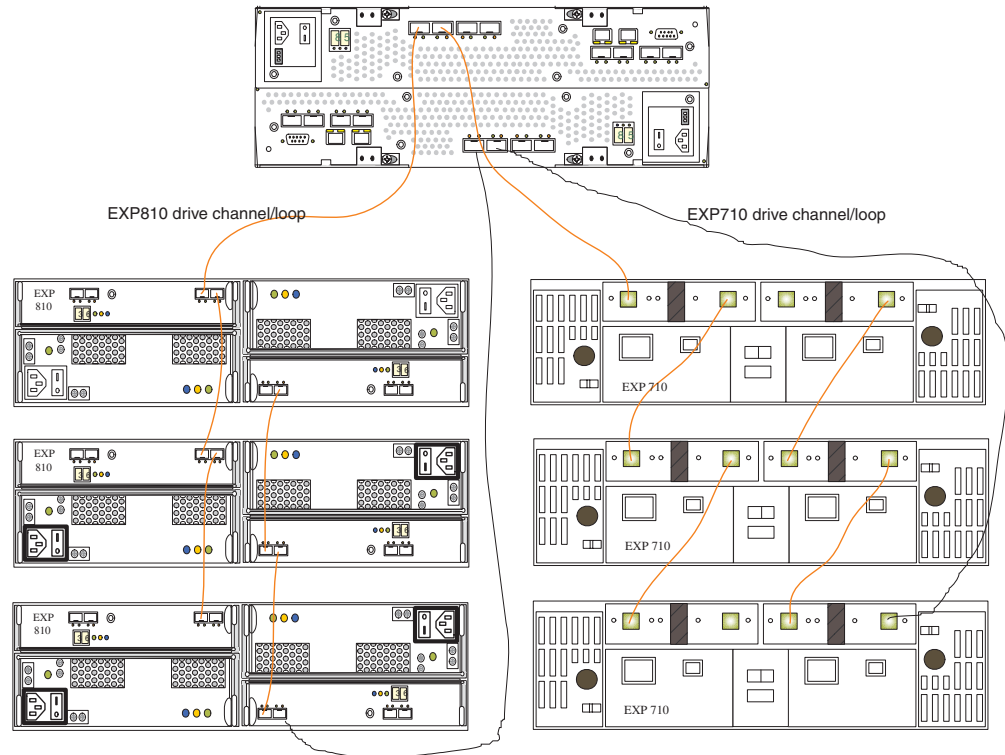


Figure 9. Preferred intermixed DS4000 EXP710 and EXP810 loop configuration

IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature

The DS4000 FC/SATA Intermix premium feature supports the concurrent attachment of Fibre Channel and SATA storage expansion enclosures to a single DS4000 controller configuration.

With this premium feature, you can create and manage distinct arrays or logical drives that are built from either Fibre Channel disks or SATA disks in a DS4000 Storage Subsystem, and allocate the drives to the appropriate applications in the attached host servers.

Notes:

1. For the most current information on the DS4000 Fibre Channel and SATA (FC/SATA) Enclosure Intermix premium feature, see the IBM System Storage Support Web site:
www.ibm.com/servers/storage/support/disk/
2. EXP810 FC/SATA Intermix is supported at the enclosure level only. You cannot intermix Fibre Channel and SATA drives within the same enclosure. For the most current information on the DS4000 Fibre Channel and SATA (FC/SATA) Enclosure Intermix premium feature and regarding future support for other Fibre Channel/SATA intermix combinations of DS4000 storage subsystems and storage expansion enclosures, contact your IBM reseller or representative, or check the DS4000 Interoperability Matrix at the IBM System Storage Support Web site:

www-03.ibm.com/servers/storage/disk/ds4000/pdf/interop-matrix.pdf

3. You must purchase the DS4000 FC/SATA Enclosure Intermix premium feature for each DS4000 Storage Subsystem that will have drive channels/loops intermixing SATA and Fibre Channel technology drives.

To ensure a successful intermixing of storage expansion enclosures, please see Appendix A, Appendix A, “IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview,” on page 135, for detailed information including:

- Intermix premium feature installation instructions
- Controller firmware requirements
- Supported combinations of DS4000 storage subsystems and storage expansion enclosures
- Recommended cabling schemes
- Important restrictions

The following restrictions apply to the use of the DS4000 FC/SATA Intermix premium feature, and should be noted:

EXP100 cabling rules

When intermixing EXP100 storage expansion enclosures with EXP710s and EXP810s behind a DS4700 or DS4800 storage subsystem, you need to follow the cabling rules that are listed in the following section:

“Intermixing EXP100s with EXP710s and EXP810s in a DS4700 or DS4800 configuration” on page 31

Setting Enclosure IDs with unique single digit values

Enclosure IDs (sometimes known as tray IDs, or server IDs) consist of two digits: x10 and x1. In 14-drive expansion enclosures (EXP100/EXP700/EXP710), you can set the enclosure ID manually. Ensure that the single digit (x1) of the enclosure ID is unique for every enclosure in a redundant drive loop pair.

Grouping DS4000 storage expansion enclosures in a redundant drive loop

Attention:

Configurations that do not follow this DS4000 storage expansion enclosures grouping restriction are not supported.

When mixing enclosures with Fibre Channel and SATA drives in a drive loop (DS4300/DS4400/DS4500) or behind a drive channel port (DS4700/DS4800), always group the enclosures with the same drive interface technology together.

DS4000 Storage Subsystem drive loop schemes

Although a variety of cable loop schemes might function acceptably, IBM recommends consistent use of only one such scheme when connecting DS4000 Storage Subsystems and expansion enclosures.

Note: In addition, there are specific restrictions that you must follow when intermixing EXP100s with EXP710s and EXP810s in a DS4700 or DS4800 configuration. Please refer to the following section:

“Intermixing EXP100s with EXP710s and EXP810s in a DS4700 or DS4800 configuration” on page 31

Figure 10 illustrates the only cable loop scheme that IBM recommends when connecting DS4000 Storage Subsystems and expansion enclosures.

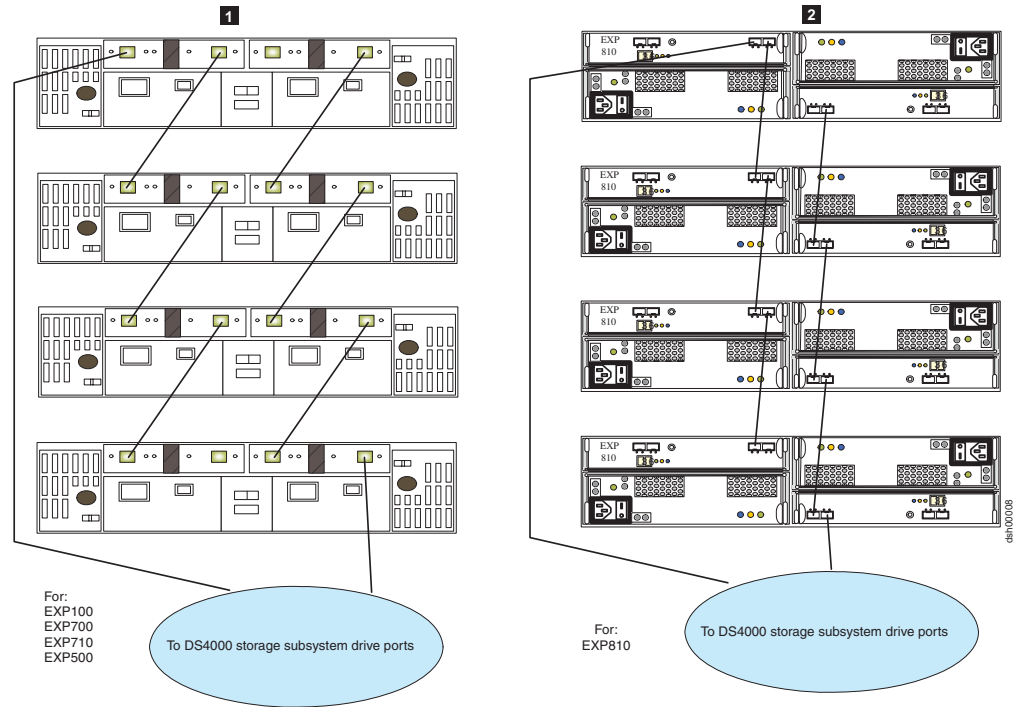


Figure 10. Recommended cable loop scheme for connecting DS4000 storage devices

Legend:

- 1** Recommended cabling for EXP100, EXP500, EXP700, and EXP710 with DS4000 Storage Subsystem
- 2** Recommended cabling for EXP810 with DS4000 Storage Subsystem

IBM cautions against inconsistent use of any cable loop scheme. Figure 11 on page 28 through Figure 14 on page 31 show unacceptable cabling loop schemes.

Attention: Do not use the cable schemes illustrated in Figure 11 on page 28 or Figure 14 on page 31 because they will affect diagnostic capability in the event of drive loop failures.

- Do not connect more than four enclosures behind each drive channel port.
- For non-EXP810, connect to the IN port of the ESM on the left and the OUT port of the ESM on the right.
- For EXP810, connect to port 1B on either the right or left ESM.

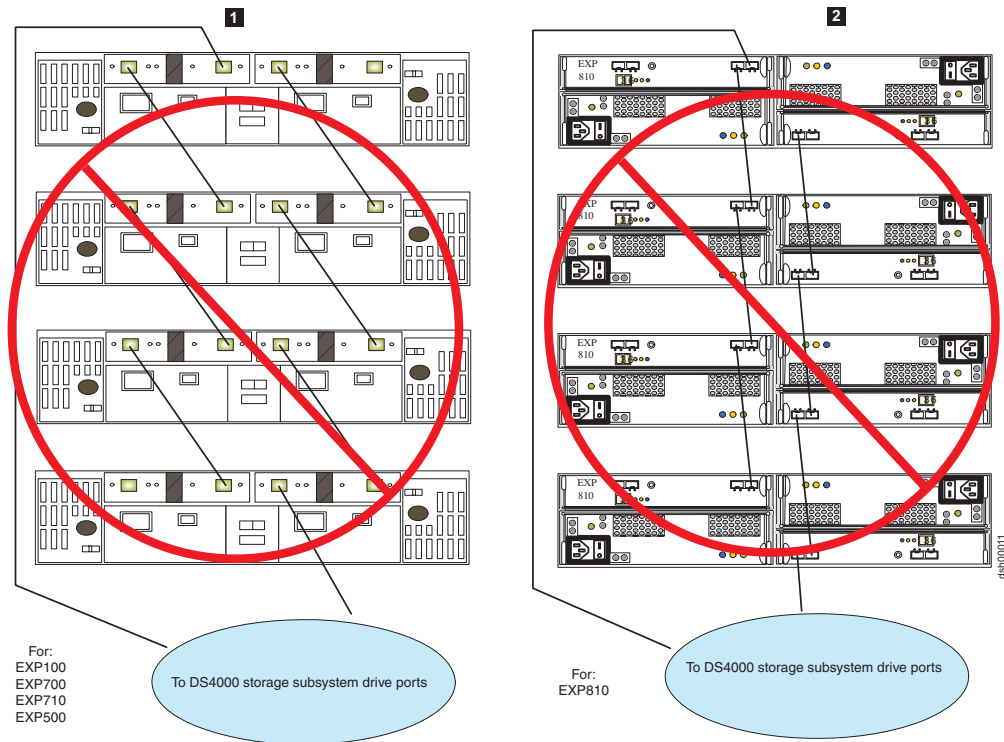


Figure 11. **Not** recommended for alternate cable loop scheme, when connecting DS4000 storage devices

Legend:

- 1** Method not recommended for cabling for EXP100, EXP500, EXP700, and EXP710 with DS4000 Storage Subsystem
- 2** Method not recommended for cabling for EXP810 with DS4000 Storage Subsystem

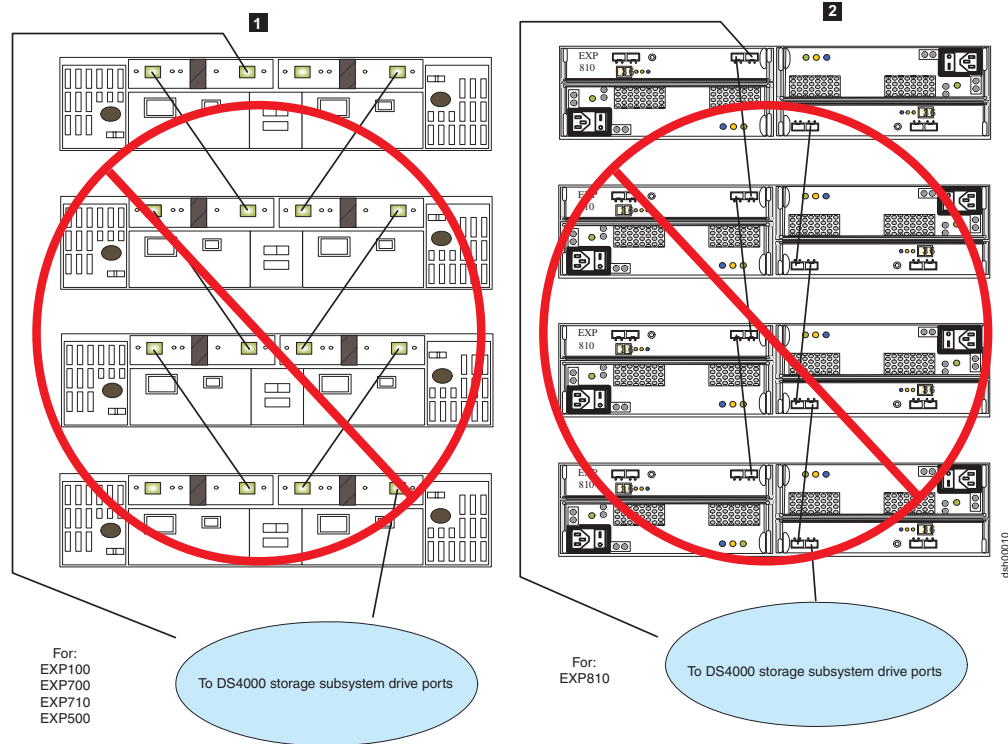


Figure 12. Not recommended alternate cable loop scheme for connecting DS4000 storage devices

Legend:

- 1** Not recommended cabling for EXP100, EXP500, EXP700, and EXP710 with DS4000 Storage Subsystem
- 2** Not recommended cabling for EXP810 with DS4000 Storage Subsystem

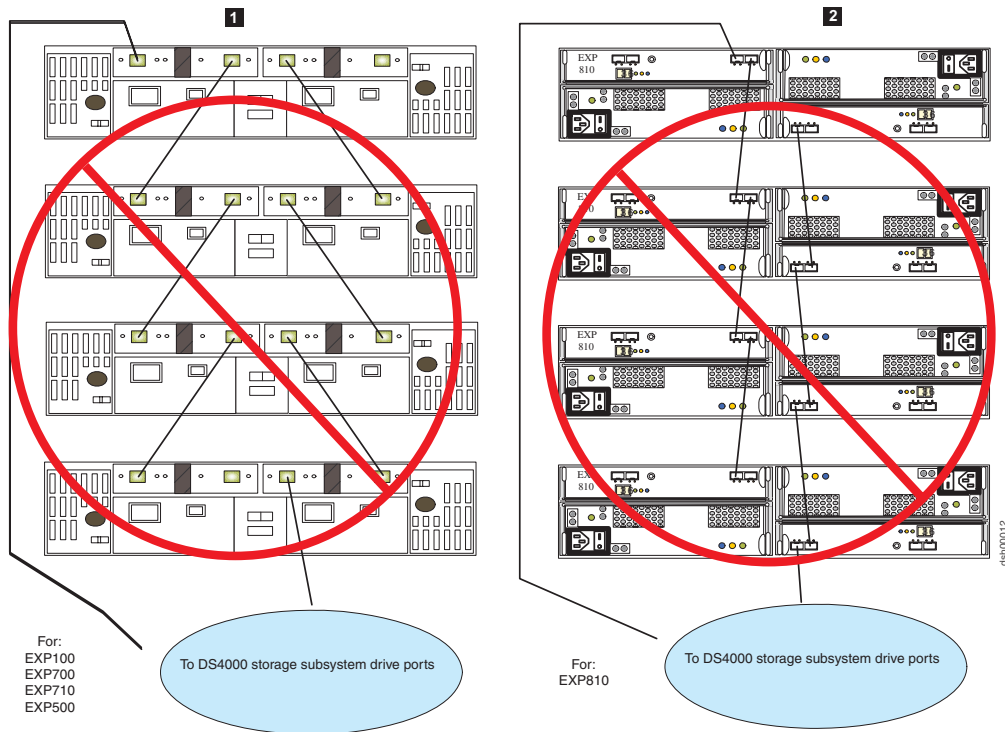


Figure 13. Unacceptable cable loop scheme for connecting DS4000 storage devices

Legend:

- 1** Unacceptable cabling for EXP100, EXP500, EXP700, and EXP710 with DS4000 Storage Subsystem
- 2** Unacceptable cabling for EXP810 with DS4000 Storage Subsystem

Note: The cable loop scheme in Figure 13 is unacceptable because both drive loops are connected to the IN port of the EXP700. Although this restriction does not specifically apply to other storage expansion enclosures, you should still avoid connecting both drive loops in the IN port to prevent accidental miscabling in the EXP700 environment.

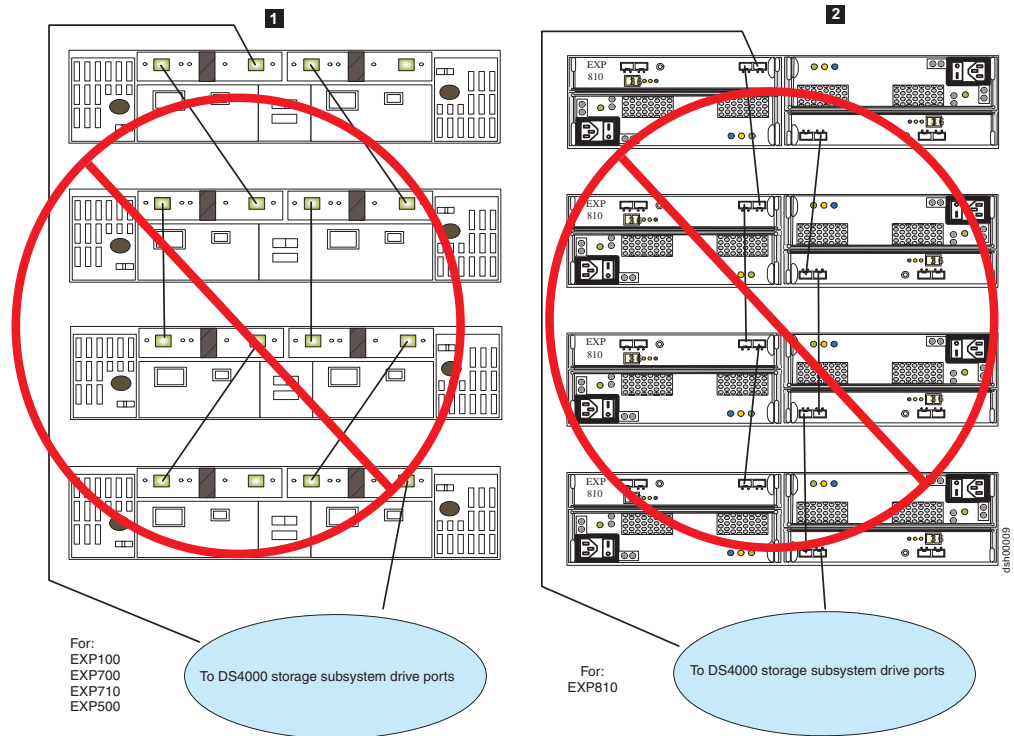


Figure 14. Unacceptable cable loop scheme for connecting DS4000 storage devices

Legend:

- 1** Unacceptable cabling for EXP100, EXP500, EXP700, and EXP710 with DS4000 Storage Subsystem
- 2** Unacceptable cabling for EXP810 with DS4000 Storage Subsystem

Note: The cable loop scheme in Figure 14 is unacceptable because of the random pattern between the storage expansion enclosures.

Intermixing EXP100s with EXP710s and EXP810s in a DS4700 or DS4800 configuration

When intermixing EXP100s, EXP710s, and EXP810s in a DS4700 or DS4800 storage subsystem configuration, if it is not possible to cable each group of enclosures by model type (EXP100s, EXP710s, and EXP810s) in a separate redundant drive loop pair or behind each port of the dual-ported redundant drive channel pair, group them so that EXP810s are between EXP100s and EXP710s.

In addition, when an EXP100 is the first storage expansion enclosure cabled directly to the storage subsystem's controller drive port, follow these rules:

- Cable from the storage subsystem controller drive port to the OUT port on the left ESM (ESM A) of the EXP100.

Note: This is a change from previous cabling recommendations where you cabled from the controller drive port to the IN port on the left ESM (ESM A) of the EXP100.

- If an EXP100 follows the initial EXP100, cable from the IN port on the left ESM (ESM A) of the first EXP100 to the OUT port on the left ESM of the next

EXP100. Continue this cabling pattern until you encounter an EXP710 or EXP810, then cable from the IN port on the left ESM (ESM A) of the EXP100 to the IN port of the EXP710 or EXP810.

- If an EXP710 or EXP810 follows the initial EXP100, cable from the IN port on the left ESM (ESM A) of the EXP100 to the IN port of the EXP710 or EXP810. To cable to the next storage expansion enclosure in the chain, cable from the OUT port of the left ESM of the EXP710 or EXP810 to the IN port of the next storage expansion enclosure.
- Continue the left ESM (ESM A) cabling pattern by cabling from the OUT port to the IN port on subsequent storage expansion enclosures until you complete the chain.

Figure 15 shows an acceptable EXP710, EXP810 and EXP100 intermix configuration in a DS4700 or DS4800 environment. The cabling is acceptable because it follows the cabling recommendations.

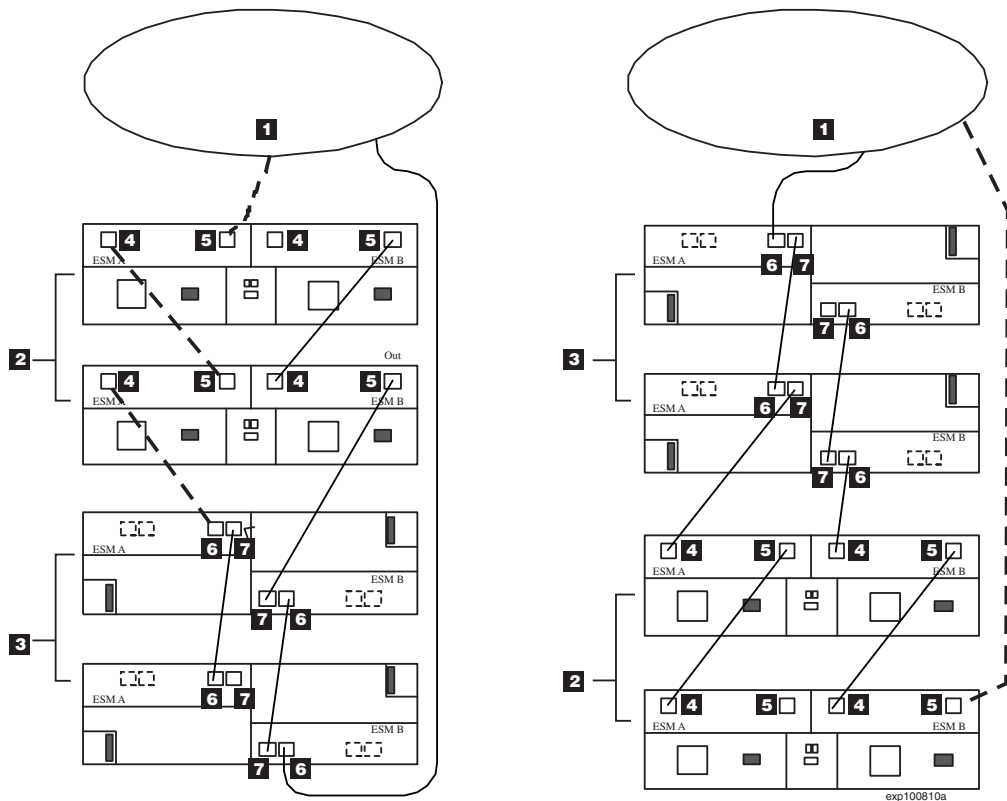


Figure 15. Acceptable EXP710, EXP810 and EXP100 intermix configuration in a DS4700 or DS4800 environment

Table 11. Description of Figure 15

Number	Description
1	DS4700 or DS4800 storage subsystem
2	EXP100
3	EXP810
4	IN port
5	OUT port
6	Port 1B

Table 11. Description of Figure 15 on page 32 (continued)

Number	Description
7	Port 1A

Figure 16 shows an unacceptable EXP710, EXP810, and EXP100 intermix configuration in a DS4700 or DS4800 environment. The cabling is unacceptable because storage subsystem controller is cabled to the IN port on the left ESM of the first EXP100.

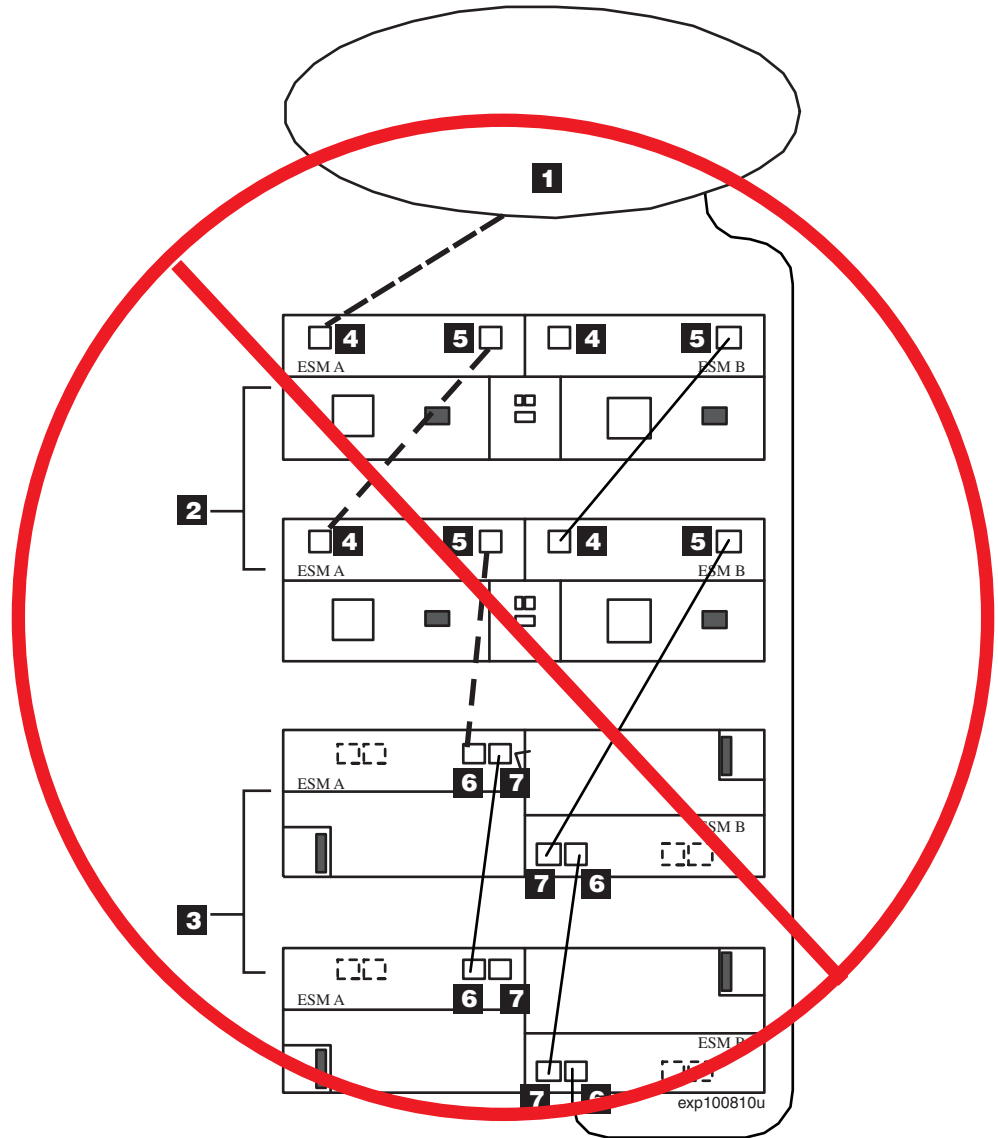


Figure 16. Unacceptable EXP710, EXP810 and EXP100 intermix configuration in a DS4700 or DS4800 environment

Table 12. Description of Figure 16

Number	Description
1	DS4700 or DS4800 storage subsystem
2	EXP100

Table 12. Description of Figure 16 on page 33 (continued)

Number	Description
3	EXP810
4	IN port
5	OUT port
6	Port 1B
7	Port 1A

Figure 17 shows cabling variations when intermixing EXP100, EXP710, and EXP810 storage expansion enclosures behind a DS4800 Storage Subsystem.

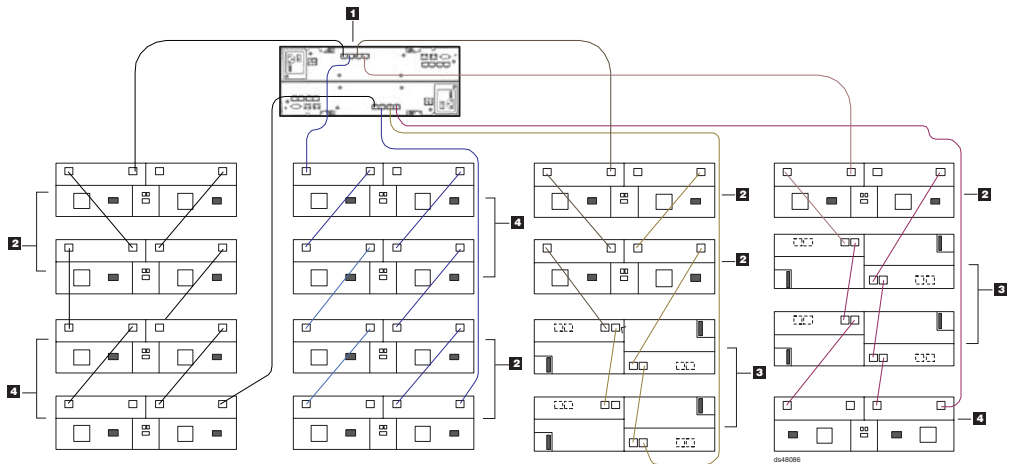


Figure 17. Cabling variations when intermixing EXP100, EXP710, and EXP810 storage expansion enclosures behind a DS4800 Storage Subsystem

Table 13. Description of Figure 17

Number	Description
1	DS4800 Storage Subsystem
2	EXP100
3	EXP810
4	EXP710

Setting enclosure IDs

Each drive enclosure (including the DS4000 storage subsystem with internal drive slots) in a DS4000 Storage Subsystem configuration must have a unique drive enclosure ID. DS4000 controllers use a combination of the enclosure ID and the number of the physical slot that a hard drive occupies to create a unique loop address or arbitrated loop physical address (AL_PA) for each drive in a drive loop. The enclosure ID consists of two digits, a tens (x10) digit and a ones (x1) digit. IBM recommends the use of the tens digit portion of the enclosure ID to differentiate enclosures from different redundant drive loop/channel pairs and the singles digit portion to differentiate enclosures in the same redundant drive loop/channel pair. The possible values for the tens and the ones digits are 0-9 for EXP420, EXP500, and EXP810 drive enclosures, and 0-7 for EXP100, EXP700, and EXP710 drive enclosures.

The enclosure ID of each enclosure (including the DS4000 storage subsystem with internal drive slots) in a redundant drive loop must have unique ones digit IDs. (This was previously a best practice recommendation, but it is now a requirement.) This setting will enforce hard AL_PAs (unchangeable between Loop Initializations [LIPs]) for the drives and facilitate drive loop problem troubleshooting in the event of an error. If the ones digits are not unique, two or more devices will have the same hard AL_PA. In such a case, the controller will use soft AL_PAs for the devices that have identical hard AL_PAs.

Important:

Changing enclosure IDs on 14-drive enclosures and storage subsystems with the mechanical enclosure ID switch requires the power cycle of the DS4000 subsystem and all enclosures in the configuration to activate the new settings. Changing the enclosure IDs on 16-drive enclosures and storage subsystems (EXP420s, EXP810s, DS4700s, or DS4200s) does not require the power cycle of all enclosures and the DS4000 subsystem, if there are no 14-drive enclosures intermixed in the configuration or if the 16-drive enclosures are only connected to a DS4000 controller with 16 internal drive slots (DS4200 or DS4700). If the enclosure IDs of the enclosures or storage subsystems with the mechanical enclosure ID switch in your DS4000 subsystem configuration are not currently set to have unique single digit values for the enclosures in the same redundant drive loop pair, make the changes to the enclosure IDs in the next maintenance schedule. This will prevent unnecessary downtime when you add enclosures of different type (especially EXP810s) to the existing enclosures in the redundant drive loop/channel pair.

You do not have to manually assign an enclosure ID for an EXP810 storage expansion enclosure. The enclosure ID is automatically assigned. However, if you do manually assign the enclosure ID for the EXP810, ensure that the enclosure ID of the EXP810s in the same drive loop are unique.

Note: If you are using an EXP100, EXP710, and EXP810 in a drive loop, you must set the enclosure ID for the EXP100 and EXP710. The EXP810 enclosure ID is automatically set.

The problem with soft AL_PA addressing is that addresses can change between LIPs. This possibility increases the difficulty of troubleshooting drive loop problems because it is difficult to ascertain whether the same device with a different address or a different device might be causing a problem. Because the DS4000 Storage Subsystem can support more enclosures than available values of the enclosure ID ones digit, Table 14 on page 36 through Table 18 on page 39 suggest enclosure ID settings for various drive expansion enclosure families to minimize soft addressing in a drive loop. Also note that soft AL_PA addressing might result in an excessive number of drive loop information events posting in the DS4000 storage subsystem Major Events Log (MEL); especially in a DS4000 storage subsystem having different storage enclosure types intermixed in the same redundant drive loop pair; for example, DS4300 subsystem configurations intermixed with EXP810s and EXP100s in the same drive loop.

Important:

The recommended enclosure ID settings were changed, starting with this release of the *IBM System Storage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*. The ID settings were modified to avoid having enclosure IDs of 0 (zero) in a drive loop/channel. Due to the physical design and

movement of the mechanical enclosure ID switch, it is possible to leave the switch in a dead zone between ID numbers, which returns an incorrect enclosure ID to the storage management software. The most commonly returned enclosure ID is 0 (zero). In addition to causing the subsystem management software to report an incorrect enclosure ID, this behavior also results in an enclosure ID conflict error with the storage expansion enclosure or DS4000 storage subsystem in which the ID has been intentionally set to 0 (zero).

The DS4200 Express and DS4700 Express storage subsystems and the EXP420 and EXP810 storage expansion enclosures do not have mechanical ID switches and are not susceptible to this problem. These storage subsystems and storage expansion enclosures automatically set the enclosure IDs. IBM recommends *not* making any changes to these settings, unless the automatic enclosure ID settings result in non-unique single digit settings for all enclosures (including the storage subsystems with internal drive slots) in a given drive loop/channel.

Table 14. EXP500 Storage Expansion Enclosure ID settings

Storage expansion enclosure	Enclosure ID setting for enclosure in the first redundant drive loop	Enclosure ID setting for enclosure in the second redundant drive loop if applicable/supported
1st unit (storage expansion enclosure or storage server with internal drive slots)	10	x0 (where x is 3-7)
2nd unit (EXP500)	11	x1 (where x is 3-7)
3rd unit (EXP500)	12	x2 (where x is 3-7)
4th unit (EXP500)	13	x3 (where x is 3-7)
5th unit (EXP500)	14	x4 (where x is 3-7)
6th unit (EXP500)	15	x5 (where x is 3-7)
7th unit (EXP500)	16	x6 (where x is 3-7)
8th unit (EXP500)	17	x7 (where x is 3-7)
9th unit (EXP500)	18	x8 (where x is 3-7)
10th unit (EXP500)	19	x9 (where x is 3-7)
11th unit (EXP500)	21	x0 (where x is 3-7)

Note: Drives in the 11th enclosures of each drive loop in Table 14 will have soft AL_PAs.

Table 15 on page 37 suggests enclosure ID settings that minimize soft addressing for EXP100 storage expansion enclosures in a drive loop.

Table 15. EXP100 Storage Expansion Enclosure ID settings

Storage expansion enclosure (unmixed)	Enclosure ID setting for enclosure in the first redundant drive loop	Enclosure ID setting for enclosure in the second redundant drive loop if applicable/supported
1st unit (EXP100 Expansion Enclosure or DS4000 Storage Subsystem with internal drive slots)	10	x0 (where x is 3-7)
2nd unit (EXP100)	11	x1 (where x is 3-7)
3rd unit (EXP100)	12	x2 (where x is 3-7)
4th unit (EXP100)	13	x3 (where x is 3-7)
5th unit (EXP100)	14	x4 (where x is 3-7)
6th unit (EXP100)	15	x5 (where x is 3-7)
7th unit (EXP100)	16	x6 (where x is 3-7)
8th unit (EXP100)	17	x7 (where x is 3-7)
9th unit (EXP100, where the first unit is a DS4300 only)	21	

Note: Except for the drives in the 9th unit, all drives in the drive loops described in Table 15 will be assigned hard AL_PAs.

Table 16 suggests enclosure ID settings that minimize soft addressing for EXP700 or EXP710 storage expansion enclosures in a drive loop.

Table 16. EXP700 or EXP710 Storage Expansion Enclosure ID settings

Storage expansion enclosure (unmixed)	Enclosure ID setting for enclosure in the first redundant drive loop	Enclosure ID setting for enclosure in the second redundant drive loop if applicable/supported
1st unit (storage expansion enclosure or DS4000 Storage Subsystem with internal drive slots)	10	x0 (where x is 3-7)
2nd unit (EXP700)	11	x1 (where x is 3-7)
3rd unit (EXP700)	12	x2 (where x is 3-7)
4th unit (EXP700)	13	x3 (where x is 3-7)
5th unit (EXP700)	14	x4 (where x is 3-7)
6th unit (EXP700)	15	x5 (where x is 3-7)

Table 16. EXP700 or EXP710 Storage Expansion Enclosure ID settings (continued)

Storage expansion enclosure (unmixed)	Enclosure ID setting for enclosure in the first redundant drive loop	Enclosure ID setting for enclosure in the second redundant drive loop if applicable/supported
7th unit (EXP700)	16	x6 (where x is 3-7)
8th unit (EXP700)	17	x7 (where x is 3-7)

Note: All drives in drive loops described in Table 16 on page 37 will be assigned hard AL_PAs.

Table 17 suggests enclosure ID settings that minimize soft addressing for the EXP500 and EXP700 storage expansion enclosure when intermixed in a redundant drive loop.

Table 17. Intermixed EXP500 and EXP700 Storage Expansion Enclosure ID settings

Storage expansion enclosure models (intermixed)	Enclosure ID setting for enclosure in the first redundant drive loop	Enclosure ID setting for enclosure in the second redundant drive loop
1st unit (EXP500 or EXP700)	10	x0 (where x is 3-7)
2nd unit (EXP500 or EXP700)	11	x1 (where x is 3-7)
3rd unit (EXP500 or EXP700)	12	x2 (where x is 3-7)
4th unit (EXP500 or EXP700)	13	x3 (where x is 3-7)
5th unit (EXP500 or EXP700)	14	x4 (where x is 3-7)
6th unit (EXP500 or EXP700)	15	x5 (where x is 3-7)
7th unit (EXP500 or EXP700)	16	x6 (where x is 3-7)
8th unit (EXP500 or EXP700)	17	x7 (where x is 3-7)
9th unit (EXP500 or EXP700)	18 for EXP500 or 21 for EXP700	x8 where x is 3-7 for EXP500 or x1 for EP700 where x is 3-7 and is not a number that was chosen for the 2nd unit above
10th unit (EXP500 or EXP700)	19 for EXP500 or 22 for EXP700	x9 where x is 3-7 for EXP500 or x2 for EP700 where x is 3-7 and is not a number that was chosen for the 3rd unit above

Note: The drives in the 9th and 10th enclosures in each drive loop described in Table 17 will have soft AL_PAs.

Table 18 on page 39 suggests enclosure ID settings that minimize soft addressing for the EXP700 and EXP710 storage expansion enclosure when intermixed in a

redundant drive loop.

Table 18. Intermixed EXP700 and EXP710 Storage Expansion Enclosure ID settings

Storage expansion enclosure models (intermixed)	Enclosure ID setting for enclosure in the first redundant drive loop	Enclosure ID setting for enclosure in the second redundant drive loop
1st unit (storage expansion enclosure or DS4000 Storage Subsystem with internal slots)	10	x0 (where x is 3-7)
2nd unit (EXP700 or EXP710)	11	x1 (where x is 3-7)
3rd unit (EXP700 or EXP710)	12	x2 (where x is 3-7)
4th unit (EXP700 or EXP710)	13	x3 (where x is 3-7)
5th unit (EXP700 or EXP710)	14	x4 (where x is 3-7)
6th unit (EXP700 or EXP710)	15	x5 (where x is 3-7)
7th unit (EXP700 or EXP710)	16	x6 (where x is 3-7)
8th unit (EXP700 or EXP710)	17	x7 (where x is 3-7)

Table 19 suggests enclosure ID settings that minimize soft addressing for the EXP100, EXP710, and EXP810 storage expansion enclosures when intermixed in a redundant drive loop. The DS4200 and DS4700 storage subsystems and the EXP420 and EXP810 storage expansion enclosures do not have mechanical enclosure ID switches. These storage subsystems and storage expansion enclosures automatically set the enclosure IDs. In DS4000 configurations with these storage subsystems or expansion enclosures, IBM recommends *not* making any changes to these settings, unless the automatic enclosure ID settings result in non-unique single digit settings for any enclosures (including the storage subsystems with internal drive slots) in a given drive loop/channel. Use the following table only in configurations that have an intermix of storage subsystems and/or expansion enclosures with mechanical enclosure ID switches (EXP100, EXP710 or DS4300) and storage subsystems and/or expansion enclosures with electronic enclosure ID (EXP810, DS4700).

Table 19. Intermixed EXP100, EXP710, and EXP810 Storage Expansion Enclosure ID settings

Storage expansion enclosure models (intermixed)	Enclosure ID setting for enclosure in the first redundant drive loop	Enclosure ID setting for enclosure in the second redundant drive loop
1st unit (EXP810 or EXP100) EXP710, or DS4000 Storage Subsystem with internal slots	10	x0(where x is 3-7)
2nd unit (EXP810 or EXP710)	11	x1(where x is 3-7)

Table 19. Intermixed EXP100, EXP710, and EXP810 Storage Expansion Enclosure ID settings (continued)

Storage expansion enclosure models (intermixed)	Enclosure ID setting for enclosure in the first redundant drive loop	Enclosure ID setting for enclosure in the second redundant drive loop
3rd unit (EXP810 or EXP710)	12	x2(where x is 3-7)
4th unit (EXP810 or EXP710)	13	x3(where x is 3-7)
5th unit (EXP810 or EXP710)	14	x4(where x is 3-7)
6th unit (EXP810 or EXP710)	15 (or 16 if connected to the DS4700 storage subsystem having default enclosure ID set at 85)	x5 (or x6 if connected to the DS4700 storage subsystem having default enclosure ID set at 85)(where x is 3-7)
7th unit (EXP810 or EXP710)	17	x7(where x is 3-7)

Note: Use the values of the enclosure IDs in the first redundant drive loop/channel pair column as recommended settings for the EXP420s attaching to DS4200s.

Determining firmware levels

There are two different methods to determine DS4000 Storage Subsystem, expansion unit, drive, and ESM firmware versions. Each method uses the DS4000 Storage Manager client that manages the DS4000 storage subsystem with the attached expansion unit.

Method one:

For controllers with firmware version 6.1x.xx.xx or later, go to the Subsystem Management window and select **Storage Subsystem -> View Profile**. For controllers with firmware version 5.xx.xx.xx or earlier select **View -> Storage Subsystem Profile**. When, under either circumstance, the Storage Subsystem Profile window opens, select the **All** tab and scroll through the **Profile For Storage Subsystem** section to locate the following information.

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

DS4000 Storage Subsystem

- NVSRAM version
- Controller firmware (and/or appware, bootware) version

See the following example or snapshot of profile information.

```
Controller in Enclosure 0, Slot A
Status: Online
Current configuration
Firmware version: 06.10.07.00
Appware version: 06.10.07.00
Bootware version: 06.10.07.00
NVS RAM version: 1722F600R910V05
```

Drives

- Firmware version
- ATA translator card (for EXP810 SATA drive CRU only)

ESM

- ESM card firmware version

Method two:

Select the appropriate procedure from the following options and complete it to obtain the specified firmware version.

To obtain the controller firmware version:

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

You must perform this step for each individual controller.

To obtain the drive and ATA translator firmware version:

Right-click the Drive icon in the Physical View pane of the Subsystem Management window and select **Properties**. The Drive Properties window opens and displays the properties for that drive.

You must perform this step for each individual drive.

To obtain the ESM firmware version:

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

To obtain the drive enclosure component firmware version:

1. Click the Drive Enclosure Component icon (the icon located furthest to the right) in the Drive Enclosure frame in the Physical View pane of the Subsystem Management window. The Drive Enclosure Component Information window opens.
2. Click the ESM icon in the left pane. The ESM information displays in the right pane of the Drive Enclosure Component Information window.
3. Locate the firmware version of each ESM in the drive enclosure.
You must perform this step for each drive expansion enclosure.

Determining the product ID and model of a drive

You can determine the product ID and model of a drive from the storage server profile through the menu option in the DS4000 Subsystem Management window. To get the profile, in the DS4000 Subsystem Management window, either click **View -> Storage Subsystem Profile** (if the controller firmware version is 05.xx.xx, or earlier) or **Storage Subsystem -> View Profile** (if the controller firmware version is 06.xx.xx, or later). When the Storage Subsystem Profile window displays, click on the **Drives** tab and scroll down to the information about the drive which product ID and model you want to verify. See Table 20 for a sample profile indicating the product ID of the drive in slot 1 of enclosure ID 1 as ST3146807FC. In addition, the Speed and Current® Data Rate fields show that this drive is a 10Krpm drive and is operating at 2 Gbps Fibre Channel data rate.

Table 20. Snapshot of profile information identifying the product ID of the drive in slot 1 of enclosure ID 1 as ST3146807FC

HOT SPARE COVERAGE: The following arrays are not protected: 1, 2 Total hot spare drives: 0 Standby: 0 In use: 0 DETAILS: Drive at Enclosure 1, Slot 1 Drive port: 1, Channel: 1; ID: 8/0xD9 Drive port: 2, Channel: 2; ID: 8/0xD9 Drive path redundancy: OK Status: Optimal Raw capacity: 136.732 GB Usable capacity: 136.732 GB Current data rate: 2 Gbps Product ID: ST3146807FC !# Firmware version: B350 Serial number: 3HY062YK00007309FAT1 Vendor: IBM-ESXS Date of manufacture: May 29, 2002 World-wide name: 20:00:00:04:cf:56:43:fb Drive type: Fibre Channel Speed: 10033 RPM Mode: Assigned Associated array: 1 Drive at Enclosure 1, Slot 2 Drive port: 1, Channel: 2; ID: 9/0xD9 Drive port: 2, Channel: 1; ID: 9/0xD9 Drive path redundancy: OK Status: Optimal Raw capacity: 136.732 GB Usable capacity: 136.732 GB Current data rate: 2 Gbps
--

DS4000 Storage Manager installation and support guides

This publication frequently cites *IBM System Storage DS4000 Storage Manager* installation and support guides, which support various versions and operating system environments. There are currently two, namely:

- *IBM System Storage DS4000 Storage Manager Installation and Support Guide for AIX[®], HP-UX, Solaris and Linux[®] on Power*
- *IBM System Storage DS4000 Storage Manager Installation and Support Guide for Intel-based Operating System Environments*

Visit the following Web site to access documentation related to your particular operating system and DS4000 Storage Manager version:

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

See Appendix C, “Additional DS4000 documentation,” on page 171 for more information.

Chapter 2. Prerequisites to adding capacity and hard drive migration

Perform the preliminary steps detailed in this chapter before you add storage capacity or migrate hard drives. After you meet these prerequisite requirements, proceed to any of the following sections to address your particular storage hardware addition or migration requirements:

- Chapter 3, “Adding or migrating hard drives,” on page 61
- Chapter 4, “Adding or migrating storage expansion enclosures,” on page 75
- Chapter 5, “Upgrading a storage subsystem in a functioning configuration,” on page 121

Failure to perform the steps listed in this section might result in loss of data availability, and in some cases, loss of data. Perform the following steps on the DS4000 Storage Subsystem to which you will migrate or add new hard drives:

- ___ Step 1. Complete a full backup of all data residing on the DS4000 Storage Subsystem.
- ___ Step 2. Verify that the backup was successful.
- ___ Step 3. Verify that the DS4000 Storage Subsystem has the latest controller firmware, nonvolatile storage random access memory (NVSRAM), and ESM firmware.
Attention: Before upgrading the controller firmware, please consult the readme file that is packaged with the firmware code for any special prerequisite tasks or any ESMs firmware version and/or stepping stone controller firmware that must be installed first before the controller can be upgraded to the firmware code that is in the firmware package. Failure to do this might result in lost of data availability. There are certain minimum controller firmware version requirements associated with various drive expansion enclosures. See Table 3 on page 5, Table 4 on page 7, and Table 5 on page 10 for related information.
- ___ Step 4. Verify that the drive firmware is at the latest level. If it is not, see “Upgrading drive firmware levels” on page 54.
- ___ Step 5. Verify that the DS4000 Storage Subsystem to which you will migrate the hard drives is in optimal state. If it is not, perform the appropriate steps listed in the Recovery Guru to bring the storage subsystem into optimal state.
- ___ Step 6. Use the Read_Link_Status function of the Storage Manager client program and the DS4000 Storage Subsystem management event log (MEL) to verify that the drive loops are in optimal state. If the DS4000 storage subsystem controller firmware is version 06.10.xx.xx or higher, use the drive channel diagnostics to determine if the drive loop is optimal.
- ___ Step 7. Investigate and resolve any errors that reported in the DS4000 Storage Subsystem MEL.
- ___ Step 8. Save and store the storage subsystem profile of the DS4000 Storage Subsystem.
- ___ Step 9. It is necessary to purchase the Fibre Channel/SATA intermix premium feature option and follow the associated instructions to activate the Fibre Channel/SATA premium feature.

___ Step 10. Before adding or migrating hard drives, be sure you establish drive model compatibility. Refer to the information for your drive options for the most current environment for your drive. You can also refer to Table 21.

Table 21. Drive capacity / interface type and speed compatibilities

Product ID	Drive capacity	Drive interface type and speed [†]	Notes
Fibre Channel (FC) disk device modules			
ST39103FC	10K / 9.1GB	1 Gbps FC-AL	
ST318203FC	10K / 18.2GB	1 Gbps FC-AL	
ST136403FC	10K / 36.4GB	1 Gbps FC-AL	
ST318304FC	10K / 18.2GB	1 Gbps FC-AL	
ST336704FC	10K / 36.4GB	1 Gbps FC-AL	
ST173404FC	10K / 73.4GB	1 Gbps FC-AL	
ST318451FC	15K / 18.2GB	1 Gbps FC-AL	
ST336605FC	10K / 36.4GB	2 Gbps FC-AL	
ST373405FC	10K / 73.4GB	2 Gbps FC-AL	
ST318452FC	15K / 18.2GB	1 Gbps FC-AL	
ST336752FC	15K / 36.4GB	1 Gbps FC-AL	
ST318432FC	15K / 18.2GB	2 Gbps FC-AL	
ST336732FC	15K / 36.4GB	2 Gbps FC-AL	
ST318307FC	10K / 18.2GB	2 Gbps FC-AL	Available as FRU replacements only
ST336607FC	10K / 36.4GB	2 Gbps FC-AL	
ST373307FC	10K / 73.4GB	2 Gbps FC-AL	
ST3146807FC	10K / 146GB	2 Gbps FC-AL	
ST318453FC	15K / 18.2GB	2 Gbps FC-AL	
ST336753FC	15K / 36.4GB	2 Gbps FC-AL	
ST373453FC	15K / 73.4GB	2 Gbps FC-AL	
HUS103073FLF21	10K / 73.4GB	2 Gbps FC-AL	
HUS103014FLF21	10K / 146GB	2 Gbps FC-AL	
HUS103030FLF21	10K / 300GB	2 Gbps FC-AL	
HUS103036FLF21	10K / 36.4G	2 Gbps FC-AL	Available as FRU replacements only
HUS103018FLF21	10K / 1.2G	2 Gbps FC-AL	Available as FRU replacements only
HUS103009FLF21	10K / 9.1G	2 Gbps FC-AL	Available as FRU replacements only
ST318454FC	15K / 18.2G	2 Gbps FC-AL	Available as FRU replacements only
ST336754FC	15K / 36.4GB	2 Gbps FC-AL	

Table 21. Drive capacity / interface type and speed compatibilities (continued)

ST373454FC	15K / 73.4GB	2 Gbps FC-AL	
ST3146854FC	15K / 146GB	2 Gbps FC-AL	
ST336854FC	15K / 36.4GB	4 Gbps FC-AL (can also operate at 2 Gbps)	
ST373554FC	15K / 73.4GB	4 Gbps FC-AL (can also operate at 2 Gbps)	
ST3146854FC	15K / 146GB	4 Gbps FC-AL (can also operate at 2 Gbps)	
MAX3036FD	15K / 36.4GB	4 Gbps FC-AL (can also operate at 2 Gbps)	
MAX3073FD	15K / 73.4GB	4 Gbps FC-AL (can also operate at 2Gbps)	
MAX3147FD	15K / 146GB	4 Gbps FC-AL (can also operate at 2 Gbps)	
ST373455FC	15K/73GB	4 Gbps FC-AL (can also operate at 2 Gbps)	
ST3146855FC	15K/146GB	4 Gbps FC-AL (can also operate at 2 Gbps)	
ST3300655FC	15K/300GB	4 Gbps FC-AL (can also operate at 2 Gbps)	
Serial ATA (SATA) Disk Device Modules			
MAXTOR 7Y250MO	7.2K / 250G	1.5 Gbps SATA can operate at enclosure 2 Gbps FC speed	For DS4100 and EXP100 only
ST3250823NS 71P7313	7.2K / 250G	1.5 Gbps SATA can operate at enclosure 2 Gbps FC speed	For DS4100 and EXP100 only
ST3400832NS 39M4575	7.2K / 400G	1.5 Gbps SATA can operate at enclosure 2 Gbps FC speed	For DS4100 and EXP100 only
ST3500641NS 39M4557 39M0181 IBM	7.2K / 500G	3 Gbps SATA II can operate at either enclosure 2 Gbps or 4 Gbps FC speed	For DS4700 Express and EXP810 only
ST3500641NS 42D0392 39M0181 IBMV	7.2K / 500G	3 Gbps SATA II can operate at either enclosure 2 Gbps or 4 Gbps FC speed	For DS4200 and EXP420 only

Table 21. Drive capacity / interface type and speed compatibilities (continued)

ST3500630NS 39M4557 42D0002 IBM	7.2K/500GB	3 Gbps SATA II can operate at either enclosure 2 Gbps or 4 Gbps FC speed	For DS4700 Express and EXP810 only
ST3500630NS 42D0392 42D0002 IBMV	7.2K/500GB	3 Gbps SATA II can operate at either enclosure 2 Gbps or 4 Gbps FC speed	For DS4200 and EXP420 only
ST3750640NS 43W9715 42D0003 IBM	7.2K/750GB	3 Gbps SATA II can operate at either enclosure 2 Gbps or 4 Gbps FC speed	For DS4700 Express and EXP810 only
ST3750640NS 43W9720 42D0003 IBMV	7.2K/750GB	3 Gbps SATA II can operate at either enclosure 2 Gbps or 4 Gbps FC speed	For DS4200 and EXP420 only
HDS725050KLA360 39M4557 39M0158 IBM	7.2K/500GB	3 Gbps SATA II can operate at either enclosure 2 Gbps or 4 Gbps FC speed	For DS4700 Express and EXP810 only
HDS725050KLA360 42D0392 39M0158 IBMV	7.2K/500GB	3 Gbps SATA II can operate at either enclosure 2 Gbps or 4 Gbps FC speed	For DS4200 and EXP420 only

† In general, FC drives are capable of operating at lower FC operating speeds than the FC speed for which the drive is rated. For example, 2 Gbps FC drives will also work at a 1 Gbps FC speed; 4 Gbps FC drives will also operate at 2 Gbps. Do not automatically assume that a given hard drive CRU can operate in a lower FC speed environment without first checking the documentation of the DS4000 storage subsystem or storage expansion enclosure: the drive might not be certified or might not have the correct form factor for that DS4000 storage subsystem or storage expansion enclosure.

Important:

Do not store DS4000 Storage Subsystem profiles in the same location as the logical drives defined on your DS4000 Storage Subsystem. Should you do so, and a RAID array failure occurs during subsequent migration, the data will be lost.

If you are migrating drives from another DS4000 Storage Subsystem, you must also perform the preceding steps 1 on page 45 through 10 on page 46 on the DS4000 Storage Subsystem from which you intend to migrate hard drives. You must also perform the following steps to flush server-cached I/O to disks.

- ___ Step 1. Stop all programs, services or processes in the host servers that access the logical drives defined in the migrated hard drives.
- ___ Step 2. Verify that there are no programs, services, or processes running in the background that might write data to the logical drives. (For example, Microsoft® MSCS service periodically writes to the “Quorum” disk.)
- ___ Step 3. Unmount the file systems to flush I/O from the server cache to disk.

Notes:

- a. In a Microsoft Windows® environment, it is also necessary for you to remove the drive letter or the mount points of the mapped LUNs instead of unmounting the file systems.

- b. Consult documentation associated with your particular operating system for detailed information regarding the unmount procedure.

After you meet prerequisites described in this section, proceed to any of the following sections to address your particular drive migration requirements:

- Chapter 3, “Adding or migrating hard drives,” on page 61
- Chapter 4, “Adding or migrating storage expansion enclosures,” on page 75
- Chapter 5, “Upgrading a storage subsystem in a functioning configuration,” on page 121

Verifying controller, NVSRAM, and ESM firmware file levels

The controller firmware and NVSRAM of the DS4000 Storage Subsystem to which you will migrate hard drives, and the ESM firmware in the DS4000 storage expansion enclosures must be at the levels indicated in Table 22 to ensure firmware compatibility between the migrating and original hardware. Additionally, DS4000 Storage Manager client software (version 8.3 or higher), in conjunction with the controller firmware level 5.30.xx.xx or higher, allows you to upgrade the ESM firmware while the storage subsystem receives I/O from the host server if you select only one drive expansion enclosure to download the ESM firmware at a time in the Select drive enclosure to download ESM firmware window.

Note: Always check the readme document included with the DS4000 Storage Subsystem controller firmware package for any “no I/Os” requirement during the controller firmware download. Certain controller firmware upgrade scenarios may require that you first quiesce host I/Os.

Tip: Even though you can upgrade the DS4000 Storage Subsystem and ESM firmware while it processes I/O from the host server, schedule upgrades to occur during time periods of low I/O between the DS4000 Storage Subsystems and host servers.

Table 22 lists IBM DS4000 machine types and model numbers, as well as their current firmware versions.

Note: Please check DS4000 readme files on the Web for the most up-to-date information about firmware and NVSRAM versions:

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

Table 22. Machine types, supported controller firmware, and supported storage management software

Product name	Machine type	Model	Supported controller firmware version	Supported Storage Manager software version
IBM System Storage DS4200 Storage Subsystem	1814	7VA/H	6.16.88.xx, 6.16.9x.xx, 6.23.xx.xx	9.16, 9.19, 9.23
IBM System Storage DS4700 Storage Subsystem	1814	70A/H 72A/H	06.16.xx.xx, 6.23.xx.xx	9.16, 9.19, 9.23

Table 22. Machine types, supported controller firmware, and supported storage management software (continued)

Product name	Machine type	Model	Supported controller firmware version	Supported Storage Manager software version
IBM System Storage DS4800 Storage Subsystem	1815	80A/H	06.16.xx.xx ¹⁰ , 6.23.xx.xx	9.16, 9.19, 9.23
		82A/H 84A/H 88A/H	06.14.xx.xx, 06.15.xx.xx, 06.16.xx.xx, 6.23.xx.xx	9.14, 9.15, 9.16, 9.19, 9.23
IBM System Storage DS4100 Storage Subsystem (Base Model)	1724	100	06.12.xx.xx	8.42, 9.10, 9.12, 9.14, 9.15, 9.16, 9.19, 9.23
IBM System Storage DS4100 Storage Subsystem (Single Controller Model)	1724	1SC 1S	06.12.xx.xx	
IBM System Storage DS4500 Disk Storage Subsystem	1742	90X 90U	5.30.xx.xx 5.40.xx.xx 5.41.xx.xx (supports EXP100 only) 06.12.xx.xx, 06.19.xx.xx, 6.23.xx.xx	8.3, 8.4, 8.41, 8.42, 9.10, 9.12, 9.14, 9.15, 9.16, 9.19, 9.23
IBM System Storage DS4300 Disk Storage Subsystem (Single Controller)	1722	6LU 6LX	5.34.xx.xx	8.41.xx.03 or later, 8.42, 9.10, 9.12, 9.14, 9.15, 9.16, 9.19, 9.23
IBM System Storage DS4300 Disk Storage Subsystem (Base Model)		60U 60X	5.33.xx.xx 5.34.xx.xx 5.40.xx.xx 06.12.xx.xx 06.19.xx.xx 6.23.xx.xx	8.3, 8.4, 8.41, 8.42, 9.10, 9.12, 9.14, 9.15, 9.16, 9.19, 9.23
IBM System Storage DS4300 Disk Storage Subsystem (Turbo Model)		60U 60X	5.41.xx.xx (supports EXP100 only) 6.12.xx.xx 06.19.xx.xx 6.23.xx.xx	
IBM System Storage DS4400 Disk Storage Subsystem (no longer available for purchase)	1742	1RU 1RX	5.00.xx.xx 5.20.xx.xx 5.21.xx.xx 5.30.xx.xx 5.40.xx.xx 6.12.xx.xx	8.0, 8.2, 8.21, 8.3, 8.41, 8.42, 9.10, 9.12, 9.14, 9.15, 9.16, 9.19, 9.23
IBM Netfinity® FAStT500 RAID Controller Enclosure Unit (no longer available for purchase)	3552	1RU 1RX	4.x, 5.00.xx.xx 5.20.xx.xx 5.21.xx.xx 5.30.xx.xx	7.0, 7.01, 7.02, 7.10, 8.0, 8.2, 8.21, 8.3, 8.41, 8.42, 9.10, 9.12, 9.14, 9.15, 9.16, 9.19, 9.23

Table 22. Machine types, supported controller firmware, and supported storage management software (continued)

Product name	Machine type	Model	Supported controller firmware version	Supported Storage Manager software version
IBM FAStT200 High Availability (HA) Storage Subsystem (no longer available for purchase)	3542	2RU 2RX	4.x, 5.20.xx.xx 5.30.xx.xx 6.23.xx.xx	7.02, 7.10, 8.0, 8.2, 8.21, 8.3, 8.41, 8.42, 9.10, 9.12, 9.14, 9.15, 9.16, 9.19, 9.23
IBM FAStT200 Storage Subsystem (no longer available for purchase)	3542	1RU 1RX	4.x, 5.20.xx.xx 5.30.xx.xx 6.23.xx.xx	7.02, 7.10, 8.0, 8.2, 8.21, 8.3, 8.41, 8.42, 9.10, 9.12, 9.14, 9.15, 9.16, 9.19, 9.23
IBM Netfinity Fibre Channel RAID Controller Unit (no longer available for purchase)	3526	1RU 1RX	4.x 6.23.xx.xx	7.0, 7.01, 7.02, 7.10, 8.0, 8.2, 8.21, 8.3, 8.41, 8.42, 9.10, 9.12

Table 22. Machine types, supported controller firmware, and supported storage management software (continued)

Product name	Machine type	Model	Supported controller firmware version	Supported Storage Manager software version
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Important:

1. Controller firmware version 06.23.xx.xx supports the DS4200, DS4300, DS4500, DS4700, and DS4800 models. This firmware allows the intermix of EXP100, EXP710, and EXP810 behind these models. It also allows the intermix of Fibre Channel and SATA drives within the EXP810 enclosure.
2. Controller firmware version 06.19.xx.xx supports only the DS4300 (standard/base and Turbo models only) and DS4500 subsystems. This firmware version allows the intermix of EXP810, EXP710, and EXP100 behind a DS4000™ storage subsystem.
3. Controller firmware versions 06.16.xx.xx support only DS4800 and DS4700 Storage Subsystems.
4. Controller firmware versions 06.15.xx.xx and 06.14.xx.xx support only DS4800 Storage Subsystems. Controller firmware level 06.15.xx.xx supports EXP100 SATA storage expansion enclosures with the DS4800 storage subsystem.
5. Controller firmware 06.16.xx.xx is required to support DS4000 EXP810 storage expansion enclosures. It does not support EXP100 storage expansion enclosures. **Do not** download 06.16.xx.xx into DS4000 storage subsystems that have EXP100 enclosures attached. If controller firmware 06.16.xx.xx is activated, the storage subsystem will not recognize the drives in EXP100 enclosures, causing loss of data availability to the RAID arrays and logical drives that are defined in those drives. Use controller firmware version 06.15.xx.xx if you have EXP100 storage expansion enclosures attached, or plan to attach them in the future.
6. EXP710 storage expansion enclosures are supported with controller firmware versions 06.1x.xx.xx or later.
7. Storage subsystem firmware must be at version 04.01.xx.xx or later (05.xx.xx.xx or later for Windows host operating systems) to be managed with Storage Manager versions 9.1x and later.
8. Storage subsystems with controller firmware version 04.00.02.xx through 4.01.xx.xx must be managed with Storage Manager 8.x.
9. Controller firmware level 06.12.xx.xx supports EXP100 SATA storage expansion enclosures with the following storage subsystems:
 - DS4100 and DS4300 Base models
 - DS4300 Turbo models
 - DS4400
 - DS4500

If you want to upgrade to 06.12.xx.xx and your controller firmware level is currently 05.41.1x.xx, you must first upgrade to firmware version 05.41.5x.xx (provided on the CD that is shipped with the EXP100, or from your IBM support representative.) After your firmware is at level 05.41.5x.xx, you can then upgrade to 06.12.xx.xx.
10. Firmware levels 5.40.xx.xx and earlier provide support for EXP500 and EXP700 storage expansion enclosures only.
11. Some firmware versions support intermixing Fibre Channel and SATA storage expansion enclosures in the same DS4000 storage subsystem, if the DS4000 FC/SATA Intermix premium feature option is enabled. See Appendix A, "IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview," on page 135 for more information about FC/SATA Intermix. Contact your IBM service representative for more information about purchasing the premium feature.
12. DS4800 model 80A/H does not support controller firmware version 6.16.14.xx and 6.16.15.xx.
13. For the latest NVSRAM versions, click the link for your storage subsystem at the following Web site:
www-1.ibm.com/servers/storage/support/disk/
14. The DS4000 storage subsystems that are shipped from the factory will show the NVSRAM version with an "M" prefix instead of the "N" prefix. Both the "M" prefix and the "N" prefix are supported.

Important::

Visit the following Web site either to verify software version levels or to identify possible interim updates to firmware and NVSRAM file versions described in Table 22 on page 49.

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

Do not automatically update the DS4000 controller firmware and NVSRAM before you upgrade the ESM firmware on the storage expansion enclosures to versions indicated in Table 23. Consult the readme file that is included in the controller firmware code package for any prerequisite tasks or required ESM firmware upgrades or stepping stone controller firmware upgrades that need to be performed first before upgrading the controller firmware to a particular version.

Table 23 lists IBM DS4000 storage expansion enclosure models by name, machine type, model number, and current ESM firmware version.

Table 23. Compatible expansion unit ESM firmware version by machine type and model number

DS4000 Storage Expansion Unit product name/model	Machine type	Model number	ESM firmware version
IBM System Storage DS4000 EXP100	1710	10U	9563 or later is required for the new 250 GB drive CRU and the 400G SATA drive option/CRU.
IBM System Storage DS4000 EXP500	3560	1RU 1RX	9166
IBM System Storage DS4000 EXP700	1740	1RU 1RX	9330
IBM System Storage DS4000 EXP710	1740	710	9640
IBM System Storage DS4000 EXP420	1812	8VA, 8VH	9865 or higher
IBM System Storage DS4000 EXP810	1812	81A, 81H, 81S, 81T	9880 or higher

Perform the following steps to upgrade ESM and controller firmware for a down-level DS4000 storage subsystem:

- ___ Step 1. Upgrade the DS4000 Storage Manager software to the latest version, which is DS4000 Storage Manager version 9.23. For additional information, see the *IBM System Storage DS4000 Storage Manager installation and support guide* for the appropriate server operating system environment at:

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

Note: To ensure the highest level of software compatibility, update the host server's multi-path software (Redundant Disk Array Controller [RDAC], IBMSAN.CDM, or Linux failover adapter driver) to the level that is either supported by or released with the controller firmware that you intend to download. See the following Web site for current details on software compatibility:

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

- ___ Step 2. Upgrade the storage expansion enclosure ESM firmware. With DS4000 Storage Manager version 8.3 or higher and controller firmware version 05.3x.xx.xx or higher, you can update the ESM firmware while the DS4000 Storage Subsystem is processing I/O from the host server if the ESM firmware download is performed to only one storage expansion enclosure at a time. If you select multiple entries in the ESM firmware download window for ESM firmware download, you must quiesce I/Os from the host servers before starting the ESM firmware download process.

Important:

Even though the DS4000 Storage Subsystem supports controller and ESM firmware upgrade while the DS4000 Storage Subsystem processes I/O from the host server, schedule controller and ESM firmware upgrades to occur during time periods of low I/O between the DS4000 Storage Subsystems and host servers.

- ___ Step 3. Upgrade the controller firmware and NVSRAM. See Table 22 on page 49 and the Web site listed earlier in conjunction with step1 on page 53.

Note: See the readme file in the DS4000 Storage Manager controller firmware package associated with the appropriate host operating system environment for a support statement about the concurrent controller firmware download (that is, downloading code to the DS4000 Storage Subsystem while it is processing I/O from the host server).

Upgrading drive firmware levels

Attention: 1 Gbps Fibre Channel drives will not operate correctly in a 2 Gbps Fibre Channel drive loop; neither will 2 Gbps Fibre Channel drives operate correctly in a 4 Gbps FC operating environment. Always make certain that a Fibre Channel drive can operate at the Fibre Channel speed of the drive loop involved before inserting it into the drive slots in a DS4000 Storage Subsystem configuration. If needed, contact IBM support to ensure the compatibility of your drives before migrating them from one DS4000 configuration to another.

Before you begin migration, upgrade the drive firmware to the latest level. Do not move or migrate Fibre Channel drives from a 1 Gbps Fibre Channel environment to a 2 Gbps Fibre Channel environment unless you have installed the latest firmware documented to enable their operation in a 2 Gbps Fibre Channel environment.

Downloading drive firmware

Important:

The following procedures assume you are using controller firmware at version 6.10.xx.xx or later. If you are using an earlier version refer to the following IBM Web site for the appropriate firmware version documentation:

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

This section provides instructions for downloading DS4000 drive firmware. See the online help for additional information.

Important:

1. IBM supports firmware download with I/O, sometimes referred to as *concurrent firmware download*. This feature is not supported for drive firmware.
2. Before starting the drive firmware download process:
 - Stop all I/O activity before downloading drive firmware to a DS4000 Storage Server.
 - Unmount the file systems on all logical drives accessing the drives that you select for firmware upgrade.
 - Complete a full backup of all data residing on the drives that you select for firmware upgrade.

Downloading Storage Manager version 9.1x drive firmware

To download drive firmware for DS4000 Storage Manager version 9.1x, perform the following steps:

1. From the Enterprise Management window, select a storage subsystem.
2. On the Enterprise Management window's menu bar, click **Tools** → **Manage Device**. The Subsystem Management window opens.
3. On the Subsystem Management window's menu bar, click **Advanced** → **Maintenance** → **Download** → **Drive Firmware/Mode pages** The Download Drive Firmware wizard window opens to the Introduction page. Read the instructions displayed and click **Next**.

Note: Storage Manager version 9.1x offers you the option to download and update up to four different firmware file types simultaneously. Previous Storage Manager versions did not offer this capability.

4. Click **Browse** to locate the server directory that contains the firmware that you plan to download.
5. Select the firmware file that you plan to download and click **OK**. The file appears listed in the "Selected Packages" window pane.
6. Select the firmware file for any additional drive types that you intend to download and click **OK**. Additional files appear listed in the "Selected Packages" window pane. A maximum total of four drive types are possible.
7. Click **Browse** to repeat step 6 until you have selected each firmware file that you plan to download.
8. When you have finished specifying the firmware packages for download, select **Next**.
9. The Select Drive window opens, containing two tabs, a **Compatible Drives** tab and an **Incompatible Drives** tab. The **Compatible Drives** tab contains a list of the drives compatible to the firmware package types that you selected. From that list, select the drives to which you plan to download the drive firmware that you selected in steps 6 and 7.

Note: The firmware that you propose to download should be listed on the **Compatible Drives** tab. If your particular drives' product ID matches the firmware type, however, and it is not listed as compatible on the tab, contact your IBM technical support representative for additional instructions.

10. Select the **Compatible Drives** tab.
Press and hold the **Ctrl** key while using your mouse to select multiple drives individually, or press and hold the **shift** key while using your mouse to select multiple drives listed in series. The compatible firmware that you selected in steps 5 and 6 will download to the drives that you select.

11. Click **Finish** to initiate download of the drive firmware to each compatible drive that you selected in step 9 on page 55.
12. The Download Drive Firmware warning opens and prompts: "Do you want to continue?" Type **yes** and click **OK** to start the drive firmware download.
13. The Download Progress window opens. Do not intervene until the download process completes.
14. Every drive scheduled for firmware download will be designated as in progress until successful or failed.

Note: Complete the following two steps if you receive a failure.

- a. Click the **Save as** button to save the error log.
 - b. On the Subsystem Management window's menu bar, click **Advanced → Trouble Shooting → Open Event Log** and complete the following tasks necessary to save the storage subsystem event log before contacting your IBM Service Representative and proceeding to step 16.
 - 1) Click the **Select all** button.
 - 2) Click **Save the Storage Subsystem Event Log**.
15. When the **Close** button appears active, the drive firmware download process is complete.
 16. Click **Close** to exit the Download Progress window.
 17. Use either of the following procedures to determine or verify what level of drive firmware resides on a particular drive:
 - Right-click on that drive in the Logical/Physical View in the Subsystem Management window and click **Properties**. The associated drive firmware version will be listed in the drive properties table.
 - Right-click on **Storage Subsystem → View Profile** in the Logical/Physical View of the Subsystem Management window.

Downloading Storage Manager version 8.x drive firmware

To download drive firmware for DS4000 Storage Manager version 8.x, perform the following steps:

1. From the Enterprise Management window, select a storage subsystem.
2. Click **Tools → Manage Device**. The Subsystem Management window opens.
3. Click **Advanced → Download → Drive Firmware**. The Download Drive Firmware window opens. It presents a list of all installed drives.
4. From the list of all installed drives, select the drive to which you plan to download drive firmware.
Press and hold the **Ctrl** key while using your mouse to select multiple drives singly, or press and hold the **shift** key while selecting multiple drives in series by using your mouse pointer.
5. Click **Browse** to identify the directory that contains the drive firmware that you intend to download.
6. Select the file containing the drive firmware that you intend to download.
7. Select **Start**. The Confirm Download window appears.
8. Type **yes** when the Confirm Download window prompts: Are you sure you want to continue?
9. The download begins and the Status window indicates progress. Do not intervene until the download process completes.

10. When the **Cancel** button appears active, the download process is complete. Click **Cancel** to close the Status window.
11. To determine or verify the level of drive firmware residing on a particular drive, click **View** → **Subsystem Profile** in the Logical/Physical View of the Subsystem Management window.

Bringing storage subsystems and drive loops into optimal state

Note: For additional information on how to make this determination, see the *DS4000 Problem Determination Guide* associated with your particular DS4000 hardware model.

After you have updated or verified that a DS4000 Storage Subsystem is using the latest firmware and NVSRAM:

- ___ Step 1. Bring the DS4000 Storage Subsystem to its optimal state before reconfiguring it with new hardware.
- ___ Step 2. Use the DS4000 Storage Manager client program to display the status of the DS4000 Storage Subsystem and to correct any problems that might cause the DS4000 Storage Subsystem to enter its Needs Attention state.
- ___ Step 3. Verify that all indicator lights on the storage subsystem are in their optimal state.
- ___ Step 4. In addition, use the Read_Link_Status function of the DS4000 Storage Manager client program and the DS4000 Storage Subsystem MEL to verify that all components in the drive loop are in their optimal states. (Optimal means that there are no drive loop component errors in the event log and no errors in the Read_Link_Status window.) If you are using controller firmware 06.10.xx.xx or later, use the drive channel diagnostics to determine if the drive loop/channel is optimal. See the DS4000 Storage Manager Client program Subsystem Management window Online help for more information on the RLS and drive channel diagnostics if they are supported by the installed version of your controller firmware.
Drive channel diagnostics are only available if you are using controller firmware version 06.10.xx.xx or later.
- ___ Step 5. If the arrays are in degraded state due to a failed drive, correct the problem before migration.

If necessary, contact the IBM Help Center for assistance with event log interpretation.

It is necessary for certain tasks to be completed before proceeding to add drives or enclosures. Before you add drives or enclosures, verify that the storage subsystem involved is not performing any of the following tasks:

- Dynamic logical drive capacity expansion (dynamic volume expansion [DVE] or dynamic capacity expansion [DCE])
- Logical drive segment size modification
- Array RAID-level modification
- User-initiated array redundancy checking (menu option **Array** → **Check Redundancy** in the Subsystem Management window)
- Remote mirror logical drive synchronization
- FlashCopy® or VolumeCopy logical drive creation

- Logical drive reconstruction or copyback (this action is sometimes referred to as logical drive sparing)

Saving the storage subsystem profile

Use the DS4000 Storage Manager client program to save a DS4000 Storage Subsystem profile. Such a profile is necessary to restore a storage subsystem configuration in the event of a catastrophic failure. Migration from one DS4000 Storage Subsystem configuration to another will require that you save both DS4000 Storage Subsystem configuration profiles involved. For details on this procedure, see one of the following:

- DS4000 Storage Manager client program Client Subsystem Management window online help
- *IBM System Storage DS4000 Storage Manager installation and support guide* associated with your particular operating system environment located at:
www-1.ibm.com/servers/storage/support/disk/
- *Saving a module profile report and state capture information to help prevent data loss* located at:
www-3.ibm.com/pc/support/site.wss/document.do?lnocid=MIGR-4VVPEF

Important:

Do not store DS4000 Storage Subsystem profiles in the same location as the logical drives defined on your DS4000 Storage Subsystem. Should you do so, and a RAID array failure occurs during subsequent migration, the data will be lost.

Handling static-sensitive devices

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

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

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

Chapter 3. Adding or migrating hard drives

To add one or more hard drives to the DS4000 storage subsystem configuration or place the drives (that made up a RAID array) in different drive slots, see the following sections:

- If you want to add one or more new hard drives to an existing DS4000 storage subsystem, see “Adding one or more new hard drives” on page 62.

Note: Any hard drive, whether new or old, might contain configuration data. Unless you intend to migrate drives from another DS4000 Storage Subsystem (retaining their configuration data), always use the this procedure to add one or more hard drives to an existing DS4000 storage subsystem configuration.

- If you are migrating drives from one DS4000 subsystem configuration to another, see “Migrating one or more hard drives” on page 67.
- If you want to place the drives (that made up a RAID array) in different drive slots, see “Migrating arrays within storage subsystems” on page 71.

Before performing the appropriate procedure, please review Chapter 2, “Prerequisites to adding capacity and hard drive migration,” on page 45 and “Overview and rules.”

Overview and rules

While adding a hard drive to either a controller or a drive expansion enclosure, observe these important rules:

- Observe proper electrostatic discharge (ESD) procedures when handling electronic equipment. See “Handling static-sensitive devices” on page 59 for additional information.
- Never alter the physical configuration of a DS4000 Storage Subsystem while it is powered off unless you are instructed to do so as part of a DS4000 configuration procedure. Specifically, never attach storage components to, or remove storage components from, a configured DS4000 Storage Subsystem while it is powered off.
- Before migrating hard drives, perform the following steps to establish drive model compatibility:
 - ___ 1. Check the drive CRU form factor options.
 - ___ 2. If the form factors are not the same, there are no replacement parts (this includes bezels and drive trays).
 - ___ 3. If the form factors are the same, check to see if the drive is supported by the DS4000 subsystem.
 - ___ 4. Ensure that the drive can operate at the storage subsystem drive loop/channel Fibre Channel speed. See Table 21 on page 46 for more information.
- The following DS4000 Storage Subsystem devices support 2 Gbps Fibre Channel hard drives:
 - DS4000 EXP700 storage expansion enclosures
 - DS4000 EXP710 storage expansion enclosures
 - DS4000 EXP810 storage expansion enclosures
 - DS4200 Express, DS4300, and DS4700 Express storage subsystems

1 Gbps Fibre Channel drives will not work properly when you insert them into the drive slots of the aforementioned DS4000 storage devices.

Attention: Always make certain that a Fibre Channel drive can operate at the Fibre Channel speed of the drive loop involved before inserting it into the drive slots in a DS4000 Storage Subsystem configuration. If needed, contact IBM support to ensure the compatibility of your drives before migrating them from one DS4000 configuration to another.

To identify a 1 Gbps Fibre Channel drive, locate the product's label and examine its ID or Model Number. Hard drives with ID or Model Number values that end with "04FC" or "03FC" are 1 Gbps Fibre Channel drives. For example, "ST173404FC", "ST318203FC" and "ST136403FC" are model numbers that appear on several 1 Gbps Fibre Channel hard drives. 1 Gbps Fibre Channel drives can also be mounted in a tray with the front bezel that is about .75 inches (1.9 centimeters) wider than the 2 Gbps drive tray bezel.

You can also obtain the drive product model and ID through the DS4000 Storage Subsystem profile. For information on how to do so, see "Determining the product ID and model of a drive" on page 42.

Note: You can refer to Table 21 on page 46 for information on the maximum Fibre Channel speed at which a given drive model can operate.

- The only DS4000 storage expansion enclosures that support the 4 Gbps drive, in addition to the 2 Gbps drive, are the EXP420 and EXP810; however, they can support only one drive speed in a single drive channel/loop pair. The 2 Gbps drives will either be put in bypassed mode or be not seen by the controllers when inserting into an EXP420 or EXP810 operating at 4 Gbps FC speed.
- The Fibre Channel drive option/CRU for the EXP700 and EXP710 is not compatible with the Fibre Channel drive option/CRU for the EXP810 even though the reported drive product ID is the same for both EXP710 and EXP810 drive CRU. Please consult the EXP710, EXP700 and EXP810 product documentation or the appropriate *Installation, User's, and Maintenance Guide* for the correct part number for drive options and drive CRUs for your drive expansion enclosure.
- Do not mix SATA and Fibre Channel drives or enclosures together in the same drive loop behind a DS4000 storage subsystem unless the FC/SATA intermix premium feature is purchased and the DS4000 Storage Subsystem is in the storage subsystem list that support FC/SATA intermix feature.
- Do not install SATA drives in Fibre Channel drive expansion enclosures.
- Do not install Fibre Channel drives in SATA drive expansion enclosures.

Adding one or more new hard drives

The following procedure outlines the steps necessary to add one or more new hard drives to empty drive slots in either DS4100, DS4200 Express, FAStT200, DS4300, or DS4700 Express controllers or in EXP100, EXP500, EXP700, EXP710, or EXP810 storage expansion enclosures. If you plan to add a used drive, ensure that there is no configuration data on the drive that you need to preserve. Add drives to a DS4000 Storage Subsystem only while it is powered on and in optimal state. See the *DS4000 Problem Determination Guide* or "Bringing storage subsystems and drive loops into optimal state" on page 57 for additional information describing how to make this determination.

Perform the steps as stated in activities 1-3, to add one or more new drives to the DS4000 storage subsystem.

Important: Do not perform the steps in this procedure if you are migrating drives from another DS4000 storage subsystem. This procedure will delete the logical drive configuration in the migrated hard drives. Instead, refer to the steps listed in “Migrating expansion enclosures with hard drives having defined logical drive configurations” on page 79.

Activity 1: Disabling the drive migration settings

Important: Review the information in Chapter 1, “Introduction,” on page 1 and perform the prerequisites described in Chapter 2, “Prerequisites to adding capacity and hard drive migration,” on page 45 before performing the activities described in this chapter.

Before you add drives to the subsystem, perform the following activity to remove any configuration data that the drives might contain:

- ___ Step 1. Open the Storage Manager client program’s Enterprise Management window.
- ___ Step 2. Right-click on the name of the DS4000 Storage Subsystem to which you intend to add drives and click **Execute Script**.
- ___ Step 3. A script editor window opens. Click **File -> Load Script**.
- ___ Step 4. A Load Script file selection window opens. Locate and select the file named DisableDriveMigration.scr and click **OK**. The DisableDriveMigration.scr file is normally located in the SCRIPTS directory of the IBM DS4000 Storage Manager Installation Compact Disc (CD). Use this file to reset the DS4000 storage subsystem setting to ignore configuration data that might reside on newly discovered hard drives. Figure 19 on page 66 provides a listing of the DisableDriveMigration.scr file.
- ___ Step 5. Click **Tools -> Verify and Execute** to run the script.
- ___ Step 6. When the script completes execution, reset both DS4000 controllers to enable the DS4000 drive migration setting.

If you used the DisableDriveMigration.scr script associated with this document and described in Figure 18 on page 65, it is not necessary for you to perform this step because the last two commands in that script file automatically reset the controllers.

To reset the controllers, open the Storage Subsystem Management window and sequentially (one at a time) reset each controller by clicking **Advanced -> Reset Controller**. Then, follow the instructions in the Reset Controller window when it opens.

Activity 2: Inserting drives

- ___ Step 1. Insert drives as pairs (two at a time) into the empty drive slots.
- ___ Step 2. Wait (up to five minutes) until each drive pair has fully spun up and displayed in the DS4000 Storage Subsystem Management window before inserting the next drive pair.

Activity 3: Re-enabling the drive migration settings

Perform this activity to re-enable the drive migration settings if you performed “Activity 1: Disabling the drive migration settings” to disable DS4000 storage subsystem drive migration settings. If you do not, whenever you might subsequently, even momentarily remove a drive from the storage subsystem for any reason, its configuration data will be cleared. When the storage subsystem next recognizes such a drive, it will display it as unconfigured.

Attention: In order to prevent data loss, set the DS4000 Storage Subsystem drive migration to enable after you complete the hard drive addition process.

- ___ Step 1. Open the Storage Manager client program Enterprise Management window.
- ___ Step 2. Right-click on the name of the DS4000 Storage Subsystem to which you want to add drives and click **Execute Script**.
- ___ Step 3. A script editor window opens. Click **File -> Load Script**.
- ___ Step 4. A Load Script file selection window opens. Locate, and select the file named EnableDriveMigration.scr and click **OK**. The file EnableDriveMigration.scr is normally located in the SCRIPTS directory of the IBM DS4000 Storage Manager Installation CD. Use this file to reset the DS4000 Storage Subsystem setting in order to check for configuration data that might reside on newly discovered hard drives. Figure 18 on page 65 provides a listing of the EnableDriveMigration.scr file.
- ___ Step 5. Click **Tools -> Verify and Execute** to run the script.
- ___ Step 6. When the script completes execution, reset both DS4000 controllers to enable the DS4000 drive migration setting.

If you use the EnableDriveMigration.scr script associated with this document and described in Figure 18 on page 65, it is not necessary for you to perform this step because the last two commands in that script file automatically reset the controllers.

To reset the controllers, open the Storage Subsystem Management window and sequentially (one at a time) reset each controller by clicking **Advanced -> Reset Controller**, and then following the instructions in the Reset Controller window when it opens.

Result: The newly added drives are ready for you to configure and map to host servers.

The next two figures list the EnableDriveMigration.scr and DisableDriveMigration.scr files.

```

// Name: Enable Drive Migration
//
// Date: 11-20-2005
// Revision: 1.4
//   Version 1.4 fixed the misleading on/off comment - CMVC 296330.
// Comments:
// This script is intended to work with controllers at Firmware 05.30.xx.xx and
// higher only.
//
// This script returned the FAStT to it's default operation of importing
// configuration information from disks.
//
// This script will reboot both controllers in the FAStT unit. If your
// hosts are configured for multi-path support, this can be done with I/O
// running to the controllers. If your hosts are not configured for
// redundant access you must schedule downtime before running this
// script.
//
// See the directions at the bottom of this script if you do not have multi
// path software installed and wish to prevent the controller restarts
//
// Show the current state of Drive Migration
show "Showing the current state of Drive Migration. The return value should";
show "be 82, which means drive migration is disable.";
show " ";
show controller[a] nvsrambyte[0x35];
show controller[b] nvsrambyte[0x35];
//
// Setting Drive Migration to Enable
show "Setting Drive Migration to Enable";
set controller[a] nvsrambyte[0x35] = 0x02,0x00;
set controller[b] nvsrambyte[0x35] = 0x02,0x00;
show "Showing the new state of Drive Migration. The return value should";
show "be 80, which means drive migration is enable. This should be the ";
show "default setting for the DS4000 controllers. ";
show " ";show controller[a] nvsrambyte[0x35];
show controller[b] nvsrambyte[0x35];
//
// Reset Controllers to make changes active. Note:
// To prevent the controllers from restarting, add '//' to the beginning
// of each of the lines below. This will comment out the restart of the
// controllers. Important: The controllers will have to be restarted for the
// changes in this script to take effect.
//
show "Resetting controller A";
reset Controller [a];
show "Resetting controller B";
reset Controller [b];
show "Drive Migration is now enabled.";

```

Figure 18. EnableDriveMigration.scr file listing

```

// Name: Disable Drive Migration
// Date: 11-20-2005
// Revision: 1.4
// Version 1.4 fixed the misleading on/off comment - CMVC 296330.
// Comments:
// This script is intended to work with controllers at Firmware 05.30.xx.xx and higher only.
// This script allows the addition of disk drives while the system is running
// and by clearing the configuration of any drives as unused capacity
// regardless of past configuration of these drives.
//
// Attention: This setting should not be left active after the new disks
// have been added to the subsystem. Leaving this setting active could
// cause the configuration for the DS4000/FASTt to be lost if the DS4000/FASTt
// is power cycled. Please run the EnableDriveMigration.scr after all of
// the disks are added. IN ADDITION, DO NOT USE THIS SCRIPT IF YOU WANT
// TO PRESERVE THE DATA IN THE DRIVES THAT YOU ARE PLANNING TO ADD INTO
// THE EXISTING DS4000 STORAGE SUBSYSTEM CONFIGURATION. Please refer to
// the DS4000 adding capacity and drive migration publication for more information.
//
// This script will reboot both controllers in the FASTt unit. If your
// hosts are configured for multi-path support, this can be done with I/O
// running to the controllers. If your hosts are not configured for
// redundant access you much schedule downtime before running this script.
//
// Show the current state of Drive Migration
show "Showing the current state of Drive Migration. The return value should";
show "be 80, which means drive migration is enable. This should be the ";
show "default setting for the DS4000 controllers. ";
show " ";
show controller[a] nvsrambyte[0x35];
show controller[b] nvsrambyte[0x35];
//
// Setting Drive Migration to Disable
show "Setting Drive Migration to Disable";
set controller[a] nvsrambyte[0x35] = 0x02,0x02;
set controller[b] nvsrambyte[0x35] = 0x02,0x02;
show "Showing the new state of Drive Migration. The return value should be";
show "82, which means drive migration is disable. Please run the enableDrive";
show "Migration.scr script as soon as you complete the inserting of ";
show "new drives into the DS4000 storage subsystem slots.";
show " ";
show controller[a] nvsrambyte[0x35];
show controller[b] nvsrambyte[0x35];
//
// Reset Controllers to make changes active
// To prevent the controllers from restarting, add '//' to the beginning of each of the
// lines below. This will comment out the restart of the controllers. Important: The
// controllers will have to be restarted for the changes in this script to take effect.
show "Resetting controller A";
reset Controller [a];
show "Resetting controller B";
reset Controller [b];
//
show "Drive Migration is now disabled. Add the new drives to the subsystem,";
show "then execute the EnableDriveMigrationScript.scr to re-enable drive ";
show "migration.";

```

Figure 19. DisableDriveMigration.scr file listing

Migrating one or more hard drives

Note: When migrating hard drives from multiple DS4000 storage servers to a single DS4000 Storage Subsystem, move all of the hard drives from the first DS4000 Storage Subsystem as an independent "set" to the destination DS4000 Storage Subsystem. Before moving hard drives as a set from subsequent DS4000 Storage Subsystem, ensure that all of the hard drives from the previous set have been successfully transferred to the destination DS4000 Storage Subsystem. If you do not transfer hard drives as "sets" to the destination DS4000 Storage Subsystem, the newly relocated arrays/logical drives that are defined in these drives might not appear in the Subsystem Management window. If you encounter problems while migrating drives, stop any further action and contact IBM support to avoid data loss.

The procedure for migrating hard drives that contain configuration data you want to preserve, is found in the following sections:

- "Activity 1: Preliminary activities"
- "Activity 2: Verifying the drive migration enable settings" on page 69
- "Activity 3: Removing the drives to be migrated" on page 69

Important: Do not use the procedure in this section if you are unsure of the quality of the data on the hard drives. Importing incorrect configuration data from hard drives could cause a DS4000 Storage Subsystem failure. Instead, refer to Chapter 3, "Adding or migrating hard drives," on page 61.

Activity 1: Preliminary activities

The following procedure describes the steps that you must perform to migrate one or more drives from a functioning DS4000 Storage Subsystem configuration to another DS4000 Storage Subsystem configuration. Drives described in the following steps are those that contain configuration data that you want to preserve. Add such drives to a DS4000 Storage Subsystem only while it is powered on and in its optimal state. See the *DS4000 Problem Determination Guide* or "Bringing storage subsystems and drive loops into optimal state" on page 57 for additional information on how to assess the state of a DS4000 Storage Subsystem.

Important:

Before you attempt to complete the drive migration procedure, review the information provided in Chapter 1 and perform the steps documented in Chapter 2, "Prerequisites to adding capacity and hard drive migration," on page 45.

Before you remove drives from a functioning DS4000 Storage Subsystem, perform the following steps to ensure that you successfully migrate the drives to the destination DS4000 Storage Subsystem.

- ___ Step 1. Perform a backup of the logical drives defined in the hard drives that you plan to migrate.
- ___ Step 2. Stop all programs, services or processes in the host servers that access the logical drives defined in the migrated hard drives. Ensure that there are not any running background programs, services or processes that write data to the logical drives. (For example, the Microsoft MSCS service periodically writes to the "Quorum" disk.)
- ___ Step 3. Unmount the file systems to flush I/O from the server cache to disks.

Notes:

- a. In a Microsoft Windows environment, remove the drive letter or the mount points of the mapped LUNs instead of unmounting the file systems.
 - b. Refer to the documentation associated with your particular operating system for detailed information regarding the unmount procedure.
- ___ Step 4. Verify that the DS4000 Storage Subsystem controller and NVSRAM of both the source and destination systems are at or above levels described in Table 22 on page 49.
- ___ Step 5. Verify that the names of the logical drives that are associated with hard drives on both the source and destination systems are unique. If they are not, make the necessary changes.
- ___ Step 6. In addition to array configuration information, any storage partitioning configuration data that may reside on drives you plan to migrate will migrate with those drives when installed on another DS4000 Storage Subsystem. For this reason, take the following precautions to facilitate the migration process and prevent problems in storage partitioning configuration data migration.
- a. If a DS4000 storage partitioning premium feature has been enabled both on a drive's original and destination DS4000 storage servers, assure that the defined host ports, hosts, and host group names are unique to each DS4000 Storage Subsystem involved in the migration.
 - b. If you must use identical names on both DS4000 Storage Subsystems, make the names unique before you perform the drive migration.
- If necessary, customize the storage partitioning information on the DS4000 Storage Subsystem to which you have migrated the drives after you complete the migration.
- ___ Step 7. Delete any flashcopies of the logical drives defined on the drives that you plan to migrate.
- ___ Step 8. Remove any remote mirror relationships using the logical drives defined on the drives that you plan to migrate.
- ___ Step 9. Ensure that the arrays and logical drives are in optimal state before starting the migration process. See the *DS4000 Problem Determination Guide* associated with your particular DS4000 hardware model or "Bringing storage subsystems and drive loops into optimal state" on page 57 for additional information on how to make this determination.
- ___ Step 10. Place the arrays defined in the hard drives that you plan to migrate in offline state. To do so, right-click on the name of the array in the Storage Subsystem Management window and click **Place -> Offline**.
- ___ Step 11. If you migrate drive expansion enclosures from a 1 Gbps Fibre Channel environment to a 2 Gbps Fibre Channel environment, verify that the Fibre Channel hard drives that you plan to migrate are each capable of 2 Gbps operation and that you have installed the latest firmware enabling them to work properly in a 2 Gbps Fibre Channel environment.

- ___ Step 12. Save the DS4000 Storage Subsystem profile of the functioning DS4000 Storage Subsystem configuration to which the migration will occur in a location other than that of the logical drives you plan to migrate.
- ___ Step 13. If you migrate the drives to a single controller DS4000 Storage Subsystem (for example, DS4300 Storage Subsystem, model 6LU or 6LX), change the logical drive's preferred owner to Controller A using the DS4000 Storage Manager client program before taking it offline and removing it from the DS4000 Storage Subsystem. To set Controller A as the logical drive preferred owner, right-click the logical drive entry in the Subsystem Management window and select **Change -> Ownership/Preferred Path -> Controller A**.

Activity 2: Verifying the drive migration enable settings

The DS4000 storage subsystem drive migration setting must be set to enable before inserting drives with configuration data. If not, the DS4000 controller ignores the configuration data in the drive and displays the drive as unconfigured and optimal. IBM recommends that you perform the steps to run the EnableDriveMigration script to ensure the drive migration setting is set to enable before inserting any drives with configuration data. See "Activity 3: Re-enabling the drive migration settings" on page 63 for instructions.

Activity 3: Removing the drives to be migrated

While the functioning DS4000 Storage Subsystem is still powered on, remove the hard drives that you plan to migrate one at a time using the following steps:

- ___ Step 1. Press on the inside of the bottom of the tray handle to release the blue latch.
- ___ Step 2. Lift the closed latch to its open position. (The latch is at a 90-degree angle to the front of the drive when open.)

Note: Your drive CRUs might have a different latching mechanism than the one shown in Figure 20 on page 70. Refer to the *Installation, User's, and Maintenance Guide* for your particular storage expansion enclosure for details.

- ___ Step 3. Using the handle, slowly pull the drive ½ inch out of its drive slot.
- ___ Step 4. Wait at least 30 seconds to allow the hard drive to spin down before fully removing it from the drive slot.
- ___ Step 5. Place the hard drive into an ESD bag or container before moving it to the new DS4000 Storage Subsystem.

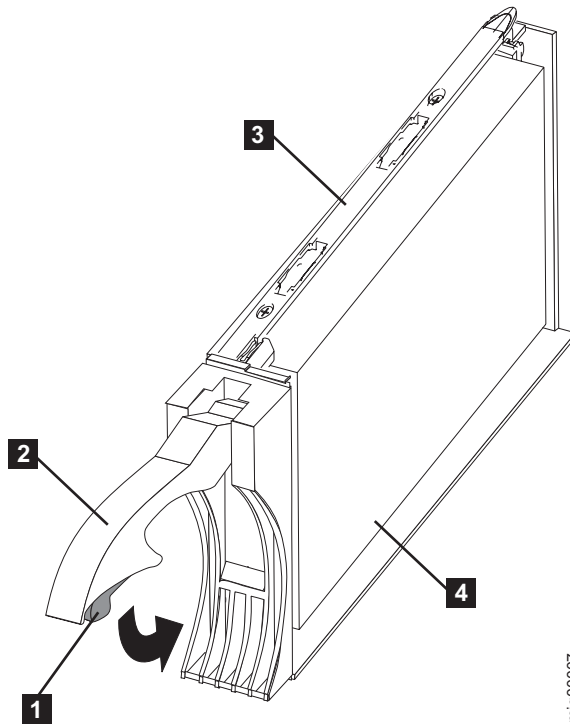


Figure 20. Drive CRU assembly

Legend:

- 1** Blue latch
- 2** Drive CRU handle
- 3** Tray
- 4** FC hard drive

Attention: Orient drives horizontally and place them in appropriate ESD bags or containers before relocation. When in transit, use only moving equipment that prevents shock to the drives. Never stack drives.

Activity 4: Inserting the drives to be migrated

Notes:

1. When migrating hard drives from multiple DS4000 Storage Subsystems to a single DS4000 Storage Subsystem, move all of the hard drives from the first DS4000 Storage Subsystem as an independent "set" to the destination DS4000 Storage Subsystem. Before moving hard drives as a set from subsequent DS4000 Storage Subsystems, ensure that all of the hard drives from the previous set have been successfully transferred to the destination DS4000 Storage Subsystem. If you do not transfer hard drives as "sets" to the destination DS4000 Storage Subsystem, the newly relocated arrays/logical drives that are defined using these drives might not appear in the Subsystem Management window.
2. Make sure the drives are compatible with the storage expansion enclosure. For example, insert a 2 GB drive into a storage expansion enclosure that supports 2 GB drives.




Perform the following steps to insert the drives to be migrated.

- ___ Step 1. While the destination DS4000 Storage Subsystem is powered on, insert the migrating drives into the empty drive slots in pairs. Wait (up to five

minutes) until the inserted drive pair is fully spun up and displayed in the DS4000 Storage Subsystem Management window before inserting the next drive pair.

___ Step 2. As the DS4000 Storage Subsystem recognizes the drives, it reads and displays the array and logical drive information in the Logical/Physical view of the DS4000 Storage Subsystem Management window. The storage subsystem represents arrays in off line state until it recognizes that you have inserted all of the drives that comprise an array.

___ Step 3. After you migrate all of the drives, manually change the state of the arrays and logical drives involved from optimal to online state if it has not changed automatically. To do so, right-click on the array name in the Storage Subsystem Management window and select **Place -> Online**. If any of the following conditions persist, contact the IBM Help Center in your geography for assistance:

- The empty drive slot icon () displayed for the drive slot into which you inserted the migrating drive.
- The Failed unconfigured drive icon () or the Failed configured drive icon () displayed for the drive slot into which you inserted the migrating drive.
- Array configuration data on the drives you have added is incomplete.
- You cannot bring the array online.

Attention: Do not initialize a drive that you want to keep (by right-clicking its icon and selecting **Initialize** from the pull-down menu) if it contains configuration or user data. Initializing any drives in a defined array causes all hard drives known to comprise that array to return to the Unconfigured Capacity storage pool, deleting their array definitions from the DS4000 Storage Subsystem configuration. The user data on such drives is lost.

Result: Once the arrays are online, they are ready to for you to configure and map to host servers. You might also then recreate flashcopies of the logical drives.

___ Step 4. Use the DS4000 Storage Manager program to view the storage partitioning definitions and make any necessary corrections.

___ Step 5. The DS4000 Storage Subsystem that the drives are migrated from will display the logical drives that are defined in these drives as “missing LUNs”. In order to remove these “missing LUNs” entries, right-click on each entry and select **Delete** from the pull-down menu.

Migrating arrays within storage subsystems

Important:

1. Ensure that your controller firmware is at or above the level documented in Table 22 on page 49. Do not rearrange more than one array at a time.
2. Unmount the file systems to flush I/O from the server cache to disks.

Notes:

- a. In a Microsoft Windows environment, remove the drive letter or the mount points of the mapped LUNs instead of unmounting the file systems.
- b. Consult documentation associated with your particular operating system for detailed information regarding the unmount procedure.

Using the configuration data on existing drives, it is possible to redistribute the drives that made up a RAID array across a storage subsystem to which you may be adding expansion enclosures. Figure 21 illustrates a storage array distributed across three drives on a single storage device before and after reordering. When you redistribute each drive to a different position in the same storage enclosure as recommended, the array automatically redistributes accordingly.

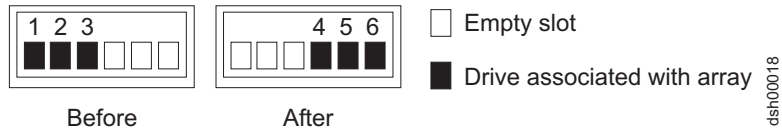


Figure 21. Manner recommended for reordering a defined array using empty slots in one storage enclosure

Figure 22 illustrates a storage array distributed across three drives on a single storage device before reordering across two storage devices. When the drives are redistributed across an additional storage enclosure in the storage subsystem as recommended, the array automatically redistributes accordingly.

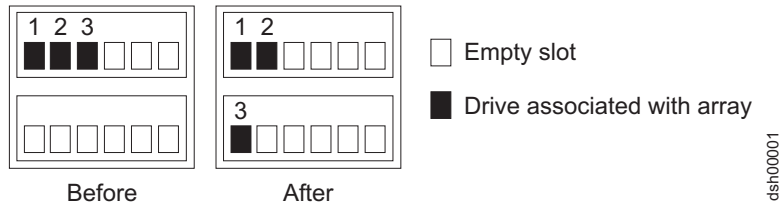


Figure 22. Manner recommended for reordering a defined array using empty slots in two storage enclosures

Figure 23 on page 73 illustrates two arrays distributed across five drives and two storage enclosures before and after reordering the same drives across other drive slots in the same two storage enclosures.

Important:

Before you attempt to reinsert any of the drives from either enclosure, place the array into offline state using the DS4000 Storage Manager client and completely remove all of the drives of both arrays from both storage enclosures and wait for the Storage Manager to remove the arrays/logical drives from the Storage Manager GUI window. After you insert the drives associated with the first array, wait until that array comes online in a DS4000 Storage Manager Subsystem Management window before you insert the drives associated with the second array.

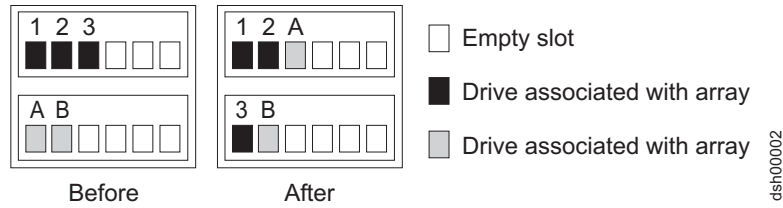


Figure 23. Reordering multiple defined arrays across previously used slots in two storage enclosures

Perform the following steps to ensure success when you reorder drives that make up arrays across different drive slots in the same DS4000 Storage Subsystem configuration.

1. Start the DS4000 Storage Manager Client program and open the Subsystem Management window (for the DS4000 Storage Subsystem which drives you intend to reorder).
2. Set the arrays that you plan to move offline.
3. Mark the drives in the arrays.
4. Unlatch the drives from their respective slots. Wait at least 2 minutes for each drive to spin down.
5. Slowly and carefully remove the drives from their slots.
6. Assure that all of the drives that made up the arrays are completely removed from their slots.
7. Wait for the storage manager to mark the arrays/logical drives as missing in the Subsystem Management window. See Figure 24.

CAUTION:

Do not proceed to step 8 until all of the defined logical drives in the array(s) whose drives are removed from the DS4000 enclosures display as missing; otherwise, the controller may mark certain drives that are part of the array as failed, causing the array to be degraded or failed.

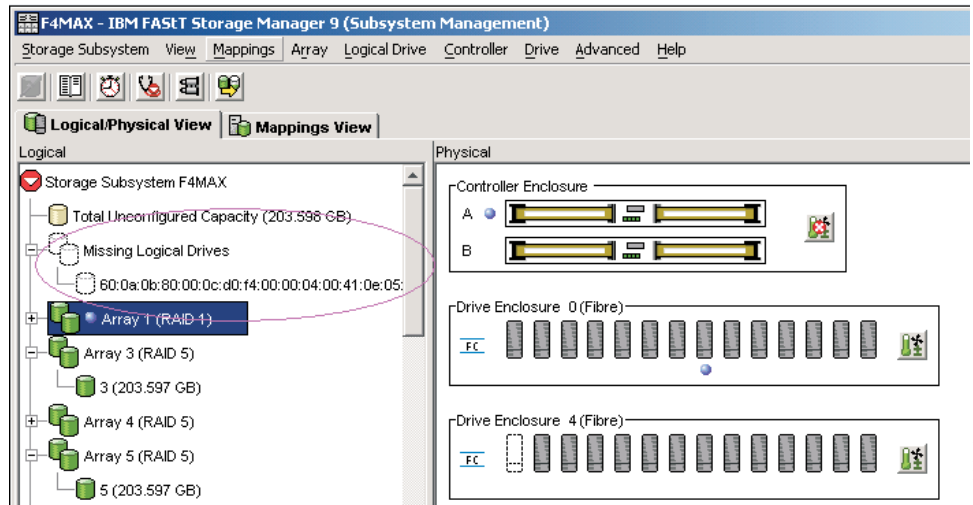


Figure 24. Subsystem Management Logical/Physical View of missing logical drives

8. Carefully reinsert all of the drives that made up a single array into the empty slots of the storage enclosure. Do not insert the drives into empty slots that are part of another array definition whose drives are still inserted in the storage

enclosures. Data on the drives you insert will be replaced with the reconstructed data from the previously installed RAID array.

9. The system will recognize the array and bring it online when you finish inserting all of the drives.
10. Repeat steps 8 on page 73 and 9 for each of the arrays that were removed from the storage enclosure.
11. Save the storage subsystem profile. See “Saving the storage subsystem profile” on page 58 for information on performing this activity.

Note: Do not reinsert drives from multiple arrays in random order into the storage enclosures.

Chapter 4. Adding or migrating storage expansion enclosures

Overview and rules

This chapter provides all the steps necessary to add or migrate storage expansion enclosures in a DS4000 Storage Subsystem.

Important:

Observe proper ESD procedures when handling electronic equipment. See “Handling static-sensitive devices” on page 59 for additional information.

Attention:

Make additions to the DS4000 Storage Subsystem only while it is powered on and in optimal state. See “Bringing storage subsystems and drive loops into optimal state” on page 57 for additional information on how to make this determination. You can complete this process while the DS4000 Storage Subsystem is receiving I/O from the host server; however, because the drive loops are interrupted momentarily during the addition process, schedule the addition to occur during time periods of low I/O between the DS4000 Storage Subsystems and host servers.

When adding storage expansion enclosures containing new hard drives to an existing DS4000 Storage Subsystem configuration, or migrating one or more DS4000 storage expansion enclosures already containing hard drives with configuration data from a functioning DS4000 Storage Subsystem to another DS4000 Storage Subsystem configuration, observe these important rules:

- Never alter the physical configuration of a DS4000 Storage Subsystem while it is powered off unless you are instructed to do so as part of DS4000 Storage Subsystem configuration procedure. Specifically, never attach storage components to or remove storage components from a configured DS4000 Storage Subsystem while it is powered off.
- Any hard drive, whether new or old, might contain configuration data. Unless you intend to migrate drives from another DS4000 Storage Subsystem (retaining their configuration data), always use the procedure to add one or more storage expansion enclosures containing one or more hard drives to a functioning DS4000 Storage Subsystem configuration. Do not use the migrating storage expansion enclosure procedure if you are unsure of the quality of the data on the hard drives. Importing incorrect configuration data from hard drives could cause a DS4000 Storage Subsystem failure.
- When migrating hard drives from multiple DS4000 Storage Subsystems to a single DS4000 Storage Subsystem, move all of the hard drives from the first DS4000 Storage Subsystem as an independent *set* to the destination DS4000 Storage Subsystem. Before moving hard drives as a set from subsequent DS4000 Storage Subsystems, ensure that all of the hard drives from the previous set have been successfully transferred to the destination DS4000 Storage Subsystem. If you do not transfer hard drives as *sets* to the destination DS4000 Storage Subsystem, the newly relocated arrays/logical drives that are defined in these drives might not appear in the Subsystem Management window.
- Before migrating hard drives, perform the following steps to establish drive model compatibility:
 - ___ 1. Check the drive CRU form factor options.

- ___ 2. If the form factors are not the same, there are no replacement parts (this includes bezels and drive trays).
 - ___ 3. If the form factors are the same, check to see if the drive is supported by the DS4000 subsystem.
 - ___ 4. Ensure that the drive can operate at the storage subsystem drive loop/channel FC speed. See Table 21 on page 46 for more information.
- Not all combinations of the supported storage expansion enclosures will be supported as storage expansion enclosures intermixed behind DS4000 Storage Subsystems.
 - Do not mix SATA and Fibre Channel drives or enclosures together in the same drive loop unless you have met the Fibre Channel/SATA intermix requirements. See “Intermixing storage expansion enclosures” on page 5 for that information.
 - Do not install SATA drives in EXP700 or EXP710 Fibre Channel drive expansion enclosures. Do not install Fibre Channel drives in EXP100 SATA drive expansion enclosures. EXP810 drive expansion enclosures can accept either Fibre Channel (FC) or SATA Enhanced Disk Drive Modules (E-DDMs); however, the intermix of FC and SATA E-DDMs in the same EXP810 enclosure is not supported at this time. Check the DS4000 interoperability matrix for the support of this capability in the future.
 - Do not attach more than four storage expansion enclosures behind a DS4700 Express or DS4800 controller drive channel port. See the *IBM System Storage DS4700 Express Storage Subsystem: Installation, User's and Maintenance Guide* or the *IBM System Storage DS4800 Storage Subsystem Installation, User's and Maintenance Guide*, for more information.
 - Always connect the DS4000 controller drive channel port to either the left or right EXP810 or EXP420 ESM drive port that is labeled 1B.
 - When intermixing the storage expansion enclosures in a redundant drive loop/channel pair behind a DS4000 Storage Subsystem, always group the storage expansion enclosures by type; for example, group the EXP100s together, group the EXP700s together, group the EXP710s and EXP810s together. The EXP710s and EXP810s are considered *Switched-ESM* types of expansion enclosures even though they have different machine types and models. Though there are no restrictions against cabling EXP710 and EXP810 storage expansion enclosures together, for ease of future maintenance and to aid in problem troubleshooting, IBM strongly recommends that you group, or plan your configuration to allow for grouping of, the drive expansion enclosures by type in a DS4000 Storage Subsystem redundant drive loop/channel pair.
 - Make sure the enclosure IDs of each storage expansion enclosure in a redundant drive loop/channel pair behind a DS4000 Storage Subsystem have unique values in the single digit (x1) position.

The following procedure combines the steps that are required to add one or more DS4000 storage expansion enclosures containing new drives to a functioning DS4000 Storage Subsystem configuration and to migrate storage expansion enclosure(s) from a DS4000 Storage Subsystem configuration to another DS4000 Storage Subsystem configuration. There will be indicators in the steps if they are specific to either adding or migrating enclosure tasks. If you are migrating storage expansion enclosures, *do not* perform the steps that are indicated as being only for adding storage expansion enclosures: performing steps designed to add storage expansion enclosures might cause the deletion of the logical drive configuration in the migrated hard drives.

Activity 1: Preliminary activities

Before adding or migrating storage expansion enclosures, the following steps are the preliminary steps that must be completed to ensure that your DS4000 Storage Subsystem will perform properly once the addition or migration is finished:

- ___ Step 1. Verify that the DS4000 Storage Subsystem is powered on and in optimal state. If this is a migrating enclosure task, also ensure that the DS4000 subsystem in which the enclosures are to be migrated is powered on and is optimal. See the *DS4000 Problem Determination Guide* associated with your particular DS4000 hardware model or “Bringing storage subsystems and drive loops into optimal state” on page 57 for additional information on how to make this determination. You can perform this process while the DS4000 Storage Subsystem is processing I/O from or to the host server; however, because the drive loops are interrupted momentarily during the addition process, schedule any additions to occur during time periods of low I/O between the DS4000 Storage Subsystem and host servers.

Note: Though there are no restrictions against cabling EXP100s with EXP700s, or EXP710s with EXP810 storage expansion enclosures, for ease of future maintenance and to aid in problem troubleshooting, IBM recommends that you group, or plan your configuration to allow for grouping of, the drive expansion enclosures by type in a DS4000 Storage Subsystem redundant drive loop/channel pair.

Review the readme and the *IBM System Storage DS4000 Storage Manager Installation and Support Guide* associated with the operating system environment of the host servers that connect to the DS4000 Storage Subsystem for any additional restrictions or required preparation tasks specific to your particular operating system environment. You will find the *IBM System Storage DS4000 Storage Manager* installation and support guides at:

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

- ___ Step 2. Verify that the DS4000 Storage Subsystem supports the DS4000 drive storage expansion enclosures you are trying to add or migrate.
- ___ Step 3. If the storage expansion enclosure to-be-migrated is not the same type as the existing storage expansion enclosures (some or all), see “Intermixing storage expansion enclosures” on page 5 for intermix information.

Note: You must group like DS4000 storage expansion enclosure types in adjacent positions on the Fibre Channel loop when they are intermixed in a DS4000 Storage Subsystem redundant drive loop configuration.

- ___ Step 4. If you are adding new enclosures with new drives, proceed with the steps in “Adding new expansion enclosures with new hard drives”; otherwise, proceed to the steps in “Migrating expansion enclosures with hard drives having defined logical drive configurations” on page 79.

Adding new expansion enclosures with new hard drives

- ___ Step 1. Unpack and mount any additional storage expansion enclosures in the rack using the mounting hardware supplied with each storage expansion enclosure.

Important: Do not fully insert hard drives into the enclosures at this time. Keep them unlatched and no less than ½ inch away from their full insertion points in the drive slots.

- Step 2. Set the enclosure ID of the additional storage expansion enclosures. Each enclosure (including the DS4000 Storage Subsystem with internal drive slots) in the DS4000 Storage Subsystem configuration must have a unique enclosure ID. In addition, enclosures (including the DS4000 Storage Subsystem with internal drive slots) that are connected together in the same redundant drive loop/channel pair must have unique single enclosure ID digits (x1s). For example, 01, 02, 03, 04, or 11, 12, 13, 14, are the correct enclosure IDs of the enclosures, including the DS4000 subsystems with internal drives that are connected together in a drive loop/channel. Whereas 01, 11, 21, 31, or 11, 11, 22, 33, are not the correct enclosure IDs of the enclosures that are connected together in a drive loop/channel pair (including the DS4000 subsystems with internal drives) because the single digits within each enclosure ID are not unique (01, 11, 21, 31) or the enclosure ID itself is not unique (11, 11, 22, 33).

In an EXP500 storage expansion enclosure, there is an enclosure ID switch mounted on each of two ESM canisters. Set each ESM canister's enclosure ID switch in the EXP500 drive enclosure to the same unique number of that in the drive loop. In EXP100, EXP700, and EXP710 storage expansion enclosures, there is only one enclosure ID switch, which is mounted between the power supplies. The EXP420/EXP810 does not have a physical switch setting for the enclosure ID; instead, it has a display that shows its enclosure ID. The controller firmware automatically sets the enclosure ID; however, you can change the enclosure ID by using the DS4000 Storage Manager Client program. For additional information, see the appropriate *DS4000 Installation, User's, and Maintenance Guide* for the particular storage expansion enclosure. Figure 25 illustrates the location of enclosure ID switches on the EXP100, EXP500, EXP700, EXP710, and EXP420/EXP810 storage enclosures.

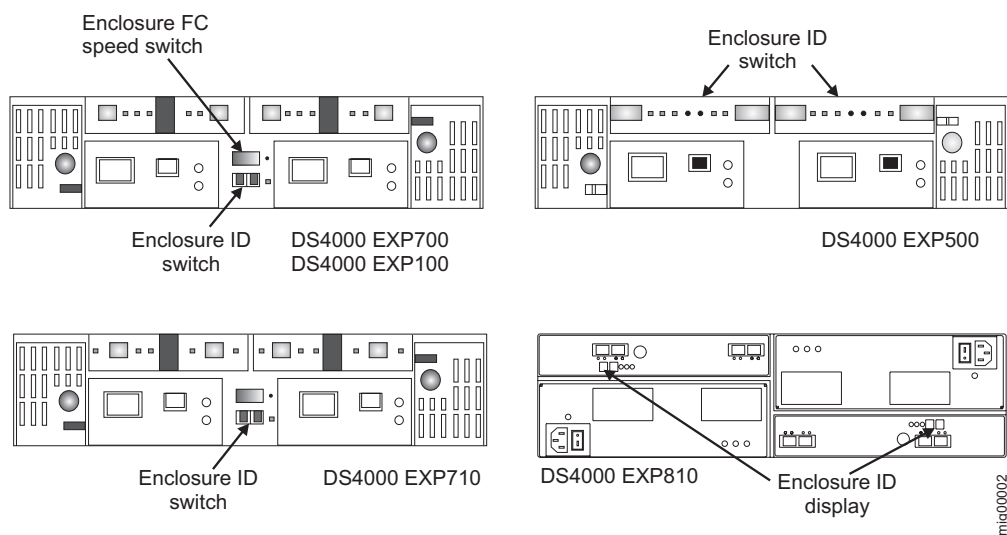


Figure 25. EXP100, EXP500, EXP700, EXP710, and EXP420/EXP810 enclosure ID and speed switches

If the DS4000 Storage Subsystem to which the storage expansion enclosure will attach is either a FAStT200, DS4100, DS4200, DS4300, or DS4700 Express, the enclosure IDs of additional storage expansion enclosures must differ from the FAStT200, DS4100, DS4200, DS4300 or DS4700 Express Storage Subsystem enclosure IDs. The enclosure IDs of FAStT200, DS4100 and DS4300 are normally set to *00* at the factory. The enclosure IDs for the DS4200 and DS4700 Express are normally set to *85* at the factory.

- ___ Step 3. Verify that the DS4000 Storage Expansion Enclosure speed switch is set to the correct drive loop speed, which is the highest speed that all enclosures in the drive loop/channel can operate in. For example, if there is a mix of drive enclosures that are FC 4 Gbps capable and FC 2 Gbps capable in the same drive loop/channel, all of the enclosures must have the speed switch set at the highest speed that *all* enclosures can operate, which is FC 2 Gbps speed.

Note: If a Fibre Channel enclosure speed switch was originally set to 1 Gbps, do not automatically set it to 2 Gbps unless you are sure that each Fibre Channel hard drive that it now contains is capable of 2 Gbps operation. Be sure you have installed the latest firmware to enable hard drive operation in a 2 Gbps Fibre Channel environment. Similarly, do not automatically change the settings from 2 Gbps to 4 Gbps unless you are sure that the installed drives are capable of 4 Gbps operation. Do *not* automatically move up to higher speed unless the installed disk drives can operate at a higher speed.

- ___ Step 4. Proceed to “Activity 6: Cabling, powering on, and verifying storage expansion unit operation” on page 84. Do *not* perform Activities 3–5.

Migrating expansion enclosures with hard drives having defined logical drive configurations

- ___ Step 1. Verify that controller firmware and NVSRAM in the both the DS4000 Storage Subsystem that the enclosures will be migrated to and the DS4000 Storage Subsystem that has the enclosures to be migrated, are at the levels recommended in Table 22 on page 49.
- ___ Step 2. Verify that the firmware of the ESMs in the storage expansion enclosures that you plan to migrate are at the levels recommended in Table 22 on page 49.
- ___ Step 3. Verify that the firmware of the ESMs in the storage expansion enclosures attached to the DS4000 Storage Subsystem to which you will migrate your drives is at the levels recommended in Table 23 on page 53.
- ___ Step 4. If you migrate storage expansion enclosures from a lower Fibre Channel environment to a higher Fibre Channel environment (for example, moving from 1 Gbps to 2 Gbps or from 2 Gbps to 4 Gbps), verify that each of the Fibre Channel hard drives that you plan to migrate are capable of higher FC speed operation and that you have installed the latest firmware, if required, enabling them to work properly in a higher FC speed Fibre Channel environment.

Data that may reside on drives you plan to migrate will migrate with those drives, when installed on another DS4000 Storage Subsystem. To ensure a successful migration, perform steps 5, 6, 7 and 8, that follow.

- ___ Step 5. Verify that the names of the logical drives that are created using the hard drives in the migrated storage expansion enclosures are unique in the DS4000 Storage Subsystem to which these storage expansion enclosures will migrate. If they are not unique, make any necessary changes.
- ___ Step 6. Verify that all of the enclosures IDs of the storage expansion enclosures in the redundant drive loop/channel have unique single digit (x1) values.
- ___ Step 7. In addition to array configuration information, any storage partitioning configuration data that may reside on drives you plan to migrate will migrate with those drives when installed on another DS4000 Storage Subsystem. For this reason, take the following precautions to facilitate the migration process and prevent problems in storage partitioning configuration data migration.
 - a. If a DS4000 storage partitioning premium feature has been enabled both on a drive's original and destination DS4000 Storage Subsystems, ensure that the defined host ports, hosts, and host group names are unique to each DS4000 Storage Subsystem involved in the migration.
 - b. If you must use identical names on both DS4000 Storage Subsystems, make the names unique before you perform the drive migration. If necessary, customize the storage partitioning information on the DS4000 Storage Subsystem to which you have migrated the drives after you complete the migration.
- ___ Step 8. Delete any flash copies of logical drives defined in the hard drives that you plan to migrate.
- ___ Step 9. Remove any remote mirror relationships that involve the logical drives defined on the drives that you plan to migrate.
- ___ Step 10. Proceed to "Activity 2: Preparing and backing up the drives."

Activity 2: Preparing and backing up the drives

Note: The following steps are for migrating enclosures with drives having defined arrays/logical drives only. Do not perform these steps if you are adding enclosures with new drives or drives containing unneeded data.

- ___ Step 1. If the arrays and logical drives involved are not in optimal state, perform the steps necessary to bring these arrays and logical drives to their optimal state before attempting migration. Use the Recovery Guru function in the DS4000 Storage Subsystem Management window of the DS4000 Storage Manger client program, or see "Bringing storage subsystems and drive loops into optimal state" on page 57 for additional information on how to make this determination.
- ___ Step 2. If the drive enclosures that you plan to migrate are not in optimal state, perform the steps necessary to bring them to their optimal state before attempting migration. Use the Recovery Guru function in the DS4000 Storage Subsystem Management window of the DS4000 Storage Manger client program, or see "Bringing storage subsystems and drive loops into optimal state" on page 57 for additional information on how to make this determination.
- ___ Step 3. Perform a backup of the logical drives defined in the storage expansion enclosures that you plan to migrate.

- ___ Step 4. Monitor the DS4000 Storage Subsystem event log for any errors in the drive loop or its components for several days before migrating storage expansion enclosures.
- ___ Step 5. Stop all programs, services or processes in the host servers that access the logical drives defined in the migrated hard drives. Ensure that there are not any running background programs, services or processes that write data to the logical drives. (For example, Microsoft MSCS service periodically writes to the “Quorum” disk.)
- ___ Step 6. Unmount the file systems to flush I/O from the server cache to disks.

Notes:

- a. In a Microsoft Windows environment, remove the drive letter or the mount points of the mapped LUNs instead of unmounting the file systems.
- b. Refer to the documentation associated with your particular operating system for detailed information regarding the Unmount procedure.
- ___ Step 7. Save the DS4000 Storage Subsystem profile of the functioning DS4000 Storage Subsystem configuration to which the migration will occur in a location other than that of the logical drives you plan to migrate.
- ___ Step 8. Place the arrays defined in the storage expansion enclosures that you plan to migrate in offline state. In the DS4000 Storage Subsystem Management window, right-click on the name of the array and click **Place -> Offline**.

Activity 3: Shutting down and moving the storage expansion enclosure(s)

Note: The following steps are for migrating enclosures with drives having defined arrays/logical drives only. Do not perform these steps if you are adding enclosures with new drives or drives containing unneeded data.

- ___ Step 1. Because removing a storage expansion enclosure from a functioning DS4000 Storage Subsystem will disrupt its drive loops, shut down the DS4000 Storage Subsystem while you remove its storage expansion enclosures for migration to another DS4000 Storage Subsystem. If you cannot shut down the DS4000 Storage Subsystem, carefully reconfigure only one drive loop, making sure that the drive loop that you modify is connected correctly and in optimal state before you attempt to reconfigure the other drive loop. For additional information on making this determination, see “Bringing storage subsystems and drive loops into optimal state” on page 57.

Take this precaution to prevent the arrays from being inadvertently failed by the DS4000 Storage Subsystem controllers because two or more drives in the arrays cannot be reached through either drive loop in the redundant drive loop pair.

Perform the following steps to verify that the drive loops are in optimal state:

- a. Physically trace the actual cable connections making sure that connections are properly modified and that the cable connectors are firmly inserted into the SFPs or GBICs.
- b. Verify that the following LEDs are not lit or briefly flashed in the modified drive loop:
 - ESM Fault
 - port bypass

- ID conflict
 - c. Verify that the controller drive loop LED remains lit. If the controller drive loop LED becomes unlit momentarily, there are problems in the drive loop and the Loop Initialization Primitives (LIPs) are generated by the DS4000 Storage Subsystem controller.
 - d. In the DS4000 Storage Manager Client Subsystem Management window, verify that there are no loss of ESM path redundancy errors in the storage expansion enclosures that are not migrated.
Do not modify the second drive loop in the redundant drive loop pair until you are sure that the first modified drive loop is operating optimally.
- ___ Step 2. Power down the storage expansion enclosures and move them to the DS4000 Storage Subsystem to which you plan to migrate them.

Notes:

- A storage expansion enclosure with 14 drives weighs up to 100 lbs. (45 kg). If necessary, remove the drives and other storage expansion enclosure components to reduce the weight of the unit for easier handling. Mark each drive before removing it in order to return it to the same drive slot when you reassemble the components at the destination location.
- Move drives only in a horizontal position using an appropriate ESD bag or container and moving equipment that prevents shock to the drives during transit. Never stack drives.

Activity 4: Verifying the drive migration enable settings

Note: The following steps are for migrating enclosures with drives having defined arrays/logical drives only. Do not perform these steps if you are adding enclosures with new drives or drives containing unneeded data.

The DS4000 Storage Subsystem drive migration setting of the DS4000 Storage Subsystem to which the enclosures will be migrated must be set to enable before inserting drives with configuration data. If not, the DS4000 controller ignores the configuration data in the drive and displays the drive as unconfigured and optimal. Verify the drive migration setting on the DS4000 Storage Subsystem to which the expansion enclosure will be migrated. IBM recommends that you perform the steps to run the EnableDriveMigration script to ensure the drive migration setting is set to enable before inserting any drives with configuration data. See “Activity 3: Re-enabling the drive migration settings” on page 63 for instructions.

Activity 5: Installing and setting storage expansion unit IDs and speeds

Note: The following steps are for migrating enclosures with drives having defined arrays/logical drives only. Do not perform these steps if you are adding enclosures with new drives or drives containing unneeded data.

- ___ Step 1. When the storage expansion enclosures and drives are at the location of the DS4000 Storage Subsystem to which they will be migrated, install them into the rack. If the drives were removed during transit, return them to the slots from which they were removed, unlatched and no less than 1/2-inch away from their full insertion points in the drive slots. If the drives were not removed, unlatch and pull them out no less than 1/2-inch away from their full insertion points in the drive slots.

- ___ Step 2. See Figure 25 on page 78 for an illustration of how to set the enclosure ID of the storage expansion enclosures. Each enclosure (including the DS4000 Storage Subsystem with internal drive slots) in the DS4000 Storage Subsystem configuration must have a unique enclosure ID. In addition, enclosures (including the DS4000 Storage Subsystem with internal drive slots) that are connected together in the same redundant drive loop/channel pair must have unique single enclosure ID digits (x1s). For example, 01, 02, 03, 04, or 11, 12, 13, 14, are the correct enclosure IDs of the enclosures, including the DS4000 subsystems with internal drives that are connected together in a drive loop/channel. Whereas 01, 11, 21, 31, or 11, 11, 22, 33, are not the correct enclosure IDs of the enclosures that are connected together in a drive loop/channel pair (including the DS4000 subsystems with internal drives) because the single digits within each enclosure ID are not unique (01, 11, 21, 31) or the enclosure ID itself is not unique (11, 11, 22, 33).

In an EXP500 Storage Expansion Unit, there is an enclosure ID switch mounted on each of two ESM canisters. Set each ESM canister's enclosure ID switch in the EXP500 drive enclosure to the same unique number in the drive loop. In the EXP100, EXP700 and EXP710 storage expansion enclosures, there is only one enclosure ID switch, which is mounted between the power supplies. The EXP420 and EXP810 do not have physical switch settings for enclosure IDs. Instead they have an LED that shows the enclosure ID. The controller firmware automatically sets the enclosure ID. However, you can change the enclosure ID by using the DS4000 Storage Manager Client program. To access the appropriate *DS4000 Storage Expansion Unit Installation and User's Guide* for additional information, see the following Web page:

<http://www-03.ibm.com/servers/storage/support/disk/>

Important:

If the DS4000 Storage Subsystem to which the storage expansion enclosure will attach is either a FASTT200, DS4100, DS4200, DS4300, or DS4700, the enclosure IDs of additional storage expansion enclosures must differ from the FASTT200, DS4100, DS4200, DS4300 or DS4700 Storage Subsystem enclosure IDs. The enclosure IDs of FASTT200, DS4100 and DS4300 are normally set to *00* at the factory. The enclosure IDs for the DS4200 and DS4700 are normally set to *85* at the factory.

- ___ Step 3. Verify that the DS4000 Storage Expansion Enclosure speed switch is set to the correct drive loop speed, which is the highest speed that all enclosures in the drive loop/channel can operate in. For example, if there is a mix of drive enclosures that are FC 4 Gbps capable and FC 2 Gbps capable in the same drive loop/channel, all of the enclosures must have the speed switch set at the highest speed that *all* enclosures can operate, which is FC 2 Gbps speed.

Note: If a Fibre Channel enclosure speed switch was originally set to 1 Gbps, do not automatically set it to 2 Gbps unless you are sure that each Fibre Channel hard drive that it now contains is capable of 2 Gbps operation. Be sure you have installed the latest firmware to enable hard drive operation in a 2 Gbps Fibre Channel environment. Similarly, do not automatically change the settings from 2 Gbps to 4 Gbps unless you are sure that the installed drives are capable of 4 Gbps operation. Do *not*

automatically move up to higher speed unless the installed disk drives can operate at a higher speed.

Note: Before you migrate hard drives, be sure to determine the compatibility of drive model capacity, interface type, and speed. For specific information about your drive options in the most current environment, see Table 21.

Activity 6: Cabling, powering on, and verifying storage expansion unit operation

This activity is for both adding and migrating enclosures.

To complete addition of DS4000 storage expansion enclosures, cable the storage expansion enclosures to the end of the functioning storage expansion enclosure drive loop to which you are migrating them. Add only one enclosure at a time to a functioning drive loop, if you intend to attach multiple storage expansion enclosures.

It is possible to connect storage expansion enclosures at either end, or in the middle, of an existing and functioning storage expansion enclosure drive loop. Figure 26 on page 85 shows possible ways of adding enclosures to existing and functioning storage expansion enclosure drive loop. The options are as follows:

- The beginning, closest to the controller (at the top, directly attached to controller A) as described in Connecting storage expansion enclosures at the beginning of (top of) a drive loop.
- The middle, between the existing storage expansion enclosures in the redundant drive loop/channel pair, as described in “Connecting storage expansion enclosures in the middle of a drive loop” on page 91.
- The end, furthest from the controller (at the bottom, directly attached to controller B) as described in Connecting storage expansion enclosures at the end of (bottom of) a drive loop.

Of the three options, IBM recommends only option 3—connection to the end (at the bottom) of a functioning storage expansion enclosure drive loop, directly attached to controller B. This is recommended because if the existing DS4000 Storage Subsystem configuration is not planned for cabling-in storage expansion enclosures at the top or the middle of the drive loop, cluttered or entangled Fibre Channel drive loop cabling may hinder drive loop troubleshooting or cause Fibre Channel cabling errors. With this in mind, and depending on your requirements, follow either of the instruction sets at “Connecting storage expansion enclosures at the end of (bottom of) a drive loop” on page 86, “Connecting storage expansion enclosures in the middle of a drive loop” on page 91, or “Connecting storage expansion enclosures at the beginning of (top of) a drive loop” on page 101.

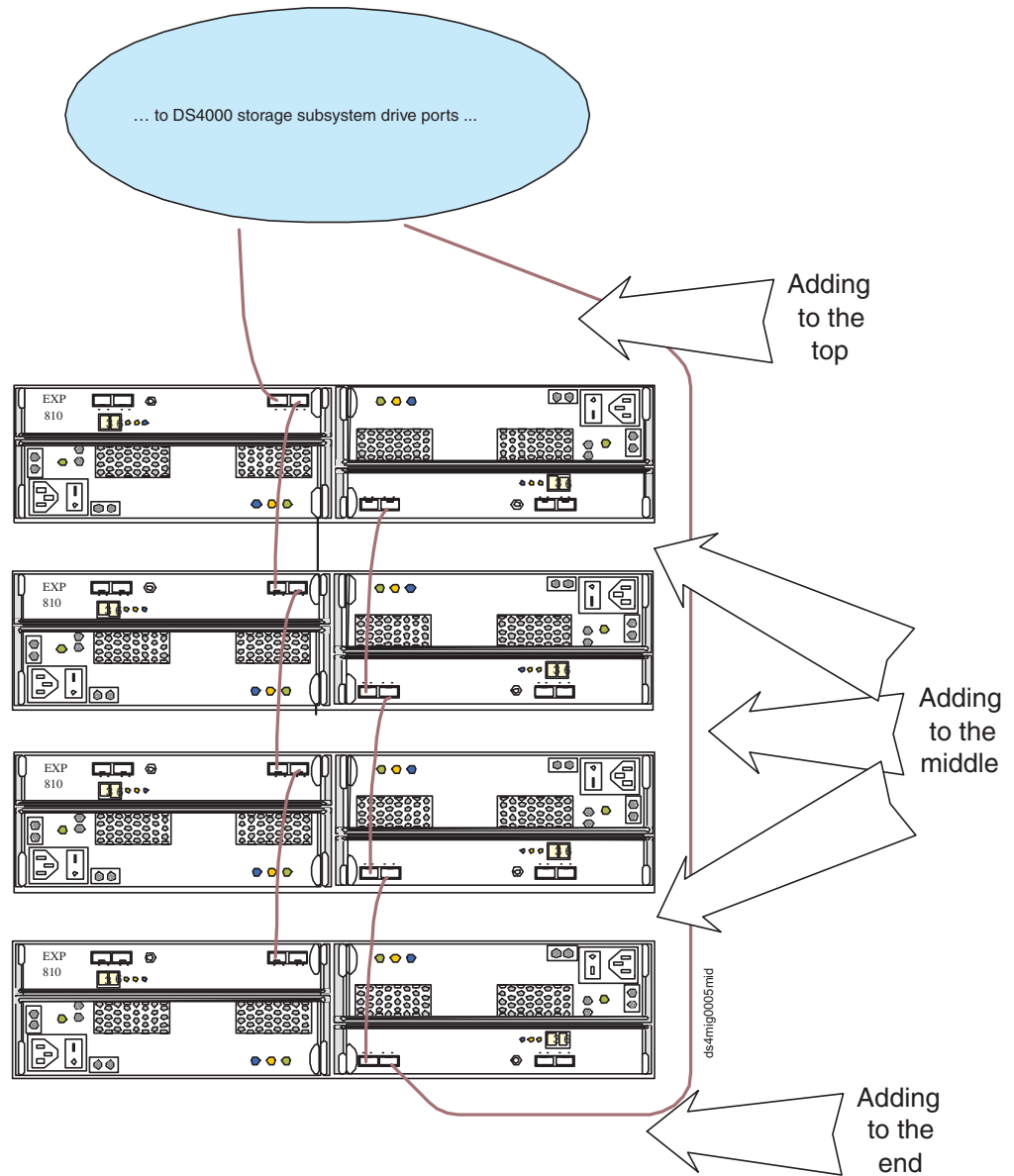


Figure 26. Example of adding expansion enclosure positions within a functioning drive loop

Depending on your DS4000 Storage Subsystem configuration, there might be unused drive ports by which you can connect the drive expansion enclosures to the DS4000 Storage Subsystem controllers. IBM recommends utilizing the unused drive ports when adding storage expansion enclosures to an existing DS4000 configuration—especially if you are adding enclosures of a different type to the configuration. Use the appropriate information in your *DS4000 Installation, User's, and Maintenance Guide* to attach the drive expansion enclosures to the DS4000 Storage Subsystem.

If your DS4000 Storage Subsystem (such as DS4400 or DS4500) has drive minihubs, do not use more than one port per drive minihub. Always leave one of the two drive ports empty in each drive minihub.

The steps and graphics in “Connecting storage expansion enclosures at the end of (bottom of) a drive loop” on page 86 and “Connecting storage expansion enclosures at the beginning of (top of) a drive loop” on page 101 illustrate how to connect 10-

or 14-drive storage expansion enclosures, for example, an EXP700 or EXP710 to a DS4300 Storage Subsystem drive loop. To connect 16-drive storage expansion enclosures—for example, an EXP810 to an existing DS4800 drive loop—follow the similar steps; however, note that the port names are different on the EXP700 than on the EXP810.

Connecting storage expansion enclosures at the end of (bottom of) a drive loop

The cabling instructions illustrated in Figure 27 on page 88, Figure 28 on page 89, and Figure 29 on page 90 describe cabling a DS4000 14-drive expansion enclosure EXP700 to the end (bottom) of a redundant drive loop of a functioning DS4300 Storage Subsystem (model 60X or 60U). The same procedure can also be used to add any 14-drive expansion enclosure to any of the DS4000 Storage Subsystems. Again, IBM recommends that you add storage expansion enclosures to existing drive loops only in this manner.

See also “DS4000 Storage Subsystem drive loop schemes” on page 26.

To add a 16-drive expansion enclosure—for example, an EXP810 or EXP420 to the DS4000 subsystem configuration—you basically follow the same steps as in adding the 14-drive enclosure to a DS4000 subsystem configuration; however, the port connections on the 16-drive enclosure will be different, as illustrated in Figure 30 on page 91 and the three steps that follow it.

- ___ Step 1. Insert the small form-factor pluggables (SFPs) or gigabit interface converters (GBICs) into only those ports you intend to use. Do not leave GBICs or SFPs inserted into port slots without connecting them to other ports using cables.
- ___ Step 2. Extend one of the drive loops (that is, drive loop A) in a DS4000 Storage Subsystem redundant drive loop pair by connecting the OUT port of the last storage expansion enclosure to the IN port of the storage expansion enclosure as shown in Figure 27 on page 88.

Note: The port name on an EXP810 is not labeled IN. See Figure 30 on page 91 for details.

Attention: Carefully reconfigure only one drive loop at a time, making sure that the drive loop you modify is properly connected and in the optimal state before you attempt to reconfigure another drive loop. Take this precaution to prevent the arrays from being inadvertently failed by the DS4000 Storage Subsystem controllers, which happens when two or more drives in the arrays cannot be reached through either drive loop in the redundant drive loop pair.

- ___ Step 3. Power on the added storage expansion enclosure unit.
- ___ Step 4. Wait a few seconds; verify that the port bypass LEDs of all of the ports in drive loop A, now extended to the storage expansion enclosure, are not lit. Using the DS4000 Storage Manager Client Subsystem Management window, verify that the storage expansion enclosure is added and displayed in the Logical/Physical view of the window. Correct any errors before proceeding to step 5 on page 87. For port bypass:
 - ___ a. Verify that the SFPs and GBICs or fibre cables are in good condition.
 - ___ b. Remove and reinsert SFPs, GBICs and fibre cables.

- ___ c. Make sure the drive expansion enclosure speed switch is set to the same speed as the existing drive expansion enclosures and the DS4000 Storage Subsystem speed setting.
- ___ d. Verify that the ESM is good by physically removing and swapping it with the other ESM in the same drive expansion enclosure. For enclosure ID conflict, set the drive expansion enclosure ID switch to values unique from the current settings in the existing drive expansion enclosures and storage server.

Call the IBM Help Center for assistance, if the problems persist.

- ___ Step 5. In the other drive loop (drive loop B) in a DS4000 Storage Subsystem redundant drive loop pair, remove the connection from the storage subsystem drive loop port to the OUT port of the last storage expansion enclosure and connect it to the OUT port of the drive enclosure as shown in Figure 28 on page 89.

Note: The port name on an EXP810 is not labeled OUT. See Figure 30 on page 91 for details.

- ___ Step 6. Wait a few seconds; verify that the port bypass LEDs of the two ports in the connection between the storage subsystem drive loop port and the OUT port of the drive enclosure are not lit. Using the DS4000 Storage Manager Client Subsystem Management window, verify that the drive enclosure does not indicate the drive enclosure lost redundancy path error. See step 4 on page 86 for possible corrective actions, as needed.

Note: The existing storage expansion enclosures will be shown with drive enclosure lost redundancy path errors until you establish the Fibre Channel cabling connection described in step 7.

- ___ Step 7. In drive loop B, cable the drive enclosure's IN port to the OUT port of the last enclosure in the already functioning storage expansion enclosure drive loop, as shown in Figure 29 on page 90.
- ___ Step 8. Wait a few seconds; verify that the port bypass LEDs of all of the ports in drive loop B to which you have added a connection are not lit. Using the DS4000 Storage Manager Client Subsystem Management window, verify that all of the drive enclosures in the DS4000 redundant drive loop pair to which the enclosure was added do not report the drive enclosure lost redundancy path error.
- ___ Step 9. Proceed to "Activity 7: Disabling DS4000 Storage Subsystem drive migration settings (for adding storage expansion enclosures with new drives only)" on page 107, only if you are adding an enclosure with a new drive. Proceed to "Activity 10: Inserting hard drives and placing logical drives online (for migrating only enclosures with drives containing logical drive configuration data)" on page 117, if you are migrating enclosures with drives having logical drive configuration data.

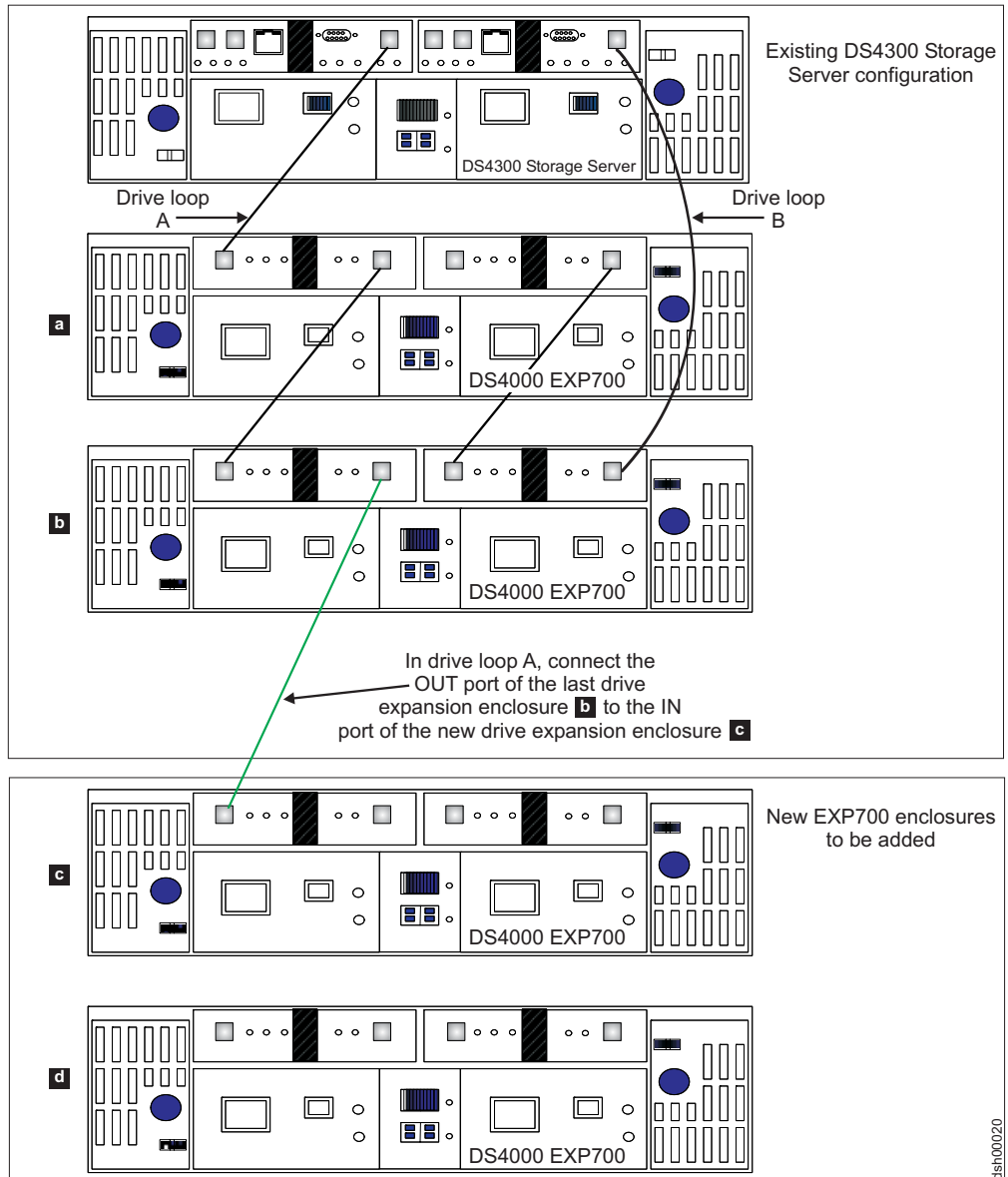


Figure 27. Cabling a single drive enclosure to the end of a functioning drive loop (step 1 of 3)

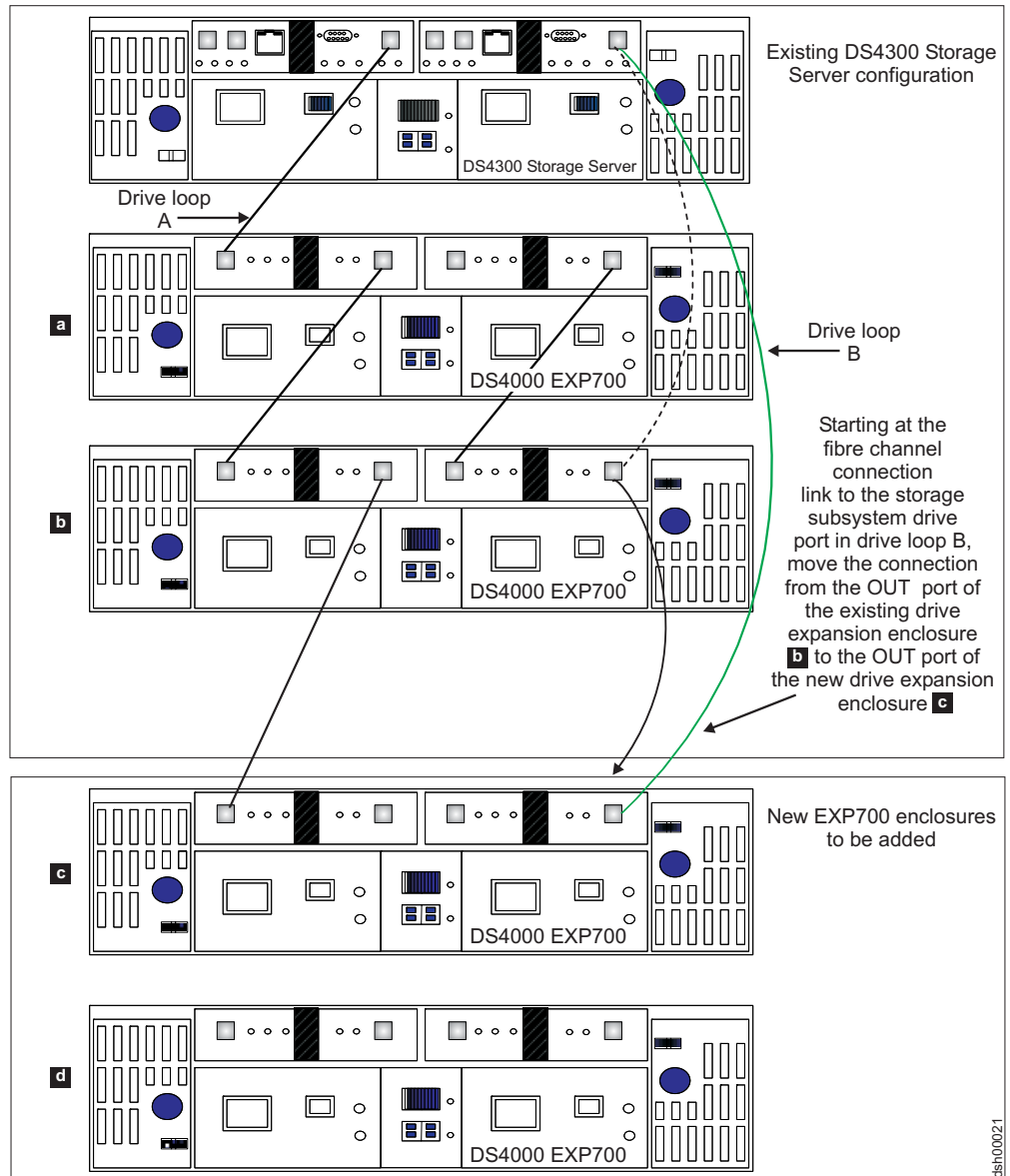


Figure 28. Cabling a single drive enclosure to the end of a functioning drive loop (step 2 of 3)

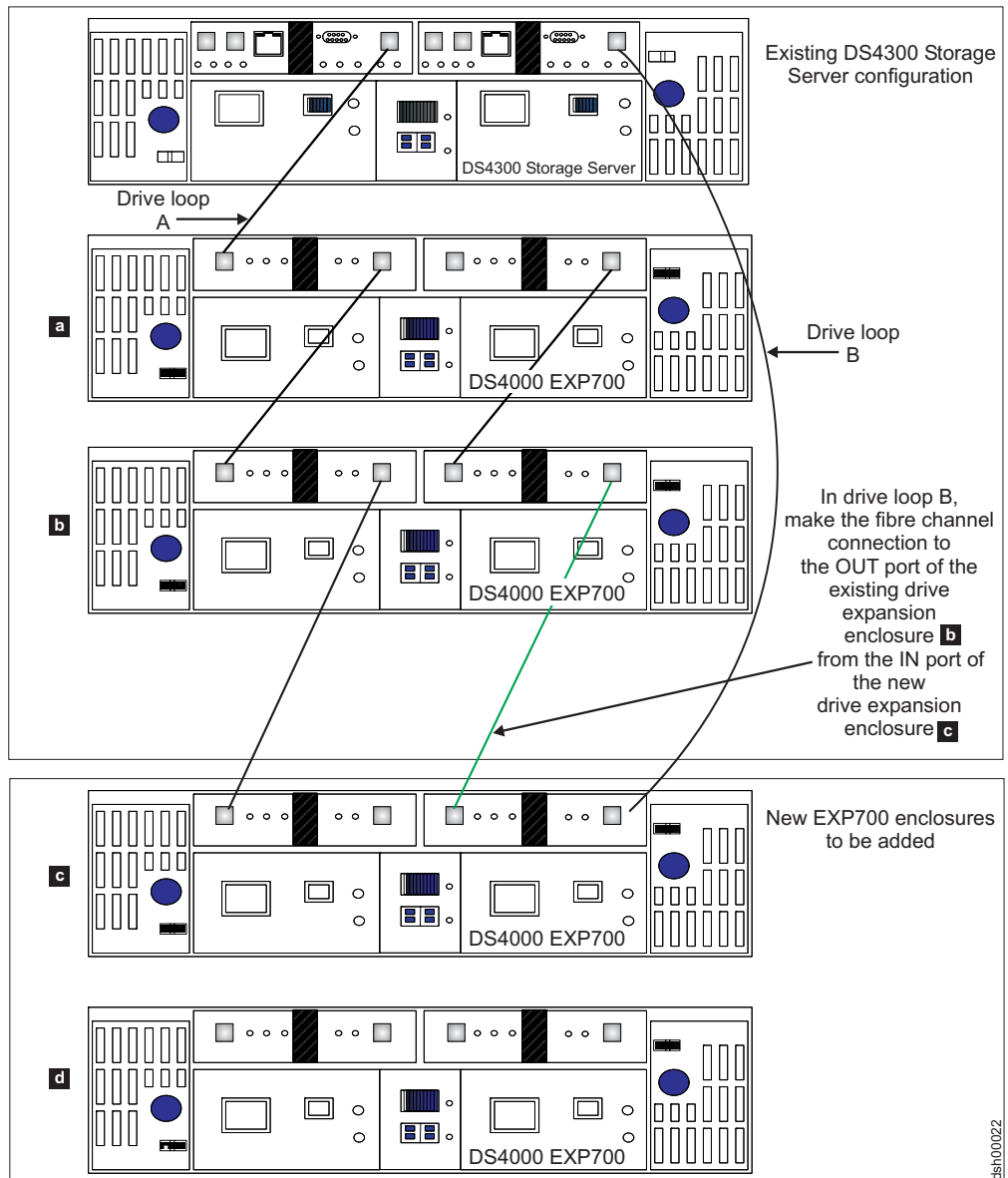


Figure 29. Cabling a single drive enclosure to the end of a functioning drive loop (step 3 of 3)

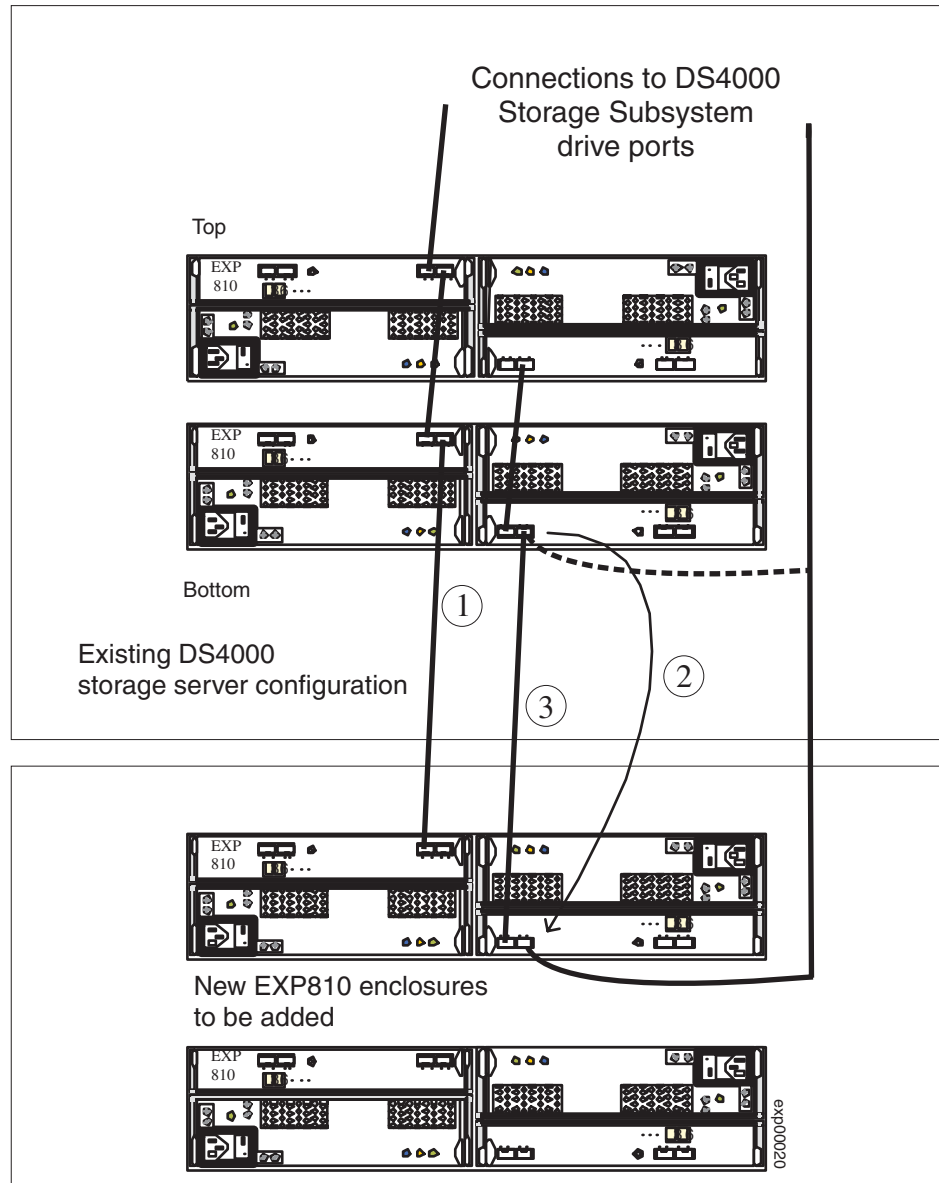


Figure 30. Cabling an EXP810 to the end of a functioning drive loop

To add an EXP810 to the end of a functioning drive channel, perform the procedure in “Connecting storage expansion enclosures at the end of (bottom of) a drive loop” on page 86, replacing steps 2, 5, and 7, with steps 1–3, below:

- ___ Step 1. Connect port 1A of the A ESM in the existing EXP810 to port 1B of the A ESM in the new EXP810.
- ___ Step 2. Move the existing connection from port 1B of the B ESM in the existing EXP810 to port 1B of the B ESM in the new EXP810.
- ___ Step 3. Connect port 1B of the B ESM in the existing EXP810 to port 1A of the B ESM in the new EXP810.

Connecting storage expansion enclosures in the middle of a drive loop

The cabling instructions illustrated in Figure 31 on page 94, Figure 32 on page 95, Figure 33 on page 96, and Figure 34 on page 97, describe cabling a DS4000 EXP700 Storage Expansion Enclosure to the middle of a redundant drive loop of a

functioning DS4300 Storage Subsystem (model 60X or 60U). The new enclosures will be cabled between the two existing storage expansion enclosures in the drive loop/channel. IBM does not recommend that you add storage expansion enclosures in this manner, especially if there is insufficient rack space to allow the methodical, uncluttered, and uniform Fibre Channel cabling of new enclosures. The disadvantages of improper planning for adding expansion enclosures in this manner, include cable management issues that contribute to troubleshooting difficulties.

To add a 16-drive expansion enclosure—for example, an EXP810 or EXP420 to the DS4000 subsystem configuration—you basically follow the same steps as in adding the 14-drive enclosure to a DS4000 subsystem configuration; however, the port connections on the 16-drive enclosure will be different. Figure 35 on page 98 shows an example of connecting a 16-drive storage expansion enclosure (EXP810) between two 16-drive expansion enclosures.

Figure 36 on page 100 illustrates the cabling of EXP810 enclosures between groups of EXP100 and EXP710 enclosures in an existing drive loop/channel.

Note: In the following steps, enclosures are referred to as *Top*, *Bottom*, or *New*. In the illustrations, these labels are found next to the enclosures.

- ___ Step 1. Insert the small form-factor pluggables (SFPs) or gigabit interface converters (GBICs) into only those ports you intend to use. Do not leave GBICs or SFPs inserted into port slots without using cables to connect them to other ports.
- ___ Step 2. Connect the IN port of the right ESM in the bottom EXP700 enclosure to the OUT port of the right ESM in the new EXP700 enclosure, rather than to the OUT port of the right ESM in the top EXP700 enclosure. See Figure 31 on page 94.

Note: The port names on an EXP810 are not labeled as IN or OUT. They are labeled as 1B or 1A.

Attention: Carefully reconfigure only one drive loop at a time, making sure that the drive loop you modify is properly connected and in the optimal state *before* you attempt to reconfigure another drive loop. Take this precaution to prevent the arrays from being inadvertently failed by the DS4000 Storage Subsystem controllers, which happens when two or more drives in the arrays cannot be reached through either drive loop in the redundant drive loop pair.

- ___ Step 3. Connect the IN port of the right ESM in the new EXP700 enclosure to the OUT port of the right ESM in the top EXP700 enclosure. See Figure 32 on page 95.
- ___ Step 4. Power on the added storage expansion enclosure unit.
- ___ Step 5. Wait a few seconds; verify that the port bypass LEDs, of all of the ports in drive loop B now extend to the storage expansion enclosure, are not lit. Using the DS4000 Storage Manager Client Subsystem Management window, verify that the storage expansion enclosure is added and displayed in the Logical/Physical view of the window. Correct any errors before proceeding to 6 on page 93. For port bypass:
 - ___ Step a. Verify that the SFPs, GBICs, and fibre cables are in good condition.
 - ___ Step b. Remove and reinsert SFPs, GBICs, and fibre cables.

- ___ Step c. Make sure the drive expansion enclosure speed switch is set to the same speed as the existing drive expansion enclosures and the DS4000 Storage Subsystem speed setting.
 - ___ Step d. Verify that the ESM is good, by physically removing it, then swapping it with the other ESM in the same drive expansion enclosure. For enclosure ID conflict, set the drive expansion enclosure ID switch to values that are unique from the current settings in the existing drive expansion enclosures and storage server. Call the IBM Help Center for assistance, if the problems persist.
- ___ Step 6. Connect the OUT port of the left ESM in the top EXP700 enclosure to the IN port of the left ESM in the new EXP700 enclosure, rather than to the IN port of the left ESM in the bottom EXP700 enclosure. See Figure 33 on page 96.
 - ___ Step 7. Connect the OUT port of the left ESM in the new EXP700 enclosure to the IN port of the left ESM in the bottom EXP700 enclosure. See Figure 34 on page 97.
 - ___ Step 8. Wait a few seconds; verify that the port bypass LEDs, of the two ports in the connection between the drive enclosure ports, are not lit. Using the DS4000 Storage Manager Client Subsystem Management window, verify that the drive enclosure does not indicate a drive enclosure lost redundancy path error. See 5 on page 92 for possible corrective actions, if needed.
- Note:** The existing storage expansion enclosures will be shown with drive enclosure lost redundancy path errors until you establish the Fibre Channel cabling connection described in 7.
- ___ Step 9. Proceed to “Activity 7: Disabling DS4000 Storage Subsystem drive migration settings (for adding storage expansion enclosures with new drives only)” on page 107, if you are only adding an enclosure with a new drive. Proceed to “Activity 10: Inserting hard drives and placing logical drives online (for migrating only enclosures with drives containing logical drive configuration data)” on page 117, if you are migrating enclosures with drives having logical drive configuration data.

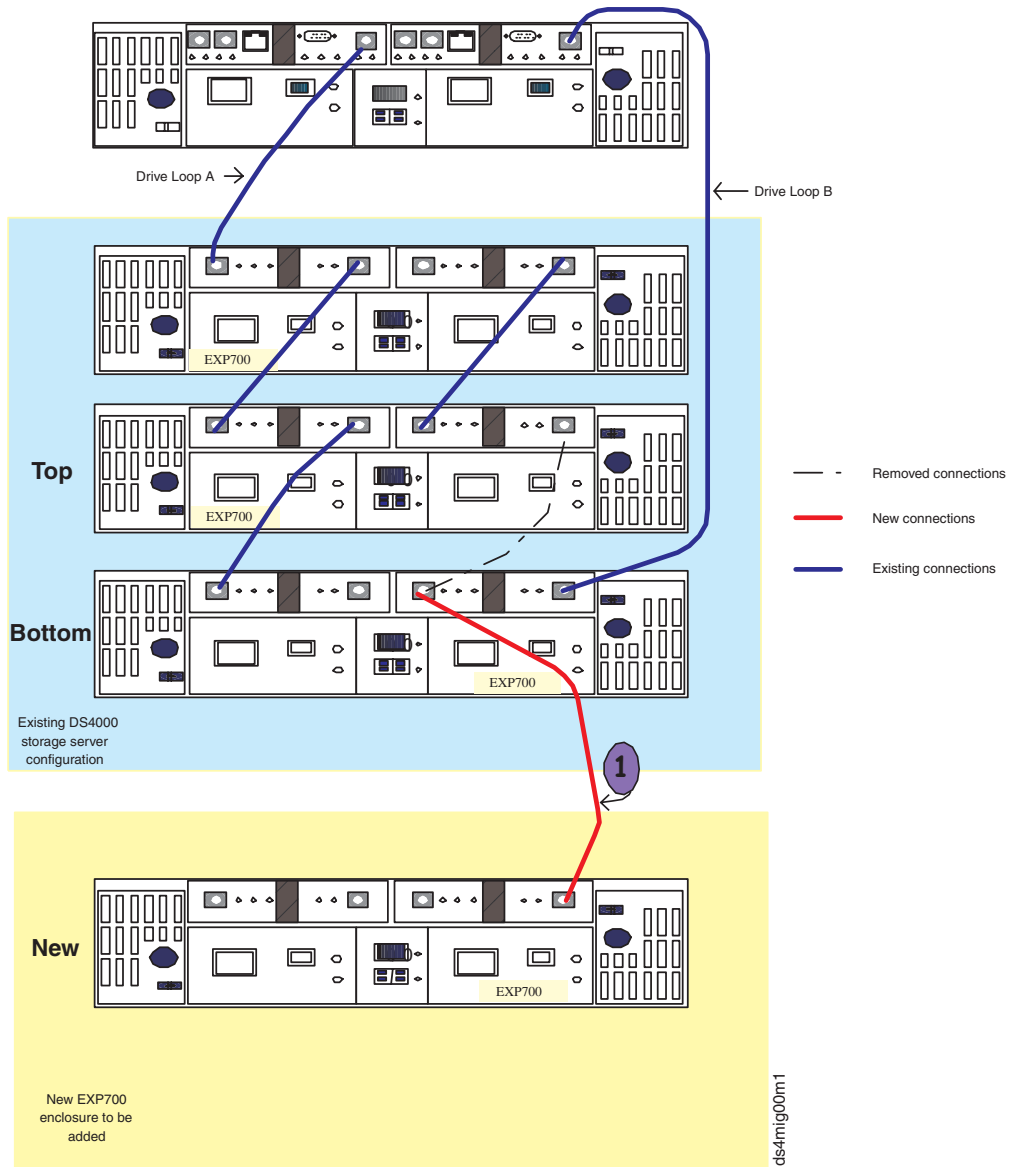


Figure 31. Connect the bottom EXP700 enclosure to the OUT port of the right ESM in the new EXP700 enclosure

1 : Connect port IN of the right ESM in the bottom EXP700 enclosure to the port OUT of the right ESM in the new EXP700 enclosure, instead of port OUT of the right ESM in the top EXP700 enclosure.

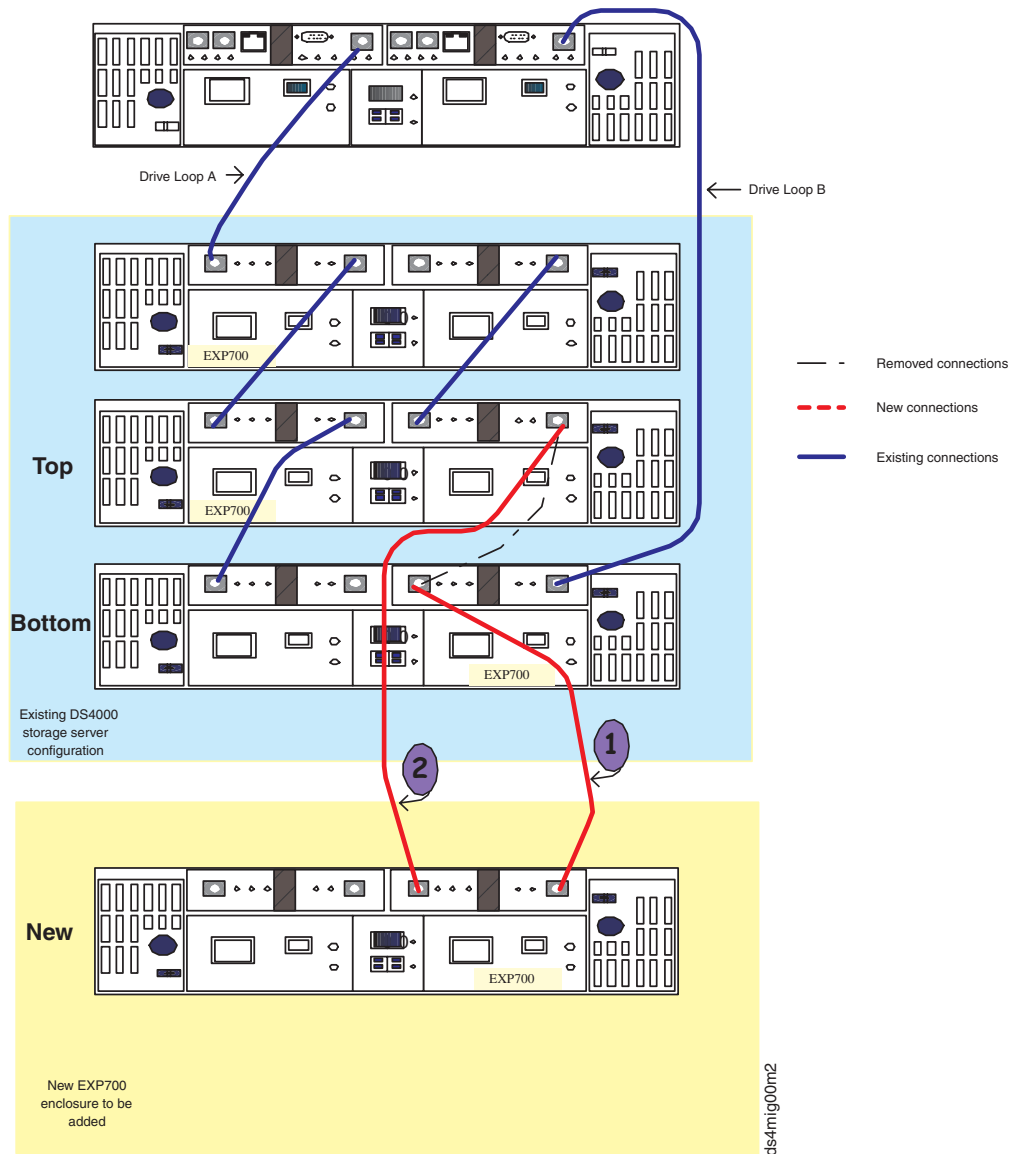


Figure 32. Connect the new EXP700 enclosure to the OUT port of the right ESM in the top EXP700 enclosure

1 : Connect port IN of the right ESM in the bottom EXP700 enclosure to port OUT of the right ESM in the new EXP700 enclosure, instead of the right ESM in the top EXP700 enclosure.

2 : Connect port IN of the right ESM in the new EXP700 enclosure to port OUT of the right ESM in the top EXP700 enclosure.

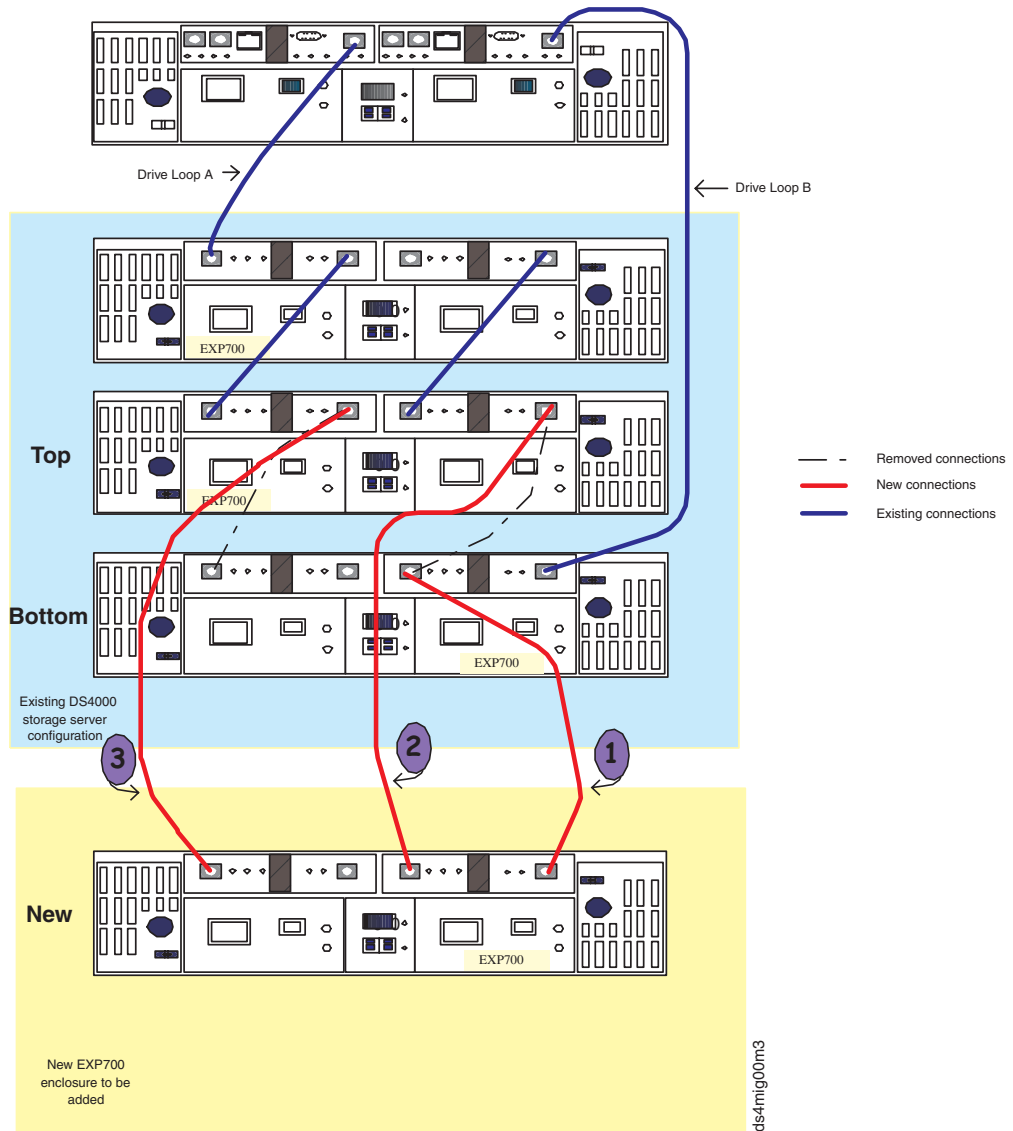


Figure 33. Connect the top EXP700 enclosure to the IN port of the left ESM in the new EXP700 enclosure

1 : Connect port IN of the right ESM in the bottom of the EXP700 enclosure to port OUT of the right ESM in the new EXP700 enclosure, instead of port OUT of the right ESM in the top EXP700 enclosure.

2 : Connect port IN of the right ESM in the new EXP700 enclosure to port OUT of the right ESM in the top EXP700 enclosure.

3 : Connect port OUT of the left ESM in the top EXP700 enclosure to port IN of the left ESM in the new EXP700 enclosure, instead of port IN of the left ESM in the bottom EXP700 enclosure.

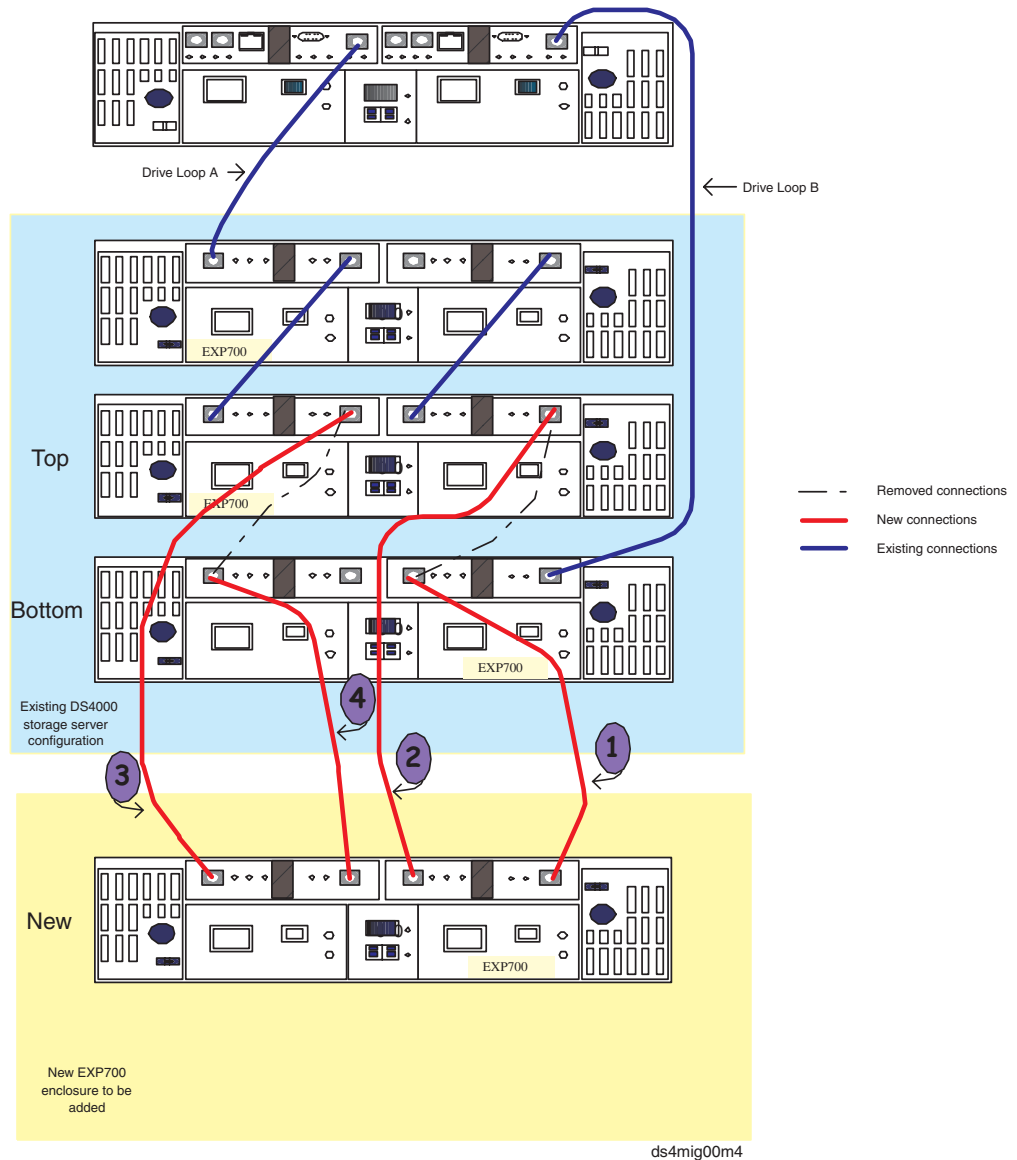


Figure 34. Connect the new EXP700 enclosure to the IN port of the left ESM in the bottom EXP700 enclosure

1 : Connect port IN of the right ESM in the bottom EXP700 enclosure to port OUT of the right ESM in the new EXP700 enclosure, instead of port OUT of the right ESM in the top EXP700 enclosure.

2 : Connect port IN of the right ESM in the new EXP700 enclosure to port OUT of the right ESM in the top EXP700 enclosure.

3 : Connect port OUT of the left ESM in the top EXP700 enclosure to port IN of the left ESM of the new EXP700 enclosure, instead of port IN of the left ESM in the bottom EXP700 enclosure.

4 : Connect port OUT of the left ESM in the new EXP700 enclosure to port IN of the left ESM in the bottom EXP700 enclosure.

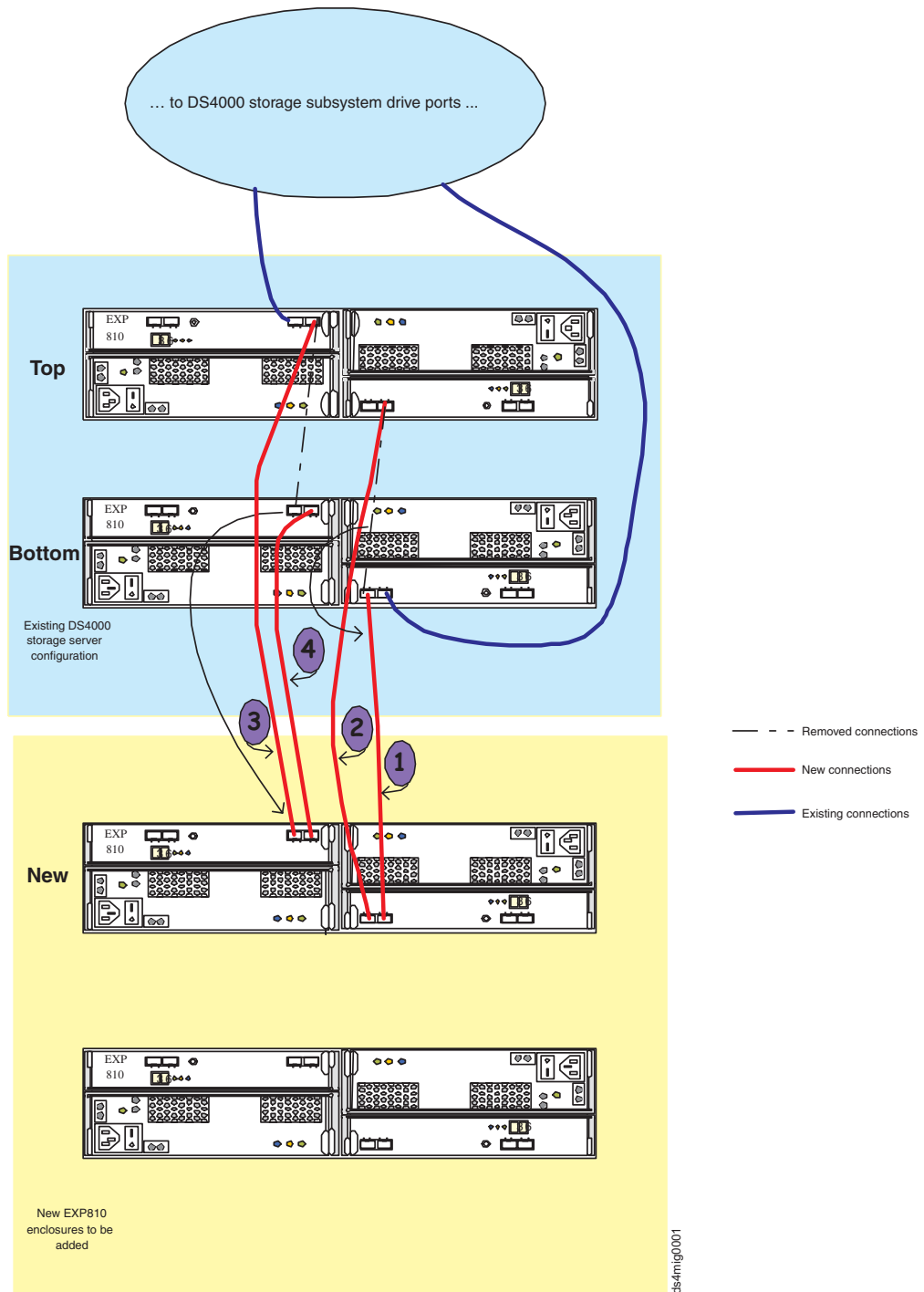


Figure 35. Cabling the EXP810 between EXP810 enclosures in the drive loop: example 1

To cable the EXP810 between EXP810 enclosures in the drive loop perform the “Connecting storage expansion enclosures in the middle of a drive loop” on page 91 with steps 2, 3, 6, and 7 being replaced by steps 1, 2, 3, and 4, seen immediately below.

- Step 1. **1**: Connect port 1A of the B ESM in the bottom EXP810 enclosure, to port 1B of the B ESM in the new EXP810 enclosure, rather than to port 1B of the B ESM in the top EXP810 enclosure.

- ___ Step 2. **2** : Connect port 1A of the B ESM in the new EXP810 enclosure, to port 1B of the B ESM in the top EXP810 enclosure.
- ___ Step 3. **3** : Connect port 1A of the A ESM in the top EXP810 enclosure, to port 1B of the A ESM in the new EXP810 enclosure, rather than to port 1B of A ESM in the bottom EXP810 enclosure.
- ___ Step 4. **4** : Connect port 1A of the A ESM in the new EXP810 enclosure, to port 1B of the A ESM in the bottom EXP810 enclosure.

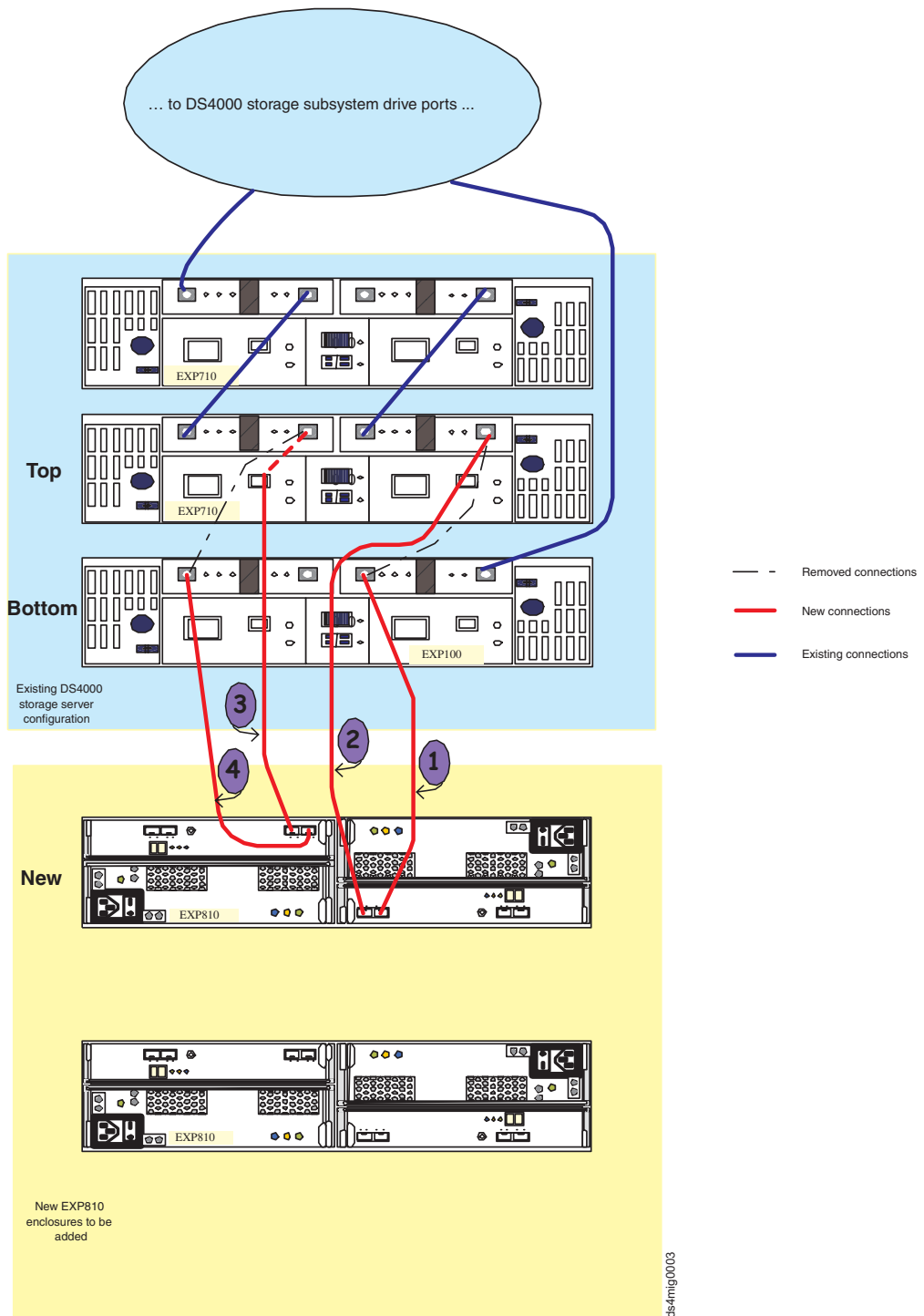


Figure 36. Cabling the EXP810 between EXP810 enclosures in the drive loop: example 2

1 : Connect port IN of the right/B ESM in the bottom EXP100 enclosure to port 1B of the B ESM in the new EXP810 enclosure, instead of port OUT of the right/B ESM in the top EXP710 enclosure.

2 : Connect port 1A of the B ESM in the new EXP810 enclosure to port OUT of the right/B ESM in the top EXP710 enclosure.

3 : Connect port OUT of the left/A ESM in the top EXP710 enclosure to port 1B of the A ESM in the new EXP810 enclosure, instead of port IN of the left/A ESM in the bottom EXP100 enclosure.

Connecting storage expansion enclosures at the beginning of (top of) a drive loop

It is possible to add storage expansion enclosures to either the beginning (top) or end (bottom) of a functioning storage expansion enclosure drive loop. The cabling instructions illustrated in Figure 37 on page 103, Figure 38 on page 104, and Figure 39 on page 105 describe cabling a DS4000 EXP700 Storage Expansion Enclosure to the beginning (top) of a redundant drive loop of a functioning DS4300 Storage Subsystem (model 60X or 60U). IBM does not recommend that you add storage expansion enclosures in this manner, especially if there is insufficient rack space to allow the methodical, uncluttered, and uniform Fibre Channel cabling of such new enclosures. Without proper planning, disadvantages of adding expansion enclosures in this manner include cable management issues that contribute to avoidable troubleshooting difficulties. (For the diagram of a properly planned addition of a new expansion enclosure at the beginning (top) of a functioning storage expansion enclosure drive loop, see Figure 43 on page 111.)

To add a 16-drive expansion enclosure—for example, an EXP810 or EXP420 to the DS4000 subsystem configuration—you basically follow the same steps as in adding the 14-drive enclosure to a DS4000 subsystem configuration; however, the port connections on the 16-drive enclosure will be different, as illustrated in Figure 30 on page 91 and the three steps that follow it.

See “DS4000 Storage Subsystem drive loop schemes” on page 26.

- ___ Step 1. Insert the small form-factor pluggables (SFPs) or gigabit interface converters (GBICs) into only those ports you intend to use. Do not leave GBICs or SFPs inserted into port slots without connecting them to other ports using cables.
- ___ Step 2. Extend one of the drive loops (that is, drive loop B) in a DS4000 Storage Subsystem redundant drive loop pair by connecting the IN port of the first (existing) storage expansion enclosure to the OUT port of the new storage expansion enclosure as shown in Figure 37 on page 103.

Note: The port name on an EXP810 is not labeled OUT. See Figure 40 on page 106 for details.

Attention: Carefully reconfigure only one drive loop at a time, making sure that the drive loop that you modify is properly connected and in optimal state before you attempt to reconfigure another drive loop. Take this precaution to prevent the arrays from being inadvertently failed by the DS4000 Storage Subsystem controllers. This happens when two or more drives in the arrays cannot be reached through either drive loop in the redundant drive loop pair.

- ___ Step 3. Power on the newly added storage expansion enclosure unit.
- ___ Step 4. Wait a few seconds; verify that the port bypass LEDs of all of the ports in drive loop B, now extended to the new storage expansion enclosure, are not lit. Using the DS4000 Storage Manager Client Subsystem Management window, verify that the new storage expansion enclosure is added and displayed in the Logical/Physical view of the window. Correct any errors before proceeding to step 5 on page 102. For port bypass:

- ___ a. Verify that the SFPs and GBICs or fibre cables are in good condition.
- ___ b. Remove and reinsert SFPs, GBICs and fibre cables.
- ___ c. Ensure that the new drive expansion enclosure speed switch is set to the same speed as the existing drive expansion enclosures and the DS4000 Storage Subsystem speed setting.
- ___ d. Verify that the ESM is good by physically removing and swapping it with the other ESM in the same drive expansion enclosure. For enclosure ID conflict, set the drive expansion enclosure ID switch to values unique from the current settings in the existing drive expansion enclosures and storage server.

Call the IBM Help Center for assistance if the problems persist.

- ___ Step 5. In the other drive loop (that is, drive loop A) in a DS4000 Storage Subsystem redundant drive loop pair, remove the connection from the DS4000 Storage Subsystem drive loop port to the IN port of the first storage expansion enclosure and connect it to the IN port of the new drive enclosure as shown in Figure 38 on page 104.

Note: The port name on an EXP810 is not labeled IN. See Figure 40 on page 106 for details.

- ___ Step 6. Wait a few seconds; verify that the port bypass LEDs of the two ports in the connection between the storage subsystem drive loop port and the IN port of the new drive enclosure are not lit. Using the DS4000 Storage Manager Client Subsystem Management window, verify that the *new* drive enclosure does not indicate the drive enclosure lost redundancy path error. See the preceding step 5 for possible corrective actions, if needed. Until you establish the Fibre Channel cabling connection described in step 4 on page 101, the existing storage expansion enclosures will appear in the Storage Manager Client Subsystem Management window with drive enclosure lost redundancy path errors.
- ___ Step 7. In drive loop A, cable the new drive enclosure's OUT port to the IN port of the first enclosure in the already functioning storage expansion enclosure drive loop as shown in Figure 39 on page 105.
- ___ Step 8. Wait a few seconds; verify that the port bypass LEDs of all of the ports in drive loop A to which you have added a new connection are not lit. Using the DS4000 Storage Manager Client Subsystem Management window, verify that all of the drive enclosures in the DS4000 redundant drive loop pair to which the new enclosure was added does not report the drive enclosure lost redundancy path error.
- ___ Step 9. Proceed to "Activity 7: Disabling DS4000 Storage Subsystem drive migration settings (for adding storage expansion enclosures with new drives only)" on page 107, if you are only adding an enclosure with a new drive. Proceed to "Activity 10: Inserting hard drives and placing logical drives online (for migrating only enclosures with drives containing logical drive configuration data)" on page 117, if you are migrating enclosures with drives having logical drive configuration data.

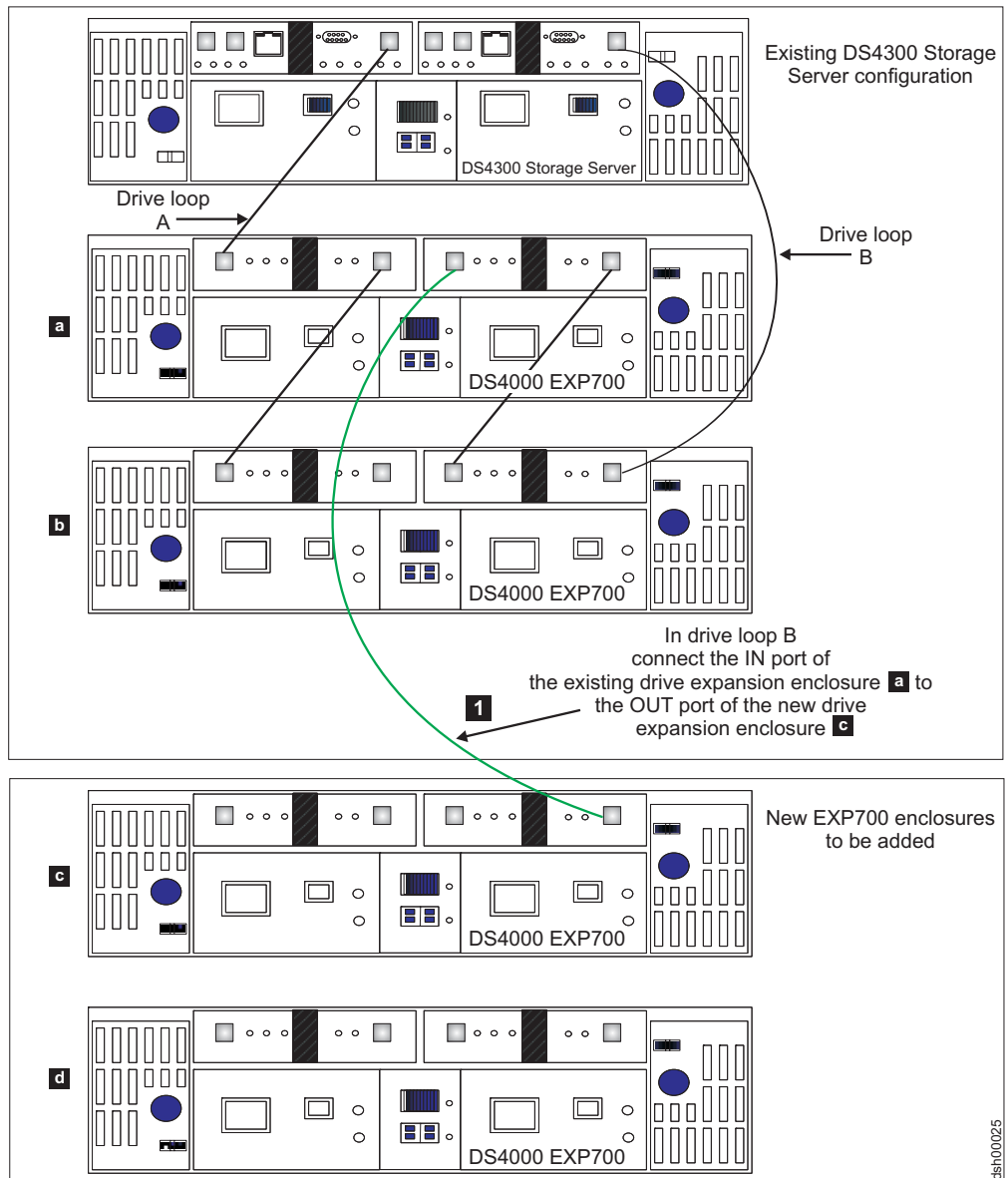


Figure 37. Cabling a single drive enclosure to the beginning of a functioning drive loop (step 1 of 3)

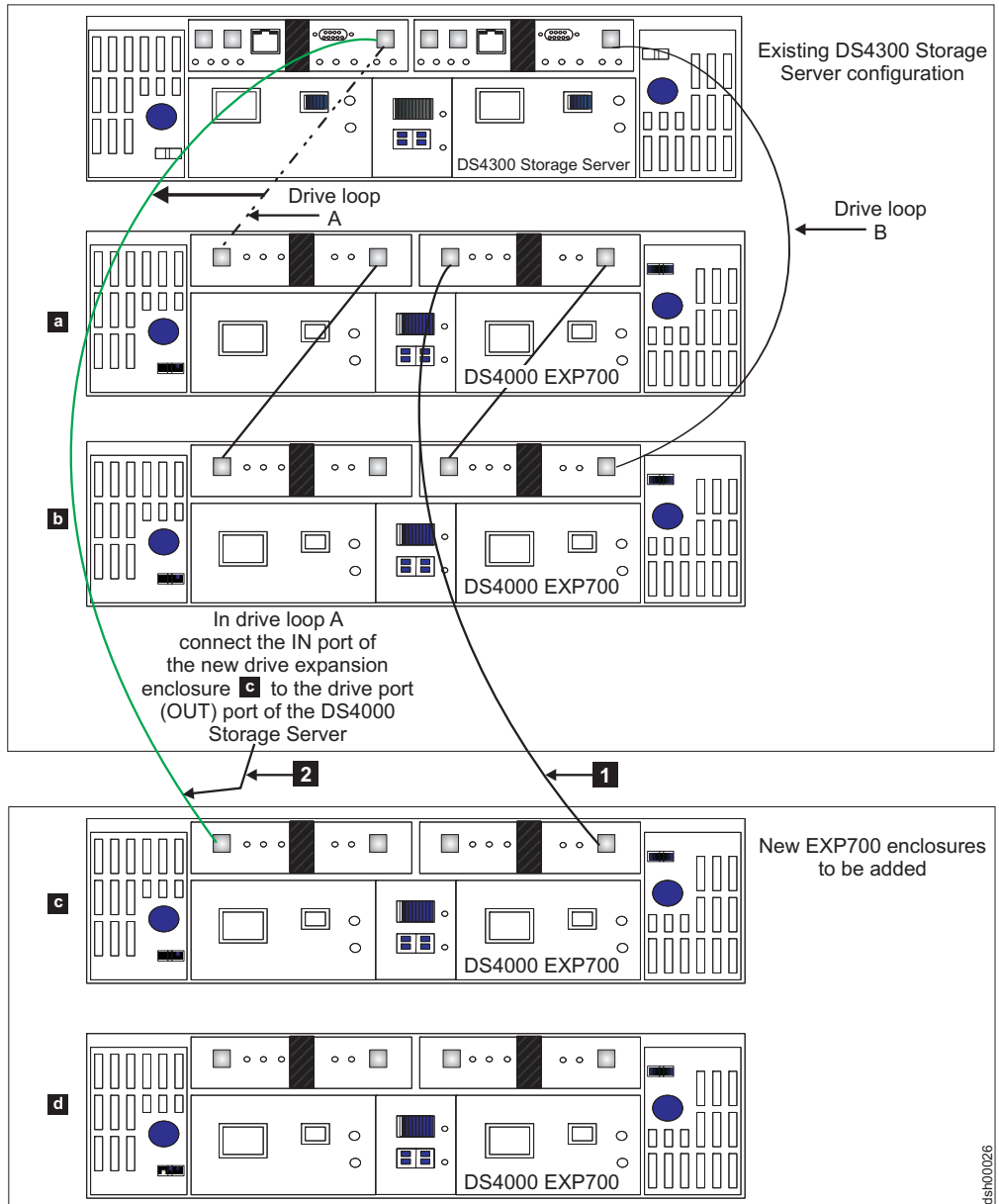


Figure 38. Cabling a single drive enclosure to the beginning of a functioning drive loop (step 2 of 3)

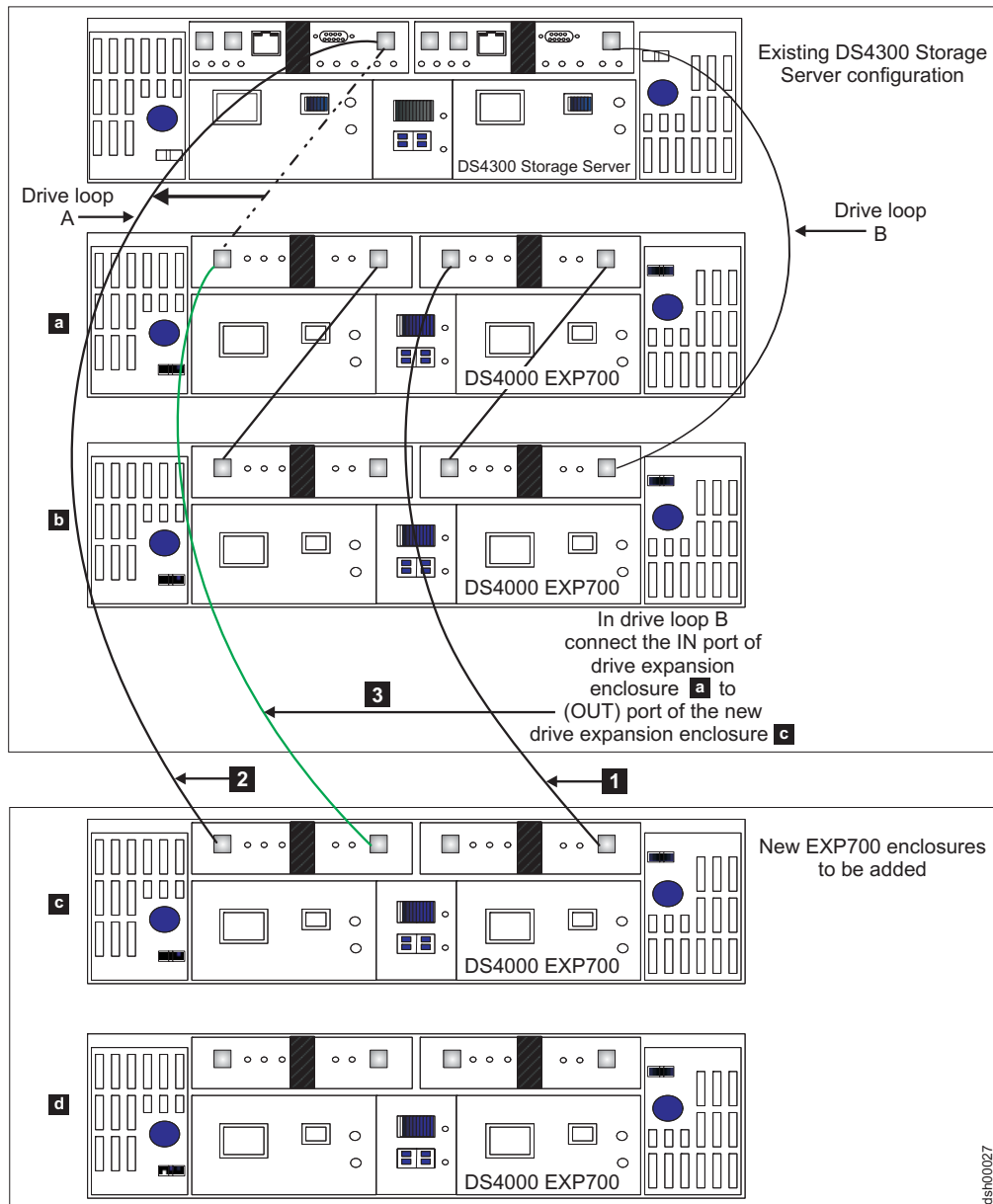


Figure 39. Cabling a single drive enclosure to the beginning of a functioning drive loop (step 3 of 3)

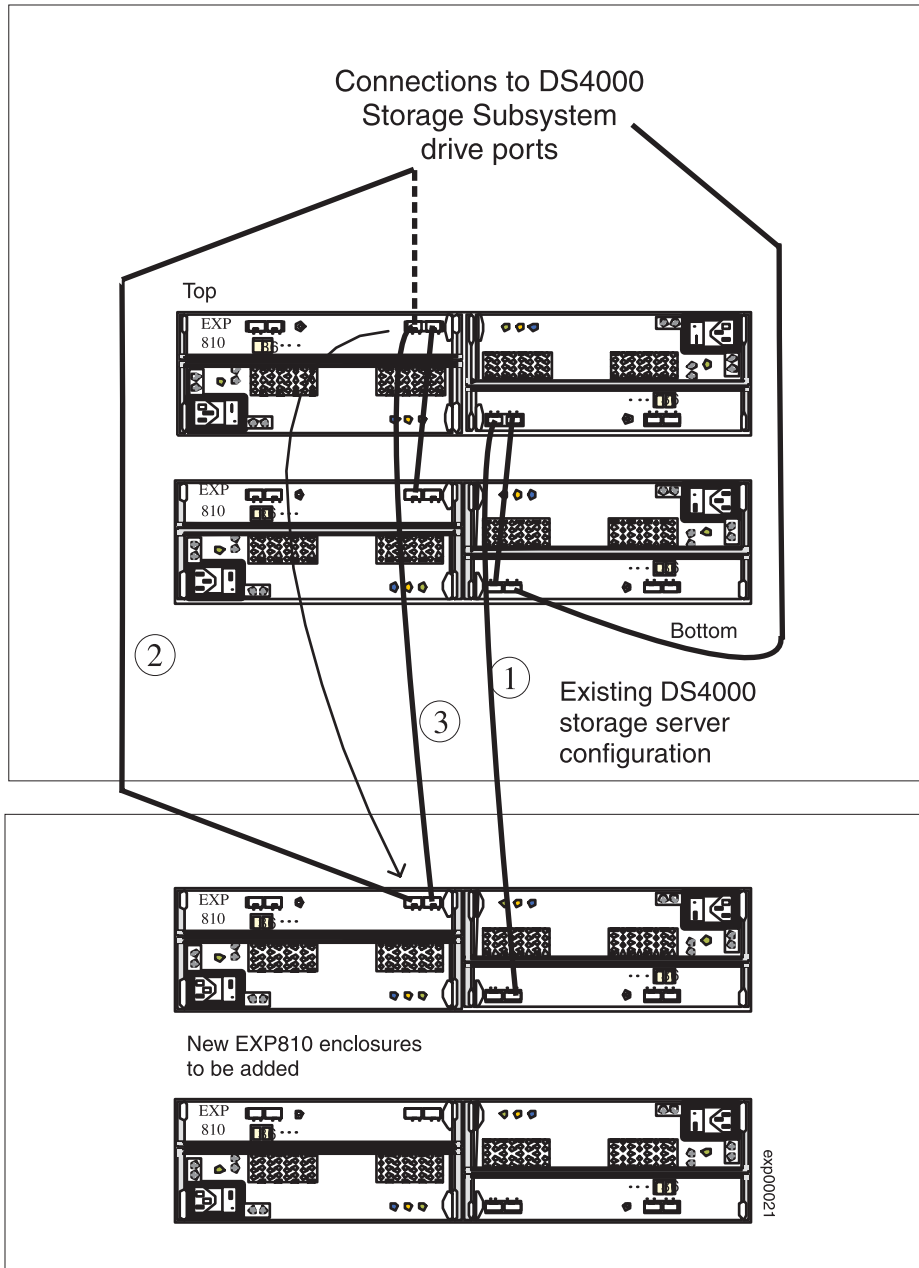


Figure 40. Cabling an EXP810 to the top of a functioning drive loop

To add an EXP810 to the top of a functioning drive channel, perform the procedure in “Connecting storage expansion enclosures at the beginning of (top of) a drive loop” on page 101, replacing steps 2, 5, and 7, with steps 1–3, below:

- ___ Step 1. Connect port 1A of the B ESM in the existing EXP810 to port 1B of the B ESM in the new EXP810.
- ___ Step 2. Move the existing connection from port 1B of the A ESM in the existing EXP810 to port 1B of the A ESM in the new EXP810.
- ___ Step 3. Connect port 1B of the A ESM in the existing EXP810 to port 1A of the A ESM in the new EXP810.

Activity 7: Disabling DS4000 Storage Subsystem drive migration settings (for adding storage expansion enclosures with new drives only)

Attention: Do not perform this activity if you want to migrate enclosures with drives having logical drive configuration and data; otherwise, the logical drive configuration will be deleted.

When you have completed cabling the new storage expansion enclosures, disable DS4000 Storage Subsystem drive migration settings as follows:

- ___ Step 1. Open the Storage Manager Client program Enterprise Management window.
- ___ Step 2. Right-click on the name of the DS4000 Storage Subsystem to which you want to add drives, and select **Execute Script**.
- ___ Step 3. A script editor window opens. Click **File -> Load Script**.
- ___ Step 4. A Load Script file selection window opens. Locate and select the `DisableDriveMigration.scr` file and click **OK**. The `DisableDriveMigration.scr` file is normally in the `SCRIPTS` directory of the IBM DS4000 Storage Manager Installation CD. This file is used to reset the DS4000 Storage Subsystem setting, in order to treat all newly-discovered hard drives as “new” drives, and to ignore any configuration information that might exist in the new hard drives. Figure 19 on page 66 contains the `DisableDriveMigration.scr` file listing.
- ___ Step 5. Click **Tools -> Verify and Execute** to run the script.
- ___ Step 6. When the script execution completes, reset both DS4000 controllers to make the disable drive migration settings effective. If you used the `DisableDriveMigration.scr` file described in this document in Figure 19 on page 66, you do not need to perform this step because the last two commands in the script file automatically reset the controllers. To reset the controllers, open the Storage Subsystem Management window and alternately (one at a time) reset each controller by clicking **Advanced -> Reset Controller** and following the instructions in the Reset Controller window when it opens.

Activity 8: Inserting drives and cabling additional storage expansion enclosures

This activity is only for adding enclosures with new drives.

After you have disabled DS4000 Storage Subsystem drive migration settings, insert drives and connect additional storage expansion enclosures to complete the installation process as follows:

- ___ Step 1. Insert the appropriate drives into empty drive slots in the new enclosure in pairs (two at a time). Wait (up to 5 minutes) until the inserted drive pair fully spins up and displays in the DS4000 Storage Subsystem Management window before inserting the next drive pair.
- ___ Step 2. To connect additional storage expansion enclosures to a functioning drive loop pair, repeat the steps of the appropriate procedure in Activity 6. Depending on whether you are adding new storage expansion enclosures to the end (bottom), the middle, or the beginning (top) of the drive loop, follow with steps 1 and 2 of “Activity 8: Inserting drives and cabling additional storage expansion enclosures.”

Figure 41 on page 109 shows the final cabling diagram after adding the second 14-drive enclosure (an EXP700) to the end of a drive loop/channel. Figure 42 on page 110 and Figure 43 on page 111 show the final results of adding the second 14-drive enclosure (an EXP700) to the beginning of the drive loop. Figure 43 on page 111 is the preferred scheme for cabling to the beginning of the drive loop, if the configuration and rack space allow for it. Figure 44 on page 112 illustrates what the cabling will look like as a result of adding the second 14-drive enclosure to the middle of a drive loop.

Figure 45 on page 113, Figure 46 on page 114, and Figure 47 on page 115, respectively, illustrate the cabling after adding the second EXP810 to the end, beginning, or middle of a drive loop/channel.

Figure 48 on page 116 illustrates adding the second EXP810 between EXP710 and EXP10 enclosures in the same drive loop/channel.

When you have completed adding enclosures, proceed to Activity 9: Re-enabling drive migration settings step1 on page 117, to re-enable the drive migration settings.

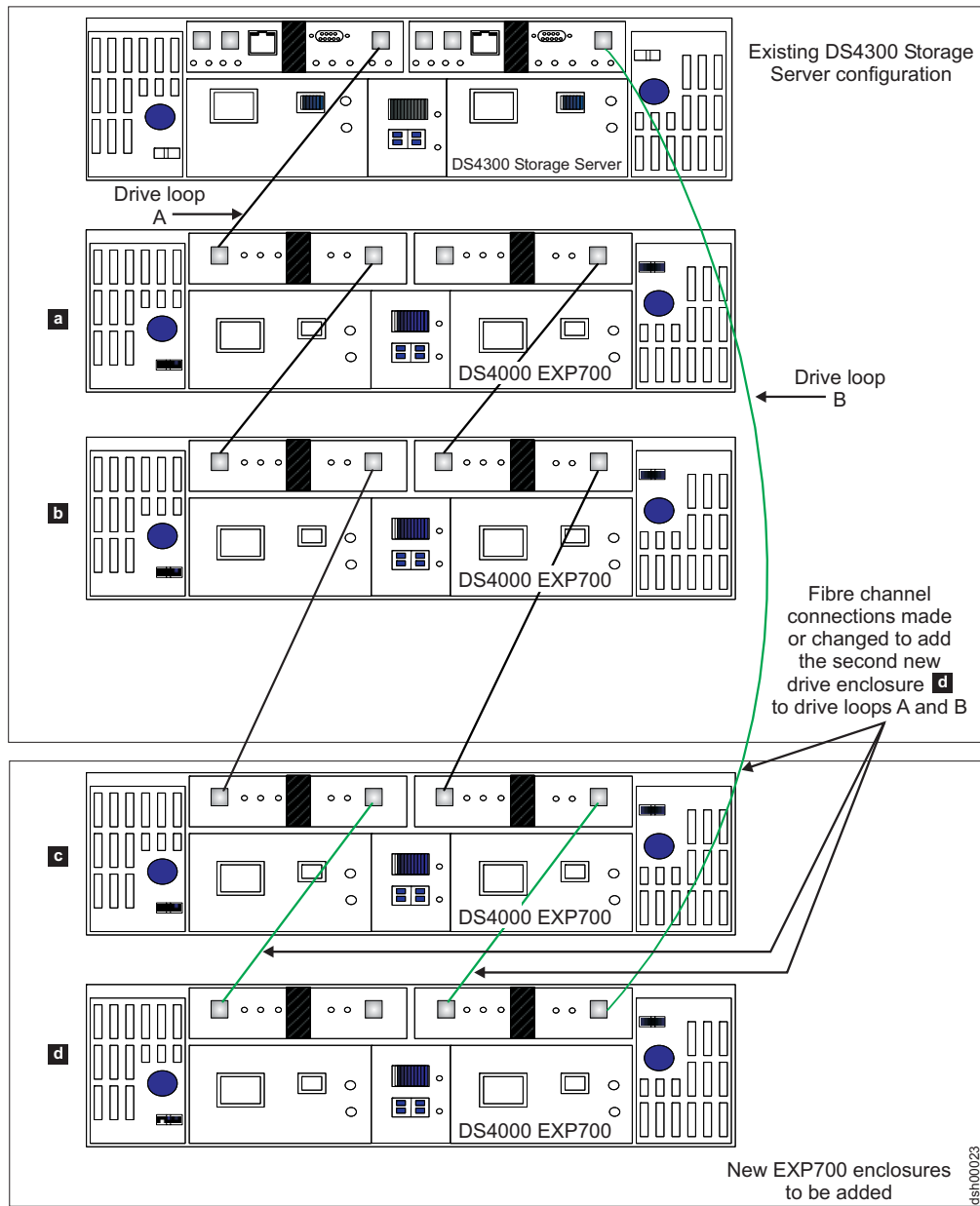


Figure 41. Cabling a second drive enclosure to the end of a functioning drive loop

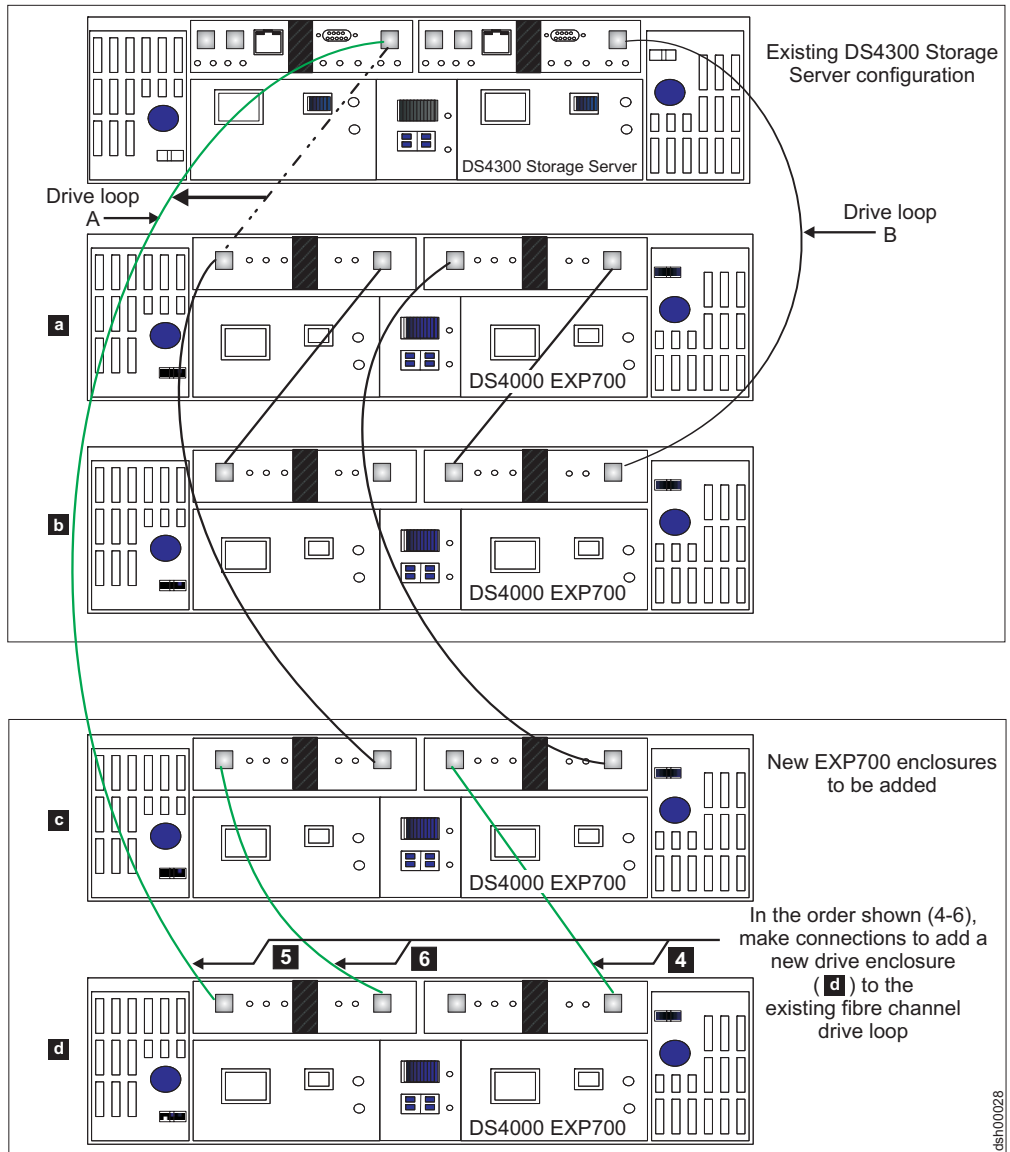


Figure 42. Cabling a second drive enclosure to the beginning of a functioning drive loop

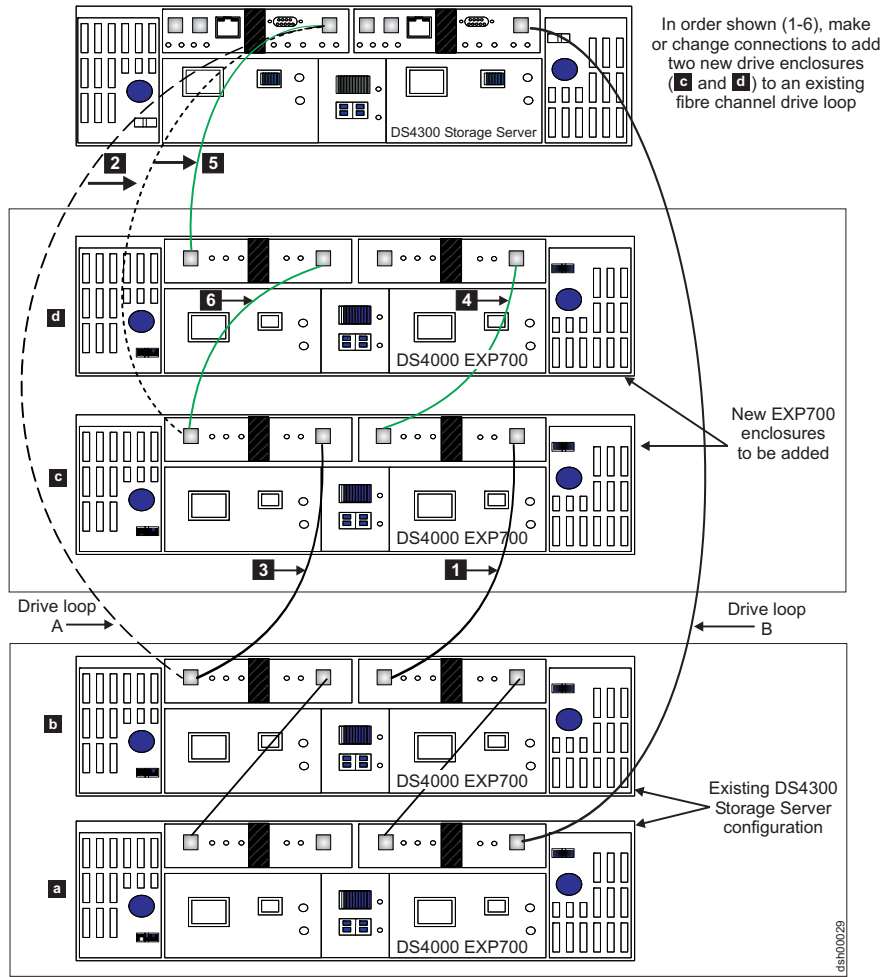


Figure 43. Recommended connection: Planned cabling of additional drive enclosures to the beginning of a functioning drive loop

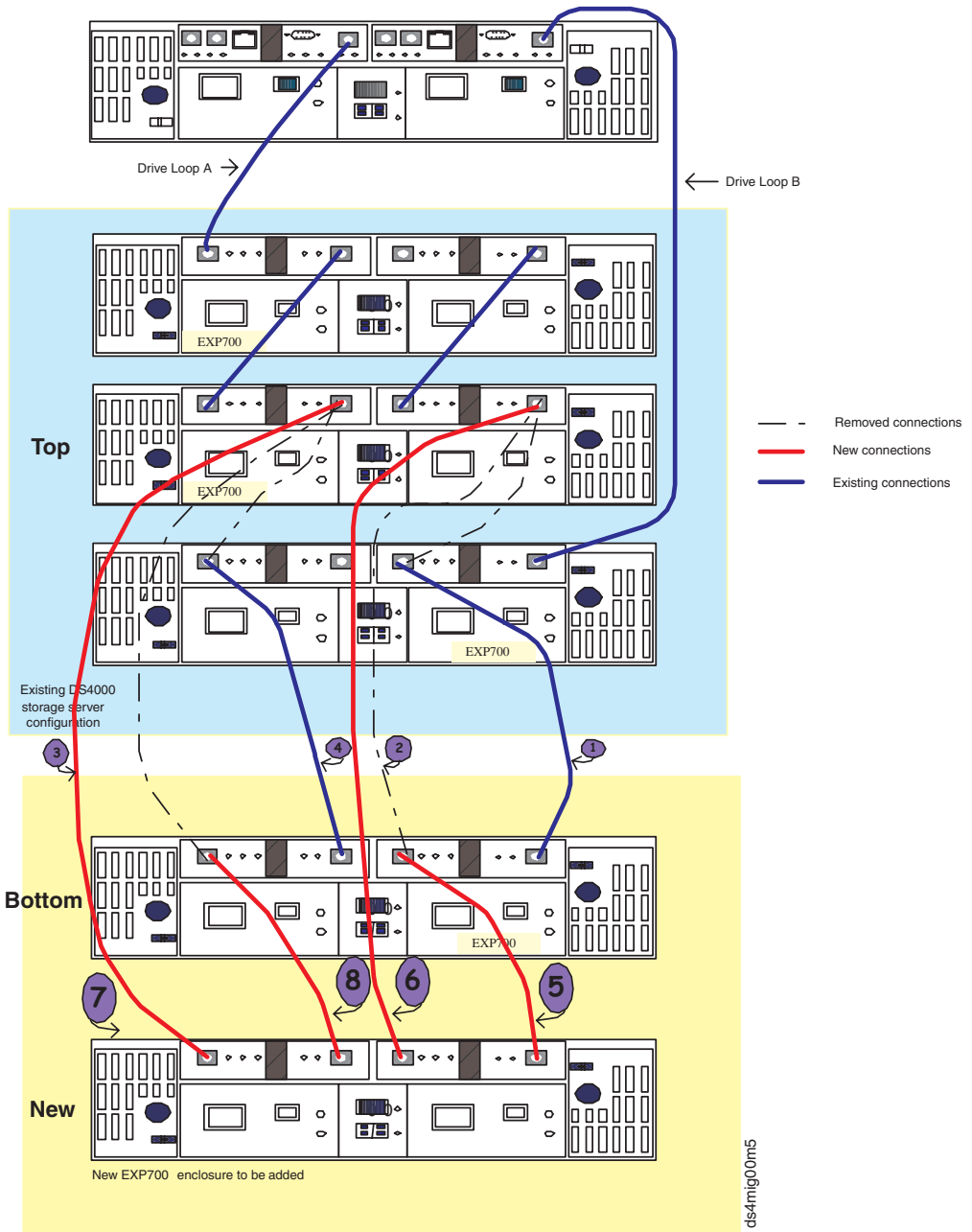


Figure 44. Cabling the second 14-drive enclosure to the middle of a drive loop

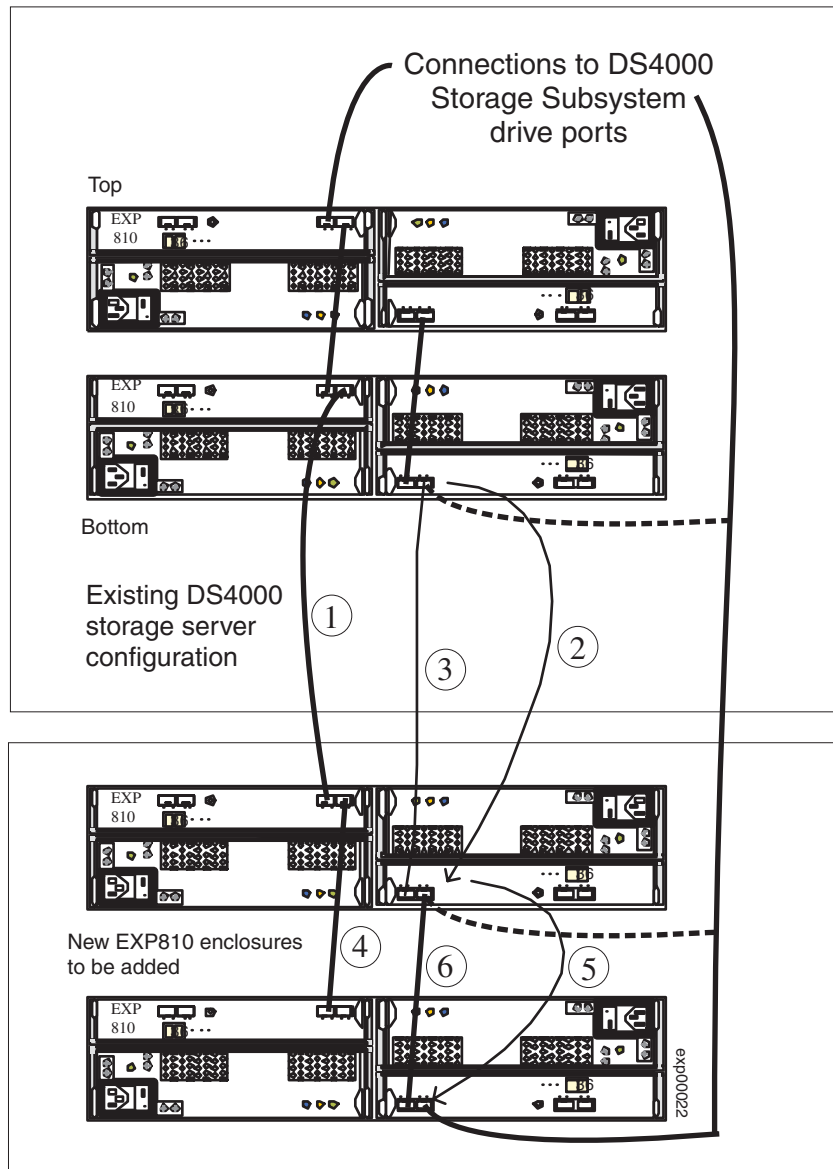


Figure 45. Cabling a second EXP810 drive enclosure to the end of a functioning drive loop

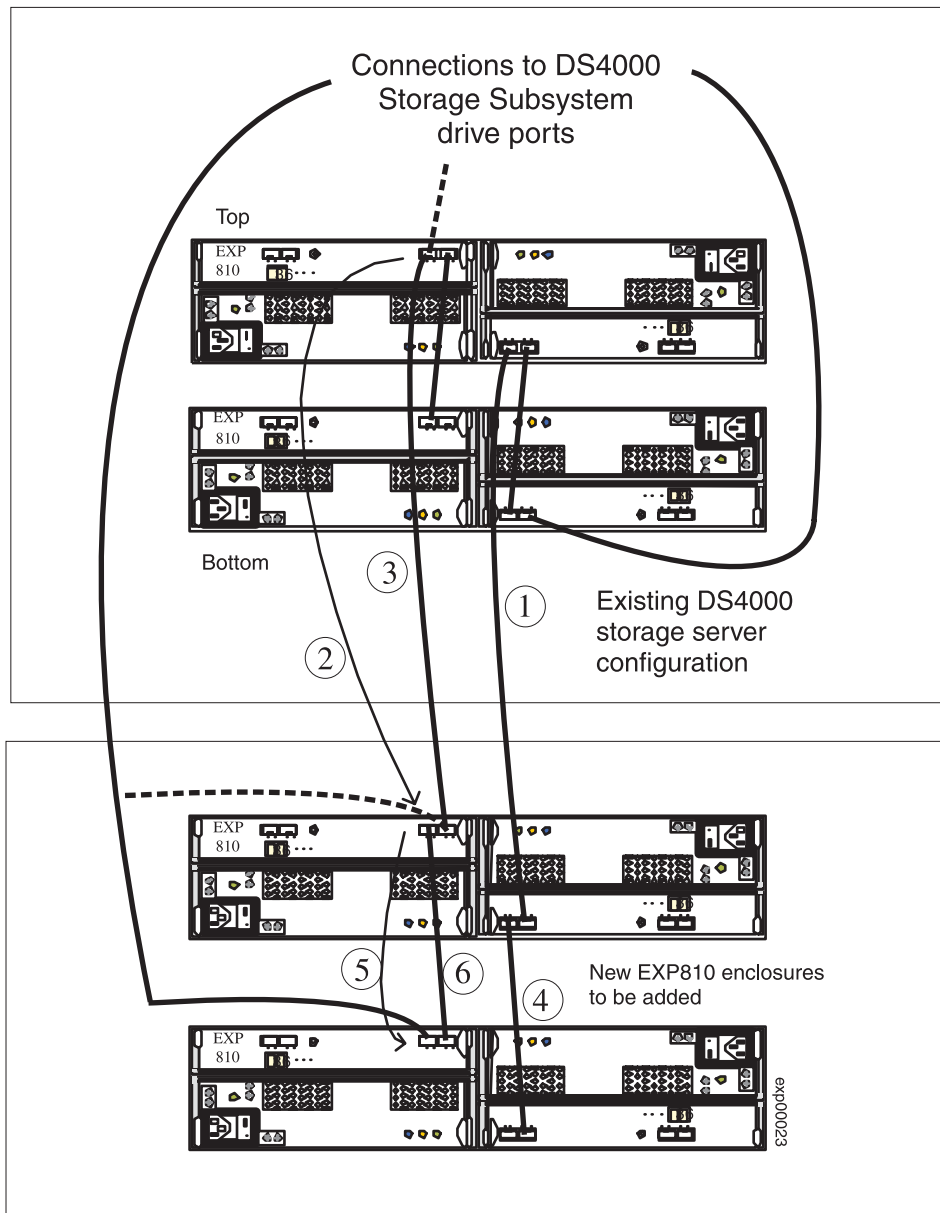


Figure 46. Cabling a second EXP810 drive enclosure to the top of a functioning drive loop

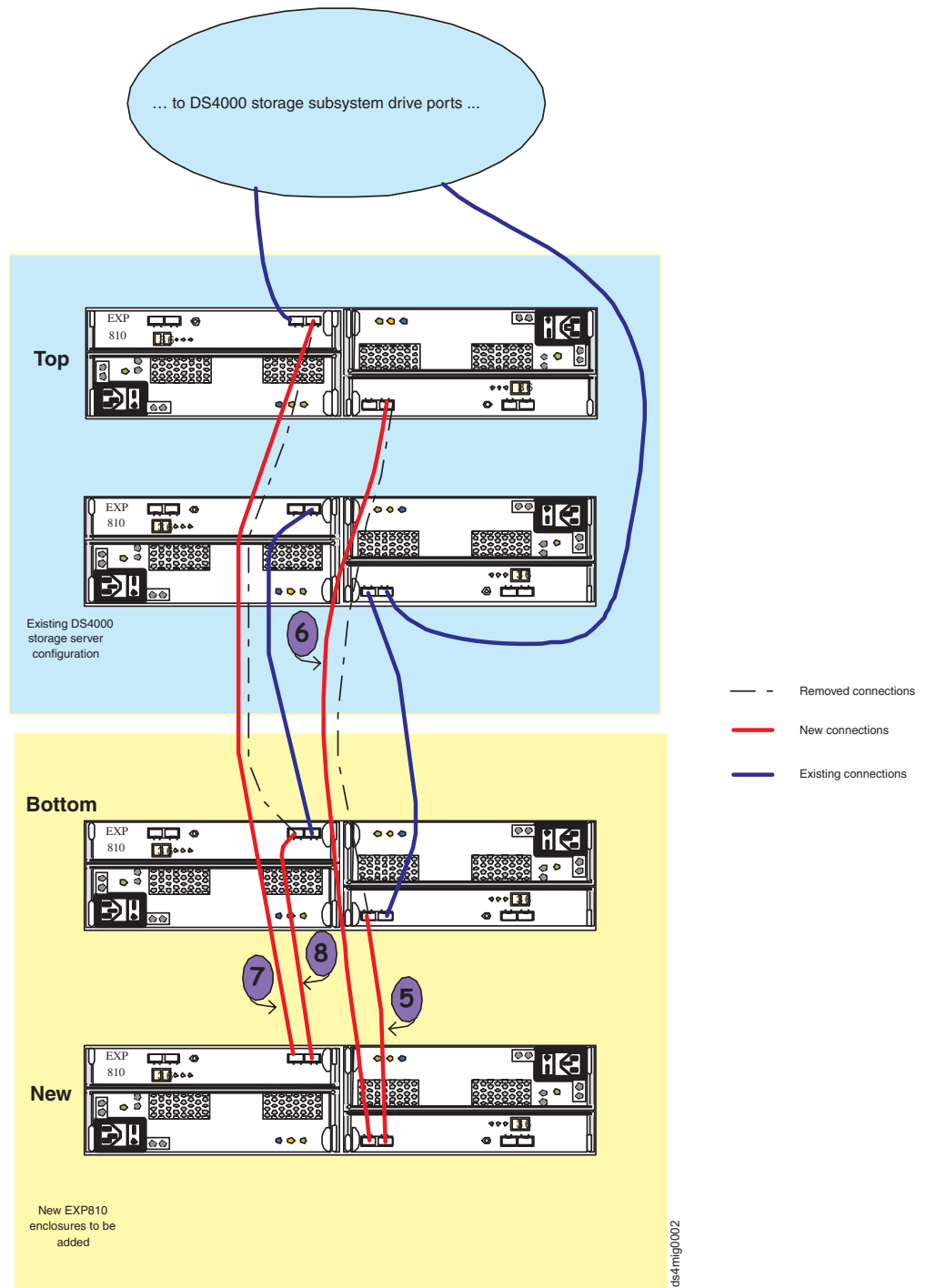


Figure 47. Cabling the second 14-drive enclosure to the middle of a drive loop

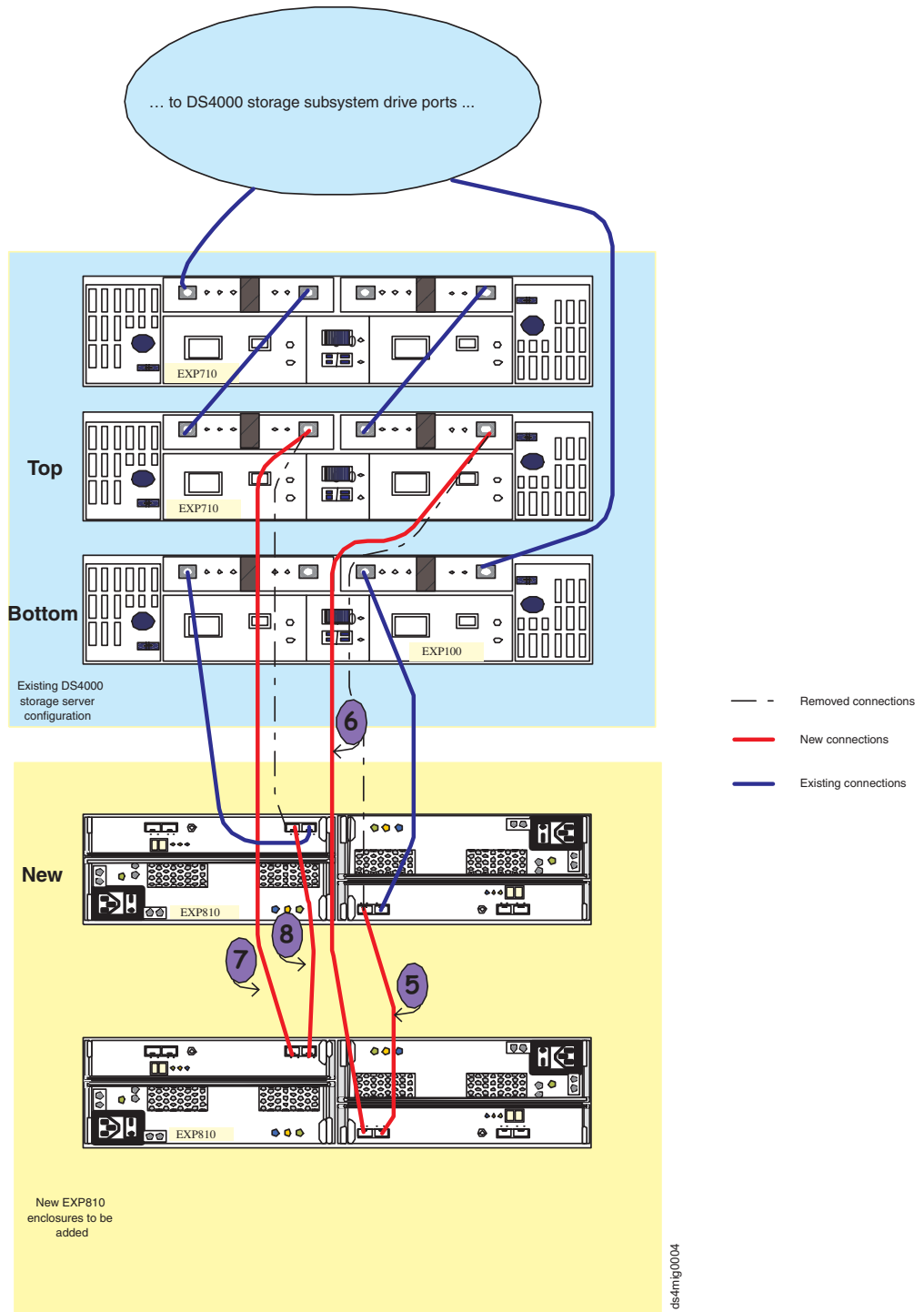


Figure 48. Cabling the second EXP810 between EXP710 and EXP100 enclosures in the same drive loop/channel

Activity 9: Re-enabling drive migration settings

If you performed steps 1 on page 107 through 6 on page 107 of Activity 7: Disabling DS4000 Storage Subsystem drive migration settings (for adding storage expansion enclosures with new drives only) to disable DS4000 Storage Subsystem

drive migration settings, perform the following steps 1 through 6 to re-enable the drive migration settings. If you should ever momentarily remove a drive from the DS4000 Storage Subsystem, the storage subsystem clears its configuration data when it later recognizes it. When this happens, the drive displays as unconfigured.

Attention: In order to prevent data loss, set the DS4000 Storage Subsystem drive migration setting to enable after you complete the hard drive addition process.

- ___ Step 1. Open the Storage Manager Client program Enterprise Management window.
- ___ Step 2. Right-click on the name of the DS4000 Storage Subsystem to which you want to add drives and click **Execute Script**.
- ___ Step 3. A script editor window opens. Click **File -> Load Script**.
- ___ Step 4. A Load Script file selection window opens. Locate and select the EnableDriveMigration.scr file and click **OK**. The file EnableDriveMigration.scr file is normally in the SCRIPTS directory of the IBM DS4000 Storage Manager Installation CD. Use this file to reset the DS4000 Storage Subsystem setting in order to check for any configuration data that might exist on the newly discovered hard drives.
- ___ Step 5. Click **Tools -> Verify and Execute** to run the script.
- ___ Step 6. When the script execution completes, reset both DS4000 controllers to make the setting effective.

If you use the EnableDriveMigration.scr script associated with this document and described in Figure 18 on page 65, it is not necessary for you to perform this step because the last two commands in that script file automatically reset the controllers. To reset the controllers, open the Storage Subsystem Management window and alternately (one at a time) reset each controller by clicking **Advanced -> Reset Controller** and following the instructions in the Reset Controller window when it opens.

- ___ Step 7. Verify (and update, if needed) the DS4000 Storage Expansion Enclosure ESM firmware and drive firmware with the latest version from the following IBM DS4000 support Web site.
www-1.ibm.com/servers/storage/support/disk/

Result: You have completed the procedure for adding enclosures. The newly added drives are now ready for you to configure and map to host servers.

Note: Listings of the EnableDriveMigration.scr and DisableDriveMigration.scr files are found in Figure 18 on page 65 and Figure 19 on page 66.




Activity 10: Inserting hard drives and placing logical drives online (for migrating only enclosures with drives containing logical drive configuration data)

Note: When migrating hard drives from multiple DS4000 Storage Subsystems to a single DS4000 Storage Subsystem, move all of the hard drives from the first DS4000 Storage Subsystem as an independent “set” to the destination DS4000 Storage Subsystem. Before moving hard drives as a set from subsequent DS4000 Storage Subsystems, ensure that all of the hard drives from the previous set have been successfully transferred to the destination DS4000 Storage Subsystem. If you do not transfer hard drives as “sets” to

the destination DS4000 Storage Subsystem, the newly relocated array may not appear in the Subsystem Management window.

- ___ Step 1. For each additional enclosure that you intend to migrate to the functioning drive loop pair, perform Activity 5: Installing and setting storage expansion unit IDs and speeds step 1 on page 82 through step 3 on page 83, Activity 6: Cabling, powering on, and verifying storage expansion unit operation step 1 on page 86 through step 4 on page 86. Figure 41 on page 109 shows the final cabling diagram after adding the second 14-drive enclosure (an EXP700) to the end of a drive loop/channel. Figure 42 on page 110 and Figure 43 on page 111 show the final results of adding the second 14-drive enclosure (an EXP700) to the beginning of the drive loop. Figure 43 on page 111 is the preferred scheme for cabling to the beginning of the drive loop, if the configuration and rack space allow for it. Figure 44 on page 112 illustrates what the cabling will look like as a result of adding the second 14-drive enclosure to the middle of a drive loop. Figure 45 on page 113, Figure 46 on page 114, and Figure 47 on page 115, respectively, illustrate the cabling after adding the second EXP810 to the end, beginning, or middle of a drive loop/channel. Figure 48 on page 116 illustrates adding the second EXP810 between EXP710 and EXP10 enclosures in the same drive loop/channel. When you have completed adding enclosures, proceed to step 2.
- ___ Step 2. Insert the drives into the empty drive slots in the new enclosure, one at a time. Wait (up to 5 minutes) until each drive pair has fully spun up and displayed in the DS4000 Storage Subsystem Management window before inserting the next drive pair.
- ___ Step 3. As the DS4000 Storage Subsystem recognizes the drives, it reads and displays the array and logical drive information on the drives in the Logical/Physical view of the DS4000 Storage Subsystem Management window. The Storage Subsystem places the array in offline state until it recognizes that you have inserted all of the drives that comprise the array.
- ___ Step 4. Once you insert all of the drives and the DS4000 Storage Subsystem recognizes them, change the state of the arrays or logical drives to the online state by right-clicking on the array name in the Storage Subsystem window and clicking **Place -> Online**.

If any of the following conditions persist, contact the IBM Help Center in your geography for assistance.

- ___ The empty drive slot icon () displayed for the drive slot into which you inserted the migrating drive.
- ___ The Failed unconfigured drive icon () or the Failed configured drive icon () displayed for the drive slot into which you inserted the migrating drive.
- ___ Array configuration data on the drives you have added is incomplete.
- ___ You cannot bring the array online.

Attention: Do not initialize a drive that you want to keep (by right-clicking its icon and selecting **Initialize** from the pull-down menu) if it contains configuration or user data. Initializing any of the drives in a defined array causes all hard drives that comprise an array to return to

the Unconfigured Capacity storage pool, deleting their array definitions from the DS4000 Storage Subsystem configuration. The user data on such drives is lost.

Result: Once the arrays are online, they are ready for you to configure and map to host servers. You might also then recreate flashcopies and remote mirror relationships.

- ___ Step 5. Use the DS4000 Storage Manager program to view the storage partitioning definitions and make any necessary corrections.
- ___ Step 6. The DS4000 Storage Subsystem that the drives are migrated from will display the logical drives that are defined in these drives as “missing LUNs.” In order to remove these “missing LUNs” entries, right-click on each entry and select **Delete** from the pull-down menu.

You have completed the procedure for migrating enclosures.

Chapter 5. Upgrading a storage subsystem in a functioning configuration

Note: When migrating hard drives from multiple DS4000 Storage Subsystems to a single DS4000 Storage Subsystem, move all of the hard drives from the first DS4000 Storage Subsystem as an independent *set* to the destination DS4000 Storage Subsystem. Before moving hard drives as a *set* from subsequent DS4000 Storage Subsystems, ensure that all of the hard drives from the previous *set* have been successfully transferred to the destination DS4000 Storage Subsystem. If you do not transfer hard drives as *sets* to the destination DS4000 Storage Subsystem, the newly relocated arrays/logical drives that are defined in these drives might not appear in the Subsystem Management window.

This procedure details the steps that are required to upgrade a DS4000 Storage Subsystem in a functioning DS4000 configuration. Where either an identical or newer DS4000 Storage Subsystem model is involved, this upgrade involves only the replacement of the DS4000 storage controller to be upgraded. DS4000 storage expansion enclosures that had been attached to drives containing configuration data will be connected to the new DS4000 Storage Subsystem. The upgraded (original) DS4000 Storage Subsystem being replaced will be either scrapped or returned to operation (redeployed) at a later date with new drives and/or new storage expansion enclosures.

Table 24 on page 123 associates each DS4000 Storage Subsystem with its supported replacements.

Important:

IBM Support is available to supply assistance and guidance to those who choose to upgrade a DS4000 Storage Subsystem.

Preliminary considerations: Storage Subsystem upgrade

While upgrading a DS4000 Storage Subsystem in a functioning configuration, remain aware of these important considerations:

- Observe proper ESD handling procedures when handling electronic equipment. See “Handling static-sensitive devices” on page 59 for additional information.
- IBM assigns premium feature entitlements only to specific DS4000 Storage Subsystems. In order to enable premium features in a replacement DS4000 Storage Subsystem configuration that had been enabled in an original DS4000 Storage Subsystem configuration, you must purchase appropriate entitlements for the replacement DS4000 Storage Subsystem. In addition, IBM assigns host kits only to specific DS4000 Storage Subsystems. You must also purchase the appropriate host kits for new DS4000 Storage Subsystems.
- See the appropriate *DS4000 Storage Controller's Installation and User's Guide* for information on the proper power on and power off sequences.

Note: The remainder of this topic pertains to the original DS4000 Storage Subsystem that is designated for replacement as either the original or old DS4000 Storage Subsystem.

This task requires that you shut down the DS4000 Storage Subsystem configuration. In addition, after the upgrade, premium features previously enabled in

the original DS4000 Storage Subsystem along with the enable-by-default premium features in the new DS4000 Storage Subsystem will automatically be placed in Out-of-Compliance state. Full data availability is retained, but you must generate new premium feature SAFE keys in order to re-enable premium features. Because IBM assigns premium feature entitlements only to specific DS4000 Storage Subsystems, you must purchase the appropriate entitlement for the new DS4000 Storage Subsystem. You can generate new SAFE keys by contacting the IBM Help Center. Be sure to have the necessary proof of purchase. Alternately, you can also generate new SAFE keys by using instructions located at the following Web site:

www.storage.ibm.com/pfeatures.html/

The new DS4000 Storage Subsystem controller identifies itself using a new Worldwide Name (WWN) that is different from the WWN used by the original DS4000 Storage Subsystem controller. For this reason, additional tasks might be required after the upgrade for any host applications or drivers that rely on the WWNs to identify logical drives defined in a given DS4000 Storage Subsystem. See your application program's documentation, your driver's user guide, or related documentation for detailed instructions on how to update the WWN of the DS4000 Storage Subsystem in the application or driver. Additionally, review the readme file and the related *IBM System Storage DS4000 Storage Manager Installation and Support Guide* for information about any preparation tasks required in addition or operating system-specific restrictions. *IBM System Storage DS4000 Storage Manager* installation and support guides are located at the following Web site:

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

Attention: Depending on your existing DS4000 Storage Subsystem configuration, you might not be able to migrate all of your drives and storage expansion enclosures to a new DS4000 Storage Subsystem configuration. For example, you cannot migrate 1 Gbps EXP500 drive expansion enclosures from a FASTt500 Storage Subsystem to a DS4300 Storage Subsystem or you cannot migrate a EXP700 drive expansion enclosures to the DS4800 Storage Subsystem before upgrading them to EXP710 drive expansion enclosures first. See Table 4 on page 7 and Table 24 on page 123 for additional information on DS4000 Storage Subsystem and storage expansion enclosure compatibility.

Contact your IBM reseller or representative if you have questions regarding the compatibility of drives and drive expansion enclosures in an existing DS4000 Storage Subsystem configuration with a new DS4000 Storage Subsystem configuration.

If you are planning to consolidate drive expansion enclosures from multiple DS4000 Storage Subsystem configurations into a single configuration with a new DS4000 Storage Subsystem, first perform the DS4000 Storage Subsystem replacement using drive expansion enclosures (and drives) from a given DS4000 Storage Subsystem configuration. After the DS4000 Storage Subsystem migration has been successfully completed, then migrate the drive expansion enclosures from the rest of the DS4000 Storage Subsystem configurations to the new DS4000 Storage Subsystem.

Table 24 on page 123 associates each DS4000 Storage Subsystem with its supported replacements. Select **View -> Rotate View -> Clockwise** to optimize the appearance of this chart.

Table 24. DS4000 storage subsystems by their supported replacements

Supported replacement DS4000 Storage Subsystem	DS4100 (Single Ctr)	DS4100 (Base)	DS4200 Express	DS4300 (Single Ctr) ³	DS4300 (Base model) ^{4, 8, 17}	DS4300 (Turbo option) ^{5, 8, 17}	DS4400	DS4500 ¹⁷	DS4700 Express	DS4800
DS4000 Storage Subsystem ^{1, 16}	✓	✓ ⁶						✓ ¹⁵		✓ ^{14, 15}
DS4100 (Single Ctr)	✓	✓ ⁶								
DS4100 (Base)		✓ ⁶								
FAST200							✓	✓		
FAST500 ²					✓ ^{7, 9}	✓ ^{7, 9}	✓			
DS4200 Express			✓							
DS4300 (Single Ctr) ³				✓		✓				
DS4300 (Base) ^{4, 8}					✓	✓	✓	✓	✓ ¹³	✓ ¹¹
DS4300 (Turbo) ^{5, 8}					✓	✓	✓	✓	✓ ¹¹	✓ ¹¹
DS4400					✓ ⁷	✓ ⁷	✓	✓	✓ ^{11, 13}	✓ ¹¹
DS4500					✓ ⁷	✓ ⁷	✓	✓	✓ ^{11, 13}	✓ ¹¹
DS4700 Express ¹⁰					✓	✓	✓ ¹²	✓ ²	✓	✓
DS4800 ¹⁰					✓	✓	✓ ¹²	✓	✓	✓

Table 24. DS4000 storage subsystems by their supported replacements (continued)

<ol style="list-style-type: none"> 1. Contact your IBM technical support representative if you have questions regarding the compatibility of drives and drive expansion enclosures in an existing DS4000 Storage Subsystem configuration with a new DS4000 Storage Subsystem configuration. 2. Set the DS4000 EXP700 storage expansion enclosure's speed switch to 1 Gbps when migrating from 2 Gbps configurations to a FAST1500 Storage Subsystem 1 Gbps configuration. 3. Single controller model (6LU/6LX) 4. Dual-controller Base model (60U/60X) 5. Dual-controller model with Turbo option (60U/60X) 6. You must run the SMcli command: <pre>set storageSubsystem redundancyMode=duplex;</pre> 	<p>to properly enable dual controller (duplex) operation. If you do not, the storage subsystem will still operating as single controller even though there are two controllers in the DS4000 chassis. Refer to the online help for information on how to execute SMcli commands.</p> <ol style="list-style-type: none"> 7. Migration to a DS4300 Storage Subsystem configuration from a FAST1500, DS4400, DS4500, or DS4800 storage subsystem configuration with more than eight drive expansion enclosures will require more than one DS4300 Storage Subsystem. See Table 2 on page 1. 8. DS4300 (Base model) and DS4300 (with Turbo option) Storage Subsystem configurations do not accommodate DS4000 EXP500 drive expansion enclosures. Do not migrate the EXP500 enclosures in FAST1500, DS4400, or DS4500 Storage Subsystem configurations to DS4300 (Base model) or DS4300 (with Turbo option) Storage Subsystem configurations. 9. You can migrate only EXP700 storage expansion enclosures from a FAST1500 Storage Subsystem to a DS4300 Storage Subsystem configuration. When you do so, you must set the EXP700 storage expansion enclosure's speed switch to 2 Gbps. 10. Migration to a non-DS4800 or a non-DS4700 Express Storage Subsystem requires the drive enclosures be operating at 2 Gbps FC speed. 11. The DS4800 and DS4700 Express Storage Subsystems do not support EXP700 (or EXP500) drive expansion enclosures. The EXP700 drive expansion enclosures must be upgraded to EXP710 in the existing DS4000 Storage Subsystem configuration before migrating it to the DS4700 Express or DS4800 Storage Subsystem. 12. You cannot replace a DS4800 or a DS4700 Express Storage Subsystem with a DS4400 storage subsystem, if the existing DS4800 configuration has EXP810s in the drive channels. 13. Migrating more than 6 EXP710s to the DS4700 Express subsystem will require two DS4700 Express storage subsystems; the maximum number of EXP710s that can be attached to a DS4700 Express is 6. 14. The required firmware is version 06.15.2x.xx and there must not be an EXP810 attached. 15. FC/SATA intermix premium feature may be required. Additionally, EXP100 must be used to migrate the drives installed in the DS4100 slots. 16. Migrating from a configuration with an integrated drive/RAID controller DS4000 storage subsystem, to the one with the RAID controller only DS4000 storage subsystem, will require an additional storage expansion enclosure for the drives that are installed inside the integrated drive/RAID controller DS4000 storage subsystem chassis. 17. Controller firmware version 6.19.xx.xx is required to support the EXP810 enclosure attachment.
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Note: If you are migrating from the FAStT200 or FAStT500, see Table 25.

Table 25. Legacy (FAStT200 / FAStT500) storage subsystems by their supported replacements

Supported replacement DS4000 Storage Subsystem		
DS4000 Storage Subsystem <small>1, 3</small>	FAStT200	FAStT500 <small>2</small>
FAStT200	✓	✓
FAStT500 <small>2</small>		✓
DS4400		✓
DS4500		✓
<p>Notes:</p> <ol style="list-style-type: none"> IBM does not currently support replacement of SATA or Fibre Channel controllers with one another. Contact your IBM support representative for assistance with this issue should the need arise. Set the DS4000 EXP700 storage expansion enclosure's speed switch to 1 Gbps when migrating from 2 Gbps configurations to a FAStT500 Storage Subsystem 1 Gbps configuration. Migrating from a configuration with an integrated drive/RAID controller DS4000 storage subsystem, to the one with the RAID controller only DS4000 storage subsystem, will require an additional storage expansion enclosure for the drives that are installed inside the integrated drive/RAID controller DS4000 storage subsystem chassis. 		

Preliminary considerations: Firmware behavior during subsystem upgrade

This section describes technical considerations regarding basic DS4000 Storage Subsystem controller firmware behavior during a DS4000 Storage Subsystem upgrade. It covers firmware behavior during system upgrade, where a new DS4000 Storage Subsystem connects to functioning drives and storage expansion enclosures, as well as firmware behavior during system redeployment, where the original (old) DS4000 Storage Subsystem serves as a logically distinct entity, optionally, using some of the drives from the original system.

DS4000 configuration behavior after upgrade and DS4000 Storage Subsystem replacement

The new DS4000 Storage Subsystem that powers up in a functioning storage expansion enclosure configuration, as part of the DS4000 Storage Subsystem upgrade process, has an impact on the following areas of the DS4000 Storage Subsystem identification and premium features:

- Worldwide Name (WWN):

The worldwide names that were used by the original DS4000 Storage Subsystem prior to the upgrade are not returned when the upgrade is complete. Rather, the new DS4000 Storage Subsystem begins to advertise itself using WWNs that are based on an embedded unique identifier from its controller blades. This statement applies to both the port WWNs and the node WWNs. Consequently, any hosts that were aware of the logical drives in the original DS4000 Storage Subsystem based on the original DS4000 Storage Subsystem's WWN values will

likely be confused. The data volumes that resided behind the previously known WWNs now reside behind a seemingly new device with different WWNs.

- **Storage Array Identifier (SAI or SA Identifier):**
The storage array identifier, or SA Identifier, is the identification value used by the DS4000 Storage Manager host software (SMclient) to uniquely identify managed storage subsystems. The DS4000 Storage Manager SMclient program maintains SA Identifier records of previously discovered storage subsystems in the host resident file, which allows it to retain discovery information in a persistent fashion. This identifier is stored on DACstore, and persists across reboots, power cycles, and so on. The new DS4000 Storage Subsystem that powers up in a functioning storage expansion enclosure configuration as part of the DS4000 Storage Subsystem upgrade process continues to use the SA Identifier of the original DS4000 Storage Subsystem.
- **SAFE Premium Feature Identifier (SAFE ID) and Premium Feature Enable Status:**
The new DS4000 Storage Subsystem retains the SAFE ID of the original DS4000 Storage Subsystem. It also retains all of the features previously enabled on the original DS4000 Storage Subsystem. The feature states, however, are set to the Out-of-Compliance state. As a result, the system sends alert notices and establishes a Needs Attention condition. Also, any features that are marked in the new controller's NVSRAM for automatic enablement are enabled, though their feature states are also set to Out-of-Compliance. You must re-enable the premium features by using premium feature SAFE key files. Because IBM assigns premium feature entitlements only to specific DS4000 Storage Subsystems, you must purchase the appropriate entitlements for the new DS4000 Storage Subsystem to enable all of the premium features previously enabled on the original DS4000 Storage Subsystem.

Redeployed DS4000 configuration behavior in an original (replaced) DS4000 Storage Subsystem

Important:

IBM Support is available to supply assistance and guidance to those who choose to redeploy a replaced DS4000 Storage Subsystem.

When you redeploy DS4000 Storage Subsystem hardware in another DS4000 Storage Subsystem's configuration, identification and premium features of the redeployed system behave somewhat differently from information described in "DS4000 configuration behavior after upgrade and DS4000 Storage Subsystem replacement" on page 125. This section describes those relevant behavioral differences.

- **Worldwide Name (WWN):**
The worldwide names that were used by the original DS4000 Storage Subsystem are retained on the redeployed system. These values are based on an embedded unique identifier from the original DS4000 Storage Subsystem controller blades, and are stored in the NVSRAM on each controller board within the controller blade. Assuming that both controllers remain fully optimal after the redeployment, they recognize the stored value and continue to use it. Consequently, any hosts that were aware of the original DS4000 Storage Subsystem, based on its WWN values, will likely be confused. The logical drives that used to reside behind the previously-known WWNs no longer reside there, because they are now part of the new DS4000 Storage Subsystem, which has a different WWN.

- **Storage Array Identifier or SA Identifier:**
 If you return one or more drives that were originally moved from a DS4000 Storage Subsystem back to the original DS4000 Storage Subsystem configuration before it is redeployed, it is possible that the SA Identifier that was used on the original DS4000 Storage Subsystem system will also be reused in the redeployed DS4000 Storage Subsystem configuration. Whether this occurs depends on the specific selection of transported drives. If certain conditions are met, however, the redeployed unit adopts the same SA Identifier that was retained by the new DS4000 Storage Subsystem. Otherwise, or in cases in which only new drives are used in the redeployed configuration, the redeployed DS4000 Storage Subsystem generates a new (and unique) SA Identifier that does not conflict with the one that was retained by the upgraded unit.
 If both the new and the redeployed DS4000 Storage Subsystem have the same SA Identifier, serious problems will result when you start the DS4000 Storage Manager SMclient program. Since there will be two DS4000 Storage Subsystems with the same SA Identifier, the DS4000 Storage Manager SMclient program will respond by arbitrarily selecting either the new or the redeployed DS4000 Storage Subsystem. The storage subsystem that the DS4000 Storage Manager SMclient program arbitrarily selects will be manageable, and the other storage subsystem will be unmanageable.
- **SAFE Premium Feature Identifier (SAFE ID)**
Premium Feature Enable status:
 If you return any drives from an original DS4000 Storage Subsystem, along with the original DS4000 Storage Subsystem controllers, to a redeployed DS4000 configuration, the SAFE ID of the original DS4000 Storage Subsystem will be retained, and all enabled features will remain fully enabled and compliant.
 If you do not move any drives from an original DS4000 Storage Subsystem, it generates a new SAFE ID when redeployed, enabling none of the premium features from the original system. This new SAFE ID prevents the system from using any previously-acquired SAFE key files and re-enabling any premium features. In cases where the original DS4000 Storage Subsystem was pre-loaded with NVSRAM codes to enable certain premium features, NVSRAM codes are cleared from the DS4000 Storage Subsystem when redeployed and powered on for the first time. Therefore, premium features that were enabled as standard features do not reactivate on the redeployed system. The system retains full data availability, but you must generate new premium feature SAFE keys in order to re-enable premium features. You can generate new SAFE keys by contacting the IBM Help Center in your geography. Be sure to have the necessary proof of purchase. Alternately, you can also generate new SAFE keys by using instructions located at the following Web site:
www.storage.ibm.com/pfeatures.html/
- **Controller IP addresses:**
 When the DS4000 Storage Subsystem controllers were assigned static IP addresses, the IP addresses were stored in the NVSRAM of the controller board as well as the DACstore on the disks. If the new (replacement) DS4000 Storage Subsystem controllers were assigned the same IP addresses as the original (replaced) DS4000 Storage Subsystem controllers, network problem will arise when the original (replaced) DS4000 Storage Subsystem is eventually redeployed. The problem will occur because two devices have the same IP address in the Ethernet network. The best practice is to assign new unique IP addresses to new (replacement) DS4000 Storage Subsystem controllers instead of using the same IP addresses as the DS4000 controllers that they replace.

Upgrading storage subsystems in functioning DS4000 configurations

Before you perform the following upgrade procedure, review and perform the steps detailed in Chapter 2, “Prerequisites to adding capacity and hard drive migration,” on page 45.

Complete the following activities to upgrade your DS4000 Storage Subsystem:

Activity 1: Preliminary activities

Perform the following steps before you disconnect storage expansion enclosures from an original DS4000 Storage Subsystem that is being replaced to ensure a successful DS4000 Storage Subsystem upgrade.

- ___ Step 1. Verify that the original DS4000 Storage Subsystem’s controller firmware and NVSRAM are at the levels shown in Table 22 on page 49.
- ___ Step 2. Verify that the firmware of the ESMs in the storage expansion enclosures is at the levels shown in Table 23 on page 53.
- ___ Step 3. Disable or delete any flashcopies of the logical drives.
- ___ Step 4. Delete any remote mirror relationships.
- ___ Step 5. If the arrays (logical drives) are not in optimal state, perform the steps necessary to bring the arrays (logical drives) into their optimal state before you attempt their migration. See the *DS4000 Problem Determination Guide* associated with your particular DS4000 hardware model or “Bringing storage subsystems and drive loops into optimal state” on page 57 for additional information on how to make this determination.
- ___ Step 6. If the drive enclosures are not in optimal state, perform the steps necessary to bring them to optimal state before attempting migration. Perform the following steps to verify that the drive loops are in optimal state:
 - ___ Step a. Physically trace the actual cable connections making sure that connections are properly modified and that the cable connectors are firmly inserted into the SFPs or GBICs.
 - ___ Step b. Verify that the following LEDs are not lit or briefly flashed in the modified drive loop:
 - ESM fault
 - Port bypass
 - ID conflict
 - ___ Step c. Verify that the controller drive loop LED remains lit. If the controller drive loop LED becomes unlit momentary, there are problems in the drive loop and the LIPs are generated by the DS4000 Storage Subsystem controller.
 - ___ Step d. In the DS4000 Storage Manager Client Subsystem Management window, verify that there are no loss of ESM path redundancy errors in the drives expansion enclosures that are not migrated.

Do not modify the second drive loop in a redundant drive loop pair until you are sure that the first modified drive loop is operating optimally. See the *DS4000 Problem Determination Guide* associated with your particular DS4000 hardware model or “Bringing storage subsystems

and drive loops into optimal state” on page 57 for additional information on how to make this determination.

- ___ Step 7. Perform a full backup of the original DS4000 Storage Subsystem and schedule it for down time. This is necessary because you must power down the DS4000 Storage Subsystem configuration during the upgrade procedure.
- ___ Step 8. Save the DS4000 Storage Subsystem profile of the original DS4000 Storage Subsystem configuration in a location other than that in which the logical drives are defined in the original DS4000 Storage Subsystem configuration.
- ___ Step 9. Stop all programs, services or processes in the host servers that access the logical drives defined in the migrated hard drives. Ensure that there are not any running background programs, services or processes that write data to the logical drives. (For example, Microsoft MSCS service periodically writes to the “Quorum” disk.)
- ___ Step 10. Unmount the file systems to flush I/O from the server cache to disks.

Notes:

- a. In a Microsoft Windows environment, remove the drive letter or the mount points of the mapped LUNs instead of unmounting the file systems.
 - b. Consult documentation associated with your particular operating system for detailed information regarding the Unmount procedure.
- ___ Step 11. Place the arrays defined on the DS4000 Storage Subsystem in offline state. In the Storage Subsystem Management window, right-click on the name of the array and select **Place -> Offline**.
 - ___ Step 12. Retrieve proofs of purchase for both the original and new DS4000 Storage Subsystems and for the additional premium feature entitlements on the new and original DS4000 Storage Subsystems. IBM support personnel will require this information to regenerate premium feature SAFE key files that were enabled in the original DS4000 Storage Subsystem for use on the new DS4000 Storage Subsystem.

Activity 2: Powering off the original DS4000 Storage Subsystem

Power down the original DS4000 Storage Subsystem and remove it from the DS4000 configuration. Do not redeploy this DS4000 Storage Subsystem in the same management domain as its upgrade (replacement) DS4000 Storage Subsystem until you regenerate its SA identifier using the instructions in “Redeploying the original (replaced) DS4000 Storage Subsystem” on page 132.

Note: See the appropriate *DS4000 Storage Controller's Installation and User's Guide* for details on the correct power off sequence.

Activity 3: Installing new DS4000 Storage Subsystems and setting minihub speed

Install the new DS4000 Storage Subsystem. For DS4400 and DS4500 storage servers, set the drive minihub speed switch to the speed of the storage expansion enclosure ports to which they are connected.

Note: The DS4300 drive loop port operates only at 2 Gbps. If you migrate storage expansion enclosures from a 1 Gbps Fibre Channel environment to a 2 Gbps Fibre Channel environment, do not automatically change the storage

expansion enclosure speed settings from 1 Gbps to 2 Gbps. Before you do, verify that each Fibre Channel drive involved is capable of 2 Gbps operation and that you have installed the latest firmware enabling them to work properly in a 2 Gbps Fibre Channel environment.

Important:

If the new DS4000 Storage Subsystem is either a FAStT200 or DS4300 Storage Subsystem, set the FAStT200 or DS4300 enclosure ID to a value unique from other EXP storage expansion enclosures in the Fibre Channel drive loop. These IDs are normally set to “0” at the factory.

Activity 4: Making connections

Insert the SFPs or GBICs into the DS4000 Storage Subsystem drive port slots and make the connections from the DS4000 Storage Subsystem to the storage expansion enclosures. For detailed information, see the appropriate *DS4000 Storage Controller's Installation and User Guide*.

Ensure that all of the DS4000 storage expansion enclosures are set to the correct Fibre Channel speed for the drive loop of the new DS4000 Storage Subsystem.

Activity 5: Powering on the expansion unit and setting IP addresses

___ Step 1. Verify that all of the storage expansion enclosures are powered on and in optimal state by examining the expansion enclosure LED states. Then, power on the new DS4000 Storage Subsystem. Using the DS4000 Storage Manager client program, verify that the DS4000 Storage Subsystem is operational and that all of the drives are recognized and in optimal state. See the *DS4000 Problem Determination Guide* associated with your particular DS4000 hardware model or “Bringing storage subsystems and drive loops into optimal state” on page 57 for additional information on how to make this determination.

Notes:

- a. Your storage subsystem will identify the new DS4000 Storage Subsystem as the machine type it replaced until you download the appropriate NVSRAM file for the new storage subsystem. For example, if you replace a FAStT500 with a DS4500, the DS4500 will be reported as a FAStT500 until you download the appropriate NVSRAM file for the DS4500.
 - b. See the appropriate *DS4000 Storage Controller's Installation and User Guide* for information on the proper power on sequence.
- ___ Step 2. If the new DS4000 Storage Subsystem is managed out-of-band, perform the steps for setting the IP addresses for new DS4000 Storage Subsystem controllers defined in the *IBM System Storage DS4000 Storage Manager Installation and Support Guide* associated with your operating system environment. *DS4000 Storage Manager* installation and support guides are located at the following Web site:
www.ibm.com/servers/storage/support/disk/




Changing DS4000 Storage Subsystem IP addresses

___ Step 1. Open the Storage Manager client program's Enterprise Management window.

Note: The new DS4000 Storage Subsystem will have the same IP addresses as the DS4000 Storage Subsystem previously removed.

- ___ Step 2. Select the entry of the DS4000 Storage Subsystem that you want to manage.
- ___ Step 3. Right-click and select **Manage Device** from the pop-up menu. The DS4000 Storage Manager Client Subsystem Management window opens.
- ___ Step 4. In the Logical/Physical view of the window, select **Controller -> Change -> Network Configuration**. The Change Network Configuration window opens.
- ___ Step 5. Select the **Slot A** tab.
- ___ Step 6. Select the radio button labeled **Specify Configuration Setting**.
- ___ Step 7. Type in the new IP address, subnet mask, and gateway information.
- ___ Step 8. Click **OK**.
- ___ Step 9. Select the **Slot B** tab.
- ___ Step 10. Select the radio button labeled **Specify Configuration Setting**.
- ___ Step 11. Type in the new IP address, subnet mask, and gateway information.
- ___ Step 12. Click **OK** to enable the IP address changes.
- ___ Step 13. Close the DS4000 Storage Manager Client Subsystem Management window.
- ___ Step 14. Right-click the entry of the DS4000 Storage Subsystem whose IP address you just changed, and select **Remove Device** from the pop-up menu.
- ___ Step 15. Click **Yes** to confirm removal of each device.
- ___ Step 16. Select **Edit -> Add Device**. The Add Device window opens.
- ___ Step 17. Type in the name or new IP address of controller A and close the window.
- ___ Step 18. Type in the name or new IP address of controller B and close the window.

Activity 6: Downloading firmware and NVSRAM and returning arrays online

- ___ Step 1. Use the DS4000 Storage Manager client program to download the firmware and the NVSRAM for the new DS4000 Storage Subsystem.
- ___ Step 2. Return the offline arrays to online state by right-clicking on the array and selecting **Place -> Online**. If any of the following conditions persist, contact the IBM Help Center for assistance:
 - The empty drive slot icon () displayed for the drive slot into which you inserted the migrating drive.
 - The Failed unconfigured drive icon () or the Failed configured drive icon () displayed for the drive slot into which you inserted the migrating drive.
 - Array configuration data on the drives you have added is incomplete.
 - You cannot bring the array online.

Activity 7: Generating and applying premium feature SAFE key files

Generate the new premium feature SAFE key files using the new DS4000 Storage Subsystem Feature Enable Identifier. Apply premium feature SAFE keys to remove Out-of-Compliance errors on enabled premium features.

Result: You are now able to recreate flashcopies and remote mirror relationships, if required.

Redeploying the original (replaced) DS4000 Storage Subsystem

As a safety measure, force generation of a new SA Identifier when you redeploy an original (replaced) DS4000 Storage Subsystem. Use the controller shell commands to generate a new SA Identifier. To gain access to the controller shell, you will require a null modem cable and a terminal emulation program that is capable of sending a BREAK signal. The setting for the terminal emulation session is 8-N-1 (8 data bits, no parity bit and 1 stop bit). Once you enter the controller shell, use the following command sequence to force the controller to generate a new SA Identifier:

```
1d </Debug  
symbolGenerateNewSAIdentifier
```

Note: It is necessary for you to run this command sequence on only one controller. Then, reset both DS4000 Storage Subsystem controllers and proceed with the normal DS4000 Storage Subsystem installation and configuration process.

Accessing the DS4000 Storage Subsystem controller shell

The following steps describe how to access the DS4000 Storage Subsystem controller shell using the terminal emulation program of your choice. One example of such a terminal emulation program for which IBM neither makes nor implies a warranty, HyperTerminal, Private Edition; version 6.3 or higher, is available for your consideration at the following Web site:

www.hilgraeve.com

A generic version of steps involved in accessing the DS4000 Storage Subsystem controller shell using the terminal emulation program of your choice follows:

- ___ Step 1. Stop all I/O on the DS4000 Storage Subsystem.
- ___ Step 2. Connect a null modem serial cable from one of the DS4000 Storage Subsystem controller communications (COM) ports to a system with an available terminal emulator.
- ___ Step 3. Open the terminal emulation program of your choice, such as the HyperTerminal, Private Edition program and from the menu bar, click **File -> Properties -> Configure**. Establish the following property settings:
 - Bits per second: 38400
 - Data bits: 8
 - Parity: None
 - Stop Bit: 1
 - Flow Control: None
- ___ Step 4. Connect to the DS4000 Storage Subsystem controller shell by sending a BREAK signal. (If you are using the HyperTerminal, Private Edition program, press the Ctrl and BREAK keys simultaneously to send the BREAK signal.)

- ___ Step 5. Repeat step 4 on page 132 until the following message displays:
"Press the space bar for baud rate within 5 seconds."
- ___ Step 6. Press the space bar within the time limit to establish the correct baud rate setting.
- ___ Step 7. Send another BREAK signal. The following message is displayed:
"Press within 5 seconds: ESC for SHELL, BREAK for baud rate."
- ___ Step 8. Press the ESC key within the time limit to access the controller shell.
- ___ Step 9. When prompted, type the following password:
infiniti
- ___ Step 10. You are now accessing the DS4000 Storage Subsystem controller shell.

Important:

Be careful when entering commands in the DS4000 Storage Subsystem controller shell. Improper use of DS4000 Storage Subsystem controller shell commands could result in loss of configuration data.

Appendix A. IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview

Note: For the most current information on the DS4000 Fibre Channel and Serial ATA (FC/SATA) Intermix premium feature, including the latest version of this Installation overview, see the IBM System Storage® Support Web site:

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

The DS4000 FC/SATA Intermix premium feature supports the concurrent attachment of Fibre Channel and SATA storage expansion enclosures to a single DS4000 controller configuration.

With this premium feature, you can create and manage distinct arrays or logical drives that are built from either Fibre Channel disks or SATA disks in a DS4000 Storage Subsystem, and allocate the drives to the appropriate applications in the attached host servers.

Note: You must purchase the DS4000 FC/SATA Enclosure Intermix premium feature for each DS4000 Storage Subsystem that will have drive channels/loops intermixing SATA and Fibre Channel technology drives.

Table 26 shows the combinations of DS4000 storage subsystems and storage expansion enclosures that this DS4000 FC/SATA Intermix premium feature currently supports.

Table 26. FC/SATA Intermix premium feature - supported configurations

DS4000 Storage Subsystem Model	Intermixing with ... (see note 7)						
	EXP100	EXP810 with SATA E-DDMs	EXP810 with FC and SATA E-DDMs (mixed EXP810)	EXP710 and EXP100	EXP700 and EXP100	[EXP710 and/or EXP810 with FC E-DDMs] and [EXP810 with SATA E-DDMs and/or mixed EXP810]	[EXP710 and/or EXP810 with FC E-DDMs] and [EXP100 and/or EXP810 with SATA E-DDMs and/or mixed EXP810]
DS4100	DS4100 storage subsystems do not support the Intermix premium feature.						
DS4200 Express	DS4200 Express storage subsystems do not currently support the Intermix premium feature. (See note 11.)						
DS4300 (standard or Turbo dual-controller) without FC drives in internal slots	N/A (See note 8)	N/A (See note 8)	Yes (See note 13)	Yes	Yes	Yes (See notes 4 and 13)	Yes (See notes 4 and 13)

Table 26. FC/SATA Intermix premium feature - supported configurations (continued)

DS4000 Storage Subsystem Model	Intermixing with ... (see note 7)						
	EXP100	EXP810 with SATA E-DDMs	EXP810 with FC and SATA E-DDMs (mixed EXP810)	EXP710 and EXP100	EXP700 and EXP100	[EXP710 and/or EXP810 with FC E-DDMs] and [EXP810 with SATA E-DDMs and/or mixed EXP810]	[EXP710 and/or EXP810 with FC E-DDMs] and [EXP100 and/or EXP810 with SATA E-DDMs and/or mixed EXP810]
DS4300 (standard or Turbo dual-controller) with FC drives in internal slots	Yes	Yes	Yes (See note 13)	Yes	Yes	Yes (See notes 4 and 13)	Yes (See notes 4 and 13)
DS4400	N/A (See note 9)	N/A (See note 9)	No	Yes	Yes	No	No
DS4500	N/A (See note 9)	N/A (See note 9)	Yes (See note 13)	Yes	Yes	Yes (See notes 4 and 13)	Yes (See notes 4 and 13)
DS4700 with SATA E-DDMs only, in internal slots	N/A (See note 1)	N/A (See note 10)	Yes (See note 13)	Yes (See note 1)	No (See note 3)	Yes (See notes 5 and 13)	Yes (See notes 1 and 13)
DS4700 with FC E-DDMs in internal slots	Yes (See note 1)	Yes	Yes (See note 13)	Yes (See note 1)	No (See note 3)	Yes (See notes 5 and 13)	Yes (See notes 1 and 13)
DS4800	N/A (See note 9)	N/A (See note 9)	Yes (See note 13)	Yes (See note 2)	No (See note 3)	Yes (See notes 5 and 13)	Yes (See notes 6 and 13)

Notes for Table 1:

1. DS4700s do not support EXP100s with controller firmware 6.16.xx.xx and earlier. Controller firmware version 6.23.xx.xx (or later) is required to support the attachment of EXP100s.
2. Requires DS4800 controller firmware version 6.15.xx.xx or 6.23.xx.xx (or later).
3. DS4700s and DS4800s do not support EXP700s.
4. Requires DS4300 or DS4500 controller firmware version 6.19.xx.xx or later.
5. Requires DS4700 or DS4800 controller firmware version 6.16.88.xx or later.
6. DS4800s require controller firmware version 6.23.xx.xx or later to support intermixing EXP810s and EXP100s.

7. EXP810s cannot be intermixed with EXP700s. You must upgrade your EXP700 to an EXP710 using the DS4000 EXP700 Models 1RU-1RX Switched-ESM Option Upgrade Kit before you can intermix with EXP810s.
8. For a DS4300 subsystem with no drives in its internal drive slots, the FC/SATA Intermix premium feature is not required to connect to a storage expansion enclosure with SATA drives only, such as an EXP100 or an EXP810 (with SATA E-DDMs only). However, a special NVSRAM file must be installed in the DS4300 subsystem to disable its internal drive slots.

Note: To find the NVSRAM file, look in the following directory of the controller firmware upgrade package: `...\NVSRAM\DS4300_FAST600_Turbo\For_attachment_of_EXP100-EXP810(SATA)_enclosures_only`

9. The FC/SATA Intermix premium feature is not required to connect a DS4400, DS4500, or DS4800 storage subsystem to a storage expansion enclosure with SATA drives only, such as an EXP100 or an EXP810 (with SATA E-DDMs only).
10. For a DS4700 subsystem with SATA drives in its internal drive slots, the FC/SATA Intermix premium feature is not required to connect to a storage expansion enclosure with SATA drives only, such as an EXP810 (with SATA E-DDMs only).
11. Configurations that are not supported at the time of publication might be supported in the future. For the most current information on the DS4000 Fibre Channel and Serial ATA (FC/SATA) Intermix premium feature, see the IBM System Storage Support Web site:
www.ibm.com/servers/storage/support/disk/
12. The FC/SATA Intermix premium feature is required to intermix a DS4700 with SATA E-DDMs in its internal slots with Fibre Channel enclosures, such as the EXP710 or the EXP810 with Fibre Channel E-DDMs
13. Intermixing FC and SATA E-DDMs within the same EXP810 is supported **only** at controller firmware version 06.23.xx.xx or later. The following DS4000 storage subsystems are supported at this firmware level: DS4300, DS4500, DS4700, and DS4800.

For information regarding future support for other Fibre Channel/SATA intermix combinations of DS4000 storage subsystems and storage expansion enclosures, contact your IBM reseller or representative or check the DS4000 Interoperability Matrix at the following Web site:

www-1.ibm.com/servers/storage/disk/ds4000/interop-matrix.html

Firmware requirements

The FC/SATA Intermix premium feature requires that you upgrade the DS4000 Storage Manager and controller firmware. See Table 27 on page 138 for the versions that are applicable to your DS4000 storage subsystem model.

Important: Before you begin the upgrade, see the readme files that are packaged with the DS4000 Storage Manager host software or controller firmware for any prerequisites and for any required updating sequences. You can also refer to the DS4000 Installation, User's, and Maintenance Guides for your specific storage subsystem and disk expansion enclosures for more information.

Table 27. Required DS4000 Storage Manager and subsystem controller firmware levels, by DS4000 subsystem model type

DS4000 Subsystem Model	DS4000 controller firmware version	DS4000 Storage Manager version
DS4300	6.19.xx.xx or later	Storage Manager 9.23 or later
DS4400	6.12.2x.xx	
DS4500	6.19.xx.xx or later	
DS4700	6.23.xx.xx or later	
DS4800	6.23.xx.xx or later	

Note: For the most current version of the DS4000 Storage Manager and storage subsystem controller firmware, see the IBM System Storage Support Web site:

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

FC/SATA Intermix Option installation kit

The FC/SATA Intermix Option installation kit includes the following items:

- *IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview* (this publication)
- The DS4000 FC/SATA Intermix premium feature entitlement document
- The DS4000 FC/SATA Intermix premium feature activation document, which includes the feature activation code and the instructions about how to generate the key file

Installing the FC/SATA Intermix premium feature

Complete the following steps to install the FC/SATA Intermix premium feature upgrade:

1. Purchase an IBM System Storage DS4000 Fibre Channel/SATA Intermix entitlement. Contact your IBM reseller or representative for additional information.
2. Upgrade your DS4000 ESM firmware to the level that is compatible with each particular enclosure type.

Attention: You should perform any required ESM code upgrades before you perform any other code upgrades. See Table 28 to find the ESM firmware levels that are compatible with each enclosure type.

Table 28. ESM firmware levels by storage expansion enclosure type

Storage expansion enclosure type	ESM firmware level
DS4000 EXP100	9563 or later (9565 is current). See note a , below.
DS4000 EXP700	9326 or later (9330 is current). See notes b and c , below.
DS4000 EXP710	9651 or later
DS4000 EXP810	9891 or later

Notes:

- a. If a DS4000 storage subsystem has an EXP100 ESM firmware version earlier than 9554 installed, you must upgrade the firmware to version 9554 before upgrading to version 9563 or 9565. (Please note that the controller firmware version must be version 5.41.1x.xx in order to upgrade the earlier version of ESM firmware to version 9554.)
 - b. You must upgrade the EXP700 ESM firmware to version 9326 or later before you upgrade the DS4000 storage subsystem controller firmware to version 06.1x.xx.xx.
 - c. DS4700 and DS4800 storage subsystems do not support DS4000 EXP700 expansion enclosures. Also, DS4300 and DS4500 storage subsystems do not support intermixing EXP700 expansion enclosures with EXP810 expansion enclosures. However, you can remove these restrictions by upgrading the EXP700 to an EXP710 by purchasing and implementing the *DS4000 EXP700 Models 1RU/1RX Switched-ESM Option Upgrade Kit*.
3. If necessary, upgrade your host software to DS4000 Storage Manager version 9.23 or later. You can download Storage Manager software from the IBM DS4000 Storage Manager Support Web site:
www.ibm.com/servers/storage/support/disk/

Refer to the appropriate Storage Manager Installation and Support Guide for your host operating system.

4. Upgrade your DS4000 Storage Subsystem controller firmware to the appropriate version for your storage subsystem model, as indicated in Table 27 on page 138. For more information, see the IBM DS4000 Storage Manager Installation and Support Guide for your host operating system. You can download the latest versions of the DS4000 Storage Subsystem controller firmware and Storage Manager host software from the DS4000 System Storage Support Web site (see link in Step 3 on page 139).
5. The DS4000 FC/SATA Intermix premium feature is entitled, and therefore it requires the use of a feature key to enable the option. To obtain the feature key identifier, you need a feature activation code, which is printed on the IBM premium feature activation card (included with this DS4000 FC/SATA Intermix premium feature kit). You also need your controller unit IBM serial number, which is printed on the label on the back of your DS4000 storage subsystem. Using the instructions in the DS4000 FC/SATA Intermix premium feature activation card, generate the FC/SATA Intermix premium feature key to enable FC/SATA Intermix functionality.

Attention: Before activating the FC/SATA Intermix premium feature, be sure to check the controller firmware readme files for the most up-to-date information. The readme files might include updated code prerequisites, specific Intermix cabling requirements, or other important information that you might need. Failure to check the readme files for this information can cause undesired results.

Note: Save the premium feature enable key file in a safe location.

FC/SATA Intermix restrictions and recommendations

Please note the following restrictions and recommendations when configuring and cabling your subsystem in an FC/SATA Intermix configuration:

- “Restrictions”
- “Recommendations” on page 150

Restrictions

Important: When you add drive expansion enclosures of different types, the grouping of the enclosure types might force the new enclosures to be cabled in the middle of the drive loop. In this case, it is strongly recommended that you power down the configuration or schedule your installations during offpeak I/O periods. You can use the performance monitor function in the DS4000 Storage Manager Subsystem Management window to determine offpeak I/O periods.

If you cannot power down the configuration to install a new enclosure in the middle of the loop, you must use DS4000 Storage Manager to verify that the interrupted drive loop is in Optimal state before you modify the other drive loop. This minimizes the possibility that arrays might fail as a result of cabling errors.

Therefore, it is also important to plan for additions to the configuration prior to your initial installation. It is also best practice to take these same precautions when you add new enclosures to either end of the redundant drive loop.

For more information, see the *IBM System Storage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*.

Compatible storage subsystems

Only the following DS4000 Storage Subsystems support the FC/SATA Intermix premium feature:

- DS4300 Standard/Base or Turbo
- DS4400
- DS4500
- DS4700
- DS4800

Limitations:

- DS4400 storage subsystems do not currently support EXP810 expansion enclosures.
- You cannot attach more than four EXP810s to one drive port that is part of a two-ported drive channel (for example, DS4700 and DS4800 subsystems have a two-port drive channel).

Note: This restriction does not apply when you are connecting enclosures to DS4300 and DS4500 drive ports.

For information regarding future DS4000 FC/SATA Intermix interoperability, contact your IBM reseller or representative or check the DS4000 Interoperability Matrix at the following Web site:

www-1.ibm.com/servers/storage/disk/ds4000/interop-matrix.html

Table 29 lists the drive types and their corresponding DS4000 storage subsystems and storage expansion enclosures.

Table 29. Drive types and their corresponding DS4000 storage subsystems and storage expansion enclosures

Drive type (see note 1)	Storage subsystem type	Storage expansion enclosure type
SATA	DS4100 DS4700 (see note 2)	DS4000 EXP100 DS4000 EXP810 (see note 2)
Fibre Channel	DS4300 Standard/Base or Turbo DS4400 DS4500 DS4700 (see note 3) DS4800	DS4000 EXP700 DS4000 EXP710 DS4000 EXP810 (see note 3)
Mixed SATA and Fibre Channel	DS4700 (see note 4)	DS4000 EXP810 (see note 4)

Notes:

1. The drive trays for the DS4700/EXP810 Fibre Channel drives and SATA E-DDMs are the same. However, this is not true of the DS4100/EXP100 SATA DDMs and the DS4300/EXP710/700 Fibre Channel DDMs, which have different drive trays from each other and from the DS4700/EXP810 Fibre Channel or SATA E-DDMs.
2. These devices are considered to be SATA drive types when populated with SATA E-DDMs.

3. These devices are considered to be Fibre Channel drive types when populated with Fibre Channel E-DDMs.
4. Intermixing FC and SATA E-DDMs in the same DS4700 or EXP810 device is supported only with controller firmware version 6.23.xx.xx or later.

Setting Enclosure IDs with unique single digit values

Ensure that the single digit (x1) of the enclosure ID for every enclosure in a redundant drive loop pair is unique. (In addition to expansion enclosures, this includes any storage subsystem that has drives installed.)

Enclosure IDs (sometimes known as tray IDs, or server IDs) consist of two digits: x10 and x1. In 14-drive expansion enclosures (EXP100/EXP700/EXP710), you can set the enclosure ID manually. In 16-drive expansion enclosures (EXP810), the enclosure ID is set automatically by the EXP810 ESM and the controller firmware. (Please refer to the appropriate Installation, User's, and Maintenance Guides for your enclosures for information on how to manually set the switches.)

If you do not set the enclosure IDs to be unique among enclosures, then drive loop errors might be randomly posted in the DS4000 subsystem Major Event Log (MEL) when you intermix different types of storage expansion enclosures in a redundant drive loop pair (such as an EXP100 with an EXP810). For example, with four enclosures attached to a DS4500 in a redundant drive loop pair, the correct enclosure ID settings should be x1, x2, x3, and x4 (where x can be any digits that can be set). Examples of incorrect settings would be 11, 21, 31, 41; or 12, 22, 32, 42. These examples are incorrect because the x1 digits are the same in all enclosure IDs (either 1 or 2).

If the enclosure IDs in your DS4000 subsystem configuration are not currently set to have unique single digit values for the enclosures in the same redundant drive loop pair, make the changes to the enclosure IDs in the next maintenance schedule. This will prevent unnecessary downtime when you add enclosures of different type (especially EXP810s) to the existing enclosures in the redundant drive loop pair.

Grouping DS4000 storage expansion enclosures in a redundant drive loop

Attention:

Configurations that do not follow this DS4000 storage expansion enclosures grouping restriction are not supported.

When mixing enclosures with Fibre Channel and SATA drives in a drive loop (DS4300/DS4400/DS4500) or behind a drive channel port (DS4700/DS4800), always group them by enclosure type. Table 26 on page 135 shows three different types of enclosures.

Note: For enclosures such as EXP710s and EXP810s, which are considered to be the same switch-ESM enclosure type even though they have different machine type, model and physical characteristic, group them next to each other by model type. See "Recommendations" on page 150 for recommended cabling diagrams.

Figure 49 shows a correct way and an incorrect way to group expansion enclosures that are attached to a DS4300, DS4400 or DS4500 storage subsystem:

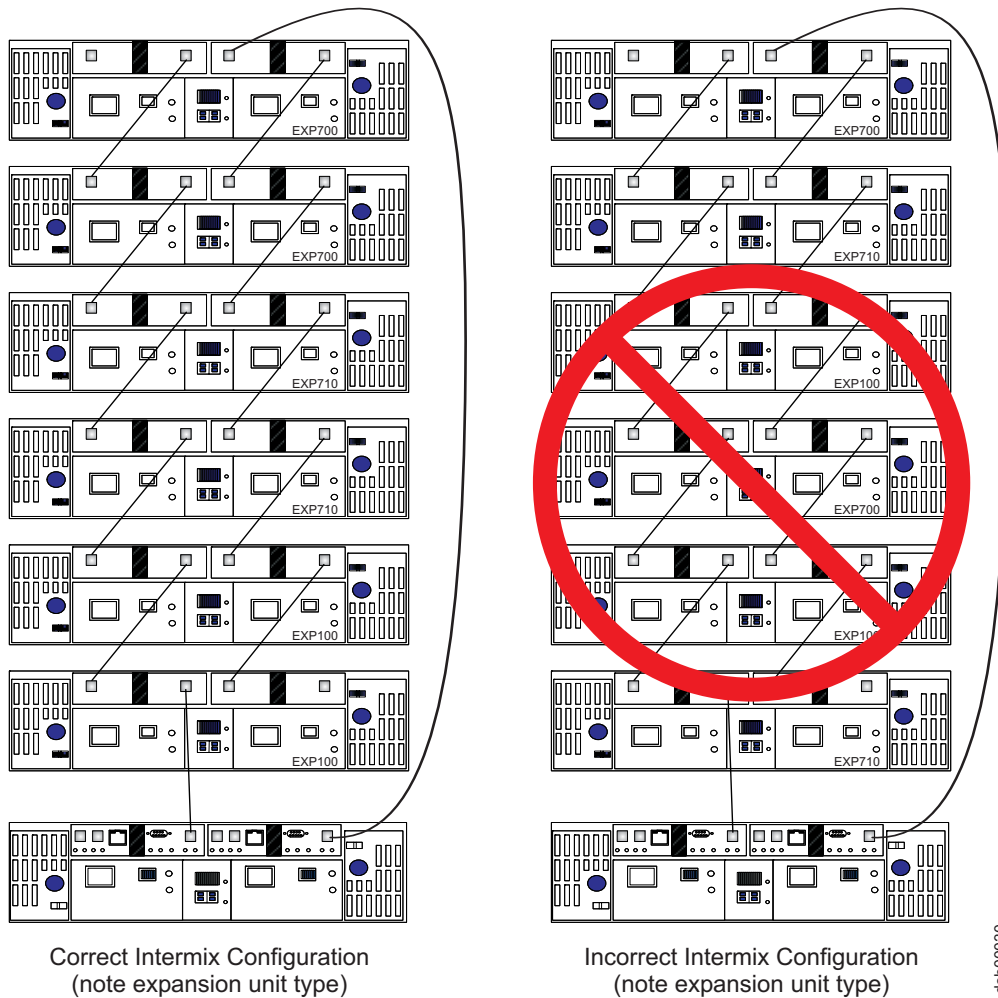


Figure 49. Correct and incorrect ways to group expansion enclosures in a redundant drive loop (DS4300 and DS4500 storage subsystems)

You must group enclosure model types together, as the configuration on the left shows. In the configuration on the left, the EXP700s are grouped together at the top of the loop, followed by the EXP710s, which are grouped together at the middle of the loop, followed by the EXP100s, which are grouped together closest to the controller.

Note: The storage expansion enclosure model type is indicated in the lower right corner of each enclosure.

In the configuration on the right, the enclosures are cabled in a random order and are not grouped by type. IBM does not support DS4000 Storage Subsystem Fibre Channel/SATA intermix configurations when they are cabled in this way.

Figure 50 on page 145 shows another incorrect way to group the expansion enclosures. In this case, the configuration is incorrect because the EXP100s are cabled between the EXP710s and the EXP810s.

Notes:

1. These figures are for illustrative purpose only. The representations of the DS4000 storage subsystems and expansion enclosures might not accurately reflect the rear view of the DS4000 products. (The cabling diagrams are correct.)
2. The controller firmware considers EXP810s and EXP710s to be the same enclosure type – a switched storage expansion unit type, which has an ESM with an embedded Fibre Channel loop switch – even though they are different models. Therefore, you must group these two enclosure models next to each other if they are contained within a drive loop or drive channel. However, you still need to group all of the EXP710s together, and group all of the EXP810s together, in the drive loop/channel.

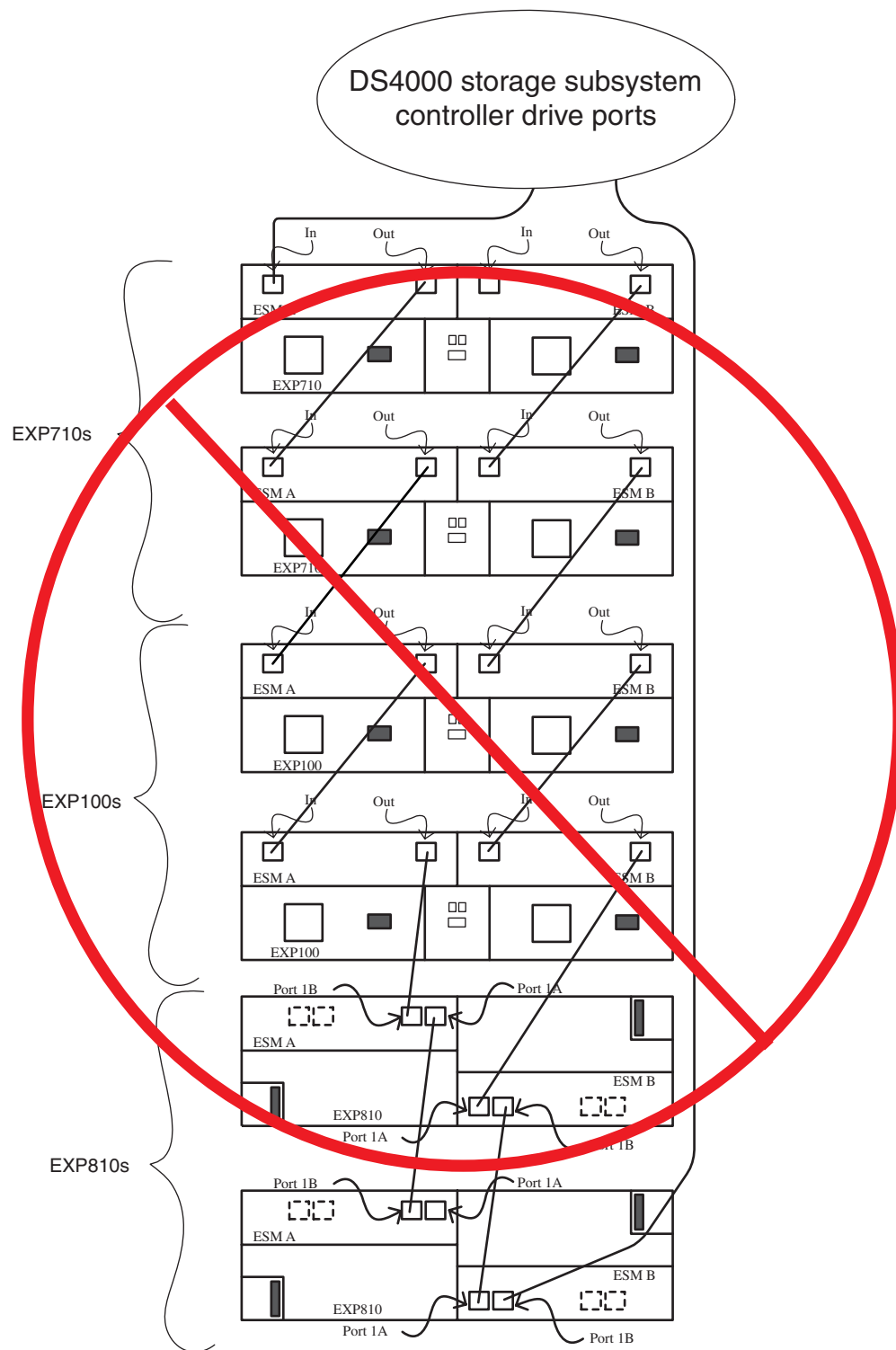


Figure 50. Second example of incorrect expansion enclosure grouping

Attention:

For the purposes of the storage expansion enclosure grouping restriction, note the following considerations:

- All models of the EXP100 are considered to be the same from a grouping perspective. For example, the EXP100 1710-10X, 1710-10U, and the 1724-1XP are considered like enclosure types and must be grouped together.
- All models of the EXP700 are considered to be the same from a grouping perspective. For example, the EXP700 1740-1RU, and the 1740-1RX are considered like enclosure types and must be grouped together.
- After the EXP700 has been upgraded with the *DS4000 EXP700 Models 1RU/1RX Switched-ESM Option Upgrade Kit*, it is considered an EXP710, regardless of the machine type and model (as labeled in the EXP700 chassis).
- The controller firmware considers EXP810s and EXP710s to be the same enclosure type – a switched storage expansion unit type, which has an ESM with an embedded Fibre Channel loop switch – even though they are different models. Therefore, you must group these two enclosure models next to each other if they are contained within a drive loop or drive channel. However, you still need to group all of the EXP710s together, and group all of the EXP810s together, in the drive loop/channel.

For more information, see the *IBM System Storage DS4000 Hard Drive and Storage Expansion Enclosure Installation and Migration Guide*.

Cannot mix drive types

Arrays must consist exclusively of either Fibre Channel or SATA drives. You cannot mix drive types in an array.

Cannot intermix drive types for hot spares

SATA drives can function as hot spares for SATA drives only.

Fibre Channel drives can function as hot spares for Fibre Channel drives only.

DS4300 Standard/Base or Turbo Intermix configuration restrictions

In DS4300 Intermix configurations, with the FC/SATA Intermix premium feature enabled and the correct NVSRAM file installed, the maximum number of expansion enclosures in a drive loop is limited to seven. This is true whether or not there are drives in the DS4300 storage subsystem drive slots.

Intermixing EXP100s with EXP710s and EXP810s in a DS4700 or DS4800 configuration

When intermixing EXP100s, EXP710s, and EXP810s in a DS4700 or DS4800 storage subsystem configuration, if it is not possible to cable each group of enclosures by model type (EXP100s, EXP710s, and EXP810s) in a separate redundant drive loop pair or behind each port of the dual-ported redundant drive channel pair, group them so that EXP810s are between EXP100s and EXP710s.

In addition, when an EXP100 is the first storage expansion enclosure cabled directly to the storage subsystem's controller drive port, follow these rules:

- Cable from the storage subsystem controller drive port to the OUT port on the left ESM (ESM A) of the EXP100.
- Note:** This is a change from previous cabling recommendations where you cabled from the controller drive port to the IN port on the left ESM (ESM A) of the EXP100.
- If an EXP100 follows the initial EXP100, cable from the IN port on the left ESM (ESM A) of the first EXP100 to the OUT port on the left ESM of the next EXP100. Continue this cabling pattern until you encounter an EXP710 or EXP810, then cable from the IN port on the left ESM (ESM A) of the EXP100 to the IN port of the EXP710 or EXP810.
 - If an EXP710 or EXP810 follows the initial EXP100, cable from the IN port on the left ESM (ESM A) of the EXP100 to the IN port of the EXP710 or EXP810. To cable to the next storage expansion enclosure in the chain, cable from the OUT port of the left ESM of the EXP710 or EXP810 to the IN port of the next storage expansion enclosure.
 - Continue the left ESM (ESM A) cabling pattern by cabling from the OUT port to the IN port on subsequent storage expansion enclosures until you complete the chain.

Figure 51 shows an acceptable EXP710, EXP810 and EXP100 intermix configuration in a DS4700 or DS4800 environment. The cabling is acceptable because it follows the cabling recommendations.

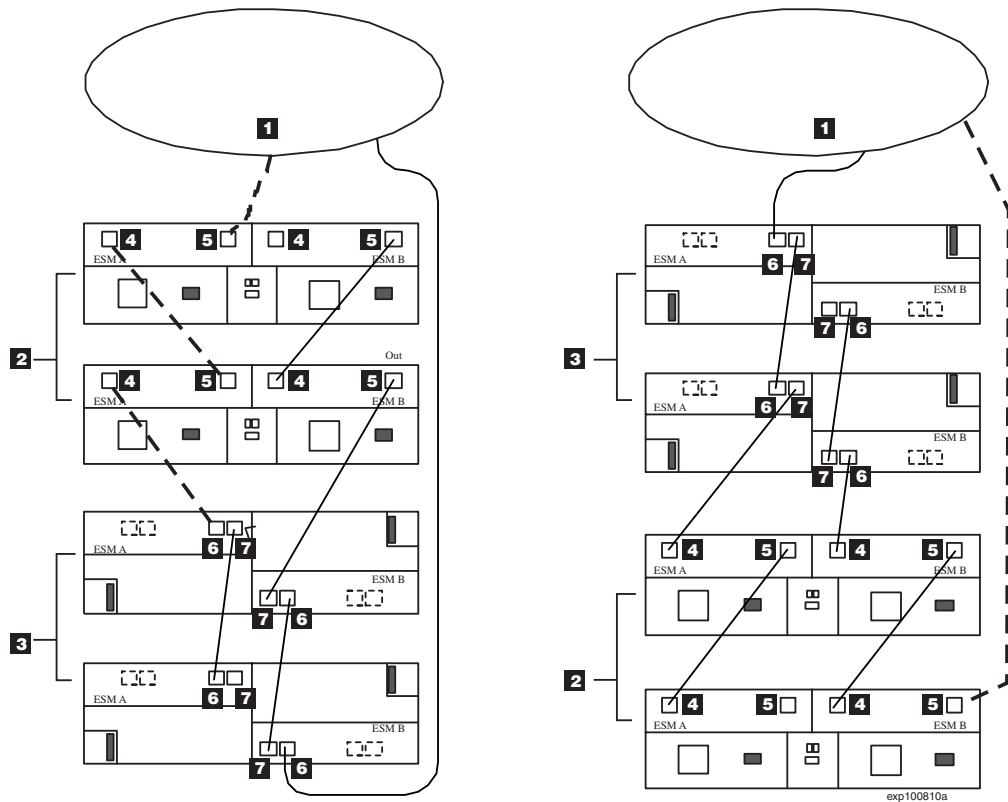


Figure 51. Acceptable EXP710, EXP810 and EXP100 intermix configuration in a DS4700 or DS4800 environment

Table 30. Description of Figure 51 on page 147

Number	Description
1	DS4700 or DS4800 storage subsystem
2	EXP100
3	EXP810
4	IN port
5	OUT port
6	Port 1B
7	Port 1A

Figure 52 on page 149 shows an unacceptable EXP710, EXP810, and EXP100 intermix configuration in a DS4700 or DS4800 environment. The cabling is unacceptable because storage subsystem controller is cabled to the IN port on the left ESM of the first EXP100.

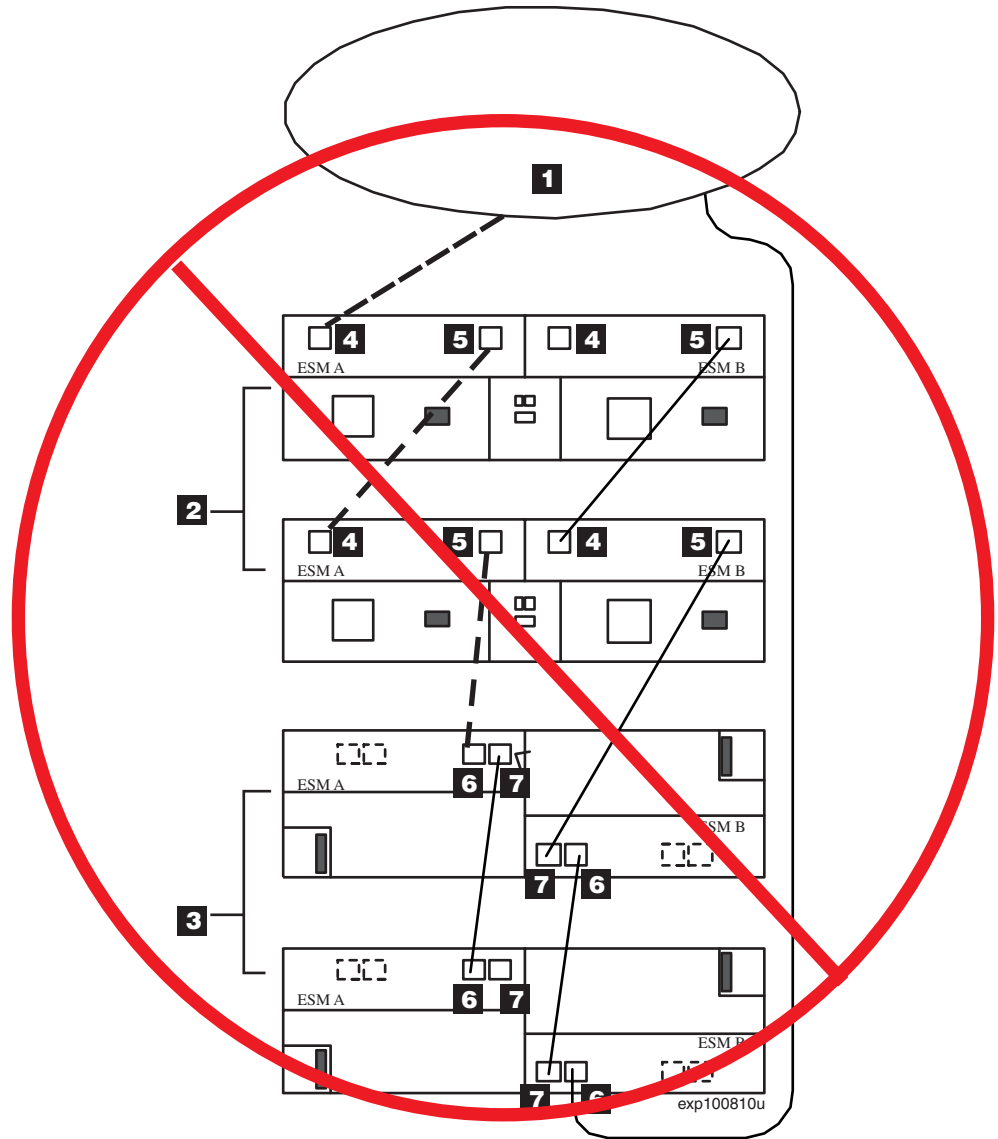


Figure 52. Unacceptable EXP710, EXP810 and EXP100 intermix configuration in a DS4700 or DS4800 environment

Table 31. Description of Figure 52

Number	Description
1	DS4700 or DS4800 storage subsystem
2	EXP100
3	EXP810
4	IN port
5	OUT port
6	Port 1B
7	Port 1A

Figure 53 on page 150 shows cabling variations when intermixing EXP100, EXP710, and EXP810 storage expansion enclosures behind a DS4800 Storage

Subsystem.

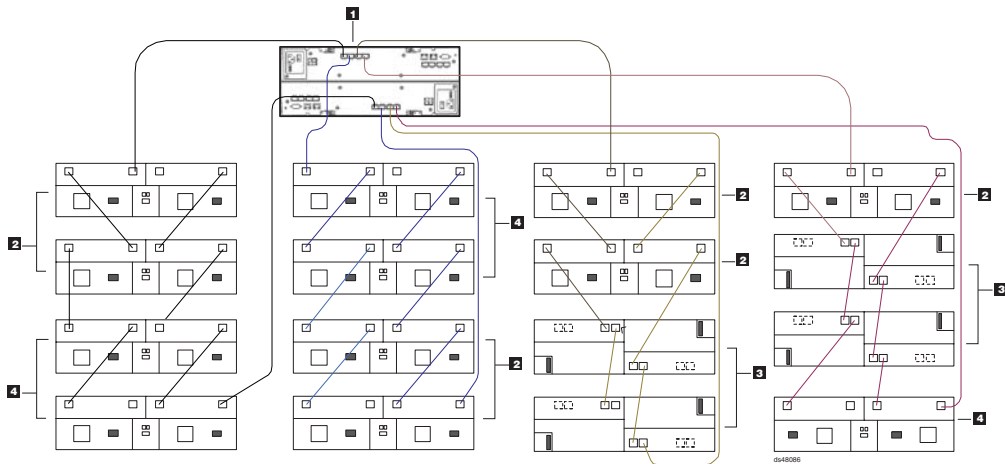


Figure 53. Cabling variations when intermixing EXP100, EXP710, and EXP810 storage expansion enclosures behind a DS4800 Storage Subsystem

Table 32. Description of Figure 53

Number	Description
1	DS4800 Storage Subsystem
2	EXP100
3	EXP810
4	EXP710

Recommendations

Please note the following recommendations when you cable your DS4000 storage subsystem configuration:

Connect only one type of expansion enclosure behind each controller drive port of the dual-ported drive channel or the drive loop

Connect only one type of expansion enclosure behind each DS4000 controller drive port.

Figure 54 on page 151 shows four EXP100s, four EXP710s, four EXP810s with Fibre-Channel drives, and four EXP810s with SATA drives. The four different expansion unit types are *not* mixed together behind the same drive port of a DS4800 drive channel.

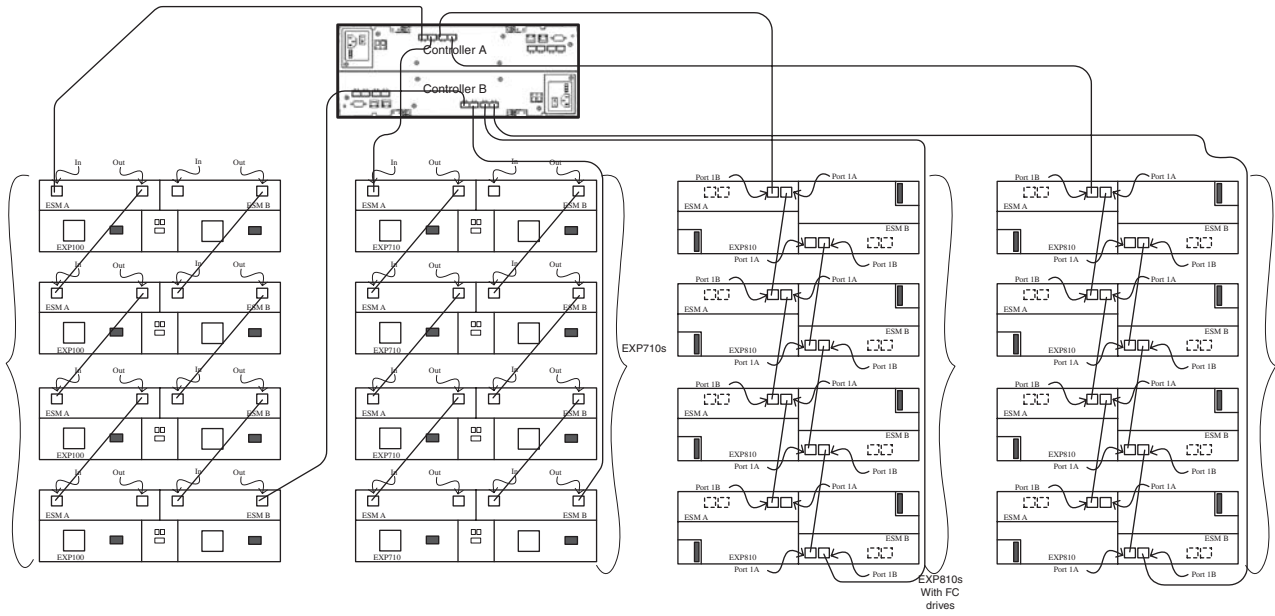


Figure 54. Example of connecting only one type of expansion enclosure (EXP100, EXP710, EXP810) behind a DS4800 controller drive port

Figure 55 shows three EXP100s and three EXP810s. The two different expansion unit types are *not* mixed together behind the same drive port of a DS4700 drive channel.

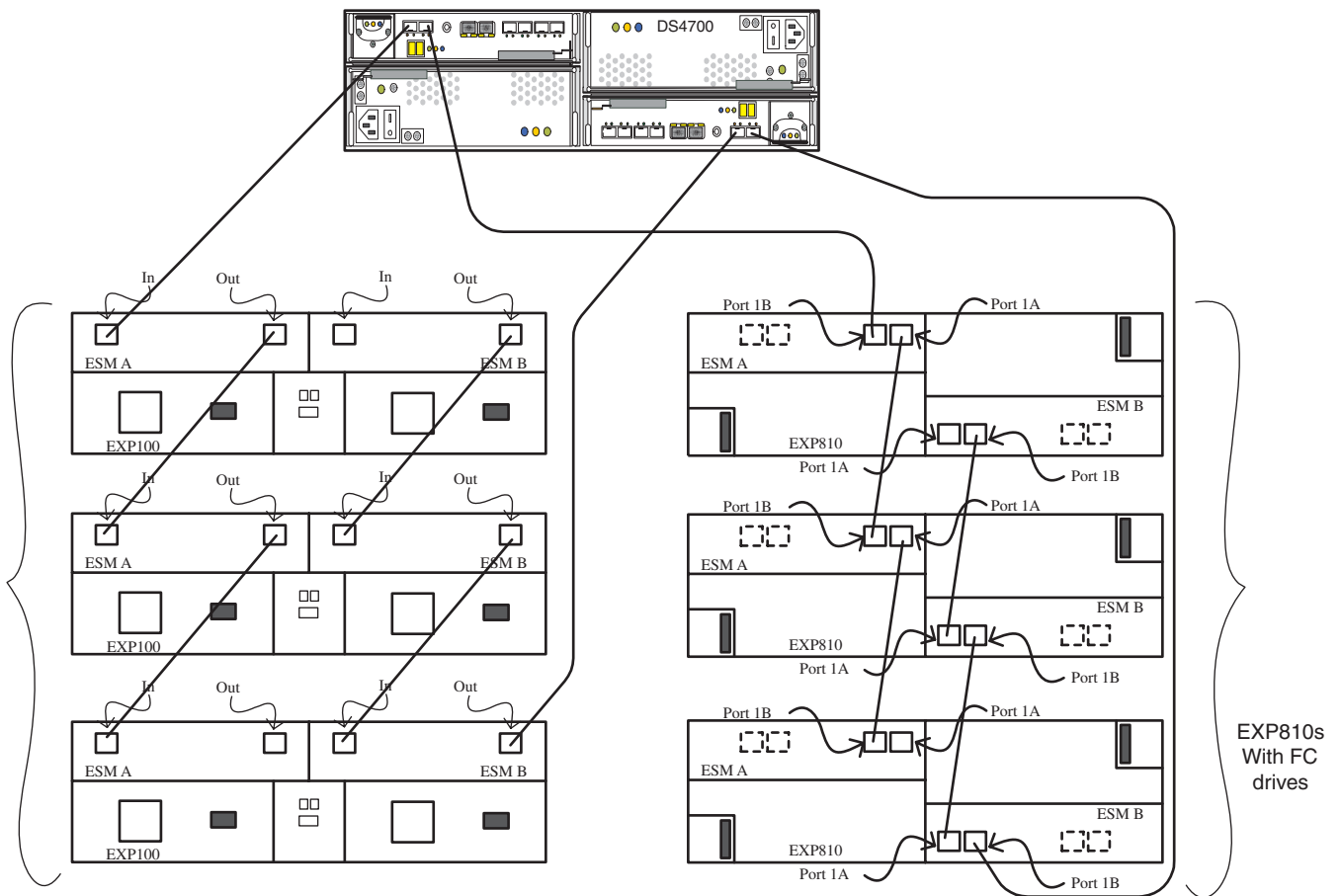


Figure 55. Example of connecting only one type of expansion enclosure (EXP100 or EXP810) behind a DS4700 controller drive port

Figure 56 shows four EXP810s and four EXP100s. The two different expansion unit types are *not* mixed together behind the same drive port of a DS4500 drive loop.

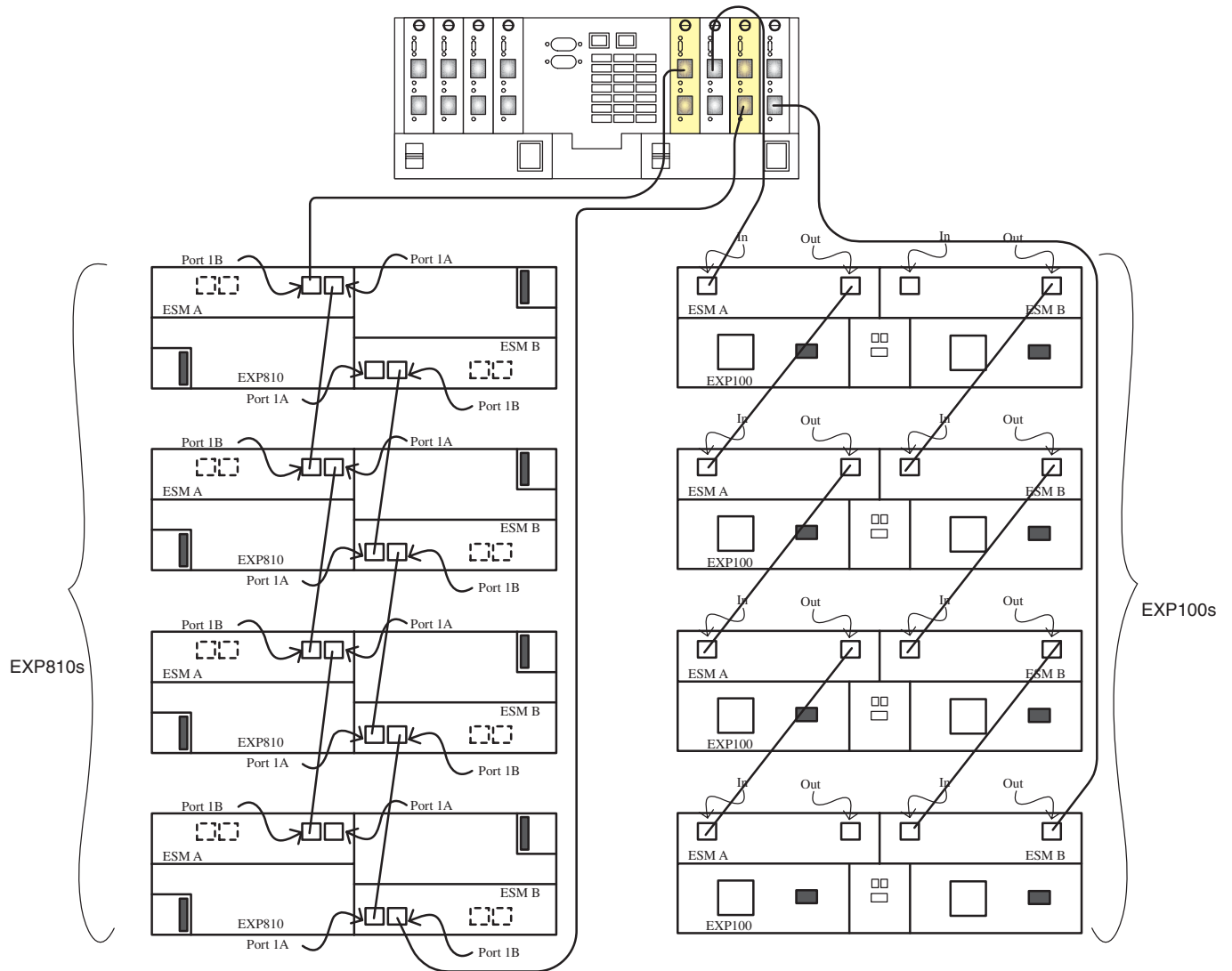


Figure 56. Example of connecting only one type of expansion enclosure (EXP810 or EXP100) behind a DS4500 controller drive port

Group EXP710 and EXP810s by model type behind each controller drive port

If it is not possible to separate EXP810 and other expansion enclosures behind different controller drive ports, group the expansion enclosures by model type behind each controller drive port. Figure 57 shows EXP710 and EXP810 enclosures that are mixed together behind a drive port, grouped together by model type. In addition, the three EXP810s with the SATA drive option are connected to a different drive channel than the EXP810 and EXP710 with the Fibre Channel drive option.

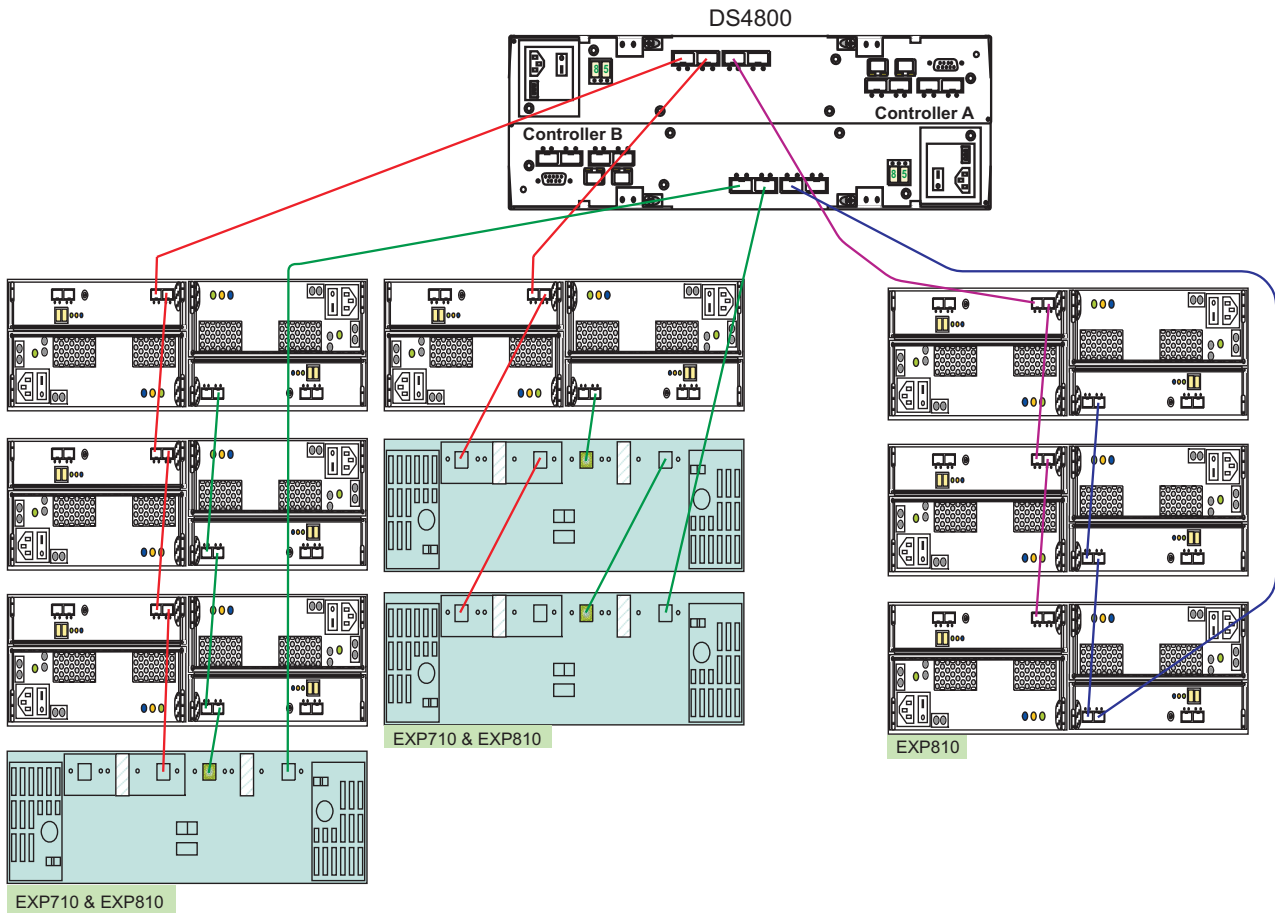


Figure 57. Example of grouping EXP810 and EXP710 model types together behind a DS4800 controller drive port

Group EXP100s and EXP810s by model type behind each DS4000 controller drive port

When intermixing the EXP100s and EXP810s behind a DS4000 storage subsystem, you might not be able to cable the EXP100s in a separate redundant drive loop pair from the EXP810s because of hardware limitations. For example, in the DS4300 only one redundant drive loop is available; or in the DS4500, one redundant drive loop might be full with other storage expansion enclosures. In this case, it is recommended that you group the enclosures by type in the redundant drive loop pair. As shown in Figure 58, cable the group of EXP100s followed by the group of EXP810s, and EXP810s followed by EXP100s.

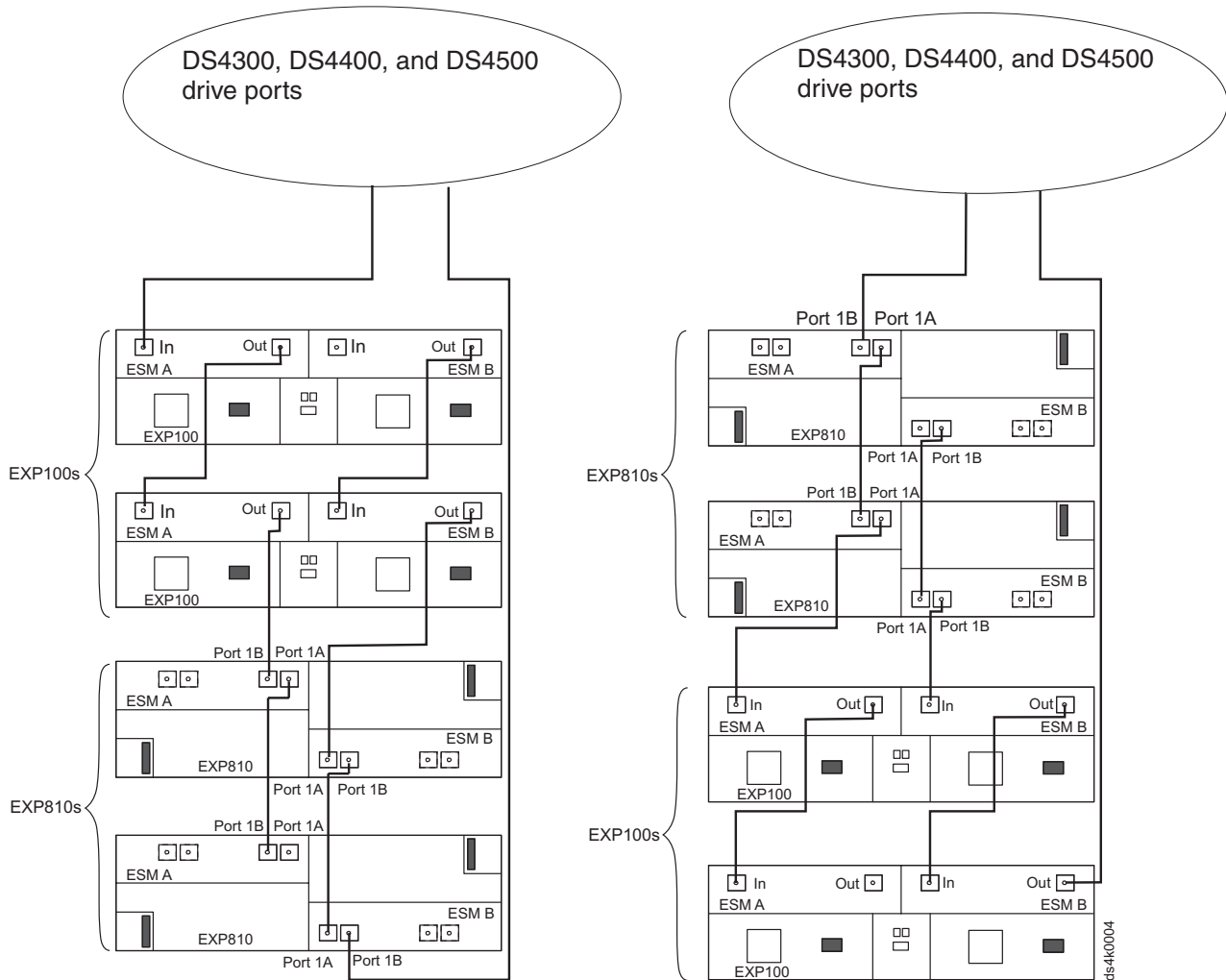


Figure 58. Example of grouping EXP810s and EXP100 model types behind a DS4000 controller drive port

Group EXP100s, EXP710s, and EXP810s behind a DS4500 or DS4800 controller drive port

When intermixing the EXP100s, EXP710s, and EXP810s behind a DS4500 or DS4800 storage subsystem, it is recommended that you cable the EXP100s in a separate redundant drive loop pair from the EXP810s and EXP710s, if possible. In Figure 59, the redundant drive loop pair on the left has EXP810s and EXP710s intermixed; the redundant drive loop pair on the right has only EXP100s.

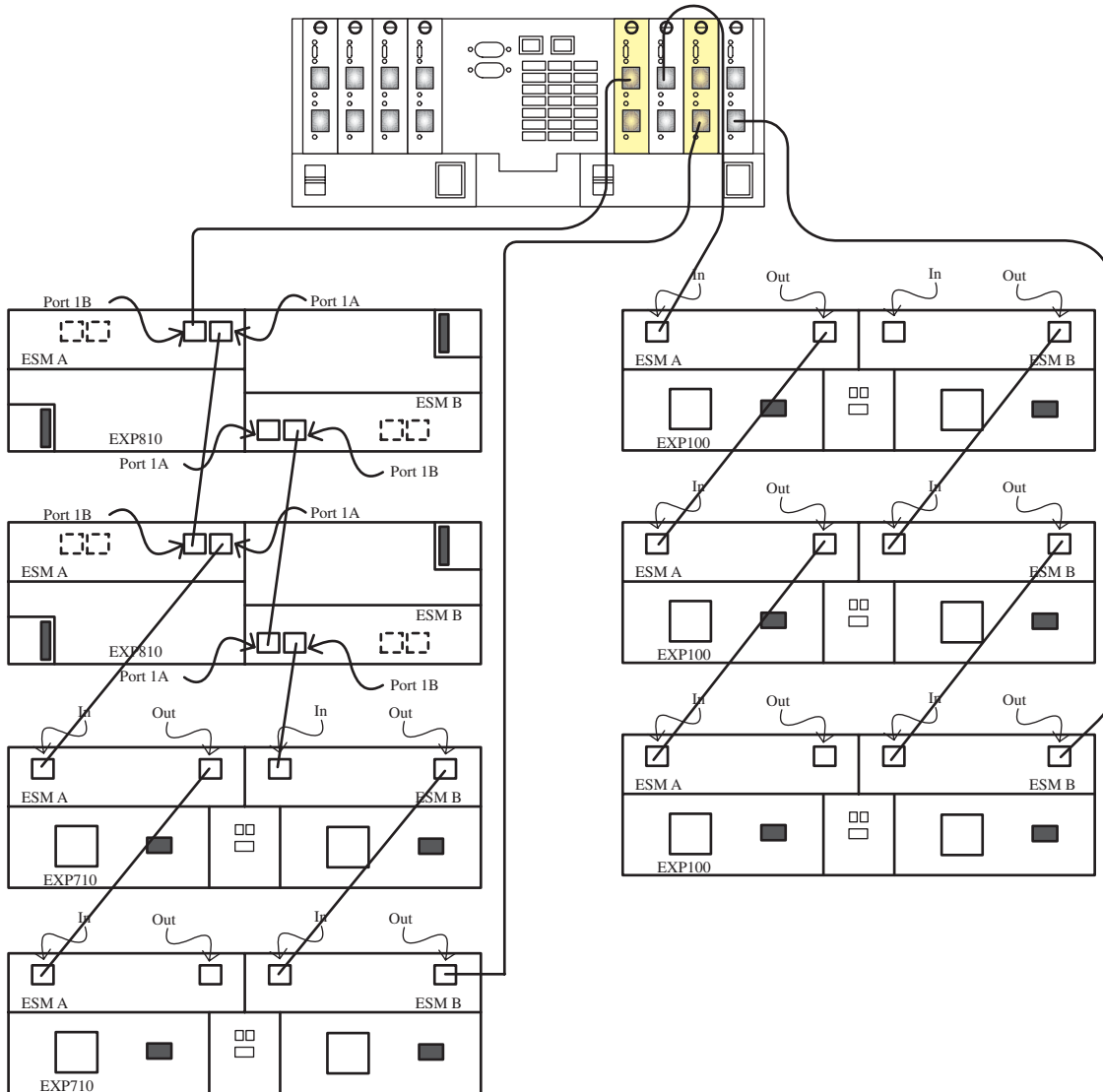


Figure 59. Example of grouping EXP100s, EXP710s, and EXP810s behind a DS4500 controller drive port

In Figure 60, the redundant drive channel on the left has EXP100s only, and the drive channel on the right has EXP810s and EXP710s intermixed.

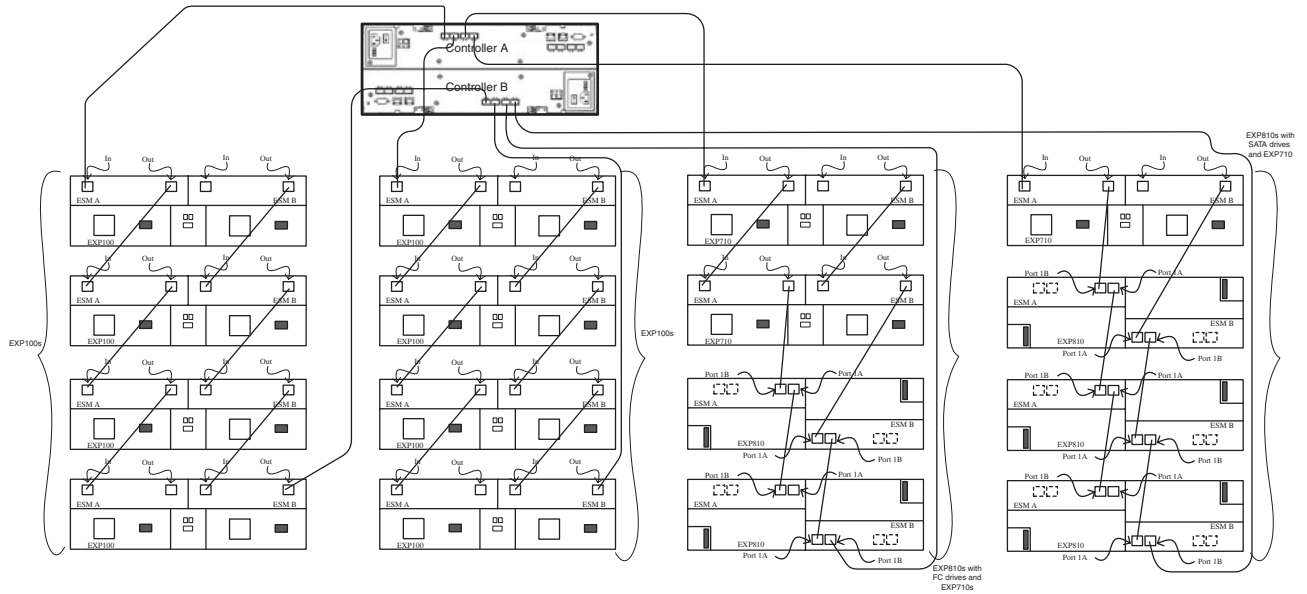


Figure 60. Example of grouping EXP100s, EXP710s, and EXP810s behind a DS4800 controller drive port

| **Group EXP100s, EXP710s, and EXP810s behind a DS4000**
| **controller drive port**

| When intermixing EXP100s, EXP710s, and EXP810s behind a DS4000 storage
| subsystem, if it is not possible to cable the EXP100s in a separate redundant drive
| loop pair (or separate drive port of the redundant dual-ported drive channel pair)
| from the EXP810s and EXP710s, it is recommended that you group the enclosures
| in such a way that the EXP810s are placed between the EXP100s and EXP710s,
| as shown in Figure 61 on page 159 and Figure 62 on page 160.

| **Requirement:** For the DS4300, this is currently a requirement.
|

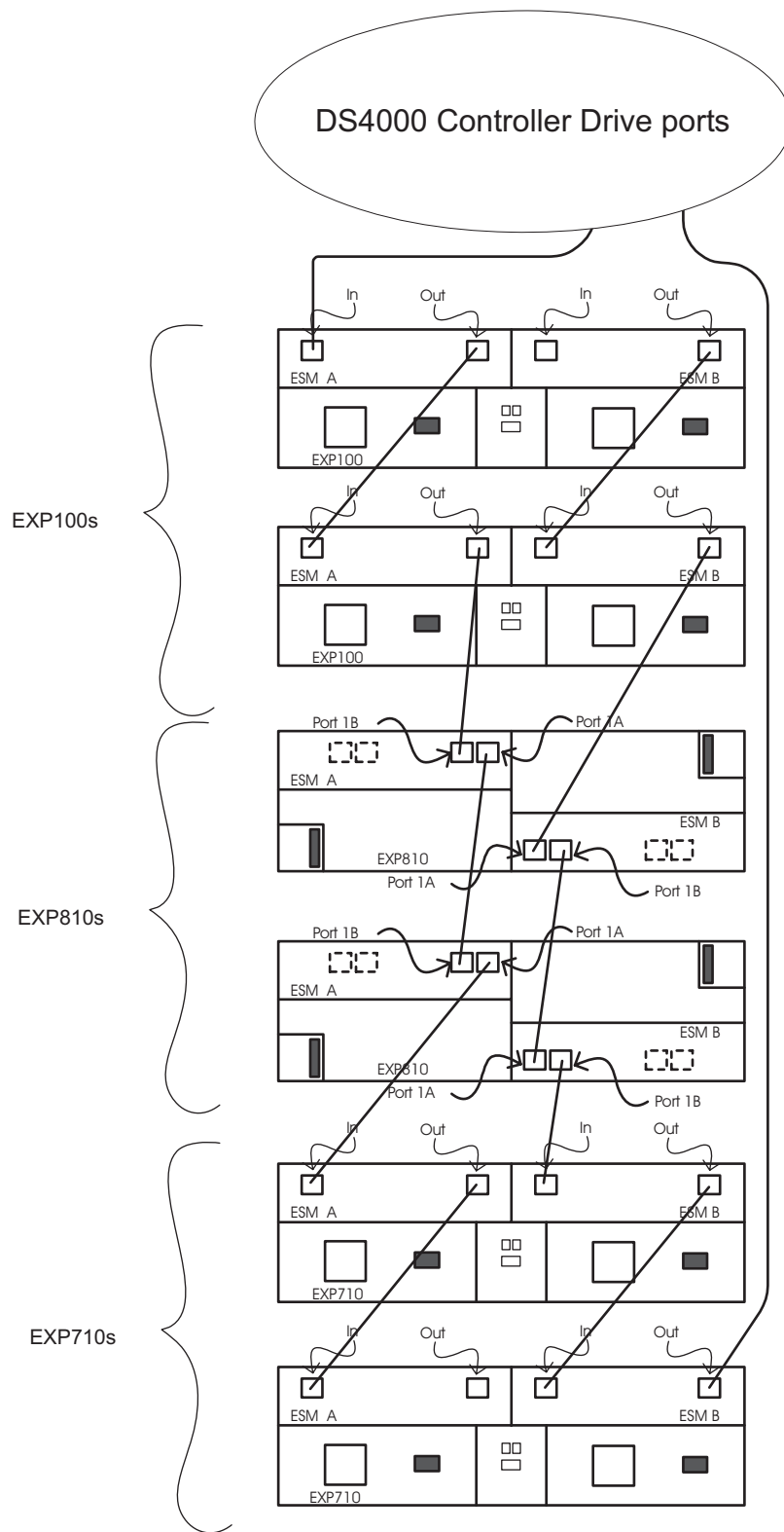


Figure 61. First example of grouping EXP100s, EXP710s, and EXP810s behind a DS4000 controller drive port

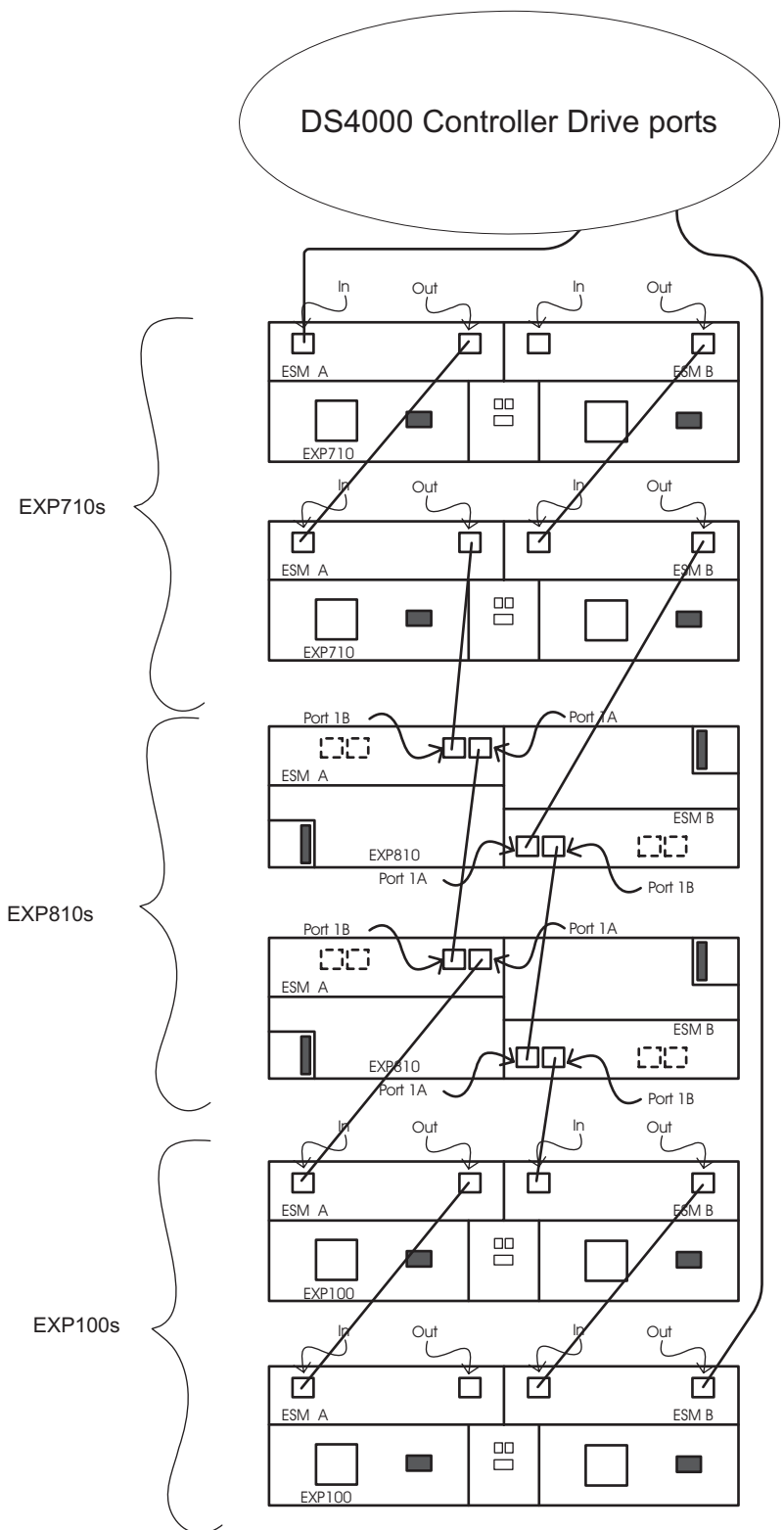


Figure 62. Second example of grouping EXP100s, EXP710s, and EXP810s behind a DS4000 controller drive port

Appendix B. Cabling storage expansion enclosures

General rules and recommendations for cabling storage expansion enclosures

Refer to these general rules and recommendations when you complete the steps described in “Activity 6: Cabling, powering on, and verifying storage expansion unit operation” on page 84.

Note: This section also refers to the cabling diagrams in “Storage expansion enclosure cabling diagrams” on page 163.

The following are general rules or limitations to follow as a guideline when you connect storage expansion enclosures to the storage subsystem:

- The DS4000 Storage Subsystem supports the connection of a maximum of two redundant drive loop pairs. The maximum number of drive enclosures per drive loop depends on the type of storage expansion enclosure and whether intermixing storage expansion enclosures of different drive slots.
- The DS4000 currently supports a maximum of 110 drives in 11 10-drive storage expansion enclosures or 112 drives in either eight 14-drive or seven 16-drive expansion enclosures per drive loop in each controller. Two drive loops from the DS4000 drive mini hubs must be connected to the same set of expansion enclosures to provide drive loop redundancy.
- When connecting the storage expansion enclosures to drive mini hubs, do not use all ports in each of the drive mini hubs. Connect the FC cable to only one port of the drive mini hub and leave the other port unoccupied.
- When cabling different types of storage expansion enclosures, if possible, do not mix different types of storage expansion enclosures in the same redundant drive loop pair. Also, when mixing different types of storage expansion enclosures in the same drive channel pair, the Link Rate Setting must be the same for each storage expansion enclosure. IBM does not support different enclosure speed settings in the same drive loop.

In addition to the previously outlined general rules, it is *strongly* recommended that you observe the following rules when connecting storage expansion enclosures to the storage subsystem:

- Ensure that the enclosure ID of all enclosures in a DS4000 storage subsystem configuration (including the DS4000 storage subsystem with internal drive slots) is unique. Enclosure IDs (sometimes known as tray IDs) consist of two digits (x10 and x1). The tens digit (x10) portion of the enclosure ID should be used to differentiate enclosures from different redundant drive loop/channel pairs, and the singles digit (x1) portion should be used to differentiate enclosures in the same redundant drive loop/channel pair. In 14-drive expansion enclosures, the enclosure ID must be set manually. In 16-drive expansion enclosures, the enclosure ID is set automatically. Refer to the Installation, User's, and Maintenance Guide for your appropriate enclosure for information on how to manually set the switches. If the enclosure IDs are not unique, an error will be posted in the DS4300 storage subsystem Major Event Log (MEL), and the ID conflict LED on the enclosure with same enclosure ID will be lit.

In addition, ensure that the single digit (x1) of the enclosure ID for every enclosure in a redundant drive loop pair is unique (including the DS4000 storage subsystem with internal drive slots). If you do not set the single digit of the enclosure IDs to be unique among enclosures in a redundant drive loop pair,

then drive loop errors might be randomly posted in the DS4000 storage subsystem Major Event Log (MEL), especially in the cases where different storage expansion enclosure types are intermixed in the same drive loop/channel behind a DS4000 subsystem configuration. For example, with four enclosures attached to the DS4000 storage subsystem drive loop, the correct enclosure ID settings should be x1, x2, x3, and x4 (where x can be any digit that can be set). Examples of incorrect settings would be 11, 21, 31, and 41 or 12, 22, 32, and 62; these examples are incorrect because the x1 digits are the same in all enclosure IDs (either 1 or 2).

Important:

Changing enclosure IDs on 14-drive enclosures—and in storage subsystems with the mechanical enclosure ID switches—requires the power cycle of the DS4000 storage subsystem, and all enclosures in the configuration, to activate the new settings. Changing the enclosure IDs on 16-drive enclosures and storage subsystems (EXP420s, EXP810s, DS4700s, or DS4200s) does not require the power cycle of all enclosures and the DS4000 subsystem, if there are no 14-drive enclosures being intermixed in the configuration or if the 16-drive enclosures are only connected to a DS4000 controller with 16 internal drive slots (DS4200 or DS4700). If the enclosure IDs of the enclosures or storage subsystems with the mechanical enclosure ID switches in your DS4000 subsystem configuration are not currently set to have unique single digit values for the enclosures in the same redundant drive loop pair, make the changes to the enclosure IDs in the next maintenance schedule. This will prevent unnecessary downtime when you add enclosures of different types (especially EXP810s) to the existing enclosures in the redundant drive loop pair.

- If it is not possible to avoid mixing different enclosure types in the same redundant drive loop pair, this rule must be strictly observed. When mixing EXP810 and EXP710 enclosures in the same drive loop with EXP100 enclosures, all of the EXP810s and EXP710s must be grouped together with the EXP100 connected to either end of the EXP810/EXP710 drive expansion enclosure group. The primary reason for this grouping is because the controller firmware considers the EXP810s and EXP710s to be the same enclosure type (switched disk expansion unit type, which have an ESM-embedded Fibre Channel loop switch) despite being different models. These two enclosure models must be grouped together if they are contained within a drive loop.

Note: You must cable all of the EXP810s together, followed by all of the EXP710s. Figure 63 on page 164 and Figure 64 on page 165 are examples of correctly cabling the intermix of EXP100 with EXP810 and EXP710 enclosures. Figure 65 on page 166 and Figure 66 on page 167 are examples of incorrectly cabling the intermix of these enclosures. One shows the EXP100s cabled between the EXP810s and EXP710s, while the other shows the EXP810s and EXP710s intermingled, not with the EXP810s grouped separately from the EXP710s, as recommended.

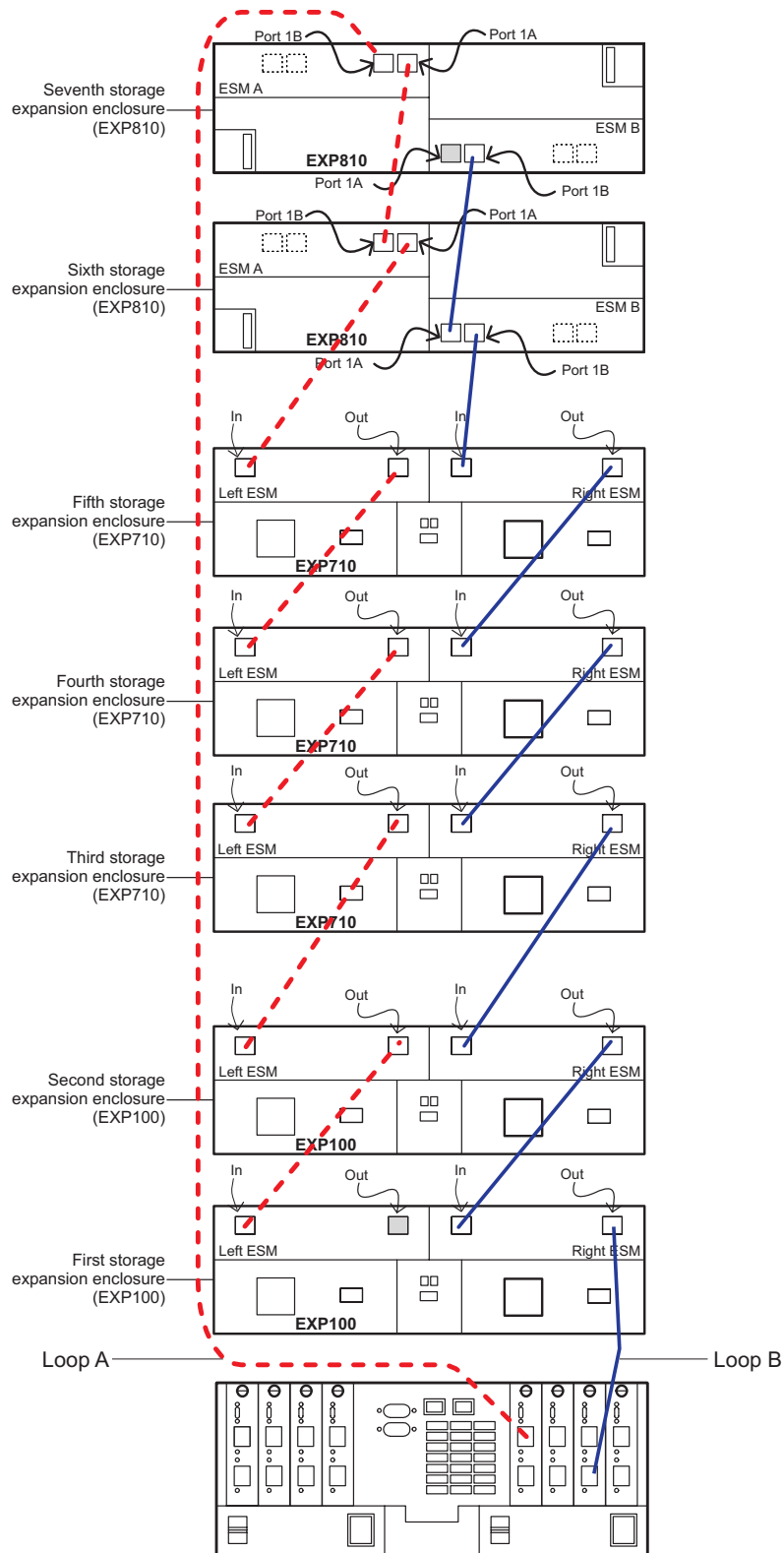
- The drive mini hub port must always be connected to the EXP810 port 1B, regardless of whether the port is on the EXP810 ESM A or ESM B. Figure 67 on page 168 is an example of correctly cabling the EXP810 1B ports to the drive mini hub port. Figure 68 on page 169 is an example of incorrect cabling showing the connection from the drive mini hub port to the incorrect EXP810 port, labeled 1A.
- The drive mini hub port must always be connected to the 10- or 14-drive storage expansion enclosure left ESM In port of the last enclosure in the group of enclosures that are cabled in a redundant drive loop pair. In addition, the drive mini hub port must always be connected to the 10- or 14-drive storage expansion enclosure right ESM Out port of the first enclosure in the group of enclosures

that are cabled in a redundant drive loop pair. Figure 69 on page 170 shows this correct cabling to the 10- or 14-drive storage expansion enclosure ESM ports.

Storage expansion enclosure cabling diagrams

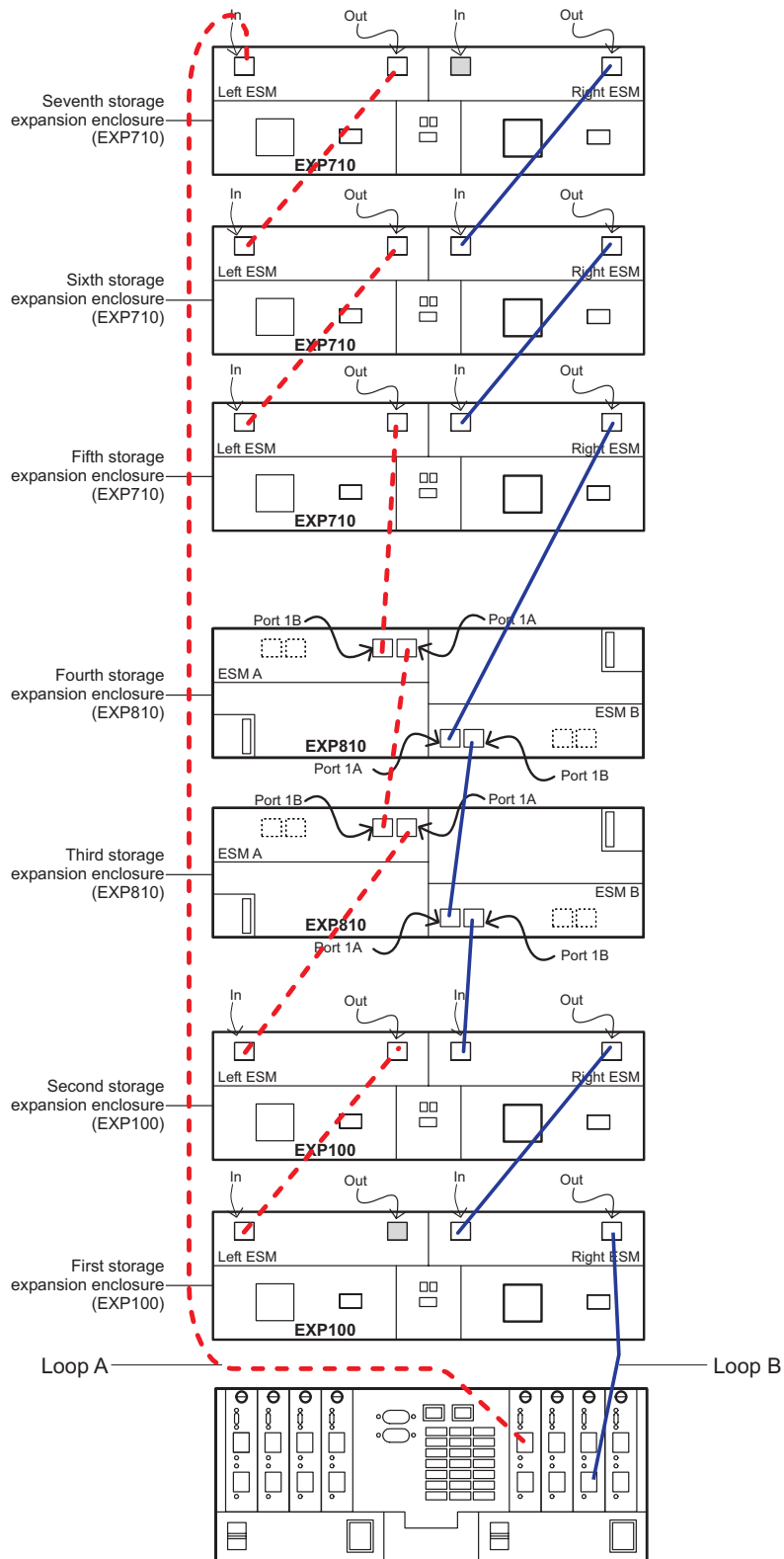
These diagrams help describe the information provided in “General rules and recommendations for cabling storage expansion enclosures” on page 161.

Note: The controllers depicted in these cabling diagrams are intended to be generic and do not correlate to any specific DS4000 Storage Subsystem.



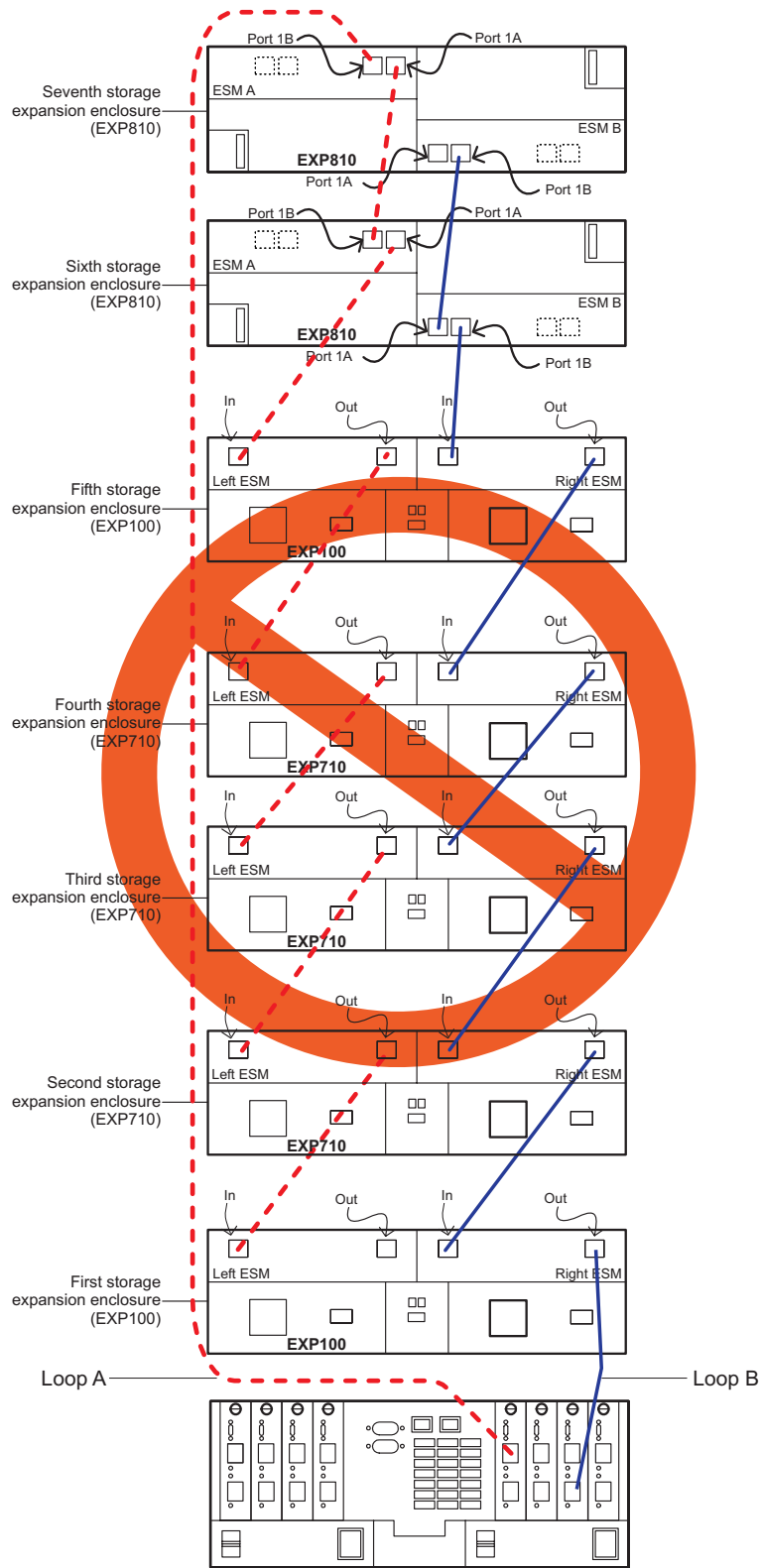
ds4500_mix3

Figure 63. Correct cabling for an intermix of EXP100, EXP710, and EXP810 expansion enclosures (example 1)



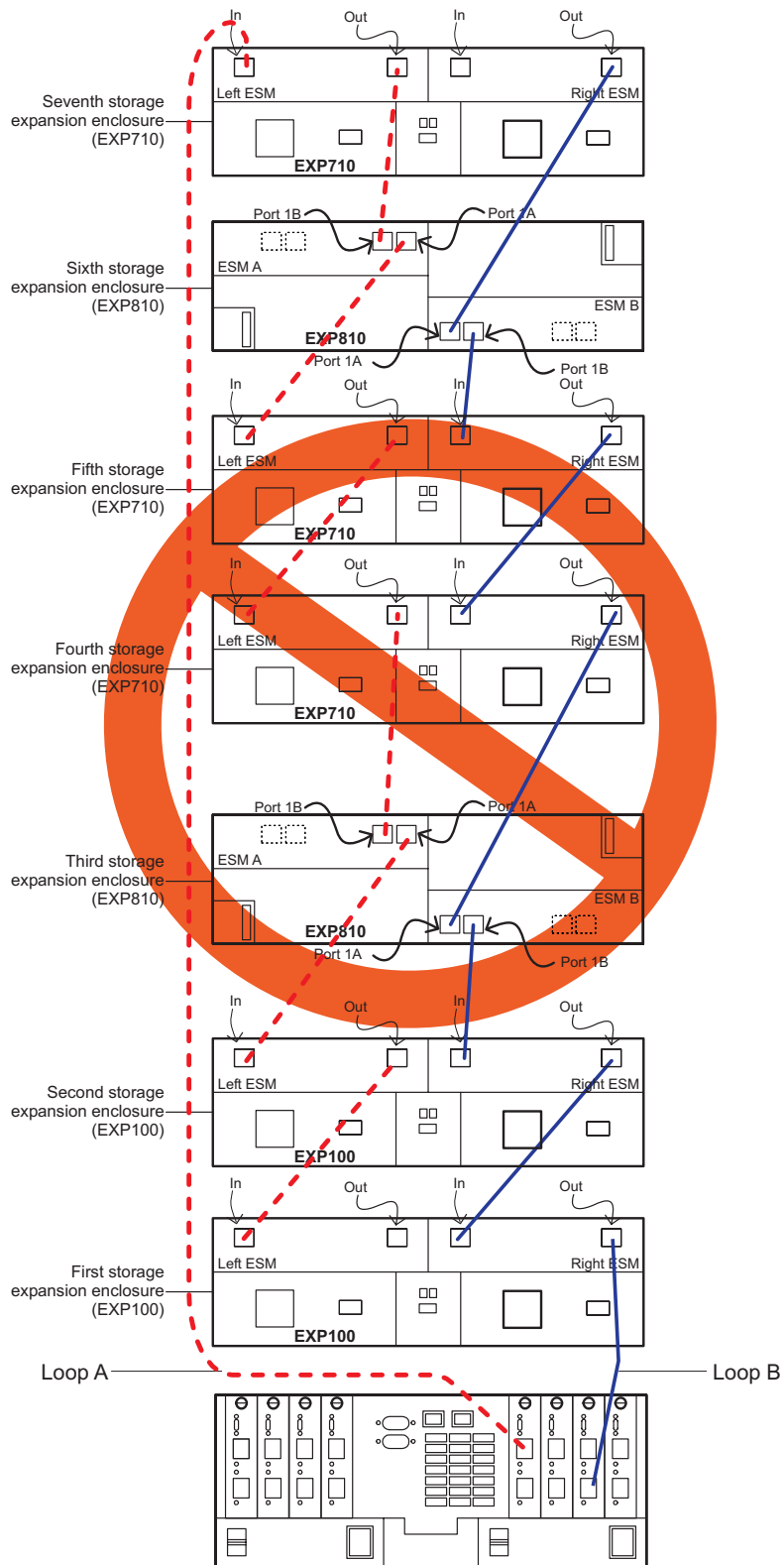
ds4500_mix4

Figure 64. Correct cabling for an intermix of EXP100, EXP710, and EXP810 expansion enclosures (example 2)



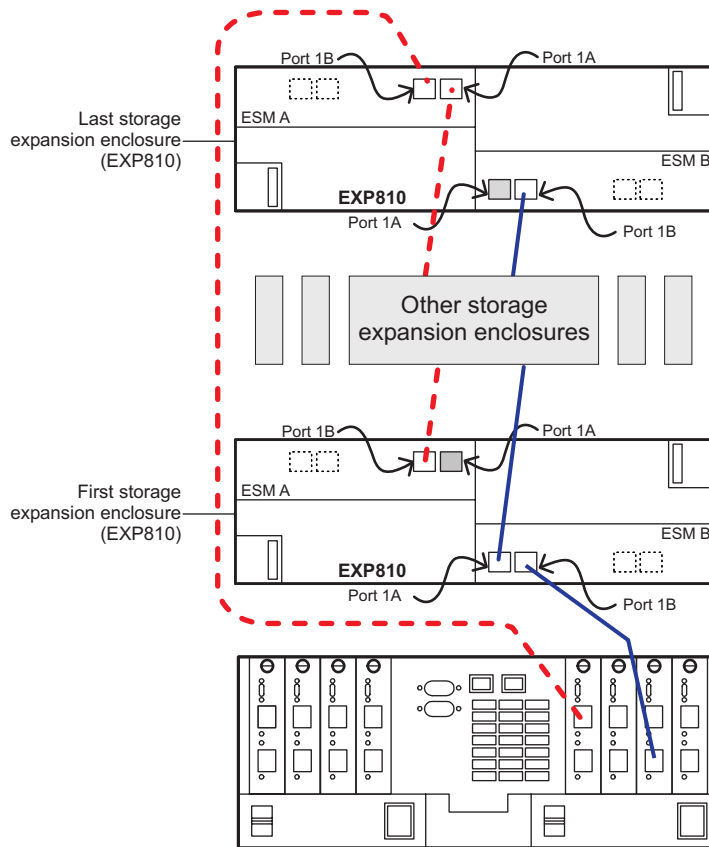
ds4500_mix5

Figure 65. Incorrect cabling for an intermix of EXP100, EXP710, and EXP810 expansion enclosures (example 1)



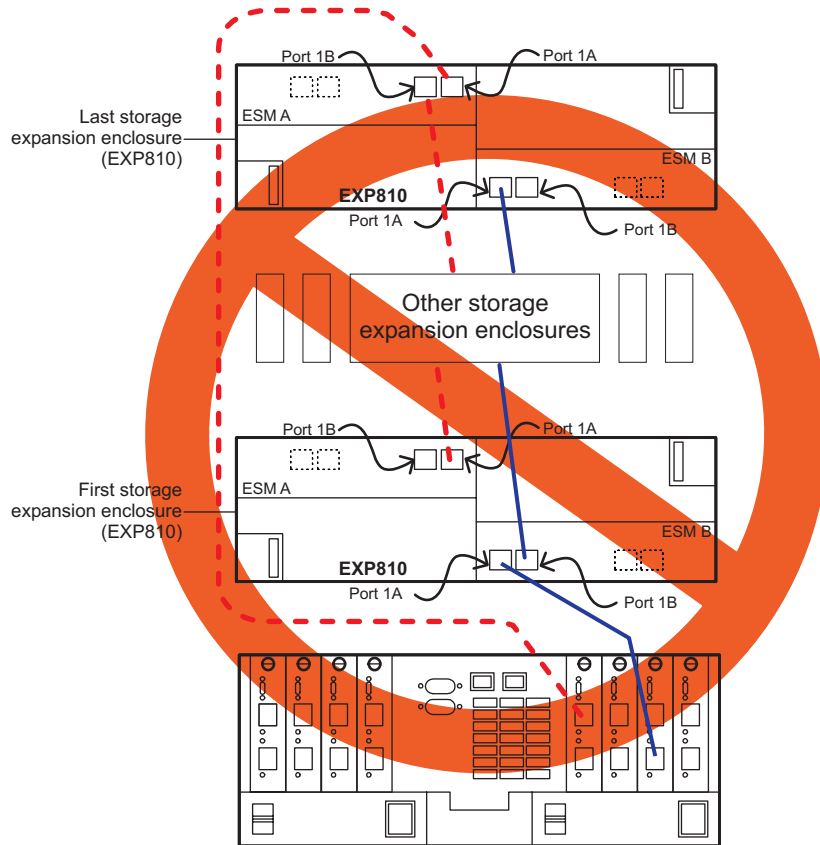
ds4500_mix6

Figure 66. Incorrect cabling for an intermix of EXP100, EXP710, and EXP810 expansion enclosures (example 2)



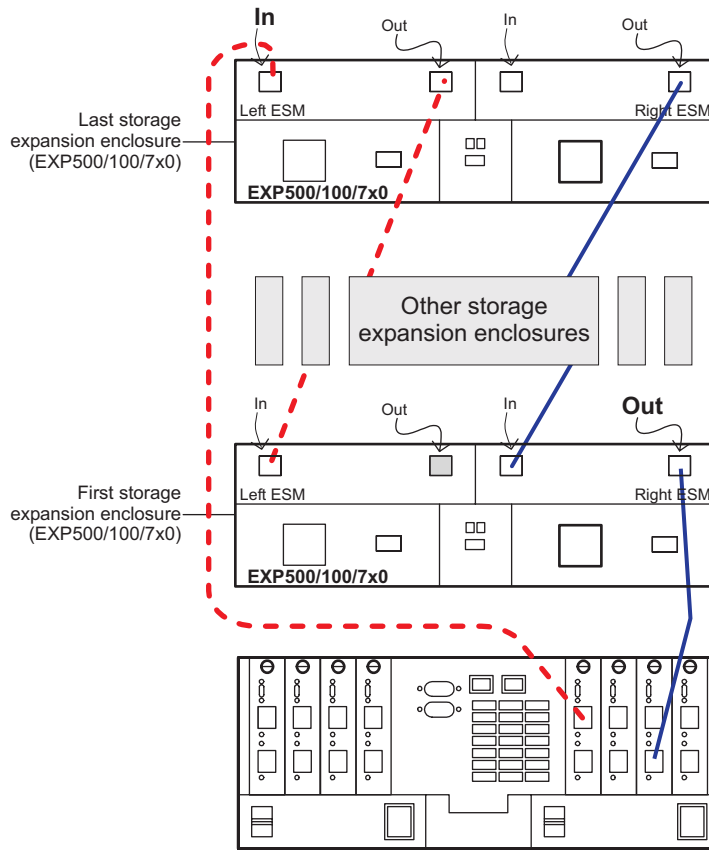
ds4500_8109

Figure 67. Correct cabling to EXP810 port 1B



ds4500_8110

Figure 68. Incorrect cabling to the EXP810 port



ds4500_8111

Figure 69. Incorrect cabling to the EXP500/EXP100/EXP700/EXP710 ports

Appendix C. Additional DS4000 documentation

The following tables present an overview of the IBM System Storage DS4000 Storage Manager, Storage Subsystem, and Storage Expansion Enclosure product libraries, as well as other related documents. Each table lists documents that are included in the libraries and what common tasks they address.

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

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

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

DS4000 Storage Manager Version 9 library

Table 33 associates each document in the DS4000 Storage Manager Version 9 library with its related common user tasks.

Table 33. DS4000 Storage Manager Version 9 titles by user tasks

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

Table 33. DS4000 Storage Manager Version 9 titles by user tasks (continued)

Title	User tasks					
	Planning	Hardware installation	Software installation	Configuration	Operation and administration	Diagnosis and maintenance
<i>IBM System Storage DS4000 Fibre Channel and Serial ATA Intermix Premium Feature Installation Overview</i>	✓	✓	✓	✓		

DS4800 Storage Subsystem library

Table 34 associates each document in the DS4800 Storage Subsystem library with its related common user tasks.

Table 34. DS4800 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM System Storage DS4800 Storage Subsystem Installation, User's and Maintenance Guide</i>	✓	✓		✓	✓	✓
<i>IBM System Storage DS4800 Storage Subsystem Installation and Cabling Overview</i>		✓				
<i>IBM TotalStorage DS4800 Controller Cache Upgrade Kit Instructions</i>	✓	✓		✓		

DS4700 Storage Subsystem library

Table 35 associates each document in the DS4700 Storage Subsystem library with its related common user tasks.

Table 35. DS4700 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM System Storage DS4700 Storage Subsystem Installation, User's and Maintenance Guide</i>	✓	✓		✓	✓	✓
<i>IBM System Storage DS4700 Storage Subsystem Fibre Channel Cabling Guide</i>		✓				

DS4500 Storage Subsystem library

Table 36 associates each document in the DS4500 (previously FASiT900) Storage Subsystem library with its related common user tasks.

Table 36. DS4500 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM TotalStorage DS4500 Storage Subsystem Installation, User's, and Maintenance Guide</i>	✓	✓		✓	✓	✓
<i>IBM TotalStorage DS4500 Storage Subsystem Cabling Instructions</i>	✓	✓				
<i>IBM TotalStorage DS4500 Rack Mounting Instructions</i>	✓	✓				

DS4400 Storage Subsystem library

Table 37 associates each document in the DS4400 (previously FAStT700) Storage Subsystem library with its related common user tasks.

Table 37. DS4400 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM TotalStorage DS4400 Fibre Channel Storage Server User's Guide</i>	✓	✓		✓	✓	✓
<i>IBM TotalStorage DS4400 Fibre Channel Storage Server Installation and Support Guide</i>	✓	✓		✓	✓	
<i>IBM TotalStorage DS4400 Fibre Channel Cabling Instructions</i>	✓	✓				

DS4300 Storage Subsystem library

Table 38 associates each document in the DS4300 (previously FAStT600) Storage Subsystem library with its related common user tasks.

Table 38. DS4300 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM TotalStorage DS4300 Storage Subsystem Installation, User's, and Maintenance Guide</i>	✓	✓		✓	✓	✓
<i>IBM TotalStorage DS4300 Rack Mounting Instructions</i>	✓	✓				
<i>IBM TotalStorage DS4300 Storage Subsystem Cabling Instructions</i>	✓	✓				
<i>IBM TotalStorage DS4300 SCU Base Upgrade Kit</i>		✓	✓			
<i>IBM TotalStorage DS4300 SCU Turbo Upgrade Kit</i>		✓	✓			
<i>IBM TotalStorage DS4300 Turbo Models 6LU/6LX Upgrade Kit</i>		✓	✓			

DS4200 Express Storage Subsystem library

Table 39 associates each document in the DS4200 Express Storage Subsystem library with its related common user tasks.

Table 39. DS4200 Express Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM System Storage DS4200 Express Storage Subsystem Installation, User's and Maintenance Guide</i>	✓	✓		✓	✓	✓
<i>IBM System Storage DS4200 Express Storage Subsystem Cabling Guide</i>		✓				

DS4100 Storage Subsystem library

Table 40 associates each document in the DS4100 (previously FAStT100) Storage Subsystem library with its related common user tasks.

Table 40. DS4100 Storage Subsystem document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM TotalStorage DS4100 Storage Server Installation, User's and Maintenance Guide</i>	✓	✓		✓	✓	✓
<i>IBM TotalStorage DS4100 Storage Server Cabling Guide</i>		✓				

DS4000 Storage Expansion Enclosure documents

Table 41 associates each of the following documents with its related common user tasks.

Table 41. DS4000 Storage Expansion Enclosure document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM System Storage DS4000 EXP810 Storage Expansion Enclosure Installation, User's, and Maintenance Guide</i>	✓	✓		✓	✓	✓
<i>IBM TotalStorage DS4000 EXP700 and EXP710 Storage Expansion Enclosures Installation, User's, and Maintenance Guide</i>	✓	✓		✓	✓	✓
<i>IBM DS4000 EXP500 Installation and User's Guide</i>	✓	✓		✓	✓	✓
<i>IBM System Storage DS4000 EXP420 Storage Expansion Enclosure Installation, User's, and Maintenance Guide</i>	✓	✓		✓	✓	✓
<i>IBM System Storage DS4000 Hard Drive and Storage Expansion Enclosures Installation and Migration Guide</i>	✓	✓				

Other DS4000 and DS4000-related documents

Table 42 associates each of the following documents with its related common user tasks.

Table 42. DS4000 and DS4000-related document titles by user tasks

Title	User Tasks					
	Planning	Hardware Installation	Software Installation	Configuration	Operation and Administration	Diagnosis and Maintenance
<i>IBM Safety Information</i>					✓	
<i>IBM TotalStorage DS4000 Hardware Maintenance Manual</i> ¹						✓
<i>IBM System Storage DS4000 Problem Determination Guide</i>						✓
<i>IBM Fibre Channel Planning and Integration: User's Guide and Service Information</i>	✓	✓			✓	✓
<i>IBM TotalStorage DS4000 FC2-133 Host Bus Adapter Installation and User's Guide</i>		✓			✓	
<i>IBM TotalStorage DS4000 FC2-133 Dual Port Host Bus Adapter Installation and User's Guide</i>		✓			✓	
<i>IBM Netfinity Fibre Channel Cabling Instructions</i>		✓				
<i>IBM Fibre Channel SAN Configuration Setup Guide</i>	✓		✓	✓	✓	

Notes:

1. The *IBM TotalStorage DS4000 Hardware Maintenance Manual* does not contain maintenance information for the IBM System Storage DS4100, DS4200, DS4300, DS4500, DS4700, or DS4800 storage subsystems. You can find maintenance information for these products in the *IBM System Storage DSx000 Storage Subsystem Installation, User's, and Maintenance Guide* for the particular subsystem.

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Glossary

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

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

www.ibm.com/ibm/terminology

This glossary also includes terms and definitions from:

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

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

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

See also

Refers you to a related term.

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

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

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

adapter. A printed circuit assembly that transmits user data input/output (I/O) between the internal bus of the

host system and the external fibre-channel (FC) link and vice versa. Also called an I/O adapter, host adapter, or FC adapter.

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

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

AGP. See *accelerated graphics port*.

AL_PA. See *arbitrated loop physical address*.

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

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

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

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

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

ATA. See *AT-attached*.

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

auto-volume transfer/auto-disk transfer (AVT/ADT).

A function that provides automatic failover in case of controller failure on a storage subsystem.

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

AWT. See *Abstract Windowing Toolkit*.

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

BIOS. See *basic input/output system*.

BOOTP. See *bootstrap protocol*.

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

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

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

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

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

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

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

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

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

CRC. See *cyclic redundancy check*.

CRT. See *cathode ray tube*.

CRU. See *customer replaceable unit*.

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

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

dac. See *disk array controller*.

dar. See *disk array router*.

DASD. See *direct access storage device*.

data striping. See *striping*.

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

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

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

DHCP. See *Dynamic Host Configuration Protocol*.

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

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

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

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

DMA. See *direct memory access*.

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

drive channels. The DS4200, DS4700, and DS4800 subsystems use dual-port drive channels that, from the physical point of view, are connected in the same way as two drive loops. However, from the point of view of the number of drives and enclosures, they are treated as a single drive loop instead of two different drive loops. A group of storage expansion enclosures are connected to the DS4000 storage subsystems using a drive channel from each controller. This pair of drive channels is referred to as a redundant drive channel pair.

drive loops. A drive loop consists of one channel from each controller combined to form one pair of redundant drive channels or a redundant drive loop. Each drive loop is associated with two ports. (There are two drive channels and four associated ports per controller.) For the DS4800, drive loops are more commonly referred to as drive channels. See *drive channels*.

DRAM. See *dynamic random access memory*.

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

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

ECC. See *error correction coding*.

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

EISA. See *Extended Industry Standard Architecture*.

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

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

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

E_port. See *expansion port*.

error correction coding (ECC). A method for encoding data so that transmission errors can be detected and corrected by examining the data on the

receiving end. Most ECCs are characterized by the maximum number of errors they can detect and correct.

ESD. See *electrostatic discharge*.

ESM canister. See *environmental service module canister*.

automatic ESM firmware synchronization. When you install a new ESM into an existing storage expansion enclosure in a DS4000 storage subsystem that supports automatic ESM firmware synchronization, the firmware in the new ESM is automatically synchronized with the firmware in the existing ESM.

EXP. See *storage expansion enclosure*.

expansion port (E_port). A port that connects the switches for two fabrics.

Extended Industry Standard Architecture (EISA). A bus standard for IBM compatibles that extends the Industry Standard Architecture (ISA) bus architecture to 32 bits and allows more than one central processing unit (CPU) to share the bus. See also *Industry Standard Architecture*.

fabric. A Fibre Channel entity which interconnects and facilitates logins of N_ports attached to it. The fabric is responsible for routing frames between source and destination N_ports using address information in the frame header. A fabric can be as simple as a point-to-point channel between two N_ports, or as complex as a frame-routing switch that provides multiple and redundant internal pathways within the fabric between F_ports.

fabric port (F_port). In a fabric, an access point for connecting a user's N_port. An F_port facilitates N_port logins to the fabric from nodes connected to the fabric. An F_port is addressable by the N_port connected to it. See also *fabric*.

FC. See *Fibre Channel*.

FC-AL. See *arbitrated loop*.

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

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

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

Fibre Channel Protocol (FCP) for small computer system interface (SCSI). A high-level fibre-channel mapping layer (FC-4) that uses lower-level fibre-channel

(FC-PH) services to transmit SCSI commands, data, and status information between a SCSI initiator and a SCSI target across the FC link by using FC frame and sequence formats.

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

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

F_port. See *fabric port*.

FRU. See *field replaceable unit*.

GBIC. See *gigabit interface converter*

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

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

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

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

GUI. See *graphical user interface*.

HBA. See *host bus adapter*.

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

heterogeneous host environment. A host system in which multiple host servers, which use different operating systems with their own unique disk storage subsystem settings, connect to the same DS4000 storage subsystem at the same time. See also *host*.

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

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

host computer. See *host*.

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

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

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

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

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

IC. See *integrated circuit*.

IDE. See *integrated drive electronics*.

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

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

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

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

integrated drive electronics (IDE). A disk drive interface based on the 16-bit IBM personal computer Industry Standard Architecture (ISA) in which the controller electronics reside on the drive itself, eliminating the need for a separate adapter card. Also known as an Advanced Technology Attachment Interface (ATA).

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

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

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

IP. See *Internet Protocol*.

IPL. See *initial program load*.

IRQ. See *interrupt request*.

ISA. See *Industry Standard Architecture*.

Java Runtime Environment (JRE). A subset of the Java Development Kit (JDK) for end users and developers who want to redistribute the Java Runtime Environment (JRE). The JRE consists of the Java virtual machine, the Java Core Classes, and supporting files.

JRE. See *Java Runtime Environment*.

label. A discovered or user entered property value that is displayed underneath each device in the Physical and Data Path maps.

LAN. See *local area network*.

LBA. See *logical block address*.

local area network (LAN). A computer network located on a user's premises within a limited geographic area.

logical block address (LBA). The address of a logical block. Logical block addresses are typically used in hosts' I/O commands. The SCSI disk command protocol, for example, uses logical block addresses.

logical partition (LPAR). (1) A subset of a single system that contains resources (processors, memory, and input/output devices). A logical partition operates as an independent system. If hardware requirements are met, multiple logical partitions can exist within a system. (2) A fixed-size portion of a logical volume. A logical partition is the same size as the physical partitions in its volume group. Unless the logical volume of which it is a part is mirrored, each logical partition corresponds to, and its contents are stored on, a single physical partition. (3) One to three physical partitions (copies). The number of logical partitions within a logical volume is variable.

logical unit number (LUN). An identifier used on a small computer system interface (SCSI) bus to distinguish among up to eight devices (logical units) with the same SCSI ID.

loop address. The unique ID of a node in fibre-channel loop topology sometimes referred to as a loop ID.

loop group. A collection of storage area network (SAN) devices that are interconnected serially in a single loop circuit.

loop port. A node port (N_port) or fabric port (F_port) that supports arbitrated loop functions associated with an arbitrated loop topology.

LPAR. See *logical partition*.

LUN. See *logical unit number*.

MAC. See *medium access control*.

management information base (MIB). The information that is on an agent. It is an abstraction of configuration and status information.

man pages. In UNIX-based operating systems, online documentation for operating system commands, subroutines, system calls, file formats, special files, stand-alone utilities, and miscellaneous facilities. Invoked by the **man** command.

MCA. See *micro channel architecture*.

media scan. A media scan is a background process that runs on all logical drives in the storage subsystem for which it has been enabled, providing error detection on the drive media. The media scan process scans all

logical drive data to verify that it can be accessed, and optionally scans the logical drive redundancy information.

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

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

MIB. See *management information base*.

micro channel architecture (MCA). Hardware that is used for PS/2 Model 50 computers and above to provide better growth potential and performance characteristics when compared with the original personal computer design.

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

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

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

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

MSCS. See *Microsoft Cluster Server*.

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

NMI. See *non-maskable interrupt*.

NMS. See *network management station*.

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

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

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

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

N_port. See *node port*.

NVS. See *nonvolatile storage*.

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

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

ODM. See *Object Data Manager*.

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

partitioning. See *storage partition*.

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

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

PDF. See *portable document format*.

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

peripheral component interconnect local bus (PCI local bus). A local bus for PCs, from Intel, that provides a high-speed data path between the CPU and up to 10 peripherals (video, disk, network, and so on). The PCI bus coexists in the PC with the Industry Standard Architecture (ISA) or Extended Industry

Standard Architecture (EISA) bus. ISA and EISA boards plug into an IA or EISA slot, while high-speed PCI controllers plug into a PCI slot. See also *Industry Standard Architecture, Extended Industry Standard Architecture*.

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

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

portable document format (PDF). A standard specified by Adobe Systems, Incorporated, for the electronic distribution of documents. PDF files are compact; can be distributed globally by e-mail, the Web, intranets, or CD-ROM; and can be viewed with the Acrobat Reader, which is software from Adobe Systems that can be downloaded at no cost from the Adobe Systems home page.

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

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

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

PTF. See *program temporary fix*.

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

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

RAID set. See *array*.

RAM. See *random-access memory*.

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

RDAC. See *redundant disk array controller*.

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

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

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

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

remote mirroring. Online, real-time replication of data between storage subsystems that are maintained on separate media. The Enhanced Remote Mirror Option is a DS4000 premium feature that provides support for remote mirroring. See also *Global Mirroring, Metro Mirroring*.

ROM. See *read-only memory*.

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

RVSD. See *recoverable virtual shared disk*.

SAI. See *Storage Array Identifier*.

SA Identifier. See *Storage Array Identifier*.

SAN. See *storage area network*.

SATA. See *serial ATA*.

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

SCSI. See *small computer system interface*.

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

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

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

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

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

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

SFP. See *small form-factor pluggable*.

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

SL_port. See *segmented loop port*.

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

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

SMruntime. A Java compiler for the SMclient.

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

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

small form-factor pluggable (SFP). An optical transceiver that is used to convert signals between

optical fiber cables and switches. An SFP is smaller than a gigabit interface converter (GBIC). See also *gigabit interface converter*.

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

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

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

SRAM. See *static random access memory*.

SSA. See *serial storage architecture*.

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

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

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

storage expansion enclosure (EXP). A feature that can be connected to a system unit to provide additional storage and processing capacity.

storage management station. A system that is used to manage the storage subsystem. A storage management station does not need to be attached to the storage subsystem through the fibre-channel input/output (I/O) path.

storage partition. Storage subsystem logical drives that are visible to a host computer or are shared among host computers that are part of a host group.

storage partition topology. In the DS4000 Storage Manager client, the Topology view of the Mappings window displays the default host group, the defined host group, the host computer, and host-port nodes. The host port, host computer, and host group topological

elements must be defined to grant access to host computers and host groups using logical drive-to-LUN mappings.

striping. Splitting data to be written into equal blocks and writing blocks simultaneously to separate disk drives. Striping maximizes performance to the disks. Reading the data back is also scheduled in parallel, with a block being read concurrently from each disk then reassembled at the host.

subnet. An interconnected but independent segment of a network that is identified by its Internet Protocol (IP) address.

sweep method. A method of sending Simple Network Management Protocol (SNMP) requests for information to all the devices on a subnet by sending the request to every device in the network.

switch. A fibre-channel device that provides full bandwidth per port and high-speed routing of data by using link-level addressing.

switch group. A switch and the collection of devices connected to it that are not in other groups.

switch zoning. See *zoning*.

synchronous write mode. In remote mirroring, an option that requires the primary controller to wait for the acknowledgment of a write operation from the secondary controller before returning a write I/O request completion to the host. See also *asynchronous write mode*, *remote mirroring*, *Metro Mirroring*.

system name. Device name assigned by the vendor's third-party software.

TCP. See *Transmission Control Protocol*.

TCP/IP. See *Transmission Control Protocol/Internet Protocol*.

terminate and stay resident program (TSR program). A program that installs part of itself as an extension of DOS when it is executed.

topology. The physical or logical arrangement of devices on a network. The three fibre-channel topologies are fabric, arbitrated loop, and point-to-point. The default topology for the disk array is arbitrated loop.

TL_port. See *translated loop port*.

transceiver. A device that is used to transmit and receive data. Transceiver is an abbreviation of transmitter-receiver.

translated loop port (TL_port). A port that connects to a private loop and allows connectivity between the private loop devices and off loop devices (devices not connected to that particular TL_port).

Transmission Control Protocol (TCP). A communication protocol used in the Internet and in any network that follows the Internet Engineering Task Force (IETF) standards for internetwork protocol. TCP provides a reliable host-to-host protocol between hosts in 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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