

**Symmetrix
DMX1000,
DMX2000,
and DMX3000**

PRODUCT GUIDE

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Regulatory Agency Information

Symmetrix DMX1000, DMX2000, and DMX3000 systems have been extensively tested and certified to meet UL60950, CSA 22.2 No 60950, IEC 60950/EN60950; Safety of Information Technology Equipment including Electrical Business Equipment, FCC Rules Part 15 Subpart B; CISPR22 Class A; European EMC Directive 89/336/EEC on, electromagnetic compatibility.

The Symmetrix DMX1000, DMX2000 and DMX3000 systems are Stationary Pluggable Type B systems.

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

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

Warning!

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

Achtung!

Dieses ist ein Gerät der Funkstörgrenzwertklasse A. In Wohnbereichen können bei Betrieb dieses Gerätes Rundfunkstörungen auftreten, in welchen Fällen der Benutzer für entsprechende Gegenmaßnahmen verantwortlich ist.

Attention!

Ceci est un produit de Classe A. Dans un environnement domestique, ce produit risque de créer des interférences radioélectriques, il appartiendra alors à l'utilisateur de prendre les mesures spécifiques appropriées.

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This equipment generates, uses, and may emit radio frequency energy. The equipment has been type tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of FCC rules, which are designed to provide reasonable protection against such radio frequency interference.

Operation of this equipment in a residential area may cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

Any modifications to this device - unless expressly approved by the manufacturer - can void the user's authority to operate this equipment under part 15 of the FCC rules.

警告使用者:

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기기의 명칭(모델명): Symmetrix DMX1000, DMX2000, and DMX3000

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As part of its effort to continuously improve and enhance the performance and capabilities of the Symmetrix product line, EMC periodically releases new versions of the Symmetrix hardware and the Enginuity Operating Environment. Therefore, some functions described in this guide may not be supported by all versions of Symmetrix hardware or Enginuity currently in use.

If your Symmetrix unit does not offer a function described in this guide, please contact your EMC representative for a hardware, software, or Enginuity update.

Audience

This product guide is part of the documentation set for the Symmetrix DMX1000, DMX2000, and DMX3000 (referenced as DMX systems in this product guide).

This product guide describes the Symmetrix DMX features and operations. This product guide is intended for the storage administrator, system programmer, or operator who is involved in acquiring, managing, or operating the Symmetrix system.

Organization

Here is an overview of where information is located in this manual.

Chapter 1, *Introducing the Symmetrix DMX Systems*, provides an overview of the Symmetrix DMX systems highlighting the performance and reliability features, and describes hardware and software options for the systems.

Chapter 2, *Symmetrix DMX Hardware*, introduces the hardware components of the Symmetrix DMX systems. It describes the main components, and the function of the host channels and devices to which the Symmetrix system can attach.

Chapter 3, *Symmetrix DMX Input/Output Operations*, discusses disk subsystems, I/O operation, and global memory management.

Chapter 4, *Performance and Optimization*, describes the Symmetrix DMX system performance features, how they affect overall performance, and how to use these features to get the best performance from the Symmetrix system.

Chapter 5, *Data Integrity, Availability, and Protection*, discusses the Symmetrix DMX system features that affect data availability and reliability.

Chapter 6, *Mainframe Features and Support*, describes Symmetrix DMX supported features. Also described are the types of errors possible with Symmetrix DMX systems, error-handling techniques, and provides an error recovery summary.

Appendix A, *Symmetrix DMX Specifications*, lists the operating, physical, environmental, and electrical specifications for the Symmetrix DMX systems.

Appendix B, *Power Sequences*, provides step-by-step instructions for powering the Symmetrix DMX systems on and off.

Appendix C, *Planning and Installation*, contains several work sheets for product installation.

Glossary defines terms used in this manual.

Related Documentation

For additional information on all Symmetrix-related publications, contact your EMC Sales Representative or refer to the EMC Powerlink website at:

<http://powerlink.emc.com>

Conventions Used in This Manual

EMC uses the following conventions for notes, cautions, warnings, and danger notices.

A note presents information that is important, but not hazard-related.



CAUTION

A caution contains information essential to avoid damage to the system or equipment. The caution may apply to hardware or software.



WARNING

A warning contains information essential to avoid a hazard that can cause severe personal injury, death, or substantial property damage if you ignore the warning.



DANGER

A danger notice contains information essential to avoid a hazard that will cause severe personal injury, death, or substantial property damage if you ignore the message.

EMC uses the following type style conventions in this guide:

Palatino, bold	◆ Dialog box, button, icon, and menu items in text ◆ Selections you can make from the user interface, including buttons, icons, options, and field names
<i>Palatino, italic</i>	◆ New terms or unique word usage in text ◆ Command line arguments when used in text ◆ Book titles
<i>Courier, italic</i>	Arguments used in examples of command line syntax
Courier	System prompts and displays and specific filenames or complete paths. For example: working root directory [/user/EMC]: c:\Program Files\EMC\Symapi\db
Courier, bold	User entry. For example: sympoll -p

MVS Type Conventions

The syntax conventions used in this guide are:

- ◆ CAPITALIZATION = must be typed
- ◆ [] = optional entry
- ◆ | = alternative parameter value
- ◆ UNDERSCORED = default value or menu selection

Abbreviations for Units of Measure

Abbreviation	Definition
A	ampere
b	bit
B	byte
b/s	bits per second
B/s	bytes per second
Btu	British thermal units
cm	centimeters
ft	foot
Gb	gigabits
GB	gigabytes
GHz	gigahertz
Hz	hertz
hr	hours
in.	inches
Kb	kilobits
Kb/s	kilobits per second
KB	kilobytes
KB/s	kilobytes per second
kg	kilograms
KHz	kilohertz
km	kilometers
kV	kilovolt
kw	kilowatt
kWh	kilowatt-hour
Mb	megabits

Abbreviation	Definition
MB	megabyte
MB/s	megabytes per second
MHz	megahertz
m	meter
mm	millimeter
ms	millisecond
lbs	pounds
ns	nanosecond
s	second
sq.	square
in ²	square inch
ft ²	square foot
V	volt
vol	volume
W	watt

Where to Get Help
For Symmetrix Systems

Obtain technical support by calling your local sales office.

For service on your Symmetrix system, call:

United States: (800) 782-4362 (SVC-4EMC)

Canada: (800) 543-4782 (543-4SVC)

Worldwide: (508) 497-7901

and ask for Customer Service.

**Sales and Customer
Service Contacts**

For the list of EMC sales locations, please access the EMC home page at:

<http://www.emc.com/contact/>

For additional information on the EMC products and services available to customers and partners, refer to the EMC Powerlink website at:

<http://powerlink.emc.com>

Your Comments

Your suggestions will help us continue to improve the accuracy, organization, and overall quality of the user publications. Please send a message to **techpub_comments@emc.com** with your opinions of this guide.

Warnings and Cautions

The following warnings and cautions pertain throughout this guide:

WARNING

Trained service personnel only.

This EMC product has more than one power supply cord. To reduce the risk of electric shock, disconnect all power supply cords before servicing.

Ground circuit continuity is vital for safe operation of the machine. Never operate the machine with grounding conductors disconnected. Remember to reconnect any grounding conductors removed for or during any installation procedure.

ATTENTION

Reservé au personnel autorisé.

Cet appareil EMC comporte plus d'un cordon d'alimentation. Afin de prévenir les chocs électriques, débranchez tous les cordons d'alimentation avant de faire le dépannage.

Un circuit de terre continu est essentiel en vue du fonctionnement sécurisé de l'appareil. Ne mettez jamais l'appareil en marche lorsque le conducteur de mise à la terre est débranché.

WARNUNG

Nur für autorisiertes Fachpersonal.

Dieses EMC Produkt verfügt über mehrere elektrische Netzanschlüsse. Zur Vermeidung eines elektrischen Schlages sind vor Servicearbeiten an der Stromversorgung alle Netzanschlüsse zu trennen.

Kontinuierliche Erdung ist notwendig während der gesamten Betriebsdauer des Gerätes. Es ist unzulässig das Gerät ohne Erdung zu betreiben. Gerät muss geerdet werden, bevor es am Stromnetz angeschlossen wird.

Additional Warnings and Cautions

Before attempting to service EMC hardware described in this document, observe the following additional Warnings and Cautions:



WARNING

The hardware enclosure contains no user-serviceable parts, so it should not be moved or opened for any reason by untrained persons. If the hardware needs to be relocated or repaired, only qualified personnel familiar with safety procedures for electrical equipment and EMC hardware should access components inside the unit or move the unit.



WARNING

This product operates at high voltages. To protect against physical harm, power off the system whenever possible while servicing.



WARNING

In case of fire or other emergency involving the EMC product, isolate the product's power and alert appropriate personnel.



CAUTION

Trained personnel are advised to exercise great care at all times when working on the EMC hardware.

Remember to:

- ◆ Remove rings, watches, or other jewelry and neckties before you begin any procedures.
- ◆ Use caution near any moving part and any part that may start unexpectedly such as fans, motors, solenoids, etc.
- ◆ Always use the correct tools for the job.
- ◆ Always use the correct replacement parts.
- ◆ Keep all paperwork, including incident reports, up-to-date, complete, and accurate.

Static Precautions

EMC incorporates state-of-the-art technology in its designs, including the use of LSI and VLSI components. These chips are very susceptible to damage caused by static discharge and need to be handled accordingly.

**CAUTION**

Before handling printed circuit boards or other parts containing LSI and/or VLSI components, observe the following precautions:

- ◆ Store all printed circuit boards in antistatic bags.
- ◆ Use a ground strap whenever you handle a printed circuit board.
- ◆ Unless specifically designed for non-disruptive replacement, never plug or unplug printed circuit boards with the power on. Severe component damage may result.

Introducing the Symmetrix DMX Systems

This chapter provides an overview of the Symmetrix DMX1000, DMX2000, and DMX3000 systems and highlights their performance, availability and serviceability features, and hardware and software options.

- ◆ Symmetrix DMX1000/2000/3000 Systems 1-2
- ◆ Symmetrix Platform and Enginuity Operating Environment 1-8
- ◆ Storage Capacities and Global Memory Requirements 1-10
- ◆ Performance Features 1-15
- ◆ Availability and Integrity Features 1-16
- ◆ Serviceability Features 1-17
- ◆ Hardware Options 1-18
- ◆ Supported Software Applications 1-20

Symmetrix DMX1000/2000/3000 Systems

Symmetrix DMX™ is EMC's next-generation family of high-end storage solutions targeted to meet uncompromising requirements of mission-critical applications, and your specific environments. Incorporating a revolutionary Direct Matrix Architecture™, the Symmetrix® DMX series establishes a new performance trajectory for the high-end, fully leverages EMC's industry-leading storage management functionality, and introduces the economic benefits of modular packaging to the high-end storage marketplace for the first time.

The patented Symmetrix Direct Matrix Architecture (refer to *Symmetrix DMX Architecture* on page 2-12) is a fundamentally new storage array technology that employs a matrix of dedicated, serial point-to-point connections instead of traditional buses or switches. Symmetrix DMX delivers direct access, from the front of the storage array to the back, guaranteeing the highest possible I/O throughput, up to 70.4 GB/s aggregate internal bandwidth. It's faster, less costly, and more reliable, and it avoids contention, latency, and bandwidth issues—and potential points of failure associated with bus and switch architectures. Combined with expanded global memory director technology and the dynamically optimized caching algorithms of the Enginuity™ storage operating environment, systems based on the Symmetrix DMX architecture deliver scalable performance to meet the most demanding information access, protection and distribution requirements.

Symmetrix DMX Performance and Functionality

With full compatibility and integration with EMC's comprehensive Automated Networked Storage™ management suite, the Symmetrix DMX series delivers the ultimate in operational efficiency for both large-scale consolidations and for remote or distributed deployment. Interoperability with existing Symmetrix 8000 series enables the cascading of your current Symmetrix install-base storage that protects your investment even as your storage demands expand.

The performance, functionality, and economic characteristics of the Symmetrix DMX series establishes a new standard for high-end storage. Combined with EMC's Automated Network Storage solutions, the Symmetrix DMX series allows you to optimize your storage investment to consolidate, protect, and manage ever-growing information assets.

Symmetrix DMX Model Offerings

EMC offers the Symmetrix DMX High Performance models and Ultra Performance models, the Symmetrix DMX-2 enhanced option. The next sections provide an overview of the Symmetrix DMX model offerings.

Figure 1-1 on page 1-5 provides a front view of the exterior of the Symmetrix DMX1000 single-bay systems. Figure 1-2 on page 1-6 provides a front view of the exterior of the Symmetrix DMX2000 dual-bay systems. Figure 1-3 on page 1-7 provides a front view of the exterior of the Symmetrix DMX3000 triple-bay systems.

Refer to For more complete descriptions of the Symmetrix DMX models, refer to Chapter 2, *Symmetrix DMX Hardware*.

Throughout this product guide, the term *Symmetrix DMX system(s)* is used to describe the common features and operations of the Symmetrix DMX1000, DMX2000, and DMX3000 models described in the following section. EMC also offers the Symmetrix DMX800 system, a rack-mounted solution, which is described in the *Symmetrix DMX800 System Product Guide*.

The features described in this user guide are supported by Enginuity Operating Environment version currently available at the time of printing.

Symmetrix DMX Models

Symmetrix DMX High Performance systems are offered in several packaging options as described in Table 1-1.

Table 1-1 Symmetrix DMX High Performance Model Descriptions

Symmetrix DMX Model	Symmetrix DMX Model Description
DMX1000	High-performance, single-bay system with single-phase power
DMX2000	High-performance, dual-bay system with single-phase power
DMX2000-3	High-performance, dual-bay system with three-phase power
DMX3000-3	High-performance, three-bay system with three-phase power

In a single-bay form factor, the DMX1000 systems have the capacity, connectivity, and throughput to handle most high-end storage applications. For higher capacity or connectivity requirements, the dual-bay DMX2000, DMX2000-3, systems are available. For highest capacity requirements, the three-bay DMX3000-3 system is available.

Symmetrix DMX-2 Options

Symmetrix DMX, with the enhanced DMX-2 features, extends a proven storage array architecture to deliver even higher levels of performance, availability, functionality, and economics.

Symmetrix DMX-2 is a new configuration option for the Symmetrix DMX series. The DMX-2 systems include high-performance directors for:

- ◆ Fibre Channel host attachments
- ◆ Fibre Channel back-end disk directors
- ◆ FICON Channel host attachments
- ◆ iSCSI channel host attachments
- ◆ GigE for SRDF Symmetrix-to-Symmetrix connections

The DMX-2 models are described in Table 1-2.

Table 1-2 Symmetrix DMX-2 Option Descriptions

Symmetrix DMX-2 Model	Symmetrix DMX-2 Description
DMX1000-M2	High-performance, single-bay system with single-phase power
DMX1000-P2	Ultra-performance, single-bay system with single-phase power
DMX2000-M2	High performance, dual-bay system with single-phase power
DMX2000-M2-3	High-performance, dual-bay system with three-phase power
DMX2000-P2	Ultra-performance, dual-bay system with single-phase power
DMX2000-P2-3	Ultra-performance, dual-bay system with three-phase power
DMX3000-M2-3	High-performance, three-bay system with three-phase power

For more information on the DMX-2 premium performance configuration option, refer to *DMX-2 Channel Directors and Disk Directors* on page 2-39.



SYM-000295

Figure 1-1 Symmetrix DMX1000 System



SYM-000296

Figure 1-2 Symmetrix DMX2000 System



Figure 1-3 Symmetrix DMX3000 System

Symmetrix Platform and Enginuity Operating Environment

The Symmetrix DMX hardware architecture (refer to *Symmetrix DMX Architecture* on page 2-12) and the Enginuity™ operating environment are the foundation for the Symmetrix DMX1000, DMX2000, and DMX3000 (DMX systems) storage platform, which consists of the following:

- ◆ Symmetrix DMX hardware
- ◆ Enginuity-based operating functions
- ◆ EMC Solutions Enabler Applications Program Interfaces (APIs)
- ◆ Symmetrix-based applications
- ◆ Host-based Symmetrix applications
- ◆ Independent Software Vendor (ISV) applications

The relationships among these software layers (and Symmetrix hardware) are illustrated in Figure 1-4.

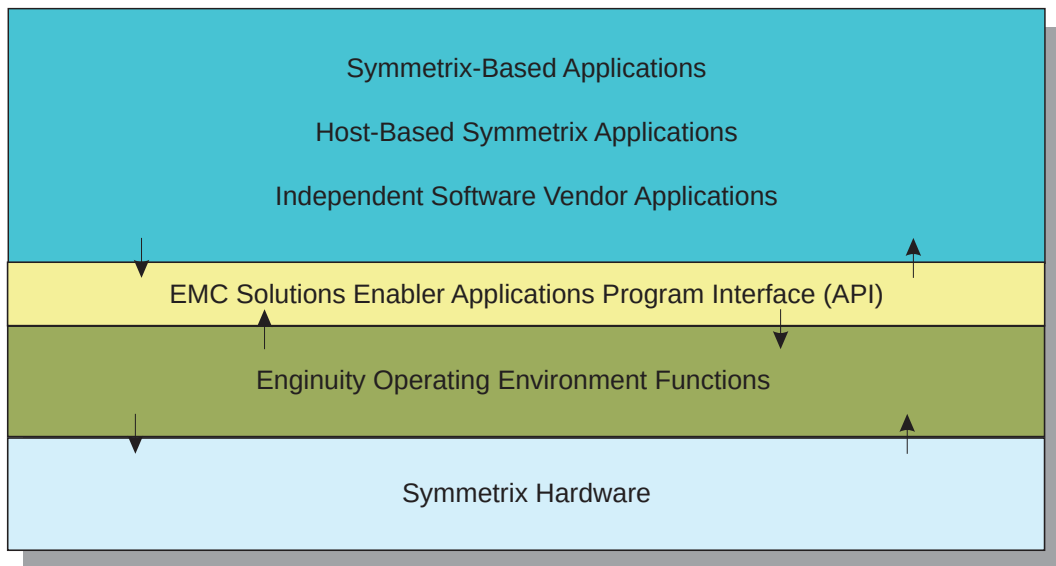


Figure 1-4 Enginuity and the Storage Platform Relationships

Enginuity Operating Environment

Symmetrix Enginuity is the operating environment for the Symmetrix DMX systems. Enginuity manages and ensures the optimal flow and integrity of information through the different hardware components of the Symmetrix system. Enginuity manages

all Symmetrix operations from monitoring and optimizing internal data flow, to ensuring the fastest response to the user's requests for information, to protecting and replicating data.

Enginuity Services

Enginuity provides the following services for the Symmetrix DMX systems:

- ◆ Manages system resources to intelligently optimize performance across a wide range of I/O requirements.
- ◆ Ensures system availability through advanced fault monitoring, detection, and correction capabilities and provides concurrent maintenance and serviceability features.
- ◆ Interrupts and prioritizes tasks from microprocessors and, for example, ensures that fencing off failed areas takes precedence over other operations.
- ◆ Offers the foundation for specific software features available through EMC's disaster recovery, business continuance, and storage management software.
- ◆ Provides functional services for both Symmetrix-based functionality and for a large suite of EMC storage application software.
- ◆ Defines priority of each task including basic system maintenance, I/O processing, application processing (for example, EMC ControlCenter™, SRDF®, TimeFinder™, and EMC ControlCenter Symmetrix Optimizer).
- ◆ Provides uniform access through APIs for internal calls and provides an external interface to allow integration with other software providers and ISVs.

EMC's Solutions Enabler APIs

EMC's Solutions Enabler APIs, are the storage management programming interfaces that provide an access mechanism for managing the Symmetrix third-party storage, switches, and host storage resources. They enable the creation of storage management applications that don't have to understand the management details of each piece within the total storage environment.

For more information on EMC's storage management APIs, contact your EMC Sales Representative or refer to the EMC Powerlink™ website at: <http://powerlink.emc.com>.

Storage Capacities and Global Memory Requirements

Storage Capacities

The Symmetrix DMX systems are available with 73 GB, 10K and 146 GB, 10K disk devices.

Table 1-3 shows the storage capacities for the Symmetrix DMX1000 system. Table 1-4 on page 1-12 shows the storage capacities for the Symmetrix DMX2000 system. Table 1-5 on page 1-13 shows the storage capacities for the Symmetrix DMX3000 system. The capacities are based on storage capacity of each disk drive and the following storage protection options:

- ◆ Mirrored (RAID 1)
- ◆ SRDF
- ◆ Parity RAID (3+1) and Parity RAID (7+1)
- ◆ RAID 5 (3+1) and RAID 5 (7+1)

The GB values shown in Tables 1-3 are based on the following conventions:

The GB₂ value is based on 1 GB = 1024 * 1024 * 1024 bytes.

The GB₁₀ value is based on 1 GB = 1000 * 1000 * 1000 bytes.

Although these values are expressed differently, they are equivalent.

RAID 5 (3+1) capacities are equivalent to Parity RAID (3+1) capacities, as are RAID 5 (7+1) capacities are to Parity RAID (7+1) as shown in Tables 1-3 through 1-5.

For detailed storage capacities, refer to Appendix A. For disk drive capacities when the Symmetrix DMX system is attached to iSeries hosts, contact your EMC Sales Representative.

A Symmetrix system reserves four 3 GB (6,140 cylinders) logical volumes (12 GB total system requirement) of disk capacity used for internal Symmetrix file system purposes.

Table 1-3 Symmetrix DMX1000 Disk Storage Capacities ^a

Available Disk Devices	Physical Disk Devices	Usable Open Systems Storage Capacities (GB ₂)	Usable Open Systems Storage Capacities (GB ₁₀)	Usable Mainframe Storage Capacities (GB ₁₀)
73 GB Disk Devices RAID 1 (Mirrored) Capacities				
32 to 72	64 to 144	2,178 ₂ to 4,902 ₂	2,339 ₁₀ to 5,263 ₁₀	2,309 ₁₀ to 5,196 ₁₀
73 GB Disk Device SRDF Capacities				
64 to 144	64 to 144	4,357 ₂ to 9,803 ₂	4,678 ₁₀ to 10,526 ₁₀	4,618 ₁₀ to 10,392 ₁₀
73 GB Disk Devices Parity RAID (3+1) Capacities				
48 to 108	64 to 144	3,267 ₂ to 7,352 ₂	3,508 ₁₀ to 7,894 ₁₀	3,464 ₁₀ to 7,794 ₁₀
73 GB Disk Devices Parity RAID (7+1) Capacities				
56 to 126	48 to 144	3,812 ₂ to 8,578 ₂	4,093 ₁₀ to 9,210 ₁₀	4,041 ₁₀ to 9,093 ₁₀
146 GB Disk Devices RAID 1 (Mirrored) Capacities				
32 to 72	64 to 144	4,352 ₂ to 9,792 ₂	4,672 ₁₀ to 10,512 ₁₀	4,627 ₁₀ to 10,411 ₁₀
146 GB Disk Devices SRDF Capacities				
64 to 144	64 to 144	8,704 ₂ to 19,584 ₂	9,344 ₁₀ to 21,024 ₁₀	9,254 ₁₀ to 20,822 ₁₀
146 GB Disk Devices Parity RAID (3+1) Capacities				
48 to 108	64 to 144	6,528 ₂ to 14,688 ₂	7,008 ₁₀ to 15,768 ₁₀	6,940 ₁₀ to 15,616 ₁₀
146 GB Disk Devices Parity RAID (7+1) Capacities				
56 to 126	64 to 144	7,616 ₂ to 17,136 ₂	8,176 ₁₀ to 18,396 ₁₀	8,097 ₁₀ to 18,219 ₁₀

a. RAID 5 (3+1) capacities are equivalent to Parity RAID (3+1) capacities, as are RAID 5 (7+1) capacities are to Parity RAID (7+1).

Table 1-4 Symmetrix DMX2000 Disk Storage Capacities ^a

Usable Disk Devices	Total Disk Devices	Usable Open Systems Storage Capacities (GB ₂)	Usable Open Systems Storage Capacities (GB ₁₀)	Usable Mainframe Storage Capacities (GB ₁₀)
73 GB Disk Devices RAID 1 (Mirrored) Capacities				
64 to 144	128 to 288	4,357 ₂ to 9,803 ₂	4,678 ₁₀ to 10,526 ₁₀	4,618 ₁₀ to 10,392 ₁₀
73 GB Disk Devices SRDF Capacities				
128 to 288	128 to 288	8,714 ₂ to 19,607 ₂	9,356 ₁₀ to 21,052 ₁₀	9,237 ₁₀ to 20,784 ₁₀
73 GB Disk Devices Parity RAID (3+1) Capacities				
96 to 216	128 to 288	6,535 to 14,705 ₂	7,017 ₁₀ to 15,789 ₁₀	6,928 ₁₀ to 15,588 ₁₀
73 GB Disk Devices Parity RAID (7+1) Capacities				
112 to 126	128 to 288	7,624 ₂ to 17,156 ₂	8,187 ₁₀ to 18,421 ₁₀	8,083 ₁₀ to 18,188 ₁₀
146 GB Disk Device, RAID 1 (Mirrored) Capacities				
64 to 72	128 to 288	8,704 ₂ to 19,584 ₂	9,344 ₁₀ to 21,024 ₁₀	9,254 ₁₀ to 20,822 ₁₀
146 GB Disk Devices SRDF Capacities				
128 to 288	128 to 288	17,408 ₂ to 39,168 ₂	18,688 ₁₀ to 42,048 ₁₀	18,508 ₁₀ to 41,644 ₁₀
146 GB Disk Devices Parity RAID (3+1) Capacities				
96 to 216	128 to 288	13,056 ₂ to 29,376 ₂	14,016 ₁₀ to 31,536 ₁₀	13,881 ₁₀ to 31,233 ₁₀
146 GB Disk Devices Parity RAID (7+1) Capacities				
112 to 252	128 to 288	15,232 ₂ to 34,272 ₂	16,352 ₁₀ to 36,792 ₁₀	16,195 ₁₀ to 36,439 ₁₀

a. RAID 5 (3+1) capacities are equivalent to Parity RAID (3+1) capacities, as are RAID 5 (7+1) capacities are to Parity RAID (7+1).

Table 1-5 Symmetrix DMX3000 Disk Storage Capacities ^a

Usable Disk Devices	Total Disk Devices	Usable Open Systems Storage Capacities (GB ₂)	Usable Open Systems Storage Capacities (GB ₁₀)	Usable Mainframe Storage Capacities (GB ₁₀)
73 GB Disk Devices RAID 1 (Mirrored) Capacities				
145 to 288	290 to 576	9,871 ₂ to 39,168 ₂	10,465 ₁₀ to 21,052 ₁₀	10,599 ₁₀ to 20,784 ₁₀
73 GB Disk Devices SRDF Capacities				
289 to 576	289 to 576	19,675 ₂ to 39,214 ₂	21,125 ₁₀ to 42,105 ₁₀	20,857 ₁₀ to 41,569 ₁₀
73 GB Disk Devices Parity RAID (3+1) Capacities				
217 to 432	289 to 576	14,773 ₂ to 29,410 ₂	15,862 ₁₀ to 31,579 ₁₀	15,661 ₁₀ to 31,177 ₁₀
73 GB Disk Devices Parity RAID (7+1) Capacities				
253 to 504	289 to 576	17,224 to 34,312 ₂	18,494 ₁₀ to 36,842 ₁₀	18,259 ₁₀ to 36,373 ₁₀
146 GB Disk Device, RAID 1 (Mirrored) Capacities				
145 to 320	290 to 576	19,720 ₂ to 58,752 ₂	21,170 ₁₀ to 63,072 ₁₀	20,968 ₁₀ to 41,644 ₁₀
146 GB Disk Devices SRDF Capacities				
289 to 576	289 to 576	39,304 ₂ to 78,336 ₂	42,194 ₁₀ to 84,096 ₁₀	41,790 ₁₀ to 83,289 ₁₀
146 GB Disk Devices Parity RAID (3+1) Capacities				
217 to 432	289 to 576	29,512 ₂ to 58,752 ₂	31,682 ₁₀ to 63,072 ₁₀	31,379 ₁₀ to 62,467 ₁₀
146 GB Disk Devices Parity RAID (7+1) Capacities				
253 to 504	289 to 576	34,408 ₂ to 68,544 ₂	36,938 ₁₀ to 73,584 ₁₀	36,585 ₁₀ to 72,878 ₁₀

a. RAID 5 (3+1) capacities are equivalent to Parity RAID (3+1) capacities, as are RAID 5 (7+1) capacities are to Parity RAID (7+1).

Global Memory Requirements

The Symmetrix DMX systems are available with global memory sizes ranging from 4 GB to 256 GB. The total global memory requirement for Symmetrix DMX systems is based upon specific system configurations and customer requirements. Besides the customer's applications, other variables that affect the amount of global memory Symmetrix DMX systems require include the:

- ◆ Number of global memory director boards
- ◆ Variable back-end disk director and front-end channel director board configurations
- ◆ Various loop configurations for disk drives
- ◆ Number of disk drives
- ◆ Disk capacity (73 GB, 146 GB)
- ◆ Number of logical volumes

Your EMC Sales Representative will assist you in determining your global memory requirements.

Additional information on memory configurations can be found in *Global Memory Directors* on page 2-41.

Performance Features

Symmetrix DMX systems offer improved performance over conventional Storage Control Unit (SCU) and Direct Access Storage Device (DASD) designs. Table 1-6 identifies many of the Symmetrix DMX and Enginuity supported features that enhance performance and increase throughput.

Table 1-6 Performance Features Roadmap

Feature	Document Sources
Direct Matrix (DMX) Architecture with up to 128 direct nonblocking data paths and up to 70.4 GB/s aggregate internal bandwidth in the DMX2000/3000 Up to 64 direct nonblocking data paths in the DMX1000 and up to 35.2 GB/s aggregate internal bandwidth for the DMX1000	• <i>Symmetrix DMX1000/2000/3000 Systems</i> on page 1-2 and <i>Symmetrix DMX Architecture</i> on page 2-12 • <i>Symmetrix DMX Component Scaling Attributes</i> on page 2-15 • <i>Symmetrix DMX Point-to-Point Message Matrix</i> on page 2-15
Symmetrix DMX global memory directors for optimized performance	• <i>Global Memory Performance Features</i> on page 4-3 • <i>Memory Striping</i> on page 4-5 • <i>Global Memory Directors</i> on page 2-41 • <i>Global Memory Director Configuration</i> on page 2-42
One hundred percent global memory fast write capabilities	• <i>Write Operations</i> on page 3-10 • <i>Disk Mirroring Concepts</i> on page 5-25
PermaCache option	• <i>PermaCache Option</i> on page 4-6
2 Gb/s Fibre Channel Drive Infrastructure	• <i>Fibre Channel Disk Devices</i> on page 2-24
• Multiple scalable channel directors, disk directors, and global memory directors • ESCON channel speeds up to 17 MB/s • FICON channel speeds up to 2 Gb/s • Fibre Channel speeds up to 2 Gb/s • iSCSI Channel speeds up to 1 Gb/s • Gigabit Ethernet (GigE) Remote Director speeds up to 1 Gb/s • DMX-2 Channel Directors and Disk Directors • FICON Cascading and Open Systems Intermix Configurations	• <i>Channel, Disk, and Global Memory Directors</i> on page 2-33 • <i>ESCON Channel Directors</i> on page 2-36 • <i>FICON Channel Directors</i> on page 2-37 • <i>Fibre Channel Directors (Front-End)</i> on page 2-34 • <i>iSCSI Channel Directors</i> on page 2-39 • <i>Gigabit Ethernet (GigE) Remote Directors</i> on page 2-38 • <i>DMX-2 Channel Directors and Disk Directors</i> on page 2-39 • <i>Symmetrix FICON Configurations</i> on page 2-54
Hypervolume Extension option	• <i>Open Systems Hypervolumes</i> on page 4-14 • <i>Mainframe Systems Hypervolumes</i> on page 4-18
Rotational Position Sense (RPS) Miss elimination	• <i>RPS Miss Elimination</i> on page 4-13
3380 and 3390 mixed track geometry	• <i>IBM CKD DASD Disk Emulation</i> on page 2-30
Compatible Parallel Access Volumes (COM-PAV)	• <i>Compatible Parallel Access Volumes (COM-PAV)</i> on page 6-5
Dynamic Parallel Access Volumes	• <i>Dynamic Parallel Access Volumes</i> on page 6-6
PPRC Command Support	• <i>PPRC Command Support</i> on page 6-9
Quality of Service Control Performance Option	• <i>Quality of Service Control Performance Option</i> on page 4-7

Availability and Integrity Features

The Symmetrix DMX systems include key enhancements that improve the reliability, availability, and serviceability. Table 1-6 highlights many of the Symmetrix DMX availability and integrity features.

Table 1-7 Availability and Integrity Features Roadmap

Feature	Document Sources
Proactive Error Detection and Remote Support	• <i>Maintaining Data Integrity</i> on page 5-18 • <i>Error Checking and Correction, and Data Integrity Protection</i> on page 5-19 • <i>Disk Error Correction and Error Verification</i> on page 5-20 • <i>Global Memory Director Data Integrity Logic</i> on page 5-21
Support for online Enginuity upgrades and updates	• <i>Nondisruptive Enginuity Upgrades</i> on page 5-16
Fully fault-tolerant design with redundant critical components and concurrent maintenance support	• <i>Reliability and Availability Features</i> on page 5-7
Channel director redundancy with end-to-end automatic channel failover and load balancing	• <i>Channel Director Redundancy</i> on page 5-7
Internal Control Data Path redundancy	• <i>Internal Control Data Path Redundancy</i> on page 5-9
Fibre Channel back-end functionality featuring redundant disk directors, disk channels, disk ports, and port bypass cards	• <i>Fibre Channel Back-End Redundancy</i> on page 5-9 • <i>Fibre Channel Arbitrated Loop Design</i> on page 5-10
Dual-initiator disk directors	• <i>Dual-Initiator Feature</i> on page 5-12
(N+1) and 2(N+1) power supply redundancy	• <i>Redundant Power Subsystem</i> on page 5-13
Advanced Communication and Environmental Control Modules	• <i>Symmetrix DMX Control and Environmental Matrix</i> on page 2-49
Symmetrix Mirroring option	• <i>Disk Mirroring Concepts</i> on page 5-25
High Performance Parity RAID (3+1), Parity RAID (7+1), RAID 5 (3+1), RAID 5 (7+1) RAID 10 data protection options	• <i>Symmetrix DMX Parity RAID Options</i> on page 5-28 • <i>Symmetrix DMX RAID 5 Options</i> on page 5-41 • <i>Symmetrix RAID 10 (Mirrored Striped Mainframe Volumes with DMSP)</i> on page 5-43
Dynamic Sparing option	• <i>Dynamic Sparing</i> on page 5-44
Nondisruptive component replacement	• <i>Reliability and Availability Features</i> on page 5-7 • <i>Nondisruptive Component Replacement</i> on page 5-15
Nondisruptive Enginuity code upgrades	• <i>Nondisruptive Enginuity Upgrades</i> on page 5-16
Nondisruptive change or remove drives	• <i>Nondisruptively Change or Remove FBA Drives</i> on page 5-16

Serviceability Features

Each Symmetrix DMX system has an integrated service processor that continuously monitors the Symmetrix environment. The service processor communicates with the EMC Customer Support Center through a customer-supplied direct phone line. The service processor automatically dials the Customer Support Center whenever the Symmetrix system detects a component failure or environmental violation. An EMC Product Support Engineer at the Customer Support Center can also run diagnostics remotely through the service processor to determine the source of a problem and potentially resolve it before the problem becomes critical. Within the DMX control e-net matrix are the Environmental Control Module and Communication Control Module. These two modules provide the low-level system-wide communications for running application software, monitoring, and system diagnostics from the service processor.

Symmetrix DMX systems feature a modular design with a low parts count for quick component replacement, should a failure occur. This low parts count minimizes the number of failure points.

The Symmetrix DMX systems feature nondisruptive replacement of its major components, including:

- ◆ Channel director boards
- ◆ Disk director boards
- ◆ Global memory director boards
- ◆ Disk devices
- ◆ Port bypass card
- ◆ Cooling fan modules
- ◆ Environmental control module
- ◆ Communications control module
- ◆ Power supplies
- ◆ Power line input modules
- ◆ Batteries
- ◆ Service processor

For more information on these components, refer to Chapter 2, *Symmetrix DMX Hardware and Nondisruptive Component Replacement* on page 5-15.

Hardware Options

EMC offers the following hardware options for the Symmetrix DMX systems.

Symmetrix Seismic Kit

Some customers require that their EMC equipment be installed to withstand significant seismic shock. Installation of the Symmetrix Seismic Kit, in combination with adequate substrate construction, will mitigate collateral damage during a seismic event.

The kit contains heavy brackets plus hardware used to attach the brackets to the frame. The brackets are attached to the floor using bolts that engage flooring substructure provided by the user.

The Seismic Kit can be installed to all Symmetrix cabinets without lifting the cabinets. To order a Symmetrix Seismic Kit, contact your EMC Sales Representative.

DMX-SILENCER

The DMX-SILENCER, shown in Figure 1-5, is a fan noise reduction option for the Symmetrix DMX1000 single-bay, DMX2000 dual-bay, and the DMX3000 triple-bay systems. The DMX-SILENCER is designed with leading edge sound reducing materials. It decreases cooling fan exhaust noise by more than 5.0 dB while maintaining Symmetrix performance standards. The sound at power on for a DMX1000 reduces from 88.0 dB to 83.0 dB with the DMX-SILENCER1 installed. The sound at power on for a DMX2000 reduces from 93.0 dB to 88.0 dB with the DMX-SILENCER2 installed. The sound at power on for a DMX3000 reduces from 93.45 dB to 88.80 dB with the DMX-SILENCER3 installed. To order the DMX-SILENCER, contact your EMC Sales Representative.

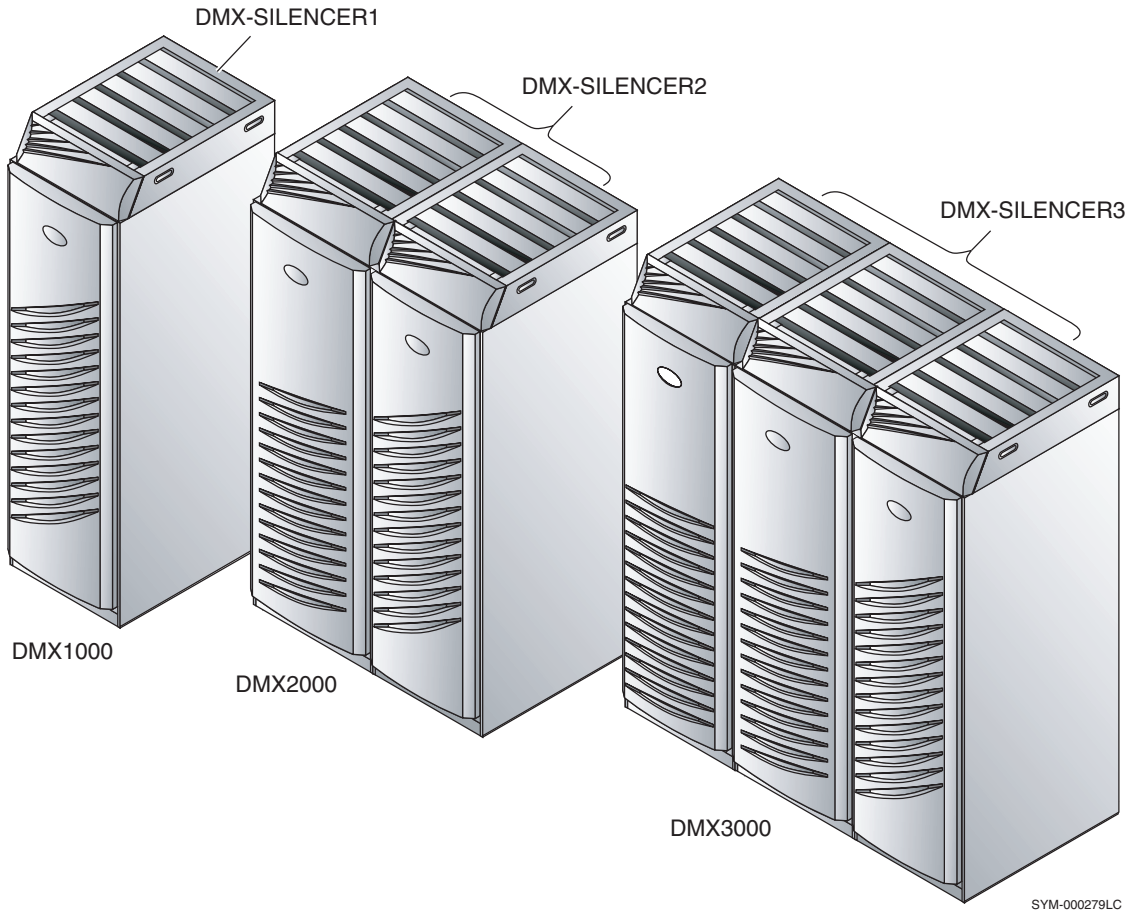


Figure 1-5 The DMX-SILENCER

Supported Software Applications

Symmetrix Enginuity operating environment is the foundation for many Symmetrix DMX software options. Tables 1-8 through 1-11 provide lists and brief descriptions of many of these options. The tables are divided into three categories:

- ◆ *Platform Software* (Table 1-8 on page 1-21)
- ◆ *Storage Management Software* (Table 1-9 on page 1-22)
- ◆ *Information Management Software* (Table 1-10 on page 1-24)
- ◆ *Infrastructure Software* (Table 1-11 on page 1-26)

Documents for these software options are available on the EMC PowerLink website at:

<http://powerlink.emc.com>

All of the software products are furnished under a license. Refer to the copyright page in this manual for the complete licensing statement. For software license, model numbers, prerequisites, and additional information, contact your EMC Sales Representative.

Platform Software

Symmetrix DMX systems support platform software applications for data migration, data mobility, replication, integration, and more.

Table 1-8 describes these software application options.

Table 1-8 Platform Software Options

Option	Description
EMC AutoSwap for Planned Outages	A utility that allows the user to change the contents of a mainframe Unit Control Block (UCB) such that the application does not know that the swap happened. It is useful for planned outages such as maintenance events and the migration of work from one resource to another. This high speed swap function is done at the discretion of the user with either an operator command or a batch job as the triggering event.
EMC AutoSwap for Unplanned Outages	Used in conjunction with EMC consistency groups (part of SRDF for mainframes), which is its prerequisite. This product performs the same operations as AutoSwap for Planned Outages, but automatically. Thus a regional disaster or site-level disaster would result in the contents of a UCB being swapped from the compromised site to the surviving site and the data being operated upon would be the R2 copies instead of the R1 copies. Again, the application would not take an interruption while the swapping was going on.
EMC CopyPoint for OS/400	Allows a secondary, offline copy of production data to be accessed by a secondary iSeries system.
EMC Double Checksum	Provides an end-to-end safeguard against data corruption by rechecking Oracle's data validation before data is written to EMC Symmetrix systems.
Symmetrix Enterprise Storage Platform (ESP)	Allows simultaneous storage and access of mainframe data and open systems data on the same Symmetrix system, or between two or more open systems and mainframe Symmetrix models.
EMC Fast Mirror Migrator	A mainframe software product that reads data from one Symmetrix system to another Symmetrix system using the channel connectivity of the mainframe to both control units. It is used for migrating data either on a permanent basis (such as the replacement of an older Symmetrix system) or on a temporary basis (such as changing a workload to a different Symmetrix resource). The user interface to Fast Mirror Migrator is via ISPF panels, a common interface technique in the mainframe community. Both <i>source</i> Symmetrix (the sender) and <i>target</i> Symmetrix system (the receiver) can be channel connected with either ESCON or FICON or mix and match both.
EMC InfoMover	Provides high-speed transfer between heterogeneous and similar MVS and UNIX-based host systems through a shared Symmetrix Enterprise storage system.
Symmetrix Data Migration Service (SDMS)	Provides continuous business operations and data availability when data is automatically migrated from older mainframe storage devices to a new Symmetrix system.
Nondisruptive Symmetrix Data Migration Service (ND-SDMS)	Software utility designed to perform data migration from one Symmetrix system to another Symmetrix system without application or system interruption.

Storage Management Software

Symmetrix DMX systems support Storage Management software that improves information management by allowing users to consolidate storage capacity for multiple hosts and servers. EMC offers powerful graphical user interface (GUI)-based tools that simplify and enhance Symmetrix configurations, performance, and status information gathering and management. Table 1-9 describes the storage management software options.

Table 1-9 Storage Management Software Options

Option	Description
EMC ControlCenter (minimum version 5.1.1 required for EMC ControlCenter products)	ControlCenter suite of software enables users to simplify and automate management of multivendor storage infrastructure through a single consistent information-centric strategy. It enables users to: • Discover: Map and display all elements and relationships of multivendor storage topology. • Monitor: View status and performance of those elements in real time; integrate with leading framework applications. • Provision: Configure and reconfigure resources to meet changing business demands. • Report: Obtain real-time and historical information on performance, utilization, and allocation.
EMC ControlCenter Symmetrix Manager	Provides real-time monitoring, configuration, and control of Symmetrix storage systems. SRDF/TimeFinder Manager is now folded into Symmetrix Manager.
EMC ControlCenter Automated Resource Manager	Provides storage resource management capabilities in three key areas: policy-based provisioning, automated alert management, and consolidated management of multivendor hosts, databases, backup systems, and mainframe tape devices.
EMC ControlCenter Symmetrix Optimizer	Automatically monitors, analyzes, and moves highly active logical volumes within the Symmetrix system to maintain optimal performance.
EMC ControlCenter StorageScope	Provides reporting capabilities that enable users to answer questions such as, 'How much storage do I have?', 'Where do I have it?', and 'Who's using it?' to facilitate capacity planning and chargeback operations.
EMC ControlCenter Workload Analyzer	Collects, correlates, and graphically presents performance information for your end-to-end storage infrastructure. It supports EMC CLARiiON and Symmetrix arrays, multi-vendor switches, open system servers, Oracle databases, and mainframe hosts.
SAN (Storage Area Network) Manager	Provides a central point of access, monitoring, and control for multivendor servers, storage networks, and storage arrays. It provides centralized configuration management (LUN Masking and Zoning) for multivendor storage arrays and network devices.

Table 1-9 Storage Management Software Options (*continued*)

Option	Description
SRDF/Asynchronous (SRDF/A)	High performance extended distance asynchronous replication solution using a Delta Set architecture for reduced bandwidth requirements and no host performance impact while also providing a consistent, restartable remote copy at all times.
SRDF/ Automated Availability Manager	Automated high availability through storage based replication and host application clustering via SRDF family and Legato AAM (a division of EMC).
SRDF/Automated Replication (SRDF/AR)	Rapid business restart over any distance with no data exposure through advanced single-hop and multi-hop configurations using combinations of TimeFinder/BCV and SRDF/S and/or SRDF/DM.
SRDF/Cluster Enabler for MSCS and SRDF/Cluster Enabler for VCS	High availability and automated failover through storage based replication and server clustering via SRDF family and MSCS and VCS.
SRDF/Consistency Groups (SRDF/CG)	Maintain data coherency across an SRDF-based configuration by monitoring data propagation from the source volumes to their corresponding target volumes to ensuring data consistency and restartability.
SRDF/Data Mobility	Rapidly transfer data from source volumes to remote volumes quickly, permitting information to be shared, content to be distributed, and access to be local to additional processing environments.
SRDF/Synchronous (Formerly SRDF)	High performance, host-independent, real-time synchronous remote replication from one Symmetrix to one or more Symmetrix systems.
TimeFinder/Consistency Groups	Maintain data coherency across TimeFinder-protected volumes to ensuring data consistency and restartability.
TimeFinder/Exchange and SQL Integration Modules	Tight integration of TimeFinder Family with Microsoft Exchange and SQL applications for automated backup and restore.
TimeFinder/Mirror (Formerly TimeFinder)	Create and use point-in-time business continuance volumes – BCVs, Clones or Mainframe SNAPS - for parallel processing activities and local restore.
TimeFinder/Snap	Pointer-based, space-saving snapshot copies for reduced recovery points and fast local data restore.

Information Management Software

Symmetrix DMX Systems support Information Management software that replicate critical business information. The SRDF® and TimeFinder Families enable you to balance your performance, availability, functionality and economic requirements to achieve required service levels for disaster recovery and business continuity.

TimeFinder/Mirror (formerly TimeFinder) enables you to make locally resident business continuance volumes for parallel processing activities like backup, testing and development and local restore, while your business applications proceed uninterrupted, servicing customers and generating revenue. TimeFinder/Snap™ offers instantly available pointer-based snapshot copies for more frequent, cost- and resource-efficient backup, restore, and mirroring tasks.

Symmetrix Remote Data Facility/Synchronous (SRDF/S, formerly SRDF) is EMC's remote, synchronous, byte-for-byte data-mirroring application for business continuity and disaster recovery needs while SRDF/Asynchronous' (SRDF/A) innovative Delta Set architecture enables unlimited distance replication with no host application and significantly reduced bandwidth requirements.

The SRDF and TimeFinder Families can be used in conjunction with each other for even greater flexibility when architecting complete information management solutions.

Table 1-10 describes the information management software options.

Table 1-10 Information Management Software Options

Option	Description
SRDF/Asynchronous (SRDF/A)	High performance extended distance asynchronous replication solution using a Delta Set architecture for reduced bandwidth requirements and no host performance impact while also providing a consistent, restartable remote copy at all times.
SRDF/ Automated Availability Manager	Automated high availability through storage based replication and host application clustering via SRDF family and Legato AAM (a division of EMC).
SRDF/Automated Replication (SRDF/AR)	Rapid business restart over any distance with no data exposure through advanced single-hop and multi-hop configurations using combinations of TimeFinder/BCV and SRDF/S and/or SRDF/DM.
SRDF/Cluster Enabler for MSCS and SRDF/Cluster Enabler for VCS	High availability and automated failover through storage based replication and server clustering via SRDF family and MSCS and VCS.
SRDF/Consistency Groups (SRDF/CG)	Maintain data coherency across an SRDF-based configuration by monitoring data propagation from the source volumes to their corresponding target volumes to ensuring data consistency and restartability.

Table 1-10 Information Management Software Options (*continued*)

Option	Description
SRDF/Data Mobility	Rapidly transfer data from source volumes to remote volumes quickly, permitting information to be shared, content to be distributed, and access to be local to additional processing environments.
SRDF/Synchronous (Formerly SRDF)	High performance, host-independent, real-time synchronous remote replication from one Symmetrix to one or more Symmetrix systems.
TimeFinder/Consistency Groups	Maintain data coherency across TimeFinder-protected volumes to ensuring data consistency and restartability.
TimeFinder/Exchange and SQL Integration Modules	Tight integration of TimeFinder Family with Microsoft Exchange and SQL applications for automated backup and restore.
TimeFinder/Mirror (Formerly TimeFinder)	Create and use point-in-time business continuance volumes – BCVs, Clones or Mainframe SNAPs - for parallel processing activities and local restore.
TimeFinder/Snap	Pointer-based, space-saving snapshot copies for reduced recovery points and fast local data restore.
Catalog Solution	A comprehensive facility for OS/390 and z/OS that enables users to manage, maintain, and recover their catalog environment with great speed, reliability, and flexibility. The Catalog Solution approach includes simple proactive diagnostic tools. Its maintenance and management facilities provide unique DUMP and REBUILD utilities to help you repair many potential logical and structural defects. Catalog Solution's fast and comprehensive validation of catalog, VVDS and VTOC relationships makes it a valuable resource for ensuring system (or data) availability.
EMC ControlCenter Replication Manager	Operates in combination with replication technologies, like EMC TimeFinder, to dramatically simplify and accelerate the management and use of local disk-based replications.
EMC ControlCenter Symmetrix Data Mobility Manager	A centralized management tool that allows you to configure, monitor, simulate, and manage the replication of data between local or remote Symmetrix devices based upon your business applications and/or business rules.
CopyCross	Allows copying mainframe tape data to Symmetrix disk storage for enhanced information availability and protection. Once the tape data has crossed over to Symmetrix storage, the mirroring capabilities of TimeFinder and SRDF can be used to achieve workload compression for increased productivity, easy and frequent local or remote backups, quick disaster recovery for critical business systems, and optimized IT processes.
EMC CopyPoint for OS/400	Allows a secondary, offline copy of production data to be accessed by a secondary iSeries system.
EMC Data Manager	A powerful combination of hardware, software, and services in a centralized, high-performance backup and restore system.

Infrastructure Software

Symmetrix DMX systems support Infrastructure software applications that provide logical presentation and seamless mobility of information. Table 1-11 describes the infrastructure software options.

ResourcePak For Windows is no longer available, however it's components can now be found in the following products: Data Relocation Utility, TimeFinder/Exchange Integration Module and TimeFinder/SQL Integration Module.

Table 1-11 Infrastructure Software Options

Option	Description
EMC PowerPath for Open Systems	Combines multiple path I/O capabilities, automatic load balancing, path failover, logical volume management, and volume mobility functions into one integrated package—for use on open server platforms connected to EMC Symmetrix, EMC CLARiiON, Hitachi Data Systems (HDS) Lightning, and HP XP (Hitachi OEM) storage systems.
Data Relocation Utility	Enables fast and flexible data mobility and migration operations for Windows environments.

This chapter describes the main hardware components of the Symmetrix DMX systems including:

- ◆ Major Components 2-2
- ◆ Symmetrix DMX Architecture.....2-12
- ◆ Symmetrix Channel Connectivity and Host Integration 2-21
- ◆ Fibre Channel Disk Devices.....2-24
- ◆ Channel, Disk, and Global Memory Directors 2-33
- ◆ Symmetrix DMX Power Subsystems 2-43
- ◆ Symmetrix DMX Control and Environmental Matrix 2-49
- ◆ Channel Attachments 2-52

Major Components

The Symmetrix DMX systems are disk array subsystems that house all Storage Control Unit functions and DASD in the DMX1000, single-bay cabinet, the DMX2000, dual-bay cabinet, or the DMX3000, three-bay cabinet. This section describes the Symmetrix DMX1000, DMX2000, and DMX3000 systems components.

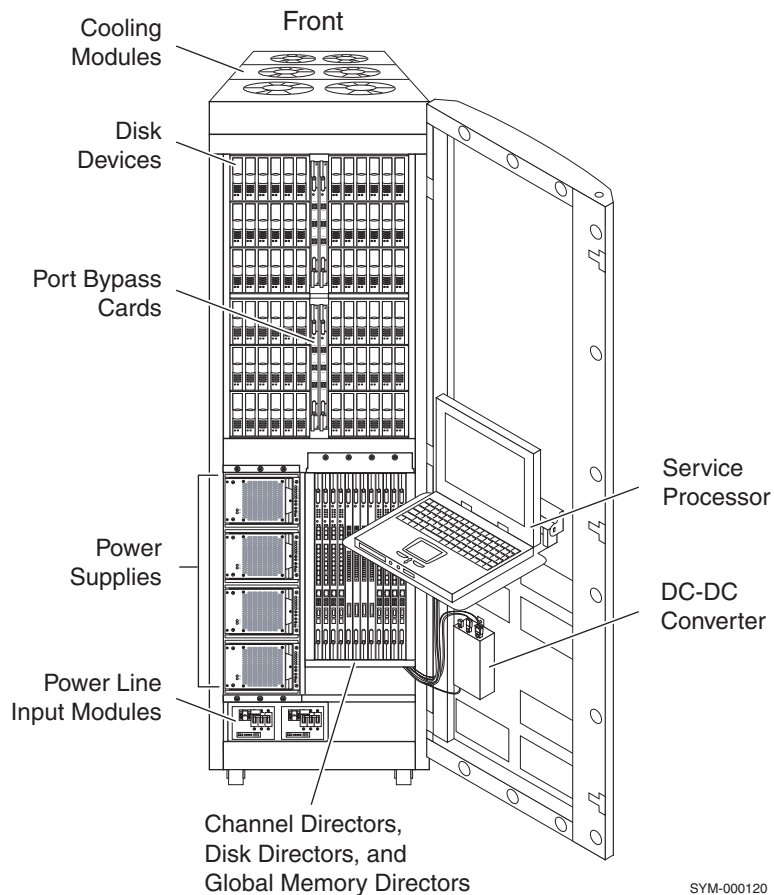
Table 2-1 Symmetrix DMX Model Component Overview

Symmetrix Model		Component Information Location
DMX1000	Main component locations, front and review views	Figure 2-1 on page 2-3, and Figure 2-2 on page 2-4
DMX2000	Main component locations, front and review views	Figure 2-3 on page 2-5, and Figure 2-4 on page 2-6
DMX3000	Main component locations, front and review views	Figure 2-5 on page 2-7, and Figure 2-6 on page 2-8
DMX1000, DMX1000-M2 DMX1000-P2	Main component descriptions	Table 2-2, <i>Symmetrix DMX1000 Component Overview</i> , on page 2-9
DMX2000, DMX2000-3, DMX2000-M2 DMX2000-M2-3 DMX2000-P2 DMX2000-P2-3	Main component descriptions	Table 2-3, <i>Symmetrix DMX2000 Component Overview</i> , on page 2-10
DMX3000-3 and DMX3000-M2-3	Main component descriptions	Table 2-4, <i>Symmetrix DMX3000-3 Component Overview</i> , on page 2-11



WARNING

To reduce the risk of personal injury, do not open the doors or move the Symmetrix DMX systems unless you are qualified and familiar with safety procedures for electrical equipment and the Symmetrix DMX. The Symmetrix DMX systems contain no user-serviceable parts. They should not be moved or opened for any reason by untrained persons. If the Symmetrix system is in need of relocation or repair, only qualified personnel should access components inside the unit or move it.



SYM-000120

Figure 2-1 Symmetrix DMX1000 (Interior View, Front)

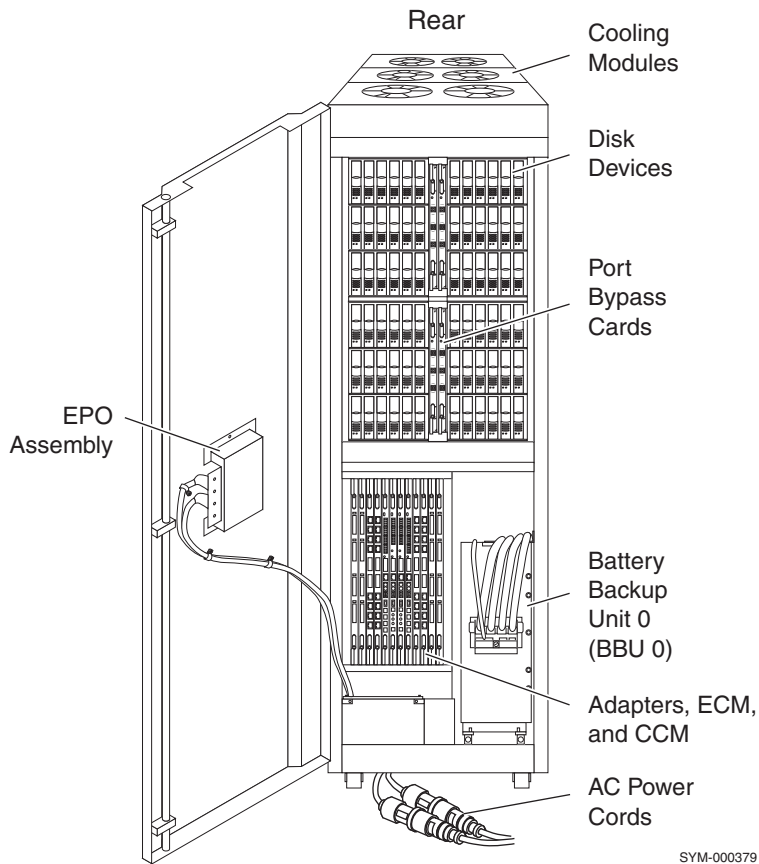
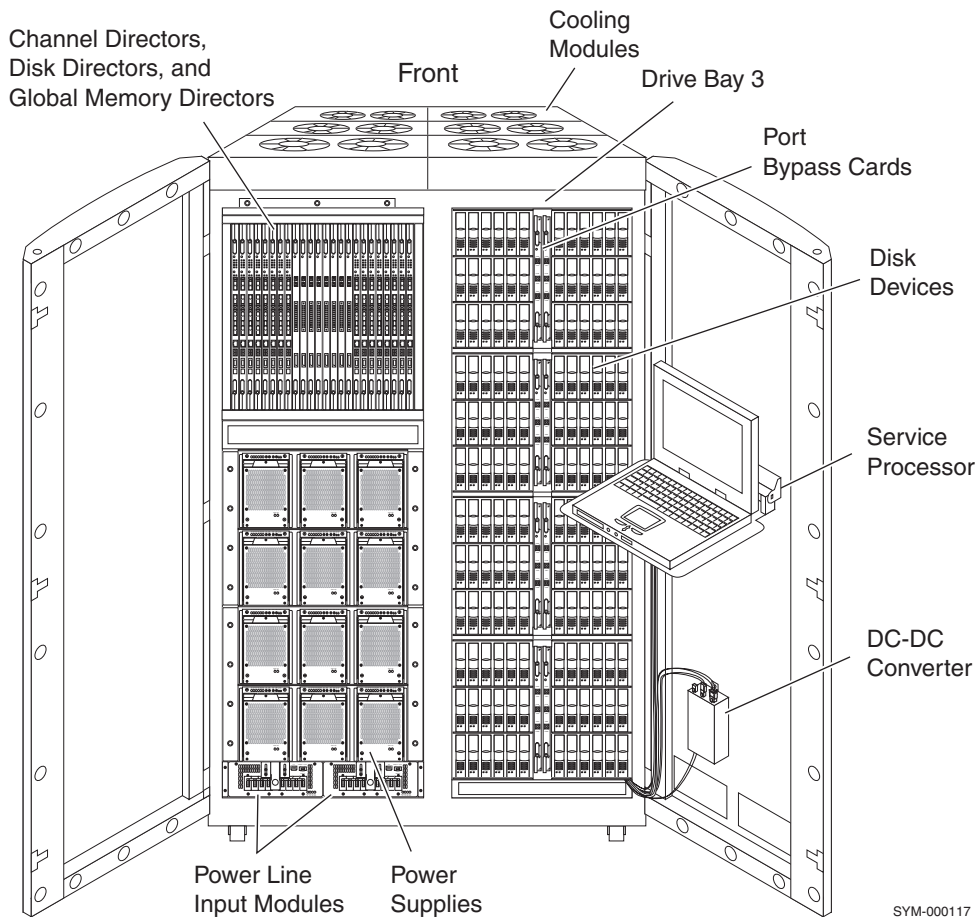
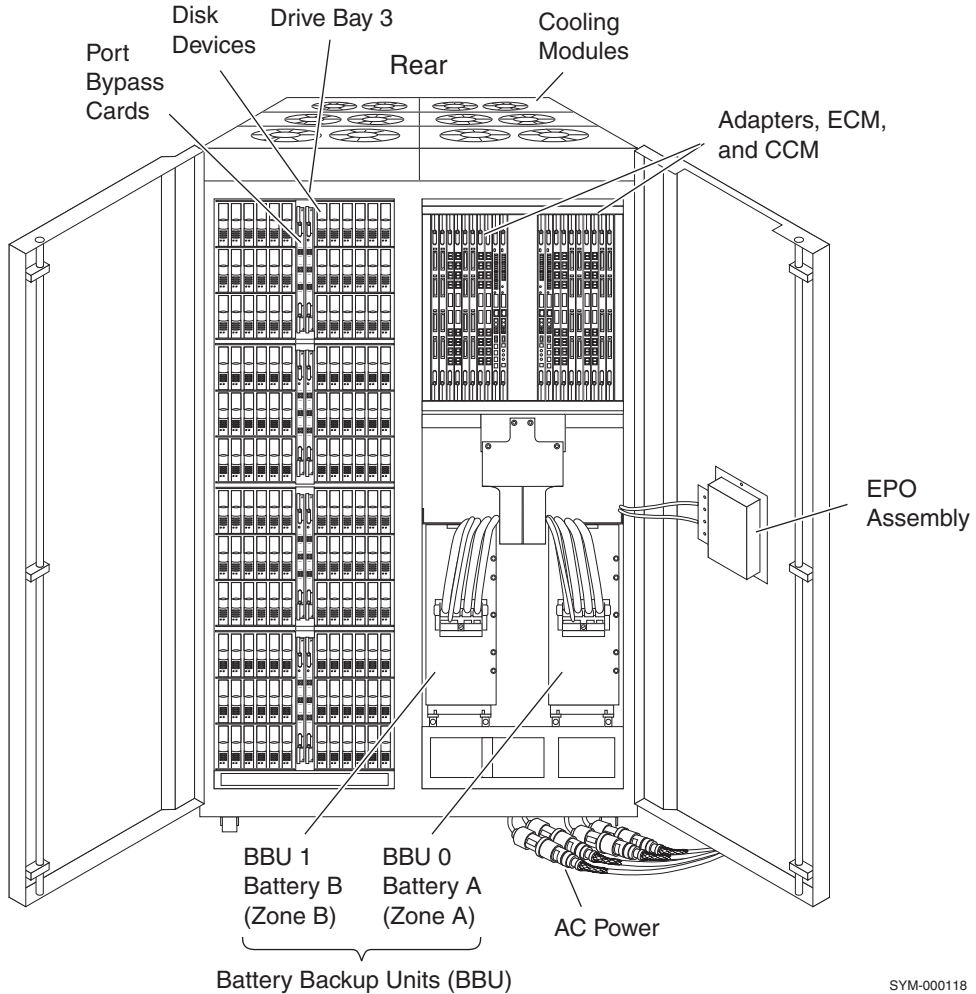


Figure 2-2 Symmetrix DMX1000 (Interior View, Rear)



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Figure 2-3 Symmetrix DMX2000 (Interior View, Front)



SYM-000118

Figure 2-4 Symmetrix DMX2000 (Interior View, Rear)

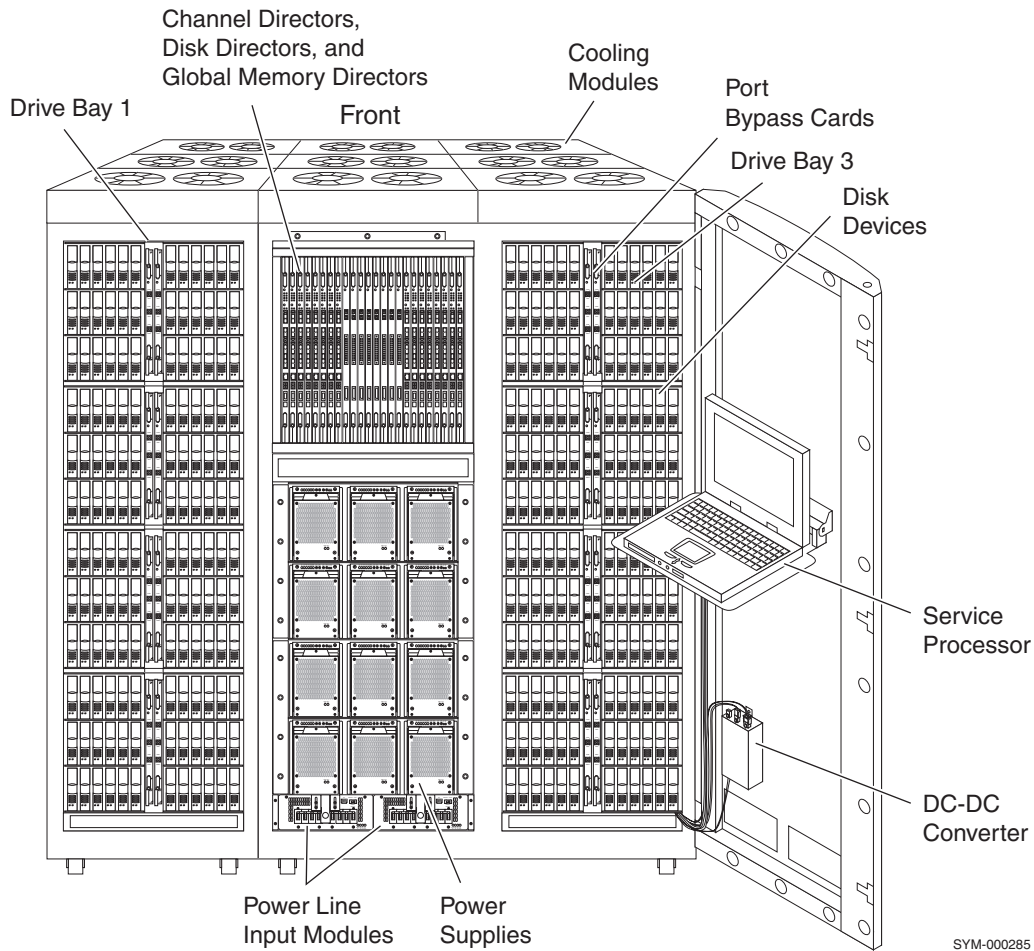
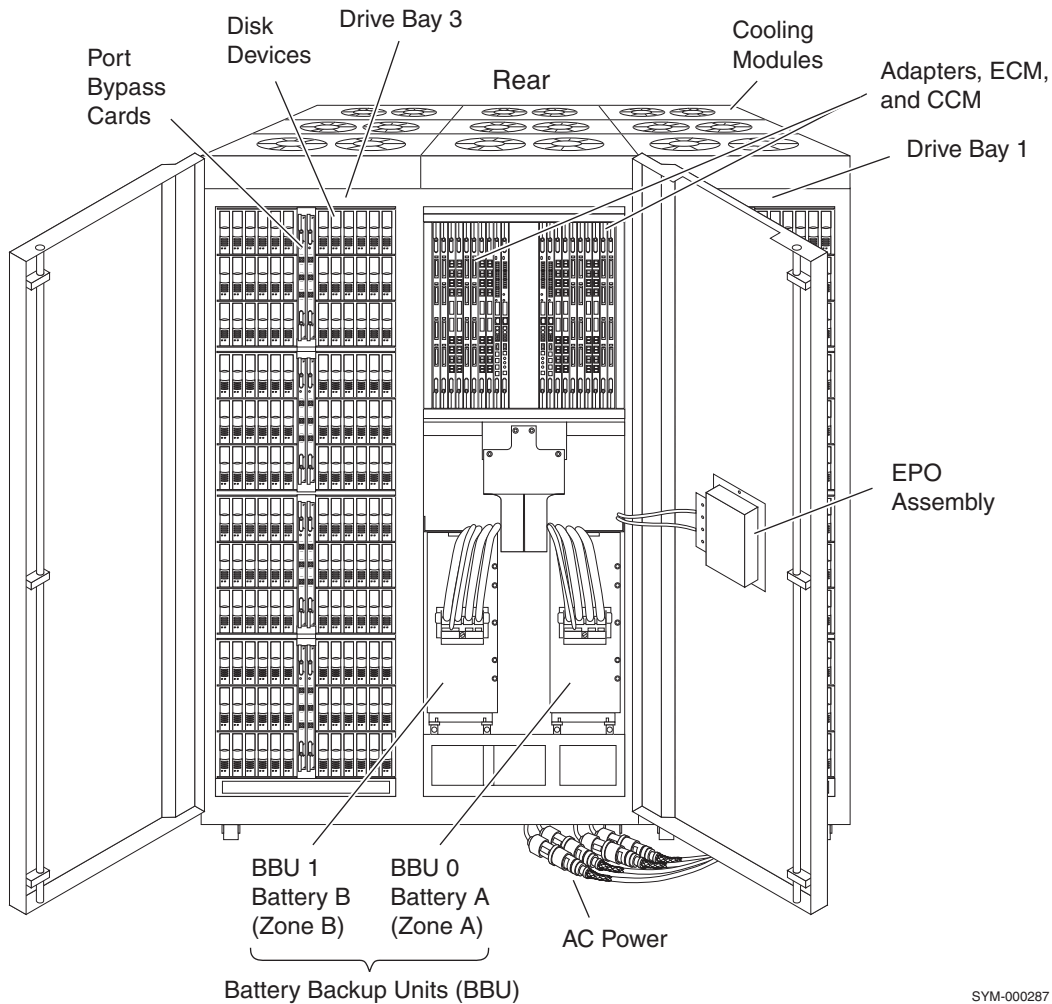


Figure 2-5 Symmetrix DMX3000 (Interior View, Front)



SYM-000287

Figure 2-6 Symmetrix DMX3000 (Interior View, Rear)

Table 2-2 Symmetrix DMX1000 Component Overview

Components	Component Descriptions
Cooling Fan Modules	Six fans maintain air circulation and cool the unit internally.
Card Cage and Midplane	The front twelve slots contain global memory directors, disk directors, and channel directors (front-end Fibre Channel, ESCON, FICON, and iSCSI channel directors, and/or GigE Remote directors). The rear slots contain the channel host adapters, GigE Remote adapters, disk adapters, and ECMs and CCMs.
Channel Directors/Adapters and Remote Director Adapters (Front-End)	Channel directors connect to the midplane in the front of the cabinet. Each channel director's adapter provides the interface to the host or network. The adapter connects to the opposite side of the midplane in the rear of the cabinet. - DMX1000 and DMX1000-M2 may support up to 6 channel directors/adapters. ^a - DMX1000-P2 may support up to 4 channel directors/adapters. ^a
Fibre Channel Disk Directors/Adapters (Back-End)	Disk directors connect to the midplane in the front of the cabinet. Each disk director's adapter provides the interface to the Fibre Channel disks. The adapter connects to the opposite side of the midplane in the rear of the cabinet. - DMX1000 and DMX1000-M2 offer 2 disk directors/adapters that support 18 drives per Fibre Channel loop. - DMX1000-P2 offers 4 disk directors/adapters that support 9 drives per Fibre Channel loop.
Global Memory Directors	Two-to-four global memory directors provide up to 128 GB total global memory.
Fibre Channel Disk Subsystem	- DMX1000 and DMX1000-P2 offer 64-to-144 low-profile Fibre Channel 73 GB and 146 GB disk devices. - DMX1000-M2 offer 120-to-144 low-profile Fibre Channel 73 GB and 146 GB disk devices. - Eight Port Bypass Cards provide loop topology with bypass capability for the Symmetrix DMX1000 Fibre Channel disk subsystem. Two cards are required for each populated disk cage.
Communications Control Module (CCM)	Two communications control modules connect to the midplane in the rear card cage acting as a communications agent between the service processor and the director processors, and providing capabilities for diagnostics and monitoring of switch fabrics.
Environmental Control Module (ECM)	Two environmental control modules connect to the midplane in the rear card cage. They monitor and log environmental events for all Symmetrix DMX FRUs (field replaceable units) and report any operational problems such as thermal excursion, voltage drop, etc.
Battery Subsystem	If AC power fails, one battery maintains power for one minute while the Symmetrix system destages write operations in an orderly way.
Power Subsystem ^b	Single-phase power zone supports up to four power supplies in redundant (N+1) scalable configurations and two Power Line Input Modules (PLIMs).
Integrated Service Processor	The service processor connects to the Symmetrix subsystem through an Ethernet communication or an RS-232 interface. The service processor uses an external modem for communicating with the EMC Customer Support Center when the Symmetrix system detects an error condition. The service processor is used to download the Symmetrix system configuration to the directors and provide diagnostic and maintenance utilities for the Symmetrix system.

a. Contact your EMC Sales Representative for specific supported configurations.

b. Refer to *Symmetrix DMX1000 Power Subsystem* on page 2-44 for single-phase power configuration information.

Table 2-3 Symmetrix DMX2000 Component Overview

Components	Component Descriptions
Cooling Fan Modules	Twelve fans maintain air circulation and cool the unit internally.
Card Cage and Midplane	The front twenty-four slots contain global memory directors, disk directors, and channel directors (front-end Fibre Channel, ESCON, FICON, and iSCSI channel directors, and/or GigE Remote directors). The rear slots contain the channel host adapters, GigE Remote adapters, disk adapters, and ECMs and CCMs.
Channel Directors/Adapters (Front-End)	Channel directors connect to the midplane in the front of the cabinet. Each channel director's adapter provides the interface to the host or network. The adapter connects to the opposite side of the midplane in the rear of the cabinet. - DMX2000, DMX2000-3, DMX2000-M2, and DMX2000-M2-3 may support up to 12 channel directors/adapters.^a - DMX2000-P2 and DMX2000-P2-3 may support up to 8 channel directors/adapters.^a
Fibre Channel Disk Directors/Adapters (Back-End)	Disk directors connect to the midplane in the front of the cabinet. Each disk director's adapter provides the interface to the Fibre Channel disks. The adapter connects to the opposite side of the midplane in the rear of the cabinet. - DMX2000, DMX2000-3, DMX2000-M2, and DMX2000-M2-3 offer 4 disk directors/adapters that support 18 drives per Fibre Channel loop. - DMX2000-P2 and DMX2000-P2-3 offer 8 disk directors/adapters that support 9 drives per Fibre Channel loop.
Global Memory Directors	Four-to-eight global memory directors provide up to 256 GB total global memory.
Fibre Channel Disk Subsystem	- DMX2000, DMX2000-3, DMX2000-P2, and DMX2000-P2-3 support 128-to-288 low-profile Fibre Channel 73 GB and 146 GB disk devices. - DMX2000-M2 and DMX2000-M2-3 supports 240-to-288 low-profile Fibre Channel 73 GB and 146 GB disk devices. - Sixteen Port Bypass Cards provide loop topology with bypass capability for all Symmetrix DMX2000 models for the Fibre Channel disk subsystem. Two cards are required for each populated disk cage.
Communications Control Module (CCM)	Two communications control modules connect to the midplane in the rear card cage acting as a communications agent between the service processor and the director processors, and providing capabilities for diagnostics and monitoring of switch fabrics.
Environmental Control Module (ECM)	Two environmental control modules connect to the midplane in the rear card cage. They monitor and log environmental events for all Symmetrix DMX FRUs (field replaceable units) and report any operational problem, such as thermal excursion, voltage drop, etc.
Battery Subsystem	If AC power fails, two batteries maintain power for one minute while the Symmetrix system destages write operations in an orderly way.
Power Subsystem ^b	Two (N+1) power zones, supporting up to twelve power supplies in redundant scalable configurations and two Power Line Input Modules (PLIMs). The DMX2000, DMX2000-M2, and DMX2000-P2 support a single-phase power configuration. The DMX2000-3, DMX2000-M2-3, and DMX2000-P2-3 support a three-phase power configuration.
Integrated Service Processor	The service processor connects to the Symmetrix subsystem through an Ethernet communication or an RS-232 interface. The service processor uses an external modem for communicating with the EMC Customer Support Center when the Symmetrix system detects an error condition. The service processor is used to download the Symmetrix system configuration to the directors and provide diagnostic and maintenance utilities for the Symmetrix system.

a. Contact your EMC Sales Representative for specific supported configurations.

b. Refer to *Symmetrix DMX2000/3000 Power Subsystem* on page 2-45 for single-phase and three-phase power information.

Table 2-4 Symmetrix DMX3000-3 Component Overview

Components	Component Descriptions
Cooling Fan Modules	Eighteen fans maintain air circulation and cool the unit internally.
Card Cage and Midplane	The front twenty-four slots contain global memory directors, disk directors, and channel directors (front-end Fibre Channel, ESCON, FICON, and iSCSI channel directors, and/or GigE Remote directors). The rear slots contain the channel host adapters, GigE Remote adapters, disk adapters, and ECMs and CCMs.
Channel Directors/Adapters (Front-End)	Channel directors connect to the midplane in the front of the cabinet. Each channel director's adapter provides the interface to the host or network. The adapter connects to the opposite side of the midplane in the rear of the cabinet. DMX3000-3 and DMX3000-M2-3 may support up to eight channel directors/adapters. ^a
Fibre Channel Disk Directors/Adapters (Back-End)	Disk directors connect to the midplane in the front of the cabinet. Each disk director's adapter provides the interface to the Fibre Channel disks. The adapter connects to the opposite side of the midplane in the rear of the cabinet. DMX3000-3 and DMX3000-M2-3 offer eight disk directors/adapters that support 18 drives per Fibre Channel loop.
Global Memory Directors	Four-to-eight global memory directors provide up to 256 GB total global memory.
Fibre Channel Disk Subsystem	- DMX3000-3 supports 289-to-576 low-profile Fibre Channel disk devices. - DMX3000M2-3 supports 480-to-576 low-profile Fibre Channel disk devices. - Thirty-two Port Bypass Cards provide loop topology with bypass capability for the DMX3000-3 and DMX3000-M2-3 Fibre Channel disk subsystem. Two cards are required for each populated disk cage.
Communications Control Module (CCM)	Two communications control modules connect to the midplane in the rear card cage acting as a communications agent between the service processor and the director processors, and providing capabilities for diagnostics and monitoring of switch fabrics.
Environmental Control Module (ECM)	Two environmental control modules connect to the midplane in the rear card cage. They monitor and log environmental events for all Symmetrix DMX FRUs (field replaceable units) and report any operational problems such as thermal excursion, voltage drop, etc.
Battery Subsystem	If AC power fails, two batteries maintain power for one minute while the Symmetrix system destages write operations in an orderly way.
Power Subsystem ^b	Two (N+1) power zones, supporting up to twelve power supplies in redundant scalable configurations and two Power Line Input Modules (PLIMs). The DMX3000-3 and DMX3000-M2-3 are available in a a three-phase power configuration.
Integrated Service Processor	The service processor connects to the Symmetrix subsystem through an Ethernet communication or an RS-232 interface. The service processor uses an external modem for communicating with the EMC Customer Support Center when the Symmetrix system detects an error condition. The service processor is used to download the Symmetrix system configuration to the directors and provide diagnostic and maintenance utilities for the Symmetrix system.

a. Contact your EMC Sales Representative for specific supported configurations.

b. Refer to *Symmetrix DMX Power Subsystems* on page 2-43 for three-phase power configuration information.

Symmetrix DMX Architecture

The Symmetrix DMX features a high-performance, Direct Matrix Architecture (DMX) supporting up to 128 point-to-point serial connections in the DMX2000/3000 (up to 64 in the DMX1000).

Symmetrix DMX technology is distributed across all channel directors, disk directors, and global memory directors in Symmetrix DMX systems. Enhanced global memory technology supports multiple regions and 16 connections on each global memory director. In the Direct Matrix Architecture, contention is minimized because control information and commands are transferred across a separate and dedicated message matrix. The major components of Symmetrix DMX architecture are the front-end channel directors (and their interface adapters), global memory directors, and back-end disk directors (and their interface adapters).

The matrix midplane provides configuration flexibility through the slot configuration. Each director slot port is hard-wired point-to-point to one port on each global memory director board.

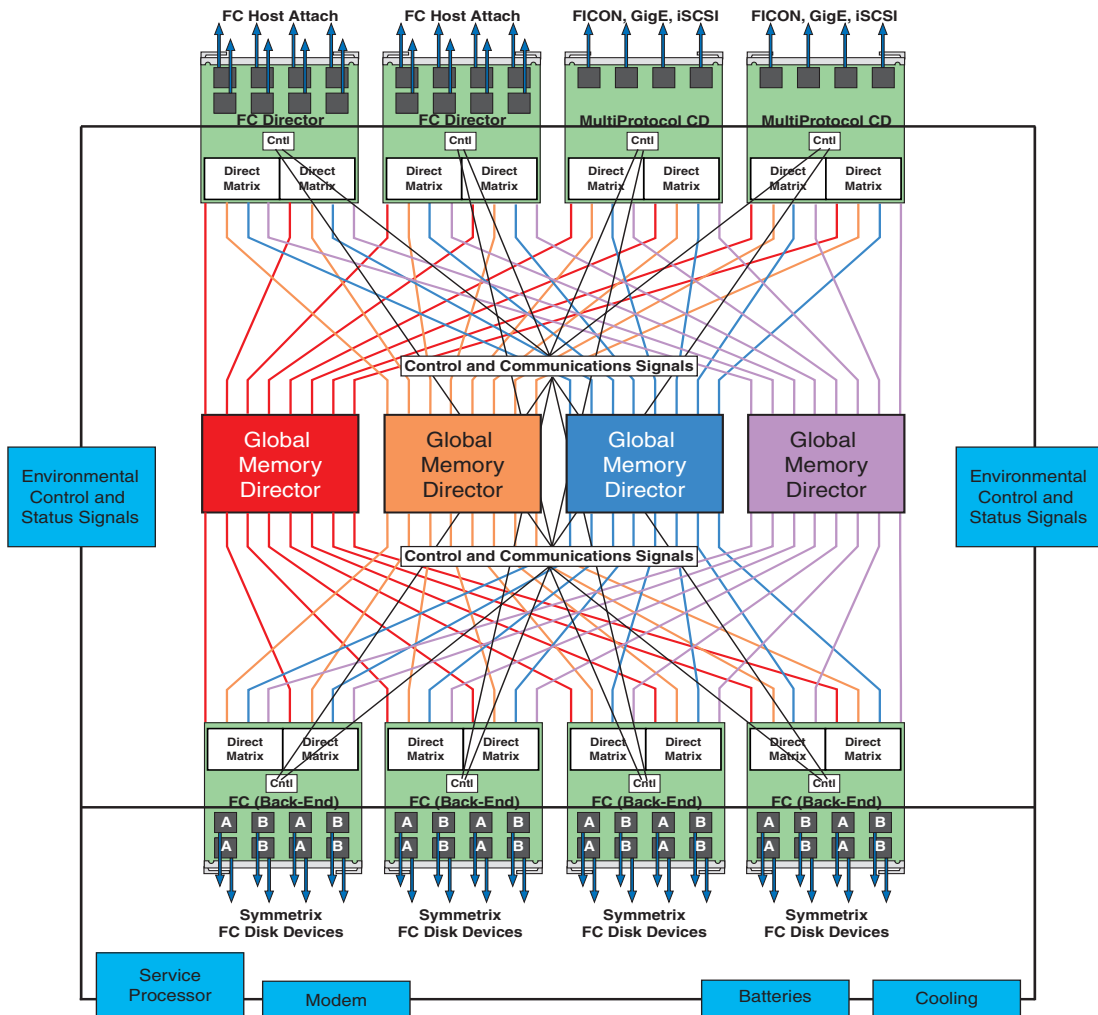
This section describes the following:

- ◆ Symmetrix DMX Systems Block Diagrams
- ◆ Symmetrix DMX Component Scaling Attributes
- ◆ Symmetrix DMX Point-to-Point Message Matrix
- ◆ Midplane Slot Configuration

Symmetrix DMX Systems Block Diagrams

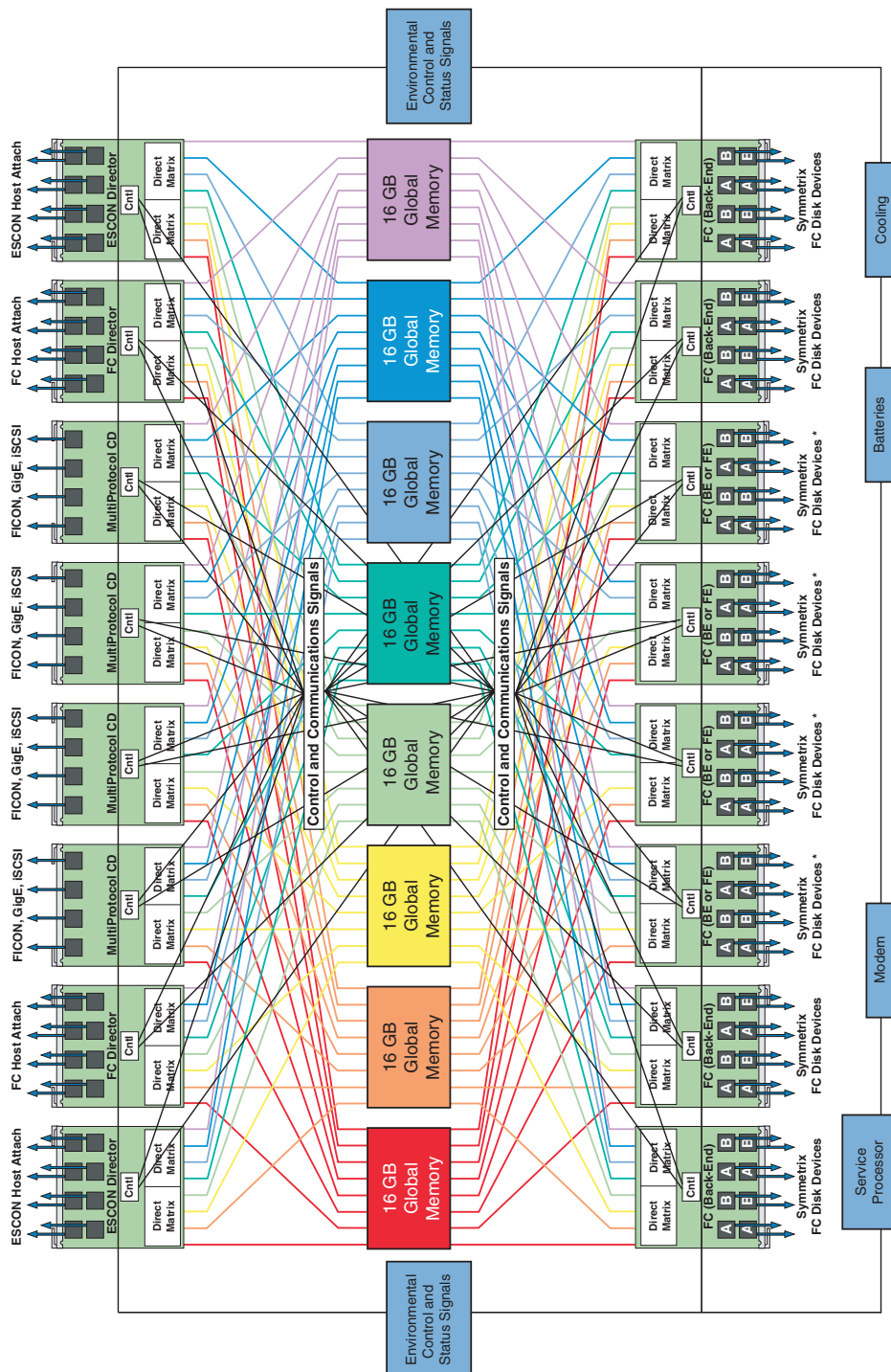
In a fully configured Symmetrix DMX1000 system, each of the eight director ports on the eight directors connects to one of the sixteen memory ports on each of the four global memory directors. That is, there are two connections between each director and each global memory director. These 64 individual point-to-point connections facilitate up to 64 concurrent global memory operations in the system. Figure 2-7 on page 2-13 illustrates the point-to-point architecture and the interconnection of the major components of the Symmetrix DMX1000 system.

In a fully configured Symmetrix DMX2000/3000 system, each of the eight director ports on the sixteen directors connects to one of the sixteen memory ports on each of the eight global memory directors. These 128 individual point-to-point connections facilitate up to 128 concurrent global memory operations in the system. Figure 2-8 on page 2-14 illustrates the point-to-point architecture and the interconnection of the major components of the Symmetrix DMX2000/3000 system.



*Notes: The DMX1000 supports Fibre Channel, FICON, ESCON, and iSCSI connections as well as GigE, Fibre Channel, and ESCON remote connections.
The DMX1000 midplane has two slots that support either front-end channel directors or back-end disk directors.

Figure 2-7 Symmetrix DMX1000 Block Diagram



*Note: The DMX2000/3000 supports Fibre Channel, FICON, ESCON, and iSCSI connections as well as GigaE, Fibre Channel, and ESCON remote connections. The DMX2000 midplane has four slots that support either front-end channel directors or back-end disk directors.

Figure 2-8 Symmetrix DMX2000/3000 Block Diagram

Symmetrix DMX Component Scaling Attributes

The Symmetrix DMX systems support multiple configurations of front-end channel directors, global memory directors, and back-end disk directors as described in Table 2-2 on page 2-9, Table 2-3 on page 2-10, and Table 2-4 on page 2-11. Unlike previous generations of Symmetrix systems, the Direct Matrix Architecture enables flexible configurations to fit your requirements. When you choose the quantity of memory (at least the minimum for your configuration), you can also choose the quantity of global memory directors. This quantity has a direct relationship to the number of internal serial data paths in the system which, in turn, can affect the performance ability of the Symmetrix DMX system.

Unlike previous Symmetrix generations, you can choose the quantity of back-end disk directors you require through the model that you choose. The DMX1000 has two back-end disk directors, while the DMX1000-P2 has four. The DMX2000, DMX2000-M2, and DMX2000-M2-3 also have four back-end disk directors. The DMX2000-P2, DMX2000-P2-3, DMX3000-3, and the DMX3000-M2-3 have the maximum of eight. Again, this attribute, along with the quantity of front-end channel directors, has a direct relationship to the performance of the Symmetrix system.

Symmetrix DMX Point-to-Point Message Matrix

Previous generations of the Symmetrix system-wide interconnect for both data and control plane functions have utilized shared multidrop bus connections. Over the past several years the multidrop bus interconnect technology has been exploited to its full potential and bandwidth limitations have been reached in sharing data performance and low latency control over the same bus.

Symmetrix DMX systems feature a point-to-point interconnect technology for its separate matrix fabrics, which have been implemented for both data plane functions and control plane functions. This Symmetrix DMX message matrix provides high bandwidth and low latency control plane communication, which manages the data movement through the Symmetrix system.

Figure 2-9 on page 2-16 is a simplified view of the Symmetrix DMX message matrix. The message fabric is made up of several fabric elements, or *FE*, connected together so that all end nodes are connected to a unique port on the outer edge of the message fabric. The end nodes are commonly referred to as the *Message Engine* or *ME*. The ME is an integral part of the CPU controller and allows the front-end and back-end processors to communicate with each other through the message fabric.

The message fabric is managed by a fabric manager, which provides initialization for the fabric elements, real-time monitoring, and diagnostic functions. The fabric manager is assigned to any one of the director processors and communicates to the fabric through special in-band fabric management packets.

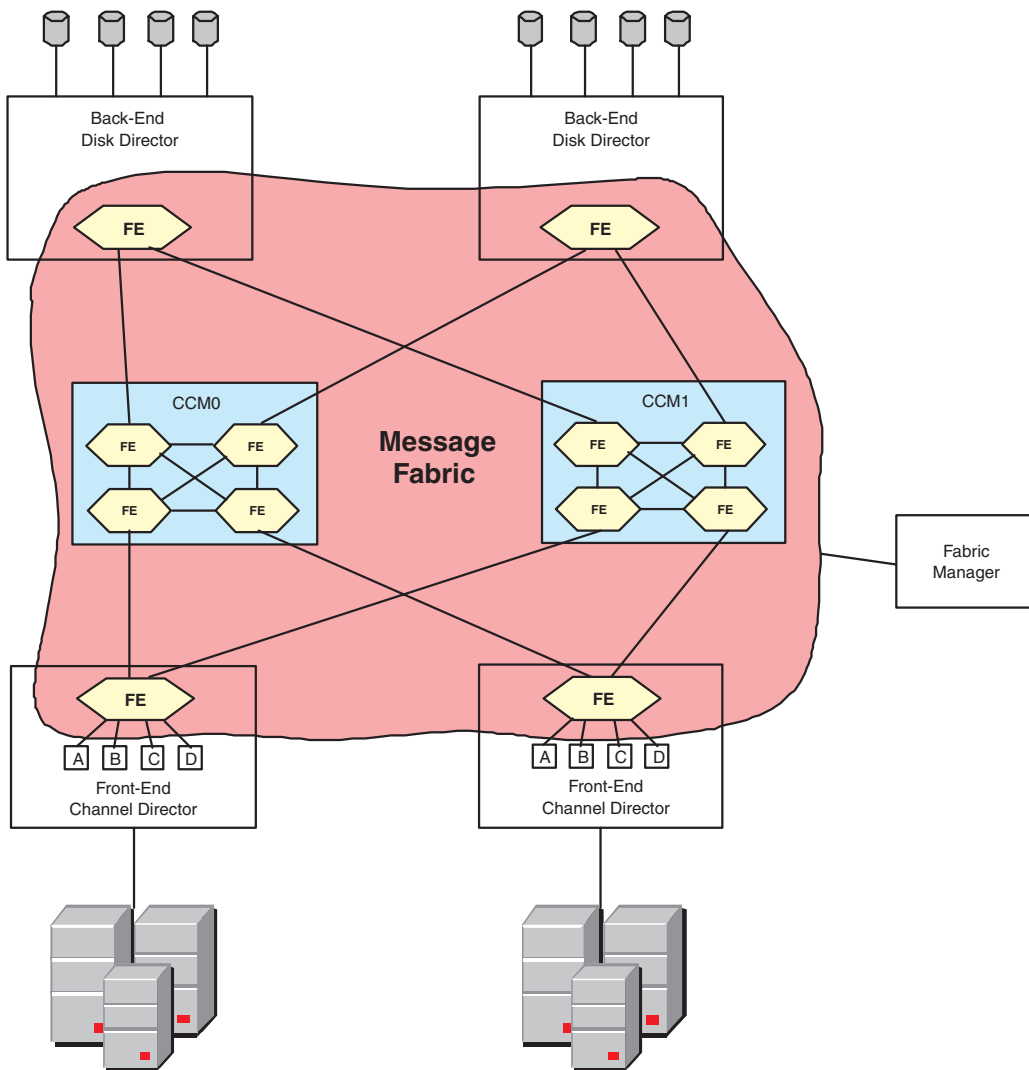


Figure 2-9 Symmetrix DMX Message Fabric

Midplane Slot Configuration

The front of the Symmetrix DMX system’s card cage midplane contains the channel directors, disk directors, and global memory directors. The rear card cage midplane contains the adapters, the Communications Control Module (CCM), and Environmental Control Module (ECM) pairs.

The Symmetrix DMX systems require certain board types to occupy particular slot locations within the card cage. Adhering to the configurations stated for each model type ensures that the physical routing of the serial signals minimizes contention for memory resources, maximizes bandwidth within the system, and maintains total redundancy to the same memory location through two completely different hardware paths. Termination of TTL signals occurs at the adapters in the end slot locations.

DMX1000 Slot Configuration

The DMX1000 system has a 12-slot midplane. Four slots in the center are reserved for global memory directors and the remaining eight slots are reserved for channel directors and disk directors (four to the left and four to the right of memory). Figure 2-10 shows the card cage layout for the global memory director boards, the Front-End (FE) and Back-End (BE) designations for the Fibre Channel directors, and the FE designations for the ESCON directors, FICON directors, iSCSI, or GigE Remote directors.

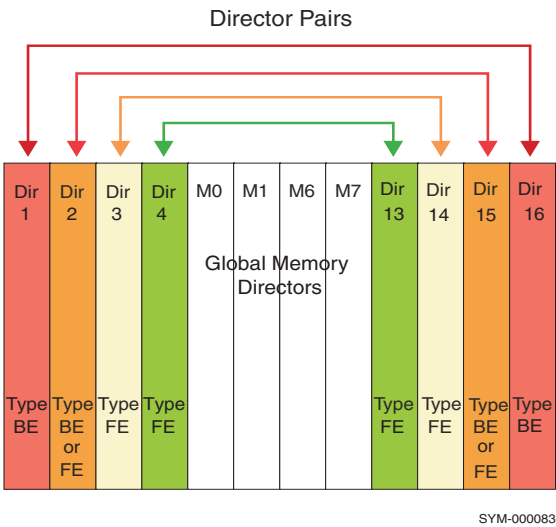
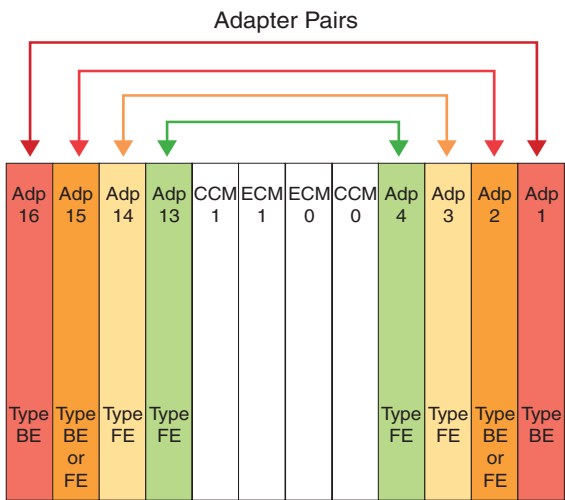


Figure 2-10 Symmetrix DMX1000 Card Cage Configurations (Front)

In the rear of the midplane (Figure 2-11 on page 2-18), the adapters reside behind their respective directors and the four slots behind the memory are reserved for the ECM and CCM pairs.

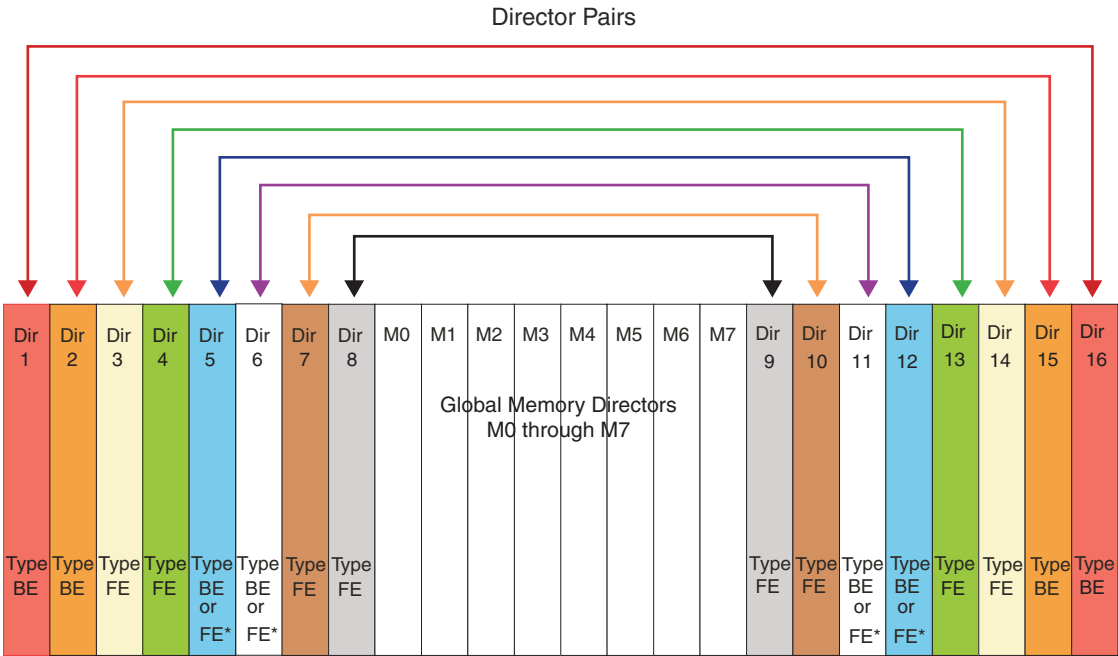


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Figure 2-11 Symmetrix DMX1000 Card Cage Configurations (Rear)

DMX2000/3000 Slot Configuration

The Symmetrix DMX2000 and DMX3000 systems have a 24-slot midplane. On the front side, the eight slots in the center of the midplane are reserved for global memory directors and the remaining 16 slots are reserved for channel directors and disk directors (eight to the left and eight to the right of memory). Figure 2-12 shows the card cage layout for the global memory directors, the Front-End (FE) and Back-End (BE) designations for the Fibre Channel directors, and the FE designations for the ESCON directors, FICON directors, iSCSI, or GigE Remote directors.

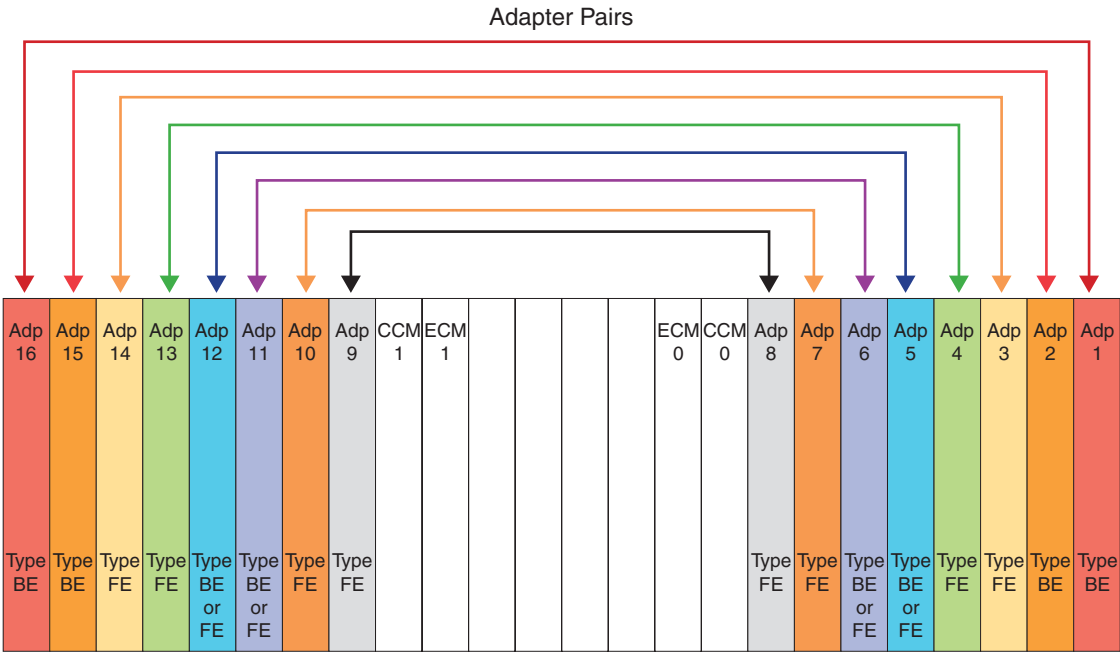


* Note: These slots in the midplanes of the DMX2000 systems can be configured with either front-end or back-end directors.

SYM-000085

Figure 2-12 Symmetrix DMX2000/3000 Card Cage Configurations (Front)

On the rear side of the midplane (Figure 2-13), the adapters reside behind their respective directors, and four slots behind the memory are reserved for the CCM and ECM pairs. The remaining four slots are for the power busbars.



* Note: These slots in the midplanes of the DMX2000 systems can be configured with either front-end or back-end adapters

SYM-000078

Figure 2-13 Symmetrix DMX2000/3000 Card Cage Configurations (Rear)

Symmetrix Channel Connectivity and Host Integration

The Symmetrix DMX systems can be integrated with all major enterprise hosts and servers. This section outlines the emulations and hosts Symmetrix systems support through Fibre Channel, ESCON, FICON, or GigE (SRDF) interfaces.

For the most current information on Symmetrix systems and specific host integration, contact your EMC Sales Representative, or refer to the EMC Powerlink website at: <http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

Channel Connectivity

The Symmetrix DMX systems support connectivity to mainframe and open systems hosts.

The Symmetrix Enterprise Storage Platform (ESP) software enabler, a software option, is required if you plan to store and access mainframe and open systems data on the same Symmetrix system. For more information on the ESP option, refer to Table 1-8 on page 1-21 or contact your EMC Sales Representative.

Open Systems Connectivity

The Symmetrix DMX systems connect to Fibre Channel open system host interfaces such as UNIX, Windows, Linux, and iSeries systems.

Mainframe Systems Connectivity

The Symmetrix DMX systems support ESCON and FICON host connectivity to mainframe systems. Enginuity level 5670 or higher is needed to support connectivity to FICON hosts.

IBM iSeries Fibre Channel Connectivity

With the Symmetrix Fibre Channel adapter, users are able to connect Symmetrix systems through fibre to the iSeries 270 and 8xx models. When using directly connected fibre devices (point-to-point) the maximum distance is 500 meters.

Fibre Channel is currently capable of running up to 2 Gbs/s full duplex with iSeries systems. Enginuity level 5670 or higher is needed to support Fibre Channel connectivity to iSeries systems. Symmetrix 73 GB and 146 GB disk drives support iSeries hosts.

Symmetrix Channel Configurations

EMC offers the following Symmetrix DMX channel directors:

- ◆ Eight-port, four-processor (8x4) ESCON directors
- ◆ Eight-port, four-processor (8x4) Fibre Channel directors
- ◆ Four-port, four-processor (4x4) Multiprotocol Channel Director (MPCD) that supports:
 - FICON host connections
 - iSCSI host connections
 - GigE SRDF connections

Mainframe Serial Channel Interfaces

Symmetrix serial channel interfaces attach to IBM S/370, S/390 (ES/9000, 309X, 308X, 43XX, and 9370), the plug-compatible manufacturer (PCM) equivalent, Amdahl, Unisys, Bull, and Siemens.

For a more detailed discussion of channel attachment options, refer to *Channel Attachments* on page 2-52.

Table 2-5 shows the IBM DASD models and controllers that Symmetrix systems emulate.

Table 2-5 IBM Controller/DASD Compatibility

IBM DASD	IBM Controller	
	3990-6	2105
3380	X	X
3390-1	X	X
3390-2	X	X
3390-3	X	X
3390-9	X	X
3390-27		X

**Supported
Mainframe
Operating Systems**

In IBM/PCM mainframe environments, the Symmetrix DMX system is operating-system independent. The memory processing algorithms are self-managed, and the Symmetrix system does not depend on host cache commands to benefit from read and write caching.

Almost every S/370 and S/390 operating system can be supported, including:

ACP/TPF	AIX/ESA	MVS/ESA	MVS/SP	MVS/XA
MVT/VSE	OS/390	VM/ESA	VM/HPO	VM/SP
VM/XA	VSE/ESA	VSE/SP		

Symmetrix DMX systems also support the following mainframe operating systems:

GC0S7	GCOS8	MSP	OS/1100	PICK
UTS				

**Supported Fibre
Channel Interfaces**

The Symmetrix DMX systems Fibre Channel interfaces attach to most open systems and iSeries hosts that have Fibre Channel connectivity.

Consult your EMC Sales Representative for the most current list of supported hosts, models, operating systems, and EMC open systems host support policies, or refer to the EMC Powerlink website at:

<http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

**Supported Cluster
Hosts**

For the most recent information on supported cluster hosts, refer to the EMC Powerlink website at: <http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

Fibre Channel Disk Devices

Symmetrix DMX systems use industry-standard 2 Gb/s Fibre Channel Disk Drive Assemblies (DDAs) for physical 73 GB and 146 GB disk devices. Symmetrix DMX models are defined by the number of DDAs configured for the Fibre Channel loops. The Symmetrix DMX models DMX1000, DMX1000-M2, DMX2000, DMX2000-M2 and DMX2000-M2-3, support 18-drive Fibre Channel loops. The Symmetrix DMX models DMX1000-P2, DMX2000-P2 and DMX2000-P2-3, support nine-drive Fibre Channel loops. The DMX3000-3 and DMX-M2-3 support 73 GB and 146 GB drives in 18-drive Fibre Channel loops.

Each DDA has the following features:

- ◆ Industry standard 3.5-inch low-profile form factor
- ◆ Integrated dual-port Fibre Channel Arbitrated Loop (FC-AL) controller
- ◆ 2 Gb/s maximum instantaneous data transfers per port
- ◆ 73 GB disk devices with 10K or 15K rpm speed; 146GB disk devices with 10K rpm speed
- ◆ 16 MB device-level data buffer on the 73 GB disk devices
- ◆ 32 MB device-level data buffer on the 146 GB disk devices
- ◆ Fibre Channel interface transports SCSI protocol

The device-level buffer can also be segmented, using the SCSI-2 command set. This allows Symmetrix control logic to issue a read command to the device, detach, then issue a data write to a different segment of the device-level buffer. The on-board microprocessor manages the read or write operation, and notifies the Symmetrix system when the read is complete.

Symmetrix DMX Disk Device Capacities

The Symmetrix DMX1000 models can contain up to 144 disk devices, the Symmetrix DMX2000 models can contain up to 288 disk devices, and the DMX3000 models can contain up to 576 disk devices. More precise storage capacity values depend on:

- ◆ Whether the user configures the disk to emulate an open systems device or a mainframe 3380 or 3390 device.
- ◆ Whether the user calculates a gigabyte to equal:
 - 1,000 * 1,000 * 1,000 bytes
 - or 1,024 * 1,024 * 1,024 bytes
- ◆ The number of logical volumes configured on the disk

- ◆ Data protection option used: (RAID 1, Parity RAID (3+1), Parity RAID (7+1), RAID 5 (3+1), RAID 5 (7+1), RAID 10, SRDF)

Table 2-6 shows the available Symmetrix cylinders and storage capacities for 73 GB and 146 GB disk devices based on the mainframe and open systems emulations. The capacities are approximate because the number of logical volumes and data protection options are not factored into the total drive capacity.

The GB values shown in Table 2-6 are based on the following conventions:
 The GB₂ value is based on 1 GB = 1024 * 1024 * 1024 bytes.
 The GB₁₀ value is based on 1 GB = 1000 * 1000 * 1000 bytes. Although the open systems GB values are expressed differently, they are equivalent.

Table 2-6 Symmetrix DMX Disk Capacities^a

Disk Device Size	Cylinders for 3380 Emulation	3380 Capacity in GB ₁₀	Cylinders for 3390 Emulation	3390 Capacity in GB ₁₀	Open Systems Cylinders	Open Systems GB ₁₀	Open Systems GB ₂
73 GB	98,204	69.93	84,910	72.17	148,734	73.1	68.08
146 GB	196,393	139.8	170,136	144.6	297,799	146	136

a. These capacities are approximate.

Symmetrix DMX Logical Volume Capacities

At Enginuity level 5670, the maximum number of logical volumes supported on Symmetrix DMX physical disk devices depends on the data protection used. Table 2-7 describes the logical volumes supported on Symmetrix DMX disk devices.

Table 2-7 Logical Volumes Supported on Symmetrix DMX Disk Devices

Symmetrix DMX 73 GB and 146 Disk Devices and Data Protection ^a	Maximum Logical Volumes	
	Symmetrix DMX	Symmetrix DMX2
Logical Volumes per Disk Device with RAID 10 Protection (mainframe data volumes only)	128	128
Logical Volumes per Disk Device with SRDF Protection (without local data protection)	77	108
Logical Volumes per Disk Device with RAID 1 Protection	77	108
Logical Volumes per Disk Device with Parity RAID (3+1) Protection	58	81
Logical Volumes per Disk Device with Parity RAID (7+1) Protection	39	55
Logical Volumes per Disk Device with RAID 5 (3+1) Protection	255	255
Logical Volumes per Disk Device with RAID 5 (7+1) Protection	255	255

a. For information on Symmetrix DMX data protection options, refer to Table 5-2 on page 5-23.

For more information on logical volumes, refer to *Open Systems Hypervolumes* on page 4-14 or *Mainframe Systems Hypervolumes* on page 4-18. Configuration requirements for Symmetrix systems vary according to the applications used. To configure logical volumes for optimum Symmetrix system performance, consult your EMC Sales Representative.

Symmetrix DMX systems can support up to 8,000 logical volumes, depending on data protection options and hardware configuration. Table 2-8 describes the maximum logical volumes supported on each Symmetrix DMX model by data protection option.

Table 2-8 Logical Volumes Supported for Symmetrix DMX Models ^a

Symmetrix DMX Model	Data Protection Option	Maximum Number of Disk Drives	Maximum Number of Disk Director Boards	Maximum Logical Volumes per System (Symmetrix DMX)	Maximum Logical Volumes per System (Symmetrix DMX-2)
DMX1000 DMX1000-M2	RAID 10	144	2	1,059	1,482
DMX1000 DMX1000-M2	RAID 1	144	2	2,420	3,388
DMX1000 DMX1000-M2	Parity RAID (3+1)	144	2	3,630	5,082
DMX1000 DMX1000-M2	Parity RAID (7+1)	144	2	4,235	5,929
DMX1000 DMX1000-M2	RAID 5 (3+1)	144	2	4,096	4,096
DMX1000 DMX1000-M2	RAID 5 (7+1)	144	2	2,048	2,048
DMX1000 DMX1000-M2	SRDF	144	2	4,840	6,776
DMX1000-P2	RAID 10	144	4	2,000	2,000
DMX1000-P2	RAID 1	144	4	4,840	6,776
DMX1000-P2	Parity RAID (3+1)	144	4	6,264	8,000
DMX1000-P2	Parity RAID (7+1)	144	4	4,914	6,930
DMX1000-P2	RAID 5 (3+1)	144	4	8,000	8,000
DMX1000-P2	PAID 5 (7+1)	144	4	4,096	4,096
DMX1000-P2	SRDF	144	4	8,000	8,000

Table 2-8 Logical Volumes Supported for Symmetrix DMX Models (*continued*)^a

Symmetrix DMX Model	Data Protection Option	Maximum Number of Disk Drives	Maximum Number of Disk Director Boards	Maximum Logical Volumes per System (Symmetrix DMX)	Maximum Logical Volumes per System (Symmetrix DMX-2)
DMX2000 DMX2000-3 DMX2000-M2 DMX2000-M2-3	RAID 10	288	4	2,000	2,000
DMX2000 DMX2000-3 DMX2000-M2 DMX2000-M2-3	RAID 1	288	4	4,840	6,776
DMX2000 DMX2000-3 DMX2000-M2 DMX2000-M2-3	Parity RAID (3+1)	288	4	7,260	8,000
DMX2000 DMX2000-3 DMX2000-M2 DMX2000-M2-3	Parity RAID (7+1)	288	4	8,000	8,000
DMX2000 DMX2000-3 DMX2000-M2 DMX2000-M2-3	RAID 5 (3+1)	288	4	8,000	8,000
DMX2000 DMX2000-3 DMX2000-M2 DMX2000-M2-3	RAID 5 (7+1)	288	4	4,096	4,096
DMX2000 DMX2000-3 DMX2000-M2 DMX2000-M2-3	SRDF	288	4	8,000	8,000
DMX2000-P2 DMX2000-P2-3	RAID 10	288	8	2,000	2,000
DMX2000-P2 DMX2000-P2-3	RAID 1	288	8	8,000	8,000
DMX2000-P2 DMX2000-P2-3	Parity RAID (3+1)	288	8	8,000	8,000
DMX2000-P2 DMX2000-P2-3	Parity RAID (7+1)	288	8	8,000	8,000

Table 2-8 Logical Volumes Supported for Symmetrix DMX Models (*continued*)^a

Symmetrix DMX Model	Data Protection Option	Maximum Number of Disk Drives	Maximum Number of Disk Director Boards	Maximum Logical Volumes per System (Symmetrix DMX)	Maximum Logical Volumes per System (Symmetrix DMX-2)
DMX2000-P2 DMX2000-P2-3	RAID 5 (3+1)	288	8	8,000	8,000
DMX2000-P2 DMX2000-P2-3	RAID 5 (7+1)	288	8	8,000	8,000
DMX2000-P2 DMX2000-P2-3	SRDF	288	8	8,000	8,000
DMX3000-3 DMX3000-M2-3	RAID 10	576	4	2,000	2,000
DMX3000-3 DMX3000-M2-3	RAID 1	576	4	8,000	8,000
DMX3000-3 DMX3000-M2-3	Parity RAID (3+1)	576	4	8,000	8,000
DMX3000-3 DMX3000-M2-3	Parity RAID (7+1)	576	4	8,000	8,000
DMX3000-3 DMX3000-M2-3	RAID 5 (3+1)	576	4	8,000	8,000
DMX3000-3 DMX3000-M2-3	RAID 5 (7+1)	576	4	8,000	8,000
DMX3000-3 DMX3000-M2-3	SRDF	576	4	8,000	8,000

a. This table shows the maximum logical volumes available for the given Symmetrix models with the maximum number of disk drives and a homogeneous protection scheme on those disk drives. The logical volume limit is a function of the number of disk drives and the number of disk director processors (CPUs). Symmetrix DMX systems that have fewer disk drives or disk directors may have fewer logical volumes available on a particular configuration.

Symmetrix DMX Disk Device Emulations

Symmetrix DMX systems support connectivity to mainframe systems and open systems hosts. When the Symmetrix DMX systems are configured to open systems hosts such as UNIX, Windows, Linux, or iSeries the Symmetrix disk devices emulate standard disk devices. When the Symmetrix DMX systems are configured to IBM z/OS/PCM system hosts, the Symmetrix disk devices emulate IBM CKD DASD.

The Symmetrix Enterprise Storage Platform (ESP) software enabler, a software option, is required if you plan to store and access mainframe and open systems data on the same Symmetrix system.

Deleting (and then Adding) Devices Online

Engenuity code 5670 supports removing and then adding devices online, which facilitates the following configuration enhancements:

- ◆ Change Device Emulation Online—Remove a CKD volume and add an FBA volume and vice-versa.

Adding a CKD volume to a Symmetrix system requires a global memory configuration change if this is the first CKD volume being added. However, the system can be configured in advance, thus avoiding an offline global memory reformat.

- ◆ Convert between mirrored and RAID protected volumes.

Open System Disk Emulation

On open systems hosts, the Symmetrix DMX logical disk volumes appear as standard SCSI disk devices with data stored in fixed-block architecture (FBA) format. All host logical volume manager software can be used with Symmetrix disk volumes.

The following paragraphs describe the FBA disk format and logical volume structure.

FBA Data and Command Format

Fixed Block Architecture (FBA) disk devices store data in fixed sized blocks (typically 512 bytes). A disk device using FBA format is viewed as a large array of blocks. The physical position of each block (cylinder and track) is usually not significant to the host. When requesting disk access for read or write, the host addresses a file by the logical block address (LBA) of the starting block and a count of the total blocks used by the file. Symmetrix channel directors and disk directors control access to global memory and disk devices, responding to host requests as a standard disk device.

Disk devices in Symmetrix DMX systems attached to iSeries hosts are configured in 520-byte blocks.

Logical Volume Structure (Open Systems)

The channel directors interact with global memory. Therefore, there is no physical meaning to cylinders, tracks, and heads on the Symmetrix logical volume from the front-end point of view. However, Symmetrix systems use a *logical* geometry definition for their logical volume structure. This geometry is reflected in the mode sense data available to the host.

Symmetrix systems use the following logical volume structure:

- ◆ Each logical volume has n cylinders
- ◆ Each cylinder has 15 tracks (heads)
- ◆ Each track has 64 blocks of 512 bytes

Therefore, a Symmetrix logical volume with n cylinders has a usable block capacity of:

$$n * 15 * 64$$

n for each volume is defined during Symmetrix configuration

To calculate the size of the logical volume:

$$\text{Number of cylinders} * \text{heads} * \text{blocks} * 512$$

$$(n * 15 * 64 * 512)$$

For information on configuring open systems logical volumes, refer to *Open Systems Hypervolumes* on page 4-14.

IBM CKD DASD Disk Emulation

The Symmetrix DMX system appears to mainframe operating systems as a 3990-6 or 2105 controller. The physical disk devices can appear to the mainframe operating system as a mix of multiple 3390 and 3380 device types. All standard models of the 3380 or 3390 volumes can be emulated up to the physical volume sizes installed. A single Symmetrix system can simultaneously support both 3380 and 3390 device emulations. Table 2-9 on page 2-30 lists the Symmetrix characteristics for some standard IBM device emulation modes. Symmetrix systems also support nonstandard device sizes, as long as the cylinder count does not exceed that of the equivalent IBM device type.

For more IBM DASD emulation characteristics, refer to Appendix A, *Symmetrix DMX Specifications* on page A-1.

Table 2-9 IBM DASD Emulation Characteristics

IBM DASD Model	MB/Volume	Bytes/Track	Bytes/Cylinder	Cylinders/Volume
3390-27	27,844	56,664	849,960	32,760
3390-9	8,514	56,664	849,960	10,017
3390-3	2,838	56,664	849,960	3,339
3390-2	1,892	56,664	849,960	2,226
3390-1	946	56,664	849,960	1,113
3380K	1,891	47,476	712,140	2,655

Mixed Track Geometries

You can configure a Symmetrix DMX system with both 3380 and 3390 track geometries on the same disk device. A single disk device can contain up to 128 logical volumes, depending on the data protection used.

For information on configuring mainframe logical volumes, refer to *Mainframe Systems Hypervolumes* on page 4-18.

IBM/PCM Data and Command Formats

All Symmetrix models support the count-key-data (CKD) and extended count-key-data (ECKD) format used by IBM 3390 and 3380 DASD. For a full description of the channel command words (CCW) supported, refer to the *IBM 3990 Storage Control Reference* or the *IBM 3380 Storage Control Model 13 Description*.

Figure 2-14 shows the CKD track format emulated for 3390 and 3380 DASD.

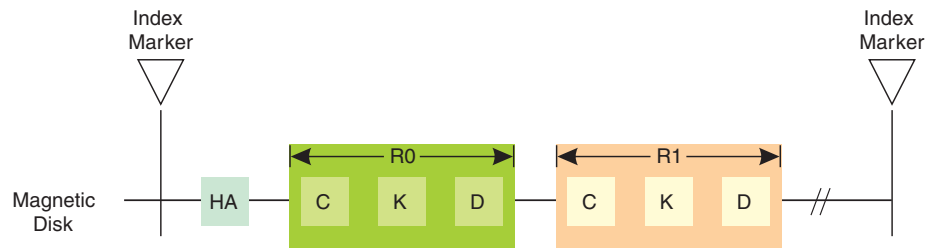


Figure 2-14 Track Format for 3390 and 3380 DASD

Track Format

All tracks are written with formatted records. The start and end of each track are defined by the index marker. Each track has the same basic format as that shown in Figure 2-14. That is, it has an index marker, home address (HA), record zero (R0), and one or more data records (R1 through Rn). These track formats are discussed in the following sections.

Information is recorded on all Symmetrix disk devices in an emulation format chosen at configuration. Each track contains certain *nondata* information (such as the address of the track, the address of each record, the length of each record, and the gaps between each area), and data information.

Index Mark — An index marker indicates the physical beginning and end of each track for each disk device (Figure 2-14).

Home Address (HA) — There is one home address on each track that defines the physical location of the track by specifying the track

address (cylinder and head location) and the condition of the track (flag byte). The flag byte indicates whether the track is usable, defective, or an alternate track.

Record Zero—R0 (Track Descriptor Record) — This is the first record after the home address. The Count field indicates its physical location (cylinder and head), record number, key length, and data length. In general, the key length is zero bytes and the data length is eight.

Data Records (R1 through Rn) — All remaining records on a track are data records. The Count field indicates the data record's physical location (cylinder and head), record number, key length, and data length. The key is optional and, when used, contains information used by an application. The data area contains the user data. To determine the number of records a track can hold, refer to the *IBM 3390 Direct Access Storage Introduction* or *IBM 3380 Direct Access Storage Introduction* for the equations for calculating this number.

Track Capacity

Track capacity is the maximum capacity achievable when there is one physical data record per track formatted without a key. Because the track can contain multiple data records, additional Address Markers, Count Areas, and gaps reduce the number of bytes available for data.

The track capacity is the number of bytes left for data records after subtracting the bytes needed for the home address, record zero, address marker, count area, cyclic check (for error correction), and the gaps for one data record.

For 3390 emulations, the track capacity is 56,664 bytes. For 3380 emulations, the track capacity is 47,476 bytes.

Channel, Disk, and Global Memory Directors

This section describes the Symmetrix DMX directors. The channel directors and global memory directors manage the storage control functions. The disk directors handle the data storage functions.

References to Symmetrix DMX1000, DMX2000, and DMX3000 systems in this section are inclusive of all model types for the particular Symmetrix DMX system referenced.

Channel Director Connectivity

All Symmetrix DMX systems provide channel connectivity through combinations of mainframe systems and open systems channel directors. These include:

- ◆ Fibre Channel directors (also used with SRDF)
- ◆ ESCON directors
- ◆ ESCON directors used for SRDF, data migration, and the SDMS (Symmetrix Data Migration Service) application
- ◆ Multiprotocol Channel Directors (MPCD) available with these channel connections:
 - FICON
 - iSCSI
 - GigE (Gigabit Ethernet) remote directors used for SRDF

The Multiprotocol Channel director and support for FICON, iSCSI and GigE channel connections require Enginuity level 5670 and higher.

Symmetrix DMX systems support mixed ESCON, FICON, Fibre Channel, and iSCSI interfaces when the required Symmetrix ESP software is installed on the Symmetrix system.

The Symmetrix DMX systems support open systems hosts such as UNIX systems, Linux systems, and Windows connectivity through Symmetrix Fibre Channel or iSCSI directors. (iSeries connectivity is only supported through Fibre Channel directors.) The Symmetrix DMX systems support mainframe connectivity through ESCON and FICON directors. Symmetrix systems connect directly to host processors through physical channel attachments.

Channel Director Descriptions

Symmetrix channel directors are single cards that occupy one slot on the Symmetrix midplane. All channel directors interface to host channels through interface adapter cards connected to the opposite side of the midplane. The Symmetrix DMX1000 may support up to six channel directors. The Symmetrix DMX2000/3000 may support up to twelve channel directors.

Appendix C, *Planning and Installation*, provides information on mainframe and open systems channel director configurations. Contact your EMC Sales Representative for specific supported configurations.

All channel directors contain four high performance microprocessors. The channel directors process data from the host and manage access to global memory over a direct matrix (DMX) technology (Figure 2-8 on page 2-14 and Figure 2-7 on page 2-13). Each channel director on the Symmetrix DMX system supports eight internal links to global memory. DMX technology is used across the Symmetrix system, as it is also designed on to each global memory director. In addition to DMX technology, each director board includes support for a separate message matrix for the transfer of control information. (For information on the Symmetrix DMX message matrix, refer to *Symmetrix DMX Point-to-Point Message Matrix* on page 2-15 and *Symmetrix DMX Control and Environmental Matrix* on page 2-49.)

Fibre Channel Directors (Front-End)

The Fibre Channel front-end director has eight FC ANSI compliant, 2 Gb/s (also configurable to 1 Gb/s) Fibre Channel interfaces for connection to host systems. The director has eight high-speed paths to global memory. The Fibre Channel director interfaces to the host channels through an eight-port Fibre Channel interface adapter and is available in the following single-mode and multimode configurations:

- ◆ Eight multimode ports
- ◆ Seven multimode ports and one single-mode port
- ◆ Six multimode ports and two single-mode ports

Each Symmetrix DMX Fibre Channel director supports eight internal links to global memory. Data transfers between host and global memory can execute concurrently across all Fibre Channel ports on a director.

Table 2-10 on page 2-35 lists the Fibre Channel front-end support capabilities for directors, their Symmetrix devices, and their addressing.

Table 2-10 Symmetrix Devices and Addressing Capabilities for Fibre Channel Front-End Directors

Maximum Symmetrix Devices and Device Addresses	Maximum Symmetrix Devices per Front-End Fibre Channel Processor ^a
Symmetrix Devices per Processor	2,048
Symmetrix Devices per Fibre Channel Director Board	8,192
Addresses Range per Port	0 - 4,095 ^b

- a. Each Fibre Channel front-end director has two processors.
- b. Address range (0x000 - 0xFFFF).

The numerical values for Symmetrix devices stated in Table 2-10 are the maximum allowed according to the architectural limits of the microcode running on the Fibre Channel front-end director. The actual limits allowed for customer environments will be lower, and are dependent on the host type, HBA and driver type/version, and overall system implementation. Also, note that using metadevices will reduce the number of host-visible volumes for a given number of devices (*Symmetrix Devices*) configured to the Fibre Channel front-end director; that is, each member of the metadevice will be counted to the allowed limit of devices configured to a Fibre Channel front-end director.

For information on Fibre Channel host attachments, refer to the *EMC Support Matrix* located on the EMC Powerlink website at:
<http://powerlink.emc.com>.

The Symmetrix DMX1000 may support up to six Fibre Channel directors. The Symmetrix DMX2000 may support up to twelve Fibre Channel directors. The Symmetrix DMX3000 may support up to eight Fibre Channel directors.

Contact your EMC Sales Representative for specific supported configurations.

Fibre Channel
Adapters
(Front-End)

The Fibre Channel adapters provide the connectivity between the host channels and the Fibre Channel front-end director through optical transceiver connections.

Symmetrix Fibre Channel directors currently support connections to a number of hosts supporting Fibre Channel connectivity. For a current list of supported hosts, refer to the appropriate host-specific EMC Host Connectivity Guide available on the EMC Powerlink website at:
<http://powerlink.emc.com> or contact your EMC Sales Representative.

Fibre Channel Directors for SRDF

The Fibre Channel host director can be Enginuity-configured as the link between Symmetrix units in a Symmetrix Remote Data Facility (SRDF) configuration. The Fibre Channel director interfaces to Symmetrix channels through the Fibre Channel interface adapter.

iSeries Fibre Channel Connectivity

The Symmetrix Fibre Channel Adapters, through fibre, connect to the iSeries 270 and 8xx models. When using directly connected fibre devices (point-to-point) the maximum distance is 500 meters in 1 Gb/s mode.

ESCON Channel Directors

The Symmetrix DMX ESCON director processes data from the host and manages access to global memory. EMC offers an eight-port, four-processor (8x4) ESCON director, which supports data transfer rates up to 17 MB/s per port with the host. The eight-port, four-processor ESCON director contains four processors (CPUs) and eight interfaces to host mainframe systems. Each ESCON directors can logically have four ESCON *engines* and therefore supports four concurrent I/Os.

The Symmetrix ESCON director can support up to 512 logical paths per port when only the A port of the A and B ports of the processor is configured and up to 256 logical paths per port when both the A and B ports are configured. Table 2-11 describes the supported ESCON director configurations.

Table 2-11 Four-Processor, Eight-Port ESCON Director Configurations

	A and B Port Enabled	A Port Enabled
Maximum LCU (Logical Control Units) per port	8 (0 to F)	8 (0 to F)
Maximum LCUs per Symmetrix system	64	64
Maximum devices per LCU	256	256
Maximum Logical Paths per port	256	512
Maximum Logical Paths per LCU per port	32	64
Maximum DMX channel addresses per one or two ports	2,048	2,048
Maximum DMX channel addresses per Symmetrix system composed of up to 8,000 base devices (physical devices) with up to 7 aliases (logical devices)	16,384	16,384
Maximum concurrent I/O host connections per Symmetrix DMX1000 system ^a	24	24
Maximum concurrent I/O host connections per Symmetrix DMX2000 system ^a	48	48
Maximum concurrent I/O host connections per Symmetrix DMX3000 system ^a	32	32

a. The maximum concurrent I/O connections is based on six ESCON directors for the DMX1000, 12 for the DMX2000 and eight for the DMX3000. Contact your EMC Sales Representative for specific supported configurations.

SDMS Support

The Symmetrix ESCON director supports the SDMS (Symmetrix Data Migration Service) application for migrating data over ESCON channels from one Symmetrix system to ESCON channels on another Symmetrix system.

SRDF Over ESCON Support

At Engenuity level 5670, Symmetrix ESCON directors support SRDF remote connections.

Multiprotocol Channel Directors

The Symmetrix DMX Multiprotocol Channel Director (MPCD), through mezzanine card technology, supports GigE, iSCSI, and FICON protocols on Symmetrix DMX systems. In four-port configurations the back adapter implements a flexible mezzanine card that delivers highly configurable support for FICON channels to mainframe systems and/or Gigabit Ethernet support for SRDF over IP connections. In two-port configurations, mezzanine cards are implemented on the main director board instead of the back adapter. FICON, Gigabit Ethernet, and iSCSI combinations can be configured on the four-port and two-port boards.

The Multiprotocol Channel director and support for FICON, iSCSI and GigE channel connections require Engenuity level 5670 and higher.

FICON Channel Directors

FICON mezzanine cards on the MPCD support *native mode point-to-point* connections and FICON *native mode switched point-to-point* connections to IBM 9672, G5/G6, and z/900 systems running z/OS, z/VM, OS/390, VM/ESA, and VSE/ESA operating systems. FICON employs ESCON protocols that have been mapped to the FC-4 upper level protocol layer of the Fibre Channel architecture. FICON supports multiple concurrent I/O connections, channel program multiplexing, and better link utilization than ESCON path switching. FICON allows the consolidation of multiple ESCON channels into one FICON channel.

The FICON mezzanine card provides up to four single-mode or multimode LC bi-directional (full duplex) connections. Symmetrix FICON channels transfer data at speeds up to 2 Gb/s.

For information on additional configuration options, refer to *Symmetrix FICON Configurations* on page 2-54.

The DMX FICON design auto-detects 2 Gb/s or 1 Gb/s at switch or channel port login time. The setting will stay at 2 Gb/s unless there is a problem or if the other port is running at 1 Gb/s. Only a switch has settings on each port for 2 Gb/s, 1 Gb/s, or auto-negotiate.

The Symmetrix DMX1000 systems may support up to six FICON channel directors. The Symmetrix DMX2000 systems may support up to twelve FICON channel directors. DMX3000 systems may support up to eight FICON channel directors. The FICON channel directors support the configurations described in Table 2-12.

Table 2-12 FICON Director Configurations

Maximum LCUs (Logical Control Units) per port	16 (0 to F)
Maximum LCUs per Symmetrix system	64
Maximum devices per LCU	256
Maximum Logical Paths per port	1,024
Maximum Logical Paths per LCU per port	64
Maximum DMX channel addresses per port	4,096
Maximum DMX channel addresses per Symmetrix system composed of up to 8,000 base devices (physical devices) with up to 7 aliases (logical devices)	16,384
Maximum concurrent I/O host connections per Symmetrix DMX1000 system ^a	24
Maximum concurrent I/O host connections per Symmetrix DMX2000 system ^a	48
Maximum concurrent I/O host connections per Symmetrix DMX3000 system ^a	32

a. The maximum concurrent I/O connections is based on six FICON directors for the DMX1000, 12 for the DMX2000 and eight for the DMX3000. Contact your EMC Sales Representative for specific supported configurations.

Gigabit Ethernet (GigE) Remote Directors

GigE remote mezzanine cards on the MPCD enable remote director functionality based upon Gigabit Ethernet technology that enable direct Symmetrix-to-IP network attachment and eliminate the need for expensive media converter appliances.

GigE support for SRDF on Symmetrix DMX systems increases the options for Symmetrix-to-Symmetrix connectivity and it allows the Symmetrix system to connect to your existing Ethernet infrastructure and directly access high-speed data transmission conduits via Internet Protocol (IP). It supports SRDF traffic to one or more remote Symmetrix systems that also have GigE remote directors installed. The GigE remote director supports TCP/IP protocols and function layers. It is fully compatible with the SRDF protocols and other Symmetrix DMX directors, drives, software, and protection schemes.

Symmetrix GigE remote channels for SRDF transfer data at speeds up to 1 Gb/s. The Symmetrix GigE remote director provides up to four 1 Gb/s Ethernet ports and connects via LC connectors. It is compatible with Symmetrix DMX and Symmetrix 8000 systems.

iSCSI Channel Directors

The Symmetrix DMX MPCD, through mezzanine card technology, supports iSCSI channel connectivity by way of Gigabit Ethernet (GigE) hardware for the Symmetrix DMX systems. The iSCSI channel director supports iSCSI channel connectivity to IP networks and to iSCSI-capable open systems server systems for block storage transfer between hosts and storage. The primary applications are storage consolidation and host extension for stranded servers and departmental workgroups. Symmetrix GigE remote channels for SRDF transfer data at speeds up to 1 Gb/s.

The Symmetrix iSCSI director provides up to four 1 Gb/s Ethernet ports and connects via LC connectors.

The iSCSI director supports TCP/IP protocols and function layers. It is fully compatible with the SRDF protocols and other Symmetrix DMX directors, drives, software, and protection schemes.

DMX-2 Channel Directors and Disk Directors

The Symmetrix DMX-2 directors dramatically increase processing power and Symmetrix performance. The DMX-2 directors include the eight-port Fibre Channel director, the Multiprotocol Channel director (MPCD), and the FICON, GigE (or iSCSI) mezzanine cards. The DMX-2 Fibre Channel director is available in the following models:

- ◆ Fibre Channel Director with eight multimode ports
- ◆ Fibre Channel director with seven multimode ports and one single-mode port
- ◆ Fibre Channel director with 6 multimode ports and two single-mode ports

The DMX-2 MPCD is offered with the following mezzanine card models:

- ◆ Four FICON ports
- ◆ Three FICON ports and one GigE (or iSCSI) port
- ◆ Two FICON ports and two GigE (or iSCSI) ports
- ◆ Four GigE (or iSCSI) ports

Also included in the DMX-2 directors is the Fibre Channel back-end disk director.

The DMX-2 directors are not backward compatible and cannot be mixed with earlier Symmetrix DMX directors (with the exception of the ESCON director). For actual Symmetrix DMX-2 director performance data, specifications, configurability, compatibility with existing Enginuity 5670, and availability, contact your EMC Sales Representative.

Fibre Channel Disk Directors (Back-End)

The Symmetrix DMX Fibre Channel back-end disk directors manage the interface to the disk drive assemblies (DDAs), and are responsible for data movement between the DDAs and global memory. Each disk director on a Symmetrix DMX system supports eight internal links to global memory.

Symmetrix DMX systems feature a 2 Gb/s Fibre Channel back-end infrastructure. The Fibre Channel disk director has four processors that support two ports each on its back adapter. Each *pair* of disk directors provides support for up to eight redundant Fibre Channel loops.

The Symmetrix DMX1000 and DMX1000-M2 systems have two disk directors that support eighteen drives per Fibre Channel loop. The DMX1000-P2 model has four disk directors that support nine drives per Fibre Channel loop.

The Symmetrix DMX2000, DMX2000-M2 and DMX2000-M2-3 have four disk directors that support up to eighteen drives per Fibre Channel loop. The DMX2000-P2 and DMX2000-P2-3 models have eight disk directors that support up to nine drives per Fibre Channel loop.

The Symmetrix DMX3000-3 and DMX3000-M2-3 systems have eight disk directors that support up to eighteen drives per Fibre Channel loop.

The Symmetrix DMX systems support the following configurations as described in Table 2-13 on page 2-41.

Table 2-13 Fibre Channel Disk Director (Back-End) Configurations

	Symmetrix DMX1000 or DMX1000-M2 18-Drive Loops	Symmetrix DMX1000-P2 9-Drive Loops	Symmetrix DMX2000, DMX2000-3 DMX2000-M2, DMX2000-M2-3, DMX3000-3, DMX3000-M2-3 18-Drive Loops	Symmetrix DMX2000-P2 and DMX2000-P2-3 9-Drive Loops
Number of Disk Directors	2	4	- Four for the DMX2000, DMX2000-3, DMX2000-M2, and DMX2000-M2-3 - Eight for the DMX3000-3, DMX3000-M2	8
Maximum Number of Disk Drives	144	144	288 for the DMX2000 and DMX2000-M2 576 for the DMX3000-3 and DMX3000-M2	288
Number of Redundant Loops per Disk Director Pair	8	8	8	8
Range of Disk Drives per Loop	1 to 18	1 to 9	1 to 18	1 to 9
Maximum Number of Disk Drives per Disk Director Pair	144	72	144	72

For information on maximum logical volumes supported on each Symmetrix DMX physical disk device and the maximum logical volumes supported for each Symmetrix DMX model, refer to *Symmetrix DMX Logical Volume Capacities* on page 2-25.

Global Memory Directors

The Symmetrix DMX global memory director technology is one of the most crucial components of a Symmetrix system. All read and write operations transfer data to or from global memory. Any transfers between the host processor, channel directors, and global memory directors are achieved at much greater electronic speeds than transfers involving disks.

Each Symmetrix DMX global memory director accommodates four separately addressable, simultaneously accessible memory regions, which greatly reduces the probability of contention for global memory access. Each global memory director is directly connected to each channel director and disk director through the direct matrix. The enhanced global memory capabilities of the Symmetrix DMX systems, as a part of the Direct Matrix architecture (DMX), allow the addition of more global memory directors to dramatically impact

system bandwidth and performance compared to previous generations of Symmetrix systems.

The DMX architecture ensures highest performance due to the following:

- ◆ Requests for global memory are expedited to reduce locking.
- ◆ Requests are intelligently arbitrated to optimize available resource usage.

Global Memory Director Configuration

The Symmetrix DMX1000 system can support up to four slots in the midplane dedicated to global memory directors and a maximum of 128 GB of global memory. The Symmetrix DMX2000/3000 system can support up to eight slots in the midplane dedicated to global memory and 256 GB of global memory. Individual global memory directors are available in 2 GB, 4 GB, 8 GB, 16 GB, and 32 GB sizes. When configuring global memory for the Symmetrix DMX systems follow these guidelines:

- ◆ A minimum of two and a maximum of four global memory director boards is required for the DMX1000 system configuration.
- ◆ A minimum of four and a maximum of eight global memory director boards is required for the DMX2000 and DMX3000 system configurations.
- ◆ Two-board global memory director configurations require boards of equal capacity.
- ◆ Global memory directors can be added one at a time to configurations of two boards and greater.
- ◆ A maximum of two different global memory director capacities is supported, and the smallest global memory director must be at least one-half the capacity of the largest global memory director.
- ◆ In global memory director configurations with more than two boards, no more than one half of the boards can be of smaller capacity than the largest capacity global memory director.

Symmetrix DMX Power Subsystems

The Symmetrix DMX power subsystems include the following features:

- ◆ 12V power rails for distribution to the card cage and disk bay
- ◆ Partitioned power zones (DMX2000/3000 only)
- ◆ Dual-line cord switching in each power module
- ◆ Centralized cabinet on/off function
- ◆ Power Line Input Modules (PLIM) shelf
- ◆ Battery backup units with on-board charge limiting and electronic status reporting



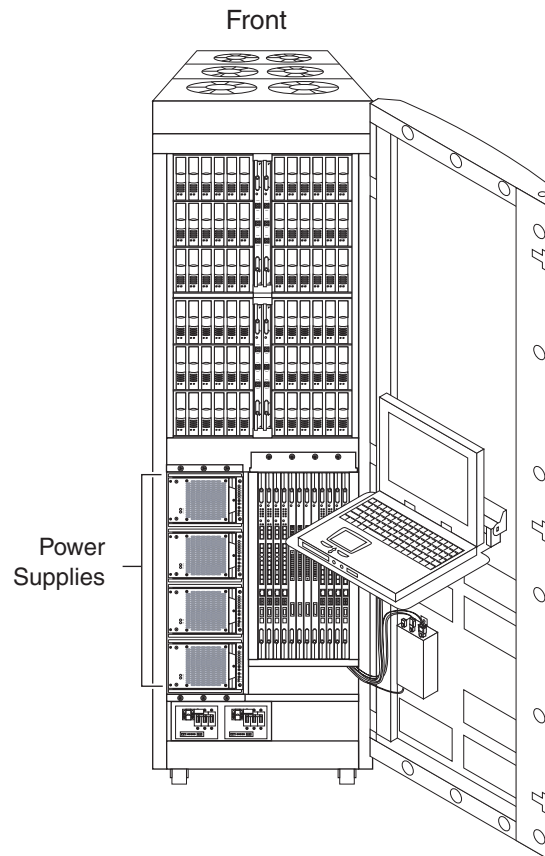
WARNING

To reduce the risk of personal injury, do not open the doors or move the Symmetrix DMX systems unless you are qualified and familiar with safety procedures for electrical equipment and the Symmetrix DMX. The Symmetrix DMX systems contain no user-serviceable parts. They should not be moved or opened for any reason by untrained persons. If the Symmetrix system is in need of relocation or repair, only qualified personnel should access components inside the unit or move it.

Symmetrix DMX1000 Power Subsystem

The single-bay Symmetrix DMX1000 system (Figure 2-15) contains a single power zone that can be populated with two-to-four redundant (N+1) single-phase power supply modules and two powerline input modules.

Minimum configurations of the DMX1000 system are available with two power modules and upgrades can be performed one power supply module at a time, depending on configuration requirements.



SYM-000120LC

Figure 2-15 Symmetrix DMX1000 System Power Modules

Symmetrix DMX2000/3000 Power Subsystem

The Symmetrix DMX2000/3000 systems (Figure 2-16 on page 2-46 and Figure 2-17 on page 2-47) have two power zones and can house up to a maximum of 12 power supply modules providing 2(N+1) redundancy. The Symmetrix DMX2000/3000 systems also have two powerline input modules.

For special instructions for Symmetrix DMX2000/3000 power cables, refer to *Symmetrix DMX2000/3000 Power Cabling* on page 2-47.

Symmetrix DMX2000 Power Configurations

The Symmetrix DMX2000 supports these single-phase and three-phase configurations:

- ◆ Single-phase power—Up to twelve power supply modules, six in each zone

A minimum configuration of the Symmetrix DMX2000 system includes four modules (two modules in each zone). Power is upgraded in the DMX2000 system, two power supply modules (one for each zone) at a time.

- ◆ Three-phase power—Two configurations are offered:
 - Six power supply modules—Three power supply modules in each zone
 - Twelve power supply modules—Six power supply modules in each zone

Symmetrix DMX3000 Power Configurations

The Symmetrix DMX3000 supports these three-phase configurations:

- ◆ Six power supply modules—Three power supply modules in each zone
- ◆ Twelve power supply modules—Six power supply modules in each zone

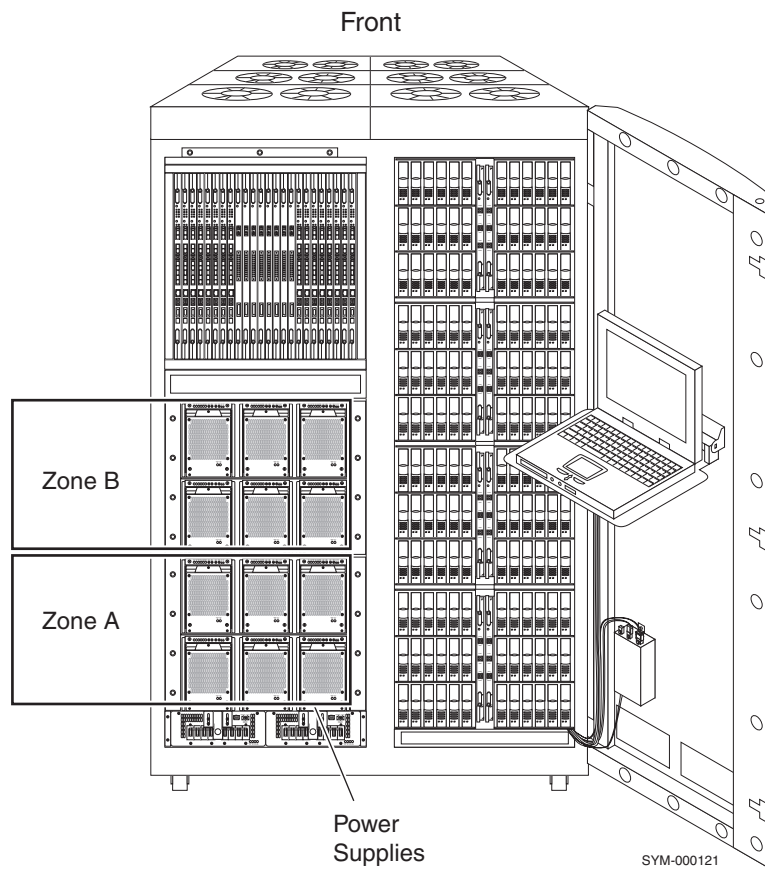


Figure 2-16 Symmetrix DMX2000 System Power Modules

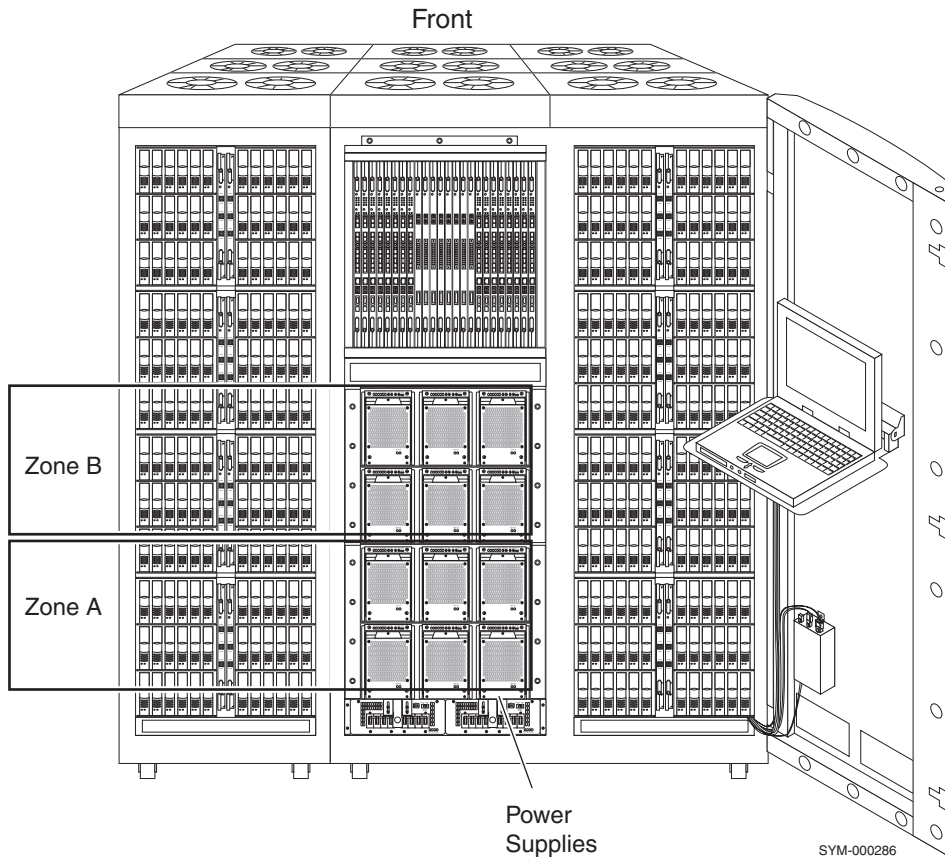


Figure 2-17 Symmetrix DMX3000 System Power Modules

Symmetrix DMX2000/3000 Power Cabling

The Symmetrix DMX2000/3000 systems have two power zones that provide redundancy in the event of a power loss. Figure 2-18 shows the crossover of the AC auxiliary wiring within the power line input module (PLIM) shelf. This allows the PLIM to be replaced nondisruptively without interruption of AC power to a power zone.

For special Symmetrix DMX2000/3000 cabling requirements, refer to *Symmetrix DMX2000/3000 Power Requirements* on page C-4.

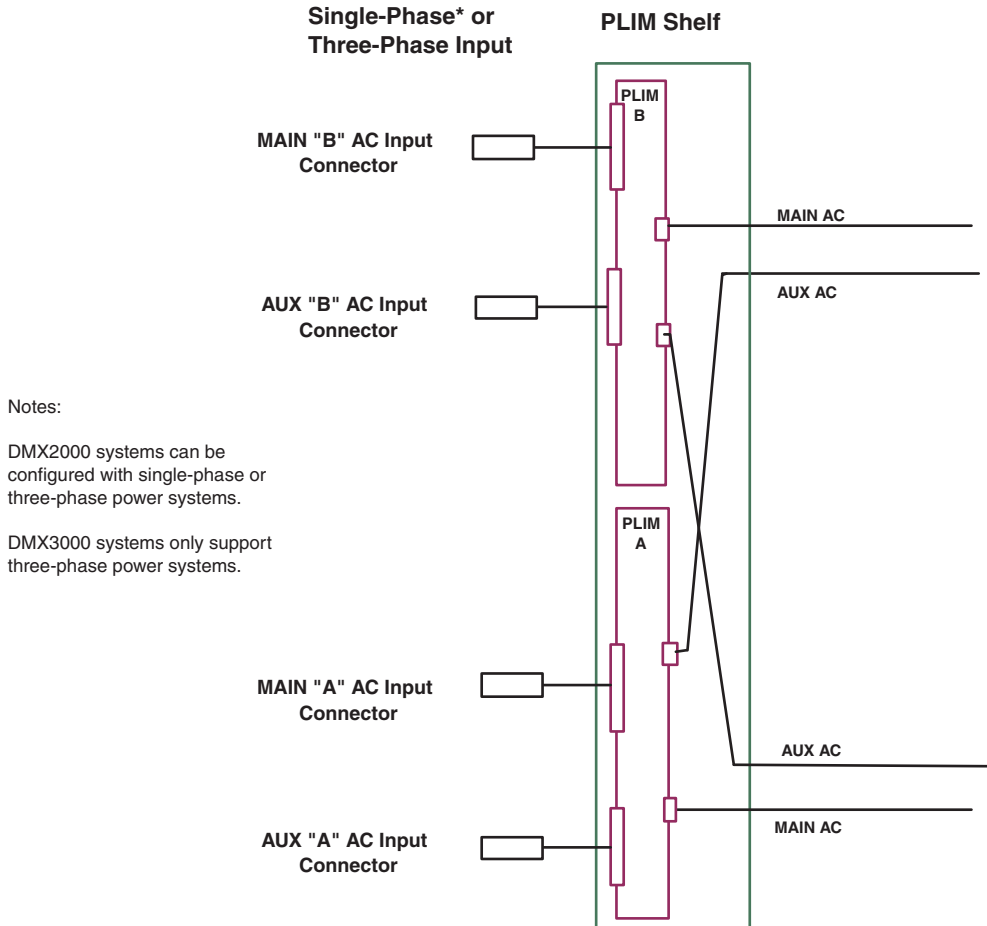


Figure 2-18 Symmetrix DMX2000/3000 Power Cabling Diagram

Symmetrix DMX Control and Environmental Matrix

Within the Symmetrix DMX message matrix are the Environmental Control Module (ECM) and Communication Control Module (CCM). These two modules provide the low-level system-wide communications for running application software, monitoring, and system diagnostics from the service processor.

Communication Control Module

The CCM's primary function is to act as a communications agent between the laptop service processor and the embedded processing nodes within the system. Figure 2-19 on page 2-50 illustrates the Ethernet fabric interconnecting the processing nodes to the service processor. External connections to the service processor provide dial home capabilities for remote monitoring and diagnostics.

The software-driven failover mechanism exists such that the Ethernet fabric remains intact should a CCM become temporarily unavailable. As a backup to the Ethernet fabric, the CCM also contains RS-232 multiplexing logic to allow for an alternate means of serial communication to embedded processing nodes within the DMX. The CCM also has the ability to issue remote commands to the director boards, global memory directors, and ECM. These commands can be issued from the laptop service processor or remotely, by the EMC Customer Support Center, providing a rich set of intelligent serviceability functions. Also within the CCM is the top-level fabric for the message matrix communications system. This is a high-speed communications fabric within the DMX that allows for fast, reliable messaging between compute nodes.

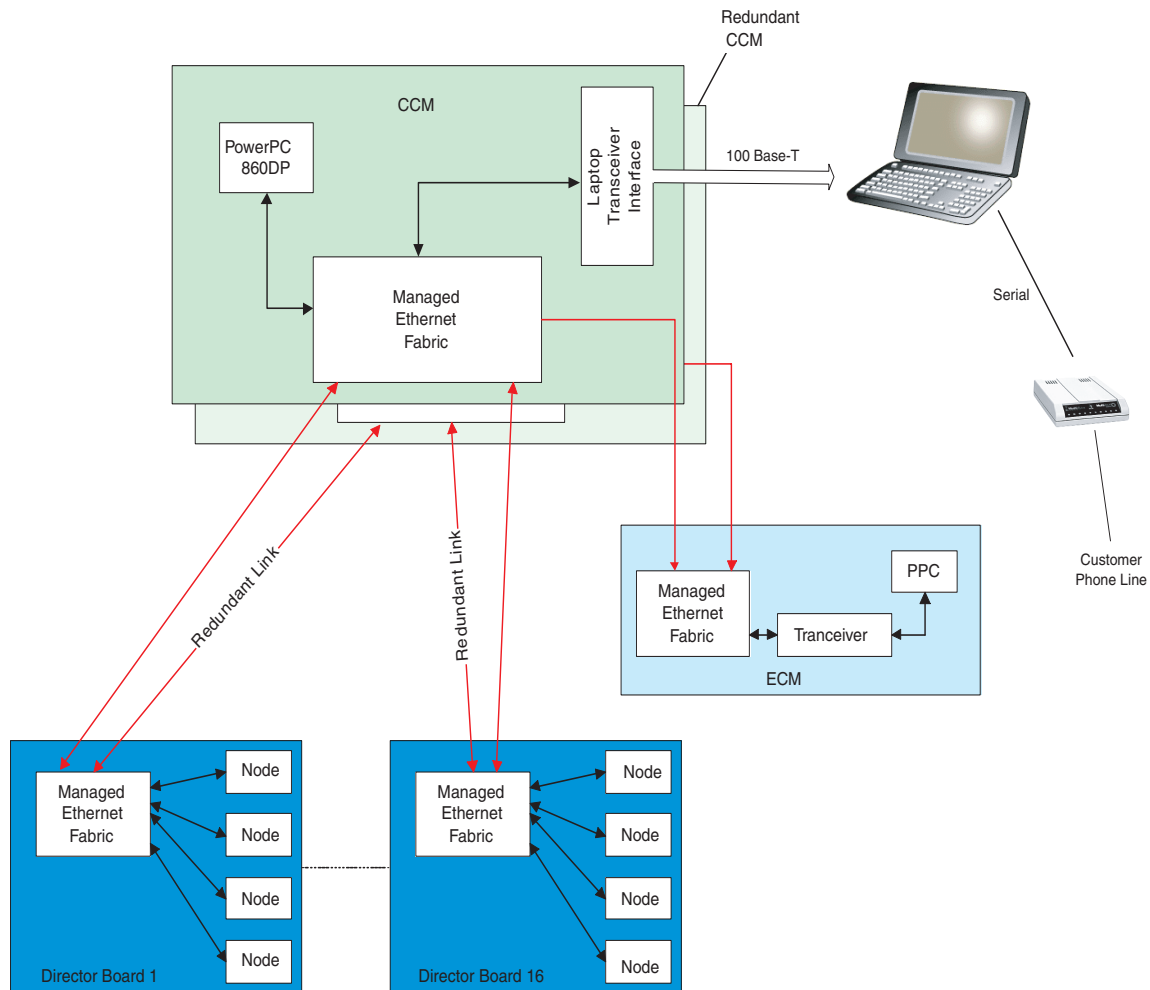


Figure 2-19 Communications Control Module Interconnect Fabric

Environmental Control Module

The ECM monitors and logs environmental events across all critical components and reports any operational problems. Critical components include channel and disk directors, global memory directors, port bypass cards, power supplies, power line input modules, fans, and various on/off switches. The ECM is capable of monitoring each component's local voltages ensuring optimum power delivery. Temperature of directors and memory are also continuously monitored. Fan speed is also varied as required to maintain optimum operating temperature. The AC power main is checked for AC failures, transfer to auxiliary, DC failures, current sharing between DC supplies, DC output voltage, specific notification of overvoltage condition, the current from each DC supply, and voltage drops across major connectors. Ailing components can be detected and replaced before a failure occurs.

Channel Attachments

Symmetrix systems can attach to ESCON channels, FICON channels, or Fibre Channels, or a mix of channel types. The physical connection to a Symmetrix channel interface occurs at the connectors on the channel adapters.

The Symmetrix Enterprise Storage Platform (ESP) option is required when both mainframe hosts (ESCON or FICON channels) and open systems hosts (Fibre Channels, iSCSI, or GigE SRDF) connect to the same Symmetrix system. Consult your EMC Sales Representative for the most current list of supported hosts, models, operating systems, and EMC open systems host support policies, or refer to the EMC Powerlink website at: <http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

FICON Channel Interface Connections

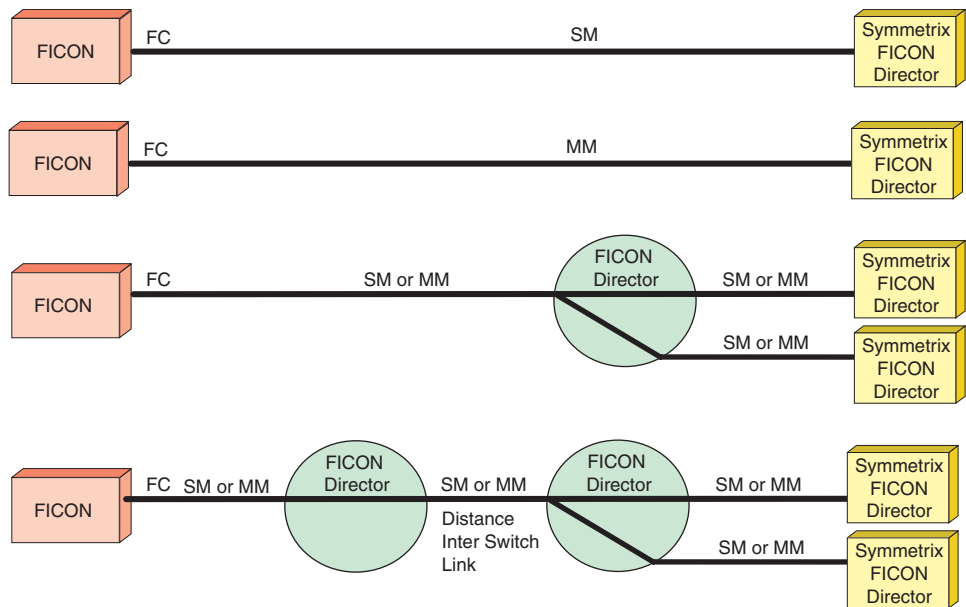
The Symmetrix DMX systems FICON directors connect to mainframe hosts. The four-port, four-processor MPCD and the FICON adapter provide the capability for four concurrent operations through four physical interfaces for communicating with the FICON channels in host systems.

For more information on the FICON director, refer to *FICON Channel Directors* on page 2-37.

FICON channels use fiber optic cables. The current FICON implementation supports data transfer rates up to 2Gb/sec. There are two types of fiber optic cables: multimode and single-mode.

Symmetrix systems directly connect to FICON single-mode or multimode cables. For information on additional configuration options, refer to *Symmetrix FICON Configurations* on page 2-54.

In the FICON environment, a link connects a host FICON channel with a Symmetrix FICON channel interface. This link can be a direct connection between the processor or LPAR and the FICON channel interface. The link can also have a FICON director that branches off to additional single-mode or multimode links with connections to Symmetrix FICON channel directors. Figure 2-20 on page 2-53 illustrates several types of FICON channel attachments.



SYM-000347

Figure 2-20 FICON Channel Attachments

Table 2-14 describes the maximum distances supported by FICON cables.

Table 2-14 Symmetrix FICON Cable Distances ^a

Cable Type	Cable Description	Maximum Supported Distance
Single-mode (SM Long wave Laser (1,310 nano meters)	9 micron, 1 Gb/s	10 km (6.2 miles) for each link - Up to 20 km (12.43 miles) for each link with IBM RPQ
	9 micron, 2 Gb/s	10 km (6.2 miles) for each link - Up to 12 km (7.45 miles) for each link with IBM RPQ
Multimode	50 micron, 1 Gb/s	500 m (1,640 ft) for each link
	50 micron, 2 Gb/s	300 m (984 ft) for each link
	62.5 micron, 1 Gb/s	250 m (820 ft) for each link
	62.5 micron, 2 Gb/s	120 m (394 ft) for each link

a. Distances are point-to-point.

Symmetrix FICON Configurations

In addition to the standard direct-connect configuration, Symmetrix DMX FICON models running Enginuity code 5670 support the use of Cascading and Open Systems Intermix configurations. Cascading can be used to reduce the number of FICON adapters and the amount of intersite cabling required by making use of switch-to-switch communication.

Intermix allows FICON zones to be added to existing Open Systems switches within a site and between sites. These two features help reduce the overall costs while providing greater FICON connectivity, backup, and recovery.

For specific Cascading and Open System Intermix configuration requirements, contact your EMC Sales Representative.

FICON Cascading Configurations

Cascading provides greatly enhanced FICON connectivity within local and remote sites through the use of switch-to-switch extensions of the CPU to the DMX FICON network. These Cascaded switches communicate over long distances using a small number of high speed lines called ISLs (Inter Switch Links). Up to a maximum of two switches may be connected together within a path between the CPU and the DMX.

Same switch vendors are required for a Cascaded configuration. The EMC and IBM branded McData and Inrange switches are supported in pairs. To support Cascading, each vendor requires specific models, hardware and software features, configuration settings, and restrictions. Specific IBM CPU models, MVS release levels, channel hardware, and microcode levels are also required.

FICON Open Systems Intermix Configurations

Open Systems Intermix allows separate FICON zones to be defined within new or existing open systems switches. These switches can also be Cascaded to further enhance connectivity and remote backup and recovery. The EMC and IBM branded McData and InRange switches are supported. To support Open Systems Intermix, each vendor requires specific models, hardware and software features, configuration settings, and restrictions. Specific IBM CPU models, MVS release levels, channel hardware, and microcode levels are also required.

ESCON Channel Interface Connections

The Symmetrix DMX ESCON directors connect to mainframe hosts. The eight-port, four-processor ESCON director provides the capability for four concurrent operations through its four physical interfaces for communicating with the serial channels in host systems.

For more information on the ESCON director, refer to *ESCON Channel Directors* on page 2-36.

ESCON channels use fiber optic cables. These serial channels are formally called the ESA/390 Enterprise Systems Connection Architecture (ESCON) I/O interface. The serial channels use point-to-point or switched point-to-point links. Each link has two physical fibers for transporting data: One for inbound signals and one for outbound signals. The current ESCON implementation supports data transfer rates up to 17 MB/s.

There are two types of fiber optic cables: multimode and single-mode. Multimode cables support a maximum link of 1.86 miles (3 km). Single-mode cables support a maximum link of 12.42 miles (20 km) with the Extended Distance Feature (XDF).

Symmetrix systems directly connect to ESCON multimode cables only.

In the ESCON environment, a link connects a host serial or ESCON channel with a Symmetrix serial channel (ESCON) interface. This link can be a direct connection between the processor, or LPAR, and the serial channel interface. This link can also have up to two ESCON Directors configured between the processor, or LPAR, and the serial channel interface. The Symmetrix system supports a maximum connection length of 26.7 miles (43 km) with two single-mode cables and one multimode cable.

Figure 2-21 on page 2-56 illustrates several types of ESCON channel attachments. Table 2-15 on page 2-57 describes cable types and supported distances.

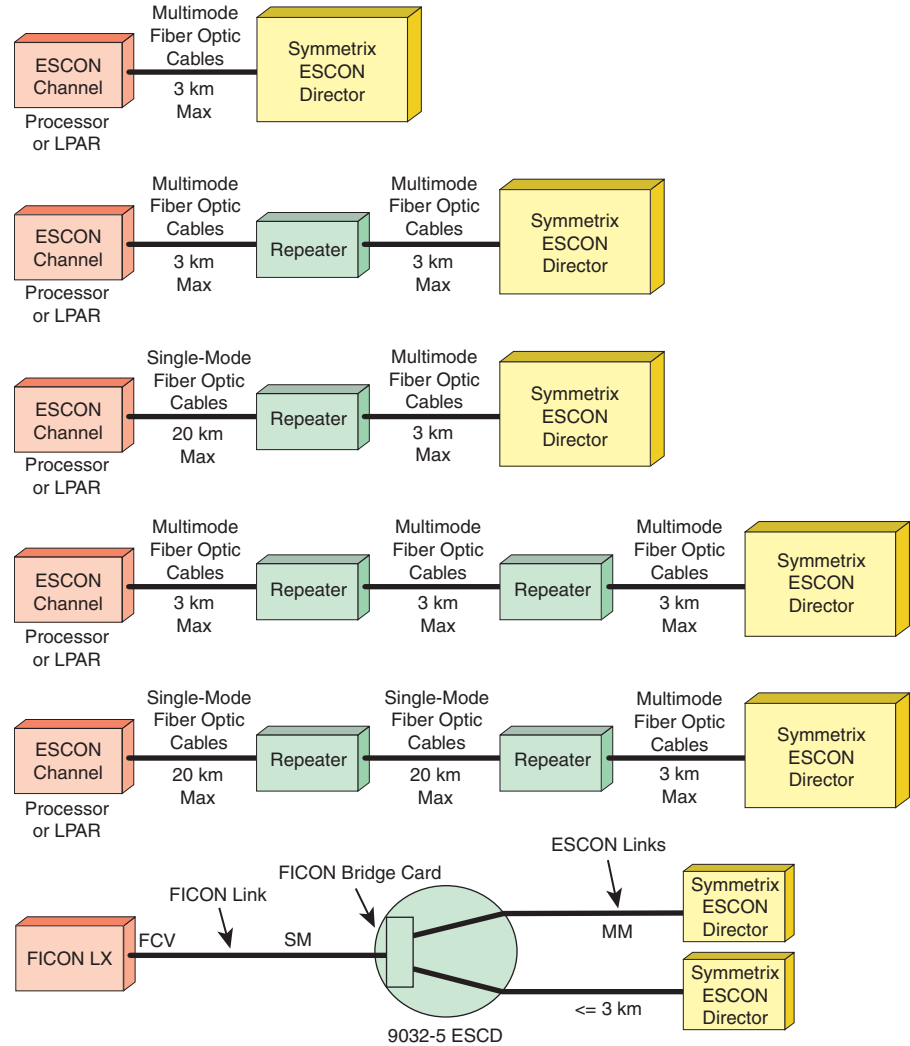


Figure 2-21 ESCON Channel Attachments

Table 2-15 Symmetrix ESCON Cable Distances

Cable Type	Cable Description	Maximum Distance ^a
Direct fiber, multimode	50 micron	2 km (1.24 miles) per cable segment
	62.5 micron	3 km (1.86 miles) per cable segment
Fiber repeaters/converters (for example, McDATA 9191 to McDATA 9191) 3 converters/repeaters maximum allowed	9 micron	30 km (18.64 miles) per cable segment
Other fiber repeaters/converters 3 converters/repeaters maximum allowed	9 micron	20 km (12.42 miles) per cable segment ^b

- a. A cable segment is a physical cable connecting one node to another.
- b. Typical best-case distance specifications are quoted; refer to specific vendor’s equipment for current information.

Mainframe Serial Channel Extenders

This section describes the various types of conversion devices and channel extenders compatible with Symmetrix systems for channel attachment. Symmetrix systems can attach to ESCON (serial) channels directly, or through ESCON channel extenders, or ESCON directors.

Each repeater can be either an ESCON director or an IBM 9036 Remote Channel Extender. If two ESCON directors are used, one of them must use ports that are dedicated to the Symmetrix-to-ESCON channel path.

ESCON Director

The ESCON director provides dynamic switching and extended link path lengths (with XDF capability) when attaching an ESCON channel (TYPE=CNC) to a Symmetrix serial channel interface. One or two ESCON directors may be configured in the channel attachment. However, one of the directors must be configured with a static connection because the ESCON architecture recognizes only one port address. The dynamic switch configuration is defined in the IOCP. The ESCON director may also be used to provide additional flexibility and extend channel lengths when used with channel converters.

Channel Extender

The IBM 9036 Remote Channel Extender (or equivalent device) attaches an ESCON channel (TYPE=CNC) to a Symmetrix serial channel interface. The Remote Channel Extender extends the distance of the connection and, depending on the model, can convert connections from multimode (3 km) to single-mode (20 km).

Connections to Symmetrix serial channel interfaces must be multimode.

Open Systems Fibre Channel Interface Connections

The Symmetrix Fibre Channel adapter provides an interface between the director and open systems host channels. Each Fibre Channel adapter is located at the rear of the midplane, opposite its corresponding channel director. These adapters provide the connectivity between the host channels and the Fibre Channel directors (FC-0 layer of the Fibre Channel standard).

The eight-port, four-processor Fibre Channel director provides the capability for four concurrent operations through its four physical interfaces for communicating with the host systems.

For more information on the Fibre Channel director, refer to *Fibre Channel Directors (Front-End)* on page 2-34.

Fibre Channel directors use fiber optic cables. The channels use Fibre Channel arbitrated loop or switched fabric links. Each link has two physical fibers for transporting data: One for inbound signals and one for outbound signals. The current Fibre Channel implementation supports data transfer rates up to 2 Gb/s.

Table 2-16 Symmetrix Fibre Channel Cable Distances ^a

Cable Type	Cable Description	Maximum Distance
Single-mode	9 micron, 1 Gb/s	10 km (6.2 miles) per cable segment
	9 micron, 2 Gb/s	10 km (6.2 miles) per cable segment
Multimode	50 micron, 1 Gb/s	500 m (1,640 ft) per cable segment
	50 micron, 2 Gb/s	250 m (820 ft) per cable segment
	62.5 micron, 1 Gb/s	300 m (984 ft) per cable segment
	62.5 micron, 2 Gb/s	150 m (492 ft) per cable segment

a. Distances are point-to-point.

For more information on Fibre Channel attachments and cables, refer to the EMC Powerlink website at: <http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

Symmetrix DMX Input/Output Operations

This chapter describes input and output operations between the Symmetrix DMX system and a host system.

- ◆ Symmetrix DMX System Operation.....3-2
- ◆ Elements of a Symmetrix I/O Operation 3-6
- ◆ I/O Performance Enhancements 3-14

Symmetrix DMX System Operation

Intelligent global memory configurations allow Symmetrix DMX disk systems to transfer data at electronic memory speeds that are much faster than physical disk speeds. Symmetrix systems are based on the principle that the working set of data at any given time is relatively small when compared to the total subsystem storage capacity. When this working set of data is in cache memory, there is a significant improvement in performance. The performance improvement achieved depends on both of the following principles:

- ◆ **Locality of Reference**—If a given piece of information is used, there is a high probability that a nearby piece of information will be used shortly thereafter.
- ◆ **Data Re-use**—If a given piece of information is used, there is a high probability that it will be re-used shortly thereafter.

These cache memory principles have been used for years on host systems (CPU and storage devices). Figure 3-1 illustrates this type of host cache memory use. The cache memory used in this manner is often a high-speed, high-cost storage unit that functions as an intermediary between the CPU and main storage.

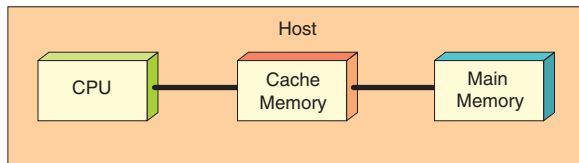


Figure 3-1 Host Cache Use

Symmetrix Global Memory Management

Symmetrix DMX systems use the same memory principle as host systems, but with enhanced caching techniques in global memory. Figure 3-2 illustrates global memory use in Symmetrix systems.

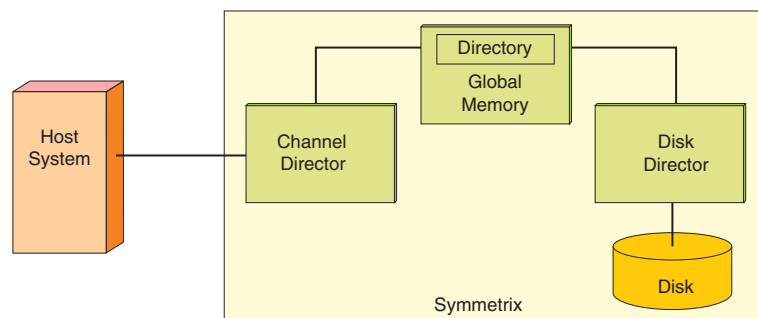


Figure 3-2 Symmetrix Global Memory Management and Data Flow

In Symmetrix systems, the channel directors and disk directors share global memory. Symmetrix channel directors attach to the CPU channels as well as to global memory. Symmetrix disk directors attach to global memory as well as the disk drives. The Symmetrix directors perform the following functions:

- ◆ The channel director handles I/O requests from the host. It accesses the directory in global memory (Figure 3-2) to determine if the request can be satisfied within global memory. The directory contains information on each memory page and blocks within each page.
- ◆ The directors manage global memory using various methods that generally result in the implementation of a Least Recently Used (LRU) algorithm. This usage model ensures that only pages of data that have been recently accessed remain in global memory.
- ◆ Using the prefetch algorithm, the disk director dynamically detects sequential data access patterns to the disk devices. The directors improve the hit ratio of these accesses by promoting blocks from the disk devices to global memory slots before that data has been requested.
- ◆ The disk director manages access to the disk drives. When a read miss occurs, the disk director also stages tracks into global memory. It also performs a background operation that destages written-to blocks to disk.

Least Recently Used (LRU) Algorithm

Figure 3-3 illustrates the data flow with the LRU algorithm. Each time a read hit or write hit occurs, the Symmetrix system marks that memory slot as most recently used and promotes it to the top of the LRU list. For each write, a written-to flag is set on the initial write to each global memory block and is cleared when the global memory block is destaged. The LRU global memory slot appears at the bottom of the LRU list. Symmetrix global memory can be subdivided into multiple LRU lists. There are sixteen independent LRUs in a Symmetrix system.

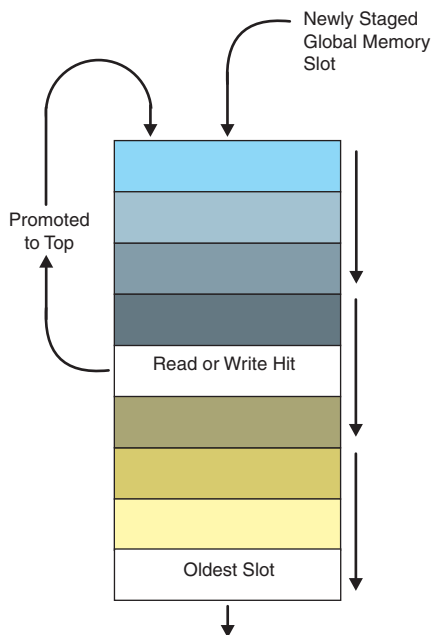


Figure 3-3 LRU and Age Link Chain Data Flow

Global Memory Quality of Service (QoS)

Global memory Quality of Service (QoS) allows the user to define (and future assign) segments of global memory to be managed by a separate LRU list, to one or more designated logical volumes. This way the user can guarantee that a certain application has a certain number of global memory slots, regardless of the activity levels of the other applications in the system and, thus, guarantee a certain level of hit ratios and performance.

Prefetch Algorithm

Symmetrix systems continually monitor I/O activity and look for access patterns. When the second sequential I/O to a track occurs, the sequential prefetch process is invoked and the next track of data is read into global memory. The intent of this process is to avoid a read miss. When the host processor returns to a random I/O pattern, the Symmetrix system discontinues the sequential process.

The prefetch algorithm reduces response time and improves the utilization of the disks. The prefetch algorithm maintains, per each logical volume, an array of statistics and parameters based on the latest sequential patterns observed on the logical volume. Prefetch dynamically adjusts, based on workload demand across all resources in the back end of the Symmetrix system. This algorithm also ensures that global memory resources are never overly consumed in order to maintain optimal performance.

Elements of a Symmetrix I/O Operation

All I/O operations require a certain response time. An I/O request begins when the application issues an I/O command and ends when the data transfer completes. The time interval from I/O request to transfer completion is the I/O response time.

This section describes:

- ◆ I/O Response Time: Mainframe Environment
- ◆ I/O Response Time: Open Systems Environment
- ◆ Symmetrix I/O Operations
- ◆ Read Operations
- ◆ Write Operations
- ◆ Write Destaging Operation

I/O Response Time: Mainframe Environment

In the mainframe environment, I/O response time can be divided into a queuing time, a pend time, a connect time, and a disconnect time, as shown in Figure 3-4.

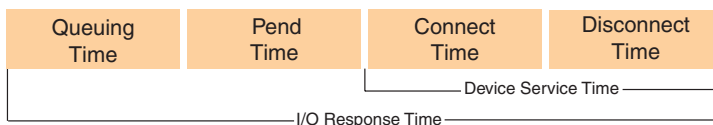


Figure 3-4 I/O Response Time (Mainframe Environment)

The **Queuing Time** is the I/O Supervisor (IOS) queue for next the event.

The **Pend Time** consists of:

- ◆ Control Unit Busy (CUB)
- ◆ Device Busy (DB)
- ◆ Director Port Busy

The **Connect Time** is the length of time the channel processes commands and transfers data.

The **Disconnect Time** is:

- ◆ The length of time it takes to retrieve data from the physical disk (device seek and latency)
- ◆ The length of time it takes to reconnect to the host
- ◆ SRDF write overhead (protocol, line latency, and so on)

I/O Response Time:
Open Systems
Environment

In the open systems environment, I/O response time can be divided into a host queuing time, a command connect time, a disconnect time, and a data connect time, as shown in Figure 3-5.

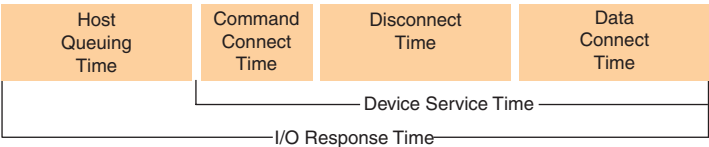


Figure 3-5 I/O Response Time (Open Systems Environment)

The **Host Queuing Time** is the time the request is in the host queue before it is dispatched on the Fibre Channel path.

The **Command Connect Time** is the length of time the channel is transferring a Fibre Channel command.

The **Disconnect Time** is the length of time involving device seek and latency. During this time the Fibre Channel path can be used by other devices.

In case of a memory hit in an I/O request, the Disconnect Time requirement is eliminated.

The **Data Connect Time** is the length of time the channel is transferring data.

Symmetrix I/O
Operations

There are four basic types of Symmetrix I/O operations (Figure 3-6 on page 3-8):

- ◆ Read Hit
- ◆ Read Miss
- ◆ Fast Write
- ◆ Delayed Fast Write

The Symmetrix system performs read operations from global memory and always processes write operations in global memory. This global memory operation is transparent to the host operating system. A read operation causes the channel director to scan the global memory directory for the requested data. If the requested data is in global memory, the channel director transfers this data immediately to the channel with a channel end and device end (or a SCSI good ending status). If the requested data is not in global memory, the disk director transfers the data from the disk device to

the global memory, and the channel director transfers the requested data from the global memory to the channel.

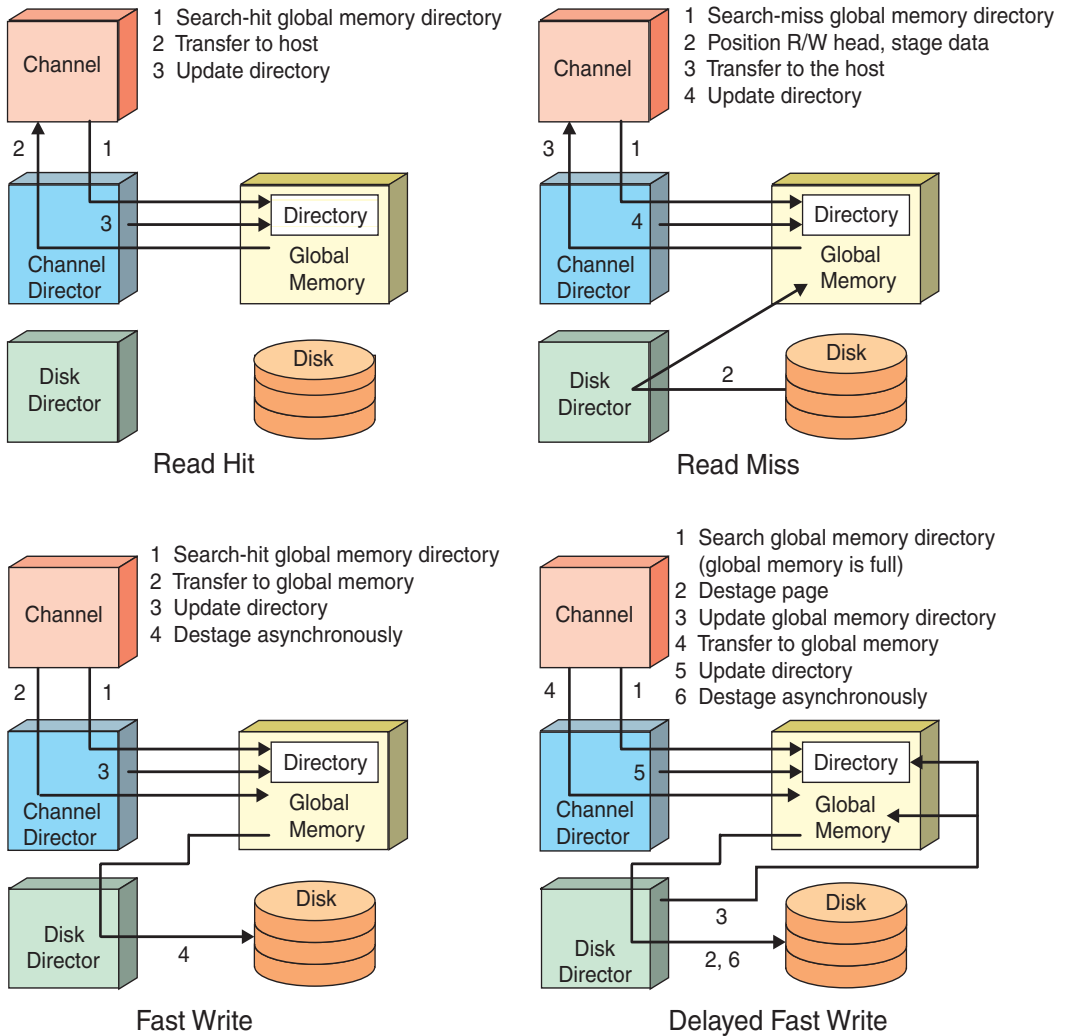


Figure 3-6 Symmetrix I/O Operations

Read Operations

There are two types of read operations: Read hit and read miss. Figure 3-7 illustrates the data flow for read operations.

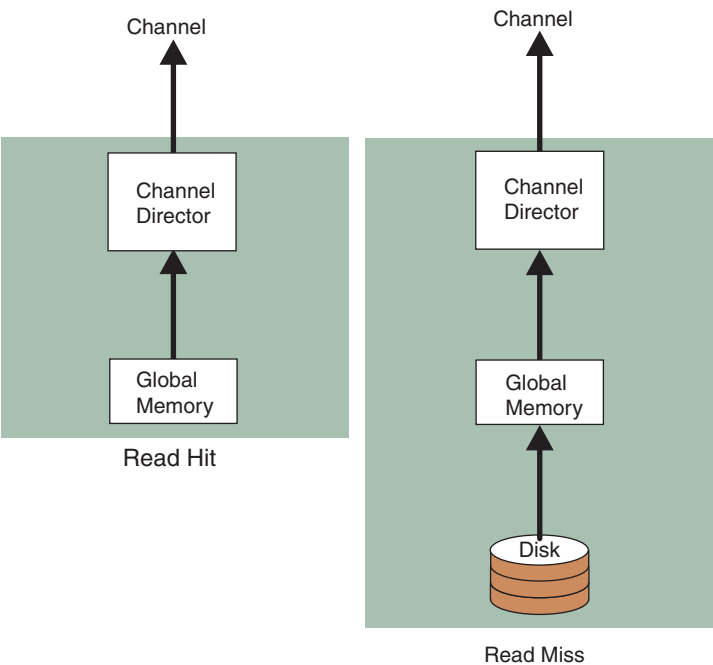


Figure 3-7 Read Operations

Read Hit In a read hit operation (Figure 3-7), the requested data resides in global memory. The channel director transfers the requested data through the channel interface to the host and updates the global memory directory. Since the data is in global memory, there are no mechanical delays due to seek, latency, and Rotational Position Sensing (RPS) miss (Figure 3-8).

For more information on RPS, refer to *Fibre Channel Disk Devices* on page 2-24.

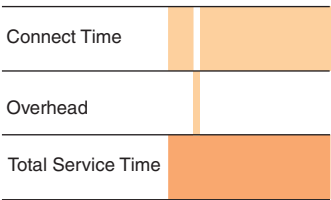


Figure 3-8 Read Hit

Read Miss In a read miss operation (Figure 3-7 on page 3-9), the requested data is not in global memory and must be retrieved from a disk device. While the channel director creates space in the global memory, the disk director reads the data from the disk device. The disk director stores the data in global memory and updates the directory table. The channel director then reconnects with the host and transfers the data. If the requested data is in the process of being prefetched (sequential read ahead), the miss is considered to be a short miss. If the requested data is not in the process of being read into global memory, the disk director requests the data from the drive. This miss is considered to be a long miss. Because the data is not in global memory, the Symmetrix system must search for the data on disk and then transfer it to the channel. This adds seek and latency times to the operation (Figure 3-9). During the disconnect time, other commands can be executed on other devices on the bus, or commands can queue to the same device.

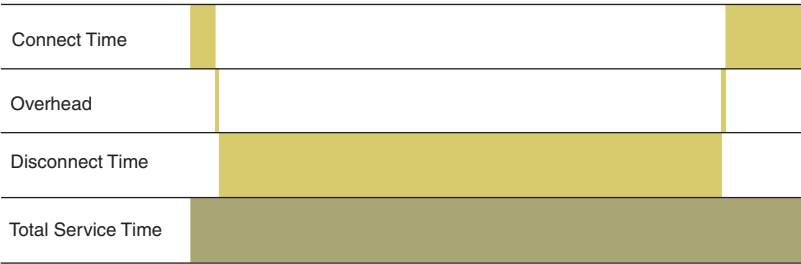


Figure 3-9 Read Miss

Write Operations

Symmetrix systems use large global memory configurations, and 100 percent global memory fast writes to ensure the highest possible performance when writing data. Symmetrix systems write operations occur as either fast write or delayed fast write operations (Figure 3-6 on page 3-8).

Fast Write A fast write occurs when the percentage of modified data in global memory is less than the fast write threshold. On a host write command, the channel director places the incoming block(s) directly into global memory.

For fast write operations (Figure 3-10), the channel director stores the data in global memory and sends a channel end and device end (or a SCSI good ending status) to the host computer. The disk director then asynchronously destages the data from global memory to the disk device.

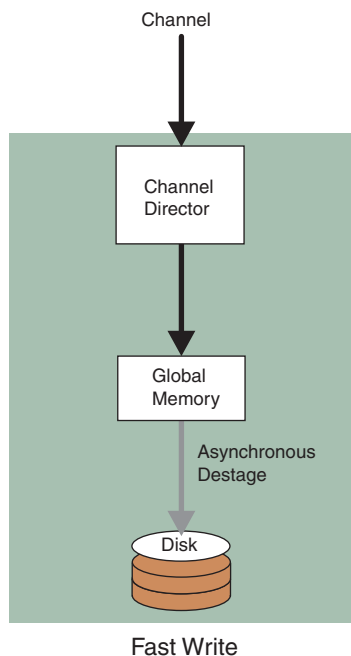


Figure 3-10 Write Operations

Fast write also allows Symmetrix systems to accommodate bursts of writes at a speed above and beyond the speed that the hard drives allow. The negative effects of *bursty* writes are minimized through this algorithm.

Because Symmetrix systems write the data directly to global memory and not to disk, there are no mechanical delays due to seek, latency, and RPS miss (Figure 3-11).

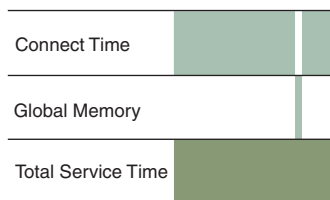


Figure 3-11 Fast Write

Delayed Fast Write

A delayed fast write occurs only when the fast write threshold has been exceeded. That is, the percentage of global memory containing modified data is higher than the fast write threshold. If this situation occurs, the Symmetrix system disconnects the channel directors from the channels.

The disk directors then destage the Least Recently Used (LRU) data to disk. When sufficient global memory space is available, the channel directors reconnect to their channels and process the host I/O request as a fast write (Figure 3-12). The Symmetrix system continues to process read operations during delayed fast writes. With sufficient global memory present, this type of global memory operation rarely occurs.

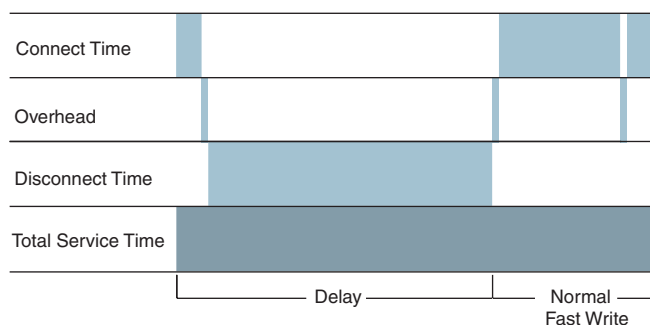


Figure 3-12 Delayed Fast Write

Write Destaging Operation

In addition to the four types of I/O operations explained earlier, Symmetrix systems perform a background operation that destages blocks back to disk. This allows any written-to or changed data to be maintained in two locations: in global memory for performance in the occurrence of re-use of that data and on disk to maintain the highest levels of data integrity. Any pending writes are assured of arrival to the intended disk, even in the event of power failure. Figure 3-13 illustrates this destaging operation.

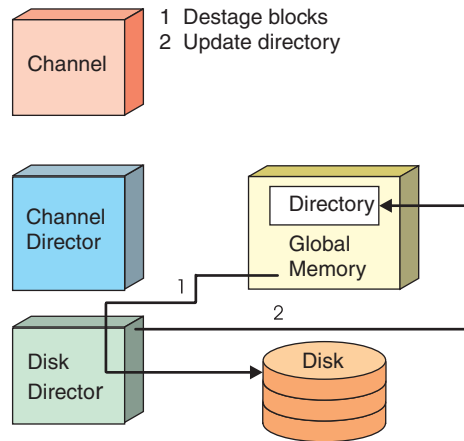


Figure 3-13 Destaging Operation

For each logical volume the Symmetrix system maintains a special data structure that points to the data that needs to be destaged in the global memory Write Pending Indicators (WPI) already discussed above. This dynamically adjusting algorithm saves disk seek and latency time by destaging data in groups of up to four tracks concurrently per logical volume.

I/O Performance Enhancements

Symmetrix systems use these techniques to enhance performance:

- ◆ Split director functions—The director operations are split into two functional parts, the channel director and disk director. The channel director services requests from the host.

The disk director services requests between global memory and disk. Splitting the director functions eliminates the processing overhead and global memory locking associated with Control Units that perform both functions.

- ◆ Multiple disk directors—The disk directors support nine-drive and 18-drive Fibre Channel drive loops. For more information on director and disk combinations, refer to *Fibre Channel Disk Devices* on page 2-24 and *Fibre Channel Disk Directors (Back-End)* on page 2-40.
- ◆ High speed global memory—Global memory speed is greater than the total speed of all components (for example, the directors) that access it.
- ◆ Disk microprocessor and buffer—Each disk device has its own microprocessor and buffer that respond to the actuator level, providing parallel processing of data. These features add another level of global memory processing and improve overall performance.
- ◆ RPS miss elimination (mainframe devices)—The dedicated microprocessor and segmented data buffer on each disk device can temporarily store data until the disk director is ready to read or write data. This eliminates rotational positional sensing (RPS) misses that occur in conventional mainframe DASD when the heads are positioned over the desired sector, but the channel path is not ready for read or write operations. The segmented data buffer of the disk device allows multiple operations to occur to the head/disk assemblies.
- ◆ Sequential access patterns—Access patterns can be sequential, random, or a combination of both. When a miss occurs on a sequential access pattern, the number of blocks brought into global memory increases, which improves the hit rate because the requested data is in global memory.

This chapter describes the performance features of the Symmetrix DMX systems and explains how to optimize these features.

- ◆ Overview 4-2
- ◆ Global Memory Performance Features 4-3
- ◆ Symmetrix File System Performance Features 4-9
- ◆ Multiple Channel Directors 4-11
- ◆ Open Systems Hypervolumes.....4-14
- ◆ Mainframe Systems Hypervolumes.....4-18
- ◆ Optimizing Symmetrix System Performance 4-22
- ◆ Multiport Volume Access for Open Systems Environments 4-23

Overview

Real world workloads consist of many different types of I/O activity. They can be read or write requests, have different data block sizes, or be skewed (some disks or host channels doing more work than others). They can also be highly random, sequential, or mixed, and they are often *bursty* (peak reads or writes can come at unexpected times). The workloads used for envelope measurements are normally static, simple, and designed to always yield certain levels of hit ratio (access of read/write data directly out of global memory), regardless of the global memory size and algorithms. In the real world, the actual application behavior is greatly influenced by the performance optimization algorithms.

Symmetrix Enginuity contains extensive algorithmic intelligence that is designed to deliver fast application response time. These algorithms optimize use of internal resources and allow end-user definition of priorities for Symmetrix operations. These unique algorithms balance the load evenly among Symmetrix components, save valuable resources, and optimize data layout based on detection of long-term workload patterns.

The Symmetrix DMX systems offer improved performance over conventional storage control units and DASD designs. The Symmetrix features described in this section allow high global memory hit ratios and less processing overhead, thus reducing response time and improving throughput.

The Symmetrix Enginuity performance optimization features are summarized in the following sections.

Global Memory Performance Features

The Symmetrix DMX global memory director design provides point-to-point, nonblocking connectivity between the front-end channel directors and back-end disk director. Each global memory director is physically partitioned into four separately addressable simultaneously accessible regions. These offload engines, utilizing Symmetrix DMX technology, implement advanced techniques while securing data integrity and optimizing available resource usage. This EMC exclusive global memory design managed by EMC's Enginuity Storage Operating Environment delivers a high performance, fault tolerant, ultra-reliable system.

The global memory directors deliver consistently high levels of system performance, improve responsiveness and consistency of responsiveness, and manage peak I/O requests through a series of techniques that essentially eliminate contention for shared global memory and optimize utilization of system resources. The underlying principles are:

- ◆ Global memory is composed of up to eight global memory directors that provide up to 256 GB of global memory in the DMX2000/3000, and up to four global memory directors that provide up to 128 GB of global memory in the DMX1000.
- ◆ Requests for global memory are expedited to reduce locking.
- ◆ Requests are intelligently arbitrated to optimize available resource usage.

This section describes the following Enginuity-supported global memory performance features:

- ◆ Global Memory ASICs
- ◆ Fast Write Capabilities
- ◆ Dynamic Mirror Service Policy (DMSP) Algorithm
- ◆ Disk Rotational Position Ordering (RPO)
- ◆ Disk Multiple Priority Queues
- ◆ PermaCache Option
- ◆ Quality of Service Control Performance Option

Global Memory ASICs

The global memory directors expedite transactions between process requests and global memory. EMC's global memory directors use Application Specific Integrated Circuits (ASICs) technology that act as intelligent offload engines to perform repetitive system critical functions. Global memory ASICs consist of the following components:

- ◆ Parallel Global Memory Regions
- ◆ Buffering
- ◆ Access Arbitration
- ◆ Memory Striping

Parallel Global Memory Regions

Symmetrix DMX global memory architecture drastically reduces memory contention by partitioning the global memory into four separately addressable, simultaneously accessible regions. In a Symmetrix DMX2000/3000 system with eight global memory directors, there are 32 separately addressable and accessible global memory regions. The DMX1000 system with four global memory directors supports 16 separately addressable and accessible global memory regions.

Buffering

Global memory ASICs buffer incoming requests from front-end channel directors and, as soon as possible, free up the global memory region being accessed. The result is a truly nonblocking architecture that is capable of massive performance scaling.

Access Arbitration

Global memory directors also arbitrate incoming requests for global memory resources in such a way as to optimally allocate global memory regions to incoming requests by appropriately timing and intelligently prefetching required information from global memory into the buffer. This results in optimal utilization of available resources.

Memory Striping

To eliminate any contention that may occur while working with large chunks of data, global memory directors stripe any data that resides on global memory across all the four regions within each global memory director. Striping is carried out in units of 64 memory words¹ across the four regions of each global memory director. For example, for an instruction requesting to write 256 memory words of data to a given address, the global memory director will break out this request into four bursts:

- ◆ The first 64-word chunk (from 1 to 64) is written to region 1
- ◆ The second chunk (from 65 to 128) is written to region 2
- ◆ The third chunk (from 129 to 192) is written to region 3
- ◆ The last chunk (from 193 to 256) is written to region 4

Striping of data across the four memory regions on the global memory directors eradicates any contention for I/O through global memory.

Fast Write Capabilities

Symmetrix systems process all write operations in global memory, eliminating the need to write data to the disk immediately. This capability results in faster response times and improved overall subsystem performance. Channel directors and disk directors dynamically allocate global memory space between reads and writes, depending on I/O activity.

Dynamic Mirror Service Policy (DMSP) Algorithm

When implementing mirroring (RAID 1) data protection in Symmetrix systems, DMSP determines which of the mirrors of a given logical volume should service a read miss (when the data is *not* found in global memory) operation. Attached BCVs can also participate in the DMSP. DMSP provides a dynamic approach to setting the optimal mirror service policy. The DMSP algorithm monitors the access patterns to the different logical volumes in the Symmetrix back end and, based on this, determines a policy for the next few minutes. The DMSP tries to achieve two goals:

- ◆ Balance the load among all of Symmetrix back-end components
- ◆ Minimize the seek time spent on the physical drives

DMSP also works with the Symmetrix file system as described in *Enhancement of Dynamic Mirror Service Policy* on page 4-9.

1. David E. Culler, Jaswinder Pal Singh, 1999: *Parallel Computer Architecture*, Morgan Kaufmann.

Disk Rotational Position Ordering (RPO)

Disk Rotational Position Ordering (RPO) optimization can more than double the number of random I/Os a disk can do. Whenever multiple I/O requests are queued on the disk, the EMC Engenuity Operating Environment can optimize the order in which the I/Os are executed. The RPO optimization reorders the I/Os based on their physical location on the drive. RPO optimization significantly reduces the effect of seeks and latency times on the overall performance of the disk. To take full advantage of the RPO optimization, the Symmetrix system needs to queue enough I/Os on the physical drives. The more I/O demand the Symmetrix system encounters, the better it will perform.

Disk Multiple Priority Queues

Disk Multiple Priority Queues enables the Symmetrix system to give better response times to I/Os that the hosts are waiting for, without sacrificing the disk RPO optimization. The multiple-priority queues algorithm handles starvation situations, so even the low priority I/Os are serviced within a time-optimized period.

PermaCache Option

The PermaCache option allows you to permanently assign mission-critical data requiring very high performance to global memory. A variable number of contiguous cylinders on the disk devices can be reserved for PermaCache backup.

PermaCache is best used for infrequently accessed data that needs instantaneous response because this data is normally not in global memory when it is requested. The Symmetrix large global memory and intelligent global memory algorithms try to keep frequently accessed data in global memory, making its assignment to PermaCache unnecessary.

Other Symmetrix options that require global memory resources affect the amount of global memory available for PermaCache. For example, enabling the Parity RAID options (in (3+1) or (7+1) mode) may require adjusting memory assignments by reducing the existing PermaCache area, lowering the write-pending ceiling of the system, or reducing the number of Symmetrix Parity RAID groups defined.

Global Memory Requirements

Your system must be configured with more than the minimum (base) amount of global memory for it to use part of that memory as PermaCache. To determine the minimum memory requirement for your Symmetrix configuration, consult your EMC Sales Representative.

Power Failures

If a power failure occurs, records that have been updated in PermaCache will be destaged to disk.

Global Memory Director Replacement

If a global memory director requires online replacement, PermaCache is unaffected, provided that the replacement board contains the same amount of global memory. Replacement with a smaller capacity memory requires that the system be brought offline and reinitialized before PermaCache will function

Online PermaCache Configuration Changes

Symmetrix Enginuity permits PermaCache configurations to be changed while the Symmetrix system is online to the host. Enabling PermaCache modifications to take place through an online configuration change allows users to set a configuration with no disruptions and avoids requirements for future maintenance.

Quality of Service Control Performance Option

Enginuity provides Symmetrix system users with the ability to assign higher or lower priority (Quality of Service (QoS) level) to various applications in their production environment by creating multiple memory slot rings. Symmetrix users decide which applications need to have priority over others. Logical device pools connected with these applications are mapped on a one-to-one basis with memory slot rings. Each memory slot ring is associated with a global memory resource pool. Global memory resource pools are carved out of the Symmetrix global memory. A larger share of global memory leads to faster performance for the associated applications. Figure 4-1 on page 4-8 depicts four resource pools with each being allocated a different amount of global memory 40%, 10%, 20%, and 30%, respectively.

Enginuity gauges effectiveness of global memory resource pool allocation to each ring by collecting and storing hit ratios pertaining to each resource pool. Enginuity running on each front-end channel director automatically stores collected statistics in their local memory. Periodically, a background task within Enginuity collects all these statistics and combines them in an area in global memory to generate a true hit ratio for each ring. This true hit ratio helps deliver true Performance on Demand to the various applications and automatically fine-tunes global memory allocation based on the customer-defined priority of applications associated with resource pools.

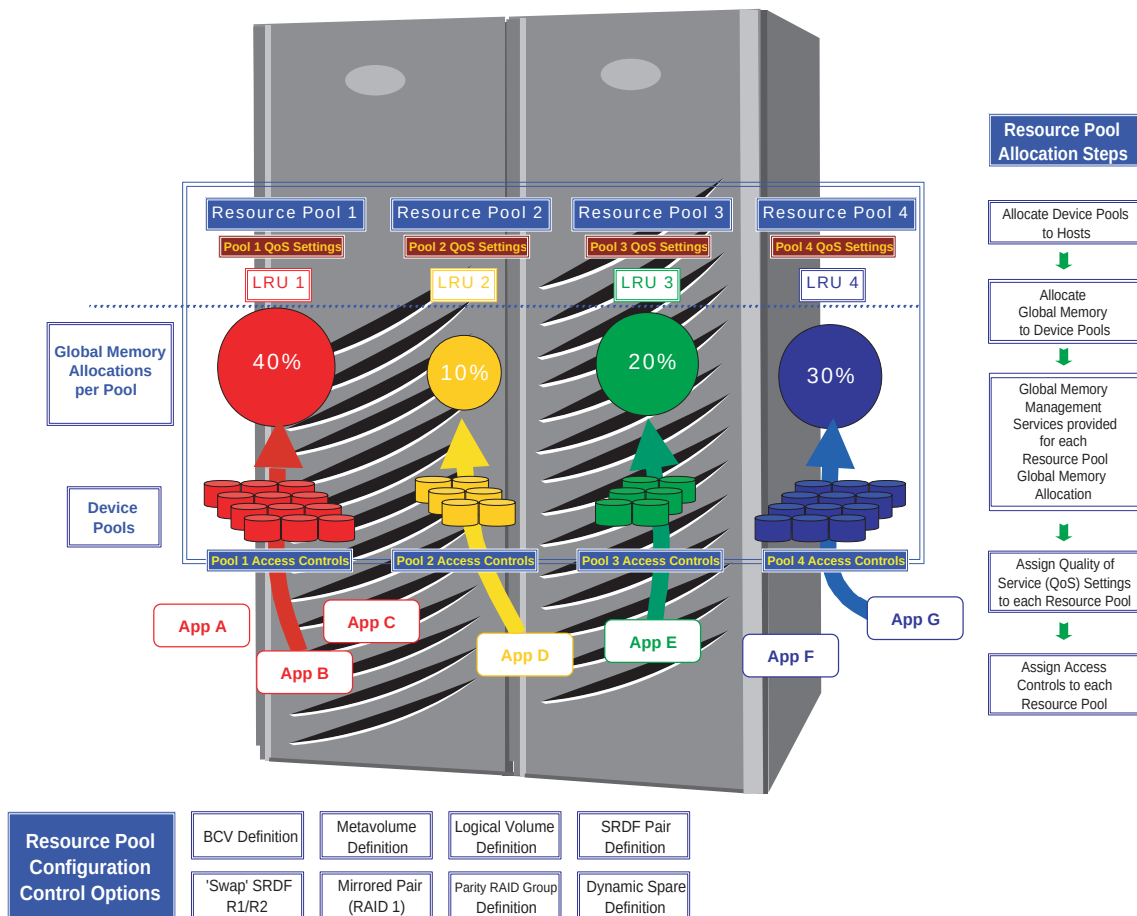


Figure 4-1 Enginuity LRU Resource Pools

Symmetrix File System Performance Features

Enginuity automatically reserves 12 GB (raw) for internal use as a Symmetrix File System (SFS). This space is automatically allocated while initially loading the Enginuity Operating Environment on Symmetrix systems and is not visible to the host environment. This 12 GB of raw SFS space is translated into 6 GB of space (mirrored configuration) and is spread equally across two volumes of 3 GB each.

The SFS generates several benefits for Symmetrix users, namely:

- ◆ Dynamically adjusting performance algorithms
- ◆ Enhancement of dynamic mirror service policy
- ◆ Enhancement of Symmetrix Optimizer
- ◆ More rapid recovery from problems
- ◆ Enhanced system audit and investigation

Dynamically Adjusting Performance Algorithms

State-of-the-art information management algorithms implemented within Enginuity need to store and use statistical data gathered over time. SFS provides a place to store this statistical database that Enginuity creates and uses to dynamically optimize algorithms and optimize performance.

Enhancement of Dynamic Mirror Service Policy

Enginuity uses SFS to store the data from sampling for Symmetrix Dynamic Mirror Service Policy (DMSP). DMSP algorithms within Enginuity collect logical volume activity samples, store this information in SFS, and use this information to make mirror service policy decisions that further enhance Symmetrix RAID 1 and RAID 10 performance.

Enhancement of Symmetrix Optimizer

Enginuity uses SFS to store information on physical spindle activity and other mirror activity. This data is used to plot a thermograph of hot (busy) and cold (idle) spindles. This thermographical information gathered over a long time period and preserved in SFS, is used to determine the hottest (busiest) and the coldest (idlest) spindles and recommend swaps.

More Rapid Recovery from Problems

SFS capacity allows the collection and analysis of longer error and event traces than previously possible. Enginuity is now able to record all historical errors and event-trace information in the extra capacity provided to Enginuity by SFS. These capabilities enhance EMC's ability to analyze and precisely resolve customer problems in a timely manner and provide better proactive customer service.

Enhanced System Audit and Investigation

Enginuity stores an Audit Log in the SFS. This enables improved investigation, both at the system level and customer environment level. Symmetrix Audit Log collects and presents a chronological list of host-initiated Symmetrix actions and activities. Manual activities (for example, physically removing/replacing a component) as well as automatically initiated scripts and EMC's Solutions Enabler activities (for example, TimeFinder or SRDF routines), are tracked and recorded in the SFS. This provides a means to oversee and historically recall how and when a Symmetrix device is being used.

Enginuity also expands capabilities for host applications built on SymmAPI™. Earlier, host applications were allowed to make entries to a Symmetrix write-only buffer. Audit Log features now enable Symmetrix ISVs and other service providers to use logged information for their own reporting purposes. The built-in system security in SymmAPI does not allow host applications to change audit logs. This reduces IOSQ (I/O Supervisor Queue Time) exposure and increases system performance.

Multiple Channel Directors

The Symmetrix DMX channel directors process data from the host and manage access to global memory over a direct matrix (DMX) technology (Figure 2-7 on page 2-13 and Figure 2-8 on page 2-14). Each channel director on the Symmetrix DMX systems supports eight internal links to global memory. The Symmetrix DMX1000 systems may support up to six channel directors that support connectivity to either mainframe systems or open systems hosts. The DMX2000 systems may support up to twelve. The DMX3000 systems may support up to eight.

For detailed information on each Symmetrix channel director, refer to *Channel Director Descriptions* on page 2-34. Contact your EMC Sales Representative for specific supported channel director configurations.

Symmetrix DMX systems support *simultaneous* connections to mainframe systems hosts and open systems hosts when the required Symmetrix ESP software is installed on the Symmetrix system.

The DMX systems support these channel directors:

- ◆ ESCON directors (mainframe hosts)
- ◆ Fibre Channel directors (open systems hosts)
- ◆ Multiprotocol channel directors with these mezzanine card connections for:
 - GigE for SRDF connectivity
 - iSCSI (open systems hosts)
 - FICON (mainframe hosts)

Channel Speeds and Cable Lengths

Symmetrix system channel speeds (data transfer rate) and cable lengths vary according to the type of channel director. This section describes the data transfer rates and supported cable lengths for the different channel directors.

Fibre Channels

Fibre Channels transfer data at speeds up to 2 Gb/s. Symmetrix systems support multimode cable lengths from 10 feet (three meters) to 984.25 feet (300 meters).

Table 2-16 on page 2-58 provides more detailed supported cable distance information. Table C-16 on page C-49 provides part numbers for EMC Fibre Channel Cables.

ESCON Channels

Symmetrix ESCON channels transfer data at speeds up to 17 MB/s. The data transfer rate depends upon the host system. Symmetrix systems support ESCON fiber cable connections to 26.7 miles (43 km) using repeaters in combination with multimode and single-mode connections (Figure 2-21 on page 2-56 and Table 2-15 on page 2-57).

Table C-6 on page C-27 provides part numbers for ESCON channel cables.

FICON Channels

Symmetrix FICON channels transfer data at speeds up to 2 Gb/s. The DMX FICON design auto-detects 2 Gb/s or 1 Gb/s at switch or channel port login time. The setting will stay at 2 Gb/s unless there is a problem or if the other port is running at 1 Gb/s. Only a switch has settings on each port for 2 Gb/s, 1 Gb/s, or auto-negotiate.

Symmetrix systems support FICON fiber cable connections up to 7.45 miles (12 km) with single-mode connections.

Table 2-14 on page 2-53 provides more detailed supported cable distance information. Table C-11 on page C-39 provides part numbers for FICON channel cables. For information on FICON multimode configuration support, contact your EMC Sales Representative.

iSCSI Channels

Symmetrix iSCSI channels transfer data at speeds up to 1 Gb/s. Symmetrix systems support iSCSI cable connections up to 524.93 feet (160 meters) with multimode connections.

GigE Remote Channels

Symmetrix GigE remote channels for SRDF transfer data at speeds up to 1 Gb/s. Symmetrix systems support GigE remote cable connections up to 524.93 feet (160 meters) with multimode connections.

Host Connectivity

Symmetrix DMX systems support connectivity to open systems hosts such as UNIX, Linux, and Windows systems through iSCSI, GigE (SRDF), and Fibre Channels. Symmetrix DMX systems support mainframe systems host connectivity through ESCON and FICON channels.

Symmetrix systems only support Fibre Channel connectivity for iSeries hosts.

Symmetrix DMX systems support *simultaneous* connections to mainframe systems hosts and open systems hosts when the required Symmetrix ESP software is installed on the Symmetrix system.

Parallel Processing

Each channel director and disk director contains four resident microprocessors, and each disk device contains one resident microprocessor. These microprocessors use advanced parallel processing to reduce processing time and improve throughput.

RPS Miss Elimination

In Symmetrix systems, each disk device contains a dedicated microprocessor and segmented data buffer that can temporarily store data until the disk director is ready to read or write data. This eliminates rotational position sensing (RPS) misses that occur in conventional DASD when the heads are positioned over the desired sector, but the channel path is not ready for read or write operations. The segmented data buffer of the disk device allows multiple operations to occur to the head/disk assemblies.

Open Systems Hypervolumes

This section describes the Hypervolume Extension feature on Symmetrix open systems units. It includes the following information:

- ◆ Hypervolume Extension Feature
- ◆ Disk Device Cylinders
- ◆ Logical Volume Mapping
- ◆ Metavolumes

To use the Hypervolume Extension feature in Symmetrix units connected to mainframe hosts, refer to *Mainframe Systems Hypervolumes* on page 4-18.

Hypervolume Extension Feature

The Hypervolume Extension feature provides configuration flexibility by allowing one physical device to be split into two or more logical volumes. This capability is particularly useful for some 32-bit implementations of UNIX that allow only 2 GB file systems per single logical disk.

The Symmetrix DMX systems allow up to 77 logical volumes on each Symmetrix DMX 73 GB or 146 GB open systems physical disk device and up to 8,000 logical volumes (address range 0x000 - 0x1F3F) per Symmetrix DMX system, depending on the hardware configuration and the data protection options.

For more information on logical volumes supported on Symmetrix DMX disk devices and systems, refer to *Symmetrix DMX Logical Volume Capacities* on page 2-25. Configuration requirements for Symmetrix systems vary according to the applications used. To configure logical volumes for optimum Symmetrix system performance, consult your EMC Sales Representative.

Disk Device Cylinders

The Symmetrix DMX systems use 3.5-inch, low-profile disk devices that are available in the following storage capacities and maximum usable Symmetrix cylinders (Table 4-1).

Table 4-1 Symmetrix Open Systems Disk Capacities and Cylinders

Drive Type	Maximum Usable Symmetrix Cylinders ^a
73 GB	148,734
146 GB	297,799

a. The maximum number of usable cylinders for one logical volume is 65,520.

UNIX and PC Server Hosts

For Symmetrix disk devices attached to UNIX or PC server hosts, each cylinder contains 15 tracks, and each track contains sixty-four 512-byte blocks.

Logical Volume Mapping

The logical-to-physical relationship that you choose can automatically apply to all devices in the unit. You can customize the logical-to-physical relationship on each device as well as the size of each logical volume. For example, if the logical-to-physical ratio chosen is 8:1, the logical volume mapping is similar to that shown in Figure 4-2.

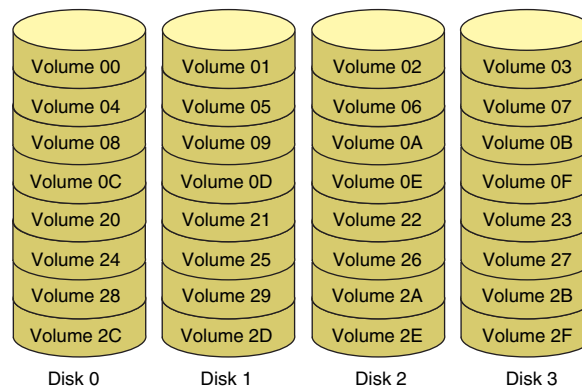


Figure 4-2 Logical Volume Mapping (8:1)

Metavolumes

Several operating systems (such as Windows NT and Windows 2000), some applications software, and some open systems environments require larger volumes than are provided by standard Symmetrix physical disk devices.

A metavolume is a logical volume set created from individual physical disks to define volumes larger than the current Symmetrix maximum hypervolume size of approximately 32 GB. Metavolumes are functionally the same as logical volume sets implemented with host volume manager software.

Physically, a metavolume is two or more Symmetrix hypervolumes presented to a host as a single addressable device. The metavolume consists of a *head device*, some number of *member devices* (optional), and a *tail device*.

Metavolume Size Requirements

Symmetrix metavolumes can contain up to 255 logical devices and be up to 7.65 TB in size. Metavolumes can be composed of nonsequential and nonadjacent volumes.

When configuring a metavolume, each metavolume device is counted as a single logical volume. Using metadevices will reduce the lot of host-visible devices. That is, each member of the metadevice must be counted toward the maximum number of host-supported logical volumes. For information on Fibre Channel host attachments, refer to the *EMC Support Matrix* located on the EMC Powerlink website at: <http://powerlink.emc.com>.

Metavolume Performance

By allowing individual physical disk devices to be grouped together into a metavolume and the use of metavolume addressing, Symmetrix systems enhance disk system functionality. To increase throughput and further improve performance, Symmetrix systems provide multiple I/O drive queues for metavolumes.

Accessing Data in a Metavolume

You can access data contained in a metavolume in two different ways:

- ◆ Concatenated volumes
- ◆ Striped data

Concatenated Volumes

Concatenated volumes are volume sets that are organized with the first byte of data at the beginning of the first volume (Figure 4-3). Addressing continues to the end of the first volume before any data on the next volume is referenced. When writing to a concatenated volume, the first slice of a physical disk device is filled, then the second, and so on, to subsequent physical disk devices.

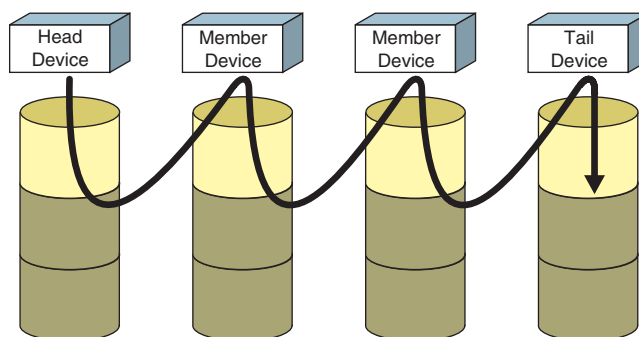


Figure 4-3 Concatenated Volumes

Striped Data

Metavolume addressing by striping also joins multiple slices to form a single volume. However, instead of using sequential address space, striped volumes use addresses that are interleaved between slices (Figure 4-4). In data striping, equal size stripes of data from each participating drive are written alternately to each member of the set.

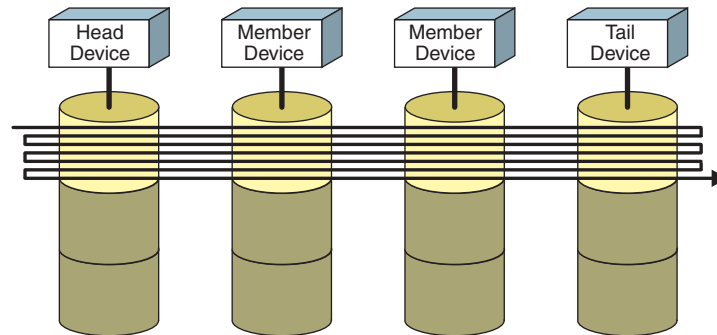


Figure 4-4 Striped Data

Configuring Metavolumes

Although members of a striped set do not have to be the same size, the effective size of each member is the actual size of the smallest member rounded down to an even cylinder count. Therefore, when configuring such a metavolume, be careful to minimize wasted space.

A customer can reconfigure metavolumes. While the Symmetrix system is online to the host, the customer can:

- ◆ Expand both concatenated and striped metavolumes
- ◆ Convert an unused volume to a concatenated or striped metavolume
- ◆ Convert a populated volume to a concatenated or striped metavolume

Striping data across the multiple drives is designed to benefit *random reads* by avoiding stacking multiple reads to a single spindle and disk director. This scheme creates a large volume, but also balances the I/O activity between the disk devices and the Symmetrix disk directors.

Mainframe Systems Hypervolumes

To use this feature in Symmetrix units connected to open systems hosts, refer to *Open Systems Hypervolumes* on page 4-14.

This section describes how to use the Hypervolume Extension feature on Symmetrix mainframe volumes. It contains the following topics:

- ◆ Hypervolume Extension Options
- ◆ Split-Volume Capability
- ◆ Extended Cylinder Addressing Option
- ◆ Determining Cylinders for Hypervolume User Data

Hypervolume Extension Options

The Symmetrix system enhances disk system functionality by supporting multiple logical volumes on each physical device.

The Hypervolume Extension feature has two usage options:

- ◆ **Split-Volume Capability**—Allows up to 128 logical volumes on each Symmetrix DMX physical disk device depending on the data protection option used.
- ◆ **Extended Cylinder Addressing**—Establishes a small logical volume at the end of physical disk device for data requiring high performance on a small volume.

Split-Volume Capability

Using the split-volume option of the Hypervolume Extension (HVE) feature, Symmetrix systems allow multiple logical volumes to reside on a single physical drive. This split-volume option provides for the consolidation of many physical DASD devices into far fewer physical high-capacity high-performance disks.

Support is provided for native IBM 3390 and 3380 track emulation with all 3390 and 3380 disk volumes being supported. No modifications are required to the operating system, application, or program software to take advantage of HVE.

The split-volume option can override the one-to-one logical-to-physical relationship on all devices in the Symmetrix unit. The logical-to-physical relationship can automatically apply to all devices in the unit. You can also customize the logical-to-physical relationship on each device, as well as the size of each logical volume.

Symmetrix DMX systems support up to 128 logical volumes per physical disk device and up to 8,000 logical volumes (address range 0x000 to 0x1F3F) per unit, depending on the Symmetrix DMX hardware configuration and the data protection options.

For more information on logical volumes supported on Symmetrix DMX disk devices and systems, refer to *Symmetrix DMX Logical Volume Capacities* on page 2-25. Configuration requirements for Symmetrix systems vary according to the applications used. To configure logical volumes for optimum Symmetrix system performance, consult your EMC Sales Representative.

Extended Cylinder Addressing Option

Extended Cylinder Addressing places a small logical volume at the end of a disk device. Each small logical volume can occupy a variable number of contiguous cylinders. This small logical volume can be as small as one cylinder in size. The maximum number of cylinders for this volume depends on the capacity of the disk device and the emulation mode selected.

This flexibility in logical volume configuration increases system performance for datasets requiring extremely high performance such as Multi-Image Manager files, JES Checkpoint, RACF Control files, catalogs, and so on.

Because the data of interest resides on a small volume, the Unit Control Block (UCB) busy conditions that arise when this data is placed on larger capacity volumes with high activity are eliminated. This reduces IOSQ (I/O Supervisor Queue Time) exposure and increases system performance.

Consult your EMC Systems Engineer regarding dataset placement on these small logical volumes.

This logical volume can be added to Symmetrix units that are configured and running without affecting existing data on the disk device by giving the volume an address beyond any currently used on the unit. This option may also be used with the PermaCache option, in which infrequently accessed datasets requiring instantaneous access reside permanently in global memory.

Determining Cylinders for Hypervolume User Data

Before you can use either HVE feature—the split-volume option or extended cylinder addressing—you must determine the *total user cylinders* on the physical disk device available for user data.

The number of cylinders available for user data depends on the:

- ◆ Symmetrix disk device cylinder capacity
- ◆ Selected disk emulation type
- ◆ Alternate, Diagnostic, and Device Support (ADDS) cylinders for the emulation type
- ◆ Internal Device Support Cylinders
- ◆ Desired number of logical volumes for the Symmetrix disk device

Table 4-2 lists the 73 GB and 146 GB disk device capacities for 3380 and 3390 emulations.

Table 4-2 Symmetrix Mainframe Disk Capacities and Cylinders

Drive Size 3.5-inch, Low-Profile	Available Symmetrix Cylinders	
	3380 Emulation	3390 Emulation
73 GB	98,204	84,910
146 GB	196,393	170,136

Table 4-3 outlines the cylinders required for full emulation per logical volume for several emulation types. It also lists the number of alternate, diagnostic, and device support cylinders (ADDS) and the Symmetrix Internal Device Support Cylinders required for each logical volume by that particular emulation type.

Table 4-3 Device Emulations and Number of Cylinders

Emulation Type	Number of Emulated Cylinders	Alt, Diag, Device Support Cylinders (ADDs)	Symmetrix Internal Device Support Cylinders	Total Support Cylinders
3380D	885	3	2	5
3380E	1,770	4	2	6
3380K	2,655	5	2	7
3390-1	1,113	4	2	6
3390-2	2,226	4	2	6
3390-3	3,339	4	2	6
3390-9	10,017	7	2	9
3390-27	32,760	0	2	2

Symmetrix DMX systems running Enginuity level 5670 and higher can support 64K cylinder CKD devices for operating systems that can exploit it.

Optimizing Symmetrix System Performance

Achieving optimal performance requires careful and detailed planning of the Symmetrix configuration according to the requirements of the host(s) you are connecting to the Symmetrix system and your performance needs.

Carefully review the issues listed below with your EMC representative before the EMC Customer Engineer installs the Symmetrix system. Appendix C, *Planning and Installation*, includes sample worksheets and checklists to assist you in this process.

Performance Guidelines for Open System Devices

Resolve the following open system device issues before installing your Symmetrix system:

- ◆ Rank distributed workloads from the busiest to the least busy (when configuring multiple hosts to a Symmetrix unit)
- ◆ Data storage capacity required for each host connected to the Symmetrix system
- ◆ Number of channels available from each host
- ◆ Nature of the applications executed on the host connected to the Symmetrix system
- ◆ Availability of a Logical Volume Manager (LVM) on the host and the use of data striping
- ◆ Use of hypervolumes on the Symmetrix system, hypervolume size, and the allocation of hypervolumes between different hosts, different channels, and different applications
- ◆ Maximum drive and file system sizes supported by each host connected to the Symmetrix system
- ◆ Requirements for device sharing
- ◆ Number of Fibre Channel directors used and the number of ports used on each director
- ◆ Special considerations for host-level mirroring for device distribution in the Symmetrix system
- ◆ Possibility of upgrading the Symmetrix system with additional drives in the future and its effect on the configuration if the model installed is not at maximum capacity

Multiport Volume Access for Open Systems Environments

Unlike most disk arrays, the Symmetrix unit can present any logical volume through any number of Fibre Channel channels to the hosts connected to the unit. Usually, a Symmetrix volume will be presented through one host channel. However, in different failover or cluster scenarios, the volume will be *visible* to different hosts on two or more Fibre Channel channels.

For example:

- ◆ A volume may be configured to be visible on two channels for host channel failover (such as EMC PowerPath® or HP-UX PV links).
- ◆ A volume can be accessed by up to 32 separate paths using EMC PowerPath.
- ◆ A volume can be configured to be visible on one channel for a hot standby scenario where one host can assume the devices of another host in case of a controller or host failure.
- ◆ A volume can be visible through all channels in cluster environments that can take advantage of such multiport volume access (such as NCR Teradata).

For more information on multiport volume access, and the most current information on Symmetrix systems and specific host integration, contact your EMC Sales Representative, or refer to the EMC Powerlink website at: <http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

This chapter discusses the Symmetrix DMX systems features and options that affect data availability and reliability.

◆ Overview	5-2
◆ Reliability and Availability Features	5-7
◆ Maintaining Data Integrity	5-18
◆ Data Protection Guidelines	5-23
◆ Disk Mirroring Concepts	5-25
◆ Symmetrix DMX Parity RAID Options	5-28
◆ Symmetrix DMX RAID 5 Options	5-41
◆ Symmetrix RAID 10 (Mirrored Striped Mainframe Volumes with DMSP)	5-43
◆ Dynamic Sparing	5-44

Overview

The Symmetrix system has many features and options to ensure a high degree of system and data availability. Many of these features and options are built into the Symmetrix design. Other availability options may be purchased separately and implemented into the Symmetrix system operation.

Symmetrix Reliability and Availability Features

The Symmetrix system design offers the following reliability and availability features:

- ◆ High-reliability components
- ◆ Global memory director redundancy
- ◆ Channel director redundancy
- ◆ Redundant internal data paths
- ◆ Internal control data path redundancy
- ◆ Fibre Channel back-end redundancy
- ◆ Dual-Initiator feature
- ◆ Redundant power subsystem
- ◆ System battery backup
- ◆ Nondisruptive maintenance and microcode upgrades and loads

These basic Symmetrix features provide protection against loss of system and data availability due to a power loss or failed component. A redundant design allows the Symmetrix system to remain online and operational during component repair. For example, if a power supply fails, the remaining power supplies share the load until the failed component is replaced. The system battery backup prevents any loss of data due to a power failure.

Symmetrix Data Integrity Protection Features

The Symmetrix system is designed with these data integrity features:

- ◆ Error checking, correction, and data integrity protection
- ◆ Disk error correction and error verification
- ◆ Global memory access path protection
- ◆ Global memory error correction and error verification
- ◆ Periodic system checks

Error verification prevents temporary errors from accumulating and resulting in permanent data loss. Symmetrix systems also evaluate the error verification frequency as a signal of a potentially failing component.

The periodic system check tests all components as well as microcode integrity. Symmetrix systems report errors and environmental conditions to the host system as well as the EMC Customer Support Center.

Data Protection Options

Although the Symmetrix system has standard features that provide a higher level of data availability than conventional DASD, the options described in this section ensure an even greater level of data recoverability and availability. These data protection options are configurable at the physical volume level so that different levels of protection can be applied to different datasets within the same Symmetrix system.

You can choose from the following Symmetrix data protection options to match your critical data requirements:

- ◆ Mirroring (RAID 1)
- ◆ Parity RAID (3+1) and Parity RAID (7+1)
- ◆ RAID 5 (3+1) and RAID 5 (7+1)
- ◆ Symmetrix Remote Data Facility (SRDF)
- ◆ Dynamic Sparing

Mirroring (RAID 1) Option

Mirroring (RAID 1) provides the highest performance, availability, and functionality for all mission-critical and business-critical applications. With the Mirroring option, Symmetrix systems maintain two identical copies of a logical volume on separate disk devices. Should the Symmetrix system be unable to read data from one of a mirrored pair, it immediately retrieves the data from the other logical volume.

For more information on the Symmetrix Mirroring option, refer to *Disk Mirroring Concepts* on page 5-25.

Parity RAID Option

The Symmetrix Parity RAID option provides high-availability data with high performance, and higher usable storage capacity than Symmetrix Mirroring. Parity RAID improves data availability on drives in Symmetrix DMX disk subsystems by using a portion of the array to store redundancy information. The data protection feature is based on a Parity RAID (3+1) volume configuration (three data volumes to one parity volume) or Parity RAID (7+1) volume configuration (seven data volumes to one parity volume).

For more information on Symmetrix Parity RAID options, refer to *Symmetrix DMX Parity RAID Options* on page 5-28.

RAID 5 Option

Engenuity code 5670 supports RAID 5 data protection. A RAID 5 device has the following attributes:

- ◆ Data blocks are striped/interleaved horizontally across the members of a RAID 5 group, similar to a striped metavolume.
- ◆ There is no separate parity drive in a RAID 5 group. Instead, parity blocks rotate amongst the group members.

Symmetrix Remote Data Facility (SRDF)

EMC's SRDF family of software products help companies manage planned data center events such as scheduled maintenance, daily backups, migrations, and application testing, as well as recovery from unplanned outages such as disasters. The following sections briefly describe the SRDF product offerings.

Each of the SRDF product offerings is sold under a separate license by EMC. For more in depth information about SRDF, refer to the *Symmetrix Remote Data Facility Product Guide*.

SRDF/Synchronous (SRDF/S formerly SRDF)

The Symmetrix Remote Data Facility / Synchronous offers high performance, host-independent, real-time synchronous remote replication from one Symmetrix to one or more Symmetrix systems. SRDF/S duplicates production (source) site data at a logical volume level to a recovery (target) site transparently to users, applications, databases, and host processors.

When a primary (source) device is down, SRDF/S enables fast switchover to the secondary (target) copy data so that critical information is again available in minutes. SRDF/S provides complete business continuance capability during the unlikely event of a data center disaster or during planned events such as daily backups, scheduled maintenance, and data center migrations or consolidations.

In either case, the same information protection capabilities are provided. After a system event, SRDF/S can resynchronize data to the source or to the target system at the user's discretion, thereby ensuring information and data consistency.

SRDF/Asynchronous (SRDF/A)

SRDF/Asynchronous is an SRDF product offering used for remote replication that allows you to maintain an asynchronous *dependent write consistent* copy of Symmetrix stored data at a remote site. In SRDF/A implementations:

- ◆ The recovery data from the target side lags behind the source by seconds or minutes.

- ◆ There is minimal host impact since the host adapter does not wait for an acknowledgement for background writes. Global memory is used as a data buffer.
- ◆ It has the potential to more efficiently use network bandwidth due to *locality of reference* (for example, applications tend to write data in proximity of time and space). SRDF/A sends data to a remote site as cycles of dependent write consistent data. The write I/Os coming in are managed in global memory buffers through complex Enginuity code algorithms and, regardless of how many times a specific block is written to, only the last write is sent over to the target box with its associated predefined timed cycles called *delta sets* (there are two alternating cycles). Therefore, less data needs to be transferred to the target system.

SRDF/ Data Mobility (SRDF/DM)

Symmetrix Remote Data Facility/Data Mobility is a special form of SRDF that permits operation in SRDF *Adaptive Copy* mode only and is designed for data replication and/or migration between two or more Symmetrix systems. SRDF/DM transfers data from source volumes to remote volumes quickly permitting information to be shared, content to be distributed, and access to be local to additional processing environments.

Adaptive copying modes facilitate data sharing and migration. These modes allow the primary and secondary volumes to be more than one I/O out of synchronization. The maximum number of I/Os that can be out of synchronization is known as the *maximum skew value*. The default value is equal to the entire logical volume. The maximum skew value for a volume can be set using the SRDF monitoring and control software.

There are two adaptive copying modes: adaptive copy write-pending (AW) mode and adaptive copy disk (AD) mode. Both modes allow write tasks to accumulate on the local system before being sent to the remote system.

Adaptive copy mode enables applications using that volume to avoid propagation delays while data is transferred to the remote site. SRDF/DM supports all Symmetrix systems and all Enginuity levels that support SRDF, and can be used for local or remote transfers. Unlike full-function SRDF, SRDF/Data Mobility is not intended for disaster recovery.

SRDF/Automated Replication (SRDF/AR)

SRDF/Automated Replication provides rapid business restart over any distance with no data exposure through advanced single-hop and multi-hop configurations using combinations of TimeFinder/BCV and SRDF/S and/or SRDF/DM.

SRDF/Consistency Groups (SRDF/CG)

SRDF/Consistency Groups maintains data coherency across an SRDF-based configuration by monitoring data propagation from the source volumes to their corresponding target volumes to ensuring data consistency and restartability.

Dynamic Sparing

Dynamic Sparing is another data protection option that you can use in conjunction with mirroring, Parity RAID, RAID 5 or SRDF. Dynamic Sparing limits the exposure after drive failure and before drive replacement. With Dynamic Sparing, the Symmetrix system maintains a small pool of spare volumes that are used only when the system detects a potentially failing device. The Dynamic Sparing feature performs a fast copy of the data and uses the spare until the original device can be replaced.

For more information on the Symmetrix Dynamic Sparing option, refer to *Dynamic Sparing* on page 5-44.

Reliability and Availability Features

Symmetrix systems have several features that allow them to maintain data integrity and maximize system availability. This section discusses several features in detail.

Reliable Components

Symmetrix systems use components that have a mean time between failure (MTBF) of several hundred thousand to millions of hours for a minimal component failure rate. A redundant design allows Symmetrix systems to remain online and operational during component repair.

A periodic system check tests all components as well as microcode integrity. Symmetrix systems report errors and environmental conditions to the host system as well as the EMC Customer Support Center.

Global Memory Director Data Integrity

Every Symmetrix system is configured with a minimum of two global memory directors to allow for online nondisruptive replacement of a failing global memory director. When a hard error is detected, or temporary errors reach a predetermined threshold, the Symmetrix service processor calls home to request an immediate maintenance action.

The memory design and global memory management algorithms allow a failing area of memory to be fenced off to prevent a loss of data. When board replacement is required, global memory usage is redirected to the remaining good boards in the system, and the suspect board is removed and replaced while the system remains online.

For information on global memory director data integrity protection, refer to *Maintaining Data Integrity* on page 5-18.

Channel Director Redundancy

Channel director redundancy is provided by configuring multiple connections from the host servers (direct connect) or Fibre Channel switch (SAN Connect) to the Symmetrix system. With SAN connectivity, through Fibre Channel switches, each Symmetrix DMX port can support multiple host attachments, enabling storage consolidation across a large number of host platforms. The multiple connections are distributed across separate channel directors to ensure uninterrupted access in the event of a channel failure. A

minimum of two connections per server or SAN is required to provide full redundancy. The following is a summary of the number of host/SAN connections available across the Symmetrix DMX series:

Table 5-1 Number of Supported Channel Directors

Model	Number Channel Directors ^a	Total Ports
Symmetrix DMX1000 and DMX1000-M2	up to 6	16 - 48
Symmetrix DMX1000-P2	up to 4	16 - 32
Symmetrix DMX2000, DMC2000-3, and DMX2000-M2	up to 12	16 - 96
Symmetrix DMX2000-P2	up to 8	16 - 64
Symmetrix DMX3000-3 and DMX3000-M2	up to 8	16 - 64

a. For specific channel director configurations, consult your EMC Sales Representative.

Channel failover functionality is required to automate the failover and fail back process to avoid an interruption to data access.

Without this functionality, a path failure due to a problem with the host bus adapter, Fibre Channel switch, fibre cable, or channel director would create the potential for the application to go down. EMC PowerPath provides this functionality and supports end-to-end, (or switch-to-storage) channel failover functionality. PowerPath provides automatic, nondisruptive failover capabilities by redirecting I/Os from a failed channel to all remaining channels for open systems devices. PowerPath can automatically detect when a path has failed and sends an error log to the host to notify it that there is an inactive path. PowerPath then fails over the existing I/O request to another active path to maintain data access and application availability—offering intelligent load balancing capabilities to optimize performance and minimize bottlenecks. All this occurs transparently to the host so the application is not stopped and data is continuously available.

Once the failed path is fixed or repaired, PowerPath automatically detects activity, brings the path back into operation, and automatically sends I/O requests down to the now-active path. The major benefits of the path failover capability is the ability to automatically detect a channel failure, transparently redirect an I/O to other available channels, and easily service and restore the failed channel without interrupting applications.

Internal Control Data Path Redundancy

Each director has two paths to connect the Symmetrix DMX message matrix between each director. Independent and redundant fault domains are provided by a plug-in Communication Control Module (CCM). These fault domains within the message matrix fabric are intelligent at the hardware level and load balance traffic between each domain. In the event that a fault occurs within one of the domains, the traffic is automatically routed by the hardware to the available domain, and the system is alerted of the faulty CCM domain for replacement. The connection is made through the plug-in CCM.

There are two CCMs per system. If we look at a fully configured Symmetrix DMX2000, for example, 16 directors are configured with 32 point-to-point serial connections. This means sixteen connections are routed to the first CCM and the other sixteen redundant connections are routed to the second CCM. The message engine (ME) component of the message matrix provides protection against rogue or run away nodes. This is done at each message engine through error correction coding configurations, allowing the nodes to receive messages. Packet CRC and sequence numbers protect each message packet transmitted. Internal data paths with the message engine and fabric element are fully parity protected.

Fibre Channel Back-End Redundancy

The Symmetrix DMX architecture incorporates a 2 Gb/s Fibre Channel back-end design to ensure high performance and full redundancy. The Fibre Channel back-end disk subsystem provides redundant paths to the data stored on the disk drives to provide non-stop access to information, even in the event of a component failure and/or replacement. The following is an overview of the redundant components of the Symmetrix DMX back-end disk subsystem.

Redundant Disk Directors

A pair of directors is used to access each disk drive. One director is connected to one physical path to the drive, and the other director is connected to a second physical path to the drive. The directors are responsible for moving data between the global memory and the disks and, as such, are each connected to the global memory through redundant internal paths, to eliminate any possible single points of failure.

Redundant Cable Paths

Each disk director is attached to its associated set of Fibre Channel disks by a separate, independent cable assembly that carries the Fibre Channel loop, control bus, and other protocol signals.

Redundant Disk Ports

Each Fibre Channel disk drive has two fully independent Fibre Channel ports that are designed to connect to two separate loops. In the Symmetrix DMX architecture, these two ports are each connected to a different port bypass card, which in turn is connected through separate cables to two different disk directors. These two pathways are completely independent of one another.

Redundant Port Bypass Cards

Each disk director in a redundant pair connects to a separate port bypass card.

Fibre Channel Arbitrated Loop Design

Symmetrix DMX systems employ an arbitrated loop design that contains monitoring and control hardware and software to maximize the performance and availability of each loop. The loop is connected in a Star-Hub topology, with the hub ports gated with a bypass switch that allows individual loop segments (that connect to a Fibre Channel disk drive) to be dynamically inserted or removed. The loop initiator is a Symmetrix Fibre Channel disk director, which feeds data into and controls the hub. All of the monitoring and control logic is contained on the port bypass card, which also contains the bypass/hub logic for the loop. To ensure the highest level of availability, the communications link to the monitoring and control functions is not carried by the Fibre Channel loop—but, rather is implemented through a separate path. If the Fibre Channel loop is not operating for some reason, the director can access the port bypass card through the control bus and reconfigure the loop into a working state.

Port Bypass Card Control

The Port Bypass card is the heart of the Symmetrix disk Fibre Channel loop and constantly monitors the loop for Fibre Channel layer 0/1 signal connection and protocol errors. If errors are detected, the controlling software program is notified and, if necessary, the bypass circuits may be used to switch out the failing loop segment(s), thereby allowing the remaining devices on the loop to operate unaffected. Each disk enclosure, which houses up to 36 individual disk drives, contains a pair of port bypass cards. Each port bypass card connects one of the ports of the 36 drives to a disk director. For each disk connection, a bypass circuit is provided and allows that disk connection to be shunted. This only occurs when the drive is not installed, the drive was just powered on, the drive was reset, or the drive is malfunctioning. In addition to the bypass circuits themselves, the card contains real-time monitors embedded within the loop that can determine if bad data is being generated on the loop. These monitors report status to the loop control software and can be useful in determining which parts of the loop are being affected by potential

hardware failures. The port bypass card also has the ability to control power to the drives, and it maintains basic configuration information so that if the loop configuration is changed (a new disk assembly is inserted, for example), it reports this to the control software program so that it may take the appropriate action. The port bypass card is located within the disk enclosures which allows replacement in the case that the isolation device itself fails. Each port of a disk is connected to a different port bypass card, so access to the data is maintained even during service operations. Figure 5-1 is an illustration of the back-end redundancy of the Symmetrix DMX system.

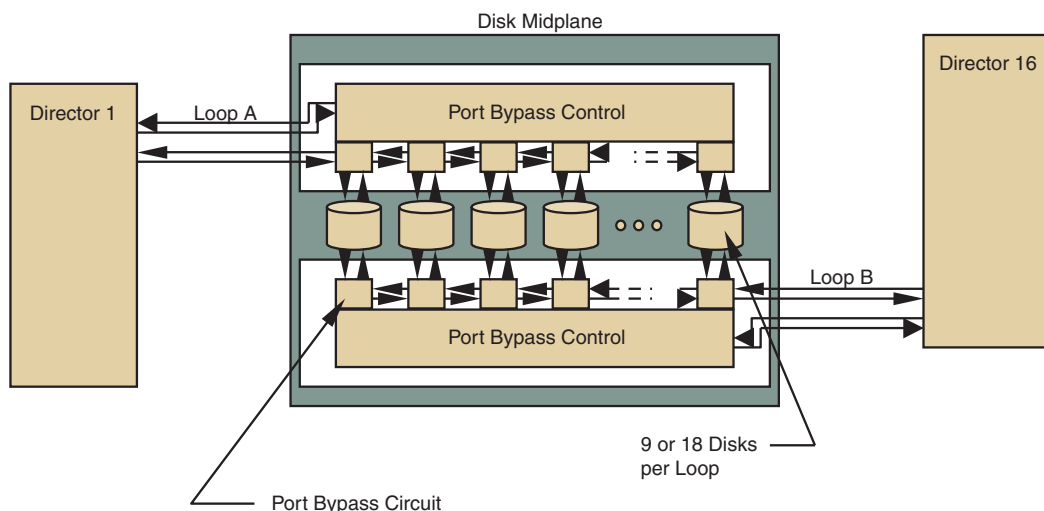


Figure 5-1 Fibre Channel Back-End Redundancy

Data Integrity for Fibre Channel Arbitrated Loops

In order to insure that the data transmitted by the disk director is the same as the data received by the disk device (and vice-versa), a multilayer protection strategy is employed. At the highest level, as data is transmitted between the global memory and the disk, a connection referred to as an exchange is established. Logical parameters that identify this connection are initialized, and then all information transferred as part of this exchange is identified with these parameters.

In addition, as the data in global memory is encapsulated into Fibre Channel frames, it is marked with a sequence number that identifies the order of the frame within the exchange and, in addition, a cyclic

redundancy checksum is computed over the data and appended to the data frame. The receiving port (after validating the exchange parameters) will recompute the checksum for the data received and compare it to the transmitted checksum to determine if there are any bytes-in-error. It will also check the sequence number to insure that the received frame is the next one expected for that exchange.

The next level of protection is designed in at the transmission layer of the Fibre Channel protocol. The data frame, with the additional information appended, is translated into special ten-bit data transmission symbols. These symbols are chosen for their ability to increase the reliability of the transmitted data, whether it is through a fiber optic or copper cable. The transmission codes also help to assist in detecting errors in transmission.

Finally, once the data has been received at the disk drive (for writes) and decoded from the transmission codes, it will then be further recoded using a very powerful linear block coding algorithm before being stored on the disk's magnetic surface. This code has the ability to not only detect errors, but to also correct them on the fly—insuring that the data read from the drive at a later time will be read perfectly.

Dual-Initiator Feature

Symmetrix DMX systems have a dual-initiator feature that ensures continuous availability of data in the unlikely event of a Symmetrix disk management hardware failure. The dual-initiator feature does not provide data availability in the event of a disk device failure. This feature works by having each of the four processors on the paired disk directors *shadow* each other's functions. For example, this feature gives each processor the capability of servicing any or all of the devices of the processor with which it is paired, should one of the processors be unable to partially or fully service its own devices.

With the dual-initiator feature, for example, each of the four processors and its port bypass card of Disk Director 1 is paired with a port bypass card and a processor of Disk Director 16 (Figure 5-2 on page 5-13.) Under normal conditions, each disk director processor services its own disk devices. If the sophisticated fencing mechanisms of the Symmetrix system detect a failure on the disk director, the system reads from or writes to the disk devices through the disk director processor's shadowed alternate path without interruption, and then notifies the EMC Customer Support Center. When the source of the failure is corrected, the Symmetrix system returns the I/O servicing of the two disk director processors to their normal state.

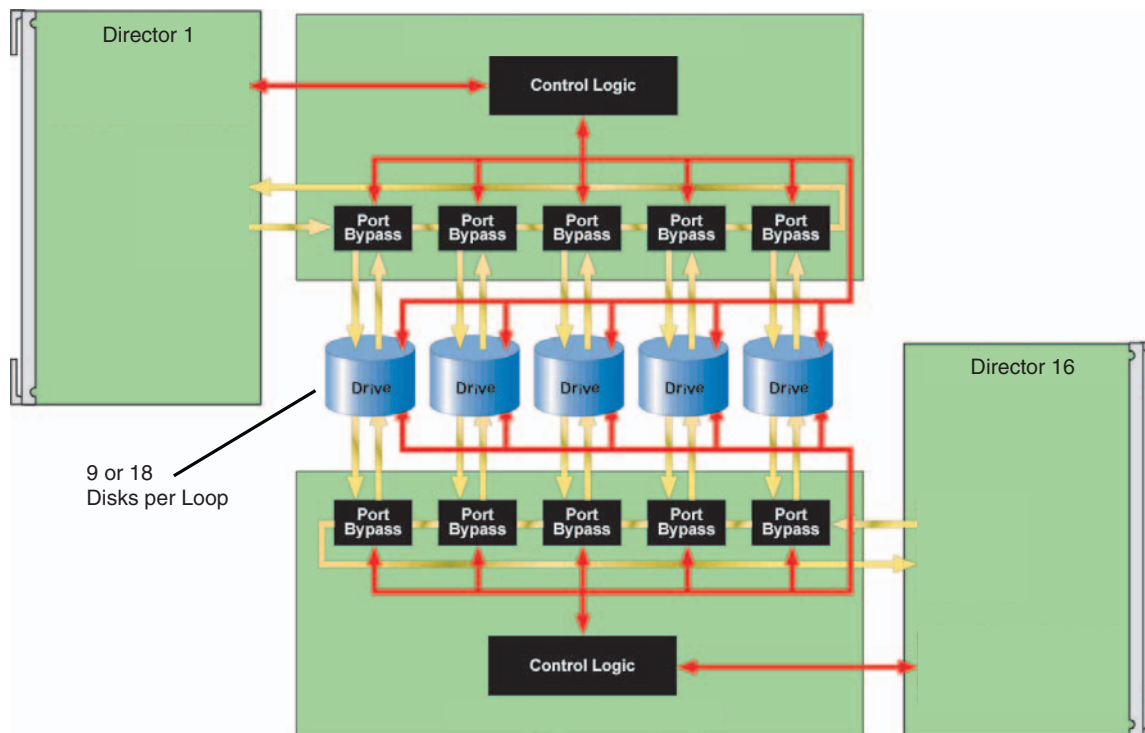


Figure 5-2 Symmetrix DMX Dual-Initiator Example

Redundant Power Subsystem

The Symmetrix DMX systems have a modular power subsystem featuring a redundant architecture that facilitates field replacement of any of its components without any interruption in processing.

The Symmetrix DMX1000 power subsystem supports an (N+1) power zone for redundancy and drive expansion. The DMX1000 system connects to two dedicated or isolated AC power lines. If AC power fails on one line, the power subsystem automatically switches to the other line.

The Symmetrix DMX2000/3000 power subsystem supports two (N+1) power zones for redundancy and drive expansion. The Symmetrix DMX2000/3000 power subsystem connects to four dedicated or isolated AC power lines.

If any Symmetrix DMX single power supply module fails, the remaining power supplies continue to share the load. The Symmetrix DMX senses the fault and reports it as an environmental error.

System Battery Backup

The Battery Backup Unit (BBU) ensures data integrity during power outages. The BBU provides the means for destaging any fast-write data that might be in global memory if AC power is lost on both lines to the unit.

In addition to providing nonvolatility to the Symmetrix system, the BBU is fully capable of powering not only all electronic components, but also all HDAs during this time. This capability eliminates emergency power off situations, meaning that the disks are always powered down in an orderly manner, extending their useful life considerably.

The BBU allows the Symmetrix system to remain online to the host system in the event of an AC power loss. The BBU maintains power for 60 seconds after AC loss and, if AC power is not restored within 60 seconds, an orderly shutdown of the system is initiated.

The BBU also prevents disk device failures due to the sharp power drops that occur during unexpected power interrupts. The BBU has sufficient capacity to ride out multiple AC outages, however it requires approximately 12 hours of uninterrupted recharge time to fully recharge the BBU. The BBU also contains a self-diagnostic controller to ensure availability and correct operation by monitoring the battery condition, charger states, and by providing status updates to the Environmental Control Module.

Symmetrix Power Failure on Mainframe Channels

When a power failure occurs, all directors send a unit check status with the environmental data-present bit set to all channels (error code 047A). Power switches immediately to the backup battery, and the Symmetrix system continues to operate normally. When the battery timer window elapses, the Symmetrix system presents SCU busy to prevent the host system from writing or reading any data at the unit. The Symmetrix system destages any fast write data still in global memory to disk, spins down the disk devices and retracts the heads, and powers down, turning off the battery at that time. The Symmetrix system will respond `not operational` to the host after it powers down.

Symmetrix Power Failure on Open Systems Channels

When a power failure occurs, power switches immediately to the backup battery and the Symmetrix system continues to operate normally. When the battery timer window elapses, the Symmetrix system presents a busy status to prevent the host system from writing or reading any data at the unit. The Symmetrix system destages any Fast Write data still in global memory to disk, spins down the disk

devices and retracts the heads, and powers down, turning off the battery at that time. The Symmetrix system will not respond to SCSI commands after it powers down.

Nondisruptive Component Replacement

Symmetrix DMX systems implement a modular design with a low parts count that improves serviceability by allowing nondisruptive component replacement, should a failure occur. The low parts count minimizes the number of failure points. The Symmetrix DMX features concurrent maintenance of all major components, including:

- ◆ Global memory director boards
- ◆ Channel director boards
- ◆ Disk director boards
- ◆ Disk devices
- ◆ Port bypass cards
- ◆ Cooling fan modules
- ◆ Environmental Control Module (ECM)
- ◆ Communications Control Module (CCM)
- ◆ Power supplies
- ◆ Power Line Input Modules (PLIMs)
- ◆ Batteries
- ◆ Service processor

The Symmetrix DMX systems provide full component-level redundancy to protect against a component failure and ensure continuous and uninterrupted access to information. To improve serviceability, the Symmetrix DMX director boards, back adapters, CCMs, and ECMs are mechanically keyed to prevent insertion to invalid slots. A *Disable Interface* feature ensures that at power up the link interfaces between any new channel or disk director and its corresponding global memory directors are disabled. Only after safeguards have been satisfied to ensure that a director has been properly replaced will a new board be activated and brought online.

This nondisruptive replacement capability allows the EMC Customer Engineer to install a new component, initialize it if necessary, and bring it online *without*:

- ◆ Disrupting access to unaffected volumes
- ◆ Powering down the Symmetrix unit
- ◆ Stopping the operating system
- ◆ Taking unaffected channel paths offline
- ◆ Taking devices offline (other than the affected device)

Nondisruptive Enginuity Upgrades

Interim updates from of the Enginuity Operating Environment can be performed at the customer site by the EMC Customer Engineer (CE). The nondisruptive upgrade will complete in 15 seconds or less. These updates provide enhancements to performance algorithms, error recovery and reporting techniques, diagnostics, and Enginuity fixes. They also provide new features and functionality for Enginuity.

During an online Enginuity code load, the EMC Customer Engineer downloads the new Enginuity code to the service processor. The new Enginuity code loads into the EEPROM areas within the channel and disk directors, and remains idle until requested for a hot load in control store.

The Symmetrix system does not require customer action during the performance of this function. All channel and disk directors remain in an online state to the host processor, thus maintaining application access. The Symmetrix system will load executable Enginuity code within each director hardware resource until all directors have been loaded.

Once the executable Enginuity code is loaded, internal processing is synchronized and the new code becomes operational.

Dynamic Reconfigurations

Symmetrix systems support dynamic reconfiguration activity without disruption to online applications such as:

- ◆ Establish/de-establish mirrored pairs
- ◆ Add/reallocate hypervolumes
- ◆ Modify channel assignments or change emulation modes

Modification to channel assignments without disruption to online applications can occur only if the application has an alternate path to the data.

Nondisruptively Change or Remove FBA Drives

This feature nondisruptively allows an FBA open systems device to be changed or deleted online regardless of the type of data protection. This feature uses the same mechanisms as other online configuration changes to ensure no impacts.

Deleting (and then Adding) Devices Online

Enginuity code 5670 supports removing and then adding devices online, which facilitates the following configuration enhancements:

- ◆ Change Device Emulation Online—Remove a CKD volume and add an FBA volume and vice-versa.

Adding a CKD volume to a Symmetrix system requires a global memory configuration change if this is the first CKD volume being added. However, the system can be configured in advance, thus avoiding an offline global memory reformat.

- ◆ Convert between mirrored and RAID protected volumes.

Maintaining Data Integrity

The Symmetrix DMX systems preserve data integrity by performing extensive error checking and correction on all data and addresses that it passes internally. The Symmetrix DMX architecture provides the most reliable hardware design in the industry. However, all hardware is subject to the effects of aging and occasional failures. The unique methods used by Symmetrix DMX systems for detecting and preventing these failures in a proactive way set it apart from all other storage solutions in providing continuous data integrity and high availability. The Symmetrix system is designed with these data integrity features:

- ◆ Remote Support
- ◆ Error checking, correction, and data integrity protection
- ◆ Disk error correction and error verification
- ◆ Global memory error correction and error verification
- ◆ Periodic system checks

Remote Support

Remote Support is an important and integral part of EMC Customer Service and Support. Every Symmetrix unit has an integrated service processor that continuously monitors the Symmetrix environment. The service processor can communicate with the EMC Customer Support Center through a customer-supplied direct phone line. Through the service processor, the Symmetrix system actively monitors all I/O operations for errors and faults. By tracking these errors during normal operation, the Symmetrix system can recognize patterns of error activity and predict a potential hard failure before it occurs. This proactive error tracking capability can often prevent component failures by fencing off, or removing from service, a suspect component before a failure occurs. The “Call Home” capabilities allow the Symmetrix system to automatically notify EMC Customer Support of potential issues before a failure actually occurs. An EMC Product Support Engineer handles these calls and can dispatch a local Customer Engineer to install a new component without disrupting access to data.

To provide remote support capabilities, the Symmetrix system is configured to phone home and alerts EMC Customer Support of a failure or potential failure. The appropriate authorized EMC Product Support Engineer is able to run system diagnostics remotely for further troubleshooting and resolution. Configuring the EMC products to allow inbound dial also enables EMC Customer Support to proactively dial in to the Symmetrix system to gather needed

diagnostic data or to attend to identified issues. The current dial-in support program for the Symmetrix system uses the latest digital key exchange technology for strong authentication, layered application security, and a centralized support infrastructure that places calls through an encrypted tunnel between EMC Customer Support and the service processor located inside the Symmetrix system.

Before any individual can initiate a call to a customer site, that person must be individually authenticated and determined to be an appropriate member of the EMC support team. Field-based personnel who might be known to the customer must still be properly associated with the specific customer’s account. An essential part of the design of the dial-in support program is that the call to the customer’s Symmetrix service processor must originate from one of several specifically designed Remote Support Networks at EMC. Within each of those EMC Support Centers, the necessary networking and security infrastructure has been built to enable both the call-EMC and call-device functions.

Error Checking and Correction, and Data Integrity Protection

In conventional DASD, the subsystem adds Error Checking and Correction (ECC) bytes to each data record field, as shown in Figure 5-3. The system uses these error checking and correction bytes to check the data and correct it, if possible. If it detects an uncorrectable error, the DASD subsystem informs the host that it has encountered bad data to avoid affecting data integrity.

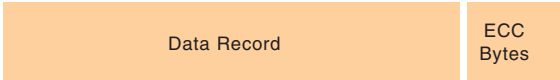


Figure 5-3 Data Record Format for Conventional DASD

Symmetrix systems, like conventional DASD, perform this level of error checking and correction when they pass data and addresses. Symmetrix systems, however, go further to ensure that the information passed belongs to the record specified. The system does this by including additional bytes with the data field of each record. These bytes contain the record ID and a double Longitude Redundancy Code (LRC) check byte, as shown in Figure 5-4. The Symmetrix system uses these bytes to check that the data is from the specified record and alarms the host if it is not. This second level of protection further ensures data integrity by preventing incorrect data from being transferred.



Figure 5-4 Symmetrix Data Record Format

Symmetrix systems assure the highest level of data integrity by checking data validity through the various levels of the data transfer in and out of global memory. Should an error be undetected at one level, it will be detected at one of the other levels.

Disk Error Correction and Error Verification

The disk directors use idle time to read data and check the polynomial correction bits for validity. All data and command words passed between the disk directors and the disk devices include frame-based CRC used to check integrity at each data transfer. If a disk read error occurs, the disk director reads all data on that track to Symmetrix global memory. The disk director writes several worst-case patterns to that track, searching for media errors.

When the test completes, the disk director rewrites the data from global memory to the disk device, verifying the write operation. The disk microprocessor maps around any bad block (or blocks) detected during the worst-case write operation, thus skipping defects in the media. If necessary, the disk microprocessor can reallocate up to 32 blocks of data on that track. To further safeguard the data, each disk device has several spare cylinders available. If the number of bad blocks per track exceeds 32 blocks, the disk director rewrites the data to an available spare cylinder. This entire process is called *error verification*.

The disk director increments a soft error counter with each bad block detected. When the internal soft error threshold is reached, the Symmetrix service processor automatically dials the EMC Customer Support Center and notifies the host system of errors through sense data. The Symmetrix system also invokes Dynamic Sparing (if the Dynamic Sparing option is enabled). This feature maximizes data availability by diagnosing marginal media errors before data becomes unreadable.

Global Memory Director Data Integrity Logic

The global memory director technology implements the following data integrity logic on the Symmetrix DMX global memory directors:

- ◆ Global Memory Error Correction and Error Verification
- ◆ Global Memory Chip Level Redundancy
- ◆ Longitude Redundancy Code (LRC)
- ◆ Byte-Level Parity Checking
- ◆ Global Memory Access Path Protection

Global Memory Error Correction and Error Verification

In addition to monitoring recoverable conditions during normal access, all locations in global memory are periodically read and rewritten to detect any increase in single-bit errors. This memory verification technique maintains a record of errors for each memory segment. If the predetermined (single-bit) error threshold is reached in a certain segment, the service processor generates a call-home for immediate attention.

Constant memory verification to detect and correct single-bit and nonconsecutive double-bit errors dramatically reduces the potential for multibit or hard errors. Should a multibit error be detected during the scrubbing process, it is considered a permanent error. This error is corrected and the segment is immediately fenced (removed from service) and the segment's contents are moved to another area alienable memory.

A service processor call-home alerts EMC Global Service Call Centers whenever an unacceptable level of errors has been detected and a nondisruptive global memory director replacement is ordered. Customer Service is immediately notified of all call-home alerts, and a Customer Service Engineer can be dispatched with the appropriate parts for speedy repair. Even in cases where errors are occurring and are easily corrected, if they exceed a preset level, the call home is executed. This represents the EMC philosophy of not accepting any errors.

Error verification maximizes data availability by significantly reducing the probability of encountering an uncorrectable error by preventing bit errors from accumulating in global memory.

In the mainframe host environment, the Symmetrix system reports uncorrectable bit errors as Equipment Checks to the CPU. These errors appear in the IBM EREP file.

Global Memory Chip Level Redundancy

Traditional cache systems usually provide for eight bits of parity information to support bit error correction and detection in a 64-bit long word. The global memory directors incorporate single-nibble correction double-nibble detection capabilities. (A nibble is four consecutive bits of information.) Global memory chip-level redundancy is achieved by internally generating 16 bits of ECC parity information and replacing the incoming parity information. This enables the system to correct up to four bit errors associated with a 64-bit-long word and can detect up to eight bit errors. It also interleaves 64 bits of information + 16 global memory director parity information (total 80 bits) across 20 memory chips on the global memory director. This results in each memory chip storing only a nibble of information corresponding to a word. So, a chip-level error will disable access only to the nibble stored on that faulty chip. However, the global memory director enables regeneration of data from the faulty chip. This leads to chip-level redundancy, making every chip on the global memory director redundant.

Longitude Redundancy Code (LRC)

Symmetrix global memory directors also incorporate sector-level Longitudinal Redundancy Checks (LRC), which further assure data integrity. The check bytes are the XOR (exclusive OR) value of the accumulated bytes in a 4 KB sector. LRC checking can detect both data errors and incorrect block access problems.

Byte-Level Parity Checking

All data paths and control paths have parity generating and checking circuitry that verify data integrity at the byte or word level. All data and command I/Os passed through the direct matrix interconnect, and within each channel/disk director and global memory director, include parity bits used to check integrity at each stage of the data transfer. This provides a system-wide error checking capability.

Global Memory Access Path Protection

Before Symmetrix global memory can accept data from a host connection, it must ensure that the area to which the data is to be written is without error. The Symmetrix system assures the highest level of data integrity by checking data validity through the various levels of the data transfer in and out of global memory.

Data Protection Guidelines

The Symmetrix data protection options ensure a higher level of data protection, recoverability, and availability than the standard Symmetrix availability and reliability features. The options listed in Table 5-2 can be purchased separately and implemented into the Symmetrix operation.



CAUTION

To ensure continuous data availability, EMC strongly recommends that you use one or more of the data protection schemes for your Symmetrix volumes as described in Table 5-2.

Table 5-2 Data Protection Options ^a

Data Protection Option	Description
Mirroring (RAID Level 1)	Provides the highest level of performance and availability for all mission-critical and business-critical applications by maintaining a duplicate copy of a volume on two disk devices. For more information, refer to <i>Disk Mirroring Concepts</i> on page 5-25.
Parity RAID	Provides: - High performance dependent upon volume layout and external striping - High availability - data from lost volume is regenerated from remaining members A Parity RAID (3+1) group consists of three data volumes to one parity volume. A Parity RAID (7+1) group consists of seven data volumes to one parity volume. For more information, refer to <i>Symmetrix DMX Parity RAID Options</i> on page 5-28.
RAID 5	Provides: - High performance with automatic striping across hypervolumes - High availability - lost hypervolumes regenerated from remaining members RAID 5 is configured in (3+1) and (7+1) groups. RAID 5 technology stripes data and distributes parity blocks across all the disk drives in the disk array. For more information, refer to <i>Symmetrix DMX RAID 5 Options</i> on page 5-41.
Symmetrix Remote Data Facility (SRDF)	Provides an information protection/ business continuance solution by maintaining a mirror image of data in multiple Symmetrix systems that can be in physically separate locations. For more information on SRDF, refer to the <i>Symmetrix Remote Data Facility Product Guide</i> .
Dynamic Sparing	Increases data availability by copying the data on a failing volume to a spare volume until the original device is replaced. Dynamic Sparing is used as additional protection for mirrored Parity RAID and SRDF volumes. For more information, refer to <i>Dynamic Sparing</i> on page 5-44 and <i>Dynamic Sparing as Additional Data Protection</i> on page 5-46. For information on RAID 5 sparing, refer to <i>RAID 5 Temporary Member Sparing</i> on page 5-41.
Symmetrix RAID 10	RAID 10 (one-zero) is a mirroring feature with striping used for mainframe environments. For more information, refer to <i>Symmetrix RAID 10 (Mirrored Striped Mainframe Volumes with DMSP)</i> on page 5-43.

a. When configuring multiple data protection options, consult your EMC Sales Representative for configuration rules.

Configuring Data Protection Options

Follow these guidelines when configuring data protection options:

- ◆ Parity RAID (3+1) and (7+1) cannot co-exist in the same frame.
- ◆ RAID 5 (3+1) and (7+1) cannot co-exist in the same frame.
- ◆ Any combination of RAID (3+1) and (7+1) – Parity RAID and/or RAID 5 – cannot co-exist in the same frame. For example, Parity RAID (3+1) is not supported with RAID 5 (7+1).
- ◆ A single parity RAID protection scheme can be configured within a frame with any combination of SRDF, BCV and mirroring protection.
- ◆ A single RAID 5 protection scheme can be configured within a frame with any combination of SRDF, *business continuance volume* (BCV) and mirroring protection.
- ◆ A single Parity RAID protection scheme and RAID 5 of the same scheme can be configured within a frame with any combination of SRDF, BCV, and mirroring protection. For example, Parity RAID (3+1) is supported with RAID 5 (3+1).

Disk Mirroring Concepts

Symmetrix Mirroring provides the highest level of performance and availability for all mission-critical and business-critical applications. Mirroring maintains a duplicate copy of a logical volume on two physical disk devices. The Symmetrix system maintains these copies internally by writing all modified data to both devices. The mirroring operation is transparent to the host.

The mirroring feature designates from two-to-four logical volumes residing on different physical devices as a mirrored volume, one volume being mirror-1 and the other volumes being mirror-2, mirror-3, and mirror-4. The host views the mirrored volumes as the same logical volume because each has the same unit address.

Advantages of Mirroring

Symmetrix Mirroring offers the following advantages:

- ◆ Improved performance over traditional mirrored (RAID 1) data protection by supporting 100 percent fast write and two simultaneous internal data transfer paths
- ◆ Protection of mission-critical data from any single point of failure
- ◆ Assurance that the second copy of data is identical to the first copy
- ◆ Superior read performance since both mirrors are used for read operations
- ◆ Continuous business operation in a situation where there is a device failure
- ◆ Automatic resynchronization of the mirrored pair after repairing the defective volume

Write Operations with Mirroring

Symmetrix systems handle a write operation to a mirrored logical volume as a normal write operation. The channel director presents channel end and device end (or a good-ending status) to the channel after data is written to, and verified in, global memory. The disk directors then destage the data to each drive of the mirrored pair asynchronously. As such, mirroring on Symmetrix systems exploits the 100-percent fast write capability, and the application does not see additional time associated with having to physically perform two disk write I/Os (one to each drive of the mirrored pair) as normally occurs with mirroring.

Read Operations with Mirroring

During read operations, if the data is not available in global memory, the Symmetrix system reads the data from the volume chosen for best system performance. Performance algorithms within the Engenuity operating environment track path busy information, as well as actuator location, and which sector is currently under the disk head in each device.

Symmetrix performance algorithms for read operations choose the best volume in the mirrored pair based upon three service policies used to balance system performance.

- ◆ **Interleave Service Policy**—Shares the read operations of the mirrored pair by reading tracks from both logical volumes in an alternating method: a number of tracks from the primary volume (M1) and a number of tracks from the secondary volume (M2). The interleave policy is designed to achieve maximum throughput.
- ◆ **Split Service Policy**—Differs from the interleave policy because read operations are assigned to either the M1 or the M2 logical volume, but not to both. Split is designed to minimize head movement.
- ◆ **Dynamic Mirror Service Policy (DMSP)**—Utilizes both Interleave and Split for maximum throughput and minimal head movement. DMSP adjusts each logical volume dynamically, based on access patterns detected. This is the default mode within the Engenuity operating system.

Error Recovery with Mirroring

In the unlikely event that a disk device fails, the Symmetrix system automatically uses mirrored volumes for that device without interruption of data availability. The Symmetrix system notifies the host operating system of the error through the message-to-operator protocol on mainframe systems and in all cases notifies the EMC Customer Support Center through an Auto-Call action. The EMC Customer Support Center Product Support Engineer (PSE) then begins the diagnostic process and, if necessary, dispatches a Customer Engineer (CE) to the customer site. Once the defective disk device is nondisruptively replaced, the Symmetrix system automatically resynchronizes the data with the new disk. During the data resynchronization process, the Symmetrix system gives priority to host I/O requests over the copy process to minimize the impact on performance. All new writes take place to both devices. The time it takes to resynchronize the mirrored pair depends on the I/O activity to the volume, the disk device, and the disk capacity.

Dynamic Mirror Service Policy

The Symmetrix Dynamic Mirror Service Policy (DMSP) is a feature of the adaptive algorithms in the Symmetrix architecture that improves the performance of read operations in mirrored and Business Continuity Volume (BCV) environments. The improved system performance is a result of the Symmetrix system balancing the load between physical disk drives and disk directors, and minimizing actuator movement.

To achieve this improved performance, the Symmetrix system measures and tracks I/O activities of logical volumes (including business continuity volumes), physical disks, and disk directors. Based on these measurements, the Symmetrix system directs read operations for mirrored data to the appropriate mirror resulting in the best overall performance of the Symmetrix system. As the access patterns and workloads change, the dynamic algorithm analyzes the new workloads and adjusts the service policies as needed.

Business Continuity Volumes

A Business Continuity Volume (BCV) is a standard device (logical volume) used for dynamic mirroring. It has additional attributes that allow it to independently support host applications and processes. It may be configured as a single mirror, a locally mirrored device, or an SRDF source (R1) device. A BCV device can be RAID 1 or SRDF protected, but it *cannot* be Parity RAID (3+1) or (7+1) protected.

A business continuity sequence first involves setting, or establishing, the BCV device as an additional mirror of a standard device. Once the BCV is established as a mirror of the standard device, it is not accessible through its original device address. The BCV device may later be separated, or split, from the standard device with which it was previously paired. After a split, the BCV device has valid data and is available for backup or other host processes through its original device address. Once host processes on the BCV device are complete, the BCV may again be mirrored to a standard device (either the same device to which it was previously attached or a different device). It can then acquire new data for other business continuity processes or update the standard device with any new data from the completed business continuity processes.

Symmetrix DMX Parity RAID Options

Symmetrix Parity RAID (Redundant Array of Independent Disks) technology is a combination of hardware and software functionality that improves data availability on drives in Symmetrix DMX systems by using a portion of the array to store redundancy information. This redundancy information, called parity, can be used to regenerate data if the data on a disk drive becomes unavailable.

The following sections describe how Parity RAID functions in Symmetrix systems and how it differs from conventional RAID:

- ◆ *Parity RAID Technology* on page 5-28
- ◆ *Data Protection Flexibility* on page 5-29
- ◆ *Parity RAID Components* on page 5-29
- ◆ *Parity RAID Modes of Operation* on page 5-33
- ◆ *Writing, Reading, and Rebuilding Data with Parity RAID* on page 5-35
- ◆ *Writing Data in a Parity RAID Group* on page 5-35
- ◆ *Reading Data in a Parity RAID Group* on page 5-36
- ◆ *Data Recovery with Parity RAID* on page 5-37

Parity RAID Technology

Parity RAID technology offers the following advantages:

- ◆ Protects a volume requiring high availability from being a single point of failure.
- ◆ High performance, even in the event of a disk failure within a Parity RAID group.
- ◆ In the case of a single disk failure, all logical volumes that were not physically stored on the failed disk device perform at the level typical of standard Symmetrix devices.
- ◆ In the event of a multiple disk failure within a Parity RAID group, data on all remaining devices within the group remains accessible.
- ◆ Automatically restores parity protection on the global memory level to the Parity RAID group after repair of a defective device.

Parity RAID employs the same technique for generating parity information as many other commercially available RAID solutions, that is, the Boolean operation EXCLUSIVE OR (XOR). However, EMC's Parity RAID implementation reduces the overhead associated with parity computation by moving the operation from controller microcode to the hardware on the XOR-capable disk drives.

Additional XOR hardware assist built into the Symmetrix global memory directors further distributes the XOR function throughout the system to improve performance in the regeneration mode of operation.

Data Protection Flexibility

Compared to a mirrored Symmetrix system, Parity RAID offers more usable capacity than a mirrored system containing the same number of disk drives. Like the Mirroring or Dynamic Sparing options, Symmetrix RAID parity protection can be dynamically added or removed. For example, for higher performance requirements and high availability, a Parity RAID group of volumes can be reconfigured as multiple mirrored pairs. Within the same Symmetrix system, data can be protected through Parity RAID, mirroring, and SRDF. Dynamic Sparing can be added to any of these data protection options.

Parity RAID Components

A Parity RAID group consists of the physical disk devices within the Symmetrix unit that are related to one another for common parity protection. The Parity RAID group is defined by the EMC Customer Engineer at the time the Symmetrix system is installed, and includes disk volumes that are designated as either data volumes or parity volumes.

The following sections describe these Parity RAID components:

- ◆ Logical Volume
- ◆ Parity RAID—Data Volume
- ◆ Parity RAID—Parity Volume
- ◆ Parity RAID Group
- ◆ Parity RAID Rank
- ◆ Parity RAID (3+1)
- ◆ Parity RAID (7+1)
- ◆ Hypervolume Extension (HVE) with Parity RAID

Logical Volume

A logical volume is a unit of storage implemented on a single Symmetrix disk drive. When Hypervolume Extension (HVE) is not used, the size of a logical volume is usually the same as a physical volume. With HVE, up to 58 logical volumes for Parity RAID (3+1) configurations and up to 39 logical volumes for Parity RAID (7+1) configurations of varying sizes can exist on a physical volume.

Parity RAID—Data Volume

A data volume is similar to a traditional logical volume. It is the *virtual volume* image presented to the host operating system and

defined as a separate unit address to the host. All data volumes within a rank must be the same size. Parity RAID does not stripe data across members of a rank as in many other RAID implementations. Instead, each data volume emulates a complete 3380 or 3390 device mapped to a mainframe host, or a complete FBA logical volume mapped to an open systems host. This methodology allows the group to sustain the loss of more than one disk drive and still service requests from all the surviving disk drives. In conventional parity-based RAID implementations that stripe data, the loss of more than one member would result in loss of all data in the entire group.

Parity RAID—Parity Volume

A parity volume is a logical volume that holds the parity information for the rank. It must be the same size as the data volumes it supports. Parity volumes do not have unit addresses and are transparent to the host software. As with the secondary (M2) volumes in a mirrored Symmetrix system, parity volumes are not included in the total device limit within a single Symmetrix system.

Parity RAID Group

A Parity RAID group consists of the physical disk devices within the Symmetrix unit that are related to one another for common parity protection. The Parity RAID group is defined within the Symmetrix system, and includes disk volumes that are designated as either data volumes or parity volumes.

Symmetrix systems employ four-processor Fibre Channel disk directors. These disk director boards are divided into an *a* side, *b* side, *c* side, and a *d* side, with each side supporting two Fibre Channel paths (labeled *A* and *B*) (Figure 5-5 on page 5-31). For optimum availability and redundancy, members of a RAID group are configured to span across multiple disk directors. The overriding configuration requirement is that each member of a RAID group must be on a different Fibre Channel path on the back end of the system.

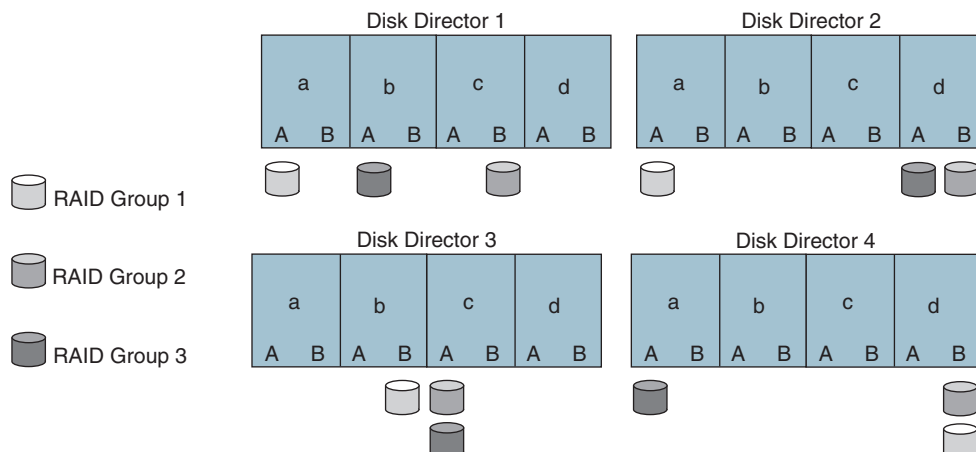


Figure 5-5 Symmetrix Parity RAID Group Disk Director Redundancy

Parity RAID Rank

A Parity RAID rank is the set of logical volumes related to each other for parity protection. Each Parity RAID group supports a minimum of one rank and, with Hypervolume Extension (HVE) enabled, a maximum of 58 ranks for Parity RAID (3+1) configurations and a maximum of 39 ranks for Parity RAID (7+1) configurations. Figure 5-6 shows a Parity RAID group consisting of four Symmetrix drives with one Parity RAID (3+1) rank defined across the group.

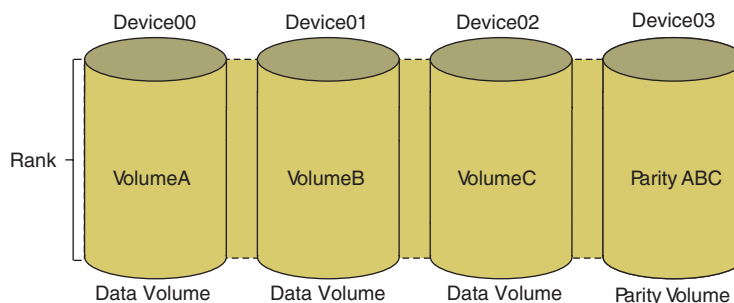


Figure 5-6 Parity RAID Group without Hypervolumes

Parity RAID (3+1)

A Parity RAID (3+1) configuration consists of Parity RAID ranks containing three data volumes and one parity volume. With this approach, effectively 75 percent of the total storage capacity of each Parity RAID group is available for storing data.

Parity RAID (7+1)

A Parity RAID (7+1) configuration consists of Parity RAID Ranks containing seven data volumes and one parity volume. With this

approach, effectively 87.5 percent of the total storage capacity of each Parity RAID group is available for storing data.

Multiple Symmetrix RAID groups with one configuration can coexist on the same Symmetrix unit. Symmetrix RAID (3+1) groups and RAID (7+1) groups cannot be configured in the same Symmetrix system, although each can be configured together with mirrored volumes. All logical volumes participating in a Symmetrix RAID group must have identical storage capacity. A Symmetrix system allows intermixing of different capacity physical disk devices within a single Symmetrix unit.

Hypervolume Extension (HVE) with Parity RAID

Symmetrix HVE is supported with Parity RAID. When using HVE, parity and data volumes are distributed among the members of a Parity RAID group, as shown in Figure 5-7.

For more information on the Symmetrix HVE feature, refer to *Open Systems Hypervolumes* on page 4-14 and *Mainframe Systems Hypervolumes* on page 4-18.

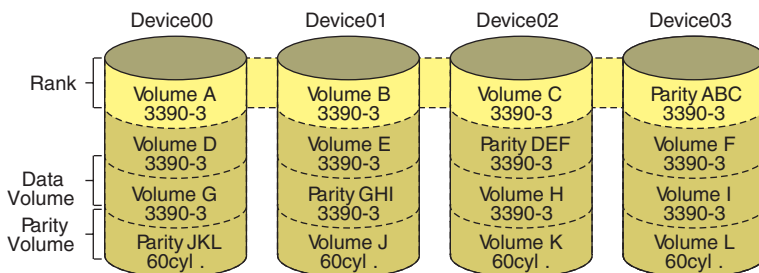


Figure 5-7 Parity RAID Group with Hypervolumes

HVE not only allows multiple logical volumes to be allocated to one physical volume, but those logical volumes that are members of a Parity RAID rank can be distributed across the multiple physical drives. The parity volume for each rank can reside on any physical volume within the Parity RAID group, as long as it is a different physical volume from those that compose the data volumes of that rank. This distributed parity provides improved performance over a single physical volume, which could become a performance bottleneck in a heavy write workload. It also provides the performance advantages normally associated with RAID 5 *striping*, without the disadvantages of data volume striping.

When using HVE and Parity RAID, all volumes that compose the Parity RAID ranks of a physical Parity RAID group must be identical in format (all 3390-1, all 3390-3, 3390-9, 3390-27, or all FBA.) However, separate Parity RAID physical groups on the same Symmetrix system can support different hypervolume configurations.

Parity RAID Modes of Operation

This section describes the following Parity RAID modes of operation:

- ◆ Normal Mode/Parity Generation
- ◆ Reduced Mode/Regeneration
- ◆ Non-RAID Mode
- ◆ Parity Rebuild

Normal Mode/Parity Generation

When a Parity RAID rank operates with all data and parity volumes functioning, it is operating in normal mode. In normal mode, the Symmetrix system accomplishes data redundancy by using the standard Parity RAID EXCLUSIVE OR (XOR) logic to generate and store XOR parity data that can then be used to reconstruct the data of a failed drive. In parity generation, a parity volume is initially formed by performing an XOR calculation on the contents of all member data volumes and writing the resulting parity to the parity volume. This bit-by-bit parity generation is illustrated in the first example in Figure 5-8 on page 5-34.

Reduced Mode/Regeneration

When a Parity RAID rank operates with one failed data volume, it is running in reduced mode. Referring to Figure 5-8 on page 5-34, the failure of device 00 would force the rank to operate in reduced mode. In Figure 5-7 on page 5-32, the failure of device 00 would cause the first three ranks to operate in reduced mode. The data on the failed volume is reconstructed by XORing the parity volume with the remaining data volumes in the same rank. This process is called *regeneration*. Regeneration is shown in the bottom two examples of Figure 5-8 on page 5-34.

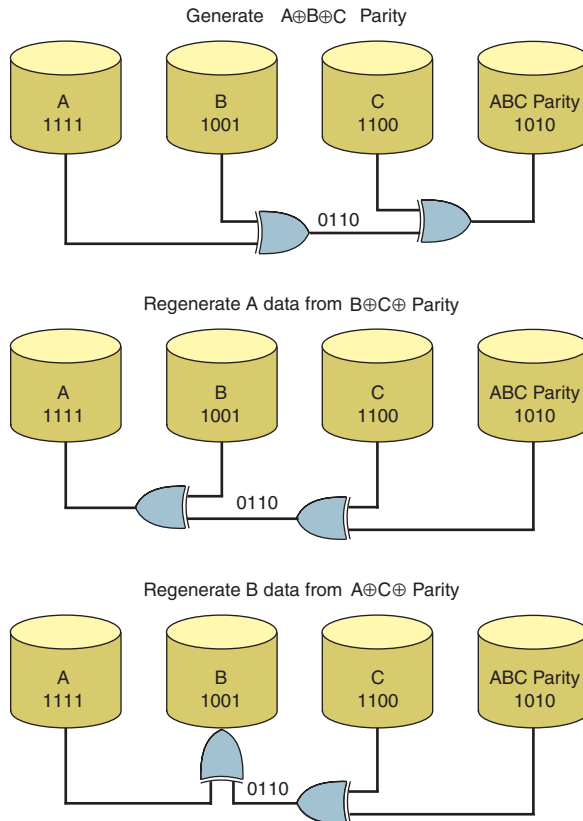


Figure 5-8 Parity Protection Logic

Non-RAID Mode

When a Symmetrix Parity RAID rank is operating with one failed *parity* volume, it is said to be running in non-RAID mode. As in reduced mode, parity protection is suspended for the rank. Again referring to Figure 5-7 on page 5-32, the failure of device 00 would cause the fourth rank to operate in non-RAID mode.

Parity Rebuild

When a parity volume fails, Symmetrix Parity RAID protection is suspended for the rank. When the failed device is replaced as part of a service action, the parity volume is reconstructed. This process is called *parity rebuild*.

Writing, Reading, and Rebuilding Data with Parity RAID

The Symmetrix Parity RAID write process is significantly different from other parity-based RAID implementations. The typical RAID implementation requires that the controller execute four discrete, sequential I/O operations:

- ◆ Read Old Data
- ◆ Read Old Parity
- ◆ Write New Data
- ◆ Write New Parity

In addition, two processing steps must be executed by the controller microcode:

- ◆ XOR old data with new data (creating difference data).
- ◆ XOR difference data with old parity (creating new parity).

In contrast, Symmetrix Parity RAID requires that the controller execute only two discrete sequential I/O operations:

- ◆ Write New Data
- ◆ Write Difference Data

The design of Symmetrix Parity RAID distributes the work of computing parity between the disk director and the disk drives, using the XOR chip located on the disk drive and the disk level buffer. The disk containing the data volume reads the old data, XORs it with the new data to compute difference data, and sends the difference data to the disk director, which then places the data in global memory. The disk containing the parity volume reads the old parity, XORs it with the difference data received from the global memory, and writes the new parity to the disk.

The parallelism introduced into the parity computation process through the use of XOR drives allows the disk director to do only half the number of back-end I/Os as do competitive RAID solutions. This reduces the impact of the write penalty significantly and improves the overall performance of Symmetrix Parity RAID compared to competitive implementations.

Writing Data in a Parity RAID Group

As with all Symmetrix operating modes, 100 percent of writes are fast writes and are satisfied in global memory. In a destaging write operation, the channel director presents a channel end/device end (or a good ending status) message to the host after data is written and verified in global memory.

In the Parity RAID write process, performing the *read old data* and *XOR* functions at the disk device level reduces the disk director's

operations to a single read (*difference data*) and two writes (new data to the data volume and difference data to the parity volume). Figure 5-9 illustrates how data is destaged to disk through the following sequence of Fibre Channel commands used in the Parity RAID write process:

- ◆ XD-Write-Read
- ◆ XP-Write

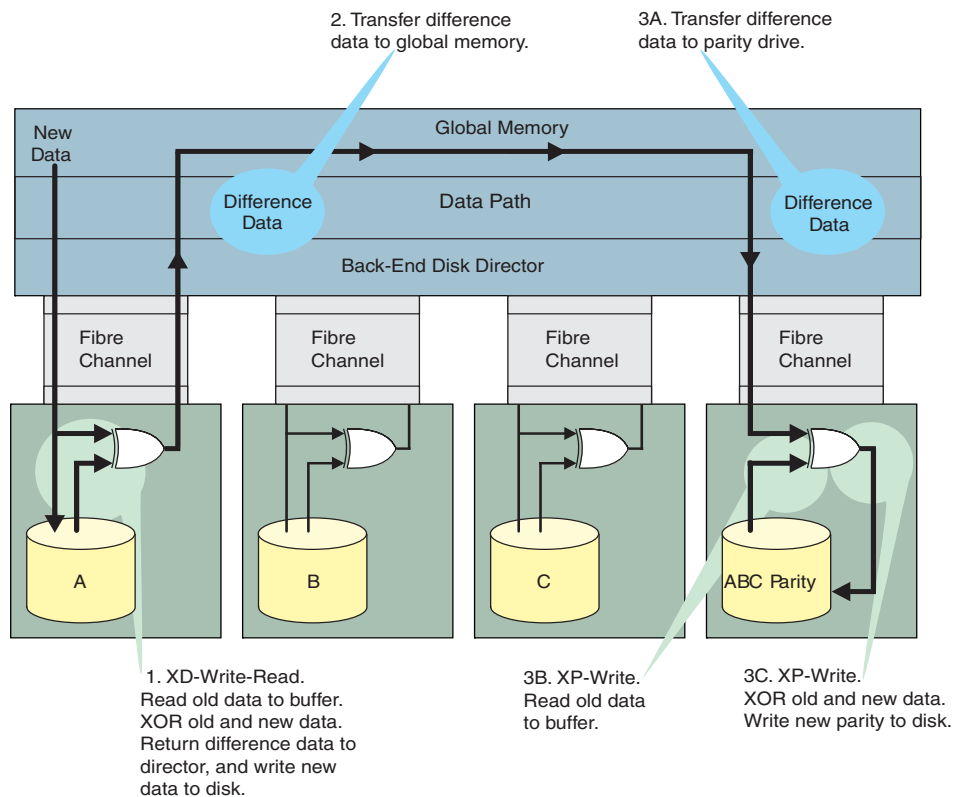


Figure 5-9 Symmetrix Parity RAID Write Operation

Reading Data in a Parity RAID Group

Read hit operations in a Symmetrix Parity RAID group are processed through global memory as in normal Symmetrix system processing. Read misses are directed to the disk drive and processed as normal Symmetrix system read misses. There is no XORing of the data, and only one disk drive is involved in servicing the request. This process offers an advantage over other implementations that stripe data across multiple disk drives. In these implementations, more than one

disk drive may be required to service the request, resulting in possible contention when multiple I/Os are serviced simultaneously.

Data Recovery with Parity RAID

Symmetrix Parity RAID provides continuous availability for all data in a Symmetrix Parity RAID group if any single physical device in the group that contains the rank fails or becomes unavailable. If a media error occurs, the affected tracks will be regenerated. When a device within the Symmetrix Parity RAID group fails or becomes unavailable, the Symmetrix Parity RAID group is put in reduced mode (Figures 5-10 and 5-11). These volumes will now serve all their I/O requests as standard Symmetrix Parity RAID data volumes. All data is still available to the host, but is unprotected against additional failures unless protected by Dynamic Sparing.

If a physical device reports too many errors, or fails completely, that volume will be taken offline by the Symmetrix subsystem. This condition causes the Symmetrix system to place a remote service call to the Customer Support Center. The Product Support Engineer at the support center determines if a disk drive has been identified for replacement and dispatches a Customer Engineer (CE) who starts the Symmetrix interactive drive replacement process. The logical volumes on the disk being replaced are placed in a not-ready state and the associated ranks will begin operating in either reduced mode or non-RAID (depending on whether the logical volume that was made not-ready contained data or parity information). After the new drive is in place, the rebuild process begins.

If the Symmetrix system is configured with Dynamic Sparing, it copies the data from the failing volume to the spare, reconstructing the data, if necessary, from parity. The Symmetrix system also invokes available spares for the remaining volumes in the Symmetrix Parity RAID group, if they are available. For more information on Dynamic Sparing used with Symmetrix Parity RAID, refer to *Dynamic Sparing with Remotely Mirrored Pairs (SRDF)* on page 5-49.

Write Requests on a Failing Volume

As write requests are made to the failing data volume, the new data is XORed with the old data and the new parity is written to the parity drive. The Symmetrix system follows the process shown in Figure 5-10 on page 5-38.

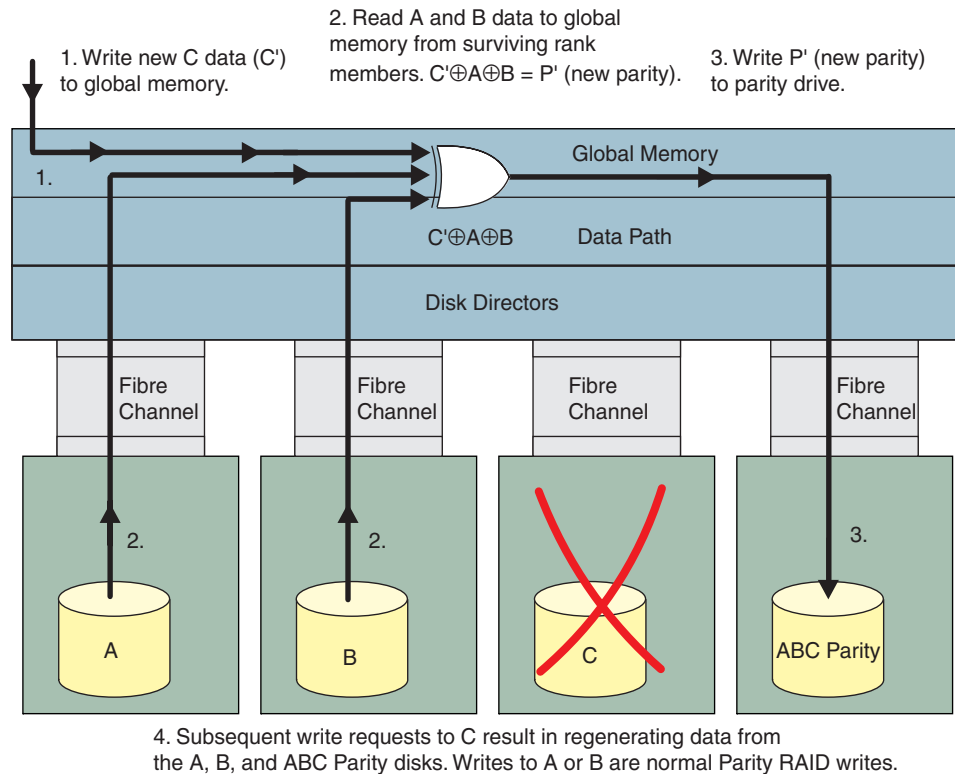


Figure 5-10 Writing to a Symmetrix Parity RAID Group in Reduced Mode

Read Requests on a Failing Volume

Read requests for data in global memory (read hit) are serviced immediately from global memory. For read requests not found in global memory (read misses), as a read request to access data from the failing volume is received, the data is automatically calculated in global memory from the XOR of the parity volume and the remaining active data volumes (Figure 5-11 on page 5-39). Then, from global memory, the regenerated data is delivered to applications that request it.

If the regenerated data received frequent read requests, it will remain in global memory according to the most recently used (MRU) global memory tables. (For more information on MRU, refer to *Symmetrix Global Memory Management* on page 3-3.) If the data is not in global memory, it is again recalculated from the remaining active drives and delivered to the applications that request it.

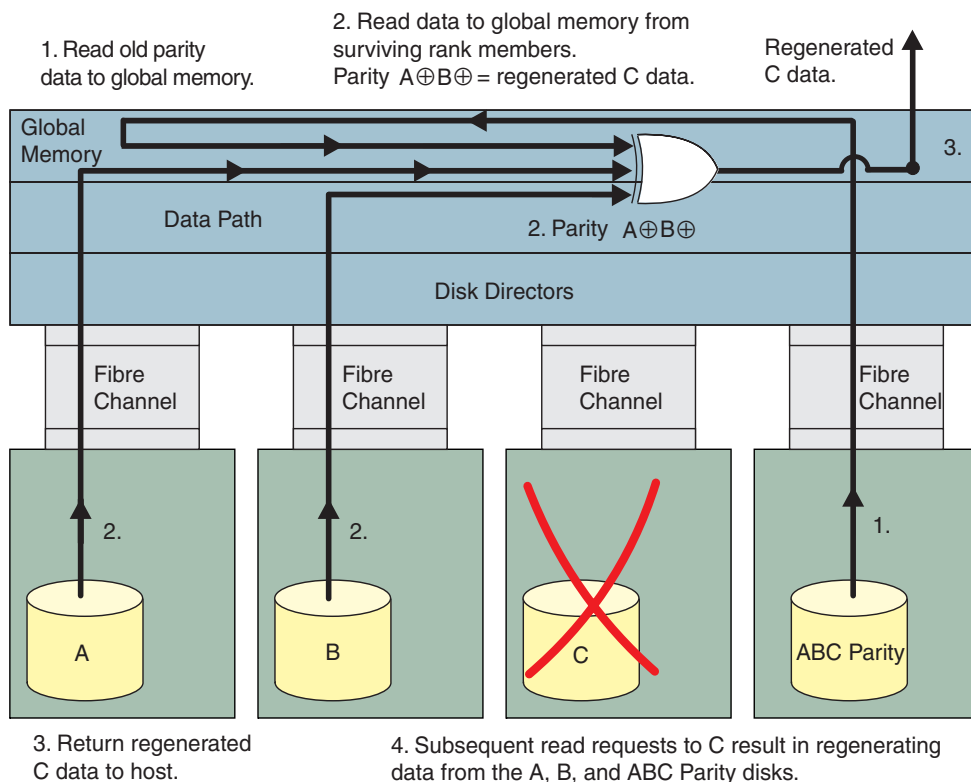


Figure 5-11 Reading from a Symmetrix Parity RAID Group in Reduced Mode

Data Volume Function When a Parity Volume Fails

If the parity volume fails, the active data volumes within the Symmetrix Parity RAID group stop creating parity and function as standard data volumes in non-RAID mode. Because data associated with individual logical volumes is not striped across multiple volumes, no single drive depends on the availability of any other drive in the Symmetrix Parity RAID group to provide access to its own data. All volumes on the remaining drives are available.

Data Recovery with Symmetrix Parity RAID and HVE

Data recovery in Symmetrix Parity RAID when using HVE is logically identical to Symmetrix Parity RAID recovery without HVE. For example, in Figure 5-7 on page 5-32, assume that volume B starts exceeding error thresholds and is about to fail. The Symmetrix data protection mechanisms then decide to remove volume B. Parity is immediately stopped within the entire Symmetrix Parity RAID group, and all subsequent requests to read or write to volume B will be served by the parity ABC volume, as described in *Data Recovery with Parity RAID* on page 5-37. As read or write requests are made to

volumes E and J, data is regenerated from the data and parity volumes in their respective ranks. No action needs to be taken on parity volume GHI, because it is now ignored. After the physical drive on which volumes B, E, and J resided is replaced, the data in these volumes is regenerated, and then the parity volumes rebuilt. Parity protection is now available.

Regenerating Data or Parity After Replacing a Disk

After the failed disk device is replaced, data is regenerated for the data volumes, or parity is rebuilt for the parity volume. For the data volume(s) on the replaced disk device, data is regenerated from the parity volume and the remaining data volumes in the Symmetrix Parity RAID group. For the parity volume on the replaced disk device, parity is generated from the Symmetrix Parity RAID group data volumes (Figure 5-12). After this process is completed, the Symmetrix system re-establishes parity protection for all volumes of the Symmetrix Parity RAID group and resumes normal mode operation.

Replace failed drive. For a replaced parity drive, rebuild parity from the data volumes. For a replaced data drive, regenerate data from the surviving data drives and the parity drive.

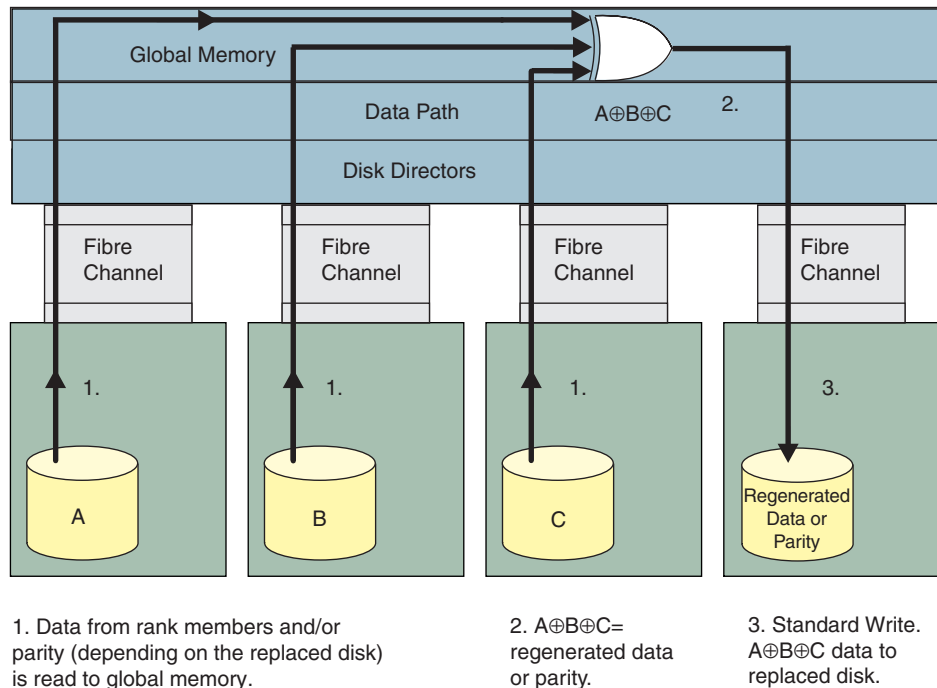


Figure 5-12 Regenerating Data or Parity after Disk Replacement

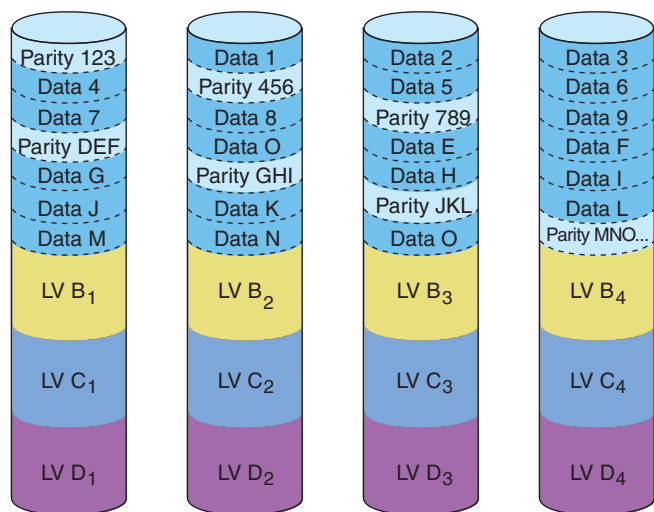
Symmetrix DMX RAID 5 Options

RAID 5 Overview

Engenuity level 5670 supports RAID 5 data protection. A RAID 5 device has the following attributes:

- ◆ Data blocks are striped (or interleaved) horizontally across the members of a RAID 5 group, similar to a striped metavolume. Each member owns some data tracks and some parity tracks.
- ◆ There is no separate parity drive in a RAID 5 group. Instead, parity blocks rotate amongst the group members.
- ◆ RAID 5 groups can be:
 - Four members per logical device, RAID 5 (3+1)
 - Eight members per logical device, RAID 5 (7+1)

Figure 5-13 shows a RAID 5 group composed of four hypervolume physical drives.



SYM-000547

Figure 5-13 RAID 5 Data/Parity (3+1)

RAID 5 Temporary Member Sparring

Unlike Dynamic Sparring in the case of Parity RAID volumes (refer to *Dynamic Sparring with Symmetrix Parity RAID Volumes* on page 5-47), the RAID 5 Temporary Member Spare is a part of the RAID group and *replaces* the failing member. In particular, if you look at the tracks on the spare, you would see some data tracks and some parity tracks;

the entire layout would be identical to that of the failing member. Engenuity supports a *direct copy* mode between the spare and the failing member. For example, once the failing drive is replaced, the Engenuity code will avoid rebuilding the data to the new drive. Instead, it will copy the tracks (both data and parity) directly from the spare to the new drive. This is a much faster way of validating the new drive. The Symmetrix system has a sense of *copy direction*. When a spare is invoked, the default copy direction is from the failing member to the spare. The spare has a mirror number of its own that never changes.

Example

In an example configuration, the spare will be invoked as a mirror3 or as a mirror4 volume. The invalid bits describing the state of the tracks on the spare will always be in the spare's mirror position, regardless of whether they are data or parity tracks.

RAID 5 Configuration Rules

When configuring RAID 5 devices, follow these rules:

- ◆ Only one spare can be invoked per RAID group.
- ◆ When a spare is invoked against a member, the same track can be valid on either the member or the spare, not both at the same time.
- ◆ Striped CKD volumes cannot be RAID 5 devices.
- ◆ BCVs cannot be RAID 5 devices.
- ◆ A virtual device cannot be a striped or a RAID 5 device.
- ◆ While Parity RAID and RAID 5 are allowed in the same Symmetrix, they are not allowed on the same device.
- ◆ A Symmetrix RAID 5 group can contain four or eight members, as in Parity RAID (3+1 and Parity RAID (7+1).
- ◆ SymmOptimizer supports RAID 5 devices.
- ◆ SRDF devices are allowed to be RAID 5 devices.
- ◆ eSNAP source and destination devices are allowed to be RAID 5 devices.
- ◆ A log device is allowed to be a RAID 5 device.
- ◆ Concurrent Copy is supported with RAID 5.

Symmetrix RAID 10 (Mirrored Striped Mainframe Volumes with DMSP)

To improve mainframe volume performance, Symmetrix RAID 10 stripes data of a logical device across multiple Symmetrix logical devices. (The feature is analogous to metavolume stripes on open systems.) Four Symmetrix devices (each one-fourth the size of the original mainframe device) appear as one mainframe device to the host. Any four Symmetrix logical devices can be chosen to define a RAID 10 group provided they are the same type (for example, IBM 3390) and have the same mirror configuration. Striping occurs across this group of four devices with a striping unit of one cylinder, as shown in Figure 5-14. Since each member of the stripe group is mirrored, the entire set is protected. Dynamic Mirror Service Policy (DMSP) can then be applied to the mirrored devices. The combination of DMSP with mirrored striping and concatenation to create a mainframe volume, as illustrated below, enables greatly improved performance in mainframe systems. RAID 10 uses four pairs of disks in its Symmetrix implementation, as illustrated below.

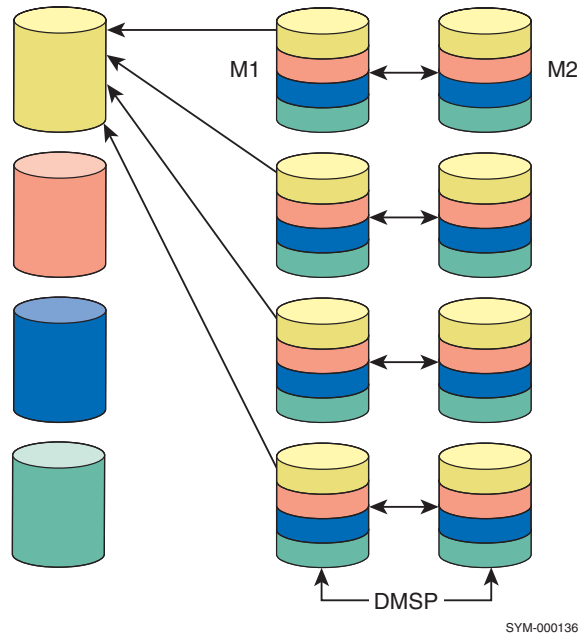


Figure 5-14 RAID 10 with Dynamic Mirror Service Policy

Dynamic Sparing

The Symmetrix system has a Dynamic Sparing option that reserves volumes as standby spares. These volumes are not user-addressable. The Dynamic Sparing function determines when a logical volume is about to fail, and copies the contents of the disk device on which that volume resides to an available spare without any interruption in processing (Figure 5-15). The Symmetrix system notifies the EMC Customer Support Center of this event with an Environmental-Data Present error, and then uses the spare until the device can be replaced.

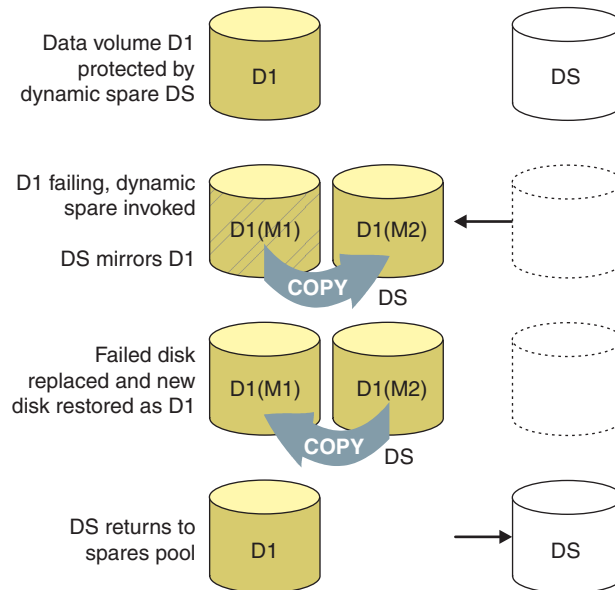


Figure 5-15 Dynamic Sparing Process

The Dynamic Sparing option increases data availability without impacting performance. It is used in combination with mirroring, Symmetrix Parity RAID, or SRDF.

EMC Customer Service is usually able to replace a failed drive within four hours. Dynamic Sparing is usually used in remote locations where EMC personnel cannot guarantee this service level agreement. The time it takes to replace and resynchronize a failed drive within a Parity RAID group depends on the I/O activity to the logical volumes, the disk device, and the disk capacity.

When Dynamic Sparing is enabled, the Symmetrix system makes its copying decision based on error statistics maintained by its directors, the intelligent disk microprocessor self-testing information, and its active error checking system. If the Symmetrix Dynamic Sparing algorithms determine that the number of errors occurring on a volume is excessive and that a hard failure is probable, it looks for an available spare in its small pool of spares.

The Symmetrix system dynamically copies all data from the device containing the failing volume to the available spare. The Symmetrix system continues to process host I/O requests at the highest priority while this copy operation takes place to minimize the effect on performance. When the copy operation completes, the Symmetrix system notifies the EMC Customer Support Center of the event. The spare and the original device work as a mirrored pair until the defective unit is replaced.

After the disk is replaced, the EMC Customer Engineer (CE) then issues commands for the Symmetrix system to dynamically copy the contents of the spare to the new device. The spare remains in use until the copy completes. When the copy has completed, the CE issues commands for the Symmetrix system to return the spare to its pool, making it available should another volume fail in the future.

Dynamic Sparing has the added benefit of allowing an EMC Customer Engineer operating onsite or from the EMC Customer Support Center to force the Symmetrix system to copy the contents of a device to an available spare. This forced copy allows the EMC Customer Engineer to test or service a disk device nondisruptively while access to data continues.

In summary, Dynamic Sparing offers the following advantages:

- ◆ Increases protection of all volumes from loss of data
- ◆ Automatically activates the spare volume without interruption prior to loss of access of a potentially failing volume
- ◆ Ensures that the spare copy is identical to the original copy
- ◆ Resynchronizes a new disk device with the dynamic spare after repair of the defective device is complete
- ◆ Increases data availability of all volumes in use without loss of any data capacity
- ◆ Dynamic Sparing is transparent to the host and requires no user intervention

Dynamic Sparing as Additional Data Protection

Dynamic Sparing is used as additional protection for volumes already protected by the Symmetrix mirroring, Symmetrix Parity RAID, or SRDF options. Dynamic Sparing provides incremental protection against failure of a second disk during the time a disk is taken offline and when it is ultimately replaced and resynchronized.

Dynamic Sparing with Locally Mirrored Pairs

When a dynamic spare is invoked for a locally mirrored pair, the Symmetrix system automatically augments the original mirrored pair with a dynamic spare volume that joins the mirrored pair as an additional or (third) mirror (Figure 5-16). Data is copied to the dynamic spare volume from the failing volume. If any data cannot be copied from the failing volume, it is copied from the other mirror. The Symmetrix system continues processing I/O requests with the spare functioning as a mirror and with no interruption in operation.

The failing disk can then be replaced and resynchronized with the mirror group. Then the dynamic spare can be returned to the spare pool.

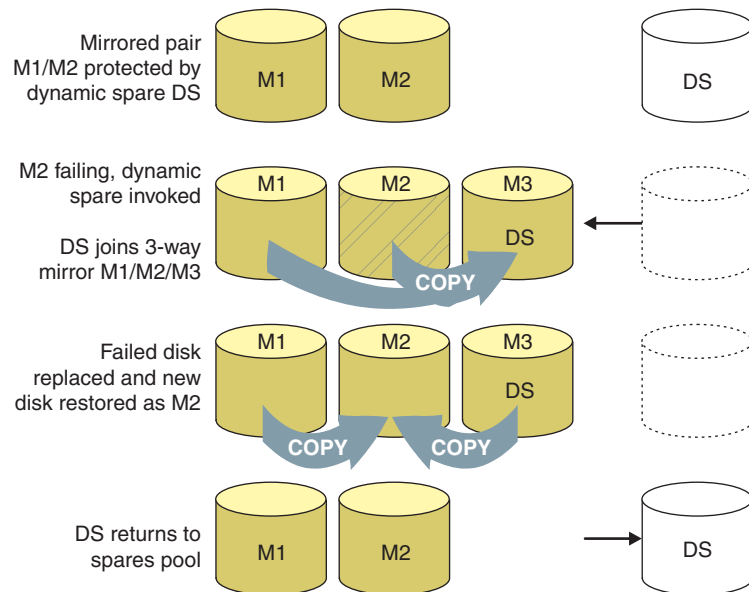


Figure 5-16 Dynamic Sparing with Locally Mirrored Pairs

Dynamic Sparing with Symmetrix Parity RAID Volumes

In a Symmetrix Parity RAID system, all data volumes of the Symmetrix Parity RAID group will be spared if there are enough dynamic spares available for all the data volumes. If a device in a Symmetrix Parity RAID group fails, the Symmetrix system will attempt to copy data from the failing device to the first spare (Figure 5-17 on page 5-48). If the system cannot copy from the failing device to the spare, the Symmetrix system then uses the parity algorithms to reconstruct the data for the failing device and then copies the data to the spare. As the failing volume receives read or write requests, the data is regenerated. Regenerated read data is sent to the requesting application. Write data is regenerated as described in Figure 5-10 on page 5-38. The Symmetrix system also invokes available spares for the remaining data devices in the Symmetrix Parity RAID group, allowing all volumes in the Parity RAID group to function as mirrored pairs.

Data Device Failure within a Parity RAID Group

If the failing data volume becomes not ready before it can be replaced, the Symmetrix system recalculates the data for the failed device from the remaining data devices and parity volume. The dynamic spare functions as a mirrored pair for that data volume. Parity RAID protection is not available for the remaining volumes of the Parity RAID rank until the failing device is replaced. All volumes of the Parity RAID group are spared if there are enough dynamic spares available. If there are not enough spares for the remaining data volumes in the group, the Symmetrix system invokes as many dynamic spares as possible for the Parity RAID group.

Parity Device Failure within a Parity RAID Group

Upon detecting that a parity volume is failing, the Symmetrix system turns off parity protection, and mirrors all data volumes to available spares. Parity RAID protection is not available until the failing device is replaced. If there are not enough spares for the data volumes in the group, the Symmetrix system will invoke as many dynamic spares as are available for the Parity RAID group.

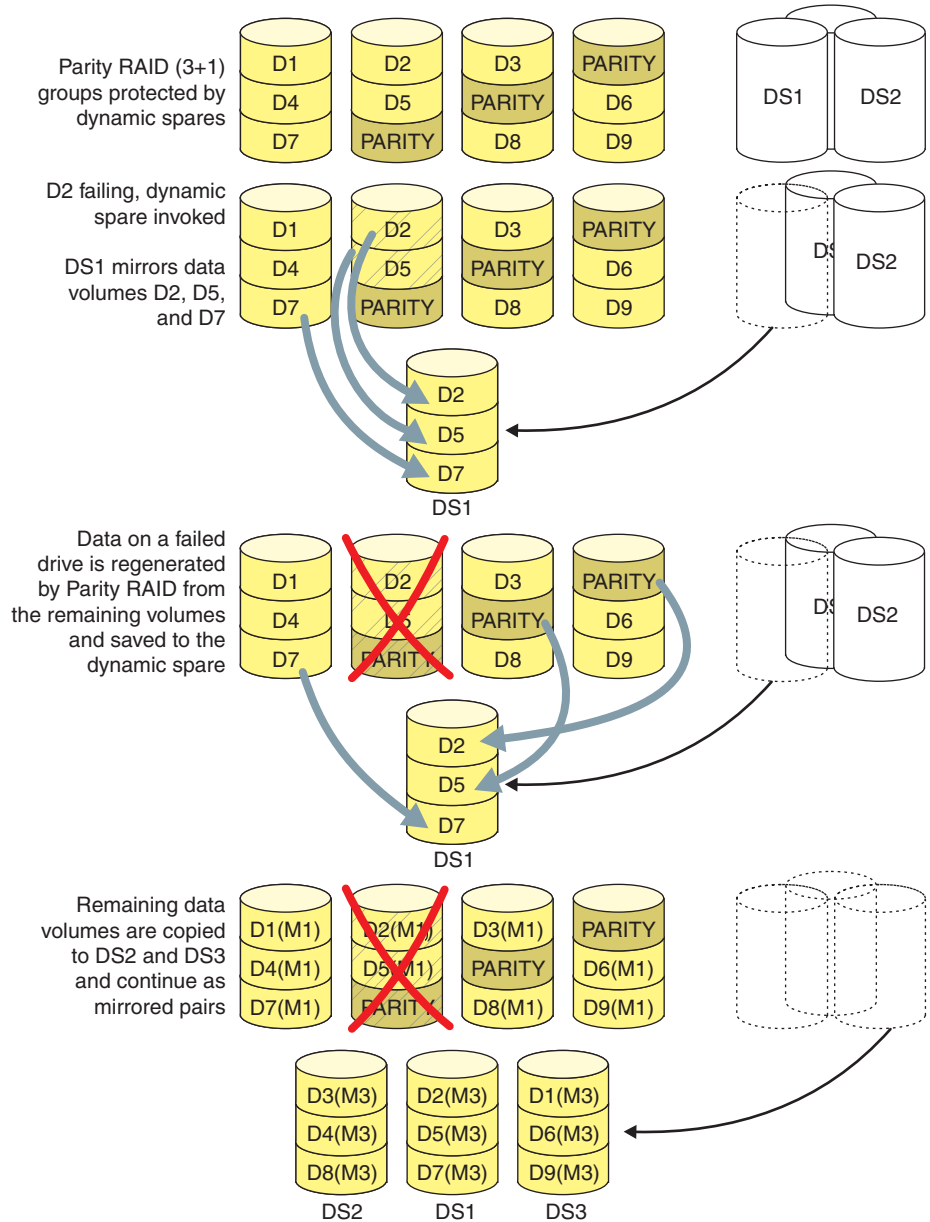


Figure 5-17 Example of Dynamic Sparing with Parity RAID (3+1) Volumes

Dynamic Sparing with Remotely Mirrored Pairs (SRDF)

When the Dynamic Sparing option is invoked for a remotely mirrored SRDF pair, the Symmetrix system automatically activates an available spare in the Symmetrix system containing the failing device and copies data from the failing device to the spare. The system continues processing I/O requests with the spare functioning as one volume of a mirrored pair while the failing device and its remote mirror all operate without interruption. If the Symmetrix system cannot copy all data from the failing device to the spare, it will retrieve the unavailable data from the *good* member of the remote pair.

For examples of Dynamic Sparing in SRDF configurations, refer to the *Symmetrix Remote Data Facility Product Guide*.

Mainframe Features and Support

The information presented in this chapter is only applicable to Symmetrix disk devices connected to mainframe hosts. The following information is described:

- ◆ Introduction 6-2
- ◆ Supported Mainframe Features 6-3
- ◆ Error Reporting and Recovery 6-13
- ◆ Sense Byte Information 6-23

Introduction

This chapter provides an overview of the Symmetrix mainframe storage solutions supported by the Enginuity operating environment. Also included are descriptions of the types of errors possible when the Symmetrix system is connected to a mainframe host, error handling techniques, and an error recovery summary.

Supported Mainframe Features

The following IBM/PCM functions and features are supported on Symmetrix DMX systems that have connections to mainframe hosts:

- ◆ Dynamic Channel Management
- ◆ Dynamic Path Reconnection
- ◆ Concurrent Copy
- ◆ Multi-Path Lock Facility/Concurrent Access
- ◆ MultiSubsystem Imaging
- ◆ Sequential Data Striping
- ◆ Partitioned Data Set (PDS) Assist
- ◆ Multiple Allegiance (MA)
- ◆ Compatible Parallel Access Volumes (COM-PAV)
- ◆ Dynamic Parallel Access Volumes
- ◆ RAID 10 Striping
- ◆ Symmetrix DMX Supported ESCON Devices and Logical Paths
- ◆ Symmetrix DMX Supported FICON Devices and Logical Paths
- ◆ PPRC Command Support
- ◆ XRC Support
- ◆ Configuring CKD Volumes
- ◆ Deleting (and Then Adding) Devices Online
- ◆ Support for 64K Cylinders
- ◆ FICON Cascading and Open Systems Intermix Configurations

Dynamic Channel Management

The Symmetrix DMX supports the Dynamic Channel Management (DCM) feature of the Intelligent Resource Director function inherent in IBM zSeries mainframe processors. DCM allows dynamic reconfiguration of channels between control units under the direction of the Workload Manager component of z/OS. Support for DCM requires the installation of a software module on the z/OS operating system that describes a control unit's internal structure. This module is called IOSTEMC and is available at the EMC FTP site:

`ftp://ftp.emc.com/pub/MVSsoft/DCM-IOSTEMC`

Dynamic Path Reconnection

Dynamic Path Reconnection (DPR) permits the Storage Control Unit (SCU) to reconnect to the host on any available channel path between the device and the host system if the original channel is busy with other operations. Without DPR, the SCU waits for the original channel path to become available again. Refer to the *IBM 3390 Direct Access Storage Introduction* or the *IBM 3380 Direct Access Storage Introduction* for more information on this function.

The DPR option must be invoked in an ESCON or FICON environment to facilitate reduction of director port busy conditions. DPR must also be enabled when using extended platform functions, such as IBM's Concurrent Copy.

DPR support is enabled by the EMC Customer Engineer at installation or service time. Consult your EMC Systems Engineer to determine if DPR is appropriate for your operating environment.

Concurrent Copy

Symmetrix systems support the IBM Concurrent Copy facility. Concurrent Copy can significantly reduce the time that data on the Symmetrix system volumes is unavailable during backup operations.

To use Concurrent Copy, the Symmetrix system must be emulating 3990-6, 3990-3, or 2105 storage control, and 3390 DASD with Dynamic Path Reconnect (DPR) and Symmetrix Differential Data Facility (SDDF) must be enabled.

Multi-Path Lock Facility/Concurrent Access

Symmetrix systems support the IBM Multi-Path Lock Facility/Concurrent Access (MPLF/CA) feature for use with the ultra-high performance Airline Control Program (ACP) and Transaction Processing Facility (TPF) host operating system environments. MPLF/CA allows multiple concurrent I/O requests to the same logical device from multiple TPF mainframes.

The Symmetrix system maintains the names and status of logical locks currently in use and responds to requests to obtain or release a lock. This allows multiple hosts to share DASD through multiple paths in an active OnLine Transaction Processing (OLTP) environment while maintaining data integrity. MPLF/CA is an enhancement and replacement for the Extended Limited Lock Facility (ELLF) and the Limited Lock Facility (LLF). The Symmetrix system must be emulating the 3990-6, 3990-3, or 2105 storage control and running Enginuity supporting the MPLF/CA feature.

MultiSubsystem Imaging

The Symmetrix DMX systems support multiple S/390 or z/OS environments by providing maximum connectivity through the use of its 3990-3, 3990-6, and 2105 emulation modes and the Hypervolume Extension feature. The Symmetrix systems support up to 16 SubSystem IDentifiers (SSIDs) with up to 256 devices per SSID.

Sequential Data Striping

The Symmetrix DMX systems are fully compatible with the IBM Sequential Data Striping function for 2105, 3990-6, and 3990-3 storage control with Extended Platform. Sequential Data Striping provides faster batch execution on large I/O-bound sequential processing requests by allowing I/O operations to be managed in parallel across as many as 16 devices.

Sequential Data Striping is available only in OS/390 (MVS), and z/OS with DFSMS environments. The Symmetrix system must be emulating 2105, 3990-6, or 3990-3 storage control and running Enginuity supporting this feature. Additionally, the Symmetrix system must have SMS-managed volumes.

Partitioned Data Set (PDS) Assist

The Symmetrix DMX systems support the IBM Partitioned Data Set (PDS) Search Assist feature for 2105, 3990-6, 3990-3, and z/OS storage control with Extended Platform. PDS Assist improves performance on large, heavily used partitioned datasets by modifying the directory search process. PDS Assist is automatically invoked with the appropriate level of OS/390 (MVS), DFSMS, and the Enginuity revision supporting this feature.

Multiple Allegiance (MA)

The Symmetrix DMX systems support Multiple Allegiance (MA), an IBM feature that improves throughput across a shared storage environment. MA allows different hosts to concurrently access the same device (have concurrent implicit allegiances), as long as I/Os do not conflict with each other.

The Symmetrix DMX systems support MA as a 2105 control unit if the COM-PAV feature is enabled on the Symmetrix system. The Symmetrix system can also support MA when the Symmetrix system is defined to the host as a 3990-6 by enabling this feature on the Symmetrix service processor.

Compatible Parallel Access Volumes (COM-PAV)

The Symmetrix DMX systems support Compatible Parallel Access Volumes (COM-PAV), an IBM feature that improves response time by reducing device contention, resulting in higher performance and throughput.

The Symmetrix DMX systems must be defined to the host as a 2105 control unit to support COM-PAV.

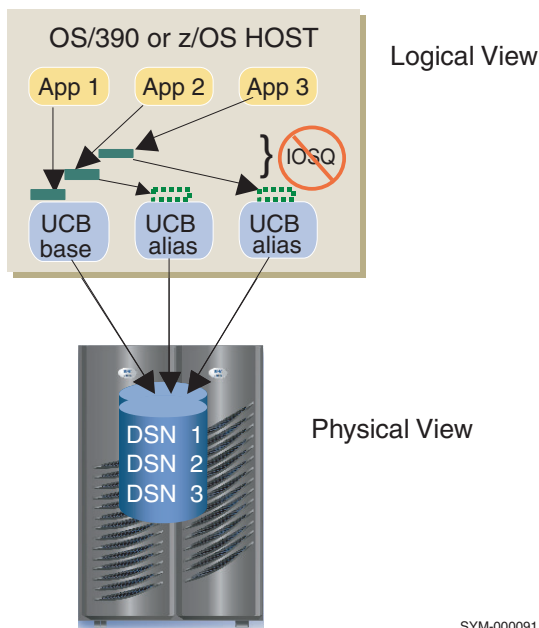
Dynamic Parallel Access Volumes

Parallel Access Volumes/Multiple Allegiance (PAV/MA) is a mainframe-exclusive feature that resolves the OS/390 or z/OS limitation allowing only one outstanding I/O operation to a device (Figure 6-1). The PAV/MA feature was introduced with the IBM ESS 2105 storage subsystem. EMC's COM-PAV/MA feature provides significant performance improvements for Symmetrix system users who are experiencing high levels of device queuing (high IOSQ time).

Enginuity adds dynamic support to the existing EMC PAV implementation. This enables the MVS Workload Manager (in Goal Mode) or the EMC PAVManage utility to reassign alias UCBs to a base UCB *on the fly*. In addition to this support for Dynamic PAV, COM-PAV/MA now allows up to seven aliases to be associated with one base device, improving the opportunity for parallel I/O operations. This further reduces, and can even eliminate, IOSQ time and enables EMC's PAV support for larger mainframe logical devices.

Enginuity level 5670 supports adding and deleting PAV base and alias features online for FICON and ESCON channels.

The EMC implementation is designed to be 100 percent compatible with IBM's implementation. The aliases can also be managed with the PAVManage utility in the ResourcePak Extended for OS/390.



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Figure 6-1 Dynamic Support of Parallel Access Volumes

RAID 10 Striping

RAID 10 (one-zero) is a mirroring feature with striping used for mainframe environments. Four Symmetrix devices (each one-fourth the size of the original IBM device) appear as one IBM device to the host, accessible by way of one channel address. Any four devices can be chosen to define a group provided they are equally sized, same type (for example, all 3390), and have the same mirror configuration.

For more information on RAID 10, refer to *Symmetrix RAID 10 (Mirrored Striped Mainframe Volumes with DMSP)* on page 5-43.

Symmetrix DMX Supported ESCON Devices and Logical Paths

At Enginuity level 5670, Symmetrix DMX systems support up to 2,048 channel addresses distributed over one or two ports per processor. Symmetrix DMX eight-port, four-processor ESCON director supports up to 512 logical paths per processor. It supports up to 512 logical paths per port when the A port only is configured or up to 256 logical paths per port when both the A and B ports are configured. Figure 6-2 shows some sample configurations.

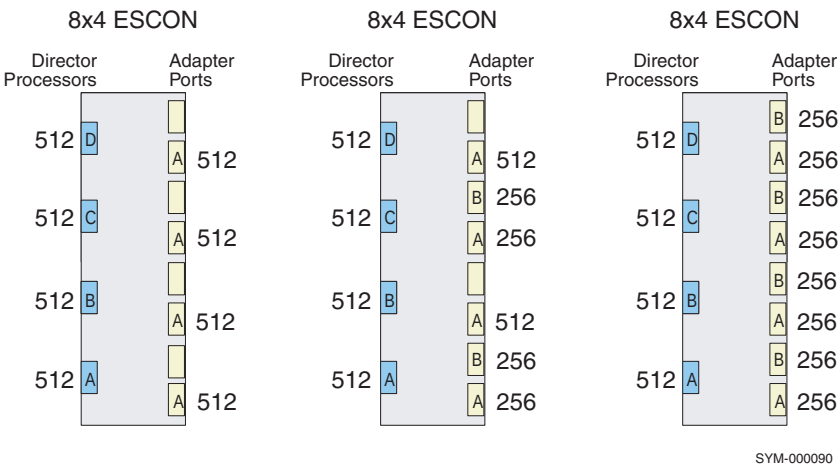
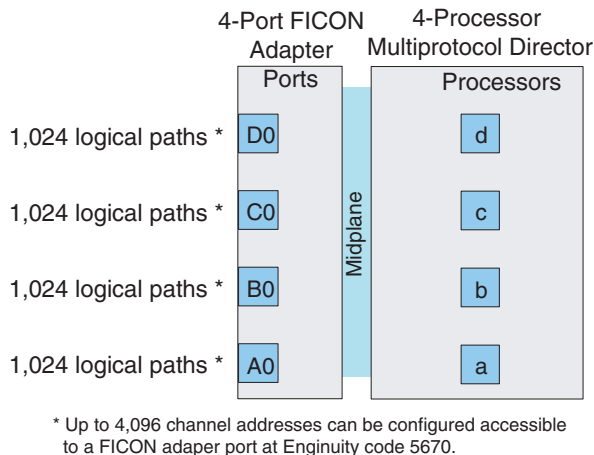


Figure 6-2 Supported ESCON Logical Paths per Port

For more ESCON director configuration information, refer to *ESCON Channel Directors* on page 2-36.

Symmetrix DMX Supported FICON Devices and Logical Paths

At Enginuity level 5670, Symmetrix DMX systems support up to 4,096 channel addresses per FICON port. The four-port, four-processor FICON adapter supports up to 1,024 logical paths per port per processor. Figure 6-2 shows a sample configuration.



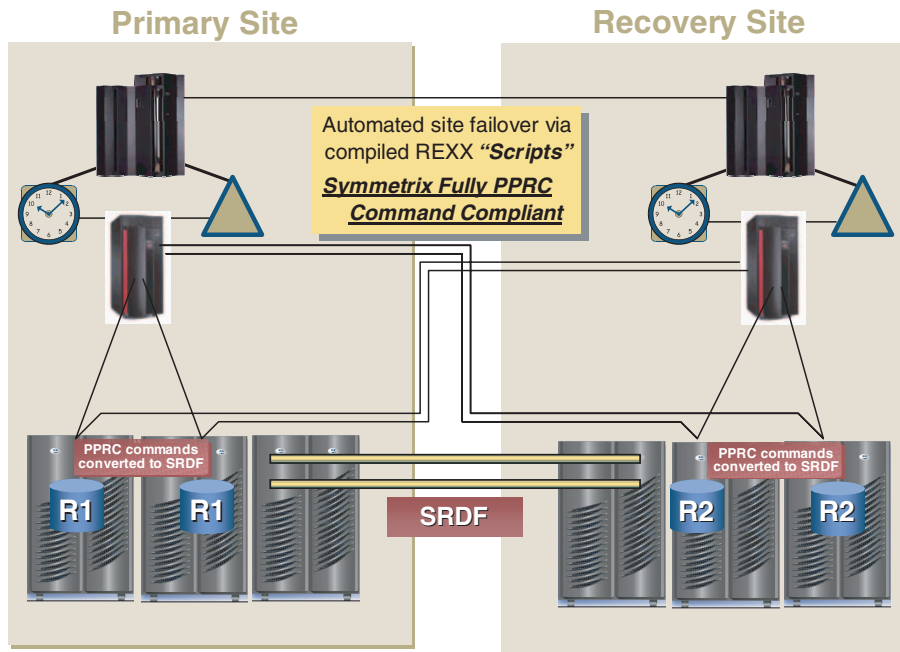
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Figure 6-3 Supported FICON Logical Paths per Port

For more FICON director configuration information, refer to *FICON Channel Directors* on page 2-37.

PPRC Command Support

Enginuity enables the Symmetrix system to support native IBM Peer-to-Peer Remote Copy (PPRC) commands. PPRC is the remote copying solution available with IBM Storage Systems (Figure 6-4). PPRC is implemented as a subset of the Dynamic SRDF feature. As a result, Symmetrix DMX systems running Enginuity level 5669 (or higher) will support PPRC commands and IBM's Geographically Dispersed Parallel Sysplex (GDPS) solution.



SYM-000092

Figure 6-4 PPRC and GDPS Support

XRC Support

Enginuity level 5670 supports IBM's XRC, level 3 functionality. IBM designed XRC as a host-based disaster recovery and workload migration solution that provides asynchronous copying of S/390 data to a remote data center located virtually anywhere in the world.

With XRC, a remote site has a point-in-time copy of the source/primary data with the following attributes:

- ◆ The copy at the remote site is not the most current one; there is a lag between the local and remote copies.

- ◆ The remote copy's data is re-startable
- ◆ Since this is an asynchronous solution, write operations do not suffer from performance degradation while transferring the data across the link.

XRC provides update sequence integrity through its mechanism of consistency groups, and journal, control, and state data sets. The basic concept is that the System Data Mover (SDM) polls, or receives attention interrupts from, the primary control units it is servicing and receives from them all new or updated records. The SDM then determines the timestamp of the most recent I/O from each control unit in the session. Once these timestamps are determined, SDM selects the smallest of these timestamps as a starting point and forms a group which includes all I/Os received at that time or prior. This set of I/Os constitutes a *consistency group* which is written to the journal data sets and then written to the volumes at the recovery site. This is depicted in Figure 6-5.

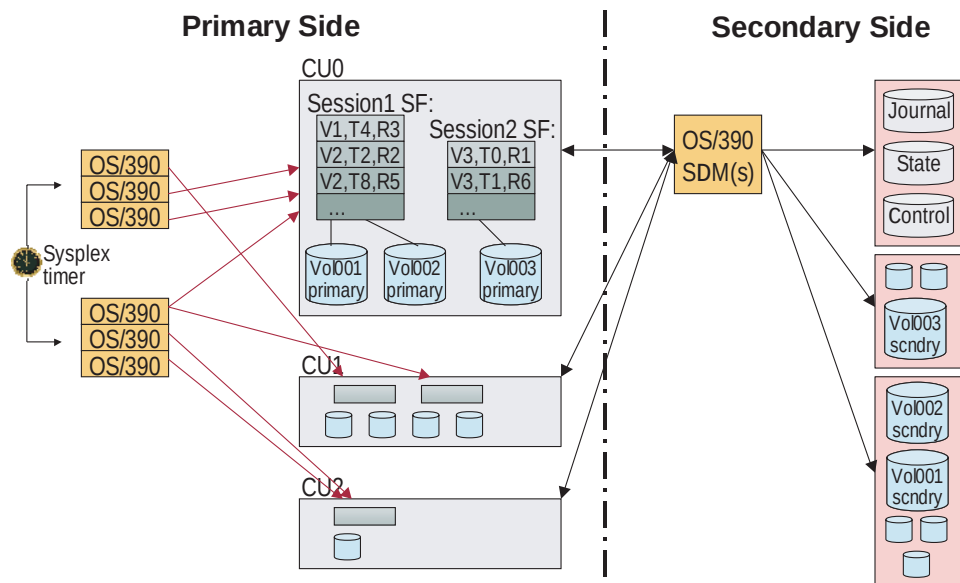


Figure 6-5 XRC Overview

Configuring CKD Volumes

Enginuity level 5670 supports mapping and unmapping CKD volumes. This capability is necessary because deleting mainframe capacity cannot take place if the volumes cannot be unmapped from a front-end port.

Deleting (and Then Adding) Devices Online

Enginuity code 5670 supports removing and then adding devices online, which facilitates the following configuration enhancements:

- ◆ Change Device Emulation Online—Remove a CKD volume and add an FBA volume and vice-versa.

Adding a CKD volume to a Symmetrix system requires a global memory configuration change if this is the first CKD volume being added. However, the system can be configured in advance, thus avoiding an offline global memory reformat.

- ◆ Convert between mirrored and RAID protected volumes.

Support for 64K Cylinders

Symmetrix DMX systems running Enginuity code 5670 and higher can support 64K cylinder CKD devices for operating systems that can exploit it.

FICON Cascading and Open Systems Intermix Configurations

In addition to the standard direct-connect configuration, Symmetrix DMX FICON models running Enginuity code 5670 support the use of Cascading and Open Systems Intermix configurations. Cascading can be used to reduce the number of FICON adapters and the amount of intersite cabling required by making use of switch-to-switch communication.

Intermix allows FICON zones to be added to existing Open Systems switches within a site and between sites. These two features help reduce the overall costs while providing greater FICON connectivity, backup, and recovery.

For specific Cascading and Open System Intermix configuration requirements, contact your EMC Sales Representative.

FICON Cascading Configurations

Cascading provides greatly enhanced FICON connectivity within local and remote sites through the use of switch-to-switch extensions of the CPU to the DMX FICON network. These Cascaded switches

communicate over long distances using a small number of high speed lines called ISLs (Inter Switch Links). Up to a maximum of two switches may be connected together within a path between the CPU and the DMX.

Same switch vendors are required for a Cascaded configuration. The EMC and IBM branded McData and Inrange switches are supported in pairs. To support Cascading, each vendor requires specific models, hardware and software features, configuration settings, and restrictions. Specific IBM CPU models, MVS release levels, channel hardware, and microcode levels are also required.

FICON Open Systems Intermix Configurations

Open Systems Intermix allows separate FICON zones to be defined within new or existing open systems switches. These switches can also be Cascaded to further enhance connectivity and remote backup and recovery. The EMC and IBM branded McData and InRange switches are supported. To support Open Systems Intermix, each vendor requires specific models, hardware and software features, configuration settings, and restrictions. Specific IBM CPU models, MVS release levels, channel hardware, and microcode levels are also required.

Error Reporting and Recovery

This section discusses the types of errors possible when the Symmetrix system is connected to a mainframe host. It also discusses error handling techniques and an error recovery summary.

Types of Errors

There are several types of errors associated with data storage. The error type is indicated in the sense information, and in error messages and reports. You should be aware, however, that the error type doesn't necessarily identify the source or the cause of the problem.

The error types detected by the Symmetrix system include the following:

- ◆ **Data Check**—The Symmetrix system has detected an error in the bit pattern read from the disk. Data checks are due to hardware problems when writing or reading data, media defects, or random events.
- ◆ **System or Program Check**—The Symmetrix system has rejected the command. This condition is attributed to the construction of the channel program. This type of error is indicated to the processor and is always returned to the requesting program.
- ◆ **Overrun**—The Symmetrix system cannot receive data at the rate it is transmitted from the host system. This error indicates a timing problem. Resubmitting the I/O operation usually corrects this error.
- ◆ **Equipment Check**—The Symmetrix system has detected an error in hardware operation.

Temporary and Permanent Errors

Whenever the Symmetrix system detects a data or equipment error, either the Symmetrix system or the host operating system will attempt to recover from the error, depending on the situation and the type of hardware involved. Error recovery can be temporary or permanent.

An error is temporary if the Symmetrix system or the host operating system can recover from the error successfully. The application is not notified of a temporary error. Temporary errors recovered within the Symmetrix system are not listed in the error report unless its internal soft error threshold has been exceeded. Temporary errors recovered by the operating system are logged by the host Error Recovery Procedures (ERP). When requested, the Symmetrix system generates sense bytes and sends them to the operating system. These sense bytes define the error.

An error is permanent from a system view if neither the host operating system nor Symmetrix system can recover from the error condition. For example, a channel director may cause a data check error. That data check is permanent to the system and is recorded in the error recording dataset (ERDS) as a permanent path error.

However, if the host system retries the read from an alternate path, and the data is read successfully from the Symmetrix system, the system does not notify the application of the error, so the error is not permanent to the application. If the read on the alternate path was not successful, the data check is permanent from both the system and application points of view.

Recoverability by Error Type

An error is recoverable if the application does not see it as a permanent error.

Data Check

When data is written, the Symmetrix system records check bytes with the data to enable data check detection. These are the error checking and correction (ECC) bytes. These bytes often provide sufficient information for the Symmetrix system to reconstruct the data should an error occur. When the Symmetrix system reconstructs the data using the ECC bytes, the data check is ECC-correctable. ECC-correctable data checks are always recoverable. The Symmetrix system relocates the block as necessary.

When the Symmetrix system cannot reconstruct the data using the ECC bytes, the data check is *ECC-uncorrectable*. In this case, the Symmetrix system retries the I/O operation. If the retry is unsuccessful, the data check is uncorrectable. This appears as a permanent error to the Symmetrix system.

For Symmetrix systems protected by mirroring, the data check is not reported to the application. The data is provided to the host through the protection mechanism (mirroring) and the Symmetrix system places a remote service call.

ICKDSF Control Statement

For an uncorrectable data check, on an unprotected Symmetrix system, use the following device support facilities (ICKDSF) control statement to reformat the home address and record zero of the track.

Do *not* use ICKDSF to assign alternate tracks in the classic IBM manner since no alternate will be assigned.

This control statement may require an operator response to permit purging of datasets on the volume. Refer to the *IBM ICKDSF User's Guide and Reference* for more information.



CAUTION

All data remaining on the track(s) operated on by this control statement will be *DESTROYED*. Restore the data from your most recent backup. Using any other means to reallocate data will affect data integrity.

Enter the following ICKDSF control statement to reassign the defective track(s):

```
INSPECT UNIT(ccuu) | SYSNAME(sysxxx) |  
DDNAME (ddname)
```

```
DEVTYPE(3380/3390) VERIFY (serial) NOPRESERVE NOASSIGN  
NOMAP -
```

```
TRACKS((cyl,head),...)
```

Specify the desired (cyl,head) in decimal notation, or as (X'cyl',X'head') if hex notation is desired.

Overrun Errors and Equipment Checks

When an overrun or equipment check is detected, the host system retries the operation. If the operation is successful on the retry, the error is recorded as recoverable. If the retry is unsuccessful, the error is recorded as unrecoverable.

Error Reporting

The Symmetrix system reports error conditions to the host and to the EMC Customer Support Center through its Autocall feature. The Symmetrix system presents a unit check status in the status byte to the channel whenever it detects an error condition such as a data check, command reject, overrun, or equipment check.

Unit Check Status

The Symmetrix system also presents a unit check status (environmental-data present) whenever it detects an environmental violation. The Symmetrix system runs a series of internal tests on its components at least once every 24 hours and monitors critical components continuously. It also runs these tests when initially powered up or when a software re-set has occurred. These tests check for a low battery charge or AC power failure, or redundant

component failure such as the failure of one device in a mirrored pair or the activation of Dynamic Sparing.

Environmental Tests Error Flag

If, while running its environmental tests, the Symmetrix system detects an error condition, it sets a flag to indicate a pending error and presents a unit check status to the host on the next I/O operation. The Symmetrix system then schedules the test that detected the error condition to be rerun more frequently. (Each test has specific deltas to regulate its execution.) If a device-level problem is detected and reported, subsequent failures of that device are not reported until the failure is fixed. If a second type of failure is detected for a device while there is a pending error-reporting condition in effect, the Symmetrix system reports the pending error on the next SIO and then the second error.

Host Sense Data

When the Symmetrix system presents a unit check status, the host retrieves the sense data from the Symmetrix system and, if logging action has been requested, places it in the Error Recording Data Set (ERDS). The EREP (Environment Recording, Editing, and Printing) program prints the error information. The sense data identifies the condition that caused the interruption and indicates the type of error and its origin. The format of the sense data may be found in the appropriate IBM reference manuals. For interpretation of the EREP reports, the appropriate IBM manual should be consulted.

Service Alerts The Symmetrix system reports the exception conditions listed in Table 6-1 to the host as Service Alerts. In 3990 controller emulation, the returned sense data is in SIM format. In 3880 emulation, environmental data is returned. In both cases, the code listed will be contained in sense bytes 22 and 23. These messages are reported across all logical paths to the device experiencing the error.

Table 6-1 Environmental Alert Messages

Sense Bytes 22-23	Meaning
E460	Dynamic Sparing was invoked by a disk director.
1463	A disk director dual-initiator failed to IMPL monitor ('DD').
E466	Hot sparing was automatically invoked by a disk director for an RDF device in the other system.
E467	RDF initiated a SIM message.
E46D	All RDF links are not operational.
E46E	All RDF links are operational now.
1470	An over-temperature condition exists.
1471	A low-battery/high-charge state exists.
1472	A Symmetrix power subsystem alarm was detected.
E473	A locally mirrored drive (source volume) is in a "not ready" state.
E474	A locally mirrored drive (source volume) is write disabled.
E475	A remotely mirrored drive is in a "not ready" state.
1476	The service processor is not responding.
1477	The AutoCall feature failed to complete a call to the EMC Customer Support Center.
1478	There is a 12V On error.
1479	The environment cable is missing.
147A	There is an AC line failure or interruption.
147B	A high-charge state was not detected within two minutes of power up; or, a clock inconsistency was found between the Symmetrix system and the service processor; or, the director was inserted without system re-set.
147C	Latched alarms were detected.
147D	There is an SRDF adapter link problem.
147E	An RDF link is now operational.
147F	The service processor called home to report an error condition (customer option).

Event Messages

Table 6-2 describes the events that appear at the host console. These events are reported at the time they occur and also appear at the Symmetrix service processor. Not all events are reported to the EMC Customer Support Center. The next section shows the format of these messages.

Table 6-2 Event Messages

Sense Bytes 22-23	Meaning
0464	Migration has completed for all migration devices.
E451	Event trace trigger. PC should call home.
E452	Event trace trigger on remote RDF Symmetrix. PC should call home.
E453	SYSCALL EMC transfer poll from host. PC should call home.
E454	Too many SUSPEND/HALT chains. Switching to Adaptive Copy Write Pending Mode. PC should call home.
E456	Automatic memory disable invoked. PC should call home.
E461	M2 is resynchronized with the M1 device after M2 is brought back to ready.
E462	M1 is resynchronized with the M2 device after M1 is brought back to ready.
E465	Device resynchronization process has begun.
E469	Fibre Channel optical module adapter reported an error. PC should call home.
E46F	Arbiter Problem. PC should call home.

Operator Messages

On OS/390 or z/OS, SIM messages will be displayed as IEA480E Service Alert Error messages. They have the format shown in Figure 6-6 and Figure 6-7.

```
*IEA480E 0D03, SCU, SERVICE ALERT, MT=3990-3, SER=,
REFCODE=147A-0000-0000
```

147A = AC Line Failure or Interruption

Figure 6-6 OS/390 or z/OS IEA480E Service Alert Error Message Format (AC Power Failure)

```
*IEA480E 0D03, SCU, SERVICE ALERT, MT=3990-3, SER=,
REFCODE=E473-0000-6200
```

Channel Address of the "Not Ready" Device

E473 = Mirror-1 Volume in "Not Ready" State

Figure 6-7 OS/390 or z/OS IEA480E Service Alert Error Message Format (Mirror-1 Volume in "Not Ready" State)

All host channel paths to that device (target volume) will report this error message. Therefore, this same message may appear several times.

The Symmetrix system also reports events to the host and to the service processor. These events are:

- ◆ The mirror-2 volume has synchronized with the source volume.
- ◆ The mirror-1 volume has synchronized with the target volume.
- ◆ Device resynchronization process has begun.

On OS/390 or z/OS, these events are displayed as IEA480E Service Alert Error messages. They have the format shown in Figure 6-8 and Figure 6-9.

```
*IEA480E 0D03,SCU,SERVICE ALERT,MT=3990-3,SER=,
REFCODE=E461-0000-6200
```

Channel Address of the Synchronized Device

E461 = Mirror-2 Volume Resynchronized with Mirror-1 Volume

Figure 6-8 OS/390 or z/OS IEA480E Service Alert Error Message Format (Mirror-2 Resynchronization)

```
*IEA480E 0D03,SCU,SERVICE ALERT,MT=3990-3,SER=,
REFCODE=E462-0000-6200
```

Channel Address of the Synchronized Device

E462 = Mirror-1 Volume Resynchronized with Mirror-2 Volume

Figure 6-9 OS/390 or z/OS IEA480E Service Alert Error Message Format (Mirror-1 Resynchronization)

EREP Reports

The Environmental Record Editing and Printing (EREP) program is an applications program that runs under the OS/390, z/OS, VM, and VSE operating systems. EREP helps you monitor the functioning of various units in your system such as the processor, I/O devices, controller, and channels by supplying information on errors that have occurred in these components.

When an error occurs, the operating system creates a record from the data captured by the hardware or software and writes it in the Error Reporting Dataset (ERDS). EREP reads records directly from the ERDS and processes them to produce the report or reports you request.

EREP Error Records

Error records processed by EREP are described in detail in the IBM EREP manual.

Refer to the *IBM EREP User's Guide and Reference* for the formats of these records.

EREP uses the information in these records to produce many types of reports. There are three System Exception Reports applicable to disk media errors with the Symmetrix system. These reports are listed below in the order you use them to identify and handle a media error situation.

- ◆ **System Error Summary (Part 2)**—This report lists permanent I/O errors (data or equipment checks) and identifies each error by job name and time.
- ◆ **Subsystem Exception DASD**—This report lists accumulated permanent and temporary I/O errors.
- ◆ **DASD Data Transfer Summary**—This report presents details on data checks.

See the IBM *EREP User's Guide and Reference* for information on how to define report requests to meet your needs.

Error Handling

As part of your routine maintenance procedure, you should generate System Exception Reports daily. From these reports, you can determine whether errors are permanent or temporary, the number of errors that have occurred, and their frequency.

If your system reports permanent errors occurring on the Symmetrix system, save the Subsystem Exception DASD report output and contact your EMC Customer Engineer.

If your system reports that temporary data check errors are occurring on the Symmetrix system, and you consider the number of temporary errors for a volume to be excessive, notify your EMC Customer Engineer.

Table 6-3 describes the error handling process you should follow for the Symmetrix system.

Table 6-3 Error Handling Steps

Step	Task	Tool(s)	Actions
1	Detect error occurrence	System Error Summary (Part 2) report (permanent errors) Subsystem Exception DASD report (temporary errors)	If permanent error, or if temporary error requires investigation, perform step 2.
2	Determine source of errors using EREP	Subsystem Exception DASD report	If the source is hardware, call the EMC Customer Engineer.

Detecting the Error

Review the System Error Summary (Part 2) to determine if permanent errors are occurring on the Symmetrix system. This report lists permanent I/O errors in sequence according to the time they occurred. Also review the Subsystem Exception DASD report. This report highlights problems related to data storage that may need further investigation. It gives the number and frequency of both permanent and temporary errors.

You can use this information to defer further handling of a particular error based on its recoverability status, location, and frequency, or take immediate action to correct the error source.

Determining the Error Source



CAUTION

Permanent data errors with a probable failing unit of VOLUME require your IMMEDIATE attention!

If the System Error Summary (Part 2) and Subsystem Exception DASD reports indicate problems with a Symmetrix device, review the Subsystem Exception DASD report to determine the failing component. This report lists error information by volume. It identifies the failing volume, the track location of the failure, the sense information received from the Symmetrix system at the time of the last failure, and the permanent and temporary error counts on that device.

Sense Byte Information

The information presented in this chapter is only applicable to Symmetrix disk devices connected to mainframe hosts.

The Symmetrix system presents a unit check status in the status byte to the channel whenever it detects an error condition. The error condition can be one of the error types associated with data such as a data check, command reject, overrun, or equipment check.

The channel issues a sense command to retrieve the sense data from the Symmetrix system. The host places the sense data in the Error Recording Dataset (ERDS) where the EREP subsequently uses it for its reports.

Sense byte error data may also appear on the system operating console. The format of the error data reported to the operator console depends on your operating system. Sense byte data at the host is presented in 24-byte mode for 3880 controller emulation and 24-byte compatibility mode or 32-byte mode for 3990 emulation.

Console Error Messages

Figure 6-10 is an example of a typical OS/390 console error message for 24-byte sense data.

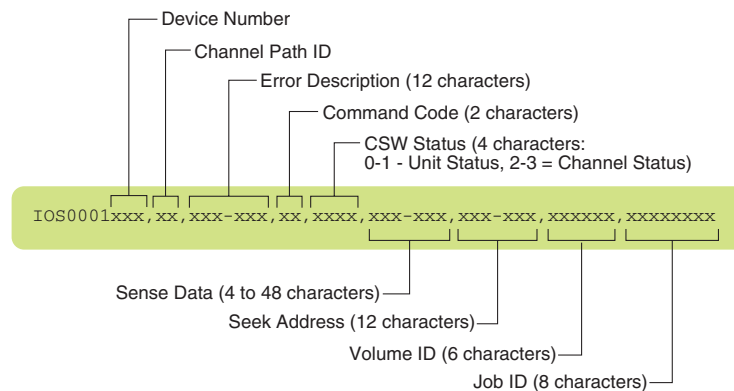


Figure 6-10 Typical Console Error Message

The unit status and channel status (CSW characters) indicate why the operation terminated. The unit status is bits 32-39 in the CSW (370 mode) and bits 0-7 of Word 2 of the SCSW (XA and ESA mode). The

channel status is bits 40-47 in the CSW (370 mode) and bits 8-15 of Word 2 of the SCSW (XA and ESA mode).

Unit Status Bits Table 6-4 lists and describes the unit status bits.

Table 6-4 Unit Status Bits

370	XA, ESA	Meaning
Bit 32	Bit 0	Attention—READY status when set in conjunction with Device End and Unit Exception.
Bit 33	Bit 1	Status modifier—When set with Unit Check, indicates a usual condition, command retry; when set with Busy, indicates the Symmetrix system is busy; when set with Device End, next CCW has been skipped.
Bit 34	Bit 2	Control-unit end—Symmetrix no longer busy.
Bit 35	Bit 3	Busy—If Status Modifier clear, the drive is busy; if Status Modifier set, the channel director is busy.
Bit 36	Bit 4	Channel end—Data or command transfer to/from channel is complete.
Bit 37	Bit 5	Device end—Device operation complete.
Bit 38	Bit 6	Unit check—Symmetrix system detected an error condition.
Bit 39	Bit 7	Unit exception—EOF on addressed track during a Read R0, Read IPL, or Read CKD, or Write Key Data or Write Data operation. If Attention and Device End set, indicates a READY status.

Channel Status Bits Table 6-5 lists and describes the channel status bits.

Table 6-5 Channel Status Bits

370	XA, ESA	Meaning
Bit 40	Bit 8	Program-controlled interruption (PCI)—CCW specified interrupt occurred.
Bit 41	Bit 9	Incorrect length—Number of bytes transferred were not equal to number of bytes specified by CCW.
Bit 42	Bit 10	Program check—CCW programming error.
Bit 43	Bit 11	Protection check—Channel attempted to address a storage area prohibited by a protection key.
Bit 44	Bit 12	Channel-data check—Incorrect parity.
Bit 45	Bit 13	Channel-control check—Channel hardware error.
Bit 46	Bit 14	Interface-control check—Invalid signal from the Symmetrix system (invalid signal sequence, overly slow response, or parity error on Bus In).
Bit 47	Bit 15	Chaining check—Channel overrun during input operation.

You can find a detailed description of these status bits in the appropriate IBM *Principles of Operation*.

Host Sense Byte Data Formats

Sense byte formats are found in the IBM reference manual appropriate for the specific Symmetrix system emulation.

**Symmetrix DMX
Specifications**

This appendix contains the specifications of the Symmetrix DMX systems.

- ◆ Storage Control.....A-2
- ◆ Physical Data A-12
- ◆ Environmental Data.....A-14
- ◆ Power and Cooling Data.....A-15
- ◆ Electrical Specifications and Power Requirements A-17

Storage Control

Emulation

3990-3, 3990-2, or 3990-6, 2105, and FBA

Channel Speeds

Up to 17 MB/s ESCON channel
Up to 2 Gb/s FICON channel
Up to 2 Gb/s Fibre Channel
Up to 1 Gb/s iSCSI channel
Up to 1 Gb/s GigE remote channel

Storage Capacities

Tables A-1 through A-8 outline capacities for the Symmetrix DMX systems. The capacities are presented based on the disk device capacities of 73 GB and 146 GB, and these methods of data protection:

- ◆ SRDF (Symmetrix Remote Data Facility)
- ◆ Mirroring (RAID 1)
- ◆ Parity RAID (3+1) or (7+1)
- ◆ RAID 5 (3+1) or (7+1)

RAID 5 (3+1) capacities are equivalent to Parity RAID (3+1) capacities, as are RAID 5 (7+1) capacities are to Parity RAID (7+1) as shown in the following tables.

The GB values shown in Tables A-1 through A-8 are based on the following conventions:

The GB₂ value is based on 1 GB = 1024 *1024 *1024 bytes.

The GB₁₀ value is based on 1 GB = 1000 *1000 *1000 bytes.

Although the open systems values are expressed differently, they are equivalent.

A Symmetrix system reserves four 3 GB (6,140 cylinders) logical volumes (12 GB total system requirement) of disk capacity used for internal Symmetrix file system purposes.

Table A-1 Symmetrix DMX Storage Capacities (73 GB Mirrored Disk Devices)

Total Disk Devices per Subsystem	Usable Disk Devices per Subsystem	Open Systems Capacity (GB ₂)	Open Systems Capacity (GB ₁₀)	Mainframe Capacity (GB ₁₀)
48 ^a	24	1,633	1,754	1,732
64	32	2,178	2,339	2,309
80	40	2,723	2,924	2,886
96 ^b	48	3,267	3,508	3,464
120	60	4,084	4,386	4,330
128	64	4,357	4,678	4,618
144 ^c	72	4,901	5,263	5,196
160	80	5,446	5,848	5,773
192 ^d	96	6,535	7,017	6,928
224	112	7,624	8,187	8,083
256	128	8,714	9,356	9,237
290 ^e	145	9,871	10,599	10,465
320	160	10,892	11,696	11,547
352	176	11,982	12,865	12,701
384	192	13,071	14,035	13,856
416	208	14,160	15,204	15,011
448	224	15,249	16,374	16,166
480	240	16,339	17,544	17,320
512	256	17,428	18,713	18,475
544	272	18,517	19,883	19,630
576 ^f	288	19,607	21,052	20,784

- a. Minimum drive capacity for a Symmetrix DMX1000 system.
- b. Minimum drive capacity for a Symmetrix DMX2000 system.
- c. Maximum drive capacity for a Symmetrix DMX1000 system.
- d. Minimum drive capacity for a Symmetrix DMX3000 system.
- e. Maximum drive capacity for a Symmetrix DMX2000 system.
- f. Maximum drive capacity for a Symmetrix DMX3000 system.

Table A-2 Symmetrix DMX Storage Capacities (73 GB SRDF Disk Devices)

Total Disk Devices per Subsystem	Usable Disk Devices per Subsystem	Open Systems Capacity (GB ₂)	Open Systems Capacity (GB ₁₀)	Mainframe Capacity (GB ₁₀)
48 ^a	48	3,267	3,508	3,464
64	64	4,357	4,678	4,618
80	80	5,446	5,848	5,773
96 ^b	96	6,535	7,017	6,928
120	120	8,169	8,772	8,660
128	128	8,714	9,356	9,237
144 ^c	144	9,803	10,526	10,392
160	160	10,892	11,696	11,547
192 ^d	192	13,071	14,035	13,856
224	224	15,249	16,374	16,166
256	256	17,428	18,713	18,475
289 ^e	289	19,675	21,125	20,857
320	320	21,785	23,392	23,094
352	352	23,964	25,731	25,403
384	384	26,142	28,070	27,713
416	416	28,321	30,409	30,022
448	448	30,499	32,748	32,332
480	480	32,678	35,088	34,641
512	512	34,856	37,427	36,951
544	544	37,035	39,766	39,260
576 ^f	576	39,214	42,105	41,569

- a. Minimum drive capacity for a Symmetrix DMX1000 system.
- b. Minimum drive capacity for a Symmetrix DMX2000 system.
- c. Maximum drive capacity for a Symmetrix DMX1000 system.
- d. Minimum drive capacity for a Symmetrix DMX3000 system.
- e. Maximum drive capacity for a Symmetrix DMX2000 system.
- f. Maximum drive capacity for a Symmetrix DMX3000 system.

Table A-3 Symmetrix DMX Storage Capacities (73 GB Parity RAID (3+1) Disk Devices) ^a

Total Disk Devices per Subsystem	Usable Disk Devices per Subsystem	Open Systems Capacity (GB ₂)	Open Systems Capacity (GB ₁₀)	Mainframe Capacity (GB ₁₀)
48 ^b	36	2,450	2,631	2,598
64	48	3,267	3,508	3,464
80	60	4,084	4,386	4,330
96 ^c	72	4,901	5,263	5,196
120	90	6,127	6,579	6,495
128	96	6,535	7,017	6,928
144 ^d	108	7,352	7,894	7,794
160	120	8,169	8,772	8,660
192 ^e	144	9,803	10,526	10,392
224	168	11,437	12,280	12,124
256	192	13,071	14,035	13,856
289 ^f	217	14,773	15,862	15,661
320	240	16,339	17,544	17,320
352	264	17,973	19,298	19,052
384	288	19,607	21,052	20,784
416	312	21,240	22,807	22,517
448	336	22,874	24,561	24,249
480	360	24,508	26,316	25,981
512	384	26,142	28,070	27,713
544	408	27,776	29,824	29,445
576 ^g	432	29,410	31,579	31,177

- a. RAID 5 (3+1) capacities are equivalent to Parity RAID (3+1) capacities.
- b. Minimum drive capacity for a Symmetrix DMX1000 system.
- c. Minimum drive capacity for a Symmetrix DMX2000 system.
- d. Maximum drive capacity for a Symmetrix DMX1000 system.
- e. Minimum drive capacity for a Symmetrix DMX3000 system.
- f. Maximum drive capacity for a Symmetrix DMX2000 system.
- g. Maximum drive capacity for a Symmetrix DMX3000 system.

Table A-4 Symmetrix DMX Storage Capacities (73 GB Parity RAID (7+1) Disk Devices) ^a

Total Disk Devices per Subsystem	Usable Disk Devices per Subsystem	Open Systems Capacity (GB ₂)	Open Systems Capacity (GB ₁₀)	Mainframe Capacity (GB ₁₀)
48 ^b	42	2,859	3,070	3,031
64	56	3,812	4,093	4,041
80	70	4,765	5,117	5,051
96 ^c	84	5,718	6,140	6,062
120	105	7,148	7,675	7,577
128	112	7,624	8,187	8,083
144 ^d	126	8,578	9,210	9,093
160	140	9,531	10,234	10,103
192 ^e	168	11,437	12,280	12,124
224	196	13,343	14,327	14,145
256	224	15,249	16,374	16,166
289 ^f	253	17,224	18,494	18,259
320	280	19,062	20,468	20,207
352	308	20,968	22,514	22,228
384	336	22,874	24,561	24,249
416	364	24,781	26,608	26,269
448	392	26,687	28,655	28,290
480	420	28,593	30,702	30,311
512	448	30,499	32,748	32,332
544	476	32,406	34,795	34,352
576 ^g	504	34,312	36,842	36,373

- a. RAID 5 (7+1) capacities are equivalent to Parity RAID (7+1) capacities.
- b. Minimum drive capacity for a Symmetrix DMX1000 system.
- c. Minimum drive capacity for a Symmetrix DMX2000 system.
- d. Maximum drive capacity for a Symmetrix DMX1000 system.
- e. Minimum drive capacity for a Symmetrix DMX3000 system.
- f. Maximum drive capacity for a Symmetrix DMX2000 system.
- g. Maximum drive capacity for a Symmetrix DMX3000 system.

Table A-5 Symmetrix DMX Storage Capacities (146 GB Mirrored Disk Devices)

Total Disk Devices per Subsystem	Usable Disk Devices per Subsystem	Open Systems Capacity (GB ₂)	Open Systems Capacity (GB ₁₀)	Mainframe Capacity (GB ₁₀)
48 ^a	24	3,264	3,504	3,470
64	32	4,352	4,672	4,627
80	40	5,440	5,840	5,784
96 ^b	48	6,528	7,008	6,940
120	60	8,160	8,760	8,676
128	64	8,704	9,344	9,254
144 ^c	72	9,792	10,512	10,411
160	80	10,880	11,680	11,568
192 ^d	96	13,056	14,016	13,881
224	112	15,232	16,352	16,195
256	128	17,408	18,688	18,508
290 ^e	145	19,720	21,170	20,968
320	160	21,760	23,360	23,136
352	176	23,936	25,696	25,449
384	192	26,112	28,032	27,763
416	208	28,288	30,368	30,076
448	224	30,464	30,704	32,390
480	240	32,640	35,040	34,704
512	256	34,816	37,376	37,017
544	272	36,992	39,712	39,331
576 ^f	288	39,168	42,048	41,644

- a. Minimum drive capacity for a Symmetrix DMX1000 system.
- b. Minimum drive capacity for a Symmetrix DMX2000 system.
- c. Maximum drive capacity for a Symmetrix DMX1000 system.
- d. Minimum drive capacity for a Symmetrix DMX3000 system.
- e. Maximum drive capacity for a Symmetrix DMX2000 system.
- f. Maximum drive capacity for a Symmetrix DMX3000 system.

Table A-6 Symmetrix DMX Storage Capacities (146 GB SRDF Disk Devices)

Total Disk Devices per Subsystem	Usable Disk Devices per Subsystem	Open Systems Capacity (GB ₂)	Open Systems Capacity (GB ₁₀)	Mainframe Capacity (GB ₁₀)
48 ^a	48	6,528	7,008	6,940
64	64	8,704	9,344	9,254
80	80	10,880	11,680	11,568
96 ^b	96	13,056	14,016	13,881
120	120	16,320	17,520	17,352
128	128	17,408	18,688	18,508
144 ^c	144	19,584	21,024	20,822
160	160	21,760	23,360	23,136
192 ^d	192	26,112	28,032	27,763
224	224	30,464	32,704	32,390
256	256	34,816	37,376	37,017
289 ^e	289	39,304	42,194	41,790
320	320	43,520	46,720	46,272
352	352	47,872	51,392	50,899
384	384	52,224	56,064	55,526
416	416	56,576	60,736	60,153
448	448	60,928	65,408	64,780
480	480	65,280	70,080	69,408
512	512	69,632	74,752	74,035
544	544	73,984	79,424	78,662
576 ^f	576	78,336	84,096	83,289

- a. Minimum drive capacity for a Symmetrix DMX1000 system.
- b. Minimum drive capacity for a Symmetrix DMX2000 system.
- c. Maximum drive capacity for a Symmetrix DMX1000 system.
- d. Minimum drive capacity for a Symmetrix DMX3000 system.
- e. Maximum drive capacity for a Symmetrix DMX2000 system.
- f. Maximum drive capacity for a Symmetrix DMX3000 system.

Table A-7 Symmetrix DMX Storage Capacities (146 GB Parity RAID (3+1) Disk Devices) ^a

Total Disk Devices per Subsystem	Usable Disk Devices per Subsystem	Open Systems Capacity (GB ₂)	Open Systems Capacity (GB ₁₀)	Mainframe Capacity (GB ₁₀)
48 ^b	36	4,896	5,256	5,205
64	48	6,528	7,008	6,940
80	60	8,160	8,760	8,676
96 ^c	72	9,792	10,512	10,411
120	90	12,240	13,140	13,014
128	96	13,056	14,016	13,881
144 ^d	108	14,688	15,768	15,616
160	120	16,320	17,520	17,352
192 ^e	144	19,584	21,024	20,822
224	168	22,848	24,528	24,292
256	192	26,112	28,032	27,763
289 ^f	217	29,512	31,682	31,379
320	240	32,640	35,040	34,704
352	264	35,904	38,544	38,174
384	288	39,168	42,048	41,644
416	312	42,432	45,552	45,115
448	336	45,696	49,056	48,585
480	360	48,960	52,560	52,056
512	384	52,224	56,064	55,526
544	408	55,488	59,568	58,996
576 ^g	432	58,752	63,072	62,467

- a. RAID 5 (3+1) capacities are equivalent to Parity RAID (3+1) capacities.
- b. Minimum drive capacity for a Symmetrix DMX1000 system.
- c. Minimum drive capacity for a Symmetrix DMX2000 system.
- d. Maximum drive capacity for a Symmetrix DMX1000 system.
- e. Minimum drive capacity for a Symmetrix DMX3000 system.
- f. Maximum drive capacity for a Symmetrix DMX2000 system.
- g. Maximum drive capacity for a Symmetrix DMX3000 system.

Table A-8 Symmetrix DMX Storage Capacities (146 GB Parity RAID (7+1) Disk Devices) ^a

Total Disk Devices per Subsystem	Usable Disk Devices per Subsystem	Open Systems Capacity (GB ₂)	Open Systems Capacity (GB ₁₀)	Mainframe Capacity (GB ₁₀)
48 ^b	42	5,712	6,132	6,073
64	56	7,616	8,176	8,097
80	70	9,520	10,220	10,122
96 ^c	84	11,424	12,264	12,146
120	105	14,280	15,330	15,183
128	112	15,232	16,352	16,195
144 ^d	126	17,136	18,396	18,219
160	140	19,040	20,440	20,244
192 ^e	168	22,848	24,528	24,292
224	196	26,656	28,616	28,341
256	224	30,464	32,704	32,390
289 ^f	253	34,408	36,938	36,585
320	280	38,080	40,880	40,488
352	308	41,888	44,968	44,536
384	336	45,696	49,056	48,585
416	364	49,504	53,144	52,634
448	392	53,312	57,232	56,683
480	420	57,120	61,320	60,732
512	448	60,928	65,408	64,780
544	476	64,736	69,496	68,829
576 ^g	504	68,544	73,584	72,878

- a. RAID 5 (7+1) capacities are equivalent to Parity RAID (7+1) capacities.
- b. Minimum drive capacity for a Symmetrix DMX1000 system.
- c. Minimum drive capacity for a Symmetrix DMX2000 system.
- d. Maximum drive capacity for a Symmetrix DMX1000 system.
- e. Minimum drive capacity for a Symmetrix DMX3000 system.
- f. Maximum drive capacity for a Symmetrix DMX2000 system.
- g. Maximum drive capacity for a Symmetrix DMX3000 system.

**MB/Volume
by Emulation Type**

3380D emulation	630
3380E emulation	1,260
3380K emulation	1,891
3390-1 emulation	946
3390-2 emulation	1,892
3390-3 emulation	2,838
3390-9 emulation	8,514
3390-27 emulation	27,844

Bytes/Track

Fixed Block Architecture (FBA) capacities are based on 512 bytes per block, 64 bytes per track, and 15 tracks per cylinder.

3380 emulations	47,476
3390 emulations	56,664
FBA	32,768

Bytes/Cylinder

Fixed Block Architecture (FBA) capacities are based on 512 bytes per block, 64 bytes per track, and 15 tracks per cylinder.

3380 emulations	712,140
3390 emulations	849,960
FBA	491,520

Cylinders/Volume

3380D emulation	885
3380E emulation	1,770
3380K emulation	2,655
3390-1 emulation	1,113
3390-2 emulation	2,226
3390-3 emulation	3,339
3390-9 emulation	10,017
3390-27 emulation	32,760
FBA (maximum)	65,520

**Disk Device Form
Factor**

1-inch	Height (Low-Profile)
3.5-inch	Width

Physical Data

Table A-9 Physical Specifications

Description	Model DMX1000 Measurement	Model DMX2000 Measurement	Model DMX3000 Measurement
Dimensions			
Height	75.4 inches (191.52 cm)	75.4 inches (191.52 cm)	75.4 inches (191.52 cm)
Width	24.1 inches (61.22 cm)	48.00 inches (121.92 cm) ^a	70.3 inches (178.56 cm)
Depth	37.5 inches (95.25 cm)	37.5 inches (95.25 cm)	37.5 inches (95.25 cm)
Clearance for Service, Airflow			
Front	36 inches (91.44 cm)	36 inches (91.44 cm)	36 inches (91.44 cm)
Rear	36 inches (91.44 cm)	36 inches (91.44 cm)	36 inches (91.44 cm)
Top	18 inches (45.7 cm)	18 inches (45.7 cm)	18 inches (45.7 cm)

a. With the DMX2000 shipping brackets in place to stabilize the system to the floor, the system width is 54 inches (137.16 cm).

Table A-10 Symmetrix DMX1000 Weights ^a

Total Physical Disk Devices	Drive Weights lbs (kg)	Total Symmetrix System Weight
48	120 lbs (54.55 kg)	1,293 lbs (587.73 kg)
96	240 lbs (109.09 kg)	1,413 lbs (642.27 kg)
128	320 lbs (145.45 kg)	1,493 lbs (678.64 kg)
144	360 lbs (163.64 kg)	1,533 lbs (696.82 kg)

a. These weights are based on a fully loaded configuration of channel directors, disk directors, global memory directors, and four power supplies.

Table A-11 Symmetrix DMX2000 Weights ^a

Total Physical Disk Devices	Drive Weights (lbs/kg)	Total Symmetrix System Weight
96	240 lbs (109.09 kg)	2,674 lbs (1,215.45 kg)
128	320 lbs (145.45 kg)	2,754 lbs (1,251.82 kg)
160	400 lbs (181.82 kg)	2,834 lbs (1,288.18 kg)
192	480 lbs (218.18 kg)	2,914 lbs (1,324.55 kg)
224	560 lbs (254.55 kg)	2,994 lbs (1,360.91 kg)
256	640 lbs (290.91 kg)	3,074 lbs (1,397.27 kg)
288	720 lbs (327.27 kg)	3,154 lbs (1,433.64 kg)

a. These weights are based on a fully loaded configuration of channel directors, disk directors, global memory directors, and 12 power supplies.

Table A-12 Symmetrix DMX3000 Weights ^a

Total Physical Disk Devices	Drive Weights (lbs/kg)	Total Symmetrix System Weight
192	480 lbs (218.18 kg)	3,646 lbs (1,657.27 kg)
224	560 lbs (254.54 kg)	3,726 lbs (1,693.64 kg)
256	640 lbs (290.91 kg)	3,806 lbs (1,730.00 kg)
288	720 lbs (327.27 kg)	3,886 lbs (1,766.36 kg)
320	800 lbs (363.64 kg)	3,966 lbs (1,802.73 kg)
352	880 lbs (400.00 kg)	4,046 lbs (1,839.09 kg)
384	960 lbs (463.36 kg)	4,126 lbs (1,875.45 kg)
416	1,040 lbs (472.73 kg)	4,206 lbs (1,911.82 kg)
448	1,120 lbs (509.09 kg)	4,286 lbs (1,948.18 kg)
480	1,200 lbs (545.45 kg)	4,366 lbs (1,984.55 kg)
512	1,280 lbs (581.82 kg)	4,446 lbs (2,020.91 kg)
544	1,360 lbs (618.18 kg)	4,526 lbs (2,057.27 kg)
576	1,440 lbs (654.55 kg)	4,606 lbs (2,093.64 kg)

a. These weights are based on a fully loaded configuration of channel directors, disk directors, global memory directors, and 12 power supplies.

Environmental Data

Table A-13 Symmetrix DMX Environmental Data

Condition	DMX1000 Setting	DMX2000 Setting	DMX3000 Setting
Operating Temperature	50° - 90° F (10° to 32° C)	50° - 90° F (10° to 32° C)	50° - 90° F (10° to 32° C)
Operating Altitude (Maximum)	8,000 ft (2,500 m)	8,000 ft (2,500 m)	8,000 ft (2,500 m)
Operating Humidity	20% to 80% Non-Condensing	20% to 80% Non-Condensing	20% to 80% Non-Condensing
Raised Floor Required	Required	Required	Required

Air Volume
Generated

English Units
2,256 cfm

Metric (SI) Units
60 cmm

Power and Cooling Data

Table A-14 DMX1000 Power Consumption and Heat Dissipation ^{a b}

Number of Disk Devices	Total Power Consumption (KVA) per System	Power Consumption Delta KVA per Drive	Heat Dissipation (Btu/Hr)	Heat Dissipation (Btu/Hr) per Drive
48	2.2	0.021	7,982	74
64	2.5	0.021	9,168	74
96	3.1	0.021	11,541	74
128	3.8	0.021	13,914	74
144	4.1	0.021	15,100	74

- a. These values represent the power consumption and heat dissipation that you can expect for your particular model. Your Symmetrix unit may perform better than the values shown here.
- b. Model DMX1000 values are calculated for a fully loaded configuration of channel directors, disk directors, and global memory directors. Contact your EMC Sales Representative for specific supported configurations.

Table A-15 DMX2000 Power Consumption and Heat Dissipation ^{a b c}

Number of Disk Devices	Total Power Consumption (KVA) per System	Power Consumption Delta KVA per Drive	Heat Dissipation (Btu/Hr)	Heat Dissipation (Btu/Hr) per Drive
96	4.3	0.021	15,964	74
144	5.3	0.021	19,523	74
216	6.78	0.021	24,862	74
288	8.24	0.021	30,201	74

- a. The values shown for total power consumption per system represent typical operation. The DMX2000 cabinets have four AC input power connections of which only two are active and supplying power to the cabinet at any given time. Each of these two power cords will be delivering approximately half of the power consumption reflected in the table above, but the total power being consumed by the cabinet remains the same as shown in the table.
- b. These values represent the power consumption and heat dissipation that you can expect for your particular model. Your Symmetrix unit may perform better than the values shown here.
- c. Model DMX2000 values are calculated for a fully loaded configuration of channel directors, disk directors, and global memory directors. Contact your EMC Sales Representative for specific supported configurations.

Table A-16 DMX3000 Power Consumption and Heat Dissipation ^{a b c}

Number of Disk Devices	Total Power Consumption (KVA) per System	Power Consumption Delta KVA per Drive	Heat Dissipation (Btu/Hr)	Heat Dissipation (Btu/Hr) per Drive
289	8.5	0.021	29,139	74
320	9.2	0.021	31,391	74
384	10.5	0.021	35,827	74
448	11.85	0.021	40,400	74
480	12.5	0.021	42,651	74
512	13.2	0.021	44,971	74
576	14.4	0.021	49,577	74

- a. The values shown for total power consumption per system represent typical operation. The DMX3000 cabinets have four AC input power connections of which only two are active and supplying power to the cabinet at any given time. Each of these two power cords will be delivering approximately half of the power consumption reflected in the table above, but the total power being consumed by the cabinet remains the same as shown in the table.
- b. These values represent the power consumption and heat dissipation that you can expect for your particular model. Your Symmetrix unit may perform better than the values shown here.
- c. Model DMX3000 values are calculated for a fully loaded configuration of channel directors, disk directors, and global memory directors. Contact your EMC Sales Representative for specific supported configurations.

Electrical Specifications and Power Requirements

Tables A-17 through A-33 describe the North American and International electrical specifications, power cables, connectors, and extension cords for the Symmetrix DMX series systems.

For pre-installation power site requirements, refer to *Symmetrix DMX1000 Power Requirements* and *Symmetrix DMX2000/3000 Power Requirements* on page C-4.

Table A-17 DMX1000 Electrical Specifications, Single-Phase

Specification	North America	International
Input Voltage	208 / 240 VAC L-L nom (240 VAC optimal)	220 / 230 / 240 VAC L-N nom (240 VAC optimal)
Range	200–240 VAC	200–240 VAC
Frequency	47–63 Hz	47–63 Hz
Circuit Breakers	32 A (minimum) to 60 A (maximum)	32 A (minimum) to 60 A (maximum)
Power Zones	One	One
Power Requirements at Customer Site (minimum)	Two 32 A ^a single-phase drops	Two 32 A ^a single-phase drops

a. 32 to 60 A based on circuit breakers used.

Table A-18 DMX1000 Power Cables and Connectors, Single-Phase

Power Cables and Connectors Included with Each System		Mating Connectors		
Power Connection	Connector Type	Vendor Part Number	EMC Part Number	EMC Model Number
Two 22-inch power cables affixed to each system	Two 60 A connectors included with power cables, Russellstoll 9P63U2T	Russellstoll 9C63U2T	037-001-237	DMX-ACONSP-60 Single-phase connector rated up to 60 A

Table A-19 DMX1000 Extension Line Cords, Single-Phase

EMC Part Number	EMC Model Number	Description
038-002-828	DMX-ACLINE	10 ft single-phase line cord with connectors on each end (one 9C63U2T and one 9P63U2T).
038-002-811	DMX-ACLINE-FL	10 ft single-phase line cord with connectors one connector (one 9C63U2T) and flying leads at the other end.

Table A-20 DMX2000 Electrical Specifications, North American

Specification	North America Single-Phase	North America Three-Phase (Delta)
Input Voltage	208 / 240 VAC L-L nom (240 VAC optimal)	208 / 240 VAC L-L nom (240 VAC optimal)
Range	200–240 VAC	200–240 VAC
Frequency	47–63 Hz	47–63 Hz
Circuit Breakers	60 A	50 A
Power Zones	Two	Two
Power Requirements at Customer Site (minimum)	Four 60 A, single-phase drops	Four 50 A, three-phase drops

Table A-21 DMX2000 Power Cables and Connectors, North American, Single-Phase

Power Cables and Connectors Included with Each System		Mating Connectors		
Power Connection	Connector Type	Vendor Part Number	EMC Part Number	EMC Model Number
Four 22-inch power cables affixed to each system	Four 60A connectors included with power cables, Russellstoll 9P63U2T	Russellstoll 9C63U2T	037-001-237	DMX-ACONSP-60 Single-phase connector rated up to 60 A

Table A-22 DMX2000 Power Cables and Connectors, North American, Three-Phase Delta

Power Cables and Connectors Included with Each System		Mating Connectors		
Power Connection	Connector Type	Vendor Part Number	EMC Part Number	EMC Model Number
Four 22-inch power cables affixed to each system	Four 50A connectors included with power cables, Russellstoll 9P54U2T	Russellstoll 9C54U2T	017-016-040	DMX-ACON3P-50 Three-phase Delta connector rated up to 50 A

Table A-23 DMX2000 North American Extension Line Cords

Description	EMC Part Number	EMC Model Number
Single-Phase, 10 ft single-phase line cord with connectors on each end (one 9C63U2T and one 9P63U2T).	038-002-828	DMX-ACLINE
Single-Phase, 10 ft single-phase line cord with connectors one connector (one 9C63U2T) and flying leads at the other end.	038-002-811	DMX-ACLINE-FL
Three-Phase Delta, 10 ft single-phase line cord with connectors on each end (one 9C63U2T and one 9P63U2T).	038-002-812	DMX-ACLINE3P

Table A-24 DMX2000 Electrical Specifications, International

Specification	International Single-Phase	International Three-Phase (WYE)
Input Voltage	220 / 230 / 240 VAC L-N nom (240 VAC optimal)	220 / 230 / 240 VAC L-N nom (240 VAC optimal)
Range	200–240 VAC	200–240 VAC
Frequency	47–63 Hz	47–63 Hz
Circuit Breakers	60 A	32 A ^a
Power Zones	Two	Two
Power Requirements at Customer Site	Four 60 A, single-phase drops	Four 32 A, three-phase drops

- a. For high voltage installations (380 - 415 VAC line-to-line), a 32 A rated circuit breaker is recommended. For International installations where a 3-phase, 4-wire DELTA source is used, a 50 A circuit breaker is required.

Table A-25 DMX2000 Power Cables and Connectors, International, Single-Phase

Power Cables and Connectors Included with Each System		Mating Connectors		
Power Connection	Connector Type	Vendor Part Number	EMC Part Number	EMC Model Number
Four 22-inch power cables affixed to each system	Four 60A connectors included with power cables, Russellstoll 9P63U2T	Russellstoll 9C63U2T	037-001-237	DMX-ACONSP-60 Single-phase connector rated up to 60 A

Table A-26 DMX2000 Power Cables and Connectors, International Three-Phase WYE

Power Cables and Connectors Included with Each System		Mating Connectors		
Power Connection	Connector Type	Vendor Part Number	EMC Part Number	EMC Model Number
Four 10 ft power cables affixed to each system	Four 32A connectors included with power cables, Garo WYE-style P-432-6	S-432-6 coupler	N/A	The Garo S-432-6 coupler is a customer supplied part. No EMC model is available.

Table A-27 DMX2000 Extension Line Cords

Description	EMC Part Number	EMC Model Number
Single-Phase, 10 ft single-phase line cord with connectors on each end (one 9C63U2T and one 9P63U2T).	038-002-828	DMX-ACLINE
Single-Phase, 10 ft single-phase line cord with connectors one connector (one 9C63U2T) and flying leads at the other end.	038-002-811	DMX-ACLINE-FL
Three-Phase Delta, 10 ft single-phase line cord with connectors on each end (one 9C63U2T and one 9P63U2T).	038-002-812	DMX-ACLINE3P

Table A-28 DMX3000 Electrical Specifications, North American, Three-Phase, Delta

Specification	North America Three-Phase (Delta)
Input Voltage	208 / 240 VAC L-L nom (240 VAC optimal)
Range	200–240 VAC
Frequency	47–63 Hz
Circuit Breakers	50 A
Power Zones	Two, three-phase
Power Requirements at Customer Site (minimum)	Four 50 A, three-phase drops

Table A-29 DMX3000 Power Cables and Connectors, North American, Three-Phase, Delta

Power Cables and Connectors Included with Each System		Mating Connectors		
Power Connection	Connector Type	Vendor Part Number	EMC Part Number	EMC Model Number
Four 22-inch power cables affixed to each system	Four 50A connectors included with power cables, Russellstoll 9P54U2T	Russellstoll 9C54U2T	017-016-040	DMX-ACON3P-50 Three-phase Delta connector rated up to 50 A

Table A-30 DMX3000 North American Extension Line Cord, Three-Phase, Delta

Description	EMC Part Number	EMC Model Number
Three-Phase Delta, 10 ft single-phase line cord with connectors on each end (one 9C63U2T and one 9P63U2T).	038-002-812	DMX-ACLINE3P

Table A-31 DMX3000 Electrical Specifications, International, Three-Phase, WYE

Specification	International Three-Phase (WYE)
Input Voltage	220 / 230 / 240 VAC L-N nom (240 VAC optimal)
Range	200–240 VAC
Frequency	47–63 Hz
Circuit Breakers	32 A ^a
Power Zones	Two, three-phase
Power Requirements at Customer Site	Four 32 A, three-phase drops

a. For high voltage installations (380 - 415 VAC line-to-line), a 32 A rated circuit breaker is recommended. For International installations where a 3-phase, 4-wire DELTA source is used, a 50 A circuit breaker is required.

Table A-32 DMX3000 Power Cables and Connectors, International Three-Phase, WYE

Power Cables and Connectors Included with Each System		Mating Connectors		
Power Connection	Connector Type	Vendor Part Number	EMC Part Number	EMC Model Number
Four 10 ft power cables affixed to each system	Four 32A connectors included with power cables, Garo WYE-style P-432-6	S-432-6 coupler	N/A	The Garo S-432-6 coupler is a customer supplied part. No EMC model is available.

Table A-33 DMX3000 International Extension Line Cord Three-Phase, WYE

Description	EMC Part Number	EMC Model Number
No extension cord is required for International three-phase power. The mating connector is a Garo S-432-6 (coupler) customer-supplied.	N/A	N/A

Power Sequences

This appendix provides instructions for powering the Symmetrix DMX systems on and off.

- ◆ Routinely Powering Up the Symmetrix DMX Systems B-2
- ◆ Routinely Powering Down the Symmetrix DMX Systems B-3
- ◆ Emergency Powerdown for the Symmetrix DMX Systems B-4

Routinely Powering Up the Symmetrix DMX Systems



CAUTION

The Symmetrix DMX systems contain no user-serviceable parts, so it should not be opened for any reason by untrained personnel. If the Symmetrix DMX is in need of repair, only qualified personnel familiar with safety procedures for electrical equipment and the Symmetrix DMX should access components inside the unit.

Perform these steps to power up the Symmetrix system after it has been powered off by the AC power switch.

1. Press the AC power (black) switch on the rear door to the up (I) position.

The Symmetrix system begins its IML procedure.

The power controls are inoperative unless the Emergency Power Off (EPO) switch on the rear door is in its enabled (up, I position). The EPO switch when turned off (down, O position) disables all power to the Symmetrix system including the backup battery systems.

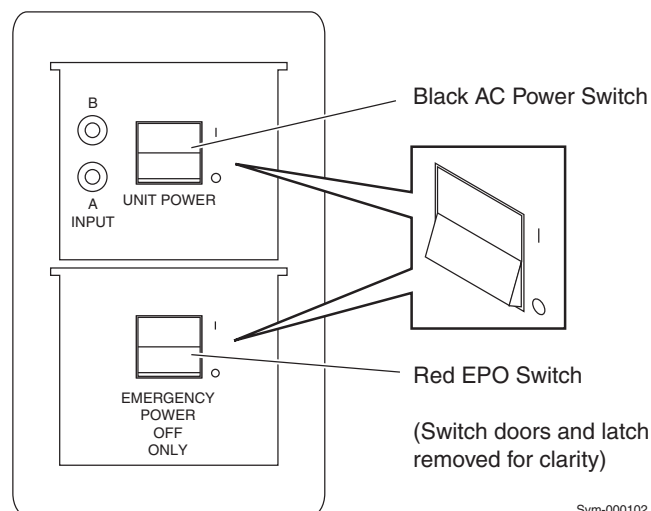


Figure B-1 Symmetrix DMX Power Switch

2. Wait at least 30 minutes for the IML procedure to complete.

The actual IML procedure time varies by system type and configuration.

Routinely Powering Down the Symmetrix DMX Systems

Perform these steps to power down the Symmetrix system using the AC (black) power switch located on the rear door of the Symmetrix system.

1. Stop all processes to the Symmetrix DMX systems.

All pending write operations should complete within five minutes. If a device fails to complete its write operations within this time period, it could indicate a problem with that device. Call the EMC Service Support Center for assistance, if necessary.

2. Press the AC (black) power switch on the rear door (Figure B-1 on page B-2) to the down (O) position. Do *not* press the EPO (red) switch.

The battery backup system automatically turns on when the Symmetrix system detects loss of AC power. The battery will keep the Symmetrix system powered for 60 seconds while it destages write operations in an orderly way.

Emergency Powerdown for the Symmetrix DMX Systems

If it becomes necessary to immediately power down the Symmetrix DMX systems:



CAUTION

Do not use this procedure for routine power down operation.

1. On the rear door, lift the cover to the red EPO switch (Figure B-1 on page B-2).
2. Lift the protective latch, then press the red EPO switch to the down (O) position.

The Symmetrix system immediately switches to backup battery power and destages any pending writes in global memory to disk. This destage operation takes approximately 20 seconds following which the Symmetrix system powers down.



CAUTION

Before restarting the Symmetrix DMX systems after an Emergency Powerdown, contact the EMC Customer Support Center.

Planning and Installation

This appendix covers the tasks you need to complete when planning or verifying the physical configuration of the Symmetrix DMX systems or creating I/O addressing schemes.

- ◆ Planning Overview C-2
- ◆ Director/Global Memory Board Layout C-13
- ◆ Mainframe Systems Installations..... C-15
- ◆ Open Systems Installations..... C-40

Planning Overview

This section guides you through the physical details related to delivery and installation of the Symmetrix DMX systems. It reviews all the necessary installation details performed by EMC personnel and outlines customer responsibilities.

Inform EMC of any labor union-based restrictions or security clearance requirements prior to delivery.

The Symmetrix DMX systems are designed for installation in a properly equipped computer room with raised floor, controlled temperature and humidity, proper airflow and ventilation, proper power and grounding, system cable routing facilities, fire equipment, and so on. One or more planning sessions with your EMC Systems Engineer and Customer Engineer may be necessary to close on all the details related to installation. Table C-1 below lists the responsibility summary at the first planning session.

Table C-1 Pre-Installation Responsibility Summary

EMC Responsibility	Customer Responsibility
Provide all details necessary for site planning and preparation.	Provide an environment which supports safe installation of the Symmetrix DMX system and promotes its reliable long-term operation.
Complete and process the Installation Planning Task Sheet and Pre-Site Survey.	Provide appropriate power, cooling and ventilation, humidity control, floor load capability, and service clearances as required.
Arrange for shipment and delivery through appropriate method.	Participate in planning sessions as required to ensure a smooth and uncomplicated installation.
Install a properly working system as promised and on schedule.	

Symmetrix DMX3000 System Presite Considerations

When planning the installation site for your Symmetrix DMX3000 system you will need to meet with your EMC representative to complete the presite plan. The Symmetrix 3000, when fully configured with 576 disk drives can weigh slightly more than 4,600 lbs. Listed below are some of the pre-installation items to consider before installing the DMX3000 system at your site:

- ◆ Weight capacities for service elevator if delivery is to another floor
- ◆ Equipment ramp needed if the receiving floor is not level with computer room floor

- ◆ Computer room floor supports, adequate to support weight load
- ◆ Length of covering required for floor protection

Physical Specifications

Physical Data on page A-12 provides overall system dimensions and weights for the Symmetrix DMX systems.

Transportation and Delivery Guidelines

Symmetrix DMX systems delivered within the United States or Canada travel by air-ride truck or van. The Symmetrix DMX systems are shrouded by custom-designed shipping material, crated, and palletted. Integrated shock absorbing casters on which the Symmetrix DMX systems rest facilitate its movement during shipping and installation.

Symmetrix DMX systems delivered Internationally normally involve air freight and are, therefore, crated for shipment.

Unless otherwise instructed, the EMC Traffic Department arranges for delivery directly to the customer's computer room. To ensure successful delivery of the Symmetrix DMX systems, EMC has formed partnerships with specially selected moving companies. These companies have moving professionals trained in the proper handling of large and very sensitive systems. These companies provide the appropriate personnel, floor layments, and any ancillary moving equipment required to facilitate delivery.

Symmetrix DMX1000 Power Requirements

The DMX1000 systems require single-phase AC power and contain a (N+1) single-phase power zone for service to redundant power supply modules. The DMX1000 can be populated with up to four (4) power supply modules.

The customer is responsible for supplying and installing the required receptacles on two separate branch circuit panels (power distribution units) for main and auxiliary power for the Symmetrix DMX1000.

For more information on power requirements, refer to *Symmetrix DMX1000 Power Subsystem* on page 2-44, *Electrical Specifications and Power Requirements* on page A-17, and *Power and Cooling Data* on page A-15.

Symmetrix DMX2000/3000 Power Requirements

The DMX2000 systems are available with single-phase or three-phase power. The DMX3000 systems are available with three-phase power. DMX2000/3000 systems have two (2) power zones providing 2 (N+1) redundancy. A fully populated system supports twelve (12) power supply modules.

For more information on power requirements, refer to *Symmetrix DMX2000/3000 Power Subsystem* on page 2-45. For *DMX 2000 Electrical Specifications and Power Requirements* on page A-17, and *Power and Cooling Data* on page A-15.

DMX2000/3000 Optimal Power Wiring Options

The customer is responsible for supplying and installing the required receptacles on separate circuits (EMC recommends four for optimal performance) for the Symmetrix DMX systems in advance of delivery. EMC also recommends that these circuits reside on four separate branch circuit panels (power distribution units) for main and auxiliary power for the Symmetrix DMX2000 and DMX3000. Figure C-1 on page C-5 shows the optimal power cabling for the Symmetrix DMX2000 and DMX3000.

Alternate Power Wiring Options

The customer is responsible for supplying and installing the required receptacles on separate circuits for the Symmetrix DMX2000/3000 system in advance of delivery. If it is not possible to supply the recommended four separate branch circuit panels (power distribution units) as described in the previous section, an alternate option is possible. To preserve the crossover functionality of the AC auxiliary wiring within the power line input module (PLIM), configure the DMX2000/3000 power cables as follows. Using Figure C-1 as a reference, connect the MAIN A and Aux A to the customer's MAIN PDU and then connect the MAIN B and Aux B to the customer's Auxiliary PDU.

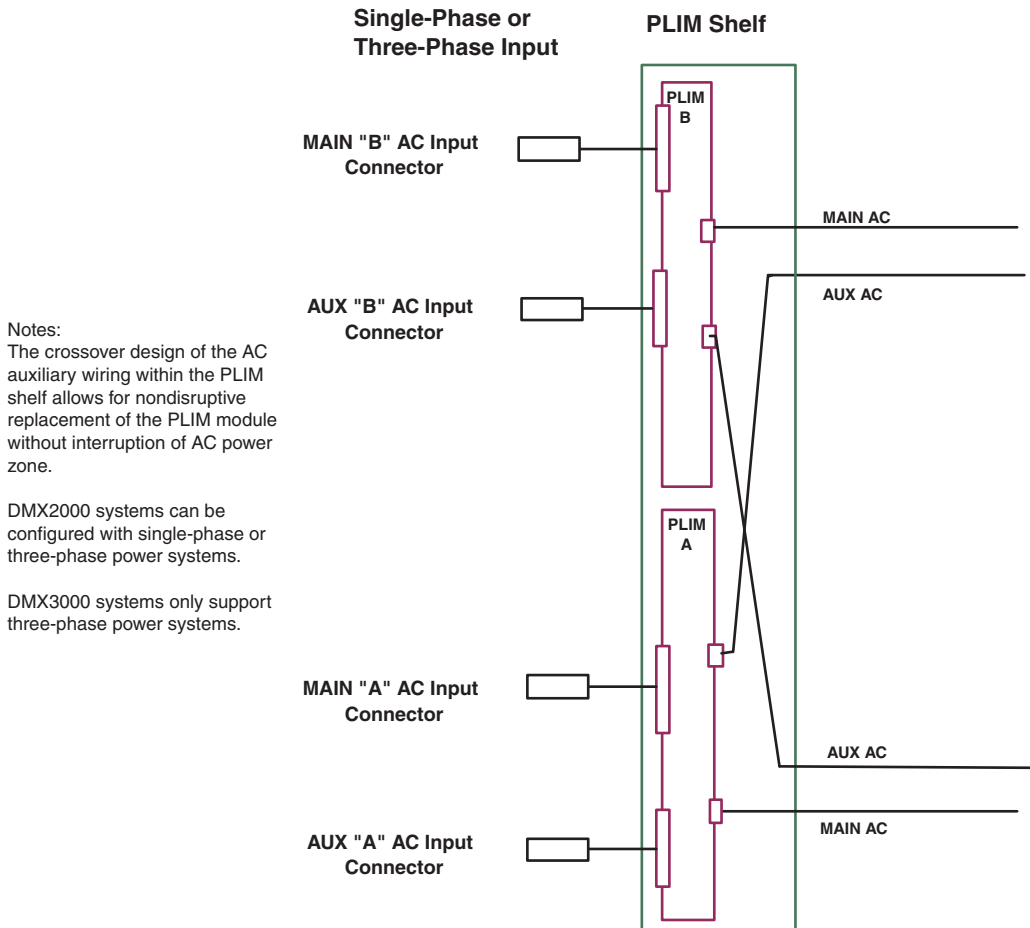


Figure C-1 Symmetrix DMX2000/3000 Power Cabling Diagram

Symmetrix Touch Current Compliance



CAUTION

The Symmetrix DMX1000, DMX2000, and DMX3000 cabinet power supplies should *not* be connected on the separate Main and Auxiliary circuit panels to *differential trip devices*. These devices are typically called GFCI (Ground Fault Circuit Interrupter), GFI (Ground Fault Interrupter), ELCB (Earth Leakage Circuit Breaker), or Residual Current Circuit Breakers.

The Symmetrix DMX systems are designated as fixed (stationary) electrical equipment with high earth-leakage markings. The intention is to connect the cabinets to the customer AC supply with the recommended rated current breakers (refer to *Electrical Specifications and Power Requirements* on page A-17 for recommended circuit breaker ratings) and the attached cables. These recommended breaker ratings are based on the maximum kW loading of the cabinet and not on the KVA figures of a particular configuration. The KVA values listed in this product manual (refer to *Power and Cooling Data* on page A-15) are intended for air conditioning and utility loading purposes only.

Because the Symmetrix DMX systems are high earth leakage devices, differential trip devices (typically 30 mA) are *not* recommended due to random activations during utility feed distortions and powerline transients interacting with the cabinet noise filters.

These differential devices can be called GFCIs (Ground Fault Circuit Interrupters), GFIs (Ground Fault Interrupters), ELCB (Earth Leakage Circuit Breakers), or other names but typically have trip ratings of 5 mA to 500 mA and are mostly intended for consumer goods rather than fixed devices.

If the Symmetrix cabinet is correctly grounded to the customer's AC power source, leakage current should not produce a voltage leading to electrical shock. Serious insulation breakdowns should trip the breakers feeding the cabinet or, preferably, should first clear fuses in individual internal modules closest to the fault.

Regulatory Compliance

The Symmetrix DMX systems meet regulatory requirements as referenced by the following UL/IEC/EN 60950 3d Edition:

5.1.7 Equipment with touch (leakage) current exceeding 3.5mA

For Stationary Permanently Connected Equipment, or Stationary Pluggable Equipment Type B, having a main protective earthing terminal, if the Touch (Leakage) Current measurements exceed 3.5mA r.m.s., all of the following conditions apply:

- The r.m.s. Protective Conductor Current shall not exceed five percent of the input current per line under normal operating conditions. If the load is unbalanced, the largest of the three-line (phase) currents shall be used for this calculation.

To measure the Protective Conductor Current, the procedure for measuring Touch Current is used, but the measuring instrument is replaced by an ammeter of negligible impedance.

- The cross-sectional area of the Protective Bonding Conductor shall not be less than 1.0 mm squared in the path of high Protective Conductor Current.
- *A label with similar wording shall be affixed adjacent to the equipment AC MAINS SUPPLY connection:*

HIGH LEAKAGE CURRENT

Earth connection essential
before connecting supply.

The Symmetrix DMX systems are Stationary Pluggable Type B systems, and have been extensively tested and certified to meet the above standard, including the application of the warning label, EMC P/N 046-000-309, in English and French. The label location for the Symmetrix DMX systems are on the inside of the front door.

Choosing a UPS

The Symmetrix system is capable of supporting two consecutive three-minute power outages before its battery power supply is depleted. If you need to extend this time period, you will need to purchase a UPS from a qualified vendor.

EMC neither offers nor recommends any specific UPS suppliers or product type for its customers. This said, EMC uses preferred suppliers for UPS systems in their facilities. Therefore, if you, the customer, are implementing a UPS, EMC recommends the following:

- ◆ When you are planning the UPS solution for the Symmetrix system and the host system is presently (or is going to be) protected with a UPS, the battery backup time you propose for the Symmetrix UPS solution should match that of the host system.
- ◆ The Symmetrix system requires independent Main and Auxiliary power feeds.
- ◆ The UPS should be equipped with an internal output isolation transformer.
- ◆ The UPS should be installed as a separately derived AC source using neutral and ground wiring to preserve the (N+1) or 2 (N+1) fault tolerance specification of the Symmetrix power system.
- ◆ Depending on the power requirements for your Symmetrix system operation, an isolation transformer/stabilizer installed in front of the UPS could further buffer the AC utility environmental factors from reaching the Symmetrix system. To determine if an isolation transformer/stabilizer is needed, consult a licensed electrician and your EMC Customer Engineer.

Environmental Specifications

The Symmetrix DMX systems requires the environmental specifications outlined in *Environmental Data* on page A-14. The customer must make sure the site meets or exceeds the specifications listed.

System Cabling Requirements

The Pre-Site Survey completed with the EMC Systems Engineer reports the cable lengths (Fibre Channel or serial) required for each host connection to the Symmetrix system. From a physical planning perspective, review the routing path(s) from the host(s) to the Symmetrix DMX systems. Resolve any physical access issues *before* the installation date.

Layout and Space Recommendations

EMC recommends that the Symmetrix DMX systems have the floor tile cutouts (24-inch floor tiles) illustrated in Figure C-3 on page C-11, Figure C-5 on page C-13, and Figure C-5 on page C-13. The floor tile cutouts accommodate the power cables, and the ESCON, FICON, or Fibre Channel cables. For the service clearance recommendations and access (raised) floor tile load requirements, refer to *Physical Data* on page A-12.



WARNING

*Before the Symmetrix DMX1000, DMX2000, or DMX3000 system is rolled into position in the computer room, note how close the wheels are to the edge of the cutout. During the Symmetrix DMX1000, DMX2000, or DMX3000 installation, the EMC Customer Engineer secures the Symmetrix unit to the floor tile with an L-shaped bracket. To maintain stability of the Symmetrix unit, do not remove the bracket. If the Symmetrix unit needs to be relocated, contact the EMC Customer Support Center. For access floor tile load requirements, refer to *Physical Data* on page A-12.*

Remote Support

Remote Support is an important and integral part of EMC's Customer Service and Support strategy. Communication between the EMC Customer Support Center and the Symmetrix DMX systems occur through the external serial modem connected to the Symmetrix service processor. This feature requires customers to provide a dedicated telephone line (for the modem). External modems for North American Symmetrix units also require 110-VAC single-phase power within six feet of the Symmetrix DMX systems. Voltage requirements for external modems for International Symmetrix units are country-specific.

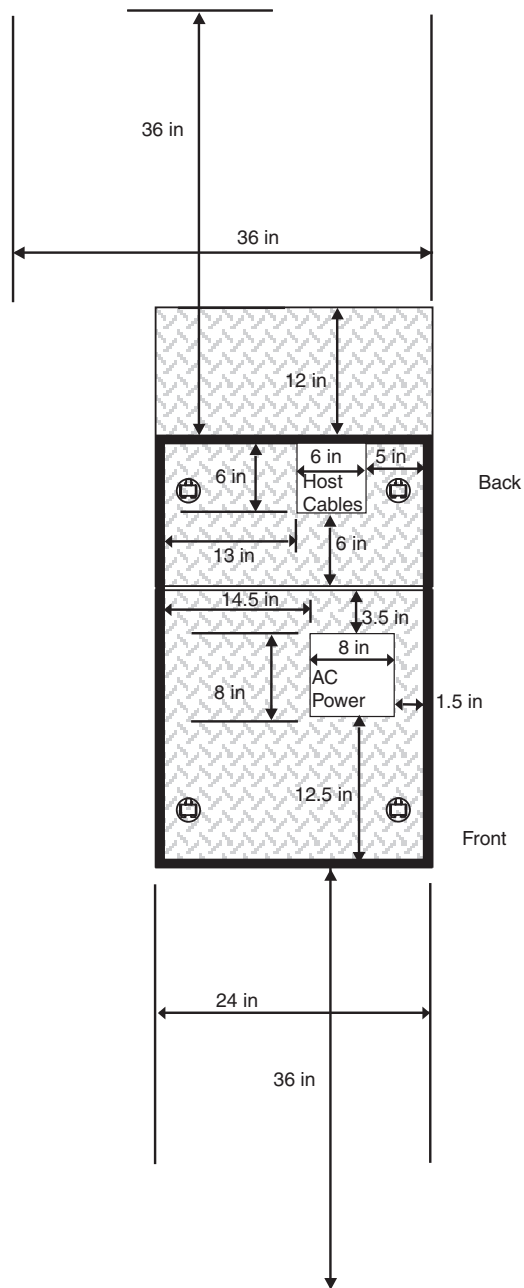


Figure C-2 Symmetrix DMX1000 Floor Tile Cutout

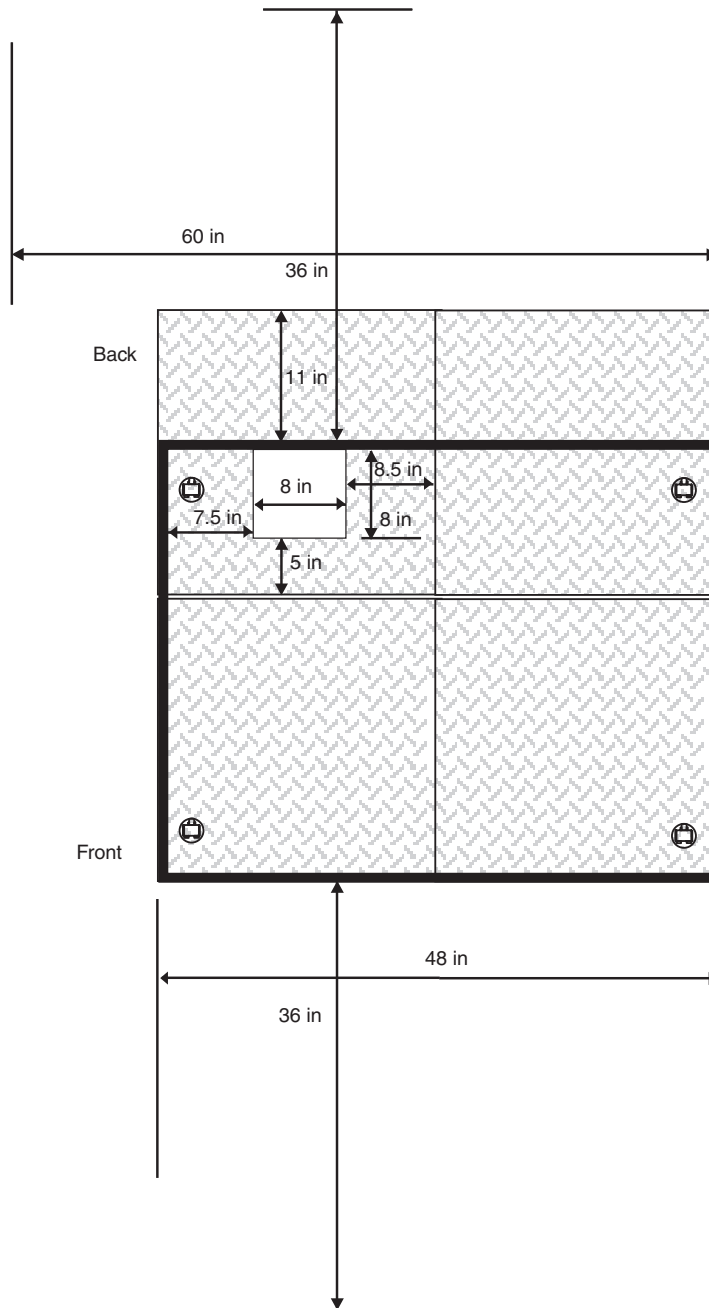


Figure C-3 Symmetrix DMX2000 Floor Tile Cutout



Figure C-4 Symmetrix DMX3000 Floor Tile Cutout

Director/Global Memory Board Layout

The Symmetrix DMX systems support open systems connectivity through Fibre Channel directors.

The Symmetrix DMX systems support mainframe connectivity through ESCON and FICON directors.

With the Symmetrix Enterprise Storage Platform (ESP) software enabler, the Symmetrix DMX supports simultaneous connections to mainframe systems and open systems hosts.

For SRDF Remote Link director configuration information, refer to the *Symmetrix Remote Data Facility Product Guide*.

Figure C-5 shows the channel director and global memory director layout in the Symmetrix DMX1000 system for a typical configuration.

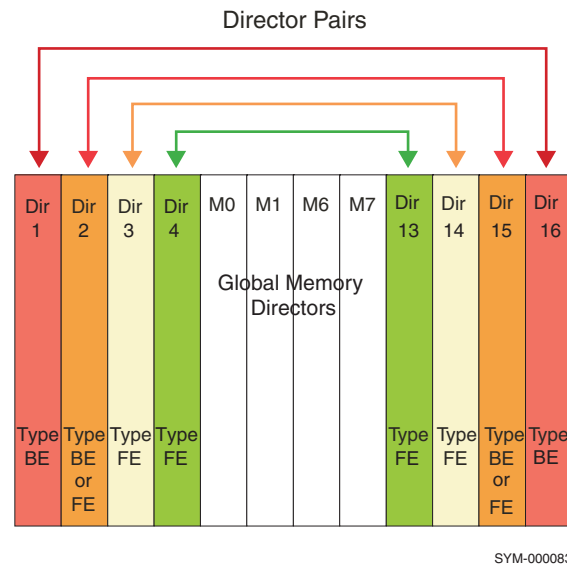
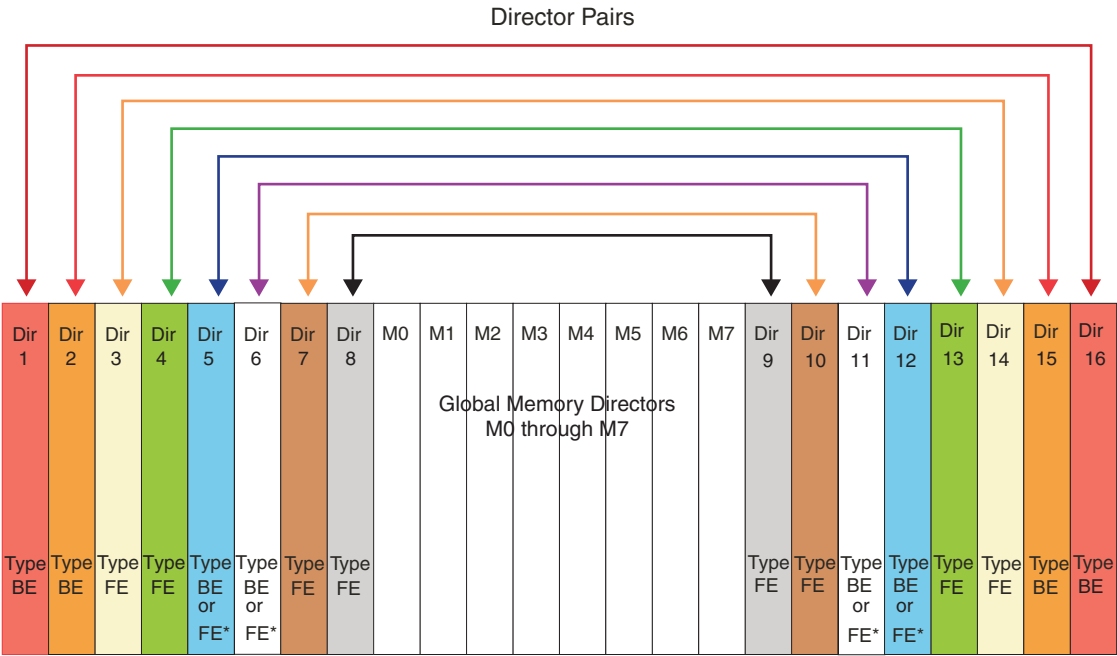


Figure C-5 Symmetrix DMX1000 Director and Global Memory Configurations

Figure C-6 on page C-14 shows the channel director and global memory director layout in the Symmetrix DMX2000/3000 system for a typical configuration.



* Note: These slots in the midplanes of the DMX2000 systems can be configured with either front-end or back-end directors.

SYM-000085

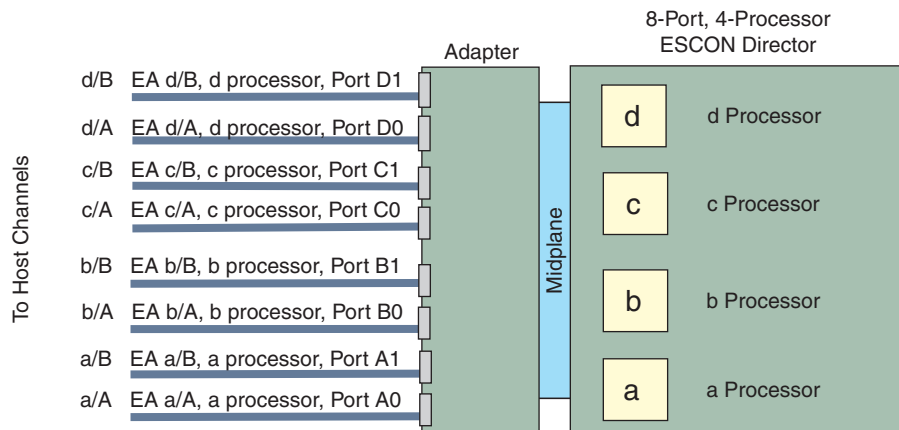
Figure C-6 Symmetrix DMX2000/3000 Director and Global Memory Configurations

Mainframe Systems Installations

For Open Systems installation requirements, refer to *Open Systems Installations* on page C-40.

Eight-Port ESCON Director Channel Designations

Figure C-7 shows the interface and channel designations of the eight-port, four-processor ESCON director that serves as the interface between the Symmetrix system and the mainframe host. The ESCON director can be configured with ports 0 and 1 ports active or with only the 0 port active. For card cage slot assignments, refer to Figure C-5 on page C-13 and Figure C-6 on page C-14.



Note:

Example of SymmWinn designation, EA = ESCON Channel director. SymmWin EA d/A defines Processor d, Port A, which is equivalent to Processor d, Port D0.

Figure C-7 Eight-Port, Four-Processor ESCON Director Designations

This section contains the following worksheets:

- ◆ Table C-2, *Symmetrix DMX1000 Eight-Port, Four-Processor ESCON Channel Path Assignments*, on page C-16
- ◆ Table C-3, *Symmetrix DMX2000/3000 Eight-Port, Four-Processor ESCON Channel Path Assignments*, on page C-18
- ◆ Table C-4, *Volume Addresses and Cylinders*, on page C-22
- ◆ Table C-5, *Volume Worksheet*, on page C-25

Table C-2 Symmetrix DMX1000 Eight-Port, Four-Processor ESCON Channel Path Assignments

Serial Channel Director	CPU (Processor #)	CHIP or Channel #	ESCON Director #	Dir Port # ^a (Host Channel)	Dir Port # (Symmetrix Connection)
2 Proc d, Port D1					
2 Proc d, Port D0					
2 Proc c, Port C1					
2 Proc c, Port C0					
2 Proc b, Port B1					
2 Proc b, Port B0					
2 Proc a, Port A1					
2 Proc a, Port A0					
3 Proc d, Port D1					
3 Proc d, Port D0					
3 Proc c, Port C1					
3 Proc c, Port C0					
3 Proc b, Port B1					
3 Proc b, Port B0					
3 Proc a, Port A1					
3 Proc a, Port A0					
4 Proc d, Port D1					
4 Proc d, Port D0					
4 Proc c, Port C1					
4 Proc c, Port C0					
4 Proc b, Port B1					
4 Proc b, Port B0					
4 Proc a, Port A1					
4 Proc a, Port A0					

Table C-2 Symmetrix DMX1000 Eight-Port, Four-Processor ESCON Channel Path Assignments (*continued*)

Serial Channel Director	CPU (Processor #)	CHIP or Channel #	ESCON Director #	Dir Port # ^a (Host Channel)	Dir Port # (Symmetrix Connection)
13 Proc d, Port D1					
13 Proc d, Port D0					
13 Proc c, Port C1					
13 Proc c, Port C0					
13 Proc b, Port B1					
13 Proc b, Port B0					
13 Proc a, Port A1					
13 Proc a, Port A0					
14 Proc d, Port D1					
14 Proc d, Port D0					
14 Proc c, Port C1					
14 Proc c, Port C0					
14 Proc b, Port B1					
14 Proc b, Port B0					
14 Proc a, Port A1					
14 Proc a, Port A0					
15 Proc d, Port D1					
15 Proc d, Port D0					
15 Proc c, Port C1					
15 Proc c, Port C0					
15 Proc b, Port B1					
15 Proc b, Port B0					
15 Proc a, Port A1					
15 Proc a, Port A0					

a. IBM 9032/9033 or plug-compatible device.

Table C-3 Symmetrix DMX2000/3000 Eight-Port, Four-Processor ESCON Channel Path Assignments

Serial Channel Director	CPU (Processor #)	CHIP or Channel #	ESCON Director #	Dir Port # ^a (Host Channel)	Dir Port # (Symmetrix Connection)
3 Proc d, Port D1					
3 Proc d, Port D0					
3 Proc c, Port C1					
3 Proc c, Port C0					
3 Proc b, Port B1					
3 Proc b, Port B0					
3 Proc a, Port A1					
3 Proc a, Port A0					
4 Proc d, Port D1					
4 Proc d, Port D0					
4 Proc c, Port C1					
4 Proc c, Port C0					
4 Proc b, Port B1					
4 Proc b, Port B0					
4 Proc a, Port A1					
4 Proc a, Port A0					
5 Proc d, Port D1					
5 Proc d, Port D0					
5 Proc c, Port C1					
5 Proc c, Port C0					
5 Proc b, Port B1					
5 Proc b, Port B0					
5 Proc a, Port A1					
5 Proc a, Port A0					

Table C-3 Symmetrix DMX2000/3000 Eight-Port, Four-Processor ESCON Channel Path Assignments (*continued*)

Serial Channel Director	CPU (Processor #)	CHIP or Channel #	ESCON Director #	Dir Port # ^a (Host Channel)	Dir Port # (Symmetrix Connection)
6 Proc d, Port D1					
6 Proc d, Port D0					
6 Proc c, Port C1					
6 Proc c, Port C0					
6 Proc b, Port B1					
6 Proc b, Port B0					
6 Proc a, Port A1					
6 Proc a, Port A0					
7 Proc d, Port D1					
7 Proc d, Port D0					
7 Proc c, Port C1					
7 Proc c, Port C0					
7 Proc b, Port B1					
7 Proc b, Port B0					
7 Proc a, Port A1					
7 Proc a, Port A0					
8 Proc d, Port D1					
8 Proc d, Port D0					
8 Proc c, Port C1					
8 Proc c, Port C0					
8 Proc b, Port B1					
8 Proc b, Port B0					
8 Proc a, Port A1					
8 Proc a, Port A0					

Table C-3 Symmetrix DMX2000/3000 Eight-Port, Four-Processor ESCON Channel Path Assignments (*continued*)

Serial Channel Director	CPU (Processor #)	CHIP or Channel #	ESCON Director #	Dir Port # ^a (Host Channel)	Dir Port # (Symmetrix Connection)
9 Proc d, Port D1					
9 Proc d, Port D0					
9 Proc c, Port C1					
9 Proc c, Port C0					
9 Proc b, Port B1					
9 Proc b, Port B0					
9 Proc a, Port A1					
9 Proc a, Port A0					
10 Proc d, Port D1					
10 Proc d, Port D0					
10 Proc c, Port C1					
10 Proc c, Port C0					
10 Proc b, Port B1					
10 Proc b, Port B0					
10 Proc a, Port A1					
10 Proc a, Port A0					
11 Proc d, Port D1					
11 Proc d, Port D0					
11 Proc c, Port C1					
11 Proc c, Port C0					
11 Proc b, Port B1					
11 Proc b, Port B0					
11 Proc a, Port A1					
11 Proc a, Port A0					

Table C-3 Symmetrix DMX2000/3000 Eight-Port, Four-Processor ESCON Channel Path Assignments (*continued*)

Serial Channel Director	CPU (Processor #)	CHIP or Channel #	ESCON Director #	Dir Port # ^a (Host Channel)	Dir Port # (Symmetrix Connection)
12 Proc d, Port D1					
12 Proc d, Port D0					
12 Proc c, Port C1					
12 Proc c, Port C0					
12 Proc b, Port B1					
12 Proc b, Port B0					
12 Proc a, Port A1					
12 Proc a, Port A0					
13 Proc d, Port D1					
13 Proc d, Port D0					
13 Proc c, Port C1					
13 Proc c, Port C0					
13 Proc b, Port B1					
13 Proc b, Port B0					
13 Proc a, Port A1					
13 Proc a, Port A0					
14 Proc d, Port D1					
14 Proc d, Port D0					
14 Proc c, Port C1					
14 Proc c, Port C0					
14 Proc b, Port B1					
14 Proc b, Port B0					
14 Proc a, Port A1					
14 Proc a, Port A0					

a. IBM 9032/9033 or plug-compatible device.

Table C-4 Volume Addresses and Cylinders

Device #	Log Vol 1	Log Vol 2	Log Vol 3	Log Vol 4	Log Vol 5
1 Address					
# Cylinders					
2 Address					
# Cylinders					
3 Address					
# Cylinders					
4 Address					
# Cylinders					
5 Address					
# Cylinders					
6 Address					
# Cylinders					
7 Address					
# Cylinders					
8 Address					
# Cylinders					
9 Address					
# Cylinders					
10 Address					
# Cylinders					
11 Address					
# Cylinders					
12 Address					
# Cylinders					
13 Address					
# Cylinders					
14 Address					
# Cylinders					

Table C-4 Volume Addresses and Cylinders (*continued*)

Device #	Log Vol 1	Log Vol 2	Log Vol 3	Log Vol 4	Log Vol 5
15 Address					
# Cylinders					
16 Address					
# Cylinders					
17 Address					
# Cylinders					
18 Address					
# Cylinders					
19 Address					
# Cylinders					
20 Address					
# Cylinders					
21 Address					
# Cylinders					
22 Address					
# Cylinders					
23 Address					
# Cylinders					
24 Address					
# Cylinders					
25 Address					
# Cylinders					
26 Address					
# Cylinders					
27 Address					
# Cylinders					
28 Address					
# Cylinders					
29 Address					
# Cylinders					

Table C-4 Volume Addresses and Cylinders (*continued*)

Device #	Log Vol 1	Log Vol 2	Log Vol 3	Log Vol 4	Log Vol 5
30 Address					
# Cylinders					
31 Address					
# Cylinders					
32 Address					
# Cylinders					

Table C-5 Volume Worksheet[illegible]

Table C-5 Volume Worksheet (continued)

[illegible]

Available EMC ESCON Cables

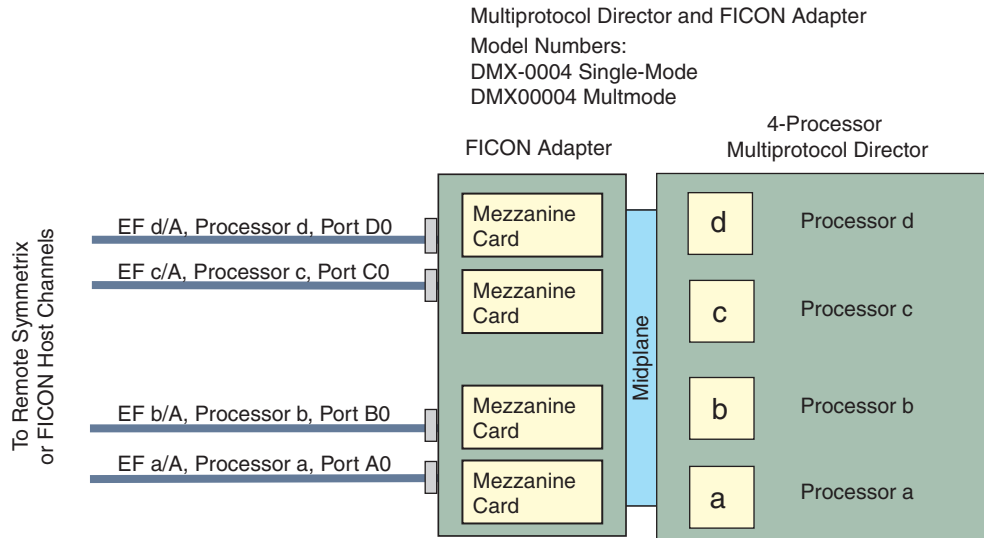
Table C-6 lists the Symmetrix DMX ESCON cables currently available from EMC. To obtain these cables, contact your EMC Sales Representative.

Table C-6 ESCON Channel Cables

Model	Description	Where Used
FC3M-62MSLC	SC/LC-3 meter w/SC coupler	For Symmetrix DMX ESCON connections to existing 62.5 micron multimode cabling using SC connectors.
FC5M-62MSLC	SC/LC-5 meter	For Symmetrix DMX ESCON connections to patch panels or ESCON switches using SC connectors.
FC10M-62MSLC	SC/LC-10 meter	
FC30M-62MSLC	SC/LC-30 meter	
FC50M-62MSLC	SC/LC-50 meter	
FC100M-62MSLC	SC/LC-100 meter	
FC1M-62MLC	LC/LC-1 meter	For Symmetrix DMX ESCON direct connection or connection to patch panels or ESCON switches using LC connectors.
FC3M-62MLC	LC/LC-3 meter	
FC5M-62MLC	LC/LC-5 meter	
FC10M-62MLC	LC/LC-10 meter	
FC30M-62MLC	LC/LC-30 meter	
FC50M-62MLC	LC/LC-50 meter	
FC100M-62MLC	LC/LC-100 meter	
FC3M-LCESCADP	LC/ESCON - 3 meter with ESCON ST coupler	For Symmetrix DMX ESCON connections to existing 62.5 micron cabling using ESCON duplex connectors.
FC3M-MTESCADP	MTRJ/ESCON - 3 meter with ESCON coupler	For connecting Symmetrix 8000 systems and Symmetrix DMX systems by way of 62.5 micron cabling to IBM directors using new MTRJ connectors.
FC3M-MTLCADP	MTRJ/LC - 3 meter with LC coupler	For connecting Symmetrix DMX systems by way of 62.5 micron cabling to IBM directors using new MTRJ connectors.

Four-Port FICON Director Channel Designations

Figures C-8 Figures C-10 shows the interface and channel designations of the four-port, four-processor, and FICON director that serves as the interface between the Symmetrix system and the mainframe host. For card cage slot assignments, refer to Figure C-5 on page C-13 and Figure C-6 on page C-14.



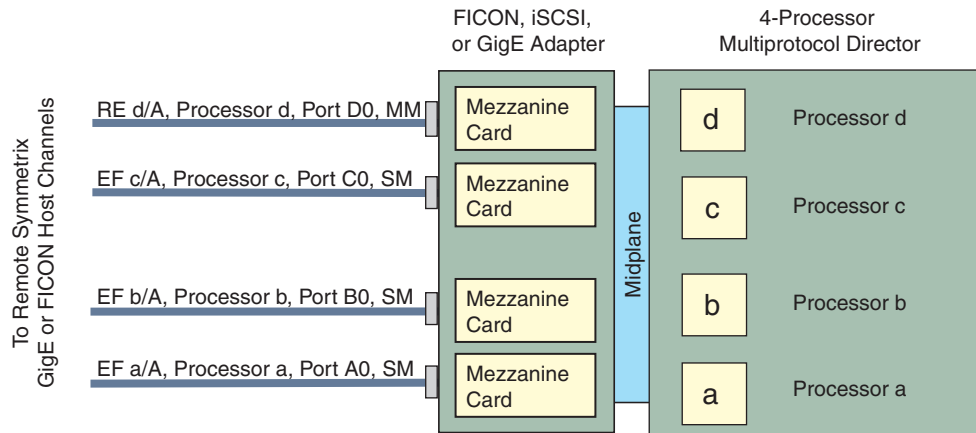
Note:

Example of SymmWin designation EF = FICON director. SymmWin EF d/A defines Processor d, Port A, which is equivalent to Processor d, Port D0.

Figure C-8 Four-Port, Four-Processor FICON Director Designations

Figure C-9 on page C-29 and Figure C-10 on page C-30 show the port designations for FICON configuration combined with GigE and iSCSI connections.

Multiprotocol Director with FICON, iSCSI, and GigE Adapter, Model Number DMX-0013



This adapter can be configured in the following combinations of FICON, iSCSI, and GigE port assignments.

Note:

Example of SymmWin designation EF = FICON Remote director and SE = iSCSI, or RE = Remote director. SymmWin RE d/A defines Processor d, Port A, which is equivalent to Processor d, Port D0. MM = Multimode. SM = Single-mode.

Processor	FICON, iSCSI, and GigE, Port Assignments	
d	GigE MM	iSCSI MM
c	FICON SM	FICON SM
b	FICON SM	FICON SM
a	FICON SM	FICON SM

Figure C-9 Four-Port, Four-Processor FICON iSCSI, and GigE Remote Director Designations

Multiprotocol Director with FICON, iSCSI, and GigE Adapter, Model Number DMX-0022

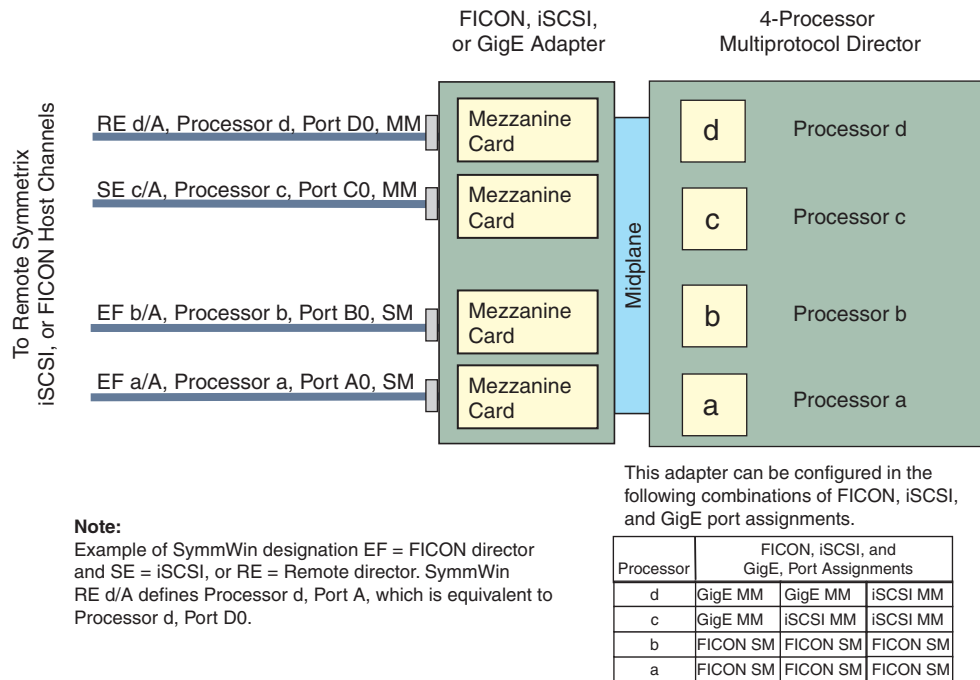


Figure C-10 Four-Port, Four-Processor FICON, iSCSI, and GigE Remote Director Designations

This section contains the following worksheets:

- ◆ Table C-7, *Symmetrix DMX1000 Four-Port, Four-Processor FICON Channel Path Assignments*, on page C-31
- ◆ Table C-8, *Symmetrix DMX2000/3000 Four-Port, Four-Processor FICON Channel Path Assignments*, on page C-32
- ◆ Table C-9, *Volume Addresses and Cylinders*, on page C-34
- ◆ Table C-10, *Volume Worksheet*, on page C-37

Table C-7 Symmetrix DMX1000 Four-Port, Four-Processor FICON Channel Path Assignments

Serial Channel Director	CPU (Processor #)	CHIP or Channel #	ESCON Director #	Dir Port # ^a (Host Channel)	Dir Port # (Symmetrix Connection)
2 Proc d, Port D0					
2 Proc c, Port C0					
2 Proc b, Port B0					
2 Proc a, Port A0					
3 Proc d, Port D0					
3 Proc c, Port C0					
3 Proc b, Port B0					
3 Proc a, Port A0					
4 Proc d, Port D0					
4 Proc c, Port C0					
4 Proc b, Port B0					
4 Proc a, Port A0					
13 Proc d, Port D0					
13 Proc c, Port C0					
13 Proc b, Port B0					
13 Proc a, Port A0					
14 Proc d, Port D0					
14 Proc c, Port C0					
14 Proc b, Port B0					
14 Proc a, Port A0					
15 Proc d, Port D0					
15 Proc c, Port C0					
15 Proc b, Port B0					
15 Proc a, Port A0					

a. IBM 9032/9033 or plug-compatible device.

Table C-8 Symmetrix DMX2000/3000 Four-Port, Four-Processor FICON Channel Path Assignments

Serial Channel Director	CPU (Processor #)	CHIP or Channel #	ESCON Director #	Dir Port # ^a (Host Channel)	Dir Port # (Symmetrix Connection)
3 Proc d, Port D0					
3 Proc c, Port C0					
3 Proc b, Port B0					
3 Proc a, Port A0					
4 Proc d, Port D0					
4 Proc c, Port C0					
4 Proc b, Port B0					
4 Proc a, Port A0					
5 Proc d, Port D0					
5 Proc c, Port C0					
5 Proc b, Port B0					
5 Proc a, Port A0					
6 Proc d, Port D0					
6 Proc c, Port C0					
6 Proc b, Port B0					
6 Proc a, Port A0					
7 Proc d, Port D0					
7 Proc c, Port C0					
7 Proc b, Port B0					
7 Proc a, Port A0					
8 Proc d, Port D0					
8 Proc c, Port C0					
8 Proc b, Port B0					
8 Proc a, Port A0					

Table C-8 Symmetrix DMX2000/3000 Four-Port, Four-Processor FICON Channel Path Assignments (*continued*)

Serial Channel Director	CPU (Processor #)	CHIP or Channel #	ESCON Director #	Dir Port # ^a (Host Channel)	Dir Port # (Symmetrix Connection)
9 Proc d, Port D0					
9 Proc c, Port C0					
9 Proc b, Port B0					
9 Proc a, Port A0					
10 Proc d, Port D0					
10 Proc c, Port C0					
10 Proc b, Port B0					
10 Proc b, Port B0					
10 Proc a, Port A0					
11 Proc d, Port D0					
11 Proc c, Port C0					
11 Proc b, Port B0					
11 Proc a, Port A0					
12 Proc d, Port D0					
12 Proc c, Port C0					
12 Proc b, Port B0					
12 Proc a, Port A0					
13 Proc d, Port D0					
13 Proc c, Port C0					
13 Proc b, Port B0					
13 Proc a, Port A0					
14 Proc d, Port D0					
14 Proc c, Port C0					
14 Proc b, Port B0					
14 Proc a, Port A0					

a. IBM 9032/9033 or plug-compatible device.

Table C-9 Volume Addresses and Cylinders

Device #	Log Vol 1	Log Vol 2	Log Vol 3	Log Vol 4	Log Vol 5
1 Address					
# Cylinders					
2 Address					
# Cylinders					
3 Address					
# Cylinders					
4 Address					
# Cylinders					
5 Address					
# Cylinders					
6 Address					
# Cylinders					
7 Address					
# Cylinders					
8 Address					
# Cylinders					
9 Address					
# Cylinders					
10 Address					
# Cylinders					
11 Address					
# Cylinders					
12 Address					
# Cylinders					
13 Address					
# Cylinders					
14 Address					
# Cylinders					

Table C-9 Volume Addresses and Cylinders (*continued*)

Device #	Log Vol 1	Log Vol 2	Log Vol 3	Log Vol 4	Log Vol 5
15 Address					
# Cylinders					
16 Address					
# Cylinders					
17 Address					
# Cylinders					
18 Address					
# Cylinders					
19 Address					
# Cylinders					
20 Address					
# Cylinders					
21 Address					
# Cylinders					
22 Address					
# Cylinders					
23 Address					
# Cylinders					
24 Address					
# Cylinders					
25 Address					
# Cylinders					
26 Address					
# Cylinders					
27 Address					
# Cylinders					
28 Address					
# Cylinders					
29 Address					
# Cylinders					

Table C-9 Volume Addresses and Cylinders (*continued*)

Device #	Log Vol 1	Log Vol 2	Log Vol 3	Log Vol 4	Log Vol 5
30 Address					
# Cylinders					
31 Address					
# Cylinders					
32 Address					
# Cylinders					

Table C-10 Volume Worksheet

[illegible]

Table C-10 Volume Worksheet (continued)

[illegible]

Available EMC FICON Cables

Table C-11 lists the Symmetrix DMX FICON cables currently available from EMC. To obtain these cables, contact your EMC Sales Representative.

Table C-11 EMC Fibre Cables -FICON 9 Micron Connect

Model Number	Description
FC1M-9MSLC	SC/LC-1 meter w/coupler
FC3M-9MSLC	SC/LC-3 meter w/coupler
FC5M-9MSLC	SC/LC-5 meter
FC10M-9MSLC	SC/LC-10 meter
FC30M-9MSLC	SC/LC-30 meter
FC50M-9MSLC	SC/LC-50 meter
FC100M-9MSLC	SC/LC-100 meter
FC5M-9MLC	LC/LC-5 meter
FC10M-9MLC	LC/LC-10 meter
FC30M-9MLC	LC/LC-30 meter
FC50M-9MLC	LC/LC-50 meter
FC100M-9MLC	LC/LC-100 meter

Open Systems Installations

For mainframe installation requirements, refer to *Mainframe Systems Installations* on page C-15.

This section contains hardware and host checklists to be used when connecting the Symmetrix DMX systems to open systems hosts. For the most current information on the Symmetrix system and specific host integration, contact your EMC Sales Representative, or refer to the EMC Powerlink website at: <http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

Symmetrix Hardware Checklist

Make sure you discuss with and obtain the following site profile information from the Customer Engineer and/or Systems Engineer. This information is necessary for each Symmetrix system you are installing (Table C-12).

Table C-12 Symmetrix Checklist for UNIX or PC Server Hosts

Symmetrix Model	
Total number of physical drives to be configured on the Symmetrix system	
Physical drive type (size)	
Total amount of Symmetrix global memory	
Number of Fibre Channel directors ^a	
Number of GigE channel directors ^a	
Number of iSCSI channel directors ^a	
Host channel director models used	
Number of channels used per director ^b	
Remote link director (SRDF) type (RA-2, RA-4) and quantity	

- If host mirroring is performed, configure an even number of channel directors.
- From a performance perspective, it is better to spread channels across as many channel directors as possible.

Host Checklist

Make sure you discuss with and provide the following host information to the Customer Engineer and/or Systems Engineer. This information is necessary for each host you are attaching to the Symmetrix system. Make a copy of this form, Table C-13 on page C-41, for each host you will attach to the Symmetrix system. When you are done you should have a checklist for each host.

Table C-13 UNIX or PC Server Host Checklist

Host Configuration Requirements	Host 1	Host 2
Host (CPU) vendor and model number.		
Host controller type and model number.		
Memory capacity of host.		
O/S revision level of host.		
I/O rate per second expected per host.		
Type of host (Fibre Channel, iSCSI) channel adapter used on host, type, and model number.		
Is this a clustered environment? Which one?		
Will devices be shared? Which ones?		
Total number of host (Fibre Channel, iSCSI) channel connections per host and to which ports will they attach?		
Specify if any narrow channels used.		
Number of logical devices needed per host (Fibre Channel, iSCSI) channel path.		
Size of volumes required to be visible to host. ^a		
Total customer-usable data storage required.		
Will host-level mirroring be used, which volumes?		
Will Symmetrix Dynamic Sparing (specify number of spares) be used, which volumes?		
Will Symmetrix Mirrored (RAID 1) be used, which volumes?		
Will Symmetrix RAID (3+1) or RAID (7+1) be used, which volumes? (You cannot mix RAID (3+1) and RAID (7+1) volumes on the same Symmetrix system.)		
Will SRDF be used, which volumes?		
Data storage utilization per host. ^b		
Average transfer size of data.		
Using raw devices or file systems?		
Size of file system.		
Will data striping be used? What type of data striping package? Will RAID 10 be used?		
Partitioning?		

Table C-13 UNIX or PC Server Host Checklist (*continued*)

Host Configuration Requirements	Host 1	Host 2
Partition sizes?		
LVM used. ^c		
What major applications are to be run?		
Database used: Oracle/Sysbase/Informix/other?		
Size of database.		
Database release version.		
Supply typical high level database schema and queries.		
Any patches or modifications related to I/O Fibre Channel?		
Additional comments:		

- a. This is the volume size needed for each volume visible on the Fibre Channel path.
- b. Percentage of available Symmetrix data capacity used by that host.
- c. Special attention is required when using a Logical Volume Manager (LVM) and/or data striping when using hypervolumes. *In general, EMC recommends using data striping on the Symmetrix system. Keep in mind that the larger the granularity of the striping, the less effective it becomes.*

Fibre Channel Cable Worksheet

The physical connection to a Fibre Channel interface occurs at the connectors on the Fibre Channel adapters located at the rear of the Symmetrix unit. You can use Table C-14 on page C-43 for cable worksheet forms.

When connecting to hosts with differential Fibre Channel interfaces, consult your EMC Sales Representative for the most current list of supported hosts, models, operating systems, and EMC open systems host support policies, or refer to the EMC Powerlink website at: <http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

Table C-14 DMX1000 Eight-Port, Four-Processor Fibre Channel Cable Worksheet

Fibre Channel Director	Cable Length Required	Cable Model Number or Part Number	Host ID Model Number
2 Proc d, Port D0			
2 Proc d, Port D1			
2 Proc c, Port C0			
2 Proc c, Port C1			
2 Proc b, Port B0			
2 Proc b, Port B1			
2 Proc a, Port A0			
2 Proc a, Port A1			
3 Proc d, Port D0			
3 Proc d, Port D1			
3 Proc c, Port C0			
3 Proc c, Port C1			
3 Proc b, Port B0			
3 Proc b, Port B1			
3 Proc a, Port A0			
3 Proc a, Port A1			
4 Proc d, Port D0			
4 Proc d, Port D1			
4 Proc c, Port C0			
4 Proc c, Port C1			
4 Proc b, Port B0			
4 Proc b, Port B1			
4 Proc a, Port A0			
4 Proc a, Port A1			

Table C-14 DMX1000 Eight-Port, Four-Processor Fibre Channel Cable Worksheet (*continued*)

Fibre Channel Director	Cable Length Required	Cable Model Number or Part Number	Host ID Model Number
13 Proc d, Port D0			
13 Proc d, Port D1			
13 Proc c, Port C0			
13 Proc c, Port C1			
13 Proc b, Port B0			
13 Proc b, Port B1			
13 Proc a, Port A0			
13 Proc a, Port A1			
14 Proc d, Port D0			
14 Proc d, Port D1			
14 Proc c, Port C0			
14 Proc c, Port C1			
14 Proc b, Port B0			
14 Proc b, Port B1			
14 Proc a, Port A0			
14 Proc a, Port A1			
15 Proc d, Port D0			
15 Proc d, Port D1			
15 Proc c, Port C0			
15 Proc c, Port C1			
15 Proc b, Port B0			
15 Proc b, Port B1			
15 Proc a, Port A0			
15 Proc a, Port A1			

Table C-15 DMX2000/3000 Eight-Port, Four-Processor Fibre Channel Cable Worksheet

Fibre Channel Director	Cable Length Required	Cable Model Number or Part Number	Host ID Model Number
3 Proc d, Port D0			
3 Proc d, Port D1			
3 Proc c, Port C0			
3 Proc c, Port C1			
3 Proc b, Port B0			
3 Proc b, Port B1			
3 Proc a, Port A0			
3 Proc a, Port A1			
4 Proc d, Port D0			
4 Proc d, Port D1			
4 Proc c, Port C0			
4 Proc c, Port C1			
4 Proc b, Port B0			
4 Proc b, Port B1			
4 Proc a, Port A0			
4 Proc a, Port A1			
5 Proc d, Port D0			
5 Proc d, Port D1			
5 Proc c, Port C0			
5 Proc c, Port C1			
5 Proc b, Port B0			
5 Proc b, Port B1			
5 Proc a, Port A0			
5 Proc a, Port A1			

Table C-15 DMX2000/3000 Eight-Port, Four-Processor Fibre Channel Cable Worksheet (*continued*)

Fibre Channel Director	Cable Length Required	Cable Model Number or Part Number	Host ID Model Number
6 Proc d, Port D0			
6 Proc d, Port D1			
6 Proc c, Port C0			
6 Proc c, Port C1			
6 Proc b, Port B0			
6 Proc b, Port B1			
6 Proc a, Port A0			
6 Proc a, Port A1			
7 Proc d, Port D0			
7 Proc d, Port D1			
7 Proc c, Port C0			
7 Proc c, Port C1			
7 Proc b, Port B0			
7 Proc b, Port B1			
7 Proc a, Port A0			
7 Proc a, Port A1			
8 Proc d, Port D0			
8 Proc d, Port D1			
8 Proc c, Port C0			
8 Proc c, Port C1			
8 Proc b, Port B0			
8 Proc b, Port B1			
8 Proc a, Port A0			
8 Proc a, Port A1			

Table C-15 DMX2000/3000 Eight-Port, Four-Processor Fibre Channel Cable Worksheet (*continued*)

Fibre Channel Director	Cable Length Required	Cable Model Number or Part Number	Host ID Model Number
9 Proc d, Port D0			
9 Proc d, Port D1			
9 Proc c, Port C0			
9 Proc c, Port C1			
9 Proc b, Port B0			
9 Proc b, Port B1			
9 Proc a, Port A0			
9 Proc a, Port A1			
10 Proc d, Port D0			
10 Proc d, Port D1			
10 Proc c, Port C0			
10 Proc c, Port C1			
10 Proc b, Port B0			
10 Proc b, Port B1			
10 Proc a, Port A0			
10 Proc a, Port A1			
11 Proc d, Port D0			
11 Proc d, Port D1			
11 Proc c, Port C0			
11 Proc c, Port C1			
11 Proc b, Port B0			
11 Proc b, Port B1			
11 Proc a, Port A0			
11 Proc a, Port A1			

Table C-15 DMX2000/3000 Eight-Port, Four-Processor Fibre Channel Cable Worksheet (*continued*)

Fibre Channel Director	Cable Length Required	Cable Model Number or Part Number	Host ID Model Number
12 Proc d, Port D0			
12 Proc d, Port D1			
12 Proc c, Port C0			
12 Proc c, Port C1			
12 Proc b, Port B0			
12 Proc b, Port B1			
12 Proc a, Port A0			
12 Proc a, Port A1			
13 Proc d, Port D0			
13 Proc d, Port D1			
13 Proc c, Port C0			
13 Proc c, Port C1			
13 Proc b, Port B0			
13 Proc b, Port B1			
13 Proc a, Port A0			
13 Proc a, Port A1			
14 Proc d, Port D0			
14 Proc d, Port D1			
14 Proc c, Port C0			
14 Proc c, Port C1			
14 Proc b, Port B0			
14 Proc b, Port B1			
14 Proc a, Port A0			
14 Proc a, Port A1			

Channel Adapters

Several Fibre Channel adapters are available in the Symmetrix system, depending on the host channel connection requirements, such as single mode or multimode, and Y-cable cluster configurations. Refer to your EMC Sales Representative for information about choosing the Fibre Channel adapter that best suits your environment.

To obtain adapter part numbers for Fibre Channel configurations, consult your EMC Sales Representative, or refer to the EMC Powerlink website at: <http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

Available EMC Fibre Channel Cables

Table C-16 lists the Symmetrix Fibre Channel cables currently available from EMC. To obtain these cables, contact your EMC Sales Representative.

Table C-16 EMC Fibre Cables - Fibre Channel Connect

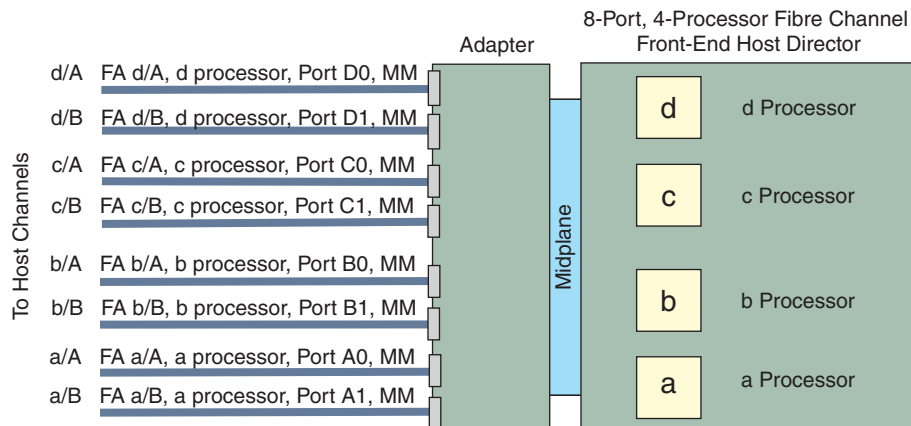
Multimode Fibre Cables - 50 Micron		Single-Mode Fibre Cables - 9 Micron	
Model Number	Description	Model Number	Description
FC1M-50MSLC	SC/LC-1 meter w/SC coupler	FC1M-9MSLC	SC/LC-1 meter w/coupler
FC3M-50MSLC	SC/LC-3 meter w/SC coupler	FC3M-9MSLC	SC/LC-3 meter w/coupler
FC5M-50MSLC	SC/LC-5 meter	FC5M-9MSLC	SC/LC-5 meter
FC10M-50MSLC	SC/LC-10 meter	FC10M-9MSLC	SC/LC-10 meter
FC30M-50MSLC	SC/LC-30 meter	FC30M-9MSLC	SC/LC-30 meter
FC50M-50MSLC	SC/LC-50 meter	FC50M-9MSLC	SC/LC-50 meter
FC100M-50MSLC	SC/LC-100 meter	FC100M-9MSLC	SC/LC-100 meter
FC1M-50MLC	LC/LC-1 meter	N/A	N/A
FC3M-50MLC	LC/LC-3 meter	N/A	N/A
FC5M-50MLC	LC/LC-5 meter	FC5M-9MLC	LC/LC-5 meter
FC10M-50MLC	LC/LC-10 meter	FC10M-9MLC	LC/LC-10 meter
FC30M-50MLC	LC/LC-30 meter	FC30M-9MLC	LC/LC-30 meter
FC50M-50MLC	LC/LC-50 meter	FC50M-9MLC	LC/LC-50 meter
FC100M-50MLC	LC/LC-100 meter	FC100M-9MLC	LC/LC-100 meter

Fibre Channel Cable Precautions

When connecting Symmetrix Fibre Channels to host channels it is important to know Symmetrix Fibre Channel hardware components and their channel designations.

Each Symmetrix Fibre Channel director occupies one slot on the Symmetrix DMX midplanes. Each director interfaces to the host channels through a Fibre Channel adapter connected to the opposite side of the midplane. The Symmetrix Fibre Channel directors contain four advanced microprocessors. Figure C-11 shows the interface and the channel designations for the four-processor, eight-port Fibre Channel director.

For channel director card cage layout descriptions, refer to Figure C-5 on page C-13, and Figure C-6 on page C-14.



Notes:

Example of SymmWinn designation,
FA = Fibre Channel director. SymmWinn
FA d/A defines Processor d, Port A, which
is equivalent to Processor d, Port D0.
MM = Multimode. SM = Singlemode.

Fibre Channel Port Assignments by Model Number

Ports	DMX-FCD8M0S	DMX-FCD7M1S	DMX-FCD6M2S
D0	MM	SM	SM
D1	MM	MM	MM
C0	MM	MM	SM
C1	MM	MM	MM
B0	MM	MM	MM
B1	MM	MM	MM
A0	MM	MM	MM
A1	MM	MM	MM

Figure C-11 Eight-Port Fibre Channel Front-End Host Director Designations

GigE and iSCSI Channel Cable Worksheet

The physical connection to a GigE Remote or the iSCSI interface occurs at the connectors on the GigE Remote or the iSCSI adapters located at the rear of the Symmetrix unit. You can use Table C-17, *Symmetrix DMX1000 Four-Port, Four-Processor GigE/iSCSI Cable Worksheet*, on page C-52 and Table C-18, *Symmetrix DMX2000/3000 Four-Port, Four-Processor GigE/iSCSI Cable Worksheet*, on page C-53 for cable worksheet forms.

When connecting to hosts with GigE/iSCSI interfaces, consult your EMC Sales Representative for the most current list of supported hosts, models, operating systems, and EMC open systems host support policies, or refer to the EMC Powerlink website at: <http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

Table C-17 Symmetrix DMX1000 Four-Port, Four-Processor GigE/iSCSI Cable Worksheet

Channel Director	Cable Length Required	Cable Model Number or Part Number	Host ID Model Number
2 Proc d, Port D0			
2 Proc c, Port C0			
2 Proc b, Port B0			
2 Proc a, Port A0			
3 Proc d, Port D0			
3 Proc c, Port C0			
3 Proc b, Port B0			
3 Proc a, Port A0			
4 Proc d, Port D0			
4 Proc c, Port C0			
4 Proc b, Port B0			
4 Proc a, Port A0			
13 Proc d, Port D0			
13 Proc c, Port C0			
13 Proc b, Port B0			
13 Proc a, Port A0			
14 Proc d, Port D0			
14 Proc c, Port C0			
14 Proc b, Port B0			
14 Proc a, Port A0			
15 Proc d, Port D0			
15 Proc c, Port C0			
15 Proc b, Port B0			
15 Proc a, Port A0			

Table C-18 Symmetrix DMX2000/3000 Four-Port, Four-Processor GigE/iSCSI Cable Worksheet

Channel Director	Cable Length Required	Cable Model Number or Part Number	Host ID Model Number
3 Proc d, Port D0			
3 Proc c, Port C0			
3 Proc b, Port B0			
3 Proc a, Port A0			
4 Proc d, Port D0			
4 Proc c, Port C0			
4 Proc b, Port B0			
4 Proc a, Port A0			
5 Proc d, Port D0			
5 Proc c, Port C0			
5 Proc b, Port B0			
5 Proc a, Port A0			
6 Proc d, Port D0			
6 Proc c, Port C0			
6 Proc b, Port B0			
6 Proc a, Port A1			
6 Proc a, Port A0			
7 Proc d, Port D0			
7 Proc c, Port C0			
7 Proc b, Port B0			
7 Proc a, Port A0			
8 Proc d, Port D0			
8 Proc c, Port C0			
8 Proc b, Port B0			
8 Proc a, Port A0			

Table C-18 Symmetrix DMX2000/3000 Four-Port, Four-Processor GigE/iSCSI Cable Worksheet (*continued*)

Channel Director	Cable Length Required	Cable Model Number or Part Number	Host ID Model Number
9 Proc d, Port D0			
9 Proc c, Port C0			
9 Proc b, Port B0			
9 Proc a, Port A0			
10 Proc d, Port D0			
10 Proc c, Port C0			
10 Proc b, Port B1			
10 Proc b, Port B0			
10 Proc a, Port A0			
11 Proc d, Port D0			
11 Proc c, Port C0			
11 Proc b, Port B0			
11 Proc a, Port A0			
12 Proc d, Port D0			
12 Proc c, Port C0			
12 Proc b, Port B0			
12 Proc a, Port A0			
13 Proc d, Port D0			
13 Proc c, Port C0			
13 Proc b, Port B0			
13 Proc a, Port A0			
14 Proc d, Port D0			
14 Proc c, Port C0			
14 Proc b, Port B0			
14 Proc a, Port A0			

Channel Adapters

Several GigE/iSCSI channel adapters are available in the Symmetrix system in with multimode configuration connections to the host channel connection requirements. Refer to your EMC Sales Representative for information about choosing the GigE/iSCSI channel adapter that best suits your environment.

To obtain adapter part numbers for iSCSI configurations, consult your EMC Sales Representative, or refer to the EMC Powerlink website at: <http://powerlink.emc.com>. From the Powerlink home page, select the menu options: Support, Document Library, Host Connectivity.

Available EMC GigE/iSCSI Channel Cables

Table C-19 lists the Symmetrix GigE/iSCSI Channel cables currently available from EMC. To obtain these cables, contact your EMC Sales Representative.

Table C-19 GigE/iSCSI Channel Cables

Model	Description	Where Used
FC5M-62MSLC	SC/LC-5 meter	For Symmetrix DMX GigE/iSCSI connection to patch panels or Ethernet switches using LC connectors.
FC10M-62MSLC	SC/LC-10 meter	
FC30M-62MSLC	SC/LC-30 meter	
FC50M-62MSLC	SC/LC-50 meter	
FC100M-62MSLC	SC/LC-100 meter	
FC1M-62MLC	LC/LC-1 meter	For Symmetrix DMX GigE/iSCSI connection to patch panels or Ethernet switches using LC connectors.
FC3M-62MLC	LC/LC-3 meter	
FC5M-62MLC	LC/LC-5 meter	
FC10M-62MLC	LC/LC-10 meter	
FC30M-62MLC	LC/LC-30 meter	
FC50M-62MLC	LC/LC-50 meter	
FC100M-62MLC	LC/LC-100 meter	

GigE/iSCSI Cable Precautions

When connecting Symmetrix (GigE or iSCSI) adapters to host channels it is important to know Symmetrix hardware components and their channel designations.

Each Symmetrix GigE/iSCSI director occupies one slot on the Symmetrix DMX midplanes. Each director interfaces to the host channels through a GigE/iSCSI adapter connected to the opposite side of the midplane. The Symmetrix GigE/iSCSI directors contain two or four advanced microprocessors. Figure C-12 shows the interface and the channel designations for the two-processor, two-port GigE Remote director. Figure C-13 on page C-57 and Figure C-14 on page C-58 show the interface and the channel designations for the four-processor, four-port GigE/iSCSI director when it is configured for GigE, iSCSI, and FICON configurations.

For channel director card cage layout descriptions, refer to Figure C-5 on page C-13, and Figure C-6 on page C-14

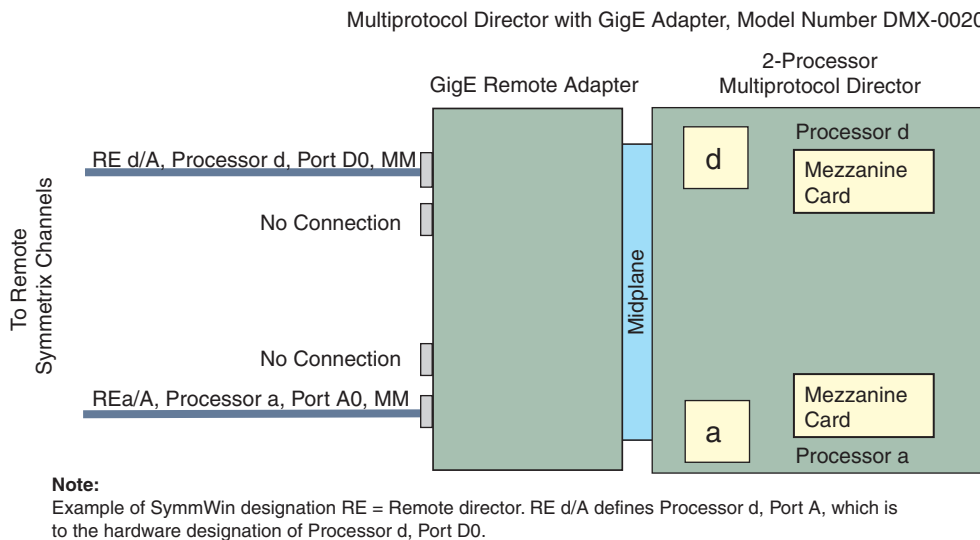
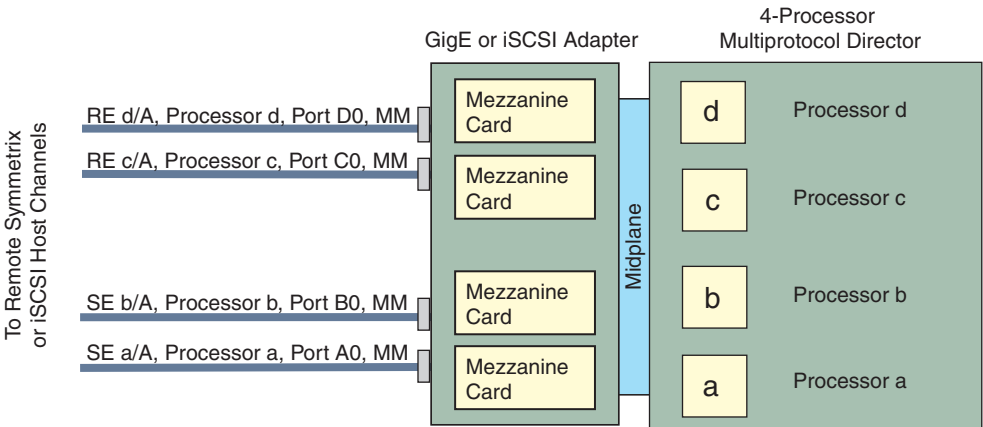


Figure C-12 Two-Port, Two-Processor GigE Remote Director Designations

Multiprotocol Director with FICON, iSCSI, and GigE Adapter, Model Number DMX-0040



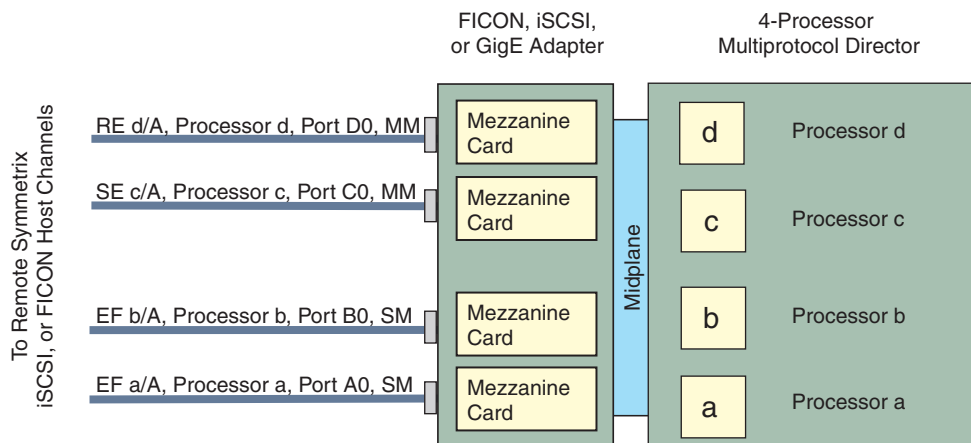
This adapter can be configured in the following combinations of iSCSI and GigE port assignments.

Note:
Example of SymmWinn designation, RE = GigE Remote director and SE = iSCSI director.
SymmWin RE d/A defines Processor d, Port A, which is equivalent to Processor d, Port D0.
MM = Multimode.

Processor	iSCSI and GigE Port Assignments				
d	iSCSI MM	GigE MM	GigE MM	GigE MM	GigE MM
c	iSCSI MM	iSCSI MM	GigE MM	GigE MM	GigE MM
b	iSCSI MM	iSCSI MM	iSCSI MM	GigE MM	GigE MM
a	iSCSI MM	iSCSI MM	iSCSI MM	iSCSI MM	GigE MM

Figure C-13 Four-Port, Four-Processor GigE Remote and iSCSI Director Designations

Multiprotocol Director with FICON, iSCSI, and GigE Adapter, Model Number DMX-0022

**Note:**

Example of SymmWin designation EF = FICON director and SE = iSCSI, or RE = Remote director. SymmWin RE d/A defines Processor d, Port A, which is equivalent to Processor d, Port D0.

This adapter can be configured in the following combinations of FICON, iSCSI, and GigE port assignments.

Processor	FICON, iSCSI, and GigE, Port Assignments		
	GigE MM	GigE MM	iSCSI MM
d	GigE MM	GigE MM	iSCSI MM
c	GigE MM	iSCSI MM	iSCSI MM
b	FICON SM	FICON SM	FICON SM
a	FICON SM	FICON SM	FICON SM

Figure C-14 Four-Port, Four-Processor GigE Remote, iSCSI, and FICON Director Designations

This glossary contains terms related to disk storage subsystems. Many of these terms are used in this manual.

A

Alternate Track	A track designated to contain data in place of a defective primary track. See also <i>Primary Track</i> .
Actuator	A set of access arms and their attached read/write heads, which move as an independent component within a head and disk assembly (HDA).
Adapter	A board that provides the physical interface between the director and disk devices (dual-initiator) or director and SCSI host channels (SCSI adapter).
ADT	Automatic Diagnostic Test.
ANSI	American National Standards Institute. A standards-setting, nongovernment organization which develops and publishes standards for voluntary use in the U.S.
Asynchronous Transmission	Transmission in which synchronization is done on a per-byte basis. The synchronizing handshake is done using REQuest and ACKnowledge signals.

B

Backplane	Card that accommodates the channel, disk, and global memory directors, and adapter cards.
Bit	The smallest unit of computer memory. A bit can hold a value of zero or one.
Business Continuance Volumes (BCVs)	A standard Symmetrix device with special attributes that allow it to independently support applications and processes, such as backup operations, restore operations, Decision Support operations, and application testing. BCV devices are available through the <i>EMC TimeFinder</i> software.
Byte	Any 8-bit unit of data storage.

C

Cache	See Global Memory.
Cache Slot	Unit of cache equivalent to one track.
Channel Director	The component in the Symmetrix subsystem that interfaces between the host channels and data storage. It transfers data between the channel and global memory.
CCOPY	Concurrent Copy Facility used on IBM DASD.
Command Descriptor Block (CDB)	The structure used to communicate commands from an initiator to a target. This structure may be 6 bytes, 10 bytes, or 12 bytes in size.
Compatible Parallel Access Volumes (COM-PAV)	Compatible Parallel Access Volumes is an IBM feature, supported by the Symmetrix unit, that improves response time, resulting in greater resource availability to the host.
Controller ID	Controller identification number of the director that the disks are channeled to for EREP usage. There is only one controller ID for the Symmetrix unit.
Count-Key-Data (CKD)	A data recording format employing self-defining record formats in which each record is represented by a count area that identifies the record and specifies its format, an optional key area that may be used to identify the data area contents, and a data area that contains the user data for the record. CKD can also refer to a set of channel

commands that are accepted by a device that employs the CKD recording format.

D

DASD	Direct access storage device.
Data Availability	Access to user data at all times by the application.
Delayed Fast Write	An operation used when there is no room in global memory for the data presented by the write operation. Therefore, the write is delayed until there is room in global memory.
Destage	The asynchronous write of new or updated data from global memory to disk device.
Device	A uniquely addressable part of the Symmetrix subsystem that consists of a set of access arms, the associated disk surfaces, and the electronic circuitry required to locate, read, and write data. See also <i>Volume</i> .
Device Address	The hexadecimal value that uniquely defines a physical I/O device on a channel path in an MVS environment. See also <i>Unit Address</i> .
Device Form Factor	Refers to the physical size and shape of a device. Example: 73 GB disk device is a 1-inch disk device in a 3.5-inch form factor.
Device Number	The value that logically identifies a disk device in a string.
Device Support Facilities Program (ICKDSF)	A program used to initialize the Symmetrix system at installation and provide media maintenance.
Diagnostics	System-level tests or firmware designed to inspect, detect, and correct failing components. These tests are comprehensive and self-invoking.
Director	See <i>Channel Director</i> or <i>Disk Director</i> .
Disk Director	The component in the Symmetrix subsystem that interfaces between global memory and the disk devices.
Dual-Initiator	A Symmetrix feature that automatically creates a backup data path to the disk devices serviced directly by a disk director, if that disk director or the disk management hardware for those devices fails.

Dynamic Sparing A Symmetrix feature that automatically transfers data from a failing disk device to an available spare disk device without affecting data availability. This feature supports all devices in the Symmetrix subsystem and is used with Mirroring, Parity RAID, and SRDF options.

Dynamic Path Reconnect (DPR) A function that allows disconnected I/O operations with the Symmetrix system to reconnect over any available channel path rather than be limited to the one on which the I/O operation was started. This function is available only on System 370/XA, System 370/ESA, and System 390/ESA systems.

E

EMIF ESCON Multiple Image Facility. Allows sharing of ESCON channels among logical partitions (LPAR).

Enginuity Enginuity is the operating environment for the EMC Symmetrix Enterprise Storage Platforms. Enginuity provides functional services for both its host Symmetrix systems as well as for a large suite of EMC Storage Application software.

EPO Emergency Power Off.

EREP Program Environmental Recording, Editing, and Printing—The program that formats and prepares reports from the data contained in the Error Recording Dataset (ERDS).

Error Verification The process of reading, checking the error correction bits, and writing corrected data back to the source.

ESA Enterprise System Architecture (mainframe systems only).

ESCON Enterprise Systems Connection.

ESCON Director Device that provides a dynamic switching function and extended link path lengths (with XDF capability) when attaching an ESCON channel to a Symmetrix serial channel interface.

ESP Enterprise Storage Platform. Symmetrix ESP is a functional enhancement that allows simultaneous storage and access of mainframe data and open systems data on the same Symmetrix system.

F

Fast Write In the Symmetrix system, a write operation at global memory speed that does not require immediate transfer of data to disk. The data is written directly to global memory and is available for later destaging.

FBA Fixed Block Architecture. Disk device data storage format using fixed size data blocks.

Fibre Channel A nominally 2 Gb/s serial data transfer interface technology, although the specification allows data transfer rates from 133 Mb/s up to 4.25 Gb/s. Data can be transmitted and received simultaneously. Common transport protocols, such as Internet Protocol (IP) and Small Computer Systems Interface (SCSI), run over Fibre Channel. Consequently, a single connectivity technology can support high-speed I/O and networking.

FC-AL Fibre Channel Arbitrated Loop. A standard for a shared access loop, in which a number of Fibre Channel devices are connected (as opposed to point-to-point transmissions). Requires a port to successfully negotiate to establish a circuit between itself and another port on the loop.

FC-SW Fibre Channel Switch Fabric. A Fibre Channel network standard where nodes are connected to a fabric topology implemented by one or more switches. Each node's N_Port connects to an F_Port on a switch. Pairs of nodes connected to an FC-SW network can communicate concurrently.

Field Replaceable Unit (FRU) A component that is replaced or added by service personnel as a single entity.

Frame Data packet format in an ESCON environment.

G

Gigabyte (GB) 10^9 bytes. The GB₂ value is based on the convention:
 1 GB = 1024 x 1024 x 1024 bytes.
 The GB₁₀ value is based on the convention:
 1 GB = 1000 x 1000 x 1000 bytes.
 Although these values are expressed differently, their values are equivalent.

Global Memory	Random access electronic system storage used to retain frequently used data for faster access by the channel.
Group	The physical disks related to each other for common parity protection when implementing the Parity RAID option.

H

HACMP	High Availability Clustered Multiprocessing. IBM's cluster system developed by CLAM Associates.
Head and Disk Assembly (HDA)	A field replaceable unit in the Symmetrix subsystem containing the disk and actuator.
Home Address (HA)	The first field on a CKD track that identifies the track and defines its operational status. The home address is written after the index point on each track.
Hypervolume Extension	The ability to define more than one logical volume on a single physical disk device making use of its full formatted capacity. These logical volumes are user-selectable in size. The minimum volume size is one cylinder and the maximum size depends on the disk device capacity and the emulation mode selected.

I

ICKDSF	See <i>Device Support Facilities Program</i> .
Identifier (ID)	A sequence of bits or characters that identifies a program, device, controller, or system.
IML	Initial Microcode Program Loading.
IMPL	Initial Microcode Program Loading.
Index Marker	Indicates the physical beginning and end of a track.
Index Point	The reference point on a disk surface that determines the start of a track.
IOCP	Input/Output Configuration Program.
Initiator	A SCSI device (usually a host system) that requests an operation to be performed by another SCSI device.

I/O Device An addressable input/output unit such as a disk device.

IPL Initial Program Loading.

K

Kilobyte (Kb) The KB₂ value is based on the convention:
1 KB = 1024 bytes.
The KB₁₀ value is based on the convention:
1 KB = 1000 bytes.
Although these values are expressed differently, their values are equivalent.

L

Least Recently Used Algorithm (LRU) The algorithm used to identify and make available the global memory space by removing the least recently used data.

Logical Unit A physical or virtual device addressable through a target. A physical device can have more than one logical unit.

Logical Unit Number (LUN) An encoded three-bit identifier for the logical unit of a SCSI device.

Logical Volume (LV) A user-defined storage device. In the Symmetrix subsystem, for example, the user can define a physical disk device as one-to-eight logical volumes.

Logical Volume Manager (LVM) Host software responsible for management of the disk subsystems. Interaction with the LVM is done through GUI or through stand-alone commands.

Long Miss A state when requested data is not in global memory and is not in the process of being fetched.

Longitude Redundancy Code (LRC) Exclusive OR (XOR) of the accumulated bytes in the data record.

LPAR Logical Partition or Logical Partitioning Mode. Mainframe system function that allows different operating systems to run concurrently in separate logical partitions. See also EMIF.

M

MA	Multiple Allegiance is an IBM feature, supported by the Symmetrix system, that improves throughput across a shared storage environment. MA allows more than one I/O from different hosts to access the same device as long as the I/Os do not conflict with each other.
Media	The disk surface on which data is stored.
Megabyte (MB)	The MB ₂ value is based on the convention: 1 MB = 1024 x 1024 bytes. The MB ₁₀ value is based on the convention: 1 MB = 1000 x 1000 bytes. Although these values are expressed differently, their values are equivalent.
Metadevice	A group of components (physical partitions) accessed as a single logical device through concatenating, striping, mirroring, logging the physical devices, or setting up RAID devices.
MII	Machine Initiated Interrupt.
Mirroring	The Symmetrix option that maintains two identical copies of a designated volume on separate disks. Each volume automatically updates during a write operation. If one disk device fails, the Symmetrix system automatically uses the other disk device.
Mirrored Pair	A logical volume with all data recorded twice, once on each of two different physical devices.
MPCD	Multiprotocol Channel Director
MVS	Multiple Virtual Storage (mainframe systems only).
Multiprotocol Channel Director	The Symmetrix DMX MPCD can be configured with various mezzanine cards, which support connects to hosts using iSCSI and FICON protocols. A GigE remote support mezzanine card supports connections between Symmetrix systems running SRDF.

P

Page Several commands use regular parameter structures that are referred to as pages. These pages are identified with a value known as a page code.

Partitioned Dataset (PDS) Assist An IBM feature for 3990 Model 6 and 3990 Model 3 with Extended Platform units. PDS Assist improves performance on large, heavily-used partitioned datasets by modifying the directory search process.

Parity RAID A Symmetrix feature that provides parity data protection on the disk device level using physical parity volumes. A Parity RAID (3+1) group consists of three data drives and one parity drive. A Parity RAID (7+1) group consists of seven data drives and one parity drive. The Parity RAID option can be also used with Hypervolume Extension to establish distributed parity.

PBX (Private Branch Exchange) Short for private branch exchange, a private telephone network used within an enterprise. Users of the PBX share a certain number of outside lines for making telephone calls external to the PBX.

Physical Partition (PP) A physical partition is the smallest unit of disk space that can be allocated in a volume group in an AIX environment. Any disk space allocated is an integral number of physical partitions. By default, a PP is 4 MB in size.

Physical ID Physical identification number of the Symmetrix director for EREP usage. This value automatically increments by one for each director installed in the Symmetrix system. This number must be unique in the mainframe system. It should be an even number. This number is referred to as the SCU_ID.

Primary Track The original track on which data is stored. See also *Alternate Track*.

Promotion The process of moving data from a track on the disk device to a memory slot.

R

RAID (Parity RAID) A Symmetrix feature that provides parity data protection on the disk device level using physical parity volumes. A Parity RAID (3+1) group consists of three data drives and one parity drive. A Parity RAID (7+1) group consists of seven data drives and one parity drive.

The Parity RAID option can be also used with Hypervolume Extension to establish distributed parity.

Read Hit The name of the action taken when data requested by the read operation is in global memory.

Read Miss The name of the action taken when data requested by the read operation is not in global memory.

Reconnect The function that occurs when a target selects an initiator to continue an operation after a disconnect.

Reconnection A reconnection exists from the assertion of the BSY signal in a RESELECTION phase until the next BUS FREE phase occurs. A reconnection can only occur between a target and an initiator.

Record Zero The first record after the home address.

Reselect The function that occurs when a target disconnects from an initiator in order to perform a time-consuming function and then, after performing that function, re-establishes the connection.

Reserved The term used for bits, bytes, fields, and code values that are set aside for future standardization.

S

SCSI Small Computer System Interface.

SCSI Address The octal representation of the unique address (0-7) assigned to a SCSI device. This address, consisting of a *target ID* and *LUN*, or *Initiator ID* and *LUN*, would normally be assigned and set in the SCSI device during system installation.

SCSI Device A host computer adapter or peripheral controller or intelligent peripheral that can be attached to the SCSI bus.

SCU_ID For 3880 storage control emulations, this value uniquely identifies the storage director without respect to its selection address. It identifies to the host system, through the EREP, the director detecting the failing subsystem component. This value automatically increments by one for each director installed. The SCU_ID must be a unique number in the host system. It should be an even number and start on a zero boundary.

SDMS	Symmetrix Data Migration Service allows continuous business operations and continuous data availability while data is automatically migrated from existing DASD to Symmetrix 5000 systems.
Serial Channel	ESCON channel (mainframe hosts).
Short Miss	Requested data is not in global memory, but is in the process of being fetched.
SIO	Start I/O.
SRDF	Symmetrix Remote Data Facility. SRDF consists of the microcode and hardware required to support Symmetrix remote mirroring.
SSID	For the Symmetrix DMX storage control emulations, this value identifies the physical components of a logical DASD subsystem. The SSID must be a unique number in the host system. It should be an even number and start on a zero boundary.
Stage	The process of writing data from a disk device to global memory. See also <i>Promotion</i> , <i>Destage</i> .
Storage Control Unit (SCU)	The component in the Symmetrix subsystem that connects the Symmetrix system to the host channels. It performs channel commands and communicates with the disk directors and global memory. See also <i>Channel Director</i> .
String	A series of connected disk devices sharing the same disk director.
Striping	The process of segmenting logically sequential data and writing the segments to multiple physical disk devices.
Symmetrix DMX	Symmetrix Direct Matrix is the architecture of non-blocking direct matrix interconnect design that supports up to 128 direct paths through the Symmetrix DMX global memory directors for the Symmetrix DMX systems.
Synchronous Transmission	A timing protocol that uses a master clock with a clock period and allowable offset that holds the sending and receiving devices in the desired phase relationship.

T

Target A SCSI device that performs an operation requested by an initiator.

Terabyte (TB) The TB₂ value is based on the convention:
1 TB = 1024x1024x1024x1024 bytes.
The TB₁₀ value is based on the convention:
1 TB = 1000x1000x1000x1000 bytes.
Although these values are expressed differently, their values are equivalent.

U

Unit Address The hexadecimal value that uniquely defines a physical I/O device on a channel path in an MVS environment. See also *Device Address*.

UNIX UNIX is an interactive, multitasking, multiuser operating system. UNIX is written in "C" language.

There are three types of UNIX files: Directories, data files, and special files. A directory is a file containing certain information about another file. A directory contained within another directory is a sub-directory.

The two most common types of UNIX are BSD (Berkeley Software Distribution) and System VR4 (developed by AT&T). Most UNIX systems are a "mix" of both types.

V

Volume A general term referring to a storage device. In the Symmetrix subsystem, a volume corresponds to a single disk device.

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